NUCLEAR ROCKET OPERATIONS

SACRAMENTO PLANT

REPORT NO. RN-S-0432

TO

AEC-NASA SPACE NUCLEAR PROPULSION OFFICE

TRANSIENT-ENGINE-SIMULATION PROGRAM
(FORTRAN IV)

NERVA PROGRAM

CONTRACT SNP-1

OCTOBER 1967

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REPORT NO. RN-S-0432

TRANSIENT-ENGINE-SIMULATION PROGRAM
(FORTRAN IV)

R. A. Wells

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C. M. Rice
Program Manager
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ABSTRACT

A finite-difference, explicit-solution, digital-computer program is described that calculates solid temperature, liquid temperature, and pressure distribution as functions of distance and time throughout the NERVA engine system. The program is coded in FORTRAN IV for use with the third-generation IBM 360-65 computer. The development of equations and the logic used in their solution are presented.

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1.0 INTRODUCTION

This report documents the present status of the transient-engine-simulation program (Program 31201) and shows the development of the equations together with the logic used in their solution. The basic aim in the development of this program was to provide a mathematical model of the various NERVA engine systems that could be used to study the performance and operating characteristics of these systems and thus provide valuable design information.

The present program is the result of several years of development effort. The earlier versions of the program were written in IBM 7094 machine language. As the program developed, options were added and program complexity increased until the size limitations of the IBM 7094 computer were reached. As additional operating capability was needed, several special-purpose versions of the program were made, each oriented toward a specific engine-system configuration.

When the IBM 360-65 computer was acquired, a decision was made to rewrite the program in FORTRAN IV specifically for this new computer. All of the special routines in the different versions of the program were to be included, as well as several new options that were considered desirable. The program was to be general enough so that almost any nuclear engine system could be analyzed by setting up the proper input.

The program in its present form provides the desired versatility. Any of the nuclear engine systems now under study (X-engine, NERVA, NRX) can be modeled by proper choice of input. In addition, the arrangement of the program into many short subroutines provides for easy modifications and for the possibility of completely replacing portions of the program with an alternative calculation procedure easily and quickly.

2.0 SUMMARY

Aerojet-General's digital simulation program for the NERVA engine system is a finite-difference, explicit-solution, digital-computer program that calculates solid temperature, liquid temperature, and pressure distribution as functions of distance and time throughout the engine system. The program is coded in FORTRAN IV for use with the third-generation IBM 360-65 computer. Analytical results are being used to define the NERVA engine system and to predict XECF and XE-1 engine-system behavior. In the past, the program was used to analyze NRX, CFDTS, and NRX/EST systems and has been upgraded by using the results of those tests.

Separate analyses of the turbopump, hot-bleed port, reflector, shield, core, nozzle, and various tanks and lines are combined to represent the transient performance of the complete engine.

The turbopump-assembly model consists primarily of an energy balance, including an energy-storage term to account for the angular energy of the rotating machinery. The representation has been expanded to handle either a single- or two-spool turbopump.

The analytical representation of the reflector, shield, and core (identified as parts in the program) is a finite-difference energy balance. A single-channel representation is used with provisions for parallel passages to simplify computation and improve computing speed but necessitates use of several unique analysis techniques. The flow channels in the various components are of different sizes and shapes and thus require incorporation of a "void fraction*" in the heat-transfer analysis. The void fraction, when used properly, satisfactorily simulates the heat transfer of a multiple-channel heat exchanger with a one-channel representation. However, this method destroys

*The void fraction is defined as the flow area divided by the total heat-transfer area (flow area plus metal area) of the heat exchanger.

the hydrodynamic characteristics. The parallel-passage closure logic allows a system to be constructed that contains a variety of branches and multiple flow paths while still retaining the basic simplicity of the single-channel part representation.

The fluid pressure distribution is obtained by analyzing the various flow channels and calculating a bulk friction factor for use with the one-channel representation. This method has been tested for nuclear engines and with test data for liquid, cold-gas, and ambient gas flows; good results have been obtained in all cases for both heat-transfer and pressure-drop characteristics.

A model was developed that treats the nozzle as a single-pass counter-current heat exchanger and includes the heat storage in the nozzle material. The tubes are divided into finite distance increments for the pressure-drop and heat-transfer calculations.

The hot-bleed-port subroutine is also a countercurrent finite-difference routine that balances the turbine flow rate from both the diluent and hot inlet pressures. Entrance loss, exit loss, vena contracta, and angle of diluent injection are considered. The diluent extraction point can be varied within the engine. The representation of the hot bleed is moderately rigorous and agrees well with component tests run on hot-bleed ports. A simplified hot-bleed-port model is also included that speeds up computation considerably and provides a simulation accurate enough for most of the runs made with the program.

A linear predictor routine is used to project the program to the succeeding time point. The predictor is accurate enough to eliminate a closure on the pump discharge pressure, which greatly reduces the overall program running time.

3.0 DISCUSSION

3.1 PROGRAM DESCRIPTION

3.1.1 General Description of System Modeled

The 31201 program is designed to provide a mathematical model of the various nuclear engines that might be under study by Aerojet's Nuclear Rocket Operations. The program represents a trade-off between the need for accurately modeling the system in great detail and the simplifications required to keep computer running time at a reasonable level.

The basic unit modeled in the program is called a "part." Each part consists of a single flow path through a solid material in which heat is generated. A part is divided up into an arbitrary number of length increments called nodes, in which finite-difference calculations of heat transfer and pressure drop are made. All nodes in a particular part are of equal length. Only one set of material thermal properties can be input for each part, and that set applies to all nodes in the part. The properties can be made a function of temperature, however. The calculation procedure used in each part is as follows:

The initial temperature for each node in the part is known. The working fluid undergoes a pressure drop due to an inlet loss coefficient before entering the first node. A heat-transfer coefficient and friction factor are calculated on the basis of conditions at the inlet to the first node. These values are then used to calculate the pressure and temperature change through that node. The resulting conditions become inlet conditions for the next node. When computations are complete for all nodes in a part, the fluid receives an additional pressure drop due to an exit loss coefficient. The equations used neglect any fluid-acceleration terms in the pressure-drop equations but do include mass storage effects due to variations of pressure

and temperature with time. When the fluid calculations are complete, the film coefficient and fluid temperature calculated above, together with the internal heat-generation rate and material thermal properties, are used in a finite-difference equation to calculate the material temperature change over some time interval, ΔT . This ΔT is chosen by considering the stability of the finite-difference temperature equations. Now, since a new initial temperature distribution is known, the entire calculation procedure can be repeated for the next time interval.

The reactor is now modeled by considering various portions of it as parts for purposes of input. For example, the core, reflector, and shield could each be represented by one part. If more detail is required in some area, that portion can be modeled as several parts arranged in series. A part can also represent some special flow path in the engine, such as the bolt coolant passage.

Those portions of the engine that cannot be modeled conveniently by using the "part" format are represented by a special routine. These areas include such items as the hot-bleed port, turbopump, nozzle and nozzle tubes, lines, and tanks.

3.1.2 Program Operation

After a particular engine system has been described in terms of the part input, additional data are used to describe the flow path through these parts. First, a main flow path is described. The parts are arranged in series and constitute a single flow path through the entire system. The remainder of the parts can then branch off from between any two of the main-flow-path parts and return to points between any other two main parts. The nozzle tubes and skirt are added to the flow path in the same manner as for the parts and can be put anywhere in the system. Finally, specifications are input to link the special routines into the flow path. These specifications

contain such data as the tap-off point for the hot-bleed port and line and tankage information. In all cases, the fluid enters the nozzle after it leaves the last part in the flow system described above.

Two basic types of systems can be analyzed, open- and closed-loop systems. In the open-loop system, fluid is supplied at an arbitrary pressure from a source not controlled by the system (e.g., a high-pressure tank), and this pressure is the only driving force on the fluid. In the closed-loop system, some of the fluid in the system is bled off and used to power a turbine. This turbine drives a pump that produces a head rise in the fluid at some point in the system.

The open-loop system has two variables, flow rate and inlet pressure; one must be specified, and the other is calculated by the program. If inlet pressure is specified, a guess is made of the flow rate. Pressure, temperature, and flow are calculated throughout the system. With this calculated pressure and temperature, the choked flow is calculated at the minimum-area point in the nozzle tubes and the main nozzle. Pressure at the nozzle is also compared with the input ambient pressure. Another flow guess is then made and the procedure is repeated until the flow is equal to the lower of the two choke flows or until the exit pressure equals the back pressure and the flow is less than choked flow. If flow is specified in the input, this flow is held constant and the inlet-pressure guess is varied until the choked-flow closure constraint is met as before.

In the closed-loop system, inlet pressure must be specified. Turbine-power-control-valve position is also input, and flow-rate guesses are made until a closure is found on choked flow as in the open-loop cases.

A predictor-corrector routine is used to provide a minimum-computer-time closure of the closed-loop system. In the corrector portion, the pump head rise is held constant and the system flow rates, pressures, and

temperatures are determined. From this information, simplified relationships are generated that relate turbine inlet conditions to system operating conditions. In the predictor, these equations are used to simulate the engine while the turbopump calculations are made. This procedure gives a new and better result for pump head rise, and a return is made to the corrector. This operation is repeated until a closure is reached.

In all of the above cases, the internal heat generation is specified as a function of position in the system and as a function of time.

3.1.3 Special Options

3.1.3.1 Chamber Pressure and Temperature Option

The transient-engine-simulation program was previously set up so that control over engine operation was obtained by changing two variables: TPCV position and the rate of internal heat generation. This system duplicates the actual means by which the engine is controlled. However, most test plans are made by specifying planned temperature and pressure ramps for the nozzle chamber. To provide for easy pretest prediction of these ramps, an option has been added to the transient program to operate at demanded chamber pressures and temperatures.

To compute engine-system operation at a particular chamber pressure (P_c) and chamber temperature (T_c), initial guesses are first made for TPCV position and heat generation. An engine operating point is calculated, and the P_c is compared with the desired P_c . If they are different, a new TPCV position is tried, and a new operating point is calculated. This procedure is continued until a correct P_c is obtained. The chamber temperature is then checked, and, if necessary, a new heat-generation guess is made. At this point, the program starts over, again varies TPCV position to close the P_c to the desired value, and rechecks T_c . When both P_c and T_c are at the proper values, the time-point calculation is considered to be complete.

Either the P_c or the T_c closure can be used alone. For example, a P_c demand and a heat-generation rate could be used as input; or, an open-loop system (no turbopump) could be used as input with flow rate and T_c used as the control variables.

3.1.3.2 Pump-Tailoff Option

It was also necessary to simulate an engine shutdown in which the reactor is scrammed and the chamber temperature is controlled by varying the system flow rate. Chamber temperature and heat generation rate are input. The TPCV position is varied at each time point until the desired chamber temperature is reached.

3.1.3.3 Addition of Heat Energy in Lines

The transient program was originally designed to calculate transient system operation during power runs. After the engine has been run for a short period of time, the major lines in the system become chilled. The heat-transfer coefficients on the outside of the lines due to natural convection are low enough so that any heat pickup in the lines can be ignored. However, when an attempt was made to accurately predict system operation during a bootstrap type of startup, the heat gained by the fluid in chilling the lines was found to be significant. A calculation was added to include this effect. An average line heat-transfer coefficient is calculated by using an experimentally determined correlation for turbulent flow through a tube:

$$h_f = 0.0217 \frac{k}{D} \left[\frac{vD\rho}{\mu} \right]^{0.8} \left[\frac{\mu C_p}{K} \right]^{0.4} \left[\frac{2T}{T + \vartheta} \right]^{0.34}.$$

The mass, initial temperature, and heat-transfer area of the line are entered. The convection relationship is used to calculate the temperature change of the pipe over the program computing interval and to calculate the resulting increase in enthalpy of the fluid flowing through the line.

$$\theta_f = \theta_i - \frac{h_f \times A_p (\theta_i - T_i)}{m C_R},$$

and

$$T_o = T_i + \frac{h_c A_p (\theta_i - T_i)}{c_p \dot{w}}.$$

3.1.3.4 Plotting Routine

Hand plotting of finished transient calculations has been found to be very time consuming. The program has been modified to prepare a tape for a program that plots key parameters against time.

As the program calculates engine-system operating data over the time range specified, all computed values are stored on a magnetic tape for each time point. This tape is read back by the computer at the finish of the transient run, and another program sorts the data, extracts specific values, changes them to a particular format, and writes them on another magnetic tape. This second tape is read by a Cal Comp plotter, and graphs of the data are prepared automatically.

The plot program is presently programed to give a series of nine plots for each run. These plots contain information on system flow rates, fluid pressures, fluid temperatures, and turbopump operation. If desired, the output tapes from a series of transient runs can be processed together to make a composite plot.

3.1.3.5 Restart Tape for Program Input

To make it easier to set up the input for a computer run, data from previous runs are stored on a magnetic tape that can be read by the computer. The tape contains system pressures, temperatures, flow rates, TPA operating parameters, and other necessary data as functions of time. A time

point can be selected from the tape that will supply reasonable initial values for the iteration routines. The tape is read as input, the proper values at the desired time are selected by the program, and the calculation begins.

By using the restart tape, an extensive run can be broken up into a series of short runs. The tape is used to supply information needed to start each section of the run.

3.1.3.6 Steady-State Option

A single program was desired that would calculate both transient engine operation and steady-state points. A number of modifications were therefore incorporated into the transient-engine-simulation program to give it steady-state capability.

The transient-heat-conduction equations were rewritten with the heat-storage term set equal to zero. The resulting equation form requires successive iterations until the solution relaxes to the steady-state values. The fluid-flow solution is basically a steady-state analysis with fluid storage and so is left unchanged from the transient option except for deletion of the fluid-storage term.

The fluid-flow and material-conduction answers depend on each other. To reach a steady-state point, a number of passes are made through the system. The fluid flow and heat transfer are alternately upgraded on the basis of data from the preceding pass. When the temperatures and pressures stop changing, a steady-state point has been reached.

One advantage of combining the steady-state program with the transient program is that a transient run can be started from a calculated steady-state point. After a steady state has been reached, the program will automatically switch to transient operation and continue with the run.

3.1.3.7 Calculation of Turbopump Efficiency from Test Data

This calculation is an option of the transient-analysis program and is used to aid in the reduction of data obtained from startup runs and to calculate turbopump operating information.

The turbopump speed input is entered as a function of time from the test data. Other system control information such as TPCV gate position and times for various valve operations are also in the input. A curve of the relationship between pump speed, head rise, and flow rate is known and is an input in the program. Since speed is known at every calculation time, the pump head rise and total work delivered are functions of only flow rate and pump efficiency. The transient program solves for the flow through the system as a function of inlet pressure, and, through an iterative process, the flow and pressure delivered by the pump are balanced by the flow and pressure required by the engine.

On the basis of engine pressures and temperatures, both the amount and state of the turbine inlet flow can be calculated. With this information, the total energy being supplied to the turbine at various times during the test is calculated. Because the total energy to the turbine and the total work from the pump are known at this point, the overall turbopump efficiency can be computed. The shaft horsepower is not known, and the individual pump and turbine efficiencies still cannot be determined. The input turbine-efficiency correlation relating U/C_o to efficiency is assumed to be valid, and the shaft horsepower is computed by using this correlation. The program then computes the pump efficiency and prints out the results for each time point.

3.1.3.8 Blowdown Option

One of the methods used to cool down the engine system is to flow ambient-temperature gas through the system. The gas, which is supplied from a large tank that is initially at a high pressure, is allowed to simply blow down through the engine. The blowdown option consists of a model of this system contained as a subroutine in the transient-engine-simulation program.

The initial mass, temperature, and pressure of the gas in the tank are entered into the program. The program calculates new pressures and temperatures as mass is removed from the tank. The gas flows out through a pressure-control valve that can limit the gas pressure to any desired value; if the tank pressure falls below the desired outlet pressure, the full tank pressure is then used. A variable loss coefficient is used to simulate the piping and valve.

The gas enters the engine system either at the pump inlet or in the pump discharge line, depending on input. The pump flow can be routed out through a vent valve whose position can vary with time. The discharge-line loss coefficient in the area between the vent valve and the point where the blowdown flow is introduced can be varied to simulate a pump shutoff valve or a check valve.

With the above arrangement, a changeover to the cooldown system can be simulated at the end of a power run. At the desired time, the blowdown-line valves are ramped open and the pump discharge is routed out through the vent valve until the turbine power-control valve shuts and the pump stops turning.

3.1.3.9 Simplified Hot-Bleed Port

The hot-bleed-port subroutine used in the transient-engine-simulation program is a detailed model of the actual hot-bleed port. Because of the complexity of the calculations, a significant portion of the overall calculation time is spent in this subroutine. A study of the results of the routine showed that answers of acceptable accuracy could be obtained over a limited range of engine operation by using a greatly simplified hot-bleed-port model. In this simplified routine, the flows are calculated by using a pipe-flow loss coefficient in the equation:

$$\Delta P = \frac{K \dot{w}^2}{2g\rho A^2} .$$

The mix-point pressure is assumed, and the hot, diluent, and turbine flows are calculated. The mix flow is then varied until all flows and pressures balance. An enthalpy balance is performed at the mix point to determine turbine inlet temperature.

The loss coefficients are obtained from runs made by using the detailed hot-bleed-port program for engine operating conditions near those where the simplified program is to be used. During any transient ramp, a time point is occasionally checked with the detailed hot-bleed-port to ensure that accuracy is being maintained.

3.1.4 Current Modifications

The two routines described here are presently being programed for incorporation into the program when they are completed.

3.1.4.1 Diluent/Hot-Bleed-Circuit Transient Program

A transient-solution diluent/hot-bleed-circuit program is being prepared for use in NERVA-engine systems analysis. The basic logic being used is the same as that in the hot-bleed-port model, Section 3.2.7, with the following exceptions:

(a) Simplified heat-transfer relationships are included to account for heat-capacitance effects from the diluent and turbine inlet lines.

(b) The general heat-transfer relationships, documented in Section 3.2.1, are included for the heat-exchanger section of the circuit.

(c) The capability is included to use K factors to calculate pressure losses at any location along the diluent line, the turbine inlet line, or the hot side of the heat exchanger.

(d) The capability is included to use Reynolds'-number-dependent friction-factor calculations and various cryogenic and noncryogenic heat-transfer film-coefficient relationships.

3.1.4.2 Turbine-Exhaust Extension Skirt

A subroutine to calculate the turbine back pressure required for the extension skirt is being incorporated.

The program model is similar to that for the nozzle tubes and cryogenic skirt, Section 3.2.5, except for provisions to handle flow at high subsonic Mach numbers. For a given inlet flow, the program will iterate to determine inlet pressure for a final Mach-number input ranging from zero to one.

In this routine, a node that is too long to provide a stable solution for the fluid will be halved in length. The criterion for nodal length is that a calculated $4f L/D$ for the node must be less than half the $4f L/D$ remaining from a Fanno line check of the fluid. The fluid is allowed to approach the Mach number desired in the tubes. If the final Mach number is below the input number, the current pressure guess is regarded as high. If the final Mach number is greater than the input number or if any Mach number in the skirt reaches one, the current pressure guess is regarded as low. The program is closed when the high- and low-pressure bounds fall within an input tolerance.

Another provision of the program is the ability to run unchoked when choke pressure would be below ambient pressure. In this case, closure is made on exit pressure equaling ambient pressure.

3.2 EQUATION FORMULATION

3.2.1 General Heat-Transfer Equations

The general heat-transfer model consists of two energy balances, one on a liquid node and one on a metal node. A control volume is assumed as follows:

The energy into the control volume is set equal to the energy out of the control volume:

$$\frac{\partial E_{in}}{\partial t} = \frac{\partial E_{out}}{\partial t}.$$

The energy balance on the liquid assumes steady flow and steady state over the distance increment and, thus, no energy storage in the liquid. Therefore,

$$\begin{aligned} h_f \Delta Z F_P \left[\theta_{(m + \frac{1}{2}, n)} - T_{(m + \frac{1}{2}, n)} \right] \\ = \dot{w} C_P \left[T_{(m + 1, n)} - T_{(m, n)} \right]. \end{aligned} \quad (19)$$

Let

$$\frac{\dot{w} C_P}{h_f \Delta Z F_P} = M \quad (20)$$

Substituting Equation 20 into Equation 19 then gives

$$T_{(m + 1, n)} - T_{(m, n)} = \frac{1}{M} \left[\theta_{(m + \frac{1}{2}, n)} - T_{(m + \frac{1}{2}, n)} \right]. \quad (21)$$

With the assumption that temperature distribution in the fluid control volume varies linearly with distance, the average temperature of the fluid node becomes

$$T_{(m + \frac{1}{2}, n)} = \frac{T_{(m + 1, n)} + T_{(m, n)}}{2}. \quad (22)$$

Now, by substituting Equation 22 into Equation 21 and solving for $T_{(m + 1, n)}$, the next fluid temperature is obtained as

$$T_{(m + 1, n)} = \frac{2\theta_{(m + \frac{1}{2}, n)} + (2M - 1) T_{(m, n)}}{2M + 1}. \quad (23)$$

The energy balance on the metal control volume is more complex than that of the liquid; the energy from the previous node, plus the nuclear energy, minus the energy lost to the next node and the fluid is equated to the energy storage,

$$\frac{\partial E_{in}}{\partial t} - \frac{\partial E_{out}}{\partial t} = \frac{\partial E_{storage}}{\partial t}$$

Substituting equivalent values gives

$$q_{m(in)} + Q_i - q_{m(out)} - q_L = \frac{\partial E_{storage}}{\partial t} \quad (24)$$

Substituting and gathering terms gives

$$\begin{aligned} \frac{2k(1-f)A_F}{f\Delta Z} \left[\theta_{(m,n)} - \theta_{(m+\frac{1}{2},n)} \right] + Q_i - \frac{2k(1-f)A_F}{f\Delta Z} \left[\theta_{(m+\frac{1}{2},n)} - \theta_{(m+1,n)} \right] \\ - \dot{w} C_P \left[T_{(m+1,n)} - T_{(m,n)} \right] = \frac{\Delta Z(1-f)A_F C_{R\rho R}}{\Delta t f} \left[\theta_{(m+\frac{1}{2},n+1)} - \theta_{(m+\frac{1}{2},n)} \right] \end{aligned} \quad (25)$$

Define N as equal to

$$\frac{\Delta Z(1-f)A_F C_{R\rho R}}{f\Delta t \dot{w} C_P} \quad (26)$$

Substituting Equation 26 into Equation 25 and gathering terms gives

$$\begin{aligned} \theta_{(m+\frac{1}{2},n+1)} - \theta_{(m+\frac{1}{2},n)} = \frac{1}{N} \left[T_{(m,n)} - T_{(m+1,n)} \right] \\ + \frac{2k\Delta t}{(\Delta Z)^2 \rho_R C_R} \left[\theta_{(m+1,n)} - 2\theta_{(m+\frac{1}{2},n)} + \theta_{(m,n)} \right] + \frac{Q_i}{\dot{w} C_P N} \end{aligned}$$

Define S as equal to

$$\frac{2k \Delta t}{(\Delta Z)^2 \rho_R C_R}.$$

If the temperature gradient in the metal node is assumed to vary linearly with distance,

$$\theta_{(m+1, n)} = \frac{\theta_{(m+\frac{3}{2}, n)} + \theta_{(m+\frac{1}{2}, n)}}{2}, \quad (29a)$$

and

$$\theta_{(m, n)} = \frac{\theta_{(m+\frac{1}{2}, n)} + \theta_{(m-\frac{1}{2}, n)}}{2}. \quad (29b)$$

Now, substituting Equations 29a and 29b into Equation (27) gives

$$\begin{aligned} \theta_{(m+\frac{1}{2}, n+1)} &= \frac{1}{N} \left[T_{(m, n)} - T_{(m+1, n)} \right] + \frac{S}{2} \left[\theta_{(m+\frac{3}{2}, n)} - 2\theta_{(m+\frac{1}{2}, n)} \right. \\ &\left. + \theta_{(m-\frac{1}{2}, n)} \right] + \frac{Q_1}{\dot{w} C_P N} + \theta_{(m+\frac{1}{2}, n)}. \end{aligned} \quad (30)$$

From Equation 23,

$$\theta_{(m+\frac{1}{2}, n)} = \frac{(2M+1) T_{(m+1, n)} - (2M-1) T_{(m, n)}}{2}. \quad (31)$$

Substituting Equation 31 into Equation 30 and gathering terms gives

$$\begin{aligned} \theta_{(m+\frac{1}{2}, n+1)} &= \theta_{(m+\frac{1}{2}, n)} \left[1 - \frac{2}{N(2M+1)} \right] + T_{(m, n)} \left[\frac{1}{N} - \frac{2M-1}{N(2M+1)} \right] \\ &+ \left[\frac{S}{2} \theta_{(m+\frac{3}{2}, n)} - 2\theta_{(m+\frac{1}{2}, n)} + \theta_{(m-\frac{1}{2}, n)} \right] + \frac{Q_1}{\dot{w} C_P N}. \end{aligned} \quad (32)$$

Let

$$U = \frac{Q_i}{\dot{w} C_P N} = \frac{H \Delta T}{\rho_R C_R}; \quad (33)$$

then substituting Equation 26 into Equation 33 gives $Q_i = \frac{H \Delta Z (1 - f) A_F}{f}$;
solving this equation for H and substituting the result in Equation 33 gives

$$U = \frac{Q_i f \Delta t}{\rho_R C_R \Delta Z (1 - f) A_F}.$$

Therefore,

$$\begin{aligned} \theta_{(m + \frac{1}{2}, n + 1)} &= \theta_{(m + \frac{1}{2}, n)} \left[1 - \frac{2}{N(2M + 1)} \right] + T_{m, n} \left[\frac{1}{N} - \frac{2M - 1}{N(2M + 1)} \right] \\ &+ \frac{S}{2} \left[\theta_{(m + \frac{3}{2}, n)} - 2\theta_{(m + \frac{1}{2}, n)} + \theta_{(m - \frac{1}{2}, n)} \right] + U. \end{aligned} \quad (34)$$

The above equation is used to calculate temperatures in the parts. The complete logic is presented in the following description, together with the equations solved:

Engine-Parts Heat Transfer:

(1) Obtain initial values such as flow rate (w) times t and Δt , temperatures (T), and ΔT .

(2) If the condition is steady state, set the number of time points to 20; if transient, to 1.

(3) Loop through the number of time increments for this time point.

(4) Deactivate the "maximum-temperature-exceeded" flag.

(5) Set the part distance equal to the first node

$$(Z = 1/2 \Delta Z_1).$$

(6) Loop through the metal temperature calculations for each node.

(7) Interpolate input curves to obtain A_f , F_p , C_R , K , and H .

(8) Average the pressure and specific heat for this node:

$$P = \frac{1}{2} (P_m + P_{m+1}); \quad C_p = \frac{1}{2} (C_{p_m} + C_{p_{m+1}}).$$

(9) If wall thickness X is zero,

$$WTERM = \frac{1-f}{f} \cdot \frac{\Delta Z \cdot A_f}{\dot{w}}.$$

If not,

$$WTERM = \frac{2 \Delta Z}{\dot{w} \Delta t} \sqrt{\pi A_f}.$$

(10) If option flag 0, 1, or 4, interpolate the input curve for the total heat-generation coefficient and compute

$$H = H \cdot H_T.$$

(11) If wall thickness X is zero,

$$M = \frac{\dot{w} C_P}{h_f \Delta Z F_P} .$$

If not,

$$M = \frac{\dot{w} C_P}{F_P \Delta Z} \cdot \frac{1}{h_f} \cdot \frac{X}{2K} .$$

(12) If $M < 1/2$, activate "too-small" flag.

(13) If steady state, compute rise:

$$U = \frac{H \cdot M \cdot \text{WTERM}}{C_P} , \text{ and}$$

$$\frac{S}{2} = \frac{K \cdot \text{WTERM} \cdot M}{C_P (\Delta Z)^2} \text{ (axial),}$$

and go to Item (17).

(14) For transient,

$$N = \frac{C_R \rho_R}{\Delta t C_P} \cdot \text{WTERM} .$$

(15) If

$$N < \frac{2}{1 + 2M} , \text{ go to Item (49).}$$

(16) Calculate

$$U = \frac{H \cdot \Delta t}{C_R \rho_R}, \quad \frac{S}{Z} = \frac{K \Delta t}{C_R \rho_R (\Delta Z)^2}.$$

(17) If steady state, calculate a new metal temperature for each node by:

$$\begin{aligned} \theta_{m, \frac{1}{2}, n+1} = & \frac{1}{2} (T_{m, n} + T_{m+1, n}) + U + \frac{S}{2} (\theta_{m+\frac{3}{2}, n} \\ & - 2\theta_{m+\frac{1}{2}, n} + \theta_{m-\frac{1}{2}, n}). \end{aligned}$$

(18) If wall thickness is zero and flow factor T_{TK} is not zero, interpolate core distance and add a radial-conduction term to the metal temperatures as follows:

If core distance Z_C equals part distance Z , then:

$$\theta_{\max} = T_{TK} - \theta_{m, \max} - T_{m, \max}.$$

Otherwise,

$$\begin{aligned} \theta_{\max} = & T_{TK} \left[(Z - Z_C) \frac{(\theta_{m, \max} - \theta_{m+1, \max})}{\Delta Z_C} + \theta_{m, \max} \right] \\ & - \left[T_{m, \max} + (Z - Z_C) \frac{(T_{m, \max} - T_{m+1, \max})}{\Delta Z_C} \right]. \end{aligned}$$

Thus, for steady state,

$$\theta_{m + \frac{1}{2}, n + 1} = (\theta_{m + \frac{1}{2}, n + 1})_{17} + \frac{3\pi K}{h_f F_p} \left(\frac{1 + \sqrt{f}}{1 - \sqrt{f}} (\theta_{\max} - \theta_{m + \frac{1}{2}, n}); \right.$$

and, for transient,

$$\theta_{m + \frac{1}{2}, n + 1} = (\theta_{m + \frac{1}{2}, n + 1})_{17} + \frac{N\pi \dot{w}_p^C K \Delta Z}{2} \left(\frac{1 - 3\sqrt{f}}{1 - \sqrt{f}} \right. \\ \left. (\theta_{\max} - \theta_{m + \frac{1}{2}, n}) \right).$$

(19) If steady state and temperature change is greater than 0.01, set flag.

(20) If metal temperatures have not been calculated for each node, return to Item (6).

(21) Extend or extrapolate end points of this part's new metal-temperature table.

(22) Obtain inlet pressure, temperature, and flow for this part.

(23) Find the inlet-plenum flow-rate change by:

$$\Delta \dot{w} = \frac{V_{\text{inlet}}}{\Delta t} (\rho_{i-1} - \rho_i).$$

(24) If mass capacitance is zero, then

$$\dot{w}_{\text{out}} = \dot{w}_{\text{in}} + \Delta \dot{w}.$$

(25) If $\dot{w}_{out} < 0$, go to Item (52).

(26) If the inlet-orifice K_i is not zero, compute the inlet pressure drop by:

$$P_{out} = P_{in} - \frac{\dot{w}^2 K_i}{2g \rho_i}.$$

(27) Update first points of T, $\dot{w}$, and P tables with current values, and obtain properties f (P, T).

(28) Set distance equal to first node for this part.

(29) Loop through the number of ΔZ points per part (nodes).

(30) Interpolate input curves to find A_f and F_p .

(31) Compute the hydraulic diameter:

$$D = \frac{4A_f}{F_p}.$$

(32) Compute the film coefficient (see Section 3.2.8).

(33) Interpolate input curve to determine the thermal conductivity, K.

(34) If input wall thickness is zero,

$$M = \frac{\dot{w} C_p}{h_f F_p \Delta Z}.$$

If not,

$$M = \frac{\dot{w} C_p}{h_f F_p \Delta Z} \left(1 + \frac{X h_f}{2K} \right)$$

(35) If $M < \frac{1}{2}$, activate "too-small" flag.

(36) Find the fluid temperature for the next node by:

$$T_{m+1, n} = \frac{2\theta_{m+1, n} + (2M - 1) T_{m, n}}{2M + 1}$$

(37) Find the fluid pressure for the next node by using:

$$P_{m+1, n} = P_{m, n} - \frac{\dot{w}^2}{2g \rho A_f^2} \left(\frac{T_{m+1, n} - T_{m, n}}{T_{m, n}} + \frac{4\phi \Delta Z}{D} \right)$$

If $P_{m+1, n} < 0$, go to Item (51).

(38) Obtain properties $f(P_{m+1, n}, T_{m+1, n})$.

(39) If mass capacitance is zero, find the flow-rate change:

$$\dot{w}_{m+1, n} = \dot{w}_{m, n} + \frac{1}{2} (\rho_{m, n-1} - \rho_{m, n}) + (\rho_{m+1, n-1} - \rho_{m+1, n}) \frac{A_f \Delta Z}{\Delta t}$$

If $\dot{w}_{m+1, n} < 0$, go to Item (52).

(40) If heat resistance has not been computed for all nodes, go to Item (29).

(41) If outlet-orifice K_o is not zero, obtain properties via outlet pressure and temperature, and calculate the pressure drop by using:

$$P_{out} = P_{in} - \frac{K_o \dot{w}^2}{2g \rho}$$

If $P_{out} < 0$, go to Item (51).

(42) Set current pressure equal to outlet pressure and obtain properties.

(43) If mass capacitance equals zero, find the outlet flow-rate change by:

$$\dot{w}_{out} = \dot{w}_{in} + \frac{V_o}{\Delta t} (\rho_i - 1 - \rho_i)$$

If $\dot{w}_{out} < 0$, go to Item (52).

(44) Set the current temperature and flow equal to outlet values.

(45) If case is steady state and the metal-temperature-difference flag has not been set, go to Item (47).

(46) If all time increments have not been processed, go to Item (3).

(47) If TC option flag is not zero, obtain metal node temperature specified for this part.

(48) If all parts have not been processed, go to Item (1). Otherwise stop.

(49) Halve the time interval and double the number of remaining time points.

(50) If the time interval is less than the minimum allowable, print " Δt too small" and stop. Otherwise, go to Item (3).

(51) Print negative-pressure-error message and stop.

(52) Print negative-flow-error message and stop.

3.2.2 Fluid Flow

From The Dynamics and Thermodynamics of Compressible Fluid Flow, by Ascher Shapiro, page 231, in the Table of Influence Coefficients for $d P_o / P_o$:

$$\frac{d P_o}{P_o} = \frac{d T_o}{T_o} \left(-\frac{\gamma M^2}{2} \right) + \frac{4\phi dx}{D} \left(-\frac{\gamma M^2}{2} \right) \left(\begin{array}{l} \text{for no body forces} \\ \text{or mass addition} \end{array} \right). \quad (1)$$

From continuity:

$$V = \frac{\dot{W}}{\rho A}.$$

For a perfect gas,

$$C = \sqrt{\gamma g R T},$$

$$M = \frac{V}{C} = \frac{\dot{W}}{\rho A \cdot (\gamma g R T_o)^{1/2}};$$

or

$$M^2 = \frac{\dot{w}^2}{\rho^2 A^2 K_g R T_o} .$$

Substituting in Equation 1 gives:

$$dP_o = \frac{P_o}{RT_o} \frac{\dot{w}^2}{\rho^2 A^2 \gamma g} \left(-\frac{\gamma}{2} \right) \left[\frac{4\phi dx}{D} + \frac{dT_o}{T_o} \right]$$

Now, assume low velocities so that total and static conditions are equal

$$\rho = \frac{P}{RT} ;$$

$$dP_o = \frac{\dot{w}^2}{\rho 2g A^2} \frac{4\phi dx}{D} + \frac{dT_o}{T_o} .$$

Rearranging gives:

$$P_{(m, n)} - P_{(m+1, n)} = \frac{\dot{w}^2}{A_F^2 2g\rho} \left[\frac{T_{(m+1, n)} - T_{(m, n)}}{T_{(m, n)}} + \frac{4\phi \Delta Z}{D} \right]$$

and

$$P_{(m+1, n)} = P_{(m, n)} - \frac{\dot{w}^2}{A_F \rho 2g} \left[\frac{T_{(m+1, n)} - T_{(m, n)}}{T_{(m, n)}} + \frac{4\phi \Delta Z}{D} \right] .$$

3.2.3 Lines and Valves

The equation used to calculate pressure drops through the lines and valves is the same as that used to calculate pressure drop through the main system:

$$\Delta P = \frac{\dot{w}^2}{2g \rho A^2} \left[\frac{T_{m+1, n} - T_{m, n}}{T_{m, n}} + \frac{4\phi \Delta Z}{D} \right].$$

The line input specifies a friction factor; the valve input gives a loss coefficient equivalent to the term $\frac{4\phi \Delta Z}{D}$.

The heat-transfer coefficients on the outside of the lines are low enough so that heat pickup by the lines can be neglected. The heat removed from the lines during a chilldown is significant, however, and must be calculated. The line is divided into a series of nodes. The thermal conductivity of the material is assumed to be very large relative to the conductance across the fluid-material interface. Conduction between nodes is ignored. The driving temperature is approximated by using the difference between average temperature of the material node and the fluid temperature at the inlet to the node. The heat-transfer rate is thus:

$$Q = h A_p \left(\theta_m + \frac{1}{2}, n - T_{m, n} \right).$$

Equating the heat transferred to the enthalpy change of the fluid and the solid node results in the equation set:

$$\theta_f = \theta_i - \frac{h_c A_p (\theta_i - T_i)}{C_R};$$

$$T_o = T_i + \frac{h_c A_p (\theta_i - T_i)}{C_p \dot{w}}.$$

3.2.4 Blowdown

The blowdown model consists of a tank filled with a gas under pressure:

Conservation of mass:

$$\frac{\partial M}{\partial t} = -\dot{w}. \quad (1)$$

Conservation of energy:

$$Q_c - \dot{w} \left(P/\rho + \frac{v^2}{2g} + U \right) = \frac{\partial(m U)}{\partial t} = m \frac{\partial U}{\partial T} + U \frac{\partial m}{\partial T}. \quad (2)$$

Substituting Equation 1 into Equation 2 gives:

$$Q_c - \dot{w} P_\rho - \frac{\dot{w} v^2}{2g} = m \frac{dU}{dt}. \quad (3)$$

Assuming a perfect gas,

$$P/\rho = LRT$$

and

$$dU = C_v dT;$$

therefore,

$$Q_c - \dot{w} LRT = m C_v \frac{dT}{dt} \quad (4)$$

Now, let $\dot{w}$ be constant in Equation 1; and let t be the time from initial conditions to present;

$$m = m_1 - \dot{w} t. \quad (5)$$

Let $h_c A_c$ represent the overall conductance between the tanked fluid and ambient conditions, then

$$Q_C = h_c A_c (T_{amb} - T). \quad (6)$$

This is the equation used to calculate pressure drop throughout the program. For drops other than from a distributed friction factor, the $4\phi \Delta Z/D$ term is replaced by a loss coefficient.

The change in flow rate over a time point is computed by assuming that the rate of density change can be approximated by subtracting the present density from the preceding-time-point density and dividing by ΔT to give:

$$\dot{w}_{(m+1, n)} = \dot{w}_{(m, n)} + \frac{A_F \Delta Z}{\Delta t} \left[\rho_{(m, n-1)} - \rho_{(m, n)} \right].$$

Combining Equations 4, 5, and 6 gives

$$\frac{C_v dT}{h_c A_c t_{amb} - T (Z + \dot{w}R/J)} = \frac{dt}{m_1 - \dot{w}t}.$$

Integrating from the initial conditions to time i (initial time = 0) gives:

$$T_i = \left[\frac{m_I - \dot{w} t_i}{m_I} \right] \frac{\frac{h_c A_c}{C} + \frac{\dot{w} R/J}{\dot{w}}}{\dot{w}} \left[T_i - \frac{h_c A_c T_{amb}}{h_c A_c + \dot{w} R/J} \right] + \frac{h_c A_c T_{amb}}{h_c A_c + \dot{w} R/J} ;$$

and, from the perfect gas law,

$$P_i = \frac{(M_I - \dot{w} t) R T_i}{\text{Volume}} .$$

Rewriting these equations in finite-difference form, the solution is now restricted to constant flow over each time increment only; and the final equations are:

$$P_n = \frac{(M_{n-1} - \dot{w}_n \Delta t) R T_n}{\text{Volume}} ,$$

$$M_n = M_{n-1} - \dot{w}_n \Delta T ,$$

$$T_n = \left[\frac{M_{n-1} - \dot{w}_n \Delta t}{M_{n-1}} \right] \left[\frac{\frac{R}{C_p J} + \frac{h_c A_c}{\dot{w}_n C}}{\dot{w}_n} \left[T_{n-1} - \frac{h_c A_c T_{amb}}{h_c A_c + \dot{w}_n R/J} \right] + \frac{h_c A_c T_{amb}}{h_c A_c + \dot{w}_n R/J} \right] .$$

3.2.5 Nozzle

The main nozzle and cryogenic skirt are represented as single-pass heat exchangers arranged in a parallel-flow circuit on the cold side and in a series circuit on the hot side. The nozzle is a counterflow heat exchanger, whereas the skirt is a parallel-flow heat exchanger. Each is divided into a series of nodes for the heat-transfer and fluid-flow calculations.

The cold-side inlet flow is divided between the nozzle and skirt tubes by iterating on the flows until the pressure drops through the two components are equal. Recombination of the fluid streams in the discharge plenum is represented by an enthalpy balance. Either of these passages can be left out by proper choice of input, or the entire routine can be flagged out if desired.

The fluid-flow calculations use the same equations as developed in Section 3.2.2. The material temperature calculations are those documented in Section 3.2.1, with the following exception: the nozzle-tube jacket can be divided into a series of radial nodes as well as axial nodes to allow a more correct modeling of this region. Because the skirt has no portions that could be considered large heat reservoirs, the effects of material heat capacitance in this component have been neglected.

3.2.6 Turbopump

3.2.6.1 Derivation of Equations

The turbopump model consists of four basic equations for (1) the turbine work, (2) the pump work, (3) a calculation of the pressure ratio across the turbine, and (4) the energy balance on the turbopump assembly.

3.2.6.1.1 Turbine Work Done

The turbine work is found by calculating the isentropic turbine work and multiplying it by a turbine efficiency factor.

Turbine work = turbine efficiency x turbine isentropic work, or

$$W_{T \text{ act}} = \eta_T \left[\dot{W}_T C_P (T_{11} - T_{12})_{\text{isen}} \right]. \quad (1)$$

Considering isentropic and ideal gas relationships,

$$T_{12} = T_{11} \left(\frac{P_{11}}{P_{12}} \right)^{\frac{\gamma-1}{\gamma}}, \quad (2)$$

where

$$\frac{\gamma-1}{\gamma} = \frac{R}{778 C_p}; \quad (3)$$

therefore,

$$T_{12} = \left(\frac{P_{11}}{P_{12}} \right)^{\frac{R}{778 C_p}}. \quad (4)$$

Now, substituting pressures for temperature and rearranging algebraically gives

$$W_{T \text{ act}} = \eta_T \dot{w}_T C_p T_{11} \left[1 - \left(\frac{P_{11}}{P_{12}} \right)^{\frac{R}{778 C}} \right]. \quad (5)$$

3.2.6.1.2 Pump Work

The pump work is the flow times the enthalpy difference across the pump divided by the pump efficiency

$$W_{P \text{ act}} = \frac{\dot{w}_P \Delta h}{\eta_P}. \quad (6)$$

3.2.6.1.3 Pressure Ratio Across the Turbine

In one possible configuration, the pressure drop across the turbine is controlled by two choked nozzles: the turbine inlet nozzle (A_{tn}) and the last-stage rotor of the turbine (A_{rn}). By using the isentropic choked equation*, P_{12} and P_{11} can be calculated from the turbine flow rate as functions of T_{12} and T_{11} , respectively:

$$P_{12} = \frac{\dot{w}_T \sqrt{T_{12}}}{A_{rn} (0.1396)} \quad \text{and} \quad P_{11} = \frac{\dot{w}_T \sqrt{T_{11}}}{A_{tn} (0.1396)}. \quad (7)$$

Solving for, and equating, the two expressions for $\dot{w}_T$ gives

$$\frac{P_{12}}{P_{11}} = \frac{A_{tn}}{A_{rn}} \sqrt{\frac{T_{12}}{T_{11}}}. \quad (8)$$

*Asher Shapiro, Dynamics and Thermodynamics of Compressible Fluid Flow, page 83, Ronald Press Co.

The actual temperature differential across the turbine is equal to the product of turbine isentropic temperature differential and turbine efficiency:

$$\Delta T = \eta_T \Delta T_{isen}, \quad (9)$$

$$(T_{12} - T_{11}) = \eta_T (T_{12 \text{ isen}} - T_{11}); \quad (10)$$

from which:

$$\frac{T_{12}}{T_{11}} = 1 - \eta_T \left(1 - \frac{T_{12 \text{ isen}}}{T_{11}} \right). \quad (11)$$

Now, since

$$\frac{T_{12 \text{ isen}}}{T_{11}} = \left(\frac{P_{12}}{P_{11}} \right)^{\frac{R}{778 C_p}}, \quad (12)$$

then

$$\frac{T_{12}}{T_{11}} = 1 - \eta_T \left[1 - \left(\frac{P_{12}}{P_{11}} \right)^{\frac{R}{778 C_p}} \right]. \quad (13)$$

Now, substituting Equation 13 into Equation 8 gives

$$\frac{P_{12}}{P_{11}} = \frac{A_{tn}}{A_{rn}} \sqrt{1 - \eta_T \left[1 - \left(\frac{P_{12}}{P_{11}} \right)^{\frac{R}{778 C_p}} \right]}. \quad (14)$$

Equation 14 lends itself to solution by digital iteration.

Another possibility is that pressure ratio is controlled by a choked nozzle at the turbine inlet and a second choked nozzle somewhere downstream of the last-stage rotor of the turbine (indicated by a subscript, 13). The line between the rotor and the choke point has an area A_{12} and a loss coefficient K_{12} .

As before:

$$P_{11} = \frac{\dot{w}_T \sqrt{T_{11}}}{A_{tn} (0.1396)} ; \quad (15)$$

$$P_{13} = \frac{\dot{w}_T \sqrt{T_{12}}}{A_{13} (0.1396)} . \quad (16)$$

Also:

$$P_{12} - P_{13} = \frac{K_{12}}{A_{12}^2} \cdot \frac{\dot{w}_T^2 R T_{12}}{(P_{12} + P_{13}) gc} , \quad (17)$$

or

$$P_{12}^2 = P_{13}^2 + \frac{K_{12}}{A_{12}^2} \cdot \frac{\dot{w}_T^2 R T_{12}}{gc} . \quad (18)$$

Substituting Equation 16 into Equation 18 gives

$$P_{12} = \sqrt{\frac{\dot{w}_T^2 T_{12}}{[A_{13} (0.1396)]^2} + \frac{K_{12}}{A_{12}^2} \cdot \frac{\dot{w}_T^2 R T_{12}}{gc}} . \quad (19)$$

Dividing Equation 15 into Equation 19 gives

$$\frac{P_{12}}{P_{11}} = \sqrt{\frac{T_{12}}{T_{11}}} 0.1396 A_{tn} \sqrt{\frac{1}{[A_{13} (0.1396)]^2} + \frac{K_{12}}{A_{12}^2} \cdot \frac{R}{gc}} . \quad (20)$$

Now, substituting Equation 13 into Equation 20 gives

$$\frac{P_{12}}{P_{11}} = A_{tn} (0.1396) \sqrt{\frac{1}{[A_{13} (0.1396)]^2} + \frac{K_{12}}{A_{12}^2} \cdot \frac{R}{gc}} \sqrt{1 - \eta_T \left[1 - \left(\frac{P_{12}}{P_{11}} \right)^{\frac{R}{C_P J}} \right]}$$

These basic equations are applied to both the single-spool and two-spool turbopump subroutines. To account for the possibility of unchoking the inlet and outlet to the turbine, a modification is made.

A table of turbine flow function vs turbine pressure ratio is included. When a pressure ratio is calculated, a flow function is found. This function is used to generate a pseudo-choked-nozzle area that gives the correct flow rate through the turbine for the unchoked conditions. Outlet pressure is kept at or above the back pressure at the turbine exit.

3.2.6.1.4 Energy Balance on the Turbopump Assembly

To obtain the pump work at time $i + 1$, the average pump work between i and $i + 1$ and the change in rotational energy over that time difference are equated to the average turbine work for the same time period, as given by

$$\frac{W_{p \text{ act } (i)} + W_{p \text{ act } (i + 1)}}{2} + \frac{d \left(\frac{I_M \omega^2}{2} \right)}{dt} = \frac{W_{T \text{ act } (i)} + W_{T \text{ act } (i + 1)}}{2} \quad (22)$$

By rearranging Equation 22

$$W_{p \text{ act } (i + 1)} = -W_{p \text{ act } (i)} - \frac{d I_M \omega^2}{dt} + W_{T \text{ act } (i)} + W_{T \text{ act } (i + 1)} \quad (23)$$

Using finite-difference integration on $\frac{d(I_M \omega^2)}{dt}$ and solving for

$$\omega^2 = \left(\frac{2\pi}{60} \right)^2 (N^2), \quad (23a)$$

$$\frac{d(I_M \omega^2)}{dt} = \frac{I_M \left(\frac{2\pi}{60} \right)^2 (N^2_{(i+1)} - N^2_{(i)})}{12 g \Delta t 778}. \quad (24)$$

Substituting Equation 24 into Equation 23 gives the equation for $W_{P \text{ act } (i+1)}$ as

$$W_{P \text{ act } (i+1)} = -W_{P \text{ act } (i)} - \left[\frac{I_M}{12g \Delta t} \left(\frac{2\pi}{60} \right)^2 \left(\frac{N^2_{(i+1)} - N^2_{(i)}}{778} \right) \right] + W_{T \text{ act } (i+1)} + W_{T \text{ act } (i)}. \quad (25)$$

3.2.6.2 Calculations

The following pages show the complete calculations in their proper order.

3.2.6.2.1 One-Spool Pump Calculations

(1) "Predictor" assume pump speed (N).

(2) Assume pump weight-flow rate ($\dot{w}$).

$$(3) P_{(\text{pump inlet})} = P_{(\text{tank})} - \frac{K_1 \dot{w}_p^2}{A^2 2g \rho_{\text{tank}}} \text{ input } K_1 A_1$$

$$(4) H_{(\text{pump inlet})} = H_{(\text{tank})} + \frac{Q_1}{\dot{w}_p} \text{ input } Q_1 = f_{(\text{time})}$$

(5) Pump inlet properties = F (H,P)

$$(6) \text{ HSV} = \left(\frac{P_{\text{pump}} - P_{\text{vapor}}}{12 \rho} \right)$$

$$(7) \frac{\Delta P}{\dot{w}_p^2} = f \left(\frac{\text{HSV}}{N^2}, N, \frac{N}{\dot{w}_p} \right) \quad (\text{table input})$$

$$(8) P_2 = P_{\text{pump inlet}} + \Delta P$$

$$(9) \dot{w}_p' \text{ from } \alpha \dot{w}_p^2 + \beta \dot{w}_p - P_2 = 0 \quad \alpha = \frac{P_2 - P_6}{\dot{w}_p^2}$$

from corrector

$$\beta = \frac{P_6}{\dot{w}_p}$$

(10) Iterate from Step 2 through Step 10 until $\dot{w}_p$ assumed = $\dot{w}_p'$.

$$(11) Q_P = \frac{\dot{w}_p}{\rho_{\text{pump inlet}} (0.002228) (1728)}$$

$$(12) h = \frac{\Delta P}{12 \rho J}$$

$$(13) \eta_{\text{pump}} = f \left(\frac{\text{HSV}}{N^2}, N, \frac{N}{\dot{w}_p} \right) \geq \eta_{\text{minimum}} (\text{input})$$

$$(14) H_2 = H_{\text{pump inlet}} + \frac{\Delta P}{9338 \eta_p \rho}$$

$$(15) T_2 = f(H, P)$$

$$(16) h' = \frac{H_2 - H_{\text{pump inlet}}}{J}$$

3.2.6.2.2 One-Spool Turbine Calculations

(1) Assume P_{12} for ratio $\left(\frac{P_{12}}{P_{11}}\right)$.

Bypass choked-flow calculation if nonchoke has been established previously.

(2) $T_{12} = T_{11} \left(\frac{P_{12}}{P_{11}}\right)^{\frac{R}{JC_p}}$

(3) $P_{12 \text{ static}} = P_{12} \left(\frac{\gamma + 1}{2}\right)^{\frac{-\gamma}{\gamma - 1}} \quad M = 1 \quad K = f(P_{11}, T_{11})$

(4) $U = 0.04768 N$

(5) $C_o = \sqrt{2g C_p J T_1 \left[1 - \left(\frac{P_{12 \text{ static}}}{P_{11}}\right)^{\frac{R}{JC_p}}\right]}$

(6) $\eta_T' = f\left(\frac{U}{C_o} \leq 0.19\right)$

(7) $\eta_T = \eta_T' \left[1 - \frac{\gamma R T_{12}}{(\gamma + 1) C_p J (T_{12} - T_{11})}\right]$

$\gamma = f(P_{11}, T_{11})$

(8) $\left(\frac{P_{12}}{P_{11}}\right) = \sqrt{\frac{K_T^2}{[2 A_{rn} (1396)]^2} + \frac{K_T^2 K_{12}^R}{A_{12}^2 g c}} \sqrt{1 - \left[\eta_T \left[1 - \left(\frac{P_{12}}{P_{11}}\right)^{\frac{R}{JC_p}}\right]\right]} \geq \frac{P_{12 \text{ min}}}{P_{11}}$

$$(9) \text{ Iterate from Step 8 to Step 9 until } \left(\frac{P_{12}}{P_{11}} \right)_{\text{assumed}} = \left(\frac{P_{12}}{P_{11}} \right).$$

$$(10) T_{12} = T_{11} \left(\frac{P_{12 \text{ min}}}{P_{11}} \right)^{\frac{R}{JC_p}} \quad \rho_{12} = f(P_{12 \text{ min}}, T_{12})$$

$$(11) P_{12 \text{ min static}} = P_{12 \text{ min}} + \frac{2g K_{TE} \dot{w}_T^2}{A_{TE}^2 \rho_{12}} \quad \text{input } K_{TE}, A_{TE}$$

$$(12) W_{T \text{ act}} = C_p \dot{w}_T T_{11} \left\{ \eta_T \left[1 - \left(\frac{P_{12}}{P_{11}} \right)^{\frac{R}{JC_p}} \right] \right\}$$

(13) If $P_{12 \text{ static}} < P_{12 \text{ min static}}$, establish turbine condition as unchoked.

$$(14) C_{\text{turbine}} = f \left(\frac{P_{11}}{P_{12 \text{ min static}}} \geq 1 \right)$$

$$(15) A_{TN}' = \frac{C}{\sqrt{\frac{\gamma g}{R} \left(\frac{2}{\gamma + 1} \right) \frac{\gamma + 1}{\gamma - 1}}} \quad \text{New } A_T \text{ to force choked-flow calculation in hot-bleed port.}$$

(16) Iterate from Step 13 through Step 16 until $A_{TN} = A_{TN}'$ (recalculated hot-bleed port each time)

$$(17) U = 0.04768 N$$

$$(18) C_o = \sqrt{2g C_p^J T_{11} \left[1 - \left(\frac{P_{12 \text{ min static}}}{P_{11}} \right)^{\frac{R}{JC_p}} \right]}$$

$$(19) \eta_T' = f \left(\frac{U}{C_o} \leq 0.19 \right)$$

$$(20) T_{12 \text{ static}} = T_{11} \left(\frac{P_{12 \text{ min static}}}{P_{11}} \right)^{\frac{R}{JC_p}}$$

$$(21) \text{Mach} = \frac{\dot{w}_T}{C^* \rho_{12} A_{RN}}$$

$$(22) T_{12} = T_{12 \text{ static}} \left[1 - M^2 \frac{(\gamma_{11} - 1)}{2} \right]$$

$$(23) \eta_T = \eta_T' \left[1 - \frac{M^2 K_{11} R T_{12 \text{ static}}}{2 C_{p11} J (T_{12} - T_{11})} \right]$$

$$(24) P_{12 \text{ stagnation}} = \frac{P_{12 \text{ min static}}}{\left[1 - \frac{M^2 (\gamma - 1)}{2} \right]^{\frac{-\gamma}{\gamma - 1}}}$$

$$(25) T_{12 \text{ stagnation actual}} =$$

$$T_{11} \left\{ 1 - \eta_T \left[1 - \left(\frac{P_{12 \text{ stagnation}}}{P_{11}} \right)^{\frac{R}{JC_p}} \right] \right\}$$

$$(26) W_{T \text{ act}} = C_{p11} \dot{w}_T T_{11} \eta_T \left[1 - \left(\frac{P_{12 \text{ stagnation}}}{P_{11}} \right)^{\frac{R}{JC_p}} \right]$$

$$(27) W_{P \text{ act}} = \frac{\dot{w}_p h}{\eta_p}$$

$$(28) \text{ (If steady state) } W_{P \text{ act}}' = W_{T \text{ act}}$$

$$(29) \text{ If steady state, vary } N_{(I+1)} \text{ assumed and iterate until } W_{P \text{ act}} = W_{p \text{ act}}'$$

$$(30) \text{ If transient, compute } N_{(I+1)}' \text{ and iterate until } N_{(I+1)} \text{ assumed} = N_{(I+1)}'$$

$$(31) N_{(I+1)}' =$$

$$N_{(I)}^2 + \frac{2g (\Delta \text{ time}) 10800 \text{ J}}{\pi^2 I_M} \frac{W_{T \text{ act}} (I+1) + W_{T \text{ act}} (I)}{2} \\ - \frac{W_{P \text{ act}} (I+1) + W_{P \text{ act}} (I)}{2}$$

If iteration by TPCV position is involved, the past time $W_{P \text{ act}} (I)$ and $W_{T \text{ act}} (I)$ are replaced by current $W_{P \text{ act}} (I+1)$ and $W_{T \text{ act}} (I+1)$ to remove averaging.

3.2.6.2.3 Two-Spool Pump

In this routine, the inducer and pump calculations are both identical to that previously described for the one-spool pump. Exit conditions from the inducer become inlet conditions to the pump.

3.2.6.2.4 Two-Spool Turbine

The calculations made on the two-spool turbine are basically similar to those on the single-spool turbine, but mid-point pressure must be iterated upon. The calculation sequence is as follows:

(1) Assume P_{mid}^o

(2) Turbine inlet properties γ_{in}, C_{pin} at Mach = 0
 $P_{mid}^o = P_{mid}'$

$$(3) \quad C = f \frac{P_{11}^o}{P_{mid}} \quad A_{TN} = \frac{C}{\sqrt{\frac{\gamma g}{R} \left(\frac{2}{\gamma + 1} \right)^{\frac{\gamma + 1}{\gamma - 1}}}}$$

(4) Iterate to hot-bleed-port subroutine until
 $A_{TN}' = A_{TN}$

$$(5) \quad T_{mid} = T_{11}^o \left(\frac{P_{mid}}{P_{11}^o} \right)^{\frac{R}{JC_p}}$$

$$(6) \quad C_o = \sqrt{2g J C_{pin} (T_{11}^o - T_{mid})}$$

$$(7) \quad \eta_T = f \left(\frac{U}{C_o} \right)$$

$$(8) \quad T_{mid}^o = T_{11}^o - \eta_T (T_{11}^o - T_{mid})$$

$$(9) \quad W_{T \text{ act}} = C_{pin} \dot{w}_T (T_{11}^o - T_{mid}^o)$$

(10) Find inducer-turbine inlet properties $\gamma_{mid}, C_{p_{mid}}$

$$(11) \quad \dot{w}_{tot} = \dot{w}_T + \dot{w}_{BC}$$

(12) Assume P_{12}, T_{12} for properties $P_{12} = P_{12}^o \text{ min},$

$$T_{12} = T_{mid}^o \left(\frac{P_{12}'}{P_{mid}^o} \right)^{\frac{R}{JC_p}}$$

$$(13) P_{12}^o = P_{12 \text{ min}}^o + \frac{K_{TE} \dot{w}_{\text{tot}}^2}{24g A_{TE}^2 \rho_{12}}$$

$$(14) \text{MACH} = \frac{\dot{w}_T}{A_{RN} (C^* \rho)_{12}}$$

$$(15) P_{12} = \frac{P_{12}^o}{\left[1 + \left(\frac{\gamma_{\text{mid}} - 1}{2} \right) \text{Mach}^2 \right]^{\frac{\gamma_{\text{mid}}}{\gamma_{\text{mid}} - 1}}}$$

$$(16) C_o = \sqrt{2g J C_{p_{\text{mid}}} (T_{\text{mid}}^o - T_{12})}$$

$$(17) \eta_{\text{TI}} = f \left(\frac{U}{C_o} \right)_{\text{inducer}}$$

$$(18) T_{12}^o \text{ isen} = T_{\text{mid}}^o \left(\frac{P_{12}^o}{P_{\text{mid}}^o} \right)^{\frac{R}{J C_{p_{\text{mid}}}}}$$

$$(19) T_{12} \text{ isen} = T_{12}^o \text{ isen} / \left[1 + \left(\frac{\gamma_{\text{mid}} - 1}{2} \right) \text{Mach}^2 \right]$$

$$(20) \eta_{\text{TI}} = \eta_{\text{TI}} \left[1 - \frac{\text{Mach}^2 R \gamma_{\text{mid}} T_{12}' \text{ isen}}{2J C_{p_{\text{mid}}} (T_{12}^o \text{ isen} - T_{\text{mid}}^o)} \right]$$

$$(21) T_{12}^o = T_{\text{mid}}^o - \eta_{\text{TI}}' (T_{\text{mid}}^o - T_{12}^o \text{ isen})$$

$$(22) T_{12} = T_{12}^o / \left[1 + \left(\frac{\gamma_{\text{mid}} - 1}{2} \right) \text{Mach}^2 \right]$$

$$(23) \text{Iterate from Step 12 through Step 23 until } T_{12} = T_{12 \text{ old}}$$

$$(24) \quad C = f \left(\frac{P_{mid}^o}{P_{12}} \right) \quad A_{mid} = \frac{C}{\sqrt{\frac{\gamma g}{R} \left(\frac{2}{\gamma + 1} \right)^{\frac{\gamma + 1}{\gamma - 1}}}}$$

$$(25) \quad \dot{w}_T' = \frac{P_{12}^o}{\sqrt{T_{mid}^o}}$$

(26) Iterate from Step 1 through Step 26. Set $P_{mid} = P_{mid}^o$ until $\dot{w}_T = \dot{w}_T'$

$$(27) \quad W_{TI \text{ act}} = C_{p_{mid}} \dot{w}_T (T_{mid}^o - T_{12}^o)$$

The speed closure equations are the same as in Steps 27 through 31 of the one-spool-turbine section. The turbine speed is closed first, and then one iteration is made on inducer speed; the turbine speed is then closed again, and another iteration is made on inducer speed until both loops are closed.

3.2.7 Hot-Bleed Port

A fairly complete model of the hot-bleed port is available as a subroutine in the 31201 program. The heat-transfer calculations are for steady-state conditions only, however. The effects of heat storage during a chilldown cannot be investigated. The hot-bleed port is a counterflow heat exchanger made by jacketing a portion of the line from the chamber to the turbine. The diluent flows through this jacket and is injected into the hot flow as it leaves the chamber. In the program, this jacketed line is divided into a series of nodes, and a heat balance calculation is made on each node. This operation gives fluid-temperature change and wall temperature. Inlet and discharge lines are represented by loss coefficients. Varying TPCV position changes the loss coefficient for the discharge line. The final closure on flow rate is determined by comparing the flow rate with the choked flow at the turbine inlet.

To keep the running time of the program as short as possible, a highly simplified hot-bleed-port subroutine has also been added to the program. Pressure drops are calculated by using equivalent K factors for the diluent line, hot-flow inlet port, and turbine line in the equation

$$\Delta P = \frac{K \dot{w}^2}{2g\rho A^2} \text{ } ^\circ$$

Heat storage in the system is calculated by using a single node and the method outlined in section 3.2.3, Lines and Valves.

The following steps contain the equations solved for pressure and flow rate, together with the iteration logic.

(1) Assume hot-weight-flow rate $\dot{w}_H$

$$(2) \quad P_{\text{mix}} = P_6 - \frac{K_H \dot{w}_H |\dot{w}_H|}{2g \rho_6} \quad \text{input } K_H$$

$$(3) \quad \dot{w}_C = \sqrt{\frac{(P_{\text{cold}} - P_6) \rho_{\text{av}} 2g}{K_C}} \quad \text{input } K_C$$

$$(4) \quad \dot{w}_T = \dot{w}_C + \dot{w}_H$$

$$(5) \quad T_{11} = \frac{\dot{w}_C T_C + \dot{w}_H T_H}{\dot{w}_T} \geq T_C$$

$$(6) \quad H_{11} = \frac{\dot{w}_C H_C + \dot{w}_H H_H}{\dot{w}_T} \geq H_C$$

$$(7) \quad P_{11} = \sqrt[2]{P_{\text{mix}}^2 - \frac{T_{11}^2 R \dot{w}_T^2 (K_V + K_{TL})}{g A_{TL}^2}} \quad \begin{array}{l} \text{Input } K_{TL}, D_{TL} \\ K_V = f(G.P.) \end{array}$$

$$(8) \quad T_{11}' = f(H, P)$$

$$(9) \quad P_{11}' = \frac{A_{TN} \dot{w}_T \sqrt{T_{11}'}}{\sqrt{\frac{Kg}{R} \left(\frac{2}{K+1} \right) \frac{K+1}{K-1}}} \quad K = f(H_{11}, P_{11})$$

(10) Iterate from Step 2 through Step 10 by varying $\dot{w}_H$ until $P_{11} = P_{11}'$

3.2.8 Film Coefficient and Friction Factor

The film coefficient is calculated from a general form of a standard correlation used for fully developed turbulent flow in a tube

$$h_f = \frac{\gamma}{A_F} \left(\frac{\dot{w} F C K^3}{4\mu^2} \right)^{.2} (CF)^\beta (PF)$$

For each region where calculations are to be made, numerical values are input for α and β . In addition, the input must specify which values of CF and PF to use from the tables shown below (stored internally in the program).

CF TABLE	
No.	Factor
1	1.0
2	T_{bulk}/T_{wall}
3	$1 + 0.01457 (\mu_{wall}/\mu_{bulk}) (\rho_{bulk}/\rho_{wall})$
4	$[1 + 0.01457 (\mu_{wall}/\mu_{bulk}) (\rho_{bulk}/\rho_{wall})] \left(\frac{\mu_{bulk} \times 10^6}{0.2103} \right)^{0.67}$
5	$2 [T_{bulk}/(T_{bulk} + T_{wall})]$
6	$2 \sigma [T_{bulk}/(T_{bulk} + T_{wall})]$ (σ is input)

PF TABLE	
No.	Factor
1	1.0
2	$\sqrt{\rho_{film}/\rho_{bulk}}$

Finally, the input must specify which temperature, as computed from a factor in the HD table, should be used to find the gas thermal properties.

HD TABLE	
No.	Factor
1	T_{bulk}
2	$\left(\frac{T_{\text{bulk}} + T_{\text{wall}}}{2} \right)$

The friction factor is found from the equation

$$\phi = A \left(\frac{0.5}{0.8686 \ln 2 N_{\text{RE}} \sqrt{0.0014 + \frac{0.125}{N_{\text{RE}}^{0.32}} - 0.8}} \right)^2$$

Property evaluation is performed at the determined temperature by using the factor in the HD table above. The constant A is from the input for each particular part.

3.2.9 Neutronics

The equation used to model the neutronics are the same basic equations as used in the X-engine common analog model:

(a) Reactivity Feedback

$$R_F = C_1 + C_2 \rho_A + C_3 \Theta_A + C_4 \Theta_A \rho_A$$

where C_1 , C_2 , C_3 , and C_4 are input constants, and ρ_A and Θ_A are average core fluid density and core material temperature, respectively.

(b) Drum Reactivity

$$R_D = C_5 \sin^2 \left(\frac{\Theta_D}{2} \right) - C_6,$$

where C_5 and C_6 are input constants, and Θ_D is the control-drum position.

(c) Total reactivity

$$R_T = R_F + R_D.$$

(d) Power

$$\frac{dP}{dt} = C_8 (R_T - C_7) P + \sum_{I=1}^6 \lambda_I C_I,$$

where C_8 and C_7 are input constants,

P is power,

λ_I is a six-group delayed neutron coefficient, and

C_I is defined by $\frac{dC_I}{dt} = \beta_I P - \lambda_I C_I$, β_I

being a six-group delayed neutron coefficient.

(e) Decay Power

$$PD = \sum_{I=1}^3 Q_I,$$

where $\frac{dQ_I}{dt} = f_I P - g_I Q_I$, with f_I and g_I input constants.

The neutronics are solved in two ways: (1) power is given to find the required drum position and (2) drum position is given to find the resulting power. In either case, the desired parameter can be input as a function of time. If the program is to close on a demanded chamber temperature, the problem is handled in the same manner as for a given-power case, with the power calculated by the program from the demanded chamber temperature.

In the case where drum position is given and the program is to calculate power, the solution is obtained in the following steps:

(1) The average core material temperature (Θ_A) and average core fluid density (ρ_A) are obtained by using a numerical average, with initial conditions in the core used the first time and with the last time point ($\text{time}_{(N)}$) used the subsequent times.

(2) Calculate the total reactivity by summing the reactivity feedback,

$$R_F = C_1 + C_2 \rho_A + C_3 \Theta_A + C_4 \Theta_A \rho_A,$$

and the drum reactivity,

$$R_D = C_5 \sin^2 \left(\frac{\Theta_D}{2} \right) - C_6,$$

with drum-position input.

(3) Find the power for the next time point ($\text{Time}_{(N+1)}$):

$$P_{(N+1)} = P_N + \left[C_8 (R_F - C_7) P_N + \sum_{I=1}^6 (\lambda_I) (XC_I) \right] \Delta t,$$

where XC_I values are input for initial conditions or are calculated from the previous time point.

(4) Update the XC_I 's for the next time point:

$$XC_{I(N+1)} = \frac{P_N \beta_I}{C_o + \lambda_I} + XC_{I(N)} - \frac{P_N \beta_I}{C_o + \lambda_I} e^{-\lambda_I \Delta t},$$

$$\text{where } C_o = \frac{\ln \frac{P_{(N+1)}}{P_{(N)}}}{\Delta t}$$

and $I = 1, 2, 3, 4, 5, \text{ and } 6.$

(5) Find the decay-power contribution to total power

$$PD = \sum_{I=1}^3 Q_I.$$

The Q_I 's are taken from input initial conditions on the first pass and are calculated on subsequent passes.

(6) Update the Q_I 's for the next time point:

$$Q_{I(N+1)} = Q_{I(N)} + \left[f_I P_{(N)} - g_I Q_{I(N)} \right] \Delta T$$

for I's of 1, 2, and 3;

(7) Sum power to obtain total power:

$$PT_{(N+1)} = P_{(N+1)} + PD_{(N+1)}.$$

(8) Convert power to internal heat generation for use in the heat-transfer equations

$$PWR = \frac{(1.055 \times 10^3) \left[PT_{(N+1)} \right]}{\text{core volume}}.$$

In the case where drum position is given, the calculation is made slightly differently. The power calculation is made on the same time grid as for the heat transfer, and this time grid is restricted to ensure calculation stability. The neutronics are solved in the following steps:

(1) The average core material temperature (θ_A) and the average core fluid density (ρ_A) are obtained by using a numerical average, with initial core conditions used the first time and the last closed time point ($\text{Time}_{(N)}$) used the subsequent times.

(2) Calculate the reactivity feedback:

$$R_F = C_1 + C_2 \rho_A + C_3 \theta_A + C_4 \theta_A \rho_A.$$

(3) Calculate decay power:

$$PD_{(N+1)} = \sum_{I=1}^3 Q_I,$$

with Q_I input as initial conditions the first pass and calculated for subsequent passes.

(4) Calculate total power in megawatts from the input internal heat generation rate:

$$PT_{(N+1)} = \frac{P_{WR(N+1)} \cdot \text{core volume}}{1.055 \times 10^3},$$

(5) Calculate power.

$$P_{(N+1)} = P_{T(N+1)} - PD_{(N+1)}.$$

(6) Find total reactivity necessary to generate this power:

$$R_T = \frac{P_{(N+1)} - P_N = \left(\sum_{I=1}^6 \lambda_I X C_{I(N)} \right) \Delta t + C_y C_8 P_{(N)} \Delta t}{C_8 P_{(N)} \Delta t}.$$

(7) Find necessary reactivity of the drums:

$$R_D = R_T - R_F.$$

(8) Calculate the control-drum position:

$$\Theta_D = 2 \sin^{-1} \sqrt{\frac{R_D + C_6}{C_5}}.$$

(9) Update XC_I 's and Q_I 's to be used in the next calculation

$$XC_{I(N+1)} = XC_{I(N)} + \left(\beta P_{(N)} - \lambda_I C_{I(N)} \right) \Delta t,$$

with $I = 1, 2, 3, 4, 5$, and 6

$$\text{and } Q_{I(N+1)} = Q_{I(N)} + \left(f_I P_{(N)} - g_I Q_{I(N)} \right) \Delta t,$$

with $I = 1, 2$, and 3 .

3.3 DESCRIPTION OF SUBROUTINES

(1) AGC HED - This subroutine prints a two-line heading on each page of the output to identify the type of run. It also keeps an output page count.

(2) BDI - Loads initial parameters such as pressures, temperatures, and loss coefficients into the proper cell in the pump-discharge-line blowdown routine.

(3) BDOWNL - The calculations of pressure and temperature in the blowdown gas storage tank, as mass is removed, are made in this subroutine. When all gas is exhausted, a message is printed.

(4) BDU - Tank temperature and pressure are calculated here for blowdown through the pump discharge line.

(5) BLOCK DATA - This is a data storage block containing the alphanumeric header information, some of the constants used in the iteration routine, and many of the numerical constants used in calculations throughout the program.

(6) CLOCK - Contains a timing routine by use of which the amount of time spent in calculations in various regions of the program can be found for running time-optimization work.

(7) CORRECT - Uses the pressures and temperatures throughout an engine system to generate coefficients for the highly simplified engine model used in the predictor portion of the closed-loop iteration scheme. Constants for the simplified hot-bleed port used in the predictor are recalculated here if the complex hot-bleed port is used in the main program.

(8) DILTAP - Removes the diluent from the main flow at the correct place in the system. The diluent-line heat-transfer calculations are done here.

(9) ENGINE - This routine contains the logic used in balancing the flows through the engine system. It controls the iterating to balance the flow rates through parallel passages based on total pressure drop, calculates the temperatures resulting from the mixing process when passages join, and subtracts some of the special flow tap-offs.

(10) ERROR - Dumps out most of the present values of the variables in the program when certain errors are encountered. After this operation, the next case is called and the program is restarted.

(11) FF - Uses flow conditions and configuration at a point and calculates a local friction factor. A variety of options can be set up to use different relationships.

(12) FLOW - This routine contains the logic that controls the iterations for pump flow, tank pressure (if a demanded flow rate is input), diluent flow, and diluent-line loss coefficient (if a particular turbine inlet temperature is demanded). It also contains the equations to calculate pressure drop in the pump inlet line.

(13) FUEL - Controls the reading in of the input data.

(14) GPSUB - This routine calculates the turbine-inlet-line loss coefficient from the current value of TPCV position. If parallel TPCVs or a bypass valve are included, these calculations are also made here.

(17) INTP - A general, one-dimensional, linear-interpolation routine used throughout the program.

(18) ITER - The iteration routine; given two values of the independent variable in an iteration and the result of the calculations made, it uses a Newton's-method scheme to predict a better value for the independent variable. Limits are set as the routine converges toward an answer.

(19) KTF - Generates the function $\sqrt{\frac{\gamma g}{R} \left(\frac{2}{\gamma + 1} \right)^{\frac{\gamma + 1}{\gamma - 1}}}$.

(20) MAIN - Dummy main program, which allows the master control portion to be a subroutine, thus permitting transfer of control to the master control region from any point in the program.

(20) MAIN - Dummy main program, which allows the master control portion to be a subroutine, thus permitting transfer of control to the master control region from any point in the program.

(21) MC - This is the master control region of the program. It contains the main logic and calls the calculation subroutine in the proper order. It contains the predictor-corrector closure logic.

(22) METALT - The finite-difference types of equations that calculate part material temperature are solved in this subroutine.

(23) MESSX - This subroutine prints a 1/2-line error message when called. The particular message is specified in the call.

(24) MOVED - This routine writes a restart tape with the essential information from each time point. If a run is terminated, the information on the tape can be used for initial conditions to restart the run at any of the completed time points. This tape is also used in the plotting program. The MOVED routine also reads the restart tape and loads the initial condition data into the input area.

(25) NODET - A routine called by METALT. Some of the heat-transfer calculations are performed here.

(26) NOZZLE - The pressure drop, flow, and fluid heat-transfer calculations on the hot side of the nozzle tubes are performed in this subroutine.

(27) PARTAG - The part order is specified by a name list in the input. This subroutine converts this name list to a number tag that is used by the remainder of the program.

(28) PDLIN - Calculates pump-discharge-line pressure drop.

(29) PREDIC - This routine calculates turbopump performance. The pump calculations are contained in the subroutine, and the turbine equations are called from other routines by PREDIC.

(30) PREDIN - Calculates initial turbine flow areas from the diameter input information.

(31) PREDTF - A table look-up is performed here at each time point for several values used in the predictor routines.

(32) PRINT - Controls the printing of the normal output from the program.

(33) PROGIN - Stores initial values in various portions of the program and calls the restart routines if necessary.

(34) SERCH - This is the triple-interpolation routine used to find data in the three-dimensional pump-data input tables.

(35) SETCI - This performs a table look-up for several variables required at each time point.

(36) SETCJ - This performs a table look-up for several variables used while closing the predictor-corrector portion of the program.

(37) SHBB - Contains the equations for a simplified model of the hot-bleed port.

(38) SKTNT - Performs the flow and heat-transfer calculations on the cold side of the cryogenic skirt tubes.

(39) SKTNZ - Performs the flow and heat-transfer calculations on the hot side of the cryogenic skirt tubes.

(40) SKTMT - The metal-temperature calculations for the cryogenic skirt are performed in this routine.

(41) TEMPQ - In this routine, the fluid temperatures through all of the parts are calculated.

(42) TUBEM - Calculates the material temperatures in the nozzle tubes.

(43) TUBES - The pressure drop, flow, and fluid heat-transfer calculations for the nozzle tubes are performed in this subroutine.

(44) TURBIN - This routine (together with TURBN) does the performance calculations on the single-spool turbine.

(45) TURBN - The isentropic spouting velocity and efficiency calculations on the turbine are performed in this routine.

(46) TZERO - Stores initial values in various portions of the program data storage at the start of each new case.

(47) UPDATE - Keeps and restores intermediate temperature and pressure values used in the P_c and T_c iterations.

(48) ZEROD - Zeroes out old data before each new case.

3.4 INPUT AND USE OF PROGRAM

Values are input on cards in column 2 through 80. Column 1 must be left blank. The first value of a set must be named and following values are loaded sequentially until another name is reached. Values are separated by a comma. For example, to put the first three values in the DELZ table would require the following:

DELZ(1) = 5, 3, 3,

If the name refers to a subscripted table and no subscript is written, all values in the table must be input.

If a number is to be repeated several times a multiplier can be used. For example, 30 * 0.0 will load 0.0 in 30 consecutive cells.

The 31201 program requires two sets of pump-data tables consisting of pump efficiency vs speed/flow ratio ($N/WDOT$, rpm-sec/lbm), speed (N , rpm), and saturated-vapor head/speed-squared ratio (HSV/N^2 , Btu/lb-rpm**2) and of pump pressure-rise/flow-squared ratio ($DELP/WDOT^2$, psia-sec**2/in.**2-lbm**2) vs $N/WDOT$, N , and HSV/N^2 . Since the tables are identical in format, the input format will be described in terms of an arbitrary function F (representing pump efficiency or $DELP/WDOT^2$) vs $N/WDOT$, N , and HSV/N^2 .

Any point in the table can be described as a point in a $M(1) \times M(2) \times M(3)$ matrix, where $M(1)$ is the number of HSV/N2 points in the Table, $M(2)$ is the number of N points, and $M(3)$ is the number of N/WDOT points. Let $F(A, B, C)$ represent the value of F corresponding to the ath value of HSV/N2, the bth value of N, and the cth value of N/WDOT. Then any value of F in the matrix can be located with the use of the proper subscripts.

The input format follows:

```
* Table = M(1), M(2), M(3),
          HSV/N2(1),....., HSV/N2 [M(1)],
          N(1),....., N[M(2)],
          N/WDOT(1),..... N/WDOT [M(3)]
          F(1,1,1),....., F(1,2,3), F(2,1,1),.....F[2,1,M(3)],
          .....F[M(1),M(2),M(3)]
```

* Insert proper name for table

Briefly stated, the values of F are input in ascending order of their subscripts where, in the case of $F(A, B, C)$, A is of higher order than B and B is of higher order than C. It is further required that the values of HSV/N2, N, and N/WDOT be entered in ascending order. The program performs a linear triple interpolation to find the value of F corresponding to given values of HSV/N2, N, and N/WDOT.

The values of $M(1)$, $M(2)$, and $M(3)$ must not be less than 1. The sum, $M(1) \times M(2) \times M(3) + M(1) + M(2) + M(3) + 3$, must not exceed 300 for the efficiency table, or 200 for the work table.

3.4.1 List of Variables and Description

The variables and their descriptions are listed on the following pages.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
AFLOW	(30,20)		in. ²	Total part flow area vs distance along part.
AJHT	(30)		in. ²	Jacket cross-section area vs distance from nozzle-tube inlet.
ANTC	(30)		in. ²	Area of outside half of tubes vs distance from nozzle-tube inlet.
ANTH	(30)		in. ²	Area of inside half of tubes vs distance from nozzle-tube inlet.
ANTW	(30)		in. ²	Total nozzle-tube flow area vs distance from nozzle-tube inlet.
ATURN			in. ²	Turbine inlet nozzle area.
BD(1)		ALINE	in. ²	Total heat-transfer area for pump-discharge blowdown line.
BD(2)		BDOWN		Flag - This cell = non zero, blowdown will be through pump.
BD(3)		BDPD		Flag - This cell = non zero, pump-discharge-line blowdown.
BD(4)		CPVOL	Btu/lb-deg	Heat capacity of fluid in pump-discharge blowdown tank.
BD(5)		IMASS	lb	Flag - Starting mass of the gas in the pump-discharge-line blowdown tank; if value = zero, mass assumed infinite (i.e., no pressure or temp change during blowdown).

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
BD(6)		LFILM	Btu/in ² sec-deg	Convective film, coefficient for heat transfer along pump-discharge blowdown line.
BD(7)		PINPUT	psia	Flag - required pressure at the inlet to the PDL blowdown line. The program uses the smaller of this value and the available pressure in the blowdown tank. If this value is zero the PDL line pressure is taken from the input curve.
BD(8)		PTNKIN	psia	Initial pressure in the pump-discharge blowdown tank.
BD(9)		TAMB	deg r	Ambient temperature.
BD(10)		TTNKIN	deg r	Initial pump-discharge blowdown-tank temperature.
BD(11)		VTANK	in. ³	Volume of pump-discharge blowdown tank.
BEND	(30)		in.	Equivalent length of bend vs location for nozzle tubes.
CAP	(30,20)		Btu/lb-deg r	Part material heat capacity vs part material temperature.
CDJ	(30)		Btu/in.-sec-deg r	Jacket thermal conductivity vs material temperature.
CDNT	(30)		Btu/in.-sec-deg r	Tube thermal conductivity vs material temperature.
CFWP	(30)		Btu/in.-sec deg r	Cold-flow wetted perimeter vs distance (new nozzle-tube model).
CG	(30)			CG vs distance (z).
CNTMAX				Max no. of iteration print lines allowed.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
CONDI	(30,20)		Btu/sec-in.-deg r	Thermal conductivity of part material vs part material temperature.
CPJ	(30)		Btu/lb-deg r	Jacket material heat capacity vs material temperature.
CPNT	(30)		Btu/lb-deg r	Tube material heat capacity vs material temperature.
CRJ	(30)		Btu/in. ² -sec-deg r	Air - Jacket contact resistance vs distance from nozzle-tube inlet
CRJNT	(30)		Btu/in. ² -sec-deg r	Tube - Jacket contact resistance vs distance from nozzle-tube inlet.
DEL	(30)			Delta vs distance (z) (New nozzle-tube model)
DELHN2	(200)			Table of $\Delta H/N^2$ for pump head rise.
DELPNT	(30)			Tube pressure-drop adjustment factor vs distance from nozzle-tube inlet.
DELPNZ	(30)			Nozzle pressure-drop adjustment factor vs distance from nozzle-tube inlet.
DELZ	(20)		in.	Length of one node
DNOZW	(30)		in. ² (in)	Main nozzle flow area (or diam) vs distance from nozzle-tube inlet.
DTURX			in.	Turbine-exit-line diameter
ERRCNT				When running stacked cases, if this number of cases has failed to run, the entire run will be terminated.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
FFTAB	(4,30)			Friction-factor input table (HD, PF, RF, ALF, vs OPT)
FLAGS(1)		ETAPFL		Flag - 0 uses given pump and turbine efficiency 1 uses given pump and calculates turbine efficiency 2 uses given turbine efficiency and calculates pump efficiency
FLAGS(2)		HBPFPG		Flag - If this value is not zero, the program uses the simplified hot-bleed-port model.
FLAGS(3)		MASS		The program will ignore mass storage for this many time points.
FLAGS(4)		MTIME	sec	The program stops when any material temperature calculation requires a smaller time interval than this.
FLAGS(5)		NTIME		The program will stop after this number of time points has been completed.
FLAGS(6)		NWIT		Maximum allowable number of pump-work iteration passes.
FLAGS(7)		OPEN		Flag - If this value is not zero, the program will ignore the turbopump loops and expect either an input inlet pressure or flow rate.
FLAGS(8)		OPTION		This cell if input is = non zero P6T6 option (= 1 PC, power), (= 2 TC, gate position), (= 3 PC, TC)
FLAGS(9)		PMINO	psia	Flag - If this value is zero, the program will use the input back-pressure curve.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
FLAGS(10)		STATE		If this value is not zero, the program ignores all transient effects and computes time points working toward a satisfactory steady-state point.
FLAGS(11)		TANK		If this value and -open- are both not zero, the program will iterate to find required inlet pressure, given flow rate. This value will be used as an initial guess.
FLAGS(12)		TAPE		If this value is not zero, a restart tape will be written.
FLAGS(13)		TFLUM	deg r	An error message is printed whenever any material temperature is greater than this value.
FLAGS(14)		TIMEI	sec	The program begins computation at this time. If the TIME is not zero, the program will require additional input for a restart case.
FLAGS(15)		TIMEX	sec	Computing time interval for fluid equations. The material temperature equations will be computed at some integral power of 2 smaller than this value.
FLAGS(16)		TMETMO	deg r	The program stops when the last node in the engine system is less than this temperature value.
FLAGS(17)		WINT	lbm	The program assumes that there is no turbine flow until W I NT LBM of fluid has passed through the pump.
FLAGS(18-27)				Variable delta time control in 10 consecutive cells with start time, first del time, time of change, new del t, new time, etc.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
FRICF	(20)			Fluid-pressure-drop friction factor.
GP	(30)		deg	TPCV gate position (o = closed) vs time
GUESS(1)		PCTCE		Closure tolerance for P_c , T_c loops
GUESS(2)		PTANK	psia	If this value is zero, the program will use the input tank pressure and tank temperature curves.
GUESS(3)		PTUROE		Closure tolerance for P8 loop.
GUESS(4)		PUMHOE		Pump-head-rise closure tolerance.
GUESS(5)		PUMOG	psia	If this value is zero, the program will use the tank pressure as the initial pump discharge pressure.
GUESS(6)		PUMWKE		Pump-work closure tolerance.
GUESS(7)		TDIL	deg r	Initial temperature of line material.
GUESS(8)		TTANK	deg r	Tank temperature.
GUESS(9)		TMETI	deg r	The program sets all material temperatures to this value. If this value is negative, the program requires additional material temperatures for each node.
GUESS(10)		TURSPD	rpm	The program uses the larger of this value and 1200 RPM as an initial guess for the turbo-pump speed.
GUESS(11)		WDILE		Diluent flow-closure tolerance.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
GUESS(12)		WDILG	lb/sec	Diluent flow guess.
GUESS(13)		WHBPG	lb/sec	Hot-bleed flow guess.
GUESS(14)		WNTE		Engine flow-closure tolerance.
GUESS(15)		WORKE		Pump-work closure tolerance.
GUESS(16)		WPUMPG	lb/sec	Pump flow-rate guess.
HBFLOW	(30)		lb/sec	Initial guess of hot-bleed-port flow vs time.
HBP(1)		ACORO	in. ²	Core outlet area.
HBP(2)		ANNUL	in.	Thickness of cold-flow annulus in the hot-bleed port.
HBP(3)		ANOZT	in. ²	Nozzle throat area.
HBP(4)	(4)	BELSEC		If this value is zero, the complex hot-bleed-port model will ignore the bellows-sections loss coefficients.
HBP(8)		CGAS	ft-lbf/lbm-deg r	Cold-fluid gas constant
HBP(9)		COMP		Diluent-line loss coefficient for compressible fluid.
HBP(10)		DCWH	in.	Diameter of diluent injection holes.
HBP(11)		DHBP	in.	Hot-bleed-port diameter.
HBP(12)		DILANG	deg	Diluent impingement angle.
HBP(13)		DPASS	in.	Diameter of the bypass holes from the diluent line to the hot-bleed-port assembly.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
HBP(14)		FCOLD		Cold-flow friction factor.
HBP(15)		FHOT		Hot-flow friction factor.
HBP(16)		HBQG	btu/sec	Hot-bleed-port heat exchanger heat-flow guess.
HBP(20)		HGAS	ft-lbf/lbm-deg r	Hot-fluid gas constant.
HBP(21)		INCOMP		Diluent-line loss coefficient for incompressible fluid.
HBP(22)		KDELP		Hot-flow inlet loss coefficient.
HBP(23)		KDIL	in.	Loss coefficient K over area squared for the diluent line, for the simplified hot-bleed port.
HBP(24)		KHBPI	in.	K over A squared for hot-bleed port and flow path for hot fluid, only for the simplified hot-bleed port.
HBP(25)		KJTUR		K for the hot-bleed-port assembly and turbine inlet line from point of hot- and cold-flow mixing to the turbine inlet nozzle, not including the TPCV for the simplified hot-bleed port.
HBP(28)		K11		Loss coefficient between TPCV and turbine.
HBP(29)		K9		Loss coefficient between end of jacketed line and TPCV.
HBP(30)		LHBP	in.	Hot-bleed-port length.
HBP(31)		MTHICK	in.	Metal thickness between hot and cold flows in hot-bleed-port heat exchanger.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
HBP (32)		NCWH		Number of diluent holes.
HBP (33)		NHBP		Number of nodes in the complex hot-bleed-port model.
HBP (34)		NPASS		Number of bypass holes.
HBP (35)		RPASS		Bypass-hole loss coefficient.
HBP (36-55)		BELLOW(1-20)		Table loss coefficients for jacketed portion of hot-bleed port, input dist., K, dist., K, etc. First distance is the distance from the hot-bleed-port inlet to the first bellows section. The last distance must be greater than the length of the hot-bleed-port jacketed line.
HFTAB	(5,30)			Film-coefficient input table (HD, CF, PF, BETA, ALF vs OPT)
HG	(30,20)		btu/sec-in. ³	Total heat generation/volume vs time.
HGF	(30,20)			Ratio of heat to total heat generation vs distance along part.
HGFJ	(30)			Jacket heat-generation fraction vs distance from nozzle-tube inlet. Fraction heat-generation rates are measured as the ratio of the actual heat generation rate at a particular distance to the total engine heat-generation rate.
HGFNTC	(30)			Fraction of heat generation of outside half of tubes vs distance from nozzle-tube inlet.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
HGFNTH	(30)			Fraction of heat generation of inside half of tubes vs distance from nozzle-tube inlet.
ITERI	(4-20)			Input to change certain values in common block used in iteration.
KDPI	(20)		in. ⁴	Part entry plenum orifice loss coefficient divided by area squared.
KDPO	(20)		in. ⁴	Part exit plenum orifice loss coefficient divided by area squared.
KPD	(30)			Pump-discharge-line loss coefficient vs time.
KPDV	(30)		in. ⁴	Vent-valve area squared/loss coefficient vs time.
KV	(30)			Pressure drop K for TPCV vs TPCV gate position (0 = closed)
MI				Prints results of each iteration after MI passes.
NBEND				No. of pairs of points in bend table.
NDELZ	(20)			Flag - Length of part = (DEL Z)* (Z points). If this value is zero, the entire part will be ignored.
NI				Maximum number of iterations permitted.
NOZTUB(16)	(16)	DNT		Flag - If this value is not zero, the program will expect the nozzle diameter to be input rather than the nozzle flow area.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
NOZTUB(17)		FNT		Flag - If this value is zero, the nozzle assembly will be ignored.
NOZTUB(18)		KNTI	in. ⁴	Tube inlet loss coefficient/area squared.
NOZTUB(19)		KNT0	in. ⁴	Tube outlet loss coefficient/area squared.
NOZTUB(20)		NODES		Number of nodes within the nozzle tubes.
NOZTUB(21)		NOZEFF		Nozzle efficiency.
NOZTUB(22)		NTDZ	in.	Distance increment for nozzle assembly.
NOZTUB(23)		THETA	(L124)	Flag - If nonzero, program will calculate and print out additional nozzle-tube material temperatures.
NOZTUB(24)		THROAT	in.	Distance to throat measured from nozzle-tube inlet along nozzle.
NOZTUB(25)		TNTIM	deg r	Initial nozzle-tube inlet temperature if different from value on input tape.
NOZTUB(26)		VNTI	in. ³	Tube inlet plenum volume.
NOZTUB(27)		VNT0	in. ³	Tube outlet plenum volume.
NT	(30)		rpm	Turbopump speed for efficiency calculations vs time.
OPT	(30)			Option for each part (selects value set in HFTAB and FFTAB)
PAMB	(30)		psia	Main nozzle back pressure vs time.

	<u>Input</u>		<u>Program</u>		<u>Description</u>
	<u>Symbol</u>	<u>(Size)</u>	<u>Symbol</u>	<u>Units</u>	
	PBD	(30)		in. ⁴	Blowdown-line area squared/loss coefficient vs time.
	PC	(30)			Chamber pressure desired vs time.
	PCARD				Punch card restart instead of tape restart data read if nonzero.
	PTL(1)	(9)	ACL	in. ²	Diluent-line heat-transfer area.
	PIL(2)		APUMI	in. ²	Pump-inlet-line area.
	PIL(3)		DCL	in.	Diluent-line fluid diameter.
	PIL(4)		DNTI	in.	Pump-discharge-line diameter.
2	PIL(5)		KNTIL		Flag - Pump-discharge-line loss coefficient. If K2 is zero, the input curve is used.
	PIL(6)		KPUMI		Pump-inlet-line loss coefficient.
	PIL(7)		MCL	lb	Diluent-line mass.
	PIL(8)		PCL	in.	Diluent-line wetted perimeter.
	PIL(9)		VALPD	psia	Check-valve pressure drop - the pump discharge pressure will be reduced by this constant amount.
	PINLET	(30)		psia	Pump-inlet fluid pressure vs time.
	PLENI	(20)		in. ³	Entry plenum volume.
	PLENO	(20)		in. ³	Exit plenum volume.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
PLINE	(30)		psia	Required pressure at line inlet vs time
PRATIO	(30)			Turbine flow coefficient vs pressure ratio (P11/P12)
PRTSS(1)		ANOZI	in. ²	Nozzle-inlet manifold area.
PRTSS(2)		APD	in. ²	Pump-discharge area.
PRTSS(3)		AREFI	in. ²	Reflector inlet plenum area.
PRTSS(4)		AREFO	in. ²	Reflector outlet plenum area.
PRTSS(5)		ARMAIN		Main-nozzle expansion ratio.
PRTSS(6)		ARTUR		Turbine expansion ratio.
PRTSS(7)		ASHL10	in. ²	Shield 1 outlet area
PRTSS(8)		ASHL20	in. ²	Shield 2 outlet area
PRTSS(9)		ATURXS	in. ²	Total area of turbine exhaust stack.
PTURMO	(30)		psi	Turbine nozzle back pressure vs time.
PUMP	(350)			Pump efficiency table.
QPD	(30)		btu/sec	Heat added to pump inlet fluid vs time.
RHOJ	(30)		lb/in. ³	Jacket material density vs jacket material temperature.
RHOMTL	(20)		lb/in. ³	Material density.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
RHONT	(30)		lb/in. ³	Nozzle-tube material density vs nozzle-tube material temperature.
RN	(30)			Recovery factor vs distance.
SJO	(30)		in.	Outside perimeter of jacket vs distance from nozzle-tube inlet.
SNOZ	(30)		in.	Main-nozzle wetted perimeter vs distance from nozzle-tube inlet.
SNTC	(30)		in.	Outside half of tube wetted perimeter vs distance from nozzle-tube inlet.
SNTH	(30)		in.	Inside half of tube wetted perimeter vs distance from nozzle-tube inlet.
SNTJ	(30)		in.	Perimeter of weld of tube-jacket vs distance from nozzle-tube inlet.
SSPRT	(30)			Times for steady-state print.
TC	(30)			Chamber temperature desired vs time.
TCLOC			in.	Thermocouple location in main nozzle from core
TIMER			sec	Program will read in new data at this time.
TINLET	(30)		deg r	Pump-inlet fluid temperature vs time.
TKJ	(30)		in.	Heat-transfer-jacket thickness vs distance from nozzle-tube inlet.
TKNTC	(30)		in.	Thickness of outside half of tube vs distance from nozzle-tube inlet.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
TKNTH	(30)		in.	Thickness of inside half of tube vs distance from nozzle-tube inlet.
TNODE	(20)			Node to close T _c option on if other than chamber conditions (- fluid, + metal).
TPA(1)	(17)	ARE		Turbine-rotor exit area.
TPA(2)		ATURO	in. ²	Area of turbine exit line to choked exhaust nozzle.
TPA(3)		ATURX	in. ²	Turbine exit area for subsonic flow.
TPA(4)		DROLNZ	in.	Turbine exit nozzle (roll-control nozzle) diameter.
TPA(5)		DTUR	in.	Turbine line (inlet) diameter.
TPA(6)		DTURNZ		Turbine inlet nozzle diameter.
TPA(7)		ETAMIN		Minimum pump efficiency to be used in the program.
TPA(8)		GATEFG	deg	Flag - Turbine-power-control-valve position; 90 deg is full open. If this value is zero, the program will use the input gate position curve.
TPA(9)		KBEAR		Bearing-coolant loss coefficient.
TPA(10)		KTURO		Flag - Turbine-exit loss coefficient from turbine exit rotor to exhaust nozzle.
TPA(11)		KTURX		Loss coefficient between turbine exit and roll nozzle.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
TPA(12)		MUPT	lbm-in. ²	Turbopump rotor inertia.
TPA(13)		NWORK	rpm	Minimum turbine speed; the program assumes that the pump requires no work below this speed.
TPA(14)		PTURI	psia	Flag - If this value is not zero the program will use the input turbine inlet pressure and temperature and assume the TPCV is closed, the turbine flow coming from an external source such as a start bottle.
TPA(15)		TIPVEL		Constant to convert turbine rpm to turbine tip speed.
TPA(16)		TTURI	deg r	Turbine inlet temperature.
TPA(17)		WWORK	rpm-sec/lb	Pump speed:flow ratio, minimum - the program assumes that the pump requires no work below this speed:flow ratio.
TTK	(20)			Radial condition term ($\theta_{max} = \theta * K - T$)
TUREFF	(30)			Ratio of tip speed to isentropic spouting velocity vs time.
TURIP	(30)		psia	Turbine inlet pressure vs time.
TURIT	(30)		deg r	Turbine inlet temperature vs time.
VALVE(1)	(5)	KL		Loss coefficient for the line in series with TPCV.
VALVE(2)		KO		Loss coefficient for entire parallel TPCV circuit on-off valve side.

<u>Input Symbol</u>	<u>(Size)</u>	<u>Program Symbol</u>	<u>Units</u>	<u>Description</u>
VALVE(3)		KVMIN		TPCV minimum loss coefficient.
VALVE(4)		VLSWT		Flag - VLSWT = 0, valve off; VLSWT = 1, valve on.
VALVE(5)		VSWTPC		Valve switch Flag - VSWTPC takes precedence over VLSWT; VSWTPC = 0, VLSWT option in control; VSWTPC = Desired PC, valve is set off if VSWTPC is less than PC; otherwise, valve is set on.
VNODES	(30)			Nozzle node-length input sequentially if desired.
VOIDF	(20)			Ratio of fluid volume to total volume of the part.
WALL	(20)		in.	Flag - Thickness of pipe wall. If this value is not zero, the program will use a finite-wall pipe model rather than a pebble-bed model for this part.
WDIL	(30)		lb/sec	Diluent flow rate vs time.
WETP	(30,20)		in.	Part wetted perimeter vs distance along part.
WPUM	(30)		lb/sec	Pump flow rate (for open loop) vs time.
WX	(5)		lb/sec	Bypass stream flow.

Alphanumeric Input

DILREM	-	Diluent removal name
LINES(365)	-	Print headings
MPARTS(30)	-	Names and order of main-stream parts
NTNAME	-	NOZ tube name
PARTS(20)	-	Name of input parts
PLNAME	-	Pump-discharge-line name
XPARTS(5.5)	-	Names and order (in,part,out) bypass parts

Restart Data Input (PCARD NONZERO)

DELHN	btu/lb	Pump head
EPUMP	btu/sec	Pump work
ETURP	btu/sec	Turbine work
HDPUM	lb-ft/lb	Pump head
HSVP	ft-lbf/lb	Pump saturated-vapor head
NTURP	rpm	Turbine speed
PPUMOP	psia	Pump outlet pressure
PTANKX	psia	Tank pressure
PTURIX	psia	Turbine inlet pressure
PTURO	psia	Turbine outlet pressure
P6N	psia	-
P8N	psia	-
QPUMP	gal/min	Pump flow
RHOFLU(30,20)	lb/in. ³	Permanent fluid density
RHOMI(20)	lb/in. ³	Old inlet density
RHOMIX	lb/in. ³	Inlet plenum density (N-1)
RHOMO(20)	lb/in. ³	Old outlet density
RHOMOX	lb/in. ³	Outlet plenum density (N-1)
RHONTM(30)	lb/in. ³	Past time tube H2 density
RHONZM(30)	lb/in. ³	Past time nozzle H2 density
TCOLD(30)	deg r	Cold-side temperature
TCORO	deg r	Core outlet temperature
THOT(30)	deg r	Hot-side temperature
TIME	sec	Time
TJACK(30)	deg r	Jacket temperature
TJKTWD(30)	deg r	Jacket temperature at tube weld
TJKWO(30)	deg r	Outside jacket wall temperature
TMETAL(30,20)	deg r	Permanent metal temperature
TNOZW(30)	deg r	Nozzle wall temperature
TNTCLD(30)	deg r	Tube cold-wall temperature
TNTHOT(30)	deg r	Tube hot-wall temperature
TNTJWD(30)	deg r	Tube temperature at jacket weld
TPUMOP	deg r	Pump outlet temperature
TTANKX	deg r	Tank temperature
T11N	deg r	-
T8N	deg r	-
WDILN	lb/sec	Diluent-line flow
WHBPN	lb/sec	HBP flow
WI	-	Integrated flow
WNOZM(30)	lb/sec	Past time nozzle flow
WNTM(30)	lb/sec	Past time tube flow
WPUMC	lb/sec	Pump flow
WPUMP	lb/sec	Pump flow

Integer Input

TPASS(10)	-	Timer (passes)-TPNT,W,C,P,TM,M,H2,,,
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3.5 OUTPUT (Sample Run)

A sample output run is shown on the next three pages.

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TIME = 2.0000 PC = 45.102 TC = 520.00

INLET CONDITIONS

P 1	T 1	P 2	T 2	N	G P	DEL H	DEL T	P PUMP	TOTL W
70.000	38.000	118.28	39.106	5036.7	38.254	0.0	1.0000	70.000	20.648

SKIRT									
Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
3.0000	271.51	39.106	101.20	3.00586D-04	2.52369D-03	12.043	0.74428	-101.53	2.0383
9.0000	264.07	38.970	100.45	2.89806D-04	2.52608D-03	12.043			
15.000	254.08	40.073	100.44	2.85803D-04	2.50421D-03	12.043			
21.000	243.53	41.196	100.44	2.84074D-04	2.46965D-03	12.043			
27.000	243.53	42.207	100.43	2.84074D-04	2.44087D-03	12.043			
33.000	233.69	43.086	100.42	2.82654D-04	2.41757D-03	12.043			
39.000	225.86	43.976	100.41	2.81709D-04	2.39552D-03	12.043			
45.000	218.19	44.880	100.41	2.83173D-04	2.36247D-03	12.043			
51.000	210.54	45.802	100.40	2.86449D-04	2.32998D-03	12.043			
57.000	203.16	46.742	100.40	2.91140D-04	2.29836D-03	12.043			
	196.04	47.701	100.40	2.97170D-04	2.26760D-03	12.043			
		48.543	99.560		2.23932D-03	12.043	0.83880	-73.269	2.6834

NOZTUBES									
Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
3.4900	452.18	39.106	101.20	1.40996D-04	2.52369D-03	4.7052	6.58928D-02	-101.53	2.0383
10.470	433.90	41.965	101.13	2.33536D-04	2.46469D-03	4.7052			
17.450	428.29	47.188	101.13	4.27647D-04	2.28628D-03	4.7052			
24.430	428.90	52.161	101.11	4.27647D-04	2.02546D-03	4.7052			
31.410	431.29	52.197	101.07	6.14940D-04	1.05511D-03	4.7052			
38.390	431.02	52.175	100.70	1.09311D-03	6.89097D-04	4.7052			
45.370	434.81	52.096	100.27	5.96850D-04	4.92692D-04	4.7052			
52.350	421.23	52.078	100.15	3.81534D-04	3.75286D-04	4.7052			
59.330	445.55	55.428	100.08	2.95917D-04	2.67340D-04	4.7052			
		65.271	100.00	2.62749D-04	1.97378D-04	4.7052			
		70.647	99.545		1.73805D-04	4.7052	0.41132	151.22	6.8150

REFLECT									
Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
2.2292	520.00	51.986	99.545	3.06327D-04	2.06051D-03	16.749	0.11812	-58.634	2.9748
6.6875	520.00	58.196	99.417	2.76145D-04	2.06068D-03	16.749			
11.146	520.00	72.723	99.302	3.05021D-04	1.98384D-04	16.749			
15.604	520.00	91.148	99.054	3.62999D-04	1.44187D-04	16.749			
20.062	520.00	113.21	98.727	4.52985D-04	1.10361D-04	16.749			
24.521	520.00	138.86	98.314	5.79905D-04	8.72114D-05	16.749			
28.979	520.00	167.66	97.809	7.48018D-04	7.03924D-05	16.749			
33.437	520.00	198.85	97.205	9.43706D-04	5.80756D-05	16.749			
37.896	520.00	231.65	96.500	1.12795D-03	4.88989D-05	16.749			
42.354	520.00	265.28	95.690	1.32064D-03	4.19378D-05	16.749			
46.812	520.00	298.70	94.776	1.48072D-03	3.65373D-05	16.749			
51.271	520.00	330.82	93.760	1.59422D-03	3.23601D-05	16.749			
		360.81	92.646		2.91123D-05	16.749			
		375.19	85.361		2.46223D-05	16.749	6.7049	1202.8	12.440

SHIELD 1									
Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
1.9750	520.00	375.19	85.361	1.46740D-03	2.46223D-05	16.749	0.84835	1202.8	12.440
5.9250	520.00	380.26	84.297	1.49819D-03	2.43785D-05	16.749			
9.8750	520.00	390.16	83.861	1.52735D-03	2.36168D-05	16.749			
		399.59	83.415		2.29184D-05	16.749			
		404.19	82.252		2.20253D-05	16.749	0.93773	1316.1	12.849

SHIELD 2									
Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
1.7500	520.00	404.19	82.252	1.83116D-03	2.20253D-05	16.047	0.87063	1316.1	12.849
5.2500	520.00	407.79	81.077	1.85917D-03	2.17930D-05	16.047			
8.7500	520.00	414.81	80.463	1.88581D-03	2.12533D-05	16.047			
12.250	520.00	421.51	79.837	1.91111D-03	2.07455D-05	16.047			
		427.87	79.200		2.02669D-05	16.047			
		430.97	77.910		1.95726D-05	16.047	0.96775	1412.0	13.131

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CORE SUP

Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
		430.97	77.910		1.957260-05	16.047	0.97973	1412.0	13.131
1.2650	520.00	434.37	76.914	6.229400-04	1.932730-05	16.047			
3.7950	520.00	440.96	76.883	6.313990-04	1.901990-05	16.047			
		444.15	75.843		1.849100-05	16.047	1.0233	1459.1	13.261

CORE

Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE	PRES DROP	ENTHALPY	ENTROPY
0.99075	520.00	444.15	75.843		1.849100-05	16.047	22.184	1459.1	13.261
2.9722	520.00	454.78	53.527	9.754290-04	1.309510-05	16.047			
4.9537	520.00	473.38	53.257	1.015520-03	1.243600-05	16.047			
6.9352	520.00	487.15	52.980	1.045360-03	1.196370-05	16.047			
8.9167	520.00	497.09	52.697	1.067010-03	1.162100-05	16.047			
10.898	520.00	504.15	52.409	1.082420-03	1.136760-05	16.047			
12.880	520.00	509.10	52.118	1.093230-03	1.117540-05	16.047			
14.861	520.00	512.53	51.824	1.100740-03	1.102490-05	16.047			
16.843	520.00	514.90	51.528	1.105910-03	1.090270-05	16.047			
18.824	520.00	516.52	51.229	1.109470-03	1.079960-05	16.047			
20.806	520.00	517.63	50.928	1.111900-03	1.070930-05	16.047			
22.787	520.00	518.39	50.625	1.113550-03	1.062760-05	16.047			
24.769	520.00	518.90	50.319	1.114680-03	1.055160-05	16.047			
26.750	520.00	519.25	50.012	1.115440-03	1.047930-05	16.047			
28.732	520.00	519.49	49.703	1.115960-03	1.040930-05	16.047			
30.713	520.00	519.66	49.392	1.116310-03	1.034090-05	16.047			
32.695	520.00	519.77	49.079	1.116550-03	1.027320-05	16.047			
34.676	520.00	519.84	48.763	1.116700-03	1.020600-05	16.047			
36.658	520.00	519.89	48.446	1.116810-03	1.013900-05	16.047			
38.639	520.00	519.93	48.127	1.116870-03	1.007190-05	16.047			
40.621	520.00	519.95	47.805	1.116920-03	1.000470-05	16.047			
42.602	520.00	519.97	47.482	1.116940-03	9.937190-06	16.047			
44.584	520.00	519.98	47.156	1.116960-03	9.869340-06	16.047			
46.565	520.00	519.98	46.828	1.116970-03	9.801110-06	16.047			
48.547	520.00	519.99	46.497	1.116970-03	9.732460-06	16.047			
50.528	520.00	519.99	46.164	1.116970-03	9.663360-06	16.047			
52.510	520.00	520.00	45.829	1.116960-03	9.593790-06	16.047			
	520.00	520.00	45.492	1.116960-03	9.523730-06	16.047			
	520.00	520.00	45.102		9.407260-06	16.047	0.22049	1730.2	14.240

NOZZLE *****

Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE
59.330	371.97	520.00	45.102	3.365230-04	9.407260-06	16.132
52.350	369.24	519.23	45.102	3.104130-04	9.421100-06	16.132
45.370	370.70	518.48	45.101	4.617030-04	9.434620-06	16.132
38.390	390.68	517.64	45.098	8.463560-04	9.449800-06	16.132
31.410	366.76	503.73	45.046	1.830510-03	9.708500-06	16.132
24.430	356.33	495.03	44.988	9.554870-04	9.846690-06	16.132
17.450	361.89	486.46	44.979	5.810140-04	1.002590-05	16.132
10.470	393.22	478.02	44.976	3.771230-04	1.020300-05	16.132
3.4900	424.54	469.74	44.975	2.510390-04	1.038240-05	16.132

NOZZLE METAL TEMPS

Z	JACKET	T COLD	T HOT	NOZ W	T H W	T C W	T J W	J T W	OUTSIDE
3.4900	515.95	512.76	392.16	393.22	391.65	512.70	520.00	520.00	520.00
10.470	514.09	508.73	360.31	361.89	359.17	508.64	520.00	520.00	520.00
17.450	512.58	504.63	354.16	356.33	352.09	504.49	520.00	520.00	520.00
24.430	510.62	498.17	363.51	366.76	359.85	497.95	520.00	520.00	520.00
31.410	507.38	484.79	385.09	390.68	378.19	484.39	520.00	520.00	520.00
38.390	513.44	498.45	367.39	370.70	363.82	498.21	520.00	520.00	520.00
45.370	516.21	504.37	367.19	369.24	365.39	504.22	520.00	520.00	520.00
52.350	519.45	473.42	370.31	371.97	369.18	473.28	520.00	520.00	520.00
59.330	512.63	508.51	383.82	385.37	382.67	508.43	520.00	520.00	520.00

NOZ-FLOW NOZ-CHOKE-FLOW FLOW ERR DILUENT K
16.132 16.146 -8.642920-04 0.99500

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SKIRT NOZZEL *****

Z DIST	METL T	TEMP	PRESSURE	FILM C	DENSITY	FLOWRATE
60.000	204.43	462.99	44.974	1.55497D-04	1.05333D-05	16.132
54.000	211.86	463.53	44.974	1.64963D-04	1.05210D-05	16.132
48.000	219.55	464.07	44.974	1.75773D-04	1.05089D-05	16.132
42.000	227.26	464.59	44.974	1.88208D-04	1.04970D-05	16.132
36.000	235.15	465.11	44.974	2.02794D-04	1.04853D-05	16.132
30.000	245.05	465.63	44.974	2.19899D-04	1.04738D-05	16.132
24.000	255.65	466.13	44.974	2.38713D-04	1.04626D-05	16.132
18.000	265.71	466.62	44.974	2.60906D-04	1.04517D-05	16.132
12.000	273.24	467.40	44.974	2.86919D-04	1.04341D-05	16.132
6.0000	280.77	469.74	44.975	3.12201D-04	1.03824D-05	16.132

SKIRT NOZZEL METAL TEMPS *****

Z	T HOT	NOZ W	T H W
3.0000	271.51	273.24	271.51
9.0000	264.07	265.71	264.07
15.000	254.08	255.65	254.08
21.000	243.53	245.05	243.53
27.000	233.69	235.15	233.69
33.000	225.86	227.26	225.86
39.000	218.19	219.55	218.19
45.000	210.54	211.86	210.54
51.000	203.16	204.43	203.16
57.000	196.04	197.25	196.04

METAL TEMP PASSES *****

NOZTUBES	SKIRT	REFLECT	SHIELD 1	SHIELD 2	CORE SUP	CORE
64.000	1.0000	0.0	0.0	0.0	0.0	0.0

PREDICTOR *****

W P	W C	W H	W N	W T	P 6	P 8	T 8	P 11	T 11
16.798	0.10000	-6.07944D-02	16.837	3.92056D-02	0.0	0.0	0.0	24.852	0.0

ENTHALPY
-111.00

ENTROPY
1.8723

Q PUMP	WP ACT	WT ACT	INT HT
1730.3	69.985	71.093	0.0

CORRECTOR *****

W P	W C	W H	W N	W T	P 6	P 8	T 8	P 11	T 11
16.813	0.70134	-8.49998D-02	16.837	0.61634	45.102	0.0	0.0	24.852	389.71

ENTHALPY
1259.1

ENTROPY
13.971

W BC
6.46004D-02

ETA T*

F PWR	WP ACT	WT ACT	PMP EF	TRB EF	H12MIX	T12MIX	P 12	T 12
29662.	69.985	71.093	0.50830	0.52953	1023.1	1023.1	13.452	359.21

ENTHALPY
1140.9

ENTROPY
13.896

BY-PASS VALVE CLOSED *****

LIST OF SYMBOLS

<u>Symbol</u>	<u>Unit</u>	<u>Description</u>
A	in. ²	Area
A _F	in. ²	Flow area
A _P	in. ²	Effective heat-transfer area
A _{RN}	in. ²	Nominal rotor choke exit area
C		Flow function
C*	in./sec	Sonic velocity
C _P -C _R	Btu/lbm-°R	Specific heat fluid, material
C _v	Btu/lbm-°R	Specific heat at constant volume
Co	ft/sec	Isentropic spouting velocity
D	in.	Diameter
f	Unitless	Void fraction
F _p	in.	Wetted perimeter
g	in.-lbm/lbf-sec ²	Gravitational constant
G.P.	deg	TPCV position
h	btu/lb	Enthalpy
h _f	Btu/sec-°R-in. ²	Convective heat-transfer film coefficient
H	ft-lbf/lbm	Pump head rise
HSV	ft-lbf/lbm	Net positive suction head
I	Btu/sec-in. ³	Internal heat generation
I _M	in. ² -lbm	Moment of inertia
J	ft/lbf/Btu	Conversion factor
k	Btu/in.-sec-°R	Thermal conductivity
K	Unitless	Loss coefficient
K _v	Unitless	TPCV loss coefficient
M	Unitless	Equation coefficient
N	Unitless (rpm)	Defined in equation 26, turbine speed
N _{Re}	Unitless	Reynolds number ($\frac{VD\rho}{\mu}$)

LIST OF SYMBOLS (cont.)

<u>Symbol</u>	<u>Units</u>	<u>Description</u>
P	lbf/in. ²	Pressure
q	Btu/sec	Heat flow
Q _i	Btu/sec	Internal heat generated
Q _p	gal/min	Flow rate
r	in.	Thickness
R	lbm/lbf-°R	Specific gas constant
S	Btu/lb-°R	Entropy
Δt	sec	Time increment
T	°R	Temperature, fluid
TPCV		Turbine power-control valve
u	°R, ft/sec	Temperature rise due to internal heat generation, turbine rotor tip speed
v	in./sec	Velocity
V	in. ³	Volume
$\dot{w}$	lbm/sec	Flow rate
W	Btu/sec	Work
ΔZ	in.	Distance
γ	Unitless	Ratio of specific heats
η _p	Unitless	Pump efficiency
η _T	Unitless	Turbine efficiency
Θ	°R	Material temperature
ν	lb/in.-sec	Viscosity
φ	Unitless	Friction factor
ρ	lbm/in. ³	Density
ω	rad/sec	Rotational speed

LIST OF SYMBOLS (cont.)

(Subscripts)

<u>Symbol</u>	<u>Description</u>
1	Pump inlet
2	Pump outlet
3	Nozzle-tube inlet
4	Nozzle-tube outlet
6	Nozzle chamber
8	Hot-bleed-port outlet
11	Turbine inlet
12	Turbine outlet
C	Cold
d	Chamber
CM	Cold mixture
f	Final
H	Hot
HM	Hot mixture
i, iN	Initial or inlet
ISEN	Isentropic
m	Distance node
MID	Mid-point between turbine and inducer turbine
N	Nozzle
n, i	Time
o	Outlet
Pact	Actual pump
PT	Turbopump
T	Turbine
Tact	Actual turbine
TE	Turbine exhaust line
TI	Inducer turbine
TL	Turbine inlet line
TN	Turbine inlet nozzle

APPENDIX

PROGRAM NOMENCLATURE AND LISTING

I. PROGRAM NOMENCLATURE

PROGRAM D31201 NOMENCLATURE		
SYMBOL	UNITS	DESCRIPTION
ACCL	-	COOLANT LINE HEAT TRANSFER AREA
ACORD	IN2	AREA OF CORE OUTLET
ADON	-	NAMLIST
AFLOW(30.20)	IN2	Z.FLOW AREA
AFLOWX	IN2	FLOW AREA
AGCHED	*****	SUBROUTINE
AJB	-	ALPHA (JB)
AJE	-	ALPHA (JE)
AJF	-	ALPHA (JF)
AJHT(30)	IN2	Z.JACKET HEAT TRNS AREA
ALINE	IN3	LINE HEAT TRANSFER AREA
ALPHA	-	PREDICTOR FACTOR PUMP OUTLET TO CORE EX
AMID	-	AREA AT MIDPOINT BETWEEN TURBINES
AMIDP	-	FLOW AREA BETWEEN INDUCER AND MAIN PUMP
ANF	-	ALPHA (NF)
ANH	-	ALPHA (NH)
ANNUL	IN	THICKNESS OF COLD FLOW ANNULUS
ANGZI	IN2	AREA NOZ INLET(MANI)
ANGZT	IN	NOZZLE THROAT AREA
ANGZTX	IN2	THROAT FLOW AREA
ANTC(30)	IN2	Z.TUBE COLD SIDE HEAT TRNS. AREA
ANTH(30)	IN2	Z.TUBE HOT SIDE HEAT TRNS AREA
ANTW(30)	IN2	Z.TUBE FLOW AREA
APD	IN2	AREA PUMP DISCHARGE
APUMI	-	PUMP INLET LINE AREA
ARE	-	TURBINE ROTOR EXIT AREA
AREFI	IN2	AREA REF INLET(PL)
AREFO	IN2	AREA REF OUTLET(PL)
ARG	-	TEMP FOR ITER CALL SEQUENCE - TUBES
ARG1	-	ARGUMENT FOR SERCH IN PREDICTOR
ARG2	-	ARGUMENT FOR SERCH IN PREDICTOR
ARMAIN	-	AREA RATIO(MAIN)
ARONZ	-	ROLL NOZZLE AREA (TURBINE EXHAUST)
ARTER	-	TURBINE AREA RATIO
ASHL10	IN2	AREA SHL1 OUTLET
ASHL20	IN2	AREA SHL2 OUTLET
ASTH(30)	IN2	Z.SKIRT TUBE HOT SIDE HT. TRNS. AREA
ASTW(30)	IN2	Z.SKIRT TUBE FLOW AREA
ATN	-	NAMLIST
ATUR	-	AREA OF TURBINE LINE
ATWRNC	-	INPUT OF NOZZLE AREA FOR NON-CHOKED FLO
ATWRAP	-	COMPUTED NOZZLE AREA FOR NON-CHOKED FLO
ATWRN2	-	ACTUAL TURBINE INLET NOZZLE AREA
ATURO	-	AREA OF TURBINE OUTLET LINE TO ATMOSPHER
ATURX	-	TURBINE EXIT AREA
ATURXS	-	TOTAL TURBINE EXHAUST STAGK
AZM	-	TEMPORARY STORAGE
AZM1	-	TEMPORARY STORAGE
AZQIN	-	NAMLIST
AZQON	-	NAMLIST
BATERM	LB/SEC	BETA/2*ALPHA
BATERS	LB2/SEC2	(BETA/2*ALPHA)**2
BB(11)	-	INPUT BLOCK
BDASK	-	A**2/K
BDASKO	-	OLD A**2/K
BDHA	IN3	LFILM*ALINE
BDLP	PSIA	LINE PRESSURE
BDN	-	MASS OF GAS
BDNO	-	OLD MASS
BDOWN	-	FLAG FOR BLOW DOWN THRU PUMP
BDOWNL	*****	SUBROUTINE
BDP	PSIA	TANK PRESSURE
BDPD	-	FLAG FOR PUMP DISCH LINE BLOW DOWN
BDRHO	LB/IN3	LINE DENSITY
BDT	-	BLOW DOWN STORAGE
BDT	DEG R	TANK TEMPERATURE

C	BDL	*****	SUBROUTINE
C	BDL	LB/SEC	LINE FLOW RATE
C	BELLOW(20)	SEC.K	BELLOW SECTION CNSTS
C	BELSEC	-	NOT 0=BELLOWS SECTIONS INPUT
C	BEND(30)	-	TABLE FOR ADDITIONAL PRESSURE LOSS
C	BETA	-	PREDICTOR FACTOR FOR CORE OUTLET PRESS.
C	BJB	-	BETA (JB)
C	BJE	-	BETA (JE)
C	BJF	-	BETA (JF)
C	BLANK	-	8 BLANK CHAR.
C	BNF	-	BETA (NF)
C	BNH	-	BETA (NH)
C	BUF(10)	-	INPUT BUFFER
C	C	-	FLOW PARAMETER ACROSS INDUCER TURBINE
C	CAP(30,20)	BTU/LB-DEGR	THETA, HEAT CAPACITY
C	CARDS(11)	-	INPUT COMMENT CARD
C	COELZ(20)	-	USED TO COMPARE RESTART AND INPUT NDELZ
C	CDJ(30)	-	THETA, JACKET THERMAL CONDUCTIVITY
C	CDJX	-	THERMAL CONDUCTIVITY-JKT BTU/SEC-IN-DEGR
C	CDMTL	BTU/SEC-IN-R	METAL THERMAL CONDUCTIVITY
C	CDNT(30)	-	THETA, TUBE THERMAL CONDUCTIVITY
C	CDNTX	-	THERMAL CONDUCTIVITY-NTC BTU/SEC-IN-DEGR
C	CDNTHX	-	THERMAL CONDUCTIVITY-NTH BTU/SEC-IN-DEGR
C	CDST(30)	-	THETA, SKIRT TUBE THERMAL CONDUCTIVITY
C	CDTHX	-	TEMPORARY STORAGE
C	CFILMA	-	COLD FILM COEFF CNST
C	CFILMB	-	COLD FILM COEFF CNST
C	CFILMC	-	COLD FILM COEFF CNST
C	CFUP(30)	-	Z, COLD FLOW WETTED PERIMETER
C	CG(30)	-	Z, CG
C	CGAS	-	COLD GAS CNST
C	CJ(20)	-	SUBSCRIPTS (ORDERS RESTART PART DATA)
C	CJB	-	GAMMA (JB)
C	CJE	-	GAMMA (JE)
C	CJF	-	GAMMA (JF)
C	CNF	-	GAMMA (NF)
C	CNH	-	GAMMA (NH)
C	CNTMAX	-	MAX NO. OF C.O. PRINT LINES ALLOWED
C	CNTMAX	-	MAX NO. OF ITER PRINT LINES ALLOWED
C	CO	*****	SUBROUTINE
C	COMENT	-	C AND 7 BLANK CHAR.
C	COMP	-	COMPRESSIBLE
C	COND	BTU/IN-SEC-R	THERMAL CONDUCTIVITY (H2 GAS PROPERTIES)
C	CONDI(30,20)	BTU/SEC-IN-R	THETA, THERMAL CONDUCTIVITY
C	CORRECT	*****	SUBROUTINE
C	CP	BTU/LB	SPECIFIC HEAT (H2 GAS PROPERTIES)
C	CPARTS(20)	-	COMPARE RESTART AND INPUT PART NAMES
C	CPDP	BTU/LB-DEGR	SPECIFIC HEAT
C	CPJ(30)	BTU/LB-DEGR	THETA, JACKET CP
C	CPNT(30)	BTU/LB-DEGR	THETA, TUBE CP
C	CPST(30)	BTU/LB-DEGR	THETA, TUBE CP
C	CPTERM	-	R/776*CP(T11,P11)
C	CPTI	-	C SUB P AT TURBINE INLET
C	CPVOL	-	SPECIFIC HEAT AT CONSTANT VOLUME
C	CPX	BTU/LB-DEGR	METAL HEAT CAPACITY
C	CR	-	Z, JACKET OUTSIDE CONTACT RESIS
C	CRJ(30)	-	Z, TUBE-JACKET CONTACT RESIS
C	CRJNT(30)	-	NT-JKT WLD CNTCT RESIST BTU/SEC-IN2-DEGR
C	CRJTX	-	OTSIDE JKT CNTCT RESIST BTU/SEC-IN2-DEGR
C	CRJX	-	OTSIDE JKT CNTCT RESIST BTU/SEC-IN2-DEGR
C	CSLUP(30,20)	BTU/LB-DEGR	SPECIFIC HEAT
C	CTAB	-	SUBSCRIPTS (TOTAL NO OF RESTART PARTS)
C	CTBL(30)	-	INDUCER TURBINE FLOW C TO P RATIO
C	CTIME	-	TIME POINT COUNTER
C	DCL	-	COOLANT LINE FLUID DIAMETER
C	DEHH	IN	DIAM OF COLD FLOW HOLES
C	DDELZ	IN	D/4DELZ
C	DEL(30)	-	Z, DELTA
C	DELM	BTU/LB	(MM*12-IN)
C	DELMH	BTU/LB	PUMP HEAD

C	DELHN	BTU/LB	PUMP HEAD
C	DELHNX	FT-LBF/LB	PUMP HEAD
C	DELHN2(200)	-	TABLE OF DELTA H OVER N SQ
C	DELPI	PSIA	INLET PRESS DROP NOZZLE TUBES
C	DELPI3	PSIA	OUTLET PRESS. DROP - SKIRT NOZZLE TUBES
C	DELPK	NONE	PRESSURE DROP FUDGE FACTOR
C	DELPK	PSIA	PRESSURE DROP FROM LAST TIME
C	DELPMT	-	TUBES DELTA PRESSURE TERM
C	DELPNT(30)	-	Z.TUBE DELP FUDGE FACTOR
C	DELPNZ(30)	-	Z.NOZZLE DELP FUDGE FACTOR
C	DELPD	PSIA	OUTLET PRESS DROP NOZZLE TUBES
C	DELPDS	PSIA	INLET PRESS. DROP - SKIRT NOZZLE TUBES
C	DELPT	-	DELTA PRESSURE TERM IN TUBES AND NOZZLE
C	DELPHQ	LB/IN3	(RHO N)-(RHO N-1)
C	DELTA	-	PRESSURE RISE ACROSS THE PUMP
C	DELTEM(20)	DEGR	DELTA TEMP
C	DELTER	IN3/SEC	-AF*DELZ/DEL
C	DELTP	-	TEMPORARY STORAGE
C	DELTX	SEC	DELTA TIME
C	DELW	LB/SEC	(WDOTM)-(WDOTM+1)
C	DELZ(20)	IN	POSITION INCREMENT
C	DELZP	-	DELTA PRESSURE TERM IN TUBES AND NOZZLE
C	DELZSQ	IN2	DELZ**2
C	DELZT	-	VARIABLE NODE THROAT FACTOR TERM
C	DELZX	IN	DELTA Z
C	DELZX4	IN	4*DELZ
C	DHBP	IN	DIAM OF HOT BLEED PORT
C	DHYDRA	IN	HYDRAULIC DIAMETER
C	DILANG	DEG	DILUENT IMPINGENT ANGLE
C	DILREN	-	DILUENT REMOVAL NAME
C	DILSTA	-	STATION FOR REMOVAL OF DILUENT
C	DILTAP	*****	SUBROUTINE
C	DINDBL	-	DIAMETER OF THE INDUCER TURBINE BLADE
C	DISPRT(20)	IN	MAX Z FOR THIS PART
C	DIST	IN	DISTANCE FROM BEGINNING OF PART
C	DNOZW(30)	IN	Z.NOZZLE FLOW DIAMETER
C	DNT	-	FLAG TO INDICATE DIAMETER INPUT
C	DNT	IN	DIAM OF NOZ TUBE INLET LINE
C	DPASS	-	DIAMETER SIZE OF BY PASS HOLES
C	DPIPE	IN	PIPE DIAMETER
C	DROLNZ	IN	DIAM OF ROLL CONTROL NOZZLE
C	DSNZW(30)	IN	Z.SKIRT NOZZLE FLOW DIAMETER
C	DTAG	-	INDEX MAPPING DILREN TO MPARTS
C	DTERM	-	4*0*DELZ/(D/)
C	DTROT	-	THROAT DIAMETER
C	DTUR	IN	DIAM OF TURBINE LINE
C	DTURBL	FT.	DIAMETER OF TURBINE BLADE
C	DTURNZ	IN	DIAM OF TURBINE NOZZLE
C	DTURX	-	DIAMETER OF THE TURBINE EXIT LINE
C	DUM	-	TEMPORARY STORAGE
C	DZTERM	IN3/SEC	DELZ*(1-F)*AF/(F*DELZ) OR (DELZ/DELZ)*PI*X*(DI-
C	EINDC	-	ENERGY REQUIRED TO DRIVE INDUCER PUMP
C	EINOP	-	ENERGY REQUIRED TO DRIVE INDUCER PUMP
C	EINTC	-	ENERGY DEVELOPED BY INDUCER TURBINE OLD
C	EINXP	-	ENERGY DEVELOPED BY INDUCER TURBINE NEW
C	ENGIN	*****	SUBROUTINE
C	ENTH	BTU/LB	ENTHALPY (H2 GAS PROPERTIES)
C	ENTHO(30)	BTU/LB	ENTHALPY - PREVIOUS NODE
C	ENTHOS(30)	BTU/LB	ENTHALPY - PREVIOUS NODE - SKIRT
C	ENTR	BTU/LB-DEGR	ENTROPY (H2 GAS PROPERTIES)
C	ENTROP	BTU/LB-DEGR	ENTROPY
C	ENTAR	-	NOT 0*FLG TO WRITE EOF ON RESTART TAPE
C	EPUNC	BTU/SEC	PUMP WORK
C	EPUMP	BTU/SEC	PUMP WORK
C	ERROR	*****	SUBROUTINE
C	ETAIMP	-	MINIMUM EFFICIENCY FOR INDUCER PUMP
C	ETAIND	-	INDUCER TURBINE EFFICIENCY
C	ETAIND	-	INDUCER PUMP EFFICIENCY
C	ETANP	-	INDUCER TURBINE EFFICIENCY (UNCORRECTED
C	ETAMIN	-	MIN ETA PUMP

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C      ETAP          -      PUMP EFFICIENCY
C      ETAPFL        -      FLAG
C      ETAT          -      ETAT(I,I+1)
C      ETATA         -      ETA T PRIME CNST A
C      ETATB         -      ETA T PRIME CNST B
C      ETATC         -      ETA T PRIME CNST C
C      ETATP         -      TURBINE EFFICIENCY BEFORE ADJUSTMENT
C      ETURC         BTU/SEC  TURBINE WORK
C      ETURP         BTU/SEC  TURBINE WORK
C      EXTRAN        -      NAMELIST
C      FCOLD         -      HBP COLD FRICTION FACTOR
C      FF           ****    SUBROUTINE
C      FFTAB(4,30)   -      FRICTION FACTOR(IHD-IPF-IRF-ALF,OPT)
C      FHQT         -      HBP HOT FRICTION FACTOR
C      FILMA(20)     -      FILM COEFF CONSTANT
C      FILMB(20)     -      FILM COEFF CONSTANT
C      FILMC(20)     -      FILM COEFF CONSTANT
C      FILMCX        BTU/IN2-S-R FILM COEFF
C      FILMHF(30,20) -      FILM COEFF BTU/IN2-SEC-DEGR
C      FILMNT        -      NOZ TUBE FILM COEF
C      FILMN2(30)    -      NOZZLE FILM COEFF BTU/IN2-SEC-DEGR
C      FILMST(30)    -      SKIRT TUBE HOT WALL FILM COEFF.
C      FILMSZ(30)    -      SKIRT NOZ. FILM COEFF.
C      FILMTC(30)    -      TUBE COLD WALL FILM COEFF BTU/IN2-SEC-DEGR
C      FILMTH(30)    -      TUBE HOT WALL FILM COEFF BTU/IN2-SEC-DEGR
C      FJ           -      INPUT BLOCK
C      FLAGS(27)     -      SUBROUTINE
C      FLOW          ****    TURBINE GAS FLOW (TEMPORARY)
C      FLOWP         -      NAMELIST
C      FLUIDN        -      NOT 0=USE FLUID TEMP
C      FLUTEM(20)    -      NOZ TUBE FRIC FACTOR, 0= NO TUBES
C      FNT          -      FRACT HEAT GEN - TUBE COLD SIDE
C      FNTC         -      FRACT HEAT GEN - TUBE HOT SIDE
C      FNTH         -      FRICTION FACTOR
C      FRICF(20)     -      SUBROUTINE
C      FUEL          ****    NAMELIST
C      FXN          -      GRAVITY(
C      G            -      GAMMA (H2 GAS PROPERTIES)
C      GAM          -      PREDICTOR FACTOR FOR DILUENT PRESSURE
C      GAMMA        -      PROPERTY GAMMA AT TURBINE INLET
C      GANT1        -      SPOUTING VELOCITY OF GAS AT TURBINE EXT
C      GASVEL       -      TPCV LOSS K.GP
C      GATE(30)      -      GATE POSITION, 0=USE CURVE
C      GATEFG        PERCENT   GATE POSITION
C      GATEP        PERCENT   GATE POSITION
C      GP(30)        DEG       T.GATE POSITION
C      GPN          PERCENT   GATE POSITION
C      GPSUB        ****    SUBROUTINE
C      GLESS(16)     -      INPUT BLOCK
C      HBEAR        -      BEARING ENTHALPY
C      HBFLOW(30)    LB/SEC    T,HBP FLOW
C      HBP(55)       -      INPUT BLOCK
C      HBPFG        -      COMPLEX HBP FLAG
C      HBPXY        -      TPCV LOSS K
C      HBPSSUB      ****    SUBROUTINE
C      HBP          LB/SEC    HBP FLOW
C      HBPNC        -      DILUENT LINE FLOW
C      HBPNC        -      NOZZLE CHOKE FLOW
C      HBG         -      INITIAL HOT BLEED HEAT TRANS GUESS
C      HBGRO        -      ENTHALPY AT HOT BLEED INLET
C      HBILX        -      ENTHALPY AT DILUENT INLET TO HOT BLEED
C      HBDUM        -      BURN HEAD
C      HF           ****    SUBROUTINE
C      HFCOEF        -      NOT=0 USE FILM TEMP FOR FILM COEF
C      HFFLG(20)     -      HOT FILM COEFF CNST
C      HFILMA        -      HOT FILM COEFF CNST
C      HFILMB        -      HOT FILM COEFF CNST
C      HFILMC        -      HOT FILM COEFF CNST
C      HFILMX        -      FILM COEFF(IHD-IPF-IRF-ALF,OPT)
C      HFILM        -      FILM COEFF(IHD-IPF-IRF-ALF,OPT)
C      HFTERN        BTU/SEC+IN3R HF OR 24447/1200+1000

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C	HG(30,20)	BTU/IN3-SEC	T,HEAT GEN
C	HGAS	-	HOT GAS CNST
C	HGCJKT	BTU/IN3-SEC	JACKET HEAT GEN COEFF
C	HGCNTC	BTU/IN3-SEC	COLD SIDE TUBE HEAT GEN COEFF
C	HGCNTH	BTU/IN3-SEC	HOT SIDE TUBE HEAT GEN COEFF
C	HGCCOF	BTU/IN3-SEC	INTERNAL HEAT GENERATION COEF
C	HGF(30,20)	-	Z,FRACTION OF HEAT GENERATION
C	HGFJ(30)	-	Z,FRACTION OF HEAT GEN. JACKET
C	HGFNTC(30)	-	Z,FRACT HEAT GEN. TUBE COLD SIDE
C	HGFNTH(30)	-	Z,FRACT HEAT GEN. TUBE HOT SIDE
C	HGJ(30)	BTU/IN3-SEC	T,JACKET HEAT GEN
C	HGNTC(30)	-	T,TUBE COLD SIDE HEAT GEN
C	HGNTH(30)	-	T,TUBE HOT SIDE HEAT GEN
C	HGYOT	BTU/IN3-SEC	TOTAL INTERNAL HEAT GEN COEF
C	HJ	BTU/LB	ENTHALPY (N-1,N)
C	HINDEX	-	ENTHALPY AT INDUCER PUMP EXIT
C	HINDIN	-	ENTHALPY AT INDUCER PUMP INLET
C	HJ	BTU/LB	ENTHALPY (N,N)
C	HK	BTU/LB	ENTHALPY (N+1/2,N)
C	HKPR	BTU/LB	ENTHALPY - ITERATION LOOP - TUBES
C	HL	BTU/LB	ENTHALPY (N+1,N)
C	HLPCF	-	ENTHALPY CALC TERM IN TUBES
C	HLRHF	-	-
C	HLRRIM	BTU/LB	ENTHALPY (N+1,N) PRIME
C	HM	BTU/LB	MAIN STREAM ENTHALPY
C	HMIX	-	ENTHALPY AT HOT AND COLD BLEED PORT MIX
C	HPIN	-	ENTHALPY AT PUMP INLET
C	HPOLT	-	-
C	HPUMI	BTU/LB	PUMP INLET ENTHALPY
C	HRNOZW(30)	-	NOZ WALL HEAT RESISTANCE IN-SEC-DEGR/BTU
C	HRNTCW(30)	-	TUBE CLD WALL HEAT RESIT IN-SEC-DEGR/BTU
C	HRNTHW(30)	-	TUBE HOT WALL HEAT RESIT IN-SEC-DEGR/BTU
C	HRNTJW	-	NT-JKT WELD HEAT RES TERM IN-SEC-DEGR/BTU
C	HRCJ	-	OUTSIDE JKT HEAT RES TERM IN-SEC-DEGR/BTU
C	HRSNZW(30)	-	SKIRT NOZ. WALL HEAT RESISTANCE
C	HRSTHW(30)	-	SKIRT TUBE HOT WALL HEAT RESISTANCE
C	HSVC	FT-LBF/LB	PUMP SATURATED VAPOR HEAD
C	HSVINP	FT	NET POSITIVE SUCTION HEAD FOR INDUCER
C	HSVP	FT-LBF/LB	PUMP SATURATED VAPOR HEAD
C	HTANKM	-	ENTHALPY OF TANK FLUID
C	HTCNT	-	METAL TEMPERATURE DIFFERENCE FLAG
C	HTCOEF	BTU/LB-S-I-R	HEAT TRANSFER COEF
C	HTQIST(30)	BTU/LB	SKIRT TUBE TOTAL ENTHALPY
C	HTWRIX	-	ENTHALPY OF TURBINE INLET GAS
C	HTERM	FT-LBF/LB-N2	SATURATED VAPOR ENTHALPY/SPEED SQRD
C	HK	BTU/LB	BY-PASS STREAM ENTHALPY
C	H12	-	H12 PRIME
C	I	-	SUBSCRIPT
C	IDELT	-	TIME CHANGE INDEX
C	IDELZS	-	FIXED PARTPS
C	IEND	-	NO. OF MAIN STREAM STATIONS
C	II	-	SUBSCRIPT
C	IN	-	STORAGE FOR MAIN STREAM INDEX I
C	INASS	-	INITIAL MASS,0=INFINITE SOURCE
C	INCOMP	-	INCOMPRESSIBLE
C	INDSF(200)	-	INDUCER PUMP EFFICIENCY
C	INDHD(300)	-	INDUCER PUMP HEAD RISE
C	INDPH	SEC2/IN2LB	INDUCER PUMP HEAD RISE
C	INDTUR	-	NOT 0=P11,T11 GIVEN INDEPENDENTLY
C	INODE	-	-
C	INTOFF(30)	-	INDUCER TURBINE EFFICIENCY
C	INTFLO	-	NOT 0=INTEGRATED FLOW REACHED
C	INTP	****	SUBROUTINE
C	ITER(20)	SEC A	PART INLET TEMP
C	ITER	****	SUBROUTINE
C	ITERI(420)	-	EQUIVALENT TO COMMON BLOCK ITERS
C	IW	-	SUBSCRIPT
C	J	-	SUBSCRIPT
C	KT	FT-LBF/STW	GAS CONSTANT,ST)
C	KN	-	TOTAL NUMBER OF PARTS

C	JJ	-	SUBSCRIPT
C	K	-	SUBSCRIPT
C	KBEAR	-	BEARING LOSS K
C	KDELP	-	K FOR DELTA P
C	KDIL	-	DILUENT LINE K
C	KDRI(20)	1/IN4	K FOR INLET PRESS DROP
C	KDPO(20)	1/IN4	K FOR OUTLET PRESS DROP
C	KEND(5)	-	NO. OF BY-PASS STATIONS PER STREAM
C	KHBPI	-	HBP INLET HOT K
C	KJTLR	-	JACKETED AND TURBINE LINE K
C	KK	-	SUBSCRIPT
C	KKT	-	K FOR KT COMPUTATION
C	KL	-	LINE LOSS K
C	KLOOP	-	SUBSCRIPT
C	KNIDP	-	FLOW K BETWEEN INDUCER AND MAIN PUMP
C	KNII	IN4	INLET ORIFICE DROP K
C	KNTIL	-	K FOR NO2 TUBE INLET LINE
C	KNTG	IN4	OUTLET ORIFICE DROP K
C	KO	-	ORIFICE LOSS K
C	KFCM	-	K FOR PCM,CC
C	KPD(30)	-	PUMP DISCHARGE LINE K
C	KPDV(30)	IN4	PUMP DISCHARGE BYPASS VALVE A2/K
C	KPHM	-	K FOR PHM,P08,CHM,CC
C	KPUMI	-	PUMP INLET LINE DELP FACTOT
C	KPUMPI	-	PUMP INLET LINE LOSS COEFFICIENT
C	KSTI	IN4	INLET ORIFICE DROP K - SKIRT
C	KSTC	IN4	OUTLET ORIFICE DROP K - SKIRT
C	KI	LB-IN2-DEGR(1/2)/LBF-SEC	
C	KIP	*****	SUBROUTINE
C	KIPMIN	-	KIPMIN = FUNCTION OF KVLMIN
C	KITRO	-	LOSS COEFFICIENT OF TURBINE OUTLET LINE
C	KITURX	-	TURBINE EXIT ADMITTANCE
C	KV(30)	-	GP,TPCV LOSS K
C	KVA	-	CNST FOR KV COMP
C	KVB	-	CNST FOR KV COMP
C	KVLMIN	-	KVLMIN = KVMIN + KL
C	KVMIN	-	KV MINIMUM
C	KVN	-	TPCV LOSS COEFFICIENT
C	KVSQRT	-	TEMP STORAGE FOR SQRT(4/(KO*KVL))
C	KWC	LB/SEC-PSIA5	RELATES WDOTC,P2,PHM
C	KWCP	LB/SEC-PSIA5	RELATES WDOTC,P2,PCM
C	KWCV	LB/IN	RELATES WDOTC,VCM
C	KWH	LB/SEC-PSIA5	RELATES WDOTH,P6,PHM
C	KWHV	LB/IN	RELATES WDOTH,VHM
C	KWT	LB/IN	RELATES WDOTT,V8
C	K1	LB2-SEC2/LB2-IN4-DEGR	
C	K11	-	K11 FOR P08
C	K2	LB2-SEC2/LB2-IN4-DEGR	
C	K3	LB2-SEC2/LB2-IN4-DEGR	
C	K4	IN-LB/LBF(1/2)-SEC	
C	KE	-	K FOR T8 PREDICTION
C	K9	-	K9 FOR P08
C	L	-	SUBSCRIPT
C	LARGE	-	NOT 0=100 LARGE
C	LEND	-	NUMBER OF BY-PASS STREAMS(5)
C	LESPO	-	NOT 0=P6 LESS THAN PQMIN
C	LFILM	-	LINE FILM COEF
C	LHBP	IN	LENGTH OF HOT BLEED PORT
C	LL	-	SUBSCRIPT
C	LOOPN	-	NOT 0=ITER ERROR, NAME OF LOOP
C	M	-	SUBSCRIPT
C	MACH	-	MACH NUMBER AT TURBINE EXIT
C	MAM3	-	METAL TEMP CALCULATION TERM
C	MASS	-	IGNORE MASS STORAGE FLAG
C	MEN2	-	METAL TEMP CALCULATION TERM
C	MC	*****	SUBROUTINE
C	MCAP	-	MASS CAPACITANCE
C	MCL	-	COOLANT LINE MASS
C	MEN1	-	METAL TEMP CALCULATION TERM
C	MEN1	-	METAL TEMP CALCULATION TERM

C	MDN2		METAL TEMP CALCULATION TERM
C	MEN3		METAL TEMP CALCULATION TERM
C	MESS	*****	SUBROUTINE
C	MESSX	*****	SUBROUTINE
C	METALT	*****	SUBROUTINE
C	METLIN		
C	METLTG	DEG R	INITIAL DILUENT LINE TEMP
C	METTEM(20)	-	NOT 0=USE METAL TEMP
C	MHT	NCNE	HEAT TRANSFER
C	MINFLD		MINIMUM FLOW RATE NOT CONSIDERED ZERO
C	MINNP		MINIMUM N (SPEED) FOR INDUCER PUMP
C	MINNW		MINIMUM N/W FOR INDUCER PUMP
C	MISCN	-	NAMLIST
C	MOVED	*****	SUBROUTINE
C	MPARTS(30)	-	NAMES AND ORDER OF MAIN STREAM PARTS
C	MSMALL(20)	-	NOT 0=M TO SMALL
C	MTAG(30)	-	INDEX MAPPING MPARTS TO PARTS
C	MTERM1	-	1-2/(N*(2M+1))
C	MTERM2	-	1+2M
C	MTERM3	-	2M-1
C	MTERM4	-	1/N-(2M+1)/(N*(2M-1))
C	MTHICK	IN	THICKNESS OF METAL BETWN CLD + HOT
C	MTIME	SEC	MINIMUM TIME INTERVAL
C	MTPNTS(20)	-	NO. TIME POINTS FOR METAL TEMPS
C	MUIT		INERTIA FACTOR FOR INDUCER PUMP
C	MLPT	LB-SQIN	MOMENT OF PUMP AND TURBINE
C	M1N	NCNE	TERM FOR ATT
C	M2N	NCNE	TERM FOR ATT
C	NAMES(10)	-	INITIAL MAIN AND BY-PASS PART NAMES
C	NAMN	-	NAMLIST
C	NBEND		
C	NCWH	-	NO. COLD FLOW HOLES
C	NDELZ(20)	-	NO. OF POSITION PTS. 0=IGNORE THIS PART
C	NEGW		NOT 0=NEGATIVE FLOW RATE
C	NHBP	-	NO. POSITION STEPS IN HBP
C	NMT	NCNE	HEAT TRANSFER TERM
C	NINDC	RPM	INDUCER PUMP DRIVE SPEED (OLD TIME)
C	NINOP	RPM	INDUCER PUMP DRIVE SPEED (PREDIGTED)
C	NK		
C	NMCKT		COUNTER FOR TUBEM
C	NQBNT		NO. OF PAIRS IN BEND TABLE
C	NCBS		NO. OF PAIRS IN BEND TABLE - SKIRT
C	NODEK		NO. NODES (SKIRT TUBES)
C	NODENT	-	NO. NODES (NOZZLE TUBES)
C	NODEPT		
C	NODES	-	NO. NODES(NOZ TUBES)
C	NODET	*****	SUBROUTINE
C	NODZ		PART NODES INDEX
C	NOFIND	-	FLAG=0,RESTART TIME OK, NONZERO NOT OK
C	NOGQP		NOT 0=QP(I+1) NOT CLOSED
C	NOGSPD		NOT 0=N(I+1) NOT CLOSED
C	NOGTC		NOT 0=DONT CHECK NOZ TUBE CHOKING
C	NOGTH		NOT 0=DOOTH(I+1) NOT CLOSED
C	NOGTRM		NOT 0=P12(I) NOT CLOSED
C	NOGTRN		NOT 0=P12(I+1) NOT CLOSED
C	NOZEFF	-	NOZZLE EFFICIENCY
C	NOZTUB(27)	-	INPUT BLOCK
C	NOZZLE	*****	SUBROUTINE
C	NPARTS	-	NUMBER OF METAL PARTS
C	NPASS	-	NUMBER OF BY PASS HOLES
C	NPBN	RPM	TURBINE SPEED
C	NSGNT	-	NO. NOZ TUBE SEGMENTS
C	NT(30)	-	T.MT
C	NTAG	-	INDEX MAPPING NTNAME TO MPARTS
C	NTCNT		CONTR WHEN COMPTG NOZ TUBE METL TEMP
C	NTDZ	IN	NOZ TUBE DELTA Z
C	NTERM	RPM-DEGR1/2	N/ROOTT
C	NTERR	-	NOT 0=NOZZLE TUBE ERROR
C	NTIME	-	NO. TIME INCREMENTS
C	NTNAME	-	NOZ TUBE NAME

C	NTPTS		NUMBER OF TIME POINTS
C	NTURC	RPM	TURBINE SPEED
C	NTURP	RPM	TURBINE SPEED
C	NWIT	-	NO. OF WP ACTUAL ITERATIONS
C	NWORK	-	N BELOW WHICH PUMP DOES NO WORK
C	NZTROT	-	THROAT NODE FACTOR
C	QMAX	-	RADIAL CONDUCTION TERM
C	OPEN	-	NOT=0, NO TURBORUMP, OPEN LOOP
C	OPT(30)	-	FF, HF OPTION, PARTS(1-20), NT(21), NOZ(22)
C	OPTION	-	1=PC, PCWR 2=TC, GP 3=PC, TC
C	OTEMP(20)	DEG R	PART OUTLET TEMP
C	OZ	-	DISTANCE FROM END OF CORE
C	PAMB(30)	PSIA	T, AMBIENT PRES
C	PARONE	-	NOT 0=NOT FIRST PART, 0=FIRST PART
C	PARTAG	****	SUBROUTINE
C	PARTI(20)	-	PART INLET
C	PARTPS(20)	-	NO. DELZ POINTS/PART
C	PARTS(20)	-	NAME OF INPUT PARTS
C	PASSX	-	FLAG
C	PAVG	-	AVERAGE P BETWEEN DILUENT AND MIX POINT
C	PBD(30)	-	A2/K FOR TUBW BLOWDOWN LINE
C	PC(30)	-	T, PC
C	PCARD	-	PUNCH CARD RESTART DATA FLAG
C	PCL	-	COOLANT LINE WETTED PERIMETER
C	PCORD	PSIA	CORE OUTLET PRESS
C	PCTCE	-	CLGSURE FOR TCPC OPTION
C	PCUR	PSIA	CURRENT PRESSURE
C	PCX	PSIA	PC DESIRED
C	PDIL	PSIA	DILUENT PRESSURE
C	PDK	-	PUMP DISCHARGE LINE K
C	PDKV	IN4	PUMP DISCHARGE BYPASS VALVE A2/K
C	PDLIN	****	SUBROUTINE
C	PDRCP(20)	PSIA	INLET PRESSURE DROP
C	PDRDPC(20)	PSIA	OUTLET PRESSURE DROP
C	PFLOW	-	PUMP FLOW TEMPORARY
C	PH	****	SUBROUTINE
C	PHBPO	PSIA	HOT BLEED PORT OUTLET PRESSURE
C	PHI	-	FRICTION FACTOR
C	PHINT(30)	-	FRICTION FACTOR - TUBES
C	PHINZ(30)	-	FRICTION FACTOR - NOZZLE
C	PHIST(30)	-	FRICTION FACTOR - SKIRT TUBES
C	PHISZ(30)	-	FRICTION FACTOR - SKIRT NOZZLE
C	PI	-	PI(3.1415927)
C	PIL(9)	-	INPUT BLOCK
C	PIN	PSIA	PRESSURE (M+1, N)
C	PINDEX	-	PRESSURE AT INDUCER PUMP EXIT
C	PINDIN	PSIA	PRESSURE AT INDUCER PUMP INLET
C	PINLET(30)	PSIA	T, INLET PRES
C	PINPUT	PSIA	INPUT PRESS, 0=USE CURVE
C	PJ	PSIA	PRESSURE (M, N)
C	PK	PSIA	PRESSURE (M+1/2, N)
C	PKPR	PSIA	PRESSURE - ITERATION LOOP - TUBES
C	PL	PSIA	PRESSURE (M+1, N)
C	PLENI(30)	IN3	INLET PLENUM
C	PLENO(30)	IN3	OUTLET PLENUM
C	PLINE(30)	-	T, LINE PRESSURE
C	PLNAME	-	PUMP DISCHARGE LINE NAME
C	PLOT	-	PLOT FLAG
C	PLPRIM	PSIA	PRESSURE (M+1, N) PRIME
C	PM(5)	PSIA	MAIN STREAM PRESSURE
C	PMID	-	PRESSURE AT INDUCER TURBINE INLET
C	PMIDSG	-	PRESSURE (STAGNATION) AT IND TURB INLET
C	PMINO	PSIA	MIN OUTLET PRESS, 0= USE CURVE
C	PMINOX	PSIA	MINIMUM OUTLET PRESSURE
C	PMIX	-	PRESSURE WHERE HOT AND COLD FLOW MIXES
C	PN	-	NAMLIST
C	PNOZ(30)	PSIA	NOZZLE PRESSURE
C	PNOZO	PSIA	NOZZLE OUTLET PRES
C	PNLI	PSIA	NOZZLE TUBES INLET PRESSURE
C	PNLIN	PSIA	INIT PRES FOR NOZ TUBES

C	PNTC	PSIA	NOZZLE TUBES OUTLET PRESSURE
C	PNTTHR	PSIA	NOZZLE TUBE THROAT PRESSURE
C	POLTE	-	OUTLET PRESS CLOSURE
C	PPIN	-	PRESSURE AT PUMP INLET
C	PPOUT	-	PRESSURE AT PUMP DISCHARGE
C	PPUMOG	PSIA	PUMP OUTLET PRESSURE
C	PPUNOP	PSIA	PUMP OUTLET PRESSURE
C	PRATIO(30)	-	P11/P12 VS. C
C	PREDFL	-	FLAG INDICATING PASS FROM PREDICTOR
C	PREDIC	*****	SUBROUTINE
C	PREDIN	*****	SUBROUTINE
C	PREDTF	*****	SUBROUTINE
C	PRES	PSIA	PRESSURE (H2 GAS PROPERTIES)
C	PRES1(20)	PSIA	INLET PRESSURE
C	PRESM	PSIA	PRESSURE FOR LAST POINT
C	PRESSQ(20)	PSIA	OUTLET PRESSURE
C	PRESS(30,20)	PSIA	PRESSURE
C	PRGUES	-	P12/P11 GUESS
C	PRINT	*****	SUBROUTINE
C	PRINTX	-	PRINT INTERVAL
C	PROGIN	*****	SUBROUTINE
C	PRPRIM	-	(P12/P11) PRIME
C	PRTERM	-	((P12/P11)**(R/776*CP)-1)*ETAT
C	PRTS(9)	-	INPUT BLOCK
C	PSNZ(30)	PSIA	SKIRT NOZZLE PRESSURE
C	PSTI	PSIA	SKIRT TUBES INLET PRESSURE
C	PSTO	PSIA	SKIRT TUBES OUTLET PRESSURE
C	PSTP	PSIA	PRESSURE FOR S(TP)
C	PSMB(30)	PSIA	SKIRT TUBE PRESSURE
C	PT	*****	SUBROUTINE
C	PTAG	-	INDEX MAPPING PLNAME TO MPARTS
C	PTANK	PSIA	TANK PRESSURE. 0= USE CURVE
C	PTANKN	PSIA	TANK PRES
C	PTANKX	PSIA	TANK PRESS
C	PTCX	PSIA	THERMOCOUPLE LOCATION PRESSURE
C	PTN	-	NAMelist
C	PINKIN	PSIA	INITIAL TANK PRESSURE
C	PTOOLG	-	FLAG INDICATING NO POWER FROM HOT BLEED
C	PTOTST(30)	PSIA	SKIRT TUBE TOTAL PRESSURE
C	PTROT	-	-
C	PTUBE(30)	PSIA	TUBE PRESSURE
C	RTURI	PSIA	TURBINE INLET PRESS. 0=NO BOT
C	PTURIX	PSIA	TURBINE INLET PRESS
C	PTURNO(30)	PSI	T.TURBINE OUTLET MIN PRES
C	PTURD	PSIA	TURBINE OUTLET PRESS
C	PTURDC	PSIA	MIN P12 I
C	PTURDE	-	TURBINE OUTLET PRESSURE CLOSURE
C	PTURDM	PSIA	MINIMUM TURBINE OUTLET PRES. 0=USE CURVE
C	PTURDP	PSIA	MIN P12 I+1
C	PTURPR	-	-
C	PTXMIN	-	MINIMUM STATIC TURBINE EXIT PRESSURE
C	PTXST	-	STATIC PRESSURE AT TURBINE EXIT
C	PUMHDE	-	PUMP HEAD CLOSURE
C	PUMIP	PSIA	PUMP INLET PRESSURE
C	PUMOG	PSIA	PUMP OUTLET PRES INITIAL GUESS. 0=OUTLET=TANK Q
C	PUMPE(30)	-	PUMP EFFICIENCY TABLE
C	PUMPH	-	PUMP HEAD/FLOW**2 FROM TABLE FOR PREDIC
C	PUMWKE	-	PUMP WORK CLOSURE
C	PVAPIN	PSIA	VAPOR PRESSURE AT INDUCER PUMP INLET
C	PVAPOR	-	VAPOR PRESSURE OF FLUID AT PUMP INLET
C	PX(9)	PSIA	BY-PASS STREAM PRESSURE
C	PCN	PSIA	-
C	PCN	PSIA	-
C	PCN	PSIA	-
C	Q	-	-
C	QCLDNT(30)	BTU/SEC	HEAT TRANSFER RATE - NOZZLE
C	QHDTNT(30)	BTU/SEC	HEAT TRANSFER - TUBES - COLD SIDE
C	QHDTST(30)	BTU/SEC	HEAT TRANSFER - TUBES - HOT SIDE
C	QHOTST(30)	-	SKIRT TUBE Q HOT
C	QHOTST(30)	-	INDUCER PUMP DISCHARGE LINE HEAT RISE
C	QHOTST(30)	-	HEAT ADDED BETWEEN INDUCER AND MAIN PUM

C	QN	GAL/REV	PUMP FLOW TO SPEED RATIO
C	QPD(30)	BTU/SEC	PUMP INLET LINE HEAT ADDED
C	QPM	GAL/MIN	PUMP FLOW
C	QPMU	BTU/SEC	PUMP INLET LINE HEAT ADDED
C	QFUMP	GAL/MIN	HEAT ADDED TO PUMP INLET LINE
C	QTERM	DELW/N(I+1)**2	PUMP FLOW
C	QUAL	-	QUALITY (H2 GAS PROPERTIES)
C	R	FT-LBF/LB-R	GAS CONST(766.6667)
C	RAD	-	RADIANS(.01745329)
C	RATIO	-	RATIO OF TURBINE PRESSURE INLET/OUTLET
C	RATIOC	-	C VALUE **SQRT(I)/P FOR NOZZLE AREA CAL
C	RB	BTU/LB-DEGR	GAS CONST(.98547)
C	REF	-	RESTART TAPE NO.
C	REFR	-	RESTART TAPE NO.
C	RESTAR	*****	SUBROUTINE
C	RESTOR	*****	SUBROUTINE
C	RF	-	RECOVERY FACTOR - NOZZLE
C	RFLU	LB/IN3	FLUID DENSITY
C	RFLUX	LB/IN3	DENSITY OF FLUID IN TUBES AND NOZ
C	RFN	-	RECOVERY FACTOR - NOZZLE
C	RFO	-	TEMPORARY STORAGE
C	RFTC	-	RECOVERY FACTOR - THERMOCOUPLE LOCATION
C	RHO	LB/IN3	DENSITY (H2 GAS PROPERTIES)
C	RHODP	LB/IN3	DENSITY FOR PRESSURE DROP
C	RHOFLU(30,20)	LB/IN3	PERMANENT FLUID DENSITY
C	RHOFTP(30,20)	LB/IN3	TEMPORARY FLUID DENSITIES
C	RHOJ(30)	LB/IN3	THETA,JACKET DENSITY
C	RHOM	-	PAST TIME TUBE FLUID DENSITY
C	RHOMI(20)	LB/IN3	OLD INLET DENSITY
C	RHOMIX	LB/IN3	INLET PLENUM DENSITY (N-1)
C	RHOMO(20)	LB/IN3	OLD OUTLET DENSITY
C	RHOMDX	LB/IN3	OUTLET PLENUM DENSITY (N-1)
C	RHCMTL(20)	LB/IN3	METAL DENSITY
C	RHOMX	LB/IN3	DENSITY FROM LAST TIME
C	RHONI(20)	LB/IN3	NEW INLET DENSITY
C	RHONIX	LB/IN3	INLET PLENUM DENSITY (N)
C	RHONO(20)	LB/IN3	NEW OUTLET DENSITY
C	RHONOX	LB/IN3	OUTLET PLENUM DENSITY (N)
C	RHONT(30)	LB/IN3	THETA,TUBE DENSITY
C	RHONTM(30)	LB/IN3	PAST TIME TUBE H2 DENSITY
C	RHONTN(30)	LB/IN3	CURRENT TUBE H2 DENSITY
C	RHGNZN(30)	LB/IN3	PAST TIME NOZZLE H2 DENSITY
C	RHONZN(30)	LB/IN3	CURRENT NOZZLE H2 DENSITY
C	RHOR	BTU/IN3-DEGR	RHOR*GR
C	RHOSIX	LB/IN3	SKIRT OUTLET PLENUM DENSITY (N-1)
C	RHOSOX	LB/IN3	SKIRT INLET PLENUM DENSITY (N-1)
C	RHOST(30)	-	THETA,SKIRT TUBE DENSITY
C	RHOSTN(30)	LB/IN3	CURRENT SKIRT TUBE H2 DENSITY
C	RHOSZN(30)	LB/IN3	CURRENT SKIRT NOZZLE H2 DENSITY
C	RHOTKM	LB/IN3	DENSITY OF TANK FLUID
C	RHOTKN	LB/IN3	DENSITY OF TANK FLUID
C	RHOX	LB/IN3	METAL DENSITY
C	RHOZ	-	TEMPORARY STORAGE
C	RHOZ1	-	TEMPORARY STORAGE
C	RHO1	-	DENSITY OF FLUID AT POINT 1
C	RHO2	-	DENSITY OF FLUID AT POINT 2
C	RHO3	-	DENSITY OF FLUID AT POINT 3
C	RHO4	-	DENSITY OF FLUID AT POINT 4
C	RN(30)	-	Z,RECOVERY FACTOR
C	RNDIST	-	DISTANCE OF NEXT NODE MIDPOINT
C	RNTROT	-	RECOVERY FACTOR AT THROAT
C	RFPASS	-	FLUX RESISTANCE OF BY PASS HOLES
C	RPM2	RPM2	N(I+1)**2
C	SAC	NONE	AXIAL CONDUCTION TERM
C	SACPR	-	TUBES METAL CALC TERM
C	SAVE	*****	SUBROUTINE
C	SAVFX(20,8)	-	SAVE AREA FOR BLOCK COMMON FX
C	SAVJ	-	SAVE AREA FOR BLOCK COMMON A201
C	SAVIJ(30,20,9)	-	SAVE AREA FOR BLOCK COMMON TABIJ

C	SAVJ	-	SAVE AREA FOR BLOCK COMMON AZ10
C	SAVN	-	SAVE AREA FOR MISC DATA
C	SAVNT(20)	-	SAVE AREA FOR MISC DATA
C	SAVPT(20,18)	-	SAVE AREA FOR BLOCK COMMON PTC
C	SCFMP(30)	-	Z,SKIRT COLD FLOW WETTED PERIMETER
C	SERCH	*****	SUBROUTINE
C	SETCI	*****	SUBROUTINE
C	SETCJ	*****	SUBROUTINE
C	SHBP	*****	SUBROUTINE
C	SJO(30)	IN	Z,JACKET OUTSIDE WET PERIMETER
C	SJOX	IN	OUTSIDE JACKET WETTED PERIMETER
C	SKBN(30)	-	TABLE FOR ADDITIONAL PRESS. LOSS -SKIRT
C	SKGG(30)	-	Z,SKIRT CG
C	SKDEL(30)	-	Z,SKIRT DELTA
C	SKDZ	IN	SKIRT TUBE DELTA Z
C	SKRN(30)	-	Z,SKIRT RECOVERY FACTOR
C	SNODES(30)	-	SKIRT VARIABLE NODS
C	SNOZ(30)	IN	Z,NOZZLE WETTED PERIMETER
C	SNOZX	IN	NOZZLE WETTED PERIMETER
C	SNTC(30)	IN	Z,TUBE COLD SIDE WET PERIMETER
C	SNICK	IN	COLD SIDE TUBE WETTED PERIMETER
C	SNTH(30)	IN	Z,TUBE HOT SIDE WET PERIMETER
C	SNHX	IN	HOT SIDE TUBE WETTED PERIMETER
C	SNTJ(30)	IN	Z,TUBE-JACKET WET PERIMETER
C	SPEED	-	PUMP SHAFT SPEED
C	SPEED2	-	TEMP CELL FOR CALCULATED PUMP SPEEDS
C	SPIN	-	TEMP CELL FOR CALCULATED PUMP SPEEDS
C	SPIN2	-	TEMP CELL FOR CALCULATED PUMP SPEEDS
C	SPRIME	BTU/LB-DEGR	S-SPRIME(ENTROPY)
C	SSNZ(30)	IN	Z,SKIRT NOZZLE WETTED PERIMETER
C	SSOUT	-	FOR STEADY STATE PRINT OUT
C	SSPRT(30)	-	STEADY STATE PRINT PNTS
C	SSTH(30)	IN	Z,SKIRT TUBE HOT SIDE WET PERIMETER
C	STATE	-	NOT=0,STEADY STATE
C	STATF	-	TEMPORARY STORAGE
C	STATIC	-	FLAG FOR STATIC P,T,H OPTION
C	STERM	BTU/LB-DEGR	S-SPRIME(ENTROPY)
C	STAG	-	(K-1)*M**2/2+1 STATIC TO STAGNATION TERM
C	SZMIN	IN	DELZ/2 - SKIRT
C	TABLE(30)	-	ITERATION PRINT FLAG(MODULE ITERATION NO.)
C	TAGSN	-	NAMLIST
C	TAMB	PSIA	AMBIENT TEMP
C	TAMBX	DEGR	AMBIENT TEMPERATURE
C	TANK	-	NOT=0,ITERATE FOR P TANK
C	TAPE	-	FLAG,1=TAPE,2=TAPE,CARD,3=CARD,NRG=PRNT
C	TAVE	-	
C	TC(30)	-	T,TC
C	TCCAR	DEGR	CURRENT COLD SIDE TEMP
C	TCFLG	-	FLAG TO NOT CLOSE ON TC
C	TCCHK	-	NOZZLE TEMPERATURE AT THROAT
C	TCLOC	DEGR	THERMOCOUPLE LOCATION - MAIN NOZZLE
C	TCOLD(30)	DEGR	COLD SIDE TEMP
C	TCORO	DEGR	CORE OUTLET TEMP
C	TCOROR	DEGR(1/2)	ROOT T4
C	TCRES	*****	SUBROUTINE
C	TCRAY	*****	SUBROUTINE
C	CTRP	-	
C	TCUR	DEGR	CURRENT FLUID TEMP
C	TCX	DEGR	TC DESIRED
C	TDELZ(20)	-	NO. OF POSITION PTS IN FLOW CONF. ORDER
C	TDPH	-	DIFFERENTIAL TEMP FOR STABILITY TEST
C	TDL	-	INITIAL DILUENT LINE TEMP
C	TDLX	DEGR	DILUENT TEMPERATURE
C	TEMP	DEGR	TEMPERATURE (H2 GAS PROPERTIES)
C	TEMPX(20)	-	NOT 0=TEMP EXCEEDED MAX
C	TEMPI(20)	DEGR	INLET TEMP
C	TEMPO(20)	DEGR	OUTLET TEMP
C	TEMPO	*****	SUBROUTINE
C	TEMPM	-	TEMPORARY STORAGE
C	TEMPY	-	

C	TFLUID(30,20)	DEGR	FLUID TEMP
C	TFLUM	DEGR	MAX ALLOWABLE FLUID TEMP
C	TFLUSR	DEGR1/2	ROOT FLUID TEMP
C	THBPO	DEGR	HOT BLEED PORT OUTLET TEMP
C	THGAR	DEGR	CURRENT HOT SIDE TEMP
C	THEDIFF	DEGR	THETA M-1/2 + THETA M+3/2
C	THETA	-	NOT 0+THETA IID. ID. IC DESIRED
C	THETA1	-	TUBEM SUBROUTINE TERMS
C	THETA2	-	TUBEM SUBROUTINE TERMS
C	THOT(30)	DEGR	HOT SIDE TEMP
C	THROAT	IN	DISTANCE TO NOZZLE THROAT
C	TIME	SEC	TIME
C	TIME1	SEC	INIT TIME, NOT=0 RESTART PROGRAM
C	TIMEINT	SEC	TIME FOR METAL TEMP CALC
C	TIMEIN	SEC	TIME
C	TIMEP	SEC	TIME INTERVAL
C	TIMER	-	TIME PCINT INPUT FLAG
C	TIMES(10)	-	DELTA TIME CHANGE POINTS
C	TIMEX	SEC	TIME INCREMENT
C	TIMEZ	-	TIME INTERVAL FOR METAL CALCULATIONS.
C	TIMEINCR(10)	SEC	TIME INCREMENT FOR METAL TEMPS
C	TEMPIN	DEGR	TEMPERATURE OF FLOW AT INDUCER INLET
C	TEMPIN(30)	DEGR	TEMPERATURE AT INDUCER TURBINE INLET
C	TIPVEL	-	TIP SPEED
C	TIPVIN	FT/SEC	INDUCER TURBINE LINEAR TIP VELOCITY
C	TJACK(30)	DEGR	JACKET TEMP
C	TJACKUR	DEGR	CURRENT JACKET TEMP
C	TJACKW(30)	DEGR	JACKET TEMP AT TUBE WELD
C	TAKSD1	-	TUBEM SUBROUTINE TERMS
C	TAKSD(30)	DEGR	OUTSIDE JACKET WALL TEMP
C	TK	-	MIDPOINT FLUID TEMP - NOZZLE
C	TKJ(30)	IN	Z.JACKET THICKNESS
C	TKJX	IN	JACKET THICKNESS
C	TKNTC(30)	IN	Z.TUBE COLD SIDE THICKNESS
C	TKNTCX	IN	COLD SIDE THICKNESS
C	TKNTM(30)	IN	Z.TUBE HOT SIDE THICKNESS
C	TKNTMX	IN	HOT SIDE THICKNESS
C	TKNTS(30)	IN	Z.SKINT TUBE HOT SIDE THICKNESS
C	TKNTS	DEGR	MAIN STREAM TEMPERATURE
C	TMETAL(30,20)	DEGR	PERMANENT METAL TEMPERATURE
C	TMETI	DEGR	INITIAL METAL TEMP
C	TMETL	DEGR	METAL TEMP
C	TMETMO	DEGR	MIN OUTLET METAL TEMP
C	TEMPIN	-	TEMPERATURE AT INDUCER TURBINE INLET
C	TEMPIN(30)	-	TEMP (ISAGINATION) AT INDUCER TURBINE INLET
C	TEMPIN	-	TEMP WHERE HOT AND COLD FLOW MIXES
C	TKRHO	LB/IN3	TANK DENSITY
C	TNODE(20)	-	NODE OF TEMP - FLUID+METAL
C	TNOZ(30)	-	NOZZLE FLUID TEMPERATURE
C	TNOZW(30)	DEGR	NOZZLE WALL TEMP
C	TNTCD1	-	TUBEM SUBROUTINE TERMS
C	TNTCLD(30)	DEGR	TUBE COLD WALL TEMP
C	TNTHOT(30)	DEGR	TUBE HOT WALL TEMP
C	TNTHT1	-	TUBEM SUBROUTINE TERMS
C	INTI	DEGR	NOZZLE TUBES INLET TEMP
C	INTIM	DEGR	INITIAL TEMP OF NOZ TUBE MATERIAL
C	INTJWD(30)	DEGR	TUBE TEMP AT JACKET WELD
C	INTINZ1	-	TUBEM SUBROUTINE TERMS
C	INTO	DEGR	NOZZLE TUBES OUTLET TEMP
C	INTO1	-	TUBEM SUBROUTINE TERMS
C	INTO1T	-	INPUT BLOCK
C	TPARTS(20)	-	PART NAMES IN FLOW CONF. ORDER
C	TPCR	-	-
C	TPIN	-	TEMP AT PUMP INLET
C	TPKPD	-	-
C	TPK2	-	-
C	TPN	-	-
C	TPNW	-	NAMELIST

C	TPOUT		TEMP AT PUMP OUTLET
C	TPQ		
C	TPIAV		
C	TP12		
C	TP120		
C	TPUNOC	DEGR	PUMP OUTLET TEMP
C	TPUNOP	DEGR	PUMP OUTLET TEMP
C	TPWH		
C	TPWRK		
C	TRQTZ		THROAT INTERPOLATION FACTOR
C	TSHT(30)	DEGR	SKIRT HOT SIDE TEMP
C	TSMT(30)	DEGR	SKIRT HOT SIDE TEMP
C	TSN2N(30)	DEGR	SKIRT NOZZLE WALL TEMP
C	TSHTOT(30)	DEGR	SKIRT TUBE HOT WALL TEMP
C	TSFI	DEGR	SKIRT TUBES INLET TEMPERATURE
C	TSTO	DEGR	SKIRT TUBES OUTLET TEMPERATURE
C	TSUB(30)	DEGR	SKIRT TUBE H2 TEMP
C	ITAC		SUBSCRIPT(TOTAL NO. OF PARTS)
C	ITANK	DEGR	TANK TEMPERATURE
C	ITADON	DEGR R	TANK TEMP
C	ITANX	DEGR	TANK TEMP
C	ITC	DEGR R	THERMOCOUPLE LOCATION TEMPERATURE
C	ITP		FRACTION FLOW
C	ITNKIN	DEGR R	TANK TEMP
C	ITQIST(30)	DEGR	SKIRT TUBE TOTAL TEMP
C	ITROT		FLUID THROAT TEMPERATURE
C	ITUBE(30)	DEGR	TUBE H2 TEMP
C	ITUR1	DEGR R	TURBINE INLET TEMP
C	ITUR10		
C	ITURIX	DEGR	TURBINE INLET TEMP
C	ITURO	DEGR	TURBINE OUTLET TEMP
C	ITXGTS		TEMP TURB EXIT (STAGNATION-ISENTROPIC)
C	ITXMIN		
C	ITXST		
C	ITXSTP		TEMP TURB EXIT (STATIC) PRIME
C	ITURBN	****	SUBROUTINE
C	ITURBN	****	SUBROUTINE
C	ITURBN	****	SUBROUTINE
C	ITURBN	****	SUBROUTINE
C	ITURBN	****	SUBROUTINE
C	ITURBN	****	SUBROUTINE
C	TUREFF(30)		TURB EFF VS. U/CO
C	TURIP(30)	PSIA	T-TURBINE INLET PRES
C	TURIT(30)	DEGR R	T-TURBINE INLET TEMP
C	TURSPD	RPM	INITIAL TURBINE SPEED
C	TURBN	DEGR	INPUT TO AZV
C	TURBN	DEGR	TEMPOTIC
C	IT(5)	DEGR R	BY-PASS STREAM TEMPERATURE
C	TZERO	****	SUBROUTINE
C	TINP1(30)		TEMPORARY STORAGE FOR THETA I
C	T1IN	DEGR	
C	T1PR	DEGR/2	ROOT T11
C	T1PR1		T12 R11
C	T1PR1(30)		TEMPORARY STORAGE FOR THETA II
C	T1PR1(30)		TEMPORARY STORAGE FOR THETA III
C	TBN	DEGR	
C	UING	DEGR	INTERNAL HEAT GENERATION TERM
C	UNCHOK		FLAG TO INDICATE NON CHOKED TURBINE EXT
C	UPDATE	****	SUBROUTINE
C	VALVE		CHECK VALVE PRESSURE DROP
C	VALVE(5)		INLET BLOCK
C	VALVE	IN/SEC	SONIC VELOCITY (H2 GAS PROPERTIES)
C	VALVE	LB/IN-SEC	VELOCITY (H2 GAS PROPERTIES)
C	VCST		VALVE SWITCH FLAG
C	VNODES(30)		VARIABLE NODES
C	VNTI	IN3	INLET PLENUM VOLUME
C	VNTO	IN3	OUTLET PLENUM VOLUME
C	VNTOT		VOLUME FRACTION
C	VNTOT	IN/SEC	SPECIFIC VOLUME (H2 GAS PROPERTIES)
C	VNTOT		VALVE SWITCH SET AT DESIRED PC

C	VTANK	IN3	TANK VOLUME
C	WALL(20)	IN	WALL THICK, NOT 0 = PIPE OPTION
C	WALLNT	IN	NOZ TUBE WALL THICKNESS
C	WATERM	LB2/IN5	WDOT**2/(2*AF**2*G
C	WBEAR		BEARING COOLANT FLOW
C	WBEAR	LB/SEC	FLOW RATE
C	WDELNI(20)	LB/SEC	INLET FLOW RATE CHANGE, PAST TIME
C	WDELNI(20)	LB/SEC	OUTLET FLOW RATE CHANGE, PAST TIME
C	WDELNI(20)	LB/SEC	CURRENT INLET FLOW RATE CHANGE
C	WDELNO(20)	LB/SEC	CURRENT OUTLET FLOW RATE CHANGE
C	WDIL(30)	-	T, DILUENT FLOW RATE
C	WDILE	-	DILUENT FLOW CLOSURE
C	WDILG	LB/SEC	INITIAL DILUENT FLOW GUESS
C	WDILN	LB/SEC	DILUENT LINE FLOW
C	WDILX	LB/SEC	DILUENT LINE FLOW
C	WTERM	LB/SEC+IN2	WDOT*(1/DELZ+5P)
C	WERROR	-	(WDOTN-WDOTNPRIME)/WDOTNPRIME
C	WETP(30,20)	IN	Z, WETTED PERIMETER
C	WETPER	IN	WETTED PERIMETER
C	WHBP	LB/SEC	HOT BLEED PORT FLOW
C	WHBPE	-	WHBPH CLOSURE
C	WHBPG	LB/SEC	INITIAL HOT BLEED FLOW GUESS
C	WHBPN	LB/SEC	HBP FLOW
C	WI	-	INTEGRATED FLOW
C	WINT	-	INTEGRATED FLOW BEFORE TPCV
C	WITER	-	NO. WDOTR OR WDOTC ITERATIONS
C	WM(5)	LB/SEC	MAIN STREAM FLOW
C	WMNIT	-	MINIMUM ITERATION FLOW
C	WNCF	-	NOZZLE CHOKES FLOW TERM
C	WNCF1	-	NOZZLE CHOKES FLOW TERM
C	WNCNOK	LB/SEC	NOZZLE CHOKES FLOW
C	WNGDEN	LB/SEC	FLOW RATE, NEXT NODE
C	WNOI	LB/SEC	INLET FLOW RATE THIS NODE
C	WNOZ	LB/SEC	MAIN NOZZLE FLOW
C	WNOZM(30)	LB/SEC	PAST TIME NOZZLE FLOW
C	WNOZM30)	LB/SEC	CURRENT NOZZLE FLOW
C	WNT	LB/SEC	NOZZLE TUBE FLOW RATE
C	WNTCK	LB/SEC	CHOKES FLOW FOR NOZZLE TUBES
C	WNTC	-	NOZZLE TUBE FLOW CLOSURE
C	WNTL	LB/SEC	NOZZLE TUBES INLET FLOW
C	WNTM(30)	LB/SEC	PAST TIME TUBE FLOW
C	WNTN(30)	LB/SEC	CURRENT TUBE FLOW
C	WNTO	LB/SEC	NOZZLE TUBES OUTLET FLOW
C	WORDS(7)	-	PRINT-OUT MESSAGE BLOCK
C	WDOT(100)	-	CHECK-OUT FLAG BLOCK
C	WDOTN	STU/SEC	CLOSURE FOR ACTUAL PUMP WORK
C	WDOTT	-	ACTUAL WORK IN PUMP
C	WPIT	-	NUMBER OF WP ACTUAL ITERATIONS
C	WPMAX	-	MAX FLOW RATE WITH DISCHARGE P AT 1500.
C	WPUM(30)	-	T, PUMP FLOW RATE
C	WPUNC	LB/SEC	PUMP FLOW
C	WPUMP	LB/SEC	PUMP FLOW
C	WPUNPE	-	PUMP FLOW RATE AS COMPUTED BY CORRECTOR
C	WPUNPS	LB/SEC	INITIAL PUMP FLOW GUESS
C	WRATE(100)	LB/SEC	INLET FLOW RATE
C	WRATEM(30,20)	LB/SEC	PAST TIME FLOW RATE
C	WRATEN(30,20)	LB/SEC	NEW FLOW RATE
C	WRATED(20)	LB/SEC	OUTLET FLOW RATE
C	WTERM	LB/IN2	WDOT**2/(2*AF**2*G*RNOM2)
C	WNGN(30)	LB/SEC	CURRENT SKIRT NOZZLE FLOW
C	WNT	LB/SEC	SKIRT TUBES INLET FLOW
C	WNTM(30)	LB/SEC	CURRENT SKIRT TUBE FLOW
C	WNTN	LB/SEC	SKIRT TUBES OUTLET FLOW
C	WNTO	IN3/LB	DELZ*(1-F)*AF/F*DELZ*WDOT OR DELZ*PI*X*(DI-X)/
C	WTTOT	-	FLOW AT TURBINE EXIT WITH BEARING FLOW
C	WTURB	LB/SEC	TURBINE FLOW
C	WTURN	LB/SEC	TURBINE FLOW RATE
C	WTURN	LB/SEC	MIN. FLOW WHICH PUMP DOES NO WORK
C	WTURN	LB/SEC	MIN. FLOW WHICH PUMP DOES NO WORK

C WX(5) LB/SEC
C XN -
C XPARTS(5,5) -
C XTAG(5,5) -
C ZERO -
C ZEROD *****
C ZFACT -
C ZM
C ZMAX IN
C ZMIN IN
C ZM1
C ZTROT
C ZTUDE

BY-PASS STREAM FLOW
NAMELIST
NAMES AND ORDER(IN,PART,OUT) BY-PASS PARTS
INDEX MAPPING XPARTS TO PARTS
ZERO(REAL*8)
SUBROUTINE
Z FACTOR (H2 GAS PROPERTIES)
NODE START DIST - TUBES AND NOZZLE
DELZ*(NMAX+1/2)
DELZ/2
NODE END DIST - TUBES AND NOZZLE
(Z-ZTHROAT)/DELTA Z

II. PROGRAM LISTING

SUBROUTINE AGC HED (/STATE/, /OPTION/)

DATE = 18SEP67

PAGE

1

SUBROUTINE AGC HED (/STATE/, /OPTION/)

DATA MAXLIN/ 80 /

REAL * 8 STATE, OPTION

REAL * 8 TRAN(4)

* 8HTRANSIEN , 8HT RUN

* 8HSTEADY S, 8HTATE RUN

REAL*8 OPTN(6)/'STANDARDPC,POWERTC,GP PC,TC TC,POWERUNDEFINE'/

REAL*8 PGNO/'D31201 '/

13 FORMAT(2A8,6X,A8,'OPTION')

14 FORMAT(1H1,2A8,35X,29HAEROJET GENERAL CORPORATION ,40X,5HPAGE ,

*14, /, 1H ,A8,46X,23HSACRAMENTO, CALIFORNIA ,38X,8HPROGRAM ,A8)

IOPT = OPTION + 1.000001

ISTAT = 1

IF (STATE .NE. 0.000) ISTAT = 3

WRITE (1,13) TRAN(ISTAT),TRAN(ISTAT+1),OPTN(IOPT)

IPAGE = 0

RETURN

ENTRY COUNT (NUM IN)

NUM LIN = NUM IN

30 LINE = LINE + NUM LIN

IF (LINE .LE. MAX LIN) GO TO 50

NUX = NUM LIN

GO TO 40

ENTRY NU PAGE

NUX = 0

40 IPAGE = IPAGE + 1

IOPT = OPTIGN + 1.000001

ISTAT = 1

IF (STATE .NE. 0.000) ISTAT = 3

WRITE (6,14) TRAN(ISTAT),TRAN(ISTAT+1),IPAGE,OPTN(IOPT),PGNO

LINE = NUX + 3

50 RETURN

END

C SUBROUTINE BDI
INITIALIZE PUMP DISCHARGE LINE BLOWDOWN
IMPLICIT REAL*8 (A-Z)
COMMON /BD/

* BDASK * BDASKQ * BDHA * BDLP * BDM *
* BDMQ * BDP * BORMQ * BDS(10) * BDT *
* BDN *

COMMON

*/BDLS/

* ALINE * BDOWN * BDPD * CPVOL * IMASS *
* LFILM * PINPUT * PTNKIN * TAMG * TTNKIN *
* VTANK *

COMMON

*/BLG/

* STAPFL * HSPFG * MASS * NTIME * NTIME *
* NNT * OPEN * OPTION * PNINO * STATE *
* TANK * TAPE * TFLUM * TIMEI * TIMEX *
* TIMEMO * WINT * TIMES(10) *

COMMON

*/FLCIDP/

* PRES * ZFACT * QUAL * TEMP * RHO *
* SAN * CP * VEL * ENTR * COND *
* VIS * VOL * ENTH *

COMMON

*/TAB1/

* AJHT(30) * ANTC(30) * ANTH(30) * ANTW(30) * CDJ(30) *
* CDNT(30) * CFWP(30) * CG(30) * CPJ(30) * CPNT(30) *
* CRJ(30) * CRJNT(30) * DEL(30) * DELPNT(30) * DELPNZ(30) *
* DNDW(30) * GATS(30) * GP(30) * HGFJ(30) * HGFNTC(30) *
* HGFNTM(30) * HGJ(30) * HGNTC(30) * HGNTM(30) * KPD(30) *
* KPDV(30) * KV(30) * NT(30) * PAMB(30) * PBD(30) *
* PC(30) * PINLET(30) * PLINE(30) * PRATIO(30) * PTURMO(30) *
* QPD(30) * RHOJ(30) * RHONT(30) * RN(30) * SJO(30) *
* SNCZ(30) * SNCT(30) * SNTH(30) * SNTJ(30) * SSPRT(30) *
* TC(30) * TINLET(30) * TKJ(30) * TKNTC(30) * TKNTH(30) *
* TUREFF(30) * VNODES(30) * WDIL(30) * WPUM(30) *
* TURIT(30) * TURIP(30) * MBFLOW(30) * MBEND(30) *

BDP = PTNKIN

BDT = TTNKIN

BDM = PINPUT

IF (BDLP.NE.0.0) GO TO 10

CALL INTP(PLINE,TIMEI,BDLP)

10 IF (BDP.LT.BDLP) BDLP=BDP

CALL PT(BDLP,BDT)

BDMQ = RHO

BDM = BDMQ

CALL INTP(BDM,TIMEI,BDASK)

BDMQ = LFILM*ALINE

RETURN

END

B
A

J
L
M
N

B
C
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S

SUBROUTINE BDOWNL(*)

DATE = 10SEP67

```

      SUBROUTINE BDOWNL(*)
      BLCK DOWN SUBROUTINE
      IMPLICIT REAL*8 (A-Z)
      COMMON /BD/
      * BDASK , BDASKO , BDHA , BDLP , BDM ,
      * BDMO , BOP , BDMO , BDS(10) , BDT
      COMMON /BDLS/
      * ALINE , BDOWN , BOPD , CRVOL , IMASS ,
      * LFILM , PINPUT , PTANKIN , TAMB , TTNKIN
      * VTANK
      COMMON /CCNS/
      * G , JAY , PI , R , RAD
      COMMON /FLUIDP/
      * PRES , ZFACT , QUAL , TEMP , RHO ,
      * GAM , CP , VEL , ENTR , COND
      * VIS
      COMMON /P/
      * ALPHA , BETA , DIST , EPUMC , EPUMP ,
      * ETURC , ETURP , FILMCX , GATEP , HDPUM ,
      * NSVC , MSVP , NHT , NHT , NTURC ,
      * NTURP , PCORD , PCUR , PDIL , PHBPQ ,
      * PMINOX , PNTI , PNTG , PPUMOC , PPUMQP ,
      * PTANKX , PTURIX , PTURO , QPUMP , RFLU ,
      * SAC , TCORR , TCUR , TDILX ,
      * THBPQ , TIME , TIMEP , TMETL , TINTI ,
      * TINTO , TPUMOC , TPUMOP , TTANKX , TTURIX ,
      * T12MIX , UIHG , WCUR , WDILX , WHBP ,
      * WNOZ , WNTGK , WNTI , WNTQ , WPUMC
      COMMON /TP/
      * AFLOWX , BATERM , BATERS , CDMTL , CPTERM ,
      * BDELZ , DELHN , DELHNX , DELPM ,
      * DELTER , DHYDRA , DPIPE , DTERM , DELPM ,
      * ENTRDP , ETATP , ETATP , GPN , DZTERM ,
      * HGCOEF , HGTOT , HPUMI , HTCOEF , HVTM ,
      * H12 , KT , KVN , KWC , KWCP ,
      * KCV , KMH , KWH , KWT , K1 ,
      * K2 , K3 , K4 , K6 , NTERM1 ,
      * NTERM2 , NTERM3 , NTERM4 , NBRN , NTERM ,
      * PHI , PNOZO , PNTTHR , PRESN , PRGUES ,
      * PRPRIM , PRTERM , PSTP , PTANKN , P6N ,
      * PEN , P8PR , QN , QPM , QTERM ,
      * RHOR , RHOTKM , RHOTKN , RPM2 , SPRIME ,
      * STERN , STSTAG , TFLUSR , TINEMT , TIMEN ,
      * TTANKN , TTURO , TVP , TTTERM , T1IN ,
      * T1ISR , TON , WATERM , WDILN , WOTERM ,
      * WERROR , WETPR , WHBPN , NI , MNCHOK ,
      * WNT , WPACTN , WATERM , WTERM , WTURN
      * WTERM , ZTUBE
      BDS(10) = BDS(9) - WPUMC * TIMEP
      IF (BDS(10) .GE. 0.0) GO TO 10
      CALL MESS('TANK EMPTY
      RETURN 1
      BDS(8) = BDS(10) / BDS(9)
      BDS(7) = BDS(8) / (BDS(1) + WPUMC * R)
      BDS(4) = TTANKX - BDS(3)
      CALL PT(BDS(8), TTANKX)
      TTANKN = BDS(3) + BDS(4) * BDS(5) * ((BDS(1) / WPUMC + R) * GAM / CP)
      BDS(8) = BDS(10) * TTANKN * R / (VTANK * 12.0 * 12.0)
      IF (BDS(8) - PTANKN .GE. 0.0) GO TO 20
      CALL MESS('BLCK DOWN COMPLETE
      GO TO 5
      BDS(9) = BDS(10)
      RETURN
      END

```

```

SUBROUTINE BDU
C  CALCULATE PUMP DISCHARGE LINE EXIT BLOWDOWN TANK CONDITIONS
IMPLICIT REAL*8 (A-Z)
COMMON /BD/
* BDASK      .BDASKO      .BDHA      .BDLP      .BDM      .
* BDNO      .BDP      .BDNO      .BDS(10)      .BDT      .
COMMON
* /BOL3/
* ALINE      .BDOWN      .BDPO      .CPVOL      .IMASS      .
* LFILM      .PINPUT      .PTNKIN      .TAMB      .TTNKIN      .
* VTANK
COMMON
* /CONS/
* BB
COMMON
* /FLAG/
* ETAPFL      .HBPFG      .MASS      .MTIME      .NTIME      .
* NWIT      .OPEN      .OPTION      .PMINO      .STATE      .
* TANK      .TAPE      .TFLUM      .TIMEI      .TIMEX      .
* TNETNO
COMMON
* /FLUIDP/
* PRES      .ZFACT      .QUAL      .TEMP      .RHO      .
* GAM      .CP      .VEL      .ENTR      .COND      .
* VIS
COMMON
* /P/
* ALPHA      .BETA      .DIST      .EPUMC      .EPUMP      .
* ETURC      .ETURP      .FILMCX      .GATEP      .HDPUM      .
* HSWC      .HSVP      .MT      .NNT      .NTURC      .
* NTURP      .PCORQ      .PCUR      .PDIL      .PHBPQ      .
* PTANGX      .PNTI      .PNTQ      .PPUMOC      .PPUMOP      .
* PTANKX      .PTURIX      .PTURO      .QPUMP      .RFLU      .
* SAC      .TCORO      .TCOROR      .TCUR      .TDILX      .
* THBPO      .TIME      .TIMEP      .TMETL      .TNTI      .
* TNETO      .TPUMOC      .TPUMOP      .TTANKX      .TTURIX      .
* TTMIX      .UING      .WCUR      .WDILX      .WHBP      .
* WNOZ      .WNTCK      .WNTI      .WNTQ      .WPUMC      .
COMMON
* /TABI/
* AJHT(30)      .ANTC(30)      .ANTH(30)      .ANTW(30)      .CDJ(30)      .
* CDNT(30)      .CFWP(30)      .CG(30)      .CPJ(30)      .CPNT(30)      .
* CRJ(30)      .CRJMT(30)      .DEL(30)      .DELPM1(30)      .DELPM2(30)      .
* DNOZ(30)      .GATE(30)      .GP(30)      .HGFJ(30)      .HGENTC(30)      .
* HGENTH(30)      .HJ(30)      .HGNTC(30)      .HGNTH(30)      .KPD(30)      .
* KPV(30)      .KY(30)      .NT(30)      .PAMB(30)      .PBD(30)      .
* PC(30)      .PINLET(30)      .PLINE(30)      .PRATIO(30)      .PTURNO(30)      .
* QPD(30)      .RHOJ(30)      .RHONT(30)      .RN(30)      .SJO(30)      .
* SNOZ(30)      .SNTC(30)      .SNTJ(30)      .SSPT(30)      .SSPT(30)      .
* TC(30)      .TINLET(30)      .TK4(30)      .TKNTC(30)      .TKNTH(30)      .
COMMON
* /TABI/
* TURBO(30)      .TURBO(30)      .TURBO(30)      .TURBO(30)      .
COMMON
* /TABI/
* BATERM      .BATERM      .BATERM      .CONTO      .CATERM      .
* DELZ      .DELHM      .DELHM      .DPIPE      .DTERM      .
* DELTER      .OHYDRA      .DPIPE      .DTERM      .DZTERM      .
* ENTROP      .ETAT      .ETATP      .GPN      .HTERM      .
* HGCOEF      .HGTOT      .HPUMI      .HTCOEF      .HVTERM      .
* KVC      .KVC      .KVC      .KNT      .KNT      .
* K3      .K3      .K3      .K6      .K6      .
* KTERM2      .KTERM3      .KTERM4      .KPRN      .KPRN      .
* PHI      .PNOZ      .PNTHR      .PRESH      .PRGUES      .
* PPRIM      .PRTERM      .PSTP      .PTANKN      .P6N      .
* P8N      .P8PR      .QN      .QPM      .QTERM      .
* RHOR      .RHOTKM      .RHOTKM      .RPM2      .SPRIME      .
* THERM      .THERM      .THERM      .THERM      .THERM      .

```

SUBROUTINE BDU

DATE = 1982 07

* TTANKN	* ITURO	* TYP	* TWTERM	* T11N	.
* T11SR	* T8N	* WATERM	* WDILN	* WDTURN	.
* WERROR	* WETPER	* WHSPN	* WI	* WNCCHK	.
* WNT	* WPACTN	* WRTURN	* WTERM	* WTURN	.
* WINTERM	* ZTUBE				.

```

BDWNO = BDASK
CALL INTP(BD, TIMEN, BDASK)
IF (INPUT.NE.0.0) GO TO 10
CALL INTRPLINE, TIMEN, BOLDP
10 IF (BDASK.EQ.0.0) GO TO 20
IF (IMASS.NE.0.0) GO TO 30
20 IF (FINPUT.EQ.0.0) GO TO 50
GO TO 60

```

```

30 BDMO = BDM
BDM = BDM * TIMEN + BDMO
IF (BDM.EQ.0.0) GO TO 40
CALL JESSX(101, BDM, BDMO, BDMHA)
40 BDT = BDMHA * TAMB / (BDM * RB + BDMHA) + (EDT - BDMHA * TAMB / (BDM * RB + BDMHA)) *
1 (BDM / BDMO) ** ((BDM * RB + BDMHA) / (BDM * CPVOL))
BDP = 12.0 * R * BDT * BDM / VTANK
IF (BDP.GT.BDLP) BDLP = BDP

```

```

50 CALL RT(BDLP, BDT)
BDMO = BDM
60 CONTINUE
END

```

I
J
K

BLOCK DATA

```

REAL*4 LINEC(3)/*CORRECTOR */
REAL*4 LINEI(6)/*INLET CONDITIONS */
REAL*4 LINEK(4)/*SKIIRT NOZZLE */
REAL*4 LINEM(6)/*METAL TEMP PASSES */
REAL*4 LINEO(6)/*NOZZLE METAL TEMPS */
REAL*4 LINEP(3)/*OPREDICTOR */
REAL*4 LINEV(4)/*O BY-PASS VALVE */
REAL*4 LINEW(33)
W0 NOZ-FLOW NOZ-CHOKE-FLOW FLOW ERR DILUENT K
W1/
REAL*4 LINEX(3)/*0*****/
REAL*4 LINEY(3)/******/
REAL*4 LINEZ(27)/******/
*****/
REAL*4 LINE1(33)
10 P 1 T 1 P 2 T 2 N
1 G P DEL H DEL T P PUMP TOTL W
1/
REAL*4 LINE2(33)
20 Z DIST METL T TEMP PRESSURE FILM C
2 DENSITY FLOWRATE PRES DROP ENTHALPY ENTROPY
2/
REAL*4 LINE3(33)
30 Z JACKET T COLD T HOT NOZ W
3 T H W T C W T J W J T W OUTSIDE
3/
REAL*4 LINE4(33)
40 W P W C W H W N W T
4 P 6 P 8 T 8 P 11 T 11
4/
REAL*4 LINE5(33)
50 Q PUMP WP ACT WT ACT INT HT
5/
REAL*4 LINE6(33)
60 F PUMP WP ACT WT ACT PMP EF TRB EF
6 H2MIX T2MIX P 12 T 12
6/
REAL*4 LINE7(33)
70 W BC ETA T*
7/
REAL*4 VCLOSE(2)/*CLOSED */
REAL*4 VOPEN(2)/*OPEN */
COMMON /LINE/LINEC,LINEI,LINEK,LINEM,LINEO,LINEP,LINEV,
*LINEX,LINEY,LINEZ,LINE1,LINE2,LINE3,LINE4,LINE5,LINE6,LINE7,
*VCLOSE,VOPEN
END

```

A

A

A

A

C

C

D

D

L

L

G

K

C

B

```

BLOCK DATA
IMPLICIT REAL*8(A-Z)
COMMON /ITERS/      ISWT(30) ,ESP(30) ,MINX(30) ,MAXX(30) ,
*PCNT1(30) ,PCNTN(30) ,ICNT(30) ,ITF(30) ,XOLD(30) ,YOLD(30) ,
*XMIN(30) ,XMAX(30) ,XNAM(30) ,YNAM(30)
REAL*8 ISWT/30*0.0D0/
REAL*8 ESP/12*.001D0,2*.0001D0,2*.0002D0,.0001D0,.0002D0,.0001D0,
*.0005D0,10*.001D0/
REAL*8 MINX/30*0.0D0,1.0D0,0.0D0,1.0D0,0.0D0,4*0.0D0,.01D0,0.0D0,
*-1.0D0,4*0.0D0,-1.0D0,11*0.0D0/
REAL*8 MAXX/3*1.0D4,1000.0D0,1.0D4,1000.0D0,1.0D4,90.0D0,3*1.0D4,
*1000.0D0,1.0D4,1.0D4,2.4D4,2.4D4,2*1.0D4,15.0D0,10.0D0,5*500.0D0,
*5*1.0D4/
REAL*8 PCNT1/.1D0,.01D0,.01D0,4*.5D0,.01D0,2*.1D0,2*.01D0,.5D0,
*7*.2D0,5*.01D0,5*.5D0/
REAL*8 PCNTN/3*1.0D0,2*.8D0,2*.65D0,1.0D0,2*.65D0,4*1.0D0,
*2*.5D0,14*1.0D0/
REAL*8 ICNT/30*0.0D0/
REAL*8 ITF/0.0D0,2*-1.0D0,7*0.0D0,-1.0D0,2*0.0D0,-1.0D0,0.0D0,
*0.0D0,2*-1.0D0,12*0.0D0/
REAL*8 XNAM/      'KV'      'TUR-WORK' , 'NOT USED' , 'PUMP-FLO' ,
*'KV'      'PUMP-FLO' , 'KV'      'IN'      'PUMP-FLO' , 'TANK-P' ,
*'DILUENT' , 'DIL-K'      'FLU-TEMP' , 'PMP-FLOW' , 'P-SPEED' , 'I-SPEED' ,
*'P-TURX'   , 'A-TURIN' , 'HOT-FLOW' , 'K-COLD' , '5*BY-FLOW' ,
*'PRESSURE' , 4*'NOT USED' /
REAL*8 YNAM/      'WORK P.T' , 'PUMP-FLO' , 'NOT USED' , 'PC' ,
*'PC'      , 'TC'      , 'TC'      , 'TC'      , 'NOZ FLOW' , 'NOZ FLOW' ,
*'DILUENT' , 'TUR TEMP' , 'FLU TEMP' , 'PMP-FLOW' , 'P-SPEED' , 'I-SPEED' ,
*'P-TURX'   , 'A-TURIN' , 'P-TURIN' , 'T-TURIN' , '5*PRESSURE' ,
*'TURB FLO' , 4*'NOT USED' /
END

```


BLOCK DATA

IMPLICIT REAL*8(A-Z)

INTEGER*4 REF/9/

INTEGER*4 REFR/15/

INTEGER*4

* DTAG	.I	.IDELZS	.IEND	.IN(S)	.
* J	.JEND	.K	.KEND(S)	.L	.
* LEND	.MTAG(30)	.NOFIND	.NTAG	.PTAG	.
* XTAG(5,5)	.II	.M	.NOBNT	.NODENT	.
* NZTROT	.NTCNT	.NNCNT	.NODEPT	.NPARTS	.
* JJ	.KK	.LL	.INODE	.KLOOP	.
* REF	.IDELT	.NTPNTS	.NODZ	.NK	.
* TTAG	.CTAG	.CJ(20)	.REFR	.	.

INITIALIZATION AREA FOR THE ITERATION SUBROUTINE ITER

COMMON

/CONS/

* G

.JAY

.PI

.R

.RAD

* RB

COMMON /ITERS/ ISWT(30) .ESP(30) .MINX(30) .MAXX(30) .

*PCNT1(30) .PCNTN(30) .ICNT(30) .ITF(30) .XOLD(30) .YOLD(30) .

*XMIN(30) .XMAX(30) .XNAM(30) .YNAM(30)

COMMON /LITER/NAMES(10),CTIME,COMENT,BLANK,MI,NI,CNTMAX,ZERO,

*ERRCNT

COMMON /TAGS/

* DTAG	.I	.IDELZS	.IEND	.IM	.
* J	.JEND	.K	.KEND	.L	.
* LEND	.MTAG	.NOFIND	.NTAG	.PTAG	.
* XTAG	.II	.M	.NOBNT	.NODENT	.
* NZTROT	.NTCNT	.NNCNT	.NODEPT	.NPARTS	.
* JJ	.KK	.LL	.INODE	.KLOOP	.
* REF	.IDELT	.NTPNTS	.NODZ	.NK	.
* TTAG	.CTAG	.CJ	.REFR	.	.

REAL*8 ISWT/30*0.000/

REAL*8 ESP/12*.00100,2*.000100,2*.000200,.000100,.000200,.000100.

GCCSD0,10.00100/

REAL*8 MINX/30*0.000,1.000,0.000,1.000,0.000,4*0.000,.0100,0.000,

*1.000,4*0.000,-1.000,11*0.000/

REAL*8 MAXX/3*1.000,1.000,0.000,1.000,1.000,0.000,1.000,98.000,3*1.000,

*1.000,0.000,1.000,1.000,2.400,2.400,2.400,2.400,15.000,10.000,5*500.000,

*5*1.000/

REAL*8 PCNT1/.100,.0100,.0100,4*.500,.0100,2*.100,2*.0100,.500,

7.200,5*.0100,5*.500/

REAL*8 PCNTN/3*1.000,2*.800,2*.6500,1.000,2*.6500,20*1.000/

REAL*8 ICNT/30*0.000/

REAL*8 ITF/0.000,2*-1.000,7*0.000,-1.000,2*0.000,-1.000,0.000,

3-1.000,12*0.000/

REAL*8 YNAM/

*KV

*P-TURX

*5*NOT USED/

REAL*8 YNAM/

*PC

*P-TURX

*5*NOT USED/

INITIALIZATION AREA FOR THE PARTS NOMENCLATURE

REAL*8 NAMES

*UPCORE

INITIALIZATION AREA FOR THE CONSTANTS

REAL*8 CTIME/0.000/

REAL*8 COMENT/1C

REAL*8 BLANK/

REAL*8 MI/0.000/

REAL*8 NI/10.000/

REAL*8 CNTMAX/2000.000/

REAL*8 G /32.1740500 /

REAL*8 JAY /777.9700 /

REAL*8 PI /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P1 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P2 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P3 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P4 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P5 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P6 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P7 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P8 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P9 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P10 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P11 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P12 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P13 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P14 /3.141592653589793238462643383279502884197169399375105820974941595721496

REAL*8 P15 /3.141592653589793238462643383279502884197169399375105820974941595721496

BLOCK DATA

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PAGE 2

REAL*8 R /766.6667D0 /
REAL*8 RAD /.01745329D0 /
REAL*8 RB /.98547D0 /
REAL*8 ZERO/0.000 /
END

25

SUBROUTINE CORECT

DATE = 10SEP67

PAGE 1

SUBROUTINE CORECT
C CGRRECT THE COEFFICIENTS FOR THE PREDICTOR PASS
IMPLICIT REAL*8 (A-Z)
COMMON /ADD/

CORECTA

* ARG	* ARG1	* ARG2	* ATURNP	* BUF(10)	.
* CARDS(11)	* DELTAP	* DTURX	* GASVEL	* MCORO	.
* HTURIX	* HFCOEF	* HPIN	* HPOUT	* HTANKN	.
* PTROT	* KVSQRT	* MACH	* NBEND	* PPOUT	.
* PFLOW	* PTURPR	* PREDFL	* PVAPOR	* PTXST	.
* TTEMPY	* PTXMIN	* PUMPH	* RF	* RNTROT	.
* TPOUT	* RATIO	* RATIOC	* SPEED	* TTROT	.
* UNCHK	* TMX	* TJKWD1	* TINTZ1	* TINTHT1	.
* T2NP1(30)	* TPIN		* TTXMIN	* THIX	.
* T2NP1(30)		* T3NP1(30)	* FILMNT	* PUM1	.
* SAVX(20,8)	* T2NP1(30)	* T3NP1(30)	* SAVN(15)	* SAVNT(20)	.
	* SAVPT(20,18)	* SAVJ(30,27)	* SAVIJ(30,20,9)		.

COMMON

/CCNS7

* G

* JAY

* PI

* R

* RAD

* RB

COMMON /EXTRA/

* PUMIP	* CPUM	* TCX	* TNKRHO	* TPT2	.
* TPCR	* TPQ	* TPK2	* TPKPD	* TPMH	.
* KPLUMPI	* HBEAR	* HBEAR	* WPUMPC		.
* ATURNZ	* ATURNZ	* ATUR	* ABOLNZ	* PMIX	.
* PAVG	* WPMAX	* DTURBL	* PIN	* TAVE	.
* CR	* TTURIP		* GAMMA	* PTOOLO	.
* HDILX	* CPTI	* GANTI	* TTXST	* KVLMIN	.
* KIPMIN	* WPCNT	* TURWK	* TCTMP	* TPNW	.
* IPWRK	* TIMER	* PCARD	* RHOM		.
* DELZP	* ZM	* ZM1	* DELPT	* DELPMT	.
* MLPHF	* MLPCF	* TK	* DTROT	* DELZT	.
* TROTZ		* RNDIST	* RFN	* Q	.
* TCHOK	* WNCF	* WNCF1	* WNNIT	* HTCNT	.
* FNTH	* THETA1	* THETA2	* MAN3	* MEN3	.
* TINTW1	* TDIFM	* SACPR	* FNTC	* MDN2	.
* MBN2	* FJ	* MCN1	* MDN1	* TINTCD1	.
* TMEZ	* ETAP	* EPT20	* NETLTM	* TPTAV	.
* FILRON	* OUM	* QMAX	* QZ	* TEMPTM(30)	.

COMMON

/ELAG/

* ETAPFL	* HBPF	* MASS	* MTIME	* NTIME	.	B
* NBIT	* OPEN	* OPTION	* PIMO	* STATE	.	C
* TANK	* TAPE	* TFLUM	* TIMEI	* TINEX	.	D
* TMEINO	* WINT	* TIMES(10)			.	E

COMMON

/FLUIDP/

* PRES	* ZFACT	* QUAL	* TEMP	* RHO	.
* SAM	* CP	* VEL	* ENTR	* COND	.
* VIS	* VOL	* ENTH			.

COMMON /HBPS/

* ACORO	* ANNUL	* ANOZT	* BELSEC	* CFILMA	.	P
* CFILMB	* CFILMC	* CGAS	* COMP	* DCNH	.	Q
* SHBP	* BILANG	* DPASS	* FGOLO	* PHOT	.	R
* INCON	* KFILMA	* KFILMB	* KFILMC	* MEAS	.	S
* KFILM	* KDILP	* KDIL	* KHBP1	* KLTUR	.	T
* KFILM	* KFILM	* KIL	* K9	* LHP	.	U
* KTHICK	* NCWH	* RHP	* NPASS	* RPASS	.	C

COMMON

/P/

* ALPHA	* BETA	* DIST	* ERUMC	* GPUMP	.
* ETURC	* ETURP	* FILMEX	* GATEP	* HDPUM	.
* HVC	* HVC	* HVT	* HNT	* NTURC	.
* HURP	* PCORO	* PCUB	* PDIL	* PHBPQ	.
* PMINOX	* PNTI	* PNTD	* PPONDC	* PPUMOP	.
* PTANKX	* PTURIX	* PTURO	* QPUMP	* RFLU	.
* SAC	* TCORD	* TCORDR	* TCUR	* TOLIX	.
* THBPQ	* TIME	* TINEP	* TNETL	* TINTI	.
* TINTD	* TINTOC	* TRUMP	* TRANKX	* TRORIX	.

```

* TI2MIX      * UIHG      * WCUR      * WDILX      * WHBP      *
* WNOZ        * WNTCK      * WNTI      * WNT0      * WPUMC      *
* WPUMP        * WTURB      *
COMMON /TP/
* ALOWX      * BATERM      * BATERS      * COMTL      * CPTERM      *
* DOBLE      * DELMN      * DELMN      * DELMN      * DELPM      *
* DELTER      * DMHYDR      * DPIPE      * DTERM      * DZTERM      *
* ENTRQP      * ETAT      * ETATP      * GPN      * MTERM      *
* HGOEF      * HGTOT      * HPUMI      * HGOEF      * HVTERR      *
* H12        * K1      * K1      * KWC      * KWC      *
* KCV        * KWH      * KWHV      * KWT      * K1      *
* K2        * K3      * K4      * K6      * MTERM1      *
* MTERM2      * MTERM3      * MTERM4      * NPRN      * NTERM      *
* PHI        * PNOZO      * PNTHR      * PRESN      * PRQUES      *
* PPRIN      * PRTERM      * RSTP      * PTANKN      * P6N      *
* PSN        * P8PR      * QN      * QRM      * QTERM      *
* RHOR      * RHOTKM      * RHOTKM      * RPM2      * SPRIME      *
* STERM      * STSTAG      * TFLUSR      * TIMEMT      * TIMEN      *
* TTANKN      * TTURO      * TVP      * TWTERM      * T11N      *
* T11SR      * T8N      * WATERM      * WDILN      * WOTERM      *
* WERROR      * WETPER      * WHSPN      * WI      * WCHOK      *
* WNT        * WPACTN      * WRTERM      * WTERM      * WTURN      *
* WTERM      * ZTUBE      *
COMMON
* /1/
* EOFTAP      * INDTUR      * INTFLO      * LARGET      * LESPO      *
* LOOPN      * MCAP      * NEGW      * NONOP      * NONSPD      *
* NGNTC      * NONW      * NOTURN      * NGTURN      * NTER      *
* PARONE      * WITER      *
ALPHA = (PPUMC-PCGRQ)/WPUMC**2
BETA = PCGRQ/WPUMC
GAMMA = PDIL/WPUMC
IF (INDTUR.NE.0.) GO TO 1000
IF (HBPFG.NE.0.) GO TO 1000
CALL PT (PCGRQ,TCGRQ)
KHBPI = (PCGRQ-PMIX)*24.*G*RHQ/WHBP**2
PAVG = (PMIX+PDIL)/2.
CALL PT (PAVG,TDILX)
KDIL = (PDIL-PMIX)*24.*G*RHQ/WDILX**2
KTUR = (PMIX**2-RTURIX**2)*G*ATUR**2/(R*ITURIX*WTURB**2) - KVN
1000 CALL TURBIN
RETURN
END

```

CORECTB
CORECTC

CORECTE
CORECTF
CORECTG

CORECTK

CORECTM

CORECTO
CORECTP

DATE = 18SEP67

ORDER

```

      * WNOZ          ,WNTCK          ,WNTI          ,WNTQ          ,WPUMC          ,
      * WPUMP          ,WTURB          ,
      * COMMON
      * /FILS/
      * ACL          ,APUMI          ,DCL          ,DNTI          ,KNTIL          ,
      * KRUH          ,MCL          ,PCL          ,VALPD          ,
      * COMMON
      * /TABI/
      * AJHT(30)      ,ANTC(30)      ,ANTH(30)      ,ANTW(30)      ,CDJ(30)      ,
      * CDNT(30)      ,CFWP(30)      ,CG(30)      ,CPJ(30)      ,CPNT(30)      ,
      * CRJ(30)      ,CRJNT(30)      ,DEL(30)      ,DELPNT(30)      ,DELPNZ(30)      ,
      * DNOZW(30)      ,GATE(30)      ,GP(30)      ,HGFJ(30)      ,HGFNTC(30)      ,
      * HGFNTH(30)      ,HGJ(30)      ,HGNTC(30)      ,HGNTH(30)      ,KPD(30)      ,
      * KPDV(30)      ,KV(30)      ,NT(30)      ,PAMB(30)      ,PBD(30)      ,
      * PC(30)      ,PINLET(30)      ,PLINE(30)      ,PRATIO(30)      ,PTURMO(30)      ,
      * QPD(30)      ,RHOJ(30)      ,RHONT(30)      ,RN(30)      ,SJO(30)      ,
      * SNGZ(30)      ,SNTC(30)      ,SNTH(30)      ,SNTJ(30)      ,SSPRT(30)      ,
      * TC(30)      ,TINLET(30)      ,TKJ(30)      ,TKNTC(30)      ,TKNTH(30)      ,
      * TUREFF(30)      ,VNODES(30)      ,WDIL(30)      ,WPUM(30)      ,
      * TURIT(30)      ,TURIP(30)      ,HBFLOW(30)      ,BEND(30)      ,
      * COMMON
      * /X/
      * EOFTAP          ,INDTUR          ,INTFLO          ,LARGET          ,LESPQ          ,
      * LOGPN          ,MCAPI          ,NEG          ,NGNQP          ,NONSPD          ,
      * NQNTC          ,NCNW          ,NOTURN          ,NQTURN          ,NTERR          ,
      * PARONE          ,WITER          ,
      IF((OPEN.EQ.0.0).AND.(INTFLO.EQ.0.0))GO TO 60
      TDILX = TCUR
      TPIAV = TCUR
      IF((STATE.EQ.0.0).AND.(MCL.NE.0.0))GO TO 20
      TPT2 = TCUR
10  PDIL = PCUR
      WCUR = WCUR - WDILX
      GO TO 60
20  IF(WDILX.NE.0.0)GO TO 30
      METLTO = METLTN
      TPT2 = TDILX
      GO TO 10
30  IF(TIME.NE.0.0)GO TO 40
      TPIAV = TCUR
      GO TO 50
40  TPIAV = .5*(TCUR + TPT2)
50  CALL PI(PCUR,TPIAV)
      CALL INTP(CPNT,METLTO,TPCR)
      CALL HF(OPT(28),WDILX,PCUR,TPIAV,ENTH,METLTO,PCL,SIG,ACL,FILMCX)
      TRQ = (METLTO - TPIAV)*ACL*FILMCX
      METLTN = -TRQ*TIMEP/(TPCR*MCL) + METLTO
      TPT2 = TRQ/(CP*WDILX) + TDILX
      GO TO 10
60  CONTINUE
      RETURN
      END

```

```

C      ENGINE
      SUBROUTINE ENGINE
      IMPLICIT REAL*8 (A-Z)
      INTEGER*4
      *DTAG      *ISAVE      *IDELZS      *IEND      *IM(5)
      *J          *JEND      *K          *KEND(5)  *L
      *LEND      *MTAG(30)   *NCFIND   *NTAG      *PTAG
      *XTAG(5,5) *II        *M          *NOBNT     *NODENT
      *AZTROT    *NTCNT     *NMCNT    *NOBPT     *NPARTS
      *JJ        *KK        *LL        *INODE    *KLOOP
      *REF       *IDELT     *NTPNTS   *NGDZ      *NK
      *TTAG      *CTAG      *CJ(20)    *REFR
      *NGBSK,NGDESK,SMCNT,STAG
      *I
      COMMON /ADD/
      *ARG      *ARG1      *ARG2      *ATURNP     *BUF(10)
      *CARDS(11) *DELTA    *DTURX     *GASVEL     *HCORO
      *          *HFCGEF   *HPIN      *HPOUT      *HTANKN
      *          *KVSQRT   *MACH      *NBEND      *PPOUT
      *          *PTURPR   *PREDFL    *PVAPOR     *PTXST
      *          *PTXMIN   *PUMPH     *RF          *RNTROT
      *          *RATIO    *RATIOC    *SPEED      *ITROT
      *          *TMX      *TJKMD1   *TNTNZ1     *TNTHT1
      *          *TPIN     *          *ITXMIN     *TMIX
      *          *UNCHK    *          *FILMNT     *QPUMI
      *          *T1NP1(30) *T2NP1(30) *T3NP1(30) *SAVN(15)  *SAVNT(20)
      *          *SAVFX(20,8) *SAVPT(20,18) *SAVJ(30,27) *SAVIJ(30,20,9)
      COMMON
      *CGNS/
      *G          *JAY      *PI        *R          *RAD
      *RB
      COMMON /EXTRA/
      *          *QPUM      *TCX        *TNKRHG     *TPT2
      *          *TPQ       *TPK2      *TPKPD      *TPWH
      *          *KPLMPI    *HBEAR     *WPUMPC     *
      *          *ATURNZ    *ATURNC   *ATUR       *AROLNZ
      *          *PAVG      *WPMAX    *DTURBL     *PMIX
      *          *CR        *TTURIP   *          *PPIIN
      *          *HDILX     *CPTI     *GANT1      *GAMMA
      *          *KTPMIN    *WPCNT     *TURK       *TIXST
      *          *TPMRK     *TIMER    *PCARD      *TCTMP
      *          *DELZP     *ZM        *RHOM       *TCTMP
      *          *HLPFH     *HLPCHF   *TK          *RHOM
      *          *TRGTZ     *          *RNDIST     *DELPT
      *          *TGMOK     *WNGF      *WNGF1      *DTROT
      *          *FMZM      *THETA1    *THETA2     *RFN
      *          *TNTWD1    *TDIFM     *SACRR      *WNNIT
      *          *MSN2      *FJ        *MCN1       *MAN3
      *          *TIMEZ     *ETAP      *TPT20      *FNTC
      *          *PIURCM    *DUM        *OMAX       *MDN1
      *          *          *          *          *NETLTN
      *          *          *          *          *QZ
      *          *          *          *          *TENTM(30)
      COMMON
      *FLAG/
      *ETAPFL     *HBRG      *MASS       *MTIME     *MTIME
      *          *NNT      *OPEN     *OPTION     *PMINO     *STATE
      *          *TANK     *TAPE     *IFLUM      *TIMEI     *TINEX
      *          *TNRHG    *NINT     *TIMES(10)
      COMMON
      *FLUIDP/
      *PRES      *ZFACT     *QUAL       *TEMP      *RHO
      *GAM       *CP        *VEL        *ENTR      *COND
      *VIS       *VOL
      COMMON
      *MISC/
      *PCX       *PDK       *POKW       *PIURDC     *PTURGP
      *          *HBPV      *HBPWC     *HBPWC      *          *
      *          *METLTO    *MINFLQ   *PASSX      *SSOUT     *WPIT
      *          *ITEMP(20) *OTEMP(20) *DELMN2(200) *PUMP(350) *FILMA(20)
      *          *FILMB(20) *FILNC(20) *TCFLG(20)
      COMMON
      *MANTAG/

```

B
CODE


```

* DILREM      ,HM      ,MX      ,MPARTS(30) ,NTNAME      ,
* PARTS(20)   ,PLNAME   ,PM(5)   ,PX(5)      ,TM(5)      ,
* TDELZ(20)   ,TPARTS(20),TX(5)   ,WM(5)      ,WX(5)      ,
* XPARTS(5,5) ,CPARTS(20),CDELZ(20)
COMMON

```

```

*/NIS/
* AJB      ,AJE      ,AJF      ,ANF      ,ANH      ,
* BJB      ,BJE      ,BJF      ,BNF      ,BNH      ,
* CJB      ,CJE      ,CJF      ,CNF      ,CNH      ,
* DNT      ,FNT      ,KNTI     ,KNTD     ,NODES     ,
* NOZEFF    ,NTDZ     ,THETA    ,THROAT   ,TNTIM     ,
* VNTI      ,VNTC
COMMON

```

F
A
B
C

E
F

```

*/P/
* ALPHA     ,BETA     ,DIST     ,EPUMC     ,EPUMP      ,
* ETURC     ,ETURP    ,FILMCX    ,GATEP     ,HDPUM      ,
* HSWC      ,HSVP     ,MHT      ,NMT      ,NTURC      ,
* NTURP     ,PCORG    ,PCUR      ,PDIL      ,PHEPD     ,
* PMINOX    ,PNTI     ,PNTD     ,PPUMOC    ,PPUMOP     ,
* PTANKX    ,PTURIX   ,PTURD     ,QPUMP     ,RFLU       ,
* SAC       ,TCORO    ,TCOROR   ,TCUR      ,TDILX      ,
* THBPQ     ,TIMEP    ,TIMEP    ,TMETL     ,TNTI       ,
* TINTD     ,TPUMOC   ,TPUMOP   ,TTANKX    ,TTURIX     ,
* T12MIX    ,UIHG     ,WCUR      ,WDILX     ,NHBP       ,
* WNOZ      ,WNTCK    ,WNTI      ,WNTO      ,WPUMC      ,
COMMON

```

```

*/TAGS/
* DTAG      ,ISAVE    ,IDELZS   ,IEND      ,IM        ,
* J          ,JEND     ,K          ,KEND      ,L          ,
* LEND      ,MTAG     ,NOFIND    ,NTAG      ,PTAG      ,
* XTAG      ,II       ,M          ,NOBNT     ,NODENT     ,
* NZTROT    ,NTCNT    ,NMCNT     ,NODEPT    ,NPARTS    ,
* JJ        ,KK       ,LL          ,INODE     ,KLOOP      ,
* REF       ,IDELT    ,NTPNTS   ,NODZ      ,NK         ,
* TTAG      ,CTAG     ,CJ         ,REFR      ,
* NGBSK,NODESK,SMCNT,STAG
COMMON

```

```

*/IPAS/
* ARE      ,ATURO     ,ATURX     ,DROLNZ    ,DTUR       ,
* DTURNZ   ,ETAMIN    ,GATEFG    ,KBEAR     ,KTUR       ,
* KTURNX   ,MUPT      ,NWORK     ,PTURI     ,TIPVEL     ,
* TTURI
COMMON

```

D
L
M
N
O

```

* EOTAP     ,INDTUR    ,INTFLO    ,LARGET    ,LESPQ      ,
* EOPM      ,MCAP      ,NEGW      ,NONOP     ,NONSRD     ,
* NNTC      ,NONW     ,NOTURN    ,NOTURN    ,NTERR      ,
* PARONE    ,WITER

```

K
A
L
N
O

```

C      IF (OPEN.NE.0.0) GO TO 10
      BEARING COOLANT FLOW
      CALL PT(PCUR,TCUR)
      KBEAR = DSORT(2,0*(PCUR+PTURD))*G*RM0/KBEAR
      KCUR = KCUR - KBEAR
      KBEAR = ENTH
      IF (IEND.LE.0) GO TO 125
      I = I

```

```

20 IF (LEND.LE.0) GO TO 85
DO 80 L=1,LEND
C      TEST FOR STRUCTURAL PART FLOW EXTRACTION
      IF (NTAG(L).NE.XTAG(1,L)) GO TO 55

```

```

C      SAVE MAIN STREAM INFO FOR ITERATION OF STRUCTURAL PART FLOW

```

```

20 PH(L) = PCUR
TH(L) = TCUR
WTL(L) = WCUR
IN(L) = I

```

```

C      SWITCH TO STRUCTURAL PART FLOW
40 KCUR = MX(L)

```

K
B

D
U
A
B
C
E
D

C ENGINE

DATE = 16SEP47

```

IF(KLOOP,LE,0)GO TO 80
DO 50 K=2,KLOOP
C   SET INDEX FOR STRUCTURAL PART CALCULATIONS
J = XTAG(K,L)
IF(J,LE,0)GO TO 45
C   STRUCTURAL PARTS
CALL TEMPO
GO TO 50
45 IF(MTAG,NE,XTAG(K,L))GO TO 46
CALL TUBES
GO TO 50
46 IF(STAG,NE,XTAG(K,L))GO TO 50
CALL SKTNT
50 CONTINUE
C   SAVE STRUCTURAL PART INFO
PX(L) = PCUR
TX(L) = TCUR
C   SWITCH TO MAIN STREAM FLOW CONDITIONS
PCUR = PM(L)
TCUR = TM(L)
C   REDUCE MAIN FLOW BY STRUCTURAL PART FLOW
WCUR = WM(L)-WX(L)
C   TEST FOR STRUCTURAL PART FLOW RETURN
55 IF(MTAG(I),NE,XTAG(KEND(L),L)) GO TO 80
C   ITERATE UNTIL MAIN AND STRUCTURAL PART FLOW PRESSURES MATCH.
60 CALL ITER(L+20,WX(L),PCUR,PX(L),270)
CALL PT(PCUR,TCUR)
HM = ENTH
CALL PT(PCUR,TX(L))
HX = ENTH
HM = (HM*WCUR + HX*WX(L))/(WCUR + WX(L))
CALL PH(PCUR,HM)
TCUR = TEMP
WCUR = WCUR + WX(L)
GO TO 80
C   RESET MAIN STREAM CONDITIONS AND RETURN TO POINT OF EXTRACTION
70 PCUR = PM(L)
TCUR = TM(L)
I = IM(L)
GO TO 40
80 CONTINUE
C   TEST FOR DILUENT REMOVAL
85 IF(DTAG,NE,MTAG(I))GO TO 90
CALL DILTAP
C   TEST FOR PUMP DISCHARGE LINE CALCULATIONS
90 IF(PTAG,NE,MTAG(I))GO TO 100
C   PUMP DISCHARGE LINE
CALL POLINE
GO TO 120
C   TEST FOR NOZZLE TUBE CALCULATIONS
100 IF(MTAG,NE,MTAG(I))GO TO 110
IF(FNT,EQ,0.0)GO TO 120
C   NOZZLE TUBES
CALL TUBES
GO TO 120
110 IF(STAG,NE,MTAG(I))GO TO 115
CALL SKTNT
GO TO 120
115 J = MTAG(I)
C   TEST FOR MAIN STREAM PART
IF(J,LE,0)GO TO 120
C   MAIN PARTS
CALL TEMPO
120 I = I + 1
IF(I,LE,IEND)GO TO 20
C   SAVE CORE CONDITIONS
125 TCORO = TCUR
PCORO = PCUR
TCMH = WNOZ*ENTH

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C ENGINE

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IF(INTFLC.EQ.C.C)GO TO 140
IF(OPEN.NE.0.0)GO TO 130
IF(HBPPG.EQ.0.0)GO TO 130
IF(INDTUR.NE.C.0)GO TO 130
C SIMPLIFIED HOT BLEED PORT
CALL SHBP
WCUR = WCUR+HBPMC-WTURB
GO TO 140
C REDUCE MAIN FLOW BY HBP FLOW
130 WCUR=WCUR-WHBP
C TEST FOR MAIN NOZZLE CALCULATIONS
C MAIN NOZZLE
140 IF(FNT.EQ.0.0)GO TO 145
CALL NOZZLE
145 IF(STAG.EQ.0)GO TO 150
CALL SKTNZ
150 CONTINUE
RETURN
END
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C      SUBROUTINE ERROR
      ERROR
      IMPLICIT REAL*8(A-Z)
      INTEGER*4
      * DTAG      * I      * IDELZS      * IEND      * IM(5)      *
      * J      * JEND      * K      * KEND(5)      * L      *
      * LEND      * MTAG(30)      * MCFIND      * NTAG      * PTAG      *
      * XTAG(5,5)      * II      * M      * NOBNT      * NOBENT      *
      * NZTROT      * NTCNT      * NMCNT      * NODEPT      * NPARTS      *
      * JJ      * KK      * LL      * INODE      * KLOOP      *
      * REF      * IDELT      * NTPNTS      * NGDZ      * NK      *
      * TTAG      * CTAG      * CJ(20)      * REFR      *
      COMMON /ADD/
      * ARG      * ARG1      * ARG2      * ATURNP      * BUF(10)      *
      * CARDS(11)      * DELTAP      * DTURX      * GASVEL      * HCORD      *
      *      * HFCDEF      * HPIN      * HPOUT      * HTANKN      *
      * HTLRX      * KVSQRT      * NACH      * NBEND      * PPOUT      *
      * PTROT      * PTURPR      * PREDFL      * PVAPOR      * PTXST      *
      * PFLOW      * PTXMIN      * PUMPH      * RF      * RNTROT      *
      *      * RATIO      * RATIOC      * SPEED      * TTROT      *
      * TEMPY      * TMX      * TJKWD1      * TINTN1      * TINTMT1      *
      * TPOUT      * TPIN      * TTXMIN      * TMIX      *
      * UNCHK      *      * FILMNT      * QPUMI      *
      * TINP1(30)      * T2NP1(30)      * T3NP1(30)      * SAVN(15)      * SAVNT(20)      *
      * SAVFX(20,8)      * SAVPT(20,18)      * SAVJ(30,27)      * SAVIJ(30,20,9)      *
      COMMON /AT/
      * ANZTX      * CDJX      * CDNTCX      * CDNTHX      * CPX      *
      * CRJTX      * CRJX      * DELH      * DELFI      * DELPK      *
      * DELPQ      * DELRHQ      * DELTX      * DELW      * DELZSQ      *
      * DELZX      * DELZX4      * HGCJKT      * HGCNTC      * HGCNTH      *
      * HI      * HJ      * HK      * HL      * HLPRIIM      *
      * HRNTJW      * HRQJ      * M1N      * M2N      * PIN      *
      * PJ      * PK      * PL      * PLPRIM      * RFLUX      *
      * RHCMIX      * RHGNOX      * RHOMX      * RHONIX      * RHONUX      *
      * RHCX      * SJOX      * SNOZX      * SNTCX      * SNTHX      *
      * TAMBX      * TCCUR      * THCUR      * THECIF      * TJKCUR      *
      * TKJX      * TKNTCX      * TKNTMX      * WNODEN      * WNOOI      *
      * ZMAX      * ZMIN      * ZTROT      *
      COMMON /AZ01/
      * CSUBP(30,20)      * FILMHF(30,20)      * PRESS(30,20)      * RHQFLU(30,20)      *
      * RHOFIP(30,20)      * TFLUID(30,20)      * TMETAL(30,20)      * WRATEN(30,20)      *
      * WRATEN(30,20)      *
      COMMON /AZ10/
      * FILMNZ(30)      * FILMTC(30)      * FILMTH(30)      * HRNOZW(30)      * HRNTCW(30)      *
      * HRNTM(30)      * PNOZ(30)      * PTUBE(30)      * RHOMTN(30)      * RHOMTN(30)      *
      * RHONZN(30)      * RHONZN(30)      * TCOLD(30)      * THOT(30)      * TJACK(30)      *
      * TJKTND(30)      * TJKTND(30)      * TNOZ(30)      * TNOZ(30)      * TNOZ(30)      *
      * TINTMT(30)      * TINTMT(30)      * TTUBE(30)      * WNOZM(30)      * WNOZM(30)      *
      * WNTN(30)      * WNTN(30)      *
      COMMON /EXTRA/
      * PUMIP      * QPUM      * TCX      * TNKRHO      * TPT2      *
      * TPCR      * TPQ      * TPX2      * TPKPD      * TPWH      *
      * KRMPI      * MBEAR      * MBEAR      * MBEAR      * WPMPC      *
      * ATURNZ      * ATURNZ      * ATUR      * ABDLNZ      * PMIX      *
      * PAVG      * WPMAX      * DTURBL      * PPIN      * TAVE      *
      * CR      * TTURIP      * GANTI      * GANNA      * PTQOLO      *
      * HDILX      * CPTI      * TURNK      * TTXST      * KVLMIN      *
      * KTPMIN      * WPCNT      * PCARD      * TCTMP      * TPNW      *
      * TPRK      * TIMER      * PCARD      * RHOM      *
      * DELZP      * ZM      * ZM1      * DELPT      * DELPMT      *
      * HLPHF      * HLPCF      * TK      * DTROT      * DELZT      *
      * TROTZ      * WNCF      * WNCF1      * WNCIT      * Q      *
      * TCHK      * WNCF1      * WNCF2      * WNCIT      * HTCNT      *
      * FNTH      * TDIFM      * TDIFM      * TDIFM      * MEN3      *
      * TINTD1      * FJ      * MCN1      * MCN1      * MCN2      *
      * MBN2      * ETAP      * TPT2D      * METLTN      * TPTAV      *
      * PTURON      * DUM      * QMAX      * QZ      * TEMPTM(30)      *
      COMMON /FLAG/
      * ETAPFL      * MBPFG      * MASS      * MTIME      * MTIME      *

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* WERROR      .WETRES      .WHSPN      .WI      .WNCCHK
* WNT          .WPACTN      .WRTERM      .WTERM      .WTURN
* WTERM
COMMON /X/
* EOFTAP      .INDTUR      .INTFLC      .LARGET      .LESPO
* LGORN       .MCAE        .NEGW       .NONQP      .NONSPD
* NONTC       .NONW       .NOTURN      .NOTURN      .NTERR
* PARONE
NAMELIST /ADDN/
* ARG         .ARG1        .ARG2        .ATURNP      .BUF
* CARDS       .DELTAP      .DTURX       .GASVEL      .HCORO
*            .HFCDEF      .HPIN        .HPOUT       .HTANKN
*            .KVSQRT      .MACH         .NBEND       .PPOUT
*            .PTURPR      .PREDFL      .PVAPOR      .PTXST
*            .PFLOW       .PUMPH        .RF          .RNTROT
*            .RATIO       .RATLOC      .SPEED       .TTROT
*            .TMX         .TJMD1       .TNTNZ1      .TNTHT1
*            .TPIN        .TTXMIN      .TMIX
*            .FILMNT
NAMELIST /ATN/
* ANOZTX      .CDJX        .CDNTCX      .CONTHX      .CPX
* CRJNTX      .CRJX        .DELM        .DELP        .DELPK
* DELP        .DELPHO      .DELT        .DELM       .DELZSQ
* DELZ        .DELZK4      .HGCJKT      .HGCNTC      .HGCNTM
* HI          .HJ         .HK          .HL         .MLPRIM
* HRNTJW      .HROJ       .M1N        .M2N        .PIN
* PJ          .PK         .PL         .PLPRIM     .RFLUX
* RHCMIK      .RHOMOX     .RHOMX      .RHONIX     .RHONGX
* RHGX        .SJOX       .SNOZX      .SNTCX      .SNTHX
* TAMBX       .TCCUR      .THCUR      .THMEDIF    .TJKCUR
* TKJX        .TKNTCX     .TKMTHX     .WNODEN     .WNOD1
* ZMAX        .ZMIN
NAMELIST /AZOIN/
* CSUBP       .FILMHF
* TFLUID      .TMETAL
NAMELIST /AZION/
* FILMZ       .FILMTC     .FILMTH      .HRNOZW      .HRNTCW
* HRNTHW      .PNOZ       .PTUBE       .RHQNTM      .RHQNTN
* RHONZM      .RHONZN     .TCOLD       .THOT        .TJACK
* TJKTMD      .TJKWO      .TNOZ       .TNOZW      .TNTCLD
* THTHOT      .TNTJWD     .TUBE        .WNOZM
* WNTM        .WNTN
NAMELIST /EXTRAN/
* PUMIP       .QPUM       .TCX         .TNKRHO      .TPT2
* TPCR        .TPQ        .TPK2        .TPKPD       .TPWH
* KPMRI       .WBEAR      .WBEAR       .WPUMPC      .PMIX
* ATURNZ      .ATURN      .ATURN       .AROLNZ      .TAVE
* PANG        .WPMAX      .DTURBL      .PPIN        .TDOLO
* CR          .TTURIP     .GAMMA       .GAMMA       .KVLMIN
* HDILX       .CPTI       .GANTI       .TTXST       .TPNW
* KIPMIN      .WPCNT      .TURNK       .TCTMP       .DELPMT
* TPRK        .TIMER      .PCARD       .RHOM        .DELZT
* DELZP       .ZM         .ZM1        .DTROT       .Q
* MLPHF       .MLPCF      .TK          .RNDIST      .HTCNT
* TROTZ       .WNCF       .WNCF1       .WNCIT       .MEN3
* TCHOK       .THEIA1     .THEIA2      .MAN3        .MDN2
* FNTH        .TDIFM      .SACPR       .FNTC        .TNTCD1
* TNTWDI      .FJ         .MCN1        .MDN1        .TPTAV
* MBN2        .ETAP       .TPT2D      .METLTN      .TEMPTM
* TIMEZ       .DUM
* FTURDM
NAMELIST /FLUIDN/
* PRES        .ZFACT      .QUAL        .TEMP        .RHO
* GAM         .CP         .VEL         .ENTR        .COND
* VIS         .VOL
NAMELIST /FXN/
* DELTEM      .FLUTEM     .NETTEM      .MSMALL      .MTPNTS
* PARTI       .PARTPS    .TENPEX
NAMELIST /LITER/NAMES,CTIME,COMENT,BLANK,MI,NI,CNTMAX,ZERO
NAMELIST /MISCN/

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* PCX      .POK      .POKV      .PTURDC      .PTUROP      ,
* HBPXV     .HBPW     .HBPWC     .HBPWNC     ,
* METLTO     .MINFLO     .PASSX     .SSOUT      .WPIT      ,
* ITEMP      .CTEMP     .FILMA     .FILMB      .FILMC      ,
* TCFLG
* NAMELIST /NAMN/
* HM        .HX        .PM        .PX        .TM        ,
* TX        .MN        .MX        .XTIME     .MI        ,
* NI
* NAMELIST /NTNZN/ CPDP .ENTHO .HKPR .PHINT .PHINZ .PKPR .PTCX ,
* QCLDNT,QHOTNT,RTFC .RHODP .TTC
* NAMELIST /FN/
* ALPHA     .BETA      .DIST      .EPUMC      .EPUMP      ,
* ETURC     .ETURP     .FILMCX     .GATEP     .HDPUM     ,
* HSVC      .HSVP      .MHT        .NHT        .NTURC     ,
* NTURP     .PCORO     .PCUR       .PDIL       .PHEPO     ,
* PMINOX     .PNTI      .PNTOC     .PPUMOC     .PPUMOP     ,
* PTANKX     .PTURIX    .PTURO     .QPUMP      .RFLU       ,
* SAC        .TCORO     .TCGROR    .TCUR       .TDILX     ,
* THEPO      .TIME      .TIMEP     .TMETL      .TNTI       ,
* INTO       .TPUMOC    .TPUMOP    .TTANKX     .TTURIX     ,
* T12MIX     .UIHG      .WCUR      .WDILX      .WHBP      ,
* WNOZ       .WNTGK     .WNTI      .WNTOC     .WPUMC      ,
* WPUMP      .WTURB
* NAMELIST /PTN/
* DISPT     .PDROPI     .PDROPO     .PRESI      .PRESO      ,
* RHOMI      .RHOMO     .RHONI     .RHOND      .TEMP I     ,
* TEMPO      .TIMEZM     .WDELM I   .WDELMO     .WDELNI     ,
* WDELNO     .WRATEI     .WRATEO
* NAMELIST /TAGSN/
* DTAG       .I         .IDELZS     .IEND       .IM        ,
* J          .JEND      .K          .KEND       .L        ,
* LEND       .MTAG      .NOFIND    .NTAG       .PTAG      ,
* XTAG       .II        .M          .NOBNT      .NODENT     ,
* NZIROT     .NTCNT     .NMCNT     .NODEPT     .NPARTS     ,
* JJ         .KK        .LL          .INODE      .KLOOP      ,
* REF        .IDELT     .NTPTS     .NODZ       .NK        ,
* TIAG       .CTAG      .CJ          .REFR
* NAMELIST /TPN/
* ALOWX      .BATERM     .BATERS     .COMTL      .CPTERM     ,
* DDELZ      .DELHM      .DELHN      .DELHNX     .DELM      ,
* DELTER     .DHYDRA     .DPIPE      .DTERM      .DZTERM     ,
* ENTROP      .ETAT      .ETATP      .GPN        .HFTERM     ,
* HGCOEF      .HGTOT     .HPUMI      .HTCOEF     .HVTERM     ,
* H12        .KT         .KMN        .KNC        .KWCP      ,
* KWCV       .KMH        .KMHV       .KNT        .K1        ,
* K2         .K3         .K4         .K6         .NTERM1     ,
* MTERM2     .MTERM3     .MTERM4     .NPRN       .NTERM      ,
* PHI        .PNOZO     .PNTTHR     .PRESM      .PRGUES     ,
* PRPRIM     .PRTERM     .PSTP       .PTANKN     .P6N        ,
* PEN        .P8PR      .QN         .QPM        .QTERM      ,
* RHCR       .RHOTKN     .RHOTKN     .RPM2       .SPRIME     ,
* STERM      .STSTAG     .TFLUSR     .TIMET      .TIMEN      ,
* TTANKN     .TTURO      .TVP        .TTERM      .T11N       ,
* T11SR      .TON        .WATERM     .WDILN      .WDERM      ,
* WERROR      .WELPER     .WHBP      .WI         .WCHOK     ,
* WNT        .WPACTN     .WTERM      .WTERM      .WTURN     ,
* WTERM      .ZTUBE
* NAMELIST /XN/
* ECFTAP     .INDTUR     .INTFLO     .LARGET      .LESPQ      ,
* EQPM       .NCAP      .NBGW       .NONGP      .NONSPO     ,
* NONTC      .NGW       .NOTURN      .NOTURN      .NTERR      ,
* PANDNE     .WITER
IF(ERRCNT.LE.0.0)GO TO 30
ERRCNT=ERRCNT+1.0
CALL MESS('ERROR *****')
WRITE(6,ADDN)
WRITE(6,ATN)
WRITE(6,AVIN)
WRITE(6,AZION)

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WRITE(6,EXTRAN)
WRITE(6,FLUIDN)
WRITE(6,FXN)
WRITE(6,LITERN)
WRITE(6,MISCN)
WRITE(6,NAMN)
WRITE(6,NTNZN)
WRITE(6,PN)
WRITE(6,PTN)
WRITE(6,TAGSN)
WRITE(6,TFN)
WRITE(6,XN)
CALL PRINT
30 CTIME = CTIME - 1.0
IF(CTIME.LE.0.0)GO TO 60
IF(TIMEX.GE.0.0)GO TO 50
40 IF(IDELT.GE.8)GO TO 50
IF(TIME.LE.TIMES(IDELT+2))GO TO 50
TIMEP = TIMES(IDELT+3)
IDELT = IDELT + 3
GO TO 40
50 TIME = TIME + TIMEP
CALL RUEL
GO TO 30
60 CALL MC
RETURN
END

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C      SLBROUTINE FF(OPT,W,P,TB,H,TW,C,FRICT)
C      THIS SUBROUTINE CALCULATES A FRICTION FACTOR
C      IMPLICIT REAL*8 (A-Z)
C      INTEGER ICPT,IHD,IPF,IRF
C
C      COMMON/ FLUID P/ A(35)
C      COMMON /DPC/ FFTAB(4,30) ,HFTAB(5,30)
C
C      USE IOPT FLAG TO SET UP EQUATION SWITCH OPTIONS.
C      ICPT = OPT
C      IHD = FFTAB(1,ICPT)
C      IPF = FFTAB(2,ICPT)
C      IRF = FFTAB(3,ICPT)
C      ALF = FFTAB(4,ICPT)
C
C      IF TB IS ZERO, H WILL BE USED TO OBTAIN BULK PROPERTIES.
C      IF (TB.NE.0.) GO TO 50
C      CALL FH (P,H)
C      TE # A(4)
C      GC TO 51
C      50 CALL PT (P,TB)
C      51 RHOB # A(5)
C
C      UP TO 5 IHD OPTIONS ARE EXPECTED. TWO ARE AVAILABLE AS OF 4/22/67
C      GO TO (1,2,3,4,5), IHD
C      1 THD = TB
C      GO TO 101
C      2 THD = 0.5*(TB+TW)
C      GO TO 101
C      3 CONTINUE
C      4 CONTINUE
C      5 CONTINUE
C      101 CALL PT (P,THD)
C      RHOHD = A(5)
C      VISHD = A(11)
C
C      UP TO 5 IPF OPTIONS ARE EXPECTED. ONE IS AVAILABLE AS OF 4/22/67.
C      GO TO (6,7,8,9,10), IPF
C      6 PF = 1.
C      GO TO 102
C      7 CONTINUE
C      8 CONTINUE
C      9 CONTINUE
C      10 CONTINUE
C
C      UP TO 5 IRF OPTIONS ARE EXPECTED. ONE IS AVAILABLE AS OF 4/22/67.
C      102 GO TO (11,12,13,14,15), IRF
C      11 RF = 1.
C      GO TO 103
C      12 CONTINUE
C      13 CONTINUE
C      14 CONTINUE
C      15 CONTINUE
C
C      103 NRE = 4.*W*RF/(C*VISHD)
C      FRICT = 0.8686*DLG((NRE*DSQRT(4.*(.0014+.125/NRE**.32))))-.8
C      FRICT = 0.25 * ALF/FRICT*PF/FRICT
C      RETURN
C      END

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C SUBROUTINE FLOW
FLOW
IMPLICIT REAL*8 (A-Z)
COMMON /ADD/
* ARG *ARG1 *ARG2 *ATURNP *BUF(10) *
* CARDS(11) *DELTA *DTURX *GASVEL *HCONQ *
* *HPCUT *HPIN *HTANKN *
* *HTURIX *KVSQRT *MACH *NBEND *PPOUT *
* *PTROT *PTURPR *PREDFL *PVPOR *PTXST *
* *PFLGW *PTXMIN *PUMPH *RF *RNTROT *
* *TEMPY *RATIO *RATIOC *SPEED *TTROT *
* *TPOUT *TMX *TJKWD1 *TNTNZ1 *TNHT1 *
* *UNCHOK *TPIN *TTXMIN *TMIX *
* *T1NP1(30) *T2NP1(30) *T3NP1(30) *SAVN(15) *SAVNT(20) *
* *SAVFX(20,8) *SAVPT(20,18) *SAVJ(30,27) *SAVIJ(30,20,9) *
COMMON /EXTRA/
* PUMIP *QPUM *TCX *TNKRHO *TPT2 *
* TPCR *TPQ *TPK2 *TPKPD *TPWH *
* KPUMPI *WBEAR *HBEAR *WPUMPC *
* ATURNZ *ATURN *ATUR *AROLNZ *PMIX *
* *RANG *MPMAX *DTURBL *PPIN *TAVE *
* *CE *CTURIP *GAMMA *PTQOLO *
* *MDILX *CPTI *GANTI *TTXST *KVLNIN *
* *KIPMIN *MPCNT *TURNK *TCTMP *TPNW *
* *TPRK *TIMER *PCARD *RROM *
* *DELZP *ZM *ZM1 *DELPT *DELPM *
* *HLPFH *HLPCF *TK *DTRT *DELZT *
* *TROZ *RNDIST *RFN *Q *
* *TCHOK *WNCF *WNC1 *WMNIT *MTONT *
* *ENTH *THETA1 *THETA2 *MAN3 *MEN3 *
* *TNTWD1 *TDIRM *SACRR *FNTC *MDN2 *
* *MBN2 *FJ *MCN1 *MDN1 *TNTCD1 *
* *TIMEZ *ETAP *TPT20 *METLTN *TPAV *
* *PILROM *DUM *QMAX *OZ *TEMPTM(30) *
COMMON
* /FLAG/
* *ETAPFL *HBPEF *MASS *MIME *NTIME *
* *NBIT *OPEN *OPTION *PMINO *STATE *
* *TANK *TAPE *TFUM *TIMEI *TIMEX *
* *TIMEMO *WINT *LINES(10) *
COMMON
* /FLCIDP/
* PRES *ZFACT *QUAL *TEMP *RHO *
* *GAM *CP *VEL *ENTR *COND *
* *VIS *VOL *ENTH *
COMMON
* *HAPS/
* *ACORD *ANNUL *ANOZT *SELSEC *CFILMA *
* *CFILMB *CFILMC *CGAS *COMP *DCWH *
* *DHBP *DILANG *DPASS *FCOLD *FHOT *
* *HBQG *HFILMA *HFILMB *HFILMC *HGAS *
* *INCOMP *KDELP *KDIL *KHBPI *KJTUR *
* *KPCN *KPMH *K21 *K9 *LHBP *
* *KTRICK *KCNH *KMBP *NPASS *RPASS *
* *BELONG(20) *
COMMON
* /RISC/
* PCX *PDK *PDKV *PTUROC *PTUROP *
* *HBPV *HBPWC *HBPWC *SSOUT *WPIT *
* *METLTO *MINFLO *PASSX *PUMP(350) *FILMA(20) *
* *TEMP(20) *TEMP(20) *BELONG(20) *
* *FLAG(20) *FILMC(20) *
COMMON
* /B/
* ALPHA *BETA *DIST *EPUNC *EPUMP *
* *ETURC *ETURP *FILMCX *GATEP *HOPUM *
* *HSVC *HSVP *MHT *NNT *NTURC *
* *NTURP *PCORO *PCUR *POIL *PHBPO *
* *PUNOC *PUNOC *PUNOC *PUNOC *

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SUBROUTINE FLOW

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* PTANKX      ,PTURIX      ,PTURO      ,QPUMP      ,RFLU      ,
* SAC         ,TCORO      ,TCOROR     ,TCUR       ,TDILX      ,
* THEPG       ,TIME       ,TIMEP      ,TMETL      ,INTI       ,
* INTO        ,TPUMOC     ,TPUMOP     ,TTANKX     ,TTURIX     ,
* T12MIX      ,UIHG       ,WCUR       ,WDILX      ,WHEP       ,
* WNOZ        ,WNTCK      ,WNTI       ,WNTD      ,WPUMC      ,
* WPUMR       ,WTURB      ,
COMMON
*/PILS/
* ACL         ,APUMI      ,DCL        ,DNTI       ,KNTIL      ,
* KPUMI       ,MCL       ,FCL        ,VALPD      ,
COMMON /TP/
* AFLOWX     ,BATERM     ,BATERS     ,CDMTL      ,CPTERM     ,
* DDELZ      ,DELHM     ,DELHN     ,DELHNX     ,DELPN     ,
* DELTER     ,DHYDRA    ,DPIPE     ,DTERM     ,DZTERM     ,
* ENTROP     ,ETAT      ,ETATP     ,GPN       ,HFTERM     ,
* HGCDEF     ,HGTOT     ,HPUMI     ,HTCDEF     ,HVTERM     ,
* H12        ,KT        ,KVN       ,KWC       ,KWCP      ,
* KWCV       ,KWH       ,KWHV      ,KWT       ,K1       ,
* K2         ,K3        ,K4        ,K6       ,MTERM1    ,
* MTERM2     ,MTERM3    ,MTERM4    ,NPRN     ,NTERM     ,
* PHI        ,PNOZO     ,PNTTHA    ,PRESM     ,PRGUES    ,
* PRPRIM     ,PRTERM    ,PSIP       ,PTANKN     ,P6N       ,
* P8N        ,P8PR      ,QN        ,QPM       ,QTERM     ,
* RHGR       ,RHOTKN    ,RHOTKN    ,RPM2     ,SPRIME    ,
* STERM      ,STSTAG    ,TFLUSR    ,TIMEMT    ,TIMEN     ,
* TTANKN     ,TTURO     ,TVP       ,TWTERM    ,T11N     ,
* T11SR      ,T8N       ,WATERM    ,WDILN     ,WCTERM    ,
* WERROR     ,WETPER    ,WHEPN     ,WI        ,WNCHOK   ,
* WNT        ,WPACTN    ,WRTERM    ,WTERM     ,WTURN     ,
COMMON
*/TPAS/
* ARE        ,ATURO     ,ATURX     ,DROLNZ     ,DTUR       ,
* DTURNZ     ,ETAMIN    ,GATEFG    ,KBEAR     ,KTURO     ,
* KTURX      ,MUPT      ,NWCRC     ,PTURI     ,TIPVEL    ,
* T1URI      ,WWORK     ,
COMMON
*/X/
* EOTAP      ,INDTUR     ,INTFLO     ,LARGET     ,LESPD     ,
* LOOPN      ,MCP       ,NEG       ,NONQP     ,NONSPD    ,
* NQNTC      ,NGN       ,NOTURN     ,NOTURN     ,NTERR     ,
* PARONE     ,WITER      ,
GO TO 20
10 IF (HBPFG.NE.0.0) GO TO 20
WDILX = HBPFC
GO TO 30
20 HBPFC = WDILX
30 TCUR = TPUMOC
IF (WPUMC.GE.0.0) GO TO 40
WPUMC = 0.0
WDILX = 0.0
HBPFC = 0.0
40 IF (XOPEN.EQ.0.0).AND.(XINTFLO.NE.0.0) GO TO 50
CALL PT (PTANKX,TCUR)
PPUMOC = PTANKX - KPUMI * WPUMC ** 2 / (2.0 * 12.0 * G * RHQ * APUMI ** 2)
PUMIP = PPUMOC
PCLR = PPUMOC
WCUR = WPUMC
CALL ENGINE
IF (XINTFLO.NE.0.0).AND.(XINDTUR.EQ.0.0) GO TO 60
HBPFC = WNCHOK
GO TO 70
60 IF (IOPEN.NE.0.0).OR.(HBPFG.NE.0.0) GO TO 70
CALL HBP SUB
70 IF (IOPEN.NE.0.0).AND.(TANK.NE.0.0) GO TO 80
CALL ITER (9,WPUMC,WNOZ,WNCHOK,&10)
GO TO 90
80 CALL ITER (10,PTANKX,WNCHOK,WNOZ,&10)
90 DUM = WDILX

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SUBROUTINE FLOW

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CALL ITER(11, DUM, MDILX, HBPWC, 610)
IF(TTURI.EQ.0.0)GO TO 100
IF(HBPG.NE.0.0)GO TO 95
CALL ITER(12,BELLOW(2),TTURIX,TTURIP,620)
GO TO 100
95 CALL ITER(12,MDIL,TTURIX,TTURIP,620)
100 CONTINUE
RETURN
END
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C      SUBROUTINE FUEL
      FUEL
      IMPLICIT REAL*8 (A-Z)
      REAL*4 LINES(333)
      INTEGER*4
      * DTAG          ,I          ,IDELZS          ,IEND          ,IM(5)          ,
      * J            ,JEND        ,K            ,KEND(5)        ,L            ,
      * LEND          ,MTAG(30)    ,NOFIND          ,NTAG          ,PTAG          ,
      * XIAG(5.5)     ,II          ,M            ,NOBNT          ,NODENT          ,
      * NZTRGT        ,NTCNT       ,NMCNT          ,NODEPT        ,NPARTS          ,
      * JJ            ,KK          ,LL            ,INODE         ,KLOQP          ,
      * REF           ,IDELT       ,NTPNTS         ,NODZ          ,NK            ,
      * TTAG          ,CTAG        ,CJ(20)         ,REFR          ,
      * NOBSK,NODESK,SNCNT,STAG
      INTEGER*4 TPASS(10)
      DIMENSION BD(11)          ,FLAGS(27)          ,GUESS(16)          ,HBF(55)          ,
      1 NOZTUB(27) ,PIL(9)      ,PRTS(9)           ,TPA(17)          ,VALVE(5)          ,
C      NUMERIC INPLT
      NAMELIST/NERVA/AFLOW,AJHT,AMIDP,ANTC,ANTH,ANTW,ASTH,ASTW,ATURNC,
      *BD,BEND,CAP,CDJ,CDNT,CDST,CFWP,CG,CNTMAX,CONDI,CPJ,CPNT,CPST,CRJ,
      *CRJNT,CTBL,DEL,DELHN2,DELFNT,DELPNZ,DELZ,DINDBL,DNOZW,DSNZW,DTURX,
      *ERRCNT,ETAINN,FFTAB,FILMA,FILMB,FILMC,FLAGS,FRICF,GP,GUESS,HBFLOW,
      *HBP,HFFLG,HFTAB,HG,HGF,HGFJ,HGFNTC,HGFNTH,HGJ,HGNTC,HGNTH,INDEF,
      *INDHD,INTEFF,ITERI,KDPI,KDPO,KMIDP,KPD,KPDV,KSTI,KSTO,KV,MI,MINNP,
      *MINNW,MUIT,NBEND,NDELZ,NI,NQBS,NQDEK,NTIP,NTIT,NTIW,NZIP,NZIT,
      *NZIW,NZTUB,NT,OPT,PAMB,PBD,PC,PCARD,PINLET,PLENI,PLENO,PLINE,
      *PRATIO,PRTS,PTURMO,PUMP,QID,GPD,RHOJ,RHOMTL,RHONT,RHUST,RN,SCFWP,
      *SJO,SKBN,SKCG,SKDZ,SKDEL,SKRN,SNODES,SNOZ,SNTC,SNTH,SN TJ,SSNZ,
      *SSPR,SSTH,STATIC,SZMIN,TC,TCLOC,TIMER,TINLET,TKJ,TKNTC,TKNTH,
      *TKSTH,TMTI,TNODE,TNOZ,TPA,TSHT,TSNZW,TSTHOT,TTK,TUREFF,TURIP,
      *TURIT,VALVE,VNODES,VOIDF,WALL,WDIL,WETP,WPUN,WX,PIL,C.
C      RESTART DATA INPUT(PCARD NONZERO)
      *DELHN,EINDP,EINTP,EPUMP,ETURP,HDPUM,HSVP,WINDP,NTURP,PPUMQP,
      *PTANKX,PTURIX,PTURO,P6N,P8N,QPUMP,RHOFLU,RHOMI,RHOMIX,RHOMO,
      *RHOMOX,RHONTM,RHONZM,TCCLD,TCERO,THGT,TIME,TJACK,TJKTW,TJKWD,
      *TMETAL,TNOZW,TNTCLD,TNTHOT,TNTJWD,TFUMQP,TTANKX,T11N,T8N,WDILN,
      *WHBPN,WI,WNOZM,WNTM,WPUNC,WPUMP,
C      ALPHA-NUMERIC INPUT
      *DILREM,LINES,MPARTS,NTNAME,PARTS,PLNAME,STNAME,XPARTS,
C      INTEGER INPUT
      *TPASS
      COMMON /ADD/
      * ARG          ,ARG1          ,ARG2          ,ATURNP          ,C(10)          ,
      * CARDS(11)     ,DELTAP        ,DTURX          ,GASVEL          ,HCORO          ,
      *              ,HFCDEF         ,HPIN           ,HPOUT          ,HTANKN          ,
      * HTURIX        ,KVSQRT        ,MACH           ,NBEND          ,PPOUT          ,
      * PEROT         ,PTURPB        ,PREDFL         ,PVPOR          ,PTXST          ,
      * PFLOW         ,PTXMIN        ,PUNPM          ,RF            ,RNRQT          ,
      *              ,RATIO          ,RATIOC         ,SPEED          ,TTROT          ,
      * TEMPY         ,TMX           ,TJKWD1         ,TNTNZ1         ,TNTH1          ,
      * TPOUT         ,TPIN          ,TXMIN          ,TMX            ,
      * UNCHOK        ,T2NP1(30)     ,T3NP1(30)     ,T3NP1(30)     ,SAVN(15)          ,SAVNT(20)          ,
      * SAVX(20,8)     ,SAVPT(20,18),SAVJ(30,27)     ,SAVJ(30,27)     ,SAVIJ(30,20,9)          ,
      COMMON /AT/
      * ANOZTX        ,CDJX          ,CNTCX          ,CNTHX          ,CPX            ,
      * CRJNTX        ,CRJX          ,DELM           ,DELP1          ,DELPK          ,
      * DELPO         ,DELRHO        ,DELTX          ,DELM          ,DELZSQ          ,
      * DELZX         ,DELZX4        ,HGCJKT         ,HGCNTC         ,HGCNTH          ,
      * HI            ,HJ            ,HK            ,HL            ,HLPRIM          ,
      * HRNTJW        ,HROJ          ,MIN            ,MZN            ,PIN            ,
      * PJ            ,PK            ,PL            ,PLPRIM         ,RFLUX          ,
      * RHOMIX        ,RHOMOX        ,RHOMX          ,RHONIX         ,RHONOX          ,
      * RHOX          ,SJOX          ,SNOZX          ,SNCTX          ,SNTH          ,
      * TAMBX         ,TCUR          ,THCUR          ,TNEDIF         ,TJKCUR          ,
      * TKJX          ,TKNTCX        ,TKNTHX         ,WNODEN         ,WNODI          ,
      * ZMAX          ,ZMIN          ,ZTROT          ,
      COMMON /AZ01/
      * CSUBP(30,20)   ,FILMHF(30,20) ,PRESS(30,20) ,RHOFLU(30,20) ,
      * RHOPT(30,20)   ,TFLUID(30,20) ,TMETAL(30,20) ,WRATEM(30,20) ,

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* WRATEN(30,20)
COMMON /AZIO/
* FILMNZ(30) * FILMTC(30) * FILMTH(30) * HRNQZW(30) * HRNTCW(30)
* HRNTHW(30) * PNOZ(30) * PTUBE(30) * RHONTM(30) * RHONTN(30)
* RHONZM(30) * RHONZN(30) * TCOLD(30) * THGT(30) * TJACK(30)
* TJKTWD(30) * TJKWO(30) * TNGZ(30) * TNOZM(30) * TNOZN(30)
* TTHGT(30) * TNTJWD(30) * TTUBE(30) * WNOZM(30) * WNOZN(30)
* WNTM(30) * WNTN(30)
COMMON
*/BDLS/
* ALINE * BDOWN * BOPD * CPVOL * IMASS
* LFILM * PINPUT * PTANKIN * TAME * TTANKIN
* VTANK
COMMON /EXTRA/
* PUMIP * QPUM * TCK * TNKRHO * TPT2
* IPCR * TPQ * TPX2 * TPXPD * TPWH
* KPUMPI * WBEAR * MBEAR * WPUMPC
* ATURNZ * ATURN * ATUR * ARCLNZ
* PAVG * WPMAX * TIPVEL * PPIA
* CR * TTURIP * GAMMA * PTCOLO
* HDILX * CPTI * GANTI * TTXST * KVLMIN
* KIPMIN * WPCNT * TURWK * TCTMP * TPNW
* TRRK * TIMER * PCARD * RHOM
* DELZP * ZM * ZM1 * DELPT * DELPMT
* HLPHF * HLPFCF * TK * DTROT * DELZT
* TRCTZ * RNDIST * RFN * Q
* TCHOK * WNCFI * WNCIT * HTCNT
* FNTH * THEA1 * THETA2 * MAN3 * MEN3
* TINTWD1 * TDIFM * SACPR * FNTC * MDN2
* MBN2 * FJ * MCN1 * MDN1 * TINTCD1
* TIMEZ * ETAP * TPT20 * METLTN * TRTAV
* PTURON * DUM * QMAX * OZ * TENPTM(30)
COMMON
*/FLAG/
* ETAPFL * HBPFG * MASS * MTIME * NTIME
* NAIT * OPEN * OPTION * PMINO * STATE
* TANK * TAPE * TFLUM * TIMEI * TIMEX
* TNETMO * WINT * TIMES(10)
COMMON
*/GUES/
* PCTCE * PTANK * PTURDE * PUMHDE * PUMOG
* PUMKE * TDIL * TTANK * TMETI * TURSPD
* WDILE * WDILG * WHBPG * WNTI * WORKE
* WPLMPG
COMMON
*/HBPS/
* ACCRO * ANNUL * ANGZT * BELSEC * CFILMA
* CFILMB * CFILMC * CGAS * COMP * DCWH
* DHBP * DILANG * DPASS * FCOLD * FHOT
* HBGG * HFILMA * HFILMB * HFILMC * HGAS
* INCOMP * KDEL * KDIL * KHPI * KJTUR
* KPCM * KPHM * K11 * K9 * LHBP
* MTHICK * NCWH * NHBP * NPASS * RPASS
* BELON(20)
COMMON /LINE/LINES
COMMON /LITER/NAMES(10) * CTIME * COMENT * BLANK * MI * NI * CNTMAX * ZERO
COMMON
*/ERRCNT/
COMMON
*/MISC/
* PCX * PDK * PDKV * PTUROC * PTUROP
* HBPKV * HBPW * HBPWC * HBPWNC
* METLTO * MINFLO * PASSX * SSOUT * WPIT
* TTEMP(20) * TTEMP(20) * DELMN2(200) * PUMP(350) * FILMA(20)
* FILMB(20) * FILMC(20) * TCFLG(20)
COMMON
*/NAMTAG/
* DILREM * HM * HX * MPARTS(30) * NTNAME
* PARTS(20) * PLNAME * PM(5) * PX(5) * TM(5)
* TDELZ(20) * TPARTS(20) * TX(5) * WM(5) * WX(5)
* XPARTS(5,5) * CPARTS(20) * CDELZ(20)

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SUBROUTINE FUEL

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* TTK(20)      ,VOIDF(20)  ,WALL(20)
* ,TNTI(20)
COMMON
*/TAGS/
* DTAG          ,I          ,IDELZS          ,IEND          ,IM          ,
* J            ,JEND        ,K            ,KEND        ,L          ,
* LEND          ,MTAG        ,NGFIND         ,NTAG         ,PTAG         ,
* XTAG          ,II         ,M            ,NOBNT         ,NODENT        ,
* NZTROT        ,NTCNT       ,NMCNT         ,NGDEPT        ,NPARTS        ,
* JJ           ,KK          ,LL           ,INODE         ,KL00P         ,
* REF           ,IDELT       ,NTPNTS        ,NODZ          ,NK          ,
* ITAG          ,CTAG        ,CJ           ,REFR          ,
* NOBSK,NODESK,SMCNT,STAG
COMMON /TIMEI/TPASS
COMMON /IP/
* AFLOWA        ,BATERM      ,BATERS         ,CDMTL         ,CPTERM        ,
* BDELZ         ,DELHM       ,DELHN         ,DELHNX        ,DELPN        ,
* DELTER        ,DHYDRA      ,DPIPE        ,DTERM         ,DZTERM        ,
* ENTROP        ,ETAT        ,ETATP         ,GPN          ,HFTERM        ,
* HGCOEF        ,HGTOT       ,HPUMI         ,HTCOEF        ,HVTERM        ,
* H12           ,KT          ,KVN          ,KWC          ,KWCP        ,
* KMCV          ,KWH         ,KWHV         ,KWT          ,K1          ,
* K2            ,K3          ,K4           ,K6           ,MTERM1       ,
* MTERM2        ,MTERM3      ,MTERM4       ,NPRN         ,NTERM        ,
* PHI           ,RNOZO       ,PNTHR        ,PRESM         ,PRGUES       ,
* PRPRIM        ,PRTERM      ,PSTP         ,PTANKN        ,P6M         ,
* P6N           ,P8PR        ,QN           ,QPM          ,QTERM        ,
* RHOR          ,RHOTKM      ,RHCTKN        ,RPM2         ,SPRIME       ,
* STERM         ,SISTAG      ,TFLUSR        ,TIMENT        ,TIMEN        ,
* ITANKN        ,TTURO       ,TVP          ,TWTERM        ,T1IN        ,
* T11SR         ,T8N         ,WATERM        ,WDILN        ,MDTERM       ,
* WERROR        ,WETPER      ,WHBPN         ,WI           ,WNCHOK       ,
* WNT           ,WPACTN      ,WRTERM        ,WTERM         ,WTURN        ,
* WTERM
COMMON /TFAS/
* ARE           ,ATURO       ,ATURX         ,DROLNZ        ,DTUR         ,
* DTURNZ        ,ETAMIN      ,GATEFG        ,KBEAR        ,KTURO        ,
* K1URX         ,MUPT        ,NWGRK         ,PTURI         ,DTURBL       ,
* ITURI         ,WWORK
COMMON /TSTP/MNIX,KDILN,KHBPN,KJTUN,NINDP,TIPVIN,EINDC,PINDIN,
* HINDIN,TINDIN,PVAPIN,HSVINP,HINDEX,EINDP,INDPH,PINDEX,ETAIND,
* PMID,TMID,EINTC,PMIDSG,TMIDSG,EINTP,ETAIN,AMID,CEE,KMIDP,AMIDP,
* QMIDP,MINNW,MINNP,ETAIMN,MUIT,DINDBL,RHO1,RHO2,RHO3,RHO4,TINDEX,
* SPIN,SPIN2,SPEED2,TTXSTP,TTTOT,TTXGIS,TTXSI,ETAINP,FLOWP,NINDC
* ,CTBL(30),INTEFF(30),QID(30),INDHD(300),INDEF(300)
COMMON
*/VALS/
* KL           ,KO          ,KVMIN         ,VLSWT         ,VSWTPC        ,
EQUIVALENCE
1(GUESS(1),PCTCE) ,{(HBP(1),ACORO) ,{(FLAGS(1),ETAPFL) ,
2(FIL(1),ACL) ,{(PRTS(1),ANOZI) ,{(NOZTUB(1),AJB) ,
3(VALVE(1),KL) ,{(TPA(1),ARE) ,
DIMENSION ITERI(420)
COMMON /IERS/
* PCNT1(30) ,PCNTN(30) ,ICNT(30) ,ITF(30) ,MINX(30) ,MAXX(30) ,
* XMN(30) ,XMAX(30) ,XNAM(30) ,YNAM(30) ,XOLD(30) ,YOLD(30) ,
EQUIVALENCE (ISWT(1),ITERI(1))
IF(CTIME.EQ.0.0)GO TO 5
IF(TIMER-TIME)70.30.70
5 CALL ZERO
30 READ(5,NERVA,END=50,ERR=60)
IF(CTIME.NE.0.0)GO TO 40
WRITE(6,80)
WRITE(6,NERVA)
40 CALL PARTAG
CALL ITERM(2,PUNWKE,0.000,0.000)
CALL ITERM(4,PCTCE,1.000,1000.000)
CALL ITERM(6,PCTCE,1.000,1000.000)
CALL ITERM(7,PCTCE,GATE(1),KV(2))
CALL ITERM(8,PCTCE,0.000,90.000)

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SUBROUTINE FUEL

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CALL ITERM(11,WDILE,0.0D0,0.0D0)
CALL ITERM(12,WDILE,0.01D0,1000.0D0)
NODENT = NODES
NCBNT = NBEND
NODESK = NODEK
NOBSK = NOBS
CALL PREDIN
GO TO 76
50 STOP
60 CALL ERROR
70 RETURN
80 FORMAT('INPUT',45X,'NERVA ENGINE TRANSIENT PROGRAM')
END
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SUBROUTINE GPSUB(GPBRCH,GPKTP,KVL)

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SUBROUTINE GPSUB(GPBRCH,GPKTP,KVL)
C   GATE POSITION SUBROUTINE
C   GPBRCH = -1, KTPMIN = 0, KTP = 1, GATE POSITION
C   IMPLICIT REAL*8 (A-Z)
COMMON /ADD/
*   ANG          *   ARG1          *   ARG2          *   ATURNP          *   BUF(10)
*   CARDS(11)    *   DELTAP        *   DTURX        *   GASVEL          *   HCDRD
*   HTURIX        *   HFCDEF        *   HPIN         *   HPOUT           *   HTANKN
*   PTROT        *   KVSQRT        *   MACH         *   NBEND           *   PPOUT
*   PFLOW        *   PTURPR        *   PREDFL       *   PVAPOR          *   PTXST
*   TEMPY        *   PTXMIN        *   PUMPH        *   RF              *   RNTROT
*   TPOUT        *   RATIC          *   RATIOC       *   SPEED           *   TTROT
*   UNCHK        *   TMX            *   TJKND1       *   TNTNZ1          *   TNHT1
*   T2NP1(30)    *   TRIN            *   TTXMIN       *   TMIX            *   TMIK
*   T1NP1(30)    *   T2NP1(30)        *   T3NP1(30)    *   FILMNT          *   GPUMI
*   SAVX(20,8)   *   SAVPT(20,18)    *   SAVJ(30,27)  *   SAVN(15)        *   SAVNT(20)
COMMON
*   FLAG/
*   ETAPFL        *   HBPFG          *   MASS          *   MTIME          *   NTIME
*   NMT           *   OPEN           *   OPTION        *   PMING          *   STATE
*   TANK          *   TAPE           *   TFLUM         *   TIMEI          *   TIMEX
*   TNETMO
COMMON
*   TABI/
*   AJHT(30)      *   ANTC(30)       *   ANTH(30)      *   ANTW(30)       *   CDJ(30)
*   CDNT(30)      *   CFWP(30)       *   CG(30)        *   CPJ(30)        *   CPNT(30)
*   CRJ(30)       *   CRJNT(30)      *   DEL(30)       *   DELPNT(30)     *   DELPNZ(30)
*   DNGZW(30)     *   GATE(30)       *   GP(30)        *   HGFJ(30)       *   HGFNTC(30)
*   HGFNTM(30)    *   HGJ(30)        *   HGNTC(30)     *   HGNTM(30)      *   KPD(30)
*   KPDV(30)      *   KV(30)         *   NT(30)        *   PAME(30)       *   PBD(30)
*   PC(30)        *   PINLET(30)     *   PLINE(30)     *   PRATIO(30)     *   PTURMO(30)
*   QPD(30)       *   RHQJ(30)       *   RHQNT(30)     *   RN(30)         *   SJD(30)
*   SNCZ(30)      *   SNTC(30)       *   SNTH(30)      *   SNTJ(30)       *   SSPRT(30)
*   TC(30)        *   TINLET(30)     *   TKJ(30)       *   TKNTC(30)      *   TKNTH(30)
*   TUREFF(30)    *   VNODES(30)     *   WDIL(30)      *   WPUM(30)       *   BEND(30)
*   TURIT(30)    *   TURIP(30)      *   HBFLOW(30)
COMMON
*   VALS/
*   KL           *   KO            *   KVMIN         *   VLSWT          *   VSWTPC
REAL*4 GPBRCH
IF(GPBRCH)1C,30,20
10 KVL=GPKTP
GO TO 60
20 KVL=GPKTP
GO TO 50
30 IF((OPTION.NE.0.0).OR.(OPTION.NE.2.0))GO TO 90
CALL INTP(KV,GPKTP,KVL)
KVL=KVL+KL
50 IF(VLSWT.EQ.0.0)GO TO 75
60 KVSQRT = 4.0/(KO*KVL)
IF(KVSQRT.GT.0.0)GO TO 65
KVSQRT = 0.0
GO TO 70
65 KVSQRT = DSQRT(KVSQRT)
IF(GPBRCH.LE.0.0)GO TO 70
KVSQRT=-KVSQRT
70 KVL = 1.0/(1.0/KO + 1.0/KVL + KVSQRT)
75 IF(GPBRCH.LE.0.0)GO TO 90
80 CALL INTP(KV,KVL-KL,KVL)
90 RETURN
END

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C SUBROUTINE HF(OPT,W,P,TB,H,TW,C,SIG,AFLO,FILMCX)
C THIS SUBROUTINE CALCULATES A FILM COEFFICIENT.

C IMPLICIT REAL*8 (A-Z)
C INTEGER IOPT,IND,ICF,IPF

C COMMON / FLUID P/ A(35)
C COMMON / DPC/ FFTAB(4,30) ,HFTAB(5,30)

C USE IOPT FLAG TO SET UP EQUATION SWITCH OPTIONS.

C IOPT = OPT
C IND = HFTAB(1,IOPT)
C ICF = HFTAB(2,IOPT)
C IPF = HFTAB(3,IOPT)
C BEXP = HFTAB(4,IOPT)
C ALF = HFTAB(5,IOPT)

C IF TB IS ZERO, H WILL BE USED TO OBTAIN BULK PROPERTIES.

C IF (TB.NE.C.) GO TO 50

C CALL PH (P,H)

C TB = A(4)

C GO TO 51

50 CALL PT (P,TB)

51 RHOB = A(5)

C VISB = A(11)

C CALL PT (P,TW)

C RHOH = A(5)

C VISW = A(11)

C UP TO 5 IND OPTIONS ARE EXPECTED. ONLY 2 AVAILABLE AS OF 4/22/67.

C GO TO (1,2),IND

1 THD = TB

C GO TO 100

2 THD = 0.5*(TB+TW)

100 CALL PT (P,THD)

C RHOHD = A(5)

C CPHD = A(7)

C KHD = A(10)

C VHD = A(11)

C UP TO 5 PF OPTIONS EXPECTED. 2 AVAILABLE AS OF 4/22/67.

C GO TO (6,7),IPF

6 PF = 1.0

C GO TO 101

7 PF = (RHOHD/RHOB)**.8

C UP TO 20 CF OPTIONS EXPECTED. 6 AVAILABLE AS OF 4/22/67.

101 GO TO (11,12,13,14,15,16),ICF

11 CF = 1.0

C GO TO 102

12 CF = TB/TW

C GO TO 102

13 CF = 1.+0.1457*VISB*RHOB/(VISB*RHOH)

C GO TO 102

14 CF = VISB/.2103E-6

C CF = (1.+0.1457*VISB*RHOB/(VISB*RHOH))*CF**.67

C GO TO 102

15 CF = 2.*TB/(TB+TW)

C GO TO 102

16 CF = 2.*SIG*TB/(TB+TW)

102 FILMCX = W*CPHD*KHD/(2.*VHD)

C IF FILMCX.LE.0.1 GO TO 103

C FILMCX = KHD*C*FILMCX**2

C IF (FILMCX.LE.0.) GO TO 103

C FILMCX = ALF*PF*(CF**BEXP)*(FILMCX**0.2)/AFLO

103 RETURN

C END

```

C      SUBROUTINE INITD
      INITD
      IMPLICIT REAL*8 (A-Z)
      INTEGER*4
      * DTAG      * I      * IDELZS      * IEND      * IM(5)      *
      * J      * JEND      * K      * KEND(5)      * L      *
      * LEND      * MTAG(30)      * M      * M      * MTAG      *
      * XTAG(5,5)      * II      * N      * NOBNT      * NODENT      *
      * NZTRCT      * NTCNT      * NMCNT      * NCDEPT      * NPARTS      *
      * JJ      * KK      * LL      * INODE      * KLOOP      *
      * REF      * IDELT      * NTFNTS      * NCDZ      * NK      *
      * TTAG      * CTAG      * CJ(20)      * REFR      *
      COMMON /A201/
      * CSUBP(30,20)      * FILMHF(30,20)      * PRESS(30,20)      * RHOFLU(30,20)      *
      * RHOFTP(30,20)      * TFLUID(30,20)      * TMETAL(30,20)      * WRATEM(30,20)      *
      * WRATEN(30,20)      *
      COMMON
      * FLAG/
      * ETAPFL      * HBPFPG      * MASS      * MTIME      * NTIME      *
      * NAIT      * OPEN      * OPTION      * PMIND      * STATE      *
      * TANK      * TAPE      * TFLUM      * TIMEI      * TIMEX      *
      * TMETNO      * WINT      * TIMES(10)      *
      COMMON
      * FLUIDP/
      * PRES      * ZFACT      * QUAL      * TEMP      * RHO      *
      * GAM      * CP      * VEL      * ENTR      * COND      *
      * VIS      * VOL      * ENTH      *
      COMMON
      * FX/
      * DELTEM(20)      * FLUTEM(20)      * METTEM(20)      * MSMALL(20)      * MTPNTS(20)      *
      * PARTI(20)      * PARTPS(20)      * TEMPEX(20)      *
      COMMON
      * GUES/
      * PCTCE      * PTANK      * PTUROE      * PUMHDE      * PUMOG      *
      * PUMWKE      * TDIL      * TTANK      * TMETI      * TURSPD      *
      * WDILE      * WDILG      * WHEPG      * WNTTE      * WORKE      *
      * WPUMPG      *
      COMMON /MISC/
      * PCX      * PDK      * PDKV      * PTUROC      * PTURUP      *
      * HBPKE      * HBPW      * HBPWC      * HBPWNC      *
      * METLTO      * MINFLO      * PASSX      * SSOUT      * WPIT      *
      * ITEMP(20)      * GTEMP(20)      * DELHN2(200)      * PUMP(350)      * FILMA(20)      *
      * FILMB(20)      * FILMC(20)      * TCFLG(20)      *
      COMMON
      * P/
      * ALPHA      * BETA      * DIST      * EPUNC      * EPUMP      *
      * ETURC      * ETURP      * FILMCX      * GATEP      * HOPUM      *
      * HSVC      * HSVP      * MHT      * NHT      * NTURC      *
      * NTURP      * PCORD      * PCUR      * PDIL      * PHEPO      *
      * PMINOX      * PNTI      * PNTQ      * PPUMOC      * PPUMOP      *
      * PTANKX      * PTURIX      * PTURO      * QPUMP      * RFLU      *
      * SAC      * TCORO      * TCOROR      * TCUR      * TDILX      *
      * THBPQ      * TIME      * TIMEP      * TMETL      * TMTI      *
      * TINTO      * TPUMOC      * TPUMOP      * TTANKX      * TTURIX      *
      * T12MIX      * UING      * WCUR      * WDILX      * WHBP      *
      * NNOZ      * WNTCK      * WNTI      * WNTQ      * WPUMC      *
      * WPUMP      * WTURB      *
      COMMON /PTC/
      * DISPR(20)      * PDROPI(20)      * PDROPG(20)      * PRESI(20)      * PRESO(20)      *
      * RHOMI(20)      * RHQNO(20)      * RHONI(20)      * RHONO(20)      * TEMPI(20)      *
      * TEMPO(20)      * TIMEZM(20)      * WDELMI(20)      * WDELMO(20)      * WDELNI(20)      *
      * WDELND(20)      * WRATEI(20)      * WRATED(20)      *
      COMMON
      * TABI/
      * AJHT(30)      * ANTC(30)      * ANTH(30)      * ANTW(30)      * CDJ(30)      *
      * CDNT(30)      * CFWP(30)      * CG(30)      * CPJ(30)      * CPNT(30)      *
      * CRJ(30)      * CRJNT(30)      * DEL(30)      * DELPNT(30)      * DELPNZ(30)      *
      * DNOZ(30)      * GATE(30)      * GP(30)      * HGFJ(30)      * HGFNTC(30)      *
      * HGFNTM(30)      * HGT(30)      * HGTTC(30)      * HGTTH(30)      * KPD(30)      *
      * KPDV(30)      * KV(30)      * NT(30)      * PAMB(30)      * PBD(30)      *

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B
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```

* PC(30)      ,PINLET(30)  ,PLINE(30)  ,PRATIO(30) ,PTURMO(30) ,
* QPD(30)     ,RHOJ(30)   ,RHCNT(30) ,RN(30)     ,SJO(30)   ,
* SNCZ(30)    ,SNTC(30)   ,SNTH(30)   ,SNTJ(30)   ,SSPRT(30) ,
* TC(30)      ,TINLET(30) ,TKJ(30)    ,TKNTC(30) ,TKNTH(30) ,
* TLREFF(30)  ,VNODES(30) ,WDIL(30)   ,WPUM(30)   ,
* TURIT(30)   ,TURIP(30)  ,MBFLOW(30) ,BEND(30)

```

```

COMMON

```

```

*/TABIJ/

```

```

* AFLOW(30,20),CAP(30,20) ,CONDI(30,20),HG(30,20) ,HGF(30,20) ,
* WETP(30,20)

```

```

COMMON

```

```

*/TABJ/

```

```

* DELZ(20)    ,FRICF(20)  ,HFFLG(20)  ,KDPI(20)   ,KDPO(20)   ,
* NOELZ(20)   ,PLENI(20)  ,PLENQ(20)  ,RMOMTL(20),TNODE(20) ,
* TTK(20)     ,VOIDF(20)  ,WALL(20)

```

```

COMMON

```

```

*/TAGS/

```

```

* DTAG        ,I          ,IDELZS      ,IEND        ,IM          ,
* J           ,JEND       ,K          ,KEND        ,L          ,
* LEND        ,MTAG       ,NOFIND      ,NTAG        ,PTAG        ,
* XTAG        ,II         ,M          ,NOBNT       ,NOCENT      ,
* NZTRDT      ,NTCNT      ,NMCNT     ,NODEPT      ,NPARTS     ,
* JJ          ,KK         ,LL         ,INODE       ,KLOOP      ,
* REF         ,IDELT      ,NTPNTS    ,NODZ        ,NK          ,
* TTAG        ,CTAG       ,CJ         ,REFR

```

```

DC 3 I=1,30,2
IF((KV(I).EQ.0.0).AND.(KV(I+1).EQ.0.0))GO TO 4

```

```

3 II = I + 1

```

```

4 DO 5 I=1,II,2

```

```

5 J = II - 1

```

```

GATE(J) = KV(I+1)

```

```

GATE(J+1) = KV(I)

```

```

DO 120 J=1,JEND

```

```

PARTPS(J) = NOELZ(J)

```

```

INODE = NOELZ(J) + 2.0

```

```

IF(TNODE(J))10,40,20

```

```

10 FLUTEM(J) = TNODE(J)

```

```

GO TO 30

```

```

20 METEM(J) = TNODE(J)

```

```

30 TCLG(J) = TNODE(J)

```

```

40 IF(TMETI.NE.0.0)GO TO 120

```

```

IF(J.GT.1)GO TO 60

```

```

IF(PMINO.NE.0.0)GO TO 50

```

```

CALL INTP(PAMB,-TIMEX,PMINOX)

```

```

GO TO 60

```

```

50 PMINOX = PMINO

```

```

DO 100 I=1,INODE

```

```

IF(TMETI.GE.0.0)GO TO 70

```

```

CALL PT(PMINOX,TMETAL(I,J))

```

```

GO TO 80

```

```

70 IF(I.GT.1)GO TO 90

```

```

CALL PT(PMINOX,TMETI)

```

```

80 IF(I.GT.1)GO TO 90

```

```

RHORI(J) = RHO

```

```

90 TMETAL(I,J) = TMETI

```

```

RHOFLU(I,J) = RHO

```

```

100 CONTINUE

```

```

IF(J.LT.JEND)GO TO 120

```

```

TCORO = TMETAL(INODE,JEND)

```

```

120 DISPRT(J) = DELZ(J)*(NOELZ(J) +.5)

```

```

RETURN

```

```

END

```

A
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C
D

SUBROUTINE INTP(TABLE,XIN,YOUT)

DATE = 18SEP67

PAGE

```
      SUBROUTINE INTP(TABLE,XIN,YOUT)
      INTP - LINEAR INTERPOLATION SUBROUTINE
      TABLE ENTRIES MUST BE X,Y PAIRS FOLLOWED BY 0,0
      MINIMUM OF 2 X,Y PAIRS - MAXIMUM OF 28 X,Y PAIRS
      CALL INTP(TABLE,XIN,YOUT)
      TABLE - TABLE STORED AS X1,Y1,X2,Y2,ECT.,0,0
      XIN - X INPUT
      YOUT - INTERPOLATED Y AT XIN
      REAL*8 TABLE(30),XIN,YOUT
      IF(TABLE(1).EQ.-1.0D0)GO TO 30
      I=1
10    I=I+2
      IF((TABLE(I+2).EQ.0.0).AND.(TABLE(I+3).EQ.0.0))GO TO 20
      IF(XIN.LE.TABLE(I))GO TO 20
      IF(I.LE.27)GO TO 10
20    YOUT = (XIN - TABLE(I-2))*(TABLE(I+1)-TABLE(I-1))/(TABLE(I) -
      1 TABLE(I-2)) + TABLE(I-1)
30    RETURN
      END
```

B
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H
I

L

N

```

SUBROUTINE ITER(I,X,YI,YJ,*)
C GENERAL NEWTON TYPE ITERATION SCHEME
C CALL ITER(I,X,YI,YJ,*)
C I - ITERATION NUMBER
C X - INDEP VARIABLE
C YI - DEP VARIABLE F(X)
C YJ - DEP VARIABLE G(X)
C * - NON-CLOSURE RETURN STATEMENT NUMBER
C ISNT - PRINT FLAG
C DEL - DEP VARIABLE TOLERANCE
C MINX - MINIMUM X
C MAXX - MAXIMUM X
C PCNT1 - FRACTIONAL AMOUNT TO INCREMENT 1ST X
C PCNTN - FRACTIONAL AMOUNT TO INCREMENT NTH X
C ICNT - COUNTER(1-15,NOT CLOSED)(0,CLOSED)
C ITF - FLAG, POS=NEWTONS, NEG=COUNTER TYPE ITERATION
C XNAM - INDEP VARIABLE NAME(8 CHAR MAX)
C YNAM - DEP VARIABLE NAME(8 CHAR MAX)
C ITERATION LOCATED IN STATEMENT
C NUMBER SUBROUTINE NUMBER
C-----
C 1 MC 50 - 60
C 2 MC 70 - 90
C 3 -
C 4 MC 115 - 120
C 5 MC 120
C 6 MC 130 - 140
C 7 MC 140
C 8 MC 150 - 160
C 9 FLOW 70 - 80
C 10 FLOW 80
C 11 FLOW 90 - 95
C 12 FLOW 90 - 95 (HBPSUB,SHBP)
C 13 TUBES 360 - 365
C 14 PREDIC 1034 - 1037
C 15 PREDIC 1040 - 1050
C 16 PREDIC 1070 - 1075
C 17 TURBIN 1040 - 2000
C 18 TURBIN 2010 - 2020
C 19 SHBP 2021 - 9998
C 20 SHBP 9998 - 9999
C 21-25 ENGINE 60
C 26-30 -
C IMPLICIT REAL*8(A-Z)
C REAL*8 X,YI,YJ
C REM TO DELTA,MIN,MAX
C INTERMEDIATE
C COMMON /ADD/
C ARG1 ARG2 ATURNP BUF(10)
C DELTAP DTURX GASVEL HCORO
C HFCDEF HPIN HPOUT HTANKN
C KVSQRT MACH NBEND PPOUT
C PTURPR PREDFL PVAPOR PTXST
C PFLW PUMPH RF RNTROT
C RATIOC SPEED TTROT
C IMX TJMWD1 TINTN1
C IPIN TTXMIN TMIX
C UNCHK FILMNT QPUMI
C T1NP1(30) T2NP1(30) T3NP1(30) SAVN(15) SAVNT(20)
C SAVF(20,8) SAVPT(20,18) SAVJ(30,27) SAVIJ(30,20,9)
C COMMON /EXTRA/
C PUMPH QPUM TCX TNRMO IPT2
C TPCR TRK2 TPKPD TPMH
C KRNPL UBEAR NBEAR WPUMPC
C ATURN ATURNC ARQLNZ PMIX
C PAVG WPMAX DTURBL PPIN TAVE
C CR TTURIP GAMMA PTOOLO
C MDILX CPTI GANTI TTXST KVLMIN
C KIPMIN WPCNT TURNK TCTMP TPNW
C TPNR TPNR PCARD RMOM

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S
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* DELZP      ,ZM      ,ZM1      ,DELPT      ,DELPMT      ,
* HLPHF      ,HLPCF      ,TK      ,DTRCT      ,DELZT      ,
* TRCTZ      ,RNDIST      ,RFN      ,Q      ,
* TCHOK      ,WNCF      ,WNCF1      ,WMNIT      ,HTCNT      ,
* FNTH      ,THETA1      ,THETA2      ,MAN3      ,MEN3      ,
* TNTWD1      ,TDIFM      ,SACPR      ,FNTC      ,MDN2      ,
* MBN2      ,FJ      ,MCN1      ,MDC1      ,TNTCD1      ,
* TIMEZ      ,ETAP      ,TPT20      ,METLTN      ,TPTAV      ,
* PTURDM      ,DUM      ,OMAX      ,OZ      ,TEMPTM(30)
COMMON /MISC/
* FCX      ,PDKV      ,PTURDC      ,PTUROP      ,
* HBPV      ,HBPW      ,HBPWC      ,HBPWNC      ,
* METLTG      ,MINFLG      ,PASSX      ,SSOUT      ,WPIT      ,
* ITEMP(20)      ,UTEMP(20)      ,DELHN2(200)      ,PUMP(350)      ,FILNA(20)
* FILMB(20)      ,FILNC(20)      ,TCFLG(20)
COMMON /P/
* ALPHA      ,BETA      ,DIST      ,EPUMC      ,EPUMP      ,
* ETURC      ,ETURP      ,FILMCX      ,GATEP      ,HDPUM      ,
* HSVC      ,HSVP      ,MHT      ,NHT      ,NTURC      ,
* NTURP      ,PCORC      ,PCUR      ,PDIL      ,PHEPD      ,
* PMINOX      ,PNTI      ,PNTD      ,PPUMOC      ,PPUMOP      ,
* PTANKX      ,PTURIX      ,PTURO      ,QPUMP      ,RFLU      ,
* SAC      ,TCORO      ,TCOROR      ,TCUR      ,TDILX      ,
* THBPQ      ,TIMEP      ,TIMEP      ,TNETL      ,TNTI      ,
* TINTO      ,TPUMOC      ,TPUMOP      ,TTANKX      ,TTURIX      ,
* T12MIX      ,UIHG      ,WCUR      ,WDILX      ,WHEP      ,
* WNOZ      ,WNTCK      ,WNTI      ,WNTD      ,WPUMC      ,
* WPLMP      ,WTURB
COMMON /ITERS/
* PCNT1(30)      ,PCNTN(30)      ,ICNT(30)      ,ITF(30)      ,XOLD(30)      ,YOLD(30)
* XMIN(30)      ,XMAX(30)      ,XNAM(30)      ,YNAM(30)
COMMON /LITER/NAMES(10),CTIME,COMENT,BLANK,M1,NI,CNTMAX,ZERO
NAMELIST /ADDN/
* ARG      ,ARG1      ,ARG2      ,ATURNP      ,
* DELTAP      ,DTURX      ,GASVEL      ,HCDRO      ,
* HFCQEF      ,HPIN      ,HPOUT      ,HTANKN      ,
* HTURIX      ,KVSQRT      ,MACH      ,NBEND      ,PPOUT      ,
* PTROT      ,PTURPR      ,PREDFL      ,PVAPOR      ,PTXST      ,
* RFLOW      ,PTXMIN      ,PUMPH      ,RF      ,RNTROT      ,
* TEMPY      ,RATIO      ,RATIOC      ,SPEED      ,TTROT      ,
* TPOUT      ,TPIN      ,TJKWD1      ,TNTNZ1      ,INTHT1      ,
* UNCHOK      ,FILMNT      ,QPUMI      ,TTXMIN      ,TMIX
NAMELIST /EXTRAN/
* PLMIP      ,QPUM      ,TCX      ,TNKRHO      ,TPT2      ,
* TPCR      ,TPQ      ,TPK2      ,TPKPD      ,TPWH      ,
* KRMPI      ,WBEAR      ,HBEAR      ,WPUMPC      ,
* ATURNZ      ,ATURN      ,ATUR      ,AROLNZ      ,PMIX      ,
* PAYG      ,WPMAX      ,DTURBL      ,PPIN      ,TAVE      ,
* CR      ,TTURIP      ,GAMRA      ,PTDLO      ,
* HDILX      ,CPTI      ,GAMTI      ,TTXST      ,KVLMIN      ,
* KTPMIN      ,WPCNT      ,TURWK      ,TCTMP      ,TPNW      ,
* TPRK      ,TIMER      ,PCARD      ,RHOM      ,
* DELZP      ,ZM      ,ZM1      ,DELPT      ,DELPMT      ,
* HLPHF      ,HLPCF      ,TK      ,DTRCT      ,DELZT      ,
* TRCTZ      ,RNDIST      ,RFN      ,Q      ,
* TCHOK      ,WNCF      ,WNCF1      ,WMNIT      ,HTCNT      ,
* FNTH      ,THETA1      ,THETA2      ,MAN3      ,MEN3      ,
* TNTWD1      ,TDIFM      ,SACPR      ,FNTC      ,MDN2      ,
* MBN2      ,FJ      ,MCN1      ,MDC1      ,TNTCD1      ,
* TIMEZ      ,ETAP      ,TPT20      ,METLTN      ,TPTAV      ,
* PTURDM      ,DUM      ,OMAX      ,OZ
NAMELIST /MISCN/
* FCX      ,PDKV      ,PTURDC      ,PTUROP      ,
* HBPV      ,HBPW      ,HBPWC      ,HBPWNC      ,
* METLTG      ,MINFLG      ,PASSX      ,SSOUT      ,WPIT
NAMELIST /PN/
* ALPHA      ,BETA      ,DIST      ,EPUMC      ,EPUMP      ,
* ETURC      ,ETURP      ,FILMCX      ,GATEP      ,HDPUM      ,
* HSVC      ,HSVP      ,MHT      ,NHT      ,NTURC

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      * NTURP      ,PCORO      ,PCUR      ,PDIL      ,PHEPO      ,
      * PMINOX     ,PNTI       ,PNTD      ,PPUMOC     ,PPUMOP     ,
      * PTANKX     ,PTURIX     ,PTURO     ,QPUMP      ,RFLU       ,
      * SAC        ,TCORO      ,TCGROR    ,TCUR       ,TDILX      ,
      * THBPO      ,TIME       ,TIMEP     ,TMETL      ,TNTI       ,
      * TINTD      ,TPUMOC     ,TPUMOP    ,TTANKX     ,TTURIX     ,
      * T12MIX     ,UIHG       ,WCUR      ,WDILX      ,WHEP       ,
      * WNOZ       ,WNTGK      ,WNTI      ,WNTD      ,WPUMC      ,
      * WPUMP      ,WTURB

      IF(ICNT(I).NE.0.0)GO TO 10
      C SAVE ORIGINAL MIN,MAX X ON 1ST PASS
      XMIN(I) = MINX(I)
      XMAX(I) = MAXX(I)
      10 DIFY = YI-YJ
      EPSY = DABS(DIFY/YJ)
      C CLOSURE TOLERANCE TEST
      IF(EPSY.GT.ESP(I))GO TO 20
      ICNT(I) = 0.0
      GO TO 30
      C CHECK FOR COUNTER ONLY PATH
      20 IF(ITF(I).LT.0.0)GO TO 70
      IF(ICNT(I).NE.0.0)GO TO 30
      DELX = EPSY
      IF(DELX.GT.1.0)DELX = 1.0
      C 1ST PASS X INCREMENT CALCULATION
      DELX = DSIGN(PCNT1(I),-DIFY)*DELX*DABS(X)
      GO TO 40
      30 DIFX = X - XOLD(I)
      DELY = YOLD(I) - DIFY
      C NTH PASS X INCREMENT CALCULATION
      DELX = PCNTN(I)*DIFX*DIFY
      IF(DELY.NE.0.0)DELX=DELX/DELY
      40 XOLD(I) = X
      INCREMENT X
      X = X + DELX
      45 IF(MINX(I).LT.X)GO TO 50
      C X EXCEEDS MIN, X = MIN
      X = MINX(I)
      GO TO 60
      C X EXCEEDS MAX, X = MAX
      50 IF(X.GT.MAXX(I))X = MAXX(I)
      60 IF(X.NE.XOLD(I))GO TO 70
      IF(ICNT(I).NE.0.0)GO TO 160
      70 ICNT(I) = ICNT(I) + 1.0
      C PRINT AFTER THE 10TH ITERATION
      IF(ICNT(I).LE.MI)GO TO 80
      C FORCE CLOSURE AFTER 15 PASSES
      IF(ICNT(I).GT.NI)GO TO 160
      GO TO 90
      C PRINT EVERY PASS IF FLAGGED
      80 IF(ISWT(I).EQ.0.0)GO TO 100
      90 IF(CNTMAX.LT.0.0)GO TO 100
      WRITE(6,180)I,ICNT(I),XNAM(I),XOLD(I),X,YNAM(I),YI,YJ,EPSY
      CNTMAX = CNTMAX - 1.0
      IF(ISWT(I).GE.0.0)GO TO 100
      WRITE(6,ADDN)
      WRITE(6,EXTRN)
      WRITE(6,MISCN)
      WRITE(6,PN)
      100 IF(ICNT(I).EQ.0.0)GO TO 170
      IF(ITF(I).LT.0.0)GO TO 160
      YOLD(I) = DIFY
      C REDUCE MIN,MAX RANGE
      IF(X-XOLD(I)).120.140.110
      110 MINX(I) = XOLD(I)
      GO TO 140
      120 MAXX(I) = XOLD(I)
      C NON-CLOSURE RETURN
      140 RETURN
      ENTRY ITERZ(I)

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M

P

Q

Q

PAGE 4

END

51

REAL FUNCTION KTF*8 (GAM)

DATE = 18SEP67

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REAL FUNCTION KTF*8 (GAM)
IMPLICIT REAL*8 (A-Z)

COMMON

* /CGNS/

* G

* JAY

* P1

* R

* RAD

* RB

REAL*8 GAM

WCFF1 = (GAM+1.)/(GAM-1.)

WCFF2 = 2./(GAM+1.)

KTF = DSORT (G*GAM*WCFF2**WCFF1/R)

RETURN

END

C NERVA TRANSIENT PROGRAM(D31201) DATE = 18SEP67 PAGE 1
C NERVA TRANSIENT PROGRAM(D31201)
DATA EMASK/ZFFFF/
EXTERNAL ERROR
CALL SPYEN(EMASK,ERROR)
CALL MC
STOP
END

SUBROUTINE MC
MAIN LOGIC
IMPLICIT REAL*8 (A-Z)
INTEGER*4

* DTAG	.I	.IDELZS	.IEND	.IM(5)
* J	.JEND	.K	.KEND(5)	.L
* LEND	.MTAG(30)	.NOFIND	.NTAG	.PTAG
* XTAG(5,5)	.II	.M	.NOBNT	.NODENT
* NZTROT	.NTCNT	.NMCNT	.NODEPT	.NPARTS
* JJ	.KK	.LL	.INODE	.KL COP
* REF	.IDELT	.NTFNTS	.NODZ	.NK
* TTAG	.CTAG	.CJ(20)	.REFR	

*NOBSK, NODESK, SMCNT, STAG

COMMON /ADD/

* ARG	.ARG1	.ARG2	.ATURNP	.BUF(10)
* CARDS(11)	.DELTAP	.DTURX	.GASVEL	.HCCRO
	.HFCGEF	.HPIH	.HPOUT	.HTANKN
* HTURIX	.KVSQRT	.MACH	.NBEND	.PPOUT
* PTRGT	.PTURPR	.PREDFL	.PVAPOR	.PTXST
* PFLOW	.PTXMIN	.PUMPH	.RF	.RNTROT
	.RATIO	.RATIOC	.SPEED	.TTROT

* TEMPY	.TMX	.TJKWD1	.TNTN1	.TNTHT1
* TPGUT	.TPIN		.TTXMIN	.TMIX
* UNCHK			.FILMNT	.QPUMI
* TINP1(30)	.T2NR1(30)	.T3NP1(30)	.SAVN(15)	.SAVNT(20)
* SAVX(20,8)	.SAVPT(20,18)	.SAVJ(30,27)	.SAVIJ(30,20,9)	

COMMON

*/AT/

* ANOZTX	.CDJX	.CNTCX	.CONTHX	.CPX
* CRJNTX	.CRJX	.DELH	.DELP	.DELPK
* DELPO	.DELRHO	.DELTX	.DELW	.DELZSQ
* DELZX	.DELZX4	.HGCJKT	.HGCNTC	.HGCNTM
* HI	.HJ	.HK	.HL	.HLPRIM
* HRNTJW	.HROJ	.MIN	.M2N	.PIN
* PJ	.PK	.PL	.PLPRIM	.RFLUX
* RHCMI	.RHOMOX	.RHOMX	.RHONIX	.RHONOX
* RHCX	.SJOX	.SNGZX	.SNTCX	.SNTMX
* TAMB	.TCCUR	.THCUR	.THEDIF	.TJKCUR
* TKLX	.TKNTCX	.TKNTHX	.WNODEN	.WNODI
* ZMAX	.ZMIN	.ZTROT		

COMMON

*/BOLS/

* ALINE	.BDOWN	.BDPD	.CPVOL	.IMASS
* LFILM	.PINPUT	.PTNKIN	.TAMB	.TTNKIN
* VTANK				

COMMON /EXTRA/

* PUMIP	.QPUM	.TCX	.TNKRHO	.TPT2
* TPCR	.TPQ	.TPK2	.TPKPD	.TPWH
* KPUMPI	.NBEAR	.HBEAR	.WPUMPC	
* ATURNZ	.ATUBRC	.ATUR	.ARDENZ	.PMIX
* PAVG	.WPMAX	.DTURBL	.PPIN	.TAVE
* CR	.TTURIP		.GAMMA	.PTGOLO
* HDILX	.CPTI	.GAMT1	.TTXST	.KVLMIN
* KTFMIN	.WPCNT	.TURNK	.TCTMP	.IPNH
* TMRK	.TIMER	.PCARD	.RHOM	
* DELZP	.ZM	.ZM1	.DELPT	.DELPMT
* HLPHE	.HLPCF	.TK	.DTROT	.DELZT
* TROT2		.RNDIST	.RFN	.Q
* TCHK	.WNCF1	.WNCF1	.WNNIT	.HTCNT
* FNTH	.THETA1	.THETA2	.MAN3	.MEN3
* TINTWD1	.TDIFM	.SACPR	.FNTC	.MDN2
* MDN2	.FJ	.MCNT	.MDN1	.TNTCD1
* TIMEZ	.ETAP	.TPT20	.METLTN	.TPTAV
* PWRON	.DUM	.GMAX	.OZ	.TEMPTM(30)

COMMON

*/FLAG/

* ETAPFL	.HBPFG	.MASS	.NTIME	.NTIME
* NWIT	.OPEN	.OPTION	.PMINO	.STATE
* TANK	.TAPE	.TFLUM	.TIMEI	.TIMEX
* TNETMO	.TINT	.TIMES(10)		

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COMMON

* /GUES/

* PCTCE

* PUMWKE

* WDILE

* WPUMPG

COMMON

* /FLUIDP/

* PRES

* GAM

* VIS

COMMON

* /LITER/NAMES(10),CTIME,COMENT,BLANK,MI,NI,CNTMAX,ZERO,

* ERRCNT

COMMON

* /MISC/

* PCX

* HBPV

* METL TO

* ITEMP(20)

* FILMB(20)

COMMON

* /NAMTAG/

* DILREM

* PARTS(20)

* TDELZ(20)

* XPARTS(5,5)

COMMON

* /P/

* ALPHA

* ETURC

* NSVC

* NTURP

* PMINGX

* PTANKX

* SAC

* THBPG

* TINT

* T12MIX

* WNOZ

* WPUMP

COMMON

* /TAG/

* AJHT(30)

* CDNT(30)

* CRJ(30)

* DNGZW(30)

* HGFNTH(30)

* KPDV(30)

* PC(30)

* QPD(30)

* SNOZ(30)

* TC(30)

* TUREFF(30)

* TURIT(30)

COMMON

* /TAGS/

* DTAG

* J

* LEND

* XTAG

* NZTRQT

* JJ

* REF

* TTAG

* NOBSK,NODESK,SMCNT,STAG

COMMON

* /TP/

* AFLOWX

* DDELZ

* DELTER

* ENTROP

* HGCDEF

* H12

.PTANK

.TDIL

.WDILG

.ZFACT

.CP

.VOL

.LITER/NAMES(10),CTIME,COMENT,BLANK,MI,NI,CNTMAX,ZERO,

.PDK

.HBPV

.MINFLO

.OTEMP(20)

.FILMC(20)

.HM

.PLNAME

.TPARTS(20)

.CPARTS(20)

.ANTC(30)

.CFWP(30)

.CRJNT(30)

.GATE(30)

.HGJ(30)

.KV(30)

.PINLET(30)

.RHOJ(30)

.SNTC(30)

.TINLET(30)

.TKJ(30)

.VNODES(30)

.TURIP(30)

.JEND

.MTAG

.IT

.NTCNT

.KK

.IDELT

.CTAG

.BATERM

.DELHM

.DHYDRA

.ETAT

.HGTGT

.KT

.PTUROE

.TTANK

.WHBPG

.QUAL

.VEL

.ENTH

.PDKV

.HBPWC

.PASSX

.DELHN2(200)

.TCFLG(20)

.HX

.PM(5)

.Tx(5)

.CDELZ(20)

.ANTH(30)

.CG(30)

.DEL(30)

.GP(30)

.HGNTC(30)

.NT(30)

.PLINE(30)

.RHONT(30)

.SNTJ(30)

.TKJ(30)

.WBIL(30)

.HBFLOW(30)

.K

.KEND

.NGFIND

.M

.NMCNT

.LL

.NT.PNTS

.CJ

.BATERS

.DELHN

.DPIE

.ETATP

.HPUMI

.KVN

.PUMHDE

.TMETI

.WNTI

.TEMP

.ENTR

.RHO

.COND

.PTURQC

.HBPWC

.SSOUT

.PUMP(350)

.MPARTS(30)

.PX(5)

.WN(5)

.EPUMC

.GATEP

.NNT

.PCUR

.PNTQ

.PTURO

.TCORR

.TIMEP

.TPUMOP

.WCUR

.WNTI

.WNTO

.EPUMP

.HDFUM

.NTURC

.PHEPD

.PPUMGP

.RFLU

.TDILX

.TNTI

.TTURIX

.WHEP

.WPUMC

.COJ(30)

.CPJ(30)

.DELPNT(30)

.DELPNZ(30)

.HGFJ(30)

.HGFNTC(30)

.KPD(30)

.PBD(30)

.PTURMO(30)

.SJC(30)

.SSPRT(30)

.TKNTH(30)

.BEND(30)

.IM

.L

.PTAG

.NODENT

.NPARTS

.KLOOP

.NK

.CDMTL

.DELHNX

.DTERM

.GPN

.HTCOEF

.HVTM

.KWC

.PUMOG

.TURSPD

.WORKE

.RHO

.COND

.PTURQC

.HBPWC

.SSOUT

.PUMP(350)

.MPARTS(30)

.PX(5)

.WN(5)

.EPUMC

.GATEP

.NNT

.PCUR

.PNTQ

.PTURO

.TCORR

.TIMEP

.TPUMOP

.WCUR

.WNTI

.WNTO

.EPUMP

.HDFUM

.NTURC

.PHEPD

.PPUMGP

.RFLU

.TDILX

.TNTI

.TTURIX

.WHEP

.WPUMC

.COJ(30)

.CPJ(30)

.DELPNT(30)

.DELPNZ(30)

.HGFJ(30)

.HGFNTC(30)

.KPD(30)

.PBD(30)

.PTURMO(30)

.SJC(30)

.SSPRT(30)

.TKNTH(30)

.BEND(30)

.IM

.L

.PTAG

.NODENT

.NPARTS

.KLOOP

.NK

.CDMTL

.DELHNX

.DTERM

.GPN

.HTCOEF

.HVTM

.KWC

.C

.H

.I

.J

.K

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      * KWCV      ,KWH      ,KWHV      ,KWT      ,K1
      * K2        ,K3        ,K4        ,K6        ,NTERM1
      * MTERM2    ,MTERM3    ,MTERMA    ,NPRN      ,NTERM
      * PH1       ,PNUZO     ,PNTHR     ,PRESM     ,PRGUES
      * PKPRIM    ,PRTERM    ,PSIP      ,PTANKN    ,P6N
      * PHR       ,P8PR      ,QN        ,QPM       ,QTERM
      * RHOR      ,RHOTKN    ,RHOTKN    ,RPM2       ,SPRINE
      * STERM     ,STAG      ,TFLUSR    ,TIMEMT    ,TIMEN
      * TTANKN    ,TTURO     ,TVP       ,TWTERM    ,TIIN
      * T11SR     ,T8N       ,WATERM    ,WDILN     ,WOTERM
      * WERROR    ,WETPER    ,WHBPN     ,WI        ,WNCHOK
      * WNT       ,WPACTN    ,WRTerm    ,WTERM     ,WTURN
      * WTERM     ,ZTUBE
      * COMMON /TSTP/HMIX,KDIEN,KHBPN,KJTUN,NINDP,TIPVIN,EINDG,PINDIN,
      * HINDIN,TINDIN,RVAPIN,HSVINP,HINDEX,EINOP,INDPH,PINDEX,ETAIND,
      * PMID,IMID,EINTC,PMIDSG,IMIDSG,EINTR,ETAIN,AMID,C,KMIDP,AMIDP,
      * QMIDP,MINNW,MINNP,ETAIMP,MUIT,DINDBL,RHO1,RHO2,RHO3,RHO4,TINDEX,
      * SPIN,SPIN2,SPEED2,TTXSTF,WTOT,TTXGIS,TTXSIS,ETAIMP,FLOWP,NINDC
      * CTBL(30),INTEFF(30),QID(30),INDHD(300),INDEF(300)
      * COMMON
      * /VALS/
      * KL        ,KO        ,KVMIN    ,VLSWT     ,VSWTRC
      * COMMON
      * EGFTAP    ,INDTUR    ,INTFLO    ,LARGET    ,LESPD
      * LOCPN     ,MCPAR     ,NEGW      ,NONGP     ,NONSPD
      * NQNTC     ,NGNW      ,NOTURN    ,NTERR
      * PARONE    ,WITER
      * INTEGER*4 MCERR
      * 10 CALL CLOCK(1)
      * CALL TIMEOUT
      * CALL FUEL
      * CALL TIMEIN
      * CALL CLOCK(1)
      * CALL AGCHED(STATE,OPTCN)
      * CALL INITD
      * TIMEP = TIMEX
      * DELTX = TIMEX
      * IDLT = 1
      * IF(TIMEX.GE.0.0)GO TO 13
      * 11 IF(TIMEI.LT.TIMES(IDLT+2))GO TO 12
      * IDLT = IDLT + 2
      * IF(IDLT.LE.8)GO TO 11
      * 12 TIMEP = TIMES(IDLT+1)
      * DELTX = TIMEP
      * 13 GTIME = NTIME
      * TIMEZ = TIMEP
      * CALL PROGIN
      * KVMIN = KVMIN + KL
      * CALL GPSUE(-1.,KVLMIN,KTRMIN)
      * CALL ITERM(1.,001D0,KTPMIN,KV(2))
      * CALL ITERM(5.PCTCE,KTPMIN,KV(2))
      * IF(BDDP.EQ.0.0)GO TO 20
      * CALL BDI
      * 20 WPCNT = NWLT
      * MCERR = 10
      * CALL WREDTF
      * 40 CALL SETCI
      * IF(WINT.LE.WI)INTFLO = 1.0
      * 45 CONTINUE
      * CALL CLOCK(10)
      * CALL CLOCK(10)
      * CALL CLOCK(12)
      * CALL FLOW
      * CALL CLOCK(2)
      * IF((OPEN.NE.0.0).OR.(INTFLO.EQ.0.0))GO TO 50
      * CALL CLOCK(3)
      * CALL CORECT
      * CALL CLOCK(3)
      * 50 IF(TIME.EQ.0.0)GO TO 110

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SUBROUTINE MC		DATE = 18SEP67	PAGE 4
	IF (TIME1.EQ.0.0)GO TO 70	B	
	IF (TIME.GT.TIME1) GO TO 70		
	IF ((OPTION.EQ.0.0).OR.(OPTION.EQ.2.0))GO TO 110	D	
	CALL ITER (1,KVN,EPUMP,ETURP,&60)	G	
	GO TO 110		
60	CALL INTR(GATE,KVN,GPN)		
	HBPV = KVN		
	IF (KVN.LT.KV(1))GPN=GATE(1)	I	
	GATEP = GPN		
	GO TO 45		
70	IF (INDTUR.NE.0.0)GO TO 110	K	
	CALL CLOCK(9)		
	CALL ITER(2,ETURC,WPUMP,WPUMC,&85)	R	
	GO TO 110		
85	CALL CLOCK(9)	S	
90	WPCNT = WPCNT - 1.0	T	
	IF (WPCNT.GT.0.0)GO TO 100		
	WPCNT = NWIT	U	
	CALL MESS('WP COUNTER EXCEEDED	A	
	IF (MCAP.LE.1.0)MCAP = 2.0		
	CALL ITERZ(2)		
	GO TO 110		
100	IF (CPEN.NE.0.0)GO TO 45	D	
	CALL SETCJ		
	CALL CLOCK(4)	E	
	CALL PREDIC		
	CALL CLOCK(4)		
	PPUMOC = PPUMCP		
	TPUMOC = TPUMCP		
	WPUMC = WPUMCP		
	GO TO 45		
110	IF (OPTION.EQ.0.0)GO TO 170	J	
	IF (PASSX.NE.0.0)GO TO 115	K	
	PASSX = 1.0	A	
	GO TO 170		
115	IF ((OPTION.EQ.2.0).OR.(INTFLO.EQ.0.0))GO TO 150	L	
	IF (OPTION.EQ.4.0)GO TO 130	M	
	IF (CPEN.EQ.0.0)GO TO 120	N	
	CALL ITER(4,WPUMC,PCX,PCORO,&100)	O	
	GO TO 150	Q	
120	CALL ITER(5,KVN,PCX,PCORO,&100)	R	
	GO TO 150	T	
130	IF (TCFLG(1).EQ.0.0)TCTMP=TCORC		
	IF (CPEN.EQ.0.0)GO TO 140	A	
	CALL ITER(6,WPUMC,TCTMP,TCX,&100)	B	
	GO TO 170		
140	CALL ITER(7,KVN,TCX,TCTMP,&100)	E	
	GO TO 170	G	
150	IF (OPTION.EQ.1.0)GO TO 170	H	
	IF (TCFLG(1).EQ.0.0)TCTMP=TCORC		
	CALL ITER(8,HGTCT,TCTMP,TCX,&160)		
	GO TO 170	L	
160	CALL TCRES		
	CALL CLOCK(6)		
	CALL METALT	O	
	CALL CLOCK(6)		
	GO TO 100	S	
170	IF ((TIME.EQ.0.0).OR.(BDOWN.EQ.0.0))GO TO 180	T	
	CALL BDOWNL(&10)		
180	IF (OPEN.NE.0.0)GO TO 235		
	IF ((OPTION.EQ.0.0).OR.(OPTION.EQ.2.0))GO TO 210	C	
	VLSNT = 1.0	D	
	IF (VSWTPC.EQ.0.0)GO TO 190	E	
	IF (VSWTPC.LT.PCORC)GO TO 200	F	
	GO TO 210	G	
190	IF (KVN.LE.KVLMIN)GO TO 210		
200	VLSNT = 0.0	I	
210	CALL GPSUE(1.0,KVN,GATEP)		
220	IF (ETAPFL.EQ.0.0)GO TO 235	K	
	TPNB = NTURC/WPUMC	L	


```

      TPNRK = MSVC/NTURC**2
      CALL MESS('PUNCH CARDS - ETAP,NTURC,TPNW,TPWRK
      PUNCH 230,ETAP,NTURC,TPNW,TPWRK
230  FORMAT(1X,'ETAP=',1PG13.5,' ',NTURC=',1PG13.5,' ',1X,'TPNW=',1PG13.5
      +', ',TPNRK=',1PG13.5,' ')
235  CALL PT(PTURO,TTURO)
      H12 = (WTURB*ENTH + WBEAR*HBEAR)/(WTURB + WBEAR)
      CALL PT(PTURO,H12)
      T12MIX = TEMP
      EFUMC = EPUMP
      ETURC = ETURP
      NTURC = NTURP
      NINDC = NINDP
      EINDC = EINDP
      EINTC = EINTP
      CALL PRINT
      IF(STATE.EQ.0.0)GO TO 240
      IF(OPEN.EQ.0.0)GO TO 240
      CALL MESS('CALL PRSS
240  WI = WI + WFUMC*TIMEP
      CALL MOVED
      CALL UPDATE
      CTIME = CTIME -1.0
      IF(CTIME.LE.0.0)GO TO 10
250  IF(OPTION.EQ.0.0)GO TO 260
      CALL TCSAV
260  IF(TIMEX.GE.0.0)GO TO 280
270  IF(IDELT.GE.8)GO TO 280
      IF(TIME.LT.TIMES(IDELT+2))GO TO 280
      TIMEP = TIMES(IDELT+3)
      DELTX = TIMEP
      IDELT = IDELT + 2
      GO TO 270
280  TINEN = TIME + TIMEP
      CALL CLOCK(6)
      CALL METALT
      CALL CLOCK(6)
      IF(TMETL.GE.TMETM)GO TO 285
      CALL MESS('METAL TEMP BELOW MINIMUM
      CALL ERROR
      GO TO 300
285  IF(MCAP.NE.0.0)MCAP=MCAP-1.0
      IF(BDPD.EQ.0.0)GO TO 290
      CALL BDU
290  IF(STATE.NE.0.0)STATE=STATE-1.0
      CALL SETCJ
      IF(OPEN.NE.0.0)GO TO 300
      IF(TINEN.EQ.0.0)GO TO 300
      CALL PREDIC
      GO TO 300
      ENTRY MCPRES
      CALL MESS('NEGATIVE PRESSURE
      IF(TIME.NE.TIMEN)GO TO 299
      IF(OPEN.NE.0.0)AND.(TANK.NE.0.0)GO TO 294
      WUNC = .5*WUNC
      GO TO 296
294  TANK2 = 1.1*PTANKX
      GO TO 296
      ENTRY MCFLOW
      CALL MESS('NEGATIVE FLOW RATE
      IF(TIME.NE.TIMEN)GO TO 299
      IF(OPEN.NE.0.0)AND.(TANK.NE.0.0)GO TO 295
      WUNC = 1.1*WUNC
      GO TO 296
295  TANK2 = .0*PTANKX
296  MCERR = MCERR-I
      DO 297 I=1,5
297  WX(I) = .5*WX(I)
      DO 298 I=1,30
298  WXX(I) = .5*WXX(I)

```

M
NQ
S
T
A
BD
G

P

A

C

I
J
L
M

Q

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```
298 CONTINUE
    IF(MCERR.GT.0)GO TO 45
299 CALL ERROR
300 TIME = TIMEN
    CALL CLOCK( 1)
    CALL TIMOLT
    IF(TIMER.EQ.0.0)GO TO 20
    CALL FUEL
    CALL TIMEIN
    CALL CLOCK( 1)
    GO TO 20
    ENTRY MCTEMP
    CALL MESS('NEGATIVE TEMPERATURE
    CALL ERROR
    RETURN
    END
```

*)

SUBROUTINE MESSX(WORDS)

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```
      SUBROUTINE MESSX(WORDS)
      PRINT MESSAGE AND RETURN OR CALL ERROR SUBR.
      CALL MESSX(' -PLACE A 52 CHAR MESSAGE HERE-
      REAL*4 WORDS(14)
      WRITE(6,10) WORDS
      CALL ERROR
      RETURN
      CALL MESSX(' -PLACE A 53 CHAR MESSAGE HERE-
      ENTRY MESS(WORDS)
      WRITE(6,10) WORDS
      RETURN
      30 FORMAT(' ',14A4)
      END
```

') Q

') P

SUBROUTINE METALT
IMPLICIT REAL*8 (A-Z)
INTEGER*4

```

* DTAG      ,I      ,IDELZS      ,IENC      ,IM(5)      ,
* J          ,JEND      ,K          ,KEND(5)      ,L          ,
* LEND      ,MTAG(30)  ,NOFIND      ,NTAG      ,PTAG      ,
* XTAG(5,5)  ,II       ,M          ,NOBNT      ,NOBENT      ,
* NZTROT      ,NTCNT      ,NMCNT      ,NODEPT      ,NPARTS      ,
* JJ         ,KK         ,LL         ,INODE      ,KLOOP      ,
* REF        ,IDELT      ,NTFNTS      ,NODZ      ,NK          ,
* TTAG      ,CTAG      ,CJ(20)      ,REFR          ,
* NGBSK,NODESK,SMCNT,STAG
COMMON /ADD/
* ARG        ,ARG1      ,ARG2      ,ATURNP      ,BUF(10)      ,
* CARDS(11)  ,DELTAP      ,DTURX      ,CASVEL      ,HCORD      ,
*          ,HFCOE      ,HPIN      ,HPOUT      ,HTANKN      ,
* HTURIX      ,KVSQRT      ,NACH      ,NBEND      ,PPOUT      ,
* PTROT      ,PTURPR      ,PREDFL      ,PVAFOR      ,PTXST      ,
* PFLOW      ,PTXMIN      ,PUMPH      ,RF          ,RNTROT      ,
*          ,RATIO      ,RATIOC      ,SPEED      ,TTROT      ,
* TEMPY      ,TMX        ,TJKWD1      ,TNTAZ1      ,TNTHT1      ,
* IPOUT      ,TPAN      ,TTXMIN      ,TMIX        ,
* UNCHK      ,FILMNT      ,FILMNT      ,QPUMI      ,
* T1NP1(30)  ,T2NP1(30)  ,T3NP1(30)  ,SAVN(15)  ,SAVNT(20)  ,
* SAVFX(20,8) ,SAVPT(20,18),SAVJ(30,27) ,SAVJ(30,20,9)
COMMON /AZ01/
* CSUBP(30,20) ,FILMHF(30,20) ,PRESS(30,20) ,RHOFLU(30,20) ,
* RHOFTP(30,20) ,TFLUID(30,20) ,TMETAL(30,20) ,WRATEN(30,20) ,
* WRATEN(30,20)
COMMON /AZ10/
* FILMNZ(30)  ,FILMTC(30)  ,FILMTH(30)  ,HBNQZW(30)  ,HRNTCW(30)  ,
* HRNTHW(30)  ,PNOZ(30)    ,PTUBE(30)    ,RHQNTM(30)  ,RHQNTN(30)  ,
* RHONZN(30)  ,RHONZN(30)  ,TCGLD(30)    ,THOT(30)    ,TJACK(30)  ,
* TJKTWD(30)  ,TJKWD(30)  ,TNGZ(30)    ,TNOZW(30)    ,TNTCLD(30)  ,
* TINTHT(30)  ,TNTJWD(30)  ,TTUBE(30)    ,WNGZN(30)    ,WNOZN(30)  ,
* WNTN(30)    ,WNTN(30)
COMMON
* /CGMS/
* G          ,JAY        ,PI         ,R          ,RAD        ,
* BB
COMMON /EXTRA/
* PUMIP      ,QPUM      ,TCX         ,TNKRHO      ,TPT2      ,
* TPCR      ,TPQ        ,TPK2        ,TPKPD      ,TPWH      ,
* KFLMPI      ,WBEAR      ,HBEAR      ,WPUMPC      ,
* ATURNZ      ,ATURN      ,ARCLNZ      ,PMIX        ,
* PAVG      ,WPMAX      ,DTURBL      ,PPIN        ,TAVE      ,
* CR          ,TTURIP      ,GANT1      ,GAMMA      ,PTOOL      ,
* HDILX      ,CPT1        ,TURMK      ,TIXST      ,KVLMIN      ,
* KIPMIN      ,WPCNT      ,PCARD      ,TCTMP      ,TPNW      ,
* TPRK      ,TIMER      ,RHOH      ,RHOM      ,
* DELZP      ,ZM         ,ZM1        ,DELPT      ,DELPMT      ,
* HLPFH      ,HLPFCF      ,TK         ,DTRCT      ,DELZT      ,
* TROTZ      ,RNDIST      ,RFN        ,Q          ,
* TCHOK      ,WNCF1      ,WNCIT      ,HTCNT      ,
* ENTH      ,THETA1      ,THETA2      ,MAN3        ,MEN3      ,
* TINTD1      ,TDIFM      ,SACPR      ,FNTC        ,NDN2      ,
* MBN2        ,FJ         ,MCN1        ,MDN1        ,INTCD1      ,
* TIMEZ      ,ETAPM      ,TPT20      ,METLTN      ,TPTAV      ,
* PIURCM      ,DUM        ,OMAX        ,OZ          ,TEMPTM(30)
COMMON
* /FLAG/
* ETAPFL      ,HBPEG      ,MASS        ,MTIME      ,NTIME      ,
* ENIT        ,OPEN      ,OPTION      ,PMINO      ,STATE      ,
* TANK        ,TAPE      ,TFLUM      ,TIMEI      ,TIMEX      ,
* TMETMO      ,WINT      ,TIMES(10)
COMMON
* /FLUIDP/
* PRES      ,ZFACT      ,QUAL        ,TEMP        ,RHO        ,
* GAM        ,CP         ,VEL        ,ENTR        ,COND      ,
* VIS        ,VOL        ,ENTH

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COMMON /FX/
* DELTEM(20) , FLUTEM(20) , METTEM(20) , MSMALL(20) , MTPNTS(20) ,
* PARTI(20) , PARTPS(20) , TEMPEX(20)
COMMON
*/MISC/
* PCX , PDK , PDKV , PTUROC , PTUROP ,
* HBPV , HBPW , HBPWC , HBPWNC ,
* METLTO , MINFLG , PASSX , SSOUT , WPIT ,
* ITEMP(20) , CTEMP(20) , DELHN2(200) , PUMF(350) , FILMA(20) ,
* FILMB(20) , FILMC(20) , TCFLG(20)
COMMON
*/NAMTAG/
* DILREM , HM , HX , MPARTS(30) , NTNAME ,
* PARTS(20) , PLNAME , PM(5) , PX(5) , TM(5) ,
* TDELZ(20) , TPARTS(20) , TX(5) , WM(5) , WX(5) ,
* MPARTS(5,5) , CPARTS(20) , CDELZ(20)
COMMON
*/P/
* ALPHA , BETA , DIST , EPUMC , EPUMP ,
* ETURC , ETURP , FILMCX , GATEP , HCPUM ,
* NSVC , NSVP , NHT , NHT , NTURC ,
* NTURP , PCORO , PCUR , PDIL , PHBPO ,
* PMINOX , PNTI , PNTQ , PPUMOC , PPUMOP ,
* PTANX , PTURIX , PTURO , QPUMP , RFLU ,
* SAC , TCORO , TCOROR , TCUR , TDILX ,
* THBPQ , TIME , TIMEP , TMETL , TMTI ,
* TINT , TPUMOC , TPUMOP , TTANKX , TTURIX ,
* T12MIX , UIHG , WCUR , WDILX , WHEP ,
* WNGZ , WNTCK , WNTI , WNTQ , WPUMC ,
* WRUMP , WTURB
COMMON /PTC/
* DISPT(20) , PDROPI(20) , PDEPO(20) , PRESI(20) , PRESQ(20) ,
* RHOMI(20) , RHONO(20) , RHONI(20) , RHOND(20) , TEMPI(20) ,
* TEMPO(20) , TIMEZM(20) , WDELM(20) , WDELMQ(20) , WDELNI(20) ,
* WDELNO(20) , WRATEI(20) , WRATEQ(20)
COMMON /SKIRTC/NOBS,NODEK,KSTI,KSTQ,SKDZ,SZMIN,STATIC,
* PSTI,ISTI,WTI,PSIO,TSTQ,WSIO,
* ASTH(30),ASTW(30),SKBN(30),CDST(30),CPSI(30),SCFWP(30),SKCG(30),
* SKDEL(30),DSNZ(30),NTIP(30),NTIT(30),NTIM(30),NZIP(30),NZIT(30),
* NZIN(30),RHGT(30),SKBN(30),SSNZ(30),SSTH(30),TKSTH(30),SNODES(30),
* ENTHOS(30),FILMSZ(30),FILMST(30),HRSNZ(30),HRSTH(30),PHIST(30),
* PHIZ(30),PSNZ(30),PSTUB(30),QHSTI(30),RHSTN(30),RHOSZN(30),
* TSHT(30),TSNZ(30),TSNZW(30),TSTHOT(30),TSTUB(30),WSNZN(30),
* WSTN(30),PTOTST(30),HTGTST(30),TTGTST(30)
COMMON /TABIJ/
* AFLOW(30,20) , CAP(30,20) , CONDI(30,20) , HGF(30,20) , NGF(30,20) ,
* WEIP(30,20)
COMMON
*/TABJ/
* DELZ(20) , FRICF(20) , HFFLG(20) , KDPI(20) , KDPO(20) ,
* NDELZ(20) , PLENI(20) , PLENO(20) , RHOMTL(20) , TNODE(20) ,
* TTK(20) , VOIDF(20) , WALL(20)
COMMON
*/TAGS/
* I , IDELZS , IEND , IM ,
* J , JEND , K , KEND , L ,
* LEND , M , NOFIND , NTAG , PTAG ,
* XTAG , II , NGENT , NGENT , NOCENT ,
* NZTRO , NTCNT , NMCM , NODEPT , NPARTS ,
* JJ , KK , LL , INODE , KLQOP ,
* RRF , IDELT , NRPMTS , NOIZ , NK ,
* TTAG , CTAG , CJ , REFR
COMMON /EP/
* AFLOWX , BATERM , BATERS , COMTL , CPTERM ,
* DDELZ , DELHN , DELHNX , DELPM ,
* DELTER , DHYDRA , DPIPE , DTERM , DZTERM ,
* ENTROP , ETAT , ETATP , GPN , HFTERM ,
* HOCOF , HGTGT , HNPUN , HNTCOF , HNTERM ,
* NIZ , KT , KVM , KWC , KWC

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      * KWCV      ,KWH      ,KWHV      ,KWT      ,K1
      * K2        ,K3        ,K4        ,K6        ,MTERM1
      * MTERM2     ,MTERM3     ,MTERM4     ,NPRN      ,MTERM
      * PHI        ,PNOZO     ,PNTTHR     ,PRESM      ,PRGUES
      * PRPRIM     ,PRTERM     ,PSTP       ,PTAKN      ,P6N
      * P6N        ,R6PR       ,QN         ,QPM        ,QTERM
      * QHOR       ,RHOTKM     ,RHOTKM     ,RPM2       ,SPRIME
      * STERM      ,STAG      ,TFLUSR     ,TINENT     ,TIMEN
      * TIANMM     ,TIURD      ,TVP        ,TTERM      ,TIN
      * TIISR      ,T8N        ,WATERM     ,WDILN      ,WTERM
      * WERROR     ,WETPER     ,WHSPN      ,W1         ,WCHOK
      * WNT        ,WPACTA     ,WRTERM     ,WTURN
      * WTERM      ,ZTUBE

      MPARTS = MTAG(IEND)
      IJ=1
      1 LL=0
      210 KLOOP=0
      IF(LEND.LE.0)GO TO 235
      LL=LL+1
      TIMEZ = TIMEP
      220 IF(MTAG(IJ).NE.XTAG(1,LL))GO TO 230
      TCUR=TM(LL)
      KLOOP=KEND(LL)-1
      KK=2
      GO TO 240
      230 IF(LL.LT.LEND)GO TO 210
      IF(MTAG(IJ).NE.XTAG(KEND(LL),LL))GO TO 235
      CALL PT(PCUR,TCUR)
      HM = ENTH
      CALL PT(PCUR,TX(LL))
      HX = ENTH
      HM = (HM*WCUR + HX*WX(LL))/(WCUR + WX(LL))
      CALL PH(PCUR,HM)
      TCUR = TEMP
      WCUR = WCUR + WX(LL)
      TM(LL) = TCUR
      235 J=MTAG(IJ)
      IF(MTAG.NE.J)GO TO 236
      CALL TUBEM
      TCUR = TINTO
      WCUR = TINTO
      GO TO 300
      236 IF(STAG.NE.J)GO TO 250
      CALL SKTMT
      TCUR = TSTO
      WCUR = TSTO
      GO TO 300
      240 J=XTAG(KK,LL)
      IF(MTAG.NE.J)GO TO 245
      CALL TUBEM
      GO TO 20
      245 IF(STAG.NE.J)GO TO 250
      CALL SKTMT
      GO TO 20
      250 IF(J.NE.0)GO TO 20
      IF(STATE.NE.0.)GO TO 2
      NTPNTS = 1
      TIMEZ = TIME
      GO TO 3
      2 NTPNTS = 20
      TIMEZ = TIMEN
      3 NTPNTS(J) = 0
      C. LOOP THRU NO. OF TIME INCREMENTS FOR THIS TIME POINT.
      PARTI(J) = TEMPI(J)
      DELTEN(J) = TCUR-TEMPI(J)
      7 IF((OPTION.NE.0.)AND.(OPTION.NE.1.)AND.(OPTION.NE.4.))GO TO 260
      CALL INTP(HG,TIMEZ,HGTGT)
      260 DO 18 L=1,NTPNTS
      TEMPEX(J) = 0.
      IF(STATE.EQ.0.) TIMEZ = TIMEZ + TIMEZ

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      HTCNT = 0.
      QZ = 0.5*DELZ(NPARTS)
      DIST = 0.5*DELZ(J)
      NCDZ = PARTPS(J)
C   CALCULATE NEW METAL TEMPERATURES FOR EACH NODE
      DO 16 I=1,NODZ
      CALL NODET(E21)
      TEMPY = SAC*(TMETAL(I+2,J)-2.*TMETAL(I+1,J) + TMETAL(I,J))
      IF(STATE.NE.0.) GO TO 4
      DUM = TMETAL(I+1,J)+(TFLUID(I,J)-TFLUID(I+1,J))/ NHT
      GO TO 5
4     DUM = 0.5*(TFLUID(I,J)+TFLUID(I+1,J))
5     DUM = DUM + TEMPY + UIHG
      IF(DUM.GE.TFLUM) TEMPEX(J) = 1.
6     TEMPTN(I) = DUM
      IF((WALL(J).NE.0.).OR.(TTK(J).EQ.0.)) GO TO 15
C   INTERPOLATE CORE DISTANCE AND CALCULATE RADIAL CONDUCTION TERM.
      M = PARTPS(NPARTS)
8     DUM = DIST - CZ
      IF (DUM) 10,11,9
9     M = M - 1
      IF (M.EQ.0) GO TO 8G
      QZ = QZ + DELZ(NPARTS)
      GO TO 8
10    OMAX = TFLUID(M,NPARTS) +
1     DUM*(TFLUID(M,NPARTS)-TFLUID(M+1,NPARTS))/DELZ(NPARTS)
      DUM = DUM*(TMETAL(M,NPARTS)-TMETAL(M+1,NPARTS))/DELZ(NPARTS)
      GO TO 12
11    OMAX = TFLUID(M,NPARTS)
12    OMAX = TTK(J)*(DUM+TMETAL(M,NPARTS))-OMAX
      DUM = 2./(1.-DSQRT(VOIDF(J)))
      IF(STATE.NE.0.) GO TO 13
      TEMPY = 0.5*(3.-DUM)*DELZ(J)*NHT*WCUR*CP
      GO TO 14
13    TEMPY = 3.*(DUM-1.)/(WETPER*FILMCX)
14    TEMPTM(I) = TEMPTM(I) + PI*CDMTL*TEMPY *(OMAX-TMETAL(I+1,J))
15    IF(STATE.EQ.0.) GO TO 16
      IF(DABS(TEMPTM(I) - TMETAL(I+1,J)).GE.0.01) HTCNT = 1.
16    DIST = DIST+DELZ(J)
C   UPDATE THIS PARTS METAL TEMPERATURE TABLE. EXTRAPOLATE END POINTS.
      NK = PARTPS(J)
      DO 17 I=1,NK
17     TMETAL(I+1,J)=TEMPTM(I)
      TMETAL(1,J) = TEMPTM(1)
      TMETAL(NK+2,J) = TEMPTM(NK)
      DUM=1.
      IF(STATE.EQ.0.) DUM= (TIMENT-TIME)/TIMEP
      TCUR = DUM*DELTEM(J)+PARTI(J)
      PCUR = PRESI(J)
      WCUR = WRATEI(J)
      CALL TEMPO
      MTPNTS(J) = MTPNTS(J)+1.
      IF((STATE.NE.0.).AND.(HTCNT.EQ.0.)) GO TO 19
19    CONTINUE
C   METAL NODE TEMP FOR TC OPTION
20    IF(WETTEM(J).EQ.0.) GO TO 20
      NK = WETTEM(J)
      TCMP = 0.5*(TFLUID(NK,J)+TFLUID(NK+1,J))
20    IF(KLGOP.EQ.0)GO TO 300
      KK=KK+1
      IF(KK.LE.KLOOP)GO TO 240
      TMLL = TCUR
      WLL = WCUR
      TMLL = TMLL
      GO TO 210
300    I1 = I1+1
      IF(I1.LE.IEND)GO TO 1
      RETURN
21    TIMENT = TIMENT - TIMEZ
      TIMEZ = 0.5*TIMEZ

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IF(TIMEZ .LT.MTIME) GO TO 22
NTPNTS = 2*(NTPNTS - L + 1)
IF (NTPNTS.GT.0) GO TO 7
22 CALL MESS('DELTA T TOO SMALL
GO TO 87
86 CALL MESS('CORE TOTAL DISTANCE LESS THAN PART DISTANCE
87 CONTINUE
RETURN
END
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SUBROUTINE MOVED
IMPLICIT REAL*8 (A-Z)
INTEGER*4
* DTAG      ,I      ,IDELZS      ,IEND      ,IM(5)      ,
* J          ,JEND      ,K          ,KENC(5)    ,L          ,
* LEND      ,NTAG(30)  ,NOFIND     ,NTAG      ,PTAG      ,
* XTAG(5,5) ,II        ,M          ,NOBNT     ,NODENT     ,
* NZTROT    ,NTCNT     ,NMCNT     ,NDEPT     ,NPARTS     ,
* JJ        ,KK        ,LL        ,INODE     ,KLOOP      ,
* REF       ,IDELT     ,NTPNTS    ,NODZ      ,NK          ,
* TTAG      ,CTAG      ,CJ(20)    ,REFR      ,
* NGBSK,NODESK,SMCNT,STAG
NAMELIST /NERVA/
B TIME ,RTANKX,TTANKX,TCORO
C PTURIX,PTURO ,WPUMC ,PPUMCP,TPUMCP,NTURP ,WPUMP ,WDILN ,WHBPN ,
D P6N ,P8N ,T8N ,T11N ,QPUMP ,EPUMP ,ETURP ,HDPUM ,WI
E DELHN ,RHOMIX ,RHOMOX ,HSVP ,TJACK ,TCOLD ,THGT ,TNOZW ,TNTHOT ,
F TNTCLD ,TNTJWD ,TJKTWD ,TJKWC ,RHONTH ,RHONZM ,WNTM ,WNOZM ,RHOMI ,
G RHGMC ,RHOFLU ,TMETAL
COMMON /ADD/
* ARG      ,ARG1      ,ARG2      ,ATURNP     ,BUF(10)    ,
* CARDS(11) ,DELTA     ,DTURX     ,GASVEL     ,HCORO      ,
*          ,HFCGEF     ,MPIN      ,HPOUT      ,MTANKN     ,
* NTURIX     ,KVSORT     ,MACH      ,NBEND      ,PPOUT      ,
* PTROT      ,PTURPR     ,PREDEL    ,PVAPOR     ,PTXST      ,
* PFLOW      ,PTXMIN     ,PUMPH      ,RF          ,RNTROT     ,
*          ,RATIO      ,RATIOC     ,SPEED      ,TTROT      ,
* TEMPY      ,TMX        ,TJKWD1    ,TNTNZ1     ,TNHT1      ,
* TPCUT      ,TPIN      ,TTXMIN     ,TMIX        ,
* UNCHK      ,          ,          ,FILMNT     ,QPUMI      ,
* T1NP1(30) ,T2NP1(30) ,T3NP1(30) ,SAVN(15)   ,SAVNT(20)  ,
* SAVFX(20,8) ,SAVPT(20,18) ,SAVJ(30,27) ,SAVIJ(30,20,9)
COMMON /AT/
* ANQZTX     ,CDJX      ,CDNTCX     ,CDNTHX     ,CPX        ,
* CRJNTX     ,CRJX      ,DELM      ,DELP1      ,DELPK      ,
* DELPO      ,DELPHO    ,DELTX      ,DELV        ,DELZSQ     ,
* DELZX      ,DELZX4    ,HGCJKT     ,HGCNTC     ,HGCNTM     ,
* MJ          ,MJ        ,MK          ,HL          ,MLPRIM     ,
* HRNTJW     ,HRDJ      ,M1N        ,M2N        ,PIN        ,
* PJ          ,PK          ,PL          ,PLPRIM     ,RFLUX      ,
* RHOMIX     ,RHOMOX     ,RHGMX      ,RHONIX     ,RHONOX     ,
* RHOX        ,SJOX      ,SNGZX      ,SNTCX      ,SNTHX      ,
* TAMBX      ,TCCUR      ,THCUR      ,THEDIF     ,TJKCUR     ,
* TKJX        ,TKNTCX     ,TKNTHX     ,WNODEN     ,WNODI      ,
* ZMAX        ,ZMIN      ,ZTROT      ,
COMMON /AZ01/
* QSUBP(30,20) ,FILMHF(30,20) ,PRESS(30,20) ,RHOFLU(30,20) ,
* RHOFTP(30,20) ,TFLUID(30,20) ,TMETAL(30,20) ,WRATEN(30,20) ,
* WRATEN(30,20)
COMMON /AZ10/
* FILMNZ(30) ,FILMTC(30) ,FILMTH(30) ,HRNCZW(30) ,HRNTCW(30) ,
* HRNTHW(30) ,PNOZ(30) ,PTUBE(30) ,RHONTH(30) ,RHONTN(30) ,
* RHONZM(30) ,RHONZN(30) ,TCOLD(30) ,THGT(30) ,TJACK(30) ,
* TJKTW(30) ,TJKWC(30) ,TNOZW(30) ,TNQZW(30) ,TNTHOT(30) ,
* TNTHOT(30) ,TNTJWD(30) ,TTUBE(30) ,WNOZM(30) ,WNOZN(30) ,
* WNTM(30) ,WNTN(30)
COMMON /EXTRA/
* PUMIP      ,QPUM      ,TCX        ,TNKRHO     ,TPT2       ,
* TPCR       ,TPQ       ,TPK2       ,TPKPD      ,TPWH       ,
* KPUMPI     ,WBEAR     ,HBEAR     ,WPUMPC     ,
* ATURNZ     ,ATURN     ,ATUR      ,AROLNZ     ,PMIX       ,
* PANG       ,WPMAX     ,DTURBL     ,PPIN       ,TAVE       ,
* CR          ,TTURIP     ,GANTI      ,GAMMA      ,PTOOLQ     ,
* MDILX      ,CPT1      ,TURMK      ,TETMP      ,KVLMIN     ,
* KIPMIN     ,WPCNT      ,PCARD      ,RHOM       ,TPNW       ,
* TPERK      ,TIMER      ,ZM1       ,DELPT      ,DELPMT     ,
* DELZP      ,ZM        ,TK          ,DTROT      ,DELZT     ,
* HLPF       ,HLPGF     ,RNDIST     ,RFN        ,Q          ,
* TROTZ      ,BNCF      ,WNCF      ,WMNIT      ,MTCNT      ,
* TCMR

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* FNTH      .THETA1    .THETA2    .MAN3      .MEN3      .
* INTWD1    .TDIFM     .SACPR     .FNTC      .MDN2      .
* MBN2      .FJ        .MCN1      .MDN1      .TNTCD1    .
* TIMEZ     .ETAP      .TPT20     .METLTN    .TPTAV     .
* PTAROM    .DUM       .OMAX      .OZ        .TEMPIM(30) .
COMMON
*/FLAG/
* ETAPFL    .HBPFG     .MASS      .NTIME     .NTIME     .
* NBIT      .OPEN      .OPTION     .PNINO     .STATE     .
* TANK      .TAPE      .TFLUM     .TIMEI     .TIMEX     .
* IMETMO    .WINT      .TIMES(10) .
COMMON
*/FZ/
* DELTEN(20) .FLUTEN(20) .NETTEN(20) .MSMALL(20) .MTPNTS(20) .
* PART1(20)  .PART5(20)  .TEMPEX(20) .
COMMON /LITER/NAMES(10).CTIME.COMENT.BLANK.MI.NI.CNTMAX.ZERO
COMMON /MISC/
* PCX       .POK       .POKV       .PTURGC     .PTURGP     .
* HBPKV     .HBPW     .HBPWC     .HBPWNC     .WPIT       .
* METLTO    .MINFLG    .PASSX     .SOUT       .FILMA(20) .
* ITEMP(20) .OTEMP(20) .DELMN2(200) .PUMP(350) .
* FILMB(30) .FILMC(20) .TCFLG(20) .
COMMON /MANTAG/
* BILREM    .HM        .HX         .MPARTS(30) .NTNAME .
* PARTS(20)  .PLNAME    .PH(5)      .PX(5)      .TH(5)     .
* IDELZ(20)  .TPARTS(20) .TX(5)      .WM(5)      .WX(5)     .
* XPARTS(5.5) .CPARTS(20) .CDELZ(20) .
COMMON
*/P/
* ALPHA     .BETA      .DIST      .EPUMC      .EPUMP      .
* ETURC     .ETURP     .FILMCX    .GATEP     .MDPUM     .
* HSCV      .HSVP      .NHT       .NHT       .NTURC     .
* KURP      .PCORD     .PCUR      .PDIL      .PHEPQ     .
* PMINOX    .PNTI      .PNTO      .PPUMOC     .PPUMQP     .
* PTANKX    .PTURIX    .PTURO     .QPUMP      .RFLU      .
* SAC       .TCORO     .TCOROR    .TCUR       .TDILX     .
* IMBPQ     .TIME      .TIMEP     .TMETL     .TNTI      .
* TMTD      .TPUMOC    .TPUMQP     .TTANKX    .TTURIX    .
* TISMIX    .UIHG      .WCUR      .WDILX     .WHEP      .
* WMOZ      .WNTCK     .WNTI      .WNTQ      .WPUMC     .
* WPUMP      .WTURB    .
COMMON /PTC/
* DISPT(20) .PDORPI(20) .PDORPO(20) .PRESI(20) .PRESQ(20) .
* RHOMI(20) .RHOMO(20) .RHONI(20) .RHONO(20) .TEMP I(20) .
* TEMPO(20) .TIMEZM(20) .WDELM1(20) .WDELMQ(20) .WDELM I(20) .
* WDELMQ(20) .WRATE1(20) .WRATEQ(20) .
COMMON
*/TAGS/
* DTAG      .I        .IDELZS    .IEND      .IM        .
* J         .JEND     .K         .KEND      .L        .
* LEND      .MTAG     .NOFIND    .NTAG      .PTAG      .
* XTAG      .II       .M         .NOBNT     .NODENT    .
* NZTROT    .MYENT    .MMCNT     .NODEPT    .MPARTS    .
* JJ        .KK       .LL        .INODE     .KLGR      .
* RGF       .IDELT    .NTPNTS    .NODZ      .NK        .
* TTAG      .CTAG     .CJ        .REFR      .
* NUBSK,NODESK,SMCNT,STAG
COMMON /TP/
* ALOWX     .BATERM    .BATERS    .CDMTL     .CPTERM     .
* DDELZ     .DELHM     .DELHN     .DELHNX    .DELPN     .
* DELTER    .DMYORA    .DPIPE     .DTERM     .DZTERM     .
* ENTRGP    .ETAT      .ETATP     .GPN       .HFTERM     .
* NGCOEF    .HGTQT     .HPUMI     .HTCOEF    .HYTERM     .
* N12       .KT        .KVN       .KWC       .KWC       .
* KVCV      .KWH      .KWHV     .KWT       .KI        .
* K2        .K3        .K4        .K6        .K6        .
* MTERM2    .MTERM3    .MTERM4    .NPRN      .MTERM1     .
* PHI       .PNOZO     .PNTTHR    .PRESN     .NTERM      .
* PPRIM     .PBTEN     .PSTP      .PTANKN    .PRGUES     .
* PGN       .PBPB     .GN        .PTANKN    .P&N       .
*          .P&N       .Q&N       .Q&N       .Q&N       .

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      * RHOR      ,RHOTKM      ,RHOTKM      ,RPM2      ,SPRIME      ,
      * STERM      ,STSTAG      ,TFLUSR      ,TIMENT      ,TIMEN      ,
      * TTANKN      ,TTURC      ,TVP      ,TWTERM      ,T1IN      ,
      * T11SR      ,T8N      ,WATERM      ,WDILN      ,WOTERM      ,
      * WERRCR      ,WETPER      ,WHBPN      ,WI      ,WNCHOK      ,
      * WNT      ,WPACTN      ,WRTERM      ,WTERM      ,WTURN      ,
      * WWTERM      ,ZTUBE
      COMMON /X/
      * EOFTAP      ,INDTUR      ,INTFLO      ,LARGET      ,LESPO      ,
      * LOCFN      ,MCAP      ,NEGW      ,NONGP      ,NONSPD      ,
      * NGNTC      ,NONW      ,NCTURN      ,NCTURN      ,NTERR      ,
      * PARONE      ,WITER
C MCVE METAL TEMPS FROM TEMPORARY TO PERMANENT STORAGE, ALSO PART INLET-
C OUTLET DENSITIES AND DELTA FLOWS FROM NEW TO OLD STORAGE
      METG=MELTN
      TPT2O=TPT2
      DO 100 I=1,ITAG
      RHOHI(I)=RHCNI(I)
      RHOHI(I)=RHCNO(I)
      WDELM(I)=-WDELNI(I)
      WDELM(I)=-WDELNO(I)
      L=PARTPS(I)+1.0
      DO 100 K=1,L
      WRATEN(K,I)=WRATEN(K,I)
      RHOFLU(K,I)=RHOFTP(K,I)
100 CONTINUE
      IF(TAPE.EQ.0.0) GO TO 110
C WRITE TIME PT. DATA NEEDED FOR RESTART ON TAPE
      IF(TAPE.GT.0.0) GO TO 99
      WRITE(6,104) (TPARTS(I),I=1,ITAG)
104 FORMAT('1 RESTART DATA',10X,'PARTS =',10A10/30X,10A10)
      WRITE(6,NERVA)
      IF(TAPE+2.0)103.102.101
103 IF(TAPE-2.0)101.102.103
102 WRITE(7,NERVA)
      GO TO 110
102 WRITE(7,NERVA)
101 IF(EOFTAP.NE.0.0) GO TO 120
      REF = REF + 1
      WRITE(REF) TTAG,(TPARTS(I),I=1,ITAG),(TDELZ(I),I=1,ITAG)
      EOFTAP=1.0
120 WRITE(REF) TIME,PTANKX,PFUMOC,PNTI,FNTD,PCORD,PTROT,PTURIX,PTURO,
      1PDIL,PMIX,TTANKX,TPUMOC,TNTI,TNTD,TCORO,TTROT,TTURIX,TTURO,
      2TDILX,TCORO,WPUMC,WRATEG(TTAG),WNOZ,WHBP,WDILX,WTURB,NTURC,QN,
      3GATEP,
      4ETAP,(ZERO,I=1,8),(PRESI(I),I=1,ITAG),(TEMP(I),I=1,ITAG),
      5WRATEI(I),I=1,ITAG),PRUMOR,TPUMOR,NTURP,WPUMP,WDILN,WHBPN,PON,
      6PEN,T8N,T11N,GPUMP,EPUMP,ETURP,HDFUM,WI,DELHN,RHOMIX,RHOMOX,
      7HMP,RHOMI(I),I=1,ITAG),(RHOMO(I),I=1,ITAG),RHOFLU,TMETAL,
      8TJACK,TCOLD,THOT,TNOZW,TNTHOT,TNTCLD,TNTJWD,TJKTWD,IJKWD,RHONTH,
      9RHONZH,MNTM,WNOZM
110 RETURN
      ENTRY RESTAR
C FIND RESTART TIME FROM TAPE TO RESTART CASE
      NDBIND=0
      READ(REF,ERR=60) CTAG,(CPARTS(I),I=1,CTAG),(CDELZ(I),I=1,CTAG)
      DO 5 II=1,CTAG
      IF(CPARTS(I).NE.TPARTS(II)) GO TO 5
      CJ(I)=II
      IF(CDELZ(I).EQ.TDELZ(II)) GO TO 7
      WRITE(6,4) CPARTS(I),CDELZ(I),TDELZ(II)
      4 FORMAT(' DELTA Z DOES NOT MATCH FOR PART ',2A4,' TAPE DEL Z = ',
      1A4,' CORE DEL Z = ',F8.0)
      NDBIND=1
      GO TO 7
5 CONTINUE
      CJ(I)=0
      WRITE(6,6) CPARTS(I)
      6 FORMAT(' CANNOT FIND A COMPARE FOR PART ',2A4)

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7 CONTINUE
  DC E I=1,CTAG
  IF (CJ(I).NE.0) GO TO 8
  CJ(I)=CJ(CTAG)
8 CONTINUE
10 READ (REFR,END=40,ERR=50) TIME,PTANKX,(TEMPY,I=1,5),PTURIX,PTURO,
  1TEMPY,
  2TEMPY,TTANKX,(TEMPY,I=1,3),TCORO,(TEMPY,I=1,5),WPUNC,(TEMPY,
  3I=1,18),(TEMPY,TEMPY,TEMPY,I=1,CTAG),PPUMP,TPUMP,NTURP,WPUMP,
  4WDILN,WHBPN,P6N,P8N,T8N,T1N,OPUMP,EPUMP,ETURP,HDPUN,WI,DELIN,
  5RHOMIX,RHOMOX,HSVP,(RHOMI(CJ(I)),I=1,CTAG),(RHOMO(CJ(I)),I=1,
  6CTAG),RHOFLI,IMETAL,TJACK,TCOLD,THOT,TNOZW,TNTHOT,TNTCLD,TNTJWD,
  7TJKTD,TJKWC,RHONTH,RHONZH,WNTM,WNOZM
  IF (TIMEI.GT.TIME) GO TO 10
  IF (TIMEI.LT.TIME) GO TO 30
  IF (OPEN.EQ.0.0) GO TO 20
  NTURP=0.0
  EPUMP=0.0
  ETURP=0.0
20 REFR=REFR+1
  RETURN
30 WRITE (6,31) TIMEI,TIME
31 FORMAT (' CANNOT FIND CORRECT TIME ON TAPE. TAPE= ',F10.4,
  1' INPUT= ',F10.4)
  NOTIND=1
  GO TO 20
40 WRITE (6,41)
41 FORMAT (' TIME ASKED FOR NOT ON TAPE. HIT ECF. ')
  GO TO 30
50 WRITE (6,51)
51 FORMAT (' ERROR TRANSFERRING DATA FROM TAPE TO CORE ')
  GO TO 10
60 WRITE (6,61)
61 FORMAT (' ERROR TRANSFERRING DATA FROM TAPE TO CORE ON ID,DELZ RECO
  1RD. WILL TRY TO MATCH NAMES AND CONTINUE. ')
  GO TO 2
  END

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SUBROUTINE NODET (*)
C REGION TO COMPLETE CONSTANTS FOR ONE PCSITICA STEP
IMPLICIT REAL*8 (A-Z)
INTEGER*4
* DTAG      .I      .IDELZS      .IEND      .IM(5)      .
* J          .JEND      .K          .KEND(5)      .L      .
* LEND      .MTAG(30)      .NCFIND      .NTAG      .PTAG      .
* XTAG(5,5)  .II        .M          .NOBNT      .NOCENT      .
* NZTRQT     .NTCNT      .NMCNT      .NODEPT      .MPARTS      .
* JJ         .KK        .LL        .INOCE      .KLOOP      .
* REF        .IDELT     .NTFNIS      .NODZ      .NK          .
* TTAG      .CTAG      .CJ(20)      .REFR      .
COMMON /ADD/
* ARG        .ARG1      .ARG2      .ATURNP      .EUF(10)      .
* CARDS(11)  .DELTAP     .DTURX      .GASVEL      .HCORO      .
*          .HFCGEF      .HPIN       .HROUT      .HTANKN      .
* hTURIX     .KVSORT     .MACH       .NBEND      .PPOUT      .
* PTROT      .PTURPR     .PREDFL     .PVAPOR     .PTXST      .
* PFLOW      .PTXMIN     .PUMPH       .RF         .RNTROT      .
*          .RATIO        .RATIOC      .SPEED       .TTROT      .
* TEMPY      .TAX        .TJKWD1     .TNTN21     .TNHT1      .
* TPOUT      .TPIN       .TTXMIN     .FILMNT      .TMIX      .
* UNCHK      .T2NP1(30) .T3NP1(30) .SAVN(15)     .QPMI      .
* T1NP1(30)  .T2NP1(30) .T3NP1(30) .SAVN(15)     .QPMI      .
* SAVFX(20,8) .SAVPT(20,18) .SAVJ(30,27) .SAVIJ(30,20,9)
COMMON /AZ01/
* CSUBP(30,20) .FILMHF(30,20) .PRESS(30,20) .RHOFLU(30,20) .
* RHOFTF(30,20) .TFLUID(30,20) .TMETAL(30,20) .WRATEM(30,20) .
* WRATEN(30,20)
COMMON
*/CONS/
* G          .JAY        .PI         .R         .RAC        .
* RB
COMMON /EXTRA/
* FUMIP      .QPUM       .TCX        .TNKFHO     .TPT2        .
* TPCR       .TPQ        .TPK2       .TPKFD      .TPWH       .
* KPLMPI     .WBEAR      .HBEAR     .WPUMPC     .
* ATURNZ     .ATUBNC     .ATUR      .AROLNZ     .PMIX        .
* PAVG       .WPMAX      .DTURBL   .PPIN       .TAVE        .
* CR         .TIURIP     .GAMMA    .PTOOLD     .KVLMIN      .
* HDILX      .CPTI       .GANT1     .TTXT       .TPNW       .
* KTPMIN     .WPCNT      .TURWK     .TCTMP      .
* TPWK       .TIMER      .PCARD     .RHOM       .
* DELZP      .ZM        .DELFT     .DELFT      .DELZT      .
* HLPFH      .HLPCF      .TK        .RNDIST     .RDNIT      .
* TROTZ      .WNCF       .WNCF1     .WNCIT      .HTCNT      .
* TCHOK      .THETA1     .THETA2    .MAN3       .MEN3       .
* FNTH       .TDIRM      .SACPR     .FNTC       .MDN2       .
* INWD1      .FJ         .MCN1      .MDN1       .TNTCD1     .
* MBN2       .ETAP       .TPT20     .METLTN     .TPTAV      .
* TIMEZ      .DUM        .OMAX      .OZ         .TEMPTM(30)
COMMON
*/FLAG/
* ETAPFL     .HOPFG      .MASS      .MTIME      .NTIME      .
* NUT        .OPEN       .OPTIGN     .PMINO      .STATE      .
* TANK       .TAPE       .TFUM       .TIMEI      .TIMEX      .
* TMETNO     .WINT       .TIMES(10)
COMMON /FLUIDP/
* PRES       .ZFACT      .QUAL      .TEMP      .RHO        .
* GAM        .CP         .VEL       .ENTR      .COND       .
* VIS        .VOL        .ENTH
COMMON
*/FZ/
* DELTEN(20) .FLUTEN(20) .NSTIEN(20) .NSMALL(20) .NTPNTS(20) .
* PARTI(20)  .PARTPS(20) .TEMPEX(20)
COMMON
*/MISC/
* PCX        .PDK        .PDKV       .PTUROC     .PTUROP      .
* HBPV       .HBPV      .HBPWC      .HBPWNC     .

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* METLTO      * MINFLO      * PASSX      * SSOUT      * WPIT
* ITEMP(20)   * OTEMP(20)   * DELHN2(200) * PUMP(350)  * FILMA(20)
* FILMB(20)   * FILMC(20)   * TCFLG(20)
COMMON
*/P/
* ALPHA      * BETA      * DIST      * EPUMC      * EPUMP
* ETURC      * ETURP      * FILMCX     * GATEP      * HDPUM
* MSVC       * MSVP      * MHT        * NMT        * NTURC
* NTARR      * PCORO     * PCUR       * PDIL       * PHSPQ
* PNTNOX     * PNTI       * PNTD       * PPUMOC     * PPUMOP
* PTANKX     * PTURIX    * PTURO      * QPUMP      * RFLU
* SAC        * TCORO     * TCOROR     * TCUR       * TDILX
* THBPQ      * TIME       * TIMEP      * TMETL      * TNTI
* TMTD       * TPUMOC     * TPUMOP     * TTANKX     * TTURIX
* TIZMIX     * UHG        * WCUR       * WDILX      * WHP
* WNOZ       * WNTGK      * WNTI       * WNTC       * WPUMC
* WRAMP      * WTURB
COMMON /TABIJ/
* AFLOW(30,20) * CAP(30,20) * CONDI(30,20) * HG(30,20) * HGF(30,20)
* WETP(30,20)
COMMON
*/TABJ/
* DELZ(20)     * FRICF(20)   * HFRLG(20)   * KDPI(20)    * KDPO(20)
* NDELZ(20)    * PLENI(20)   * PLEND(20)   * RHDMTL(20)  * TNODE(20)
* TK(20)       * VOIDF(20)   * WALL(20)
COMMON
*/TAGS/
* DTAG        * I          * IDELZS      * IEND        * IM
* J           * JEND       * K           * KEND        * L
* LEND        * MTAG       * NOFIND      * NTAG        * PTAG
* XTAG        * II        * N          * NBBNT       * NODENT
* NZTROT      * NTCNT      * NMCNT       * NDEPT       * NPARTS
* JJ         * KK        * LL         * INODE       * KLOOP
* REF         * IDELT     * NTPNTS     * NODZ        * NK
* TTAG
COMMON /TF/
* AFLOWX      * BATERM     * BATERS      * COMTL       * CPTERM
* DELZ        * DELMN      * DELMNX     * DELPM       * DELPM
* DELTER      * DHYDRA     * DPIPE       * DTERM       * DZTERM
* ENTRAP      * ETATP      * GP          * GPM         * HFTERM
* HGOEF       * HGTQT      * HPMI       * HPCOE      * HVTERM
* H12         * K          * KVN        * KWC         * KWC
* KWC         * KWH        * KWHV       * KWT         * K1
* K2          * K3         * K4         * K6          * K6
* MTERM2      * MTERM3     * MTERM4     * NPRN        * MTERM1
* PHI         * PNOZO      * PNTTHR     * PRESM       * NTERM
* PRPRIN      * PPTERM     * PSTR       * PTANKN     * PRGUES
* PEN         * PPS       * QN         * QPM         * PGN
* RHOR        * RHOAKN     * RHOAKN     * QPM         * QTERM
* STERM       * STTAG      * TFLUSR     * RPM2        * SPRIME
* TTANKN      * TTURO      * TTP        * TMENT       * TIMEN
* T1ISR       * T8N        * TVP        * TMTERM      * TIMIN
* WERROR      * WETPER     * WATERM     * WDILN       * WTERM
* WNT         * WPACTN     * WHPN       * WI          * WCHOK
* WNT         * WTUBE
* WCUR = 0.5*(WRATEN(I,J)+WRATEN(I+1,J))
CALL INTP(AFLOW(I,J),DIST,AFLOWX)
CALL INTP(WETP(I,J),DIST,WETPER)
IF(WALL(J).NE.0.) GO TO 6
DZTERM = (1.-VOIDF(J))*DELZ(J)*AFLOWX/VOIDF(J)
GO TO 5
C
6 PIPE OPTION
DPIPE = DSQRT(AFLOWX*4.0/PI)
DZTERM = DPIPE*WALL(J)*PI*DELZ(J)/TIMEZ
S
WTERM = DZTERM/WCUR
C
CP = 0.5*(CSUBP(I,J)+CSUBP(I+1,J))
CALL INTP(CAP(I,J),TMETAL(I+1,J),CR)
RHOR = RHGRTL(J)*CR
CALL INTP(CONDI(I,J),TMETAL(I+1,J),COMTL)

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1 CALL INTP(HGF(1,J),DIST,HGCCF)
HGCCF = HGCOEF * HGTOT
FILMCX = FILMHF(1,J)
C
C REGION TO COMPUTE HEAT RESISTANCE TERMS FOR ONE NODE
IF(WALL(J).NE.0.) GO TO 11
HFTERM = FILMCX
GO TO 12
11 HFTERM = 2.*FILMCX*CDMTL/(2.*CDMTL+WALL(J)*FILMCX)
12 MHT = CP *WCUR/(HFTERM*WETPER*DELZ(J))
DUM = 2.*MHT-1.
IF(DUM.GE.0.) GO TO 13
MSMALL(J) = DUM
C
13 IF( STATE.NE.0.) GO TO 4
NMT = WTERM * RHOR / (TIMEZ * CP )
TEMPY = 2.0/(1.+2.*NMT)
IF( NHT.LT.TEMPY) RETURN 1
SAC = CDMTL * TIMEZ / (RHOR * DELZ(J) * DELZ(J))
UING = HGCOEF * TIMEZ / RHOR
GO TO 2
4 UING = MHT * HGCOEF * WTERM / CP
SAC = CDMTL * WTERM * MHT / (DELZ(J) * DELZ(J) * CP )
2 CONTINUE
RETURN
END

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SUBROUTINE NOZZLE
IMPLICIT REAL*8 (A-Z)
INTEGER*4

* DTAG	.I	.IDELZS	.IEND	.IM(5)
* J	.JEND	.K	.KEND(5)	.L
* LEND	.MTAG(30)	.MOFIND	.NTAG	.PTAG
* XTAG(5,5)	.II	.M	.NOBNT	.NOCENT
* NZTRGT	.NTCNT	.NMCNT	.NODEPT	.NPARTS
* JJ	.KK	.LL	.NMODE	.KLQOP
* REF	.IDELT	.NTPNTS	.NODZ	.NK
* TTAG	.CTAG	.CJ(20)	.REFR	
*NOBSK,NODESK,SMCNT,STAG				
COMMON /ACD/				
* ARG	.ARG1	.ARG2	.ATURNP	.BUF(10)
* CARDS(11)	.DEL TAP	.DTURX	.GASVEL	.HCOG
	.HFCQEF	.HPIN	.HPOUT	.HTANKM
* MTURIX	.KVSQRT	.MACH	.NBEND	.PPOUT
* FTROT	.PTURPR	.PREDFL	.PVAPOR	.PTXST
* PFLOW	.PTXMIN	.PUMPH	.RF	.RNTROT
	.RATIO	.RATIOC	.SPEED	.TTRT
* TEMPY	.TMX	.TJKWD1	.TNTNZ1	.TNTHT1
* TPOUT	.TPIN		.TTXMIN	.TMIX
* UNCHK			.FILMNT	.QPUMI
* T1NP1(30)	.T2NP1(30)	.T3NP1(30)	.SAVN(15)	.SAVNT(20)
* SAVFX(20,8)	.SAVPT(20,18)	.SAVJ(30,27)	.SAVIJ(30,20,9)	
COMMON				
*/AT/				
* ANGZTX	.CDJX	.CDNTCX	.CDNTHX	.CPX
* CRJNTX	.CRJX	.DELH	.DELP	.DELPK
* DELPO	.DELHNO	.DELTX	.DELW	.DELZSQ
* DELZX	.DELZX4	.MGCJKT	.MGCNTC	.MGCNTH
* HI	.HJ	.HK	.HL	.MLPRIM
* HRNTJW	.HROJ	.MLN	.MZN	.PIN
* PJ	.PK	.PL	.PLPRIM	.RFLUX
* RHOMIX	.RHOMOX	.RHOMX	.RHONIX	.RHONOX
* RHGX	.SJOX	.SNOZX	.SNTCX	.SNTHX
* TAMBX	.TCCUR	.THCUR	.THEDIF	.TJKCUR
* TKNJX	.TKNTCX	.TKNTHX	.WNOZEN	.WNOZI
* ZMAX	.ZMIN	.ZTROT		
COMMON /AZ10/				
* FILMNTZ(30)	.FILMNTC(30)	.FILMTH(30)	.HRNGZW(30)	.HRNTCW(30)
* HRNTHW(30)	.PNOZ(30)	.PTUBE(30)	.RHONTM(30)	.RHONTN(30)
* RHGNZN(30)	.RHONZN(30)	.TCCLD(30)	.THOT(30)	.TJACK(30)
* TJKTWD(30)	.TJKWD(30)	.TNOZ(30)	.TNOZW(30)	.TNTCLD(30)
* TNTHOT(30)	.TNTJWD(30)	.TTUBE(30)	.WNOZM(30)	.WNOZN(30)
* WNTM(30)	.WNTM(30)			
COMMON				
*/CONS/				
* G	.JAY	.PI	.R	.RAD
* RB				
COMMON /EXTRA/				
* PUMIP	.QPUM	.TCX	.TNKRHO	.TPT2
* TPCR	.TPQ	.TPK2	.TPKPD	.TPWH
* MPUMPI	.MBEAR	.MBEAR	.MPUMPC	
* ATURNZ	.ATURNC	.ATUR	.AROLNZ	.PMIX
* PANG	.MPHAX	.DTURBL	.PPIN	.TAVE
* CR	.TTURIP		.GAMMA	.PTQOLO
* HDILX	.CPTI	.GANTI	.TTXST	.KVLMIN
* KIPMIN	.WPCNT	.TURWK	.TCTMP	.TPNW
* IPWRK	.TIMER	.PCARD	.RHOM	
* DELZP	.ZM	.ZM1	.DELPT	.DELPMT
* HLPHF	.HLPFCF	.TK	.DTROT	.DELZT
* TROTZ		.RNDIST	.RFN	.Q
* TGHOM	.WNCF	.WNCF1	.WNNIT	.HTCNT
* FNTH	.THETA1	.THETA2	.WAN3	.MEN3
* TNTWD1	.TDIFM	.SACPR	.FNTC	.MDN2
* MBN2	.FJ	.MCN1	.MDN1	.TNTCD1
* TIMEZ	.ETAP	.TPT20	.METLTN	.TPTAV
* PIUROM	.DUM	.OMAX	.OZ	.TEMPTM(30)
* SIG				


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COMMON
*/FLAG/
* ETAPFL      ,HBPFG      ,MASS      ,MTIME      ,NTIME      ,
* NBIT        ,OPEN      ,OPTION     ,PMINO      ,STATE      ,
* TANK        ,TAPE      ,TFLUM     ,TIMEI      ,TIMEX      ,
* THETMO      ,WINT      ,TIMES(10)
COMMON
*/FLUIDP/
* PRES        ,ZFACT      ,QUAL      ,TEMP      ,RHO      ,
* GAM         ,CP         ,VEL      ,ENTR      ,COND      ,
* VIS         ,VOL        ,ENTH      ,
COMMON /MISC/
* PCX         ,PDK        ,PDKV      ,RTURQC      ,PTUROPC      ,
* HBPKV       ,HBPW      ,HBPWC      ,HBPWC      ,HBPWC      ,
* METLTO      ,MINFLG     ,PASSX      ,SSOUT      ,WPIT      ,
* ITEMP(20)   ,OTEMP(20)  ,DELHN2(200) ,PUMP(350)  ,FILMA(20)  ,
* FILMB(20)   ,FILMC(20)  ,TCFLG(20)  ,
COMMON /NTNZ/
* PHINZ(30)   ,CPDP       ,ENTHO(30)  ,HKPR       ,PHINT(30)  ,
* RFTC        ,PKPR       ,PTCX      ,QCLDNT(30) ,QHGTNT(30)  ,
* RHODP       ,TCLQC      ,TTC
COMMON
*/NTS/
* AJB         ,AJE        ,AJF        ,ANF        ,ANH      ,
* BJB         ,BJE        ,BJF        ,BNF        ,BNH      ,
* CJB         ,CJE        ,CJF        ,CNF        ,CNH      ,
* DNT         ,FNT        ,KNTI      ,KNTG      ,NODES     ,
* NOZEFF      ,NTDZ      ,THETA     ,THROAT    ,TNTIM     ,
* VNTI        ,VNTG
COMMON /QPC/
* FETAB(4,30) ,HFTAB(5,30) ,OPT(30)
COMMON
*/R/
* ALPHA       ,BETA       ,DIST      ,EPUMC      ,EPUMP      ,
* ETURC       ,ETURP      ,FILMCX    ,GATEP      ,HDPUM      ,
* HSV         ,HSVP      ,NHT       ,NHT       ,NTURC      ,
* NTURP       ,PCORO      ,PCUR      ,PDIL      ,PHEPD      ,
* PMINOX      ,PNTI      ,PNTO      ,PPUMOC     ,PPUMOP      ,
* PTANKX      ,PTURIX     ,PTURQ     ,PPUMP      ,RFLU      ,
* SAC         ,TCORO      ,TCOROR    ,TCUR      ,TDILX      ,
* THBPQ       ,TIME       ,TIMEP     ,TMETL      ,TNTI      ,
* TINTO       ,TPUMOC     ,TPUMOP    ,TTANKX     ,TTURIX     ,
* T12MIX      ,UING       ,WCUR      ,WDILX      ,WHEP      ,
* WNOZ        ,WNTCK      ,WNTI      ,WNTO      ,WPUMC      ,
* WPLUMP      ,WTURB
COMMON
*/TAB1/
* ANTC(30)    ,ANTG(30)    ,ANTH(30)    ,ANTW(30)    ,CDJ(30)    ,
* CDNT(30)    ,CFWP(30)    ,CG(30)     ,CPJ(30)     ,CPNT(30)    ,
* CRJ(30)     ,CRJNT(30)   ,DEL(30)     ,DELPNT(30)  ,DELPNZ(30)  ,
* DNOZW(30)   ,GATE(30)   ,GP(30)     ,HGFJ(30)   ,HGFNTC(30)  ,
* HGFNTH(30)  ,HGJ(30)     ,HGNTC(30)  ,HGNTH(30)  ,KPD(30)    ,
* KPDV(30)    ,KV(30)     ,NT(30)     ,PAMB(30)   ,PBD(30)    ,
* PC(30)      ,PINLET(30)  ,PLINE(30)  ,PRATIO(30) ,PTURND(30)  ,
* RNOJ(30)    ,RNOJ(30)  ,RNTM(30)   ,RNTJ(30)   ,SJO(30)    ,
* T1(30)      ,TINLE(30)  ,TKJ(30)    ,TKNTC(30)  ,SSPRI(30)  ,
* TUREFF(30)  ,VNODES(30)  ,WDIL(30)   ,WPUM(30)   ,TKNTN(30)  ,
* TURIT(30)   ,TURIP(30)  ,RBFLOW(30) ,BEND(30)
COMMON
*/TAGS/
* DTAG        ,I         ,IDELZS     ,IEND        ,IM      ,
* J         ,J         ,J         ,J         ,J         ,
* K         ,K         ,K         ,K         ,K         ,
* L         ,L         ,L         ,L         ,L         ,
* M         ,M         ,M         ,M         ,M         ,
* N         ,N         ,N         ,N         ,N         ,
* O         ,O         ,O         ,O         ,O         ,
* P         ,P         ,P         ,P         ,P         ,
* Q         ,Q         ,Q         ,Q         ,Q         ,
* R         ,R         ,R         ,R         ,R         ,
* S         ,S         ,S         ,S         ,S         ,
* T         ,T         ,T         ,T         ,T         ,
* U         ,U         ,U         ,U         ,U         ,
* V         ,V         ,V         ,V         ,V         ,
* W         ,W         ,W         ,W         ,W         ,
* X         ,X         ,X         ,X         ,X         ,
* Y         ,Y         ,Y         ,Y         ,Y         ,
* Z         ,Z         ,Z         ,Z         ,Z         ,
* NOBSK,NODESK,SMCNT,STAG
COMMON /BATERM/
* BATERM      ,BATERM      ,BATERM      ,BATERM      ,

```

B
C
D
E
FF
A
B
C
E
F

SUBROUTINE NOZZLE

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PAGE 3

* DDELZ	* DELHM	* DELHM	* DELHMX	* DELPM
* DELTER	* DHYDRA	* DPIPE	* DTERM	* DZTERM
* ENTRDP	* ETAT	* ETATP	* GPN	* HFTERM
* HGCOEF	* HGTOT	* HPUM1	* HTCDEF	* HVTTERM
* H12	* KT	* KVN	* KWC	* KWCP
* KWCV	* KWH	* KWHV	* KWT	* K1
* K2	* K3	* K4	* K6	* MTERM1
* MTERM2	* MTERM3	* MTERM4	* NPRN	* MTERM
* PMI	* PNQZO	* PNTTHR	* PRESN	* PRQUES
* PRFRIM	* PRTERM	* PSTP	* PTANKN	* P6N
* PEN	* P8PR	* QN	* QPM	* QTERM
* RHCR	* RHOTKM	* RHOTKN	* RPM2	* SPRIME
* STERM	* STAG	* TFLUSR	* TIMEMT	* TIMEN
* TTANKN	* TTURO	* TWP	* TWTERM	* T11N
* T11SR	* T8N	* WATERM	* WDILN	* MTERM
* WERROR	* WETPER	* WHSPN	* WI	* WCHOK
* WNT	* WPACTN	* WRTERM	* WTERM	* WTURN
* WNTERM	* ZTUBE			
COMMON				
*/X/				
* EOFTAP	* INDTUR	* INTFLO	* LARGET	* LESPO
* EOPN	* NCAP	* NEGW	* NONGP	* MONSPD
* EONTC	* NONW	* NOTURN	* NOTURN	* NTERM
* PARONE	* WITER			

100 WNOZN(NODENT+1) = WCUR
WNCDI = WCUR

**** PCORO , TCORO ARE CORE OUTLET CONDITIONS

PJ = PCORO
PIN = PCORO
TK = TCORO
110 CALL PT (PCORO,TCORO)
HJ = ENTH
HI = ENTH
RF = 1.0

**** NOZZLE THROAT DIAMETER

CALL INTP (DNOZW,THROAT,DTROT)
ANOZTX = (PI*DTROT**2)/4.

**** CALCULATE THROAT INTERPOLATION FACTOR

IF (NTDZ.GT.0.) GO TO 150
120 DO 140 M=1,NODENT
IF (THROAT.GE.VNODES(M+1)) GO TO 140
130 DELZT = VNODES(M+1)-VNODES(M)
ZTROT = (VNODES(M)-THROAT)/DELZT
GO TO 200
140 CONTINUE
150 TROTZ = THROAT/NTDZ
NZTROT = TROTZ
ZTROT = NZTROT-TROTZ
200 DO 500 I=1,NODENT
IF (NTDZ.GT.0.) GO TO 220

**** VARIABLE NODE LENGTH

210 DELZX = VNODES(NODENT+2-I)-VNODES(NODENT+1-I)
DIST = VNODES(NODENT+1-I)+DELZX/2.
GO TO 240

**** FIXED NODE LENGTH

220 IF (I.GT.1) GO TO 230
DIST = ZMAX
DELZX = NTDZ
GO TO 240
230 DELZX = NTDZ

```

      DIST = DIST-DELZX
      ****      NOZZLE FLOW DIAMETER
240 CALL INTP (DNCZM,DIST,DHYDRA)
      AFLOWX = (PI*DHYDRA**2)/4.
      ****      NOZZLE WET PERIMETER
      CALL INTP (SNOZ,DIST,WETPER)
      ****      TUBE THERMAL CONDUCTIVITY
      CALL INTP (CONZ,THOT(NODENT+2-1),CONTHX)
      ****      TUBE HOT SIDE THICKNESS
      CALL INTP (TKNTH,DIST,TKNTHX)
260 RHCN = RHCNZM(NODENT+1-1)
      HL = HJ
      PL = PJ*2.-FIN
      HK = (HL+HJ)/2.
      PK = (PJ+PL)/2.
      PCUR = PK
      IF (PCUR.LT.0.) GO TO 530
      TCUR = TK
270 CALL PT(PK,TK)
      RHODP = RHO
      CPDP = CP
280 DELRHO = RHO-RHOM
      ****      TEST FOR MASS CAPACITANCE FLAG
      IF (MCAP.EQ.1.) GO TO 290
      WNODEN = WNODI
      GC TO 295
290 WNODEN = WNODI-DELZX*AFLOWX*DELRHO/TIMEP
      WCUR = (WNODEN+WNODI)/2.
      IF (WCUR.LT.0.) GO TO 520
      CALL INTP (DEL,DIST,SIG)
      CALL INTP (CG,DIST,HFTAB(5,OPT(23)))
      ****      SUBROUTINE FOR FILM COEFFICIENT
      CALL HF (OPT(23),WCUR,PCUR,TCUR,HK,TNOZW(NODENT+2-1),WETPER,SIG,
      *AFLOWX,FILMNZ(NODENT+1-1))
      HRNOZW(NODENT+1-1) = (TKNTHX/(2.*CONTHX)+1./FILMNZ(NODENT+1-1))/
      *WETPER
      DELTMP = THOT(NODENT+2-1) - TCUR
      HLPRI = (DELTMP*DELZX/HRNOZW(NODENT+1-1) + WNODI*HJ) / WNODEN
      RFO = RF
      ****      RECOVERY FACTOR
      CALL INTP (BFN,DIST,BF)
      HLPRI = HLPRI * (BF/BFO)
      DELH = HL - HJ
      ****      SUBROUTINE FOR FRICTION FACTOR
      CALL FF (OPT(23),WCUR,PCUR,TCUR,HK,TNOZW(NODENT+2-1),WETPER,PHI)
      PHINZ(NODENT+1-1) = PHI
      DELZP = DELZX
      ZN = DIST+DELZX/2.
      ZM = DIST-DELZX/2.
      IF (NOBNT.EQ.0) GO TO 321
      ****      TEST FOR BEND IN NODE

```

```

310 DC 320 K=1,NOBNT
    IF (BEND(2*K).GE.ZM) GO TO 320
    IF (BEND(2*K).LT.ZM1) GO TO 320
C
C      ****      ADDITIONAL PRESSURE DROP DUE TO BEND TABLE
C
    DELZP = DELZP+BEND(2*K-1)
320 CONTINUE
321 DELPT = DELZP*4.*PHI/DHYDRA
    DELFMT = DELPT/(2.*12.*G*RHODP*AFLOWX**2)
    DELPM = DELFMT*WCUR**2
330 PLPRIM = PJ-DELP
    IF (PLPRIM.LT.0.) GO TO 530
340 PL = PLPRIM
350 IF (NTDZ.GT.0.) GO TO 355
    RNDIST = VNODES (NODENT-1) + (VNODES (NODENT+1-1) - VNODES
1      (NODENT-1)) / 2.
    GO TO 360
355 RNDIST = DIST - NTDZ
360 CALL INTP (RN,RNDIST,RFN)
365 Q = DELZX / HRNOZW (NODENT+1-1) * (TCUR - THOT (NODENT+2-1))
    TMX = RFN * (TK / RF - Q / (WCUR * CPDP))
368 RHONZN(NODENT+1-1) = RHO
    WNOZI = WNODEN
370 WNCZN(NODENT+1-1) = WNODEN
    TACZ(NODENT+1-1) = TCUR
    PNCZ(NODENT+1-1) = PL+(PJ-PL)/2.
C
C      ****      TEST IF THROAT IN THIS NODE
C
400 IF (THROAT.GE.ZM) GO TO 450
    IF (THROAT.LT.ZM1) GO TO 450
410 WNOZ = WNODEN+(WNODEN-WCUR)*2.*ZTROT
    PTROT = PL+(PL-PJ)*ZTROT
420 TTROT = (TK-TMX)*(THROAT-RNDIST)/(DIST-RNDIST)+TMX
    IF (TTROT.LT.0.) GO TO 540
    CALL INTP (RN,THROAT,ENTROT)
    TCHOK = TTROT / ENTROT
    WNCF = .DSORT (TCHOK)
    WNCF1 = (PTROT*ANGZTX*NGZEFF)/WNCF
    CALL PT (PTROT,TTROT)
C
C      ****      NOZZLE CHOKE FLOW
C
    WNCCHOK = WNCF1*KTF (GAM)
    WNNIT = (WNCCHOK*PMINOX)/PTROT
450 IF (TCLOC.EQ.0.) GO TO 490
    IF (TCLOC.GE.ZM) GO TO 490
    IF (TCLOC.LT.ZM1) GO TO 490
    TTC = (TK-TMX) * (TCLOC-RNDIST) / (DIST-RNDIST) + TMX
    CALL INTP (RN,TCLOC,RTTC)
    TTC = TTC/RTTC
    PTGX = PL + (PL-PJ) * (ZM1-TCLOC) / DELZX
490 TK = TMX
    HJ = HJ
    HJ = HL
    PJ = PL
    PJ = PL
500 CONTINUE
C
C      ****      NORMAL RETURN TO MAIN PROGRAM
C
510 CONTINUE
    RETURN
C
C      ****      NEGATIVE FLOW RETURN TO MAIN PROGRAM
C
520 CALL MCFLCH
C
C      ****      NEGATIVE PRESSURE RETURN TO MAIN PROGRAM

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K

SUBROUTINE NOZZLE

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C 530 CALL MCPRES
C
C **** NEGATIVE T6 RETURN - FROM CHECKE FLW CALC
540 CALL MCTEMP
STOP
END

```

C      SUBROUTINE PARTAG
      SET-UP INDEX MAPPING OF INPUT PARTS TO ENGINE CONFIGURATION
      IMPLICIT REAL*8(A-Z)
      INTEGER*4
      * DTAG      ,I      ,IDELZS      ,IEND      ,IM(5)      ,
      * J          ,JEND      ,K          ,KEND(5)      ,L          ,
      * LEND      ,MTAG(30)      ,NOFIND      ,NTAG      ,PTAG      ,
      * XTAG(5,5)      ,II      ,M          ,NOBNT      ,NOCENT      ,
      * NZTRGT      ,NTCNT      ,NMCNT      ,NODEPT      ,NPARTS      ,
      * JJ          ,KK          ,LL          ,INODE      ,KLOOP      ,
      * REF          ,IDELT      ,NTPNTS      ,NODZ      ,NK          ,
      * TTAG      ,CTAG      ,CJ(20)      ,REFR          ,
      *NOBSK,NODESK,SMCNT,STAG
      COMMON /LITER/NAMES(10),CTIME,COMENT,BLANK,NI,NI,CNTMAX,ZERO
      COMMON
      * /NMTAG/
      * DILREM      ,HM          ,HX          ,MPARTS(30)      ,NTNAME      ,
      * PARTS(20)      ,PLNAME      ,PM(5)      ,PX(5)      ,TH(5)      ,
      * TDELZ(20)      ,TFPARTS(20)      ,TX(5)      ,WM(5)      ,WX(5)      ,
      * XPARTS(5,5)      ,CPARTS(20)      ,CDELZ(20)
      * ,SNAME
      COMMON
      * /TAGS/
      * DTAG      ,I      ,IDELZS      ,IEND      ,IM      ,
      * J          ,JEND      ,K          ,KEND      ,L      ,
      * LEND      ,MTAG      ,NOFIND      ,NTAG      ,PTAG      ,
      * XTAG      ,II      ,M          ,NOBNT      ,NOCENT      ,
      * NZTRCT      ,NTCNT      ,NMCNT      ,NODEPT      ,NPARTS      ,
      * JJ          ,KK          ,LL          ,INODE      ,KLOOP      ,
      * REF          ,IDELT      ,NTPNTS      ,NODZ      ,NK          ,
      * TTAG      ,CTAG      ,CJ          ,REFR          ,
      *NOBSK,NODESK,SMCNT,STAG
      COMMON
      * /TAEJ/
      * DELZ(20)      ,FRICF(20)      ,HFFLG(20)      ,KDPI(20)      ,KOPQ(20)      ,
      * NDELZ(20)      ,PLENI(20)      ,PLEND(20)      ,RHOMTL(20)      ,TNODE(20)      ,
      * TTK(20)      ,VOIDF(20)      ,WALL(20)
      * IEND = 0
      * JEND = 0
      * LEND = 0
      * DTAG = 0
      * NTAG = 0
      * PTAG = 0
      * STAG = 0
      DO 20 L=1,5
      KEND(L)=0
      DO 10 K=1,5
      IF ((XPARTS(K,L).NE.0.).AND.(XPARTS(K,L).NE.BLANK))
      *KEND(L)=KEND(L)+1
      10 XTAG(K,L)=0
      IF (KEND(L).NE.0)LEND=LEND+1
      20 CONTINUE
      DO 30 I=1,30
      IF ((MPARTS(I).NE.0.).AND.(MPARTS(I).NE.BLANK))IEND=IEND+1
      30 MTAG(I)=I
      DO 40 J=1,20
      IF ((PARTS(J).NE.0.).AND.(PARTS(J).NE.BLANK))JEND=JEND+1
      40 CONTINUE
      DO 55 I=1,IEND
      DO 50 J=1,JEND
      IF (MPARTS(I).NE.PARTS(J))GO TO 50
      MTAG(I)=J
      GO TO 60
      50 CONTINUE
      60 IF (MPARTS(I).NE.PLNAME)GO TO 70
      PTAG=MTAG(I)
      70 IF (MPARTS(I).NE.NTNAME)GO TO 80
      NTAG=MTAG(I)
      80 IF (MPARTS(I).NE.DILREM)GO TO 90
      DTAG=MTAG(I)

```

A
EA
B
C
DA
D
G
F
EA
B
CM
G
F
L

M

T

M
C
QE
S
T
G
B

K

```

50 IF (MPARTS(I).NE.STNAME)GO TO 95
   STAG = MTAG(I)
55 CONTINUE
   DO 130 L=1,LEND
     KLOOP=KEND(L)
     DO 120 K=1,KLOOP
       DO 100 J=1,JEND
         IF (PARTS(J).NE.XPARTS(K,L))GO TO 100
         XTAG(K,L)=J
         GO TO 120
       100 CONTINUE
       DO 120 I=1,2
         IF (MPARTS(I).NE.XPARTS(K,L))GO TO 110
         XTAG(K,L)=MTAG(I)
         GO TO 120
       110 IF (NTNAME.NE.XPARTS(K,L))GO TO 115
         IF (NTAG.EQ.0)NTAG=-I-30
         XTAG(K,L)=NTAG
         GO TO 120
       115 IF (STNAME.NE.XPARTS(K,L))GO TO 120
         IF (STAG.EQ.0)STAG=-I-30
         XTAG(K,L)=STAG
       120 CONTINUE
       130 CONTINUE
       ITAG = 0
       I = 1
       200 IF (LEND.LE.0)GO TO 230
       DO 220 L=1,LEND
         IF (MTAG(L).NE.XTAG(1,L))GO TO 230
         KLOOP = KEND(L) - 1
         IF (KLOOP.LE.0)GO TO 220
         DO 210 K=2,KLOOP
           J = XTAG(K,L)
           IF (J.LE.0)GO TO 210
           ITAG = ITAG + 1
           TDELZ(ITAG) = NDELZ(J)
           TPARTS(ITAG) = PARTS(J)
         210 CONTINUE
         220 CONTINUE
         J = MTAG(L)
         IF (J.LE.0)GO TO 240
         ITAG = ITAG + 1
         TDELZ(ITAG) = NDELZ(J)
         TPARTS(ITAG) = PARTS(J)
         230 I = I+1
         IF (I.LE.LEND)GO TO 200
       RETURN
     END

```

J
KL
PH
SN
OU
A

```

      SUBROUTINE PDLINE
      PDLINE
      IMPLICIT REAL*8 (A-Z)
      COMMON /ADD/
      * ARG      ,ARG1      ,ARG2      ,ATURNP      ,EUF(10)      ,
      * CARDS(11) ,DELTA P  ,HFCGEF    ,HPCOR0      ,HPCOR0      ,
      * HCURIX     ,KVSQRT   ,HPCIN     ,HPCOR0      ,HPCOR0      ,
      * PTROT      ,PTURPR   ,HPCOR0      ,HPCOR0      ,HPCOR0      ,
      * PFL0       ,PTXMIN   ,HPCOR0      ,HPCOR0      ,HPCOR0      ,
      * TEMPY      ,RATIO     ,HPCOR0      ,HPCOR0      ,HPCOR0      ,
      * TFCUT      ,TPIN     ,HPCOR0      ,HPCOR0      ,HPCOR0      ,
      * UNCHK      ,T2NP1(30) ,T3NP1(30) ,T3NP1(30) ,T3NP1(30) ,
      * T2NP1(30) ,T2NP1(30) ,T2NP1(30) ,T2NP1(30) ,T2NP1(30) ,
      * SAVX(20,8) ,SAVPT(20,18),SAVJ(30,27) ,SAVJ(30,20,9) ,SAVNT(20) ,
      COMMON /BD/
      * BDASK      ,BDASK0    ,BDMA      ,BDLP      ,BDM      ,
      * BDMU      ,BDP        ,BDRHO     ,BDS(10)   ,BDT      ,
      * BDM        ,BDM        ,BDM        ,BDM        ,BDM        ,
      COMMON
      */CGNS/
      * C          ,JAY       ,PI        ,R          ,RAD      ,
      * RB         ,JAY       ,PI        ,R          ,RAD      ,
      COMMON /EXTRA/
      * QPUM       ,QPM       ,JCK       ,JMKRHO     ,TBT2      ,
      * TPCR       ,TPK2      ,TPK2      ,TPK2      ,TPK2      ,
      * KPLMPI     ,HBEAR     ,HBEAR     ,HBEAR     ,HBEAR     ,
      * ATURNZ     ,ATURNZ    ,ATURNZ    ,ATURNZ    ,ATURNZ    ,
      * PAYG       ,WPMAX     ,WPMAX     ,WPMAX     ,WPMAX     ,
      * CR         ,TTURIP    ,TTURIP    ,TTURIP    ,TTURIP    ,
      * HDILX      ,CPTI      ,CPTI      ,CPTI      ,CPTI      ,
      * KTPMIN     ,WPCNT     ,WPCNT     ,WPCNT     ,WPCNT     ,
      * TFMK       ,TIMER     ,TIMER     ,TIMER     ,TIMER     ,
      * DELZP      ,ZM        ,ZM        ,ZM        ,ZM        ,
      * HLFHF      ,HLPFCE    ,HLPFCE    ,HLPFCE    ,HLPFCE    ,
      * TRCTZ      ,WNCF      ,WNCF      ,WNCF      ,WNCF      ,
      * TCHK       ,WNCF1     ,WNCF1     ,WNCF1     ,WNCF1     ,
      * ENTH       ,THETA1    ,THETA1    ,THETA1    ,THETA1    ,
      * TMTD1      ,TMTD1    ,TMTD1    ,TMTD1    ,TMTD1    ,
      * MGN2       ,FJ        ,FJ        ,FJ        ,FJ        ,
      * TIMEZ      ,ETAP      ,ETAP      ,ETAP      ,ETAP      ,
      * FTLKCM     ,DUM       ,DUM       ,DUM       ,DUM       ,
      COMMON
      */FLIDP/
      * PRES      ,ZFACT     ,ZFACT     ,ZFACT     ,ZFACT     ,
      * ZFACT     ,ZFACT     ,ZFACT     ,ZFACT     ,ZFACT     ,
      * ZFACT     ,ZFACT     ,ZFACT     ,ZFACT     ,ZFACT     ,
      COMMON /MISC/
      * PDK        ,PDK       ,PDK       ,PDK       ,PDK       ,
      * HBFKV      ,HBPWC     ,HBPWC     ,HBPWC     ,HBPWC     ,
      * METLTO     ,MINFLO    ,MINFLO    ,MINFLO    ,MINFLO    ,
      * ITEMP(20)  ,OTEMP(20) ,OTEMP(20) ,OTEMP(20) ,OTEMP(20) ,
      * FILMB(20)  ,FILMC(20) ,FILMC(20) ,FILMC(20) ,FILMC(20) ,
      COMMON
      */NAMEAG/
      * DILREM     ,HM        ,HM        ,HM        ,HM        ,
      * PARTS(20)  ,RLNAME    ,RLNAME    ,RLNAME    ,RLNAME    ,
      * TX(5)      ,WM(5)     ,WM(5)     ,WM(5)     ,WM(5)     ,
      COMMON
      */P/
      * ALPHA     ,BETA      ,BETA      ,BETA      ,BETA      ,
      * ETURC      ,ETURP     ,ETURP     ,ETURP     ,ETURP     ,
      * HVC        ,HVP       ,HVP       ,HVP       ,HVP       ,
      * MTRP       ,PCOR0     ,PCOR0     ,PCOR0     ,PCOR0     ,
      * PMINOX     ,PNTI      ,PNTI      ,PNTI      ,PNTI      ,
      * FTANKX     ,PTURIX    ,PTURIX    ,PTURIX    ,PTURIX    ,
      * SAC        ,TCOR0     ,TCOR0     ,TCOR0     ,TCOR0     ,
      * TRBPO      ,TIME      ,TIME      ,TIME      ,TIME      ,
      * TNU        ,TPUMOC    ,TPUMOC    ,TPUMOC    ,TPUMOC    ,
      * DIST       ,DIST      ,DIST      ,DIST      ,DIST      ,
      * FILMCX     ,FILMCX    ,FILMCX    ,FILMCX    ,FILMCX    ,
      * NHT        ,NHT       ,NHT       ,NHT       ,NHT       ,
      * PCUR       ,PCUR      ,PCUR      ,PCUR      ,PCUR      ,
      * PNTO       ,PNTO      ,PNTO      ,PNTO      ,PNTO      ,
      * PTURO      ,PTURO     ,PTURO     ,PTURO     ,PTURO     ,
      * TCOROR     ,TCOROR    ,TCOROR    ,TCOROR    ,TCOROR    ,
      * TIMEP      ,TIMEP     ,TIMEP     ,TIMEP     ,TIMEP     ,
      * TPUMOP     ,TPUMOP    ,TPUMOP    ,TPUMOP    ,TPUMOP    ,
      * EPUMC      ,EPUMC     ,EPUMC     ,EPUMC     ,EPUMC     ,
      * GATEP      ,GATEP     ,GATEP     ,GATEP     ,GATEP     ,
      * NHT        ,NHT       ,NHT       ,NHT       ,NHT       ,
      * PDIL       ,PDIL      ,PDIL      ,PDIL      ,PDIL      ,
      * PPUMOC     ,PPUMOC    ,PPUMOC    ,PPUMOC    ,PPUMOC    ,
      * QPUMC      ,QPUMC     ,QPUMC     ,QPUMC     ,QPUMC     ,
      * TCUR       ,TCUR      ,TCUR      ,TCUR      ,TCUR      ,
      * TNETL      ,TNETL     ,TNETL     ,TNETL     ,TNETL     ,
      * TTANKX     ,TTANKX    ,TTANKX    ,TTANKX    ,TTANKX    ,
      * EPUMP      ,EPUMP     ,EPUMP     ,EPUMP     ,EPUMP     ,
      * HDPUM      ,HDPUM     ,HDPUM     ,HDPUM     ,HDPUM     ,
      * NTURC      ,NTURC     ,NTURC     ,NTURC     ,NTURC     ,
      * PHEPQ      ,PHEPQ     ,PHEPQ     ,PHEPQ     ,PHEPQ     ,
      * PPUMOP     ,PPUMOP    ,PPUMOP    ,PPUMOP    ,PPUMOP    ,
      * RFLU       ,RFLU      ,RFLU      ,RFLU      ,RFLU      ,
      * TDILX      ,TDILX     ,TDILX     ,TDILX     ,TDILX     ,
      * TTI        ,TTI       ,TTI       ,TTI       ,TTI       ,
      * TTURIX     ,TTURIX    ,TTURIX    ,TTURIX    ,TTURIX    ,

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      * T12MIX      ,UIHG      ,WCUR      ,WDILX      ,WHEP      ,
      * WNGZ        ,WNTCK      ,WNTI      ,WNTD      ,WPUMC      ,
      * WPUMP        ,WTURB
      COMMON
      */FILS/
      * ACL          ,APUMI      ,DCL        ,DNTI        ,KNTIL      ,
      * KPUMI        ,MCL        ,PCL        ,VALPD       ,
      TCUR = TPUMOC
      INTI = TPUMOC
      PCUR = PPUMOC - VALPD
      CALL PT(PCUR,TCUR)
      WCUR = WCUR - DSQRT(((PPUMOC-FMINCX)*PCKV *2.*12.*G*RHO)
      PNTI = -(PI/(4.*DNTI))*2*PDK *WCUR**2/(2.*12.*G*RHO) + PCUR
      PCUR = PNTI
      IF(BDASK.EQ.0.0)GO TO 20
      BDW=DSIGN(1.0D0,BDLP-PNTI)*DSQRT(BDASK*2.*12.*G*(BDLP-PNTI)*BDRHO)
      IF(BDW.LT.0.0)GO TO 10
      CALL PT(PNTI,TCUR)
      HX = ENTH
      CALL PT(PNTI,EDT)
      HW = (HX*WCUR + ENTH*BDW)/(BDW + WCUR)
      CALL PH(PNTI,HM)
      TCUR = TEMP
      INTI = TCUR
10  WCUR = WCUR + BDW
20  CONTINUE
      RETURN
      END

```

Q

SUBROUTINE PREDIC

C *****
 C INITIALIZE AT THE START AND CALCULATE SCME CONSTANTS FOR THE PREDICTOR
 C AND RELATED SUBROUTINES
 C TURBO-FLMP ASSEMBLY PERFORMANCE PREDICTOR ROUTINE

PREDICA

IMPLICIT REAL*8 (A-Z)

INTEGER*4

* DTAG	* I	* IDELZS	* IEND	* IM(5)	
* J	* JEND	* K	* KEND(5)	* L	
* LEND	* MTAG(30)	* NOFIND	* NTAG	* PTAG	
* XTAG(5,5)	* II	* M	* NOBNT	* NOCENT	
* NZTRGT	* NTCNT	* NM CNT	* NODEPT	* NPARTS	
* JJ	* KK	* LL	* INODE	* KLOOP	
* REF	* IDELT	* NTPNTS	* NOOZ	* NK	
* TTAG	* CTAG	* CJ(20)	* REFR		
* NOBSK, NODESK, SMCNT, STAG					
COMMON /ADD/					
* ARG	* ARG1	* ARG2	* ATURNP	* BUF(10)	
* CARDS(11)	* DELTAP	* DTURX	* GASVEL	* HCDRO	
	* HFCOLF	* HFIN	* HFOUT	* HTANKN	
* FILRIX	* KVSQRT	* MACH	* NEEND	* PPOUT	
* PIROT	* PTURPR	* PREDFL	* PVAPCR	* PTXST	
* PFLOW	* PTXMIN	* PUMPH	* RF	* RNTROT	
	* RATIO	* RATIOC	* SPEED	* TTROT	
* TEMPY	* TMX	* TJKWD1	* TINTN1	* TINTH1	
* TROUT	* TPIN		* TTXMIN	* TMIX	
* UNCHK			* FILMNT	* QPUMI	
* TINP1(30)	* T2NP1(30)	* T3NP1(30)	* SAVN(15)	* SAVNT(20)	
* SAVX(20,8)	* SAVPT(20,18)	* SAVJ(30,27)	* SAVIJ(30,20,9)		
COMMON					
*/CCNS/					
* G	* JAY	* PI	* R	* RAD	
* RB					
COMMON /EXTRA/					
* FLMP	* QPUM	* TCX	* TNKRHO	* TPT2	
* TPCR	* TPQ	* TPX2	* TPXPD	* TPWH	
* KPUMPI	* WBEAR	* HBEAR	* WPUMPC		
* ALKNZ	* ATURNC	* ATUR	* ARQNZ	* PMIX	
* RANG	* MPMAX	* DTURBL	* PPIN	* TAVE	
* CR	* TTURIP		* GAMMA	* PTQOLO	
* KDILX	* CPT1	* GANT1	* ITXST	* KVLMIN	
* KTRMIN	* WRCNT	* TURWK	* TCTAP	* IPNM	
* TPRK	* TIMER	* PCARD	* RHGM		
* DELZP	* ZM	* ZM1	* DELPT	* DELPMT	
* HLPFH	* HLPCH	* TK	* DTROT	* DELZT	
* TRCT1		* RNCIST	* RFN	* Q	
* TCMOK	* WNCF	* WNCF1	* WMANIT	* HTCNT	
* ENTH	* THETA1	* THETA2	* MAN3	* MEN3	
* TINTD1	* TDISM	* SACRR	* KNTC	* MDN2	
* MBM2	* FJ	* MCN1	* MDN1	* TMTCD1	
* TIMEZ	* ETAP	* TPT20	* METLTN	* TPTAV	
* FLTRCH	* DUM	* OMAX	* QZ	* TEMPTH(30)	
COMMON					
*/FLAG/					
* ETAPFL	* MBPFG	* MASS	* MTIME	* NIME	
* AMIT	* OPEN	* OPTION	* PMIND	* STATE	
* TANK	* TAPE	* TFLUM	* TIMEI	* TIMEX	
* TIMEINQ	* WINT	* TIMES(10)			
COMMON					
*/FLUIDP/					
* PRES	* ZFACT	* QUAL	* TEMP	* RHO	
* GAM	* CP	* VEL	* ENTR	* COND	
* VES	* VOL	* ENTH			
COMMON					
*/HBPS/					
* ACORQ	* ANNUL	* ANQZT	* BELSEC	* CFILMA	
* CFILMB	* CFILMC	* CGAS	* COMP	* DCWH	
* DHEP	* DILANG	* DPASS	* FCOLD	* FHOT	
* HEGG	* HFILMA	* HFILMB	* HFILMC	* HGAS	
* INCOMP	* KDELP	* KDIL	* KHBPI	* KJTUR	

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* KPCM      *KPHM      *K11      *K9      *LHEP      *      U
* *THICK     *NCWH      *NHEP      *NPASS     *RPASS     *      C
* EELLON(20) *          *          *          *          *          *      D
COMMON /MISC/
* FCX        *PDK        *PDKV       *PTURDC     *PTURUP     *
* HBEKV       *HBPW       *HBPWC      *HBPWNC     *          *
* MEILTO      *MINFLQ     *PASSX     *SSOUT      *WPIT       *
* ITEMP(20)   *DTEMP(20) *DELHN2(200) *PUMP(350) *FILMA(20) *
* FILMB(20)   *FILMC(20) *TCFLG(20) *          *          *
COMMON
*/F/
* ALPHA       *BETA       *DIST       *EPUMC      *EPUMP      *
* ETLKC       *ETURP      *FILMCX     *GATEP      *HDPUM      *
* HSWC        *HSVP       *MHT         *NHT         *NTURC      *
* NTURP       *PCGRD      *PCUR        *PCIL       *PHEPO      *
* PHINOX      *PNTI       *PNTQ       *PPUMGC     *PPUMOP      *
* PTANKX      *PTURIX     *PTURD      *QPUMP      *RFLU       *
* SAC         *TCORD      *TCOROR     *TCUR       *TDILX      *
* THEPC       *TIMEP      *TIMEP      *TMETL      *TNTI       *
* INTU        *TPUMOC     *TPUMUP     *TTANKX     *TTURIX     *
* TLMIX       *UIHG       *WCUR        *WCILX      *WHEP       *
* ENGZ        *WNTCK      *WNTI       *WNTQ      *WPUMC      *
* EPUMP       *WTURB     *          *          *          *
COMMON /PILS/
* ACL         *APUMI      *DCL        *DNTI       *KNTIL      *
* KFLMI       *MCL       *PCL        *VALFC     *          *
COMMON
*/TAEI/
* AJIT(30)    *ANTC(30)    *ANTH(30)    *ANTW(30)    *CDJ(30)     *
* CDAT(30)    *CFWP(30)    *CG(30)      *CPJ(30)     *CPNT(30)    *
* CRJ(30)     *CRJNT(30)  *DEL(30)     *DELPNT(30)  *DELPNZ(30)  *
* DNOZW(30)   *GATE(30)    *GP(30)      *HGFJ(30)    *HGFNTC(30)  *
* HGENTH(30)  *HGJ(30)     *HGNTC(30)   *HGNTH(30)   *KPD(30)     *
* KPDV(30)    *KV(30)      *NT(30)      *PAME(30)    *PBD(30)     *
* FC(30)      *PINLET(30)  *PLINE(30)   *PRATIO(30)  *PTURMC(30)  *
* GPL(30)     *RHOJ(30)    *RHGNT(30)   *RN(30)      *SJO(30)     *
* SNCZ(30)    *SNTC(30)    *SNTH(30)    *SNTJ(30)    *SSPRT(30)  *
* TC(30)      *TINLET(30)  *TKJ(30)     *TKNTC(30)   *TKNTH(30)  *
* TUREFF(30)  *VNODES(30) *WDIL(30)    *WPUM(30)    *          *
* TURIT(30)   *TURIP(30)   *HBFLOW(30) *BEND(30)    *          *
COMMON /TAGS/
* CTAG        *I          *IDELZS     *IEND        *IM          *
* J           *JEND       *K          *KEND        *L          *
* LEND        *MTAG       *NCFIND     *NTAG        *PTAG       *
* XTAG        *II         *M          *NGENT       *NOCENT     *
* NZTRGT      *NTCNT      *NMCNT      *NGDEPT      *NPARTS     *
* JJ          *KK         *LL         *INODE       *KLOOP      *
* REF         *IDELT     *NTPNTS     *NODZ        *NK         *
* TTAG        *CTAG       *CJ         *REFR        *          *
*NCBSK,NCDESK,SMCNT,STAG
COMMON /TP/
* AFLUX       *BATERM     *BATERS      *CDMTL       *CHTERM     *
* DDELZ       *DELHM     *DELHN       *DELHNX      *DELM       *
* DELTER      *DHYDRA    *DPIPE       *DTERM       *DZTERM     *
* ENIROP      *ETAT       *ETATP      *GPN         *HFTERM     *
* HGEDEF      *HGTOT     *HPUMI      *HTCGEF      *HFTERM     *
* HIE         *HMT       *KWC        *KWC         *KWC        *
* KACV        *KWH       *KWT        *K1          *K1         *
* K2          *K3         *K4         *K6          *K6         *
* MTERM2      *MTERM3     *MTERM4     *NPRN        *MTERM1     *
* PHI         *PNOZO     *PNTHR      *PRESM       *NTERM      *
* PRPRIM      *PRTERM     *PSIP       *PTANKN      *PRGUES     *
* PSN         *PSPR     *QPM        *PTANKN      *PEN        *
* RMOR        *RMOTKM    *QPM        *QPM         *QTERM      *
* STERM       *STSTAG    *RPN2       *RPN2        *SPRIME     *
* TTANKN      *TTURO     *TFUSR      *TIMENT      *TIMEN      *
* T11SR       *TEN        *TVP        *TTERM       *T1IN       *
* WERROR      *WETPER     *WATERM     *TWTERM      *WDTERM     *
* WNT         *WPACTN    *WHBPN      *WI          *WNCHOK     *
* WTERM       *ZTUBE     *WTERM      *WTERM       *WTURN      *

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COMMON
*/TPAS/
* ARE ,ATURG ,ATURX ,DROLNZ ,DTUR ,
* DTLRNZ ,ETAMIN ,GATEFG ,KEEAR ,KTURD ,
* KLRX ,MUPT ,NWORK ,PTURI ,TIPVEL ,
COMMON
*/X/
* ECFTAP ,INDTUR ,INTFLO ,LARGET ,LESPO ,
* LOOPN ,MCAP ,NEGM ,NONOP ,NONSRD ,
* NCNTC ,NCN ,NGTURN ,NTERR ,
* FARGNE ,NITER ,
WFMX = (DSQRT(BETA**2+4.*ALPHA*1500.) - BETA) / (2.*ALPHA)
IF (ETAPFL.NE.0.) GO TO 1000
IF (NTURP.NE.0.) GO TO 1000
NTURP = 1.0.
1000 TIPVEL = PI*DTURBL*NTURP/60.
1010 IF (WPUMP.GT.0.) GO TO 1020
WPUMP = WFMX
1020 CALL PT (PTANKN,TTANKN)
PFIN = PTANKN - KPUMI*WPUMP**2/(24.*G*RH0*AFUMI**2)
HTANKN = ENTH
HPIN = HTANKN + GRUMI/WPUMP
CALL PH (PPIN,HPIN)
TPIA = TEMP
PVAPOR = (SATV(TPIN/1.8)*14.696
IF (PPIN.GE.PVAPOR) GO TO 1030
C *****
C SET PVAPOR EQUAL TO PPIN SUCH THAT HSVP IS ZERO
C *****
PVAPOR = PPIN
CALL MESS('GAS AT PUMP INLET
1030 HSVP = (PPIN-PVAPOR)/(12.*RH0)
ARG1 = HSVP/NTURP**2
ARG2 = NTLRF/WPUMP
IF ((ARG2.GT.NWORK).AND.(NTURP.GT.NWORK)) GO TO 1033
PLMPH = 0.
GL TO 1034
1033 K = DELHN2(1)
L = DELHN2(2)
M = DELHN2(3)
CALL SERCH(ARG1,NTURP,ARG2,K,L,M,DELHN2(4),PUMPH)
1034 DELTAP = PUMPH*WPUMP**2
PFLMCP = PFIN+DELTAP
PFLCW = WPUMP
WFLMP = (DSQRT(6ETA**2+4.*ALPHA*PPUMCP) - BETA) / (2.*ALPHA)
DUM = PFLOW
CALL ITER (14,PFLOW,DUM,WPUMP,61010)
QPUMP = WPUMP*60.*7.481 / (1728.*RH0)
DELHN = DELTAP/(12.*JAYSRHQ)
IF ((ARG2.LE.NWORK).OR.(NTURP.LE.NWORK)) GO TO 1037
K = PUMP(1)
L = PUMP(2)
M = PUMP(3)
CALL SERCH(ARG1,NTURP,ARG2,K,L,M,PUMR(4),ETAP)
IF (ETAP.GT.ETAMIN) GO TO 1038
1037 ETAP = ETAMIN
1038 HPCLT = HPIN + DELHN/ETAP
CALL PH (PFLMCP,HPCLT)
TFLMCP = TEMP
UNCHK = 0.
ATURNZ = PI*DTURNZ**2 / 4.
IF (INDTUR.NE.0.) GO TO 1040
PCORO = BETA*WPUMP
PDIL = GAMMA*WPUMP
PREDFL = 1.
CALL SHEP
1040 CALL TURBIN
IF (ETAPFL.NE.0.) GO TO 1050
EFUMP = WPUMP*DELHN/ETAP

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      IF (STATE.EQ.0.) GO TO 1060
      C *****
      C FOR STEADY STATE OPTION FIND NTURP BY BALANCING EPUMP TO ETURP
      C *****
      CALL ITER (15,NTURP ,EPUMP ,ETURP ,&1000)
      C *****
      C FOR ETAP OPTION EPUMP IS BASED ON ETURP AND INERTIA AND ETAP COMPUTED
      C *****
      1050 EPUMP = ETURC+ETURP-EPUMC - (NTURF**2-NTURC**2)*4.*PI**2*MUPT /
      1      (144.*JAY*G*TIMEX*3600.)
      IF (EPUMP.NE.0.) GO TO 1055
      ETAP = 0.
      GO TO 9999
      1055 ETAP = WFLMP*DELHN/EPUMP
      GO TO 9999
      C *****
      C FOR TRANSIENT SIMULATION NTURP IS COMPUTED FROM INERTIA AND IMBALANCE
      C OF THE WORK TERMS AND COMPARED WITH THE ORIGINAL GUESS
      C *****
      1060 IF ((OPTION.EQ.1.).OR.(OPTION.EQ.3.).OR.(OPTION.EQ.4.)) GO TO 1070
      ETURC = ETURP
      EPUMC = EPUMP
      1070 DUM = NTURP
      ARG = (NTURC**2+144.*JAY*G*TIMEX*3600.*(ETURP+ETURC-EPUMP-EPUMC)/
      1      (4.*PI**2*MUPT))
      IF (ARG.LE.0.) ARG=.98*NTURP**2
      1075 SPEED = DSQRT(ARG)
      CALL ITER (16,NTURP ,DUM ,SPEED ,&1000)
      9999 FREDFL = 0.
      RETURN
      END

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SUBROUTINE PREDIC
C TURBO-PUMP PREDICTOR FOR TWIN SPOOL
IMPLICIT REAL*8 (A-Z)
INTEGER*4

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* DTAG      .I      .IDELZS      .IEND      .IM(5)
* J          .JEND      .K          .KEND(5)
* LEND      .MTAG(30)  .K          .KEND(5)
* XTAG(5,5) .I1        .NOFIND     .NTAG      .L
* NZTRQT    .NTCNT     .NNCNT      .NOBNT      .PTAG
* JJ        .KK        .LL         .NODEPT     .NODENT
* REF       .IDELT     .NTPNTS     .INOCE      .NPARTS
* TTAG      .CTAG      .CJ(20)     .NOD2       .KLOOP
* NCBK,NCDESK,SMCNT,STAG
COMMON /ADD/
* ARG        .ARG1      .ARG2      .ATURNP      .BUF(10)
* CARDS(11)  .DELTAP     .DTURX    .GASVEL      .HCORO
* HTURIX     .HFCDEF     .HPIN     .HPOUT      .HTANKN
* PTROT      .KVSQRT     .WACH      .NGEND      .PPOUT
* PFLOW      .PTURPR     .PREDFL    .PVAPOR     .PTXST
*           .PUMPH       .RF        .RNTROT     .RTROT
* TEMPY      .RATIO      .RATIOC    .SPEED      .TTRT
* TPOUT      .TNX        .TJWD1     .TNTNZ1     .TNTHT1
* UNCHK      .TPIN       .FILMNT    .TIXMIN     .TIX
* TINP1(30)  .T2NP1(30) .T3NP1(30) .SAVN(15)   .QUM1
* SAVFX(20,8).SAVPT(20,18).SAVJ(30,27).SAVIJ(30,20,9)
COMMON
*/CONS/
* G          .JAY       .PI         .R          .RAD
* R          .PI
COMMON /EXTRA/
* PUMP       .QPM       .TCX        .TNKRHO     .TPT2
* TPCR       .TPQ       .TRK2       .TPKPD      .TPMH
* KPLMPI     .WBEAR     .HBEAR     .WPUMPC     .TPMH
* ATURNZ     .ATUENC     .ATUR      .AROLNZ     .PMIX
* PAVG       .WPMAX     .DTURBL    .PPIN       .TAVE
* CR         .TTURIP     .GAMMA    .PTOULO     .PTOULO
* MDILX      .CPTI      .GAMT1     .TCTST      .TCTMP
* KPHIN      .WPCNT     .TURWK    .PCARD      .RHOM
* TPRK       .TIMER     .ZM1      .DELPT      .DELPT
* DELZP      .HLPCE     .TK        .DTRT      .DELZT
* HLPF       .HLPCE     .RNDIST   .RFN       .Q
* TRCTZ      .WNCF      .WNCF1    .WMNIT     .HTCNT
* TCHK       .THETA1    .THETA2   .MAN3      .MEN3
* FNTH       .TDEFM     .SACPR    .FNTC      .MDN2
* TMTD1      .FJ        .MCN1     .TNTCD1    .TNTCD1
* MBN2       .ETAP      .TPT20    .METLTN    .TPTAV
* TIMEZ      .DUM       .OMAX      .OZ        .TEMPM(30)
* PBLRGM
COMMON
*/FLAG/
* ETAPFL     .HBPFG     .MASS      .MTIME     .NTIME
* NMIT       .OPEN      .OPTION    .PMINO     .STATE
* TANK       .TAPE      .TFLUM     .TIMEI     .TIMEX
* TNETMO
COMMON
*/FLUIDP/
* PRES       .ZFACT     .QUAL      .TEMP      .RHO
* GAM        .CP        .VEL       .ENTR      .COND
* VIS        .VOL
COMMON
*/HBPS/
* ACORQ      .ANNUAL    .ANGZT     .BELSEC     .CFILMA
* CFILMB     .CGAS      .COMP      .DCWH       .DCWH
* DMBP       .DILANG    .DPASS     .FCOLD      .FHOT
* HBQG       .HFILMA    .HFILMC    .HGAS       .HGAS
* INCOMP     .KDIL      .KH6FI     .KJTUR      .KJTUR
* KPCM       .KPHM      .K9        .LHEP       .LHEP
* MTHICK     .NCWH      .NHBP      .NPASS      .RPASS
* BELLON(20)

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SUBROUTINE PREDIC

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      *DTURNZ      *ETAIN      *GATEFG      *KBEAR      *KTURO      *      *
      *KTURX      *MUPT      *NWORK      *PTURI      *TIPVEL      *      *
      *TTURI      *WORK
      COMMON /TSTP/HMIX,KDIL,KHBP,KJTUN,NINDP,TIPVIN,EINDC,PINDIN,
      *HINDIN,TINDIN,PVAPIN,HSVNP,HINDEX,EINDP,INDPH,PINDEX,ETAIND,
      *PMID,PMID,EINTC,PMIDSG,TMIDSG,EINTP,ETAIN,AMID,C,MMIDP,AMIDP,
      *QMIDP,MINNW,MINNP,ETAIMN,MULT,BINDBL,RHO1,RHO2,RHO3,RHO4,TINDEX,
      *SPIN,SPIN2,SPEED2,TTXSTP,TTTOT,TTXG1S,TTX1S,ETAIMP,FLOWP,NINDC
      *CIBL(30),INTEFF(30),QID(30),INDHD(300),INDEF(300)
      COMMON
      **X/
      *EQFTAP      *INOTUR      *INTFLO      *LARGET      *LESPO      *
      *LOCPN      *MCAPI      *NEGW      *NONQP      *NONSPD      *
      *NNTC      *NONW      *NOTURN      *NOTURN      *NTERR      *
      *PARONE      *WITER
      EINTC = ETURC
      EINDC = EPUNC
      WPMAX = (DSQRT(BETA**2+4.*ALPHA*1500.) - BETA) / (2.*ALPHA)
100C IF (NINDP.EQ.0.) NINDP = 100.
      TIPVIN = PI*QIDNB*MINDF/60.
101C IF (NTURP.EQ.0.) NTURP = 100.
      TITVEL = PI*QIDNB*NTURP/60.
101E IF (WPUMP.LE.0.) WPUMP = WPMAX
      CALL PT (PTANKN,TTANKN)
      PINDIN = PTANKN - KPUMI*WPUMP**2/(24.*G*RHO*ARUMI**2)
      RHO1 = RHC
      HTANKN = ENTH
      HINDIN = HTANKN + QPUMI/WPUMP
      CALL PH (PINDIN,HINDIN)
      TINDIN = TEMP
      PVAPIN = PSATV(TINDIN/1.8)*14.696
      HSVNP = (PINDIN-PVAPIN) / (12.*RHO)
      RHO2 = RHC
      ARG1 = HSVNP/NINDP**2
      ARG2 = NINDP/WPUMP
      IF((ARG2.GT.MINNW).AND.(NINDP.GT.MINNP))GO TO 1030
      INDPH = C.
      GO TO 1040
1030 K = INDHD(1)
      L = INDHD(2)
      M = INDHD(3)
      CALL SERCH(ARG1,NINDP,ARG2,K,L,M,INDHD(4),INDPH)
104C DELTAP = INDPH*WPUMP**2
      IF ( DELTAP .LT. 0. ) DELTAP=0.
      PINDEX = PINDIN + DELTAP
      IF((ARG2.LE.MINNW).OR.(NINDP.LE.MINNP))GO TO 1050
      K = INDEF(1)
      L = INDEF(2)
      M = INDEF(3)
      CALL SERCH (ARG1,NINDP,ARG2,K,L,M,INDEF(4),ETAIND)
      IF (ETAIND.GT.ETAIMN) GO TO 1051
105C ETAIND = ETAIMN
1051 HINDEX = HINDIN + DELTAP/(ETAIND*12.*RHO*JAY)
      CALL PH (PINDEX,HINDEX)
      TINDEX = TEMP
      PPIN = PINDEX - KMIDP*WPUMP**2/(24.*G*RHO*AMIDP**2)
      RHO3 = RHC
      HPIN = HINDEX + QRIDP/WPUMP
      CALL PH (PPIN,HPIN)
      TPIN = TEMP
      PVAPOR = PSATV(TPIN/1.8)*14.696
      HSVP = (PPIN-PVAPOR)/(12.*RHO)
      RHO4 = RHC
      ARG1 = HSVP/NTURP**2
      ARG2 = NTURP/WPUMP
      IF((ARG2.GT.WORK).AND.(NTURP.GT.NWCRC)) GO TO 1060
      PUMPH = 0.
      GO TO 1070
106C K = DELHN2(1)
      L = DELHN2(2)

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      M = DELHN2(3)
      CALL SERCH(ARG1,NTURP,ARG2,K,L,M,DELHN2(4),PUMPH)
1070 DELTAP = PUMPH*WPUMP**2
      IF ( DELTAP .LT. 0. ) DELTAP=0.
      PFUMOP= PPIN+DELTAP
      DELHN = DELHN2(4)
      CALL ITER(14,PFLQW,BFLQW,WPUMP,S1015)
      SPIN = WPUMP**2*4.61 / (1728.*RHO)
      DELHN = DELTAP / (12.*JAY*RHO)
      IF ((ARG2.LE.NWORK). OR .(NTURP.LE.NWORK)) GO TO 1080
      K = PUMP(1)
      L = PUMP(2)
      M = PUMP(3)
      CALL SERCH(ARG1,NTURP,ARG2,K,L,M,PUMP(4),ETAP)
      IF (ETAP.GT.ETAMIN) GO TO 1080
1080 ETAP = ETAMIN
1090 HPDUT = HPIN + DELHN/ETAP
      CALL PH (PPUMCP,HPDUT)
      TPUMOP= TEMP
      IF (INDTUR.NE.0.) GO TO 2000
      ECDRO = GETAAMPUMP
      EPNL = CAMEAMPUMP
      SPEED1 = 1.
      CALL TURB
2000 CALL TURBIN
      EPUMP = WPUMP*(HPDUT-HPIN)
      ARG = (NTURC**2+144.*JAY*G*TIMEX*3600.*(ETURP+ETURC-EPUMP-EPUMC)
      / (4.*PI**2*MUPT))
      IF (ARG.LT.0.) ARG = .9*NTURP**2
      SPEED = DSORT(ARG)
      SPIN = NTURP
      CALL ITER(16,NTURP,SPIN,SPEED,63000)
      EINDP = WPUMP*(HINDEX-HINDIN)
      ARG = (NINDC**2+144.*JAY*G*TIMEX*3600.*(EINTP+EINTC-EINDP-EINDC)
      / (4.*PI**2*MULT))
      IF (ARG.LT.0.) ARG = .9*NINDP**2
      SPEED2 = DSORT(ARG)
      SPIN2 = NINDP
      CALL ITER(18,NINDP,SPIN2,SPEED2,64000)
      RETURN
3000 IF ((SPEED.GT.SPIN).AND.(SPEED.GT.NTURP).AND.(NTURP.LT.SPIN))
      INTURP=SPIN+.10*(SPEED-SPIN)
      IF ((SPEED.LT.SPIN).AND.(SPEED.LT.NTURP).AND.(NTURP.GT.SPIN))
      INTURP=SPIN-.10*(SPIN-SPEED)
      GO TO 1010
4000 IF ((SPEED2.GT.SPIN2).AND.(SPEED2.GT.NINDP).AND.(NINDP.LT.SPIN2))
      ININDP=SPIN2+.10*(SPEED2-SPIN2)
      IF ((SPEED2.LT.SPIN2).AND.(SPEED2.LT.NINDP).AND.(NINDP.GT.SPIN2))
      ININDP=SPIN2-.10*(SPIN2-SPEED2)
      GO TO 1000
      END

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SUBROUTINE PREDIN
C ****
IMPLICIT REAL*8 (A-Z)
COMMON /ADD/
* ARG      ,ARG1      ,ARG2      ,ATURNP      ,EUF(10)
* CARDS(11) ,DELTAP    ,HFCDEF    ,HPIN        ,HCORD
*          ,KVSORT    ,HPOUT     ,HPCOUT     ,HTANKN
*          ,PTURPR    ,MACH      ,PPOUT      ,PTXST
*          ,PTXMIN    ,PREDFL    ,PVPADR     ,RMTROT
*          ,RATIO     ,PUMPH     ,RF         ,RTROT
*          ,TATID     ,RATIOC    ,SPEED      ,TINTH1
*          ,TMX       ,TJWD1     ,TNTN21    ,TINTH1
*          ,TPIN      ,TTXMIN    ,TMIX       ,TPUMI
*          ,LNCHK     ,FILMNT    ,SAVN(15)   ,SAVNT(20)
*          ,TINP1(30) ,T2NP1(30) ,T3NP1(30) ,SAVJ(30,20,9)
*          ,SAVX(20,8) ,SAVPT(20,18),SAVJ(30,27)
COMMON
* /CONS/
* G          ,JAY        ,PI        ,R        ,RAD
* RE
COMMON /EXTRA/
* FUMIP      ,QPUM       ,TCX        ,TNKRHO    ,TPT2
* TPCR       ,TPKPD     ,TPK2       ,TPWH
* KPUMP1     ,MBEAR     ,MPCMC     ,PMIX
* ATURNZ     ,ATURN     ,AROLNZ    ,TAVE
* PAVG       ,WPMAX     ,RPIN      ,PTQQL0
* CR         ,TTURIP    ,GAMMA     ,KVLMIN
* FDILX      ,CFTI      ,GAATI     ,TPNW
* KIPMIN     ,WPCNT     ,TURWK     ,DELPT
* TPRK       ,TIMER     ,PCARD     ,DTRCT
* DELZP      ,ZM        ,ZM1       ,DELZT
* HLPF       ,HLPF      ,TK        ,RFN
* TROTZ      ,WNCF      ,RNDIST    ,WNNIT
* TCHQK      ,WNCF1     ,WNCF1     ,WNNIT
* FNTH       ,THETA1    ,THETA2    ,MAN3
* TINTW1     ,TDIFM     ,SACPR     ,MDN2
* MEN2       ,FJ        ,MCN1      ,TNTCD1
* TIMEZ      ,ETAF      ,TPT20     ,TPTAV
* PTLRGM     ,DUM       ,QMAX      ,QZ
COMMON
* /P/
* ALPHA     ,BETA       ,DIST      ,EPUMC     ,EPUMP
* ELRC      ,ETURP     ,FILMCX    ,GATEP     ,HDPUM
* FSV       ,HSVP      ,MHT       ,NHT       ,NTURC
* NTURP     ,PCORC     ,PCUR      ,PDIL      ,PHEP
* FINGX     ,PNTI      ,PNTO      ,PPUMOC    ,PPUMOP
* PTANKX    ,PTURIX    ,PTURQ    ,QPUMP     ,RFLU
* SAC       ,TCORR     ,TCORR     ,TCUR      ,TDILX
* THBP      ,TIME      ,TIMEP     ,TNETL    ,TNTI
* TIO       ,TPUMOC    ,TPUMOP    ,TIANKX   ,TTURIX
* TLENIX    ,UIHG      ,WCUR      ,WDILX    ,WHEP
* WNCZ      ,WNTCK     ,WNTI     ,WNTC     ,WPUMC
* WPLMP     ,WTURB
COMMON
* /TAB1/
* AJHT(30)  ,ANTC(30)   ,ANTH(30) ,ANTH(30) ,CDJ(30)
* CDNT(30)  ,CFNP(30)   ,CG(30)  ,CPJ(30)  ,CDJ(30)
* CRJ(30)   ,CRJNT(30) ,DEL(30) ,DEL(30) ,DEL(30)
* DNCZ(30)  ,GATE(30)   ,GP(30)  ,HGFJ(30) ,HGFNTC(30)
* HGFNTH(30),HGJ(30)   ,HGNTC(30) ,HGNTH(30) ,KPD(30)
* KPDV(30)  ,KV(30)    ,NT(30)   ,PAMB(30) ,PBC(30)
* PC(30)    ,PINLET(30) ,PLINE(30) ,PRATIO(30) ,PTURNQ(30)
* RPD(30)   ,RHQJ(30)  ,RHQNT(30) ,RHQNT(30) ,SJO(30)
* SNOZ(30)  ,SNITC(30) ,SNTH(30) ,SNTJ(30) ,SSPT(30)
* TC(30)    ,TK(30)    ,TKNTC(30) ,TKNTC(30) ,TKNTH(30)
* TUREFF(30),VNODES(30) ,WDL(30)  ,WFLUM(30)
* TURIT(30) ,TURIP(30) ,HBFLOW(30) ,BEND(30)
COMMON /TP/
* ALOWX     ,BATERM    ,BDELHN   ,CDMTL    ,CPTERM
* DDELZ     ,DELHM     ,DELHN     ,DELHNX   ,DELPM

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      * DELTER      * DHYDRA      * DPIPE      * DTERM      * DZTERM      *
      * ENTROP      * ETAT      * ETATP      * GFN      * HFTERM      *
      * FCGUEF      * HGTC      * HPLMI      * HTCCF      * HVTERM      *
      * F12      * KT      * KVN      * KWC      * KWCP      *
      * KVCV      * KWH      * KWHV      * KWT      * K1      *
      * K2      * K3      * K4      * K6      * MTERM1      *
      * MTERM2      * MTERM3      * MTERM4      * NFRN      * NTERM      *
      * PHI      * PNO2O      * PNTHR      * PRESN      * PRQUES      *
      * PPRIM      * PTERM      * PSTP      * PTANKN      * P6N      *
      * FEN      * PSPR      * QN      * QPM      * QTERM      *
      * RHCR      * RHOTKM      * RHOTKN      * RPM2      * SPRIME      *
      * STERM      * STTAG      * TFLUSR      * TIMEMT      * TIMEN      *
      * TTANKN      * ITURO      * TVF      * TWTERM      * T11N      *
      * T11SR      * T8N      * WATERM      * WDILN      * WOTERM      *
      * WERRGR      * WETPER      * WHBPN      * WI      * WNCHOK      *
      * WNT      * WPACTN      * WRTERM      * WTURN      *
      * WTERM      * ZTUBE
      *
      * COMMON
      * /IPAS/
      * ARE      * ATURX      * ATURX      * DRCLNZ      * DTUR      *
      * DILRNZ      * ETAMIN      * GATEFG      * KBEAR      * KTURO      *
      * KILRX      * MUPT      * NWORK      * PTURI      * TIPVEL      *
      * TILRI
      ATURNZ = ATURNC
      IF (ATURNZ.NE.0.) GO TO 10
      ATURNZ = PI*DTURNZ**2/4.
10  ATLR = PI*DTUR**2/4.
      ARCLNZ = PI*DRCLNZ**2/4.
      ATURX = PI*DTURX**2/4.
      IF (TIME.NE.0.) GO TO 20
      KVN = GATEP
      IF (KVN.EQ.0.) GO TO 20
      CALL GPSUB (0.,GATEP,KVN)
20  CONTINUE
      RETRN
      END

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SUBROUTINE PRELTF

C *****
C UPDATE ALL INFLT RELATIVE TO CURRENT TIME
C *****

IMPLICIT REAL*8 (A-Z)

COMMON /ADD/

* ARG	* ARG1	* ARG2	* ATURNP	* BUF(10)
* CARDS(11)	* DELTAP	* DTURX	* GASVEL	* HCORD
* FTLRIX	* HFCDEE	* HPIA	* HPOUT	* MTANKN
* FFLCT	* KVSQRT	* MACH	* NEEND	* PPOUT
* FFLCM	* PTURPR	* PREDFL	* PVAFOR	* PTXST
* TEMPY	* PTXMIN	* PUMPH	* RF	* RNTROT
* TSCUT	* RATIO	* RATIOC	* SPEED	* ITROT
* UNCHK	* TMX	* TJKN01	* TINTN21	* INTHT1
* T1NP1(30)	* TPIN		* TTXMIN	* TMIX
* T2NP1(30)			* FILMNT	* QPUM1
* T3NP1(30)			* SAVN(15)	* SAVNT(20)
* SAVFI(20,8)	* SAVFI(20,18)	* SAVJ(30,27)	* SAVIJ(30,20,9)	

COMMON /EXTRA/

* FLMP	* QFUM	* TCX	* TNRKHU	* TPT2
* TPCR	* TPQ	* TPK2	* TPKED	* TPWH
* KPUMP1	* WBEAR	* HBEAR	* WPUMPC	
* ATURN2	* ATURN3	* ATUR	* ARDLN2	* PNIX
* PAVG	* WPMAX	* DTURBL	* PPIN	* TAVE
* CR	* TTURIP		* GAMMA	* PTGOLO
* FDILX	* CPTI	* GANT1	* TTXST	* KVLMIN
* KTFMIN	* WPCNT	* TURWK	* TCTMF	* TPNW
* TFRK	* TIMER	* PCARD	* RHO	
* DELZF	* ZM	* ZM1	* DELPT	* DELPMT
* HLPHF	* HLPFCF	* TK	* DTRCT	* DELZT
* TRCTZ		* RNDIST	* RFN	* Q
* TCHK	* WNCF	* WNCF1	* WNNIT	* HTCNT
* FNTH	* THETA1	* THETA2	* MAN3	* MEN3
* TINTC1	* TDIFM	* SACPR	* FNTC	* MDN2
* MDC2	* FJ	* MCN1	* MCN1	* TINTC01
* TIMEZ	* ETAP	* TPT20	* METLTN	* TPTAV
* FILFCM	* DCM	* OMAX	* OZ	* TEMPTM(30)

COMMON

* /FLAG/	* HBPFG	* MASS	* MTIME	* NTIME
* ETAPFL	* QPEN	* OPTION	* PMINO	* STATE
* NMT	* TAPE	* TFLUM	* TIMEI	* TIMEX
* TMEIML	* WINT	* TIMES(10)		

COMMON

* /P/

* ALPHA	* BETA	* DIST	* EPUMC	* EPUMP
* ETURC	* ETURP	* FILMCX	* GATEP	* HOPUM
* HSYC	* HSYR	* NMT	* NHT	* NTURC
* NTARP	* PCORQ	* PCUR	* PDIL	* PHBPQ
* FMINOX	* PNTI	* PNTQ	* PPUMOC	* PPUMOP
* FTANKX	* PTURIX	* PTURQ	* QFUMP	* RFLU
* SAC	* TCCORQ	* TCCROR	* TCUR	* TDILX
* THEPC	* TIME	* TIMEP	* TMETL	* TINTI
* TINTQ	* TPUMOC	* TPUMOP	* TTANKX	* TTURIX
* T12MIX	* UIHG	* WCUR	* WDILX	* WHBP
* WNCZ	* WNTGK	* WNTI	* WNTQ	* WPUMC
* WPUMP	* WTURB			

COMMON /TAB1/

* AJ-T(30)	* ANTC(30)	* ANTH(30)	* ANTW(30)	* CDJ(30)
* CDNT(30)	* CFWP(30)	* CG(30)	* CPJ(30)	* CPNT(30)
* CRJ(30)	* CRJNT(30)	* DEL(30)	* DELPNT(30)	* DELPNZ(30)
* DNGZM(30)	* GATE(30)	* GP(30)	* HGFJ(30)	* HGFNTC(30)
* HGFNTH(30)	* HGJ(30)	* HGNTC(30)	* HGNTH(30)	* KPD(30)
* KPDV(30)	* KY(30)	* NT(30)	* PAMB(30)	* PBD(30)
* PC(30)	* PINLET(30)	* PLINE(30)	* PRATIO(30)	* PTURMO(30)
* GPL(30)	* RHOJ(30)	* RHGNT(30)	* RN(30)	* SJO(30)
* SNCZ(30)	* SNTC(30)	* SNTH(30)	* SNTJ(30)	* SSPRT(30)
* TC(30)	* TINLET(30)	* TKJ(30)	* TKNTC(30)	* TKNTH(30)
* TURKFF(30)	* VNODES(30)	* WDIL(30)	* WPUM(30)	
* TURIT(30)	* TURIP(30)	* HFLOW(30)	* BEND(30)	

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COMMON /TP/

* AFLOWX	.BATERM	.BATERS	.CDMTL	.CPTERM	.
* ODELZ	.DELHM	.DELHN	.DELHNX	.DELPM	.
* DELTER	.DMHYDRA	.DPIPE	.DTERM	.DZTERM	.
* ENTROP	.ETAT	.ETATP	.GFN	.HFTERM	.
* HCCDEF	.HGTOT	.HPUM1	.HTCDEF	.HVTTERM	.
* H12	.KT	.KVN	.KWC	.KWCP	.
* KUCV	.KWH	.KWHV	.KWT	.K1	.
* K2	.K3	.K4	.K6	.MTERM1	.
* MTERM2	.MTERM3	.MTERM4	.NPRN	.NTERM	.
* PHI	.PNOZO	.PNTTHR	.PRESM	.PRGUES	.
* FRPRIM	.PRTERM	.PSTP	.PTANKN	.P6N	.
* PEN	.P8PR	.QN	.QFM	.QTERM	.
* RHCR	.RHOTKM	.RHOTKN	.RPM2	.SPRIME	.
* STERM	.SISTAG	.TFLUSR	.TIMENT	.TIMEN	.
* TTANKN	.TTURO	.TVP	.TWTERM	.T11N	.
* T11SR	.T8N	.WATERM	.WDILN	.WDTERM	.
* WERROR	.WETPER	.WHBPN	.WI	.WNCHOK	.
* WNT	.WFACTN	.WRTERM	.WTERM	.WTURN	.
* WTERM	.ZTUBE				.
COMMON					
*/X/					
* EOFTAP	.INDTUR	.INTFLO	.LARGET	.LESPO	.
* LOOPN	.MCAP	.NEGW	.NONQP	.NONSPD	.
* MONTC	.MONW	.NOTURN	.NCTURN	.NTERR	.
* PARONE	.WITER				.

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CALL INTP(TURIT,TIME ,TTURIX)
TTURIP = TTURIX
IF (INDTUR.EQ.0.) GO TO 10
CALL INTP(TURIP,TIME ,PTURIX)
CALL INTP(HBFLOW,TIME ,WHBP )
CALL INTP (WDIL,TIME ,WDILX)
GO TO 20
10 CALL INTP (GP,TIME ,GATEP)
IF ((OPTION.EQ.1.).OR.(OPTION.EQ.3.).OR.(OPTION.EQ.4.))GO TO 20
KVN = GATEP
IF (KVN.EQ.0.) GO TO 20
CALL GPSUE(C.,GATEP,KVN)
20 CALL INTP (PINLET,TIME ,PTANKN)
CALL INTP (TINLET,TIME ,TTANKN)
CALL INTP (OPD,TIME ,QPUM1)
CALL INTP (PTUSMO,TIME ,PTUROM)
RETURN
END

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SUBROUTINE PRINT

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IMPLICIT REAL*8 (A-Z)

REAL*4 LINEC(3),

LINEI(6),LINEM(6),LINEN(6),LINEP(3)

REAL*4 LINEK(4),LINEV(4),LINEW(33),LINEX(3),LINEY(3),LINEZ(27)

REAL*4 LINE1(33),LINE2(33),LINE3(33),LINE4(33),LINE5(33)

REAL*4 LINE6(33),LINE7(33),VCLUSE(2),VOPEN(2)

INTEGER*4

* DTAG

* I

* IDELZ3

* IEND

* IM(5)

* J

* JEND

* K

* KEND(5)

* L

* LEND

* NTAG(30)

* NDFIND

* NTAG

* PTAG

* XTAG(5,5)

* II

* M

* NOBNT

* NOCENT

* AZTRGT

* NTCNT

* NMCNT

* NODEPT

* NPARTS

* JJ

* KK

* LL

* INODE

* KLOOP

* REF

* IDELT

* NTPNTS

* NODZ

* NK

* TTAG

* CTAG

* CJ(20)

* REFR

* NBSK,NGDESK,SMCNT,STAG

COMMON /ADD/

* ARG

* ARG1

* ARG2

* ATURNP

* BUF(10)

* CARDS(11)

* DELTAP

* DTURX

* GASVEL

* HCCRO

* HURIX

* HFCOEF

* HFIN

* HPOUT

* HTANKN

* PPROT

* KVSQRT

* MACH

* NBEND

* PPOUT

* PLOW

* PTURPR

* PREDFL

* PVAPOR

* PTXST

* TAMPY

* PTXMIN

* PUMPH

* RF

* RNTROT

* TPCUT

* RATIO

* RATIOC

* SPEED

* TTROT

* UNCHK

* TMX

* TJWD1

* TINTN21

* TINTHT1

* TINP1(30)

* T2NP1(30)

* T3NP1(30)

* FILMNT

* TMIX

* SAVFX(20,8)

* SAVPT(20,18)

* SAVJ(30,27)

* SAVN(15)

* SAVNT(20)

COMMON

* AT/

* ANQZTX

* CDJX

* COMTCX

* CONTHX

* CPX

* CRJTX

* CRJX

* DELH

* DELPI

* DELPK

* DELPO

* DELRHO

* DELTX

* DELW

* DELZSQ

* DELZX

* DELZX4

* HGCJKT

* HGCNTC

* HGCNTH

* HI

* HJ

* HK

* HL

* HLPRI

* HRNTJW

* HROJ

* MIN

* M2N

* PIN

* P

* PK

* PL

* PLPRIN

* RFLUX

* RHONIX

* RHOMOX

* RHOMX

* RHONIX

* RHONGX

* RHOX

* SJOX

* SNOZX

* SNTCX

* SNTHX

* TAMBX

* TCCUR

* THCUR

* THEDIF

* TJKCUR

* TKJX

* TKNTCX

* TKNTHX

* WNODEN

* WNODI

* ZMAX

* ZMIN

* ZTROT

COMMON /A201/

* CSUBP(30,20)

* FILMHF(30,20)

* PRESS(30,20)

* RHOFLU(30,20)

* RHOFTB(30,20)

* TFLUID(30,20)

* TMETAL(30,20)

* WRATEM(30,20)

* WRATEM(30,20)

COMMON /A210/

* FILMHZ(30)

* FILMTC(30)

* FILMTH(30)

* HNOZM(30)

* HRNTCW(30)

* HRNTHW(30)

* PNOZ(30)

* PTUBE(30)

* RHONTN(30)

* RHONTN(30)

* RHONZM(30)

* RHONZN(30)

* TCOLD(30)

* THOT(30)

* TJACK(30)

* TJKTWD(30)

* TJKTWD(30)

* TNOZ(30)

* TNOZM(30)

* TNTCLD(30)

* TINTHT(30)

* TINTJWD(30)

* TTUBE(30)

* WNOZM(30)

* WNOZN(30)

* WNTM(30)

* WNTM(30)

COMMON /BD/

* BDASK

* BDASKQ

* BDHA

* BDLP

* BDM

* BDW

* BDP

* BDRHO

* BDS(10)

* BDT

COMMON /EXTRA/

* PUMIP

* QPUM

* TCX

* TNKRHO

* TPT2

* TPCR

* TPQ

* TPX2

* TPXPD

* TPWH

* XRMPI

* WBEAR

* WBEAR

* WRMPC

* WRMPC

* ATURNZ

* ATURNZ

* ATUR

* AROLNZ

* PMIX

* PANG

* WPNAX

* DTURBL

* PPIN

* TAVE

* CR

* TTURIP

* GAMMA

* PTOOLD

* KVLMIN

* HDILX

* CPTI

* GANTI

* TTXST

* TPNW

* KIPMIN

* WPCNT

* TURWK

* TCTAP

* RHOM

* TPWRK

* TIMER

* PCARD

* RHOM

* DELPNT

* DELZP

* ZM

* ZM1

* DELPT

* DELZT

* HLPFH

* HLPFH

* TK

* DTROT

* DELZT

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* TROTZ      .WNCF      .RNDIST      .RFN      .Q      .
* TCHOK      .WNCF1     .WNNIT      .HTCNT      .
* FNTH       .THETA1    .THETA2     .MAN3      .MEN3      .
* TNTWD1     .TDIFM     .SACPR      .FNTC      .MDN2      .
* MBN2       .FJ        .MCN1       .MDN1      .TNTCD1     .
* TIMEZ      .ETAP      .TPT20     .METLTN    .TPTAV     .
* PTURON     .QUM       .QMAX       .QZ        .TEMPTM(30) .
COMMON
*/FLAG/
* ETAPFL     .HBPFG     .MASS      .MTIME     .NTIME     .
* NAIT       .OPEN      .OPTION     .PMING     .STATE     .
* TANK       .TAPE      .TFLUM     .TIME1     .TIMEX     .
* TNETMO     .WINT      .TIMES(10) .
COMMON
*/ELUIDP/
* PRES      .ZFACT     .QUAL      .TEMP      .RHO      .
* GAM       .CP        .VEL       .ENTR      .COND     .
* VIS       .VOL       .ENTH      .
COMMON
*/FX/
* DELTEM(20) .FLUTEM(20) .METTEM(20) .MSMALL(20) .MTPNTS(20) .
* PARTI(20)  .PARTPS(20) .TENPEX(20) .
COMMON
*/HBPS/
* ACORG      .ANNUL     .ANGZT     .BELSEC     .CFILMA    .
* CFILMB     .CFILMC    .CGAS      .COMP       .DCWH     .
* DHBP       .DILANG    .DPASS     .FCOLD      .FHOT      .
* HBGG       .HFILMA    .HFILMB    .HFILMC     .HGAS      .
* INCOMP     .KDLP      .KDIL      .KHBP       .KJTUR    .
* KRCM       .KPM       .K11       .K9         .LHBP      .
* NTHICK     .NCWH      .NHBP      .NPASS     .RPASS     .
* BELLOW(20) .
COMMON /LINE/LINEC,LINEI,LINEK,LINEM,LINEN,LINFP,LINEV,
* LINEW,LINEX,LINEY,LINEZ,LINE1,LINE2,LINE3,LINE4,LINE5,LINE6,LINE7,
* VCLOSE,VOPEN
COMMON /LITER/NAMES(10),CTIME,CMENT,BLANK,MI,NI,CNTMAX,ZERO
COMMON /MISC/
* PGX        .PDK       .PDKV      .PTURDC     .PTUROR     .
* HBPV       .HBPW      .HBPWC     .HBPWNC     .
* NETLTD     .MINFLD    .PASSX     .SSOUT      .WPIT      .
* ITEMP(20)  .OTEMP(20) .DELHN2(200) .PUMP(350)  .FILMA(20) .
* FILMB(20)  .FILMC(20) .TCFLG(20) .
COMMON
*/NANTAG/
* DILREM     .HM        .HX        .MPARTS(30) .NTNAME    .
* PARTS(20)  .PNAME     .PN(5)     .PX(5)      .TN(5)      .
* TDELZ(20)  .TPARTS(20) .TX(5)     .WN(5)      .WX(5)      .
* APARTS(5,5) .CPARTS(20) .CDELZ(20) .
* STNAME
COMMON
*/NTS/
* AJB        .AJE       .AJF       .ANF        .ANH        .
* BJB        .BJE       .BJF       .BNF        .BNH        .
* CJB        .CJE       .CJF       .CNF        .CNH        .
* DNT        .FNT       .KNT1      .KNT0       .NODES     .
* NSZEFF     .NTDZ      .THEYA     .THROAT     .INTIM      .
* YNT1       .VNT0     .
COMMON
*/P/
* ALPHA      .BETA      .DIST      .EPUMC     .EPUMP      .
* ETURC      .ETURP     .FILMCX    .GATEP     .HDPUM      .
* NSVC       .NSVP      .NNT       .NNT        .NTURC      .
* NTURP      .NCOR0     .PCUR      .PDIL      .PHEPG      .
* PHEMG      .PNT0      .PPUMOC    .PPUMOP     .PFLU       .
* PTANKX     .RTURIX    .RTUR0     .TCUR       .TDILX      .
* SAC        .TCOR0     .TCCROR    .TIMEP      .TNETL      .
* THBP0      .TIME      .TPUMOC    .TTANKX     .TNTI       .
* INTO       .TPUMOC    .TTURIX    .TITURIX    .
* T12MIX     .UIHG      .WCUR      .WDILX      .WHBP       .
* WNT0       .WNT1      .WNT0      .WNT0       .WPUMC      .

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* WFLMP      ,WTURB
COMMON /PTC/
* DISPR(20) ,PDROP(20) ,PDEQPO(20) ,PRESI(20) ,PRESO(20) ,
* RHOMI(20) ,RHOMO(20) ,RHONI(20) ,RHONO(20) ,TEMP(20) ,
* TEMPI(20) ,TIMEZN(20) ,WDELM(20) ,WDELMO(20) ,WDELM1(20) ,
* WDELNO(20) ,WRATEI(20) ,WRATEO(20)
COMMON /SKIRTC/NOBS,NODEK,KST1,KSTO,SKDZ,SZMIN,STATIC,
* PSTI,TSTI,WTSTI,PSTO,TSTO,WTSTO,
* ASTH(30),ASTW(30),SKBN(30),CDST(30),CPST(30),SCFWP(30),SKCG(30),
* SKDEL(30),DSNZ(30),NTIP(30),NTIT(30),NTIW(30),NZIP(30),NZIT(30),
* NZIW(30),RHOCST(30),SKRN(30),SSNZ(30),SSTH(30),TKSTH(30),SNODES(30),
* ENTHOS(30),FILMSZ(30),FILMST(30),HRSNZ(30),HRSTHW(30),PHIST(30),
* PHIZ(30),PSNZ(30),PSTUE(30),QWDTST(30),RHOCSTN(30),RHOSZN(30),
* TANT(30),TSNZ(30),TSNZ(30),TSWHT(30),TSTUB(30),WSNZ(30),
* WSTH(30),TOTST(30),HTOTST(30),TIDTST(30)
* SOTI,AZM,AZM1,STATF,RHQZ1,RHOSDX,DELPIS,RHQZ,DELPQS,RHOSIX,
* RFC,DELTP
* PHISZ(30)
COMMON
* /TAEJ/
* DLE(20) ,FRIG(20) ,HFLG(20) ,KDPI(20) ,KDPO(20) ,
* DLEZ(20) ,PLENI(20) ,PLENO(20) ,RHQMTL(20) ,TNODE(20) ,
* TK(20) ,VOIDF(20) ,WALL(20)
COMMON
* /TAGS/
* DTAG      ,I      ,IDELZS      ,IENC      ,IM      ,
* J      ,JEND      ,K      ,KEND      ,L      ,
* LEND      ,MTAG      ,NOFIND      ,NTAG      ,PTAG      ,
* TAG      ,II      ,NOBNT      ,NOBNT      ,NOBNT      ,
* NZTROT      ,NTCNT      ,NMCNT      ,NODEPT      ,NPARTS      ,
* JJ      ,KK      ,INODE      ,KLOOP      ,
* REF      ,IDELT      ,NTPTS      ,NODZ      ,NK      ,
* TTAG      ,CTAG      ,CJ      ,REFR      ,
* NOBSK,NODESK,MCNT,STAG
COMMON /TF/
* AFLOWX      ,BATERM      ,BATERS      ,CDMTL      ,CPTERM      ,
* DELZ      ,DELHM      ,DELHNX      ,DELPM      ,
* DELTER      ,DHYDRA      ,DPIPE      ,DTERM      ,
* ENTROP      ,ETAT      ,ETATP      ,GPN      ,HFTERM      ,
* HCOEF      ,HGTOT      ,HPUMI      ,HTCOEF      ,HVTERM      ,
* HI2      ,KT      ,KVN      ,KWC      ,KWCP      ,
* KVCV      ,KWH      ,KWHV      ,KWT      ,K1      ,
* K2      ,K3      ,K4      ,K6      ,MTERM1      ,
* MTERM2      ,MTERM3      ,MTERM4      ,NPRN      ,NTERM      ,
* PHE      ,RNOZO      ,PNTHR      ,PRESM      ,PRESUES      ,
* PRPRIM      ,RRTERM      ,PSTP      ,PTANKN      ,P&N      ,
* P&N      ,P&PR      ,QN      ,QPM      ,QTERM      ,
* RHOR      ,RHOTKM      ,RHOTKN      ,RPM2      ,SPRIME      ,
* STERM      ,STSTAG      ,TFLUSR      ,TIMENT      ,TIMEN      ,
* TTANKN      ,TTURO      ,TVF      ,TWTERM      ,T11N      ,
* T11SR      ,T&N      ,WATERM      ,WDILN      ,WDERM      ,
* WERROR      ,WETPER      ,WHEPN      ,WI      ,WCHOK      ,
* WNT      ,WPACTN      ,WRTERM      ,WTERM      ,WTURN      ,
* WTERM
COMMON
* /VALS/
* KL
COMMON
* /X/
* EOFTAP      ,INDTUR      ,INTFLC      ,LARGET      ,LESPO      ,
* LOOPN      ,MCAP      ,NEGW      ,RBNQP      ,MONSPO      ,
* NONTC      ,MONW      ,NOTURN      ,NOTURN      ,NTERR      ,
* PARONE      ,WITER
CALL NUPAGE
CALL COLNT(7)
WRITE(6,1040) TIME,PCORG,TCORD
WRITE(6,1010) LINE1,LINE2
WRITE(6,1010) LINE1
WRITE(6,1020) PTANKX,TTANKX,PPUMOC,TPUMOC,WTURC,GATEP,NOPUN,TIMEP,
1PUMIP,WI

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C SKIRT TUBES PRINT
IF(STAG.EC.C)GO TO 5
CALL COUNT(NODESK+6)
WRITE(6,1030)STNAME,LINEY,LINEZ
CALL PT(PSTI,TSTI)
WRITE(6,1010)LINE2
WRITE(6,1060)TSTI,PSTI,RHOSIX,WSTI,DELPIS,ENTH,ENTR
DIST = SZMIN
DO 4 I=1,NODESK
WCUR = .5*(WSTN(I) + WSTN(I+1))
WRITE(6,1020)DIST,ISTHOT(I+1),TSTUB(I),PSTUB(I),FILMST(I),
+RHOSN(I),WCUR
4 DIST = DIST + SKDZ
CALL PT(PSTO,ISTO)
WRITE(6,1060)ISTO,PSTO,RHOSOX,WSTO,DELPIS,ENTH,ENTR
IF(ENTH.EQ.0.0)GO TO 20
NOZZLE TUBES PRINT
CALL COUNT(NODENT+6)
WRITE(6,1030)NTNAME,LINEY,LINEZ
CALL PT(PNTI,TNTI)
WRITE(6,1010)LINE2
WRITE(6,1060)TNTI,PNTI,RHONIX,WNTI,DELP,ENTH,ENTR
DIST = ZMIN
DO 10 I=1,NODENT
TMETL = .5*(TNTHOT(I+1) + TNTCLO(I+1))
FILMCX = .5*(FILMTH(I) + FILMTC(I))
WCUR = .5*(WNTN(I) + WNTN(I+1))
WRITE(6,1020)DIST,TMETL,TTUBE(I),PTUBE(I),FILMCX,RHONTN(I),WCUR
10 DIST = DIST + NTDZ
CALL PT(PNTG,TNTG)
WRITE(6,1060)TNTG,PNTG,RHONGX,WNTG,DELPD,ENTH,ENTR
PARTS PRINT
DO 30 J=1,JEND
NODEPT = PARTPS(J)
CALL COUNT(NODEPT+6)
WRITE(6,1030)PARTS(J),LINEY,LINEZ
CALL PT(PRESI(J),TEMPI(J))
WRITE(6,1010)LINE2
WRITE(6,1060)TEMPI(J),PRESI(J),RHONI(J),WRATEI(J),PDROPI(J),ENTH,
+ENTR
DIST = DELZ(J)+.5
DO 25 I=1,NODEPT
TCUR = .5*(TFLUID(I,J)+TFLUID(I+1,J))
PCUR = .5*(PRESS(I,J)+PRESS(I+1,J))
WCUR = .5*(WRATEN(I,J)+WRATEN(I+1,J))
WRITE(6,1020)DIST,TMETL(I+1,J),TCUR,PCUR,FILMHF(I,J),RHOFTP(I,J),
+ANUM
DIST = DIST + DELZ(J)
25 CONTINUE
CALL PT(PRESO(J),TEMPO(J))
WRITE(6,1060)TEMPO(J),PRESO(J),RHONO(J),WRATEO(J),PCROPO(J),ENTH,
+ENTR
30 CONTINUE
NOZZLE PRINT
CALL COUNT(NODENT+6)
WRITE(6,1010)LINE2
WRITE(6,1010)LINE2(1),I=1,24)
DIST = ZMAX
DO 40 I=1,NODENT
K = NODENT-I+1
WCUR = .5*(WNCZN(K)+WNOZN(K+1))
WRITE(6,1020)DIST,TNOZ(K),PNOZ(K),FILMNZ(K),RHONZN(K),
+PCUR
40 DIST = DIST + NTDZ
CALL COUNT(NODENT+6)
WRITE(6,1010)LINE3
DIST = ZMIN
WRITE(6,1010)LINE3
DO 50 I=1,NODENT

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SUBROUTINE PRINT

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WRITE(6,1020)DIST,TJACK(K),TCOLD(K),THOT(K),TNOZW(K),TNHOT(K),
1TNTCLD(K),TATJWD(K),TJKTWD(K),TJKWD(K)
50 DIST = DIST + NTDZ
CALL COUNT(3)
WERROR = (WNCZ - WNCCHK)/WNCCHK
WRITE(6,1010)LINEW
WRITE(6,1020)WNOZ,WNCCHK, WERROR,KDIL
IF(STAG.EQ.0)GO TO 55
C SKIRT NOZZLE PRINT
CALL COUNT(NODESK+4)
WRITE(6,1010)LINEK,LINEY(1),LINEY(2),LINEZ
WRITE(6,1010)(LINE2(I),I=1,24)
DIST = NODESK+SKDZ
DO 53 I=1,NODESK
K = NODESK-I+1
WCUR = .5*(WSNZN(K)+WSNZN(K+1))
WRITE(6,1020)DIST,TSNZW(K),TSNZ(K),PSNZ(K),FILMSZ(K),RHOSZN(K),
*WCUR
53 DIST = DIST - SKDZ
CALL COUNT(NODESK+4)
WRITE(6,1010)LINEK,(LINEY(I),I=3,6),(LINEZ(K),K=1,25)
DIST = SZMIN
WRITE(6,1080)LINE3(1),LINE3(2),LINE3(3),(LINE3(I),I=11,20)
DO 54 I=1,NODESK
K = I+1
WRITE(6,1090)DIST,TSHT(I+1),TSNZW(I+1),TSTHCT(I+1)
54 DIST = DIST + SKDZ
C METAL TEMPERATURE PASSES PRINT
55 CALL COUNT(5 + ((JEND+1)/10)*2)
WRITE(6,1010)LINEW,LINEZ
WRITE(6,1010)
WRITE(6,1070)ATNAME,STNAME,(PARTS(J),J=1,JEND)
TEMPY = NMCNT
DUM = SMCNT
WRITE(6,1020)TEMPY,DUM,(MTPNTS(J),J=1,JEND)
C PREDICTOR PRINT
WTURB = DABS(-WDILN-WHBP)
CALL COUNT(11)
WNOZ = WTURB + WPUMP
WRITE(6,1010)LINEY,LINEY,LINEZ
WRITE(6,1010)LINE4
WRITE(6,1020)WPUMP,WDILA,WHBP,WNCZ,WTURB,P6N,PEN,T6N,PTURIX,T11N
CALL PT(PTURIX,T11N)
WRITE(6,1010)
WRITE(6,1010)(LINE2(I),I=28,33)
WRITE(6,1020)ENTH,ENTR
CALL PT(PRESI,TEMP1)
TPWH = TPWH - ENTH*WRAEI(1)
WRITE(6,1010)LINE5
WRITE(6,1020)QPUMP,EFUMP,ETURP,HGTCT
C CORRECTOR PRINT
CALL COUNT(14)
WTURB = DABS(-WDILX-WHBP)
WRITE(6,1010)LINEY,LINEY,LINEZ
WRITE(6,1010)LINE4
WRITE(6,1020)WPUMP,WDILX,WHBP,WNOZ,WTURB,PCORO,PHBFO,THBPO,PTURIX,
*TTURIX
CALL PT(PTURIX,TTURIX)
WRITE(6,1010)
WRITE(6,1010)(LINE2(I),I=28,33)
WRITE(6,1020)ENTH,ENTR
WRITE(6,1010)LINE7
WRITE(6,1020)WBEAR,ETATP
TPWH = TPWH + ENTH*WTURB
WRITE(6,1010)LINE6
WRITE(6,1020)TPWH, EFUNC,ETURC,ETAP,ETAT,H12,T12MIX,PTURO,TTURO
CALL PT(PTURO,TTURO)
WRITE(6,1010)
WRITE(6,1010)(LINE2(I),I=28,33)
WRITE(6,1020)ENTH,ENTR

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SUBROUTINE PRINT

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```
C      BY-PASS VLAVE PRINT
      CALL COUNT(4)
      IF (VLSWT) 60,60,70
60     WRITE(6,1010) LINEV, VCLOSE, LINEZ
      GO TO 80
70     WRITE(6,1010) LINEV, VOPEN, LINEZ
80     CONTINUE
      WRITE(6,1010) LINEX, LINEY, LINEZ
      WRITE(1,1050) TIME, NTURC
      RETURN
1010  FORMAT(33A4)
1020  FORMAT(1P5G13.5,2X,1P5G13.5)
1030  FORMAT('0',A8,3X,30A4)
1040  FORMAT('0 TIME = ',1PG13.5,5X,'PC = ',1PG13.5,8X,'TC = ',1PG13.5)
1050  FORMAT(' TIME = ',1PG12.5,' N = ',1PG12.5)
1060  FORMAT(26X,1P2G13.5,15X,1P5G13.5)
1070  FORMAT(A11,4A13,2X,5A13)
1080  FORMAT(3A4,28X,10A4)
1090  FORMAT(1PG13.5,26X,1P2G13.5,2X,1PG13.5)
      END
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SUBROUTINE PROGIN

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C
SUBROUTINE PROGIN
PROGRAM INITIALIZATION
IMPLICIT REAL*8 (A-Z)
COMMON

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*/AT/
* ANOZTX      ,CDJX      ,CDMTCX      ,CDNTHX      ,CPX
* CRJNTX      ,CRJX      ,DELM      ,DELP      ,DELPK
* DELPQ      ,DELRHO    ,DELTX      ,DELM      ,DELZSQ
* DELZX      ,DELZX4    ,HGCJKT     ,HGCNTC     ,HGCNTH
* HI          ,HJ       ,HK        ,HL        ,HLPRIM
* HRNTJW      ,HROJ     ,MIN       ,M2N       ,PIN
* PJ          ,PK       ,PL        ,PLPRIM    ,RFLUX
* RHCMIK      ,RHOMOX   ,RHCMIK    ,RHONIX    ,RHONOX
* RHOX        ,SJOX     ,SNOZX    ,SNTCX     ,SNTMX
* TAMBX       ,TCCUR    ,THCUR     ,THEDIF    ,TJKCUR
* TEJX        ,TKNTCX   ,TKNTHX   ,WNODEN    ,WNODI
* ZMAX        ,ZMIN     ,ZTROT
COMMON /BC/
* BCASK      ,BDASKO    ,BDHA      ,BDLP      ,BDM
* BDMO       ,BDP      ,BDRHO     ,BDS (10) ,BCT
* BD
COMMON /BOLS/
* ALINE      ,BDOWN     ,BDPD     ,CPVOL     ,IMASS
* LFILM      ,PINPUT    ,PTANKIN  ,TAMB      ,TTKIN
* YTANK
COMMON /CCNS/
* G          ,JAY       ,PI        ,R         ,RAC
* RB
COMMON /EXTRA/
* PUMIP      ,QRUM      ,TCX      ,TNKRHO    ,TPT2
* TPCR       ,TPQ       ,TPK2     ,TPKPD     ,TPMH
* KPAUMPI    ,WBEAR     ,HBEAR     ,WBUMPC    ,
* ATURNZ     ,ATURNK    ,ATUR     ,AROLNZ    ,PMIX
* FAVG       ,WPMAX     ,DTURBL   ,PPIN     ,TAVE
* CR         ,TTURIP    ,GANTI    ,GAMMA     ,PTOULO
* HDILX      ,CPTI      ,TURWK    ,TTXST     ,KVLMIN
* KTFMIN     ,WPCNT     ,PCARD    ,TCTMP     ,TPNW
* TPRK       ,TIMER     ,RMON     ,DELPT     ,DELPMT
* DELZP      ,ZM        ,TK        ,DTROT     ,DELZT
* HLPHF      ,HMPGF     ,RNOIST   ,RFN       ,Q
* TROTZ      ,WNCFI     ,WNCFI    ,WNNIT     ,HTCNT
* TCHOK      ,THETA1    ,THETA2   ,MAN3     ,MEN3
* FNTH       ,TDIFM     ,SACPR    ,FNTC     ,MCN2
* INTND1     ,FJ        ,MCN1     ,MDN1     ,INTCD1
* MBN2       ,ETAP      ,TPT20    ,METLTN    ,TPTAV
* TIMEZ      ,DUM       ,OMAX     ,OZ        ,TEMPTN(30)
* PIURM
COMMON
*/FLAG/
* ETAPFL     ,HBPFG     ,MASS     ,MTIME     ,NTIME
* NMIT       ,OPEN     ,OPTION    ,PHINO     ,STATE
* TANK       ,TAPE     ,TFLUM     ,TIMEI     ,TIMEX
* IMETNO
COMMON /FLUIDP/
* PRES      ,ZFACT     ,QUAL     ,TEMP      ,RHO
* GAM       ,CP        ,VEL      ,ENTR      ,COND
* VIS       ,VOL
COMMON
*/GLES/
* PCTCE      ,PTANK     ,PTURDE   ,PUMHDE    ,PUMOG
* PUMWKE     ,TOIL      ,TTANK     ,TNETI     ,TURSPD
* WDILE      ,WDILG     ,WHBPG     ,WNETE     ,WORKE
COMMON
*/MISC/
* PCX        ,PDK       ,PDKV     ,PTUROC    ,PTUROP
* HBPV       ,HBPW     ,HBPWC    ,HBPWNC    ,
* METLTO     ,MINFLD    ,PASSX    ,SSOUT     ,WPIT
* ITEMP(20)  ,OTEMP(20) ,DELHN2(200),PUMP(350),FILMA(20)
* FILMB(20) ,FILMC(20) ,TCFLG(20)

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SUBROUTINE: PROGIN

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COMMON

*/NTS/

* AJB

* BJB

* CJB

* DAI

* NOZEEF

* VNTI

COMMON

*/P/

* ALPHA

* ETURC

* HSVC

* MEURP

* PMINOX

* PTANKX

* SAC

* THEPO

* TINTO

* T12MIX

* WNOZ

* WPUMP

COMMON /ATP/

* AFLOWX

* BDEL2

* DELTER

* ENTRCP

* HGCOEF

* H12

* KMCV

* K2

* MTERM2

* PHI

* PRPRIM

* PEN

* RHOR

* STERM

* ITANKN

* T11SR

* WERRGR

* WNT

* WWTERR

COMMON

*/TPAS/

* ARE

* OTURN2

* OTURN

* T1LR1

COMMON

*XX/

* EOFTAP

* LOCPN

* NQNTC

* PARONE

IF (TIME.EQ.0.0) OR (PCARD.NE.0.0) GO TO 30

20 CALL BESTAR

30 CALL TZERO

DELHN = (PEUMOP - PTANKN) / (RHOTKN * RB * 12.0)

60 IF (FNT.EQ.0.0) GO TO 90

CALL TUBEZ

90 INDTUR = PTURI

MCAP = MASS

BDLT = UNIT

NQNTC = 1.0

INTFLO = 0.0

BDS(9) = IMASS

BDS(8) = PTANKN

NETLTO = T0IL

MINFLO = .0001

TANKX = TANK

.AJE

.BJE

.CJE

.FNT

.NTDZ

.VNTG

.BETA

.ETURP

.HSVP

.PCORQ

.PNTI

.PTURIX

.TCORD

.TIME

.TPUMOC

.UING

.WNTCK

.WTURB

.BATERM

.DELHN

.DHYDRA

.ETAT

.HGTQT

.KT

.KMH

.K3

.MTERM3

.PNOZO

.PRTERM

.P8PR

.RHOTKN

.STAG

.TNURO

.T8N

.WETPER

.WPACTN

.ZTUBE

.ATURO

.ETAMIN

.MVPT

.WNOBK

.INDTUR

.MCAP

.NONW

.WETPR

.INTFLO

.NEGW

.NOTURN

.ATURX

.GATEFG

.NWORK

.DRCLNZ

.KBEAR

.PTURI

.DTUR

.KTURO

.TIPVEL

.LARGET

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SUBROUTINE PROGIN

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RETURN
END

SUBROUTINE SERCH(X,Y,Z,L,M,N,TABLE,ANS)

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SUBROUTINE SERCH(X,Y,Z,L,M,N,TABLE,ANS)
IMPLICIT REAL*8(A-H,O-Z)
REAL*8 X,Y,Z,TABLE,ANS
DIMENSION TABLE(500)

FORMULA FOR INTERPOLATION

$XINT(A,B,C,D,E) = A + (B-A) * (E-C) / (D-C)$

LOCATE X PLANES

LLL=1
DO 100 I=2,L
I1=I
LE=LLL+1
IF(X.LE.TABLE(I1)) GO TO 10
100 CONTINUE

LOCATE Y LINES

10 MMM=1
MM=L+2
J=L+M
DO 200 I=MM,J
JJ=I
MM=MMM+1
IF(Y.LE.TABLE(JJ)) GO TO 20
200 CONTINUE

LOCATE Z POINTS

20 NNN=1
NN=L+M+2
K=L+M+N
DO 300 I=NN,K
KK=I
NNN=NNN+1
IF(Z.LE.TABLE(KK)) GO TO 30
300 CONTINUE

SET UP TABLE SUBSCRIPTS

30 J1=L+M+N+(LLL-1)*M+N+(MMM-1)*N+NNN
J2=L+M+N+(LLL-1)*M+N+(MMM-2)*N+NNN
J3=L+M+N+(LLL-2)*M+N+(MMM-1)*N+NNN
J4=L+M+N+(LLL-2)*M+N+(MMM-2)*N+NNN

SELECT TABLE CONSTANTS

X1=TABLE(I1)
X2=TABLE(I1-1)
Y1=TABLE(JJ)
Y2=TABLE(JJ-1)
Z1=TABLE(KK)
Z2=TABLE(KK-1)
Q1=TABLE(J1-1)
Q2=TABLE(J2-1)
Q3=TABLE(J2-1)
Q4=TABLE(J2-1)
Q5=TABLE(J3)

INTERPOLATE AND RETURN

A1 = XINT(Q2,Q1,Z2,Z1,Z)
A2 = XINT(Q4,Q3,Z2,Z1,Z)
A3 = XINT(Q5,Q2,Z2,Z1,Z)

A
B
C
R
S
T
U
D
E
F
H
I
K
J
L
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Q
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P
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A
B
C
D
E
F

SUBROUTINE SERCH(X,Y,Z,L,M,N,TABLE,ANS)

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A4 = XINT(Q6,Q7,Z2,Z1,Z)
A5 = XINT(A2,A1,Y2,Y1,Y)
A6 = XINT(A4,A3,Y2,Y1,Y)
ANS = XINT(A6,A5,X2,X1,X)
RETURN
END

G
R
I
J
K

C SUBROUTINE SETC1
 COMPUTE CCNSTANTS FOR ONE TIME STEP
 IMPLICIT REAL*8 (A-Z)
 COMMON /ADD/

* ARG	.ARG1	.ARG2	.ATURNP	.BUF(10)	.
* CARDS(11)	.DELTAP	.DTURX	.GASVEL	.MCOQ	.
* HTLRX	.HFCQEF	.HPIN	.HPOUT	.HTANKN	.
* DTROT	.KVSQRT	.MACH	.NBEND	.PPOUT	.
* PFLOW	.PTURPR	.PREDFL	.PVAPOR	.PTXST	.
* TPCUT	.PTXMIN	.PUMPH	.RF	.RNTROT	.
* UNCHK	.RATIO	.RATIOC	.SPEED	.TTROT	.
* T1NP1(30)	.TMX	.TJKWD1	.TNTNZ1	.TNTHT1	.
* T2NP1(30)	.TPIN		.TTXMIN	.TMIX	.
* T3NP1(30)			.FILMNT	.QPUM1	.
* SAVX(20,8)			.SAVN(15)	.SAVNT(20)	.
COMMON			.SAVIJ(30,20,9)		.

*/BDLS/						J
* ALINE	.BDOWN	.BDPD	.CPVGL	.IMASS	.	L
* LFILM	.PINPUT	.PTNKIN	.TAMB	.TTNKIN	.	M
* VTANK					.	N

COMMON /EXTRA/					
* PUMIP	.QPUM	.TCX	.TNKRHQ	.TPT2	.
* TPCR	.TPK2	.TPK2	.TPKPD	.TPWH	.
* KUMPI	.HBEAR	.HBEAR	.WPUMPC		.
* ATURNZ	.ATURNZ	.ATURNZ	.AROLNZ	.PMIX	.
* PAVG	.WPMAX	.DTURBL	.PPIN	.TAVE	.
* CR	.TTURIP		.GAMMA	.PTOOLD	.
* HDILX	.CPTI	.GAMTI	.TTXST	.KVLMIN	.
* KIPMIN	.WPCNT	.TURNK	.TCTMP	.TPNW	.
* TPERM	.TIMER	.PCARD	.RHOM		.
* DELZP	.ZM	.ZM1	.DELPT	.DELPMT	.
* HLPHE	.HLPGF	.TK	.DTROT	.DELZT	.
* TROTZ		.RNDIST	.RFN	.Q	.
* TCHK	.WNCF	.WNCF1	.WMNIT	.HTCNT	.
* FNTH	.THETA1	.THETA2	.MAN3	.MEN3	.
* TNTWD1	.TDIFM	.SACPR	.FNTC	.MDN2	.
* MBN2	.FJ	.MON1	.MDN1	.TNTCD1	.
* TIME2	.ETAP	.TPT20	.METLTN	.TRTAV	.
* PTLRGN	.QUM	.QMAX	.QZ	.TEMPTM(30)	.

COMMON					
*/FLAG/					
* ETAPFL	.HBPFG	.MASS	.MTIME	.NTIME	.
* NAIT	.OPEN	.OPTION	.PMINO	.STATE	.
* TANK	.TAPE	.TFLUM	.TIMEI	.TIMEX	.
* TIME2ND	.WINT	.TIMES(10)			.

COMMON					
*/QUES/					
* PCTCE	.PTANK	.PTUROE	.PUMHDE	.PUMOG	.
* PUMWE	.TDIL	.TTANK	.TNETI	.TURSPD	.
* WDILE	.WDILG	.WHPG	.WNT	.WORKE	.
* WPUMPG					.

COMMON					
*/MISC/					
* PCX	.PDK	.PDKV	.PTUROC	.PTURQP	.
* HBPV	.HBPV	.HBPWC	.HBPWNG		.
* METLT	.MINFLG	.PASSX	.SSQUT	.WPIT	.
* ITEMP(20)	.OTEMP(20)	.DELHN2(200)	.PUMP(350)	.FILMA(20)	.
* FILMB(20)	.FILMC(20)	.TCFLG(20)			.

COMMON					
*/P/					
* ALPHA	.BETA	.DIST	.EPUMC	.EPUMP	.
* EDRG	.ETURP	.FILMCX	.GATEP	.NDPUM	.
* NSVC	.HSVP	.NMT	.NHT	.NTURC	.
* NTURP	.PCORD	.PCUR	.PDIL	.PHBPG	.
* PMINOX	.PNTI	.PNTD	.PPUMDC	.PPUMGP	.
* PTANKX	.PTURIX	.PTURO	.QPUMP	.RFLU	.
* SAC	.TCORD	.TCORDR	.TCUR	.TDILX	.
* THBPO	.TIME	.TIMEP	.TMETL	.TNTI	.
* TMSQ	.TPUMDC	.TPUMDP	.TTANKX	.TTURIX	.

* T12MIX	.UIHG	.WCUR	.WDILX	.WHEP	.
* WNOZ	.WNTCK	.WNTI	.WNTC	.WPUMC	.
* WPUMP	.WTURB				
COMMON					
* /PILS/					
* ACL	.APUMI	.DCL	.DNTI	.KNTIL	.
* KRLMI	.MCL	.PCL	.VALPD		
COMMON					
* /TABI/					
* AJHT(30)	.ANTC(30)	.ANTH(30)	.ANTW(30)	.CDJ(30)	.
* CDNT(30)	.CFWP(30)	.CG(30)	.CPJ(30)	.CPNT(30)	.
* CRJ(30)	.CRJNT(30)	.DEL(30)	.DELPNT(30)	.DELPNZ(30)	.
* QNOZW(30)	.GATE(30)	.GP(30)	.HGFJ(30)	.HGFNTC(30)	.
* HGFNTH(30)	.HGJ(30)	.HGNTC(30)	.HGNTH(30)	.KPD(30)	.
* KPDV(30)	.KV(30)	.NT(30)	.PAMB(30)	.PBD(30)	.
* PC(30)	.PINLET(30)	.PLINE(30)	.PRATIO(30)	.PTURNQ(30)	.
* CPD(30)	.RHQJ(30)	.RHONT(30)	.RN(30)	.SJO(30)	.
* SNCZ(30)	.SNTC(30)	.SNTH(30)	.SNTJ(30)	.SSPRT(30)	.
* TC(30)	.TINLET(30)	.TKJ(30)	.TKNTC(30)	.TKNTH(30)	.
* TUREFF(30)	.VNODES(30)	.WDIL(30)	.WPUM(30)		
* TURIT(30)	.TURIP(30)	.WBFLOW(30)	.WBEND(30)		
COMMON /IP/					
* AFDLX	.BATERM	.BATERS	.CDMTL	.CPTERM	.
* BDELZ	.DELHM	.DELHN	.DELHNX	.DELPN	.
* DELTER	.DHYDRA	.DPIPE	.DTERM	.DZTERM	.
* ENTROP	.ETAT	.ETATP	.GPN	.HFTERM	.
* HGCDEF	.HGTOT	.HPUMI	.HTCDEF	.HVTTERM	.
* H12	.KT	.KVN	.KWC	.KWCP	.
* KMCV	.KMH	.KWHV	.KWT	.K1	.
* K2	.K3	.K4	.K6	.K1	.
* MTERM2	.MTERM3	.MTERM4	.NBRN	.MTERM1	.
* PH1	.PNOZO	.PNTTHR	.PRESN	.MTERM	.
* PRPRIM	.PRTERM	.PSTP	.PTANKN	.PRGUES	.
* PEN	.P8PR	.QN	.QPM	.P6N	.
* RHGR	.RHOTKM	.RHCTKN	.RPM2	.QTERM	.
* STERM	.SISTAG	.IFLUSR	.TIMEMT	.SPRIME	.
* TTANKN	.TTURQ	.TYP	.TINTERM	.TIMEN	.
* TTISR	.T8N	.WATERM	.WDILN	.T1IN	.
* WERROR	.WETPER	.WHBBN	.WI	.WNTERM	.
* WNS	.WRACTN	.WRTERM	.WINTERM	.WNCHOK	.
* WINTERM	.ZTUBE			.WTURN	.

```

TIME = TIMEN
IF(OPTION.EQ.0.0)GO TO 10
CALL INTP(PC,TIME,PCX)
CALL INTP(TC,TIME,TCX)
10 NBRN = WBRN
PDK = KNTIL
IF(PDK.GE.0.0)GO TO 20
CALL INTP(KPD,TIME,PDK)
20 CALL INTP(KPDV,TIME,PDKV)
PMINOX = PMINO
IF(PMINOX.NE.0.0)GO TO 30
CALL INTP(PAMB,TIME,PMINOX)
30 IF(OPEN.EQ.0.0)GO TO 100
IF(TANK.NE.0.0)GO TO 70
IF(PTANK.NE.0.0)GO TO 60
CALL INTP(PINLET,TIME,PTANKX)
PPUMOC = PTANKX
40 TTANKX = TTANKN
IF(BDOWN.NE.0.0)GO TO 50
CALL INTP(TINLET,TIME,TTANKX)
50 TPUMOC = TTANKX
60 CALL INTP(WDIL,TIME,WDILX)
GO TO 110
70 IF(WPUMPG.NE.0.0)GO TO 90
IF((OPTION.NE.0.0).AND.(OPTION.NE.2.0))GO TO 90
80 CALL INTP(WPUM,TIME,WPUMC)
90 IF(TTANK.EQ.0.0)GO TO 40
GO TO 60
100 PTANKX = PTANKN

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SUBROUTINE SETCI

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TTANKX = TTANKN
PPUMOC = PPUMOP
TPUMOC = TPUMOP
GATEP = GPN
NTLRC = NTURP
RHOTKM = SHOTKN
DELHN = DELHN
WPLNC = WFUPP
WPLX = WDICH
WHBP = WHBFN
HSVC = HSVP
PTUROC=PTLRCP

110 CONTINUE

RETURN

END

SUBROUTINE SETCJ

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PAGE 1

C SUBROUTINE SETCJ
OBTAIN CONSTANTS FOR TIME I+1
IMPLICIT REAL*8 (A-Z)
COMMON /ADD/

* ARG	* ARG1	* ARG2	* ATURNP	* BUF(10)
* CARDS(11)	* DELTAP	* DTURK	* GASVEL	* MCORO
* HTURIX	* HFCDEF	* MPIN	* HPOUT	* MTANKN
* PTHOT	* KVSORT	* MACH	* NBEND	* PPOUT
* PFLOW	* PTURPR	* PREBFL	* PVAPOR	* PTXST
* * * * *	* PTXMIN	* PUMPH	* RF	* RNTROT
* * * * *	* RATIO	* RATIOC	* SPEED	* TTROT
* TEMPY	* TMX	* TJKWD1	* TTNZ1	* TTNHT1
* TPCUT	* TPIN	* * * * *	* TTXMIN	* TMIX
* UNCHKOK	* * * * *	* * * * *	* FILMNT	* QPUM1
* T1NP1(30)	* T2NP1(30)	* T3NP1(30)	* SAVN(15)	* SAVNT(20)
* SAVF1(20,8)	* SAVPT(20,18)	* SAVJ(30,27)	* SAVIJ(30,20,9)	* * * * *

COMMON

*/BDLS7

* ALINE

* LFILM

* VTANK

* BDOWN

* PINPUT

* BDFD

* PTNKIN

* CPVOL

* TAME

* IMASS

* TTNKIN

J

L

M

N

COMMON /EXTRA/

* PUMIP

* TPCR

* KRAMPI

* ATURNZ

* PAVG

* CR

* HDILX

* KPMIN

* TPRK

* DELZR

* HLPHE

* TROTZ

* TCHOK

* FNTH

* TINTD1

* MBN2

* TIMEZ

* PTURON

COMMON

*/FLAG/

* ETAPFL

* NMIT

* TANK

* TIMEHO

COMMON

*/QUES/

* PTCE

* PUMKE

* WDILE

* WPUMP

COMMON

*/MISC/

* PCK

* HBPV

* METL10

* TTEMP(20)

* FILMB(20)

COMMON

*/P/

* ALPHA

* ETURC

* NSMC

* NTAMP

* PNTINX

* PTANKX

* SAC

* THBPO

* TATO

* QPUM

* TPQ

* WBEAR

* ATURNK

* WPMAX

* TTURIP

* CPTI

* WPCMT

* TIMER

* ZM

* HLPGE

* WNCF

* THETA1

* TDIFM

* FJ

* ETAP

* DUM

* TCX

* TPK2

* WBEAR

* ATUR

* DTURBL

* GANT1

* TURWK

* PCARD

* ZN1

* TK

* RNDIST

* WNCF1

* THETA2

* SACPR

* MCN1

* TPT20

* CMAX

* TNKRHO

* TPKPD

* WPUMPC

* AROLNZ

* PPIN

* GAMMA

* TTXST

* TCTMP

* RHOM

* DELPT

* DTROT

* RFN

* WMNIT

* MAN3

* FNTC

* MDN1

* METLTN

* OZ

* TPT2

* TPWH

* PMIX

* TAVE

* PTOOLO

* KVLMIN

* TPNW

* DELPMT

* DELZT

* Q

* HTCNT

* MEN3

* MDN2

* TMTCD1

* TPTAY

* TEMPTN(30)

B

C

D

E

F

G

H

I

J

K

* HBPFG

* OPEN

* TAPE

* WINT

* MASS

* OPTION

* TFLUM

* TIMES(10)

* MTIME

* PMIND

* TIMEI

* NTIME

* STATE

* TINEX

* PTANK

* TDIL

* WDILG

* PTURDE

* TTANK

* WHPG

* PUMHDE

* TMETI

* WNT

* PUMOG

* TURSPC

* WORKE

* PDK

* HBPV

* WINGLG

* TTEMP(20)

* FILMC(20)

* PDKV

* HBPV

* HBPV

* PASSK

* DELHN2(200)

* TCFLG(20)

* PTURDC

* HBPV

* HBPV

* ASSOUT

* PUMP(350)

* PTUROB

* PTUROB

* NPIT

* FILMA(20)

* BETA

* ETURP

* HBPV

* PCORO

* PNTI

* PTURIX

* TCOROR

* TIMEP

* TPUNOC

* DIST

* FILMCX

* NHT

* PCUR

* PNTC

* PTURO

* TCOROR

* TIMEP

* TPUNOP

* EPUMC

* GATEP

* NHT

* PDIL

* PPUMDC

* QPUMP

* TCUR

* TMETL

* TTANKX

* EPUMP

* HDPUM

* NTURC

* PHBPQ

* PPUMOP

* RFLU

* TDILX

* TMTI

* ETARIX

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* T12MIX      ,UIHG      ,WCUR      ,WDILX      ,WHEP      ,
* WNCZ        ,WNTCK     ,WNTI      ,WNTD      ,WPUMC      ,
* WFLUMP      ,WTURB     ,
COMMON
*/TAB1/
* AJHT(30)    ,ANTC(30)   ,ANTH(30)   ,ANTW(30)   ,CDJ(30)    ,
* CDNT(30)    ,CFWP(30)   ,CG(30)    ,CPJ(30)    ,CPNT(30)   ,
* CRJ(30)     ,CRJNT(30)  ,DEL(30)    ,DELPNT(30) ,DELPNZ(30) ,
* DNCZW(30)   ,GATE(30)   ,GP(30)     ,HGFJ(30)   ,HGFNTC(30) ,
* HGFNTM(30)  ,HGJ(30)    ,HGNTC(30)  ,HGNTM(30)  ,KPD(30)    ,
* KPDV(30)    ,KV(30)     ,NT(30)      ,PAMB(30)   ,PBL(30)    ,
* PC(30)      ,PINLET(30) ,PLINE(30)  ,PRATIO(30) ,PTURMO(30) ,
* QPD(30)     ,RHOJ(30)   ,RHOMT(30)  ,RN(30)     ,SJO(30)   ,
* SNOZ(30)    ,SNTG(30)   ,SNTH(30)   ,SNTJ(30)   ,SSPRT(30) ,
* TC(30)      ,TINLET(30) ,TKJ(30)    ,TKNTC(30)  ,TKNTH(30)  ,
* TWREFF(30)  ,VNODES(30) ,WDIL(30)   ,WPUM(30)   ,
* TURIT(30)   ,TURIP(30)  ,HBFLOW(30) ,BEND(30)   ,
COMMON /TP/
* AFLOWX     ,BATERM     ,EATERS     ,CDMTL      ,CPTERM      ,
* DDELZ      ,DELHM      ,DELHN      ,DELHNX     ,DELM      ,
* DELTER     ,DHYDRA     ,DP1PE     ,DTERM      ,DZTERM      ,
* ENTROP      ,STAT      ,ETATP      ,GPN        ,HFTERM      ,
* HSCOF      ,HGTOT      ,HPUMI      ,HTCOEF     ,HVTTERM     ,
* H12         ,KT         ,KVN        ,KWC        ,KWCP       ,
* KNCV        ,KWH        ,KWHV       ,KWT        ,K1        ,
* K2          ,K3         ,K4         ,K6         ,KTERM1     ,
* NTERM2      ,NTERM3     ,NTERM4     ,NPRN       ,NTERM      ,
* PHI         ,PNOZO      ,PNTTHR     ,PRESM      ,PRGUES     ,
* PPRIM       ,PRTERM     ,PSTP       ,PTANKN     ,P6N        ,
* PEN         ,PSPR       ,QN         ,QPM        ,QTERM      ,
* RHOR        ,RHOTKM     ,RHOTKM     ,RPM2       ,SPRIME     ,
* STERM       ,STSTAG     ,TFLUSR     ,TIMEMT     ,TIMEN      ,
* TTANKN      ,TTURO      ,TVP        ,TWTERM     ,T11N       ,
* T11SR       ,T8N        ,WATERM     ,WDILN      ,WDTERM      ,
* WERROR      ,WETPLR     ,WHBPN      ,WI         ,WNCHOK     ,
* WNT         ,WPACTN     ,WRTERM     ,WTERM      ,WTURN      ,
* WTERM       ,
COMMON
*/TPAS/
* ARE         ,ATURO      ,ATURX      ,DROLNZ     ,DTUR        ,
* DTURNZ      ,ETAMIN     ,GATEFG     ,KBEAR      ,KTURO      ,
* KTURX       ,MUPT       ,NWORK      ,PTURI      ,TIPVEL     ,
* TLRI        ,
IF(ETAPFL.EQ.0.0)GO TO 10
CALL INTP(NT,TIMEN,NTURP)
30 CALL INTP(QPD,TIMEN,QPUM)
IF(PTANK.NE.0.0)GO TO 30
CALL INTP(PINLET,TIMEN,PTANKN)
IF(BDOWN.NE.0.0)GO TO 20
CALL INTP(TINLET,TIMEN,TTANKN)
20 CALL PT(PTANKN,TTANKN)
TNKRHG = RHCM
RHOTKM = TNERMO
IF(GATEFL.NE.0.0)GO TO 60
IF(GPN.EQ.0.0)GO TO 40
IF(OPTION.EQ.0.0)GO TO 40
IF(OPTION.EQ.2.0)GO TO 50
40 CALL INTP(GP,TIMEN,GPN)
CALL INTP(KV,GPN,KVN)
HBPV = KVN
50 IF(PTURMO.NE.0.0)GO TO 60
CALL INTP(PTURMO,TIMEN,PTURP)
60 CONTINUE
RETURN
END

```

D
L
M
O

O

Q
R
S
T

U

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SUBROUTINE SHBP
C SIMPLIFIED HCT BLEED PWT SUBROUTINE
IMPLICIT REAL*8(A-Z)
COMMON /ACD/
* ARC ,ARG1 ,ARG2 ,ATURNP ,BUF(10) ,
* CARDS(11) ,DELTAP ,DTURX ,GASVEL ,HCORO ,
* ,HFCDEF ,HPIN ,HPOUT ,HTANKN ,
* ,KVSORT ,MACH ,NEEND ,PPOUT ,
* ,PTROT ,PTURPR ,PREDFL ,PVAPOR ,PTXST ,
* ,FFLCW ,PTXMIN ,PUMPH ,RF ,RNTROT ,
* ,RATIO ,RATIOC ,SPEED ,TTROT ,
* ,TEMPY ,TMX ,TJKWD1 ,TNTA21 ,TNTHT1 ,
* ,TPCUT ,TPIN ,TIXMIN ,TMIX ,
* ,UNCHOK ,FILMNT ,QPUMI ,
* ,TINP1(30) ,T2NP1(30) ,T3NP1(30) ,SAVN(15) ,SAVNT(20) ,
* ,SAVFX(20,6) ,SAVPT(20,18) ,SAVJ(30,27) ,SAVIJ(30,20,9)
COMMON
*/CLNS/
* C ,JAY ,PI ,K ,RAD ,
* RB
COMMON /EXTRA/
* ,QPUM ,TCX ,TNKRHO ,TPT2 ,
* ,TPQ ,TPK2 ,TPKH ,
* ,KPMPI ,WBEAR ,HBEAR ,WPUMPC ,
* ,ATURNZ ,ATURN ,AROLNZ ,PMIX ,
* ,FAVG ,WPMAX ,DTURBL ,PFIN ,TAVE ,
* ,CR ,TIURIP ,GAMMA ,PTOULO ,
* ,FDILX ,CPTI ,GANTI ,TTXST ,KVLMIN ,
* ,KTMIN ,WPCNT ,TURWK ,TCTMP ,TPNW ,
* ,TPWRK ,TIMER ,PCARD ,RHOM ,
* ,DELZF ,ZM1 ,DELPT ,DELMT ,
* ,HLPWF ,HLPWF ,TK ,DTROT ,DELZY ,
* ,TACTZ ,RNDIST ,RFN ,Q ,
* ,TCHK ,WNCF ,WNCF1 ,WMNIT ,HTCNT ,
* ,FNTH ,THETA1 ,THETA2 ,MAN3 ,MEN3 ,
* ,INTWD1 ,TDIFM ,SACPR ,FNTC ,MDN2 ,
* ,MBN2 ,FJ ,MDN1 ,TNTCD1 ,
* ,TIMEZ ,ETAP ,TPT20 ,TPTAV ,
* ,TPTM(30)
COMMON
* ,HBPFG ,MASS ,NTIME ,
* ,NBIT ,UFEN ,OPTION ,PMINO ,STATE ,
* ,TANK ,TAPE ,TFLUM ,TIMEI ,TIMEX ,
* ,TNETM ,TIMES(10)
COMMON
*/FLUIDP/
* ,ZFACT ,QUAL ,TEMP ,RHO ,
* ,GAM ,VEL ,VGL ,ENTH ,ENTR ,COND ,
* ,VIS
COMMON
*/GLES/
* ,PCTCE ,PTANK ,PTURDE ,PUMHDE ,PUMOG ,
* ,PUMKE ,TDIL ,TTANK ,TNETI ,TURSPD ,
* ,NDILE ,WMBPG ,WMBPG ,WMBPG ,WMBPG ,
* ,WPLMPG
*/HBP/
* ,ACCRG ,ANNUL ,ANCZT ,BELSEC ,CFILMA ,
* ,CFILMB ,CFILMC ,CGAS ,COMP ,DCWH ,
* ,CHEP ,DILANG ,DPASS ,FCOLD ,FNOT ,
* ,HECG ,HFILMA ,HFILMB ,HFILMC ,HGAS ,
* ,INCDMP ,KDIL ,KDIL ,KHBI ,KJTUR ,
* ,KCM ,KPHN ,KPHN ,K9 ,LMBP ,
* ,KTHICK ,KCMH ,KCMH ,KMBP ,NPASS ,RPASS ,
* ,BEALON(20)
COMMON /ITERS/ITERI(420)
COMMON
*/F/
* ,ALPHA ,BETA ,DIST ,EPUNC ,EPUMP ,
* ,ETAP ,ETURP ,FILMCX ,GATEP ,HDPUM ,

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```

* HSVC      .HSVP      .MHT      .NHT      .NTURC      .
* NTLRP      .PCORG      .PCUR      .PDIL      .PHEPQ      .
* PMINGX      .PNTI      .PNTU      .PFUMOC      .PPUMOP      .
* PTANKX      .PTURIX      .PTURO      .QPUMP      .RFLU      .
* SAC        .TCORO      .TCOROR      .TCUR      .TDILX      .
* THEPC      .TIME      .TIMEP      .TMETL      .TNTI      .
* INTO       .TPUMOC      .TPUMOP      .TTANKX      .TTURIX      .
* T12MIX      .UIHG      .WCUR      .WDILX      .WHBP      .
* WNOZ       .WNTCK      .WNTI      .WNTC      .WPUMC      .
* WPUMP      .WTURB

```

```

COMMON
*/TAB1/
* AJHT(30)   .ANTC(30)   .ANTH(30)   .ANTW(30)   .CDJ(30)   .
* CDNT(30)   .CFWP(30)   .CG(30)    .CPJ(30)    .CPNT(30)   .
* CRJ(30)    .CRJNT(30)  .DEL(30)   .DELPNT(30) .DELPNZ(30) .
* DMBZW(30)  .GATE(30)   .GP(30)    .HGFJ(30)   .HGFNTC(30) .
* HGFNTH(30) .HGJ(30)    .HGNTC(30) .HGNTH(30) .KPD(30)   .
* KPLV(30)   .KY(30)    .NT(30)    .PAME(30)   .PBD(30)   .
* PC(30)     .PINLET(30) .PLINE(30) .PRATIO(30) .PTURMO(30) .
* GPD(30)    .RHOJ(30)  .RHONT(30) .RN(30)     .SJO(30)   .
* SNCZ(30)   .SNTC(30)  .SNTH(30)  .SNTJ(30)   .SSFR(30)  .
* TC(30)     .TINLET(30) .TKJ(30)   .TKNTC(30)  .TKNTH(30) .
* TUREFF(30) .VNODES(30) .WDIL(30)  .WPUM(30)   .
* TURIT(30)  .TURIP(30) .HBFLOW(30)

```

```

COMMON /IP/
* AFLQW      .BATERM      .BATERS      .CDMTL      .CPTERM      .
* DDELZ      .DELHM      .DELHN      .DELHNX      .DELP      .
* DELTER      .DHYDRA      .DPIPE      .DTERM      .DZTERM      .
* ENIRCP      .ETAT      .ETATP      .GPN      .HFTERM      .
* HGCOEF      .HGTC      .HPUMI      .HTCOEF      .HVTM      .
* H12        .KT      .KVN      .KWC      .KWCP      .
* KHEV       .KWH      .KWHV      .KWT      .K1      .
* K2         .K3      .K4      .K6      .MTERM1      .
* MTERM2     .MTERM3     .MTERM4     .NPRN      .NTERM      .
* PHI        .PNOZO      .PNTTHR      .PRESM      .PRGUES      .
* PRPRIM     .PKTERM      .PSTP      .PTANKN      .P6N      .
* FEN        .P8PR      .QN      .QFM      .QTERM      .
* RHCR       .RHOTKM      .RHCTKN      .RPM2      .SPRIME      .
* STERM      .SISTAG      .TFLUSR      .TIMENT      .TIMEN      .
* TTANKN     .TTUBG      .TVF      .TWTERM      .T11N      .
* TISR       .T8N      .WATERM      .WDILN      .WDTM      .
* WERROR     .WEIPER      .WHSN      .WI      .WNCCHK      .
* WNT        .WFACTN      .WRTERM      .WTERM      .WTURN      .
* WINTERM    .ZTUBE

```

```

COMMON /IPAS/
* ARE        .ATURO      .ATURX      .DROLNZ      .DTUR      .
* DTURNZ     .ETAMIN      .GATEFG      .KBEAR      .KTURQ      .
* KTURN      .MUP      .NWORK      .PTURI      .TIPVEL      .
* T1LR1      .WWORK

```

```

INTEGER*4 I

```

```

IF (KVN.NE.0.) GO TO 1020

```

```

PMIX = (PCORO+PDIL)/2.

```

```

TMIX = (TCORO+TDILX)/2.

```

```

CALL PT (FMIX,TMIX)

```

```

WDILX = DSORT(2.4G+RHO*(PDIL-PCORO)/(KHEPI+KDIL))

```

```

SHBP01C
SHBP01D
SHBP01E
SHBP01G

```

```

C *****
C NOT BLEED GENERATES NO POWER IF HCT PRESSURE TOO LOW OR GATE CLOSED
C *****

```

```

1010 PTOCLO = 1.
PTURIX = PTURCM
WHBP = -WDILX
WTURB = 0.

```

```

SHBP01H
SHBP01I
SHBP01J
SHBP01K
SHBP01L
SHBP01M
SHBP01N

```

```

PTURIX = TDILX
GO TO 1000
1020 IF (PCORO.LE.PTUROM) GO TO 1010
PTOCLG = 0.

```

```

SHBP01O
SHBP01P
SHBP01Q
SHBP01R

```

```

IF (UNCHK.NE.0.) GO TO 2000
RATIO = PCORO/PTUROM
IF (RATIO.GT.1.5) GO TO 2000
CALL INTP (PRATIO,RATIO,RATIOC)

```

```

      ATURNZ = 2.*RATIOC*ATURNZ
      UNCHOK = 1.
2000 IF (WHBP.NE.0.) GO TO 2010
      WHEP = WHEPG
2010 CALL FT (FDIL,TDILX)
      HDILX = ENTH
2011 CALL FT (FCORC,TCORC)
      RHOMOT = RHO
      HCGRO = ENTH
      I = 0
2015 I = I + 1
      IF (I.LE.1000) GO TO 2016
      CALL MESS('HOT FLOW NOT CLOSED
      CALL ITERZ(19)
      GO TO 9999
2016 FMIX = PCORC - (KHBPI*WHBP*DABS(WHBP)/(24.*G*RHOMOT))
      PAVG = (PDIL+FMIX)/2.
      CALL FT (PAVG,TDILX)
      RHMIX = RHC
2017 ARG = (PDIL-FMIX)*24.*G*RHMIX/KDIL
      IF (ARG.GT.0.) GO TO 2018
      WHEP = WHEP +.05
C INCREASE ITERATION COUNT AND LOOP
      GO TO 2015
2018 WDILX = DSQRT(ARG)
      WTURB = WDILX*WHBP
      TTURIX = (TDILX*WDILX+TCORC*WHBP)/WTURB
      IF (TTURIX.GE.TDILX) GO TO 2020
      TTURIX = TDILX
2020 ARG = (FMIX**2 - R*TTURIX*WTURB**2*(KVN+KJTUR)/(G*ATUR**2))
      IF (ARG.GT.0.) GO TO 2021
      WHEP = WHEP -.05
C INCREASE ITERATION COUNT AND LOOP
      GO TO 2015
2021 FTURIX = DSQRT(ARG)
      HTURIX = (HDILX*WDILX+HCGRO*WHBP)/WTURB
      CALL FH (FTURIX,HTURIX)
      TTURIX = TEMP
      RTURPR = WTURB*DSQRT(TTURIX)/(ATURNZ*KTF(GAM))
      CALL ITER (19,WHBP,RTURPR,TTURIX,2015)
9999 IF (PRESFL.EQ.0.) GO TO 9999
      IF (TIURI.EQ.0.) GO TO 9999
      CALL ITER (20,KDIL,TTURIX,TTURIF,<2017)
9999 CONTINUE
      RETRN
      END

```

SHBP01S
SHBP01T
SHBP01U
SHBP02A

SHBP02C

SHBP02F

SHBP02I
SHBP02J
SHBP02K
SHBP02L

SHBP02O

SHBP02R

SHBP03C

SUBROUTINE SKTMT

C

IMPLICIT REAL*8 (A-Z)

INTEGER*4

* CTAG	,ISAVE	,IDELZS	,IENL	,IM(5)	.
* J	,JEND	,KSAVE	,KENL(5)	,L	.
* LEND	,MTAG(30)	,NOFIND	,NTAG	,PTAG	.
* XIAG(5,5)	,II	,M	,NCBNT	,NOCENT	.
* NZTRO	,NTCNT	,NMCNT	,NGDEPT	,NPARTS	.
* JJ	,KK	,LL	,INGDE	,KLOOP	.
* REF	,IDELT	,NTPNTS	,NCDZ	,NK	.
* TTAG	,CTAG	,CJ(20)	,REFR	.	.
*NLBSK,NCDESK,SMCNT,STAG,SPACE,I,K					
COMMON /ADD/					
* ARG	,ARG1	,ARG2	,ATURNP	,EUF(10)	.
* CARDS(11)	,DELTA	,DTURX	,GASVEL	,HCGRO	.
*	,HFCOE	,HPIN	,HPOUT	,HTANKN	.
* HTURIX	,KVSQRT	,MACH	,NBEND	,PPOUT	.
* FIROT	,PTURPR	,PREDFL	,PVAFOR	,PTXST	.
* FFLOW	,PTXMIN	,PUMPH	,RF	,RNTROT	.
*	,RATIO	,RATIOC	,SFEEL	,TTROT	.
* TEMPY	,TMX	,TJKWD1	,TNTA21	,TNTHT1	.
* TPCUT	,TPIN	.	,TTXMIN	,TMIX	.
* UNCHK	.	.	,FILANT	,QPUNI	.
* TINP1(30)	,T2NP1(30)	,T3NP1(30)	,SAVN(15)	,SAVNT(20)	.
* SAVFX(20,8)	,SAVPT(20,18)	,SAVJ(30,27)	,SAVIJ(30,20,9)	.	.
COMMON					
*/A1/					
* ANGZTX	,CDJX	,CDNTCX	,CDNTHX	,CPX	.
* CRJNTX	,CRJX	,DELH	,DELFI	,DELPK	.
* DELPO	,DELPHO	,DELTX	,DELW	,DELZSQ	.
* DELZX	,DELZX4	,HGCJKT	,HGCNTC	,HGCNTH	.
* HI	,HJ	,HK	,HL	,HLPRIM	.
* HANTJW	,HROJ	,M1A	,M2N	,PIN	.
* FJ	,FK	,PL	,PLPRIM	,RFLUX	.
* RHCMIX	,RHOMUX	,RHGMX	,RHGNIX	,RHONOX	.
* RHLX	,SJGX	,SNCZX	,SNTCX	,SNTHX	.
* TAMBX	,TCCUK	,THCUR	,THEDIF	,TJKCUK	.
* TAJX	,TKNTCX	,TKNTHX	,WNGDEN	,WNOOI	.
* ZMAX	,ZMIN	,ZTROT	.	.	.
COMMON /CONS/					
* G	,JAY	,PI	,R	,RAD	.
* KE	.	.	.	.	.
COMMON /EXTRA/					
* FUMIP	,QPUM	,TCX	,TKRHC	,TPT2	.
* TPCR	,TPQ	,TPK2	,TPKFD	,TPWH	.
* KPUMPI	,WBEAR	,HBEAR	,WFUMPC	.	.
* ATLRNZ	,ATURN	,ATUR	,AROLNZ	,PMIX	.
* PAYG	,WPMAX	,DTURBL	,PPIN	,TAVE	.
* CR	,TTURIP	.	,GAMMA	,PTGOLD	.
* FDILX	,CPTI	,GAMTI	,TTXST	,KVLMIN	.
* KIPMIN	,WPCNT	,TURWK	,TCTMP	,TPNW	.
* TPRK	,TIMER	,PCARD	,RHGM	.	.
* DELZP	,ZM	,ZM1	,DELFT	,DELPMT	.
* HLPHF	,HLPCH	,TK	,DTROT	,DELZT	.
* TROT2	.	,RNDIST	,RFN	,Q	.
* ICHK	,WNCF1	,WNCF1	,WMMIT	,HTCNT	.
* FNTJ	,THETA1	,THETA2	,NAN3	,MEN3	.
* TINTD1	,TDIFM	,SACPR	,FNTC	,MDN2	.
* MBN2	,FJ	,MCN1	,MDN1	,TNTCD1	.
* TIMEZ	,ETAP	,TPT20	,METLTN	,TPTAV	.
* FIUROM	,DUM	,OMAX	,OZ	,TEMPTM(30)	.
*SIG					
COMMON /FLUIDP/					
* PRES	,ZFACT	,QUAL	,TEMP	,RHO	.
* GAM	,CB	,VEL	,ENTR	,COND	.
* VIS	,VCL	,ENTH	.	.	.
COMMON /NTNZ/					
* PHINZ(30)	,CPDP	,ENTHO(30)	,HKPR	,PHINT(30)	.
* RFTC	,PKPR	,PTCX	,QCLDNT(30)	,QHONT(30)	.
.	,RHODP	,TCLOC	,TTC	.	.

```

COMMON /CFC/FFTAB(4,30),HFTAB(5,30),OPT(30)
COMMON
*/F/
* ALPHA      ,BETA      ,DIST      ,EFUNC      ,EPUMP      ,
* ETLRC      ,ETURP      ,FILMCX     ,GATEP      ,NDPUM      ,
* FSVL      ,HSVP      ,MHT      ,NHT      ,NTURC      ,
* NTARP      ,PCORQ      ,PCUR      ,PDIL      ,PHEPD      ,
* PMINGX     ,PNTI      ,PNTD      ,PFUWCC     ,PPUMOP      ,
* PTANKX     ,PTURIX     ,PTURD      ,QFUMP      ,RFLU      ,
* SAC      ,TCORQ      ,TCCROR     ,TCUR      ,TDILX      ,
* THEPL      ,TIME      ,TIMEP      ,TMETL      ,TNTI      ,
* INTO      ,TPUMUC     ,TPUMOP     ,TTANKX     ,TTURIX     ,
* T12MIX     ,UIHG      ,WCLR      ,WDILX      ,WHEP      ,
* WNLZ      ,WNTCK      ,WNTI      ,WNTC      ,WPUMC      ,
* WFLMP      ,WTURB
COMMON /SKIRTC/NGBS,NODEK,KSTI,KSTC,SKDZ,SZMIN,STATIC,
* PSTI,TSTI,WSTI,PSTO,TSTO,WSTO,
* ASTH(30),ASTN(30),SKBN(30),CDST(30),CPST(30),SCFNP(30),SKCG(30),
* SKDEL(30),CENZ(30),NTIF(30),NTIT(30),NTIW(30),NZIP(30),NZIT(30),
* NZIM(30),RHCST(30),SKAN(30),SSNZ(30),SSTH(30),TKSTH(30),SNODES(30),
* ENTHCS(30),FILMSZ(30),FILMST(30),HRSNZ(30),HRSTHW(30),PHIST(30),
* FHSZ(30),FSNZ(30),FSTUB(30),CHOTST(30),RHCSTN(30),RHDSZN(30),
* TSHT(30),TSNZ(30),TSNZW(30),TSHDT(30),TSTUB(30),WSNZN(30),
* WSTN(30),PTOTST(30),HTGTST(30),TTCTST(30),
* CDTX,AZM,AZM1,STATF,RHQZ1,RHGSOX,DELPIS,RHQZ,DELPQS,RHDSIX,
* RFU,DELTMF
COMMON /TAGS/
* DTAG      ,ISAVE      ,IDELZS     ,IEND      ,IM      ,
* J      ,JEND      ,KSAVE      ,KEND      ,L      ,
* LENJ      ,MTAG      ,NGFIND     ,NTAG      ,PTAG      ,
* XIAG      ,II      ,M      ,NGBNT      ,NOCENT      ,
* NZTROT     ,NTCNT      ,NMCNT      ,NOCEPT   ,NPARTS      ,
* JJ      ,KK      ,LL      ,INGDE      ,KLOOP      ,
* REF      ,IDELT      ,NTPTS      ,NODZ      ,NK      ,
* TIAG      ,CTAG      ,CJ      ,REFR      ,
* NCDESK,NCDESK,SMCNT,STAG,SPACE,I,K
COMMON /TF/
* AFLCX      ,EATERM     ,EATERS     ,CCMTL      ,CPTERM      ,
* ODELZ      ,DELHM      ,DELHN      ,DELHNX     ,DEALPM      ,
* DELTER     ,DHYDRA     ,DPIPE      ,DTERM      ,DZTERM      ,
* ENTROP      ,ETAT      ,ETATP      ,GPN      ,HFTERM      ,
* HCCDEF     ,HGTCT      ,HPUMI      ,HTCOEF     ,HVIERM      ,
* F12      ,KT      ,KVA      ,KWC      ,KWCP      ,
* KNCV      ,KWH      ,KWHV      ,KWT      ,K1      ,
* K2      ,K3      ,K4      ,K6      ,MTERM1      ,
* MTERM2     ,MTERM3     ,MTERM4     ,NFRN      ,NTERM      ,
* PHI      ,PNOZO      ,PNTHR      ,PRESM      ,PRGUES      ,
* PRPRIM     ,PRTERM     ,PSTP      ,PTANKN      ,P6N      ,
* P8N      ,P8PR      ,QN      ,QPM      ,QTERM      ,
* GHQR      ,RHOTKM      ,RHCTKN      ,RPM2      ,SPRIME      ,
* STERM      ,STSTAG     ,TFUSR      ,TIMENT      ,TIMEN      ,
* TTANKN     ,TTURQ      ,TVF      ,TWTERM      ,T11N      ,
* T11SR      ,T8N      ,WATERM     ,WDILN      ,WDTERM      ,
* WERHCR     ,WETPEX     ,WHEPN      ,WI      ,WNCHOK      ,
* WNT      ,WPACTN      ,WRTERM      ,WTURN      ,
* WTERM      ,ZTUBE

```

```

C **** COUNTER FOR NO. OF PASSES
C
C 100 SMCNT = 0
C
C **** COUNTER FOR NO. OF PASSES REQUIRED
C
C 110 NTCNT = 1000
C 110 HICNT = 0
C 110 THCLR = TSHT (1)
C 110 DC 200 I = 1,NODESK
C 110 IF (SKDZ.GT.C.) GO TO 130
C
C **** VARIABLE NODE LENGTH
C

```

```

120 DELZX = SNODES (I+1) - SNODES (I)
    DIST = SNODES (I) + DELZX / 2.
    DELZSQ = DELZX**2
    GC TO 150
C
C ****    FIXED NODE LENGTH
C
130 IF (I.GT.1) GC TO 140
    DIST = SZMIN
    DELZSQ = SKLZ**2
    GC TO 150
140 DELZX = SKDZ
    DIST = DIST + DELZX
150 THEDIF = TSHT (I+2) + THCLR
    THCLR = TSHT (I+1)
C
C ****    TUBE DENSITY
C
    CALL INTP (RHCST,TSHT(I+1),RHCX)
C
C ****    TUBE HOT SIDE HEAT TRANSFER AREA
C
    CALL INTP (ASTH,DIST,AFLOWX)
C
C ****    TUBE CP
C
    CALL INTP (CFST,TSHT(I+1),CPX)
C
C ****    TUBE THERMAL CONDUCTIVITY
C
    CALL INTP (CDST,TSHT(I+1),CDNTHX)
160 CDM1L = CDNTHX
    SAC = CDM1L * AFLOWX / DELZSQ
    KWT = 1.0
170 THEDIF = THEDIF - 2. * TSHT (I+1)
    THETA1 = 1. / HRSNZW (I) + 1. / HRSTHW (I)
    THETA2 = SAC * THEDIF + TSNZ (I) / HRSNZW (I) + TSTUE (I)
    T3NP1 (I+1) = THETA2 / THETA1
180 TDIFM = T3NP1 (I+1) - TSHT (I+1)
    IF (TDIFM.LT..01) GC TO 190
    HTCNT = 1.
C
C ****    NOZZLE NET PERIMETER
C
190 CALL INTP (SSNZ,DIST,SNCZX)
C
C ****    TUBE HOT SIDE NET PERIMETER
C
    CALL INTP (SSTH,DIST,SNTHX)
    TNHT1 = FILMST (I) * SNTHX * HRSTHW (I)
    TSTHOT (I+1) = (TSHT (I+1) - TSTUE (I)) / TNHT1 + TSTUE (I)
    INTNZ1 = FILMSZ (I) * SNOZX * HRSNZW (I)
    TSNZW (I+1) = (TSHT (I+1) - TSNZ (I)) / INTNZ1 + TSNZ (I)
200 CONTINUE
    K = NODESK + 1
    DO 205 M = 2,K
        TSHT (M) = T3NP1 (M)
205 CONTINUE
C
C ****    INTERPOLATION FOR TUBE END POINT VALUES
C
210 TSHT (1) = 2. * TSHT (2) - TSHT (3)
    TSHT (NODESK+2) = 2. * TSHT (NODESK+1) - TSHT (NODESK)
    TSNZW (1) = 2. * TSNZW (2) - TSNZW (3)
    TSNZW (NODESK+2) = 2. * TSNZW (NODESK+1) - TSNZW (NODESK)
    TSTHOT (1) = 2. * TSTHOT (2) - TSTHOT (3)
    TSTHOT (NODESK+2) = 2. * TSTHOT (NODESK+1) - TSTHOT (NODESK)
220 SMCNT = SMCNT + 1
    IF (MCNT.EQ.0.) GO TO 230

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SUBROUTINE SKTMT

DATE = 19SEP67

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IF(SMCNT.NE.NTCNT)GO TO 110
230 RETURN
END

COMMON /CPC/FFTAB(4,30),HFTAB(5,30),OPT(30)

```

COMMON
*/P/
* ALPHA      ,BETA      ,DIST      ,EPUMC      ,EPUMP      ,
* ETCRC      ,ETURP      ,FILMCX     ,GATEF      ,HDPUM      ,
* HSCV       ,HSPV       ,MHT        ,NHT        ,NTURC      ,
* NTLRF      ,PCURD      ,PCUR       ,PCIL       ,PHEPD      ,
* PMINOX     ,PNTI       ,PNTD       ,PPUMOC     ,PPUMOP     ,
* PTANKX     ,PTURIX     ,PTURO      ,QPUMP      ,RFLU       ,
* SAC        ,TCORD      ,TCGROR     ,TCUR       ,TDILX      ,
* THEPD      ,TIME       ,TIMP       ,TTANKX     ,TTURIX     ,
* TNU        ,TFUMOC     ,TPUMOP     ,TTANKX     ,TTURIX     ,
* T12MIX     ,UIHG       ,WCUR       ,WDILX      ,WHEP      ,
* WNLZ       ,WNTCK      ,WNTI       ,WDILX      ,WHEP      ,
* WPLMF      ,WTURB      ,WNTC      ,WPUMC      ,
COMMON /SKIRTC/NOBS,NODEK,KSTI,KSTO,SKDZ,SZMIN,STATIC,
*PSTI,TSTI,WSTI,PSTO,TSTO,WSTO,
*ASTH(30),ASTW(30),SKBN(30),COST(30),CPST(30),SCFWP(30),SKCG(30),
*SKDEL(30),DSNZ(30),NTIP(30),NTIT(30),NTIW(30),NZIP(30),NZIT(30),
*NZIW(30),RHCT(30),SKRN(30),SSNZ(30),SSTH(30),TKSTH(30),SNGDES(30),
*ENTHCS(30),FILMSZ(30),FILMST(30),HRSNZ(30),HRSTHW(30),PHIST(30),
*PHISZ(30),PSNZ(30),PSTUE(30),GHOTST(30),RHOSZN(30),RHOSZN(30),
*TEHT(30),TSNZ(30),TSNZ(30),TSTHCT(30),TSTUB(30),WSNZ(30),
*WSTN(30),FIOTST(30),HTOTST(30),TICTST(30),
*CDTHX,AZM,AZMI,STATF,RHGT1,RHOSOX,DELPI5,RHGT,DELPOS,RHOSIX,
*REQ,DELTMF
COMMON /TAGS/
* DTAG      ,ISAVE      ,IDELZ5     ,IENL       ,IM        ,
* J         ,JEND       ,KSAVE      ,KEND       ,L        ,
* LEND      ,MTAG       ,NOFIND     ,NTAG       ,PTAG      ,
* XTAG      ,II        ,M         ,NCBNT      ,NOCENT    ,
* NZTRGT    ,NTCNT      ,NMCNT      ,NODEPT     ,NPARTS    ,
* JJ        ,KK        ,LL        ,INODE      ,KLOOP     ,
* REF       ,IDELT      ,NTPNTS    ,NODZ       ,NK        ,
* TAG       ,CTAG       ,CJ        ,REFR       ,
*NCDESK,NCDESK,EMCNT,STAG,SFACE,I,K
COMMON /TF/
* AFLUX     ,BATERM     ,EATERS     ,CCMTL      ,CPTERM     ,
* BDELZ     ,DELHM      ,DELHN      ,DELHNX     ,DELPM     ,
* DELTER     ,DHYDRA     ,DPIPE     ,DTERM      ,DZTERM     ,
* ENTRCP     ,ETAT       ,ETATP      ,GPN        ,HFTERM     ,
* HGOCEF     ,HGTCT      ,HPUMI      ,HTCOEF     ,HFTERM     ,
* H12        ,KT         ,KVN       ,KWC        ,KWCR      ,
* KWCV       ,KWH       ,KWHV      ,KWT        ,K1        ,
* K2         ,K3         ,K4        ,K6         ,MTERM1    ,
* MTERM2     ,MTERM3     ,MTERM4     ,NFRN       ,NTERM     ,
* FH1        ,PNOZL      ,PNTTHR     ,PRESM      ,PRGUES     ,
* PRPRIM     ,PRTERM     ,PSTP       ,PTANKN     ,P6N        ,
* P6N        ,PSPR       ,QN        ,QPM        ,QTERM     ,
* RHOR       ,RHOTKM     ,RHOTKN     ,RPM2       ,SPRIME     ,
* STERM      ,STSTAG     ,TFLUSR     ,TIMENT     ,TIMEN     ,
* TTANKN     ,TTURC      ,TVF       ,TWTERM     ,T1IN      ,
* T1SR       ,T8N        ,WATERM     ,WDILN      ,WDERM     ,
* WLRCLR     ,WETFER     ,WHEPN      ,WI        ,WCHOK     ,
* WNT        ,WFACTN     ,WTERM      ,WTERM      ,WTURN     ,
* WTERM      ,ZTUBE
PSTI = PCUR
TSTI = TCUR
WSTI = WCUR
100 CALL FT(PCUR,TCUR)
RHCSIX = HHC
WNCDI = WCUR
IF (WNCDI.LT.C.) GO TO 410
WSTN(1) = WNCDI
C
C *** PRESSURE DROP ACROSS INLET PLENUM
C
120 DELPIS = (KSTI*WCLR**2)/(2.*12.*G*RHC)
PJ = PCUR - DELPIS
PIA = PJ
IF (PJ.LT.C.) GO TO 420

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```

130 CALL FT(PJ,TCUR)
    HJ = ENTH
    HI = ENTH
140 LC = 1.0
    IF (SKDZ.CT.0.) GO TO 160
C
C **** VARIABLE NODE LENGTH
C
150 DELZX = SNODES(I+1) - SNODES(I)
    DIST = SNODES(I) + DELZX / 2.
C
C GO TO 160
C
C **** FIXED NODE LENGTH
C
160 IF (I.GT.1) GO TO 170
    DIST = SZMIN
    DELZX = SKDZ
    GO TO 160
170 DELZX = SKDZ
    DIST = DIST + DELZX
C
C **** TUBE FLOW AREA
C
180 CALL INTP (ASTH,DIST,AFLOWX)
C
C **** TUBE HOT SIDE WET PERIMETER
C
    CALL INTP (SSTH,DIST,SNTHX)
C
C **** COLD FLOW WET PERIMETER
C
    CALL INTP (SCFWP,DIST,WETPER)
190 CHYDRA = (4.*AFLOWX) / WETPER
C
C **** TUBE THERMAL CONDUCTIVITY
C
    CALL INTP (CLST,TSHT(I+1),CDNTHX)
C
C **** TUBE HOT SIDE THICKNESS
C
    CALL INTP (TKSTH,DIST,TKNTHX)
200 HL = HJ
    FL = PJ * 2. - FIN
    HK = (HL+HJ) / 2.
    ENTHUS (I) = (HI+HJ) / 2.
    PK = (PJ+FL) / 2.
    PCUR = PK
    IF (PCUR.LT.0.) GO TO 420
210 CALL PH (PK,HK)
    TCUR = TEMP
    RHCDP = RHO
    CPDF = CP
    WNODEN = WNODEI
    WCUR = (WNODEN+WNODEI) / 2.
    IF (WCUR.LT.0.) GO TO 410
    CALL INTP (SKDEL,DIST,SIG)
C
C **** SUBROUTINE FOR FILM COEFFICIENT
    CALL HF (CPT(24),WCUR,PCUR,TCUR,HK,TSHT(I+1),WETPER,SIG,AFLOWX,
    *FILMST(I))
230 HRSTH(I) = (TKNTHX/(2.*CDNTHX)+ 1./FILMST(I))/SNTHX
    HLPFH = (TSHT(I+1)-TCUR) / HRSTH(I)
    HLPFIN = (HLPFH*DELZX+WNODEI*HJ) / WNODEN
C
C **** HLMGRIN
240 HLMGRIN = HLMGRIN
    ZM = DIST + DELZX / 2.
    ZMIE = DIST + DELZX / 2.
    IF (STATIC.NE.1.) GO TO 245
    CALL PH (FJ,HJ)
    RHGZ = RHO
    CALL INTP (ASTH,ZM,AZM)

```

```

      CALL INTP (ASTN,ZM1,AZM1)
      STATF = WCUR**2 / (2.*G)
      HL = HL + STATF / (RHCZ**2*144.*777.97) * (1./AZM**2 - 1./AZM1**2)
      CALL FH (PJ,HL)
      RHCZ1 = RHC
      HTGTST (1) = HL + STATF / (RHCZ1**2*144.*777.97*Azm1**2)
245  CONTINUE
      DELF = HL - HJ
C
C **** SUBROUTINE FOR FRICTION FACTOR
C
      CALL FF(CPT(24),WCUR,PCUR,TCUR,HK,TSTHT(I+1),WETPER,PHI)
250  PHIST (1) = PHI
      DELZP = DELZX
      IF (NCBSK.EQ.C) GO TO 280
C
C **** TEST FOR BEND IN NODE
C
260  DO 270 K = 1,NCBSK
      IF (SKBN(2*K-1).LE.ZM) GO TO 270
      IF (SKBN(2*K-1).GT.ZM1) GO TO 270
C
C **** ADDITIONAL PRESSURE DROP DUE TO BEND TABLE
C
      DELZP = DELZP + SKBN(2*K)
270  CONTINUE
      DELFT = DELH / (TCUR*CFDP) + DELZF * 4. * PHI / DHYCR
      DELFMT = DELFT / (2.*12.*G*RHCDP*AFLCMX**2)
      DELFM = DELFMT * WCUR ** 2
      PLPRIM = PJ - DELFM
      IF (PLPRIM.LT.V.) GO TO 420
290  PL = PLPRIM
      IF (STATIC.EQ.1.) GO TO 295
      PL = PL - STATF / 12. * (1./ (RHOZ1*Azm1**2) - 1./ (RHOZ*Azm**2))
      FICTST (1) = PL + STATF / (12.*RHCZ1*Azm1**2)
      CALL FH (FICTST(1),HTGTST (1))
      TTGTST (1) = TEMP
295  CONTINUE
      QHGTST (1) = DELZX / HRSTHW(1) * (TSHT(I+1)-TCUR)
C
C **** INITIALIZE FOR NEXT NODE
C
300  RHCSTN (1) = RHC
      WNCDI = WNCDELN
      WSTN (I+1) = WNCDELN
      TSTAB (1) = TCUR
      PSTAB (1) = PL + (PJ-PLPRIM) / 2.
      HI = HJ
      HJ = HL
      PIN = PJ
      PJ = PL
350  CONTINUE
C
C **** TUBE OUTLET CONDITIONS
C
      CALL PH (PL,HL)
      TSTC = TEMP
      TCUR = TEMP
360  DELFOS = (KSTC*WNCDI**2) / (RHO*2.*12.*G)
      PCUR = PL - DELFOS
      IF (PCUR.LT.C.) GO TO 420
      RHOSDX = RHO
370  WCUR = WNCDI
C
C **** NORMAL RETURN TO MAIN PROGRAM
C
      TSTC = TCUR
      PSTC = PCUR
      WSTC = WCUR
400  RETURN

```


SUBROUTINE SKINT

DATE = 19SEP67

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```
C
C ****      NEGATIVE FLOW RETURN TO MAIN PROGRAM
C
C 410 CALL MCFLW
C ****      NEGATIVE PRESSURE RETURN TO MAIN PROGRAM
C
C 420 CALL MCFRES
C          STOP
C          END
```

SUBROUTINE SKTNZ

C

IMPLICIT REAL*4 (A-Z)
INTEGER*4

* DIAG	, ISAVE	, ILELZS	, IEND	, IM(5)	,
* J	, JEND	, KSAVE	, KEND(5)	, L	,
* LEND	, LTAG(30)	, NOFINO	, NTAG	, PTAG	,
* XTAG(5,5)	, I	, M	, NCENT	, NOCENT	,
* NZTRCT	, NTCNT	, NMCNT	, NODPT	, NPARTS	,
* JJ	, KK	, LL	, INODE	, KLGOP	,
* KET	, IDELT	, NTFNTS	, NUDZ	, NK	,
* TTAG	, CTAG	, CJ(20)	, REFR		
* NCESK, NODSK, SMCNT, STAG, SPACE, I, K					
COMMON /ADD/					
* ARG	, ARG1	, ARG2	, ATURNP	, BUF(10)	,
* CARDS(11)	, DELTAP	, DTURX	, GASVEL	, MCCRO	,
	, HFCCEF	, HPIN	, HPOUT	, HTANKN	,
* FTLKIX	, KVSQRT	, MACH	, NEEND	, PPCUT	,
* FTRUT	, PTURPR	, PKEDFL	, PVAPCR	, PTXST	,
* FFLCW	, FTXMIN	, FUNPH	, RF	, RNTROT	,
	, RATIO	, RATIOC	, SPEED	, TTRUT	,
* TEMPY	, TMX	, TJKWD1	, TINTZ1	, TINTH1	,
* TPCUT	, TFIN		, TIXMIN	, TMIX	,
* UNCHOK			, FILMNT	, QPUMI	,
* T1NP1(30)	, T2NP1(30)	, T3NP1(30)	, SAVN(15)	, SAVNT(20)	,
* SAVFX(20,8)	, SAVPT(20,18)	, SAVJ(30,27)	, SAVIJ(30,20,5)		
COMMON					
*/A1/					
* ANCLIX	, COJX	, CLNTCX	, CNTFX	, CPX	,
* CRJNTX	, CRJX	, DELH	, DELPI	, DELPK	,
* DELPO	, DELRHC	, DELTX	, DELW	, DELZSQ	,
* DELZX	, DELZX4	, HGCJKT	, HGCNTC	, HGCNTH	,
* HI	, HJ	, HK	, HL	, HLPRIH	,
* HENTJH	, HROJ	, MIN	, MZN	, PIN	,
* FJ	, FK	, PL	, PLPRIM	, RFLUX	,
* RHCMIH	, RHOMUX	, RHCMIH	, RHCNIX	, RHONOX	,
* RHCX	, SJUX	, SACZX	, SNTCX	, SNTHX	,
* IAMBX	, TICCLR	, THCUR	, THEDIF	, TJKCUR	,
* TKJX	, TKNTCX	, TKNTHX	, MNODEN	, MNODI	,
* ZMAX	, ZMIN	, ZTROT			
COMMON /CCNS/					
* G	, JAY	, PI	, R	, RAD	,
* RE					
COMMON /EXTRA/					
* FLNIF	, GFUM	, ICX	, INKHL	, TPT2	,
* TRCR	, TPQ	, TPX2	, TPXPD	, TPMH	,
* KPUMPI	, MBEAR	, MBEAR	, WPUMPC		
* ATURNZ	, ATURN	, ATUR	, ARQLNZ	, PMIX	,
* FAVG	, MPMAX	, DTURBL	, PFIN	, TAVE	,
* CR	, ITURIF		, GAMMA	, PTCOLO	,
* FULX	, CPTI	, GAMT1	, TTXST	, KVLMIN	,
* KTFMIN	, WPCNT	, TURWK	, TCTMP	, TPNW	,
* TPWK	, TIMER	, PCARD	, RFUM		
* DELZP	, ZM	, ZM1	, DELPT	, DELPNT	,
* FLPHF	, HLPCHF	, TK	, DTROT	, DELZT	,
* TROTZ		, RNDIST	, RFN	, Q	,
* TCHOK	, NCE	, NACF1	, NMINIT	, NTCNT	,
* FNTH	, THETA1	, THETA2	, MEN3	, MEN3	,
* INTWD1	, TICIFM	, SACPR	, FNIC	, MDN2	,
* MEN2	, FJ	, MCN1	, MCN1	, TINTC01	,
* TIMEZ	, ETAF	, TPT20	, METLTN	, TPTAV	,
* PTLRCM	, DUM	, OMAX	, OZ	, TEMPTM(30)	,
COMMON /SIG					
COMMON /FLUIDP/					
* FRES	, ZFACT	, QUAL	, TEMP	, RHO	,
* GAP	, CF	, VEL	, ENTR	, COND	,
* VIS	, VCL	, ENTH			
COMMON /KINZ/					
* PHINZ(30)	, CPDP	, ENTHG(30)	, HKPR	, PHINT(30)	,
* RFTC	, PKPR	, PTCX	, QCLENT(30)	, GHOINT(30)	,
	, RHODP	, TCLOC	, TTC		

```

COMMON /QFC/FFTAB(4,30),HFTAB(5,30),OPT(30)
COMMON
*/F/
* ALPHA      ,BETA      ,DIST      ,EFUMC      ,EPLMP      ,
* ELURC      ,ELURP      ,FILMCX     ,GATEP      ,HOFUM      ,
* FVVC      ,HSVP      ,MHT      ,NFT      ,NTURC      ,
* NLURP      ,PCORG      ,PCUR      ,PDIL      ,PHEPO      ,
* PMINOX      ,PNTI      ,PNTQ      ,PFUMOC      ,PPUMQP      ,
* PTANKX      ,PTURIX      ,PTURO      ,QPUMP      ,RFLU      ,
* SAC      ,TCORG      ,TCORDR      ,TCUR      ,TDILX      ,
* THEPG      ,TIME      ,TIMEP      ,TMETL      ,TNTI      ,
* TNU      ,TPUMOC      ,TPUMOP      ,TTANKX      ,TTURIX      ,
* TIZMIX      ,UIHG      ,WCLUR      ,WDILX      ,WHEP      ,
* WCLZ      ,WNTCK      ,WNTI      ,WNTC      ,WPUMC      ,
* WPUMP      ,WTURB
COMMON /SKIRTC/NOBS,NODEK,KSTI,KSTO,SKDZ,SZMIN,STATIC,
* PSTI,TSTI,WSTI,PSIQ,TSTG,WSTO,
* ASTH(30),ASTW(30),SKBA(30),CDST(30),CPST(30),SCFWP(30),SKCG(30),
* SKDEL(30),DSNZW(30),NTIF(30),NTIT(30),NTIW(30),NZIP(30),NZIT(30),
* NZIW(30),RHCSI(30),SKRN(30),SSNZ(30),SSTH(30),TKSTH(30),SNODES(30),
* ENTHCS(30),FILMSZ(30),FILMST(30),HRSNZW(30),HRSSTH(30),PHIST(30),
* PHISZ(30),PSNZ(30),PSTUE(30),GHOTST(30),RHUSTN(30),RHOSZN(30),
* TSHI(30),TSNZ(30),TSNZW(30),TSTHCT(30),TSTUE(30),WSNZN(30),
* WSTN(30),PTOTST(30),HTOTST(30),TTCTST(30),
* CDTHX,AZN,AZM1,STATF,RHQZ1,RHOSCX,DELPIS,RHOZ,DELPQS,RHOSIX,
* RFO,DELTP
COMMON /TAGS/
* DTAG      ,ISAVE      ,IDELZS      ,IEND      ,IM      ,
* J      ,JEND      ,KSAVE      ,KEND      ,L      ,
* LEND      ,MTAG      ,NCFIND      ,NTAG      ,PTAG      ,
* XTAG      ,II      ,M      ,NCBNT      ,NOCENT      ,
* NZTRGT      ,NTCNT      ,NMCNT      ,NDEPT      ,NPARTS      ,
* JJ      ,KK      ,LL      ,INODE      ,KLOOP      ,
* REF      ,IDELT      ,NTPNTS      ,NODZ      ,NK      ,
* TTAG      ,CTAG      ,CJ      ,REFR      ,
* NCECK,NODESK,SMCNT,STAG,SPACE,I,K
COMMON /TP/
* AFLUX      ,BATERM      ,BATERS      ,CDMTL      ,CPTERM      ,
* DELZ      ,DELHM      ,DELHNX      ,DELMN      ,DELPN      ,
* DELTER      ,DHYDRA      ,DPIPE      ,DTERM      ,DZTERM      ,
* ENTROP      ,ETAT      ,GPN      ,HFTERM      ,HTERM      ,
* HGCDEF      ,HGTCGT      ,HPLMI      ,HTCGEF      ,HVTERM      ,
* H12      ,KT      ,KVN      ,KWC      ,KWC      ,
* KWC      ,KWH      ,KWHV      ,KWT      ,K1      ,
* K2      ,K3      ,K4      ,K6      ,MTERM1      ,
* MTERM2      ,MTERM3      ,MTERM4      ,NFRN      ,NTERM      ,
* PHI      ,PNOZO      ,PNTTHR      ,PRESM      ,PRGUES      ,
* PRPRIM      ,PRTERM      ,PSTP      ,PTANKN      ,P6N      ,
* PSN      ,PSPR      ,QN      ,QPM      ,QTERM      ,
* RHGR      ,RHQIKM      ,RHGTKN      ,RPM2      ,SPRIME      ,
* SIERM      ,STSTAG      ,TFLUSR      ,TIMEMT      ,TIMEN      ,
* TTANKN      ,TTURD      ,TVP      ,TWTERM      ,T1IN      ,
* T1SR      ,TEN      ,WATERM      ,WDILN      ,WDERM      ,
* WERRCR      ,WETPER      ,WHEPN      ,WI      ,WNCHOK      ,
* WNI      ,WPACTN      ,WRTERM      ,WTERM      ,WTURN      ,
* WTERM      ,ZTUBE
100 WSNZN(1) = WCUR
WNGDI = WCUR

```

```

C
C **** PNCZO, TNUZO ARE NOZZLE OUTLET CONDITIONS
C

```

```

PJ = PCUR
PIN = PCUR
120 CALL FT(PCUR,TCUR)
IK = TCUR
HJ = ENTH
HI = ENTH
RF = 1.0
130 DO 25C I = 1,NODESK
IF (SKDZ.GT.0.) GO TO 150

```

```

C *** VARIABLE NODE LENGTH
C
140 DELZX = SNODES(I+1) - SNODES(I)
    DIST = SNODES(I) + DELZX / 2.
    CC TO 170
150 IF (I.GT.1) GO TO 160
    DIST = SZMIN
    DELZX = SKDZ
    GO TO 170
160 DELZX = SKDZ
    DIST = DIST + DELZX
C
C *** NOZZLE FLOW DIAMETER
C
170 CALL INTP(DSNZW,DIST,DHYDRA)
    AFLCW = (PI*DHYDRA**2) / 4.
C
C *** NOZZLE WET PERIMETER
C
    CALL INTP(SSNZ,DIST,WETPER)
C
C *** TUBE THERMAL CONDUCTIVITY
C
    CALL INTP(CDST,TSHT(I+1),CDNTHX)
C
C *** TUBE HCT SIDE THICKNESS
C
    CALL INTP(TKSTH,DIST,TKNTHX)
180 HL = HJ
    PL = PJ*2. - FIN
    HK = (HL+HJ) / 2.
    PK = (PJ+PL) / 2.
    PCUR = PK
    IF (PCUR.LT.0.) GO TO 420
    TCUR = TK
190 CALL FT(PK,TK)
    RHODP = RHG
    CPDP = CP
    WNODEN = WNODI
200 WCUR = (WNODEN+WNODI) / 2.
    IF (WCUR.LT.0.) GO TO 410
    CALL INTP(SKDEL,DIST,SIG)
    CALL INTP(SKCG,DIST,HFIAB(5,CFT(25)))
C
C *** SUBROUTINE FOR FILM COEFFICIENT
C
    CALL HF(CFT(25),WCUR,PCUR,TCUR,HK,TSNZW(I+1),WETPER,SIG,AFLCW,
    *FILMSZ(I))
210 HRSNZW(I) = (TKNTHX / (2.*CDNTHX) + 1. / FILMSZ(I)) / WETPER
    DELTMP = TSHT(I+1) - TCUR
    HLPFIM = (DELTMP * DELZX / HRSNZW(I) + WNODI * HJ)
    1 HFC = RF
    / WNODEN
C
C *** RECOVERY FACTOR
C
    CALL INTP(SKRN,DIST,RF)
    HLPFIM = HLPFIM * (RF/RFL)
220 HL = HLPFIM
C
C *** SUBROUTINE FOR FRICTION FACTOR
C
    CALL FF(CFT(25),WCUR,PCUR,TCUR,HK,TSNZW(I+1),WETPER,PHI)
230 PHISZ(I) = PHI
    DELZP = DELZX
    IF (NCBSK.EC.0) GO TO 270
    ZM = DIST - DELZX / 2.
    ZM1 = DIST + DELZX / 2.
C

```

```

C **** TEST FOR BEND IN NODE
C
260 DO 260 K = 1,NCBSK
    IF (SKBN(2*K-1).LE.ZM) GO TO 260
    IF (SKBN(2*K-1).GT.ZM1) GO TO 260
C
C **** ADDITIONAL PRESSURE DROP DUE TO END TABLE
C
    DELZP = DELZP + SKBN(2*K)
260 CONTINUE
270 DELFT = DELZP * 4. * PHI / DRYDRA
    DELFMT = DELFT / (2.*12.*G*RHCDP*AFLG**2)
    DELFM = DELFMT * WCLR ** 2
    PLPRIM = PJ - DELFM
    IF (PLPRIM.LT.0.) GO TO 420
280 PL = PLPRIM
    IF (SKDZ.GT.0.) GO TO 300
    RNDIST = SNCDES (I+1) + (SNCDES (I+2) - SNCDES (I+1)) / 2.
    GO TO 310
300 RNDIST = DIST + SKDZ
310 CALL INTP (SKKN,RNDIST,HFN)
    Q = DELZX / HKSZ (I) * (TCLR - TSHT (I+1))
    TMX = RFN*(TK/RF - C/(WCLR*CPDP))
320 RHGSZ (I) = RHO
    WNGDI = WAGDEN
    WSNZ (I+1) = WLDEN
    TSZ (I) = TCLR
    PSZ (I) = PL + (PJ-PL) / 2.
330 TK = TMX
    HI = HJ
    HJ = HL
    PIN = PJ
    PJ = PL
350 CONTINUE
C
C **** NORMAL RETURN TO MAIN PROGRAM
C
400 RETURN
C
C **** NEGATIVE FLOW RETURN TO MAIN PROGRAM
C
410 CALL MCFLOW
C
C **** NEGATIVE PRESSURE RETURN TO MAIN PROGRAM
C
420 CALL MCRES
    STOP
    END

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SUBROUTINE TEMPQ
EVALUATE FINITE DIFFERENCE TEMPERATURE EQUATIONS
IMPLICIT REAL*8 (A-Z)
INTEGER*4
* DTAG          ,I          ,IDELZS          ,IEND          ,IM(5)          ,
* J             ,JEND       ,K             ,KEND(5)      ,L             ,
* LEND          ,MTAG(30)   ,NOFIND         ,NTAG         ,PTAG         ,
* XTAG(5,5)     ,II         ,M             ,NOBENT       ,NOCENT       ,
* NZTROT        ,NTCNT      ,NMCNT         ,NODEPT      ,NPARTS      ,
* JJ            ,KK         ,LL            ,INCDE       ,KLOOP       ,
* REF           ,IDELT      ,NTPNTS        ,NOBZ         ,NK             ,
* TTAG          ,CTAG       ,CJ(20)        ,REFR         ,
COMMON /ADD/
* ARG           ,ARG1       ,ARG2          ,ATURNP       ,BUF(10)       ,
* CARDS(11)     ,DELTA      ,DTURX         ,GASVEL       ,HCORO       ,
*             ,HFCDEF      ,HPIN          ,HPOUT        ,HTANKN      ,
* HTURIX        ,KVSORT     ,MACH          ,NBEND        ,PPOUT        ,
* PTRGT         ,PTURPR     ,PREDFL       ,PVAFOR       ,PTXST        ,
* PFLUW         ,PTXMIN     ,PUMPH        ,RF           ,RNRTRT      ,
*             ,RATIO       ,RATIOC       ,SPEED        ,TTROT        ,
* TEMPY         ,TMX        ,TJKWD1       ,TNTNZ1       ,TNTHT1      ,
* TPCUT         ,TPIN       ,TJXMIN      ,TTXMIN       ,TMIX        ,
* UNCHK         ,TNP1(30)   ,T2NP1(30)    ,T3NP1(30)    ,FILMNT       ,QPUMI       ,
* T1NP1(30)     ,T2NP1(30) ,T3NP1(30)    ,T4NP1(30)    ,T5NP1(30)    ,
* T6NP1(30)     ,T7NP1(30) ,T8NP1(30)    ,T9NP1(30)    ,T10NP1(30)   ,
COMMON /AZ01/
* CSUBP(30,20) ,FILMHF(30,20) ,PRESS(30,20) ,RHOFLU(30,20) ,
* RHOFTP(30,20) ,TFLUID(30,20) ,TMETAL(30,20) ,WRATEM(30,20) ,
* WRATEN(30,20) ,
COMMON /AZ10/
* FILMNZ(30)   ,FILMTC(30) ,FILMTH(30) ,HRNOZW(30) ,HRNTCW(30) ,
* HRNTHW(30)   ,PNOZ(30)   ,PTUBE(30)   ,RHONTM(30) ,RHONTN(30) ,
* RHONZM(30)   ,RHONZN(30) ,TCOLD(30)   ,THOT(30)   ,TJACK(30) ,
* TJKTWD(30)   ,TJKWD(30) ,TNGZ(30)   ,TNOZW(30) ,TNTCLD(30) ,
* TINTHOT(30) ,TINTJWD(30) ,TTUBE(30)   ,WNOZM(30) ,WNOZN(30) ,
* WNTM(30)     ,WNTN(30)   ,
COMMON
*/CONS/
* G             ,JAY        ,PI           ,R             ,RAD         ,
* RB
COMMON /EXTRA/
* FUMIP         ,QFUM       ,TCX          ,TNKRHO       ,TPT2        ,
* TPCR          ,TPQ        ,TPK2         ,TPKPD        ,TPWH        ,
* KPLMFI        ,WBEAR     ,HBEAR      ,WPUMPC       ,
* ATURNZ        ,ATURNK     ,ATUR       ,ARULNZ       ,PMIX        ,
* RAVG          ,WPMAX      ,DTURBL    ,PPIN         ,TAVE        ,
* CR            ,TTURIP     ,GANT1      ,GAMMA        ,PTGOLO     ,
* HDILX         ,CPTI       ,TURWK      ,TTXST        ,KVLMIN     ,
* KIPMIN        ,WFCNT      ,PCARD      ,TCTMP        ,TPNW        ,
* TPRK          ,TIMER      ,PCARD      ,RHO          ,
* DELZP         ,ZM         ,ZM1        ,DELPT        ,DELPMT     ,
* HLPFH         ,HLPCHF     ,TK          ,DTROT        ,DELZT      ,
* TROTZ        ,RNDIST     ,RFN         ,Q            ,
* TCMOK         ,WNCF       ,WNCF1      ,WNCIT        ,MTCNT     ,
* ENTH          ,THETA1     ,THETA2     ,MAN3         ,MEN3        ,
* TINTD1        ,TDIRM      ,SACPR      ,FNTC         ,MDN2        ,
* MBN2          ,FJ         ,MCN1       ,MDN1         ,TNTCD1     ,
* TIMEZ         ,ETAP       ,TPT20      ,METLTN       ,TPTAV      ,
* FTURCM        ,DUM        ,OMAX        ,OZ           ,TEMPTM(30) ,
COMMON
*/FLUIDP/
* PRES         ,ZFACT      ,QUAL       ,TEMP         ,RHO         ,
* GAM          ,CP         ,VEL        ,ENTR         ,COND        ,
* VIS          ,VOL        ,ENTH        ,
COMMON /FX/
* DELTEM(20)    ,FLUTEM(20) ,METTEM(20) ,MSMALL(20) ,MTPNTS(20) ,
* PARTI(20)     ,PARTPS(20) ,TEMPEX(20) ,
COMMON /MISC/
* PCX          ,PDK        ,PDKV       ,PTUROC       ,PTUROP      ,
* HSPKV        ,HBPW       ,HBPWC      ,HBPWC        ,

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* METLTO      ,MINFLO      ,PASSX      ,SSGUT      ,WPIT      ,
* ITEMP(20)   ,CTEMP(20)   ,DELHN2(200),PUMP(350)  ,FILMA(20) ,
* FILMB(20)   ,FILMC(20)   ,TCFLG(20)  ,
COMMON /DPC/ FFTAB(4,30) ,HFTAB(5,30) ,OPT(30)
COMMON
*/P/
* ALPHA      ,BETA      ,DIST      ,EPUMC      ,EPUMP      ,
* ETURC      ,ETURP      ,FILMCX      ,GATEP      ,NDPUM      ,
* HSVC      ,HSVP      ,MHT      ,NHT      ,NTURC      ,
* NTURP      ,PCORC      ,PCUR      ,PCIL      ,PHEPO      ,
* PMINOX      ,PNTI      ,PNTQ      ,PPUMOC      ,PPUMOP      ,
* PTANKX      ,PTURIX      ,PTURO      ,QPUMP      ,RFLU      ,
* SAC      ,TCORO      ,TCOROR      ,TCUR      ,TDILX      ,
* THEPQ      ,TIME      ,TIMEP      ,TMETL      ,TNTI      ,
* INTD      ,TPUMOC      ,TPUMOP      ,TTANKX      ,TTURIX      ,
* T12MIX      ,UIHG      ,WCUR      ,WOILX      ,WHEP      ,
* WNCZ      ,WNTCK      ,WNTI      ,WNTQ      ,WPUMC      ,
* WFLMP      ,WTURB
COMMON /PIC/
* DISPT(20)   ,PDROPI(20)   ,PDROPO(20)   ,PRESI(20)   ,PRESO(20) ,
* RHOMI(20)   ,RHOMO(20)   ,RHONI(20)   ,RHOND(20)   ,TEMPI(20) ,
* TEMPO(20)   ,TIMEZM(20)   ,WDELM1(20)   ,WDELMO(20)   ,WDELNI(20) ,
* WDELNO(20)   ,WRATEI(20)   ,WRATEO(20)
COMMON
*/TABIJ/
* AFLOW(30,20),CAP(30,20)   ,CONDI(30,20) ,HG(30,20)   ,HGF(30,20) ,
* WETP(30,20)
COMMON
*/TABJJ/
* DELZ(20)    ,FRICF(20)    ,HFFLG(20)    ,KDFI(20)    ,KOPQ(20) ,
* NDELZ(20)    ,PLENI(20)    ,PLENO(20)    ,RHOMTL(20) ,TNODE(20) ,
* TTK(20)      ,VOIDF(20)    ,WALL(20)
COMMON
*/TAGS/
* DTAG      ,I      ,IDELZS      ,IENG      ,IM      ,
* J      ,JEND      ,K      ,KENC      ,L      ,
* LEND      ,MTAG      ,NOFIND      ,NTAG      ,PTAG      ,
* MTAG      ,II      ,M      ,NOBNT      ,MOCENT      ,
* MTROT      ,NMCNT      ,NMDEPT      ,NPARTS      ,
* REF      ,KK      ,LL      ,INODE      ,KLOOP      ,
* REF      ,IDELT      ,NTPNTS      ,NCDZ      ,NK      ,
* CTAG      ,CJ
COMMON /TP/
* AFLOWX      ,BATERM      ,BATERS      ,CDMTL      ,CPTERM      ,
* BDELZ      ,DELHM      ,DELHN      ,DELHMX      ,DELPN      ,
* DELTER      ,DHYDRA      ,DPIPE      ,DTERM      ,DZTERM      ,
* ENTROP      ,ETAT      ,ETATP      ,GPN      ,NFTERM      ,
* KGOEF      ,HGTOT      ,HPUMI      ,HTCOEF      ,HVTERM      ,
* HI2      ,KT      ,KVN      ,KWC      ,KWCP      ,
* KWCV      ,KWH      ,KWHV      ,KWT      ,K1      ,
* K2      ,K3      ,K4      ,K6      ,MTERM1      ,
* MTERM2      ,MTERM3      ,MTERM4      ,NPRN      ,NTERM      ,
* PNE      ,PNQZO      ,PNTMR      ,PRESM      ,PRGUES      ,
* PPRIN      ,PRTERM      ,PSTP      ,PTANKN      ,P6N      ,
* PEN      ,PSPR      ,QN      ,QPM      ,QTERM      ,
* RHOR      ,RHOTKM      ,RHOTKN      ,RPM2      ,SPRIME      ,
* STERM      ,SISTAG      ,TFUSR      ,TIMEMT      ,TIMEN      ,
* TTANKN      ,TTURO      ,TVP      ,TWTERM      ,T1IN      ,
* T11SR      ,T8N      ,WATERM      ,WDILN      ,WDTERM      ,
* WERROR      ,WETPER      ,WHBPN      ,WI      ,WNCHOK      ,
* WNT      ,WPACTN      ,WRTERM      ,WTERM      ,WTURN      ,
* ZTUBE
COMMON
*/X/
* ECFTAP      ,INDTUR      ,INTFLO      ,LARGET      ,LESPQ      ,
* LOCPN      ,MCAP      ,NEGW      ,NGNQF      ,NGNSPD      ,
* NONTC      ,NCNW      ,NOTURN      ,NGTURN      ,NTERR      ,
* PARONE      ,WITER

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100LZS = PARTS(J)
INLET VALUES FOR ONE PART AT ONE TIME.

A
B
C
D

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PRESI(J) = PCUR
TEMPI(J) = TCUR
WRATEI(J) = WCUR
IF(PCUR.LT.0.) GO TO 20
CALL PT(PCUR,TCUR)
RHOI(J) = RHO
WDELNI(J) = PLENI(J)*(RHOI(J)-RHO)/TIMEP
IF(MCAP.NE.0.) GO TO 22
22 IF(WCUR.LT.0.) GO TO 30
IF(KDPI(J).EQ.0.) GO TO 102
PDRCP(J) = 0.5*KDPI(J)*WCUR*WCUR/(12.*G*RHO)
PCLR = PCLR - PDRCP(J)
102 TFLUID(I+J) = TCUR
WRATEN(I,J) = WCUR
PRESS(I,J) = PCUR
CALL PT(PCUR,TCUR)
DIST = 0.5*DELZ(J)
DO 10 I=1,IDELES
  TMETL = TMETAL(I+1,J)
  CALL INTP(WETP(I,J),DIST,WETPER)
  CALL INTP(AFLOW(I,J),DIST,AFLOWX)
  DHYDRA = 4.*AFLOWX/WETPER
  DDELZ = DHYDRA + DELZ(J)
  CALL HF(OPT(J),WCUR,PCUR,TCUR,ENTH,TMETAL(I+1,J),WETPER,SIG,
    * AFLOWX,FILMCX)
  CALL INTP(CNDI(I,J),TMETAL(I+1,J),CDMTL)
  REGION TO COMPUTE HEAT RESISTANCE TERMS FOR ONE NODE
  IF(WALL(J).NE.0.) GO TO 11
  HFTERM = FILMCX
  GO TO 12
11 HFTERM = 2.*FILMCX*CDMTL/(2.*CDMTL+WALL(J)*FILMCX)
12 MHT = CP *WCUR/(HFTERM+WETPER*DELZ(J))
  MTERM2 = 1.+2.*MHT
  MTERM3 = MTERM2 -2.
  IF(MTERM3.GE.0.) GO TO 13
  MSMALL(J) = MTERM3
13 CONTINUE
  DTERM = 4.*FRICF(J)*DELZ(J)/DHYDRA
  WRTERM = ((WCUR/AFLOWX)**2)/(2.*12.*G*RHO)
  DELTER = -1.*AFLOWX*DELZ(J)/TIMEZ
  RFL = RHO
  TFLUID(I+1,J) = (MTERM3*TCUR+2.*TMETL)/MTERM2
  TCUR = TFLUID(I+1,J)
  DELPM = ((TFLUID(I+1,J)-TFLUID(I,J))/TFLUID(I,J) + DTERM)*WRTERM
  PCUR = PCUR - DELPM
  PRESS(I+1,J) = PCUR
  IF(PCUR.LT.0.) GO TO 20
  RHOFTP(I,J) = RFLU
  FILMHF(I,J) = FILMCX
  CSLEP(I,J) = CP
  DIST = DIST + DELZ(J)
  CALL PT(PCUR,TCUR)
  IF(MCAP.EQ.0.) GO TO 2
  WRATEN(I+1,J) = WCUR
  GO TO 3
2 WRATEN(I+1,J) = 0.5*(RHOFLU(I,J) + RHOFLU(I+1,J) - RHOFTP(I,J)
  * - RHO)*AFLOWX*DELZ(J)/TIMEP + WCUR
  WCUR = WRATEN(I+1,J)
3 IF(WCUR.LT.0.) GO TO 30
10 CONTINUE
  CSUBP(IDELES+1,J) = CP
  RHOFTP(IDELES+1,J) = RHO
  OUTLET VALUES FOR ONE PART AT ONE TIME
  IF(KDPO(J).EQ.0.) GO TO 1
  CALL PT(PCUR,TCUR)
  PDROPG(J) = 0.5*KDPO(J)*WCUR*WCUR/(12.*G*RHO)
  PCUR = PCUR - PDROPG(J)
1 PRESS(J) = PCUR
  TEMPO(J) = TCUR

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A
B
C

S

F

H

I

SUBROUTINE TEMPG

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      IF(PCUR.LT.0.) GO TO 20
      CALL FT(PCUR,TCUR)
      RHONG(J) = RHO
      WDELNC(J) = PLENO(J)*{(RHOMO(J)-RHO )/TIMEP
      IF(MCAP.NE.0.) GO TO 23
      WCUR = WCUR + WDELNO(J)
23    IF(WCUR.LT.0.) GO TO 30
      WRATED(J) = WCUR
      RETURN
20    CALL MCPRES
30    CALL MCFLCN
      STOP
      END
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SUBROUTINE TUBEM
IMPLICIT REAL*8 (A-Z)
INTEGER*4
* DTAG      ,ISAVE      ,IDELZS      ,IEND      ,IM(5)      ,
* J          ,JEND      ,K            ,L            ,L            ,
* LEND      ,MTAG(30)   ,NOFIND      ,NTAG      ,PTAG      ,
* XTAG(5,5) ,IISAVE     ,MSAVE      ,NOBNT      ,NOBNT      ,
* NZTROT     ,NTCNT     ,NMCNT      ,NGDEPT     ,NPARTS     ,
* JJ         ,KK        ,LL          ,INGDE      ,KLOOP      ,
* REF        ,IDELT     ,NTPNTS     ,NCDZ       ,NK          ,
* TTAG       ,CTAG      ,CJ(20)     ,REFR       ,
* ,XSAVE(7),I,M,II
COMMON /ADD/
* ARG        ,ARG1      ,ARG2        ,ATURNP     ,BUF(10)    ,
* CARDS(11)  ,DELTAP     ,DTURX      ,GASVEL     ,HCORO      ,
*          ,HFCDEF      ,HPIN        ,HPOUT      ,HTANKN     ,
* HTURIX     ,KVSQRT     ,NACH        ,NBEND      ,PPOUT      ,
* PTROT      ,PTURPR     ,PREDFL     ,PVAFOR     ,PTXST      ,
* PFLOW      ,PTXMIN     ,PUMPH       ,RF          ,RNTROT     ,
*          ,RATIO       ,RATIOC      ,SPEED       ,TITROT     ,
* TEMPY      ,TMX        ,TJKWD1     ,TNTNZ1     ,TNTHT1     ,
* TPOUT      ,TPIN       ,TJKNZ1     ,TTXMIN     ,TMIX       ,
* UNCHK      ,          ,FILMNT      ,FILMNT     ,QPUMI      ,
* T1NP1(30)  ,T2NP1(30) ,T3NP1(30) ,SAVN(15)   ,SAVNT(20) ,
* SAVF(20,8) ,SAVPT(20,18),SAVJ(30,27),SAVIJ(30,20,9)
COMMON
* /AT/
* ANCZTX     ,CDJX      ,CONTCX     ,CONTHX     ,CPX        ,
* CKJNTX     ,CRJX      ,DELH       ,DELFI      ,DELPK      ,
* DELPO      ,DELRHC     ,DELYX     ,DELM       ,DELZSQ     ,
* DELZX      ,DELXK4    ,HGCJKT     ,HGCNTC     ,HGCNTH     ,
* HI          ,HJ        ,HK         ,HL         ,HLPRI      ,
* HRNTJW     ,HROJ      ,MIN        ,M2N        ,PIN        ,
* FJ         ,PK         ,PL         ,PLPRIM     ,RFLUX      ,
* RHCMI      ,RHGMOX     ,RHGMX     ,RHONIX     ,RHONOX     ,
* RHCX       ,SJOX      ,SNOZX     ,SNTCX      ,SNTHX      ,
* TAMBX      ,TCCUR      ,THCUR      ,THEDIF     ,TJKCUR     ,
* TKJX       ,TKNTCX    ,TKNTHX     ,WNODEN     ,WNODI      ,
* ZMAX       ,ZMIN      ,ZTROT      ,
COMMON /AZ10/
* FILMNZ(30) ,FILMTC(30) ,FILMTH(30) ,HRNGZW(30) ,HRNTCW(30) ,
* HRNTHW(30) ,PNOZ(30)  ,PTUBE(30)  ,RHONTM(30) ,RHONTN(30) ,
* RHCNZM(30) ,RHONZN(30) ,TCOLD(30) ,THOT(30)  ,TJACK(30) ,
* TJKTWD(30) ,TJKWD(30) ,TNCZ(30)  ,TNOZW(30) ,TNTCLD(30) ,
* THTOT(30)  ,TNTJWC(30) ,TTUBE(30) ,WNOZM(30) ,WNOZN(30) ,
* WNTM(30)   ,WNTN(30)
COMMON
* /CONS/
* G          ,JAY       ,PI         ,R          ,RAC        ,
* RB
COMMON /EXTRA/
* FUMIP      ,QPUM      ,TCX        ,TNKRHO     ,TPT2       ,
* TPCR       ,TPQ       ,TPK2       ,TPKFD      ,TPWH       ,
* KPWMI      ,WBEAR     ,HBEAR     ,WPUMPC     ,
* ATURNZ     ,ATURN     ,ATUR      ,AROLNZ     ,PMIX       ,
* PAVG       ,WPMAX     ,DTURBL   ,PPIN       ,TAVE       ,
* CR         ,TTURIP    ,GAMTI     ,GAMMA      ,PTOOLD     ,
* HDILX      ,CPTI      ,TURWK     ,TTXST      ,KVLMIN     ,
* KTPMIN     ,WPCNT     ,PCARD     ,TCTMP      ,TPNW       ,
* TPRK       ,TIMER     ,RHCN      ,DELPT      ,DELPMT     ,
* DELZP      ,ZM        ,ZM1       ,DTROT      ,DELZT      ,
* HLPHF      ,HLPCF     ,TK        ,RFN       ,Q          ,
* TROTZ      ,WNCF      ,RNDIST    ,WMNIT     ,HTCNT      ,
* TCHK       ,WNTA1     ,WNTA2     ,MAN3      ,MEN3       ,
* FNTH       ,TDIFM     ,SACPR     ,FNTC      ,MDN2      ,
* TMTWD1     ,FJ        ,MCN1      ,MDN1      ,TNTCD1     ,
* MBN2       ,ETAP      ,TPT20     ,METLTN    ,TPTAV      ,
* TIMEZ      ,DUM       ,OMAX      ,OZ        ,TEMPTM(30)
COMMON

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*/FLAG/
* ETAPFL      ,HBPFG      ,MASS      ,MTIME      ,NTIME      ,
* NAIT        ,OPEN      ,OPTION      ,PMINO      ,STATE      ,
* TANK        ,TAPE      ,TFLUM      ,TIMEI      ,TIMEX      ,
* TANTMG      ,WINT      ,TIMES(10)
COMMON
*/FLUIDP/
* PRES        ,ZFACT      ,QUAL      ,TEMP      ,RHO      ,
* GAM        ,CP        ,VEL      ,ENTR      ,COND      ,
* VIS        ,VCL      ,ENTH
COMMON /MISC/
* PCX        ,PDK        ,PDKV      ,PTUROC      ,PTUROP      ,
* HSPKV      ,HBPW      ,HBPWC      ,HBPWNC      ,
* METLTO      ,MINRLO      ,PASSX      ,SSOUT      ,WPIT      ,
* TTEMP(20)   ,QTEMP(20)   ,DELHN2(200) ,PUMP(350)   ,FILMA(20) ,
* FILMB(20)   ,FILMC(20)   ,TCFLG(20)
COMMON
*/NTS/
* AJB        ,AJE        ,AJF        ,ANF        ,ANF      ,
* BJB        ,BJE        ,BJF        ,BNF        ,BNH      ,
* CJB        ,CJE        ,CJF        ,CNF        ,CNH      ,
* DNT        ,FNT        ,KNTI      ,KNTC      ,NODES      ,
* NOZEFF      ,NTDZ      ,THETA      ,THROAT      ,TNTIM      ,
* VNTI      ,VNTQ
COMMON
*/P/
* ALPHA      ,BETA      ,DIST      ,EPUNC      ,EPUMP      ,
* ETURC      ,ETURP      ,FILMCX      ,GATEP      ,HCPUM      ,
* HSYC      ,HMT      ,NNT      ,NTURC      ,
* NTURP      ,RCORO      ,PCUR      ,PDIL      ,PHEPQ      ,
* PMINOX      ,PNTI      ,PNTQ      ,PPUMOC      ,PPUMOP      ,
* PTANKX      ,PTURIX      ,PTURO      ,QPUMP      ,RFLU      ,
* SAC        ,TCORO      ,TCCROR      ,TCUR      ,TDILX      ,
* THBPQ      ,TIME      ,TIMEP      ,TMETL      ,TNTI      ,
* TINTO      ,TPUMOC      ,TPUMOP      ,TTANKX      ,TTURIX      ,
* T12MIX      ,UIHG      ,WCUR      ,WDILX      ,WHEP      ,
* WNOZ      ,WNTCK      ,WNTI      ,WNTQ      ,WPUNC      ,
* WTURB
COMMON
*/TAB1/
* AJHT(30)   ,ANTC(30)   ,ANTH(30)   ,ANTW(30)   ,CDJ(30)   ,
* CDNT(30)   ,CFWP(30)   ,CG(30)    ,CPJ(30)    ,CPNT(30)   ,
* CRJ(30)    ,CRJNT(30)  ,DEL(30)   ,DEL(30)   ,DEL(30)   ,
* DNOZW(30)  ,GATE(30)   ,GP(30)    ,HGFJ(30)   ,HGFNTC(30) ,
* HGFNTH(30) ,HGCJ(30)   ,HGNTC(30) ,HGNTH(30) ,KPD(30)   ,
* KPDV(30)   ,KV(30)    ,NT(30)    ,PAMB(30)   ,PBD(30)   ,
* PC(30)     ,PINLET(30) ,PLINE(30) ,PRATIO(30) ,PTURMO(30) ,
* QPD(30)    ,RHQJ(30)   ,RHQNT(30) ,RN(30)    ,SJO(30)   ,
* SNOZ(30)   ,SNTC(30)   ,SNTH(30)   ,SNTJ(30)   ,SSPRT(30) ,
* TC(30)     ,TINLET(30) ,TKJ(30)    ,TKNTC(30) ,TKNTH(30) ,
* TUREFF(30) ,VNODES(30) ,WDIL(30)   ,WPUM(30)   ,
* TURIT(30)  ,TURIP(30)  ,HBFLOW(30) ,BEND(30)
COMMON /TAGS/
* BTAG      ,ISAVE      ,IDELZS      ,IEND      ,IM      ,
* JEND      ,JTAG      ,K        ,KEND      ,L      ,
* LEND      ,NTAG      ,NOFIND      ,NTAG      ,PTAG      ,
* XTAG      ,ISAVE      ,MSAVE      ,NOBNT      ,NOCENT      ,
* NZTROT      ,NTCNT      ,NMCMNT      ,NODEPT      ,NPARTS      ,
* JJ        ,KK        ,LL        ,INODE      ,KLOOP      ,
* REF       ,IDELT      ,NTPNTS      ,NODZ      ,NK      ,
* ITAG      ,CTAG      ,CJ
* XSAVE,I,N,II
COMMON /IP/
* ALOWX      ,BATERM      ,BATERS      ,CDMTL      ,CPTERM      ,
* DDELZ      ,DELHN      ,DELHNX      ,DELPN      ,DELPN      ,
* DELTER      ,DHYDRA      ,DPIPE      ,DTERM      ,DZTERM      ,
* ENTROP      ,ETATP      ,GPN        ,HFTERM      ,HFTERM      ,
* HGCOEF      ,HGTOT      ,HPUMI      ,HTCOEF      ,HVTERM      ,
* N12        ,KT        ,KWC        ,KWC        ,KWC        ,
* N12        ,KWH        ,KWHV        ,KWT        ,KWT        ,

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      * K2          * K3          * K4          * K6          * MTERM1
      * MTERM2      * MTERM3      * MTERM4      * NPRN          * NTERM
      * PHI         * PNOZD       * PNITHR      * PRESN         * PRQUES
      * FRFRIM      * PRTERM      * PSTP        * PTANKN        * P6N
      * PCN         * P8PR        * QN           * QPM           * QTERM
      * RMDR        * RMOTKM      * RMOTKM      * RPM2          * SPRIME
      * STERN        * STSTAG      * TFLUSR      * TIMENT        * TIMEN
      * TTANKN      * TTURO       * TVP          * TWTERM        * TIIN
      * T11SR       * T8N         * WATERM      * WDILN         * WDMTERM
      * WERROR      * WETPER      * WHBPN       * WI            * WNCHOK
      * WNT         * WPACTN      * WRTERM      * WTERM         * WTURN
      * MTERM
      COMMON
      *//
      * EOFTAP      * INOTUR      * INTFLO      * LARGET        * LESPO
      * LOOPN       * MCAP        * NEGW        * NONOP         * NONSPD
      * NQNTC       * NONW        * NOTURN      * NOTURN        * NTERR
      * PARONE      * WITER

C
100 NMCNT = 0
   IF (STATE.EG.0.) GO TO 120
C
C   **** COUNTER FOR NO. OF PASSES REQUIRED
C
110 NTCNT = 1000
   GO TO 130
120 NTCNT = 1
130 DELTX = TIMEP
140 HTCNT = 0.
   TJKCUR = TJACK(1)
   TCCUR = TCOLD(1)
   THCUR = THOT(1)
   DO 560 I=1,NODENT
   IF (NTDZ.GT.0.) GO TO 160
C
C   **** VARIABLE NODE LENGTH
C
150 DELZX = VNODES(I+1)-VNODES(I)
   DIST = VNODES(I)+DELZX/2.
   DELZSQ = DELZX**2
   GO TO 180
C
C   **** FIXED NODE LENGTH
C
160 IF (I.GT.1) GO TO 170
   DIST = ZMIN
   DELZSQ = NTDZ**2
   GO TO 180
170 DELZX = NTDZ
   DIST = DIST+DELZX
180 THEDIF = THOT(I+2)+THCUR
   THCUR = THOT(I+1)
C
C   **** TUBE DENSITY
C
   CALL INTP (RHOT,THOT(I+1),RHOK)
C
C   **** TUBE HOT SIDE HEAT TRANSFER AREA
C
   CALL INTP (ANTH,DIST,AFLDXX)
C
C   **** TUBE CP
C
   CALL INTP (CPNT,THOT(I+1),CPX)
C
C   **** TUBE THERMAL CONDUCTIVITY
C
   CALL INTP (CDNT,THOT(I+1),CDNTHX)
C
190 CDNTL = CDNTHX

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C      ****      TUBE HOT SIDE FRACT HEAT GEN
C
C      CALL INTP (HGFNTH,DIST,FNTH)
C      HGCCEF = HGTOT*FNTH
200 IF (STATE.EQ.0.) GO TO 210
C
C      ****      STEADY STATE
C
C      UIHG = HGCCEF*AFLOWX
C      KWT = 1.0
C      GO TO 220
C
C      ****      TRANSIENT
C
210 KWT = RHOX*CPX*AFLOWX/DELTX
C      SAC = (CDMTL*DELTX)/(RHOX*CPX*DELZSG)
C      UIHG = (HGCCEF*DELTX)/(RHOX*CPX)
C
220 MAN3 = HRNCZW(I)*KWT
C      MEN3 = HRNTHW(I)*KWT
C
230 IF (STATE.EQ.0.) GO TO 250
C      THEDIF = THOT(I+1) - THOT(I)
C      THETA1 = 1./MAN3+1./MEN3
C      THETA2 = SAC*THEDIF+TNCZ(I)/MAN3+TTUBE(I)/MEN3+UIHG
C      T3NP1(I+1) = THETA2/THETA1
C
C      SAC = 0.000
C      TDIFM = T3NP1(I+1) - THOT(I+1)
C      IF (TDIFM.LT.1.000) GO TO 300
C      HTCNT = 1.
C      GO TO 300
250 SACPR = (1.-2.*SAC)*MAN3*MEN3-MAN3-MEN3
C
C      ****      TEST FOR STABILITY
C
C      IF (SACPR.GT.0.) GO TO 290
C      NTCNT = 2*NTCNT
C      DELTX = DELTX/2.
C      GO TO 140
290 THETA1 = (SACPR*THOT(I+1))/(MAN3*MEN3)
C      T3NP1(I+1) = THETA1+SAC*THEDIF+TNCZ(I)/MAN3+TTUBE(I)/MEN3+UIHG
C
C      ****      TUBE COLD SIDE FRACT HEAT GEN
C
300 CALL INTP (HGFNTC,DIST,FNTC)
C      HGCCEF = HGTOT*FNTC
C      THEDIF = TCOLD(I+2)+TCCUR
C      TCCUR = TCOLD(I+1)
C
C      ****      TUBE CP
C
C      CALL INTP (CPNT,TCOLD(I+1),CPX)
C
C      ****      TUBE DENSITY
C
C      CALL INTP (RHCNT,TCOLD(I+1),RHOX)
C
C      ****      TUBE COLD SIDE HEAT TRANSFER AREA
C
C      CALL INTP (ANTC,DIST,AFLOWX)
C
C      ****      TUBE THERMAL CONDUCTIVITY
C      CALL INTP (CDNT,TCOLD(I+1),CDNTCX)
320 CDMTL = CDNTCX
C      IF (STATE.EQ.0.) GO TO 330
C
C      ****      STEADY STATE

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      SAC = C.CDG
      UING = HGCDEF*AFLQWX
      KWT = 1.0
      GO TO 340
C
C     ****      TRANSIENT
C
330 KWT= RHOX*CPX*AFLQWX/DELTX
      SAC = (CDELTX*DELTX)/(RHCX*CPX*DELZSG)
      UING = (HGCDEF*DELTX)/(RHOX*CPX)
C
C     ****      TUBE-JACKET CONTACT RESIS
C
340 CALL INTP (CRJNT,DIST,CRJNTX)
C
C     ****      TUBE-JACKET WET PERIMETER
C
      CALL INTF (SNTJ,DIST,WETPER)
C
C     ****      TUBE COLD SIDE THICKNESS
C
      CALL INTP (TKNTC,DIST,TKNTCX)
C
C     ****      JACKET THICKNESS
C
      CALL INTP (TKJ,DIST,TKJX)
C
C     ****      JACKET THERMAL CONDUCTIVITY
C
      CALL INTP (CDJ,TJACK(I+1),CDJX)
350 HRNTJB = (2./CRJNTX + TKNTCX/CDNTCX + TKJX/CDJX) / (2.*WETPER)
      MDN2 = HRNTJB*KWT
      MBN2 = HRNTC(I)*KWT
C
360 IF (STATE.EQ.0.) GO TO 370
      THEDIF = THEDIF-2.*TCOLD(I+1)
      THETA1 = 1./MDN2+1./MBN2
      THETA2 = SAC*THEDIF+TJACK(I+1)/MDN2+TTUBE(I)/MBN2+UING
      T2NP1(I+1) = THETA2/THETA1
C
      TDIFM = T2NP1(I+1)-TCOLD(I+1)
      IF (TDIFM.LT.1.0D0) GO TO 400
      HTCNT = 1.
      GO TO 400
370 SACPR = (1.-2.*SAC)*MDN2*MBN2-MDN2-MBN2
C
C     ****      TEST FOR STABILITY
C
      IF (SACPR.GT.0.) GO TO 380
      NTCNT = 2*NTCNT
      DELTX = DELTX/2.
      GO TO 140
380 THETA1 = (SACPR+TCOLD(I+1))/(MDN2*MBN2)
      T2NP1(I+1) = THETA1+SAC*THEDIF+TJACK(I+1)/MDN2+TTUBE(I)/MBN2+UING
C
C     ****      JACKET FRACT OF HEAT GEN
C
400 CALL INTP (HGFJ,DIST,FJ)
      HFCDEF = HGTOT*FJ
      THEDIF = TJACK(I+2)+TJKCUR
      TJKCUR = TJACK(I+1)
C
C     ****      JACKET CP
C
      CALL INTP (CPJ,TJACK(I+1),CPX)
C
C     ****      JACKET DENSITY
C
      CALL INTP (RHOJ,TJACK(I+1),RHOX)

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C      ****      JACKET HEAT TRANSFER AREA
C
C      CALL INTP (AJHT,DIST,AFLCWX)
410  CDMTL = CDJX
      IF (STATE.EQ.0.) GO TO 420
C
C      ****      STEADY STATE
C
C      SAC = 0.000
      UIHG = HGCDEF*AFLCWX
      KWT = 1.
      GC TO 430
C
C      ****      TRANSIENT
C
420  KWT = RHOX*CPX*AFLCWX/DELTX
      SAC = (CDMTL*DELTX)/(RHOX*CPX*DELZSQ)
      UIHG = (HGCDEF*DELTX)/(RHOX*CPX)
C
C      ****      JACKET OUTSIDE CONTACT RESIS
C
430  CALL INTP (CRJ,DIST,CRJX)
C
C      ****      JACKET OUTSIDE WET PERIMETER
C
      CALL INTP (SJC,DIST,SJCX)
440  HRCJ = TKJX / (2.*CDJX*WETPER) + 1./(CRJX*SJCX)
      MCN1 = HRCJ*KWT
      MDN1 = HRN1JW*KWT
C
C
450  IF (STATE.EQ.0.) GO TO 460
      THEDIF = THEDIF-2.*TJACK(I+1)
      THETA1 = 1./MCN1+1./MDN1
      THETA2 = SAC*THEDIF+TAMBX/MCN1+TCCUR/MDN1+UIHG
      TINP1(I+1) = THETA2/THETA1
      TDIFM = TINP1(I+1)-TJACK(I+1)
      IF (TDIFM.LT.1.000) GO TO 490
      HTCNT = 1.
      GO TO 450
460  SACPR = (1.-2.*SAC)*MCN1*MDN1-MCN1-MDN1
C
C      ****      TEST FOR STABILITY
C
      IF (SACPR.GT.0.) GO TO 470
      NTCNT = 2*HTCNT
      DELTX = DELTX/2.
      GO TO 140
470  THETA1 = (SACPR+TJACK(I+1))/(MCN1*MDN1)
      TINP1(I+1) = THETA1+SAC*THEDIF+TAMBX/MCN1+TCCUR/MDN1+UIHG
C
C      ****      NOZZLE WET PERIMETER
C
480  CALL INTP (SNOZ,DIST,SNOZX)
C
C      ****      TUBE HOT SIDE WET PERIMETER
C
      CALL INTP (SNTH,DIST,SNTHX)
C
C      ****      TUBE COLD SIDE WET PERIMETER
C
      CALL INTP (SNTC,DIST,SNTCX)
490  TNTCD1 = FILMTC(I)*SNTCX*HRNTCW(I)
      TNTCD(I+1) = (TCOLD(I+1)-TTUBE(I))/TNTCD1+TTUBE(I)
      TNTHT1 = FILMTH(I)*SNTHX*HRNTHW(I)
      TNTHT(I+1) = (THOT(I+1)-TTUBE(I))/TNTHT1+TTUBE(I)
      TNTNZ1 = FILMNZ(I)*SNOZX*HRNOZW(I)
      INCZN(I+1) = (THOT(I+1)-TNOZ(I))/TNTNZ1+TNOZ(I)
      IF (THETA.EQ.0.) GO TO 560

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C      ****      ADDITIONAL METAL TEMPS
C
55C  TJKWL(I+1) = (TJKCUR-TAMEX)/(CRJX*5JCX*HRQJ)+TAMEX
      TJKWD1 = (2.*CDJX)/(CRJTX*TKJX)+(TKNTCX*CDJX)/(CDNTCX*TKJX)+1.
      TJKTWD(I+1) = (TCCUR-TJKCUR)/TJKWD1+TJKCUR
      TNTWD1 = (2.*CDNTCX)/(CRJNTX*TKNTCX)+(CDNTCX*TKJX)/(TKNTCX*CDJX)+1.
      TNTJWD(I+1) = (TJKCUR-TCCUR)/TNTWD1+TCCUR
56C  CONTINUE
C
C      ****      TRANSFER METAL TEMPS FROM TEMPORARY TO PERMANENT STOR
C
      M = NODENT+1
      DO 57C II=2,M
      T JACK(II) = T1NP1(II)
      TCOLD(II) = T2NP1(II)
      THOT(II) = T3NP1(II)
57C  CONTINUE
C
C      ****      INTERPOLATION FOR TAELE END POINT VALUES
C
      TJACK(1) = 2.*TJACK(2)-TJACK(3)
      TJACK(NODENT+2) = 2.*TJACK(NODENT+1)-TJACK(NODENT)
      TCOLD(1) = 2.*TCOLD(2)-TCOLD(3)
      TCOLD(NODENT+2) = 2.*TCOLD(NODENT+1)-TCOLD(NODENT)
      THOT(1) = 2.*THOT(2)-THOT(3)
      THOT(NODENT+2) = 2.*THOT(NODENT+1)-THOT(NODENT)
      TNCZW(1) = 2.*TNCZW(2)-TNCZW(3)
      TNCZW(NODENT+2) = 2.*TNCZW(NODENT+1)-TNCZW(NODENT)
      TNTHOT(1) = 2.*TNTHOT(2)-TNTHOT(3)
      TNTHOT(NODENT+2) = 2.*TNTHOT(NODENT+1)-TNTHOT(NODENT)
      TNTCLD(1) = 2.*TNTCLD(2)-TNTCLD(3)
      TNTCLD(NODENT+2) = 2.*TNTCLD(NODENT+1)-TNTCLD(NODENT)
60C  NMCNT=NMCNT+1
      IF (STATE.EQ.C.) GO TO 610
      IF (HTCNT.EQ.C.) GO TO 620
61C  IF (NMCNT.NE.NTCNT) GO TO 140
62C  CCNTINUE
      RETURN
      END

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SUBROUTINE TUBES
IMPLICIT REAL*8 (A-Z)
INTEGER*4
* CTAG      ,I      ,IDELZS      ,IEND      ,IM(5)      ,
* J          ,JEND      ,K          ,KENC(5)    ,L          ,
* LEND      ,MTAG(30)  ,NOFIND     ,NTAG        ,PTAG        ,
* XTAG(5,5) ,II        ,M          ,NOBNT       ,NOCENT      ,
* NZTRCT     ,NTCNT     ,NMCNT      ,NODEPT     ,NPARTS     ,
* JJ         ,KK        ,LL        ,INGDE      ,KLOOP       ,
* REF        ,IDELT     ,NTFNTS    ,NODZ       ,NK          ,
* TTAG       ,CTAG      ,CJ(20)    ,REFR        ,
* NOBSK,NOBSK,SMCNT,STAG
COMMON /ADD/
* ARG        ,ARG1      ,ARG2      ,ATURNP     ,BUF(10)    ,
* CARDS(11)  ,DELTAP    ,DTURX     ,GASVEL     ,HCORO      ,
*          ,HFCDEF     ,HPIN      ,HPOUT      ,HTANKM     ,
* HTURIX     ,KVSQRT    ,MACH      ,NBEND      ,PPOUT      ,
* PTROT      ,PTURPR    ,PREDFL    ,PVAPOR     ,PTXST      ,
* PFLOW      ,PTXMIN    ,PUMPH     ,RF          ,RNTRT     ,
*          ,RATIO      ,RATIOC     ,SPEED       ,TTRT      ,
* TEMPY      ,TMX       ,TJKWD1    ,TNTNZ1     ,TNTH1      ,
* TPCLT      ,TPIN      ,TTXMIN    ,TTXMIN     ,TMIX       ,
* UNCHGK     ,          ,FILMNT     ,QPUMI      ,
* TINP1(30)  ,T2NP1(30) ,T3NP1(30) ,SAVN(15)   ,SAVNT(20)  ,
* SAVFX(20,8),SAVPT(20,18),SAVJ(30,27) ,SAVIJ(30,20,9)
COMMON
*/AT/
* ANCZTX     ,CDJX      ,CDNTCX     ,CDNTHX     ,CPX          ,
* CRJNTX     ,CRJX      ,DELH       ,DELP1      ,DELPK      ,
* DELPQ      ,DELRHO    ,DELTX      ,DELM       ,DELZSQ     ,
* DELZX      ,DELZX4    ,HGCJKT     ,HGCNTC     ,HGCNTH     ,
* KI         ,HJ        ,HK        ,HL         ,HLPRI      ,
* FRNTJW     ,HROJ      ,MIN        ,M2N        ,PIN        ,
* PJ         ,PK        ,PL        ,PLPRIM     ,RFLUX      ,
* RHCMI      ,RHGMUX    ,RHOX       ,RHONIX     ,RHONOX     ,
* RHCX       ,SJOX      ,SNOZX     ,SNTCX      ,SNTHX      ,
* TAMBX      ,TCCUR     ,THCUR      ,THECIF     ,TJKCUR     ,
* IMJX       ,TKNTCX    ,TKNTHX     ,WNOGEN     ,WNODI      ,
* ZMAX       ,ZMIN      ,ZTRT      ,
COMMON /AZ10/
* FILMNZ(30) ,FILMTC(30) ,FILMTH(30) ,HRNGZW(30) ,HRNTCW(30) ,
* HRNTHW(30) ,PNGZ(30)  ,PTUBE(30) ,RHONTM(30) ,RHONTN(30) ,
* RHCNZM(30) ,RHONZN(30) ,TCOLD(30) ,THCT(30)  ,TJACK(30)  ,
* TJKTD(30)  ,TJKWD(30) ,TNGZ(30)  ,TNGZW(30) ,TNTCLD(30) ,
* TNTHOT(30) ,TNTJWD(30) ,TTUBE(30) ,WNOZM(30) ,WNCZN(30) ,
* WNTM(30)   ,WNTN(30)
COMMON
*/CONS/
* G          ,JAY       ,PI        ,R          ,RAD        ,
* RB
COMMON /EXTRA/
* FUMIP      ,QPUM      ,TCX       ,TNKRHO     ,TPT2        ,
* TPCK       ,TPQ       ,TPK2      ,TPKPD      ,TPWH       ,
* KPUMPI     ,WBEAR     ,HBEAR     ,WPUMPC     ,PMIX        ,
* ATURNZ     ,ATURN     ,ATUR      ,AROLNZ     ,TAVE        ,
* PAVG       ,WPMAX     ,DTURBL    ,PPIN       ,PTOOLQ     ,
* CR         ,TTURIP    ,GANTI     ,GAMMA      ,KVLMIN     ,
* HDILX      ,CPTI      ,TURWK     ,TTXST      ,TPNW       ,
* KIPMIN     ,WPCNT     ,PCARD     ,RHOM       ,DELPT      ,
* IPWRK      ,TIMER     ,ZM1       ,DELTPT     ,DELZT      ,
* DELZP      ,ZM        ,TK        ,RFN       ,Q          ,
* HLPMP      ,HLPMP     ,RNDIST    ,WNNIT      ,NTCNT      ,
* TROTZ      ,WNCB      ,WNCF1     ,MAN3       ,MEN3       ,
* TCMQ       ,THETA1    ,THETA2    ,FNTC       ,MDN2       ,
* FNTM       ,TDIFM     ,SACPR     ,MDN1       ,TNTCD1     ,
* TNTWD1     ,FJ        ,MCN1      ,METLTN     ,TPTAV      ,
* MBN2       ,ETAP      ,TPT20     ,OZ         ,TEMPTM(30) ,
* TIMEZ      ,DUM       ,OMAX
* $10

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COMMON
*/FLAG/
* EAPFL      .HBPFG      .MASS      .MTIME      .NTIME      .
* NMT        .OPEN      .OPTION      .PMIND      .STATE      .
* TANK       .TAPE      .TFLUM      .TIMEI      .TIMEX      .
* TNETNG     .WINT      .TIMES(10)
COMMON
*/FLUIDP/
* PRES      .ZFACT      .QUAL      .TEMP      .RHO      .
* GAM      .CP      .VEL      .ENTR      .COND      .
* VIS      .VOL      .ENTH      .ENTHO(30) .HKPR      .PHINT(30) .
COMMON /NTNZ/ CPDP      .ENTHO(30) .PTCX      .QCLDNT(30) .QHOTNT(30) .
* PHINZ(30) .PKPR      .TCLOC      .TTC
COMMON
*/NTS/
* AJB      .AJE      .AJF      .ANF      .ANH      .
* BJB      .BJE      .BJF      .BNF      .BNH      .
* CJB      .CJE      .CJF      .CNF      .CNH      .
* DNT      .FNT      .KNTI      .KNTC      .NOCES      .
* NOZEFF      .NTDZ      .THETA      .THROAT      .TNTIM      .
* VNTI      .VNTD
COMMON /OPC/ FFTAB(4,30) .HFTAB(5,30) .OPT(30)
COMMON
*/P/
* ALPHA      .BETA      .DIST      .EPUMC      .EPUMP      .
* ETURC      .FILMCX      .GATEP      .HDPUM      .
* HSVC      .HSVP      .NHT      .NHTURC      .
* NTLRP      .PCDRD      .PCUR      .PDIL      .PHEPO      .
* PMINOX      .PNTI      .PNTB      .PPUMOC      .PPUMOP      .
* PTANEX      .PTUBIX      .PTURD      .QPUMP      .RFLU      .
* SAC      .TCORD      .TCUR      .TCLX      .
* THEPO      .TIME      .TIMEP      .TNETL      .TNTI      .
* TNO      .TPUMOC      .TPUMOP      .TTANKX      .TTURIX      .
* T12MIX      .UIHG      .WCUR      .WDILX      .WHEP      .
* WNGZ      .WNTCK      .WNTI      .WNTC      .WPUMC      .
* WPLMP      .WTURB
COMMON
*/TABI/
* AJNT(30) .ANTC(30) .ANTH(30) .ANTW(30) .CDJ(30) .
* CDNT(30) .CFWP(30) .CG(30) .CPJ(30) .CPNT(30) .
* CRJ(30) .CRJNT(30) .DEL(30) .DELFNT(30) .DELPNZ(30) .
* DNCZW(30) .GATE(30) .GP(30) .HGFJ(30) .HGFNTC(30) .
* HGFNTH(30) .HGJ(30) .HGNTC(30) .HGNTH(30) .KPC(30) .
* KPDV(30) .KV(30) .NT(30) .PANE(30) .PBD(30) .
* PC(30) .PINLET(30) .PLINE(30) .PRATIO(30) .PTURMO(30) .
* QPD(30) .RHQJ(30) .RHQNT(30) .RN(30) .SJO(30) .
* SNOZ(30) .SNTC(30) .SNTH(30) .SNTJ(30) .SSPRT(30) .
* TC(30) .TINLET(30) .TKJ(30) .TKNTC(30) .TKNTH(30) .
* TUREFF(30) .VNODES(30) .WDIL(30) .WPUM(30) .
* TURIT(30) .TURIP(30) .HBFLOW(30) .BEND(30)
COMMON
*/TAGS/
* DIAG      .I      .IDELZS      .IEND      .IM      .
* J      .JEND      .K      .KEND      .L      .
* LEND      .MTAG      .NOFIND      .NTAG      .PTAG      .
* XTAG      .M      .NGBNT      .NOBNT      .NODENT      .
* NZTRCT      .NTCNT      .NMCMNT      .NODEPT      .NPARTS      .
* JJ      .KK      .LL      .INGCE      .KLOOP      .
* REF      .IDELT      .NTPNTS      .NODZ      .NK      .
* TTAG      .CTAG      .CJ      .REFR
* NOBSK, NODESK, SMCNT, STAG
COMMON
*/TP/
* AFLOWX      .BATERM      .BATERS      .CDMTL      .CPTERM      .
* DELZ      .DELHN      .DELHNX      .DELPN      .
* DELTER      .DHYDRA      .DPIPE      .DTERM      .
* ENTROP      .ETAT      .GPN      .HFTERM      .
* HGCUEF      .HGTCT      .HPUNI      .HTCOEF      .HVTERM      .
* H12      .KT      .KVN      .KWC      .KWCP      .

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* KWCV	,KWH	,KWHV	,KWT	,K1	.
* K2	,K3	,K4	,K6	,MTERM1	.
* MTERM2	,MTERM3	,MTERM4	,NPRN	,NTERM	.
* PHI	,PNOZU	,PNTTHR	,PRESM	,PRGUES	.
* PPRIM	,PRTERM	,PSTP	,PTANKN	,P6N	.
* P6N	,P8PR	,QN	,QPM	,QTERM	.
* RHOR	,RHOTKM	,RHCTKN	,RPM2	,SPRIME	.
* STERM	,STSTAG	,TFLUSR	,TIMEMT	,TIMEN	.
* TTANKN	,TTURO	,TVP	,TWTERM	,T11N	.
* T11SR	,T8N	,WATERM	,WDILN	,WLTERM	.
* WEKRR	,WEIPEK	,WHBPN	,WI	,WNCHOK	.
* WNT	,WPACTN	,WRTERM	,WTEKM	,WTURN	.
* WTERM	,ZTUBE				.
* /X/					.
* EGFTAP	,INDTUR	,INTFLC	,LARGET	,LESPO	.
* LOGPN	,MCAPI	,NEGW	,NGNGP	,NONSPD	.
* NCNTC	,NCNW	,NOTURN	,NGTURN	,NTERR	.
* FARONE	,WITER				.

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C      PNTI = PCLR
      INII = TCUR
      WNTI = WCUR
100 CALL PT(PCUR,TCUR)
      RHONIX = RHC
C
C      ****      TEST FOR MASS CAPACITANCE FLAG
C
120 IF (MCAPI.EQ.1.) GO TO 130
      WNOI = WCUR
      GO TO 140
130 WNOI = WCUR + (RHONIX-RHC)*WNTI/TIMEP
140 WNTI(1) = WNOI
      IF (WNOI.LT.0.) GO TO 510
C
C      ****      PRESSURE DROP ACROSS INLET PLENUM
C
150 DELPI = (KNTI*WCUR**2)/(2.*12.*G*RHC)
      PJ = PCUR-DELPI
      PIN = PJ
      IF (PJ.LT.0.) GO TO 520
160 CALL PT(PJ,TCUR)
      HJ = ENTH
      HI = ENTH
      DO 400 I=1,NODENT
      IF (NTDZ.GT.0.) GO TO 180
C
C      ****      VARIABLE NODE LENGTH
C
170 DELZX = VNODES(I+1)-VNODES(I)
      DIST = VNODES(I)+DELZX/2.
      GO TO 200
C
C      ****      FIXED NODE LENGTH
C
180 IF (1.GT.1) GO TO 190
      DIST = ZMIN
      DELZX = NTDZ
      GO TO 200
190 DELZX = NTDZ
      DIST = DIST+DELZX
C
C      ****      TUBE FLOW AREA
C
200 CALL INTP (ANTW,DIST,AFLOWX)
C
C      ****      TUBE HOT SIDE NET PERIMETER
C
      CALL INTP (SNTH,DIST,SNTHX)
C
C      ****      TUBE COLD SIDE NET PERIMETER

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C      CALL INTF (SNTC,DIST,SNTCX)
C      SNCZX = SNTX+SNTCX
C      ****      COLD FLOW WET PERIMETER
C      CALL INTP (CFWP,DIST,WETPER)
C      210 DHYDRA = (4.*AFLOWX)/WETPER
C      ****      TUBE THERMAL CONDUCTIVITY
C      CALL INTP (CDNT,TCOLD(I+1),CDNTCX)
C      CALL INTP (CDNT,THOT(I+1),CDNTX)
C      ****      TUBE COLD SIDE THICKNESS
C      CALL INTP (TKNTC,DIST,TKNTCX)
C      ****      TUBE HOT SIDE THICKNESS
C      CALL INTP (TKNTH,DIST,TKNTHX)
C      220 RHOM = RHCNTM(I)
C      HL = HJ
C      PL = PJ+2.-FIN
C      HK = (HL+HJ)/2.
C      ENTHO (I) = (H1 + HJ)/2.
C      PK = (PJ+PL)/2.
C      PCUR = PK
C      230 IF (PCUR.LT.0.) GO TO 520
C      240 CALL PH (PK,HK)
C      TCUR = TEMP
C      RHODP = RHG
C      CPDP = CP
C      DELRHG = GMD-RHOM
C      ****      TEST FOR MASS CAPACITANCE FLAG
C      IF (MCAP.EQ.1.) GO TO 250
C      WNODEN = WNDI
C      GO TO 260
C      250 WNODEN = WNDI-DELZX*AFLOWX*DELRHG/TIMEP
C      260 WCUR = (WNODEN+WNDI)/2.
C      IF (WCUR.LT.0.) GO TO 510
C      CALL INTP (DEL,DIST,SIG)
C      ****      SUBROUTINE FOR FILM COEFFICIENT
C      CALL HF (OPT(21),WCUR,PCUR,TCUR,HK,TNTCLD(I+1),WETPER,SIG,AFLOWX,
C      *FILMTC(I))
C      HRNTHC(I) = (TKNTCX/(2.*CDNTCX)+1./FILMTC(I))/SNTCX
C      ****      SUBROUTINE FOR FILM COEFFICIENT
C      CALL HF (OPT(22),WCUR,PCUR,TCUR,HK,TNTHOT(I+1),WETPER,SIG,AFLOWX,
C      *FILMTH(I))
C      HRNTHH(I) = (TKNTHX/(2.*CDNTHX)+1./FILMTH(I))/SNTX
C      320 HLPFH = (THOT(I+1)-TCUR)/HRNTHH(I)
C      HLPCH = (TCOLD(I+1)-TCUR)/HRNTHC(I)
C      330 HLPRIH = ((HLPFH+HLPCH)*DELZX+WNDI*HJ)/WNODEN
C      HL = HLPRIH
C      DELH = HL-HJ
C      ****      SUBROUTINE FOR FRICTION FACTOR
C      CALL FF (OPT(22),WCUR,PCUR,TCUR,HK,TNTHOT(I+1),WETPER,PHI)
C      PHINT (I) = PHI

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      DELZP = DELZX
      IF (NCBNT.EQ.0) GO TO 291
      ZM = DIST-DELZX/2.
      ZM1 = DIST+DELZX/2.
C
C      ****      TEST FOR BEND IN NODE
C
280 DO 290 K=1,NOBNT
      IF (BEND(2*K).LE.ZM) GO TO 290
      IF (BEND(2*K).GT.ZM1) GO TO 290
C
C      ****      ADDITIONAL PRESSURE DROP DUE TO BEND TABLE
C
      DELZP = DELZP+BEND(2*K-1)
290 CONTINUE
291 DELPT = DELH/(TCUR*CPDP)+DELZP*4.*PHI/DHYDRA
      DELPMT = DELPT/(2.*12.*G*RHODP*AFLOWX**2)
300 DELPM = DELPMT*WCUR**2
      PLPRIM = FJ-DELPMT
      IF (PLPRIM.LT.0.) GO TO 520
      PL = PLPRIM
      PKPR = (PJ+PL)/2.
      HKPR = (HJ+HL)/2.
360 CALL PH (PKPR,HKPR)
      ARG1 = TCUR
      CALL ITER (13,TCUR,ARG1,TEMP,6245)
365 QHCTNT (I) = DELZX / HRNTHW(I) * (THOT(I+1) - TCUR)
      QCLDNT (I) = DELZX / HRNTCW(I) * (TCOLD(I+1) - TCUR)
C
C      ****      INITIALIZE FOR NEXT NODE
C
370 RHOMTN(I) = RHO
      WNODI = WNODEN
      WNTN(I+1) = WNODEN
      TTUBE(I) = TCUR
      PTUBE(I) = PKPR
380 HI = HJ
      HJ = HL
      PJ = RJ
      RJ = PL
400 CONTINUE
C      ****      TUBE OUTLET CONDITIONS
C
      CALL PH (PL,HL)
      TCUR = TEMP
410 DELPO = (KNID*WNODI**2)/(RHO*2.*12.*G)
      PCUR = PL-DELPO
      IF (PCUR.LT.0.) GO TO 520
420 CALL PT(PCUR,TCUR)
      RHONOX = RHO
C
C      ****      TEST FOR MASS CAPACITANCE FLAG
C
      IF (MCAP.EQ.1.) GO TO 440
      WNOI = WNOI
      GO TO 500
440 WNOI = WNOI + (RHONOX-RHONOX)*VNTQ/TIMEP
C
C      ****      NORMAL RETURN TO MAIN PROGRAM
C
500 PNTQ = PCUR
      TMTQ = TCUR
      WNTQ = WNOI
      RETURN
C
C      ****      NEGATIVE FLOW RETURN TO MAIN PROGRAM
C
510 CALL MCFLCW
C
C      ****      NEGATIVE PRESSURE RETURN TO MAIN PROGRAM

```

A
B
CF
G
H
I
JK
N

S

SUBROUTINE TUBES

DATE = 18SEP67

PAGE 01

C
520 CALL MCPRES
STOP
END

```

SUBROUTINE TUBEZ
IMPLICIT REAL*8 (A-Z)
INTEGER*4
* DTAG      ,I      ,IDELZS      ,IEND      ,IM(5)      ,
* J          ,JEND      ,K          ,KEND(5)      ,L          ,
* LEND      ,MTAG(30)  ,NOFIND      ,NTAG      ,PTAG      ,
* XTAG(5,5) ,II       ,M          ,NOBNT      ,NODENT      ,
* NZTRQT    ,NTCNT      ,NMCNT      ,NODEPT      ,NPARTS      ,
* JJ        ,KK        ,LL        ,INODE      ,KLOOP      ,
* REF       ,IDELT      ,NTPNTS      ,NODZ      ,NK          ,
* TTAG      ,CTAG      ,CJ(20)     ,REFR      ,
COMMON /ADD/
* ARG        ,ARG1      ,ARG2      ,ATURNP      ,BUF(10)      ,
* CARDS(11)  ,DELTA      ,DTURX      ,GASVEL      ,HCORO      ,
*          ,HFCDEF      ,HPIN      ,HPOUT      ,HTANKN      ,
* HTURIX      ,KVSQRT      ,MACH      ,NBEND      ,PPOUT      ,
* PZOT      ,PTURPR      ,PREDFL      ,PVAPOR      ,PTXST      ,
* PFLOW      ,PTXMIN      ,PUMPH      ,RF          ,RNTROT      ,
*          ,RATIO      ,RATIOC      ,SPEED      ,TTROT      ,
* TEMPY      ,TMX       ,TJKWD1     ,TNTNZ1      ,TNTHT1      ,
* TPCUT      ,TPIN      ,TTXMIN      ,TMIX       ,TPUMI      ,
* UNCHK      ,T2NP1(30) ,T3NP1(30) ,TNTN1(30) ,TNTHT1      ,
* TNP1(30)   ,TNP1(30) ,TNP1(30) ,TNP1(30) ,TNP1(30) ,
* SAVFX(20,8) ,SAVPT(20,18) ,SAVJ(30,27) ,SAVIJ(30,20,9)
COMMON
*/AT/
* ANZTX      ,CDJX      ,CDNTCX      ,CDNTHX      ,CPX          ,
* CRJTX      ,CRJX      ,DELH      ,DELPI      ,DELPK      ,
* DELPO      ,DELPHG      ,DELTX      ,DELW      ,DELZSQ      ,
* DELZX      ,DELZX4      ,HGCJKT      ,HGCNTC      ,HGCNTH      ,
* HI         ,HJ         ,HK         ,HL         ,HLPRI      ,
* HRNTJW      ,HROJ      ,HIN       ,H2N       ,PIN        ,
* PJ         ,PK         ,PL         ,PLPRIM      ,RFLUX      ,
* RHCMI      ,RHOMOX      ,RHCMI      ,RHONIX      ,RHCNOX      ,
* RHCX       ,SJOX      ,SNQZX      ,SNTCX       ,SNTHX      ,
* TAMBX      ,TCCUR      ,THCUR      ,THEDIF      ,TJKCUR      ,
* TKJX       ,TKNTCX      ,TKNTHX      ,WNOEN      ,WNOCI      ,
* ZMAX       ,ZMIN      ,ZTRQT      ,
COMMON /AZ10/
* FILMNZ(30) ,FILMTC(30) ,FILMTH(30) ,HRNOZW(30) ,HRNTCW(30) ,
* HRNTHW(30) ,PNOZ(30)   ,PTUBE(30)  ,RHONTM(30) ,RHONTN(30) ,
* RHCNZM(30) ,RHOMZN(30) ,TCOLD(30)  ,THOT(30)   ,TJACK(30) ,
* TJKTWD(30) ,TJKWD(30)  ,TNOZ(30)   ,TNOZW(30)  ,TNTCLD(30) ,
* TINTHOT(30) ,TINTJWD(30) ,TTUBE(30) ,WNOZM(30)  ,WNOZN(30) ,
* WNTM(30)   ,WNTN(30)
COMMON
*/CONS/
* G          ,JAY       ,PI        ,R          ,RAD        ,
* RB
COMMON /EXTRA/
* FUMIP      ,QPUM      ,TCX       ,TNKRHO      ,TPT2       ,
* TPCR      ,TPQ       ,TPK2      ,TPKPD      ,TPWH       ,
* KPUMPI      ,WBEAR      ,HBEAR      ,WPUMPC      ,
* ATURNZ      ,ATURN      ,ATUR      ,ABOUNZ      ,PMIX       ,
* PAVG       ,WPMAX      ,DTURBL      ,PPIN       ,TAVE       ,
* CR         ,TTURIP      ,GANT1      ,GAMMA      ,PTOOL      ,
* HDILX      ,CPTI      ,TURWK      ,TIXST      ,KVLMIN      ,
* KTPMIN      ,WPCNT      ,PCARD      ,TCTMP      ,TPNW       ,
* TPRK       ,TIMER      ,RHOM      ,RHO        ,
* DELZP      ,ZM        ,DELPT      ,DELPMT      ,
* HLPHF      ,HLPCHF      ,TK        ,DTROT      ,DELZT      ,
* TROTZ      ,WNCF      ,RNDIST      ,RFN        ,Q          ,
* TCHOK      ,WNCF1      ,WNCF1      ,WMNIT      ,HTCNT      ,
* FNTH       ,THETA1     ,THETA2     ,MAN3       ,MEN3       ,
* TINTWD1     ,TDFM      ,SAGPR      ,FNTC       ,MDN2       ,
* MBN2       ,FJ        ,MCN1       ,MDN1       ,TNTCD1      ,
* TIMEZ      ,ETAP      ,TPT2D      ,METLTN      ,TPTAV      ,
* PTUROM      ,DUM       ,OMAX      ,OZ        ,TEMPTM(30)
COMMON
*/FLAG/

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* ETAPFL	.HBPFG	.MASS	.MTIME	.NTIME	.	C
* NAIT	.OPEN	.OPTION	.PMIND	.STATE	.	D
* TANK	.TAPE	.TFLUM	.TIMEI	.TIMEX	.	E
* TMETMG	.WINT	.TIMES(10)				F
COMMON						
* /FLUIDP/						
* PRES	.ZFAC	.QUAL	.TEMP	.RHO	.	
* GAM	.CP	.VEL	.ENTR	.COND	.	
* VIS	.VCL	.ENTH				
COMMON						
* /GLES/						C
* PCTCE	.PTANK	.PTUROE	.PUMHDE	.PUMOG	.	H
* PUMWKE	.TDIL	.TTANK	.TMETI	.TURSPD	.	I
* WDILE	.WDILG	.WHBPG	.WNTE	.WORKE	.	J
* WPUMPG						K
COMMON						
* /NIS/						F
* AJB	.AJE	.AJF	.ANF	.ANF	.	A
* BJB	.BJE	.BJF	.BNF	.BNF	.	B
* CJB	.CJE	.CJF	.CNF	.CNF	.	C
* DNT	.FNT	.KNTI	.KNTD	.NODES	.	
* NGZEFF	.NTDZ	.THETA	.THROAT	.TNTIN	.	E
* VNTI	.VNTG					F
COMMON						
* /P/						
* ALPHA	.BETA	.DIST	.EPUMC	.EPUMP	.	
* ETURC	.ETURP	.FILMCX	.GATEP	.HDPUM	.	
* HSYC	.HSVP	.MHT	.NHT	.NTURC	.	
* NTURP	.PCORO	.PCUR	.PDIL	.PHBPO	.	
* PMINOX	.PNTI	.PNTD	.PPUMOC	.PPUMOP	.	
* PTANKX	.PTURIX	.PTURO	.QPUMP	.RFLU	.	
* SAC	.TCORO	.TCOROR	.ICUR	.TDILX	.	
* THEPO	.TIME	.TIMEP	.TMETL	.TNTI	.	
* INTO	.TPUMOC	.TPUMOP	.TTANKX	.ITURIX	.	
* T12MIX	.UIHG	.WCUR	.WDILX	.WHEP	.	
* WNCZ	.WNTCK	.WNTI	.WNTG	.WPUMC	.	
* WPUMP	.WTURB					
COMMON						
* /TABI/						
* AJHT(30)	.ANTC(30)	.ANTH(30)	.ANTW(30)	.CDJ(30)	.	
* CDNT(30)	.CFWP(30)	.CG(30)	.CPJ(30)	.CPNT(30)	.	
* CRJ(30)	.CRJNT(30)	.DEL(30)	.DELPNT(30)	.DELPNZ(30)	.	
* DNGZW(30)	.GATE(30)	.GP(30)	.HGFJ(30)	.HGFTTC(30)	.	
* HGFNTH(30)	.HGJ(30)	.HGNTC(30)	.HGNTH(30)	.KPD(30)	.	
* KPDV(30)	.KV(30)	.NT(30)	.PAMB(30)	.PBD(30)	.	
* PC(30)	.PINLET(30)	.PLINE(30)	.PRATIO(30)	.PTURMD(30)	.	
* QPD(30)	.RHQJ(30)	.RHQNT(30)	.RN(30)	.SJO(30)	.	
* SNOZ(30)	.SNTC(30)	.SNTH(30)	.SNTJ(30)	.SSPRT(30)	.	
* TC(30)	.TINLET(30)	.TKJ(30)	.TKNTC(30)	.TKNTH(30)	.	
* TUREFF(30)	.VNODES(30)	.WDIL(30)	.WPUM(30)		.	
* TURIT(30)	.TURIP(30)	.HBFLOW(30)	.BEND(30)		.	
COMMON						
* /TAGS/						
* DTAG	.I	.IDELZS	.IEND	.IM	.	
* J	.JEND	.K	.KEND	.L	.	
* LEND	.MTAG	.NOFIND	.NTAG	.PTAG	.	
* XTAG	.II	.M	.NOBNT	.NOCENT	.	
* NZTRGT	.NTCNT	.NM CNT	.NODEPT	.NPARTS	.	
* JJ	.KK	.LL	.INODE	.KLOOP	.	
* REF	.IDELT	.NTPNTS	.NODZ	.NK	.	
* TAG	.CTAG	.CJ	.REFR		.	
COMMON /TP/						
* AFLOWX	.BATERM	.BATERS	.CDMTL	.CPTERM	.	
* DELZ	.DELHN	.DELHN	.DELHNX	.DELPN	.	
* DELTER	.DHYDRA	.DPIPE	.DTERM	.DZTERM	.	
* ENTROP	.ETAT	.ETATP	.GPN	.HFTERM	.	
* HGCOEF	.HGTCT	.HPUMI	.HTCOEF	.HVTTERM	.	
* H12	.KT	.KVN	.KWC	.KWCP	.	
* KWCV	.KWH	.KWHV	.KWT	.K1	.	
* K2	.K3	.K4	.K6	.MTERM1	.	


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* MTERM2      * MTERM3      * MTERM4      * NBRN      * NTERM      *
* PHI         * PNOZC       * PNTTHR      * PRESN      * PRGUES      *
* PRPRIM      * PRTERM      * PSTP        * PTANKN     * P6N         *
* PEN         * P8PR        * QN          * QPM        * QTERM       *
* RHOR        * RHOTKM      * RHCTKN     * RPM2       * SPRIME      *
* STERM       * SISTAG      * TFLUSR     * TIMET      * TIMEN       *
* TTANKN      * TTURO       * TVP        * TWTERM     * T1IN       *
* T1ISR       * T8N         * WATERM     * WDILN      * WDTERM      *
* WERRGR      * WETPER      * WHBPN      * WI         * WNCHOK      *
* WNT         * WPACTN      * WRTERM     * WTURN      *
* WATERM      * ZTUBE
COMMON
*/X/
* EOFFAP      * INDTUR      * INTFLO      * LARGET      * LESPD       *
* EOPN        * MCAP        * NEGW        * NONOP       * NONSPD      *
* NGNTC       * NONW        * NOTURN      * NTERR       *
* PARONE      * WITER

10 CALL INTF (DNCZW, THROAT, DHYDRA)
   ANGZTX = (PI*DHYDRA**2)/4.
   ZMAX = (NGDENT-0.5)*NTDZ
   IF (TIMEI.NE.0.) GO TO 120
   RFLUX = 0.0
   IF (TMETI.L1.0.) GO TO 70
20 CALL PT (PMINOX, TMETI)
   RFLUX = RHO
   IF (TNTIM.EQ.0.) GO TO 40
30 TEMPY = TNTIM
   GO TO 50
40 TEMPY = TMETI
50 M = NGDENT+2
   DO 60 I=1,M
     TJACK(I) = TEMPY
     TCOLD(I) = TEMPY
     THOT(I) = TEMPY
     TNOZW(I) = TEMPY
     TINTHOT(I) = TEMPY
     TINTCLO(I) = TEMPY
     TINTJND(I) = TEMPY
     TJKTND(I) = TEMPY
     TJKWO(I) = TEMPY
60 CONTINUE
70 DO 100 K=1, NGDENT
   WNTM(K) = 0.
   WNOZM(K) = 0.
   RHONTM(K) = RFLUX
   RHONZM(K) = RFLUX
   IF (RFLUX.NE.0.) GO TO 100
   TAVE = (TINTHOT(K)+TINTCLO(K))/2.
   CALL PT (PMINOX, TAVE)
   RRCTM(K) = RHO
   CALL PT (PMINOX, TNOZW(K))
   RHONZM(K) = RHO
100 CONTINUE
   WNTM (NGDENT+1) = 0.
   WNOZM (NGDENT+1) = 0.
   RHDMIX = RHO
   RHDMOX = RHO
120 ZMIN = NTDZ/2.
   RETURN
   END

```

SUBROUTINE TURBIN
C TURBINE PERFORMANCE CALCULATION
IMPLICIT REAL*8 (A-Z)
COMMON /ADD/

TURBINA

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* ARG      ,ARG1      ,ARG2      ,ATURNP      ,EUF(10)      ,
* CARDS(11) ,DELTA P    ,DTURX      ,GASVEL      ,HCDRO      ,
*          ,HFCDEF      ,HPIN      ,HPUOT      ,HTANKN      ,
* FTLRIX     ,KVSQKT     ,MACH      ,NBEND      ,PPOUT      ,
* FTROT      ,PTURPR     ,PREDFL     ,PVAFCR      ,PTXST      ,
* PFLAG      ,PTXMIN     ,PUMPH      ,RF          ,RNTROT      ,
*          ,RATIO      ,RATIDC      ,SPEED      ,TTROT      ,
* TLMFY      ,TMX        ,TJKWD1     ,TNTAZ1     ,TNTHT1     ,
* TFLU1      ,TFIN      ,TTXMIN     ,TMIX        ,
* UNCHK      ,TNP1(30)   ,T2NP1(30)  ,T3NP1(30)  ,FILMNT      ,CPUMI      ,
* TINP1(30)  ,T2NP1(30)  ,T3NP1(30)  ,SAVN(15)    ,SAVNT(20)    ,
* SAVFX(20,8) ,SAVPT(20,18) ,SAVJ(30,27) ,SAVIJ(30,40,9)
COMMON
*/CCNS/
* G          ,JAY        ,PI         ,K          ,RAD        ,
* RE
COMMON /EXTRA/
* FLMP      ,QPUM        ,TCX        ,TNKRHC      ,TPT2        ,
* TPCR      ,TPQ         ,TPK2       ,TPKPD      ,TPWH        ,
* KPLMPI     ,WEEAR      ,MBEAR      ,WPUMPC     ,
* ATURNZ     ,ATURN      ,ATUR       ,AROLNZ     ,PMIX        ,
* PAVG       ,WPMAX      ,DTURBL     ,PPIN        ,TAVE        ,
* CR         ,TTURIP     ,GAMA      ,KVLCOLO     ,KVLMIN      ,
* FDLX       ,CFTI       ,GANTI      ,TTXST      ,TPNW        ,
* KTPMIN     ,WFCNT      ,TURWK      ,TCTMP      ,
* TPRK       ,TIMEK      ,PCARD      ,RHC        ,
* DELZP      ,ZM         ,ZM1       ,DELPT       ,DELPMT     ,
* FLPHF      ,HLPCF      ,TK        ,DTROT      ,DELZT      ,
* TROTZ      ,RNDIST     ,RDN       ,G          ,
* TCHK       ,WNCF       ,WNCF1     ,WMNIT      ,HTCNT      ,
* FNTH       ,THETA1     ,THETA2    ,MAN3       ,MEN3       ,
* INTWD1     ,TLIFM      ,SACPH     ,FNTC       ,MCN2       ,
* MCN2       ,FJ         ,MCN1      ,MCDN1      ,INTCD1     ,
* TIMLZ      ,ETAP       ,TPT20     ,METLTN     ,TPTAV      ,
* FTLRGM     ,DUM        ,OMAX       ,OZ         ,TEMPTH(30)
COMMON
*/FLAG/
* ETAPFL     ,HBPFG      ,MASS      ,MTIME      ,NTIME      ,
* NMT        ,CPEN      ,OPTION     ,PMINO      ,STATE      ,
* TANK       ,TAPE      ,TFLUM     ,TIMEI      ,TIMEX      ,
* TNETM      ,WINT       ,TIMES(10)
COMMON
*/FLUIDP/
* PRES       ,ZFACT      ,QUAL       ,TEMP       ,RHO        ,
* GAM        ,CP         ,VEL        ,ENTR       ,COND       ,
* VIS        ,VCL        ,ENTH       ,
COMMON
*/HEFS/
* ACLC       ,ANUL       ,ANCZT     ,EELSEC     ,CFILMA     ,
* CFILMB     ,CGAS       ,CGAS      ,CCMP       ,CCWH       ,
* DHBP       ,DILANG     ,DPASS     ,FCOLD      ,FHOT       ,
* HBG        ,HFILMA     ,HFILMB     ,KFILMC     ,HGAS       ,
* INCOMP     ,KDILP      ,KDIL      ,KHBFI     ,KJTUR      ,
* KPCM       ,KPHM      ,K11       ,K9         ,LHBP       ,
* KTHICK     ,NCWH       ,NHEP      ,NFASS     ,RPASS      ,
* EELLGW(20)
COMMON
*/NISC/
* PCK        ,PDKV       ,PDKV      ,PTURGC     ,PTURGR      ,
* HBPV       ,HBPW      ,HBPWC     ,HEPWNC     ,
* METLTU     ,MINFLO     ,PASSX     ,SSOUT      ,WPIT      ,
* ITEMP(20)  ,CTEMP(20)  ,DELHN2(200) ,PUMP(350)  ,FILMA(20)  ,
* FILME(20)  ,FILMC(20)  ,TCFLG(20)
COMMON
*/P/
* ALPHA      ,BETA       ,DIST      ,EPUMC      ,EPUMP      ,

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B
C
D
E
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* ETLRC      * ETURP      * FILMCX      * GATEP      * HCPUM      *
* HSYC      * HSYV      * MHT          * NHT         * NTURC      *
* NTURP      * HCCRC      * PCUR         * PCIL        * PHEPO      *
* FMINCX     * PNTI        * PNTQ         * PPUMGC      * PPUMGP      *
* FTANKX     * PTURIX       * PTLRU        * QPUMF       * RFLU        *
* SAC         * TCLR        * TCLROR       * TCR          * TDILX       *
* THEPO      * TIME         * TIMEP        * TMETL       * INTI        *
* TINTO      * TPUMOC       * TPUMOP       * TTANKX      * TTURIX      *
* TIZMIX     * UIHG         * WCUR         * WDILX       * WHEP        *
* WNEZ       * WNTCK       * WNTI         * WNTG        * WPUMC       *
* XPLA       * WTURB
COMMON
*/TAEI/
* AJHT(30)   * ANTC(30)     * ANTH(30)     * ANTW(30)     * CDJ(30)      *
* CDNT(30)   * CFWP(30)     * CG(30)       * CPJ(30)      * CPNT(30)     *
* CRJ(30)    * CRJNT(30)    * DEL(30)      * DELPNT(30)   * DELPNZ(30)   *
* DNOZW(30)  * GATE(30)     * GP(30)       * HCFJ(30)     * HGFNTC(30)   *
* HGFNTH(30) * HGJ(30)      * HGNTC(30)    * HGNTH(30)    * KPD(30)      *
* KFLV(LC)   * KV(30)       * NT(30)       * PAME(30)     * PDC(30)      *
* FC(LC)     * PINLET(30)   * PLINE(30)    * PRATIO(LC)   * PTURMO(30)   *
* GFL(LC)    * RHQJ(30)     * RHENT(30)    * KN(LC)       * SJO(30)      *
* SNCZ(30)   * SNTC(30)     * SNTH(30)     * SNTJ(LC)     * SSPRT(30)    *
* TC(30)     * TINLET(30)   * TKJ(30)      * TKNTC(30)    * TKNTH(30)    *
* TUREFF(30) * VNODES(30)   * WDIL(30)     * WFUM(30)     *
* TLRI(30)   * TURIP(30)    * HBFLOW(30)   * BEND(30)
COMMON /TF/
* AFLUX      * EATERM       * LATER5       * CDMTL        * CPTERM       *
* DELZ       * DELHM        * DELHN        * DELHNX       * DELPM        *
* DELTER     * DHYCKA      * DPIPE        * UTERM        * CZTERM       *
* ENTRCP     * ETAT        * ETATP        * GFN          * HFTERM       *
* HGOEF      * HGCT        * HPUMI        * HTCOEF       * HVTERM       *
* H12        * KT          * KVN          * KWC          * KWCP         *
* KMCV       * KWH         * KWHV         * KWT          * K1           *
* K2         * K3          * K4           * K6           * MTERM1       *
* MTERM2     * MTERM3      * MTERM4       * NFRN         * NTERM        *
* PHI        * PNUZU       * PNTTHK       * PRESM        * PRQUES       *
* FKPRIM     * PRTERM      * PSTP         * FTANKN       * PCN          *
* FEN        * P8PR       * QN           * QFM          * QTERM        *
* RHCR       * RHUTKM      * RHOTKN       * KPM2         * SPRIME       *
* STERM      * STSIAG      * TFLUSR       * TIMEMT       * TIMEN        *
* ITANKN     * ITURO       * TVF          * TWTERM       * T11N         *
* T11SR      * T8N         * WATERM       * WDILN        * WDERM        *
* WEARRR     * WETPER      * WHEPN        * WI           * WCHOK        *
* WNT        * WFACTN     * WINTERM      * WTERM        * WTURN        *
* WTERM
COMMON
*/TRAS/
* ARE        * ATURQ       * ATURX        * DRCLNZ       * DTUR         *
* DTURNZ     * ETAMIN      * GATEFG       * KBEAR        * KTURD        *
* KTLRX      * MUPT        * NWCRK        * PTURI        * TIPVEL       *
* TLRIR      * WWORK
COMMON
*/X/
* ECFTAP     * INDTUR      * INTFLG       * LARCET       * LESPO        *
* LOCPN      * MCAP        * NEGW        * NCNGP        * NONSPD       *
* NONTC      * NCNW       * NOTURN       * NGTURN       * NTERR        *
* PARONE     * WITER

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IF (RIDCL.NE.0.) GO TO 4000
IF (INDTUR.EQ.0.) GO TO 1010
CALL FT (PTURIX,TTURIX)
WTURB = PTURIX*ATURNZ*KTF(GAM) / DSQRT(TTURIX)
GO TO 1020
1010 IF (PREDFL.NE.0.) GO TO 1020
IF (THEPFG.NE.0.) GO TO 1020
CALL FT (PHEPO,THEPO)
TTURIX = THEPO
PTURIX = WTURB*DSQRT(TTURIX) / (ATURNZ*KTF(GAM))
IF (PTURIX.LE.PTUROM) GO TO 4000
1020 CALL FT (PTURIX,TTURIX)
GANTI = GAM

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TURBINB
TURBINC
TURBIND
TURBINF
TURBING
TURBINH
TURBINI
TURBINJ
TURBINL
TURBINM
TURBIND
TURBINB

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      CPTI = CP
1030 IF (UNCHOK.NE.0.) GO TO 2000
      IF (PTURC.NE.0.) GO TO 1040
      PTURC = .1*PTURIX
1040 MACH = 1.
      TTURC = TTURIX*(PTURC/PTURIX)**(R/(JAY*CPTI))
      PTXST = PTURC*(1.+MACH**2*(GANTI-1.)/2.)*(-GANTI/(GANTI-1.))
      TTXST = TTURC / (1.+MACH**2*(GANTI-1.)/2.)
      CALL TURBN
      PTURC = PTURC
      PTURC = PTURIX*ATURNZ/ARCLNZ*DSGRT(1.-ETAT*(1.-(PTURC/PTURIX)**
1(F/(JAY*CPTI))))
      DLM = PTURC
      CALL ITER (17,PTURC,DLM ,PTURC ,81040)
2000 TTXMIN = TTURIX*(PTURC/PTURIX)**(R/(JAY*CPTI))
      CALL PT (PTURC,TTXMIN)
      PTXMIN = PTURC + KTURX*TTURB**2/(24.*G*ATURX**2*RH0)
      IF (UNCHOK.NE.0.) GO TO 2010
      IF (PTXST.GT.PTXMIN) GO TO 3000
C *****
C ADJUST ATURNZ TO INSURE PROPER GAS FLOW FOR UNCHOKED TURBINE INLET NOZ
C *****
2010 ARG = PTURIX/PTXMIN
      CALL INTP(PRATIC,ARG,RATICC)
C ** GET C FOR ADJUSTING TURBINE NOZZLE AREA
      ATURNZ = RATICC/KTF(GANTI)
      UNCHK = 1.
      DLM = ATURNZ
      CALL ITER (18,ATURNZ,DLM ,ATURNZ,85000)
2020 TTXST = TTURIX*(PTXMIN/PTURIX)**(R/(JAY*CPTI))
      PTXST = PTXMIN
      CALL PT (PTXST,TTXST)
C *****
C TURBINE PERFORMANCE CALCULATIONS BASED ON SUB-SONIC GAS FLOW
C *****
      MACH = TTURC/(VEL*RH0*ARCLNZ)
      TTURC = TTXST*(1.+MACH**2*(GANTI-1.)/2.)
      PTURC = PTXST*(1.+MACH**2*(GANTI-1.)/2.)*(-GANTI/(GANTI-1.))
      CALL TURBN
3000 ETURP = CPTI*TTURC*TTURIX*ETAT*(1.-(PTURC/PTURIX)**(R/(JAY*CPTI)))
      ITURC = TTURC*(1.-ETAT*(1.-(PTURC/PTURIX)**(R/(JAY*CPTI))))
      SSSS CONTINUE
      RETURN
C *****
C IF PRESSURE AT TURBINE INLET IS TOO LOW - NO WORK IS COMPUTED
C *****
2000 PTURC = PTURC
      TTURC = TTURIX
      ETURP = 0.
      ETAT = 0.0
      GO TO 5555
5000 IF (INDTUR.NE.0.) GO TO 2020
      IF (PREDFL.NE.0.) GO TO 5010
C *****
C RECALCULATE GAS FLOW TO THE TURBINE WITH ADJUSTED INLET NOZZLE AREA
C *****
      IF (HBPRES.EQ.0.) GO TO 5020
5010 CALL SHEP
      GO TO 2000
5020 CALL HEPFLB
      GO TO 2000
      END

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TURBINC
TURBINQ
TURBINR
TURBINS
TURBINT

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TURBINF
TURBING

TURBINH

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TURBINU

TURBINB
TURBINC

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IEF2851 LOADMOD.031201
IEF2851 VOL SER NOS= D10002.
IEF2851 SYSOUT
IEF2851 VOL SER NOS= TC2564.
IEF2851 PCHOUT
IEF2851 VOL SER NOS= D10012.
IEF2851 ERS1
IEF2851 VOL SER NOS= D10008.
IEF2851 ERS1
IEF2851 VOL SER NOS= D10008 1.
IEF2851 ERS2
IEF2851 VOL SER NOS= D10007.
IEF2851 ERS3
IEF2851 VOL SER NOS= D10003.
IEF2851 ERS2
IEF2851 VOL SER NOS= D10007 1.
IEF2851 ERS3
IEF2851 VOL SER NOS= D10003 1.
IEF2851 AAAAAAAAA.AAAAAAAAA.AAAAAAAAA.AAAAAAAAA.00000031 SYSIN
IEF2851 VOL SER NOS= SYSIN .
//RUNCH EXEC PGM=RUNCHEXE
//PIN DD DSNAME=PCREUT,DISP=OLD
//POLY DD SYSOUT=A
IEF2361 ALLGC. FOR D31201 FUNCH CARDPRNT
IEF2371 PIN CN 145

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PASSED
SYSOUT
KEPT
DELETED
NCT DELETED 8
DELETED
DELETED
NCT DELETED 8
NCT DELETED 8

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00000420

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SUBROUTINE TURBIN
C CALCULATION OF SERIAL TWO SPOOL TURBINE WITH SUB-SONIC FLOW AT ALL THE
C EXIT NOZZLE

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IMPLICIT REAL*8 (A-Z)

COMMON /ADD/

* ARG	* ARG1	* ARG2	* ATURNP	* BUF(10)
* CARDS(11)	* DELTAP	* DTURX	* GASVEL	* HCORO
* HTURIX	* HFCOEF	* MPIN	* HPQUT	* MTANKN
* PTROT	* KVSORT	* NACH	* NBEND	* PPOUT
* PFLOW	* PTURPR	* PREDFL	* PVAFOR	* PTXST
*	* PTXMIN	* PUMPH	* RF	* RNTROT
*	* RATIO	* RATIOC	* SPEED	* TTROT
* TEMPY	* TMX	* TJKMD1	* TINTN21	* TINTH1
* TROUT	* TPIN		* TTXMIN	* TMIX
* UNCHK			* FILMNT	* QPUMI
* T1NP1(30)	* T2NP1(30)	* T3NP1(30)	* SAVN(15)	* SAVNT(20)
* SAVFX(20,8)	* SAVPT(20,18)	* SAVJ(30,27)	* SAVIJ(30,20,9)	

COMMON

*/CCNS/

* G

* JAY

* PI

* R

* RAD

* RB

COMMON /EXTRA/

* QUMIP	* QPUM	* TCX	* TNRHQ	* TPT2
* TPCR	* TPK2	* TPX2	* TPKPD	* TPNH
* KPLMPI	* HBEAR	* HBEAR	* WPUMPC	
* ATANKZ	* ATURNC	* ATUR	* AROLNZ	* PMIX
* PAVG	* WPMAX	* DTURBL	* PPIN	* TAVE
* CR	* TTURIP		* GAMMA	* PTOOLO
* MDILX	* CPTI	* GANTI	* TTXST	* KVLMIN
* TPCMIN	* WPCNT	* TURMK	* TCTMP	* TPNH
* TPCRK	* TIMER	* PCARD	* RHOM	
* DELZP	* ZM	* ZM1	* DELPT	* DELPMT
* HLPFH	* HLPFCF	* TK	* DTROT	* DELZT
* TROTZ		* RNDIST	* RFN	* Q
* TCHOK	* WNCF	* WNCF1	* WMNIT	* HTCNT
* FNTH	* THETA1	* THETA2	* MAN3	* MEN3
* TNRMD1	* TOLFM	* SACPR	* FNTC	* MDN2
* TNRN2	* FJ	* MCN1	* MCN1	* TINTCD1
* TIMEZ	* ETAP	* TPT20	* METLTN	* TPTAV
* PTURON	* DUM	* OMAX	* OZ	* TEMPTM(30)

COMMON

*/FLAG/

* ETAPFL	* HBPFG	* MASS	* MTIME	* NTIME
* NAIT	* OPEN	* OPTION	* PMINO	* STATE
* TANK	* TAPE	* TPLUM	* TIMEI	* TIMEX
* TMEINO	* WINT	* TIMES(10)		

COMMON

*/FLUIDP/

* PRES	* ZFACT	* QUAL	* TEMP	* RHO
* GAM	* CP	* VEL	* ENTR	* COND
* VIS	* VCL	* ENTH		

COMMON

*/MBPS/

* ACORO	* ANNUL	* ANOZT	* BEELSEC	* CFILMA
* CFILMB	* CFILMC	* CGAS	* COMP	* DCWH
* DHBP	* DILANG	* DPASS	* FCOLD	* FNOT
* HEGG	* HFILMA	* HFILMB	* HFILMC	* HGAS
* INCCMP	* KDELFP	* KDIL	* KHEPI	* KJTUR
* KPCM	* KPHM	* K11	* K9	* LHEP
* MTHICK	* NCWH	* NHBP	* NPASS	* RPASS

* BELOW(20)

COMMON

*/MISC/

* PCX	* PDK	* PDKV	* PTUROC	* PTUROP
* HBPKV	* HBPW	* HBPWC	* HBPWC	
* METLTO	* MINFLO	* PASSX	* SSOUT	* WPIT
* ITEMP(20)	* OTEMP(20)	* DELHN2(200)	* PUMP(350)	* FILMA(20)
* FILMB(20)	* FILMC(20)	* TCFLG(20)		

COMMON

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* ALPHA      *BETA      *DIST      *EFUNC      *EPUMP      *
* ETURC      *ETURP      *FILMCX      *GATEP      *HDPUM      *
* HSVC      *HSVP      *MHT      *NMT      *NTURC      *
* NTURP      *PCORO      *PCUR      *PDIL      *PHEPO      *
* PMINGX      *PNTI      *PNTQ      *PPUMOC      *PPUMOP      *
* PTANKX      *PTURIX      *PTURO      *QPUMP      *RFLU      *
* SAC      *TCORO      *TCOROR      *TCUR      *TDILX      *
* THBPQ      *TIME      *TIMEP      *TMETL      *TNTI      *
* TATO      *TPUMOC      *TPUMOP      *TTANKX      *TTURIX      *
* TI2MIX      *UING      *WCUR      *WDILX      *WHEP      *
* WNCZ      *WNTCK      *WNTI      *WNTQ      *WPUMC      *
* WPLMP      *WTURB
COMMON
*/TABI/
* AJHT(30)    *ANTC(30)    *ANTH(30)    *ANTW(30)    *CDJ(30)      *
* CDNT(30)    *CFWP(30)    *CG(30)      *CPJ(30)      *CPNT(30)      *
* CRJ(30)      *CRJNT(30)    *DEL(30)      *DELPNT(30)   *DELPNZ(30)     *
* DNOZW(30)    *GATE(30)      *GP(30)      *HGFJ(30)     *HGFNTC(30)     *
* HGFNTH(30)   *HGJ(30)      *HGNTC(30)   *HGNTH(30)   *KPD(30)       *
* KPDV(30)     *KV(30)      *NT(30)      *PAMB(30)     *PBD(30)       *
* PC(30)      *PINLET(30)   *PLINE(30)   *PRATIO(30)  *PTURMO(30)     *
* QPD(30)      *RMOJ(30)     *RHONT(30)   *RN(30)      *SJO(30)       *
* SHO2(30)     *SNTG(30)     *SNTH(30)    *SNTJ(30)    *SSPRT(30)     *
* TC(30)      *TINLET(30)   *TKJ(30)     *TKNTC(30)   *TKNTH(30)     *
* TUREFF(30)   *VMODES(30)   *WDIL(30)    *WPUM(30)    *BEND(30)      *
* TURIT(30)    *TURIP(30)    *HBFLOW(30)
COMMON /TF/
* AFLOWX      *BATERM      *BATERS      *CCMTL      *CPTERM      *
* DDELZ      *DELHM      *DELHN      *DELHNX      *DELPN      *
* DELTER      *DMYDRA      *DPIPE      *DTERM      *DZTERM      *
* ENTROP      *ETAT      *ETATP      *GPN      *HFTERM      *
* HGCOEF      *HGTGT      *HPUMI      *HTCGEF      *HYTERM      *
* H12      *KI      *KVM      *KWC      *KWCP      *
* KWCV      *KWH      *KWHV      *KWT      *KI      *
* K2      *K3      *K4      *K6      *K7      *
* MTERM2      *MTERM3      *MTERM4      *NFRN      *MTERM1      *
* PHI      *PNOZO      *PNTTHR      *PRESM      *NTERM      *
* PPRIM      *PRTERM      *PSTR      *PIANKN      *PRGUES      *
* PEN      *PSPR      *QN      *QPM      *PCN      *
* RHOR      *RHOTKM      *RHOTKN      *RPM2      *QTERM      *
* STEAM      *STSTAG      *IFLUSR      *TIMEMT      *SPRIME      *
* TTANKN      *TTURO      *TVP      *TWTERM      *TIMEN      *
* T11SR      *T8N      *WATERM      *WDILN      *TIIN      *
* WERROR      *WETPER      *WHBPN      *WI      *WOTERM      *
* WNT      *WPACTN      *WRTERM      *WTERM      *WNCHOK      *
* WTERM      *WTURB
COMMON
*/TAPAS/
* ARE      *ATURO      *ATURX      *DROLNZ      *DTUR      *
* DTURNZ      *ETANIN      *GATEFG      *KBEAR      *KTURO      *
* KTURX      *MUPT      *NWCRK      *PTURI      *KTURV      *
* TTURI      *WWORK
COMMON /TSTP/HMIX,KDILN,KHBP,N,KJTUN,NINDP,TIPVIN,EINDC,PINDIN,
*AMID,TAMD,EINTC,PMIDSG,TMIDSG,EINTP,ETAIN,AMID,C,KMIDP,AMIDP,
*AMIDP,NINNV,NINNP,ETAINM,MUIT,GINDBL,RMO1,RHO2,RHO3,RHO4,TINDEX,
*SPIN,SPIN2,SPBEB2,TTXSTP,TTOT1,TTXG1S,TTXG1S,ETAINP,FLOMP,WINDC
*CIDL(30),INTEFF(30),QID(30),INDHD(300),INDEF(300)
COMMON
*/X/
* EOFTAP      *INDTUR      *INTFLO      *LARGET      *LESPO      *
* EODM      *MCAP      *MEGQ      *NONGP      *NONSRD      *
* EODM      *WONE      *WOTURN      *NWTURN      *NTERR      *
* EODM      *WITER
IF (PTURC.EQ.0.) GO TO 3008
1000 CALL PT(TPTURIX,TTURIX)
GAMTI = GAM
CPTI = CP
IF ((PMID.EQ.0.).OR.(PMID.GT.PTURIX)) PMID = .9*PTURIX

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SUBROUTINE TURBIN

DATE = 10SEP67

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CALL INTP (PRATIO,ARG,RATIOC)
ATURNP = ATURNZ
ATURNZ = RATIOC/KTF(GANTI)
1010 CALL ITER(16,ATURNP,ATURNP,ATURNZ,62000)
      TMID = TTURIX*(PMID/PTURIX)**(R/(JAY*CPTI))
      GASVEL = DSORT(2,*.G*JAY*CPTI*(TTURIX-TMID))
      ARG = TIPVEL/GASVEL
      IF (ARG.GT.0.22) ARG = 0.22
      CALL INTP (TUREFF,ARG,ETAT)
      TMIDSG = TTURIX-ETAT*(TTURIX-TMID)
      PMIDSG = FMID
      ETURP = CPTI*WTURB*(TTURIX-TMIDSG)
      CALL PT (PMIDSG,TMIDSG)
      GANTI = GAM
      CPTI = CP
      PTXST = PTURDM
      TTXST = TMIDSG*(PTXST/PMIDSG)**(R/(JAY*CPTI))
      WTTOT = WTURB + WBEAR
1030 CALL PT (PTXST,TTXST)
      PTURO = PTURDM + KTURX*WTTOT**2/(24.*G*ATURX**2*RHO)
      MACH = WTURE/(VEL*RHO*ARGLNZ)
      PTXST = PTURO/(1.+MACH**2*(GANTI-1.)/2.)*(GANTI/(GANTI-1.))
      GASVEL = DSORT(2,*.G*JAY*CPTI*(TMIDSG-TTXST))
      ARG = TIPVIN/GASVEL
      IF (ARG.GT.0.4) ARG = 0.4
      CALL INTP (INTEFF,ARG,ETAIN)
      TTXGIS = TMIDSG*(PTURO/PMIDSG)**(R/(JAY*CPTI))
      TTXSIS = TTXGIS/(1.+MACH**2*(GANTI-1.)/2.)
      ETAINP = ETAIN*(1.-MACH**2*R*GANTI+TTXSIS/(2.*JAY*CPTI*
1      (TTMGIS-TMIDSG)))
      ITURO = TMIDSG - ETAINP*(TMIDSG-TTXGIS)
      ITXSTP = TTXST
      TTXST = ITURO/(1.+MACH**2*(GANTI-1.)/2.)
      CALL ITER(17,PTURO,ITXSTP,TTXST,61030)
      ARG = PMIDSG/PTXST
      CALL INTP (CTBL,ARG,C)
      AMID = C/KTF(GANTI)
      FLOWP = PMIDSG*AMID*KTF(GANTI)/DSORT(TMIDSG)
      CALL ITER(26,PMID,FLOWP,WTURB,64000)
      EINTP = CPTI*WTURB*(TMIDSG-ITURO)
9999 RETURN
1000 IF (INDTUR.NE.0.) GO TO 1010
      IF ((PREDFL.NE.0.).OR.(HBPG.NE.0.))GO TO 2010
      CALL HBPSLB
      GO TO 1000
9999 CALL SHRP
      GO TO 1000
9999 PTURO = PTURDM
      PMID = PTURDM
      ITURO = TTURIX
      TMID = TTURIX
      ETURP = 0.
      EINTP = 0.
      ETAT = 0.
      ETAIN = 0.
      GO TO 9999
9999 IF (PMID.LT.PTURO) PMID = 1.1*PTURO
      GO TO 1000
      END

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SUBROUTINE TURBN

DATE = 10SEP67

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* DELTER      .DHYDRA      .DPIPE      .DTERM      .DZTERM
* ENTROP      .ETAT        .ETATP      .GPN        .HFTERM
* HGCOEF      .HGTOT      .HPUMI      .HTCOEF     .HVTERM
* H12         .KT         .KVN        .KWC        .KWCP
* KBCV        .KWH        .KWHV       .KWT        .K1
* M2          .K3         .K4         .K6         .MTERM1
* MTERM2      .MTERM3     .MTERM4     .NPRM       .NTERM
* PHI         .PNOZO      .PNTFHR    .PRESM      .PRGUES
* PRPRIM      .PTERM      .RSTP      .PTANKN     .PSN
* PEN         .PSPR       .QN        .QPM        .QTERM
* RHOR        .RHOIKM     .RHOTKN    .RPM2       .SPRIME
* STERM       .STSTAG     .TFLUSR    .TIMENT     .TIMEN
* TTANKN      .TTURO      .TVF       .TWTERM     .TIIN
* T11SR       .TSN        .WATERM     .WDILN      .WQTERM
* WERROR      .WETBER     .WBSPN     .WI         .WCHOK
* WNT         .WPACTN     .WTERM     .WTERM      .WTURN
* WTERM
COMMON
*/IPAS/
* ARE         .ATURO      .ATURX      .DRCLNZ     .DTUR
* DTUANZ      .ETAMIN     .GATEFG     .KBEAR      .KTURO
* MURX        .MUP       .NWORK      .PTURI      .TIPVEL
* TURX
* TURX
GASVEL = DSORT(2.*G*JAY*CPI*TWRIX*(1.-(PTXST/PTURIX))*
1 (R/(JAY*CPI)))
ARG = TIPVEL/GASVEL
IF (ARG.GE.0.15) GO TO 1000
ARG = 0.15
1000 CALL INIP (TUREFF,ARG,ETATP)
ETAT = ETATP*(1. - (MACH**2*R*GAMT1*TXST)/(2.*JAY*CPI*(TTURO -
1 TTURIX)))
RETURN
END

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C      SUBROUTINE TZERO                                T
      FIND VALUES AT TIME ZERC
      IMPLICIT REAL*8 (A-Z)
      COMMON /ADD/
      * ARG ,ARG1 ,ARG2 ,ATURNP ,BUF(10) ,
      * CARDS(11) ,DELTAP ,DTURX ,GASVEL ,HCORO ,
      * ,HFCGEF ,HPIN ,HPOUT ,HTANKN ,
      * HTURIX ,KVSQRT ,MACH ,NBEND ,PPOUT ,
      * PTROT ,PTURPR ,PREDFL ,PVAPOR ,PTXST ,
      * PFLCW ,PTXMIN ,PUMPH ,RF ,RNTROT ,
      * ,RATIO ,RATIOC ,SPEED ,TTROT ,
      * TEMPY ,TMX ,TJKWD1 ,TNTNZ1 ,TNHT1 ,
      * TPGUT ,TPIN ,TTXMIN ,TMIX ,
      * UNCHK ,FILMNT ,QPUMI ,
      * T1NP1(30) ,T2NP1(30) ,T3NP1(30) ,SAVN(15) ,SAVNT(20) ,
      * SAVX(20,8) ,SAVPT(20,18) ,SAVJ(30,27) ,SAVIJ(30,20,9)
      COMMON
      * /BDLS/
      * ALINE ,BDOWN ,BDPD ,CFVGL ,IMASS ,
      * LFILM ,PINPUT ,PTNKIN ,TAMB ,TTNKIN ,
      * VTANK
      COMMON
      * /ELAG/
      * ETAPFL ,HBPFG ,MASS ,MTIME ,NTIME ,
      * NMIT ,OPEN ,OPTION ,PMINO ,STATE ,
      * TANK ,TAPE ,TFUM ,TIMEI ,TIMEX ,
      * TNETMC ,WINT ,TIMES(10)
      COMMON /EXTRA/
      * PUMIP ,QPUM ,TCX ,TNKRHO ,TPT2 ,
      * TPCR ,TPK2 ,TPKPD ,TPWH ,
      * KJUMPI ,WBEAR ,HBEAR ,WBPUMPC ,
      * ATURNZ ,ATURN ,AROLNZ ,PMIX ,
      * PAVG ,WPMAX ,DTURBL ,PPIN ,TAVE ,
      * CR ,TTURIP ,GAMMA ,PTCQLO ,
      * HDILX ,CPTI ,GAMT1 ,TTXST ,KVLMIN ,
      * KTFMIN ,WPCNT ,TURK ,TCTMP ,TPNW ,
      * TPRK ,TIMER ,PCARD ,RHOM ,
      * DELZP ,ZM ,ZM1 ,DELPT ,DELPMT ,
      * NLPF ,NLPFCF ,TK ,DTRGT ,DELZT ,
      * TRGTZ ,RNDIST ,RFN ,Q ,
      * TCHK ,WNCF1 ,WNCF2 ,WNNIT ,HTCNT ,
      * FNTH ,THETA1 ,THETA2 ,MAN3 ,MEN3 ,
      * INTWD1 ,TDIFM ,SACPR ,FNTC ,MDN2 ,
      * MBN2 ,FJ ,MCN1 ,MDN1 ,TNTC01 ,
      * TIMEZ ,ETAP ,TPT20 ,METLTN ,TPTAV ,
      * PTURON ,DUM ,OMAX ,OZ ,TEMPTM(30)
      COMMON
      * /FLUIDP/
      * PRES ,ZFACT ,QUAL ,TEMP ,RHO ,
      * GAM ,CP ,VEL ,ENTR ,COND ,
      * VIS ,VOL ,ENTH
      COMMON
      * /GLES/
      * PCTCE ,PTANK ,PTUROE ,PUMHDE ,PUMOG ,
      * PUMWEE ,TDIL ,TDANK ,TNETI ,TURNSP ,
      * WDIL ,WDILG ,WHSPG ,WNTI ,WORKE ,
      * WPUMP
      COMMON
      * /MISC/
      * PCX ,PDK ,PDKV ,PTUROC ,PTUROP ,
      * HBPV ,HBPW ,HBPWC ,HEPWNC ,
      * METLTO ,MINFLG ,PASSX ,SSOUT ,
      * TEMPI(20) ,OTEMP(20) ,DELNN2(200) ,PUMP(350) ,FILMA(20) ,
      * FILMB(20) ,FILMC(20) ,TCFLG(20)
      COMMON
      * /P/
      * ALPHA ,BETA ,DIST ,EPUMC ,EPUMP ,
      * ETURC ,ETURP ,FILMCX ,GATEP ,HDPUM ,
      * HSVC ,HSVP ,MHT ,NHT ,NTURC ,
      * NTURP ,PCORO ,PCUR ,PDIL ,PHEPG

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SUBROUTINE TZERO

DATE = 18SEP67

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* PMINOX      ,PNTI      ,PNTQ      ,PPUMOC      ,PPUMOP      ,
* PTANKX      ,PTURIX      ,PTURO      ,QPUMP      ,RFLU      ,
* SAC         ,TCORO      ,TCCROR      ,TCUR      ,TDILX      ,
* THEPD       ,TIME      ,TIMEP      ,TMETL      ,TNTI      ,
* TINTO       ,TPUMOC      ,TPUMOP      ,TTANKX      ,TTARIX      ,
* T12MIX      ,UIHG      ,WCUR      ,WDILX      ,WHEP      ,
* WNOZ        ,WNTCK      ,WNTI      ,WNTQ      ,WPUMC      ,
* WRAMP       ,WTURB
COMMON
*/TAB1/
* AJHT(30)     ,ANTC(30)     ,ANTH(30)     ,ANTW(30)     ,CCJ(30)      ,
* CDNT(30)     ,CFWP(30)     ,CG(30)      ,CPJ(30)      ,CPNT(30)     ,
* CRJ(30)      ,CRJNT(30)    ,DEL(30)      ,DELPNT(30)   ,DELPNZ(30)    ,
* DNOZW(30)    ,GATE(30)     ,GP(30)      ,HGFJ(30)     ,HGFNTC(30)   ,
* HGFNTH(30)   ,HGJ(30)     ,HGNTC(30)    ,HGNTH(30)    ,KPD(30)      ,
* KPDV(30)     ,KV(30)      ,NT(30)      ,PAMB(30)     ,PBD(30)      ,
* PC(30)       ,PINLET(30)   ,PLINE(30)    ,PRATIO(30)   ,PTURMO(30)   ,
* QPD(30)      ,RHOJ(30)    ,RHONT(30)    ,RN(30)      ,SJO(30)      ,
* SNCZ(30)     ,SNT(30)     ,SNTH(30)    ,SNTJ(30)     ,SSPRT(30)    ,
* TC(30)       ,TINLET(30)   ,TKJ(30)     ,TKNTC(30)    ,TKNTH(30)    ,
* TUREFF(30)   ,VNODES(30)   ,WDIL(30)    ,WPUM(30)     ,
* TURIT(30)    ,TURIP(30)    ,WBFLOW(30)   ,WBEND(30)
COMMON
*/TAB1J/
* AFLOW(30,20) ,CAP(30,20)   ,CONDI(30,20) ,HG(30,20)   ,HGF(30,20) ,
* WETP(30,20)
COMMON
*/TPAS/
* ARE         ,ATURO      ,ATURX      ,DROLNZ      ,DTUR      ,
* DTURNZ      ,ETAMIN     ,GATEFG     ,KBEAR      ,KTURO      ,
* KTURX       ,MUPT       ,NWDK      ,PTURI      ,TIPVEL     ,
* TTURI
COMMON /TP/
* AFLOWX      ,BATERM     ,BATERS     ,CDMTL      ,CPTERM     ,
* DDELZ       ,DELHM      ,DELHNX     ,DELMX      ,DELPN      ,
* DELTER      ,DHYDRA     ,DPIPE      ,DTERM      ,DZTERM     ,
* ENTROP       ,ETAT       ,ETATP      ,GPN        ,HPTERM     ,
* HSCDEF      ,HGTOT      ,HPUMI      ,HTCOEF     ,HTERM      ,
* H12         ,KV         ,KVN        ,KVC        ,KSCP       ,
* KCV         ,KMH        ,KNMV       ,KNT        ,N1        ,
* K2          ,K3         ,K4         ,K6         ,NTERN1     ,
* MTERM2      ,MTERM3     ,MTERM4     ,NPRN       ,NTERM      ,
* PHI         ,PNOZO      ,PNTTHR     ,PRESM      ,PRGUES     ,
* PRPRM       ,PRPRM      ,PSTP       ,PTANKN     ,P6N        ,
* P6N         ,PSPR       ,Q6N        ,QPM        ,QTERM      ,
* RHOR        ,RHOTKN     ,RHOTKN     ,RPN2       ,SPRINE     ,
* STERM       ,STAG       ,TFLUSR     ,TINENT     ,TINEN      ,
* TTANKN      ,TTURO      ,TVP        ,TTERM      ,TIN       ,
* TIIS        ,TSN        ,WATERM     ,WDILN      ,WCTERM     ,
* WERR        ,WETPER     ,WHEPN      ,WI         ,WCHOK     ,
* WNT         ,WPACTA     ,WRTERM     ,WTERM      ,WTURN      ,
* WTERM       ,ZTUBE
TIME = TIMEI
TIME = TIMEJ
CALL INTP(HG,TIME,HGTOT)
IF (OPEN.NE.0.0) GO TO 30
CALL SETCJ
PUMIP = PTANK
IF (PUMIP.EQ.0.0) GO TO 10
PTANKN = PUMIP
TTANKN = TTANK
IF (SDOWN.NE.0.0) TTANKN = ATANKIN
CALL PT4PTANKN(TTANKN)
TKRHO = RHO
RHOTKN = TALKRHO
10 IF (GATEFG.NE.0.0) GPN = GATEFG
CALL INTP(KV,GPN,KVN)
HBFKV = KVN
END

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SUBROUTINE TZERO

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PTANKX = PTANKN
PPUMOP = PTANKN
IF(PUMOG.NE.0.0)PPUMOP = PUMOG
TPUMOP = TTANKN
TTANKX = TTANKN
IF(PMINO.NE.0.0)PRMINOX = PMINO
NTURP = TURSPD
WPUMP = WPUMPG
WPUMC = WPUMPG
WDILN = WDILG
WHBPN = WHBFG
PCN = 0.0
PEN = 0.0
TEN = 0.0
PTURIX = 0.0
TIIN = 0.0
PTURO = PTURO
IF(OPEN.NE.C.C)PTURC = 0.0
GFUMP = 0.0
EFUMP = 0.0
ETURP = 0.0
MORUM = 0.0
WI = 0.0
DELMN = 0.0
GO TO 40
30 PTANKX = PTANK
PFUMOC = FTANK
PTANKN = FTANK
TTANKX = TTANK
IF(BDOWN.NE.0.0)TTANKX = TINKIN
TTANKN = TTANKX
TPUMOC = TTANKX
RHGTKN = C.C
GATEP = C.C
PTUROC = 0.0
GO TO 20
40 CCNTINUE
RETURN
END

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SUBROUTINE UPDATE
C      UPDATE
      IMPLICIT REAL*8 (A-Z)
      INTEGER*4
      * CTAG      ,I      ,IDELZS      ,IEND      ,IM(5)      ,
      * J      ,JEND      ,K      ,KEND(5)      ,L      ,
      * LEND      ,MTAG(30)      ,NOFIND      ,NTAG      ,PTAG      ,
      * XTAG(5,5)      ,II      ,M      ,NOBNT      ,NODENT      ,
      * NZTRQT      ,NTCNT      ,NMCNT      ,NOCEPT      ,NPARTS      ,
      * JJ      ,KK      ,LL      ,INCDE      ,KLOOP      ,
      * REF      ,IDELT      ,NTPNTS      ,NGDZ      ,NK      ,
      * TTAG      ,CTAG      ,CJ(20)      ,REFR      ,
      COMMON /ADD/
      * ARG      ,ARG1      ,ARG2      ,ATURNP      ,BUF(10)      ,
      * CARDS(11)      ,DELTAP      ,DTURX      ,GASVEL      ,HCORO      ,
      *      ,HFCOEF      ,HPIN      ,HPOUT      ,HTANKN      ,
      * MTURIX      ,KVSORT      ,MACH      ,NEEND      ,PPOUT      ,
      * PTROT      ,PTURPR      ,PREDFL      ,PVAPOR      ,PTXST      ,
      * PFLOW      ,PTXMIN      ,PUMPH      ,RF      ,RNTROT      ,
      * TEMPY      ,RATIO      ,RATIOC      ,SPEED      ,TTROT      ,
      * TPOUT      ,TPIN      ,TJKWD1      ,TNTN21      ,TNTHT1      ,
      * UNCHK      ,      ,      ,TTXMIN      ,TMIX      ,
      * TINP1(30)      ,T2NP1(30)      ,T3NP1(30)      ,FILMNT      ,QPUMI      ,
      * SAVFX(20,8)      ,SAVPT(20,18)      ,SAVJ(30,27)      ,SAVN(15)      ,SAVNT(20)      ,
      COMMON
      * /AT/
      * ANOZTX      ,CDJX      ,CDNTCX      ,CDNTHX      ,CPX      ,
      * CRJNTX      ,CRJX      ,DELH      ,DELP      ,DELPK      ,
      * DELPB      ,DELBMO      ,DELT      ,DELBW      ,DELZSQ      ,
      * DELZX      ,DELBX4      ,HGCJKT      ,HGCNTC      ,HGCNTH      ,
      * HI      ,HJ      ,MK      ,HL      ,HLPRIM      ,
      * HRNTJW      ,HROJ      ,NLA      ,HL      ,PIN      ,
      * PJ      ,PK      ,PL      ,PLPRIM      ,RFLUX      ,
      * RHCMI      ,RHOMOX      ,RHOMX      ,RHONIX      ,RHONOX      ,
      * RHCX      ,SJOX      ,SNOZX      ,SNTCX      ,SNTHX      ,
      * IAMBX      ,TCCUR      ,THCUR      ,THEDIF      ,TJKCUR      ,
      * TJKX      ,TKNTCX      ,TKNTHX      ,WNOZEN      ,WNOZI      ,
      * ZMAX      ,ZMIN      ,ZTROT      ,
      COMMON /AZ01/
      * CSUBP(30,20)      ,FILMHF(30,20)      ,PRESS(30,20)      ,RHOFLU(30,20)      ,
      * RHOFTP(30,20)      ,TFLUID(30,20)      ,TMETAL(30,20)      ,WRATEM(30,20)      ,
      * WRATEN(30,20)      ,
      COMMON /AZ1C/
      * FILMNZ(30)      ,FILMTC(30)      ,FILMTH(30)      ,HRNOZW(30)      ,HRNTCW(30)      ,
      * HRNTNW(30)      ,PNOZ(30)      ,PTUBE(30)      ,RHONTM(30)      ,RHONTN(30)      ,
      * RHONZN(30)      ,RHONZN(30)      ,TCOLO(30)      ,THOT(30)      ,TJACK(30)      ,
      * TJKTD(30)      ,TJKWD(30)      ,TNOZ(30)      ,TNOZW(30)      ,TNTCLO(30)      ,
      * TNTHOT(30)      ,TNTJWD(30)      ,TTUBE(30)      ,WNOZM(30)      ,WNOZN(30)      ,
      * WNTN(30)      ,WNTN(30)      ,
      COMMON /EXTRA/
      * PUMIP      ,QPUM      ,TCX      ,TNKRHO      ,TPT2      ,
      * TPCR      ,TPQ      ,TPK2      ,TPKPD      ,TPWH      ,
      * KRMPI      ,WBEAR      ,HBEAR      ,WPMPC      ,
      * ATURNZ      ,ATURN      ,ATUR      ,AROLNZ      ,PMIX      ,
      * PAVG      ,WPMAX      ,DTURBL      ,PPIN      ,TAVE      ,
      * CR      ,TIURIP      ,GAMMA      ,TTXST      ,PTOQLO      ,
      * HDILX      ,CPTI      ,GANT1      ,TTXMP      ,KVLMIN      ,
      * KTPMIN      ,WPCNT      ,TURWK      ,TCTMP      ,TPNW      ,
      * TPWK      ,TIMER      ,PCARD      ,RHOM      ,
      * DELZP      ,ZM      ,ZM1      ,DELPT      ,DELPNT      ,
      * MHPF      ,MHPGF      ,TK      ,DTROT      ,DELZT      ,
      * TROTZ      ,RNDIST      ,RPN      ,Q      ,
      * TCHX      ,WNCF      ,WNCF1      ,WNNIT      ,MTCNT      ,
      * FNTM      ,THETA1      ,THETA2      ,MAN3      ,MEN3      ,
      * INTWDI      ,TDIFM      ,SACPR      ,FNTC      ,MDN2      ,
      * MBN2      ,MCN1      ,MCN1      ,MDN1      ,TNTCD1      ,
      * TIMEZ      ,ETAP      ,TPT20      ,METLTN      ,TPTAV      ,
      * PTURM      ,DUM      ,OMAX      ,OZ      ,TEMPTM(30)      ,
      COMMON

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*/FX/
* DELTEM(20) ,FLUTEM(20) ,METTEM(20) ,MSMALL(20) ,MTPNTS(20) ,
* PARTI(20) ,PARTPS(20) ,TEMPEX(20)
COMMON
*/P/
* ALPHA ,BETA ,DIST ,EPUMC ,EPUMP ,
* ETURC ,ETURP ,FILMCX ,GATEP ,HDPUM ,
* HSYC ,HSVP ,MHT ,NHT ,NTURC ,
* NTURR ,PCQBO ,PCUR ,PCIL ,PHEPO ,
* FMINCX ,PNTI ,PNTD ,PPUMOC ,PPUMOP ,
* PTANKX ,PTURIX ,PTURO ,QPUMP ,RFLU ,
* SAC ,TCORO ,TCCROR ,TCUR ,TDILX ,
* THBPC ,TIME ,TIMEP ,TMETL ,TNTI ,
* TNTD ,TPUMOC ,TPUMOP ,TTANKX ,TTURIX ,
* T12MIX ,UIHG ,WCUR ,WDILX ,WHEP ,
* WNOZ ,WNTCK ,WNTI ,WNTG ,WPUMC ,
* WPUMP ,WNTGB
COMMON /PTC/
* DISPRI(20) ,PDROPI(20) ,PDFGPO(20) ,PRESI(20) ,PRESO(20) ,
* RHOMI(20) ,RHOMO(20) ,RHCNI(20) ,RHGNO(20) ,TEMPI(20) ,
* TEMPO(20) ,TIMEZN(20) ,WDEMI(20) ,WDELMC(20) ,WDELNI(20) ,
* WDELNO(20) ,WRATEI(20) ,WRATEC(20)
COMMON
*/TAGS/
* DTAG ,I ,IDELZS ,IEND ,IM ,
* J ,JEND ,K ,KEND ,L ,
* LEND ,MTAG ,NCFIND ,NTAG ,PTAG ,
* XTAG ,II ,NOENT ,NOCENT ,
* AZTRACT ,NTCNT ,NMCNT ,NODEPT ,NPARTS ,
* JJ ,KK ,LL ,IMODE ,KLOOP ,
* REF ,IDELT ,NTPNTS ,NODZ ,NK ,
* TTAG ,CTAG ,CJ ,REFR
COMMON /IP/
* AFLOWX ,BATERM ,BATERS ,CDMTL ,CPTERM ,
* DDELZ ,DELHN ,DELHNX ,DELPM ,
* DELTER ,DHYDRA ,DPIPE ,DTERM ,CZTERM ,
* ENTRGP ,ETAT ,ETATP ,GPN ,HFTERM ,
* HGOEF ,MGTOT ,HPUMI ,HTCOEF ,HFTERM ,
* H12 ,KT ,KVN ,KWC ,KWC ,K1 ,
* KWCV ,KWH ,KWHV ,KWT ,K6 ,
* K2 ,K3 ,K4 ,K5 ,K6 ,MTERM1 ,
* MTERM2 ,MTERM3 ,MTERM4 ,NPRN ,NTERM ,
* PHI ,PNOZO ,PNTTHR ,PRESM ,PRGUES ,
* PRFRIM ,PRTERM ,PSTP ,PTANKN ,P6N ,
* P8N ,P8PR ,QN ,QPM ,QTERM ,
* RHOR ,RHOTKM ,RHOTKN ,RPM2 ,SPRIME ,
* STERM ,STSTAG ,TFLUSR ,TIMEMT ,TIMEN ,
* TTANKN ,TIURO ,TVP ,TWTERM ,T11N ,
* T11SB ,T8N ,WATERM ,WDILN ,WOTERM ,
* WERROR ,WETPER ,WHBPN ,WI ,WCHOK ,
* WNT ,WFACTN ,WRTERM ,WTERM ,WTURN ,
* WTERM ,ZTUBE
DIMENSION ECUPX(20,8) ,EQUPT(20,18) ,EQUJ(30,27) ,EQUIJ(30,20,9)
EQUIVALENCE (EQUX(1,1) ,DELTEM(1)) , (EQUPT(1,1) ,DISPRI(1)) ,
1 (EQUJ(1,1) ,FILMNZ(1)) , (EQUIJ(1,1,1) ,CSUBP(1,1))
RHOMIX = RHONIX
RHOMOX = RHONOX
DO 1000 I=1,NODENT
RHONTM(I) = RHONTN(I)
RHCNZM(I) = RHONZN(I)
WNTM(I) = WNTN(I)
1000 WNOZM(I) = WNOZN(I)
WNTM(NODENT+1) = WNTN(NODENT+1)
WNOZM(NODENT+1) = WNOZN(NODENT+1)
RETURN
TCSAV
ENTRY TCSAV
DO 10 J=1,8
DO 10 I=1,JEND
SAVFX(I,J) = EQUFX(I,J)

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      DO 20 J=1,18
      DO 20 I=1,JEND
20    SAVPT(I,J) = EQUPT(I,J)
      DO 30 J=1,27
      DO 30 I=1,30
30    SAVJ(I,J) = EQUJ(I,J)
      DO 40 K=1,5
      DO 40 J=1,JEND
      NCDEPT = PARTPS(J) + 2.0
      DO 40 I=1,NCDEPT
40    SAVIJ(I,J,K) = EQUIJ(I,J,K)
      SAVNT(15) = PMINOX
      SAVNT(4)  = WPUMC
      SAVNT(5)  = PPUMOC
      SAVNT(6)  = TPUMOC
      SAVNT(7)  = NTURC
      SAVNT(8)  = HCPUM
      SAVNT(9)  = PLMIP
      SAVNT(10) = WI
      SAVNT(11) = RHCMIX
      SAVNT(12) = RHOMOX
      RETURN
C    TCRES
      ENTRY TCRES
      DO 100 J=1,6
      DO 100 I=1,JEND
100   EQUFX(I,J) = SAVFX(I,J)
      DO 200 J=1,18
      DO 200 I=1,JEND
200   EQUPT(I,J) = SAVPT(I,J)
      DO 300 J=1,27
      DO 300 I=1,30
300   EQUJ(I,J) = SAVJ(I,J)
      DO 400 K=1,5
      DO 400 J=1,JEND
      NCDEPT = PARTPS(J) + 2.0
      DO 400 I=1,NCDEPT
400   EQUIJ(I,J,K) = SAVIJ(I,J,K)
      PMINOX = SAVNT(15)
      WPUMC  = SAVNT(4)
      PPUMOC = SAVNT(5)
      TPUMOC = SAVNT(6)
      NTURC  = SAVNT(7)
      HCPUM  = SAVNT(8)
      PLMIP  = SAVNT(9)
      WI     = SAVNT(10)
      RHCMIX = SAVNT(11)
      RHOMOX = SAVNT(12)
      RETURN
      END

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C      SUBROUTINE ZERO
      ZERC DATA
      IMPLICIT REAL*8 (A-Z)
      INTEGER*4
      * CTAG          ,I          ,IDELZS          ,IEND          ,IM(5)          ,
      * J          ,JEND          ,K          ,KEND(5)          ,L          ,
      * LEND          ,MTAG(30)          ,NOFIND          ,NTAG          ,PTAG          ,
      * MTAG(5,5)          ,II          ,M          ,NOBNT          ,NOCENT          ,
      * NZTROT          ,NTCNT          ,NMCNT          ,NODEPT          ,NPARTS          ,
      * JJ          ,KK          ,LL          ,INODE          ,KLOOP          ,
      * REF          ,IDELT          ,NTFNTS          ,NODZ          ,NK          ,
      * TTAG          ,CTAG          ,CJ(20)          ,REFR          ,
      INTEGER*4 TPASS(10)
      DIMENSION      B0(11)          ,FLAGS(27)          ,GUESS(16)          ,HBP(55)          ,
      1 NOZTUB(27)          ,PIL(9)          ,PRTSS(9)          ,TPA(17)          ,VALVE(5)          ,
      EQUIVALENCE      (B0(1),ALINE)          , (FLAGS(1),ETAPFL)          ,
      1(GUESS(1),PCTGE)          , (HBP(1),ACORO)          , (NOZTUB(1),AJB)          ,
      2(PIL(1),ACL)          , (PRTSS(1),ANOZI)          , (TPA(1),ARE)          ,
      3(VALVE(1),KL)
      DIMENSION ZTABI J(3600) , ZTABI(1620) , ZAZ01(5400) , ZAZ10(810) , ZP(57) ,
      *ZAT(58) , ZTP(92) , ZFX(160) , ZPT(360) , ZX(18) , ZBD(20) , ZMISC(684) ,
      *ZADD(6919) , ZEX(115) , ZNAM(190) , ZOPC(300) , ZNTNZ(158) ,
      *ZSK(1303) , ZTS(739)
      COMMON /ADD/
      * ARG          ,ARG1          ,ARG2          ,ATURNP          ,BUF(10)          ,
      * CARDS(11)          ,DELTA          ,DTURX          ,GASVEL          ,HCORO          ,
      *          ,HFCDEF          ,HPIN          ,HPOUT          ,HTANKN          ,
      * HTURIX          ,KVSQRT          ,MACH          ,NBEND          ,PPOUT          ,
      * PTROT          ,PTURPR          ,PREDFL          ,PVAPOR          ,PTXST          ,
      * PFLOW          ,PTXMIN          ,PUMPH          ,RF          ,RMTROT          ,
      *          ,RATIO          ,RATIOC          ,SPEED          ,TTROT          ,
      * TEMPY          ,TMX          ,TJKWD1          ,TNTNZ1          ,TNTHT1          ,
      * TPGUT          ,TPIN          ,TTXMIN          ,TMIX          ,TMIX          ,
      * UNCHOK          ,TINP1(30)          ,T2NP1(30)          ,T3NP1(30)          ,FILMNT          ,QPUMI          ,
      * T1NP1(30)          ,T2NP1(30)          ,T3NP1(30)          ,SAVN(15)          ,SAVNT(20)          ,
      * SAVFX(20,8)          ,SAVPT(20,18)          ,SAVJ(30,27)          ,SAVIJ(30,20,9)
      COMMON
      * /AL/
      * ANOZTX          ,CDJX          ,CONTCX          ,CONTMX          ,CPX          ,
      * CRJNTX          ,CRJX          ,DELM          ,DELP1          ,DELPK          ,
      * DELPO          ,DELM          ,DELT          ,DELV          ,DELZSO          ,
      * DELZX          ,DELZX4          ,HGCJKT          ,HGCNTC          ,HGCNTM          ,
      * HI          ,HJ          ,HK          ,HL          ,HLPRIM          ,
      * HRNTJW          ,HROJ          ,MIN          ,M2N          ,PIN          ,
      * PJ          ,PK          ,PL          ,PLPRIM          ,RFLUX          ,
      * RHONZX          ,RHOMOX          ,RHONX          ,RHONIX          ,RHONEX          ,
      * RHONX          ,SJOX          ,SNOZX          ,SNTCX          ,SNHX          ,
      * TAMBX          ,TCCUR          ,THCUR          ,TMEDIF          ,TJACUR          ,
      * TKJX          ,TKNHCX          ,TKNHCX          ,WNOZEN          ,WNOZI          ,
      * ZMAX          ,ZMIN          ,ZTROT
      COMMON /AZ01/
      * CSUBP(30,20)          ,FILMHF(30,20)          ,PRESS(30,20)          ,RHOFLU(30,20)          ,
      * RHOFTP(30,20)          ,TFLUID(30,20)          ,TMETAL(30,20)          ,WRATEN(30,20)
      * WRATEN(30,20)
      COMMON /AZ10/
      * FILMHF(30)          ,FILMNT(30)          ,FILMTN(30)          ,HRNOZM(30)          ,HRNTCN(30)          ,
      * RHONZX(30)          ,RHONZN(30)          ,PTUBE(30)          ,RHONTM(30)          ,RHONTN(30)          ,
      * RHONZN(30)          ,RHONZN(30)          ,TCOLD(30)          ,THOT(30)          ,TJACK(30)          ,
      * TJKTD(30)          ,TJKWD(30)          ,TNOZ(30)          ,TNOZM(30)          ,TNTCLD(30)          ,
      * TNTHOT(30)          ,TNTJWD(30)          ,TTUBE(30)          ,WNOZM(30)          ,WNOZN(30)          ,
      * WNTM(30)          ,WNTN(30)
      COMMON /BD/
      * BDASR          ,BDASR          ,BDMA          ,BDLP          ,BDN          ,
      * BDP          ,BDPO          ,BDS(10)          ,BDT
      COMMON
      * /BDLS/
      * ALINE          ,BDOWN          ,BDPD          ,CPVOL          ,INASS          ,
      * LFILM          ,PINPUT          ,PTNKIN          ,TAMB          ,TTNKIN

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COMMON /EXTRA/
* PUMIP      .QPUM      .TCX      .TNKRHO      .TPT2      .
* TPCR      .TPQ      .TPK2      .TPKPD      .TPWH      .
* KPUMPI     .WBEAR     .HBEAR     .WPUMPC      .
* ATURNZ     .ATURN     .ATURNZ     .AROLNZ      .PMIX      .
* PAVG       .BPMAX     .DTURBL     .PPIN       .TAVE      .
* CR         .TTURIP    .GANTI     .GAMMA      .PTOOLQ     .
* HDILX      .CPTI      .TURBK     .TTXST      .KVLMIN     .
* KTPMIN     .MPCNT     .PCARD     .TCTMP      .TPW       .
* TPRK       .TIMER     .ZM1      .DELPT      .DELPMT     .
* DELZP      .ZM       .TK         .DTRGT      .DELZT      .
* HLPFH      .HLPCH     .RNDIST    .RFN        .O          .
* TRCTZ      .WNCF      .WNCF1     .WNNIT      .MTONT      .
* TCHOK      .THETA1    .THETA2    .MAN3       .MEN3       .
* FNTH       .TDIFM     .SACPR     .FNTC       .MDN2       .
* INTMD1     .FJ        .MCN1      .MDN1       .TMTCD1     .
* MBN2       .ETAP      .TPT20     .METLTN     .TPTAV      .
* TIMEZ      .DUM       .OMAX      .OZ         .TEMPTM(30) .
COMMON
*/FLAG/
* ETAPFL     .HBPFH     .MASS      .MTIME      .MTIME      .
* NNT        .QREN      .OPTION     .PMIND      .STATE      .
* TANK       .TAPE      .TFLUM     .TIMEI      .TIMEX      .
* TNETMD     .WINT      .TIMES(10) .
COMMON
*/FX/
* DELTEM(2C) .FLUTEM(20) .METTEM(20) .MSMALL(20) .MTPNTS(20) .
* PARTI(20)  .PARTPS(20) .TEMPEX(20) .
COMMON
*/GUES/
* PCTCE      .PTANK     .PTURDE     .PUMHDE     .PUMOG      .
* PUMHKE     .TDIL      .TANK       .TNETI      .TURSPD     .
* WDILE      .WDILG     .WHEPG      .WNTC       .WORKE      .
* WPLMPG
COMMON
*/HBPS/
* ACORG      .ANNUL     .ANGZT     .BELSEC     .CFILMA     .
* CFILMB     .CGAS      .CGAS      .COMP       .DCWH      .
* GHBP       .DILANG    .DPASS     .FCOLD      .FMDT       .
* MBQG       .HFILMA    .HFILMB     .HFILMC     .NGAS      .
* INCOMP     .KDIL      .KDIL      .KHPI       .KJTUR     .
* KPCM       .KPHM      .K11       .K9         .LHEP      .
* MTHICK     .NCWH      .NHEP      .NPASS     .RPASS      .
* BELLC(2C)
COMMON /MISC/
* PCX        .PDK       .PDKV      .PTURDC     .PTUROP      .
* HBPV       .HBPW      .HBPWC     .HBPWNC     .
* METLTD     .MINFLG    .PASSX     .SSOUT      .WPIT       .
* ITEM(20)   .DTEMP(20) .DELHN2(200) .PUMP(350)  .FILMA(20) .
* FILMB(20)  .FILMC(20) .TCFLG(20) .
COMMON /NAMTAG/
* DILREM     .HM        .HX        .MPARTS(30) .NTNAME     .
* PARTS(20)  .PLNAME    .PH(5)     .PX(5)      .TM(5)      .
* IDELZ(20)  .TPARTS(20) .TX(5)     .WM(5)      .MX(5)      .
* MPARTS(5,5) .CPARTS(20) .CDELZ(20) .
COMMON /NTNZ/
* PHINZ(30)  .CPDR      .ENTMD(30) .HKPR       .PHINT(30) .
* RFTC       .PKPR      .PTCX      .QCLDNT(30) .QOCTNT(30) .
* VNTI       .RHODP     .TGLOC     .TTC        .
COMMON
*/NTS/
* AJB        .AJE       .AJF       .ANF        .ANH        .
* BJB        .BJE       .BJF       .BNF        .BNH        .
* CJB        .CJE       .CJF       .CNF        .CNH        .
* DNT        .FNT       .KNTI      .KNTQ       .NODES     .
* NOZEFF     .NTDZ      .THETA     .THRGAT     .TNTIM     .
* VNTI       .VNTC      .
COMMON /DFC/
* FFTAB(4,30) .HFTAB(5,30) .OPT(30)
COMMON
*/P/

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* ALPHA      .BETA      .DIST      .EPUMC      .EPUMP      .
* ETRC       .ETURP     .FILMCX     .GATEP     .HDPUM     .
* HVC        .HSVP      .MHT       .NHT       .NTURC     .
* NTURP      .PCOR      .PCUR       .PDIL      .PHEP      .
* PMINGX     .PNTI      .PNTO       .PPUMOC     .PPUMQP     .
* PIANXX     .PTURIX    .PTUROR    .QPUMP     .RFLU      .
* SAC        .TCOR      .TCOROR   .TCUR      .TOILX     .
* THBPQ      .TIME      .TIMEP     .TNETL     .TNTI      .
* TINTO      .TPUMOC    .TPUMQP   .TTANKX    .TTURIX    .
* TIZMIX     .UIHG      .WCUR      .WDILX     .WHEP      .
* WNOZ       .WNTCK     .WNTI      .WNTG      .WPUMC     .
* WPUMP      .WTURB
COMMON
*/PALS/
* AGL        .APUMI     .DCL       .DNTI      .KNTIL     .
* KPLMI      .MCL       .PCL       .VALPD
COMMON
*/PRTS/
* ANOZI      .APD       .AREFI     .AREFO     .ARMAIN    .
* ARTUR      .ASHL10    .ASHL20    .ATURXS
COMMON /PTC/
* DISPT(20) .PDROP(20) .PDROPO(20) .PRESI(20) .PRESQ(20) .
* RHONI(20) .RHONO(20) .RHONI(20) .RHONO(20) .TEMPI(20) .
* TEMPO(20) .TIMEZM(20) .WDELM(20) .WDELMO(20) .WDELNI(20) .
* WDELMO(20) .WRATEI(20) .WRATEO(20)
COMMON /SKIRTC/NOBS,NOBDEK,KSTI,KSTO,SKDZ,SZMIN,STATIC.
* PSTI,TSTI,WSTI,PSIO,TSTC,WSTO.
* ASTH(30),ASTW(30),SKBN(30),COST(30),CPST(30),SCFWP(30),SKCG(30),
* SKDEL(30),DSNZW(30),NTIP(30),NTIT(30),NTIW(30),NZIP(30),NZIT(30),
* NZIW(30),RHGST(30),SKRN(30),SSNZ(30),SSTH(30),TKSTH(30),SNODES(30)
* ,ENTHOS(30),FILMSZ(30),FILMST(30),HRSNZW(30),HRSTH(30),PHIST(30),
* PHILZ(30),PSNZ(30),PSTUB(30),QHOTST(30),RHOSTN(30),RHOSZN(30),
* TEHT(30),TSNZ(30),TSNZW(30),TSTHOT(30),TSTUB(30),WSNZN(30),
* WSTN(30),FTCTST(30),HTOTST(30),TTOTST(30)
COMMON
*/TABI/
* AJHT(30)   .ANTC(30)   .ANTH(30)   .ANTW(30)   .CDJ(30)   .
* CONT(30)   .CFWP(30)   .CG(30)     .CPJ(30)   .CPNT(30)   .
* CRJ(30)    .CRJMT(30)  .DEL(30)   .DELPNT(30) .DELPNZ(30) .
* DNOZM(30)  .GATE(30)   .GP(30)    .HGFJ(30)  .HGFNTC(30) .
* HGFNTH(30) .HGJ(30)    .HGNTC(30) .HGNTH(30) .KPD(30)   .
* KPDV(30)   .KV(30)    .NT(30)    .PAMB(30)  .PBD(30)   .
* PC(30)     .PINLEI(30) .PLINE(30) .PRATIO(30) .PTURMO(30) .
* QPD(30)    .RHUJ(30)  .RHGNT(30) .RN(30)    .SJD(30)   .
* SNOZ(30)   .SNTC(30)  .SNTH(30)  .SNTJ(30)  .SSPRT(30) .
* TC(30)     .TINLET(30) .TKJ(30)   .TKNTC(30) .TKNTH(30) .
* TUREFF(30) .VNODES(30) .WDIL(30)   .WPUM(30)   .
* TURIT(30)  .TURIP(30) .HBFLOW(30) .BEND(30)
COMMON
*/TABJ/
* DELZ(20)   .FRICF(20)  .HFFLG(20) .KDP(20)   .KCPD(20)   .
* NOELZ(20)  .PLENI(20)  .PLEND(20) .RHOMTL(20) .TNODE(20) .
* TTK(20)    .VOIDF(20) .WALL(20)
COMMON
*/TABIJ/
* ARLW(30,20) .CAP(30,20) .CONDI(30,20) .H6(30,20) .HGF(30,20) .
* WETP(30,20)
COMMON /TAGS/
* DTAG      .I         .IDELZS    .IEND      .IM        .
* J         .JEND      .K         .KEND      .L        .
* LEND      .MTAG      .NOFIND    .NTAG      .PTAG      .
* XTAG      .II        .NMONT      .NOBNT     .NOCENT    .
* NZTROT    .NTGNT     .NMONT      .NODEPT    .NPARTS    .
* J         .KK        .LL        .INODE     .KLOOP     .
* REF       .IDELT     .NTPNTS    .NOBZ      .NK        .
* TTAG      .CTAG      .CJ         .REFR
COMMON /TIMET/TPASS
COMMON /TP/
* AFLWX     .BATERN     .BATERS    .CDMTL     .CPTERM    .
* DELZ      .DELHN      .DBLHN      .DELMNX    .DELPN     .

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* DELTER      ,DHYDRA      ,DPIPE      ,DTERM      ,CZTERM      ,
* ENTROP      ,ETAT      ,ETATP      ,GPN      ,HFTERM      ,
* HGCOEF      ,HGTGT      ,HPUMI      ,HTCCEF      ,HVTERM      ,
* H12         ,KT         ,KVN      ,KWC      ,KWCP      ,
* KWCY      ,KWH      ,KWHV      ,KWT      ,K1      ,
* K2         ,K3         ,K4         ,K6      ,MTERM1      ,
* MTERM2      ,MTERM3      ,MTERM4      ,NPRN      ,NTERM      ,
* PHI         ,PMOZO      ,PNITHR      ,PRESM      ,PRGUES      ,
* PRPRIM      ,PRTERM      ,PSTP      ,PTANKN      ,P6N      ,
* PEN         ,P8PR      ,QN      ,QPM      ,QTERM      ,
* RHCR      ,RHOTKM      ,RHOTKN      ,RPM2      ,SPRIME      ,
* STERM      ,STSTAG      ,TFLUSR      ,TIMENT      ,TIMEN      ,
* TTANKN      ,TTURQ      ,TMP      ,TTUTERM      ,T11N      ,
* T11SR      ,TON      ,WATERM      ,WDILN      ,WDTERM      ,
* WERROR      ,WETWER      ,WHSBN      ,WI      ,WNCCHK      ,
* WNT         ,WPACTN      ,WRTERM      ,WTERM      ,WTURN      ,
COMMON
*/TPAS/
* ARE      ,ATURO      ,ATURX      ,DROLNZ      ,DTUR      ,
* DTURNZ      ,ETAMIN      ,GATEFG      ,KBEAR      ,KTURO      ,
* KTURX      ,MURT      ,NWORK      ,PTURI      ,TIPVEL      ,
* TURI      ,NWORK
COMMON /TSTP/HMIX,KDILN,KHBRN,KJTUN,NINDP,TIPVIN,EINDC,PINDIN,
*HINCIN,TINDIN,PVAPIN,HSVINP,HINDEX,EINDP,INDPH,PINDEX,ETAIND,
*PMID,TMID,EINTC,PMIDSG,TMIDSG,EINTP,ETAIN,AMID,CEE,KMIDP,AMIDP,
*QMIDP,MINNW,MINNP,ETAMN,MUIT,DINDBL,RHO1,RHO2,RHO3,RHO4,TINDEX,
*SPIN,SPIN2,SPEED2,TTXSTP,TTTOT,TTXGIS,TTXGIS,ETAINP,FLOWP,NINDC
* ,CZL(30),INTERF(30),QID(30),INDHD(300),INDEF(300)
COMMON
*/VALS/
* KL      ,KO      ,KMIN      ,VLSMT      ,VSMTRC      ,
COMMON
*/X/
* EOFTAP      ,INDTUR      ,INTFLO      ,LARGET      ,LESPQ      ,
* LCCPN      ,MCAP      ,NEGW      ,NONGP      ,NONSPD      ,
* MNTC      ,MOWW      ,NOTURN      ,NOTURN      ,NTERR      ,
* PARONE      ,WTER
EQUIVALENCE (AFLW(1,1),ZTAB1(1)), (AJHT(1),ZTAB1(1)), (CSUBP(1,
*1),ZAZO1(1)), (FILMNZ(1),ZAZ10(1)), (ALPHA,ZP(1)), (ANOZTX,ZAT(1))
* ,(AFLCWZ,ZTP(1)), (DELTEM(1),ZFX(1)), (DISPRT(1),ZPT(1)), (EOFTAP,
*ZX(1)), (EDASK,ZBD(1)), (PCX,ZMISC(1)), (ARG,ZADD(1)), (DILREM,
*ZNAM(1)), (PUMIP,ZEX(1)), (FFTAB(1,1),ZOPC(1)), (CPDP,ZNTNZ(1))
* ,(ZSK(1),NOES), (ZTS(1),HMIX)
DO 10 I=1,11
10 BD (I) = 0.000
DO 20 I=1,27
20 FLAGS (I) = 0.000
DO 30 I=1,16
30 GUESS (I) = 0.000
DO 40 I=1,55
40 HBP (I) = 0.000
DO 50 I=1,27
50 NOZTUB(I) = 0.000
DO 60 I=1,5
60 PIL (I) = 0.000
DO 70 I=1,3
70 PRSS (I) = 0.000
DO 80 I=1,17
80 TPA (I) = 0.000
DO 90 I=1,5
90 VALVE (I) = 0.000
DO 100 J=1,20
100 DELZ (J) = 0.000
100 FRICF (J) = 0.000
100 HFFLG (J) = 0.000
100 KDPI (J) = 0.000
100 KDPO (J) = 0.000
100 NOELZ (J) = 0.000
100 PLENI (J) = 0.000

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PLEND (J) = 0.000
RHOMTL(J) = 0.000
TNODE (J) = 0.000
TTK (J) = 0.000
VOIDF (J) = 0.000
100 WALL (J) = 0.000
```

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DO 110 I=1,3660
110 ZTABI(I) = 0.000
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DO 120 I=1,1620
120 ZTABI(I) = 0.000
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DO 130 I=1,5460
130 ZAZOI(I) = 0.000
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DO 140 I=1,810
140 ZAZOI(I) = 0.000
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DO 150 I=1,57
150 ZP(I) = 0.000
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DO 160 I=1,58
160 ZAT(I) = 0.000
```

```
DO 170 I=1,52
170 ZTP(I) = 0.000
```

```
DO 180 I=1,160
180 ZP(I) = 0.000
```

```
DO 190 I=1,360
190 ZP(I) = 0.000
```

```
DO 200 I=1,18
200 ZX(I) = 0.000
```

```
DO 210 I=1,20
210 ZBD(I) = 0.000
```

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DO 220 I=1,684
220 ZMISC(I) = 0.000
```

```
DO 230 I=1,6919
230 ZAOB(I) = 0.000
```

```
DO 240 I=1,115
240 ZEX(I) = 0.000
```

```
DO 250 I=1,190
250 ZNAM(I) = 0.000
```

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DO 260 I=1,300
260 ZP(I) = 0.000
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DO 270 I=1,158
270 ZP(I) = 0.000
```

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DO 280 I=1,10
280 TPASS(I) = 0
```

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DO 290 I=1,1303
290 ZSK(I) = 0.000
```

```
DO 300 I=1,739
300 ZSK(I) = 0.000
```

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END
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