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CALCULATION OF EDDY VISCOSITY IN A COMPRESSIBLE TURBULENT BOUNDARY LAYER WITH MASS INJECTION AND CHEMICAL REACTION

Volume II

By Satoaki Omori
University of Alabama Huntsville
Huntsville, Alabama

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16. ABSTRACT

This report serves as a supplement to Reference 1. As described in Volume I of this set, the eddy viscosity is calculated through the turbulent kinetic energy, in order to include the history of the flow and the effect of chemical reaction on boundary layer characteristics. Calculations can be performed for two different cooling concepts; that is, transpiration and regeneratively cooled wall cases. For the regenerative cooling option, coolant and gas side wall temperature and coolant bulk temperature in a rocket engine can be computed along the nozzle axis. Thus, this computer program is useful in designing coolant flow rate and cooling tube geometry, including the tube wall thickness as well as in predicting the effects of boundary layers along the gas side wall on thrust performances.

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FOREWORD

This report is part of a two volume set which describes a compressible turbulent boundary layer analysis using the turbulent kinetic energy approach and a computer program that is a modified version of MABL (Reference 1) and includes wall and coolant temperature calculations. Volume I contains the description of analytical concepts to obtain the eddy viscosity by solving the turbulent kinetic energy equation and it shows the result of sample calculations.

Volume II describes the modified computer program to include the eddy viscosity calculation and serves as a supplement user's manual to Reference 1.

This work was conducted for the George C. Marshall Space Flight Center, National Aeronautics and Space Administration under the cooperative agreement between the University of Alabama in Huntsville and the George C. Marshall Space Flight Center under Modification 7, NCA 8-68.

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I. INTRODUCTION

This report serves as a supplement to Reference 1. As described in Volume I of this set, the eddy viscosity is calculated through the turbulent kinetic energy, in order to include the history of the flow and the effect of chemical reaction on boundary layer characteristics. Calculations can be performed for two different cooling concepts; that is, transpiration and regeneratively cooled wall cases. For the regenerative cooling option, coolant and gas side wall temperature and coolant bulk temperature in a rocket engine can be computed along the nozzle axis. Thus, this computer program is useful in designing coolant flow rate and cooling tube geometry, including the tube wall thickness as well as in predicting the effects of boundary layers along the gas side wall on thrust performances.

Two computer programs were developed; TBLEDY (Turbulent Boundry Layer Computer Program including Eddy Viscosity Calculations) and AIREDY (Air Flow Computer Program with mass injection of a mixture of hydrogen and nitrogen).

Since the main difference of TBLEDY from MABL (Reference 1) is found in Subroutine EDDY, and the input data for the calculations are exactly the same as in MABL, only the solution method in Subroutine EDDY and the description of program output which was modified will be shown.

The second computer program, AIREDY, was developed for the purpose of comparing the calculated results with available experimental data when combustion occurs in the boundary layer due to the mixture

of hydrogen and nitrogen injection through a porous wall. Because of the addition of the element, Nitrogen, N, to the elements, H and O, the following nine species are considered for the air flow with combustion: H, H_2, H_2O, O, OH, O_2, N, NO, and N2, the last three species having been added. Therefore, modifications to subroutines BLKDTA, ELEMTS, EXECUT, HØØDE, HPCALC, NLØUT, ØDE, PRINT, PRØFIL, SPCALC, TABLES, TFCBL (Main Routine), TPCALC, and VISCX were necessary. Common blocks in the remaining subroutines were also modified.

Subroutine EDDY calculates the turbulent kinetic energy and the eddy viscosity, and it is the same in both TBLEDY and AIREDY except for common blocks.

Since detailed descriptions of most of the boundry layer subroutines can be found in Reference 1, as well as the definitions of program symbols, only the modifications of the program input data and the printed outputs are explained.

The sample cases are included to illustrate the use of the program: one is for the rocket nozzle combustion product flow of hydrogen and oxygen with transpiration cooling, and the other is for air flow with combustion due to injection of a mixture of hydrogen and nitrogen. The listings of computer programs TBLEDY and AIREDY, are included in Appendix A and B, respectively.

II. SUBROUTINES

1. Subroutine BLKDTA

This subroutine stores atomic symbols, weights, and valences of 105 elements.

Thermal and reactants data are taken from Reference 2. The assigned enthalpy (ENTH) of each reactant for a corresponding temperature (RTEMP) is given in calories per mole in Table VII of Reference 2.

The constants used in the empirical equations for specific heat, enthalpy, and entropy, as functions of temperature are given in the form of least squares coefficients as follows:

$$\frac{Cp^\circ}{R} = a_1 + a_2T + a_3T^2 + a_4T^3 + a_5T^4$$

$$\frac{H_T^\circ}{RT} = a_1 + \frac{a_2}{2}T + \frac{a_3}{3}T^2 + \frac{a_4}{4}T^3 + \frac{a_5}{5}T^4 + \frac{a_6}{T}$$

$$\frac{S_T^\circ}{R} = a_1 \ln T + a_2T + \frac{a_3}{2}T^2 + \frac{a_4}{3}T^3 + \frac{a_5}{4}T^4 + a_7$$

The seven coefficients above are stored in the array

COEF (i, j, k)

where

i=1 for the upper temperature interval

i=2 for the lower temperature interval

j=1,...7,for the 7 coefficients, a_j,

k=1,...150 for the number of species.

TBLEDY considers k=1,2,... and 6 , H, H_2, $H_2\emptyset$, $H\emptyset$, $\emptyset H$, and $\emptyset_2$, respectively, while AIREDY includes an additional three species, k=7, 8, and 9, N, $N\emptyset$, and N_2.

2. Subroutine EDDY (Common to TBLEDY and AIREDY)

The turbulent kinetic energy equation to be solved is (See Volume I):

$$\bar{\rho}\,\bar{u}\,\frac{\partial K}{\partial S} + (\bar{\rho}\,\bar{v} + \overline{\rho' v'})\,\frac{\partial K}{\partial y} = 2k\rho\Lambda K^{1/2}\frac{\partial}{\partial y}\left(\frac{\bar{u}}{y}\right)\left|\frac{\partial \bar{u}}{\partial y}\right| + \frac{\partial}{\partial y}\left[(\mu + \alpha\,\bar{\rho}\,\Lambda K^{1/2})\right] - \bar{\rho}\mu\beta\frac{K}{\Lambda^2} - \gamma\frac{\rho K}{\Lambda} \qquad (1)$$

Assuming that the terms containing molecular viscosities, μ, are negligible, and considering the definition of eddy viscosity, ε, the above equation is written as

$$\bar{\rho}\,\bar{u}\,\frac{\partial K}{\partial s} + (\bar{\rho}\,\bar{v} + \overline{\rho' v'})\,\frac{\partial K}{\partial} = 2\,\varepsilon\,\frac{\partial \bar{u}}{\partial y}\,2 + \frac{\alpha}{K}\,\frac{\partial}{\partial y}\,\varepsilon\frac{\partial K}{\partial y} - \gamma\bar{\rho}K^{3/2}/\Lambda \qquad (2)$$

where

$$\varepsilon = \varepsilon_i = \bar{\rho}\,\ell^2\,\left|\frac{\partial \bar{u}}{\partial y}\right| \quad \text{for} \quad \bar{\rho}\,\ell^2\,\left|\frac{\partial \bar{u}}{\partial y}\right| \leq \kappa\,\Lambda\bar{\rho}K^{1/2} \qquad (3)$$

and

$$\varepsilon = \varepsilon_o = k\,\Lambda\bar{\rho}\,K^{1/2} \quad \text{for} \quad \rho\ell^2\,\left|\frac{\partial \bar{u}}{\partial y}\right| > k\,\Lambda\,\bar{\rho}\,K^{1/2} \qquad (4)$$

At the matching point where ε_i and ε_o coincide, assume that the following two terms are predominant in Eq. (2),

$$2\,\varepsilon_i\left(\frac{\partial \bar{u}}{\partial y}\right)^2 - \gamma\bar{\rho}\,K^{3/2}/\Lambda \simeq 0 \qquad (5)$$

then the substitution of Eq. (4) into Eq. (5) yields

$$\varepsilon_o \simeq \left(\frac{2k^3}{\gamma}\right)^{1/2}\bar{\rho}\,\Lambda^2\left(\frac{\partial \bar{u}}{\partial y}\right) \qquad (6)$$

This means that, at the matching point where $\varepsilon_i = \varepsilon_o$, the prandtl mixing length, ℓ, and the dissipation length, Λ could be related by

$$\ell^2 \simeq \left(\frac{2k^3}{\gamma}\right)^{1/2}\Lambda^2 \qquad (7)$$

If we select k=0.6 and $\gamma = 0.36$ in the case without mass injection, then Eq. (7) yields

$$\ell \simeq 1.048\Lambda \tag{8}$$

That is, the modeling of the dissipation length should be related to the prandtl mixing length in the vicinity of the wall, where the matching condition is considered. The polynomial relation of dissipation length is therefore defined in Volume I

$$\frac{\Lambda}{\delta} = \frac{y}{\delta}\left[0.2050\left(\frac{y}{\delta}\right)^2 - 0.5860\left(\frac{y}{\delta}\right) + 0.4310\right] \tag{9}$$

In order to nondimensionalize Eq. (2), the following symbols are defined in addition to the symbols in Reference 1:

$$\begin{aligned} \varepsilon^* &= \varepsilon/\mu_r \\ K^* &= K/U_r^2 \\ \bar{\Lambda} &= \Lambda/L\zeta \end{aligned} \tag{10}$$

(Note that the definition of the eddy viscosity, ε, is different from that in Reference 1.) Then, Eq. (2) is written as

$$\rho^* u^* \frac{\partial K^*}{\partial S^*} + \left(\rho^* v^* G' - \rho^* u^* \frac{G'\zeta'\tilde{y}}{\zeta}\right)\frac{\partial K^*}{\partial y^*}$$

$$= 2\,\varepsilon^* \frac{G'^2}{Re_r\zeta^2}\left(\frac{\partial u^*}{\partial y^*}\right)^{\frac{1}{2}} + \frac{G'}{\zeta}\frac{\partial}{\partial y^*}\left(\frac{\alpha\varepsilon^*}{Re_r\zeta}\frac{\partial K^*}{\partial y^*}\right) - \gamma\frac{\rho^* K^{*3/2}}{\zeta\bar{\Lambda}} \tag{11}$$

where

$$\varepsilon_t^* = \bar{\rho}\, \ell^2 \left|\frac{\partial \bar{u}}{\partial y}\right| / \mu_r \tag{12}$$

$$\varepsilon_o^* = k\, \Lambda\, \zeta\, \rho^* K^*\, R_{e_r} \tag{13}$$

and

$$R_{e_r} = P_r\, U_r\, L/\mu_r \tag{14}$$

Substituting the following definitions as shown in Reference 1 into Eq. (11),

$$F = \frac{G'}{R_{e_r}\, \zeta^2} \tag{15}$$

and

$$T_2 = \rho^* v^* G' - \rho^* u^* \frac{G' \zeta' \tilde{y}}{\zeta} \tag{16}$$

we obtain

$$\rho^* u^* \frac{\partial K^*}{\partial s^*} + T_2 \frac{\partial K^*}{\partial y^*} = 2\varepsilon^* F G' \left(\frac{\partial u^*}{\partial y^*}\right)^2 + \alpha F \frac{\partial}{\partial y^*}\left(\varepsilon^* \frac{\partial K^*}{\partial y^*}\right) - \gamma \frac{\rho^* K^{*\frac{3}{2}}}{\zeta\, \Lambda} \tag{17}$$

Define

$$BRKT = 2\, \varepsilon^*\, FG' (\partial u^*/\partial y^*)^2$$

$$TM1 = \alpha F G'\, \varepsilon^* \tag{18}$$

$$TM2 = \alpha F\, (\varepsilon^* G''/G' + G'\, \partial \varepsilon^*/\partial y^*) \tag{19}$$

$$TM3 = \varepsilon^{*3}\, (k\, R_{e_r}\, \zeta\, \rho^* \Lambda)^{-3} \tag{20}$$

and

$$TM4 = BRKT - \gamma\, TM3\, \rho^*/ (\xi\, \tilde{K}) \tag{21}$$

then Eq. (17) becomes

$$\rho^* u^* \frac{\partial K^*}{\partial s^*} + T2 \frac{\partial K^*}{\partial y^*} = BRKT + TM1 \frac{\partial^2 K^*}{\partial y^{*2}} + TM2 \frac{\partial K^*}{\partial y^*} \tag{22}$$

The above equation is written in a finite difference form as

$$\rho^* u^* \frac{K^*_{m+1,n} - K^*_{m,n}}{\Delta s^*} + (T2 - TM2) \left(\frac{1}{2} K^*_{y_{m,n}} + \frac{K^*_{m+1,n+1} - K^*_{m+1,n-1}}{4\, \Delta y^*} \right)$$

$$- TM1 \left(\frac{1}{2} K^*_{yy_{m,n}} + \frac{K^*_{m+1,n+1} - 2\, K^*_{m+1,n} + K^*_{m+1,n-1}}{2\, \Delta y^*} \right) = TM4 \tag{23}$$

Thus, the resulting implicit finite difference equation for the turbulent kinetic energy is written in the following form:

$$A_3(n)\, K^*_{m+1,n+1} + A_2(n)\, K^*_{m+1,n} + A_1(n)\, K^*_{m+1,n-1} = B(n) \tag{24}$$

where

$$A3(n) = \frac{T2 - TM2}{4\, \Delta y^*} - \frac{TM1}{2 \Delta y^{*2}} \tag{25}$$

$$A_2(n) = \frac{\rho^* u^*}{\Delta S^*} + \frac{TM1}{\Delta 6^{*2}} \tag{26}$$

$$A_1(n) = -A_3(n) - \frac{TM1}{\Delta y^{*2}} \tag{27}$$

and

$$B(n) = TM4 + \frac{\rho^* u^* K^*_{m,n}}{\Delta S^*} - \frac{T2 - TM2}{2} Ky^*_{m,n} + \frac{TM1}{2} Kyy^*_{m,n} \tag{28}$$

Eq. (28) is solved in Subroutine EDDY by calling Subroutine TRIM with the boundary layer conditions of

$$K^*_{n=1} = o \text{ and } K^*_{n=NMAX} = o \tag{29}$$

The constants, k, α and γ in Eq. (17) are

Physical Quantity	Program Variable
$k = 0.6$	ZK
$\alpha = 0.1/k$	ALFA
$\gamma = 0.36 + 42.0$ F in TBLEDY (Where F is the mass flow ratio defined in Volume I.)	GAMA
γ to be input in AIREDY	

The dissipation length $\tilde{\Lambda}$ is defined as BN:

$$\tilde{\Lambda} = \tilde{y} \left[0.2050 \left(\frac{\tilde{y}}{\tilde{\delta}}\right) - 0.5860 \left(\frac{\tilde{y}}{\tilde{\delta}}\right) + 0.4310\right] \tag{30}$$

The calculation methods of the inner eddy viscosity ε_i^*, and the turbulent Prandtl number are exactly the same as in Reference 1; ε_i^* being presently defined as CUV.

The remaining definitions of program variables are shown below.

Physical Quantity	Program Variable
K^*	CUU
$\partial K^*/\partial y^*$	CUUYMN
$\partial^2 K^*/\partial y^{*2}$	UUYYMN
$\tilde{\delta}_{.990}$ or $\tilde{\delta}_{.995}$	SDELTA

3. Subroutine ELEMTS (AIREDY)

This subroutine solves two element conservation equations for hydrogen and nitrogen to obtain the element mass fractions of hydrogen and nitrogen, α_H and α_N, respectively, at each mesh point in the boundary layer. The element mass fraction of oxygen, αo, is then equal to $(1-\alpha_H - \alpha_N)$ at each mesh point.

The normalized finite difference forms of the element conservation equations are the same as in Eq. (24), that is,

$$A_1\, \alpha_{m+1,\, n-1} + A_2\, \alpha_{m+1,\, n} + A_3\, \alpha_{m+1,\, n+1} = B$$

The nitrogen element conservation boundary conditions are at the edge of the boundary layer;

$$\alpha_N = \alpha_{N_e} \quad : \quad \text{ANEDGE (to be given)}$$

and at the wall;

$$\alpha_N = \alpha_{N_W} = \frac{4\,\alpha_{N_2} - \alpha_{N_3}}{3}$$

the elements, H, N, and Ø are defined in the program by IEL = 1, 2, and 3, respectively.

4. Subroutine HØØDE (AIREDY)

The main modification in the equilibrium subroutines is the definition of the program variable, ØF. In TBLEDY and Reference 1, ØF is the weight ratio of oxidizer to fuel. AIREDY defines ØF as the weight ratio of fuel to oxidizer, because the hydrogen element does not exist at the outer boundary layer edge for air flow.

5. Subroutine PRINT

The following values are calculated and printed in this subroutine:

Physical Quantity		Program Variable
$\delta_{.990}$ (AIREDY) or $\delta_{.995}$ (TBLEDY)	= Velocity thickness (in)	ZDELTA
$\tau = (\mu+\epsilon)\frac{\partial u}{\partial y}$	= Friction (lb_f/ft^2)	AØUT(1)
$\frac{\tau}{\rho_e U_e^2}$	= Dimensionless friction (-)	AØUT(2)
$\frac{\epsilon}{\rho U_e \delta}$	= Eddy viscosity (-)	AØUT(3)
$\frac{y}{\delta}$	= Distance from wall (-)	AØUT(4)
$\frac{K}{U_e^2}$	= Turbulent kinetic energy (-)	BØUT(3)
$\frac{\rho u}{\rho_e u_e}$	= Mass flow rate (-)	BØUT(4)
ϵ_i	= Prandtl eddy viscosity (lb_f sec/ft^2)	BØUT(5)
$u^+ = u/u_\tau = u/\sqrt{\tau_w/\rho}$	= Universal velocity	BØUT(6)
$y^+ = \rho y u_\tau/\mu$	= Universal distance	BØUT(7)

6. Subroutine PRØFIL

To initiate the calculation in AIREDY, the profiles of the element mass fractions, α_H, α_N and α_o are calculated as

$$\alpha_H(y) = \alpha_{H_w} + (\alpha_{H_e} - \alpha_{H_w})\, u/U_e$$

$$\alpha_N(y) = 0.80\,[1 - \alpha_H(y)]$$

and

$$\alpha_o(y) = 0.25\ \alpha_N(y)$$

The initial profiles of the turbulent kinetic energy, K*, and the eddy viscosity, ε^*, are assumed to be

$$K^* = 0.00005\, U_e^{-2}\ [1-(y/\delta)]^2\ y/\delta \quad : \text{CUU}$$

and

$$\varepsilon^* = k\, \Lambda\, \bar{\rho}\, K^{1/2} \mu_r \quad : \text{EPS}$$

7. Subroutine VISCX (AIREDY)

This subroutine was modified to include the species, N, NØ and N2.

The molecular viscosity, μ_i, of the species, N, NØ, and N_2 is tabulated as a function of temperature, in the range of T=100 through 5000°K, as in Reference 3.

III. DESCRIPTION OF PROGRAM INPUT

Only the modifications to Reference 1 are shown below.

1. Both in TBLEDY and AIREDY

[Flags and Options]

ICØØL — Integer flag, set as follows:

=0 for no regenerative cooling

=1 for the case with regenerative cooling and coolant flowing in the opposite direction to the combustion product flow.

=2 for the case with regenerative cooling and coolant flowing in the same direction as the combustion product flow.

ITHERM — Integer flag, set as follows:

=0 for the case that the internal THERMØ data are used.

=1 $THERMØ namelist is input to Subroutine ØDE.

IPØLY

=0 No polynominal coefficient calculation

=1 A set of polynominal coefficients for the corrected wall contour is to be calculated.

The following inputs are necessary, when ICØØL = 1 or 2. For ICØØL = 0, one may ignore this input data.

[Regenerative Cooling Inputs]

CØEFCL	Efficiency of the regenerative cooling (-1)
MASSL	Hydrogen Coolant mass flow rate (lb_m/sec)
RAMDW	Thermal conductivity of the cooling tube wall (BTU/ft sec. °R)
TUBEN	Number of cooling tubes (-)

[Coolant Properties Tables]

ITZTAB	Integer: Number of points in temperature versus C_{p_ℓ}, λ_ℓ, and μ_ℓ table
TZTAB	Coolant temperature table used to obtain C_{p_ℓ}, λ_ℓ, and μ_ℓ (°R)
CPLTAB	Coolant specific heat, C_{p_ℓ} (BTU/lb_m °R)
RAMTAB	Thermal conductivity of coolant, λ_ℓ (BTU/ft. sec°R)
ZMYTAB	Molecular viscosity of coolant, μ_ℓ (lb_m/ft. sec)

The length of the following tables must be identical to that of the wall temperature table (TWTAB).

[Coolant Wall Tables]

ALTAB	Cross-sectional area of each cooling tube, A_ℓ, (ft^2)
THITAB	Wall thickness of cooling tubes, t, (ft)
TLTAB	Assumed coolant temperature, T_{ℓ_o} (°R)

In the case of ICØØL = 1 or 2, that is,for regenerative cooling calculations, the table of wall temperature, TWTAB, is used to initiate computation. The gas side wall temperature is internally calculated as TWGCA at each local station. The concept and method of calculation of regeneratively cooled thrust chambers can be found in Reference 4.

2. TBLEDY

All input data are exactly the same as in Reference 1. Since a strong chemical reaction occurs in the middle of boundary layers in the case with hydrogen injection from the wall, the following constants to stretch the normal distance to the wall are recommended

GPØ = 1000.0 and SN 3 = 2.50

Although the constants, γ = GAMA and k = ZK, are printed out, ignore them. For the constant k has been set equal to 0.6, and $\gamma = 0.36 + 42.0\ F$ in subroutine EDDY.

3. AIREDY

[Flags and Options]

INJH2 Integer flag, set as follows:

=0 for the case of ideal gas injection. The free stream is also a perfect gas.

=1 for the case of a mixture of hydrogen and nitrogen injection into the air free stream flow.

- For the option of INJH2 = 1, IDEAL should be equal to 1, and do not input the data, PRI, GAMMA, and FMØLWT. AFEDGE (=0), AFTRNS, and AFWALL must be input in this case. (If AFWALL is not input, the program sets AFWALL = AFTRNS.)
- For the option of INJH2 = 0, IDEAL must also be equal to 1, and do not input, AFEDGE, AFTRNS, and AFWALL. PRI, GAMMA, and FMØLWT must be input.

[Correlation Inputs]

GAMA — The constant γ appeared in the turbulent kinetic equation. (This input may be replaced by the relation, $\gamma = 0.36 + 42.0F$, in subroutine EDDY as in TBLEDY.)

Since the constant k = ZK has been set equal to 0.60 in subroutine EDDY, one can ignore this input. The constants, GPØ and SN3, are recommended to be input as 1000.0 and 2.50, respectively.

IV. DESCRIPTION OF PROGRAM OUTPUT

The assumed profiles of the velocity, turbulent kinetic energy, and EDDY viscosity used to initiate calculations are printed after the G-function output as

i	Mesh point number (wall=1), under the heading, NØ;
u/U_e	Velocity;
K/U_e^2	Turbulent kinetic energy;
ε	EDDY viscosity (lb_f sec/ft^2)

The following additional boundary layer quantities are printed above the profiles at desired stations:

RTHETA = $R_\theta = \frac{\rho_e U_e \theta}{\mu_e}$ Reynolds number based on the momentum thickness

THLØSS = $[(2\pi r \rho_e U_e \theta \cos\alpha)(1 - \frac{\delta^*}{\theta}\frac{P}{\rho_e U_e^2})]_{exit}$

Thrust loss due to boundary layer effects (Reference 5). THLØSS is calculated in subroutine PRINT. Positive value corresponds to the thrust loss, and negative vice versa. (lb_f)

For the option of regenerative cooling calculation (ICØØL = 1 or 2) the following quantities which are mostly calculated in subroutine PARAMS according to the method in Reference 4, are printed.

Name	Description	Units
TLO: $T_{\ell}(x_i - \Delta x_{i_1})$	Assumed coolant temperature in tubes at the next station towards the injector	°R
TL1: $T_{\ell}(x_i)$	Assumed coolant temperature in tubes at the station where cooling parameters are to be obtained	°R
TL2: $T_{\ell}(x_i + \Delta x_{i_2})$	Assumed coolant temperature in tubes at the next station towards nozzle exit.	°R
TAW: T_{aw}	Adiabatic wall temperature	°R
TLCA	Calculated coolant temperature	°R
TWL: $T_{w_{\ell}}$	Calculated coolant side wall temperature	°R
TWL2	(TLCA + TL1)/2.0	°R
TWGCA: T_{wg}	Arithmetic average of the assumed and calculated gas side wall temperatures (TWALL + TWGCA)/2.0	°R
TEMPRL: $T_{w\ell}/T_{\ell}$	Temperature ratio of the calculated coolant side wall temperature to the coolant temperature	--
CPL: Cp_{ℓ}	Coolant specific heat	BTU/lb_m °R
CPSUM	Specific heat of combustion products in free stream	BTU/lb_m °R

Name	Description	IUnits
DIATUB	Equivalent diameter of each cooling tube = 2 (Cross sectional area of each tube/π)$^{-1/2}$	ft
THICK:	Thickness of cooling tubes	ft
HG: hg	Heat transfer coefficient of combustion products	BTU/ft^{2}sec°R
QWI	Specific heat transfer rate, hg (T_{aw}-T_{w1})	BTU/ft^{2}sec
SUMQWI	Total heat input through the wall into the coolant between the initial and present stations based on QWI	BTU/sec
SQWI	Specific heat transfer rate calculated as $-\frac{\mu_w}{P_{r_w}} \left[\frac{\partial h}{\partial y} + (L_e-1) \sum_i h_i \frac{\partial Y_i}{\partial y}\right]_w$	BTU/ft^{2}sec
SQWDSI	Total heat input through the wall into the coolant between the initial and present stations based upon SQWI	BTU/sec
HL: h_ℓ	Heat transfer coefficient of the coolant fluid	BTU/ft^{2}sec°R
REYL	Reynolds number of the coolant flow in cooling tubes based on the equivalent tube diameter	---
PRANDL	Prandtl number of the coolant flow: $C_{p_\ell} \mu_\ell / \lambda_\ell$	---

Name	Description	Units
RAMDL	Thermal conductivity of coolant	BTU/ft^2 sec.°R
ZMYUL	Molecular viscosity of coolant	$lb_m/ft.$ sec.
STANRE	Stanton number defined as SQWI/[CPSUME*(TAW-TWALL)]	---

Four Groups of Profiles are next printed. In Group I, the EDDY viscosity ε (EPS) has a unit of ($lb_f sec/ft^2$) in TBLEDY and AIREDY. This is the only difference from Reference 1. Group II shows the velocity boundary layer thickness, δ, DELTA in inches ($\delta = \delta_{.995}$ in TBLEDY and $\delta = \delta_{.990}$ in AIREDY) and the following profiles:

TAU: τ	Friction: $(\mu + \varepsilon)\frac{\partial \bar{u}}{\partial y}$	lb_f/ft^2
TAU/(RE*UE2)	Normalized friction: $\frac{\tau}{\rho_e U_e^2}$	---
EPS/(RHØ UE DELTA)	Normalized EDDY viscosity: $\frac{\varepsilon}{\rho U_e \delta}$	---
YTIL/DELTA	Normalized distance from wall, y/δ	---

- Group III exhibits the following profiles:

Name	Description	Units
MU: μ	Molecular viscosity of combustion products	$lb_f sec/ft^2$
Y	Normalized coordinate (See Ref. 1)	---
K/UE2	Turbulent kinetic energy nondimensionalized by U_e^2	---
RU/REUE	Normalized mass flow rate: $\rho u/\rho_e U_e$	---

Name	Description	Units
MIXEDDY	EDDY viscosity based on the Prandtl mixing length	$lb_f sec/ft^2$
UDAG: $u^\dagger$	Universal velocity: $u^\dagger = u/u_\tau = u/(\tau w/\rho)^{1/2}$	---
YDAG: $y^\dagger$	Universal distance from wall: $y^\dagger = \rho y u_\tau / \mu$	---
PRT	Turbulent Prandtl Number	---

- Group IV shows the mixture ratio, species mass fraction, molecular viscosity, and laminar Prandtl number.

Except for the mixture ratio in AIREDY, this group of profiles is the same as in Reference 1. The mixture ratio in AIREDY is that of hydrogen to oxygen and nitrogen and indicated as F/Ø.

V SAMPLE CASE

CASE I

Rocket nozzle combustion product flow of hydrogen and oxygen with transpiration cooling.

*** P&W 250K TRNSP COOLED ENGINE, H2-02, SEPT 4, 1973 ******

FLAGS AND OPTIONS

IDEAL = 0	(=1 FOR PERFECT GAS, =0 FOR HYDROGEN-OXYGEN EQUILIBRIUM)
LAMNR = 0	(=1 FOR LAMINAR FLOW, =0 FOR TURBULENT)
INCOMP= 0	(=1 FOR INCOMPRESSIBLE FLOW, =0 FOR COMPRESSIBLE)
J2D = 1	(=1 FOR AXISYMMETRIC GEOMETRY, =0 FOR TWO-DIMENSIONAL)
INTDK = 0	(=1 IF INPUT TABLES COME FROM TDK OUTPUT, =0 OTHERWISE)
ICOOL = 0	(=0 NO COOLING, =1 OPPOSITE DIRECTION, =2 SAME DIRECTION)
ITHERM = 0	(=1 FOR STHERMO NAMELIST INPUT TO ODE, =0 OTHERWISE)
IPOLY = 0	(=1 FOR CALCULATION OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, =0 OTHERWISE)

PROBLEM LIMITS AND INITIAL VALUES

SINIT = .00000000 YINIT =-12.0000000 XMAX = 6.69999999 DXI = 2.0000000-03 DELTAI = 5.0000000-04 ZETAPI = 5.0000000-04

REFERENCE QUANTITIES

BLREF = 3.5000000-01 UREF = 1.0000000+03 RHOREF = 2.0000000-03 SHOREF = 5.0000000+07

INPUT NORMALIZATION FACTORS

XN = 8.3333300-02 YN = 1.0000000+00 UEN = 1.0000000+00 PEN = 4.4596800+05 SHON = 1.0000000+00

EDGE QUANTITIES

UEDGE = 4.0000000+02 PEDGE = 1.0000000+00 TEDGE = 6.6150000+03 AMEDGE = 1.3717920+01

CONSTANTS

AFTRNS = 9.9900000-01	PRI = 0.000000	GAMMA = 0.000000	FMOLWT = 0.000000	PLAW = 7.0000000+00	PINB = 0.000000	
GPO = 1.0000000+03	SN3 = 2.5000000+00	XSTAR = 0.000000	AMWALL = 8.0000000-01	UEK = 0.000000	RHOEK = 0.000000	

CONVERGENCE AND EDGE CRITERIA

CONVRG= 5.0000000-03 EPSLN1= 1.0000000-02 EPSLN2= 1.0000000-02 EPSLN3= 1.0000000-02 EPSLIN= 0.0000000

COUNTERS

MAXIT = 2 NVI = 120 NLPRNT = 40 NSPRNT = 40 INSTAT 69999 IYPR = 1 IYEQ = 8

CORRELATION INPUTS

GAMA = .500000 ZK = .600000

STEPSIZE CONTROL TABLES

LDXLIM= 12

DXLIM	XLIM
1.000000D-02	-1.195000D+01
1.000000D-02	-1.000000D+01
1.000000D-02	-8.000000D+00
5.000000D-03	-5.000000D+00
2.000000D-03	-3.000000D+00
2.000000D-03	-1.000000D+00
1.000000D-03	-5.000000D-01
8.000000D-04	-3.000000D-01
1.000000D-03	6.000000D-01
5.000000D-03	1.500000D+00
1.000000D-02	3.500000D+00
1.000000D-02	6.700000D+00

LSKTAB= 6

SKTAB	XTABSK
1.010000D+00	-1.200000D+01
1.010000D+00	-1.000000D+01
1.010000D+00	-1.000000D+00
1.010000D+00	5.000000D-01
1.010000D+00	3.000000D+00
1.010000D+00	6.700000D+00

WALL TABLES

LTWTAB= 18

YWTAB	XTABTW
1.900000D+03	-1.200000D+01
1.900000D+03	-1.065700D+01
1.900000D+03	-7.869600D+00
1.900000D+03	-6.405500D+00
1.700000D+03	-5.124400D+00
1.700000D+03	-4.026300D+00
1.700000D+03	-2.928200D+00
1.700000D+03	-1.830100D+00
1.700000D+03	-9.151000D-01
1.700000D+03	-5.000000D-01
1.700000D+03	-3.000000D-01
1.700000D+03	0.000000
1.900000D+03	2.000000D-01
1.900000D+03	4.239000D-01
1.900000D+03	1.229500D+00
1.900000D+03	2.299700D+00
1.900000D+03	4.417600D+00
1.900000D+03	6.700000D+00

LMDTAB= 29

SMDTAB	XTABMD
2.937400D-02	-1.200000D+01
2.937400D-02	-1.100000D+01
2.937400D-02	-1.050000D+01
3.276400D-02	-9.500000D+00
2.144600D-02	-8.500000D+00
2.144600D-02	-7.500000D+00
2.495400D-02	-6.500000D+00
2.211470D-02	-5.500000D+00
3.054570D-02	-4.500000D+00
2.940200D-02	-3.500000D+00
3.320160D-02	-2.600000D+00
5.147340D-02	-2.000000D+00
6.140730D-02	-1.500000D+00
8.974200D-02	-1.000000D+00
1.319840D-01	-5.000000D-01
1.388000D-01	-2.500000D-01
1.390000D-01	-1.000000D-01
1.388000D-01	-5.000000D-02
1.370000D-01	5.000000D-02
5.000000D-02	2.000000D-01
1.104380D-02	4.000000D-01
2.456290D-02	9.500000D-01
9.093510D-03	1.900000D+00
1.085450D-02	2.100000D+00
9.658640D-03	3.000000D+00
1.047540D-02	4.200000D+00
7.420450D-03	5.300000D+00
6.704230D-03	6.400000D+00
6.600000D-03	6.700000D+00

GEOMETRY AND EDGE TABLES

LRWTAB= 18		LPETAB= 18	
RWTAB	XTABRW	PETAB	XTABPE
6.3050000+00	-1.2000000+01	9.8159509-01	-1.2000000+01
6.3050300+00	-1.0065700+01	9.8153009-01	-1.0065700+01
6.3050300+00	-7.8696000+00	9.8130009-01	-7.8696000+00
6.2891000+00	-6.4055000+00	9.8114627-01	-6.4055000+00
6.0635000+00	-5.1244000+00	9.7979335-01	-5.1244000+00
5.8360000+00	-4.0263000+00	9.7451400-01	-4.0263000+00
4.9348000+00	-2.9282000+00	9.4829864-01	-2.9282000+00
4.1170000+00	-1.8301000+00	8.3095898-01	-1.8301000+00
3.7693000+00	-9.1510000-01	6.7375548-01	-9.1510000-01
3.6800000+00	-5.0000000-01	5.7400000-01	-5.0000000-01
3.6300000+00	-3.0000000-01	5.0000000-01	-3.0000000-01
3.6653000+00	0.0000000	3.4803520-01	0.0000000
3.7300000+00	2.0000000-01	2.5000000-01	2.0000000-01
3.8945000+00	4.2390000-01	1.4405877-01	4.2390000-01
4.5093000+00	1.2295000+00	1.7614143-01	1.2295000+00
5.0288000+00	2.2997000+00	8.9880530-02	2.2997000+00
6.3523000+00	4.4176000+00	6.0309977-02	4.4176000+00
8.3800000+00	6.7000000+00	5.5000000-02	6.7000000+00

H	2.0000	.0000	.0000	.0000	.0000	100.0000	F	.00	G	298.150	F	.00000
O	2.0000	.0000	.0000	.0000	.0000	100.0000	F	.00	G	298.150	O	.00000

	FUEL	OXIDANT	MIXTURE
H,CAL/G	.00000000	.00000000	.00000000
V+	.99206344+00	.00000000	.49603174+00
V-	.00000000	-.12500000+00	-.62500000-01
ATOMS/G			
H	.99206344+00	.00000000	.49603174+00
O	.00000000	.62500000-01	.31250000-01

SPECIES BEING CONSIDERED IN THIS SYSTEM

J 9/65 H J 3/61 H2 J 3/61 H2O J 6/62 O J 3/66 OH
J 9/65 O2

VELOCITY TABLE GENERATED

EDGE VELOCITY

.110885+01	.111105+01	.111508+01	.111831+01	.114695+01	.125217+01	.168489+01	.298850+01
.428948+01	.504650+01	.560726+01	.682901+01	.774018+01	.898895+01	.941061+01	.987416+01
.105257+02	.109577+02						

AXIAL DISTANCE

-.327842+01	-.274996+01	-.214999+01	-.174999+01	-.139999+01	-.109999+01	-.799989+00	-.499986+00
-.250007+00	-.133601+00	-.819605-01	.000000	.546403-01	.115810+00	.335901+00	.628282+00
.120690+01	.183045+01						

YTIL	Y=G	GP	GPP
0.0000000	0.0000000	1.0000378+03	-1.8066330+09
1.9070164-05	9.9221459-03	3.3793619+02	-8.8929430+04
6.0701539-05	1.9844292-02	1.8117344+02	-1.6871584+06
1.3019587-04	2.9766438-02	1.1879383+02	-5.2333507+05
2.3172[illegible]	3.9688583-02	8.3189272+01	-2.1183377+05
3.6997[illegible]	4.9610729-02	6.3884879+01	-1.0134701+05
5.4767820-04	5.9532875-02	4.9943781+01	-5.4394544+04
7.6835178-04	6.9455021-02	4.0801130+01	-3.1748161+04
1.0350277-03	7.9377167-02	3.4138660+01	-1.9752972+04
1.3505696-03	8.9299313-02	2.9106493+01	-1.2924245+04
1.7177020-03	9.9221459-02	2.5195577+01	-8.8079349+03
2.1390357-03	1.0914360-01	2.2084698+01	-6.2060001+03
2.6170841-03	1.1906575-01	1.9561666+01	-4.4979017+03
3.1542841-03	1.2898790-01	1.7481823+01	-3.3388579+03
3.7530043-03	1.3891004-01	1.5743074+01	-2.5300656+03
4.4155579-03	1.4883219-01	1.4271769+01	-1.9518647+03
5.1442125-03	1.5875433-01	1.3013497+01	-1.5296823+03
5.9411973-03	1.6867648-01	1.1927303+01	-1.2154258+03
6.8087121-03	1.7859863-01	1.0981629+01	-9.7810668+02
7.7489319-03	1.8852077-01	1.0152688+01	-7.9580114+02
8.7640148-03	1.9844292-01	9.4206824+00	-6.5399908+02
9.8561099-03	2.0836506-01	8.7705089+00	-5.4237118+02
1.1027344-02	2.1828721-01	8.1698141+00	-4.5353115+02
1.2279864-02	2.2820935-01	7.6685607+00	-3.8211990+02
1.3615805-02	2.3813150-01	7.1984993+00	-3.2419250+02
1.5037310-02	2.4805365-01	6.7427745+00	-2.7680720+02
1.6546534-02	2.5797579-01	6.3057093+00	-2.3774439+02
1.8145647-02	2.6789794-01	6.0124967+00	-2.0531083+02
1.9836834-02	2.7782008-01	5.7090821+00	-1.7827196+02
2.1622304-02	2.8774223-01	5.4120186+00	-1.5540309+02
2.3504291-02	2.9766437-01	5.1383539+00	-1.3611808+02
2.5485058-02	3.0758652-01	4.8955486+00	-1.1971897+02
2.7566899-02	3.1750867-01	4.6514019+00	-1.0569790+02
2.9752144-02	3.2743081-01	4.4349154+00	-9.3657875+01
3.2043164-02	3.3735296-01	4.2317226+00	-8.3271197+01
3.4442369-02	3.4727510-01	4.0430681+00	-7.4272979+01
3.6952218-02	3.5719725-01	3.8667735+00	-6.6446611+01
3.9575215-02	3.6711939-01	3.7017108+00	-5.9613877+01
4.2313924-02	3.7704154-01	3.5468803+00	-5.3627325+01
4.5170957-02	3.8696369-01	3.4011950+00	-4.8364410+01
4.8148990-02	3.9688583-01	3.2644657+00	-4.3722845+01
5.1250759-02	4.0680798-01	3.1353872+00	-3.9614746+01
5.4479073-02	4.1673012-01	3.0135243+00	-3.5973831+01
5.7836844-02	4.2665227-01	2.8983172+00	-3.2732880+01
6.1326912-02	4.3657442-01	2.7892484+00	-2.9841926+01
6.4952302-02	4.4649656-01	2.6858556+00	-2.7256680+01
6.8716305-02	4.5641871-01	2.5877320+00	-2.4939236+01
7.2622074-02	4.6634085-01	2.4944901+00	-2.2857077+01
7.6672748-02	4.7626300-01	2.4057842+00	-2.0982175+01
8.0871796-02	4.8618514-01	2.3213179+00	-1.9290344+01
8.5222640-02	4.9610729-01	2.2407909+00	-1.7760607+01
8.9728918-02	5.0602943-01	2.1639483+00	-1.6374747+01
9.4394296-02	5.1595158-01	2.0905529+00	-1.5116889+01
9.9222573-02	5.2587373-01	2.0203837+00	-1.3973161+01
1.0421766-01	5.3579587-01	1.9532430+00	-1.2931477+01

1.0938361-01	5.4571802-01	1.8982459+00	-1.1980992+01
1.1472456-01	5.5564017-01	1.8273224+00	-1.1112498+01
1.2024482-01	5.6556231-01	1.7682147+00	-1.0317656+01
1.2594883-01	5.7548445-01	1.7114836+00	-9.5891442+00
1.3184116-01	5.8540660-01	1.6569897+00	-8.9204789+00
1.3792654-01	5.9532875-01	1.6046113+00	-8.3059040+00
1.4420986-01	6.0525090-01	1.5542335+00	-7.7402981+00
1.5069615-01	6.1517304-01	1.5057497+00	-7.2190973+00
1.5739064-01	6.2509519-01	1.4590611+00	-6.7382271+00
1.6429871-01	6.3501734-01	1.4140753+00	-6.2940423+00
1.7142593-01	6.4493947-01	1.3707086+00	-5.8832788+00
1.7877827-01	6.5486162-01	1.3289749+00	-5.5030046+00
1.8636113-01	6.6478377-01	1.2885963+00	-5.1505833+00
1.9418119-01	6.7470592-01	1.2495281+00	-4.8236435+00
2.0224470-01	6.8462806-01	1.2118779+00	-4.5200448+00
2.1055826-01	6.9455021-01	1.1754934+00	-4.2378545+00
2.1912849-01	7.0447236-01	1.1403173+00	-3.9753236+00
2.2796309-01	7.1439450-01	1.1062957+00	-3.7305691+00
2.3706878-01	7.2431665-01	1.0733781+00	-3.5036543+00
2.4645330-01	7.3423879-01	1.0415167+00	-3.2905736+00
2.5612471-01	7.4416094-01	1.0106676+00	-3.0922410+00
2.6609097-01	7.5408308-01	9.8078747-01	-2.9069759+00
2.7636059-01	7.6400523-01	9.5183778-01	-2.7337913+00
2.8694234-01	7.7392738-01	9.2377 -01	-2.5717471+00
2.9784529-01	7.8384952-01	8.9653 -01	-2.4201459+00
3.0907885-01	7.9377167-01	8.7 -01	-2.2781096+00
3.2065279-01	8.0369381-01	8.4461949-01	-2.1449706+00
3.3257723-01	8.1361596-01	8.1979764-01	-2.0201562+00
3.4486288-01	8.2353810-01	7.9570974-01	-1.9030258+00
3.5752004-01	8.3346025-01	7.7232912-01	-1.7930658+00
3.7056041-01	8.4338240-01	7.4963029-01	-1.6897849+00
3.8399614-01	8.5330454-01	7.2758912-01	-1.5927306+00
3.9783879-01	8.6322669-01	7.0618265-01	-1.5014857+00
4.1210123-01	8.7314884-01	6.8539907-01	-1.4156652+00
4.2679657-01	8.8307099-01	6.6518779-01	-1.3349136+00
4.4193847-01	8.9299312-01	6.4555849-01	-1.2589016+00
4.5754110-01	9.0291527-01	6.2648328-01	-1.1873249+00
4.7361917-01	9.1283742-01	6.0794351-01	-1.1199014+00
4.9018797-01	9.2275956-01	5.8992226+01	-1.0563693+00
5.0726339-01	9.3268171-01	5.7240316-01	-9.9648593+01
5.2486197-01	9.4260386-01	5.5537046-01	-9.4002568-01
5.4300085-01	9.5252600-01	5.3880944-01	-8.8477891-01
5.4169793-01	9.6244814-01	5.2270599-01	-8.3655043-01
5.8097170-01	9.7237029-01	5.0704503-01	-7.8915840-01
6.0084154-01	9.8229244-01	4.9181636-01	-7.4443350-01
6.2132751-01	9.9221459-01	4.7700469-01	-7.0221773-01
6.4245051-01	1.0021367+00	4.6259885-01	-6.6236355-01
6.6423231-01	1.0120589+00	4.4858724-01	-6.2473316-01
6.8669552-01	1.0219810+00	4.3495846-01	-5.8919765-01
7.0986371-01	1.0319032+00	4.2170253-01	-5.5563658-01
7.3376143-01	1.0418253+00	4.0880 -01	-5.2393696-01
7.5841420-01	1.0517475+00	3.9624 -01	-4.9399314-01
7.8384844-01	1.0616694+00	3.8404 -01	-4.6570590-01
8.1009246-01	1.0715917+00	3.7220 -01	-4.3898224-01
8.3717454-01	1.0815139+00	3.6066 -01	-4.1373478-01
8.6512497-01	1.0914360+00	3.4943 -01	-3.8988153+01
8.9397511-01	1.1013582+00	3.3851524-01	-3.6734536-01

9.2375766-01	1.1112803+00	3.2789661-01	-3.4605371-01
9.5458646-01	1.1212025+00	3.1756495-01	-3.2593836-01
9.8625774-01	1.1311246+00	3.0752642-01	-3.0693496-01
1.0179479+00	1.1410468+00	2.9776186-01	-2.8898299-01
1.0529159+00	1.1509689+00	2.8826523-01	-2.7202538-01
1.0879021+00	1.1608911+00	2.7903248-01	-2.5600828-01
1.1248485+00	1.1708132+00	2.7006561-01	-2.4088091-01
1.1613991+00	1.1807353+00	2.6132993-01	-2.2659530-01
1.1999999+00	1.1906575+00	2.5284746-01	-2.1310621-01
1.2398987+00	1.2005796+00	2.4460267-01	-2.0037081-01
1.2811456+00	1.2105018+00	2.3658969-01	-1.8834869-01
1.3237929+00	1.2204239+00	2.2880237-01	-1.7700163-01
1.3678953+00	1.2303461+00	2.2123833-01	-1.6629344-01
1.4135097+00	1.2402682+00	2.1388492-01	-1.5618993-01
1.4606958+00	1.2501904+00	2.0674324-01	-1.4665870-01
1.5095161+00	1.2601125+00	1.9980615-01	-1.3766911-01
1.5600358+00	1.2700347+00	1.9306863-01	-1.2919212-01
1.6123229+00	1.2799568+00	1.8652571-01	-1.2120023-01
1.6664491+00	1.2898789+00	1.8017266-01	-1.1366737-01
1.7224888+00	1.2998011+00	1.7400548-01	-1.0656887-01
1.7805202+00	1.3097232+00	1.6801756-01	-9.9881324-02
1.8406252+00	1.3196454+00	1.6220659-01	-9.3582539-02
1.9028891+00	1.3295675+00	1.5656727-01	-8.7651494-02
1.9674018+00	1.3394897+00	1.5109562-01	-8.2068238-02
2.0342571+00	1.3494118+00	1.4578779-01	-7.6813868-02
2.1035534+00	1.3593340+00	1.4063853-01	-7.1878443-02
2.1753937+00	1.3692561+00	1.3564504-01	-6.7223958-02
2.2498868+00	1.3791783+00	1.3080311-01	-6.2849274-02
2.3271435+00	1.3891004+00	1.2610887-01	-5.8740096-02
2.4072849+00	1.3990226+00	1.2155864-01	-5.4878912-02
2.4904347+00	1.4089447+00	1.1714974-01	-5.1251954-02
2.5767235+00	1.4188669+00	1.1287549-01	-4.7846166-02
2.6662881+00	1.4287890+00	1.0873594-01	-4.4649174-02
2.7592723+00	1.4387111+00	1.0472610-01	-4.1649241-02
2.8558271+00	1.4486333+00	1.0084283-01	-3.8835227-02
2.9561107+00	1.4585554+00	9.7082859-02	-3.6196586-02
3.0602896+00	1.4684776+00	9.3442985-02	-3.3722317-02
3.1685383+00	1.4783997+00	8.9920693-02	-3.1405936-02
3.2810404+00	1.4883219+00	8.6511055-02	-2.9235465-02

NO	U	K	EPS
1	0.0000000	0.0000000	0.0000000
2	1.1590286-04	7.9456498-10	1.9622625-12
3	3.6892612-04	2.5289751-09	1.1142465-11
4	7.9129224-04	5.4236511-09	3.4994884-11
5	1.4099497-03	9.6423947-09	8.3214253-11
6	2.2483867-03	1.5406[illegible]-08	1.6753742-10
7	3.3286277-03	2.2799[illegible]-08	3.0161889-10
8	4.6698164-03	3.1973675-08	5.0093177-10
9	6.2935941-03	4.3051795-08	7.8268352-10
10	8.2083651-03	5.6147137-08	1.1657410-09
11	1.0439688-02	7.1366175-08	1.6705615-09
12	1.3000429-02	8.8909016-08	2.3191275-09
13	1.5905869-02	1.0857206-07	3.1348841-09
14	1.9173812-02	1.3073848-07	4.1426765-09
15	2.2809658-02	1.5539869-07	5.3686697-09
16	2.6836464-02	1.8263512-07	6.8403849-09
17	3.1265012-02	2.1250843-07	8.5864376-09
18	3.6108852-02	2.4510474-07	1.0636672-08
19	4.1381352-02	2.8048615-07	1.3021998-08
20	4.7095732-02	3.1871588-07	1.5774334-08
21	5.3265108-02	3.5985293-07	1.8926547-08
22	5.9902517-02	4.0395278-07	2.2512368-08
23	6.7020957-02	4.5106[illegible]-07	2.6566323-08
24	7.4633407-02	5.0124274-07	3.1123690-08
25	8.2752862-02	5.5452896-07	3.6220178-08
26	9.1392353-02	6.1095017-07	4.1892328-08
27	1.0056497-01	6.7055701-07	4.8176922-08
28	1.1028391-01	7.3337595-07	5.5111137-08
29	1.2056245-01	7.9943427-07	6.2732381-08
30	1.3141401-01	8.6875[illegible]-07	7.1078281-08
31	1.4285219-01	9.4135655-07	8.0186160-08
32	1.5489076-01	1.0172531-06	9.0093715-08
33	1.6754352-01	1.0964539-06	1.0083809-07
34	1.8082479-01	1.1789633-06	1.1295614-07
35	1.9474894-01	1.2647508-06	1.2498424-07
36	2.0933060-01	1.3539[illegible]-06	1.3845810-07
37	2.2458473-01	1.4463118-06	1.5291261-07
38	2.4052653-01	1.5419972-06	1.6838173-07
39	2.5717160-01	1.6409343-06	1.8489827-07
40	2.7453581-01	1.7430947-06	2.0249373-07
41	2.9263542-01	1.8484431-06	2.2119809-07
42	3.1148704-01	1.9569[illegible]-06	2.4103965-07
43	3.3110780-01	2.0685311-06	2.6204485-07
44	3.5151510-01	2.1831667-06	2.8423795-07
45	3.7272689-01	2.3007818-06	3.0764092-07
46	3.9474156-01	2.4213995-06	3.3227314-07
47	4.1763801-01	2.5446592-06	3.5815120-07
48	4.4137565-01	2.6707547-06	3.8528860-07
49	4.6599444-01	2.7994963-06	4.1369555-07
50	4.9151490-01	2.9307784-06	4.4337858-07
51	5.1795817-01	3.0644854-06	4.7434044-07
52	5.4534600-01	3.2004922-06	5.0657981-07
53	5.7370081-01	3.3386629-06	5.4009016-07
54	6.0304565-01	3.4788509-06	5.7486131-07
55	6.3340435-01	3.6208974-06	6.1087720-07

56	6.6490143-01	3.7646323-06	6.4811653-07
57	6.9726219-01	3.9[illegible]9873[illegible]-06	6.8655221-07
58	7.3081271-01	4.0564232-06	7.2615090-07
59	7.3566736-01	4.2040742-06	7.6687304-07
60	7.4049827-01	4.3926043-06	8.0867205-07
61	7.4527702-01	4.5917894-06	8.5149414-07
62	7.5003512-01	4.6513293-06	8.9527813-07
63	7.5476404-01	4.8809919-06	9.3995473-07
64	7.5946520-01	4.9504926-06	9.8544653-07
65	7.6413997-01	5.0995229-06	1.0314675-06
66	7.6878947-01	5.2477594-06	1.0785225-06
67	7.7341560-01	5.3948677-06	1.1259374-06
68	7.7801903-01	5.5404889-06	1.1737082-06
69	7.8260114-01	5.6842491-06	1.2218011-06
70	7.8716318-01	5.8257956-06	1.2700522-06
71	7.9170626-01	5.9645642-06	1.3183173-06
72	7.9623151-01	6.1002795-06	1.3664413-06
73	8.0074003-01	6.2324144-06	1.4142587-06
74	8.0523291-01	6.3604889-06	1.4615931-06
75	8.0971120-01	6.4840242-06	1.5082572-06
76	8.1417591-01	6.6024784-06	1.5540529-06
77	8.1862807-01	6.7153022-06	1.5987713-06
78	8.2306863-01	6.8219306-06	1.6421933-06
79	8.2749861-01	6.9217726-06	1.6840892-06
80	8.3191892-01	7.0142145-06	1.7242198-06
81	8.3633050-01	7.0986227-06	1.7623368-06
82	8.4073428-01	7.1743410-06	1.7981831-06
83	8.4513115-01	7.2406927-06	1.8314944-06
84	8.4952202-01	7.2969974-06	1.8619994-06
85	8.5390774-01	7.3425315-06	1.8894218-06
86	8.5828920-01	7.3765761-06	1.9134811-06
87	8.6266723-01	7.3983954-06	1.9338950-06
88	8.6704270-01	7.4072449-06	1.9503808-06
89	8.7141642-01	7.4023741-06	1.9626576-06
90	8.7578923-01	7.3830916-06	1.9704491-06
91	8.8016193-01	7.3484716-06	1.9734863-06
92	8.8453536-01	7.2979552-06	1.9715105-06
93	8.8891029-01	7.2307855-06	1.9642769-06
94	8.9328753-01	7.1462072-06	1.9515581-06
95	8.9766788-01	7.0433622-06	1.9331487-06
96	9.0205210-01	6.9223748-06	1.9088693-06
97	9.0644100-01	6.7819787-06	1.8785718-06
98	9.1083533-01	6.6218043-06	1.8421442-06
99	9.1523587-01	6.4417257-06	1.7995160-06
100	9.1964339-01	6.2412216-06	1.7506642-06
101	9.2405868-01	6.0202217-06	1.6956190-06
102	9.2848248-01	5.7787345-06	1.6344897-06
103	9.3291552-01	5.5169525-06	1.5673709-06
104	9.3735843-01	5.2352873-06	1.4945487-06
105	9.4181253-01	4.9344661-06	1.4163057-06
106	9.4627798-01	4.6152738-06	1.3330269-06
107	9.5075574-01	4.2792025-06	1.2451037-06
108	9.5524658-01	3.9279055-06	1.1533381-06
109	9.5975126-01	3.5635596-06	1.0581447-06
110	9.6427053-01	3.1888783-06	9.6035180-07
111	9.6880516-01	2.8071814-06	8.6079845-07
112	9.7335591-01	2.4225071-06	7.6041378-07

113	9.7792354-01	2.0396922-06	6.6020682-07
114	9.8250892-01	1.6645025-06	5.6125772-07
115	9.8711254-01	1.3037586-06	4.6470179-07
116	9.9173545-01	9.6548970-07	3.7171070-07
117	9.9637835-01	6.5009943-07	2.8346615-07
118	1.0000000+00	3.9555842-07	2.0112888-07
119	1.0000000+00	1.8762179-07	1.2580015-07
120	1.0000000+00	5.0072574-08	5.8476916-08
121	1.0000000+00	0.0000000	0.0000000

••• P.W 250K TRNSP COOLED ENGINE, M2402, SEP. 4, 1973 ••••••

STATION	X (inch)	S	DS	RW	THETAW	ZETA	ZETAP
842	5.2893856+00	5.1855692+00	1.9314901-02	1.9293185+00	7.0616066-01	5.3440085-02	-7.6048980-03

EDGE AND WALL CONDITIONS

UEB	= 1.1554887+04	AME	= 2.7832251+00		
†EDGE	= 4.2763057+03	RHOEB	= 1.6130345-03		
SMEB	= -7.6155540+07	SMUEB	= 1.5452798-06		
PEDGEB	= 2.3384235+04	TWALL	= 1.9000000+03		
‡HLOSS	= -1.4318944+03	SMDWB	= 7.5243731-03		

PROFILE PARAMETERS

DLSTAR =	3.7603773-03	BCF =	1.2278805-03
THETA =	-8.2849694-05	STAN =	-6.0057354-05
TAUW =	1.3226699+02	TAUI =	1.4135607+02
SQW =	2.3187724+04	RTHETA =	-9.9946658+02

NO.	YBAR	Y	U/UE	H/HE	RO/ROF	ROV	EPS	T
1	0.0000000	0.0000000	0.0000000	-1.4886386-01	5.0610810-01	4.0307825-04	0.0000000	1897.5
2	3.1085439-07	9.9721459-03	9.1783095-01	-1.4869848-01	5.0359438-01	4.0306766-04	0.0000000	1931.6
3	9.8946917-07	1.9844292-02	2.9675421-02	-1.4810141-01	5.0198001-01	4.0295018-04	1.0308417-09	1963.2
4	2.1222658-06	2.9766438-02	6.3513876-02	-1.4605411-01	5.0125722-01	4.0248280-04	6.8039286-09	1992.1
5	3.7815207-06	3.9688683-02	1.1238353-01	-1.4094378-01	5.0142592-01	4.0121321-04	2.8563206-08	2018.4
6	6.0307664-06	4.9610729-02	1.7536206-01	-1.3047832-01	5.0248612-01	3.9935709-04	8.6986710-08	2042.1
7	8.9274636-06	5.9532875-02	2.4682252-01	-1.1219292-01	5.0443783-01	3.9289969-04	2.0873631-07	2063.3
8	1.2524566-05	6.9455021-02	3.1687415-01	-8.5504961-02	5.0728102-01	3.8430193-04	4.1982192-07	2081.8
9	1.6871533-05	7.9377167-02	3.7722468-01	-5.2783728-02	5.1101572-01	3.7362103-04	7.4874733-07	2097.7
10	2.2015043-05	8.9299313-02	4.2555442-01	-1.8084409-02	5.1579703-01	3.6372136-04	1.2413473-06	2110.8
11	2.7999508-05	9.9221459-02	4.6395173-01	1.5442214-02	5.2212662-01	3.5315927-04	1.9747583-06	2120.5
12	3.4867475-05	1.0914360-01	4.9569703-01	4.6760572-02	5.3101656-01	3.5961106-04	3.0533[illegible]-06	2126.5
13	4.2659941-05	1.1906575-01	5.2348339-01	7.6286454-02	5.3899544-01	3.7002855-04	4.5838297-06	2129.8
14	5.1416603-05	1.2898790-01	5.4897397-01	1.0476547-01	5.4835004-01	3.8840984-04	6.6402438-06	2131.1
15	6.1176079-05	1.3891004-01	5.7297546-01	1.3263197-01	5.5736727-01	4.1298875-04	9.2367496-06	2131.5
16	7.1976074-05	1.4883219-01	5.9576849-01	1.5992420-01	5.6557562-01	4.4064002-04	1.2311670-05	2131.7
17	8.3853552-05	1.5875433-01	6.1738037-01	1.8643777-01	5.7298722-01	4.6760931-04	1.5711612-05	2131.6
18	9.6844854-05	1.6867648-01	6.3772137-01	2.1185501-01	5.8.12608-01	4.9005925-04	1.9199592-05	2130.3
19	1.1098583-04	1.7859863-01	6.5660850-01	2.3577479-01	5.8721969-01	5.0438941-04	2.2517728-05	2127.0
20	1.2631194-04	1.8852077-01	6.7377830-01	2.5772743-01	5.9426981-01	5.0754604-04	2.5478640-05	2121.6
21	1.4285836-04	1.9844292-01	6.8907600-01	2.7741556-01	6.0120843-01	4.9782186-04	2.8013688-05	2114.9
22	1.6066006-04	2.0836506-01	7.0254866-01	2.9482593-01	6.0793263-01	4.7527080-04	3.0153096-05	2107.6
23	1.7975190-04	2.1828721-01	7.1438081-01	3.1014572-01	6.1433956-01	4.4172705-04	3.2014487-05	2100.6
24	2.0016068-04	2.2820935-01	7.2478564-01	3.2361812-01	6.2036118-01	4.0069729-04	3.3656420-05	2094.7
25	2.2194527-04	2.3813150-01	7.3398449-01	3.3551471-01	6.2599925-01	3.5434816-04	3.4104037-05	2089.7
26	2.4511660-04	2.4805365-01	7.4225731-01	3.4619537-01	6.3127428-01	3.1462921-04	3.4230526-05	2085.1
27	2.6971780-04	2.5797579-01	7.4998678-01	3.5616930-01	4.3604112-01	2.7874237-04	4.3576988-05	2080.7
28	2.9578423-04	2.6789794-01	7.5751964-01	3.6591224-01	6.4.295[illegible]-01	2.5310233-04	4.9256080-05	2076.5
29	3.2335153-04	2.7782008-01	7.6508573-01	3.7575934-01	6.4419555-01	2.4008673-04	5.6187347-05	2072.5
30	3.5245569-04	2.8774223-01	7.7278301-01	3.8587453-01	6.4797486-01	2.4036935-04	6.4161973-05	2068.5
31	3.8313315-04	2.9766437-01	7.8062490-01	3.9631569-01	6.5188391-01	2.5271057-04	7.2876031-05	2064.5
32	4.1542076-04	3.0758652-01	7.8858167-01	4.0706336-01	6.5606816-01	2.7415201-04	8.1953362-05	2060.4
33	4.4935594-04	3.1750967-01	7.9657503-01	4.1802845-01	6.6052763-01	3.0081963-04	9.1016461-05	2056.1
34	4.8497667-04	3.2743081-01	8.0450145-01	4.2907156-01	6.6511294-01	3.2921034-04	9.9774409-05	2051.7
35	5.2232156-04	3.3735296-01	8.1225962-01	4.4004245-01	6.6983145-01	3.5641565-04	1.0807073-04	2047.1
36	5.6142996-04	3.4727510-01	8.1976995-01	4.5081344-01	6.7468458-01	3.7975005-04	1.1588801-04	2042.4
37	6.0234190-04	3.5719725-01	8.2698143-01	4.6129083-01	6.7961673-01	3.9715095-04	1.2333902-04	2037.7
38	6.4509824-04	3.6711939-01	8.3387160-01	4.7142071-01	6.8454388-01	4.0766989-04	1.3063961-04	2033.0
39	6.8974072-04	3.7704154-01	8.4044406-01	4.8118869-01	6.8938197-01	4.1167137-04	1.3805579-04	2028.5
40	7.3631197-04	3.8696369-01	8.4672405-01	4.9061592-01	6.9407547-01	4.1066157-04	1.4584751-04	2024.3
41	7.8485558-04	3.9688583-01	8.5274795-01	4.9974503-01	6.9862577-01	4.0668459-04	1.5421695-04	2020.3
42	8.3541615-04	4.0680798-01	8.5855309-01	5.0862406-01	7.0308567-01	4.0147137-04	1.6327414-04	2016.5

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROV	EPS	T
43	8.8A03948-04	4.1673012-01	A.6417435-01	5.173007A-01	7.0745298-01	3.963[illegible]1266-04	1.730[illegible]642-04	2012.9
44	9.4277239-04	4.2665227-01	A.6963830-01	5.25A1251-01	7.1172727-01	3.92413C5E-04	1.8352415E-04	2009.5
45	9.9966294-04	4.3657442-01	8.7496096-01	5.3418157-01	7.1592760-01	3.90A1722E-04	1.9477652E-04	2006.2
46	1.0587605-03	4.4649656-01	8.8016590-01	5.4242746-01	7.2008325-01	3.9220425E-04	2.0A577[illegible]E-04	2003.0
47	1.1201157-03	4.5641871-01	8.8523646-01	5.5057010-01	7.2422326-01	3.9672533E-04	2.1908465E-04	2000.0
48	1.1837004-03	4.6634085-01	8.9021135-01	5.5862261-01	7.2836487-01	4.0400045E-04	2.3211717E-04	1997.2
49	1.2498088-03	4.7626300-01	8.9508560-01	5.6659210-01	7.3251358-01	4.1333153E-04	2.4551721E-04	1994.6
50	1.3182554-03	4.8618514-01	8.9985906-01	5.7447826-01	7.3664202-01	4.2405[illegible].9E-04	2.5913423E-04	1992.1
51	1.3891769-03	4.9610729-01	9.0453066-01	5.8227310-01	7.4[illegible]74294-01	4.3565793E-04	2.7293249E-04	1989.7
52	1.4626318-03	5.0602943-01	9.0909226-01	5.8996444-01	7.4481630-01	4.4767529E-04	2.8663833E-04	1987.5
53	1.5386801-03	5.1595158-01	9.1354367-01	5.9754756-01	7.4868478-01	4.5982079E-04	3.0018332E-04	1985.4
54	1.6173837-03	5.2587373-01	9.1789282-01	6.0503323-01	7.5289259-01	4.7201926E-04	3.1340461E-04	1983.5
55	1.6988065-03	5.3579587-01	9.2215020-01	6.1243781-01	7.5690384-01	4.8413808[illegible]E-04	3.2647451E-04	1981.8
56	1.7830142-03	5.4571802-01	9.2632434-01	6.1977491-01	7.6095128-01	4.9716212E-04	3.3936372E-04	1980.5
57	1.8700748-03	5.5564017-01	9.3042203-01	6.2705405-01	7.6488484-01	5.1068612E-04	3.5205605E-04	1979.4
58	1.9600581-03	5.6556231-01	9.3444853-01	6.3429058-01	7.6885169-01	5.2523252E-04	3.6462532E-04	1978.6
59	2.0530366-03	5.7548445-01	9.3840780-01	6.4148824-01	7.7280132-01	5.4102932E-04	3.7697468E-04	1977.9
60	2.1490853-03	5.8540660-01	9.4230253-01	6.4864089E-01	7.7673373-01	5.5829975E-04	3.8912232E-04	1977.4
61	2.2482801-03	5.9532875-01	9.4613439-01	6.5578303E-01	7.8064857-01	5.7721438E-04	4.0105627E-04	1977.0
62	2.3507017-03	6.0525090-01	9.4990426-01	6.6289202E-01	7.8454535-01	5.9783140E-04	4.1276123E-04	1977.0
63	2.4564319-03	6.1517304-01	9.5361238-01	6.6997819E-01	7.8842358-01	6.2006960E-04	4.2421870E-04	1977.4
64	2.5655558-03	6.2509519-01	9.5725851-01	6.7704304E-01	7.9228287-01	6.4371276E-04	4.3540595E-04	1978.3
65	2.6781412-03	6.3501734-01	9.6084221-01	6.8410863E-01	7.9612333E-01	6.6847166E-04	4.4626508E-04	1979.6
66	2.7943196-03	6.4493947-01	9.6436299-01	6.9116543E-01	7.9994538E-01	6.9[illegible]25[illegible]E-04	4.5[illegible]E-04	1981.3
67	2.9141832-03	6.5486162-01	9.6782041-01	6.9821412E-01	8.0375056E-01	7.2[illegible]16247E-04	4.6[illegible]E-04	1983.2
68	3.0377567-03	6.6478377-01	9.7121432-01	7.0512299-01	8.0753729-01	7.4447432E-04	4.7678749E-04	1985.3
69	3.1652624-03	6.7470592-01	9.7454484-01	7.1210922E-01	8.1130639-01	7.7267667E-04	4.8605264E-04	1987.6
70	3.2967222-03	6.8462806-01	9.7781252-01	7.1908945E-01	8.1505628-01	7.9852810E-04	4.9475497E-04	1990.5
71	3.4322178-03	6.9455021-01	9.8101627-01	7.2606949E-01	8.1878591-01	8.2388821E-04	5.0280912E-04	1994.3
72	3.5719208-03	7.0447236-01	9.8416337-01	7.3305666E-01	8.2249457-01	8.4871541E-04	5.1011726E-04	1998.9
73	3.7159264-03	7.1439450-01	9.8724949-01	7.4005971E-01	8.2618230-01	8.7302633E-04	5.1656586E-04	2004.5
74	3.8643542-03	7.2431664-01	9.9027847-01	7.4708958E-01	8.2984262-01	8.9682673E-04	5.2202747E-04	2010.7
75	4.0173282-03	7.3423879-01	9.9325318-01	7.5415891E-01	8.3345269-01	9.2036828E-04	5.2636318E-04	2016.9
76	4.1749766-03	7.4416094-01	9.9617561-01	7.6128245E-01	8.3701169-01	9.4261298E-04	5.2942630E-04	2023.1
77	4.3374322-03	7.5408308-01	9.9904813-01	7.6847707E-01	8.4054166-01	9.6432008E-04	5.3105929E-04	2029.7
78	4.5048378-03	7.6400523-01	1.0018736+00	7.7576198-01	8.4407553-01	9.8513217E-04	5.3109036E-04	2037.6
79	4.6773212-03	7.7392738-01	1.0046539+00	7.8315859-01	8.4764825-01	1.0051365E-03	5.2932899E-04	2047.7
80	4.8550454-03	7.8384952-01	1.0073914+00	7.9049051-01	8.5127567-01	1.0245859E-03	5.2556559E-04	2060.5
81	5.0381589-03	7.9377167-01	1.0100881+00	7.9838411-01	8.5496319-01	1.0436537E-03	5.1956701E-04	2076.0
82	5.2268205-03	8.0369381-01	1.0127479+00	8.0624112-01	8.5869686-01	1.0625192E-03	5.1108506E-04	2093.0
83	5.4211957-03	8.1361596-01	1.0153619+00	8.1436618-01	8.6227523-01	1.0843216E-03	4.9988036E-04	2109.3
84	5.6214555-03	8.2353810-01	1.0179431+00	8.2277198-01	8.6580729-01	1.1048837E-03	4.8574110E-04	2124.8
85	5.8277776-03	8.3346025-01	1.0204791+00	8.3146724-01	8.6933430-01	1.1317170E-03	4.6849599E-04	2141.4
86	6.0403461-03	8.4338240-01	1.0229737+00	8.4049933-01	8.7297469-01	1.1590433E-03	4.4800652E-04	2162.1
87	6.2593527-03	8.5330454-01	1.0254220+00	8.4997560-01	8.7684684-01	1.1881266E-03	4.2421952E-04	2189.5
88	6.4849957-03	8.6322669-01	1.0278092+00	8.5992485-01	8.8102901-01	1.2181074E-03	3.9724012E-04	2225.7
89	6.7174815-03	8.7314884-01	1.0301232+00	8.7038969-01	8.8551912-01	1.2477640E-03	3.6742512E-04	2270.5
90	6.9570238-03	8.8307098-01	1.0323404+00	8.8142384-01	8.9030437-01	1.2762535E-03	3.3549195E-04	2323.0
91	7.2038453-03	8.9299312-01	1.0344224+00	8.9302716-01	8.9559828-01	1.3015089E-03	3.0269626E-04	2384.1
92	7.4581769-03	9.0291527-01	1.0363190+00	9.0513983-01	9.0140057-01	1.3219619E-03	2.6665068-04	2452.0
93	7.7202584-03	9.1283742-01	1.0379459+00	9.1750875-01	9.0749376-01	1.3367704E-03	2.3270733-04	2524.3
94	7.9903392-03	9.2275956-01	1.0393181+00	9.3067378-01	9.1354583-01	1.3443734E-03	1.8367232E-04	2602.0
95	8.2686782E-03	9.3268171-01	1.0402467+00	9.4416438-01	9.1922474-01	1.3440045E-03	1.7123693E-04	2682.1
96	8.5555449-03	9.4260386-01	1.0405977+00	9.5613387-01	9.2431100-01	1.3371217E-03	1.2267577-04	2763.3

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROV	EPS	T
97	8.8512190-03	9.5252600-01	1.0404298+00	9.6512280-01	9.2881026-01	1.3258225-03	2.1102347-04	2850.7
98	9.1559913-03	9.6244814-01	1.0399528+00	9.7193143-01	9.3792803-01	1.3100533-03	2.3450791-04	2917.7
99	9.4701649-03	9.7237029-01	1.0392450+00	9.7741745-01	9.4664588-01	1.2930241-03	2.5891203-04	2982.9
100	9.7940546-03	9.8229249-01	1.0383576+00	9.8191669-01	9.5496164-01	1.2658091-03	2.8292255-04	3046.9
101	1.0127987-02	9.9221456-01	1.0373122+00	9.8568723-01	9.6296054-01	1.2349408-03	3.0298448-04	3100.5
102	1.0472304-02	1.0021347+00	1.0361240+00	9.8888201-01	9.7077134-01	1.2027517-03	3.2009459-04	3169.8
103	1.0827360-02	1.0120589+00	1.0348004+00	9.9159907-01	9.7852292-01	1.1628623-03	3.3459338-04	3231.0
104	1.1193523-02	1.0219810+00	1.0333472+00	9.9389780-01	9.8630045-01	1.1165369-03	3.4633531-04	3292.4
105	1.1571177-02	1.0319032+00	1.0317490+00	9.9582077-01	9.9410178-01	1.0648527-03	3.5535380-04	3354.1
106	1.1960723-02	1.0418253+00	1.0300696+00	9.9740165-01	9.9681219-01	1.0087213-03	3.6162069-04	3415.5
107	1.2362577-02	1.0517475+00	1.0282516+00	9.9866869-01	9.9932414-01	9.4929394-04	3.6515074-04	3476.3
108	1.2777173-02	1.0616696+00	1.0263165+00	9.9964579-01	9.9164174-01	8.8730876-04	3.6597566-04	3536.4
109	1.3204962-02	1.0715917+00	1.0242642+00	1.0003525+00	9.9383192-01	8.2304090-04	3.6415734-04	3596.1
110	1.3646415-02	1.0815139+00	1.0220926+00	1.0008041+00	9.9600698-01	7.5631888-04	3.5977714-04	3655.8
111	1.4102023-02	1.0914360+00	1.0197973+00	1.0010111+00	9.9822725-01	6.8663374-04	3.5292789-04	3715.7
112	1.4572296-02	1.1013582+00	1.0173719+00	1.0009796+00	9.9971566-01	6.1338090-04	3.4370622-04	3776.2
113	1.5057769-02	1.1112803+00	1.0148068+00	1.0007117+00	9.9332034-01	5.3618228-04	3.3221444-04	3837.2
114	1.5558995-02	1.1212025+00	1.0120985+00	1.0002082+00	9.9607309-01	4.5474592-04	3.1858294-04	3899.8
115	1.6076555-02	1.1311246+00	1.0092532+00	9.9947339-01	9.9914147-01	3.6772388-04	3.0297952-04	3962.2
116	1.6611054-02	1.1410468+00	1.0063013+00	9.9852362-01	9.9253042-01	2.7529620-04	2.8566529-04	4042.5
117	1.7163121-02	1.1509689+00	1.0033043+00	9.9739561-01	9.9605955-01	1.7921824-04	2.6701378-04	4118.8
118	1.7733415-02	1.1608911+00	1.0003670+00	9.9615129-01	9.9945610-01	8.2020579-05	2.4750526-04	4190.8
119	1.8322422-02	1.1708132+00	9.9760900-01	9.9487787-01	9.9244735-01	-1.3899449-05	2.2769115-04	4252.4
120	1.8931458-02	1.1807353+00	9.9517049-01	9.9368323-01	9.9485303-01	-1.0722556-04	2.0811365-04	4299.7
121	1.9560672-02	1.1906575+00	9.9318647-01	9.9268802-01	9.9667775-01	-1.9854480-04	1.8924226-04	4332.6
122	2.0211046-02	1.2005796+00	9.9177733-01	9.9201754-01	9.9807717-01	-2.9006463-04	1.7138172-04	4354.3
123	2.0883394-02	1.2105018+00	9.9105421-01	9.9179709-01	9.9896259-01	-3.8286401-04	1.5466819-04	4361.6
124	2.1578568-02	1.2204239+00	9.9108659-01	9.9212108-01	9.9934579-01	-4.7966405-04	1.3906415-04	4354.6
125	2.2297461-02	1.2303461+00	9.9188637-01	9.9301846-01	9.9934482-01	-5.8450057-04	1.2445715-04	4337.2
126	2.3041002-02	1.2402682+00	9.9337275-01	9.9441009-01	9.9915486-01	-7.0095853-04	1.1071831-04	4315.6
127	2.3810162-02	1.2501904+00	9.9536031-01	9.9625952-01	9.9895908-01	-8.3115462-04	9.7791498-05	4295.9
128	2.4605961-02	1.2601125+00	9.9757583-01	9.9778568-01	9.9884454-01	-9.7503565-04	8.5712415-05	4282.1
129	2.5429460-02	1.2700347+00	9.9975030-01	9.9919337-01	9.9922804-01	-1.1345331-03	7.4616273-05	4274.1
130	2.6281779-02	1.2799568+00	1.0016540+00	1.0000901+00	9.9933574-01	-1.2935388-03	6.4692974-05	4267.5
131	2.7164156-02	1.2898789+00	1.0030993+00	1.0004173+00	9.9879923-01	-1.4600240-03	5.6126056-05	4260.2
132	2.8077535-02	1.2998011+00	1.0039555+00	1.0002977+00	9.9851493-01	-1.6251601-03	4.9049384-05	4252.1
133	2.9023480-02	1.3097232+00	1.0042959+00	1.0001091+00	9.9815200-01	-1.7857278-03	4.3524681-05	4244.0
134	3.0003224-02	1.3196454+00	1.0041516+00	1.0000785+00	9.9779996-01	-1.9393790-03	3.9568959-05	4236.8
135	3.1018162-02	1.3295675+00	1.0037267+00	1.0000913+00	9.9755440-01	-2.0883745-03	3.7172511-05	4231.5
136	3.2069755-02	1.3394897+00	1.0030554+00	1.0000755+00	9.9748451-01	-2.2348783-03	3.6315278-05	4229.6
137	3.3159534-02	1.3494118+00	1.0023834+00	1.0001253+00	9.9758264-01	-2.3849714-03	3.6946238-05	4228.2
138	3.4289102-02	1.3593340+00	1.0016528+00	1.0001583+00	9.9780800-01	-2.5394074-03	3.8973088-05	4230.0
139	3.5460139-02	1.3692561+00	1.0011395+00	1.0001805+00	9.9821984-01	-2.7057968-03	4.2156067-05	4235.1
140	3.6674405-02	1.3791783+00	1.0006345+00	1.0001858+00	9.9881706-01	-2.8847079-03	4.5769189-05	4243.4
141	3.7933747-02	1.3891004+00	1.0004008+00	1.0001824+00	9.9952841-01	-3.0836090-03	4.8940351-05	4253.9
142	3.9240097-02	1.3990226+00	1.0001304+00	1.0001595+00	1.0002405+00	-3.2983529-03	5.0313413-05	4264.6
143	4.0595485-02	1.4089447+00	1.0000909+00	1.0001856+00	1.0008411+00	-3.5328013-03	5.0402341-05	4273.8
144	4.2002040-02	1.4188669+00	9.9999442-01	1.0009854+00	1.0012559+00	-3.7790244-03	4.8881881-05	4280.3
145	4.3461994-02	1.4287890+00	1.0000373+00	1.0007516+00	1.0014867+00	-4.0386334-03	4.9627281-05	4284.2
146	4.4977688-02	1.4387111+00	1.0000819+00	1.0005957+00	1.0016035+00	-4.3084577-03	4.4712306-05	4286.3
147	4.6551585-02	1.4486333+00	1.0000706+00	1.0004098+00	1.0016007+00	-4.5861744-03	4.8227195-05	4286.5
148	4.8186265-02	1.4585554+00	1.0002023+00	1.0002649+00	1.0014777+00	-4.8739527-03	4.6779517-05	4284.7
149	4.9884439-02	1.4684776+00	1.0000586+00	1.0001186+00	1.0012825+00	-5.1617055-03	6.3432018-05	4281.6
150	5.1648954-02	1.4783997+00	1.0002440+00	1.0000345+00	1.0009975+00	-5.4621390-03	8.6066469-05	4278.2

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROV	EPS	T
151	5.3482801-02	1.4883219+00	1.0000808+00	9.9995981-01	1.0007252+00	-5.7617182-03	1.5649894-04	4275.7
152	5.5389124-02	1.4982440+00	1.0001975+00	1.0002328+00	1.0004735+00	-6.0775823-03	1.5385319-04	4274.6
153	5.7371225-02	1.5081662+00	1.0001875+00	1.0003049+00	1.0002417+00	-6.4017118-03	3.6218154-04	4275.1
154	5.9332577-02	1.5180883+00	1.0000000+00	1.0000000+00	1.0000000+00	-6.7359893-03	0.0000000	4276.3

DELTA= 2.84025-01 (INCHES)

NO.	TAU	TAU/(RE*UE2)	EPS/(RHO*UE*DELTA)	YTIL/DELTA
2	1.6199601+02	8.4476612-04	0.0000000	1.3133533-05
3	1.8308884+02	8.4993867-04	4.6542963-07	4.1804866-05
4	1.8488132+02	8.5815078-04	3.0763742-06	8.9665205-05
5	1.8709926+02	8.6845374-04	1.2910415-05	1.5976946+04
6	1.8955342+02	8.7984513-04	3.9234569-05	2.5479862-04
7	1.9129859+02	8.8794547-04	9.3785257-05	3.7718347-04
8	1.9066225+02	8.8499198-04	1.8756705-04	5.2916027-04
9	1.8812480+02	8.7321398-04	3.3207874-04	7.1201874-04
10	1.8707953+02	8.6835972-04	5.4544944-04	9.3013095-04
11	1.9100924+02	8.8662258-04	8.5719212-04	1.1829734-03
12	2.0123023+02	9.3404516-04	1.3056704-03	1.4731436+03
13	2.1671618+02	1.0059258-03	1.9274514-03	1.8023736-03
14	2.3490682+02	1.0903608-03	2.7445186-03	2.1723467-03
15	2.5264297+02	1.1726863-03	3.7557323-03	2.5846765-03
16	2.6686524+02	1.2387014-03	4.9336273-03	3.0409741+03
17	2.7496654+02	1.2763050-03	6.2146384-03	3.5427951-03
18	2.7538530+02	1.2782488-03	7.5008359-03	4.0916748+03
19	2.6827675+02	1.2452532-03	8.6908852-03	4.6891282-03
20	2.5547906+02	1.1858504-03	9.7170093-03	5.3366532-03
21	2.3959877+02	1.1121394-03	1.0560519-04	6.0357361-03
22	2.2299909+02	1.0351890-03	1.1241299-04	6.7878541+03
23	2.0753711+02	9.6331960-04	1.1810841-04	7.5944802-03
24	1.9492374+02	9.0477242-04	1.2369857-04	8.4570950-03
25	1.8576009+02	8.6247943-04	1.3072121-04	9.3771411-03
26	1.8404719+02	8.5428701-04	1.4084651-04	1.0356125-02
27	1.8670214+02	8.6661042-04	1.5527076-04	1.1395521-02
28	1.9360037+02	8.9862977-04	1.7434893-04	1.2496822+02
29	2.0312024+02	9.4281793-04	1.9767914-04	1.3661535-02
30	2.1354668+02	9.9121405-04	2.2441760-04	1.4891180-02
31	2.2327061+02	1.0363493-03	2.5336960-04	1.6187296-02
32	2.3094511+02	1.0719719-03	2.8311173-04	1.7551440-02
33	2.3572902+02	1.0941772-03	3.1229786-04	1.8985195-02
34	2.3742823+02	1.1020644-03	3.3998886-04	2.0490163+02
35	2.3640575+02	1.0973184-03	3.6566434-04	2.2067977+02
36	2.3336696+02	1.0832133-03	3.8929407-04	2.3720299+02
37	2.2914821+02	1.0636312-03	4.1131684-04	2.5448820+02
38	2.2454625+02	1.0422704-03	4.3252740-04	2.7255266+02
39	2.2018608+02	1.0220370-03	4.5387342-04	2.9141401-02
40	2.1646292+02	1.0047503-03	4.7624715-04	3.1109027-02
41	2.1353889+02	9.9117786-04	5.0029661-04	3.3159984-02
42	2.1137711+02	9.8114312-04	5.2631918-04	3.5294158-02
43	2.0982548+02	9.7394146-04	5.5437364-04	3.7512483-02
44	2.0872175+02	9.6881829-04	5.8441277-04	3.9811936-02
45	2.0793251+02	9.6515490-04	6.1638096-04	4.2235550-02
46	2.0733058+02	9.6236091-04	6.5018911-04	4.4732409-02
47	2.0676096+02	9.5971696-04	6.8561378-04	4.7324653-02
48	2.0604401+02	9.5638911-04	7.2226593-04	5.0014484-02
49	2.0500419+02	9.5156260-04	7.5963735-04	5.2804163+02
50	2.0353237+02	9.4473088-04	7.9727537-04	5.5696014-02
51	2.0171087+02	9.3627610-04	8.3507938-04	5.8692434-02
52	1.9956610+02	9.2632078-04	8.7221822-04	6.1795887+02
53	1.9730536+02	9.1582716-04	9.0849637-04	6.5008910-02

NO.	TAU	TAU/(RE*UE2)	EPS/(RHO*UE*DELTA)	YTIL/DELTA
54	1.9496130+02	9.0494677-04	9.4344196-04	6.8334122-02
55	1.9263100+02	8.9413028-04	9.7757169-04	7.1774218-02
56	1.9022430+02	8.8295717-04	1.0108277-03	7.5331978+02
57	1.8769144+02	8.7120246-04	1.0432606-03	7.9010269-02
58	1.8498755+02	8.5865189-04	1.0748412-03	8.2812047+02
59	1.8209554+02	8.4518170-04	1.1055652-03	8.6740370-02
60	1.7896859+02	8.3071385-04	1.1354134-03	9.0798392+02
61	1.7563163+02	8.1522472-04	1.1643667-03	9.4988366-02
62	1.7207893+02	7.9873426-04	1.1923971-03	9.9316655-02
63	1.6832250+02	7.8129816-04	1.2194676-03	1.0378374-01
64	1.6438022+02	7.6299939-04	1.2455299-03	1.0839420-01
65	1.6027395+02	7.4393942-04	1.2705209-03	1.1315175-01
66	1.5602803+02	7.2423495-04	1.2943593-03	1.1806024-01
67	1.5167052+02	7.0400510-04	1.3169418-03	1.2312362-01
68	1.4722370+02	6.8336419-04	1.3381421-03	1.2834602-01
69	1.4271142+02	6.6241985-04	1.3578083-03	1.3373167-01
70	1.3815311+02	6.4126158-04	1.3757598-03	1.3928498-01
71	1.3356430+02	6.1996193-04	1.3917872-03	1.4501049-01
72	1.2895709+02	5.9857676-04	1.4056495-03	1.5091291-01
73	1.2433838+02	5.7713821-04	1.4170453-03	1.5699711-01
74	1.1971098+02	5.5565933-04	1.4257313-03	1.6326816-01
75	1.1507370+02	5.3413459-04	1.4313461-03	1.6973128-01
76	1.1042134+02	5.1253985-04	1.4335540-03	1.7639189-01
77	1.0574424+02	4.9083029-04	1.4319367-03	1.8325561-01
78	1.0102907+02	4.6894400-04	1.4260251-03	1.9032825+01
79	9.6258984+01	4.4680281-04	1.4153084-03	1.9761585+01
80	9.1413514+01	4.2431172-04	1.3992546-03	2.0512466-01
81	8.6471782+01	4.0137381-04	1.3773179-03	2.1286116-01
82	8.1395713+01	3.7781235-04	1.3490004-03	2.2083708+01
83	7.6168413+01	3.5354893-04	1.3138937-03	2.2904439-01
84	7.0798108+01	3.2862173-04	1.2715266-03	2.3750532+01
85	6.5225581+01	3.0275587-04	1.2214031-03	2.4622238+01
86	5.9402691+01	2.7572792-04	1.1631126-03	2.5520336-01
87	5.3361178+01	2.4768518-04	1.0964957-03	2.6445634+01
88	4.7110510+01	2.1867162-04	1.0218872-03	2.7398971-01
89	4.0653898+01	1.8870213-04	9.4039627-04	2.8381219-01
90	3.4053965+01	1.5806740-04	8.5405386-04	2.9393280-01
91	2.7454295+01	1.2743388-04	7.6600898-04	3.0436096-01
92	2.0625366+01	9.5736722-05	6.7044772-04	3.1510642-01
93	1.4571517+01	6.7636229-05	5.8117438-04	3.2617931-01
94	8.2738544+00	3.8404534-05	4.5567312-04	3.3759016-01
95	3.9344630+00	1.8262480-05	4.2218282-04	3.4934993+01
96	2.3461070-01	1.0889863-06	4.2340242-04	3.6146998-01
97	-2.9378405+00	-1.3636498-05	5.1492480-04	3.7396215+01
98	-5.4504690+00	-2.5299300-05	5.8970418-04	3.8683872+01
99	-7.7789522+00	-3.6107359-05	6.3133334-04	4.0011249-01
100	-9.8226895+00	-4.5593721-05	6.8217762-04	4.1379476-01
101	-1.1738319+01	-5.4485447-05	7.2822771-04	4.2790535-01
102	-1.3499068+01	-6.2658272-05	7.6706512-04	4.4245267-01
103	-1.5106625+01	-7.0120024-05	7.9948362-04	4.5745368-01
104	-1.6533284+01	-7.6742111-05	8.2512380-04	4.7292400-01
105	-1.7765155+01	-8.2460057-05	8.4412414-04	4.8887982-01
106	-1.8791246+01	-8.7222835-05	8.5657743-04	5.0533807-01
107	-1.9609464+01	-9.1020736-05	8.6267250-04	5.2231631-01

NO.	TAU	TAU/(RE*UE2)	EPS/(RHO*UE*DELTA)	YTIL/DELTA
108	-2.0223837+01	-9.3872457-05	8.8253941-04	5.3983289-01
109	-2.0645272+01	-9.5828621-05	8.5630368-04	5.5790689-01
110	-2.0890594+01	-9.6967323-05	8.4409894-04	5.7655820-01
111	-2.0979372+01	-9.7379403-05	8.2608798-04	5.9580752-01
112	-2.0924073+01	-9.7122721-05	8.0248219-04	6.1567648-01
113	-2.0710013+01	-9.6129124-05	7.7358025-04	6.3618758-01
114	-2.0272613+01	-9.4098857-05	7.3974198-04	6.5736427-01
115	-1.9495000+01	-9.0489432-05	7.0130652-04	6.7923109-01
116	-1.8245090+01	-8.4687757-05	6.5894857-04	7.0181355-01
117	-1.6494330+01	-7.6529218-05	6.1372043-04	7.2513928-01
118	-1.4122549+01	-6.5552268-05	5.6692807-04	7.4923307-01
119	-1.1421076+01	-5.3012912-05	5.1997052-04	7.7412694-01
120	-8.5488077+00	-3.9680777-05	4.7411280-04	7.9985016-01
121	-5.7211049+00	-2.6555501-05	4.3033178-04	8.2643432-01
122	-3.0883265+00	-1.4335060-05	3.8917291-04	8.5391246-01
123	-7.8108221-01	-3.6255289-06	3.5090682-04	8.8231702-01
124	1.0734292+00	4.9825083-06	3.1538385-04	9.1169002-01
125	2.3698342+00	1.0999997-05	2.8225432-04	9.4206307-01
126	3.0413700+00	1.4117048-05	2.5114625-04	9.7347750-01
127	3.1121791+00	1.4445720-05	2.2186738-04	1.0059744+00
128	2.7418292+00	1.2726677-05	1.9447711-04	1.0395967+00
129	2.1298355+00	9.8840015-06	1.6929315-04	1.0743894+00
130	1.4513379+00	6.7366373-06	1.4677596-04	1.1103993+00
131	8.3176493-01	3.8607815-06	1.2735804-04	1.1476757+00
132	3.5975784-01	1.6690786-06	1.1133153-04	1.1862700+00
133	4.0012845-02	1.8572658-07	9.8827763-05	1.2262360+00
134	-1.4384378-01	-6.6767593-07	8.9877543-05	1.2674299+00
135	-2.4183545-01	-1.1225213-06	8.4454829-05	1.3100108+00
136	-2.7612471-01	-1.2816808-06	8.2513167-05	1.3539404+00
137	-2.8071103-01	-1.3029691-06	8.3938537-05	1.4009834+00
138	-2.5120492-01	-1.1660113-06	8.8523359-05	1.4487074+00
139	-2.1296200-01	-9.8850013-07	9.5718300-05	1.4981935+00
140	-1.6038610-01	-7.4445999-07	1.0385498-04	1.5494860+00
141	-1.1214480-01	-5.2053959-07	1.1097163-04	1.6026929+00
142	-6.7674686-02	-3.1412382-07	1.1900427-04	1.6578859+00
143	-2.8022459-02	-1.3007112-07	1.2813678-04	1.7151508+00
144	-9.8048247-03	-9.5510799-08	1.3864783-04	1.7745774+00
145	1.7967436-02	8.3398980-08	1.4230920-04	1.8362602+00
146	5.8053573-03	2.6946575-08	1.4117456-04	1.9002979+00
147	2.1495412-02	9.9774692-08	1.4912831-04	1.9667947+00
148	-2.4760320-03	-1.1492933-08	1.4586551-04	2.0358596+00
149	9.3534221-03	4.3415535-08	1.4358220-04	2.1076071+00
150	5.3421143-03	2.4796352-08	1.4486822-04	2.1821575+00
151	-2.2271237-02	-1.0337582-07	1.5443502-04	2.2596372+00
152	4.9451560-02	2.2953801-07	1.4853065-04	2.3401709+00
153	-2.0907124-01	-9.7044048-07	8.2065451-04	2.4239223+00

NO.	WJ	Y	K /UE2	RU/REUF	MIXEDDY	UDAG	YDAG	PRT
1	5.2593168-07	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.5516[illegible]
2	5.3551739-07	5.2303703-06	0.0000000	4.6221443-03	3.0942178-13	2.6355260-01	1.9425671-01	1.55[illegible]
3	5.4479192-07	1.6648400-05	1.8537309-07	1.4896468-02	2.9283481-11	8.5202442-01	6.1833139-01	1.547[illegible]
4	5.5362510-07	3.5703776-05	1.7606722-06	3.1836789-02	5.6832394-10	1.8235756+00	1.3262275+00	1.54[illegible]
5	5.6207759-07	6.3627049-05	9.7685473-06	5.6352013-02	5.1250251-09	3.2266943+00	2.3631185+00	1.52[illegible]
6	5.7004864-07	1.0147240-04	3.5480319-05	8.8117001-02	2.7863757-08	5.0346994+00	3.7686997+00	1.5144453+00
7	5.7762342-07	1.5321162-04	9.2544957-05	1.2450661-01	1.0199246-07	7.0866328+00	5.5788812+00	1.4962297+00
8	5.8478714-07	2.1073570-04	1.4615102-04	1.6074424-01	2.4971021-07	9.0979173+00	7.8267542+00	1.4737056+00
9	5.9152469-07	2.8387685-04	3.2515882-04	1.9274774-01	5.5443897-07	1.0830668+01	1.0543227+01	1.4474424+00
10	5.9785261-07	3.7042044-04	5.1554022-04	2.1949971-01	9.7723539-07	1.2218286+01	1.3757449+01	1.4177232+00
11	6.0383831-07	4.7111181-04	7.8747480-04	2.4224155-01	1.5815021-06	1.332[illegible]+01	1.7497235+01	1.3849347+00
12	6.0739246-07	5.8467774-04	1.1793983-03	2.6772764-01	2.4794297-06	1.4232162+01	2.1787112+01	1.3494979+00
13	6.1457057-07	7.1778716-04	1.7185017-03	2.8215516-01	3.6227652-06	1.5029968+01	2.6658719+01	1.3116412+00
14	6.1928887-07	8.5512491-04	2.4009699-03	3.0102991-01	5.7486734-06	1.5761590+01	3.2130964+01	1.2729453+00
15	6.2349449-07	1.0293[illegible]-03	3.1799556-03	3.1933776-01	8.3195547-06	1.6450958+01	3.8229680+01	1.2332235+00
16	6.2715228-07	1.2110542-03	3.9684709-03	3.3695213-01	1.1495765-05	1.7105379+01	4.4978729+01	1.1939462+00
17	6.3026316-07	1.4109022-03	4.6459168-03	3.5375106-01	1.5144354-05	1.7725887+01	5.2401110+01	1.1556372+00
18	6.3283345-07	1.6274911-03	5.0815791-03	3.5995880-01	1.9041238-05	1.8309907+01	6.0519534+01	1.1192567+00
19	6.3458982-07	1.8674242-03	5.2027507-03	3.8557343-01	2.2924[illegible]-05	1.8852154+01	6.9358[illegible]+01	1.0887[illegible]+00
20	6.3561639-07	2.1252981-03	5.0301821-03	4.0040610-01	2.6119390-05	1.9345154+01	7.6933578+01	1.0531521+00
21	6.3606777-07	2.4037047-03	4.6536660-03	4.1427829-01	2.6743909-05	1.9784373+01	8.9273939+01	1.0246753+00
22	6.3622274-07	2.7032323-03	4.1777740-03	4.2710224-01	3.0822491-05	2.0171192+01	1.0039844+02	1.0002479+00
23	6.3636066-07	3.0244675-03	3.6923242-03	4.3887239-01	3.2915583-05	2.0510911+01	1.1232916+02	9.7941278-01
24	6.3666399-07	3.3479960-03	3.2737567-03	4.4962888-01	3.3945081-05	2.0809649+01	1.2538766+02	9.6226721-01
25	6.3712979-07	3.7344042-03	2.9812787-03	4.5947373-01	3.5455991-05	2.1073761+01	1.3867631+02	9.4849442-01
26	6.3754863-07	4.1242801-03	2.8451993-03	4.6856796-01	3.7724245-05	2.1311285+01	1.5317636+02	9.3765692-01
27	6.3781961-07	4.5382148-03	2.8642256-03	4.7702243-01	4.1476641-05	2.1533210+01	1.6854995+02	9.2933358-01
28	6.3793873-07	4.9769030-03	3.0116312-03	4.8503658-01	4.6987092-05	2.1749489+01	1.8483918+02	9.2310402-01
29	6.3794776-07	5.4404447-03	3.2499191-03	4.9286482-01	5.4084644-05	2.1966722+01	2.0206633+02	9.1856100-01
30	6.3790441-07	5.9303451-03	3.5372963-03	5.0074705-01	6.29[illegible]1155-05	2.2187722+01	2.2025387+02	9.1533397-01
31	6.3786736-07	6.4465175-03	3.8293293-03	5.0887680-01	7.1617867-05	2.2412874+01	2.3942459+02	9.1310246-01
32	6.3787539-07	6.9897820-03	4.0820811-03	5.1736332-01	8.1347420-05	2.2641325+01	2.5960151+02	9.1160136-01
33	6.3792750-07	7.5607682-03	4.2619974-03	5.2615982-01	9.1865548-05	2.2870826+01	2.8080803+02	9.1062000-01
34	6.3797859-07	8.1501150-03	4.3545631-03	5.3508446-01	1.0831585-04	2.3098411+01	3.0306785+02	9.0999676-01
35	6.3800041-07	8.7884724-03	4.3615021-03	5.4407704-01	1.0887151-04	2.3321153+01	3.2640513+02	9.0961228-01
36	6.3799413-07	9.4465021-03	4.2982576-03	5.5108614-01	1.1671586-04	2.3534786+01	3.5[illegible]+02	9.0[illegible]38216-01
37	6.3797219-07	1.0134870-02	4.1886086-03	5.62[illegible]-01	1.2397[illegible]-04	2.3743830+01	3.7[illegible]+02	9.[illegible]74879-01
38	6.37955[illegible]-07	1.0854287-02	4.0583509-03	5.7082170-01	1.3[illegible]3364-04	2.3941665+01	4.0312974+02	9.[illegible]17394-01
39	6.37962[illegible]7-07	1.1605432-02	3.9295380-03	5.7938697-01	1.3795749-04	2.4130369+01	4.3102742+02	9.0913327-01
40	6.3800653-07	1.2389030-02	3.8172937-03	5.8769038-01	1.4520986-04	2.4310677+01	4.6013036+02	9.0911188-01
41	6.3808812-07	1.3205814-02	3.7287622-03	5.9575169-01	1.5323298-04	2.4483632+01	4.9346585+02	9.0910097-01
42	6.3818953-07	1.4056536-02	3.6440610-03	6.0363637-01	1.67[illegible]9934-04	2.4650306+01	5.2206178+02	9.0909559-01
43	6.3829579-07	1.4941965-02	3.6199358-03	6.1136271-01	1.7184915-04	2.4811761+01	5.5494673+02	9.0909299-01
44	6.3840665-07	1.5862889-02	3.5924303-03	6.1894524-01	1.8235772-04	2.4968579+01	5.8914999+02	9.0909180-01
45	[illegible]	[illegible]	3.5[illegible]	[illegible]	[illegible]	2.5[illegible]	6.2[illegible]	[illegible]
46	6.3868733-07	1.7814480-02	3.5743728-03	6.3378552-01	2.0541436-04	2.5270554+01	6.6163237+02	[illegible]
47	6.3888749-07	1.8846830-02	3.5768965-03	6.4110883-01	2.1801457-04	2.5416425+01	6.9997398+02	9.0909095-01
48	6.3914261-07	1.9918043-02	3.5810199-03	6.4840046-01	2.3122734-04	2.5559261+01	7.3975900+02	9.0909091-01
49	6.3945244-07	2.1029020-02	3.5817099-03	6.5566237-01	2.4489865-04	2.5699208+01	7.8102084+02	9.0909090-01
50	6.3980130-07	2.2180686-02	3.5753982-03	6.6287457-01	2.5879801-04	2.5836263+01	8.2379391+02	9.0909090-01
51	6.4014973-07	2.3173997-02	3.5622509-03	6.7002470-01	2.7268258-04	2.5970389+01	8.6811364+02	9.0909090-01
[illegible]	[illegible]	[illegible]	3.5[illegible]-03	6.77[illegible]-01	2.8[illegible]5118-04	2.6101359+01	9.1401648+02	9.0909090-01

NO.	MU	Y	K /UE2	RU/REUE	MIXEDDY	UDAG	YDAG	PRT
53	6.4097934-07	2.5889506-02	3.4987293-03	6.8412068-01	3.0077224-04	2.6229166+01	9.6153998+02	9.0909090-01
54	6.4145878-07	2.7213756-02	3.4472458-03	6.9107470-01	3.1578226-04	2.6354036+01	1.0107228+03	9.0909090-01
55	6.4201836-07	2.8583759-02	3.3879474-03	6.9797903-01	3.3170447-04	2.6476272+01	1.0616049+03	9.0909090-01
56	6.4267358-07	3.0000621-02	3.3219072-03	7.0484137+01	3.4851791-04	2.6596117+01	1.1142274+03	9.0909090-01
57	6.4342395-07	3.1465483-02	3.2507763-03	7.1166570-01	3.6616428-04	2.6713768+01	1.1686326+03	9.0909090-01
58	6.4424455-07	3.2979524-02	3.1755038-03	7.1845233-01	3.8459096-04	2.6829375+01	1.2248643+03	9.0909090-01
59	6.4510218-07	3.4543961-02	3.0970687-03	7.2520278-01	4.0372998-04	2.6943051+01	1.2829577+03	9.0909090-01
60	6.4599612-07	3.6160050-02	3.0162431-03	7.3191816-01	4.2349965-04	2.7054874+01	1.3429885+03	9.0909090-01
61	6.4695293-07	3.7829087-02	2.9337028-03	7.3859845-01	4.4381942-04	2.7164892+01	1.4049778+03	9.0909090-01
62	6.4801275-07	3.9552410-02	2.8499928-03	7.4524298-01	4.6460185-04	2.7273131+01	1.4689922+03	9.0909090-01
63	6.4921571-07	4.1331405-02	2.7655501-03	7.5185046+01	4.8576363-04	2.7379596+01	1.5350543+03	9.0909090-01
64	6.5058833-07	4.3167500-02	2.6807077-03	7.5841951-01	5.0723752-04	2.7484282+01	1.6032472+03	9.0909090-01
65	6.5212996-07	4.5062175-02	2.5957014-03	7.6494886+01	5.2896229-04	2.7587175+01	1.6736157+03	9.0909090-01
66	6.5379192-07	4.7016957-02	2.5106734-03	7.7143770+01	5.5089918-04	2.7689269+01	1.7462166+03	9.0909090-01
67	6.5549956-07	4.9033429-02	2.4256790-03	7.7786571-01	5.7303398-04	2.7787529+01	1.8211086+03	9.0909090-01
68	6.5725130-07	5.1113225-02	2.3407034-03	7.8429177-01	5.9536917-04	2.7884974+01	1.8983526+03	9.0909090-01
69	6.5910910-07	5.3258037-02	2.2556494-03	7.9065444-01	6.1793447-04	2.7980596+01	1.9779112+03	9.0909090-01
70	6.6116672-07	5.5469416-02	2.1704464-03	7.9697223-01	6.4077722-04	2.8074410+01	2.0598939+03	9.0909090-01
71	6.6351797-07	5.7749773-02	2.0848666-03	8.0324393-01	6.6393385-04	2.8166459+01	2.1443499+03	9.0909090-01
72	6.6622481-07	6.0100385-02	1.9987325-03	8.0946902-01	6.8754694-04	2.8256760+01	2.2321370+03	9.0909090-01
73	6.6928546-07	6.2523393-02	1.9118082-03	8.1564804-01	7.1164819-04	2.8345367+01	2.3221279+03	9.0909090-01
74	6.7256268-07	6.5020808-02	1.8238857-03	8.2177544-01	7.3635457-04	2.8432339+01	2.4140822+03	9.0909090-01
75	6.7580307-07	6.7594716-02	1.7348484-03	8.2782944-01	7.6174243-04	2.8517741+01	2.5104775+03	9.0909090-01
76	6.7900125-07	7.0247274-02	1.6445319-03	8.3381055-01	7.8788647-04	2.8601646+01	2.6089939+03	9.0909090-01
77	6.8237559-07	7.2980719-02	1.5527318-03	8.3974157-01	8.1487543-04	2.8684123+01	2.7105145+03	9.0909090-01
78	6.8625653-07	7.5797366-02	1.4592581-03	8.4565694-01	8.4276470-04	2.8765245+01	2.8151252+03	9.0909090-01
79	6.9097446-07	7.8699620-02	1.3639736-03	8.5159114-01	8.7158936-04	2.8845074+01	2.9229153+03	9.0909090-01
80	6.9674782-07	8.1689970-02	1.2668469-03	8.5756776-01	9.0145779-04	2.8923670+01	3.0339773+03	9.0909090-01
81	7.0357100-07	8.4770997-02	1.1679695-03	8.6358814-01	9.3187311-04	2.9001096+01	3.1484071+03	9.0909090-01
82	7.1096984-07	8.7945378-02	1.0676562-03	8.6969168-01	9.6349262-04	2.9077320+01	3.2663041+03	9.0909090-01
83	7.1809093-07	9.1215895-02	9.6647535-04	8.7552142-01	9.9619236-04	2.9152515+01	3.3877715+03	9.0909090-01
84	7.2491538-07	9.4585423-02	8.6499095-04	8.8134272+01	1.0272466-03	2.9226630+01	3.5129163+03	9.0909090-01
85	7.3217775-07	9.8056954-02	7.6384631-04	8.8713752+01	1.0577163-03	2.9299438+01	3.6418494+03	9.0909090-01
86	7.4098924-07	1.0163359-01	6.6390621-04	8.9303019+01	1.0882153-03	2.9371062+01	3.7746862+03	9.0909090-01
87	7.5246106-07	1.0531865-01	5.6638637-04	8.9913803-01	1.1199948-03	2.9441355+01	3.9115461+03	9.0909090-01
88	7.6732772-07	1.0911517-01	4.7294958-04	9.0552977-01	1.1342353-03	2.9509897+01	4.0525531+03	9.0909090-01
89	7.8557043-07	1.1302693-01	3.8568316-04	9.1219389+01	1.1443053-03	2.9576333+01	4.1978363+03	9.0909090-01
90	8.0685387-07	1.1705741-01	3.0682192-04	9.1909941-01	1.1362778-03	2.9639998+01	4.3475292+03	9.0909090-01
91	8.3237986-07	1.2121038-01	2.3846058-04	9.2642692+01	1.1006476-03	2.9699769+01	4.5017710+03	9.0909090-01
92	8.6218316-07	1.2548971-01	1.7679038-04	9.3413851+01	1.0255508-03	2.9754223+01	4.6607040+03	9.0909090-01
93	8.9490726-07	1.2989944-01	1.2879277-04	9.4192944-01	9.0935153-04	2.9800935+01	4.8244839+03	9.0909090-01
94	9.2650004-07	1.3444376-01	7.8900662-05	9.4996471+01	7.2997398-04	2.9840332+01	4.9932607+03	9.0909090-01
95	9.6090935-07	1.3912703-01	6.4237922-05	9.5622054+01	4.2447560-04	2.9866995+01	5.1671982+03	9.0909090-01
96	9.9077869-07	1.4395379-01	6.2996524-05	9.6183594+01	6.1694745-05	2.9877073+01	5.3464647+03	9.0909090-01
97	1.0181429-06	1.4892874-01	9.1033723-05	9.6635723-01	2.3316673-04	2.9872106+01	5.5312349+03	9.0909090-01
98	1.0443903-06	1.5405678-01	1.0910364-04	9.7022110-01	4.4473959-04	2.9853559+01	5.7216909+03	9.0909090-01
99	1.0697899-06	1.5934302-01	1.3147514-04	9.7331451-01	6.5447889-04	2.9823233+01	5.9180223+03	9.0909090-01
100	1.0943372-06	1.6479242-01	1.5097653-04	9.7601636-01	7.9227526-04	2.9812756+01	6.1204245+03	9.0909090-01
101	1.1181993-06	1.7041139-01	1.6962358-04	9.7814449-01	9.5024186-04	2.9782741+01	6.3291031+03	9.0909090-01
102	1.1416286-06	1.7620478-01	1.8601726-04	9.7993641-01	1.1113040-03	2.9748626+01	6.5442710+03	9.0909090-01
103	1.1648778-06	1.8217887-01	2.0026259-04	9.8153189-01	1.2771694-03	2.9710622+01	6.7661495+03	9.0909090-01
104	1.1881137-06	1.8833985-01	2.1199532-04	9.8302365+01	1.4491316-03	2.9668899+01	6.9949693+03	9.0909090-01
105	1.2113322-06	1.9469419-01	2.2115130-04	9.8441262-01	1.6281005-03	2.9623586+01	7.2309702+03	9.0909090-01
106	1.2343235-06	2.0124861-01	2.2769462-04	9.8558313+01	1.8148784-03	2.9574794+01	7.4744023+03	9.0909090-01

NO.	HU	Y	K /UE2	RU/REUE	MIXEDDY	UDAG	YDAG	PRT
107	1.2569293-06	2.0801012-01	2.3167931-04	9.8642866-01	2.0105848-03	2.9522597+01	7.7255259+03	9.0909090-01
108	1.2791472-06	2.1490602-01	2.3315734-04	9.8694882-01	2.2169037-03	2.9467038+01	7.9846117+03	9.0909090-01
109	1.3010743-06	2.2218390-01	2.3219787-04	9.8721852-01	2.4363185-03	2.9408113+01	8.2519423+03	9.0909090-01
110	1.3228576-06	2.2961170-01	2.2888718-04	9.8734859-01	2.6723119-03	2.9345764+01	8.5278118+03	9.0909090-01
111	1.3446442-06	2.3727744-01	2.2333460-04	9.8744852-01	2.9291759-03	2.9279842+01	8.8125244+03	9.0909090-01
112	1.3665312-06	2.4519038-01	2.1567866-04	9.8757836-01	3.2109211+03	2.9210211+01	9.1064042+03	9.0909090-01
113	1.3885141-06	2.5335884-01	2.0610370-04	9.8773211-01	3.5182839-03	2.9136578+01	9.4097818+03	9.0909090-01
114	1.4109453-06	2.6179236-01	1.9482132-04	9.8788203-01	3.8525948-03	2.9056816+01	9.7230040+03	9.0909090-01
115	1.4352412-06	2.7050072-01	1.8202397-04	9.8820168-01	4.1850732-03	2.8977126+01	1.0046436+04	9.0909090-01
116	1.4614390-06	2.7949408-01	1.6806678-04	9.8872162-01	4.9265459-03	2.8892371+01	1.0380451+04	9.0909090-01
117	1.4881718-06	2.8878305-01	1.5347237-04	9.8931979-01	4.5816471-03	2.8806382+01	1.0725444+04	9.0909090-01
118	1.5133717-06	2.9837869-01	1.3884789-04	9.8981924-01	4.5611396-03	2.8721990+01	1.1081828+04	9.0909090-01
119	1.5349711-06	3.0829256-01	1.2479207-04	9.9007491-01	4.3113761-03	2.8642803+01	1.1450030+04	9.0909090-01
120	1.5516031-06	3.1853672-01	1.1178676-04	9.9004837-01	3.7997309-03	2.8572790+01	1.1830500+04	9.0909090-01
121	1.5633029-06	3.2912374-01	1.0014220-04	9.8988684-01	3.0168354-03	2.8515826+01	1.2223703+04	9.0909090-01
122	1.5710616-06	3.4006679-01	8.9957653-05	9.8986534-01	1.9861774-03	2.8475368+01	1.2630130+04	9.0909090-01
123	1.5738321-06	3.5137957-01	8.1218388-05	9.9002407-01	6.5649377-04	2.8454606+01	1.3050288+04	9.0909090-01
124	1.5715780-06	3.6307644-01	7.3739940-05	9.9043821-01	8.1295259-04	2.8456536+01	1.3484711+04	9.0909090-01
125	1.5657066-06	3.7517237-01	6.7267301-05	9.9123849-01	2.3171673-03	2.8478498+01	1.3933956+04	9.0909090-01
126	1.5583464-06	3.8768303-01	6.1538253-05	9.9253321-01	3.6341592-03	2.8521174+01	1.4398604+04	9.0909090-01
127	1.5516260-06	4.0062477-01	5.6376991-05	9.9432421+01	4.5377245+03	2.8578240+01	1.4879262+04	9.0909090-01
128	1.5469526-06	4.1401470-01	5.1722378-05	9.9646310-01	4.9863258+03	2.8641851+01	1.5376546+04	9.0909090-01
129	1.5442900-06	4.2787072-01	4.7657205-05	9.9868461-01	4.6920730-03	2.8704513+01	1.5891180+04	9.0909090-01
130	1.5420651-06	4.4221151-01	4.4383981-05	1.0005900+00	3.9589369-03	2.8758999+01	1.6423709+04	9.0909090-01
131	1.5395693-06	4.5705688-01	4.2173520-05	1.0018898+00	2.8155062-03	2.8800294+01	1.6975151+04	9.0909090-01
132	1.5367968-06	4.7242668-01	4.1334145-05	1.0024466+00	1.5176052-03	2.8825021+01	1.7545995+04	9.0909090-01
133	1.5339783-06	4.8834295-01	4.2210412-05	1.0024399+00	2.5545458-04	2.8834794+01	1.8137127+04	9.0909090-01
134	1.5314627-06	5.0482791-01	4.5181099-05	1.0019424+00	7.6469533-04	2.8830652+01	1.8749382+04	9.0909090-01
135	1.5295991-06	5.2190504-01	5.0491279-05	1.0012740+00	1.5189424-03	2.8818461+01	1.9383628+04	9.0909090-01
136	1.5286182-06	5.3959893-01	5.7741721-05	1.0005322+00	1.9199765-03	2.8799177+01	2.0040782+04	9.0909090-01
137	1.5285141-06	5.5793532-01	6.4971719-05	9.9996024-01	2.0681417-03	2.8779882+01	2.0721798+04	9.0909090-01
138	1.5291792-06	5.7694119-01	6.8534815-05	9.9945717-01	1.8924045-03	2.8758907+01	2.1427679+04	9.0909090-01
139	1.5309832-06	5.9664482-01	6.5094078-05	9.9935427-01	1.5985776-03	2.8744168+01	2.2159475+04	9.0909090-01
140	1.5339349-06	6.1707581-01	5.4103671-05	9.9945685-01	1.1968825-03	2.8729671+01	2.2918284+04	9.0909090-01
141	1.5376219-06	6.3824521-01	3.9378405-05	9.9992990-01	8.4316898-04	2.8722940+01	2.3705272+04	9.0909090-01
142	1.5414079-06	6.6017669-01	2.4962357-05	1.0003759+00	5.3498758-04	2.8719196+01	2.4521616+04	9.0909090-01
143	1.5444479-06	6.8288194-01	1.4648182-05	1.0009321+00	2.4227472-04	2.8714062+01	2.5368615+04	9.0909090-01
144	1.5469374-06	7.0671746-01	8.0318032-06	1.0012503+00	9.8421317-05	2.8711292+01	2.6247588+04	9.0909090-01
145	1.5482821-06	7.3128233-01	4.8722736-06	1.0015241+00	1.6594777-04	2.8712525+01	2.7159932+04	9.0909090-01
146	1.5490479-06	7.5678508-01	2.3644604-06	1.0016855+00	6.5129767-05	2.8713804+01	2.8107107+04	9.0909090-01
147	1.5491144-06	7.8326715-01	1.6748542-06	1.0016714+00	2.4299493-04	2.8713480+01	2.9090655+04	9.0909090-01
148	1.5484754-06	8.1077193-01	9.7759684-07	1.0016803+00	2.5100388-05	2.8717260+01	3.0112187+04	9.0909090-01
149	1.5473736-06	8.3934505-01	1.1354850-06	1.0013212+00	8.9617663-05	2.8713134+01	3.1173396+04	9.0909090-01
150	1.5461761-06	8.6903441-01	1.3430570-06	1.0012418+00	4.9306130-05	2.8718459+01	3.2276063+04	9.0909090-01
151	1.5452501-06	8.9989033-01	2.8977132-06	1.0008061+00	1.0629568-04	2.8713773+01	3.3422057+04	9.0909090-01
152	1.5448381-06	9.3196572-01	1.8534879-06	1.0006710+00	2.5111859-04	2.8717122+01	3.4613341+04	9.0909090-01
153	1.5449342-06	9.6531612-01	6.8857470-06	1.0004292+00	4.7973062-04	2.8716835+01	3.5851980+04	9.0909090-01
154	1.5452798-06	1.0000000+00	0.0000000	1.0000000+00	2.5063135+00	2.8711452+01	3.7140144+04	9.0909090-01

••• P.W 250K TRNSP COOLED ENGINE, H2-02, SEP1 4; 1973 ••••••

NO.	YBAR	O/F	C(H)	C(H2)	C(H2O)	C(O)	C(OH)	C(O2)	MU	PR
1	0.0000000	6.3443521-01	.000000	.562923	.437077	.000000	.000000	.000000	5.25432-07	.58706
2	3.1085439-07	6.3803995-01	.000000	.000000	.000000	.000000	.000000	.000000	5.35517-07	.58557
3	9.8946917-07	6.4629379-01	.000000	.000000	.000000	.000000	.000000	.000000	5.44782-07	.58403
4	2.1222658-06	6.5962968-01	.000000	.000000	.000000	.000000	.000000	.000000	5.53425-07	.58243
5	3.7815207-06	6.7963036-01	.000000	.000000	.000000	.000000	.000000	.000000	5.62047-07	.58077
6	6.0307464-06	7.0690514-01	.000000	.000000	.000000	.000000	.000000	.000000	5.70049-07	.57906
7	8.9274636-06	7.4150898-01	.000000	.000000	.000000	.000000	.000000	.000000	5.77428-07	.57729
8	1.2524566-05	7.8182187-01	.000000	.000000	.000000	.000000	.000000	.000000	5.84787-07	.57547
9	1.6871533-05	8.2441793-01	.000000	.491183	.508817	.000000	.000000	.000000	5.91625-07	.57359
10	2.2015043-05	8.6553487-01	.000000	.000000	.000000	.000000	.000000	.000000	5.97853-07	.57163
11	2.7999508-05	9.0229479-01	.000000	.000000	.000000	.000000	.000000	.000000	6.03808-07	.56950
12	3.4867475-05	9.3667773-01	.000000	.000000	.000000	.000000	.000000	.000000	6.09393-07	.56720
13	4.2659941-05	9.6760207-01	.000000	.000000	.000000	.000000	.000000	.000000	6.14571-07	.56481
14	5.1416603-05	9.9684562-01	.000000	.000000	.000000	.000000	.000000	.000000	6.19289-07	.56246
15	6.1176279-05	1.0250355+00	.000000	.000000	.000000	.000000	.000000	.000000	6.23494-07	.56026
16	7.1976274-05	1.0523451+00	.000000	.000000	.000000	.000000	.000000	.000000	6.27152-07	.55830
17	8.3853552-05	1.0796781+00	.000000	.415690	.584310	.000000	.000000	.000000	6.30263-07	.55658
18	9.6844854-05	1.1038046+00	.000000	.000000	.000000	.000000	.000000	.000000	6.32804-07	.55502
19	1.1098583-04	1.1274026+00	.000000	.000000	.000000	.000000	.000000	.000000	6.34590-07	.55362
20	1.2631194-04	1.1490533+00	.000000	.000000	.000000	.000000	.000000	.000000	6.35616-07	.55239
21	1.4285836-04	1.1685000+00	.000000	.000000	.000000	.000000	.000000	.000000	6.36068-07	.55129
22	1.6066706-04	1.1857498+00	.000000	.000000	.000000	.000000	.000000	.000000	6.36223-07	.55028
23	1.7975193-04	1.2009932+00	.000000	.000000	.000000	.000000	.000000	.000000	6.36360-07	.54932
24	2.0016868-04	1.2144669+00	.000000	.000000	.000000	.000000	.000000	.000000	6.36664-07	.54840
25	2.2194527-04	1.2264290+00	.000000	.379743	.620257	.000000	.000000	.000000	6.37130-07	.54750
26	2.4511660-04	1.2372243+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37549-07	.54667
27	2.6971780-04	1.2473521+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37819-07	.54594
28	2.9578423-04	1.2572876+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37939-07	.54532
29	3.2335153-04	1.2673744+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37948-07	.54478
30	3.5245569-04	1.2777923+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37904-07	.54427
31	3.8313315-04	1.2886094+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37867-07	.54375
32	4.1542576-04	1.2998299+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37875-07	.54318
33	4.4935694-04	1.3113774+00	.000000	.361155	.638844	.000000	.000000	.000000	6.37927-07	.54258
34	4.8497457-04	1.3231939+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37978-07	.54196
35	5.2232156-04	1.3349221+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38000-07	.54134
36	5.6142996-04	1.3466481+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37994-07	.54071
37	6.0234190-04	1.3582057+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37972-07	.54008
38	6.4509824-04	1.3695373+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37955-07	.53945
39	6.8974072-04	1.3806259+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37962-07	.53884
40	7.3631197-04	1.3914924+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38007-07	.53825
41	7.8485558-04	1.4021815+00	.000000	.342741	.657260	.000000	.000000	.000000	6.38098-07	.53768
42	8.3541615-04	1.4127461+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38190-07	.53713
43	8.8803948-04	1.4232409+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38296-07	.53659
44	9.4277239-04	1.4337104+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38407-07	.53607
45	9.9966294-04	1.4441836+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38532-07	.53557
46	1.0587605-03	1.4546873+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38687-07	.53508
47	1.1201157-03	1.4652511+00	.000000	.000000	.000000	.000000	.000000	.000000	6.38887-07	.53459
48	1.1837806-03	1.4758977+00	.000000	.000000	.000000	.000000	.000000	.000000	6.39143-07	.53410
49	1.2498088-03	1.4866437+00	.000000	.326819	.673181	.000000	.000000	.000000	6.39452-07	.53361
50	1.3182554-03	1.4974972+00	.000000	.000000	.000000	.000000	.000000	.000000	6.39801-07	.53313
51	1.3891769-03	1.5084560+00	.000000	.000000	.000000	.000000	.000000	.000000	6.40170-07	.53265
52	1.4626318-03	1.5195113+00	.000000	.000000	.000000	.000000	.000000	.000000	6.40557-07	.53218

NO.	YBAR	O/F	C(H)	C(H2)	C(H2O)	C(O)	C(OH)	C(O2)	MU	PR
53	1.5386801-03	1.5306638+00	.000000	.000000	.000000	.000000	.000000	.000000	6.40979-07	.53171
54	1.6173837-03	1.5419367+00	.000000	.000000	.000000	.000000	.000000	.000000	6.41459-07	.53125
55	1.6988065-03	1.5533625+00	.000000	.000000	.000000	.000000	.000000	.000000	6.42018-07	.53080
56	1.7831142-03	1.5649725+00	.000000	.000000	.000000	.000000	.000000	.000000	6.42474-07	.53034
57	1.8726746-03	1.5767959+00	.000000	.318777	.609623	.000000	.000000	.000000	6.43024-07	.52989
58	1.9662581-03	1.5888465+00	.000000	.000000	.000000	.000000	.000000	.000000	6.44295-07	.52944
59	2.0530366-03	1.6011940+00	.000000	.000000	.000000	.000000	.000000	.000000	6.45102-07	.52900
60	2.1490859-03	1.6138240+00	.000000	.000000	.000000	.000000	.000000	.000000	6.45996-07	.52856
61	2.2482801-03	1.6267745+00	.000000	.000000	.000000	.000000	.000000	.000000	6.46953-07	.52812
62	2.3507017-03	1.6400722+00	.000000	.000000	.000000	.000000	.000000	.000000	6.48013-07	.52769
63	2.4564319-03	1.6537432+00	.000000	.000000	.000000	.000000	.000000	.000000	6.49216-07	.52726
64	2.5655558-03	1.6678151+00	.000000	.000000	.000000	.000000	.000000	.000000	6.50588-07	.52683
65	2.6781612-03	1.6823171+00	.000000	.293786	.706214	.000000	.000000	.000000	6.52130-07	.52641
66	2.7943389-03	1.6972807+00	.000000	.000000	.000000	.000000	.000000	.000000	6.53792-07	.52599
67	2.9141830-03	1.7127411+00	.000000	.000000	.000000	.000000	.000000	.000000	6.55500+07	.52558
68	3.0377907-03	1.7287378+00	.000000	.000000	.000000	.000000	.000000	.000000	6.57251-07	.52516
69	3.1652624-03	1.7453157+00	.000000	.000000	.000000	.000000	.000000	.000000	6.59109+07	.52475
70	3.2967022-03	1.7625268+00	.000000	.000000	.000000	.000000	.000000	.000000	6.61167-07	.52434
71	3.4322178-03	1.7804306+00	.000000	.000000	.000000	.000000	.000000	.000000	6.63518-07	.52394
72	3.5719208-03	1.7990968+00	.000000	.000000	.000000	.000000	.000000	.000000	6.66225-07	.52356
73	3.7159264-03	1.8186061+00	.000000	.273488	.726511	.000000	.000000	.000000	6.69286-07	.52318
74	3.8643542-03	1.8390531+00	.000000	.000000	.000000	.000000	.000000	.000000	6.72563+07	.52280
75	4.0173282-03	1.8605491+00	.000000	.000000	.000000	.000000	.000000	.000000	6.75803-07	.52243
76	4.1749766-03	1.8832254+00	.000000	.000000	.000000	.000000	.000000	.000000	6.79001-07	.52204
77	4.3374322-03	1.9072368+00	.000000	.000000	.000000	.000000	.000000	.000000	6.82376-07	.52166
78	4.5048328-03	1.9327664+00	.000000	.000000	.000000	.000000	.000000	.000000	6.86257-07	.52130
79	4.6773212-03	1.9600311+00	.000000	.000000	.000000	.000000	.000000	.000000	6.90974-07	.52096
80	4.8550454-03	1.9892825+00	.000000	.000000	.000000	.000000	.000000	.000000	6.96748-07	.52068
81	5.0381589-03	2.0208310+00	.000000	.246745	.753255	.000000	.000000	.000000	7.03571-07	.52043
82	5.2268205-03	2.0549493+00	.000000	.000000	.000000	.000000	.000000	.000000	7.10970-07	.52019
83	5.4211957-03	2.0921416+00	.000000	.000000	.000000	.000000	.000000	.000000	7.18091-07	.51984
84	5.6214555-03	2.1332352+00	.000000	.000000	.000000	.000000	.000000	.000000	7.24915-07	.51944
85	5.8277776-03	2.1795224+00	.000000	.000000	.000000	.000000	.000000	.000000	7.32178-07	.51902
86	6.0403461-03	2.2286808+00	.000000	.000000	.000000	.000000	.000000	.000000	7.40089-07	.51871
87	6.2593527-03	2.2851827+00	.000000	.000000	.000000	.000000	.000000	.000000	7.52461+07	.51866
88	6.4849557-03	2.3451394+00	.000000	.000000	.000000	.000000	.000000	.000000	7.62126-07	.51894
89	6.7174915-03	2.4210122+00	.000005	.203765	.796235	.000000	.000000	.000000	7.80[illegible]-07	.51955
90	6.9570236-03	2.5251903+00	.000000	.000000	.000000	.000000	.000000	.000000	8.06654-07	.52041
91	7.2038453-03	2.6012337+00	.000000	.000000	.000000	.000000	.000000	.000000	8.32380-07	.52152
92	7.4581769-03	2.7118268+00	.000000	.000000	.000000	.000000	.000000	.000000	8.62183-07	.52290
93	7.7202584-03	2.8374180+00	.000000	.000000	.000000	.000000	.000000	.000000	8.94907-07	.52450
94	7.9903392-03	2.9877367+00	.000000	.000000	.000000	.000000	.000000	.000000	9.28500-07	.52628
95	8.2686792-03	3.1648118+00	.000000	.000000	.000000	.000000	.000000	.000000	9.60909+07	.52819
96	8.5555449-03	3.3470799+00	.000000	.000000	.000000	.000000	.000000	.000000	9.90779-07	.53021
97	8.8512190-03	3.5063479+00	.000001	.123869	.876130	.000000	.000001	.000000	1.01814-06	.53234
98	9.1559913-03	3.6445844+00	.000000	.000000	.000000	.000000	.000000	.000000	1.04439-06	.53461
99	9.4701649-03	3.7720486+00	.000000	.000000	.000000	.000000	.000000	.000000	1.06979-06	.53704
100	9.7940546-03	3.8915825+00	.000000	.000000	.000000	.000000	.000000	.000000	1.09434-06	.53965
101	1.0127987-02	4.0063351+00	.000000	.000000	.000000	.000000	.000000	.000000	1.11820+06	.54240
102	1.0472304-02	4.1181758+00	.000000	.000000	.000000	.000000	.000000	.000000	1.14103+06	.54529
103	1.0827360-02	4.2284194+00	.000000	.000000	.000000	.000000	.000000	.000000	1.16488-06	.54829
104	1.1193523-02	4.3377880+00	.000000	.000000	.000000	.000000	.000000	.000000	1.18811-06	.55138
105	1.1571177-02	4.4467998+00	.000011	.080717	.919254	.000000	.000018	.000000	1.21133+06	.55457
106	1.1960723-02	4.5558830+00	.000000	.000000	.000000	.000000	.000000	.000000	1.23432+06	.55785

NO.	YBAR	O/F	C(H)	C(H2)	C(H2O)	C(O)	C(OH)	C(O2)	MU	PR
107	1.2362577-02	4.6654545+00	.000000	.000000	.000000	.000000	.000000	.000000	1.25493-06	.56120
108	1.2777173-02	4.7759415+00	.000000	.000000	.000000	.000000	.000000	.000000	1.27915-06	.56461
109	1.3204962-02	4.8877915+00	.000000	.000000	.000000	.000000	.000000	.000000	1.30107+06	.56813
110	1.3646415-02	5.0014817+00	.000000	.000000	.000000	.000000	.000000	.000000	1.32286-06	.57180
111	1.4102623-02	5.1175339+00	.000000	.000000	.000000	.000000	.000000	.000000	1.34464-06	.57567
112	1.4572296-02	5.2365196+00	.000000	.000000	.000000	.000000	.000000	.000000	1.36653-06	.57977
113	1.5057769-02	5.3590403+00	.000051	.051033	.948692	.000000	.000223	.000001	1.38852-06	.58411
114	1.5558995-02	5.4855979+00	.000000	.000000	.000000	.000000	.000000	.000000	1.41095-06	.58879
115	1.6076555-02	5.6163346+00	.000000	.000000	.000000	.000000	.000000	.000000	1.43524+06	.59423
116	1.6611054-02	5.7506.69+00	.000000	.000000	.000000	.000000	.000000	.000000	1.46144-06	.60044
117	1.7163121-02	5.8865846+00	.000000	.000000	.000000	.000000	.000000	.000000	1.48817-06	.60701
118	1.7733415-02	6.0208851+00	.000000	.000000	.000000	.000000	.000000	.000000	1.51337-06	.61332
119	1.8322422-02	6.1488124+00	.000000	.000000	.000000	.000000	.000000	.000000	1.53497-06	.61875
120	1.8931458-02	6.2648872+00	.000000	.000000	.000000	.000000	.000000	.000000	1.55160-06	.62288
121	1.9560472-02	6.3637476+00	.000149	.026882	.971021	.000013	.001890	.000345	1.56330+06	.62572
122	2.0211046-02	6.4409186+00	.001962	.031386	.898929	.003717	.054586	.009420	1.57106-06	.62761
123	2.0883394-02	6.4925928+00	.001961	.031384	.898980	.003713	.054550	.009412	1.57383-06	.62833
124	2.1578568-02	6.5167006+00	.001960	.031381	.899030	.003709	.054516	.009404	1.57158-06	.62789
125	2.2297461-02	6.5126292+00	.001959	.031379	.899069	.003706	.054489	.009397	1.56571+06	.62659
126	2.3041002-02	6.4817555+00	.001958	.031377	.899114	.003703	.054458	.009390	1.55835-06	.62494
127	2.3810162-02	6.4279905+00	.001958	.031376	.899139	.003701	.054441	.009385	1.55163+06	.62342
128	2.4605961-02	6.3579923+00	.001957	.031374	.899166	.003699	.054423	.009381	1.54695-06	.62236
129	2.5429460-02	6.2784292+00	.000132	.028866	.969657	.000009	.001509	.000028	1.54429-06	.62176
130	2.6281770-02	6.1971217+00	.001956	.031371	.899225	.003694	.054384	.009370	1.54207-06	.62123
131	2.7164056-02	6.1231920+00	.001955	.031370	.899256	.003691	.054363	.009365	1.53957+06	.62061
132	2.8077535-02	6.0477270+00	.001955	.031368	.899289	.003689	.054341	.009359	1.53680-06	.61989
133	2.9023480-02	6.0403526+00	.001955	.031368	.899289	.003689	.054341	.009359	1.53398-06	.61913
134	3.0003224-02	6.0459793+00	.001954	.031366	.899322	.003686	.054318	.009353	1.53146-06	.61845
135	3.1018162-02	6.0811143+00	.001953	.031365	.899358	.003683	.054294	.009347	1.52960-06	.61795
136	3.2069756-02	6.1314761+00	.001953	.031365	.899358	.003683	.054294	.009347	1.52862-06	.61771
137	3.3159534-02	6.1889555+00	.000121	.030585	.968017	.000006	.001251	.000019	1.52851-06	.61771
138	3.4289102-02	6.2421444+00	.001952	.031363	.899393	.003680	.054270	.009341	1.52918-06	.61793
139	3.5460139-02	6.2852218+00	.001951	.031361	.899432	.003677	.054244	.009334	1.53098-06	.61846
140	3.6674405-02	6.3157395+00	.001951	.031361	.899432	.003677	.054244	.009334	1.53394+06	.61931
141	3.7933747-02	6.3291406+00	.001951	.031361	.899432	.003677	.054244	.009334	1.53762+06	.62037
142	3.9240097-02	6.3296999+00	.001951	.031359	.899472	.003674	.054217	.009327	1.54140+06	.62145
143	4.0595485-02	6.3266484+00	.001951	.031359	.899472	.003674	.054217	.009327	1.54465-06	.62237
144	4.2002040-02	6.3251072+00	.001950	.031357	.899515	.003671	.054188	.009320	1.54694+06	.62302
145	4.3461994-02	6.3145326+00	.000134	.027905	.970341	.000010	.001580	.000031	1.54828-06	.62339
146	4.4977488-02	6.3060232+00	.001950	.031357	.899515	.003671	.054188	.009320	1.54905-06	.62360
147	4.6551585-02	6.3021702+00	.001949	.031355	.899560	.003667	.054157	.009312	1.54911-06	.62362
148	4.8186265-02	6.2870442+00	.001949	.031355	.899560	.003667	.054157	.009312	1.54848-06	.62343
149	4.9884439-02	6.2903826+00	.001949	.031355	.899560	.003667	.054157	.009312	1.54737-06	.62311
150	5.1648954-02	6.2863440+00	.001949	.031355	.899560	.003667	.054157	.009312	1.54618+06	.62276
151	5.3482801-02	6.2834696+00	.001948	.031352	.899607	.003664	.054125	.009304	1.54525+06	.62246
152	5.5389124-02	6.2860990+00	.001948	.031352	.899607	.003664	.054125	.009304	1.54484-06	.62230
153	5.7371225-02	6.2896628+00	.000132	.028428	.969883	.000009	.001519	.000029	1.54493-06	.62226
154	5.9432577-02	6.2900096+00	.000132	.028421	.969883	.000009	.001526	.000029	1.54528-06	.62228

NO. ITERATIONS = 2

CASE II

Air flow with combustion due to injection of a mixture of hydrogen and nitrogen.

•••• MUZZY WITH COMBUSTION FOR B=10, 4% HYDROGEN INJECTION ••••• 6/14/73

FLAGS AND OPTIONS

IDEAL = 1		(=1 FOR PERFECT GAS, =0 FOR HYDROGEN-OXYGEN EQUILIBRIUM)
LAMNR = 0		(=1 FOR LAMINAR FLOW, =0 FOR TURBULENT)
INCOMP= 0		(=1 FOR INCOMPRESSIBLE FLOW, =0 FOR COMPRESSIBLE)
J2D = 0		(=1 FOR AXISYMMETRIC GEOMETRY, =0 FOR TWO-DIMENSIONAL)
INTDK = 0		(=1 IF INPUT TABLES COME FROM TDK OUTPUT, =0 OTHERWISE)
ICOOL = 0		(=0 NO COOLING, =1 OPPOSITE DIRECTION, =2 SAME DIRECTION)
ITHERM = 0		(=1 FOR STHERMO NAMELIST INPUT TO ODE, =0 OTHERWISE)
IPOLY = 0		(=1 FOR CALCULATION OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, =0 OTHERWISE)
INJH2 = 1		(=1 FOR HYDROGEN INJECTION,FREE STREAM=PERFCT GAS, =0 FOR PERFECT GAS INJECTION,FREE STREAM=PERFECT GAS

PROBLEM LIMITS AND INITIAL VALUES

SINIT = .00000000 XINIT = .00000000 XMAX = 36.00000000 DXI = 1.0000000-03 DELTAI = 5.000000-04 ZETAPI = 1.0000000-03

REFERENCE QUANTITIES

BLREF = 2.9166667-01 UREF = 1.0000000+02 RHOREF = 2.0000000-03 SMUREF = 5.0000000-07

INPUT NORMALIZATION FACTORS

XN = 8.3330000-02 YN = 1.0000000+00 UEN = 1.0000000+00 PEN = 2.1168000+03 SMDN = 1.0000000+00

EDGE QUANTITIES

UEDGE = 4.1500000+01 PEDGE = 1.0000000+00 TEDGE = 5.3000000+02 AMEDGE = 0.0000000

CONSTANTS

APTRNS = 4.000000-02 PRI = 0.000000 GAMMA = 0.000000 FMOLWT = 0.000000 PLAW = 7.000000+00 PAMB = 0.000000
GPO = 1.000000+03 SN3 = 2.000000+00 XSTAR = 5.830000-01 AMWALL = 0.000000 UEK = 0.000000 RHOEK = 0.000000

CONVERGENCE AND EDGE CRITERIA

CONVRG= 5.0000000-03 EPSLN1= 5.0000000+02 EPSLN2= 5.0000000-02 EPSLN3= 5.0000000-02 EPSTIN= 0.0000000

COUNTERS

MAXIT = 2 NYI = 120 NLPRNT = 40 NSPRNT = 40 INSTAT =•••• IYPR = 1 IYEQ = 4

CORRELATION INPUTS

GAMA = .500000 ZK = .600000

STEPSIZE CONTROL TABLES

LDA[illegible]

DXLIM	XLIM
5.0000000-03	1.0000000-01
1.0000000-02	5.0000000-01
1.0000000-02	2.0000000+00
1.0000000-02	4.0000000+00
1.0000000-02	6.0000000+00
1.0000000-02	8.0000000+00
1.0000000-02	1.0000000+01
1.0000000-02	1.5000000+01
1.0000000-02	2.0000000+01
1.0000000-02	2.5000000+01
1.0000000-02	3.0000000+01
1.0000000-02	3.6000000+01

LSKTAB= 3

SKTAB	XTABSK
6.0150000+00	5.0000000-02
1.0150000+00	1.0000000+01
1.0150000+00	3.6000000+01

WALL TABLES

LTWTAB= 8

TWTAB	XTABTW
5.3000000+02	0.0000000
5.6000000+02	2.0000000+00
6.0500000+02	5.0000000+00
6.5300000+02	8.0000000+00
7.1600000+02	1.2000000+01
8.4200000+02	2.0000000+01
1.0000000+03	3.0000000+01
1.1300000+03	3.6000000+01

LMDTAB= 7

SMDTAB	XTABMD
2.8000000-04	0.0000000
2.8000000-04	5.0000000+00
2.8000000-04	1.0000000+01
2.8000000-04	1.5000000+01
2.8000000-04	2.0000000+01
2.8000000-04	3.0000000+01
2.8000000-04	3.6000000+01

GEOMETRY AND EDGE TABLES

LRWTAB= 5

RWTAB	XTABRW
3.5000000+00	0.0000000
3.5000000+00	6.0000000+00
3.5000000+00	1.2000000+01
3.5000000+00	2.4000000+01
3.5000000+00	3.6000000+01

LPETAB= 2

PETAB	XTABPE
0.0000000+00	0.0000000
9.2795000-01	3.6000000+01

H	2.0000	.0000	.0000	.0000	.0000	100.0000	F	.00	G	298.150	F	.00000
O	2.0000	.0000	.0000	.0000	.0000	21.0000	F	.00	G	298.150	O	.00000
N	2.0000	.0000	.0000	.0000	.0000	79.0000	F	.00	G	298.150	O	.00000

	FUEL	OXIDANT	MIXTURE
H,CAL/G	.00000000	.00000000	.00000000
V4	.99206348+00	.00000000	.49603174+00
V8	.00000000	-.26250000-01	8.13125000-01
ATOMS/G			
H	.99206348+00	.00000000	.49603174+00
O	.00000000	.13125000-01	.65625000-02
N	.00000000	.56396354-01	.28198172-01

SPECIES BEING CONSIDERED IN THIS SYSTEM

J 9/65 H	J 3/61 H2	J 3/61 H2O	J 6/62 O	J 3/66 OH
J 9/65 O2	J 3/63 N	J 6/63 NO	J 9/65 N2	

VELOCITY TABLE GENERATED

EDGE VELOCITY

.345571+00 .352072+00

AXIAL DISTANCE

.000090 .102853+02

YTIL	Y=G	GP	GPP
0.0000000	0.0000000	1.0158591+03	-1.0168473+09
5.8349534-05	9.9914544-03	9.3577662+01	-7.9502487+05
2.1356292-04	1.9982913-02	4.9059916+01	-1.1463943+05
4.6569918-04	2.9974369-02	3.3235174+01	-3.5679384+04
8.1486322-04	3.9965826-02	2.5121712+01	-1.5431963+04
1.2617004-03	4.9957282-02	2.0185517+01	-8.0208917+03
1.8048965-03	5.9948738-02	1.6864753+01	-4.6866986+03
2.4461781-03	6.9940194-02	1.4477039+01	-2.9739907+03
3.1853125-03	7.9931651-02	1.2676952+01	-2.0031383+03
4.0226078-03	8.9923107-02	1.1270820+01	-1.4127863+03
4.9584138-03	9.9914544-02	1.0141682+01	-1.0333798+03
5.9931212-03	1.0990402-01	9.2146714+00	-7.7851184+02
7.1271628-03	1.1989749-01	8.4357141+00	-6.0105548+02
8.3610133-03	1.2988893-01	7.7519744+00	-4.7359736+02
9.6951894-03	1.3988039-01	7.2165379+00	-3.7978937+02
1.1130251-02	1.4987184-01	6.7250773+00	-3.0919701+02
1.2666802-02	1.5986330-01	6.2938058+00	-2.5505900+02
1.4305487-02	1.6985476-01	5.9121795+00	-2.1284772+02
1.6046997-02	1.7984621-01	5.5719702+00	-1.7945064+02
1.7892067-02	1.8983767-01	5.2666816+00	-1.5268213+02
1.9841477-02	1.9982913-01	4.9911086+00	-1.3097526+02
2.1896052-02	2.0982058-01	4.7410299+00	-1.1318793+02
2.4056664-02	2.1981204-01	4.5129917+00	-9.8473615+01
2.6324230-02	2.2980350-01	4.3041363+00	-8.6196035+01
2.8699717-02	2.3979495-01	4.1120822+00	-7.5870759+01
3.1184137-02	2.4978641-01	3.9348260+00	-6.7124425+01
3.3778554-02	2.5977787-01	3.7706724+00	-5.9666212+01
3.6484079-02	2.6976932-01	3.6181763+00	-5.3267283+01
3.9301875-02	2.7976078-01	3.4760986+00	-4.7745922+01
4.2233154-02	2.8975223-01	3.3433705+00	-4.2956589+01
4.5279182-02	2.9974369-01	3.2190650+00	-3.8781671+01
4.8441278-02	3.0973515-01	3.1023792+00	-3.5125690+01
5.1720816-02	3.1972660-01	2.9925941+00	-3.1910328+01
5.5119219-02	3.2971806-01	2.8891010+00	-2.9071080+01
5.8637973-02	3.3970952-01	2.7913480+00	-2.6554445+01
6.2278618-02	3.4970097-01	2.6988488+00	-2.4315791+01
6.6042751-02	3.5969243-01	2.6111723+00	-2.2317722+01
6.9932031-02	3.6968388-01	2.5279335+00	-2.0528712+01
7.3948176-02	3.7967534-01	2.4487875+00	-1.8922064+01
7.8092965-02	3.8966680-01	2.3734256+00	-1.7475046+01
8.2368242-02	3.9965826-01	2.3015690+00	-1.6169385+01
8.6775912-02	4.0964971-01	2.2329693+00	-1.4989339+01
9.1317950-02	4.1964117-01	2.1673933+00	-1.3911630+01
9.5996397-02	4.2963262-01	2.1046394+00	-1.2934888+01
1.0081336-01	4.3962408-01	2.0445203+00	-1.2044395+01
1.0577102-01	4.4961554-01	1.9868646+00	-1.1230820+01
1.1087164-01	4.5960699-01	1.9315166+00	-1.0486022+01
1.1611752-01	4.6959845-01	1.8783338+00	-9.8028729+00
1.2151109-01	4.7958991-01	1.8271857+00	-9.1751199+00
1.2705480-01	4.8958136-01	1.7779524+00	-8.5972540+00
1.3275124-01	4.9957282-01	1.7305235+00	-8.0644149+00
1.3860302-01	5.0956427-01	1.6847925+00	-7.5723010+00
1.4461288-01	5.1955573-01	1.6406805+00	-7.1170966+00
1.5078362-01	5.2954718-01	1.5980859+00	-6.6[illegible]4082+00

1.5711814-01	5.3953864-01	1.5549335+00	-6.3042135+00
1.6367942-01	5.4953010-01	1.5171488+00	-5.9408101+00
1.7029054-01	5.5952156-01	1.4786628+00	-5.6027821+00
1.7713467-01	5.6951301-01	1.4414112+00	-5.2879618+00
1.8415508-01	5.7950447-01	1.4053342+00	-4.9944000+00
1.9135514-01	5.8949593-01	1.3703762+00	-4.7203436+00
1.9873832-01	5.9948738-01	1.3364851+00	-4.4642115+00
2.0630819-01	6.0947884-01	1.3036124+00	-4.2245733+00
2.1406844-01	6.1947029-01	1.2717125+00	-4.0001360+00
2.2202286-01	6.2946175-01	1.2407430+00	-3.7897270+00
2.3017537-01	6.3945321-01	1.2106638+00	-3.5922805+00
2.3852997-01	6.4944466-01	1.1814376+00	-3.4068286+00
2.4709084-01	6.5943612-01	1.1530291+00	-3.2324888+00
2.5586221-01	6.6942757-01	1.1254053+00	-3.0684565+00
2.6484852-01	6.7941903-01	1.0985349+00	-2.9139965+00
2.7405426-01	6.8941049-01	1.0723887+00	-2.7684362+00
2.8348411-01	6.9940194-01	1.0469389+00	-2.6311594+00
2.9314288-01	7.0939340-01	1.0221593+00	-2.5016015+00
3.0303549-01	7.1938486-01	9.9802529-01	-2.3792433+00
3.1316705-01	7.2937632-01	9.7451344-01	-2.2636074+00
3.2354279-01	7.3936777-01	9.5160165-01	-2.1542548+00
3.3416812-01	7.4935923-01	9.2926891-01	-2.0507803+00
3.4504857-01	7.5935068-01	9.0749540-01	-1.9528104+00
3.5618990-01	7.6934214-01	8.8626220-01	-1.8599997+00
3.6759798-01	7.7933360-01	8.6555140-01	-1.7720257+00
3.7927887-01	7.8932505-01	8.4534569-01	-1.6886019+00
3.9123883-01	7.9931651-01	8.2562971-01	-1.6094451+00
4.0348428-01	8.0930796-01	8.0638719-01	-1.5343041+00
4.1602186-01	8.1929942-01	7.8760365-01	-1.4629425+00
4.2885837-01	8.2929087-01	7.6926516-01	-1.3951409+00
4.4200086-01	8.3928233-01	7.5135825-01	-1.3306948+00
4.5545655-01	8.4927379-01	7.3387019-01	-1.2694137+00
4.6923287-01	8.5926525-01	7.1678878-01	-1.2111203+00
4.8333753-01	8.6925671-01	7.0010231-01	-1.1556469+00
4.9777839-01	8.7924816-01	6.8379963-01	-1.1028447+00
5.1256362-01	8.8923962-01	6.6787001-01	-1.0525630+00
5.2770159-01	8.9923108-01	6.5230320-01	-1.0046684+00
5.4320093-01	9.0922253-01	6.3708940-01	-9.5903433-01
5.5907055-01	9.1921399-01	6.2221911-01	-9.1554176-01
5.7531959-01	9.2920544-01	6.0768329-01	-8.7407941-01
5.9195750-01	9.3919690-01	5.9347324-01	-8.3454253-01
6.0899400-01	9.4918835-01	5.7958058-01	-7.9683291-01
6.2643912-01	9.5917981-01	5.6599724-01	-7.6085804-01
6.4430318-01	9.6917127-01	5.5271544-01	-7.2653101-01
6.6259679-01	9.7916272-01	5.3972773-01	-6.9376996-01
6.8133095-01	9.8915418-01	5.2702688-01	-6.6249771-01
7.0051692-01	9.9914563-01	5.1460599-01	-6.3264158-01
7.2016636-01	1.0091371+00	5.0245830-01	-6.0413282-01
7.4029127-01	1.0191285+00	4.9057733-01	-5.7690667-01
7.6090399-01	1.0291200+00	4.7895683-01	-5.5090194-01
7.8201734-01	1.0391115+00	4.6759075-01	-5.2606067-01
8.0364436-01	1.0491029+00	4.5647323-01	-5.0232814-01
8.2579865-01	1.0590944+00	4.4559861-01	-4.7965252-01
8.4849416-01	1.0690858+00	4.3496138-01	-4.5798469-01
8.7174534-01	1.0790773+00	4.2456691-01	-4.3727808-01
8.9556697-01	1.0890687+00	4.1437798-01	-4.1748865-01

9.1997439-01	1.0990602+00	9.0442186-01	-3.9857449-01
9.4498342-01	1.1090517+00	3.9468237-01	-3.8049588-01
9.7061028-01	1.1190431+00	3.8515546-01	-3.6321512-01
9.9687186-01	1.1290346+00	3.7583629-01	-3.4669632-01
1.0237853+00	1.1390260+00	3.6672044-01	-3.3090540-01
1.0513687+00	1.1490175+00	3.5780355-01	-3.1580993-01
1.0796404+00	1.1590089+00	3.4908143-01	-3.0137908-01
1.1086194+00	1.1690004+00	3.4054998-01	-2.8758350-01
1.1383254+00	1.1789919+00	3.3220518-01	-2.7439517-01
1.1687786+00	1.1889833+00	3.2404318-01	-2.6178752-01
1.1999999+00	1.1989748+00	3.1606018-01	-2.4973510-01
1.2320109+00	1.2089662+00	3.0825247-01	-2.3821371-01
1.2648339+00	1.2189577+00	3.0061644-01	-2.2720023-01
1.2984919+00	1.2289491+00	2.9314860-01	-2.1667266-01
1.3330084+00	1.2389406+00	2.8584550-01	-2.0660994-01
1.3684083+00	1.2489320+00	2.7870378-01	-1.9699197-01
1.4047165+00	1.2589235+00	2.7172020-01	-1.8779962-01
1.4419593+00	1.2689150+00	2.6489153-01	-1.7901451-01
1.4801638+00	1.2789064+00	2.5821465-01	-1.7061913-01
1.5193575+00	1.2888979+00	2.5168651-01	-1.6259677-01
1.5595695+00	1.2988893+00	2.4530413-01	-1.5493139-01
1.6008294+00	1.3088808+00	2.3906456-01	-1.4760770-01
1.6431679+00	1.3188722+00	2.3296496-01	-1.4061103-01
1.6866166+00	1.3288637+00	2.2700252-01	-1.3392739-01
1.7312084+00	1.3388551+00	2.2117450-01	-1.2754335-01
1.7769772+00	1.3488466+00	2.1547820-01	-1.2144609-01
1.8239578+00	1.3588381+00	2.0991102-01	-1.1562332-01
1.8721865+00	1.3688295+00	2.0447036-01	-1.1006326-01
1.9217006+00	1.3788210+00	1.9915369-01	-1.0475466-01
1.9725387+00	1.3888124+00	1.9395855-01	-9.9686711-02
2.0247408+00	1.3988039+00	1.8888250-01	-9.4849093-02
2.0783482+00	1.4087953+00	1.8392316-01	-9.0231893-02
2.1334035+00	1.4187868+00	1.7907820-01	-8.5825618-02
2.1899506+00	1.4287783+00	1.7434532-01	-8.1621188-02
2.2480358+00	1.4387697+00	1.6972229-01	-7.7609887-02
2.3077056+00	1.4487612+00	1.6520690-01	-7.3783367-02
2.3690093+00	1.4587526+00	1.6079696-01	-7.0133622-02
2.4319970+00	1.4687441+00	1.5649039-01	-6.6652991-02
2.4967211+00	1.4787355+00	1.5228508-01	-6.3334120-02
2.5632358+00	1.4887270+00	1.4817898-01	-6.0169962-02
2.6315967+00	1.4987185+00	1.4417010-01	-5.7153771-02

NO	U	K	EPS
1	0.0000000	0.0000000	0.0000000
2	3.8146129-04	2.4309942-09	3.2726874-13
3	1.2863702-03	8.8952885-09	2.2907317-12
4	2.6050821-03	1.9389076-08	7.3718897-12
5	4.9082291-03	3.3906640-08	1.7048292-11
6	7.5966865-03	5.2439615-08	3.2791472-11
7	1.0871574-02	7.4977968-08	5.6[illegible]64[illegible]7-11
8	1.4734255-02	1.0150897-07	8.8322439-11
9	1.9186341-02	1.3201749-07	1.3100548-10
10	2.4229687-02	1.6648685-07	1.8554176-10
11	2.9866400-02	2.0489676-07	2.5334293-10
12	3.6098834-02	2.4722935-07	3.3580249-10
13	4.2929595-02	2.9344808-07	4.3429369-10
14	5.0361542-02	3.4353786-07	5.5016737-10
15	5.8397749-02	3.9746507-07	6.8474971-10
16	6.7041709-02	4.5519744-07	8.3934001-10
17	7.6296934-02	5.1670003-07	1.0152084-09
18	8.6167353-02	5.8193510-07	1.2135932-09
19	9.6657127-02	6.5096210-07	1.4356990-09
20	1.0777068-01	7.2343759-07	1.6826936-09
21	1.1951272-01	7.9961511-07	1.9557059-09
22	1.3188820-01	8.7934506-07	2.2558229-09
23	1.4490238-01	9.6257476-07	2.5840871-09
24	1.5856079-01	1.0492482-06	2.9414940-09
25	1.7286924-01	1.1393060-06	3.3289888-09
26	1.8783385-01	1.2326853-06	3.7474636-09
27	2.0346100-01	1.3293196-06	4.1977546-09
28	2.1975739-01	1.4291385-06	4.6806387-09
29	2.3673004-01	1.5320683-06	5.1968302-09
30	2.5438625-01	1.6380306-06	5.7469783-09
31	2.7273363-01	1.7469435-06	6.3316625-09
32	2.9178013-01	1.8587204-06	6.9513901-09
33	3.1153402-01	1.9732706-06	7.6065927-09
34	3.3200389-01	2.0904986-06	8.2976211-09
35	3.5319867-01	2.2103043-06	9.0247444-09
36	3.7512765-01	2.3325830-06	9.7881434-09
37	3.9780045-01	2.4572243-06	1.0587908-08
38	4.2122705-01	2.5841134-06	1.1424034-08
39	4.4541781-01	2.7131284-06	1.2296416-08
40	4.7038344-01	2.8441463-06	1.3204850-08
41	4.9613505-01	2.9770323-06	1.4149021-08
42	5.2268411-01	3.1116494-06	1.5128504-08
43	5.5004252-01	3.2478538-06	1.6142758-08
44	5.7822257-01	3.3854952-06	1.7191126-08
45	6.0723697-01	3.5244147-06	1.8272822-08
46	6.3709886-01	3.6644553-06	1.9386937-08
47	6.6782176-01	3.8054400-06	2.0532426-08
48	6.9941972-01	3.9471936-06	2.1708111-08
49	7.3190720-01	4.0895316-06	2.2912672-08
50	7.6528675-01	4.2322610-06	2.4144646-08
51	7.9956632-01	4.3751825-06	2.5402421-08
52	8.3475811-01	4.5180878-06	2.6684235-08
53	8.7086421-01	4.6607611-06	2.7988170-08
54	9.0788661-01	4.8029776-06	2.9312148-08

55	7.5927721-01	4.9445053-06	3.0653935-08
56	7.6368783-01	6.0851019-06	3.2011126-08
57	7.6806019-01	5.2245198-06	3.3381154-08
58	7.7239592-01	5.3624933-06	3.4761281-08
59	7.7669662-01	5.4937606-06	3.6148605-08
60	7.8096381-01	5.6330450-06	3.7540043-08
61	7.8519891-01	5.7650500-06	3.8932344-08
62	7.8940334-01	5.8944890-06	4.0322089-08
63	7.9357841-01	6.0210531-06	4.1705686-08
64	7.9772539-01	6.1444269-06	4.3079371-08
65	8.0184555-01	6.2642855-06	4.4439215-08
66	8.0594006-01	6.3802947-06	4.5781123-08
67	8.1001006-01	6.4921109-06	4.7100845-08
68	8.1405665-01	6.5993809-06	4.8393970-08
69	8.1808089-01	6.7017427-06	4.9655942-08
70	8.2208385-01	6.7988258-06	5.0882067-08
71	8.2606646-01	6.8902502-06	5.2067518-08
72	8.3002975-01	6.9756288-06	5.3207349-08
73	8.3397459-01	7.0545659-06	5.4296501-08
74	8.3790192-01	7.1266590-06	5.5329826-08
75	8.4181260-01	7.1914990-06	5.6302098-08
76	8.4570749-01	7.2486717-06	5.7208029-08
77	8.4958740-01	7.2977570-06	5.8042291-08
78	8.5345316-01	7.3383310-06	5.8799537-08
79	8.5730553-01	7.3699685-06	5.9474431-08
80	8.6114525-01	7.3922417-06	6.0061661-08
81	8.6497310-01	7.4047228-06	6.0555982-08
82	8.6878976-01	7.4069872-06	6.0952250-08
83	8.7259597-01	7.3986130-06	6.1245435-08
84	8.7639237-01	7.3791880-06	6.1430693-08
85	8.8017967-01	7.3482987-06	6.1503366-08
86	8.8395852-01	7.3055567-06	6.1459060-08
87	8.8772953-01	7.2505791-06	6.1293674-08
88	8.9149335-01	7.1830037-06	6.1003447-08
89	8.9525058-01	7.1024909-06	6.0585020-08
90	8.9900182-01	7.0087254-06	6.0035477-08
91	9.0274768-01	6.9014259-06	5.9352420-08
92	9.0648869-01	6.7803464-06	5.8534005-08
93	9.1022547-01	6.6452804-06	5.7579017-08
94	9.1395852-01	6.4960772-06	5.6486932-08
95	9.1768842-01	6.3326378-06	5.5257980-08
96	9.2141570-01	6.1549289-06	5.3893197-08
97	9.2514089-01	5.9629908-06	5.2394497-08
98	9.2886449-01	5.7569484-06	5.0764749-08
99	9.3258702-01	5.5370198-06	4.9007806-08
100	9.3630899-01	5.3035299-06	4.7128585-08
101	9.4003089-01	5.0569240-06	4.5133113-08
102	9.4375320-01	4.7977811-06	4.3028565-08
103	9.4747642-01	4.5268318-06	4.0823322-08
104	9.5120100-01	4.2449743-06	3.8526980-08
105	9.5492744-01	3.9532942-06	3.6150369-08
106	9.5865618-01	3.6530885-06	3.3705577-08
107	9.6238769-01	3.3458853-06	3.1205909-08
108	9.6612242-01	3.0334730-06	2.8665663-08
109	9.6986081-01	2.7179259-06	2.6101097-08
110	9.7360332-01	2.4016393-06	2.3528245-08

111	9.7735038-01	2.0873602-06	2.0965001-08
112	9.8110241-01	1.7782267-06	1.8429773-08
113	9.8485948-01	1.4778109-06	1.5941613-08
114	9.8862319-01	1.1901614-06	1.3519954-08
115	9.9239276-01	9.1985453-07	1.1184355-08
116	9.9616905-01	6.7204971-07	8.9541872-09
117	9.9995244-01	4.5254983-07	6.8482816-09
118	1.0000000+00	2.4786502-07	4.8844961-09
119	1.0000000+00	1.2528642-07	3.0792661-09
120	1.0000000+00	3.2965614-08	1.4470986-09
121	1.0000000+00	0.0000000	0.0000000

**** HUZZY WITH COMBUSTION FOR B=10, 4% HYDROGEN INJECTION ***** 6/14/73

STATION	X (FEET)	S	DS	RW	THETAW	ZETA	ZETAP
400	1.4466000+00	5.7140571+00	2.8242946-02	9.9995998-01	0.0000000	2.9689108-01	2.8442110-02

EDGE AND WALL CONDITIONS

UEB =	3.4918191+01	BME =	3.0960335-02	DLSTAR =	5.3602183-02
TEDGE =	5.3000616+02	RHOEB =	2.3098505-03	THETA =	6.8172477-03
SHEB =	-2.5575224+04	SMUEB =	3.7694773-07	TAUW =	5.4635650-04
PEDGEB =	2.1167412+03	TWALL =	8.4200000+02	SQW =	7.7305779+02
THLOSS =	-1.1345904+02	SMDWB =	2.8000217-04		

PROFILE PARAMETERS

BCF =	3.1879882-04		
STAN =	3.1607718-04		
TAUI =	1.5091831-03		
RTHETA =	1.1458418+03		

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROV	EPS	T
1	0.0000000	0.0000000	0.0000000	1.1866460+03	4.7996977-01	3.4812459-03	0.0000000	841.9
2	5.0526900-06	9.9914564-03	1.4426657-04	1.1864897+03	4.7969748-01	3.4812451-03	0.0000000	842.3
3	1.8493160-05	1.9982913-02	5.1876828-04	1.1860857+03	4.7902064-01	3.4812202-03	2.2086603-13	843.6
4	4.0326519-05	2.9974369-02	1.1207299-03	1.1854439+03	4.7793927-01	3.4811423-03	1.4953234-12	845.7
5	7.0561854-05	3.9965826-02	1.9539866-03	1.1845665+03	4.7645336-01	3.4809982-03	6.8133802-12	848.6
6	1.0921175-04	4.9957282-02	3.0306911-03	1.1834497+03	4.7455909-01	3.4807931-03	2.4284746-11	852.3
7	1.5629230-04	5.9948738-02	4.3755046-03	1.1820728+03	4.7225165-01	3.4805170-03	7.2574974-11	856.7
8	2.1182311-04	6.9940194-02	6.0172289-03	1.1804133+03	4.6954780-01	3.4800894-03	1.8844169-10	862.1
9	2.7582734-04	7.9931651-02	7.9736440-03	1.1784657+03	4.6646436+01	3.4793644-03	4.3702581-10	868.4
10	3.4833167-04	8.9923107-02	1.0255041-02	1.1762375+03	4.6300159-01	3.4782139-03	9.2653217-10	875.6
11	4.2936638-04	9.9914564-02	1.2865121-02	1.1737481+03	4.5916209-01	3.4766478-03	1.8270694-09	883.6
12	5.1898531-04	1.0990602-01	1.5821850-02	1.1709965+03	4.5492350-01	3.4748646-03	3.3844475-09	892.7
13	6.1716593-04	1.1989748-01	1.9179931-02	1.1679274+03	4.5026346-01	3.4730516-03	5.9242902-09	903.2
14	7.2400936-04	1.2988893-01	2.2987594-02	1.1644817+03	4.4516894-01	3.4711727-03	9.8521280-09	914.8
15	8.3954033-04	1.3988039-01	2.7268043-02	1.1606301+03	4.3962035-01	3.4690493-03	1.5608603-08	927.5
16	9.6380735-04	1.4987184-01	3.2038449-02	1.1563557+03	4.3370338-01	3.4664722-03	2.3647832-08	941.6
17	1.0968826-03	1.5986330-01	3.7296437-02	1.1516768+03	4.2750368-01	3.4632768-03	3.4489347-08	957.1
18	1.2387621-03	1.6985476-01	4.3031421-02	1.1466123+03	4.2095875-01	3.4594331-03	4.8481494-08	973.9
19	1.3895455-03	1.7984621-01	4.9239618-02	1.1411422+03	4.1400123-01	3.4549620-03	6.5981594-08	992.2
20	1.5493366-03	1.8983767-01	5.5901031-02	1.1352524+03	4.0679756-01	3.4498881-03	8.7234931-08	1011.8
21	1.7181429-03	1.9982913-01	6.2981469-02	1.1289525+03	3.9951422-01	3.4443624-03	1.1239813-07	1032.9
22	1.8960557-03	2.0982058-01	7.0452964-02	1.1222489+03	3.9207170-01	3.4386764-03	1.4154993-07	1055.3
23	2.0831506-03	2.1981204-01	7.8291050-02	1.1151452+03	3.8439216-01	3.4331884-03	1.7474773-07	1079.2
24	2.2795071-03	2.2980350-01	8.6474250-02	1.1076454+03	3.7661457+01	3.4283063-03	2.1210454-07	1104.4
25	2.4852089-03	2.3979495-01	9.4991739-02	1.0997444+03	3.6887795-01	3.4244095-03	2.5352412-07	1131.1
26	2.7003434-03	2.4978641-01	1.0383885-01	1.0914353+03	3.6112280-01	3.4216827-03	2.9890995-07	1159.2
27	2.9250030-03	2.5977787-01	1.1301150-01	1.0827122+03	3.5329288-01	3.4200786-03	3.4813721-07	1188.7
28	3.1592839-03	2.6976932-01	1.2250519-01	1.0735675+03	3.4547385-01	3.4194360-03	4.0105910-07	1219.7
29	3.4032867-03	2.7976078-01	1.3231678-01	1.0639925+03	3.3775140-01	3.4195663-03	4.6745307-07	1252.3
30	3.6571164-03	2.8975223-01	1.4244382-01	1.0539787+03	3.3008791-01	3.4202340-03	5.3701662-07	1286.5
31	3.9208826-03	2.9974369-01	1.5288316-01	1.0435188+03	3.2244750-01	3.4212190-03	6.1044590-07	1322.1
32	4.1946996-03	3.0973515-01	1.6363231-01	1.0326055+03	3.1488715-01	3.4223846-03	6.8848380-07	1359.4
33	4.4786862-03	3.1972660-01	1.7469047-01	1.0212306+03	3.0746383-01	3.4236345-03	7.7197432-07	1398.5
34	4.7729658-03	3.2971806-01	1.8605871-01	1.0093841+03	3.0015763-01	3.4249193-03	8.6188240-07	1439.3
35	5.0776470-03	3.3970952-01	1.9774132-01	9.9705362+02	2.9295114-01	3.4262971-03	9.5430458-07	1481.6
36	5.3929232-03	3.4970097-01	2.0975088-01	9.8418421936+02	2.8585985-01	3.4278843-03	1.0852657-06	1525.8
37	5.7188726-03	3.5969243-01	2.2211410-01	9.7084998+02	2.7889909-01	3.4297817-03	1.0020886-06	1572.3
38	6.0556590-03	3.6968388-01	2.3486490-01	9.5690711+02	2.7187373-01	3.4319627-03	1.0750366-06	1622.6
39	6.4034309-03	3.7967534-01	2.4802027-01	9.4236391+02	2.6453869+01	3.4344025-03	1.1524822-06	1678.6
40	6.7623428-03	3.8966680-01	2.6156920-01	9.2721504+02	2.5773315-01	3.4377535-03	1.2401783-06	1733.3
41	7.1325839-03	3.9965826-01	2.7549872-01	9.1145676+02	2.5229629+01	3.4419323-03	1.3374431-06	1779.4
42	7.5142295-03	4.0964971-01	2.8979529-01	8.9508867+02	2.4768382-01	3.4443940-03	1.4436034-06	1822.0

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROV	EPS	T
43	7.9075404-03	4.1964117-01	3.0438499-01	8.7815704+02	2.4332162-01	3.4416034-03	1.5442407-04	1864.5
44	8.3126634-03	4.2963262-01	3.1909465-01	8.4082513+02	2.4054155-01	3.4339909-03	1.7224495-04	1899.7
45	8.7297813-03	4.3962408-01	3.3361851-01	8.4338209+02	2.4067548-01	3.4256805-03	1.9382634-04	1908.6
46	9.1590827-03	4.4961554-01	3.4760893-01	8.2421173+02	2.4389188-01	3.4214394-03	2.2285903-04	1892.3
47	9.6007624-03	4.5960699-01	3.6083361-01	8.0963692+02	2.5058712-01	3.4280698-03	2.5877646-04	1847.9
48	1.0055022-02	4.6959845-01	3.7326235-01	7.9379256+02	2.6833288-01	3.4454735-03	2.9980431-04	1795.8
49	1.0522070-02	4.7958991-01	3.8499131-01	7.7865308+02	2.8470080-01	3.4673589-03	3.4458401-04	1756.3
50	1.1002120-02	4.8958136-01	3.9615383-01	7.6441206?+02	2.7037031-01	3.4999429-03	3.9319516-04	1723.8
51	1.1495393-02	4.9957282-01	4.0683384-01	7.5013485+02	2.7586843-01	3.5359580-03	4.4564036-04	1694.0
52	1.2002120-02	5.0956427-01	4.1707652-01	7.3666763+02	2.8128158-01	3.5749660-03	5.0197380-04	1665.8
53	1.2522935-02	5.1955573-01	4.2690571-01	7.2371124+02	2.8669620-01	3.6155727-03	5.6264274-04	1638.2
54	1.3059381-02	5.2954718-01	4.3634820-01	7.1125119+02	2.9207006-01	3.6571848-03	6.2543340-04	1611.7
55	1.3609409-02	5.3953864-01	4.4545380-01	6.9924007+02	2.9736162-01	3.6999332-03	6.8507820-04	1586.6
56	1.4168377-02	5.4953010-01	4.5429442-01	6.8759985+02	3.0264704-01	3.7449167-03	7.3907524-04	1562.4
57	1.4746053-02	5.5952156-01	4.6294928-01	6.7624287+02	3.0800255-01	3.7935258-03	7.8745126-04	1538.5
58	1.5338710-02	5.6951301-01	4.7147446-01	6.6510724+02	3.1339467-01	3.8464023-03	8.3380140-04	1515.1
59	1.5946632-02	5.7950447-01	4.7989975-01	6.5416015+02	3.1879149-01	3.9038922-03	8.7872186-04	1492.5
60	1.6570111-02	5.8949593-01	4.8824474-01	6.4338007+02	3.2424371-01	3.9666753-03	9.2301480-04	1470.3
61	1.7209446-02	5.9948738-01	4.9652581-01	6.3274915+02	3.2980205-01	4.0353276-03	9.6690947-04	1448.4
62	1.7864947-02	6.0947884-01	5.0475578-01	6.2225327+02	3.3544510-01	4.1099822-03	1.0105750-05	1426.8
63	1.8536934-02	6.1947029-01	5.1294497-01	6.1188030+02	3.4115278-01	4.1908111-03	1.0541074-05	1405.7
64	1.9225736-02	6.2946175-01	5.2110175-01	6.0161929+02	3.4695490-01	4.2783153-03	1.0975820-05	1384.8
65	1.9931690-02	6.3945321-01	5.2923317-01	5.9145952+02	3.5288134-01	4.3730262-03	1.1410071-05	1364.1
66	2.0655144-02	6.4944466-01	5.3734542-01	5.8139024+02	3.5891514-01	4.4751777-03	1.1843478-05	1343.7
67	2.1396459-02	6.5943612-01	5.4544009-01	5.7140052+02	3.6503901-01	4.5850027-03	1.2274701-05	1323.5
68	2.2156003-02	6.6942757-01	5.5353424-01	5.6147961+02	3.7128956-01	4.7031697-03	1.2709112-05	1303.6
69	2.2934159-02	6.7941903-01	5.6162061-01	5.5161668+02	3.7770346-01	4.8304177-03	1.3140284-05	1283.8
70	2.3731316-02	6.8941049-01	5.6970792-01	5.4180046+02	3.8425894-01	4.9670339-03	1.3569449-05	1264.2
71	2.4547880-02	6.9940194-01	5.7780074-01	5.3201939+02	3.9093350-01	5.1132882-03	1.3996232-05	1244.8
72	2.5384266-02	7.0939340-01	5.8590327-01	5.2226177+02	3.9777640-01	5.2701534-03	1.4420244-05	1225.6
73	2.6240902-02	7.1938486-01	5.9401973-01	5.1251593+02	4.0483690-01	5.4387131-03	1.4840409-05	1206.4
74	2.7118230-02	7.2937632-01	6.0215445-01	5.0276999+02	4.1208718-01	5.6193254-03	1.5255502-05	1187.3
75	2.8016701-02	7.3936777-01	6.1031184-01	4.9301222+02	4.1949880-01	5.8123239-03	1.5664814-05	1168.3
76	2.8936785-02	7.4935923-01	6.1849613-01	4.8323140+02	4.2713171-01	6.0190802-03	1.6067628-05	1149.4
77	2.9878962-02	7.5935068-01	6.2671165-01	4.7341677+02	4.3504584-01	6.2411199-03	1.6462475-05	1130.6
78	3.0844328-02	7.6934214-01	6.3498301-01	4.6355773+02	4.4320834-01	6.4789174-03	1.6847708-05	1111.8
79	3.1831594-02	7.7933360-01	6.4325497-01	4.5364407+02	4.5158583-01	6.7329255-03	1.7222235-05	1093.0
80	3.2843083-02	7.8932505-01	6.5159224-01	4.4366625+02	4.6024492-01	7.0050285-03	1.7584940-05	1074.3
81	3.3878738-02	7.9931651-01	6.5997971-01	4.3361515+02	4.6926028-01	7.2972978-03	1.7933914-05	1055.6
82	3.4939114-02	8.0930796-01	6.6842273-01	4.2348170+02	4.7858896-01	7.6103718-03	1.8267044-05	1036.9
83	3.6024787-02	8.1929942-01	6.7692684-01	4.1325702+02	4.8819566-01	7.9448761-03	1.8582738-05	1018.3
84	3.7136345-02	8.2929087-01	6.8549766-01	4.0293256+02	4.9815582-01	8.3033239-03	1.8879345-05	999.7
85	3.8274399-02	8.3928233-01	6.9414108-01	3.9249982+02	5.0854494-01	8.6884627-03	1.9154421-05	981.1
86	3.9439574-02	8.4927379-01	7.0286344-01	3.8195008+02	5.1932263-01	9.1011748-03	1.9405309-05	962.6
87	4.0632514-02	8.5926525-01	7.1167137-01	3.7127441+02	5.3044818-01	9.5423569-03	1.9629798-05	944.0
88	4.1853886-02	8.6925671-01	7.2057183-01	3.6046370+02	5.4200350-01	1.0015330-02	1.9825572-05	925.6
89	4.3104370-02	8.7924816-01	7.2957214-01	3.4950841+02	5.5407055-01	1.0523670-02	1.9989567-05	907.2
90	4.4384676-02	8.8923962-01	7.3868024-01	3.3839830+02	5.6660704-01	1.1068598-02	2.0118466-05	888.8
91	4.5695525-02	8.9923108-01	7.4790452-01	3.2712259+02	5.7957072-01	1.1651397-02	2.0209254-05	870.5
92	4.7037867-02	9.0922253-01	7.5725366-01	3.1567006+02	5.9304373-01	1.2276253-02	2.0258786-05	852.3
93	4.8411873-02	9.1921399-01	7.6673669-01	3.0402893+02	6.0710829-01	1.2947609-02	2.0263317-05	834.3
94	4.9818933-02	9.2920544-01	7.7636314-01	2.9218679+02	6.2172779-01	1.3667283-02	2.0218815-05	816.3
95	5.1259669-02	9.3919690-01	7.8614294-01	2.8013047+02	6.3686728-01	1.4437298-02	2.0121343-05	798.4
96	5.2734919-02	9.4918835-01	7.9608622-01	2.6784632+02	6.5258344-01	1.5262175-02	1.9947056-05	780.7

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROV	EPS	T
97	5.4245553-02	9.5917981+01	8.0620326-01	2.6532030+02	6.6893303+01	1.6146525-02	1.0751640-05	763.2
98	5.5792864-02	9.6917127-01	8.1650918-01	2.4253808+02	6.8590996-01	1.7093426-02	1.0470725-05	745.9
99	5.7376572-02	9.7916272-01	8.2699864-01	2.2948539+02	7.0351434-01	1.8106518-02	1.0119965-05	728.7
100	5.8998828-02	9.8915418-01	8.3769529-01	2.1614860+02	7.2170101+01	1.9187924-02	1.0695322-05	711.8
101	6.0660208-02	9.9914563-01	8.4860075-01	2.0251573+02	7.4042477-01	2.0339192-02	1.0193418-05	695.3
102	6.2361722-02	1.0091371+00	8.5971832-01	1.8857770+02	7.5978399-01	2.1566767-02	1.0611188-05	679.1
103	6.4104408-02	1.0191285+00	8.7104449-01	1.7433006+02	7.7989700-01	2.2878530-02	1.0946161-05	663.0
104	6.5889335-02	1.0291200+00	8.8257624-01	1.5977590+02	8.0038830-01	2.4263425-02	1.0197389-05	647.5
105	6.7717614-02	1.0391115+00	8.9428489-01	1.4493060+02	8.2088244-01	2.5707440-02	1.0344559-05	632.6
106	6.9590374-02	1.0491029+00	9.0614072-01	1.2982800+02	8.4176342-01	2.7225304-02	1.0457455-05	618.3
107	7.1508790-02	1.0590944+00	9.1807422-01	1.1452844+02	8.6346620-01	2.8834591-02	1.0476290-05	604.3
108	7.3474075-02	1.0690858+00	9.2999879-01	9.9130514+01	8.8477445-01	3.0478616-02	1.0432937-05	591.2
109	7.5487476-02	1.0790773+00	9.4176858+01	8.3786654+01	9.0447988-01	3.2091312-02	1.0342025-05	579.3
110	7.7550273-02	1.0890687+00	9.5318855-01	6.8872005+01	9.2330404-01	3.3690197-02	1.0221694-05	568.5
111	7.9663797-02	1.0990602+00	9.6399490-01	5.4238964+01	9.4200385-01	3.5291856-02	9.0918861-04	558.6
112	8.1829417-02	1.1090517+00	9.7387048-01	4.0741273+01	9.5891585-01	3.6785427-02	7.9722124-04	550.0
113	8.4048536-02	1.1190431+00	9.8244962-01	2.8496184+01	9.7237653-01	3.8049853-02	6.8804140-04	543.0
114	8.6322612-02	1.1290346+00	9.8939724-01	1.8584795+01	9.8262520-01	3.9062768-02	5.8272717-04	537.9
115	8.8653148-02	1.1390260+00	9.9448901-01	1.0798252+01	9.8973452-01	3.9798004-02	4.8222199-04	534.6
116	9.1041893-02	1.1490175+00	9.9772090-01	5.4951968+00	9.9476451-01	4.0302231-02	3.8549437-04	532.4
117	9.3489837-02	1.1590089+00	9.9936041-01	2.5022577+00	9.9874312-01	4.0646073-02	2.9514917-04	530.6
118	9.5999230-02	1.1690004+00	9.9993445-01	1.2487851+00	1.0010808+00	4.0815792-02	2.0289958-04	529.5
119	9.8571577-02	1.1789919+00	1.0000075+00	9.8859777-01	1.0010371+00	4.0799324-02	1.0825737-04	529.5
120	1.0120862-01	1.1889833+00	9.9999736-01	1.0027420+00	1.0001437+00	4.0722060-02	7.0468153-07	529.9
121	1.0391219-01	1.1989748+00	1.0000019+00	9.9901194-01	9.9999227-01	4.0693629-02	4.1229543-07	530.0
122	1.0668413-01	1.2089662+00	9.9999975-01	1.0003615+00	1.0000819+00	4.0682595-02	2.2607541-07	530.0
123	1.0952639-01	1.2189577+00	1.0000014+00	9.9957428-01	1.0000845+00	4.0686087-02	0.0000000	530.0
124	1.1244095-01	1.2289491+00	1.0000000+00	1.0000000+00	1.0000000+00	4.0640491-02	0.0000000	530.0

DELTA= 1.0391E+00 (INCHES)

NO.	TAU	TAU/(RE*UE^2)	FPS/(RHO*UE*DELTA)	YTIL/DELTA
2	4.2463447-04	1.5077450-04	0.0000000	5.8348150-05
3	4.2820032-04	1.5204063-04	6.6015136-11	2.1355786-04
4	4.3375994-04	1.5401467-04	4.4795175-10	4.6568813-04
5	4.4144727-04	1.5674420-04	2.0474394-09	8.1484389-04
6	4.5137381-04	1.6026881-04	7.3267619-09	1.2611705-03
7	4.6365210-04	1.6462845-04	2.2003017-08	1.8048537-03
8	4.7842404-04	1.6987351-04	5.7466148-08	2.4461200-03
9	4.9584620-04	1.7605957-04	1.3413973-07	3.1852369-03
10	5.1604286-04	1.8323078-04	2.8651466-07	4.0225124-03
11	5.3913326-04	1.9142946-04	5.6971523-07	4.9582961-03
12	5.6527059-04	2.0071002-04	1.0651683-06	5.9929790-03
13	5.9459289-04	2.1112145-04	1.8844518-06	7.1269937-03
14	6.2713637-04	2.2267663-04	3.1686481-06	8.3608149-03
15	6.6286984-04	2.3536440-04	5.0834092-06	9.6949594-03
16	7.0184154-04	2.4920212-04	7.8132998-06	1.1129987-02
17	7.4408836-04	2.6420264-04	1.1550850-05	1.2666501-02
18	7.8953416-04	2.8033904-04	1.6489484-05	1.4305147-02
19	8.3814640-04	2.9759973-04	2.2818652-05	1.6046616-02
20	8.8986936-04	3.1596495-04	3.0703710-05	1.7891643-02
21	9.4466897-04	3.3542258-04	4.0280574-05	1.9841006-02
22	1.0026239-03	3.5600057-04	5.1690768-05	2.1895533-02
23	1.0638794-03	3.7774978-04	6.5096187-05	2.4056093-02
24	1.1286031-03	4.0073187-04	8.0634642-05	2.6323606-02
25	1.1969323-03	4.2499346-04	9.8402335-05	2.8699036-02
26	1.2689189-03	4.5055366-04	1.1850980-04	3.1183397-02
27	1.3445705-03	4.7741519-04	1.4108615-04	3.3777753-02
28	1.4238090-03	5.0555032-04	1.6621186-04	3.6483213-02
29	1.5065059-03	5.3491343-04	1.9391803-04	3.9300942-02
30	1.5925388-03	5.6546102-04	2.2425581-04	4.2232152-02
31	1.6818208-03	5.9716229-04	2.5728987-04	4.5278108-02
32	1.7743703-03	6.3002376-04	2.9303931-04	4.8440129-02
33	1.8703108-03	6.6408922-04	3.3154243-04	5.1719589-02
34	1.9697952-03	6.9941303-04	3.7295881-04	5.5117912-02
35	2.0733349-03	7.3617676-04	4.1752947-04	5.8636582-02
36	2.1816279-03	7.7462827-04	4.6506108-04	6.2277141-02
37	2.2936882-03	8.1441739-04	5.1443183-04	6.6041184-02
38	2.4093254-03	8.5547654-04	5.6614126-04	6.9930372-02
39	2.5311621-03	8.9874410-04	6.2375473-04	7.3946421-02
40	2.6602953-03	9.4458817-04	6.8894202-04	7.8091112-02
41	2.7925410-03	9.9154460-04	7.5898513-04	8.2366287-02
42	2.9244626-03	1.0383858-03	8.3448603-04	8.6773853-02
43	3.0531322-03	1.0840723-03	9.2160890-04	9.1315784-02
44	3.1707302-03	1.1258277-03	1.0252392-03	9.5994119-02
45	3.2774569-03	1.1637231-03	1.1530544-03	1.0081097-01
46	3.3767977-03	1.1989959-03	1.3082831-03	1.0576851-01
47	3.4687973-03	1.2316621-03	1.4785460-03	1.1086901-01
48	3.5580421-03	1.2633502-03	1.6616020-03	1.1611477-01
49	3.6471947-03	1.2950055-03	1.8638402-03	1.2150820-01
50	3.7386092-03	1.3274639-03	2.0821786-03	1.2705179-01
51	3.8357398-03	1.3619520-03	2.3128706-03	1.3274809-01
52	3.9431177-03	1.4000785-03	2.5551039-03	1.3859973-01
53	4.0639054-03	1.4429665-03	2.8098271-03	1.4460945-01

NO.	TAU	TAU/(RE*UE2)	EPS/(RHO*UE*DELTA)	YTIL/DELTA
54	4.1858825-03	1.4862768-03	3.0659343-03	1.5078004-01
55	4.2871998-03	1.5222507-03	3.2985575-03	1.5711441-01
56	4.3650700-03	1.5499007-03	3.4963994-03	1.6361554-01
57	4.4236577-03	1.5707034-03	3.6604812-03	1.7028650-01
58	4.4787504-03	1.5902650-03	3.8092531-03	1.7713047-01
59	4.5300372-03	1.6084764-03	3.9465129-03	1.8415071-01
60	4.5797577-03	1.6261296-03	4.0757348-03	1.9135060-01
61	4.6277361-03	1.6431652-03	4.1976022-03	1.9873360-01
62	4.6740739-03	1.6596184-03	4.3133621-03	2.0630330-01
63	4.7186911-03	1.6754605-03	4.4238946-03	2.1406336-01
64	4.7615993-03	1.6906959-03	4.5293175-03	2.2201760-01
65	4.8027340-03	1.7053015-03	4.6294403-03	2.3016991-01
66	4.8420327-03	1.7192563-03	4.7245844-03	2.3852432-01
67	4.8795165-03	1.7325646-03	4.8151653-03	2.4708498-01
68	4.9152076-03	1.7452375-03	4.9008484-03	2.5585614-01
69	4.9490357-03	1.7572488-03	4.9810703-03	2.6484223-01
70	4.9809312-03	1.7685738-03	5.0559997-03	2.7404775-01
71	5.0108946-03	1.7792129-03	5.1259819-03	2.8347738-01
72	5.0389387-03	1.7891698-03	5.1904189-03	2.9313592-01
73	5.0649662-03	1.7984121-03	5.2484929-03	3.0302830-01
74	5.0888684-03	1.8068990-03	5.3003704-03	3.1315962-01
75	5.1106233-03	1.8146235-03	5.3464231-03	3.2353511-01
76	5.1302143-03	1.8215796-03	5.3859061-03	3.3416019-01
77	5.1475060-03	1.8277190-03	5.4178743-03	3.4504038-01
78	5.1623535-03	1.8329913-03	5.4425411-03	3.5618445-01
79	5.1747040-03	1.8373765-03	5.4603191-03	3.6758926-01
80	5.1844839-03	1.8408491-03	5.4703967-03	3.7926987-01
81	5.1915163-03	1.8433461-03	5.4717984-03	3.9122985-01
82	5.1956092-03	1.8447993-03	5.4648016-03	4.0347471-01
83	5.1966270-03	1.8451607-03	5.4498508-03	4.1601199-01
84	5.1944371-03	1.8443832-03	5.4261343-03	4.2884820-01
85	5.1887927-03	1.8423790-03	5.3927279-03	4.4199038-01
86	5.1794057-03	1.8390460-03	5.3499797-03	4.5544574-01
87	5.1660466-03	1.8343026-03	5.2983628-03	4.6922174-01
88	5.1484303-03	1.8280476-03	5.2371191-03	4.8332606-01
89	5.1261743-03	1.8201452-03	5.1654378-03	4.9776658-01
90	5.0988439-03	1.8104410-03	5.0837209-03	5.1255146-01
91	5.0659804-03	1.7987722-03	4.9924378-03	5.2768907-01
92	5.0270834-03	1.7849611-03	4.8909759-03	5.4318404-01
93	4.9815209-03	1.7687832-03	4.7787376-03	5.5905728-01
94	4.9285401-03	1.7499714-03	4.6561206-03	5.7530594-01
95	4.8673273-03	1.7282366-03	4.5235323-03	5.9194346-01
96	4.7969467-03	1.7032467-03	4.3807332-03	6.0897955-01
97	4.7163080-03	1.6746144-03	4.2275557-03	6.2642426-01
98	4.6241385-03	1.6418872-03	4.0642820-03	6.4428789-01
99	4.5189854-03	1.6045513-03	3.8911947-03	6.6258107-01
100	4.3992081-03	1.5620220-03	3.7088942-03	6.8131478-01
101	4.2629882-03	1.5136546-03	3.5180513-03	7.0050029-01
102	4.1082749-03	1.4587207-03	3.3186950-03	7.2014928-01
103	3.9328034-03	1.3964162-03	3.1110207-03	7.4027370-01
104	3.7342206-03	1.3259057-03	2.8974311-03	7.6088594-01
105	3.5102904-03	1.2463950-03	2.6801832-03	7.8199878-01
106	3.2589367-03	1.1571471-03	2.4590684-03	8.0362529-01
107	2.9786504-03	1.0576262-03	2.2345693-03	8.2577905-01

NO.	TAU	TAU/(RE*UE2)	EPS/(RHO*UE*DELTA)	YTIL/DELTA
108	2.6691203-03	9.4772164-04	2.0119121-03	8.4847403-01
109	2.3321526-03	8.2807489-04	1.7953970-03	8.7172466-01
110	1.9726676-03	7.0043295-04	1.5850645-03	8.9554572-01
111	1.5998388-03	5.6805304-04	1.3818793-03	9.1995256-01
112	1.2278733-03	4.3597964-04	1.1903295-03	9.4496100-01
113	8.7609029-04	3.1107243-04	1.0130924-03	9.7058725-01
114	5.6650693-04	2.0114900-04	8.4907525-04	9.9684815-01
115	3.2017582-04	1.1368448-04	6.9758354-04	1.0237410+00
116	1.4878954-04	5.2830540-05	5.5483848-04	1.0513438+00
117	5.1868666-05	1.8416951-05	4.2310473-04	1.0796148+00
118	1.0687432-05	3.7947748-06	2.9018892-04	1.1085931+00
119	6.9897789-07	2.4818532-07	1.8344294-04	1.1382984+00
120	-3.9575693-08	-1.4052099-08	1.0087644-04	1.1687509+00
121	1.2029458-08	4.2712865-09	5.9031103-05	1.1999715+00
122	-1.8607972-09	-6.6071124-10	3.2365818-05	1.2319817+00
123	5.6107388-10	1.9921990-10	0.0000000	1.2648039+00

NO.	MU	Y	K /UE2	RU/REUE	MIXEDDY	UDAG	YDAG	PRT
1	4.5717371-07	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.5493477+00
2	4.5735915-07	4.4936388-05	0.0000000	6.9204310-05	3.1929292-17	7.1759312-03	8.6015821-03	1.5488372+00
3	4.5788824-07	1.6446998-04	1.4296978-12	2.4850071-04	5.5579141-15	2.5803937-02	3.1482325-02	1.5459829+00
4	4.5876097-07	3.5864620-04	1.3853201-11	5.3544081-04	1.2169124-13	5.5745974-02	6.8450929-02	1.5420290+00
5	4.5997734-07	6.2754588-04	9.4413370-11	9.3098348-04	1.1043302-12	9.7192813-02	1.2012286-01	1.5364654+00
6	4.6152647-07	9.7128093-04	5.0437101-10	1.4382420-03	6.1814209-12	1.5074893-01	1.8591954-01	1.5300119+00
7	4.6339669-07	1.3899945-03	2.2330472-09	2.0443392-03	2.5894960-11	2.1769079-01	2.6406837-01	1.5222157+00
8	4.6563219-07	1.8838609-03	8.3066077-09	2.8253766-03	8.1868643-11	2.9930164-01	3.6060273-01	1.5133834+00
9	4.6827919-07	2.4530362-03	2.6744655-08	3.7194208-03	2.2481315-10	3.9661524-01	4.6056205-01	1.5034474+00
10	4.7131191-07	3.0979076-03	7.6677603-08	4.7481004-03	5.3876693-10	5.1009373-01	5.9299174-01	1.4932006+00
11	4.7470406-07	3.8185944-03	2.0003151-07	5.9071798-03	1.1405123-09	6.3992111-01	7.3094334-01	1.4822991+00
12	4.7851098-07	4.6154477-03	4.7994487-07	7.1977316-03	2.3078941-09	7.8499113-01	8.8347448-01	1.4709080+00
13	4.8278807-07	5.4888005-03	1.0653833-06	8.6360221-03	4.3033825-09	9.5402468-01	1.0650448+00	1.4594166+00
14	4.8749515-07	6.4390186-03	2.1955545-06	1.0233343-02	7.5673591-09	1.1434208+00	1.2525367+00	1.4479133+00
15	4.9258895-07	7.4665000-03	4.2182525-06	1.1987587-02	1.2559193-08	1.3563334+00	1.4992140+00	1.4365109+00
16	4.9817604-07	8.5716757-03	7.5902046-06	1.3895183-02	1.9833351-08	1.5936173+00	1.7607432+00	1.4254139+00
17	5.0436304-07	9.7550105-03	1.2860773-05	1.5944364-02	2.9872055-08	1.8551537+00	1.8472734+00	1.4147005+00
18	5.1113103-07	1.1017002-02	2.0438623-05	1.8114453-02	4.3173026-08	2.1404163+00	2.1088398+00	1.4044930+00
19	5.1847080-07	1.2358181-02	3.1556181-05	2.0385262-02	6.0125223-08	2.4492168+00	2.3455441+00	1.3948752+00
20	5.2633033-07	1.3779114-02	4.6184409-05	2.2740403-02	8.0953045-08	2.7805607+00	2.6375546+00	1.3859226+00
21	5.3465768-07	1.5280402-02	6.4974784-05	2.5161992-02	1.0585867-07	3.1327471+00	2.9249265+00	1.3777855+00
22	5.4347046-07	1.6862680-02	8.8346187-05	2.7622613-02	1.3490966-07	3.5043851+00	3.2278011+00	1.3703047+00
23	5.5278392-07	1.8526419-02	1.1674889-04	3.0094466-02	1.6800380-07	3.8942576+00	3.5463072+00	1.3634102+00
24	5.6258622-07	2.0272927-02	1.5051990-04	3.2547462-02	2.0520116-07	4.3012964+00	3.8805799+00	1.3570423+00
25	5.7286554-07	2.2102347-02	1.8979870-04	3.5040358-02	2.4668564-07	4.7249628+00	4.2307817+00	1.3512315+00
26	5.8363245-07	2.4015659-02	2.3474072-04	3.7498576-02	2.9931822-07	5.1650249+00	4.5970019+00	1.3462808+00
27	5.9490046-07	2.6013482-02	2.8554696-04	3.9926160-02	3.4174447-07	5.6212800+00	4.9794573+00	1.3421901+00
28	6.0663499-07	2.8097272-02	3.4220599-04	4.2322340-02	3.9485840-07	6.0935033+00	5.3782915+00	1.3390621+00
29	6.1880308-07	3.0267325-02	4.0448050-04	4.4690179-02	4.5164908-07	6.5815396+00	5.7934761+00	1.3371996+00
30	6.3140517-07	3.2524773-02	4.7219959-04	4.7018982-02	5.1174088-07	7.0852661+00	6.2257899+00	1.3365963+00
31	6.4443732-07	3.4870599-02	5.4524715-04	4.9296792-02	5.7467906-07	7.6045270+00	6.6748194+00	1.3382444+00
32	6.5793967-07	3.7305801-02	6.2331917-04	5.1525711-02	6.4015105-07	8.1391979+00	7.1409591+00	1.3420826+00
33	6.7195236-07	3.9831452-02	7.0620298-04	5.3711000-02	7.0792973-07	8.6892394+00	7.6244113+00	1.3480480+00
34	6.8644125-07	4.2448645-02	7.9421817-04	5.5846941-02	7.7887574-07	9.2547047+00	8.1253661+00	1.3561273+00
35	7.0136878-07	4.5158522-02	8.8804684-04	5.7928550-02	8.5013648-07	9.8358068+00	8.6441023+00	1.3663116+00
36	7.1683397-07	4.7962271-02	9.8653320-04	5.9959353-02	9.2494168-07	1.0433172+01	9.1807871+00	1.3785168+00
37	7.3293597-07	5.0861121-02	1.0846366-03	6.1947420-02	1.0025981-06	1.1048128+01	9.7356758+00	1.3927357+00
38	7.5016634-07	5.3856350-02	1.1842608-03	6.3853598-02	1.0789041-06	1.1682363+01	1.0309013+01	1.4110510+00
39	7.6916151-07	5.6949280-02	1.3000469-03	6.5610958-02	1.1461076-06	1.2336721+01	1.0901052+01	1.4307436+00
40	7.8763271-07	6.0141282-02	1.4305754-03	6.7415052-02	1.2195541-06	1.3010655+01	1.1512055+01	1.4537413+00
41	8.0329121-07	6.3433776-02	1.5982365-03	6.9507304-02	1.3196223-06	1.3703520+01	1.2142294+01	1.4869459+00
42	8.1773283-07	6.6828229-02	1.7513020-03	7.1777605-02	1.4341944-06	1.4414643+01	1.2792050+01	1.5034709+00
43	8.3264378-07	7.0326163-02	1.9535982-03	7.4063935-02	1.5407383-06	1.5140445+01	1.3441613+01	1.5283644+00
44	8.4396279-07	7.3929148-02	2.2167253-03	7.6755520-02	1.6454630-06	1.5872015+01	1.4151285+01	1.5821012+00
45	8.4750791-07	7.7638809-02	2.5771525-03	8.0293794-02	1.8439558-06	1.6594444+01	1.4841377+01	1.6716492+00
46	8.4301537-07	8.1456825-02	3.0566447-03	8.4778995-02	2.0929445-06	1.7290338+01	1.5492209+01	1.7435085+00
47	8.2955982-07	8.5384930-02	3.6049510-03	9.0420256-02	2.4656867-06	1.7948144+01	1.6344115+01	1.8468417+00
48	8.1360993-07	8.9424915-02	4.2133467-03	9.6425937-02	2.9235678-06	1.8566359+01	1.7117436+01	1.9344501+00
49	8.0163560-07	9.3578628-02	4.9165427-03	1.0190751-01	3.3627150-06	1.9149767+01	1.7812527+01	2.0209382+00
50	7.9185206-07	9.7847980-02	5.7022522-03	1.0710823-01	3.8475780-06	1.9704999+01	1.8729753+01	2.0777753+00
51	7.8288754-07	1.0223494+01	6.5617137-03	1.1223261-01	4.3930999-06	2.0236231+01	1.9548491+01	2.1403033+00
52	7.7439975-07	1.0674154-01	7.4604003-03	1.1731594-01	4.9551970-06	2.0745710+01	2.0432130+01	2.1805082+00

NO.	MU	V	K /UE2	RU/REUE	MIXEDDY	UDAG	VDAG	PRT
53	7.6604636-07	1.1136988-01	8.4338698-03	1.2239224-01	5.5559297-06	2.1234621+01	2.1318072+01	1.1449324+0
54	7.5795494-07	1.1612211-01	9.4043089-03	1.2744924-01	6.1992086-06	2.1704298+01	2.2227730+01	1.1532432+0
55	7.5024010-07	1.2100048-01	1.0213537-02	1.3246086-01	6.9008573-06	2.2157218+01	2.3161532+01	1.1595999+0
56	7.4277403-07	1.2600727-01	1.0786350-02	1.3749086-01	7.6887048-06	2.2596957+01	2.4119916+01	1.1659523+0
57	7.3542895-07	1.3114487-01	1.1332079-02	1.4258956-01	8.5786077-06	2.3027457+01	2.5103338+01	1.1722469+0
58	7.2827501-07	1.3641569-01	1.1870968-02	1.4775738-01	9.5593375-06	2.3451506+01	2.6112263+01	1.0988049+0
59	7.2138356-07	1.4182228-01	1.1531918-02	1.5298796-01	1.0416645-05	2.3870586+01	2.7147176+01	1.0851523+0
60	7.1460768-07	1.4736723-01	1.1640504-02	1.5831028-01	1.1751844-05	2.4285672+01	2.8208571+01	1.0718446+0
61	7.0780050-07	1.5305319-01	1.1704906-02	1.6375523-01	1.2968974-05	2.4697580+01	2.9296960+01	1.0584368+0
62	7.0099602-07	1.5888293-01	1.1735844-02	1.6931785-01	1.4263705-05	2.5106945+01	3.0412872+01	1.0453304+0
63	6.9421718-07	1.6485929-01	1.1741316-02	1.7499260-01	1.5631580-05	2.5514281+01	3.1554846+01	1.0329210+0
64	6.8750029-07	1.7098518-01	1.1724592-02	1.8079880-01	1.7070595-05	2.5920006+01	3.2720445+01	1.0205965+0
65	6.8088174-07	1.7726362-01	1.1687222-02	1.8675651-01	1.8579804-05	2.6324469+01	3.3931245+01	1.0087449+0
66	6.7436909-07	1.8369771-01	1.1633171-02	1.9286141-01	2.0157109-05	2.6727978+01	3.5162838+01	9.9744476-0
67	6.6797694-07	1.9029043-01	1.1566518-02	1.9910837-01	2.1801007-05	2.7130812+01	3.6424835+01	9.8677909-0
68	6.6162587-07	1.9704568-01	1.1487474-02	2.0552148-01	2.3516276-05	2.7533223+01	3.7717865+01	9.7674593-0
69	6.5523648-07	2.0396625-01	1.1395208-02	2.1212604-01	2.5309270-05	2.7935445+01	3.9042579+01	9.6735387-0
70	6.4882914-07	2.1105561-01	1.1292264-02	2.1891536-01	2.7181947-05	2.8337714+01	4.0399640+01	9.5847119-0
71	6.4241872-07	2.1831797-01	1.1181738-02	2.2588167-01	2.9136771-05	2.8740258+01	4.1789741+01	9.5007495-0
72	6.3601617-07	2.2575642-01	1.1062434-02	2.3305849-01	3.1183450-05	2.9143284+01	4.3213585+01	9.4216051-0
73	6.2963242-07	2.3337496-01	1.0932358-02	2.4048111-01	3.3334538-05	2.9547003+01	4.4671902+01	9.3474674-0
74	6.2327095-07	2.4117752-01	1.0793708-02	2.4814013-01	3.5598117-05	2.9951630+01	4.6165444+01	9.3171938-0
75	6.1693569-07	2.4916813-01	1.0649307-02	2.5602508-01	3.7982552-05	3.0357354+01	4.7694981+01	9.2495255-0
76	6.1060085-07	2.5735095-01	1.0497382-02	2.6417931-01	4.0505322-05	3.0764478+01	4.9261311+01	9.2291909-0
77	6.0423875-07	2.6573025-01	1.0335540-02	2.7264829-01	4.3186818-05	3.1173124+01	5.0865250+01	9.1858537-0
78	5.9786826-07	2.7431046-01	1.0165902-02	2.8142090-01	4.6039823-05	3.1583554+01	5.2507646+01	9.1484282-0
79	5.9150958-07	2.8309610-01	9.9911324-03	2.9048482-01	4.9078646-05	3.1996002+01	5.4189365+01	9.1468849-0
80	5.8511407-07	2.9209184-01	9.8092724-03	2.9989332-01	5.2321514-05	3.2410704+01	5.5911301+01	9.1302062-0
81	5.7863306-07	3.0130249-01	9.6179183-03	3.0970226-01	5.5802227-05	3.2827903+01	5.7674376+01	9.1174169-0
82	5.7206197-07	3.1073301-01	9.4191425-03	3.1989974-01	5.9536211-05	3.3247866+01	5.9479536+01	9.1084265-0
83	5.6538828-07	3.2038850-01	9.2153944-03	3.3047775-01	6.3540059-05	3.3670867+01	6.1327760+01	9.1019555-0
84	5.5860384-07	3.3027421-01	9.0047334-03	3.4148445-01	6.7846351-05	3.4097186+01	6.3220851+01	9.0975942-0
85	5.5170053-07	3.4039556-01	8.7849520-03	3.5300194-01	7.2492586-05	3.4527117+01	6.5157448+01	9.0947869-0
86	5.4468949-07	3.5075811-01	8.5580256-03	3.6501288-01	7.7503152-05	3.4960973+01	6.7141014+01	9.0930586-0
87	5.3899346-07	3.6136759-01	8.3261272-03	3.7750478-01	8.2903207-05	3.5399087+01	6.9171848+01	9.0920445-0
88	5.3246360-07	3.7222992-01	8.0874230-03	3.9055245-01	8.8739714-05	3.5841803+01	7.1251081+01	9.0914751-0
89	5.2579116-07	3.8335118-01	7.8399768-03	4.0423444-01	9.5066669-05	3.6289485+01	7.3379879+01	9.0911718-0
90	5.1897780-07	3.9473765-01	7.5855356-03	4.1854143-01	1.0192240-04	3.6742528+01	7.5559440+01	9.0910218-0
91	5.1201078-07	4.0639577-01	7.3258538-03	4.3346356-01	1.0934697-04	3.7201352+01	7.7790999+01	9.0909532-0
92	5.0502037-07	4.1833218-01	7.0593686-03	4.4908453-01	1.1740605-04	3.7666385+01	8.0075831+01	9.0909248-0
93	4.9813686-07	4.3055376-01	6.7845741-03	4.6549220-01	1.2617509-04	3.8138078+01	8.2415246+01	9.0909141-0
94	4.9132652-07	4.4306754-01	6.5027630-03	4.8268654-01	1.3571239-04	3.8616905+01	8.4810595+01	9.0909105-0
95	4.8456457-07	4.5588080-01	6.2150687-03	5.0066872-01	1.4607908-04	3.9103360+01	8.7261268+01	9.0909092-0
96	4.7783430-07	4.6900102-01	5.9207185-03	5.1951268-01	1.5736052-04	3.9597947+01	8.9774499+01	9.0909090-0
97	4.7111902-07	4.8243593-01	5.6190836-03	5.3929599-01	1.6964808-04	4.0101176+01	9.2346369+01	9.0909090-0
98	4.6441996-07	4.9619347-01	5.3106603-03	5.6004834-01	1.8301981-04	4.0613552+01	9.4979794+01	9.0909090-0
99	4.5773637-07	5.1028182-01	4.9958293-03	5.8180539-01	1.9755238-04	4.1135554+01	9.7676542+01	9.0909090-01
100	4.5108401-07	5.2470945-01	4.6756698-03	6.0456554-01	2.1329696-04	4.1667614+01	1.0043823+02	9.0909090-01
101	4.4447868-07	5.3948503-01	4.3512932-03	6.2832502-01	2.3027780-04	4.2210061+01	1.0324653+02	9.0909090-01
102	4.3786213-07	5.5461754-01	4.0221234-03	6.5320022-01	2.4852596-04	4.2763057+01	1.0614315+02	9.0909090-01
103	4.3116281-07	5.7011621-01	3.6880084-03	6.7932654-01	2.6802094-04	4.3326529+01	1.0912985+02	9.0909090-01
104	4.2461689-07	5.8599058-01	3.3539573-03	7.0660369-01	2.8845793-04	4.3900027+01	1.1219448+02	9.0909090-01
105	4.1846056-07	6.0225047-01	3.0242511-03	7.3410440-01	3.0932824-04	4.4482524+01	1.1528089+02	9.0909090-01
106	4.1257857-07	6.1890597-01	2.6973942-03	7.6225611-01	3.3013950-04	4.5072144+01	1.1844904+02	9.0909090-0

NO.	MU	Y	K /UE2	RU/REUE	MIXEDDY	UDAG	YDAG	PRT
107	4.0685729-07	6.3596752-01	2.3736673-03	7.9272778-01	3.5006984-04	4.5665824+01	1.2173490+02	9.0909090-01
108	4.0150483-07	6.5344588-01	2.0433172-03	8.2284102-01	3.6708976-04	4.6258862+01	1.2508056+02	9.0909090-01
109	3.9672929-07	6.7135218-01	1.7736141-03	8.5181073-01	3.7843546-04	4.6844300+01	1.2850812+02	9.0909090-01
110	3.9245075-07	6.8969779-01	1.5027965-03	8.8008284-01	3.8144004-04	4.7412338+01	1.3201978+02	9.0909090-01
111	3.8859658-07	7.0849454-01	1.2511605-03	9.0808880-01	3.7291649-04	4.7949954+01	1.3561780+02	9.0909090-01
112	3.8525480-07	7.2775459-01	1.0251997-03	9.3385983-01	3.4875382-04	4.8441073+01	1.3930450+02	9.0909090-01
113	3.8251346-07	7.4749046-01	8.2729445-04	9.5531095-01	3.0435378-04	4.8867807+01	1.4308227+02	9.0909090-01
114	3.8040252-07	7.6771510-01	6.5341950-04	9.7220665-01	2.4708810-04	4.9213387+01	1.4695361+02	9.0909090-01
115	3.7897202-07	7.8844184-01	5.0089687-04	9.8428208-01	1.7707974-04	4.9466656+01	1.5092106+02	9.0909090-01
116	3.7797860-07	8.0968450-01	3.6368542-04	9.9249734-01	1.0718375-04	4.9627412+01	1.5498726+02	9.0909090-01
117	3.7717894-07	8.3145721-01	2.4543917-04	9.9812452-01	5.0305835-05	4.9708973+01	1.5915493+02	9.0909090-01
118	3.7671407-07	8.5377464-01	1.3553877-04	1.0010152+00	1.5156792-05	4.9737515+01	1.6342684+02	9.0909090-01
119	3.7672926-07	8.7665197-01	6.4332369-05	1.0010445+00	1.5160412-06	4.9741146+01	1.6780596+02	9.0909090-01
120	3.7691207-07	9.0010489-01	2.3371722-05	1.0001610+00	1.3761527-07	4.9740645+01	1.7229521+02	9.0909090-01
121	3.7695004-07	9.2414898-01	9.7158446-06	9.9999418-01	6.0822926-08	4.9740872+01	1.7689769+02	9.0909090-01
122	3.7693315-07	9.4880143-01	3.5751703-06	1.0000816+00	1.3399942-08	4.9740764+01	1.8161659+02	9.0909090-01
123	3.7693237-07	9.7407923-01	0.0000000	1.0000859+00	6.5998596-09	4.9740846+01	1.8645518+02	9.0909090-01
124	3.7694773-07	1.0000000+00	0.0000000	1.0000000+00	2.7640693-02	4.9740776+01	1.9141685+02	9.0909090-01

**** MUZZY WITH COMBUSTION FOR B=10. 4% HYDROGEN INJECTION ***** 6/14/73

NO.	F/O	Y(H)	Y(H2)	Y(H2O)	Y(O)	Y(OH)	Y(O2)	Y(N)	Y(NO)	Y(N2)	MU	PR			
1	3.842-02	1.008-10	1.171-02	2.277-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.606-01	4.572-07	.573A4			
2	3.841-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.574-07	.57336			
3	3.840-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.574-07	.57336			
4	3.858-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.579-07	.57394			
5	3.856-02	1.008-10	1.165-02	2.277-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.607-01	4.588-07	.57410			
6	3.853-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.600-07	.57433			
7	3.848-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.615-07	.57449			
8	3.843-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.634-07	.57477			
9	3.836-02	1.008-10	1.146-02	2.277-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.608-01	4.656-07	.57540			
10	3.828-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.683-07	.57587			
11	3.818-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.713-07	.57646			
12	3.807-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.747-07	.57693			
13	3.795-02	1.008-10	1.107-02	2.278-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.611-01	4.785-07	.57833			
14	3.782-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.828-07	.57936			
15	3.767-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.875-07	.58051			
16	3.750-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.926-07	.58178			
17	3.732-02	1.008-10	1.047-02	2.280-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.616-01	4.982-07	.58316			
18	3.712-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.044-07	.58476			
19	3.691-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.111-07	.58647			
20	3.668-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.185-07	.58833			
21	3.644-02	1.008-10	9.628-03	2.281-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.622-01	5.263-07	.59036			
22	3.618-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.347-07	.59254			
23	3.591-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.435-07	.59490			
24	3.562-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.528-07	.59740			
25	3.531-02	1.008-10	8.552-03	2.284-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	0.000	5.626-07	.60008			
26	3.500-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.631-01	5.729-07	.60295			
27	3.466-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.836-07	.60599			
28	3.431-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.949-07	.60919			
29	3.395-02	1.008-10	7.240-03	2.287-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	0.000	6.066-07	.61259			
30	3.356-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.641-01	6.188-07	.61621			
31	3.317-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.314-07	.62003			
32	3.275-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.444-07	.62403			
33	3.232-02	1.008-10	5.680-03	2.291-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	0.000	6.579-07	.62827			
34	3.188-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.653-01	6.720-07	.63278			
35	3.141-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.864-07	.63753			
36	3.093-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.014-07	.64248			
37	3.043-02	1.008-10	3.853-03	2.295-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	0.000	7.168-07	.64773			
38	2.991-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.667-01	7.329-07	.65338			
39	2.937-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.502-07	.65959			
40	2.880-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.692-07	.66629			
41	2.822-02	1.008-10	1.712-03	2.300-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	0.000	7.876-07	.67314			
42	2.762-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.683-01	8.033-07	.67953			
43	2.699-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.177-07	.68583			
44	2.635-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.327-07	.69244			
45	21572-02	1.008-10	2.016-10	2.240-01	1.600-09	1.580-07	5.758-03	1.401-09	1.073-05	7.702-01	8.475-07	.70283			
46	2.509-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.430-07	.70574			
47	2.448-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.296-07	.70717			
48	2.391-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.136-07	.70799			
49	2.336-02	1.008-10	2.016-10	2.040-01	1.600-09	3.340-08	2.404-02	1.401-09	6.341-04	7.720-01	8.016-07	.70689			
50	2.283-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.919-07	.70978			
51	2.233-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.829-07	.71036			
52	2.185-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.744-07	.71077			

NO.	F/O	Y(H)	Y(H2)	Y(H2O)	Y(O)	Y(OH)	Y(O2)	Y(N)	Y(NO)	Y(N2)	MU	PR			
53	2.138-02	1.008-10	2.016-10	1.871-01	1.600-09	8.949-09	3.944-02	1.401-09	3.385-06	7.735-01	7.660-07	.71120			
54	2.094-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.580-07	.71160			
55	2.051-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.502-07	.71192			
56	2.010-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.428-07	.71218			
57	1.970-02	1.008-10	2.016-10	1.726-01	1.600-09	1.701-09	5.263-02	1.401-09	1.939-06	7.747-01	7.354-07	.71242			
58	1.931-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.283-07	.71263			
59	1.892-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.214-07	.71282			
60	1.854-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.146-07	.71298			
61	1.817-02	1.008-10	2.016-10	1.595-01	1.600-09	1.701-09	6.459-02	1.401-09	1.034-06	7.759-01	7.078-07	.71307			
62	1.781-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.010-07	.71314			
63	1.745-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.942-07	.71326			
64	1.710-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.875-07	.71333			
65	1.675-02	1.008-10	2.016-10	1.472-01	1.600-09	1.701-09	7.581-02	1.401-09	5.102-07	7.770-01	6.809-07	.71337			
66	1.640-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.744-07	.71340			
67	1.606-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.680-07	.71343			
68	1.573-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.614-07	.71343			
69	1.539-02	1.008-10	2.016-10	1.355-01	1.600-09	1.701-09	8.650-02	1.401-09	2.317-07	7.780-01	6.552-07	.71343			
70	1.506-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.488-07	.71341			
71	1.474-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.424-07	.71338			
72	1.441-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.360-07	.71334			
73	1.409-02	1.008-10	2.016-10	1.241-01	1.600-09	1.701-09	9.683-02	1.401-09	6.547-08	7.790-01	6.296-07	.71329			
74	1.377-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.233-07	.71323			
75	1.345-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.169-07	.71316			
76	1.313-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.104-07	.71309			
77	1.281-02	1.008-10	2.016-10	1.130-01	1.600-09	1.701-09	1.070-01	1.401-09	3.488-08	7.800-01	6.042-07	.71300			
78	1.249-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.979-07	.71291			
79	1.217-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.915-07	.71281			
80	1.185-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.851-07	.71271			
81	1.153-02	1.008-10	2.016-10	1.019-01	1.600-09	1.701-09	1.171-01	1.401-09	1.097-08	7.810-01	5.786-07	.71259			
82	1.122-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.721-07	.71246			
83	1.090-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.654-07	.71232			
84	1.058-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.587-07	.71218			
85	1.025-02	1.008-10	2.016-10	9.070-02	1.600-09	1.701-09	1.273-01	1.401-09	3.001-09	7.820-01	5.521-07	.71203			
86	9.931-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.455-07	.71188			
87	9.607-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.390-07	.71173			
88	9.281-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.325-07	.71157			
89	8.954-03	1.008-10	2.016-10	7.931-02	1.600-09	1.701-09	1.377-01	1.401-09	3.001-09	7.830-01	5.258-07	.71140			
90	8.625-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.190-07	.71122			
91	8.294-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.120-07	.71102			
92	7.961-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.050-07	.71081			
93	7.626-03	1.008-10	2.016-10	6.763-02	1.600-09	1.701-09	1.483-01	1.401-09	3.001-09	7.840-01	4.981-07	.71060			
94	7.289-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.913-07	.71039			
95	6.947-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.844-07	.71014			
96	6.604-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.778-07	.70995			
97	6.258-03	1.008-10	2.016-10	5.557-02	1.600-09	1.701-09	1.593-01	1.401-09	3.001-09	7.851-01	4.711-07	.70972			
98	5.908-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.644-07	.70948			
99	5.555-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.577-07	.70923			
100	5.199-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.511-07	.70897			
101	4.839-03	1.008-10	2.016-10	4.304-02	1.600-09	1.701-09	1.708-01	1.401-09	3.001-09	7.862-01	4.445-07	.70870			
102	4.476-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.379-07	.70841			
103	4.109-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.312-07	.70811			
104	3.739-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.246-07	.70780			
105	3.366-03	1.008-10	2.016-10	2.998-02	1.600-09	1.701-09	1.827-01	1.401-09	3.001-09	7.873-01	4.185-07	.70750			
106	2.992-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.126-07	.70718			

NO.	F/O	Y(H)	Y(H2)	Y(H2O)	Y(O)	Y(OH)	Y(O2)	Y(N)	Y(NO)	Y(N2)	MU	PR		
107	2.618-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.069-07	.70686
108	2.247-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.015-07	.70654
109	1.882-03	1.008-10	2.016-10	1.679-02	1.600-09	1.701-09	1.947-01	1.401-09	3.001-09	7.885-01	3.967-07	.70623		
110	1.528-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.925-07	.70592	
111	1.192-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.886-07	.70561	
112	8.834-04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.853-07	.70533	
113	6.112-04	1.008-10	2.016-10	5.458-03	1.600-09	1.701-09	2.050-01	1.401-09	3.001-09	7.895-01	3.825-07	.70504		
114	3.852-04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.804-07	.70490		
115	2.132-04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.790-07	.70476		
116	9.719-05	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.780-07	.70468		
117	3.237-05	1.008-10	2.016-10	2.893-04	1.600-09	1.701-09	2.097-01	1.401-09	3.001-09	7.900-01	3.772-07	.70456		
118	5.482-06	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.767-07	.70451		
119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.767-07	.70451		
120	3.464-09	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.769-07	.70452		
121	0.000	1.008-10	2.016-10	2.438-06	1.600-09	1.701-09	2.100-01	1.401-09	3.001-09	7.900-01	3.770-07	.70453		
122	3.592-11	1.008-10	2.016-10	2.438-06	1.600-09	1.701-09	2.100-01	1.401-09	3.001-09	7.900-01	3.769-07	.70452		
123	0.000	1.008-10	2.016-10	2.438-06	1.600-09	1.701-09	2.100-01	1.401-09	3.001-09	7.900-01	3.769-07	.70452		
124	0.000	1.008-10	2.016-10	2.438-06	1.600-09	1.701-09	2.100-01	1.401-09	3.001-09	7.900-01	3.769-07	.70453		

NO. ITERATIONS = 2

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4. Omori, Satoaki, Gross, Klaus W., and Krebsbach, Alfred, "Wall Temperature Distribution Calculation for a Rocket Nozzle Contour," NASA TN D-6825, 1972.

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APPENDIX A COMPUTER PROGRAM OF TBLEDY

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      SUBROUTINE ADDPT (IFLAG)
C         CHANGES TO SUBROUTINE ADDPT
CADDPT     ADD ANOTHER POINT TO THE BOUNDARY LAYER AND PREPARE FOR
C          RECALCULATION OF THE COEFFICIENTS OF THE LAST TWO POINTS.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                           /YTABLE/
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                        /ZCALC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON /CONST/ SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,  /CONST/
     1               EPSLN3,CONVRG,02DY,04DY,ODYSQ                       /CONST/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      DIMENSION SUBR(3)
      DATA SUBR/6HMOMNTM,6HENERGY,6HELEMTS/
C
C     INCREMENT Y-COUNTERS.
C
      NY=NY+1
      NY1=NY-1
      NY2=NY-2
C
C     EXTEND EDGE PROPERTIES TO NEW POINT.
C
      DO 500 J=1,3
      U(NY,J)=U(NY1,J)
      H(NY,J)=H(NY1,J)
      SH(NY,J)=SH(NY1,J)
      CUU(NY,J) = CUU(NY1,J)
      CUV(NY,J) = CUV(NY1,J)
      CVV(NY,J) = CVV(NY1,J)
      CWW(NY,J) = CWW(NY1,J)
      DO 100 IEL=1,NEL
  100 ALPHA(NY,J,IEL) = ALPHA(NY1,J,IEL)
      RHO(NY,J)=RHO(NY1,J)
      SMU(NY,J)=SMU(NY1,J)
      PR(NY,J)=PR(NY1,J)
      BLE(NY,J)=BLE(NY1,J)
      IF(J.GT.2)GO TO 210
      DO 200 ISP=1,NSP
      SHI(NY,J,ISP)=SHI(NY1,J,ISP)
  200 SCI(NY,J,ISP) = SCI(NY1,J,ISP)
  210 T(NY,J) = T(NY1,J)
      EPS(NY,J)=EPS(NY1,J)
      PRT(NY,J)=PRT(NY1,J)
  500 BLET(NY,J) = BLET(NY1,J)
C
```

```
C     EXTEND RHOV USING 3-POINT DERIVATIVE APPROXIMATION AT EDGE.
C
      RHOV(NY)=RHOV(NY1)+(RHOV(NY2-1)-4.*RHOV(NY2)+3.*RHOV(NY1))/2.
C
C     CALCULATE E AND F AT NY.
C
      E(NY)=RHO(NY,JA)*RGP(NY)*ZETAP*YTIL(NY)/ZETA
      F(NY)=BGP(NY)/(ZETA*ZETA*REY(NF)
C
C     CALCULATE APPROPRIATE SIGMAS FOR PUSH-DOWN STORAGE AT NY - 2.
C
      NY3=NY2-1
      GO TO (1100,1200,1300), IFLAG
C
C     CALCULATE SIGMA1 FOR MOMENTUM EQUATION.
C
 1100 SIG1(1)= SMU(NY3,JA) + EPS(NY3,JA)
      SIG1(1)= SMU(NY2,JA) + EPS(NY2,JA)
      GO TO 1400
C
C     CALCULATE SIGMA2, SIGMA3, AND SIGMA4 FOR ENERGY EQUATION.
C
 1200 DO 1250 K=NY3,NY2
      L=K-NY3+1
      TM1 = EPS(K,JA)
      TM2=SMU(K,JA)/PR(K,JA)
      TM3=TM1/PRT(K,JA)
      SIG2(L)=TM2+TM3
      SIG3(L)=SMU(K,JA)-TM2+TM1-TM3
 1250 SIG4(L) = TM2*(BLE(K,JA) - 1.0) + TM3*(BLET(K,JA) - 1.0)
      GO TO 1400
C
C     CALCULATE SIGMA5 FOR ELEMENT EQUATION.
C
 1300 DO 1350 K=NY3,NY2
      L=K-NY3+1
 1350 SIG5(L) = SMU(K,JA)*BLE(K,JA)/PR(K,JA)+EPS(K,JA)*
     1           BLET(K,JA)/PRT(K,JA)
 1400 WRITE (6,9000) SUBR(IFLAG),ISTATN,ITER
 9000 FORMAT (/49H POINT WAS ADDED TO BOUNDARY LAYER IN SUBROUTINE ,A6,
     1        11H AT STATION,I5,14H AND ITERATION,I3/)
      RETURN
      END
```

```
      SUBROUTINE ANSWER                                                  A   2
C
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     -1               GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),     /POINTS/
     -2               TTT(13)                                           /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     -1             DELN(30),A(15,30),SUB(30,3),IOSE(30),IEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     -1             BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,     /MISC/
     -2             HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),          /MISC/
     -3             NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),   /MISC/
     -4             RTEMP(15),FOX(15),DENS(15),TLN                      /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     -1             JSOL,JL1Q,IC,IQ2                                    /INDX/
      COMMON/OUTRHO/DEN(13)
C
C     PRESSURES ARE STORED IN PPP(I).
C     TEMPERATURES ARE STORED IN TTT(I).
C     COMPUTE SOUND SPEED SONVEL(I).
C
      DO 40 I=1,NPT
   40 SONVEL(I) = 3.28080*SQRT(8314.298360*GAMMAS(I)*TTT(I)/WM(I))
C
C     CALCULATE VISCOSITY, PRANDTL NUMBER, AND THERMAL CONDUCTIVITY.
C
      CALL VISCX
C
C     CALCULATE DENSITY.
C
      DO 60 I=1,NPT
      DEN(I)= PPP(I)*WM(I)/(TTT(I)*1.8)
   60 DEN(I) = 1.3688381166*DEN(I)
      RETURN
      END                                                                A 196-
```

```
      BLOCK DATA                                                          A    1
C                                                                         A    2
      DIMENSION ATAM(3,51),ATEM(3,54),DATE(2,30)
C                                                                         A    4
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),           /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,       /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),            /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),     /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                        /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,    /INDX/
     1              JSOL,JLIQ,IC,IQ2                                      /INDX/
      LOGICAL MOLES
      COMMON /SPECES/ COEF(2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1                DFLN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      INTEGER SUB
      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,           /INPUT/
     1               PHAZ(30),T1(30),T2(30)                               /INPUT/
C
      EQUIVALENCE (ATOM(1,1),ATAM),(ATOM(1,52),ATEM),(DATE,EN)
C                                                                         A   15
C     ATOMIC SYMBOLS, WEIGHTS, AND VALENCES                               A   16

C     MODIFIED FOR DUMMY ELEMENTS (4) H C N O , (101+4)=105 ELEMENTS
C                                                                         A   17
      DATA ATAM/2HH ,1.008,1.,2HHE,4.003,0.,2HLI,6.940,1.,2HBE,9.013,2.,
     1 2HB ,10.820,3.,2HC ,12.011,4.,2HN ,14.008,0.,2HO ,16.000,-2.,2HF ,  A   19
     2 19.000,-1.,2HNE,20.183,0.,2HNA,22.991,1.,2HMG,24.320,2.,2HAL,26.98  A   20
     3 0,3.,2HSI,28.090,4.,2HP ,30.975,5.,2HS ,32.066,4.,2HCL,35.457,-1.,   A   21
     4 2HAR,39.944,0.,2HK ,39.100,1.,2HCA,40.080,2.,2HSC,44.960,3.,2HTI,4   A   22
     5 7.900,4.,2HV ,50.950,5.,2HCR,52.010,3.,2HMN,54.940,2.,2HFE,55.850,   A   23
     6 3.,2HCO,58.940,2.,2HNI,58.710,2.,2HCU,63.540,2.,2HZN,65.380,2.,2HG   A   24
     7 A,69.720,3.,2HGE,72.600,4.,2HAS,74.920,3.,2HSE,78.960,4.,2HBR,79.9  A   25
     8 16,-1.,2HKR,83.800,0.,2HRB,85.480,1.,2HSR,87.630,2.,2HY ,88.910,3.   A   26
     9 ,2HZR,91.220,4.,2HNB,92.910,5.,2HMO,95.950,6.,2HTC,99.000,7.,2HRU,   A   27
     $ 101.100,3.,2HRH,102.910,3.,2HPD,106.400,2.,2HAG,107.880,1.,2HCD,11   A   28
     $ 2.410,2.,2HIN,114.820,3.,2HSN,118.700,4.,2HSB,121.760,3./            A   29
      DATA ATEM/2HTE,127.610,4.,2HI ,126.910,-1.,2HXE,131.300,0.,2HCS,13    A   30
     1 2.910,1.,2HBA,137.360,2.,2HLA,138.920,3.,2HCE,140.130,3.,2HPR,140.   A   31
     2 910,3.,2HND,144.270,3.,2HPM,147.000,3.,2HSM,150.350,3.,2HEU,152.00   A   32
     3 0,3.,2HGD,157.260,3.,2HTB,158.930,3.,2HDY,162.510,3.,2HHO,164.940,   A   33
     4 3.,2HER,167.270,3.,2HTM,168.940,3.,2HYB,173.040,3.,2HLU,174.990,3.   A   34
     5 ,2HHF,178.500,4.,2HTA,180.950,5.,2HW ,183.860,6.,2HRE,186.220,7.,2   A   35
     6 HOS,190.200,4.,2HIR,192.200,4.,2HPT,195.090,4.,2HAU,197.000,3.,2HH   A   36
     7 G,200.610,2.,2HTL,204.390,1.,2HPB,207.210,2.,2HBI,208.990,3.,2HPO,   A   37
     8 210.000,2.,2HAT,210.000,0.,2HRN,222.000,0.,2HFR,223.000,1.,2HRA,22   A   38
     9 6.000,2.,2HAC,227.000,3.,2HTH,232.000,4.,2HPA,231.000,5.,2HU ,238.   A   39
     $ 000,6.,2HNP,237.000,5.,2HPU,242.000,4.,2HAM,243.000,3.,2HCM,247.00   A   40
     $ 0,3.,2HBK,249.000,3.,2HCF,251.000,3.,2HES,254.000,0.,2HFM,253.000,   A   41
     $ 0.,2HMD,256.000,0.,
C     DUMMY H C N O
     A 2HHZ,1.008,1., 2HCZ,12.011,4., 2HNZ,14.008,0., 2HOZ,16.000,-2./
C                                                                         A   43
```

```
C
C       NOMINAL ODE THERMAL DATA AND REACTANTS DATA
C
      DATA (SUB(I,1), I=1,6)/4HH    ,4HH2   ,4HH2O ,4HO    ,4HOH   ,4HO2  /,
     1 (DATE(1,I),DATE(2,I), I =1,6)/3HJ 9,3H/65,3HJ 3,3H/61,3HJ 3,
     2 3H/61,3HJ 6,3H/62,3HJ 3,3H/66,3HJ 9,3H/65/,((MT(I,J),B(I,J),
     3 I = 1,4), J = 1,6)/2HH ,1.0,2H  ,0.0,2H  ,0.0,2H  ,0.0,2HH ,2.0,
     4 2H  ,0.0,2H  ,0.0,2H  ,0.0,2HH ,2.0,2HO ,1.0,2H  ,0.0,2H  ,0.0,
     5 2HO ,1.0,2H  ,0.0,2H  ,0.0,2H  ,0.0,2HO ,1.0,2HH ,1.0,2H  ,0.0,
     6 2H  ,0.0,2HO ,2.0,2H  ,0.0,2H  ,0.0,2H  ,0.0/,(PHAZ(I), I = 1,6)/
     7 6*1HG/,(T1(I), I = 1,6)/6*300.0/,(T2(I), I = 1,6)/6*5000.0/,
     8 TLOW,TMID,THIGH/300.0,1000.0,5000.0/,NAME(1,1),ANUM(1,1),
     9 NAME(2,1),ANUM(2,1)/2HH ,2.0,2HO ,2.0/,PECWT(1),PECWT(2)/2*100.0/
     A ,MOLES/.FALSE./,ENTH/15*0.0/,FAZ/15*1HG/,                          NEW
     B RTEMP(1),RTEMP(2)/2*298.15/,FOX(1),FOX(2)/1HF,1HO/,DENS(1),        -01
     C DENS(2)/2*0.0/,NSPEC/2/,NPROD/6/,ITHERM/0/,(SUB(I,2),SUB(I,3),
     D I = 1,6)/12*4H    /,(NAME(1,I),NAME(2,I), I = 2,5)/8*2H  /
      DATA (((COEF(I,J,K), J = 1,7), I = 1,2), K = 1,6)/2.50,4*0.0,
     1 25471.627,-0.46011763,2.50,4*0.0,25471.627,-0.46011762,3.1001901,
     2 5.1119464E-4,5.2644210E-8,-3.4909973E-11,3.6945349E-15,-877.38042
     3,-1.9629421,3.0574451,2.676520E-3,-5.8099162E-6,5.8210391E-9,
     4 -1.8122739E-12,-988.90474,-2.2997056,2.7167633,2.9451374E-3,
     5 -8.0224374E-7,1.0226682E-10,-4.8472145E-15,-29905.826,6.6305671,
     6 4.0701275,-1.1084499E-3,4.1521180E-6,-2.9637404E-9,8.0702103E-13,
     7 -30279.722,-0.32270046,2.5420596,-2.7550619E-5,-3.1028033E-9,
     8 4.5510674E-12,-4.3680515E-16,29230.803,4.9203080,2.9464287,
     9 -1.6381665E-3,2.4210318E-6,-1.6028432E-9,3.8906964E-13,29147.644,
     A 2.9639949,2.9106427,9.5931650E-4,-1.9441702E-7,1.3756646E-11,
     B 1.4224542E-16,3935.3815,5.4423445,3.8375943,-1.0778858E-3,
     C 9.6830378E-7,-1.8713972E-10,-2.2571094E-13,3641.2823,0.49370009,
     D 3.6219535,7.3618264E-4,-1.9652228E-7,3.6201558E-11,-2.8945627E-15
     E,-1201.9825,3.6150960,3.6255985,-1.8782184E-3,7.0564544E-6,
     F 6.7635137E-9,2.1555993E-12,-1047.5226,4.3052778/
      END                                                                 A  61-
```

```
      SUBROUTINE BNDCND
CBNDCND   CALCULATE QUANTITIES NECESSARY FOR BOUNDARY CONDITIONS AT
C         FORWARD STATION.
C
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SMEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,    /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
C
C     MOVE FORWARD QUANTITIES TO BACK QUANTITIES.
C
      DUEDSO=DUEDSN
      SMDWO=SMDWN
C
C     MOMENTUM EQUATION BOUNDARY CONDITIONS.
C                   AT WALL    U = 0
C                   AT EDGE    U = UE
C
      CALL LCURV (X+DX,XTDUDX,UETAB,LDUDXT,IDUDXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
      DUEDS=0.5*(DUEDSN+DUEDSO)
C
C     INTEGRATE TO OBTAIN UE AT FORWARD STATION.
C
      UEDGE=UEDGE+DUEDS*DS
C
C     CONTINUITY EQUATION BOUNDARY CONDITION.
C                   AT WALL    RHOV = MDOTW
C
      CALL LCURV (X+DX,XTABMD,SMDTAB,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETAN)
      SMDW=0.5*(SMDWN+SMDWO)
C
C     ENERGY EQUATION BOUNDARY CONDITIONS.
C                   AT WALL    H = HW
C                   AT EDGE    H = HE
C
```

```
      CALL LCURV (X+DX,XTABTW,TWTAB,LTWTAB,ITWXP,TWALL)
      CALL XNTERP (X+DX,PEDGEB,DPEDX ,IPEXP,XTABPE,PETAB,LPETAB,
     1             CPEX,IPEXP)
C
C     OBTAIN SHEDGE.
C
      SHEDGE=HEDGE-UEDGE*UEDGE/2.
      IF(IDEAL.GT.0)GO TO 300
C
C     CALL HOODE TO OBTAIN SHWALL AND HWALL.
C
      CALL HOODE (3)
      RETURN
```

```
C
C     CALL IGODE TO OBTAIN SHWALL AND HWALL.
C
300   CALL IGODE (TWALL,SHWB,PEDGEB,1,DUMMY1,DUMMY2,DUMMY3)
      SHWALL=SHWB/(UREF*UREF)
      HWALL=SHWALL
      RETURN
      END
```

```
      SUBROUTINE CONTNU
CCONTNU   INTEGRATE CONTINUITY EQUATION FROM WALL TO EDGE TO OBTAIN
C         RHOV PROFILE AT M + 1/2.
C

COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOE(250),SH(250,3)
COMMON/INDEP /S,DS,X,DX,Y(250),DY
COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1        SHI(250,2,6),SCI(250,2,6),TT(250,3),AV(250)
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1          CYTIL(6)                                          /YTABLE/
COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1         YTZETA,YEDGE                                       /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1        EPSLN3,CONVRG,02DY,04DY,ODYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,J0,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/NEW11 /J2D,UEK,RHOEK
```

```
C
C     INITIAL CONDITION - AT WALL RHOV = MDOTW
C
      RHOV(1)=SMDW
C
C     INITIALIZE PUSH-DOWN STORAGE.
C
      RUMN1=RHO(1,J0)*U(1,J0)
      RUMIN1=RHO(1,JN)*U(1,JN)
      RWAVE=0.5*(RW(1)+RW(2))
      DRWDS=0.5*(SIN(THW(1))+SIN(THW(2)))
      DO 100 I=2,NY
      RUMN=RHO(I,J0)*U(I,J0)
      RUMIN=RHO(I,JN)*U(I,JN)
      DRUDS=(RUMIN+RUMIN1-RUMN-RUMN1)/(2.*DS)
      DRUDY=(RUMIN+RUMN-RUMIN1-RUMN1)*O2DY
      RUMHNH=0.25*(RUMIN+RUMIN1+RUMN+RUMN1)
      GPNH=0.5*(BGP(I-1)+BGP(I))
      YTNH=0.5*(YTIL(I-1)+YTIL(I))
      RHOV(I)=RHOV(I-1)+DY*(-DRUDS/GPNH-FLOAT(J2D)*RUMHNH*DRWDS/
     1          (GPNH*RWAVE)+ZETAP/ZETA*YTNH*DRUDY)
C
C     PUSH-DOWN STORAGE.
C
      RUMN1=RUMN
  100 RUMIN1 = RUMIN
      RETURN
      END
```

```
      SUBROUTINE CPHS                                                    A   1
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,10S),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
C                                                                        A  12
      J = 1
      K=1                                                                A  13
      IF (TT.LE.TMID) K=2                                                A  14
      KK=0                                                               A  15
      CPSUM=0.                                                           A  16
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
```

```
20      IF (COEF(K,1,J).NE.0.) GO TO 30                                  A  17
        IF (IUSE(J).LT.0) GO TO 40                                       A  18
        KK=K                                                             A  19
        K=1                                                              A  20
        IF (KK.EQ.1) K=2                                                 A  21
30      S(J)=((((COEF(K,5,J)/4.)*TT+COEF(K,4,J)/3.)*TT+COEF(K,3,J)/2.)*TT+  A  22
     1COEF(K,2,J))*TT+COEF(K,1,J)*TLN+COEF(K,7,J)                        A  23
        HO(J)=((((COEF(K,5,J)/5.)*TT+COEF(K,4,J)/4.)*TT+COEF(K,3,J)/3.)*TT  A  24
     1+COEF(K,2,J)/2.)*TT+COEF(K,1,J)+COEF(K,6,J)/TT                     A  25
        CPSUM=CPSUM+((((COEF(K,5,J)*TT+COEF(K,4,J))*TT+COEF(K,3,J))*TT+COE  A  26
     1F(K,2,J))*TT+COEF(K,1,J))*EN(J,NPT)                                A  27
        IF (KK.EQ.0) GO TO 40                                            A  28
        K=KK                                                             A  29
        KK=0                                                             A  30
40      IF (J .EQ. NS)  RETURN
        J=J+1                                                            A  32
        GO TO 20                                                         A  33
        END                                                              A  35-
```

```
      SUBROUTINE CPSPEC (TMPR,NNPT)
CCPSPFC    THIS ROUTINE HAS BEEN MODIFIED FROM ODE SUBROUTINE CPHS TO
C          CALCULATE CP FOR EACH SPECIES (IN CAL/MOL-DEG K) AND CPBAR
C          (IN CAL/GM-DEG K).
C
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),        /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,    /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),         /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),  /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                     /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC, /INDX/
     1              JSOL,JLIQ,IC,IQ2                                   /INDX/
      COMMON/CPI    /CPI(30),CPBAR

C                                                                      A  12
      J=1
      K=1                                                              A  13
      IF(TMPR.LE.TMID)K=2
      KK=0                                                             A  15
      CPBAR=0.
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
20      IF (COEF(K,1,J).NE.0.) GO TO 30                                A  17
        IF (IUSE(J).LT.0) GO TO 40                                     A  18
        KK=K                                                           A  19
        K=1                                                            A  20
        IF (KK.EQ.1) K=2                                               A  21
```

```
 30   CPI(J) = COEF(K,1,J) + COEF(K,2,J)*TMPR + COEF(K,3,J)*TMPR**2 +
     1         COEF(K,4,J)*TMPR**3 + COEF(K,5,J)*TMPR**4
      CPI(J) = 1.9A7165D*CPI(J)
      CPBAR=CPBAR+CPI(J)*EN(J,NNPT)
      IF (KK.EQ.0) GO TO 40                                              A  28
      K=KK                                                               A  29
      KK=0                                                               A  30
 40   IF (J .EQ. NS)  RETURN
      J=J+1                                                              A  32
      GO TO 20                                                           A  33
      END                                                                A  35-
```

```
      SUBROUTINE DEBUG (SNAME)
CDEBUG    DEBUG ROUTINE FOR EXIT ON PROGRAM-DETECTED ERROR
C
      COMMON/STATN /ISTATN,MAXIT,ITER
C
      WRITE (6,9000) SNAME,ISTATN,ITER
 9000 FORMAT (/29H EXIT CALLED FROM SUBROUTINE ,A8,11H AT STATION,I5,
     1        14H AND ITERATION,I3)
      CALL SUMTAB
      CALL EXIT
      RETURN
      END
```

```
      SUBROUTINE DUMPIT
CDUMPIT   DUMP MATRIX COEFFICIENTS FOR A GIVEN DIFFERENCE EQUATION.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG55(3)
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NFL,NEL1,NSP,NMAX,NYI
      COMMON/STATN /ISTATN,MAXIT,ITER
C
      I=1
      WRITE (6,9000) ISTATN,ITER,I,U(I,JN),H(I,JN),SH(I,JN),RHOV(I)
      WRITE (6,9010) (I,(A(I-1,J),J=1,3),B(I-1),E(I),F(I),U(I,JN),
     1                H(I,JN),SH(I,JN),RHOV(I),I=2,5)
      NYL=NY-4
```

```
      WRITE (6,9010) (I,(A(I-1,J),J=1,3),B(I-1),E(I),F(I),U(I,JN),
     1                H(I,JN),SH(I,JN),RHOV(I),I=NYL,NYI)
      I=NY
      WRITE (6,9020) I,U(I,JN),H(I,JN),SH(I,JN),RHOV(I)
      WRITE (6,9030) (SIG1(I),SIG2(I),SIG3(I),SIG4(I),SIG5(I),
     1                SIGSS(I),I=1,3)
      RETURN
 9000 FORMAT (/216/110,72X,1P4E12.4)
 9010 FORMAT (110,1P10E12.4)
 9020 FORMAT (110,72X,1P4E12.4)
 9030 FORMAT (15X,1P6E12.4)
      END
```

```
      SUBROUTINE EDDY
C        CHANGES TO SUBROUTINE EDDY
CEDDY     CALCULATE TURBULENT TRANSPORT PROPERTIES.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AB(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                        /YTABLE/
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                     /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,   /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                              /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/NEWI  /ALEWIS,TLEWIS
      COMMON /EFVEC/ E(250),F(250)                                     /EFVEC/
      COMMON /MATRX/ A(250,3),B(250)                                   /MATRX/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
      COMMON/MUZZY/SDELTA
```

```
C                                                                       NEW
C                                                                       NEW
C**** FIND SDELTA AT U=0.995 *UE  FOR P.W.  MW=*,  NEW LAMDA, JULY 12,1973 ****  NEW
      DO 35 K=1,NY                                                      NEW
      I=NY+1-K                                                          NEW
      SX1=ABS(U(I,JN)-UEDGE)/UEDGE                                      NEW
      IF(SX1.GE.0.005) GO TO 30                                         NEW
      SX2=SX1                                                           NEW
      GO TO 35                                                          NEW
   30 YDELTA=Y(I+1)-DY*(SX2-0.005)/(SX2-SX1)                            NEW
      GO TO 38                                                          NEW
   35 CONTINUE                                                          NEW
   38 CALL XNTERP(YDELTA,SDELTA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,IYTILF)   NEW
C
      DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSN
C
C     FIND DELTA, THE VALUE OF YTIL AT WHICH U = 0.995 * UE.
C
C
      DO 100 K=1,NY
      I=NY+1-K
      TM1=ABS(U(I,JN)-UEDGE)/UEDGE
      IF (TM1 .GE. 0.0050)  GO TO 50
      TM2 = TM1
      GO TO 100
   50 YDELTA=Y(I+1)-DY*(TM2-0.005)/(TM2-TM1)
      GO TO 120
  100 CONTINUE
C
C     FIND DELTA CORRESPONDING TO YDELTA.
C
  120 CALL XNTERP (YDELTA,DELTA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,IYTILF)
      IYTILF=IYTILP
C
C     CALCULATE TURBULENT TRANSPORT PROPERTIES AT EACH MESH POINT.
C
      EPS(1,JN)=0.
      PRT(1,JN) = 13.60/(11.440*SQRT(PR(1,JN)))
      T1=REYINF*ZETAN
      T2=T1/26.
      DERIV=02DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
      PAREN=SMU(1,JN)*BGP(1)*DERIV/T1
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (SMDWN .NE. 0.0)  GO TO 170
      TM3 = T1*ZETAN**2/(SMU(1,JN)*(BGP(1)*DERIV)**3)
      TM4 = 1.0 + 11.80*DPEDSN*SQRT(TM3/RHO(1,JN))
      IF (TM4 .LE. 0.0)  BN = 1.0
      IF (TM4 .GT. 0.0)  BN = SQRT(TM4)
      GO TO 180
```

```
 170  TM3 = 11.80*SMDWN/SQRT(RHO(I,JN))*SQRT(TI*ZETAN**2*SMU(I,JN)/
     1       (BGP(I)*DERIV))
      TM4=DPEDSN/(SMU(I,JN)*BGP(I)*DERIV*SMDWN)
 180  DO 300 I = 2,NY
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SMDWN.EQ.0.)GO TO 190
      TERM=EXP(TM3/SMU(I,JN))
      BN=SQRT(-TM4*SMU(I,JN)*(1.-TERM)+TERM)
 190  BRKT = -T2*YTIL(I)*BN/SMU(I,JN)*SQRT(RHO(I,JN)*PAREN)
      CVV(I,JN) = BRKT
      CUV(I,JN) = 0.160*TI*BGP(I)*YTIL(I)*YTIL(I)*RHO(I,JN)*
     1              ABS(.2DY*(U(I+1,JN)-U(I-1,JN)))*(1.0-EXP(BRKT))**2
C
C     CALCULATE TURBULENT PRANDTL NUMBER.
C
 300  PRT(I,JN) = 0.40/0.440*(1.0 - EXP(BRKT))/(1.0 - EXP(26.0*
     1            SQRT(PR(I,JN))*BRKT/34.0))
      I = 2
C
C     CALCULATE TEMPORARY QUANTITIES
C
  10  UYMN = (U(I+1,JN) - U(I-1,JN))*.2DY
      RHOP = (RHO(I+1,JN) - RHO(I-1,JN))*.2DY
      UUYYMN = (CUU(I+1,J0) - 2.0*CUU(I,J0) + CUU(I-1,J0))*ODYSQ
      CUUYMN = (CUU(I+1,J0) - CUU(I-1,J0))*.2DY
      SMUY = (SMU(I+1,JN) - SMU(I-1,JN))*.2DY

      ALFA = 0.10/ZK
      T2 = RHOV(I)*BGP(I) - U(I,JN)*E(I)
       GAMA=0.360 + 42.0*ZETAN*SMDWN/(RHO(NY,JN)*U(NY,JN))                NEW
C    *.******  DISIPATION LENGTH MODIFIED MAY 9,1973  ******             NEW
      SLS = YTIL(I)/DELTA                                                NEW
      SLS2 = SLS*SLS                                                     NEW
      BN = YTIL(I)*(0.2050*SLS2-0.5860*SLS+0.4310)                       NEW
      BRKT = 2.0 *EPS(I,J0)*F(I)*BGP(I)*UYMN**2                          -01
      TM1 = F(I)*BGP(I)*EPS(I,J0)*ALFA
      DERIV = .2DY*(EPS(I+1,J0) - EPS(I-1,J0))
      TM2 = F(I)*(EPS(I,J0)*BGPP(I)/BGP(I) + BGP(I)*DERIV)*ALFA
      TM3 = (EPS(I,J0)/(ZK*TI*RHO(I,JN)*BN))**3
      TM4 = BRKT - GAMA*TM3*RHO(I,JN)/(ZETAN*BN)
C
C     COEFFICIENT OF CUU(N+1,M+1)
C
      A(I-1,3) = .5DY*(T2 - TM2) - 0.50*ODYSQ*TM1
      A(I-1,2) = RHO(I,JN)*U(I,JN)/DS + ODYSQ*TM1
      A(I-1,1) = -A(I-1,3) - ODYSQ*TM1
      B(I-1) = TM4 + RHO(I,JN)*U(I,JN)/DS*CUU(I,J0) - 0.50*(T2 - TM2)*
     1         CUUYMN + 0.50*UUYYMN*TM1
      I = I + 1
      IF (I .LE. NY1)  GO TO 10
      A(1,1) = 0.0
      A(NY2,3)=0.0
      CALL TRIM(A,CUU(2,JN),B,NY2,NMAX)
```

```
      CUU(1,JN) = 0.0                                                    NEW
      CUU(NY,JN) = 0.0                                                   NEW
      CUV(1,JN) = 0.0                                                    NEW
      DO 1000 I=2,NY1                                                    NEW
C    ..******  DISIPATION LENGTH MODIFIED MAY 9,1973  ******             NEW
      SLS = YTIL(I)/DELTA                                                NEW
      SLS2 = SLS*SLS                                                     NEW
      BN = YTIL(I)*(0.2050*SLS2-0.5860*SLS+0.4310)                       NEW
      IF( CUU(I,JN).LT.0.0)  CUU(I,JN) =0.0                              NEW
      EPS(I,JN) = BN*ZK*RHO(I,JN)*SQRT(ABS(CUU(I,JN)))*REYINF*ZETAN      -01
      IF (CUV(I,JN) .LE. EPS(I,JN))  EPS(I,JN) = CUV(I,JN)
 1000 CONTINUE
      EPS(1,JN)=0.0
      EPS(NY,JN)=0.0
C
C     SMOOTH THE EDDY VISCOSITY  *********                               NEW
C                                                                        -01
   60 DO 400 I=3,NY2                                                     NEW
      EPS(I,JA) = (EPS(I+2,JN)+EPS(I-1,JN)+EPS(I,JN)+                    NEW
     1            EPS(I+1,JN)+EPS(I+2,JN))/5.0                           NEW
C      NEW K **********   CUU(I,JN)   *********                         -02
      SLS = YTIL(I)/DELTA                                                NEW
      SLS2 = SLS*SLS                                                     NEW
      BN = YTIL(I)*(0.2050*SLS2-0.5860*SLS+0.4310)                       NEW
      CUU(I,JN) = (EPS(I,JA)/(ZK*BN*RHO(I,JN)*T1))**2                    -01
  400 EPS(I,JN) = EPS(I,JA)
C
C     CALCULATE TURBULENT LEWIS NUMBER.
C
      DO 600 I=1,NY
  600 BLET(I,JN) = TLEWIS


        RETURN
        END
```

```
      SUBROUTINE ELEMTS
CELEMTS   SOLVE EACH SYSTEM OF ELEMENT EQUATIONS FOR ELEMENT MASS
C         FRACTIONS ALPHAI(M+1,N).
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                         /YTABLE/
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,   /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                              /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,0DYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/NEW3  /AFTRNS,PLAW
C
C     FOR EACH ELEMENT EXCEPT LAST, EVALUATE COEFFICIENTS OF SYSTEM OF
C     ELEMENT CONSERVATION EQUATIONS.
C
      SIG5S(1)=SIG5(1)
      SIG5S(2)=SIG5(2)
      DO 4000 IEL=1,NEL1
      SIG5(1)=SIG5S(1)
      SIG5(2)=SIG5S(2)
      INCRMT=0
      I=2
C
C     CALCULATE TEMPORARY QUANTITIES.
C
  100 BE = E(I)
      BF=F(I)
      SIG5(3)=SMU(I+1,JA)*BLE(I+1,JA)/PR(I+1,JA)+
     1        EPS(I+1,JA)*BLET(I+1,JA)/PRT(I+1,JA)
      SIG5Y=(SIG5(3)-SIG5(1))*02DY
      AYMN=(ALPHA(I+1,JO,IEL)-ALPHA(I-1,JO,IEL))*02DY
      AYYMN=(ALPHA(I+1,JO,IEL)-2.*ALPHA(I,JO,IEL)+ALPHA(I-1,JO,IEL))*
     1      0DYSQ
      TERM=BF*BGP(I)*SIG5(2)*0DYSQ
      TMI=BGPP(I)*SIG5(2)/BGP(I)+BGP(I)*SIG5Y
```

```
      TM2=RHOV(I)*BGP(I)
      TM3=RHO(I,JA)*U(I,JA)/DS
C
C     COEFF. OF ALPHAI(M+1,N-1)
C
      A(I-1,1)=04DY*(BE*U(I,JQ)+TM2+BF*TM1)-0.5*TERM
C
C     COEFF. OF ALPHAI(M+1,N)
C
      A(I-1,2)=TM3+TERM
C
C     COEFF. OF ALPHAI(M+1,N+1)
C
      A(I-1,3)=-A(I-1,1)-TERM
C
C     RIGHT-HAND SIDE (INCLUDING U(M+1,N) TERM OBTAINED FROM MOMENTUM
C      EQUATION)
C
      B(I-1)=TM3*ALPHA(I,JO,IEL)-0.5*TM2*AYMN+
     1        0.5*BF*(TM1*AYMN+BGP(I)*SIG5(2)*AYYMN)+0.5*BE*AYMN*U(I,JN)
C
C     PUSH-DOWN STORAGE
C
      SIG5(1)=SIG5(2)
      SIG5(2)=SIG5(3)
      I=I+1
      IF (I .LE. NY1)  GO TO 100
C
C     MODIFY FIRST AND LAST ELEMENT EQUATIONS BY BOUNDARY CONDITIONS.
C
      IF(INCRMT.GT.0)GO TO 250
      BIGA=REYINF*ZETA*ZETA*SMDW*PR(1,JA)/(BGP(1)*SMU(1,JA)*BLE(1,JA))
      DENOM=2.*DY*BIGA+3.
      A(1,2)=A(1,2)+4.*A(1,1)/DENOM
      A(1,3)=A(1,3)-A(1,1)/DENOM
      B(1)=B(1)-A(1,1)*2.*DY*BIGA*AFTRNS/DENOM
      A(1,1)=0.
  250 B(NY2) = B(NY2) - A(NY2,3)*AFEDGE
      A(NY2,3)=0.
C
C     SOLVE ELEMENT EQUATIONS FOR ALPHAI(M+1,N), N=2,3,...,NY-1
C
      CALL TRIM (A,ALPHA(2,JN,IEL),B,NY2,NMAX)
C
C     APPLY BOUNDARY CONDITIONS FOR ALPHAI(M+1,1) AND ALPHAI(M+1,NY)
C
      ALPHA(1,JN,IEL)=(4.*ALPHA(2,JN,IEL)-ALPHA(3,JN,IEL)+2.*DY*BIGA*
     1                 AFTRNS)/DENOM
      ALPHA(NY,JN,IEL)=AFEDGE
      TEST = ( ALPHA(NY1,JN,IEL) - ALPHA(NY,JN,IEL))/ALPHA(NY,JN,IEL)
      IF(ABS(TEST).LE.EPSLN3)GO TO 4000
```

```
C
C     SOLUTION DOES NOT ASYMPTOTICALLY APPROACH EDGE CONDITIONS.
C     INCREASE THICKNESS OF BOUNDARY LAYER BY ADDING ONE POINT.
C
      INCRMT=INCRMT+1
      IF(INCRMT.GT.5)CALL DEBUG (6HELEMTS)
      IF(NY.EQ.NMAX)CALL DEBUG (6HELEMTS)
      CALL ADDPT (3)
      I=NY-1
      GO TO 100
 4000 CONTINUE
C
C     CALCULATE MASS FRACTION OF LAST ELEMENT (NEL) AT EACH MESH POINT.
C
      DO 5000 I=1,NY
      SUMEL=0.
      DO 4500 IEL=1,NEL1
 4500 SUMEL = SUMEL + ALPHA(I,JN,IEL)
 5000 ALPHA(I,JN,NEL) = 1.0 - SUMEL
      RETURN
      END
```

```
      SUBROUTINE ENERGY
CENERGY   SOLVE SYSTEM OF ENERGY EQUATIONS FOR ENTHALPY H(M+1,N).
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(850,3),
     1               SHI(250,2,6),SCI(250,2,6),T(250,3),AT(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                         /YTABLE/
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,   /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                              /EDGEBC/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,08YSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
C
C     EVALUATE COEFFICIENTS OF SYSTEM OF ENERGY EQUATIONS.
C
      INCRMT=0
      I=2
```

```
C
C     CALCULATE TEMPORARY QUANTITIES.
C
  100  BE = E(I)
       BF=F(I)
       T1=EPS(I+1,JA)
       T2=SMU(I+1,JA)/PR(I+1,JA)
       T3=T1/PRT(I+1,JA)
       SIG2(3)=T2+T3
       SIG3(3)=SMU(I+1,JA)-T2+T1-T3
       SIG4(3)=T2*(BLE(I+1,JA)-1.)+T3*(BLET(I+1,JA)-1.)
       SIG2Y=(SIG2(3)-SIG2(1))*.02DY
       SIG3Y=(SIG3(3)-SIG3(1))*.02DY
       SIG4Y=(SIG4(3)-SIG4(1))*.02DY
       UYMN=(U(I+1,J0)-U(I-1,J0))*.02DY
       UYYMN=(U(I+1,J0)-2.*U(I,J0)+U(I-1,J0))*.0DYSQ
       HYMN=(H(I+1,J0)-H(I-1,J0))*.02DY
       HYYMN=(H(I+1,J0)-2.*H(I,J0)+H(I-1,J0))*.0DYSQ
       TERM=BF*BGP(I)*SIG2(2)*.0DYSQ
       TM1=BGPP(I)*SIG2(2)/BGP(I)+BGP(I)*SIG2Y
       TM2=RHOV(I)*BGP(I)
       TM3=RHO(I,JA)*U(I,JA)/DS
       TERMU=BF*BGP(I)*SIG3(2)*.0DYSQ*U(I,J0)

       TMU1=BGPP(I)*SIG3(2)/BGP(I)+BGP(I)*SIG3Y
C
C     COEFF. OF H(M+1,N-1)
C
       A(I-1,1)=.04DY*(BE*U(I,J0)-TM2+BF*TM1)-0.5*TERM
C
C     COEFF. OF H(M+1,N)
C
       A(I-1,2)=TM3+TERM
C
C     COEFF. OF H(M+1,N+1)
C
       A(I-1,3)=-A(I-1,1)-TERM
C
C     RIGHT-HAND SIDE (INCLUDING U(M+1,N) TERMS OBTAINED FROM MOMENTUM
C      EQUATION)
C
C     COEFF. OF U(M+1,N-1)
C
       COEFF1=.04DY*BF*TMU1*U(I,J0)+.02DY*BF*BGP(I)*SIG3(2)*UYMN-0.5*TERMU
C
C     COEFF. OF U(M+1,N)
C
       COEFF2=-0.5*(BE*HYMN+BF*TMU1*UYMN)-0.5*BF*BGP(I)*SIG3(2)*UYYMN+
      1        TERMU
C
C     COEFF. OF U(M+1,N+1)
C
       COEFF3=-COEFF1-TERMU
```

```
C
C     EVALUATE SUMMATION OVER SPECIES
C
      SUMSP=0.
      DO 150 ISP=1,NSP
C
C     STORE TEMPORARY AVERAGES.
C
      SHIM1A=0.5*(SHI(I-1,JO,ISP)+SHI(I-1,JN,ISP))
      SHIA  =0.5*(SHI(I  ,JO,ISP)+SHI(I  ,JN,ISP))
      SHIP1A=0.5*(SHI(I+1,JO,ISP)+SHI(I+1,JN,ISP))
      SCIM1A=0.5*(SCI(I-1,JO,ISP)+SCI(I-1,JN,ISP))
      SCIA  =0.5*(SCI(I  ,JO,ISP)+SCI(I  ,JN,ISP))
      SCIP1A=0.5*(SCI(I+1,JO,ISP)+SCI(I+1,JN,ISP))
      SHIY=O2DY*(SHIP1A-SHIM1A)
      SCIY=O2DY*(SCIP1A-SCIM1A)
      SCIYY=ODYSQ*(SCIP1A-2.*SCIA+SCIM1A)
  150 SUMSP = SUMSP + SHIA*SCIY*(BGP(I)*SIG4Y + BGPP(I)*SIG4(2)/BGP(I)
     1          + BGP(I)*SIG4(2)*(SHIY*SCIY + SHIA*SCIYY)
C
C     ASSEMBLE ALL TERMS.
C
      B(I-1)=TM3*H(I,JO)-0.5*(TM2*HYMN-BF*(TM1*HYMN+BGP(I)*SIG2(2)*
     1       HYYMN))+BF*SUMSP-COEFF1*U(I-1,JN)-COEFF2*U(I,JN)-
     2       COEFF3*U(I+1,JN)
C
C     PUSH-DOWN STORAGE
C
      SIG2(1)=SIG2(2)
      SIG2(2)=SIG2(3)
      SIG3(1)=SIG3(2)
      SIG3(2)=SIG3(3)
      SIG4(1)=SIG4(2)
      SIG4(2)=SIG4(3)
      I=I+1
      IF (I .LE. NY1)  GO TO 100
C
C     MODIFY FIRST AND LAST ENERGY EQUATIONS BY BOUNDARY CONDITIONS.
C                     AT WALL    H = HW
C                     AT EDGE    H = HE
C
      IF(INCRMT.GT.0)GO TO 250
      B(1)=B(1)-A(1,1)*HWALL
      A(1,1)=0.
  250 B(NY2) = B(NY2) - A(NY2,3)*HEDGE
      A(NY2,3)=0.
C
C     SOLVE ENERGY EQUATIONS FOR H(M+1,N), N=2,3,...,NY-1
C
      CALL TRIM (A,H(2,JN),B,NY2,NMAX)
C
C     APPLY BOUNDARY CONDITIONS FOR H(M+1,1) AND H(M+1,NY)
C
      H(1,JN)=HWALL
      H(NY,JN)=HEDGE
```

```
C
C     CALCULATE SH(M+1,N) FROM H(M+1,N), N=1,...,NY
C
      DO 300 I=1,NY
  300 SH(I,JN) = H(I,JN) - U(I,JN)**2/2.0
C
C     PRINT DEBUG FOR THIS ITERATION, IF REQUESTED.
C
      IF(KENDMP.GT.0)CALL DUMPIT
      TEST = ( H(NY1,JN) - H(NY,JN))/H(NY,JN)
      IF(ABS(TEST).LE.EPSLN2)RETURN
C
C     SOLUTION DOES NOT ASYMPTOTICALLY APPROACH EDGE CONDITIONS.
C     INCREASE THICKNESS OF BOUNDARY LAYER BY ADDING ONE POINT.
C
      INCRMT=INCRMT+1
      IF(INCRMT.GT.5)CALL DEBUG (6HENERGY)
      IF(NY.EQ.NMAX)CALL DEBUG (6HENERGY)
      CALL ADDPT (2)
      I=NY1-1
      GO TO 100
      END
```

```
      SUBROUTINE EQLBRM .                                                    A   1
C     ROUTINE TO CALCULATE EQUILIBRIUM COMPOSITION AND PROPERTIES            A   2
C                                                                            A   3
      DOUBLE PRECISION X,G                                                   A   4
      DATA IE /1HE/
      DIMENSION PROW(15)
      LOGICAL CONVG,HP,TC,ISING,LOGV,TP
C                                                                            A   9
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),       /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),        /POINTS/
     2                TTT(13)                                              /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BB(15),            /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,        /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),             /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),      /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                         /MISC/
      COMMON /DOUBLE/ G(20,21),X(20)                                         A  20
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,     /INDX/
     1              JSOL,JLIQ,IC,IQ2                                       /INDX/
                                                                            A  28
```

```
      CRITV = 5.0E-6
      ISING=.FALSE.                                                    A  30
      ENNL=ALOG(ENN)                                                   A  31
      LOGV=.FALSE.                                                     A  32
      PPLN=ALOG(PP)                                                    A  33
      TLN=ALOG(TT)                                                     A  34
      CONVG=.FALSE.                                                    A  35
      ITNUMB = 100
      IF (IC) GO TO 180                                                A  37
40    TM=ALOG(PP/ENN)                                                  A  48
      IF (.NOT.TP) CALL CPHS                                           A  50
      IF (TP .AND. (CONVG .OR. ITNUMB .EQ. 100))  CALL CPHS
      IF (IC) GO TO 630                                                A  52
      IF (.NOT.CONVG.OR.JSOL.EQ.0) GO TO 50                            A  53
      ENSOL=EN(JSOL,NPT)                                               A  54
      EN(JSOL,NPT)=EN(JSOL,NPT)+EN(JLIQ,NPT)                           A  55
      IUSE(JLIQ)=-IUSE(JLIQ)                                           A  56
      IQ1=IQ1-1                                                        A  57
      DLVTP(NPT)=0.                                                    A  58


      CPR(NPT)=0.                                                      A  59
      GAMMAS(NPT)=0.                                                   A  60
      LOGV=.TRUE.                                                      A  61
50    CALL MATRIX                                                      A  62
      NUMB = IQ1 - ITNUMB
      IF (.NOT.CONVG) GO TO 90                                         A  64
      IF (LOGV.AND.JSOL.EQ.0) GO TO 70                                 A  65
      DO 60 I=1,L                                                      A  66
  60  PROW(I) = G(IQ1,I)
      IF (.NOT.LOGV) GO TO 90                                          A  69
C                                                                      A  70
C     LOGV = .TRUE.-- SET UP MATRIX TO SOLVE FOR DLVPT                 A  71
C                                                                      A  72
70    G(IQ1,IQ2)=ENN                                                   A  73
      IQ=IQ1-1                                                         A  74
      DO 80 I=1,IQ                                                     A  75
  80  G(I,IQ2) = G(I,IQ1)
  90  IF (CONVG)  IMAT = IMAT - 1
      ITST=IMAT                                                        A  83
      CALL MGAUSD                                                      A  84
      IF (ITST.NE.IMAT) GO TO 150                                      A  85
      IF (.NOT. CONVG)  GO TO 280
      IF (LOGV) GO TO 630                                              A  90
      SUM=0.                                                           A  91
      DO 130 J=1,L                                                     A  92
 130  SUM = SUM + PROW(J)*X(J)
      DLVTP(NPT)=1.+G(IQ2,IQ1)/ENN-SUM/ENN-X(IQ1)                      A  95
      CPR(NPT)=G(IQ2,IQ2)                                              A  96
      DO 140 J=1,IQ1                                                   A  97
```

```
 140  CPR(NPT) = CPR(NPT) - G(IQ2,J)*X(J)                                A 100
      LOGV=.TRUE.                                                        A 101
      GO TO 50                                                           A 102
C                                                                        A 103
C     SINGULAR MATRIX                                                    A 104
C                                                                        A 105
 150  IF (.NOT.CONVG) GO TO 160
      WRITE (6,750)
      IC=.TRUE.                                                          A 107
      GO TO 630                                                          A 108
 160  IF (.NOT.HP.OR.NPT.NE.1.OR.NC.EQ.0.OR.TT.GT.100.) GO TO 170        A 109
      WRITE (6,760)                                                      A 110
      GO TO 690                                                          A 111
 170  WRITE (6,770)
      IF (IC) GO TO 690                                                  A 113
      IF (ISING) GO TO 240                                               A 114
      NTZERO=0                                                           A 115
 180  DO 220 JJ=1,NS                                                     A 116
      IF (IUSE(JJ)) 220,200,190                                          A 117
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
 190  IF (EN(JJ,NPT).EQ.0.) GO TO 690                                    A 118
      GO TO 210                                                          A 119
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
 200  IF (EN(JJ,NPT).NE.0.) GO TO 210                                    A 120
      EN(JJ,NPT) = 1.0E-6
      ENLN(JJ) = -13.815511
      GO TO 220                                                          A 123
 210  NTZERO=NTZERO+1                                                    A 124

 220  CONTINUE                                                           A 125
      IF (.NOT.IC) GO TO 230                                             A 126
      IC=.FALSE.                                                         A 127
      GO TO 40                                                           A 128
 230  ISING=.TRUE.                                                       A 129
      WRITE (6,780)
      GO TO 40                                                           A 131
 240  IF (NTZERO.NE.(L-1)) GO TO 690                                     A 132
      IF (EQRAT.GT.1.00001.OR.EQRAT.LT.0.99999) GO TO 690                A 133
      ENN=0.                                                             A 134
      NEN=0                                                              A 135
      DO 260 I=1,L                                                       A 136
      JEN=0                                                              A 137
      DO 250 J=1,NS                                                      A 138
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (EN(J,NPT).EQ.0.) GO TO 250                                     A 139
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (A(I,J).EQ.0.) GO TO 250                                        A 140
      IF (JEN.NE.0) GO TO 260                                            A 141
      JEN=J                                                              A 142
```

```
250   CONTINUE                                                          A 143
      NEN=NEN+1                                                         A 144
      EN(JEN,NPT)=BO(I)/A(I,JEN)                                        A 145
260   CONTINUE                                                          A 146
      IF (NEN.LT.NTZERO) GO TO 690                                      A 147
      CONVG=.TRUE.                                                      A 148
      IC=.TRUE.                                                         A 149
      HSUM(NPT)=0.                                                      A 150
      DO 270 J=1,NS                                                     A 151
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (EN(J,NPT).EQ.0.) GO TO 270                                    A 152
      ENN=EN(J,NPT)+ENN                                                 A 153
      ENLN(J) = ALOG(EN(J,NPT))
      HSUM(NPT)=HSUM(NPT)+EN(J,NPT)*HO(J)                               A 156
270   CONTINUE                                                          A 157
      TM=ALOG(PP/ENN)                                                   A 158
      GO TO 40                                                          A 159
280   ITNUMB=ITNUMB-1                                                   A 160
      IF (ITNUMB .LT. 30)  CRITV = CRITV + 2.50E-7
C                                                                       A 161
C     OBTAIN CORRECTIONS TO THE ESTIMATES                               A 162
C                                                                       A 163
      KK=L+1                                                            A 164
      DLNT=X(IQ2)                                                       A 165
      IF (TP) DLNT=0.                                                   A 166
      DO 320 J=1,NS                                                     A 167
      IF (IUSE(J)) 320,290,310                                          A 168
290   DELN(J)=HO(J)*DLNT-HO(J)*S(J)-ENLN(J)-TM+X(IQ1)                   A 169
      DO 300 K=1,L                                                      A 170
 300  DELN(J) = DELN(J) + A(K,J)*X(K)
      GO TO 320                                                         A 173
310   DELN(J)=X(KK)                                                     A 174
      KK=KK+1                                                           A 175
320   CONTINUE                                                          A 176
      AMBDA=1.                                                          A 177
      AMBDA1=1.                                                         A 178
      SUM=X(IQ1)                                                        A 179

      IF (SUM.LT.0.) SUM=-SUM                                           A 180
      IF (DLNT.GT.SUM) SUM=DLNT                                         A 181
      IF (-DLNT.GT.SUM) SUM=-DLNT                                       A 182
      DO 330 J=1,NS                                                     A 183
      IF (IUSE(J).NE.0) GO TO 330                                       A 184
      IF ((EN(J,NPT).GT.0.).AND.DELN(J).GT.SUM) SUM=DELN(J)             A 185
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF ((EN(J,NPT).NE.0.).OR.DELN(J).LE.0.) GO TO 330                 A 186
      SUM1=(-9.212-ENLN(J)+ENNL)/(DELN(J)-X(IQ1))                       A 187
      IF (SUM1.LT.0.) SUM1=-SUM1                                        A 188
      IF (SUM1.LT.AMBDA1) AMBDA1=SUM1                                   A 189
330   CONTINUE                                                          A 190
      IF (SUM.GT.2.) AMBDA=2./SUM                                       A 191
      IF (AMBDA1.LT.AMBDA) AMBDA=AMBDA1                                 A 192
```

```
C
C       APPLY CORRECTIONS TO ESTIMATES                                  A 204
C                                                                       A 205
        SUM = 0.0                                                       A 206
        DO 380 J=1,NS
        IF (IUSE(J)) 380,360,370                                        A 208
360     ENLN(J)=ENLN(J)+AMBDA*DELN(J)                                   A 209
        EN(J,NPT)=0.                                                    A 210
        IF (ENLN(J) + 18.50 .LE. ENNL)  GO TO 380                       A 211
        EN(J,NPT)=EXP(ENLN(J))
        SUM=SUM+EN(J,NPT)                                               A 213
        GO TO 380                                                       A 214
370     EN(J,NPT)=EN(J,NPT)+AMBDA*DELN(J)                               A 215
380     CONTINUE                                                        A 216
        SUMN=SUM                                                        A 217
        IF (TP) GO TO 390                                               A 218
        TLN=TLN+AMBDA*DLNT                                              A 219
        TT=EXP(TLN)                                                     A 220
390     ENNL=ENNL+AMBDA*X(IQI)                                          A 221
        ENN=EXP(ENNL)                                                   A 222
        IF (LLMT(L).NE.IE) GO TO 420                                    A 223
C                                                                       A 224
C       CHECK ON REMOVING IONS                                          A 225
C                                                                       A 226
        DO 400 J=1,NS                                                   A 227
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.   A 228
        IF (A(L,J).EQ.0.) GO TO 400
        IF (EN(J,NPT).GT.0.) GO TO 420                                  A 229
400     CONTINUE                                                        A 230
        DO 410 J=1,NS                                                   A 231
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.   A 232
        IF (A(L,J).NE.0.) IUSE(J)=-10000
410     CONTINUE                                                        A 233
        L=L-1                                                           A 234
        IQI=IQI-1                                                       A 235
        GO TO 40                                                        A 236
C                                                                       A 237
C       TEST FOR CONVERGENCE                                            A 238
C                                                                       A 239
420     IF (ITNUMB.EQ.0) GO TO 440                                      A 240
        IF(NUMB.EQ.1) GO TO 40                                          A 241
        IF (AMBDA.LT.1.) GO TO 40
        SUM=(ENN-SUMN)/ENN                                              A 242
        IF (SUM.LT.0.) SUM=-SUM                                         A 243
        IF (SUM .GT. CRITV)  GO TO 40                                   A 244
        DO 430 J=1,NS
        IF (IUSE(J).LT.0) GO TO 430                                     A 246
        AA=DELN(J)/SUMN                                                 A 247
        IF (AA.LT.0.) AA=-AA                                            A 248
        IF (IUSE(J).EQ.0) AA=AA*EN(J,NPT)                               A 249
        IF (AA .GT. CRITV)  GO TO 40                                    A 250
```

```
430   CONTINUE                                                          A 252
440   CONVG=.TRUE.                                                      A 253
      IF (ITNUMB.NE.0) GO TO 450                                        A 255
      WRITE (6,840) NPT
      IF (.NOT.HP.OR.NPT.NE.1.OR.NC.EQ.0.OR.TT.GT.100.) GO TO 690       A 257
      WRITE (6,760)                                                     A 258
      TT = T
      RETURN                                                            A 260
C                                                                       A 261
C     CONVERGENCE TESTS ARE SATISFIED, TEST CONDENSED SPECIES.          A 262
C                                                                       A 263
450   IF (NC.EQ.0) GO TO 620                                            A 264
      SIZEF=0.                                                          A 265
      INC=0                                                             A 266
      DO 570 J=1,NS                                                     A 267
      IF (IUSE(J).EQ.0.OR.IUSE(J).EQ.-10000) GO TO 570                  A 268
      INC=INC+1                                                         A 269
      IF (EN(J,NPT)) 460,480,560                                        A 272
460   IF (J.NE.JSOL.AND.J.NE.JLIQ) GO TO 470                            A 273
      JSOL=0                                                            A 274
      JLIQ=0                                                            A 275
470   IQ1=IQ1-1                                                         A 276
      EN(J,NPT)=0.                                                      A 277
      GO TO 600                                                         A 278
480   KG=1                                                              A 279
      IF (IUSE(J).EQ.-IUSE(J+1)) GO TO 490                              A 280
      IF (J.EQ.1.OR.IUSE(J).NE.-IUSE(J-1)) GO TO 540                    A 281
      KG=-1                                                             A 282
490   JKG=J+KG                                                          A 283
      IF (EN(JKG,NPT).LT.0.) GO TO 570                                  A 284
      TMELT=TEMP(INC,1)                                                 A 285
      IMP=INC+KG                                                        A 286
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TMELT.EQ.TEMP(IMP,2)) GO TO 510                               A 287
      TMELT=TEMP(INC,2)                                                 A 288
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TMELT.EQ.TEMP(IMP,1)) GO TO 500                               A 289
      WRITE (6,860)                                                     A 290
C                                                                       A 291
C     JTH SPECIES A SOLID (EN=0), (J+KG)TH SPECIES A LIQUID (EN IS +)   A 292
C                                                                       A 293
500   IF (TT.GT.TMELT) GO TO 560                                        A 294
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TP.AND.TT.EQ.TMELT) GO TO 560                                 A 295
      IF (TP) GO TO 530                                                 A 296
      IF (TT.LE.TMELT-150.) GO TO 530                                   A 297
      JSOL=J                                                            A 298
      JLIQ=JKG                                                          A 299
      GO TO 520                                                         A 300
```

```
C                                                                       A 301
C     JTH SPECIES A LIQUID(EN=0), (J+KG)TH SPECIES A SOLID (EN IS +)    A 302
C                                                                       A 303
510   IF (TT.LT.TMELT) GO TO 560                                        A 304
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TP.AND.TT.EQ.TMELT) GO TO 560                                 A 305
      IF (TP) GO TO 530                                                 A 306
      IF (TT.GE.TMELT+150.) GO TO 530                                   A 307
      JSOL=JKG                                                          A 308
      JLIQ=J                                                            A 309
520   TLN=ALOG(TMELT)                                                   A 310
      TT=TMELT                                                          A 311
      EN(JKG,NPT)=.5*EN(JKG,NPT)                                        A 312
      EN(J,NPT)=EN(JKG,NPT)                                             A 313
      GO TO 590                                                         A 314
C                                                                       A 315
C     WRONG PHASE INCLUDED FOR T INTERVAL, SWITCH EN                    A 316
C                                                                       A 317
530   EN(J,NPT)=EN(JKG,NPT)                                             A 318
      IUSE(J)=-IUSE(J)                                                  A 319
      IUSE(JKG)=-IUSE(JKG)                                              A 320
      EN(JKG,NPT)=0.                                                    A 321
      GO TO 610                                                         A 322
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
540   IF (TT.LT.TEMP(INC,1).AND.TEMP(INC,1).NE.TLOW) GO TO 560          A 323
      IF (TT.GT.TEMP(INC,2)) GO TO 560                                  A 324
      SUM=0.                                                            A 327
      DO 550 I=1,L                                                      A 328
 550  SUM = SUM + A(I,J)*X(I)
      DELF=HO(J)-S(J)-SUM                                               A 331
      IF (DELF.GE.SIZEF.OR.DELF.GE.0.) GO TO 560                        A 333
      SIZEF=DELF                                                        A 334
      JDELF=J                                                           A 335
560   IF (INC.EQ.NC) GO TO 580                                          A 336
570   CONTINUE                                                          A 337
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
580   IF (SIZEF.EQ.0.) GO TO 620                                        A 338
      J=JDELF                                                           A 339
590   IQI=IQI+1                                                         A 340
600   IUSE(J)=-IUSE(J)                                                  A 341
610   CONVG=.FALSE.                                                     A 342
620   TN=NUMB                                                           A 343
      ITNUMB = 100
      GO TO 40                                                          A 346
C                                                                       A 347
C     CALCULATE EQUILIBRIUM PROPERTIES                                  A 348
C                                                                       A 349
630   SSUM(NPT)=0.                                                      A 350
      IF (JLIQ.NE.0) EN(JSOL,NPT)=ENSOL                                 A 351
      DO 640 J=1,NS                                                     A 352
      SS=S(J)                                                           A 354
      IF (IUSE(J).EQ.0) SS=SS-ENLN(J)-TM                                A 355
 640  SSUM(NPT) = SSUM(NPT) + SS*EN(J,NPT)
      IF (.NOT.IC) GO TO 650                                            A 358
      DLVPT(NPT)=-1.                                                    A 359
      DLVTP(NPT)=1.                                                     A 360
      CPR(NPT)=CPSUM                                                    A 361
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```
      GO TO 670                                                          A 362
650   SUM=0.                                                             A 363
      DO 660 J=1,L                                                       A 364
660   SUM = SUM + PROW(J)*X(J)
      DLVPT(NPT)=-2.*SUM/ENN*X(IQ1)                                      A 367
      IF (JLIQ.EQ.0) GO TO 670                                           A 368
      IUSE(JLIQ)=-IUSE(JLIQ)                                             A 369
      HSUM(NPT)=HSUM(NPT)+EN(JLIQ,NPT)*(HO(JLIQ)-HO(JSOL))               A 370
      IQ1=IQ1+1                                                          A 371
      GAMMAS(NPT)=-1./DLVPT(NPT)                                         A 372
      GO TO 680                                                          A 373
670   GAMMAS(NPT)=-1./(DLVPT(NPT)+(DLVTP(NPT)**2)*ENN/CPR(NPT))          A 374
680   TTT(NPT)=TT                                                        A 375
      PPP(NPT)=PP                                                        A 376
      HSUM(NPT)=HSUM(NPT)*TT                                             A 378
      WM(NPT)=1./ENN                                                     A 379
      RETURN
C                                                                        A 384
C     ERROR, SET TT=0                                                    A 385
C                                                                        A 386
690   TT=0.                                                              A 387
      NPT=NPT-1                                                          A 388
      RETURN
750   FORMAT (28HODERIVATIVE MATRIX SINGULAR )                           A 395
760   FORMAT (96HOLOW TEMPERATURE IMPLIES CONDENSED SPECIES SHOULD HAVE  A 396
     1 BEEN INCLUDED ON AN INSERT CARD, RESTART)                         A 397
770   FORMAT (16HOSINGULAR MATRIX)                                       A 398
780   FORMAT (8HORESTART)                                                A 399
840   FORMAT (//2X,65H100 ITERATIONS DID NOT SATISFY CONVERGENCE REQUIRE
     1MENTS FOR POINT,I3)
860   FORMAT (50HO3 PHASES OF A CONDENSED SPECIES ARE OUT OF ORDER )     A 411
      END                                                                A 417-
```

```
      SUBROUTINE EXECUT
C        CHANGES TO SUBROUTINE EXECUT
CEXECUT   EXECUTION CONTROL ROUTINE
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
     1               YYZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,    /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1             EPSLN3,CONVRG,02DY,04DY,0DYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,J0,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/OPTION/IDEAL,LAMBR,INCOMP
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
      COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,IST1,NVAR,IDRUM,LAST
      COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
      COMMON /AL/ INSTAT,EPSLIN
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      MADFLG=0
C


C     B E G I N   C A L C U L A T I O N   O F   N E W   S T A T I O N .
C
  200 ISTATN = ISTATN + 1
      IF (ISTATN .LT. INSTAT)  GO TO 100
      EPSLN1 = EPSLIN
      EPSLN2 = EPSLIN
      EPSLN3 = EPSLIN
  100 ITER = 0
C
C     CHECK IF DEBUG IS ON.
C
      KMODMP=0
      KENDMP=0
      IF (IDEBUG(1) .LE. 0)  GO TO 240
      IF (ISTATN .LT. IDEBUG(2) .OR. ISTATN .GT. IDEBUG(3))  GO TO 240
      IF(IDEBUG(1).EQ.1)KMODMP=1
      IF(IDEBUG(1).EQ.2)KENDMP=1
C
C     DETERMINE NEW STEPSIZE AND CONTOUR PROPERTIES AT FORWARD STATION.
C
  240 CALL STEP
```

```
C
C     CALCULATE ZETAN AND ZETA FOR ITER = 0.
C
      ZETAN=ZETAO+DS*ZETAP
      ZETA=0.5*(ZETAO+ZETAN)
C
C     EVALUATE WALL AND EDGE CONDITIONS AT FORWARD STATION.
C
      CALL BNDCND
C   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SMDWN.NE.0.)MADFLG=1
C
C     B E G I N   I T E R A T I O N   L O O P .
C     UPDATE SHW AND HW BASED ON LATEST O/F AT WALL.
C
  300 IF (IDEAL .EQ. 0 .AND. ITER .GT. 0)  CALL HOODE(3)
C
C     UPDATE AVERAGE PROPERTIES AND CALCULATE AUXILIARY QUANTITIES FOR
C      DIFFERENCE EQUATIONS.
C
      CALL ITERAT
C
C     SOLVE MOMENTUM EQUATION FOR U.
C
      CALL MOMNTM
C
C     UPDATE AVERAGE U FOR SUBSEQUENT EQUATIONS.
C
      IF(INCOMP.GT.0)GO TO 370
      DO 320 I=1,NY
  320 U(I,JA) = 0.50*(U(I,JO) + U(I,JN))
C
C     SOLVE ENERGY EQUATION FOR H AND SH.
C
      CALL ENERGY
      IF(IDEAL.GT.0)GO TO 340


      IF(MADFLG.EQ.0)GO TO 340
C
C     SOLVE ELEMENT EQUATIONS FOR ALPHAI.
C
      CALL ELEMTS
C
C     CALCULATE LAMINAR TRANSPORT AND THERMODYNAMIC PROPERTIES AT EACH
C      MESH POINT.
C
  340 IF (IDEAL .GT. 0)  GO TO 345
      CALL HOODE (4)
      GO TO 370
  345 DO 350 I = 1,NY
      SHB=SH(I,JN)*UREF*UREF
      CALL IGODE (T(I,JN),SHB,PEDGEB,0,RHOB,SMUB,PR(I,JN))
      RHO(I,JN)=RHOB/RHOREF
  350 SMU(I,JN) = SMUB/SMUREF
```

```
C
C     UPDATE ZETAN, ZETA, AND ZETAP.
C
  370  CALL ZFUNC
C
C     CALCULATE TURBULENT TRANSPORT PROPERTIES.
C
       IF(LAMNR.GT.0)GO TO 380
       CALL EDDY
C
C     INTEGRATE CONTINUITY EQUATION TO OBTAIN RHOV.
C
  380  CALL CONTNU
C
C     IF ITERATING ON SOLUTION, CHECK FOR CONVERGENCE OR MAXIMUM
C      ITERATIONS.
C
       IF (MAXIT .LE. 0)  GO TO 500
       IF (ITER .NE. 0)  GO TO 420
       DUDY0 = 02DY*(4.0*U(2,JN) - 3.0*U(1,JN) - U(3,JN))
       ITER=ITER+1
       GO TO 300
  420  DUDY=02DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
       IF(ABS((DUDY-DUDY0)/DUDY).LE.CONVRG)GO TO 500
       IF (ITER .GE. MAXIT)  GO TO 500
       ITER = ITER  + 1
       DUDY0=DUDY
       GO TO 300
C
C     E N D   O F   I T E R A T I O N   L O O P .
C
  500  X = X + DX
       S=S+DS
C
C     CALCULATE GROSS BOUNDARY LAYER PARAMETERS.
C
       CALL PARAMS
C
C     CHECK FOR END OF CASE.
C

       IF (X + 1.0E-6 .GE. XMAX)  GO TO 900
C
C     PRINT AT THIS STATION IF REQUIRED.
C
       CALL PRINT
C
C     CALCULATE ZETA AND ZETAP FOR NEXT STATION.
C
       ZETAP=(ZETAN-ZSTAR(I))/(DSZ(I)+DS)
       ZSTAR(I)=ZETA0
       ZETA0=ZETAN
       DSZ(I)=DS
```

```
C
C     MOVE FORWARD VALUES TO BACK VALUES.
C
      DO 600 I=1,NY
      U(I,JO)=U(I,JN)
      H(I,JO)=H(I,JN)
      SH(I,JO)=SH(I,JN)
      CUU(I,JO) = CUU(I,JN)
      CUV(I,JO) = CUV(I,JN)
      CVV(I,JO) = CVV(I,JN)
      CWW(I,JO) = CWW(I,JN)
      DO 580 IEL=1,NEL
  580 ALPHA(I,JO,IEL) = ALPHA(I,JN,IEL)
      RHO(I,JO)=RHO(I,JN)
      SMU(I,JO)=SMU(I,JN)
      PR(I,JO)=PR(I,JN)
      BLE(I,JO)=BLE(I,JN)
      DO 590 ISP=1,NSP
      SHI(I,JO,ISP)=SHI(I,JN,ISP)
  590 SCI(I,JO,ISP) = SCI(I,JN,ISP)
      T(I,JO)=T(I,JN)
      EPS(I,JO)=EPS(I,JN)
      PRT(I,JO)=PRT(I,JN)
  600 BLET(I,JO) = BLET(I,JN)
      GO TO 200
C
C     E N D   O F   S T A T I O N   C A L C U L A T I O N .
C     END OF CASE.  PRINT FINAL STATION.
C
  900 ISPRNT = 0
      ILPRNT=0
      LAST=1
      CALL PRINT
      CALL SUMTAB
      IF(IRSWR.GT.0)END FILE ITAPE
      RETURN
      END
```

```
      SUBROUTINE GFUNC
CGFUNC     GENERATE ARRAYS  OF YTIL, BGP, AND BGPP VS. NORMALIZED Y=BG
C          AT EACH MESH POINT IN THE BOUNDARY LAYER.
C
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/NEW7  /GPO,PAMB,INTDK,ZETAPI
C
      DOUBLE PRECISION DARG,DPAREN
      DATA EM1/1.7182818/
C
C     IF NO STRETCHING FUNCTION IS SPECIFIED, SET Y = YTIL.
C
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SN3.NE.0.)GO TO 150
      YTEDGE=DELTAI/(BLREF*ZETAO)
      YEDGE=YTEDGE
      TI=NYI
      DY=YEDGE/TI
      YTZETA=1.
      YZETA=YTZETA
      DO 100 I=1,NMAX
      Y(I)=FLOAT(I-1)*DY
      YTIL(I)=Y(I)
      BGP(I)=1.
  100 BGPP(I) = 0.0
      GO TO 250
C
C     APPLY NEWTON-RAPHSON ITERATION TO FIND ALPHA (SN1) AND BETA (SN2)
C      FOR STRETCHING FUNCTION.
C     FIND ALPHA AND BETA WHERE DY/DYT = INPUT VALUE.
C
  150 POWER = 1.0/SN3
      YTEDGE=DELTAI/(BLREF*ZETAO)
      I=0
      YTN=1.E-7
  160 DARG=EM1*YTN/YTEDGE+1.
      BRKT=DLOG(DARG)
      FXN=EM1/SN3*BRKT**(POWER-1.)/DARG-GPO
      FXPN=EM1/SN3*((POWER-1.)*BRKT**(POWER-2.)-BRKT**(POWER-1.))*
     1     EM1/(YTEDGE*DARG*DARG)
      YTN1=YTN-FXN/FXPN
      IF(ABS((YTN1-YTN)/YTN).LE..0001)GO TO 170
      YTN=YTN1
      I=I+1
      IF(I.GT.100)CALL DEBUG (6HGFUNC )
      GO TO 160
  170 SN1 = YTN1/YTEDGE
      SN2=(ALOG(EM1*SN1+1.))**POWER
```

```
C
C     DETERMINE YTEDGE, YEDGE, AND FIXED MESH SPACING DY.
C     ALSO DETERMINE YZETA.
C
      YEDGE=YTEDGE*((ALOG(EM1*(1.+SN1)+1.))**POWER-SN2)
      TI=NY1
      DY=YEDGE/TI
      YTZETA=1.
      YZETA=YTEDGE*((ALOG(EM1*(YTZETA/YTEDGE+SN1)+1.))**POWER-SN2)
C
C     GENERATE ARRAYS OF Y, YTIL, BGP, AND BGPP AT EACH MESH POINT.
C
      DO 200 I=1,NMAX
      Y(I) = FLOAT(I-1)*DY
      DARG=(Y(I)/YTEDGE+SN2)**SN3
      DPAREN=DEXP(DARG)-1.000
      YTIL(I)=YTEDGE*(DPAREN/EM1-SN1)
      ARG=EM1*(YTIL(I)/YTEDGE+SN1)+1.
      BRKT=ALOG(ARG)
      BGP(I)=EM1/SN3*BRKT**(POWER-1.)/ARG
  200 BGPP(I) = EM1/SN3*((POWER - 1.0)*BRKT**(POWER - 2.0) -
     1           BRKT**(POWER - 1.0))*EM1/(YTEDGE*ARG**2)
C
C     WRITE YTIL, Y, BGP, AND BGPP ARRAYS.
C
  250 YTIL(1) = 0.0
C   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SN3.EQ.0.)GO TO 300
      WRITE (6,9000)
 9000 FORMAT (1H1,31X,4HYTIL,16X,3HY=G,18X,2HGP,17X,3HGPP/)
      NYU=MIN0(NY1+31,NMAX)
      WRITE (6,9100) (YTIL(I),Y(I),BGP(I),BGPP(I),I=1,NYU)
 9100 FORMAT (20X,1P4E20.7)
C
C     SET COUNTERS.
C
  300 NY = NY1 + 1
      NY1=NY-1
      NY2=NY-2
      IYTILP=0
      IYTILF=0
      RETURN
      END
```

```
      SUBROUTINE HOODE (ICALL)
CHOODE    TFCBL - ODE INTERFACE SUBROUTINE FOR HYDROGEN-OXYGEN SYSTEM.
C
C     TFCBL COMMON BLOCKS
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /SS,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PRNO(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),TEM(250,3),AV(250)
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1


      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/NEW1  /ALEWIS,TLEWIS
      COMMON/NEW2 / RHOEB,SMUEB,REYL,SXO
      COMMON/NEW9  /IYEQ
      COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(8),AFWALL
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
C
C     ODE COMMON BLOCKS
C
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),      /POINTS/
     2                TTT(13)                                            /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHH(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
      COMMON /VISCXO/ VISCE(13),PR(13)                                   /VISCXO/
      COMMON/INODE /TIN(13),OFIN(13),HIN(13)
      COMMON/OUTODE/HOBUF(30,13)
      COMMON/OUTRHO/DEN(13)
C
      LOGICAL TP,HP,SP
      DIMENSION INDEX(13),FMWT(6)
C
```

```
C
C     SPECIES MOLECULAR WEIGHTS STORED IN FMWT IN SAME ORDER AS THERMO
C      DATA, NAMELY (1) H    (2) H2    (3) H2O    (4) O    (5) OH    (6) O2
C
       DATA (FMWT(I),I=1,6)/1.008,2.016,18.016,16.000,17.008,32.000/
       DATA BJ,SG/777.68006,32.174/
C
C     BRANCH TO APPROPRIATE LOGIC.
C
       GO TO (1000,2000,3000,4000),ICALL
C
C                          ***** ICALL = 1 *****
C
C
C     INITIALIZE ODE STORAGE AND CALCULATE CONVERSION CONSTANTS FOR
C      TFCBL - ODE INTERFACE.
C
 1000  CALL ODE
       NSP=NS
C
C     A CONSTANT ----OT CONVERTS A TFCBL QUANTITY TO AN ODE QUANTITY AND
C      INCLUDES NORMALIZATION FACTORS WHERE APPLICABLE. A CONSTANT ----TO
C      CONVERTS AN ODE QUANTITY TO A TFCBL QUANTITY.
C
       SMUTO=1./(SG*SMUREF)
       HOT=UREF*UREF/(1.8*BJ*SG)
       RHOOT=SG*RHOREF
       RETURN
C

 C                          ***** ICALL = 2 *****
 C
 C     DO AN ISENTROPIC EXPANSION, GIVEN PRESSURE AND INITIAL TEMPERATURE
 C      AT THE EDGE OF THE BOUNDARY LAYER, AND CALCULATE AN EDGE VELOCITY
 C      TABLE.
 C
 C     PERFORM INITIAL T-P CALCULATION TO ESTABLISH ENTROPY.
 C
 2000   P(1) = 4.72539576E-4*PEDGEB
        T = TEDGE/1.80
        OF=(1.-AFEDGE)/AFEDGE
 C
 C     USE INITIAL GUESSES FOR EN(I,1) AND ENLN(I) ALREADY CALCULATED
 C      BY ODE.
 C
        NPT=1
        TP=.TRUE.
        HP=.FALSE.
        SP=.FALSE.
        CALL TPCALC
 C
 C     SAVE ENTROPY AND CALCULATE VELOCITY.
 C
```

```
      SO=SSUM(1)
      SHEDGE = 1.9871650*HSUM(1)/HOT
      HEDGE=SHEDGE+UEDGE*UEDGE/2.
C
C     CALCULATE RHOEB AND SMUEB FOR INITIAL ZETAP CALCULATION.
C
      RHOEB=DEN(1)/SG
      SMUEB=VISCE(1)/SG
C
C     PROCEED THRU PRESSURE TABLE WITH S-P CALCULATIONS.
C
      IND=1
      SP=.TRUE.
      HP=.FALSE.
      TP=.FALSE.
      TIN(1) = TEDGE/1.80
2020  DO 2100 IBUF = 1,13
      P(IBUF) = 4.72539576E-4*PETAB(IND)
      INDEX(IBUF)=IND
      IND=IND+1
      IF(IND-LPETAB)2100,2100,2110
 2100 CONTINUE
 2110 NP=IBUF
      NPT = 1
      CALL SPCALC
C
C     OBTAIN ANSWERS FROM ODE  OUTPUT BUFFERS.
C
      DO 2200 IBUF=1,NP
      SHE = 1.9871650*HSUM(IBUF)/HOT
      IX=INDEX(IBUF)
2200  UETAB(IX) = SQRT(2.0*ABS(HEDGE - SHE))
      IF (IND .GT. LPETAB)  RETURN
C
C     STORE GUESSES FOR NEXT CALL TO SPCALC.
C
      TIN(1) = TTT(13)
      DO 2230 I=1,NS
2230  EN(I,1) = EN(I,13)
      GO TO 2020
C
C                          ***** ICALL = 3 *****
C
C     PERFORM A T-P CALCULATION AT THE WALL TO DETERMINE HWALL BOUNDARY
C     CONDITION.
C
3000  P(1) = 4.72539576E-4*PEDGEB
      T = TWALL/1.80
      IF((ISTATN.GT.0).OR.(ITER.GT.0))GO TO 3020
      OF=(1.-AFWALL)/AFWALL
      DO 3010 I=1,NS
      EN(I,1) = 0.10/NS
```

```
 3010  ENLN(I) = ALOG(EN(I,1))
       GO TO 3040
  3020 OF = ALPHA(1,JN,2)/ALPHA(1,JN,1)
       DO 3030 I=1,NS
       EN(I,1)=SCI(1,JN,I)/FMWT(I)
       IF(EN(I,1).LT.1.E-6)EN(I,1)=1.E-6

  3030 ENLN(I) = ALOG(EN(I,1))
  3040 NPT = 1
       TP=.TRUE.
       HP=.FALSE.
       SP=.FALSE.
       CALL TPCALC
       SHWALL = 1.987165D0*HSUM(1)/HOT
       HWALL=SHWALL
       RETURN
C
C                          ***** ICALL = 4 *****
C
C     PERFORM A SERIES OF H-P CALCULATIONS ACROSS THE BOUNDARY LAYER TO
C      OBTAIN THE THERMODYNAMIC AND LAMINAR TRANSPORT PROPERTIES AT EACH
C      MESH POINT.
C
 4000  HP = .TRUE.
       TP=.FALSE.
       SP=.FALSE.
       IND=1
 4020  DO 4200 IBUF = 1,13
       P(IBUF) = 4.72539576E-4*PEDGEB
       TIN(IBUF) = TEM(IND,JN)/1.80
       OFIN(IBUF)=ALPHA(IND,JN,2)/ALPHA(IND,JN,1)
       IF((ISTATN.EQ.IRSRD).AND.(ITER.EQ.0))GO TO 4040
       IF(ISTATN+ITER)4040,4040,4060
  4040 DO 4050 I=1,NS
 4050  EN(I,IBUF) = 0.10/NS
       TIN(IBUF)=3800.
       GO TO 4080
  4060 DO 4070 I=1,NS
       EN(I,IBUF)=SCI(IND,JN,I)/FMWT(I)
       IF(EN(I,IBUF).LT.1.E-6)EN(I,IBUF)=1.E-6

 4080  HIN(IBUF) = SH(IND,JN)*HOT
       INDEX(IBUF)=IND
       IF (IND .GE. NY)  GO TO 4210
 4200  IND = MIN0(IND+IYEQ,NY)
  4210 NP=IBUF
       NPT = 1
       CALL HPCALC
```

```
C
C     CONVERT, NORMALIZE, AND STORE ANSWERS FROM ODE BUFFERS INTO TFCBL
C      ARRAYS.
C
       DO 4300 IBUF=1,NP
       IX=INDEX(IBUF)
       RHO(IX,JN) = DEN(IBUF)/RHOOT
       SMU(IX,JN)=VISCE(IBUF)*SMUTO
       PRNO(IX,JN)=PR(IBUF)
       IF(PRI.GT.0.)PRNO(IX,JN)=PRI
       BLE(IX,JN)=1.
       TEM(IX,JN) = 1.80*TTT(IBUF)
       AV(IX)=SONVEL(IBUF)
       DO 4300 I = 1,NS
       SCI(IX,JN,I)=EN(I,IBUF)*FMWT(I)
4300   SHI(IX,JN,I) = HOBUF(I,IBUF)/HOT
       IF (IX .LT. NY)  GO TO 4020
C
C     INTERPOLATE FOR NECESSARY PROPERTIES AT MESH POINTS NOT SOLVED
C      USING ODE.
C
       CALL PHOENX (RHO(1,JN),Y,IYEQ,NY)
       CALL PHOENX (SMU(1,JN),Y,IYEQ,NY)
       CALL PHOENX (PRNO(1,JN),Y,IYEQ,NY)
       CALL PHOENX (TEM(1,JN),Y,IYEQ,NY)
C
C     INTERPOLATE FOR SCI AND SHI ONLY IF ALEWIS OR TLEWIS NOT UNITY.
C
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF((ALEWIS.EQ.1.).AND.(TLEWIS.EQ.1.))RETURN
       DO 4910 I=1,NS
       CALL PHOENX (SCI(1,JN,I),Y,IYEQ,NY)
4910   CALL PHOENX (SHI(1,JN,I),Y,IYEQ,NY)
       RETURN
       END
```

```
      SUBROUTINE HPCALC
CHPCALC   PERFORM A SERIES OF ENTHALPY-PRESSURE CALCULATIONS.
C                                                                      A   2
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),   /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),   /POINTS/
     2                TTT(13)                                         /POINTS/

      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IOSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,10),LLMT(15),BO(15),         /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,    /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),         /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),  /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                     /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC, /INDX/
     1              JSOL,JL1Q,IC,IQ2                                   /INDX/
      COMMON/INODE /TIN(13),OFIN(13),HIN(13)
      COMMON/OUTODE/HOBUF(30,13)
C                                                                      A  16
      DO 40 IP = 1,NP
C
C     SET ASSIGNED PRESSURE,ENTHALPY, O-F RATIO, AND TEMPERATURE GUESS.
C
      PP=P(IP)                                                         A  21
      TT=TIN(IP)
      OF=OFIN(IP)
      DO 150 I=1,NS
  150 ENLN(I) = ALOG(EN(I,IP))
      WP(1)=OF
      WP(2)=1.
      SUM=WP(1)+WP(2)
      DO 200 I=1,L
  200 BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/SUM
      HSUBO = HIN(IP)/1.9871650
      CALL EQLBRM                                                      A  22
      T = TT
      DO 300 I=1,NS
  300 HOBUF(I,NPT) = 1.9871650*HO(I)*TT
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TT.NE.0.) GO TO 20                                           A  24
      IF (NPT .EQ. 0)  RETURN
   20 K=0                                                              A  26
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30                               A  27
      K=NPT                                                            A  28
      IF (NPT.NE.13) GO TO 40                                          A  29
   30 CALL ANSWER
      IF (K .EQ. 0)  RETURN
      NPT=0                                                            A  36
   40 NPT=NPT+1                                                        A  37
C                                                                      A  38
C     ALL COMPOSITION GUESSES HAVE BEEN COMPUTED EXTERNALLY.
C
      RETURN
      END                                                              A  50-
```

```
      SUBROUTINE IGODE (T,SH,P,ITPHP,RHO,SMU,PR)
CIGODF    ROUTINE TO CALCULATE THERMODYNAMIC AND LAMINAR TRANSPORT
C         PROPERTIES FOR AN IDEAL GAS.
C
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
C
      BR = 49721.0110/FMOLWT
      BCP=GAMMA*BR/(GAMMA-1.)
      IF (ITPHP .LE. 0)  GO TO 20
C
C     T IS GIVEN.  CALCULATE SH.
C
      SH = BCP*T
      GO TO 30
C
C     SH IS GIVEN.  CALCULATE T.
C
   20 T=SH/BCP
   30 RHO=P/(BR*T)
      SMU=2.27E-8*SQRT(T)/(1.+198.6/T)
      PR=PRI
      RETURN
      END
```

```
      SUBROUTINE ITERAT
C         CHANGES TO SUBROUTINE ITERAT
CITERAT   PREPARE FOR AN ITERATION TO SOLVE THE DIFFERENCE EQUATIONS.
C         OBTAIN AVERAGE PROPERTIES AND RECALCULATE ITERATED AUXILIARY
C         QUANTITIES WHICH GO INTO THE DIFFERENCE EQUATIONS.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                        /YTABLE/
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      DO 100 I=1,NY
```

```
C
C     COMPUTE AVERAGE OF BACK VALUE AND LATEST ITERATED VALUE.
C
      U(I,JA)=0.5*(U(I,JO)+U(I,JN))
      H(I,JA)=0.5*(H(I,JO)+H(I,JN))
      CUU(I,JA) = 0.50*(CUU(I,JO) + CUU(I,JN))
      CUV(I,JA) = 0.50*(CUV(I,JO) + CUV(I,JN))
      CVV(I,JA) = 0.50*(CVV(I,JO) + CVV(I,JN))
      CWW(I,JA) = 0.50*(CWW(I,JO) + CWW(I,JN))
      DO 20 IEL=1,NEL
   20 ALPHA(I,JA,IEL) = 0.50*(ALPHA(I,JO,IEL) + ALPHA(I,JN,IEL))
      SH(I,JA)=0.5*(SH(I,JO)+SH(I,JN))
      RHO(I,JA)=0.5*(RHO(I,JO)+RHO(I,JN))
      SMU(I,JA)=0.5*(SMU(I,JO)+SMU(I,JN))
      PR(I,JA)=0.5*(PR(I,JO)+PR(I,JN))
      BLE(I,JA)=0.5*(BLE(I,JO)+BLE(I,JN))
      T(I,JA)=0.5*(T(I,JO)+T(I,JN))
      EPS(I,JA)=0.5*(EPS(I,JO)+EPS(I,JN))
      PRT(I,JA)=0.5*(PRT(I,JO)+PRT(I,JN))
      BLET(I,JA)=0.5*(BLET(I,JO)+BLET(I,JN))
C
C     CALCULATE AND SAVE E AND F AT EACH ZONE FOR THIS ITERATION.
C
      E(I)=RHO(I,JA)*BGP(I)*ZETAP*YTIL(I)/ZETA
  100 F(I) = BGP(I)/(ZETA**2*REYINF)
C
C     CALCULATE SIGMAS AT WALL AND FIRST INTERIOR POINT TO INITIALIZE
C     PUSH-DOWN STORAGE FEATURE.
C
      DO 500 K=1,2
      TM1=EPS(K,JA)
      TM2=SMU(K,JA)/PR(K,JA)
      TM3=TM1/PRT(K,JA)
      SIG1(K)=SMU(K,JA)+TM1
      SIG2(K)=TM2+TM3
      SIG3(K)=SMU(K,JA)-TM2+TM1-TM3
      SIG4(K)=TM2*(BLE(K,JA)-1.)+TM3*(BLET(K,JA)-1.)
  500 SIG5(K) = TM2*BLE(K,JA) + TM3*BLET(K,JA)
      RETURN
      END
```

```
      SUBROUTINE LCURV (X,XTAB,YTAB,NP,IX,Y)
CLCURV     LINEAR INTERPOLATION ROUTINE WHICH HANDLES DISCONTINUITIES.
C          (MODIFIED VERSION OF SUBROUTINE CURV.)
C
      DIMENSION XTAB(NP),YTAB(NP)
C     DEFINE LINEAR INTERPOLATION FUNCTION Q
      Q(XKM,YKM,XK,YK)=YKM+(X-XKM)*(YK-YKM)/(XK-XKM)
      IF (NP .GT. 1)  GO TO 110
C     ONE ENTRY IN TABLE
      Y = YTAB(1)
      RETURN
C     EXTRAPOLATION
C     LARGE X END OF TABLE
  110 IF (X .LT. XTAB(NP-1))  GO TO 2
      Y = Q(XTAB(NP-1),YTAB(NP-1),XTAB(NP),YTAB(NP))
      IX=NP
      RETURN
C     SMALL X END OF TABLE
    2 IF (X .GE. XTAB(2))  GO TO 49
      Y = Q(XTAB(1),YTAB(1),XTAB(2),YTAB(2))
      IX=1
      RETURN
C     INTERPOLATION
   49 IF (IX .LE. NP)  GO TO 4
      IX = NP
      GO TO 6
    4 IF (IX .GT. 0)  GO TO 6
      IX = 1
    6 IF(X-XTAB(IX)) 9,60,7
C   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
   60 IF (XTAB(IX) .NE. XTAB(IX+1))  GO TO 62
      Y = YTAB(IX+1)
      RETURN

   62 Y=YTAB(IX)
      RETURN
    7 IX=IX+1
      IF(X-XTAB(IX)) 10,60,7
    8 IX=IX+1
      GO TO 10
    9 IX=IX-1
      IF(XTAB(IX)-X) 8,60,9
C     INTERPOLATED Y
   10 Y=Q(XTAB(IX-1),YTAB(IX-1),XTAB(IX),YTAB(IX))
      RETURN
      END
```

```
      SUBROUTINE MATRIX                                                  A    1
C                                                                        A    3
      DOUBLE PRECISION G,X                                               A    4
      LOGICAL CONVG,HP,SP,TP
C                                                                        A    6
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),     /POINTS/
     2                TTT(13)                                           /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /DOUBLE/ G(20,21),X(20)                                     A   17
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
C                                                                        A   21
      IQ2=IQ1+1                                                          A   22
      IQ3=IQ2+1                                                          A   23
      KMAT=IQ3                                                           A   24
      IF (.NOT.CONVG.AND.TP) KMAT=IQ2                                    A   25
      IMAT=KMAT-1                                                        A   26
C                                                                        A   27
C     CLEAR MATRIX STORAGES TO ZERO                                      A   28
C                                                                        A   29
      DO 20 I=1,IMAT                                                     A   30
      DO 20 K=1,KMAT                                                     A   31
   20 G(I,K) = 0.0D0
      SSS=0.                                                             A   34
      HSUM(NPT)=0.                                                       A   35
C                                                                        A   36
C     BEGIN SET UP OF ITERATION MATRIX                                   A   37
C                                                                        A   38
      KK=L                                                               A   39
      DO 110 J=1,NS                                                      A   40
      H=HO(J)+EN(J,NPT)                                                  A   41
      IF (IUSE(J)) 110,30,90                                             A   42
   30 F=(HO(J)-S(J)+ENLN(J)+TM)*EN(J,NPT)                                A   43
      SS=H-F                                                             A   44
      TERM1=H                                                            A   45
      IF (KMAT.EQ.IQ2) TERM1=F                                           A   46
      DO 50 I=1,L                                                        A   47
C                                                                        A   48
C     CALCULATE THE ELEMENTS  R(I,K)                                     A   49
C                                                                        A   50
```

```
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (A(I,J).EQ.0.) GO TO 50                                        A  51
      TERM=A(I,J)*EN(J,NPT)                                             A  52
      DO 40 K=I,L                                                       A  53
   40 G(I,K) = G(I,K) + A(K,J)*TERM
      G(I,IQ1)=G(I,IQ1)+TERM                                            A  57
      G(I,IQ2)=G(I,IQ2)+A(I,J)*TERM1                                    A  58
      IF (CONVG.OR.TP) GO TO 50                                         A  59
      G(I,IQ3)=G(I,IQ3)+A(I,J)*F                                        A  60
      IF (SP) G(IQ2,I)=G(IQ2,I)+A(I,J)*SS                               A  61
   50 CONTINUE                                                          A  62
      IF (KMAT.EQ.IQ2) GO TO 80                                         A  63
      IF (CONVG.OR.HP) GO TO 60                                         A  64
      G(IQ2,IQ1)=G(IQ2,IQ1)+SS                                          A  65
      G(IQ2,IQ2)=G(IQ2,IQ2)+HO(J)*SS                                    A  66
      G(IQ2,IQ3)=G(IQ2,IQ3)+(S(J)-ENLN(J)-TM)*F                         A  67
      GO TO 70                                                          A  68

   60 G(IQ2,IQ2)=G(IQ2,IQ2)+HO(J)*H                                     A  69
      IF (CONVG) GO TO 80                                               A  70
      G(IQ2,IQ3)=G(IQ2,IQ3)+HO(J)*F                                     A  71
   70 G(IQ1,IQ3)=G(IQ1,IQ3)+F                                           A  72
   80 G(IQ1,IQ2)=G(IQ1,IQ2)+TERM1                                       A  73
      GO TO 110                                                         A  74
C                                                                       A  75
C     CONDENSED SPECIES                                                 A  76
C                                                                       A  77
   90 KK=KK+1                                                           A  78
      DO 100 I=1,L                                                      A  79
      G(I,KK)=A(I,J)                                                    A  80
  100 G(I,KMAT) = G(I,KMAT) - A(I,J)*EN(J,NPT)
      G(KK,IQ2)=HO(J)                                                   A  83
      G(KK,KMAT)=HO(J)-S(J)                                             A  84
      HSUM(NPT)=HSUM(NPT)+H                                             A  85
      IF (.NOT.SP) GO TO 110                                            A  86
      SSS=SSS+S(J)*EN(J,NPT)                                            A  87
      G(IQ2,KK)=S(J)                                                    A  88
  110 CONTINUE                                                          A  89
      SSS=SSS+G(IQ2,IQ1)                                                A  90
      HSUM(NPT)=HSUM(NPT)+G(IQ1,IQ2)                                    A  91
      G(IQ1,IQ1)=SUMN-ENN                                               A  92
C                                                                       A  93
C     REFLECT SYMMETRIC PORTIONS OF THE MATRIX                          A  94
C                                                                       A  95
      ISYM=IQ1                                                          A  96
      IF (HP.OR.CONVG) ISYM=IQ2                                         A  97
      DO 120 I=1,ISYM                                                   A  98
      DO 120 J=1,ISYM                                                   A  99
  120 G(J,I) = G(I,J)
```

```
C                                                                       A 102
C     COMPLETE THE RIGHT HAND SIDE                                      A 103
C                                                                       A 104
      IF (CONVG) GO TO 140                                              A 105
      DO 130 I=1,L                                                      A 106
      X(I)=BO(I)-G(I,IQ1)                                               A 107
  130 G(I,KMAT) = G(I,KMAT) + X(I)
      G(IQ1,KMAT)=G(IQ1,KMAT)+ENN-SUMN                                  A 110
C                                                                       A 111
C     COMPLETE ENERGY ROW AND TEMPERATURE COLUMN                        A 112
C                                                                       A 113
      IF (KMAT .EQ. IQ2)  RETURN
      IF (SP) ENERGY=SO+ENN-SUMN-SSS                                    A 115
      IF (HP) ENERGY=HSUBO/TT-HSUM(NPT)                                 A 116
      G(IQ2,IQ3)=G(IQ2,IQ3)+ENERGY                                      A 117
  140 G(IQ2,IQ2)=G(IQ2,IQ2)+CPSUM                                       A 118
      RETURN
      END                                                               A 120-
```

```
      SUBROUTINE MGAUSD                                                  A    1
C                                                                        A    2
C     SOLVE ANY LINEAR SET OF UP TO 20 EQUATIONS                         A    3
C                                                                        A    4
      DOUBLE PRECISION G,X,COEFX(20),SUM,Z                               A    5
C                                                                        A    6
      COMMON /DOUBLE/ G(20,21),X(20)                                     A    7
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
C                                                                        A   15
C     BEGIN ELIMINATION OF NNTH VARIABLE                                 A   16
C                                                                        A   17
      IUSE1 = IMAT + 1
      DO 160 NN = 1,IMAT
      IF (NN .NE. IMAT)  GO TO 30
C  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (G(NN,NN) .NE. 0.0D0)  GO TO 120
  210 IMAT = IMAT - 1
      RETURN
C                                                                        A   22
C     SEARCH FOR MAXIMUM COEFFICIENT IN EACH ROW                         A   23

C                                                                        A   24
   30 DO 60 I = NN,IMAT
      COEFX(I) = 1.0E+38
    THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (G(I,NN).EQ.0.) GO TO 60                                        A   27
      COEFX(I)=0.                                                        A   28
      DO 50 J=NN,IUSE1                                                   A   29
      SUM=G(I,J)                                                         A   30
      IF (SUM.LT.0.) SUM=-SUM                                            A   31
      IF (J.NE.NN) GO TO 40                                              A   32
      Z=SUM                                                              A   33
      GO TO 50                                                           A   34
   40 IF (SUM.GT.COEFX(I)) COEFX(I)=SUM                                  A   35
   50 CONTINUE                                                           A   36
      COEFX(I)=COEFX(I)/Z                                                A   37
   60 CONTINUE                                                           A   38
      TEMP = 1.0E+38
      I=0                                                                A   40
      DO 80 J = NN,IMAT
      IF (COEFX(J) .GE. TEMP)  GO TO 80
      TEMP = COEFX(J)
      I=J                                                                A   44
   80 CONTINUE                                                           A   45
      IF (I .EQ. 0)  GO TO 210
C                                                                        A   47
C     INDEX I LOCATES EQUATION TO BE USED FOR ELIMINATING THE NTH        A   48
C     VARIABLE FROM THE REMAINING EQUATIONS                              A   49
C      INTERCHANGE EQUATIONS I AND NN                                    A   51
C                                                                        A   52
```

```
      IF (NN .EQ. 1)  GO TO 120
      DO 110 J = NN,IUSE1                                              A  55
      Z=G(I,J)                                                         A  56
      G(I,J)=G(NN,J)
  110 G(NN,J) = Z                                                      A  59
C
C     DIVIDE NTH ROW BY NTH DIAGONAL ELEMENT AND ELIMINATE THE NTH     A  60
C     VARIABLE FROM THE REMAINING EQUATIONS                            A  61
C                                                                      A  62
  120 K=NN+1                                                           A  63
      DO 130 J=K,IUSE1                                                 A  64
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (G(NN,NN).EQ.0.) GO TO 210                                    A  65
  130 G(NN,J) = G(NN,J)/G(NN,NN)
      IF (K .EQ. IUSE1)  GO TO 160
      DO 150 I = K,IMAT
      DO 150 J=K,IUSE1                                                 A  70
  150 G(I,J) = G(I,J) - G(I,NN)*G(NN,J)
  160 CONTINUE                                                         A  73
C                                                                      A  74
C     BACKSOLVE FOR THE VARIABLES                                      A  75
C                                                                      A  76
      K = IMAT
  170 J=K+1                                                            A  78
      X(K)=0.0D0                                                       A  79
      SUM=0.0                                                          A  80
      IF (IMAT .LT. J)  GO TO 200
      DO 190 I = J,IMAT


  190 SUM = SUM + G(K,I)*X(I)
  200 X(K)=G(K,IUSE1)-SUM                                              A  85
      K=K-1                                                            A  86
      IF (K .NE. 0)  GO TO 170
      RETURN
      END                                                              A  90-
```

```
      SUBROUTINE MOMNTM
CMOMNTM   SOLVE SYSTEM OF MOMENTUM EQUATIONS FOR VELOCITY U(M+1,N).
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIGSS(3)
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
C
C     EVALUATE COEFFICIENTS OF SYSTEM OF MOMENTUM EQUATIONS (FROM FIRST
C      INTERIOR POINT TO SECOND LAST POINT IN BOUNDARY LAYER).
C
      INCRMT=0
      TM4=RHO(NY,JA)*U(NY,JA)*(UEDGE-U(NY,JO))/DS
      I=2
C
C     CALCULATE TEMPORARY QUANTITIES.
C
  100 BE = E(I)
      BF=F(I)
      SIG1(3) = SMU(I+1,JA)+EPS(I+1,JA)
      SIG1Y=(SIG1(3)-SIG1(1))*02DY
      UYMN=(U(I+1,JO)-U(I-1,JO))*02DY
      UYYMN=(U(I+1,JO)-2.*U(I,JO)+U(I-1,JO))*ODYSQ
      TERM=BF*BGP(I)*SIG1(2)*ODYSQ
      TM1=BGPP(I)*SIG1(2)/BGP(I)+BGP(I)*SIG1Y
      TM2=RHOV(I)*BGP(I)
      TM3=RHO(I,JA)*U(I,JA)/DS
C
C     COEFF. OF U(M+1,N-1)
C
      A(I-1,1)=04DY*(BE*U(I,JO)-TM2+BF*TM1)-0.5*TERM
C
C     COEFF. OF U(M+1,N)
C
      A(I-1,2)=TM3-0.5*BE*UYMN+TERM
C
C     COEFF. OF U(M+1,N+1)
C
      A(I-1,3)=-A(I-1,1)-TERM
C
C     RIGHT-HAND SIDE
C
      B(I-1)=TM3*U(I,JO)-0.5*TM2*UYMN+TM4+0.5*BF*(TM1*UYMN+
     1       BGP(I)*SIG1(2)*UYYMN)
```

```
C
C     PUSH-DOWN STORAGE
C
      SIGI(1)=SIGI(2)
      SIGI(2)=SIGI(3)
      I=I+1
      IF (I .LE. NYI)  GO TO 100
C
C     MODIFY FIRST AND LAST MOMENTUM EQUATIONS BY BOUNDARY CONDITIONS
C                    AT WALL    U = 0
C                    AT EDGE    U = UE
C
      A(1,1)=0.
      B(NY2)=B(NY2)-A(NY2,3)*UEDGE
      A(NY2,3)=0.


C
C     SOLVE MOMENTUM EQUATIONS FOR U(M+1,N), N=2,3,...,NY-1
C
      CALL TRIM (A,U(2,JN),B,NY2,NMAX)
C
C     APPLY BOUNDARY CONDITIONS FOR U(M+1,1) AND U(M+1,NY)
C
      U(1,JN)=0.
      U(NY,JN)=UEDGE
C
C     PRINT DEBUG FOR THIS ITERATION, IF REQUESTED.
C
      IF(KMODMP.GT.0)CALL DUMPIT
      TEST = ( U(NY1,JN) -U(NY,JN))/U(NY,JN)
      IF(ABS(TEST).LE.EPSLN1)RETURN
C
C     SOLUTION DOES NOT ASYMPTOTICALLY APPROACH EDGE CONDITIONS.
C     INCREASE THICKNESS OF BOUNDARY LAYER BY ADDING ONE POINT.
C
      INCRMT=INCRMT+1
      IF(INCRMT.GT.5)CALL DEBUG (6HMOMNTM)
      IF(NY.EQ.NMAX)CALL DEBUG (6HMOMNTM)
      CALL ADDPT (1)
      I=NY1-1
      GO TO 100
      END
```

```
      SUBROUTINE NLOUT
CNLOUT    WRITE TFCBL INPUT DATA.
C
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DXI
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/MULT  /XN,UEN,PEN,SMDN,YN
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON /TITLE/ TITLE(13)                                           /TITLE/
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
      COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),HPROF(50),      /INPROF/
     1                YBYNH(50),LHPROF,CHYX(6)                           /INPROF/
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/NEW3  /AFTRNS,PLAW
      COMMON/NEW5  /IYPR
      COMMON/NEW7  /GPO,PAMB,INTDK,ZETAPI
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/NEW9  /IYEQ
      COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(6),AFWALL
      COMMON/NEW11 /J2D,UEK,RHOEK
      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
      COMMON /AL/ INSTAT,EPSLIN                                          /AL/
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB,  /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI, /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20),  /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
```

```
C
      DATA UNAME,PNAME/6HUETAB ,6HPETAB /
C
C     WRITE SINGLY DIMENSIONED VARIABLES.
C
      WRITE (6,9000) TITLE
      WRITE (6,9010) IDEAL,LAMNR,INCOMP,J2D,INTDK,ICOOL,ITHERM,IPOLY
      WRITE (6,9020) SINIT,XINIT,XMAX,DXI,DELTAI,ZETAPI
      WRITE (6,9030) BLREF,UREF,RHOREF,SMUREF
      WRITE (6,9040) XN,YN,UEN,PEN,SMDN
      WRITE (6,9050) UEDGE,PEDGEB,TEDGE,AFEDGE
      WRITE (6,9060) AFTRNS,PRI,GAMMA,FMOLWT,PLAW,PAMB,GPO,SN3,
     1               XSTAR,AFWALL,UEK,RHOEK
      WRITE (6,9070) CONVRG,EPSLN1,EPSLN2,EPSLN3,EPSLIN
      WRITE (6,9080) MAXIT,NYI,NLPRNT,NSPRNT,INSTAT,IYPR,IYEQ
      WRITE (6,6) GAMA,ZK
    6 FORMAT (1X,18HCORRELATION INPUTS//5X,6HGAMA =,F10.6,5X,4HZK =,
     1        F10.6//)
      IF (ICOOL .EQ. 0)  GO TO 40
      WRITE (6,1) COEFCL,MASSL,RAMDW,TUBEN


    1 FORMAT (28H REGENERATIVE COOLING INPUTS//4X,8HCOEFCL =,F12.8,10X,
     1 7HMASSL =,F12.6,10X,7HRAMDW =,F13.10,10X,7HTUBEN =,F10.3/)
      WRITE (6,2) ITZTAB,(I,TZTAB(I),CPLTAB(I),RAMTAB(I),ZMYTAB(I),
     1            I = 1,ITZTAB)
    2 FORMAT (1H1///26H COOLANT PROPERTIES TABLES//45X,8HITZTAB =,I3//
     1 15X,1HI,9X,5HTZTAB,11X,6HCPLTAB,13X,6HRAMTAB,13X,6HZMYTAB/
     2 (14X,I2,5X,0PF10.4,5X,F13.10,5X,1PE14.8,5X,E14.8))
      WRITE (6,3) LTWTAB
    3 FORMAT (1H1,20H COOLANT WALL TABLES//44X,8HLTWTAB =,I4//15X,1HI,
     1 11X,5HALTAB,12X,6HTHITAB,12X,5HTLTAB/)
      LINESR = LNSPPG - 8
      DO 30 I = 1,LTWTAB
      WRITE (6,4) I,ALTAB(I),THITAB(I),TLTAB(I)
    4 FORMAT (13X,I3,5X,1PE13.7,5X,E13.7,5X,0PF11.4)
      LINESR = LINESR - 1
      IF (LINESR .GT. 0 .OR. I .EQ. LTWTAB)  GO TO 30
      WRITE (6,5)
    5 FORMAT (1H1/15X,1HI,11X,5HALTAB,12X,6HTHITAB,12X,5HTLTAB/)
      LINESR = LNSPPG - 5
   30 CONTINUE
C
C     WRITE STEPSIZE CONTROL TABLES.
C
```

```
   40  WRITE (6,9000)
       WRITE (6,9090) LDXLIM,LSKTAB
       WRITE (6,9100)
       LMAX=MAXO(LDXLIM,LSKTAB)
       WRITE (6,9110) DXLIM(I),XLIM(I),SKTAB(I),XTABSK(I)
       IF (LMAX .LE. 1)  GO TO 110
       DO 100 I = 2,LMAX
       IF(I.GT.LDXLIM)GO TO 80
       IF(I.GT.LSKTAB)GO TO 90
       WRITE (6,9110) DXLIM(I),XLIM(I),SKTAB(I),XTABSK(I)
       GO TO 100
    80 WRITE (6,9120) SKTAB(I),XTABSK(I)
       GO TO 100
    90 WRITE (6,9110) DXLIM(I),XLIM(I)
   100 CONTINUE
C
C     WRITE WALL TABLES.
C
   110  WRITE (6,9000)
       WRITE (6,9130) LTWTAB,LMDTAB
       WRITE (6,9140)
       LINESR=LNSPPG-8
       LMAX=MAXO(LTWTAB,LMDTAB)
       WRITE (6,9110) TWTAB(I),XTABTW(I),SMDTAB(I),XTABMD(I)
       LINESR=LINESR-1
       IF (LMAX .LE. 1)  GO TO 210
       DO 200 I = 2,LMAX
       IF(I.GT.LTWTAB)GO TO 160
       IF(I.GT.LMDTAB)GO TO 170
       WRITE (6,9110) TWTAB(I),XTABTW(I),SMDTAB(I),XTABMD(I)
       GO TO 180
   160 WRITE (6,9120) SMDTAB(I),XTABMD(I)
       GO TO 180
   170 WRITE (6,9110) TWTAB(I),XTABTW(I)

   180 LINESR=LINESR-1
       IF((LINESR.GT.0).OR.(I.EQ.LMAX))GO TO 200
       WRITE (6,9000)
       WRITE (6,9140)
       LINESR=LNSPPG-5
   200 CONTINUE
C
C     WRITE GEOMETRY AND EDGE TABLES.
C
   210  WRITE (6,9000)
     *  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF(PETAB(I).NE.0.)GO TO 220
       WRITE (6,9150) LRWTAB,LUETAB
       TABNAM=UNAME
       GO TO 230
   220 WRITE (6,9160) LRWTAB,LPETAB
       TABNAM=PNAME
```

```
230   WRITE (6,9170) TABNAM
      LINESR=LNSPPG-8
      LPUMAX=MAXO(LPETAB,LUETAB)
      LMAX=MAXO(LRWTAB,LPUMAX)
      TABVAL=PETAB(1)
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(PETAB(1).EQ.0.)TABVAL=UETAB(1)
      WRITE (6,9110) RWTAB(1),XTABRW(1),TABVAL,XTABPE(1)
      LINESR=LINESR-1
      IF (LMAX .LE. 1)  GO TO 310
      DO 300 I = 2,LMAX
      TABVAL=PETAB(I)
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(PETAB(I).EQ.0.)TABVAL=UETAB(I)
      IF(I.GT.LRWTAB)GO TO 260
      IF(I.GT.LPUMAX)GO TO 270
      WRITE (6,9110) RWTAB(I),XTABRW(I),TABVAL,XTABPE(I)
      GO TO 280
  260 WRITE (6,9120) TABVAL,XTABPE(I)
      GO TO 280
  270 WRITE (6,9110) RWTAB(I),XTABRW(I)
  280 LINESR=LINESR-1
      IF((LINESR.GT.0).OR.(I.EQ.LMAX))GO TO 300
      WRITE (6,9000)
      WRITE (6,9170) TABNAM
      LINESR=LNSPPG-5
  300 CONTINUE
C
C   WRITE EXPERIMENTAL PROFILES, IF INPUT.
C
  310  IF (LUPROF .EQ. -LHPROF)  RETURN
       WRITE (6,9000)
       WRITE (6,9180) LUPROF,LHPROF
       WRITE (6,9190)
       LMAX=MAXO(LUPROF,LHPROF)
       WRITE (6,9110) UPROF(1),YBYNU(1),HPROF(1),YBYNH(1)
       IF (LMAX .LE. 1)  GO TO 410
       DO 400 I = 2,LMAX
       IF(I.GT.LUPROF)GO TO 360
       IF(I.GT.LHPROF)GO TO 370

       WRITE (6,9110) UPROF(I),YBYNU(I),HPROF(I),YBYNH(I)
       GO TO 400
  360  WRITE (6,9120) HPROF(I),YBYNH(I)
       GO TO 400
  370  WRITE (6,9110) UPROF(I),YBYNU(I)
  400  CONTINUE
  410  IF (LAPROF .EQ. 0)  RETURN
       WRITE (6,9000)
       WRITE (6,9200) LAPROF
       WRITE (6,9210)
       DO 450 I=1,LAPROF
  450  WRITE (6,9110) APROF(I),YBYNA(I)
       RETURN
```

```
 9000  FORMAT (1H1,26X,13A6//)
 9010 FORMAT (18H FLAGS AND OPTIONS//30X,8HIDEAL = ,I2,6X,
     1 56H(=1 FOR PERFECT GAS, =0 FOR HYDROGEN-OXYGEN EQUILIBRIUM)/30X,
     2 8HLAMNR = ,I2,6X,39H(=1 FOR LAMINAR FLOW, =0 FOR TURBULENT)/30X,
     3 8HINCOMP= ,I2,6X,36H(=1 FOR INCOMPRESSIBLE FLOW, =0 FOR ,
     4 13HCOMPRESSIBLE)/30X,8HJ2D    = ,I2,6X,21H(=1 FOR AXISYMMETRIC ,
     5 33HGEOMETRY, =0 FOR TWO-DIMENSIONAL)/30X,8HINTDK = ,I2,6X,
     6 55H(=1 IF INPUT TABLES COME FROM TDK OUTPUT, =0 OTHERWISE)/30X,
     7 8HICOOL = ,I2,6X,57H(=0 NO COOLING, =1 OPPOSITE DIRECTION, =2 SAM
     8E DIRECTION)/30X,8HITHERM =,I2,6X,52H(=1 FOR STHERMO NAMELIST INPU
     9T TO ODE, =0 OTHERWISE)/30X,8HIPOLY  =,I2,6X,77H(=1 FOR CALCULATIO
     &N OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, =0 OTHERWISE)//)
 9020  FORMAT (34H PROBLEM LIMITS AND INITIAL VALUES//1X,7HSINIT =,F12.8,
     1 3X,7HXINIT =,F12.8,3X,6HXMAX =,F13.8,3X,5HDXI =,1PE12.6,3X,
     2 8HDELTAI =,E12.6,3X,8HZETAPI =,E12.6//)
 9030 FORMAT (21H REFERENCE QUANTITIES//4X,7HBLREF =,1PE14.7,4X,
     1 6HUREF =,E14.7,4X,8HRHOREF =,E14.7,4X,8HSMOREF =,E14.7//)
 9040 FORMAT (28H INPUT NORMALIZATION FACTORS//4X,7HXN     =,1PE14.7,4X,
     1 7HYN     =,E14.7,4X,7HUEN    =,E14.7,4X,7HPEN    =,E14.7,4X,
     2 7HSMDN   =,E14.7//)
 9050 FORMAT (16H EDGE QUANTITIES//4X,7HUEDGE =,1PE14.7,4X,7HPEDGE =,
     1 E14.7,4X,7HTEDGE =,E14.7,4X,8HAFEDGE =,E14.7//)
 9060  FORMAT (10H CONSTANTS//4X,8HAFTRNS =,1PE12.6,3X,5HPRI =,E12.6,3X,
     1 7HGAMMA =,E12.6,3X,8HFMOLWT =,E12.6,3X,6HPLAW =,E12.6,3X,
     2 7HPAMB  =,E12.6/1X,8HGPO     =,E12.6,3X,5HSN3 =,E12.6,3X,
     3 7HXSTAR =,E12.6,3X,8HAFWALL =,E12.6,3X,6HUEK  =,E12.6,3X,
     4 7HRHOEK =,E12.6//)
 9070 FORMAT (30H CONVERGENCE AND EDGE CRITERIA//4X,7HCONVRG=,1PE14.7,
     1 4X,7HEPSLN1=,E14.7,4X,7HEPSLN2=,E14.7,4X,7HEPSLN3=,E14.7,4X,
     2 7HEPSLIN=,E14.7//)
 9080  FORMAT (9H COUNTERS//4X,7HMAXIT =,I4,5X,5HNYI =,I4,5X,8HNLPRNT =,
     1 I4,5X,8HNSPRNT =,I4,5X,8HINSTAT =,I4,5X,6HIYPR =,I4,5X,6HIYEQ =,
     2 I4//)
 9090 FORMAT (24H STEPSIZE CONTROL TABLES//25X,7HLDXLIM=,I4,39X,
     1 7HLSKTAB=,I4)
 9100 FORMAT (15X,6HDXLIM ,19X,6HXLIM  ,19X,6HSKTAB ,19X,6HXTABSK/)
 9110 FORMAT (1P4E25.7)
 9120 FORMAT (50X,1P2E25.7)
 9130 FORMAT (12H WALL TABLES//25X,7HLTWTAB=,I4,39X,7HLMDTAB=,I4)
 9140 FORMAT (15X,6HTWTAB ,19X,6HXTABTW,19X,6HSMDTAB,19X,6HXTABMD/)
 9150 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB=,I4,39X,
     1 7HLUETAB=,I4)
 9160 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB=,I4,39X,
     1 7HLPETAB=,I4)


 9170 FORMAT (15X,6HRWTAB ,19X,6HXTABRW,19X,A6,19X,6HXTABPE/)
 9180 FORMAT (22H EXPERIMENTAL PROFILES//25X,7HLUPROF=,I4,39X,
     1 7HLHPROF=,I4)
 9190 FORMAT (15X,6HUPROF ,19X,6HYBYNU ,19X,6HHPROF ,19X,6HYBYNH /)
 9200 FORMAT (34H EXPERIMENTAL PROFILES (CONTINUED)//25X,7HLAPROF=,I4)
 9210 FORMAT (15X,6HAPROF ,19X,6HYBYNA /)
      END
```

```
      SUBROUTINE ODE
CODE       ICRPG REFERENCE PROGRAM (ODE) MODIFIED TO HANDLE EQUILIBRIUM
C          CHEMISTRY IN THE TURBULENT BOUNDARY LAYER PROGRAM AND TO
C          OPERATE IN A SUBROUTINE MODE.
C                                                                        A  10
      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),      /POINTS/
     2                TTT(13)                                            /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,THID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
C                                                                        A  33
      DIMENSION DATE(2,30),LH(2),LVM(2),LVP(2)
      INTEGER BLANK,FAZ,FOX,PHAZ,SUB
      DATA BLANK,LH,LVM,LVP/1H ,4HH,CA,4HL/G ,2HV-,1H ,2H0+,1H /
      EQUIVALENCE (DATE,EN)
      LOGICAL HP,IC,MOLES,SP,TP
C                                                                        A  39
      NAMELIST /THERMO/ ANUM,B,COEF,DATE,DENS,EQTH,FAZ,FOX,MOLES,MT,
     1                  NAME,NSPEC,NPROD,PECWT,PHAZ,RTEMP,SUB,T1,T2,
     2                  TLOW,THID,THIGH
C
C     PRESET VARIABLES TO THEIR INITIAL VALUES.
C
      TLOW = 0.0
      T = 0.0
      DO 2 I = 1,13
    2 P(I) = 0.0
      HP     =.FALSE.
      TP     =.FALSE.
      NP = 1
      OF = 0.0
      EQRAT = 0.0
      MOLES = .FALSE.
      WRITE (6,260)
      IF (ITHERM .NE. 0)  READ (5,THERMO)
      IF (ITHERM .NE. 0)  WRITE (6,THERMO)
      CALL REACT                                                         A  60
      SP=.FALSE.                                                         A 119
C
C      CALCULATIONS INVOLVING EQUIVALENCE RATIO CHANGED (7-10-69) TO
C     CORRESPOND TO DEFINITION USED IN PROGRAM A2350D.  H.M.FREY.
C
      STOIC = ABS((VPLS(1)+VMIN(1))/(VPLS(2)+VMIN(2)))
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (WP(2).NE.0.) OF=WP(1)/WP(2)                                    A 157
      WP(1) = OF
      WP(2)=1.                                                           A 159
```

```
      SUM=WP(1)+WP(2)                                                    A 160
      V2=(WP(1)*VMIN(1)+WP(2)*VMIN(2))/SUM                               A 163
      V1=(WP(1)*VPLS(1)+WP(2)*VPLS(2))/SUM                               A 164
      EQRAT = 1.0/OF/STOIC
      DO 200 I = 1,L
  200 BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/SUM
    THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (EQRAT.EQ.1.) EQRAT=1.000005                                    A 169
      HSUBO = (WP(1)*HPP(1) + WP(2)*HPP(2))/SUM
      WRITE (6,370)                                                      A 176
      WRITE (6,380) LH,HPP(2),HPP(1),HSUBO,LVP,VPLS(2),VPLS(1),V1,LVM,VM A 177
     1IN(2),VMIN(1),V2                                                   A 178
      HSUBO = HSUBO/1.9871650
      WRITE (6,390)                                                      A 180
      WRITE (6,380) (LLMT(I),BLANK,BOP(I,2),BOP(I,1),BO(I),I=1,L)        A 181
      CALL SEARCH
      IQ1=L+1                                                            A 185
      IF (NC.EQ.0) GO TO 240                                             A 186
      DO 230 J=1,NS                                                      A 187
      IF (IUSE(J).EQ.0) GO TO 230                                        A 188
      IF (IUSE(J).GT.0) IUSE(J)=-IUSE(J)                                 A 189
  230 CONTINUE                                                           A 199
  240 IC = .FALSE.
      PP=NS                                                              A 203
      NPT=1                                                              A 204
      ENN=.1                                                             A 205
      SUMN=ENN                                                           A 206
      DO 250 J=1,NS                                                      A 210
      IF (IUSE(J).EQ.-10000) IUSE(J)=0                                   A 211
      EN(J,1)=0.                                                         A 212
      ENLN(J)=0.                                                         A 213
      IF (IUSE(J).NE.0) GO TO 250                                        A 214
      EN(J,1) = ENN/(NS - NC)
      ENLN(J) = ALOG(EN(J,1))
  250 CONTINUE                                                           A 217
      JSOL=0                                                             A 218
      JLIQ=0                                                             A 219
      RETURN
  260 FORMAT (1H1)                                                       A 226
  370 FORMAT (1H0,17X,4HFUEL,13X,7HOXIDANT,12X,7HMIXTURE//)              A 237
  380 FORMAT (1H 2A4,3E18.8/)                                            A 238
  390 FORMAT (8H ATOMS/G)                                                A 239
      END                                                                A 240-
```

```
      SUBROUTINE PARAMS
CPARAMS   CALCULATE GROSS BOUNDARY LAYER PARAMETERS OF INTEREST.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/EFVEC /E(250),F(250)
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YYZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL,        /GPARAM/
     1                SQWDS,SQWO                                         /GPARAM/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/NEW11 /J2D,UEK,RHOEK
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHP(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB,  /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI, /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20),  /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
C
```

```
      DATA PIE,RJ,SG/3.141592653,777.68006,32.174/
      DIMENSION GRND(3),YGRND(3)
C
      DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSN
C
C     UPDATE INTEGRAL OVER S FOR DISPLACEMENT THICKNESS.
C
      IF((IRSRD.GT.0).AND.(ISTATN.EQ.IRSRD))GO TO 50
      IF(ISTATN.GT.0)GO TO 20
      SNTGRL=0.
      GO TO 50
   20 SNTGRL = SNTGRL + 0.50*DS*(SMDWO*ZETAO*RW(1)**J2D + SMDWN*ZETAN*
     1          RW(2)**J2D)
C
C     ACCUMULATE INTEGRALS OVER Y USING SIMPSON INTEGRATION.
C      FIRST EVALUATE INTEGRANDS AT WALL.
C
   50 T1 = RHO(NY,JN)*U(NY,JN)
      TM1=RHO(1,JN)*U(1,JN)/T1
      YGRND(1)=(1.-TM1)/BGP(1)
      YGRND(2)=TM1/BGP(1)*(1.-U(1,JN)/U(NY,JN))
      TM2=1./(ZETAN*ZETAN*REYINF)
      DO 70 I=1,NY
      E(I)=RHO(I,JN)*BGP(I)*ZETAP*YTIL(I)/ZETAN
   70 F(I) = BGP(I)*TM2
      DUDY=O2DY*(-U(3,JN)+4.*U(2,JN)+3.*U(1,JN))
      YGRND(3)=(RHOV(1)*BGP(1)*DUDY+DPEDSN)/F(1)
C
C     ACCUMULATE INTEGRALS ACROSS BOUNDARY LAYER.
C
      DO 100 I=2,NY1
      TM1=RHO(1,JN)*U(I,JN)/T1
      GRND(1)=(1.-TM1)/BGP(I)
      GRND(2)=TM1/BGP(I)*(1.-U(I,JN)/U(NY,JN))
      DUDS=(U(I,JN)-U(I,JO))/DS
      DUDY=O2DY*(U(I+1,JN)-U(I-1,JN))
      GRND(3)=(RHO(I,JN)*U(I,JN)*DUDS+(RHOV(I)*BGP(I)-U(I,JN)*E(I))*
     1          DUDY+DPEDSN)/F(I)
      IF (I .GE. NY1)  GO TO 110
      FMULT = FLOAT(4 - 2*MOD(I,2))
      DO 100 K = 1,3
  100 YGRND(K) = YGRND(K) + FMULT*GRND(K)
C
C     IF NY1 IS EVEN, COMPLETE SIMPSON INTEGRATION.  OTHERWISE, INTEGRATE
C      LAST STEP USING TRAPEZOIDAL RULE.
C
```

```
 110  IF (MOD(NY1,2) .GT. 0)  GO TO 130
      DO 125 K = 1,3
 125  YGRND(K) = (YGRND(K) + 4.0*GRND(K))*DY/3.0
      GO TO 150
 130  DO 135 K=1,3
 135  YGRND(K) = (YGRND(K) + GRND(K))*DY/3.0 + 0.50*DY*GRND(K)
C
C     EVALUATE INTEGRANDS AT NY AND COMPLETE EVALUATION OF INTEGRAL
C      PROPERTIES.  (GRND(1) AND GRND(2) ARE ZERO.)
C
 150  DUDS = (U(NY,JN) - U(NY,J0))/DS
      DUDY=02DY*(U(NY2,JN)-4.*U(NY1,JN)+3.*U(NY,JN))
      GRND(3)=(RHO(NY,JN)*U(NY,JN)*DUDS+(RHOV(NY)*BGP(NY)-
     1         U(NY,JN)*F(NY))*DUDY+DPEDSN)/F(NY)
      IF (MOD(NY,2) .LE. 0)  GO TO 170
      YGRND(3) = YGRND(3) + GRND(3)*DY/3.0
      GO TO 200
 170  YGRND(3)=YGRND(3)+0.5*DY*GRND(3)
C
C     DISPLACEMENT THICKNESS.
C
 200  DLST0 = DLSTAR
      TERM=RHO(NY,JA)*U(NY,JA)*(0.5*(RW(1)+RW(2)))**J2D
      DLSTAR=BLREF*(ZETAN*YGRND(1)+SNTGRL/TERM)
      IF((XSTAR.LT.(X-DX)).OR.(XSTAR.GT.X))GO TO 220
C
C     IF THROAT HAS BEEN REACHED, CALCULATE THROAT RADIUS CORRECTED FOR
C      DISPLACEMENT THICKNESS.

C
      DLSTTH=DLSTAR-(X-XSTAR)*(DLSTAR-DLST0)/DX
      CALL XNTERP (XSTAR,RSTAR,DER,IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
     1             IRWXF)
      THWTH=ATAN(DER)
      RSTPR=RSTAR*BLREF-DLSTTH*COS(THWTH)
C
C     MOMENTUM THICKNESS.
C
 220  THETA = BLREF*ZETAN*YGRND(2)
C
C     SKIN FRICTION.
C
      TAUI=-SMUREF*UREF*YGRND(3)/(BLREF*ZETAN)
C
C     CALCULATE WALL SHEAR STRESS TAUW.
C
      DERIV=02DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
      TMI=BGP(1)/ZETAN*SMU(1,JN)*DERIV
      TAUW=SMUREF*UREF/BLREF*TMI
C
C     LOCAL SHEAR STRESS COEFFICIENT BCF.
C
      BCF=2./REYINF*TMI/(RHO(NY,JN)*U(NY,JN)**2)
```

```
C
C     HEAT TRANSFER RATE SQW.
C
      DERIV=O2DY*(-SH(3,JN)+4.*SH(2,JN)-3.*SH(1,JN))
      SUMSP=0.
      DO 240 ISP=1,NSP
  240 SUMSP = SUMSP + SHI(1,JN,ISP)*O2DY*(4.0*SCI(2,JN,ISP) - 3.0*
     1         SCI(1,JN,ISP) - SCI(3,JN,ISP))
      DERIV=DERIV+(BLE(1,JN)-1.)*SUMSP
      TM1=BGP(1)/ZETAN*SMU(1,JN)/PR(1,JN)*DERIV
      SQW=SMUREF*UREF*UREF/BLREF*TM1
C
C     STANTON NUMBER STAN.
C
      TM2=RHO(NY,JN)*U(NY,JN)*(H(NY,JN)-H(1,JN))
      STAN=TM1/(REYINF*TM2)
C
C     UPDATE INTEGRAL OF SQW OVER S.
C
      IF((IRSRD.GT.0).AND.(ISTATN.EQ.IRSRD))GO TO 280
      IF(ISTATN.GT.0)GO TO 270
      SQWDS=0.
      GO TO 280
  270 SQWDS = SQWDS + (2.0*PIE)**J2D*BLREF**(J2D+1)*0.50*DS*(SQW0*
     1         RW(1)**J2D + SQW*RW(2)**J2D)
  280 SQW0 = SQW
      IF (ICOOL .EQ. 0)  RETURN
      TTSAVE = TT
      CPSAVE = CPSUM
C  **   CPHS CONSIDERS TEMPERATURE IN DEG-K ***
      TT = T(NY,JN)/1.8
      CALL CPHS
C  **  CPSUME  **** (BTU/LBM*DEG-R)


      CPSUME = 1.9879204312*CPSUM
      CPSUM = CPSAVE
      TT = TTSAVE
C  **  ADIABATIC WALL TEMPERATURE TAW (DEG-R)  ****
      TAW = T(NY,JN) + PR(NY,JN)**(1.0/3.0)*0.50*(U(NY,JN)*UREF)**2/
     1      (CPSUME*RJ*SG)
C  **  RHOREF  **** (LBF*SEC2/FT4)  ****
C  **  SG GRAVITIONAL FORCE (LBM/LBF*FT/SEC2)  ****
      AAKK = RHO(NY,JN)*RHOREF*SG*U(NY,JN)*UREF
C  **  AAKK  **** (LBM/FT3*FT/SEC)   ****
C  **  SQW  **** (FT*LBF/FT2*SEC)   ****
      SQWI = SQW/RJ
C  **  SQWI  **** ((FT*LBF/FT2*SEC)/(FT*LBF/BTU) = (BTU/(FT2*SEC)))
      STANRE = SQWI/(CPSUME*AAKK*(TAW - TWALL))
C  **  HG  ****  (BTU/(DEG-R*FT2*SEC))
      HG = SQWI/(TAW - TWALL)
```

```
      CALL XNTERP (X,FAREA,EP,IAX,XTABTW,ALTAB,LTWTAB,CAX,ITWXP)
      DIATUB = 2.0*SQRT(EAREA/PIE)
      CALL XNTERP (X,TL1,TP,ITLX,XTABTW,TLTAB,LTWTAB,CTLX,ITWXP)
      IF (X - DX .GE. XINIT)  GO TO 5
      TL0 = TL1
      GO TO 6
5     CALL XNTERP(X-DX,TL0,TP,ITLX,XTABTW,TLTAB,LTWTAB,CTLX,ITWXP)
6     IF (X + DX .LT. XMAX)  GO TO 8
      TL2 = TL1
      GO TO 9
8     CALL XNTERP (X+DX,TL2,TP,ITLX,XTABTW,TLTAB,LTWTAB,CTLX,ITWXP)
9     CALL XNTERP (TL1,ZMYUL,ZP,IZX,TZTAB,ZMYTAB,ITZTAB,CZX,ITPOS)
      ITPOS = IZX
      CALL XNTERP (TL1,CPL,CPP,ICX,TZTAB,CPLTAB,ITZTAB,CCX,ITPOS)
      CALL XNTERP (TL1,RAMDL,RP,IRX,TZTAB,RAMTAB,ITZTAB,CRX,ITPOS)
      PRANDL = CPL*ZMYUL/RAMDL
      REYL = MASSL*DIATUB/(ZMYUL*TUBEN*EAREA)
      CALL XNTERP (X,THICK,THP,ITHX,XTABTW,THITAB,LTWTAB,CTHX,ITWXP)
      TWL = TL1
7     TWLG = TWL
      HL = 0.0250*RAMDL/DIATUB*REYL**0.80*PRANDL**0.40*(TL1/TWL)**0.550
      SA1 = HL*(1.0 + RAMDW/(THICK*HG))
      SA2 = RAMDW/THICK
      TWL = (SA1*TL1 + SA2*TAW)/(SA1 + SA2)
      IF (ABS(TWLG - TWL) .GT. 0.010)  GO TO 7
      TEMPRL = TWL/TL1
      TWGCA = (HG*TAW + RAMDW/THICK*TWL)/(HG + RAMDW/THICK)
      QWI = HG*(TAW - TWGCA)
      SQWDSI = SQWDS/RJ
      TAWM = TWALL + SQWI/HG
      DELXBA = (DX + DX1)*BLREF/2.0
      COSAL = COS(THW(2))
      SST = COEFCL*DELXBA*QWI*(PIE*RW(2)*BLREF)**J2D/COSAL
      TLCA = (TL1 + TL2)/2.0 + SST/(CPL*MASSL)
      IF (ICOOL .EQ. 2)  TLCA = (TL0 + TL1)/2.0 + SST/(CPL*MASSL)
      SUMQWI = SUMQWI + SST*2.0
      TWG2 = (TWGCA + TWALL)/2.0
      TWL2 = (TLCA + TL1)/2.0
      RETURN
      END
```

```
      SUBROUTINE PHOENX (V,Y,NN,LL)
CPHOENX   INTERPOLATE VS. Y FOR MISSING VALUES IN V GIVEN EVERY N-TH
C         VALUE IN V.  THERE ARE A TOTAL OF L VALUES IN V.
C
      DIMENSION V(250),Y(250),F(130),X(130),CX(6)
C
      IF (NN .LE. 1)  RETURN
C
C     PACK V-VALUES INTO F AND CORRESPONDING Y-VALUES INTO X.
C
      I=1
      J=1
      F(1)=V(1)
      X(1)=Y(1)
   10 I = I + 1
      J=MIN0(J+NN,LL)
      F(I)=V(J)
      X(I)=Y(J)
      IF (J .LT. LL)  GO TO 10
      LEN = I
      IXP=0
C
C     INTERPOLATE FOR MISSING V-VALUES.
C
      JLO=2
      JHI=JLO+NN-2
   40 DO 50 J=JLO,JHI
   50 CALL XNTERP (Y(J),V(J),DER,IXP,X,F,LEN,CX,IXP)
      JLO=JHI+2
      IF (JLO .GE. LL)  RETURN
      JHI = MIN0(JLO+NN-2,LL-1)
      GO TO 40


      END
```

```
      SUBROUTINE PRINT
CPRINT     STORE ITEMS IN SUMMARY TABLE FOR THIS STATION, AND PRINT
C          PROFILES AT THIS STATION IF REQUIRED.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/STEPSZ/DXIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DXI
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZI(2),YZETA,      /ZCALC/
     1               YTZETA,YEDGE                                        /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                 /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL,        /GPARAM/
     1                SQWDS,SQWO                                          /GPARAM/
      COMMON /TITLE/ TITLE(13)                                           /TITLE/
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
      COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,ISTA,NVAR,IDRUM,LAST
      COMMON/NEWS  /IYPR
      COMMON /NEW7/ GPO,PAMB,INTDK,ZETAPI                                 /NEW7/
      COMMON /NEW11/ J2D,UEK,RHOEK                                        /NEW11/
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB,  /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI, /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUREN,TWG2,TWGCA,TWL,TZTAB(20),  /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
      COMMON/MUZZY/SDELTA                                                 NEW
      COMMON/CONST/SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,     NEW
     1             EPSLN3,CONVRG,O2DY,O4DY,ODYSQ                          NEW
C
      DIMENSION  AOUT(12),BOUT(8)
C
C     CALCULATE DIMENSIONAL WALL AND EDGE CONDITIONS.
C
      UEB=U(NY,JN)*UREF
      SA = SQRT(49721.0110*GAMMA/FMOLWT*T(NY,JN))
      IF(IDEAL.EQ.0)SA=AV(NY)
      BME=UEB/SA
```

```
      SMUEB=SMU(NY,JN)*SMUREF
      SMDWB=SMDW*RHOREF*UREF*ZETA
      SHEB=SH(NY,JN)*UREF*UREF
      RHOEB=RHO(NY,JN)*RHOREF
C
C     STORE ITEMS IN SUMMARY TABLE.
C
      ISTA=ISTA+1
      SUMARY(ISTA,1)=FLOAT(ISTATN)
      SUMARY(ISTA,2)=RW(2)
      SUMARY(ISTA,3)=UEB
      SUMARY(ISTA,4)=BME
      SUMARY(ISTA,5)=SMUEB
      SUMARY(ISTA,6)=BCF
      SUMARY(ISTA,7)=STAN
      SUMARY(ISTA,8)=DLSTAR
      SUMARY(ISTA,9)=ZETAN
      SUMARY(ISTA,10)=RW(2)*BLREF-DLSTAR*COS(THW(2))
       SUMARY(ISTA,11) = 12.0*X*BLREF                                    NEW
      SUMARY(ISTA,12)=THW(2)                                             -01
      SUMARY(ISTA,13)=T(NY,JN)
      SUMARY(ISTA,14)=PEDGEB
      SUMARY(ISTA,15)=SMDWB
      SUMARY(ISTA,16)=TAUW
      SUMARY(ISTA,17)=SQW
      SUMARY(ISTA,18)=THETA
      SUMARY(ISTA,19)=ZETAP
      SUMARY(ISTA,20) = X*BLREF + DLSTAR*SIN(THW(2))
      SUMARY(ISTA,21)=S
      SUMARY(ISTA,22)=DS
      SUMARY(ISTA,23)=SHEB
      SUMARY(ISTA,24)=RHOEB
      SUMARY(ISTA,25) = TLCA
      SUMARY(ISTA,26) = TWGCA
      SUMARY(ISTA,27)=SQWDS
      SUMARY(ISTA,28)=SNTGRL
      SUMARY(ISTA,29)=(UEDGE-U(NY,JO))/DS
      SUMARY(ISTA,30) = TWL
C
C     CHECK IF TIME TO WRITE SUMMARY TABLE BUFFER ON DRUM.
C
      IF((ISTA.LT.NSTA).AND.(LAST.EQ.0))GO TO 50
      NST=MIN0(ISTA,NSTA)
      WRITE (IDRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
      ISTA=0
      NREC=NREC+1
C
C     CHECK IF TIME TO PRINT.
C
   50 IF (ISPRNT .EQ. NSPRNT)  ISPRNT = 0
      IF(ILPRNT.EQ.NLPRNT)ILPRNT=0
      IF (ILPRNT .NE. 0)  GO TO 1000
C
C     PRODUCE SHORT PRINT OF CONTOUR PROPERTIES, WALL AND EDGE
C      CONDITIONS, AND PROFILE PARAMETERS.
C
      WRITE (6,9000) TITLE
```

```
      LINESR = LNSPPG - 5
      WRITE (6,9010)
      LINESR=LINESR-1
      XOUT = 12.0*X*BLREF                                                NEW
      WRITE (6,9020) ISTATN,XOUT,S,DS,RW(2),THW(2),ZETAN,ZETAP           -01
      LINESR=LINESR-2
      WRITE (6,9030)
      LINESR=LINESR-1
      RTHETA = REYINF/BLREF*RHO(NY,JN)*U(NY,JN)*THETA/SMU(NY,JN)
      THLOSS = (6.283185306*RW(2)*BLREF)**J2D*COS(THW(2))*(RHOEB*UEB**2*
     1          (THETA - BLREF*SNTGRL*RHOREF*UREF/(RHOEB*UEB*RW(2)**J2D))
     2          - (PEDGEB - PAMB)*DLSTAR)
      WRITE (6,9040) UEB,BME,DLSTAR,BCF,T(NY,JN),RHOEB,THETA,STAN,SHEB,
     1               SMUEB,TAUW,TAU1,PEDGEB,TWALL,SQW,RTHETA,THLOSS,SMDWB
      LINESR=LINESR-6
      IF (ICOOL .NE. 0)  WRITE (6,1) TLO,TWL,CPL,QWI,REYL,TL1,TWL2,
     1 CPSUME,SUMQWI,PRANDL,TL2,TWGCA,DIATUB,SQWI,RAMDL,TAW,TWG2,
     2 THICK,SQWDSI,ZMYUL,TLCA,TEMPRL,HG,HL,STANRE
    1 FORMAT (50X,31HREGENERATIVE COOLING PARAMETERS/5X,6HTLO  =,F10.4,
     1 5X,8HTWL     =,F10.4,5X,8HCPL     =,F15.10,5X,8HQWI     =,F15.6,5X,
     2 8HREYL    =,1PE15.9/5X,6HTL1  =,0PF10.4,5X,8HTLTAB  =,F10.4,5X,
     3 8HCPSUME =,F15.10,5X,8HSUMQWI =,F15.6,5X,8HPRANDL =,1PE15.9/5X,
     4 6HTL2  =,0PF10.4,5X,8HTWGCA  =,F10.4,5X,8HDIATUB =,F15.10,5X,
     5 8HSQWI    =,F15.6,5X,8HRAMDL  =,1PE15.9/5X,6HTAW  =,0PF10.4,5X,
     6 8HTWTAB  =,F10.4,5X,8HTHICK  =,F15.10,5X,8HSQWDSI =,F15.6,5X,
     7 8HZMYUL  =,1PE15.9/5X,8HTLCA =,0PF10.4,5X,8HTEMPRL =,F10.4,5X,
     8 8HHG      =,F15.10,5X,8HHL      =,F15.6,5X,8HSTANRE =,1PE15.9/)
      IF (ICOOL .NE. 0)  LINESR = LINESR - 7
C
C     PRODUCE LONG PRINT OF VARIABLE PROFILES FROM WALL TO EDGE.
C     FIRST PAGE.
C
      WRITE (6,9050)
      LINESR=LINESR-1
      I=1
  550 AOUT(1) = YTIL(I)*BLREF*ZETAN
      AOUT(2)=Y(I)
      AOUT(3)=U(I,JN)/U(NY,JN)
      AOUT(4)=SH(I,JN)/SH(NY,JN)
      AOUT(5)=RHO(I,JN)/RHO(NY,JN)
      AOUT(6) = RHOV(I)*ZETAN/(RHO(NY,JN)*U(NY,JN))
      AOUT(7) = EPS(I,JN)*SMUREF
      AOUT(8)=T(I,JN)
      IF(LINESR.GT.0)GO TO 570
      WRITE (6,9080)
      WRITE (6,9050)
      LINESR = LNSPPG - 4
  570 WRITE (6,9060) I,(AOUT(J),J=1,8)
      LINESR=LINESR-1
      IF (I .GE. NY)  GO TO 600
      I = MIN0(I+IYPR,NY)
      GO TO 550
  600 CONTINUE                                                           NEW
C ***.*************************************                             NEW
      WRITE(6,9080)                                                      NEW
      ZDELTA = SDELTA*RLREF*ZETAN*12.0                                   NEW
      WRITE(6,90)  ZDELTA                                                NEW
```

```
   90 FORMAT(8H  DELTA=,1PE12.5,9H (INCHES))                              NEW
      LINESR=LNSPPG-5                                                     NEW
      WRITE(6,100)                                                        NEW
  100 FORMAT(4H NO.,6X,8H  TAU   ,6X,12HTAU/(RE*UE2),1X,                  NEW
     1       20H  EPS/(RHO*UE*DELTA),2X,12H  YTIL/DELTA)                  NEW
C                                                                         NEW
      LINESR = LINESR-1                                                   NEW
      Z1 = SMUREF*UREF/(BLREF*ZETAN)                                      NEW
      Z2 = 1.0/(REYINF*ZETAN*RHO(NY,JN)*U(NY,JN)*U(NY,JN))                NEW
      Z3 = 1.0/(REYINF*ZETAN*U(NY,JN)*SDELTA)                             NEW
      I = 2                                                               NEW
  101 DUDYI = 04DY*(U(I+1,J0)-U(I-1,J0)+U(I+1,JN)-U(I-1,JN))              NEW
      AOUT(1) = BGP(I)*Z1*(SMU(I,JN)+EPS(I,JN))*DUDYI                     NEW
      AOUT(2) = AOUT(1)*Z2/Z1                                             NEW
      AOUT(3) = EPS(I,JN)*Z3/RHO(I,JN)                                    NEW
      AOUT(4) = YTIL(I)/SDELTA                                            NEW
      IF(LINESR.GT.0) GO TO 102                                           NEW
      WRITE(6,9080)                                                       NEW
      WRITE(6,100)                                                        NEW
      LINESR = LNSPPG-4                                                   NEW
  102 WRITE(6,103) I,(AOUT(J),J=1,4)                                      NEW
  103 FORMAT(I4,1P4E16.7)                                                 NEW
      LINESR=LINESR-1                                                     NEW
      IF(I.GE.NY1) GO TO 104                                              NEW
      I = MIN0(I+IYPR,NY1)                                                NEW
      GO TO 101                                                           NEW
  104 CONTINUE                                                            NEW
C                                                                         NEW
C ****************************************                                NEW
      WRITE (6,9080)                                                      NEW
      LINESR = LNSPPG-5                                                   -01
      WRITE(6,9902)
      LINESR = LINESR - 1
      I=1
  551 BOUT(1) = SMU(I,JN)*SMUREF
      BOUT(2) = YTIL(I)/YTIL(NY)
      BOUT(3) = CUU(I,JN)/U(NY,JN)**2
      BOUT(4) = RHO(I,JN)/RHO(NY,JN)*U(I,JN)/U(NY,JN)
      BOUT(5) = CUV(I,JN)*SMUREF
C     *****  U(TAU) = UT  ****
      UT = SQRT(TAUW/(RHO(I,JN)*RHOREF))
      UTT = RHO(I,JN)*RHOREF*UT/(SMU(I,JN)*SMUREF)
      BOUT(6) = U(I,JN)*UREF/UT
      BOUT(7) = UTT*YTIL(I)*BLREF*ZETAN
      BOUT(8) = PRT(I,JN)
      IF(LINESR.GT.0) GO TO 571
      WRITE (6,9080)
      WRITE(6,9902)
      LINESR=LNSPPG-4
  571 WRITE(6,9903) I, (BOUT(J), J=1,8 )
      LINESR = LINESR - 1
      IF(I.GE.NY) GO TO 601
      I =MIN0(I+IYPR,NY)
      GO TO 551
  601 IF(IDEAL.GT.0) GO TO 700
      IF (ISPRNT .NE. 0)  GO TO 700
C
```

```
C
      WRITE (6,9000) TITLE
      LINESR = LNSPPG - 5
      WRITE (6,9150)
      LINESR=LINESR-1
      I=1
  650 AOUT(1) = YTIL(I)*BLREF*ZETAN
      AOUT(2)=ALPHA(I,JN,2)/ALPHA(I,JN,1)
      AOUT(3)=SCI(I,JN,1)
      AOUT(4)=SCI(I,JN,2)
      AOUT(5)=SCI(I,JN,3)
      AOUT(6)=SCI(I,JN,4)
      AOUT(7)=SCI(I,JN,5)
      AOUT(8)=SCI(I,JN,6)
      AOUT(9)=SMU(I,JN)*SMUREF
      AOUT(10)=PR(I,JN)
      IF(LINESR.GT.0)GO TO 670
      WRITE (6,9080)
      WRITE (6,9150)
      LINESR = LNSPPG - 4
  670 WRITE (6,9160) I,(AOUT(J),J=1,10)
      LINESR=LINESR-1
      IF (I .GE. NY)  GO TO 700
      I = MIN0(I+IYPR,NY)
      GO TO 650
  700 WRITE (6,9070) ITER
C
C     CHECK IF TIME TO WRITE RESTART TAPE.
C
      IF((IRSWR.EQ.0).OR.((X+1.E-6).LT.XLIM(IDX)))GO TO 1000
C
C     UPDATE ZETA-RELATED QUANTITIES NEEDED FOR RESTART.
C
      ZP=(ZETAN-ZSTAR(I))/(DSZ(I)+DS)
      WRITE (ITAPE) ISTATN,NY,DY,ZETAN,ZETA,ZETAN,ZP,ZETA0,DS,YZETA,
     1              YTZETA,YEDGE,RSTPR,SNTGRL,SQWDS,((U(I,J),H(I,J),
     2              ALPHA(I,J,1),ALPHA(I,J,2),SH(I,J),I=1,NY),J=1,3),(
     3              RHOV(I),I=1,NY),(Y(I),YTIL(I),BGP(I),BGPP(I),I=1,
     4              NMAX)
C
C     ADVANCE PRINT STATION COUNTERS.
C
 1000 ISPRNT=ISPRNT+1
      ILPRNT=ILPRNT+1
      RETURN
 9000 FORMAT (1H1,26X,13A6//)
 9010 FORMAT (9X,7HSTATION,8X,8HX (FEET),15X,1HS,14X,2HDS,14X,2HRW,10X,
     1        6HTHETAW,12X,4HZETA,11X,5HZETAP)
 9020 FORMAT (I16,1P7E16.7/)
 9030 FORMAT (18X,24HEDGE AND WALL CONDITIONS,49X,
     1        18HPROFILE PARAMETERS)
 9040 FORMAT(7X,9HUEB    = ,1PE14.7,7X,9HBME    =,E14.7,17X,9HDLSTAR = ,
     1 E14.7,7X,9HBCF    = ,E14.7/7X,9HTEDGE  = ,E14.7,7X,9HRHOEB  = ,
     2 E14.7,17X,9HTHETA  = ,E14.7,7X,9HSTAN   = ,E14.7/7X,9HSHEB   = ,
     3 E14.7,7X,9HSMUEB  = ,E14.7,17X,9HTAUW   = ,E14.7,7X,9HTAUI   = ,
     4 E14.7/7X,9HPEDGEB = ,E14.7,7X,9HTWALL  = ,E14.7,17X,9HSQW    = ,
```

```
     5 E14.7,7X,9HRTHETA = ,E14.7/7X,9HTHLOSS = ,E14.7,7X,9HSMDWB  = ,
     6 E14.7/)
 9050 FORMAT (54H  NO.          YBAR                Y                U/UE      ,
     1 61H        H/HE            RO/ROE             ROV              EPS     ,
     2 11H          T )
 9060 FORMAT (I5,1P7E16.7,0PF11.1)
 9070 FORMAT (/18H  NO. ITERATIONS =,I3)
 9080 FORMAT (1H1)
 9150 FORMAT (54H  NO.          YBAR               O/F            C(H)       ,
     1 61HC(H2)      C(H2O)       C(O)        C(OH)       C(O2)          MU   ,
     2 11H          PR)
 9160 FORMAT (I5,1P2E16.7,0P6F11.6,1PE14.5,0PF11.6)
 9902 FORMAT(4H NO.,6X,8H    MU    ,12X,1HY,11X,8H  K /UE2,8X,8H RU/REUE,
     1      8X,8HMIXEDDY ,9X,6H UDAG ,11X,4HYDAG,13X,3HPRT)
 9903 FORMAT(I4,1P8E16.7)
      END
```

```
      SUBROUTINE PROFIL
CPROFIL   CALCULATE INITIAL DEPENDENT VARIABLE PROFILES FROM KNOWN WALL
C         AND EDGE CONDITIONS AT S = SINIT.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/MULT  /XN,UEN,PEN,SMDN,YN
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),HPROF(50),      /INPROF/
     1                YBYNH(50),LHPROF,CHYX(6)                          /INPROF/
      COMMON/NEW3  /AFTRNS,PLAW
      COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(6),AFWALL
      COMMON /TPROP / FPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      IF(LUPROF.EQ.0)GO TO 5
C
C     USE EXPERIMENTAL U OR H PROFILES.  FIRST CONVERT ARGUMENT TABLES
C      TO YTIL.
C
```

```
      TMI=YN/(BLREF*ZETAO)
      DO 410 I=1,LUPROF
  410 YBYNU(I) = YBYNU(I)*TMI
      DO 420 I=1,LHPROF
  420 YBYNH(I) = YBYNH(I)*TMI
      DO 425 I=1,LAPROF
  425 YBYNA(I) = YBYNA(I)*TMI
      IUYP=0
      DO 430 I=1,NY
      CALL XNTERP(YTIL(I),UVAL,DUMMYI,IUYP,YBYNU,UPROF,LUPROF,CUYX,IUYP)
  430 U(I,JN) = UVAL*UEDGE
      IF(LAPROF.EQ.0)GO TO 445
      IAYP=0
      DO 440 I=1,NY
      CALL XNTERP (YTIL(I),ALPHA(I,JN,1),DUMMYI,IAYP,YBYNA,APROF,
     1             LAPROF,CAYX,IAYP)
  440 ALPHA(I,JN,2) = 1.0 - ALPHA(I,JN,1)
  445 IF (INCOMP .GT. 0)  GO TO 107
      IHYP=0
      DO 450 I=1,NY

      CALL XNTERP(YTIL(I),HVAL,DUMMYI,IHYP,YBYNH,HPROF,LHPROF,CHYX,IHYP)
      SH(I,JN)=HVAL*SHEDGE
  450 H(I,JN) = SH(I,JN) - U(I,JN)**2/2.0
      GO TO 210
C
C     CALCULATE U PROFILE ACCORDING TO INPUT POWER LAW.
C
    5 TMI = 0.9*YTIL(NY)
      TM2=1./PLAW
      TM3=0.1*YTIL(NY)
      IHI=0
      DO 100 I=1,NY
      IF (IHI .GT. 0)  GO TO 30
      IF (YTIL(I) .LT. TM3)  GO TO 100
      IHI = I
   30 IF (YTIL(I) .GE. TMI)  GO TO 50
      U(I,JN) = UEDGE*(YTIL(I)/TMI)**TM2
      GO TO 100
   50 U(I,JN)=UEDGE
  100 CONTINUE
      SLOPE=U(IHI,JN)/YTIL(IHI)
      DO 105 I=1,IHI
  105 U(I,JN) = YTIL(I)*SLOPE
C
C     CALCULATE H AND SH PROFILES FOR COMPRESSIBLE OR INCOMPRESSIBLE
C     CASE.
C
```

```
      IF(INCOMP.EQ.0)GO TO 120
  107 DO 110 I = 1,NY
      SH(I,JN)=SHWALL
  110 H(I,JN) = SHWALL + U(I,JN)**2/2.0
      GO TO 210
  120 DO 200 I = 1,NY
      H(I,JN)=HWALL+U(I,JN)/UEDGE*(HEDGE-HWALL)
  200 SH(I,JN) = H(I,JN) - U(I,JN)**2/2.0
C
C     CALCULATE CONSTANT ALPHAI PROFILE ACROSS BOUNDARY LAYER.
C                   ALPHAI = ALPHAIE
C
  210 IF (LAPROF .GT. 0)  GO TO 310
      DO 300 I=1,NY
      ALPHA(I,JN,1)=AFWALL+(AFEDGE-AFWALL)*U(I,JN)/UEDGE
  300 ALPHA(I,JN,2) = 1.0 - ALPHA(I,JN,1)
C
C     CALCULATE RHOV PROFILE.
C
  310 TMI = 1.0/YTIL(NY)
      DO 500 I=1,NY
  500 RHOV(I) = SMDW + TMI*YTIL(I)
C
C     CALCULATE CUU AND EPS PROFILES
C
      DO 1000  I=1,NY
      TM2 = YTIL(I)/YTIL(NY)
      CUU(I,JN) = 5.0E-5*UEDGE**2*TM2*(1.0 - TM2)**2
 1000 EPS(I,JN)=REYINF*ZETA0*YTIL(I)*(0.205*TM2*TM2-0.586*TM2+0.431)*      NEW
     1            SQRT(CUU(I,JN))*(2.1832339 - 1.1832339*TM2)*4.1983820    -01


C
C     MOVE FORWARD VALUES TO BACK VALUES.
C
      DO 600 I=1,NY
      U(I,J0)=U(I,JN)
      SH(I,J0)=SH(I,JN)
      H(I,J0)=H(I,JN)
      CUU(I,J0)=CUU(I,JN)
      CUV(I,J0)=CUV(I,JN)
      CVV(I,J0)=CVV(I,JN)
      CWW(I,J0) = CWW(I,JN)
      U(I,JA) = U(I,J0)
      CUU(I,JA) = CUU(I,J0)
      EPS(I,J0) = EPS(I,JN)
      EPS(I,JA) = EPS(I,J0)
      DO 600 IEL = 1,NEL
  600 ALPHA(I,J0,IEL) = ALPHA(I,JN,IEL)
      RETURN
      END
```

```
      SUBROUTINE RDTAPE
CTPREAD   SEARCH RESTART TAPE FOR PROPER STATION AND READ RESTART DATA.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL,        /GPARAM/
     1                SQWDS,SQWO                                        /GPARAM/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/NEWB  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
C
      REWIND ITAPE
   10 READ (ITAPE) ISTATN
      IF(ISTATN-IRSRD)10,30,20
   20 WRITE (6,9000) IRSRD
 9000 FORMAT (//37H THERE IS NO RESTART DATA FOR STATION,I5//)
      CALL EXIT
C
C     READ RESTART DATA FOR STATION IRSRD.
C
   30 BACKSPACE ITAPE
      READ (ITAPE) ISTATN,NY,DY,ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(1),DSZ(1),
     1             YZETA,YTZETA,YEDGE,RSTPR,SNTGRL,SQWDS,((U(I,J),H(I,J)
     2             ,ALPHA(I,J,1),ALPHA(I,J,2),SH(I,J),I=1,NY),J=1,3),(RH
     3             OV(I),I=1,NY),(Y(I),YTIL(I),BGP(I),BGPP(I),I=1,NMAX)
      REWIND ITAPE
C
C     SET OTHER COUNTERS AND CONSTANTS BASED ON RESTART DATA.
C
      NY1=NY-1
      NY2=NY-2
      02DY=0.5/DY
      04DY=0.25/DY
      ODYSQ=1./(DY*DY)
      RETURN
      END
```

```
      SUBROUTINE REACT                                                    A    1
C                                                                         A    8
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),           /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/

      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,    /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,           /INPUT/
     1               PHAZ(30),T1(30),T2(30)                             /INPUT/
C
      DIMENSION ANAME(15,5),DATA(15),V(15)
      EQUIVALENCE (NAME,ANAME)                                            A   18
      DATA IZERO,LANK,OX/2H00,1H ,1HO/
      LOGICAL MOLES
C                                                                         A   21
      DO 20 K = 1,2
      WP(K)=0.                                                            A   23
      HPP(K)=0.                                                           A   24
      RHO(K)=0.                                                           A   25
      VPLS(K)=0.                                                          A   26
      VMIN(K)=0.                                                          A   27
      DO 20 J=1,15                                                        A   30
      LLMT(J)=0                                                           A   31
   20 BOP(J,K) = 0.0
      L=1                                                                 A   36
      DO 40 N = 1,NSPEC
      IF (NAME(N,1).EQ.LANK) GO TO 160                                    A   39
      WRITE (6,230) (NAME(N,I),ANUM(N,I), I = 1,5),PECWT(N),MOLES,
     1              ENTH(N),FAZ(N),RTEMP(N),FOX(N),DENS(N)
      K=2                                                                 A   44
C  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (FOX(N).EQ.OX) K=1                                               A   45
      DO 50 J=1,15                                                        A   46
   50 DATA(J) = 0.0
      RM=0.                                                               A   49
      DO 110 JJ=1,5                                                       A   50
C  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (ANUM(N,JJ).EQ.0.) GO TO 120                                     A   51
      DO 60 J=1,15                                                        A   52
      NJ=J                                                                A   53
      IF (LLMT(J).EQ.0) GO TO 70                                          A   54
      IF (NAME(N,JJ).EQ.LLMT(J)) GO TO 80                                 A   55
60    CONTINUE                                                            A   56
70    L=NJ                                                                A   57
      LLMT(J)=NAME(N,JJ)                                                  A   58
   80 DO 90 KK = 1,105
C  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (ATOM(1,KK).EQ.ANAME(N,JJ)) GO TO 100                            A   60
90    CONTINUE                                                            A   61
```

```
                                                                      A  62
      L=0                                                             A  63
      GO TO 40                                                        A  64
100   RM=RM+ANUM(N,JJ)*ATOM(2,KK)                                     A  65
      V(J)=ATOM(3,KK)
 110  DATA(J) = ANUM(N,JJ)                                            A  68
120   PCWT=PECWT(N)                                                   A  69
      IF (MOLES) PCWT=PCWT*RM                                         A  70
      WP(K)=WP(K)+PCWT                                                A  71
      IF (NAME(N,5).NE.IZERO) HPP(K)=HPP(K)+ENTH(N)*PCWT/RM           A  73
      DO 130 J=1,L
 130  BOP(J,K) = DATA(J)*PCWT/RM + BOP(J,K)
      IF (DENS(N) .LE. 0.0)  GO TO 40
      RHO(K) = RHO(K) + PCWT/DENS(N)

  40  CONTINUE                                                        A  82
160   NREAC=N-1
      IF (L .NE. 0)  GO TO 165
      WRITE (6,220)
 220  FORMAT (//20X,87HERROR IN INPUT NAMES OF REACTANTS, DOES NOT MATCH
     1 NAME IN ATOM ARRAY AS GIVEN IN BLKDTA//)
      RETURN
 165  DO 190 K = 1,2
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (WP(K).EQ.0.) GO TO 190                                      A  85
      HPP(K)=HPP(K)/WP(K)                                             A  86
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (RHO(K).NE.0.) RHO(K)=WP(K)/RHO(K)                           A  88
      DO 170 J=1,L                                                    A  89
      BOP(J,K)=BOP(J,K)/WP(K)                                         A  90
      IF (V(J).LT.0.) VMIN(K)=VMIN(K)+BOP(J,K)*V(J)                   A  91
      IF (V(J).GT.0.) VPLS(K)=VPLS(K)+BOP(J,K)*V(J)                   A  92
                                                                      A  93
170   CONTINUE                                                        A  94
      IF (MOLES) GO TO 190                                            A  95
      DO 180 N=1,NREAC
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (FOX(N).EQ.0X.AND.K.EQ.2) GO TO 180                          A  96
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (FOX(N).NE.0X.AND.K.EQ.1) GO TO 180                          A  97
      PECWT(N)=PECWT(N)/WP(K)                                         A  98
                                                                      A  99
180   CONTINUE                                                        A 100
190   CONTINUE                                                        A 102
      DO 200 N=1,NREAC
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (DENS(N).NE.0.) GO TO 200                                    A 103
      RHO(1)=0.                                                       A 104
      RETURN                                                          A 106
200   CONTINUE
      RETURN
 230  FORMAT (1X,5(A2,1X,F7.4,2X),F8.4,2X,L1,F11.2,2X,A1,2X,F8.3,2X,
     1        A1,3X,F8.5)
      END                                                             A 112-
```

```
      SUBROUTINE SEARCH                                                  A    1
C                                                                        A    2
      DIMENSION DATE(2,30)
      EQUIVALENCE (DATE,EN)
      INTEGER GAS,PHAZ,SUB
      DATA GAS/1HG/
C                                                                        A    9

      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                            /INPUT/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),H0(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IQ2                                     /INDX/
C                                                                        A   24
      NC=0                                                               A   25
      IX=0                                                               A   26
      DO 40 NS = 1,NPROD
      DO 100 K = 1,4
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (B(K,NS) .EQ. 0.0)  GO TO 110
      DO 80 I=1,L                                                        A   51
      IF (LLMT(I) .EQ. MT(K,NS))  GO TO 100
 80   CONTINUE                                                           A   53
      DO 90 J=1,L                                                        A   54
 90   A(J,NS)=0.                                                         A   55
      GO TO 40                                                           A   56
100   A(I,NS) = B(K,NS)
110   IF (NS .EQ. 30)  GO TO 150
      IUSE(NS)=0                                                         A   59
      IF (PHAZ(NS) .EQ. GAS)  GO TO 40
      NC=NC+1                                                            A   61
      TEMP(NC,1) = T1(NS)
      TEMP(NC,2) = T2(NS)
      IX=IX+1                                                            A   64
      IF (IUSE(NS-1).EQ.0.OR.NC.EQ.1) GO TO 130                          A   65
      DO 120 I=1,L                                                       A   66
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (A(I,NS).NE.A(I,NS-1)) GO TO 130                                A   67
120   CONTINUE                                                           A   68
      IX=IX-1                                                            A   69
130   IUSE(NS)=-IX                                                       A   70
 40   CONTINUE
```

```
      GO TO 160
150   WRITE (6,210) (SUB(NS,J),J=1,3)                                    A  73
160   WRITE (6,220)
      DO 170 I=1,NS,5                                                    A  78
      IS=I+4                                                             A  79
      IF (NS.LT.IS) IS=NS                                                A  80
170   WRITE (6,230) (DATE(1,J),DATE(2,J),SUB(J,1),SUB(J,2),SUB(J,3),J=I, A  81
     1IS)                                                                A  82
      RETURN                                                             A  83
210   FORMAT (45HODIMENSIONS IN/SPECES/TOO SMALL TO CONSIDER ,3A4)       A  88
220   FORMAT (42HOSPECIES BEING CONSIDERED IN THIS SYSTEM  )             A  89
230   FORMAT (5(5X,2A3,2X,3A4))                                          A  90
      END                                                                A  91-
```

```
      SUBROUTINE SPCALC
CSPCAL C   PERFORM A SERIES OF ENTROPY-PRESSURE CALCULATIONS.
C                                                                         A   2
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),     /POINTS/
     2                TTT(13)                                           /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,     /MISC/


     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),          /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),   /MISC/
     4              RTEMP(15),FOX(15),DENS(15),YLN                      /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,  /INDX/
     1              JSOL,JLIQ,IC,IQ2                                    /INDX/
      COMMON/INODE /TIN(13),OFIN(13),HIN(13)
C                                                                         A  16
C     SET O-F AND INITIAL TEMPERATURE GUESS.  (ENTROPY STORED AS SO.)
C
      TT=TIN(1)
      WP(1)=OF
      WP(2)=1.
      DO 200 I=1,L
200   BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/(WP(1) + WP(2))
      DO 60 IP=1,NP
C
C     SET ASSIGNED PRESSURE.
C
```

```
      PP=P(IP)
      CALL EQLBRM                                                        A  22
      T = TT
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TT.NE.0.) GO TO 20                                             A  24
      IF (NPT .EQ. 0)  RETURN
20    K=0                                                                A  26
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30                                 A  27
      K=NPT                                                              A  28
      IF (NPT.NE.13) GO TO 40                                            A  29
  30  IF (K .EQ. 0)  RETURN
      NPT=0                                                              A  36
40    NPT=NPT+1                                                          A  37
C     SAVE COMPOSITIONS FOR ESTIMATES OF NEXT POINT                      A  40
      DO 60 I = 1,NS
  60  EN(I,NPT) = EN(I,K)
      RETURN
      END                                                                A  50-
```

```
      SUBROUTINE STEP
CSTEP      DETERMINE NEXT STEPSIZE AND CALCULATE CONTOUR PROPERTIES AT
C          THE FORWARD STATION.
C
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DXI
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB,  /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI, /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20),  /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
```

```
C
C     MOVE FORWARD QUANTITIES TO BACK QUANTITIES;  S AND X HAVE BEEN
C      UPDATED PREVIOUSLY.
C
       THW(1)=THW(2)
       RW(1)=RW(2)
       DRWDX(1)=DRWDX(2)
C
C     DETERMINE NEW DS AND DX.
C
       IF((X+1.E-6).LT.XLIM(IDX))GO TO 30
       DX=DXLIM(IDX)
       DS=DX/COS(THW(1))
       IDX=IDX+1
       GO TO 80
   30  IF (X .LT. XTABSK(ISK))  GO TO 50
       ISK = ISK + 1
       GO TO 30
   50  DX=DX*SKTAB(ISK)
       IF(ISTATN.EQ.1)DX=DX1
       IF((IRSRD.GT.0).AND.(ISTATN.EQ.(IRSRD+1)))DX=DX1
       DS=DX/COS(THW(1))
       IF((X+DX+1.E-6).LT.XLIM(IDX)) GO TO 80
       DX=XLIM(IDX)-X
       DS=DX/COS(THW(1))
       ISPRNT=0
       ILPRNT=0
   80  IF((X+DX+1.E-6).LT.XMAX)GO TO 90
       DX=XMAX-X
       DS=DX/COS(THW(1))

C
C     CALCULATE CONTOUR PROPERTIES AT X + DX.
C
   90  CALL XNTERP (X+DX,RW(2),DRWDX(2),IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
      1                  IRWXP)
       THW(2)=ATAN(DRWDX(2))
       IF (ICOOL .EQ. 0)  RETURN
       IS = ISK
       IF ((X + DX + 1.0E-6) .LT. XLIM(IDX))  GO TO 31
       DX1 = DXLIM(IDX)
       GO TO 81
   31  IF (X + DX .LT. XTABSK(IS))  GO TO 51
       IS = IS + 1
       GO TO 31
   51  DX1 = DX1*SKTAB(IS)
       IF ((X + DX + DX1 + 1.0E-6) .LT. XLIM(IDX))  GO TO 81
       DX1 = XLIM(IDX) - (X + DX)
   81  IF ((X + DX + DX1 + 1.0E-6) .LT. XMAX)  RETURN
       DX1 = XMAX - (X + DX)
       IF (DX1 .LT. 0.0)  DX1 = 0.0
       RETURN
       END
```

```
      SUBROUTINE SUMTAB
CSUMTAB   WRITE SUMMARY TABLE OF IMPORTANT BOUNDARY LAYER PARAMETERS AT
C         EACH STATION
C
      COMMON /TITLE/ TITLE(13)                                          /TITLE/
      COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,ISTA,NVAR,IDRUM,LAST
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
C
C     IF ABNORMAL TERMINATION, WRITE CURRENT SUMMARY TABLE BUFFER ON
C     DRUM.
C
      IF (ISTA .LE. 0)  GO TO 50
      NST = ISTA
      WRITE (IDRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
      NREC=NREC+1
   50 IF (NREC .EQ. 0)  RETURN
      REWIND IDRUM




      DO 100 IREC=1,NREC
      WRITE (6,9000) TITLE
      WRITE (6,9010)
      READ (IDRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
      DO 30 I=1,NST
      SUMARY(I,10)=SUMARY(I,10)/RSTPR
   30 SUMARY(I,20) = SUMARY(I,20)/RSTPR
  100 WRITE (6,9020) ((SUMARY(I,J), J = 1,NVAR), I = 1,NST)
      RETURN
 9000 FORMAT (1H1,26X,13A6)
 9010 FORMAT (13H      STATION,11X,2HRW,10X,3HUEB,10X,3HBME,8X,5HSMUEB,
     1 10X,3HBCF,9X,4HSTAN,7X,6HDLSTAR,8X,5HZETAN,9X,4HRWPR/5X,8HX (FEET
     2),7X,6HTHETAW,11X,2HTE,7X,6HPEDGEB,8X,5HSMDWB,9X,4HTAUW,10X,3HSQW,
     3 8X,5HTHETA,8X,5HZETAP,10X,3HXPR/12X,1HS,11X,2HDS,9X,4HSHEB,8X,
     4 5HRHOEB,9X,4HTLCA,8X,5HTWGCA,8X,5HSQWDS,7X,6HSNTGRL,8X,5HDUEDS,
     5 8X,5HTWLCA)
 9020 FORMAT (0PF13.1,1P9E13.5/10E13.5/10E13.5/)
      END
```

```
      SUBROUTINE TABLES
CTABLES   NORMALIZE TABLES AND INITIALIZE TABLE POINTERS FOR SUBROUTINE
C         XNTERP.  INITIALIZE WALL AND EDGE CONDITIONS FOR PERFECT
C         GAS OR HYDROGEN-OXYGEN SYSTEM.
C
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DXI
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,    /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/MULT  /XN,UEN,PEN,SMDN,YN
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/NEW2 / RHOEB,SMUEB,REYL,SXO
C
      XNORM=XN/BLREF
C
C     NORMALIZE RW VS. X TABLE AND INITIALIZE CONTOUR PROPERTIES.
C
      DO 20 I=1,LRWTAB
      RWTAB(I)=RWTAB(I)*XNORM
   20 XTABRW(I) = XTABRW(I)*XNORM
      IRWXP=0
      CALL XNTERP (X,RW(2),DRWDX(2),IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
     1             IRWXP)
      THW(2)=ATAN(DRWDX(2))
C
C     BACK VALUES EQUAL FORWARD VALUES INITIALLY.
C

      RW(1)=RW(2)
      DRWDX(1)=DRWDX(2)
      THW(1)=THW(2)
C
C     NORMALIZE STEPSIZE TABLES AND INITIALIZE STEPSIZE DS.
C
      DO 50 I=1,LSKTAB
   50 XTABSK(I) = XTABSK(I)*XNORM
      ISK=1
      DO 100 I=1,LDXLIM
  100 XLIM(I) = XLIM(I)*XNORM
      IDX=1
      DX=DXI
      DS=DX/COS(THW(1))
```

```
C
C     SET UP MDOTW VS. X TABLE AND INITIALIZE SMDWN.
C
      DO 250 I=1,LMDTAB
      SMDTAB(I)=SMDTAB(I)*SMDN
 250  XTABMD(I) = XTABMD(I)*XNORM
      IMDXP=0
      CALL LCURV (X,XTABMD,SMDTAB,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETAO)
C
C     BACK AND AVERAGE VALUES EQUAL FORWARD VALUES INITIALLY.
C
      SMDWO=SMDWN
      SMDW=SMDWN
C
C     SET UP TW VS. X TABLE AND INITIALIZE TWALL.
C
      DO 300 I=1,LTWTAB
 300  XTABTW(I) = XTABTW(I)*XNORM
      ITWXP=0
      CALL LCURV (X,XTABTW,TWTAB,LTWTAB,ITWXP,TWALL)
      IF(IDEAL.GT.0)GO TO 390
C
C     H Y D R O G E N - O X Y G E N   E Q U I L I B R I U M .
C     PRESSURE TABLE HAS BEEN INPUT.  SET UP PE VS. X TABLE FOR
C      ISENTROPIC EXPANSION.
C
      DO 350 I=1,LPETAB
      PETAB(I)=PETAB(I)*PEN
 350  XTABPE(I) = XTABPE(I)*XNORM
      IPEXP=0
C
C     CALL HOODE TO DO ISENTROPIC EXPANSION AT EDGE OF BOUNDARY LAYER
C      TO OBTAIN EDGE VELOCITY TABLE UETAB.
C      (PEDGE AND TEDGE HAVE BEEN INPUT.)
C
      CALL HOODE (2)
C
C     SET VELOCITY TABLE LENGTH AND FLAGS.  (XTABPE IS ARGUMENT TABLE
C      FOR UETAB.)
C
      LUETAB=LPETAB
      IUEXP=0
```

```
C
C     CALL HOODE TO EVALUATE HWALL = SHWALL.
C
      CALL HOODE (3)
      GO TO 500
C
C     P E R F E C T   G A S   O P T I O N .
C     CALL IGODE FOR PERFECT GAS OPTION TO OBTAIN SHWALL AND HWALL.
C
  390 CALL IGODE (TWALL,SHWB,PEDGEB,1,DUMMY1,DUMMY2,DUMMY3)
      SHWALL=SHWB/(UREF*UREF)
      HWALL=SHWALL
C
C     CALL IGODE WITH TEDGE AND PEDGE TO OBTAIN SHEDGE AND HEDGE.
C      (HEDGE IS A CONSTANT.)
C
      CALL IGODE (TEDGE,SHEB,PEDGEB,1,RHOEB,SMUEB,DUMMY1)
      SHEDGE=SHEB/(UREF*UREF)
      HEDGE=SHEDGE+UEDGE*UEDGE/2.
C
C     GIVEN A PRESSURE TABLE, GENERATE A VELOCITY TABLE, OR VICE VERSA.
C
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(PETAB(1).EQ.0.)GO TO 450
      TM1=(GAMMA-1.)/GAMMA
      DO 410 I=1,LPETAB
      PETAB(I)=PETAB(I)*PEN
      XTABPE(I)=XTABPE(I)*XNORM
      SHE=SHEDGE*(PETAB(I)/PEDGEB)**TM1
  410 UETAB(I) = SQRT(2.0*(HEDGE - SHE))
      LUETAB=LPETAB
      IPEXP=0
      IUEXP=0
      GO TO 500
  450 FNORM = UEN/UREF
      TM1=GAMMA/(GAMMA-1.)
      PTOT = PEDGEB*(SHEDGE/HEDGE)**(-TM1)
      DO 460 I=1,LUETAB
      UETAB(I)=UETAB(I)*FNORM
      XTABPE(I)=XTABPE(I)*XNORM
      SHE=HEDGE-UETAB(I)**2/2.
      PETAB(I) = PTOT*(SHE/HEDGE)**TM1
      IF (INCOMP .EQ. 1)  PETAB(I) = PEDGEB + 0.50*RHOEB*(UEDGE**2 -
     1                               UETAB(I)**2)*UREF**2
  460 CONTINUE
      LPETAB=LUETAB
      IUEXP=0
      IPEXP=0
C
C     EVALUATE PEDGEB, DPEDSN, AND UEDGE FROM TABLES GENERATED.
C
  500 CALL XNTERP (X,UEDGE,DUMMY1,IUEXP,XTABPE,UETAB,LUETAB,CUEX,IUEXP)
C
C     WRITE VELOCITY TABLE UETAB VERSUS XTABPE.
C
      WRITE (6,9000)
 9000 FORMAT (1H1)
```

```
      WRITE (6,9010) (UETAB(I),I=1,LUETAB)
 9010 FORMAT (25H VELOCITY TABLE GENERATED//5X,13HEDGE VELOCITY//
     1        (8E15.6))
      WRITE (6,9020) (XTABPE(I),I=1,LUETAB)
 9020 FORMAT (/5X,14HAXIAL DISTANCE//(8E15.6))
C
C     USING UETAB VERSUS XTABPE, GENERATE A TABLE OF LINEAR DUEDX VERSUS
C     X AT MIDPOINTS.  INCLUDE FIRST AND LAST X.  START AT END OF UETAB.
C
      IF(LUETAB.GT.1)GO TO 520
      LDUDXT=0
      UETAB(1) = 0.0
      GO TO 560
  520 LDUDXT = LUETAB + 1
      XTDUDX(LDUDXT)=XTABPE(LUETAB)
      UETAB(LDUDXT) = (UETAB(LUETAB) - UETAB(LUETAB-1))/(XTABPE(LUETAB)
     1                 - XTABPE(LUETAB-1))
      LM1=LUETAB-1
      DO 550 I=1,LM1
      J=LUETAB+1-I
      XTDUDX(J)=0.5*(XTABPE(J-1)+XTABPE(J))
  550 UETAB(J) = (UETAB(J) - UETAB(J-1))/(XTABPE(J) - XTABPE(J-1))
      XTDUDX(1)=XTABPE(1)
      UETAB(1) = UETAB(2)
      IDUDXP=0
C
C     INITIALIZE VELOCITY DERIVATIVE.
C
  560 CALL LCURV (X,XTDUDX,UETAB,LDUDXT,IDUDXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
C
C     BACK AND AVERAGE VALUES EQUAL FORWARD VALUES INITIALLY.
C
      DUEDSO=DUEDSN
      DUEDS=DUEDSN
      CALL XNTERP (X,PEDGEB,DPEDX ,IPEXP,XTABPE,PETAB,LPETAB,CPEX,
     1             IPEXP)
      RETURN
      END
```

```
CTFCBL     TRANSPIRATION AND FILM COOLING BOUNDARY LAYER PROGRAM
C          INITIALIZATION AND CONTROL ROUTINE
C      CHANGES TO TFCBL
C
       COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
       COMMON/INDEP /S,DS,X,DX,Y(250),DY
       COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
      1               SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
       COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
       COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
      1                CYTIL(6)                                           /YTABLE/
       COMMON/MATRX /A(250,3),B(250)
       COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
      1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
      2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
      3                         XTDUDX(500),LDUDXT,IDUDXP
       COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
      1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
       COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
      1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
      2              DXI
       COMMON/EFVEC /E(250),F(250)
       COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
       COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
       COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
      1               YTZETA,YEDGE                                        /ZCALC/
       COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
       COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,     /EDGEBC/
      1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
       COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
       COMMON/MULT  /XN,UEN,PEN,SMDN,YN
       COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL,        /GPARAM/
      1                SQWDS,SQW0                                         /GPARAM/
       COMMON/CONST /SINIT,XINIT,XMAX,DFLTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
      1              EPSLN3,CONVRG,02DY,04DY,ODYSQ
       COMMON /TITLE/ TITLE(13)                                           /TITLE/
       COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
       COMMON/OPTION/IDEAL,LAMNR,INCOMP
       COMMON/STATN /ISTATN,MAXIT,ITER
       COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
       COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,NVAR,IDRUM,LAST
       COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
       COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),HPROF(50),      /INPROF/
      1                YBYNH(50),LHPROF,CHYX(6)                           /INPROF/
       COMMON/PFGAS /GAMMA,FMOLWT,PRI
       COMMON/NEW1  /ALEWIS,TLEWIS
       COMMON/NEW2 / RHOEB,SMUEB,REYL,SXO
       COMMON/NEW3  /AFTRNS,PLAW
       COMMON/NEW5  /IYPR
       COMMON/NEW7  /GPO,PAMB,INTOK,ZETAPI
       COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
       COMMON/NEW9  /IYEQ
       COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAVP,CAYX(6),AFWALL
       COMMON/NEW11 /J2D,UEK,RHOEK
       COMMON/RSTART/IRSRD,IRSWR,ITAPE
       COMMON /AL/ INSTAT,EPSLIN
```

```
      COMMON /INPUT/ C(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB, /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,   /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REY,SQWDSI, /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,   /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20), /COOL/
     4              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE             /COOL/

      REAL MASSL                                                         /COOL/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      DATA BLANK,PIE/6H      ,3.141592653/
      DIMENSION CPITAB(500),PITAB(500),ROITAB(500),TITAB(500),VITAB(500)
     1          ,XA(1500),XITAB(500),YA(1500),YITAB(500),ZMTAB(500)
      EQUIVALENCE (CPITAB,SHI(1,1,3)),(PITAB,PETAB),(ROITAB,SHI(1,1,5)),
     1            (TITAB,SHI(1,1,2)),(VITAB,SHI(1,1,4)),(XITAB,XTABRW),
     2            (YITAB,RWTAB),(ZMTAB,SHI(1,1,1)),(PEDGE,PEDGEB),
     3            (XA,SCI),(SCI(1,1,4),YA)
C
      NAMELIST /DATA/ AFEDGE,AFTRNS,AFWALL,ALTAB,APROF,BLREF,COEFCL,     /DATA/
     1                CONVRG,CPLTAB,DELTAI,DXI,DXLIM,EPSLIN,EPSLNI,      /DATA/
     2                EPSLN2,EPSLN3,FMOLWT,GAMMA,GPO,HPROF,ICOOL,IDEAL,  /DATA/
     3                IDEBUG,INCOMP,INSTAT,INTDK,IPOLY,IRSRD,IRSWR,      /DATA/
     4                ITHERM,ITZTAB,IYEQ,IYPR,J2D,LAMNR,LAPROF,LDXLIM,   /DATA/
     5                LHPROF,LMDTAB,LPETAB,LRWTAB,LSKTAB,LTWTAB,LUETAB,  /DATA/
     6                LUPROF,MASSL,MAXIT,NLPRNT,NSPRNT,NTI,PAMB,PEDGE,   /DATA/
     7                PEN,PETAB,PLAW,PRI,RAMDW,RAMTAB,RHOEK,RHOREF,RWTAB /DATA/
     8               ,SINIT,SKTAB,SMDN,SMDTAB,SMUREF,SN3,TEDGE,THITAB,   /DATA/
     9                TLTAB,TUBEN,TWTAB,TZTAB,UEDGE,UEK,UEN,UETAB,UPROF, /DATA/
     A                UREF,XINIT,XLIM,XMAX,XN,XSTAR,XTABMD,XTABPE,XTABRW /DATA/
     K               ,XTABSK,XTABTW,YBYNA,YBYNH,YBYNU,YN,ZETAPI,ZMYTAB,  /DATA/
     1                GAMA,ZK                                            /DATA/
C
      NAMELIST/TDKINP/XITAB,YITAB,PITAB,ZMTAB,TITAB,CPITAB,VITAB,ROITAB
C
C     SET CONSTANTS.
C
      NMAX=250
      LNSPPG = 58
      ITHERM = 0
      JO=1
      JN=2
      JA=3
      ALEWIS=1.
      TLEWIS=1.
C
C     INITIALIZE SUMMARY TABLE FLAGS, COUNTERS, AND CONSTANTS.
C
      NREC=0
      LAST=0
      NSTA=13
      ISTA=0
      NVAR = 30
      IDRUM=17
```

```
C
C     INITIALIZE RESTART FLAGS.
C
      ITAPE=16
      REWIND ITAPE
      IRSRD=0
      IRSWR=0
C
C     SET NOMINAL VALUES.
C
      DO 15 I=1,10

   15 TITLE(I) = BLANK
      BLREF=1.
      UREF=1.
      RHOREF=1.
      SMUREF=1.
      XN=1.
      YN=1.
      PEN=1.
      SMDN=1.
      UEN=1.
      PRI=0.
      PLAW=1.
      PAMB = 0.0
      XSTAR = 0.0
      AFWALL=-9999.
      GAMA = 0.150
      ZK = 0.40
      EPSLIN = 0.090
      INSTAT = 9999
      IPOLY = 0
      CONVRG=.005
      EPSLN1=.03
      EPSLN2=.03
      EPSLN3=.03
      IDEAL=1
      LAMNR=0
      INTDK=0
      NSPRNT=9999
      NLPRNT=50
      J2D=1
      IYPR=1
      IYEQ=4
      NEL=2
      NSP=1
      MAXIT=1
C
C     READ INPUT DATA.
C
```

```
 999  READ (5,9100) TITLE
9100  FORMAT (13A6)
      READ (5,DATA)
      SQWI = 0.0
      SQWDSI = 0.0
      SUMQWI = 0.0
      ITPOS = 1
      IZX = 0
      ICX = 0
      IRX = 0
      IAX = 0
      ITHX = 0
      ITLX = 0
C
C     IF RW, X, AND PE TABLES ARE INPUT FROM TDK, READ TDKINP NAMELIST.
C     UNUSED TDK TABLES ARE TEMPORARILY READ INTO SHI ARRAY.
C
      IF(INTDK.EQ.0)GO TO 20
      READ (5,TDKINP)

      DO 16 I=1,LRWTAB
  16  XTABPE(I) = XTARRW(I)
      DO 18 J=1,5
      DO 18 I=1,NMAX
      SHI(I,1,J)=0.
  18  SHI(I,2,J) = 0.0
C
C     PRINT TECPL INPUT DATA.
C
  20  CALL NLOUT
C
C     READ EQUILIBRIUM CHEMISTRY DATA AND INITIALIZE STORAGE IN ODE.
C      (PROGRAM PRESENTLY HANDLES HYDROGEN-OXYGEN SYSTEM ONLY.)
C
      IF(IDEAL.EQ.0)CALL HOODE (1)
C
C     SET CONSTANTS BASED ON INPUT.
C
      NEL1=NEL-1
*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF((IDEAL.GT.0).AND.(PRI.EQ.0.))PRI=.72
      IF(AFWALL.LT.0.)AFWALL=AFTRNS
      XNORM=XN/BLREF
      XINIT=XINIT*XNORM
      SINIT=SINIT*XNORM
      XMAX=XMAX*XNORM
      XSTAR=XSTAR*XNORM
      RSTPR=1.
      REYINF = RHOREF*UREF*BLREF/SMUREF
      UEDGE=UEDGE*UEN/UREF
      PEDGEB=PEDGEB*PEN
      PAMB=PAMB*PEN
```

```
C
C     INITIALIZE X, S, AND ZETA.
C
      X=XINIT
      S=SINIT
C
C     CHECK IF THIS CASE IS RESTARTED FROM A PREVIOUS CASE.  IF SO,
C     REINITIALIZE TABLES AND SKIP APPROPRIATE INITIALIZATION.
C
      IF (IRSRD .LE. 0)  GO TO 220
      CALL RDTAPE
      CALL TABLES
      UEDGE=U(NY,JN)
      DO 216 J=1,2
      DO 216 I = 1,NY
      U(I,J)=U(I,JN)
      H(I,J)=H(I,JN)
      CUU(I,J)= CUU(I,JN)
      CUV(I,J)= CUV(I,JN)
      CVV(I,J)= CVV(I,JN)
      CWW(I,J)= CWW(I,JN)
      EPS(I,J) = EPS(I,JN)
      SH(I,J)=SH(I,JN)
      ALPHA(I,J,1)=ALPHA(I,JN,1)
  216 ALPHA(I,J,2) = ALPHA(I,JN,2)

      GO TO 37
  220 ZETA0 = 0.83333333*DELTA1/BLREF
      ZETAN=ZETA0
C
C     IF U OR SH PROFILES WERE INPUT, DETERMINE ZETA0 FROM U PROFILE
C     IF INCOMPRESSIBLE OR SH PROFILE IF COMPRESSIBLE.
C
      IF(LUPROF.EQ.0)GO TO 290
      IF(INCOMP.EQ.0)GO TO 240
      DO 235 K=1,LUPROF
      I=LUPROF+1-K
      TM1=ABS((UPROF(I)-UPROF(LUPROF))/UPROF(LUPROF))
      IF (TM1 .GE. 0.010)  GO TO 233
      TM2 = TM1
      GO TO 235
  233 YBYNZ=YBYNU(I+1)-(YBYNU(I+1)-YBYNU(I))*(TM2-0.01)/(TM2-TM1)
      GO TO 250
  235 CONTINUE
  240 DO 245 K = 1,LHPROF
      I=LHPROF+1-K
      TM1=ABS((HPROF(I)-HPROF(LHPROF))/HPROF(LHPROF))
      IF (TM1 .GE. 0.010)  GO TO 243
      TM2 = TM1
      GO TO 245
  243 YBYNZ=YBYNH(I+1)-(YBYNH(I+1)-YBYNH(I))*(TM2-0.01)/(TM2-TM1)
      GO TO 250
  245 CONTINUE
  250 ZETA0 = YN/BLREF*YBYNZ
      ZETAN=ZETA0
```

```
C
C     SET INITIAL ALPHAW FOR T-P EQUILIBRIUM CALCULATION.
C
      AFWALL=APROF(1)
C
C     SET UP TABLES AND INITIALIZE X-DEPENDENT WALL AND EDGE CONDITIONS.
C
  290 CALL TABLES
      XMAX=AMIN1(XMAX,XLIM(LDXLIM),XTABSK(LSKTAB))
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(ZETAPI.EQ.0.)GO TO 23
      ZETAP=ZETAPI
      GO TO 35
C
C     CALCULATE INITIAL ZETAP IF NOT INPUT.
C
   23 REYL = RHOEB*UEDGE*UREF*BLREF/SMUEB
      IF (LAMNR .LE. 0)  GO TO 30
      SX0 = REYL*ZETA0**2*0.040
      ZETAP=2.5*SQRT(1./(REYL*SX0))
      GO TO 35
   30 SX0=((DELTA1/(BLREF*.37))**5*REYL)**.25
      ZETAP=.833*.37*.8/((REYL*SX0)**.2)
   35 ZSTAR(1) = ZETA0 - DS*ZETAP
      DSZ(1)=DS
C
C     SET UP ARRAYS OF Y, YTIL,BGP, AND BGPP AT EACH MESH POINT.
C
      CALL GFUNC
      O2DY=0.5/DY
      O4DY=0.25/DY
      ODYSQ=1./(DY*DY)
C
C     INITIALIZE U, H, SH, ALPHAI, AND RHOV PROFILES ACROSS THE BOUNDARY
C     LAYER.
C
      CALL PROFIL
      WRITE(6,31)
   31 FORMAT (1H1,33X,2HNO,17X,1HU,19X,1HK,18X,3HEPS/)
      DO 32 I=1,NY
      A1 = U(I,JN)/U(NY,JN)
      A2 = CUU(I,JN)/U(NY,JN)**2
      A3 = EPS(I,JN)*SMUREF
   32 WRITE (6,36) I,A1,A2,A3
   36 FORMAT (33X,I3,4X,1P3E20.7)
C
C     CALCULATE LAMINAR TRANSPORT AND THERMODYNAMIC PROPERTIES AT EACH
C     MESH POINT.  (BLE CONSTANT FOR NOW)
C
   37 DO 40 I = 1,NY
   40 BLE(I,JN) = ALEWIS
      IF(IDEAL.GT.0)GO TO 50
      CALL HOODE (4)
      GO TO 70
```

```
C
C     PRESET QUANTITIES WHICH ARE CONSTANT FOR IDEAL GAS OPTION.
C
   50 DO 60 I = 1,NY
      ALPHA(I,JN,1)=1.
      SHI(I,JN,1)=1.
   60 SCI(I,JN,1) = 1.0
      DO 100 I=1,NY
      SHB=SH(I,JN)*UREF*UREF
      CALL IGODE (T(I,JN),SHB,PEDGEB,0,RHOB,SMUB,PR(I,JN))
      RHO(I,JN)=RHOB/RHOREF
  100 SMU(I,JN) = SMUB/SMUREF
C
C     PRESET TURBULENT QUANTITIES.
C
   70 DO 80 I = 1,NY
        F(I)= BGP(I)/(ZETAN*ZETAN*REYINF)
      E(I) = RHO(I,JN)*BGP(I)*ZETAP*YTIL(I)/ZETAN
      PRT(I,JN)=1.
   80 BLET(I,JN) = 1.0
C
C     CALCULATE TURBULENT TRANSPORT PROPERTIES AT EACH MESH POINT.
C
      IF ( LAMNR.EQ. 0 ) GO TO 81
      DO 82  I=1,NY
   82 EPS(I,JN) = 0.0
      GO TO 83
   81 CALL EDDY
C
C     MOVE FORWARD TO BACK VALUES.
C

   83 DO 120 I = 1,NY
      RHO(I,J0)=RHO(I,JN)
      SMU(I,J0)=SMU(I,JN)
      PR(I,J0)=PR(I,JN)
      BLE(I,J0)=BLE(I,JN)
      CUU(I,J0) = CUU(I,JN)
      CUV(I,J0) = CUV(I,JN)
      CVV(I,J0) = CVV(I,JN)
      CWW(I,J0) = CWW(I,JN)
      DO 110 ISP=1,NSP
      SHI(I,J0,ISP)=SHI(I,JN,ISP)
  110 SCI(I,J0,ISP) = SCI(I,JN,ISP)
      T(I,J0)=T(I,JN)
      EPS(I,J0)=EPS(I,JN)
      PRT(I,J0)=PRT(I,JN)
  120 BLET(I,J0) = BLET(I,JN)
```

```
C
C     CALCULATE GROSS BOUNDARY LAYER PARAMETERS AT S = SINIT.
C
      IF(IRSRD.GT.0)RHO(NY,JA)=RHO(NY,JN)
      CALL PARAMS
C
C     PRINT AT INITIAL STATION.
C
      IF(IRSRD.EQ.0)ISTATN=0
      ISPRNT=0
      ILPRNT=0
      CALL PRINT
C
C     HAVING COMPLETED ALL INITIALIZATION, SOLVE THE BOUNDARY LAYER FROM
C      X = XINIT TO X = XMAX.
C
      CALL EXECUT
      IF(RSTAR.GT.0.)WRITE (6,9800) RSTPR
 9800 FORMAT (////42H THROAT RADIUS CORRECTED FOR DISPLACEMENT ,
     1        11HTHICKNESS =,1PE14.7)
      WRITE (6,330)
  330 FORMAT (///27X,75HTABLE OF CORRECTED CONTOUR POINTS NORMALIZED AND
     1 DIMENSIONAL AND DELTA STAR///17X,14HX (NORMALIZED),11X,
     2 14HY (NORMALIZED),8X,17HDELTA STAR (FEET),13X,11HX (IN FEET),
     3 14X,11HY (IN FEET)//)
      M = 0
      MAP = 0
      REWIND IDRUM
      DO 300 K = 1,NREC
      READ (IDRUM) NST,((SUMARY(I,J), J = 1,NVAR), I = 1,NST)
      DO 300 L = 1,NST
      XCCP = SUMARY(L,20)/RSTPR
      YCCP = SUMARY(L,10)/RSTPR
      IF (SUMARY(L,20) .LT. XSTAR)  GO TO 310
      MAP = MAP + 1
      XA(MAP) = XCCP
      YA(MAP) = YCCP
  310 M = M + 1
  300 WRITE (6,340) M,XCCP,YCCP,SUMARY(L,8),SUMARY(L,20),SUMARY(L,10)
  340 FORMAT (I5,1X,1PSE25.8)
    THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(RHOEK.EQ.0.)RHOEK=RHO(NY,JN)*RHOREF
    THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(UEK.EQ.0.)UEK=U(NY,JN)*UREF
      PAREN=THETA-BLREF*SNTGRL*RHOREF*UREF/(RHOEK*UEK*RW(2)**J2D)
      THI=RHOEK*UEK*UEK
      BRKT=THI*PAREN-(PEDGEB-PAMB)*DLSTAR
      THLOSS=(2.*PIE*RW(2)*BLREF)**J2D*COS(THW(2))*BRKT
      WRITE (6,9900) THLOSS
 9900 FORMAT (////14H THRUST LOSS =,1PE14.7)
      IF (IPOLY .EQ. 0)  STOP
      CALL LESQAR (XA,YA,MAP)
      END
```

```
      SUBROUTINE TPCALC
CTPCALC   PERFORM A SINGLE TEMPERATURE-PRESSURE CALCULATION.
C
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),
     2                TTT(13)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),
     3              NAMF(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),
     4              RTEMP(15),FOX(15),DENS(15),TLN
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,
     1              JSOL,JLIQ,IC,IQ2
C
      PP=P(1)

      TT = T
      WP(1)=OF
      WP(2)=1.
      SUM=WP(1)+WP(2)
      DO 200 I=1,L
  200 BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/SUM
      CALL EQLBRM
      T = TT
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TT .EQ. 0.0)  RETURN
      CALL ANSWER
      RETURN
      END
```

```
      SUBROUTINE TRIM (A,X,B,N,NN)
C
      DIMENSION A(NN,3),AA(250),B(NN),BB(250),X(NN)
C
C         FORWARD ELIMINATION
C
      AA(1)=A(1,3)/A(1,2)
      BB(1)=B(1)/A(1,2)
      DO 1 I=2,N
      AAA=A(I,2)-AA(I-1)*A(I,1)
      AA(I)=A(I,3)/AAA
    1 BB(I)=(B(I)-BB(I-1)*A(I,1))/AAA
C
C         BACK SUBSTITUTION
C
      X(N)=BB(N)
      DO 2 I=2,N
      J=N-I+1
    2 X(J)=BB(J)-X(J+1)*AA(J)
      RETURN
      END
```

```
      SUBROUTINE VISCX
CVISCX    ROUTINE TO CALCULATE VISCOSITY AND PRANDTL NUMBER FOR
C         HYDROGEN-OXYGEN SYSTEM FROM MIXTURE FORMULAS.  THIS SUBROUTINE
C         REPLACES ODE SUBROUTINE VISCX.
C
C                   VISCOSITIES (LBM/FT-SEC) STORED IN VISCE(I).
C                   PRANDTL NUMBER STORED IN PR(I).
C
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,    /INDX/
     1              JSOL,JLIQ,IC,IQ2                                      /INDX/
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1                GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),      /POINTS/
     2                TTT(13)                                            /POINTS/
      COMMON/SPECES/COEF(2,7,30),S(30),EN(30,13),DUM2(760)
      COMMON /VISCX0/ VISCE(13),PR(13)                                   /VISCX0/
      COMMON/CPI    /CPI(30),CPBAR
C
      DIMENSION EKD(6),FMU(6),FMWT(6),PHI(6,6),SMUH(50),SMUH2(50),
     1          SMUH2O(50),SMUO(50),SMUOH(50),SMUO2(50),TTAB(50)
C
C     SPECIES MOLECULAR WEIGHTS STORED IN FMWT IN SAME ORDER AS THERMO
C      DATA, NAMELY (1) H   (2) H2   (3) H2O   (4) O   (5) OH   (6) O2
C
      DATA (FMWT(I),I=1,6)/1.008,2.016,18.016,16.000,17.008,32.000/
```

```
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I= 1,10)/
     1    100.,  34.3E-6,  37.8E-6,  40.0E-6,  70.0E-6,  78.1E-6,  76.6E-6,
     2    200.,  56.9E-6,  66.6E-6,  77.1E-6, 135.1E-6, 144.2E-6, 147.9E-6,
     3    300.,  74.9E-6,  89.2E-6, 109.6E-6, 188.6E-6, 196.7E-6, 206.4E-6,
     4    400.,  90.3E-6, 108.6E-6, 143.2E-6, 234.4E-6, 241.4E-6, 256.5E-6,
     5    500., 104.2E-6, 126.1E-6, 178.6E-6, 275.0E-6, 281.2E-6, 301.0E-6,
     6    600., 117.5E-6, 142.0E-6, 214.9E-6, 311.9E-6, 318.0E-6, 341.4E-6,
     7    700., 129.9E-6, 156.8E-6, 251.5E-6, 346.4E-6, 352.2E-6, 379.1E-6,
     8    800., 141.7E-6, 170.8E-6, 287.9E-6, 379.0E-6, 384.2E-6, 414.8E-6,
     9    900., 153.0E-6, 184.5E-6, 323.5E-6, 409.8E-6, 414.5E-6, 448.5E-6,
     *   1000., 163.8E-6, 197.8E-6, 358.7E-6, 439.1E-6, 443.4E-6, 480.6E-6/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMHOH(I),SMUO2(I)
     *     ,I=11,20)/
     1   1100., 174.2E-6, 210.5E-6, 393.2E-6, 467.1E-6, 471.5E-6, 511.2E-6,
     2   1200., 184.3E-6, 222.8E-6, 426.7E-6, 494.0E-6, 499.1E-6, 540.6E-6,
     3   1300., 194.0E-6, 234.7E-6, 459.3E-6, 520.0E-6, 526.3E-6, 569.1E-6,
     4   1400., 203.5E-6, 246.2E-6, 491.0E-6, 545.3E-6, 552.5E-6, 596.8E-6,
     5   1500., 212.8E-6, 257.5E-6, 521.7E-6, 570.2E-6, 577.9E-6, 624.0E-6,
     6   1600., 221.8E-6, 268.5E-6, 551.6E-6, 594.7E-6, 602.7E-6, 650.9E-6,
     7   1700., 230.7E-6, 279.2E-6, 580.7E-6, 619.3E-6, 627.0E-6, 677.8E-6,
     8   1800., 239.3E-6, 289.7E-6, 609.0E-6, 642.9E-6, 650.7E-6, 703.7E-6,
     9   1900., 247.8E-6, 300.0E-6, 636.7E-6, 666.1E-6, 673.9E-6, 729.0E-6,
     *   2000., 256.2E-6, 310.1E-6, 663.7E-6, 688.8E-6, 696.7E-6, 753.8E-6/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=21,30)/
     1   2100., 264.0E-6, 320.1E-6, 690.1E-6, 711.0E-6, 719.1E-6, 778.2E-6,
     2   2200., 272.4E-6, 329.8E-6, 716.0E-6, 732.9E-6, 741.0E-6, 802.1E-6,
     3   2300., 280.3E-6, 339.4E-6, 741.3E-6, 754.3E-6, 762.6E-6, 825.6E-6,
     4   2400., 288.1E-6, 348.9E-6, 766.2E-6, 775.5E-6, 783.9E-6, 848.7E-6,
     5   2500., 295.8E-6, 358.2E-6, 790.5E-6, 796.3E-6, 804.9E-6, 871.5E-6,
     6   2600., 303.4E-6, 367.3E-6, 814.5E-6, 816.8E-6, 825.5E-6, 894.0E-6,
     7   2700., 310.9E-6, 376.4E-6, 838.0E-6, 837.0E-6, 845.9E-6, 916.1E-6,
     8   2800., 318.2E-6, 385.3E-6, 861.1E-6, 856.9E-6, 866.0E-6, 937.9E-6,
     9   2900., 325.5E-6, 394.1E-6, 883.8E-6, 876.6E-6, 885.8E-6, 959.5E-6,
     *   3000., 332.7E-6, 402.8E-6, 906.1E-6, 896.1E-6, 905.4E-6, 980.7E-6/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=31,40)/
     1   3100., 339.8E-6, 411.5E-6, 928.0E-6, 915.3E-6, 924.8E-6, 1001.E-6,
     2   3200., 346.9E-6, 420.0E-6, 949.6E-6, 934.2E-6, 943.9E-6, 1022.E-6,

     3   3300., 353.8E-6, 428.4E-6, 971.1E-6, 953.0E-6, 962.8E-6, 1043.E-6,
     4   3400., 360.7E-6, 436.7E-6, 992.2E-6, 971.6E-6, 981.5E-6, 1063.E-6,
     5   3500., 367.5E-6, 444.9E-6, 1013.E-6, 989.9E-6, 1000.E-6, 1083.E-6,
     6   3600., 374.2E-6, 453.1E-6, 1033.E-6, 1008.E-6, 1018.E-6, 1103.E-6,
     7   3700., 380.9E-6, 461.2E-6, 1053.E-6, 1026.E-6, 1036.E-6, 1123.E-6,
     8   3800., 387.5E-6, 469.2E-6, 1073.E-6, 1043.E-6, 1054.E-6, 1142.E-6,
     9   3900., 394.1E-6, 477.1E-6, 1093.E-6, 1061.E-6, 1072.E-6, 1161.E-6,
     *   4000., 400.6E-6, 485.0E-6, 1112.E-6, 1079.E-6, 1090.E-6, 1181.E-6/
```

```
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=41,50)/
     1   4100.,407.0E-6,492.7E-6,1131.E-6,1096.E-6,1107.E-6,1199.E-6,
     2   4200.,413.4E-6,500.5E-6,1150.E-6,1113.E-6,1124.E-6,1218.E-6,
     3   4300.,419.7E-6,508.1E-6,1169.E-6,1130.E-6,1142.E-6,1237.E-6,
     4   4400.,426.0E-6,515.7E-6,1188.E-6,1147.E-6,1159.E-6,1255.E-6,
     5   4500.,432.2E-6,523.2E-6,1206.E-6,1164.E-6,1176.E-6,1274.E-6,
     6   4600.,438.4E-6,530.7E-6,1224.E-6,1180.E-6,1192.E-6,1292.E-6,
     7   4700.,444.5E-6,538.1E-6,1243.E-6,1197.E-6,1209.E-6,1310.E-6,
     8   4800.,450.6E-6,545.5E-6,1261.E-6,1213.E-6,1226.E-6,1328.E-6,
     9   4900.,456.6E-6,552.8E-6,1278.E-6,1229.E-6,1242.E-6,1346.E-6,
     *   5000.,462.6E-6,560.0E-6,1296.E-6,1246.E-6,1258.E-6,1363.E-6/
C
      DO 100 I=1,NPT
C
C     OBTAIN SPECIES VISCOSITIES FROM TABLES.
C
      IX=0
      CALL LCURV (TTT(I),TTAB,SMUH,50,IX,EMU(1))
      CALL LCURV (TTT(I),TTAB,SMUH2,50,IX,EMU(2))
      CALL LCURV (TTT(I),TTAB,SMUH2O,50,IX,EMU(3))
      CALL LCURV (TTT(I),TTAB,SMUO,50,IX,EMU(4))
      CALL LCURV (TTT(I),TTAB,SMUOH,50,IX,EMU(5))
      CALL LCURV (TTT(I),TTAB,SMUO2,50,IX,EMU(6))
C
C     OBTAIN SPECIES CP AND CPBAR,  CONVERT CP-S TO CAL/GM-DEG K.
C
      CALL CPSPEC (TTT(I),I)
      DO 20 J=1,NS
      CPI(J)=CPI(J)/FMWT(J)
      IF(EN(J,I).LT.1.E-10)EN(J,I)=1.E-10
   20 CONTINUE
C
C     CALCULATE VISCOSITY EMUBAR (IN POISES), CONDUCTIVITY EKDBAR, AND
C     PRANDTL NUMBER PRD FROM MIXTURE FORMULAS.
C
      EMUBAR=0.
      EKDBAR=0.
      DO 40 II=1,NS
      TM=0.
      DO 50 JJ=1,NS
      IF(JJ.EQ.II)GO TO 50
      PHI(II,JJ)=(1./SQRT(8.*(1.+FMWT(II)/FMWT(JJ))))*
     1 (1.+SQRT(EMU(II)/EMU(JJ))*(FMWT(JJ)/FMWT(II))**0.25)**2.
      TM=TM+EN(JJ,I)*PHI(II,JJ)/EN(II,I)
   50 CONTINUE
      TM1=1.+TM
      TM2=1.+1.065*TM

      EMUBAR=EMUBAR+EMU(II)/TM1
      EKD(II) = EMU(II)*(1.32750*CPI(II) + 0.85896490625/FMWT(II))
   40 EKDBAR = EKDBAR + EKD(II)/TM2
C
C     STORE ANSWERS.
C
      VISCE(I)=EMUBAR*0.06722
  100 PR(I) = EMUBAR*CPBAR/EKDBAR
      RETURN
      END
```

```
      SUBROUTINE XNTERP (X,Y,YP,IXIN,XAR,YAR,IAR,CAR,IPOS)
C
      DIMENSION C(6),CAR(6),XAR(IAR),XI(4),YAR(IAR),YI(4)
C                                                                     XNTE   4
      IXO=IXIN                                                        XNTE   5
      IXMAX=IAR-1                                                     XNTE   6
      IX=IPOS                                                         XNTE   7
      IXMAX2=IXMAX-2
      IF (IX .GE. IAR)  IX = IXMAX2
      IF (IXMAX2 .GT. 0)  GO TO 202
      IF (IXMAX .GT. 0)  GO TO 207
      IXOGO = 0                                                       XNTE  11
      Y=YAR(1)                                                        XNTE  12
      YP=0.                                                           XNTE  13
      GO TO 105                                                       XNTE  14
  207 IX=2                                                            XNTE  15
      IXO          = 1                                                XNTE  16
      IXOGO=0
C                                                                     XNTE  17
      IGO=1                                                           XNTE  18
      GO TO 27
  202 DO 11 I = 1,6                                                   XNTE  21
   11 C(I)=CAR(I)                                                     XNTE  22
      IF(IXO) 12,12,13                                                XNTE  23
   12 IFIRST=1                                                        XNTE  24
      IXO=IXMAX+2                                                     XNTE  25
      IX=1                                                            XNTE  26
   13 IF(IX) 12,12,20
   20 IF (X .GE. XAR(IX))  GO TO 25
      IX = IX - 1                                                     XNTE  29
      IF(IX) 22,22,20
   22 WRITE (6,23) X,XAR(1),IAR,XAR(IAR),IX,IXMAX,YAR(1),IAR,YAR(IAR)
   23 FORMAT (//1X,27HXNTERP OUT OF RANGE...  X =,1PE15.8,3X,6HX(1) =,
     1 E15.8,3X,2HX(,I3,3H) =,E15.8/23X,4HIX =,I3,3X,7HIXMAX =,I3,3X,
     2 6HY(1) =,E15.8,3X,2HY(,I3,3H) =,E15.8//)
      CALL SUMTAB
      CALL EXIT
   25 IF (X .LE. XAR(IX+1))  GO TO 27
      IX = IX + 1
      IF(IX-IXMAX) 25,25,22                                           XNTE  37
   27 DO 28 I=1,4                                                     XNTE  38
      II=IX-2+I                                                       XNTE  39
      XI(I)=XAR(II)                                                   XNTE  40
   28 YI(I)=YAR(II)                                                   XNTE  41
      IF(IXMAX2) 203,204,205                                          XNTE  42
  203 YP=(YI(2)-YI(1))/(XI(2)-XI(1))                                  XNTE  43
      Y=YI(1)+YP*(X-XI(1))                                            XNTE  44
      GO TO 105                                                       XNTE  45
  204 IF(IX-IXO) 45,100,45                                            XNTE  46
  205 DX2 = X - XI(2)
      DX32=XI(3)-XI(2)                                                XNTE  49
```

```
   30 IF(IX-IXO) 40,31,60                                          XNTE  50
   31 IXOGO=0                                                      XNTE  51
      IF(IX-1) 32,32,33                                            XNTE  52
   32 IGO=-1                                                       XNTE  53
      GO TO 101                                                    XNTE  54
   33 IF (IX .LT. IXMAX)  GO TO 35
      IF (IFIRST .EQ. 0)  GO TO 34
      IFIRST = 0
      IGO=1                                                        XNTE  58
      GO TO 45                                                     XNTE  59
   34 IGO=1                                                        XNTE  60
      GO TO 100                                                    XNTE  61
   35 IGO=0                                                        XNTE  62
      GO TO 100                                                    XNTE  63
   40 IXOGO=-1                                                     XNTE  64
      IF (IX .LT. IXO - 1)  GO TO 42
      C(4) = C(1)
      C(5)=C(2)                                                    XNTE  67
      C(6)=C(3)                                                    XNTE  68
      GO TO 43                                                     XNTE  69
   42 C(4)=YI(2)                                                   XNTE  70
      DX42=XI(4)-XI(2)                                             XNTE  71
      DY32=YI(3)-YI(2)                                             XNTE  72
      DYOX32=DY32/DX32                                             XNTE  73
      C(6)=(DYOX32-(YI(4)-YI(2))/DX42)/(XI(3)-XI(4))               XNTE  74

      C(5)=DYOX32-C(6)*DX32                                        XNTE  75
      IF(IXOGO) 43,43, 100                                         XNTE  76
   43 IF (IX .LE. 1)  GO TO 32
      IGO = 0
   45 C(1)=YI(1)                                                   XNTE  79
      DX21=XI(2)-XI(1)                                             XNTE  80
      DX31=XI(3)-XI(1)                                             XNTE  81
      DY21=YI(2)-YI(1)                                             XNTE  82
      DYOX21=DY21/DX21                                             XNTE  83
      C(3)=(DYOX21-(YI(3)-YI(1))/DX31)/(XI(2)-XI(3))               XNTE  84
      C(2)=DYOX21-C(3)*DX21                                        XNTE  85
      IF(IXOGO) 100,100,62                                         XNTE  86
   60 IXOGO=1                                                      XNTE  87
      IF (IX - 1 .GT. IXO)  GO TO 45
      C(1) = C(4)
      C(2)=C(5)                                                    XNTE  90
      C(3)=C(6)                                                    XNTE  91
   62 IF (IX .GE. IXMAX)  GO TO 34
      IGO = 0
      GO TO 42                                                     XNTE  94
```

```
100  DX1 = X - X1(1)                                                    XNTE  97
     YB1=(C(3)*DX1+C(2))*DX1+C(1)                                       XNTE  98
     YPB1=C(3)/.5*DX1+C(2)                                              XNTE  99
     IF(IGO) 101,101,110
101  YB2 = C(4) + C(5)*DX2 + C(6)*DX2**2                                XNTE 102
     YPB2=C(6)/.5*DX2+C(5)
     IF (IGO .LT. 0)  GO TO 120                                         XNTE 105
     U1=DX2/DX32                                                        XNTE 106
     U2=U1*U1                                                           XNTE 107
     U3=U2*U1                                                           XNTE 108
     A1=3.*U2-2.*U3                                                     XNTE 109
     A1P=6.*(U1-U2)/DX32                                                XNTE 110
     Y=(1.-A1)*YB1+A1*YB2                                               XNTE 111
     YP=(1.-A1)*YPB1-A1P*(YB1-YB2)+A1*YPB2                              XNTE 112
105  IXIN=IX
     IF (IXOGO .EQ. 0)  RETURN
     DO 107 I = 1,6                                                     XNTE 117
107  CAR(I)=C(I)
     RETURN                                                             XNTE 119
110  Y=YB1                                                              XNTE 120
     YP=YPB1                                                            XNTE 121
     GO TO 105                                                          XNTE 122
120  Y=YB2                                                              XNTE 123
     YP=YPB2                                                            XNTE 124
     GO TO 105                                                          XNTE 125
     END
```

```
      SUBROUTINE ZFUNC
CZFUNC     EVALUATE BOUNDARY LAYER THICKNESS FUNCTION ZETA
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
C
C     OBTAIN YZETA WHERE U = 0.99 * UE.
C
      DO 100 K=1,NY
      I=NY+1-K
      TM1=ABS(U(I,JN)-UEDGE)/UEDGE
      IF (TM1 .GE. 0.01)  GO TO 50
      TM2 = TM1
      GO TO 100
   50 YZETA=Y(I+1)-DY*(TM2-0.01)/(TM2-TM1)
      GO TO 220
  100 CONTINUE
C
C     FIND YTZETA CORRESPONDING TO YZETA.
C
  220 CALL XNTERP (YZETA,YTZETA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,IYTILF)
      IYTILF=IYTILP
C
C     OBTAIN NEW ZETA FROM EDGE CRITERION.  THEN UPDATE ZETAP AND ZETAN.
C
      ZSTAR(3)=ZETAN*YTZETA
      ZETAP=(ZSTAR(3)-ZSTAR(1))/(DSZ(1)+DS)
      ZETAN=ZETAO+DS*ZETAP
      ZETA=0.5*(ZETAO+ZETAN)
C
C     UPDATE SMDWN,SMDW.
C
      CALL LCURV (X+DX,XTABMD,SMDTAB,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETAN)
      SMDW=0.5*(SMDWN+SMDWO)
      RETURN
      END
```

APPENDIX B COMPUTER PROGRAM OF AIREDY

Only the following modified subroutines are shown. The remaining subroutines are the same as in APPENDIX A.

ADDPT	NLOUT
BLKDTA	ODE
BNDCND	PARAMS
CONTNU	PRINT
DUMPIT	PROFIL
EDDY	RDTAPE
ELEMTS	SPCALC
ENERGY	TABLES
EXECUT	TFCBL (MAIN)
HOODE	TPCALC
HPCALC	TRIM
INTERAT	VISCX
MOMNTM	ZFUNC

```
      SUBROUTINE ADDPT (IFLAG)
C        CHANGES TO SUBROUTINE ADDPT
CADDPT    ADD ANOTHER POINT TO THE BOUNDARY LAYER AND PREPARE FOR
C         RECALCULATION OF THE COEFFICIENTS OF THE LAST TWO POINTS.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AMI(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                         /YTABLE/
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG55(3)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,J0,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON /CONST/ SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,  /CONST/
     1               EPSLN3,CONVRG,O2DY,O4DY,ODYSQ                      /CONST/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      DIMENSION SUBR(3)
      DATA SUBR/6HMOMNTM,6HENERGY,6HELEMTS/
C
C     INCREMENT Y-COUNTERS.
C
      NY=NY+1
      NY1=NY-1
      NY2=NY-2
C
C     EXTEND EDGE PROPERTIES TO NEW POINT.
C
      DO 50 J=1,3
      U(NY,J)=U(NY1,J)
      H(NY,J)=H(NY1,J)
      SH(NY,J)=SH(NY1,J)
      CUU(NY,J) = CUU(NY1,J)
      CUV(NY,J) = CUV(NY1,J)
      CVV(NY,J) = CVV(NY1,J)
      CWW(NY,J) = CWW(NY1,J)
      DO 100 IEL=1,NEL
  100 ALPHA(NY,J,IEL) = ALPHA(NY1,J,IEL)
      RHO(NY,J)=RHO(NY1,J)
      SMU(NY,J)=SMU(NY1,J)
      PR(NY,J)=PR(NY1,J)
      BLE(NY,J)=BLE(NY1,J)
      IF(J.GT.2)GO TO 210
      DO 200 ISP=1,NSP
      SHI(NY,J,ISP)=SHI(NY1,J,ISP)
  200 SCI(NY,J,ISP) = SCI(NY1,J,ISP)
  210 T(NY,J) = T(NY1,J)
      EPS(NY,J)=EPS(NY1,J)
      PRT(NY,J)=PRT(NY1,J)
  500 BLET(NY,J) = BLET(NY1,J)
C
```

```
C     EXTEND RHOV USING 3-POINT DERIVATIVE APPROXIMATION AT EDGE.
C
      RHOV(NY)=RHOV(NY1)+(RHOV(NY2-1)-4.*RHOV(NY2)+3.*RHOV(NY1))/2.
C
C     CALCULATE E AND F AT NY.
C
      E(NY)=RHO(NY,JA)*UGP(NY)*ZETAP*YTIL(NY)/ZETA
      F(NY)=BGP(NY)/(ZETA*ZETA*REYINF)
C
C     CALCULATE APPROPRIATE SIGMAS FOR PUSH-DOWN STORAGE AT NY = 2.
C
      NY3=NY2-1
      GO TO (1100,1200,1300), IFLAG
C
C     CALCULATE SIGMA1 FOR MOMENTUM EQUATION.
C
 1100 SIG1(1)= SMU(NY3,JA) + EPS(NY3,JA)
      SIG1(2)= SMU(NY2,JA) + EPS(NY2,JA)
      GO TO 1400
C
C     CALCULATE SIGMA2, SIGMA3, AND SIGMA4 FOR ENERGY EQUATION.
C
 1200 DO 1250 K=NY3,NY2
      L=K-NY3+1
      TM1 = EPS(K,JA)
      TM2=SMU(K,JA)/PR(K,JA)
      TM3=TM1/PRT(K,JA)
      SIG2(L)=TM2+TM3
      SIG3(L)=SMU(K,JA)-TM2+TM1-TM3
 1250 SIG4(L) = TM2*(BLE(K,JA) - 1.0) + TM3*(BLET(K,JA) - 1.0)
      GO TO 1400
C
C     CALCULATE SIGMA5 FOR ELEMENT EQUATION.
C
 1300 DO 1350 K=NY3,NY2
      L=K-NY3+1
 1350 SIG5(L) = SMU(K,JA)*BLE(K,JA)/PR(K,JA)+EPS(K,JA)*
     1           BLET(K,JA)/PRT(K,JA)
 1400 WRITE (6,9000) SUBR(IFLAG),ISTATN,ITER
 9000 FORMAT (/49H POINT WAS ADDED TO BOUNDARY LAYER IN SUBROUTINE ,A6,
     1        11H AT STATION,I5,14H AND ITERATION,I3/)
      RETURN
      END
```

```
      BLOCK DATA                                                          A    1
C                                                                         A    2
      DIMENSION ATAM(3,51),ATEM(3,54),DATE(2,33)
C                                                                         A    4
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),          /MISC/
     1              BCP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),AP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,IG2                                     /INDX/
      LOGICAL MOLES
      COMMON /SPECES/ COEF(2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1                DELN(30),A(15,30),SUM(30,3),IUSE(30),TEMP(50,2)
      INTEGER SUB
      COMMON /INPUT/ H(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
C
      EQUIVALENCE (ATOM(1,1),ATAM),(ATOM(1,52),ATEM),(DATE,EN)
C                                                                         A   15
C     ATOMIC SYMBOLS, WEIGHTS, AND VALENCES                               A   16

C     MODIFIED FOR DUMMY ELEMENTS (4) H C N O , (101+4)=105 ELEMENTS
C                                                                         A   17
      DATA ATAM/2HH ,1.008,1.,2HHE,4.003,0.,2HLI,6.940,1.,2HBE,9.013,2.,
     12HB ,10.82,3.,2HC ,12.011,4.,2HN ,14.008,0.,2HO ,16.000,-2.,2HF ,  A   19
     219.00,-1.,2HNE,2 ,183,0.,2HNA,22.991,1.,2HMG,24.320,2.,2HAL,26.98   A   20
     30,3.,2HSI,28.,90,4.,2HP ,30.975,5.,2HS ,32.066,4.,2HCL,35.457,-1.,  A   21
     42HAR,39.944,0.,2HK ,39.100,1.,2HCA,40.08,2.,2HSC,44.960,3.,2HTI,4   A   22
     87.90,4.,2HV ,50.95,5.,2HCR,52.01,3.,2HMN,54.940,2.,2HFE,55.850,     A   23
     43.,2HCO,58.94,2.,2HNI,58.710,2.,2HCU,63.540,2.,2HZN,65.38,2.,2HG    A   24
     7A,69.720,3.,2HGE,72.600,4.,2HAS,74.92,3.,2HSE,78.960,4.,2HBR,79.9   A   25
     816,-1.,2HKR,83.80,0.,2HRB,85.480,1.,2HSR,87.630,2.,2HY ,88.910,3.   A   26
     9,2HZR,91.22,4.,2HNB,92.91,5.,2HMO,95.95,6.,2HTC,99.000,7.,2HRU,     A   27
     $101.1 ,3.,2HRH,1 2.91,3.,2HPD,106.4,0,2.,2HAG,107.880,1.,2HCD,11   A   28
     $2.41,2.,2HIN,114.820,3.,2HSN,118.70,4.,2HSB,121.760,3./             A   29
      DATA ATEM/2HTE,127.610,4.,2HI ,126.91,-1.,2HXE,131.30,0.,2HCS,13    A   30
     12.91,1.,2HBA,137.36,2.,2HLA,138.92,3.,2HCE,140.13,3.,2HPR,140.     A   31
     291,3.,2HND,144.27,3.,2HPM,147.00,3.,2HSM,150.35,3.,2HEU,152.00      A   32
     3,3.,2HGD,157.26,3.,2HTB,158.93,3.,2HDY,162.51,3.,2HHO,164.940,     A   33
     43.,2HER,167.27,3.,2HTM,168.94,3.,2HYB,173.04,3.,2HLU,174.99,3.     A   34
     5,2HHF,178.5,4.,2HTA,180.95,5.,2HW ,183.86,6.,2HRE,186.22,7.,2      A   35
     AHOS,190.2,4.,2HIR,192.2,4.,2HPT,195.09,4.,2HAU,197.00,3.,2HH       A   36
     79,200.61,2.,2HTL,204.39,1.,2HPB,207.21,2.,2HBI,208.99,3.,2HPO,     A   37
     8210.0,0,2.,2HAT,210.000,0.,2HRN,222.000,0.,2HFR,223.00,1.,2HRA,22  A   38
     96.000,2.,2HAC,227.000,3.,2HTH,232.000,4.,2HPA,231.00,5.,2HU ,238.  A   39
     $000,6.,2HNP,237.000,5.,2HPU,242.000,4.,2HAM,243.000,3.,2HCM,247.00 A   40
     $0,3.,2HBK,249.00,3.,2HCF,251.000,3.,2HES,254.000,0.,2HFM,253.000,  A   41
     $ 0.,2HMD,256.00,0.,
C     DUMMY H C N O
     A 2HHZ,1.008,1.,2HCZ,12.011,4.,2HNZ,14.008,0.,2HOZ,16.000,-2./
C                                                                         A   43
C
```

```
C     NOMINAL GDI THERMAL DATA AND REACTANTS DATA
C
      DATA (SUB(I,1), I=1,6)/4HH   ,4HH2  ,4HH2O ,4HO   ,4HOH  ,4HO2  /,
     1 (DATE(I,1),DATE(2,I), I =1,6)/3HJ 9,3H/65,3HJ 9,3H/61,3HJ 3,
     2 3H/6 ,3HJ 6,3H/62,3HJ 3,3H/66,3HJ 9,3H/65/,((MT(I,J),B(I,J),
     3 I = 1,9), J = 1,6)/2HH  ,1.0,2H   ,0.0,2H   ,0.0,2H   ,0.0,2HH  ,2.0,
     4 2H   ,0.0,2H   ,0.0,2H   ,0.0,2HO  ,2.0,2HO  ,1.0,2H   ,0.0,2H   ,0.0,
     5 2HO  ,1.0,2H   ,0.0,2H   ,0.0,2H   ,0.0,2HO  ,1.0,2HH  ,1.0,2H   ,0.0,
     6 2H   ,0.0,2HO  ,2.0,2H   ,0.0,2H   ,0.0,2H   ,0.0/,(PHAZ(I), I = 1,6)/
     7 6*1HG/,(T1(I), I = 1,6)/6*3E0.0/,(T2(I), I = 1,6)/6*5000.0/,
     8 TLOW,TMID,THIGH/3E0.0,100.0,5000.0/,NAME(1,1),ANUM(1,1),
     9 NAME(2,1),ANUM(2,1)/2HH  ,2.0,2HO  ,2.0,/,PECW(1),PECWT(2)/100.0,
     1 21* /,MOLES/.FALSE./,ENTH/15*0.0/,FAZ/15*1HG/,
     2 RTEMP(1),RTEMP(2),RTEMP(3)/3*298.15/,FOX(1),FOX(2),FOX(3)/1HF,
     3 1H ,1HO/,DENS(1),DENS(2),DENS(3)/3*0.0/,NSPEC/3/,NPROD/9/,
     4 ITHERM/ /,(SUB(I,2),SUB(I,3),I=1,9)/18*4H    /,(NAME(I,I),
     5 NAME(2,I),NAME(3,I),I=2,5)/12*2H  /
      DATA (SUB(I,J),I=7, 9)/4HN   ,4HNO  ,4HN2  /,(DATE(I,II,DATE(2,I),
     1 I=7,9)/3HJ 3,3H/63,3HJ 6,3H/63,3HJ 9,3H/65/,((MT(I,J),B(I,J),
     2 I=1,4),J=7,9)/2HH  ,1.0,2H   ,0.0,2H   ,0.0,2H   ,0.0,
     3                2HH  ,1.0,2HO  ,1.0,2H   ,0.0,2H   ,0.0,
     4                2HN  ,2.0,2H   ,0.0,2H   ,0.0,2H   ,0.0/,
     5 (PHAZ(I),I=7,9)/3*1HG/,(T1(I),I=7,9)/3*300.0/,
     6 (T2(I),I=7,9)/3*5000.0/,
     7 NAME(3,1),ANUM(3,1)/2HN  ,2.0/,PECWT(3)/79.0/
      DATA (((COEF(I,J,K), J = 1,7), I = 1,2), K = 1,6)/2.50,4*0.0,

     1 25471.627,-0.46011762,2.50,4*0.0,25471.627,-0.46011762,3.1001901,
     2 5.1119464E-9,5.2442106E-8,-3.4997973E-11,3.6945345E-15,-877.38042
     3,-1.9629421,3.0574451,2.6765216E-3,-5.8099162E-6,5.5210391E-9,
     4 -1.8122739E-12,-968.90474,-2.2997056,2.7167633,2.9451374E-3,
     5 -8.0224374E-7,1. 2266826E-10,-4.8472145E-15,-299.05.826,6.6305671,
     6 4.0.7.1275,-1.1.84499E-3,4.1521186E-6,-2.963/404E-9,8.07.2103E-13,
     7 -3.279.722,- .3227.046,2.5421596,-2.7550A19E-5,-3.1.28033E-9,
     8 4.5515A74E-12,-4.3680515E-16,2923.0.83,4.9203.80,2.9484287,
     9 -1.6381665E-3,2.4210316E-6,-1.6.28432E-9,3.8906964E-13,29147.644,
     A 2.9639949,2.9116427,9.5931650E-4,-1.9441702E-7,1.3756646E-11,
     B 1.4224542E-16,3935.3815,5.4423445,3.8375943,-1.077A858E-3,
     C 9.6F3.37AE-7,1.A713972E-1.,-2.2571094E-13,3641.2823,0.49370009,
     D 2.6219535,7.361A264E-4,-1.965222AE-7,3.6201558E-11,-2.A945627E-15
     E ,-12.1.9F25,3.615 960,3.6255985,-1.8782184E-3,7.0554544E-6,
     F 6.7635137E-9,2.1555993E-12,-1047.5226,4.3052778/
      DATA(((COEF(I,J,K),J=1,7),I=1,2),K=7,9)/2.45.2682,0.00.10661458,
     1 -0.74653373E-7,0.1879652AE-10,-0.1025983E-14,56116.040,
     2 4.448758,2.5430714,-0.218.1A1E-4,0.54205287E-7,
     3 -0.564756.2E-10, .2099.44E-13,56098.904,4.1675744,
     4 3.1890,0.0.0133A2281,-0.52A59318E-6,0.95919332E-10,-0.84847932E-14
     5 ,9828.329,4.7458126,4.0.45.9521,-0.00341A1783,0.7981.9190E-5,
     6 -0.411393.6E-8,0.1591.676E-11,9745.3934,2.9974988,
     7 2.A963194,0.0.0151586,-0.57735277E-6,0.9980739E-10,
     8 -0.65223555E-14,-905.86184,6.1615148,3.6748261,-0.00120.8150,
     9 0.2324.1.2E-5,-0.6321/559E-9,-0.22577253E-12,-1061.1588,2.3580.42/
      END                                                              A  61-
```

```
      SUBROUTINE BNDCND
CBNDCND   CALCULATE QUANTITIES NECESSARY FOR BOUNDARY CONDITIONS AT


C          FORWARD STATION.
C
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,    /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/HZINJ/INJH2
C
C     MOVE FORWARD QUANTITIES TO BACK QUANTITIES.
C
      DUEDS0=DUEDSN
      SMDW0=SMDWN
C
C     MOMENTUM EQUATION BOUNDARY CONDITIONS.
C                   AT WALL    U = 0
C                   AT EDGE    U = UE
C
      CALL LCURV (X+DX,XTDUDX,UETAB,LDUDXT,IDUDXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
      DUEDS=0.5*(DUEDSN+DUEDS0)
C
C     INTEGRATE TO OBTAIN UE AT FORWARD STATION.
C
      UEDGE=UEDGE+DUEDS*DS
C
C     CONTINUITY EQUATION BOUNDARY CONDITION.
C                   AT WALL    RHOV = MDOTW
C
      CALL LCURV (X+DX,XTABMD,SMDTAB,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETAN)
      SMDW=0.5*(SMDWN+SMDW0)
```

```
C
C     ENERGY EQUATION BOUNDARY CONDITIONS.
C                       AT WALL    H = HW
C                       AT EDGE    H = HE
C
       CALL LCURV (X+DX,XTABTW,TWTAB,LTWTAB,ITWXP,TWALL)
       CALL XNTERP (X+DX,PEDGEB,DPEDX ,IPEXP,XTABPE,PETAB,LPETAB,
     1               CPEX,IPEXP)
C
C     OBTAIN SHEDGE.
C
       SHEDGE=HEDGE-UEDGE*UFDGE/2.
       IF((IDEAL.GT.0).AND.(INJH2.EQ.0)) GO TO 300
C
C     CALL HOODE TO OBTAIN SHWALL AND HWALL.
```

```
C
       CALL HOODE (3)
       RETURN
C
C     CALL IGODE TO OBTAIN SHWALL AND HWALL.
C
  300  CALL IGODE (TWALL,SHWB,PEDGEB,1,DUMMY1,DUMMY2,DUMMY3)
       SHWALL=SHWB/(UREF*UREF)
       HWALL=SHWALL
       RETURN
       END
```

```
      SUBROUTINE CONTNU
CCONTINU   INTEGRATE CONTINUITY EQUATION FROM WALL TO EDGE TO OBTAIN
C          RHOV PROFILE AT M + 1/2.
C

      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILE,      /YTABLE/
     1                CYTIL(6)                                         /YTABLE/
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,J0,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/NEWTI /J2D,UEP,RHOEP
C
C     INITIAL CONDITION - AT WALL RHOV = MDOTW
C
      RHOV(1)=SMDW
C
C     INITIALIZE PUSH-DOWN STORAGE.
C
      RUMN1=RHO(1,J0)*U(1,J0)
      RUMIN1=RHO(1,JN)*U(1,JN)
      RWAVE=0.5*(RW(1)+RW(2))
      DRWDS=0.5*(SIN(THW(1))+SIN(THW(2)))
      DO 10 I=2,NY
      RUMN=RHO(I,J0)*U(I,J0)
      RUMIN=RHO(I,JN)*U(I,JN)
      DRUDS=(RUMIN+RUMIN1-RUMN-RUMN1)/(2.*DS)
      DRUDY=(RUMIN+RUMN-RUMIN1-RUMN1)*O2DY
      RUMHNH=(.25*(RUMIN+RUMIN1+RUMN+RUMN1)
      GPNH=(.5*(BGP(I-1)+BGP(I))
      YTNH=(.5*(YTIL(I-1)+YTIL(I))
      RHOV(I)=RHOV(I-1)+DY*(-DRUDS/GPNH-FLOAT(J2D)*RUMHNH*DRWDS/
     1          (GPNH*RWAVE)+ZETAP/ZETA*YTNH*DRUDY)
C
C     PUSH-DOWN STORAGE.
C
      RUMN1=RUMN
   10 RUMIN1 = RUMIN
      RETURN
      END
```

```
      SUBROUTINE DUMPIT
CDUMPIT   DUMP MATRIX COEFFICIENTS FOR A GIVEN DIFFERENCE EQUATION.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG55(3)
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/STATN /ISTATN,MAXIT,ITER
C
      I=1
      WRITE (6,9000) ISTATN,ITER,I,U(I,JN),H(I,JN),SH(I,JN),RHOV(I)
      WRITE (6,9010) (I,(A(I-1,J),J=1,3),B(I-1),E(I),F(I),U(I,JN),
     1                H(I,JN),SH(I,JN),RHOV(I),I=2,5)
      NYL=NY-4

      WRITE (6,9010) (I,(A(I-1,J),J=1,3),B(I-1),E(I),F(I),U(I,JN),
     1                H(I,JN),SH(I,JN),RHOV(I),I=NYL,NY1)
      I=NY
      WRITE (6,9020) I,U(I,JN),H(I,JN),SH(I,JN),RHOV(I)
      WRITE (6,9030) (SIG1(I),SIG2(I),SIG3(I),SIG4(I),SIG5(I),
     1                SIG55(I),I=1,3)
      RETURN
 9000 FORMAT (/2I6/I10,72X,1P4E12.4)
 9010 FORMAT (I10,1P6E12.4)
 9020 FORMAT (I10,72X,1P4E12.4)
 9030 FORMAT (15X,1P6E12.4)
      END

MPILATION:        NO  DIAGNOSTICS.
```

```
      SUBROUTINE EDDY
C        CHANGES TO SUBROUTINE EDDY
CEDDY     CALCULATE TURBULENT TRANSPORT PROPERTIES.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SHU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCT(250,2,9),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                         /YTABLE/
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/WALLEC/TWALL,SHWALL,RWALL,SMDRO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,REDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,   /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                              /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JP,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/NEW1  /ALEVIS,TLEVIS
      COMMON /EFVEC/ E(250),F(250)                                     /EFVEC/
      COMMON /MATRX/ A(250,3),B(250)                                   /MATRX/
      COMMON /CMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /CMORI/
      COMMON/MUZZY/SDELTA
C
C**** FIND SDELTA AT U=0.990*UE FOR MUZZY ****
      DO 35 K=1,NY
      I=NY+1-K
      SX1=ABS(U(I,JN)-UEDGE)/UEDGE
      IF(SX1.GE.0.01) GO TO 36
      SX2=SX1
      GO TO 35
   36 YDELTA=Y(I+1)-DY*(SX2-0.01)/(SX2-SX1)
      GO TO 38
   35 CONTINUE
   38 CALL ANTERP(YDELTA,SDELTA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,ITILF)
C
      DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSP

C
C     FIND DELTA, THE VALUE OF YTIL AT WHICH U = 0.995 * UE.
C
      DO 100 K=1,NY
      I=NY+1-K
      TM1=ABS(U(I,JN)-UEDGE)/UEDGE
      IF (TM1 .GE. 0.005)  GO TO 50
      TM2 = TM1
      GO TO 100
   50 YDELTA=Y(I+1)-DY*(TM2-0.005)/(TM2-TM1)
      GO TO 120
  100 CONTINUE
```

```
C
C     FIND DELTA CORRESPONDING TO YDELTA.
C
  120 CALL XNTERP (YDELTA,DELTA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,IYTILF)
      IYTILF=IYTILP
C
C     CALCULATE TURBULENT TRANSPORT PROPERTIES AT EACH MESH POINT.
C
      EPS(I,JN)=EL
      PRT(I,JN) = 13.8*(11.44*SQRT(PR(I,JN)))
      T1=REYIFF*ZETAN
      T2=T1/24.
      DERIV=D2DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
      PAREN=SMU(I,JN)*BGP(I)*DERIV/T1
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (SMDYN .NE. 1.0)  GO TO 170
      TM3 = T1*ZETAN**2/(SMU(I,JN)*(BGP(I)*DERIV)**3)
      TM4 = 1.0 + 11.8*DPEDSN*SQRT(TM3/RHO(I,JN))
      IF (TM4 .LE. 0.0)  BN = 1.0
      IF (TM4 .GT. 0.0)  BN = SQRT(TM4)
      GO TO 180
  170 TM3 = 11.8*SMDYN/SQRT(RHO(I,JN))*SQRT(T1*ZETAN**2*SMU(I,JN)/
     1       (BGP(I)*DERIV))
      TM4=DPEDSN/(SMU(I,JN)*BGP(I)*DERIV*SMDYN)
  180 DO 300 I = 2,NY
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SMDYN.EQ.1.0)GO TO 190
      TERM=EXP(TM3/SMU(I,JN))
      SSS= -TM4*SMU(I,JN)*(1.-TERM)+TERM
      IF(SSS.GT.0.0) GO TO 200
      WRITE(6,2000) I,DPEDSN,SMU(I,JN),DERIV,SMDYN,TERM,SMU(I,JN)
 2000 FORMAT(I5,1P6E10.7)
 2001 CONTINUE
      BN = SQRT(SSS)
  190 BRKT = -T2*YTIL(I)*BN/SMU(I,JN)*SQRT(RHO(I,JN)*PAREN)
      CVV(I,JN) = BRKT
      CDV(I,JN) = 0.16*T1*BGP(I)*YTIL(I)*YTIL(I)*RHO(I,JN)*
     1             ABS(D2DY*(U(I+1,JN)-U(I-1,JN)))*(1.0-EXP(BRKT))**2
C
C     CALCULATE TURBULENT PRANDTL NUMBER.
C
  300 PRT(I,JN) = (0.4/0.440*(1.0 - EXP(BRKT))/(1.0 - EXP(26.0*
     1             SQRT(PR(I,JN))*BRKT/34.0)))
C
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SMDYN.EQ. 1.0) GAMA=0.361
      I = 2
C
C     CALCULATE TEMPORARY QUANTITIES
C
   10 UYMN = (U(I+1,JN) - U(I-1,JN))*D2DY
      RHOY = (RHO(I+1,JN) - RHO(I-1,JN))*D2DY
      DUYYMN = ((CUU(I+1,JO) - 2.0*CUU(I,JO) + CUU(I-1,JO))*ODYSQ
      CUUYMN = (CUU(I+1,JO) - CUU(I-1,JO))*D2DY
      SMUY = (SMU(I+1,JN) - SMU(I-1,JN))*D2DY
      ALFA = 0.167K
      T2 = RHOV(I)*BGP(I) - U(I,JN)*E(I)
C     **********  DISSIPATION LENGTH MODIFIED MAY 9,1973  ******
```

```
      SLS = YTIL(I)/DELTA
      SLS2 = SLS*SLS
      BN = YTIL(I)*(0.250*SLS2-0.5860*SLS+0.4310)
      BRKT = 2.0 *EPS(I,J0)*F(I)*BGP(I)*DYMN**2
      TM1 = F(I)*BGP(I)*EPS(I,J0)*ALFA
      DERIV = 020Y*(EPS(I+1,J0) - EPS(I-1,J0))
      TM2 = F(I)*(EPS(I,J0)*BGPP(I)/BGP(I) + BGP(I)*DERIV)*ALFA
      TM3 = (EPS(I,J0)/(ZK*TI*RHO(I,JN)*BN))**3
      TM4 = BRKT - GAMA*TM3*RHO(I,JN)/(ZETAN*BN)
C
C     COEFFICIENT OF CUU(N+1,M+1)
C
      A(I-1,3) = 04DY*(T2 - TM2) - 0.5D*ODYSQ*TM1
      A(I-1,2) = RHO(I,JN)*U(I,JN)/DS + ODYSQ*TM1
      A(I-1,1) = -A(I-1,3) - ODYSQ*TM1
      B(I-1) = TM4 + RHO(I,JN)*U(I,JN)/DS*CUU(I,J0) - 0.5D*(T2 - TM2)*
     1         (CUUYMN + 0.5D*ODYYMN*TM1
      I = I + 1
      IF (I .LE. NY1)  GO TO 10
      A(1,1) = 1.0
      A(NY2,3)=0.0
      CALL TRIM(A,CUU(2,JN),B,NY2,NMAX)
      CUU(1,JN) = 0.0
      CUU(NY,JN) = 0.0
      CUV(1,JN) = 0.0
      DO 100 I=2,NY1
C    ********  DISIPATION LENGTH MODIFIED MAY 9,1973  ******
      SLS = YTIL(I)/DELTA
      SLS2 = SLS*SLS
      BN = YTIL(I)*(0.250*SLS2-0.5860*SLS+0.4310)
      IF( CUU(I,JN).LT. .0)  CUU(I,JN) =0.0
      EPS(I,JN) = BN*ZK*RHO(I,JN)*SQRT(ABS(CUU(I,JN)))*REYINF*ZETAN
      IF (CUV(I,JN) .LE. EPS(I,JN))  EPS(I,JN) = CUV(I,JN)
  100 CONTINUE
      EPS(1,JN)=0.0
      EPS(NY,JN)=0.0
C
C       SMOOTH THE EDDY VISCOSITY
C
   60 DO 400 I=3,NY2
      EPS(I,JA) = (EPS(I-2,JN)+EPS(I-1,JN)+EPS(I,JN)+
     1             EPS(I+1,JN)+EPS(I+2,JN))/5.0
C       NEW F **********    CUU(I,JN)    **********
      SLS = YTIL(I)/DELTA

      SLS2 = SLS*SLS
      BN = YTIL(I)*(0.250*SLS2-0.5860*SLS+0.4310)
      CUU(I,JN) = (EPS(I,JA)/(ZK*BN*RHO(I,JN)*TI))**2
  400 EPS(I,JN) = EPS(I,JA)
C
C     CALCULATE TURBULENT LEWIS NUMBER.
C
      DO 600 I=1,NY
  600 BLET(I,JN) = TLEWIS
      RETURN
      END
```

```
      SUBROUTINE ELEMTS
CELEMTS   SOLVE EACH SYSTEM OF ELEMENT EQUATIONS FOR ELEMENT MASS
C         FRACTIONS ALPHAI(M+1,N).
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),HGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                        /YTABLE/
      COMMON/MATRX /A(250,3),B(250)
      COMMON/FFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG55(3)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/WALLBC/TWALL,SMWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SMEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,   /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                              /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,PEYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/NEW3  /AFTRNS,PLAN
C
C     FOR EACH ELEMENT EXCEPT LAST, EVALUATE COEFFICIENTS OF SYSTEM OF
C     ELEMENT CONSERVATION EQUATIONS.
C
      SIG55(1)=SIG5(1)
      SIG55(2)=SIG5(2)
      DO 400 IEL=1,NEL1
      SIG5(1)=SIG55(1)
      SIG5(2)=SIG55(2)
      INCRMT=0
      I=2
C
C     CALCULATE TEMPORARY QUANTITIES.
C
  100 BE = E(I)
      BF=F(I)
      SIG5(3)=SMU(I+1,JA)*BLE(I+1,JA)/PR(I+1,JA)+
     1        EPS(I+1,JA)*BLET(I+1,JA)/PRT(I+1,JA)
      SIG5Y=(SIG5(3)-SIG5(1))*O2DY
      AYMN=(ALPHA(I+1,JO,IEL)-ALPHA(I-1,JO,IEL))*O2DY
      AYYMN=(ALPHA(I+1,JO,IEL)-2.*ALPHA(I,JO,IEL)+ALPHA(I-1,JO,IEL))*
     1      ODYSQ
      TERM=BF*BGP(I)*SIG5(2)*ODYSQ
```

```
      TM1=BGPP(I)*SIGS(2)/BGP(I)+BGP(I)*SIGSY
      TM2=RHOV(I)*BGP(I)
      TM3=RHO(I,JA)*U(I,JA)/DS
C
C     COEFF. OF ALPHAI(M+1,N-1)
C
      A(I-1,1)=DTDY*(BE*U(I,JO)-TM2+BF*TM1)-0.5*TERM
C
C     COEFF. OF ALPHAI(M+1,N)
C
      A(I-1,2)=TM3+TERM
C
C     COEFF. OF ALPHAI(M+1,N+1)
C
      A(I-1,3)=-A(I-1,1)-TERM
C
C     RIGHT-HAND SIDE (INCLUDING U(M+1,N) TERM OBTAINED FROM MOMENTUM
C      EQUATION)
C
      B(I-1)=TM3*ALPHA(I,JO,IEL)-0.5*TM2*AYMN+
     1       0.5*BF*(TM1*AYMN+BGP(I)*SIGS(2)*AYYMN)+0.5*BE*AYMN*U(I,JN)
C
C     PUSH-DOWN STORAGE
C
      SIGS(1)=SIGS(2)
      SIGS(2)=SIGS(3)
      I=I+1
      IF (I .LE. NY1)  GO TO 100
C
C     MODIFY FIRST AND LAST ELEMENT EQUATIONS BY BOUNDARY CONDITIONS.
C
      IF(IEL.EQ.2) GO TO 251
      IF(INCRMT.GT.0)GO TO 250
      BIGA=REYINF*ZETA*ZETA*SMOW*PR(I,JA)/(BGP(I)*SMU(I,JA)*BLE(I,JA))
      DENOM=2.*DY*BIGA+3.
      ANTRNS = 1.0-AFTRNS
      A(1,2)=A(1,2)+4.*A(1,1)/DENOM
      A(1,3)=A(1,3)-A(1,1)/DENOM
      B(1)=B(1)-A(1,1)*2.*DY*BIGA*AFTRNS/DENOM
      A(1,1)=0.
  250 B(NY2) = B(NY2) - A(NY2,3)*AFEDGE
      A(NY2,3)=0.
      GO TO 252
C
  251 IF(INCRMT.GT.0) GO TO 253
      A(1,2) = A(1,2) + 4.*A(1,1)/DENOM
      A(1,3) = A(1,3) - A(1,1)/DENOM
      B(1) = B(1) - A(1,1)*2.*DY*BIGA*ANTRNS/DENOM
      A(1,1)=0.0
  253 ANEDGE=0.79
      B(NY2)=B(NY2)-A(NY2,3)*ANEDGE
      A(NY2,3)=0.0
C
  252 CONTINUE
C
C     SOLVE ELEMENT EQUATIONS FOR ALPHAI(M+1,N), N=2,3,...,NY-1
C
```

```
      CALL TRIM (A,ALPHA(2,JN,IEL),B,NY2,NMAX)
C
C     APPLY BOUNDARY CONDITIONS FOR ALPHAI(M+1,1) AND ALPHAI(M+1,NY)
C
      IF(IEL.EQ.2) GO TO 400
      ALPHA(1,JN,IEL)=(4.*ALPHA(2,JN,IEL)-ALPHA(3,JN,IEL)+2.*DY*BIGA*
     !                 AFTRNS)/DENOM
      ALPHA(NY,JN,IEL)=AFEDGE
      GO TO 4006
  400 ALPHA(1,JN,IEL) = (4.0*ALPHA(2,JN,IEL)-ALPHA(3,JN,IEL)+
     1      2.0*DY*BIGA*ANTRNS)/DENOM
      ALPHA(NY,JN,IEL)=ANEDGE
      TEST = (ALPHA(NY1,JN,IEL)-ALPHA(NY,JN,IEL))/ALPHA(NY,JN,IEL)
      IF(ABS(TEST).LE.EPSLN3) GO TO 4000
C
C
C     SOLUTION DOES NOT ASYMPTOTICALLY APPROACH EDGE CONDITIONS.
C     INCREASE THICKNESS OF BOUNDARY LAYER BY ADDING ONE POINT.
C
      INCRMT=INCRMT+1
      IF(INCRMT.GT.5)CALL DEBUG (6HELEMTS)
      IF(NY.EQ.NMAX)CALL DEBUG (6HELEMTS)
      CALL ADOPT (3)
      I=NY-1
      GO TO 10
 4000 CONTINUE
C
C     CALCULATE MASS FRACTION OF LAST ELEMENT (NEL) AT EACH MESH POINT.
C
      DO 5000 I=1,NY
      SUMEL=0.
      DO 4500 IEL=1,NEL1
      IF(ALPHA(I,JN,IEL).LE.0.0) ALPHA(I,JN,IEL)=0.0
 4500 SUMEL = SUMEL + ALPHA(I,JN,IEL)
 5000 ALPHA(I,JN,NEL) = 1.0 - SUMEL
      RETURN
      END
```

```
      SUBROUTINE ENERGY
CENERGY   SOLVE SYSTEM OF ENERGY EQUATIONS FOR ENTHALPY H(M+1,N).
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONJRG,O2DY,O4DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,MSP,NMAX,NY1
      COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
C
C     EVALUATE COEFFICIENTS OF SYSTEM OF ENERGY EQUATIONS.
C
      INCRMT=0
      I=2
C
C     CALCULATE TEMPORARY QUANTITIES.
C
  100 BF = F(I)
      BF=F(I)
      T1=EPS(I+1,JA)
      T2=SMU(I+1,JA)/PR(I+1,JA)
      T3=T1/PRT(I+1,JA)
      SIG2(3)=T2+T3
      SIG3(3)=SMU(I+1,JA)-T2+T1-T3
      SIG4(3)=T2*(BLE(I+1,JA)-1.)+T3*(BLET(I+1,JA)-1.)
      SIG2Y=(SIG2(3)-SIG2(1))*O2DY
      SIG3Y=(SIG3(3)-SIG3(1))*O2DY
      SIG4Y=(SIG4(3)-SIG4(1))*O2DY
      UYMN=(U(I+1,JO)-U(I-1,JO))*O2DY
      UYYMN=(U(I+1,JO)-2.*U(I,JO)+U(I-1,JO))*ODYSQ
      HYMN=(H(I+1,JO)-H(I-1,JO))*O2DY
      HYYMN=(H(I+1,JO)-2.*H(I,JO)+H(I-1,JO))*ODYSQ
      TERM=BF*BGP(I)*SIG2(2)*ODYSQ
      TM1=BGPP(I)*SIG2(2)/BGP(I)+BGP(I)*SIG2Y
      TM2=RHOV(I)*BGP(I)
      TM3=RHO(I,JA)*U(I,JA)/DS
      TERMU=BF*BGP(I)*SIG3(2)*ODYSQ*U(I,JO)
```

```
      TMU1=BGPP(I)*SIG3(2)/BGP(I)+EGP(I)*SIG3Y
C
C     COEFF. OF P(M+1,N-1)
C
      A(I-1,1)=(U4D)*(BF*U(I,JO)-TM2*BF*TM1)-0.5*TERM
C
C     COEFF. OF U(M+1,N)
C
      A(I-1,2)=TM3*TERMU
C
C     COEFF. OF P(M+1,N+1)
C
      A(I-1,3)=-A(I-1,1)-TERM
C
C     RIGHT-HAND SIDE (INCLUDING U(M+1,N) TERMS OBTAINED FROM MOMENTUM
C      EQUATION)
C
C     COEFF. OF U(M+1,N-1)
C
      COEFF1=BGP(I)*BF*TM1*U(I,JO)+02D*BF*BGP(I)*SIG3(2)*UYMN-0.5*TERMU
C
C     COEFF. OF U(M+1,N)
C
      COEFF2=-0.5*(BF*UYMN+BF*TM1*UYMN)-0.5*BF*BGP(I)*SIG3(2)*UYYMN+
     1        TERMU
C
C     COEFF. OF U(M+1,N+1)
C
      COEFF3=-COEFF1-TERMU
C
C     EVALUATE SUMMATION OVER SPECIES
C
      SUMSP=0.
      DO 150 ISP=1,NSP
C
C     STORE TEMPORARY AVERAGES.
C
      SHIM1A=0.5*(SHI(I-1,JO,ISP)+SHI(I-1,JN,ISP))
      SHIA  =0.5*(SHI(I  ,JO,ISP)+SHI(I  ,JN,ISP))
      SHIP1A=0.5*(SHI(I+1,JO,ISP)+SHI(I+1,JN,ISP))
      SCIM1A=0.5*(SCI(I-1,JO,ISP)+SCI(I-1,JN,ISP))
      SCIA  =0.5*(SCI(I  ,JO,ISP)+SCI(I  ,JN,ISP))
      SCIP1A=0.5*(SCI(I+1,JO,ISP)+SCI(I+1,JN,ISP))
      SHIY=02DY*(SHIP1A-SHIM1A)
      SCIY=02DY*(SCIP1A-SCIM1A)
      SCIYY=ODYSQ*(SCIP1A-2.*SCIA+SCIM1A)
  15  SUMSP = SUMSP + SHIA*SCIY*(BGP(I)*SIG4Y + BGPP(I)*SIG4(2)/BGP(I))
     1        + EGP(I)*SIG4(2)*(SHIY*SCIY + SHIA*SCIYY)
C
C     ASSEMBLE ALL TERMS.
C
      B(I-1)=TM2*H(I,JO)-0.5*(TM2*HYMN-BF*(TM1*HYMN+BGP(I)*SIG2(2)*
     1        HYYMN))+BF*SUMSP-COEFF1*U(I-1,JN)-COEFF2*U(I,JN)-
     2        COEFF3*U(I+1,JN)
C
C     PUSH-DOWN STORAGE
C
```

```
      SIG2(1)=SIG2(2)
      SIG2(2)=SIG2(3)
      SIG3(1)=SIG3(2)
      SIG3(2)=SIG3(3)
      SIG4(1)=SIG4(2)
      SIG4(2)=SIG4(3)
      I=I+1
      IF (I .LE. NY1)  GO TO 100
C
C     MODIFY FIRST AND LAST ENERGY EQUATIONS BY BOUNDARY CONDITIONS.
C                     AT WALL    H = HW
C                     AT EDGE    H = HE
C
      IF(INCRMT.GT.0)GO TO 250
      B(1)=B(1)-A(1,1)*HWALL
      A(1,1)=0.
  250 B(NY2) = B(NY2) - A(NY2,3)*HEDGE
      A(NY2,3)=0.
C
C     SOLVE ENERGY EQUATIONS FOR H(M+1,N), N=2,3,...,NY-1
C
      CALL TRIM (A,H(2,JN),B,NY2,NMAX)
C
C     APPLY BOUNDARY CONDITIONS FOR H(M+1,1) AND H(M+1,NY)
C
      H(1,JN)=HWALL
      H(NY,JN)=HEDGE
C
C     CALCULATE SH(M+1,N) FROM H(M+1,N), N=1,...,NY
C
      DO 300 I=1,NY
  300 SH(I,JN) = H(I,JN) - U(I,JN)**2/2.0
C
C     PRINT DEBUG FOR THIS ITERATION, IF REQUESTED.
C
      IF(KENDMP.GT.0)CALL DUMPIT
      TEST = ( H(NY1,JN) - H(NY,JN))/H(NY,JN)
      IF(ABS(TEST).LE.EPSLN2)RETURN
C
C     SOLUTION DOES NOT ASYMPTOTICALLY APPROACH EDGE CONDITIONS.
C     INCREASE THICKNESS OF BOUNDARY LAYER BY ADDING ONE POINT.
C
      INCRMT=INCRMT+1
      IF(INCRMT.GT.5)CALL DEBUG (6HENERGY)
      IF(NY.EQ.NMAX)CALL DEBUG (6HENERGY)
      CALL ADOPT (2)
      I=NY1-1
      GO TO 100
      END
```

```
      SUBROUTINE EXECUT
C          CHANGES TO SUBROUTINE EXECUT
CEXECUT    EXECUTION CONTROL ROUTINE
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROF  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCT(250,2,9),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUFDSO,    /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/ELREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,D2DY,D4DY,DDYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PRTCTR/NSPRNT,NLPRNT,ISPRNT,JLPRNT,LNSPPG,LINESR
      COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,ISTA,NVAR,IDRUM,LAST
      COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
      COMMON/RSTART/IRSRD,IRSWR,TAPE
      COMMON /AL/ INSTAT,EPSLIN
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
      COMMON/M2MOD/IMOM2
C

      MAINFLG=2

C
C     B E G I N   C A L C U L A T I O N   O F   N E W   S T A T I O N .
C
  200 ISTATN = ISTATN + 1
      IF (ISTATN .LT. INSTAT)  GO TO 100
      EPSLN2 = EPSLIN
      EPSLN3 = EPSLIN
      EPSLN1 = EPSLIN
  100 ITER = 0
C
C     CHECK IF DEBUG IS ON.
C
      KMODMP=0
      KENDMP=0
      IF (IDEBUG(1) .LE. 0)  GO TO 240
      IF (ISTATN .LT. IDEBUG(2) .OR. ISTATN .GT. IDEBUG(3))  GO TO 240
      IF(IDEBUG(1).EQ.1)KMODMP=1
      IF(IDEBUG(1).EQ.2)KENDMP=1
```

```
C
C     DETERMINE NEW STEPSIZE AND CONTOUR PROPERTIES AT FORWARD STATION.
C
  247  CALL STEP
C
C     CALCULATE ZETAN AND ZETA FOR ITER = 0.
C
       ZETAN=ZETA0+DS*ZETAP
       ZETA=0.5*(ZETA0+ZETAN)
C
C     EVALUATE WALL AND EDGE CONDITIONS AT FORWARD STATION.
C
       CALL BNDCND
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF(SMDWN.NE.0.)MADFLG=1
C
C     B E G I N   I T E R A T I O N   L O O P .
C     UPDATE SHW AND HW BASED ON LATEST U/E AT WALL.
C
  300  IF(ITER.GT.0) GO TO 301
       GO TO 302
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
  301  IF((INJH2.EQ.1).AND.(SMDWN.EQ.0.0))  GO TO 302
       IF((IDEAL.EQ.1).AND.(INJH2.EQ.1)) CALL HOODE(3)
       IF(IDEAL.EQ.0) CALL HOODE(3)
  302  CONTINUE
C
C     UPDATE AVERAGE PROPERTIES AND CALCULATE AUXILIARY QUANTITIES FOR
C       DIFFERENCE EQUATIONS.
C
       CALL ITERAT
C
C     SOLVE MOMENTUM EQUATION FOR U.
C
       CALL MOMNTM
C
C     UPDATE AVERAGE U FOR SUBSEQUENT EQUATIONS.
C
       IF(INCOMP.GT.0)GO TO 370
       DO 320 I=1,NY
  320  U(I,JA) = 0.5*(U(I,JO) + U(I,JN))
C
C     SOLVE ENERGY EQUATION FOR H AND SH.
C
       CALL ENERGY
       IF((IDEAL.EQ.1).AND.(INJH2.EQ.0)) GO TO 340
       IF(MADFLG.EQ.0)GO TO 340
C
C     SOLVE ELEMENT EQUATIONS FOR ALPHAI.
C
       CALL ELEMTS
```

```
C
C     CALCULATE LAMINAR TRANSPORT AND THERMODYNAMIC PROPERTIES AT EACH
C      MESH POINT.
C
  340 IF((IDEAL.EQ.1).AND.(INJH2.EQ.0)) GO TO 345
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(SMDWN.EQ.0.0) GO TO 370
      CALL HOODE (4)
      GO TO 370
  345 DO 350 I = 1,NY
      SHB=SH(I,JN)*UREF*UREF
      CALL IGODE (T(I,JN),SHB,PRDGER,0,RHOB,SMUB,PR(I,JN))
      RHO(I,JN)=RHOB/RHOREF
  350 SMU(I,JN) = SMUB/SMUREF
C
C     UPDATE ZETAN, ZETA, AND ZETAP.
C
  370 CALL ZFUNC
C
C     CALCULATE TURBULENT TRANSPORT PROPERTIES.
C
      IF(LAMNR.GT.0)GO TO 380
      CALL EDDY
C
C     INTEGRATE CONTINUITY EQUATION TO OBTAIN RHOV.
C
  380 CALL CONTNU
C
C     IF ITERATING ON SOLUTION, CHECK FOR CONVERGENCE OR MAXIMUM
C      ITERATIONS.
C
      IF (MAXIT .LE. 0)  GO TO 500
      IF (ITER .NE. 0)  GO TO 420
      DUDY0 = 02DY*(4.0*U(2,JN) - 3.0*U(1,JN) - U(3,JN))
      ITER=ITER+1
      GO TO 390
  420 DUDY=02DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
      IF(ABS((DUDY-DUDY0)/DUDY).LE.CONVRG)GO TO 500
      IF (ITER .GE. MAXIT)  GO TO 500
      ITER = ITER + 1
      DUDY0=DUDY
      GO TO 390
C
C     E N D   O F   I T E R A T I O N   L O O P .
```

```
C
 500  X = X + DX
      S=S+DS
C
C     CALCULATE GROSS BOUNDARY LAYER PARAMETERS.
C
      CALL PARAMS
C
C     CHECK FOR END OF CASE.
C
      IF (X + 1.E-6 .GE. XMAX)  GO TO 900
C
C     PRINT AT THIS STATION IF REQUIRED.
C
      CALL PRINT
C
C     CALCULATE ZETA AND ZETAP FOR NEXT STATION.
C
      ZETAP=(ZETAN-ZSTAR(I))/(DSZ(I)+DS)
      ZSTAR(I)=ZETA0
      ZETA0=ZETAN
      DSZ(I)=DS
C
C     MOVE FORWARD VALUES TO BACK VALUES.
C
      DO 600 I=1,NY
      U(I,J0)=U(I,JN)
      H(I,J0)=H(I,JN)
      SH(I,J0)=SH(I,JN)
      CUU(I,J0) = CUU(I,JN)
      CUV(I,J0) = CUV(I,JN)
      CVV(I,J0) = CVV(I,JN)
      CWW(I,J0) = CWW(I,JN)
      DO 580 IEL=1,NEL
 580  ALPHA(I,J0,IEL) = ALPHA(I,JN,IEL)
      RHO(I,J0)=RHO(I,JN)
      SMU(I,J0)=SMU(I,JN)
      PR(I,J0)=PR(I,JN)
      BLE(I,J0)=BLE(I,JN)
      DO 590 ISP=1,NSP
      SHI(I,J0,ISP)=SHI(I,JN,ISP)
 590  SCI(I,J0,ISP) = SCI(I,JN,ISP)
      T(I,J0)=T(I,JN)
      EPS(I,J0)=EPS(I,JN)
      PRT(I,J0)=PRT(I,JN)
 600  BLET(I,J0) = BLET(I,JN)
      GO TO 200
C
C     E N D   O F   S T A T I O N   C A L C U L A T I O N .
C     END OF CASE.  PRINT FINAL STATION.
C
 900  ISPRNT = 0
      ILPRNT=0
      LAST=1
      CALL PRINT
      CALL SUMTAB
      IF(INSWR.GT.0)END FILE ITAPE

      RETURN
      END
```

```
      SUBROUTINE HODE (ICALL)
CHODE     TECBL - ODE INTERFACE SUBROUTINE FOR HYDROGEN-OXYGEN SYSTEM.
C
C     TECBL COMMON BLOCKS
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /SS,DS,X,DX,Y(250),DY
      COMMON/PROF  /RHO(250,3),SMU(250,3),PRNO(250,3),BLE(250,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/WALLEC/TWALL,SHWALL,RWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,PEDGE,UEDGE,REDGE6,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSO,CFEDSN                                /EDGEBC/


      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PEGAS /GAMMA,FMOLWT,FRI
      COMMON/NEW1  /ALEWIS,TLEWIS
      COMMON/NEW2 / RHOEB,SMUEB,REYL,SXO
      COMMON/NEW3  /IYEQ
      COMMON/NEW4  /APROF(50),THYDA(5C),LAPROF,IAYP,CAYX(6),AFWALL
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
C
C     ODE COMMON BLOCKS
C
      COMMON /POINTS/ HSUM(13),SSUM(13),CPM(13),DLVTP(13),DLVPT(13),     /POINTS/
     1                GAMMAS(13),P(13),TZ,FPP(13),WM(13),SONVEL(13),
     2                  TTT(13)                                          /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HC(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BP(15),          /MISC/
     1              BPP(15,2),TM,TLOG,TMID,THIGH,PP,CPSUM,OF,FURAT,      /MISC/
     2              HSUBO,HPP(2),PPP(2),VMIN(2),VPLS(2),AP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                       /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1              JSOL,JLIQ,IC,102                                     /INDX/
      COMMON /VISCXO/ VISCE(13),PR(13)                                   /VISCXO/
      COMMON/INODE /TIN(13),OFIN(13),HIN(13)
      COMMON/OUTODE/HCPUF(30,13)
      COMMON/OUTRHO/DEN(13)
      COMMON/H2INJ/INJH2
```

```
C
      LOGICAL TP,HP,SP
      DIMENSION INDEX(13),FMWT(9)
C
C     SPECIES MOLECULAR WEIGHTS STORED IN FMWT IN SAME ORDER AS THERMO
C      DATA, NAMELY (1) H    (2) H2    (3) H2O    (4) O    (5) OH    (6) O2
C                   (7) N (8) NO (9) N2
C
      DATA (FMWT(I),I=1,6)/1.008,2.016,18.016,16.000,17.008,32.000/
      DATA (FMWT(I),I=7,9)/14.008,30.008,28.016/
      DATA BJ,SG/777.68006,32.174/
C
C     BRANCH TO APPROPRIATE LOGIC.
C
      GO TO (1000,2000,3000,4000),ICALL
C
C                          ***** ICALL = 1 *****
C
C     INITIALIZE ODE STORAGE AND CALCULATE CONVERSION CONSTANTS FOR
C      TFCBL - ODE INTERFACE.
C
 1000 CALL ODE
      NSP=NS
C
C     A CONSTANT ----OT CONVERTS A TFCBL QUANTITY TO AN ODE QUANTITY AND
C      INCLUDES NORMALIZATION FACTORS WHERE APPLICABLE. A CONSTANT ----TO
C      CONVERTS AN ODE QUANTITY TO A TFCBL QUANTITY.
C

      SMUTO=1./(SG*SMUREF)
      HOI=UREF*UREF/(1.8*BJ*SG)
      RHOOI=SG*RHOREF
      RETURN
C
C                          ***** ICALL = 2 *****
C
C     DO AN ISENTROPIC EXPANSION, GIVEN PRESSURE AND INITIAL TEMPERATURE
C      AT THE EDGE OF THE BOUNDARY LAYER, AND CALCULATE AN EDGE VELOCITY
C      TABLE.
C
C     PERFORM INITIAL T-P CALCULATION TO ESTABLISH ENTROPY.
C
2000  P(1) = 4.72539576E-4*PEDGE8
      TZ=TEDGE/1.8
C       ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973  ******
      OF = AFEDGE/(1.-AFEDGE)
C
C     USE INITIAL GUESSES FOR EN(I,1) AND ENLN(I) ALREADY CALCULATED
C      BY ODE.
C
```

```
      NPT=1
      TP=.TRUE.
      HP=.FALSE.
      SP=.FALSE.
      CALL TPCALC
C
C     SAVE ENTROPY AND CALCULATE VELOCITY.
C
      S0=SSUM(1)
      SHEDGE = 1.987165D-3*HSUM(1)/HOT
      HEDGE=SHEDGE+UEDGE*UEDGE/2.
C
C     CALCULATE RHOEB AND SMUEB FOR INITIAL ZETAP CALCULATION.
C
      RHOEB=DEN(1)/SG
      SMUEB=VISCE(1)/SG
C
C     PROCEED THRU PRESSURE TABLE WITH S-P CALCULATIONS.
C
      IND=1
      SP=.TRUE.
      HP=.FALSE.
      TP=.FALSE.
      TIN(1) = TEDGE/1.8D
2020  DO 2100 IBUF = 1,13
      P(IBUF) = 4.72539576E-4*PETAB(IND)
      INDEX(IBUF)=IND
      IND=IND+1
      IF(IND-LPETAB)2100,2100,2110
2100  CONTINUE
2110  NP=IBUF
      NPT = 1
      CALL SPCALC
C
C     OBTAIN ANSWERS FROM ODE  OUTPUT BUFFERS.
C

      DO 2230 IBUF=1,NP
      SHE = 1.987165D-3*HSUM(IBUF)/HOT
      IX=INDEX(IBUF)
2200  UETAB(IX) = SQRT(2.0*ABS(HEDGE - SHE))
      IF (IND .GT. LPETAB)  RETURN
C
C     STORE GUESSES FOR NEXT CALL TO SPCALC.
C
      TIN(1) = TTT(13)
      DO 2230 I=1,NS
2230  EN(I,1) = EN(I,13)
      GO TO 2020
```

```
C
C                          ***** ICALL = 3 *****
C
C     PERFORM A T-P CALCULATION AT THE WALL TO DETERMINE HWALL BOUNDARY
C      CONDITION.
C
3000  P(I) = 4.72539576E-4*PEDGEB
      TZ=TWALL/1.8
      IF((ISTAT.GT.0).OR.(ITER.GT.0))GO TO 3020
C      ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973 ******
      OF = AFWALL/(1.+AFWALL)
      DO 3010 I=1,NS
      EN(I,1) = 1.E-5/NS
3010  ENLN(I) = ALOG(EN(I,1))
      GO TO 3040
C      ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973 ******
3020  OF = ALPHA(I,JN,1)/(1.-ALPHA(I,JN,1))
      DO 3030 I=1,NS
      EN(I,1)=SC(I,JN,1)/FMWT(I)
      IF(EN(I,1).LT.1.E-6)EN(I,1)=1.E-6
3030  ENLN(I) = ALOG(EN(I,1))
3040  NPT = 1
      TP=.TRUE.
      HP=.FALSE.
      SP=.FALSE.
      CALL TPCALC
      SHWALL = 1.987165E-4*HSUM(1)/HCT
      HWALL=SHWALL
      RETURN
C
C                          ***** ICALL = 4 *****
C
C     PERFORM A SERIES OF H-P CALCULATIONS ACROSS THE BOUNDARY LAYER TO
C      OBTAIN THE THERMODYNAMIC AND LAMINAR TRANSPORT PROPERTIES AT EACH
C      MESH POINT.
C
4000  HP = .TRUE.
      TP=.FALSE.
      SP=.FALSE.
      IND=1
4020  DO 4200 IBUF = 1,13
      P(IBUF) = 4.72539576E-4*PEDGEB
      TIN(IBUF)=T(IND,JN)/1.8
C      ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973 ******
      OFIN(IBUF) = ALPHA(IND,JN,1)/(ALPHA(IND,JN,2)+ ALPHA(IND,JN,3))
```

```
      IF(DFIN(IBUF).LE.0.0) DFIN(IBUF)=0.0
      IF((ISTATN.EQ.IRSRD).AND.(ITER.EQ.0))GO TO 4040
      IF(ISTATN+ITER)4040,4040,4060
 4041 DO 4050 I=1,NS
4050  EN(I,IBUF) = 1.0/NS
      TIN(IBUF)=300.
      GO TO 4070
 4060 DO 4070 I=1,NS
      EN(I,IBUF)=SCI(IND,JN,I)/FMWT(I)
      IF(EN(I,IBUF).LT.1.E-6)EN(I,IBUF)=1.E-6
 4070 CONTINUE
4080  HIN(IBUF) = SHI(IND,JN)*HOT
      INDEX(IBUF)=IND
      IF (IND .GE. NY)  GO TO 4210
4200  IND = MIN(IND+IYEQ,NY)
 4210 NP=IBUF
      NPT = 1
      CALL HPCALC
C
C     CONVERT, NORMALIZE, AND STORE ANSWERS FROM CDE BUFFERS INTO TECBL
C     ARRAYS.
C
      DO 4300 IBUF=1,NP
      IX=INDEX(IBUF)
      RHO(IX,JN) = DEN(IBUF)/RHOQ
      SMU(IX,JN)=VISCE(IBUF)*SMUTC
      PRNO(IX,JN)=PR(IBUF)
      IF(PRT.GT.0.)PRNO(IX,JN)=PRT
      ALE(IX,JN)=1.
      T(IX,JN)=1.8*TTT(IBUF)
      AV(IX)=SOUVEL(IBUF)
      DO 4300 I = 1,NS
      SCI(IX,JN,I)=EN(I,IBUF)*FMWT(I)
4300  SHI(IX,JN,I) = HBUF(I,IBUF)/HOT
      IF (IX .LT. NY)  GO TO 4200
C
C     INTERPOLATE FOR NECESSARY PROPERTIES AT MESH POINTS NOT SOLVED
C     USING CDE.
C
      CALL PHOENX (RHO(1,JN),Y,IYEQ,NY)
      CALL PHOENX (SMU(1,JN),Y,IYEQ,NY)
      CALL PHOENX (PRNO(1,JN),Y,IYEQ,NY)
      CALL PHOENX(T(1,JN),Y,IYEQ,NY)
C
C     INTERPOLATE FOR SCI AND SHI ONLY IF ALEWIS OR TLEWIS NOT UNITY.
C
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF((ALEWIS.EQ.1.).AND.(TLEWIS.EQ.1.))RETURN
      DO 4910 I=1,NS
      CALL PHOENX (SCI(1,JN,I),Y,IYEQ,NY)
4910  CALL PHOENX (SHI(1,JN,I),Y,IYEQ,NY)
      RETURN
      END
```

```
      SUBROUTINE HPCALC
(HPCAL C   PERFORM A SERIES OF ENTHALPY-PRESSURE CALCULATIONS.
C                                                                      A   2
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),   /POINTS/
     1                GAMMAS(13),P(13),TZ,PPP(13),WM(13),SONVEL(13),
     2                  TTT(13)                                       /POINTS/


      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BB(15),        /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,    /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),         /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),  /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                     /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC, /INDX/
     1              JSOL,JLIQ,IC,IQ2                                   /INDX/
      COMMON/INODE /TIN(13),OFIN(13),HIN(13)
      COMMON/OUTODE/HOBUF(30,13)
C                                                                      A  16
      DO 40 IP = 1,NP
C
C     SET ASSIGNED PRESSURE,ENTHALPY, O-F RATIO, AND TEMPERATURE GUESS.
C
      PP=P(IP)                                                         A  21
      TT=TIN(IP)
      OF=OFIN(IP)
      DO 150 I=1,NS
  150 ENLN(I) = ALOG(EN(I,IP))
C      ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973  *****
      WP(1) = 1.
      WP(2) = OF
      SUM=WP(1)+WP(2)
      DO 200 I=1,L
  200 BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/SUM
      HSUBO = HIN(IP)/1.9871660
      CALL EQLBRM                                                      A  22
      TZ = TT
      DO 300 I=1,NS
  300 HOBUF(I,NPT) = 1.9871650*HO(I)*TT
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TT.NE.0.) GO TO 20                                           A  24
      IF (NPT .EQ. 0)  RETURN
   20 K=0                                                              A  26
   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30                               A  27
      K=NPT                                                            A  28
      IF (NPT.NE.13) GO TO 40                                          A  29
   30 CALL ANSWER
      IF (K .EQ. 0)  RETURN
      NPT=0                                                            A  36
   40 NPT=NPT+1                                                        A  37
C                                                                      A  38
C     ALL COMPOSITION GUESSES HAVE BEEN COMPUTED EXTERNALLY.
C
      RETURN
      END                                                              A  50-
```

```
      SUBROUTINE ITERAT
C        CHANGES TO SUBROUTINE ITERAT
CITERAT   PREPARE FOR AN ITERATION TO SOLVE THE DIFFERENCE EQUATIONS.
C         OBTAIN AVERAGE PROPERTIES AND RECALCULATE ITERATED AUXILIARY
C         QUANTITIES WHICH GO INTO THE DIFFERENCE EQUATIONS.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHT(250,2,9),SCT(250,2,9),T(250,3),AV(250)
      COMMON/TRANP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),AGP(250),AGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                        /YTABLE/
      COMMON/FFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIGSS(3)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
```

```
      DO 100 I=1,NY
C
C     COMPUTE AVERAGE OF BACK VALUE AND LATEST ITERATED VALUE.
C
      U(I,JA)=0.5*(U(I,J0)+U(I,JN))
      H(I,JA)=0.5*(H(I,J0)+H(I,JN))
      CUU(I,JA) = 0.50*(CUU(I,J0) + CUU(I,JN))
      CUV(I,JA) = 0.50*(CUV(I,J0) + CUV(I,JN))
      CVV(I,JA) = 0.50*(CVV(I,J0) + CVV(I,JN))
      CWW(I,JA) = 0.50*(CWW(I,J0) + CWW(I,JN))
      DO 20 IEL=1,NEL
   20 ALPHA(I,JA,IEL) = 0.50*(ALPHA(I,J0,IEL) + ALPHA(I,JN,IEL))
      SH(I,JA)=0.5*(SH(I,J0)+SH(I,JN))
      RHO(I,JA)=0.5*(RHO(I,J0)+RHO(I,JN))
      SMU(I,JA)=0.5*(SMU(I,J0)+SMU(I,JN))
      PR(I,JA)=0.5*(PR(I,J0)+PR(I,JN))
      BLE(I,JA)=0.5*(BLE(I,J0)+BLE(I,JN))
      T(I,JA)=0.5*(T(I,J0)+T(I,JN))
      EPS(I,JA)=0.5*(EPS(I,J0)+EPS(I,JN))
      PRT(I,JA)=0.5*(PRT(I,J0)+PRT(I,JN))
      BLET(I,JA)=0.5*(BLET(I,J0)+BLET(I,JN))
C
C     CALCULATE AND SAVE E AND F AT EACH ZONE FOR THIS ITERATION.
C
      E(I)=RHO(I,JA)*BGP(I)*ZETAP*YTIL(I)/ZETA
  100 F(I) = BGP(I)/(ZETA**2*REYNF)
C
C     CALCULATE SIGMAS AT WALL AND FIRST INTERIOR POINT TO INITIALIZE
C     PUSH-DOWN STORAGE FEATURE.
C
      DO 500 K=1,2
      TM1=EPS(K,JA)
      TM2=SMU(K,JA)/PR(K,JA)
      TM3=TM1/PRT(K,JA)
      SIG1(K)=SMU(K,JA)+TM1
      SIG2(K)=TM2+TM3
      SIG3(K)=SMU(K,JA)-TM2+TM1-TM3
      SIG4(K)=TM2*(BLE(K,JA)-1.)+TM3*(BLET(K,JA)-1.)
  500 SIG5(K) = TM2*BLE(K,JA) + TM3*BLET(K,JA)
      RETURN
      END
```

```
      SUBROUTINE MOMNTM
C*****MOMNTM   SOLVE SYSTEM OF MOMENTUM EQUATIONS FOR VELOCITY U(M+1,N).
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SH1(250,3),PR(250,3),BLE(250,3),
     1              SH1(250,2,9),SC1(250,2,9),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),HLFT(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/MATRX /A(250,3),B(250)
      COMMON/EFVEC /E(250),F(250)
      COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG55(3)
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON/CONST /NY,NY1,NY2,NY3,J0,J0+,JA,NEL,NFLI,NSP,NMAX,NY1
      COMMON/IOLBUG/IDEBUG(3),KMOMP,KENDMP
C
C     EVALUATE COEFFICIENTS OF SYSTEM OF MOMENTUM EQUATIONS (FROM FIRST
C      INTERIOR POINT TO SECOND LAST POINT IN BOUNDARY LAYER).
C
      ICRM1=2
      TM4=RHO(NY,JA)*U(NY,JA)*(UEDGE-U(NY,J0))/DS
      I=2
C
C     CALCULATE TEMPORARY QUANTITIES.
C
  100 BE = F(I)
      BF=F(I)
      SIG1(3) = SH1(I+1,JA)+EPS(I+1,JA)
      SIG1Y=(SIG1(3)-SIG1(1))*O2DY
      UYMN=(U(I+1,J0)-U(I-1,J0))*O2DY
      UYYMN=(U(I+1,J0)-2.*U(I,J0)+U(I-1,J0))*ODYSQ
      TERM=BF*BGP(I)*SIG1(2)*ODYSQ
      TM1=BGPP(I)*SIG1(2)/BGP(I)+BGP(I)*SIG1Y
      TM2=RHOV(I)*BGP(I)
      TM3=RHO(I,JA)*U(I,JA)/DS
C
C     COEFF. OF U(M+1,N-1)
C
      A(I-1,1)=O4DY*(BE*U(I,J0)-TM2+HF*TM1)-0.5*TERM
C
C     COEFF. OF U(M+1,N)
C
      A(I-1,2)=TM3-0.5*BE*UYMN+TERM
C
C     COEFF. OF U(M+1,N+1)
C
      A(I-1,3)=-A(I-1,1)-TERM
C
C     RIGHT-HAND SIDE
C
      B(I-1)=TM3*U(I,J0)-0.5*(TM2*UYMN+TM4+0.5*BF*(TM1*UYMN+
     1       BGP(I)*SIG1(2)*UYYMN)
```

```
C
C     PUSH-DOWN STORAGE
C
      SIGI(1)=SIGI(2)
      SIGI(2)=SIGI(3)
      I=I+1
      IF (I .LE. NY1)  GO TO 130
C
C     MODIFY FIRST AND LAST MOMENTUM EQUATIONS BY BOUNDARY CONDITIONS
C                     AT WALL    U = 0
C                     AT EDGE    U = UE
C
      A(1,1)=0.
      B(NY2)=B(NY2)-A(NY2,3)*UEDGE
      A(NY2,3)=0.
C
C     SOLVE MOMENTUM EQUATIONS FOR U(M+1,N), N=2,3,...,NY-1
C
      CALL TRIM (A,U(2,JN),B,NY2,UMAX)
```

```
C
C     APPLY BOUNDARY CONDITIONS FOR U(ID+1,1) AND U(ID+1,NY)
C
      U(1,JN)=0.
      U(NY,JN)=UEDGE
C
C     PRINT DEBUG FOR THIS ITERATION, IF REQUESTED.
C
      IF(KMODMP.GT.0)CALL DUMPIT
      TEST = ( U(NY1,JN1) -U(NY,JN))/U(NY,JN)
      IF(ABS(TEST).LE.EPSLN1)RETURN
C
C     SOLUTION DOES NOT ASYMPTOTICALLY APPROACH EDGE CONDITIONS.
C     INCREASE THICKNESS OF BOUNDARY LAYER BY ADDING ONE POINT.
C
      INCRMT=INCRMT+1
      IF(INCRMT.GT.5)CALL DEBUG (6HMONMNT)
      IF(NY.EQ.NMAX)CALL DEBUG (6HMONMNT)
      CALL ADDPT (1)
      I=NY1-1
      GO TO 10.
      END
```

```
      SUBROUTINE NLOG
CNLOG     WRITE TECOL INPUT DATA.
C
      COMMON/XTABLE/RRTAB(500),XTABRR(500),LRRTAB,IRRXP,CRRX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP

      COMMON/LTABLE/TMTAB(100),XTABTM(100),LTMTAB,ITMXP,
     1              SMTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DY1
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSM,DPEDSM                                /EDGEBC/
      COMMON/NORMAL/ELREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/MULT  /AM,UEN,PEN,SMUN,YM
      COMMON/CONST /SINTT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON /TITLE/ TITLE(13)                                           /TITLE/
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/STATN /ISTAIN,MAXIT,ITER
      COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
      COMMON /INPROF/ NPROF(50),YPYNU(50),LUPROF,CUYX(6),MPROF(50),      /INPROF/
```

```
     1                  YBYNH(50),LAPROF,CHYX(6)                          /INPROF/
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/NEW3  /AFTRNS,PLAW
      COMMON/NEW5  /IYPR
      COMMON/NEW7  /GPO,PAMB,INTDK,ZETAPI
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/NEW9  /IYEQ
      COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(8),AFWALL
      COMMON/NEW11 /J2D,UEK,RHOEK
      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
      COMMON /AL/ INSTAT,EPSLIN                                          /AL/
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB, /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI,/COOL/
     4              SQWI,SUMQWI,TAW,TEMPKL,THICK,THITAB(100),TLO,TL1,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20), /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAMM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
      COMMON/H2INJ/INJH2
C
      DATA UNAME,PNAME/6HUETAB ,6HPETAB /
C
C     WRITE SINGLY DIMENSIONED VARIABLES.
C
      WRITE (6,9000) TITLE
      WRITE (6,9010) IDEAL,LAMNR,INCOMP,J2D,INTDK,ICOOL,ITHERM,IPOLY
      WRITE(6,1111) INJH2
 1111 FORMAT(30X,8HINJH2 = ,I2,6X,
     152H(=1 FOR HYDROGEN INJECTION,FREE STREAM=PERFECT GAS, /
     247X,53H=0 FOR PERFECT GAS INJECTION,FREE STREAM=PERFECT GAS)
      WRITE (6,9020) SINIT,XINIT,XMAX,DXI,DELTAT,ZETAPI
      WRITE (6,9030) RLREF,UREF,RHOREF,SMUREF
      WRITE (6,9040) XN,YN,UEN,PEN,SMDN
      WRITE (6,9050) LEDGE,PEDGE,TEDGE,AFEDGE
      WRITE (6,9060) AFTRNS,PRI,GAMMA,FMOLWT,PLAW,PAMB,GPO,SN3,
     1               XSTAR,AFWALL,UEK,RHOEK
      WRITE (6,9070) CONVRG,EPSLN1,EPSLN2,EPSLN3,EPSLIN

      WRITE (6,9080) MAXIT,NYI,NLPRNT,NSPRNT,INSTAT,IYPR,IYEQ
      WRITE (6,6) GAMA,ZK
    6 FORMAT (1X,18HCORRELATION INPUTS//5X,6HGAMA =,F10.6,5X,4HZK =,
     1        F10.6//)
      IF (ICOOL .EQ. 0)  GO TO 40
      WRITE (6,1) COEFCL,MASSL,RAMDW,TUBEN
    1 FORMAT (28H REGENERATIVE COOLING INPUTS//4X,8HCOEFCL =,F12.8,10X,
     1 7HMASSL =,F12.6,10X,7HRAMDW =,F13.10,10X,7HTUBEN =,F10.3/)
      WRITE (6,2) ITZTAB,(I,TZTAB(I),CPLTAB(I),RAMTAB(I),ZMYTAB(I),
     1            I = 1,ITZTAB)
    2 FORMAT (1H1///26H COOLANT PROPERTIES TABLES//45X,8HITZTAB =,I3//
     1 15X,1HI,9X,5HTZTAB,11X,6HCPLTAB,13X,6HRAMTAB,13X,6HZMYTAB/
     2 (14X,I2,5X,3PF10.4,5X,F13.10,5X,1PE14.8,5X,E14.8))
      WRITE (6,3) (TZTAB
```

```
  3   FORMAT (1H1,20H COOLANT WALL TABLES//44X,8HLTWTAB =,I4//15X,1H1,
     1 11X,5HALTAB,12X,6HTHITAB,12X,5HTLTAB/)
      LINESR = LNSPPG - 8
      DO 30 I = 1,LTWTAB
      WRITE (6,4) I,ALTAB(I),THITAB(I),TLTAB(I)
  4   FORMAT (13X,I3,5X,1PE13.7,5X,E13.7,5X,0PF11.4)
      LINESR = LINESR - 1
      IF (LINESR .GT. 0 .OR. I .EQ. LTWTAB)  GO TO 30
      WRITE (6,5)
  5   FORMAT (1H1/15X,1H1,11X,5HALTAB,12X,6HTHITAB,12X,5HTLTAB/)
      LINESR = LNSPPG - 5
 30   CONTINUE
C
C     WRITE STEPSIZE CONTROL TABLES.
C
 40   WRITE (6,9000)
      WRITE (6,9190) LDXLIM,LSKTAB
      WRITE (6,9100)
      LMAX=MAX0(LDXLIM,LSKTAB)
      WRITE (6,9110) DXLIM(1),XLIM(1),SKTAB(1),XTABSK(1)
      IF (LMAX .LE. 1)  GO TO 110
      DO 100 I = 2,LMAX
      IF(I.GT.LDXLIM)GO TO 80
      IF(I.GT.LSKTAB)GO TO 90
      WRITE (6,9110) DXLIM(I),XLIM(I),SKTAB(I),XTABSK(I)
      GO TO 100
 80   WRITE (6,9120) SKTAB(I),XTABSK(I)
      GO TO 100
 90   WRITE (6,9110) DXLIM(I),XLIM(I)
100   CONTINUE
C
C     WRITE WALL TABLES.
C
110   WRITE (6,9000)
      WRITE (6,9130) LTWTAB,LMDTAB
      WRITE (6,9140)
      LINESR=LNSPPG-8
      LMAX=MAX0(LTWTAB,LMDTAB)
      WRITE (6,9110) TWTAB(1),XTABTW(1),SMDTAB(1),XTABMD(1)
      LINESR=LINESR-1
      IF (LMAX .LE. 1)  GO TO 210
      DO 200 I = 2,LMAX
      IF(I.GT.LTWTAB)GO TO 160
      IF(I.GT.LMDTAB)GO TO 170
      WRITE (6,9110) TWTAB(I),XTABTW(I),SMDTAB(I),XTABMD(I)
      GO TO 180
160   WRITE (6,9120) SMDTAB(I),XTABMD(I)
      GO TO 180
170   WRITE (6,9110) TWTAB(I),XTABTW(I)
180   LINESR=LINESR-1
      IF((LINESR.GT.0).OR.(I.EQ.LMAX))GO TO 200
      WRITE (6,9000)
      WRITE (6,9140)
      LINESR=LNSPPG-5
200   CONTINUE
```

```
C
C     WRITE GEOMETRY AND EDGE TABLES.
C
  210  WRITE (6,9000)
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF(PETAB(1).NE.0.)GO TO 220
       WRITE (6,9150) LRWTAB,LUETAB
       TABNAM=UNAME
       GO TO 230
  220  WRITE (6,9160) LRWTAB,LPETAB
       TABNAM=PNAME
  230  WRITE (6,9170) TABNAM
       LINESR=LNSPPG-8
       LPUMAX=MAXO(LPETAB,LUETAB)
       LMAX=MAXO(LRWTAB,LPUMAX)
       TABVAL=PETAB(1)
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF(PETAB(1).EQ.0.)TABVAL=UETAB(1)
       WRITE (6,9110) RWTAB(1),XTABRW(1),TABVAL,XTABPE(1)
       LINESR=LINESR-1
       IF (LMAX .LE. 1)  GO TO 310
       DO 300 I = 2,LMAX
       TABVAL=PETAB(I)
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF(PETAB(I).EQ.0.)TABVAL=UETAB(I)
       IF(I.GT.LRWTAB)GO TO 260
       IF(I.GT.LPUMAX)GO TO 270
       WRITE (6,9110) RWTAB(I),XTABRW(I),TABVAL,XTABPE(I)
       GO TO 280
  260  WRITE (6,9120) TABVAL,XTABPE(I)
       GO TO 280
  270  WRITE (6,9110) RWTAB(I),XTABRW(I)
  280  LINESR=LINESR-1
       IF((LINESR.GT.0).OR.(I.EQ.LMAX))GO TO 300
       WRITE (6,9000)
       WRITE (6,9170) TABNAM
       LINESR=LNSPPG-5
  300  CONTINUE
C
C    WRITE EXPERIMENTAL PROFILES, IF INPUT.
C
  310  IF (LUPROF .EQ. -LHPROF)  RETURN
       WRITE (6,9000)
       WRITE (6,9180) LUPROF,LHPROF
       WRITE (6,9190)
```

```
      LMAX=MAXO(LUPROF,LHPROF)
      WRITE (6,9110) UPROF(1),YBYNU(1),HPROF(1),YBYNH(1)
      IF (LMAX .LE. 1)  GO TO 410
      DO 400 I = 2,LMAX
      IF(I.GT.LUPROF)GO TO 360
      IF(I.GT.LHPROF)GO TO 370
      WRITE (6,9110) UPROF(I),YBYNU(I),HPROF(I),YBYNH(I)
      GO TO 400
  360 WRITE (6,9120) HPROF(I),YBYNH(I)
      GO TO 400
  370 WRITE (6,9110) UPROF(I),YBYNU(I)
  400 CONTINUE
  410 IF (LAPROF .EQ. 0)  RETURN
      WRITE (6,9000)
      WRITE (6,9200) LAPROF
      WRITE (6,9210)
      DO 450 I=1,LAPROF
  450 WRITE (6,9110) APROF(I),YBYNA(I)
      RETURN
 9000 FORMAT (1H1,26X,13A6//)
 9010 FORMAT (18H FLAGS AND OPTIONS//30X,8HIDEAL = ,I2,6X,
     1 56H(=1 FOR PERFECT GAS, =0 FOR HYDROGEN-OXYGEN EQUILIBRIUM)/30X,
     2 8HLAMNR = ,I2,6X,39H(=1 FOR LAMINAR FLOW, =0 FOR TURBULENT)/30X,
     3 8HINCOMP= ,I2,6X,36H(=1 FOR INCOMPRESSIBLE FLOW, =0 FOR ,
     4 13HCOMPRESSIBLE)/30X,8HJ2D   = ,I2,6X,21H(=1 FOR AXISYMMETRIC ,
     5 33HGEOMETRY, =0 FOR TWO-DIMENSIONAL)/30X,8HINTDK = ,I2,6X,
     6 55H(=1 IF INPUT TABLES COME FROM TDK OUTPUT, =0 OTHERWISE)/30X,
     7 8HICOOL = ,I2,6X,57H(=0 NO COOLING, =1 OPPOSITE DIRECTION, =2 SAM
     8E DIRECTION)/30X,8HITHERM =,I2,6X,52H(=1 FOR STHERMO NAMELIST INPU
     9T TO ODE, =0 OTHERWISE)/30X,8HIPOLY  =,I2,6X,77H(=1 FOR CALCULATIO
     $N OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, =0 OTHERWISE)//)
 9020 FORMAT (34H PROBLEM LIMITS AND INITIAL VALUES//1X,7HSIRIT =,F12.8,
     1 3X,7HXINIT =,F12.8,3X,6HXMAX =,F13.8,3X,5HDXI =,1PE12.6,3X,
     2 8HDELTAI =,E12.6,3X,8HZETAPI =,E12.6//)
 9030 FORMAT (21H REFERENCE QUANTITIES//4X,7HBLREF =,1PE14.7,4X,
     1 6HUREF =,E14.7,4X,8HRHOREF =,E14.7,4X,8HSMOREF =,E14.7//)
 9040 FORMAT (28H INPUT NORMALIZATION FACTORS//4X,7HXN    =,1PE14.7,4X,
     1 7HYN    =,E14.7,4X,7HUEN   =,E14.7,4X,7HPEN   =,E14.7,4X,
     2 7HSMDN  =,E14.7//)
 9050 FORMAT (16H EDGE QUANTITIES//4X,7HUEDGE =,1PE14.7,4X,7HPEDGE =,
     1 E14.7,4X,7HTEDGE =,E14.7,4X,8HAFEDGE =,E14.7//)
 9060 FORMAT (10H CONSTANTS//1X,8HAFTRNS =,1PE12.6,3X,5HPRI =,E12.6,3X,
     1 7HGAMMA =,E12.6,3X,8HFMOLWT =,E12.6,3X,6HPLAW =,E12.6,3X,
     2 7HPAMB  =,E12.6/1X,8HGPO    =,E12.6,3X,5HSN3 =,E12.6,3X,
     3 7HXSTAR =,E12.6,3X,8HAFWALL =,E12.6,3X,6HUEK  =,E12.6,3X,
     4 7HRHOEK =,E12.6//)
```

```
 9070 FORMAT (30H CONVERGENCE AND EDGE CRITERIA//4X,7HCONVRG=,1PE14.7,
     1 4X,7HEPSLN1=,E14.7,4X,7HEPSLN2=,E14.7,4X,7HEPSLN3=,E14.7,4X,
     2 7HEPSLIN=,E14.7//)
 9080  FORMAT (9H COUNTERS//4X,7HMAXIT =,I4,5X,5HNYI =,I4,5X,8HNLPRNT =,
     1 I4,5X,8HNSPRNT =,I4,5X,8HINSTAT =,I4,5X,6HIYPR =,I4,5X,6HIYEQ =,
     2 I4//)
 9090 FORMAT (24H STEPSIZE CONTROL TABLES//25X,7HLDXLIM=,I4,39X,
     1 7HLSKTAB=,I4)
 9100 FORMAT (15X,6HDXLIM ,19X,6HXLIM  ,19X,6HSKTAB ,19X,6HXTABSK/)
 9110 FORMAT (1P4E25.7)
 9120 FORMAT (50X,1P2E25.7)

 9130 FORMAT (12H WALL TABLES//25X,7HLTWTAB=,I4,39X,7HLMDTAB=,I4)
 9140 FORMAT (15X,6HTWTAB ,19X,6HXTABTW,19X,6HSMDTAB,19X,6HXTABMD/)
 9150 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB=,I4,39X,
     1 7HLUETAB=,I4)
 9160 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB=,I4,39X,
     1 7HLPETAB=,I4)
 9170 FORMAT (15X,6HRWTAB ,19X,6HXTABRW,19X,A6,19X,6HXTABPE/)
 9180 FORMAT (22H EXPERIMENTAL PROFILES//25X,7HLUPROF=,I4,39X,
     1 7HLHPROF=,I4)
 9190 FORMAT (15X,6HUPROF ,19X,6HYBYNU ,19X,6HHPROF ,19X,6HYBYNH /)
 9200 FORMAT (34H EXPERIMENTAL PROFILES (CONTINUED)//25X,7HLAPROF=,I4)
 9210 FORMAT (15X,6HAPROF ,19X,6HYBYNA /)
      END
```

```
      SUBROUTINE ODE
CODE       ICRPG REFERENCE PROGRAM (ODE) MODIFIED TO HANDLE EQUILIBRIUM
C          CHEMISTRY IN THE TURBULENT BOUNDARY LAYER PROGRAM AND TO
C          OPERATE IN A SUBROUTINE MODE.                                  A  10
C
      COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1               GAMMAS(13),P(13),TZ,PPP(13),WM(13),SONVEL(13),
     2                 TTT(13)                                          /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),H0(30),
     1               DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SU,ATOM(3,105),LLMT(15),B0(15),          /MISC/
     1               BOP(15,2),TM,TLOW,TMID,THIGH,RP,CPSUM,OF,EQRAT,     /MISC/
     2               HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),          /MISC/
     3               NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),   /MISC/
     4               RTEMP(15),FOX(15),DENS(15),TLN                      /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,   /INDX/
     1               JSOL,JLIQ,IC,IQ2                                    /INDX/
                                                                         A  33
C
      DIMENSION DATE(2,30),LH(2),LVM(2),LVP(2)
      INTEGER BLANK,FAZ,FOX,PHAZ,SUB
      DATA BLANK,LH,LVM,LVP/1H ,4HH,CA,4HL/G ,2HV-,1H ,2HV+,1H /
      EQUIVALENCE (DATE,EN)
      LOGICAL HP,IC,MOLES,SP,TP
                                                                         A  39
C
      NAMELIST /THERMO/ ANUM,B,COEF,DATE,DENS,ENTH,FAZ,FOX,MOLES,MT,
     1                  NAME,NSPEC,NPROD,PECWT,PHAZ,RTEMP,SUB,T1,T2,
     2                  TLOW,TMID,THIGH
C
C     PRESET VARIABLES TO THEIR INITIAL VALUES.
C
      TLOW = 0.0
      TZ=0.0
      DO 2 I = 1,13
    2 P(I) = 0.0
      HP     =.FALSE.
      TP     =.FALSE.
      NP = 1
      OF = 0.0
      EQRAT = 0.0
      MOLES = .FALSE.
      WRITE (6,260)
      IF (ITHERM .NE. 0)  READ (5,THERMO)
      IF (ITHERM .NE. 0)  WRITE (6,THERMO)
      CALL REACT                                                         A  60
      SP=.FALSE.                                                         A 119
C
C      CALCULATIONS INVOLVING EQUIVALENCE RATIO CHANGED (7-10-69) TO
C     CORRESPOND TO DEFINITION USED IN PROGRAM A2350D.  H.M.FREY.
C
      STOIC = ABS((VPLS(1)+VMIN(1))/(VPLS(2)+VMIN(2)))
C     *****  OF IS EQUAL TO FUEL/OXIDIZER , MAY 21, 1973  **********
C  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF( WP(1).NE.0.) OF = WP(2)/WP(1)
      WP(1) = 1.0
```

```
      WP(2) = OF
      SUM=WP(1)+WP(2)                                                    A 160
      V2=(WP(1)*VMIN(1)+WP(2)*VMIN(2))/SUM                               A 163
      VI=(WP(1)*VPLS(1)+WP(2)*VPLS(2))/SUM                               A 164
      EQRAT = OF/STOIC
      DO 200 I = 1,L
  200 BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/SUM
C*    THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (EQRAT.EQ.1.) EQRAT=1.000005                                    A 169
      HSUBO = (WP(1)*HPP(1) + WP(2)*HPP(2))/SUM
      WRITE (6,370)                                                      A 176
      WRITE (6,380) LH,HPP(2),HPP(1),HSUBO,LVP,VPLS(2),VPLS(1),VI,LVM,VM A 177
     1IN(2),VMIN(1),V2                                                   A 178
      HSUBO = HSUBO/1.9871650
      WRITE (6,390)                                                      A 180
      WRITE (6,380) (LLMT(I),BLANK,BOP(I,2),BOP(I,1),BO(I),I=1,L)        A 181
      CALL SEARCH
      IQ1=L+1                                                            A 185
      IF (NC.EQ.0) GO TO 240                                             A 186
      DO 230 J=1,NS                                                      A 187
      IF (IUSE(J).EQ.0) GO TO 230                                        A 188
      IF (IUSE(J).GT.0) IUSE(J)=-IUSE(J)                                 A 189
  230 CONTINUE                                                           A 199
  240 IC = .FALSE.
      PP=NS                                                              A 203
      NPT=1                                                              A 204
      ENN=1.                                                             A 205
      SUMN=ENN                                                           A 206
      DO 250 J=1,NS                                                      A 210
      IF (IUSE(J).EQ.-1000) IUSE(J)=0                                    A 211
      EN(J,1)=0.                                                         A 212
      ENLN(J)=0.                                                         A 213
      IF (IUSE(J).NE.0) GO TO 250                                        A 214
      EN(J,1) = ENN/(NS - NC)
      ENLN(J) = ALOG(EN(J,1))
  250 CONTINUE                                                           A 217
      JSCI=0                                                             A 218
      JLIQ=0                                                             A 219
      RETURN
  260 FORMAT (1H1)                                                       A 226
  370 FORMAT (1H0,17X,4HFUEL,13X,7HOXIDANT,12X,7HMIXTURE//)              A 237
  380 FORMAT (1H 2A4,3F18.8/)                                            A 238
  390 FORMAT (8H ATOMS/G)                                                A 239
      END                                                                A 240-
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```
      SUBROUTINE PARAMS
CPARAMS   CALCULATE GROSS BOUNDARY LAYER PARAMETERS OF INTEREST.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOY(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(850,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AB(250)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/EFVEC /E(250),F(250)
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON /GPARAM/ DISTAR,THETA,TAUW,TAUI,RCF,SQW,STAN,SNTGRL,        /GPARAM/
     1                SQWDS,SQWO                                         /GPARAM/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/NEW11 /J2D,UEK,RHOEK
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
      COMMON /MISC/ ENN,SUMN,TI,SU,ATOM(3,105),LLMT(15),BB(15),          /MISC/
     1              BUP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
     2              HSUBO,HPP(2),RHP(2),VMIN(2),VPLS(2),WP(2),           /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),    /MISC/
     4              RTEMP(15),FOX(15),DENS(15),YLN                       /MISC/
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZA(6),DELXBA,DIATUB,  /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI, /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20),  /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
```

```
C
      DATA PIE,RJ,SG/3.141592653,777.68006,32.174/
      DIMENSION GRND(3),YGRND(3)
C
      DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSN
C
C     UPDATE INTEGRAL OVER S FOR DISPLACEMENT THICKNESS.
C
      IF((IRSRD.GT.0).AND.(ISTATN.EQ.IRSRD))GO TO 50
      IF(ISTATN.GT.1)GO TO 20
      SNTGRL=0.
      GO TO 50
   20 SNTGRL = SNTGRL + 0.50*DS*(SMDWO*ZETAO*RW(1)**J2D + SMDWN*ZETAN*
     1          RW(2)**J2D)
C
C     ACCUMULATE INTEGRALS OVER Y USING SIMPSON INTEGRATION.
C     FIRST EVALUATE INTEGRANDS AT WALL.
C
C
   50 TI = RHO(NY,JN)*U(NY,JN)
      TM1=RHO(1,JN)*U(1,JN)/TI
      YGRND(1)=(1.-TM1)/BGP(1)
      YGRND(2)=TM1/BGP(1)*(1.-U(1,JN)/U(NY,JN))
      TM2=1./(ZETAN*ZETAN*REYINF)
      DO 70 I=1,NY
      E(I)=RHO(I,JN)*BGP(I)*ZETAP*YTIL(I)/ZETAN
   70 F(I) = BGP(I)*TM2
      DUDY=.5DY*(-U(3,JN)+4.*U(2,JN)+3.*U(1,JN))
      YGRND(3)=(RHOV(1)*BGP(1)*DUDY+DPEDSN)/F(1)
C
C     ACCUMULATE INTEGRALS ACROSS BOUNDARY LAYER.
C
      DO 100 I=2,NY1
      TM1=RHO(I,JN)*U(I,JN)/TI
      GRND(1)=(1.-TM1)/BGP(I)
      GRND(2)=TM1/BGP(I)*(1.-U(I,JN)/U(NY,JN))
      DUDS=(U(I,JN)-U(I,JO))/DS
      DUDY=.5DY*(U(I+1,JN)-U(I-1,JN))
      GRND(3)=(RHO(I,JN)*U(I,JN)*DUDS+(RHOV(I)*BGP(I)-U(I,JN)*E(I))*
     1          DUDY+DPEDSN)/F(I)
      IF (I .GE. NY1)  GO TO 110
      FMULT = FLOAT(4 - 2*MOD(I,2))
      DO 100 K = 1,3
  100 YGRND(K) = YGRND(K) + FMULT*GRND(K)
C
C     IF NY1 IS EVEN, COMPLETE SIMPSON INTEGRATION.  OTHERWISE, INTEGRATE
C     LAST STEP USING TRAPEZOIDAL RULE.
C
  110 IF (MOD(NY1,2) .GT. 0)  GO TO 130
```

```
      DO 125 K = 1,3
  125 YGRND(K) = (YGRND(K) + 4.0*GRND(K))*DY/3.0
      GO TO 150
  130 DO 135 K=1,3
  135 YGRND(K) = (YGRND(K) + GRND(K))*DY/3.0 + 0.5D0*DY*GRND(K)
C
C     EVALUATE INTEGRANDS AT NY AND COMPLETE EVALUATION OF INTEGRAL
C      PROPERTIES.  (GRND(1) AND GRND(2) ARE ZERO.)
C
  150 DUDS = (U(NY,JN) - U(NY,JO))/DS
      DUDY=D2DY*(U(NY2,JN)-4.*U(NY1,JN)+3.*U(NY,JN))
      GRND(3)=(RHO(NY,JN)*U(NY,JN)*DUDS+(RHOV(NY)*BGP(NY)-
     1         U(NY,JN)*F(NY))*DUDY+DPEDSN)/F(NY)
      IF (MOD(NY,2) .LE. 0)  GO TO 170
      YGRND(3) = YGRND(3) + GRND(3)*DY/3.0
      GO TO 200
  170 YGRND(3)=YGRND(3)+0.5*DY*GRND(3)
C
C     DISPLACEMENT THICKNESS.
C
  200 DLSTO = DLSTAR
      TERM=RHO(NY,JA)*U(NY,JA)*(0.5*(RW(1)+RW(2)))**J2D
      DLSTAR=BLREF*(ZETAN*YGRND(1)+SNTGRL/TERM)
      IF((XSTAR.LT.(X-DX)).OR.(XSTAR.GT.X))GO TO 220
C
C     IF THROAT HAS BEEN REACHED, CALCULATE THROAT RADIUS CORRECTED FOR
C      DISPLACEMENT THICKNESS.

C
      DLSTTH=DLSTAR-(X-XSTAR)*(DLSTAR-DLSTO)/DX
      CALL XNTERP (XSTAR,RSTAR,DER,IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
     1             IRWXF)
      THWTH=ATAN(DER)
      RSTPR=RSTAR*BLREF-DLSTTH*COS(THWTH)
C
C     MOMENTUM THICKNESS.
C
  220 THETA = BLREF*ZETAN*YGRND(2)
C
C     SKIN FRICTION.
C
      TAUI=-SMUREF*UREF*YGRND(3)/(BLREF*ZETAN)
C
C     CALCULATE WALL SHEAR STRESS TAUW.
C
      DERIV=D2DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
      TM1=BGP(1)/ZETAN*SMU(1,JN)*DERIV
      TAUW=SMUREF*UREF/BLREF*TM1
C
C     LOCAL SHEAR STRESS COEFFICIENT BCF.
C
      BCF=2./REYINF*TM1/(RHO(NY,JN)*U(NY,JN)**2)
C
C     HEAT TRANSFER RATE SQW.
C
```

```
      DERIV=D2DY*(-SH(3,JN)+4.*SH(2,JN)-3.*SH(1,JN))
      SUMSP=0.
      DO 240 ISP=1,NSP
  240 SUMSP = SUMSP + SHI(1,JN,ISP)*D2DY*(4.0*SCI(2,JN,ISP) - 3.0*
     1        SCI(1,JN,ISP) - SCI(3,JN,ISP))
      DERIV=DERIV+(BLE(1,JN)-1.)*SUMSP
      TM1=BGP(1)/ZETAN*SMU(1,JN)/PR(1,JN)*DERIV
      SQW=SMUREF*UREF*UREF/BLREF*TM1
C
C     STANTON NUMBER STAN.
C
      TM2=RHO(NY,JN)*U(NY,JN)*(H(NY,JN)-H(1,JN))
      STAN=TM1/(REYINF*TM2)
C
C     UPDATE INTEGRAL OF SQW OVER S.
C
      IF((IRSRD.GT.0).AND.(ISTATN.EQ.IRSRD))GO TO 280
      IF(ISTATN.GT.0)GO TO 270
      SQWDS=0.
      GO TO 280
  270 SQWDS = SQWDS + (2.0*PIE)**J2D*BLREF**(J2D+1)*0.5D0*DS*(SQWO*
     1        RW(1)**J2D + SQW*RW(2)**J2D)
  280 SQWO = SQW
      IF (ICOOL .EQ. 0)  RETURN
      TTSAVE = TT
      CPSAVE = CPSUM
C   **   CPHS CONSIDERS TEMPERATURE IN DEG-K ***
      TT = T(NY,JN)/1.8
      CALL CPHS
C   **  CPSUME  **** (BTU/LBM*DEG-R)
      CPSUME = 1.98792D04312*CPSUM
      CPSUM = CPSAVE
      TT = TTSAVE
C   **  ADIABATIC WALL TEMPERATURE TAW (DEG-R)  ****
      TAW = T(NY,JN) + PR(NY,JN)**(1.0/3.0)*0.5D0*U(NY,JN)*UREF)**2/
     1      (CPSUME*RJ*SG)
C   **  RHOREF  **** (LBF*SEC2/FT4)  ****
C   **  SG GRAVITIONAL FORCE (LBM/LBF*FT/SEC2)  ****
      AAKK = RHO(NY,JN)*RHOREF*SG*U(NY,JN)*UREF
C   **  AAKK  **** (LBM/FT3*FT/SEC)  ****
C   **  SQW  **** (FT*LBF/FT2*SEC)  ****
      SQWI = SQW/RJ
C   **  SQWI  **** ((FT*LBF/FT2*SEC)/(FT*LBF/BTU) = (BTU/FT2*SEC)))
      STANRE = SQWI/(CPSUME*AAKK*(TAW - TWALL))
C   **  HG  ****  (BTU/(DEG-R*FT2,SEC))
      HG = SQWI/(TAW - TWALL)
      CALL XNTERP (X,EAREA,EP,IAX,XTABTW,ALTAB,LTWTAB,CAX,ITWXP)
      DIATUB = 2.0*SQRT(EAREA/PIE)
      CALL XNTERP (X,TLI,TP,ITLX,XTABTW,TLTAB,LTWTAB,CTLX,ITWXP)
      IF (X - DX .GE. XINIT)  GO TO 5
      TLO = TLI
      GO TO 6
```

```
5     CALL XNTERP(X-DX,TLO,TP,ITLX,XTABTW,TLTAB,LTWTAB,CTLX,ITWXP)
6     IF (X + DX .LT. XMAX)  GO TO 8
      TL2 = TL1
      GO TO 9
8     CALL XNTERP (X+DX,TL2,TP,ITLX,XTABTW,TLTAB,LTWTAB,CTLX,ITWXP)
9     CALL XNTERP (TL1,ZMYUL,ZP,IZX,TZTAB,ZMYTAB,ITZTAB,CZX,ITPOS)
      ITPOS = IZX
      CALL XNTERP (TL1,CPL,CPP,ICX,TZTAB,CPLTAB,ITZTAB,CCX,ITPOS)
      CALL XNTERP (TL1,RAMDL,RP,IRX,TZTAB,RAMTAB,ITZTAB,CRX,ITPOS)
      PRANDL = CPL*ZMYUL/RAMDL
      REYL = MASSL*DIATUB/(ZMYUL*TUREN*EAREA)
      CALL XNTERP (X,THICK,THP,ITHX,XTABTW,THITAB,LTWTAB,CTHX,ITWXP)
      TWL = TL1
7     TWLG = TWL
      HL = 0.0250*RAMDL/DIATUB*REYL**0.8D*PRANDL**0.40*(TL1/TWL)**0.55
      SA1 = HL*(1.0 + RAMDW/(THICK*HG))
      SA2 = RAMDW/THICK
      TWL = (SA1*TL1 + SA2*TAW)/(SA1 + SA2)
      IF (ABS(TWLG - TWL) .GT. 0.010)  GO TO 7
      TEMPRL = TWL/TL1
      TWGCA = (HG*TAW + RAMDW/THICK*TWL)/(HG + RAMDW/THICK)
      QWI = HG*(TAW - TWGCA)
      SQWDSI = SQWDS/RJ
      TAWM = TWALL + SQWI/HG
      DELXBA = (DX + DX1)*BLREF/2.0
      COSAL = COS(THW(2))
      SST = COEFCL*DELXBA*QWI*(PIE*RW(2)*BLREF)**J2D/COSAL
      TLCA = (TL1 + TL2)/2.0 + SST/(CPL*MASSL)
      IF (ICOOL .EQ. 2)  TLCA = (TL0 + TL1)/2.0 + SST/(CPL*MASSL)
      SUMQWI = SUMQWI + SST*2.0
      TWG2 = (TWGCA + TWALL)/2.0
      TWL2 = (TLCA + TL1)/2.0
      RETURN
      END
```

```
      SUBROUTINE PRINT
CPRINT     STORE ITEMS IN SUMMARY TABLE FOR THIS STATION, AND PRINT
C          PROFILES AT THIS STATION IF REQUIRED.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
     1              SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
      COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
     1                CYTIL(6)                                         /YTABLE/
      COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DXI
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,     /ZCALC/
     1               YTZETA,YEDGE                                      /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,   /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SWW,STAN,SNTGRL,      /GPARAM/
     1                SQWDS,SQWO                                        /GPARAM/
      COMMON /TITLE/ TITLE(13)                                         /TITLE/
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
      COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,ISTA,NVAR,IDRUM,LAST
      COMMON/NEWS  /IYPR
      COMMON /NEW7/ GPO,FAMB,INTOK,ZETAPI                               /NEW7/
      COMMON /NEW11/ J2D,UEK,RHOEK                                      /NEW11/
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),    /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB, /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,   /COOL/
     3              MASSL,PRANDL,QWI,RAMUL,RAMQW,RAMTAB(20),REYL,SQWDSI,/COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,   /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20), /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE             /COOL/
      REAL MASSL                                                       /COOL/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
      COMMON/MUZZY/SDELTA
      COMMON/H2INJ/INJH2
      COMMON/CONST/SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1             EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
C
      DIMENSION AOUT(14), BOUT(8)
C
C     CALCULATE DIMENSIONAL WALL AND EDGE CONDITIONS.
C
      UEB=U(NY,JN)*UREF
      SA = SQRT(49721.*1.4*GAMMA/FMOLWT*T(NY,JN))
      IF((IDEAL.EQ.1).AND.(INJH2.EQ.1))   SA=AV(NY)
```

```
      BME=UEB/SA
      SMUEB=SMU(NY,JN)*SMUREF
      SMDWB=SMDW*RHOREF*UREF*ZETA
      SHEB=SH(NY,JN)*UREF*UREF
      RHOEB=RHO(NY,JN)*RHOREF
C
C     STORE ITEMS IN SUMMARY TABLE.
C
      ISTA=ISTA+1
      SUMARY(ISTA,1)=FLOAT(ISTATN)
      SUMARY(ISTA,2)=RW(2)
      SUMARY(ISTA,3)=UEB
      SUMARY(ISTA,4)=BME
      SUMARY(ISTA,5)=SMUEB
      SUMARY(ISTA,6)=BCF
      SUMARY(ISTA,7)=STAN
      SUMARY(ISTA,8)=DLSTAR
      SUMARY(ISTA,9)=ZETAN
      SUMARY(ISTA,10)=RW(2)*BLREF-DLSTAR*COS(THW(2))
      SUMARY(ISTA,11) = X*BLREF
      SUMARY(ISTA,12)=THW(2)
      SUMARY(ISTA,13)=T(NY,JN)
      SUMARY(ISTA,14)=PEDGEB
      SUMARY(ISTA,15)=SMDWB
      SUMARY(ISTA,16)=TAUW
      SUMARY(ISTA,17)=SQW
      SUMARY(ISTA,18)=THETA
      SUMARY(ISTA,19)=ZETAP
      SUMARY(ISTA,20) = X*BLREF + DLSTAR*SIN(THW(2))
      SUMARY(ISTA,21)=S
      SUMARY(ISTA,22)=DS
      SUMARY(ISTA,23)=SHEB
      SUMARY(ISTA,24)=RHOEB
      SUMARY(ISTA,25) = TLCA
      SUMARY(ISTA,26) = TWGCA
      SUMARY(ISTA,27)=SQWDS
      SUMARY(ISTA,28)=SNTGRL
      SUMARY(ISTA,29)=(UEDGE-U(NY,JN))/DS
      SUMARY(ISTA,30) = TWL
C
C     CHECK IF TIME TO WRITE SUMMARY TABLE BUFFER ON DRUM.
C
      IF((ISTA.LT.NSTA).AND.(LAST.EQ.0))GO TO 50
      NST=MINU(ISTA,NSTA)
      WRITE (IDRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
      ISTA=0
      NREC=NREC+1
C
C     CHECK IF TIME TO PRINT.
C
   50 IF (ISPRNT .EQ. NSPRNT)  ISPRNT = 0
      IF(ILPRNT.EQ.NLPRNT)ILPRNT=0
      IF (ILPRNT .NE. 0)  GO TO 1000
C
C     PRODUCE SHORT PRINT OF CONTOUR PROPERTIES, WALL AND EDGE
C      CONDITIONS, AND PROFILE PARAMETERS.
C
```

```
      WRITE (6,9000) TITLE
      LINESR = LNSPPG - 5
      WRITE (6,9010)
      LINESR=LINESR-1
      XOUT = X*BLREF
      WRITE (6,9020) ISTATN,XOUT,S,DS,RW(2),THWT2),ZETAN,ZETAP
      LINESR=LINESR-2
      WRITE (6,9030)
      LINESR=LINESR-1
      RTHETA = REYINF/BLREF*RHO(NY,JN)*U(NY,JN)*THETA/SMU(NY,JN)
      THLOSS = (6.28318530*RW(2)*BLREF)**J2D*COS(THW(2))*(RHOEB*UEB**2*
     1          (THETA - BLREF*SNTGRL*RHOREF*UREF/(RHOEB*UEB*RW(2)**J2D))
     2          - (PEDGEB - PAMB)*DLSTAR)
      WRITE (6,9040) UEB,BME,DLSTAR,BCF,T(NY,JN),RHOEB,THETA,STAN,SHEB,
     1               SMUEB,TAUW,TAUI,PEDGEB,TWALL,SQW,RTHETA,THLOSS,SMOWB
      LINESR=LINESR-6
      IF (ICOOL .NE. 0)  WRITE (6,1) TLO,TWL,CPL,QWI,REYL,TL1,TWL2,
     1 CPSUME,SUMQWI,PRANDL,TL2,TWGCA,DIATUB,SQWI,RAMOL,TAW,TWG2,
     2 THICK,SQWDSI,ZMYUL,TLCA,TEMPRL,HG,HL,STANRE
    1 FORMAT (5UX,31HREGENERATIVE COOLING PARAMETERS/5X,6HTLO  =,F10.4,
     1 5X,8HTWL     =,F10.4,5X,8HCPL     =,F15.10,5X,8HQWI     =,F15.6,5X,
     2 8HREYL    =,1PE15.9/5X,6HTL1  =,0PF10.4,5X,8HTLTAB  =,F10.4,5X,
     3 8HCPSUME =,F15.10,5X,8HSUMQWI =,F15.6,5X,8HPRANDL =,1PE15.9/5X,
     4 6HTL2  =,0PF10.4,5X,8HTWGCA  =,F10.4,5X,8HDIATUB =,F15.10,5X,
     5 8HSQWI    =,F15.6,5X,8HRAMOL  =,1PE15.9/5X,6HTAW  =,0PF10.4,5X,
     6 8HTWTAB  =,F10.4,5X,8HTHICK  =,F15.10,5X,8HSQWDSI =,F15.6,5X,
     7 8HZMYUL  =,1PE15.9/5X,6HTLCA =,0PF10.4,5X,8HTEMPRL =,F10.4,5X,
     8 8HHG      =,F15.10,5X,8HHL      =,F15.6,5X,8HSTANRE =,1PE15.9/)
      IF (ICOOL .NE. 0)  LINESR = LINESR - 7
C
C     PRODUCE LONG PRINT OF VARIABLE PROFILES FROM WALL TO EDGE.
C     FIRST PAGE.
C
      WRITE (6,9050)
      LINESR=LINESR-1
      I=1
  550 AOUT(1) = YTIL(I)*BLREF*ZETAN
      AOUT(2)=Y(I)
      AOUT(3)=U(I,JN)/U(NY,JN)
      AOUT(4)=SH(I,JN)/SH(NY,JN)
      AOUT(5)=RHO(I,JN)/RHO(NY,JN)
      AOUT(6) = RHOV(I)*ZETAN/(RHO(NY,JN)*U(NY,JN))
      AOUT(7) = EPS(I,JN)*SMUREF
      AOUT(8)=T(I,JN)
      IF(LINESR.GT.0)GO TO 570
      WRITE (6,9080)
      WRITE (6,9050)
      LINESR = LNSPPG - 4
  570 WRITE (6,9060) I,(AOUT(J),J=1,8)
      LINESR=LINESR-1
      IF (I .GE. NY)  GO TO 600
      I = MIN0(I+IYPR,NY)
      GO TO 550
  600 CONTINUE
C ***.**********************.**********
      WRITE(6,9080)
      ZDELTA = SDELTA*BLREF*ZETAN*12.0
```

```
      WRITE(6,90)  ZDELTA
   90 FORMAT(8H  DELTA=,1PE12.5,9H (INCHES))
      LINESR=LNSPPG-5
      WRITE(6,100)
  100 FORMAT(4H NO.,6X,8H  TAU    ,6X,12HTAU/(RE*UE2),1X,
     1       20H  EPS/(RHO*UE*DELTA),2X,12H  YTIL/DELTA)
C
      LINESR = LINESR-1
      Z1 = SMUREF*UREF/(BLREF*ZETAN)
      Z2 = 1.0/(REYINF*ZETAN*RHO(NY,JN)*U(NY,JN)*U(NY,JN))
      Z3 = 1.0/(REYINF*ZETAN*U(NY,JN)*SDELTA)
      I = 2
  101 DUDYI = 0.5*DY*(U(I+1,JO)-U(I-1,JO)+U(I+1,JN)-U(I-1,JN))
      AOUT(1) = BGP(I)*Z1*(SMU(I,JN)+EPS(I,JN))*DUDYI
      AOUT(2) = AOUT(1)*Z2/Z1
      AOUT(3) = EPS(I,JN)*Z3/RHO(I,JN)
      AOUT(4) = YTIL(I)/SDELTA
      IF(LINESR.GT.0) GO TO 102
      WRITE(6,9080)
      WRITE(6,100)
      LINESR = LNSPPG-4
  102 WRITE(6,103) I,(AOUT(J),J=1,4)
  103 FORMAT(I4,1P4E16.7)
      LINESR=LINESR-1
      IF(I.GE.NY1) GO TO 104
      I = MIN0(I+IYPR,NY1)
      GO TO 101
  104 CONTINUE
C
C ****************************************
      WRITE (6,9080)
      LINESR = LNSPPG-5
      WRITE(6,9902)
      LINESR = LINESR - 1
      I=1
  551 BOUT(1) = SMU(I,JN)*SMUREF
      BOUT(2) = YTIL(I)/YTIL(NY)
      BOUT(3) = CUU(I,JN)/U(NY,JN)**2
      BOUT(4) = RHO(I,JN)/RHO(NY,JN)*U(I,JN)/U(NY,JN)
      BOUT(5) = CUV(I,JN)*SMUREF
C     *****  U(TAU) = UT  ****
      UT = SQRT(TAUW/(RHO(I,JN)*RHOREF))
      UTT = RHO(I,JN)*RHOREF*UT/(SMU(I,JN)*SMUREF)
      BOUT(6) = U(I,JN)*UREF/UT
      BOUT(7) = UTT*YTIL(I)*BLREF*ZETAN
      BOUT(8) = PRT(I,JN)
      IF(LINESR.GT.0) GO TO 571
      WRITE (6,9080)
      WRITE(6,9902)
      LINESR=LNSPPG-4
  571 WRITE(6,9903) I, (BOUT(J), J=1,8 )
      LINESR = LINESR - 1
      IF(I.GE.NY) GO TO 601
      I =MIN0(I+IYPR,NY)
      GO TO 551
  601 IF((IDEAL.GT.0).AND.(INJH2.EQ.0)) GO TO 700
      IF (ISPRNT .NE. 0)  GO TO 700
```

```
C
C     SECOND PAGE.
C
      WRITE (6,9000) TITLE
      LINESR = LNSPPG - 5
      WRITE (6,9150)
      LINESR=LINESR-1
      I=1
  650 AOUT(1) = ALPHA(I,JN,1)/(ALPHA(I,JN,3)+ALPHA(I,JN,8))
      AOUT(2) = SCI(I,JN,1)
      AOUT(3) =SCI(I,JN,2)
      AOUT(4) =SCI(I,JN,3)
      AOUT(5) =SCI(I,JN,4)
      AOUT(6) =SCI(I,JN,5)
      AOUT(7) =SCI(I,JN,6)
      AOUT(8) =SCI(I,JN,7)
      AOUT(9) =SCI(I,JN,8)
      AOUT(10)=SCI(I,JN,9)
      AOUT(11)= SMU(I,JN)*SMUREF
      AOUT(12)= PR(I,JN)
      IF(LINESR.GT.0)GO TO 670
      WRITE (6,9080)
      WRITE (6,9150)
      LINESR = LNSPPG - 4
  670 WRITE(6,9160) I,(AOUT(J),J=1,12)
      LINESR=LINESR-1
      IF (I .GE. NY)  GO TO 700
      I = MIN0(I+IYPR,NY)
      GO TO 650
  700 WRITE (6,9070) ITER
C
C     CHECK IF TIME TO WRITE RESTART TAPE.
C
      IF((IRSWR.EQ.0).OR.((X+1.E-6).LT.XLIM(IDX)))GO TO 1000
C
C     UPDATE ZETA-RELATED QUANTITIES NEEDED FOR RESTART.
C
      ZP=(ZETAN-ZSTAR(I))/(DSZ(I)+DS)
      WRITE (ITAPE) ISTATN,NY,DY,ZETAN,ZETA,ZETAN,ZP,ZETA0,DS,YZETA,
     1              YTZETA,YEDGE,RSTPR,SNTGRL,SQWDS,((U(I,J),H(I,J),
     2 ALPHA(I,J,1),ALPHA(I,J,2),ALPHA(I,J,3),SH(I,J),I=1,NY),J=1,3),(
     3              RHOV(I),I=1,NY),(Y(I),YTIL(I),BGP(I),BGPP(I),I=1,
     4              NMAX)
C
C     ADVANCE PRINT STATION COUNTERS.
C
 1000 ISPRNT=ISPRNT+1
      ILPRNT=ILPRNT+1
      RETURN
 9000 FORMAT (1H1,26X,13A6//)
 9010 FORMAT (9X,7HSTATION,8X,8HX (FEET),15X,1HS,14X,2HDS,14X,2HRW,10X,
     1        6HTHETAW,12X,4HZETA,11X,5HZETAP)
 9020 FORMAT (I16,1P7E16.7/)
 9030 FORMAT (18X,24HEDGE AND WALL CONDITIONS,49X,
     1        18HPROFILE PARAMETERS)
 9040 FORMAT(7X,9HUEB     = ,1PE14.7,7X,9HBME     =,E14.7,17X,9HDLSTAR = ,
     1 E14.7,7X,9HBCF     = ,E14.7/7X,9HTEDGE  = ,E14.7,7X,9HRHUEB  = ,
```

```
     2 E14.7,17X,9HTHETA  = ,E14.7,7X,9HSTAN   = ,E14.7/7X,9HSHEB   = ,
     3 E14.7,7X,9HSMUEB  = ,E14.7,17X,9HTAUW   = ,E14.7,7X,9HTAUI   = ,
     4 E14.7/7X,9HPEDGEB = ,E14.7,7X,9HTWALL  = ,E14.7,17X,9HSQW     = ,
     5 E14.7,7X,9HRTHETA = ,E14.7/7X,9HTHLOSS = ,E14.7,7X,9HSMDWB   = ,
     6 E14.7/)
9050 FORMAT (54H  NO.          YBAR                 Y                U/UE      ,
     1 61H        H/HE             RO/ROE              ROV                EPS   ,
     2 11H          T )
9060 FORMAT (I5,1P7E16.7,0PF11.1)
9070 FORMAT (/18H  NO. ITERATIONS =,I3)
9080 FORMAT (1H1)
9150 FORMAT(55H  NO.  F/O   Y(H)   Y(H2)    Y(H2O)    Y(O)   Y(OH)    Y(O2)
     A 37H    Y(N)    Y(NO)   Y(N2)     MU      PR  )
9160 FORMAT(I4,1P1E10.3, 1PE10.3, 0PF9.5)
9902 FORMAT(4H NO.,6X,8H   MU    ,12X,1HY,11X,8H  K /UE2,8X,8H RU/REUE,
     1     8X,8HMIXEDDY ,9X,6H UDAG ,11X,4HYDAG,13X,3HPRT)
9903 FORMAT(I4,1P8E16.7)
      END
```

```
      SUBROUTINE PROFIL
CPROFIL   CALCULATE INITIAL DEPENDENT VARIABLE PROFILES FROM KNOWN WALL
C         AND EDGE CONDITIONS AT S = SINIT.
C
      COMMON/DEPLND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YYZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/MULT  /XN,UEN,PEN,SMDN,YN
      COMMON/COUNT /NY,NY1,NY2,NY3,J0,JN,JA,NEL,NEL1,NSP,NMAX,NYI
      COMMON/OPTION/IDEAL,LAMNP,INCOMP
      COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),HPROF(50),      /INPROF/
     1                YBYNH(50),LHPROF,CHYX(6)                           /INPROF/
      COMMON/NEW3  /AFTRNS,PLAM
      COMMON/NEW13 /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(6),AFWALL
      COMMON /TPROF / EPS(250,3),PRT(250,3),HLET(250,3)
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWO(250,3),GAMA,ZK /OMORI/
C
      IF(LUPROF.EQ.0)GO TO 5
C
C     USE EXPERIMENTAL U OR H PROFILES.  FIRST CONVERT ARGUMENT TABLES
C     TO YTIL.
```

```
C
      TMI=YN/(BLREF*ZETA0)
      DO 410 I=1,LUPROF
  410 YBYNU(I) = YBYNU(I)*TMI
      DO 420 I=1,LHPROF
  420 YBYNH(I) = YBYNH(I)*TMI
      DO 425 I=1,LAPROF
  425 YBYNA(I) = YBYNA(I)*TMI
      IUYP=3
      DO 430 I=1,NY
      CALL XNTERP(YTIL(I),UVAL,DUMMY1,IUYP,YBYNU,UPROF,LUPROF,CUYX,IUYP)
  430 U(I,JN) = UVAL*UEDGE
      IF(LAPROF.EQ.0)GO TO 445
      IAYP=1
      DO 440 I=1,NY
      CALL XNTERP (YTIL(I),ALPHA(I,JN,1),DUMMY1,IAYP,YBYNA,APROF,
     1             LAPROF,CAYX,IAYP)
      ALPHA(I,JN,2) =0.80*(1.0-ALPHA(I,JN,1))
  440 ALPHA(I,JN,3) =0.25*ALPHA(I,JN,2)
  445 IF (INCOMP .GT. 0)  GO TO 107
      IHYP=0

      DO 450 I=1,NY
      CALL XNTERP(YTIL(I),HVAL,DUMMY1,IHYP,YBYNH,HPROF,LHPROF,CHYX,IHYP)
      SH(I,JN)=HVAL*SHEDGE
  450 H(I,JN) = SH(I,JN) + U(I,JN)**2/2.0
      GO TO 210
C
C     CALCULATE U PROFILE ACCORDING TO INPUT POWER LAW.
C
    5 TM1 = 0.9*YTIL(NY)
      TM2=1./PLAW
      TM3=0.1*YTIL(NY)
      IHI=0
      DO 100 I=1,NY
      IF (IHI .GT. 0)  GO TO 30
      IF (YTIL(I) .LT. TM3)  GO TO 100
      IHI = I
   30 IF (YTIL(I) .GE. TM1)  GO TO 50
      U(I,JN) = UEDGE*(YTIL(I)/TM1)**TM2
      GO TO 100
   50 U(I,JN)=UEDGE
  100 CONTINUE
      SLOPE=U(IHI,JN)/YTIL(IHI)
      DO 105 I=1,IHI
  105 U(I,JN) = YTIL(I)*SLOPE
C
C     CALCULATE H AND SH PROFILES FOR COMPRESSIBLE OR INCOMPRESSIBLE
C      CASE.
C
```

```
      IF(INCOMP.EQ.0)GO TO 120
  107 DO 110 I = 1,NY
      SH(I,JN)=SHWALL
  110 H(I,JN) = SHWALL + U(I,JN)**2/2.0
      GO TO 210
  120 DO 200 I = 1,NY
      H(I,JN)=HWALL+U(I,JN)/UEDGE*(HEDGE-HWALL)
  200 SH(I,JN) = H(I,JN) - U(I,JN)**2/2.0
C
C     CALCULATE CONSTANT ALPHAI PROFILE ACROSS BOUNDARY LAYER.
C                     ALPHAI = ALPHAIE
C
  210 IF (LAPROF .GT. 0)  GO TO 310
      DO 300 I=1,NY
      ALPHA(I,JN,1)=AFWALL+(AFEDGE-AFWALL)*U(I,JN)/UEDGE
C     ***** ALPHA(1)=H,    ALPHA(2)=N,     ALPHA(3)=0  *****
C
      ALPHA(I,JN,2) = 0.80*(1.0-ALPHA(I,JN,1))
  300 ALPHA(I,JN,3) =0.25*ALPHA(I,JN,2)
C
C     CALCULATE RHOV PROFILE.
C
  310 TM1 = 1.0/YTIL(NY)
      DO 500 I=1,NY
  500 RHOV(I) = SMOW + TM1*YTIL(I)
C
C     CALCULATE CUU AND EPS PROFILES
C
      DO 1000  I=1,NY

      TM2 = YTIL(I)/YTIL(NY)
      CUU(I,JN) = 5.0E-5*UEDGE**2*TM2*(1.0 - TM2)**2
 1000 EPS(I,JN)=REYINF*ZETA0*YTIL(I)*(0.205*TM2*TM2-0.1586*TM2+0.431)*
     1            SQRT(CUU(I,JN))*(2.1832339 - 1.1832339*TM2)*4.198382D
C
C     MOVE FORWARD VALUES TO BACK VALUES.
C
      DO 600 I=1,NY
      U(I,J0)=U(I,JN)
      SH(I,J0)=SH(I,JN)
      H(I,J0)=H(I,JN)
      CUU(I,J0)=CUU(I,JN)
      CUV(I,J0)=CUV(I,JN)
      CVV(I,J0)=CVV(I,JN)
      CWW(I,J0) = CWW(I,JN)
      U(I,JA) = U(I,J0)
      CUU(I,JA) = CUU(I,J0)
      EPS(I,J0) = EPS(I,JN)
      EPS(I,JA) = EPS(I,J0)
      DO 600 IEL = 1,NEL
  600 ALPHA(I,J0,IEL) = ALPHA(I,JN,IEL)
      RETURN
      END
```

```
      SUBROUTINE RDTAPE
CTPREAD   SEARCH RESTART TAPE FOR PROPER STATION AND READ RESTART DATA.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL,        /GPARAM/
     1                SQWDS,SQWO                                        /GPARAM/
      COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1              EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
      COMMON/STATN /ISTATN,MAXIT,ITER
      COMMON/NEWB  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/RSTART/IRSRD,IRSWR,ITAPE
C
      REWIND ITAPE
   10 READ (ITAPE) ISTATN
      IF(ISTATN-IRSRD)10,30,20
   20 WRITE (6,9000) IRSRD
 9000 FORMAT (//37H THERE IS NO RESTART DATA FOR STATION,I5//)
      CALL EXIT
C
C     READ RESTART DATA FOR STATION IRSRD.
C
   30 BACKSPACE ITAPE
      READ (ITAPE) ISTATN,NY,DY,ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(1),DSZ(1),
     1             YZETA,YTZETA,YEDGE,RSTPR,SNTGRL,SQWDS,((U(I,J),H(I,J)
     2    ,ALPHA(I,J,1),ALPHA(I,J,2),ALPHA(I,J,3),SH(I,J),I=1,NY),J=1,3),
     A    (RH
     3             OV(I),I=1,NY),(Y(I),YTIL(I),BGP(I),BGPP(I),I=1,NMAX)
      REWIND ITAPE
C
C     SET OTHER COUNTERS AND CONSTANTS BASED ON RESTART DATA.
C
      NY1=NY-1
      NY2=NY-2
      O2DY=0.5/DY
      O4DY=0.25/DY
      ODYSQ=1./(DY*DY)
      RETURN
      END
```

```
      SUBROUTINE SPCALC
CSPCALC   PERFORM A SERIES OF ENTROPY-PRESSURE CALCULATIONS.                    A   2
C
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),          /POINTS/
     1                GAMMAS(13),P(13),TZ,PPP(13),WM(13),SONVEC(13),
     2                  TTT(13)                                               /POINTS/
      COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
     1              DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
      COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),               /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,           /MISC/

     2              HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),                /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),         /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                            /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,        /INDX/
     1              JSOL,JLIQ,IC,IQ2                                          /INDX/
      COMMON/INODE /TIN(13),OFIN(13),HIN(13)
C                                                                             A  16
C     SET O-F AND INITIAL TEMPERATURE GUESS.  (ENTROPY STORED AS SO.)
C
      TT=TIN(1)
C      ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973  ******
      WP(1) = 1.
      WP(2) = OF
      DO 200 I=1,L
  200 BO(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/(WP(1) + WP(2))
      DO 60 IP=1,NP
C
C     SET ASSIGNED PRESSURE.
C
      PP=P(IP)
      CALL EQLBRM                                                             A  22
      TZ=TT
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TT.NE.0.) GO TO 20                                                  A  24
      IF (NPT .EQ. 0)  RETURN
   20 K=0                                                                     A  26
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30                                      A  27
      K=NPT                                                                   A  28
      IF (NPT.NE.13) GO TO 40                                                 A  29
   30 IF (K .EQ. 0)  RETURN
      NPT=0                                                                   A  36
   40 NPT=NPT+1                                                               A  37
C     SAVE COMPOSITIONS FOR ESTIMATES OF NEXT POINT                           A  40
      DO 60 I = 1,NS
   60 EN(I,NPT) = EN(I,K)
      RETURN
      END                                                                     A  50.
```

```
      SUBROUTINE TABLES
CTABLES   NORMALIZE TABLES AND INITIALIZE TABLE POINTERS FOR SUBROUTINE
C         XNTERP.  INITIALIZE WALL AND EDGE CONDITIONS FOR PERFECT
C         GAS OR HYDROGEN-OXYGEN SYSTEM.
C
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
     1              PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
     2              UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                         XTDUDX(500),LDUDXT,IDUDXP
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1              SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2              DXI
      COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
      COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDS0,    /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/MULT  /XN,UEN,PEN,SMDN,YN
      COMMON/OPTION/IDEAL,LAMNR,INCOMP
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/NEW2 / RHOEB,SMUEB,REYL,SXO
      COMMON/H2INJ/INJH2
C
      XNORM=XN/BLREF
C
C     NORMALIZE RW VS. X TABLE AND INITIALIZE CONTOUR PROPERTIES.
C
      DO 20 I=1,LRWTAB
      RWTAB(I)=RWTAB(I)*XNORM
   20 XTABRW(I) = XTABRW(I)*XNORM
      IRWXP=0
      CALL XNTERP (X,RW(2),DRWDX(2),IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
     1             IRWXP)
      THW(2)=ATAN(DRWDX(2))
C
C     BACK VALUES EQUAL FORWARD VALUES INITIALLY.
C
      RW(1)=RW(2)
      DRWDX(1)=DRWDX(2)
      THW(1)=THW(2)
C
C     NORMALIZE STEPSIZE TABLES AND INITIALIZE STEPSIZE DS.
C
      DO 50 I=1,LSKTAB
   50 XTABSK(I) = XTABSK(I)*XNORM
      ISK=1
```

```
      DO 100 I=1,LDXLIM
  100 XLIM(I) = XLIM(I)*XNORM
      IDX=1
      DX=DX1
      DS=DX/COS(THW(1))
C
C     SET UP MDOTW VS. X TABLE AND INITIALIZE SMDWN.
C
      DO 250 I=1,LMDTAB
      SMDTAB(I)=SMDTAB(I)*SMDN
  250 XTABMD(I) = XTABMD(I)*XNORM
      IMDXP=0
      CALL LCURV (X,XTABMD,SMDTAB,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETA0)
C
C     BACK AND AVERAGE VALUES EQUAL FORWARD VALUES INITIALLY.
C
      SMDW0=SMDWN
      SMDW=SMDWN
C
C     SET UP TW VS. X TABLE AND INITIALIZE TWALL.
C
      DO 350 I=1,LTWTAB
  350 XTABTW(I) = XTABTW(I)*XNORM
      ITWXP=0
      CALL LCURV (X,XTABTW,TWTAB,LTWTAB,ITWXP,TWALL)
      IF((IDEAL.GT.1).AND.(INJH2.EQ.1))  GO TO 390
C
C     H Y D R O G E N - O X Y G E N   E Q U I L I B R I U M .
C     PRESSURE TABLE HAS BEEN INPUT.  SET UP PE VS. X TABLE FOR
C      ISENTROPIC EXPANSION.
C
      DO 355 I=1,LPETAB
      PETAB(I)=PETAB(I)*PEN
  355 XTABPE(I) = XTABPE(I)*XNORM
      IPEXP=0
C
C     CALL HOODE TO DO ISENTROPIC EXPANSION AT EDGE OF BOUNDARY LAYER
C      TO OBTAIN EDGE VELOCITY TABLE UETAB.
C      (PEDGE AND TEDGE HAVE BEEN INPUT.)
C
      CALL HOODE (2)
C
C     SET VELOCITY TABLE LENGTH AND FLAGS.  (XTABPE IS ARGUMENT TABLE
C      FOR UETAB.)
C
      LUETAB=LPETAB
      IUEXP=0
C
C     CALL HOODE TO EVALUATE HWALL = SHWALL.
C
      CALL HOODE (3)
      GO TO 500
```

```
C
C     P E R F E C T   G A S   O P T I O N .
C     CALL IGODE FOR PERFECT GAS OPTION TO OBTAIN SHWALL AND HWALL.
C
 390  CALL IGODE (TWALL,SHWB,PEDGEB,1,DUMMY1,DUMMY2,DUMMY3)
      SHWALL=SHWB/(UREF*UREF)
      HWALL=SHWALL
C
C     CALL IGODE WITH TEDGE AND PEDGE TO OBTAIN SHEDGE AND HEDGE.
C      (HEDGE IS A CONSTANT.)
C
      CALL IGODE (TEDGE,SHEB,PEDGEB,1,RHOEB,SMUEB,DUMMY1)
      SHEDGE=SHEB/(UREF*UREF)
      HEDGE=SHEDGE+UEDGE*UEDGE/2.
C
C     GIVEN A PRESSURE TABLE, GENERATE A VELOCITY TABLE, OR VICE VERSA.
C
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(PETAB(1).EQ.1.)GO TO 450
      TM1=(GAMMA-1.)/GAMMA
      DO 410 I=1,LPETAB
      PETAB(I)=PETAB(I)*PEN
      XTABPE(I)=XTABPE(I)*XNORM
      SHE=SHEDGE*(PETAB(I)/PEDGEB)**TM1
 410  UETAB(I) = SQRT(2.0*(HEDGE - SHE))
      LUETAB=LPETAB
      IPEXP=0
      IUEXP=0
      GO TO 500
 450  FNORM = UEN/UREF
      TM1=GAMMA/(GAMMA-1.)
      PTOT = PEDGEB*(SHEDGE/HEDGE)**(-TM1)
      DO 460 I=1,LUETAB
      UETAB(I)=UETAB(I)*FNORM
      XTABPE(I)=XTABPE(I)*XNORM
      SHE=HEDGE-UETAB(I)**2/2.
      PETAB(I) = PTOT*(SHE/HEDGE)**TM1
      IF (INCOMP .EQ. 1)  PETAB(I) = PEDGEB + 0.50*RHOEB*(UEDGE**2 -
     1                               UETAB(I)**2)*UREF**2
 460  CONTINUE
      LPETAB=LUETAB
      IUEXP=0
      IPEXP=0
C
C     EVALUATE PEDGEB, DPEDSN, AND UEDGE FROM TABLES GENERATED.
C
 500  CALL XNTERP (X,UEDGE,DUMMY1,IUEXP,XTABPE,UETAB,LUETAB,CUEX,IUEXP)
C
C     WRITE VELOCITY TABLE UETAB VERSUS XTABPE.
C
```

```
      WRITE (6,9000)
 9000 FORMAT (1H1)
      WRITE (6,9010) (UETAB(I),I=1,LUETAB)
 9010 FORMAT (25H VELOCITY TABLE GENERATED//5X,13HEDGE VELOCITY//
     1        (8E15.6))
      WRITE (6,9020) (XTABPE(I),I=1,LUETAB)
 9020 FORMAT (/5X,14HAXIAL DISTANCE//(8E15.6))
C
C     USING UETAB VERSUS XTABPE, GENERATE A TABLE OF LINEAR DUEDX VERSUS
C     X AT MIDPOINTS.  INCLUDE FIRST AND LAST X.  START AT END OF UETAB.
C
      IF(LUETAB.GT.1)GO TO 520
      LDUDXT=0
      UETAB(1) = 0.0
      GO TO 560
  520 LDUDXT = LUETAB + 1
      XTDUDX(LDUDXT)=XTABPE(LUETAB)
      UETAB(LDUDXT) = (UETAB(LUETAB) - UETAB(LUETAB-1))/(XTABPE(LUETAB)
     1                - XTABPE(LUETAB-1))
      LM1=LUETAB-1
      DO 550 I=1,LM1
      J=LUETAB+I-1
      XTDUDX(J)=0.5*(XTABPE(J-1)+XTABPE(J))
  550 UETAB(J) = (UETAB(J) - UETAB(J-1))/(XTABPE(J) - XTABPE(J-1))
      XTDUDX(1)=XTABPE(1)
      UETAB(1) = UETAB(2)
      IDUDXP=0
C
C     INITIALIZE VELOCITY DERIVATIVE.
C
  560 CALL LCURV (X,XTDUDX,UETAB,LDUDXT,IDUDXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
C
C     BACK AND AVERAGE VALUES EQUAL FORWARD VALUES INITIALLY.
C
      DUEDS0=DUEDSN
      DUEDS=DUEDSN
      CALL XNTERP (X,PEDGEB,DPEDX ,IPEXP,XTABPE,PETAB,LPETAB,CPEX,
     1             IPEXP)
      RETURN
      END
```

```
CTFCBL     TRANSPIRATION AND FILM COOLING BOUNDARY LAYER PROGRAM
C          INITIALIZATION AND CONTROL ROUTINE
C      CHANGES TO TFCBL
C
       COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
       COMMON/INDEP /S,DS,X,DX,Y(250),DY
       COMMON/PROP  /RHO(250,3),SHU(250,3),PR(250,3),BLE(850,3),

     1               SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
       COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
       COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                 CYTIL(6)                                           /YTABLE/
       COMMON/MATRX /A(250,3),B(250)
       COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWXT(6),
     1               PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEXT(6),
     2               UETAB(500),            LUETAB,IUEXP,CUEX(6),
     3                          XTDUDX(500),LDUDXT,IDUDXP
       COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1               SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
       COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
     1               SKTAB(50),XTABSK(50),LSKTAB,ISK,
     2               DXI
       COMMON/EFVEC /E(250),F(250)
       COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
       COMMON/GEOM  /RW(2),DRWDX(2),THW(2)
       COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1                YTZETA,YEDGE                                        /ZCALC/
       COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
       COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                 DUEDS,DUEDSN,DPEDSN                               /EDGEBC/
       COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
       COMMON/MULT  /XN,UEN,PEN,SMDN,YN
       COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL,        /GPARAM/
     1                 SQWDS,SQWO                                        /GPARAM/
       COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
     1               EPSLN3,CONVRG,02DY,04DY,ODYSQ
       COMMON /TITLE/ TITLE(13)                                           /TITLE/
       COMMON/COUNT /NY,NYI,NY2,NY3,JO,JN,JA,NEL,NELI,NSP,NMAX,NYI
       COMMON/OPTION/IDEAL,LAMNR,INCOMP
       COMMON/STATN /ISTATN,MAXIT,ITER
       COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPPG,LINESR
       COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,ISTA,NVAR,IDRUM,LAST
       COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
       COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),HPROF(50),      /INPROF/
     1                 YBYNH(50),LHPROF,CHYX(6)                          /INPROF/
```

```
      COMMON/PFGAS /GAMMA,FMOLWT,PRI
      COMMON/NEW1  /ALFWIS,TLEWIS
      COMMON/NEW2 / RHOEB,SMUEB,REYL,SXD
      COMMON/NEW3  /AFTRNS,PLAW
      COMMON/NEW5  /IYPR
      COMMON/NEW7  /GPO,PAMB,INTDK,ZETAPI
      COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
      COMMON/NEW9  /IYEQ
      COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAVP,CAYX(8),AFWALL
      COMMON/NEW11 /J2D,UEK,RHOEK
      COMMON/RSTART/IRSRD,IRSWR,ITAPE

      COMMON /AL/ INSTAT,EPSLIN
      COMMON /INPUT/ C(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,          /INPUT/
     1               PHAZ(30),T1(30),T2(30)                              /INPUT/
      COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
     1              CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB,  /COOL/
     2              DXI,HG,HL,IAX,ICOOL,ICA,IRX,ITHX,ITLX,ITZTAB,IZX,    /COOL/
     3              MASSL,PRANDL,QWI,RAMDL,RAMDW,RAMTAB(20),REY,SQWDSI,  /COOL/
     4              SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,    /COOL/
     5              TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20),  /COOL/
     6              ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE              /COOL/
      REAL MASSL                                                         /COOL/
      COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
      DATA BLANK,PIE/6H      ,3.141592653/
      DIMENSION PITAB(500), TITAB(500), VITAB(500)
     1         ,XA(150),XITAB(500),YA(1500),YITAB(500),ZMTAB(500)
      EQUIVALENCE (CPITAB,SHI(1,1,3)),(PITAB,PETAB),(POITAB,SHI(1,1,5)),
     1            (TITAB,SHI(1,1,2)),(VITAB,SHI(1,1,4)),(TXITAB,XTABRW),
     2            (YITAB,RWTAB),(ZMTAB,SHI(1,1,1)),(PEDGE,PEDGEB),
     3            (XA,SCI),(SCI(1,1,4),YA)
C
      NAMELIST /DATA/ AFEDGE,AFTRNS,AFWALL,ALTAB,APROF,BLREF,COEFCL,     /DATA/
     1                CONVRG,CPLTAB,DELTAI,DXI,DXLIM,EPSLIN,EPSLNI,      /DATA/
     2                EPSLN2,EPSLN3,FMOLWT,GAMMA,GPO,HPROF,ICOOL,IDEAL,  /DATA/
     3                IDEBUG,INCOMP,INSTAT,INTDK,IPOLY,IRSRD,IRSWR,      /DATA/
     4                ITHERM,ITZTAB,IYEQ,IYPR,J2D,LAMNR,LAPROF,LDXLIM,   /DATA/
     5                LHPROF,LPDTAB,LPETAB,LRWTAB,LSKTAB,LTWTAB,LUETAB,  /DATA/
     6                LUPROF,MASSL,MAXIT,NLPRNT,NSPRNT,NYI,PAMB,PEDGE,   /DATA/
     7                PEN,PETAB,PLAW,PRI,RAMDW,RAMTAB,RHOEK,RHOREF,RWTAB /DATA/
     8               ,SINIT,SKTAB,SMDN,SMDTAB,SMUREF,SN3,TEDGE,THITAB,   /DATA/
     9                TLTAB,TUBEN,TWTAB,TZTAB,UEDGE,UEK,UEN,UETAB,UPROF, /DATA/
     A                UREF,XINIT,XLIM,XMAX,XN,XSTAR,XTABMD,XTABPE,XTABRW /DATA/
     K               ,XTABSK,XTABTW,YBYNA,YBYNH,YBYNU,YN,ZETAPI,ZMYTAB,  /DATA/
     I                GAMA,ZK,INJH2
      COMMON/H2INJ/INJH2
C
```

```
      NAMELIST/TOKINP/XITAB,YITAB,PITAB,ZMTAB,TITAB,VITAB
C
C     SET CONSTANTS.
C
      NMAX=250
      LNSPPG = 58
      ITHERM = 0
      JO=1
      JN=2
      JA=3
      ALEWIS=1.
      TLEWIS=1.
C
C     INITIALIZE SUMMARY TABLE FLAGS, COUNTERS, AND CONSTANTS.
C
      NPEC=0
      LAST=0
      NSTA=13
      ISTA=0
      NVAR = 30
      IDRUM=17
C
C     INITIALIZE RESTART FLAGS.
C
      ITAPE=16
      REWIND ITAPE
      IRSRD=0
      IRSVR=0
C
C     SET NOMINAL VALUES.

C
      DO 15 I=1,10
   15 TITLE(I) = BLANK
      BLREF=1.
      UREF=1.
      RHOREF=1.
      SMUREF=1.
      XN=1.
      YN=1.
      PEN=1.
      SMDN=1.
      UEN=1.
      PRI=0.
      PLAM=1.
      PAMB = 0.0
      XSTAR = 0.0
      AFWALL=-9999.
      GAMA = 0.150
      ZK = 0.40
      EPSLIN = 0.095
      INSTAT = 9999
      IPOLY = 0
      CONVRG=.005
      EPSLNI=.03
```

```
      EPSLN2=.03
      EPSLN3=.03
      IDEAL=1
      LAMNR=0
      INTDK=0
      NSPRNT=9999
      NLPRNT=50
      J2D=1
      IYFR=1
      IYEQ=4
      NEL=2
      NSP=1
      MAXIT=1
      INJH2=0
C
C     READ INPUT DATA.
C
 999  READ (5,9100) TITLE
9100  FORMAT (13A6)
      READ (5,DATA)
      IF(INJH2.EQ.1) NEL=3
      SQWI = 0.0
      SQWDSI = 0.0
      SUMQWI = 0.0
      ITPOS = 1
      IZX = 0
      ICX = 0
      IRX = 0
      IAX = 0
      ITHX = 0
      ITLX = 0
C
C     IF KW, X, AND PE TABLES ARE INPUT FROM TDK, READ TDKINP NAMELIST.

C     UNUSED TDK TABLES ARE TEMPORARILY READ INTO SHI ARRAY.
C
      IF(INTDK.EQ.0)GO TO 20
      READ (5,TDKINP)
      DO 16 I=1,LRWTAR
   16 XTABPE(I) = XTABRW(I)
      DO 18 J=1,5
      DO 18 I=1,NMAX
      SHI(I,1,J)=0.
   18 SHI(I,2,J) = 0.0
C
C     PRINT TFCRL INPUT DATA.
C
   20 CALL NLOUT
C
```

```
C     READ EQUILIBRIUM CHEMISTRY DATA AND INITIALIZE STORAGE IN ODE.
C      (PROGRAM PRESENTLY HANDLES HYDROGEN-OXYGEN SYSTEM ONLY.)
C
       IF(IDEAL.EQ.0)CALL HOODE (1)
       IF((IDEAL.EQ.1).AND.(INJH2.EQ.1)) CALL HOODE(1)
C
C     SET CONSTANTS BASED ON INPUT.
C
       NEL=NEL-1
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF((IDEAL.GT.0).AND.(PRI.EQ.0.))PRI=.72
       IF(INJH2.EQ.1)  PRI=0.0
       IF(AFWALL.LT.0.)AFWALL=AFTRNS
       XNORM=XN/BLREF
       XINIT=XINIT*XNORM
       SINIT=SINIT*XNORM
       XMAX=XMAX*XNORM
       XSTAR=XSTAR*XNORM
       RSTPR=1.
       REYINF = RHOREF*UREF*BLREF/SMUREF
       UEDGE=UEDGE*UEN/UREF
       PEDGEB=PEDGEB*PEN
       PAMB=PAMB*PEN
C
C     INITIALIZE X, S, AND ZETA.
C
       X=XINIT
       S=SINIT
C
C     CHECK IF THIS CASE IS RESTARTED FROM A PREVIOUS CASE.  IF SO,
C      REINITIALIZE TABLES AND SKIP APPROPRIATE INITIALIZATION.
C
       IF (IRSRD .LE. 0)  GO TO 220
       CALL RDTAPE
       CALL TABLES
       UEDGE=U(NY,JN)
       DO 216 J=1,2
       DO 216 I = 1,NY
       U(I,J)=U(I,JN)
       H(I,J)=H(I,JN)
       CUU(I,J)= CUU(I,JN)
       CUV(I,J)= CUV(I,JN)


       CVV(I,J)= CVV(I,JN)
       CVW(I,J)= CVW(I,JN)
       EPS(I,J) = EPS(I,JN)
       SH(I,J)=SH(I,JN)
       ALPHA(I,J,1)=ALPHA(I,JN,1)
       ALPHA(I,J,3)=ALPHA(I,JN,3)
 216   ALPHA(I,J,2) = ALPHA(I,JN,2)
       GO TO 37
 220   ZETA0 = 0.83333333*DELTA1/BLREF
       ZETAN=ZETA0
```

```
C
C     IF U OR SH PROFILES WERE INPUT, DETERMINE ZETAO FROM U PROFILE
C      IF INCOMPRESSIBLE OR SH PROFILE IF COMPRESSIBLE.
C
       IF(LUPROF.EQ.0)GO TO 290
       IF(INCOMP.EQ.0)GO TO 240
       DO 235 K=1,LUPROF
       I=LUPROF+1-K
       TM1=ABS((UPROF(I)-UPROF(LUPROF))/UPROF(LUPROF))
       IF (TM1 .GE. 0.010)  GO TO 233
       TM2 = TM1
       GO TO 235
  233  YBYNZ=YBYNU(I+1)-(YBYNU(I+1)-YBYNU(I))*(TM2-0.01)/(TM2-TM1)
       GO TO 250
  235  CONTINUE
  240  DO 245 K = 1,LHPROF
       I=LHPROF+1-K
       TM1=ABS((HPROF(I)-HPROF(LHPROF))/HPROF(LHPROF))
       IF (TM1 .GE. 0.010)  GO TO 243
       TM2 = TM1
       GO TO 245
  243  YBYNZ=YBYNH(I+1)-(YBYNH(I+1)-YBYNH(I))*(TM2-0.01)/(TM2-TM1)
       GO TO 250
  245  CONTINUE
  250  ZETAO = YN/BLREF*YBYNZ
       ZETAN=ZETAO
C
C     SET INITIAL ALPHAW FOR T-P EQUILIBRIUM CALCULATION.
C
       AFWALL=APROF(1)
C
C     SET UP TABLES AND INITIALIZE X-DEPENDENT WALL AND EDGE CONDITIONS.
C
  290  CALL TABLES
       XMAX=AMIN1(XMAX,XLIM(LDXLIM),XTABSK(LSKTAB))
C*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
       IF(ZETAPI.EQ.0.)GO TO 23
       ZETAP=ZETAPI
       GO TO 35
C
C     CALCULATE INITIAL ZETAP IF NOT INPUT.
C
   23  REYL = RHOEB*UEDGE*UREF*BLREF/SMUEB
       IF (LAMNR .LE. 0)  GO TO 30
       SXO = REYL*ZETAO**2*0.040
       ZETAP=2.5*SQRT(1./(REYL*SXO))
       GO TO 35
```

```
   30 SXU=((DELTAI/(BLREF*.37))**.5*REYL)**.25
      ZETAP=.833*.37*.8/((REYL*SXU)**.2)
   35 ZSTAR(1) = ZETAO - DS*ZETAP
      DSZ(1)=DS
C
C     SET UP ARRAYS OF Y, YTIL,BGP, AND BGPP AT EACH MESH POINT.
C
      CALL GFUNC
      O2DY=0.5/DY
      O4DY=0.25/DY
      ODYSQ=1./(DY*DY)
C
C     INITIALIZE U, H, SH, ALPHAI, AND RHOV PROFILES ACROSS THE BOUNDARY
C      LAYER.
C
      CALL PROFIL
      WRITE(6,31)
   31 FORMAT (1H1,33X,2HNO,17X,1HU,19X,1HK,18X,3HEPS/)
      DO 32 I=1,NY
      A1 = U(I,JN)/U(NY,JN)
      A2 = CUU(I,JN)/U(NY,JN)**2
      A3 = EPS(I,JN)*SMUREF
   32 WRITE (6,36) I,A1,A2,A3
   36 FORMAT (33X,I3,4X,1P3E20.7)
C
C     CALCULATE LAMINAR TRANSPORT AND THERMODYNAMIC PROPERTIES AT EACH
C      MESH POINT.  (BLE CONSTANT FOR NOW)
C
   37 DO 40 I = 1,NY
   40 BLE(I,JN) = ALEWIS
      IF(IDEAL.GT.0)GO TO 50
      CALL HOODE (4)
      GO TO 70
C
C     PRESET QUANTITIES WHICH ARE CONSTANT FOR IDEAL GAS OPTION.
C
   53 CONTINUE
      IF(INJH2.EQ.1) GO TO 101
      DO 60 I=1,NY
      ALPHA(I,JN,1)=1.
      SHI(I,JN,1)=1.
   60 SCI(I,JN,1) = 1.0
      DO 100 I=1,NY
      SHB=SH(I,JN)*UREF*UREF
      CALL IGODE (T(I,JN),SHB,PEDGEB,U,RHOB,SMUB,PR(I,JN))
      RHO(I,JN)=RHOB/RHOREF
  100 SMU(I,JN) = SMUB/SMUREF
      GO TO 70
  101 CALL HOODE(4)
C
C     PRESET TURBULENT QUANTITIES.
C
   70 DO 80 I = 1,NY
        F(I)= BGP(I)/(ZETAN*ZETAN*REYINF)
      E(I) = RHO(I,JN)*BGP(I)*ZETAP*YTIL(I)/ZETAN
      PRT(I,JN)=1.
   80 BLET(I,JN) = 1.0
```

```
C
C     CALCULATE TURBULENT TRANSPORT PROPERTIES AT EACH MESH POINT.
C
      IF ( LAMNR.EQ. 0 ) GO TO 81
      DO 82  I=1,NY
   82 EPS(I,JN) = 0.0
      GO TO 83
   81 CALL EDDY
C
C     MOVE FORWARD TO BACK VALUES.
C
   83 DO 120 I = 1,NY
      RHO(I,J0)=RHO(I,JN)
      SMU(I,J0)=SMU(I,JN)
      PR(I,J0)=PR(I,JN)
      BLE(I,J0)=BLE(I,JN)
      CUU(I,J0) = CUU(I,JN)
      CUV(I,J0) = CUV(I,JN)
      CVV(I,J0) = CVV(I,JN)
      CWW(I,J0) = CWW(I,JN)
      DO 110 ISP=1,NSP
      SHI(I,J0,ISP)=SHI(I,JN,ISP)
  110 SCI(I,J0,ISP) = SCI(I,JN,ISP)
      T(I,J0)=T(I,JN)
      EPS(I,J0)=EPS(I,JN)
      PRT(I,J0)=PRT(I,JN)
  120 BLET(I,J0) = BLET(I,JN)
C
C     CALCULATE GROSS BOUNDARY LAYER PARAMETERS AT S = SINIT.
C
      IF(IRSRD.GT.0)RHO(NY,JA)=RHO(NY,JN)
      CALL PARAMS
C
C     PRINT AT INITIAL STATION.
C
      IF(IRSRD.EQ.0)ISTATN=0
      ISPRNT=0
      ILPRNT=0
      CALL PRINT
C
C     HAVING COMPLETED ALL INITIALIZATION, SOLVE THE BOUNDARY LAYER FROM
C      X = XINIT TO X = XMAX.
C
      CALL EXECUT
      IF(RSTAR.GT.0.)WRITE (6,9800) RSTPR
 9800 FORMAT (////42H THROAT RADIUS CORRECTED FOR DISPLACEMENT ,
     1         11HTHICKNESS =,1PE14.7)
      WRITE (6,330)
  330 FORMAT (///27X,75HTABLE OF CORRECTED CONTOUR POINTS NORMALIZED AND
     1 DIMENSIONAL AND DELTA STAR///17X,14HX (NORMALIZED),11X,
     2 14HY (NORMALIZED),8X,17HDELTA STAR (FEET),13X,11HX (IN FEET),
     3 14X,11HY (IN FEET)//)
      M = 0
      MAP = 0
      REWIND IDRUM
      DO 300 K = 1,NREC
      READ (IDRUM) NST,((SUMARY(I,J), J = 1,NVAR), I = 1,NST)
```

```
      DO 300 L = 1,NST
      XCCP = SUMARY(L,2 )/RSTPP
      YCCP = SUMARY(L,1 )/RSTPR
      IF (SUMARY(L,20) .LT. XSTAR)  GO TO 310
      MAP = MAP + 1
      XA(MAP) = XCCP
      YA(MAP) = YCCP
  310 M = M + 1
  300 WRITE (6,340) M,XCCP,YCCP,SUMARY(L,8),SUMARY(L,20),SUMARY(L,10)
  340 FORMAT (I5,1X,1P5E25.8)
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(RHOEK.EQ.0.)RHOEK=RHO(NY,JN)*RHOREF
*   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(UEK.EQ.0.)UEK=U(NY,JN)*UREF
      PAREN=THETA-BLREF*SNTGRL*RHOREF*UREF/(RHOEK*UEK*RW(2)**J2D)
      TMI=RHOEK*UEK*UEK
      BRKT=TMI*PAREN-(PEDGFB-PAMB)*DLSTAR
      THLOSS=(2.*PIE*RW(2)*BLREF)**J2D*COS(THW(2))*BRKT
      WRITE (6,9900) THLOSS
 9900 FORMAT (////14H THRUST LOSS =,1PE14.7)
      IF (IPOLY .EQ. 0)  STOP
      CALL LESOAR (XA,YA,MAP)
      END
```

```
      SUBROUTINE TPCALC
CTPCALC   PERFORM A SINGLE TEMPERATURE-PRESSURE CALCULATION.                A   2
C
      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),      /POINTS/
     1                GAMMAS(13),P(13),TZ,PPP(13),WM(13),SONVEL(13),
     2                  TTT(13)                                           /POINTS/
      COMMON /MISC/ ENN,SUMN,TT,SU,ATOM(3,105),LLMT(15),BB(15),           /MISC/
     1              BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,       /MISC/
     2              HSUBO,HPP(2),RHO(2),VMIN(2),VELS(2),WP(2),            /MISC/
     3              NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),     /MISC/
     4              RTEMP(15),FOX(15),DENS(15),TLN                        /MISC/
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,    /INDX/
     1              JSOL,JLIQ,IC,IQ2                                      /INDX/
                                                                          A  16
C
      PP=P(1)
      TT=TZ
      WP(1) = 1.
      WP(2) = OF
      SUM=WP(1)+WP(2)
      DO 200 I=1,L
  200 B(I) = (WP(1)*BOP(I,1) + WP(2)*BOP(I,2))/SUM                        A  22
      CALL EQLBRM
      TZ=TT
C  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TT .EQ. 0.0)  RETURN
      CALL ANSWER
      RETURN                                                              A  50
      END
```

```
      SUBROUTINE TRIM (A,X,B,N,NN)
C
      DIMENSION A(NN,3),AA(250),B(NN),BB(250),X(NN)
C
C          FORWARD ELIMINATION
C
      AA(1)=A(1,3)/A(1,2)
      BB(1)=B(1)/A(1,2)
      DO 1 I=2,N
      AAA=A(I,2)-AA(I-1)*A(I,1)
      AA(I)=A(I,3)/AAA
    1 BB(I)=(B(I)-BB(I-1)*A(I,1))/AAA
C
C          BACK SUBSTITUTION
C
      X(N)=BB(N)
      DO 2 I=2,N
      J=N-I+1
    2 X(J)=BB(J)-X(J+1)*AA(J)
      RETURN
      END
```

```
      SUBROUTINE VISCX
CVISCX     ROUTINE TO CALCULATE VISCOSITY AND PRANDTL NUMBER FOR
C          HYDROGEN-OXYGEN SYSTEM FROM MIXTURE FORMULAS.  THIS SUBROUTINE
C          REPLACES ODE SUBROUTINE VISCX.
C
C                    VISCOSITIES (LBM/FT-SEC) STORED IN VISCE(I).
C                    PRANDTL NUMBER STORED IN PR(I).
C
      COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,    /INDX/
     !              JSOL,JLIQ,IC,IQ2                                      /INDX/


      COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),     /POINTS/
     1              GAMMAS(13),P(13),TZ,PPP(13),WM(13),SONVEL(13),
     2                TTT(13)                                           /POINTS/
      COMMON/SPECES/COEF(2,7,30),S(30),EN(30,13),DUM2(760)
      COMMON /VISCX0/ VISCE(13),PR(13)                                   /VISCX0/
      COMMON/CPI    /CPI(30),CPMAR
C
      DIMENSION FKD(9),EMU(9),FMWT(9),PHI(9,9),SMUH(50),SMUH2(50),
     1          SMUH2O(50),SMUO(50),SMUOH(50),SMUO2(50),TTAB(50)
     1         ,SMUN(50),SMUNO(50),SMUN2(50)
C
C     SPECIES MOLECULAR WEIGHTS STORED IN FMWT IN SAME ORDER AS THERMO
C      DATA, NAMELY (1) H   (2) H2   (3) H2O   (4) O   (5) OH   (6) O2
C                   (7) N (8) NO (9) N2
C
      DATA (FMWT(I),I=1,6)/1.008,2.016,18.016,16.000,17.008,32.000/
      DATA (FMWT(I),I=7,9)/14.008,30.008,28.016/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I= 1,10)/
     1    100., 34.3E-6, 37.8E-6, 40.0E-6, 70.0E-6, 78.1E-6, 76.6E-6,
     2    200., 56.9E-6, 66.6E-6, 77.1E-6,135.1E-6,144.2E-6,147.9E-6,
     3    300., 74.9E-6, 89.2E-6,109.6E-6,188.6E-6,196.7E-6,206.4E-6,
     4    400., 90.3E-6,108.6E-6,143.2E-6,234.4E-6,241.4E-6,256.5E-6,
     5    500.,104.2E-6,126.1E-6,178.6E-6,275.0E-6,281.2E-6,301.0E-6,
     6    600.,117.5E-6,142.0E-6,214.9E-6,311.9E-6,318.0E-6,341.4E-6,
     7    700.,129.9E-6,156.8E-6,251.5E-6,346.4E-6,352.2E-6,379.1E-6,
     8    800.,141.7E-6,170.8E-6,287.9E-6,379.0E-6,384.2E-6,414.8E-6,
     9    900.,153.0E-6,184.5E-6,323.5E-6,409.8E-6,414.5E-6,448.5E-6,
     *   1000.,163.8E-6,197.8E-6,358.7E-6,439.1E-6,443.4E-6,480.6E-6/
C
```

```
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=1,20)/
     1   1100.,174.2E-6,210.5E-6,393.2E-6,467.1E-6,471.5E-6,511.2E-6,
     2   1200.,184.3E-6,222.8E-6,426.7E-6,494.0E-6,499.1E-6,540.6E-6,
     3   1300.,194.9E-6,234.7E-6,459.3E-6,520.0E-6,526.3E-6,569.1E-6,
     4   1400.,203.5E-6,246.2E-6,491.0E-6,545.3E-6,552.5E-6,596.8E-6,
     5   1500.,212.8E-6,257.5E-6,521.7E-6,570.2E-6,577.9E-6,624.0E-6,
     6   1600.,221.8E-6,268.5E-6,551.6E-6,594.7E-6,602.7E-6,650.9E-6,
     7   1700.,230.7E-6,279.2E-6,580.7E-6,619.3E-6,627.0E-6,677.8E-6,
     8   1800.,239.3E-6,289.7E-6,609.0E-6,642.9E-6,650.7E-6,703.7E-6,
     9   1900.,247.8E-6,300.0E-6,636.7E-6,666.1E-6,673.9E-6,729.0E-6,
     *   2000.,256.2E-6,310.1E-6,663.7E-6,688.8E-6,696.7E-6,753.8E-6/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=21,30)/
     1   2100.,264.0E-6,320.1E-6,690.1E-6,711.0E-6,719.1E-6,778.2E-6,
     2   2200.,272.4E-6,329.8E-6,716.0E-6,732.9E-6,741.0E-6,802.1E-6,
     3   2300.,280.3E-6,339.4E-6,741.3E-6,754.3E-6,762.6E-6,825.6E-6,
     4   2400.,288.1E-6,348.9E-6,766.2E-6,775.5E-6,783.9E-6,848.7E-6,
     5   2500.,295.8E-6,358.2E-6,790.5E-6,796.3E-6,804.9E-6,871.5E-6,
     6   2600.,303.4E-6,367.3E-6,814.5E-6,816.8E-6,825.5E-6,894.0E-6,
     7   2700.,310.9E-6,376.4E-6,838.0E-6,837.0E-6,845.9E-6,916.1E-6,
     8   2800.,318.2E-6,385.3E-6,861.1E-6,856.9E-6,866.0E-6,937.9E-6,
     9   2900.,325.5E-6,394.1E-6,883.8E-6,876.6E-6,885.8E-6,959.5E-6,
     *   3000.,332.7E-6,402.8E-6,906.1E-6,896.1E-6,905.4E-6,980.7E-6/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=31,40)/
     1   3100.,339.8E-6,411.5E-6,928.0E-6,915.3E-6,924.8E-6,1001.E-6,
     2   3200.,346.9E-6,420.0E-6,949.6E-6,934.2E-6,943.9E-6,1022.E-6,
     3   3300.,353.8E-6,428.4E-6,971.1E-6,953.0E-6,962.8E-6,1043.E-6,
     4   3400.,360.7E-6,436.7E-6,992.2E-6,971.6E-6,981.5E-6,1063.E-6,
     5   3500.,367.5E-6,444.9E-6,1013.E-6,989.9E-6,1000.E-6,1083.E-6,
     6   3600.,374.2E-6,453.1E-6,1033.E-6,1008.E-6,1018.E-6,1103.E-6,
     7   3700.,380.9E-6,461.2E-6,1053.E-6,1026.E-6,1036.E-6,1123.E-6,
     8   3800.,387.5E-6,469.2E-6,1073.E-6,1043.E-6,1054.E-6,1142.E-6,
     9   3900.,394.1E-6,477.1E-6,1093.E-6,1061.E-6,1072.E-6,1161.E-6,
     *   4000.,400.6E-6,485.0E-6,1112.E-6,1079.E-6,1090.E-6,1181.E-6/
C
      DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH2O(I),SMUO(I),SMUOH(I),SMUO2(I)
     *     ,I=41,50)/
     1   4100.,407.0E-6,492.7E-6,1131.E-6,1096.E-6,1107.E-6,1199.E-6,
     2   4200.,413.4E-6,500.5E-6,1150.E-6,1113.E-6,1124.E-6,1218.E-6,
     3   4300.,419.7E-6,508.1E-6,1169.E-6,1130.E-6,1142.E-6,1237.E-6,
     4   4400.,426.0E-6,515.7E-6,1188.E-6,1147.E-6,1159.E-6,1255.E-6,
     5   4500.,432.2E-6,523.2E-6,1206.E-6,1164.E-6,1176.E-6,1274.E-6,
     6   4600.,438.4E-6,530.7E-6,1224.E-6,1180.E-6,1192.E-6,1292.E-6,
     7   4700.,444.5E-6,538.1E-6,1243.E-6,1197.E-6,1209.E-6,1310.E-6,
     8   4800.,450.6E-6,545.5E-6,1261.E-6,1213.E-6,1226.E-6,1328.E-6,
     9   4900.,456.6E-6,552.8E-6,1278.E-6,1229.E-6,1242.E-6,1346.E-6,
     *   5000.,462.6E-6,560.0E-6,1296.E-6,1246.E-6,1258.E-6,1363.E-6/
```

```
C
      DATA SMUN/
     1       67.9 E-6,123.1E-6,166.6E-6,203.7E-6,237.0E-6,267.6E-6,
     2      296.0E-6,322.6E-6,347.9E-6,372.3E-6,
     3      396.4E-6,419.9E-6,442.4E-6,464.3E-6,485.6E-6,506.4E-6,
     4      526.7E-6,546.6E-6,566.1E-6,585.2E-6,
     5      603.9E-6,622.4E-6,640.5E-6,658.3E-6,675.9E-6,693.2E-6,
     6      710.3E-6,727.2E-6,743.8E-6,760.3E-6,
     7      776.5E-6,792.6E-6,808.5E-6,824.2E-6,839.7E-6,855.1E-6,
     8      870.4E-6,885.5E-6,900.4E-6,915.3E-6,
     9      929.9E-6,944.5E-6,958.9E-6,973.3E-6,987.5E-6,1001.6E-6,
     A     1015.6E-6,1029.4E-6,1043.2E-6,1056.9E-6/
      DATA SMUNO/
     1       69.8E-6,136.5E-6,192.0E-6,239.7E-6,282.0E-6,320.5E-6,
     2    356.2E-6,389.9E-6,421.9E-6,452.4E-6,481.6E-6,509.5E-6,536.4E-6,
     3    562.5E-6,588.0E-6,612.9E-6,637.6E-6,662.1E-6,686.4E-6,709.8E-6,
     4    732.8E-6,755.4E-6,777.6E-6,799.4E-6,820.9E-6,842.1E-6,863.0E-6,
     5    883.5E-6,903.9E-6,923.9E-6,943.6E-6,963.3E-6,982.7E-6,
     6    1001.9E-6,1020.8E-6,1039.6E-6,1058.1E-6,1076.5E-6,1094.7E-6,
     7    1112.8E-6,1130.6E-6,1148.4E-6,1165.9E-6,1183.3E-6,1200.6E-6,
     8    1217.8E-6,1234.8E-6,1251.7E-6,1268.4E-6,1285.1E-6/
      DATA SMUN2/
     1     72.4E-6,131.3E-6,177.7E-6,217.2E-6,252.7E-6,285.4E-6,
     2    315.6E-6,344.0E-6,371.0E-6,397.1E-6,
     3    422.7E-6,447.8E-6,471.8E-6,495.2E-6,517.9E-6,540.1E-6,
     4    561.7E-6,582.9E-6,603.7E-6,624.0E-6,
     5    644.0E-6,663.7E-6,683.0E-6,702.1E-6,720.8E-6,739.3E-6,
     6     757.5E-6,775.5E-6,793.3E-6,810.8E-6,
     7    828.1E-6,845.3E-6,862.2E-6,879.0E-6,895.5E-6,912.0E-6,
     8    928.2E-6,944.3E-6,960.3E-6,976.1E-6,
     9    991.7E-6,1007.3E-6,1022.7E-6,1037.9E-6,1053.1E-6,1068.1E-6,
     *   1083.0E-6,1097.8E-6,1112.5E-6,1127.1E-6/
C
C
      DO 100 I=1,NPT
C
C     OBTAIN SPECIES VISCOSITIES FROM TABLES.
C
      IX=0
      CALL LCURV (TTT(I),TTAB,SMUH,50,IX,EMU(1))
      CALL LCURV (TTT(I),TTAB,SMUH2,50,IX,EMU(2))
      CALL LCURV (TTT(I),TTAB,SMUH2O,50,IX,EMU(3))
      CALL LCURV (TTT(I),TTAB,SMUO,50,IX,EMU(4))
      CALL LCURV (TTT(I),TTAB,SMUOH,50,IX,EMU(5))
      CALL LCURV (TTT(I),TTAB,SMUO2,50,IX,EMU(6))
      CALL LCURV(TTT(I),TTAB,SMUN ,50,IX,EMU(7))
      CALL LCURV(TTT(I),TTAB,SMUNO,50,IX,EMU(8))
      CALL LCURV(TTT(I),TTAB,SMUN2,50,IX,EMU(9))
C
C     OBTAIN SPECIES CP AND CPBAR.  CONVERT CP-S TO CAL/GM-DEG K.
C
      CALL CPSPEC (TTT(I),I)
      DO 20 J=1,NS
      CPI(J)=CPI(J)/FMWT(J)
      IF(EN(J,I).LT.1.E-10)EN(J,I)=1.E-10
   20 CONTINUE
```

```
C
C     CALCULATE VISCOSITY EMUBAR (IN POISES), CONDUCTIVITY EKDBAR, AND
C      PRANDTL NUMBER PRD FROM MIXTURE FORMULAS.
C
      EMUBAR=0.
      EKDBAR=0.
      DO 40 II=1,NS
      TM=0.
      DO 50 JJ=1,NS
      IF(JJ.EQ.II)GO TO 50
      PHI(II,JJ)=(1./SQRT(8.*(1.+FMWT(II)/FMWT(JJ))))*
     1 (1.+SQRT(EMU(II)/EMU(JJ))*(FMWT(JJ)/FMWT(II))**0.25)**2.
      TM=TM+EN(JJ,1)*PHI(II,JJ)/EN(II,1)
   50 CONTINUE
      TM1=1.+TM
      TM2=1.+1.065*TM
      EMUBAR=EMUBAR+EMU(II)/TM1
      EKD(II) = EMU(II)*(1.32250*CPI(II) + 0.8569849625/FMWT(II))
   40 EKDBAR = EKDBAR + EKD(II)/TM2
C
C     STORE ANSWERS.
C
      VISCE(I)=EMUBAR*0.06722
  100 PR(I) = EMUBAR*CPBAR/EKDBAR
      RETURN
      END
```

```
      SUBROUTINE ZFUNC
CZFUNC    EVALUATE BOUNDARY LAYER THICKNESS FUNCTION ZETA.
C
      COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
      COMMON/INDEP /S,DS,X,DX,Y(250),DY
      COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,        /YTABLE/
     1                CYTIL(6)                                          /YTABLE/
      COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
     1              SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
      COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,       /ZCALC/
     1               YTZETA,YEDGE                                       /ZCALC/
      COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
      COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,     /EDGEBC/
     1                DUEDS,DUEDSN,DPEDSN                                /EDGEBC/
      COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
      COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NY1
C
C     OBTAIN YZETA WHERE U = 0.99 * UE.
C
      DO 100 K=1,NY
      I=NY+1-K
      TM1=ABS(U(I,JN)-UEDGE)/UEDGE
      IF (TM1 .GE. 0.010)  GO TO 50
      TM2 = TM1
      GO TO 100
   50 YZETA=Y(I+1)-DY*(TM2-0.01)/(TM2-TM1)
      GO TO 220
  100 CONTINUE
C
C     FIND YTZETA CORRESPONDING TO YZETA.
C
  220 CALL XNTERP (YZETA,YTZETA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,IYTILF)
      IYTILF=IYTILP
C
C     OBTAIN NEW ZETA FROM EDGE CRITERION.  THEN UPDATE ZETAP AND ZETAN.
C
      ZSTAR(3)=ZETAN*YTZETA
      ZETAP=(ZSTAR(3)-ZSTAR(1))/(DSZ(1)+DS)
      ZETAN=ZETAO+DS*ZETAP
      ZETA=0.5*(ZETAO+ZETAN)
C
C     UPDATE SMDWN,SMDW.
C
      CALL LCURV (X+DX,XTABMD,SMDTAB,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETAN)
      SMDW=0.5*(SMDWN+SMDWO)
      RETURN
      END
```

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