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

Volume II

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Final Report

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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.

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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 Boundary 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, H₂, H₂O, O, OH, O₂, N, NO, and N₂, the last three species having been added. Therefore, modifications to subroutines BLKDTA, ELEMETS, EXECUT, HODE, HPCALC, NLOUT, ODE, PRINT, PROFIL, 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 boundary 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:

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

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

$$\frac{S_T^\circ}{R} = a_1 \ln T + a_2 T + \frac{a_3 T^2}{2} + \frac{a_4 T^3}{3} + \frac{a_5 T^4}{4} + a_7$$

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, H₂, H₂O, H₂O, O₂, and O₂,

respectively, while AIREDY includes an additional three species,

k=7, 8, and 9, N, N₂, and N₂.

2. Subroutine EDDY (Common to TBLEDY and AIREDY)

The turbulent kinetic energy equation to be solved is

(See Volume I):

$$\begin{aligned} \overline{\rho u} \frac{\partial K}{\partial s} + (\overline{\rho v} + \overline{\rho'v'}) \frac{\partial K}{\partial y} = 2k\rho\Lambda K^{1/2} \left(\frac{\partial \overline{u}}{\partial y} \right) \left| \frac{\partial \overline{u}}{\partial y} \right|^{3/2} \\ + \frac{\partial}{\partial y} [(\mu + \alpha \overline{\rho} \Lambda K^{1/2})] - \overline{\rho} \mu \beta \frac{K}{\Lambda^2} - \gamma \frac{\overline{\rho} K}{\Lambda} \end{aligned} \quad (1)$$

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

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

where

$$\epsilon = \epsilon_1 = \overline{\rho} \ell^2 \left| \frac{\partial \overline{u}}{\partial y} \right| \quad \text{for} \quad \overline{\rho} \ell^2 \left| \frac{\partial \overline{u}}{\partial y} \right| \leq \kappa \Lambda \overline{\rho} K^{1/2} \quad (3)$$

and

$$\epsilon = \epsilon_0 = k \Lambda \overline{\rho} K^{1/2} \quad \text{for} \quad \overline{\rho} \ell^2 \left| \frac{\partial \overline{u}}{\partial y} \right| > k \Lambda \overline{\rho} K^{1/2} \quad (4)$$

At the matching point where ϵ_1 and ϵ_0 coincide, assume that the following two terms are predominant in Eq. (2),

$$2 \epsilon \left(\frac{\partial \overline{u}}{\partial y} \right)^2 - \gamma \overline{\rho} K^{3/2} / \Lambda \approx 0 \quad (5)$$

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

$$\epsilon_0 \approx \left(\frac{2k^3}{\gamma} \right)^{1/2} \overline{\rho} \Lambda^2 \left(\frac{\partial \overline{u}}{\partial y} \right) \quad (6)$$

This means that, at the matching point where $\epsilon_1 = \epsilon_0$, the prandtl mixing length, ℓ , and the dissipation length, Λ could be related by

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

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

$$l \approx 1.048\Lambda \quad (8)$$

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

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

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

$$\begin{aligned} \epsilon^* &= \epsilon / \mu_T \\ K^* &= K / U_T^2 \\ \Lambda &= \Lambda / L\zeta \end{aligned} \quad (10)$$

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

$$\begin{aligned} \rho^* u^* \frac{\partial K^*}{\partial S^*} + (\rho^* v^* G' - \rho^* u^* \frac{G' \zeta' y}{\zeta}) \frac{\partial K^*}{\partial y^*} \\ = 2 \epsilon^* \frac{G'^2}{Re_T \zeta^2} \left(\frac{\partial u^*}{\partial y^*} \right)^{\frac{1}{2}} + \frac{G'}{\zeta} \frac{\partial}{\partial y^*} \left(\frac{\alpha \epsilon^*}{Re_T \zeta} \frac{\partial K^*}{\partial y^*} \right)^{-\gamma} \frac{\rho^* K^*}{\zeta \Lambda} \end{aligned} \quad (11)$$

where

$$\epsilon_i^* = \bar{\rho} \ell^2 \left| \frac{\partial u}{\partial y} \right| / \mu_r \quad (12)$$

$$\epsilon_0^* = k \bar{\Lambda} \zeta \rho^* K^* R_{e_r} \quad (13)$$

and

$$R_{e_r} = P \bar{r} U_r L / \mu_r \quad (14)$$

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

$$F = \frac{G'}{R_{e_r} \zeta^2} \quad (15)$$

and

$$T_2 = \rho^* v^* G' - \rho^* u^* \frac{G' \zeta' \bar{y}}{\zeta} \quad (16)$$

we obtain

$$\begin{aligned} \rho^* u^* \frac{\partial K^*}{\partial s^*} + T_2 \frac{\partial K^*}{\partial y^*} &= 2 \epsilon^* F G' \left(\frac{\partial u^*}{\partial y^*} \right)^2 + \alpha F \frac{\partial}{\partial y^*} \left(\epsilon^* \frac{\partial K^*}{\partial y^*} \right) \\ &\quad - \gamma \frac{\rho^* K^{*2}}{\zeta \bar{\Lambda}} \end{aligned} \quad (17)$$

$$\begin{aligned} \text{Define BRKT} &= 2 \epsilon^* F G' (\partial u^* / \partial y^*)^2 \\ \text{TM1} &= \alpha F G' \epsilon^* \end{aligned} \quad (18)$$

$$\text{TM2} = \alpha F (\epsilon^* G'' / G' + G' \partial \epsilon^* / \partial y^*) \quad (19)$$

$$\text{TM3} = \epsilon^{*3} (k R_{e_r} \zeta \rho^* \bar{\Lambda})^{-3} \quad (20)$$

and

$$TM4 = BRKT - \gamma TM3 \rho^* / (\xi \tilde{N}) \quad (21)$$

then Eq. (17) becomes

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

The above equation is written in a finite difference form as

$$\rho^* u^* \frac{K^*_{m+1,n} - K^*_{m,n}}{\Delta s^*} + (T2 - TM2) \left(\frac{1}{2} K^*_{m,n} + \frac{K^*_{m+1,n+1} - K^*_{m+1,n-1}}{4 \Delta y^*} \right) - TM1 \left(\frac{1}{2} K^*_{yy,m,n} + \frac{K^*_{m+1,n+1} - 2 K^*_{m+1,n} + K^*_{m+1,n-1}}{2 \Delta y^*} \right) = TM4 \quad (23)$$

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

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

where

$$A_3(n) = \frac{T2 - TM2}{4 \Delta y^*} - \frac{TM1}{2 \Delta y^{*2}} \quad (25)$$

$$A_2(n) = \frac{\rho^* u^*}{\Delta s^*} + \frac{TM1}{\Delta y^{*2}} \quad (26)$$

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

and

$$B(n) = TM4 + \frac{\rho^* u^* K_{m,n}^*}{\Delta S^*} - \frac{T2 - TM2}{2} Ky_{m,n}^* + \frac{TM1}{2} Kyy_{m,n}^* \quad (28)$$

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

$$K_{n=1}^* = 0 \text{ and } K_{n=NMAX}^* = 0 \quad (29)$$

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

<u>Physical Quantity</u>	<u>Program Variable</u>
$k = 0.6$	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:

$$\tilde{\Lambda} = \tilde{y} [0.2050 \left(\frac{\tilde{y}}{\tilde{\delta}}\right) - 0.5860 \left(\frac{\tilde{y}}{\tilde{\delta}}\right)^2 + 0.4310] \quad (30)$$

The calculation methods of the inner eddy viscosity ϵ_1^* , and the turbulent Prandtl number are exactly the same as in Reference 1; ϵ_1^* being presently defined as CUV.

The remaining definitions of program variables are shown below.

<u>Physical Quantity</u>	<u>Program Variable</u>
K^*	CUU
$\partial K^* / \partial y^*$	CUUYMN
$\partial^2 K^* / \partial y^{*2}$	UUYMN
$\tilde{\delta}.990$ 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, α_o , 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;

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

and at the wall;

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

the elements, H, N, and ϕ 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:

<u>Physical Quantity</u>		<u>Program Variable</u>
$\delta_{.990}$ or $\delta_{.995}$ (AIREDY) (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 PROFIL

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

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

and

$$\epsilon^* = k \Lambda \bar{\rho} K^{1/2} / \mu_T \quad : \quad EPS$$

7. Subroutine VISCX (AIREDY)

This subroutine was modified to include the species, N, N \emptyset and N $_2$.

The molecular viscosity, μ_1 , of the species, N, N \emptyset , 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 polynomial coefficient calculation
- =1 A set of polynomial coefficients for the
corrected wall contour is to be calculated.

The following inputs are necessary, when $IC\phi\phi L = 1$ or 2 .

For $IC\phi\phi L = 0$, one may ignore this input data.

[Regenerative Cooling Inputs]

$C\phi EFCL$ 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. $^{\circ}R$)
 $TUBEN$ Number of cooling tubes (-)

[Coolant Properties Tables]

$ITZTAB$ Integer: Number of points in temperature versus
 $C_{p\ell}$, λ_{ℓ} , and μ_{ℓ} table
 $TZTAB$ Coolant temperature table used to obtain $C_{p\ell}$,
 λ_{ℓ} , and μ_{ℓ} ($^{\circ}R$)
 $CPLTAB$ Coolant specific heat, $C_{p\ell}$ (BTU/ lb_m $^{\circ}R$)
 $RAMTAB$ Thermal conductivity of coolant, λ_{ℓ} (BTU/ft. sec $^{\circ}R$)
 $ZMYTAB$ 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, $T_{\ell o}$ ($^{\circ}R$)

In the case of $IC\emptyset\emptyset L = 1$ 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

$$GP\emptyset = 1000.0 \quad \text{and} \quad SN\ 3 = 2.50$$

Although the constants, $\gamma = \text{GAMA}$ and $k = \text{ZK}$, 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:

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

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

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.

<u>Name</u>	<u>Description</u>	<u>Units</u>
TL0: $T_{\ell}(x_1 - \Delta x_{11})$	Assumed coolant temperature in tubes at the next station towards the injector	$^{\circ}\text{R}$
TL1: $T_{\ell}(x_1)$	Assumed coolant temperature in tubes at the station where cooling parameters are to be obtained	$^{\circ}\text{R}$
TL2: $T_{\ell}(x_1 + \Delta x_{12})$	Assumed coolant temperature in tubes at the next station towards nozzle exit.	$^{\circ}\text{R}$
TAW: T_{aw}	Adiabatic wall temperature	$^{\circ}\text{R}$
TLCA	Calculated coolant temperature	$^{\circ}\text{R}$
TWL: $T_{w\ell}$	Calculated coolant side wall temperature	$^{\circ}\text{R}$
TWL2	$(TLCA + TL1)/2.0$	$^{\circ}\text{R}$
TWGCA: T_{wg}	Arithmetic average of the assumed and calculated gas side wall temperatures $(TWALL + TWGCA)/2.0$	$^{\circ}\text{R}$
TEMPRL: $T_{w\ell}'/T_{\ell}$	Temperature ratio of the calculated coolant side wall temperature to the coolant temperature	--
CPL: $C_{p\ell}$	Coolant specific heat	BTU/lbm $^{\circ}\text{R}$
CPSUM	Specific heat of combustion products in free stream	BTU/lbm $^{\circ}\text{R}$

<u>Name</u>	<u>Description</u>	<u>Units</u>
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 $-\frac{\mu_w}{Pr_w} \left[\frac{\partial h}{\partial y} + (Le-1) \sum_i h_{i1} \frac{\partial Y_{i1}}{\partial y} \right]_w$	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: $C_{p_l} \mu_l / \lambda_l$	---

<u>Name</u>	<u>Description</u>	<u>Units</u>
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_fsec/ft²) 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: $(\mu + \epsilon) \frac{\partial \bar{u}}{\partial y}$	lb _f /ft ²
TAU/(RE*UE2)	Normalized friction: $\frac{\tau}{\rho_e U_e^2}$	---
EPS/(RHØ UE DELTA)	Normalized EDDY viscosity: $\frac{\epsilon}{\rho_e U_e \delta}$	---
YTIL/DELTA	Normalized distance from wall, y/δ	---

• Group III exhibits the following profiles:

<u>Name</u>	<u>Description</u>	<u>Units</u>
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: $\rho^u / \rho_e U_e$	---

<u>Name</u>	<u>Description</u>	<u>Units</u>
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/ϕ .

V SAMPLE CASE

CASE I

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

FLAGS AND OPTIONS

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

PROBLEM LIMITS AND INITIAL VALUES

SINITY = .00000000 XINITY = -12.00000000 XMAX = 6.69999999 DX1 = 2.000000-03 DELTAT = 5.000000-04 ZETAPl = 5.000000-04

REFERENCE QUANTITIES

HLREF = 3.502500-01 UREF = 1.000000+03 RHOREF = 2.000000-03 SMURFF = 5.000000-07

INPUT NORMALIZATION FACTORS

XN = 8.333330-02 YN = 1.000000+00 UEN = 1.000000+00 PEN = 4.459680+05 SMON = 1.000000+00

EDGE QUANTITIES

UEEDGE = 4.000000+02 PEEDGE = 1.000000+00 TERGE = 6.615000+03 AFEDGE = 1.371792+01

CONSTANTS

AFTRYS = 9.990000-01 PRI = 0.000000 GAMPA = 0.000000 FMOLWT = 0.000000 PLAM = 7.000000+00 PAMB = 0.000000
GPO = 1.000000+03 SM3 = 2.500000+00 XSTAR = 0.000000 AFWALE = 8.000000-01 UCK = 0.000000 RHOEK = 0.000000

CONVERGENCE AND EDGE CRITERIA

CONVRG = 5.000000-03 EPSLNI = 1.000000-02 EPSLN2 = 1.000000-02 EPSLN3 = 1.000000-02 EPSLIN = 0.000000

COUNTERS

MAXIT = 2 NVI = 120 NLPRTY = 40 NSPRNT = 40 INSTAT = 69999 IYPR = 1 IYEO = 0

CORRELATION INPUTS

GAMA = .000000 ZK = .000000

STEP SIZE CONTROL TABLES

DLXLM	LOXLM= 12	XLIM	ESKTAB= 6	SKTAB	XTABSK
1.0000000-02		-1.1950000+01		1.0100000+00	-1.2000000+01
1.0000000-02		-1.0000000+01		1.0100000+00	-1.0000000+01
1.0000000-02		-8.0000000+00		1.0100000+00	-1.0000000+01
5.0000000-03		-5.0000000+00		1.0100000+00	5.0000000-01
2.0000000-03		-1.0000000+00		1.0100000+00	3.0000000+00
1.0000000-03		-5.0000000+01		1.0100000+00	6.2000000+00
1.0000000-03		-3.0000000+01			
1.0000000-03		6.0000000+01			
5.0000000-03		1.5000000+00			
1.0000000-02		3.5000000+00			
1.0000000-02		6.0000000+00			

WALL TABLES

LTWTAB= 16

XTABTW

SMHTAB

XTABMD

WTAB	XTABTW	SMHTAB	XTABMD
1.900000+03	-1.200000+01	2.937400-02	-1.200000+01
1.900000+03	-1.006570+01	2.937400-02	-1.100000+01
1.900000+03	-7.869600+00	2.937400-02	-1.050000+01
1.900000+03	-6.905500+00	3.276400-02	-9.500000+00
1.700000+03	-5.124400+00	2.146600-02	-8.500000+00
1.700000+03	-4.002630+00	2.146600-02	-7.500000+00
1.700000+03	-2.928200+00	2.495400-02	-6.500000+00
1.700000+03	-1.930100+00	2.211470-02	-5.500000+00
1.700000+03	-9.151000-01	3.054570-02	-4.900000+00
1.700000+03	-5.000000-01	2.940200-02	-3.500000+00
1.700000+03	-3.800000-01	3.320160-02	-2.600000+00
1.700000+03	0.000000	5.147340-02	-2.000000+00
1.900000+03	2.000000-01	6.140730-02	-1.500000+00
1.900000+03	4.239000-01	8.974200-02	-1.000000+00
1.900000+03	1.229500+00	1.319840-01	-5.000000-01
1.900000+03	2.299700+00	1.388000-01	-2.500000+01
1.900000+03	4.417600+00	1.390000-01	-1.000000-01
1.900000+03	6.700000+00	1.388000-01	-5.000000-02
		1.370000-01	5.000000-02
		5.000000-02	2.000000-01
		1.104380-02	4.000000-01
		2.456290-02	9.500000-01
		9.093510-03	1.400000+00
		1.085450-02	2.100000+00
		9.658640-03	3.000000+00
		1.477540-02	4.200000+00
		7.420550-03	5.300000+00
		6.704230-03	6.400000+00
		6.600000-03	6.700000+00

GEOMETRY AND EDGE TABLES

RM TAB	LRW TAB = 18	XTAB RM	PETAB	EPETAB = 18	XTAB PE
6.3050000+00	-1.2000000+01	9.8159509-01	-1.2000000+01		
6.3050000+00	-1.0065700+01	9.8150000-01	-1.0065700+01		
6.3050000+00	7.8696000+00	9.8130000-01	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	9.7451404-01	-4.0263000+00		
4.9348000+00	-2.9282000+00	9.4829664-01	-2.9282000+00		
4.8170000+00	-1.8310000+00	8.3095099-01	-1.8310000+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	5.6000000-01	-3.0000000-01		
3.6650000+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		
4.5003000+00	1.2295000+00	1.1614141-01	1.2295000+00		
5.0286000+00	2.2997000+00	8.9880530-02	2.2997000+00		
6.3523000+00	4.4176000+00	6.6309977-02	4.4176000+00		
8.3800000+00	6.7000000+00	5.5000000-02	6.7000000+00		

M 2.0000 .0000 .0000 .0000 .0000 100.0000 F .00 6 298.150 F .00000
 O 2.0000 .0000 .0000 .0000 .0000 100.0000 F .00 6 298.150 O .00000

FUEL OXIDANT MIXTURE

H.CAL/G .00000000 .00000000 .00000000
 V+ .9920634E+00 .00000000 .4960317E+00
 V- .00000000 -.1250000E+00 -.6250000E-01
 ATOMS/G
 H .9920634E+00 .00000000 .4960317E+00
 O .00000000 .6250000E-01 .3125000E-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

.11085+01	.111105+01	.111508+01	.111831+01	.114695+01	.125217+01	.168489+01	.298850+01
.428948+01	.504650+01	.560726+01	.692901+01	.774018+01	.898895+01	.949061+01	.987416+01
.165257+02	.109577+02						

AXIAL DISTANCE

-.327842+01	-.274928+01	-.421499+01	-.174999+01	-.139999+01	.109999+01	.479989+00	-.499986+00
-.250007+00	-.134501+00	-.181965+01	.000000	.546403+01	.115810+00	.335901+00	.628282+00
.120690+01	.183045+01						

YTL

Y=6

G/P

G/P

0.000000	0.000000	1.0003778+03	-1.8066330+09
1.9070164+05	9.9221459+03	3.3793019+02	-8.8929430+04
6.0701539+05	1.9844292+02	1.0117344+02	1.6871584+04
1.3019587+04	2.9766438+02	1.1679330+02	-5.2333507+05
2.1192111+04	3.6688583+02	8.3189272+01	-2.1183377+05
3.6997281+04	4.9610729+02	6.3484579+01	-1.0134701+05
5.4767820+04	5.9532075+02	4.9943731+01	-5.4394544+04
7.6835178+04	6.9455021+02	4.0601130+01	3.1748161+04
1.0350277+03	7.9377167+02	3.4138660+01	-1.9752972+04
1.3505666+03	8.9299313+02	2.9106443+01	-1.2924245+04
1.7177020+03	9.9221459+02	2.5195577+01	-8.8070349+03
2.1370352+03	1.0914360+01	2.2298468+01	-6.206001+03
2.6170841+03	1.1906575+01	1.9561666+01	-4.4979017+03
3.1542841+03	1.2898790+01	1.7481820+01	-3.3388579+03
3.7530043+03	1.3891004+01	1.5743074+01	-2.5300656+03
4.4155579+03	1.4883219+01	1.4371769+01	-1.9518647+01
5.1442175+03	1.5875433+01	1.313497+01	-1.5296823+01
5.9411973+03	1.6867648+01	1.192733+01	-1.2154258+01
6.8087121+03	1.7859863+01	1.0981629+01	-9.7810688+02
7.7489319+03	1.8852077+01	1.0152688+01	-7.9583114+02
8.7640148+03	1.9844292+01	9.4206824+00	-6.5399908+02
9.8561059+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	7.1984973+00	-3.2419250+02
1.5037310+02	2.4805365+01	6.7327745+00	-2.7680720+02
1.6546534+02	2.5797579+01	6.3857093+00	-2.3774439+02
1.8145647+02	2.6789794+01	6.0324957+00	-2.0531043+02
1.9836834+02	2.7782008+01	5.7790821+00	-1.7821196+02
2.1622304+02	2.8774223+01	5.5420146+00	-1.5546309+02
2.3504291+02	2.9766437+01	5.3183539+00	-1.3611408+02
2.5485058+02	3.0758652+01	4.8555460+00	-1.1971697+02
2.7566899+02	3.1750867+01	4.6514019+00	-1.0569790+02
2.9752144+02	3.2743081+01	4.4349150+00	-9.3657875+01
3.2043164+02	3.3735296+01	4.2317226+00	-8.3271197+01
3.4423369+02	3.4727510+01	4.0430681+00	-7.4272979+01
3.6952218+02	3.5719725+01	3.8667735+00	-6.6446614+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	3.4013953+00	-4.8364410+01
4.8148990+02	3.9688583+01	3.2644657+00	-4.3722845+01
5.1250759+02	4.0680798+01	3.135307+00	-3.9616766+01
5.4479073+02	4.1673017+01	3.0135263+00	-3.5973831+01
5.7836844+02	4.2665227+01	2.8983172+00	-3.2732880+01
6.1376912+02	4.3657442+01	2.7892484+00	-2.9984926+01
6.4952302+02	4.4649656+01	2.6858591+00	-2.7256680+01
6.8716395+02	4.5641871+01	2.5877320+00	-2.4939236+01
7.2622076+02	4.6634085+01	2.4944991+00	-2.2857077+01
7.6672748+02	4.7626300+01	2.4057862+00	-2.0982175+01
8.0871776+02	4.8618514+01	2.3213179+00	-1.9290344+01
8.5222640+02	4.9610729+01	2.2407989+00	-1.7760607+01
8.9728918+02	5.0602943+01	2.1639483+00	-1.6337474+01
9.4394296+02	5.1595158+01	2.0905520+00	-1.5116889+01
9.9222573+02	5.2587373+01	2.0203837+00	-1.3973161+01
1.0421766+01	5.3579587+01	1.9532433+00	-1.2931977+01

1.0938361-01	5.4571002-01	1.8482452+00	-1.198-992+01
1.1472456-01	5.5544017-01	1.8273226+00	-1.1112498+01
1.2024482-01	5.6556231-01	1.7682167+00	-1.0317656+01
1.2594883-01	5.7544445-01	1.7114836+00	-9.5891442+00
1.3184116-01	5.8540669-01	1.6569697+00	-8.9204789+00
1.3792654-01	5.9533287-01	1.6046113+00	-8.3059040+00
1.4420986-01	6.0525090-01	1.5542335+00	-7.7402981+00
1.5049615-01	6.1517304-01	1.507497+00	-7.2190973+00
1.5739364-01	6.2509519-01	1.4490611+00	-6.7392271+00
1.6429871-01	6.3501734-01	1.4440753+00	-6.2940423+00
1.7142593-01	6.4493947-01	1.3707266+00	-5.8832788+00
1.7877817-01	6.5486167-01	1.3262749+00	-5.5030046+00
1.8636113-01	6.6478377-01	1.2885053+00	-5.1505833+00
1.9418119-01	6.7470592-01	1.2495261+00	-4.8223643+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
2.1912869-01	7.0447236-01	1.1403173+00	-3.9753236+00
2.2786309-01	7.1439450-01	1.1062757+00	-3.7306691+00
2.3684678-01	7.2431664-01	1.0733781+00	-3.5003754+00
2.4612471-01	7.3423879-01	1.0418167+00	-3.2895738+00
2.5560997-01	7.4416094-01	1.0105976+00	-3.0922410+00
2.6536659-01	7.5408308-01	9.878747-01	-2.9069754+00
2.7536659-01	7.6400523-01	9.518377-01	-2.7337913+00
2.8559234-01	7.7392738-01	9.207777-01	-2.5717411+00
2.9607880-01	7.8384952-01	8.946311-01	-2.4214697+00
3.0682780-01	7.9377167-01	8.7-2037-01	-2.2781096+00
3.1785279-01	8.0369381-01	8.5461949-01	-2.1457906+00
3.2917723-01	8.1361596-01	8.197976-01	-2.0201562+00
3.4082768-01	8.2353810-01	7.9570974-01	-1.9030258+00
3.5275204-01	8.3346025-01	7.7422912-01	-1.7930658+00
3.6496661-01	8.4338240-01	7.4463129-01	-1.6897849+00
3.7749614-01	8.5330454-01	7.258912-01	-1.5927386+00
3.903879-01	8.6322669-01	7.0618263-01	-1.5014857+00
4.036123-01	8.7314884-01	6.853497-01	-1.4156652+00
4.1730657-01	8.8307099-01	6.651677-01	-1.3349136+00
4.31473847-01	8.9299312-01	6.4558049-01	-1.2589016+00
4.4615410-01	9.0291527-01	6.2448278-01	-1.1873249+00
4.6131917-01	9.1283742-01	6.0794351-01	-1.1199014+00
4.76918797-01	9.2275956-01	5.8992226+01	-1.0563693+01
4.9296339-01	9.3268171-01	5.7240316-01	-9.9644959+01
5.0946197-01	9.4260386-01	5.5537640-01	-9.4002568-01
5.265065-01	9.5252600-01	5.3809644-01	-8.8677891-01
5.4416979-01	9.6244814-01	5.2477599-01	-8.3655043-01
5.6247170-01	9.7237029-01	5.0704503-01	-7.8915840-01
5.814154-01	9.8229244-01	4.9181636-01	-7.4443350-01
6.0132751-01	9.9221459-01	4.7700449-01	-7.0221773-01
6.2245051-01	1.021367+00	4.6259885-01	-6.6236355-01
6.4489552-01	1.120589+00	4.4858724-01	-6.2473316-01
6.6869552-01	1.2219810+00	4.3495849-01	-5.8919765-01
6.9376143-01	1.3239337+00	4.2172753-01	-5.5563658-01
7.1994420-01	1.4241825+00	4.0881042-01	-5.2393694-01
7.474444-01	1.5247475+00	3.9424644-01	-4.9379314-01
7.764444-01	1.6246644+00	3.8040471-01	-4.6577590-01
8.0692246-01	1.7242105+00	3.6722105-01	-4.3898224-01
8.3717458-01	1.8235139+00	3.5465929-01	-4.1373478-01
8.6512497-01	1.9214360+00	3.4244335-01	-3.8988153+01
8.9397511-01	2.018582+00	3.30851524-01	-3.6734536-01

9.2375766+01	1.1112803+00	3.2789661+01	-3.4605371-01
9.5450666+01	1.1212025+00	3.1756955+01	-3.2593836-01
9.8675774+01	1.1311246+00	3.0757642+01	-3.0693976-01
1.0120479+00	1.1410468+00	2.9776176+01	-2.8898299-01
1.0529159+00	1.1509689+00	2.8826523+01	-2.7202538-01
1.0979021+00	1.1608911+00	2.7903294+01	-2.5600828-01
1.1240485+00	1.1708132+00	2.700567+01	-2.4086091-01
1.1613991+00	1.1807353+00	2.6132963+01	-2.2659530-01
1.1999999+00	1.1906575+00	2.5284745+01	-2.1310621-01
1.2398987+00	1.2005796+00	2.4460267+01	-2.0037061-01
1.2811456+00	1.2105018+00	2.3658969+01	-1.8834869-01
1.3237929+00	1.2204239+00	2.2880237+01	-1.7702163-01
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	2.0674374+01	-1.4665870-01
1.5095161+00	1.2601125+00	1.9980615+01	-1.3766911+01
1.5600358+00	1.2700347+00	1.9306867+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	1.740048+01	-1.0656887-01
1.7805232+00	1.3097232+00	1.6801756+01	-9.9881324-02
1.8406252+00	1.3196454+00	1.6220657+01	-9.3582539-02
1.9028891+00	1.3295675+00	1.5654727+01	-8.7651494-02
1.9674018+00	1.3394897+00	1.5109562+01	-8.2068238-02
2.0342571+00	1.3494118+00	1.4578739+01	-7.6813868-02
2.1035534+00	1.3593340+00	1.4063653+01	-7.1874443-02
2.1753937+00	1.3692561+00	1.3564506+01	-6.7221958-02
2.2498683+00	1.3791783+00	1.3080311+01	-6.2849274-02
2.3271435+00	1.3891004+00	1.2610987+01	-5.8740096-02
2.4072849+00	1.3990226+00	1.2155864+01	-5.4878912-02
2.4904347+00	1.4089447+00	1.1714476+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
3.0602846+00	1.4684776+00	9.3442965-02	-3.3725317-02
3.1685383+00	1.4783997+00	8.920073-02	-3.1405936-02
3.2810404+00	1.4883219+00	8.6511055-02	-2.9235845-02

NO	U	K	EPS
1	0.000000	0.000000	0.000000
2	1.1590286-04	7.945498-10	1.9622625-12
3	3.6892612-04	2.5289751-09	1.1142465-11
4	7.9129224-04	5.4236511-09	3.4994884-11
5	1.4699497-03	9.6423947-09	8.3214253-11
6	2.2485867-03	1.5406435-08	1.6753742-10
7	3.3246277-03	2.2799115-08	3.0161889-10
8	4.6698164-03	3.1973675-08	5.0093177-10
9	6.2935943-03	4.3051795-08	7.8268352-10
10	9.2083651-03	5.6147137-08	1.1657410-09
11	1.0439688-02	7.1366175-08	1.6705615-09
12	1.3000428-02	8.8409016-08	2.3191275-09
13	1.5995869-02	1.0457564-07	3.1348841-09
14	1.9173812-02	1.3773848-07	4.1426765-09
15	2.2809658-02	1.5538869-07	5.3586697-09
16	2.6836464-02	1.8263312-07	6.8403849-09
17	3.1265012-02	2.1258843-07	8.5864376-09
18	3.6108852-02	2.4510474-07	1.0636672-08
19	4.1381352-02	2.8198615-07	1.3021998-08
20	4.7095732-02	3.1971569-07	1.5774334-08
21	5.3265108-02	3.5985293-07	1.8926547-08
22	5.992517-02	4.0395279-07	2.2512368-08
23	6.702957-02	4.5104689-07	2.6566323-08
24	7.4633497-02	5.0124274-07	3.1123640-08
25	8.2752862-02	5.5452396-07	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	7.9941477-07	6.2732381-08
30	1.3141401-01	8.6976965-07	7.1078201-08
31	1.4285218-01	9.4135655-07	8.0186160-08
32	1.5489070-01	1.0172531-06	9.0093715-08
33	1.6754352-01	1.0964539-06	1.0083809-07
34	1.8082479-01	1.1789633-06	1.1245614-07
35	1.9474894-01	1.2547608-06	1.2498424-07
36	2.0933060-01	1.3539107-06	1.3845810-07
37	2.2458473-01	1.4463118-06	1.5291241-07
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	2.0249371-07
41	2.9263542-01	1.8484431-06	2.2119809-07
42	3.1148704-01	1.9569383-06	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	2.3107818-06	3.0764092-07
46	3.9474156-01	2.4213385-06	3.3227314-07
47	4.1763871-01	2.5446593-06	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	2.9307789-06	4.4337858-07
51	5.1795817-01	3.0644854-06	4.7434044-07
52	5.4534600-01	3.2004922-06	5.0657961-07
53	5.7373081-01	3.3386629-06	5.4009016-07
54	6.0304565-01	3.4788509-06	5.7586131-07
55	6.3340435-01	3.6208974-06	6.1087720-07

56	6.6490143-01	3.7646323-06	6.4811653-87
57	6.9726218-01	3.9798733-06	6.8655221-07
58	7.3081271-01	4.0564292-06	7.2615090-07
59	7.3566736-01	4.2640742-06	7.6687304-07
60	7.4049877-01	4.3926083-06	8.0867205-07
61	7.4527702-01	4.5017894-06	8.5149414-07
62	7.5003512-01	4.6513223-06	8.9527813-07
63	7.5476494-01	4.809919-06	9.3995473-07
64	7.5946520-01	4.9504926-06	9.8544653-07
65	7.6413997-01	5.099529-06	1.0316675-08
66	7.6878947-01	5.2477594-06	1.0785225-08
67	7.7341581-01	5.3948677-06	1.1259274-08
68	7.7801913-01	5.5404169-06	1.1737082-08
69	7.8261114-01	5.6842491-06	1.2218011-08
70	7.8716318-01	5.8257456-06	1.2700522-08
71	7.9170626-01	5.9645662-06	1.3183173-08
72	7.9623151-01	6.1002775-06	1.3664413-08
73	8.0024003-01	6.2322414-06	1.4142587-08
74	8.0523291-01	6.3604989-06	1.4615931-08
75	8.0971120-01	6.4840282-06	1.5082577-08
76	8.1417591-01	6.6124784-06	1.5540529-08
77	8.1862807-01	6.7153022-06	1.5987713-08
78	8.2306863-01	6.8219306-06	1.6421933-08
79	8.2749861-01	6.9217726-06	1.6840892-08
80	8.3191892-01	7.0142145-06	1.7242198-08
81	8.3633050-01	7.0986277-06	1.7623368-08
82	8.4073428-01	7.1743110-06	1.7981831-08
83	8.4513115-01	7.2406977-06	1.8314944-08
84	8.4952202-01	7.2969974-06	1.8619994-08
85	8.5390774-01	7.3425315-06	1.8894218-08
86	8.5824920-01	7.3765761-06	1.9134811-08
87	8.6266723-01	7.3983954-06	1.9330950-08
88	8.6704270-01	7.4072449-06	1.9503808-08
89	8.7141642-01	7.4023741-06	1.9626576-08
90	8.7578923-01	7.3830316-06	1.9704491-08
91	8.8016193-01	7.3484715-06	1.9734863-08
92	8.8453336-01	7.2979552-06	1.9715105-08
93	8.8891029-01	7.2307855-06	1.9642769-08
94	8.9328753-01	7.1462072-06	1.9515581-08
95	8.9766708-01	7.043627-06	1.9331487-08
96	9.0205210-01	6.9223743-06	1.9080693-08
97	9.0644100-01	6.7819777-06	1.8785718-08
98	9.1083333-01	6.6218043-06	1.8421442-08
99	9.1523587-01	6.4417257-06	1.7995160-08
100	9.1964339-01	6.241221-06	1.7506642-08
101	9.2405688-01	6.0902217-06	1.6956190-08
102	9.2848244-01	5.7787345-06	1.6344697-08
103	9.3291552-01	5.5169575-06	1.5673709-08
104	9.3735863-01	5.2352893-06	1.4945487-08
105	9.4181253-01	4.9344661-06	1.4163057-08
106	9.4627798-01	4.6152738-06	1.3302699-08
107	9.5075574-01	4.2792025-06	1.2451037-08
108	9.5524658-01	3.9779055-06	1.1533381-08
109	9.5975126-01	3.5635596-06	1.0581447-08
110	9.6427053-01	3.1888783-06	9.6035190-07
111	9.6880516-01	2.8071814-06	8.6079845-07
112	9.7335591-01	2.4225071-06	7.6041378-07

113	9.7792354-01	2.0396972-06	6.6020562-07
114	9.8250892-01	1.6645025-06	5.6125772-07
115	9.8711254-01	1.3037586-06	4.6470179-07
116	9.9173545-01	9.6549970-07	3.7171070-07
117	9.9637835-01	6.5809983-07	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	5.0072374-08	5.8476916-08
121	1.0000000+00	0.0000000	0.0000000

*** P.W 250K TRNSP COOLED ENGINE, H2+O2, SEP. 4, 1973 *****

STATION	X (inch)	S	OS	RW	THEYAM	ZETA	ZETAP
642	5.2893856+00	5.1855492+00	1.9314901-02	1.9293185+00	7.0616066-01	5.3244085-02	-7.6048980-03

EDGE AND WALL CONDITIONS		PROFILE PARAMETERS	
UEB	RHE	DLSTAR	BCF
1.1554887+04	2.7832251+00	3.7603773-03	1.2278805-03
4.2763057+03	1.6130345-03	-8.2849694-05	-6.0057354-05
-7.6155540+07	1.5452798-06	1.3226699+02	1.4135607+02
2.3384235+04	1.9000000+03	2.3187724+04	-9.9946658+02
-1.4318944+03	7.5243731-03		

NO.	YBAR	V	U/UE	H/HE	RO/ROF	ROV	EPS	T
1	0.0000760	0.0000310	0.0000000	-1.4866386-01	5.0611010-01	4.0337825-04	0.0000000	1877.5
2	3.1085439-07	9.9721459-03	9.1783095-01	-1.4866944-01	5.0359430-01	4.0336766-04	0.0000000	1931.6
3	9.8946917-07	1.9844922-02	2.9675421-02	-1.4810141-01	5.0198001-01	4.0295018-04	1.0308117-09	1963.2
4	2.1222658-06	2.9766438-02	6.3513876-02	-1.4602817-01	5.0125722-01	4.0248280-04	6.8039286-09	1972.1
5	3.7815767-06	3.9688583-02	1.1230351-01	-1.4094378-01	5.0142592-01	4.0121371-04	2.8563706-08	2018.4
6	6.0337664-06	4.9610729-02	1.7536206-01	-1.3047832-01	5.0248612-01	3.9935709-04	8.6986710-08	2042.1
7	8.9274336-06	5.9533705-02	2.4682252-01	-1.1219292-01	5.0443783-01	3.9289969-04	2.0873531-07	2053.3
8	1.2524566-05	6.9455021-02	3.81687415-01	-8.550491-02	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	4.6255542-01	-1.8084509-02	5.1597970-01	3.6372136-04	1.2413473-06	2110.8
11	2.7999508-05	9.9721459-02	4.6395173-01	1.5442214-02	5.2121262-01	3.5315927-04	1.9745753-06	2123.5
12	3.4867475-05	1.0914360-01	4.8956970-01	4.6765777-02	5.3301656-01	3.5961106-04	3.9533744-06	2128.5
13	4.2659941-05	1.1926575-01	5.2348339-01	7.6286454-02	5.3899544-01	3.7062855-04	4.5636297-06	2129.8
14	5.1416603-05	1.2696790-01	5.4897397-01	1.10476547-01	5.4483500-01	3.8840384-04	6.6402438-06	2131.1
15	6.1176079-05	1.3891054-01	5.7297546-01	1.3263197-01	5.5736727-01	4.1298875-04	9.2367496-06	2132.5
16	7.1976074-05	1.4893219-01	5.9576849-01	1.5992420-01	5.6555762-01	4.4064702-05	1.2311670-05	2133.7
17	8.395352-05	1.5875433-01	6.1738037-01	1.8643777-01	5.7298722-01	4.6760931-04	1.5711612-05	2134.6
18	9.6844854-05	1.6876748-01	6.3777137-01	2.1185501-01	5.812608-01	4.9005925-04	1.9199592-05	2130.3
19	1.108583-04	1.7859863-01	6.5660850-01	2.3577479-01	5.8721967-01	5.0438941-04	2.2517728-05	2127.0
20	1.2631194-04	1.8852077-01	6.7377830-01	2.5772743-01	5.9426981-01	5.0754664-04	2.5478640-05	2121.6
21	1.4285936-04	1.9844922-01	6.8907600-01	2.7741554-01	6.0123843-01	4.9782186-04	2.8013688-05	2114.9
22	1.6065006-04	2.0836506-01	7.0254866-01	2.9428593-01	6.0793263-01	4.7521080-04	3.0153096-05	2107.6
23	1.7975190-04	2.1828721-01	7.1438081-01	3.1014577-01	6.1431956-01	4.4172705-04	3.2014487-05	2100.6
24	2.0016868-04	2.2820935-01	7.2478564-01	3.2361817-01	6.236118-01	4.0064929-04	3.3456642-05	2094.7
25	2.2194527-04	2.3813150-01	7.3398449-01	3.3551471-01	6.2999925-01	3.5454816-04	3.5104037-05	2089.7
26	2.4511660-04	2.4805365-01	7.4225731-01	3.4619537-01	6.3127428-01	3.1452921-04	3.9723026-05	2085.1
27	2.6971780-04	2.5797574-01	7.4998678-01	3.5616933-01	6.3040412-01	2.7874237-04	4.3576988-05	2080.7
28	2.9578423-04	2.6789794-01	7.5751964-01	3.6591221-01	6.2832957-01	2.5310233-04	4.9256080-05	2076.5
29	3.2335153-04	2.7782008-01	7.6580573-01	3.7575934-01	6.4419555-01	2.4008673-04	5.6187347-05	2072.5
30	3.5245569-04	2.774223-01	7.7278301-01	3.8587453-01	6.4797886-01	2.4036935-04	6.4161973-05	2068.5
31	3.8313315-04	2.9766437-01	7.8042490-01	3.9631568-01	6.5188391-01	2.5271057-04	7.2876031-05	2064.5
32	4.1542676-04	3.0758652-01	7.8858167-01	4.0706336-01	6.5840616-01	2.70815201-04	8.1953362-05	2060.4
33	4.4935594-04	3.1750461-01	7.96557503-01	4.1802845-01	6.6652763-01	3.0081963-04	9.1016461-05	2056.1
34	4.8497667-04	3.2743081-01	8.0450145-01	4.2907156-01	6.6651294-01	3.2921034-04	9.9774409-05	2051.7
35	5.2232156-04	3.3735296-01	8.1225962-01	4.4004245-01	6.66983145-01	3.5641595-04	1.0807073-04	2047.1
36	5.6142996-04	3.4727516-01	8.1976995-01	4.5081344-01	6.67468458-01	3.7975005-04	1.1588801-04	2042.4
37	6.0233190-04	3.5719725-01	8.2698143-01	4.6129083-01	6.7461673-01	3.9715095-04	1.2333902-04	2037.7
38	6.4509824-04	3.6711939-01	8.3387160-01	4.7142071-01	6.84454388-01	4.0766589-04	1.3063961-04	2033.0
39	6.8974072-04	3.7704154-01	8.4044406-01	4.8118864-01	6.8938197-01	4.1167137-04	1.3805579-04	2028.5
40	7.3633192-04	3.8696362-01	8.472405-01	4.9061592-01	6.9407547-01	4.1066157-04	1.4584751-04	2024.3
41	7.8485558-04	3.9688583-01	8.5274765-01	4.9974503-01	6.9862577-01	4.06688459-04	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.	YEAR	Y	U/UF	H/M/E	RO/ROF	ROV	EPS	T
43	0.860398-04	4.1673012-01	8.6417435-01	5.1730078-01	7.0745229-01	3.9631266-04	1.7304542-04	2.12.9
44	0.427229-04	4.2665227-01	8.6963630-01	5.2581751-01	7.1172727-01	3.9241305-04	1.8352415-04	203.05
45	0.966294-04	4.2365742-01	8.7496096-01	5.23418157-01	7.159276-01	3.90917222-04	1.9470597-04	203.02
46	1.0587605-03	4.4647656-01	8.801559-01	5.4242746-01	7.2008325-01	3.9270425-04	2.0457718-04	203.10
47	1.1201157-03	4.4544187-01	8.8523646-01	5.4505701-01	7.2422324-01	3.9672533-04	2.1908465-04	203.03
48	1.1837705-03	4.6634085-01	8.9021135-01	5.5862261-01	7.2836487-01	4.0400045-04	2.3211717-04	1957.2
49	1.2498288-03	4.7626300-01	8.9500856-01	5.6659217-01	7.3251358-01	4.1333315-04	2.4551721-04	1994.6
50	1.3182554-03	4.8610514-01	8.9985905-01	5.7447822-01	7.3664702-01	4.24358.9-04	2.5513423-04	1992.1
51	1.3891769-03	4.9610729-01	9.0453066-01	5.8227310-01	7.4.74294-01	4.3585793-04	2.7293249-04	1987.7
52	1.4626318-03	5.0622643-01	9.0902226-01	5.8996444-01	7.4481630-01	4.4767529-04	2.8663933-04	1987.5
53	1.538801-03	5.1595158-01	9.1354367-01	5.9754750-01	7.4686478-01	4.59882079-04	3.0018232-04	1955.4
54	1.6173837-03	5.2587373-01	9.1789282-01	6.0533323-01	7.5289759-01	4.7201926-04	3.1340481-04	1953.5
55	1.6988265-03	5.3579507-01	9.2215320-01	6.1243781-01	7.5690394-01	4.82438081-04	3.2647451-04	1941.8
56	1.7830142-03	5.4571802-01	9.2632334-01	6.1977491-01	7.6.93128-01	4.9716212-04	3.3936372-04	1983.5
57	1.8700748-03	5.5564017-01	9.3044083-01	6.2705605-01	7.6488484-01	5.10368612-04	3.5205605-04	1979.4
58	1.9600581-03	5.6556231-01	9.3444883-01	6.3429050-01	7.6585149-01	5.2523252-04	3.6462532-04	1978.6
59	2.0530366-03	5.7548445-01	9.3840780-01	6.4148424-01	7.688137-01	5.4102932-04	3.7677468-04	1977.9
60	2.149085-03	5.8540660-01	9.4230253-01	6.484489-01	7.7473373-01	5.5829975-04	3.8912232-04	1977.4
61	2.2482601-03	5.9532875-01	9.4613439-01	6.5578303-01	7.8.64457-01	5.7721438-04	4.0105627-04	1977.0
62	2.3507017-03	6.0525090-01	9.4990428-01	6.6289202-01	7.8454535-01	5.9783140-04	4.1276123-04	1977.0
63	2.4564319-03	6.1517304-01	9.5361238-01	6.6997817-01	7.8442358-01	6.2006960-04	4.2421870-04	1977.4
64	2.5655580-03	6.2509519-01	9.5725551-01	6.7704304-01	7.9228287-01	6.4371276-04	4.3540575-04	1973.3
65	2.6781412-03	6.3501734-01	9.6084221-01	6.8448639-01	7.941233-01	6.6847165-04	4.4629508-04	1979.6
66	2.7943306-03	6.4493947-01	9.643828-01	6.9111643-01	7.9.04330-01	6.94324-04	4.57650-04	1941.3
67	2.914123-03	6.5486162-01	9.678281-01	6.9817112-01	8.0.17506-01	7.216247-04	4.68760-04	1943.2
68	3.037757-03	6.6478377-01	9.712132-01	7.0512798-01	8.0753729-01	7.4447432-04	4.7676747-04	1953.3
69	3.1652224-03	6.7470592-01	9.7454884-01	7.1210223-01	8.1133639-01	7.7267667-04	4.8605268-04	1987.6
70	3.2967.22-03	6.8462806-01	9.7781752-01	7.1908945-01	8.1505628-01	7.9852810-04	4.94750497-04	1980.5
71	3.4322178-03	6.9455071-01	9.8101877-01	7.2606949-01	8.1873591-01	8.2308621-04	5.0280912-04	1974.3
72	3.5719208-03	7.0447236-01	9.8416337-01	7.3305688-01	8.2249457-01	8.4871541-04	5.1011726-04	1992.7
73	3.7159264-03	7.1439450-01	9.8724949-01	7.4005971-01	8.2618230-01	8.7326333-04	5.1656586-04	2008.5
74	3.8643542-03	7.2431644-01	9.9022867-01	7.4708958-01	8.2984267-01	8.9652673-04	5.2202747-04	2010.7
75	4.0173282-03	7.3423679-01	9.9325318-01	7.5415891-01	8.3345267-01	9.2076328-04	5.2926318-04	2016.9
76	4.1749766-03	7.4416094-01	9.9617551-01	7.6128245-01	8.3701169-01	9.4261296-04	5.2942330-04	2023.1
77	4.3374322-03	7.5408308-01	9.9904813-01	7.6847707-01	8.4.354166-01	9.643208-04	5.3105228-04	2029.7
78	4.5048378-03	7.6400523-01	1.0016736-00	7.7576198-01	8.4407553-01	9.8513217-04	5.3109033-04	2037.6
79	4.6773212-03	7.7392738-01	1.0046539+00	7.8315859-01	8.4764425-01	1.0051365+03	5.2932499-04	2047.7
80	4.8550454-03	7.8384952-01	1.0073914+00	7.9049051-01	8.5127567-01	1.0245859-03	5.2556559-04	2060.5
81	5.0381589-03	7.9377167-01	1.0100821+00	7.983811-01	8.5498319-01	1.0436537+03	5.1956701-04	2076.0
82	5.2248205-03	8.0369381-01	1.0127479+00	8.0624118-01	8.5895986-01	1.0635192+03	5.1108505-04	2093.0
83	5.4211957-03	8.1361526-01	1.0153619+00	8.1436618-01	8.6225223-01	1.0843216+03	4.9988036-04	2109.3
84	5.6214455-03	8.2353010-01	1.0179431+00	8.2277188-01	8.6587229-01	1.1048937+03	4.8574310-04	2124.8
85	5.8277776-03	8.3346025-01	1.0204791+00	8.3146724-01	8.693343-01	1.1317170+03	4.6849649-04	2141.4
86	6.0403461-03	8.4338240-01	1.0229720+00	8.4049933-01	8.7287469-01	1.1590433+03	4.4800552-04	2162.1
87	6.2531527-03	8.5330454-01	1.0254220+00	8.4997560-01	8.7684684-01	1.1861266+03	4.2421952-04	2189.5
88	6.4849957-03	8.6322669-01	1.0278097+00	8.5992485-01	8.8102901-01	1.2181070+03	3.9724012-04	2225.7
89	6.717415-03	8.7314844-01	1.0301237+00	8.7038969-01	8.8551927-01	1.2477640+03	3.6742512-04	2270.5
90	6.9570238-03	8.8307098-01	1.0323406+00	8.8142388-01	8.9302716-01	1.2762535+03	3.3543195-04	2323.0
91	7.2038453-03	8.9299312-01	1.0344224+00	8.9302716-01	8.955828-01	1.3015089+03	3.0268266-04	2364.1
92	7.4581769-03	9.0291527-01	1.0363190+00	9.0513983-01	9.0140057-01	1.3219619+03	2.6645068-04	2400.0
93	7.7202584-03	9.1283742-01	1.0379459+00	9.1750875-01	9.0749376-01	1.3367704+03	2.3270733-04	2541.3
94	7.9903392-03	9.2275956-01	1.0393181+00	9.3067378-01	9.1354583-01	1.3443734+03	1.8367232-04	2625.0
95	8.2686787-03	9.3268171-01	1.0402467+00	9.4416438-01	9.1922474-01	1.3440045+03	1.7120093-04	2700.1
96	8.5555449-03	9.4260386-01	1.0405977+00	9.5613387-01	9.243100-01	1.3371217+03	1.7267577-04	2700.1

NO.	YBAR	Y	U/IE	H/HE	RO/ROE	ROV	EPS	T
97	8.851219+03	9.525260-01	1.040424+00	9.665122+01	9.288122+01	1.3258225-03	2.1102347-04	2850.7
98	9.1559913-03	9.6244414-01	1.0399524+00	9.7193143-01	9.3292023-01	1.3105333-03	2.3450791-04	2917.7
99	9.4701649+03	9.7237029-01	1.0392450+00	9.87741745-01	9.3664584-01	1.2902741-03	2.4091701-04	2942.9
100	9.7940546+03	9.8229244-01	1.0383576+00	9.84191669-01	9.3795166-01	1.2658091-03	2.0222255-04	3044.4
101	1.0127987-02	9.9221456-01	1.0373122+00	9.8548723-01	9.4296054-01	1.2349408-03	3.0298448-04	3104.5
102	1.0472304+02	1.0521367+00	1.0361240+00	9.8884701-01	9.4577134-01	1.2027517-03	3.2009459-04	3169.8
103	1.0827365-02	1.0120589+00	1.0348004+00	9.9159907-01	9.4852292-01	1.1626223-03	3.3459338-04	3231.0
104	1.1193523-02	1.0219810+00	1.0333472+00	9.9389780-01	9.5133005-01	1.1165369-03	3.4633531-04	3292.4
105	1.1571177-02	1.0319032+00	1.0317490+00	9.9582077-01	9.5417174-01	1.0648527-03	3.5535380-04	3354.1
106	1.1960723-02	1.0418253+00	1.0308268+00	9.9740165-01	9.5681219-01	1.0087213-03	3.6162069-04	3415.5
107	1.2362577-02	1.0517475+00	1.0282514+00	9.9866869-01	9.5932414-01	9.4929394-04	3.6515074-04	3476.3
108	1.2771737-02	1.0616696+00	1.0263145+00	9.9964579-01	9.6164174-01	8.8730876-04	3.6597566-04	3536.4
109	1.3204962-02	1.0715917+00	1.0242642+00	1.0003525+00	9.6383192-01	8.2304090-04	3.6415734-04	3596.1
110	1.3646415-02	1.0815139+00	1.0220926+00	1.0004041+00	9.6602698-01	7.5631888-04	3.5977714-04	3655.8
111	1.4102023-02	1.0914360+00	1.0197973+00	1.0010111+00	9.6827725-01	6.8863374-04	3.5292789-04	3715.7
112	1.4572296-02	1.1013582+00	1.0173714+00	1.0009793+00	9.7071566-01	6.1338090-04	3.4370622-04	3776.2
113	1.5057769-02	1.1112803+00	1.0148068+00	1.0007117+00	9.7332034-01	5.3618228-04	3.3221444-04	3837.2
114	1.5558995-02	1.1212025+00	1.0120985+00	1.0002082+00	9.7607307-01	4.5474592-04	3.1858294-04	3899.8
115	1.6076555-02	1.1311246+00	1.0092532+00	9.9747339-01	9.7914147-01	3.6772388-04	3.0297952-04	3968.2
116	1.6611054-02	1.1410468+00	1.0063013+00	9.9852362-01	9.8253042-01	2.7529620-04	2.8566529-04	4012.5
117	1.7143121-02	1.1509489+00	1.0033043+00	9.9739561-01	9.8605955-01	1.7921824-04	2.6701378-04	4118.8
118	1.7733415-02	1.1608911+00	1.0003670+00	9.9615129-01	9.8945610-01	8.2020579-05	2.4750926-04	4190.8
119	1.8322622-02	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	9.9348323-01	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	9.9177333-01	9.9201754-01	9.9807217-01	-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	1.5466419-04	4361.6
124	2.1578568-02	1.2204239+00	9.9108659-01	9.9212108-01	9.9934579-01	-4.7966405-04	1.3904415-04	4354.6
125	2.2297461-02	1.2303461+00	9.918637-01	9.9301849-01	9.9934482-01	-5.8450057-04	1.2445715-04	4337.2
126	2.3041002-02	1.2402682+00	9.9337275-01	9.9440009-01	9.9915486-01	-7.0095453-04	1.1071831-04	4315.4
127	2.3810162-02	1.2501904+00	9.9536031-01	9.9699457-01	9.9859084-01	-8.3115407-04	9.7791498-05	4295.9
128	2.4605961-02	1.2601126+00	9.9775883-01	9.9779560-01	9.9684548-01	-9.7533565-04	8.5712415-05	4282.1
129	2.5429966-02	1.2700347+00	9.9975030-01	9.9919337-01	9.9522806-01	-1.1353331-03	7.4616773-05	4274.1
130	2.6201777-02	1.2799566+00	1.0016540+00	1.0004001+00	9.9293574-01	-1.2735338-03	6.4692744-05	4267.5
131	2.7164566-02	1.2898769+00	1.0030033+00	1.0034171+00	9.9279923-01	-1.4600240-03	5.6126056-05	4260.2
132	2.8077535-02	1.2998011+00	1.0039555+00	1.0032977+00	9.9851693-01	-1.6251601-03	4.9049384-05	4252.1
133	2.90003224-02	1.3097232+00	1.0042959+00	1.0001091+00	9.9615900-01	-1.7957278-03	4.3524681-05	4244.0
134	3.00003224-02	1.3196454+00	1.0041516+00	1.0000745+00	9.9779996-01	-1.9393790-03	3.9568959-05	4236.8
135	3.1018162-02	1.3295675+00	1.0037267+00	1.0003913+00	9.9755440-01	-2.0883745-03	3.7172511-05	4231.5
136	3.2069755-02	1.3394897+00	1.0030554+00	1.0007755+00	9.9744451-01	-2.2348783-03	3.6315278-05	4226.6
137	3.3159534-02	1.3494118+00	1.0023834+00	1.0012453+00	9.9752644-01	-2.3849714-03	3.6946238-05	4228.2
138	3.4289102-02	1.3593340+00	1.0016528+00	1.0015583+00	9.9784000-01	-2.5394074-03	3.8973088-05	4230.0
139	3.5460139-02	1.3692561+00	1.0013955+00	1.0014705+00	9.9821884-01	-2.7057968-03	4.2156067-05	4235.1
140	3.6674405-02	1.3791783+00	1.0006345+00	1.0014580+00	9.9817006-01	-2.8847079-03	4.5769189-05	4243.4
141	3.7933747-02	1.3891004+00	1.0004008+00	1.0014024+00	9.9952441-01	-3.0836090-03	4.8940351-05	4253.9
142	3.9240097-02	1.3990226+00	1.0001304+00	1.0013595+00	1.0020405+00	-3.2983529-03	5.0313413-05	4264.6
143	4.0595405-02	1.4089447+00	1.0000900+00	1.0011450+00	1.0008411+00	-3.5328013-03	5.0402341-05	4273.8
144	4.2002040-02	1.4188669+00	9.9999442-01	1.0009954+00	1.0012559+00	-3.7790244-03	4.881881-05	4280.3
145	4.3461994-02	1.4287890+00	1.0000373+00	1.0007516+00	1.0014467+00	-4.0386334-03	4.9627281-05	4294.2
146	4.4977688-02	1.4387111+00	1.0000819+00	1.0005957+00	1.0016035+00	-4.3084577-03	4.4712300-05	4286.3
147	4.6551585-02	1.4486333+00	1.0000206+00	1.0004098+00	1.0016007+00	-4.5861744-03	4.8227195-05	4286.5
148	4.8186265-02	1.4585554+00	1.0000203+00	1.0002646+00	1.0014777+00	-4.8739527-03	4.6779517-05	4284.7
149	4.9884439-02	1.4684776+00	1.0000586+00	1.0000166+00	1.0012625+00	-5.1617055-03	6.3432018-05	4281.6
150	5.1648954-02	1.4783997+00	1.0000240+00	1.00003145+00	1.0009975+00	-5.4521390-03	8.6066469-05	4278.2

NO.	YBAR	Y	U/UE	H/HE	RO/ROE	ROY	EPS	T
151	5.3482801-02	1.4883219+00	1.0000808+00	9.995981-01	1.0007252+00	-5.7617182+03	1.5649894+04	427507
152	5.5389124-02	1.4982440+00	1.0001975+00	1.0002328+00	1.0004735+00	-6.075823+03	1.5385319+04	427406
153	5.7371225-02	1.5081662+00	1.0001875+00	1.0003069+00	1.0002417+00	-6.4017118+03	3.6218154+04	427511
154	5.9332577-02	1.518083+00	1.0000000+00	1.0000000+00	1.0000000+00	-6.7359893+03	0.0000000	427603

DELTA= 2.84025-01 (INCHES)

NO.	TAU	TAU/(RE*UE2)	EPSZ/(RHO*UE*DELTA)	YTIL/DELTA
2	1.6199601+02	8.4476612-04	0.000000	1.3133533-05
3	1.830884+02	8.4993627-04	4.6542963-09	4.1804866-05
4	1.8488132+02	8.5815278-04	3.0763742-08	8.2665205-05
5	1.8709926+02	8.68445374-04	1.2910415-07	1.5976846+04
6	1.8955342+02	8.7984513-04	3.7234569-07	2.5479862-04
7	1.9129859+02	8.8794567-04	9.3785257-07	3.7718347+04
8	1.9066225+02	8.8499198-04	1.8756705-06	5.2916027-04
9	1.8812480+02	8.7321398-04	3.3207874-06	7.1201874-04
10	1.8707933+02	8.6835972-04	5.4544744-06	9.3013075-04
11	1.9100924+02	8.8661258-04	6.5719212-06	1.1829734-03
12	2.0123023+02	9.3404510-04	1.3056704-05	1.4731436+03
13	2.1671618+02	1.0059258-03	1.9274514-05	1.8023736-03
14	2.3490882+02	1.0903608-03	2.7445186-05	2.1723467-03
15	2.5264297+02	1.1726863-03	3.7557323-05	2.5846765-03
16	2.6686524+02	1.2387014-03	4.9336273-05	3.0409741-03
17	2.7496654+02	1.2763050-03	6.2146384-05	3.5427951-03
18	2.7538539+02	1.2782480-03	7.5068359-05	4.0916748-03
19	2.6827675+02	1.2452532-03	8.6908852-05	4.6891282-03
20	2.5547906+02	1.1888504-03	9.7170093-05	5.3366532-03
21	2.3959877+02	1.1171394-03	1.0560519-04	6.0357361-03
22	2.2299009+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	9.0472247-04	1.2369857-04	8.4570850-03
25	1.8376009+02	8.6687943-04	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	2.0315024+02	9.4281793-04	1.9767914-04	1.3661535-02
30	2.1354668+02	9.9121405-04	2.2441760-04	1.4991180-02
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	3.3998868-04	2.0490163+02
35	2.3640575+02	1.0973184-03	3.6566434-04	2.2067977+02
36	2.3336686+02	1.0832133-03	3.8929407-04	2.3720299+02
37	2.2914821+02	1.0636312-03	4.1131684-04	2.5448820+02
38	2.245625+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	3.1109927-02
41	2.1353809+02	9.9117786-04	5.0299661-04	3.3159984+02
42	2.113771+02	9.8114312-04	5.2631918-04	3.5294168+02
43	2.0942548+02	9.7394146-04	5.5433664-04	3.7512483-02
44	2.0872175+02	9.6801829-04	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	2.0674096+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	9.0849837-04	6.5008910+02

CO
OO

NO.	TAU	TAU/(RE+UE2)	EPS/(RHO+UE+DELTA)	YTL/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	1.8789144+02	8.7120246-04	1.0432606-03	7.9010269-02
58	1.8498755+02	8.5865189-04	1.0748412-03	8.2812047+02
59	1.8208554+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	1.1649367-03	9.4989366+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	1.6027305+02	7.4393947-04	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	6.6241905-04	1.3578083-03	1.3373167-01
70	1.3815311+02	6.4128148-04	1.3757598-03	1.3928498-01
71	1.3356430+02	6.1996193-04	1.3917472-03	1.4501049-01
72	1.2895709+02	5.9857676-04	1.4056495-03	1.5091291-01
73	1.2433838+02	5.7713821-04	1.4170653-03	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	5.1253926-04	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	1.4280251-03	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	2.2093708-01
83	7.6188413+01	3.5358893-04	1.3138937-03	2.2904439-01
84	7.0798108+01	3.2882173-04	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	1.0218072-03	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	1.2622480-05	4.2218282-04	3.4934993-01
96	2.3461070-01	1.0889863-06	4.2340242-04	3.6146998-01
97	-2.9378403+00	-1.3636498-05	5.1492480-04	3.7392151-01
98	-5.4504690+00	-2.5799303-05	5.6970418-04	3.8683872-01
99	-7.7789522+00	-3.6197359-05	6.3133334-04	4.0011249-01
100	-9.0226895+00	-4.5593721-05	6.8217762-04	4.1379676-01
101	-1.1738319+01	-5.4485447-05	7.2822771-04	4.2790535-01
102	-1.3499068+01	-6.2688272-05	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	8.5657443-04	5.0533807-01
107	-1.9609464+01	-9.1020736-05	8.6267250-04	5.2231631-01

NO. TAU EPS (RHO*UF*DELTA) YTEL/DELTA

109	-2.0223837+01	-9.3872457-05	8.6253941-04	5.3983289-01
109	-2.0645272+01	-9.5828621-05	8.5630368-04	5.5790689-01
110	-2.0890594+01	-9.6967373-05	8.4409894-04	5.7655820-01
111	-2.0979372+01	-9.7379403-05	8.2608798-04	5.9580752-01
112	-2.0924073+01	-9.7127721-05	8.0248219-04	6.1567648-01
113	-2.0710013+01	-9.6129124-05	7.7358025-04	6.3618758-01
114	-2.0272613+01	-9.4398857-05	7.3974198-04	6.5736427-01
115	-1.9495000+01	-9.0489432-05	7.0130652-04	6.7923109-01
114	-1.8245090+01	-8.4687757-05	6.5894857-04	7.0181355-01
117	-1.6444330+01	-7.6329218-05	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	-9.5488077+00	-3.9683777-05	4.7411280-04	7.9985316-01
121	-5.7211049+00	-2.6555501-05	4.3033178-04	8.2643432-01
122	-3.0803265+00	-1.4335000-05	3.8917271-04	8.5391246-01
123	-7.8108221-01	-3.6255288-06	3.5090682-04	8.8231702-01
124	1.0734292+00	4.9825043-06	3.1538395-04	9.1169002-01
125	2.3698342+00	1.0999997-05	2.8225632-04	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	1.0395947+00
129	2.1298355+00	9.8840015-06	1.6929315-04	1.0743494+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	-2.4103545-01	-1.1225213-06	8.4454829-05	1.3104108+00
134	-2.7612471-01	-1.2816800-06	8.2513167-05	1.3549404+00
137	-2.8071103-01	-1.5729691-06	8.3938537-05	1.4009834+00
138	-2.5120492-01	-1.1660113-06	8.8523359-05	1.4487074+00
139	-2.1296209-01	-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	-5.4235395-07	1.1097163-04	1.6026929+00
142	-6.7674686-02	-3.1412382-07	1.1400427-04	1.6578859+00
143	-2.8022459-02	-1.3307112-07	1.1413678-04	1.7151508+00
144	39.8048247-03	-9.5510799-08	1.1064783-04	1.7745774+00
145	1.7967436+02	8.3398980-08	1.1230920-04	1.8362602+00
146	5.8053573+03	2.6946575-08	1.0117456-04	1.9002979+00
147	2.1495412+02	9.9774692-08	1.0912831-04	1.96667947+00
148	-2.4760320+03	-1.1492933-08	1.0586551-04	2.0358596+00
149	9.3534221+03	4.3415535-08	1.4358820-04	2.1076071+00
150	5.3421143+03	2.4796352-08	1.9486822-04	2.1821575+00
151	-2.2271237-02	-1.0337582-07	3.5443502-04	2.2596372+00
152	4.9451560+02	2.2953801-07	3.4853065-04	2.3401709+00
153	-2.0907124-01	-9.7045048-07	8.2065651-04	2.4239223+00

NO.	SU	Y	K / UEZ	RU/REUF	MIXEDDY	UDAG	VDAG	ERT
1	5.2593168-07	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.5516155-00
2	5.2303733-06	0.000000	0.000000	4.6221443+03	3.0942178-13	2.6352260+01	1.9425671-01	1.5505511-00
3	1.6644800-05	1.8537309-07	1.7606722-06	1.4896468-02	2.9283441-11	8.5202442-01	6.1633119-01	1.5472347-00
4	5.5362510-07	3.5703726-05	9.7685473-06	3.1836789+02	5.68822394-10	1.8235756+00	1.37622295-00	1.5472292-00
5	5.6207500-07	6.3627049-05	3.5440319-05	6.3352013-02	1.7502551-09	3.2266993+00	2.3631185-00	1.5344933-00
6	5.7004864-07	1.6147240-04	9.2544452-05	8.8117001-02	2.7863757-08	5.0346994+00	3.8786997+00	1.5344553-00
7	5.7762342-07	1.5031152-04	1.4615102-04	1.2450661+01	1.0199246-07	7.0866328+00	5.5788812+00	1.4952297-00
8	5.3478714-07	2.1073570-04	2.8377685-04	1.6074724+01	1.0199246-07	9.0799173+00	7.8267542+00	1.4737056+00
9	5.9152469-07	2.8377685-04	3.2513802-04	1.6074724+01	2.6443307-07	1.0833668+01	1.0532227+01	1.4474425+00
10	5.9765261-07	3.7542044-04	5.1554022-04	2.1949071-01	9.7723539-07	1.2218276+01	1.3757449+01	1.4173232+00
11	6.0368331-07	4.7111301-04	7.8767483-04	2.4224155-01	1.5815721-04	1.3327728+01	1.7497215+01	1.4092347+00
12	6.0739266-07	5.3667274-04	1.1793993-03	2.6272764-01	3.4794297-04	1.4232162+01	2.1787112+01	1.3794979+00
13	6.1457057-07	7.61779716-04	1.7185017-03	2.0217561-01	3.6227652-06	1.5029968+01	2.6656719+01	1.3114412+00
14	6.1928887-07	8.5512491-04	2.4009699-03	3.0192991-01	5.7486734-06	1.5761940+01	3.2130944+01	1.2729453+00
15	6.2349449-07	1.029375-03	3.1799558-03	3.1933776-01	8.3195547-05	1.6453153+01	3.8222950+01	1.2323233+00
16	6.2715228-07	1.8211542-03	3.9564709-03	3.3695213-01	1.1495765-05	1.7103379+01	4.4978729+01	1.1939152+00
17	6.3028316-07	1.4109072-03	4.6459169-03	3.5375106-01	1.5144354-05	1.775887+01	5.2401110+01	1.1553372+00
18	6.3285345-07	1.6224911-03	5.0915791-03	3.5995880-01	1.5041238-05	1.8305907+01	6.0519563+01	1.1192567+00
19	6.3458982-07	1.8674242-03	5.2027507-03	3.8557343-01	2.2924750-05	1.8552154+01	6.9756133+01	1.0887178+00
20	6.3561639-07	2.1252981-03	5.0301821-03	4.0070610-01	2.6619390-05	1.9345154+01	7.6933578+01	1.0531521+00
21	6.3606777-07	2.4037047-03	4.6536660-03	4.1427029-01	2.6574399-05	1.9784373+01	8.9273919+01	1.0274875+00
22	6.3622274-07	2.7032323-03	4.1777740-03	4.2710724-01	3.0622491-05	2.0171192+01	1.0239644+02	1.0002479+00
23	6.3636006-07	3.0274575-03	3.6923242-03	4.3887239-01	3.255583-05	2.0510911+01	1.1232916+02	9.7941278-01
24	6.3664399-07	3.3479960-03	3.2737567-03	4.4962888-01	3.3945091-05	2.0909949+01	1.2508756+02	9.2267213-01
25	6.3712979-07	3.7344042-03	2.9812787-03	4.5947373-01	3.5455991-05	2.1073761+01	1.3867631+02	9.4894442-01
26	6.3759863-07	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	2.1747489+01	1.8483918+02	9.2231040-01
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	6.3797441-07	5.9303451-03	3.5372983-03	5.0074705-01	6.2511155-05	2.2187722+01	2.2025387+02	9.1533197-01
31	6.3786736-07	6.4465175-03	3.6293293-03	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	9.1665548-05	2.2870826+01	2.8080903+02	9.1062000-01
34	6.3797859-07	8.1501150-03	4.3545411-03	5.3508446-01	1.0631595-04	2.3098411+01	3.0306785+02	9.0999676-01
35	6.3800041-07	8.7884728-03	4.3615021-03	5.4407704-01	1.1887151-04	2.3321153+01	3.2640513+02	9.0961228-01
36	6.3799413-07	9.4465021-03	4.2982576-03	5.5108614-01	1.1671006-04	2.3534786+01	3.5584945+02	9.0938216-01
37	6.3797219-07	1.0134870-02	4.1888086-03	5.6231400-01	1.2397093-04	2.3743030+01	3.7941000+02	9.0917487-01
38	6.3795548-07	1.0854287-02	4.0583509-03	5.7082170-01	1.3793344-04	2.3941665+01	4.0312976+02	9.0917394-01
39	6.379627-07	1.1605432-02	3.9295380-03	5.7938897-01	1.3785749-04	2.4130369+01	4.3102742+02	9.0913327-01
40	6.380653-07	1.2389040-02	3.8172937-03	5.8769038-01	1.4520986-04	2.4316677+01	4.6013036+02	9.0911188-01
41	6.380812-07	1.3205814-02	3.7287622-03	5.9575169-01	1.5323298-04	2.4483632+01	4.9046585+02	9.0910977-01
42	6.3818953-07	1.4056538-02	3.6440613-02	6.0363637-01	1.6719934-04	2.4650306+01	5.2706178+02	9.0909559-01
43	6.3829579-07	1.4941965-02	3.6199358-03	6.1136271-01	1.7188915-04	2.4811701+01	5.5494673+02	9.0909299-01
44	6.3840865-07	1.5862889-02	3.5924303-03	6.1894524-01	1.8235772-04	2.4968579+01	5.8914999+02	9.0909180-01
45	6.3852322-07	1.6821188-02	3.5655222-03	6.2723222-01	1.9383222-04	2.5132222+01	6.2723222+02	9.0909180-01
46	6.3868733-07	1.7814480-02	3.5743728-03	6.3378552-01	2.0541436-04	2.5276554+01	6.6163237+02	9.0909180-01
47	6.3884749-07	1.8848310-02	3.5768965-03	6.4110883-01	2.1811457-04	2.5416425+01	6.9997398+02	9.0909091-01
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	2.4489845-04	2.5699208+01	7.8102044+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	6.4018973-07	2.3373997-02	3.5622509-03	6.7002470-01	2.7260758-04	2.5970369+01	8.6811364+02	9.0909090-01
52	6.4058591-07	2.4655591-02	3.5455591-03	6.7712020-01	2.8655119-04	2.6101359+01	9.1401648+02	9.0909090-01

NO.	MU	Y	K / UEZ	RU/REFUE	MIXEDNY	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	Y.0909090-01
54	6.4145848-07	2.7213756-02	3.4472458-03	6.9107470-01	3.1578226-04	2.6354036+01	1.0107228+03	Y.0909090-01
55	6.4201836-07	2.8583759-02	3.3879474-03	6.9797903-01	3.3170447-04	2.6476272+01	1.0616049+03	Y.0909090-01
56	6.4267358-07	3.000621-02	3.3219072-03	7.0484137-01	3.4851791-04	2.6596117+01	1.1142274+03	Y.0909090-01
57	6.432395-07	3.1465483-02	3.2507763-03	7.1166570-01	3.6216478-04	2.67133768+01	1.1686326+03	Y.0909090-01
58	6.4424455-07	3.2979524-02	3.1755038-03	7.1845233-01	3.8459296-04	2.6829375+01	1.2248663+03	Y.0909090-01
59	6.4510218-07	3.4543941-02	3.0970687-03	7.2520278-01	4.0312298-04	2.6943051+01	1.2829577+03	Y.0909090-01
60	6.4599612-07	3.6162050-02	3.0162431-03	7.3191816-01	4.2349965-04	2.7054874+01	1.3429495+03	Y.0909090-01
61	6.4695293-07	3.7829087-02	2.9337028-03	7.3859045-01	4.4381942-04	2.7164892+01	1.4049778+03	Y.0909090-01
62	6.4801275-07	3.9552410-02	2.8499928-03	7.4524298-01	4.6480165-04	2.7273131+01	1.4669842+03	Y.0909090-01
63	6.4921571-07	4.1331405-02	2.7655501-03	7.5185046-01	4.8727633-04	2.7379596+01	1.5350543+03	Y.0909090-01
64	6.5058033-07	4.3167500-02	2.6907077-03	7.5841951-01	5.072752-04	2.7484282+01	1.6032477+03	Y.0909090-01
65	6.5212996-07	4.5062175-02	2.6257014-03	7.6494886-01	5.2892279-04	2.7587175+01	1.6733615+03	Y.0909090-01
66	6.5379192-07	4.7016957-02	2.5106734-03	7.7143770-01	5.508918-04	2.7689227+01	1.7462169+03	Y.0909090-01
67	6.5549556-07	4.9033429-02	2.4256790-03	7.7786571-01	5.7333398-04	2.7787529+01	1.8211086+03	Y.0909090-01
68	6.5725110-07	5.1113225-02	2.3407034-03	7.8429177-01	5.9536917-04	2.7884974+01	1.8983526+03	Y.0909090-01
69	6.5910910-07	5.328037-02	2.2556694-03	7.9065444-01	6.173447-04	2.798596+01	1.9781112+03	Y.0909090-01
70	6.6116672-07	5.5469616-02	2.1704469-03	7.9677223-01	6.407722-04	2.807941+01	2.061105+03	Y.0909090-01
71	6.6331797-07	5.7749773-02	2.0946666-03	8.0324393-01	6.6375365-04	2.8166459+01	2.1490347+03	Y.0909090-01
72	6.6522481-07	6.0103385-02	1.9987325-03	8.094694-01	6.8754594-04	2.8256760+01	2.2321370+03	Y.0909090-01
73	6.6928546-07	6.2523393-02	1.9118082-03	8.1564804-01	7.116419-04	2.8345367+01	2.3221279+03	Y.0909090-01
74	6.7256268-07	6.502308-02	1.8238857-03	8.2177544-01	7.3635457-04	2.8432339+01	2.4140822+03	Y.0909090-01
75	6.758037-07	6.7594716-02	1.7344484-03	8.2782944-01	7.6174243-04	2.8517741+01	2.5104775+03	Y.0909090-01
76	6.7900125-07	7.0247274-02	1.6445319-03	8.3381055-01	7.8786847-04	2.8601646+01	2.6089939+03	Y.0909090-01
77	6.8237559-07	7.298719-02	1.5527318-03	8.3974157-01	8.1487543-04	2.8684123+01	2.7105145+03	Y.0909090-01
78	6.8625653-07	7.5797366-02	1.4592581-03	8.4565694-01	8.4276470-04	2.8765245+01	2.8151252+03	Y.0909090-01
79	6.9097446-07	7.8699620-02	1.3639736-03	8.5159114-01	8.7158936-04	2.8845074+01	2.9229153+03	Y.0909090-01
80	6.9674782-07	8.1689970-02	1.2684699-03	8.5756776-01	9.0145779-04	2.8923670+01	3.0339773+03	Y.0909090-01
81	7.0357100-07	8.479997-02	1.1879695-03	8.6358814-01	9.3187311-04	2.9001996+01	3.1484071+03	Y.0909090-01
82	7.1096944-07	8.7945378-02	1.0476562-03	8.6967168-01	9.6349262-04	2.9077320+01	3.2663041+03	Y.0909090-01
83	7.1809093-07	9.1215895-02	9.2647535-04	8.7521422-01	9.9619236-04	2.9152515+01	3.3877715+03	Y.0909090-01
84	7.2491538-07	9.4585423-02	8.6499095-04	8.8134272-01	1.0272446-03	2.9226630+01	3.5129163+03	Y.0909090-01
85	7.3217775-07	9.8056954-02	7.6484631-04	8.8713752-01	1.0577163-03	2.9299438+01	3.6418484+03	Y.0909090-01
86	7.4098924-07	1.0163359-01	6.6390621-04	8.9303019-01	1.0882153-03	2.9371062+01	3.774682+03	Y.0909090-01
87	7.5246106-07	1.0531855-01	5.6438637-04	8.9913803-01	1.1149448-03	2.9441355+01	3.9115461+03	Y.0909090-01
88	7.6732772-07	1.0911517-01	4.7294958-04	9.0552977-01	1.1343053-03	2.9509897+01	4.0525531+03	Y.0909090-01
89	7.8557043-07	1.1302693-01	3.6568316-04	9.1219389-01	1.1443053-03	2.9576333+01	4.1978363+03	Y.0909090-01
90	8.0685387-07	1.170571-01	3.0882192-04	9.1909941-01	1.1362778-03	2.9639998+01	4.3475292+03	Y.0909090-01
91	8.3237986-07	1.2121038-01	2.3846058-04	9.2642692-01	1.106476-03	2.9699769+01	4.5017710+03	Y.0909090-01
92	8.6218316-07	1.2548971-01	1.7679038-04	9.3413951-01	1.023508-03	2.9754223+01	4.6607040+03	Y.0909090-01
93	8.9490726-07	1.2989944-01	1.2879277-04	9.4192944-01	9.0935153-04	2.9803332+01	4.8244839+03	Y.0909090-01
94	9.2650004-07	1.3444376-01	7.6900662-05	9.4946471-01	7.2897328-04	2.9840332+01	4.9932260+03	Y.0909090-01
95	9.6090935-07	1.3912703-01	6.4237922-05	9.5622054-01	4.247560-04	2.986695+01	5.1671982+03	Y.0909090-01
96	9.9077869-07	1.4395379-01	6.2996523-05	9.6183594-01	6.1694745-05	2.9877073+01	5.3464647+03	Y.0909090-01
97	1.0181429-06	1.4892874-01	6.1033723-05	9.6635723-01	2.3316573-04	2.9872106+01	5.5312349+03	Y.0909090-01
98	1.0443923-06	1.5405678-01	5.9710364-04	9.7070110-01	4.4473959-04	2.9858555+01	5.716769+03	Y.0909090-01
99	1.0697899-06	1.593430-01	5.8147514-04	9.7474451-01	6.2477089-04	2.9830233+01	5.918025+03	Y.0909090-01
100	1.0943332-06	1.6479269-01	5.5097653-04	9.7621636-01	7.9277526-04	2.9812756+01	6.1204245+03	Y.0909090-01
101	1.1181993-06	1.7041139-01	5.16942358-04	9.7814449-01	9.5024186-04	2.9787741+01	6.3291031+03	Y.0909090-01
102	1.1416286-06	1.7620478-01	4.8601726-04	9.7994364-01	1.1113040-03	2.9748626+01	6.542710+03	Y.0909090-01
103	1.1648778-06	1.8217887-01	2.0026259-04	9.8153189-01	1.2771894-03	2.9710622+01	6.7661495+03	Y.0909090-01
104	1.1881137-06	1.8833985-01	2.1199532-04	9.8302365-01	1.4491316-03	2.9668899+01	6.9949693+03	Y.0909090-01
105	1.2113322-06	1.9463418-01	2.2115130-04	9.8441262-01	1.6281005-03	2.9623586+01	7.2309702+03	Y.0909090-01
106	1.2343235-06	2.0124861-01	2.2769462-04	9.8558313-01	1.8148784-03	2.9574794+01	7.4744023+03	Y.0909090-01

NO.	HU	Y	K /UEZ	RU/REUE	MIXEDDY	UDAG	YDAG	PRT
107	1.2569293-06	2.0RU1012-01	2.3167931-04	9.8642886-01	2.01CSA48-03	2.9522597-01	7.7255259+03	9.0909090-01
108	1.2791472-06	2.149U602-01	2.3315734-04	9.8694882-01	2.2169037-03	2.9467038-01	7.9896117+03	9.0909090-01
109	1.3010743-06	2.2218390-01	2.3219767-04	9.8721452-01	2.4363145-03	2.9408113+01	8.2519473+03	9.0909090-01
110	1.3228576-06	2.2261170-01	2.2888710-04	9.8734859-01	2.6723119-03	2.9345764+01	8.5278118+03	9.0909090-01
111	1.3446442-06	2.3727766-01	2.2333460-04	9.8744652-01	2.9291759-03	2.9279862+01	8.8125246+03	9.0909090-01
112	1.3665312-06	2.4519098-01	2.1567866-04	9.8757836-01	3.0219663-03	2.9210211+01	9.1354042+03	9.0909090-01
113	1.3885141-06	2.5335884-01	2.0610370-04	9.8771321-01	3.0182839-03	2.9136578+01	9.4037818+03	9.0909090-01
114	1.4109453-06	2.6179236-01	1.9482132-04	9.8788073-01	3.0875988-03	2.9050816+01	9.7230040+03	9.0909090-01
115	1.4324412-06	2.7050072-01	1.8202397-04	9.8820148-01	4.0160732-03	2.8977126+01	1.0046436+04	9.0909090-01
116	1.4614390-06	2.7949808-01	1.6806678-04	9.8871142-01	4.1265459-03	2.8892371+01	1.0380451+04	9.0909090-01
117	1.4881718-06	2.8878305-01	1.5347237-04	9.8931979-01	4.05816471-03	2.8806382+01	1.0725444+04	9.0909090-01
118	1.5133717-06	2.9837869-01	1.3884789-04	9.8981924-01	4.0611396-03	2.8721990+01	1.1081828+04	9.0909090-01
119	1.5349711-06	3.0829256-01	1.2479207-04	9.9007441-01	4.0113761-03	2.8642803+01	1.1435030+04	9.0909090-01
120	1.5516031-06	3.1853672-01	1.1178676-04	9.9004937-01	3.9797399-03	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	1.9616774-03	2.8475368+01	1.2630130+04	9.0909090-01
123	1.5738321-06	3.5137957-01	8.1218388-05	9.9002407-01	6.05649377-04	2.8454606+01	1.3050288+04	9.0909090-01
124	1.5715780-06	3.6307644-01	7.3739940-05	9.9043821-01	8.01725259-04	2.8455535+01	1.3484711+04	9.0909090-01
125	1.5657066-06	3.7517237-01	6.7267301-05	9.9123849-01	2.0171673-03	2.8478098+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	9.9432921-01	4.5377245-03	2.8578240+01	1.4879262+04	9.0909090-01
128	1.5469526-06	4.1401479-01	5.1722378-05	9.9646310-01	4.9063258-03	2.8641851+01	1.5376566+04	9.0909090-01
129	1.5429000-06	4.2787072-01	4.7657205-05	9.9888661-01	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	3.9589359-03	2.8758999+01	1.6423799+04	9.0909090-01
131	1.5395693-06	4.5705640-01	4.2173520-05	1.0018898+00	1.8155062-03	2.8800294+01	1.6754595+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	1.0034399+00	2.5545458-04	2.8934794+01	1.8137127+04	9.0909090-01
134	1.5314627-06	5.0482791-01	4.5181099-05	1.0019424+00	7.6495333-04	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	5.741721-05	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	1.5291782-06	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	2.2159495+04	9.0909090-01
140	1.5339349-06	6.1707581-01	5.4103671-05	9.9945085-01	1.1948825-03	2.8722671+01	2.2918284+04	9.0909090-01
141	1.5376214-06	6.3826521-01	3.9378065-05	9.9922000-01	0.414868-04	2.8722760+01	2.3792972+04	9.0909090-01
142	1.5410029-06	6.6072450-01	2.4962337-05	1.0003709+00	5.3498768-04	2.8715196+01	2.4521616+04	9.0909090-01
143	1.5446479-06	6.8325106-01	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	7.3128733-01	4.8722734-06	1.0015241+00	1.6594777-04	2.8712525+01	2.7159932+04	9.0909090-01
146	1.5491479-06	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	7.826715-01	1.748842-06	1.0016714+00	2.4298493-04	2.8713480+01	2.9090655+04	9.0909090-01
148	1.5484754-06	8.1077193-01	9.7759684-07	1.0016823+00	2.5103988-05	2.8712260+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	2.8716459+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	1.5438381-06	9.3196572-01	1.8534879-06	1.0004710+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	2.5863135+00	2.8711452+01	3.7101444+04	9.0909090-01

... P.W 250K TRNSP COOLED ENGINE, H2-O2, SEPI 4, 1973 ...

NO.	YEAR	O/F	C (H)	C (H2)	C (H2O)	C (O)	C (OH)	C (O2)	MU	PR
1	0.000000	6.3443521-01	.000000	.562923	1.437677	.000000	.000000	.000000	5.25432-07	.58706
2	3.1045439-C2	6.3843995-01	.000000	.000000	.000000	.000000	.000000	.000000	5.35517-07	.58557
3	9.8946917-07	6.4649379-01	.000000	.000000	.000000	.000000	.000000	.000000	5.44782-07	.58403
4	2.1222158-06	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	6.0307654-06	7.0690514-01	.000000	.000000	.000000	.000000	.000000	.000000	5.70049-07	.57906
7	8.9274636-06	7.4150998-01	.000000	.000000	.000000	.000000	.000000	.000000	5.77428-07	.57729
8	1.2524566-05	7.8192187-01	.000000	.000000	.000000	.000000	.000000	.000000	5.84787-07	.57547
9	1.6871533-05	8.2441793-01	.000000	.000000	.000000	.000000	.000000	.000000	5.91625-07	.57359
10	2.7015243-05	8.6553487-01	.000000	.000000	.000000	.000000	.000000	.000000	5.97853-07	.57163
11	2.7999508-05	9.0299479-01	.000000	.000000	.000000	.000000	.000000	.000000	6.03408-07	.56950
12	3.4867475-05	9.3667773-01	.000000	.000000	.000000	.000000	.000000	.000000	6.09393-07	.56720
13	4.2659941-05	9.6760297-01	.000000	.000000	.000000	.000000	.000000	.000000	6.14517-07	.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	6.23474-07	.56026
16	7.1976574-05	1.0523451+00	.000000	.000000	.000000	.000000	.000000	.000000	6.27152-07	.55830
17	8.3853552-05	1.0786781+00	.000000	.000000	.000000	.000000	.000000	.000000	6.30763-07	.55658
18	9.6844854-05	1.1038066+00	.000000	.000000	.000000	.000000	.000000	.000000	6.33780-07	.55502
19	1.1098583-04	1.1274026+00	.000000	.000000	.000000	.000000	.000000	.000000	6.34590-07	.55362
20	1.2631174-04	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	6.36668-07	.55129
22	1.6066506-04	1.1857498+00	.000000	.000000	.000000	.000000	.000000	.000000	6.36223-07	.55028
23	1.7975193-04	1.2099332+00	.000000	.000000	.000000	.000000	.000000	.000000	6.33660-07	.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	.000000	.000000	.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	2.6971785-04	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	4.4935594-04	1.3113774+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37727-07	.54258
34	4.8497667-04	1.3231939+00	.000000	.000000	.000000	.000000	.000000	.000000	6.37778-07	.54186
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	7.8495558-04	1.4021815+00	.000000	.000000	.000000	.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	6.38294-07	.53659
44	9.4272339-04	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	.000000	.000000	.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	1.538601-03	1.536638+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	1.6988045-03	1.5533625+00	.000000	.000000	.000000	.000000	.000000	.000000	6.42018-07	.53080
56	1.7830142-03	1.5649725+00	.000000	.000000	.000000	.000000	.000000	.000000	6.42744-07	.53034
57	1.8700740-03	1.5774959+00	.000000	.316777	.669723	.000000	.000000	.000000	6.43424-07	.52989
58	1.9600051-03	1.5900056+00	.000000	.000000	.000000	.000000	.000000	.000000	6.44145-07	.52944
59	2.0530366-03	1.6011940+00	.000000	.000000	.000000	.000000	.000000	.000000	6.44910-07	.52900
60	2.1490850-03	1.6138240+00	.000000	.000000	.000000	.000000	.000000	.000000	6.45726-07	.52856
61	2.2482801-03	1.6267745+00	.000000	.000000	.000000	.000000	.000000	.000000	6.46593-07	.52812
62	2.3507017-03	1.6400722+00	.000000	.000000	.000000	.000000	.000000	.000000	6.47511-07	.52769
63	2.4564319-03	1.6537432+00	.000000	.000000	.000000	.000000	.000000	.000000	6.48481-07	.52726
64	2.5655558-03	1.6678151+00	.000000	.000000	.000000	.000000	.000000	.000000	6.49508-07	.52683
65	2.6781612-03	1.6823171+00	.000000	.293786	1766214	.000000	.000000	.000000	6.52130-07	.52641
66	2.7943389-03	1.6972407+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	1.7287379+00	.000000	.000000	.000000	.000000	.000000	.000000	6.57251-07	.52516
69	3.1652624-03	1.7453157+00	.000000	.000000	.000000	.000000	.000000	.000000	6.59107+07	.52475
70	3.2967522-03	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	1726511	.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	4.0173292-03	1.8605491+00	.000000	.000000	.000000	.000000	.000000	.000000	6.75903-07	.52243
76	4.1749766-03	1.8832254+00	.000000	.000000	.000000	.000000	.000000	.000000	6.79301-07	.52204
77	4.3374322-03	1.9072368+00	.000000	.000000	.000000	.000000	.000000	.000000	6.82776-07	.52166
78	4.5048328-03	1.9327664+00	.000000	.000000	.000000	.000000	.000000	.000000	6.86257-07	.52130
79	4.6773212-03	1.9598031+00	.000000	.000000	.000000	.000000	.000000	.000000	6.90974-07	.52096
80	4.8556054-03	1.9879225+00	.000000	.000000	.000000	.000000	.000000	.000000	6.95748-07	.52068
81	5.0381589-03	2.0200010+00	.000000	.246745	1753255	.000000	.000000	.000000	7.03571-07	.52043
82	5.2260205-03	2.0554993+00	.000000	.000000	.000000	.000000	.000000	.000000	7.10970-07	.52019
83	5.4211957-03	2.0929216+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	2.1785224+00	.000000	.000000	.000000	.000000	.000000	.000000	7.32178-07	.51902
86	6.0403461-03	2.2276809+00	.000000	.000000	.000000	.000000	.000000	.000000	7.39889-07	.51871
87	6.2593527-03	2.2801877+00	.000000	.000000	.000000	.000000	.000000	.000000	7.48246+07	.51866
88	6.4852357-03	2.3345194+00	.000000	.000000	.000000	.000000	.000000	.000000	7.57128-07	.51894
89	6.7174015-03	2.3901177+00	.000000	.263766	1796935	.000000	.000000	.000000	7.66531-07	.51855
90	6.9570736-03	2.4501903+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	2.7118688+00	.000000	.000000	.000000	.000000	.000000	.000000	8.62183-07	.52290
93	7.7212584-03	2.8374100+00	.000000	.000000	.000000	.000000	.000000	.000000	8.94907-07	.52450
94	7.9923392-03	2.9877367+00	.000000	.000000	.000000	.000000	.000000	.000000	9.24500-07	.52628
95	8.2868792-03	3.1648118+00	.000000	.000000	.000000	.000000	.000000	.000000	9.60099-07	.52819
96	8.5555449-03	3.3470799+00	.000000	.000000	.000000	.000000	.000000	.000000	9.90779-07	.53021
97	8.8512190-03	3.5663479+00	.000000	.123869	1876130	.000000	.000000	.000000	1.01814-06	.53234
98	9.1559913-03	3.8445844+00	.000000	.000000	.000000	.000000	.000000	.000000	1.04439-06	.53461
99	9.4701649-03	3.7720086+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	1.0372364-02	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	1919254	.000000	.000018	.000000	1.21133-06	.55457
106	1.1960723-02	4.5558830+00	.000000	.000000	.000000	.000000	.000000	.000000	1.23432-06	.55755

NO.	YBAR	O/F	C(H)	C(H2)	C(H20)	C(I)	C(10H)	C(I2)	MU	PR
107	1.2362577-02	4.6654545+00	.000000	.000000	.000000	.000000	.000000	.000000	1.25493-06	.56120
108	1.2771713-02	4.77759415+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	5.0314817+00	.000000	.000000	.000000	.000000	.000000	.000000	1.32286-06	.57180
111	1.4102023-02	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	.094892	.000000	.000223	.000001	1.38952-06	.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	5.8865844+00	.000000	.000000	.000000	.000000	.000000	.000000	1.48817-06	.60701
118	1.7733415-02	6.0204851+00	.000000	.000000	.000000	.000000	.000000	.000000	1.51337-06	.61332
119	1.8322622-02	6.1488124+00	.000000	.000000	.000000	.000000	.000000	.000000	1.53497-06	.61875
120	1.8931450-02	6.2648872+00	.000000	.000000	.000000	.000000	.000000	.000000	1.55160-06	.62288
121	1.9560672-02	6.3637476+00	.000149	.026882	.0971021	.000013	.001890	.000045	1.56330+06	.62572
122	2.0211046-02	6.4459186+00	.001962	.031386	.098929	.003717	.054586	.009420	1.57106-06	.62761
123	2.0893394-02	6.4925028+00	.001961	.031384	.098980	.003713	.054550	.009412	1.57383-06	.62833
124	2.1578568-02	6.5167036+00	.001960	.031381	.099030	.003709	.054516	.009404	1.57158-06	.62899
125	2.2297461-02	6.5126292+00	.001959	.031379	.099069	.003706	.054489	.009397	1.56571+06	.62659
126	2.3041002-02	6.4817555+00	.001958	.031377	.099114	.003703	.054458	.009390	1.55835-06	.62494
127	2.3810162-02	6.4279905+00	.001958	.031376	.099139	.003701	.054441	.009385	1.55163+06	.62342
128	2.4605961-02	6.3579923+00	.001957	.031374	.099166	.003699	.054423	.009381	1.54695-06	.62236
129	2.5429460-02	6.2784292+00	.000132	.028666	.096657	.003009	.001509	.000028	1.54429-06	.62176
130	2.6281770-02	6.1971217+00	.000156	.031371	.099225	.003694	.054384	.009370	1.54207-06	.62123
131	2.7164056-02	6.1231920+00	.001955	.031370	.099256	.003691	.054363	.009365	1.53957+06	.62061
132	2.8077335-02	6.0477700+00	.001955	.031368	.099289	.003689	.054341	.009359	1.53680-06	.61989
133	2.9023480-02	6.0035226+00	.001955	.031368	.099289	.003689	.054341	.009359	1.53398-06	.61913
134	3.0003224-02	6.0459793+00	.001954	.031366	.099322	.003686	.054318	.009353	1.53146-06	.61845
135	3.1018162-02	6.08.1143+00	.001953	.031365	.099358	.003683	.054294	.009347	1.52860-06	.61795
136	3.2069755-02	6.1314761+00	.001953	.031365	.099358	.003683	.054294	.009347	1.5262-06	.61771
137	3.3159534-02	6.1899555+00	.000121	.030585	.098017	.003006	.001251	.000019	1.52851-06	.61771
138	3.4289102-02	6.2421444+00	.001952	.031363	.099393	.003680	.054270	.009341	1.52918-06	.61793
139	3.5460139-02	6.2852218+00	.001951	.031361	.099432	.003677	.054244	.009334	1.53098+06	.61846
140	3.6674405-02	6.3157395+00	.001951	.031361	.099432	.003677	.054244	.009334	1.53394+06	.61931
141	3.7933747-02	6.3291406+00	.001951	.031361	.099432	.003677	.054244	.009334	1.53762+06	.62037
142	3.9240097-02	6.3296999+00	.001951	.031359	.099472	.003674	.054217	.009327	1.54140+06	.62145
143	4.0595485-02	6.3266494+00	.001951	.031359	.099472	.003674	.054217	.009327	1.54465+06	.62237
144	4.2002040-02	6.3251072+00	.001950	.031357	.099515	.003671	.054188	.009320	1.54894+06	.62302
145	4.3461994-02	6.3145328+00	.000134	.027905	.0970341	.003030	.001580	.000031	1.54828-06	.62339
146	4.4977688-02	6.3060232+00	.001950	.031357	.099515	.003671	.054188	.009320	1.54905+06	.62360
147	4.6551585-02	6.32.172+00	.001949	.031355	.099560	.003667	.054157	.009312	1.54911-06	.62362
148	4.8186265-02	6.2870442+00	.001949	.031355	.099560	.003667	.054157	.009312	1.54848+06	.62343
149	4.9884439-02	6.2903826+00	.001949	.031355	.099560	.003667	.054157	.009312	1.54737-06	.62311
150	5.1648954-02	6.2863440+00	.000149	.031355	.099560	.003667	.054157	.009312	1.54618+06	.62276
151	5.3482801-02	6.2834696+00	.001948	.031352	.099607	.003664	.054125	.009304	1.54525+06	.62246
152	5.5389124-02	6.2860920+00	.001948	.031352	.099607	.003664	.054125	.009304	1.54484+06	.62230
153	5.7371225-02	6.2896628+00	.000132	.028428	.0969883	.003009	.001519	.000029	1.54493+06	.62226
154	5.9432577-02	6.2900096+00	.000132	.028421	.0969883	.003009	.001524	.000029	1.54528+06	.62226

NO. ITERATIONS = 2

CASE II

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

..... MUZZY WITH COMBUSTION FOR R=10. 48 HYDROGEN INJECTION 6/14/73

FLAGS AND OPTIONS

IDEAL = 1 (01 FOR PERFECT GAS, 00 FOR HYDROGEN+OXYGEN EQUILIBRIUM)
LAMNR = 0 (01 FOR LAMINAR FLOW, 00 FOR TURBULENT)
I:COMP = 0 (01 FOR INCOMPRESSIBLE FLOW, 00 FOR COMPRESSIBLE)
J2D = 0 (01 FOR AXISYMMETRIC GEOMETRY, 00 FOR TWO-DIMENSIONAL)
INTDK = 0 (01 IF INPUT TABLES COME FROM TOK OUTPUT, 00 OTHERWISE)
ICOO = 0 (00 NO COOLING, 01 OPPOSITE DIRECTION, 02 SAME DIRECTION)
ITHERM = 0 (01 FOR SYNERGIC NAMELIST INPUT TO ODE, 00 OTHERWISE)
IPOLY = 0 (01 FOR CALCULATION OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, 00 OTHERWISE)

INJH2 = 1 (01 FOR HYDROGEN INJECTION, FREE STREAM, PERFECT GAS,
00 FOR PERFECT GAS INJECTION, FREE STREAM, PERFECT GAS)

PROBLEM LIMITS AND INITIAL VALUES

SINIT = .00000000 XINIT = .00000000 XMAX = 30.00000000 OXI = 1.000000-03 DELTA1 = 5.000000-04 ZETAPI = 1.000000-01

REFERENCE QUANTITIES

BLREF = 2.916667-01 UREF = 1.000000+02 RHOREF = 2.000000-03 SMUREF = 5.000000-07

INPUT NORMALIZATION FACTORS

XN = 8.333000-02 YN = 1.000000+00 UEN = 1.000000+00 PEN = 2.116800+03 SHDN = 1.000000+00

EDGE QUANTITIES

HEEDGE = 4.150000+01 PEDGE = 1.000000+00 TEDGE = 5.300000+02 AFEDGE = 0.000000

CONSTANTS

APTRNS = 4.000000-02 PRI = 0.000000 GAMMA = 0.000000 FMOLWT = 0.000000 PLAM = 7.000000+00 PAMB = 0.000000
SPD = 1.000000+03 SNJ = 2.000000+00 XSTAR = 5.830000-01 AFWALL = 0.000000 UEK = 0.000000 RHOGK = 0.000000

CONVERGENCE AND EDGE CRITERIA

CONVRG = 5.000000-03 EPSLN1 = 5.000000+02 EPSLN2 = 5.000000-02 EPSLN3 = 5.000000-02 EPSITN = 0.000000

COUNTERS

KAXIT = 2 NYI = 120 NLPRNT = 40 NSPRNT = 40 INSTAT = 0000 IYPR = 1 IYEQ = 4

CORRELATION INPUTS

GAMA = .000000 ZK = .000000

STEP SIZE CONTROL TABLES

DXLIM	LDLIM	XLIM	SKTAB	LSKTAB= 3	XTARSK
5.000000+03		1.000000-01	4.015000+00		5.000000-02
1.000000-02		5.000000-01	1.015000+00		1.000000+01
1.000000-02		2.000000+00	1.015000+00		3.600000+01
1.000000-02		4.000000+00			
1.000000-02		6.000000+00			
1.000000-02		8.000000+00			
1.000000-02		1.000000+01			
1.000000-02		1.500000+01			
1.000000-02		2.000000+01			
1.000000-02		2.500000+01			
1.000000-02		3.000000+01			
1.000000-02		3.600000+01			

WALL TABLES

TWTAB	LYMTAB= 0	XSTART	SMDTAB	LMDTAB= 7	XTARM0
5.3000000+02		0.0000000	2.8000000-04		0.0000000
5.6000000+02		2.0000000+00	2.8000000-04		5.0000000+00
6.0500000+02		5.0000000+00	2.8000000-04		1.0000000+01
6.5300000+02		8.0000000+00	2.8000000-04		1.5000000+01
7.1400000+02		1.2000000+01	2.8000000-04		2.0000000+01
8.4200000+02		2.0000000+01	2.8000000-04		3.0000000+01
1.0000000+03		3.0000000+01	2.8000000-04		3.6000000+01
1.1300000+03		3.6000000+01			

GEOMETRY AND EDGE TABLES

RWTAB	LRWTAB= 5	XTABRM	PETAB	LPETAB= 2	XTABPE
3.5000000+00	0.0000000	0.0000000	9.0000000+00	0.0000000	0.0000000
3.5000000+00	6.0000000+00	6.0000000+00	9.2995000+01	3.6000000+01	3.6000000+01
3.5000000+00	1.2000000+01	1.2000000+01			
3.5000000+00	2.1000000+01	2.1000000+01			
3.5000000+00	3.4000000+01	3.4000000+01			

	FUEL	OXIDANT	MIXTURE								
H	2.0000	.0000	.0000	.0000	100.0000	F	.00	G	298.150	F	.00000
O	2.0000	.0000	.0000	.0000	21.0000	F	.00	G	298.150	O	.00000
N	2.0000	.0000	.0000	.0000	79.0000	F	.00	G	298.150	O	.00000
MICAL/G											
	.00000000	.00000000	.00000000	.00000000							
VJ	199206348500	.00000000	.00000000	.4960317400							
VB	100000000	.26280000-01	.13125000-01	.13125000-01							
ATOMS/G											
H	199206348500	.00000000	.00000000	.4960317400							
O	100000000	.13125000-01	.65625000-02								
N	100000000	.56396333-01	.28198172-01								

SPECIES BEING CONSIDERED IN THIS SYSTEM

J 9/65	H	J 3/61	H2	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

.000000 .102853+02

YTL YG GP GPP

0.000000	0.000000	1.0158591+03	-1.0168473+09
5.8349534-05	9.9914549-03	9.3577662+01	-7.9502487+05
2.1356292-04	1.4982913-02	4.9059916+01	-1.1463943+05
4.6569918-04	2.9974349-02	3.3235174+01	-3.5679384+04
6.1486322-04	3.9965826-02	2.5121712+01	-1.5431963+04
1.2617004-03	4.9957282-02	2.0185517+01	-8.020897+03
1.8048945-03	5.9948738-02	1.684753+01	-4.6886986+03
2.4461781-03	6.9940194-02	1.4477039+01	-2.9739907+03
3.1653125-03	7.9931651-02	1.2676952+01	-2.0031363+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	1.0999662-01	9.2146714+00	-7.7851184+02
7.1271628-03	1.1982749-01	8.4357111+00	-6.0100549+02
8.3610133-03	1.2988893-01	7.7519745+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	1.6986330-01	6.2938058+00	-2.5505900+02
1.4305487-02	1.8985476-01	5.9121795+00	-2.1284772+02
1.6046997-02	1.7984651-01	5.571972+00	-1.7945064+02
1.7892067-02	1.6983767-01	5.2666816+00	-1.5269213+02
1.9841477-02	1.5982913-01	4.9911046+00	-1.3097526+02
2.1876052-02	2.0982058-01	4.7410299+00	-1.1318793+02
2.4056644-02	2.1981204-01	4.5129917+00	-9.8473615+01
2.6324230-02	2.2980350-01	4.3041343+00	-8.6196035+01
2.8699717-02	2.3979495-01	4.1129822+00	-7.5870759+01
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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	3.4760946+00	-4.7745972+01
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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	2.6988468+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
7.3948174-02	3.7967534-01	2.4487875+00	-1.8922204+01
7.8092965-02	3.8966680-01	2.3734256+00	-1.7475046+01
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1.1087164-01	4.5960699-01	1.9315166+00	-1.0486022+01
1.1611752-01	4.6959845-01	1.8783338+00	-9.8026729+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
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1.3865302-01	5.0956427-01	1.6847975+00	-7.5723010+00
1.4461288-01	5.1955573-01	1.6406805+00	-7.1170966+00
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9.498342-01	1.1090517+00	3.9468237-01	-3.8049588-01
9.7061028-01	1.1190431+00	3.8515546-01	-3.6321512-01
9.9687180-01	1.1290346+00	3.7583629-01	-3.4649632-01
1.0237053+00	1.1390260+00	3.6672044-01	-3.3090540-01
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1.0796404+00	1.1590089+00	3.4908143-01	-3.0137908-01
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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
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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

*** MUZZY WITH COMBUSTION FOR B-10, 48 HYDROGEN INJECTION *** 6/14/73

STATION 400 1.446600+00 5.7140571+00 2.8742946+02 9.9225988-01 0.0000000 2.9489108-01 2.8442110-02

EDGE AND WALL CONDITIONS

UEN = 3.4918191+01 BME = 9. 3.0980315-02 DLSTAR = 5.3602183-02 RCF = 3.67988442-04

YEDGE = 5.3000616+02 RHOEB = 2.3098505-03 THEYA = 6.8172477-03 STAN = 3.1160771A-04

SHEB = -2.5575224+04 SMUEB = 3.7694773-07 TAUW = 5.4635650-04 TAU1 = 1.5091831-01

PEDEGB = -2.1167412+03 TWALL = 8.4200000+02 SOW = 7.7305779+02 RHMETA = 1.14584918+03

THLOSS = -1.1345904+02 TMDWB = 2.8000217-04

PROFILE PARAMETERS

THEMAM 0.0000000 ZETA

NO.	YEAR	Y	U/UE	H/H/E	RO/ROE	ROV	EPS	T
1	0.0000000	0.0000000	0.0000000	1.186460+03	4.796977-01	3.4812459-03	0.0000000	441.9
2	5.2526900-06	9.9911564-03	1.4426657-04	1.1864887+03	4.7969748-01	3.4812451-03	0.0000000	442.3
3	1.8493160-05	1.9982913-02	5.1876828-04	1.1860857+03	4.7972064-01	3.4812202-03	2.2086603-13	443.6
4	4.0326519-05	2.9974369-02	1.1207299-03	1.1854439+03	4.7793927-01	3.4811423-03	1.4953234-12	445.7
5	7.0561854-05	3.9965826-02	1.49539866-03	1.1845685+03	4.7845336-01	3.4809982-03	6.8133802-12	448.6
6	1.0921175-04	4.9957282-02	3.0306911-03	1.1834497+03	4.7455909-01	3.4807931-03	2.4284746-11	452.3
7	1.5629230-04	5.9948738-02	4.3755046-03	1.1820728+03	4.7225165-01	3.4805170-03	7.2574978-11	454.7
8	2.1182311-04	6.9940194-02	6.0172289-03	1.1804133+03	4.6954780-01	3.4800894-03	1.8844169-10	462.1
9	2.7582734-04	7.9931651-02	7.9736440-03	1.1784657+03	4.6646436+01	3.4793644-03	4.3702581-10	468.4
10	3.4833167-04	8.9923107-02	1.0255041-02	1.1762375+03	4.6300159-01	3.4782139-03	9.2653217-10	475.6
11	4.2933638-04	9.9914564-02	1.2865121-02	1.1737481+03	4.5916209-01	3.4766478-03	1.8270894-09	483.6
12	5.1898531-04	1.0990602-01	1.5821850-02	1.1709965+03	4.5492350-01	3.4748646-03	3.3844475-09	492.7
13	6.1716593-04	1.1989748-01	1.9179931-02	1.1679274+03	4.5026346-01	3.4730516-03	5.9262902-09	503.2
14	7.2400936-04	1.2988893-01	2.2987594-02	1.1644817+03	4.4516894-01	3.4711727-03	9.8521280-09	514.8
15	8.3954033-04	1.3988039-01	2.7268043-02	1.1606301+03	4.3942035-01	3.4690493-03	1.5608603-08	527.5
16	9.6380735-04	1.4987184-01	3.2038449-02	1.1563557+03	4.3370338-01	3.4664722-03	2.3667832-08	541.6
17	1.0968626-03	1.5986330-01	3.7296437-02	1.1516768+03	4.2750368-01	3.4632768-03	3.4489347-08	557.1
18	1.2387621-03	1.6985876-01	4.3031421-02	1.1466123+03	4.2095875-01	3.4594331-03	4.8841694-08	573.9
19	1.3895855-03	1.7984421-01	4.9239618-02	1.1414422+03	4.1400123-01	3.4549620-03	6.5981594-08	592.2
20	1.5493366-03	1.8983767-01	5.5901031-02	1.1352524+03	4.0677956-01	3.4498891-03	8.7236931-08	611.8
21	1.7181429-03	1.9982913-01	6.2981469-02	1.1289525+03	3.9951422-01	3.4443624-03	1.12339813-07	632.9
22	1.8960557-03	2.0982058-01	7.0429264-02	1.1222489+03	3.9207170-01	3.4386788-03	1.51549933-07	655.3
23	2.0831506-03	2.1981204-01	7.8291050-02	1.1151452+03	3.8439216-01	3.4331884-03	1.7476793-07	679.2
24	2.2795071-03	2.2980350-01	8.6474250-02	1.1076456+03	3.7661457-01	3.4283063-03	2.1210454-07	709.4
25	2.4852089-03	2.3979495-01	9.4991739-02	1.0997444+03	3.6887795-01	3.4244095-03	2.5352412-07	741.1
26	2.7003434-03	2.4978641-01	1.0383885-01	1.0914353+03	3.6112280-01	3.4216827-03	2.9490995-07	775.2
27	2.9250030-03	2.5977787-01	1.1301150-01	1.0827122+03	3.5329288-01	3.4200786-03	3.4813721-07	818.7
28	3.1592839-03	2.6976932-01	1.2250519-01	1.0735675+03	3.4547385-01	3.4194360-03	4.0105910-07	869.7
29	3.4032667-03	2.7976078-01	1.3231678-01	1.0639925+03	3.3775140-01	3.4195663-03	4.5745307-07	925.3
30	3.6571164-03	2.8975223-01	1.4244382-01	1.0539787+03	3.3008791-01	3.4202340-03	5.1701662-07	986.5
31	3.9208226-03	2.9974369-01	1.5288316-01	1.0435168+03	3.2244750-01	3.4221900-03	5.7944590-07	1052.1
32	4.1946996-03	3.0973515-01	1.6363231-01	1.0326055+03	3.1488715-01	3.4223846-03	6.4448380-07	1129.4
33	4.4786862-03	3.1972660-01	1.7469047-01	1.0212308+03	3.0746383-01	3.4236345-03	7.1197432-07	1218.5
34	4.7729658-03	3.2971906-01	1.8605871-01	1.0093841+03	3.0015763-01	3.4249193-03	7.8188240-07	1319.3
35	5.0776870-03	3.3970952-01	1.9774132-01	9.9705362+02	2.9295116-01	3.4262971-03	8.5430658-07	1431.6
36	5.3929232-03	3.4970097-01	2.0975088-01	9.8421936+02	2.8585985-01	3.4278843-03	9.2852857-07	1555.8
37	5.7188726-03	3.5969243-01	2.2211410-01	9.7084998+02	2.7889909-01	3.4297817-03	1.0020888-06	1672.3
38	6.0556590-03	3.6968388-01	2.3486490-01	9.5490711+02	2.7187373-01	3.4344025-03	1.0750366-06	1722.6
39	6.4034309-03	3.7967534-01	2.4802027-01	9.4236391+02	2.6453869-01	3.4349627-03	1.1524827-06	1778.6
40	6.7623428-03	3.8966680-01	2.6156920-01	9.2723315+02	2.5723315-01	3.4375335-03	1.2401783-06	1733.3
41	7.1325839-03	3.9965826-01	2.7549872-01	9.1145676+02	2.5229429-01	3.4419323-03	1.3374431-06	1779.6
42	7.5192295-03	4.0964971-01	2.8979527-01	8.9508867+02	2.4768382-01	3.4443940-03	1.4436034-06	1822.0

NO.	YBAR	Y	U/UE	H/M/E	RO/ROE	ROV	FPS	Y
43	7.9075404-03	4.1964117-01	3.04386899-01	0.7815794+02	2.4332162-01	3.4416034-03	1.8442407-04	1.668.5
44	8.2963262-01	4.2963262-01	3.1909445-01	0.4082513+02	2.4054155-01	3.4339909-03	1.7274495-04	1.999.7
45	8.7297613-03	4.3962408-01	3.3361851-01	0.4338200+02	2.4067548-01	3.4256805-03	1.9382634-04	1.908.6
46	9.1590027-03	4.4961554-01	3.4760893-01	0.2621173+02	2.4389188-01	3.4214394-03	2.2285903-04	1.92.3
47	9.6007424-03	4.5960699-01	3.6083361-01	0.0963692+02	2.5058712-01	3.4280698-03	2.5887744-04	1.947.9
48	1.0055022-02	4.6959845-01	3.7326735-01	7.9337256+02	2.6833288-01	3.4454735-03	2.6980331-04	1.95.8
49	1.0522070-02	4.7958991-01	3.8499131-01	7.7865308+02	2.6470080-01	3.44673589-03	3.4458401-04	1.958.3
50	1.1002120-02	4.8958136-01	3.9645383-01	7.6441208+02	2.6730703-01	3.4499429-03	3.43319516-04	1.973.8
51	1.1495393-02	4.9957282-01	4.0683384-01	7.5013385+02	2.7586843-01	3.4599580-03	4.45640316-04	1.994.0
52	1.202120-02	5.0956427-01	4.1707652-01	7.3666763+02	2.8128158-01	3.4749660-03	5.0197380-04	1.945.8
53	1.2522335-02	5.1955573-01	4.2769057-01	7.2371124+02	2.8669620-01	3.4855727-03	5.4264274-04	1.938.2
54	1.303381-02	5.2954718-01	4.3634520-01	7.1125119+02	2.9207006-01	3.49571848-03	6.2543340-04	1.911.7
55	1.3601409-02	5.3953010-01	4.4545300-01	6.9924007+02	2.9736162-01	3.50999332-03	6.8507820-04	1.888.6
56	1.4188377-02	5.4953010-01	4.5429442-01	6.8759985+02	3.0264704-01	3.52449167-03	7.3907526-04	1.862.4
57	1.4746653-02	5.5952156-01	4.6294928-01	6.7624287+02	3.0800255-01	3.5395258-03	7.8745126-04	1.838.5
58	1.5336710-02	5.6951301-01	4.7147446-01	6.6510724+02	3.1339467-01	3.5464023-03	8.3329140-04	1.815.1
59	1.5946632-02	5.7950447-01	4.7989975-01	6.5416015+02	3.1879149-01	3.55308922-03	8.7272186-04	1.792.5
60	1.6570111-02	5.8949593-01	4.8824474-01	6.4338007+02	3.2424371-01	3.5666753-03	9.2301480-04	1.770.3
61	1.7209446-02	5.9948738-01	4.9652581-01	6.3274915+02	3.2990205-01	4.0353276-03	9.6680947-04	1.748.4
62	1.7864947-02	6.0947884-01	5.0557578-01	6.2225327+02	3.3544510-01	4.099822-03	1.0105750-05	1.726.8
63	1.8536934-02	6.1947028-01	5.129497-01	6.1188030+02	3.4115278-01	4.190811-03	1.0541024-05	1.705.7
64	1.9225736-02	6.2946175-01	5.210175-01	6.0161429+02	3.4695490-01	4.2783153-03	1.0975820-05	1.684.8
65	1.9931690-02	6.3945321-01	5.2923317-01	5.9145952+02	3.5288134-01	4.3730262-03	1.1410071-05	1.664.1
66	2.0655144-02	6.4944466-01	5.3734542-01	5.8139024+02	3.5891514-01	4.4751777-03	1.1844787-05	1.643.7
67	2.1396459-02	6.5943412-01	5.4544409-01	5.7140052+02	3.6503901-01	4.5854027-03	1.2276701-05	1.623.5
68	2.2156003-02	6.6942757-01	5.5353474-01	5.6147961+02	3.7128956-01	4.7031697-03	1.2709112-05	1.603.6
69	2.2934159-02	6.7941903-01	5.6162061-01	5.5176168+02	3.7720346-01	4.8304177-03	1.3140286-05	1.583.8
70	2.3731316-02	6.8941049-01	5.6970792-01	5.4180046+02	3.84725894-01	4.9670339-03	1.3569449-05	1.564.8
71	2.4547080-02	6.9940194-01	5.7780074-01	5.3201939+02	3.9093350-01	5.1132882-03	1.3996232-05	1.544.8
72	2.5384266-02	7.0939340-01	5.8590327-01	5.2221777+02	3.9777640-01	5.2701534-03	1.4420244-05	1.525.6
73	2.624092-02	7.1938484-01	5.9401973-01	5.1251593+02	4.0483670-01	5.4387131-03	1.4840409-05	1.508.4
74	2.7118230-02	7.2937632-01	6.0215445-01	5.0276999+02	4.1208718-01	5.6193254-03	1.5255502-05	1.487.3
75	2.8016701-02	7.3936777-01	6.1031184-01	4.9301222+02	4.1949880-01	5.8123239-03	1.5664814-05	1.468.3
76	2.893785-02	7.4935923-01	6.1849413-01	4.8323140+02	4.2713171-01	6.0190802-03	1.6087628-05	1.449.4
77	2.9878962-02	7.5935068-01	6.2671165-01	4.7341677+02	4.3505584-01	6.2411199-03	1.6482475-05	1.430.6
78	3.0843728-02	7.6934214-01	6.3496301-01	4.6355773+02	4.4320234-01	6.4789174-03	1.6847708-05	1.411.8
79	3.1831594-02	7.7933330-01	6.4325497-01	4.5364407+02	4.5158583-01	6.7329255-03	1.7222335-05	1.393.0
80	3.2843083-02	7.8932250-01	6.5159224-01	4.4366625+02	4.6024492-01	7.0050285-03	1.7584940-05	1.374.3
81	3.3878738-02	7.9931651-01	6.5997971-01	4.3361515+02	4.6926028-01	7.2972978-03	1.7933914-05	1.355.6
82	3.4939114-02	8.0930796-01	6.68442273-01	4.2348170+02	4.7858896-01	7.6103718-03	1.8267044-05	1.336.9
83	3.6024787-02	8.1929942-01	6.7692684-01	4.1325702+02	4.8819566-01	7.9448761-03	1.8582738-05	1.318.3
84	3.7136345-02	8.2929087-01	6.8549766-01	4.0293256+02	4.9815582-01	8.3033239-03	1.8879345-05	1.300.7
85	3.8274399-02	8.392823-01	6.9441408-01	3.9249982+02	5.0853494-01	8.6884627-03	1.9154421-05	0.81.1
86	3.9439574-02	8.4927379-01	7.0286344-01	3.8195008+02	5.1932763-01	9.0101748-03	1.9405300-05	0.62.6
87	4.0632514-02	8.5926525-01	7.1167137-01	3.7127443+02	5.3044818-01	9.5423569-03	1.9682979-05	0.44.0
88	4.1853886-02	8.6925671-01	7.2057183-01	3.6063370+02	5.4200350-01	1.0015330-02	1.9825572-05	0.25.6
89	4.3104370-02	8.7924814-01	7.2957214-01	3.4950641+02	5.5407055-01	1.0523670-02	1.9989567-05	0.07.2
90	4.4384676-02	8.8923942-01	7.3868024-01	3.3839830+02	5.6660704-01	1.1068598-02	2.0118466-05	0.88.8
91	4.5695525-02	8.9923108-01	7.4790452-01	3.2739330+02	5.7957072-01	1.1651397-02	2.0209254-05	0.70.5
92	4.7037667-02	9.0922253-01	7.5725366-01	3.1567006+02	5.9304373-01	1.2276253-02	2.0292784-05	0.52.3
93	4.8411873-02	9.1921399-01	7.6673669-01	3.0402893+02	6.0710829-01	1.2947609-02	2.0374317-05	0.34.3
94	4.9918923-02	9.2920544-01	7.7636314-01	2.9218679+02	6.2172779-01	1.3667283-02	2.04714815-05	0.16.3
95	5.1259669-02	9.3919470-01	7.8614299-01	2.8013047+02	6.3686728-01	1.4437298-02	2.0571343-05	0.08.4
96	5.2734919-02	9.4918835-01	7.9608622-01	2.6784632+02	6.5268344-01	1.5262175-02	1.9987058-05	0.00.7

NO	YBAR	Y	U/ZUE	H/ME	RO/ROE	ROV	EPS	T
97	5.424553-02	9.5917981+01	8.0620326-01	2.5532030+02	6.6893303+01	1.6146525-02	1.9751640-05	763.2
98	5.5792664-02	9.6917127+01	8.1650418-01	2.14253808+02	6.8590996-01	1.7093426-02	1.9470725-05	745.9
99	5.7376572-02	9.7916272+01	8.2699664-01	2.12948539+02	7.0351434-01	1.6106518-02	1.9119965-05	728.7
100	5.8998628-02	9.8915418+01	8.3789529-01	2.1414860+02	7.2170101-01	1.9187924-02	1.8695322-05	711.8
101	6.0680208-02	9.9914563+01	8.4860075-01	2.0251573+02	7.4042477-01	2.0339192-02	1.8193418-05	695.3
102	6.2361722-02	1.0091371+00	8.5971832-01	1.8857770+02	7.5927839-01	2.1566676-02	1.7611188-05	679.1
103	6.4104408-02	1.0191285+00	8.7104449-01	1.17433006+02	7.7999700-01	2.2878530-02	1.74946161-05	663.0
104	6.5889335-02	1.0291200+00	8.8257824-01	1.5977590+02	8.0038830-01	2.4263425-02	1.74197389-05	647.5
105	6.7717614-02	1.0391115+00	8.9428689-01	1.14493060+02	8.2088244-01	2.5707440-02	1.7344559-05	632.6
106	6.9590374-02	1.0491029+00	9.0614072-01	1.12982800+02	8.4176342-01	2.7225306-02	1.74457455-05	618.3
107	7.1508790-02	1.0590944+00	9.1807822-01	1.11452844+02	8.6346620-01	2.8834591-02	1.7476290-05	604.3
108	7.3474075-02	1.0690858+00	9.2999879-01	9.9130514+01	8.8477445-01	3.0478616-02	1.7433293-05	591.2
109	7.5487476-02	1.0790773+00	9.4174858-01	8.3786654+01	9.0447988-01	3.2091312-02	1.7420225-05	579.3
110	7.7550273-02	1.0890667+00	9.5318855-01	6.0720059+01	9.2330404-01	3.3690197-02	1.74221694-05	568.5
111	7.9663797-02	1.0990602+00	9.6399690-01	5.4238964+01	9.4200385-01	3.5291856-02	1.74091881-04	558.6
112	8.1829417-02	1.1090517+00	9.7387048-01	4.0741273+01	9.5891585-01	3.6785427-02	1.7372124-04	550.0
113	8.4048536-02	1.1190431+00	9.8244962-01	2.8496184+01	9.7237853-01	3.8049853-02	1.73404140-04	543.0
114	8.6322612-02	1.1290346+00	9.8939724-01	1.8584795+01	9.8262520-01	3.9062768-02	1.7327217-04	537.9
115	8.8653148-02	1.1390260+00	9.9448901-01	1.0798252+01	9.8973852-01	3.9798004-02	1.73227199-04	534.6
116	9.1041893-02	1.1490175+00	9.9772090-01	5.4951968+00	9.9476451-01	4.0302231-02	1.731549437-04	532.4
117	9.3489837-02	1.1590089+00	9.9936061-01	2.5022577+00	9.9874312-01	4.0646073-02	1.7314917-04	530.6
118	9.5992330-02	1.1690004+00	9.9993445-01	1.12487851+00	1.0010808+00	4.0815792-02	1.73089958-04	529.5
119	9.8571577-02	1.1789919+00	1.0000075+00	9.6859777-01	1.0010371+00	4.0799324-02	1.72825737-04	529.5
120	1.0120862-01	1.1889833+00	9.9999736-01	1.0027420+00	1.0001437+00	4.0722060-02	1.7048153-02	529.9
121	1.0391219-01	1.1989748+00	1.0000019+00	9.9901194-01	9.9999227-01	4.0693629-02	1.7229563-02	530.0
122	1.0648413-01	1.2089662+00	9.9999975-01	1.0003615+00	1.0000819+00	4.0682595-02	1.72607541-02	530.0
123	1.0952439-01	1.2189577+00	1.0000014+00	9.9957628+01	1.0000845+00	4.06465087-02	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

NO.	TAU	DELTA = 1.03915 * 00 (INCHES)	TAU / (RE * UE * I)	FPS / (RHO * UE * DELTA)	Y TIL / DELTA
2	4.2463447-04	1.5077450-04	0.000000	5.8348150-05	
3	4.2620032-04	1.5204063-04	4.6015136-11	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	1.6462445-04	2.2003017-08	1.8046537-03	
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	4.0725124-03	
11	5.3913326-04	1.9142946-04	5.6971523-07	4.9582961-03	
12	5.6527059-04	2.0071002-04	1.0651683-06	5.929790-03	
13	5.9459289-04	2.1112145-04	1.8844518-06	7.1269937-03	
14	6.2713637-04	2.2267663-04	3.1686441-06	8.3608149-03	
15	6.6286964-04	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	2.8033994-04	1.6489484-05	1.4305147-02	
19	8.3814640-04	2.9759973-04	2.2818652-05	1.6046616-02	
20	8.898693A-04	3.1596495-04	3.0703710-05	1.7891643-02	
21	9.446897-04	3.3542258-04	4.0280574-05	1.9841066-02	
22	1.0026239-03	3.5600057-04	5.1690788-05	2.1895533-02	
23	1.0638774-03	3.7774978-04	6.5096187-05	2.4056093-02	
24	1.1286031-03	4.0073187-04	8.0434642-05	2.632360A-02	
25	1.1969323-03	4.2499346-04	9.8402335-05	2.8499036-02	
26	1.2689189-03	4.5055366-04	1.1850980-04	3.1183397-02	
27	1.3445705-03	4.7741519-04	1.4108615-04	3.377753-02	
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	1.969752-03	6.9941303-04	3.7295881-04	5.5117912-02	
35	2.0733349-03	7.3617676-04	4.1752927-04	5.8436582-02	
36	2.1816279-03	7.7462827-04	4.6506108-04	6.2277141-02	
37	2.2936982-03	8.1441739-04	5.1443183-04	6.6041184-02	
38	2.4093254-03	8.5547654-04	5.6414126-04	6.9930372-02	
39	2.5311821-03	8.9874110-04	6.2375473-04	7.3946421-02	
40	2.6602953-03	9.4458817-04	6.8894202-04	7.8091112-02	
41	2.7925410-03	9.9154450-04	7.5898513-04	8.2366287-02	
42	2.9244626-03	1.0383858-03	8.3448683-04	8.6773853-02	
43	3.0531322-03	1.0840723-03	9.2160880-04	9.1315784-02	
44	3.1707302-03	1.1258277-03	1.0252392-03	9.5994119-02	
45	3.2745669-03	1.1637231-03	1.1530544-03	1.0081097-01	
46	3.3767977-03	1.1989959-03	1.3082831-03	1.057851-01	
47	3.4689773-03	1.2316621-03	1.4785440-03	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	3.7366092-03	1.3274639-03	2.0821786-03	1.2705179-01	
51	3.8257398-03	1.3619520-03	2.3128706-03	1.3274809-01	
52	3.9131177-03	1.4000785-03	2.5551039-03	1.3859973-01	
53	4.0039054-03	1.4429665-03	2.8098271-03	1.4440945-01	

NO. TAU EPS/IRHOUE DELTA YUIL/DELTA

54	4.158825-03	1.486276-03	3.065934-03	1.5078004-01
55	4.271998-03	1.5222507-03	3.2985575-03	1.5711441-01
56	4.365070-03	1.5499007-03	3.4963994-03	1.6361554-01
57	4.4236577-03	1.5707034-03	3.6601812-03	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	4.577577-03	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	4.3133671-03	2.0630330-01
63	4.7166911-03	1.6754605-03	4.4238946-03	2.1406336-01
64	4.7615993-03	1.6906939-03	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	1.7325546-03	4.8151653-03	2.4708498-01
68	4.9152076-03	1.7452375-03	4.9008444-03	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	5.0389367-03	1.7891698-03	5.1904189-03	2.9313592-01
73	5.0649662-03	1.7984121-03	5.2484929-03	3.0302830-01
74	5.0886844-03	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	3.9122955-01
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	5.0998439-03	1.8104410-03	5.0837209-03	5.1255146-01
91	5.0659804-03	1.7987722-03	4.9924378-03	5.2748907-01
92	5.0270834-03	1.7849611-03	4.8909759-03	5.4318804-01
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	4.7163060-03	1.6746144-03	4.2275557-03	6.2442426-01
98	4.6241365-03	1.641882-03	4.0642820-03	6.4428789-01
99	4.5189854-03	1.6045513-03	3.8911947-03	6.6258107-01
100	4.3992061-03	1.5620220-03	3.7088942-03	6.8131478-01
101	4.2629862-03	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	7.6086544-01
105	3.5102904-03	1.2463950-03	2.6801832-03	7.8199878-01
106	3.2589367-03	1.1571471-03	2.4590684-03	8.0342529-01
107	2.9786504-03	1.0576263-03	2.2345493-03	8.2577905-01

NO.	TAU	TAU/(RE*UE2)	EPS/(RHO*UE*DELTA)	YTL/DELTA
108	2.6681203-03	9.477214-04	2.0119121-03	8.4447403-01
109	2.3321524-03	8.2907489-04	1.7953970-03	8.7172446-01
110	1.9726676-03	7.0043295-04	1.5850645-03	8.9554572-01
111	1.5998368-03	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	5.4650693-04	2.0114900-04	8.4907525-04	9.9684815-01
115	3.2017587-04	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	3.7947748-04	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	1.0087664-04	1.1687509+00
121	1.2029458-08	4.2712865-09	5.9031103-05	1.1999715+00
122	1.8407972-09	6.6071124-10	3.2365818-05	1.2319817+00
123	5.6107368-10	1.9921990-10	0.0000000	1.2648039+00

NO.	MU	Y	K /UEZ	RU/REUE	MIXEDDY	UDAG	YVAG	PRT
1	4.571371-07	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.5493477300
2	4.5735915-07	4.4936388-05	0.000000	4.920310-05	3.41929292-17	7.1759312-03	0.000000	1.5484372500
3	4.5768824-07	1.6446998-04	1.4296978-12	2.4450071-04	5.5579141-15	2.5803937-02	3.1482325-02	1.5459829500
4	4.5876097-07	3.5864620-04	1.3853201-11	5.3540081-04	1.2169124-13	5.5745974-02	6.4550929-02	1.5420790000
5	4.5997734-07	6.2754588-04	9.4413370-11	9.3098348-04	1.1043302-12	9.7192813-02	1.2012284-01	1.5464654000
6	4.6152667-07	9.7128093-04	5.0437101-10	4.1382420-03	6.1814209-12	1.5074893-01	1.4571954-01	1.5400119000
7	4.6339669-07	1.3899945-03	2.2330472-09	2.0463392-03	2.5894940-11	2.1740079-01	2.6404837-01	1.5422157000
8	4.6543219-07	1.8838609-03	8.3066077-09	2.8253766-03	8.11868643-11	2.9930164-01	3.0402773-01	1.5333383400
9	4.6827919-07	2.4530362-03	2.4644655-08	3.7194208-03	2.2401315-10	3.9461524-01	4.4956205-01	1.5334474000
10	4.7131191-07	3.0979076-03	7.6677603-08	4.7410004-03	5.33876693-10	5.1099373-01	5.9279174-01	1.5133200600
11	4.7470406-07	3.8105944-03	2.0003151-07	5.9071758-03	1.1605123-09	6.3992111-01	7.3094334-01	1.5022791000
12	4.7851098-07	4.6154477-03	4.7994477-07	7.1977314-03	2.3307894-09	7.8499113-01	8.3347448-01	1.4909080000
13	4.8278807-07	5.4868005-03	1.0653833-06	8.6360221-03	4.3303825-09	9.5402468-01	1.0564489+00	1.4794166000
14	4.8749515-07	6.4390186-03	2.1955545-04	1.1947587-02	1.2559193-08	1.14334208+00	1.4292140+00	1.4665109000
15	4.9258895-07	7.4665000-03	4.2182525-04	1.1947587-02	1.2559193-08	1.3563333+00	1.4292140+00	1.4665109000
16	4.9417604-07	8.5714757-03	7.5902066-04	1.3895183-02	1.9833351-08	1.5936173+00	1.6407437+00	1.4454139000
17	5.0436300-07	9.7550105-03	1.2860773-05	1.5944364-02	2.9872055-08	1.8551537+00	1.8472734+00	1.4447005000
18	5.1113103-07	1.1017002-02	2.0438623-05	1.8114453-02	4.3173026-08	2.1404163+00	2.1884399+00	1.4244930000
19	5.1847080-07	1.2358181-02	3.1556181-05	2.0345242-02	6.0125223-08	2.4492168+00	2.3455641+00	1.4148752000
20	5.2433033-07	1.3779114-02	4.6184409-05	2.2740403-02	8.0953045-08	2.7805607+00	2.6375546+00	1.4054226000
21	5.3465768-07	1.5280402-02	4.974744-05	2.5141992-02	1.0585847-07	3.1327471+00	2.9278265+00	1.3972855000
22	5.4370646-07	1.862680-02	8.83346187-05	2.7622613-02	1.3490946-07	3.5043851+00	3.2278011+00	1.3893047000
23	5.5276319-07	1.8526419-02	1.1674889-04	3.0094466-02	1.6400380-07	3.8942576+00	3.5463072+00	1.3819102000
24	5.6258622-07	2.0272927-02	1.5051920-04	3.2547462-02	2.0520116-07	4.3012966+00	3.8805799+00	1.3750423000
25	5.7286554-07	2.2102347-02	1.8979870-04	3.5000358-02	2.4468564-07	4.7249628+00	4.2707617+00	1.3748415000
26	5.8363245-07	2.4115659-02	2.3474072-04	3.7498576-02	2.9931822-07	5.1450249+00	4.5970019+00	1.3724808000
27	5.9490046-07	2.6013882-02	2.8554696-04	3.9926160-02	3.4174447-07	5.6212800+00	4.9779573+00	1.3671901000
28	6.0663499-07	2.8097272-02	3.4220599-04	4.2223400-02	3.9485840-07	6.0933333+00	5.3782915+00	1.3552062100
29	6.1880308-07	3.0267325-02	4.0448050-04	4.4690179-02	4.5164908-07	6.5815396+00	5.7934761+00	1.3471996000
30	6.3140517-07	3.2524773-02	4.7219959-04	4.7018982-02	5.1174088-07	7.0852661+00	6.2257899+00	1.3425963000
31	6.4443732-07	3.4870594-02	5.4524715-04	4.9726792-02	5.7467906-07	7.6045270+00	6.7481919+00	1.3318244400
32	6.5793967-07	3.7305401-02	6.2331917-04	5.1525711-02	6.4015105-07	8.1391979+00	7.1409591+00	1.3304026000
33	6.7195236-07	3.9831452-02	7.0620298-04	5.3711000-02	7.0792973-07	8.6892394+00	7.6294113+00	1.3223116000
34	6.8644125-07	4.2448645-02	7.9421817-04	5.5846941-02	7.7787574-07	9.2547047+00	8.1253661+00	1.3212730000
35	7.0136878-07	4.5158522-02	8.8804684-04	5.7928550-02	8.5013648-07	9.8358068+00	8.6441023+00	1.3104080000
36	7.1683397-07	4.7942271-02	9.8653320-04	5.9953353-02	9.2494188-07	1.0433172+01	9.1807871+00	1.3185168000
37	7.3293597-07	5.0441121-02	1.0846346-03	6.1947420-02	1.0025981-06	1.1048128+01	9.7356758+00	1.3147357000
38	7.5016634-07	5.3456350-02	1.1842608-03	6.3853598-02	1.0189041-06	1.1682363+01	1.0309013+01	1.3110510000
39	7.6916151-07	5.6949280-02	1.3000469-03	6.5610958-02	1.1461076-06	1.2336721+01	1.0901052+01	1.3078230000
40	7.8763271-07	6.0141282-02	1.4305754-03	6.7415052-02	1.2195581-06	1.3010655+01	1.1512055+01	1.3037613000
41	8.0329121-07	6.3433776-02	1.5982365-03	6.9507304-02	1.3196223-06	1.3703520+01	1.2142294+01	1.2969459000
42	8.1773283-07	6.6528229-02	1.7513020-03	7.1777805-02	1.4341944-06	1.4414643+01	1.2947050+01	1.2934705000
43	8.3266378-07	7.0326163-02	1.9535982-03	7.4003935-02	1.5407383-06	1.5140445+01	1.3441613+01	1.2883666000
44	8.4396279-07	7.3929148-02	2.2167253-03	7.6755520-02	1.6454630-06	1.5872015+01	1.4115128+01	1.2842102000
45	8.4750791-07	7.7436809-02	2.5771525-03	8.0293794-02	1.6594444-06	1.6594444+01	1.4241377+01	1.2735492000
46	8.4301537-07	8.1456825-02	3.0566447-03	8.4778995-02	2.0929845-06	1.7290338+01	1.5692709+01	1.2735063000
47	8.2955962-07	8.5364930-02	3.6049510-03	9.0420256-02	2.4656867-06	1.7948144+01	1.6344115+01	1.2646417000
48	8.1360993-07	8.9424915-02	4.2133447-03	9.6445937-02	2.9735678-06	1.8566359+01	1.7117436+01	1.2344501000
49	8.0163560-07	9.3578628-02	4.9165427-03	1.0490751-01	3.3627150-06	1.9149767+01	1.7912527+01	1.2225343000
50	7.9185208-07	9.7847980-02	5.7022522-03	1.0710823-01	3.8475780-06	1.9704999+01	1.8729753+01	1.2177733000
51	7.8288754-07	1.0223494+01	6.5617137-03	1.1223241+01	4.3930999+06	2.0236231+01	1.9549491+01	1.1936033000
52	7.7439975-07	1.0674154+01	7.4604003-03	1.1731594+01	4.9551970+06	2.0745710+01	2.0432130+01	1.1880892000

NO.	MU	Y	K / JUEZ	RU/REUE	MIXEDDY	UDAG	YUAG	PRT
53	7.6604636-07	1.1136988-01	8.433869A-03	1.2739224-01	5.5559297-06	2.1734621+01	2.1118077+01	1.1469324+0
54	7.5755494-07	1.1617211-01	9.4043089-03	1.2744742-01	6.1992086-06	2.1704298+01	2.2277710+01	1.1532432+0
55	7.5024010-07	1.2100048-01	1.0213537-02	1.3246086-01	6.9008573-06	2.2157218+01	2.3141532+01	1.1195999+0
56	7.4277403-07	1.2600727-01	1.0786350-02	1.3749086-01	7.6887048-06	2.2596597+01	2.4119916+01	1.1759523+0
57	7.3542895-07	1.3114467-01	1.1132079-02	1.4258956-01	8.5786077-06	2.3027457+01	2.6510333+01	1.1122469+0
58	7.2827501-07	1.3641569-01	1.1337098-02	1.4775738-01	9.5593375-06	2.3451506+01	2.6112263+01	1.0086049+0
59	7.2138356-07	1.4182228-01	1.1531918-02	1.5298796-01	1.0416645-05	2.3870584+01	2.7147176+01	1.0851523+0
60	7.1460768-07	1.4736723-01	1.1640504-02	1.5831022-01	1.1751845-05	2.4285672+01	2.8208571+01	1.0718446+0
61	7.0780050-07	1.5305319-01	1.1704906-02	1.6375523-01	1.2668974-05	2.4697580+01	2.8996961+01	1.0586436+0
62	7.0099602-07	1.5882933-01	1.1735844-02	1.6931785-01	1.4263705-05	2.5108945+01	3.0012872+01	1.0458304+0
63	6.9421718-07	1.6485929-01	1.1741316-02	1.7499260-01	1.5631580-05	2.5514271+01	3.1558446+01	1.0329710+0
64	6.8750029-07	1.7098518-01	1.1724592-02	1.8079880-01	1.7070595-05	2.5920006+01	3.2729445+01	1.0205945+0
65	6.8088174-07	1.7726362-01	1.1687222-02	1.8475651-01	1.8579804-05	2.6324469+01	3.3931245+01	1.0087449+0
66	6.7436904-07	1.8369771-01	1.1633171-02	1.9286141-01	2.0157109-05	2.6727978+01	3.5142838+01	9.6744476-C
67	6.6797694-07	1.9029063-01	1.1566518-02	1.9910837-01	2.1801007-05	2.71130812+01	3.6424835+01	9.6477809-C
68	6.6162587-07	1.9704568-01	1.1487474-02	2.0552148-01	2.3516276-05	2.7533223+01	3.7717865+01	9.67474593-C
69	6.5523648-07	2.0396625-01	1.1395208-02	2.1212604-01	2.5309270-05	2.79935445+01	3.9042579+01	9.6735387-C
70	6.4892914-07	2.1105561-01	1.1292264-02	2.1891536-01	2.7181947-05	2.8337714+01	4.0399640+01	9.5947117-0
71	6.4241872-07	2.1831797-01	1.1161738-02	2.2588167-01	2.9136771-05	2.8740258+01	4.1789741+01	9.40744895-C
72	6.3601617-07	2.2575642-01	1.1062434-02	2.3305849-01	3.1183450-05	2.9143284+01	4.3213585+01	9.43161051-0
73	6.2963242-07	2.3337496-01	1.0932358-02	2.4048111-01	3.3334538-05	2.9547003+01	4.4671902+01	9.3726478+0
74	6.2327045-07	2.4117752-01	1.0793708-02	2.4814013-01	3.5598117-05	2.9951630+01	4.6145444+01	9.3171938+0
75	6.1693569-07	2.4916813-01	1.0649307-02	2.5602508-01	3.780522-05	3.0357354+01	4.7794981+01	9.2495255-C
76	6.1040085-07	2.5735095-01	1.0497382-02	2.6417931-01	4.0505322-05	3.0764478+01	4.9241311+01	9.2291909-0
77	6.0423875-07	2.6573025-01	1.0335540-02	2.7246829-01	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	5.2507428+01	9.1484282-0
79	5.9150958-07	2.8309410-01	9.9911374-03	2.9048482-01	4.9276646-05	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	3.0997203-01	5.5802227-05	3.2827903+01	5.76474376+01	9.1174169-0
82	5.7206197-07	3.1073301-01	9.4191425-03	3.1989974-01	5.9536211-05	3.3247866+01	5.94795366+01	9.1088265-0
83	5.6538828-07	3.2038850-01	9.2153944-03	3.3047775-01	6.3540059-05	3.3670947+01	6.1377747+01	9.1019555-0
84	5.5869384-07	3.3027421-01	9.0047338-03	3.4148445-01	6.7846351-05	3.4097184+01	6.3250061+01	9.0975942-0
85	5.5204053-07	3.4039556-01	8.7849570-03	3.5370194-01	7.2492586-05	3.4527117+01	6.5157448+01	9.0847869-0
86	5.4548949-07	3.5075811-01	8.5580256-03	3.6501288-01	7.7503152-05	3.4960973+01	6.7141014+01	9.0730586-0
87	5.3899346-07	3.6136759-01	8.3261272-03	3.7750478-01	8.290327-05	3.5399087+01	6.9171848+01	9.0620445-0
88	5.3246360-07	3.7222992-01	8.0874230-03	3.9055245-01	8.8739714-05	3.5841803+01	7.1251081+01	9.0514751-0
89	5.2579116-07	3.8335118-01	7.8399768-03	4.0423444-01	9.5066669-05	3.6289485+01	7.3379879+01	9.0411714-0
90	5.1997780-07	3.9473745-01	7.5855356-03	4.1854143-01	1.0172240-04	3.6742528+01	7.5559440+01	9.0310718-0
91	5.1201028-07	4.0639577-01	7.3258538-03	4.3346354-01	1.0934697-04	3.7201352+01	7.7790999+01	9.02009532-0
92	5.0502037-07	4.1833218-01	7.0593686-03	4.4908453-01	1.1740605-04	3.7666385+01	8.0075831+01	9.0080248-0
93	4.9813686-07	4.3055376-01	6.7845741-03	4.6549220-01	1.2617509-04	3.8138078+01	8.2415246+01	9.0009141-0
94	4.9132652-07	4.4306754-01	6.5027630-03	4.8268653-01	1.3571239-04	3.8616905+01	8.4410595+01	9.0009105-0
95	4.8456457-07	4.5588080-01	6.2150687-03	5.0066872-01	1.4407908-04	3.9103360+01	8.7261268+01	9.0009092-0
96	4.7783430-07	4.6900102-01	5.92707185-03	5.1951269-01	1.5236052-04	3.9597947+01	8.9774899+01	9.0009090-0
97	4.7119302-07	4.8243593-01	5.6190836-03	5.3929599-01	1.6164808-04	4.0101176+01	9.23446369+01	9.0009090-0
98	4.6441946-07	4.9619347-01	5.3106603-03	5.6004839-01	1.6830181-04	4.0613552+01	9.4079794+01	9.0009090-0
99	4.5773637-07	5.1028182-01	4.9958293-03	5.8180538-01	1.7755238-04	4.1135554+01	9.7676542+01	9.0009090-01
100	4.5108401-07	5.2470945-01	4.6756698-03	6.0466554-01	2.1329696-04	4.1667614+01	1.0043823+02	9.0009090-01
101	4.4447868-07	5.3948503-01	4.3512932-03	6.2832502-01	2.3027780-04	4.2210061+01	1.0326653+02	9.0009090-01
102	4.3786213-07	5.5461754-01	4.0221234-03	6.5220022-01	2.4852596-04	4.2763057+01	1.0613315+02	9.0009090-01
103	4.3116281-07	5.7011621-01	3.6880084-03	6.7932254-01	2.6802094-04	4.3326529+01	1.0912985+02	9.0009090-01
104	4.2461689-07	5.8599058-01	3.3539573-03	7.0440369-01	2.8845793-04	4.3900027+01	1.1218488+02	9.0009090-01
105	4.1846056-07	6.0225047-01	3.0242511-03	7.3441040-01	3.0932824-04	4.4482524+01	1.1528089+02	9.0009090-01
106	4.1252852-07	6.1890597-01	2.6873942-03	7.64225611-01	3.32013950+04	4.5072144+01	1.1844904+02	9.0009090-01

NO.	MU	Y	K / UEZ	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	9.0009090-01
108	4.0150483-07	6.5344588-01	2.0433172-03	8.2284102-01	3.6708976-04	4.6258862+01	1.2508056+02	9.0009090-01
109	3.9672929-07	6.7135218-01	1.7736141-03	8.5181073-01	3.7843546-04	4.6844300+01	1.2850812+02	9.0009090-01
110	3.9245075-07	6.8969779-01	1.5027965-03	8.8008284-01	3.8144004-04	4.7412338+01	1.3201978+02	9.0009090-01
111	3.8859658-07	7.0849454-01	1.2511605-03	9.0008880-01	3.7291649-04	4.7949954+01	1.3561780+02	9.0009090-01
112	3.8525480-07	7.2775459-01	1.0251997-03	9.3385983-01	3.4875382-04	4.8441073+01	1.3930450+02	9.0009090-01
113	3.8251346-07	7.4749046-01	8.2729445-04	9.5531095-01	3.0435378-04	4.8867807+01	1.4208227+02	9.0009090-01
114	3.8040282-07	7.6771510-01	6.5341950-04	9.7220665-01	2.4708810-04	4.9213387+01	1.4495361+02	9.0009090-01
115	3.7897202-07	7.8844184-01	5.0089667-04	9.8428208-01	1.7707974-04	4.9466656+01	1.5092104+02	9.0009090-01
116	3.7797860-07	8.0968450-01	3.6368542-04	9.9249734-01	1.0718375-04	4.9627412+01	1.5498726+02	9.0009090-01
117	3.7717894-07	8.3145721-01	2.4543917-04	9.9812452-01	5.0305835-05	4.9708973+01	1.5815493+02	9.0009090-01
118	3.7671407-07	8.5377464-01	1.3553877-04	1.0010152+00	1.5156792-05	4.9737515+01	1.6342786+02	9.0009090-01
119	3.7627226-07	8.7665197-01	6.4332349-05	1.0010445+00	1.5160412-06	4.9741140+01	1.6780596+02	9.0009090-01
120	3.7691207-07	9.0010489-01	2.3371722-05	1.0001610+00	1.3761527-07	4.9740645+01	1.7229521+02	9.0009090-01
121	3.7695004-07	9.2414898-01	9.7158446-04	9.9999418+01	6.0822926-08	4.9740872+01	1.7689769+02	9.0009090-01
122	3.7693315-07	9.4880143-01	3.5751703-06	1.0000814+00	1.3399942-08	4.9740744+01	1.8161659+02	9.0009090-01
123	3.7693237-07	9.7407923-01	0.0000000	1.0000859+00	6.5998596-09	4.9740846+01	1.8645518+02	9.0009090-01
124	3.7694773-07	1.0000000+00	0.0000000	1.0000000+00	2.7640693-02	4.9740776+01	1.9141685+02	9.0009090-01

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

No.	F/O	Y(H)	Y(H2)	Y(H2O)	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
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
3	3.840-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.579-07
4	3.858-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.588-07
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	4.600-07
6	3.853-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.615-07
7	3.848-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.634-07
8	3.843-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.654-07
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	4.683-07
10	3.828-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.713-07
11	3.818-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.747-07
12	3.807-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.785-07
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	4.828-07
14	3.782-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.875-07
15	3.747-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.926-07
16	3.750-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.982-07
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	5.044-07
18	3.712-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.111-07
19	3.691-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.185-07
20	3.648-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.263-07
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	5.347-07
22	3.618-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.435-07
23	3.591-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.528-07
24	3.542-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.626-07
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	7.631-01	5.729-07
26	3.500-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.836-07
27	3.466-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.949-07
28	3.431-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.066-07
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	7.641-01	6.188-07
30	3.356-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.314-07
31	3.317-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.444-07
32	3.275-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.579-07
33	3.232-02	1.008-10	5.840-03	2.291-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.653-01	6.727-07
34	3.188-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.864-07
35	3.141-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.014-07
36	3.093-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.168-07
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	7.667-01	7.329-07
38	2.991-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.502-07
39	2.937-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.692-07
40	2.880-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.876-07
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	7.683-01	8.033-07
42	2.762-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.177-07
43	2.699-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.327-07
44	2.635-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.440-07
45	2.572-02	1.008-10	2.014-10	2.240-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.702-01	8.475-07
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
47	2.448-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.294-07
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
49	2.336-02	1.008-10	2.014-10	2.040-01	1.600-09	1.701-09	3.200-09	1.401-09	3.001-09	7.720-01	8.014-07
50	2.283-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.879-07
51	2.233-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.707-07
52	2.185-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.544-07

No.	F/O	Y(H)	Y(H2)	Y(H20)	Y(O)	Y(OH)	Y(O2)	Y(N)	Y(N0)	Y(N2)	MU	PR
53	2.138-02	1.008-10	2.016-10	1.871-01	1.800-09	8.949-09	3.944-02	1.401-09	3.385-06	7.735-01	0.000	7.660-07
54	2.094-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.560-07
55	2.051-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.502-07
56	2.010-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.428-07
57	1.970-02	1.008-10	2.016-10	1.756-01	1.600-09	1.701-09	5.263-02	1.401-09	1.939-06	7.747-01	0.000	7.354-07
58	1.931-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.283-07
59	1.892-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.214-07
60	1.854-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.144-07
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	0.000	7.078-07
62	1.781-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.010-07
63	1.745-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.942-07
64	1.710-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.875-07
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	5.162-07	7.770-01	0.000	6.809-07
66	1.640-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.744-07
67	1.605-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.680-07
68	1.573-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.616-07
69	1.535-02	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	0.000	6.552-07
70	1.506-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.488-07
71	1.474-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.424-07
72	1.441-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.360-07
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	0.000	6.296-07
74	1.377-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.233-07
75	1.345-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.169-07
76	1.313-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.104-07
77	1.281-02	1.008-10	2.016-10	1.139-01	1.600-09	1.701-09	1.070-01	1.401-09	3.482-08	7.800-01	0.000	6.042-07
78	1.249-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.979-07
79	1.217-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.915-07
80	1.185-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.851-07
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	0.000	5.786-07
82	1.122-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.721-07
83	1.090-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.654-07
84	1.058-02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.587-07
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	0.000	5.521-07
86	9.931-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.455-07
87	9.607-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.390-07
88	9.281-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.325-07
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	0.000	5.258-07
90	8.625-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.190-07
91	8.294-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.122-07
92	7.961-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.050-07
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	0.000	4.981-07
94	7.289-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.913-07
95	6.947-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.844-07
96	6.604-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.774-07
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	0.000	4.711-07
98	5.908-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.644-07
99	5.555-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.577-07
100	5.199-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.511-07
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	0.000	4.445-07
102	4.476-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.379-07
103	4.109-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.312-07
104	3.739-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.246-07
105	3.368-03	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	0.000	4.185-07
106	2.993-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.120-07

NO.	F/O	Y(H)	Y(H2)	Y(H20)	Y(O)	Y(OH)	Y(O2)	Y(N)	Y(N0)	Y(N2)	MU	PR
107	2.61R-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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
109	1.882-03	1.000-10	2.016-10	0.000	1.679-02	1.701-04	1.600-09	1.947-01	1.947-01	1.401-09	3.001-09	0.000
110	1.528-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
111	1.192-03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
112	8.034-04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
113	6.112-04	1.000-10	2.016-10	0.000	5.458-03	1.701-04	1.600-09	2.050-01	2.050-01	1.401-09	3.001-09	0.000
114	3.852-04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
115	2.132-04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
116	9.719-05	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
117	3.237-05	1.000-10	2.016-10	0.000	2.893-04	1.701-04	1.600-09	2.097-01	2.097-01	1.401-09	3.001-09	0.000
118	5.482-06	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120	3.464-09	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
121	0.000	1.000-10	2.016-10	0.000	2.438-06	1.701-04	1.600-09	2.100-01	2.100-01	1.401-09	3.001-09	0.000
122	3.592-11	1.000-10	2.016-10	0.000	2.438-06	1.701-04	1.600-09	2.100-01	2.100-01	1.401-09	3.001-09	0.000
123	0.000	1.000-10	2.016-10	0.000	2.438-06	1.701-04	1.600-09	2.100-01	2.100-01	1.401-09	3.001-09	0.000
124	0.000	1.000-10	2.016-10	0.000	2.438-06	1.701-04	1.600-09	2.100-01	2.100-01	1.401-09	3.001-09	0.000

NO. ITERATIONS = 2

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3. Suehla, Roger A., "Estimated Viscosities and Thermal Conductivities of Gases at High Temperature," NASA TR R-132, 1962.
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),
|      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),YTYILP,|YTYILF,      /YTABLE/
|      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/
|      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/
|      EPSLN3,CQVVRG,02DY,04DY,0DYSQ      /CONST/
COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMORI/
C
DIMENSION SUBR(3)
DATA SUBR/6HMMONTH,6HENERGY,6HELFMYS/
C
INCREMENT Y-COUNTERS.
NY=NY+1
NY1=NY-1
NY2=NY-2
C
EXTEND EDGE PROPERTIES TO NEW POINT.
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

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C   EXTEND RHOV USING 3-POINT DERIVATIVE APPROXIMATION AT EDGE.
C
C    $RHOV(NY) = RHOV(NY1) + (RHOV(NY2-1) - 4 * RHOV(NY2) + 3 * RHOV(NY1)) / 2$ 
C
C   CALCULATE E AND F AT NY.
C
C    $E(NY) = RHO(NY,JA) * RGP(NY) * ZETA * YTIL(NY) / ZETA$ 
C    $F(NY) = BGP(NY) / (ZETA * ZETA * REYINF)$ 
C
C   CALCULATE APPROPRIATE SIGMAS FOR PUSH-DOWN STORAGE AT NY - 2.
C
C   NY3=NY2-1
C   GO TO (1100,1200,1300), IFLAG
C
C   CALCULATE SIGMA1 FOR MOMENTUM EQUATION.
C
C   1100 SIG1(1) = SMU(NY3,JA) + EPS(NY3,JA)
C       SIG1(1) = SMU(NY2,JA) + EPS(NY2,JA)
C       GO TO 1400
C
C   CALCULATE SIGMA2, SIGMA3, AND SIGMA4 FOR ENERGY EQUATION.
C
C   1200 DO 1250 K=NY3,NY2
C         L=K-NY3+1
C         TM1 = EPS(K,JA)
C         TM2=SMU(K,JA)/PR(K,JA)
C         TM3=TM1/PRT(K,JA)
C         SIG2(L)=TM2+TM3
C         SIG3(L)=SMU(K,JA)-TM2+TM1-TM3
C   1250 SIG4(L) = TM2*(BLE(K,JA) - 1.0) + TM3*(BLET(K,JA) - 1.0)
C         GO TO 1400
C
C   CALCULATE SIGMAS FOR ELEMENT EQUATION.
C
C   1300 DO 1350 K=NY3,NY2
C         L=K-NY3+1
C   1350 SIG5(L) = SMII(K,JA)*BLE(K,JA)/PR(K,JA)+EPS(K,JA)*
C             BLET(K,JA)/PRT(K,JA)
C   1400 WRITE (6,9000) SUBR(IFLAG),ISTATN,ITER
C   9000 FORMAT (/49H POINT WAS ADDED TO BOUNDARY LAYER IN SUBROUTINE ,A6,
C             /I1H AT STATION,15,14H AND ITERATION,13/)
C       RETURN
C     END

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SUBROUTINE ANSWER

```

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/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(3,105),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 NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),
A 2
/PPOINTS/
/PPOINTS/
/PPOINTS/
/MISC/
/MISC/
/MISC/
/MISC/

```

```

4 RTEMP(15),FOX(15),DENS(15),PLN
COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,
1 JSOL,JL10,IC,IQ2
COMMON/OUTRHO/DEN(13)
/MISC/
/INDX/
/INDX/

```

```

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))

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```

C
C CALCULATE VISCOSITY, PRANDTL NUMBER, AND THERMAL CONDUCTIVITY.
C

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```

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) = 1.3488381166*DEN(I)
RETURN
END

```

A 196-

```

BLOCK DATA
C
DIMENSION ATAM(3,51),ATEM(3,54),DATE(2,30)
C
COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),
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),PFCWT(15),ENTH(15),FAZ(15), /MISC/
4 RTEMP(15),FOX(15),DENS(15),TLN /MISC/
COMMON /INDX/ CONV,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
ATOMIC SYMBOLS, WEIGHTS, AND VALENCES
C
MODIFIED FOR DUMMY ELEMENTS (4) H C N O , (101+4)=105 ELEMENTS
C
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 19 219.000,-1.,2HNE,20.183,0.,2HNA,22.991,1.,2HMG,24.320,2.,2HAL,26.98
A 20 30.3,2HSL,28.090,4.,2HP,30.975,5.,2HS,32.066,4.,2MCL,35.457,-1.,
A 21 42HAR,39.944,0.,2HK,39.100,1.,2HCA,40.080,2.,2HSC,44.960,3.,2HTI,4
A 22 57.900,4.,2HV,50.950,5.,2HR,52.010,3.,2HMN,54.940,2.,2HFE,55.850,
A 23 63.,2HCO,58.940,2.,2HNI,58.710,2.,2HCU,63.540,2.,2HZN,65.380,2.,2HG
A 24 7A,69.720,3.,2HGE,72.600,4.,2HAS,74.920,3.,2HSE,78.960,4.,2HRR,79.9
A 25 816,-1.,2HKR,83.800,0.,2HRR,85.480,1.,2HSR,87.630,2.,2HY,88.910,3.
A 26 9.2HZR,91.220,4.,2HNR,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 12.410,2.,2HIN,114.820,3.,2HSN,118.700,4.,2HSB,121.760,3./
A 29 DATA ATEM/2HTE,127.610,4.,2HT,126.910,-1.,2HXE,131.300,0.,2HCS,13
A 30 12.910,1.,2HRA,137.360,2.,2HLA,138.920,3.,2HCE,140.130,3.,2HPR,140.
A 31 2910,3.,2HND,144.270,3.,2HPM,147.000,3.,2HSM,150.350,3.,2HEU,152.00
A 32 30,3.,2HGD,157.260,3.,2HTA,158.930,3.,2HNY,162.510,3.,2HMO,164.940,
A 33 43.,2HER,167.270,3.,2HTM,168.940,3.,2HYR,173.040,3.,2HLU,174.990,3.
A 34 5.2HMF,178.500,4.,2HTA,180.950,5.,2HW,183.860,6.,2HRE,186.220,7.,2
A 35 4HOS,190.200,4.,2HIR,192.200,4.,2HPT,195.090,4.,2HAU,197.000,3.,2HH
A 36 7G,200.610,2.,2HTL,204.390,1.,2HPR,207.210,2.,2HBI,208.990,3.,2HPO,
A 37 210.000,2.,2HAT,210.000,0.,2HRN,222.000,0.,2HFR,223.000,1.,2HRA,22
A 38 96.000,2.,2HAC,227.000,3.,2HTM,232.000,4.,2HPA,231.000,5.,2HU,238.
A 39 50,3.,2HNP,237.000,5.,2HPU,242.000,4.,2HAM,243.000,3.,2HCM,247.00
A 40 50,3.,2HRK,249.000,3.,2HCF,251.000,3.,2HES,254.000,0.,2HFM,253.000,
A 41 6.0.,2HMO,256.000,3.,
C DUMMY H C N O
C A 2HZ,1.008,1., 2HCZ,12.011,4., 2HNZ,14.008,0., 2HOZ,16.000,-2./
A 43

```

C
C
C

NOMINAL ODE THERMAL DATA AND REACTANTS DATA

DATA (SUB(1,1), I=1,6)/4HH ,4HH2 ,4HH2O ,4HO ,4HOH ,4HO2 /,
1 (DATE(1,1),DATE(2,1), 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(1,J),B(1,J),
3 I = 1,4), J = 1,6)/2HH ,1.0,2H ,0.0,2H ,0.0,2H ,0.0,2H ,2.0,
4 2H ,0.0,2H ,0.0,2H ,0.0,2H ,2.0,2H ,1.0,2H ,0.0,2H ,0.0,
5 2H ,1.0,2H ,0.0,2H ,0.0,2H ,0.0,2H ,1.0,2H ,1.0,2H ,0.0,
6 2H ,0.0,2H ,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 ,2.0,2H ,2.0/, PECWT(1), PECWT(2)/2*100.0/
A ,MOLES/.FALSE./, ENTH/15*0.0/, FAZ/15*1HG/,
B RTEMP(1), RTEMP(2)/2*298.15/, FOX(1), FOX(2)/1HF, 1HO/, DENS(1),
C DENS(2)/2*0.0/, NSPEC/2/, NPROD/6/, I THERM/O/, (SUB(1,2), SUB(1,3),
D I = 1,6)/12*4H /, (NAME(1,1), NAME(2,1), I = 2,5)/8*2H /
DATA ((COEF(I,J,K), J = 1,7), I = 1,2), K = 1,6)/8*50,4*0.0,
1 25471.627,-0.46011763,2.50,4*0.0,25471.627,-0.46011762,3.1001901,
2 5.1119464E-4,5.2444210E-8,-3.4909973E-11,3.6946349E-15,-877.38042
3,-1.9629421,3.0574451,2.476520E-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-3,4.1571180E-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-3,2.4210316E-6,-1.6028432E-9,3.8906964E-13,29147.644,

NEW
-01

A 2.9639949,2.9106427,9.5931650E-4,41.9441702E-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),XTARTW(100),LTWTAB,ITWRP,
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         YZETA,YEDGE      /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMOWN
COMMON /EDGEBC/ TEDGE,SMEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,    /EDGEBC/
1         DUEDS,DUEDSN,DPEDSN  /EDGEBC/
COMMON/NORMAL/BLRFF,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,CPETAB,
i          CPEX,IPEXP)
C
C  OBTAIN SHEDGE.
C
C  SHEDGE=HEDGE-UEDGE+UEDGE/2.
C  IF(IDEAL.GT.0)GO TO 300
C
C  CALL HOODE TO OBTAIN SHWALL AND HWALL.
C
C  CALL HOODE (3)
C  RETURN

```

```

C
C  CALL IGODE TO OBTAIN SHWALL AND HWALL.
C
300 CALL IGODE (TWALL,SHWB,PEDGEB,I,DUMMY1,DUMMY2,DUMM?3)
C  SHWALL=SHWB/(UREF+UREF)
C  HWALL=SHWALL
C  RETURN
C  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),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),
i          SHI(250,2,6),SCI(250,2,6),TY(250,3),AV(250)
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,          /YTABLE/
i          CYTIL(6)          /YTABLE/
COMMON/GEOM /RW(2),DRWDX(2),THW(2)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,          /ZCALC/
i          YTZETA,YEDGE          /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
i          EPSLN3,CONVRG,02DY,04DY,0DYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NELI,NSP,NMAX,NYI
COMMON/NEWII /J2D,UEK,RHOEK

```

```

C
C INITIAL CONDITION - AT WALL RHOV = MDOTW
C
C RHOV(1)=SMDW
C
C INITIALIZE PUSH-DOWN STORAGE.
C
C RUMNI=RHO(1,J0)*U(1,J0)
C RUMINI=RHO(1,JN)*U(1,JN)
C RWAVE=0.5*(RW(1)+RW(2))
C DRWDS=0.5*(SIN(THW(1))+SIN(THW(2)))
C DO 100 I=2,NY
C RUMN=RHO(1,J0)*U(I,J0)
C RUMIN=RHO(1,JN)*U(I,JN)
C DRUDS=(RUMIN+RUMINI-RUMN-RUMNI)/(2.*DS)
C DRUDY=(RUMIN+RUMN-RUMINI-RUMNI)*0.2DY
C RUMHMH=0.25*(RUMIN+RUMINI+RUMN+RUMNI)
C GPNH=0.5*(BGP(I-1)+BGP(I))
C YTNH=0.5*(YTIL(I-1)+YTIL(I))
C RHOV(I)=RHOV(I-1)+DY*(-DRUDS/GPNH-FLOAT(J2D)*RUMHMH*DRWDS/
C | (GPNH*RWAVE)+ZETAP/ZETA*YTNH*DRUDY)
C
C PUSH-DOWN STORAGE.
C
C RUMNI=RUMN
C 100 RUMINI = RUMIN
C RETURN
C END

```

```

SUBROUTINE CPHS
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),
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 NAME(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
A 1
A 12
J = 1
K=1
IF (TT,LE,TMID) K=2
A 13
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+
    COEF(K,2,J)*TT+COEF(K,1,J)*TLN+COEF(K,7,J)      A 22
    HO(J)=(((COEF(K,5,J)/5.)*TT+COEF(K,4,J)/4.)*TT+COEF(K,3,J)/3.)*TT
    +COEF(K,2,J)/2.)*TT+COEF(K,1,J)+COEF(K,6,J)/TT  A 23
    CPSUM=CPSUM+(((COEF(K,5,J)*TT+COEF(K,4,J)*TT+COEF(K,3,J)*TT+COE
    F(K,2,J)*TT+COEF(K,1,J))*EN(J,NPT)              A 24
    IF (KK.EQ.0) GO TO 40                A 25
    K=KK                                  A 26
    KK=0                                  A 27
40  IF (J.EQ.NS) RETURN                 A 28
    J=J+1                                 A 29
    GO TO 20                              A 30
    END                                    A 31

```

SUBROUTINE CPSPFC (TMPR,NNPT)
 THIS ROUTINE HAS BEEN MODIFIED FROM ONE SUBROUTINE CPMS TO
 CALCULATE CP FOR EACH SPECIES (IN CAL/MOL-DEG K) AND CPBAR
 (IN CAL/GM-DEG K).

```

COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
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),
BOP(15,2),YM,TLOW,THID,THIGH,PP,CPSUM,OF,EQRAT,
HSURQ,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),
NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),
RTEMP(15),FOX(15),DENS(15),TLN
COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,
JSOL,JLIQ,IC,IQ2
COMMON/CP1 /CP1(30),CPBAR

```

```

C
J=1
K=1
IF (TMPR.LE.TMID) K=2
KK=0
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 12
    IF (IUSE(J).LT.0) GO TO 40          A 13
    KK=K                                A 14
    K=1                                  A 15
    IF (KK.EQ.1) K=2                    A 16

```

```

30 CPI(J) = COEF(K,1,J) + COEF(K,2,J)*TMPR + COEF(K,3,J)*TMPR**2 +
      COEF(K,4,J)*TMPR**3 + COEF(K,5,J)*TMPR**4
      CPI(J) = 1.987165J*CPI(J)
      CPBAR=CPBAR+CPI(J)*EN(J,NNPT)
      IF (KK.EQ.0) GO TO 40
      K=KK
      KK=0
40 IF (J .EQ. NS) RETURN
      J=J+1
      GO TO 20
      END

```

A 28
A 29
A 30
A 32
A 33
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 ,A6,11H AT STATION,15,
      14H AND ITERATION,13)
      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),SIG5S(3)
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NELI,NSP,HMAX,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),
      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),
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),
SIG5S(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),
SMI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
COMMON/TPROP /EPS(250,3),PRT(250,3),RLET(250,3)
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),YTYILP,YTYILF, /YTABLE/
CYTIL(6) /YTABLE/
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA, /ZCALC/
YTZETA,YEDGE /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMOWO,SMOW,SMOWN
COMMON /EDGEBC/ TEDGF,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUEDSO, /EDGEBC/
DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
EPSLN3,CONVRG,02DY,04DY,0DYSQ
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

```

NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW

C
C**** FIND SDELTA AT U=0.995 *UE FOR P.W. MW=0, NEW LAMDA, JULY 12,1973 ****

DO 35 K=1,NY
I=NY+1-K
SX1=ABS(U(I,JN)-UEDGE)/UEDGE
IF(SX1.GE.0.005) GO TO 30
SX2=SX1
GO TO 35
30 TDELTA=Y(I+1)-DY*(SX2-0.005)/(SX2-SX1)
GO TO 38
35 CONTINUE
38 CALL XNTERP(TDELTA,SDELTA,DUMMY1,IYTILP,Y,YTIL,NY,CYTIL,IYILF)

C
DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSN

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.0.0050) 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,IYILF)
IYILF=IYTILP

C
C CALCULATE TURBULENT TRANSPORT PROPERTIES AT EACH MESH POINT.

C
EPS(I,JN)=0.
PRT(I,JN) = 13.60/(11.440*SQRT(PR(I,JN)))
T1=REY|NF*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
130 THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF(SHOWN.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(T1+ZETAN**2*SMU(I,JN)/
      (BGP(I)*DERIV))
      TM4=DPEOSN/(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)
      CUV(I,JN) = BRKT
      CUV(I,JN) = 0.160*T1*BGP(I)*YTIL(I)*YTIL(I)*RHO(I,JN)*
      ABS(02DY*(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*
      SQRT(PRT(I,JN)*BRKT/34.0))
      I = 2
C
C CALCULATE TEMPORARY QUANTITIES
C
10 UYMN = (U(I+1,JN) - U(I-1,JN))*02DY
      RHOP = (RHO(I+1,JN) - RHO(I-1,JN))*02DY
      UUYMN = (CUU(I+1,JO) - 2.0*CUU(I,JO) + CUU(I-1,JO))*0DYSQ
      CUYMN = (CUU(I+1,JO) - CUU(I-1,JO))*02DY
      SMUY = (SMU(I+1,JN) - SMU(I-1,JN))*02DY

      ALFA = 0.10/ZK
      T2 = RHO(I)*BGP(I) - U(I,JN)*E(I)
      GAMA=0.360 + 42.0*ZETAN*SMDWN/(RHO(NY,JN)*U(NY,JN))
C *..... DISSIPATION LENGTH MODIFIED MAY 9,1973 *..... NEW
      SLS = YTIL(I)/DELTA NEW
      SLS2 = SLS*SLS NEW
      BN = YTIL(I)*(0.250*SLS2-0.5860*SLS+0.4310) NEW
      BRKT = 2.0 *EPS(I,JO)*F(I)*BGP(I)*UYMN**2 *01
      TM1 = F(I)*BGP(I)*EPS(I,JO)*ALFA
      DERIV = 02DY*(EPS(I+1,JO) - EPS(I-1,JO))
      TM2 = F(I)*(EPS(I,JO)*BGPP(I)/BGP(I) + BGP(I)*DERIV)*ALFA
      TM3 = (EPS(I,JO)/(ZK*T1*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) - 0.50*0DYSQ*TM1
      A(I-1,2) = RHO(I,JN)*U(I,JN)/DS + 0DYSQ*TM1
      A(I-1,1) = -A(I-1,3) - 0DYSQ*TM1
      B(I-1) = TM4 + RHO(I,JN)*U(I,JN)/DS*CUU(I,JO) - 0.50*(T2 - TM2)*
      CUUYMN + 0.50*UUYMN*TM1
      I = I + 1
      IF (I .LE. NY1) GO TO 10
      A(I,1) = 0.0
      A(NY2,3)=0.0
      CALL TRIM(A, CUU(2,JN), B, NY2, NMAX)

```

```

CUU(I,JN) = 0.0
CUU(NY,JN) = 0.0
CUV(I,JN) = 0.0
DO 1000 I=2,NY1
C ..***** DISSIPATION 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.C.0) CUU(I,JN) =0.0 NEW
EPS(I,JN) = BN*ZK*RHO(I,JN)*SQRT(ABS(CUU(I,JN)))*REYINF*ZETAN NEW
IF (CUV(I,JN) .LE. EPS(I,JN)) EPS(I,JN) = CUV(I,JN) -01
1000 CONTINUE
EPS(I,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
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 NEW
400 EPS(I,JN) = EPS(I,JA) -01

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 ALPHA(I+4,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),
  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),IYVILP,IYVILF, /YTABLE/
  CYTIL(6) /YTABLE/
COMMON/MATRIX /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/
  YZETA,YEDGE /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDEGE,AFEDGE,DUEDSO, /EDGEBC/
  DUEDS,DUEDSN,OPEDSN /EDGEBC/
COMMON/NORMAL/BLREF,UREP,RHOREF,SMUREF,REYINF
COMMON/CONST /SINI,T,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
  EPSLN3,CONVRG,O2DY,O4DY,O0YSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/NEW3 /AFTRNS,PLAW
  
```

C FOR EACH ELEMENT EXCEPT LAST, EVALUATE COEFFICIENTS OF SYSTEM OF
 C ELEMENT CONSERVATION EQUATIONS.

```

C
C
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 CALCULATE TEMPORARY QUANTITIES.

```

C
C
100 BE = E(I)
BF=F(I)
SIG5(3)=SMU(I+1,JA)*BLE(I+1,JA)/PR(I+1,JA)+
  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))*
  O0YSQ
TERM=BF*BGP(I)*SIG5(2)*O0YSQ
THI=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 ALPHA(M+1,N-1)
C
      A(I-1,1)=0.4DY*(BE*U(I,JQ)-TM2+BF*TM1)-0.5*TERM
C
C      COEFF. OF ALPHA(M+1,N)
C
      A(I-1,2)=TM3+TERM
C
C      COEFF. OF ALPHA(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,JQ,IEL)-0.5*TM2*AYMN+
      I      0.5*BF*(TM1*AYMN+BGP(I)*SIG5(2)*AYMN)+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(I,JA)/(BGP(I)*SMU(I,JA)*BLE(I,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 ALPHA(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 ALPHA(M+1,1) AND ALPHA(M+1,NY)
C
      ALPHA(1,JN,IEL)=(4.*ALPHA(2,JN,IEL)-ALPHA(3,JN,IEL)+2.*DY*BIGA*
      I      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 ADAPT (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,NEL
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,OX,Y(250),DY
COMMON/PROP /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
COMMON /YTABLE/ YTIL(250),BGP(250),BGRP(250),IYTILP,IYTILF, /YTABLE/
COMMON/MATRX /A(250,3),B(250) /YTABLE/
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,SHDWO,SHDW,SHDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEEDGE,UEEDGE,PEEDGE,AFEDGE,DUEDSO, /EDGEBC/
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2, /EDGEBC/
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 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*(RLET(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,JO)-U(I-1,JO))*02DY
    UYYMN = (U(I+1,JO)-2.*U(I,JO)+U(I-1,JO))*0DY5Q
    HYMN = (H(I+1,JO)-H(I-1,JO))*02DY
    HYYMN = (H(I+1,JO)-2.*H(I,JO)+H(I-1,JO))*0DY5Q
    TERM = BF*BGP(I)*SIG2(2)*0DY5Q
    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)*0DY5Q*U(I,JO)

    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,JO)-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,JO)+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+
    i      TERMU

C
C   COEFF. OF U(M+1,N+1)
C
    COEFF3 = -COEFF1-TERMU

```



```

C
C   EVALUATE SUMMATION OVER SPECIES
C
C   SUMSP=0.
C   DO 150 ISP=1,NSP
C
C   STORE TEMPORARY AVERAGES.
C
C   SHIMIA=0.5*(SHI(I-1,JO,ISP)+SHI(I-1,JN,ISP))
C   SHIA =0.5*(SHI(I ,JO,ISP)+SHI(I ,JN,ISP))
C   SHIPJA=0.5*(SHI(I+1,JO,ISP)+SHI(I+1,JN,ISP))
C   SCIMIA=0.5*(SCI(I-1,JO,ISP)+SCI(I-1,JN,ISP))
C   SCIA =0.5*(SCI(I ,JO,ISP)+SCI(I ,JN,ISP))
C   SCIPJA=0.5*(SCI(I+1,JO,ISP)+SCI(I+1,JN,ISP))
C   SHIY=02DY*(SHIPJA-SHIMIA)
C   SCIY=02DY*(SCIPJA-SCIMIA)
C   SCIYY=0DYSQ*(SCIPJA-2.*SCIA+SCIMIA)
150 SUMSP = SUMSP + SHIA*SCIY*(BGP(I)*SIG4Y + BGPP(I)*SIG4(2)/BGP(I))
C   I      + BGP(I)*SIG4(2)*(SHIY*SCIY + SHIA*SCIYY)
C
C   ASSEMBLE ALL TERMS.
C
C   B(I-1)=TM3*H(I,JO)-0.5*(TM2*HYMN-BF*(TM1*HYMN+BGP(I)*SIG2(2)*
C   I      HYMN))+BF*SUMSP*COEFF1*U(I-1,JN)-COEFF2*U(I,JN)-
C   2      COEFF3*U(I+1,JN)
C
C   PUSH-DOWN STORAGE
C
C   SIG2(1)=SIG2(2)
C   SIG2(2)=SIG2(3)
C   SIG3(1)=SIG3(2)
C   SIG3(2)=SIG3(3)
C   SIG4(1)=SIG4(2)
C   SIG4(2)=SIG4(3)
C   I=I+1
C   IF (I .LE. NY1) GO TO 400
C
C   MODIFY FIRST AND LAST ENERGY EQUATIONS BY BOUNDARY CONDITIONS.
C   AT WALL   H = HW
C   AT EDGE   H = HE
C
C   IF(INCRMT.GT.0)GO TO 250
C   B(1)=B(1)-A(1,1)*HWALL
C   A(1,1)=0.
250 B(NY2) = B(NY2) - A(NY2,3)*HEDGE
C   A(NY2,3)=0.
C
C   SOLVE ENERGY EQUATIONS FOR H(M+1,N), N=2,3,...,NY-1
C
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
C   H(1,JN)=HWALL
C   H(NY,JN)=HEDGE

```

```

C
C   CALCULATE SH(M+1,N) FROM H(M+1,N), N=1,..,NY
C
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
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
C   INCRMT=INCRMT+1
IF(INCRMT.GT.5)CALL DEBUG (6HENERGY)
IF(NY.EQ.NMAX)CALL DEBUG (6HENERGY)
CALL ADPPT (2)
I=NYI-1
GO TO 100
END

```

```

SUBROUTINE EQLBRM .
ROUTINE TO CALCULATE EQUILIBRIUM COMPOSITION AND PROPERTIES
DOUBLE PRECISION X,G
DATA IE /IHE/
DIMENSION PROW(15)
LOGICAL CONVG,HP,IC,ISING,LOGV,TP
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/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),
1 BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,
2 HSURD,HPP(2),RHO(2),VMIN(2),VPLS(2),*P(2),
3 NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),
4 RTEMP(15),FOX(15),DENS(15),TLN
COMMON /DOUBLE/ G(20,21),X(20)
COMMON /INDX/ CONVG,TP,HP,SP,HOLES,NP,NPT,L,NS,KHAT,IMAT,IQI,NC,
1 JSOL,JLIQ,IC,IQ2

```

A	1
A	2
A	3
A	4
A	9
/POINTS/	
/POINTS/	
/POINTS/	
/MISC/	
/MISC/	
/MISC/	
/MISC/	
/MISC/	
A	20
/INDX/	
/INDX/	
A	28

	CRITY = 5.0E-6	A	30
	ISING=.FALSE.	A	31
	ENNL=ALOG(ENN)	A	32
	LOGV=.FALSE.	A	33
	PPLN=ALOG(PP)	A	34
	TLN=ALOG(TT)	A	35
	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		A 107
	WRITE (6,750)		A 108
	IC=.TRUE.		A 109
	GO TO 630		A 110
160	IF (.NOT.HP.OR.NPT.NE.1.OR.NC.EQ.0.OR.TT.GT.100.) GO TO 170		A 111
	WRITE (6,760)		A 113
	GO TO 690		A 114
170	WRITE (6,770)		A 115
	IF (IC) GO TO 690		A 116
	IF (ISING) GO TO 240		A 117
	NTZERO=0		
180	DO 220 JJ=1,NS		
	IF (IUSE(JJ)) 220,200,190		
	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		
240	IF (NTZERO.NE.(L-1)) GO TO 690		A 131
	IF (EQRAT.GT.1.00701.OR.EQRAT.LT.0.99999) GO TO 690		A 132
	ENN=0.		A 133
	NEN=0		A 134
	DO 260 I=1,L		A 135
	JEN=0		A 136
	DO 250 J=1,NS		A 137
	THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.		A 138
	IF (EN(J,NPT).EQ.?) 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
	AMBDAI=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
	SUMI=(-9.212-ENLN(J)+ENNL)/(DELN(J)-X(IQ1))	A 187
	IF (SUMI.LT.0.) SUMI=-SUMI	A 188
	IF (SUMI.LT.AMBDAI) AMBDAI=SUMI	A 189
330	CONTINUE	A 190
	IF (SUM.GT.2.) AMBDA=2./SUM	A 191
	IF (AMBDAI.LT.AMBDA) AMBDA=AMBDAI	A 192

C		A 204
C	APPLY CORRECTIONS TO ESTIMATES	A 205
C		A 206
	SUM = 0.0	
	DO 380 J=1,NS	A 208
	IF (IUSE(J)) 380,360,370	A 209
360	ENLN(J)=ENLN(J)+AMBDA*DELN(J)	A 210
	EN(J,NPT)=0.	A 211
	IF (ENLN(J) + 18.50 .LE. ENNL) GO TO 380	
	EN(J,NPT)=EXP(ENLN(J))	A 213
	SUM=SUM+EN(J,NPT)	A 214
	GO TO 380	A 215
370	EN(J,NPT)=EN(J,NPT)+AMBDA*DELN(J)	A 216
380	CONTINUE	A 217
	SUMN=SUM	A 218
	IF (TP) GO TO 390	A 219
	TLN=TLN+AMBDA*DLNT	A 220
	TT=EXP(TLN)	A 221
390	ENNL=ENNL+AMBDA*X(IQ1)	A 222
	ENN=EXP(ENNL)	A 223
	IF (LLMT(L).NE.IE) GO TO 420	A 224
C		A 225
C	CHECK ON REMOVING IONS	A 226
C		A 227
	DO 400 J=1,NS	A 228
	* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.	
	IF (A(L,J).EQ.0.) GO TO 400	A 229
	IF (EN(J,NPT).GT.0.) GO TO 420	A 230
400	CONTINUE	A 231
	DO 410 J=1,NS	A 232
	* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.	
	IF (A(L,J).NE.0.) IUSE(J)=-10000	A 233
410	CONTINUE	A 234
	L=L-1	A 235
	IQ1=IQ1-1	A 236
	GO TO 40	A 237
C		A 238
C	TEST FOR CONVERGENCE	A 239
C		A 240
420	IF (ITNUMB.EQ.0) GO TO 440	A 241
	IF (NUMB.EQ.1) GO TO 40	
	IF (AMBDA.LT.1.) GO TO 40	A 242
	SUM=(ENN-SUMN)/ENN	A 243
	IF (SUM.LT.0.) SUM=-SUM	A 244
	IF (SUM .GT. CRITV) GO TO 40	
	DO 430 J=1,NS	A 246
	IF (IUSE(J).LT.0) GO TO 430	A 247
	AA=DELN(J)/SUMN	A 248
	IF (AA.LT.0.) AA=-AA	A 249
	IF (IUSE(J).EQ.0) AA=AA+EN(J,NPT)	A 250
	IF (AA .GT. CRITV) GO TO 40	

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 (INC.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= Q1 -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 (TY.LT.TMELT) GO TO 560	A 304
*	THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.	
	IF (TP.AND.TY.EQ.TMELT) GO TO 560	A 305
	IF (TP) GO TO 530	A 306
	IF (TY.GE.TMELT+150.) GO TO 530	A 307
	JSOL=JKG	A 308
	JLIQ=J	A 309
520	TLN=ALOG(TMELT)	A 310
	TY=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 (TY.LT.TEMP(INC,1).AND.TEMP(INC,1).NE.TLOW) GO TO 560	A 323
	IF (TY.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.SIZFF.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(IJ)-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

	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(IQI)	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
	IQI=IQI+1	A 371
	GAMMAS(NPT)=-1./DLVPT(NPT)	A 372
	GO TO 680	A 373
670	GAMMAS(NPT)=-1./((DLVPT(NPT)+(DLVPT(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 (96HLOW TEMPERATURE IMPLIES CONDENSED SPECIES SHOULD HAVE BEEN INCLUDED ON AN INSERT CARD, RESTART)	A 396 A 397
770	FORMAT (16HOSINGULAR MATRIX)	A 398
780	FORMAT (8HORESTART)	A 399
840	FORMAT (//2X,65HIQU ITERATIONS DID NOT SATISFY CONVERGENCE REQUIRE MENTS FOR POINT,13)	
860	FORMAT (50H03 PHASES OF A CONDENSED SPECIES ARE OUT OF ORDER)	A 411
	END	A 417-

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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,D,S,X,DX,Y(250),DY
COMMON/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
COMMON/TPROP /EPS(250,3),PRT(250,3),BLET(250,3)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),Y7ETA, /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMBW,SMDWN /ZCALC/
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO, /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF /EDGEBC/
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NELI,NSP,NMAX,NYI
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,ISTAT,NVAR,IDRUM,LAST
COMMON/IDEBU/IDEBU(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
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 (IDEBU(1) .LE. 0) GO TO 240
    IF (ISTATN .LT. IDEBU(2) .OR. ISTATN .GT. IDEBU(3)) GO TO 240
    IF (IDEBU(1).EQ.1)KMODMP=1
    IF (IDEBU(1).EQ.2)KENDMP=1
C
C      DETERMINE NEW STEPSIZE AND CONTOUR PROPERTIES AT FORWARD STATION.
C
240  CALL STEP

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```

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 BNDEND
* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
  IF(SMDWN.NE.0.)MADFLG=1
C
C R E G I N   I T E R A T I O N   L O O P .
C 1) 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
1) UPDATE AVERAGE PROPERTIES AND CALCULATE AUXILIARY QUANTITIES FOR
  DIFFERENCE EQUATIONS.
C
  CALL ITERAT
C
  SOLVE MOMENTUM EQUATION FOR U.
C
  CALL MOMNTM
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
  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 ALPHA1.
C
  CALL ELEMTS
C
C CALCULATE LAMINAR TRANSPORT AND THERMODYNAMIC PROPERTIES AT EACH
  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,PEDEGB,0,RHOB,SMUR,PR(I,JN))
  RHO(I,JN)=RHOB/RHOREF
350 SHU(I,JN) = SMUR/SHUREF

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C
C   UPDATE ZETAN, ZETA, AND ZETAP.
C
C   370 CALL ZFUNC
C
C   CALCULATE TURBULENT TRANSPORT PROPERTIES.
C
C     IF(LAMNR.GT.0)GO TO 380
C     CALL EDDY
C
C   INTEGRATE CONTINUITY EQUATION TO OBTAIN RHOV.
C
C   380 CALL CONTNU
C
C   IF ITERATING ON SOLUTION, CHECK FOR CONVERGENCE OR MAXIMUM
C   ITERATIONS.
C
C     IF (MAXIT .LE. 0) GO TO 500
C     IF (ITER .NE. 0) GO TO 420
C     DUDY0 = 02DY*(4.0*U(2,JN) - 3.0*U(1,JN) - U(3,JN))
C     ITER=ITER+1
C     GO TO 300
C   420 DUDY=02DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
C     IF(ABS((DUDY-DUDY0)/DUDY).LE.CONVR6)GO TO 500
C     IF (ITER .GE. MAXIT) GO TO 500
C     ITER = ITER + 1
C     DUDY0=DUDY
C     GO TO 300
C
C   END OF ITERATION LOOP .
C
C   500 X = X + DX
C     S=S+DS
C
C   CALCULATE GROSS BOUNDARY LAYER PARAMETERS.
C
C     CALL PARAMS
C
C   CHECK FOR END OF CASE.
C
C
C     IF (X + 1.0E-6 .GE. XMAX) GO TO 900
C
C   PRINT AT THIS STATION IF REQUIRED.
C
C     CALL PRINT
C
C   CALCULATE ZETA AND ZETAP FOR NEXT STATION.
C
C     ZETAP=(ZETAN-ZSTAR(1))/(DSZ(1)+DS)
C     ZSTAR(1)=ZETA0
C     ZETA0=ZETAN
C     DSZ(1)=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
590 SHI(I,JO,ISP)=SHI(I,JN,ISP)
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 END OF STATION CALCULATION.
C END OF CASE. PRINT FINAL STATION.
C
900 ISPRNT = 0
ILPRNT=0
LAST=1
CALL PRINT
CALL SUMTAB
IF(I,RSWR.GT.0)END FILE ITAPE
RETURN
END

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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),IYFILP,IYTILF,      /YTABLE/
I        CYTIL(6)                                             /YTABLE/
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),OSZ(2),YZETA,    /ZCALC/
I        YTZETA,YEDGE                                       /ZCALC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/CONST /SINI,T,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
I        EPSLN3,CONVRG,O2DY,O4DY,O0YSQ
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
IF NO STRETCHING FUNCTION IS SPECIFIED, SET V = YTIL.
C
* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF(SN3.NE.0.)GO TO 150
YTEDGE=DELTA1/(BLREF*ZETA0)
YEDGE=YTEDGE
T1=NYI
DY=YEDGE/T1
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
APPLY NEWTON-RAPHSON ITERATION TO FIND ALPHA (SN1) AND BETA (SN2)
FOR STRETCHING FUNCTION.
FIND ALPHA AND BETA WHERE DY/DYT = INPUT VALUE.
C
150  POWER = 1.0/SN3
YTEDGE=DELTA1/(BLREF*ZETA0)
I=0
YTN=1.E-7
160  DARG=EM1*YTN/YTEDGE+1.
BRKT=DLOG(DARG)
FXN=EM1/SN3*BRKT**POWER/DARG-GPO
FXPN=EM1/SN3*((POWER-1.)*BRKT**POWER-2.)*BRKT**POWER-1.)*
I    EM1/(YTEEDGE*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

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C
C DETERMINE YTEDGE, YEDGE, AND FIXED MESH SPACING DY.
C ALSO DETERMINE YZETA.
C
YEDGE=YTEEDGE*((ALOG(EMI*(1.+SN1)+1.))**POWER-SN2)
TI=NYI
DY=YEDGE/TI
YTZETA=1.
YZETA=YTEEDGE*((ALOG(EMI*(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)/YTEEDGE+SN2)**SN3
DPAREN=DEXP(DARG)-1.000
YTIL(I)=YTEEDGE*(DPAREN/EMI-SN1)
ARG=EMI*(YTIL(I)/YTEEDGE+SN1)+1.
BRKT=ALOG(ARG)
BGP(I)=EMI/SN3*BRKT**((POWER-1.)/ARG)
200 BGPP(I) = EMI/SN3*((POWER - 1.0)*BRKT**((POWER - 2.0) -
I BRKT**((POWER + 1.0))*EMI/(YTEEDGE*ARG**2)
C
C WRITE YTIL, Y, BGP, AND BGPP ARRAYS.
C
250 YTIL(I) = 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 (I1,3I1,4HYTIL,16X,3HY=G,18X,2HGPP,17X,3HGPP/)
NYU=MIND(NYI+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 = NYI + 1
NYI=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/INDEF /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 XTODUX(500),LODUXT,IOUXP
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,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,NYI

COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/PFGAS /GAMMA,FMOLWT,PR
COMMON/NEW1 /ALEWIS,TLEWIS
COMMON/NEW2 / RHOEB,SMUEB,REYL,SXD
COMMON/NEW9 /IYEQ
COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,[AYP,CAYX(8),AFWALL
COMMON/RSTART/IRSPD,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),WH(13),SONVEL(13), /POINTS/
2 TTT(13) /POINTS/
COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HQ(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 HSUR0,HPP(2),RHH(2),VMIN(?),VPLS(?),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,[MAT,IQ1,NC, /INDX/
1 JSOL,JLIQ,IC,IQ2 /INDX/
COMMON /VISCXO/ VISC(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 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
C DATA (FMWT(I),I=1,6)/1.008,2.016,18.016,16.000,17.008,32.000/
C DATA BJ,SG/777.68006,32.174/
C
C BRANCH TO APPROPRIATE LOGIC.
C
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
C 1000 CALL ODE
C 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
C SHUTO=1./(SG*SMUREF)
C HOT=UREF*UREF/(1.8*BJ*SG)
C RHOOT=SG*RHOREF
C 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
C 2000 P(1) = 4.72539576E-4*PEDGEB
C T = TEDGE/1.80
C OF=(1.-AFEDGE)/AFEDGE
C
C USE INITIAL GUESSES FOR EN(I,1) AND ENLN(I) ALREADY CALCULATED
C BY ODE.
C
C NPT=1
C TP=.TRUE.
C HP=.FALSE.
C SP=.FALSE.
C CALL TPCALC
C
C SAVE ENTROPY AND CALCULATE VELOCITY.
C
C

```

```

SQ=SSUM(I)
SHEDGE = 1.9871650*HSUM(I)/HOT
HEDGE=SHEDGE+UEDGF+UEDGE/2.
C
C CALCULATE RHOEB AND SMUEB FOR INITIAL ZETAP CALCULATION.
C
RHOEB=DEN(I)/SG
SMUEB=VISCE(I)/SG
C
C PROCEED THRU PRESSURE TABLE WITH S-P CALCULATIONS.
C
IND=I
SP=.TRUE.
HP=.FALSE.
TP=.FALSE.
TIN(I) = 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(I) = 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
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,I))
      GO TO 3040
3020 OF = ALPHA(I,JN,2)/ALPHA(I,JN,1)
      DO 3030 I=1,NS
      EN(I,I)=SCI(I,JN,1)/FMWT(I)
      IF(EN(I,I).LT.1.E-6)EN(I,I)=1.E-6

```

```

3030 ENLN(I) = ALOG(EN(I,I))
3040 NPT = 1
      TP=.TRUE.
      HP=.FALSE.
      SP=.FALSE.
      CALL TPCALC
      SHWALL = 1.9871650*HSUM(I)/HOT
      HWALL=SHWALL
      RETURN

```

```

C
C
C
C
C
C
C

```

```

***** ICALL = 4 *****

```

```

PERFORM A SERIES OF H-P CALCULATIONS ACROSS THE BOUNDARY LAYER TO
OBTAIN THE THERMODYNAMIC AND LAMINAR TRANSPORT PROPERTIES AT EACH
MESH POINT.

```

```

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
      OF(IN(IBUF))=ALPHA(IND,JN,2)/ALPHA(IND,JN,1)
      IF((ISTATN.EQ.1RSRD).AND.(ITER.EQ.0))GO TO 4040
      IF(ISTATN+ITER)4040,4040,4060
      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,1)/FMWT(I)
      IF(EN(I,IBUF).LT.1.E-6)EN(I,IBUF)=1.E-6
4080 H(IN(IBUF)) = SH(IND,JN)*HOT
      INDEX(IBUF)=IND
      IF (IND .GE. NY) GO TO 4210
4200 IND = M1NO(IND+1YEQ,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)/RH00T
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
4300 SCI(IX,JN,I)=EN(I,IBUF)*FHWT(I)
SHI(IX,JN,I) = H0BUF(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(I,JN),Y,IYEQ,NY)
CALL PHOENX (SMU(I,JN),Y,IYEQ,NY)
CALL PHOENX (PRNO(I,JN),Y,IYEQ,NY)
CALL PHOENX (TEM(I,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
4910 CALL PHOENX (SCI(I,JN,I),Y,IYEQ,NY)
CALL PHOENX (SHI(I,JN,I),Y,IYEQ,NY)
RETURN
END

```

```

SUBROUTINE HPCALC
CHPCALC  PERFORM A SERIES OF ENTHALPY-PRESSURE CALCULATIONS.
C
COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),
1 GAMMAS(13),P(13),T,PPP(13),WM(13),SQNVEL(13),
2 TTT(13)
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),YEMP(50,2)
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, /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,KHAT,IMAT,IQI,NC, /INDX/
1 JSOL,JLIQ,IC,IQ2 /INDX/
COMMON/INODE /TIN(13),OFIN(13),HIN(13)
COMMON/OUTODE/HOBUF(30,13)
C
DO 40 IP = 1,NP
C
C SET ASSIGNED PRESSURE, ENTHALPY, O-F RATIO, AND TEMPERATURE GUESS.
C
PP=P(IP)
TT=TIN(IP)
OF=OFIN(IP)
150 DO 150 I=1,NS
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
T = TT
A 21
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
IF (NPT.EQ.0) RETURN
A 22
20 K=0
A 24
* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30
A 26
K=NPT
A 27
IF (NPT.NE.13) GO TO 40
A 28
30 CALL ANSWER
A 29
IF (K.EQ.0) RETURN
NPT=0
A 34
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
C        COMMON/PFGAS /GAMMA,FHOLWT,PR
C
C        BR = 49721.0110/FHOLWT
C        BCP=GAMMA*BR/(GAMMA-1.)
C        IF (ITPHP .LE. 0) GO TO 20
C
C        T IS GIVEN.  CALCULATE SH.
C
C        SH = BCP*T
C        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=PR
   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),
i          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/
i          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/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,          /ZCALC/
i          YTZETA,YEDGE                                                /ZCALC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NELI,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
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        EXTRAPOLEATION
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
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	DOUBLE PRECISION G,X	A 3
	LOGICAL CONV G,HP,SP,TP	A 4
C	COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),	A 6
1	GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),	/POINTS/ /POINTS/
2	TTT(13)	/POINTS/
1	COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HQ(30),	
1	DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)	
1	COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BQ(15),	/MISC/
1	BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,	/MISC/
2	HSUR0,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
1	COMMON /INDX/ CONV G,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,I,MAT,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.CONV G.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) = 0.000	
	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=HQ(J)*EN(J,NPT)	A 41
	IF (IUSE(J)) 110,30,90	A 42
30	F=(HQ(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)*TERM	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)+TERM	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=I,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=I,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)=B0(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	A 115
	IF (SP) ENERGY=SQ+ENN-SUMN-SSS	A 116
	IF (HP) ENERGY=HSUB0/TT-HSUM(NPT)	A 117
	G(IQ2,IQ3)=G(IQ2,IQ3)+ENERGY	A 118
140	G(IQ2,IQ2)=G(IQ2,IQ2)+CPSUM	
	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/	
	I JSOL,JLIQ,IC,IQ2	/INDX/	
C		A	15
C	BEGIN ELIMINATION OF NTH VARIABLE	A	16
C		A	17
	IUSE1 = IMAT + 1		
	DO 160 NN = 1,IMAT		
	IF (NN .NE. IMAT) GO TO 30		
:*	THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.		
	IF (G(NN,NN) .NE. 0.000) 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		A 60
C	DIVIDE NTH ROW BY NTH DIAGONAL ELEMENT AND ELIMINATE THE NTH	A 61
C	VARIABLE FROM THE REMAINING EQUATIONS	A 62
C		A 63
120	K=NN+1	A 64
	DO 130 J=K, IUSE1	
	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)=0.000	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
C MOMNTM SOLVE SYSTEM OF MOMENTUM EQUATIONS FOR VELOCITY U(M+1,N).
C
COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
COMMON/INDEP /S,D9,X,DX,Y(250),DY
COMMON/PROP /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
SHI(250,2,6),SCI(250,2,6),T(250,3),AV(250)
COMMON/YPROP /EPS(250,3),PRT(250,3),BLET(250,3)
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF, /YTABLE/
CYTIL(6) /YTABLE/
COMMON/MATRIX /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 /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDEGE,AFEDGE,DUEDSO, /EDGEBC/
DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
EPSLN3,CONVRG,02DY,04DY,0DYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/IDEBUG/IDEBUG(3),KMOOMP,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))*0DYSQ
TERM=BF*BGP(I)*SIG1(2)*0DYSQ
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=NYI-1
  GO TO 100
END

```

SUBROUTINE NLOUT
 CNLOUT WRITE TFCBL INPUT DATA.
 C

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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      XTODUX(500),LODUXT,IDUXP
COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,

1      SMDTAB(100),XTARMD(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,UEEDGE,PEDGEB,AFEDGE,DUEDSO, /EDGEBC/
1      DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SHUREF,REYINF
COMMON/MULT /XN,UEN,PEN,SMON,YN
COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
1      EPSLN3,CONVRG,02DY,04DY,0DYSQ
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 /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),HPROF(50), /INPROF/
1      YRYNH(50),LHPROF,CHYX(6) /INPROF/
COMMON/PFGAS /GAMMA,FMOLWT,PR
COMMON/NEW3 /AFTRNS,PLAW
COMMON/NEWS /IYPR
COMMON/NEW7 /GPO,PAMB,INTOK,ZETAP
COMMON/NEW8 /RSTAR,RSTPR,XSTAR,DLSTD,DLSTTH
COMMON/NEW9 /IYEQ
COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(6),AFWALL
COMMON/NEW11 /J2D,UEK,RHOEK
COMMON /INPUT/ R(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,IA,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX, /COOL/
3      MASSL,PRANDL,QWI,RANDL,RANDW,RAMTAB(20),REYL,SQWDSI, /COOL/
4      SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLD,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/

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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,ICOOI,ITHERM,IPOLY
      WRITE (6,9020) SINIT,XINIT,XMAX,DXI,DELTAI,ZETAI
      WRITE (6,9030) BLREF,UREF,RHOREF,SMUREF
      WRITE (6,9040) XN,YN,UEN,PEN,SHDN
      WRITE (6,9050) UEDGE,PEDGE,TEDGE,AFEDGE
      WRITE (6,9060) AFTRNS,PRI,GAMMA,FMOLWT,PLAW,PAMB,GPO,SN3,
      XSTAR,AFWALL,UEK,RH0EK
      WRITE (6,9070) CONVRG,EPSLN1,EPSLN2,EPSLN3,EPSLN
      WRITE (6,9080) MAXIT,NYI,NLPRNT,NSPRNT,INSTAT,IYPR,IYEQ
      WRITE (6,6) GAMA,ZK
6      FORMAT (1X,18H CORRELATION INPUTS//5X,6HGAMA =,F10.6;5X,4HZK =,
      F10.6//)
      IF (ICOOI.EQ. 0) GO TO 40
      WRITE (6,1) COEFCL,MASSL,RAMDW,TUBEN

1      FORMAT (28H REGENERATIVE COOLING INPUTS//4X,8HCOEFCL =,F12.8;10X,
      7HMASSL =,F12.6;10X,7HRAMDW =,F13.10;10X,7HTUBEN =,F10.3/)
      WRITE (6,2) ITZTAB,(1,ITZTAB(1),CPLTAB(1),RAMTAB(1),ZMYTAB(1),
      I = 1,ITZTAB)
2      FORMAT (1H1//26H COOLANT PROPERTIES TABLES//45X,8HITZTAB =,I3//
      1 15X,1H1,9X,5HTZTAB,11X,6HCPLTAB,13X,6HRAMTAB,13X,6HZMYTAB/
      2 (14X,12,5X,OPF10.4,5X,F13.10,5X,IPE14.8,5X,E14.8))
      WRITE (6,3) LTWTAB
3      FORMAT (1H1,20H COOLANT WALL TABLES//44X,8HLTWTAB =,I4//15X,1H1,
      1 11X,5HALTAB,12X,6HTHTITAB,12X,5HTLTAB/)
      LINESR = LNSPPG - 8
      DO 30 I = 1,LTWTAB
      WRITE (6,4) I,ALTAB(I),THITAB(I),TLTAB(I)
4      FORMAT (13X,13,5X,IPE13.7,5X,E13.7,5X,OPF11.4)
      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,6HTHTITAB,12X,5HTLTAB/)
      LINESR = LNSPPG - 5
30     CONTINUE
C
C      WRITE STEPSIZE CONTROL TABLES.
C

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40 WRITE (6,9000)
   WRITE (6,9090) 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)
' 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

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230 WRITE (6,9170) TABNAM
    LINESR=LNSPPG-8
    LPUMAX=MAX0(LPETAB,LUETAB)
    LMAX=MAX0(LRWYTAB,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) RWYTAB(1),XTABRW(1),TABVAL,XTABPE(1)
    LINESR=LINESR-1
    IF (LMAX .LE. 1) GO TO 310
    DO 300 I = 2,LMAX
    TABVAL=PETAB(1)
    THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
    IF(PETAB(1).EQ.0.)TABVAL=UETAB(1)
    IF(I.GT.LRWYTAB)GO TO 260
    IF(I.GT.LPUMAX)GO TO 270
    WRITE (6,9110) RWYTAB(1),XTABRW(1),TABVAL,XTABPE(1)
    GO TO 280
260 WRITE (6,9120) TABVAL,XTABPE(1)
    GO TO 280
270 WRITE (6,9110) RWYTAB(1),XTABRW(1)
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=MAX0(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(1),YBYNU(1),HPROF(1),YBYNH(1)
    GO TO 400
360 WRITE (6,9120) HPROF(1),YBYNH(1)
    GO TO 400
370 WRITE (6,9110) UPROF(1),YBYNU(1)
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(1),YBYNA(1)
    RETURN

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9000 FORMAT (1H1,26X,13A6//)
9010 FORMAT (18H FLAGS AND OPTIONS//30X,8HIDEAL = ,12,6X,
1 56H(=1 FOR PERFECT GAS, =0 FOR HYDROGEN-OXYGEN EQUILIBRIUM)/30X,
2 8HLAMNR = ,12,6X,39H(=1 FOR LAMINAR FLOW, =0 FOR TURBULENT)/30X,
3 8HINCOMP = ,12,6X,36H(=1 FOR INCOMPRESSIBLE FLOW, =0 FOR ,
4 13HCOMPRESSIBLE)/30X,8HJ2D = ,12,6X,21H(=1 FOR AXISYMMETRIC ,
5 33HGEOMETRY, =0 FOR TWO-DIMENSIONAL)/30X,8HINTDK = ,12,6X,
6 55H(=1 IF INPUT TABLES COME FROM TDK OUTPUT, =0 OTHERWISE)/30X,
7 8HICOO = ,12,6X,57H(=0 NO COOLING, =1 OPPOSITE DIRECTION, =2 SAM
8 E DIRECTION)/30X,8HITHERM = ,12,6X,52H(=1 FOR THERMO NAMELIST INPU
9 T TO ODE, =0 OTHERWISE)/30X,8HIPOLY = ,12,6X,77H(=1 FOR CALCULATIO
0 N OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, =0 OTHERWISE)//)
9020 FORMAT (34H PROBLEM LIMITS AND INITIAL VALUES//1X,7H5INIT =,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,8HRMREF =,E14.7,4X,8HSMQREF =,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 7HSMON =,E14.7//)
9050 FORMAT (16H EDGE QUANTITIES//4X,7HUEDGE =,1PE14.7,4X,7HPEDGE =,
1 1E14.7,4X,7HTEGE =,E14.7,4X,8HAFEDGE =,E14.7//)
9060 FORMAT (10H CONSTANTS//1X,8HAFTRNS =,1PE12.6,3X,5HPR1 =,E12.6,3X,
1 7HGAMMA =,E12.6,3X,8HFMOLEWT =,E12.6,3X,6HPLAW =,E12.6,3X,
2 7HPAMB =,E12.6,1X,8HGPO =,E12.6,3X,5HNS3 =,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 7HEPSLN =,E14.7//)
9080 FORMAT (9H COUNTERS//4X,7HMAXIT =,14,5X,5HNYI =,14,5X,8HNLPRNT =,
1 14,5X,8HNSPRNT =,14,5X,8HINSTAT =,14,5X,6HIYPR =,14,5X,6HIYEQ =,
2 14//)
9090 FORMAT (24H STEPSIZE CONTROL TABLES//25X,7HLDXLIM =,14,39X,
1 7HLSKTAB =,14)
9100 FORMAT (15X,6HDXLIM ,19X,6HXLIM ,19X,6H5KTAB ,19X,6HXTABSK/)
9110 FORMAT (1P4E25.7)
9120 FORMAT (50X,1P2E25.7)
9130 FORMAT (12H WALL TABLES//25X,7HLTWTAB =,14,39X,7HLMDTAB =,14)
9140 FORMAT (15X,6HTWTAB ,19X,6HXTABTW,19X,6HSMDTAB,19X,6HXTABMD/)
9150 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB =,14,39X,
1 7HLUETAB =,14)
9160 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB =,14,39X,
1 7HLPETAB =,14)

9170 FORMAT (15X,6HRWTAB ,19X,6HXTABRW,19X,A6,19X,6HXTABPE/)
9180 FORMAT (22H EXPERIMENTAL PROFILES//25X,7HLUPROF =,14,39X,
1 7HLHPROF =,14)
9190 FORMAT (15X,6HUPROF ,19X,6HYBYNU ,19X,6HHPROF ,19X,6HYBYNH /)
9200 FORMAT (34H EXPERIMENTAL PROFILES (CONTINUED)//25X,7HLAPROF =,14)
9210 FORMAT (15X,6HAPROF ,19X,6HYBYNA /)
END

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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
COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,
1      PHAZ(30),T1(30),T2(30)
COMMON /POINTS/ MSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),
1      GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),
2      YTT(13)
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(16),BO(15),
1      BOP(15,2),TM,TLOW,THID,THIGH,PP,C=SUM,OF,EQRAT,
2      HSUBO,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),
3      NAME(15,5),ANUM(15,5),PECWT(19),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
DIMENSION DATE(2,30),LH(2),LVM(2),LVP(2)
INTEGER BLANK,FAZ,FOX,PHAZ,SUB
DATA BLANK,LH,LVM,LVP/IH ,4HH,CA,4HL/G ,2HV-,IH ,2HV+,IH /
EQUIVALENCE (DATE,EN)
LOGICAL HP,IC,MOLFS,SP,TP
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,THID,THIGH
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
SP=.FALSE.
C
CALCULATIONS INVOLVING EQUIVALENCE RATIO CHANGED (7-10-69) TO
CORRESPOND TO DEFINITION USED IN PROGRAM A23500. 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)
WP(1) = OF
WP(2)=1.

```

A 10
/INPUT/
/INPUT/
/POINTS/
/POINTS/
/POINTS/
/MISC/
/MISC/
/MISC/
/MISC/
/INDX/
/INDX/
A 33

A 39

A 60
A 119

A 157

A 159

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SUM=WP(1)+WP(2) A 160
VZ=(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
IN(2),VMIN(1),VZ 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
IQI=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 (IH1) A 226
370 FORMAT (1H0,17X,4HFUEL,13X,7HOXIDANT,12X,7HMIXTURE//) A 237
380 FORMAT (1H 2A4,3E18.8/) A 238
390 FORMAT (RH 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(250,3,2),RHOV(250),SH(250,3)
 COMMON/INDEP /S,D9,X,DX,Y(250),DY
 COMMON/PROP /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),

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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,GPEX(6),
2          UETAB(500),          LUETAB,IUEXP,CUEX(6),
3          XTDUDX(500),LDUDXT,LDUDXP
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/ ZETA0,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,SQW,STAN,SNTGRL,          /GPARAM/
1          SQWDS,SQWO                                                 /GPARAM/
COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SR2,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,DLSTH
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,THID,THIGH,PP,CPSUM,OF,EQRAT,          /MISC/
2          HSURQ,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,I COOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,          /COOL/
3          MASSL,PRANDL,QWI,RAHDL,RANDW,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,TAWH,STANRE                  /COOL/
REAL MASSL                                                         /COOL/
    
```

C

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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.([STATN.EQ.([RSRD]))GO TO 50
IF([STATN.GT.0)GO TO 20
SNTGRL=0.
GO TO 50
20 SNTGRL = SNTGRL + 0.50*DS*(SMDWO*ZETA0*RW(1)**J2D + SMDWN*ZETA0*
I 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(1,JN)*BGP(I)*ZETAP*YTIL(I)/ZETAN
70 F(I) = BGP(I)*TM2
DUDY=02DY*(-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(1,JN)/T1
GRND(1)=(1.-TM1)/BGP(1)
GRND(2)=TM1/BGP(1)*(1.-U(1,JN)/U(NY,JN))
DUDS=(U(1,JN)-U(1,J0))/DS
DUDY=02DY*(U(I+1,JN)-U(I-1,JN))
GRND(3)=(RHO(1,JN)*U(1,JN)*DUDS+(RHOV(1)*BGP(1)*U(1,JN)*E(I))*
I DUDY+DPEDSN)/F(1)
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

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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)-
    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
C
    DLSTTH=DLSTAR-(X-XSTAR)*(DLSTAR-DLSTO)/DX
    CALL XINTERP (XSTAR,RSTAR,DER,IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
    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
    TAUJ=-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))
    TMJ=BGP(1)/ZETAN*SMU(1,JN)*DERIV
    TAUW=SMUREF*UREF/BLREF*TMJ
C
C LOCAL SHEAR STRESS COEFFICIENT BCF.
C
    BCF=2./REY[INF*TMJ]/(RHO(NY,JN)*U(NY,JN)**2)

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```

C
C   HEAT TRANSFER RATE SQW.
C
    DERIV=02DY*(-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)*02DY*(4.0*SCI(2,JN,ISP) - 3.0*
    |   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/(REYNF*TM2)
C
C   UPDATE INTEGRAL OF SQW OVER S.
C
    IF((IRSRD.GT.0).AND.(ISTATN.FQ.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*(SQWO*
    |   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 = 1.9879204312*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/
    |   (CPSUME*RJ*SG)
C   ..   RHOREF   .... (LBF*SEC2/FT4)   ....
C   ..   SG GRAVITONAL FORCE (LBM/LRF*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*LRF/RTU) = (BTU/(FT2*SEC)))
    STANRE = SQWI/(CPSUME*AAKK*(TAW - TWALL))
C   ..   HG   .... (BTU/(DEG-R*FT2*SEC))
    HG = SQWI/(TAW - TWALL)

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```

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,ZMYTAR,ITZTAB,CZX,ITPOS)
ITPOS = IZX
CALL XNTERP (TL1,CPL,CPP,ICX,TZTAB,CPLTAB,ITZTAB,CGX,ITPOS)
CALL XNTERP (TL1,RAMDL,RP,IRX,TZTAB,RAMTAR,ITZTAB,CRX,ITPOS)
PRANDL = CPL*ZMYUL/RAMD
REYL = MASSL*DIATUB/(ZMYUL*TUBEN*EAREA)
CALL XNTERP (X,THICK,TMP,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 (ICOOOL .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)
C PHOENX 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
      PACK V-VALUES INTO F AND CORRESPONDING Y-VALUES INTO X.
C
      I=1
      J=1
      F(I)=V(I)
      X(I)=Y(I)
10  I = I + 1
      J=MIND(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 = MIND(JLO+NN-2,LL-1)
      GO TO 40

      END

```

SUBROUTINE PRINT

C PRINT STORE ITEMS IN SUMMARY TABLE FOR THIS STATION, AND PRINT
 C PROFILES AT THIS STATION IF REQUIRED.

```

COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,2),RHOV(250),SH(250,3)
COMMON/INDEP /S,DG,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),RLET(250,3)
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTIIF, /YTABLE/
1 CYTIL(6) /YTABLE/
COMMON/STEPSZ/DX1IM(50),XLIM(50),LDXLIM,IDX,
1 SKTAB(50),XTARSK(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 YZETA,YEDGE /ZCALC/
COMMON/WALLRC/TWALL,SHWALL,HWALL,SMOWO,SMOW,SMOWN
COMMON /EDGEBC/ YEDGE,SHEDGE,HEDGE,UEDGE,PEDEGE,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,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,IDRUH,LAST
COMMON/NEWS /IYPR
COMMON /NEW7/ GPO,PAMB,INTDK,ZETAPI /NEW7/
COMMON /NEW11/ J2D,UEK,RHOEK /NEW11/
COMMON/NEWB /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
COMMON/PFGAS /GAMMA,FHOLWT,PR1
COMMON/RSTART/IRSRD,IRSWR,ITAPE
COMMON /COOL/ ALTAB(100),CAX(6),CCR(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,IYHX,ITLX,ITZTAB,IZX, /COOL/
3 MASSL,PRANDL,QWT,RAMDL,RAMDW,RAMTAB(20),REYL,SQWDSI, /COOL/
4 SQW1,SUMQW1,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,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2, NEW
1 EPSLN3,CONVRG,O2DY,O4DY,ODYSQ NEW

```

C DIMENSION AOUT(12),BOUT(8)

C CALCULATE DIMENSIONAL WALL AND EDGE CONDITIONS.

```

UEB=U(NY,JN)*UREF
SA = SQRT(49721.0110*GAMMA/FHOLWT*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
C

STORE ITEMS IN SUMMARY TABLE.

```

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
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,JO))/DS
SUMARY(ISTA,30)=TWL

```

NEW
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C
C
C

CHECK IF TIME TO WRITE SUMMARY TABLE BUFFER ON DRUM.

```

IF((ISTA.LT.NSTA).AND.(LAST.EQ.0))GO TO 50
NST=MIND(ISTA,NSTA)
WRITE (IDRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
ISTA=0
NREC=NREC+1

```

C
C
C

CHECK IF TIME TO PRINT.

```

50 IF (ISPRNT .EQ. NSPRNT) ISPRNT = 0
IF (ILPRNT.EQ.NLPRNT)ILPRNT=0
IF (ILPRNT .NE. 0) GO TO 1000

```

C
C
C
C

PRODUCE SHORT PRINT OF CONTOUR PROPERTIES, WALL AND EDGE CONDITIONS, AND PROFILE PARAMETERS.

WRITE (6,9000) TITLE

```

LINESR = LNSPPG - 5
WRITE (6,9010)
LINESR=LINESR-1
XOUT = 12.0*X*BLRFF
WRITE (6,9020) 1STATN,XOUT,S,DS,RW(2),THW(2),ZETAN,ZETAP
LINESR=LINESR-2
WRITE (6,9030)
LINESR=LINESR-1
RTHETA = REYINF/RLREF*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 - (PEDGER = PAMB)*DLSTAR)
WRITE (6,9040) UER,BME,DLSTAR,BCF,T(NY,JN),RHOER,THETA,STAN,SHEB,
1 SMUEB,TAUW,TAUI,PEDGER,TWALL,SQW,RTHETA,THLOSS,SMDWB
LINESR=LINESR-6
IF (ICOOOL.NE.0) WRITE (6,1) TLO,TWL,CPL,QWI,REYL,TL1,TWL2,
1 CPSUME,SUMQWI,PRANDL,TL2,TWGCA,DIATUB,SQWI,RAMD,TAU,TWG2,
2 THICK,SQWDSI,ZMYUL,TLCA,TEMPRL,HG,HL,STANRE
1 FORMAT (50X,31HREGENERATIVE COOLING PARAMETERS/SX,6HTLO =,F10.4,
1 5X,8HTWL =,F10.4,5X,8HCPL =,F15.10,5X,8HQWI =,F15.6,5X,
2 8HREYL =,1PE15.9/5X,6HTL1 =,OPF10.4,5X,8HTLTAB =,F10.4,5X,
3 8HCPSUME =,F15.10,5X,8HSUMQWI =,F15.6,5X,8HPRANDL =,1PE15.9/5X,
4 6HTL2 =,OPF10.4,5X,8HTWGCA =,F10.4,5X,8HDIATUB =,F15.10,5X,
5 8HSQWI =,F15.6,5X,8HRAMD =,1PE15.9/5X,6HTAU =,OPF10.4,5X,
6 8HTWTAB =,F10.4,5X,8HTHICK =,F15.10,5X,8HSQWDSI =,F15.6,5X,
7 8HZMYUL =,1PE15.9/5X,6HTLCA =,OPF10.4,5X,8HTEMPRL =,F10.4,5X,
8 8HHG =,F15.10,5X,8HHL =,F15.6,5X,8HSTANRE =,1PE15.9/)
IF (ICOOOL.NE.0) LINESR = LINESR - 7

```

NEW
-01

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)*SHUREF
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+1YPR,NY)
GO TO 550
600 CONTINUE

```

C
WRITE(6,9080)
ZDELTA = SDELTA*RLREF*ZETAN*12.0
WRITE(6,90) ZDELTA

NEW
NEW
NEW
NEW
NEW


```

C
WRITE (6,9000) TITLE
LINE5R = LNSPPG - 5
WRITE (6,9150)
LINE5R=LINE5R-1
I=1
650 AOUT(1) = YTIL(1)*BLREF*ZETAN
AOUT(2)=ALPHA(1,JN,2)/ALPHA(1,JN,1)
AOUT(3)=SCI(1,JN,1)
AOUT(4)=SCI(1,JN,2)
AOUT(5)=SCI(1,JN,3)
AOUT(6)=SCI(1,JN,4)
AOUT(7)=SCI(1,JN,5)
AOUT(8)=SCI(1,JN,6)
AOUT(9)=SMU(1,JN)*SMUREF
AOUT(10)=PR(1,JN)
IF(LINE5R.GT.0)GO TO 670
WRITE (6,9000)
WRITE (6,9150)
LINE5R = LNSPPG - 4
670 WRITE (6,9160) I,(AOUT(J),J=1,10)
LINE5R=LINE5R-1
IF (I .GE. NY) GO TO 700
I = MIN0(I+1YPR,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(1))/(DSZ(1)+DS)
WRITE (1TAPE) ISTATN,NY,DY,ZETAN,ZETA,ZETAN,ZP,ZETA0,DS,YZETA,
1 YTZETA,YEDGE,RSTPR,SNTGRL,SQWDS,((U(I,J),H(I,J),
2 ALPHA(1,J,1),ALPHA(1,J,2),SH(1,J),I=1,NY),J=1,3),(
3 RHOV(I),I=1,NY),(Y(I),YTIL(1),BGP(1),RGPP(1),I=1,
4 NMAX)
C
C ADVANCE PRINT STATION COUNTERS.
C
1000 ISPRNT=ISPRNT+1
I LPRNT=I LPRNT+1
RETURN
9000 FORMAT (1H1,26X,13A6//)
9010 FORMAT (9X,7HSTATION,8X,8HX (FEET),15X,1HS,14X,2HDS,14X,2HRW,10X,
1 6HTHETA W,12X,4HZETA,11X,5HZETA P)
9020 FORMAT (116,1P7E16.7//)
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,9HTEGE = ,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,9HPEDGE = ,E14.7,7X,9HTWALL = ,E14.7,17X,9HSQW = ,

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5 E14.7,7X,9HRTHTETA = ,E14.7/7X,9HHTHLOSS = ,E14.7,7X,9HSMOWB = ,
6 E14.7/1
9050 FORMAT (54H NO.          YBAR          Y          U/UE          ,
1 61H          H/HE          RO/ROE          ROV          EPS          ,
2 11H          T )
9060 FORMAT (15,1P7E16.7,OPF11.1)
9070 FORMAT (/18H NO. ITERATIONS =,13)
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 (15,1P2E16.7,OP6F11.6,1PE14.5,OPF11.5)
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,3MPRT)
9903 FORMAT(14,1PBE16.7)
END

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```

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),IYVILP,IYVILF, /YTABLE/
1 CYTIL(6) /YTABLE/
COMMON /ZCALC/ ZETA0,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,UEEDGE,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/NEWID /APROF(50),YBYNA(50),LAPROF,{AYP,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),CWN(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

```

```

      TM1=YN/(BLREF*ZETA0)
      DO 410 I=1,LUPROF
410   YBYNU(I) = YBYNU(I)*TM1
      DO 420 I=1,LHPROF
420   YBYNH(I) = YBYNH(I)*TM1
      DO 425 I=1,LAPROF
425   YBYNA(I) = YBYNA(I)*TM1
      IUYP=0
      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=0
      DO 440 I=1,NY
      CALL XNTERP(YTIL(I),ALPHA(I,JN,1),DUMMY1,IAYP,YBYNA,APROF,
      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,DUMMY1,IHYP,YBYNH,HPROF,LHPROF,CHYX,IHYP)
450   SH(I,JN)=HVAL*SHEDGE
      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.)*YTIL(NY)
      IMI=0
      DO 100 I=1,NY
      IF (IMI .GT. 0) GO TO 30
      IF (YTIL(I) .LT. TM3) GO TO 100
      IMI = 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(IMI,JN)/YTIL(IMI)
      DO 105 I=1,IMI
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 ALPHA1 PROFILE ACROSS BOUNDARY LAYER.
C      ALPHA1 = 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  TM1 = 1.0/YTIL(NY)
      DO 500 I=1,NY
500  RHOV(I) = SMDW + 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**TM2-0.586**TM2+0.431)*
      I          SQR(CUU(I,JN))*(2.1832339 - 1.1832339*TM2)*4.1983820
C
C      MOVE FORWARD VALUES TO BACK VALUES.
C
      DO 600 I=1,NY
      U(I,JO)=U(I,JN)
      SH(I,JO)=SH(I,JN)
      H(I,JO)=H(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)
      U(I,JA) = U(I,JO)
      CUU(I,JA) = CUU(I,JO)
      EPS(I,JO) = EPS(I,JN)
      EPS(I,JA) = EPS(I,JO)
      DO 600 IEL = 1,NEL
600  ALPHA(I,JO,IEL) = ALPHA(I,JN,IEL)
      RETURN
      END

```

NEW
-01

```

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,V(250),DY
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTIFF, /YTABLE/
CYTIL(6) /YTABLE/
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA, /ZCALC/
YZETA,YEDGE /ZCALC/
COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,STAN,SNTGRL, /GPARAM/
SQWDS,SQW0 /GPARAM/
COMMON/CONST /SINIT,XINIT,XMAX,DFLTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
EPSLN3,CONVRG,O2DY,O4DY,ODYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NELI,NSP,NMAX,NYI
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/NEWB /RSTAR,RSTPR,XSTAR,DLSTO,DLSTH
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,15//)
CALL EXIT
C
C READ RESTART DATA FOR STATION IRSRD.
C
30 BACKSPACE ITAPE
READ (ITAPE) ISTATN,NY,DY,ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(1),DSZ(1),
YZETA,YTZETA,YEDGE,RSTPR,SNTGRL,SQWDS,((U(I,J),H(I,J)
1 ,ALPHA(I,J,1),ALPHA(I,J,2),SH(I,J),I=1,NY),J=1,3),(RH
2 OV(I),I=1,NY),(Y(I),YTIL(I),BGP(I),BGPP(I),I=1,NMAX)
3
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 REACT		A 1
C	COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),		A 8
	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/ CONV,GP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,	/INDX/	
	1 JSOL,JL1Q,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/2HOO,1H ,1HO/		
	LOGICAL MOLES		
C	DO 20 K = 1,2		A 21
	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,1),ANUM(N,1), I = 1,5),PECWT(N),MOLES,		
	1 ENTH(N),FAZ(N),RTEMP(N),FOX(N),DENS(N)		
	K=2		A 44
	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
	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		
	THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.		
	IF (ATOM(I,KK).EQ.ANAME(N,JJ)) GO TO 100		A 60
90	CONTINUE		A 61

```

L=0
GO TO 40
100 RM=RM+ANUM(N,JJ)*ATOM(2,KK)
V(J)=ATOM(3,KK)
110 DATA(J) = ANUM(N,JJ)
120 PCWT=PECWT(N)
IF (MOLES) PCWT=PCWT*RM
WP(K)=WP(K)+PCWT
IF (NAME(N,5).NE. IZERO) HPP(K)=HPP(K)+ENTH(N)*PCWT/RM
DO 130 J=1,L
130 BOP(J,K) = DATA(J)*PCWT/RM + BOP(J,K)
IF (DENS(N) .LE. 3.0) GO TO 40
RHO(K) = RHO(K) + PCWT/DENS(N)

40 CONTINUE
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
I NAME IN ATOM ARRAY AS GIVEN IN RLKDTA//)
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
HPP(K)=HPP(K)/WP(K)
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (RHO(K).NE.0.) RHO(K)=WP(K)/RHO(K)
DO 170 J=1,L
BOP(J,K)=BOP(J,K)/WP(K)
IF (V(J).LT.0.) VMIN(K)=VMIN(K)+BOP(J,K)*V(J)
IF (V(J).GT.0.) VPLS(K)=VPLS(K)+BOP(J,K)*V(J)
170 CONTINUE
IF (MOLES) GO TO 190
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
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (FOX(N).NE.0X.AND.K.EQ.1) GO TO 180
PECWT(N)=PECWT(N)/WP(K)
180 CONTINUE
190 CONTINUE
DO 200 N=1,NREAC
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (DENS(N).NE.0.) GO TO 200
RHO(1)=0.
RETURN
200 CONTINUE
RETURN
230 FORMAT (1X,5(A2,1X,F7.4,2X),F8.4,2X,L1,F11.2,2X,A1,2X,F8.3,2X,
I A1,3X,F8.5)
END

```

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A 62
A 63
A 64
A 65
A 68
A 69
A 70
A 71
A 73
A 82
A 85
A 86
A 88
A 89
A 90
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A 96
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A 98
A 99
A 100
A 102
A 103
A 104
A 106
A 112-

```

	SUBROUTINE SEARCH	A	1
C		A	2
	DIMENSION DATE(2,30)		
	EQUIVALENCE (DATE,EN)		
	INTEGER GAS,PHAZ,SUB		
	DATA GAS/IHG/		
C		A	9
	COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,	/INPUT/	
	PHAZ(30),T1(30),T2(30)	/INPUT/	
	COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),H0(30),		
	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/	
	BOP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,	/MISC/	
	HSURQ,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),	/MISC/	
	NAMF(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),	/MISC/	
	RTEMP(15),FOX(15),DENS(15),TLN	/MISC/	
	COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,	/INDX/	
	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=1,	A	81
	IS)	A	82
	RETURN	A	83
210	FORMAT (45H0DIMENSIONS IN/SPECES/TOO SMALL TO CONSIDER ,3A4)	A	88
220	FORMAT (42H0SPECIES BEING CONSIDERED IN THIS SYSTEM)	A	89
230	FORMAT (5(5X,2A3,2X,3A4))	A	90
	END	A	91-

```

SUBROUTINE SPCALC
CSPCALC PERFORM A SERIES OF ENTROPY-PRESSURE CALCULATIONS.
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) /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) /POINTS/
COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),
1 BOP(15,2),TM,TLOW,THID,THIGH,PP,CPSUM,OF,EQRAT, /MISC/

2 HSUB0,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),VLN /MISC/
COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQI,NC, /INDX/
1 JSOL,JLQ,IC,IQZ /INDX/
COMMON/INODE /TIN(13),OFIN(13),MIN(13)

C
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

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```

PP=P(IP)
CALL EQLRRM
T = TT
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (TT.NE.0.) GO TO 20
IF (NPT .EQ. 0) RETURN
20 K=0
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30
K=NPT
IF (NPT.NE.13) GO TO 40
30 IF (K .EQ. 0) RETURN
NPT=0
40 NPT=NPT+1
C SAVE COMPOSITIONS FOR ESTIMATES OF NEXT POINT
DO 60 I = 1,NS
60 EN(I,NPT) = EN(I,K)
RETURN
END

```

A 22
A 24
A 26
A 27
A 28
A 29
A 36
A 37
A 40
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 XTODUX(500),LDUDXT,LDUDXP
COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
1 SKTAB(50),XTARSK(50),LSKTAB,ISK,
2 DXI
COMMON/GEOM /RW(2),DRWDX(2),THW(2)
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1 EPSLN3,CONVRG,OZDY,OQDY,OOYSQ
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/PRNTCT/NSPRNT,NLPRNT,ISPRNT,ILPRNT,LNSPP6,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,RANDL,RANDW,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 ZHYTAB(20),ZHYUL,ITPOS,TWL2,TAWH,STANRE /COOL/
REAL MASSL /COOL/

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```

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=DXI
    IF((IRSRD.GT.0).AND.(ISTATN.EQ.(IRSRD+1)))DX=DXI
    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 XINTER (X+DX,RW(2),DRWDX(2),IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
    I
    IRWXP)
    THW(2)=ATAN(DRWDX(2))
    IF (ICOOOL .EQ. 0) RETURN
    IS = ISK
    IF ((X + DX + 1.0E-6) .LT. XLIM(IDX)) GO TO 31
    DXI = DXLIM(IDX)
    GO TO 81
31  IF (X + DX .LT. XTABSK(IS)) GO TO 51
    IS = IS + 1
    GO TO 31
51  DXI = DXI*SKTAB(IS)
    IF ((X + DX + DXI + 1.0E-6) .LT. XLIM(IDX)) GO TO 81
    DXI = XLIM(IDX) - (X + DX)
81  IF ((X + DX + DXI + 1.0E-6) .LT. XMAX) RETURN
    DXI = XMAX - (X + DX)
    IF (DXI .LT. 0.0) DXI = 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,DRUM,LAST
COMMON/NEWB /RSTAR,RSTPR,XSTAR,DLSTO,DLSTH
C
C IF ABNORMAL TERMINATION, WRITE CURRENT SUMMARY TABLE BUFFER ON
C DRUM.
C
IF (ISTA .LE. 0) GO TO 50
NST = ISTA
WRITE (DRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
NREC=NREC+1
50 IF (NREC .EQ. 0) RETURN
REWIND DRUM

DO 100 IREC=1,NREC
WRITE (6,9000) TITLE
WRITE (6,9010)
READ (DRUM) 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,5HSDWB,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,5HQUEDS,
5 8X,5HTWLCA)
9020 FORMAT (0PF13.1,1P9E13.5/10E13.5/10E13.5/)
END

```

SUBROUTINE TABLES

```

CTARLFS 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),XTARPE(500),LPETAB,IPEXP,CPEX(6),
2 UETAB(500), LUETAB,IUEXP,CUEX(6),
3 XTDUDX(500),LDUDXT,LDUDXP
COMMON/LTABLE/TWTAB(100),XTARTW(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 YZETA,YEDGE /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEEDGE,PEEDGE,AFEDGE,DUEDSO, /EDGEBC/
1 DUEDS,DUEDSN,DPENSN /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/MULT /XN,UEN,PEN,SMON,YN
COMMON/OPTION/IDEAL,LAMNR,INCOMP
COMMON/PGAS /GAMMA,FMOLWT,PR
COMMON/NEW2 /RHOEB,SMUEB,REYL,SXD
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*ZETA0)
C
C   RACK 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
      XTABTW(I) = XTABTW(I)*XNORM
300  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
C CALL HOODE (3)
C 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,PEDGE,1,DUMMY1,DUMMY2,DUMMY3)
C SHWALL=SHWB/(UREF*UREF)
C HWALL=SHWALL
C
C CALL IGODE WITH TEDGE AND PEDGE TO OBTAIN SHEDGE AND HEDGE.
C (HEDGE IS A CONSTANT.)
C
C CALL IGODE (TEDGE,SHEB,PEDGE,1,RHOEB,SHUEB,DUMMY1)
C SHEDGE=SHEB/(UREF*UREF)
C 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.
C IF (PETAB(1).EQ.0.)GO TO 450
C TM1=(GAMMA-1.)/GAMMA
C DO 410 I=1,LPETAB
C PETAB(I)=PETAB(I)*PEN
C XTABPE(I)=XTABPE(I)*XNORM
C SHE=SHEDGE*(PETAB(I)/PEDGE)**TM1
410 UETAB(I) = SQRT(2.0*(HEDGE - SHE))
C LUETAB=LPETAB
C IPEXP=0
C IUEXP=0
C GO TO 500
450 FNORM = UEN/UREF
C TM1=GAMMA/(GAMMA-1.)
C PTOT = PEDGE*(SHEDGE/HEDGE)**(-TM1)
C DO 460 I=1,LUETAB
C UETAB(I)=UETAB(I)*FNORM
C XTABPE(I)=XTABPE(I)*XNORM
C SHE=HEDGE-UETAB(I)**2/2.
C PETAB(I) = PTOT*(SHE/HEDGE)**TM1
C IF (INCOMP.EQ. 1) PETAB(I) = PFEDGE + 0.50*RHOEB*(UEDGE**2 -
C UETAB(I)**2)*UREF**2
460 CONTINUE
C LPETAB=LUETAB
C IUEXP=0
C IPEXP=0
C
C EVALUATE PEDGE, 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
C WRITE (6,9000)
C 9000 FORMAT (1H1)

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```

      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 (1/5X,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
      XTODUX(LDUDXT)=XTABPE(LUETAB)
      UETAB(LDUDXT) = (UETAB(LUETAB) - UETAB(LUETAB-1))/XTABPE(LUETAB)
      1      - XTABPE(LUETAB-1))
      LMI=LUETAB-1
      DO 550 I=1,LMI
      J=LUETAB+I-1
      XTODUX(J)=0.5*(XTABPE(J-1)+XTABPE(J))
550  UETAB(J) = (UETAB(J) - UETAB(J-1))/(XTABPE(J) - XTABPE(J-1))
      XTODUX(1)=XTABPE(1)
      UETAB(1) = UETAB(2)
      IDUXP=0
C
C   INITIALIZE VELOCITY DERIVATIVE.
C
560  CALL LCURV (X,XTODUX,UETAB,LDUDXT,IDUXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
C
C   BACK AND AVERAGE VALUES EQUAL FORWARD VALUES INITIALLY.
C
      DUEDSO=DUEDSN
      DUEDS=DUEDSN
      CALL XINTER (X,PEDGE,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           SHJ(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),RGPP(250),IYTILP,IYTILF,           /YTABLE/
1           CYTIL(6)                                               /YTABLE/
COMMON/MATRIX /A(250,3),B(250)
COMMON/XTABLE/RWTAB(500),XTABRW(500),LRWTAB,IRWXP,CRWX(6),
1           PETAB(500),XTARPE(500),LPETAB,IPEXP,CPEX(6);
2           UETAB(500),           LUETAB,IUEXP,CUEX(6),
3           XTUDUX(500),LDUDXT,IDUDXP
COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
1           SMDTAB(100),XTARMD(100),LMDTAB,IMDXP
COMMON/STEPSZ/DXLIM(50),XLIM(50),LDXLIM,IDX,
1           SKTAB(50),XTARSK(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,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUEDSO,           /EDGEBC/
1           DUEDS,DUEDSN,DPEDSN                                     /EDGEBC/
COMMON/NORMAL/BLREF,IREF,RHOREF,SMUREF,REYINF
COMMON/MULT  /XN,IEN,PEN,SMON,YN
COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAU1,BCF,SQW,STAN,SNTGRL,           /GPARAM/
1           SQWDS,SQWN                                              /GPARAM/
COMMON/CONST /SINIT,XINIT,XMAX,DFLTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
1           EPSLN3,CONVRG,02DY,04DY,0DY9Q
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/IDEBUG/IDEBUG(3),KMODMP,KENDMP
COMMON /INPROF/ UPROF(50),YRYNU(50),LUPROF,CUYX(6),HPROF(50),           /INPROF/
1           YRYNH(50),LHPROF,CHYX(6)                               /INPROF/
COMMON/PFGAS /GAMMA,FMOLWT,PR1
COMMON/NEW1  /ALEWIS,LEWIS
COMMON/NEW2  /RHOEB,SMUER,REYL,SXD
COMMON/NEW3  /AFTRNS,PLAW
COMMON/NEWS  /IYPR
COMMON/NEW7  /GPO,PAMB,INTDK,ZETAP1
COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
COMMON/NEW9  /IYEQ
COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IYVP,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,ICX,IRX,ITHX,ITLX,ITZTAB,IZX, /COOL/
3 MASSL,PRANDL,QWI,RANDL,RANDW,RMTAB(20),REY,SQWDSI, /COOL/
4 SQWI,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TL1, /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 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,PEDGER),
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,EPSLN,EPSLN1, /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,EAPROF,LDXLIM, /DATA/
5 LHPROF,LMTAB,LPETAB,LRWTAB,LSKTAB,LTWTAB,LUETAB, /DATA/
6 LUPROF,MASSL,MAXIT,NLPRNT,NSPRNT,N?I,PAMB,PEDGE, /DATA/
7 PEN,PETAB,PLAW,PRI,RANDW,RMTAB,RHOEK,RHOREF,RWTAB /DATA/
8 ,SINIT,SKTAB,SMDN,SMDTAB,SMUREF,SN3,TEGE,THITAB, /DATA/
9 TLTAB,TUBEN,TWTAB,TZTAB,UEGE,UEK,UPEN,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,7K /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
IRSRO=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)
      SQW1 = 0.0
      SQWDS1 = 0.0
      SUMQW1 = 0.0
      IYPOS = 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 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)

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=PEDGER*PEN
      PAMB=PAMB*PEN

```

```

C
C INITIALIZE X, S, AND ZETA.
C
C X=XINIT
C 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 (IRSRO .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 ALPHA FOR T-P EQUILIBRIUM CALCULATION.
C
C   AFWALL=APROF(I)
C
C   SET UP TABLES AND INITIALIZE X-DEPENDENT WALL AND EDGE CONDITIONS.
C
290 CALL TABLES
   XMAX=AMINI(XMAX,XLIM(LDXLIM),XTABSK(LSKTAR))
• 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*ZETA0**2*0.040
   ZETAP=2.5*SQRT(1./(REYL*SXO))
   GO TO 35
30 SXO=((DELTA1/(BLREF*.37))**.5*REYL)**.25
   ZETAP=.833*.37*.8/((REYL*SXO)**.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
C
C   CALL GFUNC
C   O2DY=0.5/DY
C   O4DY=0.25/DY
C   ODYSQ=1./(DY*DY)
C
C   INITIALIZE U, H, SH, ALPHA1, AND RHOV PROFILES ACROSS THE BOUNDARY
C   LAYER.
C
C   CALL PROFIL
C   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 = CU(I,JN)/U(NY,JN)**2
   A3 = EPS(I,JN)*SMUREF
32 WRITE (6,36) I,A1,A2,A3
36 FORMAT (33X,13,4X,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 MOODE (4)
   GO TO 70

```



```

C
C   CALCULATE GROSS BOUNDARY LAYER PARAMETERS AT S = SINIT.
C
C   IF (IRSRD.GT.0) RHO(NY,JA)=RHO(NY,JN)
C   CALL PARAMS
C
C   PRINT AT INITIAL STATION.
C
C   IF (IRSRD.EQ.0) ISTATN=0
C   ISPRNT=0
C   ILPRNT=0
C   CALL PRINT
C
C   HAVING COMPLETED ALL INITIALIZATION, SOLVE THE BOUNDARY LAYER FROM
C   X = XINIT TO X = XMAX.
C
C   CALL EXECUT
C   IF (IRSTAR.GT.0) WRITE (6,9800) RSTPR
9800  FORMAT (////42H THROAT RADIUS CORRECTED FOR DISPLACEMENT ,
1     11H THICKNESS = ,1PE14.7)
C   WRITE (6,330)
330  FORMAT (///27X,75HTABLE OF CORRECTED CONTOUR POINTS NORMALIZED AND
1     1 DIMENSIONAL AND DELTA STAR///17X,14HX (NORMALIZED),11X,
2     2 14HY (NORMALIZED),8X,17HDELTA STAR (FEET),13X,11HX (IN FEET),
3     3 14X,11HY (IN FEET)//)
C   M = 0
C   MAP = 0
C   REWIND IDRUM
C   DO 300 K = 1,NREC
C   READ (IDRUM) NST,((SUMARY(I,J), J = 1,NVAR), I = 1,NST)
C   DO 300 L = 1,NST
C   XCCP = SUMARY(L,20)/RSTPR
C   YCCP = SUMARY(L,10)/RSTPR
C   IF (SUMARY(L,20) .LT. XSTAR) GO TO 310
C   MAP = MAP + 1
C   XA(MAP) = XCCP
C   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 (15,1X,1P5E25.8)
C   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
C   IF (RHOEK.EQ.0) RHOEK=RHO(NY,JN)*RHOREF
C   THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
C   IF (UEK.EQ.0) UEK=U(NY,JN)*UREF
C   PAREN=THETA-BLREF*SNTGRL*RHOREF*UREF/(RHOEK+UEK*RW(2))*J2D)
C   TH1=RHOEK*UEK*UEK
C   BRKT=TH1*PAREN-(PEDGEB-PAMB)*DLSTAR
C   THLOSS=(2.*PIE*RW(2)*BLREF)*J2D*COS(THW(2))*BRKT
C   WRITE (6,9900) THLOSS
9900  FORMAT (////14H THRUST LOSS = ,1PE14.7)
C   IF (IPOLY .EQ. 0) STOP
C   CALL LESPAR (XA,YA,MAP)
C   END

```


SUBROUTINE TPCALC
 CTPCALC PERFORM A SINGLE TEMPERATURE-PRESSURE CALCULATION.

C	COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),	A 2
	GAMMAS(13),P(13),T,PPP(13),WM(13),SONVEL(13),	/POINTS/
	TYT(13)	/POINTS/
1	COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BO(15),	/MISC/
	BOP(15,2),TM,TLOW,TMID,THIGH,PP,COSUM,OF,EQRAT,	/MISC/
2	HSURD,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),	/MISC/
	NAMF(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),	/MISC/
3	RTEMP(15),FOX(15),DENS(15),TLN	/MISC/
4	COMMON /INDX/ CONVG,TP,WP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,	/INDX/
	JSOL,JLIQ,IC,IQ2	/INDX/
1		A 16

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)*ROP(I,1) + WP(2)*ROP(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

```

A 22

A 50-

```

SUBROUTINE TRIM (A,X,B,N;NN)
C
DIMENSION A(NN,3),AA(250),B(NN),RB(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,IP,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/
C
1 GAMMAS(13),P(13),T,PPP(13),WH(13),SONVEL(13), /POINTS/
2 TTY(13) /POINTS/
COMMON/SPECES/COEF(2,7,30),S(30),EN(30,13),DUM2(760)
COMMON /VISCX0/ VISCX(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),SMUD(50),SMUOH(50),SMUO2(50),TTAB(50)
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),SMUH20(I),SMUO(I),SMUOH(I),SMUO2(I)
 ,I=1,10)/
 1 100., 34.3E-6, 37.8E-6, 40.0E-6, 70.0E-6, 7A.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,
 0 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),SMUH20(I),SMUO(I),SMUOH(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, 658.7E-6, 703.7E-6,
 9 1900., 247.8E-6, 300.0E-6, 636.7E-6, 666.1E-6, 673.9E-6, 729.0E-6,
 0 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),SMUH20(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, 854.9E-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,
 0 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),SMUH20(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,
 0 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),SMUH20(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
C      DO 100 I=1,NPT
C
C      OBTAIN SPECIES VISCOSITIES FROM TABLES.
C
C      IX=0
C      CALL LCURV (TTT(I),TTAB,SMUH,50,IX,EMU(1))
C      CALL LCURV (TTT(I),TTAB,SMUH2,50,IX,EMU(2))
C      CALL LCURV (TTT(I),TTAB,SMUH20,50,IX,EMU(3))
C      CALL LCURV (TTT(I),TTAB,SMUO,50,IX,EMU(4))
C      CALL LCURV (TTT(I),TTAB,SMUOH,50,IX,EMU(5))
C      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
C      CALL CPSPEC (TTT(I),I)
C      DO 20 J=1,NS
C      CP(I,J)=CPI(J)/FMWT(J)
C      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
C      EMUBAR=0.
C      EKDBAR=0.
C      DO 40 II=1,NS
C      TM=0.
C      DO 50 JJ=1,NS
C      IF(JJ.EQ.II)GO TO 50
C      PHI(II,JJ)=(1./SQRT(8.*(1.+FMWT(II)/FMWT(JJ))))*
C      (1.+SQRT(EMU(II)/EMU(JJ))*(FMWT(JJ)/FMWT(II))*0.25)*0.2.
C      TM=TM+EN(JJ,I)*PHI(II,JJ)/EN(II,I)
50 CONTINUE
C      TM1=1.+TM
C      TM2=1.+1.065*TM

C      EMUBAR=EMUBAR+EMU(II)/TM1
C      EKD(II) = EMU(II)*(1.32750*CP(II) + 0.85896490625/FMWT(II))
40 EKDBAR = EKDBAR + EKD(II)/TM2

C
C      STORE ANSWERS.
C
C      VISCE(I)=EMUBAR*0.06722
100 PR(I) = EMUBAR*CPBAR/EKDBAR
C      RETURN
C      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)		
		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(I)	XNTE	12
	YP=0.	XNTE	13
	GO TO 105	XNTE	14
207	IX=7	XNTE	15
	IXO = 1	XNTE	16
	IXOGO=0		
		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		
	IF (IX) 22,22,20	XNTE	29
22	WRITE (6,23) X,XAR(I),IAR,XAR(IAR),IX,IXMAX,YAR(I),IAR,YAR(IAR)		
23	FORMAT (//IX,27HXNTERP OUT OF RANGE... X =,1PE15.8,3X,6HX(1) =,		
	1 E15.8,3X,2HX(,13,3H) =,E15.8/23X,4HX =,13,3X,7HXIXMAX =,13,3X,		
	2 6HY(1) =,E15.8,3X,2HY(,13,3H) =,E15.8//		
	CALL SUHTAB		
	CALL EXIT		
25	IF (X .LE. XAR(IX+1)) GO TO 27		
	IX = IX + 1	XNTE	37
	IF (IX=IXMAX) 25,25,22	XNTE	38
27	DO 28 I=1,4	XNTE	39
	I1=IX-2+I	XNTE	40
	X1(I)=XAR(I1)	XNTE	41
28	YI(I)=YAR(I1)	XNTE	42
	IF (IXMAX2) 203,204,205	XNTE	43
203	YP=(YI(2)-YI(1))/(X1(2)-X1(1))	XNTE	44
	Y=YI(1)+YP*(X-X1(1))	XNTE	45
	GO TO 105	XNTE	46
204	IF (IX=IXO) 45,100,45		
205	DX2 = X - X1(2)	XNTE	49
	DX32=XI(3)-X1(2)		

30	IF (IX=IX0) 40,31,60	XNTE	50
31	IX0G0=0	XNTE	51
	IF (IX=1) 32,32,33	XNTE	52
32	IG0=-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		
	IG0=1	XNTE	58
	GO TO 45	XNTE	59
34	IG0=1	XNTE	60
	GO TO 100	XNTE	61
35	IG0=0	XNTE	62
	GO TO 100	XNTE	63
40	IX0G0=-1	XNTE	64
	IF (IX .LT. IX0 - 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)-X1(2)	XNTE	71
	DY32=YI(3)-YI(2)	XNTE	72
	DY0X32=DY32/DX32	XNTE	73
	C(6)=(DY0X32-(YI(4)-YI(2))/DX42)/(X1(3)-X1(4))	XNTE	74
	C(5)=DY0X32-C(6)*DX32	XNTE	75
	IF (IX0G0) 43,43, 100	XNTE	76
43	IF (IX .LE. 1) GO TO 32		
	IG0 = 0		
45	C(1)=YI(1)	XNTE	79
	DX21=XI(2)-X1(1)	XNTE	80
	DX31=XI(3)-X1(1)	XNTE	81
	DY21=YI(2)-YI(1)	XNTE	82
	DY0X21=DY21/DX21	XNTE	83
	C(3)=(DY0X21-(YI(3)-YI(1))/DX31)/(X1(2)-X1(3))	XNTE	84
	C(2)=DY0X21-C(3)*DX21	XNTE	85
	IF (IX0G0) 100,100,62	XNTE	86
60	IX0G0=1	XNTE	87
	IF (IX - 1 .GT. IX0) 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		
	IG0 = 0		
	GO TO 42	XNTE	94

100	DX1 = X - XI(1)	XNTE 97
	YB1=(C(3)*DX1+C(2))*DX1+C(1)	XNTE 98
	YPB1=C(3)/.5*DX1+C(2)	XNTE 99
	IF(IG0) 101,101,110	
101	YB2 = C(4) + C(5)*DX2 + C(6)*DX2**2	XNTE 102
	YPB2=C(6)/.5*DX2+C(5)	
	IF (IG0 .LT. 0) GO TO 120	
	U1=DX2/DX32	XNTE 105
	U2=U1*U1	XNTE 106
	U3=U2*U1	XNTE 107
	A1=3.*U2-2.*U3	XNTE 108
	A1P=6.*(U1-U2)/DX32	XNTE 109
	Y=(1.-A1)*YB1+A1*YB2	XNTE 110
	YP=(1.-A1)*YPB1-A1P*(YB1-YB2)+A1*YPB2	XNTE 111
		XNTE 112
105	IXIN=IX	
	IF (IX0GO .EQ. 0) RETURN	
	DO 107 I = 1,6	XNTE 117
107	CAR(I)=C(I)	
	RETURN	
110	Y=YB1	XNTE 119
	YP=YPB1	XNTE 120
	GO TO 105	XNTE 121
120	Y=YB2	XNTE 122
	YP=YPB2	XNTE 123
	GO TO 105	XNTE 124
	END	XNTE 125

```

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/

COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP, /YTABLE/
COMMON /ZCALC/ ZETAO,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA, /ZCALC/
COMMON /ZCALC/ YTZETA,YEDGE /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUEDSO, /EDGEBC/
COMMON /EDGEBC/ DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLREF,IUREF,RHOREF,SMUREF,REYINF
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI

C
C  OBTAIN YZETA WHERE  $U = 0.99 \cdot U_E$ .
C
DO 100 K=1,NY
I=NY+1-K
TM1=ABS(U(1,JN)-UEDGE)/UEDGE
IF (TM1 .GE. 0.010) GO TO 50
TM2 = TM1
GO TO 100
50 YZETA=Y(1+I)-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*YZETA
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

```


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

ADDPT	NLOUT
BLKDTA	ODE
BNCND	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),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/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA, /ZCALC/
1      YTZETA,YEDGE /ZCALC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,PEYINF
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,ODDY,ODDY,ODYSR /CONST/
COMMON /MORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /MORI/
C
DIMENSION SUHR(3)
DATA SUHR/6HMMOMNTM,6HENERGY,6HELEMTS/
C
INCREMENT Y-COUNTERS.
C
NY=NY+1
NY1=NY-1
NY2=NY-2
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 IFL=1,NEL
100 ALPHA(NY,J,IFL) = ALPHA(NY1,J,IFL)
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
200 SHI(NY,J,ISP)=SHI(NY1,J,ISP)
210 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
C  $RHOV(NY) = RHOV(NY1) + (RHOV(NY2) - 1) - 4. * RHOV(NY2) + 3. * RHOV(NY1)) / 2.$ 
C
C CALCULATE E AND F AT NY.
C
C  $L(NY) = RHO(NY, JA) * BGP(NY) * ZETA * YI(LNY) / ZETA$ 
C  $F(NY) = BGP(NY) / (ZETA * ZETA * REYINF)$ 
C
C CALCULATE APPROPRIATE SIGMAS FOR PUSH-DOWN STORAGE AT NY = 2.
C
C NY3 = NY2 - 1
C GO TO (1100, 1200, 1300), IFLAG
C
C CALCULATE SIGMA1 FOR MOMENTUM EQUATION.
C
C 1100 SIG1(I) = SMU(NY3, JA) + EPS(NY3, JA)
C SIG1(I) = SMU(NY2, JA) + EPS(NY2, JA)
C GO TO 1400
C
C CALCULATE SIGMA2, SIGMA3, AND SIGMA4 FOR ENERGY EQUATION.
C
C 1200 DO 1250 K = NY3, NY2
C L = K - NY3 + 1
C TM1 = EPS(K, JA)
C TM2 = SMU(K, JA) / PR(K, JA)
C TM3 = TM1 / PRT(K, JA)
C SIG2(L) = TM2 + TM3
C SIG3(L) = SMU(K, JA) - TM2 + TM1 - TM3
C 1250 SIG4(L) = TM2 * (BLE(K, JA) - 1.0) + TM3 * (BLET(K, JA) - 1.0)
C GO TO 1400
C
C CALCULATE SIGMAS FOR ELEMENT EQUATION.
C
C 1300 DO 1350 K = NY3, NY2
C L = K - NY3 + 1
C 1350 SIG5(L) = SMU(K, JA) * BLE(K, JA) / PR(K, JA) + EPS(K, JA) *
C BLE(K, JA) / PRT(K, JA)
C 1400 WRITE (6, 9000) SURR(IFLAG), ISTATN, ITER
C 9000 FORMAT (1/49H POINT WAS ADDED TO BOUNDARY LAYER IN SUBROUTINE ,A6,
C 1 11H AT STATION,15,14H AND ITERATION,13/)
C RETURN
C END

```

```

BLOCK DATA
C
DIMENSION ATAM(3,51),ATEM(3,54),DATE(2,33)
C
COMMON /MISC/ ENN,SUMN,TT,SO,ATOM(3,105),LLMT(15),BD(15),
1 BCP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT, /MISC/
2 HSUB,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,IQ,NC, /INDX/
1 JSOL,JLIQ,IC,IQZ /INDX/
LOGICAL MOLES
COMMON /SPECES/ COEF(2,7,30),S(30),EN(30,13),ENLN(30),HO(30),
1 DELN(30),A(15,30),SCH(30,3),IUSE(30),TEMP(50,2)
INTEGER SLB
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
ATOMIC SYMBOLS, WEIGHTS, AND VALENCES
C
MODIFIED FOR DUMMY ELEMENTS (4) H C N O , (101+4)=105 ELEMENTS
C
DATA ATAM/2HF,1.008,1.,2HHE,4.003,0.,2HLT,6.940,1.,2HBE,9.013,2.,
12HB,16.820,3.,2HC,12.011,4.,2FM,14.008,0.,2HO,16.000,-2.,2HF,
219.000,-1.,2HNE,2.183,0.,2HNA,22.991,1.,2HMG,24.320,2.,2HAL,26.98
30,3.,2HSE,28.96,4.,2HP,30.975,5.,2HS,32.066,4.,2HCL,35.457,-1.,
42HAR,39.944,0.,2HK,39.944,1.,2HCA,40.080,2.,2HSC,44.960,3.,2HI,4
67.930,4.,2HV,50.950,5.,2HCK,52.010,3.,2HMN,54.940,2.,2HFE,55.850,
43.,2HCO,58.94,2.,2HNI,58.710,2.,2HCU,63.540,2.,2HZN,65.380,2.,2HG
A,69.720,3.,2HGE,72.600,4.,2HAS,74.920,3.,2HSE,78.960,4.,2HBR,79.9
816,-1.,2HKR,83.80,0.,2HRR,85.480,1.,2HSR,87.630,2.,2HY,88.910,3.
9,2HZR,91.224,4.,2HNR,92.91,5.,2HMO,95.950,8.,2HTC,99.000,7.,2HRU,
910,1.,2HRH,12.910,3.,2HPO,106.400,2.,2HAG,107.860,1.,2HCO,11
62.410,2.,2HIN,114.820,3.,2HSA,118.700,4.,2HSH,121.760,3./
DATA ATEM/2HTE,127.610,4.,2HT,126.910,-1.,2HXE,131.300,0.,2HCS,13
12.910,1.,2HBA,137.360,2.,2HIA,138.920,3.,2HCE,140.130,3.,2HPR,140.
2910,3.,2HND,144.270,3.,2HPI,147.000,3.,2HSM,150.350,3.,2HEU,152.00
30,3.,2HGD,157.260,3.,2HTB,158.930,3.,2HDY,162.510,3.,2HMO,164.940,
43.,2HER,167.270,3.,2HTM,168.940,3.,2HYB,173.040,3.,2HLU,174.990,3.
5,2HNF,178.500,4.,2HTA,180.950,5.,2HW,183.840,6.,2HRE,186.220,7.,2
AHOS,190.200,4.,2HIR,192.200,4.,2HPT,195.090,4.,2HAU,197.000,3.,2HH
76.200,610,2.,2HTL,204.390,1.,2HPR,207.210,2.,2HRI,208.990,3.,2HPU,
2210.000,2.,2HAT,210.000,0.,2HRN,222.000,0.,2HFR,223.000,1.,2HRA,22
96.000,2.,2HAC,227.000,3.,2HTH,232.000,4.,2HPA,231.000,5.,2HU,238.
000,6.,2HNP,237.000,5.,2HPO,242.000,4.,2HAM,243.000,3.,2HCM,247.00
50,3.,2HRK,249.000,3.,2HCP,251.000,3.,2HES,254.000,0.,2HFM,253.000,
5.0.,2HMD,256.000,0.
C
DUMMY H C N O
A 2HZZ,1.008,1., 2HCZ,12.011,4., 2HNZ,14.008,0., 2HOZ,16.000,-2./
C
C

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NOMINAL GDF THERMAL DATA AND REACTANTS DATA

```

DATA (SUR(1,1), I=1,6)/4HH , 4HH2 , 4HH20 , 4HU , 4H0H , 4H0Z /,
1 (DATE(1,1), DATE(2,1), I = 1,6)/3HU 9,3H/65,3HU 9,3H/61,3HU 3,
2 3H/6 , 3H/62,3HU 3,3H/66,3HU 9,3H/65/, (MT(1,J),R(1,J),
3 I = 1,6), J = 1,6)/2HH , 1.0,2H , 0.0,2H , 0.0,2H , 0.0,2H , 2.0,
4 2H , 0.0,2H , 0.0,2H , 0.0,2H , 2.0,2H , 1.0,2H , 0.0,2H , 0.0,
5 2H , 1.0,2H , 0.0,2H , 0.0,2H , 0.0,2H , 1.0,2H , 1.0,2H , 0.0,
6 2H , 0.0,2H , 0.0,2H , 0.0,2H , 0.0,2H , 0.0/, (PHAZ(1), I = 1,6)/
7 6*1HG/, (T(1), I = 1,6)/6*30.0/, (T(2), I = 1,6)/6*5000.0/,
8 TLOW,THIGH/300.0,1000.0,5000.0/, NAME(1,1), ANUM(1,1),
9 NAME(2,1), ADDR(2,1)/2HH , 2.0,2H , 2.0,2H , 2.0,2H , 2.0,2H /, PECT(1), PECT(2)/100.0,
10 71.0, PONESZ, FALSE.0, ENTH/15.0,0/, FAZ/15.1HG/,
11 RTEMP(1), RTEMP(2), RTEMP(3)/3*298.15/, FOX(1), FOX(2), FOX(3)/1HF,
12 T1,1HG/, DENS(1), DENS(2), DENS(3)/3*0.0/, NSPEC/3/, NPROD/9/,
13 THERM/2/, (SUB(1,2), SUR(1,3), I=1,9)/18*4H /, (NAME(1,1),
14 NAME(2,1), NAME(3,1), I=2,5)/12*2H /
DATA (SUR(1,1), I=7, 9)/4HN , 4HN2 /, (DATE(1,1), DATE(2,1),
1 I = 7,9)/3HU 3,3H/63,3HU 6,3H/63,3HU 9,3H/65/, (MT(1,J),R(1,J),
2 I=1,9), J=7,9)/2HH , 1.0,2H , 0.0,2H , 0.0,2H , 0.0,
3 2HH , 1.0,2H , 1.0,2H , 0.0,2H , 0.0,
4 2HH , 2.0,2H , 0.0,2H , 0.0,2H , 0.0/,
5 (PHAZ(1), I=7,9)/3*1HG/, (T(1), I=7,9)/3*300.0/,
6 (T(2), I=7,9)/3*5000.0/,
7 NAME(3,1), ANUM(3,1)/2HH , 2.0,2H , PECT(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, -0.4611763, 2.50, 4.000, 25471.627, -0.46011762, 3.1001901,
2 5.1119464E-4, 5.2444210E-8, -3.4919973E-11, 3.6945345E-15, -877.38042
3 -1.9629421, 3.0574451, 2.676520E-3, -5.8089162E-6, 5.5710391E-9,
4 -1.0122739E-12, -968.90474, -2.2997056, 2.7167633, 2.9451374E-3,
5 -8.0224374E-7, 1.226682E-10, -4.8472145E-15, -29905.826, 6.6305671,
6 4.01711275, -1.1084499E-3, 4.1521180E-6, -2.9637404E-9, 8.0702103E-13,
7 -3.779.722, -0.32271046, 2.5421596, -2.7550619E-5, -3.1128033E-9,
8 4.5510674E-12, -4.3680515E-16, 29230.833, 4.9203080, 2.9464287,
9 -1.6381665E-3, 2.04210316E-6, -1.6028432E-9, 3.8906964E-13, 29147.644,
10 2.9639949, 2.9106427, 9.5931650E-4, -1.9441702E-7, 1.3756646E-11,
11 1.4224542E-16, 3935.3815, 5.4423445, 3.8375943, -1.0778858E-3,
12 9.6830378E-7, 1.08713972E-10, -2.2571094E-13, 3641.2823, 0.49370009,
13 2.6219535, 7.3618264E-4, -1.9652224E-7, 3.6201558E-11, -2.8945627E-15
14 -12.1.9825, 3.615.960, 3.6255985, -1.8782184E-3, 7.0554544E-6,
15 6.7435137E-9, 2.1555993E-12, -1047.5226, 4.3052778/
DATA ((COEF(I,J,K), J=1,7), I=1,2), K=7,9)/2.4502682, 0.00010661458,
1 -0.74653373E-7, 0.18796524E-10, -0.10259839E-14, 56116.040,
2 4.448758, 2.5030714, -0.218.1181E-4, 0.54205287E-7,
3 -0.56475602E-13, -0.20999044E-13, 56098.904, 4.1675744,
4 3.1890, 0.013382281, -0.5269318E-6, 0.95919332E-10, -0.64847932E-14
5 .9828.329, 6.7458126, 4.00459521, -0.0034181783, 0.79819190E-5,
6 -0.61139316E-8, 0.15919676E-11, 9745.3934, 2.9974988,
7 2.8963194, 0.001515866, -0.57235277E-6, 0.99807393E-10,
8 -0.65223555E-14, -905.86184, 6.1615148, 3.6748261, -0.001208150,
9 0.23240102E-5, -0.63217559E-9, -0.22577253E-12, -1061.1588, 2.358042/
END

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A 61-

SUBROUTINE BNDPND
 CBNDPND CALCULATE QUANTITIES NECESSARY FOR BOUNDARY CONDITIONS AT

```

C      FORWARD STATION.
C
COMMON/INDEP /S,DS,X,DX,Y(250),DY
COMMON/XTABLE/RWTAB(500),XTARW(500),LRWTAB,IRWXP,CRWX(6),
1      PETAB(500),XTARPE(500),LPETAB,IPEXP,CPEX(6),
2      UETAB(500),          LUETAB,IUEXP,CEXE(6),
3      XTIDUX(500),LDUDXT,IDUDXP
COMMON/LTABLE/TWTAB(100),XTARTW(100),LTWTAB,ITWXP,
1      SMDTAB(100),XTARMD(100),LMDTAB,IMDXP
COMMON/GEOM  /RW(2),DRDA(2),THW(2)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
1      YZETA,YEDGE      /ZCALC/
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEEDGE,UEEDGE,PEEDGE,AFEDGE,DUEDSO, /EDGEBC/
1      DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLPEF,UREF,RHOREF,SMUREF,REYINF
COMMON/OPTION/IDEAL,LAMNR,IACMP
COMMON/HZINJ/INJP2
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,UE,TAP,LDUDXT,IDUDXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
      DUEDS=0.5*(DUEDSN+DUEDSO)
C
C      INTEGRATE TO OBTAIN UE AT FORWARD STATION.
C
      UEDGE=UEEDGE+DUEDS*DS
C
C      CONTINUITY EQUATION BOUNDARY CONDITION.
C      AT WALL    RHOV = MDCTW
C
      CALL LCURV (X+DX,XTARMD,SMDTAR,LMDTAB,IMDXP,SMDWN)
      SMDWN=SMDWN/(RHOREF*UREF*ZETAN)
      SMDW=0.5*(SMDWN+SMDWO)

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

```

```

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

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SUBROUTINE CONTINU
CCOBT=U INTEGRATE CONTINUITY EQUATION FROM WALL TO EDGE TO OBTAIN
C RHOV PROFILE AT  $M + 1/2$ .
C

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COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
COMMON/INDEP /S,DS,X,FX,Y(250),DY
COMMON/PROP /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 /YTABLE/ YTIL(250),BGP(250),BGPP(250),YTILP,YTILF, /YTABLE/
CYTIL(6) /YTABLE/
COMMON/GFOM /RW(2),DRWD(2),THW(2)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(3),DSZ(2),YZETA, /ZCALC/
YTZETA,YEDGE /ZCALC/
COMMON/WALLHC/TRAIL,SHWALL,HWALL,SMDW0,SMDW,SMDWN
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1 EPSLN3,CONVRG,O2DY,O4DY,O4YSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/NEV11 /J2D,UEF,RHOEX
C
C INITIAL CONDITION - AT WALL RHOV = MPOTV
C
RHOV(I)=SMDW
C
C INITIALIZE PUSH-DOWN STORAGE.
C
RUMN1=RHO(I,JO)*U(I,JO)
RUMIN1=RHO(I,JN)*U(I,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,JO)*U(I,JO)
RUMIN=RHO(I,JN)*U(I,JN)
DRUDS=(RUMIN+RUMIN1)-RUMN-FUPP1/(2.*DS)
DRUDY=(RUMIN+RUMN-RUMIN1-RUMN1)*O2DY
RUMHMH=.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)*RUMHMH*DRWDS/
1 (GPNH*RWAVE)+ZETAP/ZETA*YTNH*DRUDY)
C
C PUSH-DOWN STORAGE.
C
RUMN1=RUMN
RUMIN1 = RUMIN
RETURN
END

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SUBROUTINE DUMPIIT
CDUMPIIT  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/MATRIX /A(250,3),B(250)
COMMON/EFVEE /E(250),F(250)
COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
COMMON/COUNT /NY,NY1,NY2,NY3,,JO,JN,JA,NEL,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 SIG5S(I),I=1,3)
RETURN
9000 FORMAT (/2I6/1I2,72X,1P4E12.4)
9010 FORMAT (110,1P1E12.4)
9020 FORMAT (110,72X,1P4E12.4)
9030 FORMAT (15X,1P6E12.4)
END

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MPILATION: NO DIAGNOSTICS.

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SUBROUTINE EDDY
C      CHANGES TO SUBROUTINE EDDY
CFEDY  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),SMU(250,3),PR(250,3),BLE(250,3),
1          SHI(250,2,9),SC1(250,2,9),T(250,3),AV(250)
COMMON/TPROP /EPS(250,3),PRT(250,3),HLET(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/WALLFC/TFALL,SHWALL,HWALL,SMDF0,SMDF,SMDFN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEEDGE,UEEDGE,PEEDGE,AFEDGE,DUEDSO, /EDGEBC/
1          DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/CONST /SINI,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1          EPSLN3,CONVRG,ODDY,OHDY,ODYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NP,NMAX,NYI
COMMON/NEWI /ALEY1S,1LEY1S
COMMON /FVEC/ F(250),F(250) /FVEC/
COMMON /MATRX/ A(250,3),B(250) /MATRX/
COMMON /CMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CW(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(1,JN)-UEEDGE)/UEEDGE
IF(SX1.GE.0.010) GO TO 31
SX2=SX1
GO TO 35
30 TDDELTA=Y(I+1)-DY*(SX2-0.010)/(SX2-SX1)
GO TO 3R
35 CONTINUE
38 CALL ANTEFF(TDELTA,SDELTA,DUMNY,IYTILP,Y,YTIL,NY,CYTIL,ITILF)
C
DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSN
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(1,JN)-UEEDGE)/UEEDGE
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

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C
C FIND DELTA CORRESPONDING TO YDELTA.
C
120 CALL XNTERF (YDELTA,DELTA,DUMMY),IYTIIP,Y,YTIL,NY,CVTIL,IYTILF)
IYTILF=IYTIIP
C
C CALCULATE TURBULENT TRANSPORT PROPERTIES AT EACH MESH POINT.
C
EPSI(I,JN)=0.
PRT(I,JN) = 13.61/(11.440*SQRT(PR(I,JN)))
T1=REYIIF*ZETAN
T2=T1/26.
DERIV=02DY*(-U(I+1,JN)+4.*U(I,JN)-3.*U(I-1,JN))
PAREN=SMU(I,JN)*RGP(I)*DERIV/V1
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (SMDWN.EQ.1.0) GO TO 170
TM3 = T1*ZETAN**2/(SMU(I,JN)*(BGP(I)*DERIV)**3)
TM4 = 1.0 + 11.61*DPEDSN*SQRT(TM3/RHO(I,JN))
IF (TM4.EQ.1.0) RN = 1.0
IF (TM4.GT.1.0) RN = SQRT(TM4)
GO TO 180
170 TM3 = 11.61*SMDWN/SQRT(RHO(I,JN))*SQRT(T1*ZETAN**2*SMU(I,JN)/
      (RGP(I)*DERIV))
      TM4=DPEDSN/(SMU(I,JN)*BGP(I)*DERIV*SMDWN)
180 DO 300 I = 2,NY
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (SMDWN.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(6,200) I,DPEDSN,SMU(I,JN),DERIV,SMDWN,TERM,SMU(I,JN)
2000 FORMAT(15,1P6E17.7)
2001 CONTINUE
BN = SQRT(SSS)
190 BRKT = -T2*YTIL(I)*BN/SMU(I,JN)*SQRT(RHO(I,JN)*PAREN)
CVV(I,JN) = BRKT
CIV(I,JN) = 1.16.*T1*BGP(I)*YTIL(I)*YTIL(I)*RHO(I,JN)*
      ABS(02DY*(U(I+1,JN)-U(I-1,JN)))*(1.0-EXP(BRKT))**2
C
C CALCULATE TURBULENT PRANDTL NUMBER.
C
300 PRT(I,JN) = (40/0.440*(1.0 - EXP(BRKT)))/(1.0 - EXP(26.0*
      SQRT(PRT(I,JN))*BRKT/34.0))
C
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (SMDWN.EQ.1.0) GAMA=0.361
I = 2
C
C CALCULATE TEMPORARY QUANTITIES
C
10 UYMN = (U(I+1,JN) - U(I-1,JN))*02DY
RHOY = (RHO(I+1,JN) - RHO(I-1,JN))*02DY
UUYMN = (CUU(I+1,JO) - 2.*CUU(I,JO) + CUU(I-1,JO))*02DYSQ
CUCYMN = (CUU(I+1,JO) - CUU(I-1,JO))*02DY
SMUY = (SMU(I+1,JN) - SMU(I-1,JN))*02DY
ALFA = 1.10/ZK
T2 = RHOV(I)*RGP(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,J)*F(I)*RGP(I)*UYMN**2
TM1 = F(I)*RGP(I)*EPS(I,J)*ALFA
DERIV = 020Y*(EPS(I+1,J) - EPS(I-1,J))
TM2 = F(I)*(EPS(I,J)*BGFP(I)/BCP(I) + RGP(I)*DERIV)*ALFA
TM3 = (EPS(I,J)/(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) = 040Y*(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,J) - 0.50*(T2 - TM2)*
      (CUYMN + 0.50*UUYMN*TM1)
I = I + 1
IF (I*LE*NY) GO TO 10
A(I,1) = 0.0
A(NY2,3) = 0.0
CALL TRIM(A, CUU(2,JN), B, NY2, NMAX)
CUU(I,JN) = 0.0
CUU(NY,JN) = 0.0
CUV(I,JN) = 0.0
DO 1000 I=2,NY
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)
IF (CUU(I,JN)*LT*.0) CUU(I,JN) = 0.0
EPS(I,JN) = BN*ZK*RHO(I,JN)*SORT(ABS(CUU(I,JN)))*REYINF*ZETAN
IF (CUV(I,JN)*LE*EPS(I,JN)) EPS(I,JN) = CUV(I,JN)
1000 CONTINUE
EPS(I,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)+
      EPS(I+1,JN)*EPS(I+2,JN))/5.0
C NEV K ***** CUU(I,JN) *****
SLS = YTIL(I)/DELTA

SLS2 = SLS*SLS
BN = YTIL(I)*(0.250*SLS2-0.5860*SLS+0.4310)
CUU(I,JA) = (EPS(I,JA)/(ZK*TI*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) = TLENTS
RETURN
END

```

SUBROUTINE ELEMTS

CFLPMTS SOLVE EACH SYSTEM OF ELEMENT EQUATIONS FOR ELEMENT MASS
 C FRACTIONS ALPHA(I+1,N).

```

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),
  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),BEP(250),HGPP(250),IYTILP,IYTILF, /YTABLE/
  CYTIL(6) /YTABLE/
COMMON/MATRIX /A(250,3),B(250)
COMMON/FFVEC /E(250),F(250)
COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG5S(3)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZETAP,ZSTART3,DSZ(2),YZETA, /ZCALC/
  YTZETA,YEDGE /ZCALC/
COMMON/WALLBC/TWALL,SHRALL,HWALL,SMDW0,SMBW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEdge,UEdge,PEdge,AFEDGE,DUEDS0, /EDGEBC/
  DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLRFF,UREF,RHOREF,SHUREF,PEYINF
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
  EPSLN3,CONVRG,OZDY,ODUY,ODYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/NEJ3 /AFTRNS,PLAY
  
```

C FOR EACH ELEMENT EXCEPT LAST, EVALUATE COEFFICIENTS OF SYSTEM OF
 C ELEMENT CONSERVATION EQUATIONS.

```

SIG5S(1)=SIG5(1)
SIG5S(2)=SIG5(2)
DO 401,0 IEL=1,NEL,1
  SIG5(I)=SIG5S(I)
SIG5(2)=SIG5S(2)
INCRMT=:
  I=2
  
```

C CALCULATE TEMPORARY QUANTITIES.

```

100 BE = F(I)
BF=F(I)
SIG5(3)=SMU(I+1,JA)*BLE(I+1,JA)/PR(I+1,JA)+
  EPS(I+1,JA)*BLET(I+1,JA)/PRT(I+1,JA)
SIG5Y=(SIG5(3)-SIG5(1))*OZDY
AYINN=(ALPHA(I+1,JO,IEL)-ALPHA(I-1,JO,IEL))*OZDY
AYYMN=(ALPHA(I+1,JO,IEL)-2.*ALPHA(I,JO,IEL)+ALPHA(I-1,JO,IEL))*
  ODYSQ
  TERM=BF*BGP(I)*SIG5(2)*ODYSQ
  
```

```

      TM1=HGPP(1)*SIG5(2)/BGP(1)+BGP(1)*SIG5Y
      TM2=R4QV(1)*HGPP(1)
      TM3=RHO(1,JA)*U(1,JA)/DS
C
C      COEFF. OF ALPHA1(M+1,N+1)
C
      A(I-1,1)=0.4*DY*(BE*U(1,JQ)-T1/2+BF*TM1)-0.5*TERM
C
C      COEFF. OF ALPHA1(M+1,N)
C
      A(I-1,2)=TM3+TERM
C
C      COEFF. OF ALPHA1(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(1,JO,IEL)-0.5*TM2*AYMN+
      1      0.5*BF*(TM1*AYMN+AGP(1)*SIG5(2)*AYMN)+0.5*BE*AYMN*U(1,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(IEL.F0.2) GO TO 251
      IF(INCRMT.GT.0) GO TO 250
      BIGA=REYINF*ZETA*ZETA*SMOW*PR(1,JA)/(BGP(1)*SMU(1,JA)*BLE(1,JA))
      DENOM=2.*DY*BIGA+3.
      ANTRNS = 1.-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.
253 ANEDGE=0.79.
      B(NY2)=B(NY2)-A(NY2,3)*ANEDGE
      A(NY2,3)=0.
C
252 CONTINUE
C
C      SOLVE ELEMENT EQUATIONS FOR ALPHA(M+1,N), N=2,3,...,NY-1

```

```

CALL TRIM (A,ALPHA(2,JN,IEL),B,NY2,NMAX)
C
C APPLY BOUNDARY CONDITIONS FOR ALPHA(M+1,1) AND ALPHA(M+1,NY)
C
IF(TEL.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 4000
400 ALPHA(1,JN,IEL) = (4.0*ALPHA(2,JN,IEL)-ALPHA(3,JN,IEL)+
!          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 DFBUG (4,HELEMTS)
IF(NY.EQ.NMAX)CALL DFBUG (1,HFELEMTS)
CALL ADAPT (3)
I=NY-1
GO TO 111
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(I+1,N).
C
COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
COMMON/INDEF /S,DS,X,DX,Y(250),DY
COMMON/PROP /RHO(250,3),SHU(250,3),PR(250,3),BLE(250,3),
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),RGP(250),RGPP(250),IYTILP,IYTLF, /YTABLE/
CYTIL(6) /YTABLE/
COMMON/MATPX /A(250,3),B(250)
COMMON/FFVEC /E(250),F(250)
COMMON/SIGMAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG6(3)
COMMON/WALLBC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDEGE,UEDEGE,PEDGEB,AFEDGE,DUEDSO, /EDGEBC/
DUEDS,DUEDSN,DPEDSN /EDGEBC/
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
EPSLN3,CONVRG,G2DY,G4DY,ODYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JU,UN,JA,NEL,NEL1,MSP,NMAX,NYI
COMMON/IDEBUG/IDEBUG(3),KMODMP,KENDMP
C
C EVALUATE COEFFICIENTS OF SYSTEM OF ENERGY EQUATIONS.
C
INCRM=L
I=2
C
C CALCULATE TEMPORARY QUANTITIES.
C
DO 100 J=1,N
BF = F(I)
BF = F(J)
T1 = EPS(I+1,JA)
T2 = SHU(I+1,JA)/PR(I+1,JA)
T3 = T1/PRT(I+1,JA)
SIG2(3) = T2 + T3
SIG3(3) = SHU(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)) * G2DY
SIG3Y = (SIG3(3) - SIG3(1)) * G2DY
SIG4Y = (SIG4(3) - SIG4(1)) * G2DY
UYMN = (U(I+1,JU) - U(I-1,JU)) * G2DY
UYYN = (U(I+1,JU) - 2.*U(I,JU) + U(I-1,JU)) * ODYSQ
HYMN = (H(I+1,JU) - H(I-1,JU)) * G2DY
HYYN = (H(I+1,JU) - 2.*H(I,JU) + H(I-1,JU)) * ODYSQ
TERM = BF * RGP(1) * SIG2(2) * ODYSQ
TM1 = RGPP(1) * SIG2(2) / RGP(1) + RGP(1) * SIG2Y
TM2 = RHOV(1) * RGP(1)
TM3 = RHO(I,JA) * U(I,JA) / DS
TERMU = BF * RGP(1) * SIG3(2) * ODYSQ * U(I,JU)
100

```



```

      TM2=FGPF(1)*SIG3(2)/BGP(1)+FCP(1)*SIG3Y
C
C COEFF. OF H(N+1,I-1)
C
      A(I-1,1)=0.4D)**(BF*U(1,JO)-TM2+BF*TM1)-0.5*TERM
C
C COEFF. OF H(N+1,N)
C
      A(I-1,2)=TM3+TERM
C
C COEFF. OF H(N+1,N+1)
C
      A(I-1,3)=-A(I-1,1)-TERM
C
C RIGHT-HAND SIDE (INCLUDING U(N+1,N) TERMS OBTAINED FROM MOMENTUM
C EQUATION)
C
C COEFF. OF U(N+1,N-1)
C
      CCOEFF1=0.4*(BF*TM1)*U(1,JO)+0.2D)*BF*BGP(1)*SIG3(2)*UYMN-0.5*TERMU
C
C COEFF. OF U(N+1,N)
C
      CCOEFF2=-0.5*(BF*UYMN+BF*TM1)*UYNN)-0.5*BF*BGP(1)*SIG3(2)*UYMN+
1      TERMU
C
C COEFF. OF U(N+1,I+1)
C
      CCOEFF3=-CCOEFF1)-TERMU
C
C EVALUATE SUMMATION OVER SPECIES
C
      SUMSP=L
      DO 150 ISP=1,MSP
C
C STORE TEMPORARY AVERAGES.
C
      SHMIA=L.5*(SMI(I-1,JO,ISP)+SMI(I-1,JN,ISP))
      SHIA=L.5*(SMI(I,JO,ISP)+SMI(I,JN,ISP))
      SHPIA=L.5*(SMI(I+1,JO,ISP)+SMI(I+1,JN,ISP))
      SCMIA=L.5*(SCI(I-1,JO,ISP)+SCI(I-1,JN,ISP))
      SCIA=L.5*(SCI(I,JO,ISP)+SCI(I,JN,ISP))
      SCPIA=L.5*(SCI(I+1,JO,ISP)+SCI(I+1,JN,ISP))
      SHIY=0.2IY*(SHPIA-SHMIA)
      SCIY=0.2IY*(SCPIA-SCMIA)
      SCIYY=0.0YSG*(SCPIA-2.*SCIA+SCMIA)
150 SUMSP = SUMSP + SHIA*SCIY*(FGPF(1)*SIG4Y + BGP(1)*SIG4(2)/BGP(1))
1      + FGP(1)*SIG4(2)*(SHIY*SCIY + SHIA*SCIYY)
C
C ASSEMBLE ALL TERMS.
C
      B(I-1)=TM2*H(1,JO)-0.5*(TM2*UYNN-BF*(TM1)*UYMN+BGP(1)*SIG2(2)*
1      UYNN)+BF*SUMSP-CCOEFF1*U(I-1,JN)-CCOEFF2*U(1,JN)-
2      CCOEFF3*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.1) 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 DUMPI
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 (4HENERGY)
IF (NY.EQ.NMAX) CALL DEBUG (6HENERGY)
CALL ADAPT (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/PROP  /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
              SHI(250,2,Y),SCI(250,2,9),T(250,3),AV(250)
COMMON/TPROP /EPS(250,3),PRT(250,3),HLET(250,3)
COMMON /ZCALC/ ZETA0,ZETA,ZETAN,ZE1AP,ZSTAR(3),DSZ(2),YZETA,      /ZCALC/
              YTZETA,YEDGE      /ZCALC/
COMMON/PALLBC/TWALL,SIWALL,HWALL,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUFDSO,    /EDGEBC/
              DUEDS,DUEDSN,CHEDSN      /EDGEBC/
COMMON/NORFAL/ZREF,UREF,RHOREF,SMUREF,REYINF
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,LPSLN1,EPSLN2,
              EPSLN3,CONVKG,CDUY,CDYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/OPTION/IDEAL,IAMNR,JNOMP
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/PRINTC /ISPPNT,ILPFLT,ISPPNT,ILPRT,LNSPPG,LINESR
COMMON/SOLARY/SUMARY(15,30),NREC,NSIA,ISTA,NVAR,DRUM,LAST
COMMON/DEBUG/IDEBUG(3),KMODMP,KENDMP
COMMON/START/IRSRD,IRSWR,ITAPE
COMMON /AL/  INSTAT,EPSLIN
COMMON /ONPT/ CUV(250,3),CVV(250,3),CVW(250,3),CWP(250,3),GAMA,ZK /OMORI/
COMMON/H21001:JN2

```

```

MADFLG#0

```

```

C
C      BEGIN CALCULATION OF NEW STATION.
C

```

```

200  ISTATN = ISTATN + 1
      IF (ISTATN .GT. ISTAT) GO TO 100
      LPSLN1 = EPSLIN
      LPSLN2 = EPSLIN
      LPSLN3 = EPSLIN

```

```

100  ITER = 0

```

```

C
C      CHECK IF DEBUG IS ON.
C

```

```

      KMODMP=0
      KENDMP=0
      IF (IDEBUG(1) .EQ. 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 STFP
C
C CALCULATE ZETAN AND ZETA FOR ITER = 0.
C
ZETAN=ZETA0+DS*ZETAP
ZETA=.15*(ZETA0+ZETAN)
C
C EVALUATE WALL AND EDGE CONDITIONS AT FORWARD STATION.
C
CALL HNDEND
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF(SMDWN.EQ.1.)MADFLG=1
C
C BEGIN ITERATION LOOP.
C UPDATE SH* AND HW BASED ON LATEST D/F 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 320
DO 32 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 ENRGY
IF((IDEAL.EQ.1).AND.(INJH2.EQ.0)) GO TO 340
IF(MADFLG.EQ.1)GO TO 340
C
C SOLVE ELEMENT EQUATIONS FOR ALPHA.
C
CALL ELEMTS

```

```

C
C CALCULATE LAMINAR TRANSPORT AND THERMODYNAMIC PROPERTIES AT EACH
C MESH POINT.
C
C 340 IF((IDEAL.EQ.1).AND.(INJM2.EQ.0)) GO TO 345
C THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
C IF(SMDWN.EQ.0.0) GO TO 370
C CALL HOODE (4)
C GO TO 370
345 DO 350 I = 1,NY
SHB=SH(I,JN)*UREF*UREF
CALL IGODE (I(I,JN),SHB,PE,GER,0,RHOH,SMUB,PR(I,JN))
RHO(I,JN)=RHOH/RHOREF
350 SMU(I,JN) = SMUB/SMUREF
C
C UPDATE ZETAN, ZETA, AND ZETAP.
C
C 370 CALL ZFUNC
C
C CALCULATE TURBULENT TRANSPORT PROPERTIES.
C
C IF(LAMNR.GT.0)GO TO 380
C CALL EDDY
C
C INTEGRATE CONTINUITY EQUATION TO OBTAIN RHOV.
C
C 380 CALL CONTNU
C
C IF ITERATING ON SOLUTION, CHECK FOR CONVERGENCE ON MAXIMUM
C ITERATIONS.
C
C IF (MAXIT .LE. 0) GO TO 500
C IF (ITER .NE. 0) GO TO 420
C DUDYO = 02DY*(4.*U(2,JN) - 3.*U(1,JN) - U(3,JN))
C ITER=ITER+1
C GO TO 300
420 DUDY=02DY*(-U(3,JN)+4.*U(2,JN)-3.*U(1,JN))
C IF (ABS((DUDY-DUDYO)/DUDY) .LE. CONVRG) GO TO 500
C IF (ITER .GE. MAXIT) GO TO 500
C ITER = ITER + 1
C DUDYO=DUDY
C GO TO 300
C
C F N D O F I T E R A T I O N L O O P .

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```

C
500 X = X + DX
   S=S+DS
C
C CALCULATE GROSS BOUNDARY LAYER PARAMETERS.
C
   CALL PARANS
C
C CHECK FOR END OF CASE.
C
   IF (X + 1.E-6 .GE. XMAX) GO TO 900
C
   PRINT AT THIS STATION IF REQUIRED.
C
   CALL PRINT
C
C CALCULATE ZETA AND ZETAP FOR NEXT STATION.
C
   ZETAP=(ZETAN-ZSTAR(1))/(DSZ(1)+DS)
   ZSTAR(1)=ZETA0
   ZETA0=ZETAN
   USZ(1)=DS
C
C MOVE FORWARD VALUES TO BACK VALUES.
C
   DO 400 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 500 IEL=1,NEL
500 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 E N D   O F   C A S E .   P R I N T   F I N A L   S T A T I O N .
C
900 ISPRNT = 0
   ILPRNT=C
   LAST=J
   CALL PRINT
   CALL SUMTAP
   IF(INSWR.GT.2)END FILE ITAPE

RETURN
END

```

```

SUBROUTINE HOODE (ICALL)
CHCODE  TFCBL = ODE INTERFACE SUBROUTINE FOR HYDROGEN-OXYGEN SYSTEM.
C
C  TFCBL COMMON BLOCKS
C
COMMON/DEPEND/UC(250,3),HC(250,3),ALPHA(250,3,3),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(250,2,9),SCI(250,2,9),T(250,3),AV(250)
COMMON/XTABLE/RPTAB(500),XTARPE(500),LRWTAB,IRXP,CRWX(6),
1          PETAR(500),XTARPE(500),LPETAB,IPEXP,CPEX(6),
2          UETAB(500),          LUETAB,IUEXP,CUEX(6),
3          XTDUDX(500),LTDUDX,LDUDXP
COMMON//ALLFC//TALL,SHWALL,HYALL,SMOWO,SMOW,SMOYN
COMMON /EDGEFC/ TEDGE,SHEDGE,HEGE,UEGE,PEDGE,AFEDGE,DUESO, /EDGEHC/
1          DUES,DUFOSU,CFEEN  /EDGEBC/

COMMON/ACFHAL/BLFF,UREF,RHOREF,SMUREF,REYINF
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JOA,JA,NEL,NEL1,NSP,NHAX,NYI
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/PEGS /GAMMA,FMOLT,FRI
COMMON/NEV1 /ALEP1S,TLAP1S
COMMON/NEV2 /RHOB,SHUER,REYL,SXU
COMMON/NEV3 /IYER
COMMON/NEV4 /ZAROF(50),YHYA(50),LAPROF,IAYP,CAYX(6),AFWALL
COMMON/RSTART/IRSPD,IRSPK,ITAPE

C
C  ODE COMMON BLOCKS
C
COMMON /POINTS/ NSUB(13),SUM(13),CPR(13),DLVTP(13),DLVPT(13), /POINTS/
1          GAMMAS(13),P(13),TZ,FPP(13),WM(13),SUNVEL(13),
2          TTT(13) /POINTS/
COMMON/SPECES/COFF (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/ ENH,SUMN,IT,SO,ATOM(3,105),LLMT(15),BO(15), /MISC/
1          B,P(15,2),TM,TLON,TMID,THIGM,PP,CFSUM,OF,FWRAT, /MISC/
2          NSUBC,NPP(2),FPP(2),VMIN(2),VPLS(2),RP(2), /MISC/
3          NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15), /MISC/
4          RTMP(15),FOX(15),DENS(15),TLN /MISC/
COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,INAT,IQI,NC, /INDX/
1          JSOL,JLIQ,IC,102 /INDX/
COMMON /VISCXO/ VISCX(13),PR(13) /VISCXO/
COMMON/INODE /TIN(13),OFIN(13),MINI(13)
COMMON/OUTODE/OUTOF(30,13)
COMMON/OUTRHO/DEF(13)
COMMON/H2INJ/INH2

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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 RJ,SG/777.68,06.32.174/
C
BRANCH TO APPROPRIATE LOGIC.
C
GO TO (100,200,300,400),ICALL
C
C ***** ICALL = 1 *****
C
INITIALIZE ODE STORAGE AND CALCULATE CONVERSION CONSTANTS FOR
C TFCBL - ODE INTERFACE.
C
100 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)
HO1=UREF*UREF/(1.8*RJ*SG)
RHOD1=SG*PHOREF
RETURN
C
C ***** ICALL = 2 *****
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
PERFORM INITIAL T-P CALCULATION TO ESTABLISH ENTROPY.
C
200 P(1) = 4.72539576E-4*PEDEGE
TZ=TEDGE/1.8
C ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17, 1973 *****
OF = AFEDGE/(1.-AFEDGE)
C
USE INITIAL GUESSES FOR EN(1,1) AND ENLN(1) 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 = 1.9871650*HSUM(1)/HOT
HEUGE=SHEDGE+UEUGE*UEUGE/2.

C
C CALCULATE RHOEH AND SMUEH FOR INITIAL ZETAP CALCULATION.
C
RHOEH=DEN(1)/SG
SMUEH=VISCE(1)/SG

C
C PROCEED THRU PRESSURE TABLE WITH S-P CALCULATIONS.
C
IND=1
SP=.TRUE.
HP=.FALSE.
TP=.FALSE.
2020 TIN(1) = TEDGE/1.80
DO 2100 IBUF = 1,13
P(IBUF) = 4.72539576E-4*PETAB(IND)
INDEX(IBUF)=IND
IND=IND+1
IF (IND=1PETAB) 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) = SURT(2.0*ABS(HEUGE - SHE))
IF (IND.GT. LPETAB) RETURN

C
C STORE GUESSES FOR NEXT CALL TO SPCALC.
C
TJH(1) = TTT(13)
DO 2230 I=1,NS
2230 EN(I,1) = EN(I,13)
GO TO 2020

```

```

C
C
C          ***** ICALL = 3 *****
C
C  PERFORM A T-P CALCULATION AT THE WALL TO DETERMINE HWALL BOUNDARY
C  CONDITION.
C
3010  P(I) = 4.72539576E-4*PEDEGB
      TZ=TWALL/1.80
      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) = 0.31/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)=50(I(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 = 1.9871650*HNSUM(I)/HCT
      HWALL=SHWALL
      RETURN
C
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 IPUF = 1,13
      P(IPUF) = 4.72539576E-4*PEDEGB
      TIR(IPUF)=T(IND,JN)/1.80
C      ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973 *****
      OFIN(IPUF) = ALPHA(IND,JN,1)/(ALPHA(IND,JN,2)+ ALPHA(IND,JN,3))

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IF((IFIN(IBUF).LE.0) .OR. (IFIN(IBUF).EQ.0)
IF((I*STATN.EQ.(PSPD).AND.(ITER.EQ.0)) GO TO 4040
IF((I*STATN+ITER)4,40,4040,4,60
4240 DO 4250 I=1,NS
4250 EN(I,IBUF) = 2.0/NS
      TII(I,IBUF)=36.0
      GO TO 4260
4260 DO 4270 I=1,IS
      EN(I,IBUF)=SCI(IND,UN,I)/FM(I)
      IF(EN(I,IBUF).LT.1.E-6)EN(I,IBUF)=1.E-6
4270 CONTINUE
4280 HIR(I,IBUF) = SH(IND,UN)*HOT
      INGE(I,IBUF)=JND
      IF (INT (.GE. NY) GO TO 4210
4290 IND = MIN(I,IND+IYEQ,NY)
4210 NPF=IBUF
      NPT = J
      CALL MPCALC
C
C CONVERT, NORMALIZE, AND STORE ANSWERS FROM CDE BUFFERS INTO TFCBL
C ARRAYS.
C
DO 4300 IBUF=1,NP
  IX=INDEX(IBUF)
  RHO(IX,UN) = DEN(IBUF)/RHO01
  SMU(IX,UN)=VISCE(IBUF)*SPMTC
  PRNO(IX,UN)=PR(IBUF)
  IF(PRI.GT.0.)PRNO(IX,UN)=PRI
  RLE(IX,UN)=1.
  T(IX,UN)=1.E-6*TTT(IBUF)
  AV(IX)=SCNVEL(IBUF)
  DO 4310 I = 1,NS
    SCI(IX,UN,I)=EN(I,IBUF)*FM(I)
4300 SHI(IX,UN,I) = HIRUF(I,IBUF)/HOT
    IF (IX .LT. NY) GO TO 4320
C
C INTERPOLATE FOR NECESSARY PROPERTIES AT MESH POINTS NOT SOLVED
C USING ODE.
C
CALL PHOENX (RHO(1,UN),Y,IYEQ,NY)
CALL PHOENX (SMU(1,UN),Y,IYEQ,NY)
CALL PHOENX (PRNO(1,UN),Y,IYEQ,NY)
CALL PHOENX (T(1,UN),Y,IYEQ,NY)
C
C INTERPOLATE FOR SCI AND SHI ONLY IF ALE*IS OR TLE*IS NOT UNITY.
C
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF((ALE*IS.EQ.1.) .AND. (TLE*IS.EQ.1.))RETURN
DO 4910 I=1,NS
  CALL PHOENX (SCI(1,UN,I),Y,IYEQ,NY)
4910 CALL PHOENX (SHI(1,UN,I),Y,IYEQ,NY)
  RETURN
END

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SUBROUTINE HPCALC
CHFCALC  PERFORM A SERIES OF ENTHALPY-PRESSURE CALCULATIONS.
C
COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),
1          GAMMAS(13),P(13),TZ,PP(13),WM(13),SONVEL(13),
2          TTT(13)
C
COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HU(30),
1          DELN(30),A(15,30),SUB(30,3),IUSE(30),TEMP(50,2)
COMMON /MISC/ ENN,SUMN,TT,SB,ATOM(3,105),LLMT(15),HB(15),
1          BCP(15,2),TM,TLOW,THID,THIGH,PP,CPSUM,OF,EQRAT,
2          HSUBJ,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),
3          NAME(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,IQI,NC,
1          JSOL,JLI4,IC,IQ2
COMMON/INODE /TIN(13),OFIN(13),HIN(13)
COMMON/OUTODE/HURUF(30,13)
C
DO 40 IP = 1,NP
C
C   SET ASSIGNED PRESSURE, ENTHALPY, O-F RATIO, AND TEMPERATURE GUESS.
C
PP=P(IP)
IT=TIN(IP)
OF=OFIN(IP)
DO 15L I=1,NS
15C 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 20L I=1,L
20C BC(I) = (WP(1)*BUP(I,1) + WP(2)*HOP(I,2))/SUM
HSUBJ = HIN(IP)/1.987165U
CALL EQLBRM
TZ = TT
A 16
DO 30L I=1,NS
30C HGBUF(I,NPT) = 1.987165L*HU(I)*TT
THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
IF (TT.NE.L) GO TO 20
IF (NPT.EQ.L) RETURN
A 21
A 24
A 26
A 27
A 28
A 29
A 36
A 37
A 38
C
C   ALL COMPOSITION GUESSES HAVE BEEN COMPUTED EXTERNALEY.
C
RETURN
END
A 50-

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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
          SHI(250,2,7), SCI(250,2,9), T(250,3), AV(250)
COMMON/TEMP  / LPS(250,3), PRT(250,3), MLET(250,3)
COMMON /YTABLE/  YTIL(250), YGP(250), YGPP(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), SIG5S(3)
COMMON /ZCALC/  ZETA0, ZETA, ZETAN, ZETAP, ZSTAR(3), DSZ(2), YZETA,      /ZCALC/
          YTZETA, YEDGE                                             /ZCALC/
COMMON/NORMAL/ BLREF, BREF, RHOREF, SMUREF, REYINF
COMMON/COUNT  / NY, NY1, NY2, NY3, JO, JN, JA, NEL, NEL1, NBP, NMAX, NYI
COMMON /DMOR1/  CU(250,3), CV(250,3), CVV(250,3), CWA(250,3), GAMA, ZK /DMOR1/

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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) = 0.5*(CUU(I,JO) + CUU(I,JN))
CUV(I,JA) = 0.5*(CUV(I,JO) + CUV(I,JN))
CVV(I,JA) = 0.5*(CVV(I,JO) + CVV(I,JN))
CWW(I,JA) = 0.5*(CWW(I,JO) + CWW(I,JN))
DO 20 IEL=1,NEL
20 ALPHA(I,JA,IEL) = 0.5*(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)*RGP(I)*ZETA*YTIL(I)/ZETA
100 F(I) = RGP(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

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SUBROUTINE MOMNTM
COMMON/TH 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,T(250),DY
COMMON/PROP /RHO(250,3),SMU(250,3),PR(250,3),BLE(250,3),
! SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
COMMON/TPROP /EPS(250,3),PRT(250,3),MLFT(250,3)
COMMON /YTABLE/ YTIL(250),BGP(250),BGRP(250),IYTILP,IYTLF, /YTABLE,
! CYTIL(6) /YTABLE,
COMMON/MATRX /A(250,3),R(250)
COMMON/EFVEC /E(250),F(250)
COMMON/SIGNAS/SIG1(3),SIG2(3),SIG3(3),SIG4(3),SIG5(3),SIG6(3)
COMMON /EDGEBC/ TEDGE,SHEDGE,HEGE,UEGE,PEGE,AFEDGE,DUEDSO, /EDGEBC,
! DUEDS,DUEDSN,PEDSN /EDGEBC,
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
! EPSLN3,CONVRG,ODY,ODY,ODYSQ
COMMON/CORIT /NY,NY1,NY2,NY3,JO,JU,JA,NEL,NFL1,NSP,NMAX,NYI
COMMON/TOEBUG/IDERUG(3),KENDMP,KENDMP
C
C EVALUATE COEFFICIENTS OF SYSTEM OF MOMENTUM EQUATIONS (FROM FIRST
C INTERIOR POINT TO SECOND LAST POINT IN BOUNDARY LAYER).
C
INCRM=1
TN4=RHO(NY,JA)*H(NY,JA)*UEGE-U(NY,JO)/DS
I=2
C
C CALCULATE TEMPORARY QUANTITIES.
C
! BE = F(I)
! BF = F(I)
SIG1(3) = SMU(I+1,JA)+EPS(I+1,JA)
SIG1Y=(SIG1(3)-SIG1(1))*ODY
UYMN=(U(I+1,JO)-U(I-1,JO))*ODY
UYMNB=(U(I+1,JO)-2*U(I,JO)+U(I-1,JO))*ODYSQ
TERM=BF*BGP(1)*SIG1(2)*ODYSQ
TN1=BGRP(1)*SIG1(2)/BGP(1)+BGP(1)*SIG1Y
TN2=RHOV(1)*BGP(1)
TN3=RHO(1,JA)*U(1,JA)/DS
C
C COEFF. OF U(I+1,N-1)
C
A(I-1,1)=ODY*(BF*U(1,JO)-TN2+BF*TN1)-.5*TERM
C
C COEFF. OF U(I+1,N)
C
A(I-1,2)=TN3-.5*BE*UYMN+TERM
C
C COEFF. OF U(I+1,N+1)
C
A(I-1,3)=-A(I-1,1)-TERM
C
C RIGHT-HAND SIDE
C
B(I-1)=TN3*U(1,JO)-.5*(TN2*UYMN+TN1*U(I)*UYMN+
! BGRP(1)*SIG1(2)*UYMNB)

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C
C   PUSH-DOWN STORAGE
C
      SIG1(1)=SIG1(2)
      SIG1(2)=SIG1(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 = D
C           AT EDGE   U = UE
C
      A(1,1)=0.
      B(NY2)=B(NY2)-A(NY2,3)*UE
      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,IMAX)

```



```

C
C APPLY BOUNDARY CONDITIONS FOR U(I+1,1) AND U(I+1,NY)
C
C U(I,1N)=0.
C U(NY,1N)=U(ONE)
C
C PRINT DEBUG FOR THIS ITERATION, IF REQUESTED.
C
C IF(KMODMP.GT.1)CALL DUMPT
C TEST = ( U(NY,1N) - U(NY,1N) ) / U(NY,1N)
C 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
C INCRMT=INCRMT+1
C IF(INCRMT.GT.5)CALL DEBUG (4,INCRMT)
C IF(NY.EQ.NMAX)CALL DEBUG (6,INCRMT)
C CALL ADPT (1)
C I=NYI-1
C GO TO 1J.
C END

```

```

SUBROUTINE NLC01
C/ROUT WRITE TFCOL INPUT DATA.
C
COMMON/XTAB/RTAB(500),XTABY(500),LRRTAB,LRWXP,CRAX(6),
1 PFTAB(500),XTARPE(500),LPETAB,IPEXP,CPEX(6),
2 UETAB(500), LUETAB,IUEXP,CUEX(6),
3 XTUDUX(500),LUDUXT,LDUDXP

COMMON/IT/BLF/INTAB(100),XTARTB(100),LTTTAB,ITXP,
1 SYDTAB(100),XTARMD(100),LMDTAB,IMDXP
COMMON/STEPS7/DX1IM(50),PL1F(50),LDXLIM,IDX,
1 SYTAB(50),XTABSK(50),LSXTAB,ISK,
2 DXI

COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUEDSO, /EDGEBC/
1 DUEDS,DUEDSM,DPEDSM /EDGEBC/
COMMON/NORMAL/FLREF,UREF,R1,OREF,SPUREF,REYINF
COMMON/MULT /XAF,UBEN,PEN,SKLN,YF
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1 EPSLN3,CONVRG,ODDY,ODDY,ODYSQ

COMMON /TITLE/ TITLE(13) /TITLE/
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/OPTIO/IDEAL,IAMNR,IACMP
COMMON/STAT/ISTATN,MAXIT,ITER
COMMON/PRNTCT/NSPNT,NLPRNT,ISPNT,ILPRNT,LNSPPG,LINESR
COMMON /INPROF/ HPROF(50),YRPMU(50),LUPROF,CUYX(6),HPROF(50) /INPROF/

```

```

1          YBYNH(50),LHPRF,CHYX(6)                                /INPROF/
COMMON/PFGAS /GAMMA,FHOLWT,PRI
COMMON/NEW3 /AFTRNS,PLAW
COMMON/NEW5 /IYPR
COMMON/NEW7 /GPO,PAMB,INTOK,ZETAPI
COMMON/NEW8 /RSTAR,RSTPR,XSTAR,DLSTO,DLSTH
COMMON/NEW9 /IYEQ
COMMON/NEW10 /APPCF(50),YBYNA(50),LAPROF,TAYP,CAYX(8),AFWALL
COMMON/NEW11 /J2D,UEK,RHCEK
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,GPLTAB(20),    /COOL/
1          CPSUME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXRA,DIATUB,    /COOL/
2          DXI,HG,HL,IX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,      /COOL/
3          MASSL,PRANDL,QWI,RANDL,RANDW,RAMTAB(20),REYL,SQWDSI,    /COOL/
4          SQPI,SUMQWI,TAR,TEMPKL,THICK,THITAB(100),TLO,TLI,      /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 /OMOR/ (UU(250,3),CUV(250,3),CVV(250,3),CWW(250,3),GAMA,ZK /OMOR/
COMMON/HZINJ/INJH2

C
DATA UNAME,FNAME/4HUETAB ,6HPETAB /

C
C WRITE SINGLY DIMENSIONED VARIABLES.
C
WRITE (6,9000) TITLE
WRITE (6,9010) IDEAL,LAMNR,INCOMP,J2D,INTOK,ICOOL,ITHERM,IPOLY
WRITE(6,1111) INJH2
1111 FORMAT(30X,8HTINJH2 = ,12.6X,
152H(=) FOR HYDROGEN INJECTION,FREE STREAM**PERFCT GAS, /
247X,53H(=) FOR PERFECT GAS INJECTION,FREE STREAM**PERFECT GAS)
WRITE (6,9020) SINIT,XINIT,XMAX,DXI,DELTA1,ZETAPI
WRITE (6,9030) ALREF,UREF,RHOREF,SMUREF
WRITE (6,9040) XN,YN,UEN,PEN,SMON
WRITE (6,9050) LEDGE,PEDGEB,TEGE,AFEDGE
WRITE (6,9060) AFTRNS,PRI,GAMMA,FPOLYT,PLAW,PAMP,GPO,SN3,
1          XSTAR,AFWALL,UEK,RHCEK
WRITE (6,9070) CONVRG,EPSLN1,EPSLN2,EPSLN3,EPSLIN

WRITE (6,9080) MAXIT,NYI,NLPRNT,NSFRNT,INSTAT,IYPR,IYEQ
WRITE (6,6) GAMA,ZK
6  FORMAT (1X,18H CORRELATION INPUTS//5X,6HGAMA =,F10.6,5X,4HZK =,
1          F10.6//)
1  IF (ICOOL .EQ. 0) GO TO 40
WRITE (6,1) COEFCL,MASSL,RANDW,TUBEN
1  FORMAT (28H REGENERATIVE COOLING INPUTS//4X,8HCOEFCL =,F12.8,10X,
1  7HMASSL =,F12.6,10X,7HRANDW =,F13.10,10X,7HTUBEN =,F10.3/)
WRITE (6,2) ITZTAB,(1,TZTAB(1),CPLTAB(1),RAMTAB(1),ZMYTAB(1),
1          I = 1,ITZTAB)
2  FORMAT (1H1//26H COOLANT PROPERTIES TABLES//45X,8HITZTAB =,13//
1  15X,1H1,9X,5HTZTAB,11X,6HCPLTAB,13X,6HRAMTAB,13X,6HZMYTAB/
2  (14X,12.5X,5FF10.4,5X,F13.10,5X,1PE14.8,5X,E14.8))
WRITE (6,3) ITAR

```

```

3  FORMAT (1H1,2GH COOLANT WALL TABLES//44X,8H1TWTAB =,14//16X,1H1,
1  11X,5H1TAB,12X,6H1HTITAB,12X,5H1TLTAB/)
   LINESR = LNSPPG - 8
   DO 30 I = 1,11WTAB
   WRITE (6,4) I,ALTAB(I),THTAB(I),TLTAB(I)
4  FORMAT (13X,13,5X,1PE13.7,5X,E13.7,5X,CPF11.4)
   LINESR = LINESR - 1
   IF (LINESR .GT. 0 .OR. I .EQ. 11WTAB) GO TO 30
   WRITE (6,5)
5  FORMAT (1H1/16X,1H1,11X,5H1TAB,12X,6H1HTITAB,12X,5H1TLTAB/)
   LINESR = LNSPPG - 5
30  CONTINUE

```

C
C
C

WRITE STEPSIZE CONTROL TABLES.

```

40  WRITE (6,9000)
   WRITE (6,9090) 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
C

WRITE WALL TABLES.

```

110  WRITE (6,9000)
   WRITE (6,9130) 11WTAB,LMDTAB
   WRITE (6,9140)
   LINESR=LNSPPG-8
   LMAX=MAX0(11WTAB,LMDTAB)
   WRITE (6,9110) 11WTAB(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.11WTAB)GO TO 160
   IF(I.GT.LMDTAB)GO TO 170
   WRITE (6,9110) 11WTAB(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) 11WTAB(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(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=MAX0(LPETAB,LUETAB)
  LMAX=MAX0(LRWTAB,LPUMAX)
  TABVAL=PETAB(I)
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
  IF(PETAB(I).EQ.0.)TABVAL=UETAB(I)
  WRITE (6,9110) RWTAB(I),XTABRW(I),TABVAL,XTABPE(I)
  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 (6,9160)
  WRITE (6,9170) TABNAM
  LINESR=LNSPPG-8
300 CONTINUE
C
C   WRITE EXPERIMENTAL PROFILES, IF INPUT.
C
310 IF (LUPROF .EQ. -LHPROF) RETURN
  WRITE (6,9190)
  WRITE (6,9180) LUPROF,LHPROF
  WRITE (6,9190)

```

```

LMAX=MAX0(LUPROF,LHPROF)
WRITE (6,911J) UPROF(1),YBYNU(1),HPROF(1),YBYNH(1)
IF (LMAX .LE. 1) GO TO 41J
DO 43J I = 2,LMAX
IF (I.GT.LUPROF)GO TO 36J
IF (I.GT.LHPROF)GO TO 37J
WRITE (6,911J) UPROF(1),YBYNU(1),HPROF(1),YBYNH(1)
GO TO 43J
36J WRITE (6,912J) HPROF(1),YBYNH(1)
GO TO 43J
37J WRITE (6,911J) UPROF(1),YBYNU(1)
43J CONTINUE
41J IF (LAPROF .EQ. 0) RETURN
WRITE (6,903J)
WRITE (6,920J) LAPROF
WRITE (6,921J)
DO 45J I=1,LAPROF
45J WRITE (6,911J) APROF(1),YBYNA(1)
RETURN
903J FORMAT (1H1,26X,13A6//)
920J FORMAT (18H FLAGS AND OPTIONS//30X,8HIDEAL = ,12,6X,
1 56H(=1 FOR PERFECT GAS; =0 FOR HYDROGEN-OXYGEN EQUILIBRIUM)/30X,
2 8HILAMNR = ,12,6X,39H(=1 FOR LAMINAR FLOW; =0 FOR TURBULENT)/30X,
3 8HINCOMP = ,12,6X,36H(=1 FOR INCOMPRESSIBLE FLOW; =0 FOR ,
4 13HCOMPRESSIBLE)/30X,8HJ2D = ,12,6X,21H(=1 FOR AXISYMMETRIC ,
5 33HGEOMETRY, =0 FOR TWO-DIMENSIONAL)/30X,8HINTDK = ,12,6X,
6 55H(=1 IF INPUT TABLES COME FROM TDK OUTPUT; =0 OTHERWISE)/30X,
7 8HICOOI = ,12,6X,57H(=0 NO COOLING, =1 OPPOSITE DIRECTION, =2 SAM
8E DIRECTION)/30X,8HITHERM = ,12,6X,52H(=1 FOR THERMO NAMELIST INPU
9T TO ONE, =0 OTHERWISE)/30X,8HIPOLY = ,12,6X,77H(=1 FOR CALCULATIO
0N OF COEFFICIENTS FOR CORRECTED WALL CONTOUR, =0 OTHERWISE)//)
922J FORMAT (34H PROBLEM LIMITS AND INITIAL VALUES//1X,7HSIRIT =,F12.8,
1 3X,7HXINIT =,F12.8,3X,6HXMAY =,F13.8,3X,5HDXI =,1PE12.6,3X,
2 8HDELTA1 =,E12.6,3X,8HZETAPI =,E12.6//)
933J FORMAT (21H REFERENCE QUANTITIES//4X,7HBLREF =,1PE14.7,4X,
1 6HUREF =,E14.7,4X,8HRMREF =,E14.7,4X,8HSMREF =,E14.7//)
934J FORMAT (28H INPUT NORMALIZATION FACTORS//4X,7HXM =,1PE14.7,4X,
1 7HYN =,E14.7,4X,7HUEN =,E14.7,4X,7HPEN =,E14.7,4X,
2 7HSDN =,E14.7//)
935J FORMAT (16H EDGE QUANTITIES//4X,7HUEDGE =,1PE14.7,4X,7HPEDGE =,
1 E14.7,4X,7HTEGE =,E14.7,4X,8HAFEDGE =,E14.7//)
904J 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,8HAFYALL =,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 7HEPSLN=,E14.7//)
9080 FORMAT (9H COUNTERS//4X,7HMAXIT =,14,5X,5HNYI =,14,5X,8HNLPRT =,
1 14,5X,8HNSPRT =,14,5X,8HINSTAT =,14,5X,6HIYPR =,14,5X,6HIYEQ =,
2 14//)
9090 FORMAT (24H STEPSIZE CONTROL TABLES//25X,7HLXLIM=,14,39X,
1 7HLSKTAB=,14)
9100 FORMAT (15X,6HDXLIM ,19X,6HXLIM ,19X,6HSKTAB ,19X,6HXTABSK/)
9110 FORMAT (1PE25.7)
9120 FORMAT (5X,1P2E25.7)

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```

9130 FORMAT (12H WALL TABLES//25X,7HLTWTAB=,14,39X,7HLMDTAB=,14)
9140 FORMAT (15X,6HTWTAB ,19X,6HXTABTW,19X,6HSDWTAB,19X,6HXTABMD/)
9150 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB=,14,39X,
1 7HLUETAB=,14)
9160 FORMAT (25H GEOMETRY AND EDGE TABLES//25X,7HLRWTAB=,14,39X,
1 7HLPETAB=,14)
9170 FORMAT (15X,6HRYTAB ,19X,6HXTABRW,19X,A6,19X,6HXTABPE/)
9180 FORMAT (22H EXPERIMENTAL PROFILES//25X,7HLUPROF=,14,39X,
1 7HLHPROF=,14)
9190 FORMAT (15X,6HUPROF ,19X,6HYBYNU ,19X,6HHPROF ,19X,6HYBYNH /)
9200 FORMAT (34H EXPERIMENTAL PROFILES (CONTINUED)//25X,7HLAPROF=,14)
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
COMMON /INPUT/ B(4,30),IPOLY,ITHERM,MT(4,30),NPROD,NSPEC,
1          PHAZ(30),T1(30),T2(30)
COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),
1          GAMMAS(13),P(13),TZ,PPP(13),WH(13),SONVEC(13),
2          TTT(13)
COMMON/SPECES/COFF(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),
1          B0P(15,2),TM,TLOW,TMID,THIGH,RP,CPSUM,OF,EQRAT,
2          HSUBD,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),
3          NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),
4          RTEMP(15),FOX(15),DENS(15),FLM
COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,
1          JSOL,JLIQ,IC,IQ2
C
DIMENSION DATE(2,30),LH(2),LVM(2),LVP(2)
INTEGER BLANK,FAZ,FOX,PHAZ,SUR
DATA BLANK,LH,LVM,LVP/1H,4HH,CA,4HL/G,2HV-.1H,2HV+.1H /
EQUIVALENCE (DATE,EN)
LOGICAL HP,IC,MOLES,SP,TP
C
NAMelist /THERMO/ ANUM,B,COFF,DATE,DENS,ENTH,FAZ,FOX,MOLES,MT,
1          NAME,NSPEC,NPROD,PECWT,PHAZ,RTEMP,SUB,T1,T2,
2          TLOW,TMID,THIGH
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
SP=.FALSE.
C
CALCULATIONS INVOLVING EQUIVALENCE RATIO CHANGED (7-10-69) TO
CORRESPOND TO DEFINITION USED IN PROGRAM A2350D. H.M.FREY.
C
STOIC = ABS((VPLS(1)+VMIN(1))/(VPLS(2)+VMIN(2)))
***** OF IS EQUAL TO FUEL/OXIDIZER , MAY 21, 1973 *****
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

```

A 18
/INPUT/
/INPUT/
/POINTS/
/POINTS/
/MISC/
/MISC/
/MISC/
/MISC/
/MISC/
/INDX/
/INDX/
A 33

A 39

A 60
A 119

```

      WP(2) = OF
      SUM=WP(1)+WP(2)
      V2=(WP(1)*VMIN(1)+WP(2)*VMIN(2))/SUM
      V1=(WP(1)*VPLS(1)+WP(2)*VPLS(2))/SUM
      EQRAT = OF/STOIC
      DO 220 I = 1,L
220  BC(I) = (WP(1)*ROP(I,1) + WP(2)*ROP(I,2))/SUM
C* THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (EQRAT.EQ.1.) EQRAT=1.000005
      HSUBC = (WP(1)*HPP(1) + WP(2)*HPP(2))/SUM
      WRITE (6,370)
      WRITE (6,380) LH,HPP(2),HPP(1),HSUBC,LVP,VPLS(2),VPLS(1),V1,LVM,VM
      IN(2),VMIN(1),V2
      HSURC = HSURC/1.9871650
      WRITE (6,390)
      WRITE (6,380) (LLMT(I),BLANK,ROP(I,2),ROP(I,1),RO(I),I=1,L)
      CALL SEARCH
      IQ=L+1
      IF (NC.EQ.0) GO TO 240
      DO 230 J=1,NS
      IF (IUSE(J).EQ.0) GO TO 230
      IF (IUSE(J).GT.0) IUSE(J)=-IUSE(J)
230  CONTINUE
      240  IC = .FALSE.
      PP=NS
      NPT=1
      ENN=.1
      SUM=ENN
      DO 250 J=1,NS
      IF (IUSE(J).EQ.-1000) IUSE(J)=0
      EN(J,1)=C.
      ENLN(J)=0.
      IF (IUSE(J).NE.0) GO TO 250
      EN(J,1) = ENN/(NS - NC)
      ENLN(J) = ALOG(EN(J,1))
250  CONTINUE
      JSCI=.
      JI=NL
      RETURN
260  FORMAT (1F1)
370  FORMAT (1H0,17X,4HFUEL,13X,7HOXIDANT,12X,7HMIXTURE//)
380  FORMAT (1H 2A4,3F18.8/)
390  FORMAT (8H ATOMS/G)
      END

```

A 160
 A 163
 A 164
 A 169
 A 176
 A 177
 A 178
 A 180
 A 181
 A 185
 A 186
 A 187
 A 188
 A 189
 A 199
 A 203
 A 204
 A 205
 A 206
 A 210
 A 211
 A 212
 A 213
 A 214
 A 217
 A 218
 A 219
 A 226
 A 237
 A 238
 A 239
 A 240-

SUBROUTINE PARAMS

CPARAMS CALCULATE GROSS BOUNDARY LAYER PARAMETERS OF INTEREST.

```

COMMON/DEPEND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
COMMON/INDEF /S,DC,X,DX,Y(250),DY
COMMON/PROP /RHO(250,3),SHU(250,3),PR(250,3),BLE(250,3)

1          SHI(250,2,9),SCI(250,2,9),T(250,3),AR(250)
COMMON /YTABLE/ YTIL(250),BGP(250),BGPP(250),IYTILP,IYTILF,      /YTABLE/
1          CYTIL(6)                                               /YTABLE/
COMMON/XTABLE/RWTAB(500),XTARRW(500),LRWTAB,IRWXP,CRWX(6),
1          PETAB(500),XTABPE(500),LPETAB,IPEXP,CPEX(6),
2          UETAB(500),          LUETAB,IUEXP,EUEX(6),
3          XTUDUX(500),LDUDXT,LDUDXP
COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
1          SMDTAB(100),XTARMD(100),LMDTAB,IMDXP
COMMON/EFVEC /E(250),F(250)
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/WALLRC/TWALL,SHWALL,HWALL,SMDWO,SMDW,SHDWN
COMMON /EDGERC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,      /EDGERC/
1          DUEDS,DUEDSN,DPEDSN                                       /EDGERC/
COMMON/NORMAL/DLREF,UREF,RHOREF,SMUREF,REYINF
COMMON /GPARAM/ DISTAR,THETA,TAUW,TAUI,PCF,SQW,STAN,SNTGRL,      /GPARAM/
1          SQWDS,SQW0                                               /GPARAM/
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1          EPSLN3,CONVRG,OZDY,O4DY,ODYSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/NEWB /RSTAR,RSTPR,XSTAR,DLSTO,DLSTTH
COMMON/NEW1 /J2D,UEK,RHOEK
COMMON/RSTART/IRSRD,IRSWF,I1APE
COMMON /MISC/ ENN,SUMN,T1,SU,ATOM(3,105),LLMT(15),B0(15),      /MISC/
1          BUP(15,2),TM,TLOW,THID,THIGH,PP,CPSUM,OF,EQRAT,      /MISC/
2          HSUBG,HPP(2),RHP(2),VMIN(2),VPLS(2),WP(2),          /MISC/
3          NAME(15,5),ANUM(15,5),PECNT(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),CZA(6),DELXBA,DIATUB, /COOL/
2          DXI,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,  /COOL/
3          MASSL,PRANDL,QWI,RANDL,RANDW,RAMTAB(20),REYL,SQWDS, /COOL/
4          SQW1,SUMQWI,TAW,TEMPRL,THICK,THITAB(100),TLO,TLI,  /COOL/
5          TL2,TLCA,TLTAR(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20), /COOL/
6          ZMYTAB(20),ZMYUL,ITPOS,TWL2,TAWM,STANRE             /COOL/
REAL MASSL
    
```

```

C
DATA PIF,RJ,SG/3.141592653,777.68006,32.174/
DIMENSION GRND(3),YGRND(3)
C
DPEDSN=-RHO(NY,JN)*U(NY,JN)*DUEDSN
C
UPDATE INTEGRAL OVER S FOR DISPLACEMENT THICKNESS.
C
IF((IRSRD.GT.0).AND.(ISTATN.EQ.IRSRD))GO TO 50
IF(ISTATN.GT.L)GO TO 2U
SNTGRL=0.
GO TO 5U
20. SNTGRL = SNTGRL + 0.50*DS*(SMDWO*ZETA0*RW(1)**J2D + SMDWN*ZETAN*
1      RK(2)**J2D)
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(1)*ZETAP*YTIL(I)/ZETAN
70  F(I) = BGP(1)*TM2
    DUDY=02DY*(-U(3,JN)+4.*U(2,JN)+3.*U(1,JN))
    YGRND(3)=(RHOV(1)*BGP(1)*DUDY+DPEDSN)/F(1)
C
ACCUMULATE INTEGRALS ACROSS BOUNDARY LAYER.
C
DO 100 I=2,NY1
    TM1=RHO(I,JN)*U(I,JN)/T1
    GRND(1)=(1.-TM1)/BGP(1)
    GRND(2)=TM1/BGP(1)*(1.-U(I,JN)/U(NY,JN))
    DUDS=(U(I,JN)-U(I,J0))/DS
    DUDY=02DY*(U(I+1,JN)-U(I-1,JN))
    GRND(3)=(RHO(I,JN)*U(I,JN)*DUDS+(RHOV(1)*BGP(1)*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
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 Y = 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(Y))*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  DUUS = (U(NY,J1) - U(NY,J0))/DS
      DUDY=02DY*(U(NY2,J1)-4.0*U(NY1,J1)+3.0*U(NY,J1))
      GRND(3)=(RHO(NY,J1)*U(NY,J1)*DUUS+(RHOV(NY)*BGP(NY)-
1  U(NY,J1)*F(NY))*DUDY+DPEDSN)/F(NY)
      IF (MOD(NY,2) .LE. 3) 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 ANTERP (XSTAR,RSTAR,DER,IRWXP,XTABRW,RWTAB,LRWTAB,CRWX,
1  IRWXP)
      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
      TAU1=-SMUREF*UREF*YGRND(3)/(BLREF*ZETAN)
C
C  CALCULATE WALL SHEAR STRESS TAUW.
C
      DERIV=02DY*(-U(3,J1)+4.0*U(2,J1)-3.0*U(1,J1))
      TM1=BGP(1)/ZETAN*SMU(1,J1)*DERIV
      TAUW=SMUREF*UREF/BLREF*TM1
C
C  LOCAL SHEAR STRESS COEFFICIENT BCF.
C
      BCF=2./REYINF*TM1/(RHO(NY,J1)*U(NY,J1)**2)
C
C  HEAT TRANSFER RATE SQW.
C

```

```

DERIV=02DY*(-SH(3,JN)+4.*SH(2,JN)-3.*SH(1,JN))
SUMSP=0.
DO 240 ISP=1,NSP
240 SUMSP = SUMSP + SH[(1,JN,ISP)*02DY*(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*(SQW*
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 = 1.9879204312*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/SFC2/FT4) ****
C ** SG GRAVITATIONAL FORCE (LBM/LHF*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*LRF/BTU) = (BTU/(FT2*SEC)))
STANNE = SQWI/(CPSUME*AAKK*(TAW - TWALL))
C ** HG **** (BTU/(DEG-R*FT2*SEC))
HG = SQWI/(TAW - TWALL)
CALL XNTERP (X,EAREA,EP,IX,XTABTW,ALTAB,LTWTAB,CAX,ITWXP)
DIATUH = 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,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,IX,TZTAB,ZMYTAB,ITZTAB,CZX,ITPOS)
   ITPOS = IX
   CALL XNTERP (TL1,CPL,CPP,ICX,TZTAB,CPLTAB,ITZTAB,CCX,ITPOS)
   CALL XNTERP (TL1,RAMD,RP,IRX,TZTAB,KAMTAB,ITZTAB,CRX,ITPOS)
   PRANDL = CPL*ZMYUL/RAMD
   REYL = MASSL*DIATUB/(ZMYUL*TUREN*EAREA)
   CALL XNTERP (X,THICK,TMP,ITHX,XTABTW,THITAB,LTWTAB,CTHX,ITWXP)
   TWL = TL1
7   TWLG = TWL
   HL = .0250*RAMD/DIATUB*REYL*.00080*PRANDL*.0040*(TL1/TWL)*.0050
   SA1 = HL*(1.0 + RAMD/(THICK*HG))
   SA2 = RAMD/THICK
   TWL = (SA1*TL1 + SA2*TAW)/(SA1 + SA2)
   IF (ABS(TWLG - TWL) .GT. .0010) GO TO 7
   TEMPRL = TWL/TL1
   TWGCA = (HG*TAW + RAMD/THICK*TWL)/(HG + RAMD/THICK)
   QWI = HG*(TAW - TWGCA)
   SQWDSI = SQWDS/RJ
   TANM = TWALL + SQWI/HG
   DELXBA = (DX + DX1)*BLREF/2.0
   COSAL = COS(THW(2))
   SST = COEFFCL*DELXBA*QWI*(PIE*RW(2)*BLREF)*.020/COSAL
   TLCA = (TL1 + TL2)/2.0 + SST/(CPL*MASSL)
   IF (ICool .EQ. 2) TLCA = (TLJ + 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),XTASK(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,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUEDSO,      /EDGEBC/
1          DUEDS,DUEDSN,DPEDSN      /EDGEBC/
COMMON/NORMAL/BLREF,UREF,PHOREF,SMUREF,REYINF
COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SWW,STAN,SNTGRL,      /GPARAM/
1          SQWDS,SQW0      /GPARAM/
COMMON /TITLE/ TITLE(13)      /TITLE/
COMMON/COUNT /NY,NY1,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/NEWS  /IYPR
COMMON /NEW7/ GPO,FAMB,INTDK,ZETAPI      /NEW7/
COMMON /NEW11/ J2D,UEK,RHUEK      /NEW11/
COMMON/NEW8  /RSTAR,RSTPR,XSTAR,DLSTO,DLSTH
COMMON/PFGAS /GAMMA,FMOLWT,PR1
COMMON/RSTART/IRSRD,IRSWR,IYAPE
COMMON /COOL/ ALTAB(100),CAX(6),CCX(6),COEFCL,CPL,CPLTAB(20),      /COOL/
1          CPSIME,CRX(6),CTHX(6),CTLX(6),CZX(6),DELXBA,DIATUB,      /COOL/
2          UX1,HG,HL,IAX,ICOOL,ICX,IRX,ITHX,ITLX,ITZTAB,IZX,      /COOL/
3          MASSL,PRANDL,QWI,RAMUL,RAMON,RMTAB(20),REYL,SQWDS1,      /COOL/
4          SQW1,SUMQW1,TAU,TEMPRL,THICK,THITAB(100),TLO,TLI,      /COOL/
5          TL2,TLCA,TLTAB(100),TUBEN,TWG2,TWGCA,TWL,TZTAB(20),      /COOL/
6          ZHYTAB(20),ZHYUL,ITPOS,TWL2,TAWM,STANRE      /COOL/
REAL MASSL      /COOL/
COMMON /OMORI/ CUU(250,3),CUV(250,3),CVV(250,3),CWA(250,3),GAMA,ZK /OMORI/
COMMON/MUZZY/SDELTA
COMMON/H2INJ/INJH2
COMMON/CONST/SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1          EPSLN3,CONVRG,02DY,04DY,0DYSQ
C
C      DIMENSION AOUT(14), BOUT(8)
C
C      CALCULATE DIMENSIONAL WALL AND EDGE CONDITIONS.
C
      UFB=U(NY,JN)*UREF
      SA = SQRT(49721.0116*GAMMA/FMOLWT*T(NY,JN))
      IF((IDEAL.EQ.1).AND.(INJH2.EQ.1)) SA=AV(NY)

```

```

BME=UER/SA
SMUEB=SMU(NY,JN)*SMUREF
SMDWB=SMDW*RHOREF*UREF*ZETA
SHEB=SH(NY,JN)*UREF*UREF
RHOEB=RHO(NY,JN)*RHOREF

```

```

C
C
C
CORE ITEMS IN SUMMARY TABLE.

```

```

ISTA=ISTA+1
SUMARY(ISTA,1)=FLOAT(ISTATN)
SUMARY(ISTA,2)=RW(2)
SUMARY(ISTA,3)=UF8
SUMARY(ISTA,4)=BME
SUMARY(ISTA,5)=SMUEB
SUMARY(ISTA,6)=RCF
SUMARY(ISTA,7)=STAN
SUMARY(ISTA,8)=DLSTAR
SUMARY(ISTA,9)=ZETAN
SUMARY(ISTA,10)=RV(2)*BLREF-DLSTAR*CUS(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)=TAUK
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)=(PEJEDGE-U(NY,JN))/DS
SUMARY(ISTA,30) = TWL

```

```

C
C
C
CHECK IF TIME TO WRITE SUMMARY TABLE BUFFER ON DRUM.

```

```

IF((ISTA.LT.NSTA).AND.(LAST.EQ.U))GO TO 5C
NST=MINU(ISTA,NSTA)
WRITE (IDRUM) NST,((SUMARY(I,J),J=1,NVAR),I=1,NST)
ISTA=J
NREC=NREC+1

```

```

C
C
C
CHECK IF TIME TO PRINT.

```

```

5J IF (ISPRNT.EQ.NSPRNT) ISPRNT = U
IF (ILPRNT.EQ.NLPRNT) ILPRNT=U
IF (ILPRNT.NE. J) GO TO 1UDD

```

```

C
C
C
PRODUCE SHORT PRINT OF CONTOUR PROPERTIES, WALL AND EDGE
CONDITIONS, AND PROFILE PARAMETERS.
C

```

```

WRITE (6,900J) TITLE
LINE$R = LNSPPG - 5
WRITE (6,901J)
LINE$R=LINE$R-1
XOUT = X*BLREF
WRITE (6,902J) ISTATN,XOUT,S,DS,RW(2),THW(2),ZETAN,ZETA$P
LINE$R=LINE$R-2
WRITE (6,903J)
LINE$R=LINE$R-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*SN*GRL*RHOER*UREF/(RHOEB*UEB*RW(2)**J2D))
2 - (PEDGER - PAMB)*DLSTAR)
WRITE (6,904J) UER,BME,DLSTAR,BCF,T(NY,JN),RHOER,THETA,STAN,SHEB,
1 SMUEB,TAUW,TAUI,PEDGER,TWALL,SQW,RTHETA,THLOSS,SMO$B
LINE$R=LINE$R-6
IF (ICOO$ .NE. 3) WRITE (6,1) TLO,TWL,CPL,QWI,REYL,TL1,TWL2,
1 CPSUM$,SUMQWI,PRANDL,TLZ,TWGA,DIATUB,SQWI,RANDL,TAW,TW$2,
2 THICK,SQWDSI,ZMYUL,TLCA,TEMPRL,HG,HL,STANRE
1 FORMAT (5UX,3IHREGENERATIVE COOLING PARAMETERS/SX,6HTLO =,F10.4,
1 5X,8HTWL =,F10.4,5X,8HCPL =,F15.10,5X,8HQWI =,F15.6,5X,
2 8HRFY$ =,1PE15.9/SX,6HTL1 =,UPF10.4,5X,8HTLYAB =,F10.4,5X,
3 8HCPSUM$ =,F15.10,5X,8HSUMQWI =,F15.6,5X,8HPRANDL =,1PE15.9/SX,
4 6HTL2 =,UPF10.4,5X,8HTWGA =,F10.4,5X,8HDIATUB =,F15.10,5X,
5 8HSQWI =,F15.6,5X,8HRANDL =,1PE15.9/SX,6HTAW =,UPF10.4,5X,
6 8HTLYAB =,F10.4,5X,8HTHICK =,F15.10,5X,8HSQWDSI =,F15.6,5X,
7 8HZMYUL =,1PE15.9/SX,6HTLCA =,UPF10.4,5X,8HTEMPRL =,F10.4,5X,
8 8HNG =,F15.10,5X,8HML =,F15.6,5X,8HSTANRE =,1PE15.9/
IF (ICOO$ .NE. 0) LINE$R = LINE$R - 7
C
C PRODUCE LONG PRINT OF VARIABLE PROFILES FROM WALL TO EDGE.
C FIRST PAGE.
C
WRITE (6,905J)
LINE$R=LINE$R-1
I=1
55J AOUT(1) = YL(1)*BLREF*ZETA$N
AOUT(2)=Y(1)
AOUT(3)=U(1,JN)/U(NY,JN)
AOUT(4)=SH(1,JN)/SH(NY,JN)
AOUT(5)=RHO(1,JN)/RHO(NY,JN)
AOUT(6) = RHOV(1)*ZETA$N/(RHO(NY,JN)*U(NY,JN))
AOUT(7) = EPS(1,JN)*SMUREF
AOUT(8)=T(1,JN)
IF(LINE$R.GT.,)GO TO 57J
WRITE (6,906J)
WRITE (6,905J)
LINE$R = LNSPPG - 4
57J WRITE (6,906J) I,(AOUT(J),J=1,8)
LINE$R=LINE$R-1
IF (I .GE. NY) GO TO 60J
I = MIN2(I+1YPR,NY)
GO TO 55J
60J CONTINUE
C .....
WRITE(6,908J)
ZDELTA = SDELTA*BLREF*ZETA$N*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*UEZ),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 = 0.4DY*(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(14,1P4E16.7)
LINESR=LINESR-1
IF(I.GE.NY) GO TO 104
I = MIN(I+1YPR, NY)
GO TO 101
104 CONTINUE

```

```

C
C .....
WRITE (6,9J8)
LINESR = LNSPPG-5
WRITE(6,99J2)
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) = CUU(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(6,99J2)
LINESR=LNSPPG-4
571 WRITE(6,99J3) I, (BOUT(J), J=1,8)
LINESR = LINESR - 1
IF(I.GE.NY) GO TO 601
I = MIN(I+1YPR, 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,2))
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.2)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+1YPR,NY)
GO TO 650
700 WRITE (6,9070) ITER
C
C CHECK IF TIME TO WRITE RESTART TAPE.
C
IF((IRSMR.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(1))/(DSZ(1)+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),BGP(I),I=1,
4 NMAX)
C
C ADVANCE PRINT STATION COUNTERS.
C
1000 ISPRNT=ISPRNT+1
ILPRNT=ILPRNT+1
RETURN
9000 FORMAT (1H1,25X,13A6//)
9010 FORMAT (7X,7HSTATION,8X,9HX (FEET),15X,1HS,14X,2HDS,14X,2HRW,1UX,
1 6HTHETA,12X,4HZETA,11X,5HZETA)
9020 FORMAT (116,1P7E16.7//)
9030 FORMAT (18X,24HEDGE AND WALL CONDITIONS,49X,
1 18HPROFILE PARAMETERS)
9040 FORMAT(7X,9HUEB = ,E14.7,7X,9HME = ,E14.7,17X,9HDLSTAR = ,
1 E14.7,7X,9HBCF = ,E14.7/7X,9HTEGE = ,E14.7,7X,9HRHUEB = ,

```

```

2 E14.7,17X,9HTHETA = ,E14.7,7X,9HSTAN = ,E14.7,7X,9HSHEB = ,
3 E14.7,7X,9HSMUER = ,E14.7,17X,9HTAU4 = ,E14.7,7X,9HTAU1 = ,
4 E14.7,7X,9HPEDGER = ,E14.7,7X,9HTWALL = ,E14.7,17X,9HSQW = ,
5 E14.7,7X,9HRTHEA = ,E14.7,7X,9HTHLOSS = ,E14.7,7X,9HSMDB = ,
6 E14.7/)
9050 FORMAT (54H NO.          YHAR          Y          U/UE          ,
1 61H          H/HE          RO/ROE          ROV          EPS          ,
2 11H          T )
9060 FORMAT (15,1P7E16.7,UPF11.1)
9070 FORMAT (/18H NO. ITERATIONS =,13)
9080 FORMAT (11H)
9150 FORMAT(55H NO. F/O  Y(H)  Y(H2)  Y(H20)  Y(O)  Y(OH)  Y(O2)
1 37H  Y(N)  Y(NO)  Y(N2)  MU  PR  )
9160 FORMAT(14,1PE13.3,1PE13.3,UPF9.5)
9902 FORMAT(4H NO.,6X,8H MU ,12X,1HY,11X,8H K /UE2,8X,8H RU/REUE,
1 6X,8HXEDDY ,9X,6H UDAG ,11X,4HYDAG,13X,3HPRT)
9903 FORMAT(14,1PE16.7)
END

```

SUBROUTINE PROFIL

C PROFIL CALCULATE INITIAL DEPENDENT VARIABLE PROFILES FROM KNOWN WALL
C AND EDGE CONDITIONS AT S = SIN1.

```

COMMON/DEPLND/U(250,3),H(250,3),ALPHA(250,3,3),RHOV(250),SH(250,3)
COMMON /YTABLE/ YTIL(250),HGP(250),HGPP(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/WALLBC/TWALL,SHWALL,HWALL,SMDB,SMDB,SMDBN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGE,AFEDGE,DUEDSO, /EDGEBC/
1 DUEDSN,DUEDSN,DPEDSN /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/MULT /XN,UEN,PEN,SHDN,YN
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/OPTION/IDEAL,LAMNP,INCOMP
COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYA(6),HPROF(50), /INPROF/
1 YBYNH(50),LHPROF,CHYX(6) /INPROF/
COMMON/NEW3 /AFTRNS,PLAW
COMMON/NEW1: /APROF(50),YBYNA(50),LAPROF,IAYP,CAYX(6),AFWALL
COMMON /TPROF / EPS(250,3),PRT(250,3),HLET(250,3)
COMMON /OMORI/ CUH(250,3),CUV(250,3),CVV(250,3),CWN(250,3),GAMA,ZK /OMORI/

```

C IF(LUPROF.EQ.0)GO TO 5

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=J
      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.J)GO TO 445
      IAYP=L
      DO 440 I=1,NY
      CALL XNTERP (YTIL(I),ALPHA(I,JN,1),DUMMY1,IAYP,YBYNA,APROF,
      LAPROF,CAYX,IAYP)
      ALPHA(I,JN,2) =D.RQ*(1.0-ALPHA(I,JN,1))
440  ALPHA(I,JN,3) =C.25*ALPHA(I,JN,2)
445  IF (INCOMP .GT. C) 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  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) = SH*WALL
110  H(I, JN) = SH*WALL + U(I, JN)**2/2*U
      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*U
C
C   CALCULATE CONSTANT ALPHA1 PROFILE ACROSS BOUNDARY LAYER.
C       ALPHA1 = ALPHA1E
C
210  IF (LAPROF .GT. 0) GO TO 310
      DO 300 I = 1, NY
      ALPHA(I, JN, 1) = AF*WALL + (AF*EDGE - AF*WALL)*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) = SMDV + 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)*
      SQRT(CUU(I, JN))*(2.1832339 - 1.1832339*TM2)*4.198382U
C
C   MOVE FORWARD VALUES TO BACK VALUES.
C
      DO 600 I = 1, NY
      U(I, JO) = U(I, JN)
      SH(I, JO) = SH(I, JN)
      H(I, JO) = H(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)
      U(I, JA) = U(I, JO)
      CUU(I, JA) = CUU(I, JO)
      EPS(I, JO) = EPS(I, JN)
      EPS(I, JA) = EPS(I, JO)
      DO 600 IEL = 1, NFL
600  ALPHA(I, JO, 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/ ZETA0,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,SQWD /GPARAM/
COMMON/CONST /SINIT,XINIT,XMAX,DELTA1,SN1,SN2,SN3,EPSLN1,EPSLN2,
1 EPSLN3,CONVRG,O2DY,O4DY,O0YSQ
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NEL1,NSP,NMAX,NYI
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/NEVB /RSTAR,RSTPP,XSTAR,DLST0,DLSTH
COMMON/RSTART/IRSRD,IRSWR,ITAPE
C
REWIND ITAPE
10 READ (ITAPE) ISTATN
IF (ISTATN=IRSRD) 1J,30,20
20 WRITE (6,90) IRSRD
9000 FORMAT (//37H THERE IS NO RESTART DATA FOR STATION,IS//)
CALL EXIT
C
READ RESTART DATA FOR STATION IRSRD.
C
30 BACKSPACE ITAPE
READ (ITAPE) ISTATN,NY,DY,ZETA0,ZETA,ZETAN,ZETAP,ZSTAR(1),DSZ(1),
1 YZETA,YTZETA,YEDGE,RSTPP,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 (RM
3 OV(I),I=1,NY),(Y(I),YTIL(I),BGP(I),BGPP(I),I=1,NMAX)
REWIND ITAPE
C
SET OTHER COUNTERS AND CONSTANTS BASED ON RESTART DATA.
C
NYI=NY-1
NYZ=NY-2
O2DY=.5/DY
O4DY=.25/DY
O0YSQ=1./(DY*DY)
RETURN
END

```

```

SUBROUTINE SPCALC
CSPCALC  PERFORM A SERIES OF ENTROPY-PRESSURE CALCULATIONS.
C
COMMON /POINTS/ HSUM(13),SSUM(13),CPR(13),DLVTP(13),DLVPT(13),
1          GAMMAS(13),P(13),TZ,PPP(13),WM(13),SONVEC(13),
2          TTT(13)
COMMON/SPECES/COEF (2,7,30),S(30),EN(30,13),ENLN(30),HD(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),
1          BUP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EQRAT,
2          HSUBD,HPP(2),RHO(2),VMIN(2),VPLS(2),WP(2),
3          NAME(15,5),ANUM(15,5),PECWT(15),ENTHI(15),FAZ(15),
4          RTEMP(15),FOX(15),DENS(15),TLN
COMMON /INDX/ CONVG,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ,NC,
1          JSOL,JLIQ,IC,IQ2
COMMON/INODE /TIN(13),OFIN(13),MIN(13)
C
C          A  2
C          /POINTS/
C          /POINTS/
C          /MISC/
C          /MISC/
C          /MISC/
C          /MISC/
C          /INDX/
C          /INDX/
C          A  16
C          SET O-F AND INITIAL TEMPERATURE GUESS. (ENTROPY STORED AS S0.)
C
C          TT=TIN(1)
C          ***** OF IS EQUAL TO FUEL/OXIDIZER WEIGHT RATIO, MAY 17,1973 *****
C          WP(1) = 1.
C          WP(2) = OF
C          DO 200 I=1,L
200  B0(I) = (WP(1)*BUP(I,1) + WP(2)*BUP(I,2))/(WP(1) + WP(2))
C          DO 60 IP=1,NP
C
C          SET ASSIGNED PRESSURE.
C
C          PP=P(IP)
C          CALL EQLBRM
C          TZ=TT
C          A  22
C          THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
C          IF (TT.NE.3.) GO TO 20
C          IF (NPT.EQ. 0) RETURN
C          A  24
20  K=J
C          A  26
C          THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
C          IF (IP.EQ.NP.OR.TT.EQ.0.) GO TO 30
C          K=NPT
C          A  27
C          IF (NPT.NE.13) GO TO 40
C          A  28
30  IF (K.EQ. J) RETURN
C          A  29
C          NPT=J
C          A  36
40  NPT=NPT+1
C          A  37
C          SAVE COMPOSITIONS FOR ESTIMATES OF NEXT POINT
C          DO 60 I = 1,NS
C          A  40
60  EN(I,NPT) = EN(I,K)
C          RETURN
C          END
C          A  50

```

SUBROUTINE TABLES

CTABLES NORMALIZE TABLES AND INITIALIZE TABLE POINTERS FOR SUBROUTINE
 C XNTERP. INITIALIZE *ALL 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     XTUDUX(500),LDUDXT,IDUDXP
COMMON/LTABLE/TWTAB(100),XTABTW(100),LTWTAB,ITWXP,
1     SMDTAB(100),XTABMD(100),LMDTAB,IMDXP
COMMON/STEPS7/DXLIM(50),XLIM(50),LDXLIM,IDX,
1     SKTAB(50),XTABSK(50),LSKTAB,ISK,
2     DXT
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,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEEDGE,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,PR1
COMMON/NEW? /RHOEB,SMUEB,REYL, SX0
COMMON/H2INJ/INJH2
  
```

XNORM=XN/BLREF

NORMALIZE RW VS. X TABLE AND INITIALIZE CONTOUR PROPERTIES.

```

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))
  
```

BACK VALUES EQUAL FORWARD VALUES INITIALLY.

```

RW(1)=RW(2)
DRWDX(1)=DRWDX(2)
THW(1)=THW(2)
  
```

NORMALIZE STEPSIZE TABLES AND INITIALIZE STEPSIZE DS.

```

DO 50 I=1,LSKTAB
50  XTABSK(I) = XTABSK(I)*XNORM
  ISK=1
  
```



```

DO 100 I=1,LOXLIM
100 XLIM(I) = XLIM(I)*XNORM
    IDX=I
    DX=DXI
    DS=DX/COS(THW(I))
C
C SET UP MDTW 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
SMDWO=SMDWN
SMDW=SMDWN
C
C SET UP TW VS. X TABLE AND INITIALIZE TWALL.
C
DO 300 I=1,LTWTAR
300 XTARTW(I) = XTARTW(I)*XNORM
    ITWXP=0
    CALL LCURV (X,XTARTW,TWTAR,LTWTAR,ITWXP,TWALL)
    IF((IDFAL.GT.1).AND.(INJM2.EQ.1)) GO TO 390
C
C HYDROGEN - OXYGEN EQUILIBRIUM.
C PRESSURE TABLE HAS BEEN INPUT. SET UP PE VS. X TABLE FOR
C ISENTROPIC EXPANSION.
C
DO 350 I=1,LPETAB
350 PETAB(I)=PETAB(I)*PEN
    XTARPE(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 (PEGE AND TEDGE HAVE BEEN INPUT.)
C
CALL HOODE (2)
C
C SET VELOCITY TABLE, LENGTH AND FLAGS. (XTARPE 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,PEDGE,1,DUMMY1,DUMMY2,DUMMY3)
    SHWALL=SHWB/(UREF*UREF)
    HWALL=SHVALL
C
C   CALL IGODE WITH TEDGE AND PEDGE TO OBTAIN SHEDGE AND HEDGE.
C   (HEDGE IS A CONSTANT.)
C
    CALL IGODE (TEDGE,SHEB,PEDEGR,1,RHOEH,SMUEB,DUMMY1)
    SHEDGE=SHEB/(URFF*UREF)
    HEDGE=SHEDGE+UEDE*UEDE/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)/PEDEGB)**TM1
410  UETAB(I) = SQRT(2.*C*(HEDGE - SHE))
    LUETAB=LPETAB
    IPEXP=0
    IUEXP=0
    GO TO 500
450  FNORM = UEN/UREF
    TM1=GAMMA/(GAMMA-1.)
    PTOT = PEDEGB*(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) = PEDEGB + 0.50*RHOEB*(UEDE**2 -
    UETAB(I)**2)*UREF**2
460  CONTINUE
    LPETAB=LUETAB
    IPEXP=0
    IUEXP=0
C
C   EVALUATE PEDGE, DPEDSN, AND UEDGE FROM TABLES GENERATED.
C
500 CALL XNTERP (X,UEDE,DUMMY1,IUEXP,XTABPE,OETAB,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,13MEDGE VELOCITY//
      1 (RE15.6))
      WRITE (6,9020) (XTABPE(I),I=1,LUETAB)
9020 FORMAT (/5X,14HAXIAL DISTANCE// (RE15.6))
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=J
      UETAB(1) = J.5
      GO TO 560
520  LDUDXT = LUETAB + 1
      XTUDDX(LDUDXT)=XTABPE(LUETAB)
      UETAB(LDUDXT) = (UETAB(LUETAB) - UETAB(LUETAB-1))/(XTABPE(LUETAB)
      1 - XTABPE(LUETAB-1))
      LMI=LUETAB-1
      DO 550 I=1,LMI
      J=LUETAB+1-I
      XTUDDX(J)=J.5*(XTABPE(J)+XTABPE(J+1))
550  UETAB(J) = (UETAB(J) - UETAB(J-1))/(XTABPE(J) - XTABPE(J-1))
      XTUDDX(1)=XTABPE(1)
      UETAB(1) = UETAB(2)
      LDUDXP=J
C
C   INITIALIZE VELOCITY DERIVATIVE.
C
560  CALL LCURV (X,XTUDDX,UETAB,LDUDXT,LDUDXP,DUEDX)
      DUEDSN=DUEDX*COS(THW(2))
C
C   BACK AND AVERAGE VALUES EQUAL FORWARD VALUES INITIALLY.
C
      DUEDSO=DUEDSN
      DUEDS=DUEDSN
      CALL XNTRP (X,PEDGE,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(250,3),

1          SHI(250,2,9),SCI(250,2,9),T(250,3),AV(250)
COMMON/TPROP /EPS(250,3),PRT(250,3),RLET(250,3)
COMMON /YTABLE/ YTIL(250),BGP(250),BGGP(250),YTILP,ITILP,      /YTABLE/
1          CYTIL(6)                                             /YTABLE/
COMMON/MATRIX /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          XTUDUX(500),LDUDXT,IUDXP
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,SMDWO,SMDW,SMDWN
COMMON /EDGEBC/ TEDGE,SHEDGE,HEDGE,UEDGE,PEDGEB,AFEDGE,DUEDSO,   /EDGEBC/
1          DUEDS,DUEDSN,OPEDSN                                   /EDGEBC/
COMMON/NORMAL/BLREF,UREF,RHOREF,SMUREF,REYINF
COMMON/MULT  /XN,UEN,PEN,SMDN,YN
COMMON /GPARAM/ DLSTAR,THETA,TAUW,TAUI,BCF,SQW,SIAN,SNTGRL,      /GPARAM/
1          SQWDS,SQWO                                             /GPARAM/
COMMON/CONST /SINIT,XINIT,XMAX,DELTAI,SN1,SN2,SN3,EPSLN1,EPSLN2,
1          EPSLN3,CONVRG,OZDY,OHDY,ODYSQ
COMMON /TITLE/ TITLE(13)                                         /TITLE/
COMMON/COUNT /NY,NY1,NY2,NY3,JO,JN,JA,NEL,NELI,NSP,NMAX,NYI
COMMON/OPTION/IDEAL,LAMN,INCOMP
COMMON/STATN /ISTATN,MAXIT,ITER
COMMON/PRNTCT/NSPRT,NLPPNT,ISPRT,ILPRT,LNSPPG,LINESR
COMMON/SUMARY/SUMARY(15,30),NREC,NSTA,ISTA,NVAR,IDRUM,LAST
COMMON/IDEBU/IDEBU(3),KMODMP,KENDMP
COMMON /INPROF/ UPROF(50),YBYNU(50),LUPROF,CUYX(6),MPROF(50),   /INPROF/
1          YBYNH(50),LHPROF,CHYX(6)                               /INPROF/

```

```

COMMON/PFGAS /GAMMA,FMOLWT,PRI
COMMON/NEW1 /ALFWS,TLEWS
COMMON/NEW2 /RHOEB,SMUEB,REYL,SXD
COMMON/NEW3 /AFTRNS,PLAV
COMMON/NEW5 /IYPR
COMMON/NEW7 /GPO,PAMB,INTDK,ZETAPI
COMMON/NEW8 /RSTAR,RSTPH,XSTAR,DLSTU,DLSTH
COMMON/NEW9 /IYEQ
COMMON/NEW10 /APROF(50),YBYNA(50),LAPROF,IYVP,CAYX(8),AFWALL
COMMON/NEW11 /J2D,UEK,RHOEK
COMMON/RSTART/IRSRD,IRSWR,ITAPE

```

```

COMMON /AL/ INSTAT,EPSLIN
COMMON /INPUT/ C(4,30),IPOLY,ITHEKM,MT(4,30),NPROD,NSPEC, /INPUT/
                PHAZ(30),T1(30),T2(30) /INPUT/
1 COMMON /COOL/ ALTAB(100),CAY(6),CCX(6),COEFCL,CPL,CPLTAB(20), /COOL/
                CPSUME,CRX(6),CTHX(6),CTLX(6),CZA(6),DELXEA,DIATUB, /COOL/
2 DXI,HG,HL,IX,ICOOOL,ICF,IRX,ITHX,ITLX,ITZTAB,IZX, /COOL/
3 MASSL,PRANDL,OWI,RAMDW,RAMDW,RAMTAB(20),REY,SQWDSI, /COOL/
4 SCWJ,SUMQWJ,TAW,TEMPKL,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/

```

```

DATA BLANK,PIE/6H ,3,141592653/
DIMENSION PITAB(500),TITAB(500),VITAB(500)
1 ,XA(150),XITAB(500),YA(150),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)),(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,EPSLN1, /DATA/
2 FPSLN2,EPSLN3,FMOLWT,GAMMA,GPO,HPROF,ICOOOL,IDEAL, /DATA/
3 INERUG,INCOMP,INSTAT,INTDK,IPOLY,IRSRD,IRSWR, /DATA/
4 ITHRM,ITZTAB,IYEQ,IYPR,J2D,LAMNR,LAPROF,LDXLIM, /DATA/
5 LHPROF,LMTAB,LPETAB,LMTAB,LSKTAB,LTWTAB,LUETAB, /DATA/
6 LUPROF,MASSL,MAXIT,NLPRNT,NSPRNT,NTI,PAMB,PEDGE, /DATA/
7 PFN,PFTAB,PLAV,PRI,RAMDW,RAMTAB,RHOEK,RHOREF,RWTAB /DATA/
8 SINIT,SKTAB,SMON,SMDTAB,SMUREF,SNJ,TEDEGE,THITAB, /DATA/
9 TLTAB,TUBEN,TWTAB,TZTAB,UEDGE,UEK,UEN,UETAB,UPROF, /DATA/
A UREF,XINIT,XLIM,XMAY,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/TKINP/XITAB,YITAB,PITAB,ZMTAB,TITAB,VITAB
C
C      SET CONSTANTS.
C
      NMAX=250
      LNSPPG = 58
      ITERM = 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
C
15  DO 15 I=1,10
      TITLE(I) = BLANK
      BLREF=1.
      UREF=1.
      RHOREF=1.
      SMUREF=1.
      XN=1.
      YN=1.
      PEN=1.
      SPDN=1.
      UFN=1.
      PRI=0.
      PLAN=1.
      PAMB = 0.0
      XSTAR = 0.0
      AFWALL=-9999.
      GAMA = 0.150
      ZK = 0.60
      EPSLIN = 0.090
      INSTA1 = 9999
      IPOLY = 0
      CONVRG=.005
      EPSLNI=.03

```

```
EPSLN2=.J3
EPSLN3=.J3
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 (5,910J) TITLE
910C FORMAT (13A6)
READ (5,DATA)
IF(INJH2.EQ.1) NEL=3
SQWI = 0.0
SQWDSI = 0.0
SUMQWI = 0.0
ITPOS = ?
ITX = 0
ICX = U
IRX = 0
IAX = 0
ITHX = 0
ITLX = J
```

```
C
C IF KW, X, AND PE TABLES ARE INPUT FROM TDK, READ TDKINP NAMELIST.
```

```
C
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,LRNTAR
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) = 1.0
```

```
C
C PRINT TFCAL 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
C   IF((IDEAL.EQ.0)CALL HOODE (1)
C   IF(((IDEAL.EQ.1).AND.(INJH2.EQ.1)) CALL HOODE(1)
C
C   SET CONSTANTS BASED ON INPUT.
C
C   NFLI=NEL-1
C*  THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
C   IF(((IDEAL.GT.0).AND.(PRI.EQ.0))PRI=.72
C   IF((INJH2.EQ.1) PRI=0.0
C   IF((AFWALL.LT.0.)AFWALL=AFTRNS
C   XNORM=XN/BLREF
C   XINIT=XINIT*XNORM
C   SINIT=SINIT*XNORM
C   XMAX=XMAX*XNORM
C   XSTAR=XSTAR*XNORM
C   RSTPR=1.
C   REYINF = RHOREF*UREF*BLREF/SMUREF
C   UEDGE=UEGE*UEN/UREF
C   PEDGER=PEDEGER*PEN
C   PAMB=PAMB*PEN
C
C   INITIALIZE X, S, AND ZETA.
C
C   X=XINIT
C   S=SINIT
C
C   CHECK IF THIS CASE IS RESTARTED FROM A PREVIOUS CASE; IF SO,
C   REINITIALIZE TABLES AND SKIP APPROPRIATE INITIALIZATION.
C
C   IF (IRSRD .LE. 0) GO TO 220
C   CALL ROTAPE
C   CALL TABLES
C   UEDGE=U(NY,JN)
C   DO 216 J=1,2
C   DO 216 I = 1,NY
C   U(I,J)=U(I,JN)
C   H(I,J)=H(I,JN)
C   CUU(I,J)= CUU(I,JN)
C   CLV(I,J)= CLV(I,JN)
C
C   CVV(I,J)= CVV(I,JN)
C   CWW(I,J)= CWW(I,JN)
C   EPS(I,J) = EPS(I,JN)
C   SH(I,J)=SH(I,JN)
C   ALPHA(I,J,1)=ALPHA(I,JN,1)
C   ALPHA(I,J,3)=ALPHA(I,JN,3)
216 ALPHA(I,J,2) = ALPHA(I,JN,2)
C   GO TO 37
220 ZETA0 = 0.83333333*DELTA1/BLREF
C   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 YRYNZ=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 YRYNZ=YBYNH(I+1)-(YBYNH(I+1)-YBYNH(I))*(TM2-0.01)/(TM2-TM1)
      GO TO 250
245 CONTINUE
250 ZETA0 = YN/BLREF*YRYNZ
      ZETAN=ZETA0
C
C SET INITIAL ALPHA 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=AMINI(XMAX,XLIM(LDXLIM),XTABSK(LSKTAB))
C THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF(ZETAP1.EQ.0)GO TO 29
      ZETAP=ZETAP1
      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 SXU=((DELTA I/(BLREF*.37))*.5*REYL)***.25
   ZETAP=.833*.37*.8/((REYL*.5XG)***.2)
35 ZSTAR(I) = ZETA0 - DS*ZETAP
   DSZ(I)=DS
C
C   SET UP ARRAYS OF Y, YTIL, RGP, AND BGP AT EACH MESH POINT.
C
   CALL GFUNC
   O2DY=.5/DY
   O4DY=.25/DY
   ODYSQ=1./(DY*DY)
C
C   INITIALIZE U, H, SH, ALPHA, 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,13,4X,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.
40  SCI(I,JN,1) = 1.0
   DO 100 I=1,NY
   SHB=SH(I,JN)*UREF*UREF
   CALL IGODE (I(I,JN),SHB,PE,DGER,0,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) = HGP(I)/(ZETAN*ZETAN*REYINF)
   E(I) = RHO(I,JN)*RGP(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
C   IF ( LAMNK.EQ. 0 ) GO TO B1
C   DO R2 J=1,NY
R2 EPS(I,JN) = U.0
C   GO TO B3
R1 CALL EDDY
C
C   MOVE FORWARD TO BACK VALUES.
C
C
83 DO 120 I = 1,NY
RHO(I,JO)=RHO(I,JN)
SHU(I,JO)=SMU(I,JN)
PR(I,JO)=PR(I,JN)
BLE(I,JO)=BLE(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 110 ISP=1,NSP
SHI(I,JO,ISP)=SHI(I,JN,ISP)
111 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)
120 BLET(I,JO) = BLET(I,JN)
C
C   CALCULATE GROSS BOUNDARY LAYER PARAMETERS AT S = SINIT.
C
C   IF(IRSRO.GT.0)RHO(NY,JA)=RHO(NY,JN)
C   CALL PARAMS
C
C   PRINT AT INITIAL STATION.
C
C   IF(IRSRO.EQ.0)ISTATN=0
C   ISPRNT=J
C   ILPRNT=J
C   CALL PRINT
C
C   HAVING COMPLETED ALL INITIALIZATION, SOLVE THE BOUNDARY LAYER FROM
C   X = XINIT TO X = XMAX.
C
C   CALL EXECUT
C   IF(RSTAR.GT.0)WRITE (6,9800) RSTPR
9800 FORMAT (///42H THROAT RAD,US CORRECTED FOR DISPLACEMENT ,
1      11HTHICKNESS =,1PE,14.7)
C   WRITE (6,330)
330 FORMAT (///27X,75HTABLE OF CORRECTED CONTOUR POINTS NORMALIZED AND
1 DIMENSIONAL AND DELTA STAR///17X,14MX (NORMALIZED),11X,
2 14HY (NORMALIZED),8X,17HDELTA STAR (FEET),13X,11HX (IN FEET),
3 14X,11HY (IN FEET)//)
C   M = 0
C   MAP = 0
C   REWIND IDRUM
C   DO 300 K = 1,NREC
C   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
320 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.J.)RHOEK=RHO(NY,JN)*RHOREF
• THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
  IF(U EK.EQ.U)UEK=U(NY,JN)*UREF
  PAREN=THETA*BLREF*SNTGRL*RHORFF*UREF/(RHOEK*UEK*RW(2))*J2D)
  TMI=RHOEK*UEK*UEK
  BRKT=TMI*PAREN-(PEDGFB-PAMB)*DLSTAK
  THLOSS=(2.*PIE*RW(2)*BLREF,)*J2D*COS(THW(2))*BRKT
WRITE (6,9900) THLOSS
9900 FORMAT (////14H THRUST LOSS =,1PF14.7)
IF (IPOLY .EQ. U) 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),
      GAMMAS(13),P(13),TZ,PPP(13),WN(13),SONVEL(13),
      TTT(13)
      /POINTS/
1
2      COMMON /MISC/ ENN,SUMN,TT,SD,ATOM(3,105),LLMT(15),BR(15),
      BCP(15,2),TM,TLOW,TMID,THIGH,PP,CPSUM,OF,EURAT,
      /MISC/
1      HSURU,HPP(2),RHO(2),VMIN(2),VPLS(2),NP(2),
      /MISC/
2      NAME(15,5),ANUM(15,5),PECWT(15),ENTH(15),FAZ(15),
      /MISC/
3      RTEMP(15),FOX(15),DENS(15),TLN
      /INDX/
4      COMMON /INDX/ CONVGT,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT,IMAT,IQ1,NC,
      /INDX/
1      JSOL,JLIQ,IC,IQ2
      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)*RUP(I,1) + WP(2)*BUP(I,2))/SUM
      CALL EQLRRM
      TZ=TT
      A 22

      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(1,2)-AA(I-1)*A(I,1)
      AA(I)=A(I,3)/AAA
1      BB(I)=(B(I)-PB(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 (LHM/FT-SEC) STORED IN VISCE(I).
C        PRANDTL NUMBER STORED IN PR(I).
C
COMMON /INDX/ CONV,TP,HP,SP,MOLES,NP,NPT,L,NS,KMAT;IMAT,IQ,NC, /INDX/
1          JSQ,JLIW,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),SORVEL(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/CP1 /CP1(30),CPHAR

C
DIMENSION FKW(9),FMU(9),PHAT(9),PHI(9,9),SMUH(50),SMUH2(50),
1          SMUH20(50),SMUO(50),SMUOH(50),SMUO2(50),ITAB(50)
1          ,SMUN(50),SMUNO(50),SMUN2(50)

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 (ITAB(I),SMUH(I),SMUH2(I),SMUH20(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),SMUH20(I),SMUO(I),SMUOH(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.,194.5E-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,
0 2000.,256.2E-6,310.1E-6,663.7E-6,688.8E-6,694.7E-6,753.8E-6/

DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH20(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-6,864.0E-6,937.9E-6,
9 2900.,325.5E-6,394.1E-6,883.8E-6,876.6E-6,885.8E-6,959.5E-6,
0 3000.,332.7E-6,402.8E-6,906.1E-6,896.1E-6,905.4E-6,980.7E-6/

DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH20(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-6,1001.0E-6,
2 3200.,346.9E-6,420.0E-6,949.6E-6,934.2E-6,943.9E-6,1022.0E-6,
3 3300.,353.8E-6,428.4E-6,971.1E-6,953.0E-6,962.8E-6,1043.0E-6,
4 3400.,360.7E-6,436.7E-6,992.2E-6,971.6E-6,981.5E-6,1063.0E-6,
5 3500.,367.5E-6,444.9E-6,1013.0E-6,989.9E-6,1000.0E-6,1083.0E-6,
6 3600.,374.2E-6,453.1E-6,1033.0E-6,1008.0E-6,1018.0E-6,1103.0E-6,
7 3700.,380.9E-6,461.2E-6,1053.0E-6,1026.0E-6,1036.0E-6,1123.0E-6,
8 3800.,387.5E-6,469.2E-6,1073.0E-6,1043.0E-6,1054.0E-6,1142.0E-6,
9 3900.,394.1E-6,477.1E-6,1093.0E-6,1061.0E-6,1072.0E-6,1161.0E-6,
0 4000.,400.6E-6,485.0E-6,1112.0E-6,1079.0E-6,1090.0E-6,1181.0E-6/

DATA (TTAB(I),SMUH(I),SMUH2(I),SMUH20(I),SMUO(I),SMUOH(I),SMUO2(I)
 ,I=41,50)/

1 4100.,407.0E-6,492.7E-6,1131.0E-6,1096.0E-6,1107.0E-6,1199.0E-6,
2 4200.,413.4E-6,500.5E-6,1150.0E-6,1113.0E-6,1124.0E-6,1218.0E-6,
3 4300.,419.7E-6,508.1E-6,1169.0E-6,1130.0E-6,1142.0E-6,1237.0E-6,
4 4400.,426.0E-6,515.7E-6,1188.0E-6,1147.0E-6,1159.0E-6,1255.0E-6,
5 4500.,432.2E-6,523.2E-6,1206.0E-6,1164.0E-6,1176.0E-6,1274.0E-6,
6 4600.,438.4E-6,530.7E-6,1224.0E-6,1180.0E-6,1192.0E-6,1292.0E-6,
7 4700.,444.5E-6,538.1E-6,1243.0E-6,1197.0E-6,1209.0E-6,1310.0E-6,
8 4800.,450.6E-6,545.5E-6,1261.0E-6,1213.0E-6,1226.0E-6,1328.0E-6,
9 4900.,456.6E-6,552.8E-6,1278.0E-6,1229.0E-6,1242.0E-6,1346.0E-6,
0 5000.,462.6E-6,560.0E-6,1296.0E-6,1246.0E-6,1258.0E-6,1363.0E-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,
5 633.9E-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 1011.9E-6,1029.8E-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,
0 1083.0E-6,1097.8E-6,1112.5E-6,1127.1E-6/

```

C
C

```

DO 100 I=1,NPT
OBTAIN SPECIES VISCOSITIES FROM TABLES.

```

C
C

```

IX=J
CALL LCURV (TTT(I),TTAB,SMUN,50,IX,EMU(1))
CALL LCURV (TTT(I),TTAB,SMUN2,50,IX,EMU(2))
CALL LCURV (TTT(I),TTAB,SMUN20,50,IX,EMU(3))
CALL LCURV (TTT(I),TTAB,SMUN0,50,IX,EMU(4))
CALL LCURV (TTT(I),TTAB,SMUN0H,50,IX,EMU(5))
CALL LCURV (TTT(I),TTAB,SMUN02,50,IX,EMU(6))
CALL LCURV (TTT(I),TTAB,SMUN,50,IX,EMU(7))
CALL LCURV (TTT(I),TTAB,SMUN0,50,IX,EMU(8))
CALL LCURV (TTT(I),TTAB,SMUN2,50,IX,EMU(9))

```

C
C
C

```

OBTAIN SPECIES CP AND CPBAR. CONVERT CP-S TO CAL/GM-DEG K.

```

```

CALL CPSPEC (TTT(I),I)
DO 25 J=1,NS
CPI(J)=CPI(J)/FMWT(J)
IF (EN(J,1).LT.1.E-10)EN(J,1)=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.+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)*(1.32750*CP1(II) + 0.85696490625/FMWT(II))
 40 EKDBAR = EKDBAR + EKD(II)/TM2

C
 C STORE ANSWERS.
 C

VISCE(1)=EMUBAR*0.06722
 100 PR(1) = 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/ ZETA0,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,PEDGE,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,NELI,NSP,NMAX,NYI

C
C  OBTAIN YZETA WHERE U = 0.99 * UE.
C
DO 100 K=1,NY
I=NY+1-K
TM1=ABS(U(I,JN)-UEGE)/UEGE
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 XINTERP (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*YZETA
ZETAP=(ZSTAR(3)-ZSTAR(1))/(DSZ(1)+DS)
ZETAN=ZETA0+DS*ZETAP
ZETA=0.5*(ZETA0+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

```