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**MOMENTUM/ENERGY INTEGRAL
TECHNIQUE (MEIT) USER'S MANUAL**

10 K/Kwong, K. / Suchsland, H. / Tong
Acurex Corporation / Aerotherm Division
~~Aerospace Systems Division~~
485 Clyde Avenue
Mountain View, California 94042

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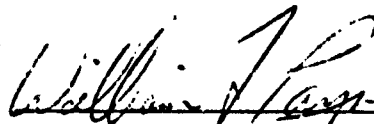
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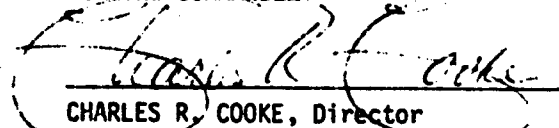
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WILLIAM F. PAYNE, Project Manager

FOR THE COMMANDER


CHARLES R. COOKE, Director
Solid Rocket Division


Dr. Clark Hawk
Acting Chief
Ballistic and Space Propulsion
Branch

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rocket nozzle environments.

A significant difference between MEIT and previous boundary layer codes is its ability to account for the effects of surface roughness.



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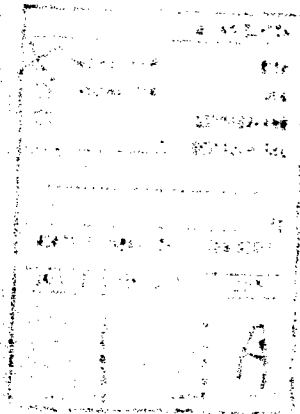
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LIST OF SYMBOLS

B'	blowing parameters, $\rho_w v_x / \rho_e u_e C_M$
c_p	specific heat at constant pressure
$C_f/2$	friction coefficient, $\tau_w / \rho_e u_e^2$
C_h	Stanton number, $\dot{q}_w / \rho_e u_e (h_r - h_w)$
f	transitional intermittency factor
F	recovery factor
h	enthalpy
h_r	recovery enthalpy
h_t	total enthalpy = $h + u^2/2$
H	shape factor, δ^*/θ
$I_{x,y,z}$	influence coefficient (Equation (20))
k	roughness height
p	pressure
Pr	Prandtl number
$\dot{q}_w$	wall heat flux
r	radial coordinate
R	Reynolds analogy factor $\equiv C_h / C_f/2$
s	stream length
T	temperature
u	streamwise velocity component
v	body normal velocity component
y	distance in surface normal direction, radial coordinate
γ	isentropic exponent, ratio of specific heats, c_p/c_v
δ^*	boundary layer displacement thickness

LIST OF SYMBOLS (concluded)

θ	boundary layer momentum thickness
$\lambda_{x,y}$	blowing reduction parameter
μ	viscosity
ν	kinematic viscosity, μ/ρ
ρ	density
ϕ	boundary layer energy thickness
τ	skin friction

Subscripts

e	boundary layer edge
∞	freestream
l	laminar flow
t	turbulent flow
tr	transitional flow
w	wall

Superscripts

$'$	reference properties
-----	----------------------

SECTION 1

INTRODUCTION

In predicting rocket nozzle performance and analyzing Arc Plasma Generator (APG) data, the heat and mass transfer coefficient must be defined. In the past, the heat transfer coefficient has been calculated within Aerotherm by some boundary layer integral codes such as ARGEIBL (Reference 1) or BLIMP (Reference 2). Both of these computer codes assume that the boundary layer develops on a smooth wall. It has been shown (see Reference 3) that surface roughness developed in rocket nozzle and APG environments can cause substantial heat transfer augmentation. To account for this and other boundary layer effects, the Momentum/Energy Integral Technique (MEIT) computer program has been developed.

The MEIT methodology was originally developed to predict nosetip ablation on reentry vehicles. This methodology has been validated for reentry environment and is currently an important part of the ASC code (Reference 4). The methodology employed by MEIT solves both the integral momentum and energy equations. In addition, it utilizes heat transfer and skin friction laws based on the most recent roughness heating and friction data.

MEIT was developed from ASC by extracting all the subroutines that are related to the boundary layer calculation. Any nonapplicable subroutines, unnecessary variables and common block variables were deleted and a driver routine was written to read in all the required input. To tailor it for rocket nozzle applications, the input and output formats were modified so that they are compatible with the usage requirements of rocket nozzle designers.

MEIT was verified by comparing solutions to solutions generated by ARGEIBL and BLIMP. Solutions from the TBL code (Reference 5) which is developed by Pratt and Whitney Aircraft Company, were also used. Both smooth and rough wall solutions were considered in the MEIT checkout. Like ARGEIBL and other integral techniques, the heat transfer coefficient generated by MEIT must be decreased by 25 percent.

In Section 2, a brief description of the MEIT methodology is presented. This is followed by the verification of MEIT in Section 3. Section 4 provides the input and output formats and Section 5 presents two sample problems. A listing of the program is given in Section 6.

SECTION 2

MEIT METHODOLOGY

The MEIT methodology was originally developed to predict nosetip ablation in reentry vehicles. A detailed description of the methodology is given in Reference 6. Only the essential information will be presented in Section 2.

The MEIT methodology solves both the boundary layer integral momentum and energy equations. The required input are surface shape, boundary layer edge conditions, boundary layer gas properties and wall conditions (see Section 4). To solve these two equations, the local shape factor, recovery factor, Stanton number and friction coefficient must be defined. The effects of surface roughness, transpiration, acceleration, and boundary layer properties are taken into account in terms of influence coefficients. These influence coefficients are included in the formulation of both the local Stanton number and friction coefficient. The solution procedure is carried out by an implicit finite difference scheme. Although MEIT is designed primarily for rocket nozzle environment, which consists of turbulent flow; both laminar and transitional flow situations are also included.

In Section 2.1, the basic equations are presented. This is followed by the formulation of local shape factor, recovery factor, Stanton number, and friction coefficient in Section 2.2. The solution procedure is described in Section 2.3.

2.1 BASIC EQUATIONS

The two boundary layer integral equations solved by MEIT are:

Integral momentum equation

$$\frac{1}{r\rho_e u_e^2} \frac{d}{ds} (r\rho_e u_e \theta) = \frac{C_f}{2} + \frac{(\rho v)_w u_e}{\rho_e u_e^2} + \frac{H\theta}{\rho_e u_e^2} \frac{dp}{ds} \quad (1)$$

Integral energy equation

$$\frac{1}{r\rho_e u_e (h_{t,e} - h_w)} \frac{d}{ds} (r\rho_e u_e (h_{t,e} - h_w) \phi) = C_h \left(\frac{h_r - h_w}{h_{t,e} - h_w} \right) + \frac{(\rho v)_w (h_{t,e} - h_w)}{\rho_e u_e (h_{t,e} - h_w)} \quad (2)$$

where the momentum and energy thicknesses are respectively:

$$\theta \equiv \int_0^\infty \frac{\rho u}{\rho_e u_e} \left(\frac{u_e - u}{u_e} \right) dy \quad (3)$$

$$\phi \equiv \int_0^\infty \frac{\rho u}{\rho_e u_e} \left(\frac{h_{t,e} - h_t}{h_{t,e} - h_w} \right) dy \quad (4)$$

The boundary layer shape factor, H , is defined as:

$$H = \frac{\delta^*}{\theta} \quad (5)$$

where δ^* , the displacement thickness is given by:

$$\delta^* = \int_0^\infty \left(1 - \frac{\rho u}{\rho_e u_e} \right) dy \quad (6)$$

The total enthalpy at the boundary layer edge is defined by

$$h_{t,e} = h_e + \frac{u_e^2}{2} \quad (7)$$

while the recovery enthalpy is given by

$$h_r = h_e + F \frac{u_e^2}{2} \quad (8)$$

where F is the recovery factor.

The heat transfer rate and skin friction are related to the Stanton number and friction coefficient respectively by:

$$\tau_w = \rho_e u_e^2 \frac{C_f}{2} \quad (9)$$

$$\dot{q}_w = \rho_e u_e C_H (h_r - h_w) \quad (10)$$

In order to facilitate the solutions of equations (1) and (2), besides the required input of surface shape, boundary layer edge conditions, boundary layer gas properties, and wall conditions, the local shape factor, recovery factor, Stanton number and friction coefficient have to be formulated.

2.2 SHAPE FACTOR, RECOVERY FACTOR, STANTON NUMBER AND FRICTION COEFFICIENT

The shape and recovery factors are evaluated in MEIT by the following relations.

For laminar flow:

$$H_\ell = 3.029 \frac{T_w}{T_e} - 0.614 \quad (11)$$

$$F_\ell = Pr^{1/2} \quad (12)$$

For turbulent flow:

$$H_t = 2.285 (1 + 3.2e^{-n}) \frac{T_w}{T_e} - 0.96 \quad (13)$$

$$F_t = Pr^{1/3} \quad (14)$$

where n, the turbulent velocity profile exponent, is given by:

$$n = \frac{0.37 + \ln Re_0}{2.79 - 0.14 \ln Re_0} \quad (15)$$

The friction coefficient and the Stanton number are evaluated by the basic wall shear and heat flux laws respectively. Both of these laws are based on incompressible flow along a smooth, isothermal, impervious, flat plate. The friction coefficient and Stanton number are:

for laminar flow

$$\frac{C_{f,l,o}}{2} = \frac{0.245}{Re_\theta} \quad (16)$$

$$C_{h,l,o} = \frac{0.22}{Pr^{1/3} Re_\phi} \quad (17)$$

And for turbulent flow

$$\frac{C_{f,t,o}}{2} = \frac{0.245}{Re_\theta} + \frac{0.0123 Re_\theta}{100 + Re_\theta} (\log_{10} Re_\theta)^{-1.6} \quad (18)$$

$$C_{h,t,o} = \frac{0.22}{Pr^{1/3} Re_\phi} + \frac{0.0123 Re_\phi}{Pr^{1/3} (100 + Re_\phi)} (\log_{10} Re_\phi)^{-1.6} \quad (19)$$

In order to account for the various boundary layer effects, the Stanton number and friction coefficient given above are modified by the corresponding influence coefficients:

$$C_{x,y} = C_{x,y,o} \prod_z I_{x,y,z} \quad \begin{matrix} \text{for } x = h, f \\ y = l, t \end{matrix} \quad (20)$$

The influence coefficients are shown by $I_{x,y,z}$ where the subscripts x and y indicate whether the influence coefficient pertains to heat or momentum transfer ($x = h$ or f) and laminar or turbulent flow ($y = l$ or t), respectively. The subscript z indicates the type of phenomenon for which the basic laws are being modified.

Four phenomena are considered by MEIT. These phenomena and their corresponding z -subscripts are given in Table 1. The influence coefficients corresponding to each of these effects are formulated below.

TABLE 1

Phenomena	z-subscript of influence coefficient
acceleration	β
transpiration	B'
boundary layer properties	p
roughness	r

Acceleration

In laminar flow,

$$I_{f,l,\beta} = (1 + 3\beta)^{1/3}, \quad \beta > 0$$

$$I_{f,l,\beta} = 1.0, \quad \beta < 0$$

$$I_{h,l,\beta} = (1 + 4\beta)^{1/6}, \quad \beta > 0$$

$$I_{h,l,\beta} = 1.0, \quad \beta < 0$$

$$\text{where: } \beta \equiv \frac{2\xi}{u_e} \frac{du_e}{d\xi}$$

$$\xi \equiv \int_0^s \rho_e \nu_e u_e r^2 ds$$

In turbulent flow, only the first terms of the appropriate basic turbulent laws are modified by the above influence coefficients.

Transpiration

Blowing effects are modeled with adaptations to film theory (Reference 7).

$$I_{h,y,B'} = \frac{\ln(1 + 2\lambda_{h,y} R'B')}{2\lambda_{h,y} R'B'}, \quad y = l, t$$

$$I_{f,y,B'} = \frac{\ln(1 + 2\lambda_{f,y} R'RB')}{2\lambda_{f,y} R'RB'}, \quad y = l, t$$

where: $R \equiv C_h/C_{f/2}$ = Reynolds Analogy Factor

R' = Mass to heat transfer coefficient ratio

$\lambda_{x,y}$ = Blowing reduction parameter.

R is a dependent variable which is evaluated during the solution process. Both R' and $\lambda_{x,y}$ are input (see Section 4). MEIT, however, does provide build-in default values for $\lambda_{x,y}$. These default values are:

$$\lambda_{h,l} = \lambda_{f,l} = 0.5$$

$$\lambda_{h,t} = \lambda_{f,t} = 0.35$$

Boundary Layer Properties

Boundary layer properties of density, viscosity, and Prandtl number are evaluated at the reference enthalpy h'

$$h' = ah_e + bh_r + ch_w$$

The property influence coefficients are:

$$I_{x,y,p} = \left(\frac{\rho'}{\rho_e}\right)^d \left(\frac{\mu'}{\mu_e}\right)^e, \quad x = f, h; \quad y = l, t$$

where the constants a , b , c , d , and e for all combinations of x and y are given in Table 2.

TABLE 2

Constants Used to Evaluate Property Influence Coefficients

Property influence coefficients	Constant				
	a	b	c	d	e
$I_{f,l,p}$	0.23	0.19	0.58	0	0
$I_{h,l,p}$	0.23	0.19	0.58	1	1
$I_{f,t,p}$	0.36	0.19	0.45	1	0.25
$I_{h,t,p}$	0.36	0.19	0.45	1	0.25

Surface Roughness

In laminal flow,

$$I_{h,l,r} = I_{f,l,r} = 1$$

In turbulent flow, the influence coefficient due to surface roughness is based on correlations from PANT and Stanford heat transfer data (Reference 8 and 9), as well as Stanford and NSWC friction data (Reference 9 and 10). The turbulent influence coefficients due to roughness are:

$$I_{f,t,r} = 1 + 0.5 f(k/\theta) g(X)$$

$$I_{h,t,r} = 1 + 0.3 f(k/\theta) g(X)$$

where: $f(k/\theta) = 1 + 0.09 (k/\theta) + 0.53 (1 - e^{-k/\theta})$

$$g(X) = X + 1.5 (1 - e^{-X}) \quad \text{for } X > 0$$

$$= 0 \quad \text{for } X \leq 0$$

$$X = \log \frac{k^+}{15.5}$$

$$K^+ = \frac{\rho_e u_e k}{\mu_e} \frac{\mu_e}{\mu_w} \left(\frac{\rho_w}{\rho_e} \right)^{1/2} \sqrt{\frac{C_{f,t,s}}{2}}$$

$C_{f,t,s}$ = smooth wall friction coefficient given by equation (19)

k = surface roughness

k is input either as function of material or location (see Section 4).

The above formulations for H , F , C_h , $C_{f/2}$ are only for laminar and turbulent flows. To evaluate these four parameters for transitional flow the following relation is used:

$$P = (1 - f) P_l + f P_t \quad (21)$$

where P is one of the four parameters above and f is the transitional intermittency factor.

The transitional intermittency employed in MEIT is based on the work of Persh (Reference 11), and according to the interpretation of Dahm (Reference 12).

$$f = 1 - \frac{\alpha}{Re_\theta^2 (C_{f,t} - C_{f,l})}$$

where

$$\alpha = Re_{\theta,tr}^2 (C_{f,t} - C_{f,l})_{tr}$$

and the subscript tr refers to conditions at the transition point.

f is set to zero in laminar flow, unity in turbulent flow, and varies between 0 and 1 in transitional flow.

—This completes the formulation of the four required parameters used in the solutions of equations (1) and (2).

2.3 SOLUTIONS OF BOUNDARY LAYER INTEGRAL EQUATIONS

As mentioned above, the required input to MEIT are surface shape, boundary layer edge conditions, boundary layer gas properties, and wall conditions. These quantities are input in terms of body points. A finer grid in terms of integration points, which include all the body points, is generated by the program to ensure adequate solution accuracy of the integral equations. The boundary layer edge conditions, gas properties and wall conditions at each integration point are obtained by linear interpolation from the input. The solution procedures of the boundary layer integral equations (1) and (2) consist of:

- start-up series solutions at the first three integration points
- finite difference numerical solutions for the rest of the integration points

The solutions at the first integration point are given by:

$$\theta_1 = \sqrt{\frac{0.245 \nu_1 (1 + R_1 B_1')}{(3 + H) \left. \frac{du_e}{ds} \right|_1}} \frac{z}{\pi C_{f,l,z}}$$

$$\phi_1 = \sqrt{\frac{0.22 \nu_1 (1 + B_1')}{2 Pr \left. \frac{du_e}{ds} \right|_1}} \frac{z}{\pi C_{h,l,z}}$$

The solutions at the second and third integration point are related to the first integration point by:

$$\theta = \theta_1 (1 + a\psi^2)$$

$$\phi = \phi_1 (1 + b\psi^2)$$

$$\text{where: } a = \frac{\frac{13 + H_1}{4} \frac{\alpha}{\gamma} + \frac{1}{3} - \frac{0.659 (3 + H_1) \alpha (\gamma-1)}{\gamma} - \frac{(H_1 - 0.614) \alpha (\gamma-1)}{\gamma}}{8 + 2H_1}$$

$$b = \frac{1}{6} \left[\frac{3\alpha}{\gamma} + \frac{1}{3} - \frac{2 \times 0.659 \alpha (\gamma-1)}{\gamma} - \frac{2(1-F_2)(1+B') \alpha (\gamma-1)}{(1 - T_w/T_1)\gamma} \right]$$

$$\psi = s/R_{\text{ref}}$$

$$\text{and } \alpha = \frac{1 - (p_3/p_1)}{\psi_3^2}$$

In the above formulation, R_{ref} is an arbitrary constant radius and γ is the isentropic exponent. The subscripts 1 and 3 denote the first and third integration point condition respectively.

The solutions of the first three integration points were originally derived for reentry nosetip ablation prediction, and consider the first integration point to be a stagnation point. In MEIT, these solutions serve only as the start up procedure and should be ignored in the output.

For the rest of the integration points, the following implicit finite difference scheme is used:

$$F_{x,I} = F_{x,I-1} + 0.5(F'_{x,I-1} + F'_{x,I})(s_I - s_{I-1}) \quad x = f, h$$

$$\text{where: } F_f = r \rho_e u_e^2 \theta \quad (\text{see Equation (1)})$$

$$F_h = r \rho_e u_e (h_{t,e} - h_w) \phi \quad (\text{see Equation (2)})$$

$$F'_f = \frac{dF_f}{ds}$$

$$F'_h = \frac{dF_h}{ds}$$

I is the integration point index and F'_f and F'_h are both evaluated from equation (1) and (2) respectively.

Since the values of $F_{x,I}$ depend on $F'_{x,I}$, the solution is obtained by iteration. This iteration is local because closure is obtained at each integration point before proceeding down the body to the next integration point. Convergence is based on changes of less than 0.1 percent in both the heat and momentum transfer coefficients between successive iterations. If the iteration fails to converge in 30 tries, a local explicit solution is obtained by setting $F'_{x,I} = F'_{x,I-1}$, and subsequently reevaluating $F'_{x,I}$ based on the resulting value of $F_{x,I}$, before proceeding to the next integration point.

SECTION 3

VERIFICATION OF MEIT

Three computer programs were used in the check out of MEIT. These three codes are:

- ARGEIBL
- BLIMP
- TBL

Both ARGEIBL and BLIMP have no provisions to account for surface roughness. ARGEIBL solves only the energy integral equation and the heat transfer coefficients it calculates are routinely multiplied by 0.75 to improve their accuracy. BLIMP uses an exact implicit technique to solve the boundary layer differential conservation equations. The solution from BLIMP is believed to be the most accurate of these codes and was used as the primary criterion to determine the validity of MEIT in the check out. TBL is developed by Pratt and Whitney Aircraft Company and, like MEIT, it uses both the momentum and energy integral equations to calculate the Stanton number. It also has build-in routines to account for surface roughness.

The check out is performed by generating and comparing heat transfer coefficients for two typical rocket nozzle environments using these four computer codes. The selected rocket nozzle environments are the Aerojet MX upper stage and the C/CAN nozzle. The results of the check out and the conclusions and recommendations are summarized below.

3.1 AEROJET MX UPPER STAGE NOZZLE

An analysis of the Aerojet MX upper stage nozzle by BLIMP, ARGEIBL, and MEIT as used to validate MEIT. The geometry of the nozzle is shown

in Figure 1. A listing of the nozzle wall coordinates is given in Table 3. The nozzle has a 3.146-inch radius throat and it uses a PEG/FEFO propellant. The elemental composition of the propellant and the associated chamber conditions are given in Table 4. All this information was obtained from Reference 13. The edge conditions were calculated by the ACE code (Reference 14), and the results in terms of edge pressure, temperature, enthalpy, and velocity are presented in Figure 2. The nozzle radius is plotted as a function of stream length in Figure 3. A wall temperature of 5500°R was used in all the following calculations.

Smooth wall solutions were obtained using MEIT, ARGEIBL, and BLIMP, and the heat transfer coefficients from these solutions are compared in Figure 4. The MEIT and ARGEIBL solutions are very close to each other for regions downstream of the throat. Both of these solutions are high compared to BLIMP results. As mentioned above, the ARGEIBL solution must be reduced by a 0.75 factor to accurately predict the heat transfer coefficient. Using 0.75 as the modifier, the modified MEIT and ARGEIBL solutions are again compared to the BLIMP solution in Figure 5. From this figure, it can be seen that both the reduced MEIT and ARGEIBL solutions compare much better with the BLIMP solution. This shows that MEIT, like ARGEIBL, requires a modifier of 0.75.

For the unblown, smooth wall and turbulent flow calculations (as in the above case) it can be shown from Section 1 and Reference 1 that MEIT is solving the same Energy Integral Equation as in ARGEIBL (i.e., for this case the Momentum Integral Equation does not enter into the solution process). It is therefore of interest to find out the reasons for the difference in the MEIT and ARGEIBL heat transfer coefficient solutions. The chief reason is the different formulation for the local Stanton number in the two codes. In MEIT, the local Stanton number is given by equation (19)

$$C_{h,t,o} = \left[\frac{0.22}{Pr^{1/3} Re_\phi} + \frac{0.0123 Re_\phi}{Pr^{1/2} (100 + Re_\phi)} (\log Re_\phi)^{-1.6} \right]$$

and modified by the influence coefficients due to acceleration and boundary layer properties. In ARGEIBL, the Stanton number is defined by:

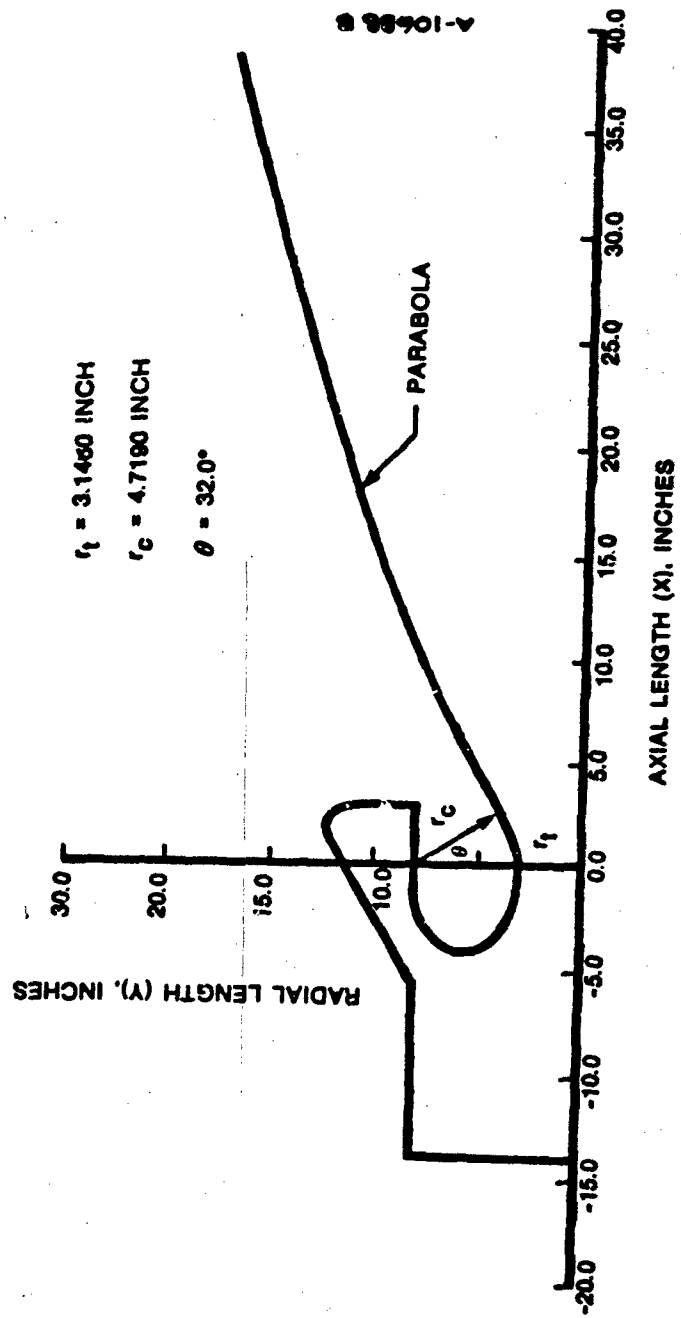


Figure 1. Geometry of the Aerojet MX upper stage nozzle.

TABLE 3. WALL COORDINATES OF THE AEROJET MX UPPER STAGE NOZZLE

X, IN.	Y, IN.	
-4.00	5.40	NOSE CAP
-3.89	4.96	
-3.72	4.67	
-3.54	4.44	
-3.30	4.25	
-3.04	4.02	
-2.76	3.83	
02.38	3.65	
02.08	3.52	
-1.70	3.39	
-1.32	3.30	
-0.94	3.22	
-0.58	3.19	
-0.20	3.147	
0	3.146	THROAT
0.165	3.149	
0.411	3.164	
0.657	3.19	
1.06	3.27	
1.45	3.38	
1.99	3.588	
2.36	3.78	
3.62	4.54	
7.53	6.64	
10.32	7.95	
14.89	9.87	
20.43	11.93	
25.20	13.5	
30.60	15.2	
38.60	17.5	EXIT

TABLE 4. PEG/FEFO PROPELLANT DATA

$P_{\text{CHAMBER}} = 102. \text{ ATM}$

$T_{\text{CHAMBER}} = 6912. \text{ }^{\circ}\text{R}$

ELEMENTAL COMPOSITION

ELEMENT	GM ATOMS 100 GRAMS
H	2.39527
C	1.13509
N	1.79248
O	2.27887
F	0.07275
Al	0.68563
Cl	0.07071

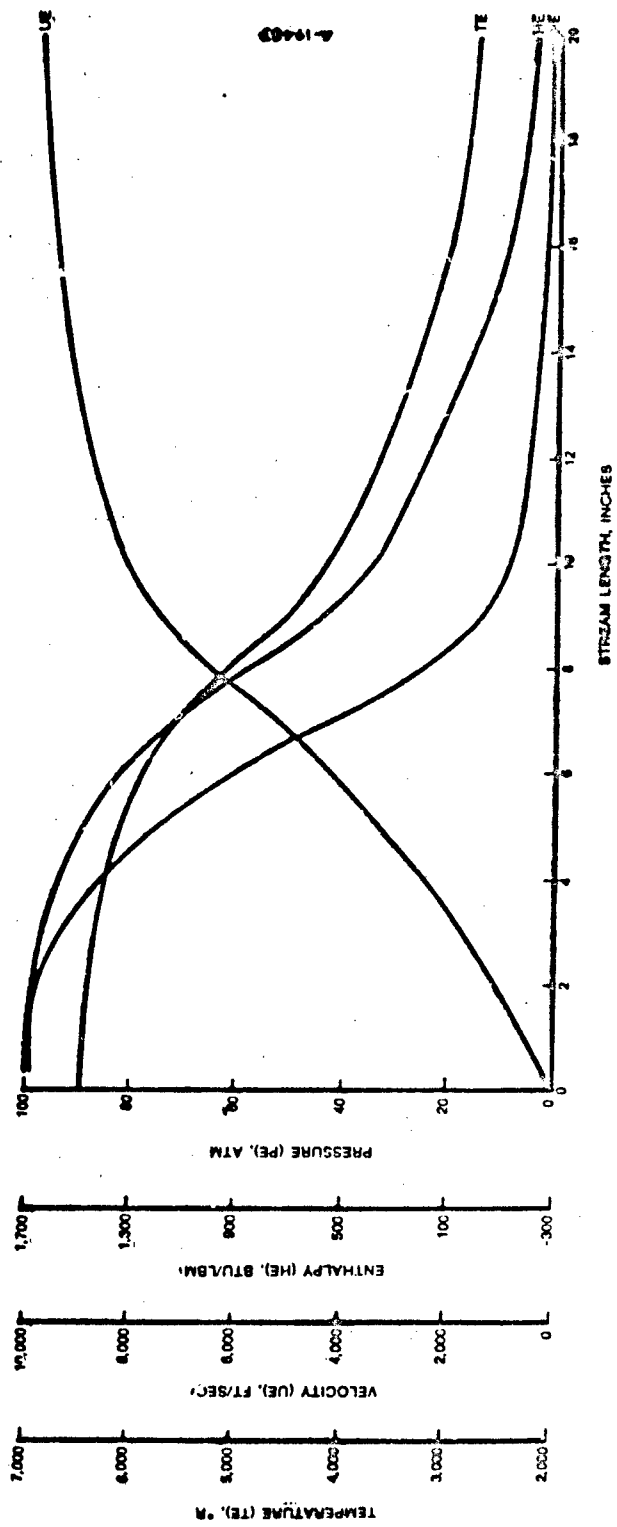


Figure 2. Edge conditions of the Aerojet MX upper stage nozzle.

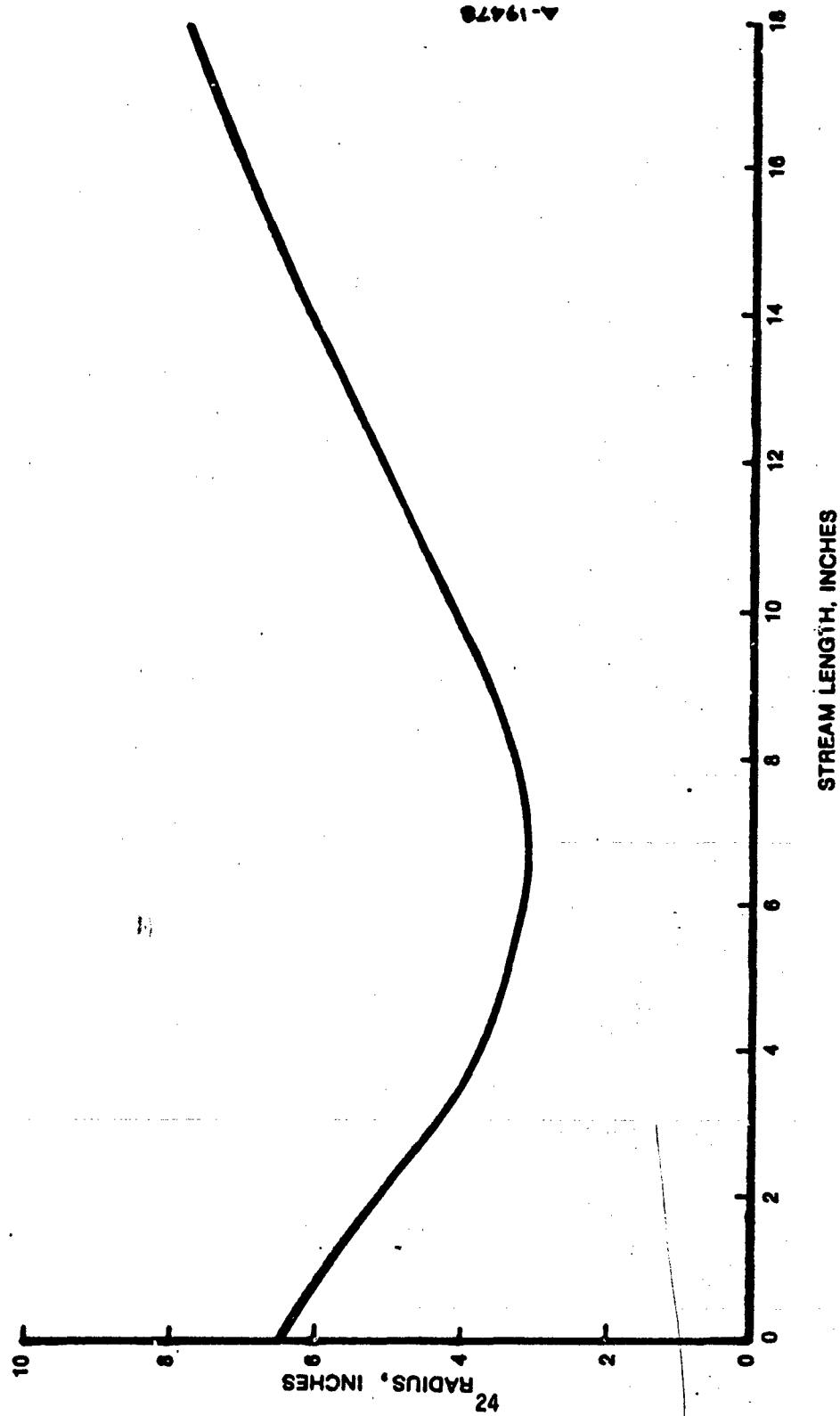


Figure 3. Nozzle radius vs. stream length for the Aerojet MX upper stage nozzle.

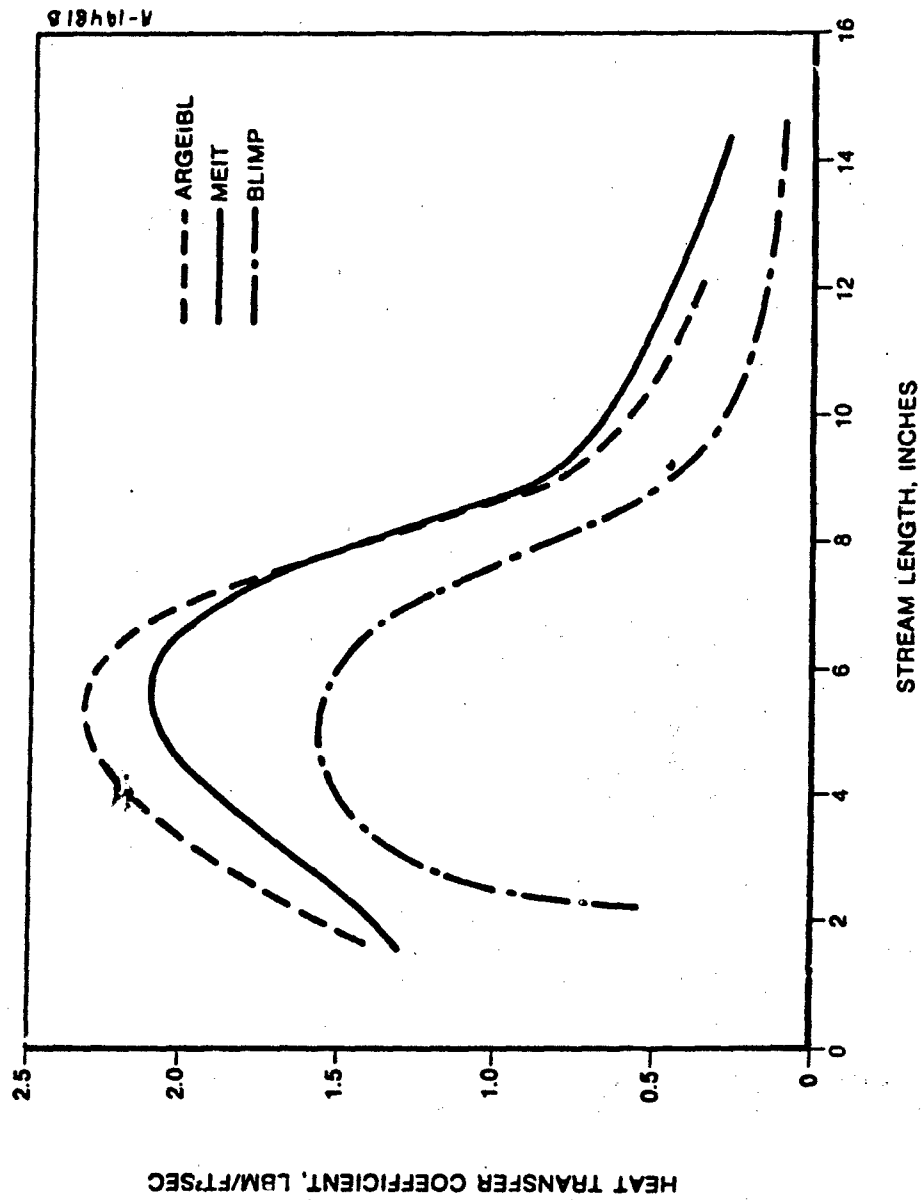


Figure 4. Heat transfer coefficient for the Aerojet MX upper stage nozzle.

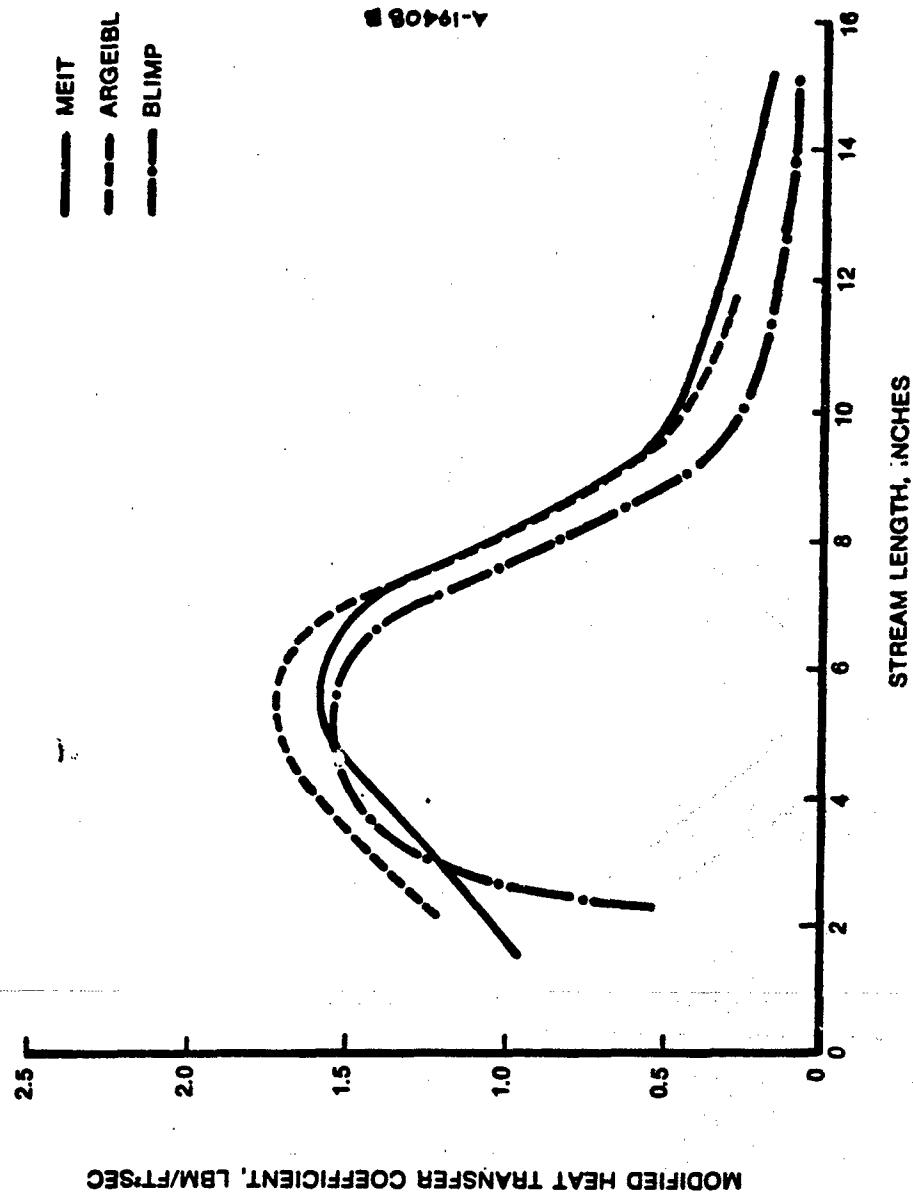


Figure 5. Modified heat transfer coefficient for the Aerojet MX upper stage nozzle.

$$C_h = \frac{0.0130 \left(\frac{\rho'}{\rho}\right)^{1/4}}{(Pr')^{1/6} Re^{1/4}}$$

where the subscript ' denotes properties evaluated at the reference enthalpy.

Other reasons are differences in the subroutines built in each code. These are the following:

- ARGEIBL uses the trapezoidal rule to calculate the numerical integration whereas MEIT uses an averaging technique.
- ARGEIBL uses a cubic curve fit to interpolate the required properties whereas MEIT uses a linear interpolation.

To check if MEIT is indeed solving the same energy integral equation as in ARGEIBL for the unblown, smooth wall and turbulent flow calculation, the Stanton number formulation in MEIT was replaced by the ARGEIBL formulation, and a solution was obtained using this new 'ARGEIBL-MEIT' code. The heat transfer coefficients from this calculation are again compared to those given by ARGEIBL in Figure 6. The two solutions compare very well in the nose cap region and the differences in other locations are basically due to the different inherent routines mentioned above.

In order to check the surface roughness formulation, a rough wall solution was generated by MEIT. A roughness height of 2 mil was used throughout the nozzle. The roughness augmentation from this calculation is compared to those given in Reference 15 in Figure 7. The results from Reference 15 are based on local energy thickness and conditions given by the smooth wall BLIMP solution and were hand-calculated using the MEIT surface roughness formulation. Figure 7 shows that these two solutions compare very well with each other. The higher values given by Reference 15 are mainly due to the use of smooth wall momentum thicknesses in the hand calculation.

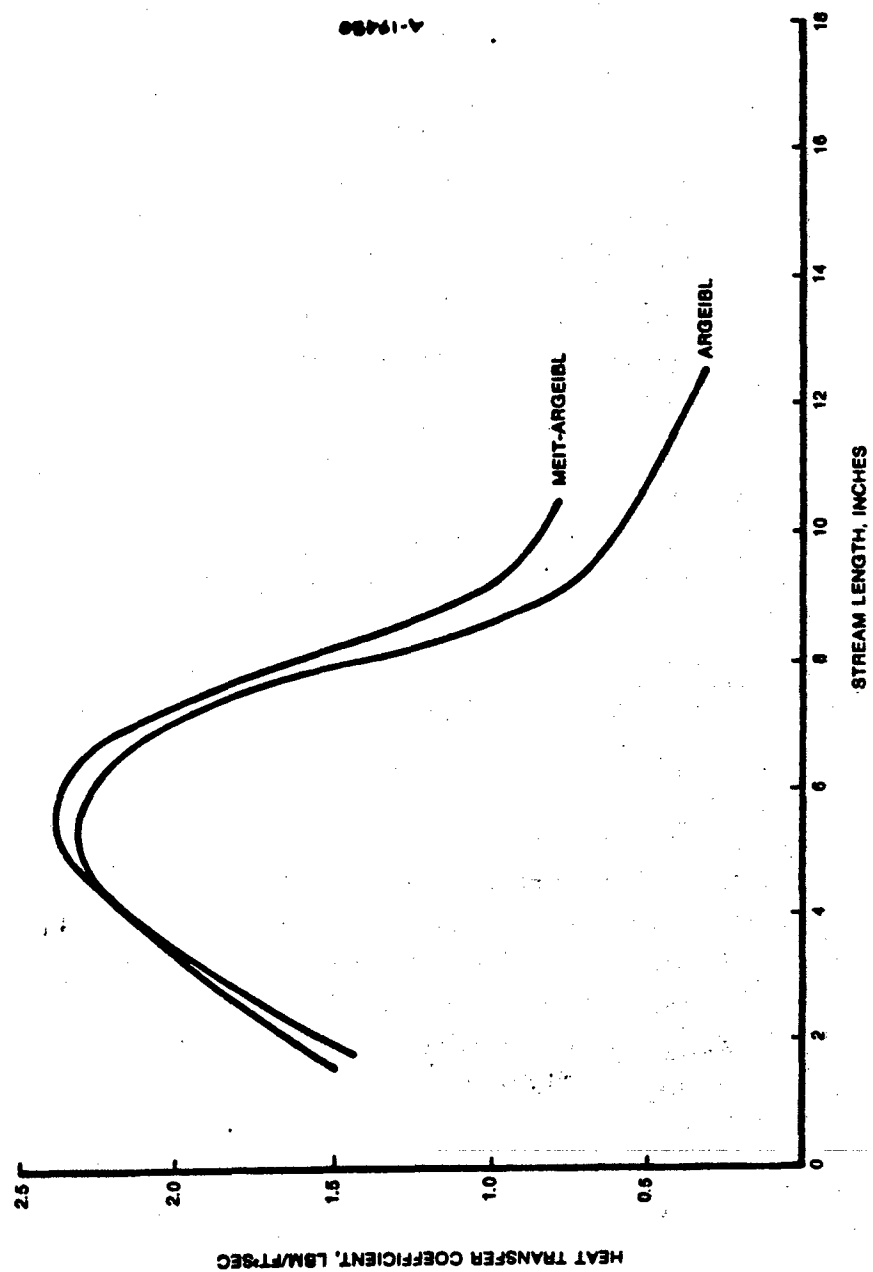


Figure 6. Heat transfer coefficient for the Aerojet MX upper stage nozzle.

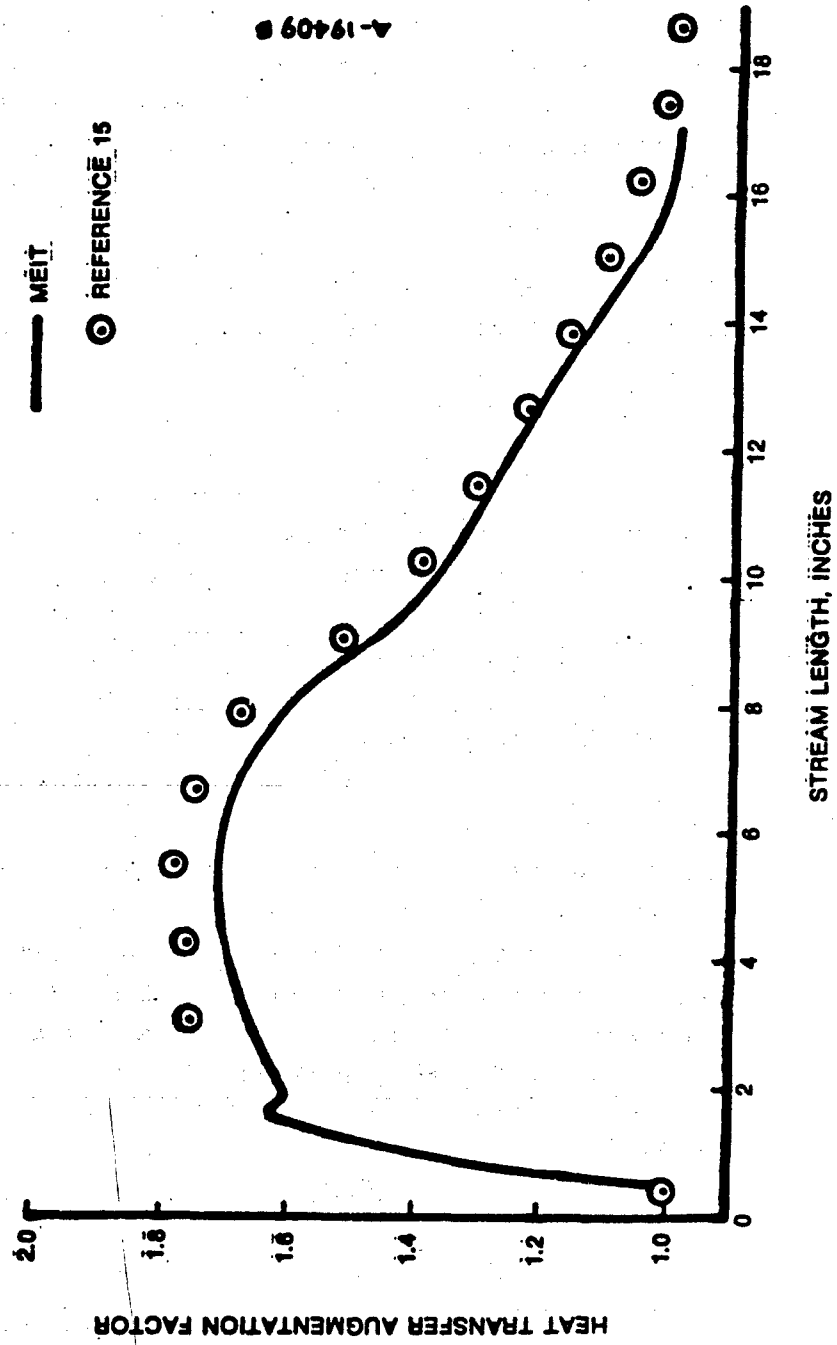


Figure 7. Predicted heat transfer augmentation factor for the Aerojet MX upper stage nozzle.

3.2 C/CAN NOZZLE

The C/CAN nozzle is used primarily to compare the rough wall solutions generated by MEIT and TBL. The geometry of the nozzle is shown in Figure 8. A listing of the wall coordinates of the nozzle is given in Table 5. The nozzle has a throat radius of 0.960 inch and uses a HT 90/18 propellant. The elemental composition of the propellant and the chamber conditions are given in Table 6. The above information was obtained from Reference 16. The edge conditions were again calculated by ACE and are presented in Figure 9. The nozzle radius vs. stream length plot is given in Figure 10 and the wall temperature is assumed to be 4939°R.

Both smooth and rough wall calculations were performed by MEIT. Smooth and rough wall solutions generated by TBL were furnished to Aero-therm by Atlantic Research Corporation (Reference 16). The rough wall calculations were based on a roughness height of 2 mil. The solutions are compared in Figure 11. For the smooth wall case, the MEIT and TBL solutions are almost identical. For the rough wall case, MEIT predicts lower heat transfer coefficients than TBL except for locations just downstream of the combustion chamber. According to Reference 16, the TBL solutions, like those generated by ARGEIBL, are normally modified by modifying factors to make them compatible with measured values. These modifying factors are developed from actual motor firing data. However, since there were no firing data available at the time of the check out, the question of whether MEIT or TBL is more accurate in rough wall prediction cannot be answered at this time.

Reference 16 also indicates that the roughness modelling in TBL would not approach the smooth wall modelling when the surface roughness is reduced. To make sure that this is not the case for MEIT, an additional MEIT calculation was performed using a roughness height of 0.01 mil. The results are exactly the same as the smooth wall solutions shown in Figure 11. This indicates that MEIT is self-consistent.

3.3 CONCLUSIONS AND RECOMMENDATIONS

The findings and conclusions based on the above discussion are summarized below:

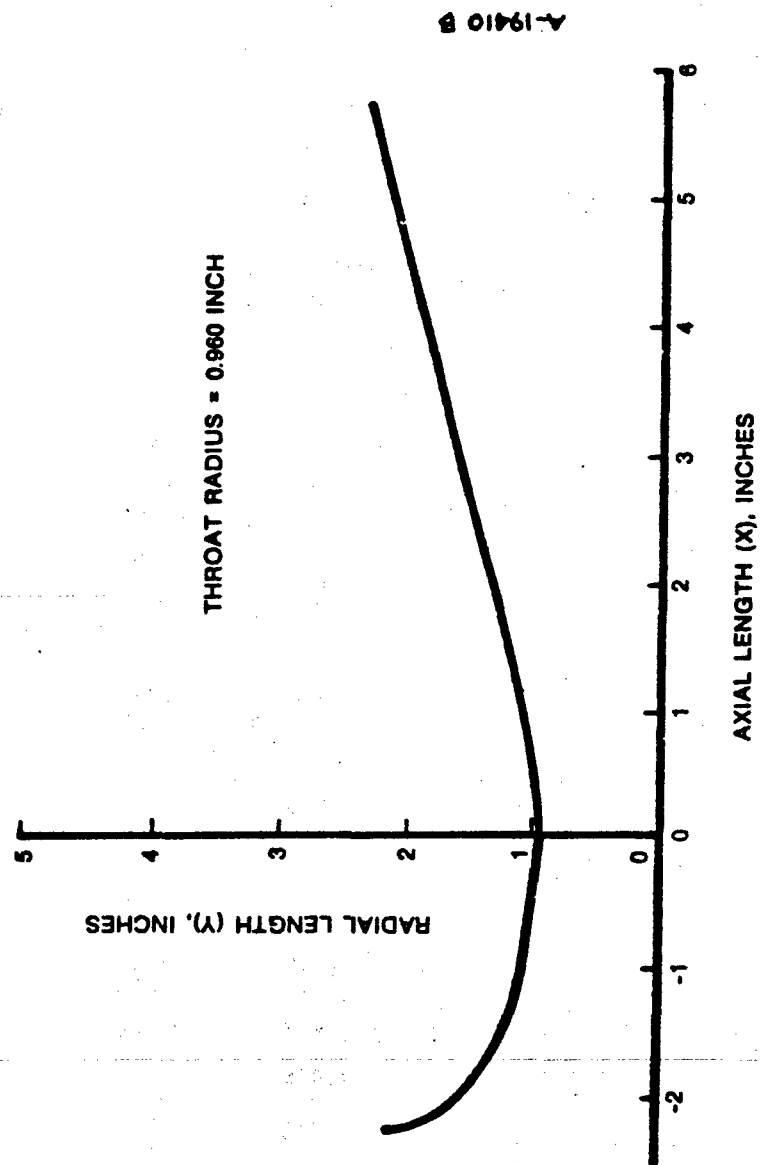


Figure 8. Geometry of the C/CAN nozzle.

TABLE 5. WALL COORDINATES OF THE C/CAN NOZZLE

X, IN.	Y, IN.	
-2.25	2.12	
-2.20	1.836	
-2.0	1.526	
-1.85	1.410	
-1.50	1.252	
-1.10	1.114	
-0.80	1.041	
-0.54	0.991	
-0.30	0.971	
-0.10	0.961	
0.0	0.960	
0.10	0.961	
0.20	0.965	
0.40	0.980	
0.60	1.005	
0.80	1.041	
1.20	1.141	
1.70	1.275	
2.45	1.475	
3.45	1.743	
4.45	2.011	
5.70	2.346	

TABLE 6. HT 90/18 PROPELLANT DATA

$P_{\text{Chamber}} = 68.027 \text{ atm}$

$T_{\text{Chamber}} = 6627.6 \text{ }^{\circ}\text{R}$

$H_{\text{Chamber}} = - 812.70 \text{ Btu/lbm}$

ELEMENTAL COMPOSITION:

Element	<u>Gm Atoms</u> <u>100 gram</u>
H	3.4976
C	.6936
N	.6177
O	2.4857
Al	.6671
Cl	.6128

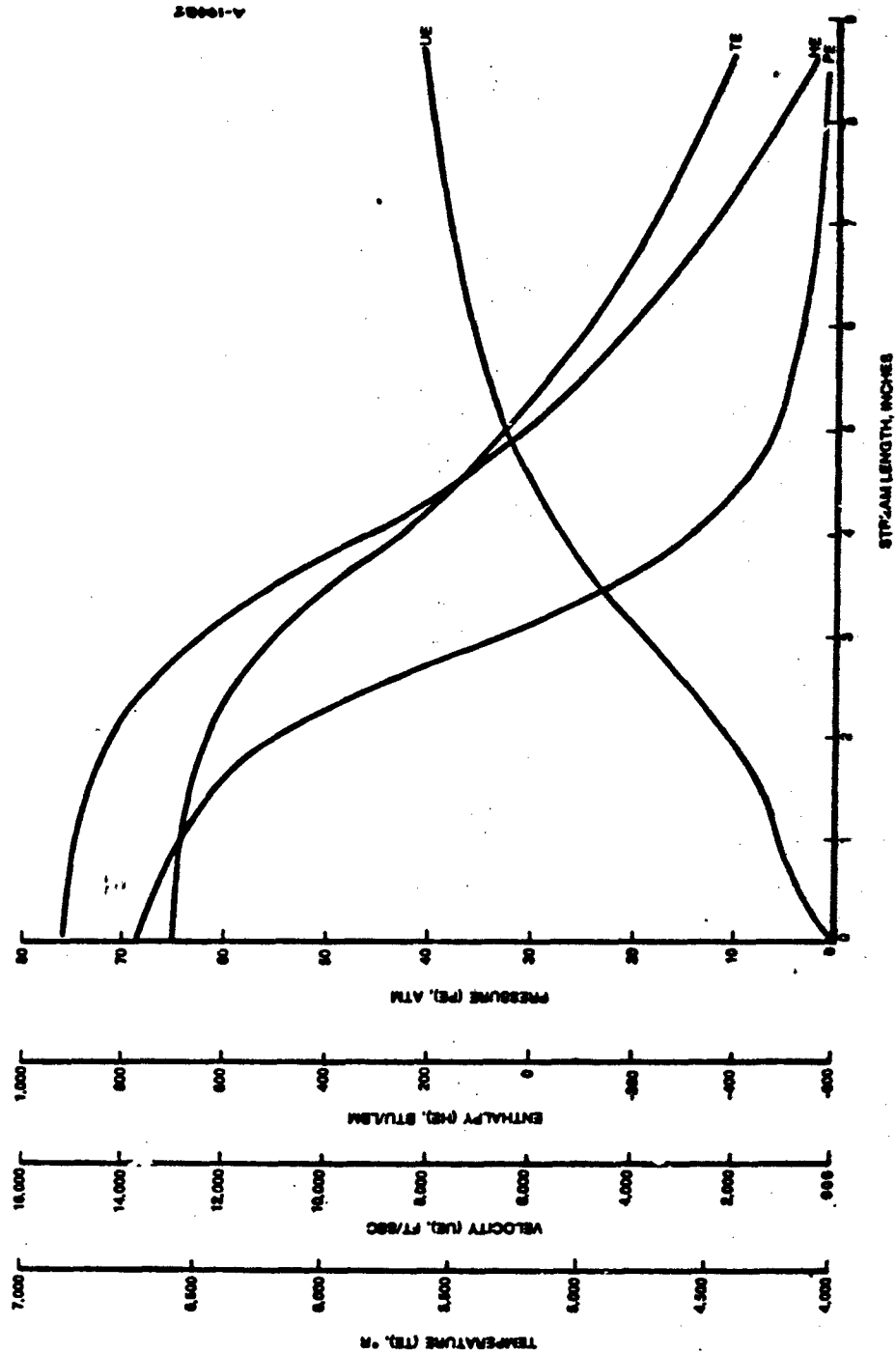


Figure 9. Edge conditions of the C/CAN nozzle.

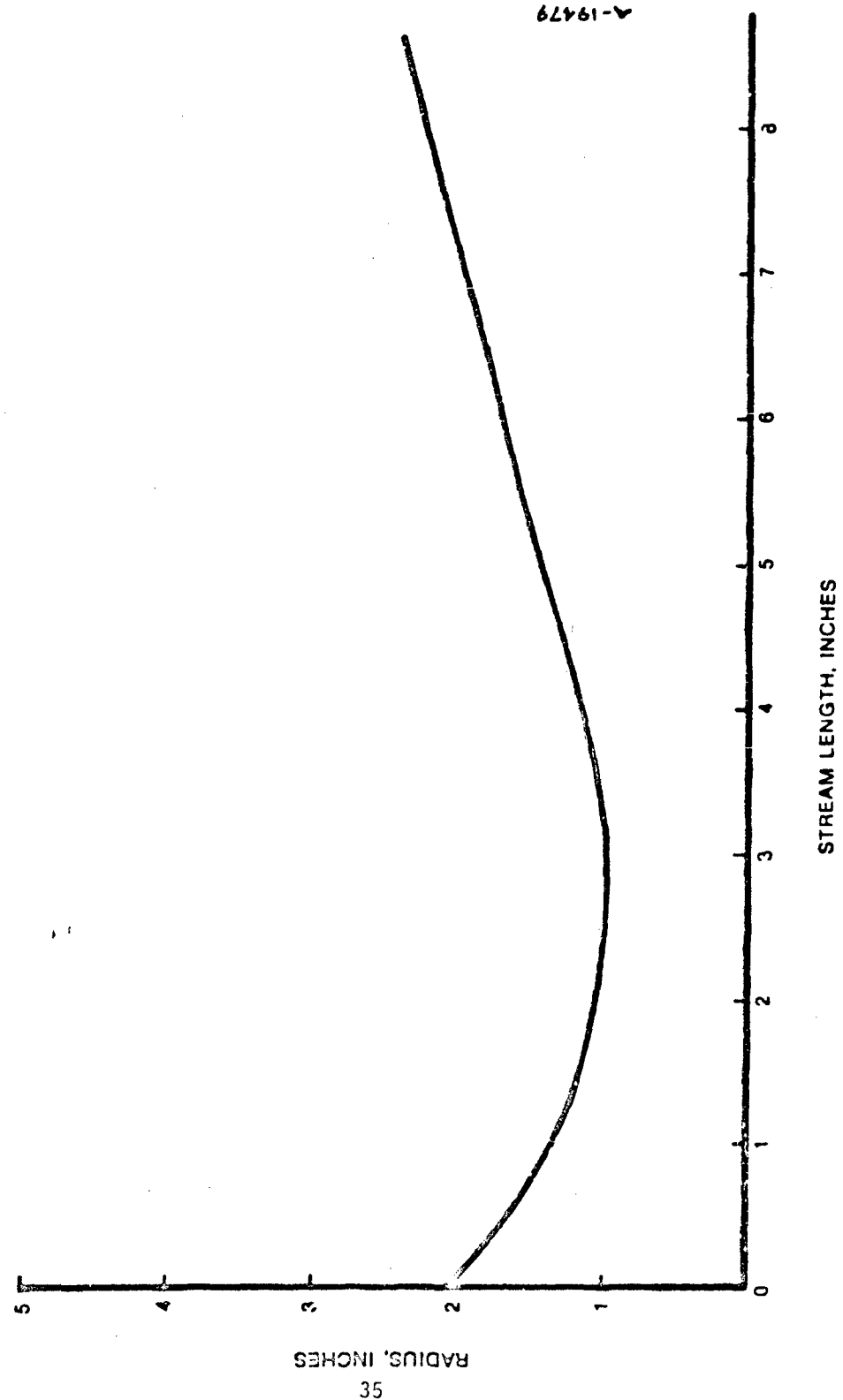


Figure 10. Nozzle radius vs. stream length for the C/CAN nozzle.

A-19479

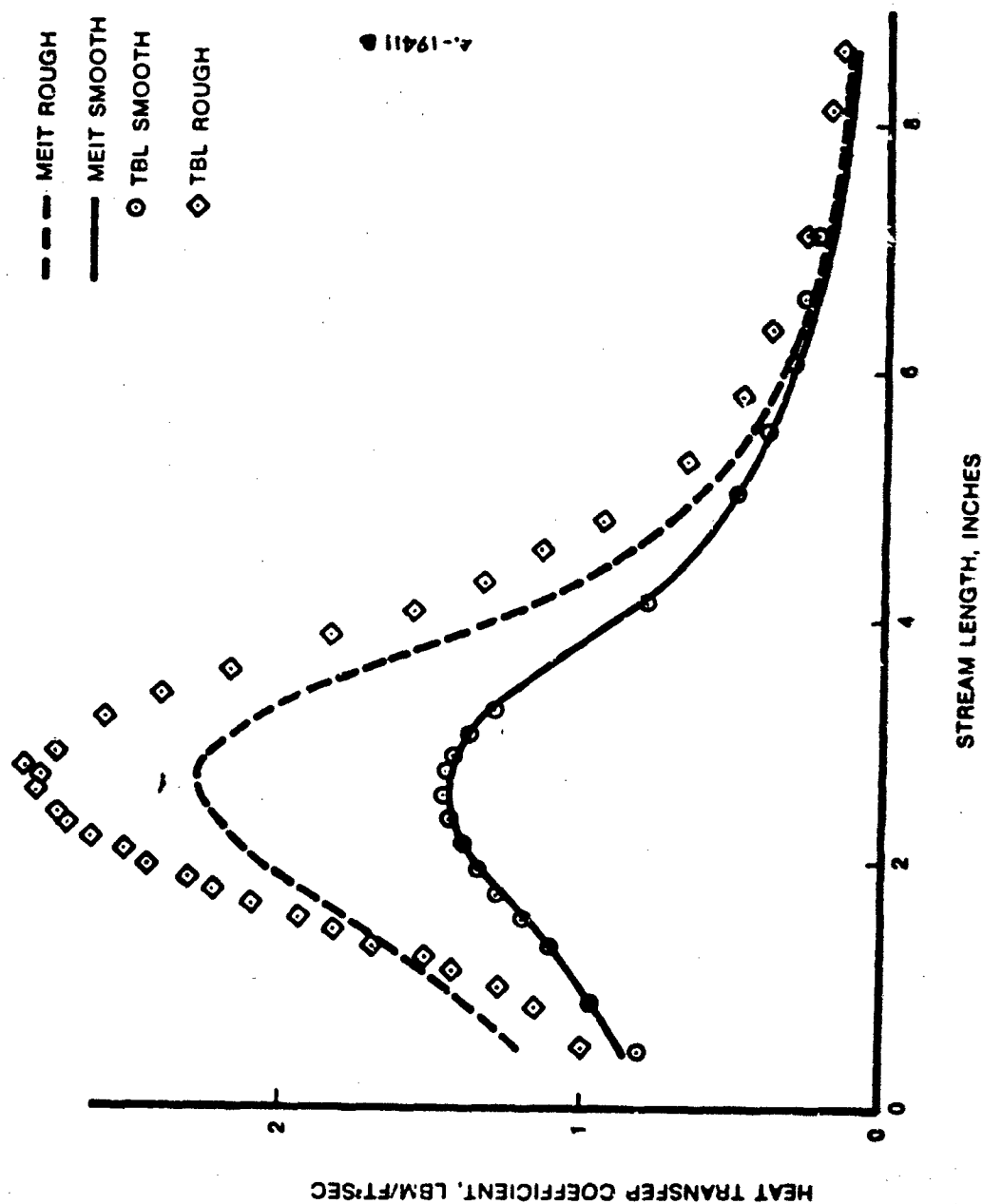


Figure 11. Heat transfer coefficients for the C/CAN nozzle.

- For nonblown, smooth wall and turbulent flow, both MEIT and ARGEIBL solve the same energy integral equation.
- Using the BLIMP solution as the criterion and a modifying factor of 0.75, the modified MEIT solution is better than the modified ARGEIBL solution.
- MEIT and TBL predict essentially the same heat transfer coefficient for smooth wall calculation.
- For rough wall calculation, MEIT predicts a lower heat transfer coefficient than TBL except in regions immediately downstream of the combustion chamber.
- MEIT is self-consistent in its roughness modelling.

The recommendations are:

- For both smooth and rough wall calculations, a factor of 0.75 should be used to modify the heat transfer coefficient generated by MEIT.
- Experiments or analyses should be conducted to deduce the heat transfer coefficient from actual motor firing data to check the validity of the surface roughness modelling in MEIT.
- A technique needs to be devised to evaluate nozzle material roughnesses for input into MEIT.
- When there is no firing data to modify the TBL heat transfer coefficient, the MEIT solution modified by a 0.75 factor should be used for rough wall predictions.

SECTION 4

DESCRIPTIONS OF INPUT AND OUTPUT

This section provides detailed user oriented input instructions and a description of the output. The input instructions are presented in Section 4.1 and the output features are covered in Section 4.2.

4.1 INPUT INSTRUCTIONS

The program input consists of three card sets:

1. General program constants and transition information
2. Surface shape, boundary layer edge and wall conditions
3. Boundary layer gas properties

The description of these three card sets is given below.

Card Set 1 - Control Cards

This card set is made up of three cards which provide general program constants and transition information. The four blowing reduction parameters, $\lambda_{x,y}$, which are used to calculate the blowing influence coefficients (see Section 2.2), are also included in this card set

Card No.	Column	Format	Data	Unit
1	1	I1	NSM - No. of material, up to 3 allowed	-
	2	I1	IROUGH - Roughness height input flag 0 - Input as function of material (see below) 1 - Input as function of location (see Card Set 2)	-

Card No.	Column	Format	Data	Unit
2	3-10	F8.5	CMH - Mass to heat transfer coefficient ratio, default value = 1.0	-
	11-20	F10.5	GAM2 - Isentropic exponent, default value = 1.2	-
	1-10	F10.5	BTS - $\lambda_{f,t}$, default value = 0.5	-
	11-20	F10.5	BTH - $\lambda_{h,t}$, default value = 0.5	-
	21-30	F10.5	BLS - $\lambda_{f,1}$, default value = 0.35	-
	31-40	F10.5	BLH - $\lambda_{h,1}$, default value = 0.35	-
	41-50	F10.5	RUFL - Surface roughness height as function of material, input only if IROUGH = 0	mil

Repeat card 2 for each material (number of cards equals NSM).

2 + NSM	1-2	I2	NS - No. of body points (maximum 60)	-
	2-4	I2	IBRUPT - Abrupt transition flag 0 - laminar and transitional flow 1 - fully turbulent flow.	-
	8-6	I2	NREYCR - Transition flag 0,7 - all turbulent 1 - all laminar 4 - transitional	-
	7-8	I2	IPRNT - Output print flag 1 - Detailed output at body point 2 - Detailed output at integration point	-
	9-12		Blank	
	13-22		DLTRAN - Axial location at which transition takes place, input only if NREYCR = 4	in

Card Set 2 - Body Point Data

This card set is made up of nine subsets and they provide the surface sharp, edge and wall condition information to the program. The nine subsets are:

- IMAT - Material index, default value = 1
- ZSP - Axial wall coordinates (in.)

- RSP - radial wall coordinates (in)
- PE - Edge pressure (atm)
- HE - Edge enthalpy (Btu/lbm)
- UE - Edge velocity (ft/sec)
- TSP - Wall temperature (°R)
- BPSP - Blowing parameter $\equiv (\rho v)_w / \rho_e u_e C_M$
- RUF2 - Surface roughness height (mil)
RUF2 is input only if IROUGH = 1 (see Card Set 2).

The nine subsets are input in the above order. Each of these subsets has NS entries and each entry corresponds to a point on the heated surface of the body. The input format of all the subsets are F10.3 except IMAT which uses an input format of I10. The values of each subset are entered eight to a card. Since the solution for the first body point is based on stagnation conditions (see Section 2), it is recommended that the first entry in the velocity subset (UE) be zero.

Card Set 3 - Gas Property Tables

The gas property table provides the thermodynamic and transport properties of the boundary layer gas. This table is divided into subtables based on pressure. Within each pressure subtable, they are ordered either on temperature or enthalpy. If they are ordered on temperature, the same temperature array must be used for all other pressure subtables. The same is true for the enthalpy entries if the properties are input as functions of enthalpy and pressure.

Card No.	Column	Format	Data	Unit
1	1-3	I3	IPMAX - No. of pressure entries (maximum 21)	
	4-6	I3	IHMAX - No. of temperature or enthalpy entries (maximum 35)	
	7-12	I3	LTB - Temperature enthalpy flag 0- Properties input as functions of pressure and enthalpy 1- Properties input as functions of pressure and temperature	

Card No.	Column	Format	Data		Unit
2	1-10	F10.3	PT	- Pressure	atm
3 to IPMAX + 2					
	1-12	E12.4	HT	- Enthalpy	Btu/lbm
	13-24	E12.4	TEMP	- Temperature	°R
	25-36	E12.4	EMT	- Molecular weight	
	37-60		Blank		
	61-72	E12.4	ET	- Viscosity	lbm/ft-sec
	73-80	F8.4	GT	- Prandtl No.	

Cards 3 to IPMAX + 2 are repeated until the total number of pressures is equal to IPMAX. Note the pressure, enthalpy, and temperature entries must be input in ascending order.

4.2 OUTPUT DESCRIPTION

MEIT output can be divided into three categories. These are:

- Output of Input
- Output of Calculation Results
- Debug Output

The descriptions of each of these output are given below.

Output of Input

The program output begins with the output of the input. This output is made up of three parts:

- General program information
- Thermodynamic table
- General input information table

The general program information prints out the program constants contained in the first three input cards. These include mass to heat transfer coefficient ratio, isentropic exponent, the four blowing reduction parameters, and transition information. The FORTRAN names corresponding to

these variables are given in Section 4.1. The thermodynamic table tabulates the thermodynamic and transient properties of the boundary layer gas as functions of pressure. This table is self-explanatory. The general input information table gives the surface shape, boundary layer edge conditions and wall conditions. The variables printed in this table, their FORTRAN names and definitions are listed below:

- BODY PT NO (J)
Index of the body points
- INTEG PT NO (I)
Index of the integration point for which the computed parameters are printed
- MATL NO (MATL)
Material index.
- STREAM LENGTH, inch (S)
Stream length along the heated surface from the initial point to the integration points
- AXIAL LENGTH, inch (Z)
Axial coordinate of the integration points with respect to the initial point
- RADIAL LENGTH, inch (R)
Radial coordinate of the integration points with respect to the centerline
- BODY ANGLE, degrees (THETB)
Angle which the tangent to the surface makes with respect to the centerline
- NORMALIZED ABLATION RATE (BPSP)
Normalized ablation rate B' at the wall

$$B' \equiv \frac{(\rho v)_w}{\rho_e u_e C_M}$$
- WALL TEMP, °R (TW)
Temperature of the wall

- SURFACE ROUGHNESS, mil (RUFMIL)
Surface roughness height of the wall material
- PRESSURE, atm (PE)
Edge pressure of the boundary layer
- ENTHALPY, Stu/lbm (HE)
Edge enthalpy of the boundary layer
- VELOCITY, ft/sec (UE)
Edge velocity of the boundary layer

Output of Calculation Results

The results of the code calculations are printed out in three tables.
These three tables are:

1. Viscous Flow - Edge Properties
2. Viscous Flow - Wall and B. L. Recovery Properties
3. Viscous Flow - Boundary Layer Solution

The variables printed in each table, their FORTRAN names and definitions are listed below.

1. Viscous Flow - Edge Properties Table

- BODY PT NO (J)
Index of the body points
- INTEG PT NO (I)
Index of the integration point for which the computed parameters are printed
- STREAM LENGTH, inch (S)
Stream length along the heated surface from the initial point to the integration points
- VELOCITY, ft/sec (UE)
Velocity at the edge of the boundary layer
- MACH NO (HCAM)
Mach number at the edge of the boundary layer

- ENTHALPY, Btu/lbm (HE)
Enthalpy at the edge of the boundary layer
- TEMPERATURE, °R (TE)
Temperature at the edge of the boundary layer
- DENSITY, lbm/ft³ (ROE)
Density at the edge of the boundary layer
- VISCOSITY, lbm/ft-sec (VISE)
Viscosity at the edge of the boundary layer
- UNIT RE NO, 1/ft (URE)
Unit Reynolds number at the edge of the boundary layer

Note that the Mach number given in this table is valid only if there are no condensed species in the freestream.

2. Viscous Flow - Wall and B.L. Recovery Properties Table

- BODY PT NO (J)
Index of the body points
- INTEG PT NO (L)
Index of the integration point for which the computer parameters are printed
- STREAM LENGTH, inch (S)
Stream length along the heated surface from the initial point to the integration points
- WALL TEMPERATURE, °R (TW)
Temperature at the wall
- WALL ENTHALPY, Btu/lbm (HW)
Enthalpy of gas at wall temperature and pressure
- WALL DENSITY, lbm/ft³ (ROW)
Density of gas at wall temperature and pressure
- WALL VISCOSITY, lbm/ft-sec (VISW)
Viscosity of gas at wall temperature and pressure

- RECOVERY ENTHALPY, Btu/lbm (HR)
Recovery enthalpy defined by $h_r \equiv h_e + F (h_t - h_e)$
- RECOVERY FACTOR (RECOV)
Recovery Factor defined by $F = Pr^n$, $n = \begin{cases} 1/2 & \text{for laminar flow} \\ 1/3 & \text{for turbulent flow} \end{cases}$
- SENSBLE CONV HEAT FLUX, Btu/ft² sec
Sensible convective heat flux defined by $\dot{q}_w = \rho_e u_e C_H (h_r - h_w)$
- CF/2
Function coefficient $C_f/2 \equiv \tau_w / (\rho_e u_e^2)$

3. Viscous Flow - Boundary Layer Solution Table

- BODY PT NO (J)
Index of the body points
- INTEG PT NO (I)
Index of the integration point for which the computed parameters are printed
- STREAM LENGTH, inch (S)
Stream length along the heated surface from the stagnation point to the integration points
- MOMENTUM THICKNESS, mil (THE)
Momentum thickness θ of the boundary layer
- ENERGY THICKNESS, mil (PHI)
Energy thickness ϕ of the boundary layer
- SHAPE FACTOR (HSF)
Boundary layer shape factor, $H \equiv \delta^*/\theta$

where $\delta^* \equiv \int_0^\delta \left(1 - \frac{\rho u}{\rho_e u_e}\right) dy$ is the boundary layer displacement thickness.

- MOM THICK RE NO (RETH)
Reynolds number based on the momentum thickness, $Re_\theta = \frac{\rho_e u_e \theta}{\mu_e}$

- ENERGY THICK RE NO (REPH)
Reynolds number based on the energy thickness, $Re_\phi = \frac{\rho_e u_e \phi}{\mu_e}$
- HEAT TRANS COEFFICIENT, lbm/ft²sec (RUCH)
Heat transfer coefficient, $\rho_e u_e C_h \equiv \dot{q}_w / (h_r - h_w)$
where C_h is the Stanton number and $\dot{q}_w$ is the wall heat flux
- REYNOLDS ANAL FAC (RAF)
Reynolds analogy factor $C_h / (C_f/2)$
- INTERMITTENCY (ADML)
Boundary layer intermittency factor f , where $0 \leq f \leq 1$ for flow ranging from fully laminar to fully turbulent regime
- HEAT TRANS AUGMENT (RUFST)
Heat transfer augmentation due to surface roughness, this quantity is equivalent to the roughness influence coefficient

As mentioned in Section 2, the solutions for the first three integration points are only for start up purpose. These solutions should be ignored in the output.

Debug Output

There are four error messages output by MEIT. The error messages and their meanings are given below.

- ***** Wrong Pressure Input Ordering
The pressure entries in the boundary layer gas properties table are not in ascending order.
- ***** Wrong Temperature/Enthalpy Input Ordering
The temperature or enthalpy entries in the boundary layer gas properties table are not in ascending order.
- ***** Input Temperature/Enthalpy Error
The corresponding temperature or enthalpy entries in the boundary layer gas properties table are not the same for different pressure entries.

- Computation of MEIT equations did not converge at Point I. The MEIT calculations at Integration Point I did not converge after 30 tries.

There are also other debug output built in MEIT. However, since these output are only useful to the very sophisticated users who are intimately familiar with the program logic, they are not described here.

SECTION 5

SAMPLE PROBLEMS

Presented in this section are two sample problems which were run on a Univac 1108 Digital Computer. For each sample problem, the following is presented:

- A brief description of the nature of the problem and solution.
- A listing of the input data deck.
- A listing of the output.

Sample Problem 1

This is a smooth wall calculation for the Aerojet MX upper stage nozzle with a PEG/FEFO propellant. The details of this system were described in Section 3. A total of 21 body points were input. The wall temperature was assumed to be 5500°R. A IPRNT = 1 option was used which printed out only the body point solutions.

INPUT LISTING OF SAMPLE PROBLEM NO. 1

1 .7089 1.2704

21 1 7 1

0. 1.65361 2.01637 2.81659 3.17910 3.85984 4.23981 4.61979
 9.97964 5.36262 5.96134 5.72631 5.97230 6.21041 6.62102 7.00631
 7.91796 13.08933 20.08066 30.76366 44.16533 58.20000 3.20000 3.20000
 0.00000 4.93994 6.44000 4.02000 3.63004 3.39000 3.27000 3.30004
 3.18996 3.17004 3.16004 3.14904 3.16404 3.18996 3.27000 3.30004
 3.780006.63996 9.87 13.5 17.4996 17.4996 17.4996 17.4996
 180.00000 97.23560 94.27290 90.00630 83.27080 74.44780 69.87120 63.15230
 59.24808 54.85899 47.74930 44.58640 40.00090 35.78010 29.09960 22.65110
 11.333322.6765 1.2638 .6355 .3356 .3356 .3356 .3356
 1692.200001650.700001637.690001605.200001522.100011477.100011431.660001370.14999
 1331.200001304.300001197.360001156.240001094.199991028.10001 915.30000 763.88000
 456.29003-31.62 -296.84 -443.52 -594.98
 .000001295.1000111648.000002056.000002648.299993261.500003611.399994015.20001
 9281.099984465.599984977.099985179.799995371.599985765.799996286.299996743.20001
 7845.700019423.2 9976.5 10388. 10700.
 5500. 5500. 5500. 5500. 5500. 5500. 5500. 5500.
 5300. 5500. 5500. 5500. 5500. 5500. 5500. 5500.
 5300. 5500. 5500. 5500. 5500. 5500. 5500. 5500.

6 16

1. 1.65361 2.01637 2.81659 3.17910 3.85984 4.23981 4.61979
 9.97964 5.36262 5.96134 5.72631 5.97230 6.21041 6.62102 7.00631
 7.91796 13.08933 20.08066 30.76366 44.16533 58.20000 3.20000 3.20000
 0.00000 4.93994 6.44000 4.02000 3.63004 3.39000 3.27000 3.30004
 3.18996 3.17004 3.16004 3.14904 3.16404 3.18996 3.27000 3.30004
 3.780006.63996 9.87 13.5 17.4996 17.4996 17.4996 17.4996
 180.00000 97.23560 94.27290 90.00630 83.27080 74.44780 69.87120 63.15230
 59.24808 54.85899 47.74930 44.58640 40.00090 35.78010 29.09960 22.65110
 11.333322.6765 1.2638 .6355 .3356 .3356 .3356 .3356
 1692.200001650.700001637.690001605.200001522.100011477.100011431.660001370.14999
 1331.200001304.300001197.360001156.240001094.199991028.10001 915.30000 763.88000
 456.29003-31.62 -296.84 -443.52 -594.98
 .000001295.1000111648.000002056.000002648.299993261.500003611.399994015.20001
 9281.099984465.599984977.099985179.799995371.599985765.799996286.299996743.20001
 7845.700019423.2 9976.5 10388. 10700.
 5500. 5500. 5500. 5500. 5500. 5500. 5500. 5500.
 5300. 5500. 5500. 5500. 5500. 5500. 5500. 5500.
 5300. 5500. 5500. 5500. 5500. 5500. 5500. 5500.

54000000	19236+02	58760+00	-53917-01	39785-00	9378
72000000	19194+02	65175+00	-10135+00	4157-00	9555
90000000	19019+02	81593+00	-16219+00	28338-00	9827
108000000	18667+02	95318+00	-23180+00	43977-00	9996
126000000	18675+02	10675+01	-38623+00	49327-00	9963
144000000	18505+02	12809+01	-38233+00	45757-00	9929
162000000	18315+02	15833+01	-45818+00	46471-00	9393
171000000	18216+02	19839+01	-99534+00	46793-00	9376
28.					
63000000	20655+02	12487+01	-70183+00	25462-00	9953
81000000	20203+02	18486+01	-54271+00	2602-00	9841
99000000	19551+02	64332+00	-18723+00	27561-00	9672
118000000	19351+02	49922+00	-19093+01	30888-00	9621
136000000	19356+02	49883+00	-5883-02	31480-00	9616
154000000	19329+02	49545+00	-16094-02	39201-00	9611
172000000	19327+02	49884+00	-19408-02	35503-00	9608
190000000	19321+02	46657+00	-51994-02	37982-00	9600
208000000	19386+02	49156+00	-1323-01	48278-00	9589
226000000	19276+02	52575+00	-28214-01	42376-00	9575
244000000	19274+02	52268+00	-51711-01	48267-00	9558
262000000	19183+02	63227+00	-83063-01	45997-00	9538
280000000	19855+02	70170+00	-12357+00	47284-00	9516
298000000	18941+02	77845+00	-16911+00	48731-00	9492
316000000	18808+02	85909+00	-21853+00	49883-00	9466
334000000	18734+02	90018+00	-24035+00	50410-00	9452
352000000	20957+02	12480+01	-73045+00	26150-00	8899
370000000	20951+02	10662+01	-68399+00	26473-00	8929
388000000	19755+02	73388+00	-89757+00	28046-00	8733
406000000	19403+02	49758+00	-59957-01	30198-00	8636
424000000	19336+02	3337+00	-8628-01	31522-00	8623
442000000	19334+02	4642+00	-85728-02	34218-00	8613
460000000	19331+02	45031+00	-25150-02	35512-00	8609
478000000	19325+02	46313+00	-8655-02	38000-00	8601
496000000	19313+02	48316+00	-96855-02	48278-00	8591
514000000	19292+02	50933+00	-20713-01	48473-00	8577
532000000	19253+02	54561+00	-38624-01	48442-00	8562
550000000	19195+02	59281+00	-64883-01	46220-00	8544
568000000	19111+02	64936+00	-96885-01	47818-00	8525
586000000	19017+02	71295+00	-13487+00	49227-00	8503
604000000	18921+02	78182+00	-17748+00	50491-00	8479
622000000	18837+02	81644+00	-28029+00	51073-00	8467
70.					
68000000	21181+02	12249+01	-73080+00	26372-00	3189
86000000	20674+02	10947+01	-63809+00	27090-00	9966
104000000	19904+02	73710+00	-35735+00	2839-00	9778
122000000	19444+02	82672+00	-18322+00	30339-00	9655
140000000	19341+02	49863+00	-6379-02	31882-00	9631
158000000	19335+02	48882+00	-36518-02	38222-00	9615
176000000	19328+02	48177+00	-28598-02	35319-00	9610
194000000	19319+02	47942+00	-81844-02	38009-00	9602
212000000	19308+02	50178+00	-17285-01	40345-00	9592
230000000	19267+02	53285+00	-34221-01	4216-00	9579
248000000	19217+02	57373+00	-54313-01	46325-00	9564
266000000	19147+02	62386+00	-82828-01	46355-00	9548
284000000	19055+02	67990+00	-11712+00	48005-00	9529
302000000				49087-00	9509

.14200+04	.68943+04	.18932+02	.74131+00	-.15596+00	.50017-04	.4407
.17100+04	.64102+04	.18093+02	.77323+00	-.17671+00	.51030-04	.4475
100.						
-.63000+03	.23513+04	.21293+02	.12100+01	-.74121+00	.26079-04	.5154
-.50000+03	.24720+04	.20018+02	.10934+01	-.64426+00	.27397-04	.5030
-.34000+03	.26100+04	.20023+02	.08073+00	-.59572+00	.28664-04	.4314
-.18000+03	.26033+04	.19527+02	.56084+00	-.14160+00	.30401-04	.4674
-.90000+02	.30503+04	.19418+02	.48972+00	-.63285+01	.31654-04	.4641
.90000+02	.34468+04	.19349+02	.45173+00	-.11190+01	.34237-04	.4617
.18000+03	.36462+04	.19340+02	.45190+00	-.57561+02	.35527-04	.4612
.34000+03	.40410+04	.19331+02	.46114+00	-.40264+02	.38016-04	.4603
.54000+03	.44252+04	.19322+02	.47722+00	-.73947+02	.40359-04	.4593
.72000+03	.47949+04	.19305+02	.49721+00	-.15242+01	.42547-04	.4580
.90000+03	.51477+04	.19276+02	.52499+00	-.28595+01	.44378-04	.4565
.10000+04	.54798+04	.19231+02	.56100+00	-.08193+01	.46440-04	.4550
.12600+04	.57801+04	.19167+02	.60608+00	-.70058+01	.48131-04	.4532
.14400+04	.60729+04	.19086+02	.65871+00	-.10555+00	.49637-04	.4513
.16200+04	.63352+04	.18987+02	.71543+00	-.14164+00	.51033-04	.4492
.17100+04	.64588+04	.18932+02	.74503+00	-.14103+00	.51603-04	.4481

SAMPLE PROBLEM 1 OUTPUT

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

NUMBER OF MATERIALS = 1
 CR/CH = .78398
 ISENTROPIC EXPONENT = 1.27000

MATL	OTS	BTM	OLS	OLM
1	.35000	.35000	.35000	.35000

NS = 21
 ISRUPT = 1
 METER = 7
 IPANT = 1
 OLTRAN = .00000 INCHES

ABRUPT TRANSITION

FLOW IS TURBULENT

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

THERMODYNAMIC TABLE *****

PRESSURE = .300ATM				PRANDTL NUMBER
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	
-530.0000	1801.7000	19.4270	.000022	.4589
-348.0000	1984.2000	19.3350	.000024	.4584
-360.0000	2405.5000	19.3270	.000027	.4606
-180.0000	2824.8000	19.3270	.000030	.4613
-90.0000	3031.2000	19.3260	.000031	.4613
90.0000	3432.6000	19.3190	.000034	.4609
180.0000	3628.5000	19.3090	.000035	.4604
360.0000	3975.5000	19.2670	.000038	.4591
548.0000	4274.5000	19.1850	.000039	.4570
720.0000	4520.8000	19.0650	.000041	.4543
900.0000	4724.7000	18.9080	.000042	.4511
1080.0000	4896.5000	18.7500	.000043	.4476
1260.0000	5043.7000	18.5370	.000044	.4440
1440.0000	5172.5000	18.3300	.000044	.4402
1620.0000	5286.2000	18.1270	.000045	.4364
1710.0000	5341.6000	18.0210	.000045	.4345

PRESSURE = 1.000ATM				PRANDTL NUMBER
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	
-530.0000	1869.0000	19.6330	.000023	.4648
-348.0000	2002.0000	19.5890	.000024	.4600
-360.0000	2406.2000	19.5260	.000027	.4606
-180.0000	2825.1000	19.5270	.000030	.4613
-90.0000	3031.5000	19.5260	.000031	.4613
90.0000	3437.0000	19.5220	.000034	.4610
180.0000	3635.0000	19.5170	.000035	.4606
360.0000	4003.5000	19.2910	.000038	.4593
540.0000	4332.5000	19.2360	.000040	.4578
720.0000	4615.6000	19.1440	.000041	.4555
900.0000	4855.5000	19.0190	.000043	.4527
1080.0000	5059.6000	18.6670	.000044	.4496
1260.0000	5235.6000	18.6950	.000045	.4463
1440.0000	5389.8000	18.5090	.000046	.4429
1620.0000	5527.1000	18.3150	.000046	.4393
1710.0000	5555.5000	18.2160	.000047	.4376

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

PRESSURE = 25.000ATM				
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-630.0000	2176.0000	20.6530	.000025	.4955
-540.0000	2254.7000	20.2030	.000026	.4841
-360.0000	2479.9000	19.5510	.000028	.4672
-180.0000	2832.0000	19.3510	.000030	.4621
-90.0000	3034.8000	19.3360	.000031	.4616
90.0000	3441.9000	19.3290	.000034	.4611
180.0000	3442.8000	19.3270	.000036	.4603
360.0000	4035.8000	19.3210	.000038	.4600
540.0000	4412.3000	19.3060	.000040	.4589
720.0000	4766.0000	19.2760	.000042	.4575
900.0000	5095.4000	19.2260	.000044	.4558
1080.0000	5394.9000	19.1530	.000046	.4538
1260.0000	5645.3000	19.0580	.000047	.4516
1440.0000	5908.9000	18.9410	.000049	.4492
1620.0000	6128.9000	18.8080	.000050	.4466
1710.0000	6231.3000	18.7360	.000050	.4452

PRESSURE = 50.000ATM				
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-630.0000	2260.9000	20.9570	.000026	.5049
-540.0000	2442.3000	20.4910	.000027	.4929
-360.0000	2838.3000	19.7540	.000028	.4733
-180.0000	2847.7000	19.4030	.000030	.4636
-90.0000	3048.5000	19.3560	.000032	.4623
90.0000	3443.2000	19.3340	.000034	.4613
180.0000	3644.0000	19.3310	.000036	.4609
360.0000	4038.6000	19.3250	.000038	.4601
540.0000	4412.6000	19.3140	.000040	.4591
720.0000	4782.6000	19.2920	.000042	.4577
900.0000	5124.6000	19.2530	.000044	.4562
1080.0000	5441.7000	19.1950	.000046	.4544
1260.0000	5732.0000	19.1160	.000048	.4528
1440.0000	5996.7000	19.0170	.000049	.4503
1620.0000	6237.9000	18.9010	.000050	.4479
1710.0000	6350.6000	18.8370	.000051	.4467

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

PRESSURE = 75.000ATM				
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-630.0000	2313.1000	21.1510	.000027	.5109
-350.0000	2390.6000	20.6780	.000027	.4986
-360.0000	2583.1000	19.9040	.000028	.4778
-180.0000	2866.5000	19.4660	.000030	.4655
-90.0000	3048.6000	19.3650	.000032	.4631
90.0000	3444.8000	19.3410	.000034	.4615
180.0000	3645.0000	19.3350	.000036	.4610
360.0000	4048.0000	19.3280	.000038	.4602
540.0000	4423.1000	19.3190	.000040	.4592
720.0000	4790.3000	19.3000	.000043	.4579
900.0000	5138.5000	19.2670	.000045	.4564
1080.0000	5464.5000	19.2170	.000046	.4548
1260.0000	5766.1000	19.1470	.000048	.4529
1440.0000	6042.7000	19.0580	.000049	.4509
1620.0000	6296.3000	18.9520	.000051	.4487
1710.0000	6419.2000	18.9330	.000051	.4475

PRESSURE = 100.000ATM				
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-630.0000	2351.2000	21.2950	.000027	.5154
-350.0000	2429.3000	20.8180	.000027	.5030
-360.0000	2618.0000	20.0230	.000029	.4814
-180.0000	2885.2000	19.5290	.000030	.4674
-90.0000	3058.3000	19.4180	.000032	.4641
90.0000	3446.8000	19.3490	.000034	.4617
180.0000	3646.2000	19.3400	.000036	.4612
360.0000	4041.0000	19.3310	.000038	.4603
540.0000	4425.2000	19.3220	.000040	.4593
720.0000	4794.5000	19.3050	.000043	.4580
900.0000	5147.7000	19.2760	.000045	.4565
1080.0000	5479.5000	19.2310	.000046	.4550
1260.0000	5788.1000	19.1670	.000048	.4532
1440.0000	6072.5000	19.0860	.000050	.4513
1620.0000	6335.2000	18.9870	.000051	.4492
1710.0000	6486.8000	18.9320	.000052	.4481

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

GENERAL INPUT INFORMATION *****

CCDY PT NO	INTEG PT NO	RATL NO	STREAM LENGTH INCH (S)	AXIAL LENGTH INCH (Z)	RADIAL LENGTH INCH (R)	BODY ANGLE DEG (THETB)	NORMALIZED ABLATION RATE (BPSP)	WALL TEMP DEG R (TW)	SURFACE ROUGHNESS RIL (RUFIL)	---EDGE CONDITION--- PRESSURE ATM (PE)	ENTHALPY BTU/LBM (HE)	VELOCITY FT/SEC (UE)
1	1	1	.00	.000	6.460	-42.418	.000	5500.00	.000	100.00	1692.20	.00
2	7	1	2.85	1.034	4.950	-45.334	.000	5500.00	.000	97.24	1658.70	1295.10
3	9	1	2.83	2.016	4.440	-47.770	.000	5500.00	.000	94.37	1637.89	1648.60
4	11	1	3.53	2.517	4.020	-34.190	.000	5500.00	.000	90.01	1603.28	2086.00
5	13	1	4.29	3.179	3.650	-25.127	.000	5500.00	.000	83.27	1592.10	2648.30
6	15	1	5.02	3.860	3.390	-18.264	.000	5500.00	.000	74.45	1477.10	3281.50
7	17	1	5.41	4.240	3.300	-12.612	.000	5500.00	.000	69.47	1431.66	3611.40
8	19	1	5.00	4.620	3.220	-8.437	.000	5500.00	.000	63.15	1370.15	4015.20
9	21	1	6.16	4.930	3.190	-3.845	.000	5500.00	.000	59.36	1331.20	4251.13
10	23	1	6.55	5.353	3.170	-4.319	.000	5500.00	.000	56.86	1304.30	4406.60
11	25	1	6.75	5.551	3.146	-3.305	.000	5500.00	.000	47.75	1197.36	4977.10
12	27	1	6.91	5.726	3.149	2.508	.000	5500.00	.000	44.59	1156.24	5179.60
13	29	1	7.16	5.972	3.164	4.753	.000	5500.00	.000	40.08	1094.15	5471.60
14	31	1	7.40	6.218	3.190	9.272	.000	5500.00	.000	35.70	1020.10	5765.60
15	33	1	7.82	6.621	3.270	13.563	.000	5500.00	.000	29.10	915.30	6236.50
16	35	1	8.22	7.006	3.300	21.472	.000	5500.00	.000	22.65	783.86	6743.20
17	37	1	9.21	7.918	3.780	28.187	.000	5500.00	.000	11.33	456.29	7065.70
18	39	1	13.12	13.039	6.640	25.916	.000	5500.00	.000	2.68	-81.62	5423.20
19	74	1	23.16	20.451	9.670	21.215	.000	5500.00	.000	1.27	-236.84	9978.50
20	102	1	54.09	30.764	13.500	17.835	.000	5500.00	.000	.64	-483.52	10308.00
21	123	1	40.03	44.164	17.500	16.618	.000	5500.00	.000	.34	-594.93	10700.00

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

VISCOS FLOW - EDGE PROPERTIES

BODY PT NO	INTS PT NO	STREAM LENGTH INCH	VELOCITY FT/SEC (UE)	MACH NO (MACH)	ENTHALPY BTU/LBM (HE)	TEMPERATURE DEG R (TE)	DENSITY LBM/FT3 (ROE)	VISCOSITY LBM/FT-SEC (VISE)	UNIT RE NO 1/FT (URE)
1	1	.0000	.0	.0000	1692.2	6434.0	4.031-01	5.154-05	0.000
2	7	2.2535	1295.1	.2759	1656.7	6384.2	3.954-01	5.128-05	9.985+06
3	9	2.8018	1646.8	.3574	1637.9	6351.7	3.859-01	5.112-05	1.245+07
4	11	3.0350	2086.0	.4542	1605.3	6299.8	3.714-01	5.084-05	1.524+07
5	13	4.2934	2348.3	.5509	1552.1	6213.6	3.487-01	5.039-05	1.833+07
6	15	5.0225	3281.5	.7274	1477.1	6094.2	3.184-01	4.976-05	2.108+07
7	17	5.8130	3611.4	.8058	1431.7	6021.3	3.018-01	4.937-05	2.202+07
8	19	5.8013	4015.2	.9042	1370.1	5917.8	2.787-01	4.861-05	2.293+07
9	21	6.1826	4281.1	.9630	1331.2	5853.1	2.651-01	4.846-05	2.326+07
10	23	6.3459	4405.6	1.0022	1304.3	5806.9	2.560-01	4.823-05	2.339+07
11	25	6.7460	4977.4	1.1513	1197.4	5627.0	2.224-01	4.723-05	2.343+07
12	27	6.9210	5175.8	1.2063	1156.2	5555.5	2.103-01	4.684-05	2.328+07
13	29	7.1975	5471.6	1.2873	1094.1	5449.1	1.931-01	4.626-05	2.284+07
14	31	7.4050	5755.0	1.3723	1026.1	5350.0	1.760-01	4.559-05	2.227+07
15	33	7.8158	6236.3	1.5146	918.3	5127.6	1.494-01	4.485-05	2.096+07
16	35	8.2162	6743.2	1.6803	783.9	4877.8	1.244-01	4.391-05	1.919+07
17	38	9.2117	7665.7	2.1090	456.3	4223.1	7.092-02	3.912-05	1.426+07
18	53	13.1212	9425.2	2.9745	-81.6	3051.7	2.321-02	3.153-05	6.924+06
19	74	23.1608	9976.5	3.4421	-296.6	2556.7	1.311-02	2.818-05	4.656+06
20	102	34.0322	10380.0	3.8909	-463.5	2169.8	7.760-03	2.521-05	3.197+06
21	138	48.0780	10700.0	4.3148	-595.0	1877.2	4.750-03	2.294-05	2.215+06

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

***** VISCIOUS FLOW - WALL AND B. L. RECOVERY PROPERTIES *****

BODY PT NO	INTS PT NO	STREAM LENGTH INCH	WALL TEMPERATURE DEG R	WALL ENTHALPY BTU/LBM	WALL DENSITY LBM/FT3	WALL VISCOSITY LBM/FT-SEC	RECOVERY ENTHALPY BTU/LBM	RECOVERY FACTOR	SENSBL CONV HEAT FLUX BTU/FT2-SEC	CF/2
(J)	(I)	(8)	(TM)	(HW)	(ROV)	(VISU)	(HR)	(RECOV)		
1	1	.0000	3500.0	1092.0	4.767-01	4.655-05	1692.2	.6721	2.864+02	1.000+30
2	7	2.2535	3500.0	1092.0	4.654-01	4.655-05	1684.4	.7673	8.660+02	2.264+03
3	9	2.6816	3500.0	1093.8	4.656-01	4.655-05	1679.5	.7673	9.407+02	2.096+03
4	11	3.5350	3500.0	1095.3	4.307-01	4.655-05	1672.0	.7673	1.030+03	1.922+03
5	13	4.2938	3500.0	1097.7	3.983-01	4.655-05	1659.6	.7673	1.104+03	1.797+03
6	15	5.0225	3500.0	1101.3	3.560-01	4.655-05	1642.1	.7673	1.128+03	1.703+03
7	17	5.4130	3500.0	1103.8	3.321-01	4.655-05	1631.6	.7673	1.112+03	1.652+03
8	19	5.6013	3500.0	1107.4	3.018-01	4.655-05	1617.3	.7673	1.073+03	1.616+03
9	21	6.1626	3500.0	1109.7	2.836-01	4.655-05	1608.3	.7673	1.033+03	1.560+03
10	23	6.5459	3500.0	1111.3	2.716-01	4.655-05	1602.0	.7673	1.006+03	1.548+03
11	25	6.7460	3500.0	1118.4	2.279-01	4.655-05	1577.2	.7673	8.963+02	1.574+03
12	27	6.9110	3500.0	1121.7	2.128-01	4.655-05	1567.7	.7673	8.456+02	1.546+03
13	29	7.1575	3500.0	1126.4	1.912-01	4.655-05	1553.3	.7673	7.705+02	1.525+03
14	31	7.4050	3500.0	1132.0	1.702-01	4.655-05	1538.0	.7673	6.905+02	1.503+03
15	33	7.6150	3500.0	1142.1	1.386-01	4.655-05	1512.0	.7673	5.597+02	1.471+03
16	35	8.2162	3500.0	1157.6	1.077-01	4.655-05	1481.6	.7673	4.182+02	1.437+03
17	38	9.8117	3500.0	1216.5	8.360-02	4.649-05	1406.0	.7673	1.479+02	1.332+03
18	53	15.1212	3500.0	1391.9	1.295-02	4.641-05	1281.8	.7673	-2.629+01	1.031+03
19	74	28.1600	3500.0	1550.6	9.813-03	4.635-05	1231.7	.7673	-3.575+01	8.782+04
20	102	34.0932	3500.0	1714.8	2.869-03	4.627-05	1191.9	.7673	-5.727+01	7.600+04
21	138	48.0780	3500.0	1953.9	1.485-03	4.618-05	1159.4	.7673	-8.687+01	6.692+04

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

VISCOS FLOW - BOUNDARY LAYER SOLUTION

BODY PT NO	INTEG PT NO	STREAM LENGTH INCH	MOMENTUM THICKNESS MIL	ENERGY THICKNESS MIL	SHAPE FACTOR	NON THICK RE NO	ENERGY THICK RE NO	HEAT TRANS COEFFICIENT LBR/FT ² -SEC	REYNOLDS ANAL FAC	INTER- MITTENCY	HEAT TRANS AUSMENT
(J)	(I)	(S)	(TME)	(PHI)	(HSF)	(RETH)	(REPH)	(INUCH)	(RAF)	(ADPL)	(RUFST)
1	1	.000	.422	1.026	1.975	0.000	0.000	4.771-01	.9780	.00	1.000
2	2	2.2535	1.658	3.502	1.096	1.376+03	2.981+03	1.464+00	1.2628	1.00	1.000
3	3	2.8618	1.594	4.801	1.081	2.012+03	4.981+03	1.606+00	1.2273	1.00	1.000
4	4	3.5350	2.085	5.832	1.083	2.677+03	7.405+03	1.786+00	1.2002	1.00	1.000
5	5	4.2988	2.261	6.963	1.100	3.433+03	1.063+04	1.765+00	1.1839	1.00	1.000
6	6	5.0223	2.403	8.037	1.133	4.208+03	1.406+04	2.085+00	1.1722	1.00	1.000
7	7	5.4130	2.523	8.654	1.155	4.630+03	1.590+04	2.108+00	1.1687	1.00	1.000
8	8	5.8013	2.594	9.384	1.190	4.937+03	1.784+04	2.104+00	1.1635	1.00	1.000
9	9	6.1628	2.636	9.976	1.211	5.437+03	1.523+04	2.072+00	1.1785	1.00	1.000
10	10	6.5459	3.068	10.654	1.225	5.981+03	2.077+04	2.051+00	1.1627	1.00	1.000
11	11	6.7460	2.741	11.379	1.299	5.333+03	2.222+04	1.953+00	1.1210	1.00	1.000
12	12	6.9110	2.769	11.890	1.328	5.370+03	2.296+04	1.896+00	1.1246	1.00	1.000
13	13	7.1073	2.863	12.591	1.372	5.430+03	2.397+04	1.805+00	1.1199	1.00	1.000
14	14	7.4088	2.971	13.446	1.424	5.512+03	2.495+04	1.701+00	1.1146	1.00	1.000
15	15	7.8158	3.173	15.099	1.518	5.533+03	2.629+04	1.514+00	1.1046	1.00	1.000
16	16	8.2162	3.398	17.344	1.645	5.430+03	2.774+04	1.291+00	1.0881	1.00	1.000
17	17	9.2117	4.247	26.760	2.052	5.046+03	3.180+04	7.608-01	1.0512	1.00	1.000
18	18	15.1212	9.441	63.936	3.204	5.437+03	3.690+04	2.388-01	1.0390	1.00	1.000
19	19	23.1600	15.329	123.554	4.005	5.947+03	4.570+04	1.196-01	1.0409	1.00	1.000
20	20	34.0922	25.402	36.436	4.867	6.235+03	2.570+04	7.129-02	1.1637	1.00	1.000
21	21	48.6780	38.608	50.479	5.799	6.251+03	9.320+03	4.761-02	1.3996	1.00	1.000

Sample Problem 2

A rough wall calculation for the C/CAN nozzle with a HT 90/18 propellant was performed. The details of this system were given in Section 3. Fifty-six body points were input. The surface roughness and the wall temperature used in this calculation are 2 mil and 4939°R respectively. Solutions at all the integration points were printed (1PRNT=2).

55 178

2.

[illegible]

9 18 1

1.	26667+04	90000+03	28803+02	34863+00	-33776-01	14746-04	6444
	26990+04	12600+04	27118+02	32084+00	-4321+00	18310-04	3702
	19698+04	16200+04	22876+02	1123+01	-49873+00	21204-04	4607
	17560+04	19800+04	22341+02	44314+00	-3915-02	24118-04	4643
	18994+04	23400+04	22337+02	43167+00	-10621-02	26909-04	4746
	14428+04	27000+04	22327+02	44164+00	-6240-02	29563-04	4813
	12754+04	30600+04	22294+02	46731+00	-18977-01	32096-04	4871
	11871+04	34200+04	22236+02	48883+00	-27994-01	34326-04	4920
	92789+03	37800+04	22165+02	51523+00	-38372-01	36867-04	4954
	7125+03	41400+04	22664+02	58244+00	-6579-01	39124-04	4969
	4335+03	45000+04	21888+02	72883+00	-13551+00	41296-04	4959
	3171+03	48600+04	21937+02	10032+01	-27779+00	43365-04	4907
	4953+03	52200+04	20938+02	14912+01	-53823+00	45303-04	4799
	1211+03	55800+04	19364+02	22588+01	-96797+00	47063-04	4613
	19008+04	59400+04	18529+02	32253+01	-14434+01	48603-04	4346
	32249+04	63000+04	16811+02	40748+01	-13315+01	49928-04	4035
	4774+04	66600+04	15126+02	43731+01	-19062+01	51117-04	3746
	69360+04	72000+04	13237+02	35309+01	-14271+01	52916-04	3437
2.	26590+04	90000+03	28854+02	32882+00	-13201-01	14748-04	6473
	24880+04	12600+04	28006+02	64148+00	-23923+00	18362-04	6059
	11287+04	16200+04	24688+02	13833+01	-78374+00	21386-04	5082
	17427+04	19800+04	22408+02	52343+00	-74456-01	24143-04	4660
	15998+04	23400+04	22339+02	43147+00	-19953-02	26910-04	4746
	14443+04	27000+04	22333+02	43397+00	-30331-02	29563-04	4813
	12856+04	30600+04	22316+02	45123+00	-10426-01	32099-04	4861
	1180+04	34200+04	22278+02	47342+00	-20529-01	34332-04	4904
	94313+03	37800+04	22223+02	49298+00	-28673-01	36876-04	4941
	76260+03	41400+04	22154+02	52482+00	-41386-01	39141-04	4965
	54314+03	45000+04	22555+02	59063+00	-71052-01	41331-04	4973
	3545+03	48600+04	21889+02	70821+00	-13265+00	43442-04	4957
	42780+02	52200+04	21604+02	91314+00	-24632+00	45466-04	4913
	3411+03	55800+04	21129+02	12437+01	-43650+00	47382-04	4830
	8715+03	59400+04	20391+02	17263+01	-71892+00	49164-04	4693
	14990+04	63000+04	19831+02	23303+01	-10701+01	50743-04	4499
	23509+04	66600+04	18933+02	29463+01	-14121+01	52239-04	4261
	43277+04	72000+04	15963+02	35308+01	-16896+01	54168-04	3892
3.	26495+04	90000+03	28866+02	31416+00	-10725-01	14749-04	6482
	25088+04	12600+04	28249+02	56254+00	-17726+00	18376-04	6160
	21283+04	16200+04	25549+02	12181+01	-68520+00	21466-04	5390
	17797+04	19800+04	22379+02	69741+00	-23909+00	24144-04	4702
	14888+04	23400+04	22344+02	43581+00	-53166-02	26910-04	4748
	14880+04	27000+04	22335+02	43217+00	-23115-02	29564-04	4812
	12873+04	30600+04	22322+02	44597+00	-79521-02	32100-04	4859
	11280+04	34200+04	22292+02	46683+00	-17126-01	34334-04	4899
	95143+03	37800+04	22244+02	48604+00	-23321-01	36879-04	4934
	77480+03	41400+04	22184+02	51098+00	-35093-01	39146-04	4960
	58883+03	45000+04	22103+02	55846+00	-53653-01	41340-04	4973
	46647+03	48600+04	21376+02	64035+00	-98824-01	43462-04	4966

11397.03	5280.00	21766.02	70260.00	-17815.00	49905.00	4930
20751.03	5500.00	21422.02	10106.01	-3115.00	47430.00	4881
62059.03	35400.00	20885.02	13490.01	-52568.00	49300.00	4784
11521.00	63000.00	20185.02	17982.01	-79810.00	51019.00	4639
19389.00	66600.00	19079.02	23103.01	-10999.01	52587.00	4447
43727.00	7200.00	17232.02	29000.01	-19049.01	54670.00	4114
26						
26979.00	90000.03	20075.02	30946.00	-79996.02	14749.00	6400
25101.03	12600.00	24330.02	50316.00	-1250.00	18300.00	6237
22959.00	16200.00	23008.02	10311.01	-3551.00	21532.00	5561
18221.00	19800.00	23015.02	97447.00	-60448.00	24197.00	4812
16228.00	23400.00	22362.02	44962.00	-21289.01	26911.00	4752
14954.00	27000.00	22330.02	88144.00	-27953.02	29346.00	4812
12086.00	30600.00	2327.02	44182.00	-60799.02	32100.00	4837
11283.00	34200.00	22303.02	46050.00	-13092.01	34533.00	4894
95699.03	37800.00	22663.02	47961.00	-2029.01	36082.00	4928
78077.03	41000.00	22211.02	50057.00	-80218.01	39151.00	4954
59087.03	45000.00	22143.02	53567.00	-49902.01	41346.00	4971
39269.03	48600.00	22044.02	59317.00	-75000.01	43477.00	4970
16282.03	52200.00	21887.02	69211.00	-13039.00	45333.00	4954
11370.03	55800.00	21637.02	84992.00	-22368.00	47512.00	4913
45422.03	59400.00	21347.02	10049.01	-34840.00	49400.00	4846
9037.03	63000.00	20675.02	14066.01	-52030.00	51169.00	4743
14000.00	66600.00	19093.02	18000.01	-82368.00	52051.00	4597
86300.00	72000.00	18374.02	24146.01	-13101.01	53103.00	4317
20						
26801.00	90000.03	20079.02	30737.00	-61323.02	14750.00	4490
25100.00	12600.00	20512.02	47902.00	-10730.00	18391.00	4573
22716.00	16200.00	20691.02	93433.00	-4602.00	21544.00	5062
14600.00	19800.00	23420.02	11013.01	-61087.00	24245.00	4916
16047.00	23400.00	22389.02	47250.00	-45157.01	26916.00	4759
1457.00	27000.00	22341.02	43107.00	-3956.02	29564.00	4812
12092.00	30600.00	22330.02	43992.00	-53087.02	32101.00	4856
11379.00	34200.00	22309.02	45723.00	-12168.01	34536.00	4892
5907.03	37800.00	22273.02	47601.00	-20111.01	36084.00	4924
78512.03	41000.00	22225.02	49557.00	-27782.01	39133.00	4951
40101.03	45000.00	22163.02	52580.00	-40062.01	41332.00	4968
40503.03	48600.00	22077.02	57230.00	-44435.01	43484.00	4971
18573.03	52200.00	21944.02	65250.00	-10935.00	45549.00	4960
70084.03	55800.00	21735.02	78007.00	-10499.00	47541.00	4950
80330.03	59400.00	21412.02	96975.00	-30201.00	49431.00	4876
77748.03	63000.00	20936.02	12321.01	-47127.00	51247.00	4790
12786.00	66600.00	20278.02	15613.01	-60714.00	52973.00	4668
32696.00	72000.00	18955.02	21104.01	-10472.01	55512.00	4422
40						
26502.00	90000.03	20081.02	30616.00	-52886.02	14750.00	4491
25169.00	12600.00	20562.02	45924.00	-43794.01	18394.00	4294
2275.00	16200.00	20936.02	87210.00	-43765.00	21503.00	5761
18508.00	19800.00	23760.02	11503.01	-6692.00	24284.00	5004
16082.00	23400.00	22424.02	50171.00	-75503.01	26921.00	4768
2461.00	27000.00	22343.02	43299.00	-55623.02	29545.00	4813
12896.00	30600.00	22332.02	43802.00	-49408.02	32101.00	4856
11289.00	34200.00	22313.02	45502.00	-11052.01	34537.00	4891
96173.03	37800.00	22279.02	47349.00	-18760.01	36885.00	4922
78799.03	41000.00	22234.02	49235.00	-26175.01	39135.00	4948
60628.03	45000.00	22177.02	51933.00	-37063.01	41335.00	4967
41273.03	48600.00	22090.02	55987.00	-50117.01	43489.00	4971

..19373+03	..3220+04	..2179+02	..6234+00	..76026+01	..45537-04	..4962
..45950+02	..35800+04	..2179+02	..72805+00	..16202+00	..47556-04	..4938
..38864+03	..59400+04	..2-12+02	..90181+00	..26375+00	..49478-04	..4892
..78287+03	..63000+04	..35+02	..11282+01	..1088+00	..51313-04	..4818
..11385+04	..66600+04	..2415+02	..14166+01	..60199+00	..53047-04	..4711
..20566+04	..72000+04	..19326+02	..19151+01	..93781+00	..55441-04	..4490
80.						
..25553+04	..90800+03	..28883+02	..30352+00	..17065+02	..14750-04	..4492
..25166+04	..12600+04	..28997+02	..44777+00	..44364+01	..16396-04	..6509
..22587+04	..16206+04	..2711+02	..62753+00	..40227+00	..21597-04	..5817
..19387+04	..19800+04	..24043+02	..11645+01	..68970+00	..24317-04	..5978
..16123+04	..25400+04	..22467+02	..53997+00	..11016+00	..26927-04	..4779
..14464+04	..27000+04	..2347+02	..4361+00	..77871+02	..29585-04	..4814
..12999+04	..30600+04	..22353+02	..43813+00	..48151+02	..32101-04	..4856
..11296+04	..34200+04	..22313+02	..45341+00	..10260+01	..34537-04	..4496
..94212+03	..37800+04	..22284+02	..47158+00	..17729+01	..36885-04	..4828
..79018+03	..41400+04	..22241+02	..49001+00	..24981+01	..39156-04	..4946
..60952+03	..45000+04	..22167+02	..51508+00	..34971+01	..41356-04	..4965
..41818+03	..48600+04	..22113+02	..55138+00	..53788+01	..4342-04	..4870
..28947+03	..52200+04	..22004+02	..61320+00	..82289+01	..45563-04	..4964
..27827+02	..55800+04	..21836+02	..71890+00	..14639+00	..47547-04	..4943
..30806+03	..59400+04	..21581+02	..85953+00	..23710+00	..49497-04	..4803
..45649+03	..63000+04	..21205+02	..10376+01	..16889+00	..51345-04	..4837
..18765+04	..66600+04	..20680+02	..13169+01	..34243+00	..53098-04	..4780
..19096+04	..72000+04	..19590+02	..17762+01	..47611+00	..55553-04	..4837
60.						
..26383+04	..9400+03	..2888+02	..30468+00	..2707+02	..14750-04	..4493
..28199+04	..12600+04	..28623+02	..43925+00	..7732+01	..16397-04	..6521
..2371+04	..16200+04	..2724+02	..79300+00	..3748+00	..21608-04	..5861
..19363+04	..19800+04	..2262+02	..11626+01	..59611+00	..24344-04	..5141
..16173+04	..23400+04	..22315+02	..57032+00	..14712+00	..26933-04	..4791
..14468+04	..27000+04	..22351+02	..43670+00	..10475+01	..29546-04	..4815
..12982+04	..30600+04	..22334+02	..43763+00	..8324+02	..32101-04	..4856
..11202+04	..34200+04	..22317+02	..45218+00	..96680+02	..34537-04	..4889
..94413+03	..37800+04	..22284+02	..47035+00	..16903+01	..36886-04	..4919
..79178+03	..41400+04	..22247+02	..48818+00	..24038+01	..39157-04	..4944
..61203+03	..45000+04	..22194+02	..51150+00	..33392+01	..41356-04	..4964
..42323+03	..48600+04	..22124+02	..54511+00	..50378+01	..43499-04	..4970
..21678+03	..52200+04	..22023+02	..60146+00	..1988+01	..45567-04	..4963
..14627+02	..55800+04	..21867+02	..69038+00	..13487+00	..47375-04	..4947
..28344+03	..59400+04	..21632+02	..82312+00	..21747+00	..49511-04	..4818
..61388+03	..63000+04	..21287+02	..10037+01	..33749+00	..51365-04	..4850
..18888+04	..66600+04	..20803+02	..12421+01	..59778+00	..53136-04	..4762
..18003+04	..72000+04	..19790+02	..16788+01	..79340+00	..55609-04	..4874
70.						
..26584+04	..98800+03	..28883+02	..38420+00	..39357+02	..14750-04	..4493
..25289+04	..12600+04	..28643+02	..43258+00	..71809+01	..16398-04	..6529
..28137+04	..16200+04	..27350+02	..76659+00	..3271+00	..2161-04	..5893
..19324+04	..19800+04	..2484+02	..11531+01	..59411+03	..24366-04	..5193
..16226+04	..23400+04	..22668+02	..60611+00	..18469+00	..26941-04	..4883
..14472+04	..27000+04	..22353+02	..43919+00	..13621+01	..29561-04	..4814
..12908+04	..30600+04	..22334+02	..43783+00	..49605+02	..32102-04	..4856
..11306+04	..34200+04	..22319+02	..45128+00	..21210+02	..34538-04	..4888
..94383+03	..37800+04	..22291+02	..46878+00	..16219+01	..36886-04	..4917
..79310+03	..41400+04	..22251+02	..48649+00	..32250+01	..39157-04	..4943
..61887+03	..45000+04	..22201+02	..50939+00	..32138+01	..41355-04	..4962
..42363+03	..48600+04	..22184+02	..54023+00	..48074+01	..43496-04	..4969

..22259+03	.52200+00	.22037+02	.59236+00	..77009-01	.45371-04	.4966
..44459+01	.59400+00	.21492+02	.67448+00	..12592+00	.47581-04	.4950
..26781+03	.59400+00	.21673+02	.79603+00	..20223+00	.49522-04	.4916
..50336+03	.63000+00	.21351+02	.96546+00	..31336+00	.51307-04	.4861
..96908+03	.66600+00	.20908+02	.11856+01	..46272+00	.53166-04	.4779
..17151+04	.72000+00	.19950+02	.15074+01	..74292+00	.55633-04	.4603

SAMPLE PROBLEM 2 OUTPUT

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

NUMBER OF MATERIALS = 1
 CM/CH = .76168
 ISENTROPIC EXPONENT = 1.16490

MATL	STS	BTM	SLS	SLM
1	.35000	.35000	.50000	.50000

NS = 56
 ISRUPT = 1
 MREYCR = 7
 IPANT = 2
 OLTRAN = .00000 INCHES

ABRUPT TRANSITION

FLOW IS TURBULENT

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)
THERMODYNAMIC TABLE

PRESSURE = 1.000ATM				
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2646.7000	980.0000	28.0080	.000015	.6444
-2435.0000	1260.0000	27.1180	.000016	.5702
-1969.6000	1620.0000	22.6780	.000021	.4607
-1756.0000	1980.0000	22.3410	.000024	.4653
-1595.4000	2340.0000	22.3370	.000027	.4746
-1442.8000	2700.0000	22.3270	.000030	.4815
-1279.4000	3060.0000	22.2940	.000032	.4871
-1107.1000	3420.0000	22.2360	.000035	.4920
-927.0900	3780.0000	22.1650	.000037	.4954
-731.2500	4140.0000	22.0640	.000039	.4969
-498.3500	4500.0000	21.8800	.000041	.4959
-191.7100	4860.0000	21.5570	.000043	.4907
249.6500	5220.0000	20.9580	.000045	.4799
916.1100	5580.0000	19.9640	.000047	.4613
1900.8000	5940.0000	18.5290	.000049	.4346
3224.9000	6300.0000	16.6110	.000050	.4035
4767.6000	6660.0000	15.1260	.000051	.3746
6954.0000	7200.0000	13.2370	.000053	.3437

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

PRESSURE = 5.000ATM				PRANDTL
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	NUMBER
-2649.0000	900.0000	26.8540	.000015	.6475
-2486.0000	1260.0000	26.0000	.000018	.6059
-2126.7000	1620.0000	24.6880	.000021	.5082
-1762.7000	1980.0000	22.4080	.000024	.4660
-1595.8000	2340.0000	22.3320	.000027	.4746
-1444.5000	2700.0000	22.3330	.000030	.4813
-1283.6000	3060.0000	22.3160	.000032	.4861
-1119.0000	3420.0000	22.2780	.000035	.4904
-945.1300	3780.0000	22.2230	.000037	.4941
-762.6000	4140.0000	22.1540	.000039	.4965
-585.1400	4500.0000	22.0550	.000041	.4973
-331.4500	4860.0000	21.8890	.000043	.4957
-42.7800	5220.0000	21.6040	.000045	.4913
341.1100	5580.0000	21.1290	.000047	.4830
871.1500	5940.0000	20.3910	.000049	.4693
1599.0000	6300.0000	19.3510	.000051	.4499
2550.9000	6660.0000	16.0580	.000052	.4261
4327.7000	7200.0000	15.9630	.000054	.3892

PRESSURE = 10.000ATM				PRANDTL
ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	NUMBER
-2649.3003	900.0000	26.8660	.000015	.6482
-2500.8000	1260.0000	26.0490	.000018	.6160
-2192.3000	1620.0000	25.5490	.000021	.5330
-1779.7000	1980.0000	22.5790	.000024	.4702
-1600.3000	2340.0000	22.3440	.000027	.4748
-1445.0000	2700.0000	22.3350	.000030	.4812
-1287.3000	3060.0000	22.3220	.000032	.4859
-1123.0000	3420.0000	22.2920	.000035	.4899
-951.4500	3780.0000	22.2440	.000037	.4934
-772.4000	4140.0000	22.1840	.000039	.4960
-580.8300	4500.0000	22.1030	.000041	.4973
-366.4700	4860.0000	21.9760	.000043	.4966
-112.4700	5220.0000	21.7660	.000046	.4938
207.3100	5580.0000	21.4250	.000047	.4881
628.5000	5940.0000	20.8820	.000049	.4784
1192.1000	6300.0000	20.1010	.000051	.4639
1930.9000	6660.0000	19.0790	.000053	.4447
3372.7000	7200.0000	17.2320	.000055	.4114

MOMENTUM ENERGY INTEGRATION TECHNIQUE (WEII)

PRESSURE = 20.000ATM

ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2.9000	900.0000	26.8750	.000015	.6486
-7.1000	1260.0000	26.8300	.000018	.6237
-15.9000	1620.0000	26.3080	.000022	.5561
-22.1000	1980.0000	23.0150	.000024	.4612
-1602.0000	2340.0000	22.3620	.000027	.4752
-1445.4000	2700.0000	22.3580	.000030	.4612
-1288.6000	3060.0000	22.3270	.000032	.4657
-1126.3000	3420.0000	22.3030	.000035	.4894
-956.9900	3780.0000	22.2630	.000037	.4928
-786.7700	4140.0000	22.2110	.000039	.4954
-595.8700	4500.0000	22.1830	.000041	.4971
-392.6900	4860.0000	22.0840	.000043	.4970
-162.6200	5220.0000	21.8870	.000046	.4954
112.7000	5580.0000	21.6370	.000048	.4915
458.4200	5940.0000	21.2770	.000049	.4848
904.3700	6300.0000	20.6750	.000051	.4743
1480.0000	6660.0000	17.8930	.000053	.4597
2620.4000	7200.0000	16.3740	.000055	.4317

PRESSURE = 30.000ATM

ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2680.1000	900.0000	26.8750	.000015	.6498
-2514.4000	1260.0000	26.5120	.000018	.6273
-2271.6000	1620.0000	26.6910	.000022	.5662
-1869.0000	1980.0000	23.4200	.000024	.4916
-1604.7000	2340.0000	22.3690	.000027	.4759
-1445.7000	2700.0000	22.3410	.000030	.4612
-1289.2000	3060.0000	22.3300	.000032	.4856
-1127.9000	3420.0000	22.3030	.000035	.4892
-959.8700	3780.0000	22.2730	.000037	.4924
-786.1200	4140.0000	22.2230	.000039	.4931
-601.8100	4500.0000	22.1630	.000041	.4968
-405.0300	4860.0000	22.0770	.000043	.4971
-185.7500	5220.0000	21.9440	.000046	.4960
70.8840	5580.0000	21.7350	.000048	.4938
383.3600	5940.0000	21.4120	.000049	.4876
777.4800	6300.0000	20.9360	.000051	.4790
1278.6000	6660.0000	20.2780	.000053	.4668
2269.8000	7200.0000	18.9550	.000055	.4322

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

PRESSURE = 40.000ATM

ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2650.2000	900.0000	26.8810	.000015	.6491
-2516.9000	1260.0000	26.5620	.000018	.6296
-2287.5000	1620.0000	26.9360	.000022	.5761
-1894.8000	1980.0000	23.7600	.000024	.5004
-1608.2000	2340.0000	22.4240	.000027	.4766
-1446.1000	2700.0000	22.3450	.000030	.4813
-1289.6000	3060.0000	22.3320	.000032	.4856
-1128.9000	3420.0000	22.3150	.000035	.4891
-961.7500	3780.0000	22.2790	.000037	.4922
-787.9900	4140.0000	22.2340	.000039	.4948
-606.2800	4500.0000	22.1770	.000041	.4967
-412.7300	4860.0000	22.0980	.000043	.4971
-199.7300	5220.0000	21.9790	.000046	.4962
45.0980	5580.0000	21.7940	.000048	.4938
338.6400	5940.0000	21.5120	.000049	.4892
702.0700	6300.0000	21.0950	.000051	.4818
1158.5000	6660.0000	20.5150	.000053	.4711
2056.6000	7200.0000	19.3260	.000055	.4490

PRESSURE = 50.000ATM

ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2650.3000	900.0000	26.8830	.000015	.6492
-2518.6000	1260.0000	26.5970	.000018	.6309
-2299.7000	1620.0000	27.1110	.000022	.5817
-1915.7000	1980.0000	24.8400	.000024	.5078
-1612.5000	2340.0000	22.4670	.000027	.4779
-1446.4000	2700.0000	22.3470	.000030	.4814
-1289.9000	3060.0000	22.3350	.000032	.4856
-1129.6000	3420.0000	22.3150	.000035	.4890
-963.1200	3780.0000	22.2840	.000037	.4920
-790.1000	4140.0000	22.2410	.000039	.4946
-609.5200	4500.0000	22.1870	.000041	.4965
-418.1800	4860.0000	22.1150	.000043	.4970
-209.4700	5220.0000	22.0040	.000046	.4964
27.6270	5580.0000	21.8360	.000048	.4943
308.8800	5940.0000	21.5610	.000049	.4903
630.6200	6300.0000	21.2050	.000051	.4818
1076.5000	6660.0000	20.6800	.000053	.4711
1509.6000	7200.0000	19.5900	.000055	.4490

MOENTUM ENERGY INTEGRATION TECHNIQUE (MEII)

PRESSURE = 60.000ATM

ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2659.3000	900.0000	26.6640	.000015	.6493
-2519.9000	1260.0000	26.6230	.000018	.6321
-2337.1000	1620.0000	27.2440	.000022	.5861
-1936.3000	1980.0000	24.2020	.000024	.5191
-1617.3000	2340.0000	22.5150	.000027	.4791
-1446.8000	2700.0000	22.3510	.000030	.4618
-1290.2000	3060.0000	22.3340	.000032	.4656
-1130.2000	3420.0000	22.3170	.000035	.4809
-969.1900	3780.0000	22.2800	.000037	.4919
-791.7500	4140.0000	22.2470	.000039	.4944
-618.0300	4500.0000	22.1940	.000041	.4964
-422.3300	4860.0000	22.1240	.000043	.4970
-216.7400	5220.0000	22.0280	.000046	.4965
15.6270	5580.0000	21.8670	.000048	.4947
285.4400	5940.0000	21.6320	.000050	.4910
612.6000	6300.0000	21.2870	.000051	.4854
1016.0000	6660.0000	20.8050	.000053	.4762
1600.3000	7200.0000	19.7900	.000056	.4574

PRESSURE = 70.000ATM

ENTHALPY (BTU/LBM)	TEMPERATURE (DEG R)	MOLECULAR WEIGHT	VISCOSITY (LB/SEC-FT)	PRANDTL NUMBER
-2659.4000	900.0000	26.6850	.000015	.6493
-2519.9000	1260.0000	26.6430	.000018	.6329
-2317.7000	1620.0000	27.3500	.000022	.5895
-1932.6000	1980.0000	24.4860	.000024	.5195
-1622.6000	2340.0000	22.5680	.000027	.4805
-1407.2000	2700.0000	22.3550	.000030	.4816
-1296.4000	3060.0000	22.3360	.000032	.4856
-1130.6000	3420.0000	22.3190	.000035	.4888
-963.0500	3780.0000	22.2910	.000037	.4917
-793.1000	4140.0000	22.2510	.000039	.4943
-614.0700	4500.0000	22.2010	.000041	.4952
-423.6500	4860.0000	22.1340	.000043	.4969
-222.3500	5220.0000	22.0370	.000046	.4966
4.4499	5580.0000	21.8920	.000048	.4950
267.6130	5940.0000	21.6730	.000050	.4916
583.3600	6300.0000	21.3510	.000051	.4861
969.0800	6660.0000	20.9000	.000053	.4779
1712.1000	7200.0000	19.9500	.000056	.4603

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

GENERAL INPUT INFORMATION

BODY PT NO	INTG PT NO	MATL NO	STREAM LENGTH INCH (S)	AXIAL LENGTH INCH (Z)	RADIAL LENGTH INCH (R)	BODY ANGLE DEG (THETB)	NORMALIZED ABLATION RATE (BPSP)	WALL TEMP DEG R (TW)	SURFACE ROUGHNESS MIL (RUFIL)	---EDGE CONDITION---	VELOCITY FT/SEC (UE)
(J)	(I)	(MATL)								PRESSURE ATM (PE)	ENTHALPY BTU/LBM (HE)
1	1	1	.00	-2.250	2.120	-60.015	.000	4939.00	2.000	68.03	909.76
2	2	1	.05	-2.242	2.073	-79.511	.000	4939.00	2.000	67.06	908.61
3	3	1	.10	-2.233	2.025	-78.608	.000	4939.00	2.000	67.70	907.86
4	4	1	.14	-2.225	1.978	-77.904	.000	4939.00	2.000	67.34	906.92
5	5	1	.19	-2.217	1.931	-77.201	.000	4939.00	2.000	67.38	905.97
6	6	1	.24	-2.208	1.883	-76.497	.000	4939.00	2.000	67.21	905.02
7	7	1	.29	-2.200	1.836	-75.793	.000	4939.00	2.000	67.05	904.07
8	8	1	.33	-2.183	1.799	-71.358	.000	4939.00	2.000	66.37	903.57
9	9	1	.37	-2.167	1.762	-66.923	.000	4939.00	2.000	66.06	903.06
10	10	1	.41	-2.150	1.725	-62.488	.000	4939.00	2.000	66.00	902.56
11	11	1	.46	-2.125	1.684	-59.040	.000	4939.00	2.000	66.65	901.72
12	12	1	.51	-2.100	1.644	-55.592	.000	4939.00	2.000	66.51	900.88
13	13	1	.55	-2.075	1.612	-52.656	.000	4939.00	2.000	66.35	899.94
14	14	1	.59	-2.050	1.579	-49.720	.000	4939.00	2.000	66.20	899.01
15	15	1	.62	-2.025	1.552	-47.071	.000	4939.00	2.000	66.03	897.99
16	16	1	.66	-2.000	1.526	-44.421	.000	4939.00	2.000	65.85	896.98
17	17	1	.69	-1.975	1.504	-42.057	.000	4939.00	2.000	65.76	896.43
18	18	1	.73	-1.950	1.481	-39.693	.000	4939.00	2.000	65.67	895.89
19	19	1	.76	-1.925	1.462	-37.534	.000	4939.00	2.000	65.48	894.74
20	20	1	.79	-1.900	1.443	-35.375	.000	4939.00	2.000	65.29	893.59
21	21	1	.82	-1.875	1.427	-32.958	.000	4939.00	2.000	65.19	892.98
22	22	1	.85	-1.850	1.410	-30.541	.000	4939.00	2.000	65.09	892.37
23	23	1	.88	-1.825	1.397	-27.935	.000	4939.00	2.000	64.99	891.74
24	24	1	.91	-1.800	1.384	-25.330	.000	4939.00	2.000	64.88	891.11
25	25	1	.96	-1.750	1.361	-24.779	.000	4939.00	2.000	64.85	889.09
26	26	1	1.02	-1.700	1.339	-24.228	.000	4939.00	2.000	64.22	887.07
27	27	1	1.07	-1.650	1.316	-23.868	.000	4939.00	2.000	63.98	885.61
28	28	1	1.13	-1.600	1.294	-23.509	.000	4939.00	2.000	63.75	884.18
29	29	1	1.18	-1.550	1.273	-22.778	.000	4939.00	2.000	63.37	881.81
30	30	1	1.23	-1.500	1.252	-22.048	.000	4939.00	2.000	62.99	879.46
31	31	1	1.29	-1.450	1.233	-21.302	.000	4939.00	2.000	62.58	877.92
32	32	1	1.34	-1.400	1.213	-20.556	.000	4939.00	2.000	62.18	874.37
33	33	1	1.39	-1.350	1.195	-19.795	.000	4939.00	2.000	61.75	871.64
34	34	1	1.45	-1.300	1.177	-19.034	.000	4939.00	2.000	61.32	868.90
35	35	1	1.50	-1.250	1.161	-18.259	.000	4939.00	2.000	60.87	865.97
36	36	1	1.55	-1.200	1.144	-17.484	.000	4939.00	2.000	60.42	863.04
37	37	1	1.61	-1.150	1.129	-16.696	.000	4939.00	2.000	59.78	859.84
38	38	1	1.66	-1.100	1.114	-15.908	.000	4939.00	2.000	59.14	854.64
39	39	1	1.71	-1.050	1.100	-15.241	.000	4939.00	2.000	58.64	851.26
40	40	1	1.76	-1.000	1.087	-14.574	.000	4939.00	2.000	58.14	847.89
41	41	1	1.81	-.950	1.074	-13.763	.000	4939.00	2.000	57.43	843.10
42	42	1	1.86	-.900	1.062	-12.953	.000	4939.00	2.000	56.74	838.31
43	43	1	1.92	-.850	1.052	-12.131	.000	4939.00	2.000	56.00	833.18
44	44	1	1.97	-.800	1.041	-11.310	.000	4939.00	2.000	55.26	828.06

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

BODY PT NO	INTES PT NO	MATL NO	STREAM LENGTH INCH (S)	AXIAL LENGTH INCH (Z)	RADIAL LENGTH INCH (R)	BODY ANGLE DEG (THETB)	NORMALIZED ABLATION RATE (BPSP)	WALL TEMP DEG R (TW)	SURFACE ROUGHNESS RIL (RUFMIL)	---EDGE CONDITION--- PRESSURE ATM (PE)	ENTHALPY BTU/LBM (HE)	VELOCITY FT/SEC (UE)
21	45	1	2.02	-.750	1.031	-10.757	.000	4939.00	2.000	39.52	822.60	2162.50
21	46	1	2.07	-.700	1.022	-10.204	.000	4939.00	2.000	53.76	817.13	2229.00
22	47	1	2.12	-.650	1.013	-9.507	.000	4939.00	2.000	53.76	809.87	2312.50
23	48	1	2.17	-.600	1.005	-8.811	.000	4939.00	2.000	51.81	802.60	2396.00
23	49	1	2.22	-.550	.998	-7.638	.000	4939.00	2.000	51.00	796.42	2462.00
24	50	1	2.27	-.500	.991	-6.466	.000	4939.00	2.000	50.21	790.24	2528.00
24	51	1	2.34	-.453	.984	-5.962	.000	4939.00	2.000	48.79	779.01	2637.33
24	52	1	2.40	-.400	.978	-5.457	.000	4939.00	2.000	47.42	767.79	2746.67
24	53	1	2.47	-.300	.971	-4.953	.000	4939.00	2.000	46.00	756.56	2856.00
25	54	1	2.52	-.250	.968	-3.879	.000	4939.00	2.000	45.02	747.42	2937.00
25	55	1	2.57	-.200	.965	-2.805	.000	4939.00	2.000	43.99	738.28	3018.00
26	56	1	2.62	-.150	.963	-2.119	.000	4939.00	2.000	42.92	728.67	3098.50
26	57	1	2.67	-.100	.961	-1.432	.000	4939.00	2.000	41.68	719.06	3178.00
27	58	1	2.72	-.050	.961	-.716	.000	4939.00	2.000	40.17	702.72	3266.00
27	59	1	2.77	.000	.960	.000	.000	4939.00	2.000	38.53	686.39	3353.00
28	60	1	2.82	.050	.961	.716	.000	4939.00	2.000	38.11	682.12	3448.50
28	61	1	2.87	.100	.961	1.432	.000	4939.00	2.000	37.70	677.86	3546.00
29	62	1	2.92	.150	.963	2.119	.000	4939.00	2.000	36.45	664.65	3589.50
29	63	1	2.97	.200	.968	2.805	.000	4939.00	2.000	35.24	651.44	3633.00
30	64	1	3.02	.250	.971	3.547	.000	4939.00	2.000	34.02	637.61	3711.00
30	65	1	3.07	.300	.975	4.289	.000	4939.00	2.000	32.83	623.78	3766.00
31	66	1	3.12	.350	.978	5.000	.000	4939.00	2.000	31.64	609.35	3860.50
31	67	1	3.17	.400	.980	5.711	.000	4939.00	2.000	30.49	594.92	3942.00
32	68	1	3.22	.450	.985	6.418	.000	4939.00	2.000	29.34	579.92	4022.00
32	69	1	3.27	.500	.991	7.125	.000	4939.00	2.000	28.23	564.91	4102.00
33	70	1	3.32	.550	.998	7.968	.000	4939.00	2.000	27.13	549.35	4182.00
33	71	1	3.37	.600	1.005	8.611	.000	4939.00	2.000	26.06	533.79	4262.00
34	72	1	3.42	.650	1.013	9.507	.000	4939.00	2.000	25.01	517.59	4341.00
34	73	1	3.48	.700	1.022	10.204	.000	4939.00	2.000	23.99	501.59	4420.00
35	74	1	3.53	.750	1.031	10.757	.000	4939.00	2.000	22.98	484.98	4500.50
35	75	1	3.58	.800	1.041	11.310	.000	4939.00	2.000	22.07	468.57	4580.50
36	76	1	3.63	.850	1.051	12.131	.000	4939.00	2.000	21.07	451.27	4660.50
36	77	1	3.68	.900	1.062	12.953	.000	4939.00	2.000	20.15	434.18	4741.00
37	78	1	3.73	.950	1.074	13.653	.000	4939.00	2.000	19.26	416.62	4821.50
37	79	1	3.78	1.002	1.087	14.753	.000	4939.00	2.000	18.40	399.06	4902.00
38	80	1	3.83	1.067	1.105	14.812	.000	4939.00	2.000	17.08	370.64	4982.00
38	81	1	3.92	1.133	1.123	14.672	.000	4939.00	2.000	15.86	342.23	5062.00
38	82	1	3.99	1.200	1.141	14.931	.000	4939.00	2.000	14.73	313.81	5142.00
39	83	1	4.08	1.283	1.163	14.955	.000	4939.00	2.000	13.77	286.36	5222.00
39	84	1	4.16	1.367	1.185	14.979	.000	4939.00	2.000	12.88	262.92	5302.00
39	85	1	4.25	1.450	1.207	15.003	.000	4939.00	2.000	12.05	237.47	5382.00
40	86	1	4.33	1.533	1.230	15.003	.000	4939.00	2.000	11.23	211.19	5462.00
40	87	1	4.42	1.617	1.252	15.003	.000	4939.00	2.000	10.47	184.91	5542.00
40	88	1	4.51	1.700	1.275	15.003	.000	4939.00	2.000	9.77	158.63	5622.00
41	89	1	4.59	1.783	1.297	14.967	.000	4939.00	2.000	9.28	132.21	5702.00
41	90	1	4.68	1.867	1.319	14.931	.000	4939.00	2.000	8.66	113.78	5782.00
41	91	1	4.77	1.950	1.341	14.696	.000	4939.00	2.000	8.15	91.36	5862.00

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

BODY PT NO (J)	INTG PT NO (I)	MATL NO (MATL)	STREAM LENGTH INCH (S)	AXIAL LENGTH INCH (Z)	RADIAL LENGTH INCH (R)	BODY ANGLE DEG (THET)	NORMALIZED ABLATION RATE (BPSP)	WALL TEMP DEG R (TW)	SURFACE ROUGHNESS MIL (AUFMIL)	PRESSURE ATM (PE)	---EDGE CONDITION--- ENTHALPY BTU/LBM (HE)	VELOCITY FT/SEC (UE)
42	92	1	4.88	2.033	1.363	14.931	.000	4939.00	2.800	7.66	68.57	6438.67
42	93	1	4.94	2.117	1.386	14.967	.000	4939.00	2.800	7.20	45.79	6518.33
42	94	1	5.02	2.200	1.408	15.003	.000	4939.00	2.800	6.77	23.00	6598.08
43	95	1	5.11	2.283	1.430	15.039	.000	4939.00	2.800	6.43	4.57	6631.67
43	96	1	5.20	2.367	1.453	15.075	.000	4939.00	2.800	6.11	-13.85	6713.33
43	97	1	5.28	2.450	1.475	15.111	.000	4939.00	2.800	5.81	-32.27	6778.00
44	98	1	5.37	2.533	1.497	15.147	.000	4939.00	2.800	5.52	-50.81	6838.00
44	99	1	5.46	2.617	1.520	15.183	.000	4939.00	2.800	5.24	-69.33	6898.00
44	100	1	5.54	2.700	1.542	15.219	.000	4939.00	2.800	4.98	-87.89	6958.00
45	101	1	5.63	2.783	1.564	15.255	.000	4939.00	2.800	4.72	-106.49	7018.67
45	102	1	5.72	2.867	1.587	15.291	.000	4939.00	2.800	4.48	-125.08	7078.33
45	103	1	5.80	2.950	1.609	15.327	.000	4939.00	2.800	4.25	-143.68	7138.00
46	104	1	5.89	3.033	1.631	15.363	.000	4939.00	2.800	4.08	-157.63	7178.67
46	105	1	5.97	3.117	1.654	15.399	.000	4939.00	2.800	3.92	-171.59	7218.33
46	106	1	6.06	3.200	1.676	15.435	.000	4939.00	2.800	3.77	-185.54	7258.00
47	107	1	6.15	3.283	1.698	15.471	.000	4939.00	2.800	3.62	-199.47	7301.00
47	108	1	6.23	3.367	1.721	15.507	.000	4939.00	2.800	3.48	-213.41	7343.00
47	109	1	6.32	3.450	1.743	15.543	.000	4939.00	2.800	3.34	-227.34	7388.00
48	110	1	6.41	3.533	1.766	15.579	.000	4939.00	2.800	3.16	-245.85	7439.33
48	111	1	6.49	3.617	1.788	15.615	.000	4939.00	2.800	2.99	-264.36	7493.67
48	112	1	6.58	3.700	1.810	15.651	.000	4939.00	2.800	2.84	-282.87	7548.00
49	113	1	6.66	3.783	1.832	15.687	.000	4939.00	2.800	2.72	-296.67	7597.67
49	114	1	6.75	3.867	1.855	15.723	.000	4939.00	2.800	2.61	-310.46	7647.33
49	115	1	6.84	3.950	1.877	15.759	.000	4939.00	2.800	2.51	-324.26	7697.00
50	116	1	6.92	4.033	1.899	15.795	.000	4939.00	2.800	2.40	-337.96	7748.00
50	117	1	7.01	4.117	1.922	15.831	.000	4939.00	2.800	2.31	-351.67	7798.00
50	118	1	7.10	4.200	1.944	15.867	.000	4939.00	2.800	2.21	-365.37	7848.00
51	119	1	7.18	4.283	1.966	15.903	.000	4939.00	2.800	2.15	-374.44	7899.33
51	120	1	7.27	4.367	1.989	15.939	.000	4939.00	2.800	2.09	-383.52	7950.67
51	121	1	7.35	4.450	2.011	15.975	.000	4939.00	2.800	2.04	-392.59	7998.00
52	122	1	7.44	4.533	2.033	16.011	.000	4939.00	2.800	1.98	-406.09	8048.00
52	123	1	7.53	4.617	2.056	16.047	.000	4939.00	2.800	1.93	-415.59	8098.00
52	124	1	7.61	4.700	2.078	16.083	.000	4939.00	2.800	1.79	-433.09	8148.00
53	125	1	7.70	4.783	2.100	16.119	.000	4939.00	2.800	1.72	-446.46	8198.00
53	126	1	7.79	4.867	2.123	16.155	.000	4939.00	2.800	1.65	-459.82	8248.00
53	127	1	7.87	4.950	2.145	16.191	.000	4939.00	2.800	1.58	-473.19	8298.00
54	128	1	7.96	5.033	2.167	16.227	.000	4939.00	2.800	1.49	-482.03	8348.00
54	129	1	8.04	5.117	2.190	16.263	.000	4939.00	2.800	1.45	-499.72	8398.00
54	130	1	8.13	5.200	2.212	16.299	.000	4939.00	2.800	1.41	-508.46	8448.00
55	131	1	8.22	5.283	2.234	16.335	.000	4939.00	2.800	1.37	-517.24	8498.00
55	132	1	8.30	5.367	2.257	16.371	.000	4939.00	2.800	1.33	-526.00	8548.00
55	133	1	8.39	5.450	2.279	16.407	.000	4939.00	2.800	1.30	-534.77	8598.00
56	134	1	8.48	5.533	2.301	16.443	.000	4939.00	2.800	1.26	-543.54	8648.00
56	135	1	8.56	5.617	2.324	16.479	.000	4939.00	2.800	1.22	-552.31	8698.00
56	136	1	8.65	5.700	2.346	16.515	.000	4939.00	2.800			

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

VISCOS FLOW - EDGE PROPERTIES

BODY PT NO	INTG PT NO	STREAM LENGTH INCH	VELOCITY FT/SEC (UE)	MACH NO (MACH)	ENTHALPY BTU/LBM (HE)	TEMPERATURE DEG R (TE)	DENSITY LBM/FT3 (RDE)	VISCOSITY LBM/FT-SEC (VISE)	UNIT RE NO 1/FT (URE)
1	1	.0000	0	.0000	909.8	6597.1	2.960-01	5.285-05	0.000
	2	.0401	93.5	.0219	908.8	6595.5	2.953-01	5.284-05	5.237+05
	3	.0961	187.3	.0439	907.9	6594.0	2.947-01	5.283-05	1.083+06
	4	.1442	278.4	.0652	906.9	6592.5	2.941-01	5.283-05	1.350+06
	5	.1922	370.9	.0869	906.0	6591.0	2.934-01	5.282-05	2.060+06
	6	.2403	463.3	.1086	905.0	6589.5	2.928-01	5.281-05	2.569+06
2	7	.2884	555.8	.1303	904.1	6588.0	2.922-01	5.280-05	3.075+06
	8	.3289	578.9	.1527	903.6	6587.2	2.916-01	5.280-05	3.200+06
	9	.3695	602.0	.1751	903.1	6586.4	2.912-01	5.279-05	3.328+06
3	10	.4101	625.1	.1975	902.6	6585.6	2.906-01	5.279-05	3.448+06
	11	.4517	659.7	.2200	901.7	6584.3	2.901-01	5.278-05	3.632+06
4	12	.4933	694.4	.2425	900.9	6583.0	2.894-01	5.277-05	3.816+06
	13	.5350	729.0	.2650	899.9	6581.5	2.888-01	5.276-05	3.999+06
5	14	.5766	763.6	.2875	899.0	6580.0	2.882-01	5.275-05	4.180+06
	15	.6182	798.2	.3100	897.0	6578.5	2.875-01	5.274-05	4.360+06
6	16	.6598	832.8	.3325	896.4	6576.9	2.868-01	5.274-05	4.539+06
	17	.7014	867.4	.3550	895.9	6575.2	2.862-01	5.274-05	4.717+06
7	18	.7429	901.9	.3775	894.7	6573.4	2.855-01	5.273-05	4.894+06
	19	.7845	936.4	.4000	893.0	6570.6	2.848-01	5.272-05	5.067+06
8	20	.8261	970.9	.4225	891.7	6567.7	2.841-01	5.271-05	5.241+06
	21	.8677	1005.0	.4450	889.1	6564.6	2.834-01	5.270-05	5.418+06
9	22	.9093	1039.5	.4675	887.1	6561.5	2.824-01	5.268-05	5.593+06
	23	.9509	1074.0	.4900	885.6	6559.2	2.811-01	5.265-05	5.768+06
10	24	.9925	1108.5	.5125	884.2	6557.0	2.792-01	5.264-05	5.943+06
	25	1.0341	1143.0	.5350	881.8	6553.4	2.777-01	5.260-05	6.118+06
11	26	1.0757	1177.5	.5575	879.5	6549.9	2.762-01	5.258-05	6.293+06
	27	1.1173	1212.0	.5800	876.9	6545.9	2.747-01	5.256-05	6.468+06
12	28	1.1589	1246.5	.6025	874.4	6542.1	2.731-01	5.254-05	6.643+06
	29	1.2005	1281.0	.6250	871.6	6537.9	2.714-01	5.252-05	6.818+06
13	30	1.2421	1315.5	.6475	868.9	6533.8	2.697-01	5.250-05	6.993+06
	31	1.2837	1350.0	.6700	866.0	6529.4	2.679-01	5.248-05	7.168+06
14	32	1.3253	1384.5	.6925	863.0	6525.1	2.661-01	5.246-05	7.343+06
	33	1.3669	1419.0	.7150	859.8	6518.8	2.645-01	5.244-05	7.518+06
15	34	1.4085	1453.5	.7375	854.6	6512.3	2.618-01	5.241-05	7.693+06
	35	1.4501	1488.0	.7600	851.3	6507.2	2.590-01	5.238-05	7.868+06
16	36	1.4917	1522.5	.7825	847.9	6502.1	2.571-01	5.235-05	8.043+06
	37	1.5333	1557.0	.8050	843.4	6494.9	2.543-01	5.232-05	8.218+06
17	38	1.5749	1591.5	.8275	838.3	6487.7	2.515-01	5.228-05	8.393+06
	39	1.6165	1626.0	.8500	833.2	6480.2	2.486-01	5.224-05	8.568+06
18	40	1.6581	1660.5	.8725	828.1	6472.6	2.457-01	5.220-05	8.743+06
	41	1.6997	1695.0	.8950	823.0				
19	42	1.7413	1729.5	.9175	817.9				
	43	1.7829	1764.0	.9400	812.8				
20	44	1.8245	1798.5	.9625	807.7				
	45	1.8661	1833.0	.9850	802.6				
	46	1.9077	1867.5	1.0075	797.5				
	47	1.9493	1902.0	1.0300	792.4				
	48	1.9909	1936.5	1.0525	787.3				
	49	2.0325	1971.0	1.0750	782.2				
	50	2.0741	2005.5	1.0975	777.1				
	51	2.1157	2040.0	1.1200	772.0				
	52	2.1573	2074.5	1.1425	766.9				
	53	2.1989	2109.0	1.1650	761.8				
	54	2.2405	2143.5	1.1875	756.7				
	55	2.2821	2178.0	1.2100	751.6				
	56	2.3237	2212.5	1.2325	746.5				
	57	2.3653	2247.0	1.2550	741.4				
	58	2.4069	2281.5	1.2775	736.3				
	59	2.4485	2316.0	1.3000	731.2				
	60	2.4901	2350.5	1.3225	726.1				
	61	2.5317	2385.0	1.3450	721.0				
	62	2.5733	2419.5	1.3675	715.9				
	63	2.6149	2454.0	1.3900	710.8				
	64	2.6565	2488.5	1.4125	705.7				
	65	2.6981	2523.0	1.4350	700.6				
	66	2.7397	2557.5	1.4575	695.5				
	67	2.7813	2592.0	1.4800	690.4				
	68	2.8229	2626.5	1.5025	685.3				
	69	2.8645	2661.0	1.5250	680.2				
	70	2.9061	2695.5	1.5475	675.1				
	71	2.9477	2730.0	1.5700	670.0				
	72	2.9893	2764.5	1.5925	664.9				
	73	3.0309	2799.0	1.6150	659.8				
	74	3.0725	2833.5	1.6375	654.7				
	75	3.1141	2868.0	1.6600	649.6				
	76	3.1557	2902.5	1.6825	644.5				
	77	3.1973	2937.0	1.7050	639.4				
	78	3.2389	2971.5	1.7275	634.3				
	79	3.2805	3006.0	1.7500	629.2				
	80	3.3221	3040.5	1.7725	624.1				
	81	3.3637	3075.0	1.7950	619.0				
	82	3.4053	3109.5	1.8175	613.9				
	83	3.4469	3144.0	1.8400	608.8				
	84	3.4885	3178.5	1.8625	603.7				
	85	3.5301	3213.0	1.8850	598.6				
	86	3.5717	3247.5	1.9075	593.5				
	87	3.6133	3282.0	1.9300	588.4				
	88	3.6549	3316.5	1.9525	583.3				
	89	3.6965	3351.0	1.9750	578.2				
	90	3.7381	3385.5	1.9975	573.1				
	91	3.7797	3420.0	2.0200	568.0				
	92	3.8213	3454.5	2.0425	562.9				
	93	3.8629	3489.0	2.0650	557.8				
	94	3.9045	3523.5	2.0875	552.7				
	95	3.9461	3558.0	2.1100	547.6				
	96	3.9877	3592.5	2.1325	542.5				
	97	4.0293	3627.0	2.1550	537.4				
	98	4.0709	3661.5	2.1775	532.3				
	99	4.1125	3696.0	2.2000	527.2				
	100	4.1541	3730.5	2.2225	522.1				
	101	4.1957	3765.0	2.2450	517.0				
	102	4.2373	3799.5	2.2675	511.9				
	103	4.2789	3834.0	2.2900	506.8				
	104	4.3205	3868.5	2.3125	501.7				
	105	4.3621	3903.0	2.3350	496.6				
	106	4.4037	3937.5	2.3575	491.5				
	107	4.4453	3972.0	2.3800	486.4				
	108	4.4869	4006.5	2.4025	481.3				
	109	4.5285	4041.0	2.4250	476.2				
	110	4.5701	4075.5	2.4475	471.1				
	111	4.6117	4110.0	2.4700	466.0				
	112	4.6533	4144.5	2.4925	460.9				
	113	4.6949	4179.0	2.5150	455.8				
	114	4.7365	4213.5	2.5375	450.7				
	115	4.7781	4248.0	2.5600	445.6				
	116	4.8197	4282.5	2.5825	440.5				
	117	4.8613	4317.0	2.6050	435.4				
	118	4.9029	4351.5	2.6275	430.3				
	119	4.9445	4386.0	2.6500	425.2				
	120	4.9861	4420.5	2.6725	420.1				
	121	5.0277	4455.0	2.6950	415.0				
	122	5.0693	4489.5	2.7175	409.9				
	123	5.1109	4524.0	2.7400	404.8				
	124	5.1525	4558.5	2.7625	399.7				
	125	5.1941	4593.0	2.7850	394.6				
	126	5.2357	4627.5	2.8075	389.5				
	127	5.2773	4662.0	2.8300	384.4				
	128	5.3189	4696.5	2.8525	379.3				
	129	5.3605	4731.0	2.8750	374.2				
	130	5.4021	4765.5	2.8975	369.1				
	131	5.4437	4800.0	2.9200	364.0				
	132	5.4853	4834.5	2.9425	358.9				
	133	5.5269	4869.0	2.9650	353.8				
	134	5.5685	4903.5	2.9875	348.7				
	135	5.6101	4938.0	3.0100	343.6				
	136	5.6517	4972.5	3.0325	338.5				
	137	5.6933	5007.0	3.0550	333.4				
	138	5.7349	5041.5	3.0775	328.3				
	139	5.7765	5076.0	3.1000	323.2				
	140	5.8181	5110.5	3.1225	318.1				
	141	5.8597	5145.0	3.1450	313.0				
	142	5.9013	5179.5	3.1675	307.9				
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MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

BODY PT NO	INTG PT NO	STREAM LENGTH INCH (S)	VELOCITY FT/SEC (UE)	MACH NO (MACH)	ENTHALPY BTU/LBM (HE)	TEMPERATURE DEG R (TE)	DENSITY LBM/FT3 (HOE)	VISCOSITY LBM/FT-SEC (VISE)	UNIT RE NO 1/FT (UNL)
21	48	2.0173	2162.5	.5123	822.6	6464.7	2.426-01	5.215-05	1.006+07
21	46	2.0582	2229.0	.5284	817.2	6456.8	2.356-01	5.212-05	1.023+07
22	47	2.1190	2312.5	.5487	809.9	6446.4	2.357-01	5.207-05	1.047+07
22	48	2.1697	2396.0	.5690	802.6	6436.1	2.318-01	5.201-05	1.068+07
23	49	2.2202	2462.0	.5851	796.4	6427.4	2.283-01	5.197-05	1.082+07
23	50	2.2706	2528.0	.6013	790.2	6418.9	2.253-01	5.192-05	1.097+07
24	51	2.3376	2637.3	.6282	779.0	6402.9	2.195-01	5.184-05	1.117+07
24	52	2.4096	2746.7	.6551	767.8	6387.2	2.180-01	5.176-05	1.135+07
24	53	2.4716	2856.0	.6822	756.6	6371.7	2.085-01	5.168-05	1.152+07
25	54	2.5217	2937.0	.7023	747.4	6359.4	2.042-01	5.162-05	1.162+07
25	55	2.5718	3010.0	.7225	738.3	6347.2	1.999-01	5.155-05	1.176+07
26	56	2.6219	3086.3	.7426	728.7	6334.5	1.955-01	5.149-05	1.177+07
26	57	2.6719	3179.0	.7628	719.1	6322.1	1.912-01	5.143-05	1.162+07
27	58	2.7219	3306.0	.7948	702.7	6301.4	1.841-01	5.132-05	1.186+07
27	59	2.7719	3433.0	.8272	686.4	6275.0	1.774-01	5.118-05	1.198+07
28	60	2.8219	3464.9	.8593	682.1	6268.2	1.757-01	5.111-05	1.198+07
28	61	2.8719	3496.0	.8934	677.9	6261.3	1.740-01	5.111-05	1.198+07
29	62	2.9219	3539.3	.9275	664.7	6240.5	1.697-01	5.108-05	1.189+07
29	63	2.9720	3683.0	.9518	651.4	6219.9	1.639-01	5.069-05	1.164+07
30	64	3.0221	3776.0	.9760	637.6	6198.9	1.588-01	5.077-05	1.181+07
30	65	3.0722	3869.0	.9904	623.8	6178.2	1.538-01	5.067-05	1.178+07
31	66	3.1224	3960.9	.9945	609.3	6157.1	1.488-01	5.058-05	1.164+07
31	67	3.1726	4052.0	.9886	594.9	6136.4	1.440-01	5.044-05	1.157+07
32	68	3.2229	4142.3	1.0128	579.9	6114.5	1.391-01	5.033-05	1.149+07
32	69	3.2732	4233.0	1.0370	564.9	6092.6	1.344-01	5.021-05	1.130+07
33	70	3.3237	4322.0	1.0610	549.3	6070.3	1.297-01	5.009-05	1.129+07
33	71	3.3741	4411.0	1.0851	533.8	6048.7	1.251-01	4.998-05	1.104+07
34	72	3.4243	4499.0	1.1090	517.7	6026.8	1.205-01	4.986-05	1.087+07
34	73	3.4756	4587.0	1.1330	501.6	6005.4	1.161-01	4.978-07	1.078+07
35	74	3.5265	4628.3	1.1457	485.0	5984.0	1.117-01	4.964-05	1.041+07
35	75	3.5774	4670.0	1.1583	468.4	5963.0	1.074-01	4.953-05	1.013+07
36	76	3.6283	4800.3	1.1932	451.3	5942.0	1.032-01	4.942-05	1.008+07
36	77	3.6795	4931.0	1.2286	431.2	5914.2	9.924-02	4.928-05	9.938+06
37	78	3.7311	5015.3	1.2530	417.4	5887.4	9.853-02	4.912-05	9.935+06
37	79	3.7826	5100.0	1.2775	399.1	5859.0	9.156-02	4.897-05	9.936+06
38	80	3.8317	5227.7	1.3150	370.6	5814.6	8.574-02	4.873-05	9.198+06
38	81	3.9207	5355.3	1.3527	342.2	5772.0	8.027-02	4.850-05	8.664+06
38	82	3.9558	5483.0	1.3905	313.8	5731.4	7.513-02	4.828-05	6.533+06
39	83	4.0760	5586.3	1.4222	288.4	5696.3	7.076-02	4.809-05	7.223+06
39	84	4.1622	5693.7	1.4540	262.9	5662.5	6.653-02	4.791-05	7.919+06
39	85	4.2484	5799.0	1.4859	237.5	5629.3	6.253-02	4.773-05	7.221+06
40	86	4.3347	5901.0	1.5172	211.2	5597.4	5.830-02	4.755-05	7.508+06
40	87	4.4211	6003.0	1.5491	184.9	5561.7	5.532-02	4.738-05	7.012+06
40	88	4.5074	6105.0	1.5819	158.6	5520.5	5.211-02	4.713-05	6.737+06
40	89	4.5936	6167.0	1.6089	136.2	5484.1	4.932-02	4.693-05	6.502+06
40	90	4.6798	6269.0	1.6360	113.8	5448.9	4.677-02	4.673-05	6.273+06
41	91	4.7660	6331.0	1.6632	91.4	5414.8	4.434-02	4.655-05	6.058+06

MOMENTUM ENERGY INTEGRATION TECHNIQUE (HEIT)

BODY PT NO	INTES PT NO	STREAM LENGTH INCH (S)	VELOCITY FT/SEC (UE)	MACH NO (MACH)	ENTHALPY BTU/LBM (HE)	TEMPERATURE DEG R (TE)	DENSITY LBM/FT ³ (ROE)	VISCOSITY LBM/FT-SEC (VISE)	UNIT RE NC 1/F ² (URE)
42	92	4.823	6430.7	1.6899	68.6	5301.2	4.196-02	4.636-03	5.631-16
	93	4.9389	6510.3	1.7167	45.8	5348.7	3.971-02	4.618-03	5.598-16
	94	5.0248	6590.0	1.7436	23.0	5377.5	3.757-02	4.601-03	5.582-16
	95	5.1111	6631.7	1.7646	4.6	5292.5	3.590-02	4.587-03	5.564-16
43	96	5.1974	6713.3	1.7850	-13.8	5271.5	3.428-02	4.575-03	5.539-06
	97	5.2836	6775.0	1.8063	-32.3	5277.3	3.276-02	4.562-03	4.865-16
	98	5.3699	6835.0	1.8277	-50.8	5221.3	3.129-02	4.548-03	4.703-16
	99	5.4562	6895.0	1.8493	-69.4	5192.4	2.989-02	4.531-03	4.549-16
44	100	5.5425	6955.0	1.8711	-87.9	5153.1	2.856-02	4.515-03	4.401-16
	101	5.6287	7013.7	1.8927	-106.5	5133.0	2.727-02	4.497-03	4.253-16
45	102	5.7150	7072.3	1.9143	-125.1	5103.5	2.603-02	4.480-03	4.108-06
	103	5.8013	7131.0	1.9361	-143.7	5074.5	2.484-02	4.463-03	3.969-06
	104	5.8876	7173.7	1.9521	-157.6	5033.0	2.398-02	4.451-03	3.864-16
46	105	5.9738	7216.3	1.9681	-171.6	5031.0	2.314-02	4.439-03	3.782-16
	106	6.0601	7259.0	1.9842	-185.5	5010.9	2.234-02	4.427-03	3.668-06
	107	6.1464	7301.0	2.0004	-199.5	4989.7	2.155-02	4.415-03	3.564-06
47	108	6.2327	7343.0	2.0167	-213.4	4968.2	2.080-02	4.403-03	3.469-06
	109	6.3189	7385.0	2.0331	-227.3	4946.8	2.007-02	4.391-03	3.376-16
	110	6.4052	7429.3	2.0548	-241.8	4918.3	1.913-02	4.374-03	3.283-06
48	111	6.4915	7473.7	2.0766	-255.8	4889.9	1.824-02	4.358-03	3.186-16
	112	6.5778	7518.0	2.0987	-269.4	4861.5	1.729-02	4.342-03	3.089-06
	113	6.6640	7567.7	2.1146	-286.7	4830.4	1.676-02	4.330-03	2.993-06
	114	6.7503	7627.3	2.1305	-310.5	4819.4	1.616-02	4.317-03	2.898-06
49	115	6.8366	7667.0	2.1466	-324.3	4798.3	1.558-02	4.305-03	2.799-06
	116	6.9229	7706.0	2.1628	-338.0	4776.4	1.502-02	4.292-03	2.697-06
	117	7.0091	7745.0	2.1794	-351.7	4753.4	1.449-02	4.279-03	2.593-06
50	118	7.0954	7784.0	2.1960	-365.4	4730.7	1.397-02	4.265-03	2.489-06
	119	7.1817	7823.7	2.2069	-374.4	4715.8	1.363-02	4.256-03	2.384-06
51	120	7.2679	7863.7	2.2179	-388.5	4701.0	1.330-02	4.248-03	2.279-06
	121	7.3542	7903.0	2.2288	-392.6	4686.4	1.298-02	4.239-03	2.174-06
	122	7.4405	7947.3	2.2451	-406.1	4664.7	1.251-02	4.227-03	2.069-06
52	123	7.5268	7994.7	2.2614	-419.6	4643.3	1.206-02	4.214-03	1.964-06
	124	7.6130	8044.7	2.2777	-433.1	4622.2	1.162-02	4.202-03	1.859-06
	125	7.6993	8095.3	2.2938	-446.5	4601.5	1.120-02	4.190-03	1.754-06
53	126	7.7855	8144.7	2.3098	-459.8	4581.1	1.079-02	4.178-03	1.649-06
	127	7.8719	8195.0	2.3266	-473.2	4560.9	1.039-02	4.166-03	1.544-06
	128	7.9581	8245.0	2.3433	-482.8	4540.7	1.013-02	4.158-03	1.439-06
54	129	8.0444	8295.0	2.3606	-490.9	4521.2	9.661-03	4.150-03	1.334-06
	130	8.1307	8345.3	2.3784	-508.5	4501.6	9.637-03	4.143-03	1.229-06
	131	8.2170	8395.7	2.3964	-517.2	4480.6	9.613-03	4.134-03	1.124-06
55	132	8.3032	8445.0	2.4137	-526.0	4460.6	9.589-03	4.125-03	1.019-06
	133	8.3895	8495.0	2.4316	-534.7	4440.6	9.565-03	4.115-03	9.09-06
	134	8.4758	8545.0	2.4495	-543.3	4420.6	9.541-03	4.106-03	8.08-06
56	135	8.5621	8595.0	2.4674	-552.0	4400.6	9.517-03	4.097-03	7.07-06
	136	8.6483	8645.0	2.4853	-560.8	4380.6	9.493-03	4.088-03	6.06-06

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)
 VISCIOUS FLOW - WALL AND B. L. RECOVERY PROPERTIES

BODY PT NO (J)	INTG PT NO (I)	STREAM LENGTH INCH (S)	WALL TEMPERATURE DEG R (TW)	WALL ENTHALPY BTU/LBM (HW)	WALL DENSITY LBM/FT ³ (RHO)	WALL VISCOSITY LBM/FT-SEC (VISH)	RECOVERY ENTHALPY BTU/LBM (HR)	RECOVERY FACTOR (RECUV)	SENSBL CONV HEAT FLUX BTU/FT ² -SEC	CF/2
1	1	.0008	939.0	-380.4	0.170-01	0.395-05	909.8	.6998	9.480+02	1.000+00
	2	.0081	939.0	-380.3	0.160-01	0.395-05	908.9	.6998	9.464+02	2.719-02
	3	.0961	939.0	-380.2	0.150-01	0.395-05	908.4	.6998	9.435+02	1.358-02
	4	.1442	939.0	-380.1	0.140-01	0.395-05	908.0	.6998	8.312+02	1.116-02
	5	.1922	939.0	-380.1	0.130-01	0.395-05	908.1	.7882	1.746+03	1.432-02
	6	.2403	939.0	-380.1	0.120-01	0.395-05	908.4	.7882	1.713+03	1.855-02
2	7	.2884	939.0	-380.0	0.110-01	0.395-05	908.9	.7882	1.750+03	0.588+03
	8	.3269	939.0	-380.0	0.105-01	0.395-05	908.0	.7882	1.599+03	7.079+03
	9	.3695	939.0	-379.9	0.099-01	0.395-05	908.8	.7882	1.538+03	6.611-03
3	10	.4101	939.0	-379.9	0.094-01	0.395-05	908.7	.7882	1.544+03	6.562-03
	11	.4577	939.0	-379.9	0.085-01	0.395-05	908.6	.7882	1.563+03	6.219-03
4	12	.5053	939.0	-379.8	0.077-01	0.395-05	908.5	.7882	1.585+03	6.181-03
	13	.5463	939.0	-379.7	0.067-01	0.395-05	908.3	.7882	1.620+03	6.845-03
5	14	.5873	939.0	-379.7	0.057-01	0.395-05	908.2	.7882	1.656+03	8.594+03
	15	.6237	939.0	-379.6	0.047-01	0.395-05	908.0	.7882	1.698+03	9.970-03
6	16	.6602	939.0	-379.6	0.036-01	0.395-05	907.9	.7882	1.720+03	9.784-03
	17	.6930	939.0	-379.5	0.031-01	0.395-05	907.8	.7882	1.700+03	9.524+03
7	18	.7274	939.0	-379.5	0.025-01	0.395-05	907.7	.7882	1.721+03	9.468-03
	19	.7588	939.0	-379.4	0.013-01	0.395-05	907.6	.7882	1.783+03	9.688-03
8	20	.7902	939.0	-379.3	0.002-01	0.395-05	907.4	.7882	1.813+03	9.868-03
	21	.8202	939.0	-379.3	3.995-01	0.395-05	907.3	.7882	1.800+03	9.834-03
9	22	.8501	939.0	-379.3	3.989-01	0.395-05	907.2	.7882	1.806+03	9.778-03
	23	.8783	939.0	-379.2	3.983-01	0.395-05	907.1	.7882	1.814+03	9.716-03
10	24	.9065	939.0	-379.2	3.976-01	0.395-05	907.0	.7882	1.830+03	9.689-03
	25	.9313	939.0	-379.1	3.966-01	0.395-05	906.9	.7882	1.849+03	9.655-03
11	26	1.0162	939.0	-378.9	3.936-01	0.395-05	906.2	.7882	1.957+03	9.902-03
	27	1.0710	939.0	-378.8	3.921-01	0.395-05	906.0	.7882	1.983+03	9.965-03
12	28	1.1257	939.0	-378.7	3.907-01	0.395-05	905.3	.7882	2.042+03	9.983-03
	29	1.1800	939.0	-378.6	3.883-01	0.395-05	905.6	.7882	2.092+03	9.988-03
13	30	1.2343	939.0	-378.4	3.860-01	0.395-05	905.3	.7882	2.138+03	9.984-03
	31	1.2879	939.0	-378.3	3.835-01	0.395-05	904.5	.7882	2.182+03	9.986-03
14	32	1.3416	939.0	-378.1	3.810-01	0.395-05	904.8	.7882	2.221+03	9.988-03
	33	1.3948	939.0	-377.9	3.784-01	0.395-05	904.0	.7882	2.265+03	9.989-03
15	34	1.4479	939.0	-377.8	3.758-01	0.395-05	903.7	.7882	2.303+03	9.768-03
	35	1.5006	939.0	-377.6	3.733-01	0.395-05	903.2	.7882	2.345+03	9.765-03
16	36	1.5532	939.0	-377.4	3.702-01	0.395-05	902.8	.7882	2.385+03	9.799-03
	37	1.6058	939.0	-377.1	3.663-01	0.395-05	902.0	.7882	2.410+03	9.785-03
17	38	1.6576	939.0	-376.8	3.624-01	0.395-05	901.5	.7882	2.461+03	9.674-03
	39	1.7094	939.0	-376.6	3.593-01	0.395-05	900.9	.7882	2.514+03	9.653-03
18	40	1.7612	939.0	-376.4	3.562-01	0.395-05	900.4	.7882	2.563+03	9.648-03
	41	1.8127	939.0	-376.1	3.519-01	0.395-05	899.6	.7882	2.605+03	9.648-03
19	42	1.8643	939.0	-375.7	3.476-01	0.395-05	898.9	.7882	2.643+03	9.628-03
	43	1.9154	939.0	-375.4	3.431-01	0.395-05	898.0	.7882	2.677+03	9.597-03
20	44	1.9664	939.0	-375.0	3.386-01	0.395-05	897.3	.7882		

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

BODY PT NO (J)	INTEG PT NO (I)	STREAM LENGTH INCH (S)	WALL TEMPERATURE DEG R (TU)	WALL ENTHALPY BTU/LBM (HW)	WALL DENSITY LBM/FT ³ (RHO)	WALL VISCOSITY LBM/FT-SEC (VISM)	RECOVERY ENTHALPY BTU/LBM (HRI)	RECOVERY FACTOR (RECOV)	SENSBL CONV HEAT FLUX BTU/FT ² -SEC	CF/2
21	45	2.0173	4939.0	-374.7	3.339-01	4.395-05	896.3	.7882	2.705+03	0.567-03
	46	2.0682	4939.0	-374.3	3.293-01	4.395-05	895.4	.7882	2.735+03	0.561-03
22	47	2.1190	4939.0	-373.8	3.233-01	4.395-05	894.1	.7882	2.775+03	0.573-03
	48	2.1697	4939.0	-373.3	3.173-01	4.395-05	893.0	.7882	2.804+03	0.580-03
23	49	2.2202	4939.0	-372.9	3.124-01	4.395-05	891.9	.7882	2.812+03	0.582-03
	50	2.2706	4939.0	-372.5	3.075-01	4.395-05	890.9	.7882	2.825+03	0.581-03
	51	2.3374	4939.0	-371.7	2.988-01	4.395-05	888.6	.7882	2.845+03	0.583-03
24	52	2.4046	4939.0	-370.9	2.903-01	4.395-05	885.0	.7882	2.858+03	0.584-03
	53	2.4716	4939.0	-370.0	2.821-01	4.395-05	883.3	.7882	2.865+03	0.585-03
25	54	2.5217	4939.0	-369.4	2.756-01	4.394-05	881.7	.7882	2.860+03	0.586-03
	55	2.5718	4939.0	-368.7	2.692-01	4.394-05	879.9	.7882	2.854+03	0.587-03
26	56	2.6219	4939.0	-368.0	2.627-01	4.394-05	878.2	.7882	2.840+03	0.582-03
	57	2.6719	4939.0	-367.3	2.563-01	4.394-05	876.9	.7882	2.834+03	0.583-03
27	58	2.7219	4939.0	-366.1	2.498-01	4.394-05	874.9	.7882	2.818+03	0.581-03
	59	2.7719	4939.0	-364.8	2.357-01	4.394-05	872.0	.7882	2.778+03	0.575-03
28	60	2.8219	4939.0	-364.5	2.332-01	4.394-05	871.2	.7882	2.731+03	0.568-03
	61	2.8719	4939.0	-364.1	2.306-01	4.394-05	870.4	.7882	2.719+03	0.563-03
29	62	2.9219	4939.0	-363.1	2.230-01	4.394-05	867.6	.7882	2.690+03	0.558-03
	63	2.9720	4939.0	-362.0	2.155-01	4.394-05	865.1	.7882	2.652+03	0.553-03
30	64	3.0221	4939.0	-360.9	2.080-01	4.394-05	862.2	.7882	2.607+03	0.548-03
	65	3.0722	4939.0	-359.8	2.008-01	4.394-05	859.5	.7882	2.561+03	0.543-03
31	66	3.1224	4939.0	-358.6	1.934-01	4.394-05	856.4	.7882	2.508+03	0.538-03
	67	3.1726	4939.0	-357.4	1.864-01	4.394-05	853.5	.7882	2.456+03	0.533-03
32	68	3.2229	4939.0	-356.1	1.793-01	4.394-05	850.2	.7882	2.398+03	0.528-03
	69	3.2732	4939.0	-354.7	1.725-01	4.394-05	847.1	.7882	2.340+03	0.523-03
33	70	3.3237	4939.0	-353.3	1.657-01	4.394-05	843.6	.7882	2.277+03	0.518-03
	71	3.3741	4939.0	-351.8	1.592-01	4.393-05	840.2	.7882	2.216+03	0.513-03
34	72	3.4249	4939.0	-350.3	1.527-01	4.393-05	836.5	.7882	2.151+03	0.508-03
	73	3.4756	4939.0	-348.8	1.465-01	4.393-05	833.0	.7882	2.082+03	0.503-03
35	74	3.5265	4939.0	-347.3	1.403-01	4.393-05	828.4	.7882	1.973+03	0.498-03
	75	3.5774	4939.0	-345.7	1.344-01	4.393-05	824.9	.7882	1.886+03	0.493-03
36	76	3.6285	4939.0	-344.1	1.286-01	4.393-05	821.3	.7882	1.860+03	0.493-03
	77	3.6795	4939.0	-342.5	1.230-01	4.393-05	817.2	.7882	1.825+03	0.493-03
37	78	3.7311	4939.0	-340.5	1.175-01	4.393-05	812.9	.7882	1.793+03	0.491-03
	79	3.7826	4939.0	-338.5	1.122-01	4.393-05	808.8	.7882	1.689+03	0.486-03
38	80	3.8317	4939.0	-335.1	1.042-01	4.392-05	801.1	.7882	1.583+03	0.481-03
	81	3.9207	4939.0	-331.7	9.667-02	4.392-05	794.0	.7882	1.484+03	0.476-03
39	82	3.9898	4939.0	-328.3	8.973-02	4.392-05	787.4	.7882	1.388+03	0.471-03
	83	4.0760	4939.0	-325.3	8.308-02	4.392-05	780.3	.7882	1.300+03	0.466-03
40	84	4.1622	4939.0	-322.2	7.642-02	4.392-05	773.5	.7882	1.220+03	0.461-03
	85	4.2484	4939.0	-319.2	7.331-02	4.392-05	767.2	.7882	1.144+03	0.456-03
41	86	4.3347	4939.0	-316.0	6.834-02	4.391-05	759.7	.7882	1.067+03	0.451-03
	87	4.4211	4939.0	-312.6	6.370-02	4.391-05	752.5	.7882	9.950+02	0.446-03
42	88	4.5074	4939.0	-309.3	5.937-02	4.391-05	745.7	.7882	9.269+02	0.441-03
	89	4.5936	4939.0	-305.3	5.538-02	4.391-05	739.2	.7882	8.692+02	0.436-03
43	90	4.6798	4939.0	-301.9	5.254-02	4.391-05	732.6	.7882	8.157+02	0.431-03
	91	4.7660	4939.0	-298.2	4.949-02	4.390-05	726.7	.7882	7.652+02	0.426-03

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

BOOY PT NO	INTES PT NO	STREAM LENGTH INCH (S)	WALL TEMPERATURE DEG R (TW)	WALL ENTHALPY BTU/LBM (MW)	WALL DENSITY LBM/FT3 (ROW)	WALL VISCOSITY LBM/FT-SEC (VISH)	RECOVERY ENTHALPY BTU/LBM (HR)	RECOVERY FACTOR (RECOV)	SENSBL CONV HEAT FLUX BTU/FT2-SEC	CF/2
42	92	4.823	4339.0	-234.3	4.649-02	4.390-05	719.9	.7882	7.153+02	2.867-03
	93	4.9385	4339.0	-230.5	4.367-02	4.390-05	713.4	.7882	6.686+02	2.818-03
	94	5.0248	4339.0	-286.7	4.103-02	4.390-05	707.1	.7882	6.243+02	2.768-03
	95	5.1111	4339.0	-283.6	3.898-02	4.390-05	701.5	.7882	5.893+02	2.708-03
	96	5.1974	4339.0	-280.5	3.784-02	4.389-05	696.1	.7882	5.567+02	2.668-03
	97	5.2836	4339.0	-277.3	3.519-02	4.389-05	690.8	.7882	5.255+02	2.624-03
	98	5.3699	4339.0	-274.2	3.341-02	4.389-05	685.1	.7882	4.953+02	2.581-03
	99	5.4562	4339.0	-271.0	3.171-02	4.389-05	679.6	.7882	4.669+02	2.539-03
	100	5.5425	4339.0	-267.6	3.010-02	4.389-05	674.2	.7882	4.399+02	2.496-03
	101	5.6287	4339.0	-261.9	2.855-02	4.388-05	668.4	.7882	4.124+02	2.452-03
	102	5.7150	4339.0	-256.3	2.707-02	4.388-05	662.8	.7882	3.866+02	2.409-03
	103	5.8013	4339.0	-250.6	2.566-02	4.388-05	657.2	.7882	3.618+02	2.357-03
	104	5.8876	4339.0	-246.3	2.465-02	4.387-05	652.0	.7882	3.437+02	2.313-03
	105	5.9738	4339.0	-242.0	2.367-02	4.387-05	648.4	.7882	3.270+02	2.288-03
	106	6.0601	4339.0	-237.7	2.273-02	4.387-05	644.2	.7882	3.110+02	2.266-03
	107	6.1464	4339.0	-233.3	2.182-02	4.387-05	639.0	.7882	2.955+02	2.213-03
	108	6.2327	4339.0	-229.0	2.093-02	4.386-05	635.5	.7882	2.807+02	2.179-03
	109	6.3189	4339.0	-224.7	2.011-02	4.386-05	631.3	.7882	2.669+02	2.158-03
	110	6.4052	4339.0	-218.8	1.933-02	4.386-05	625.4	.7882	2.549+02	2.118-03
	111	6.4915	4339.0	-212.9	1.862-02	4.386-05	619.6	.7882	2.418+02	2.074-03
	112	6.5778	4339.0	-207.1	1.795-02	4.385-05	613.9	.7882	2.215+02	2.021-03
	113	6.6640	4339.0	-202.4	1.659-02	4.385-05	609.5	.7882	2.037+02	1.979-03
	114	6.7503	4339.0	-198.2	1.569-02	4.385-05	605.2	.7882	1.929+02	1.945-03
	115	6.8366	4339.0	-193.8	1.505-02	4.385-05	600.9	.7882	1.825+02	1.912-03
	116	6.9229	4339.0	-189.3	1.443-02	4.384-05	596.6	.7882	1.725+02	1.877-03
	117	7.0091	4339.0	-184.8	1.393-02	4.384-05	592.4	.7882	1.631+02	1.842-03
	118	7.0954	4339.0	-180.4	1.346-02	4.384-05	588.2	.7882	1.539+02	1.797-03
	119	7.1817	4339.0	-177.4	1.290-02	4.384-05	585.3	.7882	1.479+02	1.763-03
	120	7.2679	4339.0	-174.4	1.234-02	4.383-05	582.5	.7882	1.373+02	1.729-03
	121	7.3542	4339.0	-171.4	1.219-02	4.383-05	579.7	.7882	1.309+02	1.727-03
	122	7.4405	4339.0	-166.9	1.168-02	4.383-05	575.4	.7882	1.249+02	1.727-03
	123	7.5268	4339.0	-162.3	1.120-02	4.383-05	571.3	.7882	1.192+02	1.727-03
	124	7.6130	4339.0	-157.0	1.073-02	4.382-05	567.1	.7882	1.137+02	1.727-03
	125	7.6993	4339.0	-153.5	1.028-02	4.382-05	562.9	.7882	1.085+02	1.728-03
	126	7.7856	4339.0	-148.7	9.844-03	4.382-05	558.7	.7882	1.033+02	1.721-03
	127	7.8719	4339.0	-144.2	9.443-03	4.382-05	554.6	.7882	1.000+02	1.713-03
	128	7.9581	4339.0	-141.1	9.176-03	4.381-05	551.9	.7882	9.693+01	1.713-03
	129	8.0444	4339.0	-138.1	8.916-03	4.381-05	549.2	.7882	9.391+01	1.714-03
	130	8.1307	4339.0	-135.0	8.664-03	4.381-05	546.5	.7882	9.095+01	1.712-03
	131	8.2170	4339.0	-132.0	8.419-03	4.381-05	543.8	.7882	8.809+01	1.711-03
	132	8.3032	4339.0	-128.9	8.181-03	4.381-05	541.1	.7882	8.530+01	1.718-03
	133	8.3895	4339.0	-125.9	7.949-03	4.381-05	538.4	.7882	8.259+01	1.718-03
	134	8.4758	4339.0	-122.0	7.724-03	4.381-05	535.7	.7882	7.997+01	1.718-03
	135	8.5621	4339.0	-119.8	7.505-03	4.380-05	533.0	.7882	7.742+01	1.709-03
	136	8.6483	4339.0	-116.7	7.292-03	4.380-05	530.4	.7882		

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

VISCOS FLOW - BOUNDARY LAYER SOLUTION

BODY PT NO	INTG PT NO	STREAM LENGTH INCH	MOMENTUM THICKNESS MIL	ENERGY THICKNESS MIL	SHAPE FACTOR	FORM THICK RE NO	ENERGY THICK RE NO	HEAT TRANS COEFFICIENT LBM/FT ² -SEC	REYNOLDS ANAL FAC	INTER- MITTENCY	HEAT TRANS AUGMENT
(J)	(I)	(S)	(TME)	(PHI)	(NSF)	(RETH)	(REPM)	(RUCH)	(RAF)	(ADML)	(HUFERT)
1	1	.000	.261	.638	1.654	0.000	0.000	7.348-01	.9777	.00	1.808
	2	.041	.261	.639	1.654	1.223-01	2.782-01	7.341-01	.9774	.00	1.808
	3	.091	.261	.640	1.654	2.448-01	5.576-01	7.322-01	.9765	.00	1.808
	4	.142	.310	.852	1.655	0.004-01	1.100-02	6.453-01	.7060	.00	1.808
	5	.192	.317	1.101	1.332	0.082-01	1.891-02	1.353-00	.8574	1.00	1.546
	6	.243	.691	1.387	1.173	1.479-02	2.949-02	1.330-00	.9291	1.00	1.542
2	7	.284	.788	1.591	1.095	2.020-02	4.078-02	1.354-00	.9736	1.00	1.559
	8	.329	1.142	1.876	1.038	2.630-02	5.083-02	1.241-00	1.0377	1.00	1.518
3	9	.401	1.271	2.180	1.003	3.163-02	6.806-02	1.209-00	1.0424	1.00	1.507
	10	.477	1.367	2.369	.979	3.653-02	7.886-02	1.194-00	1.0349	1.00	1.504
4	11	.503	1.448	2.603	.944	4.138-02	9.010-02	1.213-00	1.0174	1.00	1.511
	12	.563	1.491	3.003	.933	4.605-02	1.001-03	1.258-00	1.0014	1.00	1.518
5	13	.587	1.533	3.171	.924	5.069-02	1.184-03	1.286-00	.9868	1.00	1.529
	14	.627	1.554	3.308	.917	5.340-02	1.377-03	1.319-00	.9728	1.00	1.539
6	15	.682	1.588	3.429	.910	5.606-02	1.599-03	1.336-00	.9605	1.00	1.558
	16	.727	1.684	3.597	.894	6.496-02	1.827-03	1.364-00	.9649	1.00	1.556
7	17	.758	1.757	3.844	.891	6.955-02	2.137-03	1.321-00	.9795	1.00	1.549
	18	.802	1.795	4.026	.888	7.410-02	2.480-03	1.337-00	.9654	1.00	1.551
8	19	.850	1.825	4.193	.882	7.839-02	2.858-03	1.386-00	.9444	1.00	1.566
	20	.883	1.898	4.306	.872	8.290-02	3.281-03	1.409-00	.9475	1.00	1.573
9	21	.905	1.957	4.419	.869	8.684-02	3.744-03	1.399-00	.9613	1.00	1.568
	22	.963	2.009	4.539	.869	9.058-02	4.231-03	1.404-00	.9628	1.00	1.567
10	23	1.012	2.021	4.704	.865	9.542-02	4.722-03	1.410-00	.9634	1.00	1.567
	24	1.071	2.044	4.917	.861	1.008-03	5.230-03	1.423-00	.9585	1.00	1.569
11	25	1.126	2.047	5.129	.855	1.089-03	5.753-03	1.479-00	.9419	1.00	1.583
	26	1.180	2.242	5.272	.850	1.168-03	6.281-03	1.517-00	.9419	1.00	1.592
12	27	1.234	2.258	5.421	.848	1.221-03	6.811-03	1.523-00	.9505	1.00	1.590
	28	1.289	2.276	5.570	.845	1.276-03	7.341-03	1.544-00	.9452	1.00	1.592
13	29	1.346	2.301	5.722	.843	1.334-03	7.886-03	1.590-00	.9344	1.00	1.602
	30	1.398	2.332	5.871	.841	1.396-03	8.441-03	1.629-00	.9344	1.00	1.602
14	31	1.457	2.364	6.023	.839	1.459-03	9.003-03	1.666-00	.9253	1.00	1.617
	32	1.506	2.401	6.174	.837	1.526-03	9.578-03	1.701-00	.9220	1.00	1.623
15	33	1.552	2.440	6.330	.836	1.595-03	1.016-03	1.735-00	.9192	1.00	1.629
	34	1.603	2.475	6.483	.835	1.661-03	1.065-03	1.768-00	.9159	1.00	1.634
16	35	1.654	2.455	6.633	.835	1.720-03	1.116-03	1.798-00	.9099	1.00	1.638
	36	1.709	2.450	6.782	.835	1.783-03	1.168-03	1.832-00	.9086	1.00	1.644
17	37	1.761	2.505	6.933	.834	1.842-03	1.221-03	1.884-00	.9000	1.00	1.649
	38	1.812	2.559	7.083	.833	1.903-03	1.276-03	1.925-00	.9000	1.00	1.661
18	39	1.864	2.564	7.231	.833	1.966-03	1.333-03	1.969-00	.9042	1.00	1.662
	40	1.918	2.572	7.381	.834	2.022-03	1.391-03	2.009-00	.8951	1.00	1.671
19	41	1.964	2.584	7.531	.835	2.078-03	1.450-03	2.044-00	.8929	1.00	1.676
	42	2.014	2.603	7.680	.835	2.139-03	1.510-03	2.075-00	.8901	1.00	1.681
20	43	2.064	2.603	7.830	.835	2.200-03	1.570-03	2.104-00	.8888	1.00	1.684

MOMENTUM ENERGY INTEGRATION TECHNIQUE (MLIT)

BODY PT NO	INTEL PT NO	STREAM LENGTH INCH	MOMENTUM THICKNESS MIL	ENERGY THICKNESS MIL	SHAPE FACTOR	MON THICK RE NO	ENERGY THICK RE NO	HEAT TRANS COEFFICIENT LBH/FT ² -SEC	REYNOLDS ANAL FAC	INTER- MITTENCY	HEAT TRANS AUGMENT
(J)	(I)	(SI)	(THE)	(PHI)	(MSF)	(RETH)	(REPH)	(KUCH)	(RAAF)	(ADML)	(HJFSMT)
21	45	2.0173	2.629	7.995	.836	2.203+03	6.282+03	2.128+00	.8880	1.00	1.687
21	46	2.0882	2.653	7.635	.837	2.266+03	6.520+03	2.154+00	.8842	1.00	1.690
22	47	2.1190	2.643	7.748	.839	2.305+03	6.758+03	2.189+00	.8703	1.00	1.696
22	48	2.1697	2.644	7.869	.841	2.352+03	7.001+03	2.214+00	.8783	1.00	1.700
23	49	2.2202	2.688	8.021	.842	2.425+03	7.235+03	2.223+00	.8816	1.00	1.699
23	50	2.2706	2.734	8.176	.843	2.499+03	7.472+03	2.236+00	.8802	1.00	1.700
24	51	2.3376	2.751	8.356	.846	2.560+03	7.777+03	2.258+00	.8757	1.00	1.702
24	52	2.4046	2.774	8.547	.850	2.625+03	8.087+03	2.272+00	.8741	1.00	1.704
25	53	2.4716	2.809	8.748	.853	2.697+03	8.401+03	2.283+00	.8734	1.00	1.705
25	54	2.5217	2.840	8.905	.856	2.749+03	8.621+03	2.283+00	.8732	1.00	1.704
25	55	2.5718	2.873	9.067	.858	2.802+03	8.843+03	2.282+00	.8732	1.00	1.703
26	56	2.6219	2.911	9.235	.861	2.854+03	9.055+03	2.276+00	.8734	1.00	1.701
26	57	2.6719	2.937	9.408	.864	2.894+03	9.268+03	2.275+00	.8673	1.00	1.701
27	58	2.7219	2.904	9.590	.871	2.871+03	9.480+03	2.270+00	.8572	1.00	1.703
27	59	2.7719	2.897	9.779	.878	2.873+03	9.699+03	2.270+00	.8638	1.00	1.701
28	60	2.8219	3.019	9.956	.879	2.994+03	9.877+03	2.245+00	.8810	1.00	1.681
28	61	2.8719	3.141	10.133	.879	3.117+03	1.005+04	2.203+00	.8735	1.00	1.686
29	62	2.9219	3.178	10.332	.885	3.148+03	1.024+04	2.203+00	.8723	1.00	1.681
29	63	2.9720	3.203	10.538	.891	3.165+03	1.042+04	2.161+00	.8714	1.00	1.677
30	64	3.0221	3.233	10.756	.897	3.181+03	1.058+04	2.131+00	.8708	1.00	1.673
30	65	3.0722	3.267	10.980	.903	3.198+03	1.075+04	2.100+00	.8705	1.00	1.668
31	66	3.1214	3.307	11.214	.909	3.213+03	1.090+04	2.065+00	.8702	1.00	1.662
31	67	3.1725	3.349	11.455	.915	3.228+03	1.104+04	2.028+00	.8702	1.00	1.656
32	68	3.2229	3.396	11.710	.922	3.240+03	1.117+04	1.988+00	.8703	1.00	1.650
32	69	3.2732	3.445	11.971	.923	3.253+03	1.132+04	1.947+00	.8706	1.00	1.643
33	70	3.3237	3.499	12.244	.935	3.261+03	1.141+04	1.903+00	.8709	1.00	1.636
33	71	3.3741	3.553	12.523	.942	3.269+03	1.152+04	1.859+00	.8712	1.00	1.629
34	72	3.4249	3.611	12.813	.949	3.272+03	1.161+04	1.812+00	.8768	1.00	1.620
34	73	3.4756	3.670	13.109	.956	3.273+03	1.169+04	1.762+00	.8860	1.00	1.606
35	74	3.5265	3.731	13.410	.962	3.279+03	1.176+04	1.687+00	.8767	1.00	1.596
35	75	3.5774	3.790	13.716	.969	3.281+03	1.183+04	1.629+00	.8658	1.00	1.584
36	76	3.6285	3.850	14.015	.976	3.274+03	1.188+04	1.606+00	.8679	1.00	1.589
36	77	3.6793	3.914	14.322	.985	3.258+03	1.193+04	1.573+00	.8679	1.00	1.589
37	78	3.7311	3.983	14.635	.995	3.230+03	1.198+04	1.520+00	.8732	1.00	1.579
37	79	3.7826	4.048	15.118	1.004	3.217+03	1.201+04	1.472+00	.8726	1.00	1.570
38	80	3.8317	4.147	15.736	1.020	3.179+03	1.206+04	1.393+00	.8708	1.00	1.555
38	81	3.8807	4.244	16.385	1.035	3.155+03	1.210+04	1.318+00	.8701	1.00	1.540
39	82	3.9298	4.355	17.066	1.049	3.097+03	1.213+04	1.244+00	.8733	1.00	1.524
39	83	4.0760	4.511	17.720	1.062	3.091+03	1.214+04	1.176+00	.8805	1.00	1.507
40	84	4.1622	4.681	18.401	1.074	3.089+03	1.214+04	1.113+00	.8837	1.00	1.491
40	85	4.2484	4.851	19.112	1.086	3.081+03	1.214+04	1.053+00	.8869	1.00	1.475
40	86	4.3347	5.036	19.909	1.098	3.067+03	1.212+04	9.917+01	.8900	1.00	1.458
40	87	4.4211	5.217	20.729	1.111	3.048+03	1.211+04	9.339+01	.8925	1.00	1.441
40	88	4.5074	5.399	21.571	1.127	3.031+03	1.211+04	8.766+01	.8970	1.00	1.424
40	89	4.5936	5.581	22.342	1.141	3.024+03	1.211+04	8.320+01	.9021	1.00	1.409
40	90	4.6798	5.768	23.142	1.155	3.015+03	1.210+04	7.863+01	.9052	1.00	1.394
41	91	4.7660	5.955	23.974	1.166	3.002+03	1.209+04	7.467+01	.9084	1.00	1.379

MORENTUM ENERGY INTEGRATION TECHNIQUE (MEIT)

BODY PT NO	INTS PT NO	STREAM LENGTH INCH	MORENTUM THICKNESS MIL	ENERGY THICKNESS MIL	SHAPE FACTOR	MOE THICK RE NO	ENERGY THICK RE NO	HEAT TRANS COEFFICIENT LBH/FI2-SEC	REYNOLDS ANAL FAC	INTER- MITTENCY	HEAT TRANS AUGMENT
(J)	(I)	(S)	(THE)	(PHI)	(HSE)	(RETH)	(REPH)	(MUCH)	(RAI)	(ADML)	(RUFST)
92	92	9.828	6.153	24.005	1.182	2.985+03	1.207+04	7.053-01	.9116	1.00	1.363
93	93	9.935	6.351	25.832	1.195	2.963+03	1.203+04	6.660-01	.9144	1.00	1.348
94	94	9.024	6.557	26.820	1.208	2.940+03	1.203+04	6.282-01	.9194	1.00	1.332
95	95	9.111	6.745	27.630	1.219	2.926+03	1.199+04	5.982-01	.9250	1.00	1.318
96	96	9.197	6.945	28.450	1.228	2.911+03	1.194+04	5.700-01	.9264	1.00	1.305
97	97	9.283	7.139	29.352	1.238	2.894+03	1.190+04	5.428-01	.9319	1.00	1.292
98	98	9.369	7.338	30.263	1.249	2.876+03	1.186+04	5.164-01	.9355	1.00	1.278
99	99	9.452	7.536	31.193	1.262	2.857+03	1.183+04	4.912-01	.9387	1.00	1.265
100	100	9.542	7.732	32.168	1.275	2.839+03	1.180+04	4.671-01	.9421	1.00	1.252
101	101	9.628	7.938	33.212	1.288	2.813+03	1.179+04	4.433-01	.9453	1.00	1.238
102	102	9.719	8.144	34.416	1.302	2.788+03	1.178+04	4.206-01	.9485	1.00	1.224
103	103	9.801	8.358	35.601	1.315	2.764+03	1.177+04	3.985-01	.9545	1.00	1.210
104	104	9.887	8.532	36.460	1.325	2.748+03	1.174+04	3.823-01	.9608	1.00	1.198
105	105	9.973	8.714	37.533	1.335	2.732+03	1.171+04	3.672-01	.9644	1.00	1.187
106	106	10.061	8.895	38.250	1.343	2.715+03	1.167+04	3.528-01	.9681	1.00	1.177
107	107	10.144	9.080	39.200	1.355	2.697+03	1.164+04	3.384-01	.9719	1.00	1.166
108	108	10.237	9.264	40.170	1.365	2.678+03	1.161+04	3.247-01	.9756	1.00	1.155
109	109	10.319	9.439	41.166	1.376	2.656+03	1.158+04	3.118-01	.9763	1.00	1.144
110	110	10.402	9.681	42.703	1.390	2.625+03	1.158+04	2.948-01	.9781	1.00	1.130
111	111	10.493	9.915	43.948	1.405	2.591+03	1.157+04	2.784-01	.9820	1.00	1.115
112	112	10.578	10.158	45.948	1.419	2.559+03	1.157+04	2.624-01	.9893	1.00	1.099
113	113	10.660	10.346	47.164	1.430	2.533+03	1.153+04	2.508-01	.9966	1.00	1.087
114	114	10.750	10.545	48.417	1.441	2.509+03	1.152+04	2.400-01	1.0009	1.00	1.075
115	115	10.836	10.743	49.703	1.452	2.484+03	1.149+04	2.296-01	1.0053	1.00	1.063
116	116	10.929	10.944	51.050	1.464	2.460+03	1.147+04	2.193-01	1.0103	1.00	1.051
117	117	11.021	11.143	52.401	1.476	2.435+03	1.145+04	2.098-01	1.0151	1.00	1.048
118	118	11.114	11.351	53.803	1.488	2.411+03	1.143+04	2.003-01	1.0244	1.00	1.027
119	119	11.207	11.584	54.607	1.497	2.393+03	1.138+04	1.935-01	1.0331	1.00	1.018
120	120	11.267	11.828	55.450	1.505	2.377+03	1.133+04	1.881-01	1.0376	1.00	1.009
121	121	11.342	11.761	56.270	1.513	2.359+03	1.129+04	1.827-01	1.0379	1.00	1.002
122	122	11.405	11.986	57.445	1.525	2.335+03	1.127+04	1.763-01	1.0335	1.00	1.000
123	123	11.468	12.204	59.472	1.537	2.309+03	1.123+04	1.703-01	1.0306	1.00	1.000
124	124	11.510	12.426	61.152	1.549	2.283+03	1.124+04	1.645-01	1.0240	1.00	1.000
125	125	11.553	12.659	62.913	1.562	2.258+03	1.122+04	1.588-01	1.0253	1.00	1.000
126	126	11.596	12.897	64.734	1.574	2.232+03	1.120+04	1.533-01	1.0224	1.00	1.000
127	127	11.639	13.150	66.615	1.585	2.209+03	1.119+04	1.479-01	1.0234	1.00	1.000
128	128	11.681	13.482	67.726	1.593	2.191+03	1.115+04	1.443-01	1.0261	1.00	1.000
129	129	11.724	13.509	68.863	1.601	2.174+03	1.111+04	1.410-01	1.0249	1.00	1.000
130	130	11.767	13.656	70.000	1.609	2.158+03	1.107+04	1.378-01	1.0238	1.00	1.000
131	131	11.810	13.828	71.175	1.619	2.143+03	1.103+04	1.346-01	1.0228	1.00	1.000
132	132	11.853	14.004	72.366	1.628	2.128+03	1.100+04	1.315-01	1.0219	1.00	1.000
133	133	11.896	14.183	73.589	1.637	2.114+03	1.097+04	1.284-01	1.0203	1.00	1.000
134	134	11.939	14.367	74.848	1.647	2.099+03	1.093+04	1.254-01	1.0191	1.00	1.000
135	135	11.982	14.553	76.133	1.656	2.084+03	1.090+04	1.225-01	1.0177	1.00	1.000
136	136	12.025	14.740	77.446	1.666	2.070+03	1.087+04	1.196-01	1.0163	1.00	1.000

Section 6. Program Listing

A listing of the Fortran source deck is given in this section. The common block and block data are presented first, the driver routine which is the main program is given next, followed by all the subroutines in the program.

COMBLK

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      COMMON /PROC/
      COMMON /CONST/
      * ALMAX, ALMIN, DEXMIN, DLTRIN, DLTRAN, USHANG, HJUNCTN, HZEROT, IATH,
      * IBRUPT, ICARB, IFL609, IHMAX, IL, IFMAX, IPRFL6, IPRNT, IRON,
      * IRSTRY, ISHFL6, ISS, JL, LG, LL, MATN, NAM, NCL,
      * NOMEAL, NOSLO, NPRTBL, NREYCR, NSHTBL, NTFIX, NTINT, NTRUSR, OX,
      * OY, PR, RNI, RSIDE, SPHTC, STRD, THETA, TRNTIM, ZHAX,
      * ZSIDE1, ZSTAG1,
      * AGLAW(3), ALCL(50), ALT(60), AM(60), BGLAW(3), BLN(3),
      * BLS(3), BTH(3), BTS(3), CGRAW(3), CHOSTT(60), CMH(3),
      * CZI(50), DEL(19), DGLAW(3), DM1(50,25), DPI(50), EGLAW(3),
      * ENT(35,21), ET(35,21), FE(35,21), FLPT(21), FLTT(35,21),
      * GT(35,21), HFO(3), HT(35), JROUGH(3), KHI(5,5,3),
      * MERODE(3), NLO(5,5,3), NMAT(50,25), NMG(3), NPR(3),
      * PA(60), PSTT(60), PT(21), RECORD(36), REM(30),
      * RHO(3), RUFL(3), RUFMAX(3), RUF1(3), SGI(50), TA(60),
      * TBFP(1950), TCHEM(1950), YCP(30,3), TENT(35,21), TEP(30,3), TFO(3),
      * THZ(60,3), TIMT(60), TIMUSR(250), TKP(60,3), TLMC(1950), TNG(5,3),
      * TPR(5,3), TPSTR(60), TTP(60,3), TTS(1950), VEL(60), X(50),
      * XDIF(60), XINIT(50), XPHTBL(60), Y(25), YOIF(5), YINIT(50)

      COMMON /ENVR/
      * ALTINF, AMACH, A1, A2, CDRA6, DEN, DUOZ, EMW2, EMW2,
      * E2, GAM1, GAM2, METAUG, HT2, H1, H2, INOSE,
      * KSHOLD, LCT, LTT, NOSTRN, NPGENV, NT, NTS, PT2,
      * P1, P2, REYCR, RN, ROT2, RO1, RO2, SC, IC, STRAN,
      * TSTAGP, TT2, T1, T2, UR1, VIST2, VIS2, V1, V2,
      * ADML(150), ALTEND(250), BETA(150), BETP(150), BP(150), DRGED(250),
      * CSEE(150), DROS(150), ENTR(150), HCAR(150), HE(150), HR(150),
      * HSF(150), HW(150), IPT(150), MATL(150), PE(150), PEPI(150),
      * PHI(150), R(150), RAF(150), REPH(150), RETH(150), ROE(150),
      * ROUE(150), ROW(150), RUCH(150), RUF(150), RUFMT(150), S(150),
      * SOR(150), SRB(150), TE(150), THE(150), THETB(150), TIMEND(250),
      * TP(150), TUE(150), TW(150), UE(150), URE(150), VISE(150),
      * VISW(150), XSHC(150), YBAR(150), YSHC(150), Z(150), ZSIDED(250),
      * ZSPEND(250)

      COMMON /RECS/
      * CZ, OPART1, OTH, IUSER, MT, MTNU, NPG, NS, S6,
      * TIMENU, TIMEP, TS, VR,
      * BLEN(60,2), BPSP(60), CMGX(60), CMFX(60), DELKE(60), DFIF(60),
      * OPART(60), EFFK(60), EMOOT(60), FI(60), FVM(60), GKR(60),
      * HRSP(60), INI(38), ILO(38), IMAT(60,18), IR(38), NB(60,3),
      * PRSP(60), RI(60,2), RSP(60), RSPNU(60), RUCHSP(60), SDOT(60),
      * SDOTE(60), SP(60), SRAY(60), TANFI(60), THETSP(60), TSP(60),
      * VIMP(60), ZI(60,2), ZSP(60), ZSPNU(60)

      COMMON /COND/
      * ANGLE, DLTC, DLT, DLTS, FIKLM, KEND, KL, KLF, KMAX,
      * KSTART, NOUT, QOOTRM, QOOTMO, STRM, TERMA, TERMB, TERMC,
      * DELTAA(60), DOR(60), NREG(80,25), QW(60), T(50,25), TIW1(60),
      * TT(60,18), X8(60,15), Y8(60,15)

      END
      COMMON /CONUNT/ PROC
      COMMON /UNITS/
      * ATM, BTU, BTUCAL, CMFT, DEGFR, DEGRK, DENH2O, EINRIC, ELBFT3,
      * EMETER, ERICR, ENHFT, FT, FTHIL, FT2, GC, PI, P102,
      * RAD, RU, SIG, STOTEN

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86

00111	110	C	•	FT-LBF/BTU
00111	120	C	•	•
00111	130	C	•	MIL/FT
00111	140	C	•	ENEYER / 3.280039
00111	150	C	•	FT/METER
00111	160	C	•	STOYER / 930.
00111	170	C	•	STANDARD TEMPERATURE
00111	180	C	•	DEG R = DEG F + DEG R
00111	190	C	•	DEG R = DEG F + DEG R
00111	200	C	•	RU / .73033
00111	210	C	•	UNIVERSAL GAS CONSTANT,
00111	220	C	•	(LBM/HOLE)/(LBM/FT ³)-(DEG R)
00111	230	C	•	816 / 4.75502E-13
00111	240	C	•	STEFAN-BOLTZMANN CONSTANT,
00111	250	C	•	BTU/FT ² -DEG R ⁴ -SEC
00111	260	C	•	DATA ELDT3 / 62.4280E-6
00111	270	C	•	(LBM/FT ³)/(LBM/R ³)
00111	280	C	•	BTUCAL / 251.996
00111	290	C	•	CAL/BTU
00111	300	C	•	DEH20 / 62.4280
00111	310	C	•	DENSITY OF WATER
00111	320	C	•	DEGRK / 1.8
00111	330	C	•	DEG R/DEG K
00111	340	C	•	ENHFT / 3.280039E-3
00111	350	C	•	FT/MM
00111	360	C	•	EMICMM / .001
00111	370	C	•	MM/MICRON
00111	380	C	•	EINPIC / 39.3701E-6
00111	390	C	•	INCH/MICRON
00111	400	C	•	CMFT / .03280839
00111	410	C	•	FT/CM
00111	420	C	•	END

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00101 10
00107 20
00110 30
00111 40
00112 50
00113 60
00114 70
00119 80
00124 90
00125 95
00127 100
00131 110
00132 120
00137 130
00137 140
00140 150
00144 160
00144 170
00145 180
00147 190
00152 200
00161 210
00161 220
00174 230
00176 240
00201 250
00202 260
00203 270
00205 280
00206 290
00207 300
00210 310
00213 320
00215 330
00217 340
00221 350
00224 360
00226 370
00227 380
00241 390
00242 400
00250 410
00254 420
00258 430
00263 440
00264 450
00265 460
00267 470
00271 480
00271 490
00273 500
00276 510
00277 520
00282 530
00303 540
00305 550
00307 560
00307 570

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DRIVEN

```

INCLUDE COMON
COMMON/RUFF/ROUGH,RUF2(150)
COMMON/TABLE/LTB
DIMENSION STOR(35,21)
CZ=0.
OPART1=0.
READ(5,99) NSM,IKROUGH,CMH(1),GAM2,S(1),RM
FORMAT(211,F8.3,F10.5)
IF(CMH(1)-LT-.00001) CMH(1)=1.
IF(GAM2-LT-.00001) GAM2=1.2
CALL LCOUNT(-94)
WRITE(6,101) NSM,CMH(1),GAM2
FORMAT(///,T10,22NUMBER OF MATERIALS = ,I3,T10,8CMH/CM = ,F10.5,
* /T10,22MISCENTROPIC EXPONENT = ,F10.5)
IF(ABS(RM)-GT-.00001) WRITE(6,101)RM
FORMAT(110,76THE INITIAL SOLUTION IS THE STAGNATION SOLUTION OF A
* SPHERE WITH A RADIUS OF ,F8.3,6INCHES)
IF(ABS(RM)-LT-.00001) RM=1.0
DO 102 I=1,NSM
IF(ROUGH.EQ.1) READ(5,170) B7S(I),B7H(I),BLS(I),BLH(I)
IF(ROUGH.EQ.0) READ(5,103) B7S(I),B7H(I),BLS(I),BLH(I),RUF1(I),
* RUF2(I),RUF1(I)
IF(ROUGH.EQ.1) GO TO 600
DO 601 I=1,NSM
RUF1(I)=RUF1(I)/12000.
RUF2(I)=RUF2(I)/12000.
RUF1(I)=RUF1(I)/12000.
CONTINUE
FORMAT(4F10.5)
FORMAT(7F10.5)
DO 104 I=1,NSM
IF(ABS(B7S(I))-LT-.00001) B7S(I)=0.35
IF(ABS(B7H(I))-LT-.00001) B7H(I)=.35
IF(ABS(BLS(I))-LT-.00001) BLS(I)=0.5
IF(ABS(BLH(I))-LT-.00001) BLH(I)=0.5
WRITE(6,106)
FORMAT(///,T10,4WHATL,727,3B7S,744,3B7H,759,3BLS,775,3BLH/)
WRITE(6,105) (I,B7S(I),B7H(I),BLS(I),BLH(I),I=1,NSM)
FORMAT(111,12,728,F10.5,T59,F10.5,T59,F10.5,T71,F10.5)
READ(5,120) NS,IBRUPT,NREYCR,IPANT,DLTRAN,ICARD,JROUGH(1)
FORMAT(4I2,F10.5,2I2)
WRITE(6,50) NS,IBRUPT,NREYCR,IPANT,DLTRAN
FORMAT(///,T10,5NHS = ,I2/T10,9HIBRUPT = ,I2/T10,9HNREYCR = ,I2/
* T10,9HIPRANT = ,I2/T10,9HOLTRAN = ,F10.5,8H INCHES/)
DLTRAN=DLTRAN/12.
IF(ABS(JROUGH(1))-NE.1) GO TO 131
WRITE(6,1130)
FORMAT(///,T10,93HTRANSITION PROXIMITY AUGMENTATION TO LAMINAR HEATI
* NG )
CONTINUE
IF(IBRUPT.EQ.0) WRITE(6,1120)
FORMAT(///,T10,20HTRANSITIONAL HEATING)
IF(IBRUPT.EQ.1) WRITE(6,2120)
FORMAT(///,T10,17HABRUPT TRANSITION)
IF(ABS(NREYCR).EQ.0) NREYCR=7
IF(ABS(NREYCR).EQ.2) GO TO 122
IF(ABS(NREYCR).EQ.3) GO TO 122

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000301
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000301
000307
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000317
000317
000324
000327

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00101 10
00102 20
00103 30
00104 40
00105 50
00106 60
00107 70
00108 80
00109 90
00110 100
00111 110
00112 120
00113 130
00114 140
00115 150
00116 160
00117 170
00118 180
00119 190
00120 200
00121 210
00122 220
00123 230
00124 240
00125 250
00126 260
00127 270
00128 280
00129 290
00130 300
00131 310
00132 320
00133 330
00134 340
00135 350
00136 360
00137 370
00138 380
00139 390
00140 400
00141 410
00142 420
00143 430
00144 440
00145 450
00146 460
00147 470
00148 480
00149 490
00150 500
00151 510
00152 520
00153 530
00154 540
00155 550
00156 560
00157 570
00158 580
00159 590
00160 600
00161 610
00162 620

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SUBROUTINE ESTATE(IND,P,M,E,TEMP,EM,S,RO,A)

THIS ROUTINE LOOKS UP THE PROPERTIES OF THE GAS USING THE TABLES

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000 INPUT ***
INDU = FLAG FOR SECOND INDEPENDENT VARIABLE
1 FOR ENTHALPY INPUT
3 FOR TEMPERATURE INPUT
P = PRESSURE, ATM

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000 OUTPUT ***
H = ENTHALPY, BTU/LBM
E = VISCOSITY, LBM/FT-SEC
Y = TEMPERATURE, DEG R
EM = MOLECULAR WT., LBM/MOLE
S = PRANDTL NUMBER
RO = DENSITY, LBM/FT3
A = SPEED OF SOUND, FT/SEC

```

```

INCLUDE CORON
INCLUDE CONUNT
COMMON/TABLE/LTS
PLINE(X,XL,XU,YL,YU) = (X-XL)/(XU-XL)*(YU-YL)+YL

```

FIND PRESSURE INDEX

```

PLP = ALOG(P)
18TRT=2
DO 10 IP=18TRT,IPMAX
IF (PLPT(IP),GT,PLP) GO TO 20
10 CONTINUE
IP = IPMAX
20 IP1 = IP-1
DO FLIP

```

```

IF (LTS,NE,1) GO TO 40
IF (IND,EG,1) INDU=3
IF (IND,EG,3) INDU=1
IF (IND,EG,1) TEMPM=
IF (IND,EG,3) HSTEMP
GO TO 30

```

```

09 INDU=IND
30 GO TO (100,200,300), INDU
200 CONTINUE
WRITE(19,1971)
1971 FORMATT STOPPED IN ESTATE, IND CANNOT EQUAL 2.1
STOP

```

```

C FIND INITIAL GUESS FOR ENTHALPY CORRESPONDING TO INPUT TEMPERATURE
C
330 CONTINUE
YU1VN = TEMP
MCOUNT = 1
DO 310 IT=18TRT,1PMAX
IF (TEMP(IT,IP1),GT,TEMP) GO TO 320
310 CONTINUE

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00163 630
00164 640
00165 650
00166 660
00171 670
00173 680
00175 690
00176 700
00177 710
00200 720
00200 730
00200 740
00200 750
00201 760
00202 770
00205 780
00207 790
00211 800
00212 810
00213 820
00213 830
00213 840
00213 850
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      IT = IMAX
      320 IT1 = IT-1
      ML = FLINE(TEMP,TENT(IT1,IP1),TENT(IT,IP1),MT(IT1),MT(IT))
      DO 330 IT=ISTRT,IMMAX
      IF (TENT(IT,IP1),GT,TEMP) GO TO 340
      330 CONTINUE
      340 IT1 = IT-1
      IM = IMAX
      MU = FLINE(TEMP,TENT(IT1,IP1),TENT(IT,IP1),MT(IT1),MT(IT))
      M = FLINE(FLP,FLPT(IP1),FLPT(IP),ML,MU)
      C *** START OF ITERATION LOOP ON ENTHALPY
      C
      C
      100 CONTINUE
      120 DO 130 IM=ISTRT,IMMAX
      IF (MT(IM),GT,M) GO TO 140
      130 CONTINUE
      IM = IMAX
      140 IM1 = IM-1
      GO TO (150,150,180), INDU
      C
      C
      C LOOK UP VISCOSITY FROM ENTHALPY AND PRESSURE
      C
      C
      150 CONTINUE
      160 EL = FLINE(IM,MT(IM1),MT(IM),ET(IM,IP1),ET(IM,IP1))
      EU = FLINE(IM,MT(IM1),MT(IM),ET(IM,IP),ET(IM,IP))
      170 E = FLINE(FLP,FLPT(IP1),FLPT(IP),EL,EU)
      C
      C
      C LOOK UP TEMPERATURE FROM ENTHALPY AND PRESSURE
      C
      C
      180 TL = FLINE(IM,MT(IM1),MT(IM),TENT(IM1,IP1),TENT(IM,IP1))
      TU = FLINE(IM,MT(IM1),MT(IM),TENT(IM1,IP),TENT(IM,IP))
      TEMP = FLINE(FLP,FLPT(IP1),FLPT(IP),TL,TU)
      GO TO (150,150,420), INDU
      420 YIND = TEMP
      430 IF(YGIVN,EG,0.) GO TO 440
      IF(ABS(YIND-YGIVN)/YGIVN,LT,.00010) GO TO 500
      GO TO 450
      440 IF(ABS(YIND-YGIVN),LT,.00100) GO TO 500
      450 CALL XSOLVEIM,YIND,YGIVN,COUNT,XLO,YLO,XHI,YHI
      GO TO 100
      C
      C *** END OF ITERATION LOOP ON ENTHALPY
      C
      C
      500 CONTINUE
      GO TO (150,200,520), INDU
      520 EL = FLINE(IM,MT(IM1),MT(IM),ET(IM,IP1),ET(IM,IP1))
      EU = FLINE(IM,MT(IM1),MT(IM),ET(IM,IP),ET(IM,IP))
      530 E = FLINE(FLP,FLPT(IP1),FLPT(IP),EL,EU)
      TEMP = YGIVN
      550 CONTINUE
      C
      C
      C LOOK UP MOLECULAR WT. AND GAMMA FROM ENTHALPY AND PRESSURE
      C
      C
      C AND CALCULATE DENSITY AND SPEED OF SOUND
      C
      C
      EML = FLINE(IM,MT(IM1),MT(IM),EMT(IM1,IP1),EMT(IM,IP1))
      EMU = FLINE(IM,MT(IM1),MT(IM),EMT(IM1,IP),EMT(IM,IP))

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CM = FLIN(FLP,FLPT(IP1),FLPT(IP1),EVL,EMU)
CL = FLIN(M,MT(IM1),MT(IM1),GT(IM1,IP1),GT(IM,IP1))
CU = FLIN(M,MT(IM1),MT(IM1),GT(IM1,IP1),GT(IM,IP1))
G = FLIN(FLP,FLPT(IP1),FLPT(IP1),6L,6U)
IF(L78-NE,1) GO TO 510
YSTORETEMP
TEMPH
H=STORE
CONTINUE
NO = P/(TEMP*RU/EM)
A=SQRT(GAR2*P/NO*5C*ATN*F12)
RETURN
END

510

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00111 110
00112 120
00113 130
00114 140
00115 150
00116 160
00117 170
00120 180
00121 190
00122 200

SUBROUTINE MSHAPE(I,ILT,SHPFAC)
C-----
C
C THIS ROUTINE COMPUTES THE LAMINAR AND TURBULENT SHAPE FACTORS
C-----
C
C
C INCLUDE COMMON
C 80 TO (10,20), ILT
10 CONTINUE
SHPFAC=5.029*TM(I)/TE(I)-0.64
60 TO 30
20 CONTINUE
ALRTH=ALOG(RETH(I))
EN=10.37*ALRTH/(12.79-0.19*ALRTH)
SHPFAC=2.285*(1.+3.2*EXP(-EN))*TM(I)/TE(I)-0.96
30 CONTINUE
RETURN
END

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00101 SUBROUTINE NEST
00102 INCLUDE COMMON
00103 INCLUDE COMMON
00104 COMMON/RUFF/ROUGH,RUF2(150)
00105 COMMON/PRCAL/PRL,PAT
00106 DIMENSION OPF(150),OTF(150),EMW(50),ZETA(150),CI(150),DPOS(150),
00107 *STORE(25),UEIP(150)
00108 C-----
00109 C *** ASSIGN INITIAL OR KNOWN VALUES
00110 CALL ESTATE(1,PE(1),HE(1),VISE(1),TE(1),EMW(1),PRE,ROE(1),AE)
00111 CALL ESTATE(3,PE(1),HW(1),VISV(1),TSP(1),EMW,PRW,ROW(1),AW)
00112 MPR=.42*HE(1)+.58*HW(1)+.19*(PRW+.5)*UE(1)+.2/6C/8TU/2.
00113 CALL ESTATE(1,PE(1),HPR,VISPR,TR,EMPR,PR,HOPR,APR)
00114 RECOV=SOR(PR)
00115 DO 3 I=1,NTY
00116   SOR(I)=S(I)/RN
00117   ZETA(I)=0.25*(SOR(I)+2)-0.25*SOR(I)*SIN(2.0*SOR(I))-
00118     * 0.125*COS(2.0*SOR(I))
00119   RUCH(I)=0.0
00120   TUE(I)=0.0
00121   AQML(I)=0.0
00122   3 CONTINUE
00123   RAF(1)=RECOV
00124   HR(1)=MT2
00125   HCAR(1)=0.0
00126   URE(1)=0.0
00127   YBAR(1)=0.0
00128   RETH(1)=0.0
00129   REPH(1)=0.0
00130   CSEE(1)=0.0
00131   BETP(1)=0.5
00132   BETP(2)=0.5
00133   CI(1)=0.0
00134   STIRAG=1.
00135   UE(1)=0.0
00136   TUT=0.0
00137   MSFT=0.0
00138   ACT=0.0
00139   ASRL=1.
00140   ASRT=1.
00141   RATIO=0.
00142   NOSTRAN=0
00143   STRAN=1.E10
00144   *****
00145   IF(ROUGH.EQ.1) RUF(1)=RUF2(1)
00146   IF(ROUGH.EQ.0) CALL RUFNEST(1,RUF(1))
00147   *****
00148 C
00149 C

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00202 000263
00203 000301
00205 000314
00206 000327
00207 000337
00211 000337
00213 000342
00214 000350
00215 000350
00220 000351
00221 000351
00222 000357
00223 000361
00224 000362
00226 000365
00230 000372
00231 000375
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00240 000435
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00255 000503
00256 000530
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C *** FILL IN INTEGRATION POINT VARIABLES DEFINED AT BODY POINTS
IF(UE(1),LY,000000) UE(1)=0
9999 PE(1)=ALOS(PE(1))
DO 7 I=1,NT
CALL TBLP(S(I),SP,TW(I),TSP,NS)
CALL TBLP(S(I),SP,WP(I),WPSP,NS)
CALL TBLP(S(I),SP,HV(I),HE,NS)
IF(THROUGH.EQ.1) CALL TBLP(S(I),SP, KUF(I),KUF2,NS)
CALL TBLP(S(I),SP,UEIP(I),UE,NS)
CALL TBLP(S(I),SP,PEPI(I),PE,NS)
IF(EP(1),LY,000000) EP(1)=0.000001
7 CONTINUE
NSH1=NS-1
I=0
DO 995 IXX=1,NT
HE(1)=HW(1)
PEPI(1)=EXP(PEPI(1))
UE(1)=UEIP(1)
PE(1)=PEPI(1)
995 PEPI(1)=PEPI(1)/PE(1)
IF(UE(1),LC,1.0) UE(1)=0.
NTW1=NT-1
DO 27 I=2,NTW1
27 CALL @ORTC(2,S(I-1),S(I),S(I+1),S(I),PE(I-1),PE(I),PE(I+1),OPDS(I))
OPDS(1)=0
OPDS(NT)=OPDS(NT-1)
I=2
IF (IOEBUG.EQ.1)
WRITE(6,1001) I,PEPI(1),UE(1)
1001 FORMAT(15X,I6H1,PEPI(1),UE(1)/10X,I5.2E15.6)
ALFA=(1.0-PEPI(1))/(SOR(1)+2)
OUDZ=(UE(2)-UE(1))/(S(2)-S(1))
C *** COMPUTE WALL PROPERTIES
DO 45 I=1,NT
CALL ESTATE(3,PE(I),HW(I),VISH(I),TW(I),EMW,PRW,ROW(I),AW)
45 CONTINUE
C *** BEGINNING OF LOOP TO CALCULATE
C *** LAMINAR AUG. DUE TO TRANSITION PROXIMITY, RSRL
C *** KLIT=0
C ****

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00316 1460
00317 1470

S4 CONTINUE
C KLIT=KLIT+1
C MAT = MATL(1)
C IF (IOEUC.EQ.1)
C WRITE(6,1006) KLIT,STRAN,THE(1),RSRL
C 1006 FORMAT(10D,22HKLIT,STRAN,THE(1),RSRL /1X,13.3X,1P3E13.6)
C IF (NOSTRAN.EQ.1.AND..XROUGH(1).GT.0.AND.KLIT.GT.1)
C S CALL LAMRUS(1,RSRL)
C ASRLAMASRL=0
C DUOS=DUOZ
C LIT=1
C *** ITERATE S.P. SOLUTIONS
C DO 60 ITER=1,3
C CALL SRI(1,C1,C2)
C CALL MSHAPE(1,1,MSF(1))
C THE(1)=SORT(C1*(1.0+KAF(1)*BP(1)*CMH(1))*VISE(1)/
C (ROE(1)*(1.0+MSF(1))*DUOS))
C PHI(1)=SORT(C2*(1.0+BP(1)*CMH(1))*VISE(1)/(2.0*ROE(1)*DUOS))
C RAF(1)=C2*THE(1)/(C1*PHI(1))
C 60 CONTINUE
C THE(1)=THE(1)*RSRL
C PHI(1)=PHI(1)*RSRL
C C1=C1*RSRLA
C C2=C2*RSRLA
C RUCH(1)=C2*VISE(1)/PHI(1)
C TUE(1)=0.0
C RUFST(1)=RSRL
C IF (KLIT.EQ.1) RUCHN=RUCH(1)
C METAUS=RUCH(1)/RUCHN
C DTF(1)=0.0
C OPF(1)=0.0
C *** SERIES SOLUTION FOR I=2,3
C GAM2 = (GAM2-1.)/GAM2
C A=(0.3333+(13.0*MSF(1))*ALFA/(4.0*GAM2))-
C S (MSF(1)+0.614)*ALFA*GAM2-0.659*ALFA*GAM2*(3.0+MSF(1))/
C S (8.0+2.0*MSF(1))
C B=(0.3333+3.0*ALFA/GAM2-
C S 1.318*ALFA*GAM2-2.0*ALFA*GAM2*(1.0-RECOV))/(1.0*BP(1)*CMH(1))/
C S (1.0-TW(1)/TE(1))/6.
C DO 63 I=2,3
C IF (XROUGH.EQ.1) GO TO 2001
C CALL RUFNES(I,RUF(I))
C 2001 CONTINUE
C THE(1)=THE(1)*(1.0+AS(SOR(I)*2))
C PHI(1)=PHI(1)*(1.0+BS(SOR(I)*2))
C UE(1)=DUOZ*S(1)*(1.0+ALFA*(SOR(I)*2)/(4.0*GAM2))
C ROE(1)=ROE(1)*(1.0+ALFA*(SOR(I)*2)/GAM2)
C MAT1 = MAT
C MAT = MATL(1)

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00334 2630 IF (THE(11).LE.0.) THE(11) = THEN
00336 2630 IF (ITER.LE.2) GO TO 80
00340 2630 IF (ABS(RESIP-RESIPE).LT.1.E-10) GO TO 80
00342 2630 PHI(11) = PHIN - (PHIN - PHIO)*RESIP/(RESIP - RESIPE)
00344 2630 RAT = PHI(11)/PHIN
00346 2630 IF (RAT .GT. 2 .OR. RAT .LT. .5) PHI(11) = PHIN - RESIP
00348 2630 80 CONTINUE
00350 2630 IF (PHI(11).LE.0.) PHI(11) = PHIN
00352 2630 REPH(11) = URE(11)*THE(11)
00354 2630 REPH(11) = URE(11)*PHI(11)
00356 2630 C *** COMPUTE LAMINAR INPUTS TO MEIT
00358 2630 IF (IDEBUG.NE.0)
00360 2630 WRITE(6,999) I,ITER,LYT,DUOS,DUOZ,UE(11),CI(11),CSEE(11),BETPI(11),
00362 2630 THE(11),PE(11),THE(11),PHI(11)
00364 2630 999 FORMAT(1H0,62HPRGM MEIT I,ITER,LYT,DUOS,DUOZ,UE,CI,CSEE,BETP,NE,
00366 2630 SPE,THE,PHI /1X,315,1X,8(E15.6))
00368 2630 IF (LYT.EQ.3) GO TO 100
00370 2630 C *****
00372 2630 CALL SR1(11,C1,C2)
00374 2630 C *****
00376 2630 TUL=C1*VISE(11)/THE(11)
00378 2630 RCL=C2*VISE(11)/PHI(11)
00380 2630 IF (S(11).GE.STRAM) GO TO 90
00382 2630 TUL=TUL*SRSLA
00384 2630 RCL=RCL*SRSLA
00386 2630 90 CONTINUE
00388 2630 IF (IDEBUG.NE.0)
00390 2630 WRITE(6,998) I,LYT,TUL,C1,C2,BETP(11),BP(11)
00392 2630 998 FORMAT(15X,29H1,LYT,TUL,C1,C2,BETP(11),BP(11)/10X,213,1P5E15.6)
00394 2630 C *****
00396 2630 CALL HSHAPE(11,1,MSFL)
00398 2630 C *****
00400 2630 IF (LYT.EQ.1) GO TO 120
00402 2630 C *** COMPUTE TURBULENT INPUTS TO MEIT
00404 2630 C *****
00406 2630 100 CALL SR2 (1, CFO2, CH, RSRTH, RSRTH)
00408 2630 TUT=ROE(11)*UE(11)*CFO2
00410 2630 TUT = RSRTH*TUTS
00412 2630 IF (LYT.LT.3.AND.TUT.LT.TUL) TUT=TUL
00414 2630 C *****
00416 2630 RCT=ROE(11)*UE(11)*CH
00418 2630 RCT = RSRTH*ACTS
00420 2630 IF (LYT.LT.3.AND.RCT.LT.RCL) RCT=RCL
00422 2630 RSRTRCT/RCT8
00424 2630 C *****
00426 2630 CALL HSHAPE(11,2,MSFT)
00428 2630 C *****
00430 2630 IF (LYT.EQ.3) ADML(1)=1.0
00432 2630 IF (LYT.EQ.2) GO TO 110
00434 2630 50 TO 120
00436 2630 C *** COMPUTE INTERMITTENCY, PERSCH
00438 2630 110 TUE(11)=TUT-ROE(11)*UE(11)*TAMP/RET(11)*PERSH
00440 2630 IF (IDEBUG.NE.0)
00442 2630 WRITE(6,1005) TUE(11),TUL,TUT,TUTS,RSRTH,RCL,RCT,ACTS,RSRTH,CFO2,CH
00444 2630 1005 FORMAT(1H0,49HTUE,TUL,TUT,TUTS,RSRTH,RCL,RCT,ACTS,RSRTH,CFO2,CH
00446 2630 , /E15.6))
00448 2630 C *****
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00664 3190 IF (ABS(TUT-TUL),LT,1.E-7) GO TO 119
00666 3200 ADML(I)=TUE(I)-TUL/(TUT-TUL)
00667 3210 IF (ADML(I),LT,0.) ADML(I)=1.
00671 3220 IF (ADML(I),GT,0.999) LTT=5
00673 3230 GO TO 120
00674 3240 LTT=0
00675 3250 ADML(I)=0.
00676 3260 INXT = I
00677 3270 C *** COMPUTE TRANSITIONAL MIX
00700 3280 120 CONTINUE
00701 3290 PR=PR+ADML(I)*(PRT-PR)
00702 3300 RECOV=SORT(PRL)+ADML(I)*(PRT-PR)
00703 3310 TUE(I)=TUL+ADML(I)*(TUT-TUL)
00704 3320 RUCH(I)=RCL+ADML(I)*(RCT-RCL)
00705 3330 RAF(I)=RUCH(I)/TUE(I)
00706 3340 IF (IDEBUG,NE,0)
00707 3350 SWRITE(6,1000) ADML(I),PR,MI(I),ROE(I),UE(I),THE(I),ROI,
00708 3360 * V1,TW(I),TE(I),MCAM(I),GAZ,MSFT,TUL,TUE(I),TUT,TRNP,RETH(I)
00709 3370 * ,RSRTH,RCL,RCT,ACTS,RSRTH,CF02,CH
00710 3380 FORMAT(1H0,100H ADML(I),PR,MI(I),ROE(I),UE(I),THE(I),ROI,
00711 3390 * V1,TW(I),TE(I),MCAM(I),GAZ,MSFT,TUL,TUE,TUT,TRNP,RETH(I) /
00712 3400 * 2X,32HRSRTH,RCL,RCT,ACTS,RSRTH,CF02,CH/
00713 3410 * 8(1X,E15.6))
00714 3420 RUFST(I)=RSRL+ADML(I)*(RSRT-RSRL)
00715 3430 MSF(I)=MSFL+ADML(I)*(MSFT-MSFL)
00716 3440 MR(I)=ME(I)+RECOV *UE(I)*2/2./BTU/GC
00717 3450 IF (IDEBUG,NE,0)
00718 3460 *WRITE (6,173) I,ITER,ADML(I),TUE(I),RUCH(I),ROE(I),UE(I),
00719 3470 * ,TE(I),THE(I),VISE(I),ENTR(I),DTF(I),DPF(I),THE(I),PHI(I),
00720 3480 * VISE(I),ENTR(I),DTF(I),DPF(I),THE(I),PHI(I),VISE(I),THE(I),VISE(I),
00721 3490 * 1PTE13.6)
00722 3500 C *** INTEGRAL MOMENTUM AND ENERGY LONS
00723 3510 HT2=ME(I)+UE(I)*2/2./GC/RTU
00724 3520 DTF(I)=R(I)+UE(I)+TUE(I)-1.+RAF(I)*BP(I)*CMH(I)
00725 3530 DPF(I)=R(I)+RUCH(I)*MR(I)+HT2-MU(I)*BP(I)*CMH(I)
00726 3540 C
00727 3550 IF (ITER,EQ,1) GO TO 161
00728 3560 C
00729 3570 RAIT=ABS((TUE(I)-TUEOLD)/TUE(I))
00730 3580 RATR=ABS((RUCH(I)-RUCHO)/RUCH(I))
00731 3590 IF (RATR,LT,.001,AND,RATR,LT,.001) GO TO 162
00732 3600 GO TO 160
00733 3610 161 CONTINUE
00734 3620 LTTSTR = LTT
00735 3630 STORE(1) = ME(I)
00736 3640 STORE(2) = ENTR(I)
00737 3650 STORE(3) = TE(I)
00738 3660 STORE(4) = VISE(I)
00739 3670 STORE(5) = ROE(I)
00740 3680 STORE(6) = UE(I)
00741 3690 STORE(7) = MCAM(I)
00742 3700 STORE(8) = URE(I)
00743 3710 STORE(9) = BETP(I)
00744 3720 STORE(10) = THE(I)
00745 3730 STORE(11) = PHI(I)
00746 3740 STORE(12) = RETH(I)
00747 3750 STORE(13) = RETH(I)
002435 002435 IF (ABS(TUT-TUL),LT,1.E-7) GO TO 119
002443 002443 ADML(I)=TUE(I)-TUL/(TUT-TUL)
002452 002452 IF (ADML(I),LT,0.) ADML(I)=1.
002460 002460 IF (ADML(I),GT,0.999) LTT=5
002467 002467 GO TO 120
002471 002471 LTT=0
002472 002472 ADML(I)=0.
002473 002473 INXT = I
002474 002474 C *** COMPUTE TRANSITIONAL MIX
002475 002475 120 CONTINUE
002476 002476 PR=PR+ADML(I)*(PRT-PR)
002502 002502 RECOV=SORT(PRL)+ADML(I)*(PRT-PR)
002507 002507 TUE(I)=TUL+ADML(I)*(TUT-TUL)
002520 002520 RUCH(I)=RCL+ADML(I)*(RCT-RCL)
002525 002525 RAF(I)=RUCH(I)/TUE(I)
002532 002532 IF (IDEBUG,NE,0)
002536 002536 SWRITE(6,1000) ADML(I),PR,MI(I),ROE(I),UE(I),THE(I),ROI,
002536 002536 * V1,TW(I),TE(I),MCAM(I),GAZ,MSFT,TUL,TUE(I),TUT,TRNP,RETH(I)
002536 002536 * ,RSRTH,RCL,RCT,ACTS,RSRTH,CF02,CH
002536 002536 FORMAT(1H0,100H ADML(I),PR,MI(I),ROE(I),UE(I),THE(I),ROI,
002603 002603 * V1,TW(I),TE(I),MCAM(I),GAZ,MSFT,TUL,TUE,TUT,TRNP,RETH(I) /
002608 002608 * 2X,32HRSRTH,RCL,RCT,ACTS,RSRTH,CF02,CH/
002608 002608 * 8(1X,E15.6))
002608 002608 RUFST(I)=RSRL+ADML(I)*(RSRT-RSRL)
002608 002608 MSF(I)=MSFL+ADML(I)*(MSFT-MSFL)
002613 002613 MR(I)=ME(I)+RECOV *UE(I)*2/2./BTU/GC
002613 002613 IF (IDEBUG,NE,0)
002623 002623 *WRITE (6,173) I,ITER,ADML(I),TUE(I),RUCH(I),ROE(I),UE(I),
002623 002623 * ,TE(I),THE(I),VISE(I),ENTR(I),DTF(I),DPF(I),THE(I),PHI(I),
002623 002623 * VISE(I),ENTR(I),DTF(I),DPF(I),THE(I),PHI(I),VISE(I),THE(I),VISE(I),
002653 002653 * 1PTE13.6)
002653 002653 C *** INTEGRAL MOMENTUM AND ENERGY LONS
002653 002653 HT2=ME(I)+UE(I)*2/2./GC/RTU
002653 002653 DTF(I)=R(I)+UE(I)+TUE(I)-1.+RAF(I)*BP(I)*CMH(I)
002653 002653 DPF(I)=R(I)+RUCH(I)*MR(I)+HT2-MU(I)*BP(I)*CMH(I)
002674 002674 C
002674 002674 IF (ITER,EQ,1) GO TO 161
002674 002674 C
002674 002674 RAIT=ABS((TUE(I)-TUEOLD)/TUE(I))
002674 002674 RATR=ABS((RUCH(I)-RUCHO)/RUCH(I))
002674 002674 IF (RATR,LT,.001,AND,RATR,LT,.001) GO TO 162
002674 002674 GO TO 160
002674 002674 161 CONTINUE
002674 002674 LTTSTR = LTT
002674 002674 STORE(1) = ME(I)
002674 002674 STORE(2) = ENTR(I)
002674 002674 STORE(3) = TE(I)
002674 002674 STORE(4) = VISE(I)
002674 002674 STORE(5) = ROE(I)
002674 002674 STORE(6) = UE(I)
002674 002674 STORE(7) = MCAM(I)
002674 002674 STORE(8) = URE(I)
002674 002674 STORE(9) = BETP(I)
002674 002674 STORE(10) = THE(I)
002674 002674 STORE(11) = PHI(I)
002674 002674 STORE(12) = RETH(I)
002674 002674 STORE(13) = RETH(I)

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01020 376* STORE(14) = REPH(I)
01021 377* STORE(15) = HR(I)
01022 378* STORE(16) = ADML(I)
01023 379* STORE(17) = RUCH(I)
01024 310* STORE(18) = RAF(I)
01025 311* STORE(19) = RUFST(I)
01026 312* STORE(21) = HSF(I)
01027 313* STORE(22) = DTF(I)
01028 314* STORE(23) = DPF(I)
01029 315* STORE(24) = TUE(I)
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376* STORE(14) = REPH(I)
377* STORE(15) = HR(I)
378* STORE(16) = ADML(I)
379* STORE(17) = RUCH(I)
310* STORE(18) = RAF(I)
311* STORE(19) = RUFST(I)
312* STORE(21) = HSF(I)
313* STORE(22) = DTF(I)
314* STORE(23) = DPF(I)
315* STORE(24) = TUE(I)
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C 160 CONTINUE
  IF (RAT - .05) 60, 67, 67
C *****
C 67 CALL MEIEX(I,1,DTF(I),DPF(I),RSRL,LTTSTR,STORE)
C *****
  GO TO 71
  60 IF (RAT - .05) 71, 69, 69
  69 DPF(I) = DPF(I-1)
C *****
C CALL MEIEX(I,2,DTF(I),DPF(I),RSRL,LTTSTR,STORE)
C *****
C 71 CONTINUE
  IF (IDEBUG.EQ.0) 60 TO 162
  CALL LCOUN(5)
  WRITE(6,150) I,RAT,RATR
150 FORMAT(/,30X,56H COMPUTATION OF MEIT EQUATIONS DID NOT CONVERGE AT
  * POINT,14/
  * 55X,18H(TUE-TUE010)/TUE =,1PE12.5/
  * 55X,19H(RUCH-RUCH01)/RUCH =,1PE12.5)
162 CONTINUE
C *** DETERMINE TRANSITION PARAMETERS
170 IF (LTT.NE.0) 60 TO 175
  LTT=2
  IF (IBRUPT.EQ.1) LTT = 3
  PERSH = 2.
  TRNP = (TUT-TUL)*RETH(I)*PEKSH/ROE(I)/UE(I)
  IF (INXT.NE.1) STRAN = S(I)-RATIO(S(I)-S(INXT))
  IF (IDEBUG.EQ.1)
    WRITE(6,1007) I,INXT,LTT,RATIO,STRAN
1007 FORMAT(10H,22H,1,INXT,LTT,RATIO,STRAN /1X,313,2X,1PE12.5)
C *****
C 175 IF (LTT.LE.1) CALL TRANS(I,INXT,RATIO)
C *****
  IF (LTT.EQ.0) 60 TO 65
  IF (KLIT.EQ.2) 60 TO 176
  IF (NOSTRN.NE.1) 60 TO 176
  GO TO 54
176 CONTINUE
  I=I+1
  IF (I.LE.NTT) 60 TO 65
C *** END OF LOOP
C
  GO 180 I=1,NS
  ISUB = IPT(I)
  RUCHSPI(I) = RUCH(ISUB)
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00181 432*
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MRSP(I) = MRISUB)
PRES(I) = PEISUB)
100 CONTINUE
RETURN
END

01125 4330
01126 4340
01127 4350
01131 4360
01132 4370

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00101 10 SUBROUTINE MEITER(I, ITR, DIF, OPF, ASAL, LTTSTR, STORE)
00102 20 DIMENSION STORE(25)
00103 30 INCLUDE COMON
00104 40 C-----
00105 50 GO TO (100, 200), ITR
00106 60 100 CONTINUE
00107 70 LTT = LTTSTR
00108 80 ME(I) = STORE(1)
00109 90 ENTR(I) = STORE(2)
00110 100 TE(I) = STORE(3)
00111 110 VISE(I) = STORE(4)
00112 120 ROE(I) = STORE(5)
00113 130 UE(I) = STORE(6)
00114 140 MCAM(I) = STORE(7)
00115 150 URE(I) = STORE(9)
00116 160 BETP(I) = STORE(10)
00117 170 THE(I) = STORE(11)
00118 180 PHI(I) = STORE(12)
00119 190 REYN(I) = STORE(13)
00120 200 REPH(I) = STORE(14)
00121 210 HR(I) = STORE(15)
00122 220 ADML(I) = STORE(16)

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00101 10 SUBROUTINE OUTPUT
00102 20 C
00103 30 C
00104 40 C
00105 50 C
00106 60 C
00107 70 C
00108 80 C
00109 90 C
00110 100 C
00111 110 C
00112 120 C
00113 130 C
00114 140 C
00115 150 C
00116 160 C
00117 170 C
00118 180 C
00119 190 C
00120 200 C
00121 210 C
00122 220 C
00123 230 C
00124 240 C
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00126 260 C
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00129 290 C
00130 300 C
00131 310 C
00132 320 C
00133 330 C
00134 340 C
00135 350 C
00136 360 C
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00138 380 C
00139 390 C
00140 400 C
00141 410 C
00142 420 C
00143 430 C
00144 440 C
00145 450 C
00146 460 C
00147 470 C
00148 480 C
00149 490 C
00150 500 C

      THIS ROUTINE WRITES THE RESULTS OF THE INVISCID FLOW SOLUTION

      INCLUDE CORON
      INCLUDE CORUNT
      WRITE TITLE AND HEADING

      CALL LCOUNT(-3)
      WRITE(6,20040)
20040 FORMAT(50X,25HGENERAL INPUT INFORMATION/50X,25(1H*))
      CALL LCOUNT(6)
      WRITE(6,20060)
20060 FORMAT(75,4HBODY,T11,4HINTG,T19,4HMAIL,T26,6HSTREAM,T36,8HAXIAL,
+79S,6HRAIAL,T36,4HBODY,T65,18HNORMALIZED,T61,4HMAIL,T69,
+7HESURFACE,T105,20M---EDGE CONDITION---/T3,2HPT,T6,2HNO,T11,2HPT,
+T14,2HNO,T20,2HNO,T26,6HLENGTH,T36,6HLENGTH,T45,6HLENGTH,T56,
+5HANGLE,T64,13HABLATION RATE,T81,4HICRP,T88,9HROUGHNESS,T101,
+8HMPRESSURE,T112,8HENTHALPY,T129,8HVELOCITY/T27,4HINCH,T37,4HINCH,
+T46,4HINCH,
+T56,3HDEG,T69,3HDEG R,T91,3HML,T103,3HATN,T112,7HBTU/LBM,T124,
+6HFT/SEC,T74,3H(J),T12,3H(J),T18,6H(MATL),T27,3H(S),T37,3H(2),T46,
+3H(R),T55,7H(THET),T67,6H(BPSP),T81,4H(1W),T89,8H(RUFIL),T103,
+4H(PE),T114,4H(ME),T125,4H(UE)/)
20121 FORMAT(1X,14,T11,13,T20,12,T25,F7,2,T35,F8,3,T44,F9,3,T54,F8,3,
+T64,F8,3,T79,F7,2,T89,F8,3,T101,F6,2,T111,F9,2,T123,F8,2)
      J = 1
      DO 100 I=1,NT
      IF (LCI-ST,1) GO TO 300
      CALL LCOUNT(-6)
      WRITE(6,20060)
      300 IF (IPT(J),NE,1) GO TO 400
      SINCH=S(I)*FT
      ZINCH=(Z(I)+28P(1))*FT
      RINCH=R(I)*FT
      THERAD = THE78(I)*RAD
      RUFIL=RUF(I)*FTML
      CALL LCOUNT(1)
      WRITE(6,20121) J,I,MATL(I),SINCH,ZINCH,RINCH,THERAD,BPSP(I),TW(I),
+RUFIL,PE(I),ME(I),UE(I)
      J = J+1
      60 TO 100
      900 IF (IABS(IPRNT),NE,2) GO TO 100
      SINCH=S(I)*FT
      ZINCH=(Z(I)+28P(1))*FT

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RINCHSR(I)OFT
THERAD = THETB(I)*RAD
RUFILRUF(I)*FTIL
C
CALL LCOUNT(I)
WRITE(6,20121) J,I,NATL(I),SINCH,ZINCH,RINCH,THERAD,BPSP(I),TV(I),
RUFIL,PE(I),NE(I),UE(I)
100 CONTINUE
C
RETURN
END

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00161	CALL LCOUNT(1)	000105
00162	WRITE(6,20120) I,SIMCH,UE(I),MEAN(I),WE(I),TE(I),ROE(I),VISE(I),	000110
00162	U RE(I)	000110
00175	20120 FORMAT(1X,I10,F13.4,F13.1,F14.3,F13.1,F13.1,1PE13.3,1PE14.3,	000130
00175	1PE16.3)	000130
00176	100 CONTINUE	000130
00176	C	000130
00176	C	000130
00176	C	000130
00200	CALL LCOUNT(-3)	000130
00201	WRITE(6,40120)	000130
00203	40120 FORMAT(73X,59HVISCOS FLOW - WALL AND B. L. RECOVERY PROPERTIES/	000133
00203	59X,49(13H))	000140
00203	C	000140
00204	CALL LCOUNT(6)	000140
00205	WRITE(6,40140)	000140
00207	40140 FORMAT(4X,4HBOOT,4X,5HINIEG,4X,6HSTREAR,8X,4HFWALL,9X,4HFWALL,9X,	000143
00207	4HFWALL,8X,4HFWALL,7X,4HRECOVERY,4X,8HRECOVERY,3X,11HSENSBL CONV,	000148
00207	6X,4HCF/2/	000148
00207	3X,5HPT NO,4X,5HPT NO,4X,6HLENGTH,4X,11HTEMPERATURE,4X,	000150
00207	8HENTHALPY,5X,7HDENSITY,5X,9HVISCOSITY,4X,8HENTHALPY,5X,	000150
00207		000150


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00101 10 SUBROUTINE QADRTC(J,X1,X2,X3,X,Y1,Y2,Y3,Y)
00101 20 C-----
00101 30 C-----
00101 40 C-----
00101 50 C THIS ROUTINE PERFORMS A THREE POINT QUADRATIC CURVE FIT
00101 60 C-----
00101 70 C-----
00101 80 C-----
00101 90 C-----
00103 100 A=Y2
00104 110 O=(X3-X2)*(Y2-Y1)*(X3-X1)
00105 120 B=((Y3-Y2)*(X2-X1)*(Y2-Y1)+(X3-X2)*(Y2-Y1))/O
00106 130 C=((Y3-Y2)*(X2-X1)-(Y2-Y1)*(X3-X2))/O
00107 140 IF (J.GT.1) GO TO 10
00111 150 Y2=B*(X-X2)+C*(X-X2)**2
00112 160 RETURN
00113 170 10 Y2=B+2.*C*(X-X2)
00114 180 RETURN
00110 190 END
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SUBROUTINE RUFES(I,RIF)
  INCLUDE COMMON
  INCLUDE COMUNT
  MAT = MATL(I)
  RUFT=0.
  CALL TBLPIS(I),SP,EFFKI,EFFKINS)
  SCALLOPE ROUGHNESS MODEL *****
  IF (RUF1(MAT),LE-1.E-7) GO TO 8
  IF (I,GT,KSHOLD) GO TO 10
  RUF=RUFL(MAT)/(PEPI(I)*PT2*ATM)**0.77
  IF (RUF,GT,RUFMAX(MAT)) RUF = RUFMAX(MAT)
  IF (THETB(I),GT,0.9*OR,THETBINTT),GE,0.5) GO TO 9
  RAT=(RUF-RUFL(MAT))/(0.5-THETB(I))
  RUF=RUFL(MAT)+RAT*(THETB(I)-THETB(NTT))
  GO TO 9
  8 RUF=RUFMAX(MAT)
  9 RUF=RUFL(MAT)+ADML(I)*(RUF-RUFL(MAT))
  10 RIF=MAX1(RUFL(MAT),EFFKI,RUFT)
  RETURN
END

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00101 SUBROUTINE SR1(I,C1,C2)
00102 INCLUDE COMON
00103 COMMON/PACAL/PRL,PRT
00104 C *** LAMINAR SHEAR AND HEAT TRANSFER FACTORS
00105 MAT = MATL(I)
00106 C8=2.*BL3(MAT)*BP(I)*RAF(3)*CMH(1)
00107 C1=0.245
00108 IF (C8.GT.0.001) C1=C1*ALOG(1.0+C8)/C8
00109 IF (BETP(I).GT.0.) C1=C1*(1.0+3.0*BETP(I))*0.3333
00110 RECOV=SQRT(PR)
00111 HREF=0.42*HE(I)+0.58*HW(I)+0.19*RECOV*(HT2-HE(I))
00112 CALL ESTATE(1,PE(I),HREF,HREF,TRF,RNW,PRL,RORF,AA)
00113 VISR=HREF
00114 HT2=HE(I)+UE(I)*2./32.174/770.150
00115 REFFRORF=VISR*(HT2-HW(I))/(ROE(I)*VISE(I)*(HR(I)-HW(I)))
00116 IF (REFF.LE.0.) REFF=1.
00117 C8=2.*BLN(MAT)*BP(I)*CMH(1)
00118 C2=220*REFF/PR*0.3333
00119 IF (BETP(I).GT.0.) C2=C2*(1.0+4.*BETP(I))*0.1667
00120 IF (C8.GT.0.001) C2=C2*ALOG(1.0+C8)/C8
00121 RETURN
00122 END
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00101	1*	SUBROUTINE SR2 (I, C3, C5, RSKTH, RSKTH)	000005
00103	2*	INCLUDE COMMON	000020
00110	3*	COMMON/PRCAL/PRL,PR	000035
00110	4*	TURBULENT SHEAR AND HEAT TRANSFER FACTORS	000037
00111	5*	RECOV=PR**0.3333	000051
00112	6*	HREF=0.55*HE(I)*0.45*HV(I)*0.15*RECOV*(MT2-HE(I))	000053
00113	7*	CALL ESTATE(1,PE(I),HREF,EREF,TRF,MMW,PRT,RORF,AA)	000062
00114	8*	VISR=ENERF	000065
00115	9*	REFRORF/ROE(I)*(VISR/VISE(I))*0.25	000101
00116	10*	MAT = MATL(I)	000103
00117	11*	CB=2.*BYS(MAT)*BP(I)*RAF(I)*CMH(I)	000117
00120	12*	BC=1.0	000125
00121	13*	IF (CB.GT.0.001) BC=ALOG(1.0+CB)/CB	
00123	14*	C4=1.	
00124	15*	IF (BETP(I).GT.0.) C4=(1.+3.*BETP(I))*0.3333	
00126	16*	C3 = .245*C4/RETH(I)	
00127	17*	IF (RETH(I).GT.2.) C3 = C3*.0123*RETH(I)/(100.*RETH(I))/	

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      S ALOG10(RETH(I))=1.6
      C3=C3*REFP*BC
      CB=2.*BTH(MAT)*BP(I)*CNH(1)
      BC=1.0
      IF (CB.GT.0.001) BC=ALOG(1.0+CB)/CB
      C6=1.
      IF (BETP(I).GT.0.) C6=1.+*.8BETP(I))=0.1667
      C5 = .22/PR=1.3333*C6/REPH(I)
      IF (REPH(I).GT.2.) C5 = C5+.0123/SQRT(PR)*REPH(I)/(100.+REPH(I))/
      S ALOG10(REPH(I))=1.6
      C3=C3*REFP*BC
      C
      ROUGHNESS INFLUENCE COEFFICIENTS -
      RSRTM = 1.
      RSRTM = 1.
      IF (RUF(I) .LE. 0.) GO TO 10
      ROVIS = VISE(I) / VISE(I) * SORT (ROW(I) / ROE(I))
      SLOPE = .09*RUF(I)/THE(I) + .53*(1. - EXP(-RUF(I)/THE(I))) + 1.
      ABSIS = ALOG10(REPH(I))*RUF(I)*ROVIS *SQRT(C3)/15.5)
      FUNCT = ABSIS - 1.5*(EXP(-ABSIS) - 1.)
      RSRTM = 1. + AMAX1(.5*SLOPE*FUNCT , 0. )
      RSRTM = 1. + AMAX1(.3*SLOPE*FUNCT , 0. )
10 CONTINUE
      RETURN
      END

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00101 SUBROUTINE TRANS(I,INXT,RATIO)
00102 INCLUDE COMMON
00103 INCLUDE COMUNT
00104 INXT=I
00105 GO TO (100,200,300,400,500,500,500,700),NREYCH
00106
00107 C *** ALL LAMINAR FLOW
00108 100 GO TO 1000
00109
00110 C *** RE THEA VS. EDGE MACH NO.
00111 200 CALL TBLP(MCAM(I),AR,REYCH,REM,NAR)
00112 IF (RETH(I),LT,REYCH) GO TO 1000
00113 RATIO=(RETH(I)-REYCH)/(RETH(I)-RETH(I-1))
00114 INXT=I-1
00115 GO TO 700
00116
00117 C *** RE STREAMLENGTH VS. EDGE MACH NO.
00118 300 CALL TBLP(MCAM(I),AR,REYCH,REM,NAR)
00119 IF (S(I),URE(I),LT,REYCH) GO TO 1000
00120 RATIO=(S(I)-URE(I)-REYCH)/(S(I)-URE(I)-S(I-1)*URE(I-1))
00121 INXT=I-1
00122 GO TO 700
00123
00124 C *** AXIAL DISTANCE VS. ALTITUDE
00125 400 ZTRAN=DLTRAN
00126 IF (Z(I),LT,ZTRAN) GO TO 1000
00127 RATIO=(Z(I)-ZTRAN)/(Z(I)-Z(I-1))
00128 INXT=I-1
00129 GO TO 700
00130
00131 C *** PANT ROUGH WALL CRITERION
00132 500 IF (I,GT,KSHOLD) GO TO 600
00133 IF (NREYCH,EG,6) GO TO 504
00134 PSYETH(I)/TE(I)
00135 GO TO 506
00136
00137 504 PSY = 1.08*(I)+(9+.1*(CARB))*.1+.25*(P(I))*ROE(I)/ROW(I)
00138 506 TPII=RETH(I)*((RUF(I))/(PSY*THE(I)))*.0.70)
00139 IF (TPII),LT,255.0) GO TO 1000
00140 DO 510 J=1,I
00141 IF (TP(J),GE,215.0) GO TO 515
00142 510 CONTINUE
00143 515 I=J-1
00144 IF (I,LT,4) I=4
00145 IF (I,GT,4) RATIO=(215.-TP(I))/(TP(I+1)-TP(I))
00146 INXT=I+1
00147 GO TO 700
00148
00149 C *** CONE TRANSITION
00150 600 IF (RETH(I),LT,275.0*EXP(0.13*(MCA(I))) GO TO 1000
00151 GO TO 700
00152
00153 C *** TRANSITION AT I=4
00154 700 LTY=0
00155 IF (I,LT,KSHOLD) NOSTRM = 1
00156 1000 CONTINUE
00157 RETURN
00158 END
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00254 1070 SX2 = SX2+2(1)002
00255 1080 SX2 = SX2+XY2
00256 1090 SX2X = SX2X+XY202(1)
00257 1100 FNUM = FNUM+1
00260 1110 IF (THETB(1).LT..00139) GO TO 120
00262 1120 CONTINUE
00264 1130 DENO = SX002-SX20FNUM+1.E-10
00265 1140 BSH = (SX0SX2-SX2X0FNUM)/DENO/2.
00266 1150 CSH = (SX20SX2-SX2X0SX)/DENO
00267 1160 B2MC=BSH002-CSH
00270 1170 IF(B2MC) 95,99,96
00274 1180 94 RN = 100.
00276 1190 GO TO 130
00278 1200 95 WRITE(6,98) B2MC,BSH,CSH,DENO,SX,SX2,SX2X,SX2X,FNUM
00310 1210 98 FORMAT(/6H B2MC=E12.5,2XSH BSH=E12.5,2XSM CSH=E12.5,2XSM DENO=E12.
00310 1220 95./6H SX=E12.5,2XSM SX2=E12.5,2XSM SX2X=E12.5,2XSM SX2X=F12.5,2X.
00310 1230 96H FNUM=E12.5/)
00310 1240
C
00310 1250
C
00310 1260
00311 1270 RM=0.1440SINI*THETSP(2))/RUCH(2)
00312 1280 RN=PT20RN002/FT
00313 1290 WRITE(6,97) RN
00316 1300 97 FORMAT(36H MINIMUM NOSE RADIUS CONSTRAINT ON.10X.4HRN =.1PE11.4)
00317 1310 GO TO 130
00320 1320 94 RN=SORT(B2MC)
00321 1330 130 CONTINUE
C
00321 1340
C
00321 1350 CALCULATE KSHOLD .....
00322 1360 DO 500 I=1,NTT
00325 1370 J=NTT-I
00326 1380 IF((THETB(J)-THETA-DSHANG).GE.0.) GO TO 501
00330 1390 500 CONTINUE
00332 1400 501 KSHOLOBJ=1
00333 1410
C
00334 1420 RETURN
00334 1430 END

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00111 280
00112 290
00113 300

SUBROUTINE XSOLVE(X,Y,YGIVN,NCOUNT,XLO,YLO,XHI,YHI)
-----
C
C
C THIS ROUTINE IS USED IN ITERATION FOR X WHICH SATISFIES THE
C EQUATION Y = F(X) WHEN Y = YGIVN
C
C-----
C
C NOTE: A GOOD INITIAL GUESS IS ESSENTIAL FOR THE SOLUTION.
C
C--- INPUT ---
C X = AN ESTIMATED VALUE OF THE SOLUTION
C Y = CALCULATED FROM Y = F(X) IN THE CALLING ROUTINE
C YGIVN = THE VALUE OF Y FOR WHICH THE X VALUE IS BEING SOLVED
C NCOUNT = A COUNTER WHICH MUST BE 1 WHEN XSOLVE IS FIRST CALLED
C
C--- OUTPUT ---
C X = A VALUE OF X WHICH MORE CLOSELY SATISFIES THE EQUATION
C YGIVN = F(X)
C XLO,YLO,XHI,YHI = THE COORDINATES OF THE TWO POINTS WHICH ARE
C CONNECTED BY A STRAIGHT LINE TO SOLVE FOR X
C
C IF (NCOUNT-2) 10,20,30
10 XLO = X
YLO = Y
X = XLO+ABS(.011*XLO)
NCOUNT = 2
RETURN
20 XHI = X

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00114 310 YMI = Y
00115 320 X = (Y6IVN-YLO)/(YMI-YLO)*(XMI-XLO)+XLO
00116 330 NCOUNT = NCOUNT+1
00117 340 RETURN
00120 350 DYLO = YLO-Y6IVN
00121 360 DYMI = YMI-Y6IVN
00122 370 IF (DYLO+DYMI) 40,40,70
00123 380 IF (Y-Y6IVN) 60,50,50
00125 390
00125 400 YLO AND YMI STRADDLE Y6IVN WITH YLO CLOSER TO Y6IVN
00125 410
00130 420 50 XMI = X
00131 430 YMI = Y
00132 440 60 TO 100
00132 450
00132 460 YLO AND YMI STRADDLE Y6IVN WITH YMI CLOSER TO Y6IVN
00133 470
00133 480 60 XLO = X
00134 490 YLO = Y
00135 500 60 TO 100
00136 510 DYLO = ABS(DYLO)
00137 520 DYMI = ABS(DYMI)
00140 530 IF (DYMI.LT.DYLO) 60 TO 90
00140 540
00140 550 YLO AND YMI ON SAME SIDE OF Y6IVN WITH YLO CLOSER TO Y6IVN
00140 560
00142 570 80 IF (ABS(Y-Y6IVN).LT.DYLO) 60 TO 85
00144 580 X = X+(XMI-X)/5.
00145 590 60 TO 200
00146 600 XMI = XLO
00147 610 YMI = YLO
00150 620 XLO = X
00151 630 YLO = Y
00152 640 60 TO 100
00152 650
00152 660 YLO AND YMI ON SAME SIDE OF Y6IVN WITH YMI CLOSER TO Y6IVN
00152 670
00153 680 90 IF (ABS(Y-Y6IVN).LT.DYMI) 80 TO 95
00155 690 X = X-(X-XLO)/5.
00156 700 60 TO 200
00157 710 95 XLO = XMI
00160 720 YLO = YMI
00161 730 XMI = X
00162 740 YMI = Y
00163 750 100 X = (Y6IVN-YLO)/(YMI-YLO*(1.E-10))*(XMI-XLO)+XLO
00164 760 200 CONTINUE
00165 770 NCOUNT = NCOUNT+1
00166 780 IF(NCOUNT.LE.100) 80 TO 300
00170 790 WRITE(6,250) X,Y,Y6IVN,NCOUNT,XLO,YLO,XMI,YMI
00202 800 FORMAT(1X,10(1H:),X5OLVE X,Y,Y6IVN,NCOUNT,XLO,YLO,XMI,YMI,/11X,
00202 810 3E12.5,15,4E12.5)
00203 820 STOP
00204 830 300 CONTINUE
00205 840 RETURN
00206 850 END

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