EXPERIMENTAL INVESTIGATION OF WAKES BEHIND TWO-DIMENSIONAL SLENDER BODIES AT MACH NUMBER SIX

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ABSTRACT

An experimental investigation has been conducted to determine mean flow properties for both near and far wakes behind several twodimensional slender bodies at $M_m = 6$. Three adiabatic wall models consisting of a flat plate model and two 20⁰ included angle wedge models (H = .15'', H = .3'') were tested. The effect of wall temperature on wake properties was examined by cooling the larger of these two wedge models with the internal flow of liquid nitrogen $(T_W/T_o = .19)$. Free stream Reynolds numbers were varied from $Re_{m}/in. = .5 \times 10^{5}$ to 2×10^{5} for each of these four configurations. In the far wake, measurements of total temperature, as determined with hot wire probes, and Pitot and static pressures were used to derive all other mean flow properties. The effect of transition on these far wake data was determined. Near wake flows were laminar for all adiabatic wall tests and at least for the two lowest test Reynolds numbers of the cold wall wedge. Base region flow field mappings and shear layer profiles were obtained for the .3"H wedge model by combining Pitot pressure data with hot wire measurements of total temperature and mass flux. These results illustrated that for slender bodies with flat bases, the basic structure for laminar near wakes is appreciably more complex for hypersonic than for supersonic flow primarily because, in hypersonic flow, the corner expansion fan extends into the separated shear layers and base region shocks now become imbedded within the viscous portion of the shear layers.

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LIST OF SYMBOLS

- b spanwise length
- c flat plate chord length
- C Chapman-Rubesin factor (= $\rho \mu / \rho_a \mu_a$)
- d hot wire diameter
- D reference length
- E wake energy thickness (= $\int_{-\infty}^{\infty} \frac{\rho u}{\rho_e u_e} (1 \frac{T_t}{T_t}) dy$) g normalized enthalpy excess [=(h-h_e)/h_e]
- $g(s_1)$ molecular speed ratio function
- h static enthalpy
- \overline{h} convective heat transfer coefficient (= q/(T_w-T_{aw}))
- H total base height
- I hot wire current
- k conductivity
- *l* hot wire length
- length of pressure tubing
- L flat plate chord length
- M Mach number
- M mass of gas in given volume
- Nu Nusselt number (= hd/k)
- p pressure
- p_t_Pitot pressure
- $p_o \equiv p_{t_n}$ freestream total pressure
- Pr Prandtl number
- q heat transfer rate per unit area
- Q throughput
- r recovery factor

R wire resistance

R gas constant

Reynolds number Re

reference wire resistance for zero current and zero ^oC resistance parameter (= $\frac{\alpha_r T_t}{1+\alpha_r (T_{awm}-T_r)}$) R s

molecular speed ratio (= $\gamma \gamma / 2$ M) s₁

St Stanton number

time t

т temperature

 $T_o \equiv T_t \equiv T_t_e$ free stream total temperature

velocity u

limiting velocity ratio along dividing streamline (=.587) u_{*}

U pipe flow resistance

V volume of system

normalized velocity defect (= $\frac{u_e - u}{u_a}$) w

axial distance from model base x

transformed axial distance from model base (= $\int_{0}^{x} \frac{\rho_e^{u} e^{\mu}e}{\rho_{\infty}^{u} \omega^{\mu} \omega} dx$) \mathbf{x} lateral distance from wake centerline У

y transformed lateral distance from wake centerline

$$\left(=\frac{\rho_{e}^{u}e}{\rho_{\infty}^{u}\omega}\right) \xrightarrow{Re_{\infty}HC} \int_{0}^{y} \frac{\rho}{\rho_{e}} dy$$

accommodation coefficient

 α_{r} slope of wire calibration curve ($R_{wm} \sim T_{wm}$) for zero current γ specific heat ratio

α

 δ shear layer or wake total temperature thickness

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

 Δx axial distance between a zero intercept transition distance, obtained by extrapolating transition location data to infinite Reynolds number, and a transition location

 η_{2} experimental recovery ratio for continuum flow

 $\eta_{\mathfrak{c}}$ — theoretical recovery ratio for free molecule flow

 η_* recovery ratio for infinite length wire (= T_{aw*}/T_t)

 $\bar{\eta}_{*}$ normalized recovery ratio for infinite length wire $((\eta_{*}-\eta_{c})/(\eta_{f}-\eta_{c}))$

 θ wedge included angle

$$\overline{\theta}$$
 wake momentum thickness $\left(=\int_{0}^{\infty}\frac{\rho u}{\rho_{e}u_{e}}\left(1-\frac{u}{u_{e}}\right)dy\right)$,

00

 $\overline{\theta}_{av\sigma}$ average wake momentum thickness

μ viscosity

$$v_{o}$$
 dimensionless quantity $\left(=\frac{\ell}{d}\sqrt{\frac{k_{t}}{k_{w}}} Nu_{t}\right)$
o density

 τ plate thickness

 $\begin{array}{ll} \overline{\chi} & \text{hypersonic viscous interaction parameter} \left(=\frac{M^3/\overline{C}}{\sqrt{Re_x}}\right) \\ \psi & \text{streamline} (=\int_{v}^{v} \rho u dy) \\ \psi_N & \text{Nusselt number}^0 \text{ end loss correction factor} (=\frac{Nu_t}{Nu_m}) \\ \psi_r & \text{recovery temperature end loss correction factor} (=\frac{T_{aw*}}{T_{awm}}) \\ \omega_0 & \text{dimensionless quantity} (=\frac{tanhv}{v}) \end{array}$

Subscripts

aw zero heat transfer (adiabatic wall)

b base

BL boundary layer edge

c	continuum flow
С	constant
¢.	centerline
e	edge
f	free molecule flow
Н	total base height
m	measured
NW	near wake edge
ο	initial condition
r	evaluated at reference temperature (= 273 ⁰ K)
S	support
sp	rear stagnation point
S	shock wave
t	local stagnation quantity
TE	trailing edge
TR	transition
w	wire
ws	wedge surface
w	wall
1	upstream of shock
2	downstream of shock
00	free stream conditions
*	refers to infinitely long wire

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I. INTRODUCTION

The wake of a body moving at high speeds through air (figure 1) has intrigued investigators for many years. Originally, because of the interest in base drag estimates, this problem was looked upon primarily as a "base pressure problem." However, with the advent of hypersonic vehicles and the necessity to understand and evaluate wake observable phenomena, attention has more recently been focused on not only the near but also the far wake regimes. To date, reasonable progress has been made in analytically treating the laminar and turbulent far wake, including the effects of transition, once initial profile data have been provided (1-7). As a result current studies are now concentrating on the near wake (that portion of the wake upstream of and including the wake neck) with the intent of suitably evaluating the complex coupling processes that occur within the base regions of hypersonic wakes. In these regions separated shear layers, which initially may often be considered as constant pressure mixing regions, enclose a low speed, recirculating flow which extends downstream to the location where the shear layers coalesce to form the wake's rear stagnation point. In the vicinity of this point the flow recompresses as the shear layers turn parallel to the wake axis. This turning process generates the wake shock observed experimentally in hypersonic wake investigations. The wake thickness beyond the stagnation point continues to thin down because of the acceleration of the wake flow until the neck or minimum thickness location is reached. In many cases, the separated shear layers for low supersonic flows and even for hypersonic flows behind blunt

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bodies, experience negligible lateral pressure gradients (8). This is not the case however for high speed flow in the base regions of slender bodies with flat bases. The rapid expansion of the boundary layer at the body's trailing edge gives rise to inviscid rotational flow phenomena with lip shocks becoming deeply imbedded within the vortical flow of the shear layer (9,10). The Chapman dividing streamline model based on conservation of mass within the recirculating flow region (11), and the significance of base region mixing due to momentum transport as outlined in the Crocco-Lees Theory (12) are indeed still applicable for the slender body near wake. However, the outer flow is highly complicated in this latter case and at the present time the complete matching procedure which joins the base region flow to the pre-separated boundary layer is not satisfactorily understood. Furthermore this coupling process is dependent on the upstream influence of the corner expansion and the pronounced profile distortion that takes place in the vicinity of the trailing edge. Thus a current need exists for experimentally investigating the near wake with emphasis on flow field mappings and shear layer profiles.

The far wake investigation reported herein has been carried out because it was realized early in the present investigation that not only did there appear to be a scarcity of such data for slender bodies with which to verify existing theory, but the effect of transition on mean flow properties, the approach of laminar wake flow to classical linear theory and the effect of model cooling on the far wake properties seemed to merit further study. In addition it was well known that the onset of transition and its proximity to the near

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wake could appreciably alter the base region properties. For example, as Crocco and Lees have shown (12), the significant increase in base region mixing associated with the onset of turbulence in the separated shear layers of the base region, results in a substantial increase in the amount of recompression the flow is able to sustain. In fact, even for transitional flow a significant rise in base region mixing may occur, if the most forward location of the wake's "transition zone" is in the vicinity of the wake's "critical point". This characteristic wake location (the point where the wake goes supersonic on the "average") is located just upstream of the centerline sonic point. Since the downstream pressure appears dominated by the inviscid flow and is relatively insensitive to Reynolds number effects, the increased recompression capability results in a lowering of the base pressure with a correspondingly greater expansion of the separated shear layers. It is therefore important to determine the most forward location of the wake transition region, so that an experimental investigation of the laminar near wake can be undertaken with confidence that the flow corresponds to only laminar conditions, and does not include the additional effects of turbulent mixing phenomena. Thus the far wake results reported in Section VI.1 were obtained prior to initiating the near wake investigation discussed in Section IV.2.

It is with these ideas in mind that the present study has been undertaken. It is a study which examines experimentally the effects of free stream Reynolds number, wall temperature ratio and model geometry on the flow properties of hypersonic wakes behind two

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dimensional slender bodies. Taken together the complete set of results serves not only as a means for verifying existing theory but also provides additional insight into those hypersonic wake regions which are not yet amenable to analytical treatment.

II. TEST APPARATUS AND EXPERIMENTAL TECHNIQUES II.1 Wind Tunnel

Leg I of the GALCIT Hypersonic Wind Tunnel (13) with a nominal Mach number of 6 was used to obtain the present set of wake measurements. This tunnel is a continuous flow, closed return device with a 5''x 5'' test section. A usable test rhombus extends from 23'' (model position) to approximately 33'' downstream of the nozzle throat. Tests were made for stagnation pressures of $p_0 = 10$, 35, 60 and 85 psig corresponding to free stream Reynolds numbers of $Re_{\infty}/in. = .465, .94, 1.42, and 1.9 \times 10^{5}/in$. A reservoir stagnation temperature of $275^{\circ}F$ and a dew point of $-40^{\circ}F$ was maintained for all tests which satisfactorily eliminated condensation effects. Table I summarizes the various test conditions covered during the current experimental investigation.

Because of the boundary layer along the tunnel wall the Mach number in the test section varies slightly with stagnation pressure and with axial position. Pitot and static pressure surveys both in the axial and vertical centerplanes were made without a model in the tunnel ('fred' tunnel) to determine the magnitude of such variations and to establish suitable corrections to measured data. The results of these surveys, which compare favorably with similar data of Dewey (8), Herzog (14), and Behrens (7), are shown in figures 2, 3 and 4. Since flow conditions were sensitive to wall boundary layer effects, the tunnel was always warmed up for approximately 2 hours before any data were taken. This provided sufficient time for the temperature of the tunnel wall (figure 2) to reach its equilibrium level.

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In comparing free stream stagnation temperatures, as measured with hot wire probes, with the reservoir temperature of 408°K, a consistent deficiency of 1 to 2% was observed. Such a result was similarly found by Behrens (7). A calibration check using an iron constantan thermocouple located 1 inch upstream of the nozzle throat confirmed the accuracy of the automatic regulator which set the reservoir temperature. However some energy loss takes place as the low speed air accelerates through the nozzle and it is tentatively concluded that this is the primary cause for the noted deficiency. In any event, all results cited in this report have been suitably normalized so that this effect is relatively unimportant to final results.

II.2 Wind Tunnel Models

For the present investigation four separate models consisting of a flat plate model and three wedge models of 20° included angle, were fabricated from Ketos steel. The geometry of these models and the manner in which they were installed in the tunnel are shown in figure 5. The leading edges of all models were carefully machined to thicknesses less than .002¹¹. Alignment with the free stream flow was established either by checking the symmetry of Pitot pressure traces in the wake or by comparing the lower and upper surface pressures, as was the case for the one wedge model which had surface pressure taps (.3w-1, Table I). To minimize the interference effects from the boundary layer on the tunnel wall, fences were designed for the wedge models. These fences were triangular in shape, 1/16''in thickness, and attached perpendicular to the base. They were

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located 3/4" from the tunnel wall and extended two base heights downstream.

The first model tested was a flat plate with a 1" chord and .0156" thickness. Both the leading and trailing edges of the plate were tapered to a 4° included angle with an edge thickness of approximately .0017". The plate was tested while under tension to eliminate vibration.

The smallest of the wedge models, one with a base height of .15", was the next configuration investigated. Two base taps, .0135" in diameter, were installed on the model centerline and a base pressure lead, .042" stainless steel tubing, was flush mounted in a groove on the base and brought out of the tunnel through one of the side ports.

In order to extend the base pressure results of this small wedge model and also to obtain surface pressure data near the trailing edge of a 20° wedge, another model with the same included angle but with a base height of .3", was machined from a solid piece of Ketos steel. Surface and base pressure taps were installed as noted in figure 5c with the pressure leads, .042" stainless steel tubing, being flush mounted in surface grooves and led out one of the side ports.

The design of the final 20⁰ wedge was determined by the need to test a .3¹¹ base height model, which could be cooled by the internal flow of liquid nitrogen. This model was constructed in a rib and skin configuration by first machining the upper, lower, and base surfaces and then soldering them together in the manner shown

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in figure 5d. The thicknesses of the three surfaces were initially somewhat oversize so that the assembled model could be machined to the specified dimensions. Four copper constantan "Ceramo" thermocouples, each enclosed within ceramic insulation and a .040" stainless steel shroud, were spot welded to internal surfaces at locations specified in figure 5d. Cylindrical model supports, containing nitrogen coolant lines and the thermocouple leads, were soft-soldered to each end of the model. Leak free mounting was insured by soft soldering metal bellows to these supports after the model was installed in thermally insulating micarta inserts and aligned in the tunnel. These bellows proved satisfactory in not only sealing the model in its mountings under extremely cold temperature conditions but also in allowing for the contraction and expansion of the tunnel side walls during the start and shut down operation of the tunnel. Although this model was designed primarily for cold wall testing, it was also used as an adiabatic wall model, and a complete set of wake measurements were obtained for both cold and adiabatic wall conditions. This proved important to final results since the effects of cooling on wake properties were readily discernible.

A schematic diagram of the nitrogen cooling system developed during the current investigation is presented in figure 6. The system's inlet side consisted of one nitrogen pressurizing bottle with gauge, a pressurized storage tank, and a cooling bath, all in series with the model. Similarly, a cooling bath and storage tank, vented to atmosphere, were attached in series on the outlet side. This

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arrangement made it possible to cycle the nitrogen from one tank to the other with relative ease while achieving spanwise uniformity in model temperature $(77^{\circ}K)$ with only approximately 1 psig inlet pressure. Some frost buildup was observed on the model, approximately .002" after about two minutes of operation at this low temperature level. However most transverse traces took less than two minutes duration so that the effect of frost buildup would seem to be relatively unimportant. After each trace, the nitrogen flow was shut off and the subsequent heating of the model rapidly "burned" off any accumulated frost. Unfortunately some temperature gradient always existed in the chordwise direction since the leading edge could never be sufficiently cooled due to its lack of direct contact with the liquid nitrogen. This was evident in that the frost buildup always began about .1" downstream of the leading edge. Such a gradient will influence the initial boundary layer and subsequent interaction effects.

II.3 Probe Design and Instrumentation

A) Pitot Pressure Probe

Pitot pressure surveys were made for the present set of wake measurements with a .042" diameter probe flattened at the forward end to a .004" by .035" opening, figure 7. The probe positioning mechanism of the tunnel activated a Helipot potentiometer which in turn converted probe positions to linear electric signals for . use in a Moseley XY recorder. A 5 psi Statham pressure transducer was used for most measurements to convert pressures to

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electrical signals which were recorded, after suitable amplification, on the XY recorder. The transducer was calibrated against a mercury manometer and the results are shown in figure 8. Near the base of the various models, where measured pressures fell below the lower limit of the transducer's range of linearity, Pitot pressures on the centerline were more accurately measured by means of a silicon micromanometer. A vacuum reference pressure for this manometer was maintained at less than a .5 microns by combining a diffusion pump in series with a mechanical vacuum pump. The precision gauge on the manometer permitted reading pressure levels to within .5 mm of silicon.

B) Static Pressure Probes

Static pressures along the wake centerline were measured with the above-mentioned silicon micromanometer using pressure probes fabricated from .042'' stainless steel tubing. The conical tipped probe shown in figure 7 was identical to that designed and calibrated by Behrens (15). On this probe three pressure orifices were located ten diameters behind the shoulder of a 20° cone tip. Although this probe was used for the majority of the static pressure measurements, its tip to orifice length prevented taking measurements near the base of a model, and additional probes were used to obtain near wake data for the largest wedge model tested. These probes, three in number, consisted of 2'' lengths of .042'' tubing with one end capped off. For each probe two orifices were located at a prescribed distance from the capped tip and the open end was soft-soldered to a pressure lead holder. In practice the sealed tip of the probe was placed in contact with the base of the model on the wake centerline and the subsequent pressure recorded by the precision micromanometer. Since tip to orifice lengths were different for each of the three probes, it was then possible to obtain a distribution of static pressure on the wake centerline. Great care was exercised to maintain all probes at zero angle of attack because of the pronounced sensitivity of static pressure probes to angle of attack effects (16).

C) Stagnation Point Probe

Because of the significance in near wake studies of the rear stagnation point, a special probe (figure 9) was fabricated to aid in determining the location of this point. This probe was made from .032" stainless steel tubing and actually consisted of two pressure leads. A spanwise section of the tubing, sealed at the centerline location, was joined at each end to these leads. Pressure taps, one facing upstream and the other downstream, were located on alternate sides of the center cap. When in use the pressure leads were brought out of the tunnel through the probe strut system and attached to opposite sides of a silicon "U" tube. The probe was then maneuvered along the wake centerline in the base region until the pressure levels were equal. In principle, as the probe moved into and out of the recirculating region, the pressure levels would be unequal at every position except the rear stagnation point since, except for that location, one tap would either be experiencing "base type" flow while the other would be under impact pressure conditions, or vice versa. In this manner the location where the pressures just balanced each

other, namely the rear stagnation point, was determined.

D) Hot Wire Anemometer

The hot wire probes used for the current set of measurements were similar to those designed by Dewey (17) and modified by Herzog (14). Each probe consisted of a platinum-10% rhodium wire approximately .030'' in length, soft-soldered to two needle supports, figure 10. Chromel Alumel thermocouple wires (.001'') were spot welded to within .005'' of one support tip for each of the probes. All wires were annealed and calibrated in the manner outlined by Dewey (17). From these calibration measurements wire resistivity coefficients (α_r) and reference resistances (R_r) for zero current were determined. Manufacturer specified resistance values for 68° F were checked against these calibration results and slight variations, less than 1% were observed.

For the actual flow measurements, the instrumentation system (figure 11) developed by Herzog (14) was used with considerable success. This system not only automatically positioned the probe in the tunnel but was also capable of measuring and recording on IBM cards the probe position, support temperature, and wire voltages corresponding to five known currents. A comprehensive description of this system is furnished by Herzog (14) and a discussion of the manner in which the measured data were reduced to furnish adiabatic wire temperatures and measured Nusselt numbers is given in Appendix A.

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III. DATA REDUCTION AND ACCURACY ESTIMATES III.1 Corrections to Measured Data

All Pitot and static pressure measurements have been adjusted so as to account for the tunnel axial gradients discussed in Section II. This was accomplished by dividing the measured pressure at a given axial location by the ratio of the pressure at the same location to the pressure at the location corresponding to the model's leading edge under "free" tunnel conditions, figure 3. Since lateral gradients in Pitot pressures under "free" tunnel conditions (figure 4) were relatively minor no corrections have been made to the measured data for these effects.

Virtual leak corrections were also made for Pitot and static pressure measurements as well as base pressure data. Because all high vacuum systems experience some outgassing or even small in-leaks, a pretest calibration of each probe was carried out using the silicon micromanometer to determine, if necessary, suitable corrections for these effects. As discussed in reference 21, such corrections are determined for a sealed system with a given volume by first measuring the change of pressure per unit time for that system. The product of the volume and this rate of pressure change can be shown to be proportional to the mass inflow rate for a sealed system. Using the perfect gas law and assuming small volume changes this follows from:

$$V \frac{dp}{dt} = \frac{dM}{dt} R_T$$

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The noted product is often termed the throughput in vacuum technology and given the designation Q. Under actual test conditions this mass flow is exhausted out the probe opening and, as a result, a certain pressure drop occurs along the length of pressure lead between the micromanometer and the probe orifice. Since the pressure levels for the present measurements corresponded to viscous rather than free molecular flow, it can be shown from Hagen-Poiseuille pipe flow theory that the resistance to such a mass flow is given by:

$$U = \frac{\pi D^4}{128\mu \ell_p} \overline{p}$$

and the resultant pressure drop is then determined from:

$$\Delta \mathbf{p} = \frac{\mathbf{Q}}{\mathbf{U}}$$

For many pressure measurements this virtual leak correction is relatively unimportant and can often be disregarded. On the other hand, in regions where very low pressures exist, such as base recirculation regions behind slender two dimensional bodies, this pressure loss can prove significant to final results and should be accounted for where applicable. Thus all low pressure data herein have been corrected for this effect whenever the estimated pressure drop was greater than 1% of the measured data.

A) Pitot Pressure Probes

Additional corrections to Pitot pressure data, such as those associated with angle of attack, streamline displacement and viscous effects were also investigated. Probe angles of attack were maintained within $+1^{\circ}$ to the local flow direction for all measurements except the separated shear layer and outer flow regimes of the near wake. For these cited exceptions the angle of attack varied by as much as $\pm 10^{\circ}$. Since the data of Matthews (22), McCarthy (16) and also Dewey (8) indicate that even for these angles, corrections to Pitot pressure data are negligible, no corrections for angle of attack effects have been applied to any of the Pitot pressure data presented herein.

Similarly, streamline displacement effects for those shear flows investigated herein were also found to be unimportant. Dewey (8) indicates that these effects become negligible when the ratio of free shear layer thickness to probe size is greater than 2. For the present set of experiments this ratio was greater than 25.

The final correction, that of viscous effects, was examined with the aid of figure 12. In this figure the different flow regimes covered during the present tests are easily discernible. Although the Reynolds numbers for those measurements in supersonic flow were sufficiently high, according to Matthews' results so as not to make necessary any viscous corrections for the supersonic data (<1%), such is not the case for the subsonic measurements. Using the data of Sherman (23) which describes the variation of the normalized viscous correction

$$\frac{p_{\text{impact}} p_{\text{impact w/o viscous effects}}}{\frac{1}{2}\rho u^2}$$

as a function of Reynolds number, this correction has been applied to all subsonic Pitot pressure data measured during the current investigation. For some of the low Reynolds number results herein this correction reduced measured data by as much as 20%.

B) Static Pressure Measurements

Since the conical probe shown in figure 7 was identical to the probe calibrated by Behrens (15), all corrections for viscous interaction effects have been carried out using the results of reference 15. In that reference Behrens indicates that the increase in pressure associated with viscous interaction phenomena is given by

$$\frac{P_{m}}{p} - 1 = .065 \overline{\chi} + .040 \overline{\chi}^{2}, \quad \overline{\chi} = \frac{M^{3} \gamma \overline{C}}{\gamma \overline{Re_{x}}}$$

For the present measurements the noted corrections were always less than 2%. Figure 12 indicates the various flow regions covered by this probe during the present tests and illustrates the range of applicability for the Behrens' data.

Those data taken with the base region probes have been left uncorrected for low Reynolds number effects. From the Behrens' results such corrections to probes of this diameter appear to be less than 1%. If any corrections are in order it would seem that interaction effects resulting from the probe's interference with the base recirculation region should be considered. Because of the difficulty in obtaining a quantitative measure of this correction, such an effect has not been accounted for, and there exists greater uncertainty in the resulting data (Section III.3.)

C) Rear Stagnation Point Probe

During a pretest checkout of the virtual leak effects associated with the stagnation point probe it was determined that the required corrections to each of the two measured pressures were identical. Therefore the uncertainty in the measured location of the rear stagnation point was caused primarily by the base interference effects. No corrections were made to the data for this effect and the resultant uncertainty is discussed in Section III.3.

D) Hot Wire Probe

The hot wire probe, with the availability of suitable calibration data, has been shown to be an effective tool in carrying out mean flow measurements (17,24). By direct measurement it determines recovery temperature and heat transfer rate for a wire (cylinder) immersed normal to a fluid stream. These measurements, when corrected for end-loss effects and coupled with established calibration results, can then provide stagnation temperature and mass flux data for the flow in question. A detailed discussion of the manner in which the raw data measurements have been reduced, corrected and finally combined with recovery temperature and Nusselt number calibration data is presented in Appendix A.

III.2 Mean Flow Calculations

By suitably combining the corrected data discussed in the previous section, with the compressible flow relations (25), final mean flow calculations have been carried out for the present investigation. Because of the characteristics peculiar to the various wake regions examined, several different computation procedures were necessary. All these calculations were made on an IBM 7094 using semiprofile traces of Pitot pressure and total temperature

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along with a third independently measured quantity. For the majority of the present results this third quantity was the static pressure which was assumed constant across the wake and equal to its value at the centerline. This procedure was followed not only for all far wake results herein but also for those neck and base regions within the wake shock boundaries. For comparison purposes flow field results for these latter regions were also calculated by using semiprofile traces of the mass flux data in place of static pressures. All other shear layer data were computed by similarly combining mass flux data with Pitot pressure and total temperature results. For those regions of inviscid flow located between the nose shock and the shear layer edge, as determined from total temperature profile traces, total temperatures and stagnation pressures remained constant throughout since it was assumed that all streamlines suffered the same total head loss in passing through the leading edge shock. As a result, the calculation procedure adopted herein for determining mean flow properties for these isentropic, inviscid regions combined total pressures, as calculated from the nose shock orientation and free stream conditions, with free stream total temperatures and measured Pitot pressures. Admittedly, curvature of the nose shock wave near the model's leading edge invalidates the assumption that all streamlines within such inviscid regions experience the same total head losses. In fact it is estimated that stagnation pressures along streamlines closest to shear layer edges may in some cases be 10 to 20% less than stagnation pressures based on the "straight" portion of the nose shock. However, even

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with this uncertainty in stagnation pressure, derived mean flow results are still within the accuracy limits of hot wire data (Section III.3) and thus the assumption that stagnation pressures remained invariant for these outer inviscid regions was considered reasonable. For one model, the smallest wedge configuration (.15w), total temperature distributions were not measured, and calculations in this case were made by assuming that all stagnation temperatures remained constant and equal to the free stream value. Streamline calculations for the base region were performed by integrating mass flux data from the nose shock toward the wake centerline. Since near the wake centerline such a procedure results in appreciable errors, additional streamline data were obtained by integrating from the centerline out to the wake shock. For these calculations the first computation procedure described above was used wherein static pressure was assumed constant across the integration region.

All profile results for the present investigation have been normalized with respect to edge conditions. Althrough the definition of edge location is often somewhat nebulous, depending on whether total temperature or velocity traces are used, the values for edge properties can be established with some degree of consistency. For example, most transverse traces of Pitot pressure in the far wake exhibit the existence of a maximum value outside the viscous

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wake and within the wake shock boundaries. Such a value, when present, has been used to compute edge properties. For several of the most aft locations of the smallest wedge model investigated (.15w) the "inviscid" Pitot pressure traces, instead of displaying a peak, exhibit initially a plateau followed by a gradual rise until the wake shock position is reached (Appendix C). The slight rise in Pitot pressure between the plateau region and the wake shock is believed caused by the weakening of the leading edge shock by the expansion fan generated at the base of the model. Thus streamlines in the far wake at increasing lateral distances from the centerline of the wake will exhibit lower total head losses with corresponding Pitot pressure variations. As a result the edge property data for these traces has been based on the plateau pressure level in lieu of the maximum "inviscid" value. In the near wake all edge results correspond to mean flow data as measured at the actual edge location determined from total temperature traces.

III.3 Accuracy Estimates

A) Free Stream Mach Number

The free stream Mach numbers herein were determined under "free" tunnel conditions from the ratio of measured Pitot pressures to the tunnel's reservoir pressure (25). Because the magnitudes of reservoir and free stream Pitot pressures were relatively high and thus could be measured very precisely, Mach numbers so computed were correspondingly quite accurate. However some repeatability difficulties existed due to wall boundary layer

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effects, which caused the flow in the test section for a given set of measurements to deviate somewhat from that for the tunnel survey results. This effect was most pronounced at $p_0 = 35$ psig since transition of the wall boundary layer occurred at this pressure. By combining measurement accuracies with repeatability difficulties it is estimated that values of the free stream Mach number, which have been used herein for flow field calculations, are accurate to within .5%. B) Positioning and Alignment

From repeatability checks and by examining the reliability of position indicators it is estimated that probe position uncertainty was within \pm .002". In order to eliminate the mechanical backlash effects, all vertical and axial positionings of a probe were carried out by moving the probe upward and forward respectively. It is interesting to note that the semiprofile results herein are perhaps even more accurate from a position standpoint than the cited \pm .002", since final results were established by averaging full profile data and thus any systematic offset would be compensated for in the reduction procedure.

Alignment of the pressure probes with the free stream direction was accomplished through use of a precision level. Because the tunnel used for the present investigation was designed with the flow parallel to the horizontal, this level was capable of aligning the pressure probe to within $.5^{\circ}$ of the axial flow direction.

C) Pitot Pressure Measurements

In Section III.1 it was indicated that all Pitot pressure results herein have been corrected for axial tunnel gradients,

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subsonic viscous effects and even virtual leak phenomena. Presumably, therefore, the uncertainties in Pitot pressures due to these effects have been all but eliminated. On the other hand, the effects of streamline displacement, angle of attack, lateral tunnel gradients, and viscous interaction in supersonic flow have been examined and are believed to have a cumulative error amounting to less than +1%. Since extreme care was exercised to minimize errors caused by electronic circuitry, transducer calibration, and Moseley recording uncertainties, only an additional +1% uncertainty is expected from all these effects. Admittedly, for the large pressures measured outside the viscous wake regions, the percentage error arising from , recording uncertainties is much smaller than for the centerline data, and thus this latter error estimate probably should be only about +.5% for such data. By taking into consideration all these effects the overall error for Pitot pressure measurements is believed to be within 2%.

D) Static Pressure Measurements

As mentioned above for Pitot pressure data, corrections for low Reynolds number effects, axial tunnel gradients and virtual leak phenomena have also been made to static pressure measurements, and thus any uncertainties caused by these effects should be of negligible importance to final results. In addition the use of a precision micromanometer for measuring these pressures reduced considerably possible recording errors. Thus the primary cause for error with these data appeared to be angle of attack effects and the assumption that the static pressure was constant across the wake. Several

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lateral surveys were made to check this latter assumption and slight dips in the pressure traces were observed near the wake edges for laminar flow conditions. However, since static pressure probes are exceptionally sensitive to angle of attack as brought out by McCarthy (16), it is tentatively concluded that the noted "dips" are caused by probe alignment difficulties that occur near the wake edge. As a result, static pressures across the wake have been assumed constant and equal to the value at the wake centerline for all the far wake computations herein. Since centerline data are accurate to within 2% when all uncertainty factors are considered, it is estimated that the assumption of zero lateral pressure gradient causes an error in the value used for the pressure at the wake's edge to be approximately +5%. Because those static pressure probes, used to measure recirculation region pressures, caused some base interference effects the resulting measured data are uncertain at the lower pressures by as much as +7%.

E) Stagnation Point Measurements

Since the accuracy of the stagnation point probe in measuring the location of the rear stagnation point is dependent to a great extent on probe diameter, the smallest tubing size, .032" OD, consistent with structural requirements was used for its construction. Possible virtual leak effects for this small probe, though of importance in quantitative pressure measurements, we re not significant to final comparative results because, as discussed in Section III.2, any such effects tended to be self-compensating. Therefore, recognizing the interference effects which exist when the probe is situated just

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at the rear stagnation point, it is estimated that measured values of $(x/H)_{sp}$ are accurate to within one probe diameter, namely \pm .032''. For the .3'' wedge model, the only configuration for which rear stagnation point locations were measured, this amounts to an uncertainty of within one-tenth of a base height.

F) Base and Surface Pressure Measurements

The lowest pressures measured during the present investigation were the base pressures and great care was exercised in obtaining these data. Not only were measurements made by the already mentioned precision micromanometer and virtual leak effects accounted for, but spanwise three dimensional effects were minimized, if not eliminated altogether, by use of base fences. Pronounced base pressure increases were observed at the higher tunnel pressures for the .3" wedge models when the models were tested without fences as compared to similar data with fences. Apparently the boundary layer on the tunnel sidewall, turbulent at these high pressures, caused a significant cross flow to occur because of turbulent mixing effects and the pressure differential which existed between the sidewall boundary layer and the recirculation region. Dewey (8), on the other hand, observed no difference between the base pressures with and without fences. However, the included angles of Dewey's models $(45^{\circ} \text{ and } 30^{\circ})$ were larger than the present 20[°] case. For the .15'' wedge model, with its higher aspect ratio, no indication of cross flow effects was evident since the data with and without fences were nearly identical.

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In determining the suitable fence configuration for these models, it was considered necessary not only to position the fences near the edges of the sidewall boundary layers, but also to extend their length downstream to at least the wake's centerline sonic point. To determine the final spanwise separation distance of the fences (b = 3.5") measurements of base pressures and Pitot pressure profiles in the far wake were carried out for separation distances of both 2.5 and 3.5 inches. Since both sets of data were virtually identical, the 3.5 inch separation distance, with its correspondingly larger aspect ratio, was selected for the final design. Taking all the above factors into consideration it is estimated that base pressure uncertainties vary from + 5% at the lowest pressure level tested, $p_0 = 10 \text{ psig}$, to $\pm 3\%$ at $p_0 = 100 \text{ psig}$. These noted uncertainty estimates correspond to those data measured by base pressure taps. Since the wedge model designed for the cold wall tests (.3w-2) was fabricated without such base taps, all base pressure data for this model were taken with the Pitot pressure probe positioned within .001" to .002" of the base on the wake centerline. Comparison of base pressure data obtained in this manner with "tap" data for the adiabatic wall model (.3w-1) indicated that these Pitot probe data were high at the lowest pressure investigated by +7% due to base interference effects. Thus the uncertainty factors for cold wall base pressure data range from +7% for $p_0 = 10$ psig to $\pm 5\%$ at $p_o = 85 psig.$

Since surface pressures measured with the .3" wedge model, (.3w-1) were relatively high, it was possible to obtain data with good

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accuracy. For example the small pressure error that occurred due to virtual leak effects was essentially negligible when compared to the magnitude of the measured pressure. Similarly the slight reading uncertainty that existed with the precision micromanometer was relatively unimportant in determining the overall uncertainty for the surface pressure data. Thus, based primarily on repeatability results, it is estimated that the surface pressure data herein are accurate to within $\pm 2\%$.

G) Hot Wire Anemometer Measurements

In making uncertainty estimates for hot wire data, consideration must be given to such factors as the reliability of the temperature-resistivity data for a given probe, measurement and recording procedures, probe end loss corrections, and finally wire calibration results for determining stagnation temperature and mass flux data from a wire's recovery temperature and Nusselt number. One advantage in evaluating the first of these factors is that often post-test calibrations are possible which enable a redetermination of a probe's temperature-resistivity curve. As Dewey has indicated (17), starting loads and exposure of these annealed hot wires for long periods of time at high temperature levels sometimes cause slight shifting of calibration curves. Thus post-test results offer a method for estimating any resulting uncertainties. Several wires used for the present results were therefore recalibrated after testing and changes in reference resistance due to tunnel exposure effects of less than \pm .02 ohms ($\pm 1/2^{\circ}$ K) were observed. No variations in resistivity coefficient (α_{n}) were evident however. Although on occasion some

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wire calibration curves exhibited slight deviation from linearity, only those wires which had a variation of less than .02 ohms for the temperature range considered were used to obtain the results herein. Thus the overall uncertainty arising from wire calibration effects is estimated at being about \pm .04 ohms, i.e., $\pm 1^{\circ}$ K.

The actual hot wire data were obtained with the system designed and used by Herzog (14). Hot wire resistances as measured by this system are accurate to within \pm .02 ohms. An additional uncertainty in adiabatic wire resistance of \pm .02 ohms exists because of slight errors that arise when reducing the measured data (Appendix B.1). The curve fitting technique discussed in Appendix B.1 although reasonably accurate in determining the zero power intercept (adiabatic wire resistance), is however somewhat poorer when evaluating the zero current slope of the resistance power curve because of the high sensitivity of this slope to the measured data. Since measured Nusselt numbers are proportional to these slopes it is estimated that these data are thus only accurate to within $\pm 2\%$.

The end loss corrections to measured hot wire data herein varied between 1.05 and 1.2 for adiabatic wire temperatures and ranged from .13 to .85 for measured Nusselt numbers. Any estimate of the uncertainty associated with these corrections has to take into consideration not only the analysis of Dewey but the dependence of such corrections on other measured quantities with their own accuracy limitations. By using these accuracy estimates with an analysis of the dependence of derived parameters on measured data, uncertainties in stagnation temperatures arising from end loss

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corrections have been made. These uncertainties vary from $\pm 2^{\circ}$ K for edge data to as much as $\pm 10^{\circ}$ K for those centerline measurements corresponding to cold wall, low Nusselt number conditions. In a similar manner it is estimated that uncertainties in final Nusselt numbers due to end loss corrections alone are approximately $\pm 3\%$.

The final factor of importance in evaluating hot wire accuracies is the recovery factor and Nusselt number calibration data. Dewey (17) indicates that recovery factors as determined from his correlation results have a maximum uncertainty of less than $\pm 1.5\%$ for all values of Mach number and Reynolds number. On the other hand, for the Reynolds numbers covered during the present investigation and using the Nusselt-Reynolds number correlation of Kubota (Appendix A), the uncertainty in mass flux data (Reynolds number) for given values of Mach number and Nusselt number is less than $\pm 5\%$.

In determining overall accuracies for stagnation temperatures and mass flux data some improvement over the accumulated uncertainties mentioned above is possible. This was accomplished by reducing the effects of data scatter with proper curve fairing, by averaging full profile data into semiprofile results, and finally by compensating for possible systematic errors through suitably normalized final results. Several repeatability checks confirmed the acceptability of this procedure. When all these effects are considered together with the specified uncertainty factors the overall accuracies for stagnation temperature and mass flux data are as shown in Table II. This table also summarizes uncertainty estimates for all other measurements and those derived results which are of interest to the study herein.

IV. RESULTS AND DISCUSSION

IV.1 Far Wake

A) Mean Flow Results

To initiate a discussion on the results from the present set of far wake measurements, it seems appropriate to begin by first examining data along the wake's centerline and edge for each of the four configurations under investigation. These data are indicated in figures 15 through 22, and the trends exhibited by a given flow variable are observed to be quite similar for all four cases. The one pronounced exception, as might be expected, occurs for the total temperature and enthalpy data for the highly cooled model (figures 18b and 20d) and these results will be discussed shortly.

i) Centerline Static Pressure

In figures 15a through 15d-2 static pressure data along the wake centerline are presented. Except for the flat plate results, these data illustrate the degree of recompression the flow experiences in rising from the low pressures in the base region to the downstream pressure levels. It was not possible to determine the amount of recompression for the flat plate model, since any attempt to measure centerline pressures near the model's trailing edge would result in appreciable flow disturbance (figure 15a). In any event, all pressure data indicate an initial overshoot followed by a gradual decay back to free stream conditions. A slight oscillatory feature to this decay is observed, especially downstream of the cold wall model (figure 15d-1). This type of behavior has been observed by other investigators such as Martellucci et al. (26) and

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Badrinarayanan (27) and as of now there still does not exist a satisfactory explanation. It is interesting to note that the decay of the centerline pressure from its "overshoot" value seems to commence at locations closer to the base as the Reynolds number increases. As will be shown shortly, these initial decay locations, in general, coincide with the onset of the wake transition region, which likewise moves forward with increasing Reynolds number. It is not surprising then that the flow will attempt to readjust itself to free stream levels at a faster rate, once turbulent diffusion effects begin to play a more dominant role.

For the wedge data, rough estimates have been made of maximum pressures at the overshoot location and these are labeled "Inviscid Estimate" in figure 15. To obtain these approximations, inviscid flow along the wedge face was expanded to measured base pressure values and then turned through an oblique shock which would bring the flow parallel to the wake's axis. All the calculated values are seen to be within 5% of the overshoot pressures. Such a finding, in spite of the fact that base pressures vary as much as 25% for the Reynolds numbers considered, illustrates that the inviscid flow plays a significant role in downstream pressure levels.

One final observation appears worthy of comment at this time and that is the noticeable inflection in the centerline pressure curves near the bases of the adiabatic and cold wall wedges (figures 15c-2 and 15d-2). Such a trend has been similarly observed by Hama (28) in his experiments with wedges in supersonic flows. For his results Hama points out that this effect is caused by an expansion

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fan emanating from the region of interaction of the base's lip shock with the wake shock. For the present set of measurements the lip shock and wake shock, as determined from transverse Pitot pressure surveys, appear to form a continuous shock structure (Section IV.2). This was found also by Hama in his experiments at high Mach numbers and occurs because the lip shock turns more toward the wake axis as the Mach number increases until eventually it appears to coalesce with the wake shock. The fact that the noted change in centerline pressure gradient occurs for Hama's high Mach number data and for the present results, suggests that some shock interaction phenomena may be taking place for these cases even though, with the current measurement resolutions, two distinct shocks are not discernible in the base regions.

ii) Centerline Mach Number

Mach numbers along the wake centerline and edge have been computed using Pitot and static pressure measurements, and these results are shown in figure 16. As discussed in Section III, static pressures at the edge have been assumed equivalent to static pressures measured on the wake's centerline. The centerline data of figure 16 illustrate a tendency to break away from the curve corresponding to the lowest Reynolds number at progressively moreforward locations as the Reynolds number is increased. Such an upstream movement of the ''break away'' point with increasing Reynolds number reflects the influence of transition on the centerline flow. This trend has also been observed in other wake investigations.

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Behrens (7) in his experiments on hypersonic wakes behind cylinders and also Sato and Kuriki (29) in their investigation of incompressible flow behind a flat plate, have compared such growth increases in centerline mean flow data with fluctuation measurements. Both investigations have shown that these pronounced centerline deviations are not necessarily indicative of fully developed turbulent flow but only of the termination of a linear growth region characterized by linear stability theory, and the initiation of a region of non-linear instabilities. The absence of any "break away" phenomena for the lowest Reynolds number data suggests that these data correspond to completely laminar flow, even to the most aft location at which measurements were made. Additional discussion of the laminar nature of these lower Reynolds number results will be made in Section IV. 1-B.

Except for the cold wall model, all centerline Mach number data illustrate that the onset of the transition region is well downstream of the centerline sonic point. Since disturbances in supersonic flow cannot propagate upstream, the near wake for the adiabatic wall 20° wedge (.3w-2A) is experiencing steady, laminar flow for the present set of measurements, even for the highest Reynolds number under investigation. This result is not necessarily true for the near wake of the cold wall wedge especially at $\text{Re}_{\infty H} =$ 5.5×10^4 (.3w-2C). The proximity of the "break away" location to the centerline sonic point is obvious from the data of figure 16 and the possible effect of fluctuations on the base region should be kept in mind when examining the near wake results for this case. The trend of transition to move closer to the base with cooling, however, is an effect predicted by linear stability theory (6).

In an attempt to verify the consistency of the Mach number results in figure 16, a comparison was made using the data for the two adiabatic wall wedges. Since free stream Reynolds numbers were equal for two test conditions for each model, even though base heights differed by a factor of two, it would be expected that axial Mach numbers should be in agreement. Figure 17 presents the results of this correlation and the comparison is seen to be quite favorable.

iii) Centerline Total Temperature

Corrected total temperatures along the wake centerline for both the flat plate and the large 20° wedge models are shown in figure 18. Similar data for .15" base height wedge were not measured and all results specified herein for this 20° wedge model correspond to the assumption of isoenergetic flow, namely $T_t = T_{t_{\infty}}$. Figure 18 again illustrates the increase in centerline growth rate as the flow experiences the onset of transition. The upstream movement of the most forward location of the transition region with increasing Reynolds number, is again clearly evident, and offers another illustration of the effect of turbulent diffusion on the wake's mean flow properties. Total temperature data were obtained only up to 6 inches downstream of the wedge bases because of probe support limitations. The absence of data forward of x/H = 1.5 for the 20° wedge data (excluding the wall temperature measurement) was caused by the ineffectiveness of the hot wire probe in very low

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density, low speed flow. Convective heat losses from the wire were so small that the wire temperature became dominated by probe support effects resulting in unacceptably inaccurate total temperatures. The variation of total temperature with Reynolds number and the distribution of total temperature within such a near wake region are of considerable importance to development of the wake downstream. The inability to obtain such information from the present investigation points out the necessity of other techniques for obtaining total temperature data in base flow regions. For example, several investigators have succeeded in measuring near wake temperatures behind slender bodies in both shock tubes and shock tunnels taking advantage of transient phenomena.

Examining the total temperature data of figure 18 clearly illustrates the pronounced effect which model cooling has on centerline total temperatures. Since wall temperature ratios $(T_W/T_{t_{\infty}} = .03 \rightarrow .12)$ associated with high speed entry into the atmosphere correspond to cold wall conditions, the cold wall data $(T_W/T_{t_{\infty}} = .19)$ would seem to be of more practical interest than the adiabatic wall results $(T_W/T_{t_{\infty}} = .87)$. The measured wall temperature, incidentally, for the adiabatic wall model agrees favorably with that predicted by theory for laminar flow (r = .85) at $M_{\infty} = 6$. iv) Centerline Velocity

Centerline velocity data for all four models used in the current investigation are presented in figure 19. Since the Mach number and total temperature data used to generate these results have already been discussed, little comment seems necessary at

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this time. The typical growth increases associated with the onset of transition are again clearly evident. The comparison between linear wake theory (5) and the lowest Reynolds number data for the adiabatic wall models is seen to be quite reasonable. The results for the larger wedge model (.3w-2A) are the least favorable and this is primarily the result of applying the theory not far enough downstream where the velocity defect has become sufficiently small $(1 - \frac{u}{u_e} << 1)$ as required by linear theory. Additional discussion of the validity of using linear theory for the present results will be presented shortly.

v) Centerline Enthalpy

Another quantity which is of interest in any study of far wakes, especially with the extreme temperatures associated with high speed reentry, is that of the distribution of enthalpy along the wake centerline. Figure 20 presents the results from the current investigation and, as might be expected, an appreciable difference between the adiabatic and cold wall data is evident. All three adiabatic wall cases are quite similar in their decay characteristics, even to displaying the upstream movement of transition with increasing Reynolds number. Results of linear theory calculations are also shown on figures 20a, 20b and 20c illustrating the effects of Prandtl number and initial conditions on the computations. The cold wall results indicate a maximum centerline temperature of almost triple free stream values and in addition, for the low Reynolds number data, these relatively high temperatures persist for some distance downstream, a factor of great importance in evaluating wake observable

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phenomena. The sharp temperature rise taking place in the vicinity of the base occurs primarily within the recirculating zone of the base region. This result and the fact that a maximum temperature occurs somewhat downstream of the rear stagnation point can be explained by examining the balance between thermal and kinetic energy along the wake centerline. Since the flow velocities within the recirculating zone are small, the total energy of the centerline flow initially consists primarily of thermal energy. The axial distribution of enthalpy along the centerline thus follows closely the total enthalpy variation (figure 18). However once downstream of the rear stagnation point the flow velocities increase rapidly with the result that the centerline enthalpy attains a maximum followed by a gradual decay as the kinetic energy of the flow increases and begins to account for a greater share of the centerline total enthalpy. This latter effect is clearly in evidence in the adiabatic wall cases wherein, because the total enthalpy is nearly constant in the far wake, the enthalpy decay along the centerline is just matched by the kinetic energy increase.

vi) Integral Thicknesses

Integral wake thicknesses for the present results are presented in figure 21. Integration of the boundary layer equations indicates that the expected variation for these thickness data should be as follows:

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$$\frac{d}{d(x/H)} \left[\frac{\rho_e u_e^2}{\rho_e u_{e_{\infty}}^2} \frac{\overline{\theta}}{\overline{H}} \right] = -\frac{\rho_e u_e}{\rho_{\infty} u_{\infty}^2} \frac{du_e}{d(x/H)} \frac{\delta^*}{H} = \frac{1}{\rho_{\infty} u_{\infty}^2} \frac{dp}{d(x/H)} \frac{\delta^*}{\overline{H}}$$
$$\frac{d}{\rho_e u_e} \frac{dp}{\overline{\rho_e} u_e} \frac{\overline{h}}{\overline{H}} = 0$$
$$\frac{d}{d(x/H)} \left[\frac{\rho_e u_e}{\rho_{\infty} u_{\infty}} \frac{\overline{h}}{\overline{H}} \right] = 0$$
$$\frac{d}{d(x/H)} \left[\frac{\delta^*}{\rho_{\infty} u_{\infty}} \frac{\overline{h}}{\overline{H}} \right] = 0$$
$$\frac{d}{\overline{h}} = \int_{0}^{\infty} \frac{(1 - \frac{\rho u}{\rho_e u_e}) d(y/H)}{\rho_e u_e} (1 - \frac{u}{u_e}) d(y/H)$$
$$\frac{\overline{h}}{\overline{H}} = \int_{0}^{\infty} \frac{\rho u}{\rho_e u_e} (1 - \frac{T}{T_{te}}) d(y/H)$$

The slight increases in momentum thickness with axial distance are partially caused by the small axial pressure gradients depicted in figure 15 and the transverse entropy gradient characteristic of some viscous wakes. This latter effect is brought about because some of the streamlines passing through the stronger portions of the curved bow shock first enter the viscous far wake at varying distances downstream. The additional "drag" associated with these streamlines is similar to the outer wake drag typical of blunt bodies which experience extensive normal shock pressure losses. Some growth of momentum thickness (drag) with axial distance is thus not surprising.

Similar explanations based on fluid mechanical phenomena cannot be made to account for the slight increase in energy thickness of the cold wall data. Since these data should remain constant with axial distance, the small growth rate experienced by the energy

thickness in figure 21d represents a measure of the cumulative error occurring for the present results. Considering the various corrections and calibrations associated with the current measuring techniques such a result, however, is not unexpected.

vii) Wake Thickness

Figure 22 presents results of wake thickness and wake shock position for the four models used in the current investigation. The rapid change in Pitot pressure at the wake shock (figure 44) clearly determines the location of this shock. The midpoint of this sharp Pitot pressure change has been used as the wake shock position. The wake edge data of figure 22 were obtained by determining those locations where the tangent to the maximum transverse gradient in Pitot pressure intersected the edge value of Pitot pressure. This definition coincides, within the accuracy of the present results, with the total-temperature edge (figure 45). From the data in figure 22 estimates of wake neck position are possible by noting the location of the minimum thickness point. Further, these results indicate that all the wakes initially grow almost linearly with downstream distance until, except for the low Reynolds number data, some point is reached where a sudden growth rate change takes place. The new growth rate again is nearly constant. Since fluctuations bring about increases in wake growth rates, these data are good indicators of the breakdown of the steady laminar flow condition. The upstream movement of this "transition" point with increasing Reynolds number is very noticeable. Similar results for wake thickness were obtained by Demetriades (30) in his experiments on hypersonic flows behind

20⁰ wedges using hot wire probes to measure turbulent fluctuations.B) Analysis of Transition

Wake transition distance is defined as the axial distance downstream from the base of a body to a location where the effects of transition produce a pronounced change in flow characteristics. In Demetriades' measurements behind 20⁰ wedges (30) and also Sato and Kuriki's data for incompressible flow behind a flat plate (29), the onset of increased turbulent fluctuations was designated as the beginning of transition. A similar approach has been used by Behrens for flow behind cylinders in hypersonic flow (7). The present results correspond to a transition location based on the axial distance from the model base to the position in the wake where the wake thickness growth rate shows a sudden change. These transition locations are specified in figure 22 and are replotted in figure 23 as a function of reciprocal of Reynolds number. The results therein illustrate that a linear variation exists not only when free stream Reynolds numbers are used but also when the Reynolds number is based on edge conditions. This linear variation in turn can be used to define a transition Reynolds number since the slope of the curves, for each of the models, corresponds to a Reynolds number based on the axial distance between a zero intercept distance, obtained by extrapolating the measured data to infinite Reynolds number, and the transition location. As explained by Lees (31), the noted linear variation of transition distance cannot continue indefinitely as the Reynolds number is decreased. In fact a minimum critical Reynolds number is reached below which viscous dissipation

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prevents the existence of wake turbulence. Thus all curves in figure 23 would eventually curve upward if lower Reynolds number measurements had been made. Demetriades illustrates this effect in his measurements (30).

From the results of figure 23 the following transition Reynolds numbers seem appropriate:

Model	Re _{∞∆x}	^x _H) _{TR} o	Re _{e Ax}	$\left(\frac{x}{H}\right)_{TR}$
Flat Plate	50,000	35		
20 ⁰ Wedge, adiabatic wall	3.5×10^5	8.5	2.8×10^5	8.5
20 ⁰ Wedge, cold wall	3.3×10^5	2.0	2.5×10^{5}	2.0

Although the flat plate value corresponds closely to the result which Demetriades obtained by extrapolating his wedge data to the 0° included angle case (flat plate) [Re_{$\infty \Delta x} = 56,000$], the zero intercept distance found herein $[x/H]_{TR_{\circ}} = 35$] differs substantially from his data $[x/H]_{TR_{\circ}} = 15$]. H, as used both for the present correlation and Demetriades' results, represents the sum of the total boundary layer displacement thickness, as calculated, and the plate thickness. A satisfactory explanation for the noted discrepancy is not known at the present time.</sub>

On the other hand, present transition results for the adiabatic wall 20° wedge data not only show agreement between the two different sized models, but are seen to compare favorably with those data measured by Demetriades in his turbulent fluctuation experiments. This agreement occurs both in terms of free stream transition Reynolds number ($\operatorname{Re}_{\infty \wedge \mathbf{r}} = 3. \times 10^5$, Demetriades) and the zero intercept distance. In addition, transition data for flow behind sharp nosed cones at $M_{\infty} = 6$ indicate that a transition Reynolds number based on edge conditions ($\operatorname{Re}_{e\Delta x} = 2.3 \times 10^5$), compares favorably with the present data. Such findings verify the use of the present mean flow technique for locating the approximate location of transition in lieu of detailed flow turbulence measurements.

It should be pointed out, however, that centerline properties apparently "sense" the onset of transition a short distance upstream , of those locations of transition as defined from wake thickness results. This is evident from figure 16 by comparing these transition locations with the initial deviation of the centerline Mach number data from the low Reynolds number results. These centerline deviations become important when evaluating the forward extent of the transition zone and its relevancy to the laminar nature of the near wake. For example, from figure 16, it is questionable whether or not the near wake for the cold wall wedge at $\text{Re}_{\infty H} = 5.5 \times 10^4$ is indeed completely laminar, since the centerline Mach number data therein commence deviating as far upstream as x/H = 3.

Figure 23 illustrates the pronounced effect which cooling has on wake transition. The significant upstream movement of transition distance for a given Reynolds number with cooling indicates the increased flow instabilities associated with cold wall bodies.

As a final comment on these transition results, it is appropriate to reexamine the low Reynolds number data of figures 15 through 22. Since now transition Reynolds numbers are available,

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it is possible to make estimates of transition distances for these cases. The results are:

Model	\mathbf{x}_{TR}
Flat Plate, L = 1 inch	7.5L
20° Wedge, adiabatic wall, H = .15 inch	58.5H
20° Wedge, adiabatic wall, H = .3 inch	33.5H
20° Wedge, cold wall, H = .3 inch	27.5H

These results additionally substantiate the earlier claim that the low Reynolds number data were representative of laminar flow for large downstream distances. Furthermore, the absence of the ''break away'' phenomena in the centerline measurements also verifies that such data correspond to laminar flow even to the farthest downstream station at which measurements were made.

C) Comparison of Present Results with Linear Wake Theory

The two-dimensional linear wake theory, as derived by Kubota (4) for compressible flow and arbitrary streamwise pressure gradient, incorporates the Oseen type approximation along with the assumption that the initial velocity and enthalpy distributions correspond to delta functions. A modified version of this theory has been developed by Gold wherein arbitrary initial profiles are acceptable (5). Basically the theory requires, in addition to the necessity for the boundary layer equations to remain valid, that the velocity defect be small (1 - $\frac{u}{u_e} \ll 1$), and that both the Prandtl number and Chapman-Rubesin factor (C = $\frac{\rho_e^{\mu}e}{\rho\mu}$) be constant. Under these assumptions and with the additional approximation of negligible axial pressure gradient, which would seem appropriate from the far wake results of figure 15, the linear wake theory gives the following results:

$$w \equiv \frac{u_e^{-u}}{u} = \frac{1}{\sqrt{4\pi \bar{x}/H}} \int_{-\infty}^{\infty} w_o(\bar{\xi}/H) \exp\left[-\frac{(\bar{\xi}/H - \bar{y}/H)^2}{4\bar{x}/H}\right] d(\bar{\xi}/H)$$

$$g \equiv \frac{h-h_e}{h_e} = \sqrt{\frac{Pr}{4\pi\bar{x}/H}} \int_{-\infty}^{\infty} g_o(\bar{\xi}/H) \exp\left[-\frac{Pr(\bar{\xi}/H-\bar{y}/H)^2}{4\bar{x}/H}\right] d(\bar{\xi}/H)$$

where
$$\overline{y} = \frac{\rho_e u_e}{\rho_\infty u_\infty} \sqrt{Re_{\infty H}C} \int_0^y \frac{\rho}{\rho_e} dy$$

$$\overline{\xi} = \frac{\rho_e u_e}{\rho_\infty u_\infty} \sqrt{Re_{\infty H}C} \int_0^{\xi} \frac{\rho}{\rho_e} d\xi$$

$$\overline{x} = \int_0^x \frac{\rho_e u_e^{\mu}}{\rho_\infty u_\infty^{\mu} \omega} dx$$

 $w_{o}(\xi/H) = \frac{u_{e}^{-u}}{u_{e}}$ at initial wake station where $x = x_{o}$

$$g_{0}(\xi/H) = \frac{h-h}{h_{e}}$$
 at initial wake station where $x = x_{0}$

This formulation of the linear wake solution has been programmed on the IBM 7094^{*} and various calculations have been carried out to examine the effect of initial conditions and Prandtl number on the computations. Several results of these calculations are shown in figures 19 and 20, where centerline distributions of velocity and enthalpy for the low Reynolds number cases are compared with measured adiabatic wall data. In general, the flat plate calculations of

* Behrens, private communication both velocity and enthalpy are in favorable agreement with the data. The velocity results, for the small base height 20° wedge (.15w), similarly agree with the data. However such agreement is not as satisfactory for the large wedge model (.3w-2A) for both velocity and enthalpy results due apparently to the use of initial conditions $\left(\frac{x}{H}\right)_{\circ} = 10$) not sufficiently far downstream where velocity defects are small enough to justify using linear theory.

The relatively large deviation between theory (Pr = .75) and data for the enthalpy results of the small wedge, figure 20b, are perhaps due mainly to the lack of measured total temperature data. The noted variations therefore should not be taken too seriously. Shown also on this figure is the effect of varying Prandtl number from .75 to 1. The Pr = 1 case, which compares quite favorably with the data, may be more realistic here since it too corresponds to constant total enthalpy.

Velocity and enthalpy profile distributions have also been calculated and these results are presented in figures 24 and 25 as functions of the transformed y coordinate. For the flat plate and small wedge models, the comparisons between predicted and measured velocities appear to be quite good. A better correlation in the case of the large wedge data (.3H-2A) for both velocity and enthalpy results would be possible if the initial stations were chosen further downstream say at $x/H)_0 = 15$ instead of $x/H)_0 = 10$. The flat plate enthalpy profiles, as predicted, are not in very satisfactory agreement with the measured data even though centerline results agree quite favorably. Again this indicated deviation would improve considerably by making use of an initial station further downstream.

From linear theory it can also be shown that velocity defect results for all models should correlate well with the normalized axial distance

$$\overline{\mathbf{x}}/\mathrm{Re}_{\overline{\theta}_{\mathrm{avg}}}\overline{\theta}_{\mathrm{avg}}$$

The results of such a correlation are presented in figure 26 and the collapsing of the data for all three adiabatic wall models investigated verifies the use of this normalized distance.

In general, the low Reynolds number far wake data obtained during the present investigation under adiabatic wall conditions show very satisfactory agreement with linear theory. Such a finding further substantiates the laminar, steady nature of these data and illustrates the value of this theory as an effective method of analysis for the laminar far wake behind two-dimensional slender bodies. IV.2 Near Wake

A) Near Wake Geometry for a Flat Plate in Hypersonic Flow

The flow in the vicinity of the trailing edge of a flat plate represents a problem in fluid mechanics which has been of interest to investigators for many years. Since some near wake measurements were made during the present investigation of the flat plate hypersonic wake, it was considered desirable to report on available data even though, because of inherent measurement limitations, results were limited primarily to near wake geometries. Figure 27 presents these geometry data for each of the four Reynolds numbers investigated. Shear layer and wake thicknesses were determined from total temperature distributions (figure 45) whereas both the wake and leading edge shocks were located from pilot pressure traces (figure 44). Those boundary layer edge locations indicated on the figure were calculated from the weak interaction theory (36) and the finding of Kendall (32), from his flat plate study, that $\delta^*/\delta \doteq$.75. The existence of the wake shock illustrates that the flow recompresses as it turns back to the free stream direction from its trailing edge orientation. The two degree reverse taper to the trailing edge, and the thin but finite thickness of the plate are clearly not in keeping with the infinitesimally thin flat plate assumption of analytical studies. Also shown in figure 27 are centerline sonic point locations $(x/L \doteq .2)$ as determined by extrapolating the Mach number data of figure 16a.

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Correlation of the wake thickness data with predicted boundary layer thicknesses are shown in figure 28. The favorable correlation indicated in figure 28 illustrates the dependence of the near wake thickness on the plate boundary layer thickness. The fact that the initial wake thickness is somewhat larger than what would be predicted from boundary layer theory can be accounted for by analyzing the mass flow balance between the boundary layer and near wake. This analysis indicates that

$$\begin{bmatrix} \rho u \delta & (1 - \frac{\delta^*}{\delta}) \end{bmatrix}_{BL} = \begin{bmatrix} \rho u \delta & (1 - \frac{\delta^*}{\delta}) \end{bmatrix}_{NW}$$

where $\delta^* = \int_0^{\delta} (1 - \frac{\rho u}{\rho_e u_e}) dy$

Since

$$\left(\frac{\delta^{*}}{\delta}\right)_{\mathrm{BL}} \doteq \left(\frac{\delta^{*}}{\delta}\right)_{\mathrm{NW}}$$

and $^{u}BL \stackrel{*}{=} ^{u}NW$

the mass balance equation reduces to

However, assuming isentropic flow, it follows that

$$\delta_{\rm NW} \doteq \left(\frac{{\rm p}_{\rm BL}}{{\rm p}_{\rm NW}}\right)^{1/\gamma} \delta_{\rm BL}$$

Thus, because the near wake pressures are lower than the plate pressures (figure 15a), some increase in wake thickness over that predicted by boundary layer theory is expected.

Another wake feature that can be determined with reasonable accuracy from the present results is the wake neck thickness. From the wake growth results of figure 22a it is estimated that the neck occurs at or near x/L = .5. The resulting thicknesses are presented in figure 29 as a function of free stream Reynolds numbers and a square root variation with Reynolds number is evident. The variation of the neck thickness with Reynolds number in this manner can be deduced from a mass balance analysis, similar to that described above for the initial near wake thickness, and on the dependence, according to boundary layer theory, of the thickness of the trailing edge boundary layer on the square root of Reynolds number.

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B) Near Wake Behind 20⁰ Wedge

The near wake behind slender bodies has been the subject of many experimental investigations for the past several years. Both shock tunnel facilities and continuous flow wind tunnels have been used for these investigations. Mach numbers ranging from low supersonic to hypersonic values and flow regimes from all laminar through transitional to fully turbulent flow have been examined. The primary aim has been to define a physically realistic model for the flow which will be amenable to analytical study. Since many of these investigations were somewhat limited in the amount and type of measurements that could be obtained, it was felt early in the current experimental program that a reasonably detailed study of the near wake with hot wire and Pitot probes would prove meaningful even though some accuracy difficulties would be experienced. Such data, although able to provide only limited information on the base recirculation region, because of previously mentioned hot wire uncertainties in subsonic flows, would furnish an interesting supplement to the near wake data already available.

i) Neck Thickness

By examining the wake growth results of figure 22 the minimum wake thickness values have been determined for all three of the 20° wedges used in the present investigation. These neck thickness results are presented in figure 29 as a function of Reynolds number and a square root variation is apparent. The mass balance analysis discussed above for the flat plate results (Section IV.2A), and which provided an explanation for the dependence of the flat plate neck

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thickness on the square root of Reynolds number, is similarly applicable for these wedge data. Consistency of the adiabatic wall results is evident in that the data for both the H = .15'' and H = .3'' wedges coincide in a favorable manner. Also shown on the figure are trailing edge boundary layer thicknesses as measured from total temperature profiles for the three tenths base height wedge under adiabatic and cold wall conditions. From boundary layer theory these data should vary with the square root of Reynolds number and the results of figure 29 satisfactorily indicate this trend.

In conducting an investigation of this type it is of interest to determine the significant scaling parameters which play a dominant role in establishing the flow field. Although the neck thickness data in figure 29 illustrate that a correlation with Reynolds number exists, it is also indicated therein that, when presenting the data in this manner, the results for the adiabatic and cold wall wedges correspond to two separate curves. However, if the data are replotted in terms of the thickness of the trailing edge boundary layer, both the adiabatic and cold wall data collapse to one curve (figure 30). This result additionally verifies Chapman's (37) finding that the noted thickness represents an important length scale for near wake flows. Figure 30 also indicates that for flow approaching zero boundary layer thickness the neck thickness behaves properly for this inviscid limit and becomes negligibly small.

ii) Wedge Surface Pressure

The upstream influence of the low base pressure and the corner expansion on wedge surface pressures is illustrated in figure

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31. These adiabatic wall data were obtained with the solid wedge model (.3w-1A) discussed in Section II and indicate that the flow first "senses" low base pressures roughly two to three boundary layer thicknesses upstream of the base. Also shown on the figure for comparison purposes are calculated trailing edge pressures as determined using Kendall's results from his investigation of hypersonic flow over a flat plate (32).

Unfortunately, the small size of the model used in the present investigation prevented making pressure distribution measurements along the model base. Hama's results for such base pressure data on 12⁰ wedges (28), clearly demonstrate that an undershoot in pressure first occurs on the base after which the flow undergoes a rise in pressure to the base pressure value. Such a trend is indicative of flow which remains attached to a surface so long as a favorable (decreasing) pressure gradient exists but then tends to separate once it senses an unfavorable (increasing) pressure gradient. Thus separation of the flow from the body does not necessarily occur just at the corner but in fact occurs some distance below the corner and only when a sufficient overexpansion takes place such that the surface pressure falls below the final base pressure level. This off-corner separation result is further substantiated from the flow field mapping results to be discussed in detail shortly. These data illustrate that zero velocity and sonic line extrapolations upstream to the base, intercept the base line below the corner in the manner depicted by Hama. This finding supports the conclusion of Hama that the lip shock in the near wake is caused by a separating boundary layer and thus

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is similar to the separation shock generated in the near wake of a cylinder.

iii) Wedge Base Pressure

The results of base pressure measurements for the three wedge models are presented in figure 32. These data show the variation of base to free stream pressure ratio with trailing edge Reynolds number as determined from inviscid flow theory. Also shown in figure 32 for comparison purposes, are the adiabatic wall data of Dewey for both 30° and 45° wedges (8). General agreement in both trend and magnitude is seen to exist for all adiabatic wall results. The significant decrease in base pressure with increasing Reynolds number is again emphasized by the present results. Consistency of the present adiabatic wall data is illustrated by the correlation of results from both the small (.15w) and large (.3w-2A) 20° wedges. Figure 32 also indicates that a drop in base pressure is associated with model cooling.

Since Chapman (37) as well as others have pointed out the dependence of base pressure on the thickness of the trailing edge boundary layer, and further, because a successful correlation of both adiabatic and cold wall neck thickness data has also been achieved herein with this scaling parameter, a correlation of the base pressure data has also been made with the trailing edge thickness and the results are shown in figure 33. For the adiabatic wall data the weak interaction theory modified per Kendall's results has been used to determine $(\delta/H)_{TE_{Theorv}}$. On the other hand, the cold wall trailing

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edge thickness is based on Chapman-Rubesin boundary layer theory for arbitrary wall temperature (38). Base pressure estimates using Chapman's dividing streamline model (11) have been made and results for $\theta = 45^{\circ}$ and $\theta = 20^{\circ}$ are shown on figure 33. According to the idealized version of this model, the flow along the dividing streamline separating the base's recirculating flow from the outer flow, attains a maximum velocity of $u_*/u_e = \overline{u}_* = .587$ and then recompresses isentropically and instantaneously to the downstream pressure level. Thus

$$\frac{p_{b}}{p_{\infty}} = \left(\frac{p_{sp}}{p'} \frac{1}{\eta}\right) \left(\frac{1 + \frac{\gamma - 1}{2} M'^{2}}{1 + \frac{\gamma - 1}{2} \frac{M'^{2}}{1 - \overline{u}_{*}^{2}}}\right)^{\gamma/\gamma - 1}$$

Here, ()' refers to downstream conditions determined by expanding inviscid wedge flow isentropically back to the free stream direction. Such a computation method has been found to give essentially the same results, as one where inviscid wedge flow is first overexpanded, then recompressed through a weak oblique shock back to the free stream direction. The factor, $\frac{P_{sp}}{p!} \frac{1}{\eta}$, represents a "recompression efficiency factor" and accounts for the uncertainties in the analysis. Although the estimates on figure 33 are invariant with Reynolds numbers, the overall levels seem to compare favorably with the measured data for an "efficiency factor" of one. This favorable magnitude result occurs even though the isentropic recompression assumption of the Chapman analysis is seen not to be realistic for the present results (figure 15). Although the method of correlation used in figure 33 still retains the wedge angle as an important variable in the base pressure determination, it is clear that the data for each wedge scales favorably with the trailing edge thickness. Admittedly, for the adiabatic wall data, this is an expected result since it has already been shown that the base pressure varies with trailing edge Reynolds number (figure 32). However, as was found in correlating the neck thickness data discussed above, the important finding indicated by the figure 33 results is the collapsing of both the adiabatic wall and cold wall base pressure data for the present investigation to a single curve. This result further substantiates the significance of the trailing edge thickness as a suitable length scale for the base flow problem.

In an effort to determine additional characteristic parameters for the base pressure data several other combinations of variables have been attempted. One finding is that all adiabatic wall data from both Dewey's and the present studies collapse to one curve with only $\pm 7\%$ scatter by presenting p_b/p_{∞} as a function of free stream Reynolds number based on the base height (figure 34). This result, indicating only minor dependence on wedge angle, was similarly found by Cheng et al. (39) in their experimental investigation of wakes behind wedges in low density flow.

iv) Rear Stagnation Point

The rear stagnation point location is the position on the wake axis where the flow stagnates and separates the reverse flow in the base region from the downstream wake. Most initial conditions for near wake calculations make use of profile data corresponding to the

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location of the rear stagnation point. In addition, relatively high temperatures exist at this point, as discussed in Section IV.1, and thus electron densities can be correspondingly large in actual atmospheric entry. For the present set of measurements with the three-tenths base height wedge and for both adiabatic and cold wall conditions, the position of the rear stagnation point has been located at x/H = .75. These results are evident from the data of figure 35 wherein centerline static and Pitot pressure data were plotted as a function of axial distance. Although the location of the point where the curves coalesce (rear stagnation point) may be somewhat uncertain because of the small cross angles involved, the resulting locations of the rear stagnation points are believed to be accurate to within + .1 H at least for all the adiabatic wall data and for those results corresponding to the two lowest Reynolds numbers of the cold wall model. An uncertainty estimate somewhat larger may seem more realistic for the two highest Reynolds number cold wall. data because of the greater difficulty in accurately determining the crossover point. The x/H) = .75 result was also confirmed, for the adiabatic wall condition, by use of the differential pressure probe discussed in Section II. Both of these methods for determining the rear stagnation point position have been used by Martellucci, et al. (26) in their experiments on the turbulent near wake of a cone at M = 6 and similar agreement between the two techniques was obtained. The values of x/H = .75 for the present results are in good agreement with the summary curve of reference 26 showing the variation of rear stagnation point location with trailing edge Reynolds

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number. The data used by Martellucci et al. for this summary comprise measurements from not only wedges but also cones and cylinders as well under cold and adiabatic wall temperatures and even both laminar and turbulent flow conditions. A satisfactory correlation of most data and a general trend indicating a slight aft movement of the rear stagnation point with trailing edge Reynolds numbers (trailing edge boundary layer thickness) are evident. The movement aft of x/H)_{sp} for the high Reynolds number cold wall data in the present investigation may appear to have occurred (figure 35b) but the noted data uncertainty prevents concluding such a trend. If such were the case however, it would be in agreement with the summary data of reference 26 for decreasing trailing edge boundary layer thickness. v) Wall Temperature Ratio

Of interest in an experimental investigation of this nature is the comparison between already existing data and current results. One such comparison, in the case of the cold wall model, is the relationship of the temperature at the wake's rear stagnation point to the model's wall temperature. Figure 36 presents a summary of results from other investigations along with the present data showing this relationship in terms of normalized temperature ratios. The free stream stagnation temperature has been used as a normalizing parameter for the data. It is evident from figure 36 that the present cold wall results compare favorably with previous data.

vi) Typical Shear Layer Profiles

Before analyzing flow field mappings of the near wake behind the three-tenths base height wedge, it seems appropriate to discuss

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briefly several typical profiles for the near wake shear layers. These profiles, all for the low Reynolds number adiabatic wall case, are plotted in figure 37 in overlap fashion with the base geometry, so as to illustrate the manner in which characteristic lines and/or regions are distinguishable. For example, figure 37a, showing transverse Pitot pressure traces, indicates that the leading edges and wake shock positions were determined from the Pitot pressure gradients occurring at these respective locations. The relatively slight change in Pitot pressure gradient indicated near the axis for the x/H = .5 trace is more suggestive of compression Mach waves, and thus has been associated with the lip shock arising from the flow separation at the base. From these data, and also the profile results of figure 44, showing all the Pitot pressure data taken during the current investigation, it can be seen that both the wake and lip shocks have substantial width $(\Delta \frac{y}{H})_{S} \doteq .10$ H). This was similarly observed by Dewey (8) in his studies of the near wake behind a cylinder. A computation was made of the orientation of the leading edge shock wave based on the assumption of weak shock-boundary-layer interaction and the existence of simple wave flow between the boundary layer edge and the shock wave. The calculated result was within $.5^{\circ}$ of the measured shock wave angle at the model's trailing edge. The u = 0line indicated in figure 37a corresponds to those transverse locations where the static pressure, as measured on the wake's centerline, and Pitot pressure are equal. This line terminates at the rear stagnation point location which has been determined in a similar manner.

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One near wake characteristic, which has not been determined to any great extent by existing near wake investigations, is the location of the shear layer edge. Figure 37b presents total temperature profiles for the near wake shear layer, and the temperature overshoot, typical of adiabatic wall boundary layer profiles, is evident. The locations where the overshoot decreases to zero, namely where the total temperature achieves equilibrium with the free stream total temperature, represents the shear layer edge. This edge, in essence, corresponds to the boundary between that portion of the flow unaffected by the temperature of the wall and that part of the flow which has been affected by the wall through the action of viscosity and heat conductivity. It will be recalled that in the far wake either Pitot pressure or total temperature results could be used to determine the wake edge. In the near wake region, downstream of the base, such use of the Pitot pressure data is not possible because of the Pitot pressure gradients associated with the expansion fan outside the shear layer. At the trailing edge, where the effect of the expansion fan on Pitot pressure is quite small, values of the boundary layer thickness based on the Pitot pressure profile compare favorably with edge data derived from total temperature traces. The one open symbol indicated in figure 37b on the model surface at x/H = -.5 corresponds to a calculated boundary layer thickness based on the Chapman-Rubesin compressible boundary layer theory (38) for arbitrary wall temperatures. The thickness so noted agrees favorably with similar thickness estimates based on the weak interaction theory. An interesting result of figure 37b is the location and

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variation of the shear layer's edge with axial distance. Not only is the wake neck, defined as the wake's minimum thickness location, not located near the wake's rear stagnation point, but it even occurs downstream of the centerline sonic point as will be shown shortly. The tendency of the shear layer to avoid turning sharply downstream of the model base indicates that extremely low densities exist within the immediate vicinity of the base. This result is of significance to the development of the viscous sublayer postulated in many of the analytical techniques currently under investigation. Complete total temperature profile data for the current investigation are presented in figure 45 and the above comments, regarding the shear layer edge, are seen to hold true for all cases.

The Mach number distributions of figure 37c illustrate that rather high Mach numbers ($M \ge 6$) are experienced by the separated shear layers in the present near wake investigation. This constitutes a major distinction between near wakes behind slender bodies with flat bases, and near wakes behind blunt nosed bodies with rounded bases such as spheres and cylinders where shear layer Mach numbers are usually less than three (8). From figure 37c the location of the sonic line and the manner in which it fairs smoothly into the centerline sonic point is clearly apparent. Such a line is also arrived at directly by locating the position where the ratio of static pressure, assumed equal to the pressure on the centerline, to Pitot pressure corresponds to the value at Mach number unity, namely, $p/p_{t_2})_{M=1} = .5283$. This represents a satisfactory method for determining the sonic line since the static

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pressure, as will be shown shortly, is nearly constant across the base region up to the wake (or lip) shock. Between the wake shock and shear layer edge, the accuracy with which certain flow data, such as Mach number, static pressure, and static temperature, have been determined is rather poor as discussed in Section III. The present method for determining these data using hot wire measurements was shown to have inherent uncertainties that limit data accuracy at high Mach numbers. This point should be kept in mind when evaluating certain trends and even data scatter. On the other hand, those data within the wake shock boundaries correspond to low Mach numbers (M < 3) and thus should be reasonably accurate.

Several interesting results from the present investigation have been obtained from static pressure profiles such as those shown in figures 37d and 42. All the data in figure 37d, represented by open symbols and below the shear layer edge, are the values of static pressure arrived at by combining Pitot pressures with total temperatures and mass flux data from hot-wire measurement. Within the accuracy limits specified in Table II, the results indicate that, not only is the static pressure constant from the centerline out to the wake shock and equal to the value measured at the centerline with a static pressure probe, but also that the static pressure, at least for x/H = 1.5, from the wake shock out to the shear layer edge is, in addition to being constant, equal to the base pressure. The data near the corner show that the effects of the corner expansion become progressively more dominant within the shear layer, until at the trailing edge, the entire shear layer

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from the edge down to the zero velocity line is experiencing large lateral pressure gradients. Thus, clearly the shear layer cannot be considered as a region of constant transverse pressure until several boundary layer thicknesses downstream of the base. Such a pressure gradient exists also in the case of attached flow negotiating an expansion corner. Because these data show that the static pressure is roughly constant from the wake axis out to the base region shocks, a simplified data reduction procedure was carried out, in which all the wake profiles and the flow field mappings within the base region shock boundaries have been derived by calculations based on a zero pressure gradient assumption in a manner similar to all far wake results. Figure 37d also shows the locations of the leading and trailing rays of the corner expansion fan defined by the method of tangents indicated on the figure. Admittedly the determination of these limiting rays for the corner expansion is somewhat arbitrary. In fact it may even seem more appropriate to select the round off points experienced by these curves as more representative of the location for the leading and trailing rays. If such a technique were used, the leading and trailing rays would be displaced outward and inward respectively from the location indicated in figure 37d. However, the difficulty in consistently locating the round off points resulted in appreciable uncertainty in the final orientation of the limiting rays. Thus the present technique, based on the tangent to the maximum static pressure slope, has been adopted for determining the leading and trailing ray positions. The leading ray orientation, incidentally, as

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determined in this manner agrees very well with the Mach wave angle for the inviscid wedge flow of the present investigation. Normally, since the total pressure is constant within the outer inviscid region, the leading ray can be determined from the Pitot pressure data directly. However the trailing ray, since it becomes immersed in the shear layer, cannot be located by Pitot pressure data alone, and thus the present results, using hot wire measurements, provide another characteristic line which has not been determined in most near wake measurements to date. Because the Mach number decreases in the shear layer as the trailing ray approaches the base, a slight curvature of this line is observed. The Mach wave angles for the local flow along a trailing ray have been compared with the orientation of the trailing ray itself and a satisfactory agreement was obtained. The forward extension of the leading ray of the expansion fan shows the approximate region of upstream influence to which the body boundary layer is subjected. Recognizing the fact that some outward adjustment of this estimate of the leading ray position is warranted because of the above-mentioned uncertainty in locating this line, the extent of upstream influence agrees in general with the results of the surface pressure measurements discussed earlier.

The final set of shear layer profiles, which merit some attention, are the velocity and static enthalpy results of figures 37e and 37f respectively. Results such as these are often used as initial profiles for analytical studies of the near wake. The data of figure 37e and also the complete profile results of figure 43 illustrate that

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the velocity profiles experience a noticeable gradient change in the vicinity of the wake shock. The small velocity variation that occurs in the shear layer outside the wake shock, at least for the downstream stations, is not entirely unexpected since the velocity is relatively insensitive to the variations in the high Mach numbers which exist in this region of the shear layer. The enthalpy data of figure 37f point out that peak enthalpies for the near wake of an adiabatic wall model occur on the wake axis. Shortly, similar data will be presented for the near wake behind the cold wall wedge and a pronounced difference in enthalpy distribution will be in evidence. vii) Near Wake Flow Field Mappings

Perhaps the most important set of results, from the present near wake investigation, are the flow field mappings for both the adiabatic and cold wall models shown in figures 38 and 39. The data presented in these figures not only indicate the location of the characteristic lines discussed in the previous section, but also illustrate the relative orientation of base region streamlines, constant total pressure lines and, as in the case of the cold wall wedge, lines of constant total temperature. Position accuracy for these lines is estimated to vary from \pm .01H at the base station to about \pm .02H at stations further downstream. The streamlines were obtained by integrating profile data from the leading edge shock down to the wake shocks, at which location they were then matched with calculated streamline values arrived at by integrating from the wake centerline using the assumption of zero pressure gradient. In an effort to verify the streamline orientation for the adiabatic case, additional calculations of flow direction were made by combining Pitot pressure data, both upstream and downstream of the wake shock, with centerline pressure data. The resulting flow orientation angles are indicated by the short lines drawn to the shock location symbols. The comparison between the streamlines and these flow direction lines is seen to be very favorable. The tendency of the flow to be disinclined to negotiate the sharp turn at the base is clearly obvious in all the figures. Further, the small mass flow present within the lower portions of the shear layer is now well pointed out. The resulting low Reynolds numbers then suggest that any viscous layer which is developing within the shear layer will experience an appreciable growth rate. This follows by noting that, as a first approximation, the viscous layer will grow according to the flat plate boundary layer theory:

$$\frac{\delta_{e}}{H} \approx 5 \sqrt{x/H} / \sqrt{Re_{e_{H}}}$$

$$\frac{d(\delta_{e}/H)}{d(x/H)} \sim \frac{2.5}{\sqrt{x/H} \sqrt{Re_{e_{H}}}}$$

At station x/H = 0.1, which is just downstream of the base separation point, the Reynolds number is of the order of 200 for the data corresponding to figure 38a. A thickness of about $\delta_e/H = 0.1$ and a growth rate $(d(\delta_e/H)/d(x/H))$ corresponding to approximately 30° are thus calculated for this station. By making a rough estimate of the location and orientation of the inner edge of the viscous layer from the position of the sonic and u = 0 lines in figure 38a, it is

seen that such a viscous layer edge is in only fair agreement with the so-labeled line indicated in the figure. This line has been determined as the locus of points where the total pressure lines begin to diverge from the streamlines. However, considering the uncertainties associated with both measured and calculated results, such a discrepancy, which represents a rough estimate of the orientation and location accuracy for the viscous layer's measured edge, does not seem unreasonable. The fact that the total pressure remains almost invariant along streamlines within the shear layer and for some distance downstream of the corner, as indicated in the figure, illustrates that such a flow corresponds to an isentropic turn, so often postulated in analytical studies. Although the various data uncertainties discussed in Section III are inherent in the flow field mapping results, the consistent trends exhibited by both cold and adiabatic wall data for all Reynolds numbers investigated offer substantial verification for the noted findings. The complexity of the base region problem is now quite obvious. At one time it had been speculated that the viscous layer was contained within the wake shock boundaries and that inviscid rotational characteristic methods could then be utilized for the flow between the wake shock and shear layer edge. It is seen that this analytic model is open to question since the wake shock now appears to be imbedded within the viscous layer itself. Admittedly the viscous layer edge tends to move toward the wake shock with increasing Reynolds number and cooling, but even at the highest Reynolds number cold wall results, figure 39d-1, it still is observed to be distinctly above the wake shock itself. The

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cold wall total temperature lines exhibited in figure 39-2 indicate only minor variations of total temperature along streamlines outside the base region shock boundaries. Apparently the effects of thermal diffusion and viscous dissipation compensate each other in such a manner that total temperature variations along streamlines within this viscous region are negligible.

Various other results can be deduced from the data of figures 38 and 39. For example the projection upstream of the lip shock, sonic line and zero velocity line all indicate that flow separation is apparently occurring, not at the base corner, but actually some distance below the corner, as experiments of Hama have indicated. In addition, these figures show that the shear layer edge and location of wake shocks move toward the centerline with increasing Reynolds number and model cooling. Also, with cooling, the lip shock exhibits a tendency to "originate" farther upstream than for the low Reynolds number adiabatic wall cases. This result is evident from the Pitot pressure profile data of figure 44. With regard to the lip shock strength, it has been found that at x/H = 1.0, the farthest downstream position where the lip shock may be estimated to exist and where it appears to be the strongest, a variation of p_2/p_1 from 1.75 to 2 exists for all the near wake results of figures 38 and 39. These values of shock strength agree very well with Hama's correlation of wedge data (28) and further substantiate his claim that the lip shocks found in near wakes behind slender bodies are not necessarily negligible but, indeed, may be quite strong. The noted shock strengths, it should be pointed out, were

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obtained by ratioing centerline static pressures at x/H = 1.0 to base pressure data, since the static pressure profiles already discussed, indicated that pressures "upstream" of the lip and wake shocks were essentially equal in magnitude to base pressures, and that the pressures downstream were constant and equal to centerline values of static pressure.

Since detailed flow field mappings, such as presented in figures 38 and 39, provide a "picture" of the base region flow, a comparison can be made between such a "picture" and a Schlieren photograph of a given flow. This type of comparison is shown in figure 38d-2, where the base region mapping results for the high Reynolds number, adiabatic wall case (figure 38d-1), have been superimposed on a Schlieren photograph of the near wake behind a 20[°] wedge under virtually the same free stream conditions. The locations of the nose and wake shocks and the leading ray of the expansion fan as determined by the detailed flow field mapping and those as shown by the Schlieren photograph are seen to be in very favorable agreement. A similar comparison regarding the wedge boundary layer was not possible because light reflection effects due to model misalignment, obscured the boundary layer along the wedge surface in the Schlieren photograph (figure 1). The large density gradients which exist in the expansion fan and which extend into the shear layer itself, as results herein have indicated, are clearly shown by the "white shading" of the Schlieren portion of figure 38d-2. The inability of Schlieren photography to locate shear layer edges in these high speed wake flows, is thus well illustrated by this figure. At lower supersonic

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speeds and even for hypersonic flows behind blunt bodies where density gradients in the vicinity of and outside the shear layer edge become negligibly small, the edge of the shear layer is easily discernible. For these latter flows the corner expansion fan does not extend into the separated shear layer in the manner shown by the present flow field mappings. For slender bodies with flat bases, this result represents another major distinction between supersonic and hypersonic near wake flows.

viii) Static Enthalpy Profiles for Near Wake of Cold Wall Wedge

Of current interest to wake investigators is the temperature distribution within separated shear layers of near wakes behind high speed vehicles. It is well known that in boundary layers on a cold wall a local temperature peak, or "hot spot," exists within the boundary layer. The possible existence of similar off-axis hot spots has also been postulated in the case of near wakes behind cold wall bodies. The behavior of the static enthalpy as shown in figure 37f is quite typical of adiabatic wall boundary layer flow with the peak in enthalpy occurring on the wake centerline. Similar data for the highest Reynolds number investigated for the cold wall wedge are presented in figure 40. Not only is the off-axis peak evident in this latter figure but its initial magnitude $(\frac{h}{h_{\infty}} \neq 2.8)$, compares quite favorably with the maximum value as calculated by the theory of reference 38 for a laminar boundary layer with heat transfer. In addition, it appears that the location of this peak at each axial station corresponds approximately to the same streamline indicating that such "hot spots" follow along streamlines. These data also point

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out the rapid rise of centerline temperature with axial distance such that the enthalpy distribution downstream of the base exhibits both two "hot spots" of approximately equal peak temperature as well as two "cold spots." Additional static enthalpy data for the other Reynolds numbers are presented in figure 41, and similar trends are indicated. These results not only confirm the existence of off axis "hot spots", but also illustrate that the peak temperatures existing within the shear layer downstream of the base are comparable to the temperatures of the flow on the wake centerline. The data of figure 41 further illustrate that the noted hot spots coalesce with centerline temperature peaks within two base heights downstream from the model base.

V. SUMMARY OF RESULTS

An experimental investigation has been conducted to determine mean flow properties for both near and far wakes behind several twodimensional slender bodies at $M_{\infty} = 6$. Three adiabatic wall models, consisting of a flat plate model ($\alpha = 1^{\prime\prime}$, $\tau = .0156^{\prime\prime}$) and two 20[°] included angle wedge models ($H = .15^{\prime\prime}$, $H = .3^{\prime\prime}$) were tested. The effect of wall temperature on wake properties was examined by cooling the larger of these two wedge models with the internal flow of liquid nitrogen. Free stream Reynolds number per inch were varied from $.5 \times 10^5$ to 2×10^5 for each of these four configurations.

V.1 Far Wake

The main results which have been obtained from the far wake investigation are as follows:

 Wake transition distances based on wake thickness data agreed favorably with results from hot wire fluctuation measurements. Mean flow properties along the wake centerline, however, first deviated from laminar steady conditions somewhat upstream of "wake thickness" transition locations.

2. Transition in the far wake moved upstream with increasing Reynolds number and decreasing wall temperature.

3. Satisfactory agreement between experimental data for all low Reynolds number, adiabatic wall cases and linear wake theory confirmed that the flow in the far wake for these cases was laminar to the farthest downstream stations at which measurements were obtained.

4. Base region flows for the three adiabatic wall

configurations were laminar for all test Reynolds numbers. For the cold wall wedge, the flow in the base region was laminar at least for the two lowest test Reynolds numbers.

5. Maximum centerline pressures in the far wake for all four configurations were generally 10% higher than the free stream pressure. These "overshoot" pressures depended primarily on the inviscid flow field and, because they occurred at locations relatively far downstream, illustrated that the wake recompression process was spread out over a considerable axial distance.

6. For the cold wall wedge $(T_W/T_o = .19)$ the maximum enthalpy along the wake centerline for all test Reynolds numbers occurred about two base heights downstream of the model base and was approximately triple the magnitude of the free stream enthalpy. When the far wake was laminar, the decay rate of enthalpy was extremely small.

V.2 Near Wake

The main results which were obtained from the present investigation of near wakes behind a 20[°] wedge model (H = .3'') under adiabatic and cold wall ($T_W/T_o = .19$) conditions are as follows:

1. Collapsing of adiabatic and cold wall data was accomplished by correlating both base pressure and wake neck thickness measurements with trailing edge boundary layer thickness. This successful correlation, which illustrated that base pressures increased with increasing trailing edge thickness, further substantiated that the thickness of the trailing edge boundary layer represents a significant length scale for the near wake problem. 2. The flow along the wake centerline became supersonic for all cases within an axial distance of two base heights.

3. Base region rear stagnation points were located at approximately three quarters of a base height downstream of the model base for all cases.

4. The temperature ratio at the rear stagnation point for the cold wall wedge for all test Reynolds numbers was approximately $T_{sp}/T_{o} = .34$.

5. For the cold wall wedge, peaks in static temperatures occurred in the shear layers outside the wake shock structure. Initial magnitudes of these peak temperatures agreed favorably with estimates from laminar boundary layer theory. These ''hot spots'' followed along streamlines and coalesced with centerline temperature peaks within two base heights downstream from the model base.

6. Wake shocks, shear layer edges, base region sonic lines, and even "viscous layer edges" moved closer to the wake centerline with increasing Reynolds number and decreasing wall temperature.

7. The boundary layer on the wedge surface was influenced by the low base pressure two to three boundary layer thicknesses upstream of the base. Separation of this boundary layer appeared to occur on the model base slightly below the corner. A "separation" shock, similar to that appearing in the near wakes of bodies with rounded bases, was generated during the separation process.

8. In this Mach number six study, the base separation shock, which "rotates" toward the wake axis with increasing Mach numbers, coalesced with the wake recompression shock to form a

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single shock structure.

9. Most of the outer flow of the separated boundary layer turned very slowly in the vicinity of the base with the result that the amount of mass flow contained within the base region proper corresponded to a small fraction of the total boundary layer flow. The structures of the base regions behind the present slender bodies were thus established by flows of very low densities.

10. The supersonic turning of the separated boundary layer, though gradual, caused appreciable lateral pressure gradients in the near wake shear layers. These gradients became negligible once the flow had progressed several boundary layer thicknesses downstream of the base. The downstream boundary of this pressure gradient zone was represented, approximately, by a Mach wave originating from the vicinity of the corner. Downstream of this boundary and above the wake shock, static pressures were constant and equivalent to the base pressures. For Mach numbers appreciably higher than the present case, this region of constant pressure should decrease in extent because the noted Mach wave boundary rotates toward the wake axis with increasing Mach number.

11. Inside the wake shocks, lateral gradients in pressure were negligible.

12. Initially, during the corner turning process, the variation of total pressure along streamlines was negligible. This ''isentropic turn'' extended downstream to where constant total

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pressure lines began diverging from streamlines. The locus of these points of divergence separated the inviscid rotational flow from the viscous flow of the shear layer. These "viscous layer edges" were positioned in the outer portions of the shear layers indicating that wake shocks were imbedded within viscous regions of the shear layers.

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APPENDIX A

HOT WIRE ANEMOMETRY TECHNIQUES

FOR MEAN FLOW MEASUREMENTS

A.1 Raw Data Measurements

Hot wire raw data are obtained by exposing a short, small diameter wire to a given flow condition, and measuring the wire resistance corresponding to each of several heating currents. By extrapolating the variation of resistance with wire power (I²R), i.e., wire heat loss, to zero power, the adiabatic wire resistance is obtained. A pretest calibration giving the correlation between wire resistance and temperature then enables the determination of the adiabatic wire temperature. Measured Nusselt number is also determined from the resistance-power curve since it is proportional to the slope of this curve at zero power (17). Appendix B.1 describes the computer program by which both the zero-power resistance and slope were determined for the present results.

A.2 End Loss Analysis

In using hot wire probes it is often necessary to carry out end loss corrections to account for the conduction of heat from the wire to the probe supports so that results correspond to infinite wire data. These corrections were formulated by Dewey (17) from his analysis of the conduction of heat from a finite length wire to two end supports at a temperature, T_s . The wire was assumed to be in uniform flow with uniform temperature existing at each crosssection. Additionally it was assumed that the thermal conductivity of the wire remained constant and that the electrical resistance varied linearly with temperature. His results are

$$T_{aw} = \psi_r T_{awm}$$

 $Nu_t = \psi_N Nu_m$

where ψ_r and ψ_N , recovery ratio and Nusselt number end loss correction factors respectively, are given by:

$$\psi_{\mathbf{r}} = \frac{1 - \frac{T_{s}}{T_{awm}} \omega_{o}}{1 - \omega_{o}}$$

$$\psi_{\mathbf{N}} = (1 - \omega_{o}) \left[1 + \frac{st_{s}}{2} - \frac{\left\{ (2\omega_{o} - 1)\omega_{o} - \frac{1}{\cos^{2}\nu_{o}} \right\}}{(1 - \omega_{o})^{2}} \right]$$

The Nusselt number end loss correction factor stated here is that derived by Behrens (7) as a corrected version to the one formulated by Dewey. Examination of these formulae indicates that an iterative scheme using infinite wire calibration results, to be discussed shortly, is necessary for solution since the Nusselt number itself is a required input to both correction factors.

In many experiments both static and Pitot pressure measurements are carried out jointly, and only one of the two measurements provided by the hot wire probe is necessary since three independently measured quantities are sufficient to define completely the flow at a given location. This redundancy in measured data makes it possible to compare the Nusselt number correction factor, as measured, with that derived through Dewey's end loss analysis. From measured values of static pressure, Pitot pressure and adiabatic wire temperature and using the iterative calculation procedure described in Appendix B.3 the complete flow field was determined for various transverse traces across the wake behind a slender body at $M_{\infty} = 6$. Values of Nusselt numbers obtained with these data were then ratioed to measured Nusselt numbers to determine <u>measured</u> end loss correction factors. When these factors, for a given wire, were plotted as a function of the dimensionless quantity ω_0 , plots such as shown in figure 13 resulted. Here ω_0 is given by

$$\omega_{0} = \frac{\tanh v_{0}}{v_{0}}$$

where

$$v_0 = \sqrt{\left(\frac{l}{d}\right)^2 \frac{k_t}{k_w}} Nu_t$$

The functional form shown in figure 13 was considered appropriate for comparing measured with predicted values of Nusselt number end loss correction factors because the formula for ψ_N indicated that ψ_N depended more strongly on ω_0 than on the resistance parameter s, or the nondimensional support temperature t_s . In general, noticeable differences were observed to exist between measured and predicted results. The tendency of all the data for one wire to describe a single curve (within $\pm 5\%$), suggested possible systematic errors were involved. Replotting the correction factor data as a function of ν_0 , instead of ω_0 , illustrated that these measured results appeared to be consistently offset from the Behrens' curve by a nearly constant percentage of ν_{0} . This offset can perhaps best be explained by noting that inaccuracies in wire conductivity and wire aspect ratio exist because of measurement difficulties. For example the function ν_{a} , being directly proportional to the aspect ratio, is thus subject to question and would be off by a constant percentage amount for a given percentage error in aspect ratio. In any event, the measured results demonstrate that a calibration curve, showing the variation of Nusselt number correction factor with the function ω_{λ} , can be established for each wire in lieu of the Behrens' formula. Such curves were obtained for all the wires used in the present investigation. To check the suitability of using these calibration curves in conjunction with measured Nusselt numbers to determine mean flow data, comparison calculations were made for representative profile results. Both stagnation temperature and Nusselt number were calculated using Pitot pressure, adiabatic wire temperature and either static pressure or measured Nusselt number with a corresponding wire calibration curve for the Nusselt number correction factor. The results indicated that stagnation temperatures compared to within 1% whereas Nusselt number results differed by at most 5%. Such a favorable comparison confirmed the acceptability of this calibration procedure for determining Nusselt number data in regions of the flow where static pressure measurements were unavailable. All shear layer data presented herein were obtained in this manner since the large pressure gradients for these layers prevented making static pressure measurements.

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It should be pointed out that this method of calibrating Nusselt number correction factors in a known flow is similar, in certain respects, to the flow calibration technique proposed by Demetriades^{*} for flows where $M \ge 3$. This latter procedure is based on establishing, for each hot wire, a calibration curve showing the variation of measured Nusselt number with Reynolds number. Such a correlation is obtained by carrying out hot wire measurements in free stream flow under varying Reynolds number conditions. For small changes in support temperature and local stagnation temperature this approach was shown to be quite accurate in determining Reynolds number. For many of the present results for M> 3 the Nusselt number correction factor shows only minor dependence on Mach number and support temperature. Furthermore when air and wire conductivity undergo only slight changes, the correlation results shown in figure 13, which indicate that

$$\psi_{N} = \frac{Nu_{t}}{Nu_{m}} = \psi_{N} \left(\omega_{0} = \frac{\tanh \nu_{0}}{\nu_{0}} \right)$$
$$= \psi_{N} \left(\nu_{0} = \sqrt{\left(\frac{\ell}{d}\right)^{2} \frac{k_{t}}{k_{w}}} Nu_{t} \right)$$

also suggest the following simplified relationship

$$Nu_m = Nu_m (Nu_t)$$

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Thus, since it has been shown (7, 24) that for $M \ge 2$ the Nusselt-Reynolds number correlation is independent of Mach number, it follows that, as in Demetriades' case for $M \ge 3$,

$$Nu_m = Nu_m (Re_t)$$

It should be emphasized, however, that for this calibration technique to be applicable, the above noted assumptions should be valid. For those flows where appreciable stagnation and support temperature gradients exist and especially for M < 2, the present method (figure 13) would seem more appropriate.

A.3 Infinite Wire Calibrations

In using the hot wire probe to conduct mean flow measurements the investigator relies on established calibration data for a perfectly conducting cylinder (wire) infinite in extent. Such data, consisting of recovery factor $(T_{aw_{\chi}}/T_{t})$ and Nusselt number given as functions of Mach number and Reynolds number, in combination with end-loss corrections, permit the determination of local stagnation temperatures and mass flow rates from hot-wire measurements. Many experimental and theoretical studies have been made to determine such calibration data, and a comprehensive review is given by Dewey (17). Figure 12 shows the range of test conditions for the hot-wire probes used in the present investigation and it is evident that most of the measurements fell within the transitional regime. Furthermore, many measurements occurred at low supersonic speeds and thus the recovery factor and heat transfer correlation of Behrens (7) were not applicable, since his data were not only independent of Mach number but also were valid only for $M \ge 2$.

i) Normalized Recovery Factor

Dewey, by combining the data of several investigators with his own measurements (17), found that a single curve $(\pm .1 \text{ in } \eta_*)$ could satisfactorily describe the variation of a normalized recovery factor with Knudsen number from continuum flow to free molecule flow for all Mach numbers greater than approximately .7. This normalized recovery factor has been used herein and is given by:

$$\overline{\eta}_* = \frac{\eta_* - \eta_c}{\eta_f - \eta_c}$$

where η_{c} and η_{f} are the continuum and free molecule recovery factors respectively.

ii) Nusselt-Reynolds Number Correlation

Sherman (20), in examining heat transfer data for spheres in subsonic flow, found that a single curve of the form

$$St/St_{f} = \frac{1}{1 + \frac{St_{f}}{St_{c}}}$$

correlated data from continuum flow through free-molecule flow. Such a result suggested that perhaps a similar correlation may exist even for higher Mach numbers. Kubota^{*} in re-examining the data used by Dewey for his heat transfer correlation found that, indeed, such a correlation existed. By normalizing Nusselt number with the Nusselt number for free molecular flow ($\alpha = 1$)

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$$\operatorname{Nu}_{f} = \frac{\overline{\operatorname{hd}}}{k_{t}} = \frac{\gamma - 1}{2(\pi)^{3/2} \gamma} \alpha \operatorname{Re}_{t} \operatorname{Pr}_{t} \left(\frac{g(s_{1})}{s_{1}}\right)$$

and plotting the result as a function of the normalized Nusselt number for incompressible continuum flow (Nu_c / Nu_f) (the M = 0 curve in Dewey's correlation), Kubota found the results shown in figure 14. Not only did a single curve seem appropriate for correlating the data but one form which appeared reasonable for correlation purposes

$$\frac{\mathrm{Nu}_{\mathrm{t}}}{\mathrm{Nu}_{\mathrm{f}}} = \frac{1}{1 + \frac{\mathrm{Nu}_{\mathrm{f}}}{\mathrm{Nu}_{\mathrm{c}}}}$$

was identical to that of Sherman. Although this correlated curve did show noticeable deviation (+15%) from the Dewey measurements as the continuum flow regime is approached $(Nu_c/Nu_f < 1, Re_t > 10)$ it seemed satisfactory for the present calculations since it was always within 5% of Dewey's results for the range of Reynolds numbers covered in the present tests $(Re_t < 4, Nu_c/Nu_f > 1.91)$. This form for the Nusselt-Reynolds number correlation also was much simpler than that established by Dewey and thus proved easier to check out and use in machine computations. For Mach numbers greater than 1 these results are believed within -5% of measured data. For lower Mach numbers and for Reynolds numbers greater than 4.0 the correlation results of Dewey would seem more appropriate.

^{*}This formula was misquoted in reference (17).

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APPENDIX B

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DATA REDUCTION PROGRAMS.

B.1) Raw Data Program

Although some modifications have been made in the hot wire raw data program as established by Herzog (14), the basic purpose, input requirements and output data for this program remain the same. The input data to this program consist of punched IBM cards representing initial hot wire measurements as recorded by the Automatic Hot Wire Recording System. The data for a given input card lists hot wire position, probe support temperature, and attenuated hot wire voltages corresponding to each of 5 currents and 5 bucking voltages. In the raw data program these hot wire voltages are transformed from their digitized form to my readings using system calibration data, and the known wire currents and bucking voltages. Conversion of these data in turn to hot wire resistance (R_m) and power (I^2R) results is straightforward. Once in this form the wire resistance (R_{awm}) and curve slope $\left(\frac{dR_m}{dR_m}\right)$ corresponding to zero power are determined by fitting a parabolic curve to the data with a least squares procedure. Often more accurate and consistent results were possible if only those data corresponding to the lowest four currents were used to obtain this fit. After completing several additional calculations, the program, as output for each probe position, lists and punches out on IBM cards such results as normalized probe position, adiabatic wire resistance and temperature, zero power slope of the resistance power curve, and probe support temperature. These cards are then used directly as input data to the plotting and end loss programs.

-90- B. La) Raw Data Program ID Listing			
NPT	NPT	number of data points to be used in calcula- tion of slope (dR/dI^2R) and R_{awm}	
IARRAY	IARRAY	code name (hot wire, or Run No)	
ID	ID	identification number	
ALPHA	α_{r}	slope of calibration curve of $R_{wm}(\Omega)$ versus T_{wm} (°C) for zero current, (1/°K)	
RR	R _r	reference resistance as calibrated for zero current and zero $^{O}C, \Omega$	
L	1/d	wire aspect ratio	
CO(I),	I = 11,15	voltage calibration factors for each of five currents	
CO(I),	I = 16,20	bucking voltages for each of five currents, mv	
CO(I),	I = 21, 25	constant current values (five), mv	
PCI	%	% injection	
XD	x/D	probe tip position in axial direction	
CO(1)	У _о	centerline probe position in transverse di- rection relative to a standard position, in.	
Q1	y	probe position in transverse direction rela- tive to a standard position, in.	
A(J), J=1	,5 C(ΔE _{HW})	attenuated hot wire voltage decrement, mv	
Q7	Ts	support temperature, ^o C	
CORN	CORN	card number	
VC	v _c	support temperature correction factor	
SC	Se	support temperature correction decrement, ^o C	
DR	D	reference diameter, in.	
B(J),J=1,5 △E _{HW}		hot wire voltage decrement for each of five currents, mv	
C(J), J=	1,5 E _m	measured hot wire voltage for each of five currents, Mv	

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D(J),J=1	,5 R _{wm}	measured hot wire resistance for each of five currents, Ω
E(J),J=1	,5 I ² R _{wm}	measured hot wire power for each of five currents, $(ma)^2 \Omega$
Z1	y/D	normalized axial distance
Z2	R _{awm}	wire resistance for zero current, Ω
Z3	$[dR_{wm}/dI^2R_{wm}]$] _{I=0}
		slope of resistance-power curve at $I = 0$, $(ma)^{-2}$
Z4	T _{awm}	wire temperature for zero current, ^o K
Z5	Numkt	product of measured Nusselt number and air conductivity, $\Omega(ma)^2/{}^{\circ}C$ in.
Z 6	Ts	corrected support temperature, ^O K
\$IBFT		
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C 210	C MAIN DECK	
C FIR	ST CARD MUST HAVE IN COL 1 3.4. OR5 FOR NO OF POINTS	
	REAL LO NUKO, NUKMINO NUKMAX	
	LATA NAME / GHHOT WI/; NRUN / GHRUN NU/	
	DIMENSION A(5) +B(5) +C(5) +D(5) +E(5) +CO(30) +IARRAY(13) +TITLE(10) +	
	1 X(200), TM(200), NUKO(200)	
	DIMENSION DIF(5)	
	DIMENSION SLOPE(5)	
	DIMENSION COEF(3)	
	READ(5.610) NPT	
610	FORMAT(11)	
10	WEITE (6.516) IARRAY	
516	FORMAT(1H1 20X13A6)	
	IF(IARRAY(1) + EQ+NAME) GO TO 16	
15	IF(IARRAY(1).NE.NRUN) GO TO 17	
	GO TO 19	
16	READ 503, IARRAY, ID, ALPHA, RR, L, (CO(I), I = 11, 15)	
	READ (5,504) (CO(I),I=16,25)	
	<u>READ (5,507) VC, SC, DR</u>	
	CO(3) # ALPHA *•001	
	$\frac{CO(2) = RR}{CO(6) = 1}$	
	READ (5.502) LARRAY	
	GO TO 15	
17	CONTINUE	
C ERR	OR RETURN - PACK MUST START WITH NEW PCI, XD, CO(1)	
·····	WRITE (6.510)	
	STOP	
<u>C BEG</u>	INNING OF PACK - READ PER CENT INJECTION, X/D, C.P.	
<u>ر</u>		
	CONTINUE	
	CONTINUE READ 505, IARRAY, PCI, XD, CO(1) PRES = 0.	
	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q.	
20	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) <u>PRES = Q</u> K = 0 <u>READ (5,500)Q1, (A(J),J=1, 5), Q7,CORNO</u>	
20	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1. 5). Q7.CORNO IF(Q1.EQ.0.0) G0 TO 60	
20	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1. 5). Q7.CORNO IF(Q1.EQ.0.0) G0 TO 60 D0 30 J = 1. 5	
20	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1. 5). Q7.CORNO IF(Q1.EQ.0.0) G0 TO 60 DO 30 J = 1.5 B(J) = A(J) * CO(J+10)	
20	$\begin{array}{c} CONTINUE \\ READ 505 + IARRAY + PCI + XD + CO(1) \\ PRES = Q + \\ K = 0 \\ READ (5 + 500)Q1 + (A(J) + J = 1 + 5) + Q7 + CORNO \\ IF (Q1 + EQ + 0 + 0) & GO TO 60 \\ DO 30 J = 1 + 5 \\ B(J) = A(J) + CO(J + 10) \\ C(J) = B(J) + CO(J + 15) \end{array}$	
20	$\begin{array}{c} CONTINUE \\ READ 505 + IARRAY + PCI + XD + CO(1) \\ PRES = Q + \\ K = 0 \\ READ (5 + 500)Q1 + (A(J) + J = 1 + 5) + Q7 + CORNO \\ IF (Q1 + EQ + 0 + 0) & GO TO 60 \\ DO 30 J = 1 + 5 \\ B(J) = A(J) + CO(J + 10) \\ C(J) = B(J) + CO(J + 15) \\ D(J) = C(J) + CO(J + 20) \\ \hline \end{array}$	
20	$\begin{array}{c} CONIINUE \\ READ 505 + IARRAY + PCI + XD + CO(1) \\ PRES = Q + \\ K = 0 \\ READ (5 + 500)Q1 + (A(J) + J = 1 + 5) + Q7 + CORNO \\ IF (Q1 + EQ + 0 + 0) & GO TO 60 \\ DO 30 J = 1 + 5 \\ B(J) = A(J) + CO(J + 10) \\ C(J) = B(J) + CO(J + 15) \\ D(J) = C(J) / CO(J + 20) \\ E(J) = C(J) + CO(J + 20) \\ CONTINUE \end{array}$	
20	$\begin{array}{c} CONTINUE \\ READ 505,IARRAY, PCI, XD, CO(1) \\ PRES = Q_{0} \\ K = 0 \\ READ (5,500)Q1, (A(J),J=1, 5), Q7,CORNO \\ IF(Q1,EQ,0,0) GO TO 60 \\ DO 30, J = 1, 5 \\ B(J) = A(J) * CO(J+10) \\ C(J) = B(J) + CO(J+15) \\ D(J) = C(J) / CO(J+20) \\ E(J) = C(J) / CO(J+20) \\ E(J) = C(J) * CO(J+20) \\ CALL SISO(E,D,NPT,SLOPE,X1,COEE) \\ \end{array}$	
20 	$\begin{array}{c} CONTINUE \\ READ 505,IARRAY, PCI, XD, CO(1) \\ PRES = Q_{0} \\ K = 0 \\ READ (5,500)Q1, (A(J),J=1, 5), Q7,CORNO \\ IF(Q1,EQ,0,0) GO TO 60 \\ DO 30, J = 1, 5 \\ B(J) = A(J) * CO(J+10) \\ C(J) = B(J) + CO(J+15) \\ D(J) = C(J) / CO(J+20) \\ E(J) = C(J) / CO(J+20) \\ E(J) = C(J) * CO(J+20) \\ CONTINUE \\ CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) \\ IN = 6 - NPT \end{array}$	
	$\begin{array}{c} CONTINUE \\ READ 505,IARRAY, PCI, XD, CO(1) \\ PRES = Q_{\bullet} \\ k = 0 \\ READ (5,500)Q1 (A(J),J=1,5) Q7,CORNO \\ IF(Q1,EQ,0,0) GO TO 60 \\ DO 30 J = 1,5 \\ B(J) = A(J) * CO(J+10) \\ C(J) = B(J) + CO(J+15) \\ D(J) = C(J) / CO(J+20) \\ E(J) = C(J) / CO(J+20) \\ E(J) = C(J) * CO(J+20) \\ CONTINUE \\ CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) \\ IN = 6 - NPT \\ DO 35 J = IN,5 \end{array}$	
20	$\begin{array}{c} CONTINUE \\ READ 505,IARRAY, PCI, XD, CO(1) \\ PRES = Q_{\bullet} \\ K = 0 \\ READ (5,500)Q1 (A(J),J=1,5), Q7,CORNO \\ IF(Q1,EQ,0,0) GO TO 60 \\ DO 30 J = 1,5 \\ B(J) = A(J) * CO(J+10) \\ C(J) = B(J) + CO(J+15) \\ D(J) = C(J) / CO(J+20) \\ E(J) = C(J) / CO(J+20) \\ E(J) = C(J) * CO(J+20) \\ CONTINUE \\ CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) \\ IN = 6 - NPT \\ DO 35 J = IN,5 \\ DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) \end{array}$	
20	$\begin{array}{l} \hline CONTINUE \\ \hline READ 505,IARRAY, PCI, XD, CO(1) \\ \hline PRES = Q_{0} \\ \hline K = 0 \\ \hline READ (5,500)Q1, (A(J),J=1,5), Q7,CORNO \\ \hline IF(Q1,EQ,0,0) GO TO 60 \\ \hline DO 30, J = 1,5 \\ \hline B(J) = A(J) * CO(J+10) \\ \hline C(J) = B(J) + CO(J+15) \\ \hline D(J) = C(J) / CO(J+20) \\ \hline E(J) = C(J) / CO(J+20) \\ \hline E(J) = C(J) * CO(J+20) \\ \hline CONTINUE \\ \hline CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) \\ \hline IN = 6 - NPT \\ \hline DO 35, J = IN,5 \\ \hline DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) \\ \hline D(J) = D(J) - DEVAL \\ \hline \end{array}$	
<u> </u>	$\begin{array}{l} \hline CONTINUE \\ \hline READ 505,IARRAY, PCI, XD, CO(1) \\ \hline PRES = Q_{0} \\ \hline K = 0 \\ \hline READ (5,500)Q1, (A(J),J=1,5), Q7,CORNO \\ \hline IF(Q1,EQ,0,0) GO TO 60 \\ \hline DO 30, J = 1,5 \\ \hline B(J) = A(J) * CO(J+10) \\ \hline C(J) = B(J) + CO(J+15) \\ \hline D(J) = C(J) / CO(J+20) \\ \hline E(J) = C(J) / CO(J+20) \\ \hline E(J) = C(J) * CO(J+20) \\ \hline CONTINUE \\ \hline CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) \\ \hline IN = 6 - NPT \\ \hline DO 35, J = IN,5 \\ \hline DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) \\ \hline DIF(J) = D(J) - DEVAL \\ \hline CONTINUE \\ \hline \end{array}$	
20 30 35	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1. 5). Q7.CORNO IF(Q1.EQ.0.0) GO TO 60 DO 30 J = 1. 5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) E(J) = C(J) * CO(J+20) CONTINUE CALL LSISQ(E,D.NPT,SLOPE,X1.COEF) IN = 6 - NPT DO 35 J = IN.5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIF(AX = DIF(IN)	
20 	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1. 5). Q7.CORNO IF(Q1.EQ.0.0) GO TO 60 DO 30 J = 1. 5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) E(J) = C(J) * CO(J+20) CONTINUE CALL LSTSQ(E,D,NPT,SLOPE,X1.COEF) IN = 6 - NPT DO 35 J = IN.5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIFMAX = DIF(IN) IJ = IN+1	
20 	CONTINUE READ 505, IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1. 5). Q7.CORNO IF(Q1.EQ.0.0) GO TO 60 DO 30 J = 1. 5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) CONTINUE CALL LSISQ(E,D.NPT,SLOPE,X1.COEF) IN = 6 - NPT DO 35 J = IN.5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIFMAX = DIF(IN) IJ = IN+1 DO 36 J = IJ.5	
20 	CONTINUE READ 505+IARRAY+ PCI+ XD+ CO(1) PRES = Q+ K = 0 READ (5+500)Q1+ (A(J)+J=1+5)+ Q7+CORNO IF(Q1+EQ+0+0+) GO TO 60 DO 30 J = 1+5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) E(J) = C(J) * CO(J+20) CONTINUE CALL LSTSQ(E+D+NPT+SLOPE+X1+COEF) IN = 6 - NPT DO 35 J = IN+5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE CONTINUE DIF(MAX = DIF(IN) IJ = IN+1 DO 36 J = IJ+5 IF(ABS(DIFMAX) +GT+ ABS(DIF(J))) GO TO 36	
20	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = Q READ (5,500)Q1, (A(J),J=1, 5), Q7,CORNO IF(Q1.EQ.0.0) GO TO 60 DO 30 J = 1, 5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) CONTINUE CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) IN = 6 - NPT DO 35 J = IN,5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIFMAX = DIF(IN) IJ = IN+1 DO 36 J = IJ,5 IF(ABS(DIFMAX) .GT. ABS(DIF(J))) GO TO 36 DIFMAX = DIF(J)	
20	CONTINUE READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1.5). Q7.CORNO IF(Q1.EQ.0.0) GO TO 60 DO 30 J = 1.5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) E(J) = C(J) * CO(J+20) CONTINUE CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) IN = 6 - NPT DO 35 J = IN.5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIFMAX = DIF(IN) IJ = IN.41 DO 36 J = IJ.5 IF(ABS(DIFMAX) .GT. ABS(DIF(J))) GO TO 36 DIFMAX = DIF(J) CONTINUE ZI = COLLUA DP	
	<u>CONTINUE</u> READ 505,IARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1. (A(J).J=1.5). Q7.CORNO IF(Q1.EQ.0.0) GO TO 60 DO 30 J = 1.5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) * CO(J+20) E(J) = C(J) * CO(J+20) CONTINUE CALL LSTSQ(E,D,NPT,SLOPE,X1,COEF) IN = 6 - NPT DO 35 J = IN.5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIF(AD = DIF(IN) IJ = IN+1 DO 36 J = IJ.5 IF(ABS(DIFMAX) .GT. ABS(DIF(J))) GO TO 36 DIFMAX = DIF(J) CONTINUE Z1 = (Q1 - CO(1))/ DR Z2 = X1	
20 30 35 36	CONTINUE READ 505+IARRAY+ PCI+ XD+ CO(1) PRES = Q+ K = 0 READ (5+500)Q1+ (A(J)+J=1+5)+ Q7+CORNO IF(Q1+EQ+0+0) GO TO 60 DO 30 J = 1+5 B(J) = A(J) * CO(J+10) C(J) = B(J) + CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) CONTINUE CALL LSTSQ(E+D+NPT+SLOPE+X1+COEF) IN = 6 - NPT DO 35 J = IN+5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIF(AX = DIF(1N) IJ = IN+1 DO 36 J = IJ+5 IF(ABS(DIFMAX)+GT+ABS(DIF(J))) GO TO 36 DIFMAX = DIF(J) CONTINUE Z1 = (Q1 - CO(1))/ DR Z2 = X1 Z3 = SLOPE(1)	
20 30 35 36	CONTINUE READ 505+1ARRAY, PCI, XD, CO(1) PRES = Q. K = 0 READ (5.500)Q1, (A(J),J=1, 5), Q7,CORNO IF (Q1+EQ+0+0) GO TO 60 D0 30 J = 1, 5 B(J) = A(J) * CO(J+10) C(J) = B(J) * CO(J+15) D(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) E(J) = C(J) / CO(J+20) CONTINUE CALL LSTSQ(E,D+NPT+SLOPE+X1+COEF) IN = 6 - NPT D0 35 J = IN+5 DEVAL = COEF(1) + COEF(2)*E(J) + COEF(3) * E(J) * E(J) DIF(J) = D(J) - DEVAL CONTINUE DIF(MAX = DIF(1N) IJ = IN+1 D0 36 J = IJ+5 IF (ABS(DIFMAX) + GT+ ABS(DIF(J))) GO TO 36 DIFMAX = DIF(J) CONTINUE Z1 = (Q1 - CO(1)) / DR Z2 = X1 Z3 = SLOPE(1) Z4 = 273+2 + (Z2-CO(2)) / (CO(2)*CO(3))	

	•	Z6 = 0	7*(1.	- vc)	- sc	+ 273	•2		. <u></u>				
	515	WRITE FORMAT	(6,5) (1X3)	15) PC 1PCI 2	1,XD, XF3.1	Z1,Z2, <u>,2X2HX</u>	Z3•Z4 D2XF5	•25•2 •2•2X	6• 10HZ1		CORNO	•DIFN 2X6F12	1AX 2•6•
	:	1 PUNCH	2X2	2HID2X PC	(13,2X4	4HC•N• • Z1•	1XI3 Z2 • Z	•1X F 3• Z4	8•5) • Z5•	Z6 •		ID	•
	÷	1 CORNO				<u> </u>			- f				
		WRITE	(6,52	20) (L 20) (E)(J), . [(J),J:	<u>J=1,5)</u> =1,5)			<u> </u>				
	520	FORMAT	(5E2	20.8)					,			,	
	500	GO TO FORMAT	20 [(F4•3	3,5F4.	3,F5.	<u>1,48x1</u>	3)						
	502	FORMAT	[(13A6	5)	1412.2	YE9.7.	59.6.	E9.9.	558.6	1			
<u></u>	504	FORMAT	[[(4X 5 F	7.4.5	6F7.61		1.0.0.0.9	0.00	21 0 00		·····		
	510	FORMAT	$\frac{1}{15x}$	55 - 2	RROR I	RETURN	- PA	CK MU	<u>st st</u>	ART	UTH P	<u>CI • X</u>	D. CP//
	507	FORMA	(E4)	3.1XF	4.1.	1XF4•3	<u>;</u>						
	600	FORMAT 11XF5•1	[(F3•] • 18)	L, FS (1)	5•2+1X (I3•1X	F6•3 • 1 13)	XF5+2	,1XF8	•6 • 1X		<u>β</u> F5.	191XE.	11.59
•	60	CONTIN	NUE	, , , , , ,									
		END						1	na - La transfor F		en de se andere de la se		
			- <u>}</u>										
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SIBF	TC LST DECK
	SUBROUTINE LSTSQ(X,Y,N,SLOPE,YINCEP,B)
	DIMENSION X(5), Y(5), C(10), A(50,3), B(50,1)
	NO=3
· · · ·	IF (N+EQ+2) NO=2
	$DO \ 10 \ I = 1,10$
10	$IN = G_{N}$
	$DO 2O I = IN_{5}$
	$x_2 = x(1) + x(1)$
	C(1) = C(1) + X(1)
	C(3) = C(3) + X2 + X(1)
	C(4) = C(4) + X2 + X2
	C(5) = C(5) + Y(1)
	$\frac{\zeta(6) = \zeta(6) + \chi(1) + \chi(1)}{\zeta(7) = \zeta(7) + \chi(2) + \chi(1)}$
2	
	A(1+1) = N
	A(1,2) = C(1)
	A(2+1) = C(1)
	A(2,2) = C(2)
	A(2,3) = C(3)
	A(3,1) = C(2)
	A(3,3) = C(4)
	B(1,1) = C(5)
	B(2,1) = C(6)
	$\frac{B(3 \bullet 1)}{CA(1)} = C(7)$
	$YINCEP = B(1_01)$
	SLOPE(1) = B(2.1)
	END
•	
-	
	and the second

B.2 Raw Data Plotting Program

Currently this program has the capability of plotting, as a function of y/H, adiabatic wire temperature, probe support temperature, and zero power slope of the resistance-power curve. Punched output from the raw data program are used directly as input to this program. Some flexibility is possible in the plotting routines since three different models or variable ranges in y/H and T_{awm} are made available. These were necessary in order to scrutinize the raw data not only for both the adiabatic and cold wall wedge models but also for the flat plate configuration.

B.2a) Plot Program ID Listing

NUK	^{Nu k} t	product of measured Nusselt number and air conductivity, Ω (ma) ² /(^o K in)
PCI	%	% injection
YD	y/D	normalized transverse distance
TM	T awm	wire temperature for zero current, ^{o}K
TS	т _s	support temperature, ^O K
XD	x/D	normalized axial distance
ID	ID	identification number
SLP	[dR/dI ² R]	I=0 slope of resistance-power curve at zero power, $(ma)^{-2}$
MODE	Ĺ	plotting format, 1, 2 or 3
PR		plot request - PR > 2 implies only "SLP" data will be plotted

-97-

1	
SIBEIC	PLO DECK
С	PUT ONE BLANK CARD BETWEEN EACH SET OF DATA.
<u> </u>	PUT AN ADDITIONAL BLANK CARD TO SEPARATE TWO MODELS.
с с	ADD ONE MORE BLANK CARD AT END OF ALL DATA (TOTAL 3)
C se	MODEL 1 PLOTS 1 SHEET FOR EACH 3 SETS
<u> </u>	PLUS 1 SHEET FOR REMAINING SETS
Č	MODEL 2 PLOTS I SHEET FOR EACH 7 SETS
C	MODEL 3 PLOTS 1 SHEET FOR EACH 7 SETS
<u> </u>	PLUS 1 SHEET FOR REMAINING SETS
C .	
	TIME 100 PC1(40). YD(4000). TM(4000). SLP(4000). NN(40).
1	TITLE(12) • X(200) • Y(200)
	DIMENSION XDD(40), TS(4000), TX(200)
	DIMENSION DATMIN(3), DATMAX(3), DELTA(3), NPLOT(3)
	DIMENSION DAXMIN(3), DAXMAX(3)
	DATA (DAXMIN(1), DAXMAX(1), $1=1,3$) $-1,31,-1,31,-2,2,2$
4	DATA (DATMIN(1)) DAIMAX(1); DELIA(1); 1=1;5) / -450+;500+;250+;
A	
	DATA (TITIF(I), $I=1,12$) / 6H \bullet 6H \bullet 6H \bullet 6H \bullet
1	6H • 6H • 6H • 6H • 6H •
2	6H96H/
5 (CONTINUE
	READ (5,524) MODEL PR
	IF (MODEL .EQ. 0) STOP
	WRITE (6,600) MODEL
	XMIN = DAXMIN(MODEL)
	$\frac{1}{1} = 1$
10 /	V = N + 1
f	READ (5,500) PERCEN, XD, YD(N), SLP(N), TM(N), TS(N), ID
	IF(1D .EQ. 0) GO TO 20
	SLP#SLP(N)
ر	SEPTIMESEP
, ,	DCILL) = PERCEN
	GO TO 10
20 0	CONTINUE
1	N(J) = N - 1
	J = J + 1
	IF (JOGTO 40) STOP
ł	CAD 1202001 PERCENO ADO TOTATOSLPINTOTMINTOTSINTOTO
	51 D=51 D+(10,++5,)
<u>*</u>)	
	IFIID ANEA O I GO TO 10
] =] =]
	(F (PR-1a) 21a21a61
21	JK # 0
	WRITE (6.1001) (NN(11).1 = 1.1)
	TMIN = DATMIN(MODEL)
	TMAX = DATMAX (MODEL)
	CALL PPLOTI

B.2b) Fortran Listing of Hot Wire Plot Program

	$\frac{DO}{C} \frac{DO}{C} \frac{1}{2} = \frac{1}{2} \frac{1}{2}$
	ASEI = ASEI + A
	$\frac{1}{10} = \frac{1}{10} + \frac{1}{10} = \frac{1}{10} $
<u> </u>	
42	
	IMIN - DAIMIN(MODEL)
	CONTINUE
	r = r r r r r r r r r r r r r r r r r r
<u></u>	JJ = JK + KK
	X(KK) = YD(JJ)
<u> </u>	Y(KK) = -TM(JJ)
	TX(KK) = -TS(JJ)
52	CONTINUE
	WRITE (6,510) XDD(I), PCI(I)
	CALL XYPLT(NPT,Y,X, TMIN,TMAX,XMIN,XMAX,TITLE,LAB)
	IF (IN EQ. NPLOT(MODEL)) GO TO 45
	IF(ISET*EQ+J) GO TO 45
	GO TO 47
45	CONTINUE
	IN = O
	LAB = 1
	CALL XYPLI(NPI)IX,X ,IMIN, MAX, XMIN, XMAX, IIILE, LAB)
·····	
	IMAX = IMAX - DELTAIMODEL
	JK = NN(1)
	IF (LAD \bullet EW 1) CALL FPLOID
60	
61	
	ISET = 0
	CALL PPLOT1
	J = 1 = 1 = 1
	ISET = ISET + 1
•	IN = IN+1
	IF (IN .EQ. 1 .AND. ISET .EQ. J) GO TO 69
	IF(IN.EQ.4) GO TO 65
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	IF(ISET-EQ- J) GO TO 65
	IF (IN-EQ-1) GO TO 67
	<u>GO 10 68</u>
63	
	$\frac{1}{1000} = -0000$
67	CONTINUE
	LAB = 0
	YMINK = -800.
	YMAXK = 2200.
	GO TO 68
65	CONTINUE
	LAB = 1
	1N = 0
68	CONTINUE

	Y Y	(1) = YM	AXK+10.						
-	<u> </u>	$\frac{2}{2} = Y($	1)						
		J /U KK J ≕ JK +	= 19NJ Kk				-		
	X	(KK) = Y	D(JJ)			· · · · · · · · · · · · · · · · · · ·			
	Y TO C	(KK) = -5	LP(JJ)	•					
	70 CC 11	NIINUE	511) XOD	ITT PCI	1)				
	C/	ALL XYP	LT(N3+Y+)	(,YMINK,Y	MAXK , XMI	N.XMAX,TI	TLE,LAB)		
	Y1	11NK = Y	MINK - 7	50.					
	Y	4AXK = Y	MAXK - 79	50•					
•••••	5	- (LAB •	EQ. 1) C/	ALL PPLOT	4			······································	
	11	LLAB .	EQ. 1 .AI	ND. I .NE	J) CALI	PPLOT1	·		
	80 C	ONTINUE					÷		
	500 E	DRMAT(F3	•1• F5•2	2.1XF6.3.	7xF8.6.1)	(F5.1.13)	F5.1.19XI	3)	
	501_E	ORMATI 6F	10.0)						
	510 F	DRMAT 1/	10X6HX/D	= F10.2,	10X 21HPI	ER CENT	NJECTION	= F10•2•	
	511 F	ORMATIZ	10X6HX/D	= F10.20	10X 21H	PER CENT	INJECTION	= F10.2.	
_	1	LOX ZOHP	LOT OF NI	UKO VS Y/	D)				
	524	FORMAT (5X, 12,3	XF5•0)	0051 10		1		,
	600	FORMAT (1H19 //9	TOX: SHM	UDELS IL	• // ij		<u></u>	
	610	EORMAT L	5X. 6E20	.4)		· · · · · · · · · · · · · · · · · · ·			
	630	FORMAT I	140, 1/,	10X, 6HP	PLOT1 /)				
	640	EORMAT (<u>1H0. 10X</u>	• <u>6HPPLOT</u>	4_/)				
	620 1000 E						÷		
		ORMAT 15X	1HU . 10A	$F12_{a}2_{b}10X$	4HY = E1	5.8.10x4	IX = F12.2	•10X4HY =	E1
	1000 -	ORMAT(5X B)	4HX =	F12.2.10X	<u>4HY = E1</u>	5.8.10X4	1X = F12.2	*•10X4HY =	E1
	1000 F	ORMAT(5X B) ORMAT(5(4HX = 10x 110.10x)	F12.2.10X	<u>4HY = E1</u>	5.8.10X4	<u>1X = F12.2</u>	•10X4HY =	Ε1
	1000 F 1001 F C	DRMAT(5X B) DRMAT(5(USE CONT SIBLDR#M	4HX = 1 110+10X) ROL CARD: LICPPI	F12•2•10X } S•	<u>4HY = E1</u>	5.8.10X4H	<u>1X = F12.2</u>	:,10X4HY =	Ε1
	1000 F 1 1001 F C C	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M	4HX = 110+10X) ROL CARD: LCPP1 LLXYR (1)	5. NSTEAD OF	4HY = E1	5•8•10X4H	1X = F12.2	<u>10X4HY =</u>	Ε1
	1 1001 F C C \$ IBLDR#	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M END MJCPPI	4HX = 110+10X) ROL CARD: LICPPI LLXYR (1)	S•	4HY = E1: MLLXYP)	5.6.10X4	1 <u>X = F12.2</u>	!•10X4HY =	E1
	1000 F 1001 F C C SIBLDR* SIBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M END MJCPPI MJCPPI MLLXYR	4HX = 110+10X) ROL CARD: LCPPI LLXYR (1)	5+ S+ NSTEAD OF	4HY = E1: MLLXYP)	5•8•10X4	1 <u>X = F12.2</u>	:•10X4HΥ =	E1
	1 1 1001 F C C SIBLDR* SIBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$IBLDR*M \$IBLDR*M END MJCPPI MLLXYR	HUY IUA 4HX = 110.10X) ROL CARD: LICPPI LLXYR (1)	5. S.	4HY = E1: MLLXYP)	5•8•10x4	1 <u>x = F12.2</u>	2,10X4HΥ =	El
	1 1 1001 F C C \$18LDR* \$18LDR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M SIBLDR*M MJCPPI MLLXYR	4HX = 110+10X) ROL CARD: LLCPPI LLXYR (1)	5. S.	4HY = E1: MLLXYP)	5.8.10X4	1x = F12.2	2,10X4HY =	E1
	1 1001 F C C S IBLDR* S IBLDR*	ORMAT(5X B) ORMAT(5(USE CONT \$1BLDR*M \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HOY TOX 4HX = Iloslox) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1: MLLXYP)	5.8.10X4	1 <u>X = F12.2</u>	!,10X4HY =	E1
	1 1001 F C C SIBLDR* SIBLDR*	ORMAT(5X B) ORMAT(5(USE CONT \$1BLDR*M \$1BLDR*M S1BLDR*M MJCPPI MLLXYR	4HX = 110+10X) ROL CARD: LCPPI LLXYR (1)	5+ NSTEAD OF	4HY = E1:	5.8.10X4	1 <u>X = F12.2</u>	2,10X4HY =	E1
	1000 F 1001 F C C S 18LDR# S 18LDR#	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MJCPPI MLLXYR	HO, IOA 4HX = IIO+IOX) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1: MLLXYP)	5.8.10X4	1 <u>x = F12.2</u>	:,10X4HY =	E1
	1 1001 Fr C C S IBLDR* \$ IBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$IBLDR*M \$IBLDR*M MJCPPI MLLXYR	HOY IOA 4HX = 110+10X) ROL CARD: LICPPI ILLXYR (1)	5. NSTEAD OF	4HY = E1: MLLXYP)	5•8•10x4t	1x = F12.2	:,10X4HY =	El
	1 1001 F C C S IBLDR* S IBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HOY TOA 4HX = 110.10X) ROL CARD: LICPPI LLXYR (1)	5. NSTEAD OF	4HY = E1	5•8•10x4ł	1 <u>X</u> = F12.2	:,10X4HY =	El
	1 1001 F C C SIBLDR* SIBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HO, IOA 4HX = Iloslox) ROL CARD: LCPPI ILXYR (I)	5. NSTEAD OF	4HY = E1:	5.6.10X4	1X = F12.2	*,10X4HY =	E1
	1 1001 F C C S 18LDR* S 18LDR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MJCPPI MLLXYR	HO, IOA 4HX = I <u>IO+IOX</u>) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1:	5.8.10X4	1 <u>X = F12.</u>	:,10X4HY =	E1
	1 1001 F1 C C S 18LDR# S 18LDR#	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M END MJCPPI MLLXYR	HO, IOA 4HX = IIO+IOX) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1:	5.8.10X4	1 <u>X</u> = <u>F</u> 12.2	:,10X4HY =	E 3
	1 1001 Fi C C S IBLDR* S IBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$IBLDR*M \$IBLDR*M MJCPPI MLLXYR	HOY IOA 4HX = IIO+IOX) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1	5.8.10X4	1x = F12	:,10X4HY =	E1
	1 1001 Fi C C S IBLDR* S IBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$IBLDR*M \$IBLDR*M MJCPPI MLLXYR	HOY IOA 4HX = 110+10X) ROL CARD: LICPPI ILLXYR (1)	5. NSTEAD OF	4HY = E1:	5.8.10X4	1x = F12.2	:,10X4HY =	E1
	1 1001 Fi C C S IBLDR* S IBLDR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HO, IOA 4HX = 110.10X) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1:	5 • 8 • 1 0 X 4 ł	1x = F12	:,10X4HY =	E1
	1 1001 F C C S IBL DR* S IBL DR*	DRMAT(5X B) DRMAT(5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HOY IOA 4HX = 110.10X) ROL CARD: LICPPI LLXYR (I)	5. NSTEAD OF	4HY = E1	5 • 8 • 1 0 X 4 ł	1x = F12	:,10X4HY =	E1
	1 1 1 1 1 1 1 1 1 C C C S 18LDR* S 18LDR*	DRMAT (5X B) DRMAT (5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HO, IOA 4HX = I10+10X) ROL CARD: LICPPI ILLXYR (1)	5. NSTEAD OF	4HY = E1:	5.8.10X4ł	1X = F12.2	:,10X4HY =	E1
	1 1001 F C C S 18L DR* S 18L DR*	DRMAT (5X B) DRMAT (5(USE CONT \$1BLDR*M \$1BLDR*M MJCPPI MLLXYR	HO, IOA 4HX = IIO + IOX) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1:	5.8.10X4	1 <u>X</u> = <u>F12.</u>	:,10X4HY =	E1
	1 1001 Fi C C S 18LDR* S 18LDR*	DRMAT (5X B) DRMAT (5(USE CONT \$IBLDR*M \$IBLDR*M MJCPPI MLLXYR	Ind I TOA 4HX = Ilo IOX) ROL CARD: LICPPI ILLXYR (I)	5. NSTEAD OF	4HY = E1	5.8.10X4	1X = F12	:,10X4HY =	E1

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B.3 Hot Wire End Loss Program--Static Pressure Version

The purpose of this program is to determine total temperatures by making suitable end loss corrections to measured adiabatic wire temperatures using the end loss analysis developed by Dewey (17). The present program is actually an updated version of Dewey's original end loss program as modified by Herzog (14). Current input requirements consist of adiabatic wire resistance, probe support temperature, wire calibration data, tabulated semiprofiles of Pitot pressure, and centerline static pressures which have been corrected for viscous and tunnel gradient effects. An interpolation procedure determines the Pitot pressure corresponding to each probe position. IBM punched cards from the raw data program are used directly to furnish probe position, adiabatic wire resistance, and probe support temperature data. Since Mach number is readily determined from the Pitot and static pressures, all other flow quantities involved in the end loss analysis can be computed once an initial trial value of stagnation temperature is selected. The end loss correction factor corresponding to this initial estimate then determines a revised stagnation temperature value. The computation is cycled until a specified convergence criterion is met. In general, convergence based on a differential between trial and calculated stagnation temperatures of .04⁰K is possible within 5 iterations.

B.3a)	End Loss P (Static and I	rogram ID Listing Nusselt number version)
Q1	%	% injection
Q2	x/D	normalized axial distance
Q3	y/D	normalized transverse distance
Q4	^{Nu} m ^k t	product of measured Nusselt number and air conductivity (based on local total temperature), Ω (ma) ² / ⁰ K in
Q5		open
Q6	P _t	local measured Pitot pressure, mmHg
Q7	T _s	support temperature, ^O K
Q8	$(p_t_2/p_o) \ge 10$	2 measured local Pitot pressure, normalized to free stream total pressure
Q9	(p/p ₀) _c x10 ²	corrected local static pressure, as normalized to free stream total pressure $\left(\frac{p}{p_{o}}\right)_{m}\left(\frac{p}{p_{m}}\right)_{v}\left(\frac{p_{LE}}{p_{x}}\right)_{\infty}\left(\frac{p_{t2_{x}}}{p_{t2_{x}}}\right)_{LE} \infty$
Q10	$p_o = p_{t_o}$	free stream total pressure, mmHg
Q11	$\eta_s = T_s^{\infty}/T_t$	support temperature ratio
Q12	ID	hot wire identification number
Q13	Rr	reference resistance as calibrated for zero current and zero ^o C,
Q14	l/d	wire aspect ratio
Q15	đ	wire diameter, cm
Q16	$\alpha_{\mathbf{r}}$	slope of wire calibration curve, 1/ ⁰ K
Z18	Nu _t	Nusselt number for wire of infinite length
Z19	$\overline{\eta}_* = \frac{(\eta_* - \eta_c)}{\eta_c - \eta_c}$	/ normalized recovery ratio for infinite wire
Z20	M	Mach number
Z21	T _t	corrected local total temperature, ^O K

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		-103-
Z22	ρυ	local mass flow, gmm/cm ² sec
Z23	u.	local velocity, cm/sec
Z24	Τ _∞	free stream static temperature, ^O K
Z25	Re td	Reynolds number based on local total tem- perature and wire diameter
Z26	Re d	Reynolds number based on local static tem- perature and wire diameter
Z27	Τ.	recovery temperature for infinite wire, ^O K
Z28	$Kn = \sqrt{\frac{\pi \gamma}{2}} M/Re$	local Knudsen number
Z29 ´	~ ⁻ T	open
Z30	$\Psi_r = \frac{\eta_*}{\eta} = \frac{T_*}{T_m}$	recovery ratio end loss correction factor
Z31	$\overline{\Psi}_{r} = \overline{\eta}_{*} / \overline{\eta}_{m}$	normalized form of recovery ratio end loss correction factor
Z32	$\psi_{N} = Nu_{t}/Nu_{m}$	Nusselt number end loss correction factor
Z33	$(p/p_{t2})_{c}$	Rayleigh-Pitot ratio (w/correction)
Z34	Tawm	measured adiabatic wall temperature for finite length wire, ^O K
Z35	Z35	number of iterations
Z37	Z37	convergence code
Z98	p _t /p _o	ratio of local total to free stream total pressure
Z99	p/p _o	ratio of local static to free stream total pressure
C1	c ₁	constant in wire conductivity relation
C2	C ₂	constant in wire conductivity relation
C5	^η m;	initial value for η_m
C40	R	gas constant, cm ² /sec ⁰ K
C41	γ	specific heat ratio

C42	T _R	reference temperature (273 [°] K), [°] K
EPS	$\epsilon = \eta_* - \eta_m$	generated
ETAS	$\eta_* = T_*/T_o$	recovery ratio for infinite wire
FKO	k _t	conductivity of air based on local total tempera- ture
FKW	k _w	wire conductivity, cal/sec cm ⁰ K
FMUN	$\eta_{\rm m} = T_{\rm awm}/T$	t measured recovery ratio
FMUO	μ _t	viscosity of air based on local total temperature, gmm/cm sec
FNBR	$\overline{\eta}_{m} = \frac{\eta_{m} - \eta_{c}}{\eta_{f} - \eta_{c}}$	normalized recovery ratio for finite length wire
FNU	$\nu = \frac{\ell}{d} \sqrt{\frac{k_t}{k_w}} I$	^{Nu} t
FNUC	η _c	experimental recovery ratio for continuum flow
FNUF	η _f	theoretical recovery ratio for free molecule flow
S	$\alpha_{r}T_{t}/[1+\alpha_{r}]$	$T_{awm} - T_R$)]
		generated
SS	γ <u>72</u> Μ	generated
TAW	f _l (ss)	table
TSBZ	g ₁ (ss)	table
TS	$\tau_{\rm s} = \eta_{\rm s} - \eta_{\rm m}$	generated
VISIN	μ _∞	viscosity based on local static temperature, gm/cm sec
WO	$\omega_{o} = \tanh v_{o}/2$	vo
	•	generated
SLP	$[dR_{wm}/dI^2R_{v}]$	vm []] I=0

slope of resistance-power curve at I = 0, (ma)⁻²

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DYD	DYD	correction constant for transverse coor- dinate
RAWM	R _{awm}	wire resistance for zero current, Ω
D		open
F17		open
Y1	Yl	storage for η_m
¥2	¥2	storage for Nu _t
¥3	¥3	storage for M
¥6		open
NX35	NX 3 5	iteration number for PRLCM subroutine
NUCO	Nuc	Nusselt number for continuum flow
IDXX	IDXX	input integer code (1 or 2) to indicate input location of $(p'_t/p_o)_m \ge 10^2$
NOP	NOP	number of entires in table of $(p_1/p_0) \times 10^2$ versus y/D t_2^{2} versus y/D
IQ12	IQ12	hot wire number
Q20		open
NUFM	Nu	Nusselt number for free molecule flow
Q17		open
Q18		open
Q19	$\operatorname{Re}_{t} \mu_{t} / T_{t} / p_{t}$	Mach number function
FNUM	Nu _m	measured Nusselt number
NZ35	NZ35	iteration number for main program
NY35	NY35	iteration number for Mach number program
Q8V	$(p_{t_2}/p_0)_m \times 10^2$	measured local Pitot pressure, normalized to free stream total pressure (table)

1 1 126 • • • • • • • • • • • • • • • • • • •	1261.1 292001597 24.10 .06489004 16 	XD 0.1500E 01 YD 0.3000E-02 235 5 X 35 2 M 0.192 4E 01 U 0.5606E 05 RHOU 0.1008E-00 TIMF 0.2111E 03 LTCE-CC N*BR 0.6499E-01 PU 0.4510E-00 REC 0.1191E-CC RIMF C.1846E-0C PSIR 0.11C2E 01 T* 0.4220E 03 MUG 0.2394E-01 LTCE-CC N*BR 0.1CCGE CI KINF 0.1551E 02 PSIB 0.2185E CI NU C.1356E 01 N#BR C.4577E-00 NC 0.9531E 00 MF 0.1148E 01 139E-00 NUP 0.9031E-01 MC 0.6337E 00 NM 0.1C43E CI TM 0.3831E 03 NS C.9813E 00 TS 0.3606E 03 RR 0.2410E 02 197E-02 N* 0.1148E CI CVD -0.4000E-02	
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SIBETC MAI DECK	A CONTRACT OF THE REPORT OF THE AND A CONTRACT OF THE REPORT OF
C MAIN PROGRAM	
DIMENSION TBL1(46) TBL1P(46)•TBL3(46)•TBL3P(46)•TBL4(13)•
1 TBL4P(13), TBL5(43), TBL5P(4	3),TBL6(45),TBL6P(45),TBL6PP(45),
2 TBL7(91) • TBL7P(91) • TBL8(40).TBL8P(40).YD(100).08V(100)
DIMENSION 737/31	
DIMENSION 201007	100 Joy For 707 707 700 320 701 700
COMMON 218,219,220,221,222,	223,224,225,220,221,228,230,231,232,
1233,234,235,237,01,02,05,04	0,641,642,91,92,93,94,995,96,997,98,
2010,011,012,013,014,015,016	•Q17•Q18•Q19•Q20•Q9•D•EPS•ETAS•FK0•
3EKW . EMUN . EMUO . ENBR . ENU . ENUC	.ENUE .ENUM .ETT .N735 .SO .SS .TAW .TS.
415020VISININU0110120150100M	ADD INDEDIRAWING SEPTIDID
COMMON /CONST/TBLI, TBLIP, TB	L3918L3P918L4918L4P918L2918L0918L0P9
<u>1 TBL6PP+ TBL5P+ TBL7+ TBL7P</u>	• TBL8• TBL8P
50 READ (5,51) 1DXX,010,014,01	6,Q13,Q9,DYD,NOP
51 FORMAT (14.6X6F10.0.3X13)	
GO TO (310,320), IDYY	۱۹۹۸ - میزان میزانی میزانی است. ۱۹۹۸ - ۱۹۹۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰
	•
320 READ (5913) (YUL101=19NUP)	
13 FORMAT (16F5.5)	
READ (5+14) (Q8V(1)+1=1+NOP)
14 FORMAT (16F5.4)	
10 DEAD (5-12) 01-02-02-DAWM-6	10.07.1012
10 FORMATIES 1. 1VEA 2 1VEA 2 1	VEE D IVER 4.10VEE 1.10VIAL
12 FURMAI(#3+1+1AF4+2+1AF0+3+1	XL3+541YL0+041AYL3414121
<u>YD1=Q3+DYD</u>	
YD12=YD1*YD1	
YD1=SQRT(YD12)	
CALL TRIKE (YD1.YD.Q8.Q8V.N	OP1
310 READ (5,11) Q1, Q2, Q3, RAWM	•SLP• Q7• Q8• Q9• 1Q12
11 FORMAT(F3.1.1XF4.2.1XF6.3.1	<u>XF5.2,1XF8.6,19XF5.1, 1XF5.4,1XF4.4,</u>
1 8XI3)	,
330 IF (RAWM-EQ.0.) GO TO 50	
012 = 1012	,
	ALUES
$C40 = 2871000 \bullet 0$	
C41 = 1.4	
$C42 = 273 \cdot 2$	
015 = 000254	
$218 = 0 \bullet 1$	
Z34=273_2+(RAWM-Q13)/(Q16*Q	131
Q4=(Q13*Q16)/(3•14159265*Q1	4*SLP*•0001) /
REAL NUCO	
NUCO = 0.5	
	0000077
$\frac{1}{100} = \frac{1}{100} = \frac{1}$	euuuuri
Z33 = Q9/Q8	
NO = 91	
CALL TBLKP (Z33,TBL7,Z20,TB	L7P,NO)
Q6 = Q10 * Q8 / 100	
SS = 7208000710.540411	مرین میں باشن میں بار ایک میں بالک میں -
33 - 22043WN110434(41)	
NU = 40	
CALL TBLKP (SS,TBL6,TAW,TBL	6P (NO)
CALL TBLKP ISSATBLGATSBZATB	L 6PP_NO1
NO1 = 40	
CALL TOLKO /750.401 A. EMIC. 4	D) 4D - NO1 1
ENUE - (TAUCADAL ALA -	
FNUF = (IAW/(SBZ) /(1+0 + +	> ×(∠∠U**∠+) × (L41-1+0}}
<u>COMPUTE</u>	
NZ35 = 1	
FMUN= 95	·
721=734/FMIN	
	•
ETASG=ETAS	
ETASE (EMUN) #230	

B.3d) Fortran Listing of Hot Wire End Loss Program--Static Pressure Version

-	1	08	•
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	FMUN = 2.0
2	0 Z21=Z34/FMUN
	CALL PRICM FIASG=FIAS
	ETASF=FMUN*Z30
	HETASI=ETASG-ETASF
,	FMUN1=FMUN+((FMUN1-•95)/(HETASO-HETAS1))#HETAS1
	IE (ABS((EMUN+EMUN1)/EMUN1)-+00011 25+25+30
2	5 FMUN=FMUN1
	221=234/FMUN
	CALL PRICM
3	0 IF (NZ35-20) 40 200 200
4	0 IF (FMUN1-3.5) 41,200,200
4	1 FMUN = FMUN1
20	GO TO 20
EU	GO TO (310+10)+ IDXX
	END
* 	
	an di serie
······································	
•	

SIBET(PRL DECK
	SUBROUTINE PRLCM
	DIMENSION IBL1(46) IBL1P(46) IBL3(46) IBL3P(46) IBL4(13)
	[IBL4P(13), TBL5(43), IBL5P(43), IBL6(45), IBL6P(45), IBL6PP(45),
	2 BL/(91), IBL/P(91), IBLB(40), IBLBP(40)
	DIMENSION 23/13)
· · · · · · · · · · · · · · · · · · ·	
	3F KW 9F MUN 9F MUU 9F NBK 9F NU 9F NU C 9F NU F 9F NUM 9F 1 / 9N2 33 50 955 9 FAW 9 F5 9 . F 6 7 - V T C T N. WO - V 1 - V 2 - V 2 - V 4 - N V 3 5 - NU C 0 - DAWA - C D
•	
	COMMON / CONST/IDEITIDEITIDESTDESTJEETTIDETTIDETTIDETTIDEUTIDEUTIDEUTIDEUT
	NO = 40
	$1 \times 1^{-1} \times 1^{-1}$
	7242721/(1+0+0.5) (24) = 1-01 + (720 + 21)
	CALL TREKP(724 TRE3 VISIN TRE3P NO1)
	VISIN=VISIN=(0.000001)
10	1, 1220-10, 10914911 725-1, 33864061//FMH0#SORT///C41+1, 18C60#721//2, *C611)11*///C61
<u> </u>	
•	
11	725=(1-3386+06)/(FMU0+50RT((C4)+1-)*(40*72)/(2-*(4))))*(1-/((C4)
······································	$+1_{0}$ $+7_{0}$ $+7_{0}$ $+7_{0}$ $+7_{0}$ $+7_{0}$ $+7_{0}$ $+1_{0}$ $+$
	$+1_{0}$ / (((()+1_{0})) **(1_{0}) (((()-1_{0}))) * ((()-1_{0})) *720 *720 / 2_{0}) **_{0} 51
12	728=(VISIN#720/(725#FMI0))#\$0RT(0_5#C41#3_1415927)
	REAL NUCO
	REAL NUEM
	REAL NUC1
	NX35 = 1
13	IF (NX35-20) 15.15.14
14	NZ35 = 20
. ·	GU TO 990
15	FRNU = -Z25+1.45*(NUCO**(.128*((2NUCO)**4.)+2.67))
	DFRN= 725*((a128*((2a-NUCO)**4a)+2a67)/NUCO-a512*
	((2NUCO)**3.)*ALOG(NUCO))
•	
	NX35=NX35+1
•	IF (ABS((NUC1-NUC0)/NUC1)-+0001) 30+30+20
20	NUCO=NUC1
	GO TO 13
30	NUCO=NUC1
	NUFM=+01796*(TSBZ/SS)*Z25
	718 = NICO(1 + (NICO/NUFM))
	ENU = SORT((014**2)*(FK0/FKW)*218)
	$WO = (EXP(2_00*FNU) - 1_00)/(FNU*(EXP(FNU*2_00) + 1_00))$
	N01=43
	CALL_TBLKP(228+TBL5+219+TBL5P+N01)
	231 = 1.0 + WO + (1.0+(FNUC-011) / (FMUN-FNUC)) / (1WO)
	ETAS=Z19*(FNUF-FNUC) + FNUC
	$/30 = (1 + 107 \pm 40)/(3 + 1)/(3 + 40)$
990	RETURN
	END

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SUBRUU	
DIMENS	TON TRI 1 (46) • TRI 1P (46) • TRL 3 (46) • TRL 3P (46) • TRL 4 (13) •
1 TBL4P	(13), TBL5(43), TBL5P(43), TBL6(45), TBL6P(45), TBL6PP(45),
2 TBL7(91) • TBL 7P(91) • TBL8(40) • TBL8P(40)
DIMENS	ION Z37(3)
	<u>Z18,Z19,Z20,Z21,Z22,Z23,Z24,Z25,Z26,Z27,Z28,Z30,Z31,Z32,</u>
1233923	4 • 2 3 5 • 2 3 7 • C 1 • C 2 • C 3 • C 4 0 • C 4 1 • C 4 2 • W 1 • W 2 • W 3 • W 4 • W 3 • W 6 • W 1 • W 6 • W 6 • W 1 • W 6
JEKW.EM	
4TSBZ V	ISIN • WO • Y1 • Y2 • Y3 • Y6 • NX35 • NUCO • RAWM • SLP • DYD
COMMON	/CONST/TBL1, TBL1P, TBL3, TBL3P, TBL4, TBL4P, TBL5, TBL6, TBL6P,
1 TBL6P	P, TBL5P, TBL7, TBL7P, TBL8, TBL8P
Z23=Z2	0*SQRT(C41*C40*Z24)
726-72	725 # FMU0 / Q15
727=72	1#(FNUC+(FNUE-FNUC)#719)
Z30=(1	• 0-WO* (Q11/FMUN))/(1•0-WO)
<u> </u>	0 9
FNUM =	(Q4/(FKO*4.187*2.54)) * 1.0E-6
<u>Z32=Z1</u>	8/FNUM
FNBR=Z	19/231
21 798 =	-1eU/ 31931932
GO TO	40
32 Z98 =	Q8 /((6.0*Z20*Z20/(Z20*Z20+5.0))*(36.0*Z20*Z20/((Z20*Z20
1 + 5.0)*(7.0*Z20*Z20-1.0)))**2.5 }
40 ID = Q	12 + •01
WRITE	(6,500) ID,Q2,Q3, NZ35, NX35,Z20,Z23,Z22,
1 22492 2 ENUICA	219299929892239226923092279218906 9219922892319FN09FN0R9
500 FORMAT	(2HHW13+11X4HXD F11+4+1X4HYD F11+4+1X4H735 12+2X4HX35 1)
200 . 0.0.00	
1 2X4HM	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/9
<u>1 2X4HM</u> 24HTO	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HREO E11.4.
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u>	E11.4,1X4HU E11.4,1X4HRHOUE11.4,1X4HTINFE11.4/, E11.4,1X4HPINFE11.4,1X4HPO E11.4,1X4HREO E11.4, NFE11.4,1X4HPSIRE11.4,1X4HT* E11.4,1X4HRUO E11.4/,
1 2X4HM 24HTO 31X4HRI 44HPT	E11.4,1X4HU E11.4,1X4HRHOUE11.4,1X4HTINFEI1.4/, E11.4,1X4HPINFE11.4,1X4HPO E11.4,1X4HREO E11.4, NFE11.4,1X4HPSIRE11.4,1X4HT* E11.4,1X4HREO E11.4/, E11.4,1X4HN*BRE11.4,1X4HT* E11.4,1X4HPSIBE11.4,
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u>	E11.4,1X4HU E11.4,1X4HRHOUE11.4,1X4HTINFE11.4/, E11.4,1X4HPINFE11.4,1X4HPO E11.4,1X4HREO E11.4, NFE11.4,1X4HPSIRE11.4,1X4HT* E11.4,1X4HRUO E11.4/, E11.4,1X4HN*BRE11.4,1X4HKINFE11.4,1X4HPSIBE11.4, E11.4,1X4HNMBRE11.4,1X4HKC E11.4,1X4HNF E11.4/,
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4HTM	E11.4,1X4HU E11.4,1X4HRHOUE11.4,1X4HTINFE11.4/, E11.4,1X4HPINFE11.4,1X4HPO E11.4,1X4HREO E11.4, NFE11.4,1X4HPSIRE11.4,1X4HT* E11.4,1X4HRUO E11.4/, E11.4,1X4HN*BRE11.4,1X4HKINFE11.4,1X4HPSIBE11.4, E11.4,1X4HNMBRE11.4,1X4HKO E11.4,1X4HPSIBE11.4, E11.4,1X4HNMBRE11.4,1X4HNO E11.4,1X4HNF E11.4/, E11.4,1X4HNUM E11.4,1X4HWO E11.4,1X4HNM E11.4, E11.4,1X4HNUM E11.4,1X4HWO E11.4,1X4HRM E11.4,
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4FTM 84HALPA	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HREO E11.4., NFE11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HREO E11.4., E11.4.1X4HN*BRE11.4.1X4HT* E11.4.1X4HPSIBE11.4., E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4., E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4., E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNF E11.4., E11.4.1X4HNUM E11.4.1X4HVO E11.4.1X4HRK E11.4., E11.4.1X4HNX E11.4.1X4HVO E11.4.1X4HRK E11.4., E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN <u>71X4HTM</u> 84HALPA RETURN	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HTEO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HT* E11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HVO E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4.
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4HTM 84HALPA RETURN 2 END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HTEO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HKO E11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNO E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.//
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4HTM 84HALPA <u>RETURN</u> 2 END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HKO E11.4.1X4HPSIBE11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HRK E11.4. E11.4.1X4HNS E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.//)
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4HTM 84HALPA <u>RETURN</u> , END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HVO E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4.
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4FTM 84HALPA RETURN , END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFEJ1.4/, E11.4.1X4HPINFE11.4.1X4HRO E11.4.1X4HTEO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4/, E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4/, E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4/, E11.4.1X4HN* E11.4.1X4HDYD E11.4//)
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4FTM 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFEJ1.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HVO E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.//)
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN <u>71X4FTM</u> 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.//)
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN <u>71X4FTM</u> 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.//)
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4F.TM 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HREO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNO E11.4.1X4HNF E11.4. E11.4.1X4HNM E11.4.1X4HWO E11.4.1X4HRM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.7.
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4F.TM 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HREO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HKINFE11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HVO E11.4.1X4HRR E11.4. E11.4.1X4HNS E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.7.
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4F.TM 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HREO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HKINFE11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HVO E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.7.
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4F.TM 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HREO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.7.
<u>1 2X4HM</u> 24HTO <u>31X4HRI</u> 44HPT <u>51X4HNU</u> 64HPSIN 71X4F.TM 84HALPA <u>RETURN</u> . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4.
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4F.TM 84HALPA RETURN . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRHOUE11.4.1X4HTEO E11.4. NFE11.4.1X4HPINFE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HWO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4.
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4F.TM 84HALPA RETURN . END	Ell•4+1X4HU Ell•4+1X4HRHOUEll•4+1X4HTINFEI1•4/+ Ell•4+1X4HPINFEll•4+1X4HPO Ell•4+1X4HREO Ell•4+ NFE11•4+1X4HPSIRE11•4+1X4HT* Ell•4+1X4HNUO Ell•4+ Ell•4+1X4HN*BRE11•4+1X4HKINFEll•4+1X4HPSIBE11•4+ Ell•4+1X4HNUM Ell•4+1X4HNC Ell•4+1X4HNF Ell•4/+ Ell•4+1X4HNUM Ell•4+1X4HWO Ell•4+1X4HRR Ell•4/+ Ell•4+1X4HNS Ell•4+1X4HTS Ell•4+1X4HRR Ell•4/+ Ell•4+1X4HN* Ell•4+1X4HDYD Ell•4//)
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4F.TM 84HALPA RETURN . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRPO E11.4.1X4HREO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4. E11.4.1X4HNUM E11.4.1X4HNO E11.4.1X4HNM E11.4. E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4./, E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4./, E11.4.1X4HN* E11.4.1X4HDYD E11.4.//)
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4H.TM 84HALPA RETURN . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HRPO E11.4.1X4HREO E11.4. NFE11.4.1X4HPSIRE11.4.1X4HVO E11.4.1X4HPSIBE11.4. E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HKO E11.4.1X4HNF E11.4. E11.4.1X4HNM E11.4.1X4HVO E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4.
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4F.TM 84HALPA RETURN . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HT1NFE11.4/, E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HT1NFE11.4/, NFE11.4.1X4HPSIRE11.4.1X4HT* E11.4.1X4HREO E11.4/, E11.4.1X4HN*BRE11.4.1X4HKINFE11.4.1X4HPSIBE11.4. E11.4.1X4HNMBRE11.4.1X4HNC E11.4.1X4HNF E11.4/, E11.4.1X4HNM E11.4.1X4HNO E11.4.1X4HRR E11.4/, E11.4.1X4HNS E11.4.1X4HTS E11.4.1X4HRR E11.4. E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4/, E11.4.1X4HN* E11.4.1X4HDYD E11.4.7
1 2X4HM 24HTO 31X4HRI 44HPT 51X4HNU 64HPSIN 71X4FTM 84HALPA RETURN . END	E11.4.1X4HU E11.4.1X4HRHOUE11.4.1X4HTINFE11.4/, E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HTINFE11.4./, E11.4.1X4HN*BRE11.4.1X4HT* E11.4.1X4HREO E11.4./, E11.4.1X4HN*BRE11.4.1X4HRT E11.4.1X4HPS BE11.4., E11.4.1X4HNMBE11.4.1X4HNC E11.4.1X4HNF E11.4./, E11.4.1X4HNM E11.4.1X4HWO E11.4.1X4HRM E11.4., E11.4.1X4HNM E11.4.1X4HVO E11.4.1X4HRR E11.4./, E11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRR E11.4./, E11.4.1X4HN* E11.4.1X4HDYD E11.4.7/)

SIBETC BLO DECK
BLOCK DATA
1 THLADII31 TH 5(43) TH 5P(43) TH 6(45) TH 6P(45) TH 6P(45)
2 TBL7(91) • TBL7P(91) • TBL8(40) • TBL8P(40)
DIMENSION Z37(3)
COMMON /CONST/TBL1, TBL1P, TBL3, TBL3P, TBL4, TBL4P, TBL5, TBL6, TBL6, TBL6P,
1 TBL6PP, TBL5P, TBL7, TBL7P, TBL8, TBL8P
$\frac{DATA (TBL1(I) + I = 1,41)}{200 + 100 +$
3 • 380 • • 390 • • 400 • • 410 • • 420 • • 430 • /
DATA (TBL1(1)) = 42,46)/440,450,460,470,480.480.480.480.480.480.480.480.480.480.
DATA (TBL1P(1)+I = 1+41)/ 0+7039+0+9117+1+131+1+350+1+558+1+784
1 9109969202109204259206409208559306893028193049293070393091294011
4 211-9 270-9 546/
421190+37090+3437 DATA (TR) 10(1)+1 = 42+46)/8+706+8+868+9+030+9+192+9+3477
DATA ($TBL3(1)$, $I = 1,46$)/ $30,40,50,60,70,80,90,100,110$
1 +120 + 130 + 140 + 150 + 160 + 170 + 180 + 190 + 200 + 210 + 220 + 230 + 240 +
2 ,250,,240,,270,,280,,290,,300,,310,,320,,330,,340,,350,,360,,370,
3 , 380 , , 390 , , 400 , , 410 , , 420 , , 430 , , 440 , , 450 , , 460 , , 470 , , 480 , /
DATA $(TBL3P(1), 1 = 1, 46)$ / $215 \cdot (, 281 \cdot 1, 34) \cdot (, 34) \cdot (3, 416 \cdot 3, 485 \cdot 6, 555) \cdot (, 56)$
$\frac{1}{2} \frac{2}{2} \frac{2}{2} \frac{1}{2} \frac{1}$
3 1893 1939 1985 2030 2075 2118 22160 2202 2245 2286 2327
4 • • 2366 • • 2406 • • 2445 • • 2485 • • 2520 • • 2560 • • 2595 • /
DATA (TBL4(1) + 1 = 1 + 13) / 0 + 90 + 2 + 0 + 4 + 0 + 6 + 1 + 0 + 1 + 2 + 1 + 4 + 1 + 6 + 1 + 0 + 0
1 8,2.0,2.2,8.0/
$\frac{DATA (TBL4P(I),I = 1,13)}{1.0,0.998,0.995,0.991,0.985,0.977,0.9}$
1 (090e96490e95990e95590e95290e950900950e9507 DATA (TRUS/1):1 = 3.e43)/0.05.0.06.0.07.0.08.0.09.0.10.0.11.0.
$\frac{1}{12.0.14.0.15.0.17.0.19.0.29.0.23.0.25.0.30.0.35.0.40.0.50.0.60.0.60}$
2 70.0.80.00.90.1.0.1.1.1.2.1.3.1.4.1.5.1.7.1.9.2.0.2.5.3.0.3.5.4.0.
3 5.0,6.0,7.0,8.0,10.0,12.0,20./
DATA (TBL5P(I)) = 1,43) / 0.02,0.03,0.042,0.054,0.068,0.082,0.00
1 97,0.112,0.144,0.158,0.188,0.218,0.232,0.272,0.294,0.350,0.397,0.
3 •800\$0•826\$0•849\$0•858\$0•895\$0•916\$0•932\$0•944\$0•960\$0•970\$0•977\$
0.474 (1816(1)) = 1.45)/ $0.220.440.650.881.001.4231.441.651.882$
1 •0 • 2 • 2 • 2 • 4 • 2 • 6 • 2 • 8 • 3 • 0 • 3 • 2 • 3 • 6 • 3 • 6 • 3 • 8 • 4 • 0 • 4 • 2 • 4 • 4 • 4 • 4 • 6 • 4 • 8 • 5 • 0 • 5 •
2 2,5.4,5.6,5.8,6.0,6.2,6.4,6.6,6.8,7.0,97.2,7.4,7.6,7.8,8.0,8.2,
38.4.8.6.8.8.9.0/
DATA (TBL6P(I)+I = 1,45)/ 9.80271+10.94784+12.89399+15.69746+19
<u>1 •43609•24•20781•30•12863•37•32923•45•95230•56•14932•68•07771•81•8</u>
2 994/99/0 / 902911508828/913603/82191596433619185021/09921308992/92
4 756 568 01730 530 41 82 567 567 579 769 31 885 89 927 563
5 1014-61-1107-11-1205-2+1309-1+1418-8+1534-7+1656-7+1785-2+
6 1920+4+2062+2+2210+9+2367+0+2530+2+2700+7/
DATA (TBL6PP(1)+1 = 1+45)/ 9+61234+10+16410+11+04924+12+22282+13
1 •63288,15,22758,16,96068,18,79408,20,69872,22,65358,24,64392,26+6
2 5990+28-69470+30+74382+32+80398+34+87300+36+94914+39+03112+41+118
3 UU143e20904145e3035414/e40108149e50126151e60366153e/0808155e81428 4 e57.93200e60e03114e62e141e64e249e64e359e64e647e70e680e73e693e
5 76.802.76.910.79.025.81.130.82.242.85.252.87.461.80.561.91.474.
6_93_782#95_886/
DATA(TBL7P(1)+1 = 1+91)/ 8+0+7+95+7+90+7+85+7+80+7+75+7+70+7+65+
1. 7.60.7.55.7.5.7.4.7.3.7.2.7.1.7.0.6.9.6.8.6.7.6.6.6.6.5.6.6.4.6.3.

2 6.2.66.1.66.0.55.2.9.55.86.5.7.125.65.26.45.53.46.15.25.25.1.55.0.74.69.46.9.46.86.47. 3 4.66.46.05.46.46.40.14.46.00.20.97.86.47.79.26.45.25.35.46.45.25.12.71.16.61.25 5 1.44.11.31.12.11.11.10.97.86.47.46.05.44.43.35.25.42.25.12.25.12.25.12.55.01.25.7 0 4.03.20.7 DATA (18L7(1).41 = 1.91)7.01207. 0.01222.01237.01253.01253 4 .01255.01327.013129.01335.013354.01372.014699.01448.01488. 2 .01530.01574.001319.01667.01716.01766.012459.00537.02631 4 .02230.022834.02295.03362.03187.003319.02547.02547.02637.02631 4 .02230.022834.02295.03062.03167.03319.025497.052567.05376.02537 5 .06157.00513.00531.02528.007765.06291.05249.02364.03368 2 .03338.04120.043144.005221.00774.029471.02527.052567.052567.052565.05825 6 .06513.00513.026910.07323.07765.06291.05249.02366.03868.094661.1014. 7 .0082.01730.02834.02380.03655.4159.4689.05281.05560.07209. 9 .1640.8430.08560.09833.9335.05227.07755.9725.83.05560.07883 2 .0268.02330.03665.04159.04689.03655.05283.05933.05560.07209. 9 .1640.8430.08560.9183.93355.05283.0575.9725.05845.03983. 1 .9994.1173.01266.0131.11.1489.05669.0575.9725.05867.05827.05287.05827.0587 2 .026.0513.00530.03655.04159.04689.0594.05283.059843.039643.03963 1 .9994.1207 END	2 6+2+6+1+6+0+5+2+5+6+5+7+2+6+5+5+5+5+2+5+2+5+2+5+2+5+3+5+2+3+3+2+2+1+4+4+5+3+3+2+2+3+3+2+3+3+2+3+3+2+3+3+2+3+3+2+3+3+2+3+3+3+2+3+3+3+2+3+3+3+2+3+3+3+2+3+3+3+2+3			·						
3 4.6.4.0.0.4.4.4.0.3 4.4.2.4.144.0(3.9.9.3.6.3.7, 3.6.3.7, 3.6.3.3, 3.3.4.3.2.3.1.1 4.1.2.1.2.1.2.1.2.1.2.1.2.1.2.1.2.1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.1.2.1.1.0.5.2 6.03.3.0.7 DATA (18L711)1 - 1.91)7/01207 012227.012237.012237.012037.012037.01233.0.12609. 1.01285.01302.01319.0.01335.0.01354.001375.010409.01468.014689.014689.014689.014689.014689.014689.014689.014539.0.01537.0.024397.022317.022317.022317.026317.023197.023197.026317.026341.02648.020749.02021.02644.03121.0170.02231.00708468.007641.01047.02497.02231.00708468.007641.0170.0224.077.026341.02497.02231.00708468.007641.0170.00172.007786.0450.02031.007661.0170.00172.007786.0450.02031.007661.01047.00331.000646.007641.01047.00321.007786.0450.02031.00708640.007661.01047.00391.00256.007209.02093.1.0994.1201.0230.037865.0457.02031.0070869.02063.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007661.01047.009646.007660.007661.01047.009646.007660.009646.009646.009646.009646.009646.009646.009646.009646.009646.009646.009646.009646.009646.0096467.0097647.0096467.00976479.009647.00976479.009647.00976479.009647.00976479.009647.00976479.009647.00976479.00976479.00976479.00976479.00976479.00976479.00976479.00976479.00976479.00976479.00976479.00976479.	3 4.6044.516.444.324.444.044.043.973.663.773.663.853.4443.243.273.1 4 3.0027.972.881.2772.6672.572.2442.232.222.212.012.971.491.681.711.601.55 5 1.441.331.2211.11.10.099.88.77.66.55.441.353.372.252.221.125.114.055 6 .033107 OATA (19L7(1).1 = 1.91)7.01207.01222.012237.012537.012537.012637. 1 01285.01302.013123.013354.013354.013372.01409.0121468.014688.014888. 2 01530.01574.0013137.01267.01716.01768.01423.014688.01488. 2 01530.01574.0013137.012628.02268.022649.022469.022459.02237.026376. 3 02202.02067.021365.02228.02268.022469.022459.022459.02537.0263768. 3 02203.012021.02067.021365.02223.007785.002291.005246.005256.05829. 4 02730.021351.042345.00362.007852.00785.002391.005266.05829. 3 03238.005135.005313.00690.07323.007785.002291.005246.00505266.05829. 4 026157.005131.005313.00690.07323.007785.002291.005246.203660.7209. 5 03038.005133.00530.005260.03123.00785.02263.5913.055266.05829. 4 02622.1173.126661.3171.01897.16227.173.01945.21422.2268. 5 0262.02687.0280.0355.0133.027.00575.0273.5913.06560.7209. 9 .72400.8230.0355.0133.2200.3855.0133.20775.27725.2844.2930.2963. 1 .9994.1207 END	2	6.2.6	.1.6.0	.5.9.5.8	5.7.5.6.5	.5.5.4.5	•3,5.2,5.	1,5.0,4.9,	4.8,4.7,
4 4 40224924022 - 22022 - 22224 - 2232 - 2222 - 2222 - 212 -	4 3.0.22.972.88.22.77.22.672.57.24.92.23.72.27.217.2071.97.14.801.771.401.55 5 14.01.13.11.201.11.400.97.880.77.605.55.44.335.372.501.2253.01263. 0ATA (TBL7(1).1 = 1.91)7.01207.01227.011237.011499.012498.01269. 1.01285.101302.10139.101336.101354.01372.101409.012498.014880. 2.01530.01574.01619.01667.001716.001768.01253.012880.01939 3.02021.022067.02034.02208.02208.02284.02364.02499.002537.03609.03699. 5.03338.104120.02945.00245.00232.00774.004987.03459.03609.03609.03766 5.03338.104120.02945.00323.00778.004987.003459.03609.03609.03609. 5.03338.104120.02945.00323.00778.004987.003459.03609.03609.03609. 5.03338.104120.02945.03732.00778.004987.003459.03609.03609.03629. 5.03338.104120.02945.03732.00778.004987.003459.03609.03609.03768 5.03338.104120.02945.03732.00778.004987.003459.03609.03609.03769 5.03238.104120.02945.0323.00778.004987.003459.036096.07609.03 5.03238.104120.0295.0323.00778.004987.003459.036096.07609.03 5.03238.104120.0280.0365.04159.04689.05283.03913.068048.009661.0104 7.1089.1173.112660.13718.1889.1622.01773.02454.0306.0350.0299.3 5.02628.0230.03280.03655.04159.04689.05283.0513.03293.0778.099451.0142.02368.0 7.7400.8300.08556.09183.02351.0323.0778.09785.0723.0778.09454.0393.0500.09983. 1.9994.0107 END	3	4.6.4	. 5 . 4 . 4	•4•3•4•2	4.1.4.0.2	.9.3.8.3	•7•3•6•3•	5 . 3 . 4 . 3 . 3 .	3.2,3.1,
5 14411.3112211.11100497483941405244433974942972421534405972401293401223 DATA (18L711)41 = 1+917/-01207+01222+01237+01323+01327-014984,-01488, 2 01530+01574+01619+01667+01716+01768+01823+01880+019394 3 02202+02207+022184+02208+02248+02364+02249+020537+02631 4 02730+02834+02945+003062+03187+03319+03499+03609+037684 5 03938+06120+04314+005221+00747+04987+05247+025267+052526+052526+052526+052526+052526+052526+052526+052526+02329 6 06157+06513+06900+07322+07785+08291+06864+09961+1014+ 7 +1089+1173+1256+1371+1489+1622+1773+19547+1242+2368 6 +2628+2930+3260+3685+4159+4689+5283+5913+6560+7209 9 +7460+8430+8956+9183+935+975+9725+9844+9930+9983+ 1 +9974+1207 END 2	> 1.4.1.3.1.2.2.1.4.1.0.9.9.8.9.0.90.9.9.9.9.9.9.9.9.2.9.2.2.2.2.2.2.	4	3.0.2	.9,2.8	.2.7.2.6	2.5,2.4,2	• 3 • 2 • 2 • 2	•1•2•0•1•	991.891.7.	1.6,1.5
0 • •23190 / DATA (18L7(1)+1 = 1.91)/*01207. •01227.•01237.•01253.•01269. 101285.•01302.•01519.•01539.•01236.•012372.•01498.•01488.•01488.•014939. 3 •02200.•01539.•01519.•01567.•01716.•01768.•01223.•012880.•01498.• 4 •02730.•02834.•01549.•01567.•01716.•01768.•02494.•02537.•02525.•02581. 4 •02730.•02834.•02955.•021062.•02284.•022864.•02497.•05287.•05285.•0386988.•0386988.•038698.•0386988.•03869888.•03869888.•038698.•038688.•038688.•038688.•0386988.•038698.•03	0 00310/ 0014 (1017(1),1 = 1.91)/.01207, 01222.01237.01253.01269, 1 01285.01302.01319.01336.01354.01372.01499.01448.01488. 2 01530.01574.01619.01667.01716.001768.01235.012880.01939 3 022021.022067.02136.02208.02284.02364.023649.02497.05537.03609.03768 5 023938.064120.02451.01622.0178.00178.003459.053609.03698.03768 5 023938.064120.004314.00523.047747.004987.05247.05526.0329. 6 06157.06513.005900.07323.007785.0628.08488.096461.01048 7 .01089.1173.12666.1371.11889.1622.01773.1955.2142.02368. 6 202280.3280.3685.0459.05609.5281.05918.05504.21078. 9 .7640.8330.8956.9183.93955.9575.9725.9844.9930.9983. 1 .9994.130/ END	5	1.4.1	•3•1•2	.1.1.1.0		••••	,	2310290159	•19•059
1 .01285+01302+01312+01326+01326+01372+01409+01446+01468, 2 .01530+01574+01619+01667+01716+01768+01823+018828+01893 1 .02021+02067+02136+02208+02284+02244+02459+02537+022831 2 .02730+02834+022945+03062+03187+03319+03459+03659+03568 2 .03938+04120+03314+0523+007785+06291+008848+09461+1014+ 2 .006157+06513+06900+07323+07785+06291+008848+09461+1014+ 2 .0069+1173+1266+1371+1469+1622+01773+1945+2142+2368+ 3 .02620+2300+3280+3665+4159+4689+5283+5913+6560+7209+ 9 .7640+6420+8956+9183+9395+9575+9725+9844++9930+9983+ 1 .099+41407 EN0	1 - 012 03 - 013 02 + 013 12 + 013 25 + 013 25 + 013 72 + 01409 + 01445 + 01486 + 01939 + 2 - 01530 + 01574 + 01619 + 01667 + 01716 + 01768 + 01823 + 01880 + 01939 + 3 - 02002 + 02208 + 0.02306 + 0.02208 + 0.02449 + 0.02459 + 0.02537 + 0.02537 + 0.02537 + 0.02526 + 0.03768 + 5 - 03938 + 02730 + 0234 + 0.0232 + 0.0774 - 0.0487 + 0.05247 + 0.05267 + 0.05265 + 0.0526 + 0.05265 + 0.05265 + 0.05265 + 0.0526 + 0.05265 + 0.0526	0		U /	1.1 = 1.0	211/01203	01222		01253012	69.
2 •01530 • 01574 • 01619 • 01667 • 01716 • 01769 • 01823 • 01808 • 01399 3 •02002 • 02067 • 02136 • 02208 • 02204 • 02264 • 02449 • 0257 • 02537 • 02577 • 02537 • 02577 • 02577 • 02577 • 02577 • 02577 • 02577 • 02577 • 02577 • 02577 • 02577 • 02	2 - 0.15300157401619016670171601768018230188001399 3 - 022021.0206702136022080228402364024490253702531 4 - 027300283402435024520286402364024490253702537 5 - 03338041200243502452045230474704987022470526205829. 6 - 061570651310690007323077850829108848094611014. 7 - 1089117312661371148916221773194521422368. 8 - 2628052890459415746895230591365607209. 9 .7660843089564157468952305913591309884499309983. 1 .9994.1207 ENC	,	-012H	5	02 • 01319		01354	1372	09.01448-	•01488-
3 02002+02087+02136+02208+02284+0236+02384+02337+02837	3 020021 02007 02136 02208 02284 02284 02236 0362 03765 0360 03765 03766		-0153		74 . 01619	01667.	01716.00	1768 • • 018	23.001880	•01939•
• 0.2730.+0.2834.+0.2945.+0.3062.+0.3187.+0.3319.+0.3459.+0.3569.+0.37667. • 0.0381.+0.4250.+0.4314.+0.4523.+0.074747.+0.49487.+0.2527.+0.5526.+0.5829. • 0.06157.+0.0513.+0.6900.+0.7323.+07785.+0.8291.+0.8848.+0.9461.+1.014+ * 1.089.+1173.+1.266.+1.371.+1.4897.+1.622.+1773.+1.945.+2142.+2.368. • 2.6261.+230.+2360.+1.365.+4159.+4689.+5283.+5513.+0550.+7209. • 7.6401.+84301.+8556.+2183.+2395.+2575.+9725.+9844.+9930.+9983. 1.9994.*1.07 END END	<pre></pre>	3	•0200	2 020	67 . 02130	5, 02208,	02284.0	2364 . 024	49 0 . 537 .	•02631•
5 .03938,.04120.04314.04523.04747.04987.05247.052526.05829 6 .06157.060513.06900.07323.07785.06251.06848.099461.0146 7 .1089.1173.01266.1371.1489.01222.01773.0945.02142.02368. 8 .2626.2930.03280.03685.04159.04689.05283.05913.06560.7209. 9 .7840.08300.03250.02183.02395.02575.0723.02844.0930.0983. 1 .9994.120/ END 	5 .03938,.04120.04214.0423.04747.04987.04987.002247.02526.05829. 6 .06157.06513.04090.0723.007785.06291.008848.09461.01046 7 .1089.1173.01266.01371.01457.04687.0185.0283.05913.04550.07209. 9 .74540.84300.84300.03655.0157.04687.05283.05913.04550.07209. 9 .74540.84300.84300.03555.0123.02925.0575.0725.09844.09930.09983. 1 .9994.120/ END	4	.0273	0++028	34 . 0294	5.03062.0	031870	3319034	59,.03609,	.03768,
6 .061570651306900.07323.07785.08291088480994611014. 7 .108911731266.13711689.1222177319455.21422368. 8 .26282930328036854159468952835913455607209. 9 .7640843082569183939595759725984499309983. 1 .9994.107 ENU	6 • 06157.006513.006900.0723.007765.008291.008640.009461.0104. 7 .1089.0173.01945.01420.2388. 8 .2628.02930.3280.03665.0159.4689.05283.05913.0560.07209. 9 .7260.06530.08956.0183.093951.9575.09725.09844.09930.0983, 1 .99940.1607 END	5	•0393	8 041	209.04314	404523.	04747.0	4987 052	47,.05526,	.05829,
7 . 10891731266137114891622173194521842288 8 .2628293032803685415946892583591345607209. 9 .7640843089569183939595759725984499309983. 1 .9994.140/ ENU	7 . 1089 1173 1266 1371 1489 1622 1773 1945 2148 2368. 8 . 2626 2300 32800 3655 40159 4689 5283 5913 45500 7209. 9 . 71840 8956 9183 9395 9575 9725 9844 9930 9983. 1 . 9954.1 07 ENU	6	•0615	7.065	13.06900	0,.07323,	077850	8291,.088	48,09461,	•1014•
8 - 2628 - 2930 - 3250 - 3263 - 9153 - 9375 - 9725 - 9844 - 9930 - 7209 - 725 - 9844 - 9930 - 9983 - 1 - 9994 - 1 - 07	8 - 2628 - 2930 - 3280 - 3280 - 308 - 308 - 918 - 928 - 922 - 928 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 928 - 928 - 728 - 728 - 928 - 928 - 728		•1089	1173	<u></u>	1371++1489	· · 1622 · ·	$1773 \bullet 194$	5002142002	368,
Y - (104040420000000000000000000000000000000	Y 1.6494.64301.6776.777577777777777777777777777777777	8	•2628	••2930	9056	3683994133	40079	228390291 9725994		2099
		<u> </u>	+ 1040	1.0/	9 8 9 7 2 9 8 8	710390737		714299704	4902730907	7039
		*	END	1100/						
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							<u></u>	<u>in a constant and the second second</u>	والمعرجية والمتحدثة فطور أورز والمحدود	<u>ىكە مەمەرىم بەرمۇغانىغىغۇرارى</u>

~	THIS CURPOUTINE DEPENDE TABLE LOOK-UP OPERATIONS
Ç.	DO 100 1=1-NO
	VAR1=VAR(1)
100	IF (VO-VAR1) 200,150,100
100	WRITE (6,900)VO,NO
900	FORMAT (34H VARIABLE EXCEEDS TABLE FOR VALUE E11.4.13H TABLE SIZ
	FO =FCN(NO)
	<u>GO TO 300</u>
150	FO=FCN(1) GO_TO_300
200	IF (1-1) 210,290,210
210	[]=[-] TFMP=V0-VAR(]])
	TEM1=VAR(I)-VAR(I1)
	RATIO=TEMP/TEM1
	GO TO 300
290	FO=FCN(I)
300	END
•	
	<u></u>

B.4 Hot Wire End Loss Program -- Nusselt Number Version

As Dewey (17) and Herzog (14) have already indicated, considerable difficulty was experienced in the initial set up and check out of this extensive end loss program. This difficulty arose because the method of successive substitution was used to compute local Mach numbers from Pitot pressures and Reynolds numbers, and this computation procedure did not always converge. It was therefore necessary to establish a double iteration procedure based on Newton's method to calculate simultaneously end loss corrections both for adiabatic wire temperature and Nusselt number. The input data for this program consist of Pitot pressures, adiabatic wire resistances, probe support temperatures, measured slopes of wire resistance-power curve corresponding to zero power (dR/dI^2R) . and wire calibration data including Nusselt number correction factors (Appendix A) determined with the aid of the previous program. Input values of R_{awm} , T_{s} and $dR/dI^{2}R$ are obtained directly from the punched card output of the raw data program. Pitot pressure input data at a given axial location consist of tabulated semiprofiles of pressures, and values corresponding to specific probe positions are determined by interpolation. Starting with initial trial values for stagnation temperature and Nusselt number, the computation is cycled until a convergence criterion is met. In most cases satisfactory convergence takes place within 5 to 6 iterations.

|--|

Number Version	
ETRETC MALL DECK	and and an an
DIMENSION TRUI (46) TRUI P(46) TRU 3/	46) • T9L 3P(46) • TBL 4(13) • TBL 4P(13)
1.TBI 5(43).TBL 5P(43).TBL 6(45).TBL 6P	(45) • TBL6PP (45) • TBL7(19) • TBL7P
2(19),YD(100),Q8V(100)	e de la companya de l La companya de la comp
DIMENSION Z37(3)	!
COMMON Z18,Z19,Z20,Z21,Z22,Z23,Z24,	Z25,Z26,Z27,Z23,Z30,Z31,Z32,
1233,234,235,237,01,02,05,040,041,04	+2+01+02+03+04+05+06+07+08+
2010,011,012,013,014,015,016,017,018	3,Q19,Q20,Q9,D,EPS,ETAS,FK0,
3FKW, FMUN, FMUO, FNBR, FNU, FNUC, FNUF, FN	NUM+FI7+NZ35+SO+SS+TAW+TS+
4TSBZ+VISIN+W0+Y1+Y2+Y3+Y6+NY35+NUCC	D,RAWM,SLP,DYD
COMMON /CONST/TBL1,TBL1P,TBL3,TBL3F	• , TBL4 , TBL4 P , TBL5 , TBL6 , TBL6 P ,
1 TEL6PP, TEL5P, TEL7, TEL7P	
CMAIN_PROGRAM	
50 READ (5,51) IDXX,Q10,Q14,Q16,Q13,Q9	9.DYD.NOP
51 FORMAT (14+6X6F10+0+3X13)	۱ ۱
READ (5.500) TBL7P	· · ·
500 FORMAT (16F5.2)	
GO TO (310,320),1DXX	
<u>320 READ (5.13) (YD(1).I=1.NOP)</u>	·
13 FURMAI (10F7+5)	
10 PEAD (5,12) 01,02,03, PAWMASE D.07, 10	112
$\frac{10 \text{ KCAU (3912) GIGE (GS) KANASCE (GT)}{12 EDOMATIES, 1,1 YE4, 2,1 YE4, 3,1 YE5, 2,1 YE5, 2,1$	xF8.6.19XF5.1.19X131
YD1=SORT(YD12)	
CALL TBLKP (YD1+YD+Q8+Q8V+NOP)	
GO TO 330	
310 READ (5.11) Q1. Q2. Q3. RAWM.SLP. Q	7 • Q8 • Q9 • IQ12
11 FORMAT(F3.1.1XF4.2.1XF6.3.1XF5.2.1)	xF8.6,19xF5.1, 1xF5.4,1xF4.4,
1 8XI3)	
330 IF (RAWM.EQ.0.) GO TO 50	
Q12 = IQ12	
NZ35=1	and a second
20 CALL FSTCM	
30 CALL PRICM	·
CALL M22	• • •
80_IF (ABS((220-Y3)/220)01) 150.150	• 100
100 IF (NZ35-20) 120,200,200	
120 NZ35=NZ35+1	
CALL ADDCM	
	100-100
150 IF (ABS((FMUN-Y1)/FMUN)-+0005) 1/0	• 100 • 100
$\frac{1/0 + 1 + 185(1/18 + Y2)/(18) - 0005) + 200(21)}{200 + 225 + 5440 + 5007 + 721 + 200}$	
200 GI9 = 223 FM00 SGR(221)/GG	
IFUUUU000001_ZU102U102U2	
SS - 770#C007/0-5#C/11	
33 - 220*39KTT002*5417	
CALL TOLKO (CC. TOLK. TAW. TOLKO - NO.)	
CALL IDERY ISSTIDLOTIAWTIDLOYINU) CALL TRIKO (CC.TRIK.TCR7.TRIKOD.NA)	N N N N N N N N N N N N N N N N N N N
NO1 = 40	
CALL TRIKE (720-TRI 4-FNUC-TRI 4P-NOT	1)
FNUE = ITAW/TER71 /11_0 = 5 #17201	##2a) # (C41-1a0))
COMPLITE	THE THE AVEL
N735 ± 1	
FM(N=205)	
721=734/FMIN	

B.4c) Fortran Listing of Hot Wire End Loss Program--Nusselt Number Version

	ETACG-ETAC
· ·	ETASE=(FMUN)+Z30
	HETASO=ETASG-ETASF
220	HUN = 2+0 Z21=Z34/FMUN
.	CALL PRLCM
	ETASG=ETAS
	ETAST=FMUN#250 HETAS1=ETASG-ETASF
	FMUN1=FMUN+((FMUN195)/(HETASO-HETAS1))*HETAS1
	NZ35=NZ35+1 TE (ABS((EMUN-EMUN1)/EMUN1)0001) 225+225+230
225	FMUN=FMUN1
	Z21=Z34/FMUN
	GO TO 202
230	IF (NZ35-20) 240+202+202
240	IF (FMUN1-3+5) 241+202+202 FMUN = FMUN1
	GO TO 220
202	CALL OUTPUT
	GO TO (310,107, 10XX END
	un en
·	

<u>\$1B</u>	ETC_FSTDECK
	SUBROUTINE FSTCM
	DIMENSION TBL1(46), TBL1P(46), TBL3(46), TBL3P(46), TBL4(13), BL4P(13)
	1,18L5(43),18L5P(43),18L6(45),18L6P(45),18L6P(45),18L6P
	2(19) Divence (20), 227(2)
	DIMENSION 23(13) COMMON 119,719,720,721,722,723,726,725,726,727,728,730,731,732
	1253123412331231101102100100000000000000000
	41587.VISIN.WO.YI.Y2.Y3.Y6.NY35.NUCO.RAWM.SLP
	COMMON /CONST/TBL1.TBL1P.TBL3.TBL3P.TBL4.TBL4P.TBL5.TBL6.TBL6P.
	1 TBL6PP+TBL5P+TBL7+TBL7P
с	SET CONSTANTS
	REAL NUCO
	C1=0•072
	C2=0•000077
	C5=1∙025
	C40=2871000•0
	C41=1.4
	C42=273.0
	Q15 = •000254
<u> </u>	SET INITIAL VALUES
	EPS=0.06
	FNU = 1.5
	FMUN = 1.025
	NZ35=1
	$Y_1 = C_5$
	<u>SO=0-5</u>
	73 = 2
	L/2 = 2 e
<u> </u>	
`	734≈273•2+(RAWM-Q13)/(Q16*Q13)
<u></u>	(4=(013*016)/(3*14)59265*014*SLP**0001)
	FKW=(1+1Z34-C42)*C2
	Z21=Z34/FMUN
	NO=46
	CALL TBLKP(Z21+TBL1+FK0+TBL1P+NO)
	FK0≈FK0*(0.00001)
	FNUM = (Q4/(FKO*4.187*2.54)) + 1.0E-6
	$Q6 \approx Q10 * Q8 / 100$
	Q11 = Q7 / Z21
	IS = (07 - 734) / 721
	CALL BSIT
	NO1≈46
	CALL TBLKP(Z21+TBL3+FMU0+TBL3P+NO1)
	FMU0=FMU0*(0=000001)
	RETURN
	FND.
	The second s

	1	1	9	-
--	---	---	---	---

SIBFTC PRI DECK
SUBROUTINE PRLCM
DIMENSION TBL1(46), TBL1P(46), TBL3(46), TBL3P(46), T31.4(13), TBL4P(1
1,TBL5(43),TBL5P(43),TBL6(45),TBL6P(45),TBL6P(45),TBL6PP(45),TBL7(19),TBL7P
2(19)
DIMENSION Z37(3)
COMMON Z18, Z19, Z20, Z21, Z22, Z23, Z24, Z25, Z26, Z27, Z28, Z30, Z31, Z32,
1233,234,235,237,01,02,05,040,041,022,03,04,005,006,07,008
2410, G11, G12, G13, G14, G15, G16, G17, G18, G19, G20, G9, D) EPS, ETAS (FRO)
3FKW+FMUN+FMUO+FNBR+FNU+FNUC+FNUH+FNUM+F17+NZ35+SU+SS+TAW+TS+
4TSBZ + VISIN, WO + YI + YZ + Y3 + Y6 + NY 35 + NUCO + RAWM + SLP
1 18 GPP: 18L3P : 18L3: 18L7P
$11 W = \frac{1}{2} (27 - 23 + 1) (7 - 1)$
13 = (0(-2)4) / 221
CALL TREED WOATRE 7-732-TRE 7P-NO1
$W_0 = (F_XP(2, 0) + F_NU) - 1 + 0) / (F_NU) + (F_XP(F_NU) + 2 + 0) + 1 + 0) $
NO1=46
CALL TBLKP(Z2)+TBL3+FMU0+TBL3P+N01)
FMU0=FMU0*(0.0000001)
Z24=Z21/(1+0+0+5*(C41-1+0)*(Z20**2))
CALL TBLKP(Z24,TBL3,VISIN,TBL3P,NO1)
VISIN=VISIN*(0.0000001)
CALL NUOREO
228=(VISIN*220/(225*FMUO))*SQRT(0.5*C41*3.1415927)
NO1 = 43
CALL TBLKP(228,TBL5,219,TBL5P,NO1)_
NO1 = 13
CALL TBLKP (Z20,TBL4,FNUC,TBL4P,NO1)
Z31=1.0+W0*(1.0+(FNUC-Q11)/(Y1-FNUC))/(1.0-W0)
SS=Z20*SQRT(0.5*C41) (
NO = 45
CALL TBLKP(SS+TBL6+TAW+TBL6P+NO)
CALL TBLKP(SS,TBL6,TSBZ,TBL6PP,NO)
FNUF=(TAW/TSBZ)/(1+0++5*(Z20**2)*(C41-1+0))
ETAS=Z19* (FNUF-FNUC1+FNUC
230=(1(Q7*WO/Z34))/(1WO)
FMUN=ETAS/Z30
FNBR=Z19/Z31
<u>GO TO 50</u>
10 NO = 46
CALL IBLKP(ZZI,IBLI,FKO,IBLIP,NO)
FKU=FKO*(0.00001)
(J1] = Q7 / Z21
CALL IBLKP(221, IBL3, FMUU, IBL3P, NO1)
TMUC=FMUC#(0.0000001)
CALL IBLAFIZ249IDL39VISIN9IDL3F9NUI
227 = Q17*W0/(FMUU#5WKI(221)) 13 730-107671847307778458000114609770 8468143-16180371
12 220=1VI3IN*62U/1627*FMUU/1*5URI(U07*641*30141372()
REAL NULU
RCAL NULL NY26 • 1

13	$V_{1} = 10$
16	$\frac{1}{50} = \frac{1}{225 + 1} + \frac{1}{52} + \frac{1}{21} + \frac{1}{22} + \frac{1}$
10	DFRN= Z25*((•128*((2•-NUCO)++4•)+2•67)/NUCO+•512*
	1((2NUCO)**3.)*ALOG(NUCO))
	NUC1=NUCO-FRNU/DFRN
	IF (ABS((NUC1-NUC0)/NUC1)0001) 30.30.20
20	NUCO=NUC1
30	GO TO 13
· · · ·	NUFM=+01796*(TSBZ/SS)*Z25
	Z18 = NUCO/(1++(NUCO/NUFM)) ENUL = SORT((014**2,)*(EKO/EKW)*718)
	WO =(EXP(2.0*FNU)-1.0)/(FNU*(EXP(FNU*2.0)+1.0))
	N01=43
	$\frac{CALL}{231} = 1.0 + WO + (1.0 + (FNUC-Q11) / (FMUN-FNUC)) / (1.0 - WO)$
	ETAS=Z19*(FNUF-FNUC) + FNUC
50	
	END
•	
	· · · · · · · · · · · · · · · · · · ·

SIBFIC OUT DECK
SUBROUTINE OUTPUT
DIMENSION TBL1(46), TBL1P(46), TBL3(46), TBL3P(46), TBL4(13), TBL4P(13)
1,TBL5(43),TBL5P(43),TBL6(45),TBL6P(45),TBL6PP(45),TBL7(19),TBL7P
2(19)
DIMENSION Z37(3)
COMMON Z18,Z19,Z20,Z21,Z22,Z23,Z24,Z25,Z26,Z27,Z28,730,Z31,Z32,
1233,234,235,237,01,02,05,040,041,042,01,02,03,04,05,06,07,08,
2010,011,012,013,014,015,016,017,018,019,020,09,D,EPS,ETAS,FK0,
3FKW+FMUN+FMUO+FNBR+FNU+FNUC+FNUF+FNUM+FI7+NZ35+SO+SS+TAW+TS+
4ISBZ+VISIN+WO+Y1+Y2+Y3+Y6+NY35+NUCO+RAWM+SLP+DYD
COMP.ON /CONST/TBL1,TBL1P,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6P,
1 TBL6PP+TBL5P+TBL7+TBL7P
IF (ABS((Q19-+0000855)/+0000855)-+000001) 10+10+20
20 CALL ADDCM
CALL PRLCM
CALL M22
$10 \ Z21 = Z34/FMUN$
Z22 = Z25 * FMUQ / Q15
Q20=Q6*{{{(7•*Z20*Z20-1•)/(6•*Z20*Z20)}**2•5)* 491•67
723 = 2 * 020/722
226=225*FMU0/VISIN
Z27=Z21*(FNUC+(FNUF+FNUC)*Z19)
Z30=(1.0-WO*(Q11/FMUN))/(1.0-WO)
40 IF (Z20-1.0) 41.41.42
$41 \ Z99 = (Q6/Q10)/$
$1 \qquad (1 \circ 0 + \circ 5 * (C41 - 1 \circ 0) * Z20 * Z20) * * (C41 / (C41 - 1 \circ 0))$
$Z98 = Q6/Q10^{-1}$
<u>60 TO 50</u>
42 Z99=((•5*(C41+1•0)*Z20*Z20)**(C41/(C41-1•0))*((C41+1•0)/(2•0*C41*Z
<u>120+Z20-C41+1+0))**(1+0/(C41-1+0)})**(-1+0)*Q6/Q10</u>
$Q8 = Q8/100 \bullet 0$
<u>Z98 = Q8 /((6.0*Z20*Z20/(Z20*Z20+5.0))*(36.0*Z20*Z20/((Z20*Z20</u>
1 + 5•0)*(7•0*Z20*Z20-1•0)))**2•5)
50 ID = Q12 + 01
WRITE (6,500) ID,Q2,Q3, NZ35, NY35,Z20,Z23,Z22,
1 Z24+Z21+Z99+Z98+Z25+Z26+Z30+Z27+Z18+Q8 +Z19+Z28+Z31+FNU+FNBR+
2 FNUC, FNUF, Z32, FNUM, WO, FMUN, Z34, Q11, Q7, Q13, Q16, ETAS, DYD,
3RAWM.SLP
500 FORMAT(2HHW13,11X4HXD E11.4,1X4HYD E11.4,1X4HZ35 12,2X4HY35 12,
<u>1 2X4HM E11.491X4HU E11.491X4HRHOUE11.491X4HTINFE11.4/9</u>
· 24HTO E11.4.1X4HPINFE11.4.1X4HPO E11.4.1X4HREO E11.4.9
<u>31X4HRINFE11.491X4HPSIRE11.491X4HT*</u> E11.491X4HNUOE11.4/9
44HPT E11.4,1X4HN*BRE11.4,1X4HKINFE11.4,1X4HPSIBE11.4,
51X4HNU E11.4.1X4HNMBRE11.4.4.1X4HNC E11.4.1X4HNF E11.4/.
64HPSINE11.4,1X4HNUM E11.4,1X4HWO E11.4,1X4HNM E11.4,
71X4HTM_E11+4+1X4HNS_E11+4+1X4HTS_E11+4+1X4HRR_E11+4/+
84HALPAE11.4.1X4HN* E11.4.1X4HDYD E11.4.1X4HRAWME11.4.
91X4HSLP E11+4//)
RETURN
END

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	C ADD DECK
	SUBROUTINE ADDCM
	DIMENSION IBLI (46) (18LIP (40) (18L3) (40) (18L3) (40) (18L3) (40) (18L3) (18L
	2(19)
	DIMENSION Z37(3)
	COMMON Z18+Z19+Z20+Z21+Z22+Z23+Z24+Z25+Z26+Z27+Z28+Z30+Z31+Z32+
	1233,234,235,237,C1,C2,C5,C40,C41,C42,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,
	2010,011,012,013,014,015,016,017,018,019,020,09,0,00,00,00,00,00,00,00,00,00,00,00,
	3FKW9FMUN9FMUU9FNDK9FNU9FNUL9FNUL9FNUF9FNUM9F1/9N23293391AW9139 ATCB7_VICIN_WO_Y1_Y2_Y3_Y6_NY35_NHCO_RAWMsCIP
<u></u>	COMMON /CONST/TBL1, TBL1P, TBL3, TBL3P, TBL4, TBL4P, TBL5, TBL6, TBL6P,
	1 TBL6PP, TBL5P, TBL7, TBL7P
	Z21=Z34/FMUN
	(ALL BLKP(221) BL1) + KU + BL1P + NU
<u></u>	FNUM = (Q4/(FKO*4.187*2.54)) * 1.0E-6
	227=221*(FNUC+(FNUF-FNUC)*219)
	Q11 = Q7 / Z21
	$Z_{30} = (1 \cdot 0 - WO + (Q11/FMUN)) / (1 \cdot 0 - WO)$
	EVII = COPT(0) 4+014+718+EVO/EVW).
	Y3=Z20
	Y1=FMUN
والمتعاد والمراجع المراجع	, YZ=418
	RETURN
	END
<u></u>	
· · ·	
*	
í.	***************************************

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SIBFTC M22 DECK
SUBROUTINE M22
DIMENSION TBL1(46), TBL1P(46), TBL3(46), TBL3P(46), TBL4(13), TBL4P(13)
1,TBL5(43),TBL5P(43),TBL6(45),TBL6P(45),TBL6PP(45),TBL7(19),TBL7P
2(19)
DIMENSION Z37(3)
COMMON 718.719.720.721.722.723.724.725.726.727.728.730.731.732.
1733-734-735-737-01-02-05-040-041-02-03-04-05-06-07-08-
2010-011-012-013-016-015-016-017-018-019-020-09-D-EPS-ETAS-EK0-
3 FK W & FM IN & FM IO & FNRR & FNIL
ATSP7 MONTH MODYL V2 V3 V6 NV35 NICO RAMASI P
COMMON / CONST/TBI 1. TBI 10. TBI 3. TBI 30. TBI 40. TBI 40. TBI 5. TBI 6. TBI 60.
N = 50 = -11 T = -(N = 5 - 1) = 13 - 13 - 10
12 V(-1)
$\frac{11}{240} = \frac{13}{24}$
CALL NUUREU CA-1/75*EENUD#SOPT/CA0#721#/CA1#1_01//2_0#CA1111//0_3386#0611##2
15 (720 %) \ 16 16 15
15 {(220~3.6) 14914912 > 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
1-1-0))
<u>GO 10 16</u>
15 + 4 = (1 + 1 + 5 + (241 - 1 + 3 + (220 + 2)) + (-5 + (241 + 1 + 3 + (220 + 2)) + (-(241 + 1 + 3))
$\frac{1((41-1)) * ((2) * (41 * 720 * 720 - (41+1)) / ((41+1)) * * (2) / ((41-1))}{1}$
16 Z20=Y5
CALL NUOREO
G5 = ((225 + FMU0 + SQR + (240 + 221 + (241 + 1 + 0)) + (2 + 0 + (241 + 1))) + (0 + 3386 + 96)) + 2
$\frac{1}{17} F_{5} = (\bullet_{5} + (C_{41} + 1_{\bullet}) + 220 + 220) + (1_{\bullet} + \bullet_{5} + (C_{41} - 1_{\bullet}) + 220 + 220) + (-(C_{41} + 1_{\bullet}) / (C_{41} + 1_{\bullet}) + (C_{41} + 1_{\bullet}) / (C_{41} + 1_{\bullet}) + (C_{41} + 1_{\bullet}) / (C_{41} + 1_{\bullet}) + (C_{41} + 1_{\bullet}) / (C_{41} + 1_{\bullet})$
GO TO 19
$\frac{18 F5=(1++5*(C41-1)*(220**2))*(-5*(C41+1))*(220**2))**(-(C41+1))}{18 F5=(1++5*(C41-1))*(220**2))**(-(C41+1))}$
1(C41-1.) + ((2.*(41*Z20*Z20-C41+1.)/(C41+1.)) * * (2./(C41-1.))
19 220 = Y5 - (G5 - F5) * (Y5 - Y4) / (G5 - F5 - G4 + F4)
IF (ABS(Z20-Y5)-+005) 40+40+20
20 IF (Z20-Y5) 30,40,50
30 IF (ABS(Z20-Y4)-+005) 60+60+70
70 IF (Z20-Y4) 80,60,90
80 NY35 = NY35+1
<u>IF (Z20-1.) 69.72.73</u>
69 IF (Z20-•2) 71•71•502
<u>71 Y5 = 1.</u>
$Z_{20} = Y_{5}$
CALL NUOREO
G5=((Z25*FMUO*SQRT(C40*Z21*(C41+1.0)/(2.0*C41)))/(0.3386*Q6))**2
<u>F5=(.5*(C4]+1.)*Z20*Z20)*(1.+.5*(C4]-1.)*Z20*Z20)**(-(C4]+1.)/(C41</u>
1-1.))
<u>Z20 = •3</u>
703 CALL NUOREO
Y4 = Z20

G4=((Z25*FMUO*SQRT(C40*Z21*(C41+1.0)/(2.0*C41)))/(0.3386*Q6))**2 F4=(.5*(C41+1.)*Z20*Z20)*(1.+.5*(C41-1.)*Z20*Z20)**(-(C41+1.)/(C41

-.

 $\frac{1-1.}{1-1.}$ $\frac{1-1.}{1-1.}$ $\frac{1}{1-1.}$ $\frac{1}{1-1.}$

502 Y4 = 220

.

CALL NUOREO
G4=((Z25*FMUO*SQRT(C40*Z21*(C41+1.0)/(2.0*C41)))/(0.3386*Q6))**2
$\frac{1}{1-1+1}$
Y5 = 1.0
220 = Y5
CALL NUOREO
G5=((Z25*FMUO*SQRT(C40*Z21*(C41+1.0)/(2.0*C41)))/(0.3386*Q6))**2
$\frac{1}{1} + \frac{1}{2} + \frac{1}$
1-1+1) IF 164-F41 503-60-71
503 IF (65-F5) 200.72.504
504 Z20 = Y5-(G5-F5)*(Y5-Y4)/(G5-F5-G4+F4)
IF (NY35-12) 505+505+200
505 IF (ABS(Z20-Y4)++002) 990+990+506
506 Y4=Z20
G4=(1223*FMUU*SQR)(C40*221*(C41+1+0)/(2+0*C41))/(0+3300*Q0))**2 F4=(-5+(C41+1+1+1+720*720)*(1++5+(C41+1+0)/(2+0*C41))/(0+3300*Q0))**2
1-1.))
NY35 = NY35+1
GO TO 504
72 Z20 = 1.0
GO TO 990
(3 Y) = Y4
GO TO 10
60 Z20 = Y4
GO TO 990
90 Y4 = Z20
NY35 = NY35 + 1
GO TO 10
40 220 = 12
50 Y4 = Y5
Y5 = Z20
<u>NY35 = NY35 + 1</u>
IF (Z20-10•) 10,990,990
200 N 235 = 20
900 IF (720-10-) 997-997-993
993 720 = 10.0
Y4=2.
Y5 = 10•
992 60 10 994
994 CALL NUOREO
E I URN

THEIC	SUBROUTINE BSIT
	DIMENSION TBL1(46), TBL1P(46), TBL3(46), TBL3P(46), TBL4(13), TBL4
1	•TBL5(43),TBL5P(43),TBL6(45),TBL6P(45),TBL6PP(45),TBL7(19),TB
2	(19)
	DIMENSION Z37(3)
	COMMON 218,219,220,221,222,223,224,225,226,227,228,230,231,23
1	233, 234, 235, 237, C1, C2, C5, C40, C41, C42, Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8,
2	<u>010,011,012,013,014,015,016,017,018,019,020,09,D,EPS,ETAS,FK0</u>
3	FKW, FMUN, FMUO, FNBR, FNU, FNUC, FNUF, FNUM, FI7, NZ35, SO, 55, TAW, TS,
4	ISBZ, VISIN, WO, Y1, Y2, Y3, Y6, NY35, NUCO, RAWM, SLP
	COMMON /CONST/TBLI,TBLIP,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6
1	TBL6PP+TBL5P+TBL7+TBL7P
-	THIS IS A DIRECT BISECTION FOR FNU
20	<u>1F (FNU-8.0) 40.40.950</u>
40	IF (U-8-FNU) 609609960
60	
	CON = (FRO)FRW)*FNOM*((G14)**2)
	$\frac{101 = 19}{2000 + 100}$
	$\frac{FIN - 1FNU + 2 (FIL)}{2}$
	15 (11) - 00021 990 - 80
80	IE (ETN-(ON) 100.990.200.
100	
	BOTT=FNU
	GO TO 300 -
200	10P≈FNU
	BOTT = 0.8
	GO TO 300
300	V = 5*(TOP+BOTT)
301	IF (V-7.995) 302.302,950
302	IF (V-0.805) 960.303.303
303	FWO=((EXP(2.0*V)-1.0)/(EXP(2.0*V)+1.0))/V
	NO1 = 19
	CALL TBLKP(FWO,TBL7,Z32,TBL7P,NO1)
	$FV = (V * * 2 \cdot) / Z 3 2$
	X2=ABS(FV-CON)
	$\frac{1F}{1} \frac{1}{2} 1$
310	1F (FV-CON) 40099009500
_400	
500	
	<u>INF-Y</u>
000	
	60 TO 990
960	WRITE (6.951)
051	FORMAT (15H NU EXCEEDS 8.0)
771	
	GO TO 990
940	WRITE (6.961)
961	FORMAT (13H NU BELOW 0+B)
	FNU = .81
	uQ 10 990
990	RETURN
	END

SUBROUTINE NUOREO DIMENSION TBL1(46), IBL1P(46), IBL3(46), TBL3P(46), TBL4(13), TBL4P(1) 1, TBL5(43), TBL5P(43), TBL6(45), TBL6P(45), TBL6PP(45), TBL7(19), TBL7F 2(19) DIMENSION 237(3) COMMON Z18+Z19+Z20, Z21+Z22+Z23+Z24+Z25+Z26+Z27+Z28+Z30+Z31+Z32+ 1Z33+Z34+Z35+Z37+C1+C2+C5+C40+C41+C42+Q1+Q2+Q3+Q4+Q5+Q6+Q7+Q8+ 2Q10,Q11+Q12+Q13,Q14+Q15+Q16+Q17+Q18+Q19+Q20+Q9+D+EPS+ETAS+FK0+ 3FKW+FMUN+FMU0+FNBR+FNU+FNUF+FNUF+FNUF+F17+NZ35+S0+S5+TAW+T5+ 4TSB2+VISIN+W0+Y1+Y2+Y3+Y6+NY35+NUC0+RAWM+SLP COMMON /CONST/TBL1+TBL1P+TBL3+TBL3P+TBL4+TBL4P+TBL5+TBL6+TBL6P+ 1 TBL6PP+TBL5P+TBL7+TBL7P REAL NUC0 REAL NUC1 REAL NUC1 REAL NUC1 REAL NUC1 REAL NUC1 REAL NUC1 1F (128 - \$01) 950+950+5 5 IF (218 - \$5) 6+6+960 6 SS = Z20*SQRT(+5*C41) N0 = 45 CALL TBLKP (SS+TBL6+TSB2+TBL6PP+NO) NX35=1 10 IF (NX35+20) 11+11+12 11 NUFM=(+02604)*(TSB2/S5)*NUC0**(+128*((2+NUC0)**4+)+2+67) FNUS=-Z18+NUC0/(1++(NUC0/NUFM)) DNUS=((1+(NUC0/NUFM)) **(+2+))*(1++(NUC0/NUFM)*(+128*((2+NUC0))) NUC1 = NUC0 -FNUS/DNUS
DIMENSION_TBL1(46)+TBL1P(46),TBL3(46)+TBL3P(46)+TBL4(13)+TBL4P(1 1+TBL5(43)+TBL5P(43)+TBL6(45)+TBL6P(45)+TBL6PP(45)+TBL7(19)+TBL7F 2(19) DIMENSION_Z37(3) COMMON_Z18+Z19+Z20+Z21+Z22+Z23+Z24+Z25+Z26+Z27+Z28+Z30+Z31+Z32+ 1233+Z34+Z35+Z37+C1+C2+C5+C40+C41+C42+Q1+Q2+Q3+Q4+Q5+Q6+Q7+Q8+ 2Q10+Q11+Q12+Q13+Q14+Q15+Q16+Q17+Q18+Q19+Q20+Q9+D+EPS+ETA5+FK0, 3FKW+FMUN+FMU0+FNBF+FNU+FNUF+FNUM+F17+NZ35+S0+S5+TAW+T5+ 4TSBZ+VISIN+W0+Y1+Y2+Y3+Y6+NY35+NUC0+RAWM+SLP COMMON_/CONST/TBL1+TBL1P+TBL3+TBL3P+TBL4+TBL4P+TBL5+TBL6+TBL6P+ TBL6PP+TBL5P+TBL7+TBL7P REAL_NUC1 REAL_NUC1 REAL_NUC1 REAL_NUC1 REAL_NUC1 NO = 45 CALL_TBLKP_(S5+TBL6+TSBZ+TBL6PP+N0) NX35=1 10 IF_(NX35+20)_11+11+12 11 NUFM=(+02604)*(TSBZ/S5)*NUC0**(+128*((2+NUC0)**4+)+2+67) FNUS=-Z18+NUC0/(1++(NUC0/NUFM))* DNUS=((1+(NUC0/NUFM))**(+2+)*4+D+C0) 1*4+1+2+67-512*NUC0*((2+NUC0)**3+)*ALOG(NUC0)]) NUC1 = NUC0_FNUS/DNUS
<pre>1.TBL5(43),TBL5P(43),TBL6(45),TBL6P(45),TBL6PP(45),TBL7(19),TBL7F 2(19) DIMENSION 237(3) COMMON 218,219,220,221,222,223,224,225,226,227,228,230,231,232, 1233,234,235,237,C1,C2,C5,C40,C41,C42,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8, 2Q10,Q11,Q12,Q13,Q14,Q15,Q16,Q17,Q18,Q19,Q20,Q9,D,EP5,ETA5,FK0, 3FKw,FMUN,FMUO,FNBR,FNU,FNUC,FNUF,FNUM,FI7,N235,S0,S5,TAW+T5, 4TSBZ,VISIN,W0,Y1,Y2,Y3,Y6,NY35,NUC0,RAWM,SLP COMMON /CONST/TBL1,TBL1P,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6P, 1TBL6PP,TBL5P,TBL7,TBL7P REAL NUC0 REAL NUC1 REAL NUC1 REAL NUC1 REAL NUC1 CALL TBLKP (SS,TBL6,TSBZ,TBL6PP,N0) NX35=1 10 IF (NX35+20) 11,11,12 11 NUFM=(+02604)*(TSBZ/SS)*NUC0**(+128*((2-NUC0)**4+)+2+67) FNUS=-Z18+NUC0/(1+(NUC0/NUFM))*(+128*((2-NUC0)) NUS=(11+(NUC0/NUFM))**(-2+))*(1+(NUC0/NUFM)*(+128*((2-NUC0))) NUC1 = NUC0 -FNUS/DNUS</pre>
2(19) DIMENSION 237(3) COMMON 218+219+220+221+222+223+224+225+226+227+228+230+231+232+ 1233+234+235+237+C1+C2+C5+C40+C41+C42+01+02+03+06+07+08+ 2010+011+012+013+014+015+016+01+02+03+04+05+06+07+08+ 2010+012+013+014+015+016+014+014+014+00+00+00+00+00+00+00+00+00+00+00+00+00
DIMENSION Z37(3) COMMON Z18,Z19,Z20,Z1,Z22,Z23,Z24,Z25,Z26,Z27,Z28,Z30,Z31,Z32, IZ33,Z34,Z35,Z37,C1,C2,C5,C40,C41,C42,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8, 2Q10,Q11,Q12,Q13,Q14,Q15,Q16,Q17,Q18,Q19,Q20,Q9,D,EPS,ETAS,FK0, 3FKw,FMUN,FMUO,FNBR,FNU,FNUC,FNUF,FNUM,FI7,NZ35,S0,S5,TAW,T5, 4ISBZ,VISIN,W0,Y1,Y2,Y3,Y6,NY35,NUC0,RAWM,SLP COMMON /CONST/TBL1,TBL1P,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6P, 1 TBL6PP,TBL5P,TBL7,TBL7P REAL NUCO REAL NUCO REAL NUCI REAL NUCI REAL NUFM IF (Z18 - \$01) 950,950,5 5 IF (Z18 + 5) 6,6,960 6 SS = Z20*SQRT(\$5*C41) NO = 45 CALL TBLKP (SS,TBL6,TSBZ,TBL6PP,NO) NX35=1 10 IF (NX35+20) 11,11,12 11 NUFM=(\$02604)*(TSBZ/SS)*NUCO**(\$128*((2*-NUCO)**4*)+2*67) FNUS=-Z18+NUCO/(1*(NUCO/NUFM)) DNUS=((1*(NUCO/NUFM))**(\$2*))*(1*(NUCO/NUFM)*(\$128*((2*-NUCO)) 1**4*)+2*67-\$512*NUCO*((2*-NUCO)**3*)*ALOG(NUCO)) NUC1 = NUCO ~FNUS/DNUS
COMMON Z18,Z19,Z20,Z21,Z22,Z23,Z24,Z25,Z26,Z27,Z28,Z30,Z31,Z32, 1Z33,Z34,Z35,Z37,C1,C2,C5,C40,C41,C42,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8, 2G10,Q11,Q12,Q13,Q14,Q15,Q16,Q17,Q18,Q19,Q20,Q9,D,EPS,ETAS,FK0, 3FKW,FMUN,FMUO,FNBR,FNU,FNUC,FNUF,FNUM,FI7,NZ35,S0,S5,TAW,T5, 4ISBZ,VISIN,W0,Y1,Y2,Y3,Y6,NY35,NUC0,RAWM,SLP COMMON /CONST/TBL1,TBL1P,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6P, 1 TBL6PP,TBL5P,TBL7,TBL7P REAL NUC0 REAL NUC1 REAL NUC1 REAL NUC1 NO = 45 CALL TBLKP (SS,TBL6,7SBZ,TBL6PP,NO) NX35=1 10 IF (NX35+20) 11+11+12 11 NUFM=(.02604)*(TSBZ/SS)*NUC0**(.128*((2NUC0)**4.)+2.67) FNUS=-Z18+NUC0/(1.+(NUC0/NUFM)) DNUS=((1.+(NUC0/NUFM))**(-2.))*(1.+(NUC0/NUFM)*(.128*((2NUC0) 1*4.)+2.67512*NUC0*((2NUC0)**3.)*ALOG(NUC0)) NUC1 = NUC0 -FNUS/DNUS
1233,234,235,237,C1,C2,C5,C40,C41,C42,Q1,Q2,Q3,04,Q5,Q6,Q7,Q8, 2Q10,Q11,Q12,Q13,Q14,Q15,Q16,Q17,Q18,Q19,Q20,Q9,D,EPS,ETAS,FK0, 3FKW,FMUN,FMUO,FNBR,FNU,FNUC,FNUM,FI7,NZ35,S0,S5,TAW,TS, 4TSBZ,VISIN,W0,Y1,Y2,Y3,Y6,NY35,NUCO,RAWM,SLP COMMON /CONST/TBL1,TBL1P,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6P, 1 TBL6PP,TBL5P,TBL7,TBL7P REAL NUCO REAL NUC1 REAL NUC1 REAL NUC1 REAL NUC4 IF (218 - 01) 950,950,5 5 IF (218 - 5) 6+6+960 6 SS = 220*SQRT(.5*C41) NO = 45 CALL TBLKP (SS,TBL6,TSBZ,TBL6PP,NO) NX35=1 10 IF (NX35+20) 11+11+12 11 NUFM=(+02604)*(TSBZ/SS)*NUCO**(+128*((20-NUC0)**40)+2067) FNUS=-Z18+NUC0/(10+(NUC0/NUFM)) DNUS=((10+(NUC0/NUFM)) DNUS=((10+(NUC0/NUFM))*(-128*((20-NUC0))) NUC1 = NUC0 -FNUS/DNUS
2Q10.Q11.Q12.Q13.Q14,Q15.Q16.Q17.Q18.Q19.Q20.Q9.D.EPS.ETAS.FK0, 3FKW.FMUN.FMU0.FNBR.FNU.FNUC.FNUF.FNUM.FI7.N235.S0.SS.TAW.TS. 4TSBZ.VISIN.W0.Y1.Y2.Y3.Y6.NY35.NUCO.RAWM.SLP COMMON /CONST/TBL1.TBL1P.TBL3.TBL3P.TBL4.TBL4P.TBL5.TBL6.TBL6P. 1 TBL6PP.TBL5P.TBL7.TBL7P REAL NUCO REAL NUC1 REAL NUC1 REAL NUFM IF (Z18 - 01) 950.950.5 5 IF (Z18 - 5.) 6.6.960 6 SS = Z20*SQRT(.5*C41) NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) NX35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO))) 1*4.1+2.67512*NUCO*((2NUCO)**3.)*AL0G(NUCO)) NUC1 = NUCO -FNUS/DNUS
3FKW+FMUN+FMUO+FNBR+FNU+FNUC+FNUF+FNUM+FI7+NZ35+SO+SS+TAW+TS+ 4TSBZ+VISIN+WO+Y1+Y2+Y3+Y6+NY35+NUCO+RAWM+SLP COMMON /CONST/TBL1+TBL1P+TBL3+TBL3P+TBL4+TBL4P+TBL5+TBL6+TBL6P+ 1 TBL6PP+TBL5P+TBL7+TBL7P REAL NUCO REAL NUC1 REAL NUC1 REAL NUFM IF (Z18 - 01) 950+950+5 5 IF (Z18 - 5+) 6+6+960 6 SS = Z20*SQRT(+5*C41) NO = 45 CALL TBLKP (SS+TBL6+TSBZ+TBL6PP+NO) NX35=1 10 IF (NX35+20) 11+11+12 11 NUFM=(+02604)*(TSBZ/SS)*NUCO**(+128*((2+NUCO)**4+)+2+67) FNUS=-Z18+NUCO/(1+(NUCO/NUFM)) DNUS=((1+(NUCO/NUFM))**(-2+))*(1+(NUCO/NUFM)*(+128*((2+NUCO))) 1*4++2+67-+512*NUCO*((2+NUCO)**3+)*ALOG(NUCO)) NUC1 = NUCO -FNUS/DNUS
<pre>415B2*VISIN.w0o*Y1*Y2*Y3*Y6*NY35*NUCO*RAWM*SEP COMMON /CONST/TBL1*TBL1*TBL3*TBL3*TBL4*TBL4*TBL5*TBL6*TBL6*TBL6* 1 TBL6P*TBL5*TBL7*TBL7* REAL NUCO REAL NUC1 REAL NUC1 REAL NUC1 NO = 45 5 IF (218 - 01) 950*950*5 5 IF (218 - 5*) 6*6*960 6 SS = 220*SQRT(*5*C41) NO = 45 CALL TBLKP (SS*TBL6*TSB2*TBL6PP*NO) NX35=1 10 IF (NX35+20) 11*11*12 11 NUFM=(*02604)*(TSB2/SS)*NUCO**(*128*((2*NUCO)**4*)+2*67) FNUS=-218*NUCO/(1*(NUCO/NUFM)) DNUS=((1*(NUCO/NUFM))**(-2*))*(1*(NUCO/NUFM)*(*128*((2*NUCO)) 1*4*1+2*67*512*NUCO*((2*NUCO)**3*)*AL05(NUCO)) NUC1 = NUCO -FNUS/DNUS</pre>
<pre>COMMON /CONST/18L1.18L1P+18L3,18L3P+18L4P+18L4P+18L3+18L6P+ 1 TBL6PP+TBL5P+TBL7+TBL7P REAL NUC0 REAL NUC1 REAL NUFM IF (Z18 - 01) 950+950+5 5 IF (Z18 + 5+) 6+6+960 6 SS = Z20*SQRT(+5*C41) NO = 45 CALL TBLKP (SS+TBL6+TSBZ+TBL6PP+NO) NX35=1 10 IF (NX35+20) 11+11+12 11 NUFM=(+02604)*(TSBZ/SS)*NUCO**(+128*((2+NUCO)**4+)+2+67) FNUS=-Z18+NUCO/(1+(NUCO/NUFM)) DNUS=((1+(NUCO/NUFM))**(-2+))*(1+(NUCO/NUFM)*(+128*((2+NUCO))) 1*4++2+67-+512*NUCO*((2+NUCO)**3+)*AL0G(NUCO)) NUC1 = NUCO -FNUS/DNUS</pre>
<pre> T BLOPP: TBL3P: TBL7: TBL7: REAL NUC0 REAL NUC1 REAL NUC1 REAL NUTM IF (218 - 01) 950:950:5 5 IF (218 - 5.) 6:6:960 6 SS = Z20*SQRT(.5*C41) NO = 45 CALL TBLKP (SS:TBL6:TSBZ:TBL6PP:NO) HX35=1 10 IF (NX35=20) 11:11:12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUC0 -FNUS/DNUS </pre>
REAL NUCO REAL NUCI REAL NUFM IF (Z18 - 01) 950,950,5 5 IF (Z18 - 5.) 6,6,960 6 SS = Z20*SQRT(.5*C41) NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) NX35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1*4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
REAL NUFM IF (Z18 - 01) 950,950,5 5 IF (Z18 - 5.) 6,6,960 6 SS = Z20*SQRT(.5*C41) NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) NX35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1*4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
IF (Z18 - •01) 950,950,5 5 IF (Z18 - 5•) 6,6,960 6 SS = Z20*SQRT(•5*C41) NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) 1X35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1*4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
<pre>5 IF (Z18 - 5.) 6.6.960 6 SS = Z20*SQRT(.5*C41) NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) NX35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS</pre>
6 SS = Z20*SQRT(.5*C41) NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) 1X35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
NO = 45 CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) (X35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
CALL TBLKP (SS.TBL6.TSBZ.TBL6PP.NO) 1X35=1 10 IF (NX35-20) 11.11.12 11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO))) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
<pre>NX35=1 10 IF (NX35+20) 11+11+12 11 NUFM=(+02604)*(TSBZ/SS)*NUCO**(+128*((2+-NUCO)**4+)+2+67) FNUS=-Z18+NUCO/(1+(NUCO/NUFM)) DNUS=((1++(NUCO/NUFM))**(-2+))*(1+(NUCO/NUFM)*(+128*((2+-NUCO)) 1**4+)+2+67-+512*NUCO*((2+-NUCO)**3+)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS</pre>
10 IF (NX35-20) 11+11+12 11 NUFM=(+02604)*(TSBZ/SS)*NUCO**(+128*((2+-NUCO)**4+)+2+67) FNUS=-Z18+NUCO/(1+(NUCO/NUFM)) DNUS=((1++(NUCO/NUFM))**(-2+))*(1+(NUCO/NUFM)*(+128*((2+-NUCO))) 1**4+)+2+67-+512*NUCO*((2+-NUCO)**3+)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
11 NUFM=(.02604)*(TSBZ/SS)*NUCO**(.128*((2NUCO)**4.)+2.67) FNUS=-Z18+NUCO/(1.+(NUCO/NUFM)) DNUS=((1.+(NUCO/NUFM))**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
FNUS=-Z18+NUCO/(1++(NUCO/NUFM)) DNUS=((1++(NUCO/NUFM))**(-2+))*(1++(NUCO/NUFM)*(+128*((2+-NUCO))) 1**4+)+2+67-+512*NUCO*((2+-NUCO)**3+)*ALOG(NUCO))) NUC1 = NUCO -FNUS/DNUS
DNUS=((1.+(NUCO/NUFM})**(-2.))*(1.+(NUCO/NUFM)*(.128*((2NUCO) 1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO)}) NUC1 = NUCO -FNUS/DNUS
<u>1**4.)+2.67512*NUCO*((2NUCO)**3.)*ALOG(NUCO)))</u> NUC1 = NUCO -FNUS/DNUS
NUC1 = NUCO - FNUS/DNUS
NX35=NX35+1
IF (ABS((NUCO-NUCI)/NUCI)0001) 30.30.20
$12 \text{ NZ}_{22} = 20$
951 FORMAT (194 NUO 1 ESS THAN 0-01)
GO 10 990
960 WRITE (6,961)
961 FORMAT (16H NUO EXCEEDS 5.0)
$225 = 20 \cdot 0$
GO TO 990
30 NUCO = NUC1
Z25 = 1.45*NUCO**(.128*((2NUCO)**4.)+2.67)
990 RETURN
END
n an

SIBETC BLO DECK
BLOCK DATA
DIMENSION IBLI(46) IBLIP(46) IBL2(46) IBL3P(46) IBL4P(13) IBL4P(13) IBL4P(13) IBL4P(13) IBL7P
DIMENSION Z37(3)
COMMON /CONST/TBL1,TBL1P,TBL3,TBL3P,TBL4,TBL4P,TBL5,TBL6,TBL6P,
1 TBL6PP, TBL5P, TBL7, TBL7P
DATA (18(11)) = 194677 50 + 940 + 950 + 900 + 900 + 900 + 900 + 900 + 9100 +
2 ,250 , 260 , 270 , 280 , 290 , 300 , 310 , 320 , 330 , 340 , 350 , 360 , 370
3 ,380.,390.,400.,410.,420.,430.,440.,450.,460.,470.,480./
DATA (TBL1P(I), I = 1, 46) / 0.7039, 0.9117, 1.131, 1.350, 1.558, 1.784
1 +1.996,2.210,2.425,2.640,2.855,3.068,3.281,3.492,3.703,3.912,4.11
<u>2</u> <u>9</u> <u>4</u> <u>9</u>
4 211.8.378.8.545.8.706.8.868.9.030.9.192.9.347/
DATA (TBL3(I)+I = 1+46)/ 30++40++50++60++70++80++90++100++110+
1 +120 + 130 + 140 + 150 + 160 + 170 + 180 + 190 + 200 + 210 + 220 + 230 + 240 +
2 +250 + 260 + 270 + 280 + 290 + 300 + 310 + 320 + 330 + 340 + 350 + 360 + 370 +
$\frac{3}{5}380 \bullet * 390 \bullet * 400 \bullet * 410 \bullet * 420 \bullet * 420 \bullet * 440 \bullet * 420 \bullet * 450 \bullet * 440 \bullet * 450 \bullet * 470 \bullet * 480 \bullet 7$
$1 22 \cdot 9 \cdot 692 \cdot 9 \cdot 763 \cdot 3 \cdot 831 \cdot 9 \cdot 899 \cdot 0 \cdot 964 \cdot 6 \cdot 1029 \cdot 1091 \cdot 1152 \cdot 1212 \cdot 1211 \cdot 1271 \cdot $
2 1329.,1385.,1440.,1494.,1547.,1599.,1650.,1700.,1750.,1798.,1846.
3 ,1893 , 1939 , 1985 , 2030 , 2075 , 2118 , 2160 , 2202 , 2245 , 2286 , 2327
4 • • 2366 • • 2406 • • 2445 • • 2485 • • 2520 • • 2560 • • 2595 • /
DATA (TBL4(I), I = 1, 13) / 0, 0, 0, 2, 0, 4, 0, 6, 0, 8, 1, 0, 1, 2, 1, 4, 1, 6, 1, 0, 1, 2, 0, 2, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
$\frac{1}{1} = \frac{1}{2} = \frac{1}$
1 70+0+964+0+959+0+955+0+952+0+950+0+950/
DATA (TBL5(I)+I = 1+43)/ 0+05+0+06+0+07+0+08+0+09+0+10+0+11+0+
1 12,0.14,0.15,0.17,0.19,0.20,0.23,0.25,0.30,0.35,0.40,0.50,0.60,0.
$\frac{2.70,0.80,0.90,1.0,1.1,1.2,1.3,1.4,1.5,1.7,1.9,2.0,2.5,3.0,3.5,4.0,}{2.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1$
3 2+0+0+0+0+7+0+8+0+10+0+12+0+22+07 DATA (TBISD/1)+1 = 1+43)/ D+02+0+03+0+042+0+054+0+068+0+082+0+0
$1 97 \cdot 0.112 \cdot 0.144 \cdot 0.158 \cdot 0.188 \cdot 0.218 \cdot 0.232 \cdot 0.272 \cdot 0.294 \cdot 0.350 \cdot 0.397 \cdot 0.294 \cdot 0.350 \cdot 0.397 \cdot 0.294 \cdot 0.294$
2 437,0,505,0,558,0,603,0,640,0,672,0,700,0,724,0,744,0,765,0,783,0
3 •800,0.826,0.849,0.858,0.895,0.916,0.932,0.944,0.960,0.970,0.977,
4 0.982,0.990,1.0,1.0/
DAIA (IBL6(I))I = 1945)/ 0029004900090089100910291049106910892
$\frac{1}{2} \frac{1}{2} \frac{1}$
38.4.8.6.8.8.9.0/
DATA (TBL6P(I),I = 1,45)/ 9.80271,10.94784,12.89399,15.69746,19
1. +43609+24+20781+30+12863+37+32923+45+95230+56+14932+68+07771+81+8
2 9947,97.77902,115.88287,136.37821,159.43361,185.21769,213.89927,2
$\frac{3.45 \bullet 64801 \bullet 780 \bullet 63340 \bullet 319 \bullet 02474 \bullet 360 \bullet 99204 \bullet 406 \bullet 70528 \bullet 456 \bullet 33364 \bullet 510 \bullet 04}{4.756 \bullet 568}$
5 1014_61_1107_11_1205_2_1309_1_40229970901534_701656_7_1705_2
6 1920-4-2062-2-2210-9-2367-0-2530-2-2700-7/
DATA (TBL6PP(I)) = 1.45)/ 9.61234.10.16410.11.04924.12.22282.13
1 +63288,15+22758,16+96068,18+79408,20+69872,22+65358,24+64392,26+6
2 5990+28+69470+30+74382+32+80398+34+87300+36+94914+39+03112+41+118
3 UU+43-20904+45+30354+47+40108+49+50126+51+60366+53+70808+55+81428 4 -57-82200+60-03114+62+141+64+248
5 74+802+76+910+79+025+81+130+R3+242+85+352+87+461+80+200+72+
6 93.782.95.886/
DATA (TBL7(I)+1 = 1+19)/ 0+1++15++2++25++3++35++4++45+
1 = 5 = = 5 5 = = 6 5 = = 7 = = 7 5 = = 8 = = 8 5 = = 9 = 9 = 9 = 9 = 9 = 9 = 9 = 9 = 9 = 9 = 9 = = 9 = = 9
F NI 3

.
	DIMENSION VAR(100),FCN(100)
C	THIS SUBROUTINE PERFORMS TABLE LOOK-UP. OPERATIONS.
	DO 100 1=1•NO VAR1=VAR(I)
	IF (VO-VAR1) 200,150,100
100	CONTINUE WRITE (6,900)VO.NO
900	FORMAT (34H VARIABLE EXCEEDS TABLE FOR VALUE E11.4.13H TABLE SIZ
	= 15) FO = FCN (NO)
	GO TO 300
150	GO TO 300
200	1F (1-1) 210+290+210
210	TEMP=V0-VAR(II)
	TEM1=VAR(1)-VAR(11)
	RATIO=TEMP/TEM1 FO=RATIO=(FCN(I)-FCN(II))+FCN(II)
•	GO TO 300
<u>290</u> 300	RETURN
	END
	`
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B.5 Mean Flow Program

This program calculates the local flow properties in a fluid stream from three independent flow properties using the compressible flow relations (25). Either one of three sets of input data may be used in the program. All sets use Pitot pressure and total temperature data, and the distinction between input types exists because the third input property might be centerline static pressure, total pressure downstream of the nose shock, or mass flux data. As mentioned in Section II, this variation in input data was necessary because the static pressures could not be measured directly in the vicinity of the base. Therefore, the third independent measurement in those base regions was either mass flux data in the base shear layers or the total pressure in the inviscid isentropic region outside the shear layer. Unfortunately, double roots difficulty in solving for Mach number from the measured data requires that the mass flux version of the mean flow program be used only for $M \ge 1$.

B.5a) <u>M</u>	lean Flow Program	n ID Listing
PO	^p o ^{≡p} t	free stream total pressure, mmHg
то	$T_o = T_{t_o} = T_{t_o}$	free stream total temperature, ^o K
MFS	M _∞	free stream Mach number
REOFS	Re _{t∞}	free stream Reynolds number based on free stream mass flux, reference length and viscosity corresponding to free stream total temperature
TFS	Τ _∞	free stream static temperature, ^O K
DO	Pt _o	free stream stagnation density, gmm/cm^3
PFS	P_{∞}	free stream static pressure, mmHg
QFS	$\mathbf{q}_{\mathbf{w}}$	free stream dynamic pressure, gmf/cm^2
DFS	ρ _∞	free stream static density, gmm/cm^3
UFS	u _∞	free stream velocity, cm/sec
DUFS	$ ho_{\infty}u_{\infty}$	free stream mass flux, gmm/cm^2 sec
DIA	D states and states	reference length, cm
REFS	Re _∞	Reynolds number corresponding to free stream mass flux, viscosity based on free stream static temperature, and a given reference length
MUFS	۳°	viscosity based on free stream static temperature, gmm/sec cm
MUO	₽t∞	viscosity based on free stream total temperature, gmm/sec cm
NOSP	NOSP	number (integer) of profiles for data set
NTYPE	NTYPE	integer (1 or 2) indicating mean flow cal- culation procedure; mass flux version (1) or static pressure version (2)
NPTS	NPTS	number (integer) of data points for given profile
XD	x/D	axial distance from base ratioed to refer- ence length

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YD	y/D	lateral distance from centerline ratioed to reference length
TT	$\mathbf{T}_{\mathbf{t}}$	local total temperature, ^o K
PPM PIBM	$(p_{t2}/p_o)_m$ $(\frac{p}{p_o})_m (\frac{p}{p_m})_v (\frac{p_{LE}}{p_x})_v$	measured Pitot pressure ratioed to free stream total pressure $p_{t_{2}}$ $p_{t_{2}}$ $m_{t_{2}}$
		product of corrected (viscous interaction and tunnel gradient) static pressure, Pitot pressure tunnel gradient factor, and reciprocal of free stream total pressure; the ratio of PIBM to PPM gives corrected Rayleigh-Pitot ratio for determining Mach number
REOM	Re _{tdm}	measured local Reynolds number based on wire diameter and viscosity corresponding to local total temperature
PPG	$\left(p_{t_2} / p_{t_2} \right)_{\text{LF}}$	free stream Pitot pressure axial gradient
М	M N	local Mach number
Q	P	local dynamic pressure, gmf/cm ²
P	p/p∞	ratio of local static pressure to free stream static pressure
PT	p _t /p _o	ratio of local total pressure to free stream total pressure
TTTTE	T _t /T _o	ratio of local total temperature to free stream total temperature
UUE	u/u _e	ratio of local velocity to edge velocity
TTE	T/T _e	ratio of local static temperature to edge static temperature
DDE	p/p _e	ratio of local density to edge density
DUDUE	pu/peue	ratio of local mass flux to edge mass flux
KN	$K_n = \sqrt{\frac{\pi \gamma}{2}} M/Re$	local Knudsen number

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		-133 -
UE	u _e /u _∞	ratio of edge velocity to free stream velocity
DE	ρ _e /ρ _∞	ratio of edge density to free stream density
TE	T_e/T_{∞}	ratio of edge static temperature to free stream static temperature
TTOE	$T_{t_e} \equiv T_{t_{\infty}} \equiv T_{o}$	edge total temperature, ^O K
RET	Re _{tD}	local Reynolds number based on reference length and total temperature
W	UDEL	
н	TDEL	
MUE	۴e	viscosity based on edge static temperature, gmm/sec cm
MU	μ	viscosity based on local static temperature, gmm/sec cm
MUT	μ _t	viscosity based on local total temperature, gmm/sec cm
C	٩ ^µ /٩ _e ^µ e	ratio of local density-viscosity product to edge density-viscosity product
PTM	₽ _t /₽ _o	ratio of local total pressure to free stream total pressure for region between shear layer edge and leading edge shock
PPPT	P _{t2} /P _t	ratio of local Pitot pressure to local total pressure
PPP	p/p _t	ratio of local static pressure to local Pitot pressure
PPC	$\left(\frac{p_{t_2}}{p_{o}}\right)_{c}$	ratio, as corrected for tunnel gradient, of local Pitot pressure to free stream total pressure
FM	$\operatorname{Re}_{t}^{\mu}\sqrt{T_{t}}/p_{t_{2}}$	Mach number function
MDEF	$\frac{\rho u}{\rho_e u_e} \begin{pmatrix} u_e - u \\ e \end{pmatrix} = e$	generated
EDEF	$\left(\frac{T_{te}-T_{t}}{T_{te}}\right)\frac{\rho u}{\rho_{e}u_{e}}$	generated

RE	ReD	local Reynolds number based on reference length and static temperature
UDEF	(u-u _¢)/(u _e -u _¢)	ratio of local-centerline velocity defect to edge-centerline velocity defect
DDEF	(p-p _¢)/(p _e -p _¢)	ratio of local-centerline density defect to edge-centerline defect
TDEF	$(T_{\xi}-T)/(T_{\xi}-T_{e})$	ratio of centerline-local static temperature excess to centerline-edge static tempera- ture excess
TTDEF	$(T_t - T_t_{t_{t_{t_{t_{t_{t_{t_{t_{t_{t_{t_{t_{$) ratio of local-centerline total temperature . defect to edge-centerline total temperature . defect
UDIF	$(u_e - u)/(u_e - u_{c})$	ratio of edge-local velocity difference to edge-centerline density difference
DDIF	(ρ _e -ρ)/(ρ _e -ρ _¢)	ratio of edge-local density difference to edge-centerline density difference
TDIF	$(T-T_{e})/(T_{e}-T_{e})$	ratio of local-edge static temperature dif- ference to centerline-edge static tempera- ture difference
TTDIF	$(T_t_e^{-T_t})/(T_o^{-T_t}_{t_e})$) ratio of edge-local total temperature dif- ference to edge-centerline total tempera- ture difference
UDEL	$(u_e^{-u})/u_e$	ratio of edge-local velocity defect to edge velocity
DDEL	(p _e -p)/p _e	ratio of edge-local density defect to edge density
TDEL	$(T-T_e)/T_e$	ratio of local-edge static temperature excess to edge static temperature
TTFS	T/T_{∞}	ratio of local static temperature to free stream static temperature
UUFS	u/u _∞	ratio of local velocity to free stream velocity
DDFS	ρ/ρ _∞	ratio of local density to free stream density
DUDUF	S ρu/ρ _∞ u _∞	ratio of local mass flux to free stream mass flux

DIST

 $\int_{\Omega} \left(1 - \frac{\rho u}{\rho_e u_e}\right) d\left(\frac{y}{D}\right) \quad \text{ratio of displacement thickness to refer$ $ence length, } \delta^*/D$

MOMT

DELI

DEL2

ratio of momentum thickness to reference length, $\overline{\theta}/D$

EMT $\int_{0}^{\infty} \left(1 - \frac{T_{t}}{T_{te}}\right) \frac{\rho u}{\rho_{e} u_{e}} d\left(\frac{y}{D}\right)$

ratio of energy thickness to reference length, E/D

DMUDMU
$$\rho u \mu / \rho_{\infty} u_{\infty} \mu_{\infty}$$

ratio of local mass flux-viscosity product to free stream mass flux-viscosity product

YB
$$\frac{\overline{y}}{D} = \frac{\rho_e^u e}{\rho_{\infty}^u u_{\infty}} \gamma \overline{Re_{\infty}} \int_{0}^{\infty} \frac{\rho}{\rho_e} d\left(\frac{y}{D}\right)$$

 $\frac{\rho u}{\rho_e u_e} \left(1 - \frac{u}{u_e}\right) d\left(\frac{y}{D}\right)$

ratio of transformed y coordinate to reference length

ratio of wake total temperature semithickness (ξ -e) to reference length

square root of ratio of transformed axial distance (based on Kubota's linear wake theory) plus "effective origin" of wake from centerline velocity extrapolation, to reference length

square root of ratio of transformed axial distance (based on Kubota's linear wake theory) plus "effective origin" of wake from centerline static temperature extrapolation, to reference length

ratio of wake semi-thickness in terms of transformed lateral distance and based on UDIF = .5 location, to reference length

ratio of wake semi-thickness in terms of transformed lateral distance and based on TDIF = .5 location, to reference length

ratio of lateral distance to wake semithickness

 $\left(\frac{\overline{x}}{D} + \frac{\overline{x}_{o}}{D}\right)^{1/2}$ DEL3

 δ_{e}/D

 $\left(\frac{\overline{x}}{\overline{D}} + \frac{\overline{x}}{\overline{D}}\right)^{1/2}$

DEL4 UDIF = .5

DEL5 $\frac{y}{D}$ TDIF = .5

YDEL1 y/S

YBDEL1 YBDEL2 YBDEL3 YBDEL4 YBDEL5	$\overline{y}/\text{DEL } 1 \rightarrow 5$	generated
XOU	$\left(\frac{\overline{x}}{\overline{D}} + \frac{x_{o}}{\overline{D}}\right)_{u} - x/D$	generated
XOT	$\left(\frac{\overline{x}}{D} + \frac{\overline{x}}{D}\right)_{x} - x/D$	generated
SF	SF	code number 0, 2, or 101 for use in base region (NTYPE = 1) describing calculation procedure for streamline determination (mass flux integration from leading edge shock 2, 101 or centerline 0) and method of calculating mean flow (use of Reynolds number 2 or total pressure behind leading edge shock 101)
REOO	Re _∞	Reynolds number code which instructs pro- gram to calculate mean flow quantities from total pressure behind leading edge shock when measured Reynolds number is both greater than REOO and exceeds edge Reynolds number
YBC	YBC	for NTYPE = 1, SF >1 implies lateral position of data point from centerline in terms of y/D; for NTYPE = 2, and NTYPE = 1, SF < 1.0 implies YB) \overline{C}
UCL	u _¢ /u _∞	ratio of centerline velocity to free stream velocity
DCL	P¢/P∞	ratio of centerline density to free stream density
TCL	T¢∕T∞	ratio of centerline static temperature to free stream static temperature
TTCL	T _t ę., ,	centerline total temperature, ^o K
RW2	$\left(1 - \frac{u_{e}}{u_{e}}\right)^{-2}$	square of ratio of edge velocity to edge- centerline velocity defect
RH 2	$\left(\frac{T_{c}}{T_{e}}-1\right)^{-2}$	square of ratio of edge static temperature to centerline-edge static temperature excess

$$QMOMT \frac{\rho_e u_e^2}{\rho_\infty u_\infty^2} \frac{\overline{\theta}}{\overline{D}}$$

EMTM
$$\frac{\rho_e^{u}e}{\rho_{\infty}^{u}u_{\infty}} = \frac{E}{D}$$

PSII

 $\frac{\rho_{\infty} u_{\infty}}{\rho_{\infty} u_{\infty} D} = \int_{0}^{y} \frac{\rho u}{\rho_{\infty} u_{\infty}} d\left(\frac{y}{D}\right)$ erence length with ratio of edge mass flux $\frac{\psi}{\rho_{\infty} u_{\infty} D} = \int_{0}^{y} \frac{\rho u}{\rho_{\infty} u_{\infty}} d\left(\frac{y}{D}\right)$

v

integrated mass flux from centerline to data point location as ratioed to free stream mass flux

product of ratio of energy thickness to ref-

$$\int \frac{\rho u}{\rho_{\infty} u_{\infty}} d\left(\frac{y}{D}\right)$$

yS integrated mass flux from centerline to data point as ratioed to free stream mass flux; for this case integration starts at leading edge shock, i.e., SF > 1

$$PSI \qquad \frac{\psi}{\rho_{\infty} u_{\infty} D} = \frac{y_{S}}{D} +$$

product of ratio of momentum thickness to reference length with ratio of edge dynamic pressure to free stream dynamic pressure

B. 51	o Ty	pical]	Input I)ata fo	rr Mea	n Flov	v Prog	ram (NTYP	E 1)			
\$DAT/		* 12 * 12	•	· . •									
		1 515	3.	402.		6.14		• 762		2•		• 7442	
0•1		•			17	.+						•	
1.045	5 • 0	•045	•145	•245	•345	•415	•455	•47	•495	•520	•545	.57	• 595
4•9	6.21	6.21	6.185	56.085	55.94	4.9	2•2	1•4	•63	•37	•215	•13	•08
402.	402.	402.	402.	402.	402.	402.	406.	402 •	388.	382.	372.	367 .	3.62 •
4.91	4.91	4.91	4.91	4.91	4.91	4.91	2.25	1.5	•73	•46	•29	•19	•13
SEND.	JOB												· ·

82.7

3.7442E 00 0.2742E-C4 SF= 0.2006F 01 PTM UFS= 0.1016E 03 DFS+ 0.7620E 00 0.2831E 01 CIA= PFS= MFS= 0.6140E 01 D0= C.5951E-02 B.5c) Typical Output Data for Mean Flow Program (NTYPE 1)
 NOSP= 1 NTYPE= 1 P0a 0.5151E 04 T0= 0.4020E 03
 RECFS= C.7832E 04 REFS= 0.5480E 05 TFS= 0.4707E 02
 LFS= 0.8446E C5 ULFS= C.2358E C1

0.1000E 01 0.1622E 01 0.2939E-00 0.3162E-00 1.0000E 00 0.1000E 01 0.1608E 01 0. 0.2654E-00 0.3162E-00 0.8000E 00 0. -0.2882E-00 0.3162E-00 0.9507E 00 C.ICOOE 01 0.15916 01 G. -0.3534E-16 0.3162E-00 -0.3534E-16 0. -0.2939E-00 0.3162E-00 0.1045E 01 -0.2325E-00 0.3162E-00 0.7000E 00 0.3162E-00 0.6300E 00 0.1010E 01 0.2123E 01 -0.9241E-04 0.1000E 01 0.1619E 01 32 10 010 G.1463E 0.1000E 0.1C00E 0 0.1463E 0 0. TTTTE TTTFS EMT CCCEL CCCEL 1 C.7446E OC -0. 0. -0.3534E-16 0.1434E 01 0 -0.3534E-16 -0.3534E-16 -0.3534E-16 0.7446E UC -C. 0.6496E-03 0.1128E-C1 0.2547E 02 0.1434E 01 0.7447E 0C 0.1942E-01 0.2077E-02 0.1108E-01 0.8194E 02 0.1426E 01 C.7449E CC 0.9692E-C1 0.3424E-C2 0.1024E-C1 0.1378E C3 0.1378E C3 0.7448E 00 0.2087E-00 0.4617E-02 0.9048E-02 0.1924E 03 0.1340E 01 0.7446E 0C C.1000E 01 C.5004E-02 C. 0.2266E 03 0.2266E 03 C. C.1473E-0C 0.2754E 01 C.5389E-02 0.7446E 0C -0.3534E-16 PT CCEF MOMT VBDELS YBDELS 0. 0. -0.3534E-16 0. 0.4023E 01 C.186CE-01 -C.4022E-01 C.185CE-01 0.8154E 02 C. C.3782E C1 C.1983E-C0 -0.9023E-01 0.1973E-00 C.1924E 03 C. C. -C.3534E-16 -C.3534E-16 -C.3534E-16 C.3924E 01 C.9250E-01 -0.6654E-01 C.9203E-01 C.1378E 03 C. C.2823E 01 C.1CCCE C1 -C.9798E-01 C.10CCE 01 C.2266E 03 C.1984E C1 -C.2675E 01 -C.8727E-01 10 C.2823E 01 -C.3534E-16 C.1257E-01 ដ 62 C.4048E (C. C.4048E (с. с.2547E (с. LDEF C1ST TOEF YBDEL4 EMTP 1 C.2327E 03 C.1872E 05 C.3534E-16 0.3862E 01 -0. C.1839E C3 0.1464E C5 C. -C.3534E-16 -C.3534E-16 -C.3534E-16 C.3839E 03 C.3839E 01 C.3866E-02 C.8188E 02 0.6748E 04 -C.4621E-02 9 C.2327E 03 C.1872E 05 C.8C54E 02 0.8654E 01 C.1176E-C2 0.2317E 03 C.1864E 05 0.22805 C3 0.1833E O5 0. 0.3747E 01 0.3747E 01 0.6198E-02 C.2226E 03 0.1788E C5 0. 0.6085E 03 0.3616E 01 0.3616E 01 0.8359E-02 C.1839E 03 C.1464E 05 C.7166E 03 C.7166E 03 C.723E 01 C.9059E-C2 c RET FOEF YBCEL3 CHLOML CHLOML C.ICCCE 01 C.ICCCE 01 -C.35346-16 C.4618E 01 C.81C7E 05 C.1444E-01 C.1CCCE 01 C.1CCCE 01 C.1CCCE 01 C.1CCCE 01 C.46186 01 C.81C76 05 C.14446-01 C.1CCC6 01 C.1CCC6 01 C.93746 CC C.4623E 01 C.8C88E 05 C.1411E-01 C.1CCCE 01 C.1CCCE 01 C.1CCCE 01 0.6989E CC C.4643E 01 C.8C1CE 05 C.1283E-01 C.1263E-01 C.1CCCE 01 C.1CCCE 01 C.4629E-00 C.4673E 01 C.7853E 05 0.1105E-01 0.1000E 01 C.1CCGE 01 C.2317E-0C C.39136 01 C.22552E 05 C.15266-01 C.ICCCE 01 C.ICCCE 01 C.E644E-01 0²0 55 C.4517E C C.4517E (XC1** -C ** -C RE PGEF PS1 -C.451Ct C1 C.2534E-CC C.221CE-C1 -C. C.3162E-CC C.849CE C2 C.491CE C1 C.3113E-CC C.45CCE-C1 C.45CCE-C1 C.3162E-CC C.3162E-CC C.491CE C1 C.2543E-CC C.6185E-C1 C.138EE-CC C.3162E-CC C.845CE C2 C.451CE C1 C.2575E-CC C.6085E-C1 C.2344E-CC C.3162E-CC C.3162E-CC C.845CE C2 C.451CE 01 C.2534E-CC C.2534E-CC C.4521CE-C1 C.43C6E-01 C.3162E-CC C.845CE C2 C.491CE C1 C.2634E-CC 0.5940E-01 C.3301E-00 C.3162E-CC C.845CE C2 C.491CE C1 C.3113E-CC C.45CCE-C1 C.3971E-CC C.3162E-CC C.3162E-CC C.845CE C2 C.225CE C1 C.7731E CC C.225CE-C1 -C. RR0 PPC VCELI RY2 RY2 RY2 .1 -C.3534E-16 C.1CCOE C1 C.3165E-01 C.3534E-16 -C.3534E-16 -C.3534E-16 -C.3534E-L6 0.1279E C1 C.3582E-C1 -C.3534E-16 0.1CCCE C1 0.7852E 04 -C.3534E-16 0.1279E C1 C.3582E-01 -0.3534E-16 0.1000E C1 0.7852E 04 -C.3534E-16 0.1274E 01 0.3574E-01 -C.3534E-16 0.9815E C0 0.7852E C4 -C.3534E-16 0.1252E C1 0.3543E-01 -0.3534E-16 C.5080E C0 0.7852E 04 -C.3534E-16 C.1221E C1 0.3498E-01 -0.3534E-16 0.8027E C0 0.7852E Q4 -C.3534E-16 C.1CCCE C1 C.3165E-C1 C.3165E-C1 -O.3534E-16 -C.3534E-L6 0.4644E-CC 0.4955E-C1 ×CC. **5** U. Q.7852E C C.ICCOE 01 NPTS= PPF CCC CCC CLOUFS CCIF VBCEL2 YBCEL2 0.4900E-01 0.1000E 01 0.1869E 01 0.2294E-03 -0.3534E-16 -C.3534E-16 0.6210E-01 0.1294E 01 0.2390E 01 0.2294E-03 0.1000E 01 0.1000E 01 0.6210E-01 0.1294E C1 C.2390E C1 0.2294E-03 0.1000E C1 C.8054E C2 0.61855-01 0.1288E C1 0.2380E C1 C.22946-03 C.9806E C0 0.2591E C3 0.6085E-01 0.1265E 01 0.2340E 01 0.2294E-03 0.5031E 00 0.4357E 03 0.5940E-01 C.1233E 01 0.2282E 01 0.2294E-03 0.7913E C0 0.6085E 03 C.4900E-01 C.1C00E C1 C.1869E C1 C.2294E-03 C.2200E-01 0.4845E-00 C.8678E CO ΰ 0.71665 0.4620E C3 C.1COCE C1 C.1525E C1 0.1525E C1 -0.3534E-16 -0.3534E-16 0.4C2CE C3 0.11C5E C1 0.2456E C1 0.1C76E-C0 0.1C00E C1 0.1C0CE C1 0.4C2CE C3 0.1107E C1 C.2485E C1 0.3461E~CC 0.5814E C0 0.1C0CE C1 0.11096 C1 0.11096 C1 0.24966 C1 -0. 0.10006 C1 0.10006 C1 000000 009800 8558 5 000 0.4C2CE 0.1C95E 0.2441E 0.5821E C.9C75E C.1C0CE 0.47268 C.16876 0.23776 0.81336 0.81336 0.86176 0.86176 C.4C6CE (0.1451E (0.5345E (0.4C2CE C.1CCCE 0.1525E C.5586E c.lccc C.ICCCE-CO C.1C45E C1 C.1C60E C1 C.5689E CC C. -C.3534E-16 -C.3534E-16 c. c.lae5e-cc c. C.145CE-CC C.9885E CC C.5581E CC C.8154E C2 C.1C65E-CC C. C.45C0E-C1 C.5687E CC C.5575E CC C.2547E C2 C.10856-CC C. C.245CE-CC C.5858E CC C.5589E CC C.1378E C3 C.5854E-C1 C.5854E-C1 C. C.345CE-CC C.591CE CC 0.9600E 00 C.1924E 03 C.8711E-01 C. C.415CE-CC C.1CCCE C1 C.5688E CC C.2266E CC C.455CE-CC C.5585E CC C.5286E CC ដូ C.5587E 7C LLE LLE 78 71 70 71 70 71 70 71 * JX

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-C.3154E 01 C.23564E 01 C.22964E C3 -C.1727E-C3 C.1714E C1 -C.64C3E C1 -C.64C3E C1 -C.2423E 03 -C.2423E 03	C:9585 CC C:99585 CC -C:11605 02 -C:89616 01 -C:89616 01 -C:89616 01 -C:24505 03 -C:11885-C3 -C:11885-C3 -C:17685 CC		C.4997E-CC -C.29C1E C2 C.1C32E-C1 -C.1935E 02 C.2483E 03 C.48C9E-03	C.4681E-CC -C.3816E C2 C.3456E-C1 C.2443E C2 -C.2483E C3 C.6124E-C3 C.6124E-C3
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4CE 01 CLA= 16-C2 FFS=	54 57 75 75 75 75 75 75 75 75 75 75 75 75	C.5372E 01 C.33C2E 05 C.33C2E 05 C.1CCCE 01 C.1CCCE 01 C.2243E-02	C.115C5E 01 C.1184E 04 C.5827E-01 C.6815E 01 C.6254E 01 C.62243E-02	C.1715E 01 C.1452E 04 C.6055E-01 C.6615E 01 C.6256E 01 C.6254E 01	C.2232E 01 C.2579E 04 C.6278E-01 C.6815E 01 C.6256E 01 C.62243E-02	C.31C1E 01 C.5534E-01 C.5534E-01 C.4254E 01 C.4254E 01 C.2243E-02	C.41C5E Q1 C.1326E 05 C.3226E-01 C.4815E 01 Q.6256E 01 -C.2243E-02	C.446CE 01 C.1765E 05 C.1593E-01 C.4815E 01 C.4815E 01 C.422438-02	C.511CE 01 C.2766E 05 C.1C2CE-02
.) #F5= C.61 2 CC= C.555	53706-C3 APT RR PPC VCEL1 CEL3 RP2 RP2 RP2 RP2 RP2 RP2 RP2 RP2 RP2 RP2	C.451CE C1 C.7235E C1 C.7235E C1 C.2CCEE-C1 C.2C36E C1 C.2236E C1 C.2236E C1	C.451CE C1 C.5665E C1 C.1835E-C2 C.1835E-C2 C.2236E C1 C.2236E C1 C.2236E C1	C.451CE C1 C.5112E C1 C.5286E-02 C.19236E-02 C.2236E C1 C.2236E C1 C.1004E-00	C.451CE G1 C.3851E G1 C.3851E G1 C.3678E-C2 C.3846E-C2 C.2236E C1 C.2236E C1 C.2236E C1	C.451CE C1 C.2365E C1 C.6855E-C2 C.65765E C2 C.5765E C1 C.2236E C1 C.1CC4E-CC	C.451CE C1 C.1377E C1 C.1183E-C1 C.7692E CC O.2236E O1 C.1004E-CC	C.451CE C1 C.1161E C1 0.13926-C1 C.8462E CC C.2236E C1 C.1CC46-CC	C.225CE C1 C.821EE CC C.1815E-C1
gram (NTYPE 2 * 0.402CE C3 S* 0.47C7E C	P184= P184= CUCUE FPP FA FA FA FA FA FA FA FA FA FA	0.5370E-03 0.1CCCE 01 C.2658E-C1 0.1276E-03 C.2533E C2 C.2533E C2	0.53706-C3 0.13776-C0 0.29016-C0 0.12766-C3 C.100C6 01 0.54746 01	G.5370E-C3 C.1627E-CC C.2332E-CC O.1276E-03 C.5CC1E CC C.5CC1E CC	0.5370E-03 0.2352E-CC 0.1450E-CC 0.1276E-03 0.1276E-03 C.67C0E CC C.5474E C1	0.5370E-C3 C.3885E-CC 0.7782E-01 0.1276E-C3 C.38276-CC 0.5474E 01	C.5370E-C3 C.6162E CC C.4512E-01 C.1276E-01 C.1276E-03 O.1705E-00 C.5474E C1	C.5370E-C3 0.7C91E CC 0.3834E-C1 C.1276E-C3 0.1174E-CC C.5474E C1	C.5370E-C3 C.9118E CC Q.2934E-Q1
Mean Flow Proy 153E 04 TC •5480E C5 TF •2358E C1	0.10066 01 884 CCE CLDUFS MLT CCIF CCIF	0.20206-01 C.10006 C1 0.75686 C0 0.22946-03 -0.32526 01 0.78716 C3	C.1850E-02 0.2405E-00 C.1042E-00 C.2114E-03 0.1000E 01 0.3676E 01	C.2300E-C2 C.2602E-00 C.1232E-C0 C.2126E-C3 C.5741E C0 C.5741E C0	0.37CDE-02 0.3208E-C0 0.178CE-C0 0.178CE-C0 0.2156E-03 0.8942E 00 0.2143E 01	C.6900E-C2 C.4531E-C0 O.2940E-C0 O.2215E-C0 O.7202E C3 C.3676E C1	C.1190E-01 C.6502E C0 C.4663E-C0 C.2282E-C3 O.4606E-00 O.4606E-00	0.14006-C1 C.7296E C0 0.5367E C0 0.2306E-C3 0.356CE-C0 0.6954E C1	0.1830E-01 C.5188E CO C.6901E CO
Dutput Data for 2 PC= 0.5 04 REFS= 0 5 CLFS= 0	E C1 PPG= 116 116 116 116 116 111 1101F 1101F	0.4C20E C3 C.1C0CE C1 C.77C3E C0 C.77C3E C0 C.1C47E C1 0.3516E C2 C.3516E C2	C.359CE C3 0.4155E C1 0.1853E-C0 0.1853E-C0 C.1000E C1 0.1000E C1	G.362CE C3 C.364CE C1 C.2C04E-C0 C.5685E-C2 C.8763E CC C.8763E CC D.9302E CC	C.369CE C3 0.3114E C1 C.24716-CC C.13216-C1 0.6244E C0 C.7074E C0	C.383CE C3 C.2208E C1 0.345CE-C0 C.25C2F-C1 0.3334E-C0 0.419E-C0	0.359C6 C3 0.1538E C1 C.5C08E C0 0.4402E-C1 0.1225E-C0 0.6977E-C1	0.4C5CE C3 C.137CE C1 C.562CE C0 0.5405E-C1 0.6576E-C1 0.6576E-C1	C.4C20E C3 C.1C89E C1 C.7078E C0
B.5e) Typical (MCSF= 1 NTYPE RECFS= C.7832E LFS= 0.8446E C	XC* C.SCCC YC LLE LLE LLFS YE TCEL TTCEF	C.2600E-CC C.1CCCE C1 C.5825E CC C. C.2749E C1 C.2749E C1	-C. C.5726E CC C.5626E CC C.3155E C1 C.3155E C1	C.5560E-C1 C.6255E CC C.6145E CC C.2106E C1 C.22106 C1 C.2246E C1 C.2846E C1	C.1CCCE-CC C.7331E CC C.7263E CC C.4751E C1 C.2114E C1 C.2326E-CC	C.156CE-CC C.8575E CC C.8425E CC C.8215E CC C.8215E C1 C.126E C1 C.126E C1 C.156E C1	C.2CCCE-CC C.9476E CC C.9311E CC C.1311E C2 C.5381E 00 C.9362E 00	C.22CCE-CC C.5719E CC C.5545E CC C.1555E C2 C.1555E C2 C.37C4E-CC C.1C7CE C1	C.26CCE-CC C.5923E CC C.575CE CC

ų

C.2135E C2 C.E855E-C1 C.ICCCE C1	0.7855E-C1 0.1201E-C1 .C.	C.2294E-03 0.1069E-C0 C.556EE C1	C.1276E-C3 C.28C6E-01 C.5474E C1	C.1CCCE C1 C.2234E C1 C.1CC4E+CC	C.6819E 01 C.6256E 01 -C.2243E-02	C.9566E CL C.9433E CC C.9418E-C2	C.9715F CC C.3415E 01 C.2315E-C2	C.7659E-CZ C.3137E C1 C.15CCé 21	0.61156-01 1.22356 01 0.21396 52
C.235CE-CC C.1CCCE C1 C.925E CC .3414E C2 .1CCCE C1	0.4020E C3 C.1000E C1 0.7703E C0 C.1328F-C0 C.	C.2C2CE-C1 C.1CCOE 01 C.7568E C0 C.2294E-C3 C.2294E-C3 C.2294E-C3	C.537CE-C3 C.1C00E 01 O.2658E-C1 C.1276E-C3 C.1276E-C3 C.1276E-C3 C.1276E-C3	C.15CCE C1 C.7235E CC C.7235E CC C.128EE C1 C.128EE C1 C.128EE C1 C.128EE C1 C.128EE C1 C.1204E-CC	C.53726 01 C.33C2E 05 C. 8419E 01 C.6256E 01 C.6256E 01	C.75566 C2 C.55286 C4 C. C.15276 C2 C.15276 C2 C.15276 C2 C.93376-02	C.9713c CC C.1555E-CC C.1555E-CC C.1555E-CC C.1555F-CC C.55457E 01 C.2315E-C2	U-4314E-CC C-1CCOE G1 C-1256F-01 C- C- C- C- C- C- C- C- C- C-	C. ICUCE 01 0.1261E 01 0.3064E-72 0. 0.2236E 01 0.3414E 02 0.3414E 02

SIBFIC MAL DECK
DIMENSION IV(200), MUV(200), TU(50), PPM(50), HI(50), REUM(50), (
1901 V (1=1-36+980-72-871F06
(2 = SOP 1/1 + 4/2 + 8/1) + 1000
(4=SORT(3-1416*-7)
1000 READ (5.1) NOSP. NTYPE. PO. TO. MES. DIA.SE.PTM
1 FORMAT (215-6F10-0)
WRITE (6.6) NOSP. NTYPE. PO. TO. MES. DIA.SF.PTM
6 FORMAT (1)+1+1+5HN05P=+12+2×6HN1YPF=+12+2×3HP0=+F12+4+4+2+3HT0=+
$1 = 12 + 4 + 3 \times 4 + 10 = 5 = 5 = 12 + 4 + 2 \times 4 + 10 = 5 = 5 = 12 + 4 + 4 \times 3 + 10 = 5 = 5 = 5 = 5 = 5 = 5 = 5 = 5 = 5 = $
TEMP = 1. + MFS**2/5.
$TEMP7 = TEMP**3 \bullet 5$
IFS = TO / TEMP
D0=C1*P0/I0
DFS = D0/TEMP**2.5
UFS=SQRT(TFS)*MFS*C2
QFS=DFS*UFS**2/1960.
DUFS = DFS*UFS
CALL TBLKP(TFS)TV,MUFS,MUV,44)
MUFS=MUFS*1+0E-7
CALL TBLKP(TO,TV,MUO,MUV,44) j
MU0=MU0+1.0E-7
REFS = DFS*UF5*DIA/MUFS
REOFS = REFS*MUFS/MUO
PFS=P0/TEMP7
WRITE (6,7) REOFS, REFS, TFS, DO, PFS, QFS, DFS, UFS, DUFS)
7 FORMAT (1X6HREOFS=,E12.4,2X5HREFS=,E12.4,2X4HTFS=,E12.4,2X3HDO=,
1E12•4•3X4HPF5=•E12•4•2X4HQFS=•E12•4•2X4HDF5=•E12•4
21X4HUFS=,E12.4,4X5HDUFS=,E12.4)
C PROFILE DATA CALCULATION
NOS=1
GO 10 (10,20), NIYPE
10 READ (5,2) XD, PPG, NPIS,XOU,XOT,REOO
2 FURMAI (2F10.49,110,3F10.4)
WRITE (6)16) XD9 PPG9 NPIS9X009X019RE00
10 FUKMAI (1HU)1X3HXU=3E12.492X4HPPG=9E12.492X2HNP15=913.9
· · · · · · · · · · · · · · · · · · ·
A11X3HDET.10XAHUDEE.0XAHDDEE.0XAHTTEC/EXADUDEE.0XAHDDEC.0XAHD
ZIAJHEEETTAVAJHEETTAVAANNUEETTÄÄÄÄEVEETTÄÄÄÄNNELETTÄÄÄÄÄNNUNITTÄÄÄÄÄEMIT 6522HVRA1140HDCI1.092HMHTA1092HEMA119EHVDELTAVAUNELEALOVAUNELTA
89X4HDEL \$ 7X4HDEL \$ 7X4HDEL 7X4HDEL \$ 7
READ (5-3) (YD(1), 1=1-NPTS)
READ (5,3) (PPM(1), I=1,NPTS)
READ (5+3) (TT(1)+ I=1+NPTS)
READ (5+3) (REOM(1)+ I=1+NPTS)
3 FORMAT (16F5.0)
GO TO 30
20 READ (5+2) XD+ PPG+ NPTS+PIBM+XOU+XOT
$PIBM = PIBM*_0001$
WRITE (6.8) XD. PPG. PIBM. NPTS.XOU.XOT
8 FORMAT (1H0+1X3HXD=+E15+4+2X4HPPG=+E15+4+2X5HPIBM=+E15+4+

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<u> </u>	57X3HPPP+10X3HPPC+10X4HMDEF+9X4HEDEF+9X4HDIST+9X4HMUMT+9X3HEMT/	-	
L	77X4HTDEF • 9X4HUDEL • 9X4HDDEL / 5X4HTDEL • 9X4HUDIF • 9X4HDDIF • 9X4HTDIF •	<u>.</u>	
	89X4HDEL3,9X4HDEL4,9X6HDMUDMU,7X6HYBDEL4,7X6HYBDEL5,7X4HDEL2/		
	95X5H, [[DEF 98X5H] [DIF 98X6HYBDEL297X3HKW2910X3HKH2910A3HP519		
	REAU (5.3) (YD(1)) I=1 (NPTS)		
·	READ (5,3) (PPM(1), I=1,NPTS)	•	
	READ (5.3) (IT(1). 1=1.NPTS)	-	
30			
<u> </u>	EMT = 0	•	
-	$YB = Q_{A}$		
	MDEF=0.		
<u>+</u>		÷	
	TTE=1.	• .	
	DDE=1.	•	
	DUDUE=1.		
		• .	
	DEL2=SQRT(XD+XOU)		
	DEL3=SQRT(XD+XOT)	,	
	DEL4=1.0	•	•
ĺ			
29	YDI=YD(1)		
	YDEL1=YDI/DEL1	_	
	$PPM(\mathbf{I}) = PPM(\mathbf{I}) * 0 1$		
<u></u>	IF (1 .EQ. 1) GO TO 31		
23	JF (1 eLte N) GO 10 32 GO TO 140.50) e NTYPE		
37	PPM(1)=PPM(1)/•01	•	
·	<u>GO TO 31</u>		
4(CALL TBLKP(TT(I),TV,MUT,MUV,44)		
<u></u>	MUT=MUT+1+0E-7	•	
	IF (SF-100) 43943943 (IF (SF - 100-) 47.47.44		
47	'RME=REOM(1)		
	REM=REOM(I)		
	IF (REM-RE00) 45,46,46		
40	<u>IF (REM-RME) 45044044</u>		
	CALL TRIKD(PDPT=PDV=M=MPV=10))		
<u>itaan ahaan ah</u>	GO TO 60		
45	FM=REOM(1)*MUT*SQRT(TT(1))/PPM(1)*PPG/PO		
and a second sec	F=FN+1.0E04		
	<u>IF (F=_85) 41#41#42</u>		
(4)	REAM(1)=(FM*PPM(1)*PA)/(MUT*SQRT(TT(1))*PPG)		
	M=8.0		
<u></u>	<u>60 10 60</u>		
42	CALL TBLKP(F+FV+M+MFV+101)		
	100 10 50		
e. 2	CALL TO VO (DDD DDDV, W, MV, 111)		

, ·

	CALL TRUKPITTIIS TV-MUT-MUV-443
	MUT=MUT*1+0E-7
60	MS = M**2
	TEMP1 = MS/5.
	<u>TEMP2 = 5. / (6.*MS)</u>
	IF (M-),) 60,60,65
. 64	Q= • 7 * 1 • 36 * PO * PP(* (M**2 •) * (5 • / (5 • + M**2 •)) * * 3 • 5
	_GO_TO_66
65	TEMP5 = ((7•*MS-1•) /(6•*MS))**2•5
	$TEMP6 = ((7 \bullet *MS - 1 \bullet) / 6 \bullet) * * 2 \bullet 5$
	Q=C3*P0*PPC*TEMP5
00	$\frac{11FS = 11(11 / 1FS/(10TICMP1))}{GO TO (61.62) + NTYDE}$
61	IF (SF=1=0) 71=62=62
71	DUDUFS = (REOM(I)*MUT)/(+000254*DUFS)
	UUFS = Q/(QFS*DUDUFS)
	GO TO 63
62	UUES = M / MES*SQRT(TTES)
	DUDUFS = Q / QFS / UUFS
02	CALL TRI KDITTESTES TV MILAMIIV 441
-	MU=MU*1.0E-7
:	DMUDMU =DUDUFS*MU/MUFS
88	_RET = DUDUFS*DFS*UFS*DIA/MUT
· ·	RE = RET*MUT / MU
L 7	
Q (P-FFC*(EMF(*(30/(30+M**20))**30) DT±DDC
	GO TO 69
68	P = PPC+TEMP7+(TEMP2)++3.5+TEMP6
	PT = PPC*(1./6.+TEMP2)**3.5*TEMP6
69	<u>PPP = P / PPC/TEMP7</u>
	KN = C4*M**/02/(KC**000234)
	TE = ITFS
2	DE = DDFS
	FMUE=MU
	TTOE = TT(I)
70	IF(1 _NF 21, 60 TO 80
	UCL = UUFS
·	DCL = DDFS
: 	TCL=TIFS
	TTCL=TT(1)
	<u>RW/=la/(la-(ULL/UL))**/a</u> PH2=1,///TC//TF)-1,)**2,
80	UUE = UUES / UE
	DDE = DDFS / DE
	DUDUE = DUDUFS / DE / UE
	C=DDE*MU/FMUE
	$\frac{MDEF}{TTTE} = \frac{TT(1)}{TTTE}$
	TTF # TTFS / TF
	EDEF = DUDUE*(1TTTTE)
	UDEF = (UUFS-UCL) / (UE-UCL)
÷ .	DDEF = (DDFS-DCL) / (DE-DCL)
	TDEF=(TCL-TTFS)/(TCL-TE)
	11067=(11(1)~11(L)/(1106~11(L) 1061=(116-10165)/116
1	41

.

DDIF=I•-DDEF
TDIF=1TDEF
TTDIF=10-TTDEF
IF (1 • EQ• 1) GO TO 100
IF (1 •EQ• 2) GO TO 98
DELYD = YD(I) - YD(I-I)
DIST = (2DUDUES-DUDUE) / 2.*DELYD + DIST
MOMT = (MDEES+MDEE) / 2.*DELYD + MOMT
EMT = (()TITTES)*DUDUES+()TITTE)*DUDUE) / 2.*DELYD+EMT
YB # ((DDES+DDE) / 2-*DELYD)*DE*UE*SQRT(REES)+ YB
VADEL 2-VALUEL 2
TBUELSEYBJUELS
98 GO 10 (100,97), NIYPE
97 IF (UDIF-TDIF) 99.99.109
99 IF (DEL4-1+0) 101+101+102
102 IF (DEL5 .EQ. 1.0) GO TO 109
IF (DEL4 .EQ. 1.0) GO TO 99
<u>GO TO 100</u>
101 IF (UDIF-,500) 103,104,105
104 DEL 4=YB
IF (DEL5 .EQ. 1.0) GO TO 109
GO TO 4
105 DUDUES=DUDUE
MDEFS=MDEF
I I I I F S = I I I I F
IF INII ONEO NPISI GO IO 200
1=160
DEL4=2.
DEL5=2
GO TO 4
200 GO TO 5
'103 DEL4=YB0+(YB -YB0)*(UDIF0-•500)/(UDIF0-UDIF)
IF (DEL5 .FQ. 1.0) GO TO 109
GO TO 4
109 IF (DEL5=1=0) 111=111=102
111 IF (TDIF-•500) 113•114•105
114 DEL5=YB
IF (DEL4 .EQ. 1.0) GO TO 99
GO TO A
113 DEL5= YBO+(YB-YBO)*(TDIFO-05)/(TDIFO-TDIF)
IF (DF(4 = FQ= 1=0) GO TO 99
4 N=1
XH = 0.0
YBDEL4=0+0
YBDELSEORO
GO TO 5
100 DUDUES & DUDUE

TITTES = TT	TITE
QMOMT=MOMT*	*UE*UE*DE
EMTM=EMT+DE	E*UE
YBC=YB+SQRT	T(C)
PSI1=UE+DE+	*(YD(1)-DIST)
17 15741+01 89 DSI±(DE11+1)	/ 90909909 HF#DF#/DIst_YD/I))
YBC=DEL1-YD	DI
90 WRITE (6.9)) YD(I),TT(I),PPM(I),PIBM,REOM(I),M,Q,P,PT,TTTE
1+UUE+TTE+DD	DE, DUDUE, KN, RE, RET, UDEF, DDEF, TTFS, UUFS,
3YDEL1.DEL5	•YBDEL3•TDEF•UDEL•DDEL•TDEL•UDIF•DDIF•TDIF•DEL3•DE
4DMUDMU, YBDE	EL4.YBDEL5.DEL2.TTDEF.TTDIF.YBDEL2.RW2.RH2.PSI.QMOM
5EMTM+C+YBC	
9 FORMAT (1H0	0+10E13+4/(1X+10E13+4))
5 I = I + I NI = I - 1	
IF (NI •NE•	• NPTS) GO TO 29
NOS=NOS+1	
IF (NOS .GT	T. NOSP) GO TO 1000
<u> </u>	201 •N1 TPE
	,
· · · · · · · · · · · · · · · · · · ·	
	######################################
	a de la companya de l La companya de la comp
	nen en
•	

<u></u> \$16	OFTC BLO DECK
	BLOCK DATA
·	REAL MV, MUV, MFV, MPV
	DIMENSION TV(200), MUV(200), PPPV(200), MV(200), MV(200), FV(200),
~	
<u>b</u>	$\frac{1}{2} \frac{1}{2} \frac{1}$
h	2 + 250 + 260 + 270 + 280 + 290 + 300 + 310 + 320 + 330 + 340 + 350 + 360 + 370 +
	3 ,380 , 390 , 400 , 410 , 420 , 430 , 440 , 450 ,/
	DATA (MUV(I),I = 1,44)/0.0,215.7,281.1,347.3,416.3,485.6,555.1,
	1622.9,692.9,763.3,831.9,899.0,964.6,1029.,1091.,1152.,1212.,1271.,
	2 1329.,1385.,1440.,1494.,1547.,1599.,1650.,1700.,1750.,1798.,1846.
	3 ,1893.,1939.,1985.,2030.,2075.,2118.,2160.,2202.,2245.,2286.,2327
-	4 • • 2366 • • 2406 • • 2445 • • 2485 • /
<u> </u>	TABLE 2 M=F (P/PFS)
	DATA $(PPPV(1)) = = 1 + 1 + 1 + 1 + 0 + 0 + 0 + 0 + 0 + 0 +$
Law	
	1 - 0.1285 - 0.1302 - 0.1319 - 0.1356 - 0.1356 - 0.1356 - 0.1499 - 0.1498
	3 • 02002 • 02067 • 02136 • 02208 • 02284 • 02364 • 02449 • 02537 • 02631 •
	4 • 02730 • 02834 • 02945 • 03062 • 03187 • 03319 • 03459 • 03609 • 03768 •
**************************************	5 • 03938 • 04120 • 04314 • 04523 • 04747 • 04987 • 05247 • 05526 • 05829 •
	6 •061579•065139•069009•07323•077859•082919•088489•094619•10149
	7 •1089 • • 1173 • • 1266 • • 1371 • • 1489 • • 1622 • • 1773 • • 1945 • • 2142 • • 2368 •
	8 • 2628 • 2930 • • 3280 • • 3685 • • 4159 • • 4689 • • 5283 • • 5913 • • 6560 • • 7209 •
	9 •7640,•8430,•8956,•9183,•9395,•9575,•9725,•9844,•9930,•9983,
#	1 • 9994 • 1 • 0/
	DATA (MV(I),I=1,111) /10+99+9+8+9+7+9+6+9+5+9+4+9+3+9+2+9+1+9+0+
· • • • • • • • • • • • • • • • • • • •	18.9,8.8,8.7,8.6,8.5,8.4,8.3,8.2,8.1,
	1 8+0,7+95,7+90,7+85,7+80,7+75,7+70,7+65,
	17.60,7.55.7.5,7,4,7.3,7.2,7.1,7.0,6.9,6.8,6.7,6.6,6.5,6.4,6.3,
	2 6 • 2 • 6 • 1 • 6 • 0 • 5 • 9 • 5 • 8 • 5 • 7 • 5 • 6 • 5 • 5 • 5 • 4 • 5 • 3 • 5 • 2 • 5 • 1 • 5 • 0 • 4 • 9 • 4 • 8 • 4 • 7 •
	3 4+6,4+5,4+4+4+3,4+2,4+0,1,4+0,3+3+3+2+3+2+3+5+3+5+3+3+3+3+3+2+3+1+
C C	
<u>_</u>	DATA (FV(1), 1=1.101) / .83858388839283978397839984048406.
	1.8409.8414.8418.8423.8423.8427.88431.88435.88435.88452.8845788457
-1.5	2 • 8467 • 8473 • 8480 • 8485 • 8491 • 8497 • 8504 • 8513 • 8521 • 8530 • 8539 •
	3.8548, 8557, 8565, 8575, 8589, 8600, 8613, 8621, 8631, 8649, 8662,
	4.8676,.8691,.8706,.8721,.8742,.8762,.8780,.8798,.8819,.8843,.8865,
	5.8894,.8918,.8944,.8975,.90099042,.9077,.9114,.9155,.9196,.9247.
	6.9299,.9343,.9403,.9464,.9523.9596,.9667,.9753,.9837,.9933,
	71.0035,1.0149,1.0265,1.0403,1.0536,1.0695,1.0864,1.1046,1.1248,
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<u>s 1</u> 8	C TBL DECK	
	SUBROUTINE TBLKP(VO,VAR,FO,FCN,NO) DIMENSION VAR(100),FCN(100)	
C	THIS SUBROUTINE PERFORMS TABLE LOOK-UP OPERATIONS.	
	VAR1=VAR(I)	
	IF (VO-VAR1) 200+150+100	
10	WRITE (6,900)VO,NO	
5	FORMAT (34H VARIABLE EXCEEDS TABLE FOR VALUE E11.4.13H TABLE 1=15)	SIZE
	FO =FCN(NO)	
15	GO TO 300 FO=FCN(I)	
<u></u>	GO TO 300	_
20	IF (I-1) 210+290+210 I1=I-1	
	RATIO=TEMP/TEM1	
	F0=RATIO*(FCN(I)-FCN(I1))+FCN(I1)	
29	FO=FCN(I)	
30	RETURN States and the second states and the	
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C.1) <u>ID I</u>	isting f	or Tabulated Mean Flow Data
D .	D	reference length, inches
MFS	M∞	free stream Mach number
P	p/p∞	ratio of local static pressure to free stream static pressure
PITO	$\frac{p_{t2}}{p_o} \ge 1$	0^3 ratio (x 10^3), as corrected for tunnel gradient, of local Pitot pressure to free stream total pressure
PO	р _о	free stream total pressure, mm Hg
PPCE	^p t2e Po	ratio, as corrected for tunnel gradient, of edge Pitot pressure to free stream total pressure
PTM	$\frac{P_t}{P_o}$	ratio of local total pressure to free stream total pressure for region between shear layer edge and leading edge shock
REFS	Re∞D	free stream Reynolds number based on reference length
то	To	free stream total temperature, ^O K
TT	Tt	local total temperature, ^O K
TTTTE	T _{te} /T	ratio of local total temperature to free stream total temperature
TW	Two file	wall temperature, ^o K
UUE	u/u _e	ratio of local velocity to edge velocity
XD	x/D	axial distance from base ratioed to reference length
YD	y/D	lateral distance from centerline ratioed to refer- ence length

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•02	0 2.40 .911	•020 2•70 •913	•020 3.10 -918	•020 3•69 •923	•020 4•16 •926
60°	0 2.80 .928	•030 3•20 •928	•030 3•50 •933	•030 4•09 •940	•040 5•25 •963
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•08	10 13.2 1.01	•090 18•3 1•01	•080 13•7 1•01	•090 18•7 1•01	•120 26•2 1•00
-00°	0 18.2 1.00	•100 23•0 1•00	•090 18•8 1•01	•100 23•5 1•01	<pre>*150 27*4 1*00</pre>
•10	15 24.0 1.00	•105 24•7 1•00	•100 23.4 1.00	•110 25•5 1•00	•200 27•9 1•00
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•0°	0 5.88 968	•040 6•24 •973	•040 6•61 •973	•040 7•27 •975	•040 8•20 •975
•00	0 8.33 .998	•060 8•16 •998	•060 8•03 1•00	•060 8•57 1•00	•060 9.32 1.00
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C.3) TABULATED MEAN FLOW DATA FOR 20 DEGREE WEDGE (H=.15)

•800 24•1 1•00 25•3 5•64 P110 5.55 6 • 42 7.59 17.5 2.00 26.5 26.6 400 9.73 •500 13•1 .700 22.1 •40 26•1 XD =3. 5. 7. 10. 15. 20. 25. 30. 35. 40. 50. 55. 60. P =.6888 .996 1.04 1.07 1.10 1.11 1.11 1.07 1.06 1.06 1.05 1.05 PPCE=19.4 21.2 22.8 24.4 25.7 26.3 26.6 26.5 26.2 26.0 26.0 26.1 26.1*001 25. • 200 •300 • 600 •100 2.40 •000 2 •700 22•6 •800 24•3 •600 14•0 •800 20•0 •000 7.18 •200 7.83 18.7 P110 5.21 6.00 13.5 28.8 28.9 5.01 5.11 7.37 •00 25•3 •00 24•0 1.80 26.3 •400 9.69 1.25 25.3 • 50 25 • 6 9**°**63 1.40,26.1 2.50 26.1 3.00 27.1 4.00 28.1 60. 20. 300 .500 5.00 •200 •400 •050 6.00 •000 ç •000 6.99 •200 7.55 •400 9.41 •600 13•5 •800 20•0 4.47 9.63 14.3 19.9 23.0 2.50 26.1 4.00 27.4 4.67 25**•**1 25**•**7 23.9 24**°**6 28.1 28.3 P110 4.37 4.87 5.36 6.95 24.3 25.4 2.00 25.8 55 e 15 00.1 1.25 .150 • 050 • 400 • 600 • 50 5.00 • 000 • 300 . 800 1.00 1.20 2 MFS=6.04.PDn=1259.10=TT=402.0REFS=6987. .0=.15 •000 6.80 •200 7.36 •400 9•41 •600 14•0 •800 20•8 1•00 24•1 1•25 25•0 14.8 20.2 3.60 3.70 4.20 4.70 6•50 9•70 PITO 3.e80 22.9 23.8 25.4 2.00 25.9 26.3 27.0 27.9 •00 24•3 24.4 10. 50. • 100 .150 3.00 • 400 • 500 • 300 •600 • 700 800 4°00 5.00 0000 1.10 •50 6.00 Ž •800 21•9 1•00 23•6 1•40 25•4 •300 7•95 •400 9•35 •500 11•7 •600 15•0 9•00 14•5 26•0 26•2 2.80 2.90 3.20 3.50 P170 4.00 5.80 L.00 22.8 •600 19•7 •650 21•2 .700 22.0 •800 22•6 •000 6•36 700 18.5 .100 6.45 •200 7•01 \$0° 1. •100 •150 •200 • 300 • 500 2.00 2.80 000° •050 • 400 5 •300 7.82 •400 9.33 •500 11•8 •600 14•3 P110 5.20 18°0 20•8 2.30 2.40 2.60 2.90 3.40 8.20 13.1 2.1.4 22.0 •000 6.13 24.7 25.6 26e2 .200 6.79 700 19.4 26.1 100 6.32 **•800 22•6** 35 e 6 1.40 •100 • 150 • 200 • 500 • 600 •00 •020 • 000 •300 • 400 800 e750 2.80 2 •500 12•4 •600 16•6 •300 7.85. 25.9 **P110** 1.80 1.85 2.00 2.30 4.30 11.2 13.5 14.2 •000 5 • 84 •200 6•60 26.4 7.01 •800 23•4 26.5 •100 6.03 .700 20.8 XD =30. XO 83. 1.40 •500 •550 1.00 .150 2.40 •000 •050 .200 •300 •400 e575 20 0039 CARDS

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XD 3_{\circ} 7_{\circ} 10_{\circ} 15_{\circ} 20_{\circ} 35_{\circ} 40_{\circ} 55_{\circ} 5							n den de la management de la companya de la companya de la management	an a subset of the second state of the subset of the subse
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PPCE=18+9 21=0 72=5 24+3 25=4 26+0 25+7 26+0 25+9 25+11 200 5+11 200 5+7 110 25+11 200 25+11 200 25+11 200 25+11 200 25+11 200 25+11 200 25+11 200 25+11 200 25+1 2400 24+0 2400 24+0 2400 24+0 2400 24+0 2400 24+0 2400 24+0 2400 24+0 24+0 24+0		p ≝₀787	•943 1•01 1	•04 1•07 1•	08 1.09 1.0	7 1.07 1.04	1.02 1.00	1.00 1.00
XD 3.0 7.5 7.6 7.5 7.0 2.5 2		PPCE=18.9	21•0 22•5 2	4.3.25.4 26	•0 25•7 <u>*</u> 25•	7 26.0 25.9	25.9 25.9	25.9 25.8*.0
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050 1.41 057 2.01 .050 2.491 .050 2.491 .050 4.92 .110 .200 7.7 150 2.61 .100 2.82 .100 3.71 .100 5.71 .200 5.70 3.70 110 115 .200 7.7 .150 5.69 .400 14.97 .150 5.70 116 .200 2.43 .200 4.91 .200 5.69 .400 14.97 .800 2.44 116 .200 2.45 .200 2.45 .200 5.41 .200 5.69 .400 14.97 .800 2.44 160 2.400 14.97 .800 2.44 .200 2.45 .200 2.45 .200 2.45 .200 2.45 .200 2.45 .200 2.45 .400 14.97 .800 2.44 .400 14.97 .800 2.45 .400 14.97 .800 2.45 .400 14.97 .400 14.97 .400 2.45 1.400 2.46 1.400 2.46 1.400 2.46 2.400		•000 1•31	•000 1.91	•000 2•52	•000 3.21	•000 3.98	•000 4•82	•000 5•49
150 1.61 1100 2.32 1100 2.37 3.10 3.71 1100 4.93 1105 5.11 2.00 3.00 100 <td></td> <td>•050 1•41</td> <td>• 050 2 • 01</td> <td>•050 2•62</td> <td>•050 3•31</td> <td>• 050 4•08</td> <td>•050 4•92</td> <td>•100 5•97</td>		•050 1•41	• 050 2 • 01	•050 2•62	•050 3•31	• 050 4•08	•050 4•92	•100 5•97
•150 2=12 0.50 2.50 3.60	· · · · · · · · · · · · · · · · · · ·	•100 1.61	•100 2•32	•100 2•92	•100 3.71	<pre>.100 4.38</pre>	.100 5.11	•200 7•71
•200 2-92 270 4-67 270 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-70 5-97 5-90 2-44 2-7 5-90 2-44 2-7 5-90 2-44 5-70 10 1-7 800 2-44 2-7 5-90 2-44 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-80 2-46 2-7 2-80 2-46 2-7 2-80 2-46 2-80 2-46 <td< td=""><td></td><td>e150 2e12</td><td>•150 2•82</td><td>e150 3.62</td><td>•150 4.31</td><td>.150 4.97</td><td>.150 5.70</td><td>•300 10•5</td></td<>		e150 2e12	•150 2•82	e150 3.62	•150 4.31	.150 4.97	.150 5.70	•300 10•5
\circ 250 4.23 \circ 570 5.24 \circ 250 6.24 \circ 550 5.92 \circ 550 7.36 \circ 550 8.16 \circ 500 12.2 \circ 370 5.84 \circ 500 13.5 \circ 500 13.5 \circ 500 15.3 \circ 400 13.5 \circ 500 24.6 \circ 400 13.5 \circ 500 13.5 \circ 500 24.6 \circ 500 24.6 \circ 500 24.6 \circ 500 24.6 \circ 475 14.8 \circ 500 18.6 \circ 500 24.5 \circ 600 22.7 \circ 600 23.7 \circ 600 24.6 \circ 600 24.6 \circ 600 24.6 \circ 475 14.8 \circ 500 18.6 \circ 600 22.1 800 24.4 800 24.6 800 24.6 \circ 600 24.7 \circ 600 24.7 \circ 475 14.8 \circ 500 18.6 \circ 600 22.1 800 24.4 100 25.4 200 25.6 600 22.7 2.00 25.7 \circ 475 14.8 \circ 600 20.45 \circ 600 24.5 100 24.3 100 25.4 100 24.5 100 25.4 100 25.6 100 25.6 100 25.6 00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.6 000 27.6 000 26.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7 2.00 25.7		•200 2•92	•200 3.83	•200 4•73	•200 5•41	•200 5.97	•200 6•69	•400 14•5
370 5.84 300 7.55 300 8.45 350 10.6 600 24 640 11.8 400 11.8 400 11.8 400 11.7 800 24 6450 11.8 640 11.8 640 11.8 640 11.8 600 24 6450 11.8 650 20.6 50.6 50.6 50.7 20.7 20.0 25.7 200 24.6 645 11.8 650 20.6 20.6 20.6 24.6 11.67 2600 24.6 100 24.7 1000 24.7 2000 24.7 2000 24.7 2000 24.7 2000 24.7 1000 24.7 2000 24.7 2000 24.7 2000 24.7 2000 24.7 2000 24.7 1000 24.7 1000 24.7 1000 24.7 1000 24.7 1000 24.7 1000 24.7 2000 $24.$		e250 4.23	.250 5.24	•250 6•24	<pre>\$250 6.92</pre>	•250 7•36	•250 8•16	•500 18.6
0350 0350 0350 1002 0350 1168 6500 2166 5500 1967 1000 2475 1000 2475 1000 2245 5000 2245 1000 2245 1000 2257 2000 2265 1000 2245 8000 2245 1000 2257 2000 2250 2250 2265 1000 2245 8000 2245 1000 2250 2260 1000 2265 1000 2265 1000 2265 1000 2265 1000 2265 1000 2265 2900 2466 1000 2260 1260 2500 1260 2500 1260		•300 5.84	• 300 7 • 55	•300 8•45	*300 9.52	• 300 9 • 55	•300 10•0	•600 22•2
\bullet 400 11.0 2 \bullet 400 13.5 \bullet 400 15.8 \circ 500 19.5 \bullet 600 22.7 \circ 00 25. \bullet 475 14.8 \circ 500 19.6 \circ 500 19.6 \circ 500 19.5 \circ 600 22.7 \circ 00 25.1 \bullet 475 14.8 \circ 500 19.9 \circ 700 22.5 \circ 600 24.2 \circ 600 25.7 \circ 00 25.6 \bullet 550 19.9 \circ 700 22.5 \circ 900 24.3 \circ 600 25.4 \circ 00 26.6 \circ \bullet 650 20.7 \bullet 60 20.6 \circ 00 20.5 \circ 900 24.3 \circ 100 25.4 \circ 00 26.6 \bullet 650 20.7 \bullet 60 20.5 \circ 900 24.3 \circ 100 25.4 \circ 00 26.6 \circ 60 26.7 \bullet 650 20.7 \bullet 50 20.7 \bullet 50 26.1 \bullet 60 27.5 \bullet 700 11.6 \bullet 00 14.7 \bullet 000 6.948 \circ 00 11.3 \bullet 00 11.6 \bullet 00 13.6 \bullet 60 15.7 \bullet 60 15.7 \bullet 700 6.948 \circ 00 19.9 \bullet 001 12.7 \bullet 60 117.6 \bullet 00 19.7 \bullet 60 15.7 \bullet 001 16.2 \circ 300 11.8 \circ 300 11.2 \circ 600 14.7 \bullet 600 14.7 \bullet 60 17.6 \bullet 60 17.6 \bullet 700 26.7 \circ 200 12.6 \circ 200 12.6 \circ 200 14.7 \bullet 00 17.6 \bullet 00 17.6 \bullet 000 14.1		e350 8e36	•350 10•2	e350 11.8	•400 15•9	•400 15•3	•400 14•7	•800 24•4
•450 13.9 450 16.4 500 20.5 600 22.7 2.00 22.7 2.00 25.4 600 22.7 2.00 25.4 600 25.4 600 25.4 600 25.4 600 26.7 500 24.6 800 24.6 800 24.6 800 24.6 600 20.7 550 500 25.4 2.000 26.7 550 60 16.6 60.6		•400 11•2	•400 13•5	•400 15•8	•500 21•1	•500 20.6	•500 19•5	1.00 24.9
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•550 19.9 700 22.5 900 24.3 1.000 25.4 2.000 26.0 •650 20.7 $40.$ $45.$ 55.4 2.000 26.0 26.0 •000 6.96 100 8.05 100 11.6 000 14.0 15.0 000 17.4 000 17.4 000 17.4 000 17.4 000 17.4 000 17.4 000 17.4 000 17.4 000 17.4 000 000 11.6 <		•475 14•8	•500 18•6	•600 22.1	•800 24•2	• 800 24•6	.800 24.6	
6600 20.65 $1.50 25.4 2.00 26.0$ $650 20.7$ $40.650 20.7$ $650 20.7$ $40.650 20.0116$ $0000 11.6$ $0000 11.6$ $0000 6.96$ $0000 11.6$ $0000 6.96$ $0000 11.6$ $0000 6.96$ $0000 11.6$ $0000 6.96$ $0000 11.6$ $0000 11.2$ $0000 11.2.7$ $0000 6.96$ $0000 11.6$ $0000 11.2 - 2000 20.4 - 8000 11.2 - 2000 21.2 - 2000 21.2 - 2000 21.2 - 2000 21.2 - 2000 21.2 - 2000 21.2 - 2000 21.2 - 2000 21.2 - 2000 22.2 - 2000 21.2 - 2000 21.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 22.2 - 2000 25.$			•550 19•9	• 700 22•5	•900 24•3	1.00 25.1	1.00 25.7	
xD =30. $650 \ 20.67$ $40.650 \ -60.67$ $45.6 \ -50.60.756 \ -50.60.$. e600 20e5			1.50 25.4	2.00 26.0	
XD 30_{0} 35_{0} 40_{0} 45_{0} 50_{0} 55_{0} 60_{0} 000 6.48 000 8.05 000 11.6 000 14.6 000 14.6 000 0100 6.96 0100 8.05 0100 10_{0} 3.200 12.6 2000 14.65 2200 0200 8.68 0200 9.75 0200 12.7 6000 17.6 6000 17.6 0300 11.62 0300 11.8 0300 12.7 6000 17.6 6000 17.6 0400 14.61 0400 14.67 0800 27.6 8000 21.9 1000 21.9 0600 20.7 6000 19.9 6000 17.6 6000 17.6 6000 17.6 0800 24.61 18.00 23.6 1000 24.67 1.200 24.62 1.600 21.9 1.000 2600 24.61 1.600 24.67 1.200 24.62 1.600 21.60 21.600 21.600 2.000 24.61 1.600 24.67 1.200 24.62 1.600 21.600 21.600 22.600 2.000 24.61 1.600 24.67 1.600 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.00 25.9 <			e650 20e7					
•000 6.48 •000 8.43 •100 9.95 •000 13.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 14.6 •000 15.6 •200 15.6 •200 15.6 •200 15.6 •000 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 17.6 •600 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 •800 19.7 10.0 21.6 10.0 21.6 10.0	Subsequences of the second s second second sec second second s second second s second second se	XD =30.	35 e	40.	45 e	50.	55e	60.
•100 6.96 •100 8.43 •100 10.3 *200 12.4 •200 13.5 •200 14.5 •200 15.5 •400 15.5 100 21.5 100 21.5 100 21.5 100 21.5 100 21.5 10.0 21.5 10.0 21.5 10.5		•000 6.48	•000 8•05	•000 9 •95	•000 11•6	•000 13.0	•000 14•0	•000 14.9
-200 8-68 -200 9-75 -200 11-3 -400 15-0 -400 15-5 -400 17-4 -600 11-4 -600 11-6 11-60 21-4 11-60 21-4 11-60 21-4 11-60 24-4 11-60 24-4 11-60 24-4 11-60 24-4 11-60 24-4 1-60 <td>, and a set of the set</td> <td>•100 6.96</td> <td>•100 8•43</td> <td>•100 10•3</td> <td>•200 12•4</td> <td>•200 13.5</td> <td>•200 14•5</td> <td>•200 15•2</td>	, and a set of the set	•100 6.96	•100 8•43	•100 10•3	•200 12•4	•200 13.5	•200 14•5	•200 15•2
•300 11.02 •300 12.0 7.600 18.1 •600 17.6 •600 17.4 •600 19.7 •400 14.1 •400 14.4 •400 14.6 800 21.6 800 20.4 800 19.7 800 19.1 •600 20.7 •600 19.9 •600 19.1 1.000 23.8 1.000 21.9 2.000 25.9 2.000 25.0 2.000 25.9 2.000 25.9 2.000 25.9 </td <td></td> <td>•200 8•68</td> <td>•200 9•75</td> <td>•200 11.3</td> <td>•400 14•7</td> <td>•400 15.0</td> <td>•400 I5•5</td> <td>•400 15.9</td>		•200 8•68	•200 9•75	•200 11.3	•400 14•7	•400 15.0	•400 I5•5	•400 15.9
•400 14•1 •400 14•4 •400 14•7 •800 21•6 •800 20•4 •800 19•7 •800 19 •800 21•9 100 21• •600 20•7 •600 19•9 •600 19•1 1•00 23•7 1•00 21•9 1•00 21• •800 24•1 •800 23•5 1•00 24•2 1•20 23•7 1•20 23•7 1•20 23•7 1•20 23•7 1•20 24•2 1•20 23•7 1•20 24•2 1•20 23•7 1•20 23•7 1•20 23•7 1•20 23•7 1•20 23•7 1•20 23•7 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1•20 24•1 1±60 24•1 1±60 24•1 1±60 24•1 1±60 24•1 1±60 24•1 25±0 2±60 2±60 2±		•300 11.2	•300 11.8	• 300 12•7	•600 18•1	• 600 17.6	•600 17•4	•600 17.4
•600 20.7 •600 19.9 •600 19.1 1.00 23.7 1.00 22.8 1.00 21.9 1.00 23.1 •800 24.1 800 22.7 1.20 24.7 1.20 24.2 1.20 23.7 1.20 24.4 1.000 24.9 1.000 24.6 2.000 25.6 2.000 25.5 1.600 24.4 2.000 25.7 1.200 24.6 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.000 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 2.600 25.9 3.600 25.9 3.600 25.9 4.000 26.0 2.600 25.9 4.000 26.9 4.000 26.9 4.000 26.9 4.000 26.9 4.000 26.9 4.000 26.9 4.000 26.0 2.600 27.6 4.00		•400 14.1	•400 14•4	•400 14•7	•800 21•6	• 800 20•4	•800 19•7	•800 19•4
•800 24•1 •800 23•6 •800 22•7 1.20 24•7 1.20 24•2 1.20 25•0 1.60 24•8 1.00 24•8 1.00 24•9 1.00 24•5 2•00 25•6 2•00 25•9 2·00 25•2 2·00 25•2 2.00 25•7 1.60 25•6 3•00 25•9 3·00 25•9 2·00 25•3 2·00 25•2 2·00 25•2 2.00 25•7 1.60 25•9 1.60 25•9 3·00 25•9 2·00 25•3 2·00 25•3 2.00 26•0 2.00 25•9 3·00 25•9 3·00 25•3 3·00 25•3 3·00 25•3 5.00 27•5 2·00 27•5 3·00 27•5 3·00 25•3 3·00 25•3 3·00 25•3	de) ∖arrent debrenens de son thin agen, tenden by debre by ordering a son tenden son and son to some	•600 20.7	•600 19•9	•600 19•1	1.00 23.7	1.00 22.8	1.00 21.9	1.00 21.3
1.00 24.6 1.00 24.9 1.00 24.5 2.00 25.6 2.00 25.5 1.60 24. 2.00 25.7 1.60 25.7 1.60 25.5 2.00 25.9 2.00 25.2 2.00 25.5 2.00 25.5 2.00 25.5 2.00 25.5 2.00 25.5 2.00 25.5 2.50 25.5 <	•	•800 24•1	•800 23•6	.800 22.7	1.20 24.7	1.20 24.2	120 23.7	1.20 23.0
2.00 25.7 1.60 25.6 3.00 25.9 2.00 25.2 2.00 25.5 2.00 26.0 2.00 25.9 4.00 26.9 3.00 25.9 2.50 25.0 2.00 26.0 2.00 25.9 4.00 26.9 3.00 25.9 2.50 25.0 2.00 26.0 2.00 25.9 5.00 27.5 3.00 25.0 5.00 27.6 4.00 26.0 27.6 4.00 26.0 2.00 27.6 27.6 2.00 27.6 2.00 25.0		1.00 24.8	1.00 24.9	1.00 24.5	2.00 25.6	2.00 25.5	1.60 25.0	1.60 24.9
2.00 26.0 2.00 25.9 2.50 25.0 5.00 27.5 3.00 25. 6.00 27.6 4.00 26. 5.00 27.6 4.00 26.		2.00 25.7	1.60 25.7	1.60 25.6	3.00 25.9	3.00 25.9	2.00 25.2	2.00 25.3
5.00 27.5 3.00 25. 6.00 27.6 4.00 26. 5.00 27.			2.00 26.0	2.00 25.9		4.00 26.9	3.00 25.9	2.50 25.6
6.00 27.6 4.00 26. 5.00 27.		-				5.00 27.5		3.00 25.8
5.00 27.		and an and a second				6.00 27.6		4.00 26.5
	•							5.00 27.1

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PPCE=21.4 2 PPCE=21.4 2 XD =3. XD =3. 000 1.22 000 1.22 050 1.32 0100 1.62 050 1.32 050 1.52 050 1.52 000 1.52 000 1.52 000 1.52 000 1.52 000 1.52 000 1.52 000000000000000000000000000000000000	•942 •999 1	0. 15. 20	1. 25. 30.	35. 40.	45. 50.	55. 60.
PPCE=21.44 2 XD =3. YD P1T0 •000 1.22 •050 1.32 •150 2.44 •250 3.55 •250 5.28 •250 7.61 •250 7.61			08 1.07 1.0	5 1.04 1.03	1.01 1.01	1.01 1.02
XD #3. YD PITO •000 1.22 •050 1.32 •100 1.62 •150 2.44 •200 3.55 •250 5.28 •250 7.61	2202 2304 2	97 6967 11963	•07 6•07 0•0	0.07 0.07 6	7007 CO07	
YD P170 •000 1-22 •050 1-32 •100 1-62 •150 2-44 •200 3-55 •250 5-28 •300 7-61	5 9	7.	10.	15.	20.	25.
•000 1•22 •050 1•32 •100 1•62 •150 2•44 •250 3•55 •250 5•28 •250 7•61	YD PITO	YD P170	YD PITO	YD PITO	YD PITO	YD PITO
•050 1•32 •100 1•62 •150 2•44 •200 3•55 •250 5•28 •300 7•61	•000 2 •02	•000 2•52	••000 3.22	.000 4.21		•000 6•62
•100 1.62 •150 2.44 •200 3.55 •250 5.28 •300 7.61	•050 2•12	•050 2•63	•050 3•32	•050 4•31	•050 5•36	•100 7•60
• 150 2•44 • 200 3•55 • 250 5•28 • 300 7•61	•100 2•53	•100 3•23	«100 3.93	•100 4•91	•100 5.96	•200 9•93
•200 3•55 •250 5•28 •300 7•61	e150 3.54	•150 4•24	•150 4.83	•150 5•81	•150 6•95	•300 13•6
•250 5•28 •300 7•61	•200 5•06	•200 5•96 [,]	•2nn 6•54	•200 7•51	•200 8•64	•400 17.8
•300 7.61	• 250 7.79	•250 9•09	•250 9•36	•250 10•1	•250 10•9	•500 21•9
	•300 11•3	•300 12•8	•300 13•3	•300 13.4	•300 13•4	•600 24•0
COULUCEO	•350 15•5	•350 16•9	•350 17•6	•350 17.0	•350 16•5	•700 25•0
6400 14.4	•400 18•4	•400 20•5	.400 20°7	•400 20°5	•400 19•9	•800 25•4
e425 15e9	•450 20•2	•450 22•1	•450 22 •6	•450 22°5	•500 23•5	1.00 25.8
	•500 20.8	•500 22•9	•500 23•7	• 500 23 • 7	•600 24•8	1.40 26.2
n an	•550 21.00	•600 23•4	•600 24•6	•600 24.7	•700 25•3	2.00 26.5
	•575 21•2		•700 24 •9	•700 25 •1	800 25.6	
			•800 25•0	•800 25°4	1.00 25.9	
				1•00 25•7	1.60 26.8	
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			37	22	2	50.5
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•500 20•2	•600 21•4	800 23	1.00 24.l	1.00 23.0	1.00 22.2	1.00 Z1.8
•600 22•7	•800 24•3	1.00 25.0	1.20 25.2	1.20 24.7	1.20 23.9	1.20 23.5
•700 24•3	1.00 25.6	1.40 26.2	1.40 25.7	1.40 25.7	1.40 25.0	1.40 24.8
800 25.1	1.40 26.2	2.00 26.6	2.00 26.0	2•00 25•9	2.00 25.9	2.00 25.8
1.00 25.7	2.00 26.4	3.00 26.8	3.00 26.5	3.00 26.4	3.00 26.4	3.00 26.3
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PPCCE=19:0 71:0 YD <th>,</th> <th>×1/ - 76</th> <th></th> <th>100 170 21</th> <th></th> <th>· · · · · · · · · · · · · · · · · · ·</th> <th>42. 50.</th> <th>55• 60•</th>	,	×1/ - 76		100 170 21		· · · · · · · · · · · · · · · · · · ·	42. 50.	55 • 60•
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8000 65-30 1.001 9943 8000 65-30 1000 65-30 1000 65-30 1000 65-30 1000 65-30 1000 65-30 1000 65-30 1000 65-30 1500 1001 1000 10-97 1500 10-97 <td></td> <td>•9000</td> <td>66.80</td> <td>1.000</td> <td>.9931</td> <td>• 9000</td> <td>66.00</td> <td>1.000</td> <td>•9889</td> <td>1.000</td> <td>55°93</td> <td>1.000</td> <td>.9862</td>		•9000	66.80	1.000	.9931	• 9000	66.00	1.000	•9889	1.000	55°93	1.000	.9862
• 7500 64+50 1*001 • 7000 56.00 1*001 1*001 5750 58.94 1* • 7000 62*50 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*001 1*011 0*010 0*591 1*011 0*011		e8000	65 a 30	1.000	e9943	• 8000	62°00	1.000	• 9922	• 0000	53.94	1.000	.9879
 *7500 62.57 1.000 *7500 52.50 1.000 *6750 61.001 *6750 44.001 *017 *6750 44.001 *017 *6750 44.001 *017 *6750 44.00 *017 *6190 14.00 *914 *5191 12.00 *914 *5150 5.500 5.970 *9151 65.97 *9161 5.970 5.519 5.500 5.970 *9151 65.97 7.992 1. *5500 5.000 *970 15.998 9 *5700 5.971 1.000 *9179 66.800 1.000 2.554 7.900 *9290 5.554 1.500 5.564 1. *1900 65.77 1.000 *971 1.000 *970 1.000 *971 1.000 <		•7500	64.50	1.000	• 9950	• 7000	56.00	1.000	•9973	.8000	50.94	1.000	• 9903
<pre>6676 61:00 1:000 9778 6550 47:00 1:017 9754 6:700 4:95 1: 66570 59:50 1:017 9744 5:757 9:800 9:8157 6:500 2:98 1: 66150 44:00 1:017 9744 5:550 9:800 9:8150 6:570 7:992 1: 66150 44:00 1:017 9:974 5:500 1:990 9:978 6:575 7:592 1: 65250 3:150 9:973 6:598 4:700 1:050 9:978 6:554 5:555 1:550 7:992 1: 65250 3:150 9:509 6:591 5:500 1:990 9:9179 6:505 5:554 5:557 1:998 9: 65250 3:150 9:509 6:591 5:500 1:990 9:9179 6:505 5:554 5:557 1:998 9: 65250 3:150 9:509 5:538 4:700 1:050 9:9179 6:505 5:554 5:557 1:959 65000 1:600 8:930 5:538 4:700 1:050 9:9179 6:505 3:544 9: 1=100 67.07 1:000 9730 1:930 6:680 1:000 9:941 1:550 6:644 1: 1=100 67.07 1:000 9730 1:200 5:941 1:500 5:44 1: 1=000 5:071 1:000 9730 1:200 5:951 1:000 9:951 1:500 5:44 1: 1=000 5:071 1:000 9:921 1:000 9:951 1:000 9:951 1:500 5:44 1: 8500 5:071 1:000 9:921 1:000 9:51 1:000 9:951 1:000 1:569 1: 6500 5:071 1:000 9:827 1:000 9:51 1:000 9:51 1:000 1:500 5:44 1: 8500 5:44 1:000 9:827 1:000 9:51 1:000 9:51 1:000 1:500 1:569 1: 8500 5:451 1:000 9:921 1:000 9:57 1:000 2:521 1: 8500 5:44 1:000 0:000 1:501 1:000 9:55 1:000 0:000 2:051 1: 8500 2:051 1:000 0:091 1:000 0:0951 1:000 0:0521 1: 8500 2:051 1:000 0:001 1:011 0:000 9:57 1:000 0:0521 1:000 0:0521 1: 8500 2:051 1:000 0:051 1:000 0:091 1:000 0:051 1:000 0:0521 1: 8500 1:057 0:058 0:010 1:051 0:001 0:051 1:000 0:0521 1: 8500 1:057 0:058 0:010 1:021 0:000 0:0521 0:000 0:052 1:000 0:0521 1: 8500 1:057 0:058 0:081 0:001 0:011 0:012 0:053 0:000 0:001 0:051 1:000 0:0521 0: 8500 1:057 0:051 0:001 0:021 0:010 0:052 0:081 0:000 0:0521 0: 8250 1:0417 0:057 0:098 0:000 0:001 0:011 0:010 0:051 1:000 0:0521 0: 8250 0:010 1:057 0:058 0:081 0:000 0:021 0:011 0:051 0:021</pre>		•7000	62.50	1.000	• 9966	•6750	53.0n	1.000	1.000	.7500	58.94	1.000	•9921
<pre>66500 58.50 1.000 1.000 6.750 33.00 1.017 9593 6.750 21.95 12.97 1. 66150 44.00 1.0017 9.744 6.5500 9.800 9826 8517 6.592 1.598 1. 65150 12.50 9204 6.977 5.910 1.500 1.990 6.905 5.550 4.4750 15.98 1. 55500 1.600 8931 5.538 6.4700 1.015 0.9005 5.554 5.550 3.546 9 55000 1.600 8931 5.538 6.4700 1.015 0.9005 5.554 5.520 3.546 9 55000 1.600 8931 5.538 6.4700 1.015 0.9005 5.554 5.520 3.546 9 5500 1.600 8931 5.538 6.4700 1.015 0.9005 5.554 5.520 3.546 9 5000 1.600 8931 5.538 6.4700 1.015 0.9005 5.554 5.520 3.546 9 5000 1.600 8931 5.538 6.4700 1.015 0.9005 5.554 5.520 3.546 9 5000 1.600 8931 1.600 9971 1.600 9444 1.550 65.04 1. 1.0100 65.077 1.000 9771 1.000 9444 1.550 65.04 1. 1.0100 65.077 1.000 9771 1.000 9491 1.550 65.04 1. 1.0100 65.077 1.000 9771 1.000 9947 1.550 65.04 1. 80500 63.077 1.000 9771 1.000 9947 1.550 65.04 1. 80500 63.077 1.000 9771 1.000 9947 1.550 65.04 1. 80500 63.077 1.000 9771 1.000 9947 1.550 65.04 1. 80500 64.1 1.000 9771 1.000 9947 1.550 65.04 1. 80500 64.1 1.000 9771 1.000 9971 1.000 9487 1.550 65.04 1. 80500 64.1 1.000 9771 1.000 9757 1.000 9487 1.550 65.04 1. 80500 54.59 1.000 9927 1.000 9957 1.000 29.57 1.000 29.57 1. 80500 54.59 1.000 9967 1.000 29.51 1.000 29.51 1.000 29.51 1. 80500 54.59 1.0017 8878 6.600 1.5.27 1.000 29.57 1.000 29.57 1. 80500 1.647 9.576 5.590 5.272 1.015 9134 4.500 5.813 4.450 1.569 1. 80500 1.647 9.576 5.8081 5.500 5.231 1.000 29.51 1.000 29.51 1. 80500 1.847 9.576 5.8081 5.500 2.331 1.0017 8888 3.400 2.632 1. 80500 1.847 9.577 6.516 3.300 2.631 1.001 2.631 1. 82500 1.841 907 8.516 8.300 2.641 1.0017 8.818 3.3400 2.632 1. 82500 1.841 907 8.516 8.300 2.631 1.001 8.921 4.500 2.043 2.612 1. 82500 1.841 907 8.516 8.530 8.081 1.0017 8.818 3.3400 2.632 1. 82500 1.841 907 8.516 8.516 8.300 1.0017 8.818 3.3400 2.632 1. 82500 1.841 9.977 6.516 8.300 2.041 1.0017 8.818 3.3400 2.632 1. 82500 1.841 9.977 6.516 8.300 2.041 1.0017 8.280 2.040 2.612 1. 8250 8.546 8.900 1.0492 8.554 8.2750 2.2200 9.778 8.778 8.718 1. 82750 8.9403 8.554 8.2750 2</pre>	and a state of the second s	e6750	61.00	1.000	• 9978	e500	47.00	1.007	•9724	• 1000	49.95	1.000	1.000
•6250 49.00 1.015 .9750 5.600 5.750 2.998 1 •5500 5.500 5.300 .9776 5.550 5.550 7.992 1 •5500 5.500 5.300 .9776 .5000 1976 .5000 1976 .5000 1992 1 •5000 12.600 .8930 .5538 .4700 1.600 .5970 9 .5970 9 •5000 16.600 .8931 .5538 .4700 1.605 .5500 .5554 .5557 .5570 .4992 1 •5000 16.600 .8931 .5538 .4700 1.605 .5500 .5554 .5557 .5570 .5571 .5970 .998 .5597 .9 .5597 .9 .4250 1.577 .9 .4250 1.577 .9 .4250 1.577 .9 .4250 1.577 .9 .4250 1.577 .9 .4250 1.577 .5 .5574 .5576 .5641 1.5 .5554 .5554 .5556 .5556 .5556 .5560 <		•6500	58.50	1.000	1.000	e6250	33•00	1.017	•9593	• 6750 4	41.96	1.002	.9836
•6150 44.00 1.017 9774 6550 5500 5550		•6250	49.00	1.015	•9661	•6150	26.00	1.017	•9279	.6500	76.62	1.012	.9739
•5750 12.50 •9715 •9161 •5500 •500 15.93 15.90 15.93 15.90 15.90 15.93 15.90 15.97 19.99 15.90 15.90 15.91 19.99 15.90 15.91 19.99 15.90 15.91 15.90 15.94 9 15.90 15.91 15.90 15.94 9 15.90 15.94 15.90 15.94 15.94 9 15.90 15.94 15.94 15.94 15.94 15.94 15.94 15.96 15.96 15.95 15.95 15.95 15.95 15.95 15.95 15.95 15.95 16.95 15.95 16.95 16.95 16.95 16.95 16.95 16.95 16.95 16.95 16.95 15.95 16.95 16.95 16.95 16.95 16.95 16.95 16.95 16.95 16.95		•6150	44.00	1.017	•9774	e5750	9.800	e9826	.8517	.6250	20.98	1.017	• 9805
•5500 6.000 •9453 •8086 •5250 •5750 7.992 1 •5250 3.150 •9301 •5000 1.900 9179 •5554 •597 9 •5000 1.600 •8931 •5000 1.904 •931 •5000 2.9554 •597 9 •5000 1.600 •8931 •5000 1.600 •9130 •5538 •4701 1.000 •4750 1.998 9 •5000 1.601 •701 •701 •711 •750 •5541 •4750 1.958 •471 1.958 •		e5750	12.50	•9776	•9161	•5500	5.300	.9577	•8150	.6100	15.98	1.020	.9817
•5250 3•150 9204 6597 5564 5554 55560 3•566 597 9 •5000 1•600 8930 5538 44700 1050 5554 -5500 2•597 9 •5000 1•600 8930 5538 44700 1056 4550 1.0548 9 •5000 6700 10 9716 1.375 6777 1.000 9448 1.550 66.04 1.5 1al90 65.01 1000 9731 1.000 9731 1.000 9744 1.550 66.04 1.5 1al00 65.41 1.000 9731 1.000 9731 1.000 9744 1.5 1al00 65.41 1.000 9963 1.6400 65.45 1.000 9744 1.5 1al00 65.41 1.000 9971 1.000 9974 1.1 1.000 9744 1.5 1.600 2.5 1.6 1.1 1.0 1.5 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0		•5500	6+000	.9453	•8086	•5250	3.200	•9378	•7705	.5750	7.992	1.010	• 9466
•5000 1.600 .8930 .5038 .4700 1.050 .5500 2.557 .9 *4750 1.591 .5000 2.557 .5000 2.557 .9 *4750 1.500 .5531 .5100 .5591 .598 .9 *4750 1.500 .517 .500 2.557 .5	and the second se	•5250	3.150	•920 4	•6997	• 5000	1°900	e119e	•6805	.5500 4	4 • 895	1.000	.9157
*5000 2.597 *4750 1.598 *4750 1.598 *4750 1.598 *4750 1.598 *4750 1.598 *4750 1.598 *4750 1.597 *4750 1.597 *4750 1.597 *4750 1.597 *4750 1.597 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *4750 1.576 *476 1.600 *476 1.600 *476 1.600 *476 1.600 *476 1.570 *476 1.600 *476 1.600 *470 1.570 *470 1.570 *470 1.570 *470 1.570 *470		•5000	1.600	.8930	•5638	•4700	1.050	e9005	•5554	•5250	3.546	•9876	.8881
•4750 1.998 •9 •4500 1.548 •9 •4500 1.548 •9 •4500 1.548 •9 •4500 1.548 •9 •5 •5 1.000 •9716 1.375 67.71 1.000 •9444 1.550 66.04 1. 1.000 65.17 1.000 •9730 1.8200 65.901 1.900 9444 1.501 1.0000 66.17 1.000 •9730 1.8200 65.901 1.900 9446 1. 0.0000 65.17 1.000 9771 1.600 9447 1.000 9446 1. 0.9000 65.17 1.000 9771 1.600 9574 1.000 9747 1. 0.9000 65.41 1.000 9921 1.000 9974 1.000 9771 1. 9000 9744 1. 1. 1.000 9774 1.000 9774 1.000 9774 1.000 9767 1.000 9764 1.000 9764 1.0000 9769 1.0000 <td>and a second second</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>.5000</td> <td>2.597</td> <td>.9751</td> <td>.8827</td>	and a second	1								.5000	2.597	.9751	.8827
XD= 5 1 XD= 5 1 XD= 5 1 1-190 68-06 1-000 9716 1-375 67-70 1-570 65-04 1-570 1-100 67-07 1-000 9771 1-000 6973 1-500 65-64 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>No. of Concession, Name of Street, or Stre</td><td></td><td>.4750</td><td>1.998</td><td>• 9652</td><td>.8114</td></t<>								No. of Concession, Name of Street, or Stre		.4750	1.998	• 9652	.8114
XD= 5 1 1 XD= 5 1 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>- 4500</td> <td>1.548</td> <td>.9527</td> <td>.7450</td>										- 4500	1.548	.9527	.7450
XD= •5 1 1 XD= •5 1										4 26.0	270	90.20	1007
101 1				-			-				•		
1.190 68.05 1.000 9716 1.375 67.07 1.000 95.44 1.550 65.64 1.400 65.64 1.400 65.64 1.400 65.64 1.400 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.600 65.64 1.717 1.001 711 1.600 65.64 1.600 774 1.610 47.17 1. 717 1.600 56.90 1.600 55.69 1.600 55.69 1.600 55.69 1.600 55.69 1.717 1.71 1.71 1.71 1.600 56.90 1.600 27.69 1.600 27.64 1.600 27.64 1.600 27.64 1.600 27.64 1.600 27.64 1.600 27.64 1.717 1.717 1.717 1.600 27.64 1.600 27.64 1.600 27.64 1.600 27.64 1.600		AU=		n i			- 	9			-	•	
1•100 67-07 1.000 65-84 1. 5000 55-84 1. 1•000 65-17 1.000 9730 1.200 65-64 1. 0 9000 53-71 1.000 9771 1.200 65-64 1. 0 8500 54-59 1.000 9771 1.005 56-90 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1. 1.000 55-64 1.000 55-64 1.000 55-64 1.000 55-64 1.000 55-64 1.000 55-64 1.00		1e190	68°06	1.000	•9716	1.375	67°10	1.000	•9484	1.550 (56.04	1.000	• 9393
1+000 66±17 1+000 9730 1+200 65+91 1+400 65-64 1 0 000 63+77 1+000 9750 1+100 63-91 1+000 65-64 1 0 000 63+77 1+000 9770 1+100 63-64 1 300 65-690 1 1 200 56-90 1		1°100	67.07	1.000	•9723	1.300	66 . 80	1.000	•9491	1.500 6	55 . 84	1.000	•9395
•9000 63•77 1.000 9770 1.000 63.91 1.000 9535 1.200 56.90 1 •8500 61.818 1000 9827 1.000 9574 1.100 67.01 1 •8500 54.65 1.000 9827 1.000 56.45 1.000 37.44 1 •7600 46.41 1.000 9901 9900 43.11 1.000 9927 9000 37.44 1 •7600 46.41 1.000 9901 9900 43.11 1.000 29.20 1 •7600 46.41 1.000 9901 0.9901 9900 21.6107 20.00 37.44 1 •5700 36.44 1.000 9901 1.000 9967 8000 21.617 10.00 21.617 10.00 21.617 10.6		1.000	66e17	1.000	•9730	1.200	65°90	1.000	•9498	1.400 6	55.64	1.000	.9397
8500 61.8 1 .000 9771 1 .050 61.2 1 .000 55.90 1 .200 55.90 1 .100 47.17 1 .100 47.117 1 .100 47.111 1 .100 1 .100	-	°9000	63 . 77	1.000	•9750	1.100	63.91	1.000	•9514	1.300 €	53.46	1.000	•9414
<pre> •8000 54•59 1.000 9927 1.000 56.45 1.000 0.9574 1.00 47.17 1. •7600 46.41 1.000 9901 .9900 43.11 1.000 9967 9000 27.44 1. •7200 36.43 1.001 1.000 .9901 .9000 29.11 1.000 0.9827 9000 29.20 1. •5500 17.17 1.012 9738 .7000 19.11 1.000 0.9967 8000 21.85 1. •5500 4.990 1.017 8878 .6800 16.92 1.007 0.9385 .6100 10.63 1. •5500 2.144 0.077 8455 .5500 0.577 0.077 0.9385 .6100 10.663 1. •5500 2.144 0.077 8455 .5500 0.272 1.017 0.9383 .4000 37.31 1.025 9831 .4500 5.809 1. •5000 3.094 1.017 8455 .5500 4.231 1.0.07 0.9385 .6100 10.65 1. •5000 3.094 1.007 8455 .5500 4.231 1.027 8863 .4000 3.327 1. •4000 1.597 9976 .781 .4500 3.033 1.0027 8863 .4000 3.9327 1. •3750 1.6417 9972 .6987 .3750 2.111 1.027 8863 .3400 2.633 1. •3250 1.347 9652 .6987 .3750 2.111 1.027 8838 .3400 2.631 1. •3250 1.277 9577 6.616 .3300 1.891 1.017 8283 .3400 2.631 1. •3250 1.277 9577 6.615 .3300 2.041 1.005 7756 .2850 4.667 1. •2750 .9481 .9403 .5554 .2750 2.014 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.014 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.014 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.014 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.014 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.014 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 1.005 7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 .0055 .7756 .2850 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 .0952 .7138 .2750 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 .0055 .7138 .2750 4.661 1. •2750 .9481 .9403 .5554 .2750 2.024 .0055 .7138 .2750 4.661 1. •2760 .9481 .9403 .5554 .2755 .2920 .9922 .7138 .2750 4.661 1. •2750 .9481 .9403 .5554 .2750 2.920 .9922 .7138 .2750 4.661 1. •2760 .9481 .9403 .5554 .2755 .2920 .9922 .7138 .2750 4.661 1. •2760 .9481 .9403 .5554 .2750 2.920 .9922 .7138 .2750 4.661 1. •2760 .9480 .9922 .718 .9922 .718 .2750 .9922 .718 .2750 4.661 1. •2776 .2750 .</pre>	-	e8500	61.18	1.000	•9771	1.050	61 . 22	1.000	e9535	1.200 5	56.90	1.000	• 9466
•7600 46.41 1.000 9901 6900 43.11 1.000 97.44 1. •7200 36.43 1.000 1.000 8000 30.16 1.000 9827 9900 29.20 1. •5500 17.17 1.012 9738 *7000 19.11 1.000 9967 8000 21.685 1. •5500 4.990 1.0017 8878 *6000 9.557 1.0007 *9385 6100 10.663 1. •5500 3.094 1.0017 8878 *6000 9.557 1.0017 *9385 5100 10.663 1. •5000 3.094 1.0017 8878 *6000 4.531 1.0027 93831 4.500 5.803 1. 4.500 5.803 1. 4.500 5.803 1. 4.500 5.803 1. 4.500 5.803 1. 5.500 1. 5.500 1. 5.500 5.833 1. 5.500 5.803 1. 5.500 5.833 1.000 5.803 1.5 7.500 1. 5.563 <	-	e8000	54.59	1.000	•9827	1.000	56.45	1.000	°9574	1.100 4	47.17	1.000	•9550
<pre>~7200 36.43 1.000 1.000 .8000 30.16 1.000 .9827 .9000 29.20 1.</pre>		e7600	46.41	1.000	1066.	• 9000	43 ° 11	1.000	•9693	1.000	37.44	1.000	•9643
•6500 17.17 1.012 9738 *7000 19.11 1.000 9967 8000 21.85 1. •5900 8.084 1.022 9082 .6800 16.92 1.000 .7000 15.65 1. •5500 4.990 1.017 .8878 .6000 9.557 1.007 .9385 .6100 10.653 1. •5500 3.094 1.0017 .8878 .6000 9.557 1.017 .9878 .6000 5.809 1. •5000 3.094 1.0017 .88455 .5500 4.231 1.077 .99134 .4500 3.327 1. •4000 1.5597 .9776 7801 .4500 3.336 1.0027 .8863 .44000 3.327 1. •3750 1.6417 .9726 .7331 1.0277 .8863 .3400 2.6781 1.8 .3600 2.6781 1.8 .3600 2.6781 1.8 .3600 2.6781 1.8 .3600 2.6781 1.8 .3750 2.8 .3756 .2751 .8 .3756		e7200	36.43	1.000	1.000	• 8000	30°16	1.000	•9827	• 9000	29°20	1.000	.9732
•5900 8.084 1.022 9982 66800 16.92 1.000 1.000 7000 15.69 1 •5500 4.990 1.017 8878 .6000 9.557 1.007 .9385 .6100 10.653 1 •5000 3.094 1.0017 .8875 .5500 6.272 1.015 .9134 .5000 5.809 1 •5000 3.094 1.0017 .8455 .5500 6.272 1.015 .9134 .5000 5.809 1 •4500 2.0146 .9925 8081 .5000 4.231 1.0027 .8831 .4500 3.327 1 •4000 1.597 .9776 .7331 .4500 2.339 1.0027 .8643 .4000 2.781 1 1 1 1 1 1 .9727 1 1 .8577 1 1 .8607 2.6532 1 1 1 1 .8700 2.6532 1 1 1 .8700 2.6532 1 1 .82750 2.850 4.6657 1 <	-	•6500	17.17	1.012	•9738	• 7000	19.11	1.000	•9967	.8000	21.85	1.000	•9822
•5500 4.990 1.0017 8878 .6000 9.557 1.0017 .9385 .6100 10.653 1 •5000 3.094 1.0017 .8455 .5500 6.272 1.015 .9134 .5000 5.809 1 •4500 2.0146 .9925 .8081 .5500 4.231 1.072 .8831 .44500 4.320 1 •4000 1.557 .9776 .7871 .4500 3.036 1.077 .8663 .4000 3.327 1 •3750 1.417 .9726 .7331 .4500 2.339 1.077 .8643 .4000 3.327 1 •3750 1.417 .9726 .7331 .4000 2.339 1.077 .86487 .3600 2.6532 1 •3250 1.6417 .9726 .7331 .4000 2.6111 1.027 .88487 .3400 2.6532 1 •3250 1.6717 .9577 .6616 .3300 1.8911 1.077 .8283 .3400 2.6532 1 .6677 1 .6616	-	•5900	8°084	1.022	• 9082	•6800	16.92	1.000	1.000	.7000	15.69	1.000	•9911
<pre> •\$700 3.094 1.007 8455 .5500 6.272 1.015 .9134 .5000 5.809 1. •\$500 2.146 .9925 8081 .5000 4.231 1.025 .8831 .4500 4.320 1. •\$700 1.597 .9776 .7871 .4500 3.036 1.077 .8663 .4000 3.327 1. •3750 1.417 .9726 .7331 .4000 2.339 1.077 .86487 .3600 2.781 1. •3750 1.417 .9577 .6616 .3300 1.891 1.017 .8283 .3000 3.972 1. •3250 1.277 .9577 .6616 .3300 1.891 1.017 .8283 .3000 3.972 1. •2750 .9481 .9403 .5554 .2750 2.041 1.005 .7756 .2850 4.667 1. •2750 .9481 .9403 .5554 .2750 2.320 .9925 .7138 .2750 4.6618 1. </pre>	 A för Atten Möhnland och mit för Verbland måre skyrningener i mannander i men att som etter som etter	e5500	4.990	1.017	.8878	•6000	9.557	1.007	e9385	•6100 1	10.63	1.000	1.000
•4500 2-146 -9925 -8081 -5000 4-231 1+0.25 -8831 -4500 3-327 1 •4000 1-597 -9776 -7871 -4500 3-036 1+0.27 -8663 -4000 3-327 1 •3750 1-417 -9726 -7331 -4000 2-339 1+0.027 -86487 -3600 2-781 1 •3500 1-447 -9726 -7331 -4000 2-339 1+0.027 -88487 -3600 2-6327 1 •3500 1-347 -9652 -6987 -3750 2-111 1-027 -8388 -3400 2-6532 1 •3250 1-277 -9577 -6616 -3300 1-891 1-002 -3756 -2850 4-6677 1 •3000 1-148 -9502 -6159 -3000 2-041 1-005 -7756 -2850 4-6677 1 •3000 1-148 -9554 -5554 -2750 2-9525 -9128 2750 4-6618 1	-	•5000	3.094	1.007	•8455	e5500	6.272	1.015	e9134	• 5000	608°:	1.015	•8906
<pre> #4000 1.557 .9776 .7871 .4500 3.036 1.027 .8663 .4000 3.327 1. .3750 1.4417 .9726 .7331 .4000 2.339 1.0030 .8487 .3600 2.781 1. .3500 1.347 .9652 .6987 .3750 2.111 1.027 .8388 .3400 2.653 1. .3250 1.277 .9577 .6616 .3300 1.891 1.017 .8283 .3000 3.972 1. .3200 1.148 .9502 .6159 .3000 2.041 1.005 .7756 .2850 4.667 1. .2750 .9481 .9403 .5554 .2750 2.320 .9925 .7138 .2750 4.6618 1. </pre>		•4500	2.146	•9925	•8081	•5000	4°231	1.025	e8831	.4500 4	4 a 3 2 0	1.025	.8769
•3750 1.4417 •9726 •7331 •4000 2.0339 1.6030 0.8487 0.3600 2.6781 1. •3500 1.347 9652 66987 .33750 2.0111 1.027 .8388 .3400 2.6532 1. •3250 1.277 .9577 .6616 .3300 1.891 1.017 .8283 .3000 3.972 1. •3000 1.148 .9502 .6159 .3000 2.041 1.005 .7756 .2850 4.6667 1. •2750 .9481 .9403 .5554 .2750 2.9320 .9925 .7138 .2750 4.6618 1.		000te	1.597	•9776	•7871	•4500	3.036	1.027	e8663	• • 0000	3.327	1.032	•8544
<pre> •3500 1.347 .9652 .6987 .3750 2.111 1.027 .8388 .3400 2.6632 1. •3250 1.277 .9577 .6616 .33300 1.891 1.017 .8283 .3000 3.972 1. •3000 1.148 .9502 .6159 .3000 2.041 1.005 .7756 .2850 4.667 1. •2750 .9481 .9403 .5554 .2750 2.320 .9925 .7138 .2750 4.618 1. </pre>)	e3750	1.417	•9726	.7331	•4000	2.3339	1.030	•8487	.3600 2	2.781	1.032	•8644
•3250 1•277 •9577 •6616 •3300 1•891 1•017 •8283 •3000 3•972 1• •3000 1•148 •9502 •6159 •3000 2•041 1•005 •7756 •2850 4•667 1• •2750 •9481 •9403 •5554 •2750 2•320 •9925 •7138 •2750 4•618 1•		e3500	1.347	•9652	•6987	•3750	2.111	1.027	•8388	. 3400 2	2.632	1.030	. 8443
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1.000 64.20 1.000 9915 1.005 64.20 1.000 9915 1.000 64.20 1.000 991 1.000 64.20 1.000 994 2.000 64.20 1.000 994 2.000 63.40 1.000 994 2.000 63.40 1.000 994 2.000 63.40 1.000 994 2.000 63.40 1.000 994 2.000 951 1.000 694 2.000 951 1.000 594 2.000 954 2.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.001 1.000 9515 1.000 9516 1.001 1	1.020	P110	TITTE UL	JE J	Id 0/	10 11	TTE U	UE	YD P110	111 (TE UUE
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<pre>*7000 66.30 1=000 =9947 *7000 56.30 1=000 =000 *7500 55.90 1=000 *9 *6300 5*70 1=000 =9947 *7000 =5950 1=010 *9 *6300 5*00 1=000 *550 2*00 1=010 *981 *700 55.90 1=010 *9 *5500 5*00 =500 1=000 *550 5*00 1=012 *0 *5500 5*00 *500 1=010 *500 *550 2*050 1=010 *0 *5500 5*000 9552 *7158 *5500 5*50 *950 *6516 *6500 1=010 *0 *5500 5*000 9552 *7158 *5500 5*50 *950 *6516 *6500 1=010 *0 *5500 5*000 9552 *7158 *5500 1=050 *550 2*000 1=010 *0 *5500 2*500 *9219 *500 *550 2*050 1=010 *0 *5500 2*000 *9219 *000 *010 1=750 *9512 *550 2*000 1=000 *0 *5500 2*000 *9210 *000 *9710 1=000 *922 *0 *250 2*370 5*00 *000 *9710 1=000 *948 1=500 4*00 *9751 *0 *250 2*000 5*00 1=000 *9710 1=000 *948 1=50 1=000 *923 *0 *250 2*00 1=000 *9710 1=000 *948 1=50 1=000 *923 *0 *250 1=000 *9710 1=000 *9710 1=000 *948 1=500 1=000 *923 *250 1=000 *9710 1=000 *9710 1=000 *948 1=500 1=000 *923 *250 1=000 *9710 1=000 *9710 1=000 *948 1=500 1=000 *92 *250 1=000 *9710 1=000 *9710 1=000 *948 1=500 1=000 *92 *250 1=000 *9710 1=000 *9710 1=000 *955 1=000 1=000 *9 *250 1=000 *9710 1=000 *9710 1=000 *955 1=000 *920 1=000 *9 *250 1=000 *9710 1=000 *9740 1=000 *965 1=000 *920 1=000 *9 *250 1=000 *9740 1=000 *9740 1=000 *955 1=000 *955 1=000 *920 1=000 *9 *250 1=000 *9740 1=000 *9740 1=000 *955 1=000 *950 1=000 *9 *250 1=000 *9740 1=000 *9740 1=000 *955 1=000 *950 1=000 *9 *250 1=000 *9740 1=000 *9740 1=000 *955 1=000 *950 1=000 *9 *250 1=000 *9740 1=000 *9740 1=000 *955 1=000 *950 1=000 *9 *250 1=000 *9740 1=000 *9740 1=000 *955 1=000 *970 1=000 *9 *250 1=000 *9740 1=000 *976 *000 1=000 *976 *000 1=000 *9 *250 1=000 *9740 1=000 *976 *000 1=000 *976 *000 1=000 *9 *250 1=000 *9910 *000 1=000 *975 *120 *000 1=000 *9 *250 1=000 *9740 1=000 *976 *000 1=000 *9 *250 1=000 1=010 *970 *000 1=000 *976 *000 1=000 *0 *2750 1=000 *974 *200 1=012 *000 2=000 *014 *000 2=000 1=000 *9 *2750 1=000 *970 *000 2=000 2=000 2=000 2=00 2=000 2=000 2=000 200 2</pre>	•8000	62.40	1.000 •95	929	8000 62	.40 l.	• 000	9929	• 9000 62•6	0 1.0	56 · 00
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•6300 54.00 1.000 65.00 1.000 55.00 1.000 55.00 1.000 <td< td=""><td>•6500</td><td>57.70</td><td>1.000 .95</td><td>968</td><td>6500 54</td><td>•00 1.</td><td>000</td><td>• 000</td><td>• 1500 59•5</td><td>0 1 0</td><td>56• 00</td></td<>	•6500	57.70	1.000 .95	968	6500 54	•00 1.	000	• 000	• 1500 59•5	0 1 0	56• 00
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•5250 2-376 -9279 -5444 -5750 1-550 <td< td=""><td>.5500</td><td>6.000</td><td>•9552 •71</td><td>158</td><td>•5500 4•</td><td>280 .9</td><td>. 101</td><td>7468</td><td>•6250 20•5</td><td>0 1.0</td><td>10 . 9</td></td<>	.5500	6.000	•9552 •71	158	•5500 4•	280 .9	. 101	7468	•6250 20•5	0 1.0	10 . 9
*500 1=750 1=750 1=750 1=750 1=750 1=750 1=750 1=751 3=400 99751 8 *500 *550 3=400 99751 8 5500 3=400 9952 7 *450 1=100 *9715 1=8 *4500 1=120 9300 9502 1 *450 1=000 *9715 1=355 64+20 1=000 9933 5 64+20 1=000 9933 5 64+20 1=000 9933 5 64+20 1=000 9933 5 64+20 1=000 9933 5 64+20 1=000 9933 5 5 5 1=000 9933 5 5 5 1=000 9933 5 5 1=000 96 1=000 9751 1=000 95 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751 1=000 9751<	.5250	2.350	•9279 •54	484	•5250 2 ·	650 • 9	• 205	6616	•6000 11•5	0 1.0	12 •9(
*5500 *850					• 5000 I.	750 .9	254 .	6302	•5750 7•50	0 1 • 0	07 .85
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XD= •5 1 •4500 1.400 9403 •7 XD= •5 •450 1.500 6400 9300 9320 6930 9300 9300 9320 6930 9320 6930 9320 6930 9320 6930 9320 6930 9320 6930 9320 6930 9494 1.500 69420 1.0000 9944 1.500 69420 1.0000 9972 1.0000 9972 1.0000 9972 1.0000 9972 1.0000 9976 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 9963 1.0000 99762 1.0000 99762 1.0000 99762 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 99763 1.0000 </td <td>n de la companya de</td> <td>and and a second second second second</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>•4750 1•80</td> <td>0 • 95</td> <td>02 .78</td>	n de la companya de	and and a second second second second							•4750 1•80	0 • 95	02 .78
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	•6800	31°00	1.000	1.000	.6500	16.60	1.000	•9933	. 8000	23.00	1.000	.9752
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XD= e1 e25 e5 e5 e5 1 | PCE=3.85 .213 .505 .540 .616 .785 .974 1.02 1.01 1.05 1.07 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 XD= .1 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 XD= .1 6.1 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 YD PITO <ttte<yd< td=""> PITO<ttte<yd< td=""> .17 27 .5 1.0 1.0 1.0</ttte<yd<></ttte<yd<> | P =.218 .217 .505 .540 .616 .785 .974 1.02 1.001 1.066 1.07 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.7 17.6 16.5 17.6 16.5 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 16.7 17.6 16.7 17.6 16.7 17.6 16.7 17.6 16.7 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 | P =*218 217 505 540 616 785 974 1.02 1.03 1.06 1.07 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 25.9 26.0*.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 25.9 26.0*.001 VD PITO TTTE VD PITO TTTE VD 110 TTTE VD 100 155 303 000 224 4.47 •320<•123 | P =.218 .217 .505 .540 .616 .785 .974 1.02 1.01 1.06 1.07 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 XD= 01 .07 .25 .55 10.6 1.65 10.6 1.65 .001 YD PITO <ttte<yd< td=""> 0.25 .25 .548 .000 .155 .303 .000 .224 .443 .000 .123 .248 .000 .155 .303 .000 .224 .447 .320 .123 .248 .000 .155 .303 .025 .675 .447 .325 .154 .220 .129 .2125 .259 .335 .497 .464</ttte<yd<> | PC==218 277 505 540 616 785 974 1.02 1.001 1.005 1.007 PPCE=3.85 4014 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 YD PITO TTTE 25 10.0 1.05 1.5 1.5 YD PITO TTTE 000 123 248 000 155 303 000 224 434 000 123 216 000 123 248 000 155 303 000 222 643 320 123 216 020 123 248 100 155 303 005 332 675 644 *320 123 2248 100 155 303 055 344 405 447 *325 124 025 615 335 055 494 454 454 *335 15 256 335 954 495 675 454 | PC==218 277 505 540 616 775 974 1.02 1.001 1.005 1.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 26.0*.001 VD PITO TTTE VD PITO TTTE VD 11.5 1.5 VD PITO TTTE VD PITO TTTE VD 11.6 1.55 VD 0.00 123 24.8 0.00 155 303 000 224 4.44 *000 123 216 0.00 123 24.8 1000 155 303 000 224 4.44 *325 *154 *23 2123 24.8 1000 155 303 0050 4.94 4.47 *325 *154 *175 *203 025 54.94 4.47 4.47 | P =*218 277 5505 540 6616 775 974 1.02 1.001 1.005 1.007 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0*.001 XD= 1 .25 777 5616 17.8 20.3 22.4 23.5 25.9 26.0*.001 YD PITO TTTE VD PITO 777E 1.5 26.0*.001 YD PITO TTTE VD PITO 777E 24.8 0.00 155 303 000 229 344 434 000 0.123 2216 0.23 199 335 0125 335 025 335 025 345 447 0325 0.123 2248 0100 0155 333 025 335 025 675 644 0325 0.123 2219 24.8 0100 0155 336 025 637 644 0325 0.124 64 | PCE=3.85 .213 .505 .540 .616 .785 .974 1.02 1.001 1.005 1.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.00*001 YD PTG TTTE .25 .299 16.4 17.8 20.3 22.4 23.9 1.00 1.55 447 YD PTG TTTE .250 .000 .123 .248 .000 .155 .303 .000 .234 .444 .320 124 .100 .155 .303 .005 .335 .647 .447 .320 123 .248 .100 .155 .303 .005 .344 .000 .524 .444 .325 .314 .105 .325 .315 .657 .484 .656 .447 .647 .325 .314 .1155 .226 .323 .025 .447 .646 .444 .646 .645 .447 .646 .650 | PCE=3.85 .213 .505 .540 .616 .785 .974 1.02 1.001 1.005 1.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.00*.001 YD PTO <ttte< td=""> .25 .293 16.4 17.8 20.3 22.4 23.4 17.10 YD PTO<ttte< td=""> .25 .230 .000 .123 .248 .000 .155 .303 .000 .224 .447 .000 .123 .214 .100 .125 .248 .000 .155 .303 .005 .447 .447 .320 .124 .100 .155 .303 .005 .447 .444 .325 .134 .105 .346 .007 .292 .344 .005 .447 .325 .314 .1155 .303 .005 .447 .000 .354 .000 .246 .000 .055 .447 .055 .447 .056 .447</ttte<></ttte<> | P **218 277 5505 540 616 785 974 1.02 1.001 1.005 1.001 PPCE=3.85 4014 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.00*001 YD PITO <ttte< td=""> VD PITO<ttte< td=""> 10 1116 1117 1.5 YD PITO<ttte< td=""> VD PITO<ttte< td=""> 233 248 000 155 303 000 2292 3172 600 524 443 0000 123 248 000 155 303 005 292 317 467 325 0124 230 125 248 100 155 303 055 344 464 325 618 427 303 055 497 400 546 447 325 618 427 317 548 332 567 444 400 6697 447 175 546 140 2.644 653 274 <td< td=""><td>PCE=3.85
.218 .277 .505 .540 .616 .785 .974 1.002 1.001 1.005 1.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0%.001 YD P170 TTTE YD P170 TTTE 1.5</td><td>PCE=3.85 401 .505 540 616 .785 .974 1.02 1.001 1.005 1.001 PPCE=3.85 4014 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.9 26.0%.001 YD P1T0 TTTE VD P1T0 TTTE 1.5 <td< td=""><td>PCE=3.85 *218 *217 *505 540 616 775 974 1.02 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.05 2.00 2.000</td><td>PCE=3.85 .213 .505 .540 .616 .785 .974 1.002 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.</td><td>PCCE=3.85 *218 271 505 540 616 785 974 1.02 1.001 1.05 1.07 PCCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.6 25.9 26.00*.001 PCCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 24.6 17.17 1.5 1.6 1.5 1.5 1.6 1.7 5.46 1.00 1.7 5.46 1.00 1.5 4.44 1.5 4.44 4.44 4.44 1.5 5.44 1.6</td><td>PPCE=3.88 641 6.13 15.60 19.64 17.805 5.40 6.16 7.85 5.40 6.101 1.001 1.001 1.001 1.001 1.001 1.001 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.010 1.011 1.010 1.011 1.010 1.011 1.010 1.011 1.0101 1.010 1.010</td><td>PPCE=3.88 \$ 000 100 100 100 100 100 100 100 110 11111 1</td><td>P *218 218 217 505 540 616 7185 974 1.02 1.001 1.005 1.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 26.00*.001 1.55 25.9 26.00*.001 YD PITO<ttte<yd< td=""> 17.7 17.0 17.7 1.55 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 100 15.5 25.9 15.6 25.9 26.00*.001 17.1 10.0 17.1 10.0 17.1 10.0 10.1 10.1 11.1 11.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.0</ttte<yd<></td><td>PC **218 218 277 505 540 616 775 591 100 100 105 100 105</td><td>PP =
#218 218 218 218 218 218 218 218 218 218 211 505 540 615 375 915 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100</td><td>PCCE=3.85 %14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.6 25.9 26.00*001 XD *1 *10 1777 YD 11 170 1775 25.5 23.6 19.6 19.9 16.4 178 200 52.6 25.9 26.00*001 YD *10 1775 *10 175 5.00 51.5 51.9 50.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 52.4 43.4 60.0 12.7 44.4 43.4 60.0 12.7 54.4 60.0 12.7 54.4 60.7 53.1 54.4</td><td>PPCE=3.88 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.6 25.9 26.0**001 YD 110 1171 110 1171 110 1171 110 1171 YD 110 1171 170 1771 100 155 303 000 222 441 320 123 2216 000 123 248 100 155 303 005 439 441 320 319 350 275 398 397 155 487 495 441 370 618 422 300 617 455 447 447 375 618 427 506 447 175 646 100 127 441 441 375 618 427 506 447 126 447 126 447 126 447 126 447 126 447 126 126 126 447 126 447 126 447 126 126</td><td>PC = 218 277 505 540 616 775 504 100</td><td>PC = -218 218 218 218 218 218 218 218 218 211 505 556 556 256 256 556 256 540 500 212 218 100 117 110 $1111E$ 100 123 216 000 123 2248 000 155 335 395 395 497 494 496 497 494 496 497 494 496 497 494 496 497 497 496 497 497 496 497 497 496 497 496 497 496 497 496 497 497 496 496</td><td>PC = *.218 211 550 540 615 754 1.02 1.00 1.00 YD 110 1110 1111 YD 10 1110 1111 100</td><td>PCCE3138 x118 x117 5505 5540 6606 100 100 100 100 100 100 100 100 100 100 100 100 115 100 100 115 100 100 115 100 100 115 100 100 115 100 100 115 1000 100 100</td><td>Pression 200 213 5560 5500 5560 5500</td><td>PCEF=18 *118 *217 505 544 102 102 102 102 101 101 ND 110 1171E VD 110 1171E 101 110 1171E 101 110 1171E 101 110 111 110 111 110 111 101 111 101 111 100 101</td><td>PCE=3.58 4.14 6.13 5.65 5.46 6.56 5.56 5.60 001 ND= 100 1170 1171 100 1170 1171 100 110 1111 ND= 101 1171 100 117 110 1171 100 110 1111 100 112 218 200 112 218 200 157 588 77 500 505 517 444 000 524 444 000 524 444 000 525 545
545 545 545 545 5</td><td>PFCEF3.85 4.14 6.11 50.5 5.40 6.16 778 50.3 2.54 23.5 26.6 55.9 26.00 001 10 117 117 115 117 115 117 115</td><td>PCE=3.85 4.14 6.13 15.6 1.97 6.44 1.78 20.3 2.246 2.540 2.540 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.546 2.547 1.155 2.115 2.115 2.115 2.115 2.116 2.223 2.125 2.546 2.000 2.53 4.547 4.54</td><td>PECE=3:05 -101 -218</td><td>PFEE*218 2118 2711 505 546 735 246 255 26.00*001 PD 110 TTTE V 00 110 TTTE V 10 2110 111E PD 110 TTTE V 000 1210 2715 256 1545 100 151 216 100 210 111E 111E<</td><td>PC = -218 211 5.6 5.40 1.00 1.07 PC = -218 2.11 5.6 5.9 5.44 100 1.5 1.07 1.07 PC = -218 2.11 1.1</td><td>PF ==.518 2118 2118 2118 2118 2118 2118 2118 2111 2105 1001 1011 1111 10111 1011 1011</td><td>PC ==218 2118 2118 2111 54.6 19.9 16.4 17.8 00.3 21.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.1 1.0.7 11.1 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 11.0 1.0.7 <td< td=""><td>PFC=3:18 2:18 2:18 2:18 2:19 1:00 1:17 1:00</td><td>Preferation 218 <th< td=""><td>PCE-3:18 2:18 2:18 2:18 2:18 2:18 2:18 2:11 2:00 1:00
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218 <th< td=""><td>PCE-3:18 2:18 2:18 2:18 2:18 2:18 2:18 2:11 2:00 1:10 1:10 1:00 1:00 1:10</td><td>Preferation Prove with a state s</td></th<></td></td<></td></td<> | PCE=3.85 *218 *217 *505 540 616 775 974 1.02 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.05 2.00 2.000 | PCE=3.85 .213 .505 .540 .616 .785 .974 1.002 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1.005 1.001 1. | PCCE=3.85 *218 271 505 540 616 785 974 1.02 1.001 1.05 1.07 PCCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 24.6 25.6 25.9 26.00*.001 PCCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 24.6 17.17 1.5 1.6 1.5 1.5 1.6 1.7 5.46 1.00 1.7 5.46 1.00 1.5 4.44 1.5 4.44 4.44 4.44 1.5 5.44 1.6 | PPCE=3.88 641 6.13 15.60 19.64 17.805 5.40 6.16 7.85 5.40 6.101 1.001 1.001 1.001 1.001 1.001 1.001 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.010 1.011 1.010 1.011 1.010 1.011 1.010 1.011 1.0101 1.010 1.010 | PPCE=3.88 \$ 000 100 100 100 100 100 100 100 110 11111 1 | P *218 218 217 505 540 616 7185 974 1.02 1.001 1.005 1.001 PPCE=3.85 4.14 6.13 15.6 19.9 16.4 17.8 20.3 22.4 23.5 26.00*.001 1.55 25.9 26.00*.001 YD PITO <ttte<yd< td=""> 17.7 17.0 17.7 1.55 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 19.9 15.6 100 15.5 25.9 15.6 25.9 26.00*.001 17.1 10.0 17.1 10.0 17.1 10.0 10.1 10.1 11.1 11.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.0</ttte<yd<> | PC **218 218 277 505 540 616 775 591 100 100 105 100 105 | PP = #218 218 218 218 218 218 218 218 218 218 211 505 540 615 375 915 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100 105 100
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	.6500	59.00	1.000	• 9966	•7000	59.00.	1.000	.9957	.7000	58.44	1.000	• 9935
	•6000	55.70	1.000	•9994	.6500	56.00	1.000	•9983	•6800	55.94	1.000	•9956
	•5950	55.00	1.000	1.000	•6200	54.00	1.000	1.000	.6600	50.95	1.000	1.000
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	•5500	18.00	•8955	•8939	•5750	-22.00	•9328	.9730	. 6000	23.48	.9950	.9650
	•5250	7.400	•7711	•7744	• 5500	12.50	•8458	•9364	.5500	9.491	•9030	.9117
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where the second se	•4750	1.300	• 4975	•5149	.5000	3.600	•7214	•7699	.4500	2.048	.7537	.7916
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					•4500	1.380	•6294	•6094	.3500	•9291	• 6070	•6726
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A DESCRIPTION OF THE PARTY OF	.8000	58.88	1.000	•9757	1.050	60.03	1.000	•9555	1.100	48.96	1.000	.9547
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	•4500	2.844	•8408	•8648	•5500	9.159	•9701	•9862	• 5000	7.845	•9826	• 9937
	•4000	1.896	•7960	• 7912	• 5000	6.471	•9527	• 9066	.4500	6.058	•9677	•9627
	•3500	1.347	•7463	• 7394	•4500	4.530	•9279	•9303	• 4000	4.667	•9552	.9512
	.3000	1.118	•6915	•6918	•4000	3.186	•9080	•9012	.3500	3.525	•9378	•9148
THE THE TRANSPORT OF A CONTRACT OF A CONTRAC	•2500	1.228	•6169	•6695	.3500	2.290	.8856	• 8382	• 3000	2°731	• 9254	• 9060
	.2250	1.148	• 5697	•6420	.3000	1.762	.8632	•8199	• 2500	2.185	• 9005	•8855
	•2000	.9681	•5149	•6134	•2500	1.414	.8259	.8017	• 2300	1.986	•8706	.8747
	•1750	•6986	•4677	•5691	•2100	1.254	.7910	•7733	• 2000	2.681	•8383	.8398
	e1500	•4691	•4055	•5136	•1750	1.842	•7463	•7665	• 1750	4.369	•8060	• 7609

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×D=		0•0			•	1			•	25	
٩Y	PITO	TTTTE	UUE	٩D	PITO	TTTE	UUE	۲D	P110	TTTE	UUE
	61.75	1.000	• 9934	1.030	61.75	1.000	•7916°	1.075	61.72	1.000	.9854
0006•	61.55	1.000	• 9935	1.000	61.55	1.000	•9918	1.000	61.42	1.000	•9856
.8000	60.96	1.000	•9940	• 9000	61.25	1.000	•9920	• 9000	60.93	1.000	•9860
• 7000	59.96	1.000	• 9948	•8000	60.56	1.000	•9926	.8000	60.23	1.000	•9866
.6500	59.06	1.000	• 9955	.7000	59.16	1.000	•9937	• 7000	58.34	1.000	.9881
:6000	56.77	1.000	.9975	.6500	55.78	1.000	•9966	•6750	55.75	1.000	• 9903
.5850	53.78	1.000	1.000	.6100	51.79	1.000	1.000	•6500	48.78	1.000	• 9964
•5750	49.80	•9926	.9773	• 5900	41.83	1.005	+619.	•6400	44.80	1.000	1.000
.5500	23.90	•8685	.9133	•575ô	31.87	.9677	•9672	-6250	36.83	1.002	.9856
•5250	9.163	• 7444	• 7078	• 5500	17.93	.851.1	•9684	.5900	20.91	1.017	.9420
• 5000	3.187	•6203	•5267	.5250	9.163	.7816	•9125	.5500	10.45	•9429	•8794
•4750	1.195	•4963	• 3938	•5000	3.586	•7196	.7572	• 5000	4.480	•8313	.8043
				•4750	2.141	•6700	•6629	•4500	2.041	• 7395	•7699
new starts way - American and American American American American American American American American American				•4500	1.295	•6005	•5745	•4000	I.145	•6576	• 7061
				•4250	•8566	•5459	•4454	.3500	.8960	•5583	•6515
And a second s	The second se		and a second	•4000	•6972	•4839	•5170	• 3250	•9457	.5087	•6021
				•3750	•6175	•4218	•6117	• 3000	•7964	•4467	•5887
×D=		• •				•	-		1	• 7	
1.150	61.69	1.000	.9732	1.315	61.63	1.000	•9533	1.480	61.57	1.000	.9450
1.100	61.49	1.000	•9733	1.300	61.43	1.000	•9535	1.400	61.07	1.000	• 9454
1.000	60+80	1.000	•9739	1.200	60.74	1.000	•9540	1.300	60.58	1.000	• 9458
• 9000	60.10	1.000	•9744	1.100	60.14	1.000	•9545	1.200	57.60	1.000	• 9482
•8000	58.61	1.000	•9276•	1.000	58.05	1.000	•9561	1.100	49.26	1.000	• 9550
•7500	52.24	1.000	•9810	• 9000	47.71	1.000	•9648	1.000	40.02	1.000	•9634
•7000	38.81	1.000	•9933	• 8000	33.80	1.000	•9781	• 9000	31.58	1.000	•9719
•6700	32 • 34	1.000	1.000	• 7000	22.37	1.000	•9912	• 8000	23.93	1.000	• 9806
•6500	27.36	1.002	• 9695	•6300	16.10	1.000	1.000	•7000	17.87	1.000	•9887
•6100	18.91	1.017	• 9692	•6000	13.82	• 9926	•9878	• 6000	12.7.1	1.000	• 9968
•5500	9.652	•9752	•8791	• 5500	10.14	1116.	•9882	•5600	10.92	1.000	1.000
•5000	5.373	•9057	•8647	• 5000	7.058	•9529	•9310	.5000	8.739	•9851	•9844
• 4500	2.985	•8437	.8387	• 4500	4.970	• 9226	•9143	• 4500	7.100	•9727	•9845
0004.	1.841	•7816	• 7910	• 4000	3.479	•8983	•8923	-4000	5.660	• 9479	.9511
.3500	1•294	•7295	.7238	e3500	2.416	•8610	•8476	•3500	4.419	•9256	.9517
• 3000	1.045	•6650	• 6945	• 3000	1.759	•8313	•8103	• 3000	3.426	• 9057	• 8972
•2750	1.154	•6328	•6818	•2500	1.352	•8065	•7814	•2500	2•632	•8784	•8894
•2500	1.224	•5931	•6438	•2100	1.223	• 7866	.7537	•2100	2.383	•8586	.8516
•2250	1.144	•5459	• 6523	•2000	1.243	• 7816	•7749	•1750	5.313	•8362	8759
•2000	• 9453	•4839	•6324	.1750	1.690	.7370	•7418	•1500	4.916	• 8065	.8481
•1750	•6667	•4293	•5424	•1500	2.535	•6824	•7164	•1250	3.972	•7196	.7972
								•			

YD 9700 61-00 9700 60-50 8000 60-00 7000 59-30 6500 58-50 5250 33-00 5250 11-50 9600 9500 3-500 9600	TTTTF UUE 0 1.000 9950 0 1.000 9954 0 1.000 9954 0 1.000 9954		
•9700 61.00 •9000 60.50 •7000 59.30 •7000 59.30 •6500 58.50 •57.10 •5750 33.00 •500 33.00 •500 33.00	n 1.000 .9950 n 1.000 .9954 n 1.000 .9958 n 1.000 .9958 n 1.000 .9954	YD PITO TITTE UUE	YD PITO TITTE UUE
• 9000 60.57 • 7000 59.30 • 7000 59.30 • 6500 58.57 • 5750 58.57 • 5750 33.07 • 5750 33.07 • 5750 33.07	0 1.000 .9954 0 1.000 .9958 0 1.000 .9958	1.000 61.000 1.000 .9942	1.050 60.94 1.000 .9916
• 8000 60-00 • 7000 59-30 • 6500 59-30 • 6000 57-10 • 5750 59-00 • 5750 33-00 • 5750 33-00 • 5750 33-00 • 5750 33-00 • 5750 - 9600	0 1.000 .9958 0 1.000 .9964	.9000 60.40 1.000 .9946	1.000 60.74 1.000 .9917
•7000 59.30 •6500 58.50 •6000 57.10 •5750 59.00 •5750 33.00 •5250 11.50 •4750 •9600	0 1.000 .9964	•8000 59•90 I•000 •9950	•9000 60.29 1.000 •9921
• 6500 58-50 • 6000 57-10 • 5750 55-00 • 5500 33-00 • 5750 11-50 • 5750 • 9600	0 1.000 0071	~7000 58.90 1.000 .9959	.8000 59.64 1.000 .9926
•6000 57.1(•5750 55.00 •5500 33.00 •5250 11.50 •500 3.500 •4750 •9600	U 10000 07711	•6000 54•00 1•000 1•000	~7000 58.44 1.000 .9936
•5750 55.00 •5500 33.00 •5250 11.50 •5000 3.500 •4750 •9600	0 1.000 .9982	•5750 30•00 •9677 •9858	•6500 54•75 1•000 •9967
•5500 33•00 •5250 11-50 •5000 3•500 •4750 •9600	0 1.000 1.000	<pre></pre>	<pre>•6350 50.95 1.000 1.000</pre>
•5250 11.51 •5000 3.500 •4750 •9600	0 .9677 .9395	•5250 6•700 •7940 •8747	•6250 46.95 1.007 .9949
• \$000 3.500 • 4750 • 9600 ****	0 .7940 .8518	•5000 3•600 •7072 •8165	•6000 32.97 1.017 .9727
•4750 •960f ***	0 •6203 •6370	•4750 1.970 •6328 •7263	•5500 10.99 •9553 •9314
	0 •4218 •3398	•4500 1.100 •5583 •6221	•5000 4•196 •8313 •8373
		•4250 •7700 •4715 •5489	•4500 1•898 •7320 •7945
		•4000 •6000 •3970 •4963	•4000 1•049 •6377 •7163
	and a second	•3750 •4500 •3226 •4534	•3700 •7992 •5658 •6907
		•3500 •2000 •2 481 •2927	•3500 •8492 •5211 •6151
-42	na mana mana mana mana mana mana mana m	n an	•3300 •8991 •4715 •5903
-07			
	•5	1.	1.5
1.125 60.88	8 1.000 .9750	1.295 60.79 1.000 .9529	1°450 60°67 1°000 •9436
1.100 60.58	8 1.000 .9753	1.200 59.99 1.000 .9535	1.400 60.17 1.000 .9440
1.000 60.18	8 1.000 .9756	.1.100 59.39 1.000 .9540	1.300 59.67 1.000 .9444
•9000 59•68	8 1.000 .9760	1.000 58.00 1.000 .9551	1.200 58.28 1.000 .9455
•8000 58•88	8 1.000 .9767	•9500 53 81 1 000 •9585	1.100 50.42 1.000 .9519
•7500 54.35	9 1.000 .9804	•9000 47.63 1.000 •9637	1.000 40.48 1.000 .9607
•7000 42 •91	1 1.000 .9905	.8000 34.08 1.000 .9766	•9000 31.82 1.000 •9693
e6600 33e43	3 1.000 1.000	•7000 23•12 1•000 •9890	•8000 24•66 1•000 •9774
•6500 30.94	4 1.005 .9865	•6100 15•25 1•000 1•000	•7000 18•30 1•000 •9857
6000 18.96	6 1.017 .9869	•6000 14 835 89975 1.000	•6000 12•93 1•000 •9940
• 5500 10•38	8 • 9926 • 9351	•5500 10•76 •9926 •9880	•5200 9•647 1•000 1•000
•5000 5•140	0 •9305 •9053	•5000 7•573 •9801 •9823	•5000 8.851 •9975 •9919
• 4500 2 • 944	4 •8561 •8612	•4500 5.132 .9578 .9335	•4500 7.011 •9926 •9856
«4000 1 °747	7 .7940 .7923	•4000 3.438 •9256 •9251	•4000 5.370 •9851 •9503
\$3500 1°148	8 .7320 .7203	•3500 2•392 •8933 •8786	.3500 4.078 .9677 .9255
•3300 1.018	8 • 7072 • 6875	•3000 1.724 .8561 .8254	.3000 3.133 .9479 .8999
-3000 •978C	0 •6576 •7115	•2500 1•295 •8189 •7775	•2500 2•287 •9256 •8305
•2600 1•198	8 e5583 e6348	•2000 1.196 •7692 •7798	•2000 1.790 •8983 •8139
•2400 1•148	8 • 5 2 1 1 • 6 5 3 3	•1750 1•365 •6824 •7065	<pre>.1800 1.740 .8834 .7996</pre>
•2250 1•048	8 •4913 •6399	•1500 2•093 •5831 •7149	<pre>。1500 4.674 .8437 .8071</pre>
•2000 •7984	4 •4417 •5839	"1350 2.392 "5509 6753	•1250 4•177 •7816 •7769

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TABLE I

Г	е	s	t	S	um	m	a	ry	•

Model	p _o , psig	^{Re} ∞/in.	M _∞	T _t	T _{model,}	Measured data	x Ħ
Flat Plate c=1.0 in., τ = .016 in. (FP)	10 35 60 85	.47x10 ⁵ .94 1.40 1.90x10 ⁵	6.04 6.07 6.08 6.10	403 404 404 404	Ad. Wall	$\frac{p_{t_2}}{p_o}, p_{\xi}, T_t$.1→9 (<u>x</u>)
20 ⁰ Wedge H = .15 in. (.15w)	10 35 60 85	.47x10 ⁵ .94 1.40 1.90x10 ⁵	6.04 6.07 6.08 6.10	402 402 402 402	Ad. Wall	$\frac{\mathbf{p}_{t_2}}{\mathbf{p}_o}$, \mathbf{p}_{t_2}	5-→60
20 [°] Wedge H = .15 in. (.15w)	10 [*] 20 35 [*] 50	.47x10 ⁵ .67 .94 1.22	6.05 6.10 6.11 6.11	400 402 402 402	Ad. Wall	р _b	0
20 ⁰ Wedge H = .3 in. (3w-1)	60 [*] 70 85 [*] 100	1.42 1.60 1.90 2.18x10 ⁵	6.12 6.13 6.14 6.15	402 402 402 402		₽ _b ₽ _{₩s}	0 (15 (45 (65
20 ⁰ Wedge H = .3 in. (.3w-2A)	10 35 60 85	.47x10 ⁵ .94 1.40 1.90x10 ⁵	6.05 6.11 6.12 6.14	400 402 402 402	348 350 351 351	$\frac{P_{t_2}}{P_o}, P_{t_i}, T_t, Nu_t$	0→30
20 ⁰ Wedge H = .3 in. (.3w-2C)	10 35 60 85	.47x10 ⁵ .94 1.40 1.90x10 ⁵	6.04 6.11 6.12 6.14	402 402 403 403	77 77 77 77 77	^P t ₂ , P _¢ , T _t , ^{Nu} t	0→30

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TABLE II

Accuracy Summary

Ouantitu	Overall Unce	rtainty
Quantity	Shear Layer	Wake
Measured Data		······
p _{t2} /P _o	± 2%	± 2%
P_{ϕ}/P_{∞}		± 2%
p_e/p_{∞} (Far Wake)		± 5%
Tawm	±.5%	± .5%
Nu ₄	± 3%	ویوی دوره دلله
p_{b}/p_{∞} (Base Tap)	± 4%	
$p_{\rm b}/p_{\infty}$ (& Probe-Low Re)	+ 7%	
$p_{ws}^{\prime}/p_{\infty}$ (Ad. Wall)	± 2%	· · · · · · · · · · · · · · · · · · ·
x/H) _{sp}	±.1H	
Derived Result		
T_{t}/T_{o} (MinEdge)	$\pm 1\%$	±1%
T_{\downarrow}/T_{a} (MaxAd. Wall)	± 2%	± 1%
T _t /T (MaxCold Wall)	$\pm 15^{\circ}$ K	$\pm 10^{\circ}$ K
pu/pou	± 5%	
u/u	± 7%	± 2%
M	±15%	± 3%
p/p _m	± 20%	
p_{+}/p_{-}	± 20%	± 4%
T/T	±15%	± 3%
x,y	±.002 in.	±.002 in
ψ/ρ _w u _w H		
$T_{t} \qquad 0 \le \frac{x}{H} \le .25$	±.01H	
$ \frac{T_{o}}{P_{c}} \left(\frac{x}{H} \right) = .25 $	±.02H	
0/0		



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x = O (THIRD PORT CENTERLINE)



x = 2 in.





FIG. 5 a. FLAT PLATE MODEL (FP)



FIG. 5 6. 20° WEDGE MODEL - H-. 15" (.15 W)





















SCALE: FULL DIMENSIONS: INCHES FIG.7 STATIC AND PITOT PRESSURE PROBES



FIG. 8 CALIBRATION OF STATHAM PRESSURE TRANSDUCER

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*IO-TURN PRECISION POTENTIOMETERS SWITCHING RELAYS SHOWN IN HIGH CURRENT POSITION

Fig. 11. Simplified Schematic for Hot Wire Recording System



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CORRELATION OF MEASURED RESULTS FOR FLAT PLATE WITH THEORETICAL VARIATION FROM DEWEY'S END LOSS ANALYSIS



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FIG.15b VARIATION OF STATIC PRESSURE ALONG WAKE CENTERLINE AT M. = 6

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FIG. 16 C VARIATION OF CENTERLINE AND EDGE MACH NUMBER WITH AXIAL DISTANCE AT M. =6 20° WEDGE MODEL-H = .3-ADIABATIC WALL









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FIG.24a COMPARISON OF VELOCITY DEFECT DATA WITH LINEAR THEORY FOR $M_{\infty} = 6$ AND $R_{0} = 4.7 \times 10^{4}$

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FIG.25a COMPARISON OF ENTHALPY EXCESS DATA WITH LINEAR THEORY FOR M₀₀=6 AND Re₀₀₁=4.7×10⁴





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FLAT PLATE AT Mo = 6

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FIG.31 SURFACE PRESSURE DISTRIBUTION NEAR TRAILING EDGE OF 20°, ADIABATIC WALL WEDGE AT $M_{\infty} = 6$



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FIG.35 b REAR STAGNATION POINT LOCATION FOR NEAR WAKE BEHIND 20° WEDGE AT M_{co} =6 (H = .3)



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