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SUPERSONIC AERODYNAMIC HEAT TRANSFER
AND PRESSURE DISTRIBUTIONS ON A SPHERE-
CONE MODEL AT HIGH ANGLES OF YAW

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SUPERSONIC AERODYNAMIC HEAT TRANSFER AND
PRESSURE DISTRIBUTIONS ON A SPHERE-CONE
MODEL AT HIGH ANGLES OF YAW

by

Lionel Pasiuk

ABSTRACT: Measurements of the static pressure and aerodynamic heat transfer on the surface of a sphere-cone model at Mach numbers of 3.23 and 4.33, and angles of yaw of 6° and 18° have been made. The results of several theoretical methods for calculating both the laminar and turbulent heat transfer to the body along the most windward and leeward streamlines are compared with the experimental measurements. The experimental laminar heat-transfer distributions are nearly alike for the two Mach numbers, when they are expressed in the form of the Nusselt number divided by the square root of the Reynolds number. The experimental heat-transfer data indicate that an increasing angle of yaw can induce transition from laminar to turbulent boundary layer.

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Supersonic Aerodynamic Heat Transfer and Pressure Distribution
on a Sphere-Cone Model at High Angles of Yaw

This report represents the experimental phase of a project undertaken at NOL to obtain a more complete understanding of the heat transfer to blunt re-entry type bodies at angles of yaw. Measurements of the surface pressures and heat transfer to a yawed sphere-cone model in supersonic air flow have been made, and the data are compared with several theories.

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Captain, USN
Commander

FLORIAN GEINER
By direction

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SYMBOLS

C_p	local pressure coefficient
$C_{p_{max}}$	stagnation point pressure coefficient
c_p	specific heat at constant pressure
H	enthalpy
k	thermal conductivity
M	Mach number
n	coordinate normal to model surface
Nu	Nusselt number, $Qc_{pO}r/k_{Oe}(H_{Oe}-H_w)$
p	local static pressure
p'_O	stagnation point pressure
Q	local heat-transfer rate
R	model base radius
Re	Reynolds number as given by $\frac{\rho_{Oe} H_{Oe}^{1/2} r}{\mu_{Oe}}$
Re_{∞}	free-stream Reynolds number per unit length as given by $\rho_{\infty} U_{\infty} / \mu_{\infty}$
S	distance along a meridian on the surface of the model measured from the point where the axis of symmetry intersects the surface of the spherical nose
T	local static temperature
t	time
U_{∞}	free-stream velocity
W	velocity in the roll direction
α	angle of yaw
η	an angle that describes the inclination of the model surface to the free-stream flow and is the angle between the free-stream velocity vector and the line normal to the surface

μ	viscosity
ρ	density
ψ	roll angle

Subscripts

ADJ	adjusted
MEAS	measured
o	stagnation conditions
o_e	local stagnation conditions at the outer edge of the boundary layer
w	the external surface of the model
∞	free stream

INTRODUCTION

High-speed missiles such as ballistic missile re-entry bodies, maneuverable interceptor missiles, and hypersonic glide vehicles are apt to fly at angles of yaw; therefore, it is necessary for the missile designer to be able to estimate the effect of the angle of yaw on the aerodynamic heat transfer to these missiles.

This report represents the experimental phase of a project undertaken at the Naval Ordnance Laboratory to achieve a better understanding of the problem of heat transfer to bodies at angles of yaw. Surface pressure and heat transfer data are presented for a sphere-cone model exposed to a supersonic air stream at angles of yaw. The heat-transfer data are obtained by measuring the steady-state temperatures on the boundaries of the model shell and solving the steady-state three-dimensional heat conduction equation utilizing an iteration process. Some comparisons are made between the experimental and theoretical heat-transfer data on the most windward and leeward streamlines of the model. Additional calculations along the streamlines will be made and the results will be presented in a future report.

The sphere-cone model used for this experimental investigation has been used previously to obtain heat-transfer data at $M = 3.23$, $\alpha = 0^\circ$, and $M = 4.83$, $\alpha = 0^\circ$ and 6° , and the data are reported in reference (1).

EXPERIMENTAL TESTING EQUIPMENT

Test Facility

Both the heat transfer and pressure measurements were made in the NOL Supersonic Wind Tunnel No. 2 which is described in reference (2). The supply conditions of the test are listed in the following table.

M	T_o	P_o	Re_{∞}
3.23	318°K	980 mm Hg	$2.43 \times 10^6 \text{ft}^{-1}$
4.83	320°K	2090 mm Hg	$2.50 \times 10^6 \text{ft}^{-1}$

Description of Model

The sphere-cone model is made from type 347 stainless steel. It is instrumented with 60 stainless steel-constantan thermojunctions and each thermojunction is formed by welding

constantan wire of 0.005-inch diameter to the model wall. As shown in figure 1, the thermojunctions and pressure taps lie in the same meridian plane. The 11 pressure taps are located on one side of the axis of symmetry and the thermojunctions are located on the other side. The thermojunctions are located on both the inside and outside surfaces of the model wall. Table 1 gives the S/R values of both the thermojunctions and pressure taps. A more complete description of the construction of the sphere-cone model can be found in reference (1).

Instrumentation

A schematic diagram of the test setup is shown in figure 2. Continuous traces of p/p_0 versus roll angle are recorded for one surface pressure tap at a time on a Kendall pressure ratio recorder which is described in reference (3). The surface pressure and supply pressure could also be read independently on a Wallace and Tiernan mercury manometer and Wallace and Tiernan pressure gage, respectively, in order to check the pressure ratio recorder.

The roll angle is recorded on the pressure ratio recorder and also displayed on the console of a self-balancing potentiometer which is a single channel of ADAPS (ref. (4)). The ADAPS is essentially a self-balancing potentiometer that balances the voltage drop across a variable resistor. The variable resistor is mounted on the model support and is geared to the rolling motion of the model. The rolling motion of the model is transmitted to the pressure ratio recorder by mounting a servo-transmitter on the ADAPS. The servo-transmitter is geared to the drive shaft of ADAPS and it sends an electrical signal to a servo-receiver on the pressure ratio recorder and to the visual readout.

Cooling of the sphere-cone model is achieved by circulating DC 200 silicone oil through the inside of the model. The silicone oil is passed through a coiled tube of a heat exchanger, the coil being immersed in a solid carbon dioxide-alcohol bath. A Taylor temperature controller keeps the silicone oil at a constant temperature of $223^{\circ}\text{K} + 0.5^{\circ}\text{K}$. The temperature of the silicone oil is $230^{\circ}\text{K} + .5^{\circ}\text{K}$ as it enters the model, and is $235^{\circ}\text{K} + .5^{\circ}\text{K}$ as it leaves the model. These temperatures are continually monitored on two General Electric millivolt recorders.

The output of each of the thermocouples is measured with a single channel of PADRE (ref. (5)), which is a self-balancing potentiometer. The potentiometer is set to a full-scale reading of 1 MV, thereby giving a voltage sensitivity of $\pm 0.6 \mu\text{V}$ and a temperature sensitivity of $\pm 0.02^{\circ}\text{K}$. The

thermocouples are automatically switched one at a time to the potentiometer.

As shown in figure 3, the thermocouples on the outside surface of the model use an ice-water bath as a reference. The thermocouples on the inside surface and in the model wall, at a given S/R station, use the temperature on the outside surface at that S/R station as a reference. Because temperature differences exist that give a voltage greater than 1 MV, it is necessary to provide a millivolt source to counteract any signals in excess of 1 MV.

EXPERIMENTAL PROCEDURE

Pressure Data

Each of the 11 surface pressure taps is connected one at a time to the pressure ratio recorder. A continuous trace of p/p_0' versus ψ is produced when the model is rolled from the most windward to the most leeward position. The rolling motion is stopped every 15° , and the surface pressure and supply pressure are read on a mercury manometer and pressure gage, respectively.

Temperature Data

The temperature distribution through the model wall is obtained in the following manner. With the supply conditions of the wind tunnel and the model coolant constant with respect to time, the model is placed at the initial roll position of $\psi = 0^\circ$. After the temperatures throughout the model wall reach their steady-state values, they are recorded. The model is then rotated to the next roll position and this procedure is repeated. Temperature measurements are made in the region $0^\circ \leq \psi \leq 180^\circ$, at increments of $\Delta\psi = 15^\circ$.

RESULTS AND DISCUSSION

Pressure Results

Pressure distributions on the sphere-cone model are presented in table 2. They are given in the dimensionless form p/p_0' versus S/R for various values of the roll angle ψ in increments of 5° .

Figures 4, 5, 6, and 7 are representative plots of p/p_0' versus S/R for $\psi = 0^\circ$, 90° , and 180° at $\alpha = 6^\circ$ and 18° at $M = 3.23$ and 4.83 . The Newtonian flow ($C_p/C_{p_{\max}} = \cos^2\eta$) predicts a pressure distribution on the spherical nose that

is slightly higher than the experimental data. On the conical afterbody the pressures calculated from Newtonian flow and the Kopal cone tables (refs. (6), (7), and (8)) are slightly lower than the experimental data. Both the Newtonian and Kopal values predict a constant pressure as a function of S/R along the most windward and leeward streamlines of the cone section, whereas the experimental pressure distributions show a slight overexpansion in the region of the sphere-cone junction and then a slight compression to a constant pressure with increasing S/R.

For various values of S/R a cross plot of the pressure distributions, that is, p/p_0 versus ψ , is shown in figure 8. The data for $\alpha = 18^\circ$ at Mach numbers of 3.23 and 4.83 are presented. The experimental data are shown as they are recorded, that is, as continuous curves of pressure versus roll angle. The pressure level is slightly greater at $M = 3.23$ than at $M = 4.83$.

Temperature Results

All of the measured temperature distributions are presented in table 3. They are given in degrees Kelvin versus S/R for various values of roll angle ψ in increments of 15° .

Figures 9, 10, and 11 are plots of the measured wall temperatures of the model, versus S/R, for $\psi = 0^\circ$, 90° , and 180° , and with $M = 4.83$ and $\alpha = 18^\circ$. Notice that the temperature on the surface of the spherical nose of the model at S/R = 0 varies almost 3°C as ψ goes from 0° to 180° . Under ideal conditions, that is, if tunnel supply conditions and the temperature of the coolant fluid inside the model remain constant, the temperature at the point S/R = 0 should remain constant because this point is on the axis of rotation of the spherical nose of the model and remains in the same position relative to the air flow. As can be seen in figure 12 the varying temperature at S/R = 0 gives a discontinuity in the temperature distribution at S/R = 0. It is likely that the discontinuity is caused by an asymmetry in the geometry of the model due to the presence of the pressure taps. In order to eliminate this discontinuity, the temperature at S/R = 0, for all roll positions of $\psi > 0^\circ$, is adjusted so that it is equal to the temperature at $\psi = 0^\circ$. Then the assumption is made that the entire temperature distribution at a constant roll position shifts by the same amount as the change in temperature at S/R = 0. The equation for the temperature adjustment is:

$$T_{\text{ADJ}}(\psi, S/R) = T_{\text{MEAS}}(0, 0) - T_{\text{MEAS}}(\psi, 0) + T_{\text{MEAS}}(\psi, S/R) \quad (1)$$

This alters the temperature distribution as a function of the roll angle, but does not change the temperature difference across the wall. The adjustments in temperature do not change the ratio T_w/T_o more than 5 percent. Figure 12 illustrates how the discontinuity in the temperature distribution is eliminated by the temperature adjustment. Figure 13 is a plot of temperature versus roll angle for $M = 4.83$, $\alpha = 180^\circ$, and $S/R = 0$ and 0.52 . This figure illustrates how the temperature distribution in the roll direction is affected by the temperature adjustment.

Heat-Transfer Data Reduction

The calculation of the aerodynamic heat transfer is performed by utilizing the steady-state method. A detailed description of the steady-state method can be found in reference (9). In general, this method requires the solution of the three-dimensional, steady-state heat conduction equation. Specifically for this problem, the shell of the model is separated into two regions. The first region is the spherical section and the second region is the conical section. The three-dimensional steady-state heat conduction equation is written in spherical and rectangular coordinate systems for the first and second regions, respectively. Then the heat conduction equation is replaced by a set of finite difference equations and the steady-state adjusted temperatures on the boundaries of the model shell are used to compute the temperature within the model shell utilizing an iteration process. The calculated temperature field is then used to find the temperature gradient normal to the model surface, and the local aerodynamic heat transfer to the model surface is:

$$Q = k \frac{\partial T}{\partial n} \quad (2)$$

The variation of the thermal conductivity of the stainless-steel model as a function of temperature has been measured by the National Bureau of Standards and the results are presented in reference (10). In the temperature region,

$$223^\circ\text{K} \leq T \leq 273^\circ\text{K}$$

the thermal conductivity can be approximated by

$$k = (6.354 \times 10^{-6}) T + (2.31 \times 10^{-3}) \quad (3)$$

where the units are:

$$\begin{aligned} T & \text{ } ^\circ\text{K} \\ k & \text{ BTU/sec-ft-}^\circ\text{K} \end{aligned}$$

Heat-Transfer Results

Heat-transfer results are given in the form of the Nusselt number divided by the square root of the Reynolds number as suggested in reference (11) and the equation is:

$$\frac{Nu}{Re^{1/2}} = \frac{Qc_{p_o} r/k_{o_e} (H_{o_e} - H_w)}{(\rho_{o_e} H_{o_e} r/\mu_{o_e})^{1/2}} \quad (4)$$

If c_p = constant (c_p varies about 0.3 percent in the temperature range encountered in this experiment) and if the local stagnation density, pressure, and enthalpy are constant about the body, then equation (4) can be written in the form:

$$Nu/Re^{1/2} = (\text{constant}) \frac{Q}{T_o - T_w} \quad (5)$$

where

$$(\text{constant}) = \frac{r/k_{o_e}}{(\rho_{o_e} H_{o_e} r/\mu_{o_e})^{1/2}} \quad (6)$$

Figure 14 is a plot of the heat-transfer data versus S/R for $M = 4.83$, $\alpha = 18^\circ$, and $\psi = 0^\circ, 90^\circ$, and 180° .

Theoretical calculations of the laminar heat transfer have been made for both the windward ($\psi = 0^\circ$) and leeward ($\psi = 180^\circ$) streamlines and the results are shown in figure 14. On the windward streamline ($\psi = 0^\circ$), the analysis of Vaglio-Laurin (ref. (12)) as formulated by Zakkay (ref. (11)) is used to compute the heat transfer downstream from the aerodynamic stagnation point. Using this method two calculations are made. The first calculation is made under the assumption that the heat transfer on the windward streamline is equivalent to that on an axially symmetric sphere-cone body which has a new cone half angle of the actual body plus the angle of yaw. In the second calculation, the effect of the crosswise velocity gradient $dw/d\psi$ on the spreading of the streamlines of the inviscid flow is approximately accounted for and the value of $dw/d\psi$ is determined by using equations (1) and (A-22) of reference (11) and is assumed to be constant. The three constants in equation (1) of reference (11) are determined from the pressures that were measured at a constant S/R = 2.481, and $\psi = 0^\circ, 90^\circ$, and 180° . Both calculations give the same heat-transfer values on the spherical nose of the body and these values are from 0 percent to 13 percent higher than experimental data. On the conical section of the body the former calculation compares favorably with the experimental data, as may be seen from figure 14, while the latter calculation predicts heat-transfer values that are approximately 30 percent higher than the measured data.

Another theoretical heat-transfer curve using the method of Reshotko (ref. (13)) is also computed for the most windward streamline of the cone. Reshotko's analysis is for a sharp cone at an angle of yaw and as might be expected, the theoretical results seem to approach the measured heat-transfer values toward the base of the cone.

Since the measured static pressure distribution is relatively constant for ψ between 135° and 180° on the conical section of the model, a calculation of the laminar heat transfer was made using flat-plate theory, and the results were transformed to the cone geometry by multiplying the flat-plate results by $\sqrt{3}$. This computation was made using the results of figure 6 of reference (14). The results agree favorably with the experimental data.

The heat transfer versus S/R for $M = 3.23$, $\alpha = 180^\circ$, and $\psi = 0^\circ$, 90° , and 180° is shown in figure 15. Theoretical calculations of the heat transfer using the same methods described in the previous paragraph are also shown in figure 15. When the heat-transfer rates are presented in the form of $Nu/Re^{1/2}$, the experimental and theoretical laminar heat-transfer distributions do not change very much between $M = 3.23$ and $M = 4.83$. In figure 15, there is a sharp increase in the heat-transfer rates on the $\psi = 90^\circ$ and 180° curves, indicating that a transition from laminar to turbulent flow has taken place. Theoretical values of the turbulent heat transfer to the leeward streamline have been obtained by transforming the flat-plate theoretical results of reference (14) so that they apply for a sharp cone. The theoretical results compare very well with the experimental data.

It is interesting to note that the experimental data in figure 15 indicate that there is no transition from laminar to turbulent boundary layer on the most windward streamline ($\psi = 0^\circ$).

In order to illustrate where transition begins, figures 16 and 17 are presented. Figure 16 is a plot of the experimental heat-transfer parameter $Nu/Re^{1/2}$ versus ψ with S/R as a parameter. Values for S/R equal to 0.301, 1.392, and 2.636 are shown. The first two curves indicate that the heat-transfer rates decrease as ψ increases, whereas, the third curve shows that there is a sharp rise in the heat-transfer rates at $\psi = 75^\circ$. In figure 17, the experimental $Nu/Re^{1/2}$ is plotted against S/R and the $\psi = 60^\circ$ data are completely laminar, however, the $\psi = 75^\circ$ data show a sharp increase in the heat-transfer rates. The location of the laminar, transitional, and turbulent boundary layers on the conical section of the sphere-cone model are shown in figure 18. These regions are determined from the experimental

heat-transfer data. The point where the heat-transfer rates begin to rise is taken as the end of the laminar region and the point where the heat-transfer values reach a maximum is taken as the end of the transition region.

The region where transition begins is one where a true three-dimensional boundary layer with crossflow (that is, flow in the boundary layer normal to the external inviscid streamlines) does exist. Experiments having to do with flow on a rotating disk (ref. (15)) verify that a three-dimensional laminar boundary layer is extremely unstable. The Reynolds number based on local flow conditions and distance from the aerodynamic stagnation point to the base of the cone on the most windward streamline is 1.4×10^6 , and there is no indication of transition. The Reynolds number at the beginning of transition at the point $S/R = 1.6$ and $\psi = 90^\circ$ is only 0.7×10^6 .

CONCLUSIONS

Newtonian flow theory predicts pressures on the surface of the spherical nose of the sphere-cone model that are slightly higher than the experimental data. The surface pressures given by the Kopal cone tables are slightly higher than those measured on the surface of the cone. Neither computational method is adequate for predicting the pressures in the region of the sphere-cone junction.

The theoretical laminar heat-transfer distributions along the windward streamline approach the experimental data toward the base of the cone. In the region of the sphere-cone junction the theoretical laminar heat-transfer rates are over 100 percent higher than the experimental measurements. The prediction of both the laminar and turbulent heat-transfer rates to the leeward streamline are in very good agreement with the experimental data.

The experimental laminar heat-transfer distributions are very nearly the same for both the Mach number 3.23 and 4.83 data, when they are expressed in the form of the Nusselt number divided by the square root of the Reynolds number.

The Mach number 3.23 experimental heat-transfer data indicate that increasing angles of yaw can cause transition from a laminar to a turbulent boundary layer in a region on the conical section of the model between the most windward and leeward streamlines. The experimental turbulent heat-transfer at a point on the cone that is midway between the most windward and leeward streamlines are approximately 50 percent higher than the experimental laminar heat transfer at the most

windward streamline. This transition is probably due to the extreme instability of the three-dimensional laminar boundary layer that exists in this region.

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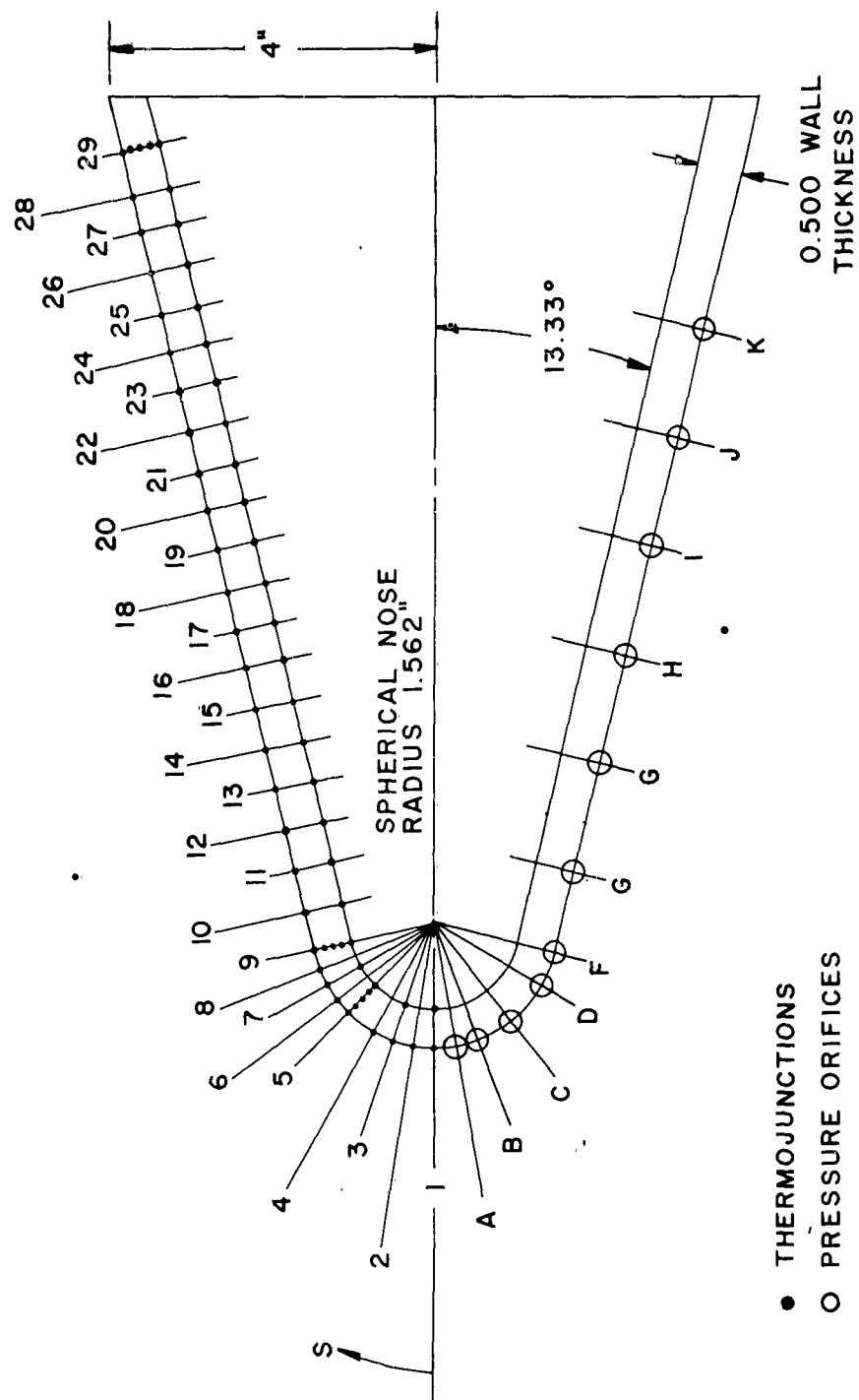


FIG. 1 SPHERE-CONE MODEL SHOWING THE LOCATION OF PRESSURE ORIFICES AND THERMOJUNCTIONS

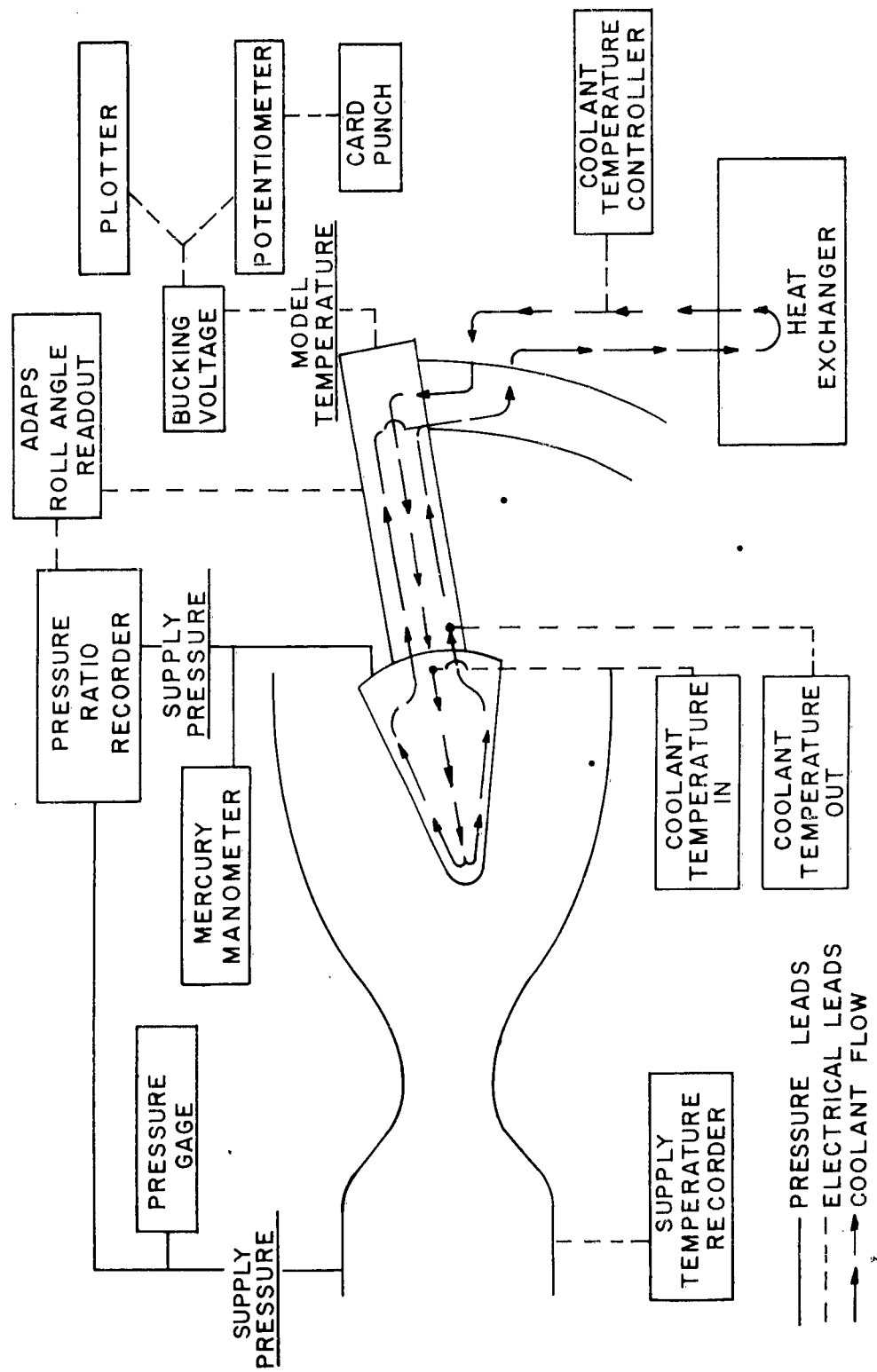


FIG 2 SCHEMATIC DIAGRAM OF THE TEST SETUP

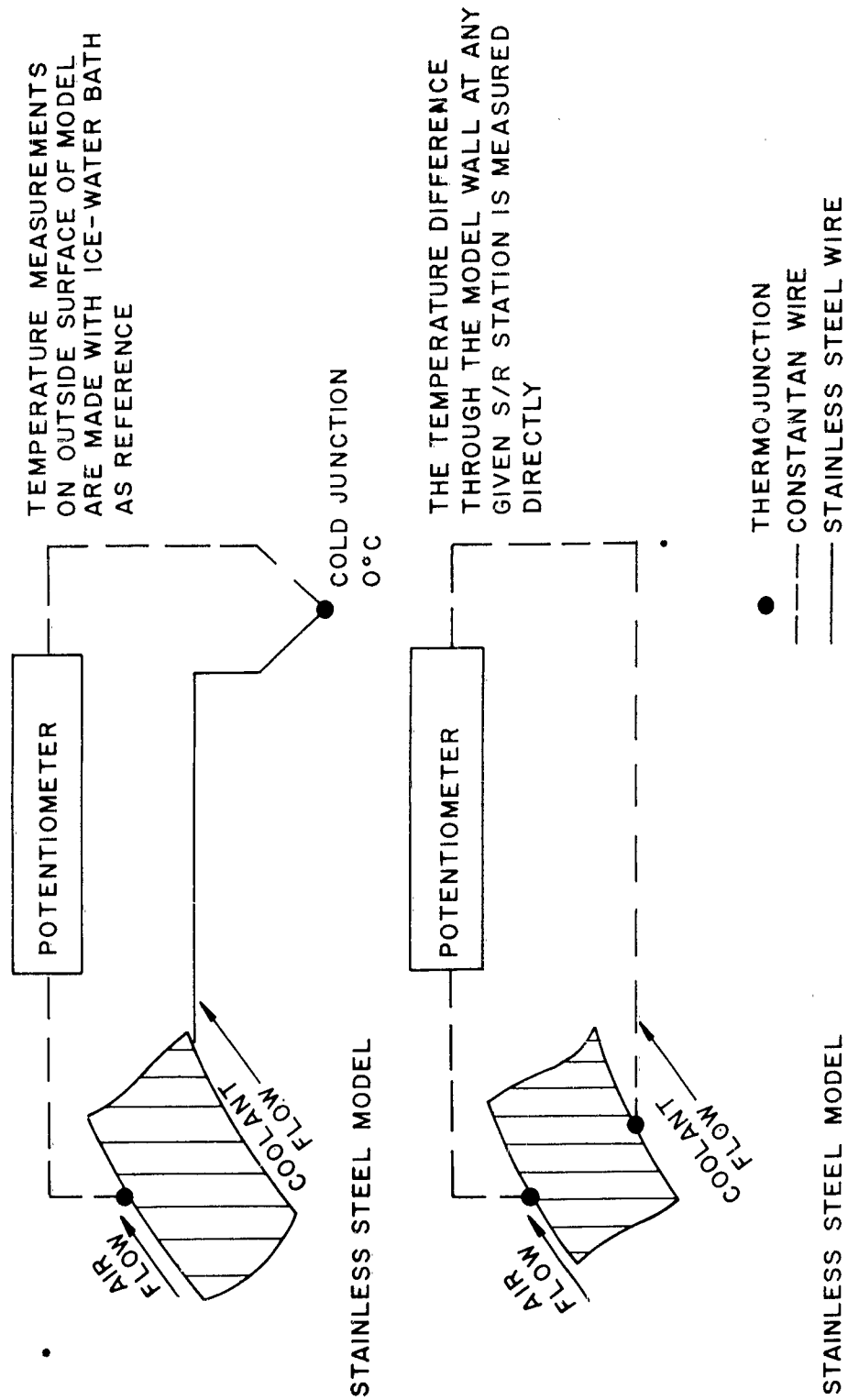


FIG. 3 SCHEMATIC DIAGRAM OF THERMOCOUPLE WIRING

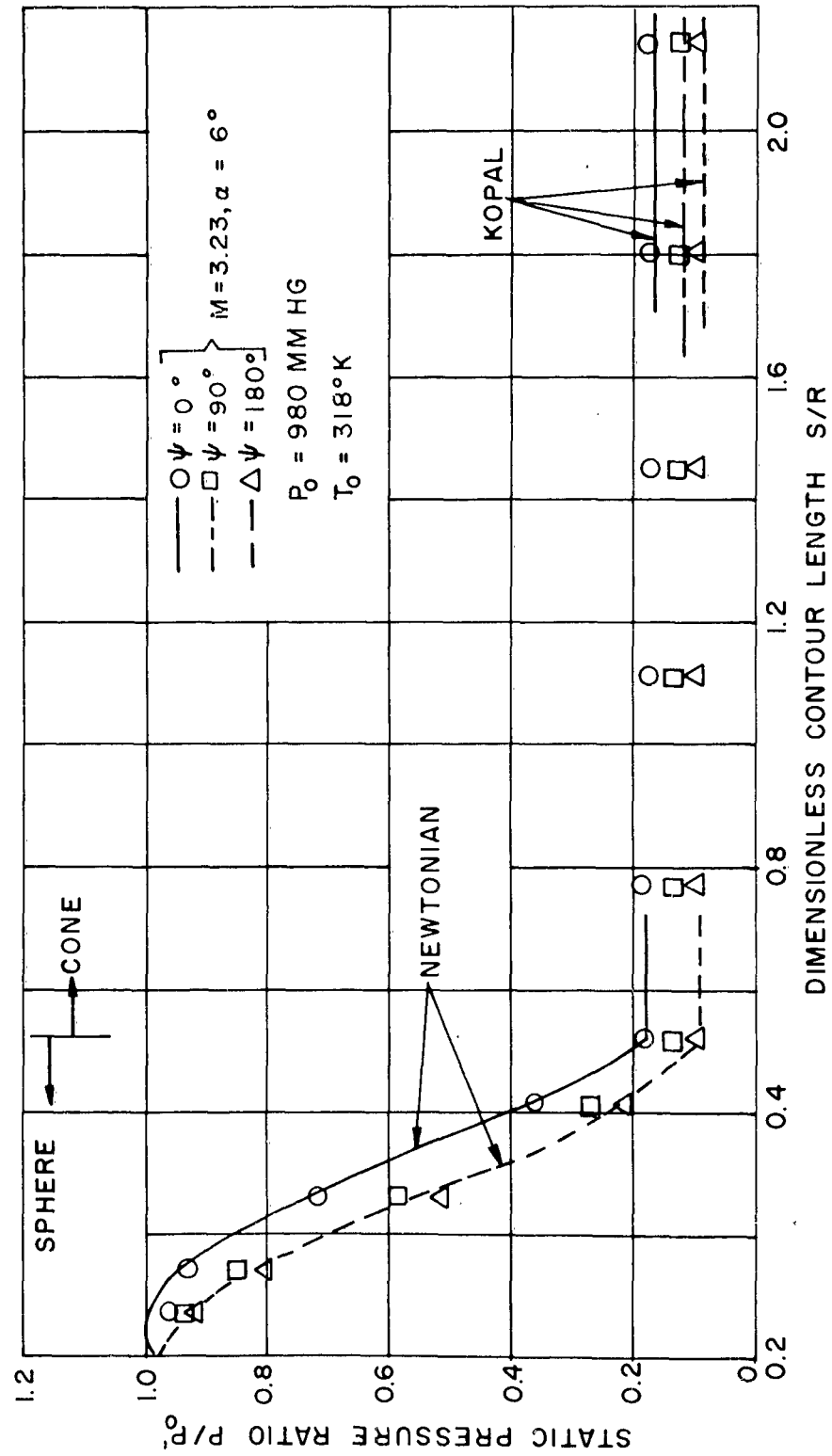


FIG. 4 SURFACE PRESSURE DISTRIBUTION OVER THE SPHERE-CONE MODEL AT $M=3.23, \alpha=6^\circ$

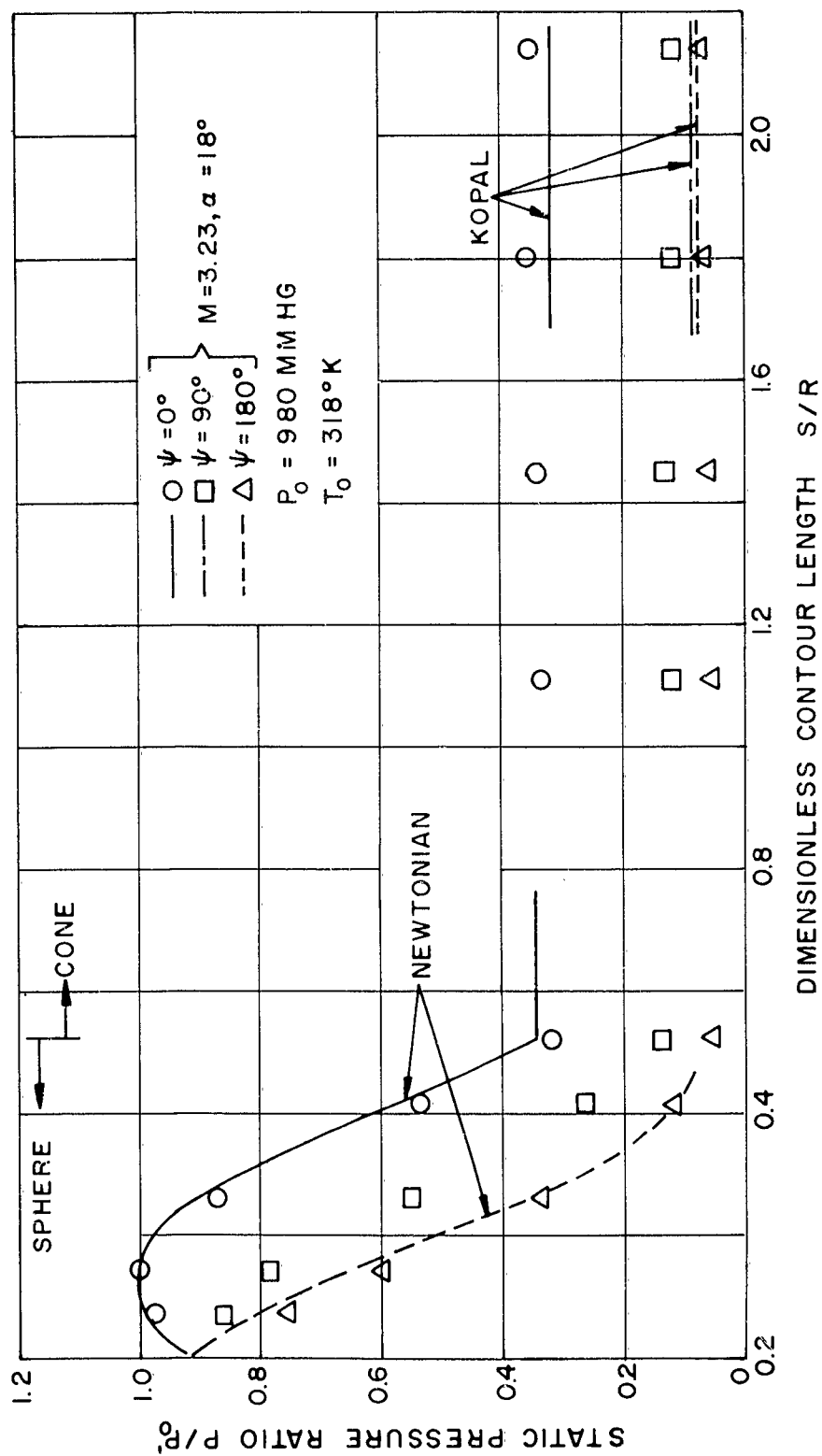


FIG. 5 SURFACE PRESSURE DISTRIBUTION OVER THE SPHERE-CONE MODEL AT $M=3.23, \alpha=18^\circ$

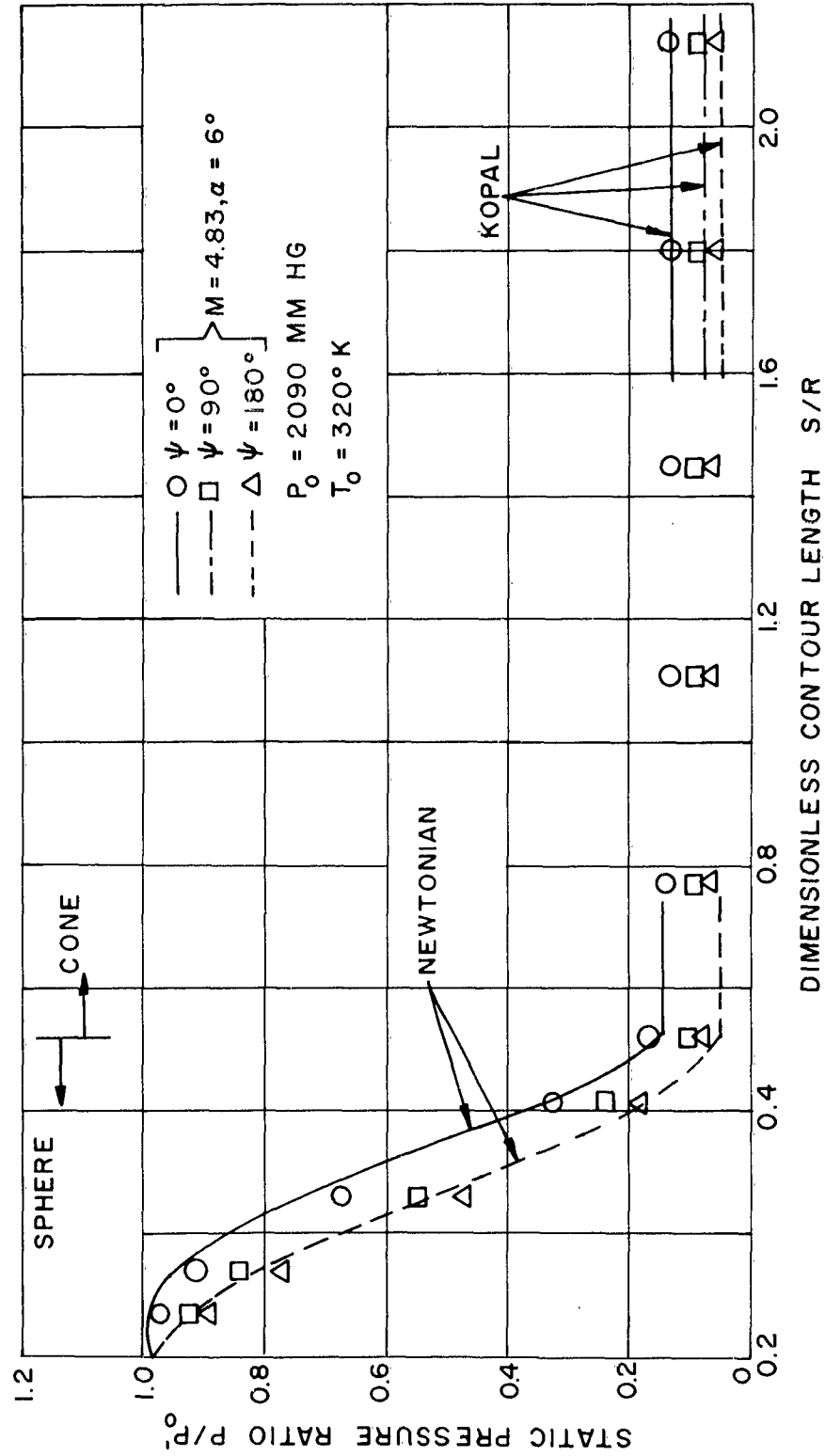


FIG. 6 SURFACE PRESSURE DISTRIBUTION OVER THE SPHERE-CONE MODEL AT $M=4.83, \alpha=6^\circ$

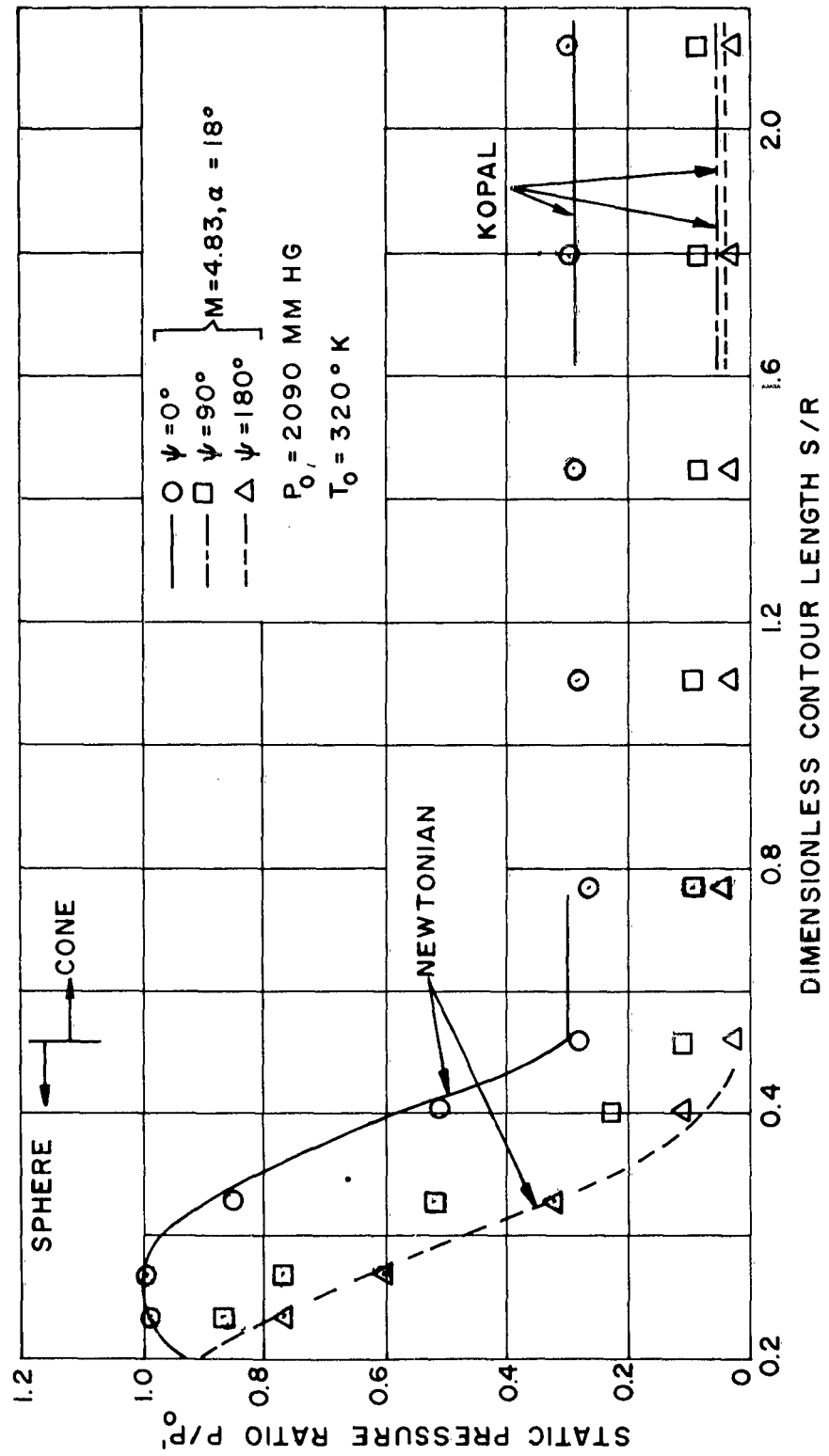


FIG. 7 SURFACE PRESSURE DISTRIBUTION OVER THE SPHERE-CONE MODEL AT $M=4.83, \alpha=18^\circ$

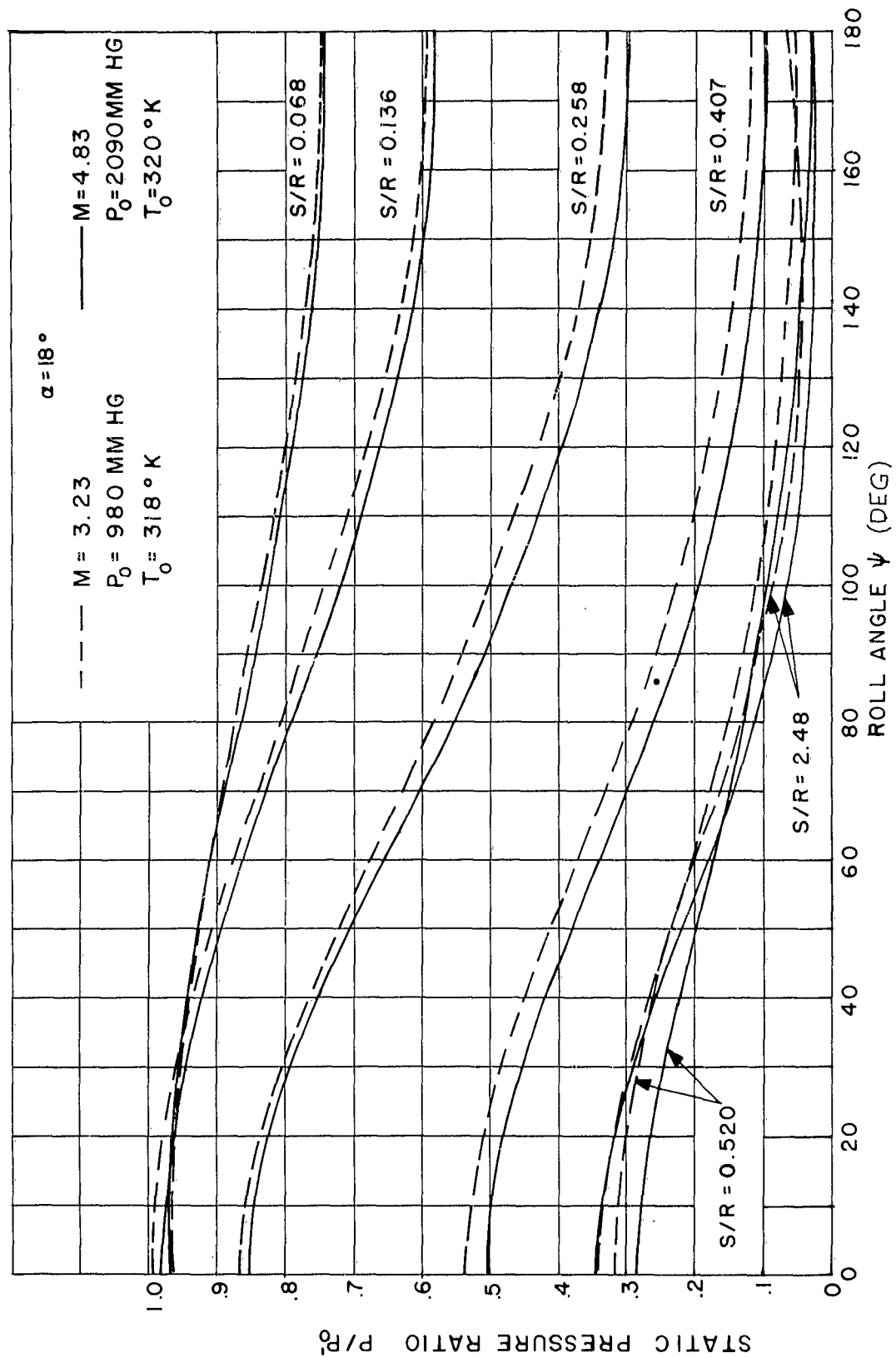


FIG. 8 COMPARISON BETWEEN THE $M=3.23$ AND $M=4.83$ SURFACE PRESSURE DISTRIBUTION OVER THE SPHERE-CONE MODEL AT $\alpha=18^\circ$

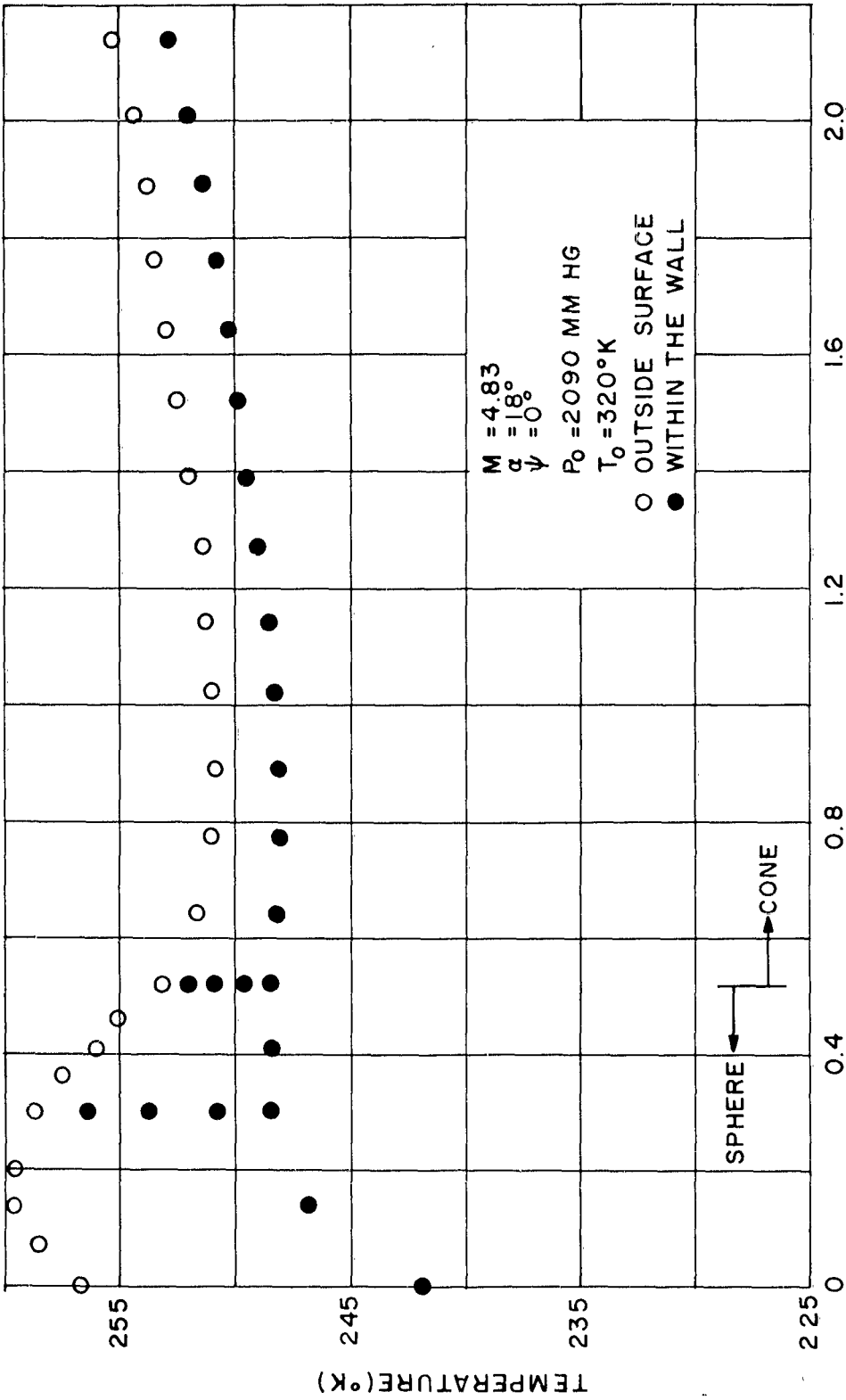


FIG. 9 THE MEASURED INTERNAL AND EXTERNAL WALL TEMPERATURE DISTRIBUTION ON THE SPHERE- CONE MODEL AT $M = 4.83, \alpha = 18^\circ$ AND $\psi = 0^\circ$

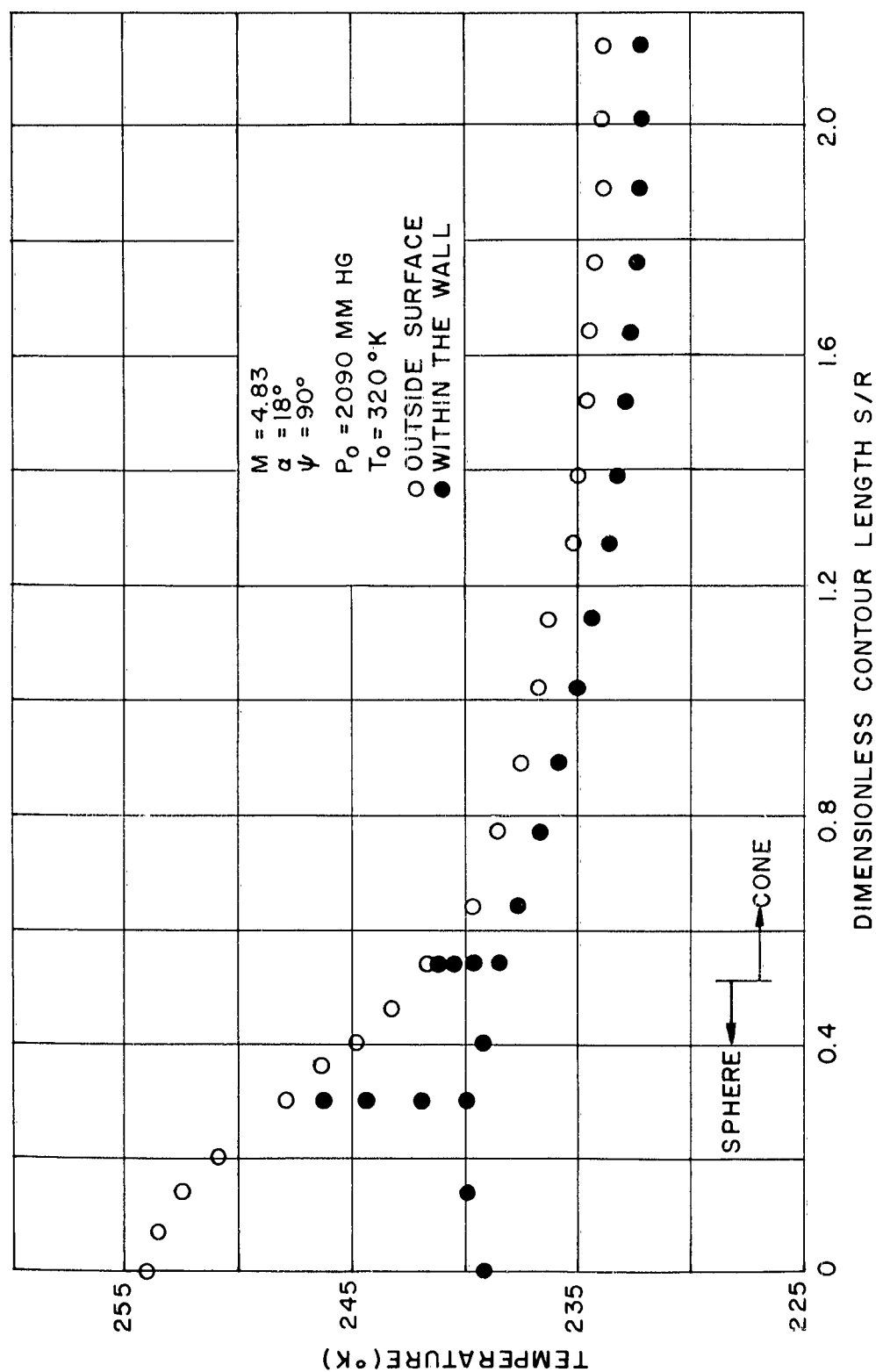


FIG. 10 THE MEASURED INTERNAL AND EXTERNAL WALL TEMPERATURE DISTRIBUTION ON THE SPHERE- CONE MODEL AT $M = 4.83, \alpha = 18^\circ$ AND $\psi = 90^\circ$

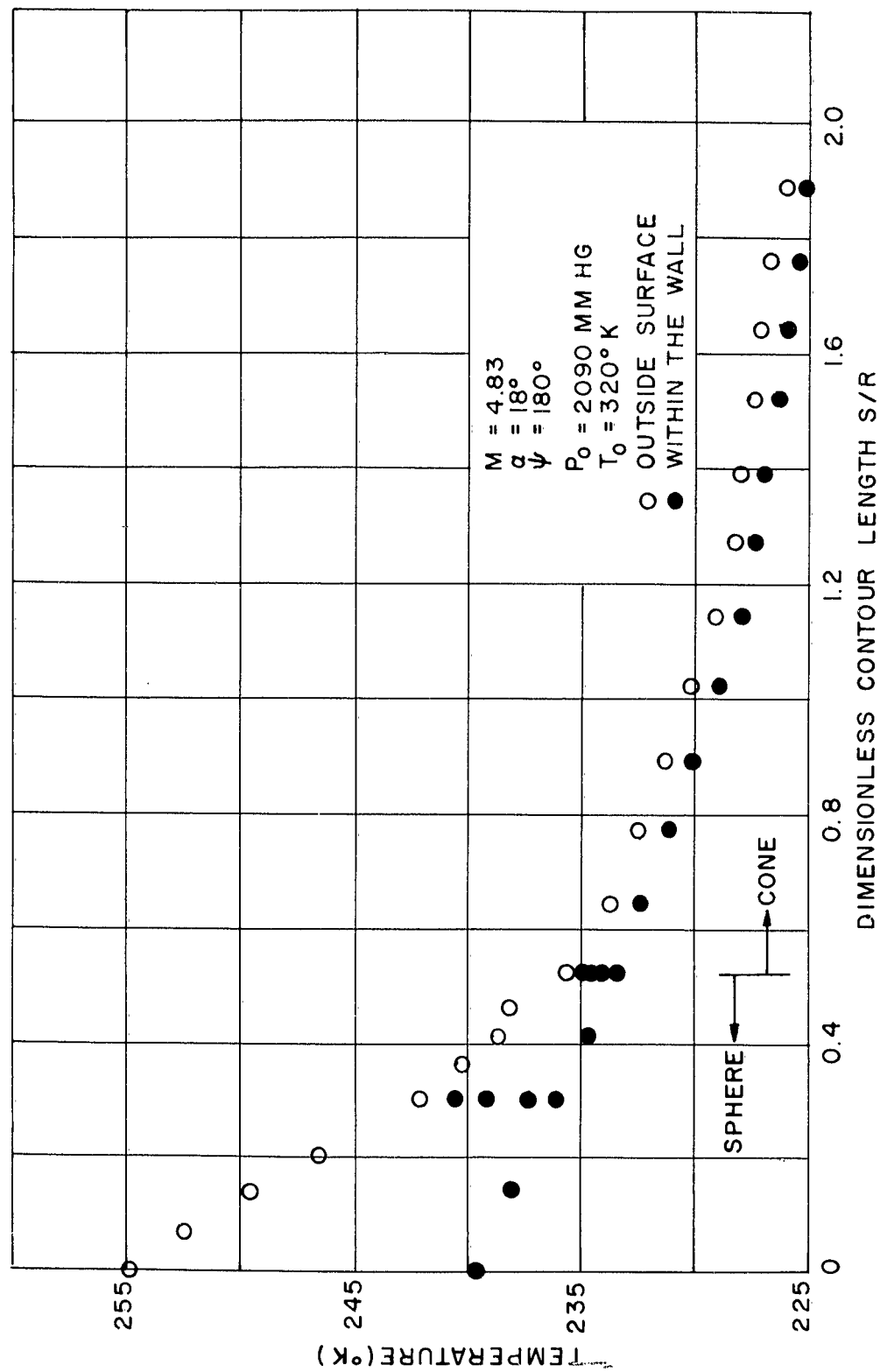


FIG. 11 THE MEASURED INTERNAL AND EXTERNAL WALL TEMPERATURE DISTRIBUTION ON THE SPHERE-CONE MODEL AT $M = 4.83, \alpha = 18^\circ$ AND $\psi = 180^\circ$

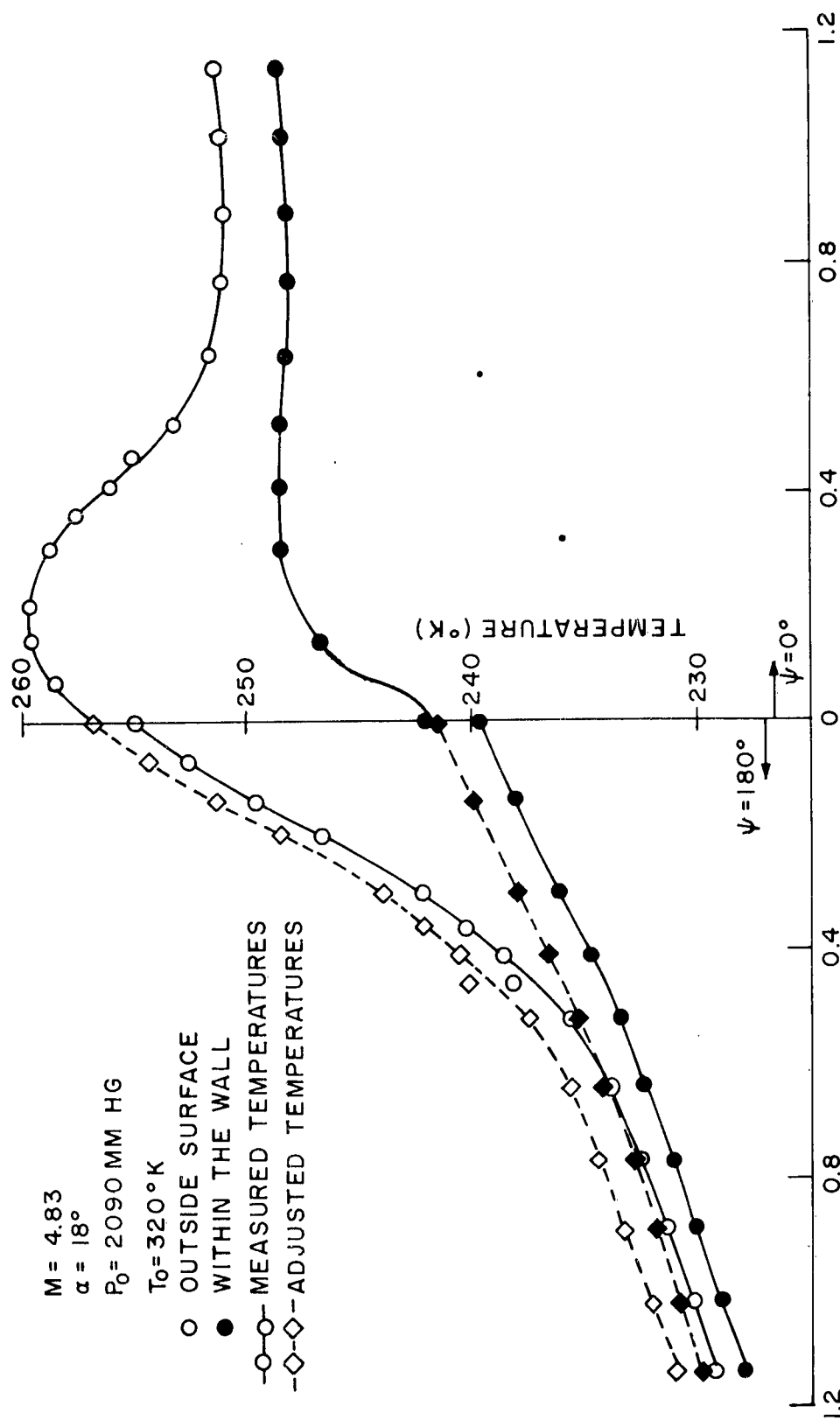


FIG. 12 THE MEASURED AND ADJUSTED INTERNAL AND EXTERNAL WALL
 TEMPERATURE DISTRIBUTIONS ON THE SPHERE-CONE MODEL
 AT $M = 4.83$, $\alpha = 18^\circ$, AND $\psi = 0^\circ$, AND 180°

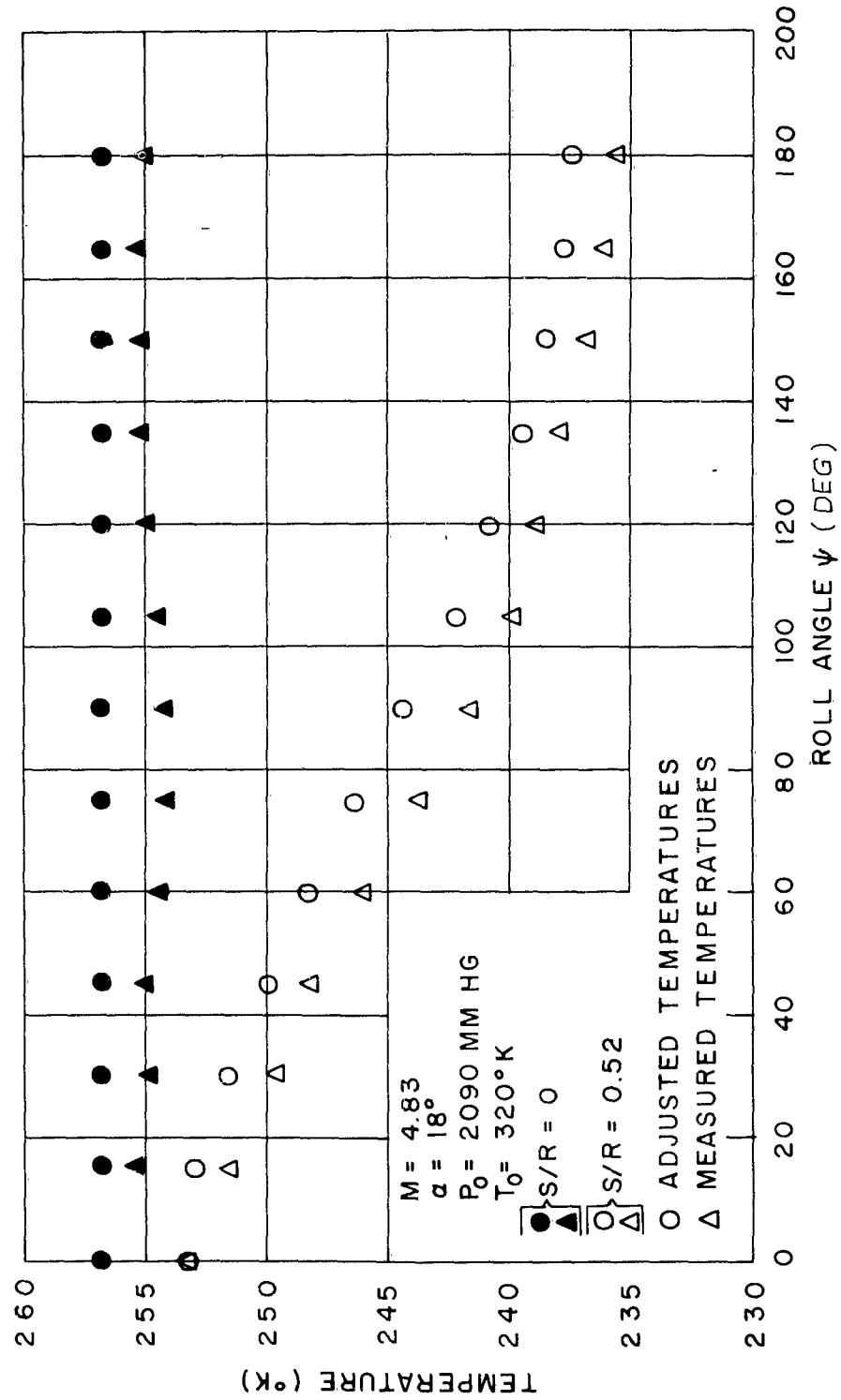


FIG.13 COMPARISON BETWEEN ADJUSTED AND MEASURED TEMPERATURES ON THE SURFACE OF THE SPHERE - CONE MODEL AT $M = 4.83$, $\alpha = 18^\circ$, AND $S/R = 0$, AND 0.52

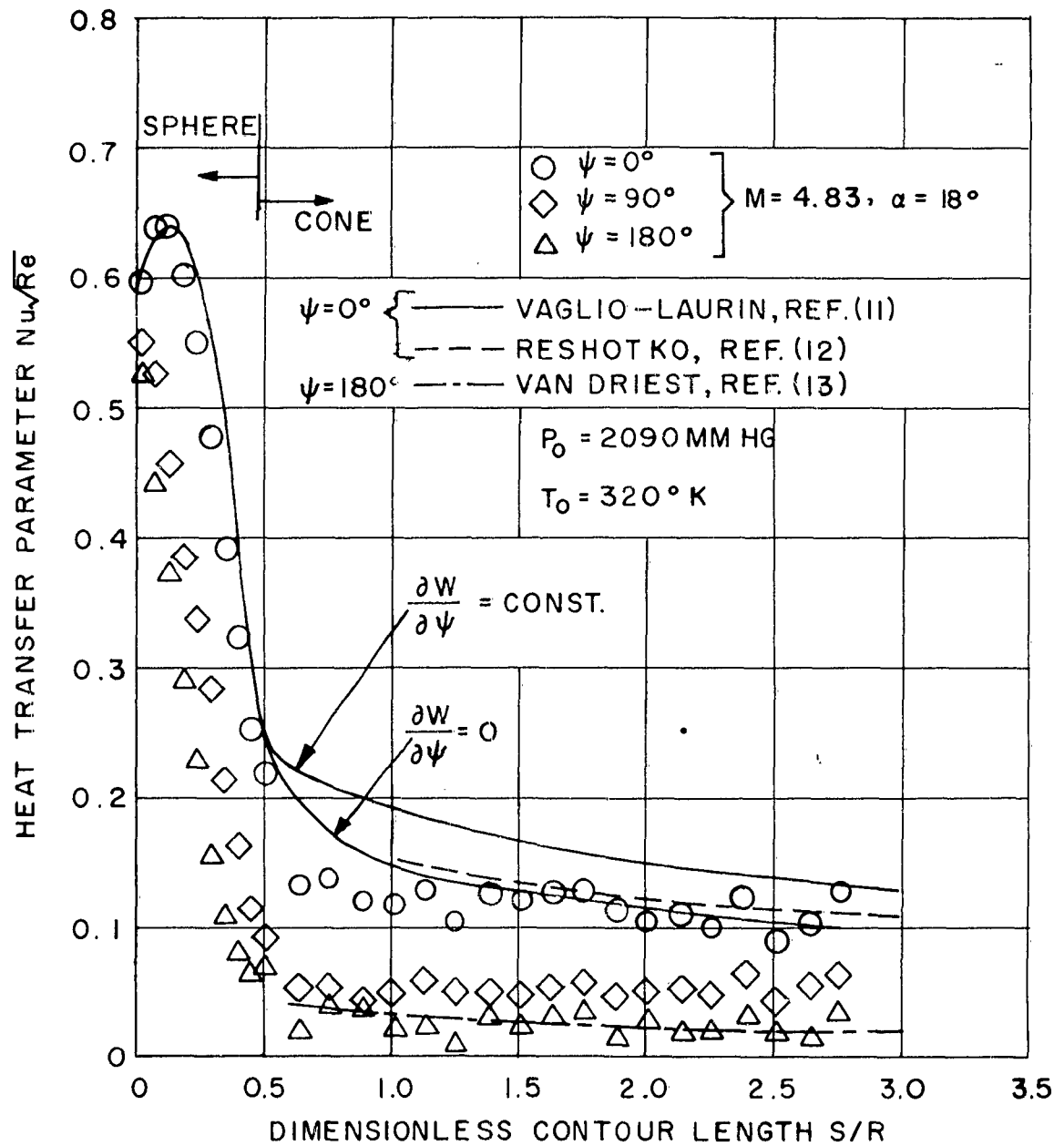


FIG.14 HEAT-TRANSFER DISTRIBUTION TO THE SURFACE OF A SPHERE - CONE MODEL AT $M = 4.83$ AND $\alpha = 18^\circ$

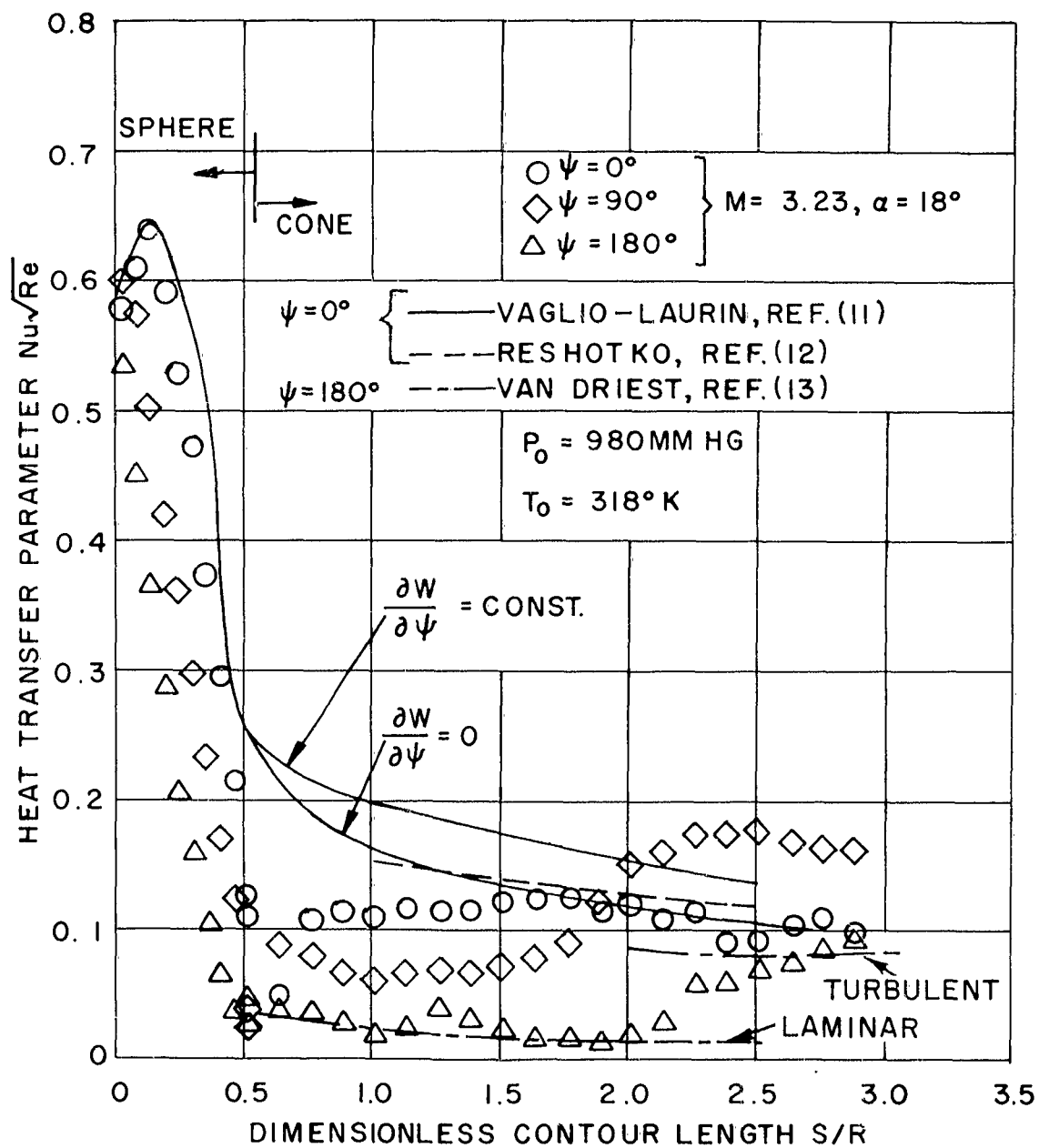


FIG.15 HEAT-TRANSFER DISTRIBUTION TO THE SURFACE OF A SPHERE - CONE MODEL AT $M = 3.23$ AND $\alpha = 18^\circ$

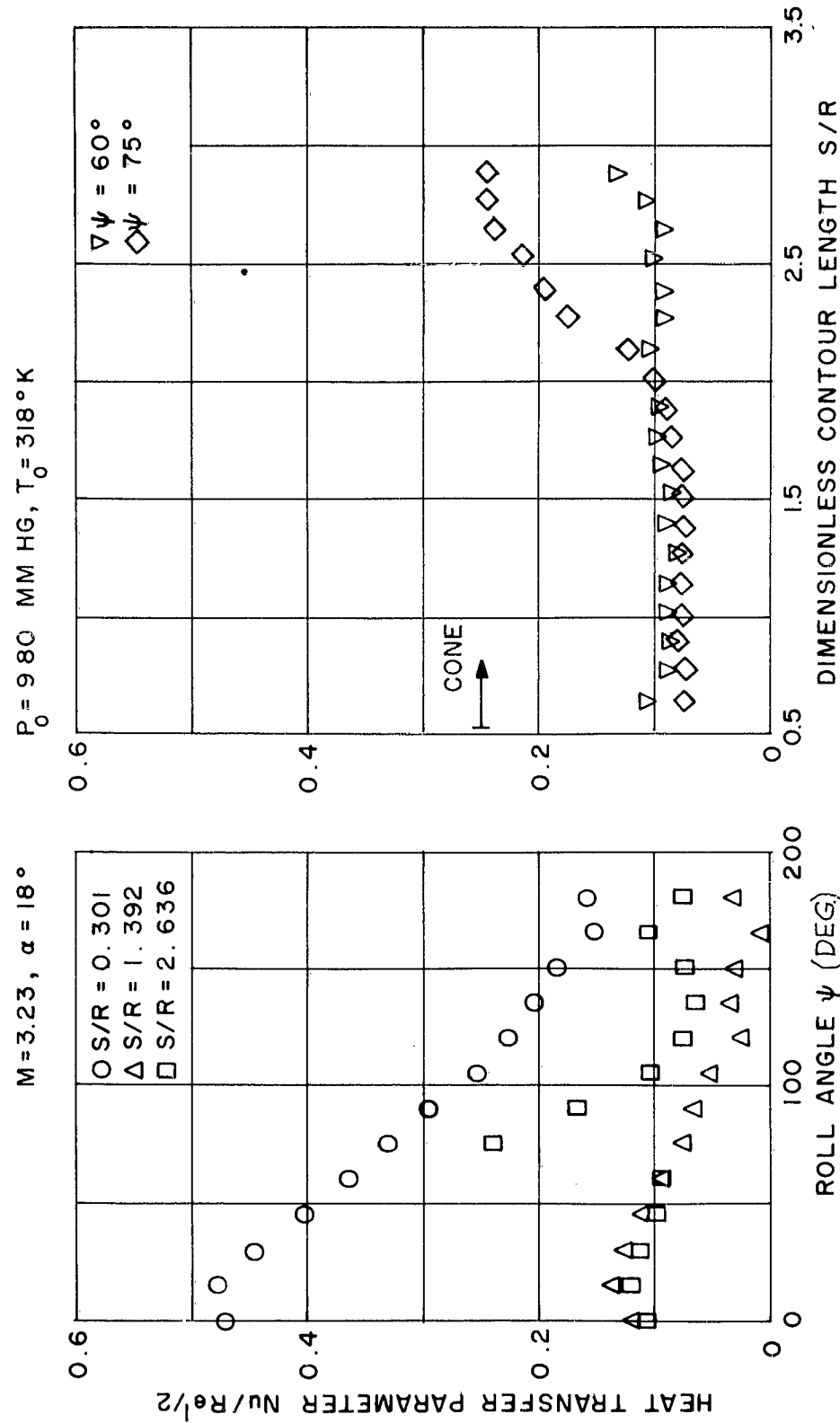


FIG. 16 HEAT TRANSFER VERSUS ROLL ANGLE FOR CONSTANT VALUES OF $S/R = 0.301, 1.392$ AND 2.636 AT $M = 3.23$ AND $\alpha = 18^\circ$

FIG. 17 HEAT TRANSFER VERSUS S/R FOR CONSTANT VALUES OF $\psi = 60^\circ$ AND 75° AT $M = 3.23$ AND $\alpha = 18^\circ$

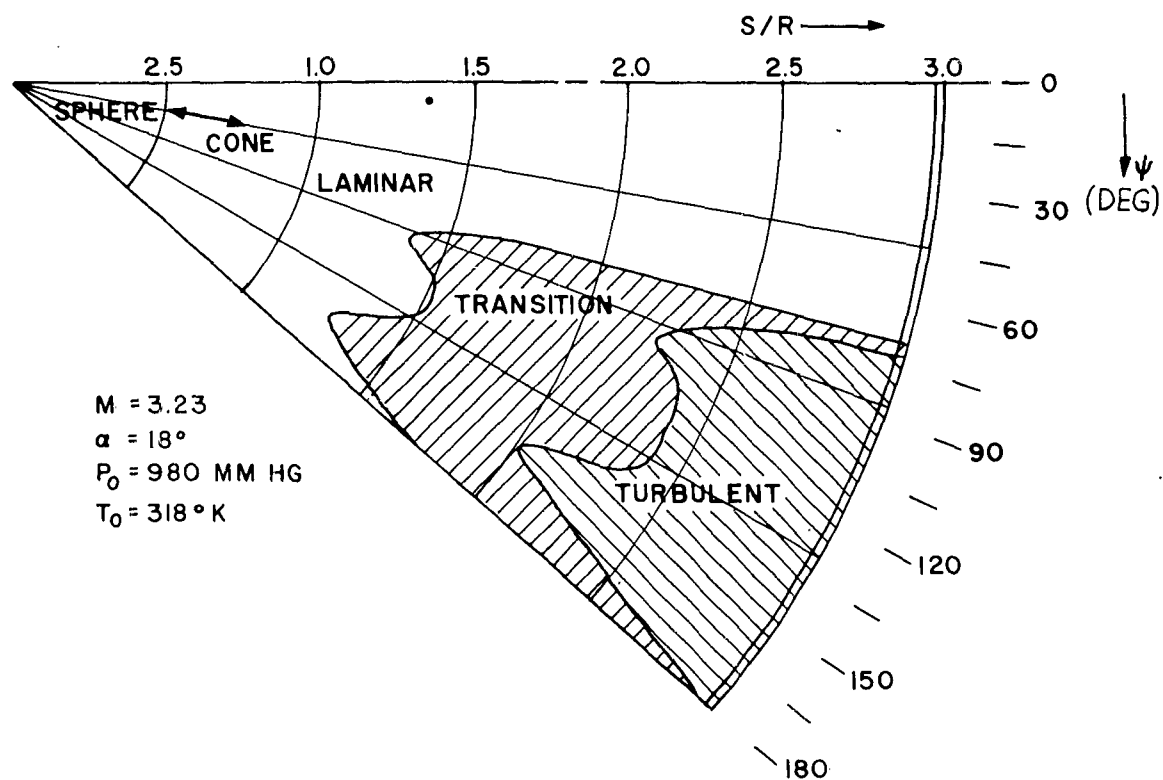


FIG.18 THE REGIONS OF LAMINAR, TRANSITIONAL AND TURBULENT BOUNDARY LAYERS AT $M = 3.23$, $\alpha = 18^\circ$

Table 1
THERMOJUNCTION AND PRESSURE ORIFICE LOCATIONS

THERMOJUNCTION LOCATIONS			PRESSURE ORIFICE LOCATIONS		
SPHERE		CONE		CONE	
Station	S/R	Station	S/R	Station	S/R
1	0.068	10	0.645	20	1.890
2	0.136	11	0.769	21	2.014
3	0.204	12	0.894	22	2.138
4	0.305	13	1.018	23	2.263
5	0.356	14	1.143	24	2.387
6	0.407	15	1.267	25	2.512
7	0.455	16	1.392	26	2.636
8	0.520	17	1.516	27	2.761
9		18	1.640	28	2.885
		19	1.765	29	3.010
				A	0.068
				B	0.136
				C	0.258
				D	0.407
				E	0.520
				F	0.769
				G	1.112
				H	1.454
				I	1.796
				J	2.138
				K	2.481

Table 2

PRESSURE DISTRIBUTION ON SPHERE-CONE MODEL

MACH NUMBER = 4.8

ANGLE OF ATTACK = 18.0 DEGREES

SUPPLY PRESSURE = 2090.0 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

DIMENSIONLESS CONTOUR LENGTH

ROLL ANGLE	0.068	0.136	0.258	0.407	0.520	0.769	1.112	1.454	1.796	2.138	2.481
0	0.9909	0.9949	0.9642	0.5128	0.2849	0.2658	0.2764	0.2903	0.2998	0.3039	0.3041
5	0.9905	0.9934	0.9612	0.5101	0.2834	0.2639	0.2736	0.2878	0.2981	0.3019	0.3023
10	0.9887	0.9888	0.9566	0.5052	0.2802	0.2602	0.2707	0.2839	0.2934	0.2969	0.2981
15	0.9865	0.9851	0.9476	0.4980	0.2749	0.2558	0.2646	0.2765	0.2861	0.2914	0.2920
20	0.9812	0.9778	0.9351	0.4862	0.2675	0.2487	0.2561	0.2661	0.2746	0.2807	0.2820
25	0.9777	0.9697	0.9201	0.4735	0.2594	0.2416	0.2473	0.2568	0.2638	0.2704	0.2715
30	0.9724	0.9607	0.9052	0.4596	0.2504	0.2313	0.2358	0.2450	0.2504	0.2575	0.2602
35	0.9656	0.9487	0.8859	0.4437	0.2394	0.2216	0.2240	0.2314	0.2367	0.2436	0.2462
40	0.9595	0.9350	0.8650	0.4239	0.2274	0.2076	0.2086	0.2143	0.2184	0.2272	0.2277
45	0.9531	0.9198	0.8434	0.4012	0.2096	0.1960	0.1930	0.1971	0.2033	0.2069	0.2081
50	0.9465	0.9049	0.8217	0.3865	0.2013	0.1894	0.1801	0.1852	0.1879	0.1932	0.1966
55	0.9382	0.8906	0.8085	0.3675	0.1896	0.1761	0.1681	0.1706	0.1723	0.1764	0.1806
60	0.9282	0.8724	0.7824	0.3471	0.1759	0.1644	0.1541	0.1547	0.1551	0.1585	0.1622
65	0.9193	0.8566	0.7647	0.3266	0.1643	0.1519	0.1429	0.1409	0.1398	0.1419	0.1449
70	0.9094	0.8390	0.7420	0.3069	0.1525	0.1405	0.1321	0.1280	0.1260	0.1273	0.1292
75	0.9003	0.8222	0.7255	0.2881	0.1412	0.1300	0.1205	0.1153	0.1121	0.1133	0.1151
80	0.8903	0.8038	0.7072	0.2699	0.1299	0.1202	0.1100	0.1051	0.0999	0.1001	0.1024
85	0.8803	0.7860	0.6890	0.2504	0.1187	0.1116	0.1017	0.0940	0.0887	0.0884	0.0906
90	0.8705	0.7652	0.6682	0.2331	0.1058	0.1031	0.0907	0.0809	0.0784	0.0762	0.0782
95	0.8617	0.7489	0.6504	0.2131	0.1133	0.0994	0.0786	0.0691	0.0657	0.0647	0.0654
100	0.8526	0.7339	0.6308	0.2043	0.1062	0.0941	0.0731	0.0648	0.0606	0.0585	0.0608
105	0.8436	0.7181	0.6142	0.1910	0.0997	0.0877	0.0684	0.0594	0.0557	0.0533	0.0545
110	0.8360	0.7027	0.6004	0.1788	0.0931	0.0816	0.0640	0.0557	0.0496	0.0471	0.0474
115	0.8272	0.6877	0.5863	0.1668	0.0867	0.0762	0.0601	0.0510	0.0440	0.0420	0.0422
120	0.8184	0.6729	0.5729	0.1563	0.0840	0.0711	0.0564	0.0472	0.0411	0.0376	0.0386
125	0.8111	0.6599	0.5603	0.1466	0.0809	0.0674	0.0525	0.0433	0.0372	0.0347	0.0337
130	0.8045	0.6484	0.5499	0.1378	0.0780	0.0638	0.0489	0.0403	0.0339	0.0306	0.0322
135	0.7982	0.6369	0.5388	0.1295	0.0756	0.0604	0.0449	0.0362	0.0318	0.0286	0.0316
140	0.7943	0.6294	0.5315	0.1229	0.0744	0.0581	0.0411	0.0322	0.0290	0.0256	0.0286
145	0.7892	0.6216	0.5244	0.1178	0.0731	0.0564	0.0393	0.0322	0.0290	0.0261	0.0240
150	0.7855	0.6145	0.5178	0.1133	0.0722	0.0545	0.0388	0.0320	0.0288	0.0264	0.0247
155	0.7818	0.6098	0.5133	0.1092	0.0708	0.0525	0.0366	0.0300	0.0268	0.0246	0.0229
160	0.7791	0.6045	0.5080	0.1063	0.0691	0.0508	0.0346	0.0285	0.0253	0.0231	0.0215
165	0.7765	0.6003	0.5038	0.1033	0.0676	0.0493	0.0331	0.0270	0.0238	0.0216	0.0200
170	0.7755	0.5979	0.5014	0.1014	0.0659	0.0476	0.0314	0.0253	0.0221	0.0200	0.0184
175	0.7743	0.5969	0.5004	0.1001	0.0647	0.0464	0.0302	0.0241	0.0209	0.0188	0.0172
180	0.7742	0.5966	0.5001	0.0995	0.0640	0.0457	0.0295	0.0234	0.0202	0.0181	0.0165

Table 2 (cont'd.)

MACH NUMBER = 3.2

ANGLE OF ATTACK = 18.0 DEGREES

SUPPLY PRESSURE = 980.0 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 319.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONTOUR LENGTH											
	0.063	0.136	0.258	0.407	0.520	0.769	1.112	1.454	1.796	2.138	2.481	
0	0.9682	0.9956	0.8663	0.5366	0.3154	(LOCAL STATIC PRESSURE)/(PITOT PRESSURE)						0.3439
5	0.9664	0.9956	0.8643	0.5355	0.3158	0.3282	0.3386	0.3545	0.3503	0.3483	0.3403	
10	0.9651	0.9943	0.8557	0.5304	0.3125	0.3229	0.3293	0.3474	0.3434	0.3359	0.3359	
15	0.9624	0.9870	0.8469	0.5204	0.3070	0.3180	0.3224	0.3403	0.3364	0.3291	0.3291	
20	0.9589	0.9777	0.8351	0.5094	0.3006	0.3103	0.3143	0.3295	0.3255	0.3180	0.3180	
25	0.9554	0.9671	0.8201	0.4964	0.2930	0.2983	0.3034	0.3165	0.3127	0.3074	0.3074	
30	0.9523	0.9585	0.8051	0.4840	0.2855	0.2855	0.2908	0.3001	0.2997	0.2975	0.2975	
35	0.9485	0.9487	0.7861	0.4720	0.2767	0.2751	0.2791	0.2869	0.2873	0.2866	0.2866	
40	0.9401	0.9341	0.7638	0.4506	0.2619	0.2572	0.2581	0.2692	0.2705	0.2694	0.2694	
45	0.9339	0.9209	0.7450	0.4334	0.2504	0.2422	0.2469	0.2526	0.2577	0.2537	0.2537	
50	0.9280	0.9081	0.7249	0.4128	0.2360	0.2285	0.2303	0.2356	0.2427	0.2360	0.2360	
55	0.9187	0.8915	0.6999	0.3907	0.2203	0.2139	0.2152	0.2203	0.2256	0.2177	0.2177	
60	0.9094	0.8738	0.6754	0.3706	0.2053	0.1971	0.2000	0.2044	0.2091	0.1996	0.1996	
65	0.8992	0.8575	0.6513	0.3529	0.1947	0.1836	0.1861	0.1890	0.1916	0.1801	0.1801	
70	0.8926	0.8418	0.6301	0.3337	0.1799	0.1708	0.1726	0.1759	0.1750	0.1653	0.1653	
75	0.8846	0.8267	0.6091	0.3167	0.1682	0.1554	0.1613	0.1593	0.1582	0.1492	0.1492	
80	0.8747	0.8113	0.5887	0.2994	0.1567	0.1439	0.1485	0.1461	0.1452	0.1375	0.1375	
85	0.8641	0.7943	0.5669	0.2802	0.1445	0.1308	0.1370	0.1317	0.1328	0.1229	0.1229	
90	0.8537	0.7739	0.5425	0.2590	0.1302	0.1162	0.1260	0.1162	0.1154	0.1072	0.1072	
95	0.8449	0.7589	0.5255	0.2482	0.1213	0.1074	0.1138	0.1039	0.1043	0.0950	0.0950	
100	0.8336	0.7417	0.5039	0.2334	0.1151	0.1001	0.1034	0.0944	0.0957	0.0853	0.0853	
105	0.8274	0.7257	0.4835	0.2186	0.1063	0.0910	0.0959	0.0869	0.0869	0.0758	0.0758	
110	0.8177	0.7103	0.4650	0.2069	0.0972	0.0835	0.0895	0.0796	0.0791	0.0676	0.0676	
115	0.8080	0.6959	0.4464	0.1936	0.0906	0.0769	0.0840	0.0738	0.0723	0.0599	0.0599	
120	0.8007	0.6820	0.4303	0.1817	0.0846	0.0707	0.0785	0.0694	0.0654	0.0535	0.0535	
125	0.7918	0.6674	0.4139	0.1722	0.0802	0.0650	0.0738	0.0636	0.0608	0.0480	0.0480	
130	0.7819	0.6548	0.3976	0.1618	0.0731	0.0623	0.0654	0.0588	0.0559	0.0449	0.0449	
135	0.7757	0.6433	0.3848	0.1538	0.0698	0.0579	0.0608	0.0548	0.0535	0.0415	0.0415	
140	0.7693	0.6325	0.3706	0.1463	0.0659	0.0570	0.0614	0.0566	0.0548	0.0402	0.0402	
145	0.7615	0.6239	0.3596	0.1401	0.0619	0.0555	0.0577	0.0559	0.0548	0.0440	0.0440	
150	0.7567	0.6150	0.3514	0.1357	0.0568	0.0559	0.0577	0.0559	0.0559	0.0459	0.0459	
155	0.7545	0.6095	0.3454	0.1315	0.0568	0.0579	0.0586	0.0572	0.0579	0.0473	0.0473	
160	0.7503	0.6038	0.3399	0.1260	0.0552	0.0577	0.0586	0.0586	0.0623	0.0517	0.0517	
165	0.7470	0.5989	0.3348	0.1224	0.0522	0.0583	0.0592	0.0601	0.0659	0.0552	0.0552	
170	0.7461	0.5947	0.3313	0.1218	0.0524	0.0586	0.0594	0.0625	0.0683	0.0590	0.0590	
175	0.7461	0.5940	0.3293	0.1207	0.0522	0.0586	0.0606	0.0625	0.0692	0.0619	0.0619	
180	0.7461	0.5940	0.3293	0.1176	0.0510	0.0575	0.0588	0.0639	0.0692	0.0621	0.0621	

Table 2 (cont'd.)

PRESSURE DISTRIBUTION ON SPHERE-CONE MODEL

PACH NUMBER = 3.2

ANGLE OF ATTACK = 6.0 DEGREES

SUPPLY PRESSURE = 980.0 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 318.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONTOUR LENGTH										
	0.068	0.136	0.258	0.407	0.520	0.769	1.112	1.454	1.796	2.138	2.481
	(LOCAL STATIC PRESSURE)/(PISTON PRESSURE)										
0	0.9624	0.9310	0.7165	0.3593	0.1817	0.1843	0.1757	0.1741	0.1777	0.1808	0.1710
5	0.9609	0.9277	0.7143	0.3587	0.1812	0.1834	0.1750	0.1737	0.1768	0.1794	0.1699
10	0.9596	0.9224	0.7094	0.3571	0.1806	0.1817	0.1730	0.1728	0.1759	0.1783	0.1680
15	0.9569	0.9173	0.7054	0.3549	0.1799	0.1806	0.1722	0.1713	0.1746	0.1772	0.1671
20	0.9540	0.9114	0.6992	0.3516	0.1794	0.1779	0.1706	0.1695	0.1726	0.1752	0.1653
25	0.9505	0.9063	0.6928	0.3474	0.1788	0.1783	0.1680	0.1666	0.1706	0.1719	0.1631
30	0.9481	0.9003	0.6855	0.3448	0.1772	0.1761	0.1638	0.1640	0.1691	0.1691	0.1627
35	0.9454	0.8946	0.6787	0.3423	0.1757	0.1741	0.1618	0.1604	0.1677	0.1662	0.1600
40	0.9425	0.8860	0.6692	0.3372	0.1737	0.1710	0.1591	0.1571	0.1660	0.1627	0.1562
45	0.9401	0.8773	0.6581	0.3315	0.1719	0.1673	0.1562	0.1543	0.1627	0.1624	0.1534
50	0.9388	0.8720	0.6495	0.3253	0.1688	0.1631	0.1529	0.1525	0.1587	0.1587	0.1507
55	0.9388	0.8650	0.6378	0.3171	0.1629	0.1580	0.1485	0.1498	0.1549	0.1556	0.1472
60	0.9383	0.8601	0.6278	0.3112	0.1591	0.1536	0.1450	0.1459	0.1509	0.1525	0.1428
65	0.9392	0.8557	0.6188	0.3059	0.1551	0.1509	0.1421	0.1421	0.1472	0.1492	0.1397
70	0.9392	0.8517	0.6082	0.2966	0.1512	0.1474	0.1379	0.1388	0.1450	0.1450	0.1357
75	0.9410	0.8539	0.6027	0.2895	0.1481	0.1450	0.1361	0.1350	0.1417	0.1370	0.1372
80	0.9397	0.8524	0.5962	0.2818	0.1454	0.1410	0.1344	0.1324	0.1372	0.1333	0.1339
85	0.9372	0.8480	0.5903	0.2747	0.1414	0.1377	0.1313	0.1291	0.1313	0.1286	0.1302
90	0.9350	0.8429	0.5834	0.2694	0.1368	0.1344	0.1228	0.1262	0.1269	0.1251	0.1260
95	0.9348	0.8393	0.5783	0.2639	0.1326	0.1291	0.1264	0.1220	0.1233	0.1211	0.1209
100	0.9341	0.8365	0.5724	0.2590	0.1291	0.1262	0.1231	0.1189	0.1211	0.1180	0.1187
105	0.9326	0.8340	0.5662	0.2530	0.1251	0.1231	0.1193	0.1145	0.1171	0.1158	0.1156
110	0.9322	0.8318	0.5587	0.2471	0.1218	0.1207	0.1158	0.1129	0.1136	0.1129	0.1125
115	0.9306	0.8294	0.5518	0.2422	0.1171	0.1173	0.1120	0.1114	0.1123	0.1105	0.1109
120	0.9291	0.8256	0.5441	0.2373	0.1158	0.1154	0.1109	0.1101	0.1101	0.1083	0.1081
125	0.9286	0.8219	0.5383	0.2336	0.1143	0.1123	0.1083	0.1059	0.1081	0.1050	0.1048
130	0.9273	0.8161	0.5324	0.2285	0.1120	0.1090	0.1070	0.1036	0.1052	0.1041	0.1039
135	0.9255	0.8128	0.5266	0.2241	0.1092	0.1059	0.1017	0.1008	0.1034	0.1030	0.1030
140	0.9262	0.8113	0.5242	0.2265	0.1094	0.1056	0.1012	0.1014	0.1045	0.1032	0.1025
145	0.9246	0.8080	0.5204	0.2270	0.1076	0.1054	0.0992	0.1008	0.1023	0.1014	0.1008
150	0.9231	0.8060	0.5176	0.2254	0.1065	0.1039	0.0970	0.0988	0.1012	0.1012	0.1008
155	0.9218	0.8038	0.5151	0.2243	0.1043	0.1023	0.0952	0.0970	0.1006	0.1008	0.1008
160	0.9196	0.8015	0.5138	0.2217	0.1021	0.1008	0.0955	0.0970	0.1001	0.1003	0.1008
165	0.9198	0.7993	0.5131	0.2183	0.1003	0.0997	0.0957	0.0970	0.1006	0.0999	0.1003
170	0.9187	0.7993	0.5120	0.2172	0.0986	0.0979	0.0957	0.0970	0.1006	0.0997	0.0994
175	0.9187	0.7993	0.5109	0.2164	0.0983	0.0972	0.0948	0.0970	0.1006	0.0992	0.0990
180	0.9187	0.7993	0.5109	0.2159	0.0972	0.0972	0.0944	0.0957	0.0992	0.0988	0.0988

Table 2 (cont'd.)
PRESSURE DISTRIBUTION ON SPHERE-CONE MODEL

MACH NUMBER = 4.8
ANGLE OF ATTACK = 6.0 DEGREES
SUPPLY PRESSURE = 2090.0 MILLIMETERS OF HG.
SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONTOUR LENGTH										
	0.668	0.136	0.258	0.407	0.520	0.769	1.112	1.454	1.796	2.138	2.481
0	0.9753	0.9191	0.6785	(LOCAL STATIC PRESSURE)/(PILOT PRESSURE)	0.3292	0.1693	0.1429	0.1360	0.1356	0.1343	0.1389
5	0.9740	0.9184	0.6772	0.3267	0.1666	0.1422	0.1378	0.1356	0.1340	0.1385	0.1382
10	0.9740	0.9171	0.6755	0.3260	0.1649	0.1421	0.1378	0.1358	0.1331	0.1375	0.1377
15	0.9725	0.9152	0.6728	0.3233	0.1637	0.1405	0.1372	0.1346	0.1323	0.1356	0.1353
20	0.9691	0.9123	0.6681	0.3187	0.1615	0.1377	0.1348	0.1336	0.1314	0.1343	0.1329
25	0.9664	0.9076	0.6613	0.3145	0.1584	0.1350	0.1329	0.1312	0.1292	0.1316	0.1302
30	0.9642	0.9044	0.6564	0.3105	0.1573	0.1319	0.1301	0.1291	0.1272	0.1291	0.1275
35	0.9625	0.9014	0.6493	0.3064	0.1541	0.1276	0.1260	0.1285	0.1258	0.1291	0.1262
40	0.9605	0.9003	0.6421	0.3007	0.1503	0.1262	0.1253	0.1252	0.1228	0.1248	0.1215
45	0.9586	0.8958	0.6363	0.2965	0.1473	0.1233	0.1235	0.1225	0.1187	0.1199	0.1177
50	0.9551	0.8902	0.6297	0.2921	0.1449	0.1206	0.1203	0.1198	0.1164	0.1162	0.1135
55	0.9515	0.8856	0.6181	0.2833	0.1383	0.1162	0.1157	0.1157	0.1123	0.1139	0.1091
60	0.9488	0.8792	0.6130	0.2797	0.1329	0.1149	0.1144	0.1139	0.1086	0.1100	0.1030
65	0.9448	0.8721	0.6024	0.2725	0.1297	0.1101	0.1106	0.1106	0.1059	0.1064	0.1012
70	0.9404	0.8650	0.5929	0.2662	0.1257	0.1064	0.1081	0.1074	0.1029	0.1024	0.0985
75	0.9367	0.8618	0.5856	0.2611	0.1245	0.1049	0.1034	0.1047	0.0995	0.0986	0.0934
80	0.9321	0.8559	0.5794	0.2574	0.1211	0.1029	0.1008	0.1015	0.0961	0.0956	0.0900
85	0.9285	0.8486	0.5669	0.2483	0.1181	0.0990	0.0978	0.0986	0.0937	0.0919	0.0870
90	0.9252	0.8421	0.5530	0.2400	0.1105	0.0950	0.0953	0.0941	0.0890	0.0885	0.0834
95	0.9221	0.8346	0.5488	0.2323	0.1069	0.0934	0.0903	0.0865	0.0801	0.0814	0.0772
100	0.9221	0.8301	0.5419	0.2280	0.1042	0.0910	0.0890	0.0872	0.0789	0.0791	0.0752
105	0.9186	0.8247	0.5345	0.2245	0.1022	0.0883	0.0865	0.0826	0.0764	0.0764	0.0723
110	0.9157	0.8174	0.5275	0.2186	0.0992	0.0846	0.0836	0.0812	0.0755	0.0743	0.0701
115	0.9120	0.8110	0.5204	0.2137	0.0971	0.0821	0.0824	0.0789	0.0736	0.0730	0.0694
120	0.9091	0.8057	0.5137	0.2093	0.0949	0.0802	0.0796	0.0774	0.0721	0.0709	0.0660
125	0.9076	0.7995	0.5073	0.2052	0.0917	0.0775	0.0769	0.0755	0.0706	0.0698	0.0640
130	0.9052	0.7948	0.5002	0.2007	0.0897	0.0757	0.0748	0.0750	0.0698	0.0672	0.0623
135	0.9020	0.7872	0.4948	0.1963	0.0863	0.0730	0.0745	0.0723	0.0669	0.0659	0.0613
140	0.8998	0.7834	0.4919	0.1965	0.0885	0.0743	0.0735	0.0716	0.0657	0.0633	0.0601
145	0.8990	0.7802	0.4889	0.1932	0.0865	0.0738	0.0711	0.0696	0.0644	0.0633	0.0586
150	0.8980	0.7770	0.4853	0.1902	0.0843	0.0725	0.0704	0.0691	0.0639	0.0617	0.0581
155	0.8963	0.7760	0.4814	0.1835	0.0823	0.0709	0.0699	0.0682	0.0620	0.0606	0.0569
160	0.8963	0.7743	0.4814	0.1873	0.0823	0.0699	0.0684	0.0671	0.0608	0.0601	0.0562
165	0.8963	0.7731	0.4804	0.1865	0.0807	0.0696	0.0681	0.0666	0.0608	0.0601	0.0562
170	0.8963	0.7726	0.4789	0.1853	0.0807	0.0696	0.0684	0.0660	0.0603	0.0601	0.0562
175	0.8963	0.7726	0.4789	0.1845	0.0802	0.0693	0.0679	0.0652	0.0601	0.0601	0.0562
180	0.8963	0.7726	0.4784	0.1838	0.0791	0.0682	0.0674	0.0633	0.0575	0.0591	0.0562

Table 3
TEMPERATURE DISTRIBUTION ON SPHERE-CONE MODEL. (NOSE SECTION)

MACH NUMBER = 4.82

ANGLE OF ATTACK = 18 DEGREES

SUPPLY PRESSURE = 2090 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

S/R	D	ROLL ANGLE (DEGREES)										180		
		0	15	30	45	60	75	90	105	120	135		150	165
		TEMPERATURE, °K												
0.	0.	256.8	255.4	254.8	255.0	254.4	254.1	254.1	254.5	254.9	255.2	255.1	255.3	255.0
0.	0.500	242.0	240.4	240.3	239.9	239.8	239.3	239.2	240.0	240.0	240.7	240.7	240.2	239.7
0.068	0.	258.6	257.0	255.9	255.8	254.8	254.2	253.6	253.4	253.3	253.4	253.0	253.0	252.6
0.136	0.	259.7	257.9	256.6	256.1	254.7	253.6	252.5	252.0	251.3	250.9	250.3	250.0	249.6
0.136	0.500	246.8	243.9	242.9	242.2	241.0	240.4	239.9	239.7	239.2	239.3	238.6	238.2	238.1
0.204	0.	259.7	258.0	256.3	255.7	253.8	252.8	250.9	250.0	249.2	248.4	247.6	247.2	246.7
0.305	0.	258.8	256.9	255.3	254.2	252.1	249.9	248.0	246.5	245.4	244.4	243.4	242.7	242.2
0.305	0.500													
0.305	0.375	250.9	248.7	247.4	246.6	244.9	243.2	241.9	240.8	240.1	239.3	238.6	237.9	237.4
0.305	0.250	253.8	251.8	250.4	249.6	247.7	245.8	244.3	243.1	242.1	241.3	240.5	239.8	239.2
0.305	0.125	256.5	254.5	253.1	252.1	250.2	248.1	246.3	244.9	243.8	242.8	241.8	241.1	240.6
0.356	0.	257.6	255.8	254.1	252.8	250.4	248.5	246.4	244.8	243.7	242.5	241.4	240.7	240.3
0.407	0.	255.1	254.5	252.7	251.3	249.1	247.0	244.8	243.1	241.8	240.7	239.7	239.1	238.7
0.407	0.500	248.5	246.6	244.9	243.9	242.1	240.7	239.2	237.9	237.1	236.4	235.6	235.0	234.8
0.455	0.	255.1	253.3	251.4	250.0	247.6	245.5	243.3	242.0	240.5	239.8	238.9	238.3	238.2
0.520	0.	253.3	251.6	249.5	248.2	245.9	243.7	241.7	239.9	238.9	237.9	236.8	236.2	235.6
0.520	0.500	248.5	246.5	244.8	243.5	241.8	240.0	238.5	237.1	236.3	235.6	234.5	233.9	233.4
0.520	0.375	249.7	248.1	246.3	245.2	243.2	241.3	239.6	238.1	237.2	236.3	235.2	234.6	234.1
0.520	0.250	251.0	249.4	247.5	246.4	244.3	242.3	240.5	238.8	237.9	237.0	235.9	235.2	234.6
0.520	0.125	252.1	250.4	248.6	247.3	245.1	243.0	241.1	239.4	238.4	237.4	236.2	235.5	234.9

Table 3 (cont'd.)

TEMPERATURE DISTRIBUTION ON SPHERE-CONE MODEL, (CONE SECTION)

MACH NUMBER = 4.82

ANGLE OF ATTACK = 18 DEGREES

SUPPLY PRESSURE = 2090 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

S/R	D	ROLL ANGLE (DEGREES)					TEMPERATURE, °K																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
		0	15	30	45	60	75	90	105	120	135	150	165	180																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

Table 3 (cont'd.)

TEMPERATURE DISTRIBUTION ON SPHERE-CONE MODEL (NOSE SECTION)

MACH NUMBER = 3.23

ANGLE OF ATTACK = 18 DEGREES

SUPPLY PRESSURE = 980 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 318.0 DEGREES KELVIN

S/R	D	ROLL ANGLE (DEGREES)										165	180	
		0	15	30	45	60	75	90	105	120	135			150
		TEMPERATURE, °K												
0.	0.	266.6	265.8	265.7	264.9	264.5	264.0	263.7	264.4	264.3	264.4	264.5	264.6	264.5
0.	0.500	246.0	246.0	248.0	245.5	245.1	245.5	244.5	244.7	244.7	245.6	245.7	244.8	244.2
0.068	0.	268.4	267.6	267.7	266.3	265.3	264.4	263.5	263.5	262.9	262.4	262.1	261.9	261.5
0.136	0.	269.8	268.9	268.5	266.7	265.3	263.7	262.3	261.5	260.9	260.1	259.4	259.1	258.7
0.136	0.500	254.9	254.4	252.7	251.6	250.3	249.1	247.9	248.0	247.6	247.3	246.6	246.1	246.0
0.204	0.	269.5	268.8	268.0	266.3	264.4	262.6	260.7	259.8	258.5	257.3	256.4	255.9	255.5
0.305	0.	268.6	267.9	266.6	264.3	262.1	260.0	257.7	256.4	254.6	253.2	252.0	251.1	250.8
0.305	0.500	259.8	259.3	258.0	256.0	254.1	252.5	250.5	249.7	248.6	247.6	246.6	245.8	245.6
0.305	0.375	263.2	262.6	261.4	259.4	257.3	255.6	253.5	252.5	251.1	250.0	248.9	248.0	247.8
0.305	0.125	266.3	265.5	264.4	262.2	260.1	258.2	256.0	254.8	253.2	251.9	250.6	249.6	249.3
0.356	0.	267.3	266.7	265.5	263.1	260.6	258.5	256.0	254.4	252.6	251.0	250.0	249.1	248.8
0.407	0.	265.8	265.2	264.1	261.6	259.1	256.8	254.3	252.7	250.7	249.2	248.0	247.2	246.8
0.407	0.500	257.2	256.6	255.5	253.3	251.4	249.6	247.6	246.5	245.4	244.4	243.5	242.8	242.5
0.455	0.	264.6	264.0	262.8	260.2	257.7	255.3	252.9	251.1	249.1	247.7	246.8	246.4	246.0
0.520	0.	262.7	262.1	261.0	258.5	256.0	253.5	251.0	249.2	247.3	245.8	244.8	244.1	243.8
0.520	0.500	257.3	256.5	255.7	253.4	251.3	249.3	247.2	245.8	244.6	243.5	242.5	241.8	241.5
0.520	0.375	258.8	258.1	257.3	255.1	252.9	250.8	248.6	247.1	245.7	244.5	243.4	242.6	242.3
0.520	0.250	260.4	259.7	258.8	256.6	254.3	252.0	249.7	248.1	246.6	245.3	244.2	243.4	243.0
0.520	0.125	261.8	261.0	260.0	257.7	255.3	253.0	250.6	248.9	247.2	245.8	244.7	243.8	243.4

Table 3 (cont'd.)

MACH NUMBER = 3.23

ANGLE OF ATTACK = 18 DEGREES

SUPPLY PRESSURE = 980 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 318.0 DEGREES KELVIN

S/R	D	0	15	30	45	60	75	90	105	120	135	150	165	180
		TEMPERATURE, °K												
		ROLL ANGLE (DEGREES)												
0.645	0.	261.3	260.8	259.7	257.2	254.6	252.0	249.4	247.4	245.4	244.1	243.0	242.4	242.1
0.645	0.500	257.4	256.7	255.8	253.6	251.3	249.1	246.9	245.3	243.8	242.7	241.7	240.9	240.7
0.769	0.	261.3	260.7	259.4	256.9	254.1	251.4	248.7	246.6	244.4	242.9	242.0	241.4	241.3
0.769	0.500	257.8	257.0	255.8	253.6	251.2	248.7	246.3	244.7	243.0	241.8	240.7	240.0	239.8
0.894	0.	261.5	260.8	259.4	256.6	253.6	250.7	248.0	245.7	243.3	241.8	240.8	240.3	240.1
0.894	0.500	258.5	257.5	256.0	253.5	250.8	248.2	245.7	243.9	242.1	240.8	239.7	239.0	238.9
1.018	0.	261.8	260.9	259.3	256.4	253.3	250.3	247.3	244.9	242.7	241.2	240.0	239.2	239.0
1.018	0.500	258.9	257.7	256.0	253.1	250.3	247.7	245.0	243.2	241.4	240.0	238.8	238.1	237.9
1.143	0.	262.3	261.2	259.5	256.3	253.1	250.1	246.9	244.4	242.3	240.8	239.5	238.7	238.4
1.143	0.500	259.3	257.8	255.8	252.7	249.7	246.6	243.5	241.7	240.6	239.3	238.1	237.3	237.1
1.267	0.	262.4	261.3	259.4	256.0	252.7	249.6	246.5	243.9	241.7	240.3	239.0	238.1	237.8
1.267	0.500	259.9	258.3	256.1	252.9	249.9	247.1	244.4	242.3	240.6	239.3	238.1	237.2	236.9
1.392	0.	263.1	261.9	259.8	256.3	253.0	249.8	246.8	244.3	241.9	240.9	239.6	238.5	238.0
1.392	0.500	260.4	258.7	256.5	253.1	250.0	247.2	244.5	242.5	240.4	239.5	238.3	237.4	237.0
1.516	0.	263.6	262.4	260.1	256.6	253.1	249.9	247.1	244.6	242.0	241.2	240.2	238.9	238.2
1.516	0.500	260.9	259.2	256.8	253.3	250.2	247.2	244.7	242.6	240.3	239.6	238.6	237.5	236.9
1.640	0.	264.1	262.9	260.5	257.1	253.7	250.4	248.1	245.5	242.7	242.0	241.5	239.8	238.9
1.640	0.500	261.4	259.8	257.3	253.9	250.7	247.7	245.6	243.4	240.8	240.4	239.4	238.3	237.3
1.765	0.	264.9	263.6	261.0	257.6	254.4	251.5	249.5	246.9	243.8	243.0	242.8	240.9	239.4
1.765	0.500	262.0	260.4	257.6	254.3	251.2	248.3	246.6	244.2	241.4	241.0	240.2	239.0	237.7
1.890	0.	265.5	264.2	261.6	258.1	255.0	252.5	251.2	248.0	244.7	243.9	243.5	242.1	240.0
1.890	0.500	262.9	261.3	258.4	255.0	252.0	249.4	248.1	245.3	242.3	242.0	241.3	240.2	238.4
2.014	0.	266.7	265.1	262.4	259.0	256.1	253.9	253.3	249.5	245.8	245.1	244.6	244.1	241.4
2.014	0.500	264.2	262.2	259.2	255.8	253.0	250.6	249.6	246.4	243.3	243.1	242.3	241.5	239.5
2.138	0.	268.1	266.3	263.3	259.7	256.8	253.6	250.9	247.5	244.3	243.1	242.5	242.8	240.8
2.138	0.500	265.9	263.7	260.5	256.7	253.7	250.9	250	247.5	244.3	244.1	243.5	242.6	240.8
2.263	0.	270.1	268.0	264.5	260.5	257.5	254.7	252.5	249.6	246.8	246.1	245.7	245.5	242.8
2.263	0.500	268.0	265.6	261.7	257.6	254.4	251.8	249.6	247.5	245.1	244.6	243.9	243.3	241.8
2.387	0.	272.4	270.2	266.3	261.7	258.5	255.9	253.6	252.6	248.7	247.5	246.9	246.9	245.7
2.387	0.500	270.6	268.0	263.5	258.8	255.2	252.5	250.9	249.1	245.7	245.0	244.1	243.7	242.6
2.512	0.	274.4	272.2	268.0	262.9	259.2	256.9	255.9	252.6	248.8	247.4	246.7	246.6	245.9
2.512	0.500	273.1	270.7	265.8	260.1	256.2	253.4	251.2	249.6	246.2	245.2	244.3	243.7	243.3
2.636	0.	276.5	274.4	270.2	264.5	260.8	257.6	255.6	253.2	249.2	247.5	246.9	246.9	246.5
2.636	0.500	275.3	273.1	268.4	261.7	257.5	254.4	252.4	249.9	246.5	245.0	244.1	243.8	243.8
2.761	0.	278.1	276.0	272.1	266.3	262.5	258.1	255.1	252.7	249.6	247.6	247.1	247.3	247.0
2.761	0.500	277.0	274.9	270.6	263.6	258.8	254.1	251.2	248.3	245.7	244.1	243.9	243.9	243.9
2.885	0.													
2.885	0.500													
3.010	0.	278.9	277.1	273.7	268.7	265.2	264.2	258.9	254.5	250.4	248.0	247.8	248.8	248.3
3.010	0.375	277.9	276.1	272.7	267.4	262.3	260.4	255.7	251.9	248.9	246.1	245.5	246.0	246.0
3.010	0.250	278.2	276.3	272.8	267.6	263.0	261.6	256.7	252.7	248.9	246.7	246.2	246.6	246.6
3.010	0.125	278.6	276.8	273.5	268.2	264.1	263.0	257.9	253.7	249.7	247.4	247.0	247.9	247.5

Table 3 (cont'd.)
TEMPERATURE DISTRIBUTION ON SPHERE-CONE MODEL, (NOSE SECTION)

MACH NUMBER = 3.23

ANGLE OF ATTACK = 6 DEGREES

SUPPLY PRESSURE = 980 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

S/R	D	ROLL ANGLE (DEGREES)										150	165	180
		0	15	30	45	60	75	90	105	120	135			
		TEMPERATURE, °K												
0.	0.	265.3	265.1	264.3	263.5	263.1	263.2	262.6	262.6	262.9	263.2	263.1	263.3	262.2
0.	0.500	246.1	245.5	245.8	243.6	244.5	244.9	242.8	243.2	243.2	244.0	243.1	243.0	242.1
0.068	0.	266.1	265.7	264.7	263.5	262.6	262.4	261.7	261.6	262.0	262.3	262.2	262.4	261.2
0.136	0.	266.4	265.8	264.7	263.3	261.9	261.4	260.6	260.5	260.6	260.7	260.5	260.8	259.7
0.136	0.500	252.4	251.3	249.2	248.3	246.5	245.7	244.9	245.6	246.0	246.0	245.6	245.6	244.5
0.204	0.	265.7	265.1	263.7	262.5	260.4	259.8	258.9	258.8	258.8	258.8	258.4	258.6	257.5
0.305	0.	263.1	262.5	261.1	259.7	257.5	256.7	255.5	255.4	255.2	254.9	254.5	254.5	253.5
0.305	0.500	255.1	254.5	252.9	251.5	249.3	248.8	247.8	247.8	247.8	247.5	247.1	247.2	246.2
0.305	0.375	258.1	257.6	256.1	254.7	252.5	252.0	250.9	250.8	250.8	250.5	250.1	249.1	248.1
0.305	0.125	260.8	260.2	258.5	257.4	255.3	254.6	253.5	253.3	253.1	252.8	252.4	252.4	251.4
0.356	0.	261.4	260.8	259.4	258.0	255.8	255.0	253.6	253.5	253.2	252.9	252.4	252.4	251.2
0.407	0.	259.4	258.9	257.5	256.3	254.0	253.2	251.8	251.5	251.2	250.8	250.3	250.3	249.2
0.407	0.500	252.2	251.5	249.9	248.6	246.2	245.7	244.7	244.6	244.6	244.3	243.9	243.9	242.9
0.455	0.	258.4	257.7	256.4	254.9	252.8	252.0	250.7	250.3	249.9	249.6	249.2	249.0	247.8
0.520	0.	256.1	255.4	254.2	252.7	250.6	249.9	248.5	248.0	247.6	247.2	246.7	246.6	245.4
0.520	0.500	251.8	251.1	249.7	248.2	245.9	245.4	244.3	244.0	243.8	243.5	243.1	243.0	241.9
0.520	0.375	253.0	252.3	251.0	249.6	247.4	246.8	245.6	245.3	245.0	244.7	244.2	244.1	243.0
0.520	0.250	254.2	253.5	252.2	250.9	248.7	248.1	246.8	246.4	246.2	245.8	245.3	245.2	244.1
0.520	0.125	255.1	254.4	253.2	251.8	249.6	249.0	247.6	247.2	247.0	246.7	246.0	246.1	244.9

Table 3 (cont'd.)

TEMPERATURE DISTRIBUTION ON SPHERE-CONE MODEL, (CONE SECTION)

MACH NUMBER = 3.23

ANGLE OF ATTACK = 6 DEGREES

SUPPLY PRESSURE = 980 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

S/R	D	0	15	30	45	60	75	90	105	120	135	150	165	180
ROLL ANGLE (DEGREES)														
TEMPERATURE, °K														
0.645	0.	254.4	253.9	252.5	251.1	249.0	248.2	246.9	246.2	245.7	245.2	244.7	244.5	243.3
0.645	0.500	251.5	250.2	249.5	248.1	245.8	245.1	244.1	243.5	243.2	242.8	242.3	242.3	241.2
0.769	0.	253.7	253.4	251.9	250.5	248.4	247.6	246.2	245.2	244.7	244.1	243.5	243.3	242.1
0.769	0.500	251.1	250.7	249.1	247.8	245.4	244.8	243.6	242.8	242.4	241.9	241.5	241.4	240.4
0.894	0.	253.6	253.1	251.3	249.8	247.7	246.8	245.2	244.2	243.6	242.9	242.3	240.1	241.5
0.894	0.500	251.4	250.8	248.8	247.2	245.0	244.2	242.7	242.0	241.4	240.7	240.3	238.3	243.9
1.018	0.	253.4	253.3	250.9	249.1	247.0	245.9	244.2	243.0	242.5	241.7	241.0	240.9	239.6
1.018	0.500	251.3	251.0	248.4	246.4	244.3	243.3	241.6	240.7	240.3	239.5	239.0	239.1	237.9
1.143	0.	253.3	252.8	250.6	248.6	246.5	245.3	243.5	242.3	241.5	240.8	240.0	239.9	238.6
1.143	0.500	251.3	250.4	247.9	245.1	243.6	242.4	240.7	239.7	239.2	238.6	238.7	238.0	236.8
1.267	0.	253.3	252.7	250.3	248.1	245.9	244.5	242.7	241.3	240.4	239.7	239.0	238.7	237.2
1.267	0.500	251.6	250.7	247.9	245.7	243.5	242.0	240.5	239.2	238.6	238.0	237.4	237.3	236.1
1.392	0.	254.0	253.3	250.6	248.2	245.9	244.3	242.5	241.0	240.0	239.3	238.7	238.3	236.9
1.392	0.500	252.1	251.1	248.0	245.8	243.4	241.8	240.2	238.9	238.5	237.4	237.0	236.7	235.4
1.516	0.	254.7	253.9	250.8	248.2	245.7	243.9	242.1	240.6	239.5	238.7	238.1	237.5	236.0
1.516	0.500	252.9	251.8	248.3	245.7	243.1	241.4	239.7	238.3	237.2	236.6	236.2	235.6	234.3
1.640	0.	255.7	254.8	251.3	248.4	245.6	243.7	241.9	240.3	239.0	238.1	237.6	236.8	235.1
1.640	0.500	254.0	252.7	248.9	245.9	243.0	241.0	239.5	238.1	236.9	236.1	235.7	234.8	233.4
1.765	0.	256.9	255.9	252.2	248.8	245.5	243.6	241.7	240.0	238.6	237.4	236.9	236.0	234.2
1.765	0.500	255.1	253.8	249.7	246.1	242.7	240.6	239.1	237.6	236.6	235.2	234.0	233.0	231.9
1.890	0.	257.8	256.8	252.8	249.0	245.2	243.0	241.1	239.4	238.0	236.4	235.8	234.8	233.0
1.890	0.500	256.5	255.3	250.7	246.6	242.8	240.5	238.8	237.4	236.1	234.9	234.4	233.4	231.9
2.014	0.	259.3	258.3	253.8	249.6	245.4	243.0	241.0	239.2	237.8	236.3	235.2	234.4	232.5
2.014	0.500	258.1	256.9	251.8	247.3	242.9	240.4	238.7	237.2	236.0	234.5	233.7	232.1	231.2
2.138	0.	260.7	259.6	254.9	250.2	245.6	242.9	240.8	239.0	237.7	236.1	235.0	233.9	231.9
2.138	0.500	259.7	258.4	253.3	248.1	243.3	240.6	238.6	237.1	235.9	234.4	232.3	231.7	230.8
2.263	0.	262.2	261.1	256.3	250.8	246.0	243.0	240.7	239.0	237.8	236.1	235.0	233.7	231.4
2.263	0.500	261.2	260.0	254.7	248.7	243.6	240.6	238.5	237.0	235.9	234.4	233.6	232.5	230.2
2.387	0.	263.6	262.6	257.8	251.8	246.5	243.5	241.0	239.4	238.3	236.8	235.6	234.6	232.3
2.387	0.500	262.6	261.4	256.3	250.6	245.0	242.9	240.9	239.5	238.5	237.4	236.1	235.0	232.7
2.512	0.	264.7	263.6	259.0	252.7	246.9	243.6	241.3	239.9	238.9	237.6	236.4	235.3	233.1
2.512	0.500	264.0	262.7	257.8	250.8	244.7	241.3	238.9	237.6	236.8	235.5	234.7	233.6	231.4
2.636	0.	265.8	264.7	260.2	253.9	247.5	244.0	241.4	240.0	239.2	238.6	237.9	236.9	234.5
2.636	0.500	265.1	264.0	259.1	252.1	245.3	241.7	239.2	237.9	237.3	236.4	235.9	234.8	232.2
2.761	0.	266.6	265.6	261.2	255.0	248.4	244.5	242.1	240.8	240.3	240.1	239.8	238.5	235.8
2.761	0.500	265.8	264.7	260.0	253.3	246.0	242.1	239.6	238.4	238.1	237.4	236.3	235.2	232.4
2.885	0.													
2.885	0.500													
3.010	0.	266.3	265.5	261.7	256.3	249.9	245.7	243.8	242.7	242.5	243.2	242.0	237.5	234.3
3.010	0.375	265.5	264.7	260.8	255.3	248.4	243.9	241.8	240.6	240.5	240.7	239.3	235.9	233.3
3.010	0.250	265.7	264.9	260.9	255.4	248.7	244.4	242.3	241.1	241.0	241.4	240.0	236.4	233.7
3.010	0.125	265.9	265.3	261.4	255.9	249.4	245.1	243.0	241.8	241.7	242.2	241.0	237.1	234.0

Table 4
HEAT TRANSFER COEFFICIENT ON SPHERE-CCNE MODEL, (NOSE SECTION)

MACH NUMBER = 4.0
ANGLE OF ATTACK = 18.0 DEGREES
SUPPLY PRESSURE = 2090.0 MILLIMETERS OF HG.
SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

RCLL ANGLE	DIMENSIONLESS COEFFICIENT LENGTH					
	C.411	C.356	0.301	0.246	0.192	0.137
0.	C.465	(MUSSELT NO.)/(SQUARE ROOT OF REYNOLDS NO.)				
15.	0.2562	C.3270	0.3932	C.4811	C.5529	0.6032
30.	C.2616	C.3190	0.3855	C.4512	C.5140	0.5710
45.	C.2293	C.2909	0.3571	C.4368	C.5006	0.5331
60.	C.1888	C.2429	0.3237	C.3987	C.4487	0.5014
75.	C.2065	C.2115	0.2971	C.3664	0.4709	0.5058
90.	C.1558	C.1953	0.2637	C.3412	C.4206	0.4979
105.	0.1156	C.1627	C.2163	0.2858	0.3392	0.3884
120.	C.0835	C.1182	0.1680	0.2400	0.3214	0.3795
135.	C.0694	C.1054	C.1617	0.2205	0.2940	0.3502
150.	C.0641	C.0851	0.1371	0.1852	C.2538	0.3287
165.	0.0639	C.0915	0.1256	C.1933	0.2654	0.3216
180.	C.0498	C.0700	0.0987	C.1581	C.2156	0.2986
	C.0651	C.0815	C.1105	C.1570	0.2286	0.2916
						0.6414
						0.5924
						C.5408
						0.5242
						0.5058
						0.5233
						0.5218
						0.5282
						0.5127
						0.4678
						0.4715
						0.4737
						0.4735
						0.4456
						0.5983
						0.5800
						0.5493
						0.5540
						0.5665
						0.5344
						0.5547
						0.5499
						0.5421
						0.5282
						0.5303
						0.5470
						0.5281

Table 4 (cont'd.)

HEAT TRANSFER COEFFICIENT ON SPHERE-CCONE MODEL, (CONE SECTION)

MACH NUMBER = 4.8

ANGLE OF ATTACK = 15.0 DEGREES

SUPPLY PRESSURE = 2090.0 C MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 320.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONTOUR LENGTH					
	C.520	C.645	C.769	C.894	1.018	1.143
0.						
15.						
30.						
45.						
60.						
75.						
90.						
105.						
120.						
135.						
150.						
165.						
180.						

(MUSSELT NO.)/(SQUARE ROOT OF REYNOLDS NO.)

C.1378	0.1210	C.1185	0.1286	0.1039		
C.1372	0.1258	C.1339	0.1325	0.1185		
C.1699	0.1173	C.1132	0.1276	0.1061		
C.1464	0.0993	C.1044	0.1000	0.0932		
C.1365	0.0747	C.0788	0.0781	0.0710		
C.0824	0.0748	C.0776	0.0784	0.0477		
C.0957	0.0542	C.0495	0.0585	0.0506		
C.1006	0.0469	C.0276	0.0414	0.0260		
C.0531	0.0334	C.0311	0.0366	0.0197		
C.0746	0.0291	C.0324	0.0325	0.0183		
C.0440	0.0305	C.0358	0.0288	0.0158		
C.0726	0.0311	C.0377	0.0254	0.0177		
C.0723	0.0223	C.0394	0.0242	0.0109		

1.640

1.516

1.392

1.267

1.143

1.018

0.894

0.769

0.645

0.520

0.440

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ROLL ANGLE	DIMENSIONLESS CONTOUR LENGTH					
	1.765	1.890	2.014	2.138	2.262	2.387
0.						
15.						
30.						
45.						
60.						
75.						
90.						
105.						
120.						
135.						
150.						
165.						
180.						

(MUSSELT NO.)/(SQUARE ROOT OF REYNOLDS NO.)

C.1290	0.1129	C.1069	0.1112	C.1016	0.1261	0.0901
C.1460	0.1331	C.1368	0.1417	0.1144	0.1545	0.1362
C.1298	0.1240	C.1266	0.1155	0.1131	0.1305	0.1038
C.1176	0.0995	C.1257	0.0968	0.0967	0.0921	0.0903
C.1017	0.0764	C.0921	0.0842	0.0829	0.0915	0.0804
0.0801	0.0692	C.0740	0.0667	0.0642	0.0785	0.0608
C.0591	0.0480	C.0524	0.0542	0.0502	0.0666	0.0466
C.0468	0.0331	C.0360	0.0434	0.0316	0.0467	0.0346
C.0451	0.0223	C.0335	0.0349	0.0214	0.0373	0.0212
C.0366	0.0238	C.0243	0.0272	0.0187	0.0327	0.0198
C.0375	0.0253	C.0170	0.1182	0.0091	0.0294	0.0159
C.0360	0.0268	C.0338	0.0195	0.0182	0.0347	0.0200
C.0351	0.0160	C.0285	0.0222	0.0221	0.0352	0.0195

2.885

2.761

2.636

2.512

2.387

2.262

2.138

2.014

1.890

1.765

1.640

1.516

1.392

1.267

1.143

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0.894

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0.520

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Table 4 (cont'd.)
HEAT TRANSFER COEFFICIENT ON SPHERE-CCNE MODEL, (INCOE SECTION)

MACH NUMBER = 2.2
ANGLE OF ATTACK = 12.0 DEGREES
SUPPLY PRESSURE = 980.0 MILLIMETERS OF HG.
SUPPLY TEMPERATURE = 318.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS COEFFICIENT LENGTH				0.137	0.082	0.027
	C.465	C.411	C.356	C.301	C.246		
C.	C.2125	C.2935	C.3722	C.4710	C.5296	C.6400	0.5765
15.	C.2182	C.2932	C.3759	C.4766	C.5245	0.6278	0.5827
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135.	0.0460	C.0859	C.1344	0.2033	0.2702	0.4100	0.5267
150.	C.0346	C.0722	C.1150	C.1855	C.2461	0.3939	0.5346
165.	C.0382	C.0687	C.1092	C.1502	C.2398	0.3751	0.5309
180.	C.0364	C.0654	C.1044	0.1579	C.2045	0.4513	0.5374

(NUSSELT NO.)/(SQUARE ROOT OF REYNOLDS NO.)

Table 4 (cont'd.)

HEAT TRANSFER COEFFICIENT ON SPHERE-CCNE MODEL, (CCNE SECTION:)

WAF NUMBER = 1.2

ANGLE CF JACK = 12.0 DEGREES

SUPPLY PRESSURE = 980 C MILLIMETERS OF H₂O.

SUPPLY TEMPERATURE = 318.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONTOLUR LENGTH-				(ALUSSELT AC.)/SQUARE RCCT CF REYNOLDS AC.)					
	C.520	C.645	G.769	C.894	1.018	1.143	1.267	1.372	1.516	1.640
C.1094		C.0478	C.1084	C.1151	C.1102	C.1165	0.1140	0.1165	0.1218	0.1249
15.	C.1098	0.1881	0.1117	0.1379	C.1420	C.1393	0.1453	0.1434	0.1362	0.1408
30.	C.1078		C.0792	C.1176	C.1284	C.1278	0.1217	0.1241	0.1261	0.1212
45.	C.0721		C.0839	C.1081	C.1136	C.1187	C.1166	C.1111	0.1115	0.1086
60.	C.0847	C.1996	C.0889	C.0872	C.0883	C.0893	0.0823	C.0919	0.0856	0.0962
75.	C.0374	C.0741	C.0725	C.0791	C.0792	C.0778	0.0767	0.0752	0.0775	0.0756
90.	C.0213	C.0870	C.0775	C.0641	C.0595	C.0667	0.0671	C.0674	0.0712	0.0775
105.	C.0070	C.0239	C.0366	C.0421	C.0440	C.0412	0.0304	0.0412	0.0427	0.0528
120.	C.0132	C.0396	C.0307	C.0201	C.0185	C.0159	0.0216	0.0238	0.0261	0.0319
135.	C.0171	C.0196	C.0196	C.0138	C.0253	C.0315	0.0322	0.0348	0.0397	0.0454
150.	C.0127	C.0303	C.0241	0.0221	C.0187	C.0249	0.0206	0.0295	0.0401	0.0491
165.	C.0237	C.0297	C.0281	0.0205	C.0227	C.0229	0.0095	0.0084	0.0162	0.0343
180.	C.0250	C.0375	C.0334	C.0258	C.0165	C.0241	0.0402	0.0296	0.0251	0.0175

ROLL ANGLE	DIMENSIONLESS CONICULAR LENGTH					2.512	2.636	2.761	2.885
	2.014	2.138	2.263	2.387	2.512				
	1.850	(ALUSSET AG.) / (SQUARE ROOT OF REYNOLDS NO.)							
		2.014	2.138	2.263	2.387	2.512	2.636	2.761	2.885
		0.1224	0.1063	0.1136	0.0902	0.0922	0.1056	0.1101	0.0990
15.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
30.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
45.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
60.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
75.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
90.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
105.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
120.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
135.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
150.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
165.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990
180.		0.1235	0.1122	0.1063	0.0902	0.0922	0.1056	0.1101	0.0990

Table 4 (cont'd.)

HEAT TRANSFER COEFFICIENT ON SPHERE-CONE MODEL, (NOSE SECTION)

MACH NUMBER = 4.2

ANGLE OF ATTACK = 6.0 DEGREES

SUPPLY PRESSURE = 900.0 MILLIMETERS OF HG.

SUPPLY TEMPERATURE = 316.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONTOUR LENGTH									
	C.465	C.411	C.358	0.301	C.246	C.192	C.137	0.082	0.027	
0.										
15.										
30.										
45.										
60.										
75.										
90.										
105.										
120.										
135.										
150.										
165.										
180.										

(JUSSELY NO.)/(SQUARE ROOT OF REYNOLDS NO.)

C.1826	C.2290	C.3056	C.3995	C.4781	0.5534	0.6032	0.6103	0.6142	
C.1974	C.2241	C.2981	C.4051	C.4642	0.5324	0.5899	0.6046	0.6183	
C.1699	C.2174	C.2923	0.3914	C.4459	0.5136	0.5638	0.5854	0.6068	
C.1284	C.2090	0.2717	C.3416	0.4202	0.4726	0.5307	0.5448	0.5781	
C.1601	C.1969	C.2521	C.2996	C.3752	0.4385	C.4624	0.4904	0.5525	
C.1439	C.1734	C.2374	0.2903	C.3538	0.4129	0.4672	0.4897	0.5499	
C.1356	C.1746	C.2212	C.2724	C.3603	0.4230	0.4768	0.4940	0.5452	
C.1171	C.1590	C.2175	C.2686	C.3611	0.4276	0.4852	0.5250	0.5603	
C.1063	C.1566	C.2050	C.2652	C.3482	0.4336	0.4920	0.5454		
C.1062	C.1473	C.1928	C.2627	C.3509	0.4443	0.5016	0.5592		
C.1070	C.1482	C.2041	C.2811	C.3581	0.4518	0.4990	0.5684		
C.0958	C.1477	C.1926	C.2836	0.3565	0.4278	0.5073	0.5733		
C.0939	C.1442	C.2048	C.2878	0.3600	0.4312	0.5096	0.5749		

Table 4 (cont'd.)

HEAT TRANSFER COEFFICIENT ON SPHERE-CONE MODEL, (CONE SECTION)

MACH NUMBER = 3.2
 ANGLE OF ATTACK = 6.0 DEGREES
 SUPPLY PRESSURE = 980.0 MILLIMETERS OF HG.
 SUPPLY TEMPERATURE = 318.0 DEGREES KELVIN

ROLL ANGLE	DIMENSIONLESS CONIC LENGTH					
	C.645	C.767	C.874	1.018	1.142	1.267
C.520						
		(MUSSELT NO.)/(SQUARE ROOT OF REYNOLDS NO.)				
C.1562	C.0982	C.0766	C.0817	C.0702	C.0745	C.0575
C.1551	C.0952	C.0913	C.0776	C.0750	C.0806	C.0709
C.1247	C.0847	C.0836	C.0751	C.0706	C.0791	C.0620
C.0508	C.1055	C.1020	C.0942	C.0875	C.0996	C.0719
C.1477	C.0650	C.0712	C.0660	C.0677	C.0780	C.0575
C.1249	C.0720	C.0807	C.0755	C.0712	C.0782	C.0585
C.1095	C.0752	C.0771	C.0715	C.0694	C.0736	C.0591
C.1087	C.0652	C.0662	C.0618	C.0564	C.0648	C.0455
C.0671	C.0618	C.0647	C.0612	C.0603	C.0612	C.0417
C.0664	C.0508	C.0530	C.0429	C.0481	C.0522	C.0356
C.0922	C.0537	C.0535	C.0519	C.0493	C.0490	C.0307
C.0394	C.0453	C.0444	C.0448	C.0432	C.0452	C.0267
C.0197	C.0444	C.0451	C.0375	C.0394	C.0442	C.0172

	1.392	1.516	1.640
	0.0713	0.0494	0.0744
	0.0816	0.0318	0.0860
	0.0725	0.0656	0.0680
	0.0803	0.0758	0.0788
	0.0700	0.0675	0.0730
	0.0669	0.0628	0.0689
	0.0692	0.0688	0.0722
	0.0581	0.0578	0.0591
	0.0528	0.0541	0.0518
	0.0459	0.0470	0.0468
	0.0501	0.0500	0.0552
	0.0425	0.0409	0.0460
	0.0385	0.0363	0.0349

ROLL ANGLE	DIMENSIONLESS CONIC LENGTH					
	1.765	1.890	2.014	2.128	2.263	2.387
C.0778						
		(MUSSELT NO.)/(SQUARE ROOT OF REYNOLDS NO.)				
C.0891	C.0544	C.0584	C.0554	C.0549	C.0602	C.0475
C.0761	C.0681	C.0738	C.0669	C.0660	C.0759	C.0570
C.0822	C.0600	C.0602	C.0535	C.0577	C.0657	C.0566
C.0737	C.0668	C.0721	C.0655	C.0625	C.0680	C.0605
C.0772	C.0551	C.0618	C.0564	C.0602	C.0648	C.0505
C.0760	C.0564	C.0619	C.0542	C.0553	C.0692	C.0563
C.0670	C.0613	C.0675	C.0595	C.0595	C.0673	C.0523
C.0573	C.0697	C.0542	C.0492	C.0494	C.0608	C.0476
C.0490	C.0445	C.0494	C.0464	C.0479	C.0586	C.0436
C.0591	C.0259	C.0393	C.0370	C.0392	C.0540	C.0479
C.0489	C.0382	C.0435	C.0344	C.0293	C.0397	C.0292
C.0366	C.0324	C.0159	C.0201	C.0191	C.0327	C.0144
	C.0164	C.0305	C.0262	C.0198	C.0318	C.0144

	2.512	2.636	2.761	2.885
	0.0497	0.0497	0.0581	0.0577
	0.0594	0.0594	0.0657	0.0648
	0.0605	0.0605	0.0639	0.0587
	0.0625	0.0625	0.0675	0.0569
	0.0529	0.0529	0.0598	0.0733
	0.0576	0.0576	0.0598	0.0600
	0.0550	0.0550	0.0674	0.0664
	0.0499	0.0499	0.0588	0.0689
	0.0496	0.0496	0.0551	0.0752
	0.0611	0.0611	0.0745	0.0917
	0.0433	0.0433	0.0665	0.0957
	0.0237	0.0237	0.0276	0.0366
	0.0245	0.0245	0.0355	0.1096

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