## NASA <br> Reference Publication 1130

1988

# Galileo Probe Parachute Test Program: Wake Properties of the Galileo Probe at Mach Numbers From 0.25 to 0.95 

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## GALILEO PROBE PARACHUTE TEST PROGRAM:

# WAKE PROPERTIES OF THE GALILEO PROBE AT MACH NUMBERS FROM 0.25 TO 0.95 

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## SUMMARY


#### Abstract

The results of surveys of the near and far wake of the Galileo Probe are presented for Mach numbers from 0.25 to 0.95. The trends in the data resulting from changes in Mach number, radial and axial distance, angle of attack, and a small change in model shape are shown in crossplots based on the data. A rationale for selecting an operating volume suitable for parachute inflation based on low Mach number flight results is outlined.


## INTRODUCTION

The deployment, inflation, performance, and stability of a parachute in the wake of a payload to which it is attached are frequently sensitive to the velocity gradients of the wake itself. This sensitivity is expected to be particularly great for cases in which the wake diameter is comparable to that of the parachute because the radial velocity gradient is largest at the periphery of the parachute before the parachute is fully open. That is to say, a very small parachute (such as a drogue) may deploy and inflate satisfactorily in a large wake (because only small differences of imposed velocity occur near it), whereas a somewhat larger parachute might inflate slowly or not at all. In contrast, the larger parachute may inflate satisfactorily in the wake of a small payload - the usual configuration employed in parachute development and structural tests. The descent parachute configuration of the Pioneer Venus Large Probe (ref. 1) is believed to have exhibited a "reluctance" to open at Mach numbers above 0.6 both for the system tests in the Earth's atmosphere and for the actual Probe during its flight in the atmosphere of Venus. The rather gradual inflation did not compromise the collection of scientific data in the Venutian atmosphere because no critical events, such as entering a recognized cloud layer, occurred before the altitude for parachute deployment and inflation. In the case of the Galileo Probe (ref. 2), on the other hand, it is most important to deploy and inflate the parachute somewhat earlier, i.e., at higher Mach number, in order to remove the instrumented descent configuration from the aeroshell and permit operation of the cloud-analysis instrument before entering the first clouds in the postulated atmosphere of Jupiter.

[^0]During Earth-based flight tests to verify adequate system behavior for the Galileo flight conditions, however, the inflation was achieved at an undesirably low Mach number; once inflation was complete, the performance and stability proved to be the same as the earlier tests and flights. Rather than accept the loss of the scientific data and the risk of even further delayed inflation for the flight in the atmosphere of Jupiter, it was decided to investigate the reasons for the marginal behavior and to seek means to ensure prompt inflation at the desired flight Mach number. In order to relate the anticipated wake-survey data to the earlier experience, tests at conditions spanning those for both Venus and Jupiter were desired. Two types of tests were believed necessary in order to guide decisions on design variations: wake-flow surveys and tests of scale model parachutes. This report describes the wake-flow study and suggests a simple rationale for employing the summary plots derived from the data. Tests of a scale model parachute are reported in reference 3.

## TEST EQUIPMENT AND TEST FACILITY

## Probe Models

The wakes of two one-eighth-scale models (6-in. diameter) of the Galileo Entry Probe aeroshell were surveyed in the NASA Ames 6 - by $6 . \mathrm{ft}$ transonic wind tunnel to define the initial operating environment of the descent parachute. The principal configuration represented the expected form of the "ablated" Galileo Probe deceleration-module heat shield. The second configuration represented the "ballasted" configuration to be used in a planned system drop test to verify that parachute deployment, inflation, performance, and stability were satisfactory. The two model profiles are shown in figure 1 . In addition to matching the forebody profile for the
system drop test, the model in figure 1(b) also is essentially the same as that of the Pioneer Venus Large Probe; thus the results from both programs can be directly related. The principal difference between the latter model and the Pioneer Venus Large Probe is the short cylinder between the $45^{\circ}$ half-angle cone and the base. In neither case was the form of the afterbody (from the rim of the cylinder aft) made to simulate a real configuration because of the expected insensitivity to the afterbody of the distant wake flow and most of the reverse-flow region. At high Reynolds numbers (above critical for transition), the flow separates at the cone-cylinder junction at subsonic and transonic speed.

The models were affixed to the support structures at a pivot located 0.084 model diameter ahead of the base plane. Thus, when positive angles of attack were set, the center of the model base moved slightly in the direction of negative $Z$.

The area surrounding the model noses was covered by a fairly densely spaced single layer of glass spheres out to a radius of 0.167 model diameter to assure early transition to turbulent boundary-layer flow. This feature in combination with the nominal test Reynolds number 1.5 million, was used to assure good simulation of full-scale flow. A brief sequence of tests was run at $R e_{D}$ equal to 3 million and showed no alteration of flow patterns.

## Model Supports

Two types of support were used during the tests. All of the data reported herein were obtained with the models supported on the sting-strut assembly shown in figure 2. A few preliminary tests were run with the ablated-form model mounted conventionally on a long slender sting equipped with a fixed rake of five pitot-pressure tubes located 2.6 model diameters from the model base. Tests were conducted with and without the strut in place about 0.3 model diameter from the base. The strut reduced the size of the wake significantly at $M=0.95$; therefore, the two-diameter extension sting was installed to reduce the interference. Subsequent surveys with the traversing survey probe described later revealed a wake profile which matched that of the sting-mounted model much more closely. Directly comparable tests using only the five-tube probe were not possible, but it was concluded that support interference was reduced to a degree which would allow accurate determination of data trends with Mach number, distance downstream and angle of attack, and model profile. The strut was stabilized with guy wires to avert possible coupled torsionbending oscillations.

## Wake Survey Apparatus

All of the data presented herein were obtained using the pitot-static probe illustrated in figure 3. Included on this
probe were forward- and aft-facing pitot tubes; the forwardfacing tube incorporated a coaxial static-pressure tube as well (four orifices at 0.29 model diameter from its tip). This spacing permitted good determination of flow properties in weak and moderately strong axial pressure gradients. The aft-facing pitot tube was about 1 model diameter downstream of the static-pressure taps, so that strong gradients made interpretation of the data in the reverse-flow region difficult. After completing the far-wake survey, the forward-facing pitotstatic probe was accordingly converted to aft-facing (fig. 3(b)) by bending it through $180^{\circ}$. The orifice nearest the inside of this bend was sealed with epoxy to avoid the strongest aerodynamic effects of the bend. Even with this alteration, the strong pressure gradients in the reverse-flow region required that the separation between pitot and static orifices be recognized in obtaining the data. This was accomplished by traversing the probe in increments of 1.75 -in. ( 0.29 model diameter) and using the measurement in adjacent test sequence points to obtain spatially coincident measurements of pitot and static pressures.

The same procedure can, in effect, be achieved with the far-wake results by interpolation of the static-pressure data to obtain coincident determination of the pressures; this has not been done in reducing the data because the gradients there are an order of magnitude less severe than in the reverse-flow region.

Pitot and static-pressure measurements made using probes of this sort are degraded if the local flow is highly inclined (more than $10^{\circ}$ ) relative to the tube axis. Since this degradation is small for angles less than about $10^{\circ}$, the only regions in the wake where errors are expected to be large are well removed from the axis in the near wake. Approximate numerical analysis of the wake profiles downstream of the model by more than 5 model diameters indicated that radial inflow into the accelerating wake resulted in inclinations of less than $3^{\circ}$. Unsteadiness of the flow in the wake doubtless interfered with the static-pressure determination; since the goal of the present surveys was to determine the qualitative influence of Mach number, position, and angle of attack on dynamic-pressure distribution, the small and slowly changing bias on the static-pressure measurement was ignored in studying the data.

The pitot-static probe was located at the tip of the short radial arm so that as the survey assembly was rolled, the probe moved to the left or right to survey at positions other than the vertical plane of symmetry. The location of the roll mechanism is indicated in figure 4.

Vertical positioning of the survey probe was accomplished by translating the wind tunnel model-support body of revolution (BOR) by simultaneous operation of its two positioning screws. Streamwise positioning of the survey probe was effected by means of the linear-actuator mechanism connected between the probe arm and the roll mechanism. The maximum extension range of the linear actuator was slightly less than 4 model diameters; it was therefore necessary to
position the model-support strut at several stations along the test-section ceiling to achieve the full streamwise array of surveys desired.

## Deflections of Survey Apparatus

As noted above, the entire survey apparatus was cantilevered from a large floor-to-ceiling strut located in the entrance to the wind tunnel diffuser. The maximum cantilever length is approximately 12 ft . Late in the test program it was discovered that aerodynamic loads deflected the apparatus upward by an amount that is believed to be influenced by extension length, dynamic pressure, Mach number, roll position, and position relative to the model's wake. Additionally, backlash in the vertical-positioning drive may have yielded a small irregularity in vertical position, although calibration tests without airflow revealed no such effect greater than about $0.5 \%$ of the model diameter. The aerodynamic deflection, on the other hand, produced in one case a deflection of at least $8 \%$ of the model diameter. As far as could be determined, this deflection was nearly constant for a given test condition and streamwise position of the survey probe (axial and roll), so that the shapes of the vertical profiles of dynamic pressure, Mach number, etc., were preserved, but the absolute position of the survey probe relative to the model axis was not accurately known. From a study of the flow-profile plots, the effect of the elastic deflection can be seen to yield a "movement" of the wake progressively in the $+Z$ direction as the dynamic pressure increased; i.e., increasing Mach number at constant Reynolds number. A similar lateral deflection may have occurred as well, but observation was not possible.

Interpretations of the profiles of flow properties were therefore based on the assumption that vertical deflection was constant throughout any one run, i.e., vertical traverse. Also, where effects of angle of attack were under study, it was assumed that deflection was independent of angle of attack.

## TESTS

Most of the test period was spent obtaining the complete survey of the static and pitot pressure variations in the wake of the "ablated" model configuration supported on the strut. The matrix of test conditions and survey points is detailed in table 1. The abbreviated test matrix for the second, i.e., "ballasted," model consists of runs 333 through 335 . In this listing an entry is made in a column only at the run at which that parameter is changed. The special tests, designed to reveal the extent of support interference on the nominal wake properties, are not included.

The test sequence was dictated by the most efficient use of tunnel time, except that the special support interference
study was accomplished first to obtain early assurance that support interference would not be excessive.

While the test airflow conditions were being established, the survey apparatus was maneuvered into the desired position: for height, $Z$, by raising the BOR conventionally used for model support, for lateral position, $Y$, by rotating the roll positioner on the BOR and extending the survey apparatus linear actuator to the desired streamwise position, $X$. Each run thereafter consisted of a vertical traverse to all the points at which measurements were needed.

Succeeding runs were made at the remaining lateral positions desired for the same axial station before moving to the next axial station. Once the three linear dimensions had been adequately surveyed, the next Mach number was established and the desired spacial survey was completed. The time required to position the survey probe was sufficient to assure equilibration of the pressure sensors without additional delay.

The only occasions requiring breaks in the wind tunnel operation were those to adjust the streamwise location of the model-support strut and its guy wires, adjust the angle of attack of the model (by rotation about the pivot inside the model), or exchange the ablated model for the ballasted model. At each such break in the testing, the glass-bead boundary-layer trip area was inspected and refurbished as needed.

## RESULTS

All of the wake-survey results for both the ablated and ballasted configurations supported on the short sting with strut are provided in table 2 . Table 2 has been subdivided into four sections. Sections 2 a and 2 c present data for the ablated model shape with the pitot-static probe facing forward. Section $2 b$ presents data for the ballasted model profile, and section 2 d presents data for the ablated shape with the pitot-static probe facing aft. Data were taken at Mach numbers of $0.25,0.60,0.80,0.85,0.90$, and 0.95 at a Reynolds number of 0.75 million based on model diameter. The pitot-static surveys yielded profiles of Mach number, dynamic pressure, velocity, and static pressure as functions of vertical position relative to the horizontal axis of the small sting at selected lateral positions and several axial stations between 1 and 11 model diameters downstream from the model base.

Definitions of column headings are presented in table 2. To preserve direct accountability of the table, the actual run numbers and order of table 1 may facilitate rapid location of a desired test listing. Gaps in the number sequence represent runs made at a Mach number of 1.1 ; these runs were deleted because of serious disturbance of the flow by the normal-shock wave upstream of the linear actuator of the survey system.

A few unexplained anomalies have been observed in individual sequence (i.e., data-point) listings. These anomalies have not been deleted.

Selected groups of runs have been plotted and crossplotted in figures 5 through 8 to reveal the shape, Mach number, distance, and angle-of-attack effects on the properties of the wake. In these plots attention is concentrated on the variation of the ratio of local dynamic pressure to freestream dynamic pressure. Other parameters, such as velocity or pitot pressure, may be as meaningful in applying the results for various purposes. Sufficient information is tabulated so that such plots may be constructed.

All of the tabulated results, with the exception of runs 367 through 390 , are presented with no post-test alteration. These exceptions are the tests made with the modified (reversed by a $180^{\circ}$ bend) pitot-static tube. In these tests, very strong axial gradients resulted in a large static pressure difference between the positions of the pitot and static pressure orifices. Therefore, the $X$ increment used in these tests was selected so that the static pressure determined at a particular sequence point could be used with the pitot pressure obtained at the previous sequence point. The tabulated data have been treated in this manner.

With considerable effort the same kind of correction can be applied to the data from surveys at 3.5 model diameters, and farther, behind the base. There is little to be gained, however, because the pressure gradients are an order of mag. nitude less severe than in the reverse flow near the model base.

## DISCUSSION OF RESULTS

## Far-Wake Region

The momentum defect in the wake of a simple nonlifting body is directly equivalent to the drag of the body. The wakes of the two aerodynamic models used in this study illustrate that the ballasted model has slightly less drag than the more bluff ablated model used in most of the tests. The profiles of dynamic pressure (fig. 5) show a smaller loss in the wake core of the ballasted model than in the wake core of the ablated model. The extent and precision of the surveys in this study are not sufficient to determine the absolute drag coefficients with great accuracy, but the difference is clear. While the two configurations showed only modest differences in dynamic pressure loss (and gradients of dynamic pressure), much greater changes were observed for the ablated model as Mach number and distance from the model to the survey station were changed. The lower portion of each part of figure 6 illustrates the rapid increase of dynamic pressure in the wake core as the survey station is moved downstream from the wake stagnation point -0 dynamic
pressure. Even as far downstream as 11 model diameters, the continued recovery toward free-stream conditions is clear.

This acceleration of the wake core is achieved at the cost of deceleration of the airflow immediately outside the wake; at all times the total loss in momentum flux must represent the model drag. This redistribution of momentum is summarized in the contour plots of constant dynamic pressure presented in the upper portions of figure 6. At some distance downstream of the body, probably about 6 model diameters from the base, the profiles become "similar." That is, when normalized to the maximum loss in velocity at the core and to the local wake diameter, the profile plots will remain unchanged. Once similarity is established, the radial gradients are seen to vary as the 1.5 power of the maximum loss at the core.

## The Effects of Angle of Attack

The total drag of bodies like those tested in this study is quite insensitive to angle of attack, for angles of attack very much less than the body cone half angle; therefore the total change in loss of momentum in the wake was correspondingly slight as angle of attack increased to $20^{\circ}$. The generation of even a modest lift force, however, results in the discharge of a trailing vortex system which rolls up into a vortex pair at great distances downstream. This vortex system causes the wake to move in a direction opposite to that of the lift vector. This deflection of the wake is the most prominent feature in the vertical profiles of dynamic pressure ratio at angles of attack of both plus and minus $10^{\circ}$ and $20^{\circ}$ (fig. 7). The surveys revealed no further major changes in the dynamic pressure profiles.

## Reverse-Flow Region

In deploying the Galileo Probe parachute, it is necessary first to propel a small drogue through the near wake of the probe (where the flow moves toward the base). Further, the drogue must then remove the afterbody heat shield and drag it through the volume of reverse flow before the main parachute can be drawn aft in turn. In order to permit estimation of the performance requirements placed on the drogue, the reverse-flow region was surveyed in detail using the modified pitot-static probe (runs 367 through 390 ). These data are summarized as contour plots of dynamic pressure in figure 8.

The length of the reverse flow increases significantly as Mach number increases from 0.25 to 0.95 . The relative severity of the reverse flow, on the other hand, diminishes.

The dynamic pressure profiles deduced (from crossplotting the data) to act along the axis of the flow core are shown in figure 8.

## APPLICATION OF RESULTS TO DESIGN OF GALILEO PROBE PARACHUTE CONFIGURATION

Experience with the Pioneer Venus Large Probe (ref. 1) and with the System Drop Test Configuration for the Galileo Probe (ref. 2) suggested a "reluctance" to inflate at Mach numbers above 0.60 . In these cases the parachutes were deployed at approximately 5.5 Probe diameters behind the Probe base. The present data indicate that at this location and flight speed the loss of dynamic pressure near the wake core was severe and the wake diameter was comparable to that of the parachute itself. It is believed that these features combined to cause poor inflation. The result of increasing the Mach number was to aggravate the loss of dynamic pressure and increase the wake size. A slight aggravation was noted when the blunter shape of the Galileo (ablated form) was substituted for that of the Pioneer Venus Large Probe. In order to promote satisfactory parachute inflation for the more severe Galileo requirements, it is necessary, therefore, to find that region in the wake which appears to be more conducive to reliable inflation than that for the Pioneer Venus case at Mach 0.60.

The mixing of external-flow air with the wake is found to produce a rapidly improving wake profile with increasing distance downstream. A comparison of the appropriate profiles suggests that proper parachute inflation can be achieved for the Galileo at a Mach number of 0.80 by incorporating only a modest increase in deployment distance.

## CONCLUSIONS

The wakes of the Galileo Probe and a system drop test configuration have been surveyed to determine the variation of flow properties between the model base and a station almost 11 model diameters downstream.

It was found that (compared to the Pioneer Venus Large Probe) the wake of the more bluff configuration (the shape representative of the expected ablated heat shield after entry into Jupiter) had slightly larger dynamic pressure losses and that the severity of these losses increased markedly with Mach numbers from 0.25 to 0.95 . Further, it was found that entrainment of adjacent air monotonically increased the wake size and the dynamic pressure in the core.

It was also found that the length of the reverse-flow region immediately downstream of the model increased slightly with increasing Mach number whereas the relative severity of the reverse flow diminished substantially.

A simple rationale was described whereby a region in which a parachute might be expected to inflate at high speed may be identified based on successful parachute operation at lower speed.

## Ames Research Center

National Aeronautics and Space Administration Moffett Field, California, August 24, 1984

## REFERENCES

1. Nolte, L. J.; and Sommer, S. C.: Probing a Planetary Atmosphere - Pioneer Venus Spacecraft Description. AIAA paper 75-1160, Sept. 1975.
2. Givens, J. J.; Nolte, L. J.; and Pochettino, L. R.: Galileo Atmospheric Entry Probe System - Design, Development, and Test. AIAA paper 83-0098, Jan. 1983.
3. Corridan, R. E.; Givens, J. G.; and Kepley, B. M.: Transonic Wind-Tunnel Investigation of the Galileo Probe Parachute Configuration. AIAA Paper 84-0823, Apr. 1984.

TABLE 1.- TEST CONDITION LISTING

| Run <br> No. | Mach No. | $X / D_{B}$ | $Y / D_{B}$ | Alpha | Run <br> No. | Mach No. | $X / D_{B}$ | $Y / D_{B}$ | Alpha |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 144 | 0.95 | 7.0 | 0.02 | 0 | 194 | 0.95 | 8.5 | -0.45 | +20 |
| 145 | 1 | 8:5 | -0.44 |  | 195 | 0.90 | 10.9 | 0 |  |
| 146 |  |  | 0 |  | 196 | 0.90 | 8.5 | 1 |  |
| 147 | $\downarrow$ | $\downarrow$ | 0.44 |  | 197 | 0.85 | 10.9 |  |  |
| 148 | 0.80 | 7.0 | 0 |  | 198 | 0.85 | 8.5 | $\downarrow$ |  |
| 149 |  | 8.5 | -0.44 |  | 199 | 0.80 | 10.9 | 0.41 |  |
| 150 |  |  | 0 |  | 200 |  |  | 0 |  |
| 151 | $\downarrow$ | $\downarrow$ | 0.44 |  | 201 |  |  | -0.38 |  |
| 152 | 0.60 | 7.0 | 0 |  | 202 |  | $\nabla$ | -0.48 |  |
| 153 |  | 8.5 | -0.44 |  | 203 |  | 8.5 | 0.43 |  |
| 154 |  |  | 0 |  | 204 |  |  | 0 |  |
| 155 | $\downarrow$ |  | 0.44 |  | 205 |  |  | -0.36 |  |
| 156 | 0.95 |  | -0.39 |  | 206 | $\nabla$ | $\downarrow$ | -0.45 |  |
| 157 | 1 |  | 0 |  | 207 | 0.60 | 10.9 | 0.41 |  |
| 158 |  | $\downarrow$ | 0.43 |  | 208 |  |  | 0 |  |
| 159 |  | 10.5 | 0.41 |  | 209 |  |  | -0.38 |  |
| 160 |  |  | 0 |  | 210 |  | $\downarrow$ | -0.48 |  |
| 161 |  |  | -0.38 |  | 211 |  | 8.5 | 0.43 |  |
| 162 |  | $\downarrow$ | -0.48 |  | 212 |  |  | 0 |  |
| 163 | $\downarrow$ | 10.0 | 0 |  | 213 |  |  | -0.36 |  |
| 164 | 0.80 | 10.9 | 0.41 |  | 214 | $\nabla$ | $\downarrow$ | 0.45 |  |
| 165 |  |  | 0 |  | 215 | 0.25 | 10.9 | 0.41 |  |
| 166 |  |  | -0.38 |  | 216 |  |  | 0 |  |
| 167 |  | $\downarrow$ | -0.48 |  | 217 |  |  | -0.38 |  |
| 168 | $\downarrow$ | 10.0 | 0 |  | 218 |  | $\downarrow$ | -0.48 |  |
| 169 | 0.60 | 10.9 | 0.41 |  | 219 |  | 8.5 | 0.43 |  |
| 170 | 1 |  | 0 |  | 220 |  |  | 0 |  |
| 171 |  |  | -0.38 |  | 221 |  |  | -0.36 |  |
| 172 |  | $\downarrow$ | -0.48 |  | 222 | $\downarrow$ | $\dagger$ | -0.45 | $\nabla$ |
| 173 | $\downarrow$ | 10.0 | 0 |  | 223 | 0.95 | 10.9 | 0.41 | -20 |
| 174 | 0.90 | 10.9 |  |  | 224 | 1 |  | 0 |  |
| 175 | 0.90 | 0.85 |  |  | 225 |  |  | -0.38 |  |
| 176 | 0.85 | 0.85 |  |  | 226 |  | $\downarrow$ | -0.48 |  |
| 177 | 0.85 | 10.9 | $\downarrow$ |  | 227 |  | 8.5 | 0.43 |  |
| 178 | 0.25 |  | 0.41 |  | 228 |  |  | 0 |  |
| 179 |  |  | 0 |  | 229 |  |  | -0.36 |  |
| 180 |  |  | -0.38 |  | 230 | $\downarrow$ | $\downarrow$ | -0.45 |  |
| 181 |  | $\downarrow$ | -0.48 |  | 231 | 0.90 | 10.9 | 0 |  |
| 182 |  | 10.0 | 0 |  | 232 | 0.90 | 8.5 |  |  |
| 183 |  | 7.0 | 0 |  | 233 | 0.85 | 10.9 |  |  |
| 184 |  | 8.5 | -0.45 |  | 234 | 0.85 | 8.5 | $\downarrow$ |  |
| 185 |  | 1 | 0 |  | 235 | 0.80 | 10.9 | 0.41 |  |
| 186 | $\downarrow$ | $\downarrow$ | 0.43 | $\nabla$ | 236 |  | 0 | 0 |  |
| 187 | 0.95 | 10.9 | 0.41 | +20 | 237 |  |  | -0.38 |  |
| 188 |  |  | 0 |  | 238 |  | $\downarrow$ | -0.48 |  |
| 189 |  |  | -0.36 |  | 239 |  | 8.5 | 0.43 |  |
| 190 |  | $\downarrow$ | -0.48 |  | 240 |  |  | 0 |  |
| 191 |  | 8.5 | 0.43 |  | 241 |  |  | -0.36 |  |
| 192 |  | 1 | 0 |  | 242 | $\downarrow$ | $\downarrow$ | -0.45 |  |
| 193 | $\downarrow$ | $\downarrow$ | -0.36 | $\downarrow$ | 243 | 0.60 | 10.9 | 0.41 | $\downarrow$ |

TABLE 1.- CONTINUED

| Run <br> No. | Mach No. | $X / D_{B}$ | $Y / D_{B}$ | Alpha | $\begin{aligned} & \text { Run } \\ & \text { No. } \end{aligned}$ | Mach No. | $X / D_{B}$ | $Y / D_{B}$ | Alpha |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 244 | 0.60 | 10.9 | 0 | -20 | 294 | 0.25 | 8.5 | -0.45 | +10 |
| 245 |  |  | -0.38 |  | 295 | 0.95 | 10.9 | 0.41 | -10 |
| 246 |  | $\dagger$ | -0.48 |  | 296 |  |  | 0 | 1 |
| 247 |  | 8.5 | 0.43 |  | 297 |  |  | -0.38 |  |
| 248 |  |  | 0 |  | 298 |  | $\dagger$ | -0.48 |  |
| 249 |  |  | -0.36 |  | 299 |  | 8.5 | 0.43 |  |
| 250 | $\dagger$ | $\dagger$ | -0.45 |  | 300 |  |  | 0 |  |
| 251 | 0.25 | 10.9 | 0.41 |  | 301 |  |  | -0.36 |  |
| 252 |  |  | 0 |  | 302 | $\downarrow$ | $\downarrow$ | -0.45 |  |
| 253 |  |  | -0.38 |  | 303 | 0.90 | 10.9 | 0 |  |
| 254 |  | $\downarrow$ | -0.48 |  | 304 | 0.90 | 8.5 | , |  |
| 255 |  | 8.5 | 0.43 |  | 305 | 0.85 | 8.5 |  |  |
| 256 |  |  | 0 |  | 306 | 0.85 | 10.9 | $\nabla$ |  |
| 257 |  | , | -0.36 | , | 307 | 0.80 |  | 0.41 |  |
| 258 | $\dagger$ | $\dagger$ | -0.45 | $\checkmark$ | 308 | 1 |  | 0 |  |
| 259 | 0.95 | 10.9 | 0.41 | +10 | 309 |  |  | -0.38 |  |
| 260 |  |  | 0 |  | 310 |  | $\dagger$ | -0.48 |  |
| 261 |  | 1 | -0.38 |  | 311 |  | 8.5 | 0.43 |  |
| 262 |  | $\dagger$ | -0.48 |  | 312 |  | ) | 0 |  |
| 263 |  | 8.5 | 0.43 |  | 313 | , | 1 | -0.36 |  |
| 264 |  |  | 0 |  | 314 | $\checkmark$ | $\dagger$ | -0.45 |  |
| 265 |  | 1 | -0.36 |  | 315 | 0.60 | 10.9 | 0.41 |  |
| 266 | $\downarrow$ | $\checkmark$ | -0.45 |  | 316 |  |  | 0 |  |
| 267 | 0.90 | 10.9 | 0 |  | 317 |  | , | -0.38 |  |
| 268 | 0.90 | 8.5 |  |  | 318 |  | $\downarrow$ | -0.48 |  |
| 269 | 0.85 | 10.9 | 1 |  | 319 |  | 8.5 | 0.43 |  |
| 270 | 0.85 | 8.5 | $\dagger$ |  | 320 | 1 | 1 | 0 |  |
| 271 | 0.80 | 10.9 | 0.41 |  | 322 | $\dagger$ | $\dagger$ | -0.45 |  |
| 272 |  |  | 0 |  | 323 | 0.25 | 10.9 | 0.41 |  |
| 273 |  | 1 | -0.38 |  | 324 |  |  | 0 |  |
| 274 |  | $\nabla$ | -0.48 |  | 325 |  | 1 | -0.38 |  |
| 275 |  | 8.5 | 0.43 |  | 326 |  | $\downarrow$ | -0.48 |  |
| 276 |  |  | 0 |  | 327 |  | 8.5 | 0.43 |  |
| 277 |  |  | -0.36 |  | 328 |  |  | 0 |  |
| 278 | $\dagger$ | $\dagger$ | -0.45 |  | 329 |  |  | -0.36 |  |
| 279 | 0.60 | 10.9 | 0.41 |  | 330 | $\downarrow$ | $\downarrow$ | -0.45 | $\dagger$ |
| 280 |  | 1 | 0 |  | 333 | 0.95 | 5.5 | 0 | 0 |
| 281 |  |  | -0.38 |  | 334 | 0.80 |  | 1 |  |
| 282 |  | $\dagger$ | -0.48 |  | 335 | 0.25 | $\dagger$ |  |  |
| 283 |  | 8.5 | 0.43 |  | 340 | 0.95 | 3.5 | $\dagger$ |  |
| 284 |  |  | 0 |  | 341 |  | 5.5 | 0.44 |  |
| 285 |  |  | -0.36 |  | 342 |  |  | 0 |  |
| 286 | $\checkmark$ | $\downarrow$ | -0.45 |  | 343 |  | $\dagger$ | -0.44 |  |
| 287 | 0.25 | 10.9 | 0.41 |  | 344 | $\downarrow$ | 7.0 | 0 |  |
| 288 |  |  | 0 |  | 345 | 0.90 | 7.0 | , |  |
| 289 |  |  | -0.38 |  | 346 | 1 | 5.5 |  |  |
| 290 |  | $\downarrow$ | -0.48 |  | 347 | $\dagger$ | 3.5 |  |  |
| 291 |  | 8.5 | 0.43 |  | 349 | 0.85 | 7.0 |  |  |
| 292 | 1 | 1 | 0 | - | 350 | 1 | 5.5 | 1 | 1 |
| 293 | $\downarrow$ | $\checkmark$ | -0.36 | $\nabla$ | 351 | $\nabla$ | 3.5 | $\checkmark$ | $\dagger$ |

TABLE 1.- CONCLUDED

| $\begin{aligned} & \text { Run } \\ & \text { No. } \end{aligned}$ | Mach No. | $X / D_{B}$ | $Y / D_{B}$ | Alpha | Run <br> No. | Mach <br> No. | $X / D_{B}$ | $Y / D_{B}$ | Alpha |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 352 | 0.80 | 3.5 | 0 | 0 | 372 | 0.90 | 0.25 | 0 | 0 |
| 353 |  | 5.5 | 0.44 |  | 373 |  | 0.40 | 1 |  |
| 354 |  |  | 0 |  | 374 | $\downarrow$ | 0.50 |  |  |
| 355 |  | $\dagger$ | -0.44 |  | 375 | 0.85 | 0.17 |  |  |
| 356 | $\dagger$ | 7.0 |  |  | 376 |  | 0.25 |  |  |
| 357 | 0.60 | 7.0 | $\downarrow$ |  | 377 |  | 0.40 |  |  |
| 358 |  | 5.5 | 0.44 |  | 378 | $\downarrow$ | 0.50 |  |  |
| 359 |  |  | 0 |  | 379 | 0.80 | 0.17 |  |  |
| 360 |  | $\downarrow$ | -0.44 |  | 380 |  | 0.25 |  |  |
| 361 | $\dagger$ | 3.5 | 0 |  | 381 |  | 0.40 |  |  |
| 362 | 0.25 | 3.5 | 0 |  | 382 | $\checkmark$ | 0.50 |  |  |
| 363 |  | 5.5 | 0.44 |  | 383 | 0.60 | 0.18 |  |  |
| 364 |  | 1 | 0 |  | 384 | $1$ | 0.25 |  |  |
| 365 | 1 | $\nabla$ | -0.44 |  | 385 | 1 | 0.40 |  |  |
| 366 | $\downarrow$ | 7.0 | 0 |  | 386 | $\downarrow$ | 0.50 |  |  |
| 367 | 0.95 | 0.17 | - |  | 387 | 0.25 | 0.18 |  |  |
| 368 |  | 0.25 |  |  | 388 | , | 0.25 |  |  |
| 369 |  | 0.40 |  |  | 389 | 1 | 0.40 | 1 | 1 |
| 370 | $\downarrow$ | 0.50 | , |  | 390 | $\downarrow$ | 0.50 | $\downarrow$ | $\downarrow$ |
| 371 | 0.90 | 0.17 | $\dagger$ | $\downarrow$ |  |  |  |  |  |

## TABLE 2.- MEASURED WAKE PROPERTIES

## Heading Definitions

Run: $\quad$ Serial number within the test program.
Test P TN: Identifier for the entire test program.
CONF: Configuration of model and support system.
Ablated model mounted on short sting and strut supported from ceiling of wind tunnel test section; forwardfacing pitot-static probe. (Sections 2 a and 2c.)

Ballast-profile model supported as in 5 . (Section 2b.)
Ablated model supported as in 5 , except that pitot-static probe is bent to face downstream. (Section 2d.)
Mach: Mach number in free-stream wind tunnel flow.
RN/L: $\quad$ Reynolds number per unit length $(1 \mathrm{ft})$ in free-stream flow.
PT:
Q:
Pressure in stagnation chamber upstream of wind tunnel test section, pounds per square foot.
Dynamic pressure of wind tunnel free-stream airflow. $\mathrm{Q}=0.7 \mathrm{M}^{2} \times \mathrm{P}$, pounds per square foot.
P: Static pressure of wind tunnel free-stream airflow, pounds per square foot.
TT: $\quad$ Temperature of air in stagnation chamber of wind tunnel, ${ }^{\circ} \mathrm{F}$.
Alpha: Inclination of model axis to an intersecting line parallel to the free-stream direction.
Seq: $\quad$ Serial number of data record within run.
X/DB: Distance from model base to streamwise station of pitot orifice on pitot-static tube, diameters of model base.
Y/DB: Horizontal component of distance from axis of short sting to pitot orifice on pitot static tube, diameters of model base.

Z/DB: $\quad$ Vertical component of distance from axis of small sting to pitot orifice of pitot-static probe, diameters of model base.

MF/M: Ratio of Mach number determined from measured pitot and static pressures on the pitot-static probe to Mach.
MA/M: As above, but using the pressure acting on the aft-facing pitot probe.
QF/Q: Ratio of dynamic pressure acting on pitot-static probe to the free-stream dynamic pressure.
QA/Q: As above, but using the pressure acting on the aft-facing pitot tube.
VF/V: Ratio of air velocity deduced from pitot-static tube to free-stream velocity.
VA/V: As above but using aft-facing pitot tube.
CP: Static pressure acting on pitot-static probe minus free-stream static pressure, all divided by free-stream dynamic pressure. $\mathrm{CP}=(\mathrm{PF}-\mathrm{P}) / \mathrm{Q}$.

PF: Static pressure acting on static pressure orifices of pitot-static probe, pounds per square foot.
PF/P: $\quad$ Ratio of static pressure acting on pitot-static probe to free-stream static pressure.

Table 2(a)

Configuration 5 - Ablated model mounted on short sting and strut supported from ceiling of wind tunnel test section: forward-facing pitot-static probe.


| RUN | TSTp | TN C | CRNF | NACH | RN/ | 1 FT | 6 | p | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 146 | 5711 | 66 | 5 | 0.952 | 1.47 | 78688 | 243. 5 | 384 | 70.4 | 0.00 |  |  |  |  |
| SEG | MACH | 6 |  | $x / C B$ | $Y / 0$ P | $2 / 08$ | MF/N | MA/M | QF/Q | QA/Q | $V F / V$ | VA/V | $C P$ | PF/0 |
| 1 | 0.952 | 243.5 |  | 8.49 | C. 00 | -2.0? | 0.895 |  | 0.807 |  | 0.909 |  | 0.014 | 1.009 |
| 2 | 0.954 | 244.0 |  | 8.49 | 0.00 | -1.53 | C. 928 |  | 0.870 |  | 0.938 |  | 0.015 | 1.010 |
| 3 | 0.952 | 243.5 |  | 8.49 | 0.00 | -1.02 | 0.926 |  | 0.858 |  | 0.936 |  | 0.001 | 1.000 |
| 4 | 0.953 | 244.0 |  | 8.49 | 0.00 | -0.69 | C. 898 |  | 0.30 ? |  | 0.911 |  | -0.007 | 0.996 |
| 5 | 0.953 | 244.0 |  | 8.49 | 0.00 | -0.53 | 0.868 |  | 0.749 |  | 0.885 |  | -0.011 | 0.993 |
| 6 | 0.953 | 244. C |  | 8.49 | 0.00 | -0.36 | 0.852 |  | C. 720 |  | 0.871 |  | -0.014 | 0.991 |
| 7 | 0.951 | 243.5 |  | 8.49 | 0.00 | -0.19 | C. 819 |  | 0.664 |  | 0.841 |  | -0.018 | 0.989 |
| 8 | 0.951 | 243.5 |  | 8.49 | 0.00 | -0.02 | 0.819 |  | 0.660 |  | 0.840 |  | -0.023 | 0.986 |
| 9 | 0.952 | 244.0 |  | 8.49 | 0.00 | 0.15 | C. 756 |  | 0.625 |  | 0.820 |  | -0.023 | 0. 985 |
| 10 | 0.952 | 244.0 |  | 8.49 | 0.00 | 0.31 | 0.801 |  | 0.630 |  | 0.824 |  | $-0.027$ | 0. c 83 |
| 11 | 0.952 | 244.0 |  | 8.49 | C. 00 | 0.48 | 0.798 |  | 0.628 |  | 0.821 |  | -0.020 | 0.987 |
| 12 | 0.950 | 243.5 |  | 8.49 | 0.00 | 0.64 | 0.825 |  | 0.673 |  | 0.346 |  | -0.017 | 0.990 |
| 13 | 0.949 | 243.0 |  | 8. 49 | 0.00 | 0.98 | 0.912 |  | 0.833 |  | 0.924 |  | 0.003 | 1.C02 |
| 14 | 0.949 | 243.0 |  | 8.49 | 0.00 | 1.48 | C. 970 |  | 0.961 |  | 0.915 |  | 0.034 | 1.021 |
| 15 | 0.948 | 242.7 |  | 8.49 | 0.00 | 1.98 | 0.975 |  | 0.975 |  | 0.978 |  | 0.042 | 1.026 |


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| 226 | 5711 | 166 |  | 50.953 | 31.482 | 689 | 244．C | 394 | 69.8 | －20．00 |  |  |  |  |
| SEQ | MACH | 6 |  | X／C．${ }^{\text {P }}$ | Y／C？ 7 | 7／CP | MF／N | M $A / M$ | QF／0 | QA／W | VF／V | VA／V | CO | PF／P |
| 1 | 0.953 | 244. |  | 1C．87 | －C．49－2 | 2．04 | C． 969 |  | 0.959 |  | 0.972 |  | 0.038 | 1．C24 |
| 2 | 0.953 | 244． |  | 1 C .87 | －C．4e－1 | 1． 55 | C． 368 |  | 0.959 |  | 0.972 |  | 0.038 | 1.024 |
| 3 | 0.952 | 243. |  | 10.87 | －0．48－1 | 1.04 | 0.953 |  | 0.919 |  | 0.959 |  | 0.020 | 1.013 |
| 4 | 0.952 | 243. |  | 10.88 | －0．48－0 | 0.71 | C． 350 |  | 0.798 |  | 0.904 |  | 0.013 | 1．008 |
| 5 | $0.95 ?$ | 243. |  | 10.87 | －C．48－0 | 0.54 | C． 86 C |  | 0.745 |  | 0.878 |  | 0.009 | 1.006 |
| $t$ | 0.950 | 243. |  | 10.87 | $-\mathrm{C} .48-0$ | 0.37 | C． 860 |  | 0.742 |  | 0.878 |  | 0.003 | 1． CO 2 |
| 7 | 0.950 | 243. |  | 10.87 | －C．4E－0 | 0.20 | C． 841 |  | C． 709 |  | 0.860 |  | 0.004 | 1.003 |
| 8 | 0.950 | 243. |  | 10.87 | － $0.48-0$ | ． 04 | 0.855 |  | 0.734 |  | 0.873 |  | 0.006 | 1.004 |
| 9 | 0.951 | 243. |  | 1 C .88 | － 0.48 O | 0.13 | 0．859 |  | 0.739 |  | 0.877 |  | 0.003 | 1.002 |
| 10 | 0.951 | 243. |  | 1 C .88 | －0．48 | 0.29 | C． 871 |  | 0.759 |  | 0.837 |  | 0.002 | 1．col |
| 11 | 0.951 | 243. |  | 1 C .88 | －C．48 0 | 0.46 | C． 895 |  | 0.806 |  | 0.909 |  | 0.007 | 1.005 |
| 12 | 0.951 | 242. |  | 1 C .87 | $-C .48 \quad 0$ | 0.64 | C． 907 |  | 0.832 |  | 0.919 |  | 0.020 | 1.012 |
| 13 | 0.948 | 24？． |  | 10.88 | $-0.480$ | 0.97 | C． 942 |  | 0.907 |  | 0.950 |  | 0.033 | 1．021 |
| 14 | 0.947 | 242. |  | 10.87 | $-\mathrm{C} .48 \mathrm{l}$ | 1.16 | C．956 |  | 0.936 |  | 0.962 |  | 0.039 | 1．0？．4 |
| 15 | 0.947 | 242． |  | 10.87 | －0．48 1 | 1.47 | C．961 |  | 0.952 |  | 0.967 |  | 0.049 | 1．C31 |
| 16 | 0.945 | 241. |  | $1 \mathrm{C}$. | －C．48 1 | 1.97 | 0．965 |  | 0.962 |  | 0.970 |  | 0.053 | 1.033 |




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| 237 | 571 | 166 | 5 C .8 C | C 1.5 | 12757 | 222.5 | 497 | 70.8 | -20.00 |  |  |  |  |
| SEC | MACH | G | x/cra | Y/D8 | Z/C? | MF/M | MA/M | QF/Q | QA/Q | VF/V | VANV | CP | PF/D |
| 1 | C. 800 | 22?.5 | 1 C .87 | -0. 28 | -2.04 | C. 971 |  | 0.962 |  | 0.974 |  | 0.044 | 1.020 |
| 2 | 0.799 | 222.6 | $1 \mathrm{C}$. | -C. 38 | -1. 54 | C. 972 |  | 0.959 |  | 0.975 |  | 0.035 | 1.015 |
| 3 | 0.798 | 222.C | 1 C .87 | -0.38 | -1.05 | 0.958 |  | 0.924 |  | 0.902 |  | 0.016 | 1.007 |
| 4 | 0.799 | 222.t | 1 C .87 | -0.38 | -0.71 | C.90t |  | 0.825 |  | 0.916 |  | 0.009 | 1.004 |
| 5 | 0.798 | 22?.0 | 1 C .87 | -0.38 | -0.54 | 0.881 |  | 0.778 |  | 0.893 |  | 0.004 | 1.002 |
| 6 | 0.799 | 222.C | 1 C .87 | -0.38 | -0.37 | 0.877 |  | C. 770 |  | 0.889 |  | 0.001 | 1.001 |
| 7 | 0.800 | 222.5 | 1 C .87 | -0.38 | -0. 19 | 0.86? |  | 0.747 |  | 0.876 |  | 0.006 | 1.003 |
| 8 | 0.800 | 222.5 | 1 C .87 | -0.38 | -0.03 | C. 870 |  | 0.762 |  | 0.883 |  | 0.013 | 1.006 |
| 9 | 0.799 | 222.t | 1 C .87 | -0.38 | 0.13 | C. 8 E 5 |  | 0.754 |  | 0.878 |  | 0.018 | 1.008 |
| 10 | C. 799 | 222.t | 1 C .87 | -0.38 | 0.30 | C. 880 |  | 0.777 |  | 0.891 |  | 0.007 | 1.003 |
| 11 | C. 800 | 223.1 | 1 C .87 | $-0.38$ | 0.47 | C. 883 |  | 0.787 |  | 0.894 |  | 0.023 | 1.010 |
| 12 | 0.801 | 223.6 | 1 C .87 | -0.38 | 0.63 | C.9C7 |  | 0.828 |  | 0.916 |  | 0.016 | 1.007 |
| 13 | 0.759 | 22?.6 | 1 C .87 | -C.38 | 0.96 | 0.939 |  | 0.8 .91 |  | 0.946 |  | 0.022 | $1 . \mathrm{Cl} 10$ |
| 14 | 0.800 | 22?. | 1C.87 | -0.38 | 1.17 | C. 964 |  | 0.935 |  | 0.908 |  | 0.015 | 1.007 |
| 15 | C.800 | 222.5 | 1 C .87 | -0.38 | 1.47 | 0.987 |  | 0.981 |  | 0.989 |  | 0.013 | 1.006 |
| 16 | C. 803 | 223.5 | 10.87 | -C. 38 | 1.96 | 0.988 |  | 0.982 |  | 0.989 |  | 0.016 | 1.007 |



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| RUN | TST | F TA | CCNF | F NaCl | - $\mathrm{RN} / \mathrm{l}$ | 1 PT | 6 | $p$ | TT | ALPHA |  |  |  |  |
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| 298 | 571 | 166 |  | 50.952 | 21.48 | 3692 | 245.1 | 386 | 71.6 | -10.00 |  |  |  |  |
| SFE | MACH | 0 |  | $\mathrm{x} / \mathrm{CB}$ | $Y /{ }^{\text {P }}$ | $2 / 08$ | MF/N | MA/M | QF/0 | OA/Q | VF/V | va/v | CP | pr/p |
| 1 | 0.952 | 245.1 |  | 1 C .87 | -C.48 | -2.04 | C. 970 |  | 0.963 |  | 0.975 |  | 0.036 | 1.023 |
| 2 | 0.952 | 245.1 |  | 10.87 | -0.48 | -1.54 | c.973 |  | 0.966 |  | 0.977 |  | 0.031 | 1.019 |
| 3 | 0.954 | 245.7 |  | 1 C .87 | -0.48 | -1.04 | 0.959 |  | 0.931 |  | 0.965 |  | 0.019 | 1.C!2 |
| 4 | 0.954 | 245.7 |  | 1 C .87 | -C.48 | -0.71 | 0.904 |  | 0.820 |  | 0.917 |  | 0.007 | 1.005 |
| 5 | 0.954 | 245.7 |  | 10.87 | -C.48 | -0.54 | 0.886 |  | 0.790 |  | 0.901 |  | 0.010 | 1. cot |
| 6 | 0.954 | 245.7 |  | $1 \mathrm{C}$. | -C.48 | -0.38 | 0.875 |  | 0.766 |  | 0.891 |  | 0.002 | 1.001 |
| 7 | 0.954 | 245.7 |  | 10.87 | -C.48 | -0.20 | 0.868 |  | 0.751 |  | 0.885 |  | -0.004 | 0.998 |
| 8 | 0.954 | 245.7 |  | 1 C .87 | -0.48 | -0.04 | 0.857 |  | 0.733 |  | 0.875 |  | -0.004 | ก. 598 |
| 9 | 0.954 | 245.7 |  | 10.87 | -0.48 | 0.12 | 0.859 |  | 0.736 |  | 0.876 |  | -0.00? | 0.999 |
| 10 | 0.954 | 245.7 |  | 10.87 | -0.48 | 0.28 | C. 86 C |  | 0.741 |  | 0.378 |  | 0.032 | 1.001 |
| 11 | 0.954 | 245.7 |  | 10.87 | -0.48 | 0.46 | C. 869 |  | 0.757 |  | 0.386 |  | 0.005 | 1. CO 3 |
| 12 | 0.952 | 245.1 |  | 10.87 | -C.48 | 0.63 | 0.897 |  | 0. 809 |  | 0.911 |  | 0.006 | 1.004 |
| 13 | 0.954 | 245.7 |  | 1 C .87 | -0.48 | 0.96 | 0.946 |  | 0.904 |  | 0.954 |  | 0.016 | 1.010 |
| 14 | 0.952 | 245.1 |  | 10.87 | -0.48 | 1.16 | C. 954 |  | 0.930 |  | 0.961 |  | 0.033 | 1.021 |
| 15 | 0.951 | 244.6 |  | 10.87 | -0.48 | 1.46 | C. 964 |  | C. 956 |  | 0.969 |  | 0.045 | 1.028 |
| 16 | 0.949 | 244.2 |  | 10.87 | -C.48 | 1.97 | c.968 |  | 0.969 |  | 0.973 |  | 0.053 | 1.034 |




| RUN | TST | TN | CCNF | var．h | H RA／ | ／PT | 6 | D | TT | ALPHA |  |  |  |  |
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| 302 | 571 | 166 |  | 0.95 | 31.48 | 8269 | 24 E． 3 | $3 \varepsilon 7$ | 73.6 | －10．00 |  |  |  |  |
| SFG | MACH | 6 |  | $\mathrm{x} / \mathrm{CR}$ | Y／CB | I／Ca | MF／N | MA／M | QF／0 | QA／Q | VF／V | vas | $C^{\circ}$ | DF／D |
| 1 | 0.953 | 246.3 |  | ع． 48 | －0．45 | $-2.03$ | C．970 |  | 0.961 |  | 0.974 |  | 0.033 | 1.021 |
| $?$ | 0.954 | 246.8 |  | 8.48 | －0．45 | －1．52 | 0.975 |  | 0.969 |  | 0.978 |  | 0.031 | 1.070 |
| 3 | 0.954 | 246.8 |  | 8.48 | －0．45 | －1．03 | 0.371 |  | 0.953 |  | 0.975 |  | 0.016 | 1.010 |
| 4 | 0.954 | 246.8 |  | 8.48 | －0．45 | －0．68 | c． 911 |  | 0.831 |  | 0.923 |  | 0.002 | 1.001 |
| 5 | 0.954 | 246.8 |  | 8.48 | －0．45 | －0．52 | 0.881 |  | 0.774 |  | 0.897 |  | －0．005 | 0.997 |
| 6 | 0.953 | 246． 8 |  | 8.48 | －0．45 | －0．36 | 0.859 |  | 0.733 |  | 0.377 |  | －0．011 | 0.993 |
| 7 | 0.953 | 246.8 |  | 8.48 | －0．45 | －0．18 | 0.845 |  | 0.707 |  | 0.864 |  | －0．015 | 0.990 |
| $\varepsilon$ | 0.952 | 246．3 |  | $\varepsilon .48$ | －0．45 | －0．03 | 0.825 |  | 0.671 |  | 0.846 |  | －0．021 | 0.986 |
| 9 | 0.953 | 246.8 |  | 8.48 | －0．45 | 0.13 | 0.824 |  | 0.672 |  | 0.345 |  | －0．018 | 0.988 |
| 10 | 0.953 | 246.8 |  | 8.48 | －0．45 | 0.31 | 0.842 |  | 0.701 |  | 0.862 |  | －0．018 | 0.588 |
| 11 | 0.953 | 24 ¢． 8 |  | 8.48 | －0．45 | 0.48 | 0.862 |  | 0.735 |  | 0.879 |  | －0．015 | 0.990 |
| 12 | 0.952 | 246.3 |  | 8.48 | －0．45 | 0.64 | 0.886 |  | 0.783 |  | 0.901 |  | －0．003 | 0.998 |
| 13 | C．950 | 245.8 |  | 8.43 | －0．45 | 0.98 | C． 950 |  | 0.907 |  | 0.957 |  | 0.009 | 1.006 |
| 14 | 0.950 | $245 . \varepsilon$ |  | 8.48 | －C．45 | 1.18 | C． 9 ¢9 |  | 0.954 |  | 0.973 |  | 0.026 | 1.017 |
| 15 | 0.950 | 245.8 |  | 8.48 | －0．45 | 1.49 | 0.970 |  | 0.965 |  | 0.975 |  | 0.039 | 1． 025 |
| 16 | 0.949 | 245.4 |  | 8.48 | －0．45 | 1.95 | C． 973 |  | 0.974 |  | 0.977 |  | 0.045 | 1.028 |



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| RUN | TST | F TA | CCNF | MACH | H PN/L | $1 \quad \mathrm{PT}$ | 6 | P | TT | ALPHA |  |  |  |  |
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| 312 | 571 | 66 | 5 | C. 800 | 01.521 | 1774 | 22.7 .4 | 507 | 77.2 | -10.00 |  |  |  |  |
| SFG | MACH | 9 |  | $\times / 08$ | Y/CD | $2 / 08$ | MF/N | M $4 / \mathrm{M}$ | OF/O | Qa/Q | VF/V | VAIV | $\mathrm{C}^{p}$ | Pr/p |
| 1 | 0. 800 | 227.4 |  | 8.49 | -0.01 | -2.02 | 0.896 |  | 0.810 |  | 0.906 |  | 0.019 | 1.COR |
| 2 | 0.800 | 227.4 |  | 8.49 | -C.Cl | -1.53 | 0.913 |  | 0.839 |  | 0.922 |  | 0.015 | $1 . \operatorname{CO7}$ |
| 3 | 0.800 | 227.4 |  | 8.49 | -0.01 | -1.02 | C. 909 |  | 0.830 |  | 0.918 |  | 0.010 | 1.005 |
| 4 | 0.800 | 227.4 |  | 8.49 | -C.C1 | -0.69 | C. 877 |  | 0.769 |  | 0.389 |  | 0.000 | 1.000 |
| 5 | ก. 800 | 227.4 |  | 8.49 | -0.01 | -0. 53 | c. 8 ¢0 |  | 0.737 |  | 0.373 |  | -0.007 | 0.997 |
| 6 | C. 800 | 227.4 |  | 8.48 | -0.01 | -0. 36 | 0.839 |  | 0.702 |  | 0.854 |  | -0.009 | 0.596 |
| 7 | 0.800 | 227.4 |  | 8.48 | -C.Cl | -0.19 | C. 913 |  | 0.661 |  | 0.829 |  | 0.000 | 1.000 |
| 8 | 0. 800 | 227.4 |  | 8.49 | -0.01 | -0.02 | 0.827 |  | 0.683 |  | 0.842 |  | -0.004 | 0.998 |
| 9 | 0.800 | 227.4 |  | 8.48 | -C.C1 | 0.14 | C. 834 |  | 0.696 |  | 0.849 |  | -0.001 | 1.000 |
| 10 | 0.799 | 226.9 |  | 8.48 | -0.01 | 0.32 | C. 820 |  | 0.673 |  | 0.835 |  | 0.00? | 1.001 |
| 11 | C.757 | 226.4 |  | 8.49 | -0.01 | 0.49 | 0.856 |  | 0.732 |  | 0.869 |  | -0.00? | 0.999 |
| 12 | 0.799 | 226.9 |  | 8.49 | -0.C1 | 0.65 | C. 875 |  | 0.773 |  | 0.891 |  | -0.001 | 1.000 |
| 13 | 0.799 | 22t.9 |  | 8.48 | -0.01 | 0.98 | 0.943 |  | 0.889 |  | 0.949 |  | 0.001 | 1.000 |
| 14 | 0.804 | 228. 5 |  | 8.48 | -0.01 | 1.17 | 0.981 |  | 0.961 |  | 0.983 |  | -0.001 | 0.999 |
| 15 | 0.805 | 228.8 |  | 8.48 | -0.01 | 1.48 | $0.98 t$ |  | 0.975 |  | 0.968 |  | 0.007 | 1.003 |
| 16 | 0.964 | 227.7 |  | 8.48 | -0.01 | 1.98 | 0.982 |  | 0.976 |  | 0.934 |  | 0.027 | 1.012 |







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## TABLE 2(b)

Configuration 6 - Ballast-profile model as supported in Configuration 5.



Table 2(c)

Configuration 5 - Ablated model mounted on short sting and strut supported from ceiling of wind tunnel test section: forward-facing pitot-static probe.




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Table 2(d)

Configuration 7 - Ablated model mounted on short sting and strut supported from ceiling of wind tunnel test section aft-facing pitot-static probe.


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| RUN | TST | f TA C | CCNF | NaCH | FA/L | -T | 6 | $\bigcirc$ | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 269 | 571 | 66 | 7 | 0.950 | 01.485 | 685 | 243.5 | 395 | 68.8 | 0.00 |  |  |  |  |
| SES | NaCH | 5 |  | $x / C^{8}$ | Y/0 ${ }^{\text {a }}$ | z/CP | MF/M | MA/M | DF/0 | QA/Q | VF/V | VA/V | CP | F |
| 1 | 0.950 | 243.5 |  | C. 53 | C. Cl | 0.40 | 0.267 | 0.184 | 0.053 | 0.025 | 0.289 | $0.1 ¢ 9$ | -0.407 | 0.743 |
| 2 | 0.949 | 243.0 |  | 0.8 ? | $0 . \mathrm{Cl}$ | 0.40 | C. 265 | 0.600 | 0.051 | C. 000 | 0.286 | 0.000 | -0.441 | 0.727 |
| 3 | 0.949 | 243.0 |  | 1.11 | 0.00 | 0.40 | 0.251 |  | 0.044 |  | 0.272 |  | -0.485 | 0.694 |
| 4 | 0.949 | 243.1 |  | 1.41 | 0.00 | 0.39 | 0.165 | 0.000 | 0.020 | 0.000 | 0.184 | 0.080 | -0.495 | 0.688 |
| 5 | 0.949 | 243.1 |  | 1.69 | -0.00 | 0.39 | C. 204 | 0.173 | 0.029 | 0.021 | 0.221 | 0.187 | -0.485 | 0.694 |
| 6 | 0.949 | 243.1 |  | 1.99 | -C.01 | 0.39 | 0.268 | 0.299 | 0.052 | 0.005 | 0.239 | $0.32 ?$ | $-0.437$ | 0. 725 |
| 7 | 0.949 | 243.6 |  | 2.27 | -C.CI | 0.39 | 0.242 | 0.296 | C. 046 | C. 063 | 0.263 | 0.319 | -0.358 | 0.774 |
| 9 | 0.949 | 243.6 |  | 2.56 | -C.Cl | 0.39 | 0.177 | 0.233 | 0.026 | 0.046 | 0.191 | 0.252 | -0.246 | 0.245 |
| 9 | 0.349 | 243.6 |  | 2.85 | -C.Cl | 0.38 | 0.CEC | 0.13 C | 0.003 | C. 015 | 0.065 | 0.141 | -0.147 | 0.907 |
| 10 | 0.949 | 243.0 |  | 3.14 | -0.02 | 0.39 | C.OCC | C.ccc | 0.000 | 0.000 | 0.000 | 0.060 | -0.074 | 0.953 |
| 11 | 0.950 | 243.0 |  | 3.44 | -C.C2 | 0.38 | C.OCC | 0.000 | 0.000 | 0.000 | 0.000 | -. OCO | -0.009 | C. 995 |
| 12 | 0.952 | 243.5 |  | 3.73 | -C.C2 | 0.38 |  |  |  |  |  |  | 0.029 | 1.019 |
| 13 | 0. 952 | 243.5 |  | 4.02 | $-0.03$ | 0.38 | 0.000 |  | 0.000 |  | 0.000 |  | 0.029 | 1.C19 |

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| RUN | TST | - 10 |  | NAC | RA | PT | 6 | 0 | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 373 | 571 | 136 | 7 | 0.899 | 91.4 | 702 | 235.0 | 415 | 70.9 | U.co |  |  |  |  |
| SFG | MACH | 6 |  | X/CR | Y/CP | 2108 | MF/N | MA/M | QF/0 | DA/G | VF/V | V $4 / V$ | Co | F/0 |
| 1 | 0.899 | 235. C |  | C. 53 | C. 01 | 0.40 | C. 279 | 0.184 | 0.061 | $0.0<7$ | 0.299 | 0.1c8 | -0.381 | 0.785 |
| 2 | C.900 | 235.5 |  | C. 82 | 0.01 | 0.40 | C. 276 |  | 0.058 |  | 0.295 |  | -0.419 | 0.762 |
| 3 | 0.900 | 235.5 |  | 1.11 | 0.00 | 0.40 | c.297 |  | 0.065 |  | 0.318 |  | -0.46t | 0.736 |
| 4 | 0.900 | 235.5 |  | 1.41 | 0.00 | 0.40 | 0.293 | 0.039 | 0.062 | 0.001 | 0.314 | 0.04 ? | -0.49? | 0.720 |
| 5 | 0.900 | 235.5 |  | 1.69 | -0.00 | 0.39 | c.2ts | 0.278 | 0.052 | 0.038 | 0.238 | 0.244 | -0.481 | 0.727 |
| 6 | 0.902 | 235.s |  | 1.98 | -0.01 | 0.39 | 0.243 | 0.306 | 0.044 | 0.070 | 0.200 | 0.327 | $-0.436$ | 0.752 |
| 7 | 0.900 | 234.9 |  | 2.27 | -C.Cl | 0.39 | C. 192 | 0.278 | C. 030 | 0.063 | 0.206 | 0.298 | -0.340 | 0.807 |
| 8 | 0.900 | 234.9 |  | 2.56 | -0.01 | 0.39 | C. 175 | 0.241 | C. 028 | C. 050 | 0.193 | 0. 258 | -0.229 | 0. 870 |
| 9 | 0.900 | 234.9 |  | 2.85 | -C.Cl | 0.39 | c.000 | 0.113 | 0.000 | 0.012 | 0.000 | 0.122 | -0.115 | c. 535 |
| 10 | 0.901 | 235.4 |  | 3.14 | -C.C2 | 0.38 |  | c. 000 |  | 0.000 |  | 0.000 | -0.025 | 0.986 |
| 11 | 0.901 | 235.4 |  | 3.44 | -C.02 | 0.38 |  |  |  |  |  |  | 0.033 | 1.619 |
| 12 | C.901 | 235.4 |  | 3.73 | -C.C? | 0.38 |  |  |  |  |  |  | 0.058 | 1.033 |
| 13 | 0.898 | 234.5 |  | 4.01 | -C.C? | 0.38 | C.OC0 |  | C.000 |  | 0.000 |  | 0.055 | 1.031 |



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| RUN | TSTI | P TA | CCNF | NaCl | F RA／L | FT | 6 | $\bigcirc$ | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $37 t$ | 571 | 166 | 7 | 0.848 | 81.497 | 731 | 229.9 | 457 | 71.6 | 0.00 |  |  |  |  |
| SFG | MACH | C |  | x／re | Y／CB | 2／Eㅁ | MF／N | MA／M | QF／0 | 0a／6 | VF／V | VA／V | $C^{P}$ | PF／$/ \mathrm{P}$ |
| 1 | 0.848 | 229.5 |  | C． 53 | 0.01 | 0.25 | 0.254 | 0.254 | 0.052 | 0.052 | 0.270 | 0.271 | －0．394 | 0.802 |
| 2 | 0.350 | 230.7 |  | C． 80 | 0.01 | 0.25 | 0.340 | 0.248 | C． 090 | 0.048 | 0.361 | 0.264 | －0．433 | 0.781 |
| 3 | 0.851 | 230.6 |  | 1.11 | C． 00 | 0.25 | 0.365 | 0.169 | 0.101 | 0.022 | 0.387 | 0．181 | －0．472 | 0.761 |
| 4 | 0.852 | 230.9 |  | i． 41 | C． 00 | 0.34 | 0.409 | 0.255 | 0.126 | 0.049 | 0.432 | 0.271 | －0．483 | 0.754 |
| 5 | 0.851 | 230.6 |  | 1.69 | －0．00 | 0.24 | 0.469 | 0.321 | 0.167 | C．078 | 0.494 | 0.341 | －0．476 | 0.759 |
| 6 | 0．852 | 230.5 |  | 1.98 | －C．Cl | 0.24 | 0.457 | 0.338 | 0.164 | 0.090 | 0.481 | 0.359 | －0．424 | 0.785 |
| 7 | 0.852 | 230.9 |  | 2.27 | －C．C 1 | 0.24 | C．4c6 | 0.351 | 0.137 | 0.103 | 0.429 | 0.373 | －0．327 | 0.834 |
| 8 | 0.853 | 231．3 |  | 2.56 | －c．cl | 0.24 | 0.288 | 0.284 | 0.074 | 0.072 | 0.307 | 0．3C2 | －0．207 | 0.894 |
| 9 | 0.854 | 731.2 |  | 2.85 | －C．Cl | 0.24 | c． 125 | 0.123 | C． 018 | 0.015 | 0.145 | 0.131 | －0．070 | 0.964 |
| 10 | 0.851 | 230.5 |  | 3.13 | －0．0？ | 0.23 | c．0cc | 0.04 C | C． 000 | c． 002 | 0.000 | 0.043 | 0.012 | 1.006 |
| 11 | 0.851 | 230.6 |  | 3.44 | －C．C？ | 0.23 | C．000 |  | 0.000 |  | 0.000 |  | 0.048 | 1.024 |
| 12 | 0.851 | 231.0 |  | 3.73 | －C．02 | 0.23 | C．OCC |  | 0.000 |  | 0.000 |  | 0.065 | 1.033 |
| 13 | 0.851 | 230.6 |  | 4.01 | －C．03 | 0.23 |  |  |  |  |  |  | 0.059 | 1.030 |


| RUN | TST | in 0 | CrNf | nar | H RA | ft | $r$ | p | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 377 | 571 | 165 | 7 | 0.85 | 31.50 | 727 | 230.1 | 452 | 69.0 | 0.00 |  |  |  |  |
| SFG | MACH | 0 |  | $\mathrm{x} / \mathrm{CB}$ | $Y / D^{\circ}$ | 2/00 | MF/N | Ma/M | CF/O | Qa/Q | VF/V | va/v | C. ${ }^{\text {P }}$ | PF/P |
| 2 | 0.853 | 230.1 |  | C. 53 | C.Cl | 0.40 | C. 25.1 | 0.174 | c. 051 | C. 025 | 0.267 | 0.186 | -0.374 | 0.810 |
|  | C. 850 | 22.9 .4 |  | C. 81 | O.Cl | 0.40 | C. 222 | 0.000 | 0.030 | 0.000 | 0.237 | 0.000 | -0.418 | 0.789 |
| 4 | 0.848 | 228.6 |  | 1.10 | c.co | 0.40 | 0.271 | 0.075 | 0.056 | 0.004 | 0.288 | 0.080 | -0.465 | 0.766 |
| 5 | 0.848 | 728.6 |  | 1.41 | 0.00 | 0.40 | C. 266 | 0.000 | 0.053 | C. 000 | 0.283 | 0.0c0 | -0.498 | 0.749 |
| 6 | 0.850 | 229.0 |  | 1.69 | -c.00 | 0.39 | c. 320 | 0.145 | 0.078 | 0.016 | 0.340 | 0.155 | -0.48? | 0.756 |
| 7 | 0.850 | 229.0 |  | 1.98 | -C.Cl | 0.39 | C. $3 \mathrm{C} /$ | 2.303 | C. C 72 | c. 0.072 | 0.323 | 0.322 | -0.429 | 0.783 |
| 8 | 0. 850 | 228.9 |  | 2.?7 | -0.01 | 0.39 | 0.263 | 0.311 | 0.658 | 0.001 | 0.280 | 0.330 | -0.324 | 0.836 |
| 9 | 0.851 | 229.3 |  | ?. 56 | -C.01 | 0.39 | 0.140 | 0.243 | 0.018 | 0.053 | 0.150 | 0.258 | -0.1.98 | 0.900 |
| 10 | 0.851 | 229.3 |  | 2.85 | -0.01 | 0.38 | C.ce4 | 0.169 | C.CC7 | c. 027 | 0.089 | 0.180 | -0.088 | 0.956 |
| 11 | 0.852 | 229.8 |  | 3.13 | -c. 02 | 0.38 |  |  |  |  | 0. | O. | 0.006 | 1.003 |
| 12 | 0.85 ? | 229.8 |  | 2.44 | -C.c2 | 0.38 |  |  |  |  |  |  | 0.045 | 1.023 |
| 13 | 0.952 | 229.8 |  | 3.72 | -C.02 | 0.38 |  |  |  |  |  |  | 0.058 | 1.c29 |
| 14 | 0.85c | 229.0 |  | 4.01 | -0.c3 | 0.38 |  |  |  |  |  |  | 0.055 | 1.028 |


| PUN | TST F | ta | CTNF | NaCH | H DM/L | PT | 6 | P | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 378 | 5711 | 66 | 7 | C. 849 | 91.494 | 126 | 228.5 | 453 | 69.8 | 0.00 |  |  |  |  |
| SFO | MACH | 6 |  | $\mathrm{X} / \mathrm{C}^{\text {P }}$ | y/re | Z/DR | me / N | M $A$ / | QF/0 | 0A/O | VF/V | VAN | $C^{\circ}$ | DF/D |
| 1 | 0.849 | 228.5 |  | C. 53 | C. 01 | 0.50 | 0.124 |  | 0.013 |  | 0.133 |  | -0.368 | 0.814 |
| 2 | 0.848 | 228.6 |  | C. 81 | C. Cl | 0.50 | c. 225 |  | 0.040 |  | 0.240 |  | -0.414 | 0.792 |
| 3 | 0.849 | 229.1 |  | 1.11 | c. 00 | 0.50 | 0.203 |  | 0.032 |  | 0.216 |  | -0.461 | 0.767 |
| 4 | 0.854 | 230.5 |  | 1.49 | c.cc | 0.50 | 0.199 |  | 0.029 |  | 0.212 |  | -0.500 | 0.745 |
| 5 | 0.854 | 230.5 |  | 1.69 | -C.CO | 0.49 | 0.114 | 0.000 | 0.010 | 0.000 | 0.122 | 0.000 | -0.474 | 0.758 |
| 6 | 0.854 | 230.0 |  | 1.98 | -C.Cl | 0.49 | 0.163 | 0.234 | 0.021 | 0.043 | 0.174 | 0.249 | -0.413 | 0.789 |
| 7 | 0.852 | 229.7 |  | 2.27 | -C.Cl | 0.49 | 0.156 | 0.249 | 0.021 | 0.052 | 0.167 | 0.266 | -0.312 | 0.841 |
| 8 | 0.952 | 229.8 |  | 2.55 | -C.01 | 0.49 | 0.03? | 0.114 | C.CCl | c. 012 | 0.035 | 0.122 | -0.185 | 0.906 |
| 9 | 0.852 | 229.7 |  | 2.85 | -C.Cl | 0.49 |  | 0.000 |  | 0.000 |  | 0.000 | -0.090 | 0.954 |
| 10 | 0.852 | 230.3 |  | 3.14 | -C.C2 | 0.48 |  |  |  |  |  |  | -0.011 | 0.995 |
| 11 | 0.851 | 230.0 |  | 3.44 | -0.0? | 0.48 |  |  |  |  |  |  | 0.040 | 1.020 |
| 12 | 0.851 | 230.C |  | 3.73 | -C.02 | 0.48 |  |  |  |  |  |  | 0.045 | 1.023 |
| 13 | 0.853 | 230.2 |  | '.Cl - | -0.03 | 0.48 |  |  |  |  |  |  | 0.039 | 1.020 |







| RUN | TST | TA | CONF | Nat | R RN/L | PT | 6 | P | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 383 | 571 | 166 | 7 | 0.60 | 11.513 | S00 | 178.5 | 705 | 70.3 | 0.00 |  |  |  |  |
| SEO | MACH | G |  | x/[3 | y/re | Z/DB | MF/N | MA/M | OF 10 | 0a/0 | VFIV | VAN | CD | P/0 |
|  | 0.601 | 178.5 |  | C. 53 | C. Cl | 0.18 | 0.298 | 0.244 | 0.080 | 0.054 | 0.308 | 0.252 | -0.382 | 0.903 |
| 2 | 0.599 | 177.3 |  | C. 8 ? | C.Cl | 0.18 | 0.410 | 0.360 | 0. 148 | 0.114 | 0.422 | 0.371 | -0.466 | 0.883 |
| 3 | 0.597 | 176.7 |  | 1.10 | 0.00 | 0.18 | C. 502 | 0.370 | C. 221 | C. 120 | 0.515 | 0.381 | -0.496 | 0.876 |
| 4 | 0.597 | 176.7 |  | 1.41 | 0.00 | 0.19 | C. 536 | 0.394 | 0.253 | 0.137 | 0.549 | 0.405 | -0.486 | 0.879 |
| 5 | 0.597 | 176.7 |  | 1.69 | -C.CO | 0.18 | C. 494 | 0.375 | C. 220 | 0.126 | 0.507 | 0.386 | -0.401 | 0.900 |
| 6 | 0.597 | 176.7 |  | 1.99 | -0.01 | 0.18 | 0.373 | 0.340 | 0.130 | C. 109 | 0.384 | 0.351 | -0.252 | 0.937 |
| 7 | 0.600 | 177.9 |  | 2.26 | -C.Cl | 0.17 | 0.140 | 0.159 | 0.019 | 0.025 | 0.145 | 0.165 | -0.090 | 0.977 |
| 8 | 0.599 | 177.3 |  | 2.56 | -C.01 | 0.17 | c.00c | 0.1000 | C. 000 | C. 000 | 0.000 | 0.060 | 0.015 | 1.004 |
| 9 | 0.599 | 177.3 |  | 2.85 | $-\mathrm{C.Cl}$ | 0.17 | c.000 | 0.000 | 0.000 | C. 000 | 0.000 | 0.000 | 0.048 | 1.C12 |
| 10 | 0.600 | 177.9 |  | 3.13 | -C.c2 | 0.17 | C.OCC |  | C. 000 |  | 0.000 |  | 0.043 | 1.011 |
| 11 | 0.600 | 177.9 |  | 3.43 | -0.02 | 0.17 | C. 000 |  | 0.000 |  | 0.000 |  | 0.023 | 1.00t |
| 12 | 0.601 | 178.5 |  | 3.72 | -C.c2 | 0.16 |  |  |  |  |  |  | 0.030 | 1.008 |
| 13 | 0.600 | 177.9 |  | $4 . C 1$ | $-0.03$ | 0.16 |  |  |  |  |  |  | -0.001 | 1.000 |


| RUN | TST | TA | CCNF | NaCt | EA/L | PT | 6 | $\bigcirc$ | TT | ALPHA |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 384 | 571 | 66 | 7 | 0.600 | 1.511 | $\varepsilon 99$ | 177.s | 705 | 70.0 | 0.00 |  |  |  |  |
| SFG | MarH | G |  | $x /{ }^{\text {P }}$ | $Y / 0^{\circ}$ | $2 / 0^{\circ}$ | ve/n | va/n | CF/Q | 0410 | VF/V | vas | CP | PF/P |
| 1 | 0.600 | 177.9 |  | C. 53 | C. 01 | 0.25 | C. 271 | 0.191 | 0.066 | 0.032 | 0.280 | 0.197 | -0.435 | 0.890 |
| 2. | 0.60? | 178.5 |  | C. 8 ? | 0.01 | 0.25 | $0.3 \in 1$ | 0.236 | 0.115 | c. 049 | 0.372 | 0.244 | -0.474 | 0.880 |
| 3 | C.6Cl | 178.5 |  | 1.11 | C.CC | 0.25 | C. 490 | 0.294 | 0.209 | 0.075 | 0.503 | 0.304 | -0.510 | 0.871 |
| 4 | 0.601 | 178.5 |  | 1.41 | c.00 | 0.24 | C.453 | 0.362 | 0.213 | 0.115 | 0.506 | 0.373 | -0.494 | 0.875 |
| 5 | 0.600 | 177.5 |  | 1.69 | -0.00 | 0.24 | 0.446 | 0.313 | 0.180 | 0.088 | 0.459 | 0.323 | -0.388 | 0.902 |
| 6 | 0.590 | 177.3 |  | 1.98 | C.Cl | 0.24 | C. 324 | 0.331 | 0.098 | 0.103 | 0.334 | 0.341 | -0.245 | 0.939 |
| 7 | 0.599 | 177.3 |  | 2.27 | -0.Cl | 0.24 | 0.165 | 0.299 | 0.026 | C. 087 | 0.170 | 0.369 | -0.115 | 0.971 |
| 8 | 0.597 | 176.7 |  | 2.56 | C. Cl 1 | 0.24 | c.cco | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.008 | 1.002 |
| 9 | 0.600 | 177.9 |  | 2.85 | C.Cl | 0.24 | 0.00C | 0.000 | c. 000 | 0.000 | 0.000 | 0.0CO | 0.038 | 1.010 |
| 10 | 0.600 | 177.9 |  | 3.13 | -0.02 | 0.23 | C.000 |  | 0.000 |  | 0.000 |  | 0.047 | 1.012 |
| 11 | 0.6 Cl | 178.5 |  | 2.44 | - .0 .2 | 0.23 | C.OCC |  | C. 060 |  | 0.000 |  | 0.041 | 1.010 |
| 12 | 0.600 | 177.9 |  | 3.73 | -0.02 | 0.23 | 0.000 |  | 0.000 |  | 0.000 |  | 0.011 | 1.003 |
| 12 | $0.6 C 2$ | 178.5 |  | 4.01 | -C.C3 | 0.23 |  |  |  |  |  |  | 0.011 | 1.003 |




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| RUN | TST | TN C | F | NaCH | H RN/L | Pr | 6 | ${ }^{\circ}$ | TT | AL |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 389 | 5711 | 66 | 7 | 0.252 | 21.524 | 1884 | 8 C .1 | $180 ?$ | 65.4 | . 00 |  |  | co | $\rho$ |
| SEC | MACH | Q |  | $x /{ }^{\text {R }}$ | $Y / \Gamma \mathrm{P}$ | $2 / 10$ | MF/N | MA/M | CF | A |  |  |  |  |
| 1 | 0.252 | 80.1 |  | C. 53 | C. 01 | 0.40 | C.11C | 0.219 | 0 | ก. |  | 1 |  |  |
| 2 | 0.252 | 80.1 |  | 0.82 | 0.01 | 0.40 | C. 3 C 7 | 0.1800 | C. 092 | C.040 | 201 | 0.012 0.134 | . 607 | c.73 |
| 3 | 0.251 | 75.5 |  | 1.11 | 0.00 | 0.40 | C. 260 | 0.133 0.396 | -.066 | 0.15 | 0.201 0.310 | 0. 359 | -0.555 | 6 |
| 4 | 0.751 | 79.5 |  | 1.40 | 0.00 | 0.40 | 0.204 | 0.396 0.371 | 0.0642 0.041 | C. 136 | 0.206 | 0.373 | -0.34? | 0. 585 |
| 5 | 0.250 | 78.8 78.8 |  | 1.48 1.98 | -0.00 -0.01 | n.39 | C. 120 | 0.23? | 0.014 | C. 053 | 0.121 | 0.233 | -0.155 | 93 |
| 7 | 0.751 | 79.5 |  | 2.27 | -0.01 | 0.35 | c.0cc | 0.000 | C. 200 | C. 000 | 0.000 | - 0.00 | -0.010 | -000 |
| 8 | 0.251 | 79.5 |  | 2.56 | -C.Cl | 0.35 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | C | 17 |  |
| 9 | 0.251 | 79 |  | 2.85 | $\mathrm{C} . \mathrm{Cl}$ | 0.39 | O.OCC | $0 . C O C$ | C. 000 | c. 000 | 0.000 | 0.0ch | 0.019 |  |
| , | 0.250 | 78.8 |  | 3.13 | . 02 | . 38 | c | $0 . \mathrm{cos}$ |  |  |  |  |  |  |



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## ALL DIMENSIONS NORMALIZED TO MODEL DIAMETER MODEL DIAMETER $=6 \mathrm{in}$.

Figure 1.- Scale models tested in 6 - by 6 - ft transonic wind tunnel. (a) Ablated configuration. (b) Ballasted configuration.


ALL DIMENSIONS NORMALIZED TO MODEL DIAMETER MODEL DIAMETER = 6 in.

Figure 2.- Model and sting-strut support.

a) FAR-WAKE CONFIGURATION

b) NEAR-WAKE CONFIGURATION (CONFIGURATION "A" MODIFIED BY BENDING)

Figure 3.- Pitot-static probe.


Figure 4.- Test setup.


Figure 5.- Radial profiles of dynamic pressure. $X / D_{B}=5.5, Y / D_{B}=0, R=0.75$ million, $\alpha=0^{\circ}$.


Figure 6.- Axial profile and spatial contours of dynamic pressure in wake of ablated Galileo probe. $\alpha=0.0^{\circ}$, $R_{D}=0.75$ Million.


Figure 6.- Concluded.


Figure 7.- Effect of angle of attack on dynamic-pressure profiles, $X / D_{B}=8.5, M=0.80, R_{D}=0.75$ million.


Figure 8.- Contours of constant reverse dynamic pressure in near wake of ablated model, $\alpha=0, R_{D}=0.75$ million, $Y / D_{B}=0$.


Figure 8.- Continued.


Figure 8.- Concluded.

| Report Documentation Page |  |  |
| :---: | :---: | :---: |
| 1. Report No. NASA RP-1130 | 2. Government Accession No. | 3. Recipient's Catalog No. |
| 4. Title and Subtitle <br> Galileo Probe Parachute Test Program: Wake Properties of the Galileo Probe at Mach Numbers From 0.25 to 0.95 |  | 5. Report Date <br> April 1988 |
|  |  | 6. Performing Organization Code |
| 7. Author(s) <br> Thomas N. Canning (Portola Valley, CA) and Thomas M. Edwards |  | 8. Performing Organization Report No. A-9643 |
|  |  | 10. Work Unit No. |
| 9. Performing Organization Name and Address <br> Ames Research Center <br> Moffett Field, CA 94035 |  |  |
|  |  | 11. Contract or Grant No. |
|  |  | 13. Type of Report and Period Covered |
| 12. Sponsoring Agency Name and Address <br> National Aeronautics and Space Administration Washington, DC 20546-0001 |  | Reference Publication |
|  |  | 14. Sponsoring Agency Code |

15. Supplementary Notes

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## 16. Abstract

The results of surveys of the near and far wake of the Galileo Probe are presented for Mach numbers from 0.25 to 0.95 . The trends in the data resulting from changes in Mach number, radial and axial distance, angle of attack, and a small change in model shape are shown in crossplots based on the data. A rationale for selecting an operating volume suitable for parachute inflation based on low Mach number flight results is outlined.

| 17. Key Words (Suggested by Author(s)) <br> Blunt body aerodynamics <br> Transonic wake characteristics <br> Parachute performance, Transonic flow <br> Wind tunnel tests | 18. Distribution Statement <br> Unclassified - Unlimited |  |
| :--- | :--- | :--- | :--- |
| 19. Security Classif. (of this report) <br> Unclassified | 20. Security Classif. (of this page) <br> Unclassified | Subject Category - |


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