NASA-CR-193673

GRANT
IN-02-CR
180096
P- 4

FINAL TECHNICAL REPORT
GRANT NAG-1-961

For the Period January 27, 1989-January 26, 1990

Submitted to: Mr. J. B. Anders, Jr.
Technical Officer
Mail Stop 163
NASA-Langley Research Center
Hampton, VA 23665-5225

EXPLORATORY STUDY OF IN-PLANE STREAMLINE CURVATURE EFFECTS ON A TURBULENT BOUNDARY LAYER AT A MACH NUMBER OF 3

By

Seymour M. Bogdonoff
Gas Dynamics Laboratory
Department of Mechanical and Aerospace Engineering
Princeton University, Princeton, NJ 08544

(NASA-CR-193673) EXPLORATORY STUDY OF IN-PLANE STREAMLINE CURVATURE EFFECTS ON A TURBULENT BOUNDARY LAYER AT A MACH NUMBER OF 3 Final Technical Report, 27 Jan. 1989 - 26 Jan. 1990 (Princeton Univ.) 4 p

N94-13292

Unclas

G3/02 0180096

May 1991

EXPLORATORY STUDY OF IN-PLANE STREAMLINE CURVATURE EFFECTS ON A TURBULENT BOUNDARY LAYER AT A MACH NUMBER OF 3

GRANT NAG-1-961
January 27, 1989-January 26, 1990

Introduction

The subject grant, NAG-1-961, was a program to study in-plane streamline curvature effects in a turbulent boundary layer at a Mach number of 3. The original proposal was for a 3-year program to explore in-plane streamline curvature effects on a supersonic turbulent boundary layer using three-dimensional pressure fields generated by fins and wall geometry. The purpose of these tests was to compare these streamline curvature effects to the more classical two-dimensional curvature generated by wall shape and imposed pressure gradients, previously considered primarily in a plane normal to the floor. The program was specifically laid out to connect with a Langley interest in such effects and to support the activities of a NASA employee, Katherine McGinley, studying for an advanced degree at Princeton. The studies were carried out in the Mach number of 3, 8 x 8 inch High Reynolds Number Supersonic Tunnel. The usual surface visualization and mean wall static pressures were supplemented by the use of many small high frequency wall static pressure gauges (Kulites) to get some indication of the amplification of boundary layer disturbances by the in-plane streamline curvature caused by the three-dimensional pressure fields imposed on the boundary layer.

Initial Phase

The first phase of the proposed 3-year program concentrated on using a thick turbulent boundary layer (the wind tunnel wall boundary layer used extensively in previous studies) and a three-dimensional pressure field imposed by thin swept wedges mounted on the floor. The primary instrumentation was surface visualization by an evaporating film technique and mean static pressures and high frequency wall static pressures obtained by Kulite gauges. This first phase was to be the basis for continuing studies of flowfield parameters and local heat transfer.

This research program was terminated at the end of one year, so that only the data noted above was completed.

Results

A family of thin swept wedges for different sweeps and for several wedge angles were constructed and tested to provide some general information on the upstream influence of the interactions caused by such configurations. No previous data in this regime was available. This geometry was chosen since it seemed to have the possibility of generating strong in-plane curvature in the lower regions of the boundary layer while imposing only small pressure gradients. The primary data obtained was surface visualization, using an evaporative film technique which gave a good indication of the general size of the upstream influence region. Selecting a configuration which had a significant region for probing would thus permit the placement of instrumentation to examine the disturbed flowfield.

From this general set of experiments, several swept wedges were selected, and detailed surface tests were completed on surface visualization, mean static pressures, and high frequency wall static pressures with various configurations of the static pressure instrumentation in the region upstream of the fin. Repeat tests were carried out in several instances to clarify and amplify the original results.

Preliminary analysis of the data sets was completed by Ms. McGinley and discussed with the Laboratory staff. The program terminated at the end of the year when Ms. McGinley returned to Langley with the full set of data obtained during her stay at the Gas Dynamics Laboratory. To date, no formal report on these results has been generated, although the preliminary results have been discussed in several meetings and seminars.

All funds under the subject grant have been expended.