

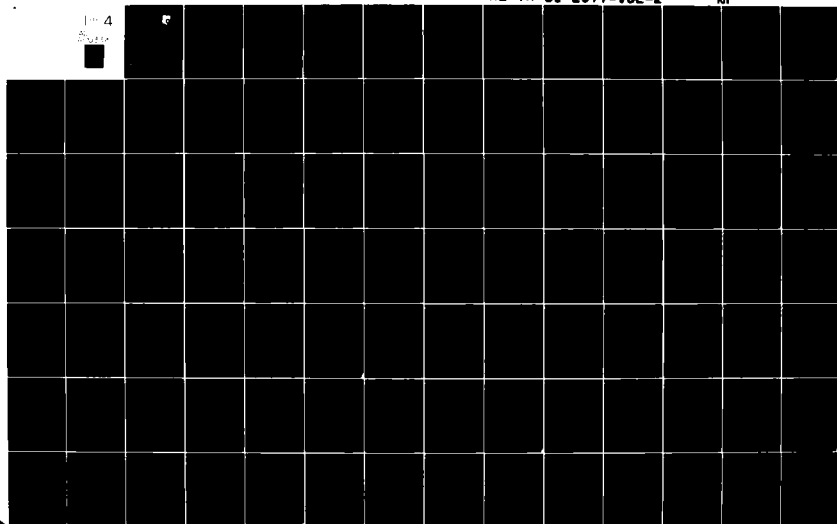
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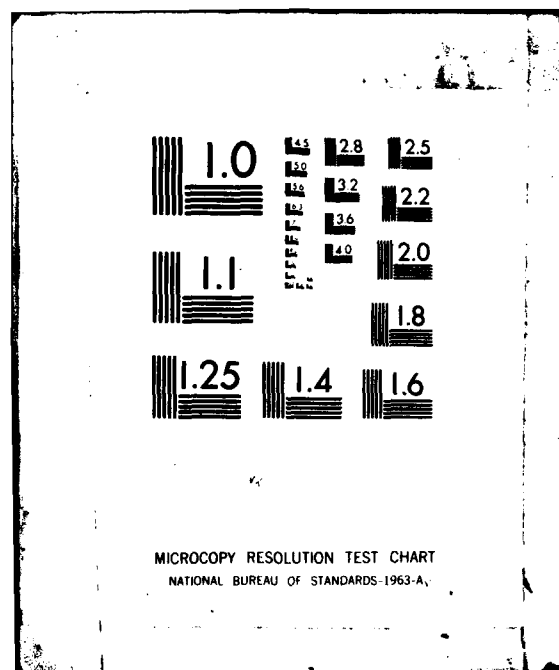
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# EXPERIMENTAL INVESTIGATION OF TURBINE ENDWALL HEAT TRANSFER

Volume II. Linear and Annular Cascade  
Summary Data Sets

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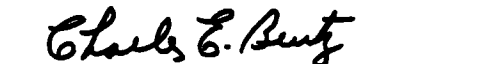
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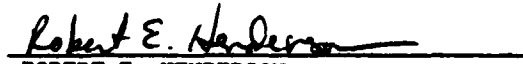
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This technical report has been reviewed and is approved for publication.

  
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| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br><br>Turbine Heat Transfer, Turbine Secondary Flow, Turbine Endwall Heat Transfer,<br>Turbine Cascades, Heat Transfer Data Base                                                                                                                                                                                                                         |                                                                                        |                                               |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br><br>Two turbine cascades were tested at simulated engine conditions to provide a<br>data base of endwall heat transfer data. This data base is intended to be<br>sufficiently complete to provide verification data for refined computational<br>models developed to predict first-stage stator endwall heat transfer in ad-<br>vanced turbine engines. |                                                                                        |                                               |

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20. ABSTRACT (Cont)

A linear, two-dimensional cascade provided the bulk of the data. This cascade provided data to separate the effects of exit Mach number, exit Reynolds number, inlet boundary layer thickness, gas-to-wall temperature ratio, inlet pressure gradients, and inlet temperature gradients. In addition, adiabatic wall temperature and inlet turbulence intensity data are available for the linear cascade runs. A computerized data base was generated. This data base, with its associated software management system, provides the user with relatively easy access to the vast amount of data generated.

A full annular, three-dimensional cascade was used to acquire data for identifying the radial pressure gradient effects. Tests in the annular cascade were run over a wide range of exit Mach and Reynolds numbers and gas-to-wall temperature ratios, all at levels typical of advanced engines.

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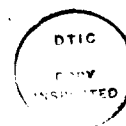
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## 1.0 INTRODUCTION

This volume contains summary plots of the results of both the linear and annular cascade test programs. Detailed local tabulated data will be available on magnetic tape, as described in Volume III.

The details of the linear and annular cascade test plans were presented in Volume I. It is intended that the test plans outlined in Volume I be utilized with the summary plots in Volume II to aid the reader in selecting specific groups of runs for analysis. The data presented in this volume should be adequate to identify data trends for the analyst. It should also provide sufficient detail to the designer to estimate endwall cooling levels and to locate areas of high heat transfer rates. However, detailed information on local endwall heating rates for both the analyst and designer will require utilization of the overall data base, described in Volume III.

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## 2.0 LINEAR CASCADE

The data in this section will include summaries of all Phase I and Phase II results for the linear cascade. Run conditions are summarized and general descriptions of the types of data plots that are available are given. The availability of specific plots for each run is tabulated and the individual plots for each run are then presented.

### 2.1 RUN CONDITIONS

The plan for the linear cascade investigation was organized to span the range of factors expected to influence vane endwall heat transfer and associated cascade aerodynamics, except for radial pressure gradient effects covered in the annular cascade task. Details of the various series of tests were given in Section 4 of Volume I and will not be repeated here. A summary of the inlet and exit flow conditions for the linear cascade runs is given in Table 1.

TABLE 1. LINEAR CASCADE RUN CONDITIONS

| Run No. | Gas temperature<br>(°F) | Inlet conditions         |                           |             |                                     | Exit conditions |                                     |                 |
|---------|-------------------------|--------------------------|---------------------------|-------------|-------------------------------------|-----------------|-------------------------------------|-----------------|
|         |                         | Total pressure<br>(psia) | Static pressure<br>(psia) | Mach number | Reynolds number<br>$\times 10^{-6}$ | Mach number     | Reynolds number<br>$\times 10^{-6}$ | Expansion ratio |
| 57      | 197                     | 21.4                     | 20.9                      | 0.19        | 0.43                                | 0.71            | 1.34                                | 1.40            |
| 61      | 226                     | 37.5                     | 36.5                      | 0.20        | 0.81                                | 1.10            | 2.76                                | 2.13            |
| 63      | 227                     |                          | 15.3                      | 0.14        | 0.23                                | 0.30            | 0.46                                | 1.06            |
|         |                         | 21.0                     | 21.0                      | 0.18        | 0.19                                | 0.70            | 0.59                                | 1.37            |
| 67      | 226                     |                          | 21.1                      | 0.18        | 0.23                                | 0.71            | 0.74                                | 1.39            |
| 68      | 227                     |                          | 15.3                      | 0.09        | 0.07                                | 0.27            | 0.20                                | 1.05            |
| 69      | 227                     | 51.0                     | 50.3                      | 0.20        | 0.50                                | 1.10            | 1.68                                | 2.11            |
| 70      | 228                     | 15.4                     | 15.4                      | 0.10        | 0.06                                | 0.28            | 0.17                                | 1.05            |
| 71      | 227                     | 51.0                     | 54.4                      | 0.19        | 0.43                                | 1.09            | 1.52                                | 2.07            |
| 74      | 227                     | 21.2                     | 21.2                      | 0.19        | 0.17                                | 0.69            | 0.52                                | 1.36            |
| 105     | 223                     | 20.9                     | 20.9                      | 0.20        | 0.46                                | 0.71            | 1.31                                | 1.40            |
| 107     | 227                     | 36.8                     | 36.8                      | 0.23        | 0.94                                | 1.10            | 2.83                                | 2.13            |
| 108     | 228                     | 15.8                     | 15.8                      | 0.11        | 0.18                                | 0.31            | 0.48                                | 1.07            |
| 110     | 229                     | 53.3                     | 53.3                      | 0.23        | 0.60                                | 1.12            | 1.82                                | 2.11            |
| 111     | 227                     | 20.8                     | 20.8                      | 0.20        | 0.20                                | 0.68            | 0.59                                | 1.36            |
| 112     | 226                     | 22.0                     | 21.7                      | 0.20        | 0.27                                | 0.72            | 0.78                                | 1.40            |
| 113     | 226                     | 21.8                     | 21.8                      | 0.21        | 0.19                                | 0.72            | 0.54                                | 1.40            |
| 114     | 226                     | 15.4                     | 15.4                      | 0.10        | 0.08                                | 0.28            | 0.21                                | 1.05            |
| 116     | 225                     | 42.3                     | 42.3                      | 0.19        | 0.40                                | 0.70            | 1.20                                | 1.37            |
| 118     | 222                     | 34.5                     | 33.9                      | 0.18        | 0.31                                | 0.69            | 0.96                                | 1.36            |
| 119     | 229                     | 58.4                     | 58.4                      | 0.19        | 0.57                                | 0.71            | 1.74                                | 1.39            |
| 121     | 229                     | 31.3                     | 31.3                      | 0.18        | 0.30                                | 0.69            | 0.92                                | 1.36            |
| 122     | 227                     | 37.0                     | 37.0                      | 0.12        | 0.21                                | 0.30            | 0.50                                | 1.06            |
| 123     | 227                     | 64.0                     | 64.0                      | 0.10        | 0.32                                | 0.30            | 0.96                                | 1.06            |
| 124     | 227                     | 33.9                     | 33.9                      | 0.18        | 0.31                                | 0.69            | 0.95                                | 1.36            |
| 125     | 227                     | 33.3                     | 33.3                      | 0.18        | 0.30                                | 0.69            | 0.94                                | 1.37            |
| 126     | 227                     | 31.7                     | 31.7                      | 0.21        | 0.34                                | 0.69            | 0.91                                | 1.36            |
| 127     | 225                     | 34.4                     | 34.4                      | 0.09        | 0.16                                | 0.28            | 0.48                                | 1.06            |
| 128     | 225                     | 33.0                     | 33.0                      | 0.14*       | 0.23*                               | 0.70            | 0.92                                | 1.38            |

TABLE 1. (CONT)

| Run No. | Inlet conditions              |                          |                           |             |                                     | Exit conditions |                                     |                 |
|---------|-------------------------------|--------------------------|---------------------------|-------------|-------------------------------------|-----------------|-------------------------------------|-----------------|
|         | Gas total temperature<br>(°F) | Total pressure<br>(psia) | Static pressure<br>(psia) | Mach number | Reynolds number<br>$\times 10^{-6}$ | Mach number     | Reynolds number<br>$\times 10^{-6}$ | Expansion ratio |
| 166     | 818                           | 59.2*                    | 57.9                      | 0.18*       | 0.52*                               | 0.71            | 1.65                                | 1.38            |
| 168     | 788                           | 62.5*                    | 62.2                      | 0.08*       | 0.25*                               | 0.30            | 0.91                                | 1.06            |
| 169     | 822                           | 45.0*                    | 44.0                      | 0.18*       | 0.39*                               | 0.69            | 1.23                                | 1.36            |
| 170     | 807                           | 56.8*                    | 54.9                      | 0.22*       | 0.62*                               | 1.06            | 1.85                                | 2.01            |
| 171     | 787                           | 56.4*                    | 54.0                      | 0.26*       | 0.71*                               | 1.05            | 1.87                                | 1.98            |
| 172     | 800                           | 33.9*                    | 32.8                      | 0.21*       | 0.36*                               | 0.70            | 0.96                                | 1.38            |
| 173     | 787                           | 45.2*                    | 43.7                      | 0.22*       | 0.50*                               | 0.71            | 1.30                                | 1.38            |
| 174     | 780                           | 59.8*                    | 57.9                      | 0.22*       | 0.65*                               | 0.69            | 1.69                                | 1.36            |

\*Distorted inlet runs require special handling of these values (see text).

## 2.2 DESCRIPTION OF SUMMARY DATA

A total of eight summary data items, listed in Table 2, are available for the linear cascade runs.

TABLE 2. LINEAR CASCADE SUMMARY DATA ITEMS

1. Aero summary sheet
2. Heat transfer endwall hotside temperature contours
3. Endwall passage pressure contours
4. Adiabatic endwall temperature contours
5. Heat transfer endwall Stanton number contours
6. Vane  $V/V_c$  plots
7. Exit flowfield aero summary plots
8. Inlet flowfield temperature and velocity profiles

Not all data items are available for all runs. Some runs, as explained in Volume I, contain only heat transfer data with no exit aero survey available. Similarly, the baseline "cold" aero runs contain no heat transfer data. In addition, some data sets are formed from a composite of runs. This resulted from instrumentation problems during a run creating erroneous results for a portion of the data. Only the portion that was affected was repeated, thereby creating data sets consisting of results from more than one run, but with all runs made at identical run conditions. Table 3 lists the data items that are available for each run, and where data sets are a composite of more than one run, the additional run numbers are given.

The individual data items will be discussed to explain how they were developed and what the format of each item is.

TABLE 3. AVAILABILITY OF SUMMARY DATA FOR LINEAR CASCADE

| Page No. | Run No. | Run Conditions | Aero Summary Table | Endwall Temperature Contours | Endwall Pressure Contours | Adiabatic Temperature Contours | Endwall Stanton No. Contours | Vane $V/V_{crit}$ Plot | Exit Aero Summary Plots | Inlet Profiles |
|----------|---------|----------------|--------------------|------------------------------|---------------------------|--------------------------------|------------------------------|------------------------|-------------------------|----------------|
| 10-14    | 57      | X              | X                  |                              | X                         |                                |                              | X                      | X                       |                |
| 14-17    | 61      | X              | X                  |                              | X                         |                                |                              | X                      | X                       |                |
| 18-21    | 67      | X              | X                  |                              | X                         |                                |                              | X                      | X                       |                |
| 22-29    | 86*     | X              | X                  | 96                           | 96                        | 96                             | 96                           | X                      | X                       | 177            |
| 30-36    | 87*     | X              | X                  | 95                           | 95                        | 95                             | 95                           | X                      | X                       |                |
| 37-44    | 89*     | X              | X                  | 93C                          | 93C                       | 93C                            | 93C                          | X                      | X                       | 176            |
| 45-52    | 91*     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       | 179            |
| 53-57    | 94      | X              |                    | X                            | X                         | X                              |                              |                        |                         |                |
| 59-72    | 98      | X              |                    | X                            | X                         | X                              |                              |                        |                         |                |
| 63-69    | 99      | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 70-74    | 105     | X              | X                  |                              | X                         | X                              |                              | X                      | X                       |                |
| 75-79    | 107     | X              | X                  |                              | X                         | X                              |                              | X                      | X                       |                |
| 80-84    | 108     | X              | X                  |                              | X                         | X                              |                              | X                      | X                       |                |
| 85-91    | 109     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 92-98    | 111     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 99-105   | 112     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 106-112  | 113     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 113-119  | 114     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 120-127  | 116     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       |                |
| 128-133  | 118     | X              |                    | X                            | X                         | X                              | X                            |                        |                         |                |
| 134-141  | 122     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       | X              |
| 142-149  | 123     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       | X              |
| 150-157  | 124     | X              | X                  | X                            | X                         | X                              | X                            | X                      | X                       | X              |
| 158-163  | 131*    | X              |                    | X                            | X                         | 125                            | X                            |                        |                         | 125            |
| 164-169  | 132     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 170-175  | 133     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 176-181  | 149     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 182-187  | 150     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 188-191  | 165     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 194-199  | 166     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 200-205  | 168     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 206-211  | 169     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 212-217  | 170     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 218-223  | 171     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 224-229  | 172     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 230-235  | 173     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |
| 236-241  | 174     | X              |                    | X                            | X                         | X                              | X                            |                        |                         | X              |

\*Results of this run are a composite of two or more identical conditions. Run numbers of additional runs are given where data is used.

### 2.2.1 Aero Summary Sheet

This data sheet includes the pertinent inlet and exit conditions that were used to set up the run. These include the inlet total pressure, static pressure, total temperature, Mach number,  $V/V_c$ , and Reynolds number based on true chord. The ideal exit conditions are also given on the summary sheet. The same parameters as given for the inlet are listed for the exit. The ideal exit values are based on measured exit static pressures and the isentropic flow assumption. The summary sheet also gives the cascade expansion ratio and static pressure ratio.

A summary of the exit flow field traverse data is given in the form of mixed-out conditions for each span position at which data was taken. The method for calculating mixed-out properties assumes that a hypothetical uniform property state exists downstream of the cascade. It then solves conservation equations between cascade exit and mixed-out state for the unknown mixed-out parameters. The equations solved conserve energy, mass, axial momentum and tangential momentum, and require an iterative solution. One side of each equation is an integral, which may be evaluated from test data, and the other side contains only mixed-out variables.

The mixed-out variables listed include the mass flow per passage in lb/sec, the total pressure in psia, the total temperature in °F, the Mach number, the exit gas angle, the pressure loss coefficient based on ideal dynamic pressure, and the kinetic energy loss coefficient.

#### 2.2.2 Heat Transfer Endwall Temperature Contours

The 53 measured hotside passage temperatures on the endwall are curve fit, then used to obtain interpolated temperatures for the nodes of the finite element model. The finite element program can generate contour plots from node values of a given variable. Using this capability, the interpolated hotside temperatures in °F at each node are contour plotted to provide the heat transfer endwall temperature contours.

#### 2.2.3 Endwall Passage Pressure Contours

The 42 endwall static pressure values in psia are used to generate pressure values for the 338 nodes of the endwall finite element model, using an interpolation algorithm identical to that used for the endwall temperature. Similarly, these interpolated node pressures are then used to generate a contour plot using the plotting routine from the finite element program.

#### 2.2.4 Adiabatic Endwall Temperature Contours

Similar to the two preceding plots, this contour plot is developed by curve fitting the 90 adiabatic endwall temperature measurements in °F, interpolating the results to determine values at each of the 338 nodes of the endwall finite element model. The results are then contour plotted by the finite element plotting routine.

#### 2.2.5 Endwall Stanton Number Contours

This contour plot is developed by using the local endwall heat transfer coefficient that is determined at each node by the finite element solution technique. The Stanton number is calculated at each node, based on the heat transfer coefficient at that node and the average inlet flow conditions. These values are then contour plotted by the finite element plotting routine.

The sign convention on the heat flux was changed for run 149 and all subsequent runs. This was done to eliminate the negative Stanton numbers shown on runs prior to 149. In comparing data from different runs, all Stanton numbers should be considered positive and for runs prior to 149, the MAX and MIN locations and values shown on the contour plots should be reversed.

#### 2.2.6 Vane $V/V_c$ Plots

Static pressure measurements were made on the suction and pressure surfaces of cascade airfoils at 5%, 20%, and 50% of span. These local static pressures were then used to calculate local values of  $V/V_c$  based on an upstream total pressure read from one element of the inlet core pressure rake. These values of  $V/V_c$  at the three spanwise positions were then plotted as a function of percent axial chord.

### 2.2.7 Exit Flowfield Aero Summary Plots

This sheet contains four plots that summarize the exit traverse results. The pressure loss coefficient and exit air angle are plotted as a function of percent span. The values are the mixed-out values previously tabulated on the aero summary sheet.

Also shown are local contour plots of the pressure loss coefficient and the air turning angle. The pressure loss coefficient plot shows the contour representing changes in level from the wall out to midspan, and also in the circumferential direction across the passage. A similar contour plot for the air angle gives contours for the difference between the local air turning angle and the mixed-out value at each span location.

### 2.2.8 Inlet Temperature and Velocity Profiles

The data for these plots were taken with the traversing inlet probe described in Section 3 of Volume I. Measurements of temperature and pressure were made upstream of the cascade from the endwall out to midspan, with added emphasis placed on the boundary layer region.

The temperature data that are plotted are an average of several readings. This is done to eliminate variations due to slight fluctuations in the gas temperature. All temperature data plotted are in °F.

Similarly, pressure measurements represent an average of several readings and, in addition, are time corrected based on changes in inlet reference total pressure. The pressure measurements are then used with a probe calibration and inlet static pressure measurements to calculate inlet velocities. These velocities, in ft/sec, are then plotted from the wall out to midspan.

## 2.3 DATA SUMMARY

This section contains the data summary sheets for all linear cascade tests with the exception of the inlet turbulence measurements. The results are arranged in numerical order of run number as listed in Table 3. Recall that not all data items are available for all runs.

LINEAR CASCADE DATA  
GMA 200 TURBINE VANE CASCADE

RUN # 57

DATE: 01/03/79

TIME: 2:14:45

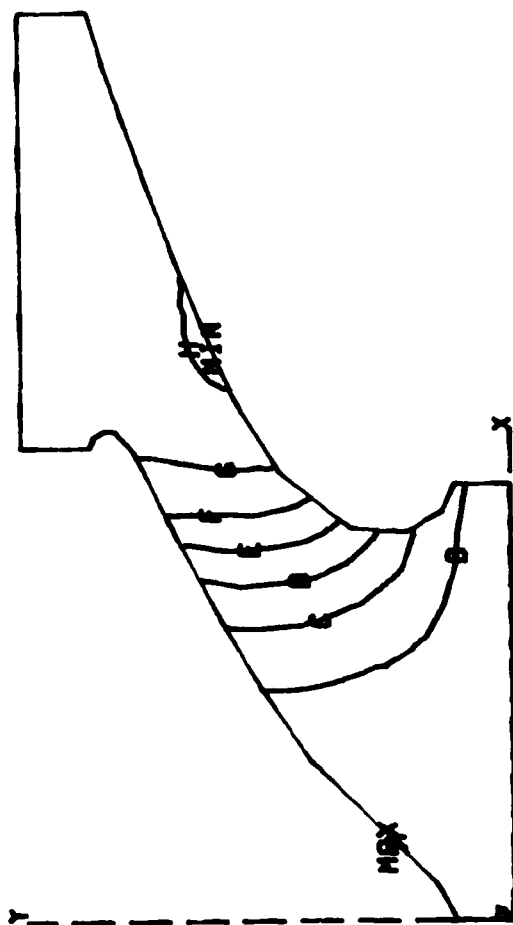
| INLET CONDITIONS |         |        |        |      |           |
|------------------|---------|--------|--------|------|-----------|
| PTOTAL           | PSTATIC | TTOTAL | MACH # | V/V* | REY/10**6 |
| 21.41            | 20.90   | 656.85 | .186   | .203 | .429      |

| IDEAL EXIT CONDITIONS |        |        |        |      |           |
|-----------------------|--------|--------|--------|------|-----------|
| PTOTAL                | STATIC | TTOTAL | MACH # | V/V* | REY/10**6 |
| 21.41                 | 15.26  | 656.85 | .713   | .744 | 1.345     |

CASCADE OPERATING CONDITION  
EXPANSION RATIO = 1.403      STATIC PRESSURE RATIO = .730

\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS  | PT3   | TT3  | M3   | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|------|------|-------|-------|-------|
| 50.2    | 1.083 | 21.19 | 657. | .699 | 19.82 | .0356 | .0290 |
| 40.1    | 1.076 | 21.18 | 659. | .697 | 19.75 | .0364 | .0297 |
| 30.1    | 1.086 | 21.17 | 660. | .695 | 19.97 | .0395 | .0322 |
| 25.1    | 1.098 | 21.13 | 661. | .693 | 20.25 | .0459 | .0375 |
| 20.1    | 1.101 | 21.03 | 661. | .687 | 20.50 | .0615 | .0505 |
| 15.1    | 1.099 | 20.95 | 661. | .679 | 20.68 | .0763 | .0628 |
| 12.1    | 1.099 | 20.95 | 661. | .671 | 20.82 | .0778 | .0644 |
| 9.0     | 1.084 | 20.96 | 662. | .659 | 20.72 | .0767 | .0639 |
| 6.1     | 1.032 | 20.97 | 662. | .626 | 20.25 | .0815 | .0690 |
| AVERAGE | 1.080 | 21.08 | 660. | .680 | 20.19 | .0550 | .0454 |



| MAX | LEGEND   | MIN |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 21199.98 |     |
| B   | 20289.97 |     |
| C   | 19399.96 |     |
| D   | 18499.95 |     |
| E   | 17599.94 |     |
| F   | 16699.93 |     |
| G   | 15799.93 |     |
| H   | 14899.93 |     |
| MAX | 21207.00 |     |
| MIN | 14779.70 |     |

RUN 57  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:02:38 01/049

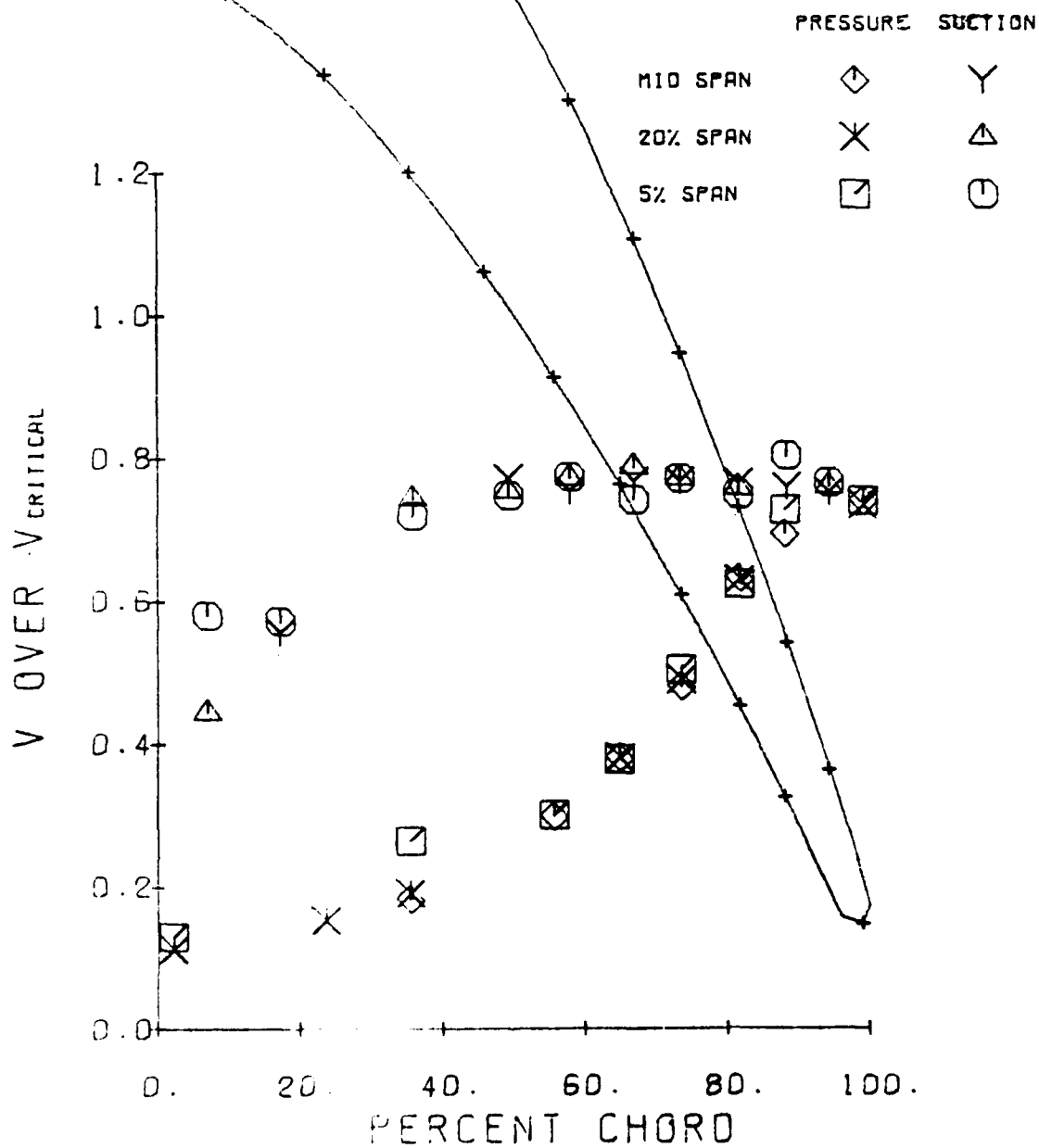
# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 57

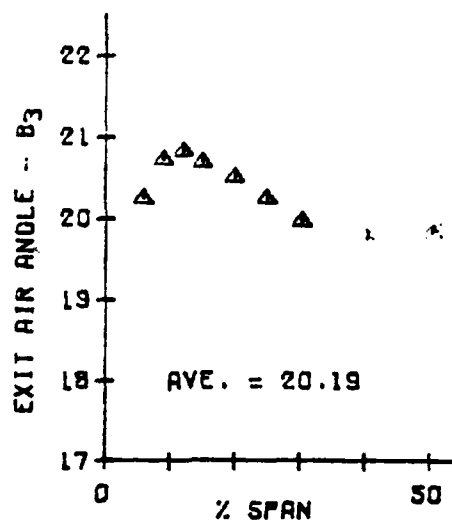
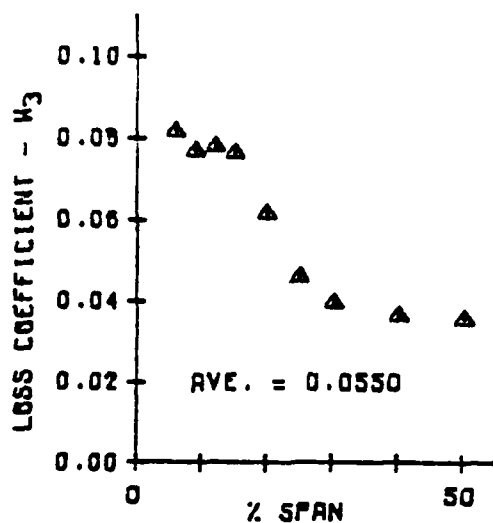
DATE = 01/03/79

EXPANSION RATIO = 1.403

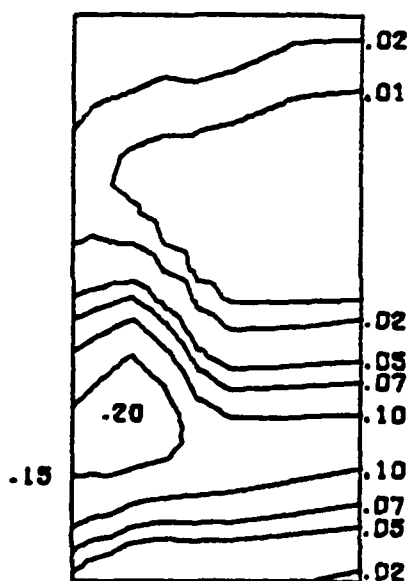
AIRFLOW →





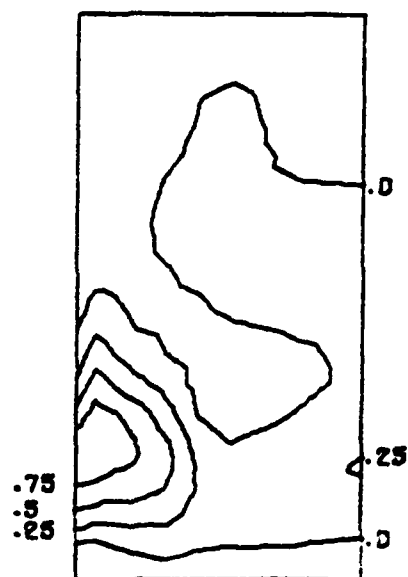


LOCAL  $H$   
CONTOURS



SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE

LOCAL  $B$  - SPAN AVG  $B_3$   
CONTOURS



EXIT MACH NO. = 0.71 REYNOLDS NO. =  $1.55 \times 10^6$

RUN 57 AERODYNAMIC EXIT DATA

# GMA 200 TURBINE VANE CASCADE

RUN # 01

DATE: 01/03/79

TIME: 3:41:22

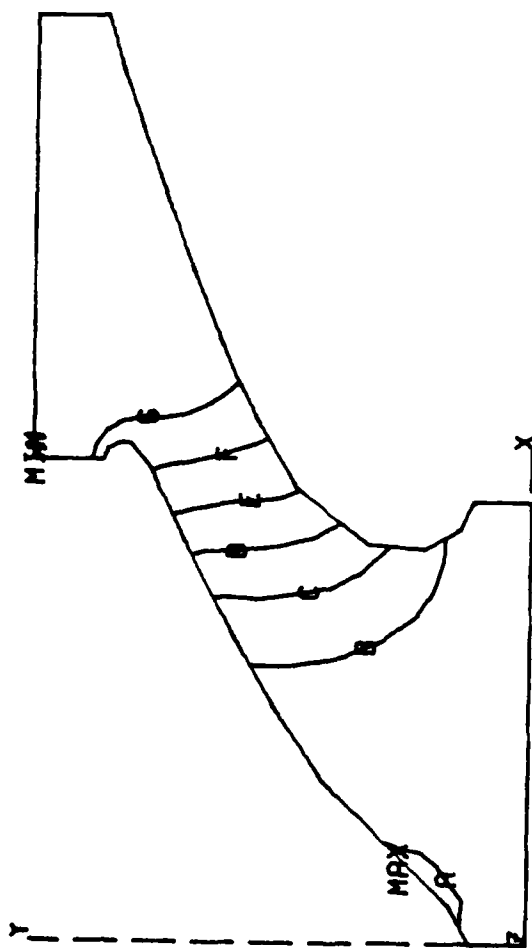
| INLET CONDITIONS |         |        |        |      |           |
|------------------|---------|--------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE | MACH # | V/V* | REY/10**6 |
| 37.53            | 36.51   | 656.25 | .199   | .217 | .846      |

| IDEAL EXIT CONDITIONS |        |        |        |       |           |
|-----------------------|--------|--------|--------|-------|-----------|
| PTOTLE                | STATIC | TTOTAL | MACH # | V/V*  | REY/10**6 |
| 37.53                 | 17.62  | 656.25 | 1.099  | 1.080 | 2.764     |

| CASCADE OPERATING CONDITION |       |
|-----------------------------|-------|
| EXPANSION RATIO             | 2.130 |
| STATIC PRESSURE RATIO       | .483  |

## \*\*\* FIXED OUT CONDITION SUMMARY \*\*\*

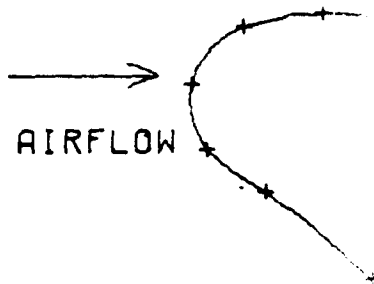
| X SPAN  | MASS  | PT    | TT3  | M3    | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|------|-------|-------|-------|-------|
| 50.1    | 1.974 | 36.07 | 653. | 1.023 | 19.33 | .0772 | .0514 |
| 40.0    | 1.969 | 36.11 | 655. | 1.029 | 19.30 | .0756 | .0501 |
| 30.1    | 1.973 | 36.11 | 657. | 1.027 | 19.33 | .0750 | .0497 |
| 25.0    | 1.971 | 36.07 | 658. | 1.024 | 19.35 | .0768 | .0511 |
| 20.1    | 1.970 | 35.97 | 657. | 1.018 | 19.39 | .0823 | .0549 |
| 15.1    | 1.966 | 35.71 | 654. | 1.007 | 19.44 | .0967 | .0657 |
| 12.0    | 1.959 | 35.57 | 657. | 1.004 | 19.44 | .0991 | .0648 |
| 9.1     | 1.962 | 35.71 | 658. | 1.011 | 19.43 | .0931 | .0624 |
| 5.9     | 1.955 | 35.57 | 657. | 1.019 | 19.42 | .0973 | .0646 |
| AVERAGE | 1.967 | 35.94 | 656. | 1.021 | 19.37 | .0830 | .0555 |



| MMM | LEGEND | MMM | PSI   |
|-----|--------|-----|-------|
| A   | B      | C   | 37.00 |
| D   | E      | F   | 34.00 |
| G   | H      | MAX | 31.00 |
| MIN |        |     | 28.00 |
|     |        |     | 25.00 |
|     |        |     | 22.00 |
|     |        |     | 19.00 |
|     |        |     | 16.00 |
|     |        |     | 37.11 |
|     |        |     | 15.62 |

RUN 61  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:08:15 81/049

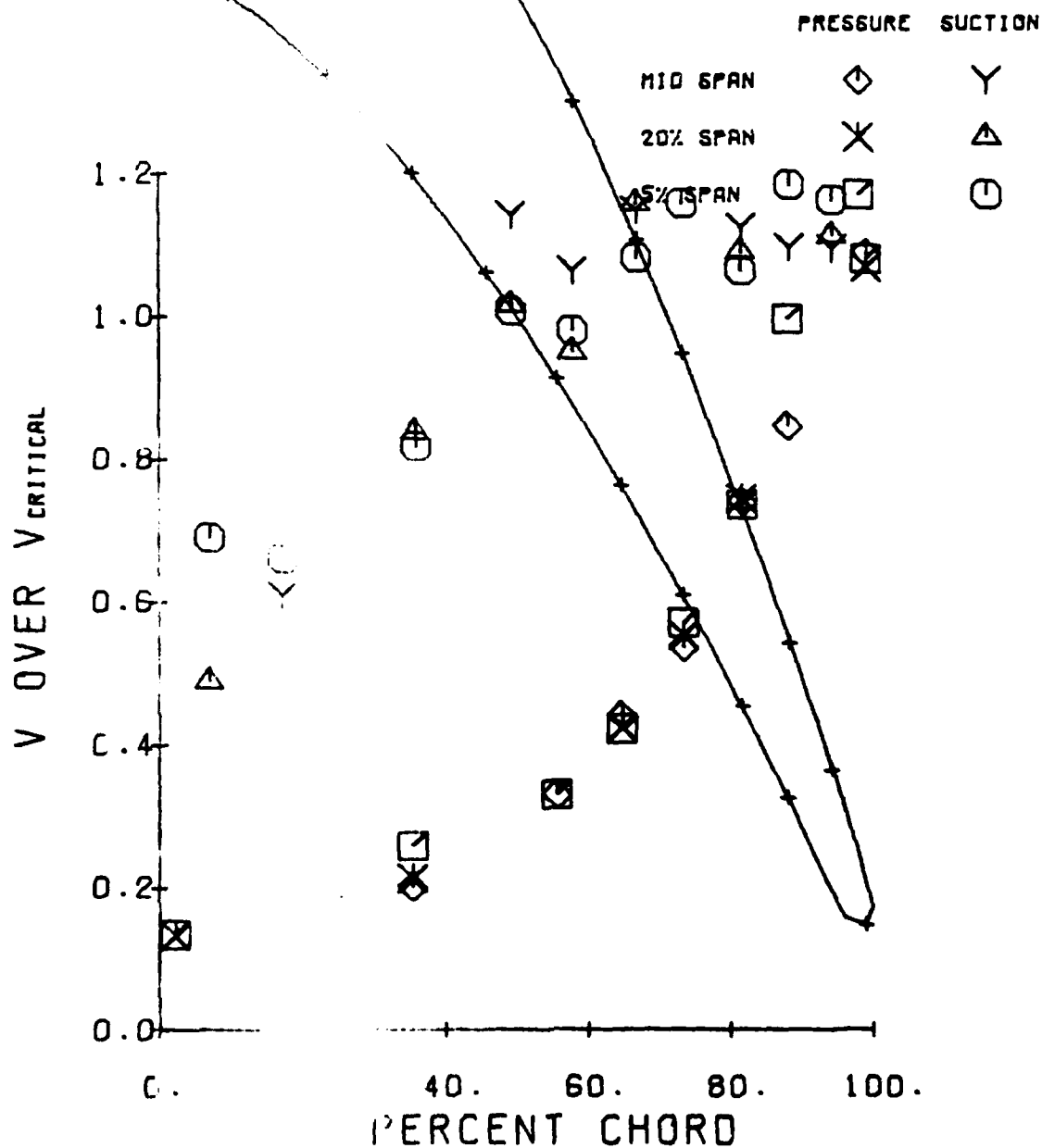
# ENDWALL HEAT TRANSFER LINEAR CASCADE

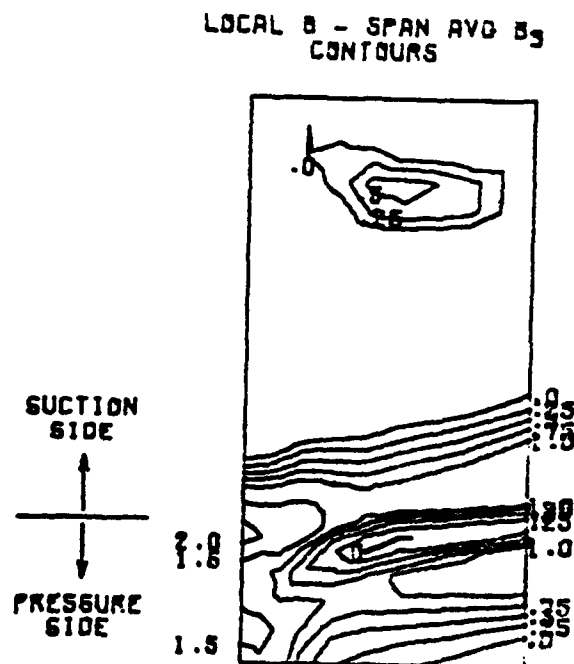
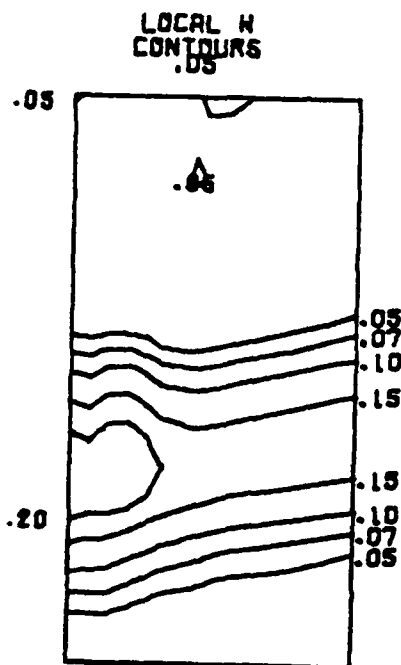
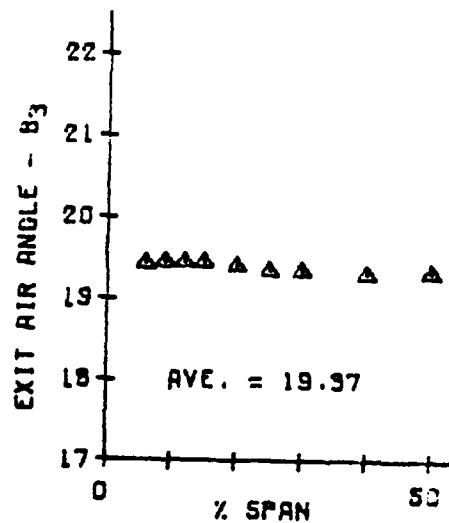
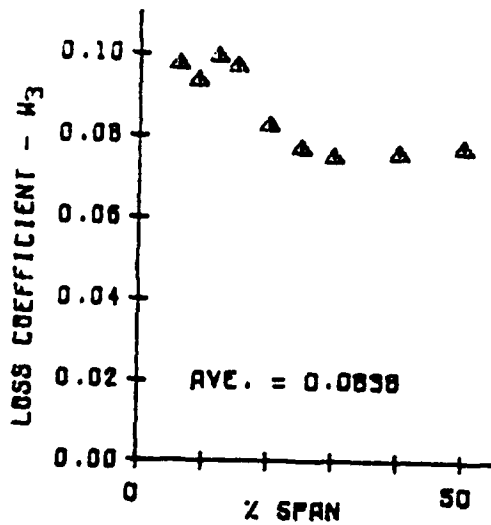


RUN # = 61

DATE = 01/03/79

EXPANSION RATIO = 2.130





EXIT MACH NO. = 1.10 REYNOLDS NO. =  $2.79 \times 10^6$

RUN 51 AERODYNAMIC EXIT DATA

# GMA 240 TURBINE VANE CASCADE

RUN # 57

DATE: 01/09/79

TIME: 4:24:55

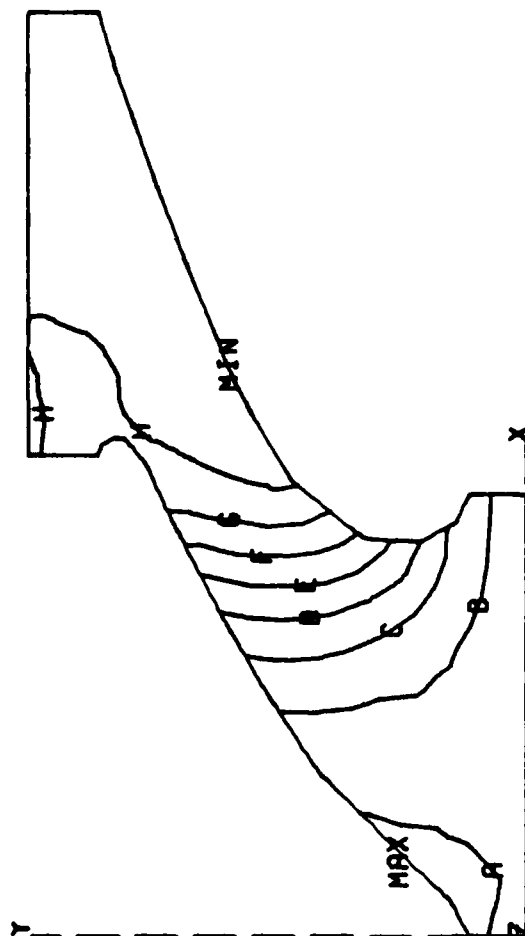
| INLET CONDITIONS |        |        |        |      |           |
|------------------|--------|--------|--------|------|-----------|
| PTOTLE           | PSOTLE | TTOTLE | MACH # | V/V* | REY/10**6 |
| 15.50            | 15.29  | 684.66 | .142   | .155 | .227      |

| IDEAL EXIT CONDITIONS |        |        |        |      |           |
|-----------------------|--------|--------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL | MACH # | V/V* | REY/10**6 |
| 15.50                 | 14.59  | 684.66 | .296   | .321 | .459      |

| CASCADE OPERATING CONDITION |                             |
|-----------------------------|-----------------------------|
| EXPANSION RA IO= 1.062      | STATIC PRESSURE RATIO= .955 |

## \*\*\* MIXED OUT CONOITION SUMMARY \*\*\*

| X SPAN  | MASS | PT3   | TT3  | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|------|------|-------|-------|-------|
| 50.1    | .398 | 15.47 | 683. | .270 | 20.85 | .0376 | .0364 |
| 40.1    | .397 | 15.47 | 683. | .270 | 20.80 | .0400 | .0380 |
| 30.1    | .399 | 15.48 | 683. | .268 | 20.99 | .0465 | .0450 |
| 25.1    | .400 | 15.48 | 683. | .266 | 21.22 | .0597 | .0578 |
| 20.1    | .399 | 15.48 | 683. | .263 | 21.48 | .0767 | .0744 |
| 15.1    | .400 | 15.48 | 683. | .263 | 21.56 | .0884 | .0780 |
| 12.0    | .400 | 15.44 | 684. | .263 | 21.51 | .0772 | .0745 |
| 9.0     | .392 | 15.44 | 684. | .262 | 21.12 | .0768 | .0764 |
| 0.0     | .374 | 15.44 | 684. | .261 | 20.20 | .0837 | .0812 |
| AVERAGE | .394 |       | 683. | .266 | 20.98 | .0685 | .0587 |



|     |          |     |
|-----|----------|-----|
| MAX | LEGEND   | MIN |
| A   | PSI      |     |
| B   | (E-03)   |     |
| C   | 15499.99 |     |
| D   | 15379.99 |     |
| E   | 15299.99 |     |
| F   | 15199.99 |     |
| G   | 15099.99 |     |
| H   | 14999.99 |     |
| MAX | 14899.99 |     |
| MIN | 14799.99 |     |
|     | 15517.31 |     |
|     | 14702.38 |     |

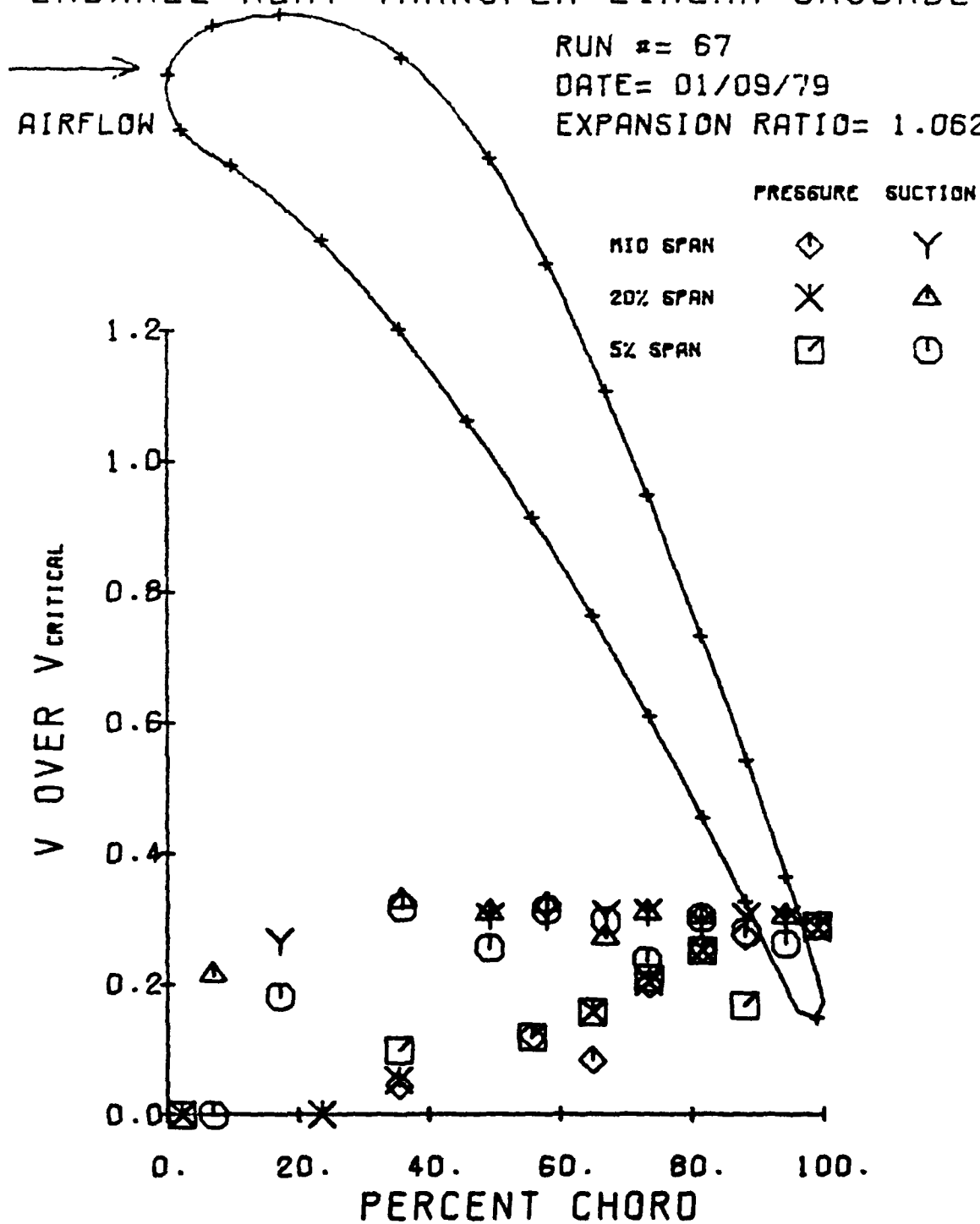
RUN 67  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:33:56 61/049

# ENDWALL HEAT TRANSFER LINEAR CASCADE

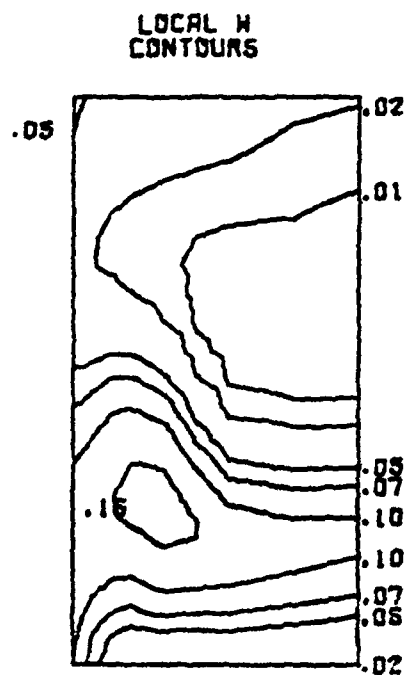
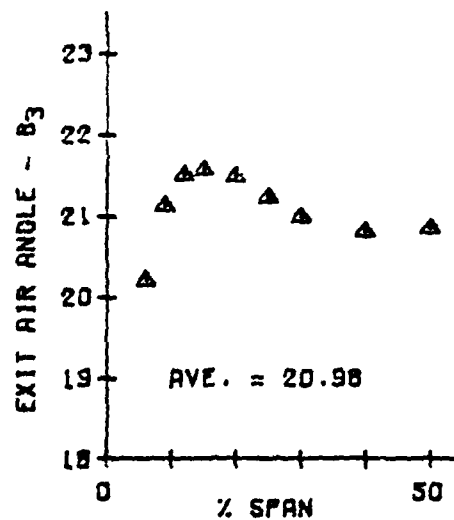
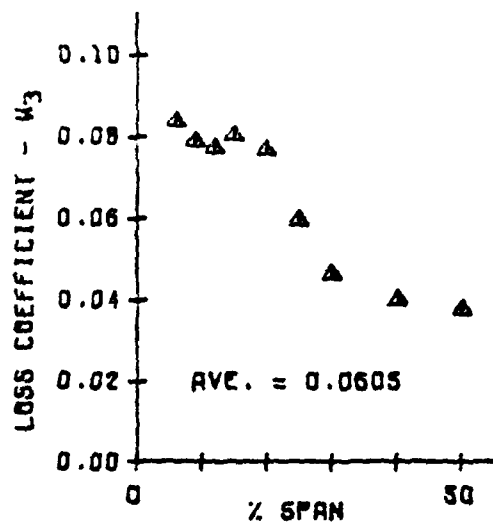
RUN # = 67

DATE = 01/09/79

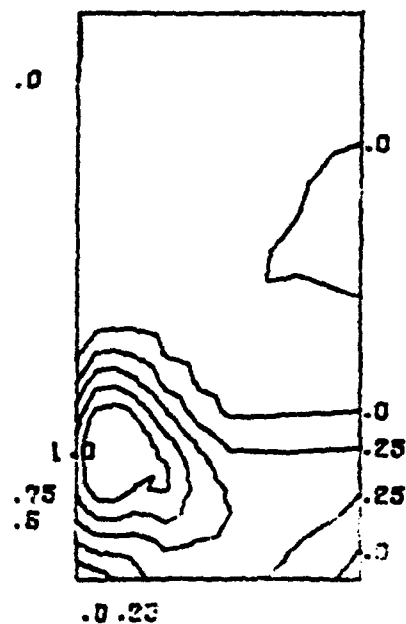
EXPANSION RATIO = 1.062







LOCAL  $B$  - SPAN AVE  $B_3$  CONTOURS



SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE

EXIT MACH NO. = 0.90 REYNOLDS NO. =  $4.59 \times 10^2$

RUN 67 AERODYNAMIC EXIT DATA

# GMA 200 TURBINE VANE CASCADE

RUN # 86

DATE: 10/10/79

TIME: 12:13:43

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 21.42            | 20.97   | 1274.34 | .178   | .193 | .186      |

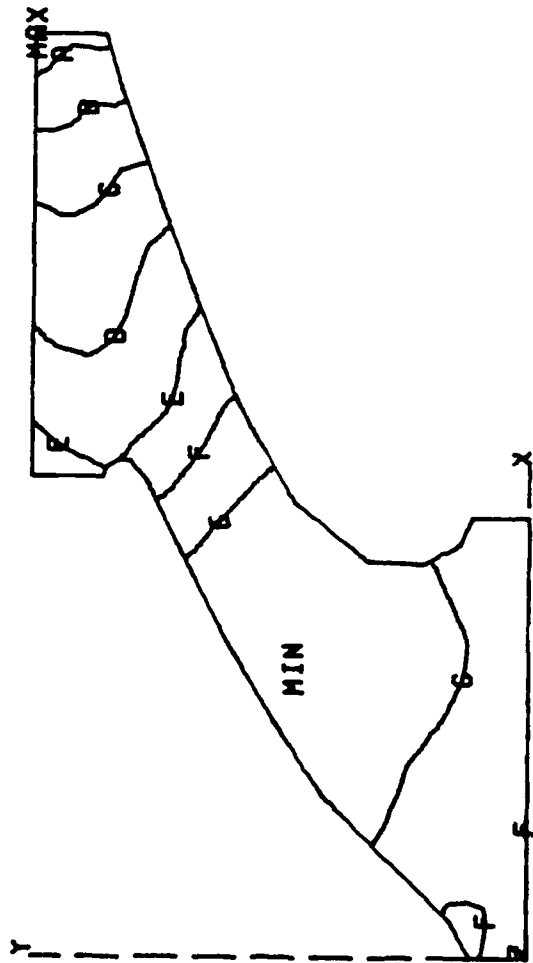
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 21.42                 | 15.60  | 1274.34 | .697   | .726 | .594      |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.373      STATIC PRESSURE RATIO= .744

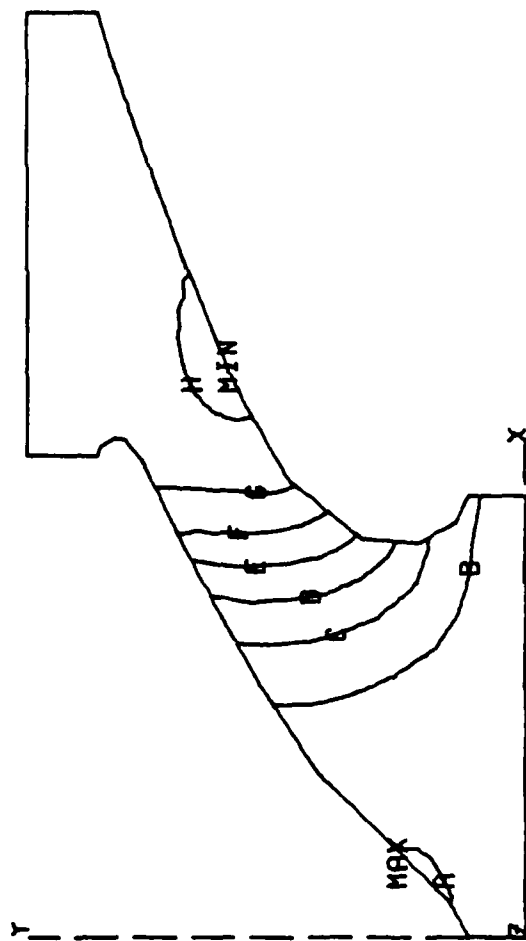
## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| X SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 50.0    | .764 | 21.25 | 1217. | .585 | 19.19 | .0290 | .0240 |
| 39.8    | .751 | 21.25 | 1240. | .685 | 19.06 | .0300 | .0248 |
| 29.9    | .752 | 21.23 | 1247. | .686 | 19.15 | .0323 | .0267 |
| 24.9    | .752 | 21.22 | 1255. | .686 | 19.26 | .0346 | .0286 |
| 20.0    | .750 | 21.15 | 1242. | .682 | 19.19 | .0465 | .0385 |
| 14.8    | .761 | 21.02 | 1234. | .675 | 19.68 | .0685 | .0570 |
| 11.9    | .767 | 20.98 | 1222. | .672 | 19.84 | .0763 | .0635 |
| 8.5     | .765 | 20.96 | 1233. | .671 | 19.90 | .0791 | .0659 |
| 6.3     | .758 | 20.96 | 1216. | .670 | 19.58 | .0788 | .0656 |
| AVERAGE | .756 | 21.14 | 1235. | .680 | 19.35 | .0485 | .0402 |



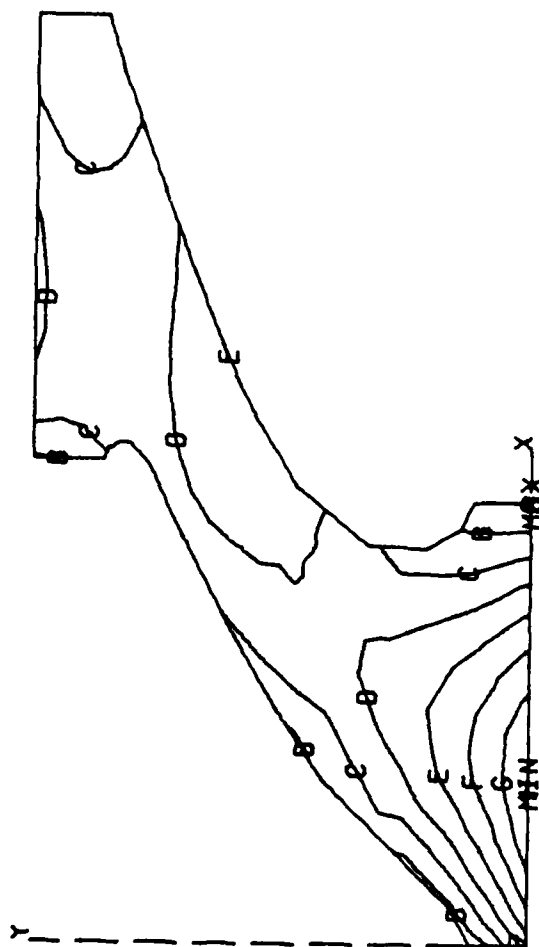
| MIN | LEGEND       | MAX     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 5.10000E 02  |         |
| B   | 5.00000E 02  |         |
| C   | 4.90000E 02  |         |
| D   | 4.80000E 02  |         |
| E   | 4.70000E 02  |         |
| F   | 4.60000E 02  |         |
| G   | 4.50000E 02  |         |
| MAX | 5.16393E 02  |         |
| MIN | 4.42954E 02  |         |

RUN 96 MACH .7 TGAS 800. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:42:28 79/303



\*\*\* LEGEND \*\*\*  
 PSI  
 (E-03)  
 20999.98  
 20199.98  
 19399.98  
 18599.97  
 17799.97  
 16999.97  
 16199.96  
 15399.96  
 21025.16  
 15163.00  
 A B C D E F G H  
 MAX MIN

RUN 96 MACH .7 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:46:18 80/161



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 7.23000E 02  
 B 7.15000E 02  
 C 7.07000E 02  
 D 6.99000E 02  
 E 6.91000E 02  
 F 6.83000E 02  
 G 6.75000E 02  
 H 6.67000E 02  
 MAX 7.23760E 02  
 MIN 6.66820E 02

RUN 96 MACH .7 TGAS 800. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:59:44 79/303

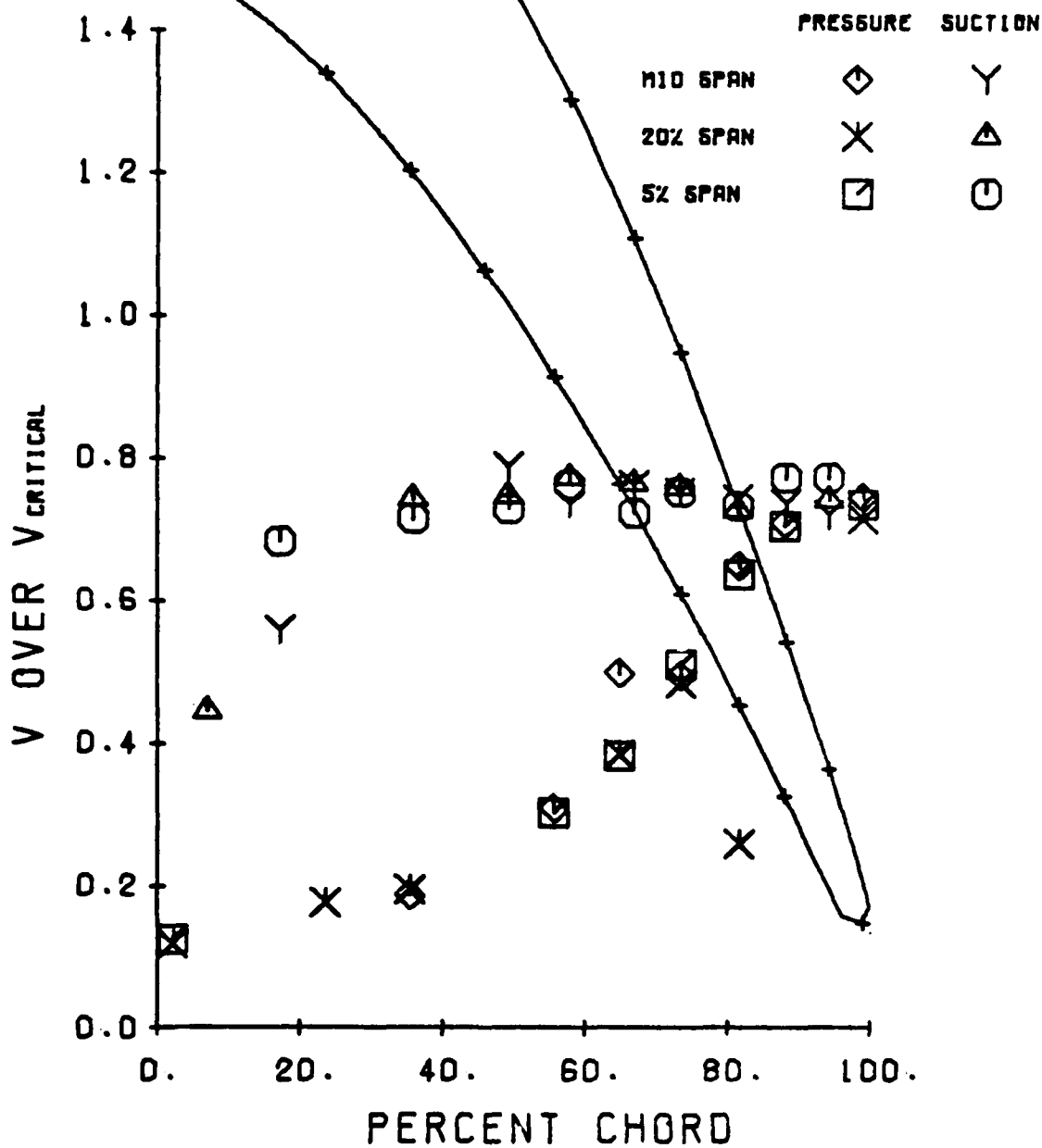


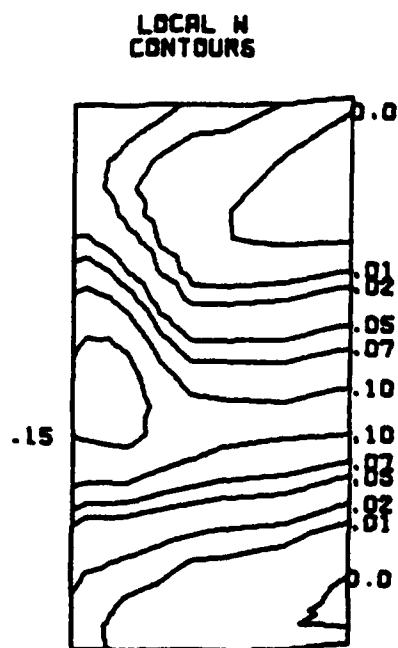
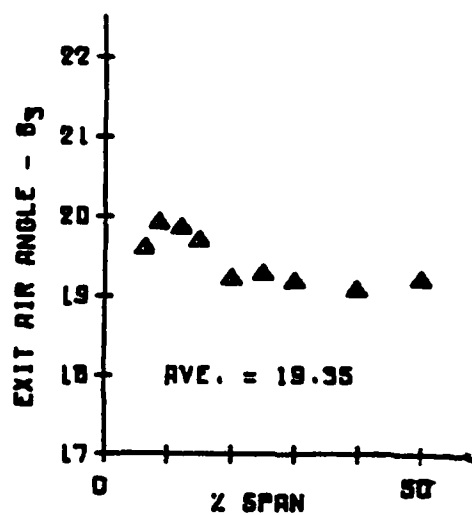
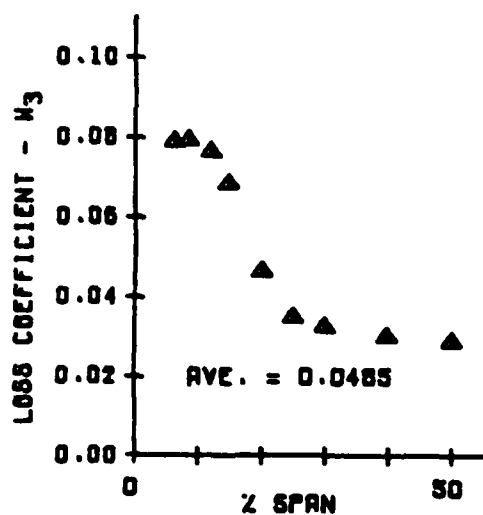
MAX LEGEND MAX  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A -1.40000E-03  
 B -2.30000E-03  
 C -3.20000E-03  
 D -4.10000E-03  
 E -5.00000E-03  
 F -5.89999E-03  
 G -6.79999E-03  
 H -7.69998E-03  
 MAX -1.44385E-03  
 MIN -8.03468E-03

RUN 96 MACH .7 TGAS 800. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 12.47.43 79/303

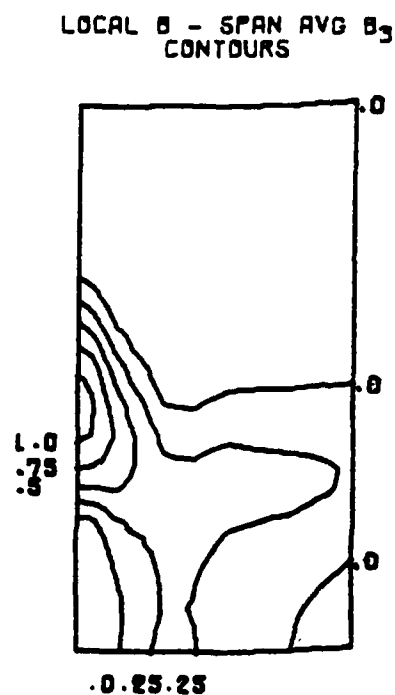
# ENDWALL HEAT TRANSFER LINEAR CASCADE

AIRFLOW →  
 RUN # = 86  
 DATE = 10/10/79  
 EXPANSION RATIO = 1.375





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.70 REYNOLDS NO. =  $5.94 \times 10^5$

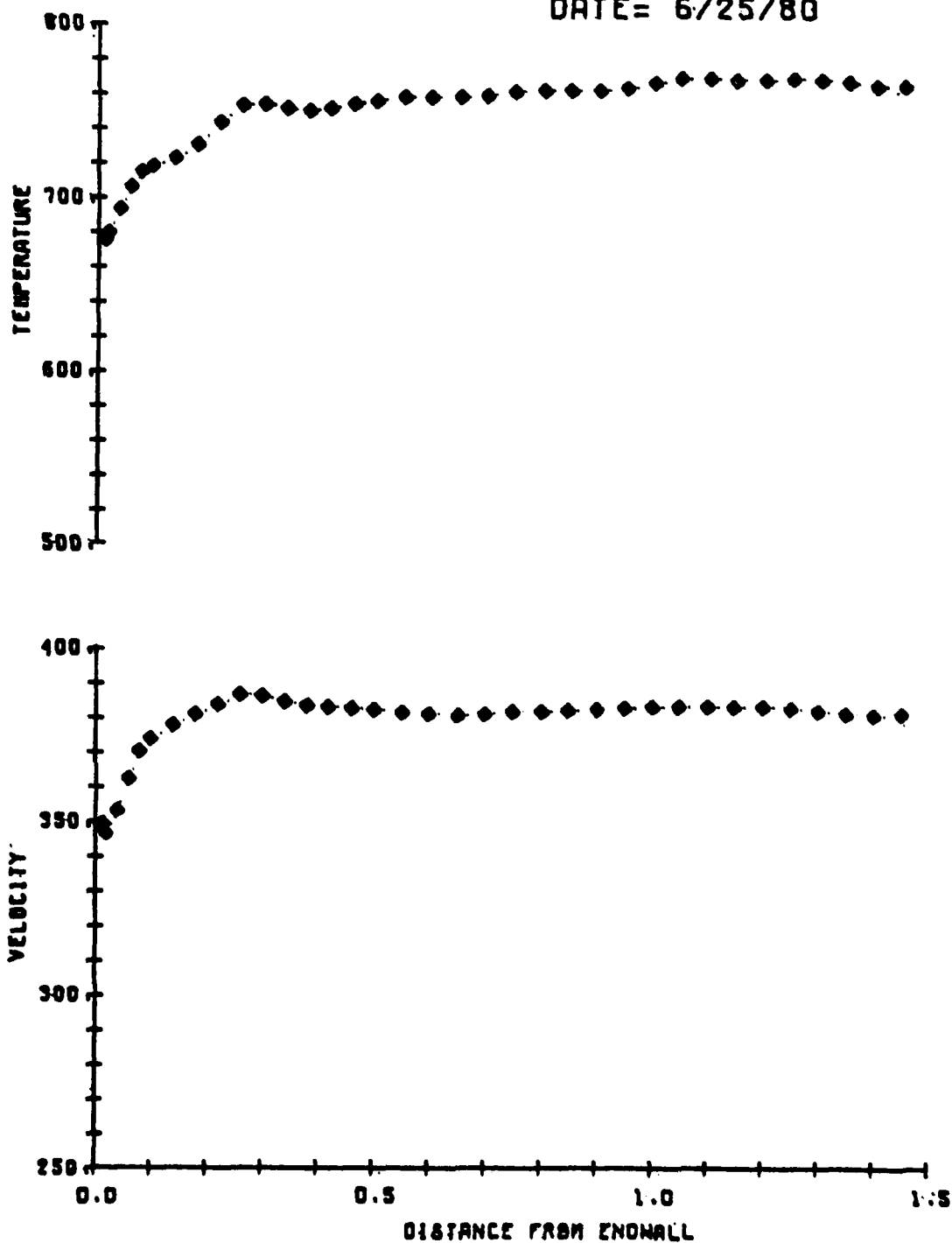
RUN 86 AERODYNAMIC EXIT DATA



# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 177

DATE = 6/25/80



# GMA 200 TURBINE VANE CASCADE

RUN # 87

DATE: 10/11/79

TIME: 7:51:40

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 21.59            | 21.11   | 1073.99 | .180   | .196 | .232      |

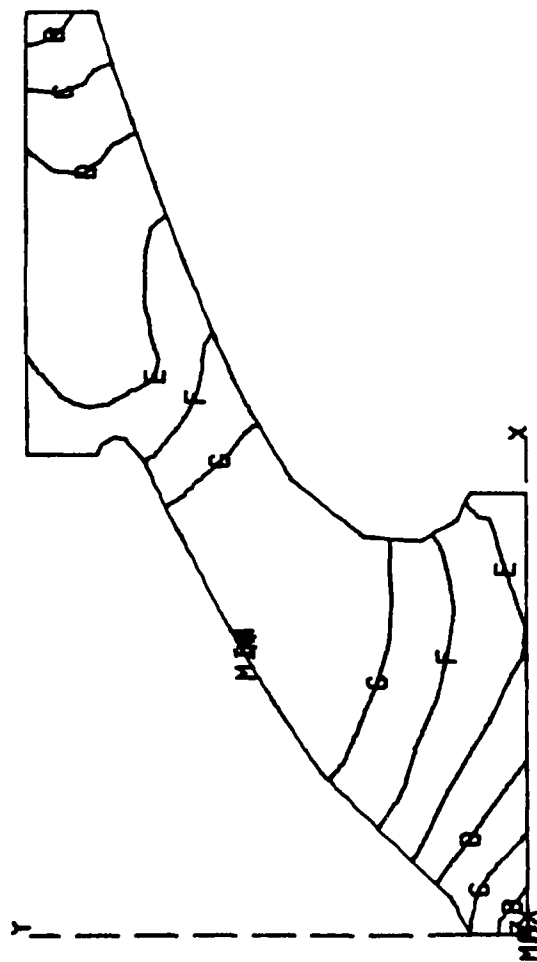
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 21.59                 | 15.50  | 1073.99 | .710   | .740 | .741      |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.393      STATIC PRESSURE RATIO= .734

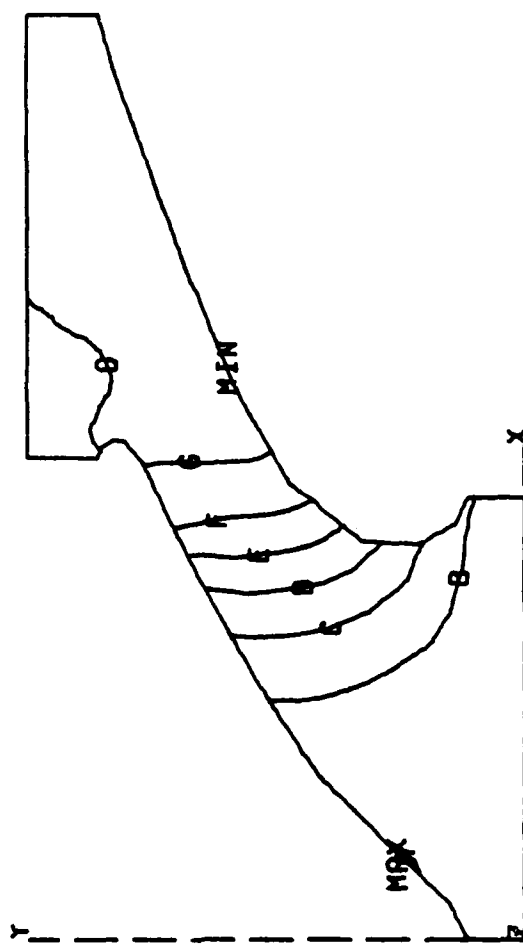
## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 50.0    | .772 | 21.43 | 1041. | .697 | 17.63 | .0259 | .0212 |
| 39.8    | .778 | 21.39 | 1033. | .705 | 17.63 | .0316 | .0258 |
| 29.9    | .778 | 21.39 | 1042. | .704 | 17.68 | .0315 | .0257 |
| 24.9    | .782 | 21.37 | 1031. | .703 | 17.76 | .0344 | .0281 |
| 19.8    | .787 | 21.27 | 1031. | .697 | 17.97 | .0520 | .0426 |
| 14.7    | .793 | 21.14 | 1035. | .689 | 18.40 | .0731 | .0602 |
| 11.9    | .803 | 21.11 | 1021. | .687 | 18.57 | .0780 | .0643 |
| 9.8     | .799 | 21.10 | 1033. | .686 | 18.59 | .0793 | .0654 |
| 9.8     | .793 | 21.10 | 1008. | .690 | 18.17 | .0792 | .0651 |
| AVERAGE | .785 | 21.28 | 1030. | .697 | 17.94 | .0495 | .0406 |



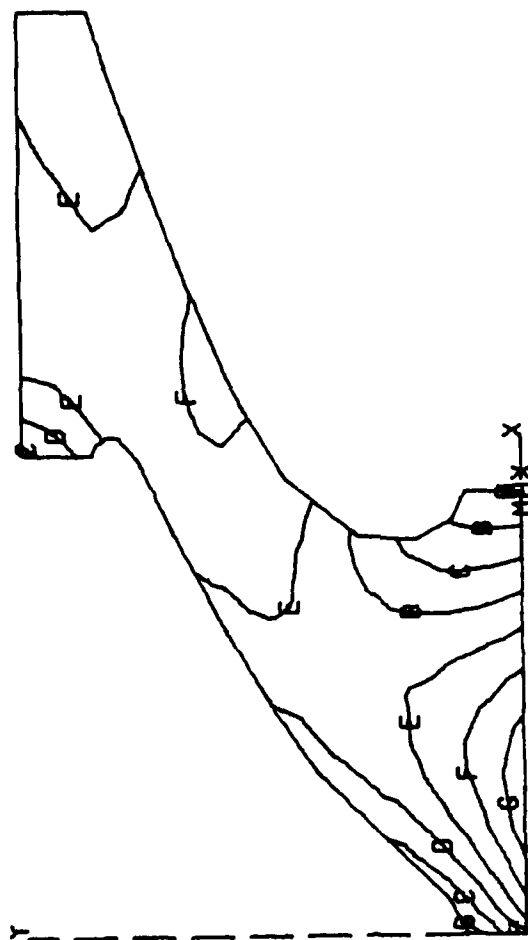
| MMM | LEGEND       | MMM     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 3.95000E 02  |         |
| B   | 3.89000E 02  |         |
| C   | 3.83000E 02  |         |
| D   | 3.77000E 02  |         |
| E   | 3.71000E 02  |         |
| F   | 3.65000E 02  |         |
| G   | 3.59000E 02  |         |
| H   | 3.53000E 02  |         |
| MAX | 3.95469E 02  |         |
| MIN | 3.52921E 02  |         |

RUN 95 MACH .7 TCAS 600. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:23:53 79/303



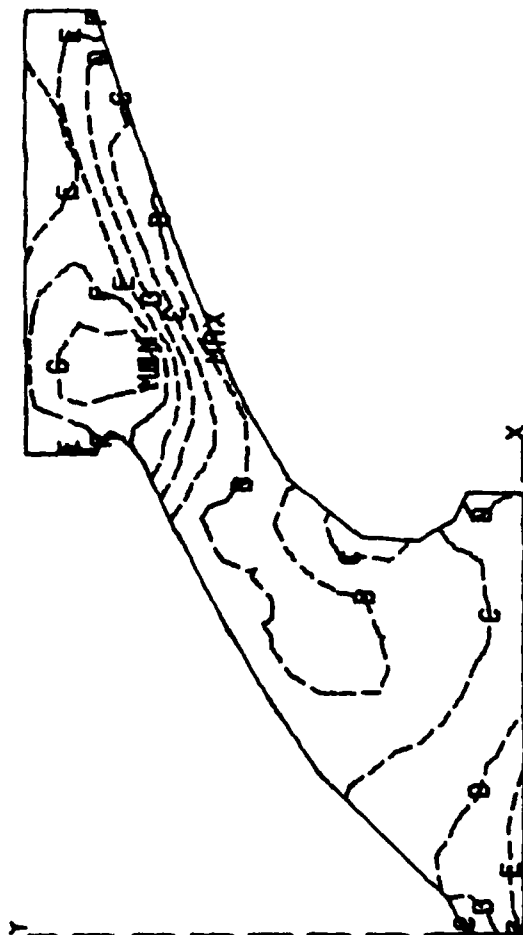
| MMM | LEGEND | PSI      | MMM |
|-----|--------|----------|-----|
|     |        | (E-03)   |     |
| A   |        | 21999.98 |     |
| B   |        | 20999.98 |     |
| C   |        | 19999.98 |     |
| D   |        | 18999.98 |     |
| E   |        | 17999.98 |     |
| F   |        | 16999.98 |     |
| G   |        | 15999.98 |     |
| MAX |        | 22009.54 |     |
| MIN |        | 15277.69 |     |

RUN 95 MACH .7 TGAS 600 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:54:01 80/161



| *** | LEGEND       | ***     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 5.39000E 02  |         |
| B   | 5.35000E 02  |         |
| C   | 5.31000E 02  |         |
| D   | 5.27000E 02  |         |
| E   | 5.23000E 02  |         |
| F   | 5.19000E 02  |         |
| G   | 5.15000E 02  |         |
| MAX | 5.39376E 02  |         |
| MIN | 5.12283E 02  |         |

RUN 95 MACH .7 TGAS 600. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:46:19 79/303



MAX LEGEND MAX  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A -1.90000E-03  
 B -2.70000E-03  
 C -3.50000E-03  
 D -4.30000E-03  
 E -5.10000E-03  
 F -5.89999E-03  
 G -6.69999E-03  
 H -7.49999E-03  
 MAX -1.94118E-03  
 MIN -7.56337E-03

RUN 95 MACH .7 TGRS 600. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:29:38 79/303

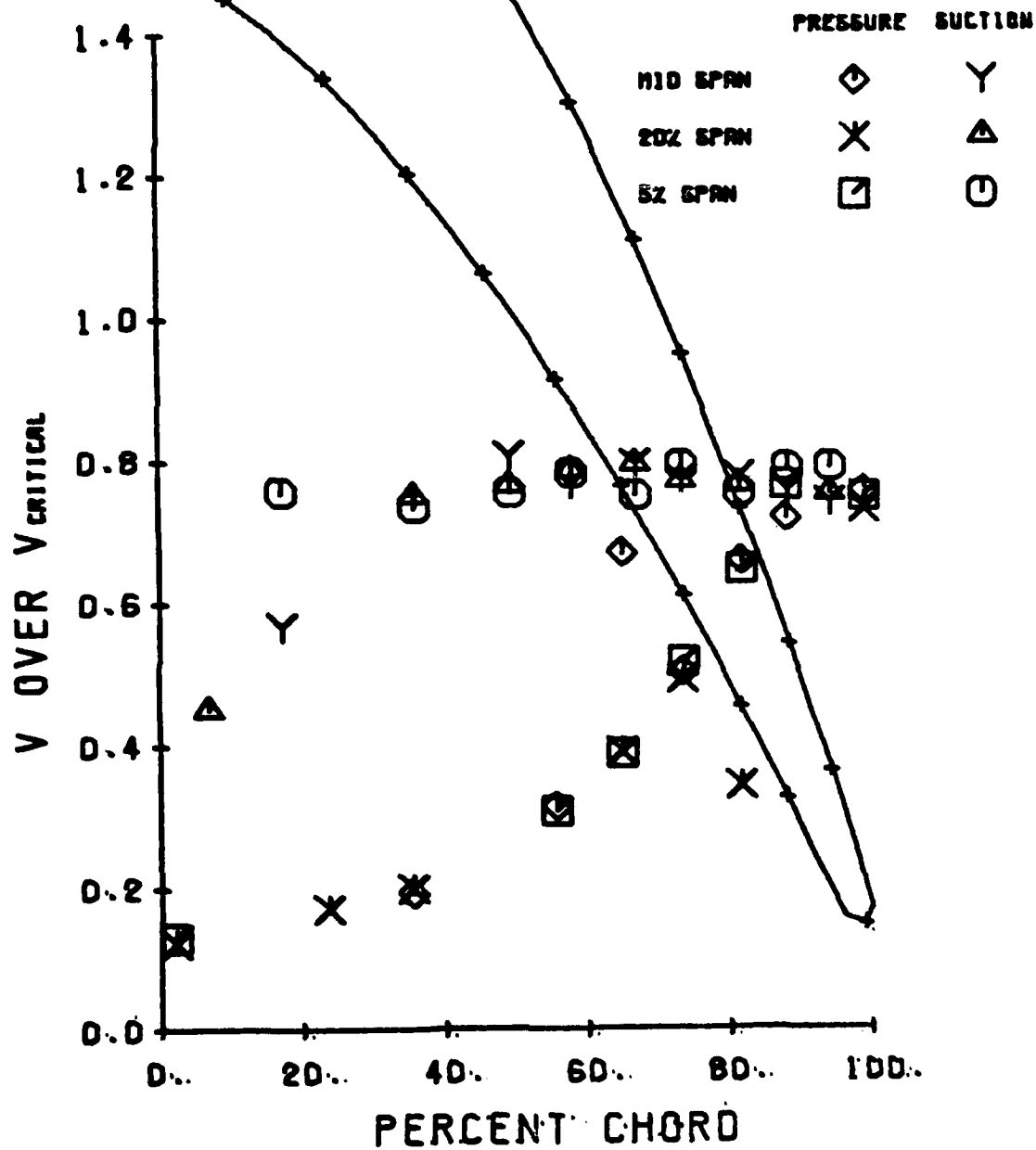
# ENDWALL HEAT TRANSFER LINEAR CASCADE

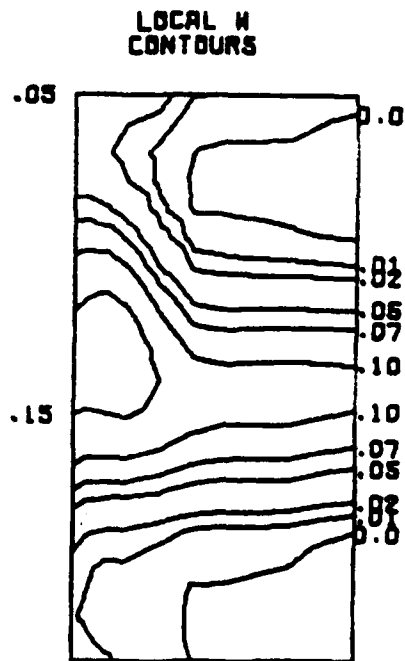
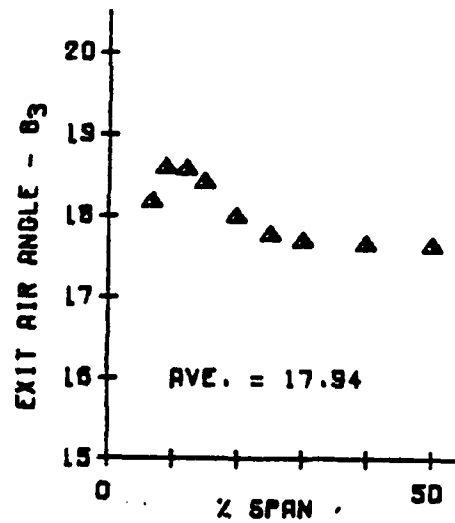
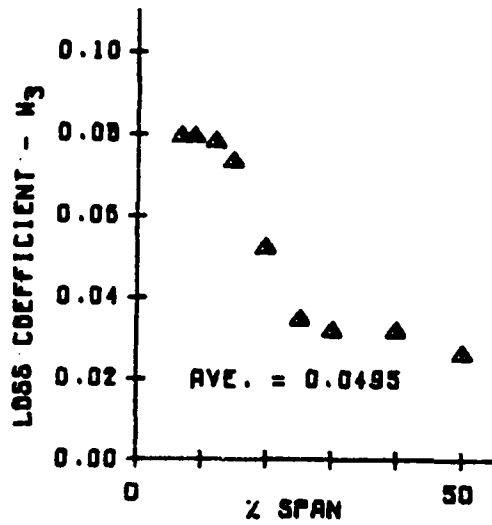
RUN # = 87

DATE = 10/11/79

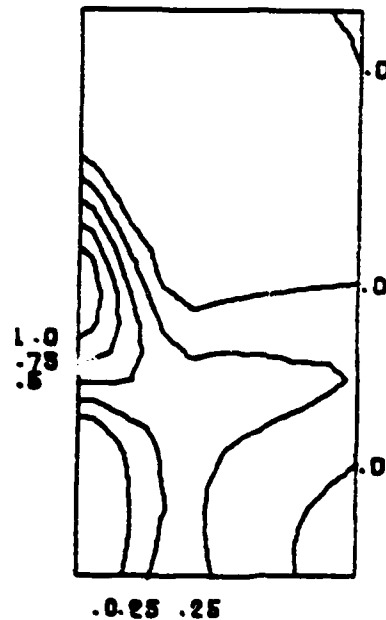
EXPANSION RATIO = 1.395

AIRFLOW →





LOCAL  $B$  - SPAN AVG  $B_3$  CONTOURS



SUCTION  
SIDE  
 ↑  
 PRESSURE  
SIDE

EXIT MACH NO. = 0.71 REYNOLDS NO. =  $7.41 \times 10^5$

RUN 87 AERODYNAMIC EXIT DATA



# GMA 200 TURBINE VANE CASCADE

# 59

DATE: 10/15/79

TIME: 14:14:27

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 15.42            | 15.34   | 1245.13 | .090   | .498 | .476      |

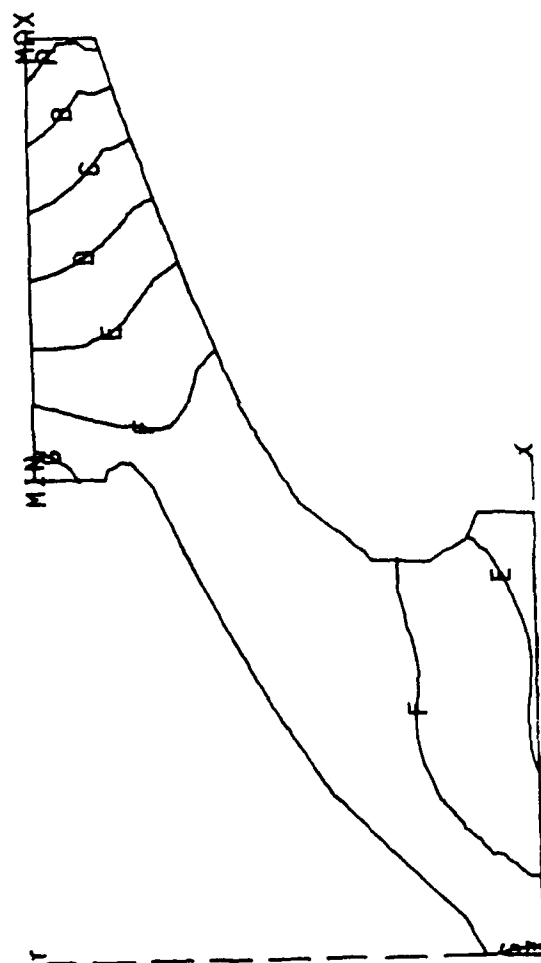
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 15.42                 | 14.68  | 1245.13 | .270   | .291 | .205      |

CASCADE OPERATING CONDITION

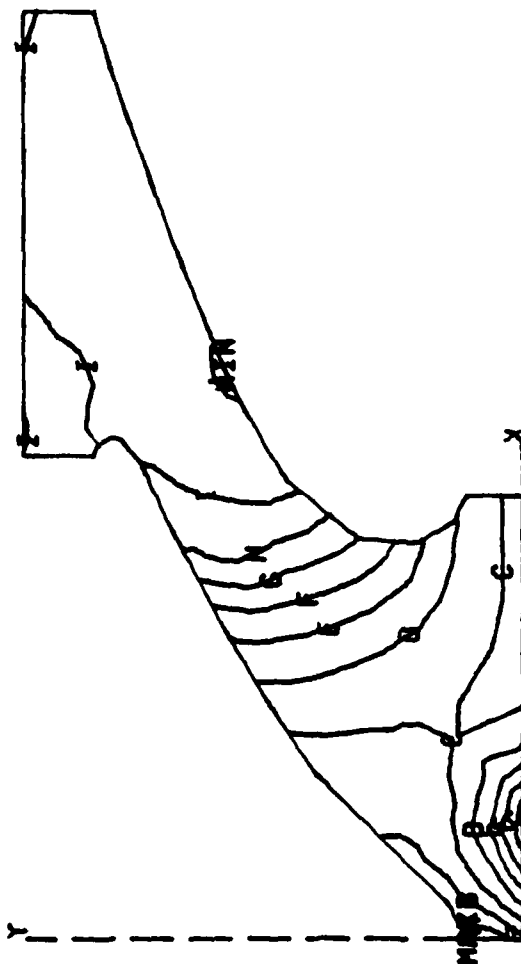
EXPANSION RATIO= 1.050      STATIC PRESSURE RATIO= .957

## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

|      | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|------|------|-------|-------|------|-------|-------|-------|
| 49.7 | .263 | 15.39 | 1233. | .263 | 19.18 | .0432 | .0422 |
| 39.7 | .260 | 15.39 | 1236. | .263 | 19.35 | .0392 | .0381 |
| 29.7 | .265 | 15.39 | 1235. | .264 | 19.29 | .0416 | .0404 |
| 24.7 | .204 | 15.39 | 1246. | .263 | 19.30 | .0407 | .0447 |
| 19.7 | .262 | 15.38 | 1242. | .261 | 19.30 | .0501 | .0565 |
| 14.7 | .203 | 15.36 | 1238. | .258 | 19.60 | .0804 | .0781 |
| 9.7  | .264 | 15.30 | 1223. | .257 | 19.61 | .0823 | .0802 |
| 4.7  | .262 | 15.36 | 1246. | .256 | 19.31 | .0824 | .0801 |
|      | .251 | 15.37 | 1189. | .256 | 19.21 | .0845 | .0787 |
|      | .254 | 15.38 | 1228. | .261 | 19.33 | .0570 | .0553 |

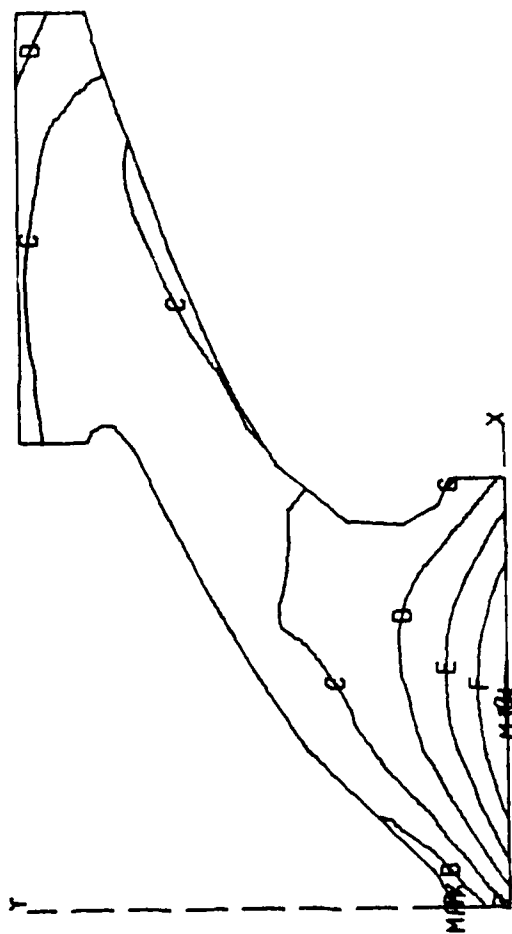


RUN 93C MACH .27 TGAS 793. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 8:31:57 80/050



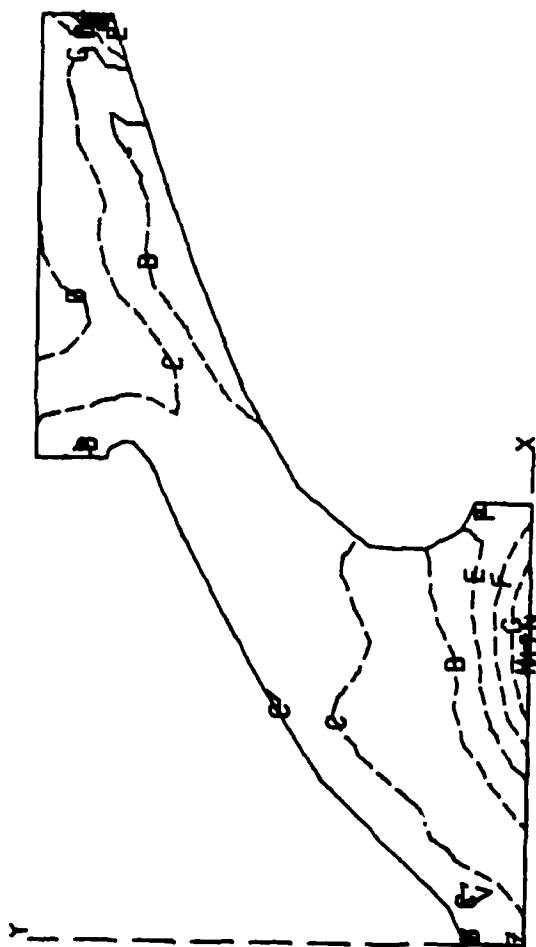
| MM  | LEGEND   | MM |
|-----|----------|----|
|     | PSI      |    |
|     | (E-03)   |    |
| A   | 15499.99 |    |
| B   | 15399.99 |    |
| C   | 15299.99 |    |
| D   | 15199.99 |    |
| E   | 15099.99 |    |
| F   | 14999.99 |    |
| G   | 14899.99 |    |
| H   | 14799.99 |    |
| I   | 14699.99 |    |
| J   | 14599.99 |    |
| MAX | 15588.85 |    |
| MIN | 14592.20 |    |

RUN 93C MACH=.27 TGAS=793 ENDWALL PRESSURE CONTOURS  
 CONTOUR\_PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:47:50 80/212



| MAX | LEGEND       | MAX         |
|-----|--------------|-------------|
|     | UNITS = TEMP |             |
|     | SYMBOL       | CONTOUR     |
| A   |              | 7.10000E 02 |
| B   |              | 6.90000E 02 |
| C   |              | 6.70000E 02 |
| D   |              | 6.50000E 02 |
| E   |              | 6.30000E 02 |
| F   |              | 6.10000E 02 |
| G   |              | 5.90000E 02 |
| MAX |              | 7.17676E 02 |
| MIN |              | 5.87429E 02 |

RUN 93C MACH .28 TCAS 811. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:38:31 79/303



MAX LEGEND F MAX  
 (E-03)  
 B -2.00  
 C -4.00  
 D -6.00  
 E -8.00  
 F -10.00  
 G -12.00  
 H -14.00  
 MAX -.21  
 MIN -14.75

RUN 93C MACH .27 TGRS 793. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 8:33:09 80/050

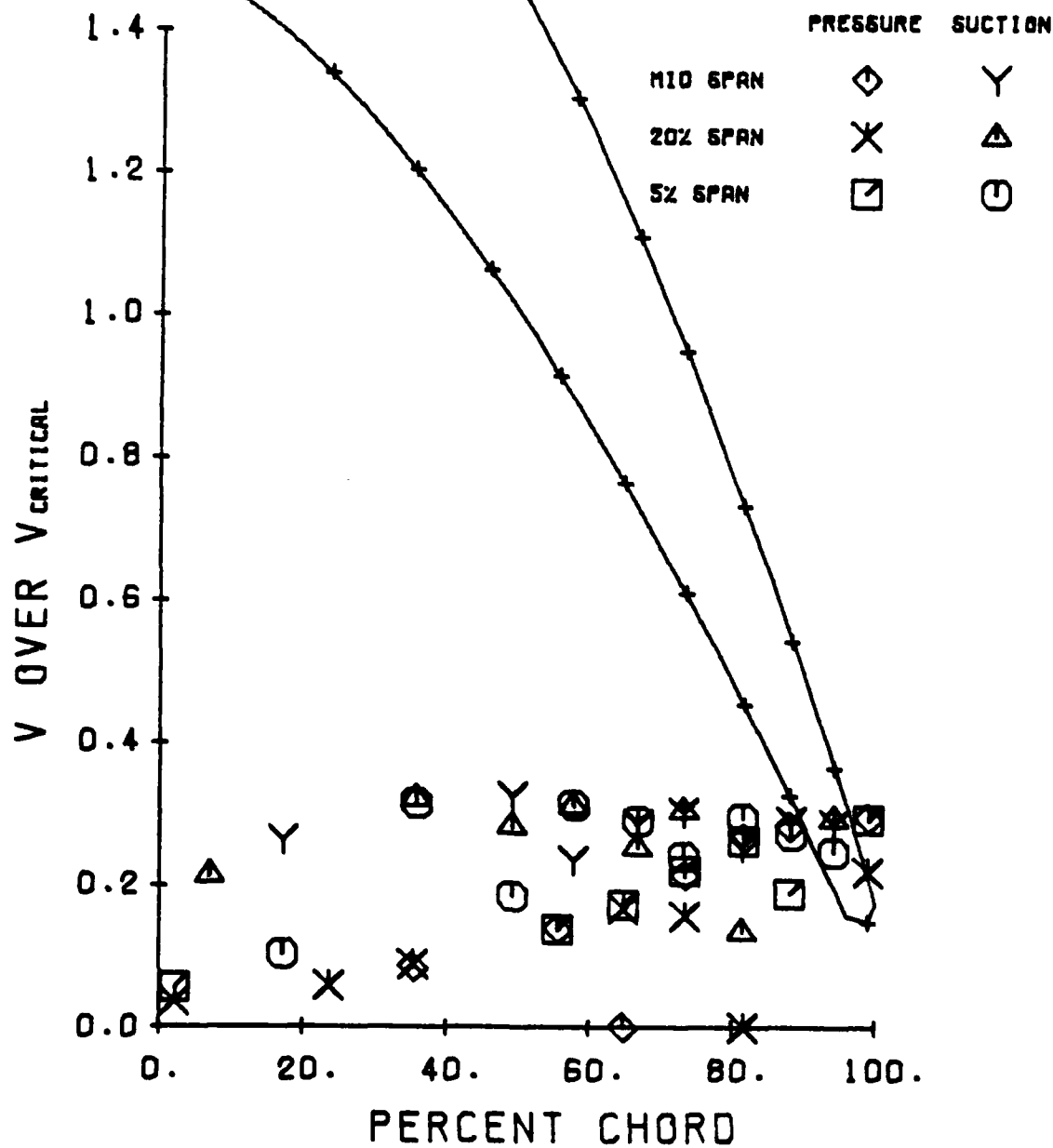
# ENDWALL HEAT TRANSFER LINEAR CASCADE

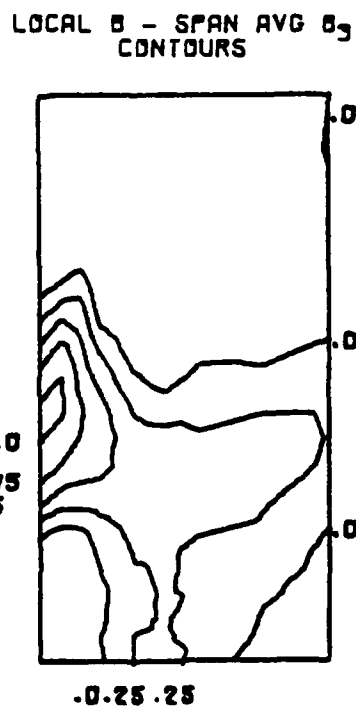
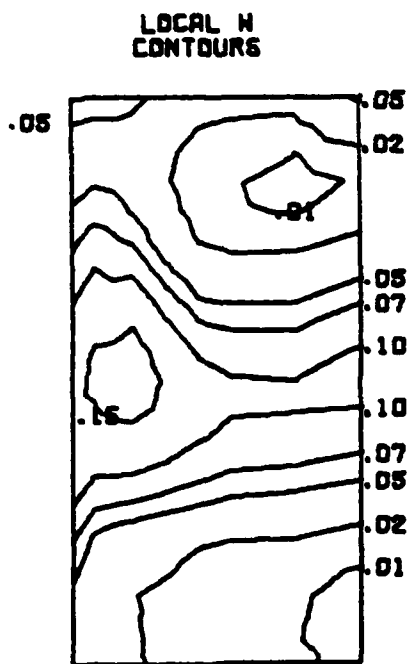
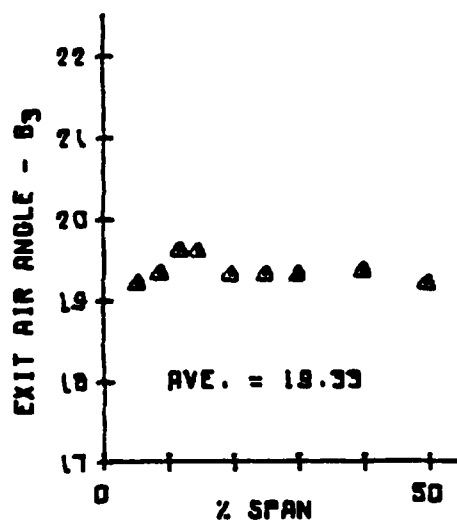
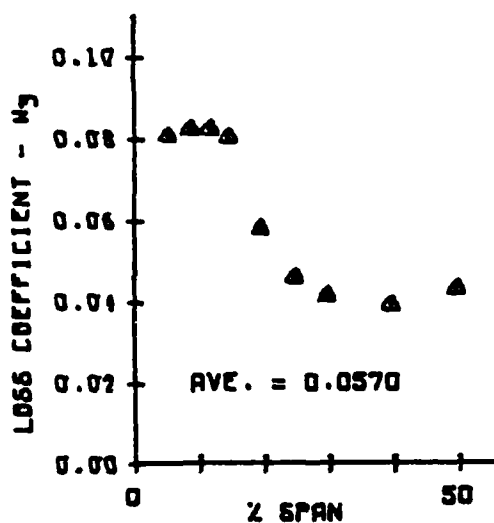
RUN # = 89

DATE = 10/15/79

EXPANSION RATIO = 1.051

AIRFLOW →





SUCTION  
SIDE  
↑  
PRESSURE  
SIDE  
↓

1.0  
.75  
.5

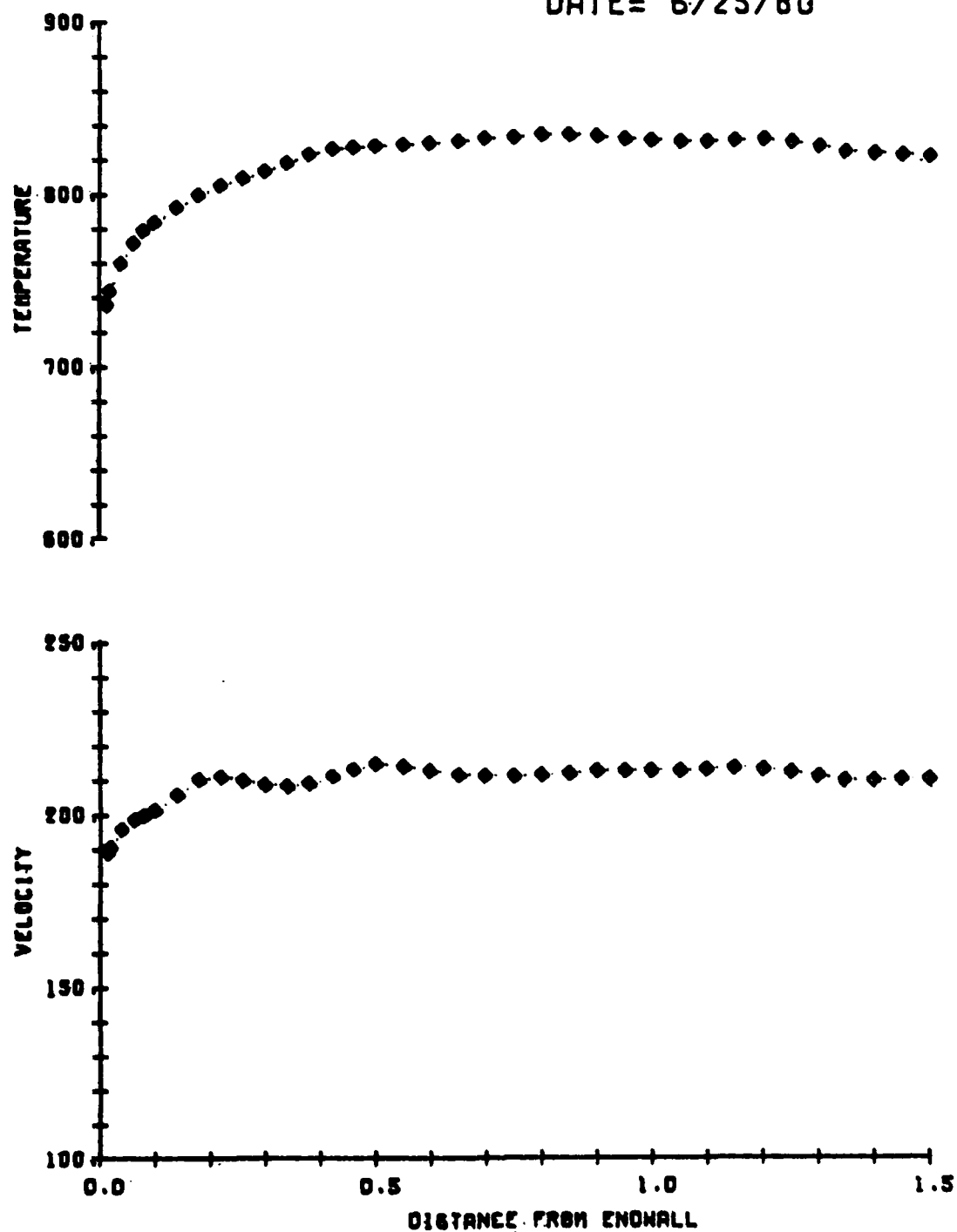
EXIT MACH NO. = 0.27 REYNOLDS NO. =  $2.05 \times 10^5$

RUN 89 AERODYNAMIC EXIT DATA

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 176

DATE = 6/25/80





# GMA 200 TURBINE VANE CASCADE

RUN # 91

DATE: 10/10/79

TIME: 11:52:47

|        |         | INLET CONDITIONS |        |      |           |
|--------|---------|------------------|--------|------|-----------|
| PTOTLE | PSTATIC | TTOTLE           | MACH # | V/V* | REY/10**6 |
| 51.66  | 50.27   | 1276.97          | .200   | .217 | .502      |

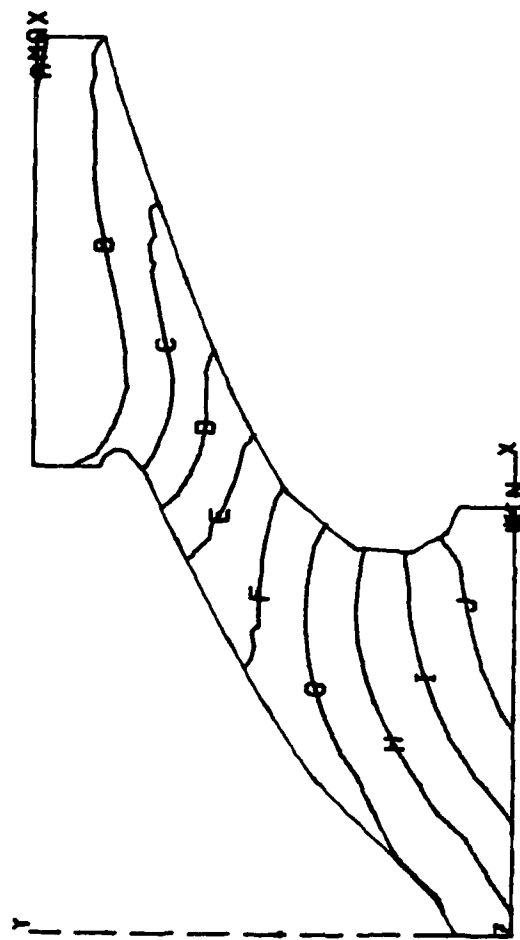
|        |        | IDEAL EXIT CONDITIONS |        |       |           |
|--------|--------|-----------------------|--------|-------|-----------|
| PTOTLE | STATIC | TTOTAL                | MACH # | V/V*  | REY/10**6 |
| 51.66  | 24.52  | 1276.97               | 1.100  | 1.083 | 1.675     |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 2.107      STATIC PRESSURE RATIO= .408

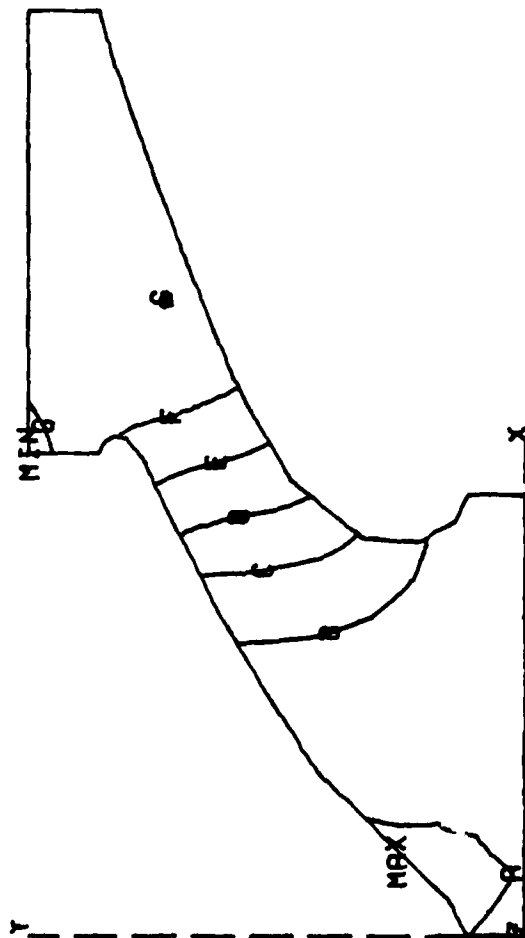
## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS  | PT3   | TT3   | M3    | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|-------|-------|-------|-------|-------|
| 49.9    | 1.827 | 49.58 | 1215. | 1.045 | 17.81 | .0784 | .0520 |
| 46.1    | 1.829 | 49.67 | 1199. | 1.049 | 17.67 | .0750 | .0496 |
| 29.9    | 1.819 | 49.89 | 1217. | 1.052 | 17.63 | .0664 | .0439 |
| 25.1    | 1.808 | 49.83 | 1216. | 1.050 | 17.53 | .0688 | .0455 |
| 20.3    | 1.918 | 49.90 | 1208. | 1.054 | 17.57 | .0661 | .0436 |
| 15.5    | 1.814 | 49.64 | 1206. | 1.051 | 17.60 | .0759 | .0502 |
| 12.4    | 1.839 | 49.26 | 1169. | 1.041 | 17.70 | .0902 | .0601 |
| 9.2     | 1.844 | 49.08 | 1177. | 1.035 | 17.85 | .0974 | .0651 |
| 6.7     | 1.828 | 49.09 | 1196. | 1.036 | 17.84 | .0972 | .0649 |
| AVERAGE | 1.824 | 49.60 | 1203. | 1.047 | 17.68 | .0777 | .0516 |



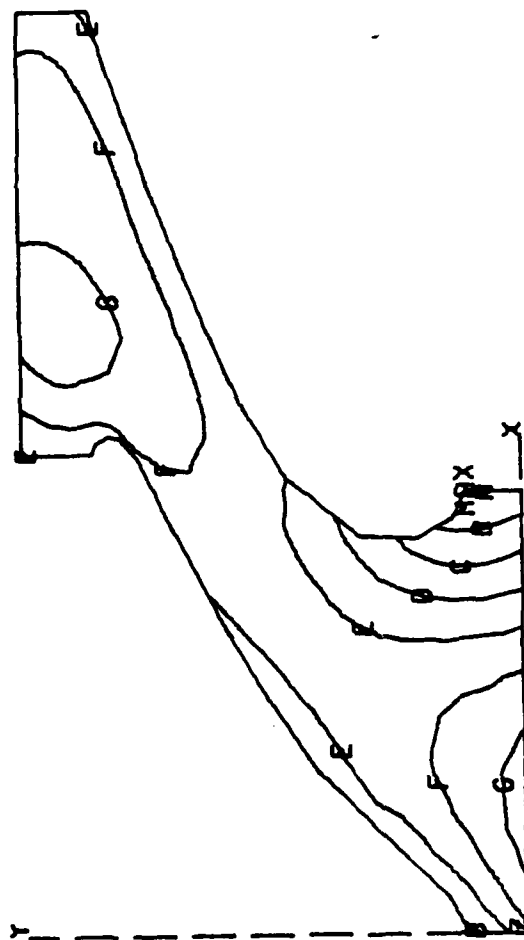
MAX LEGEND MAX  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 6.30000E 02  
 B 6.20000E 02  
 C 6.10000E 02  
 D 6.00000E 02  
 E 5.90000E 02  
 F 5.80000E 02  
 G 5.70000E 02  
 H 5.60000E 02  
 I 5.50000E 02  
 J 5.40000E 02  
 K 5.30000E 02  
 MAX 6.31622E 02  
 MIN 5.29113E 02

RUN 91 MACH 1.1 TGAS 800. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:17:45 79/291



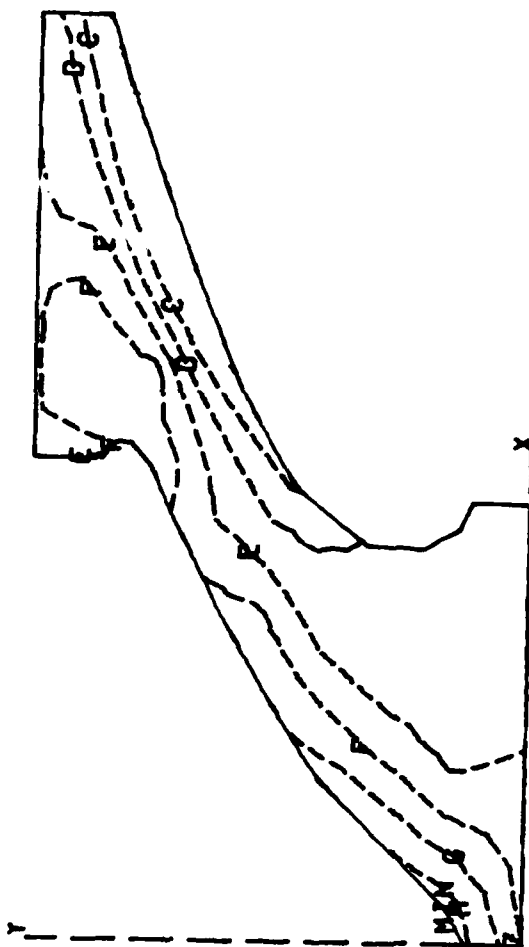
| MAX | LEGEND | MAX   |
|-----|--------|-------|
| A   | PSI    | 52.00 |
| B   |        | 47.00 |
| C   |        | 42.00 |
| D   |        | 37.00 |
| E   |        | 32.00 |
| F   |        | 27.00 |
| G   |        | 22.00 |
| MAX |        | 52.27 |
| MIN |        | 19.33 |

RUN 91 MACH 1.1 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:23:28 80/158



| MMM | LEGEND       | MMM     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 7.02000E 02  |         |
| B   | 6.95000E 02  |         |
| C   | 6.88000E 02  |         |
| D   | 6.81000E 02  |         |
| E   | 6.74000E 02  |         |
| F   | 6.67000E 02  |         |
| G   | 6.60000E 02  |         |
| MAX | 7.02676E 02  |         |
| MIN | 6.56242E 02  |         |

RUN 91 MACH 1.1 TGAS 800. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 8:48:03 79/305



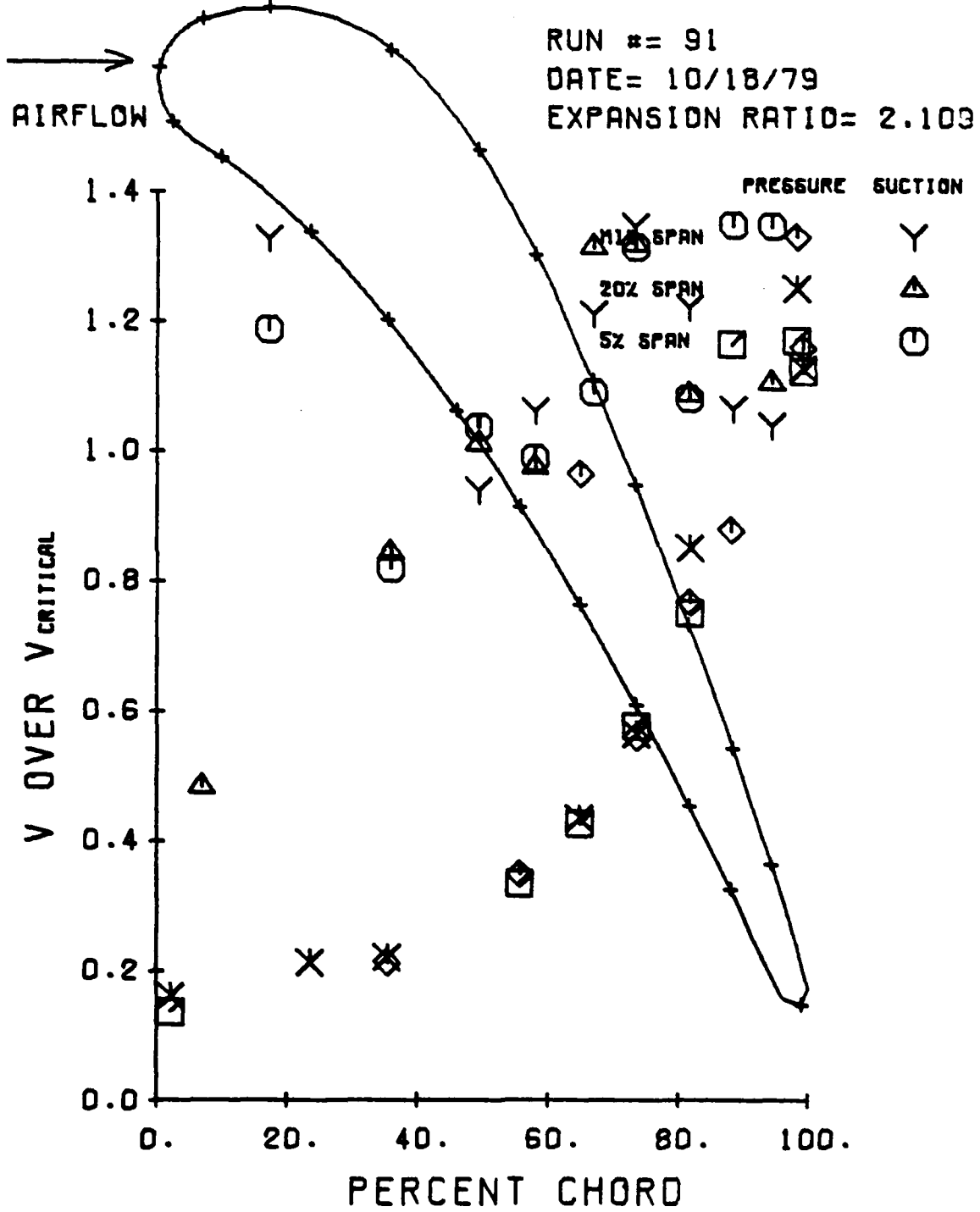
MIN LEGEND MIN  
 UNITS = TEMP  
 SYMBOL CONTOUR

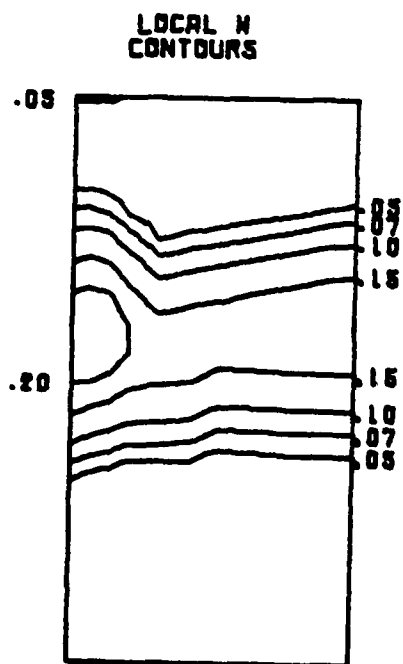
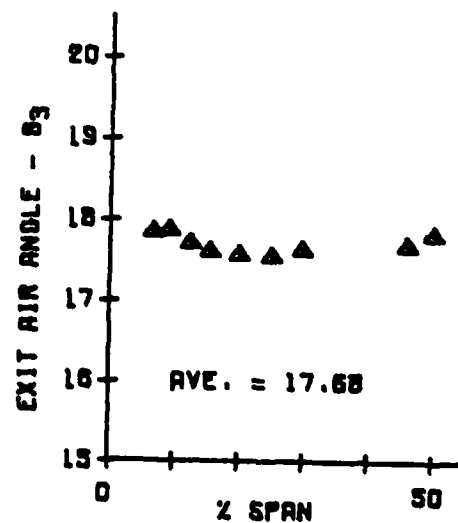
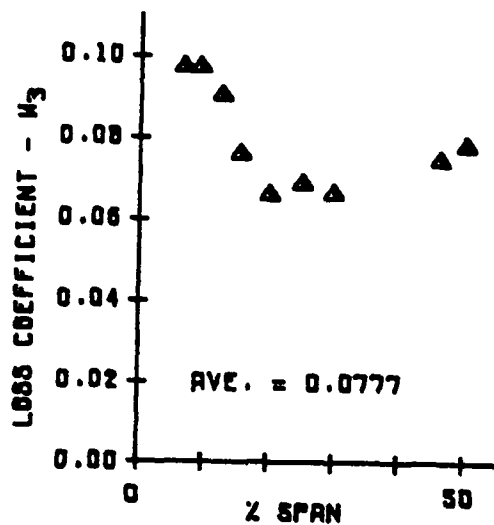
C -1.00000E-03  
 D -2.00000E-03  
 E -3.00000E-03  
 F -4.00000E-03  
 G -5.00000E-03  
 H -5.99999E-03

MIN -6.49403E-03

RUN 91 MACH 1.1 TGAS 800. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:18:05 79/291

# ENDWALL HEAT TRANSFER LINEAR CASCADE



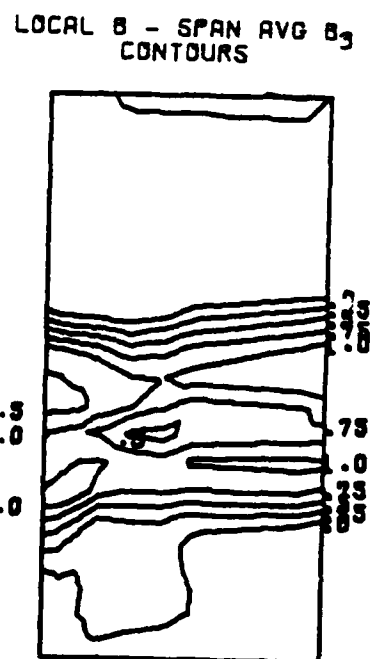


SUCTION  
SIDE

↑

↓

PRESSURE  
SIDE



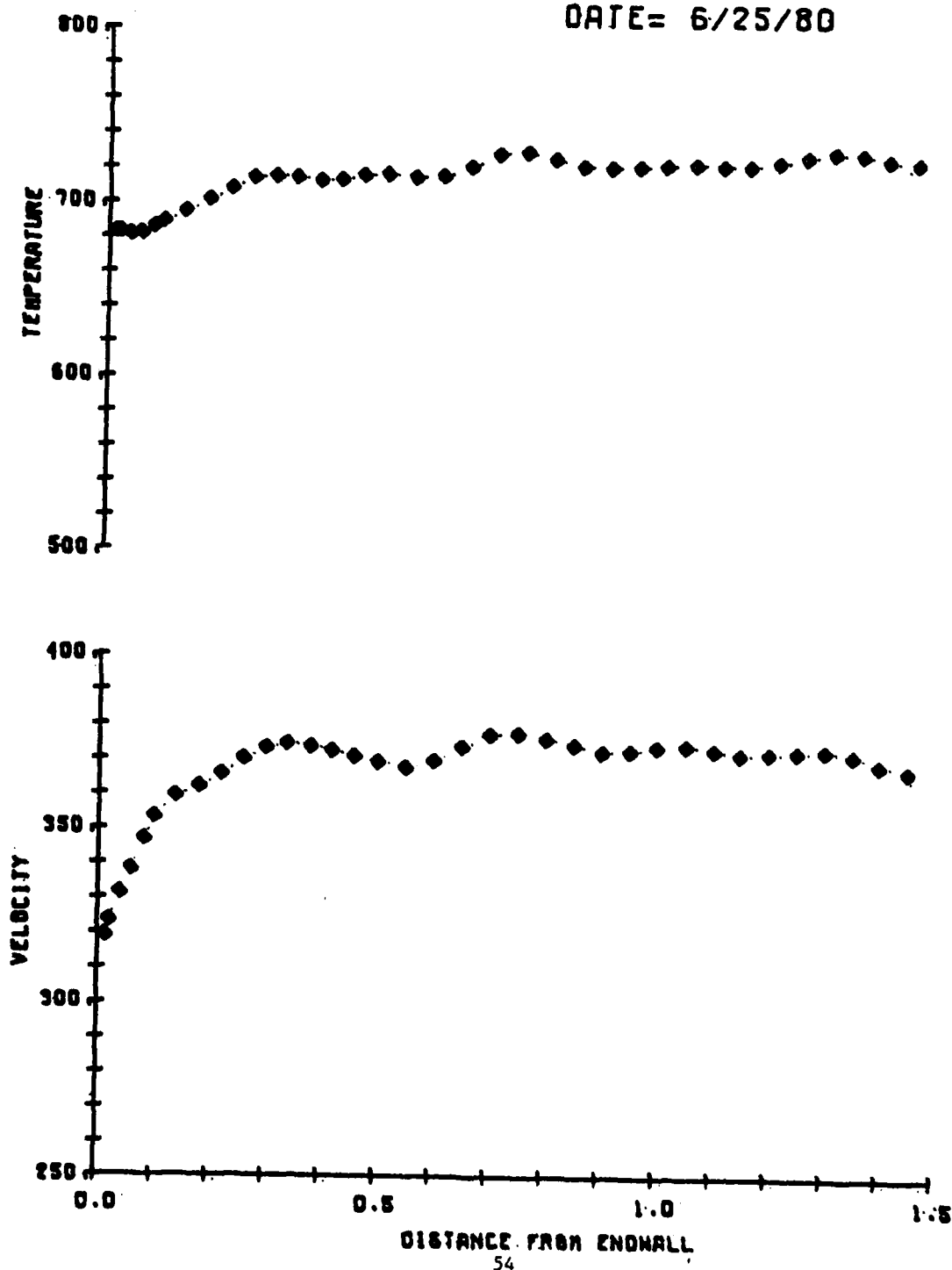
EXIT MACH NO. = 1.10 REYNOLDS NO. =  $1.67 \times 10^6$

RUN 91 AERODYNAMIC EXIT DATA

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 179

DATE = 6/25/80





# GMA 200 TURBINE VANE CASCADE

RUN # 94

DATE: 10/24/70

TIME: 8: 6:44

|        |         | INLET CONDITIONS |        |      |           |  |  |
|--------|---------|------------------|--------|------|-----------|--|--|
| PTOTLE | PSTATIC | TTOTLE           | MACH # | V/V* | REY/10**6 |  |  |
| 15.49  | 15.37   | 1391.52          | .106   | .114 | .073      |  |  |

| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .17295                    | 8210517.         | 929.09                 |

CP - BTU/LRM/F  
.260

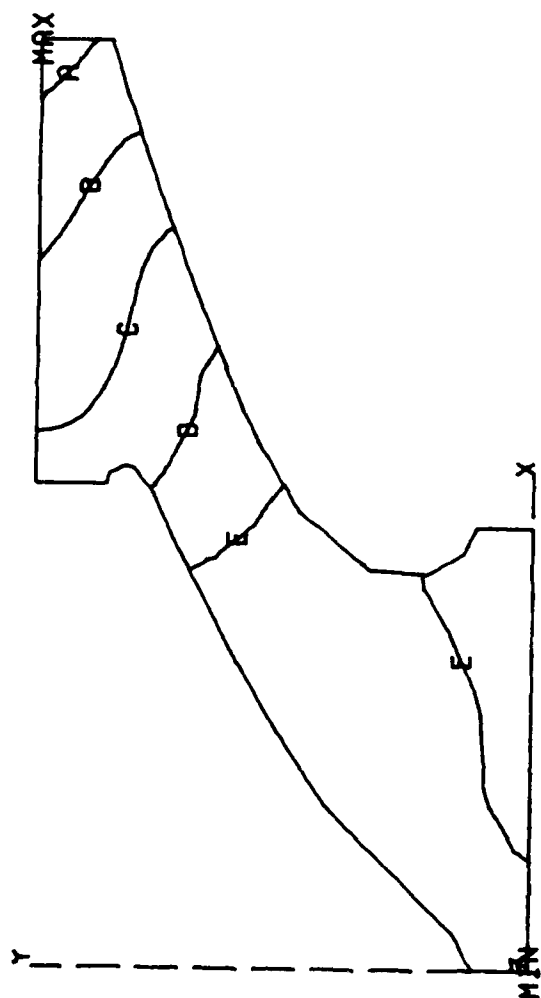
ORIFICE

MASS FLOW RATE

.36 CASCADE

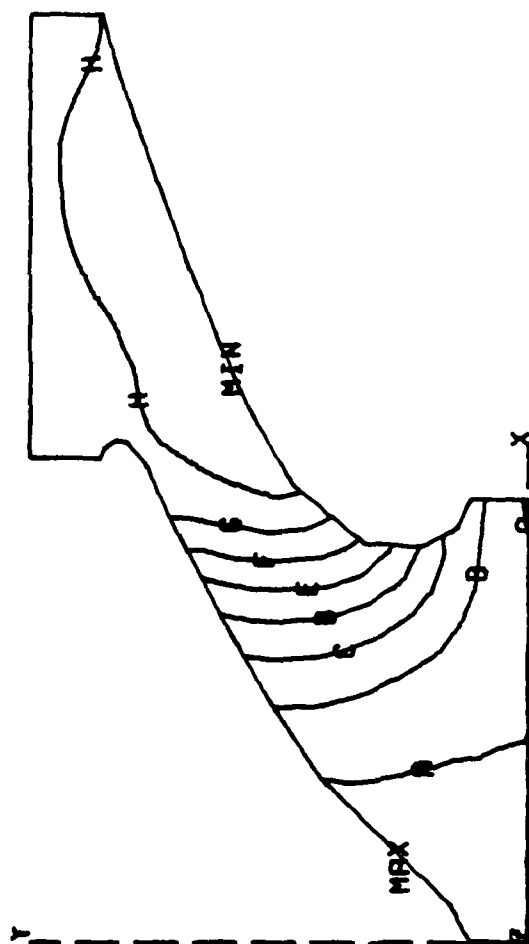
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 15.49                 | 14.68  | 1391.52 | .283   | .305 | .189      |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.055                       | .955                   |



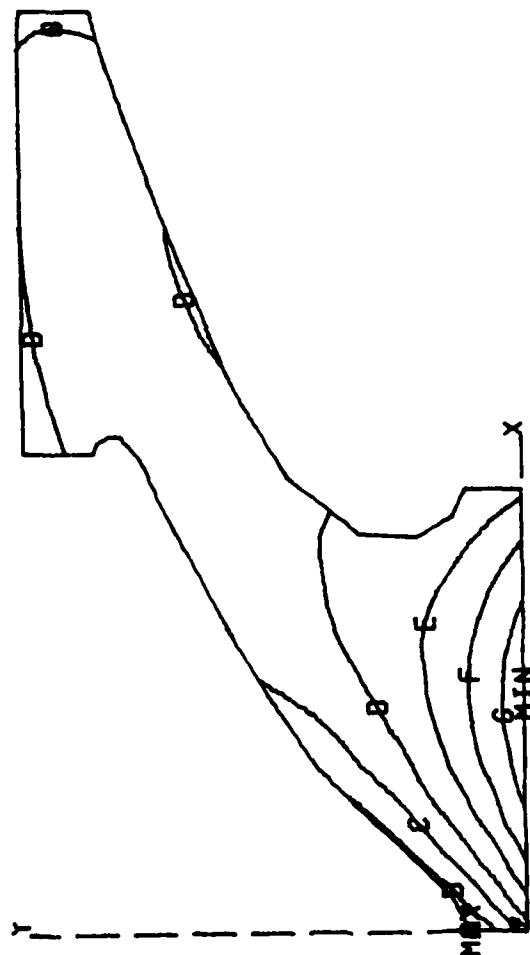
| MIN | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 550.00 |
| B   |        | 530.00 |
| C   |        | 510.00 |
| D   |        | 490.00 |
| E   |        | 470.00 |
| MAX |        | 559.84 |
| MIN |        | 450.88 |

RUN 94 MACH .3 TGAS 1000. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:31:25 80/045



| MAX | LEGEND   | MAX |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 15399.99 |     |
| B   | 15299.99 |     |
| C   | 15199.99 |     |
| D   | 15099.99 |     |
| E   | 14999.99 |     |
| F   | 14899.99 |     |
| G   | 14799.99 |     |
| H   | 14699.99 |     |
| MAX | 15448.65 |     |
| MIN | 14603.29 |     |

RUN 94 MACH .3 TGRS 1000 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:39:27 80/158



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 9.90000E 02  
 B 9.60000E 02  
 C 9.30000E 02  
 D 9.00000E 02  
 E 8.70000E 02  
 F 8.40000E 02  
 G 8.10000E 02  
 MAX 9.92881E 02  
 MIN 7.89215E 02

RUN 94 MACH .3 TGAS 1000. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:07:28 79/304



MAX LEGEND MIN  
F  
(E-03)

|     |        |
|-----|--------|
| C   | -2.00  |
| D   | -4.00  |
| E   | -6.00  |
| F   | -8.00  |
| G   | -10.00 |
| MIN | -11.32 |

RUN 94 MACH .3 TGAS 1000. HEAT TRANSFER ENDWALL  
CONTOUR PLOT OF STANTON NUMBER.  
SCALE = 1.0000 PLOT TIME AND DATE = 18:31:48 80/045

GMA 200 TURBINE VANE CASCADE

RUN # 98

DATE: 10/30/79

TIME: 4:40:21

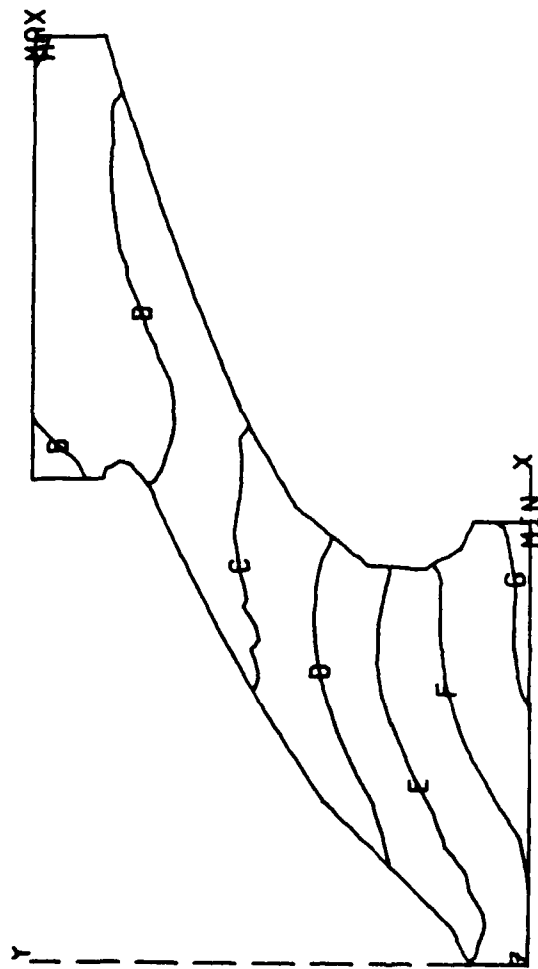
| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 55.58            | 54.38   | 1477.25 | .187   | .202 | .428      |

| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO -LBM/IN3 *10**4       | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .57868                    | 14975222.        | 1008.54                |
| CP - BTU/LRM/F            |                  |                        |
| .263                      |                  |                        |

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 9.31           | CASCADE |

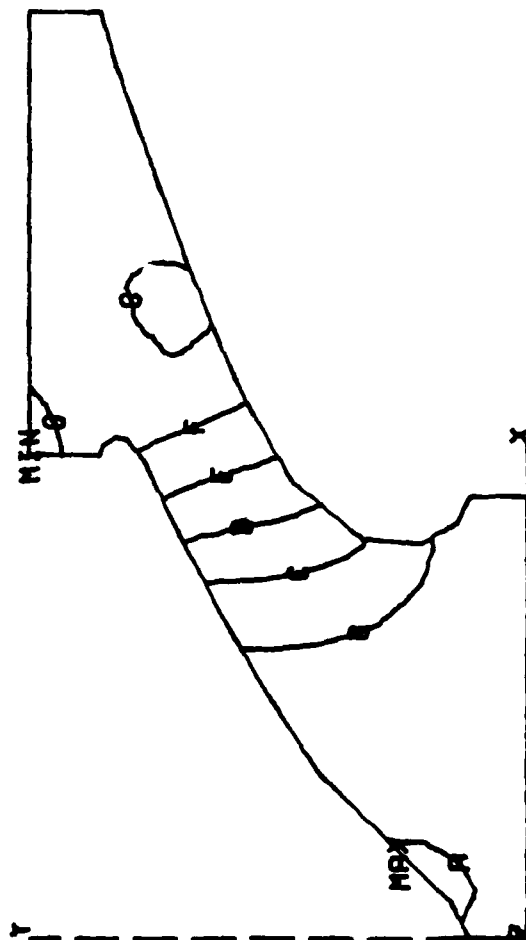
| IDEAL EXIT CONDITIONS |        |         |        |       |           |
|-----------------------|--------|---------|--------|-------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V*  | REY/10**6 |
| 55.68                 | 26.85  | 1477.25 | 1.090  | 1.075 | 1.516     |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 2.074                       | .494                   |



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 730.00 |
| B   |        | 710.00 |
| C   |        | 690.00 |
| D   |        | 670.00 |
| E   |        | 650.00 |
| F   |        | 630.00 |
| G   |        | 610.00 |
| MAX |        | 733.29 |
| MIN |        | 603.50 |

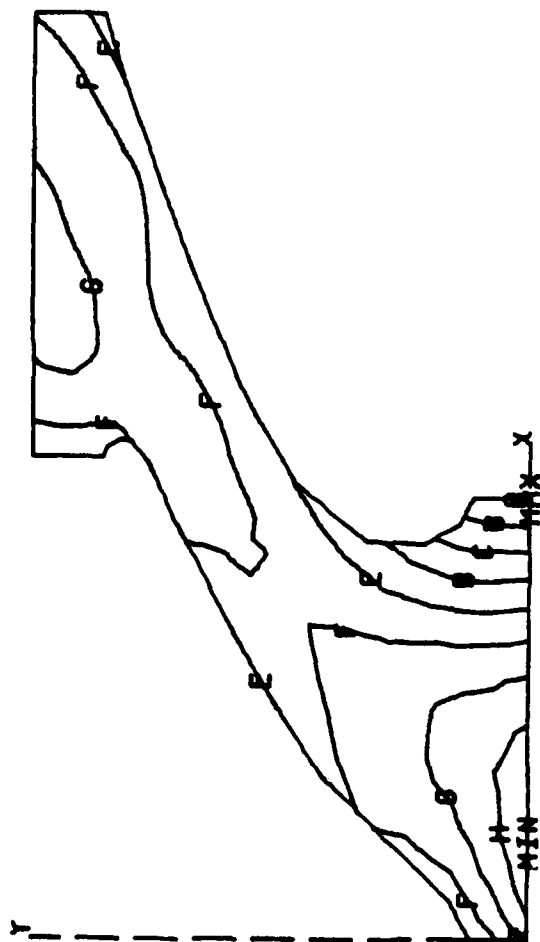
RUN 98 MACH 1.1 TGAS 1000. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:38:48 80/050



| MIN | LEGEND | MIN |
|-----|--------|-----|
|     | PSI    |     |
|     | 55.00  |     |
|     | 50.00  |     |
|     | 45.00  |     |
|     | 40.00  |     |
|     | 35.00  |     |
|     | 30.00  |     |
|     | 25.00  |     |
|     | 21.75  |     |
|     | MAX    |     |
|     | MIN    |     |

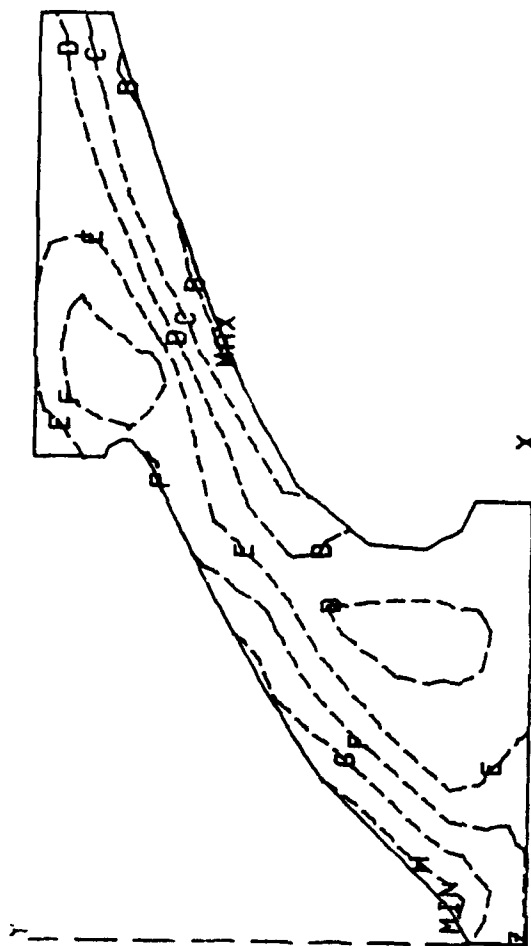
RUN 98 MACH 1.1 TGAS 1000 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 13:34:20 80/158





| MIN | LEGEND       | MIN     |
|-----|--------------|---------|
|     | UNITS - TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 8.80000E 02  |         |
| B   | 8.70000E 02  |         |
| C   | 8.60000E 02  |         |
| D   | 8.50000E 02  |         |
| E   | 8.40000E 02  |         |
| F   | 8.30000E 02  |         |
| G   | 8.20000E 02  |         |
| H   | 8.10000E 02  |         |
| MAX | 8.81845E 02  |         |
| MIN | 8.00573E 02  |         |

RUN 98 MACH 1.1 TGAS 1000. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:50:37 79/304



| MAX | LEGEND   | MIN |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| B   | -1000.00 |     |
| C   | -2000.00 |     |
| D   | -3000.00 |     |
| E   | -4000.00 |     |
| F   | -5000.00 |     |
| G   | -6000.00 |     |
| H   | -6999.99 |     |
| MAX | -655.42  |     |
| MIN | -7660.68 |     |

RUN 98 MARCH 1.1 TGAS 1000. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:39:21 80/050

GMA 200 TURBINE VANE CASCADE

RUN # 99

DATE: 10/30/79

TIME: 7:34: 0

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 21.75            | 21.25   | 1442.00 | .186   | .201 | .171      |

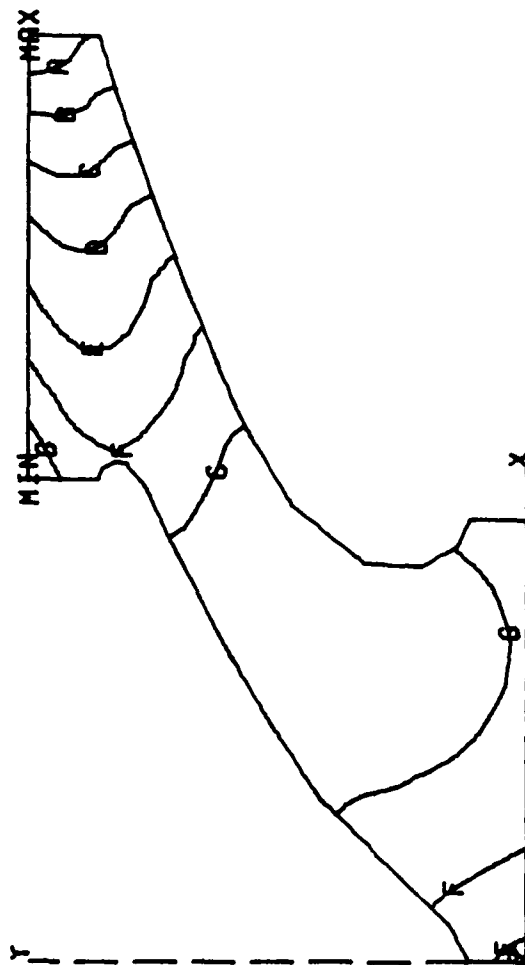
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 21.75                 | 15.94  | 1442.00 | .692   | .721 | .519      |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.365      STATIC PRESSURE RATIO= .750

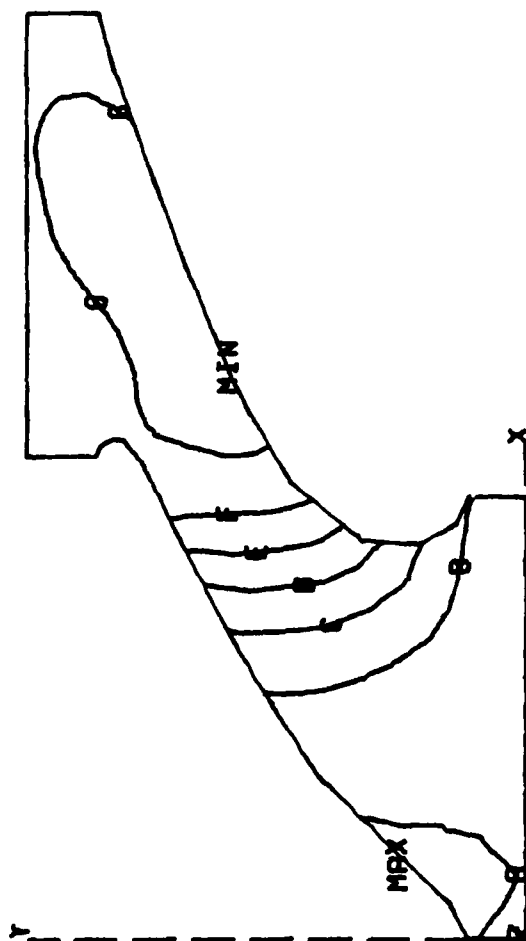
\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 50.1    | .672 | 21.53 | 1392. | .677 | 18.01 | .0377 | .0314 |
| 40.1    | .670 | 21.54 | 1386. | .678 | 17.90 | .0371 | .0306 |
| 29.9    | .661 | 21.54 | 1441. | .679 | 17.96 | .0359 | .0298 |
| 24.9    | .660 | 21.53 | 1416. | .677 | 17.98 | .0373 | .0311 |
| 20.0    | .661 | 21.47 | 1431. | .672 | 18.05 | .0484 | .0403 |
| 14.9    | .683 | 21.34 | 1359. | .664 | 18.45 | .0715 | .0509 |
| 11.9    | .691 | 21.29 | 1348. | .660 | 18.73 | .0810 | .0679 |
| 8.9     | .690 | 21.27 | 1351. | .658 | 18.73 | .0838 | .0704 |
| 7.0     | .688 | 21.28 | 1336. | .653 | 18.56 | .0827 | .0694 |
| AVERAGE | .574 | 21.44 | 1388. | .671 | 18.19 | .0534 | .0446 |



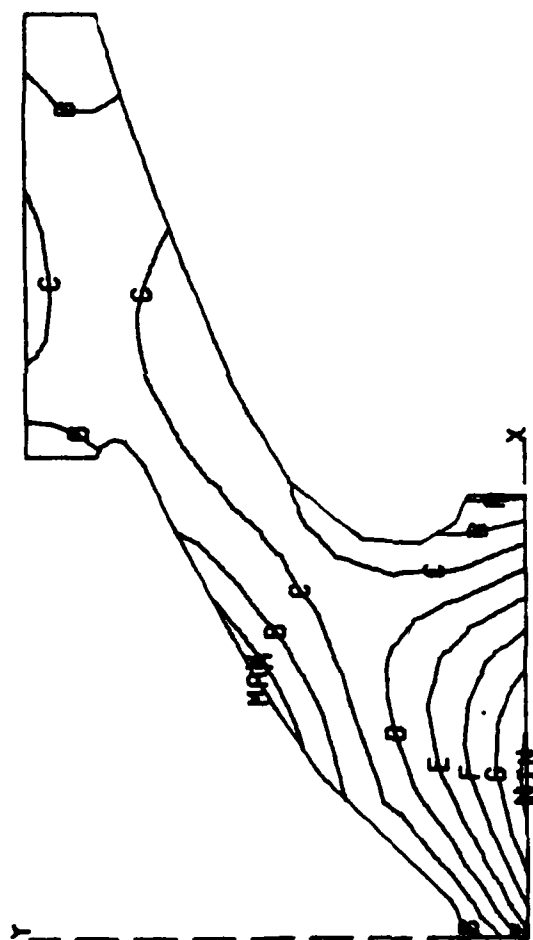
| SYM | LEGEND       | SYM |
|-----|--------------|-----|
|     | UNITS = TEMP |     |
| A   | 5.80000E 02  |     |
| B   | 5.70000E 02  |     |
| C   | 5.60000E 02  |     |
| D   | 5.50000E 02  |     |
| E   | 5.40000E 02  |     |
| F   | 5.30000E 02  |     |
| G   | 5.20000E 02  |     |
| MAX | 5.88439E 02  |     |
| MIN | 5.11049E 02  |     |

RUN 99 MACH .7 TGAS 1000. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:33:54 79/305



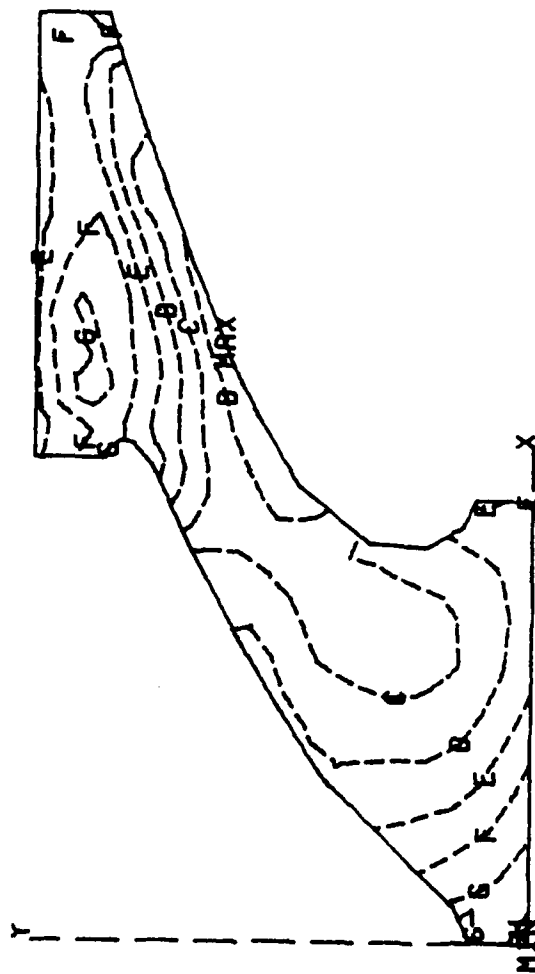
| MAX | LEGEND   | MIN |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 21299.98 |     |
| B   | 20399.98 |     |
| C   | 19499.97 |     |
| D   | 18599.96 |     |
| E   | 17699.95 |     |
| F   | 16799.94 |     |
| G   | 15899.94 |     |
| MAX | 21398.39 |     |
| MIN | 15340.86 |     |

RUN 99 MACH .7 TGAS 1000 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 13:50:17 80/158



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 8.50000E 02  
 B 8.40000E 02  
 C 8.30000E 02  
 D 8.20000E 02  
 E 8.10000E 02  
 F 8.00000E 02  
 G 7.90000E 02  
 H 7.80000E 02  
 MAX 8.55605E 02  
 MIN 7.77689E 02

RUN 99 MACH .7 TGAS 1000. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:04:22 79/304



MAX LEGEND MAX  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A -1.90000E-03  
 B -2.60000E-03  
 C -3.30000E-03  
 D -4.00000E-03  
 E -4.69999E-03  
 F -5.39999E-03  
 G -6.09999E-03  
 H -6.79998E-03  
 MAX -1.92371E-03  
 MIN -7.13911E-03

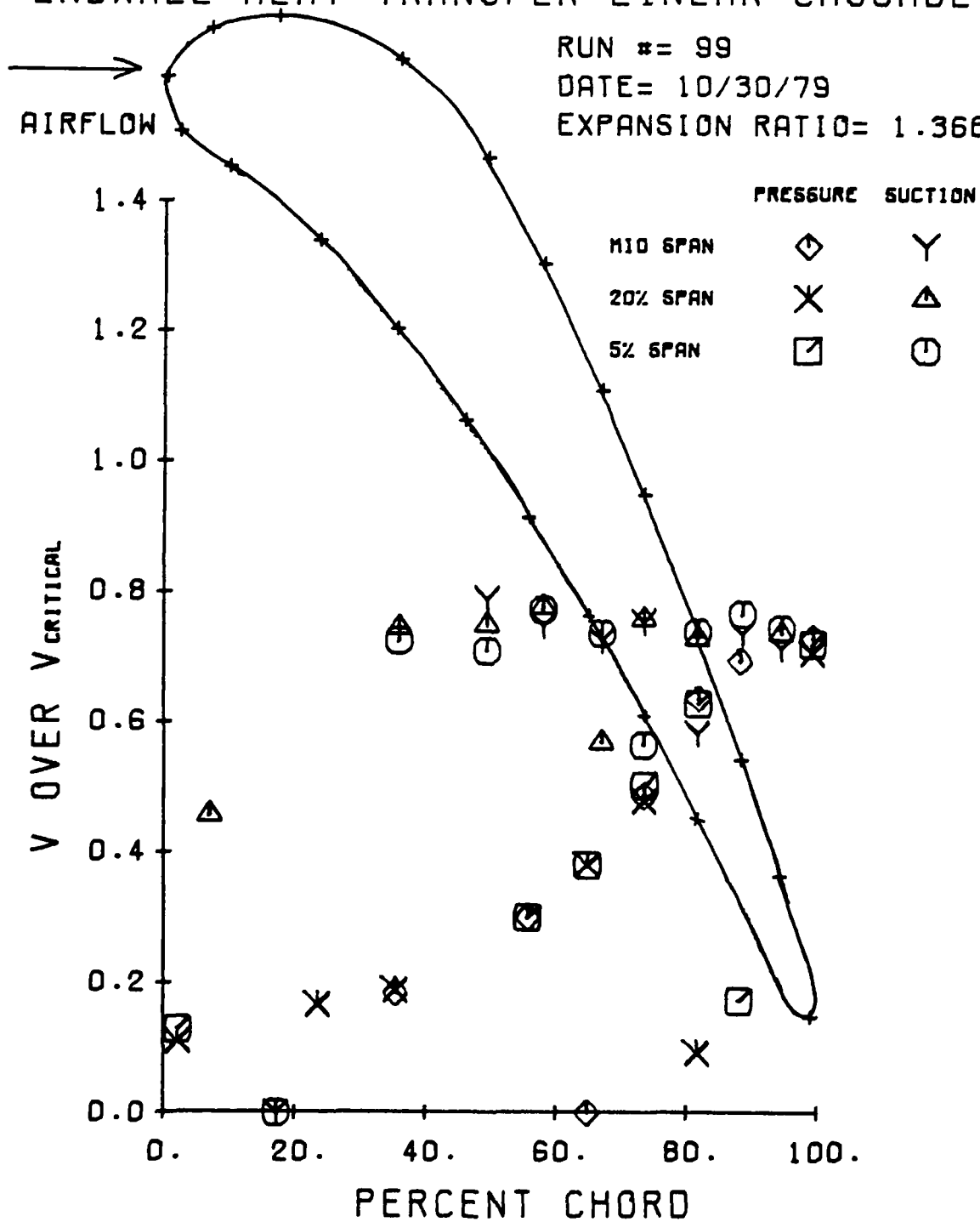
RUN 99 MACH .7 TGAS 1000. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:34:36 79/305

# ENDWALL HEAT TRANSFER LINEAR CASCADE

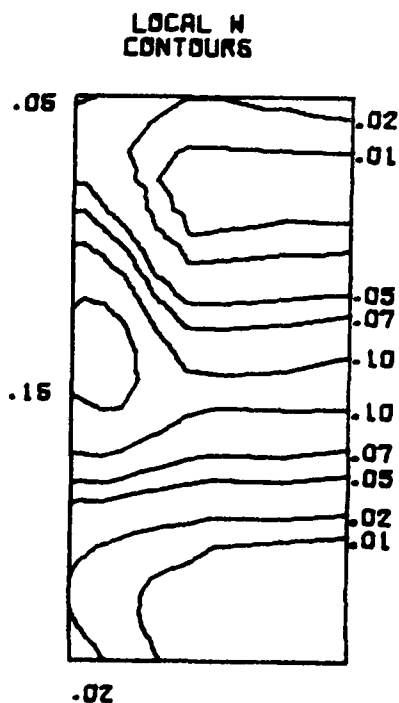
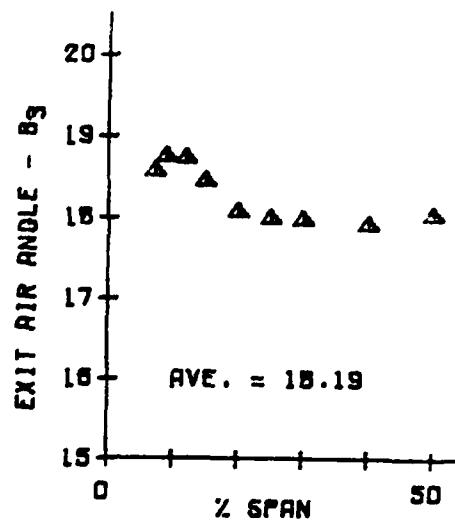
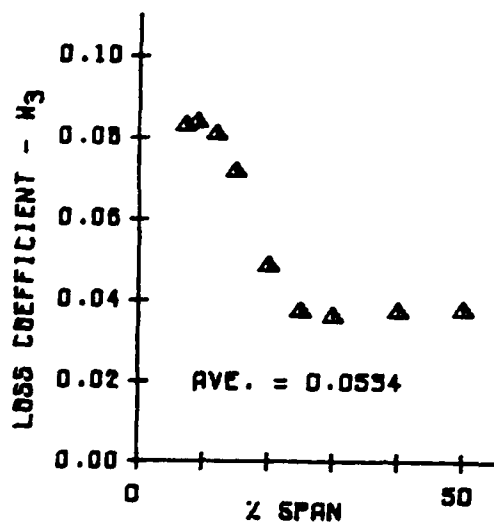
RUN # = 99

DATE = 10/30/79

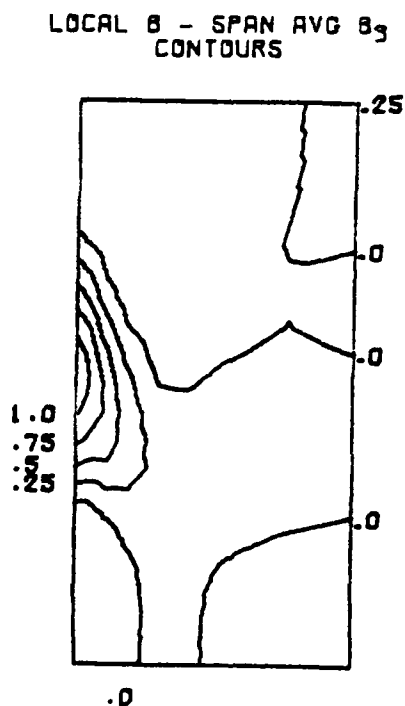
EXPANSION RATIO = 1.366







SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.69 REYNOLDS NO. =  $5.19 \times 10^5$

RUN 99 AERODYNAMIC EXIT DATA

USA 200 TURBINE VANE CASCADE

RUN #100

DATE: 11/05/79

TIME: 7:30: 5

| INLET CONDITIONS |         |        |        |      |           |
|------------------|---------|--------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE | MACH # | V/V* | REY/12**6 |
| 21.49            | 20.80   | 672.99 | .223   | .222 | .457      |

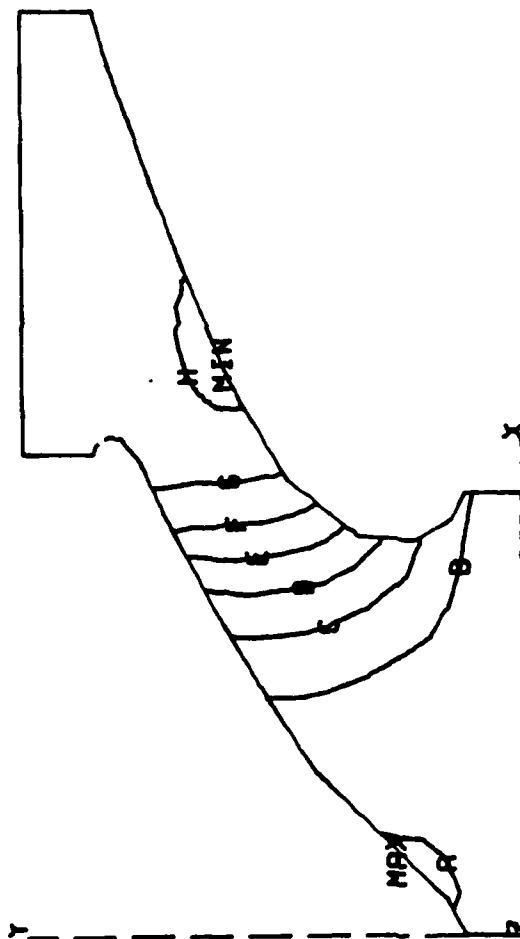
| IDEAL EXIT CONDITIONS |        |        |        |      |           |
|-----------------------|--------|--------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL | MACH # | V/V* | REY/12**6 |
| 21.49                 | 15.30  | 672.99 | .714   | .745 | 1.311     |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.404      STATIC PRESSURE RATIO= .733

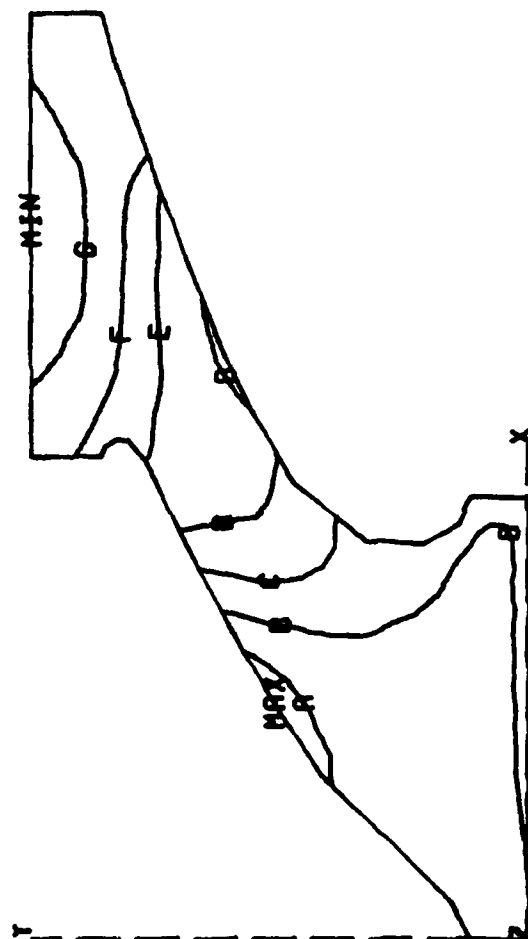
\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| Z SPAN  | MASS  | PT3   | TT3  | M3   | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|------|------|-------|-------|-------|
| 49.5    | .985  | 21.15 | 674. | .705 | 18.10 | .0526 | .0427 |
| 39.9    | .985  | 21.14 | 673. | .707 | 18.11 | .0545 | .0442 |
| 29.9    | .987  | 21.10 | 672. | .705 | 18.17 | .0611 | .0496 |
| 24.9    | .980  | 21.02 | 673. | .701 | 18.27 | .0729 | .0594 |
| 19.9    | .995  | 20.91 | 673. | .694 | 18.73 | .0915 | .0748 |
| 14.9    | 1.000 | 20.81 | 673. | .688 | 18.98 | .1008 | .0876 |
| 12.0    | .900  | 20.81 | 672. | .688 | 18.75 | .1068 | .0876 |
| 11.2    | .800  | 20.81 | 671. | .687 | 18.97 | .1067 | .0886 |
| 9.0     | .702  | 20.80 | 671. | .687 | 18.15 | .1067 | .0892 |
| AVERAGE | .900  | 20.90 | 673. | .695 | 18.31 | .0794 | .0849 |



| MIN | LEGEND   | MAX |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 21299.98 |     |
| B   | 20399.98 |     |
| C   | 19499.97 |     |
| D   | 18599.96 |     |
| E   | 17699.95 |     |
| F   | 16799.94 |     |
| G   | 15899.94 |     |
| H   | 14999.94 |     |
| MAX | 21352.20 |     |
| MIN | 14772.29 |     |

RUN 105 MACH .7 TGAS 200 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:34:43 80/158



| MAX | LEGEND       | MIN     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 2.11000E 02  |         |
| B   | 2.10000E 02  |         |
| C   | 2.09000E 02  |         |
| D   | 2.08000E 02  |         |
| E   | 2.07000E 02  |         |
| F   | 2.06000E 02  |         |
| G   | 2.05000E 02  |         |
| MAX | 2.11360E 02  |         |
| MIN | 2.04255E 02  |         |

RUN 105 MACH .7 TGAS 200. ADIABATIC ENDWALL THICK B.L.  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 13:02:02 79/318

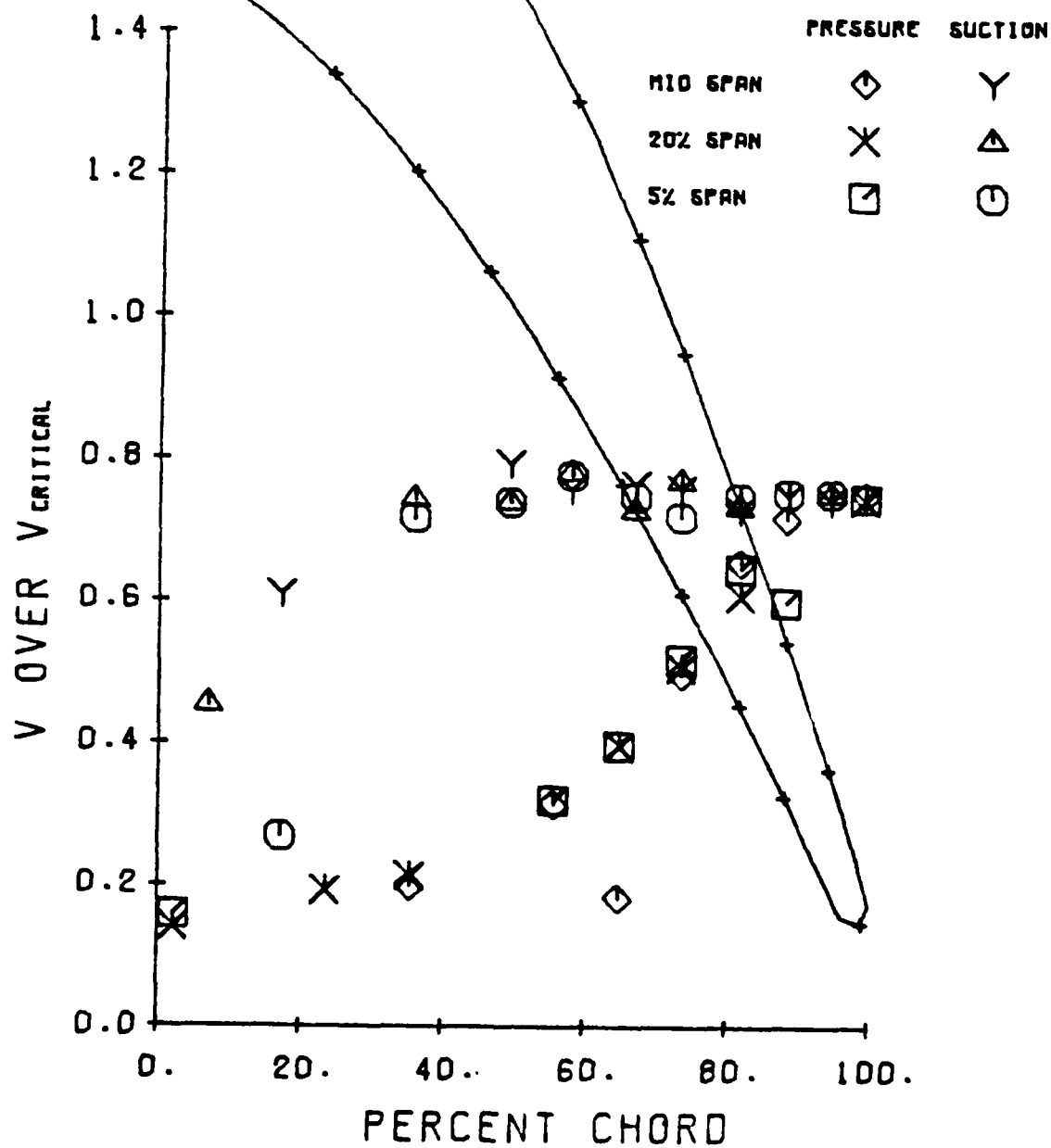
# ENDWALL HEAT TRANSFER LINEAR CASCADE

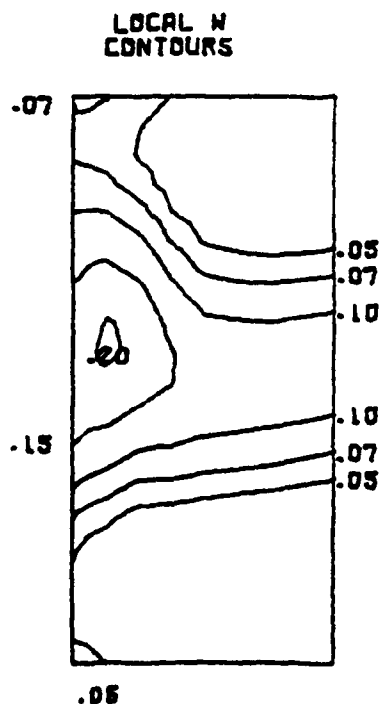
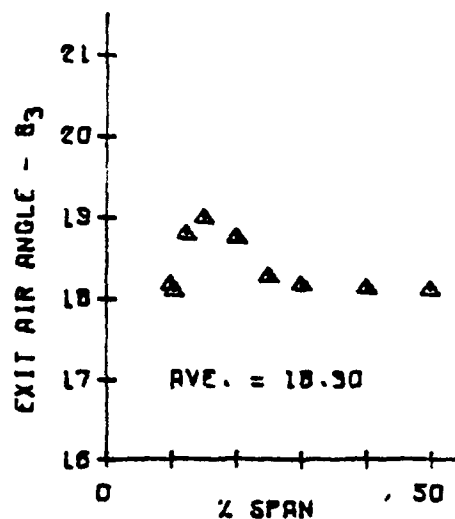
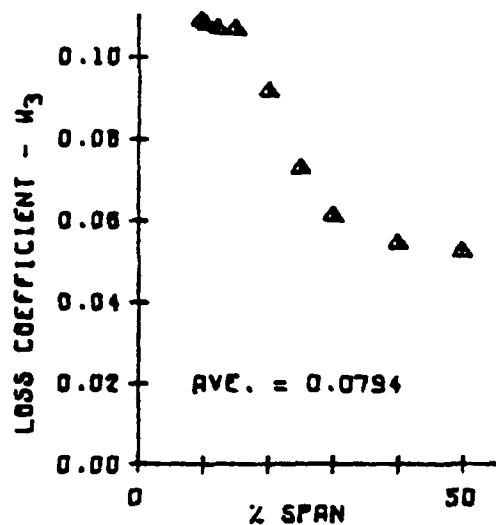
RUN # = 105

DATE = 11/06/79

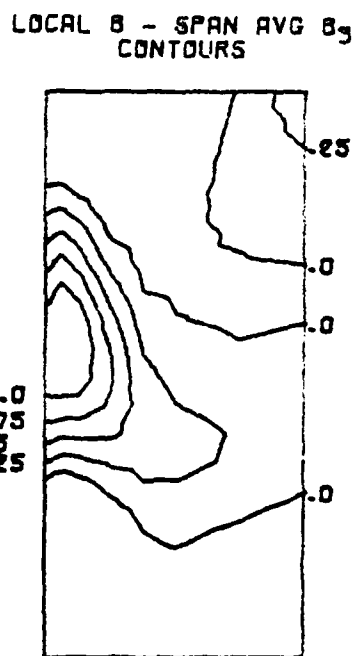
EXPANSION RATIO = 1.402

AIRFLOW →





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.71 REYNOLDS NO. =  $1.31 \times 10^6$

RUN 105 AERODYNAMIC EXIT DATA

GMA 240 TURBINE VANE CASCADE

RUN #107

DATE: 11/07/79

TIME: 11:32:11

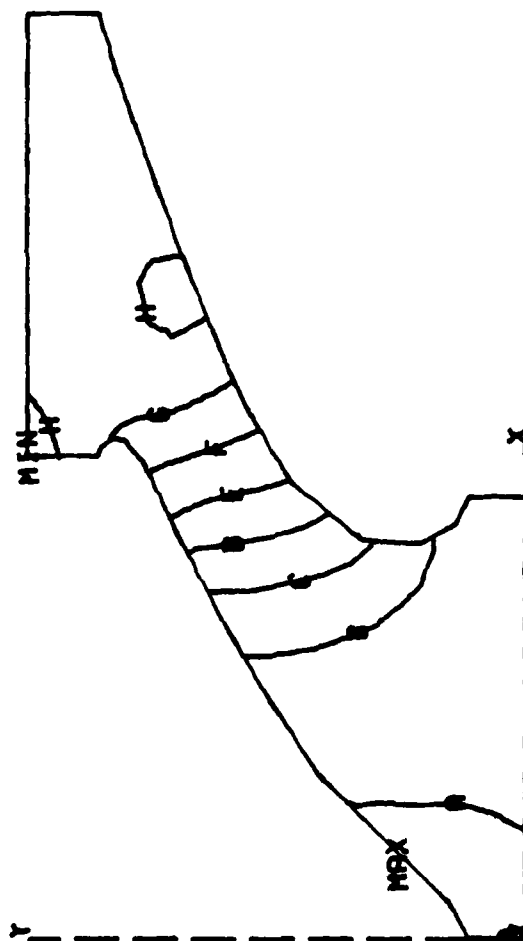
|        |         |                  |        |      |           |
|--------|---------|------------------|--------|------|-----------|
| PTOTLE | PSTATIC | INLET CONDITIONS |        |      |           |
| 38.20  | 36.83   | TTOTLE           | MACH # | V/V* | REY/10**6 |
|        |         | 657.35           | .229   | .250 | .937      |

|        |        |                       |        |       |           |
|--------|--------|-----------------------|--------|-------|-----------|
|        |        | IDEAL EXIT CONDITIONS |        |       |           |
| PTOTLE | STATIC | TTOTAL                | MACH # | V/V*  | REY/10**6 |
| 38.20  | 17.96  | 657.35                | 1.097  | 1.079 | 2.828     |

CASCADE OPERATING CONDITION  
 EXPANSION RATIO= 2.127      STATIC PRESSURE RATIO= .488

\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

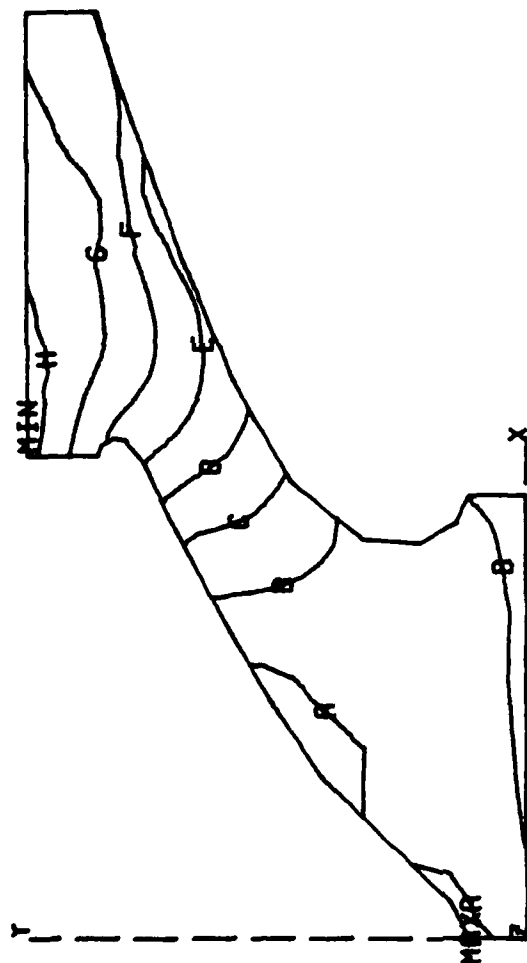
| % SPAN  | MASS  | PT3   | TT3  | M3    | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|------|-------|-------|-------|-------|
| 50.1    | 1.871 | 36.66 | 664. | 1.034 | 18.08 | .0787 | .0522 |
| 40.1    | 1.853 | 36.04 | 668. | 1.031 | 17.95 | .0800 | .0529 |
| 30.1    | 1.836 | 36.61 | 668. | 1.032 | 17.78 | .0814 | .0538 |
| 24.9    | 1.860 | 36.58 | 667. | 1.032 | 18.03 | .0830 | .0549 |
| 20.0    | 1.876 | 36.32 | 668. | 1.023 | 18.31 | .0964 | .0641 |
| 15.0    | 1.860 | 35.95 | 666. | 1.010 | 18.39 | .1157 | .0777 |
| 12.0    | 1.860 | 35.89 | 666. | 1.013 | 18.39 | .1182 | .0792 |
| 11.7    | 1.860 | 35.89 | 665. | 1.015 | 18.39 | .1182 | .0791 |
| 11.4    | 1.861 | 35.87 | 666. | 1.014 | 18.39 | .1193 | .0795 |
| AVERAGE | 1.858 | 36.34 | 666. | 1.024 | 18.13 | .0955 | .0635 |



| MAX | LEGEND | MAX   |
|-----|--------|-------|
| A   | B      | C     |
| D   | E      | F     |
| G   | H      | MAX   |
|     |        | MIN   |
|     |        | PSI   |
|     |        | 37.00 |
|     |        | 34.00 |
|     |        | 31.00 |
|     |        | 28.00 |
|     |        | 25.00 |
|     |        | 22.00 |
|     |        | 19.00 |
|     |        | 16.00 |
|     |        | 37.33 |
|     |        | 13.53 |

RUN 107 MACH 1.1 TGAS 200 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:23:39 80/158





\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 2.01000E 02  
 B 1.99000E 02  
 C 1.97000E 02  
 D 1.95000E 02  
 E 1.93000E 02  
 F 1.91000E 02  
 G 1.89000E 02  
 H 1.87000E 02  
 MAX 2.01384E 02  
 MIN 1.86124E 02

RUN 107 MACH 1.1 TGAS 200. ADIABATIC ENDWALL THICK B.L.

CONTOUR PLOT OF TEMPERATURE

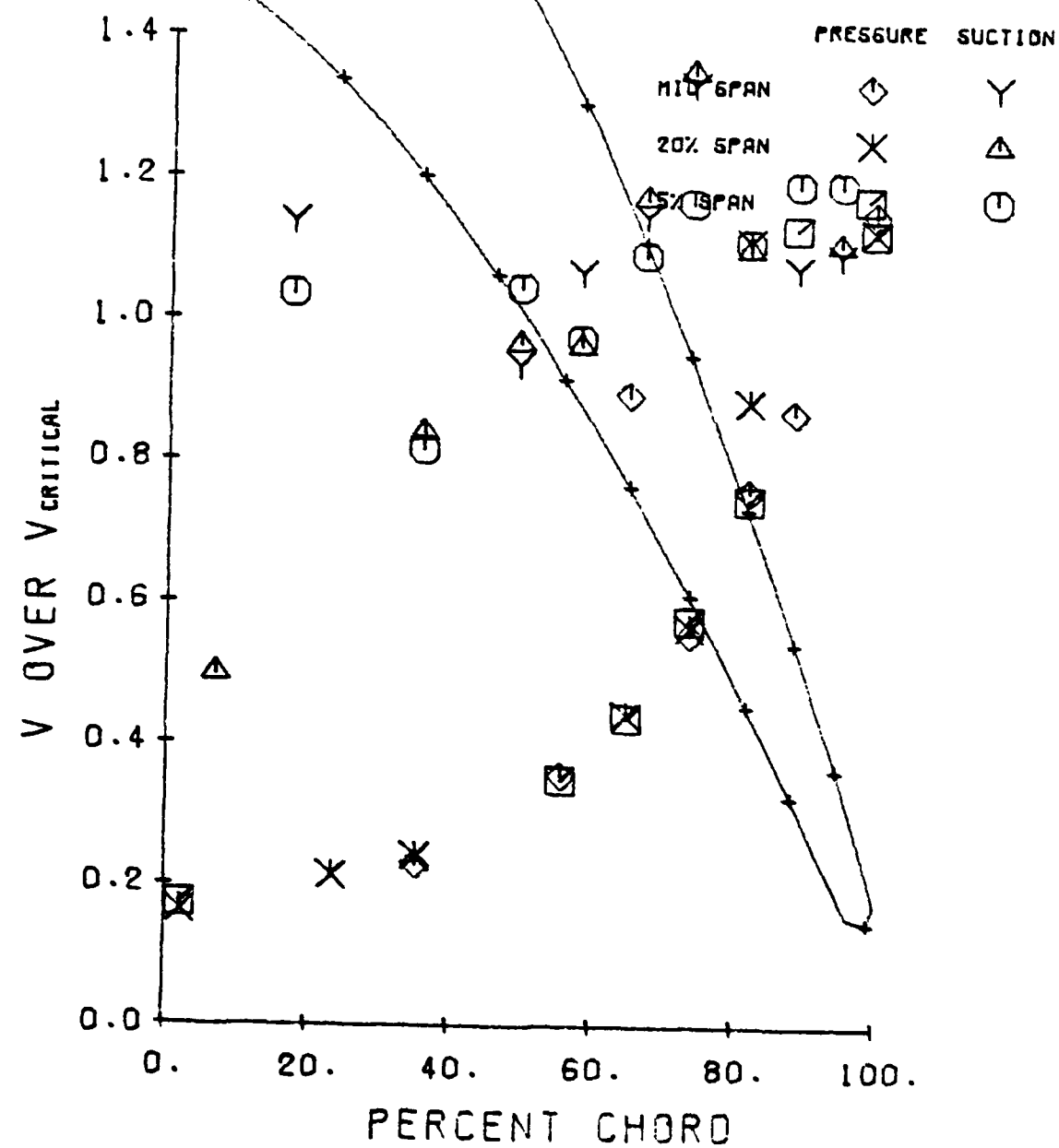
SCALE = 1.0000 PLOT TIME AND DATE = 10:42:36 79/311

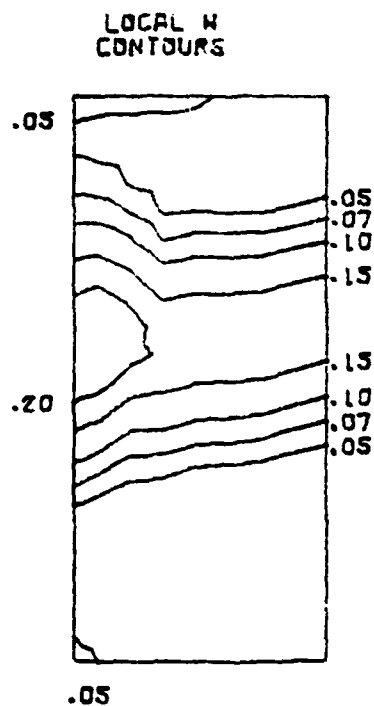
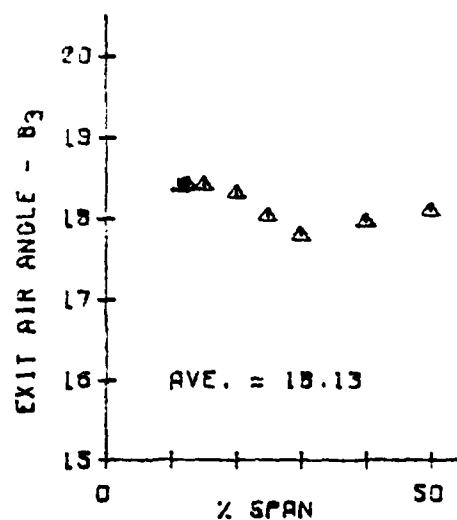
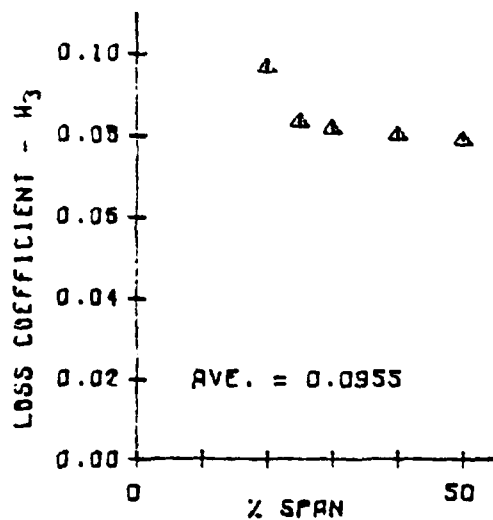
# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 107

DATE = 11/07/79

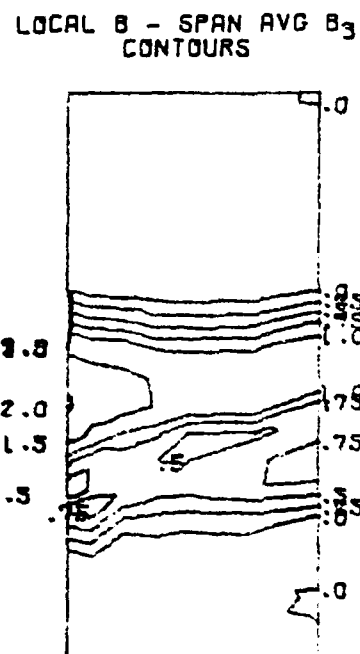
EXPANSION RATIO = 2.122





↑  
SUCTION  
SIDE

↓  
PRESSURE  
SIDE



EXIT MACH NO. = 1.10 REYNOLDS NO. =  $2.33 \times 10^6$

RUN 107 AERODYNAMIC EXIT DATA

GMA 220 TURBINE VANE CASCADE

RUN #146

DATE: 11/07/79

TIME: 8:21:53

| INLET CONDITIONS |         |        |        |      |           |
|------------------|---------|--------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE | MACH # | V/V* | REY/10**6 |
| 15.91            | 15.78   | 687.72 | .109   | .119 | .179      |

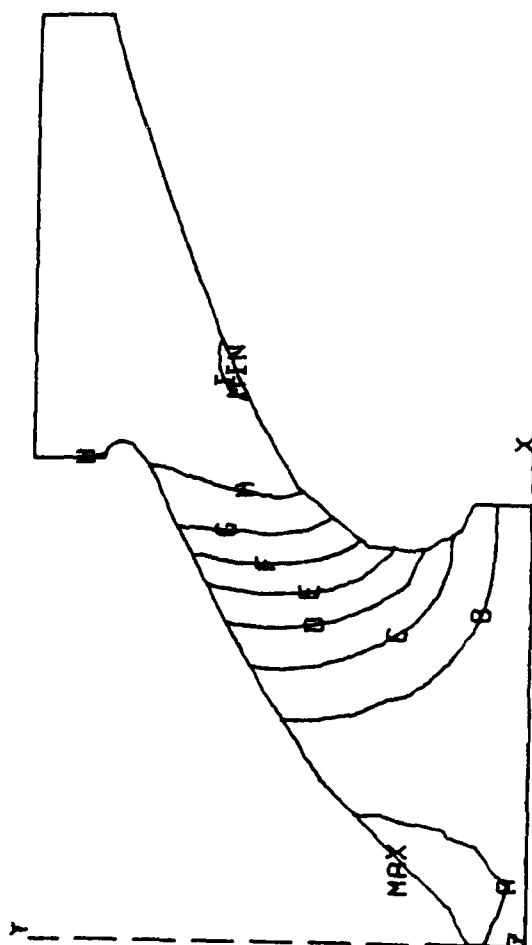
| IDEAL EXIT CONDITIONS |        |        |        |      |           |
|-----------------------|--------|--------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL | MACH # | V/V* | REY/10**6 |
| 15.91                 | 14.92  | 687.72 | .306   | .332 | .484      |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.067      STATIC PRESSURE RATIO= .945

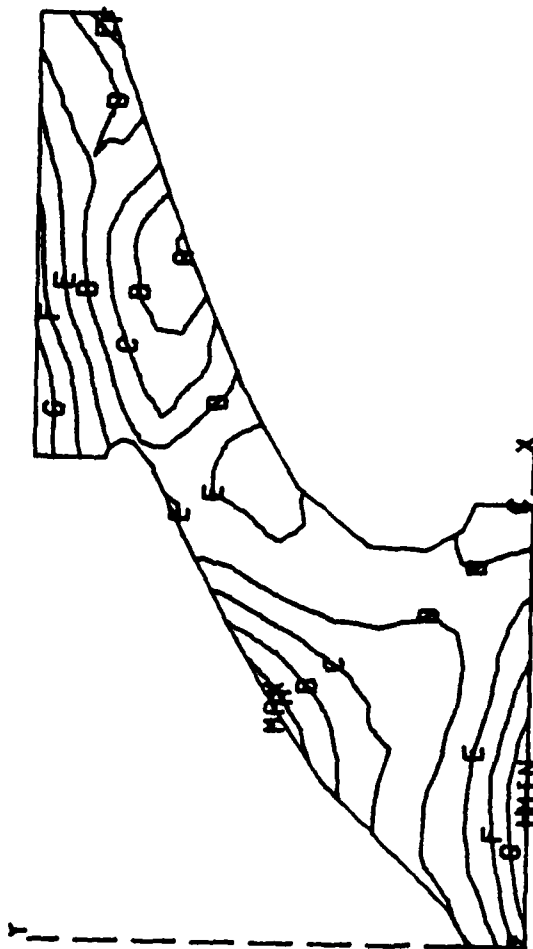
\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| X SPAN  | MASS | PT3   | TT3  | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|------|------|-------|-------|-------|
| 50.0    | .410 | 15.86 | 687. | .294 | 19.33 | .0597 | .0575 |
| 39.8    | .410 | 15.85 | 687. | .294 | 19.34 | .0649 | .0625 |
| 29.8    | .407 | 15.83 | 686. | .291 | 19.37 | .0856 | .0825 |
| 24.8    | .405 | 15.81 | 686. | .289 | 19.43 | .1714 | .0977 |
| 19.0    | .405 | 15.80 | 686. | .287 | 19.59 | .1117 | .1077 |
| 14.8    | .390 | 15.81 | 685. | .286 | 18.93 | .1115 | .1076 |
| 12.5    | .343 | 15.82 | 687. | .261 | 18.06 | .1127 | .1074 |
| 11.2    | .332 | 15.82 | 687. | .261 | 17.44 | .1098 | .1065 |
| 10.7    | .333 | 15.83 | 687. | .261 | 17.50 | .1086 | .1054 |
| AVERAGE | .387 | 15.83 | 686. | .284 | 18.93 | .0903 | .0871 |



|     |          |     |
|-----|----------|-----|
| MAX | LEGEND   | MAX |
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 15599.99 |     |
| B   | 15499.99 |     |
| C   | 15399.99 |     |
| D   | 15299.99 |     |
| E   | 15199.99 |     |
| F   | 15099.99 |     |
| G   | 14999.99 |     |
| H   | 14899.99 |     |
| I   | 14799.99 |     |
| MAX | 15621.22 |     |
| MIN | 14792.51 |     |

RUN 108 MACH .3 TGAS 200 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:58:27 80/158



| MMM | LEGEND       | MMM     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 2.27700E 02  |         |
| B   | 2.27500E 02  |         |
| C   | 2.27300E 02  |         |
| D   | 2.27100E 02  |         |
| E   | 2.26900E 02  |         |
| F   | 2.26700E 02  |         |
| G   | 2.26500E 02  |         |
| H   | 2.26300E 02  |         |
| MAX | 2.27796E 02  |         |
| MIN | 2.26285E 02  |         |

RUN 108 MACH .3 TGAS 200. ADIABATIC ENDWALL THICK B.L.  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:47:43 79/311

# ENDWALL HEAT TRANSFER LINEAR CASCADE

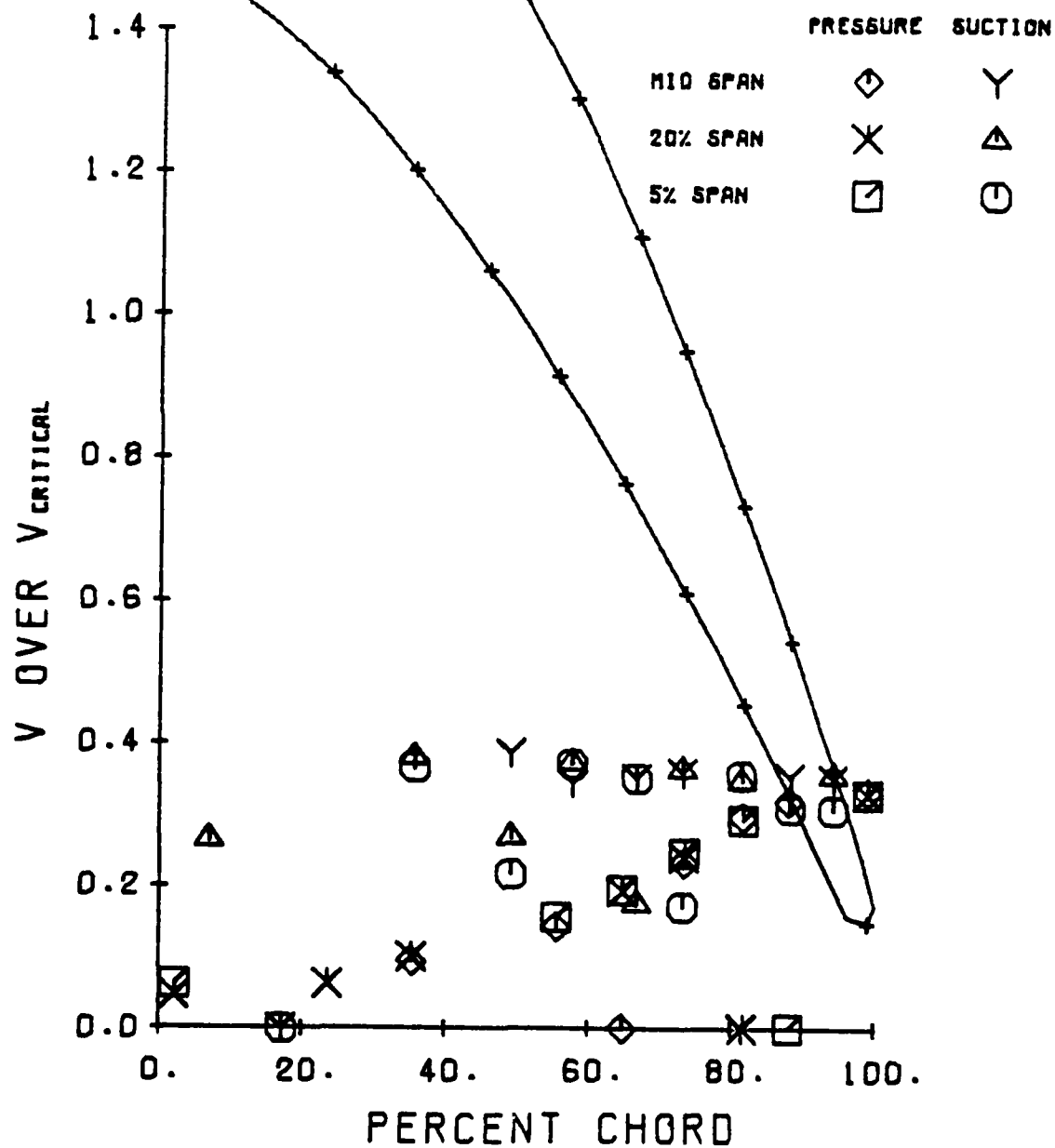
RUN # = 108

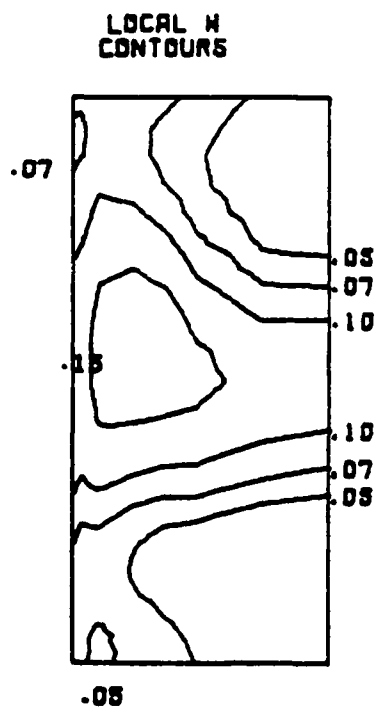
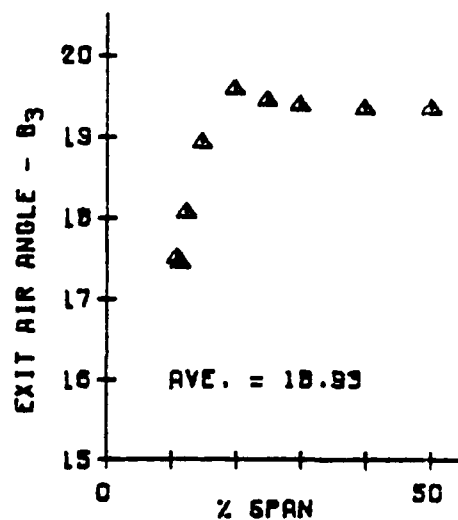
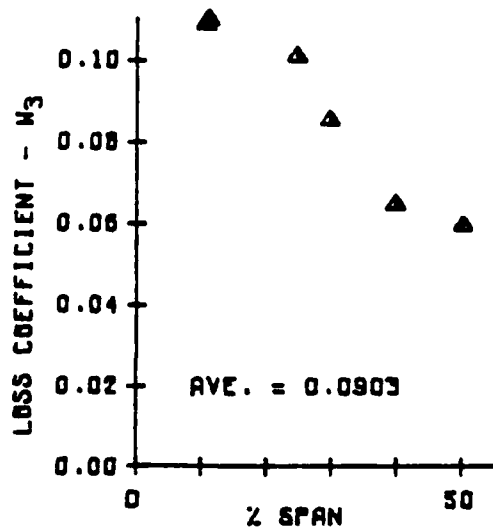
DATE = 11/07/79

EXPANSION RATIO = 1.066

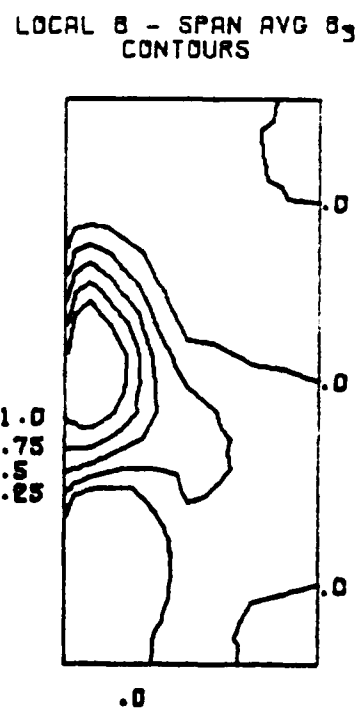


AIRFLOW





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.91 REYNOLDS NO. =  $4.84 \times 10^5$

RUN 108 AERODYNAMIC EXIT DATA



# GMA 200 TURBINE VANE CASCADE

RUN #109

DATE: 11/19/79

TIME: 9:20:24

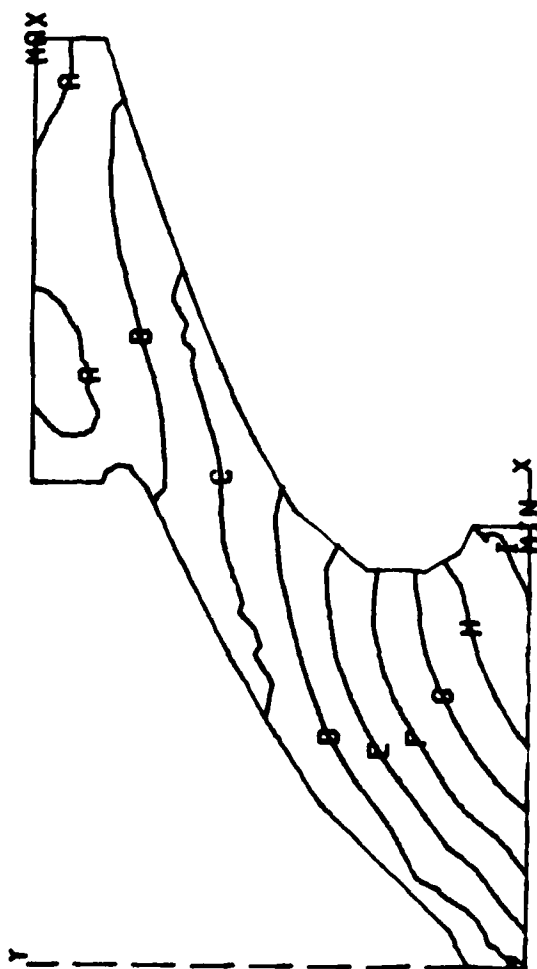
| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/IN**6 |
| 55.16            | 53.32   | 1259.33 | .229   | .244 | .603      |

| IDEAL EXIT CONDITIONS |        |         |        |       |           |
|-----------------------|--------|---------|--------|-------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V*  | REY/IN**6 |
| 55.16                 | 26.13  | 1259.33 | 1.116  | 1.100 | 1.818     |

CASCADE OPERATING CONDITION  
EXPANSION RATIO= 2.111      STATIC PRESSURE RATIO= .492

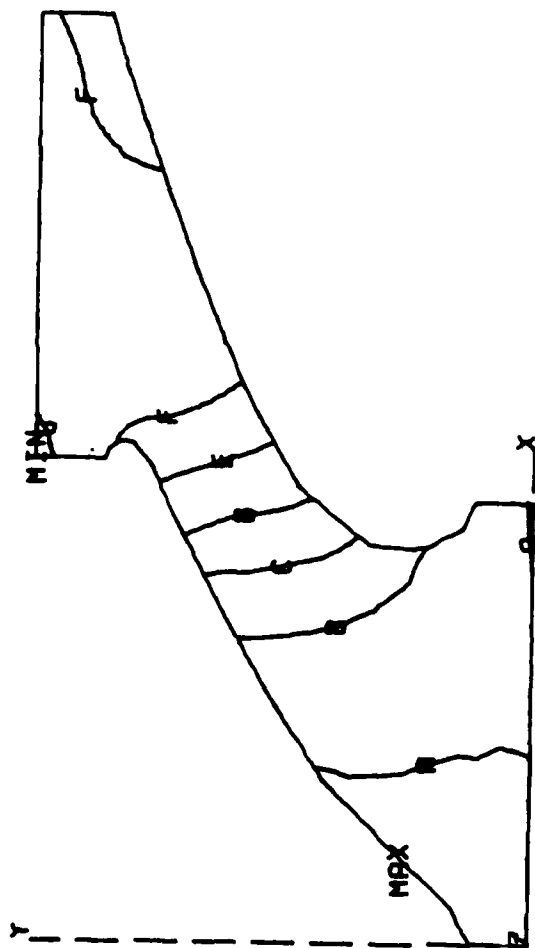
## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS  | PT3   | TT3   | M3    | BETA3 | OMEGA | FSAN  |
|---------|-------|-------|-------|-------|-------|-------|-------|
| 49.9    | 2.091 | 52.98 | 1207. | 1.079 | 19.43 | .0756 | .0502 |
| 39.0    | 1.951 | 53.08 | 1173. | 1.078 | 17.95 | .0722 | .0479 |
| 30.0    | 1.941 | 53.09 | 1194. | 1.078 | 17.81 | .0721 | .0478 |
| 25.1    | 1.940 | 52.98 | 1139. | 1.078 | 17.79 | .0705 | .0501 |
| 19.9    | 1.943 | 52.85 | 1162. | 1.077 | 17.63 | .0641 | .0532 |
| 14.9    | 1.934 | 52.33 | 1175. | 1.065 | 17.86 | .0664 | .0559 |
| 11.9    | 1.925 | 51.99 | 1175. | 1.061 | 17.91 | .1107 | .0742 |
| 8.9     | 1.941 | 51.83 | 1167. | 1.062 | 18.25 | .1153 | .0775 |
| 7.5     | 1.954 | 51.81 | 1167. | 1.064 | 18.13 | .1158 | .0777 |
| AVERAGE | 1.951 | 52.05 | 1101. | 1.073 | 18.07 | .0872 | .0587 |



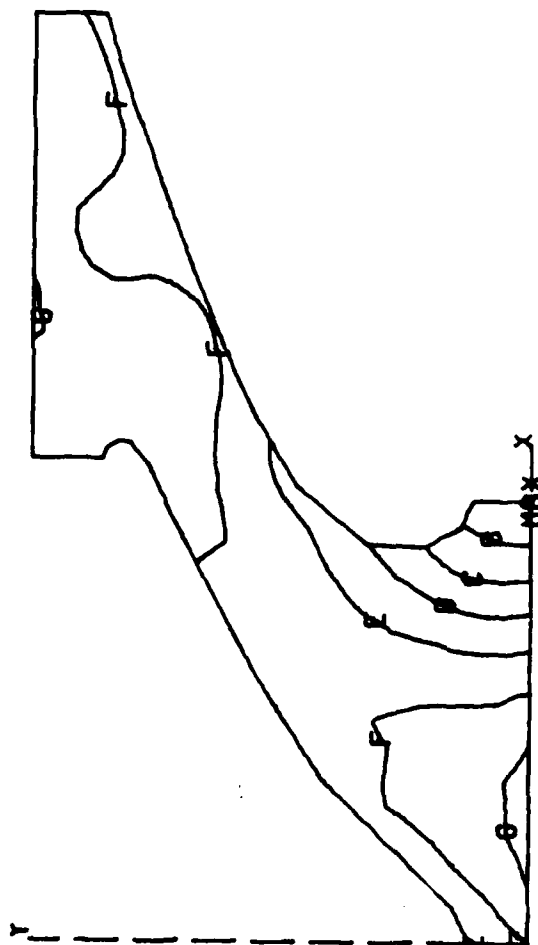
| MMM | LEGEND       | MMM     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 6.30000E 02  |         |
| B   | 6.20000E 02  |         |
| C   | 6.10000E 02  |         |
| D   | 6.00000E 02  |         |
| E   | 5.90000E 02  |         |
| F   | 5.80000E 02  |         |
| G   | 5.70000E 02  |         |
| H   | 5.60000E 02  |         |
| I   | 5.50000E 02  |         |
| MAX | 6.37654E 02  |         |
| MIN | 5.45074E 02  |         |

RUN 109 MACH 1.1 TGAS 800. THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:38:23 79/331



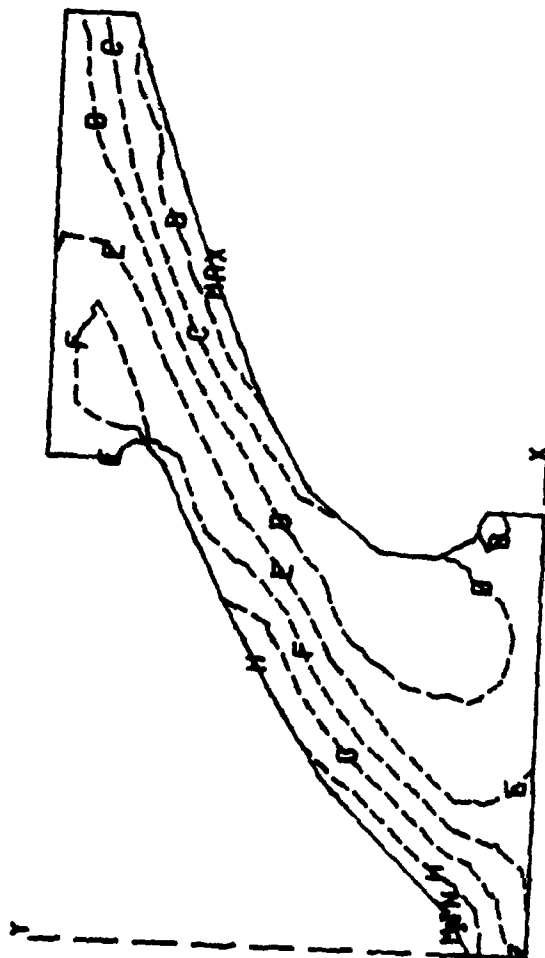
| MM | LEGEND | MM |
|----|--------|----|
|    | PSI    |    |
|    | 52.00  |    |
|    | 47.00  |    |
|    | 42.00  |    |
|    | 37.00  |    |
|    | 32.00  |    |
|    | 27.00  |    |
|    | 22.00  |    |
|    | 52.96  |    |
|    | 19.95  |    |
|    | MAX    |    |
|    | MIN    |    |

RUN 109 MACH 1.1 TGRS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:09:17 80/150



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 7.12000E 02  
 B 7.06000E 02  
 C 7.00000E 02  
 D 6.94000E 02  
 E 6.88000E 02  
 F 6.82000E 02  
 G 6.76000E 02  
 MAX 7.12091E 02  
 MIN 6.73447E 02

RUN 109 MACH 1.1 TGAS 800. THICK B.L. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:26:30 79/331



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR

|     |              |
|-----|--------------|
| B   | -1.00000E-03 |
| C   | -2.00000E-03 |
| D   | -3.00000E-03 |
| E   | -4.00000E-03 |
| F   | -5.00000E-03 |
| G   | -5.99999E-03 |
| H   | -6.99999E-03 |
| I   | -7.99999E-03 |
| MAX | -1.53242E-04 |
| MIN | -8.16856E-03 |

RUN 109 MACH 1.1 TGAS 800. THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:46:27 79/331

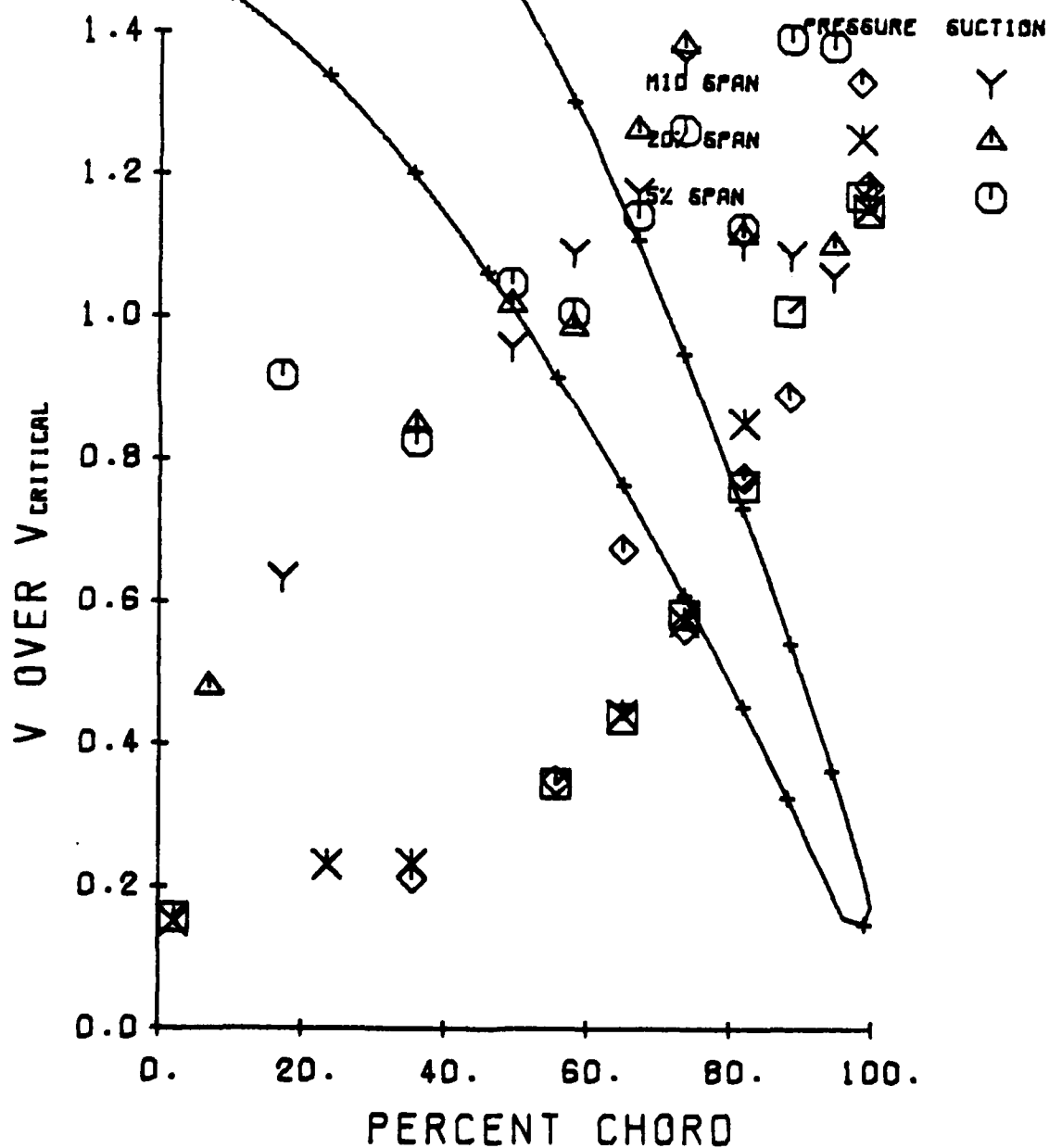
# ENDWALL HEAT TRANSFER LINEAR CASCADE

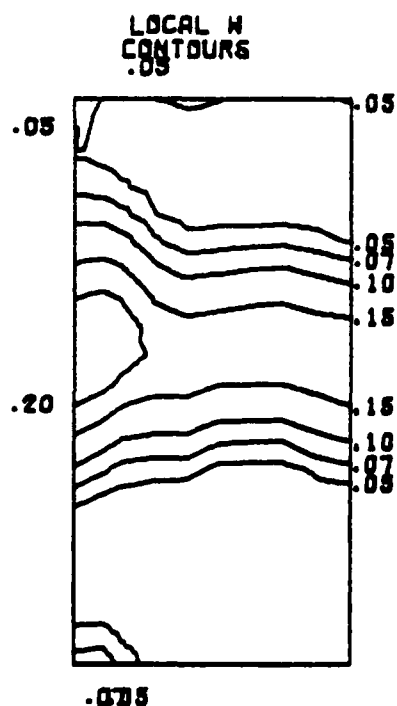
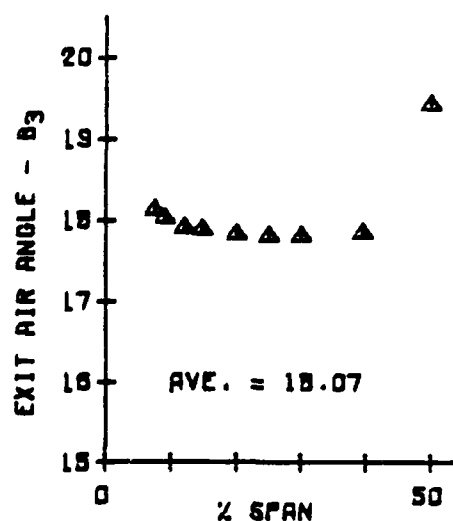
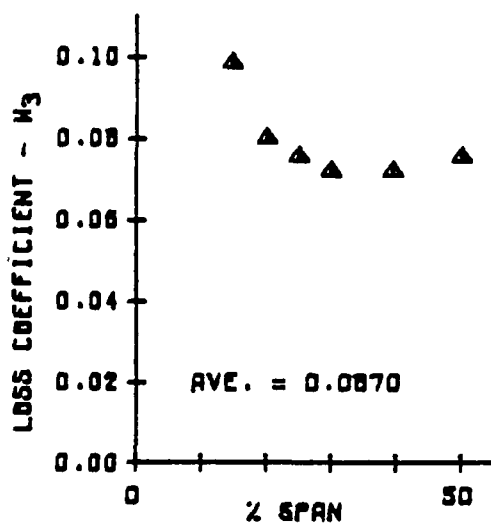
RUN # = 109

DATE = 11/19/79

EXPANSION RATIO = 2.105

AIRFLOW →



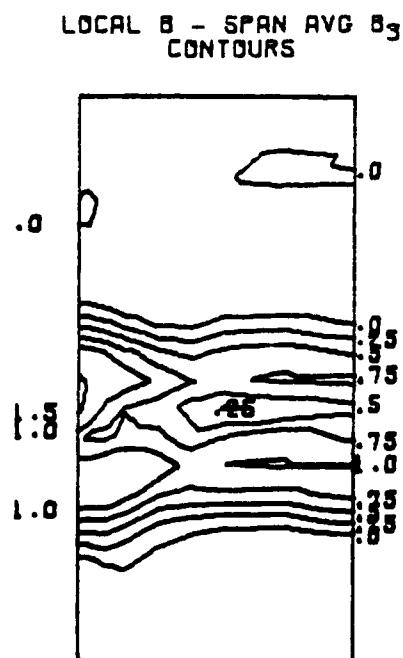


SUCTION  
SIDE

↑

↓

PRESSURE  
SIDE



EXIT MACH NO. = 1.12 REYNOLDS NO. =  $7.10 \times 10^5$

RUN 109 AERODYNAMIC EXIT DATA

# GMA 200 TURBINE VANE CASCADE

RUN #111

DATE: 11/21/79

TIME: 12:16: 6

PTOTLE  
21.31

PSTATIC  
20.77

## INLET CONDITIONS

TTOTLE MACH #  
1267.02 .195

V/V\*  
.211

REY/10\*\*6  
.203

PTOTLE  
21.31

STATIC  
15.67

## IDEAL EXIT CONDITIONS

TTOTAL MACH #  
1267.02 .685

V/V\*  
.715

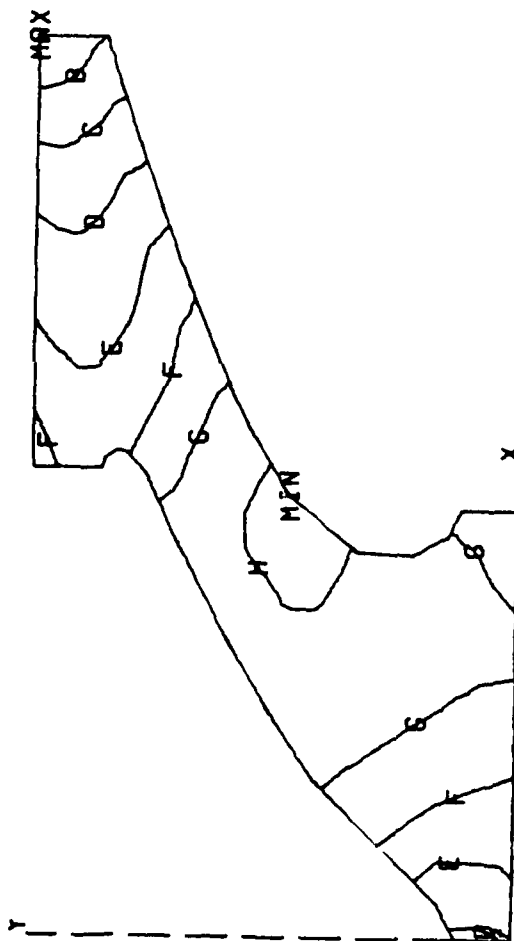
REY/10\*\*6  
.589

CASCADE OPERATING CONDITION  
EXPANSION RATIO= 1.360 STATIC PRESSURE RATIO= .755

## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

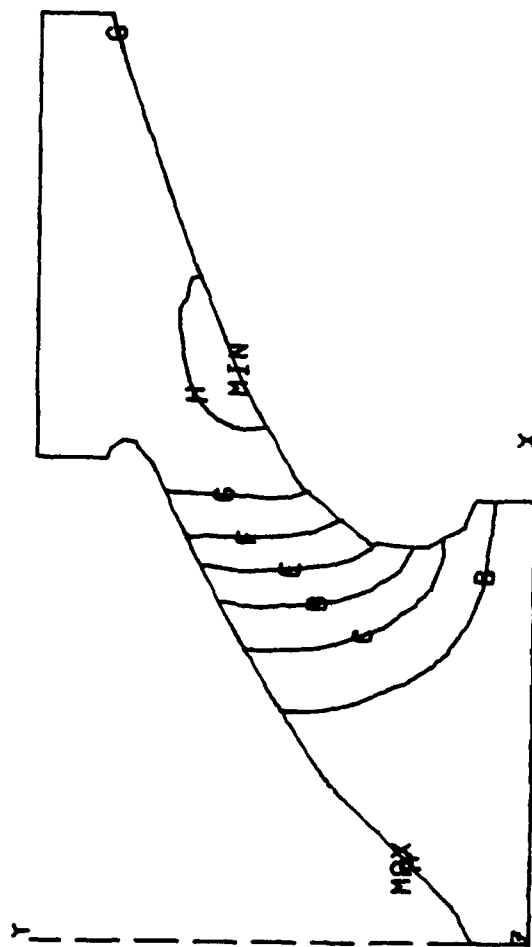
| X SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 50.2    | .793 | 21.09 | 1237. | .675 | 20.54 | .0395 | .0329 |
| 40.0    | .791 | 21.05 | 1248. | .675 | 20.57 | .0449 | .0373 |
| 30.0    | .791 | 21.02 | 1211. | .673 | 20.32 | .0513 | .0427 |
| 24.9    | .791 | 20.96 | 1214. | .670 | 20.45 | .0616 | .0514 |
| 19.7    | .770 | 20.86 | 1267. | .664 | 20.52 | .0794 | .0663 |
| 14.8    | .773 | 20.77 | 1227. | .659 | 20.45 | .0946 | .0793 |
| 11.9    | .771 | 20.77 | 1232. | .658 | 20.44 | .0948 | .0795 |
| 9.0     | .737 | 20.74 | 1229. | .656 | 19.56 | .1002 | .0841 |
| 7.3     | .720 | 20.72 | 1243. | .654 | 19.23 | .1243 | .0876 |
| AVERAGE | .773 | 20.92 | 1235. | .667 | 20.25 | .0687 | .0574 |





\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 5.26000E 02  
 B 5.18000E 02  
 C 5.10000E 02  
 D 5.02000E 02  
 E 4.94000E 02  
 F 4.86000E 02  
 G 4.78000E 02  
 H 4.70000E 02  
 MAX 5.26098E 02  
 MIN 4.67791E 02

JN 111 MACH .7 TGAS 800 THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:01:06 79/331



| MIN | LEGEND | PSI      | MIN |
|-----|--------|----------|-----|
| A   | B      | (E-03)   |     |
| B   | C      | 20999.98 |     |
| C   | D      | 20199.98 |     |
| D   | E      | 19399.98 |     |
| E   | F      | 18599.97 |     |
| F   | G      | 17799.97 |     |
| G   | H      | 16999.96 |     |
| H   | MAX    | 15399.96 |     |
|     | MIN    | 21001.79 |     |
|     |        | 15092.55 |     |

RUN 111 MACH .7 TCAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:44:18 80/161

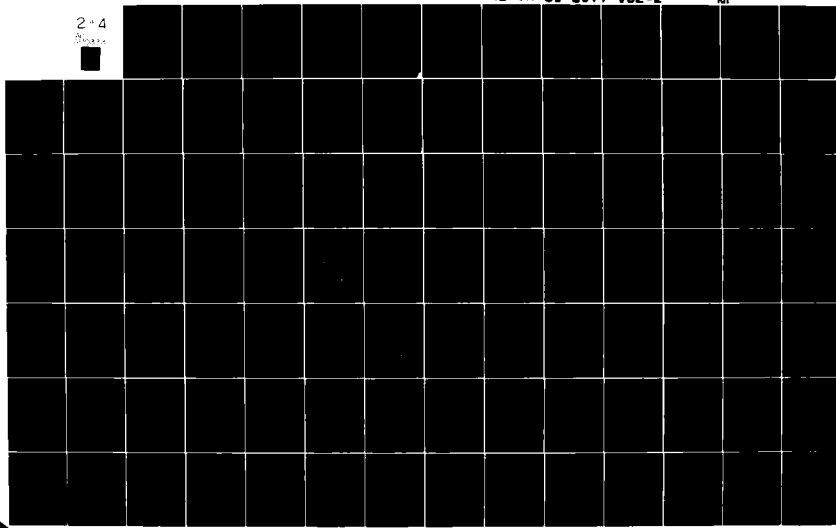
AD-A110 333

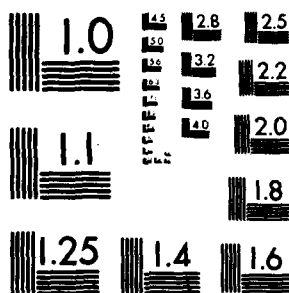
GENERAL MOTORS CORP INDIANAPOLIS IN DETROIT DIESEL A--ETC F/8 21/5  
EXPERIMENTAL INVESTIGATION OF TURBINE ENDWALL HEAT TRANSFER. VO--ETC(U)  
AUG 81 L D MYLTON, M S MIHELIC, E R TURNER F33615-77-C-2030  
DDA-EDR-10363-VOL-2 AFMIL-TR-81-2077-VOL-2 NI

UNCLASSIFIED

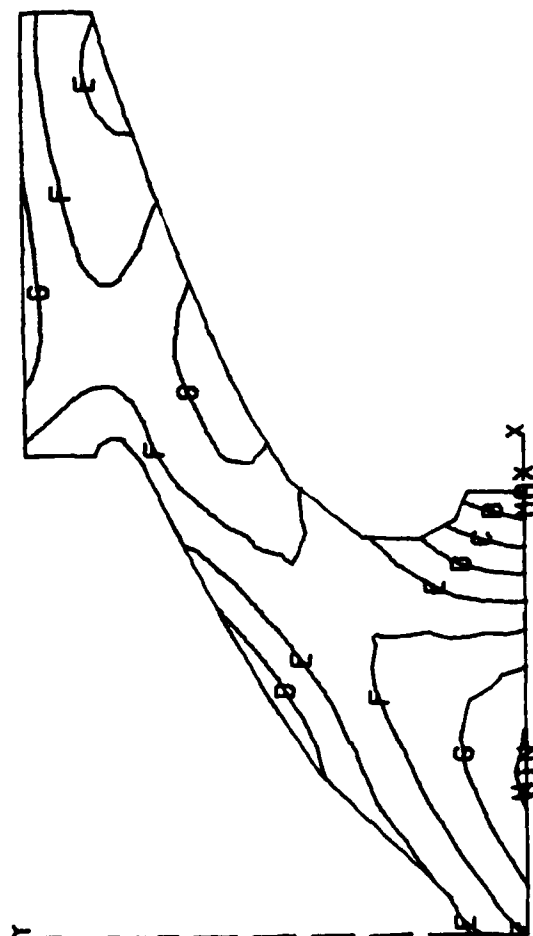
2-4

5 pages





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



MMM LEGEND MMM  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 7.36000E 02  
 B 7.30000E 02  
 C 7.24000E 02  
 D 7.18000E 02  
 E 7.12000E 02  
 F 7.06000E 02  
 G 7.00000E 02  
 H 6.94000E 02  
 MAX 7.36035E 02  
 MIN 6.92656E 02

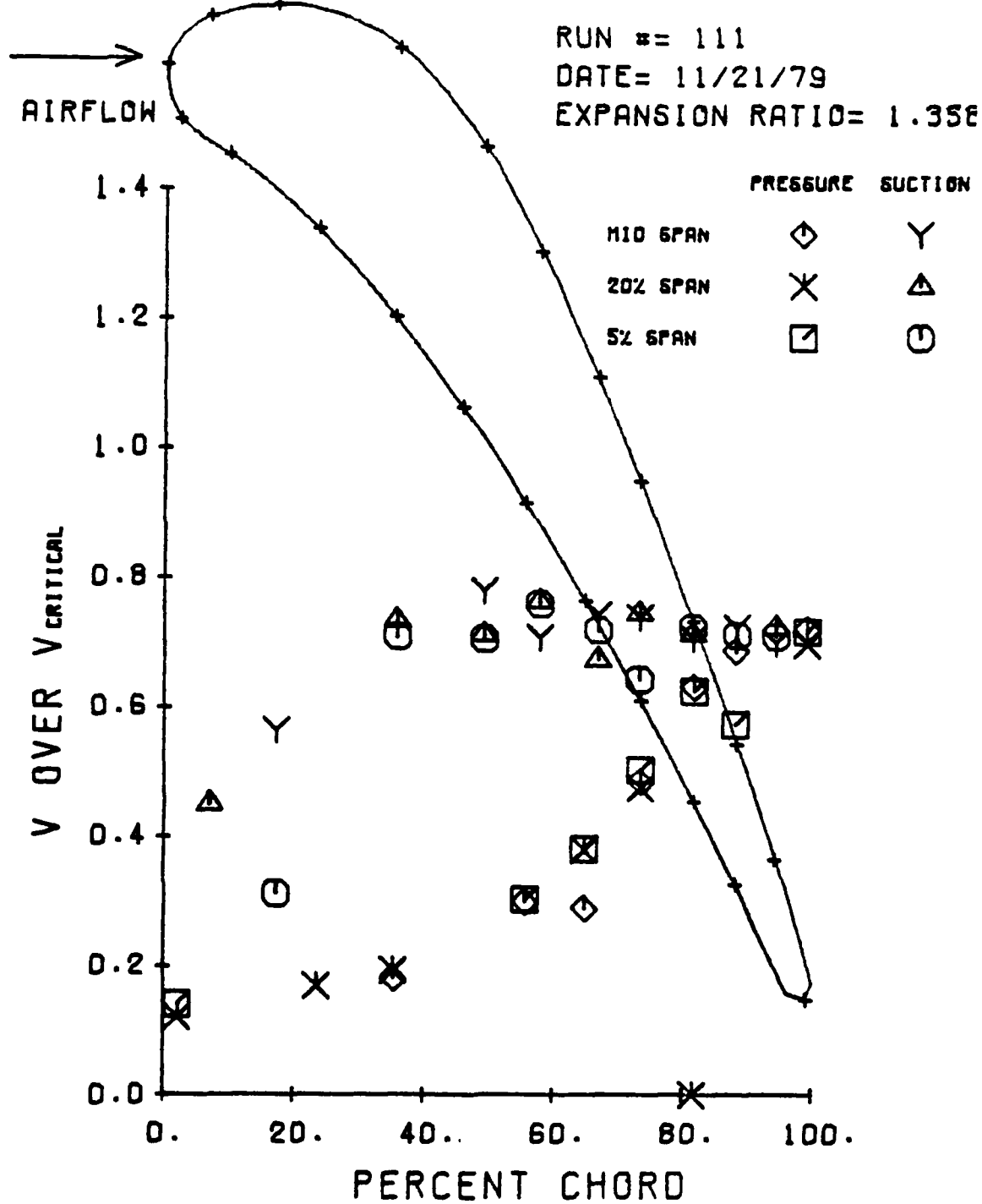
RUN 111 MACH .7 TGAS 800 THICK B.L. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:59:53 79/331

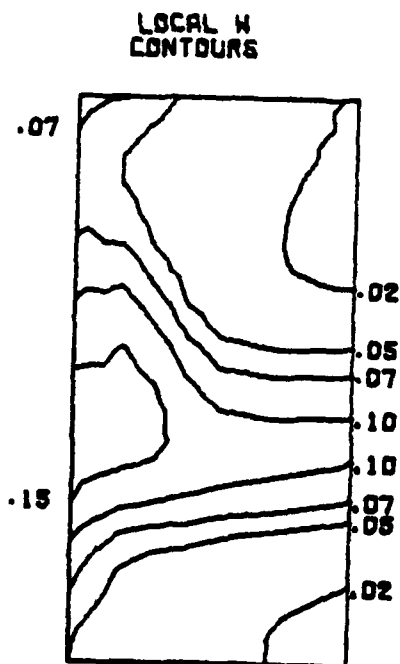
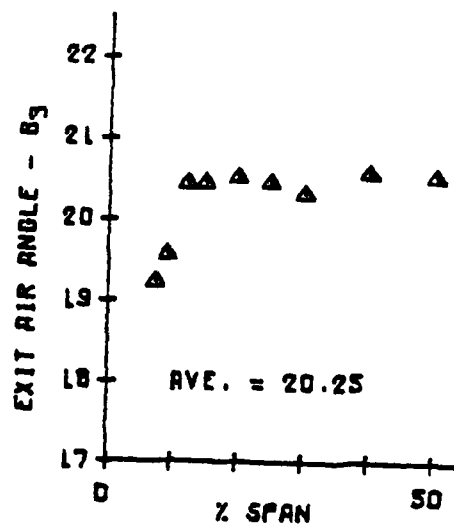
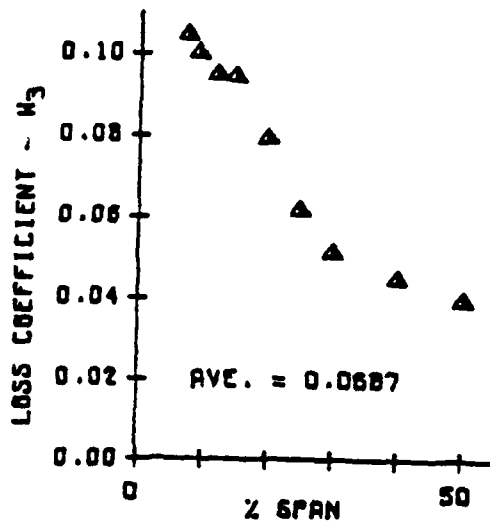


| MAX | LEGEND       | MIN     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | -1.00000E-03 |         |
| B   | -2.00000E-03 |         |
| C   | -3.00000E-03 |         |
| D   | -4.00000E-03 |         |
| E   | -5.00000E-03 |         |
| F   | -5.99999E-03 |         |
| G   | -6.99999E-03 |         |
| H   | -7.99999E-03 |         |
| I   | -8.99999E-03 |         |
| MAX | -1.17523E-03 |         |
| MIN | -9.47570E-03 |         |

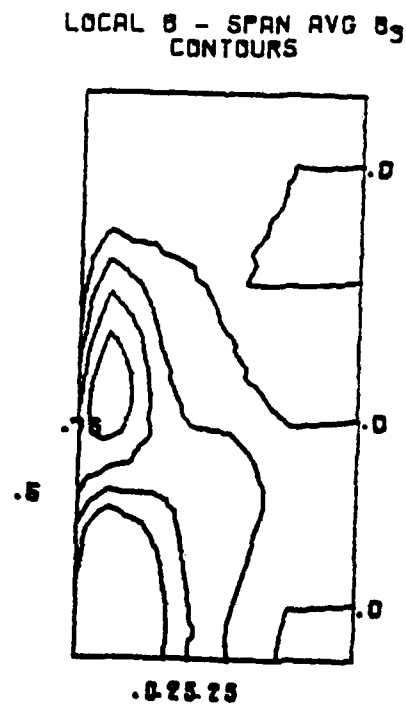
RUN 111 MACH .7 TCAS 800 THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:02:03 79/331

# ENDWALL HEAT TRANSFER LINEAR CASCADE





SUCTION  
SIDE  
↑  
—  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.69 REYNOLDS NO. =  $5.89 \times 10^5$

RUN 111 AERODYNAMIC EXIT DATA



GMA 200 TURBINE VANE CASCADE

RUN #112

DATE: 11/27/79

TIME: 12:42:14

|        |         |                  |        |      |           |  |
|--------|---------|------------------|--------|------|-----------|--|
| PTOTLE | PSTATIC | INLET CONDITIONS |        |      |           |  |
| 22.34  | 21.72   | TTOTLE           | MACH # | V/V* | REY/10**6 |  |
|        |         | 1065.52          | .203   | .221 | .272      |  |

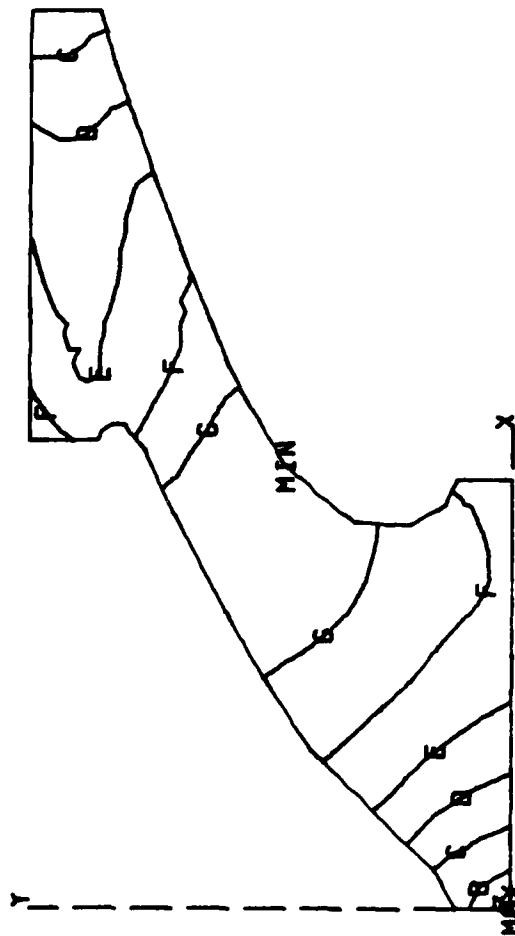
|        |        |                       |        |      |           |  |
|--------|--------|-----------------------|--------|------|-----------|--|
|        |        | IDEAL EXIT CONDITIONS |        |      |           |  |
| PTOTLE | STATIC | TTOTAL                | MACH # | V/V* | REY/10**6 |  |
| 22.34  | 15.92  | 1065.52               | .718   | .748 | .779      |  |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.403      STATIC PRESSURE RATIO= .733

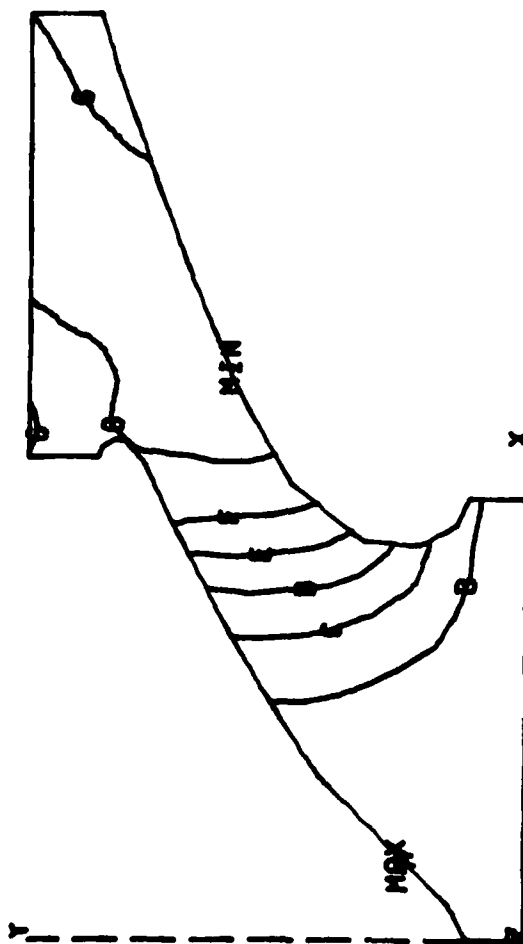
\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| X SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 49.8    | .921 | 22.08 | 1035. | .703 | 20.38 | .0408 | .9333 |
| 40.4    | .913 | 22.06 | 1042. | .701 | 20.21 | .0442 | .9361 |
| 30.2    | .914 | 22.02 | 1037. | .698 | 20.27 | .0509 | .9417 |
| 24.7    | .917 | 21.95 | 1028. | .693 | 20.40 | .0621 | .9510 |
| 19.6    | .923 | 21.84 | 1018. | .686 | 20.63 | .0792 | .9653 |
| 14.6    | .931 | 21.76 | 1014. | .679 | 20.96 | .0926 | .9766 |
| 12.5    | .921 | 21.74 | 1006. | .677 | 20.72 | .0960 | .9795 |
| 8.9     | .900 | 21.72 | 994.  | .673 | 20.17 | .1002 | .9832 |
| 7.7     | .880 | 21.71 | 992.  | .671 | 19.72 | .1223 | .9850 |
| AVERAGE | .911 | 21.91 | 1022. | .689 | 20.30 | .0691 | .9570 |



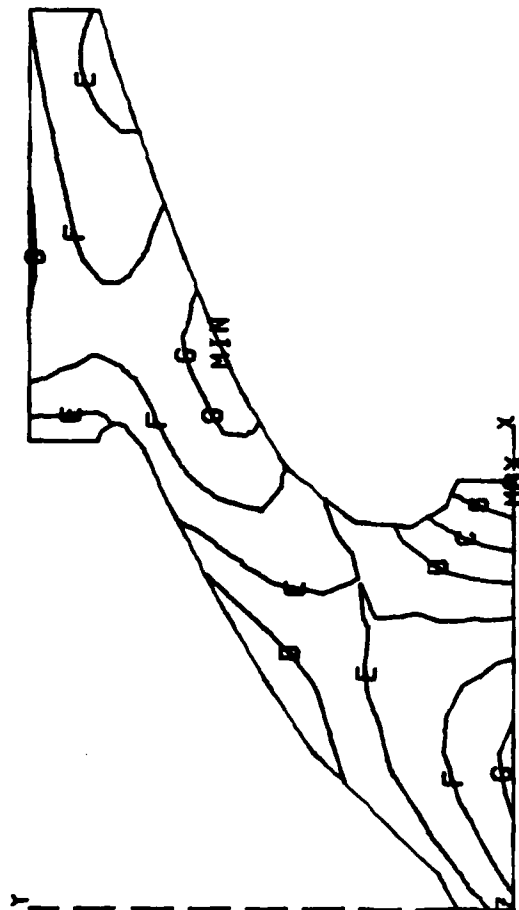
| MIN          | LEGEND      | MAX |
|--------------|-------------|-----|
| UNITS = TEMP |             |     |
| SYMBOL       | CONTOUR     |     |
| R            | 4.30000E 02 |     |
| B            | 4.23000E 02 |     |
| C            | 4.16000E 02 |     |
| D            | 4.09000E 02 |     |
| E            | 4.02000E 02 |     |
| F            | 3.95000E 02 |     |
| G            | 3.88000E 02 |     |
| MAX          | 4.30473E 02 |     |
| MIN          | 3.82642E 02 |     |

RUN 112 MACH .7 TGAS 600 THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 21:24:23 79/346



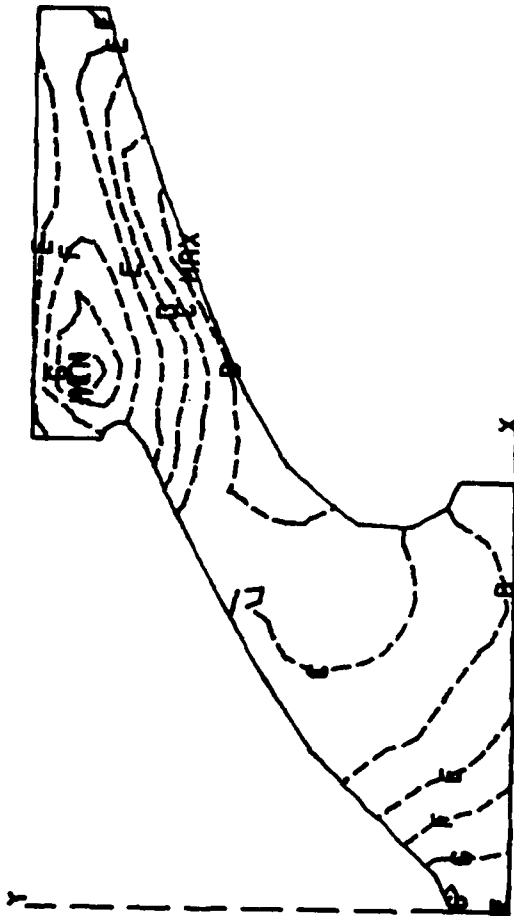
| MAX | LEGEND   | MAX |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 21999.98 |     |
| B   | 20999.98 |     |
| C   | 19999.98 |     |
| D   | 18999.98 |     |
| E   | 17999.98 |     |
| F   | 16999.98 |     |
| G   | 15999.98 |     |
| MAX | 22004.74 |     |
| MIN | 15260.77 |     |

RUN 112 MACH .7 TGRS 600 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:09:45 80/161



MIN LEGEND MIN  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 5.69000E 02  
 B 5.65000E 02  
 C 5.61000E 02  
 D 5.57000E 02  
 E 5.53000E 02  
 F 5.49000E 02  
 G 5.45000E 02  
 MAX 5.69250E 02  
 MIN 5.43969E 02

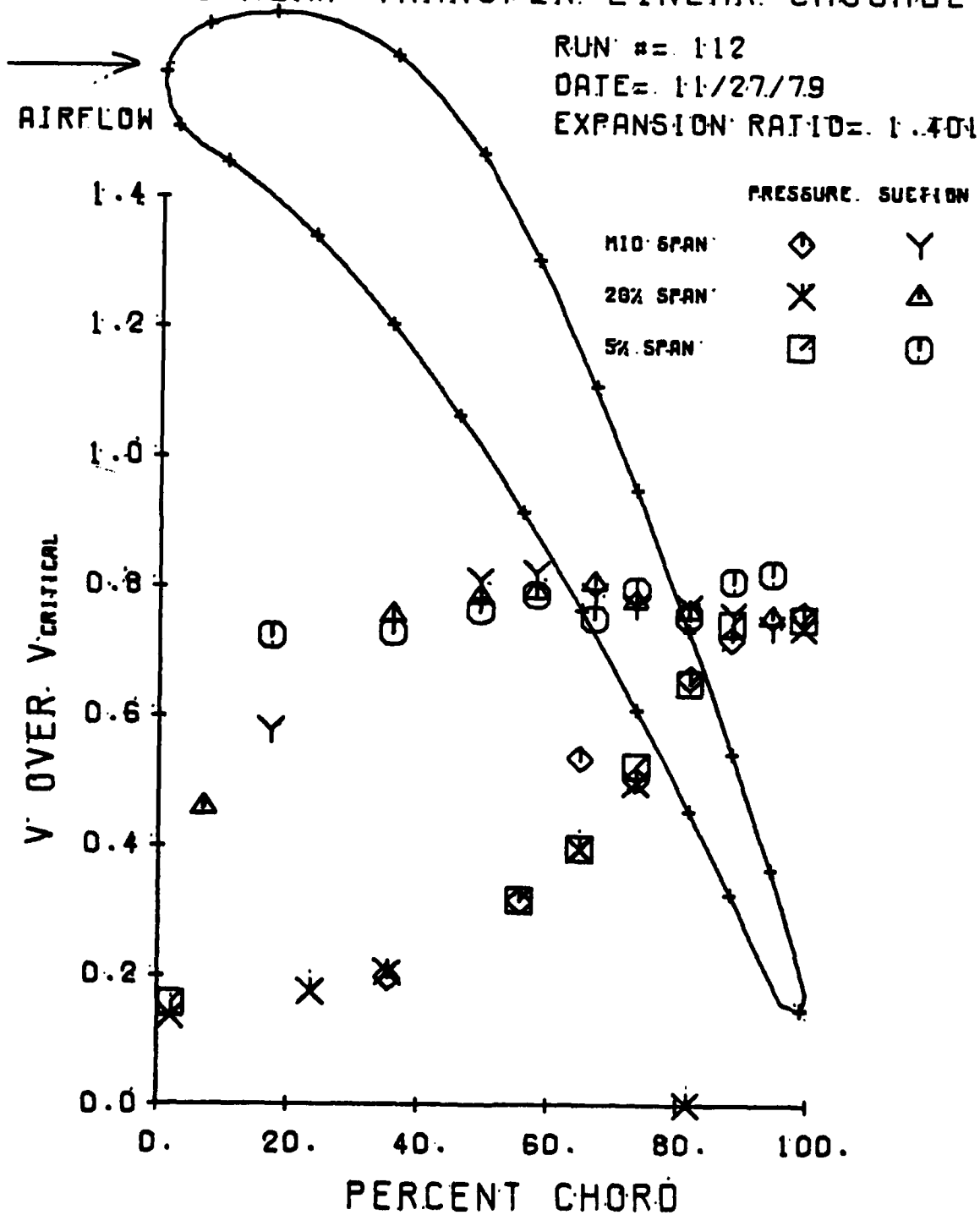
RUN 112 MACH .7 TCAS 600 THICK B.L. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:13:05 79/331

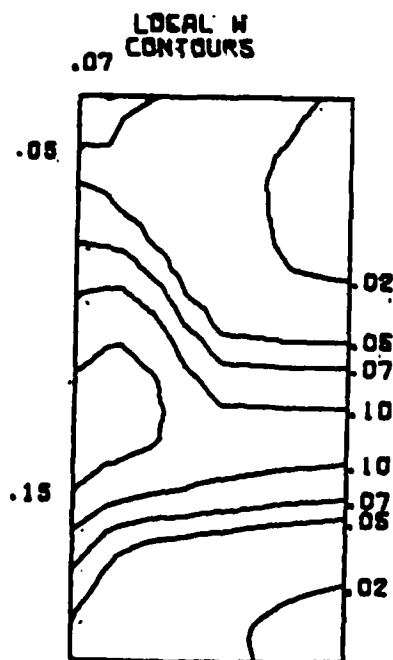
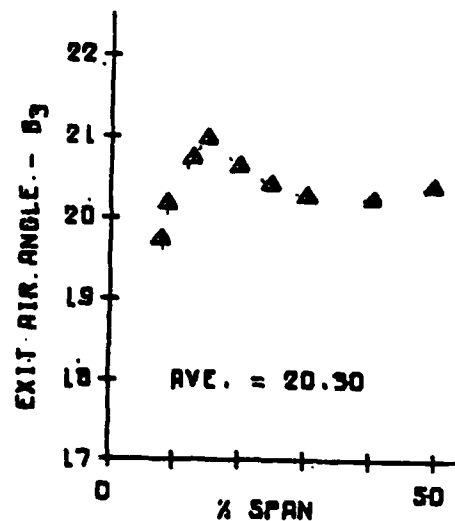
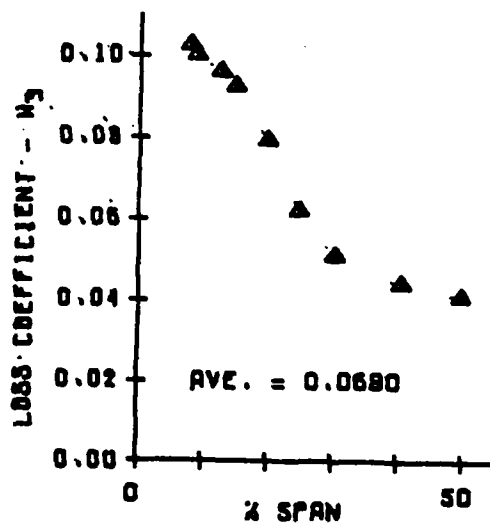


MINA LEGEND MINA  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A -1.00000E-03  
 B -2.00000E-03  
 C -3.00000E-03  
 D -4.00000E-03  
 E -5.00000E-03  
 F -5.99999E-03  
 G -6.99999E-03  
 H -7.99999E-03  
 MAX -1.09463E-03  
 MIN -8.86411E-03

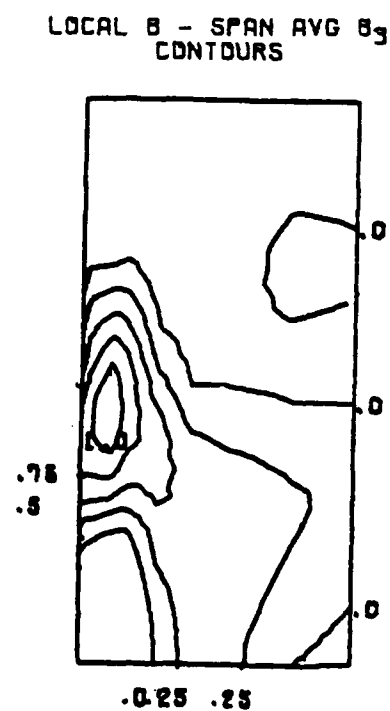
RUN 112 MACH .7 TGAS 600 THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 21:24:43 79/348

# ENDWALL HEAT TRANSFER. LINEAR. CASCADE





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.72 REYNOLDS NO. =  $7.79 \times 10^5$

RUN 112 AERODYNAMIC EXIT DATA

GMA 200 TURBINE VANE CASCADE

RUN #113

DATE: 11/27/79

TIME: 13:53:51

|        |         |                  |        |      |           |  |
|--------|---------|------------------|--------|------|-----------|--|
|        |         | INLET CONDITIONS |        |      |           |  |
| PTOTLE | PSTATIC | TTOTLE           | MACH # | V/V* | REY/10**6 |  |
| 22.41  | 21.78   | 1460.07          | .207   | .224 | .193      |  |

|        |        |                       |        |      |           |  |
|--------|--------|-----------------------|--------|------|-----------|--|
|        |        | IDEAL EXIT CONDITIONS |        |      |           |  |
| PTOTLE | STATIC | TTOTAL                | MACH # | V/V* | REY/10**6 |  |
| 22.41  | 15.99  | 1460.07               | .723   | .750 | .541      |  |

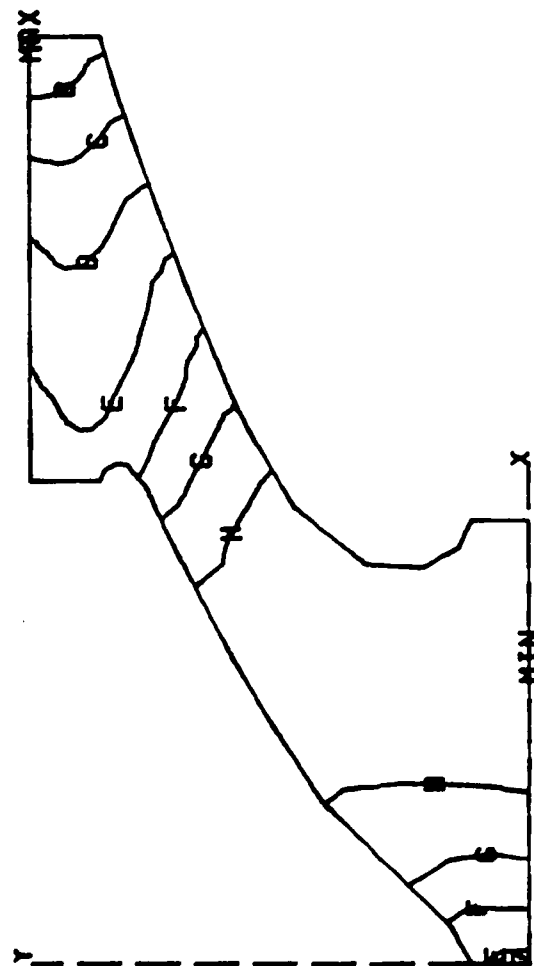
CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.402      STATIC PRESSURE RATIO= .734

\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

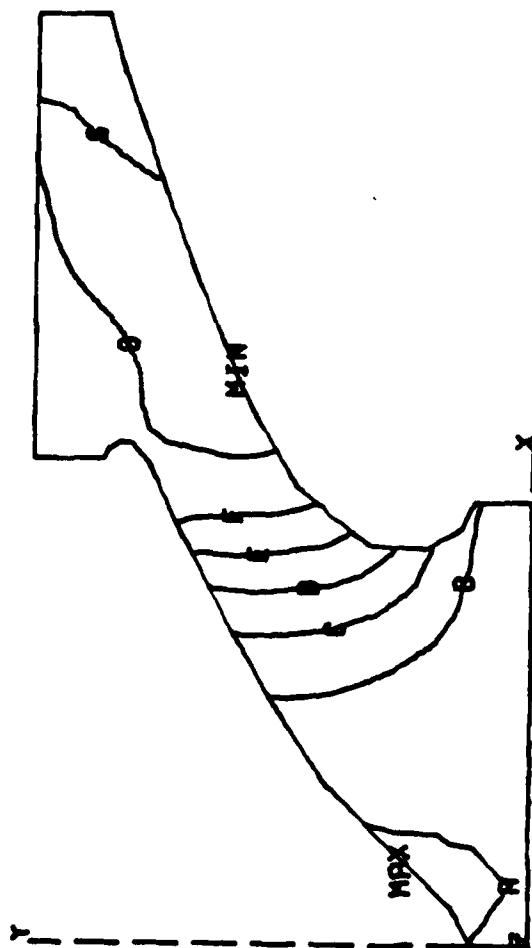
| % SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 50.1    | .783 | 22.14 | 1401. | .705 | 20.17 | .0421 | .0346 |
| 39.9    | .779 | 22.13 | 1389. | .703 | 19.97 | .0453 | .0372 |
| 29.9    | .785 | 22.08 | 1381. | .700 | 20.12 | .0524 | .0431 |
| 25.8    | .780 | 22.02 | 1406. | .698 | 20.31 | .0618 | .0508 |
| 19.8    | .776 | 21.90 | 1376. | .693 | 20.12 | .0801 | .0661 |
| 14.9    | .780 | 21.80 | 1359. | .686 | 20.50 | .0958 | .0794 |
| 11.0    | .780 | 21.77 | 1389. | .686 | 20.78 | .1004 | .0832 |
| 9.8     | .768 | 21.74 | 1356. | .685 | 20.06 | .1059 | .0878 |
| 7.7     | .745 | 21.76 | 1369. | .606 | 19.48 | .1018 | .0843 |
| AVERAGE | .775 | 21.97 | 1382. | .695 | 20.07 | .0703 | .0580 |





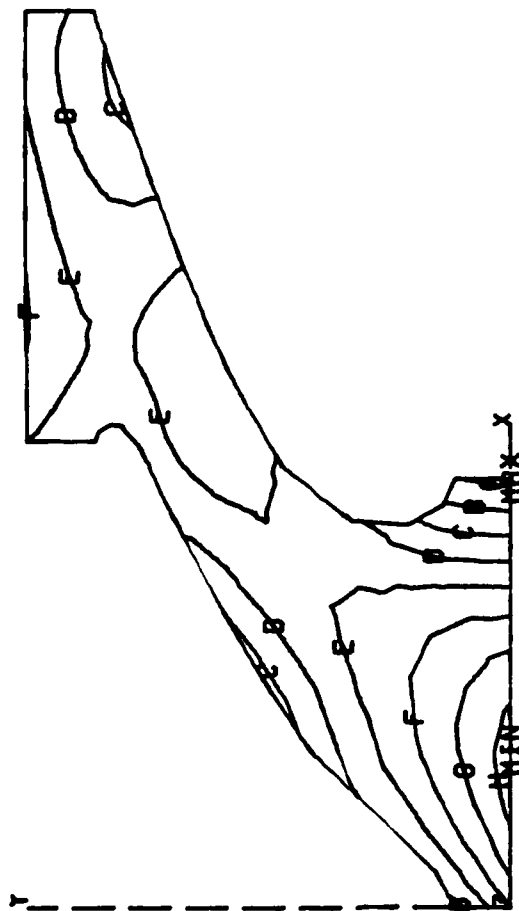
| MMM | LEGEND       | MMM     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 6.10000E 02  |         |
| B   | 6.00000E 02  |         |
| C   | 5.90000E 02  |         |
| D   | 5.80000E 02  |         |
| E   | 5.70000E 02  |         |
| F   | 5.60000E 02  |         |
| G   | 5.50000E 02  |         |
| H   | 5.40000E 02  |         |
| MAX | 6.11269E 02  |         |
| MIN | 5.30661E 02  |         |

RUN 113 MACH .7 TGAS 1000 THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:07:23 79/331



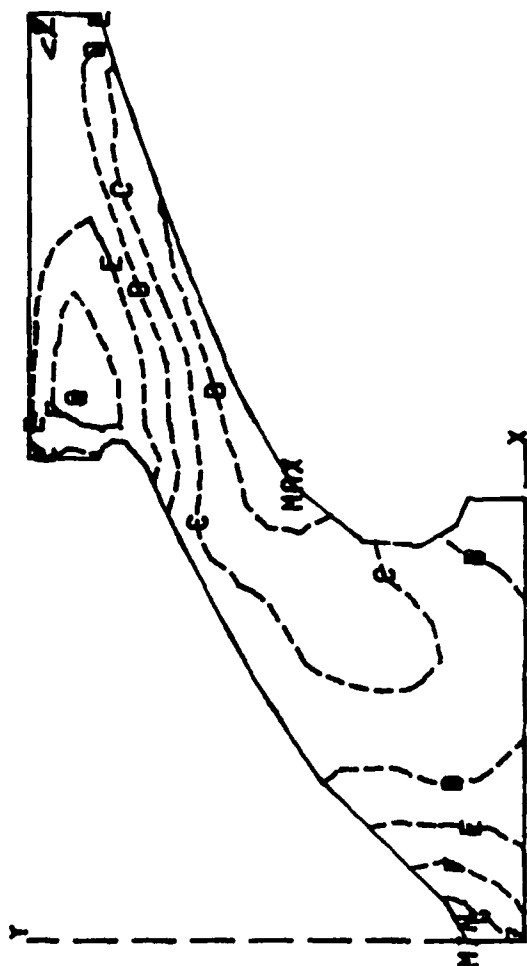
| MAX | LEGEND | PSI      | MAX |
|-----|--------|----------|-----|
|     |        | (E-03)   |     |
| A   |        | 21999.98 |     |
| B   |        | 20999.98 |     |
| C   |        | 19999.98 |     |
| D   |        | 18999.98 |     |
| E   |        | 17999.98 |     |
| F   |        | 16999.98 |     |
| G   |        | 15999.98 |     |
| MAX |        | 22097.33 |     |
| MIN |        | 15372.94 |     |

RUN 113 MACH .7 TGAS 1000 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:14:54 80/161



| MAX | LEGEND       | MAX     |
|-----|--------------|---------|
|     | UNITS - TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 8.50000E 02  |         |
| B   | 8.40000E 02  |         |
| C   | 8.30000E 02  |         |
| D   | 8.20000E 02  |         |
| E   | 8.10000E 02  |         |
| F   | 8.00000E 02  |         |
| G   | 7.90000E 02  |         |
| H   | 7.80000E 02  |         |
| MAX | 8.53562E 02  |         |
| MIN | 7.75487E 02  |         |

RUN 113 MACH .7 TGAS 1000 THICK B.L. ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:20:07 79/331

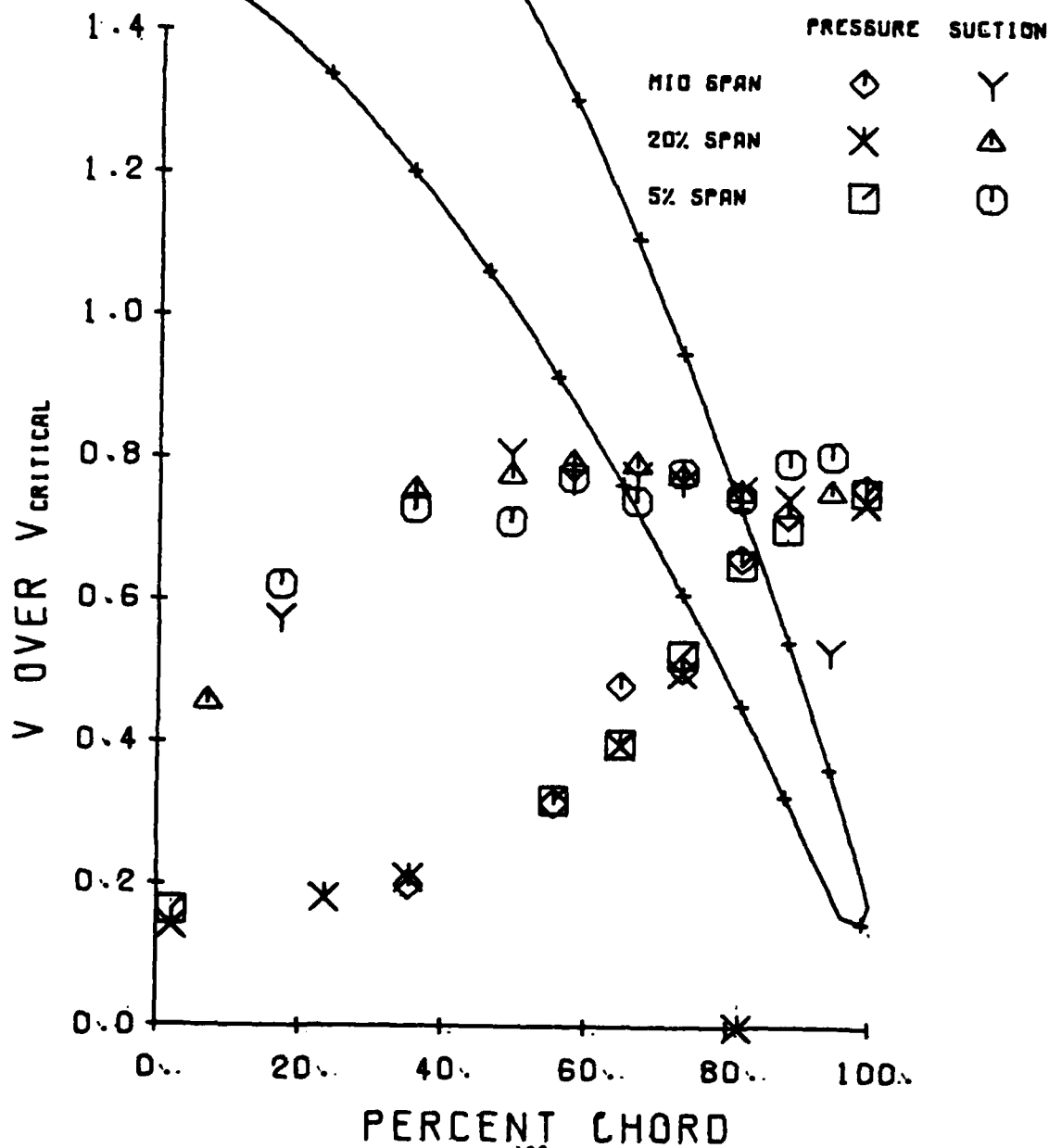


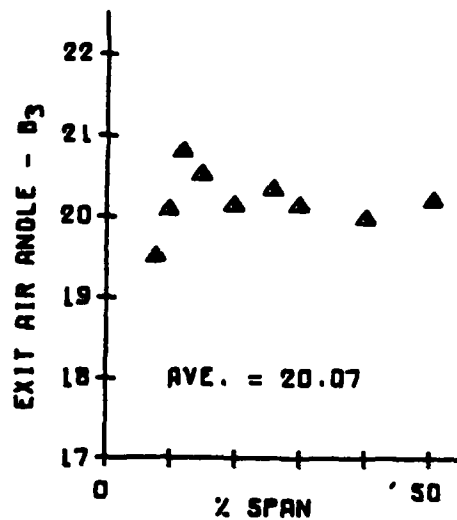
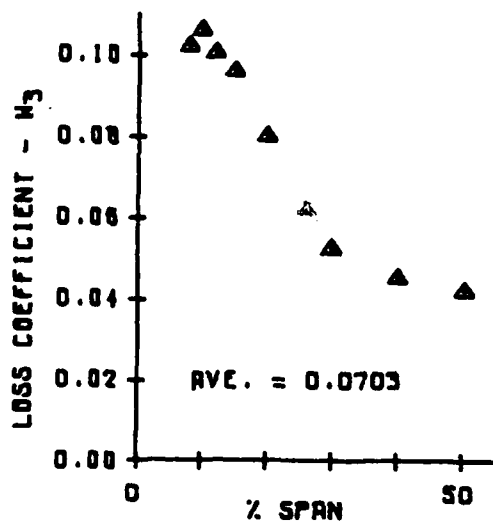
MMM LEGEND MMM  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A -1.40000E-03  
 B -2.20000E-03  
 C -3.00000E-03  
 D -3.80000E-03  
 E -4.60000E-03  
 F -5.39999E-03  
 G -6.19999E-03  
 MAX -1.40029E-03  
 MIN -6.78639E-03

RUN 113 MACH .7 TGAS 1000 THICK B.L. HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:08:10 79/331

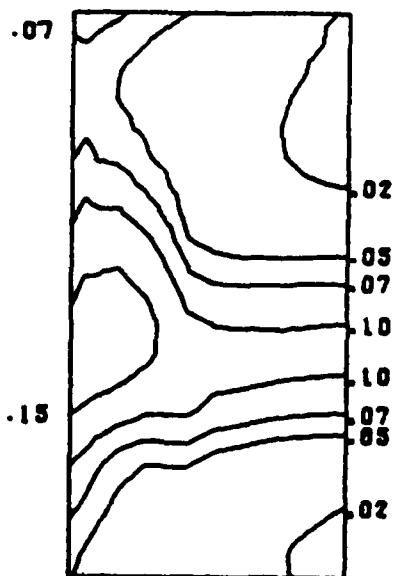
# ENDWALL HEAT TRANSFER LINEAR CASCADE

AIRFLOW →  
 RUN # = 113  
 DATE = 11/27/79  
 EXPANSION RATIO = 1.400



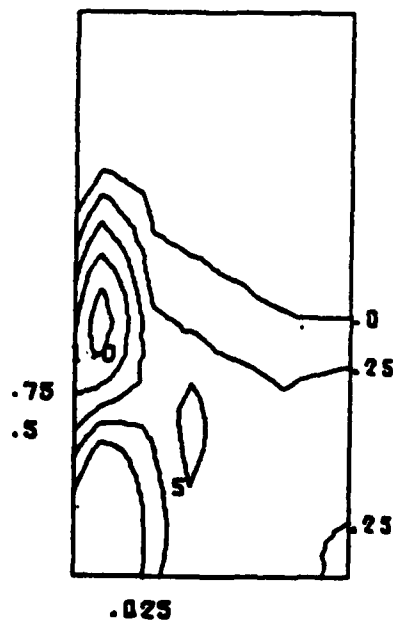


LOCAL  $W$   
CONTOURS



SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE

LOCAL  $B$  - SPAN AVG  $B_3$   
CONTOURS



EXIT MACH NO. = 0.72 REYNOLDS NO. =  $5.41 \times 10^5$

RUN 113 AERODYNAMIC EXIT DATA

# GMA 200 TURBINE VANE CASCADE

RUN #114

DATE: 11/27/79

TIME: 14:40: 4

| PTOTLE | PSTATIC | INLET CONDITIONS |        | V/V* | REY/10**6 |
|--------|---------|------------------|--------|------|-----------|
| 15.50  | 15.39   | TTOTLE           | MACH # |      |           |
|        |         | 1236.35          | .104   | .113 | .002      |

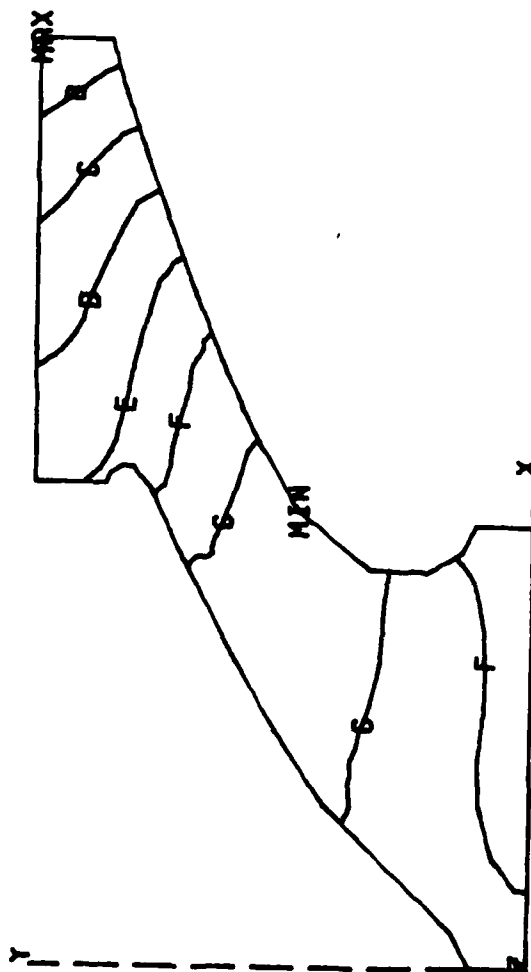
| PTOTLE | STATIC | IDEAL EXIT CONDITIONS |        | V/V* | REY/10**6 |
|--------|--------|-----------------------|--------|------|-----------|
| 15.50  | 14.71  | TTOTAL                | MACH # |      |           |
|        |        | 1236.35               | .278   | .300 | .213      |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.054      STATIC PRESSURE RATIO= .956

## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

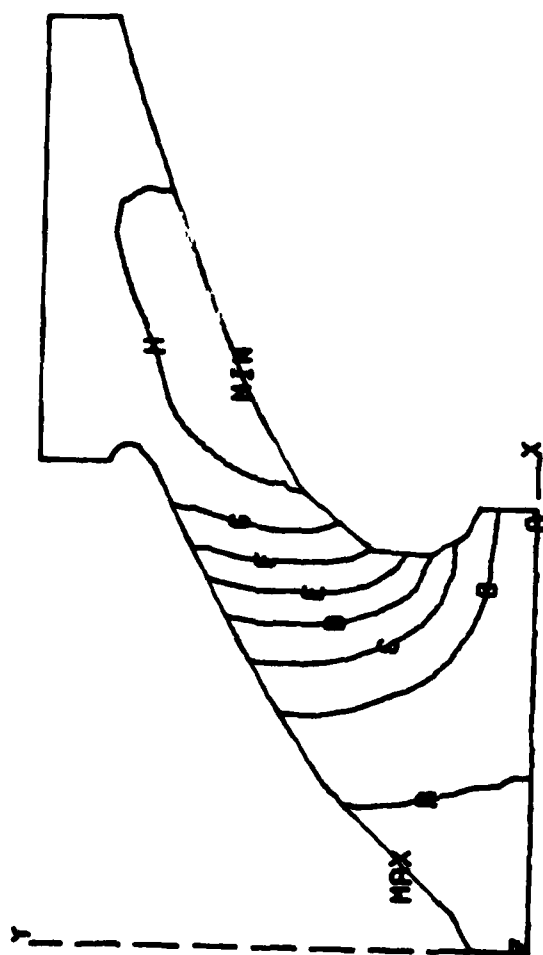
| X SPAN  | MASS | PT3   | TT3   | M3   | DETAS | OMEGA | FBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 49.9    | .302 | 15.45 | 1208. | .269 | 21.29 | .0055 | .0635 |
| 39.6    | .303 | 15.44 | 1232. | .268 | 21.65 | .0750 | .0727 |
| 30.3    | .296 | 15.45 | 1212. | .266 | 21.27 | .0736 | .0714 |
| 24.7    | .302 | 15.44 | 1203. | .264 | 21.65 | .0800 | .0835 |
| 19.9    | .296 | 15.42 | 1176. | .261 | 21.19 | .1021 | .1050 |
| 14.9    | .289 | 15.42 | 1201. | .260 | 20.96 | .1008 | .1028 |
| 12.0    | .261 | 15.42 | 1195. | .260 | 20.26 | .1119 | .1087 |
| 9.0     | .264 | 15.42 | 1107. | .257 | 19.00 | .1121 | .1090 |
| 7.0     | .250 | 15.42 | 1172. | .250 | 18.50 | .1105 | .1103 |
| AVERAGE | .290 | 15.43 | 1202. | .264 | 20.81 | .0971 | .0674 |



| MIN | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 425.00 |
| B   |        | 417.00 |
| C   |        | 409.00 |
| D   |        | 401.00 |
| E   |        | 393.00 |
| F   |        | 385.00 |
| G   |        | 377.00 |
| MAX |        | 425.90 |
| MIN |        | 373.05 |

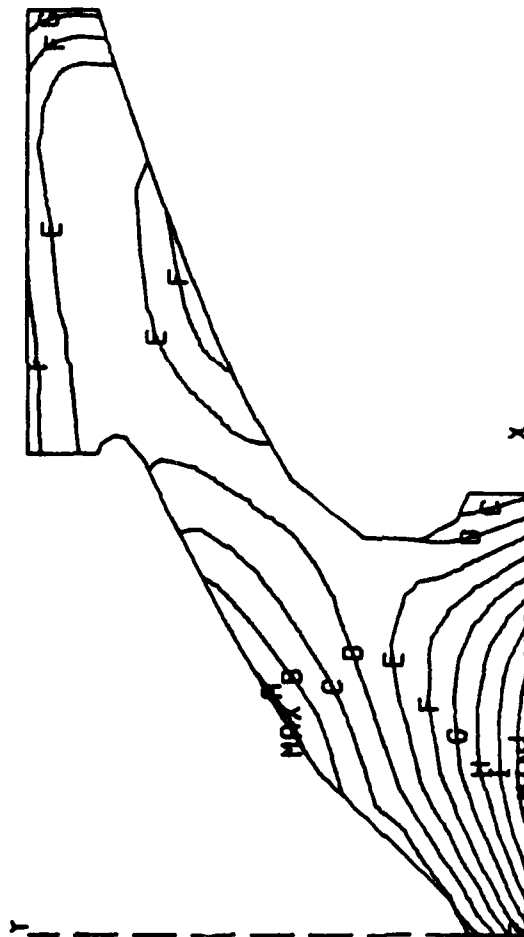
RUN 114 MACH .3 TGAS 800 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:02:43 80/014





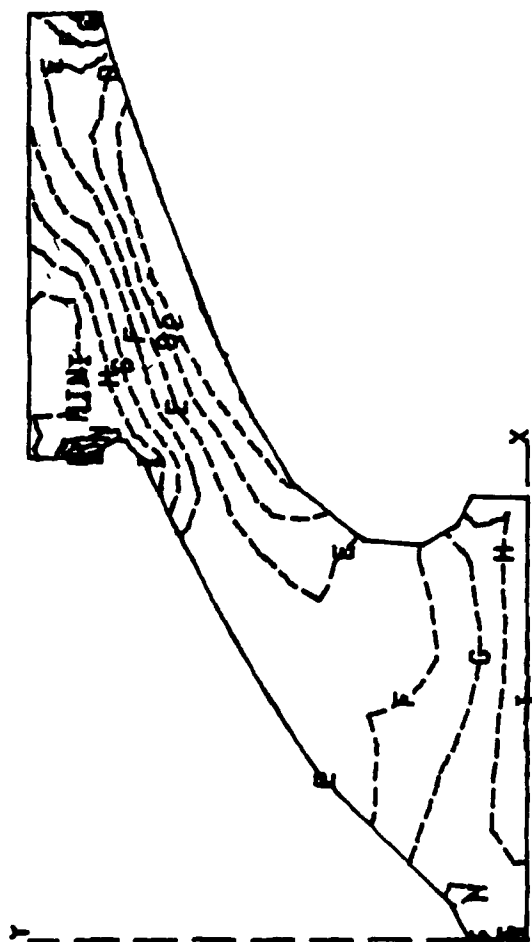
| MAX | LEGEND   | MAX    |
|-----|----------|--------|
| A   | 15399.99 | 1E-031 |
| B   | 15299.99 |        |
| C   | 15199.99 |        |
| D   | 15099.99 |        |
| E   | 14999.99 |        |
| F   | 14899.99 |        |
| G   | 14799.99 |        |
| H   | 14699.99 |        |
| MAX | 15431.57 |        |
| MIN | 14626.61 |        |

RUN 114 MACH .3 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:21:32 80/181



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 7.30000E 02  
 B 7.20000E 02  
 C 7.10000E 02  
 D 7.00000E 02  
 E 6.90000E 02  
 F 6.80000E 02  
 G 6.70000E 02  
 H 6.60000E 02  
 I 6.50000E 02  
 J 6.40000E 02  
 MAX 7.32149E 02  
 MIN 6.35212E 02

RUN 114 MACH .3 TCAS 800 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:08:58 79/331



LEGEND

F  
(E-06)

-1000.00  
-2000.00  
-3000.00  
-4000.00  
-5000.00  
-6000.00  
-6999.99

MIN -7549.52

RUN 114 MACH .3 TGRS 800 HEAT TRANSFER ENDWALL  
CONTOUR PLOT OF STANTON NUMBER.

SCALE = 1.0000 PLOT TIME AND DATE = 18:03:15 80/014

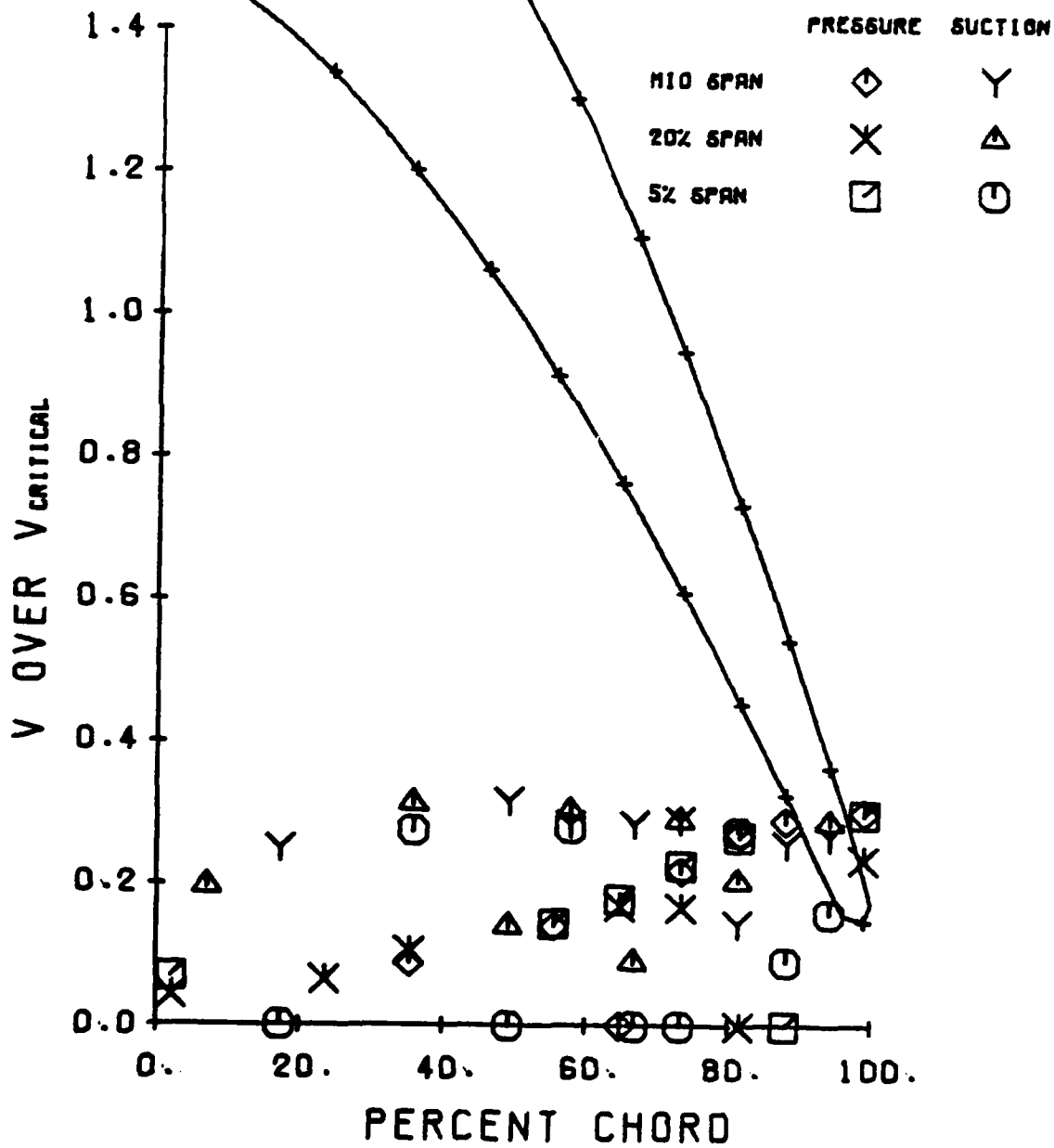
# ENDWALL HEAT TRANSFER LINEAR CASCADE

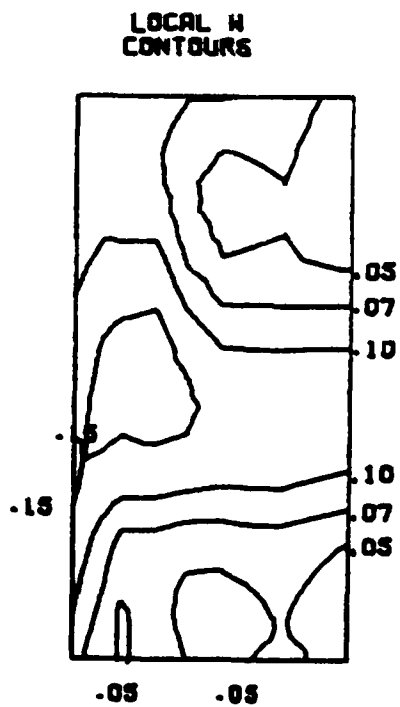
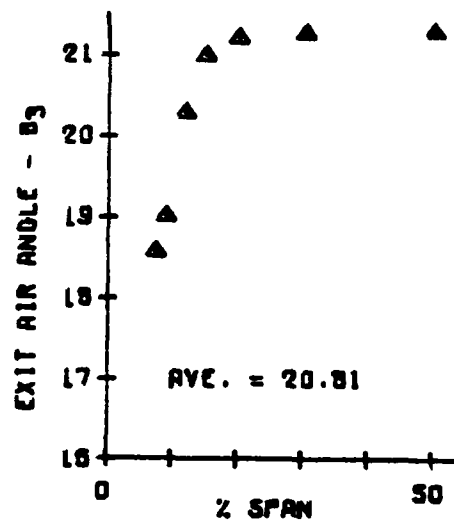
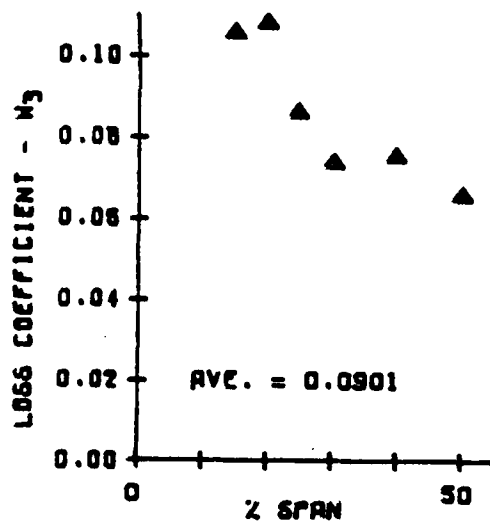
RUN # = 114

DATE = 11/27/79

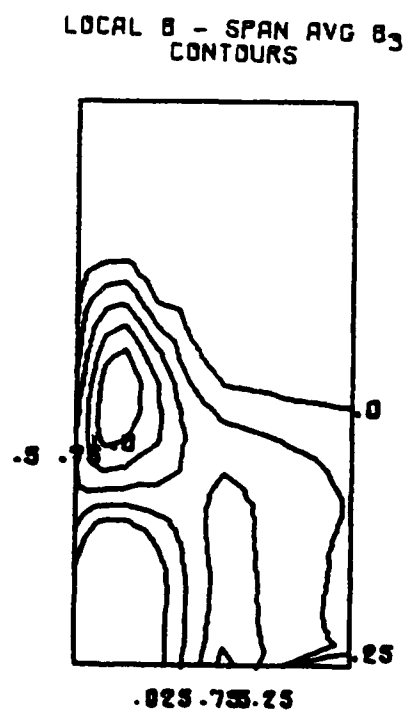
EXPANSION RATIO = 1.052

AIRFLOW →





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



EXIT MACH NO. = 0.28 REYNOLDS NO. =  $2.13 \times 10^5$

RUN 114 AERODYNAMIC EXIT DATA

GMA 200 TURBINE VANE CASCADE

RUN #110

DATE: 12/11/79

TIME: 11:49: 7

|        |         |                  |        |      |           |  |
|--------|---------|------------------|--------|------|-----------|--|
|        |         | INLET CONDITIONS |        |      |           |  |
| PTOTLE | PSTATIC | TTOTLE           | MACH # | V/V* | REY/10**6 |  |
| 43.41  | 42.34   | 1275.32          | .192   | .208 | .405      |  |

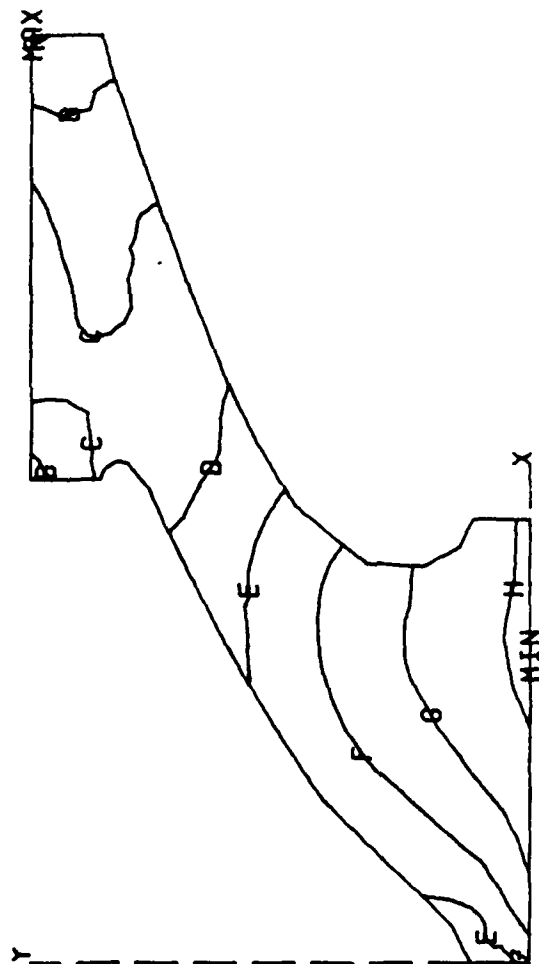
|        |        |                       |        |      |           |  |
|--------|--------|-----------------------|--------|------|-----------|--|
|        |        | IDEAL EXIT CONDITIONS |        |      |           |  |
| PTOTLE | STATIC | TTOTAL                | MACH # | V/V* | REY/10**6 |  |
| 43.41  | 31.61  | 1275.32               | .697   | .726 | 1.202     |  |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.373      STATIC PRESSURE RATIO= .747

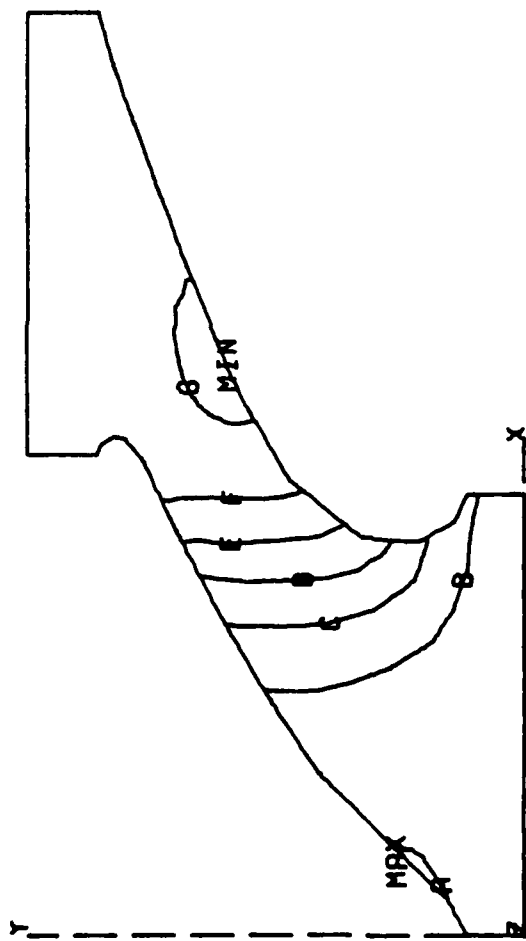
\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS  | PT3   | TT3   | M3   | DETA3 | OMEGA | EBAR  |
|---------|-------|-------|-------|------|-------|-------|-------|
| 50.5    | 1.508 | 42.95 | 1211. | .680 | 18.83 | .0394 | .0327 |
| 40.0    | 1.509 | 43.04 | 1213. | .684 | 18.72 | .0318 | .0263 |
| 29.5    | 1.495 | 43.02 | 1227. | .682 | 18.69 | .0333 | .0275 |
| 20.7    | 1.515 | 43.00 | 1204. | .682 | 18.75 | .0353 | .0293 |
| 20.0    | 1.533 | 42.79 | 1195. | .675 | 19.12 | .0533 | .0443 |
| 10.0    | 1.563 | 42.58 | 1102. | .669 | 19.58 | .0709 | .0591 |
| 12.0    | 1.561 | 42.52 | 1106. | .667 | 19.73 | .0766 | .0639 |
| 9.8     | 1.565 | 42.52 | 1175. | .667 | 19.62 | .0767 | .0640 |
| 0.0     | 1.559 | 42.42 | 1183. | .665 | 19.69 | .0851 | .0711 |
| AVERAGE | 1.530 | 42.80 | 1200. | .676 | 19.11 | .0527 | .0438 |



| MMM | LEGEND | MMM |
|-----|--------|-----|
|     | F      |     |
| A   | 570.00 |     |
| B   | 560.00 |     |
| C   | 550.00 |     |
| D   | 540.00 |     |
| E   | 530.00 |     |
| F   | 520.00 |     |
| G   | 510.00 |     |
| H   | 500.00 |     |
| MAX | 571.17 |     |
| MIN | 497.33 |     |

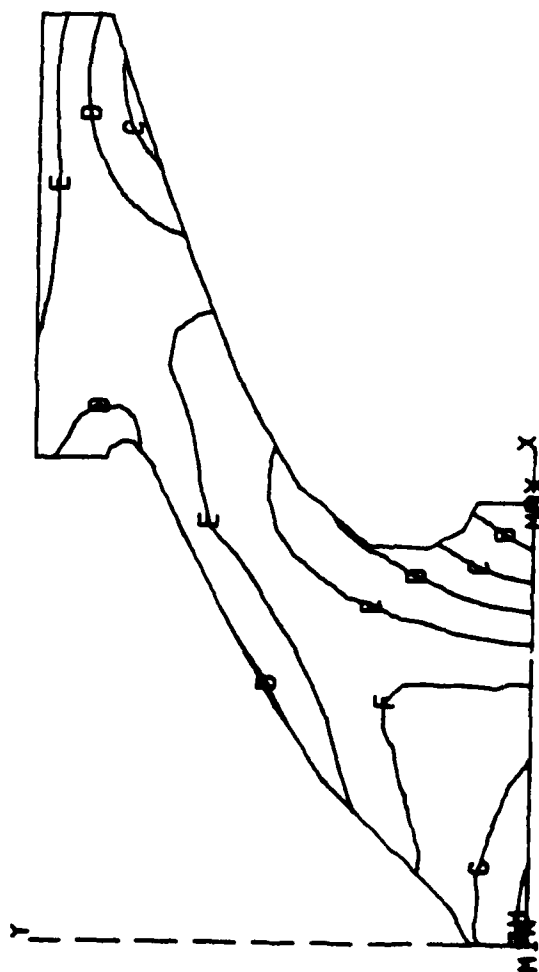
RUN 116 MACH .7 TGAS 800. RE 1.2E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:36:35 80/003



| MMM | LEGEND | MMM | PSI   |
|-----|--------|-----|-------|
| A   |        |     | 43.00 |
| B   |        |     | 41.00 |
| C   |        |     | 39.00 |
| D   |        |     | 37.00 |
| E   |        |     | 35.00 |
| F   |        |     | 33.00 |
| G   |        |     | 31.00 |
| MAX |        |     | 43.04 |
| MIN |        |     | 30.39 |

RUN 116 MACH .7 TGRS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:41:06 80/176





| MIN | LEGEND       | MIN     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 7.25000E 02  |         |
| B   | 7.17000E 02  |         |
| C   | 7.09000E 02  |         |
| D   | 7.01000E 02  |         |
| E   | 6.93000E 02  |         |
| F   | 6.85000E 02  |         |
| G   | 6.77000E 02  |         |
| H   | 6.69000E 02  |         |
| MAX | 7.25496E 02  |         |
| MIN | 6.66625E 02  |         |

RUN 116 MACH .7 TGAS 800. RE 1.2E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:47:44 79/347



| MMM | LEGEND | MMM      |
|-----|--------|----------|
|     | F      | (E-06)   |
| A   |        | -2200.00 |
| B   |        | -3000.00 |
| C   |        | -3800.00 |
| D   |        | -4600.00 |
| E   |        | -5400.00 |
| F   |        | -6200.00 |
| G   |        | -6999.99 |
| MAX |        | -2208.44 |
| MIN |        | -7686.63 |

RUN 116 MACH .7 TGRS 800. RE 1.2E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:39:52 80/003

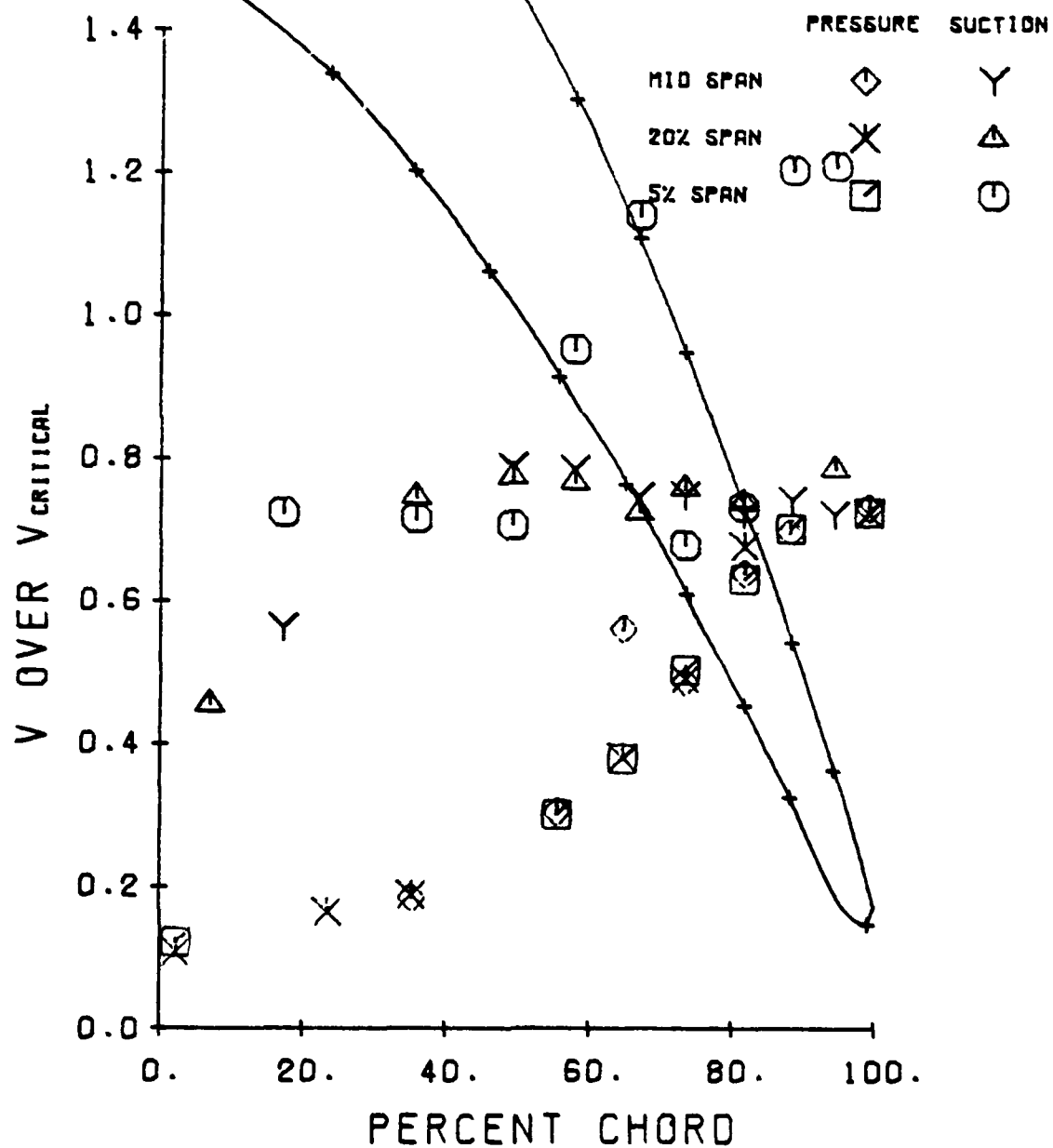
# ENDWALL HEAT TRANSFER LINEAR CASCADE

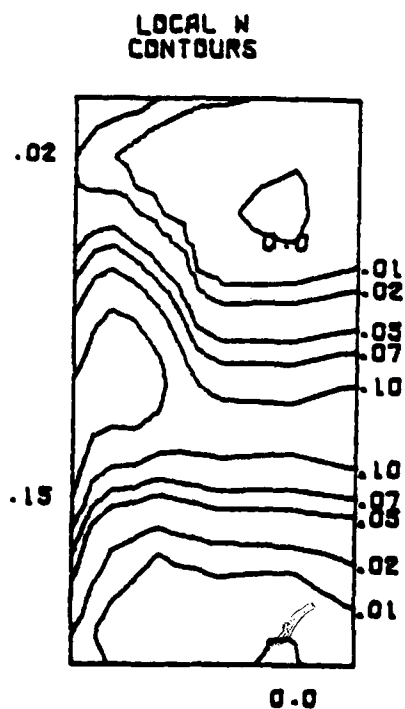
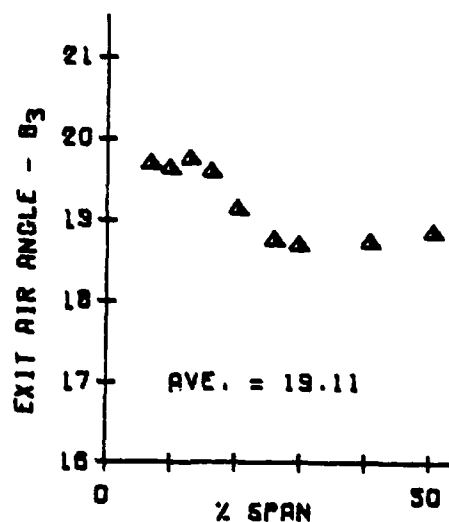
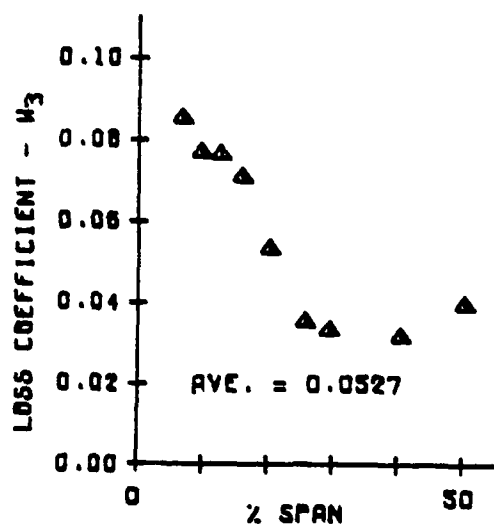
RUN # = 116

DATE = 12/11/79

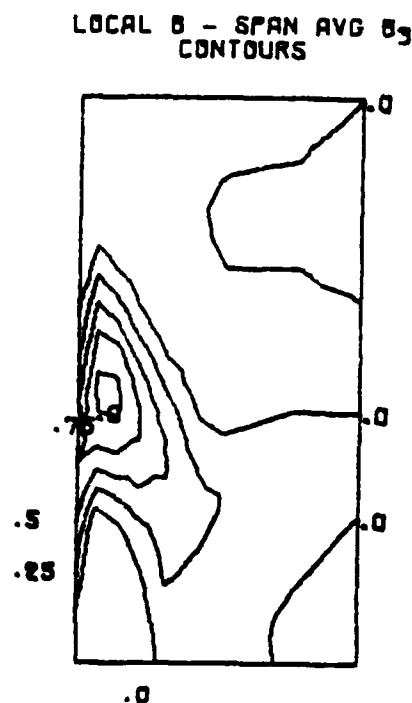
EXPANSION RATIO = 1.374

AIRFLOW →





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



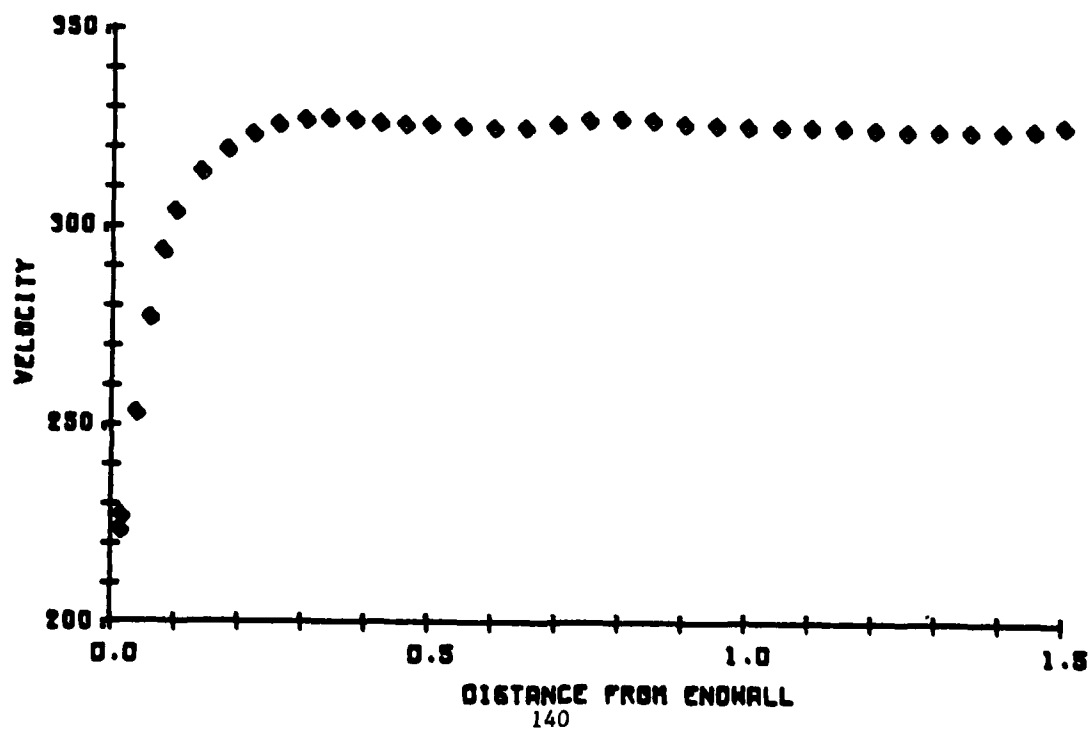
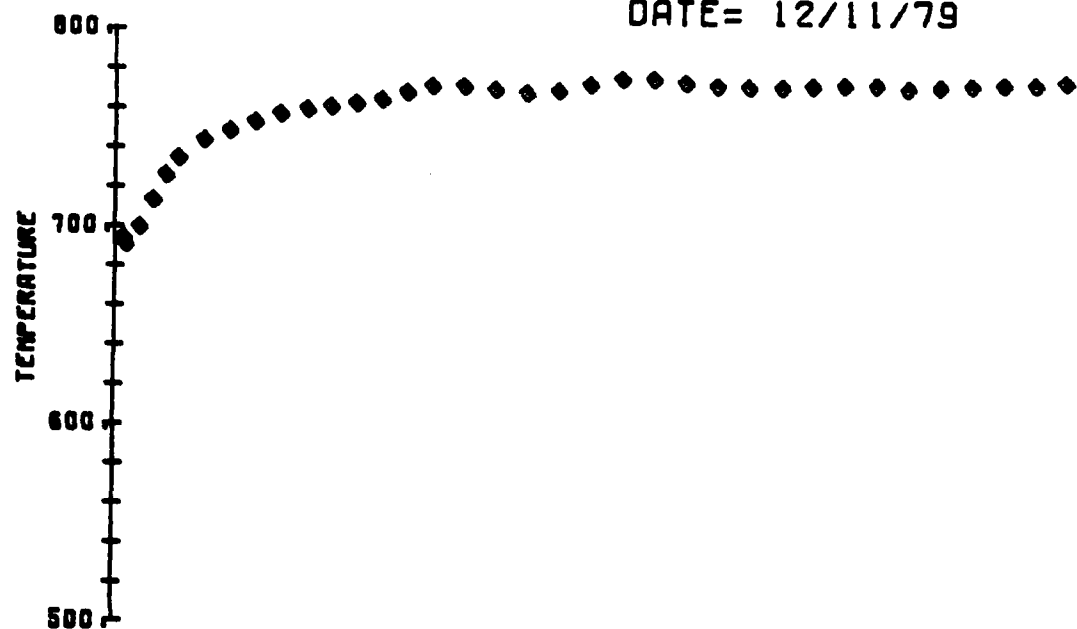
EXIT MACH NO. = 0.70 REYNOLDS NO. =  $1.20 \times 10^6$

RUN 116 AERODYNAMIC EXIT DATA

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 116

DATE = 12/11/79



GMA 220 TURBINE VANE CASCADE

RUN #110

DATE: 12/13/79

TIME: 7: 6:19

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 34.34            | 33.58   | 1244.41 | .180   | .196 | .311      |

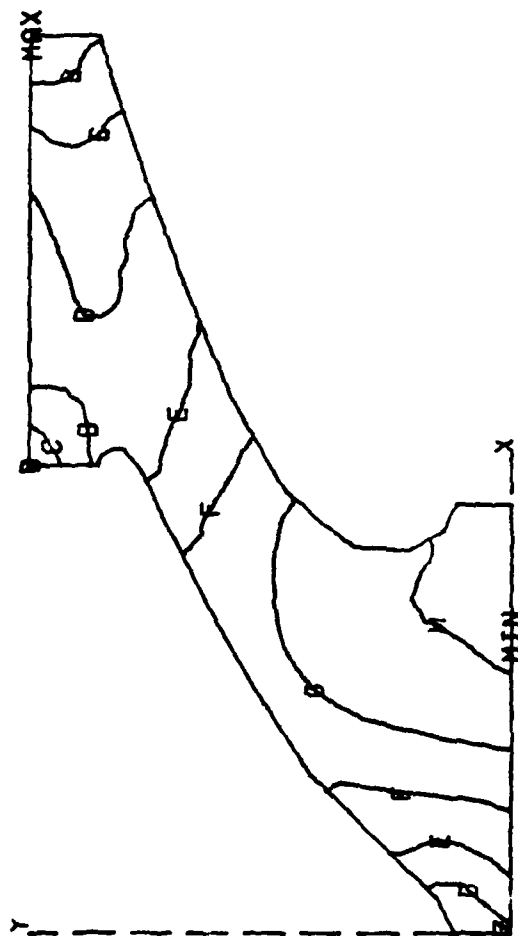
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/INS *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .42418                    | 13436438.        | 777.42                 |

CP - BTU/LBM/F  
.256

| ORIFICE | MASS FLOW RATE |  | CASCADE |
|---------|----------------|--|---------|
|         | 5.55           |  |         |

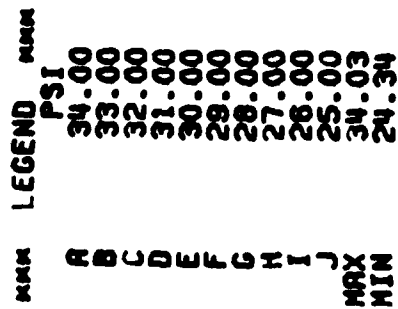
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 34.34                 | 25.30  | 1244.41 | .683   | .713 | .967      |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO*            | STATIC PRESSURE PATIO* |
| 1.357                       | .753                   |



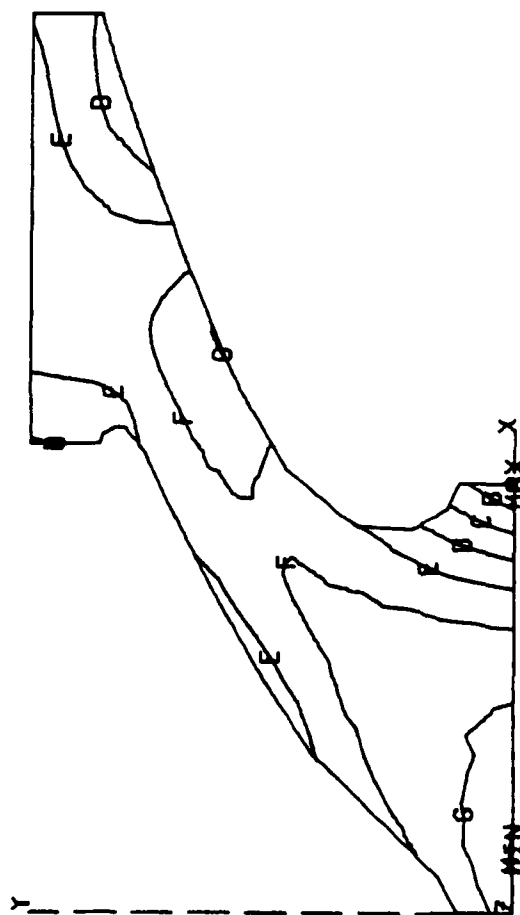
\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 5.50000E 02  
 B 5.42000E 02  
 C 5.34000E 02  
 D 5.26000E 02  
 E 5.18000E 02  
 F 5.10000E 02  
 G 5.02000E 02  
 H 4.94000E 02  
 MAX 5.50027E 02  
 MIN 4.92130E 02

RUN 118 MACH .7 TGAS 800 RE 1.0E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 19:06:13 79/347



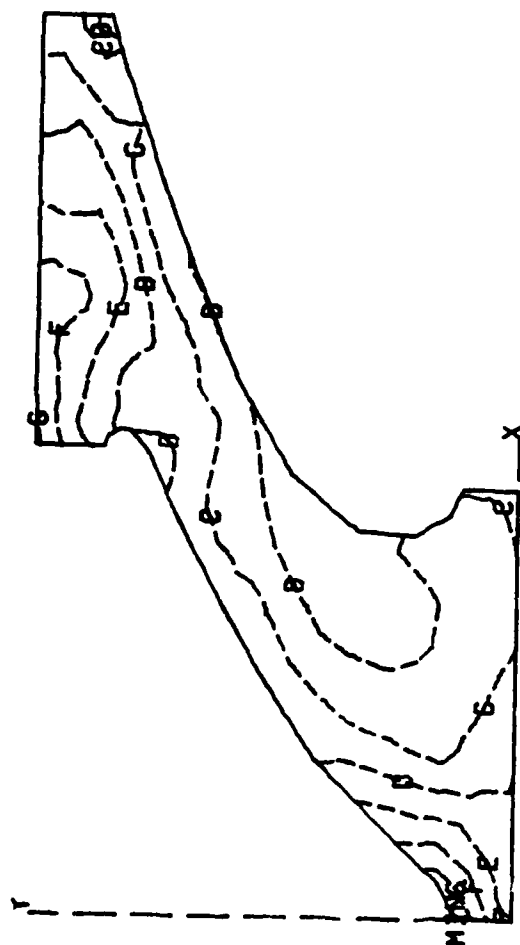
.....





\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 7.24000E 02  
 B 7.16000E 02  
 C 7.08000E 02  
 D 7.00000E 02  
 E 6.92000E 02  
 F 6.84000E 02  
 G 6.76000E 02  
 H 6.68000E 02  
 MAX 7.24468E 02  
 MIN 6.67099E 02

RUN 118 MACH .7 TGRS 800 RE 1.0E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:22:27 79/347



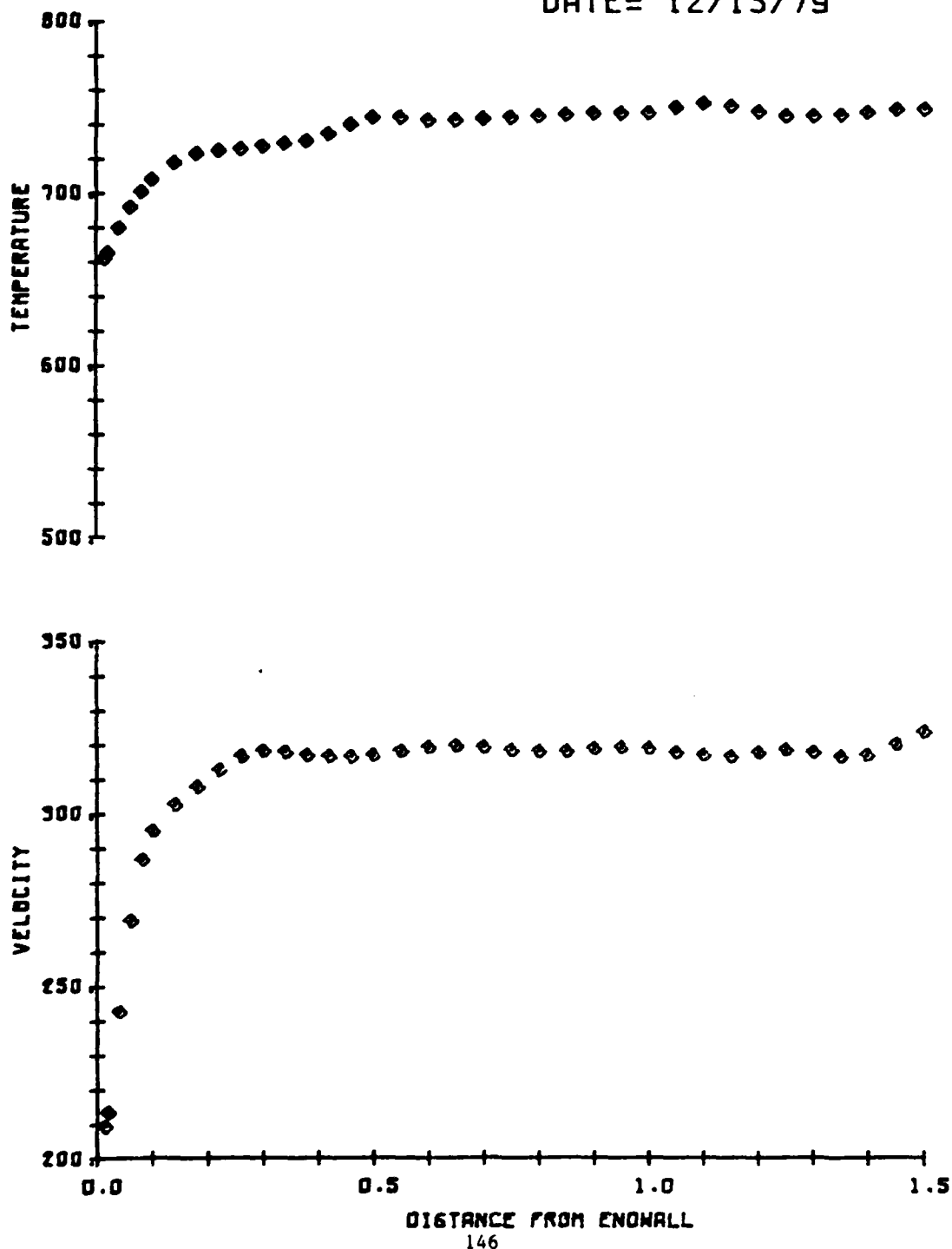
PLANE LEGEND MIN  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A -2.00000E-03  
 B -3.00000E-03  
 C -4.00000E-03  
 D -5.00000E-03  
 E -5.99999E-03  
 F -6.99999E-03  
 G -7.99999E-03  
 H -8.99999E-03  
 MAX -2.06821E-03  
 MIN -9.22695E-03

RUN 118 MACH .7 TGAS 800 RE 1.0E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 19:06:56 79/347

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 118

DATE = 12/13/79



# GNA 204 TURBINE VANE CASCADE

RUN #122

DATE: 01/07/80

TIME: 7:30:41

|        |         |                  |        |      |           |  |
|--------|---------|------------------|--------|------|-----------|--|
| PTOTLE | PSTATIC | INLET CONDITIONS |        |      |           |  |
| 59.01  | 58.42   | TTOTLE           | MACH # | V/V* | REY/10**6 |  |
|        |         | 1225.85          | .186   | .202 | .566      |  |

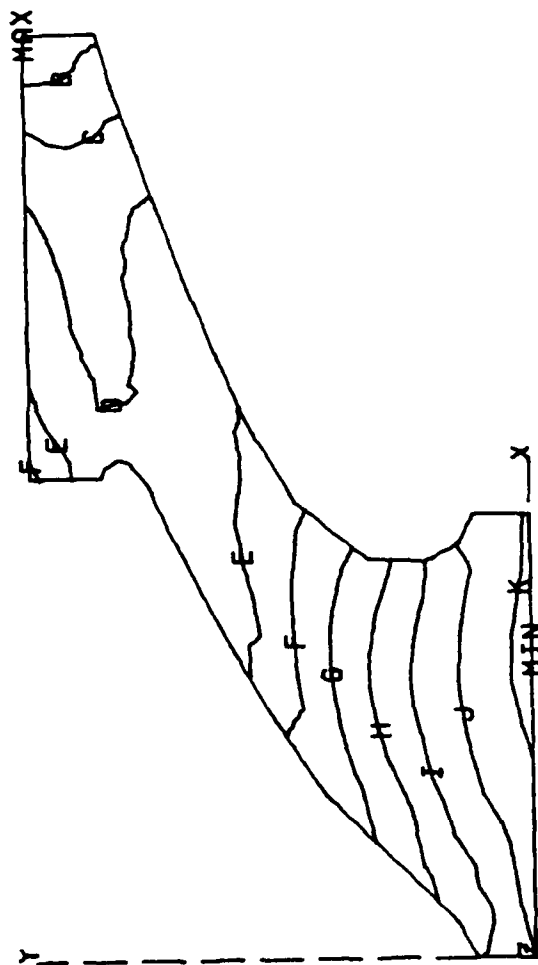
|        |        |                       |        |      |           |  |
|--------|--------|-----------------------|--------|------|-----------|--|
| PTOTLE | STATIC | IDEAL EXIT CONDITIONS |        |      |           |  |
| 59.81  | 43.12  | TTOTAL                | MACH # | V/V* | REY/10**6 |  |
|        |        | 1228.85               | .738   | .737 | 1.745     |  |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.367      STATIC PRESSURE RATIO= .738

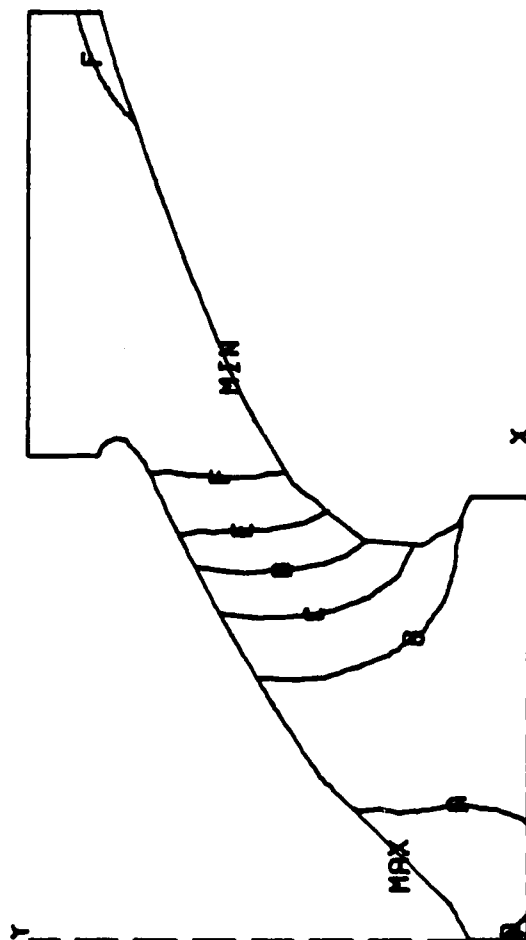
## \*\*\* MIXED CUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS  | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|-------|------|-------|-------|-------|
| 49.9    | 2.492 | 59.12 | 1217. | .689 | 18.90 | .0417 | .0344 |
| 40.0    | 1.931 | 59.15 | 1226. | .689 | 17.42 | .0396 | .0329 |
| 29.9    | 2.130 | 59.14 | 1206. | .690 | 19.12 | .0410 | .0338 |
| 20.0    | 1.942 | 59.05 | 1211. | .667 | 17.51 | .0461 | .0380 |
| 19.9    | 1.973 | 59.02 | 1201. | .681 | 17.86 | .0577 | .0503 |
| 14.9    | 2.112 | 59.46 | 1192. | .674 | 19.29 | .0822 | .0684 |
| 11.0    | 2.032 | 59.44 | 1175. | .673 | 18.44 | .0836 | .0695 |
| 6.9     | 2.030 | 59.42 | 1162. | .672 | 18.37 | .0844 | .0726 |
| 7.3     | 1.927 | 59.57 | 1164. | .671 | 17.54 | .0879 | .0732 |
| AVERAGE | 2.077 | 59.05 | 1202. | .652 | 18.15 | .1567 | .0447 |



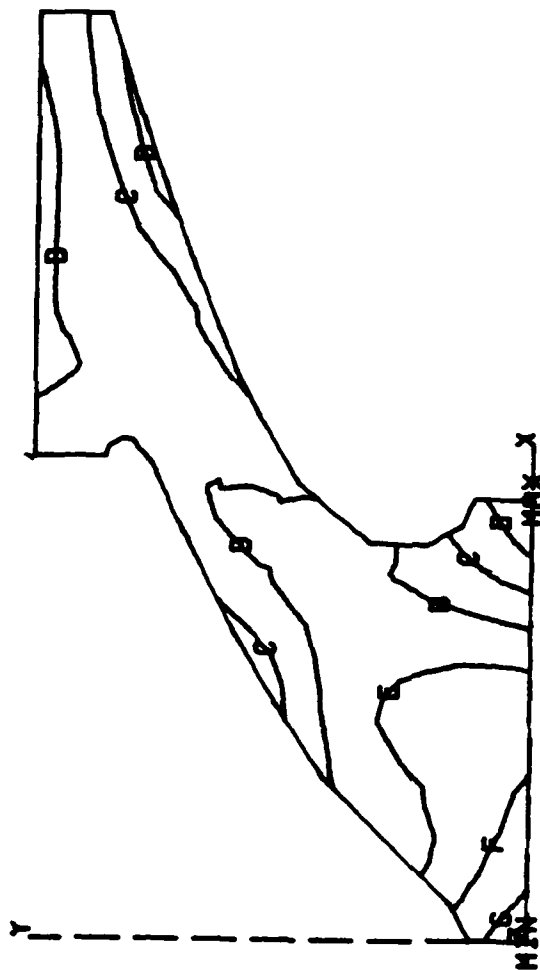
| MMM | LEGEND | MMM |
|-----|--------|-----|
| A   | 640.00 | F   |
| B   | 630.00 |     |
| C   | 620.00 |     |
| D   | 610.00 |     |
| E   | 600.00 |     |
| F   | 590.00 |     |
| G   | 580.00 |     |
| H   | 570.00 |     |
| I   | 560.00 |     |
| J   | 550.00 |     |
| K   | 540.00 |     |
| MAX | 640.06 |     |
| MIN | 536.41 |     |

RUN 122 MACH .7 TGAS 800 RE 1.7E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:20:48 80/011



| MIN | LEGEND | MIN |
|-----|--------|-----|
|     | PSI    |     |
| A   | 59.00  |     |
| B   | 56.00  |     |
| C   | 53.00  |     |
| D   | 50.00  |     |
| E   | 47.00  |     |
| F   | 44.00  |     |
| MAX | 59.40  |     |
| MIN | 41.31  |     |

RUN 122 MACH .7 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:01:56 80/162



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 743.00 |
| B   |        | 735.00 |
| C   |        | 727.00 |
| D   |        | 719.00 |
| E   |        | 711.00 |
| F   |        | 703.00 |
| G   |        | 695.00 |
| MAX |        | 743.02 |
| MIN |        | 688.28 |

RUN 122 MACH .7 TGAS 800 RE 1.7E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:30:59 80/007



| MAX | LEGEND | F        | MIN |
|-----|--------|----------|-----|
|     |        | (E-06)   |     |
| A   |        | -800.00  |     |
| B   |        | -1600.00 |     |
| C   |        | -2400.00 |     |
| D   |        | -3200.00 |     |
| E   |        | -4000.00 |     |
| F   |        | -4800.00 |     |
| G   |        | -5600.00 |     |
| H   |        | -6400.00 |     |
| MAX |        | -812.80  |     |
| MIN |        | -8714.18 |     |

RUN 122 MACH .7 TGAS 800 RE 1.7E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:21:43 80/011

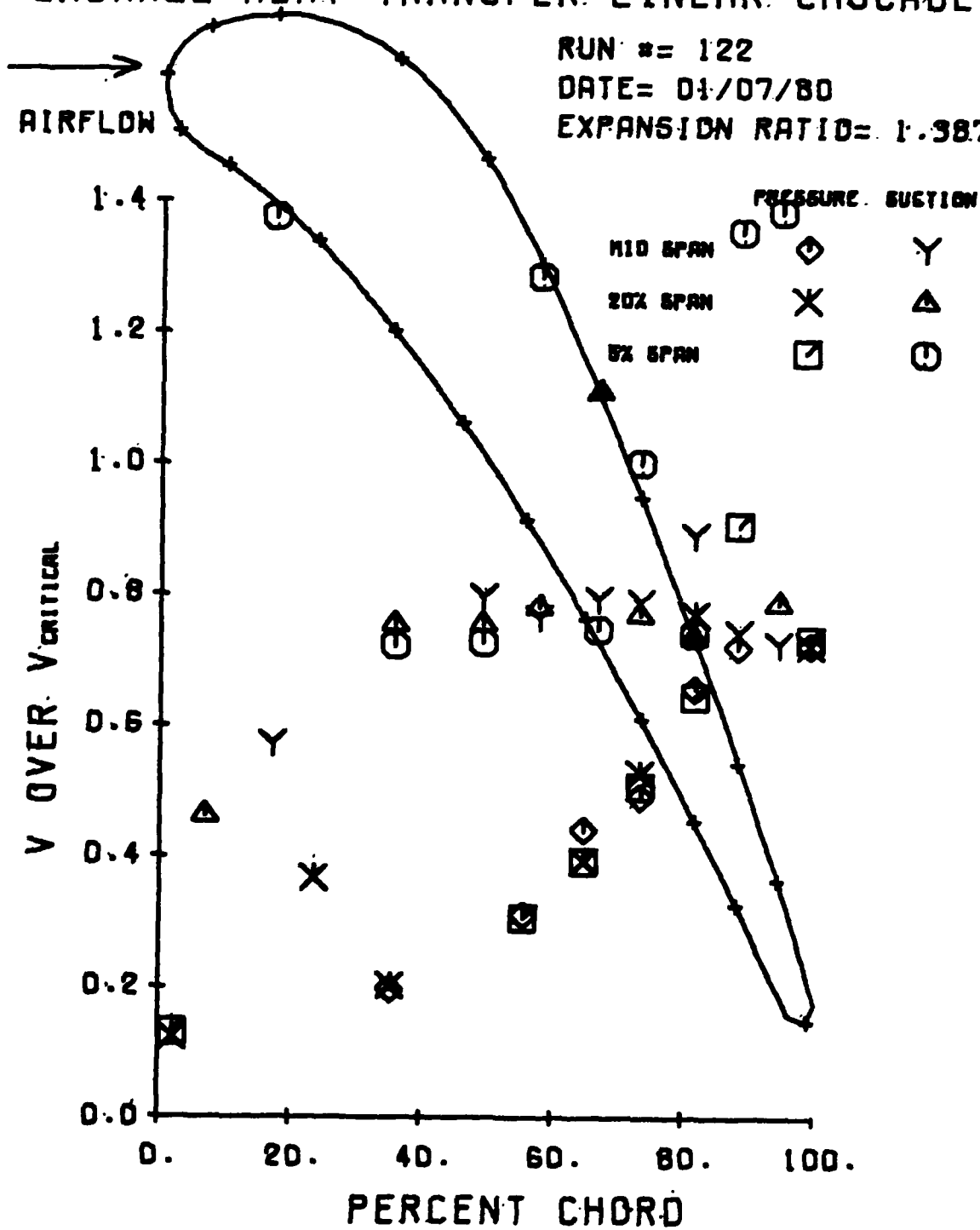


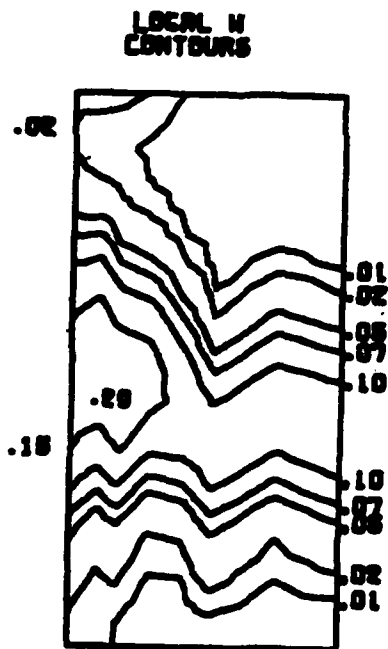
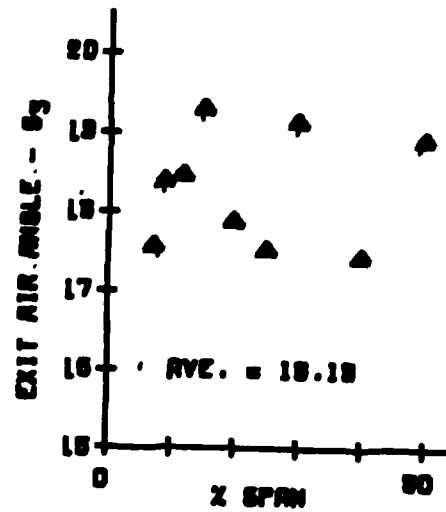
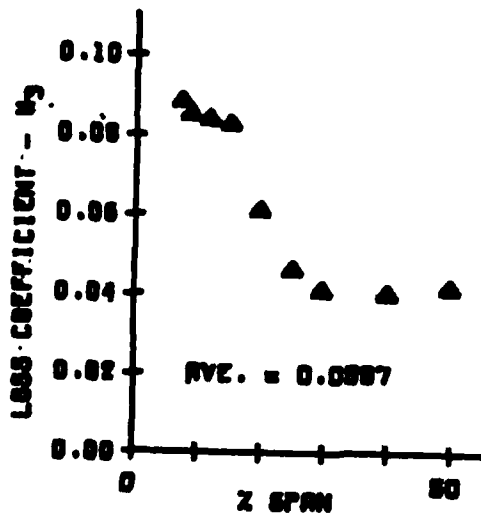
# ENDWALL HEAT TRANSFER. LINEAR. CASCADE

RUN # = 122

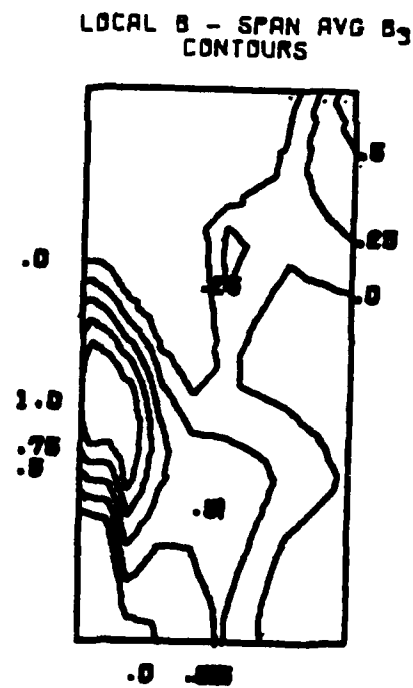
DATE = 01/07/80

EXPANSION RATIO = 1.387





SUCTION  
SIDE  
  
 PRESSURE  
SIDE



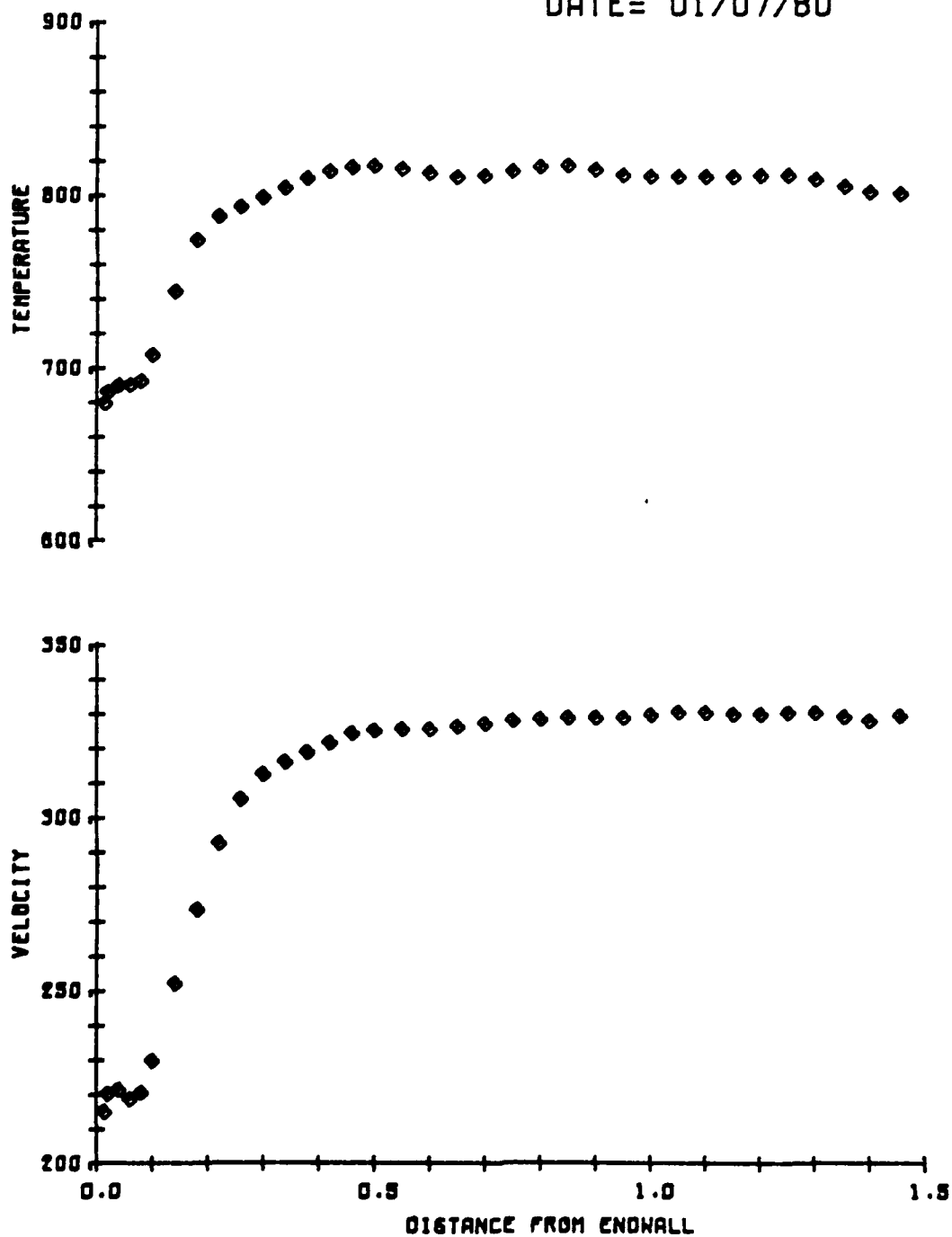
EXIT MACH. NO. = 0.71 REYNOLDS NO. =  $1.74 \times 10^5$

RUN 122 AERODYNAMIC EXIT DATA

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 122

DATE = 01/07/80



GMA 200 TURBINE VANE CASCADE

RUN #123

DATE: 01/07/80

TIME: 2:47:15

|        |         |                  |        |      |           |  |
|--------|---------|------------------|--------|------|-----------|--|
|        |         | INLET CONDITIONS |        |      |           |  |
| PTOTLE | PSTATIC | TTOTLE           | MACH # | V/V* | REY/10**6 |  |
| 31.99  | 31.26   | 1229.75          | .183   | .199 | .298      |  |

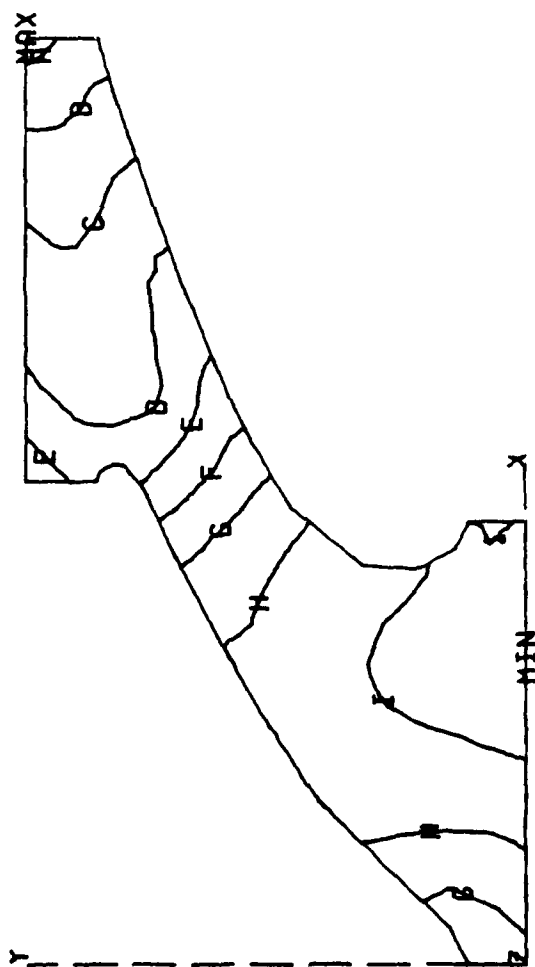
|        |        |                       |        |      |           |  |
|--------|--------|-----------------------|--------|------|-----------|--|
|        |        | IDEAL EXIT CONDITIONS |        |      |           |  |
| PTOTLE | STATIC | TTOTAL                | MACH # | V/V* | REY/10**6 |  |
| 31.99  | 23.49  | 1229.75               | .687   | .717 | .916      |  |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.362      STATIC PRESSURE RATIO= .751

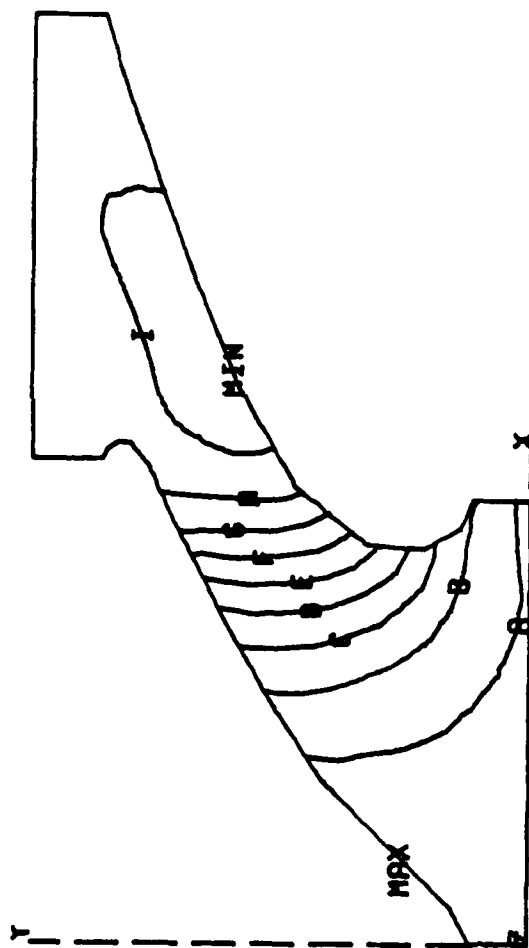
\*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| X SPAN  | MASS  | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|-------|-------|-------|------|-------|-------|-------|
| 49.9    | 1.182 | 31.68 | 1212. | .669 | 20.20 | .0368 | .0307 |
| 44.0    | 1.063 | 31.67 | 1198. | .668 | 18.01 | .0374 | .0312 |
| 30.0    | 1.167 | 31.67 | 1217. | .669 | 19.99 | .0377 | .0314 |
| 25.0    | 1.111 | 31.64 | 1227. | .667 | 18.94 | .0409 | .0341 |
| 20.0    | 1.109 | 31.51 | 1240. | .663 | 18.99 | .0467 | .0474 |
| 14.9    | 1.240 | 31.35 | 1199. | .659 | 20.79 | .0758 | .0635 |
| 11.9    | 1.155 | 31.31 | 1191. | .658 | 20.50 | .0798 | .0669 |
| 8.9     | 1.155 | 31.27 | 1208. | .656 | 20.19 | .0847 | .0717 |
| 7.5     | 1.070 | 31.22 | 1204. | .654 | 18.65 | .0907 | .0762 |
| AVERAGE | 1.124 | 31.51 | 1205. | .664 | 19.34 | .0562 | .0470 |



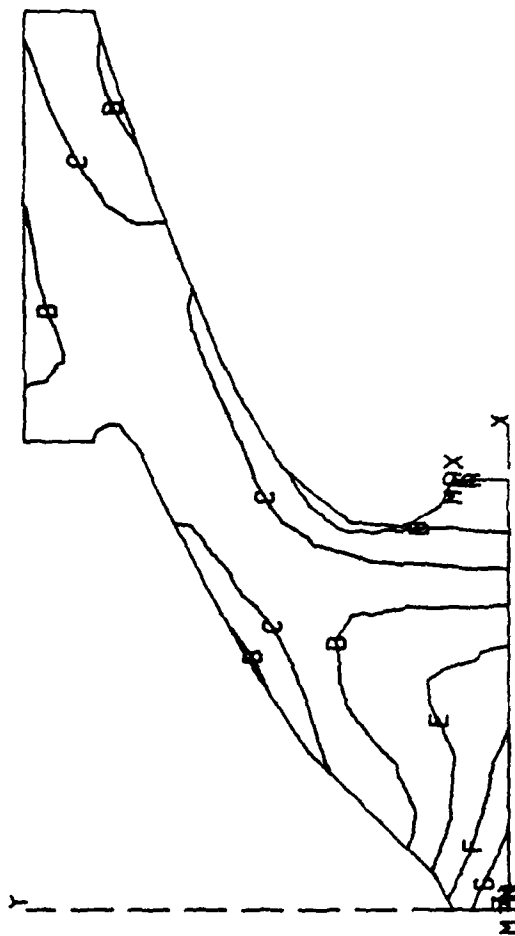
| MMM | LEGEND | MMM |
|-----|--------|-----|
|     | F      |     |
| A   | 590.00 |     |
| B   | 580.00 |     |
| C   | 570.00 |     |
| D   | 560.00 |     |
| E   | 550.00 |     |
| F   | 540.00 |     |
| G   | 530.00 |     |
| H   | 520.00 |     |
| I   | 510.00 |     |
| MAX | 593.49 |     |
| MIN | 504.09 |     |

RUN 123 MACH .7 TGI 800 RE .9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:09:44 80/014



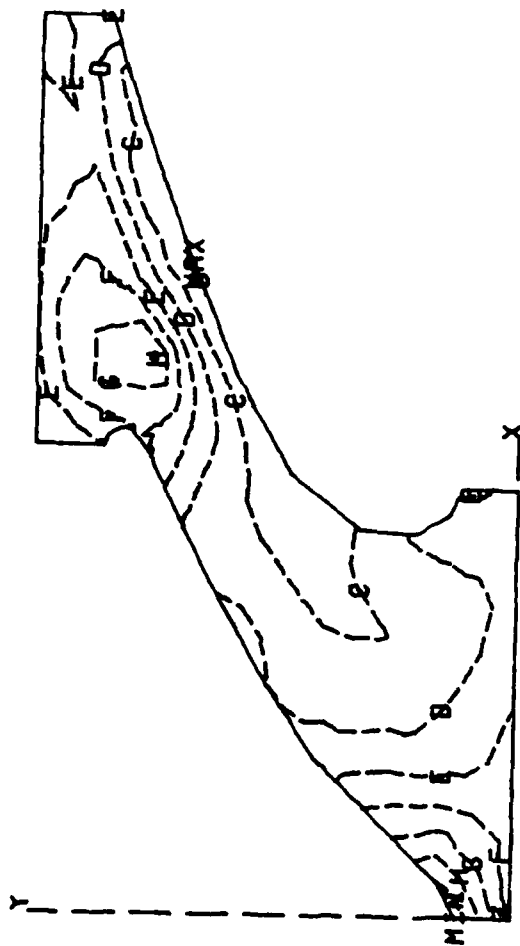
| MAX | LEGEND | PSI   | MIN |
|-----|--------|-------|-----|
| A   | B      | 31.00 |     |
| B   | C      | 30.00 |     |
| C   | D      | 29.00 |     |
| D   | E      | 28.00 |     |
| E   | F      | 27.00 |     |
| F   | G      | 26.00 |     |
| G   | H      | 25.00 |     |
| H   | I      | 24.00 |     |
| I   | MAX    | 23.00 |     |
|     | MIN    | 31.61 |     |
|     |        | 22.18 |     |

RUN 123 MACH .7 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:09:08 80/162



| MMM | LEGEND | MMM    |
|-----|--------|--------|
| A   | B      | 743.00 |
| B   | C      | 737.00 |
| C   | D      | 731.00 |
| D   | E      | 725.00 |
| E   | F      | 719.00 |
| F   | G      | 713.00 |
| G   | H      | 707.00 |
| MAX |        | 743.48 |
| MIN |        | 698.40 |

RUN 123 MACH .7 TCAS 800 RE .9E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:03:54 80/014



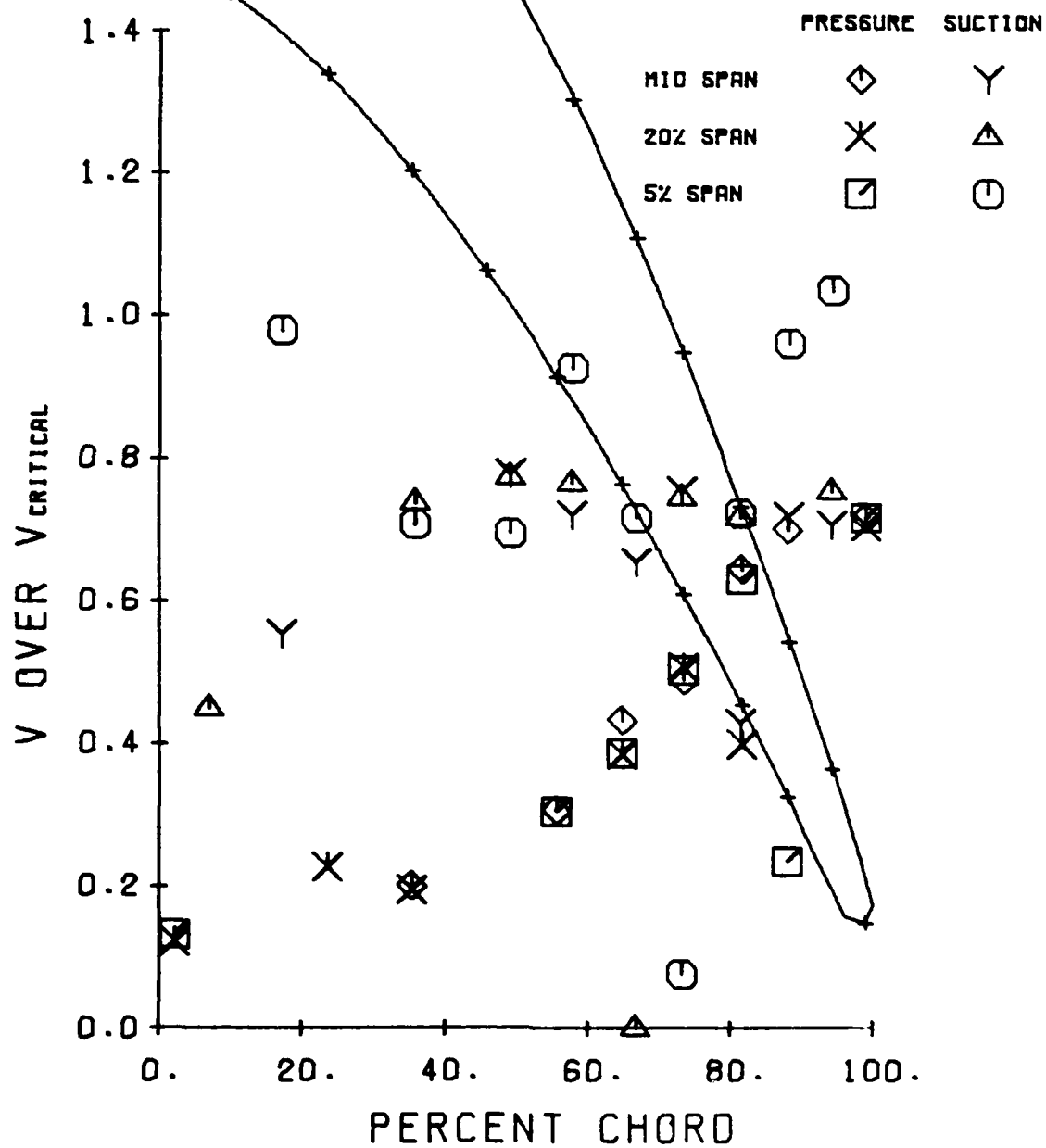
| MAX | LEGEND   | MIN |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -1000.00 |     |
| B   | -2000.00 |     |
| C   | -3000.00 |     |
| D   | -4000.00 |     |
| E   | -5000.00 |     |
| F   | -6000.00 |     |
| G   | -6999.99 |     |
| H   | -7999.99 |     |
| I   | -8999.99 |     |
| MAX | -1778.22 |     |
| MIN | -9971.96 |     |

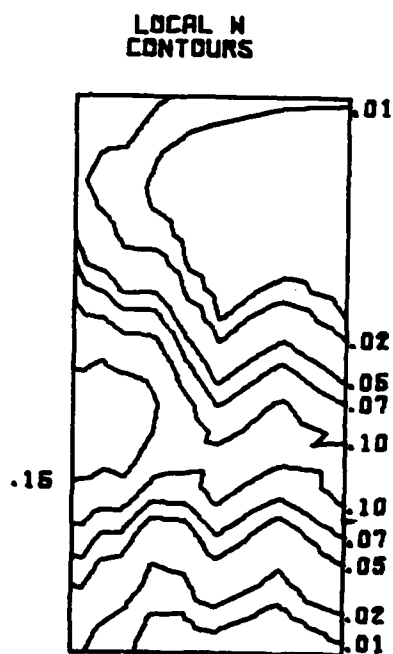
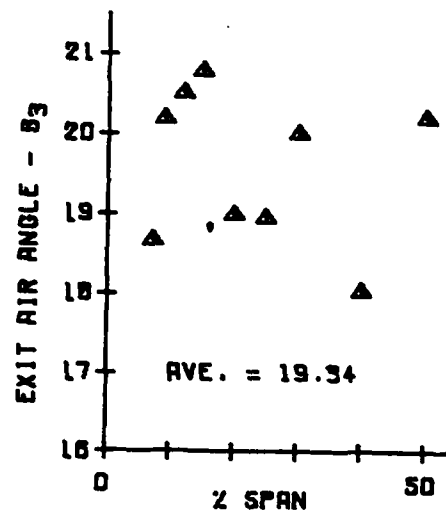
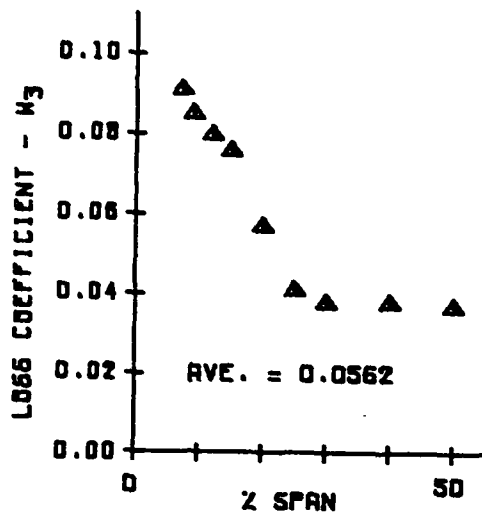
RUN 123 MACH .7 TGAS 800 RE .9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:10:51 80/014



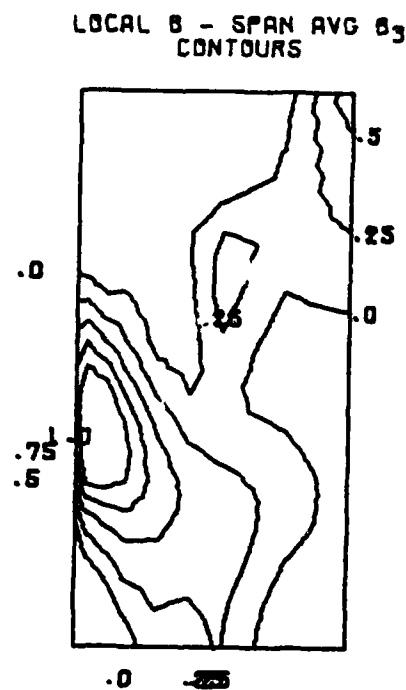
# ENDWALL HEAT TRANSFER LINEAR CASCADE

AIRFLOW →  
 RUN # = 123  
 DATE = 01/07/80  
 EXPANSION RATIO = 1.363





SUCTION  
SIDE  
↑  
↓  
PRESSURE  
SIDE



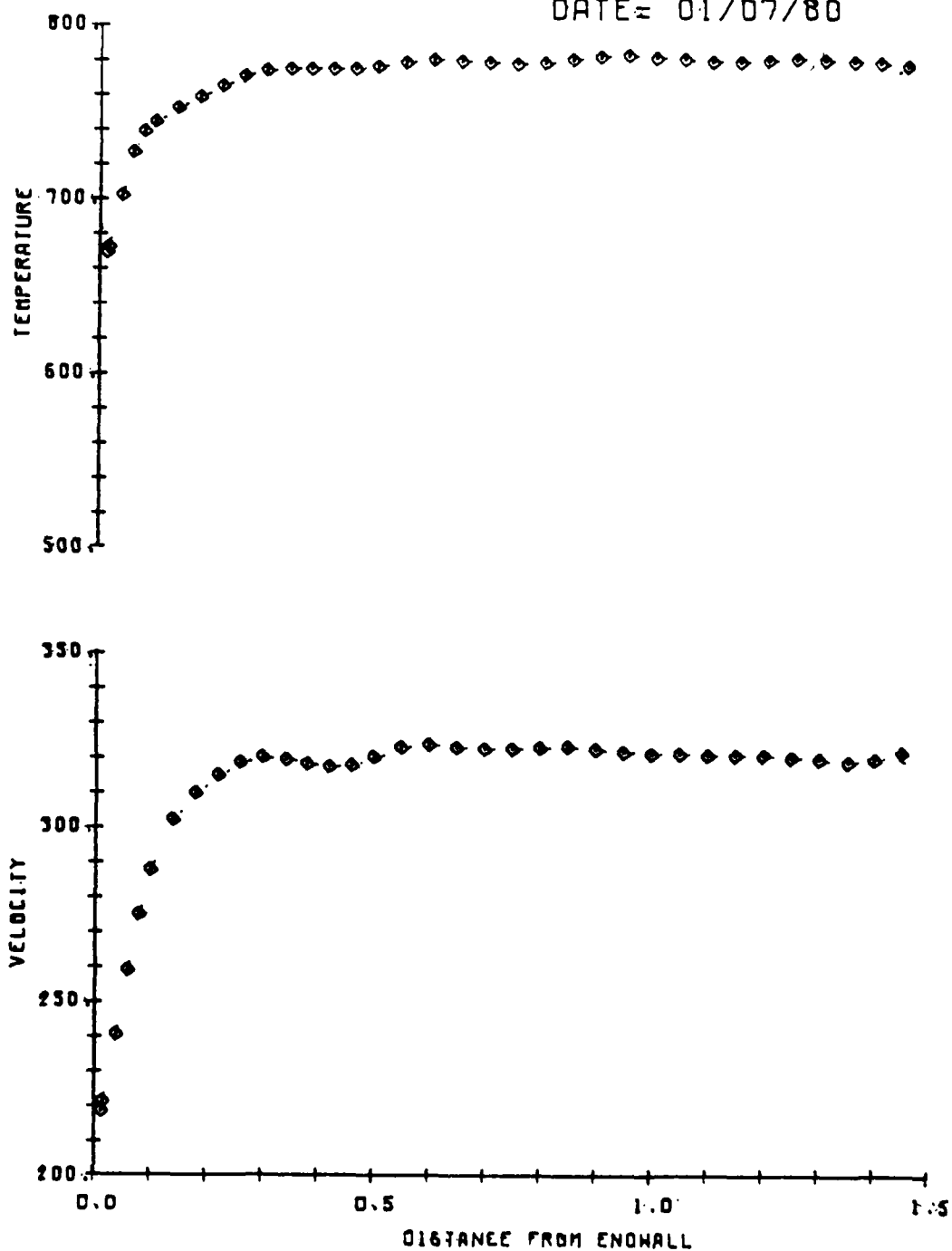
EXIT MACH NO. = 0.69 REYNOLDS NO. =  $9.16 \times 10^5$

RUN 123 AERODYNAMIC EXIT DATA

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 123

DATE = 01/07/80



# GMA 201 TURBINE VANE CASCADE

RUN #124

DATE: 01/07/80

TIME: 14:38:50

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 37.35            | 36.99   | 1345.54 | .120   | .130 | .228      |

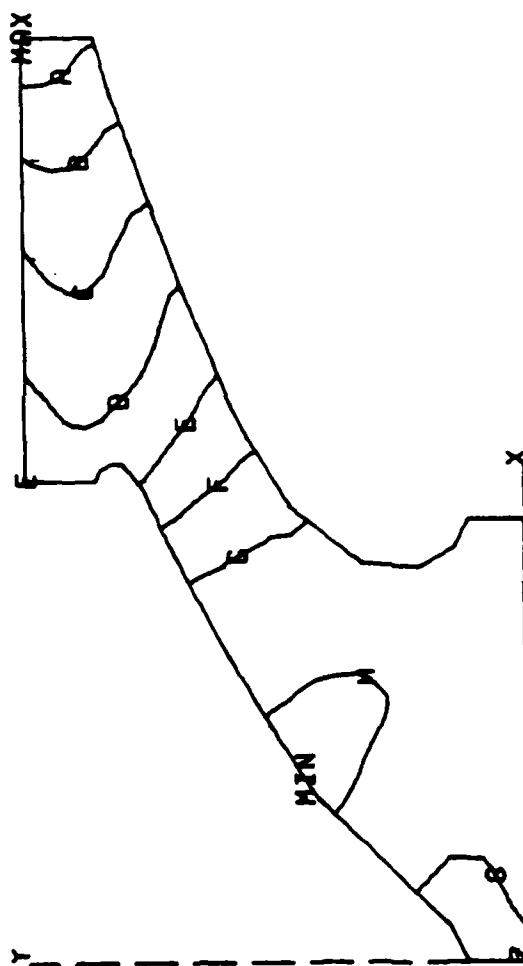
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/12**6 |
| 37.35                 | 35.11  | 1345.54 | .303   | .327 | .525      |

CASCADE OPERATING CONDITION

EXPANSION RATIO= 1.064      STATIC PRESSURE RATIO= .949

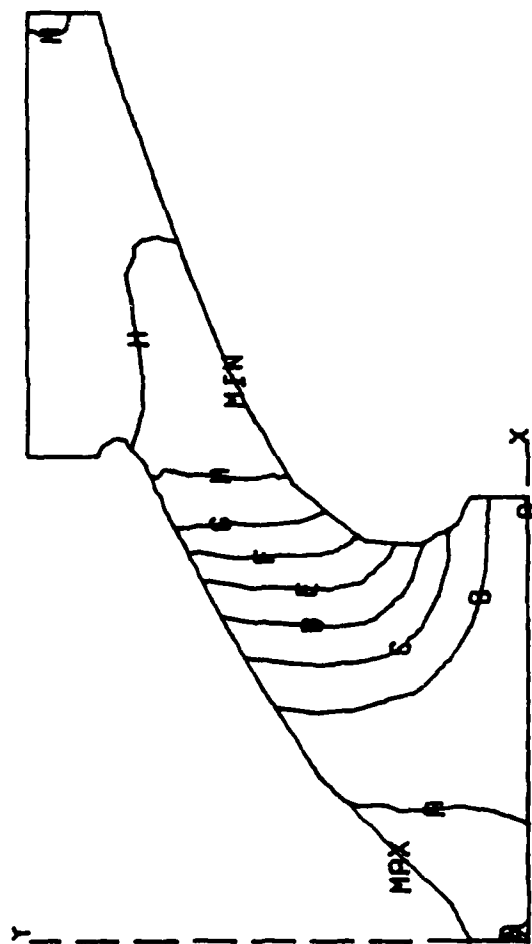
## \*\*\* MIXED OUT CONDITION SUMMARY \*\*\*

| % SPAN  | MASS | PT3   | TT3   | M3   | BETA3 | OMEGA | EBAR  |
|---------|------|-------|-------|------|-------|-------|-------|
| 50.0    | .767 | 37.31 | 1329. | .290 | 22.72 | .0221 | .0214 |
| 40.0    | .731 | 37.31 | 1344. | .259 | 21.16 | .0234 | .0226 |
| 30.0    | .735 | 37.34 | 1327. | .288 | 21.28 | .0272 | .0262 |
| 20.0    | .710 | 37.25 | 1357. | .267 | 21.78 | .0350 | .0338 |
| 10.0    | .733 | 37.24 | 1355. | .257 | 21.54 | .0527 | .0509 |
| 15.0    | .744 | 37.20 | 1340. | .283 | 22.01 | .0711 | .0687 |
| 11.0    | .735 | 37.21 | 1345. | .281 | 21.95 | .0772 | .0775 |
| 0.0     | .715 | 37.21 | 1357. | .254 | 21.30 | .0552 | .0665 |
| AVERAGE | .733 | 37.25 | 1345. | .255 | 21.50 | .0439 | .0424 |



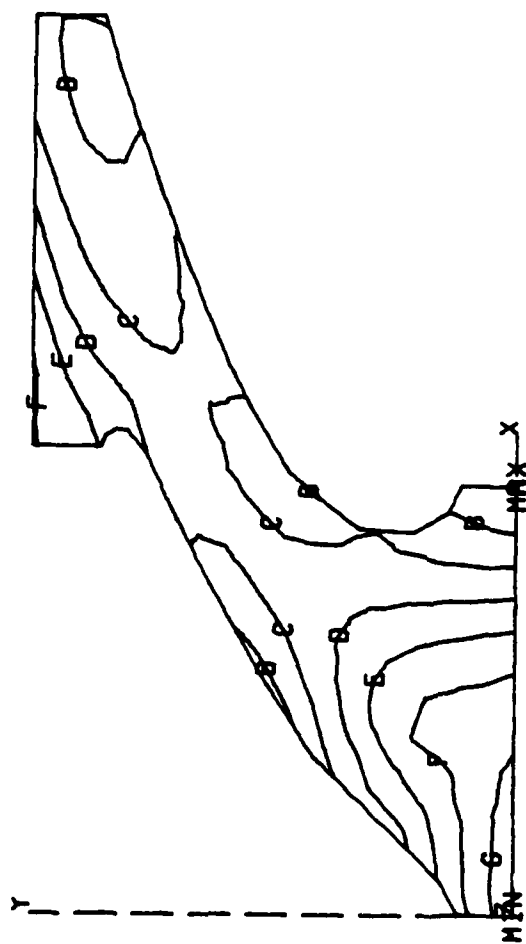
| POINT | LEGEND | TEMP   |
|-------|--------|--------|
| A     | F      | 520.00 |
| B     |        | 510.00 |
| C     |        | 500.00 |
| D     |        | 490.00 |
| E     |        | 480.00 |
| F     |        | 470.00 |
| G     |        | 460.00 |
| H     |        | 450.00 |
| MAX   |        | 526.67 |
| MIN   |        | 448.69 |

RUN 124 MACH.3 TGAS 800 RE .56E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:19:25 80/014



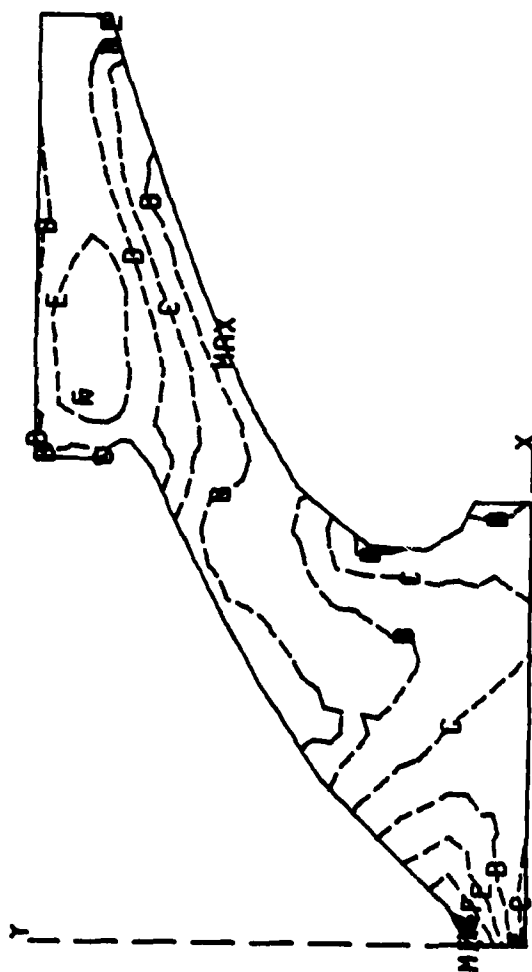
| MAX | LEGEND | PSI      | MIN |
|-----|--------|----------|-----|
| A   | (E-03) | 37399.98 |     |
| B   |        | 37099.97 |     |
| C   |        | 36799.97 |     |
| D   |        | 36499.97 |     |
| E   |        | 36199.96 |     |
| F   |        | 35899.96 |     |
| G   |        | 35599.96 |     |
| H   |        | 35299.96 |     |
| MAX |        | 37468.61 |     |
| MIN |        | 35068.82 |     |

RUN 124 MACH .7 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:38:14 80/162



| MIN | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 752.00 |
| B   |        | 744.00 |
| C   |        | 736.00 |
| D   |        | 728.00 |
| E   |        | 720.00 |
| F   |        | 712.00 |
| G   |        | 704.00 |
| MAX |        | 752.36 |
| MIN |        | 697.22 |

RUN 124 MACH.3 TGRS 800 RE .56E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:20:49 80/014

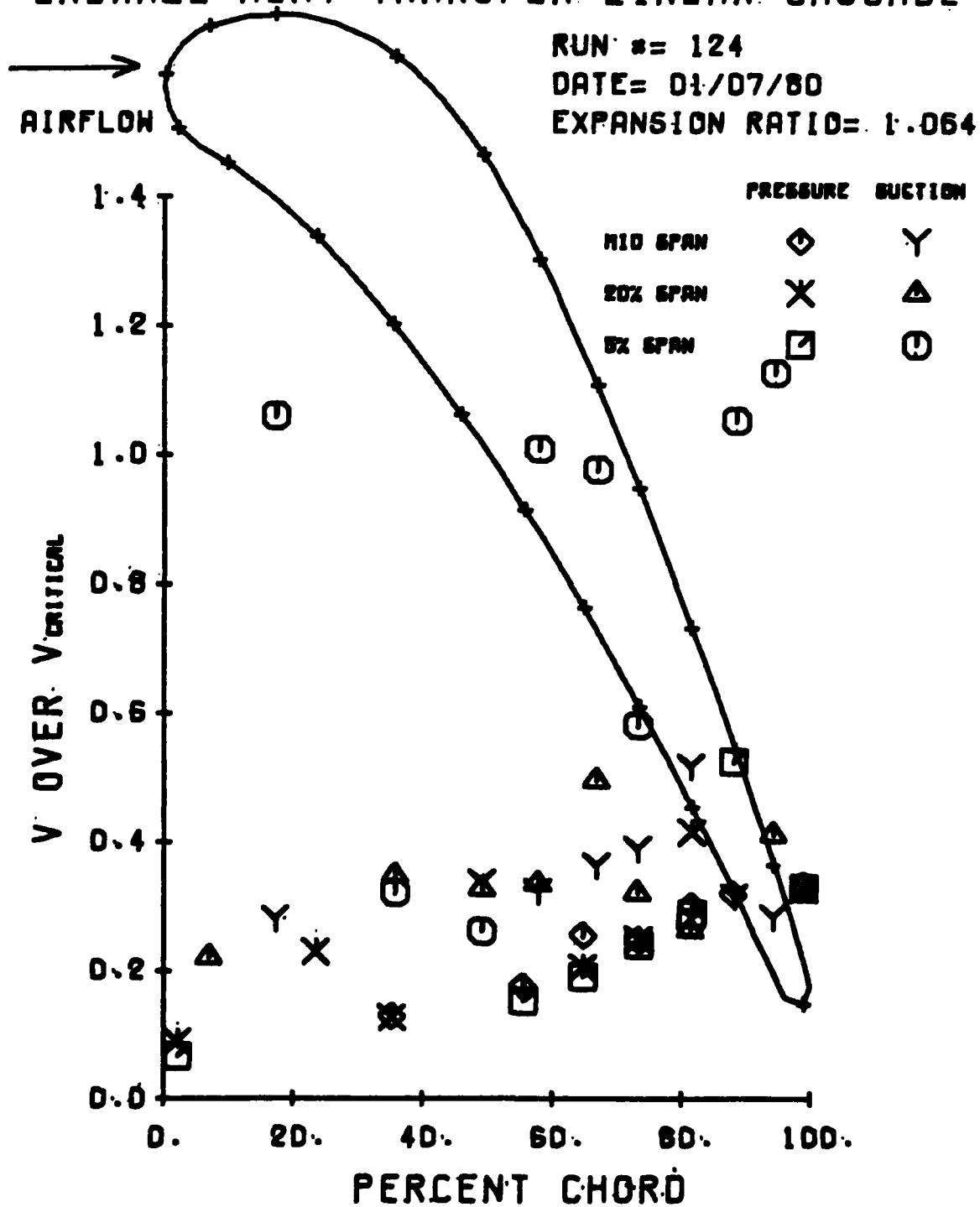


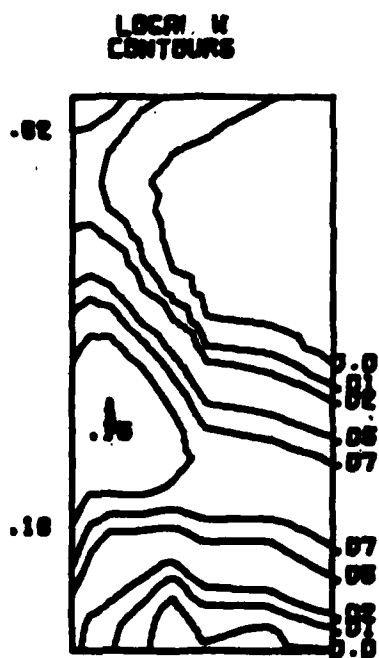
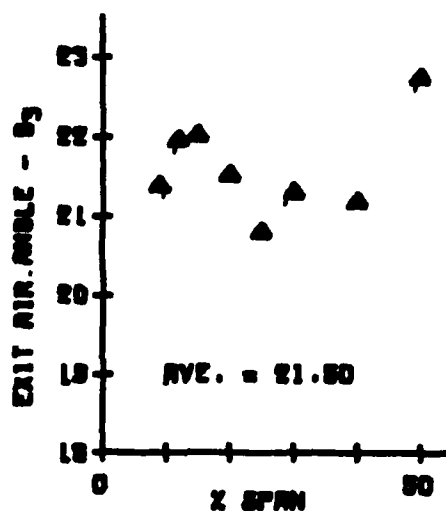
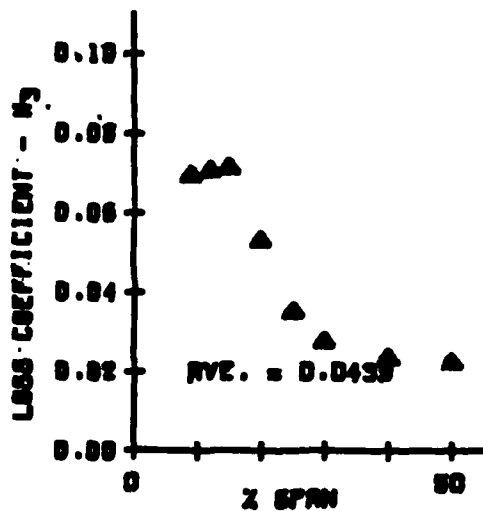
| MM  | LEGEND | MM       |
|-----|--------|----------|
|     | F      | (E-06)   |
| A   | B      | -2200.00 |
| B   | C      | -3100.00 |
| C   | D      | -4000.00 |
| D   | E      | -4900.00 |
| E   | F      | -5799.99 |
| F   | G      | -6699.99 |
| G   | H      | -7599.98 |
| H   | MAX    | -8499.98 |
| MAX | MIN    | -2208.20 |
| MIN |        | -8647.31 |

RUN 124 MACH.3 TGAS 800 RE .56E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:19:57 80/014

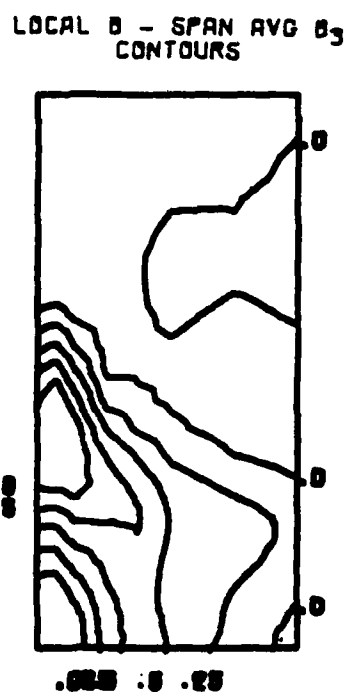


# ENDWALL HEAT TRANSFER LINEAR CASCADE





SUCTION  
SIDE  
 ↑  
 ↓  
 PRESSURE  
SIDE



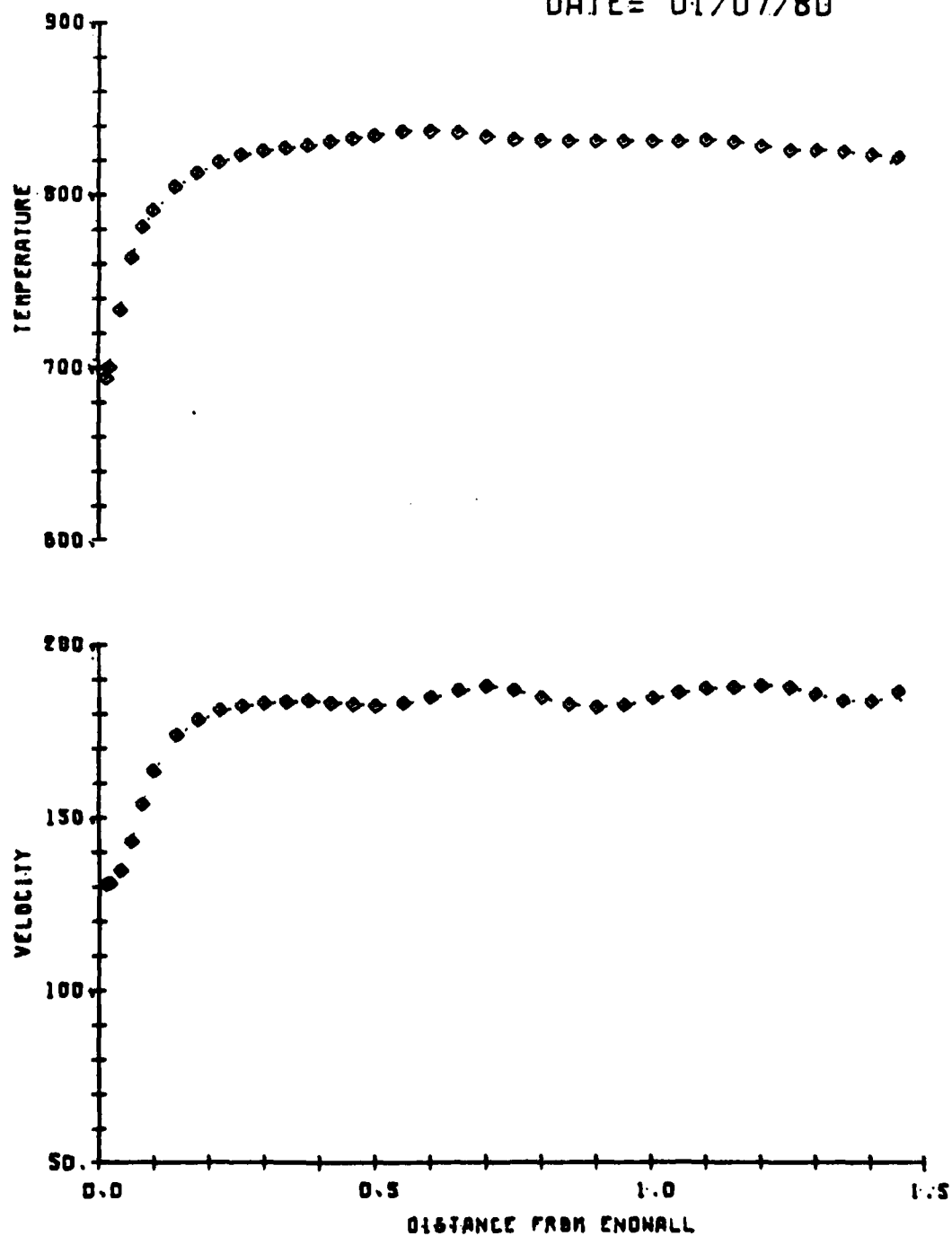
EXIT MACH NO. = 0.30 REYNOLDS NO. =  $8.08 \times 10^5$

RUN 124 AERODYNAMIC EXIT DATA

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 124

DATE = 01/07/80



# 3MA 270 TURBINE VANE CASCADE

RUN #101

DATE: 2/8/84

TIME: 4:10: 2

## INLET CONDITIONS

| PTOTLE | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
|--------|---------|---------|--------|------|-----------|
| 63.65  | 63.49   | 1280.30 | .090   | .096 | .283      |

## STANTON CALCULATION INPUT

| WHD - LBM/IN <sup>2</sup> * 10**4 | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
|-----------------------------------|------------------|------------------------|
| .77641                            | 6841468.         | 818.74                 |

CP = BTU/LBM/F  
.257

## MASS FLOW RATE

ORIFICE

5.69

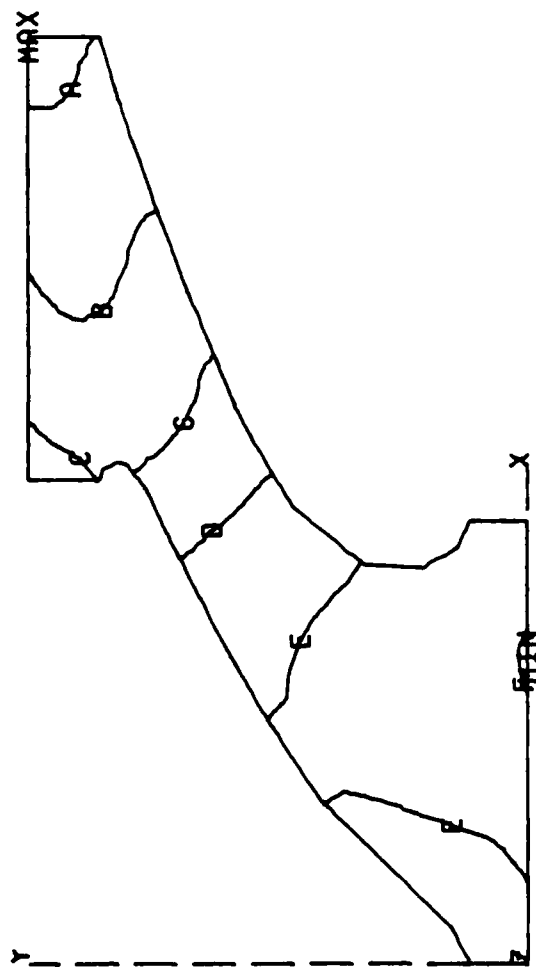
CASCADE

## IDEAL EXIT CONDITIONS

| PTOTLE | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
|--------|--------|---------|--------|------|-----------|
| 63.45  | 59.95  | 1280.30 | .305   | .320 | .929      |

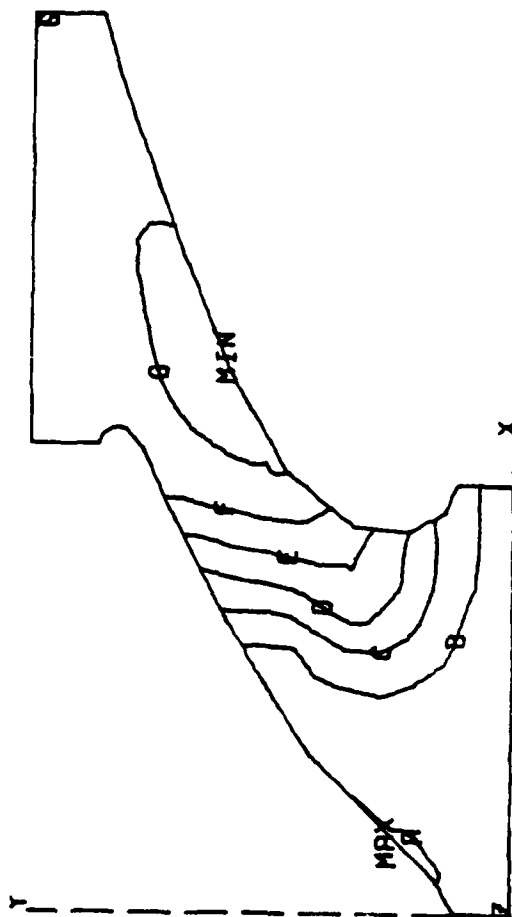
## CASCADE OPERATING CONDITION

| EXPANSION RATIO= | STATIC PRESSURE RATIO= |
|------------------|------------------------|
| 1.065            | .944                   |



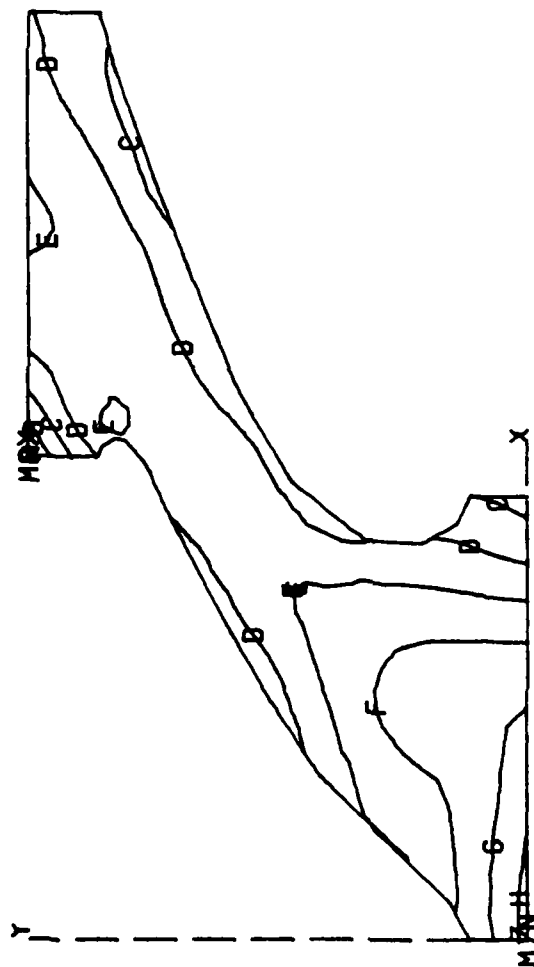
| LEGEND | F      |
|--------|--------|
| A      | 630.00 |
| B      | 610.00 |
| C      | 590.00 |
| D      | 570.00 |
| E      | 550.00 |
| F      | 530.00 |
| MAX    | 638.05 |
| MIN    | 528.84 |

RUN 131 MACH .3 TGAS 840 RE .9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:43:12 80/046



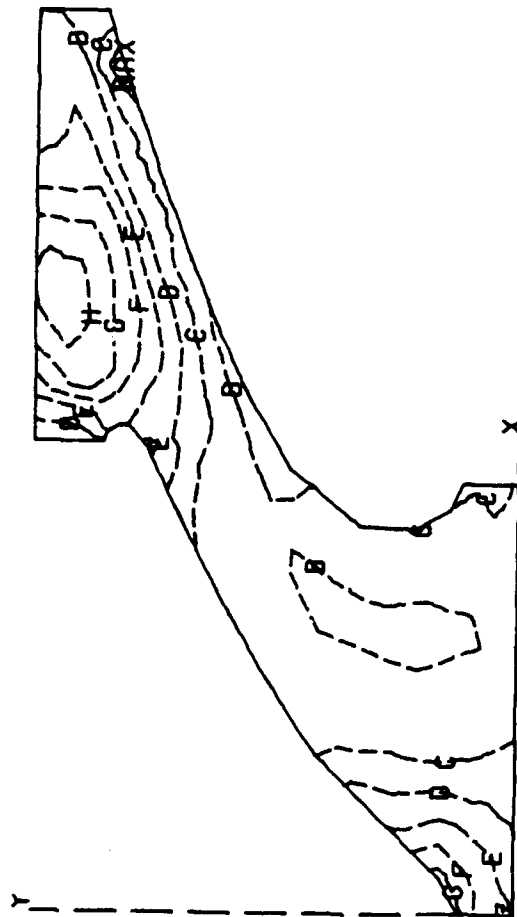
\*\*\* LEGEND \*\*\*  
 PSI  
 (E-03)  
 63599.97  
 62999.97  
 62399.96  
 61799.95  
 61199.94  
 60599.94  
 59999.94  
 53621.54  
 59665.22  
 A B C D E F G  
 MAX  
 MIN

RUN 131 MACH .3 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:01:06 80/176



| MIN | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 750.00 |
| B   |        | 743.00 |
| C   |        | 736.00 |
| D   |        | 729.00 |
| E   |        | 722.00 |
| F   |        | 715.00 |
| G   |        | 708.00 |
| H   |        | 701.00 |
| MAX |        | 750.97 |
| MIN |        | 698.58 |

RUN 125 MACH.3 TGAS 800 RE .92E06 ADIABATIC  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:35:47 80/036



| MAX | LEGEND   | MIN |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -2000.00 |     |
| B   | -3000.00 |     |
| C   | -4000.00 |     |
| D   | -5000.00 |     |
| E   | -6000.00 |     |
| F   | -6999.99 |     |
| G   | -7999.99 |     |
| H   | -8999.99 |     |
| MAX | -2153.22 |     |
| MIN | -9410.52 |     |

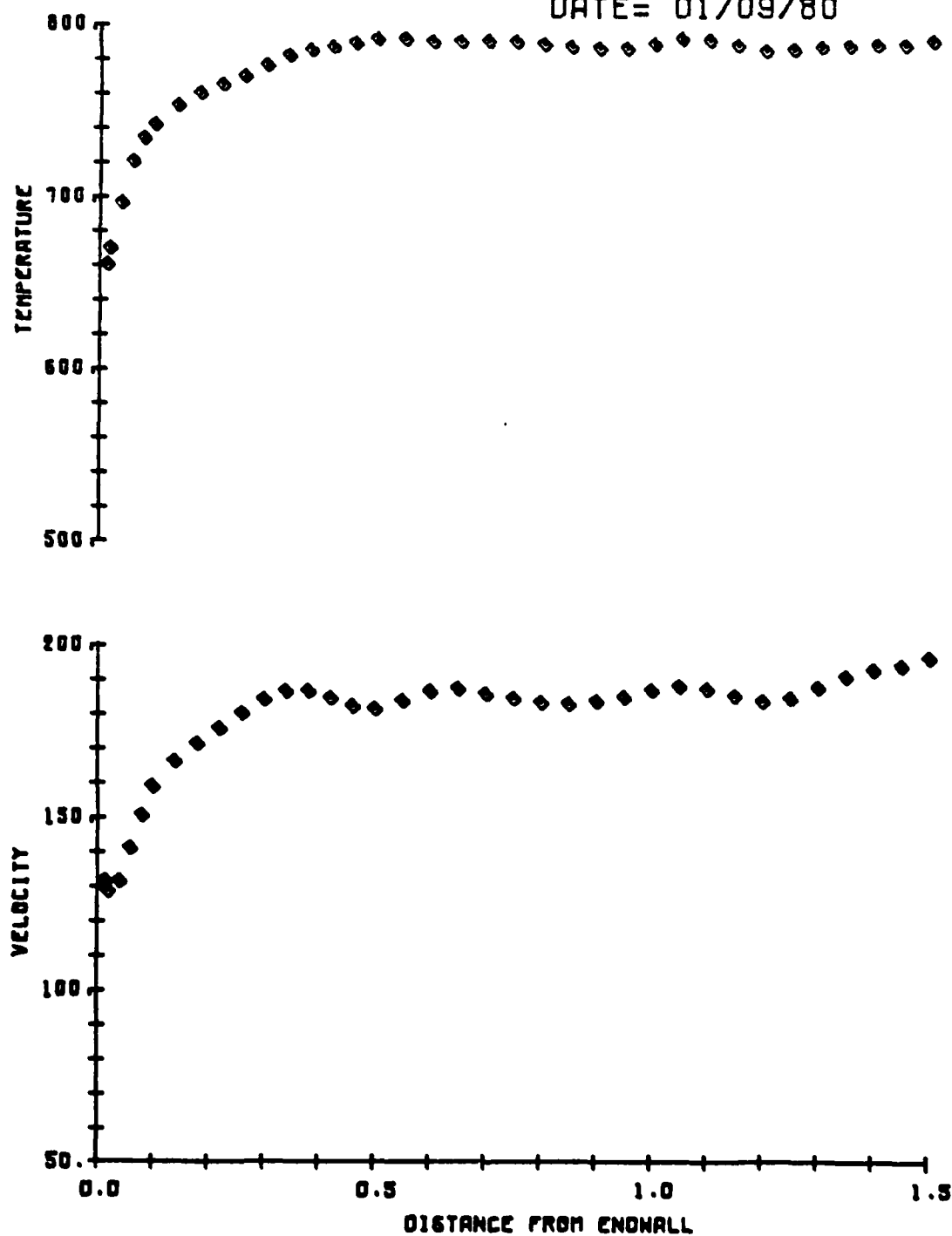
RUN 131 MACH .3 TCAS 840 RE .9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:43:36 80/046



# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 125

DATE = 01/09/80



GMA 200 TURBINE VANE CASCADE

RUN #132

DATE: 2/6/80

TIME: 7:42:42

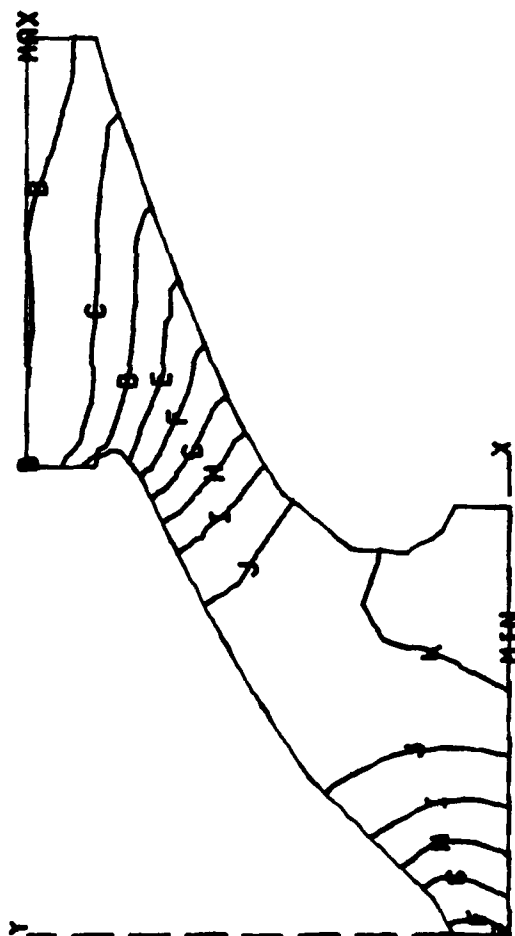
| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 34.68            | 33.92   | 1284.28 | .181   | .196 | .324      |

| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .41507                    | 13700412.        | 817.03                 |
| CP - BTU/LBM/F            |                  |                        |
| .257                      |                  |                        |

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 5.72           | CASCADE |

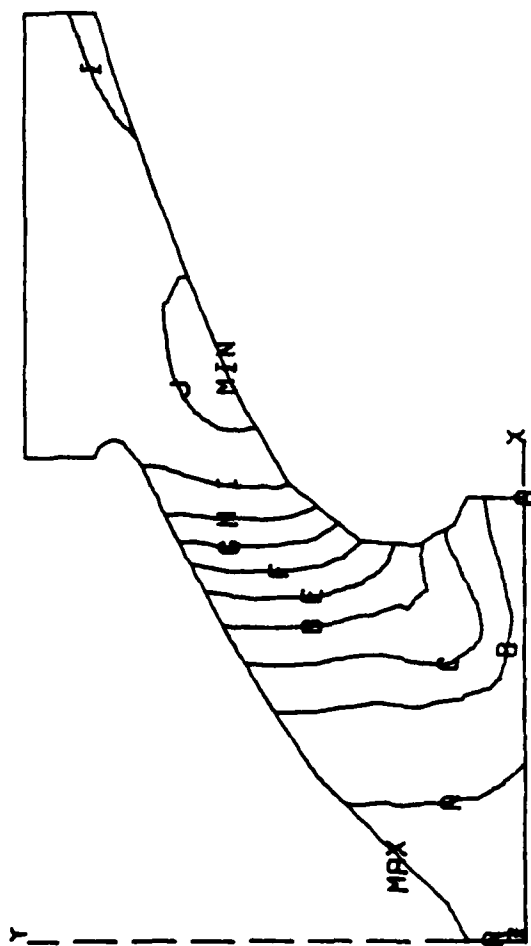
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 34.68                 | 25.46  | 1284.28 | .686   | .717 | .945      |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.362                       | .751                   |



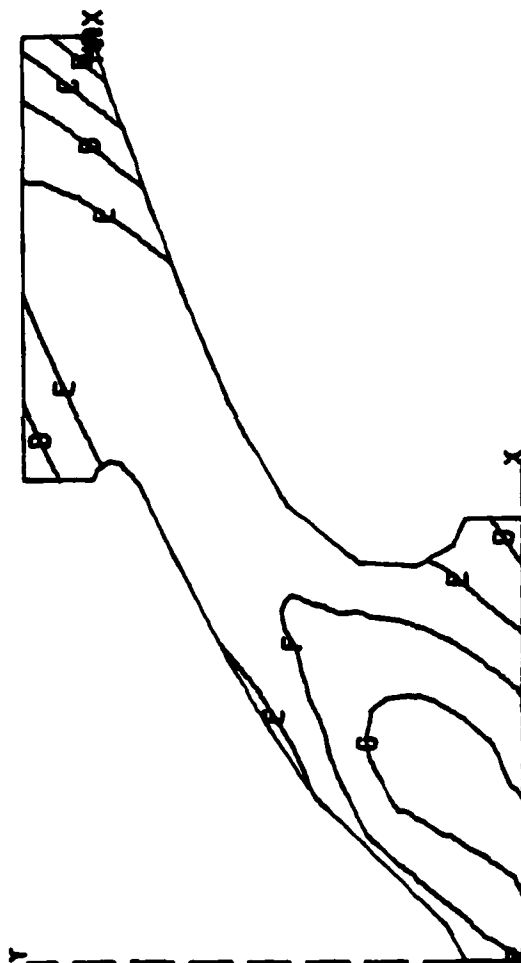
| MM  | LEGEND | MM |
|-----|--------|----|
| A   | 650.00 | F  |
| B   | 640.00 |    |
| C   | 630.00 |    |
| D   | 620.00 |    |
| E   | 610.00 |    |
| F   | 600.00 |    |
| G   | 590.00 |    |
| H   | 580.00 |    |
| I   | 570.00 |    |
| J   | 560.00 |    |
| K   | 550.00 |    |
| MAX | 650.03 |    |
| MIN | 545.04 |    |

RUN 132 MACH .7 TGRS 800 RE.9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:57:19 80/050



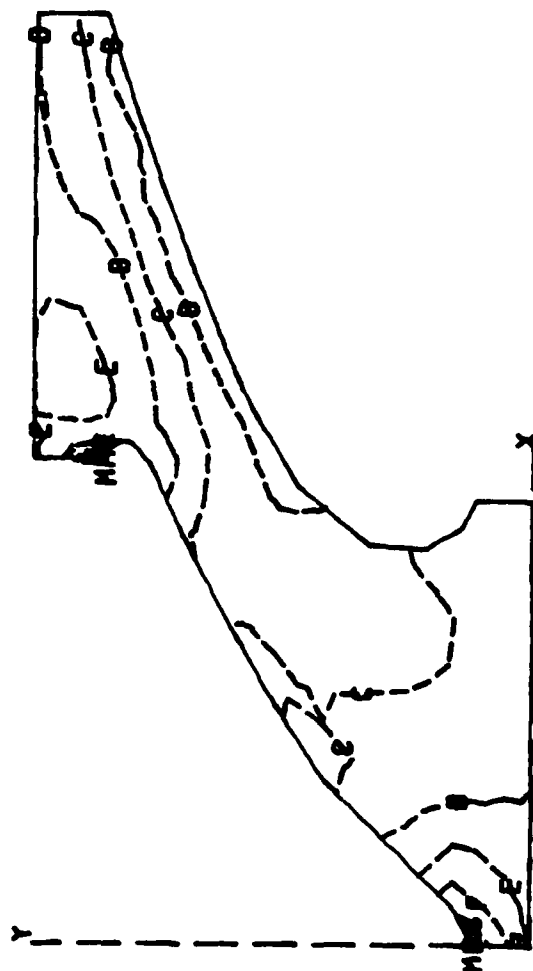
| MAX | LEGEND | MAX   |
|-----|--------|-------|
|     |        | PSI   |
| A   | B      | 34.00 |
| B   | C      | 33.00 |
| C   | D      | 32.00 |
| D   | E      | 31.00 |
| E   | F      | 30.00 |
| F   | G      | 29.00 |
| G   | H      | 28.00 |
| H   | I      | 27.00 |
| I   | J      | 26.00 |
| MAX |        | 25.00 |
| MIN |        | 34.24 |
|     |        | 24.51 |

RUN 132 MACH .7 TGRS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:51:44 80/162



| MMM | LEGEND | MMM |
|-----|--------|-----|
| A   | 786.00 | F   |
| B   | 776.00 | G   |
| C   | 766.00 | MAX |
| D   | 756.00 | MIN |
| E   | 746.00 |     |
| F   | 736.00 |     |
| G   | 726.00 |     |
| MAX | 786.95 |     |
| MIN | 719.75 |     |

RUN 132 MACH .7 TGRS 800 RE2 .9E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 7:53:38 80/163



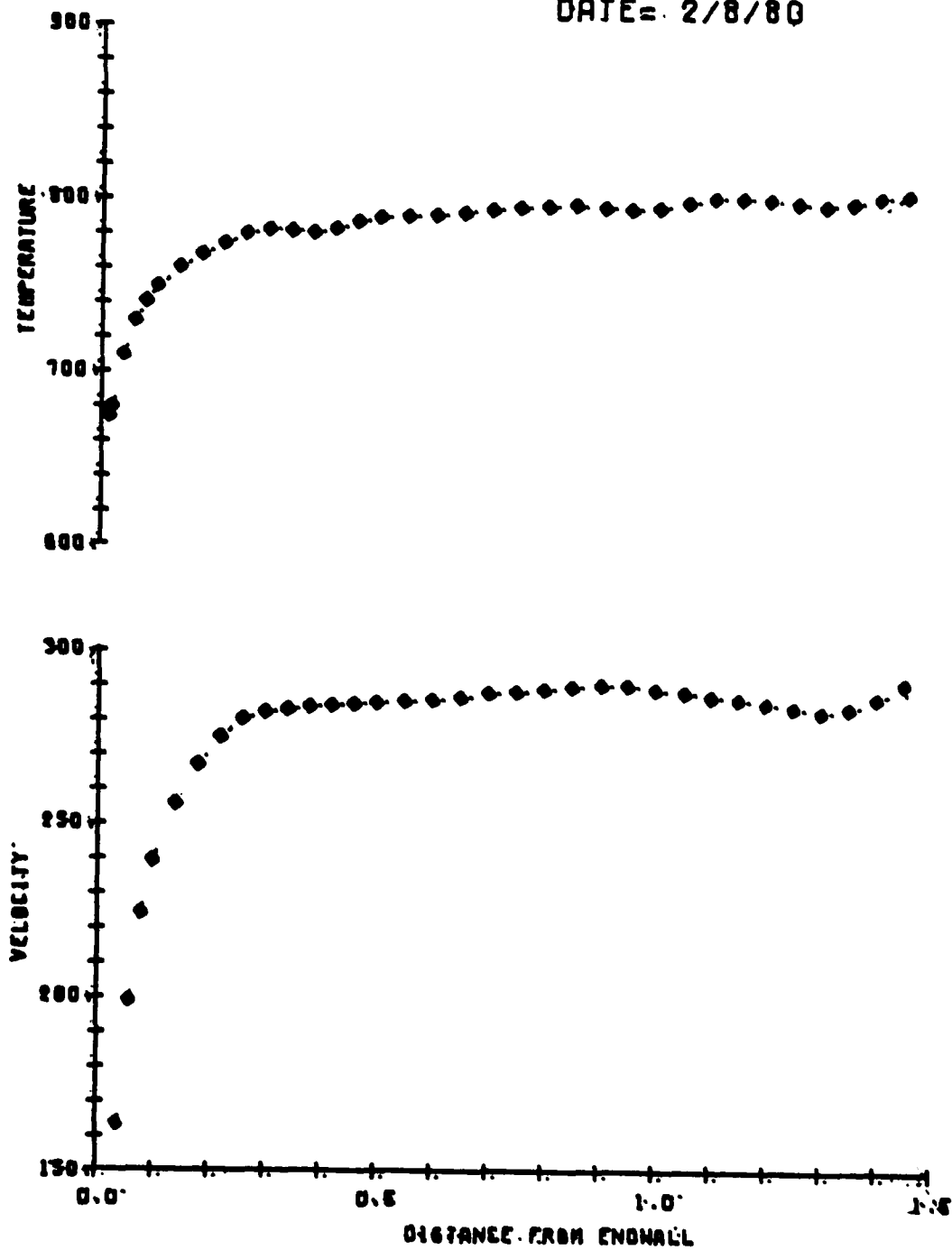
| MAX | LEGEND     | MIN    |
|-----|------------|--------|
|     | $10^{-03}$ |        |
| B   | -1.00      |        |
| C   | -3.00      |        |
| D   | -5.00      |        |
| E   | -7.00      |        |
| F   | -9.00      |        |
| G   | -11.00     |        |
| H   | -13.00     |        |
| MIN |            | -13.23 |

RUN 132 MACH .7 TGAS 800 RE.9E08 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:57:40 80/050

# ENDWALL HEAT TRANSFER. LINEAR. CASCADE

RUN # = 132

DATE = 2/8/80



GMA 200 TURBINE VANE CASCADE

RUN #133

DATE: 2/8/80

TIME: 8:59: 3

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/12**6 |
| 34.21            | 33.30   | 1283.77 | .176   | .190 | .289      |

STANTON CALCULATION INPUT

|                      |                  |                        |
|----------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4 | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .44757               | 13282300.        | 816.98                 |
| CP - BTU/LBM/F       |                  |                        |
| .257                 |                  |                        |

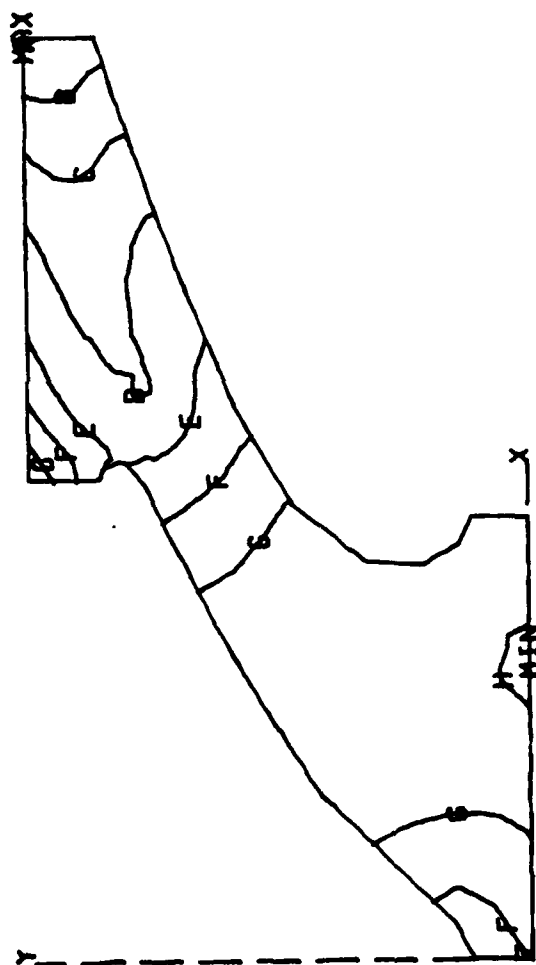
|         |                |      |         |
|---------|----------------|------|---------|
| ORIFICE | MASS FLOW RATE | 4.29 | CASCADE |
|---------|----------------|------|---------|

| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/12**6 |
| 34.21                 | 24.86  | 1283.77 | .693   | .722 | .931      |

CASCADE OPERATING CONDITION

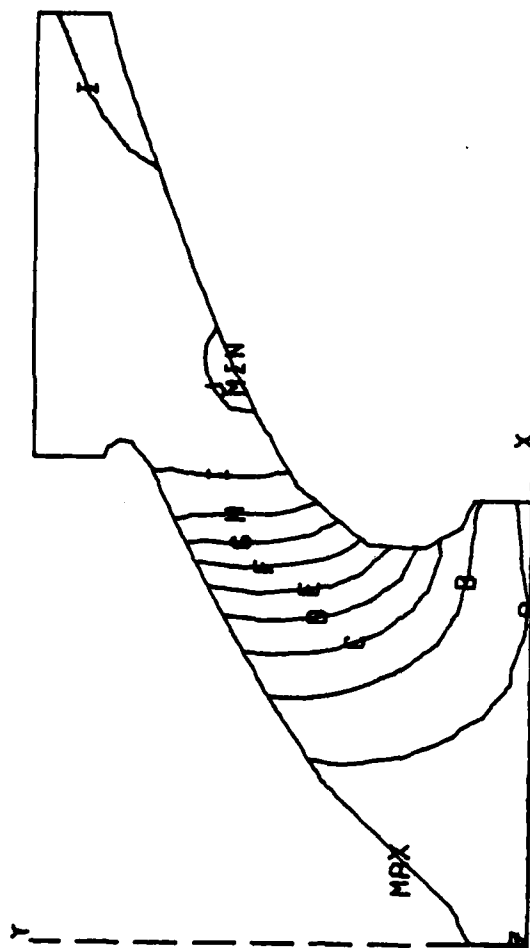
|                  |       |                        |      |
|------------------|-------|------------------------|------|
| EXPANSION RATIO= | 1.368 | STATIC PRESSURE RATIO= | .746 |
|------------------|-------|------------------------|------|





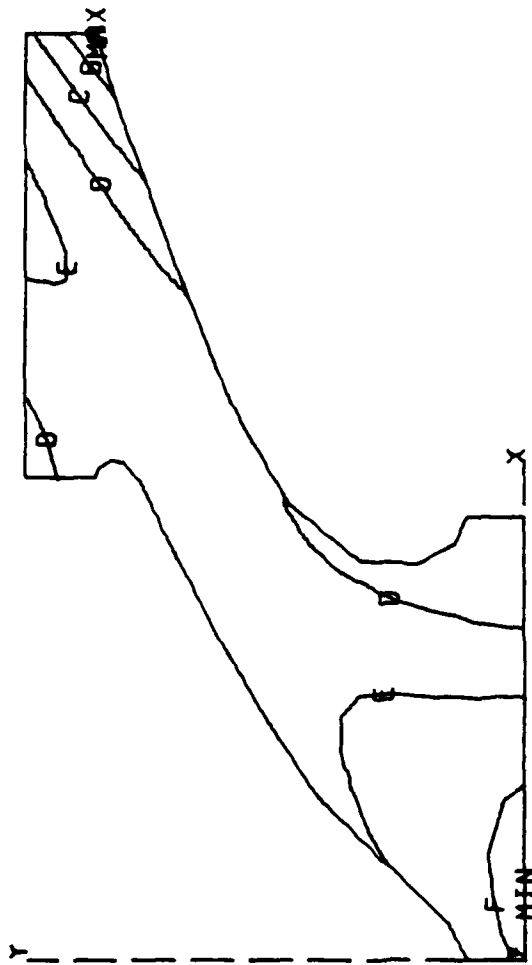
| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 536.00 |
| B   |        | 527.00 |
| C   |        | 518.00 |
| D   |        | 509.00 |
| E   |        | 500.00 |
| F   |        | 491.00 |
| G   |        | 482.00 |
| H   |        | 473.00 |
| MAX |        | 536.96 |
| MIN |        | 471.89 |

133 MACH .7 TGAS 800 RE.9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:54:35 80/050



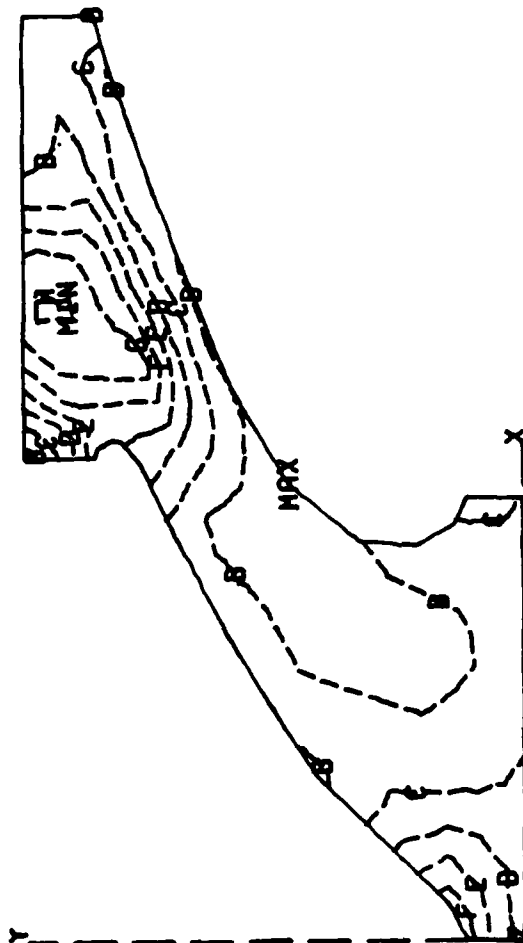
| MAX | LEGEND | MAX   |
|-----|--------|-------|
| A   | PSI    | 33.00 |
| B   |        | 32.00 |
| C   |        | 31.00 |
| D   |        | 30.00 |
| E   |        | 29.00 |
| F   |        | 28.00 |
| G   |        | 27.00 |
| H   |        | 26.00 |
| I   |        | 25.00 |
| J   |        | 24.00 |
| MAX |        | 33.59 |
| MIN |        | 23.77 |

RUN 133 MACH .7 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:02:54 80/162



| MMM | LEGEND | MMM    |
|-----|--------|--------|
| A   | F      | 800.00 |
| B   |        | 780.00 |
| C   |        | 760.00 |
| D   |        | 740.00 |
| E   |        | 720.00 |
| F   |        | 700.00 |
| MAX |        | 801.27 |
| MIN |        | 692.98 |

RUN 133 M2 .7 TCAS 800 RE2 .9E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:42:14 80/169



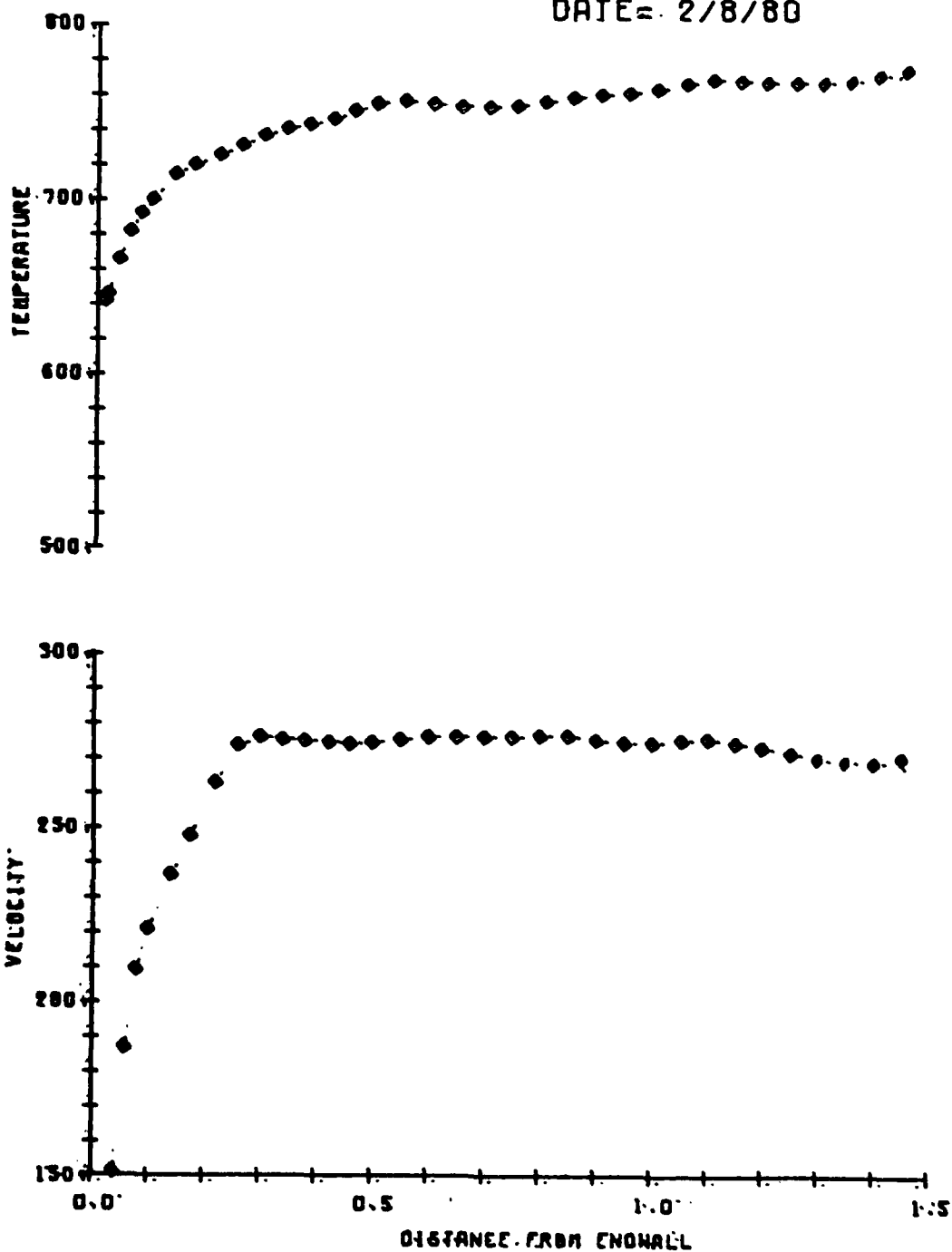
| MAX | LEGEND | F        | MIN |
|-----|--------|----------|-----|
| A   | (E-06) | -1600.00 |     |
| B   |        | -2400.00 |     |
| C   |        | -3200.00 |     |
| D   |        | -4000.00 |     |
| E   |        | -4800.00 |     |
| F   |        | -5600.00 |     |
| G   |        | -6400.00 |     |
| H   |        | -7199.99 |     |
| MAX |        | -1630.59 |     |
| MIN |        | -7298.04 |     |

RUN 133 MACH .7 TGAS 800 RE.9EQ6 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:54:58 80/050

# ENDWALL HEAT TRANSFER. LINEAR CASCADE

RUN # = 133

DATE = 2/8/80



GMA 200 TURBINE VANE CASCADE

RUN #149

DATE: 3/27/80

TIME: 9:21: 8

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 32.67            | 31.69   | 1262.35 | .212   | .229 | .339      |

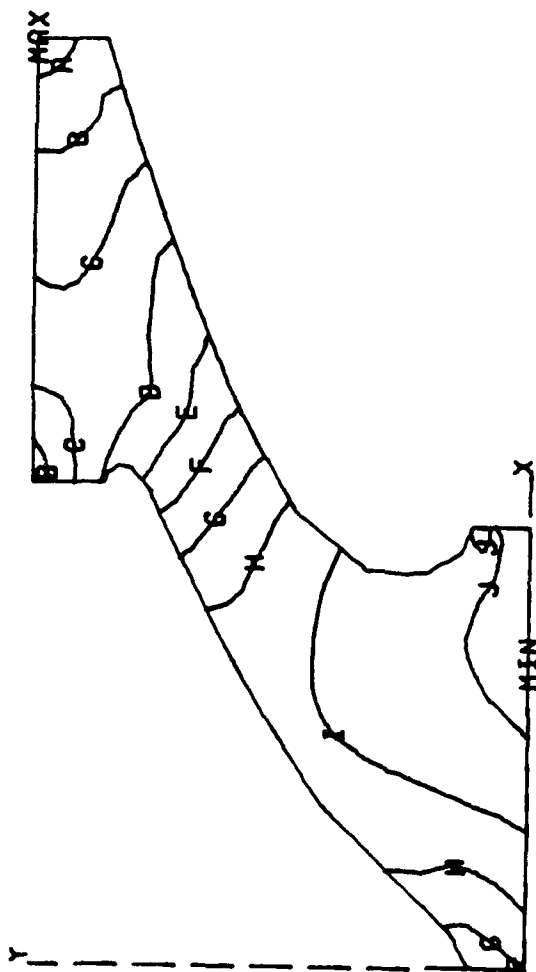
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .39542                    | 15656892.        | 792.47                 |

CP - BTU/LBM/F  
.257

| ORIFICE | MASS FLOW RATE |  | CASCADE |
|---------|----------------|--|---------|
|         | 5.46           |  |         |

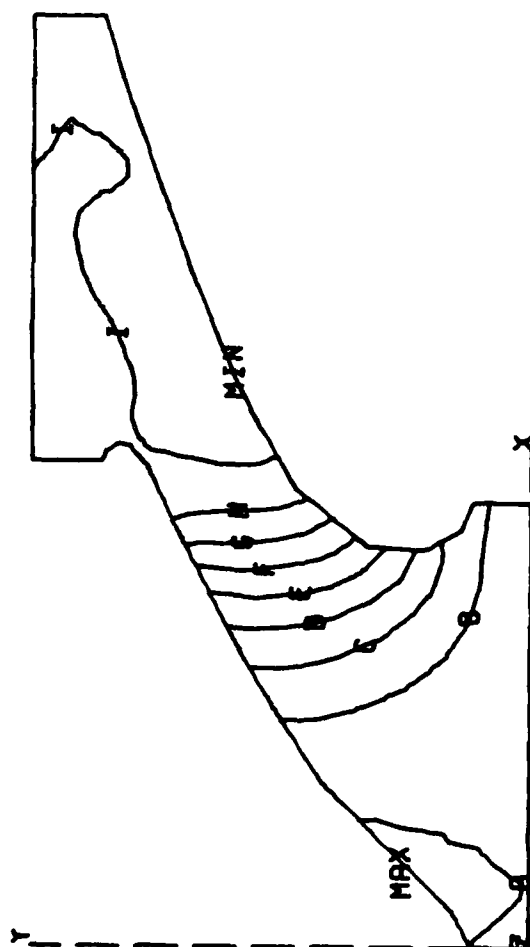
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 32.67                 | 23.99  | 1262.35 | .687   | .717 | .908      |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.361                       | .757                   |



| MMM | LEGEND | FFF    |
|-----|--------|--------|
| A   | B      | 600.00 |
| B   | C      | 590.00 |
| C   | D      | 580.00 |
| D   | E      | 570.00 |
| E   | F      | 560.00 |
| F   | G      | 550.00 |
| G   | H      | 540.00 |
| H   | I      | 530.00 |
| I   | J      | 520.00 |
| MAX |        | 510.00 |
| MIN |        | 605.09 |
|     |        | 506.52 |

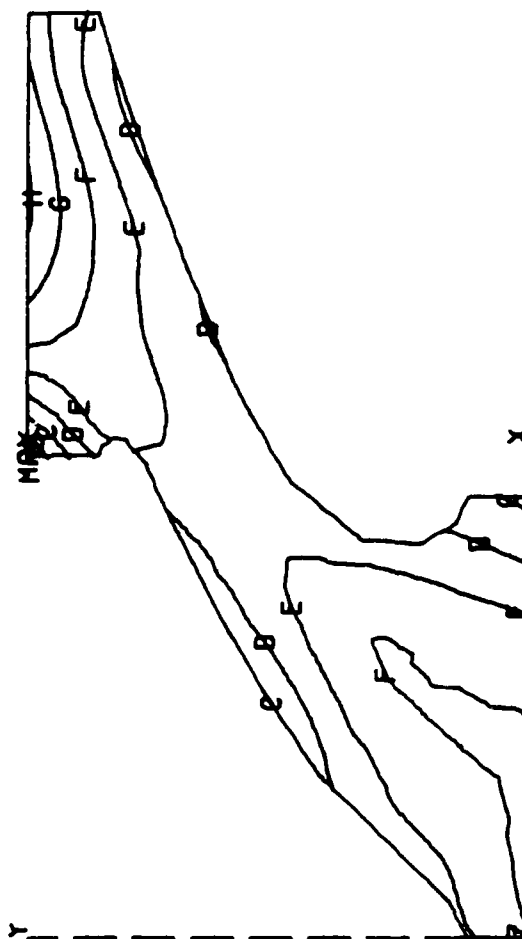
RUN 149 MACH .7 TGAS 800 RE .9E06 H.T. ENDWALL THICK B.L.  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:17:50 80/092



|     |        |       |
|-----|--------|-------|
| MAX | LEGEND | MAX   |
| A   | PSI    | 32.00 |
| B   |        | 31.00 |
| C   |        | 30.00 |
| D   |        | 29.00 |
| E   |        | 28.00 |
| F   |        | 27.00 |
| G   |        | 26.00 |
| H   |        | 25.00 |
| I   |        | 24.00 |
| MAX |        | 32.17 |
| MIN |        | 23.12 |

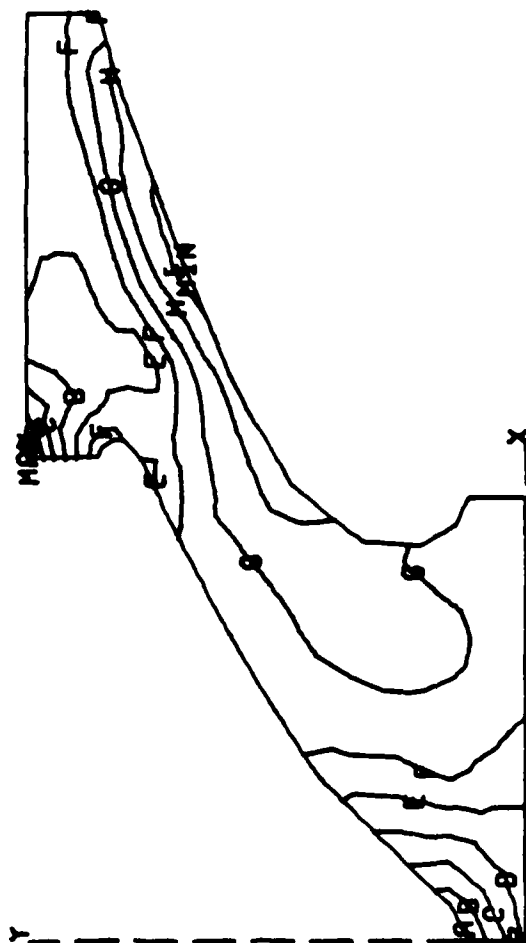
RUN 149 MARCH .7 TGRS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:39:38 80/162





| MAX | LEGEND | MAX    |
|-----|--------|--------|
|     | F      |        |
| A   |        | 764.00 |
| B   |        | 757.00 |
| C   |        | 750.00 |
| D   |        | 743.00 |
| E   |        | 736.00 |
| F   |        | 729.00 |
| G   |        | 722.00 |
| H   |        | 715.00 |
| MAX |        | 764.13 |
| MIN |        | 714.16 |

RUN 149 MACH .7 TGAS 800 RE .9E06 ADIABATIC ENDWALL THICK B.L.  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:32:41 80/092



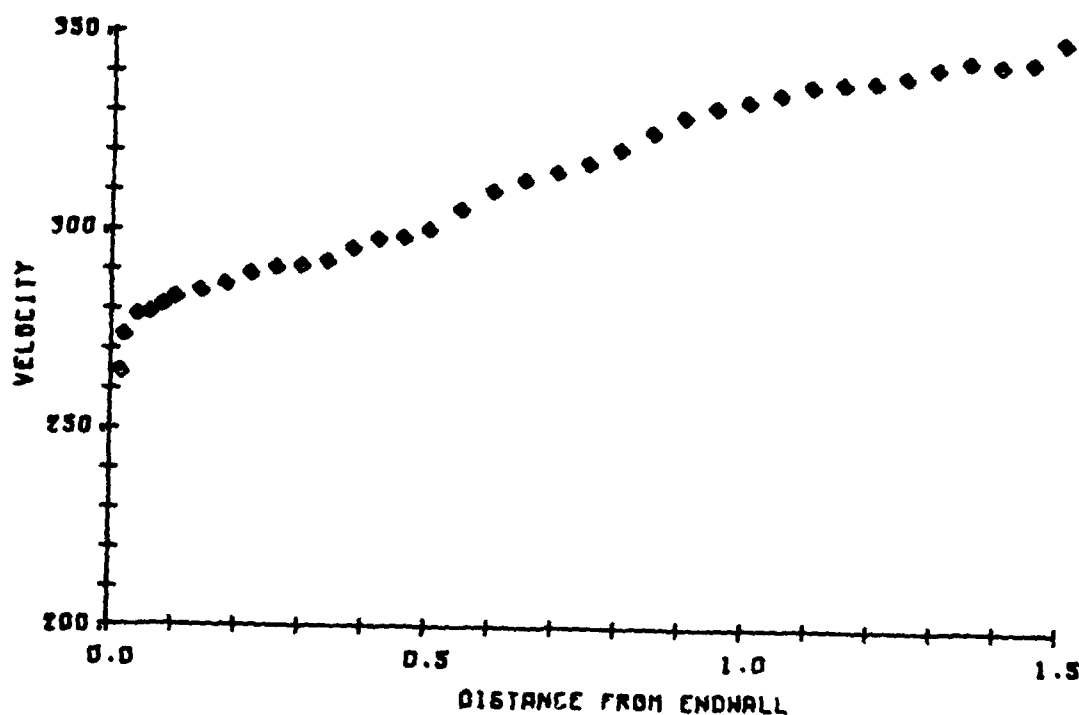
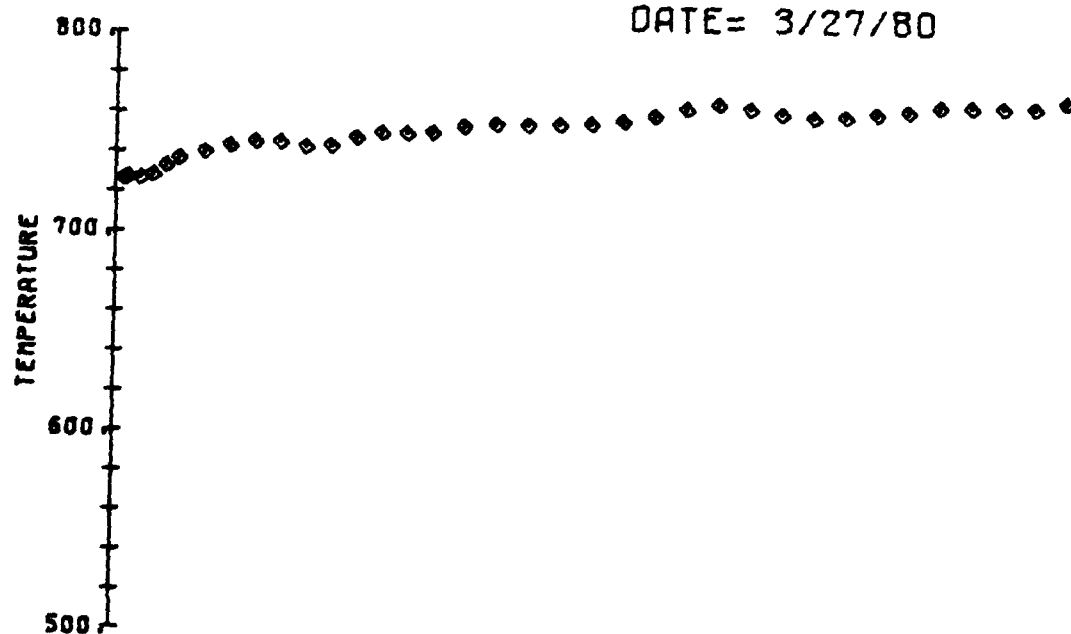
MAX LEGEND F MAX  
 (E-06)  
 9000.00  
 8000.00  
 6999.99  
 5999.99  
 4999.99  
 3999.99  
 2999.99  
 1999.99  
 999.99  
 9621.72  
 481.87  
 A B C D E F G H I  
 MAX  
 MIN

RUN 149 MACH .7 TCAS 800 AE .9E06 H.T. ENDWALL THICK B.L.  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:18:21 80/092

# ENDWALL HEAT TRANSFER LINEAR CASCADE=

RUN # = 149

DATE = 3/27/80



GMA 200 TURBINE VANE CASCADE

RUN #150

DATE: 3/27/809

TIME: 10:11:33

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 34.59            | 34.31   | 1253.40 | .109   | .119 | .190      |

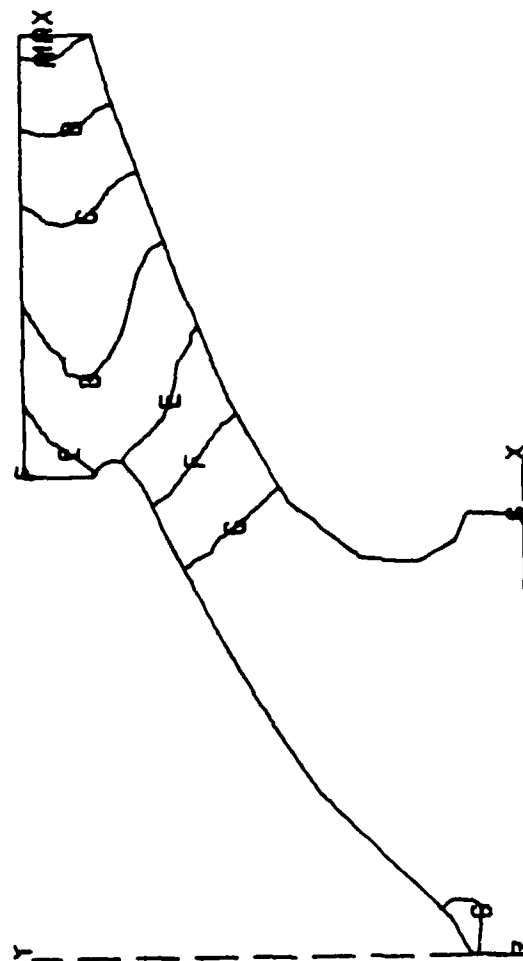
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| $\rho$ - LBM/IN3 *10**4   | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .42863                    | 8077319.         | 791.01                 |

CP - BTU/LBM/F  
.257

| ORIFICE | MASS FLOW RATE |  | CASCADE |
|---------|----------------|--|---------|
|         | 2.98           |  |         |

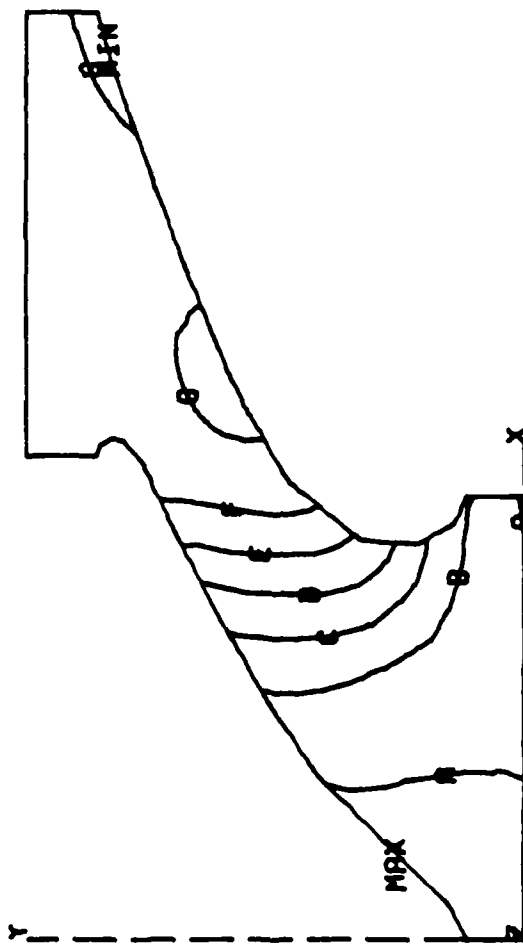
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 34.59                 | 32.65  | 1253.40 | .292   | .315 | .491      |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO*            | STATIC PRESSURE RATIO* |
| 1.059                       | .952                   |



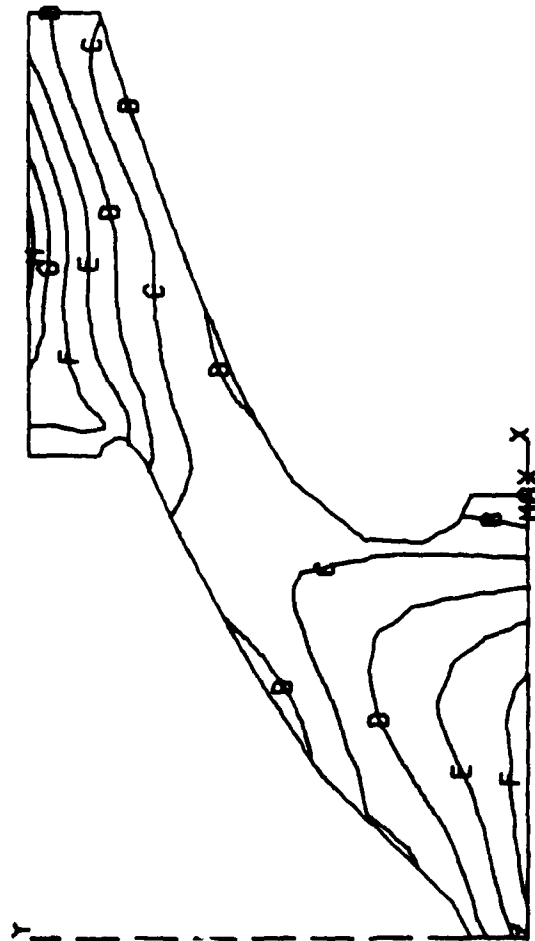
\*\*\* LEGEND \*\*\*  
 F  
 A 520.00  
 B 510.00  
 C 500.00  
 D 490.00  
 E 480.00  
 F 470.00  
 G 460.00  
 MAX 523.51  
 MIN 450.59  
 \*DENOTES HIDDEN

RUN 150 MACH .3 TCAS 800 AE .5E06 H.T. ENDWALL THICK B.L.  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:17:51 80/151



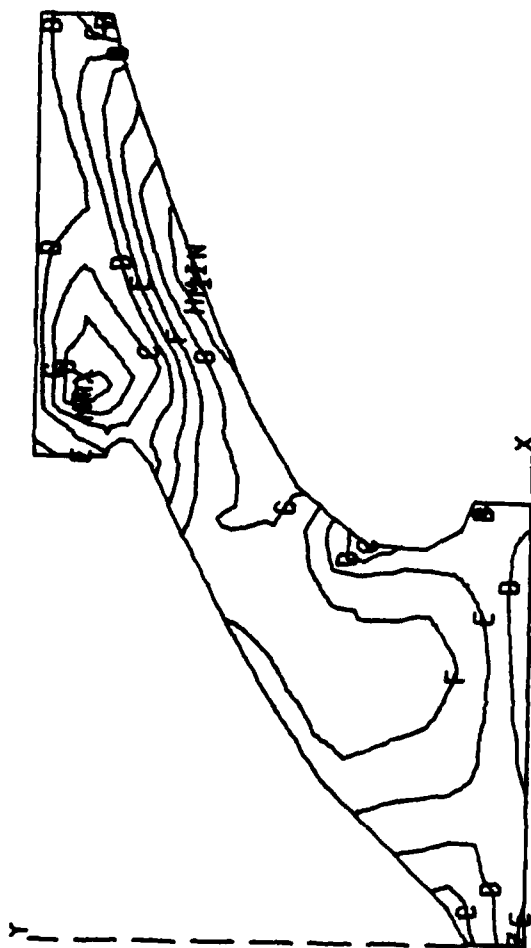
| NUM | LEGEND   | MIN |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 34299.97 |     |
| B   | 33999.97 |     |
| C   | 33699.96 |     |
| D   | 33399.96 |     |
| E   | 33099.96 |     |
| F   | 32799.96 |     |
| G   | 32499.95 |     |
| MAX | 34383.76 |     |
| MIN | 32381.67 |     |

RUN 150 MACH .3 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:40:37 80/168



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 757.00 |
| B   |        | 750.00 |
| C   |        | 743.00 |
| D   |        | 736.00 |
| E   |        | 729.00 |
| F   |        | 722.00 |
| G   |        | 715.00 |
| H   |        | 708.00 |
| MAX |        | 757.08 |
| MIN |        | 705.52 |

RUN 150 MACH .3 TGAS 800 RE .5E06 ADIABATIC ENDWALL THICK B.L.  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:42:06 80/092



| MAX | LEGEND  | MIN |
|-----|---------|-----|
|     | F       |     |
|     | IE-06)  |     |
|     | 9000.00 |     |
|     | 8000.00 |     |
|     | 6999.99 |     |
|     | 5999.99 |     |
|     | 4999.99 |     |
|     | 3999.99 |     |
|     | 2999.99 |     |
|     | 1999.99 |     |
|     | 999.99  |     |
|     | 9604.82 |     |
|     | 759.50  |     |
|     | MAX     |     |
|     | MIN     |     |

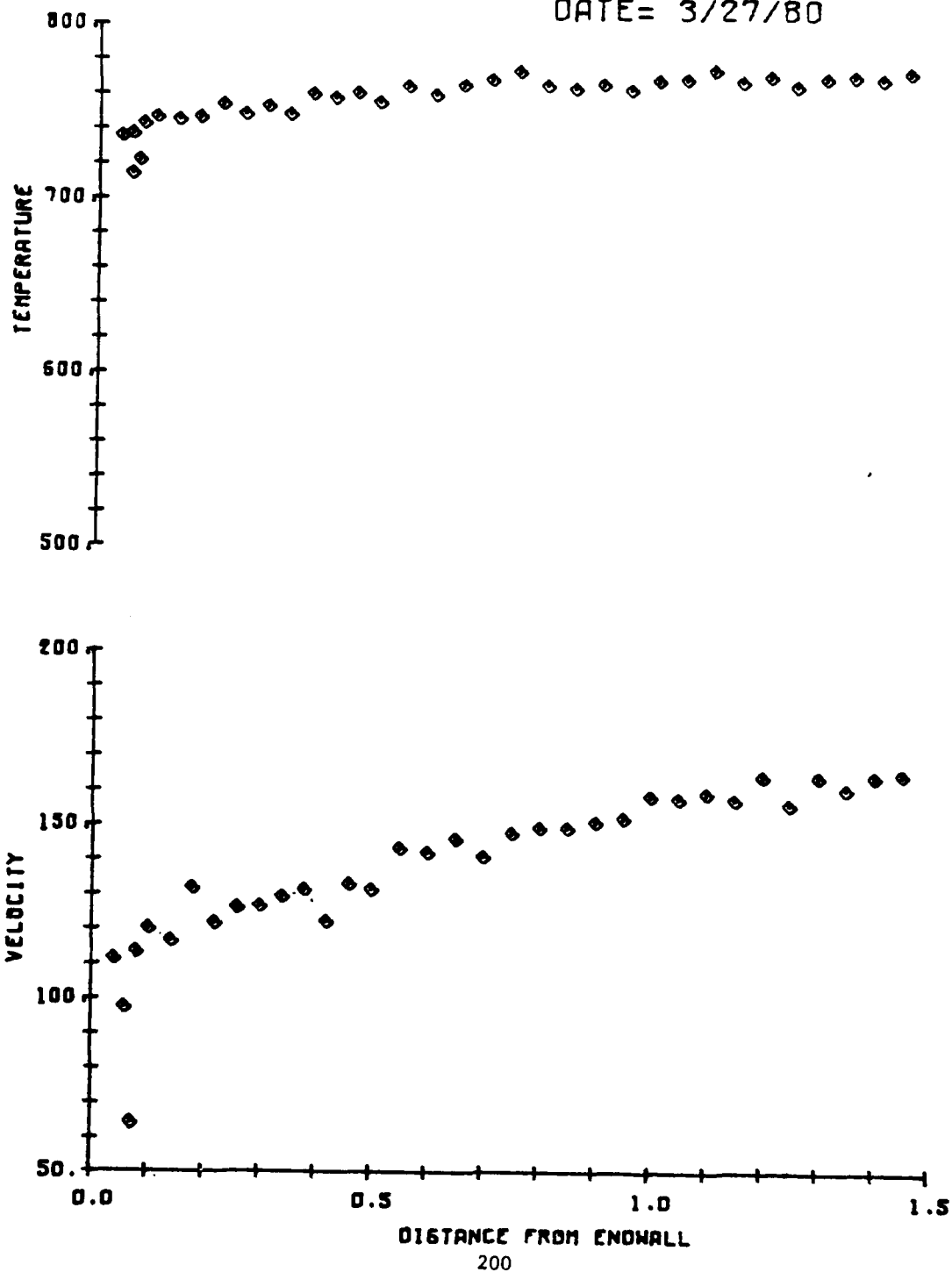
RUN 150 MACH .3 TCAS 800 RE .5E06 H.T. ENDWALL THICK B.L.  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:19:13 80/151



# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 150

DATE = 3/27/80



GMA 200 TURBINE VANE CASCADE

RUN #165

DATE: 5/14/80

TIME: 4:18:37

|        |         | INLET CONDITIONS |        |      |           |
|--------|---------|------------------|--------|------|-----------|
| PTOTLE | PSTATIC | TTOTLE           | MACH # | V/V* | REY/10**6 |
| 33.47  | 33.03   | 1265.29          | .139   | .151 | .231      |

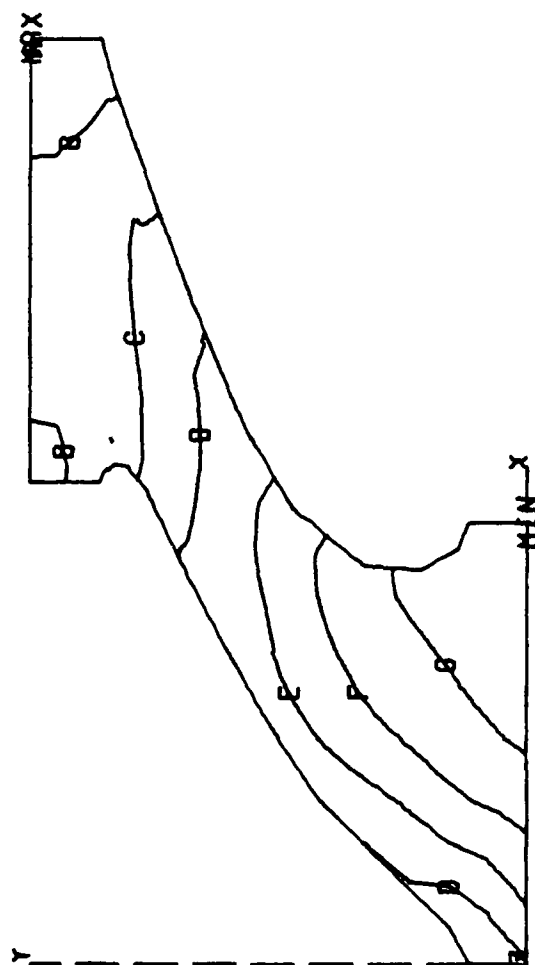
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO -LBM/IN3 *10**4       | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .40936                    | 10339674.        | 801.18                 |

CP - BTU/LBM/F  
.257

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 4.91           | CASCADE |

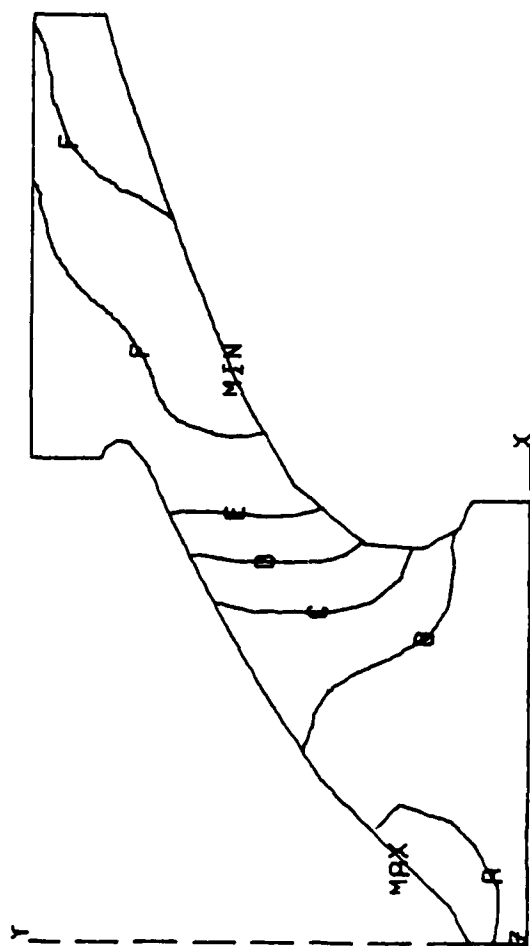
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 33.47                 | 24.13  | 1265.29 | .708   | .737 | .944      |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.387                       | .731                   |



| MM  | LEGEND | MM     |
|-----|--------|--------|
| A   | F      | 547.00 |
| B   |        | 537.00 |
| C   |        | 527.00 |
| D   |        | 517.00 |
| E   |        | 507.00 |
| F   |        | 497.00 |
| G   |        | 487.00 |
| MAX |        | 547.89 |
| MIN |        | 478.26 |

9UN 165 M2 .7 TGAS 800 AE2 .93E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:08:56 80/144



| MAX | LEGEND | MIN   |
|-----|--------|-------|
| A   | PSI    | 34.00 |
| B   |        | 32.00 |
| C   |        | 30.00 |
| D   |        | 28.00 |
| E   |        | 26.00 |
| F   |        | 24.00 |
| MAX |        | 34.31 |
| MIN |        | 23.36 |

RUN 165 MACH .7 TCAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:14:40 80/168

AD-A110 333

GENERAL MOTORS CORP INDIANAPOLIS IN DETROIT DIESEL A--ETC F/G 21/5  
EXPERIMENTAL INVESTIGATION OF TURBINE ENDWALL HEAT TRANSFER, VO--ETC(U)  
AUG 81 L D HYLTON, M S MIHELIC, E R TURNER F33615-77-C-2030

UNCLASSIFIED

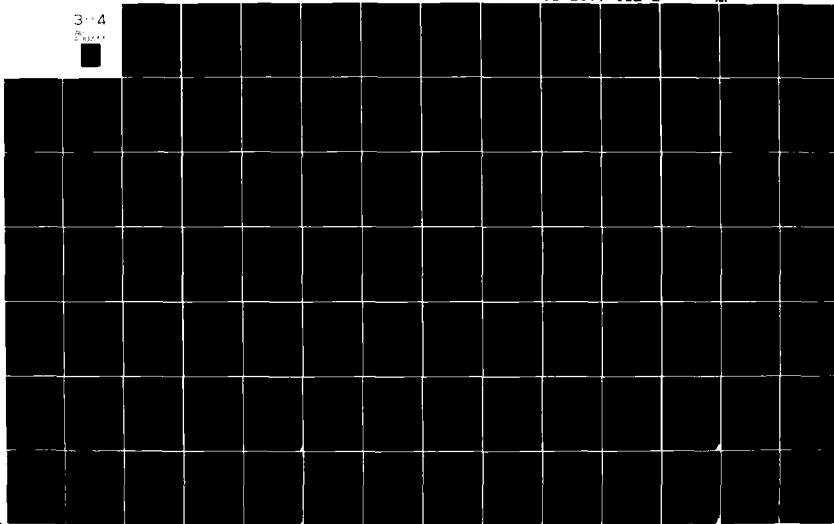
DDA-EDR-10363-VOL-2

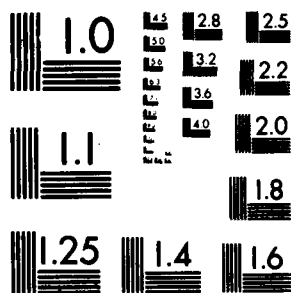
AFWAL-TR-81-2077-VOL-2

NI

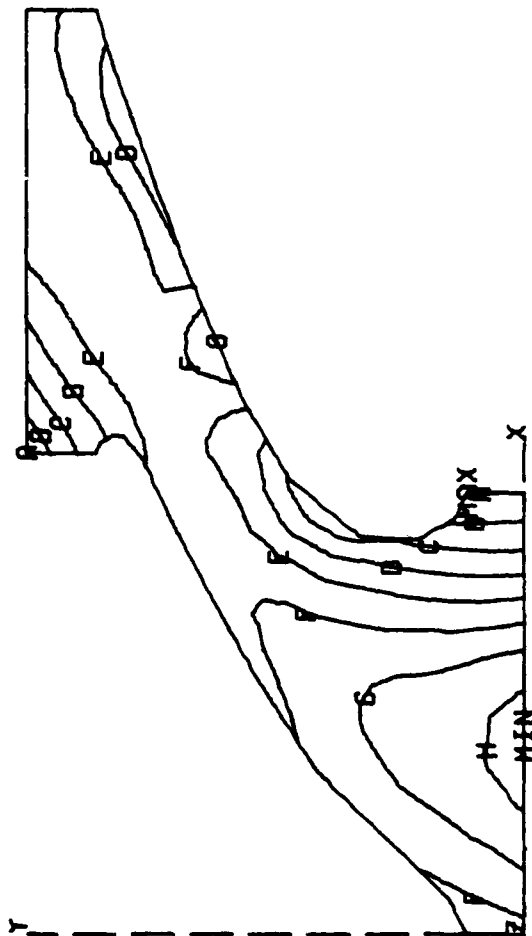
3-4

3-4



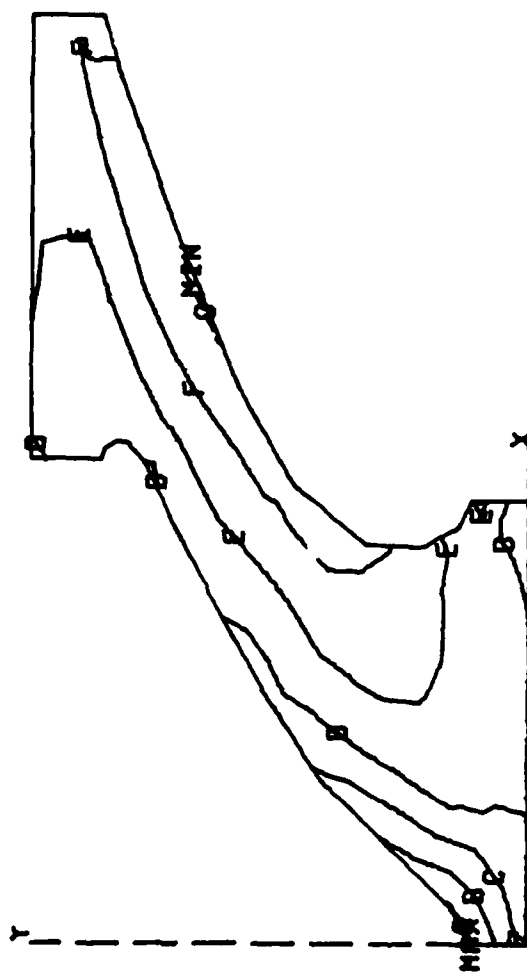


MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



| MMM | LEGEND | MMM |
|-----|--------|-----|
|     | F      |     |
| A   | 627.00 |     |
| B   | 622.00 |     |
| C   | 617.00 |     |
| D   | 612.00 |     |
| E   | 607.00 |     |
| F   | 602.00 |     |
| G   | 597.00 |     |
| H   | 592.00 |     |
| MAX | 627.54 |     |
| MIN | 589.65 |     |

RUN 165 M2 .7 TGRS 800 RE2 .93E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 11:33:40 80/144



| MAX | LEGEND | MAX   |
|-----|--------|-------|
| A   | (E-03) | 12.00 |
| B   |        | 10.00 |
| C   |        | 8.00  |
| D   |        | 6.00  |
| E   |        | 4.00  |
| F   |        | 2.00  |
| MAX |        | 12.30 |

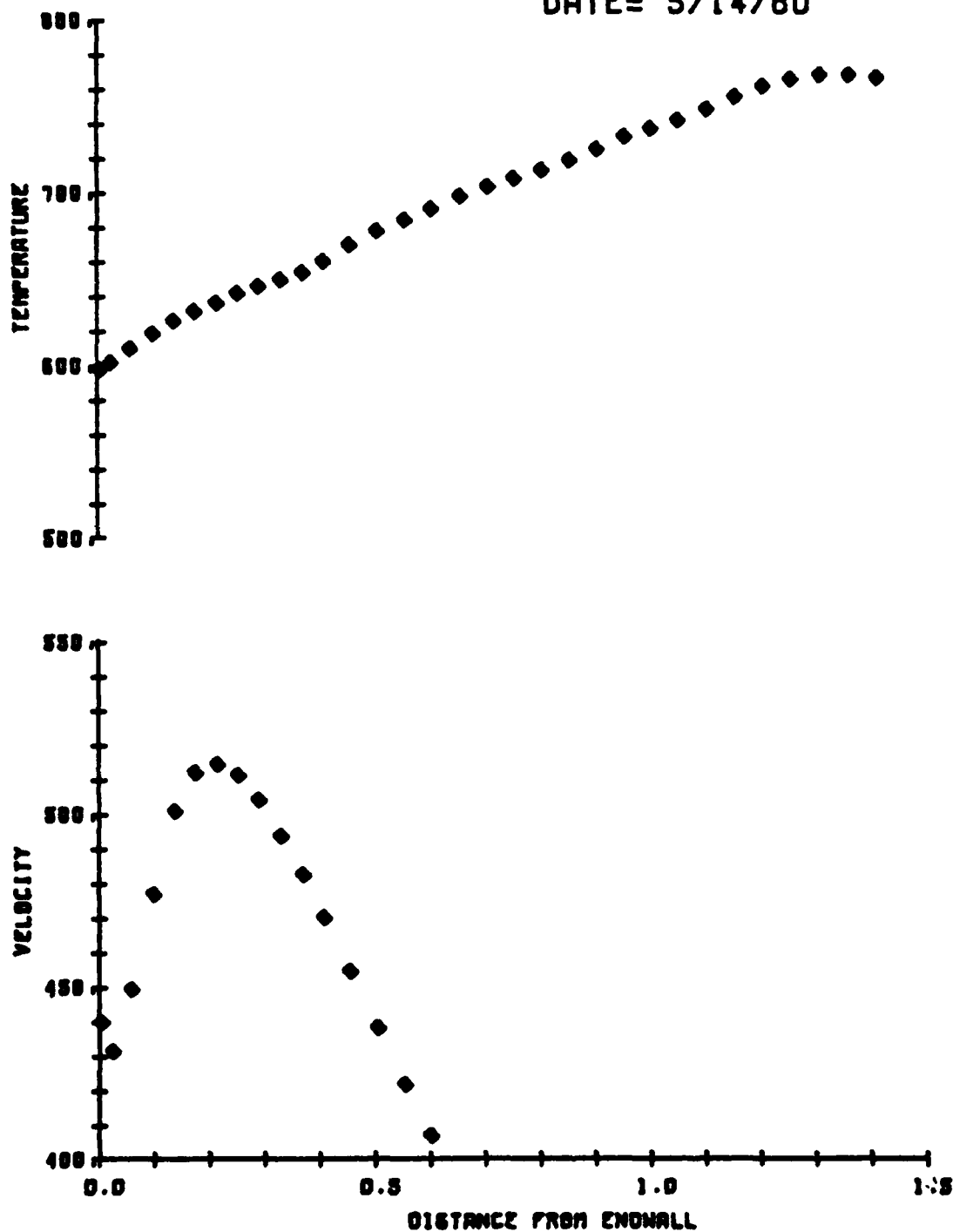
RUN 165 M2 .7 TGRS 800 RE2 .93E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:09:53 80/144



# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 165

DATE = 5/14/80



GMA 200 TURBINE VANE CASCADE

RUN #166

DATE: 5/14/80

TIME: 7:17:20

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 58.89            | 57.60   | 1255.81 | .181   | .196 | .529      |

RHO - LBM/INJ \*10\*\*4  
.72085

STANTON CALCULATION INPUT  
VELOCITY - IN/HR  
13346318.

STREAM TEMPERATURE - F  
788.73

CP - BTU/LBM/F  
.257

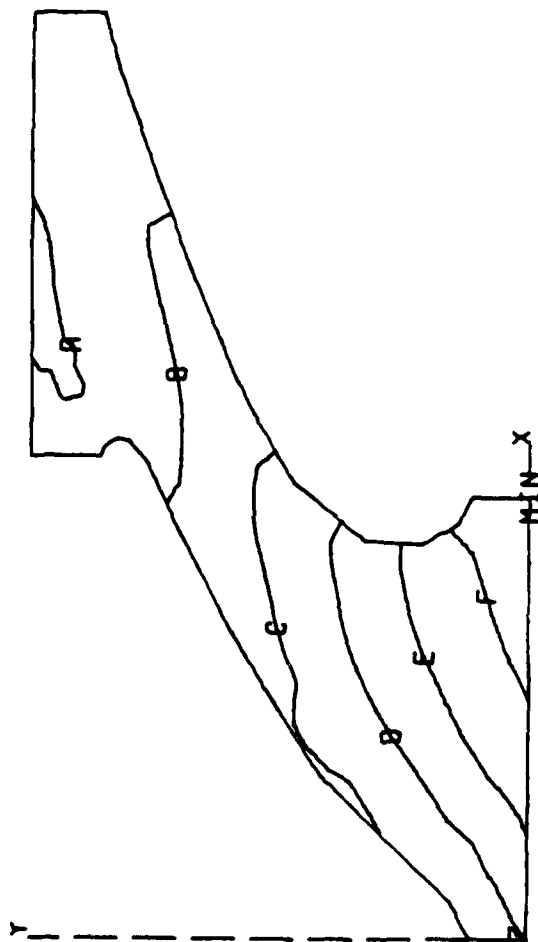
ORIFICE

MASS FLOW RATE

8.95 CASCADE

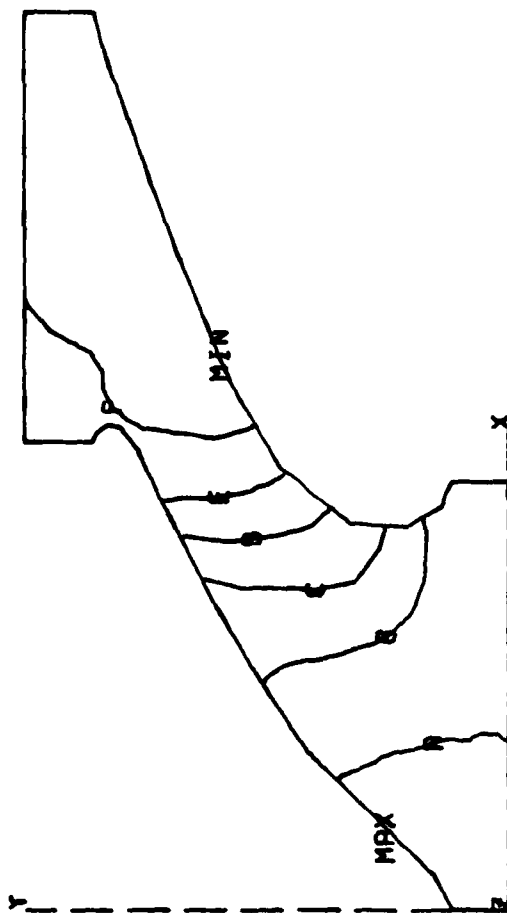
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 58.89                 | 42.59  | 1255.81 | .705   | .734 | 1.670     |

CASCADE OPERATING CONDITION  
EXPANSION RATIO= 1.383      STATIC PRESSURE RATIO= .739



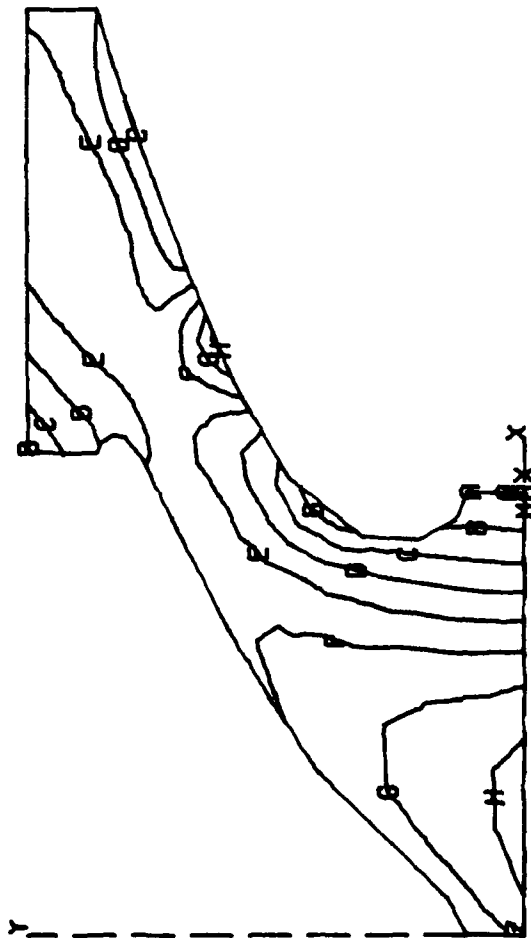
\*\*\* LEGEND \*\*\*  
 F  
 A 610.00  
 B 590.00  
 C 570.00  
 D 550.00  
 E 530.00  
 F 510.00  
 \*MAX 611.53  
 \*MIN 497.55  
 \*DENOTES HIDDEN

RUN 166 M2 .7 TGAS 800 RE2 1.66E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:40:08 80/172



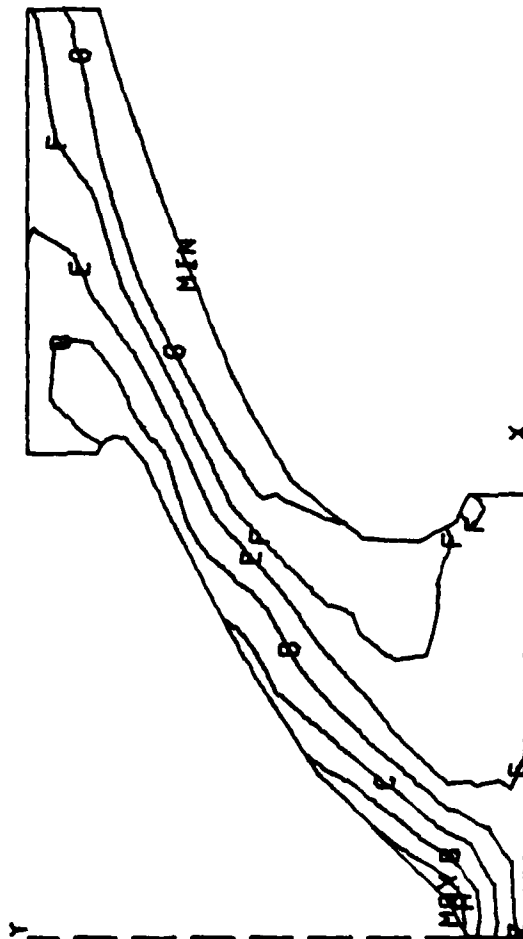
| MM | LEGEND      | MM      |
|----|-------------|---------|
|    | PSI         |         |
|    | 58.00       |         |
|    | 55.00       |         |
|    | 52.00       |         |
|    | 49.00       |         |
|    | 46.00       |         |
|    | 43.00       |         |
|    | 58.91       |         |
|    | 41.21       |         |
| MM | A B C D E F | MAX MIN |

RUN 166 MACH .7 TGRS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:34:24 80/178



| MMM | LEGEND | MMM |
|-----|--------|-----|
|     | F      |     |
| A   | 648.00 |     |
| B   | 642.00 |     |
| C   | 636.00 |     |
| D   | 630.00 |     |
| E   | 624.00 |     |
| F   | 618.00 |     |
| G   | 612.00 |     |
| H   | 606.00 |     |
| MAX | 648.34 |     |
| MIN | 602.90 |     |

RUN 166 M2.7 TGAS 800 AE2 1.66E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE - 1.0000 PLOT TIME AND DATE - 11:00:25 80/144



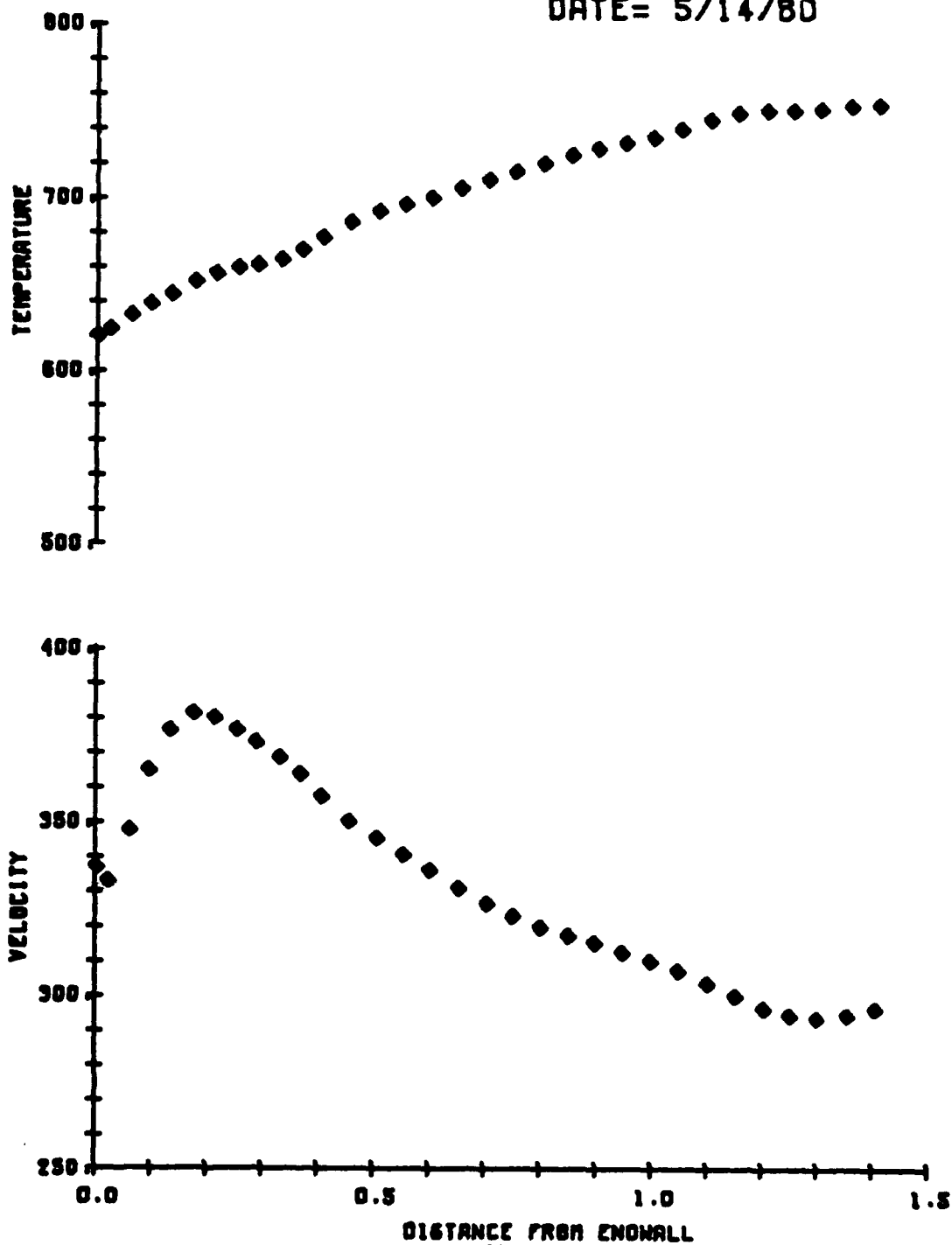
| MAX | LEGEND  | MAX     |
|-----|---------|---------|
|     | F       |         |
|     | (E-06)  |         |
| A   | 7000.00 |         |
| B   | 6000.00 |         |
| C   | 5000.00 |         |
| D   | 4000.00 |         |
| E   | 2999.99 |         |
| F   | 1999.99 |         |
| G   | 999.99  |         |
| MAX |         | 7954.69 |

RUN 166 M2 .7 TGRS 800 RE2 1.66E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:40:37 80/172

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 166

DATE = 5/14/80



GMA 200 TURBINE VANE CASCADE

RUN #160

DATE: 5/16/82

TIME: 6:23:20

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 62.21            | 61.93   | 1238.01 | .060   | .087 | .255      |

| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .78256                    | 5897160.         | 775.89                 |

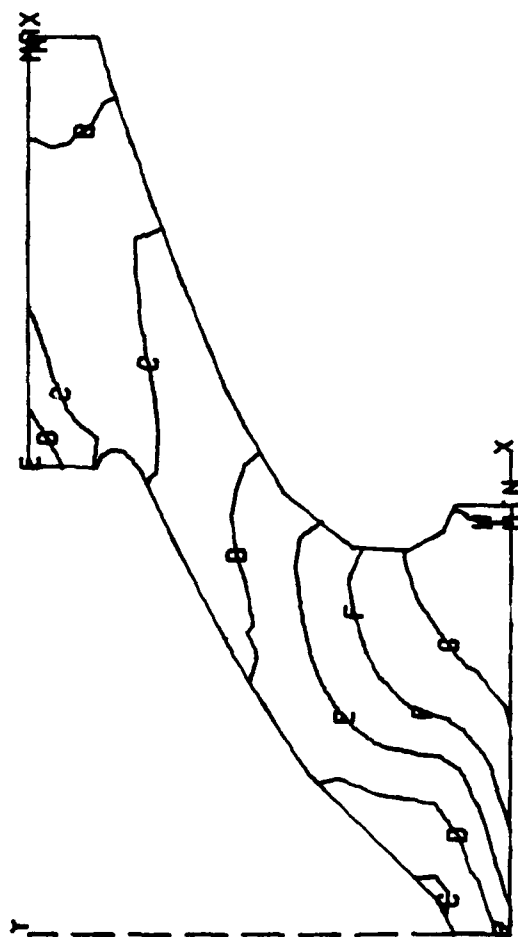
CP - BTU/LBM/F  
.256

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 5.02           | CASCADE |

| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 62.21                 | 58.48  | 1238.01 | .302   | .326 | .523      |

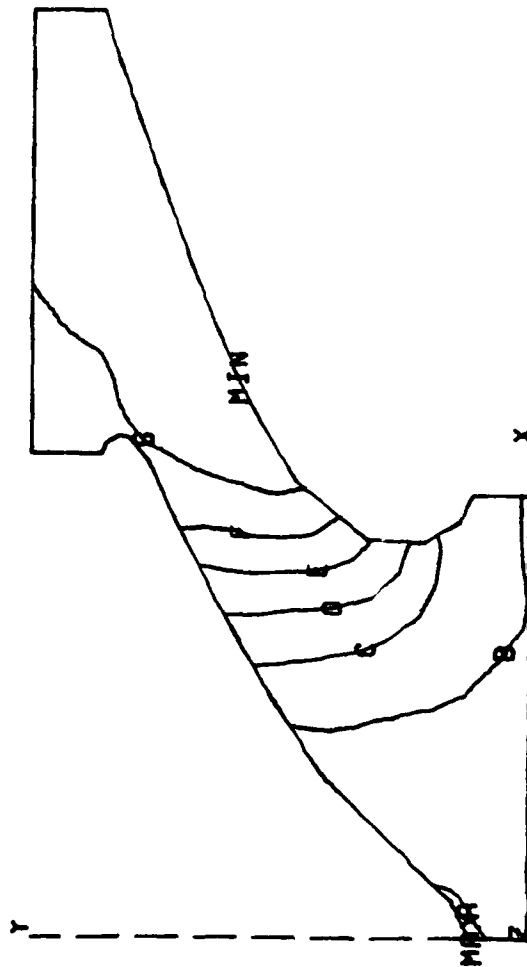
| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO*            | STATIC PRESSURE RATIO* |
| 1.064                       | .944                   |





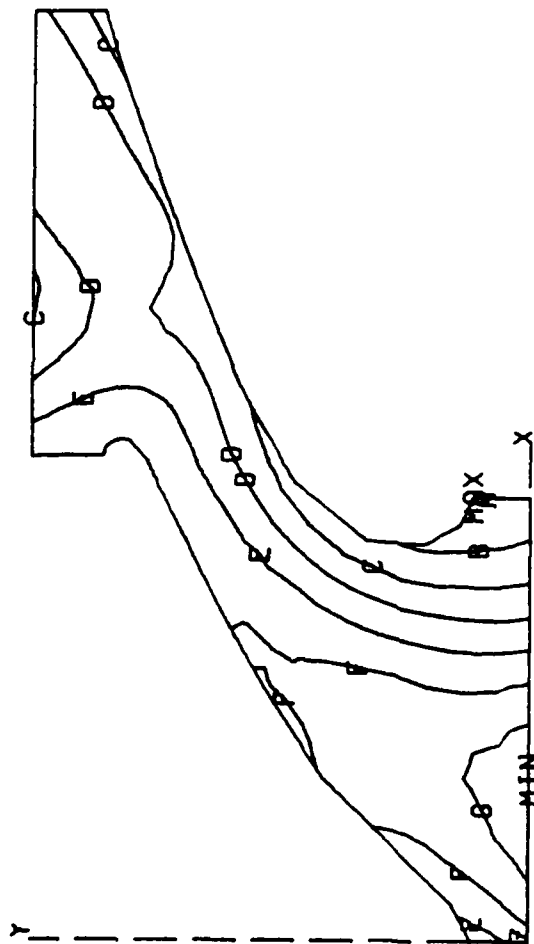
| MAX | LEGEND | MIN    |
|-----|--------|--------|
| R   | F      | 570.00 |
| B   |        | 560.00 |
| C   |        | 550.00 |
| D   |        | 540.00 |
| E   |        | 530.00 |
| F   |        | 520.00 |
| G   |        | 510.00 |
| H   |        | 500.00 |
| MAX |        | 571.02 |
| MIN |        | 496.24 |

RUN 168 M2 .3 TGAS 800 RE2 .9E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:16:36 80/144



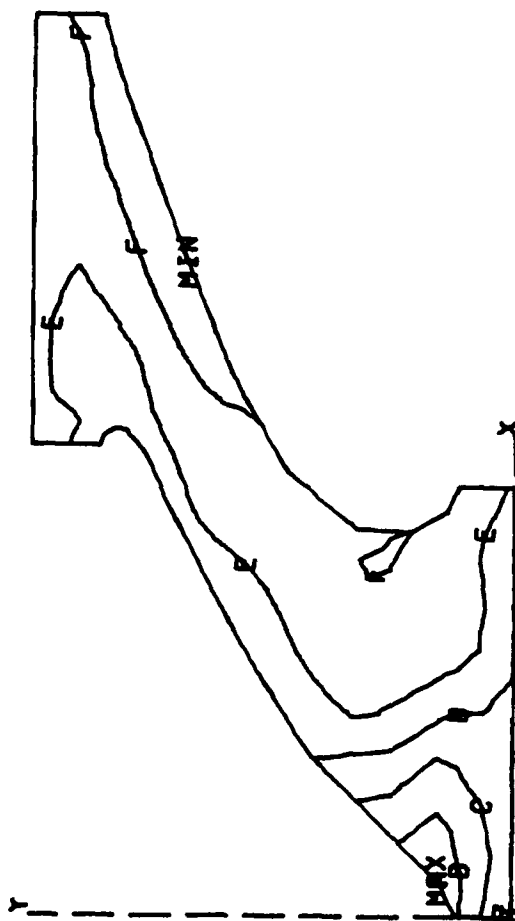
| MAX | LEGEND   | MAX |
|-----|----------|-----|
|     | PSI      |     |
|     | (E-03)   |     |
| A   | 62899.96 |     |
| B   | 62199.95 |     |
| C   | 61499.94 |     |
| D   | 60799.93 |     |
| E   | 60099.91 |     |
| F   | 59399.90 |     |
| G   | 58699.89 |     |
| MAX | 62975.63 |     |
| MIN | 58193.57 |     |

RUN 168 MACH .7 TGAS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 8:17:16 80/179



| MMM | LEGEND | MMM    |
|-----|--------|--------|
| A   | F      | 636.00 |
| B   |        | 630.00 |
| C   |        | 624.00 |
| D   |        | 618.00 |
| E   |        | 612.00 |
| F   |        | 606.00 |
| G   |        | 600.00 |
| MAX |        | 636.84 |
| MIN |        | 595.13 |

RUN 168 M2.3 TGAS 800 RE2 .9E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 9:33:56 81/047



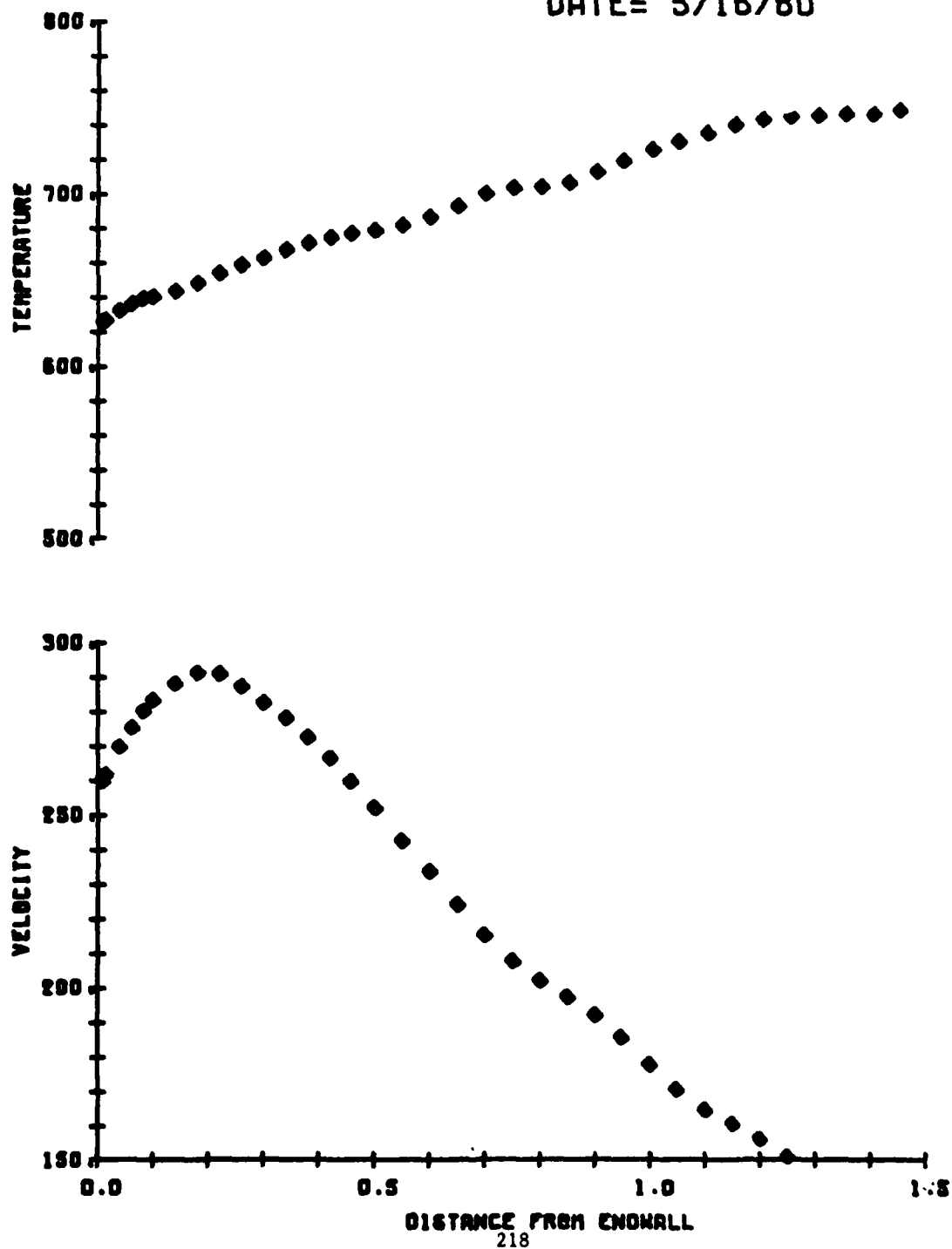
| MAX | LEGEND | MAX |
|-----|--------|-----|
| A   | (E-03) |     |
| B   | 18.00  |     |
| C   | 15.00  |     |
| D   | 12.00  |     |
| E   | 9.00   |     |
| F   | 6.00   |     |
| MAX | 18.16  |     |
| MIN | .64    |     |

RUN 168 M2 .3 TGAS 800 RE2 .9E08 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:17:28 80/1144

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 168

DATE = 5/16/80



# GMA 200 TURBINE VANE CASCADE

RUN #169

DATE: 5/28/80

TIME: 7:11:47

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 43.27            | 42.27   | 1249.27 | .186   | .201 | .401      |

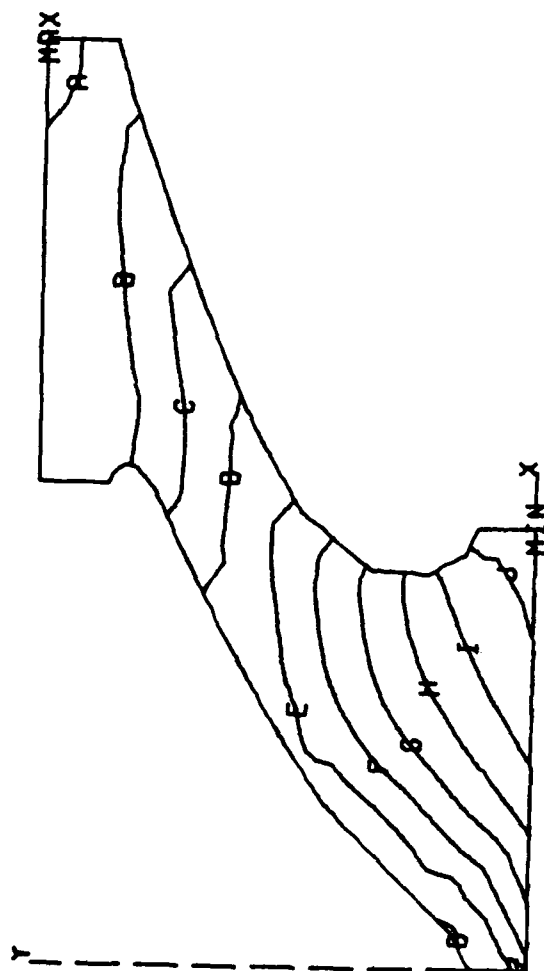
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .53194                    | 13665990.        | 781.81                 |

CP = BTU/LBM/F  
.256

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 6.45           | CASCADE |

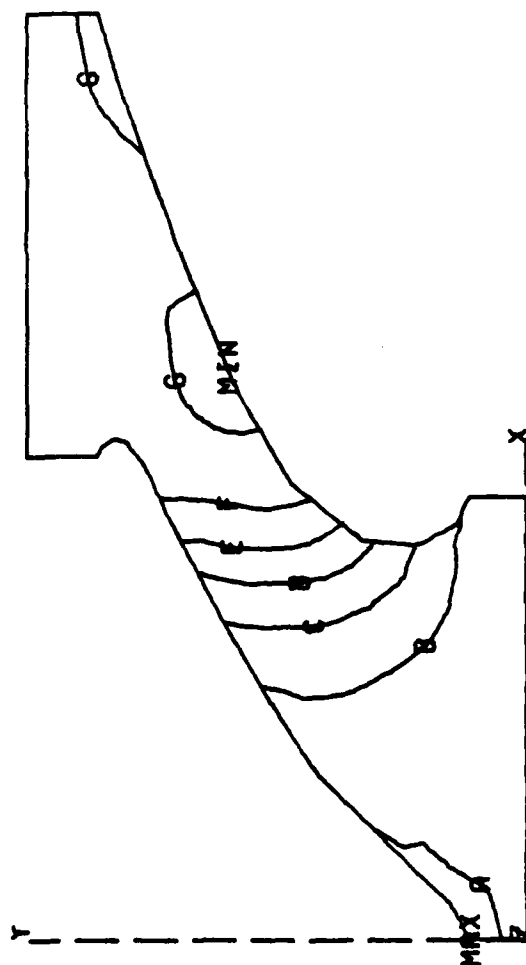
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 43.27                 | 31.64  | 1249.27 | .692   | .721 | 1.222     |

| CASCADE OPERATING CONDITION |                             |
|-----------------------------|-----------------------------|
| EXPANSION RATIO= 1.368      | STATIC PRESSURE RATIO= .748 |



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | B      | 590.00 |
| B   | C      | 580.00 |
| C   | D      | 570.00 |
| D   | E      | 560.00 |
| E   | F      | 550.00 |
| F   | G      | 540.00 |
| G   | H      | 530.00 |
| H   | I      | 520.00 |
| I   | J      | 510.00 |
| MAX |        | 500.00 |
| MIN |        | 495.37 |
|     |        | 494.61 |

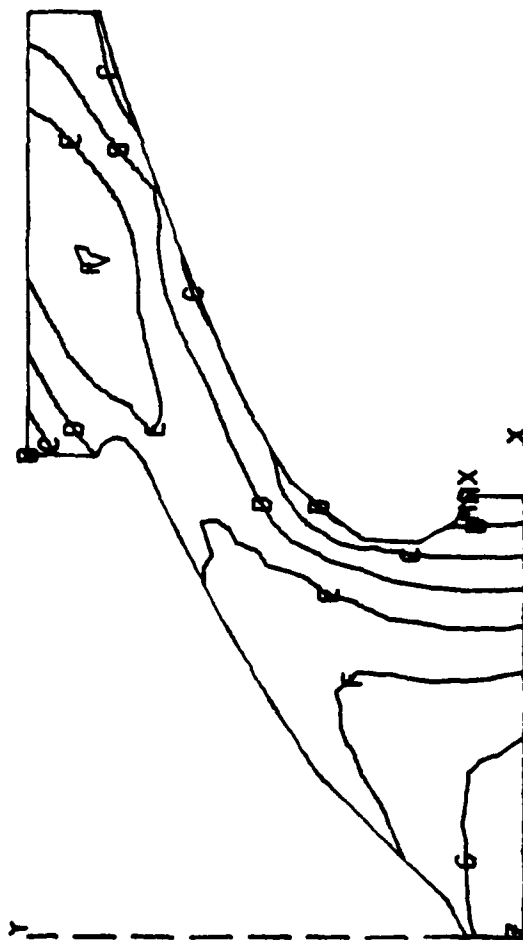
RUN 169 M2=.7 TGAS=800 RE2=1.2E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:54:47 80/150



| MM  | LEGEND | MM |
|-----|--------|----|
|     | PSI    |    |
| A   | 43.00  |    |
| B   | 41.00  |    |
| C   | 39.00  |    |
| D   | 37.00  |    |
| E   | 35.00  |    |
| F   | 33.00  |    |
| G   | 31.00  |    |
| MAX | 43.21  |    |
| MIN | 30.33  |    |

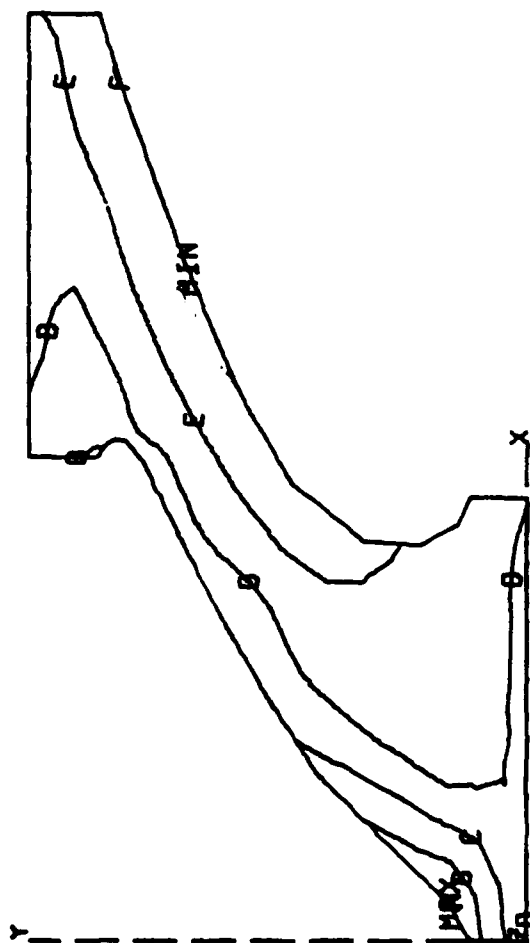
RUN 169 MACH .7 TGRS 800 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:34:28 80/169





| XXX | LEGEND | XXX |
|-----|--------|-----|
|     | F      |     |
| A   | 703.00 |     |
| B   | 697.00 |     |
| C   | 691.00 |     |
| D   | 685.00 |     |
| E   | 679.00 |     |
| F   | 673.00 |     |
| G   | 667.00 |     |
| MAX | 703.04 |     |
| MIN | 662.33 |     |

RUN 169 M2 .7 TGRS 800 RE2 1.2E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:37:06 80/177



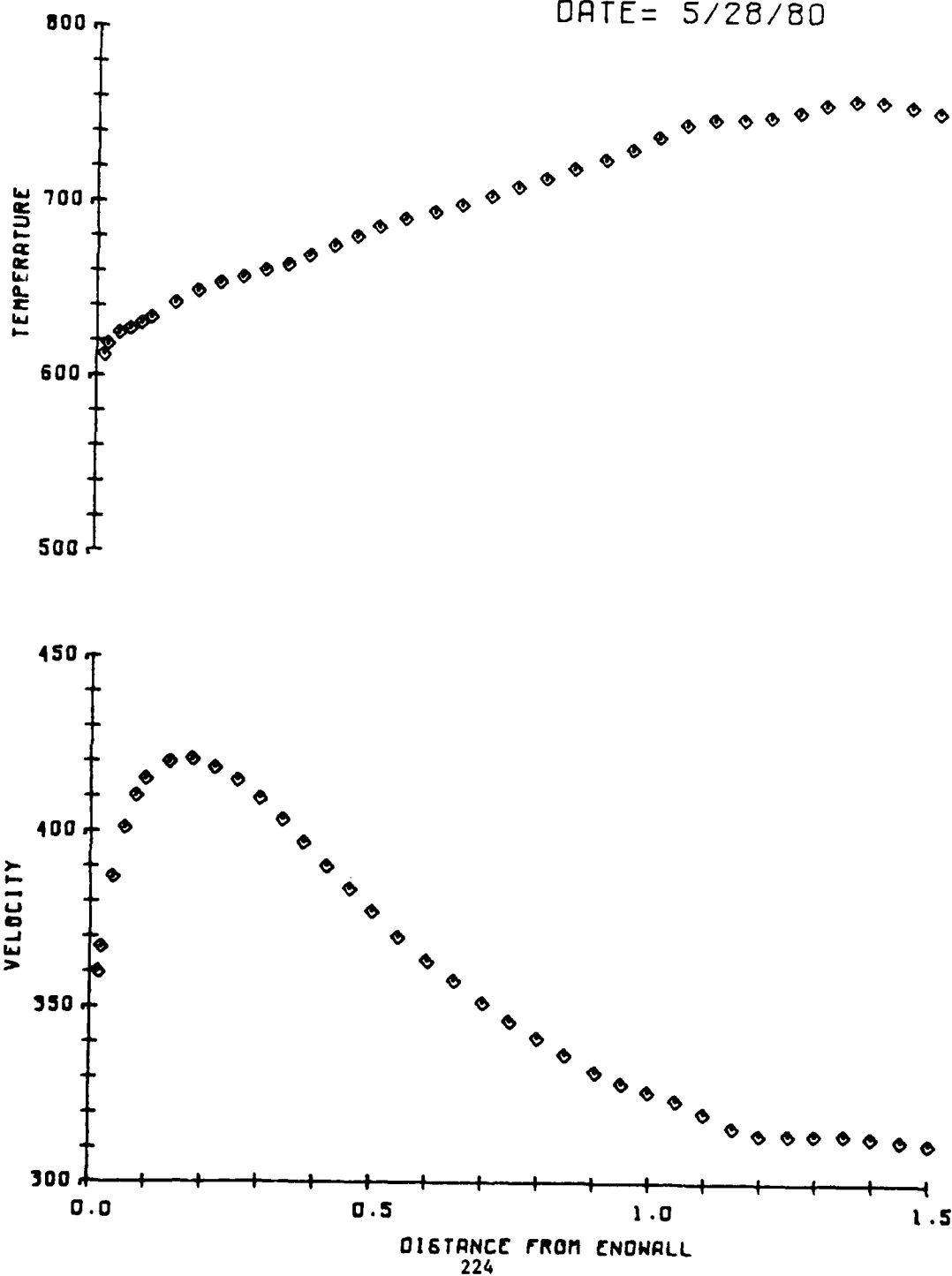
|     |         |       |
|-----|---------|-------|
| MAX | LEGEND  | MAX   |
|     | F       |       |
| A   | (E-031) |       |
| B   | 10.00   |       |
| C   | 8.00    |       |
| D   | 6.00    |       |
| E   | 4.00    |       |
|     | 2.00    |       |
| MAX |         | 10.27 |

RUN 169 M2=.7 TGAS=800 RE2=1.2E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 12:55:30 80/150

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 169

DATE = 5/28/80



GMA 200 TURBINE VANE CASCADE

RUN #170

DATE: 5/30/80

TIME: 7:27:26

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 56.64            | 54.83   | 1277.69 | .219   | .237 | .600      |

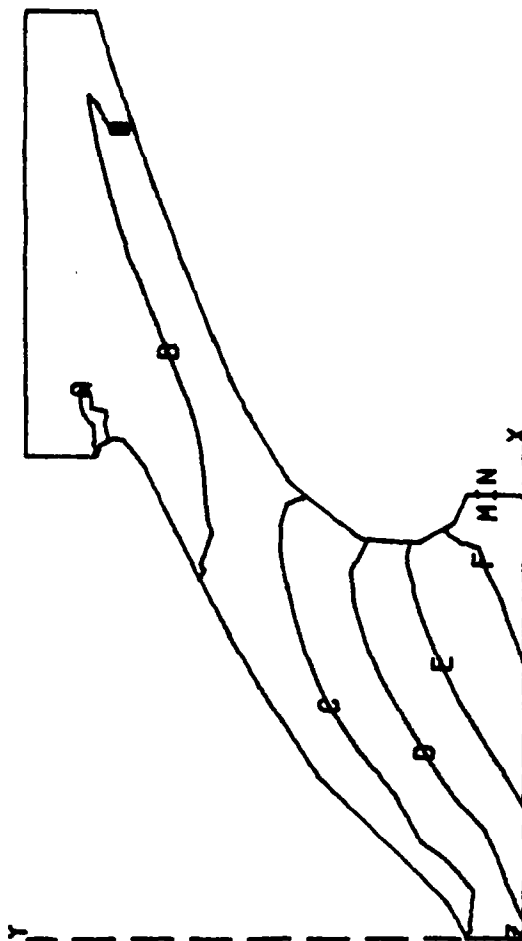
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO -LBM/IN3 *10**4       | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .67631                    | 16294938.        | 806.99                 |

CP = BTU/LBM/F  
.257

| MASS FLOW RATE |              |
|----------------|--------------|
| ORIFICE        | 9.56 CASCADE |

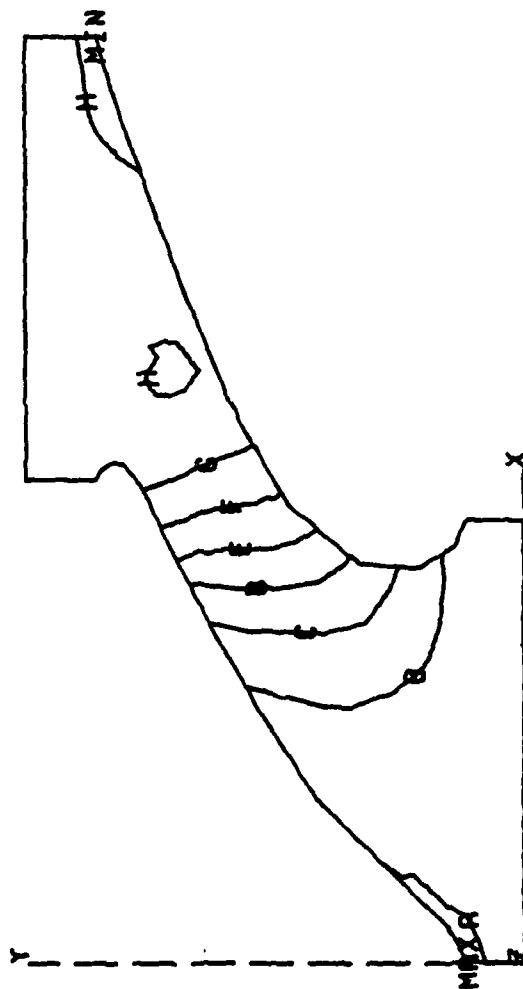
| IDEAL EXIT CONDITIONS |        |         |        |       |           |
|-----------------------|--------|---------|--------|-------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V*  | REY/10**6 |
| 56.64                 | 28.05  | 1277.69 | 1.065  | 1.054 | 1.830     |

| CASCADE OPERATING CONDITION |                             |
|-----------------------------|-----------------------------|
| EXPANSION RATIO= 2.019      | STATIC PRESSURE RATIO= .512 |



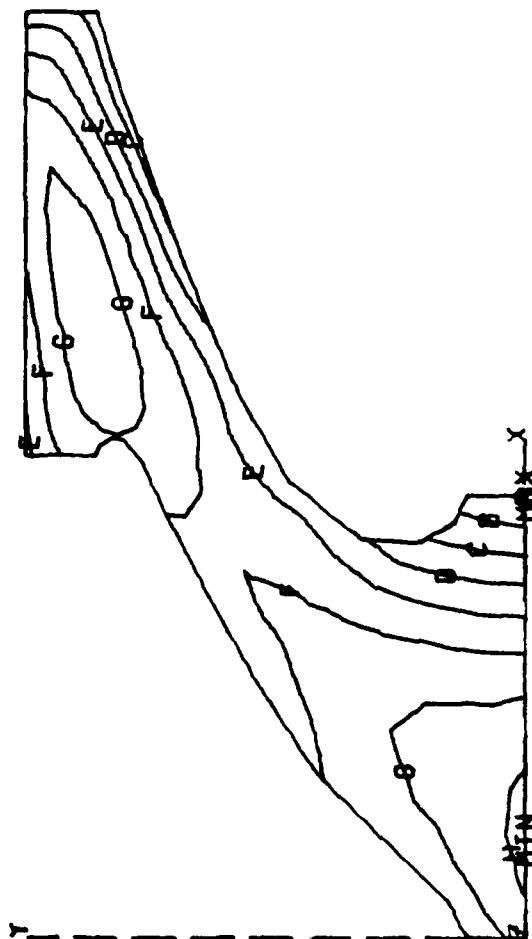
| MMM | LEGEND | MMM |
|-----|--------|-----|
|     | F      |     |
| A   | 620.00 |     |
| B   | 600.00 |     |
| C   | 580.00 |     |
| D   | 560.00 |     |
| E   | 540.00 |     |
| F   | 520.00 |     |
| MAX | 620.44 |     |
| MIN | 504.95 |     |

RUN 170 M2 1.06 TGRS 800 RE2 1.8E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE ~ 1.0000 PLOT TIME AND DATE ~ 20:45:14 81/085



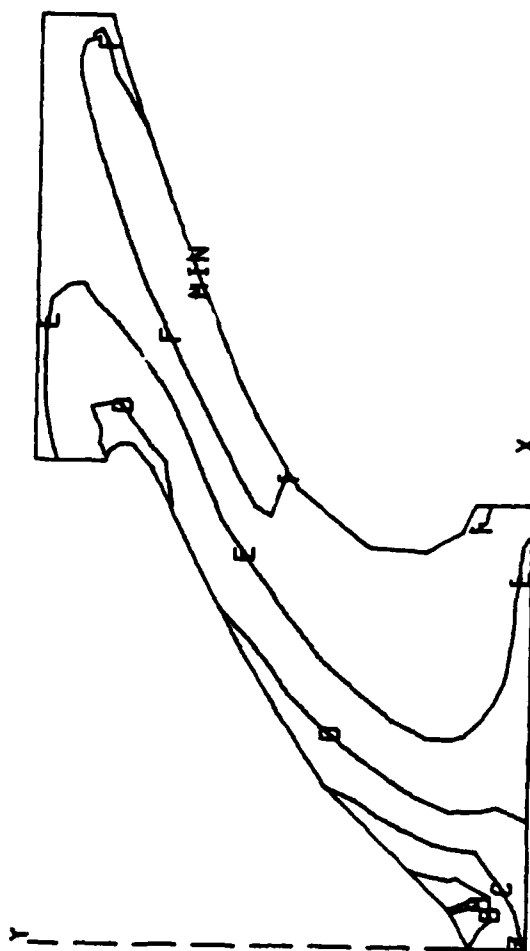
| MM  | LEGEND | MM |
|-----|--------|----|
|     | PSI    |    |
| A   | 56.00  |    |
| B   | 52.00  |    |
| C   | 48.00  |    |
| D   | 44.00  |    |
| E   | 40.00  |    |
| F   | 36.00  |    |
| G   | 32.00  |    |
| H   | 28.00  |    |
| MAX | 56.22  |    |
| MIN | 26.57  |    |

RUN 170 MARCH 1.07 TGRS 800 ENDNALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:47:24 80/169



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 699.00 |
| B   |        | 693.00 |
| C   |        | 687.00 |
| D   |        | 681.00 |
| E   |        | 675.00 |
| F   |        | 669.00 |
| G   |        | 663.00 |
| H   |        | 657.00 |
| MAX |        | 699.76 |
| MIN |        | 655.09 |

RUN 170 M2 1.06 TCAS 800 RE2 1.8E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 8:13:13 80/170



MMM LEGEND MMM  
 F  
 (E-03)  
 11.00  
 9.00  
 7.00  
 5.00  
 3.00  
 1.00  
 -1.00  
 11.29  
 A B C D E F G  
 MAX

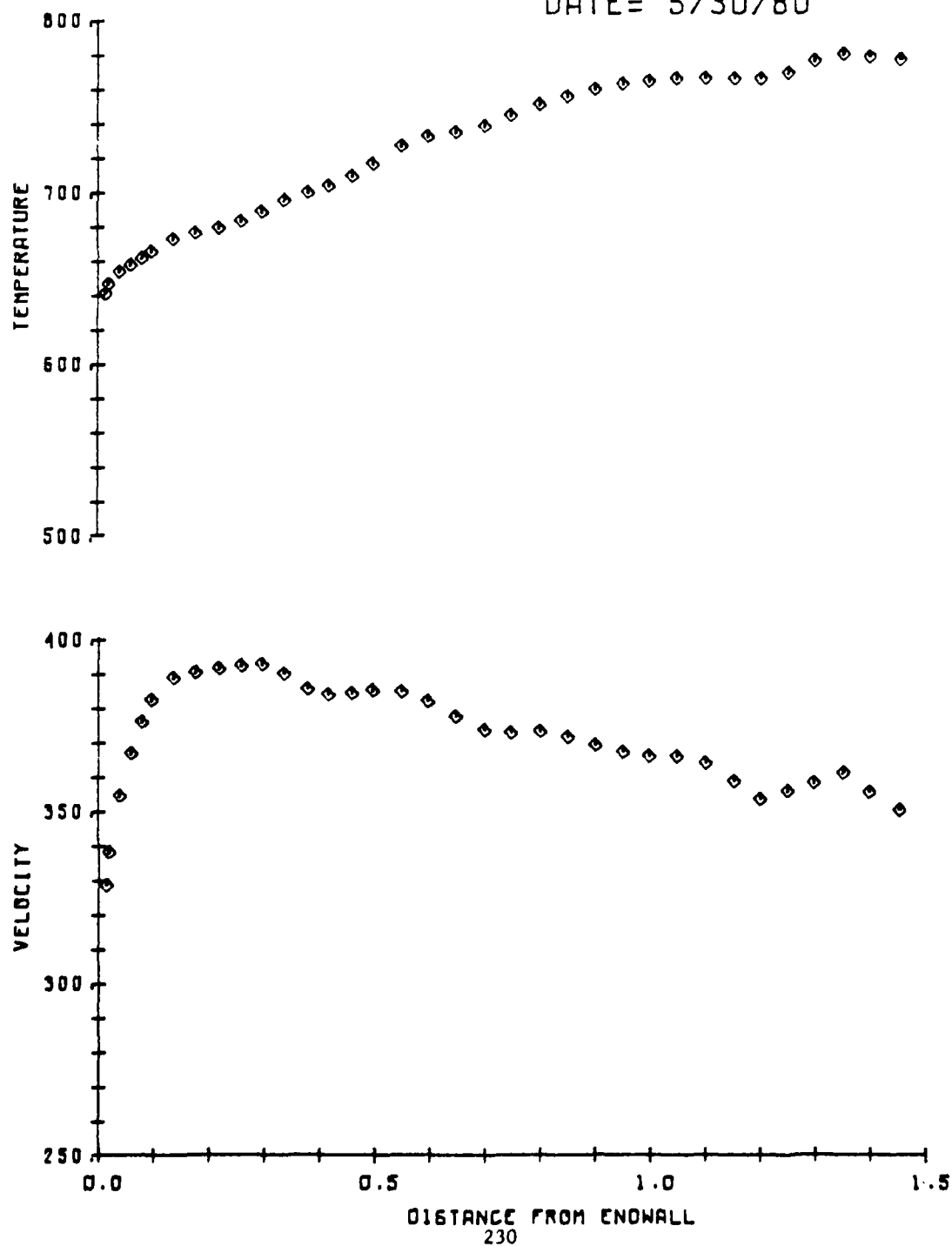
RUN 170 M2 1.06 IGAS 800 RE2 1.8E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 20:46:14 81/085



# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 170

DATE = 5/30/80



GMA 200 TURBINE VANE CASCADE

RUN #171

DATE: 6/9/80

TIME: 7:20: 9

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 56.07            | 53.78   | 1266.32 | .248   | .268 | .675      |

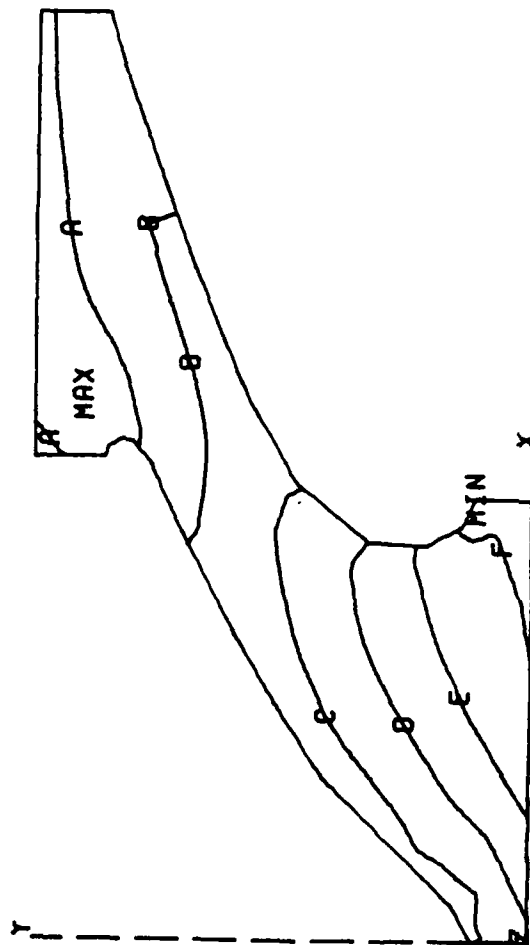
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO -LBM/IN3 *10**4       | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .67094                    | 18355352.        | 792.64                 |

CP - BTU/LBM/F  
.257

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 9.28           | CASCADE |

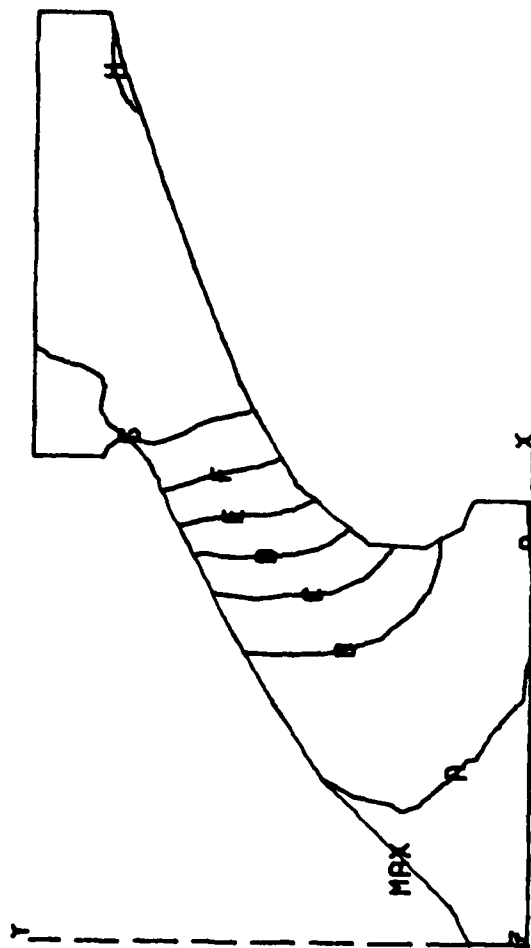
| IDEAL EXIT CONDITIONS |        |         |        |       |           |
|-----------------------|--------|---------|--------|-------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V*  | REY/10**6 |
| 56.07                 | 28.07  | 1266.32 | 1.056  | 1.046 | 1.829     |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.997                       | .522                   |



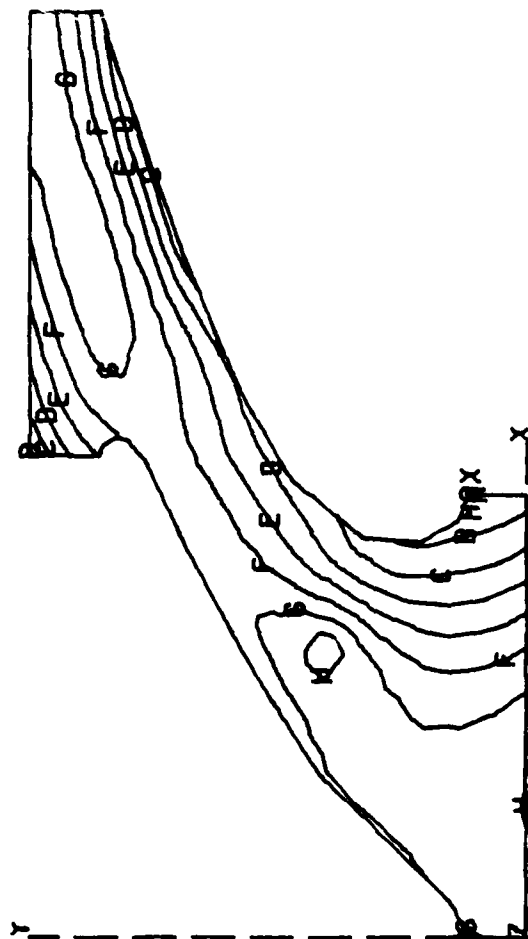
| MM  | LEGEND | MM |
|-----|--------|----|
| A   | 630.00 |    |
| B   | 610.00 |    |
| C   | 590.00 |    |
| D   | 570.00 |    |
| E   | 550.00 |    |
| F   | 530.00 |    |
| MAX | 636.52 |    |
| MIN | 521.25 |    |

RUN 171 MACH 1.05E06 TGRS 800 RE2 1.8E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:40:11 80/171



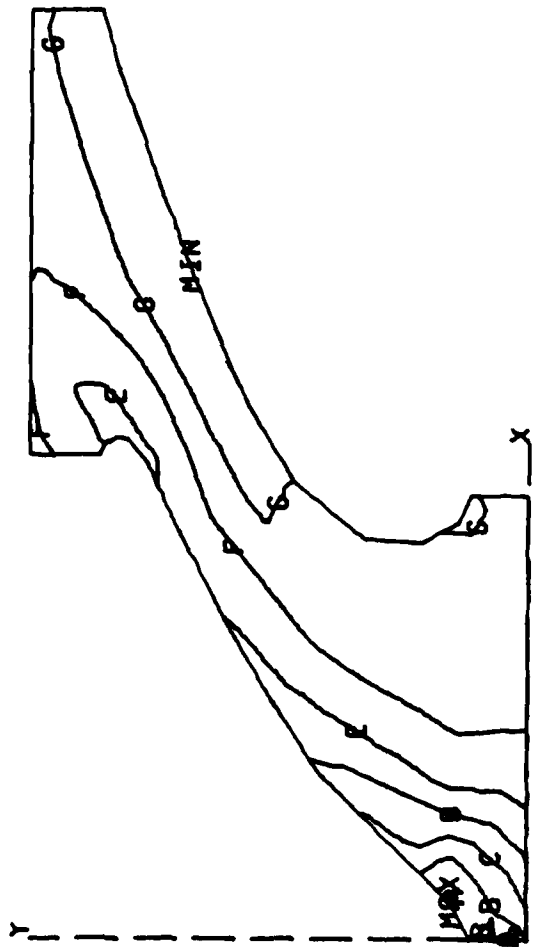
| MIN | LEGEND | MIN |
|-----|--------|-----|
|     | PSI    |     |
| A   | 54.00  |     |
| B   | 50.00  |     |
| C   | 46.00  |     |
| D   | 42.00  |     |
| E   | 38.00  |     |
| F   | 34.00  |     |
| G   | 30.00  |     |
| H   | 26.00  |     |
| MAX | 54.92  |     |
| MIN | 25.51  |     |

RUN 171 MACH 1.05E06 TGRS 800 RE2 1.8E06 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:22:39 80/163



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | F      | 710.00 |
| B   |        | 703.00 |
| C   |        | 696.00 |
| D   |        | 689.00 |
| E   |        | 682.00 |
| F   |        | 675.00 |
| G   |        | 668.00 |
| H   |        | 661.00 |
| MAX |        | 710.37 |
| MIN |        | 658.44 |

RUN 171 MACH 1.05E06 TGRS 800 RE2 1.8E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:50:15 80/170



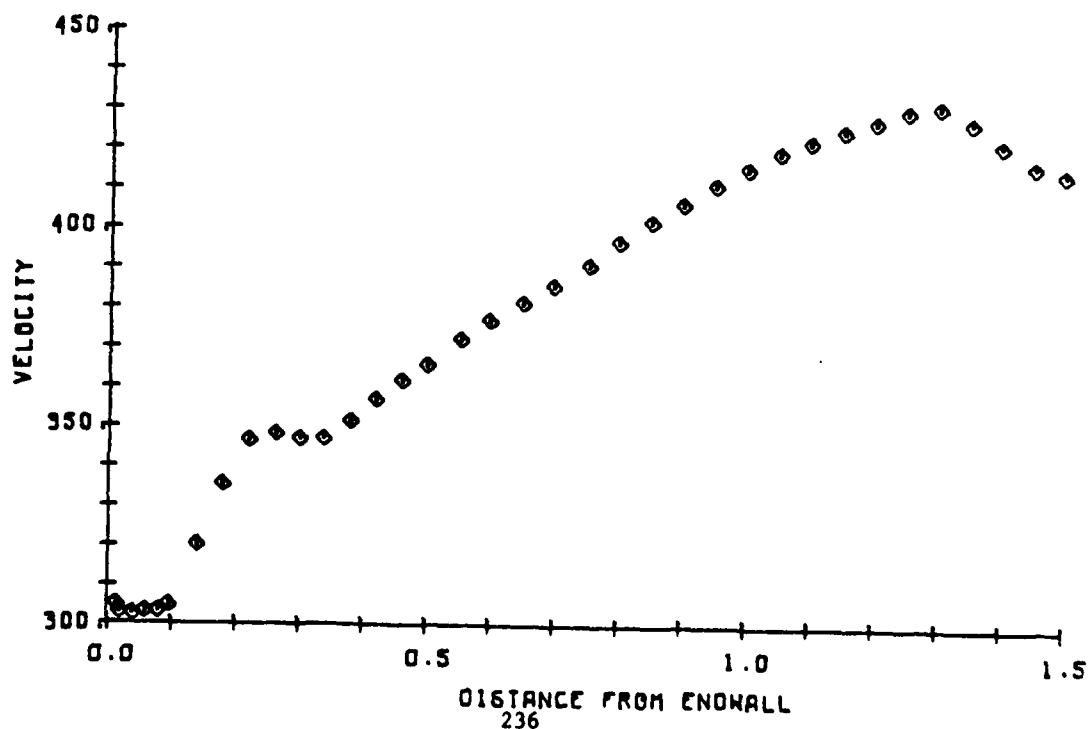
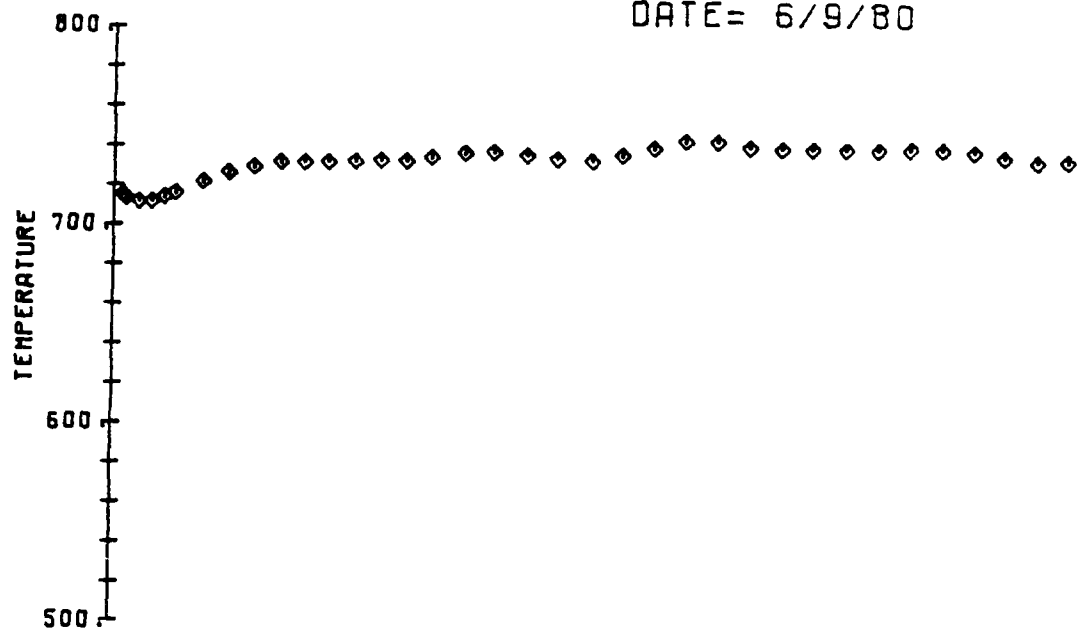
| MAX | LEGEND | F     | MAX   |
|-----|--------|-------|-------|
|     | (E-03) |       |       |
| A   |        | 13.00 |       |
| B   |        | 11.00 |       |
| C   |        | 9.00  |       |
| D   |        | 7.00  |       |
| E   |        | 5.00  |       |
| F   |        | 3.00  |       |
| G   |        | 1.00  |       |
| MAX |        |       | 13.58 |

RUN 171 MACH 1.05E06 TGAS 800 RE2 1.8E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:40:34 80/171

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 171

DATE = 6/9/80



GMA 200 TURBINE VANE CASCADE

RUN #172

DATE: 6/11/80

TIME: 4:21: 3

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 33.87            | 32.83   | 1259.67 | .214   | .232 | .356      |

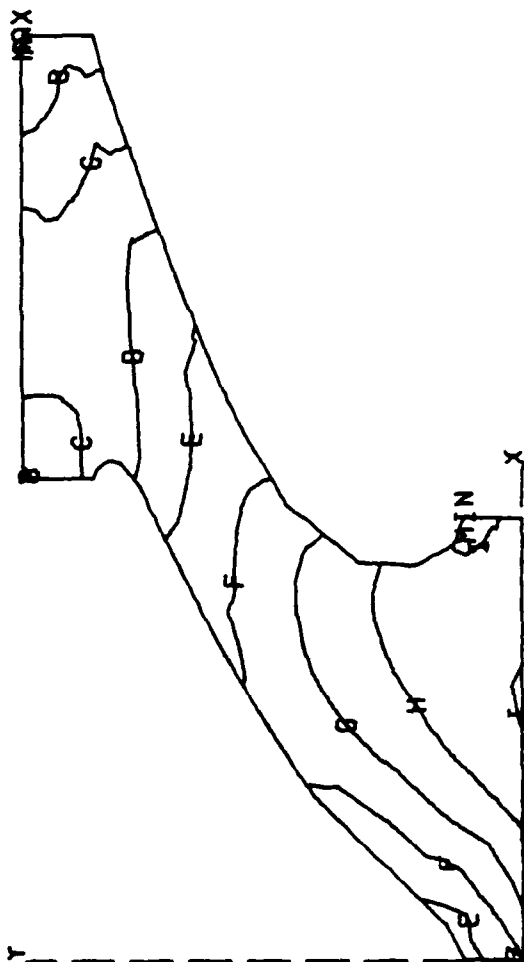
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO -LBM/IN3 *10**4       | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .41064                    | 15805562.        | 789.60                 |
| CP - BTU/LBM/F            |                  |                        |
| .257                      |                  |                        |

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 5.03           | CASCADE |

| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 33.87                 | 24.50  | 1259.67 | .704   | .733 | .957      |

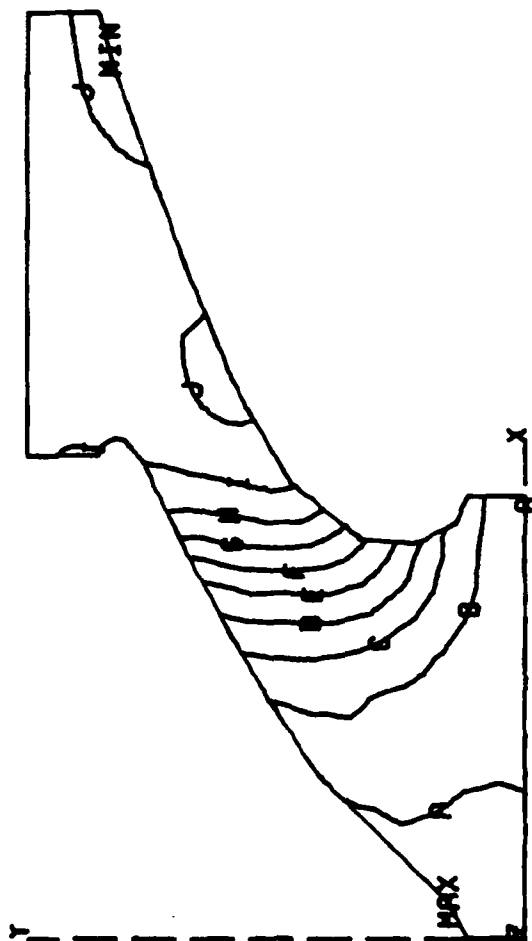
| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.382                       | .746                   |





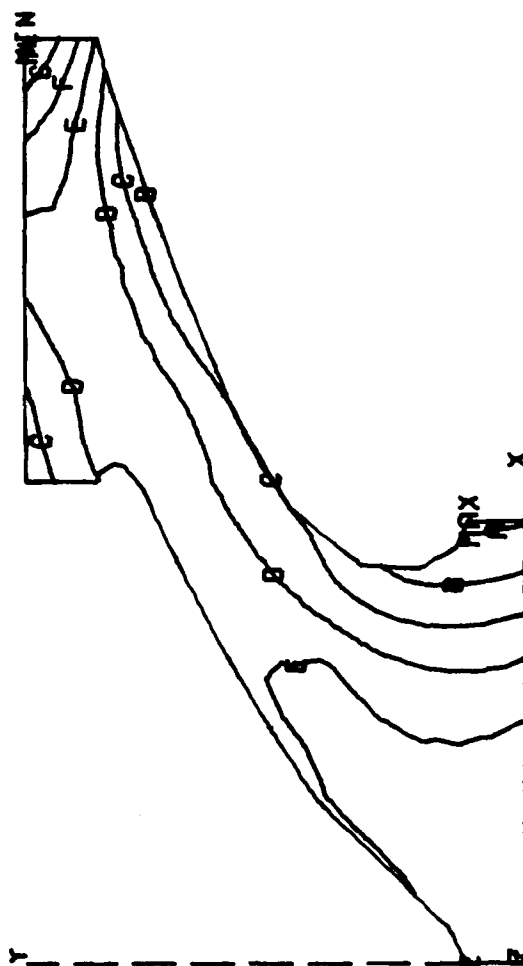
| MAX | LEGEND | MIN |
|-----|--------|-----|
|     | F      |     |
| R   | 580.00 |     |
| B   | 570.00 |     |
| C   | 560.00 |     |
| D   | 550.00 |     |
| E   | 540.00 |     |
| F   | 530.00 |     |
| G   | 520.00 |     |
| H   | 510.00 |     |
| I   | 500.00 |     |
| MAX | 581.35 |     |
| MIN | 498.92 |     |

RUN 172 MACH.7 TGRS 800 RE2 .96E05 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 7:51:10 80/171



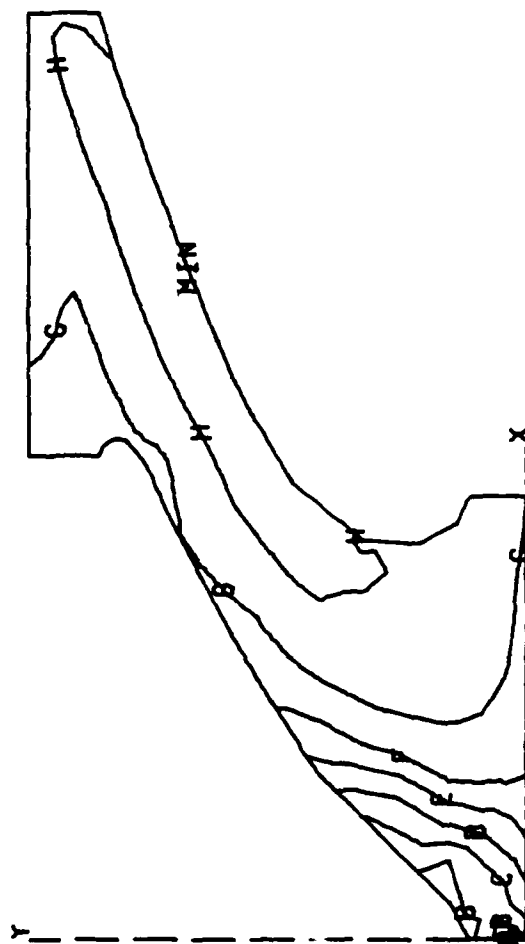
| MAX | LEGEND | MIN |
|-----|--------|-----|
|     | PSI    |     |
| A   | 33.00  |     |
| B   | 32.00  |     |
| C   | 31.00  |     |
| D   | 30.00  |     |
| E   | 29.00  |     |
| F   | 28.00  |     |
| G   | 27.00  |     |
| H   | 26.00  |     |
| I   | 25.00  |     |
| J   | 24.00  |     |
| MAX | 33.31  |     |
| MIN | 23.22  |     |

RUN 172 MACH.7 TGRS 800 AE2 .98E06 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:32:43 80/163



| MAX | LEGEND | MIN    |
|-----|--------|--------|
| A   | F      | 730.00 |
| B   |        | 720.00 |
| C   |        | 710.00 |
| D   |        | 700.00 |
| E   |        | 690.00 |
| F   |        | 680.00 |
| G   |        | 670.00 |
| H   |        | 660.00 |
| MAX |        | 732.81 |
| MIN |        | 655.81 |

RUN 172 MACH.7 TGRS 800 RE2 .96E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:10:09 80/170



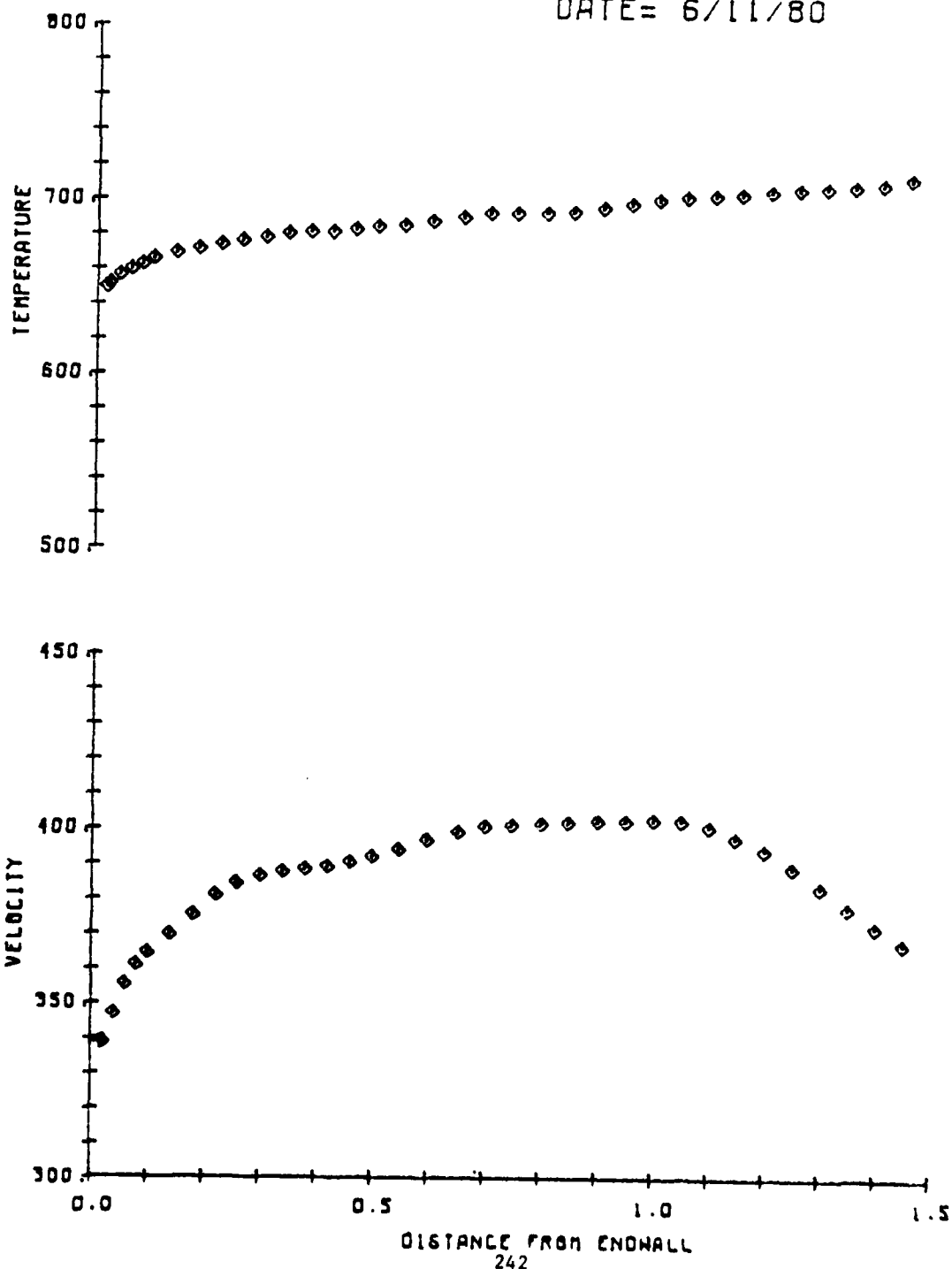
| MIN | LEGEND | MAX   |
|-----|--------|-------|
|     | F      |       |
|     | (E-03) |       |
|     | 16.00  |       |
|     | 14.00  |       |
|     | 12.00  |       |
|     | 10.00  |       |
|     | 8.00   |       |
|     | 6.00   |       |
|     | 4.00   |       |
|     | 2.00   |       |
|     |        | 16.09 |
|     | MRX    |       |

RUN 172 MARCH.7 TGRS 800 RE2 .96E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 7:51:34 80/171

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 172

DATE = 6/11/80



GMA 200 TURBINE VANE CASCADE

RUN #173

DATE: 6/11/80

TIME: 10:45:29

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 45.23            | 43.73   | 1243.55 | .223   | .241 | .503      |

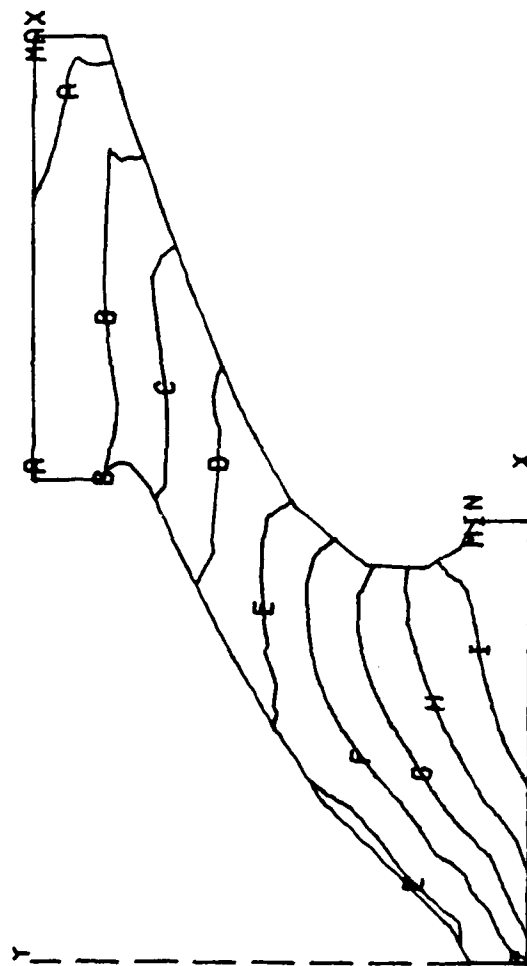
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .55437                    | 16373602.        | 772.78                 |

CP - BTU/LBM/F  
.256

| MASS FLOW RATE |              |
|----------------|--------------|
| ORIFICE        | 6.42 CASCADE |

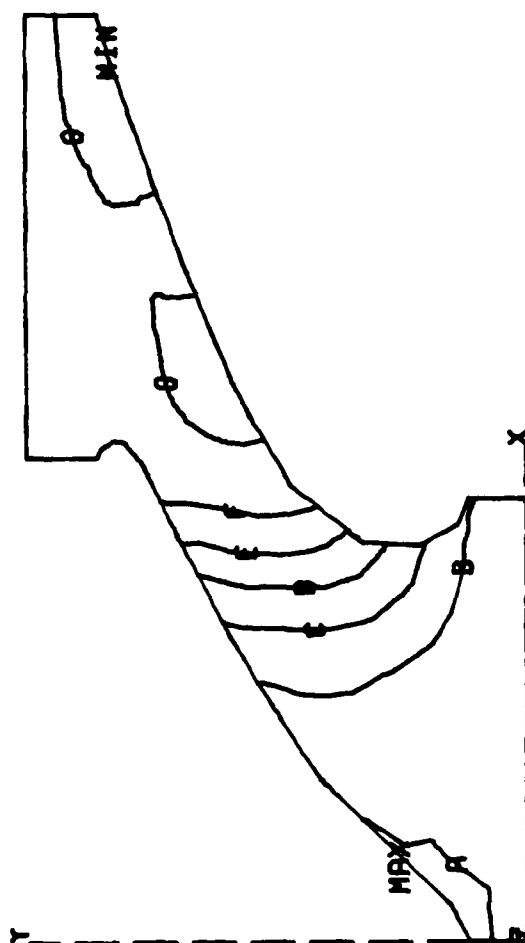
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 45.23                 | 32.70  | 1243.55 | .705   | .734 | 1.298     |

| CASCADE OPERATING CONDITION |                             |
|-----------------------------|-----------------------------|
| EXPANSION RATIO= 1.383      | STATIC PRESSURE RATIO= .748 |



| MAX | LEGEND | MAX |
|-----|--------|-----|
|     | F      |     |
| A   | 580.00 |     |
| B   | 570.00 |     |
| C   | 560.00 |     |
| D   | 550.00 |     |
| E   | 540.00 |     |
| F   | 530.00 |     |
| G   | 520.00 |     |
| H   | 510.00 |     |
| I   | 500.00 |     |
| MAX | 587.92 |     |
| MIN | 490.42 |     |

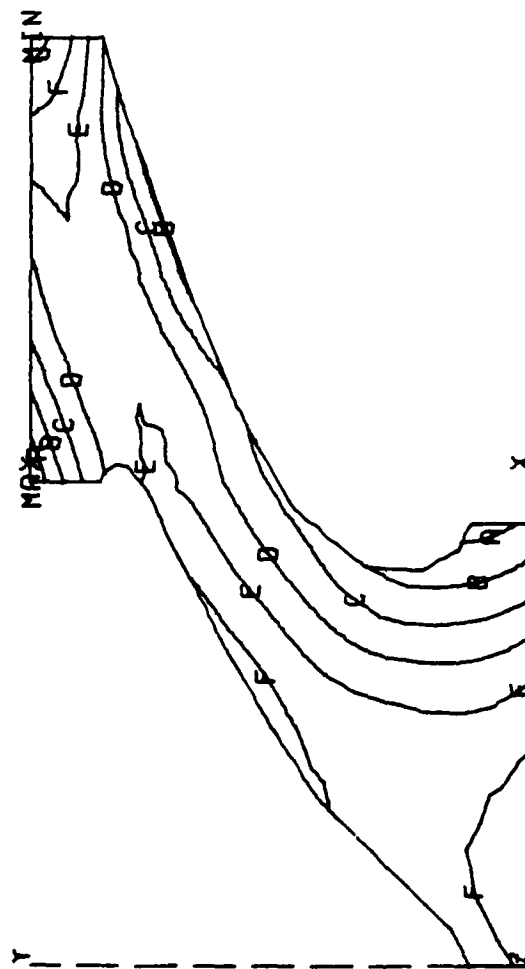
RUN 173 MACH .7 TCAS 800 RE2 1.25E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:18:57 80/172



| MAX | LEGEND | PSI | MIN |
|-----|--------|-----|-----|
| A   | B      | C   | D   |
| E   | F      | G   | MAX |
| MIN |        |     |     |

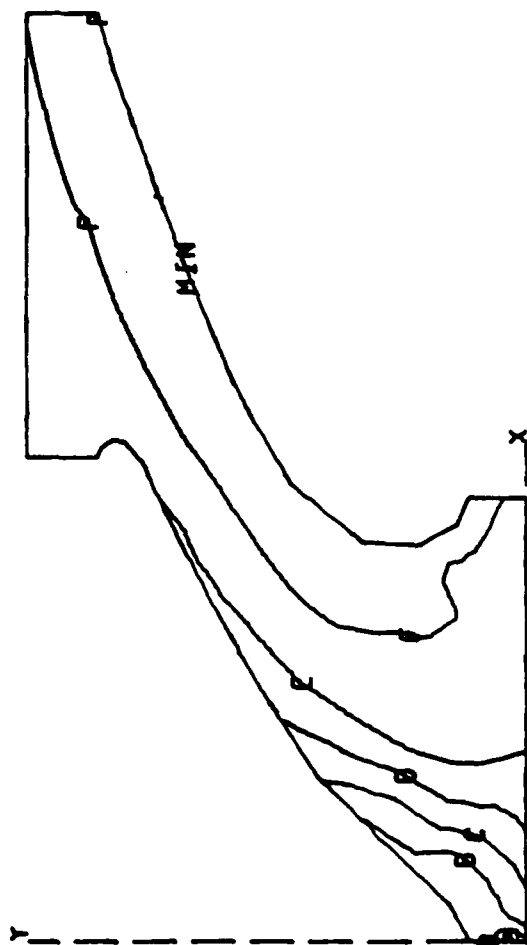
RUN 173 MACH .7 TGAS 800 RE2 1.25E06 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 18:42:50 80/163





| MAX | LEGEND | F      | MIN |
|-----|--------|--------|-----|
| A   |        | 700.00 |     |
| B   |        | 690.00 |     |
| C   |        | 680.00 |     |
| D   |        | 670.00 |     |
| E   |        | 660.00 |     |
| F   |        | 650.00 |     |
| G   |        | 640.00 |     |
| MAX |        | 709.06 |     |
| MIN |        | 634.30 |     |

RUN 173 MACH .7 TGAS 800 RE2 1.25E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 16:28:53 80/170



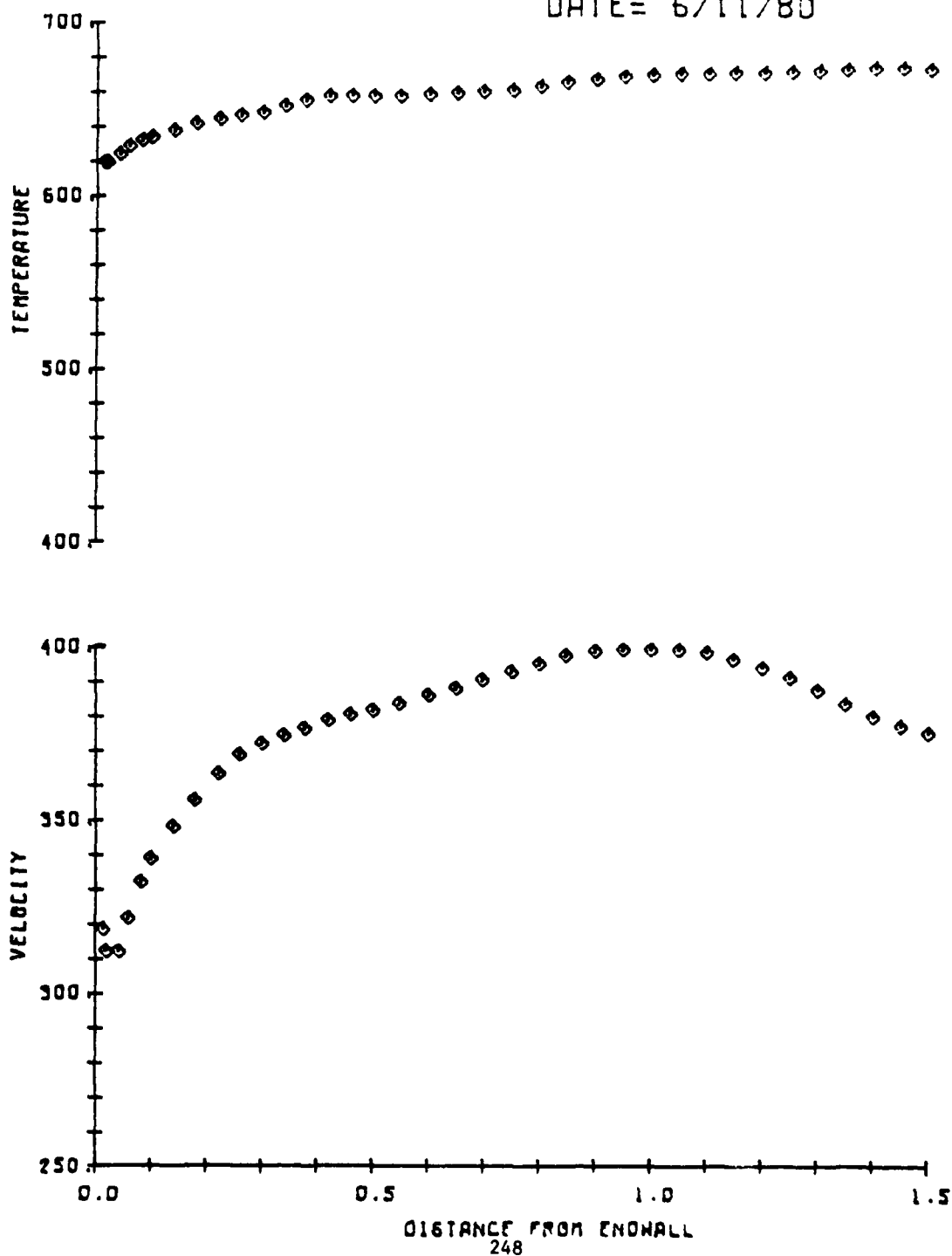
| MAX | LEGEND | MAX   |
|-----|--------|-------|
|     | (E-03) |       |
| A   | 12.00  |       |
| B   | 10.00  |       |
| C   | 8.00   |       |
| D   | 6.00   |       |
| E   | 4.00   |       |
| F   | 2.00   |       |
| MAX |        | 12.52 |

RUN 173 MACH .7 TGRS 800 RE2 1.25E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 10:19:19 80/172

# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 173

DATE = 6/11/80



# GMA 200 TURBINE VANE CASCADE

RUN #174

DATE: 6/13/80

TIME: 4:19:32

| INLET CONDITIONS |         |         |        |      |           |
|------------------|---------|---------|--------|------|-----------|
| PTOTLE           | PSTATIC | TTOTLE  | MACH # | V/V* | REY/10**6 |
| 58.93            | 56.87   | 1255.88 | .229   | .247 | .663      |

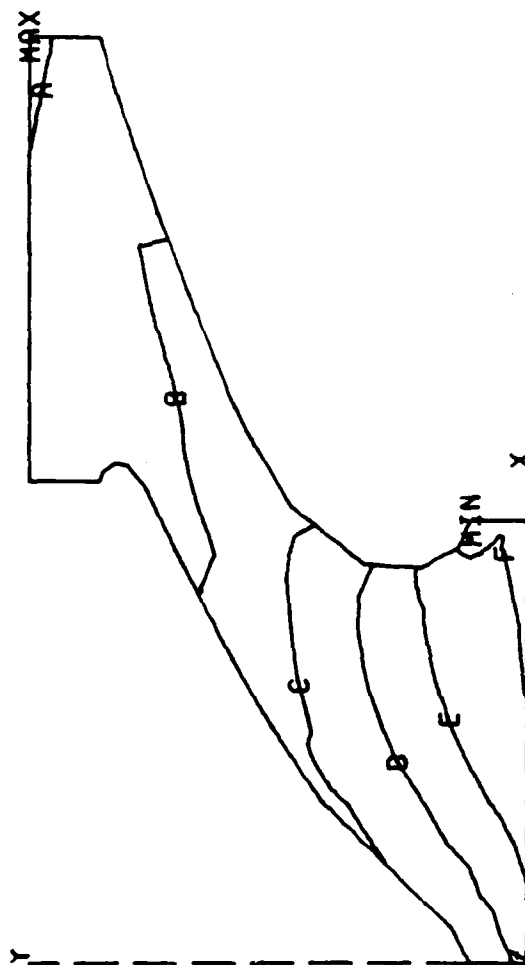
| STANTON CALCULATION INPUT |                  |                        |
|---------------------------|------------------|------------------------|
| RHO - LBM/IN3 *10**4      | VELOCITY - IN/HR | STREAM TEMPERATURE - F |
| .71427                    | 16855192.        | 784.38                 |

CP - BTU/LBM/F  
.257

| ORIFICE | MASS FLOW RATE |         |
|---------|----------------|---------|
|         | 8.92           | CASCADE |

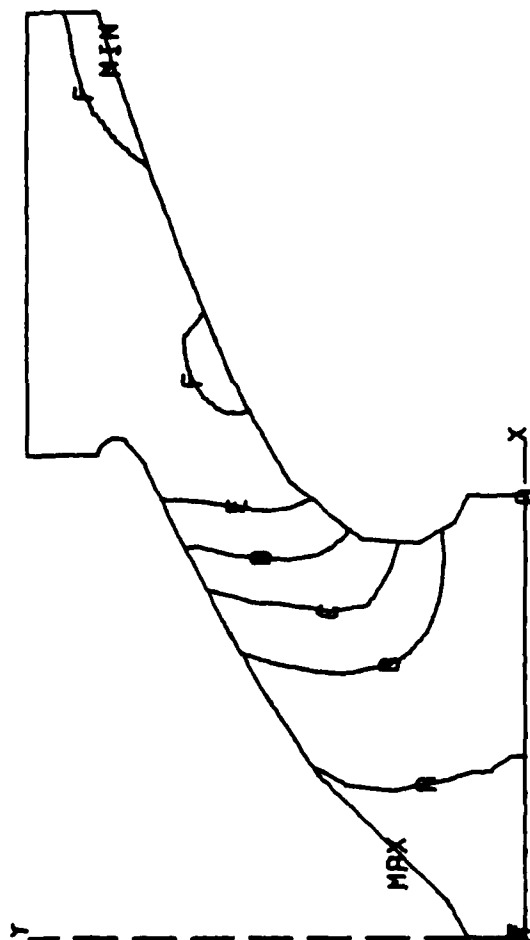
| IDEAL EXIT CONDITIONS |        |         |        |      |           |
|-----------------------|--------|---------|--------|------|-----------|
| PTOTLE                | STATIC | TTOTAL  | MACH # | V/V* | REY/10**6 |
| 58.93                 | 43.03  | 1255.88 | .693   | .723 | 1.656     |

| CASCADE OPERATING CONDITION |                        |
|-----------------------------|------------------------|
| EXPANSION RATIO=            | STATIC PRESSURE RATIO= |
| 1.369                       | .757                   |



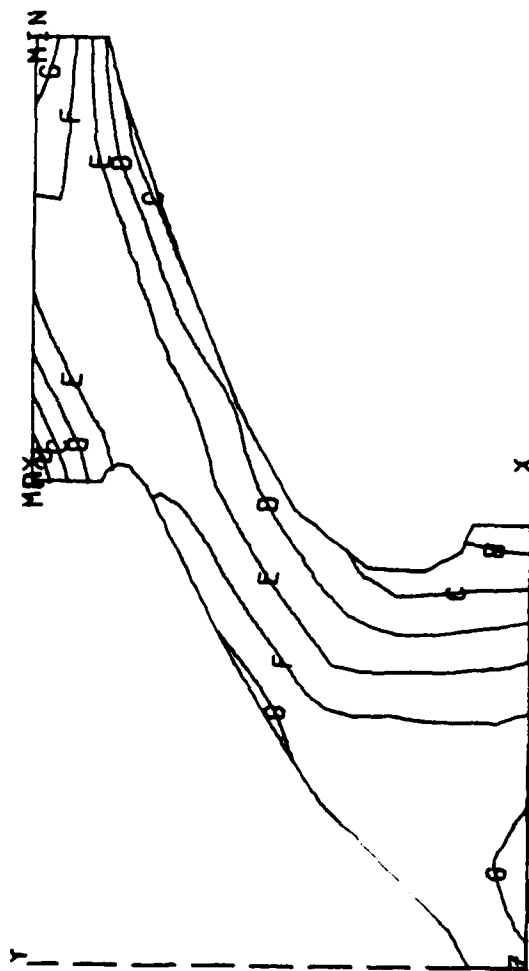
| MMM | LEGEND | MMM    |
|-----|--------|--------|
| A   | B      | 620.00 |
| B   | C      | 600.00 |
| C   | D      | 580.00 |
| D   | E      | 560.00 |
| E   | F      | 540.00 |
| F   | MAX    | 624.14 |
| MAX | MIN    | 513.20 |

RUN 174 MACH .7 TGRS 800 RE2 1.66E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:44:56 80/170



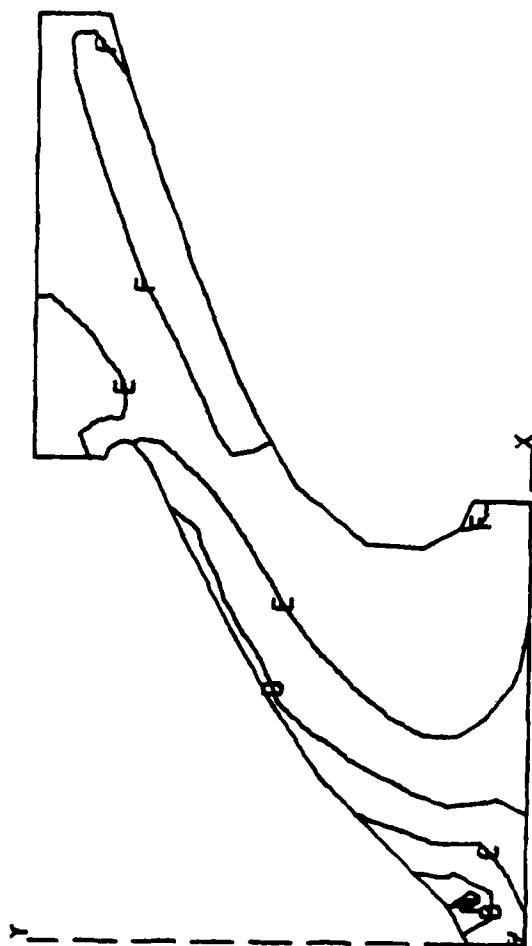
|     |        |     |
|-----|--------|-----|
| MAX | LEGEND | MAX |
| R   | PSI    |     |
| B   | 57.00  |     |
| C   | 54.00  |     |
| D   | 51.00  |     |
| E   | 48.00  |     |
| F   | 45.00  |     |
| MAX | 57.66  |     |
| MIN | 39.82  |     |

RUN 174 MACH .7 TGRS 800 RE2 1.66E06 ENDWALL PRESSURE CONTOURS  
 CONTOUR PLOT OF PRESSURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 15:22:22 80/176



| MAX | LEGEND | MAX    |
|-----|--------|--------|
| A   | B      | 694.00 |
| B   | C      | 685.00 |
| C   | D      | 676.00 |
| D   | E      | 667.00 |
| E   | F      | 658.00 |
| F   | G      | 649.00 |
| MAX |        | 640.00 |
| MIN |        | 631.50 |

RUN 174 MACH .7 TGAS 800 RE2 1.66E06 ADIABATIC ENDWALL  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 1.0000 PLOT TIME AND DATE = 14:08:42 80/168



| MM     | LEGEND | MM |
|--------|--------|----|
|        | F      |    |
| (E-03) |        |    |
| A      | 11.00  |    |
| B      | 9.00   |    |
| C      | 7.00   |    |
| D      | 5.00   |    |
| E      | 3.00   |    |
| F      | 1.00   |    |
| MAX    | 11.57  |    |

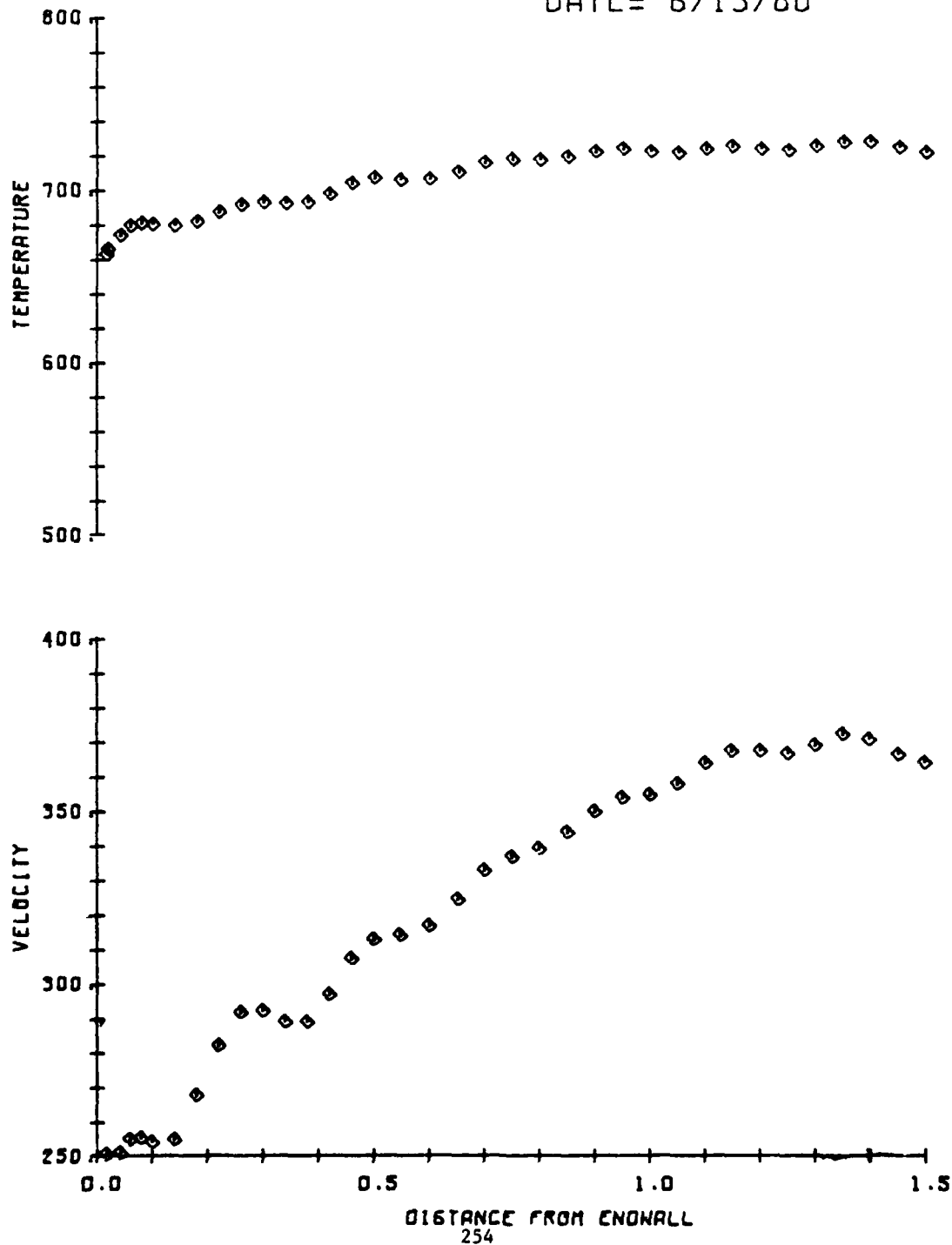
RUN 174 MACH .7 TCAS 800 RE2 1.66E06 HEAT TRANSFER ENDWALL  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 1.0000 PLOT TIME AND DATE = 17:45:19 80/170



# ENDWALL HEAT TRANSFER LINEAR CASCADE

RUN # = 174

DATE = 6/13/80



### 3.0 ANNULAR CASCADE

The data in this section will include summaries of results from all annular cascade tests. Run conditions are summarized and general descriptions of available types of data plots are given. Availability of specific plots for each run is discussed and then individual plots for each run are presented.

#### 3.1 RUN CONDITIONS

The annular cascade was intended to supply data on the effects of the one important variable that could not be simulated in the linear 2-D cascade, the radial pressure gradient. Determining the effects of the radial pressure gradient required making heat transfer measurements on both the hub and tip endwalls.

Data was taken over a range of exit Mach and Reynolds numbers and at various gas temperatures. Variation in gas temperature provided data over a range of wall-to-gas temperature ratios. Details of the test plan were discussed in Section 4 of Volume I and will not be repeated here. The inlet and exit flow conditions for the annular cascade runs are summarized in Table 4.

#### 3.2 DESCRIPTION OF SUMMARY DATA

The data on the annular cascade was not as extensive as on the linear cascade. Summary contour plots are presented for the hub and tip endwalls, but only hotside temperature contours and Stanton number contours are presented.

As with the linear cascade data, the measured hotside passage temperatures on the endwall were curve fit, with the results then used to obtain interpolated temperatures for the nodes of the finite element model. Separate models were required for the hub and tip, due to the difference in geometry in the 3-D annular cascade. Using the contour plotting capabilities of the finite element program, the interpolated hotside temperatures in °F at each node were then contour plotted for the hub and tip endwalls.

The Stanton number contour plots were developed by using the local endwall heat transfer coefficient that is determined at each node by the finite element solution technique. The Stanton number is calculated at each node based on the heat transfer coefficient at that node and the average inlet flow conditions. These values for both the hub and tip endwalls are then contour plotted by the finite element plotting routine. Because of the sign convention employed in the heat flux measurements, the Stanton numbers on the contour plots are negative. The absolute values should be used. This will result in the reversal of the MAX and MIN locations shown on the contour plots.

The annular cascade exit aero data summary consists of three pages per run. The first page lists tabulated values of the various loss parameters. The different parameters are explained in Section 6 of Volume I. The second page shows a contour plot of the exit air angle and a plot of the mixed-out air angle versus percent span. The final page shows exit pressure loss coefficient contours and mixed-out pressure loss coefficient versus percent span.

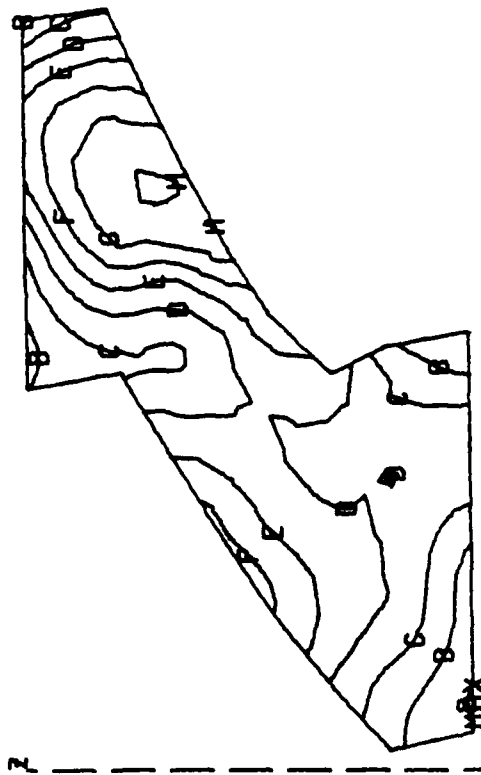
#### 3.3 DATA SUMMARY

This section contains the data summary sheets for all annular cascade runs. Results are presented for each run in the following order: hub heat transfer, tip heat transfer, and exit aero surveys. Runs are arranged in numerical order. Run conditions are given in Table 4.

TABLE 4. ANNULAR CASCADE RUN CONDITIONS

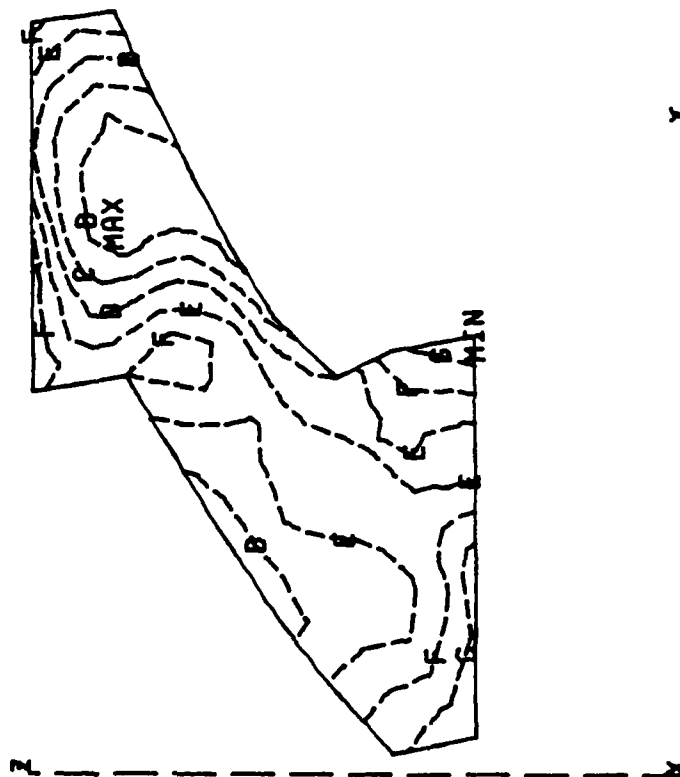
| Page<br>Nos. | Run No. | Inlet conditions                 |                             |                                  |                                  | Exit conditions |                                        |                    |
|--------------|---------|----------------------------------|-----------------------------|----------------------------------|----------------------------------|-----------------|----------------------------------------|--------------------|
|              |         | Gas total<br>temperature<br>(°F) | Total<br>pressure<br>(psia) | Hub static<br>pressure<br>(psia) | Tip static<br>pressure<br>(psia) | Mach<br>number  | Reynolds<br>number<br>$\times 10^{-6}$ | Expansion<br>ratio |
| 245-248      | 19      | 251                              | 30.2                        | 29.2                             | 29.3                             | 0.70            | 0.71                                   | 1.38               |
| 249-252      | 21      | 324                              | 33.7                        | 32.7                             | 32.8                             | 0.70            | 0.70                                   | 1.39               |
| 253-256      | 46      | 425                              | 47.6                        | 46.0                             | 46.1                             | 1.11            | 1.01                                   | 2.14               |
| 257-263      | 52-53*  | 425                              | 33.4                        | 32.2                             | 32.3                             | 1.09            | 0.71                                   | 2.09               |
| 264-270      | 58-59*  | 424                              | 38.9                        | 37.7                             | 37.8                             | 0.70            | 0.70                                   | 1.38               |
| 271-277      | 61-62*  | 429                              | 28.4                        | 27.6                             | 27.7                             | 0.68            | 0.50                                   | 1.36               |
| 278-284      | 64-65*  | 422                              | 55.8                        | 54.2                             | 54.4                             | 0.70            | 1.01                                   | 1.39               |
| 285-288      | 67      | 429                              | 23.9                        | 23.0                             | 23.1                             | 1.10            | 0.50                                   | 2.14               |
| 289-292      | 71      | 425                              | 13.7                        | 13.2                             | 13.2                             | 1.12            | 0.29                                   | 2.17               |
| 293-299      | 73-75*  | 425                              | 15.1                        | 14.6                             | 14.7                             | 0.70            | 0.27                                   | 1.39               |
| 300-303      | 77      | 512                              | 43.9                        | 42.7                             | 42.8                             | 0.70            | 0.70                                   | 1.38               |
| 304-307      | 84      | 424                              | 73.3                        | 70.8                             | 70.9                             | 1.11            | 1.56                                   | 2.14               |
| 308-314      | 88-89*  | 424                              | 81.1                        | 78.7                             | 78.9                             | 0.70            | 1.46                                   | 1.38               |
| 315-321      | 91-92*  | 422                              | 60.4                        | 59.7                             | 59.8                             | 0.39            | 0.70                                   | 1.11               |

\*Dual run numbers indicate combined aero and heat transfer runs with heat transfer data recorded under first number and aero recorded under second number.



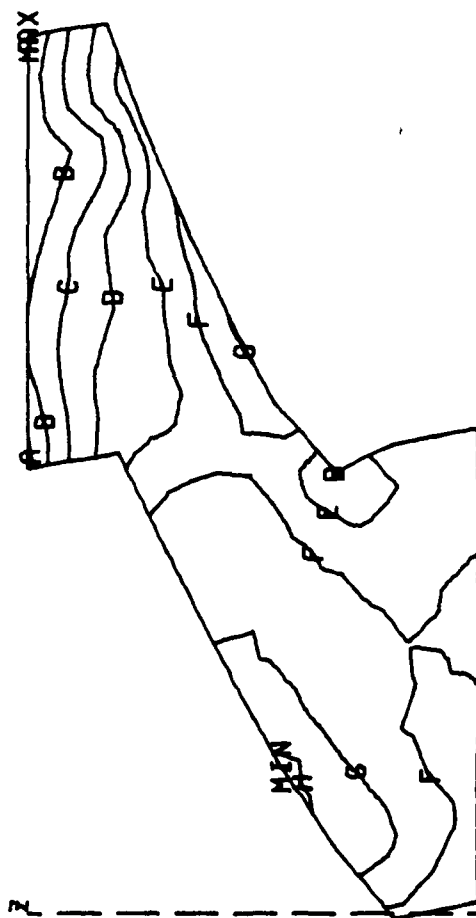
MMM LEGEND MMM  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 1.24000E 02  
 B 1.22000E 02  
 C 1.20000E 02  
 D 1.18000E 02  
 E 1.16000E 02  
 F 1.14000E 02  
 G 1.12000E 02  
 H 1.10000E 02  
 MAX 1.24237E 02  
 MIN 1.09764E 02

RUN 19 MACH=.7 TGAS=250. RE=.7E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 12:22:07 79/337



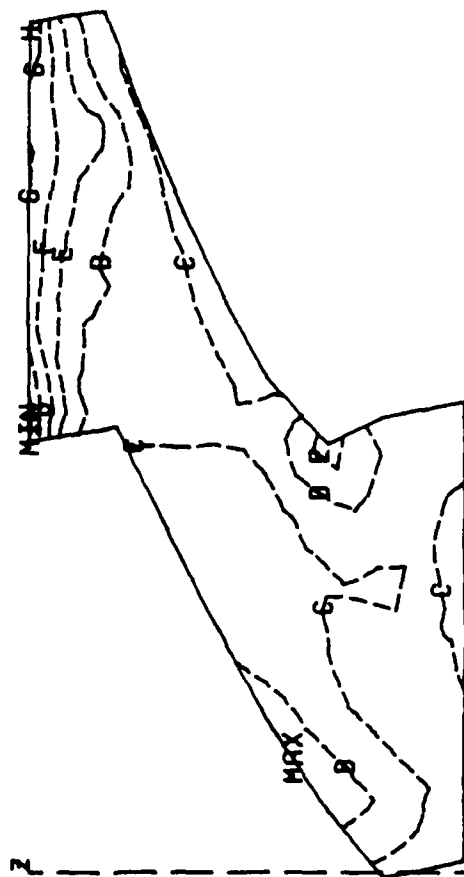
| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -2200.00 |     |
| B   | -2900.00 |     |
| C   | -3600.00 |     |
| D   | -4300.00 |     |
| E   | -5000.00 |     |
| F   | -5699.99 |     |
| G   | -6399.99 |     |
| MAX | -2212.25 |     |
| MIN | -7060.48 |     |

Y  
 RUN 19 MACH=.7 TGAS=250. RE=.7E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 12:23:07 79/337



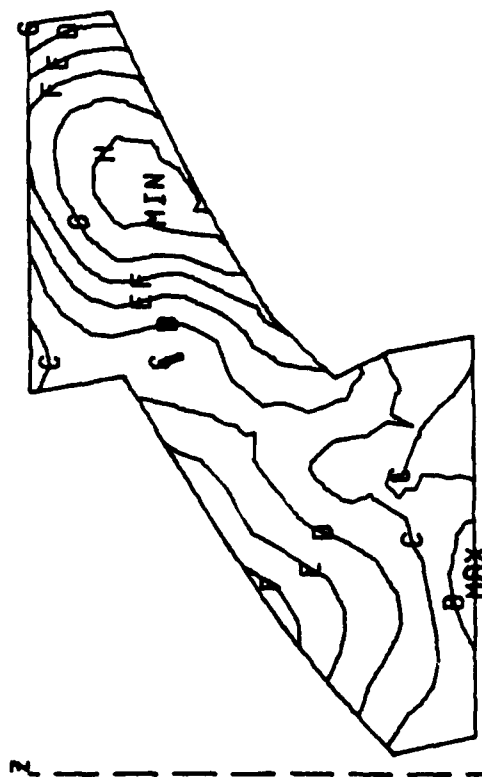
| MAX | LEGEND | MIN    |
|-----|--------|--------|
| A   | F      | 169.00 |
| B   |        | 164.00 |
| C   |        | 159.00 |
| D   |        | 154.00 |
| E   |        | 149.00 |
| F   |        | 144.00 |
| G   |        | 139.00 |
| H   |        | 134.00 |
| MAX |        | 169.75 |
| MIN |        | 133.14 |

RUN 19 MACH=.7 TGAS=250. RE=.7E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 16:43:14 80/021



| MAX | LEGEND | MIN |
|-----|--------|-----|
|     | F      |     |
|     | (E-03) |     |
| A   | -2.00  |     |
| B   | -4.00  |     |
| C   | -6.00  |     |
| D   | -8.00  |     |
| E   | -10.00 |     |
| F   | -12.00 |     |
| G   | -14.00 |     |
| H   | -16.00 |     |
| MAX | -2.86  |     |
| MIN | -16.62 |     |

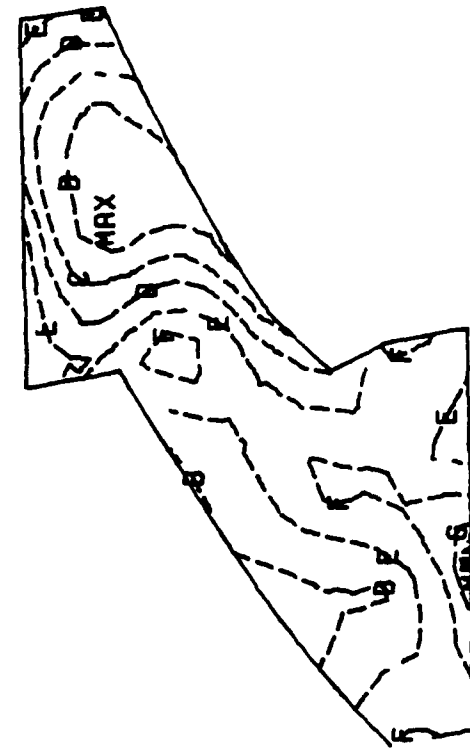
RUN 19 MACH=.7 TGRS=250. RE=.7E06 ANNUAL AA TIP  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 16:46:59 80/021



MAX LEGEND MAX  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 1.56000E 02  
 B 1.53000E 02  
 C 1.50000E 02  
 D 1.47000E 02  
 E 1.44000E 02  
 F 1.41000E 02  
 G 1.38000E 02  
 H 1.35000E 02  
 MAX 1.56131E 02  
 MIN 1.33402E 02

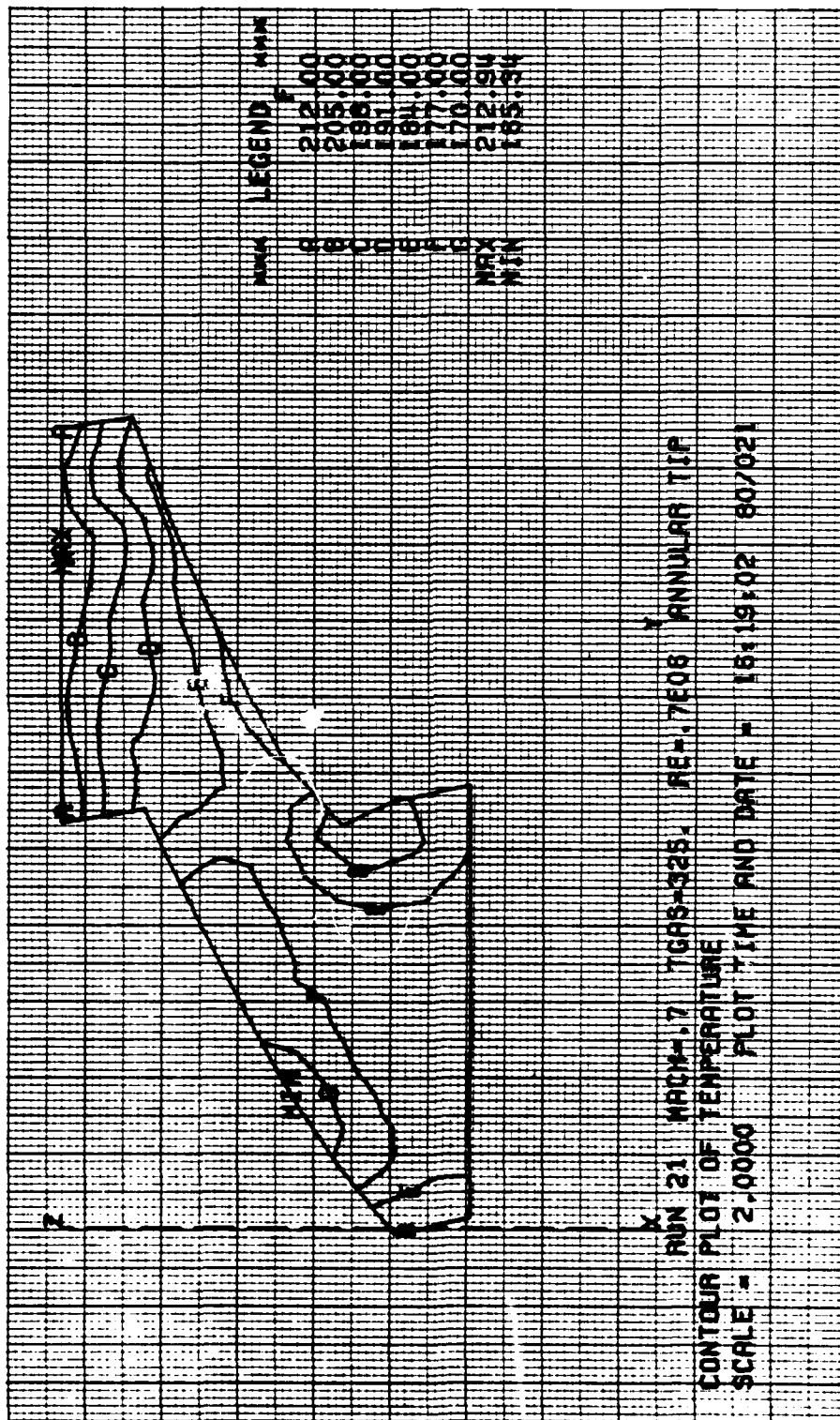
RUN 21 MACH=.7 TGAS=250. RE=.7E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 12:58:59 79/337

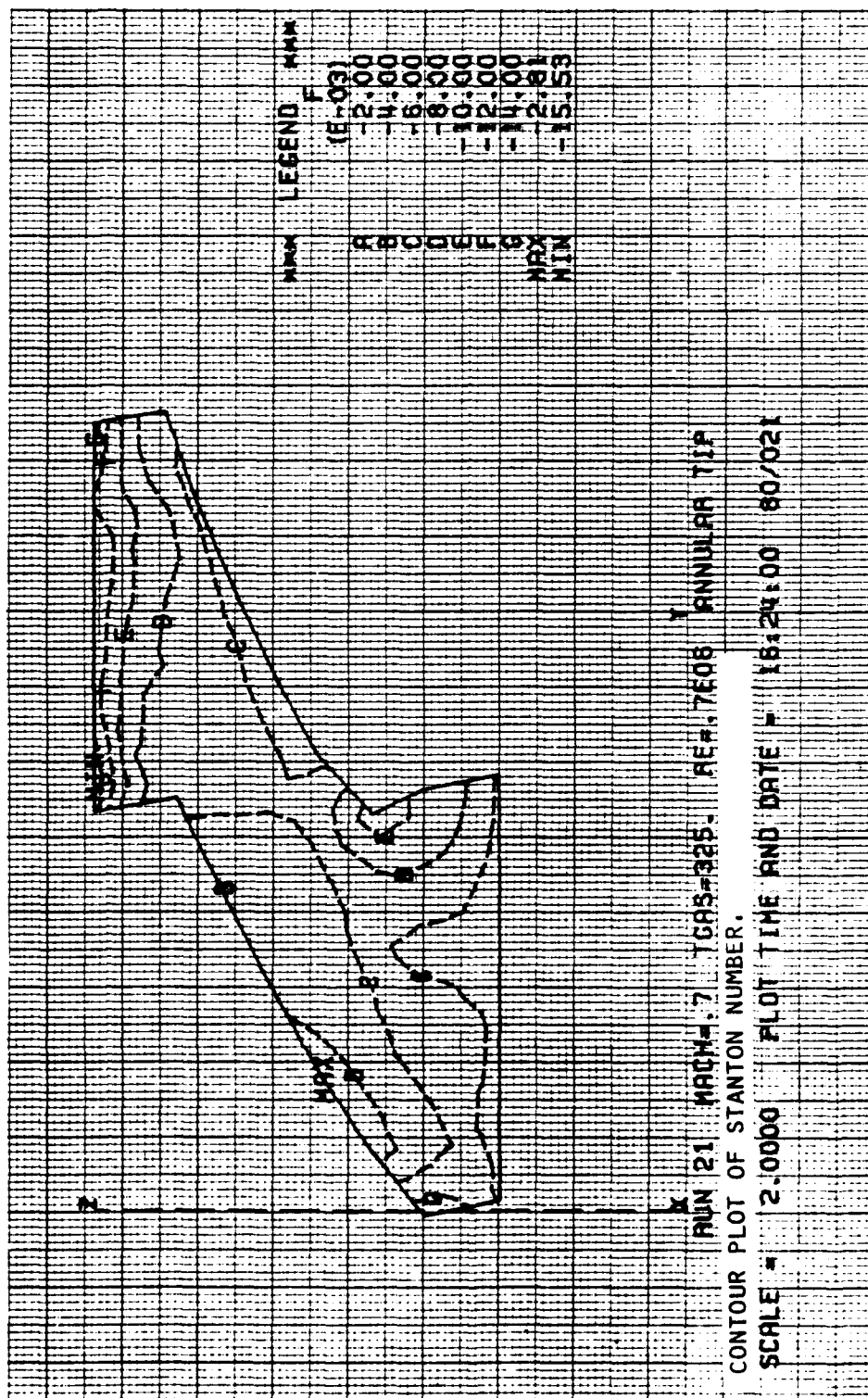


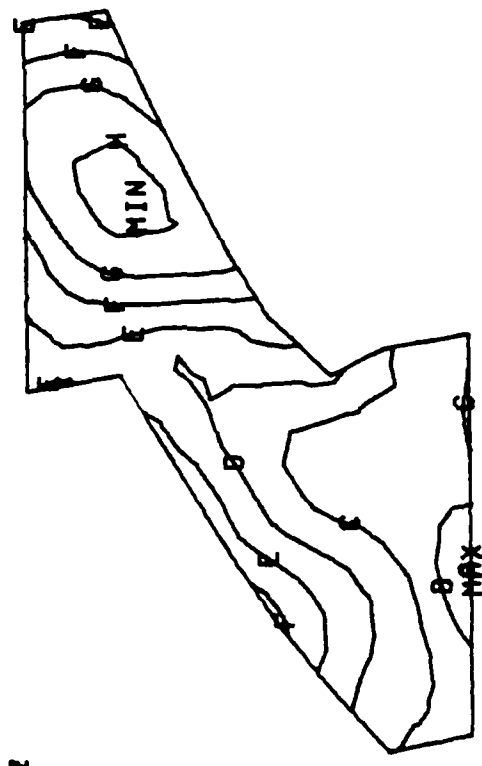


| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -2000.00 |     |
| B   | -2800.00 |     |
| C   | -3500.00 |     |
| D   | -4400.00 |     |
| E   | -5200.00 |     |
| F   | -6000.00 |     |
| G   | -6799.99 |     |
| H   | -7599.99 |     |
| MAX | -2094.33 |     |
| MIN | -7683.68 |     |

RUN 21 MACH=.7 IGRS-250. RE-.7E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLUT TIME AND DATE = 17:02:34 60/008





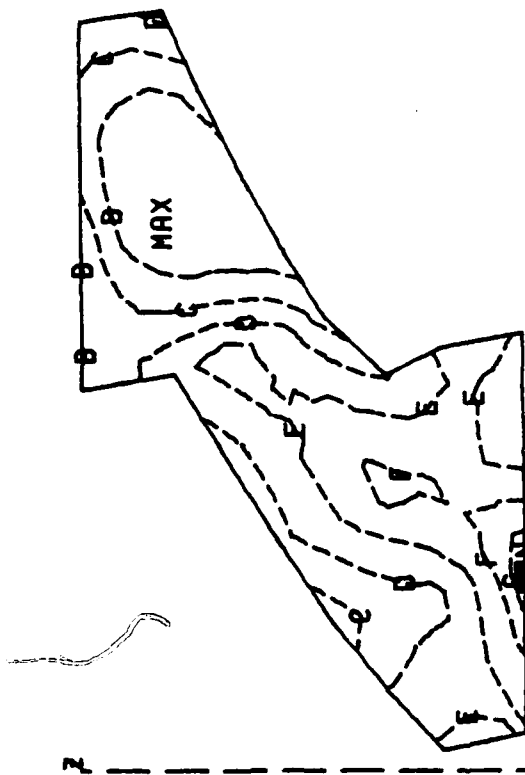


MMX LEGEND MMX

UNITS = TEMP

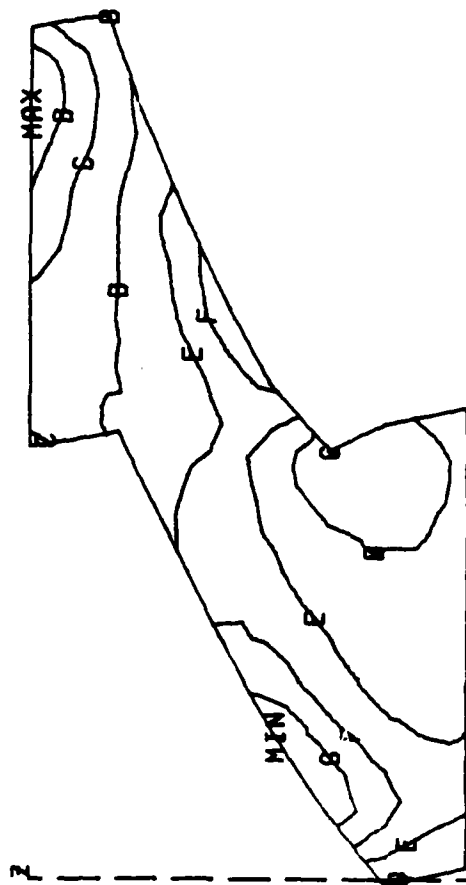
| SYMBOL | CONTOUR     |
|--------|-------------|
| A      | 2.31000E 02 |
| B      | 2.24000E 02 |
| C      | 2.17000E 02 |
| D      | 2.10000E 02 |
| E      | 2.03000E 02 |
| F      | 1.96000E 02 |
| G      | 1.89000E 02 |
| H      | 1.82000E 02 |
| MAX    | 2.31681E 02 |
| MIN    | 1.80053E 02 |

RUN 46 MACH 1.1 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 17:31:18 79/324



| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -1600.00 |     |
| B   | -2600.00 |     |
| C   | -3600.00 |     |
| D   | -4600.00 |     |
| E   | -5600.00 |     |
| F   | -6600.00 |     |
| G   | -7599.99 |     |
| H   | -8599.99 |     |
| MAX | -1652.89 |     |
| MIN | -8632.46 |     |

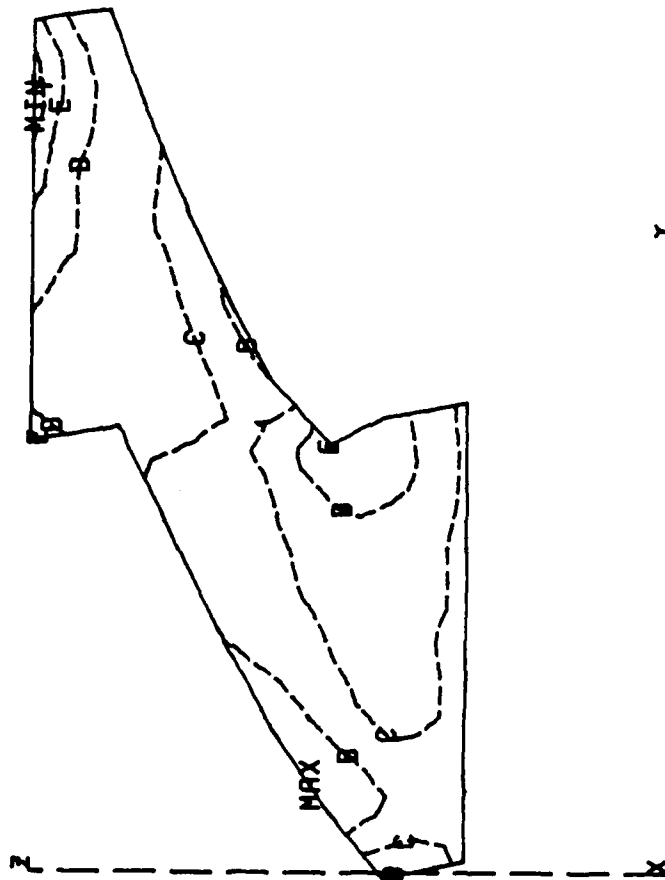
RUN 46 MACH 1.1 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:13:04 80/010



| MAX | LEGEND | F | MIN |
|-----|--------|---|-----|
| A   | B      | C | D   |
| E   | F      | G | MAX |
| MIN |        |   |     |

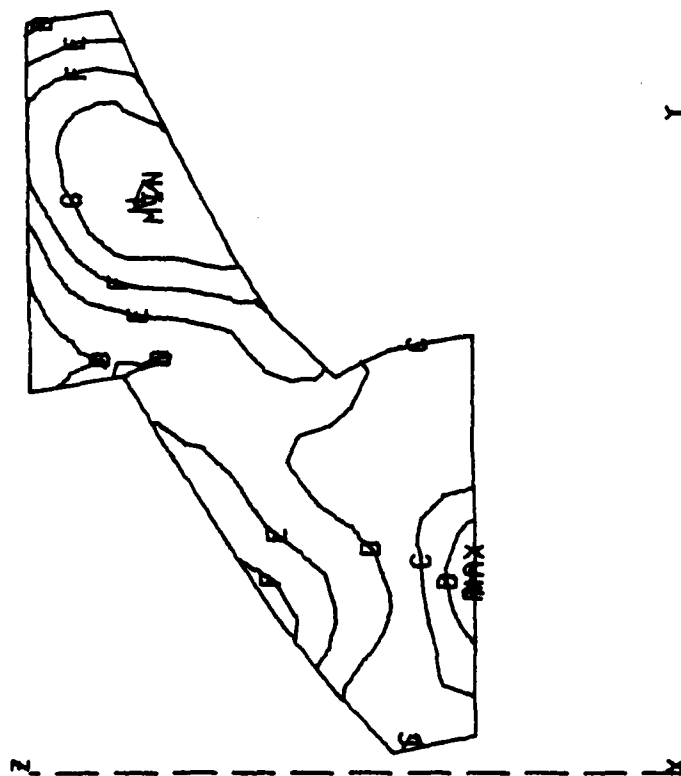
294.00  
284.00  
274.00  
264.00  
254.00  
244.00  
234.00  
294.30  
226.88

RUN 46 MACH 1.1 ANNULAR TIP  
CONTOUR PLOT OF TEMPERATURE  
SCALE = 2.0000 PLOT TIME AND DATE = 7:46:20 80/017



RUN 46 MACH 1.1 ANNULAR TIP  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 7:46:31 80/017

| MIN | LEGEND | MAX |
|-----|--------|-----|
|     | F      |     |
|     | (E-03) |     |
| A   | -2.00  |     |
| B   | -4.00  |     |
| C   | -6.00  |     |
| D   | -8.00  |     |
| E   | -10.00 |     |
| F   | -12.00 |     |
| MAX | -2.24  |     |
| MIN | -13.33 |     |



\*\*\* LEGEND \*\*\*  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 1.96000E 02  
 B 1.91000E 02  
 C 1.86000E 02  
 D 1.81000E 02  
 E 1.76000E 02  
 F 1.71000E 02  
 G 1.66000E 02  
 H 1.61000E 02  
 MAX 1.96670E 02  
 MIN 1.60839E 02

RUN 52 MACH 1.1 RE .7E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 12:41:42 79/334

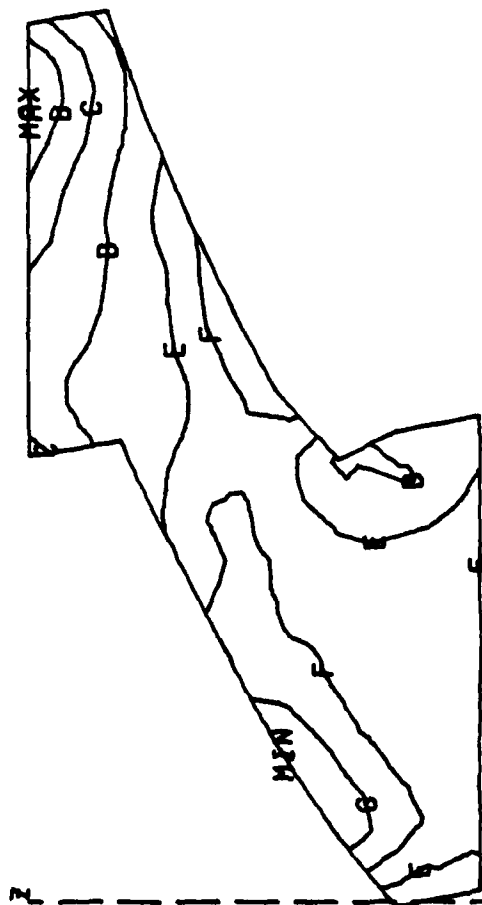




| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -2000.00 |     |
| B   | -2900.00 |     |
| C   | -3800.00 |     |
| D   | -4700.00 |     |
| E   | -5600.00 |     |
| F   | -6499.99 |     |
| G   | -7399.99 |     |
| H   | -8299.99 |     |
| MAX | -2083.14 |     |
| MIN | -8410.64 |     |

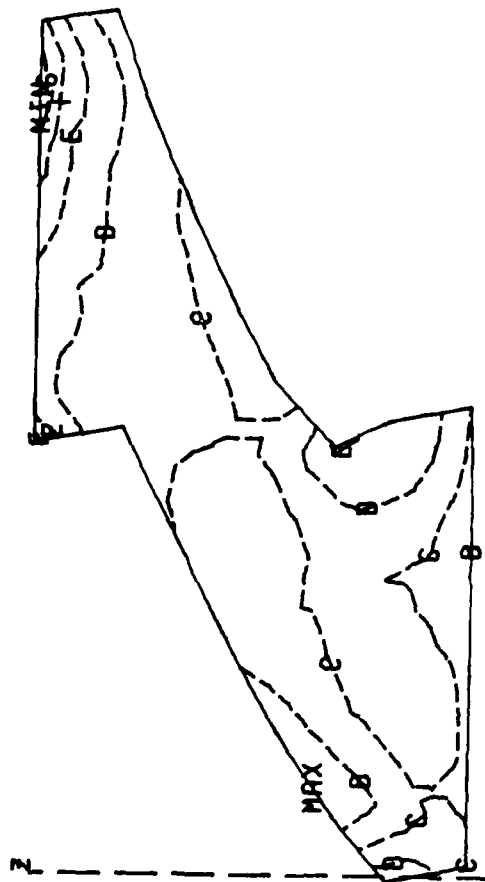
Y  
 RUN 52 MACH 1.1 RE .7E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.

SCALE = 2.0000 PLOT TIME AND DATE = 18:17:44 80/014



| MAX | LEGEND | F | MAX |
|-----|--------|---|-----|
| A   | B      | C | D   |
| E   | F      | G | MAX |
| MIN |        |   |     |

RUN 52 MACH 1.1 RE .7E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 17:13:13 80/028



| MM  | LEGEND | MM |
|-----|--------|----|
|     | (E-03) |    |
| A   | -2.00  |    |
| B   | -4.00  |    |
| C   | -6.00  |    |
| D   | -8.00  |    |
| E   | -10.00 |    |
| F   | -12.00 |    |
| G   | -14.00 |    |
| MAX | -2.62  |    |
| MIN | -15.30 |    |

RUN 52 MACH 1.1 RE .7E06 ANNULAR TIP  
 CONTOUR PLOT OF STANTON NUMBER,  
 SCHLE = 2.0000 PLOT TIME AND DATE = 17:13:42 80/028

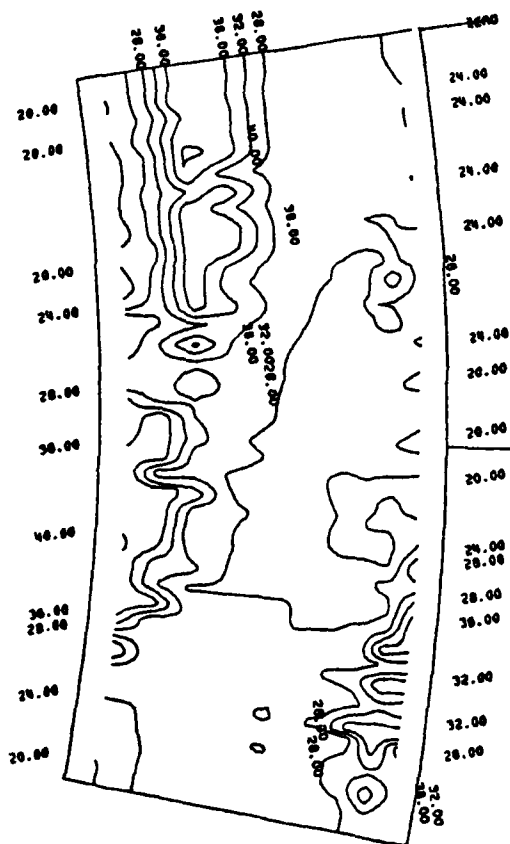
# 11-20-79 VANE SURVEY W/HT SURVEY

TIME 10:20 RDG 53 RIG 1 BU 51

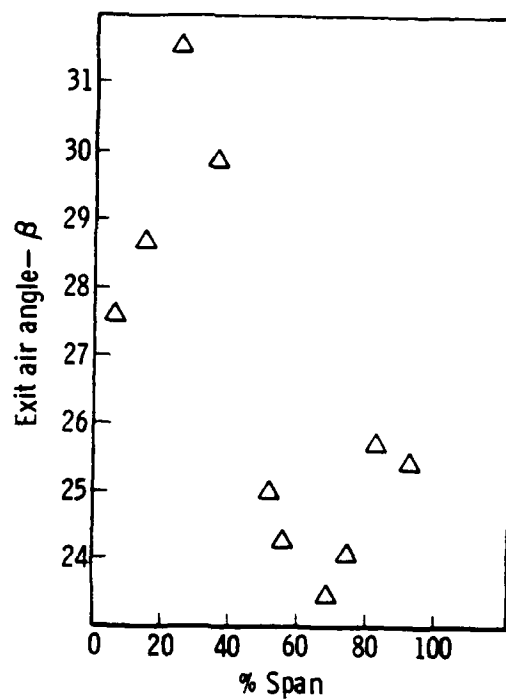
\*\*\*  
 KE COEF 0.09033  
 OMEGA ID 0.12789  
 OMEGA ACT 0.17995  
 COMPLETE PASSAGE DATA  
 DELTA P/P 0.0677  
 FLOW RATE 4.440  
 \*\*\*

| RADIUS<br>INCHES | O/O SPAN | KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | FLOW/L<br>LB/SEC IN |
|------------------|----------|---------|----------------------|-----------------------|-----------------------|---------------------|
| 4.5400           | 91.852   | 0.14254 | 0.19776              | 0.25758               | 0.09448               | 5.38093             |
| 4.4900           | 84.444   | 0.07226 | 0.10466              | 0.12028               | 0.05096               | 6.24744             |
| 4.4400           | 77.037   | 0.04797 | 0.07048              | 0.07913               | 0.03482               | 7.62084             |
| 4.3900           | 69.630   | 0.03695 | 0.05500              | 0.06088               | 0.02761               | 7.51053             |
| 4.3100           | 57.778   | 0.03401 | 0.05155              | 0.05613               | 0.02651               | 6.57683             |
| 4.2800           | 53.333   | 0.03355 | 0.05116              | 0.05567               | 0.02656               | 6.44471             |
| 4.1700           | 37.037   | 0.02869 | 0.04459              | 0.04883               | 0.02392               | 6.36375             |
| 4.1000           | 26.667   | 0.04902 | 0.07696              | 0.08501               | 0.04213               | 6.53933             |
| 4.0300           | 16.296   | 0.15593 | 0.23194              | 0.31745               | 0.12941               | 6.88042             |
| 3.9700           | 7.407    | 0.24630 | 0.34661              | 0.61615               | 0.19675               | 6.52975             |

| KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | GAS ANGLE<br>MIXED | KE MIX/KE |
|---------|----------------------|-----------------------|-----------------------|--------------------|-----------|
| 0.15756 | 0.21801              | 0.27879               | 0.10284               | 25.5343            | 1.10534   |
| 0.08468 | 0.12212              | 0.13911               | 0.05878               | 25.7567            | 1.17187   |
| 0.05310 | 0.07854              | 0.08523               | 0.03861               | 24.1206            | 1.10673   |
| 0.03949 | 0.05937              | 0.06312               | 0.02972               | 24.5742            | 1.06857   |
| 0.03576 | 0.05464              | 0.05779               | 0.02803               | 24.2727            | 1.05131   |
| 0.03499 | 0.05379              | 0.05685               | 0.02786               | 24.9708            | 1.04298   |
| 0.04181 | 0.06477              | 0.06925               | 0.03418               | 29.9198            | 1.45718   |
| 0.06188 | 0.09600              | 0.10619               | 0.05166               | 31.6230            | 1.26252   |
| 0.16887 | 0.25123              | 0.33552               | 0.13900               | 28.7319            | 1.08299   |
| 0.27622 | 0.38953              | 0.63809               | 0.21744               | 27.6099            | 1.12146   |



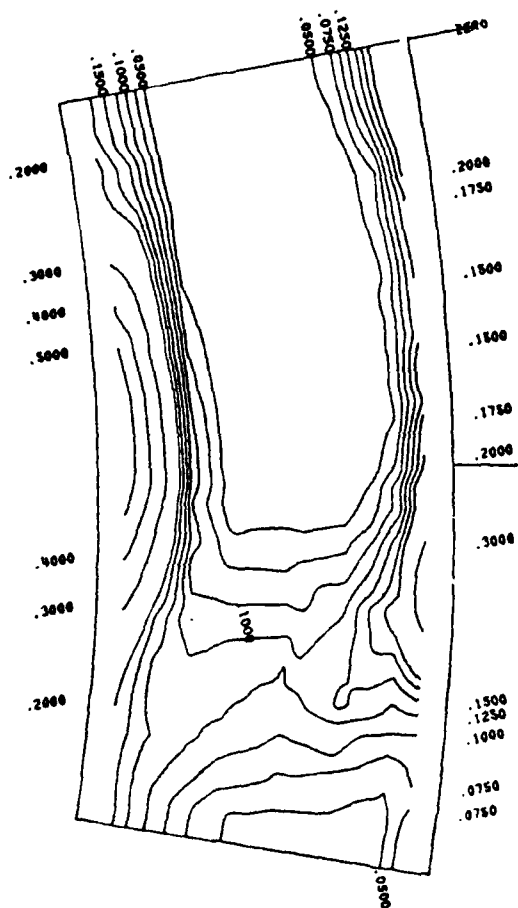
Local  $\beta$  contours



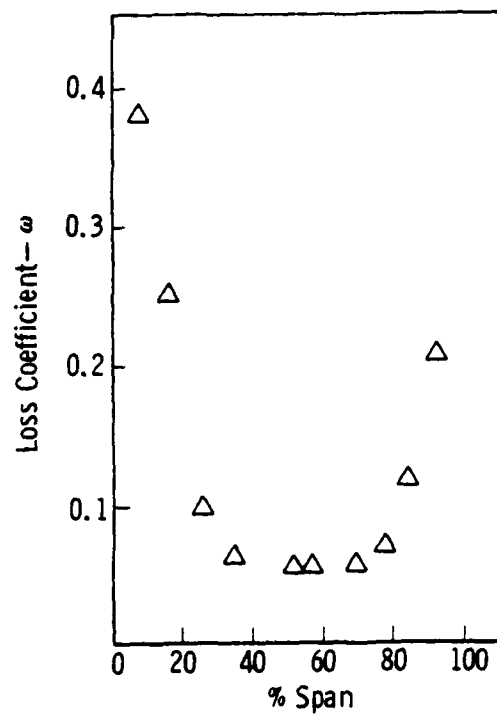
Exit Mach No. = 1.1 Reynolds No. =  $0.7 \times 10^6$

Reading 53 - aerodynamic exit data

TE-80-996



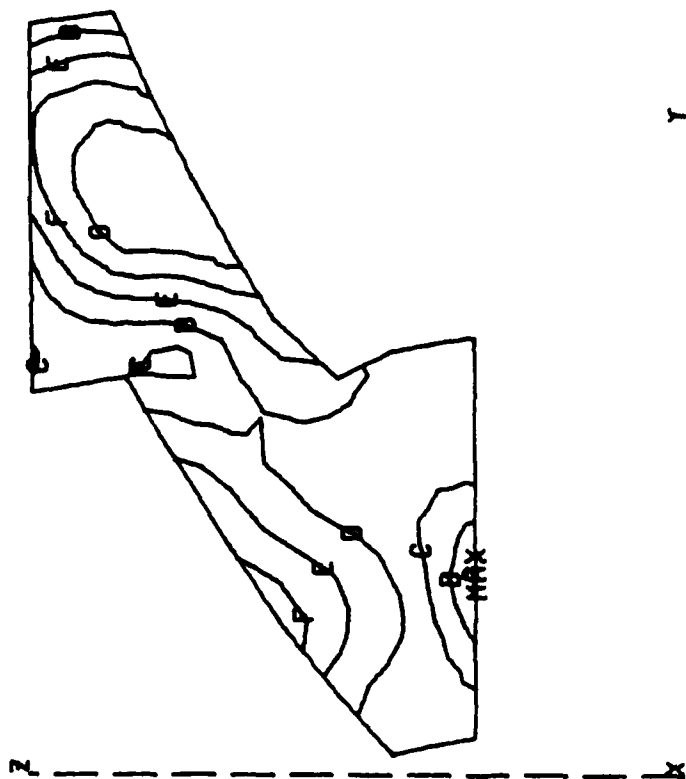
Local  $\omega$  contours



Exit Mach No. = 1.1 Reynolds No. =  $0.7 \times 10^6$

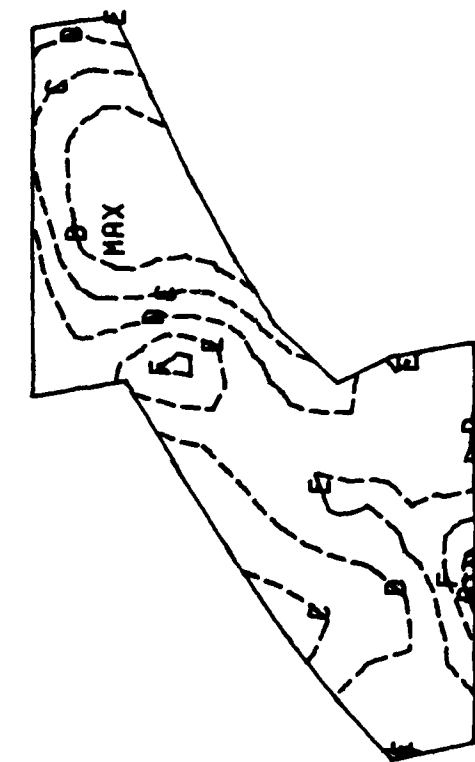
Reading 53 - aerodynamic exit data

TE-80-997



XXX LEGEND XXX  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 2.02000E 02  
 B 1.97000E 02  
 C 1.92000E 02  
 D 1.87000E 02  
 E 1.82000E 02  
 F 1.77000E 02  
 G 1.72000E 02  
 MAX 2.02639E 02  
 MIN 1.67281E 02

RUN 58 MACH .7 RE .7E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 12:05:23 79/338

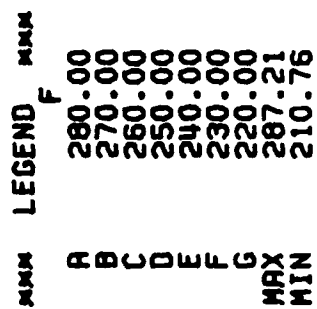


MAX LEGEND F MAX  
 (E-06)  
 A -2100.00  
 B -3000.00  
 C -3900.00  
 D -4800.00  
 E -5700.00  
 F -6600.00  
 G -7499.99  
 MAX -2116.71  
 MIN -8277.28

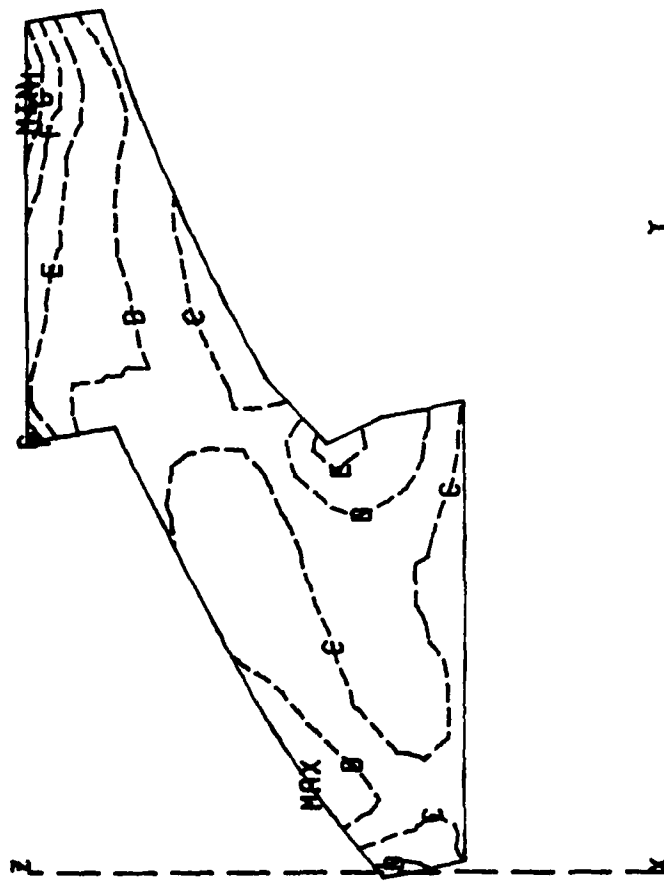
RUN 58 MACH .7 RE .7E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.

SCALE = 2.0000 PLOT TIME AND DATE = 18:28:37 80/014





279



|     |        |     |
|-----|--------|-----|
| MAX | LEGEND | MIN |
| A   | F      |     |
| B   | 1E-031 |     |
| C   | -2.00  |     |
| D   | -4.00  |     |
| E   | -6.00  |     |
| F   | -8.00  |     |
| G   | -10.00 |     |
| H   | -12.00 |     |
| MAX | -14.00 |     |
| MIN | -16.00 |     |
|     | -2.49  |     |
|     | -16.88 |     |

RUN 58 MACH .7 RE .7E06 ANNULAR TIP<sup>Y</sup>

CONTOUR PLOT OF STANTON NUMBER.

SCALE = 2.0000 PLOT TIME AND DATE = 17:45:10 80/028

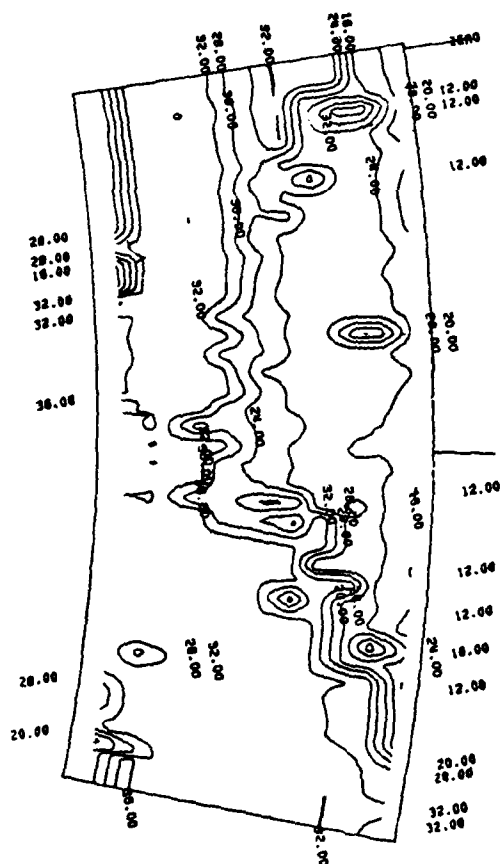
# 11-20-79 VANE SURVEY W/HT SURVEY

TIME 13:37 RDG 59 RIG 1 8U 51

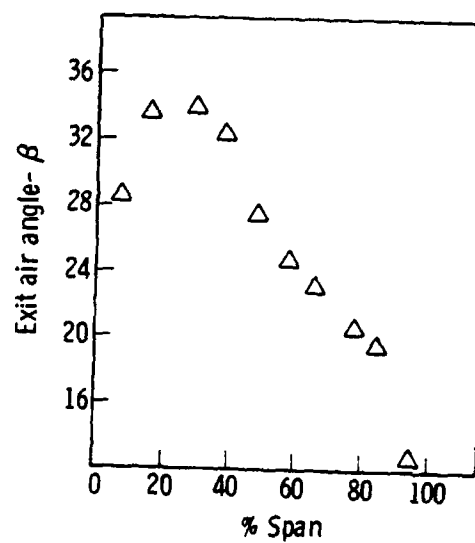
\*\*\*\* COMPLETE PASSAGE DATA \*\*\*\*  
 KE COEF 0.08076 OMEGA ID 0.09315 DELTA P/P 0.0262 FLOW RATE 4.613

| RADIUS<br>INCHES | O/O SPAN | KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | FLOW/L IN<br>LB/SEC |
|------------------|----------|---------|----------------------|-----------------------|-----------------------|---------------------|
| 4.5600           | 94.815   | 0.18097 | 0.20849              | 0.26549               | 0.05077               | 6.51383             |
| 4.4900           | 84.444   | 0.07324 | 0.08643              | 0.09565               | 0.02167               | 8.40333             |
| 4.4400           | 77.037   | 0.04657 | 0.05551              | 0.06001               | 0.01413               | 9.09713             |
| 4.3700           | 66.667   | 0.03330 | 0.03991              | 0.04247               | 0.01041               | 8.79849             |
| 4.3200           | 59.259   | 0.02777 | 0.03344              | 0.03204               | 0.00893               | 7.52171             |
| 4.2500           | 49.889   | 0.02525 | 0.03061              | 0.03204               | 0.00832               | 7.03134             |
| 4.1700           | 37.037   | 0.01654 | 0.02016              | 0.02114               | 0.00563               | 6.51747             |
| 4.1200           | 29.630   | 0.03297 | 0.04030              | 0.04259               | 0.01150               | 5.81755             |
| 4.0300           | 16.296   | 0.12548 | 0.15008              | 0.18521               | 0.04631               | 5.57561             |
| 3.9700           | 7.407    | 0.22673 | 0.26629              | 0.39560               | 0.07994               | 3.51175             |

| KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | GAS ANGLE<br>MIXED | KE MIX/K |
|---------|----------------------|-----------------------|-----------------------|--------------------|----------|
| 0.18418 | 0.21217              | 0.26932               | 0.05152               | 13.1021            | 1.01700  |
| 0.08737 | 0.10278              | 0.11455               | 0.02540               | 19.9414            | 1.01640  |
| 0.06231 | 0.07334              | 0.07973               | 0.01850               | 20.9419            | 1.01320  |
| 0.05097 | 0.06277              | 0.06470               | 0.01554               | 23.3523            | 1.01320  |
| 0.04285 | 0.05138              | 0.05416               | 0.01340               | 25.3459            | 1.01320  |
| 0.03330 | 0.04029              | 0.04198               | 0.01280               | 27.2333            | 1.01320  |
| 0.02046 | 0.02499              | 0.02564               | 0.00594               | 32.5344            | 1.01320  |
| 0.03521 | 0.04310              | 0.04504               | 0.01225               | 34.3355            | 1.01320  |
| 0.12754 | 0.15399              | 0.18202               | 0.04519               | 34.0025            | 1.01320  |
| 0.24825 | 0.29159              | 0.41160               | 0.09555               | 34.7499            | 1.01320  |



Local  $\beta$  contours



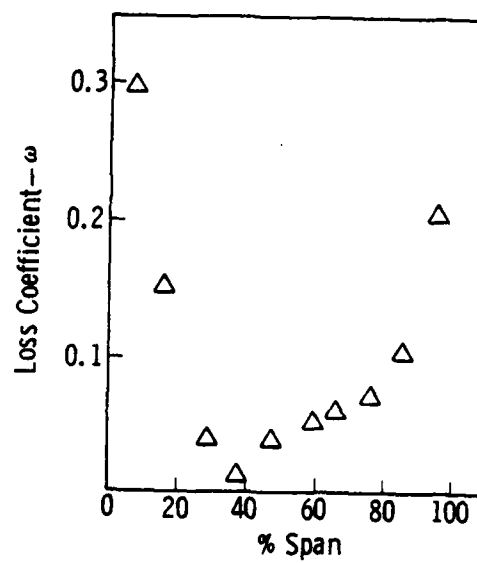
TE-80-998

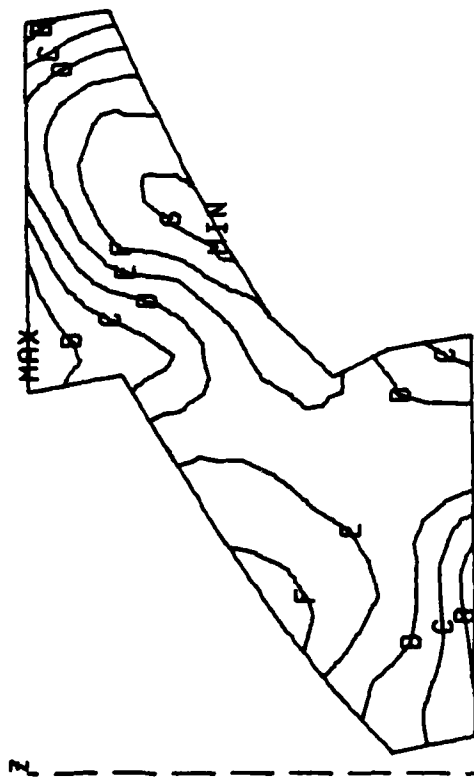
Exit Mach No. = 0.7 Reynolds No. =  $0.7 \times 10^6$   
 Reading 59 - aerodynamic exit data



Exit Mach No. = 0.7 Reynolds No. =  $0.7 \times 10^6$   
Reading 59 - aerodynamic exit data

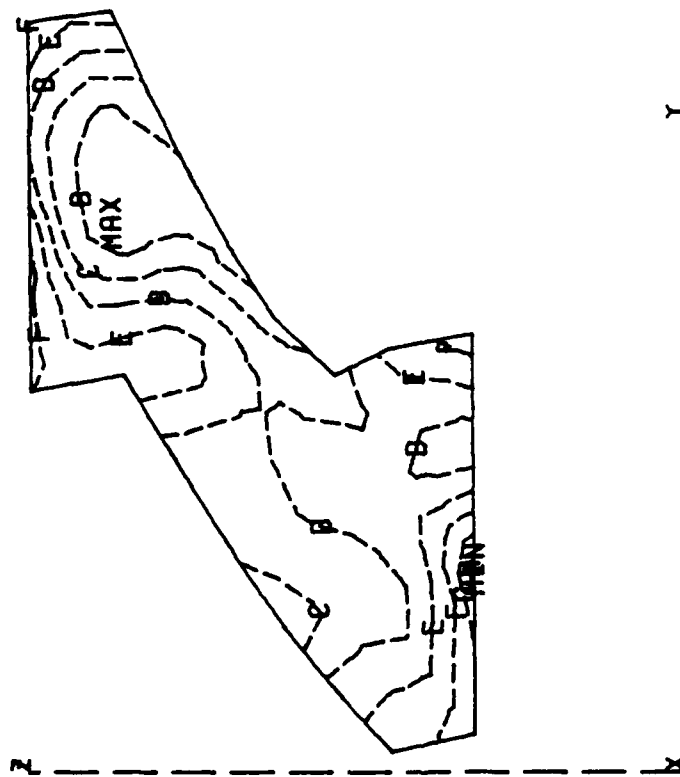
TE-80-999





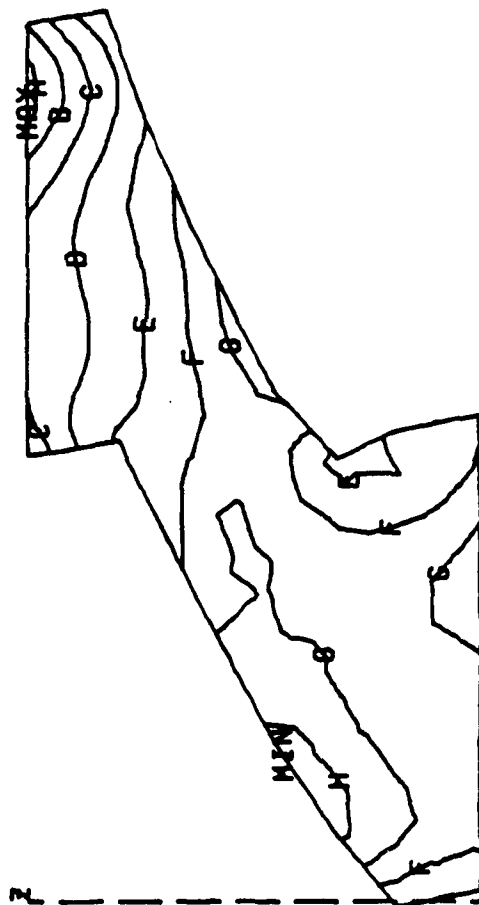
MMM LEGEND MMM  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 1.81000E 02  
 B 1.77000E 02  
 C 1.73000E 02  
 D 1.69000E 02  
 E 1.65000E 02  
 F 1.61000E 02  
 G 1.57000E 02  
 MAX 1.81015E 02  
 MIN 1.54915E 02

RUN 61 MACH .7 RE .5E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 13:43:56 79/338



| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -2600.00 |     |
| B   | -3400.00 |     |
| C   | -4200.00 |     |
| D   | -5000.00 |     |
| E   | -5800.00 |     |
| F   | -6600.00 |     |
| G   | -7399.99 |     |
| H   | -8199.99 |     |
| MAX | -2651.94 |     |
| MIN | -8516.12 |     |

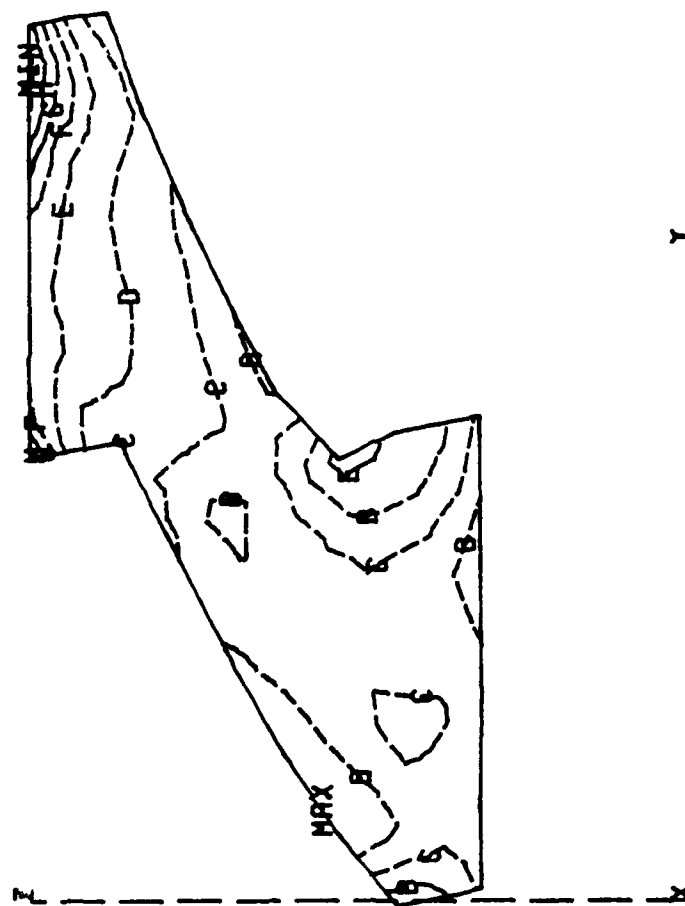
RUN 61 MACH .7 RE .5E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER,  
 SCALE = 2.0000 PLOT TIME AND DATE = 17:57:04 80/015



| MAX | LEGEND | MIN    |
|-----|--------|--------|
| A   | F      | 270.00 |
| B   |        | 260.00 |
| C   |        | 250.00 |
| D   |        | 240.00 |
| E   |        | 230.00 |
| F   |        | 220.00 |
| G   |        | 210.00 |
| H   |        | 200.00 |
| MAX |        | 272.83 |
| MIN |        | 196.41 |

RUN 61 MACH .7 RE .5E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:03:29 80/030





| MAX | LEGEND | MIN |
|-----|--------|-----|
| A   | (E-03) |     |
| B   | -3.00  |     |
| C   | -5.00  |     |
| D   | -7.00  |     |
| E   | -9.00  |     |
| F   | -11.00 |     |
| G   | -13.00 |     |
| H   | -15.00 |     |
| I   | -17.00 |     |
| MAX | -19.00 |     |
| MIN | -3.04  |     |
|     | -19.93 |     |

RUN 61 MACH .7 RE .5E06 ANNULAR TIP  
CONTOUR PLOT OF STANTON NUMBER.

SCALE = 2.0000 PLOT TIME AND DATE = 18:04:03 80/030

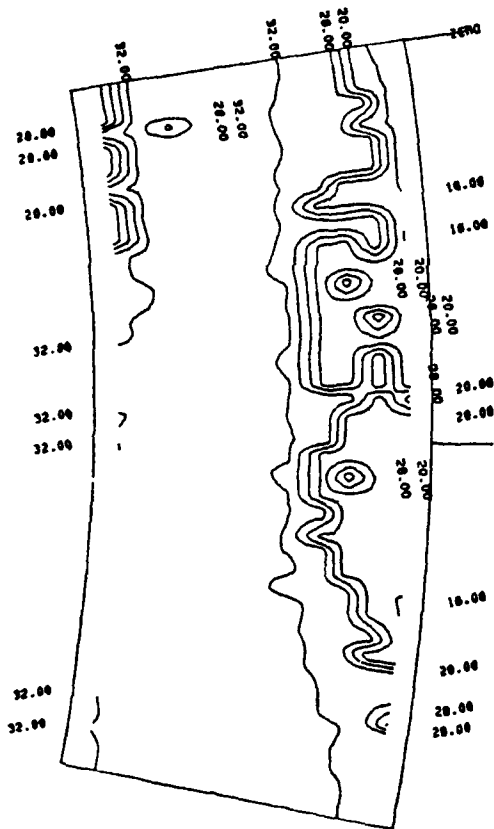
# 11-26-79 VANE SURVEY W/HIT SURVEY

TIME 0:02 RDC 62 RIC 1 90 51

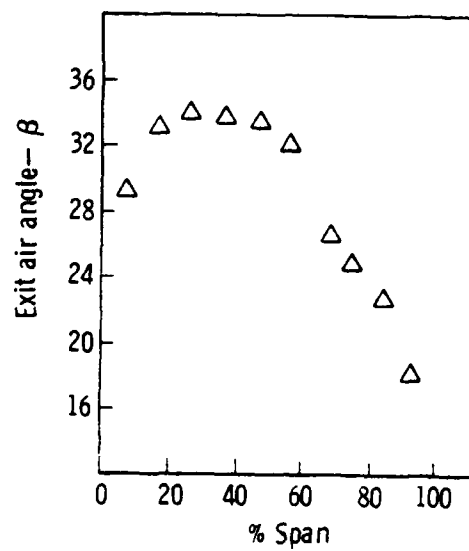
\*\*\*  
KE COEF 0.07536  
OMEGA ID 0.06549  
OMEGA ACT 0.11207  
DELTA P/P 0.0231  
FLOW RATE 3.689  
\*\*\*

| RADIUS<br>INCHES | W/SPAN  | KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | FLOW/L<br>L/S/SEC IN |
|------------------|---------|---------|----------------------|-----------------------|-----------------------|----------------------|
| 02.333           | 0.12166 | 0.12166 | 0.15213              | 0.14030               | 0.03532               | 4.75005              |
| 14.334           | 0.27043 | 0.27043 | 0.08141              | 0.08225               | 0.01950               | 5.95199              |
| 26.335           | 0.03380 | 0.03380 | 0.04000              | 0.04258               | 0.00997               | 6.41652              |
| 38.336           | 0.02358 | 0.02358 | 0.02803              | 0.02950               | 0.00697               | 6.61194              |
| 50.337           | 0.11827 | 0.11827 | 0.01832              | 0.01955               | 0.00475               | 6.54370              |
| 62.338           | 0.01182 | 0.01182 | 0.01234              | 0.01312               | 0.00222               | 6.30423              |
| 74.339           | 0.01182 | 0.01182 | 0.01670              | 0.01760               | 0.00469               | 5.38804              |
| 86.340           | 0.01432 | 0.01432 | 0.00556              | 0.00715               | 0.00189               | 5.00519              |
| 98.341           | 0.01294 | 0.01294 | 0.15403              | 0.18912               | 0.04333               | 4.61241              |
| 110.342          | 0.23919 | 0.23919 | 0.27817              | 0.42607               | 0.07579               | 3.60541              |

| KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | GAS ANGLE<br>MIXED | KE MIX/KE |
|---------|----------------------|-----------------------|-----------------------|--------------------|-----------|
| 0.14262 | 0.16464              | 0.19709               | 0.03817               | 18.4940            | 1.08549   |
| 0.02339 | 0.09789              | 0.10551               | 0.02385               | 13.2381            | 1.20748   |
| 0.04609 | 0.05345              | 0.05870               | 0.01338               | 25.3073            | 1.39034   |
| 0.03456 | 0.04008              | 0.04273               | 0.01004               | 26.8983            | 1.46534   |
| 0.01580 | 0.01896              | 0.01933               | 0.00484               | 32.1231            | 1.01376   |
| 0.01182 | 0.01287              | 0.01304               | 0.00338               | 33.1916            | 1.03783   |
| 0.01589 | 0.01698              | 0.01728               | 0.00457               | 33.6805            | 1.01128   |
| 0.05425 | 0.06662              | 0.07137               | 0.01836               | 34.1495            | 1.01332   |
| 0.13047 | 0.15596              | 0.18478               | 0.04381               | 33.5522            | 1.00782   |
| 0.25172 | 0.29781              | 0.42411               | 0.09407               | 29.4712            | 1.06645   |

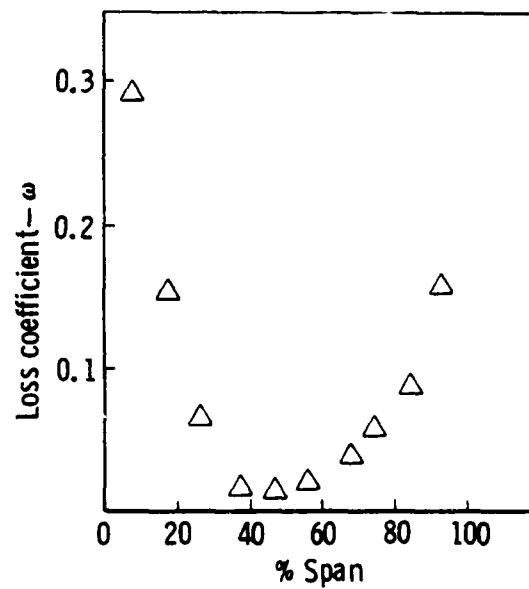
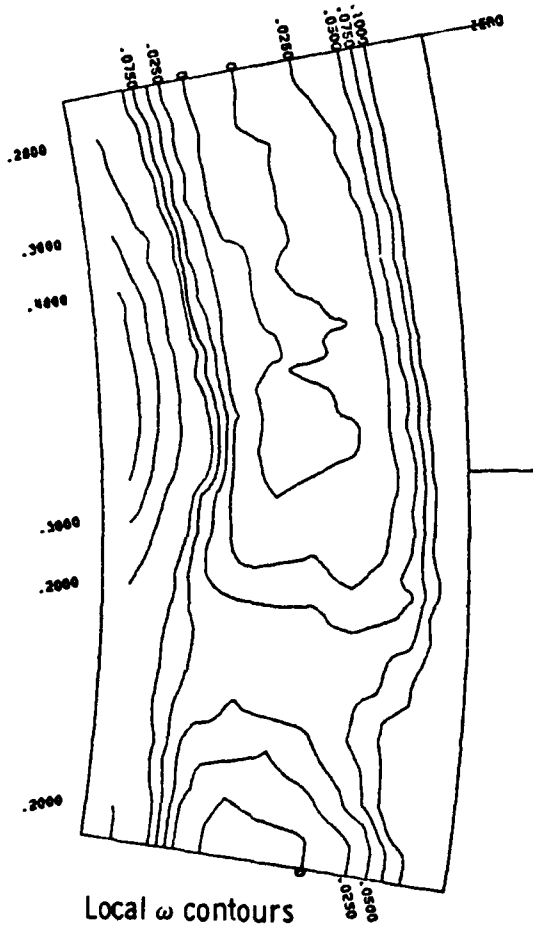


Local  $\beta$  contours



Exit Mach No. = 0.7 Reynolds No. =  $0.5 \times 10^6$   
 Reading 62 - aerodynamic exit data

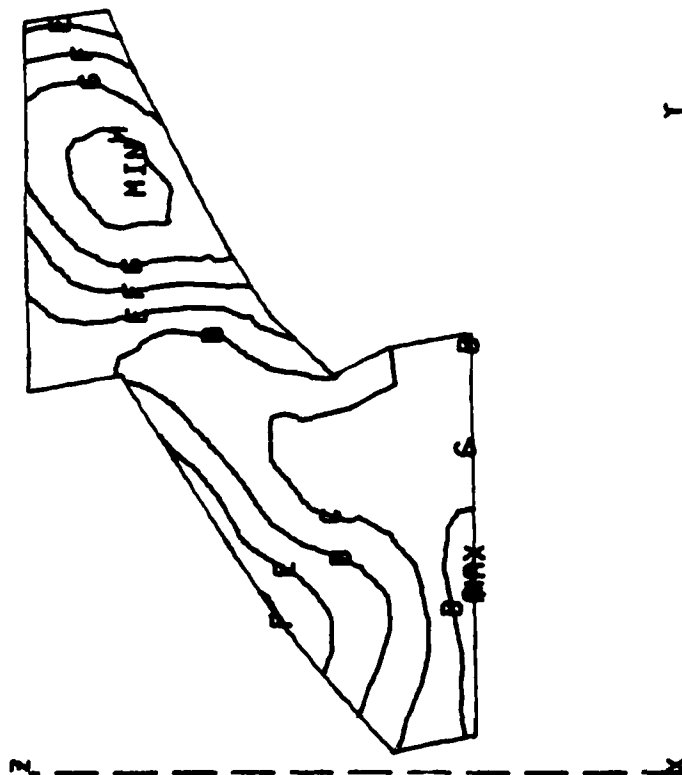
TE-80-1000



Exit Mach No. = 0.7 Reynolds No. =  $0.5 \times 10^6$

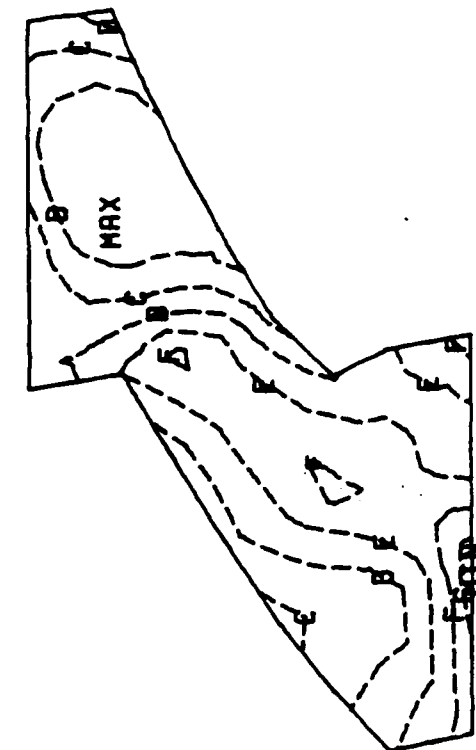
Reading 62 - aerodynamic exit data

TE-80-1001



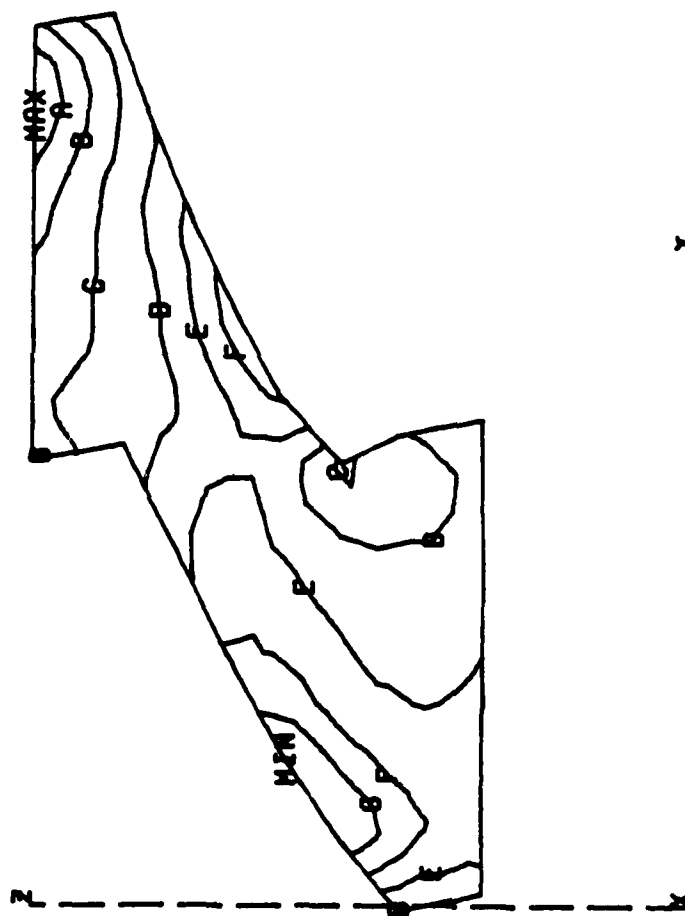
| MIN | LEGEND       | MIN     |
|-----|--------------|---------|
|     | UNITS - TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 2.36000E 02  |         |
| B   | 2.29000E 02  |         |
| C   | 2.22000E 02  |         |
| D   | 2.15000E 02  |         |
| E   | 2.08000E 02  |         |
| F   | 2.01000E 02  |         |
| G   | 1.94000E 02  |         |
| H   | 1.87000E 02  |         |
| MAX | 2.36778E 02  |         |
| MIN | 1.84863E 02  |         |

RUN 64 MACH .7 RE 1.E08 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE - 2.0000 PLOT TIME AND DATE - 16:18:10 79/338



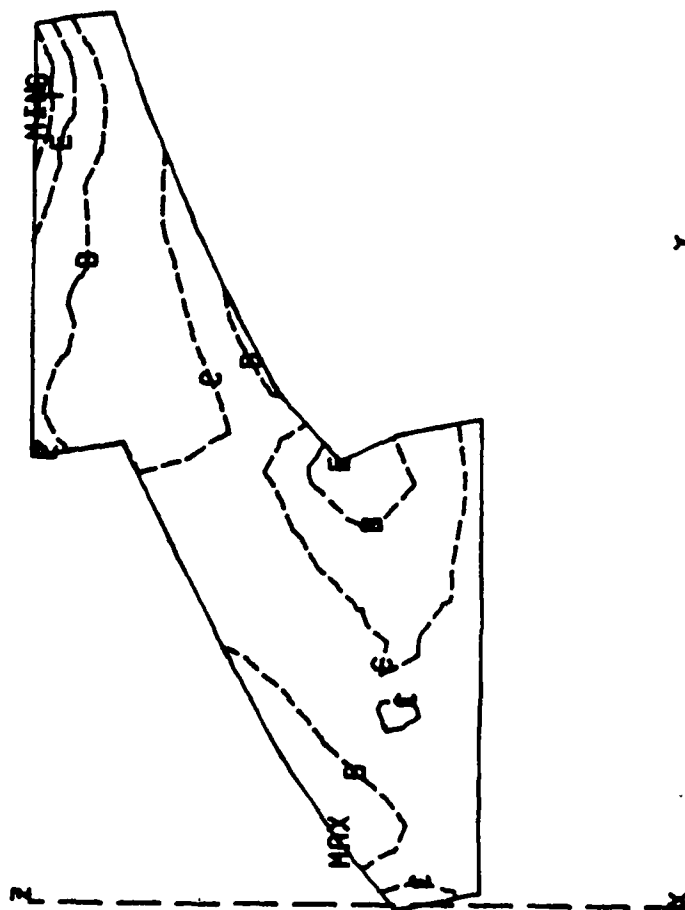
| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -1600.00 |     |
| B   | -2600.00 |     |
| C   | -3600.00 |     |
| D   | -4600.00 |     |
| E   | -5600.00 |     |
| F   | -6600.00 |     |
| G   | -7599.99 |     |
| MAX | -1636.23 |     |
| MIN | -8509.50 |     |

RUN 64 MARCH .7 RE 1.E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:09:49 80/015



| MAX | LEGEND | MAX |
|-----|--------|-----|
|     | F      |     |
| A   | 300.00 |     |
| B   | 290.00 |     |
| C   | 280.00 |     |
| D   | 270.00 |     |
| E   | 260.00 |     |
| F   | 250.00 |     |
| G   | 240.00 |     |
| MAX | 309.42 |     |
| MIN | 232.43 |     |

RUN 64 MACH .7 RE 1.E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:18:07 80/030



| MIN | LEGEND | MIN |
|-----|--------|-----|
|     | F      |     |
|     | (E-03) |     |
| A   | -2.00  |     |
| B   | -4.00  |     |
| C   | -6.00  |     |
| D   | -8.00  |     |
| E   | -10.00 |     |
| F   | -12.00 |     |
| G   | -14.00 |     |
| MAX | -2.09  |     |
| HIN | -14.65 |     |

RUN 64 MACH .7 RE 1.E06 ANNULAR TIP<sup>Y</sup>  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:18:36 80/030



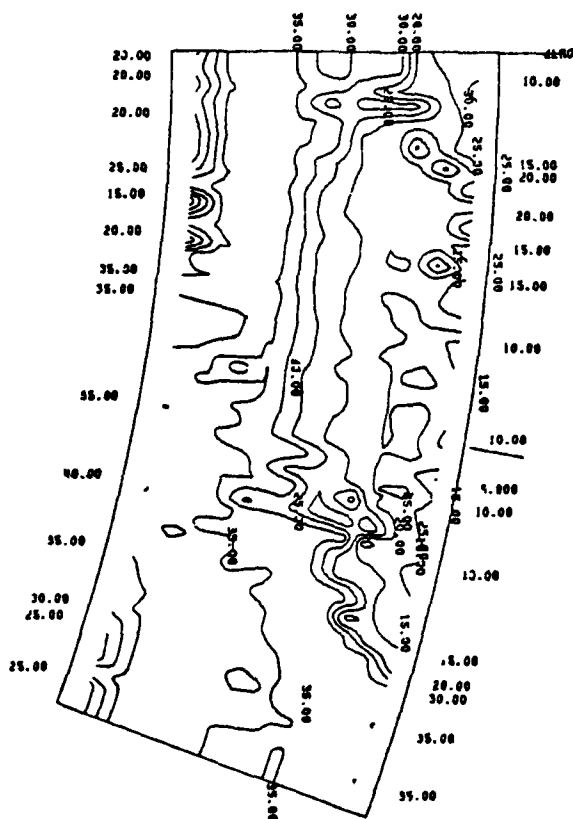
# 11-26-79 VANE SURVEY W/HT SURVEY

TIME 10:40 RDG 65 RIG 1 RU 51

\*\*\*  
 KE COEF 0.06716  
 OMEGA ID 0.07846  
 OMEGA ACT 0.09859  
 COMPLETE PASSAGE DATA  
 DELTA P/P 0.0229  
 FLOW RATE 7.008  
 \*\*\*

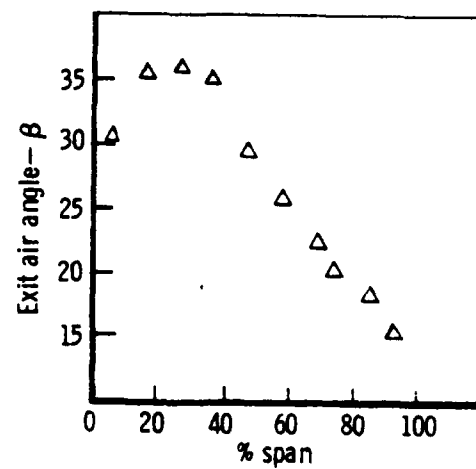
| RADIUS | O/O SPAN | KE COEF | OMEGA ID | OMEGA ACT | DELTA P/P | FLOW RATE |
|--------|----------|---------|----------|-----------|-----------|-----------|
| 1.4300 | 93.333   | 0.12789 | 0.14937  | 0.17857   | 0.03749   | 10.25639  |
| 4.4300 | 84.444   | 0.06630 | 0.07854  | 0.08811   | 0.02023   | 13.14618  |
| 4.4300 | 75.556   | 0.04746 | 0.05662  | 0.06250   | 0.01494   | 14.01215  |
| 4.4300 | 69.630   | 0.03575 | 0.04298  | 0.04619   | 0.01153   | 13.90891  |
| 4.4300 | 59.259   | 0.02708 | 0.03286  | 0.03462   | 0.00905   | 11.71078  |
| 4.4300 | 48.889   | 0.01965 | 0.02402  | 0.02507   | 0.00680   | 10.28974  |
| 4.4300 | 37.037   | 0.00547 | 0.00666  | 0.00736   | 0.00193   | 9.17661   |
| 4.4300 | 24.146   | 0.02212 | 0.02733  | 0.02886   | 0.00810   | 8.14738   |
| 4.4300 | 17.778   | 0.08823 | 0.10774  | 0.12536   | 0.03269   | 7.59893   |
| 4.4300 | 7.407    | 0.19727 | 0.23507  | 0.33152   | 0.07306   | 5.92925   |

| KE COEF | OMEGA ID | OMEGA ACT | DELTA P/P | GAS ANGLE | KE MIX/KE |
|---------|----------|-----------|-----------|-----------|-----------|
| MIXED   | MIXED    | MIXED     | MIXED     | MIXED     | 1.25119   |
| 0.16001 | 0.18534  | 0.22750   | 0.04530   | 15.1706   | 1.29777   |
| 0.08604 | 0.10167  | 0.11318   | 0.02572   | 18.6776   | 1.48099   |
| 0.07028 | 0.08362  | 0.09125   | 0.02157   | 20.0236   | 1.62954   |
| 0.05326 | 0.06967  | 0.07489   | 0.01822   | 22.6162   | 1.59324   |
| 0.04315 | 0.05212  | 0.05499   | 0.01407   | 25.4702   | 1.43725   |
| 0.02824 | 0.03450  | 0.03573   | 0.00965   | 29.1776   | 1.22735   |
| 0.00671 | 0.00831  | 0.00838   | 0.00240   | 35.2536   | 1.06088   |
| 0.02347 | 0.02909  | 0.02996   | 0.00861   | 36.2799   | 1.01332   |
| 0.08941 | 0.10973  | 0.12325   | 0.03326   | 35.8477   | 1.01332   |
| 0.21965 | 0.26135  | 0.35382   | 0.07924   | 30.5656   | 1.11344   |

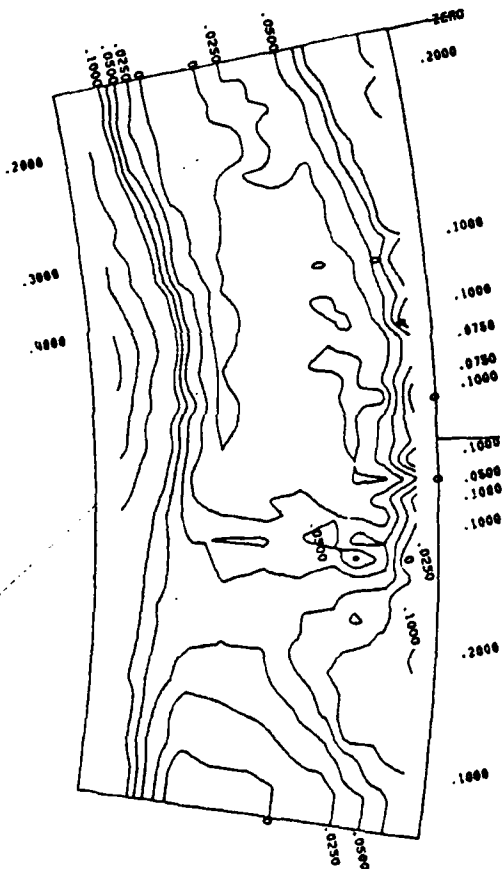


Local  $\beta$  contours

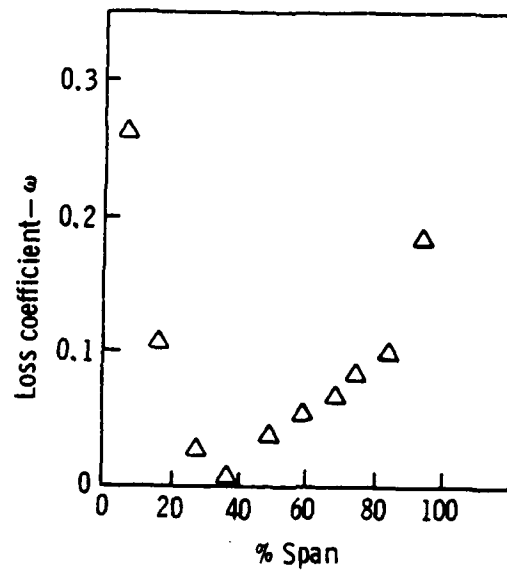
Exit Mach No. - 0.7 Reynolds No. -  $1 \times 10^6$   
Reading 65-aerodynamic exit data



TE-80-1002

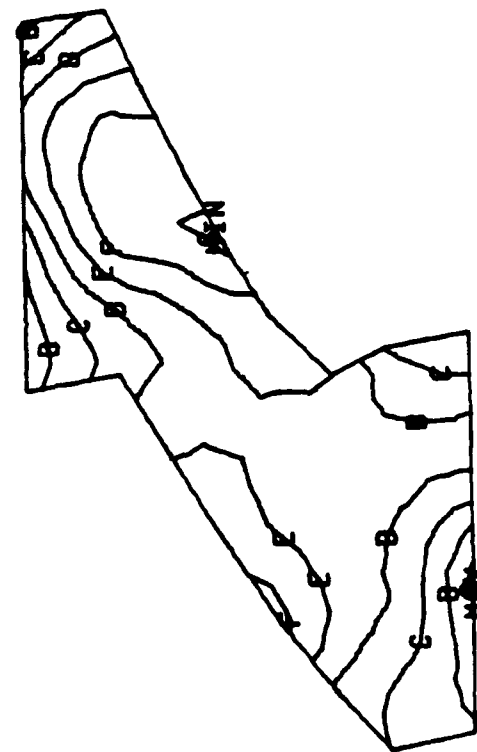


Local  $\omega$  contours



Exit Mach No. - 0.7 Reynolds No. -  $1 \times 10^6$   
 Reading 65 - aerodynamic exit data

TE-80-1003

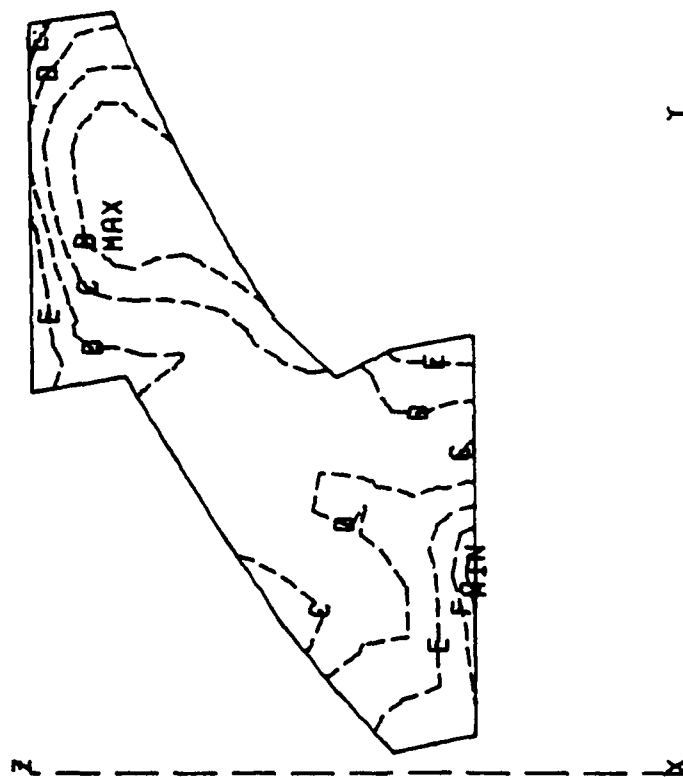


| MAX | LEGEND       | MAX     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 1.73000E 02  |         |
| B   | 1.69000E 02  |         |
| C   | 1.65000E 02  |         |
| D   | 1.61000E 02  |         |
| E   | 1.57000E 02  |         |
| F   | 1.53000E 02  |         |
| G   | 1.49000E 02  |         |
| MAX | 1.73574E 02  |         |
| MIN | 1.48061E 02  |         |

RUN 67 MACH 1.1 RE .5E06 ANNULAR HUB

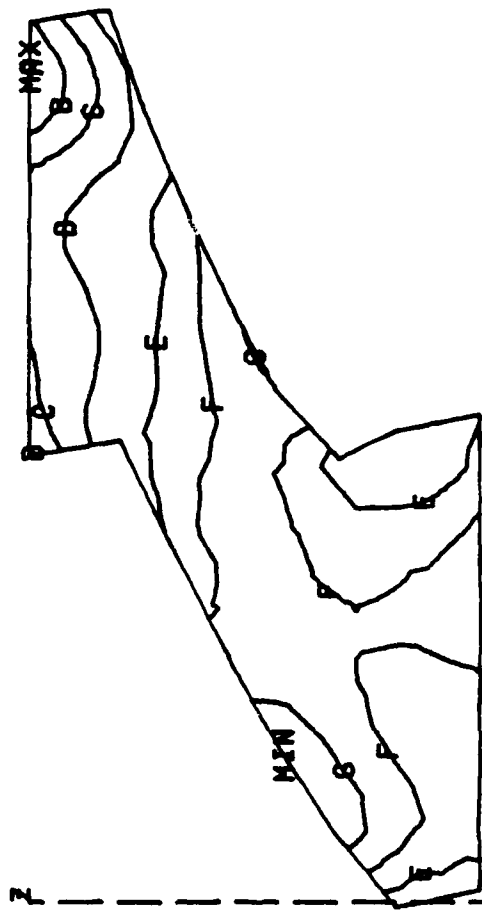
CONTOUR PLOT OF TEMPERATURE

SCALE = 2.0000 PLOT TIME AND DATE = 17:51:42 79/338



|     |        |          |
|-----|--------|----------|
| MMX | LEGEND | MMX      |
|     | F      | (E-06)   |
| A   |        | -2600.00 |
| B   |        | -3500.00 |
| C   |        | -4400.00 |
| D   |        | -5299.99 |
| E   |        | -6199.99 |
| F   |        | -7099.99 |
| G   |        | -7999.98 |
| MAX |        | -2648.71 |
| MIN |        | -8621.85 |

RUN 67 MACH 1.1 RE .SE06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:23:08 80/015



| MMM | LEGEND | F      | MMM |
|-----|--------|--------|-----|
| A   | B      | C      | D   |
| E   | F      | G      | MAX |
| MIN |        |        |     |
|     |        | 256.00 |     |
|     |        | 246.00 |     |
|     |        | 236.00 |     |
|     |        | 226.00 |     |
|     |        | 216.00 |     |
|     |        | 206.00 |     |
|     |        | 196.00 |     |
|     |        | 189.42 |     |

RUN 67 MACH 1.1 RE .5E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:32:23 80/030

AD-A110 333

GENERAL MOTORS CORP INDIANAPOLIS IN DETROIT DIESEL A--ETC F/G 21/5  
EXPERIMENTAL INVESTIGATION OF TURBINE ENDWALL HEAT TRANSFER. VO--ETC(U)  
AUG 81 L D HYLTON, M S WIMELC, E R TURNER F33615-77-C-2030

UNCLASSIFIED

DDA-EDR-10363-VOL-2

AFWAL-TR-81-2077-VOL-2

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4-4

4-4

4-4

4-4

4-4

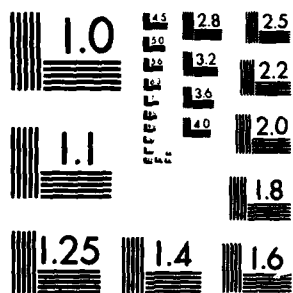
END

DATE

FILED

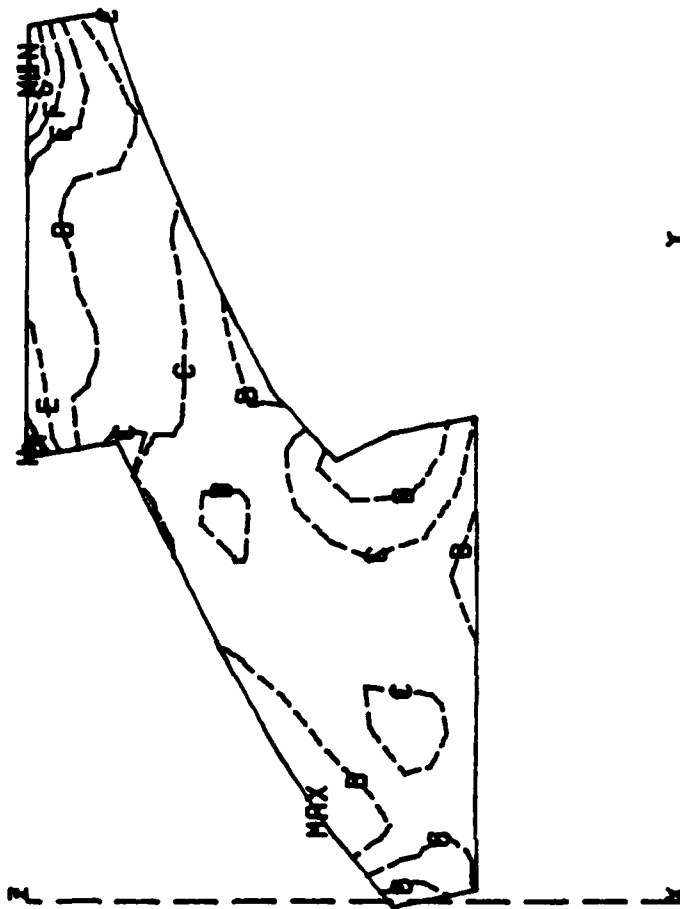
2 82

DTIC



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



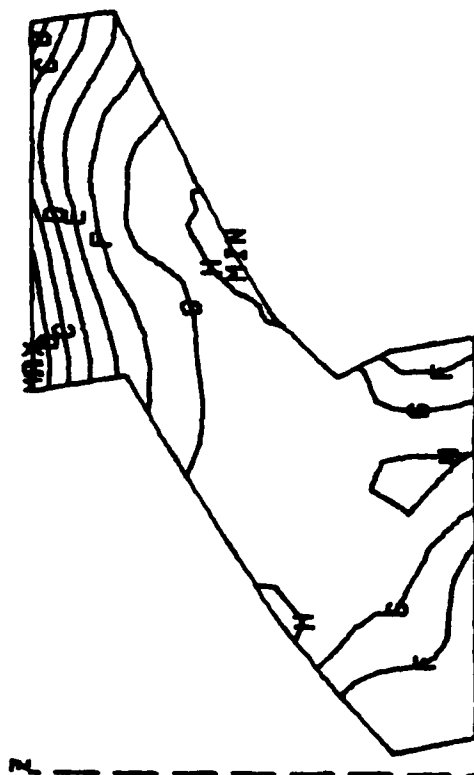


RUN 67 MACH 1.1 RE .5E06 ANNULAR TIP

CONTOUR PLOT OF STANTON NUMBER.

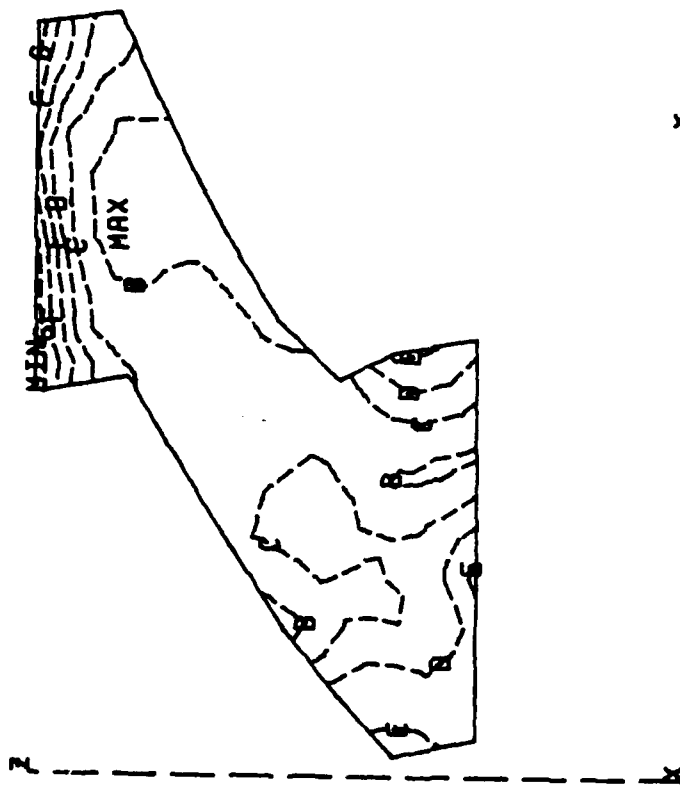
SCALE = 2.0000 PLOT TIME AND DATE = 18:32:57 80/030

| MAX | LEGEND | MIN |
|-----|--------|-----|
| A   | (E-03) |     |
| B   | -3.00  |     |
| C   | -5.00  |     |
| D   | -7.00  |     |
| E   | -9.00  |     |
| F   | -11.00 |     |
| G   | -13.00 |     |
| H   | -15.00 |     |
| MAX | -17.00 |     |
| MIN | -3.05  |     |
|     | -17.21 |     |



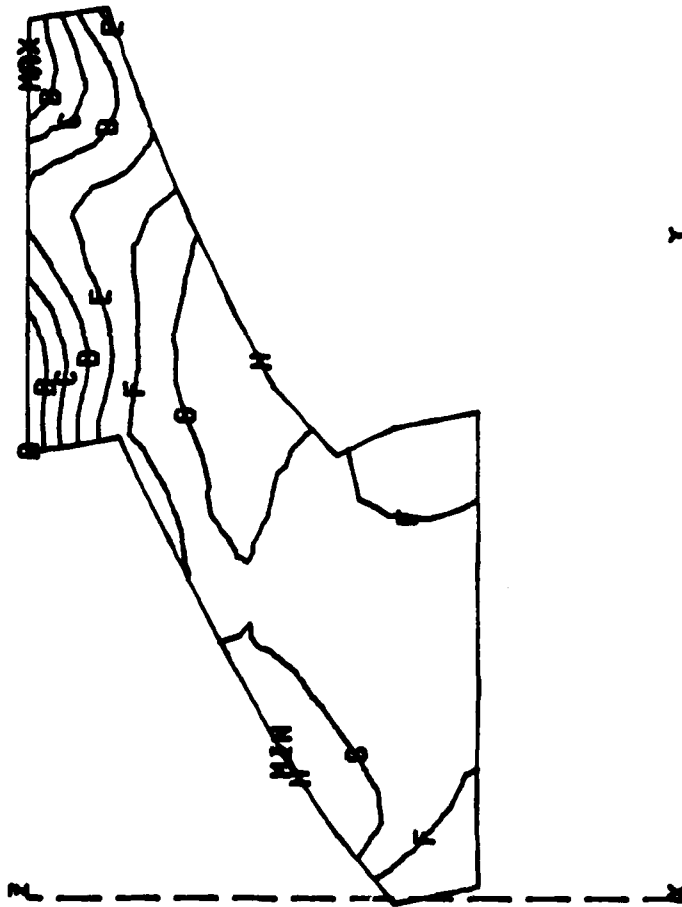
MMM LEGEND MMM  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 1.49000E 02  
 B 1.46000E 02  
 C 1.43000E 02  
 D 1.40000E 02  
 E 1.37000E 02  
 F 1.34000E 02  
 G 1.31000E 02  
 H 1.28000E 02  
 MAX 1.49083E 02  
 MIN 1.26144E 02

RUN 71 MACH 1.1 RE .3E08 Y ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:15:46 79/338



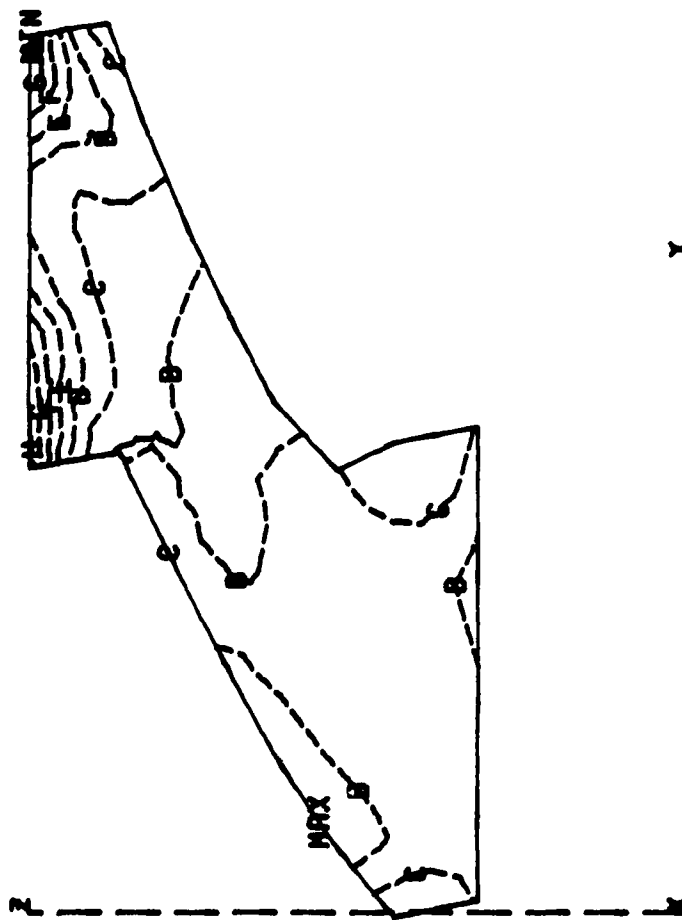
| MAX | LEGEND | F      | MAX |
|-----|--------|--------|-----|
|     |        | (E-06) |     |
| A   | B      | C      | D   |
| E   | F      | G      | MAX |
|     |        |        | MIN |

RUN 71 MARCH 1.1 RE .3E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 19:06:10 80/022



| MAX | LEGEND | MAX    |
|-----|--------|--------|
|     | F      | 222.00 |
| A   | B      | 213.00 |
| B   | C      | 204.00 |
| C   | D      | 195.00 |
| D   | E      | 186.00 |
| E   | F      | 177.00 |
| F   | G      | 168.00 |
| G   | H      | 159.00 |
| H   | MAX    | 222.71 |
| MAX | MIN    | 158.61 |

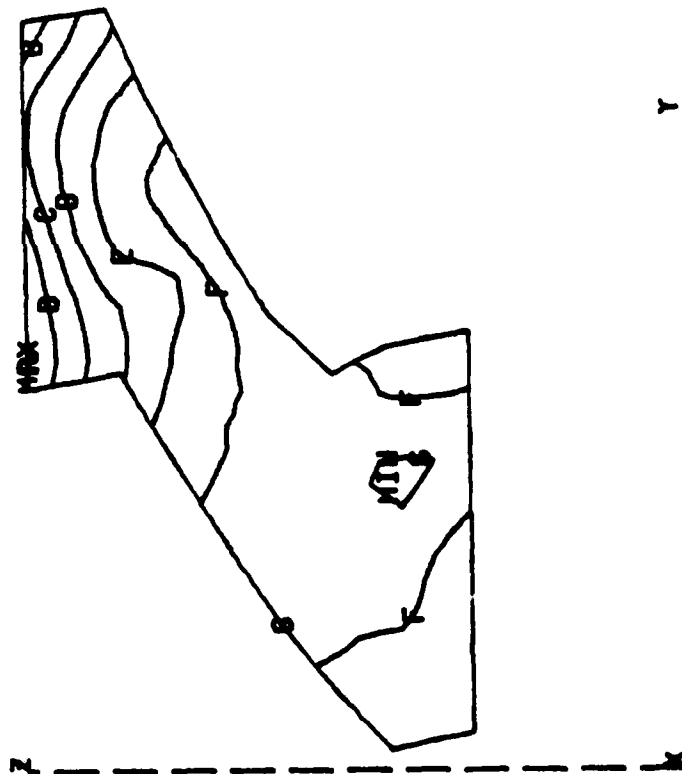
RUN 71 MACH 1.1 RE .3E06 ANNULAR TIP  
 Y  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE - 2.0000 PLOT TIME AND DATE - 17:16:50 80/031



LEGEND F

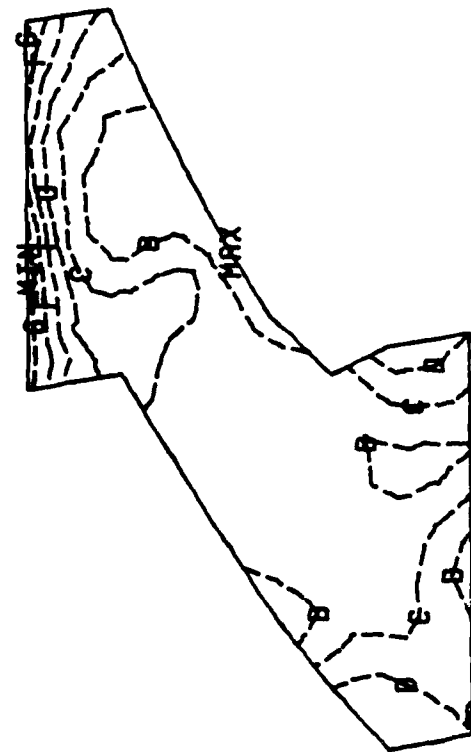
| MAX | MIN    |
|-----|--------|
| A   | (E-03) |
| B   | -3.00  |
| C   | -6.00  |
| D   | -9.00  |
| E   | -12.00 |
| F   | -15.00 |
| G   | -18.00 |
| H   | -21.00 |
| MAX | -24.00 |
| MIN | -3.94  |
|     | -25.32 |

RUN 71 MACH 1.1 RE .3E06 ANNULAR TIP  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE - 2.0000 PLOT TIME AND DATE - 17.17.23 80/031



MIN LEGEND MIN  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 1.53000E 02  
 B 1.49000E 02  
 C 1.45000E 02  
 D 1.41000E 02  
 E 1.37000E 02  
 F 1.33000E 02  
 G 1.29000E 02  
 MAX 1.53126E 02  
 MIN 1.28036E 02

RUN 73 MACH .7 RE .3E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:41:34 79/338



MAX LEGEND MAX

(E-06)

-3900.00

-4800.00

-5700.00

-6600.00

-7499.99

-8399.99

-9299.98

-9924.17

-9914.93

A

B

C

D

E

F

G

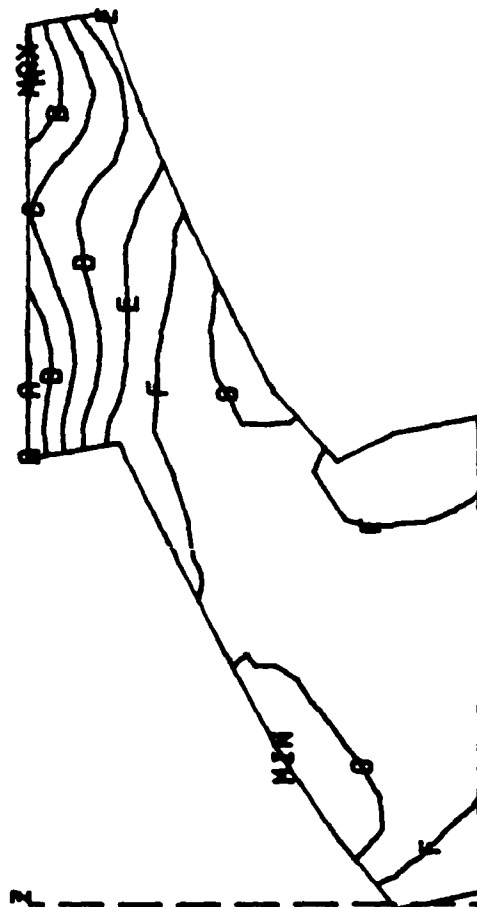
MAX

MIN

RUN 73 MARCH .7 RE .3E06 ANNULAR HUB

CONTOUR PLOT OF STANTON NUMBER,

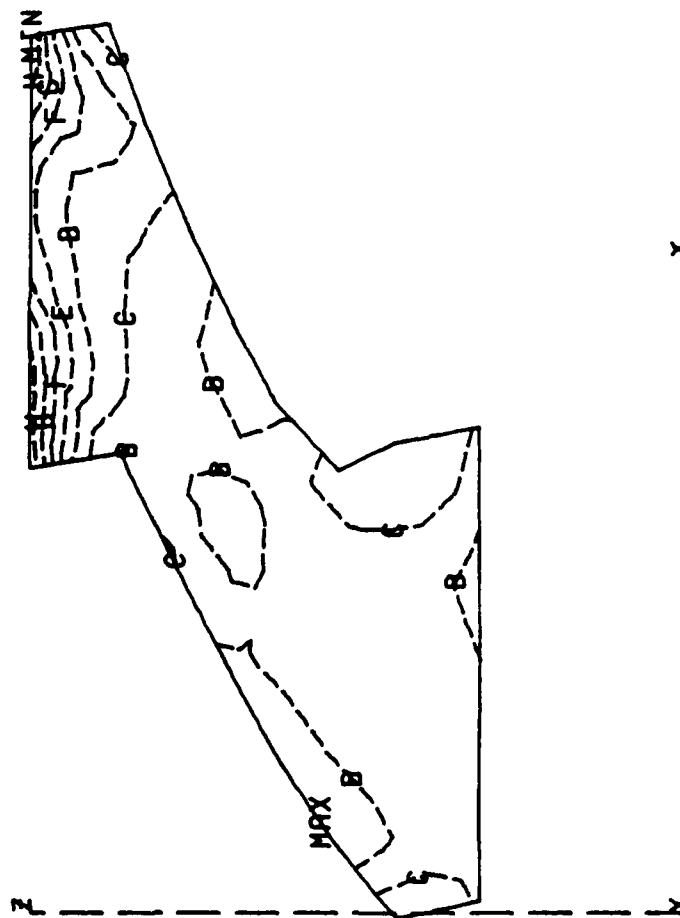
SCALE = 2.0000 PLOT TIME AND DATE = 19:17:59 80/022



| MAX | LEGEND | F | MAX |
|-----|--------|---|-----|
| A   | 230.00 |   |     |
| B   | 220.00 |   |     |
| C   | 210.00 |   |     |
| D   | 200.00 |   |     |
| E   | 190.00 |   |     |
| F   | 180.00 |   |     |
| G   | 170.00 |   |     |
| MAX | 232.84 |   |     |
| MIN | 162.24 |   |     |

RUN 73 MACH .7 RE .3E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 17:34:33 80/031





| MMM | LEGEND | MMM |
|-----|--------|-----|
|     | F      |     |
|     | (E-03) |     |
| A   | -3.00  |     |
| B   | -6.00  |     |
| C   | -9.00  |     |
| D   | -12.00 |     |
| E   | -15.00 |     |
| F   | -18.00 |     |
| G   | -21.00 |     |
| H   | -24.00 |     |
| MAX | -3.89  |     |
| MIN | -26.76 |     |

RUN 73 MACH .7 RE .3E06 ANNULAR TIP  
 CONTOUR PLOT OF STANTON NUMBER.

SCALE = 2.0000 PLOT TIME AND DATE = 17:34:44 80/031

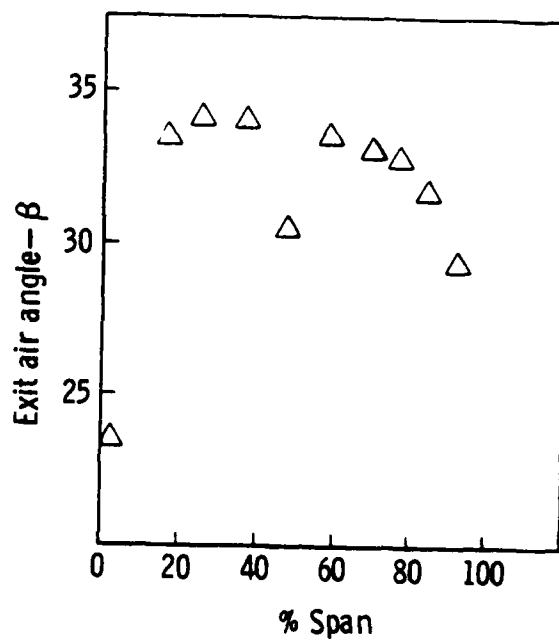
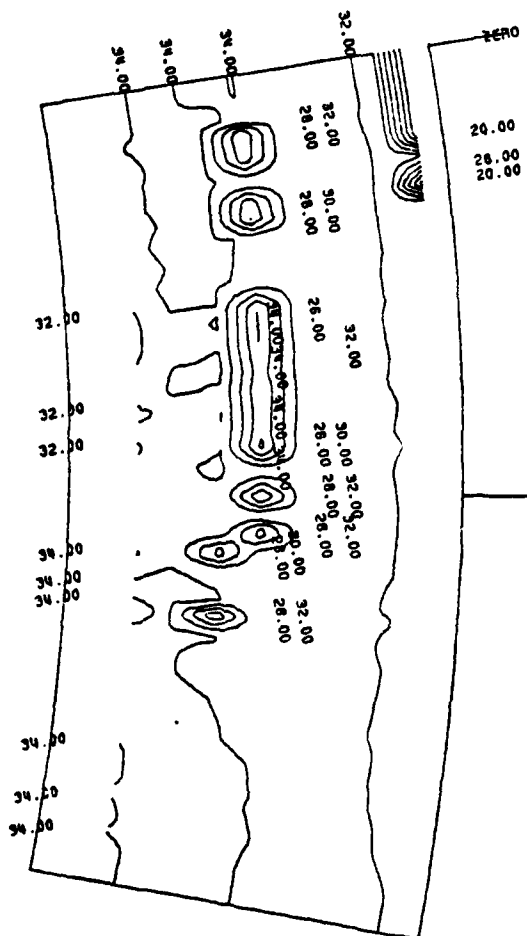
# 11-26-79 VANE SURVEY W/HT SURVEY

TIME 13:52 RDG 75 RIG 1 BU 51

\*\*\*  
 KE COEF 0.07426  
 OMEGA ID 0.08474  
 OMEGA ACT 0.10985  
 COMPLETE PASSAGE DATA  
 DELTA P/P 0.0237  
 FLOW RATE 2.134  
 \*\*\*

| RADIUS<br>INCHES | O/O SPAN | KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS | FLOW/L<br>LB/SEC IN |
|------------------|----------|---------|----------------------|-----------------------|-------------------|---------------------|
| 4.5500           | 93.333   | 0.12550 | 0.14608              | 0.17259               | 0.03563           | 2.04277             |
| 4.4900           | 84.444   | 0.05437 | 0.06436              | 0.06968               | 0.01607           | 3.09635             |
| 4.4400           | 77.037   | 0.02141 | 0.02555              | 0.02705               | 0.00652           | 3.38497             |
| 4.3900           | 69.630   | 0.00930 | 0.01111              | 0.01197               | 0.00289           | 3.52583             |
| 4.3200           | 59.259   | 0.00690 | 0.00822              | 0.00906               | 0.00219           | 3.29806             |
| 4.2500           | 48.889   | 0.01450 | 0.01758              | 0.01846               | 0.00481           | 3.56831             |
| 4.1800           | 38.519   | 0.02237 | 0.02728              | 0.02862               | 0.00767           | 3.56009             |
| 4.1000           | 26.667   | 0.08228 | 0.09939              | 0.11483               | 0.02862           | 3.51841             |
| 4.0400           | 17.778   | 0.16502 | 0.19611              | 0.25870               | 0.05767           | 3.38694             |
| 3.9700           | 7.407    | 0.24180 | 0.28316              | 0.43302               | 0.08529           | 3.01699             |

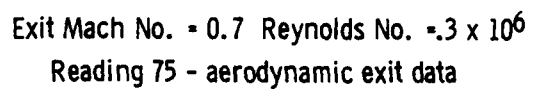
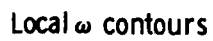
| KE COEF<br>MIXED | OMEGA ID<br>MIXED | OMEGA ACT<br>MIXED | DELTA P/P<br>MIXED | GAS ANGLE<br>MIXED | KF MIX/KF |
|------------------|-------------------|--------------------|--------------------|--------------------|-----------|
| 0.13070          | 0.15192           | 0.17913            | 0.03672            | 29.2839            | 1.04144   |
| 0.05464          | 0.06480           | 0.06929            | 0.01618            | 31.6764            | 1.00502   |
| 0.02138          | 0.02564           | 0.02631            | 0.00654            | 32.4457            | 0.99863   |
| 0.00936          | 0.01129           | 0.01142            | 0.00293            | 32.8170            | 1.00695   |
| 0.00706          | 0.00857           | 0.00864            | 0.00228            | 33.2253            | 1.02417   |
| 0.01874          | 0.02279           | 0.02332            | 0.00620            | 30.9414            | 1.29207   |
| 0.02306          | 0.02822           | 0.02904            | 0.00791            | 33.6894            | 1.03105   |
| 0.08300          | 0.10080           | 0.11210            | 0.02901            | 34.0638            | 1.00871   |
| 0.16743          | 0.20030           | 0.25046            | 0.05877            | 33.2242            | 1.01462   |
| 0.25663          | 0.29486           | 0.41816            | 0.07680            | 23.8915            | 1.06133   |



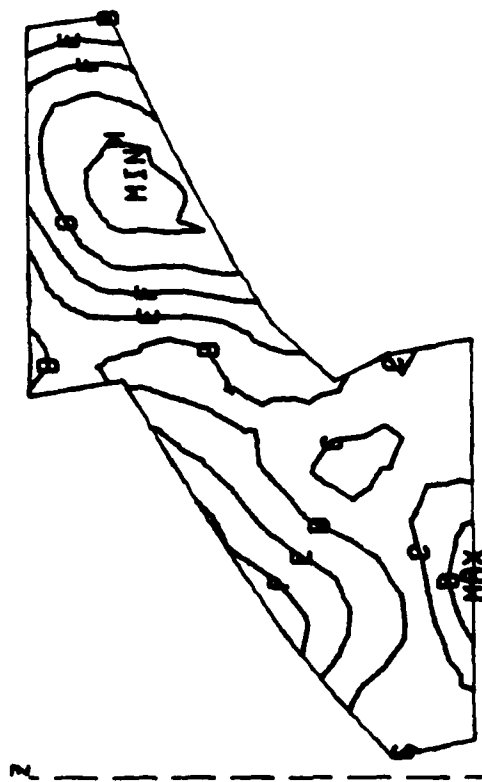
Exit Mach No. = 0.7 Reynolds No. =  $3 \times 10^6$

Reading 75 - aerodynamic exit data

TE-80-1004

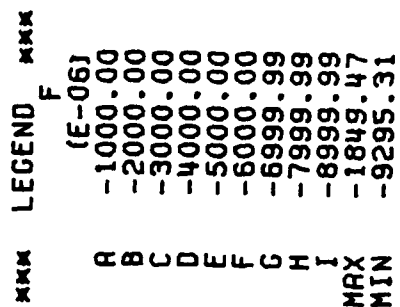


315

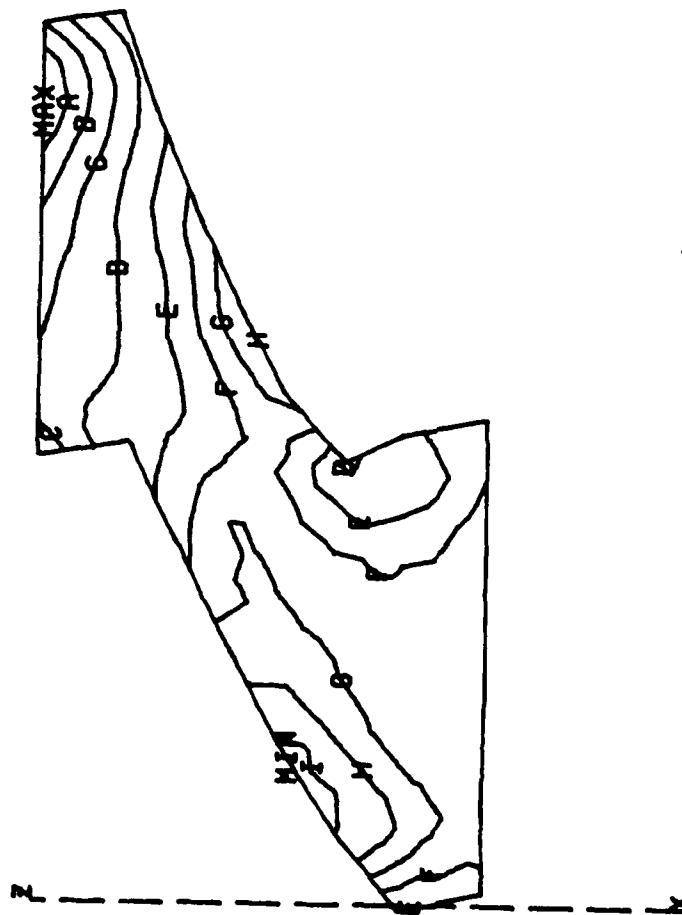


MIN LEGEND MIN  
 UNITS - TEMP  
 SYMBOL CONTOUR  
 A 2.53000E 02  
 B 2.46000E 02  
 C 2.39000E 02  
 D 2.32000E 02  
 E 2.25000E 02  
 F 2.18000E 02  
 G 2.11000E 02  
 H 2.04000E 02  
 MAX 2.53738E 02  
 MIN 2.01452E 02

RUN 77 MACH .7 RE .7E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 18:52:49 79/338

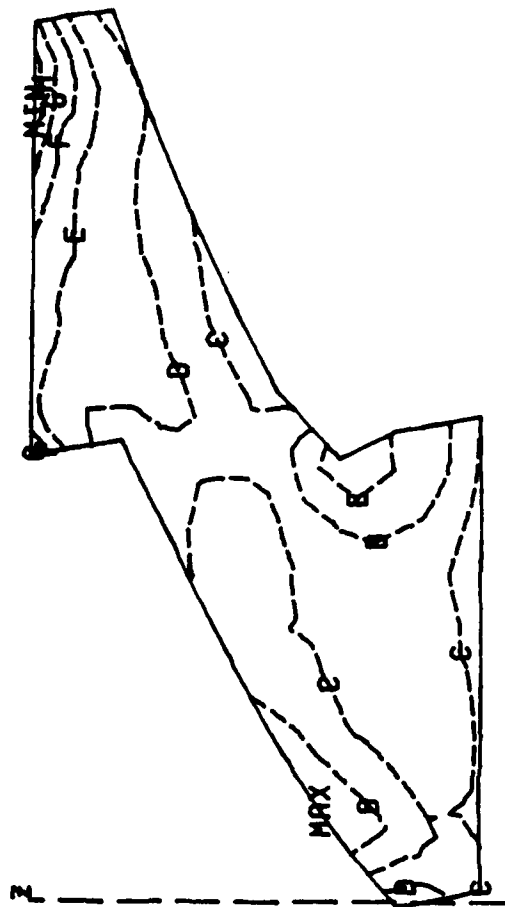


RUN 77 MACH .7 RE .7E06 ANNULAR HUB  
CONTOUR PLOT OF STANTON NUMBER.  
SCALE = 2.0000 PLOT TIME AND DATE = 18:11



| MAX | LEGEND | MAX |
|-----|--------|-----|
| A   | B      | C   |
| B   | C      | D   |
| C   | D      | E   |
| D   | E      | F   |
| E   | F      | G   |
| F   | G      | H   |
| G   | H      | I   |
| H   | I      | MAX |
| I   | MAX    | MIN |

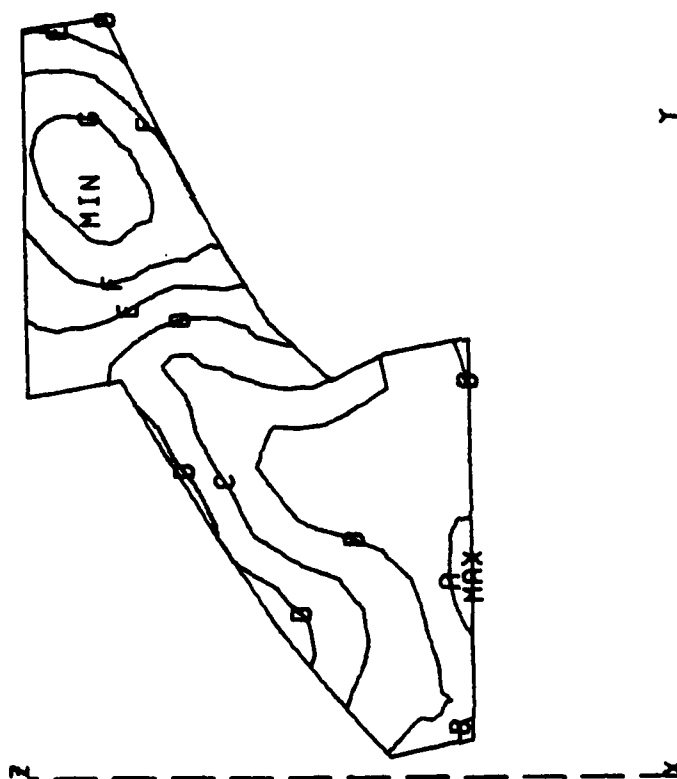
RUN 77 MACH .7 RE .7E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 17:44:01 80/031



| MMM | LEGEND | FFF    |
|-----|--------|--------|
| A   | (E-03) | -2.00  |
| B   |        | -4.00  |
| C   |        | -6.00  |
| D   |        | -8.00  |
| E   |        | -10.00 |
| F   |        | -12.00 |
| G   |        | -14.00 |
| H   |        | -16.00 |
| MAX |        | -2.67  |
| MIN |        | -17.32 |

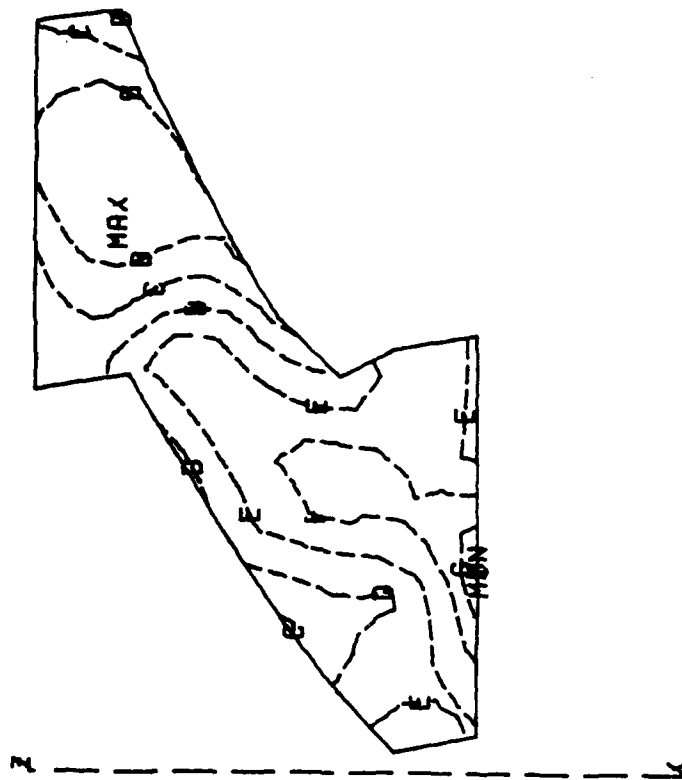
RUN 77 MACH .7 RE .7E06 ANNULAR TIP  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE " 2.0000 PLOT TIME AND DATE = 17:44:23 80/031





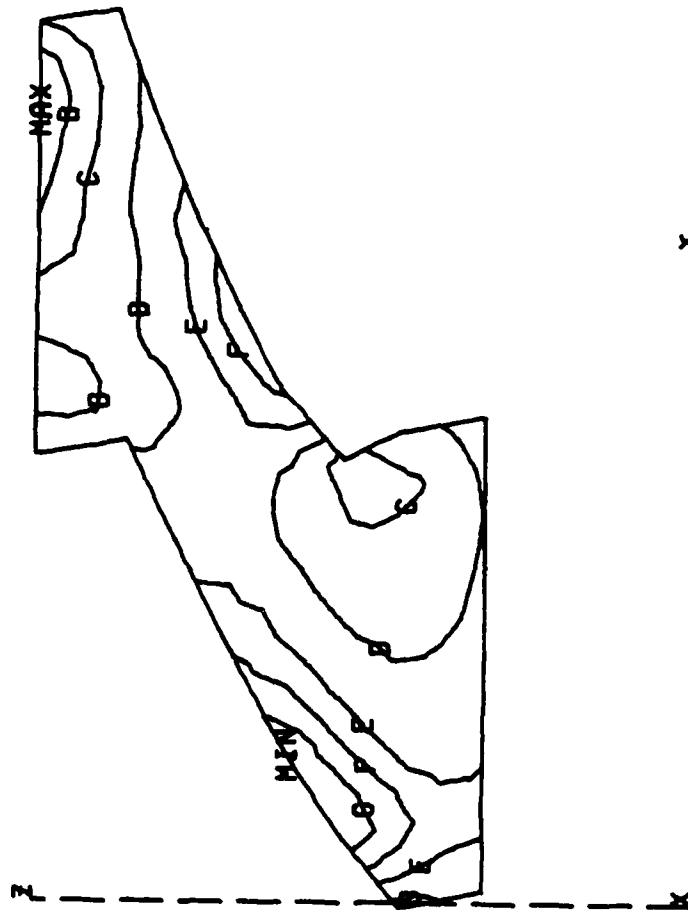
| MMM | LEGEND       | MMM     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 2.60000E 02  |         |
| B   | 2.50000E 02  |         |
| C   | 2.40000E 02  |         |
| D   | 2.30000E 02  |         |
| E   | 2.20000E 02  |         |
| F   | 2.10000E 02  |         |
| G   | 2.00000E 02  |         |
| MAX | 2.66565E 02  |         |
| MIN | 1.95523E 02  |         |

RUN 84 MACH 1.1 RE 1.5E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 19:25:08 79/338



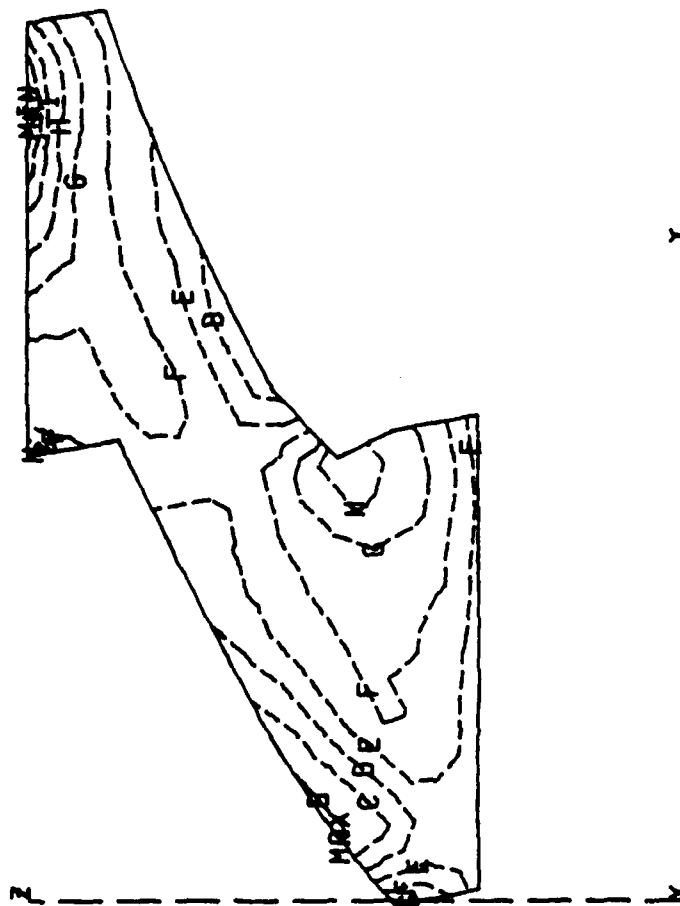
| MMM | LEGEND   | MMM |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -1000.00 |     |
| B   | -2000.00 |     |
| C   | -3000.00 |     |
| D   | -4000.00 |     |
| E   | -5000.00 |     |
| F   | -6000.00 |     |
| G   | -6999.99 |     |
| H   | -7999.99 |     |
| MAX | -1043.13 |     |
| MIN | -8182.26 |     |

RUN 84 MACH 1.1 RE 1.5E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 17:24:39 80/017



| LEGEND | F      | 3000 | 3000 |
|--------|--------|------|------|
| A      | 318.00 |      |      |
| B      | 308.00 |      |      |
| C      | 298.00 |      |      |
| D      | 288.00 |      |      |
| E      | 278.00 |      |      |
| F      | 268.00 |      |      |
| G      | 258.00 |      |      |
| MAX    | 318.35 |      |      |
| MIN    | 250.58 |      |      |

RUN 84 MACH 1.1 RE 1.5E06 ANNULAR TIP  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 13:54:17 80/032

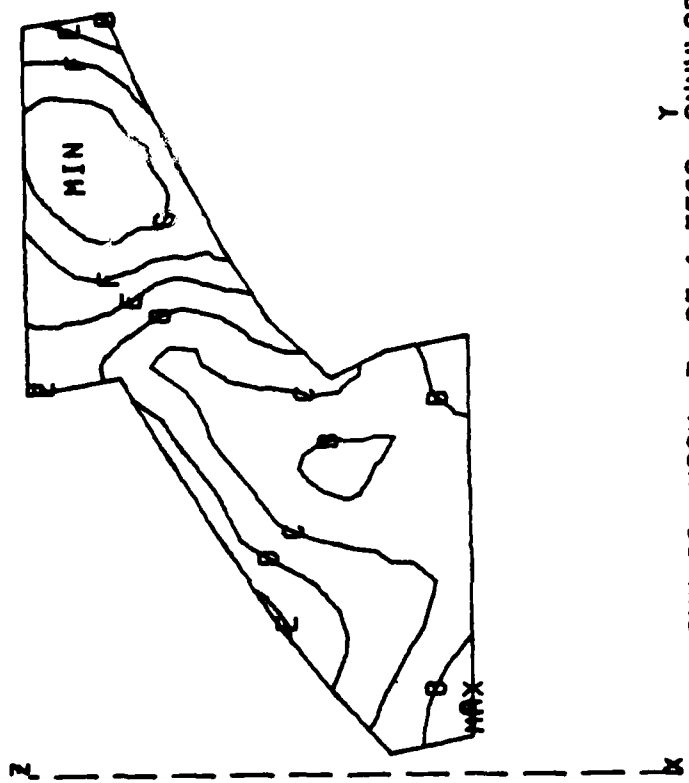


| MIN | LEGEND   | MIN |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -1000.00 |     |
| B   | -2000.00 |     |
| C   | -3000.00 |     |
| D   | -4000.00 |     |
| E   | -5000.00 |     |
| F   | -6000.00 |     |
| G   | -6999.99 |     |
| H   | -7999.99 |     |
| I   | -8999.99 |     |
| J   | -9999.99 |     |
| K   | MINIMUM  |     |
| MAX | -1832.45 |     |
| MIN | MINIMUM  |     |

RUN 84 MARCH 1.1 RE 1.5E06 ANNULAR TIP

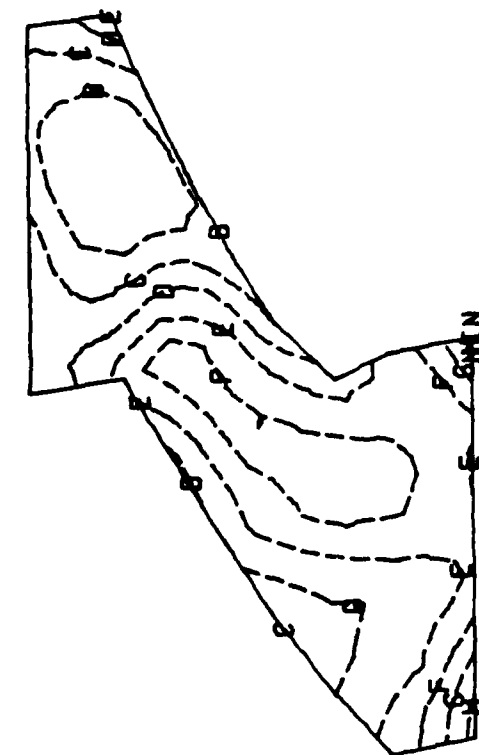
CONTOUR PLOT OF STANTON NUMBER.

SCALE = 2.0000 PLOT TIME AND DATE = 13:54:39 80/032



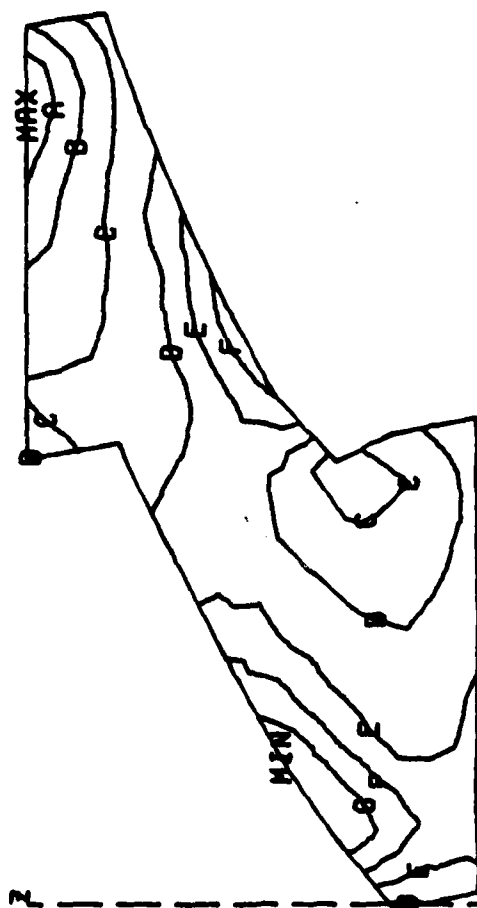
| MIN | LEGEND       | MIN     |
|-----|--------------|---------|
|     | UNITS = TEMP |         |
|     | SYMBOL       | CONTOUR |
| A   | 2.66000E 02  |         |
| B   | 2.56000E 02  |         |
| C   | 2.46000E 02  |         |
| D   | 2.36000E 02  |         |
| E   | 2.26000E 02  |         |
| F   | 2.16000E 02  |         |
| G   | 2.06000E 02  |         |
| MAX | 2.66899E 02  |         |
| MIN | 1.99650E 02  |         |

RUN 88 MACH .7 RE 1.5E06 ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 19:38:27 79/338



| MIN | LEGEND   | MAX |
|-----|----------|-----|
|     | F        |     |
|     | (E-06)   |     |
| A   | -1000.00 |     |
| B   | -2000.00 |     |
| C   | -3000.00 |     |
| D   | -4000.00 |     |
| E   | -5000.00 |     |
| F   | -6000.00 |     |
| G   | -6999.99 |     |
| H   | -7999.99 |     |
| MAX | -1287.71 |     |
| MIN | -8413.76 |     |

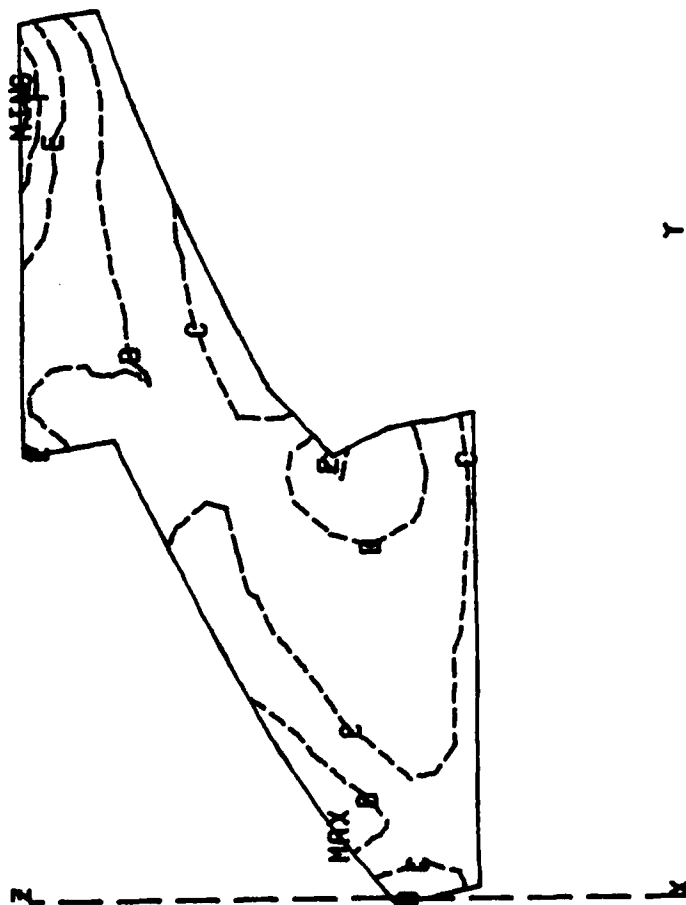
RUN 88 MACH .7 RE 1.5E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 19:28:19 80/022



| MAX | LEGEND | F | MAX |
|-----|--------|---|-----|
| A   | B      | C | D   |
| E   | F      | G | MAX |
| MIN |        |   |     |

320.00  
310.00  
300.00  
290.00  
280.00  
270.00  
260.00  
329.43  
252.22

RUN 88 MACH .7 RE 1.5E06 ANNULAR TIP  
CONTOUR PLOT OF TEMPERATURE  
SCALE = 2.0000 PLOT TIME AND DATE = 17:11:52 80/032



RUN 88 MACH .7 RE 1.5E06 ANNULAR TIP  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE " 2.0000 PLOT TIME AND DATE - 17:12:17 80/032

| MAX | LEGEND | MAX    |
|-----|--------|--------|
|     | F      | (E-03) |
| A   | B      | -1.00  |
| C   | D      | -3.00  |
| E   | F      | -5.00  |
| G   |        | -7.00  |
|     |        | -9.00  |
|     |        | -11.00 |
|     |        | -13.00 |
|     |        | -1.87  |
|     |        | -14.01 |
| MAX |        |        |
| MIN |        |        |



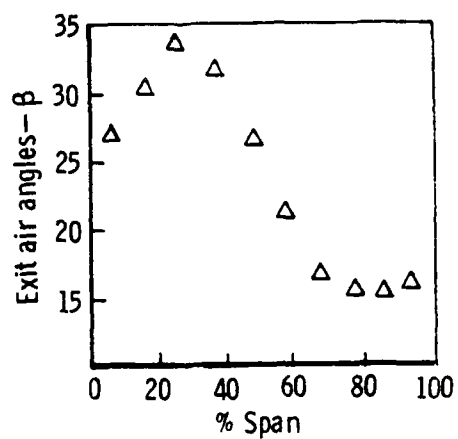
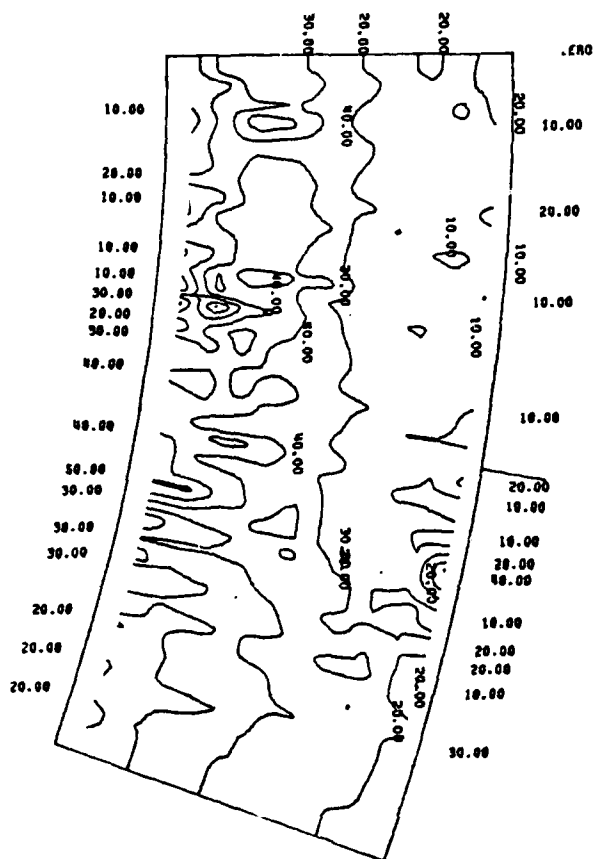
12-3-79 VANE SURVEY--W/HT SURVEY

TIME 8:53 RDC R9 RIC 1 RU 51

\*\*\*  
 KFC COEF 0.03261  
 OMEGA ID 0.09473  
 OMEGA ACT 0.12694  
 DELTA P/P 0.0267  
 FLTH RATE 0.007  
 \*\*\*

COMPLETE PASSAGE DATA

| RADIUS<br>INCHES | O/U SPAN          | KE COEF            | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | FLTH RATE<br>P/SFC IN |
|------------------|-------------------|--------------------|----------------------|-----------------------|-----------------------|-----------------------|
| 4.5600           | 94.815            | 0.09303            | 0.11326              | 0.13390               | 0.02301               | 11.933725             |
| 4.5000           | 85.926            | 0.05558            | 0.06536              | 0.07485               | 0.01643               | 15.120093             |
| 4.4400           | 77.037            | 0.04131            | 0.04881              | 0.05532               | 0.01254               | 17.995133             |
| 4.3800           | 68.148            | 0.03284            | 0.03911              | 0.04360               | 0.01026               | 17.743382             |
| 4.3100           | 57.778            | 0.03459            | 0.04157              | 0.04503               | 0.01115               | 15.254384             |
| 4.2500           | 48.889            | 0.03044            | 0.03702              | 0.03950               | 0.01033               | 12.408009             |
| 4.1800           | 38.519            | 0.02483            | 0.02590              | 0.03219               | 0.00849               | 9.99117               |
| 4.1000           | 25.667            | 0.05256            | 0.06259              | 0.07219               | 0.01829               | 9.25771               |
| 4.0200           | 17.773            | 0.14567            | 0.17424              | 0.22026               | 0.05128               | 5.92319               |
| 3.9700           | 17.407            | 0.24305            | 0.28361              | 0.44775               | 0.08538               | 8.31102               |
| KE COEF          | OMEGA ID<br>MIXED | OMEGA ACT<br>MIXED | DELTA P/P<br>MIXED   | GAS ANGLE             |                       |                       |
| 0.15495          | 0.13614           | 0.22977            | 0.03420              | 1.77312               |                       | 1.77312               |
| 0.15715          | 0.07939           | 0.08223            | 0.01670              | 1.20810               |                       | 1.20810               |
| 0.05297          | 0.06334           | 0.00729            | 0.01015              | 1.54800               |                       | 1.54800               |
| 0.04360          | 0.05224           | 0.00512            | 0.01350              | 1.07800               |                       | 1.07800               |
| 0.04124          | 0.04970           | 0.00230            | 0.01727              | 21.1812               |                       | 1.19223               |
| 0.03029          | 0.04273           | 0.00464            | 0.01180              | 26.6732               |                       | 1.19223               |
| 0.03038          | 0.03715           | 0.00647            | 0.01520              | 31.5954               |                       | 1.23237               |
| 0.07014          | 0.08498           | 0.09287            | 0.02420              | 33.9744               |                       | 1.33993               |
| 0.17175          | 0.20495           | 0.25036            | 0.05414              | 30.2010               |                       | 1.17732               |
| 0.33055          | 0.46030           | 0.58302            | 0.10450              | 20.0000               |                       | 1.51102               |

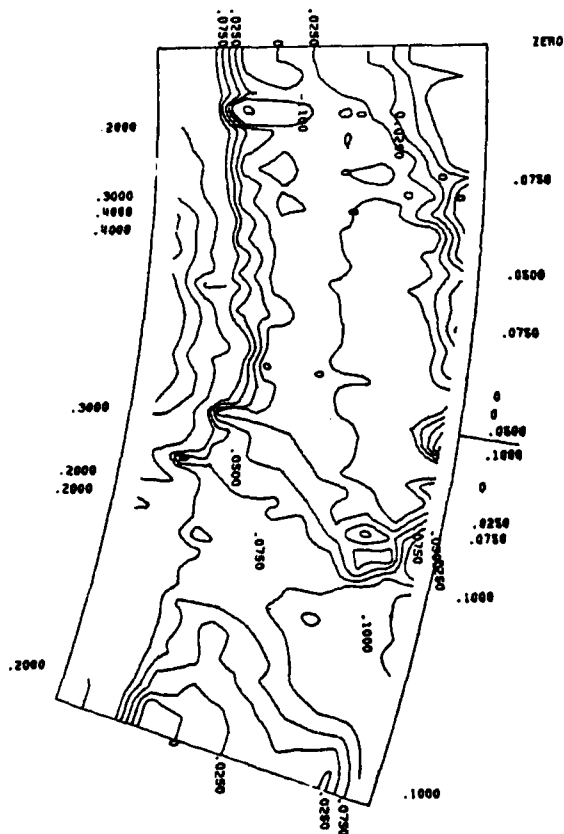


Local  $\beta$  contours

Exit Mach No. = 0.7 Reynolds No. =  $1.46 \times 10^6$

Reading 89 - aerodynamic exit data

TE-80-1006



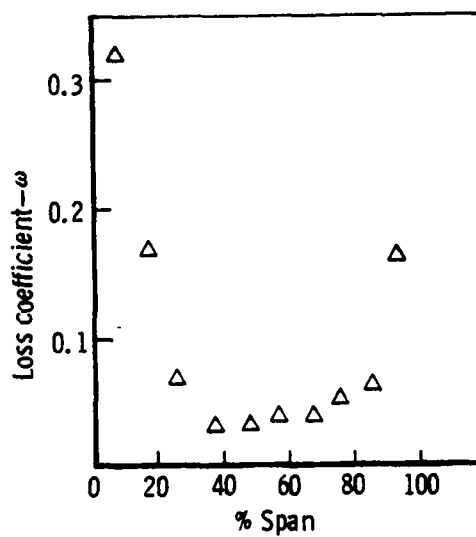
Local  $\omega$  contours

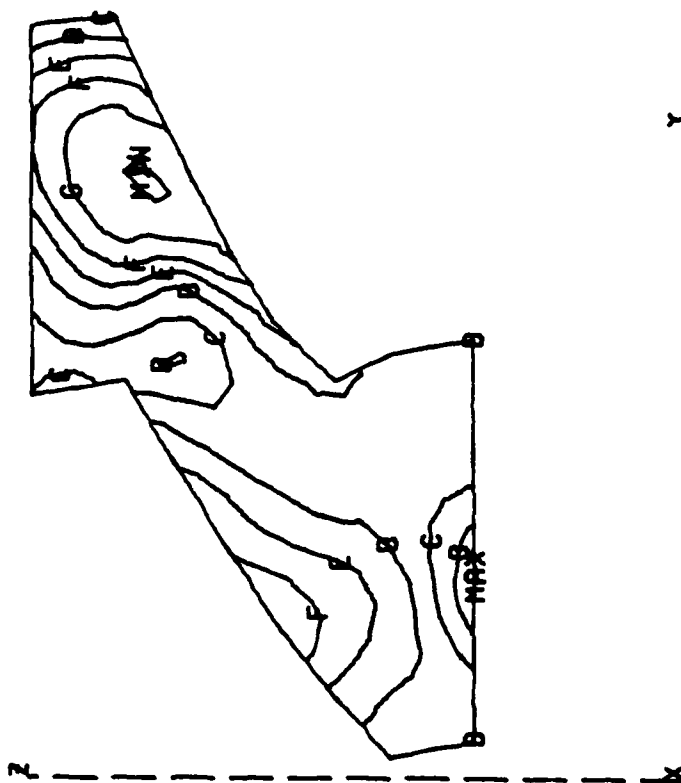
Exit Mach No. = 0.7

Reynolds No. =  $1.46 \times 10^6$

Reading 89 - aerodynamic exit data

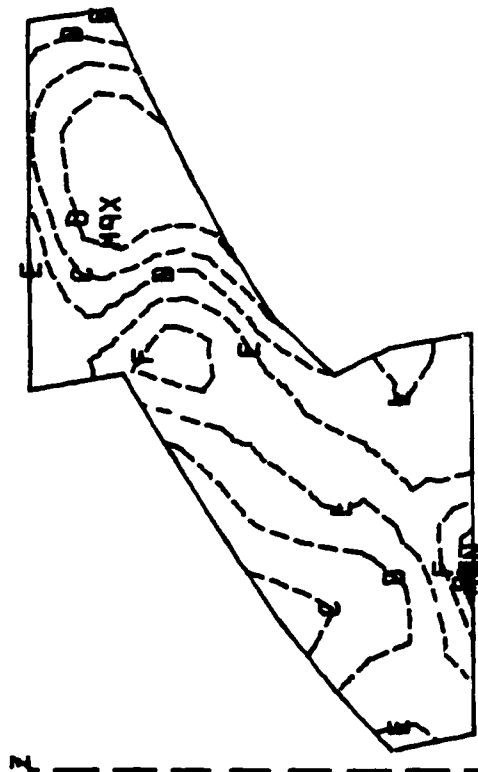
TE-80-1007





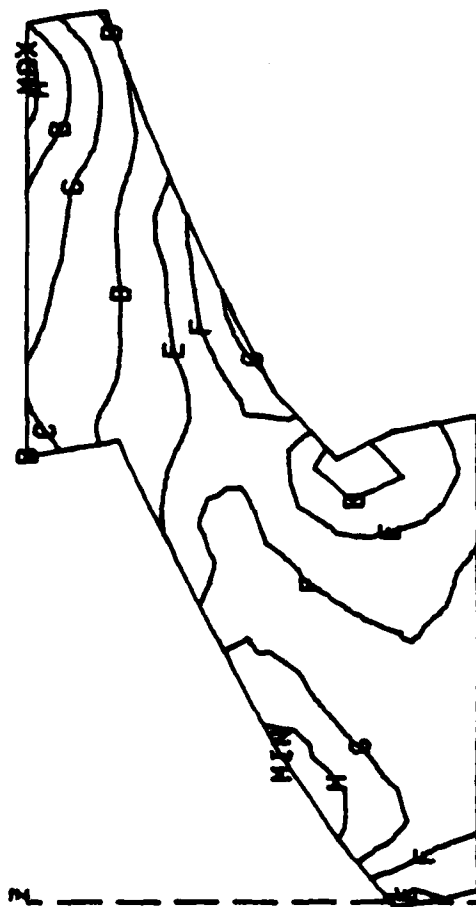
MMM LEGEND MMM  
 UNITS = TEMP  
 SYMBOL CONTOUR  
 A 2.08000E 02  
 B 2.03000E 02  
 C 1.98000E 02  
 D 1.93000E 02  
 E 1.88000E 02  
 F 1.83000E 02  
 G 1.78000E 02  
 H 1.73000E 02  
 MAX 2.08248E 02  
 MIN 1.72516E 02

AUN 91 MACH .4 RE .7E06 Y ANNULAR HUB  
 CONTOUR PLOT OF TEMPERATURE  
 SCALE = 2.0000 PLOT TIME AND DATE = 19:50:24 79/338



| MMX | LEGEND   | MMX |
|-----|----------|-----|
|     | F        |     |
|     | 1E-061   |     |
| A   | -2000.00 |     |
| B   | -2900.00 |     |
| C   | -3800.00 |     |
| D   | -4700.00 |     |
| E   | -5600.00 |     |
| F   | -6499.99 |     |
| G   | -7399.99 |     |
| H   | -8299.99 |     |
| MAX | -2059.85 |     |
| MIN | -8450.50 |     |

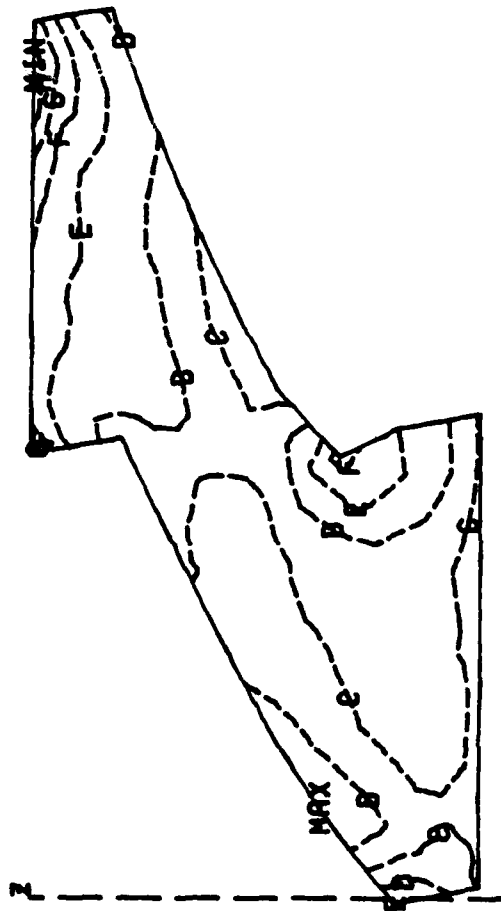
RUN 91 MARCH 4 9E .7E06 ANNULAR HUB  
 CONTOUR PLOT OF STANTON NUMBER.  
 SCALE = 2.0000 PLOT TIME AND DATE = 17.42.28 60/017



| MAX | LEGEND | MIN |
|-----|--------|-----|
| A   | B      | C   |
| D   | E      | F   |
| G   | H      | MAX |
| MIN |        |     |

290.00  
280.00  
270.00  
260.00  
250.00  
240.00  
230.00  
220.00  
292.90  
215.91

RUN 91 MACH .4 RE .7E06 ANNULAR TIP  
CONTOUR PLOT OF TEMPERATURE  
SCALE = 2.0000 PLOT TIME AND DATE = 17:22:14 80/032



| MIN | LEGEND | MIN |
|-----|--------|-----|
|     | F      |     |
|     | (E-03) |     |
| A   | -2.00  |     |
| B   | -4.00  |     |
| C   | -6.00  |     |
| D   | -8.00  |     |
| E   | -10.00 |     |
| F   | -12.00 |     |
| G   | -14.00 |     |
| H   | -16.00 |     |
| MAX | -2.64  |     |
| MIN | -17.03 |     |

RUN 91 MARCH .4 RE .7E06 ANNULAR TIP

CONTOUR PLOT OF STANTON NUMBER.  
SCALE = 2.0000 PLOT TIME AND DATE = 17:22:29 80/032

# 12-1-79 VANE SURVEY W/HT SURVEY

TIME 1330 QDG 02 RIT 1 RU 51

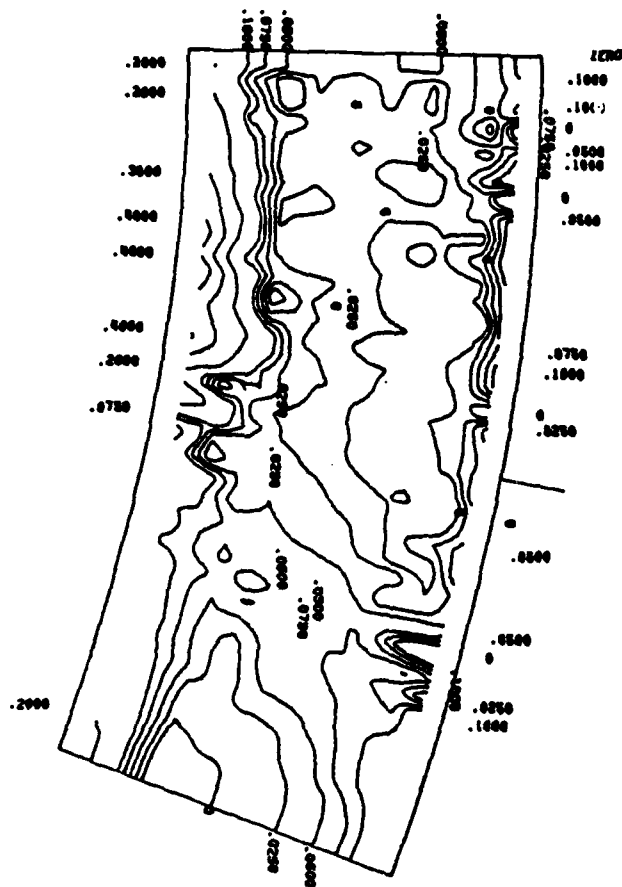
\*\*\*  
 KE COEF 0.07645  
 OMEGA ID 0.07793  
 OMEGA ACT 0.09923  
 COMPLETE PASSAGE DATA P/P 0.0086  
 FLOW RATE 4.461  
 \*\*\*

| RADIOS<br>INCHES | W/O SPAN | KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | DELTA P/P<br>MASS AVG | FLOW/L<br>L/SEC IN |
|------------------|----------|---------|----------------------|-----------------------|----------------------|-----------------------|-----------------------|-----------------------|--------------------|
| 2.5400           | 92.333   | 0.09146 | 0.09657              | 0.10871               | 0.09657              | 0.10871               | 0.00864               | 0.00864               | 7.91735            |
| 2.5400           | 85.926   | 0.04593 | 0.04861              | 0.05412               | 0.04861              | 0.05412               | 0.00864               | 0.00864               | 9.12515            |
| 2.5400           | 74.074   | 0.02972 | 0.02843              | 0.03145               | 0.02843              | 0.03145               | 0.00864               | 0.00864               | 9.70044            |
| 4.2100           | 69.030   | 0.03265 | 0.02434              | 0.02747               | 0.02434              | 0.02747               | 0.00864               | 0.00864               | 9.08133            |
| 4.2100           | 57.778   | 0.02436 | 0.02601              | 0.03192               | 0.02601              | 0.03192               | 0.00864               | 0.00864               | 7.44537            |
| 2.5400           | 48.880   | 0.02452 | 0.03053              | 0.03770               | 0.03053              | 0.03770               | 0.00864               | 0.00864               | 5.26182            |
| 2.5400           | 37.037   | 0.02430 | 0.02589              | 0.03539               | 0.02589              | 0.03539               | 0.00864               | 0.00864               | 5.09113            |
| 4.2100           | 28.148   | 0.01119 | 0.01323              | 0.01348               | 0.01323              | 0.01348               | 0.00864               | 0.00864               | 4.78596            |
| 2.5400           | 17.778   | 0.01515 | 0.01323              | 0.01348               | 0.01323              | 0.01348               | 0.00864               | 0.00864               | 3.00080            |
| 2.5400           | 7.407    | 0.02130 | 0.02597              | 0.02016               | 0.02597              | 0.02016               | 0.00864               | 0.00864               | 2.52261            |

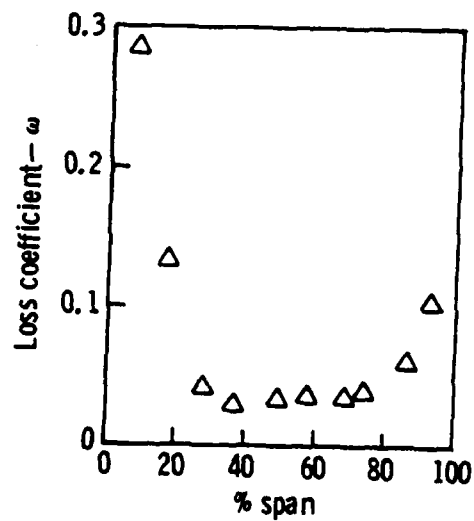
| KE COEF | OMEGA ID<br>MASS AVG | OMEGA ACT<br>MASS AVG | DELTA P/P<br>MASS AVG | GAS ANGLE<br>MIXED | KE MIX/KE |
|---------|----------------------|-----------------------|-----------------------|--------------------|-----------|
| 0.09481 | 0.10011              | 0.11125               | 0.00864               | 8.3416             | 1.03656   |
| 0.02527 | 0.02231              | 0.02646               | 0.00582               | 12.0527            | 1.27945   |
| 0.03004 | 0.04252              | 0.04441               | 0.00439               | 18.5107            | 1.49654   |
| 0.03254 | 0.03464              | 0.03581               | 0.00335               | 16.5321            | 1.41730   |
| 0.03355 | 0.03579              | 0.03712               | 0.00358               | 20.5924            | 1.37697   |
| 0.03321 | 0.03444              | 0.03568               | 0.00354               | 24.7010            | 1.12925   |
| 0.04147 | 0.03163              | 0.03267               | 0.00333               | 31.0068            | 1.22066   |
| 0.04147 | 0.04442              | 0.04664               | 0.01475               | 31.9027            | 1.32957   |
| 0.02536 | 0.03368              | 0.03430               | 0.01403               | 33.0074            | 1.18094   |
| 0.02704 | 0.02854              | 0.02994               | 0.00335               | 32.7591            | 1.26777   |







Local  $\omega$  contours



Exit Mach No. = 0.4 Reynolds No. =  $0.7 \times 10^6$

Reading 92 - aerodynamic exit data

TE-80-1009

#### 4.0 TURBULENCE MEASUREMENTS

Inlet turbulence intensity measurements were made in the linear cascade. The measurements were made with the DDA laser doppler anemometer (LDA), which is described in detail in Section 3.2.7 of Volume I. For this application the system was aligned in 15° off-axis backscatter, with a fringe spacing of 7.72  $\mu\text{m}$  and a laser power of 350 mw.

As explained in Section 3.2.7 of Volume I, optical access to the cascade was provided by installing quartz windows in the endwall that had previously been used for making the adiabatic endwall temperature measurements. This optical access allowed turbulence intensity measurements to be made midway between vanes 3 and 4 at a point 0.16 inch downstream of the vane leading edge plane. Traverses were made across the span and data was taken at 1/2-inch intervals over a range from 1 inch on each side of the centerline. Measurements could not be taken closer than 1/2 inch to the endwall due to reflections.

Measurements were made at inlet gas temperatures of 600°F, 800°F, and 1000°F with the facility burner operating. At these three temperature levels measurements were made at an exit Mach number of 0.7 and at Reynolds numbers matching those of the baseline heat transfer tests. An additional set of data was taken at an exit Mach number of 0.3 and a gas temperature of 800°F. This condition provided inlet flow parameters different from the 0.7 exit Mach number cases.

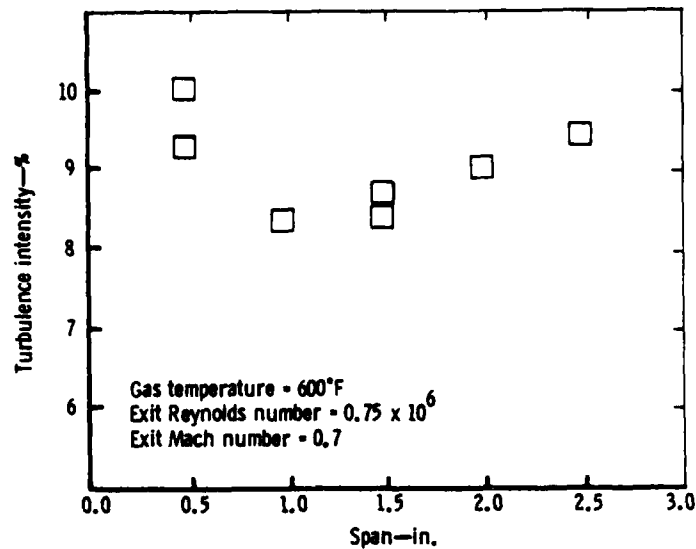
Span-averaged values of the turbulence intensity did not indicate the variation with gas temperature that was expected. Table 5 lists these values with the associated run conditions.

TABLE 5. SPANWISE-AVERAGED TURBULENCE INTENSITY

| <u>Gas<br/>Temperature<br/>(°F)</u> | <u>Exit<br/>Mach<br/>Number</u> | <u>Exit<br/>Reynolds<br/>Number</u> | <u>Turbulence<br/>Intensity<br/>(%)</u> |
|-------------------------------------|---------------------------------|-------------------------------------|-----------------------------------------|
| 600                                 | 0.7                             | $0.75 \times 10^6$                  | $9.35 \pm 0.47$                         |
| 800                                 | 0.7                             | $0.60 \times 10^6$                  | $7.95 \pm 0.40$                         |
| 1000                                | 0.7                             | $0.54 \times 10^6$                  | $7.90 \pm 0.40$                         |
| 800                                 | 0.3                             | $0.20 \times 10^6$                  | $8.43 \pm 0.42$                         |

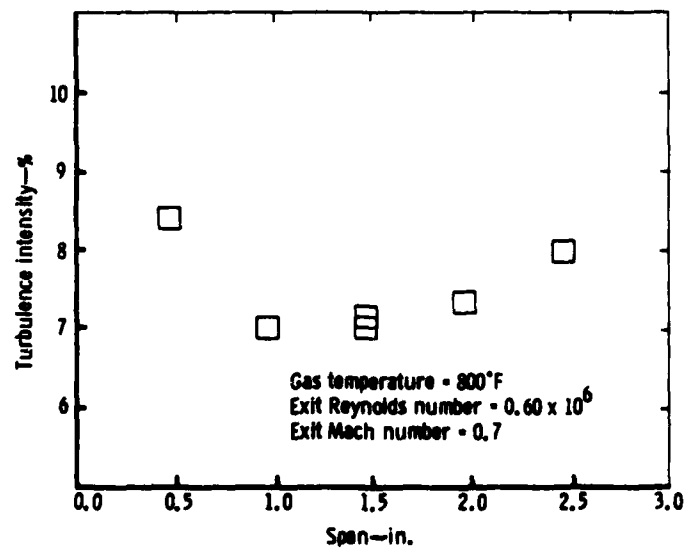
The uncertainty limits on the turbulence intensity reflect only the statistical uncertainty inherent in making the calculation from 1000 particle velocities.

The spanwise profiles were as expected, with minimum values of the turbulence intensity measured at midspan and the level increasing as the wall was approached. At a point 1/2 inch from the wall, levels were nominally 15% higher than the midspan values. The spanwise profiles for the four runs in Table 5 are shown in Figures 1 through 4. In the figures the 0.00 span position represents the heat transfer endwall, whereas the 3.00 span position represents the quartz window.



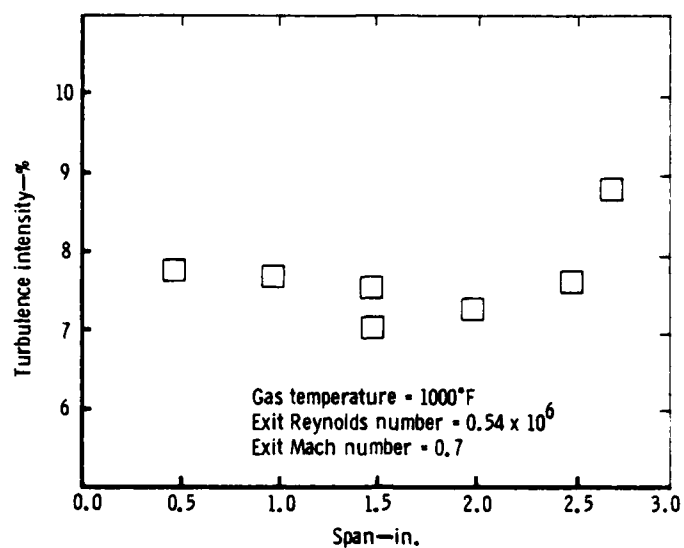
TE81-4592

Figure 1. Spanwise turbulence intensity variation at 600°F.



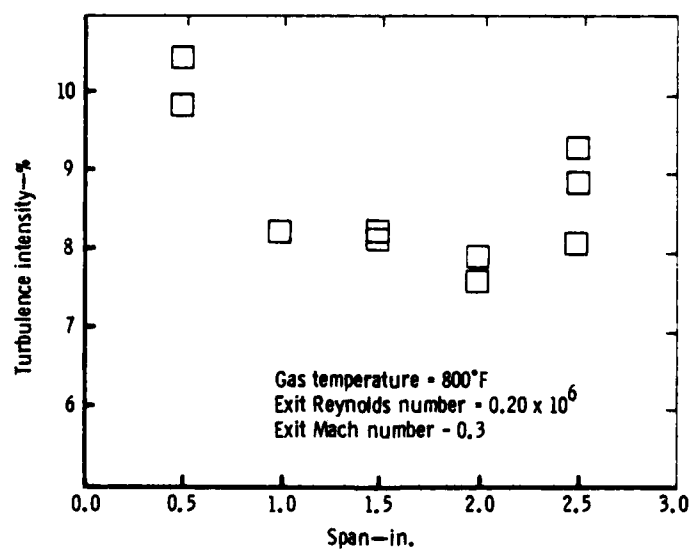
TE81-4593

Figure 2. Spanwise turbulence intensity variation at 800°F.



TE81-4594

Figure 3. Spanwise turbulence intensity variation at 1000°F.



TE81-4596

Figure 4. Spanwise turbulence intensity variation at 800°F for reduced exit Mach number.

END

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