

33-34

70767

p. 24

Abstract for the Elventh CFD Working Group Meeting:

A Fine-Grid Model for the  
ASRM Aft Segment with Gimballed Nozzle

Presented By: Dr. Edward J. Reske

Results from computational fluid dynamic analyses for complex three-dimensional internal flows in the Advanced Solid Rocket Motor (ASRM) are presented. In particular, flow visualization and tabulated results from a fine-grid model consisting of 1.5 M grid points for the ASRM Aft Segment at the 19-second burn time with an 8-degree nozzle gimbal angle are shown. The results from this model will enable characterization of various aspects of the ASRM internal environment, and in particular will allow an assessment of the heat transfer and stresses exerted on the submerged nozzle, casing insulation, and nozzle-case joint.

# **A Fine-Grid Model for the ASRM Aft Segment With Gimbaled Nozzle**

**Eleventh Workshop for CFD  
Applications in Rocket Propulsion**

**April 20-22, 1993**

**Ed Reske**

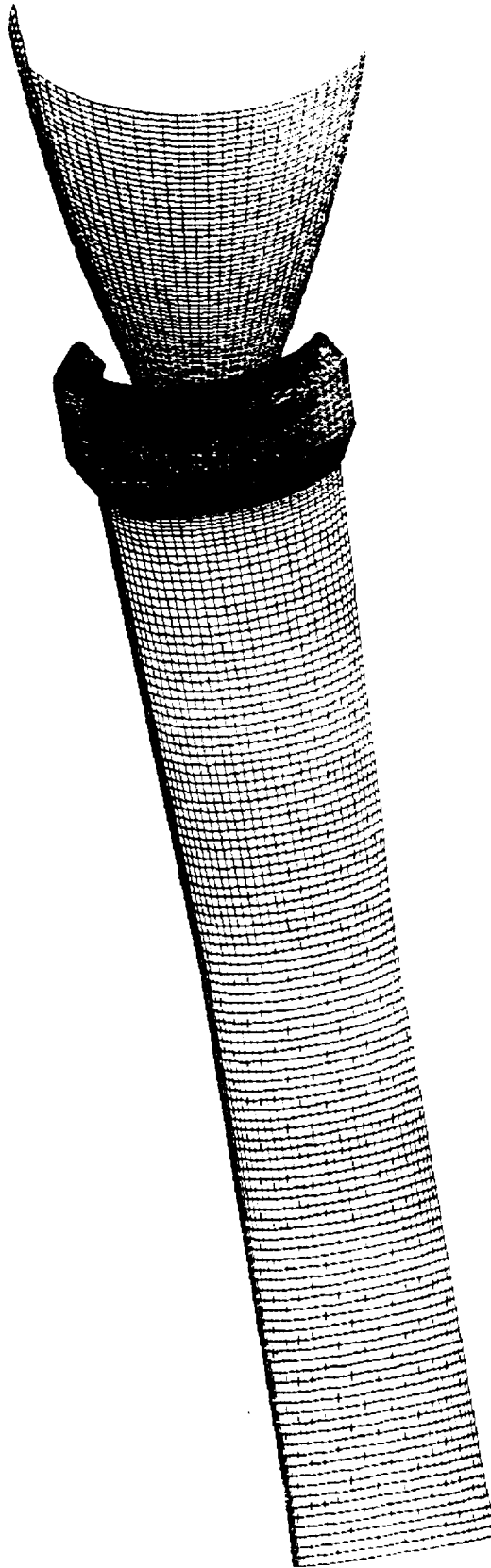
**MSFC, CFD Branch**

**Animation by Catherine Dumas,  
Sverdrup Technology**

**GEOMETRY**

**Fine Grid Model for ASRM at 19 seconds with 8-degree Gimbal Angle  
Surface Geometry: Dimensions 127 X 311 X 37 = 1.46 M Grid Points**

**127x311x37 GRID**



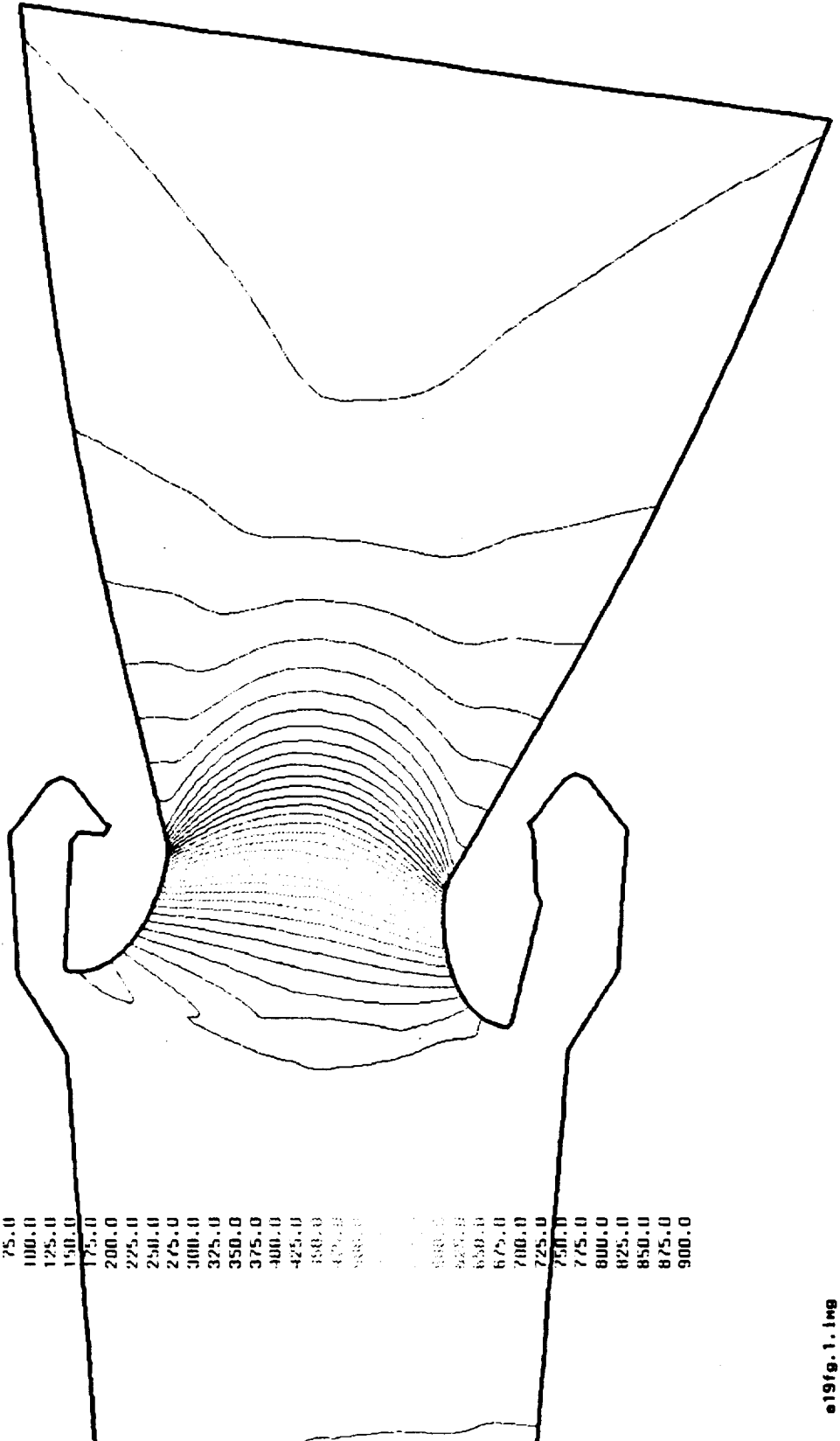
019fg.2.img

NORMALIZED PRESSURE

Fine Grid Model for ASBH at 19 seconds with 8-degree Gimbal Angle  
 Pressure in PSIA 4/21/93

- CONTOUR LEVELS
- 0.0
  - 25.0
  - 50.0
  - 75.0
  - 100.0
  - 125.0
  - 150.0
  - 175.0
  - 200.0
  - 225.0
  - 250.0
  - 275.0
  - 300.0
  - 325.0
  - 350.0
  - 375.0
  - 400.0
  - 425.0
  - 450.0
  - 475.0
  - 500.0
  - 525.0
  - 550.0
  - 575.0
  - 600.0
  - 625.0
  - 650.0
  - 675.0
  - 700.0
  - 725.0
  - 750.0
  - 775.0
  - 800.0
  - 825.0
  - 850.0
  - 875.0
  - 900.0

0.224 MACH  
 0.00 DEG ALPHA  
 4.56x10\*\*6 Re  
 127x311x37 GRID



e19fg.1.img

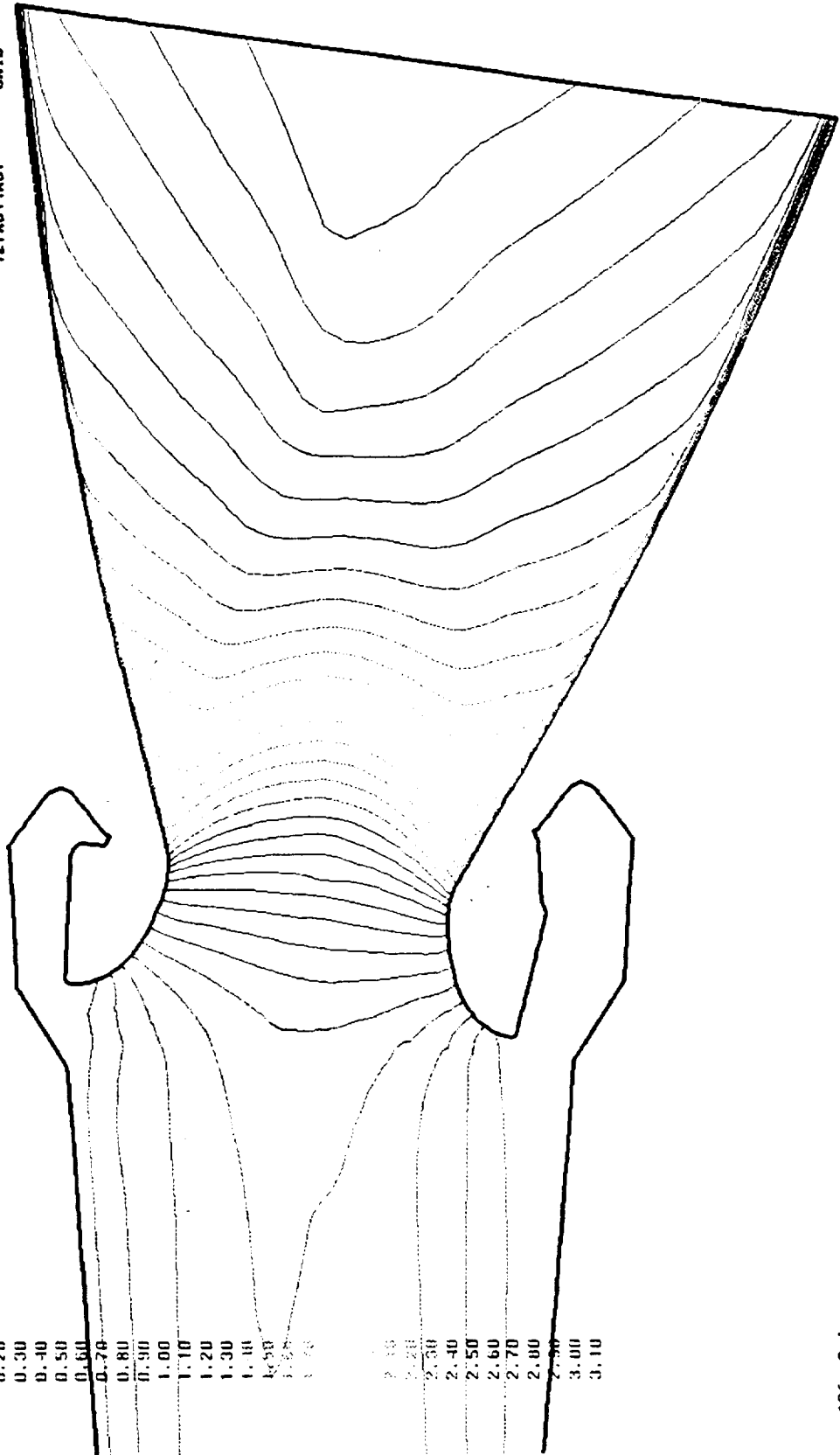
MACH NUMBER

Fine Grid Model for ASRM at 19 seconds with 8-degree Gimbal Angle

GE POOR QUALITY

MACH 0.224  
ALPHA 0.00 DEG  
Re 4.56x10<sup>06</sup>  
GRID 127x311x37

CONTOUR LEVELS  
0.00  
0.10  
0.20  
0.30  
0.40  
0.50  
0.60  
0.70  
0.80  
0.90  
1.00  
1.10  
1.20  
1.30  
1.40  
1.50  
1.60  
1.70  
1.80  
1.90  
2.00  
2.10  
2.20  
2.30  
2.40  
2.50  
2.60  
2.70  
2.80  
2.90  
3.00  
3.10

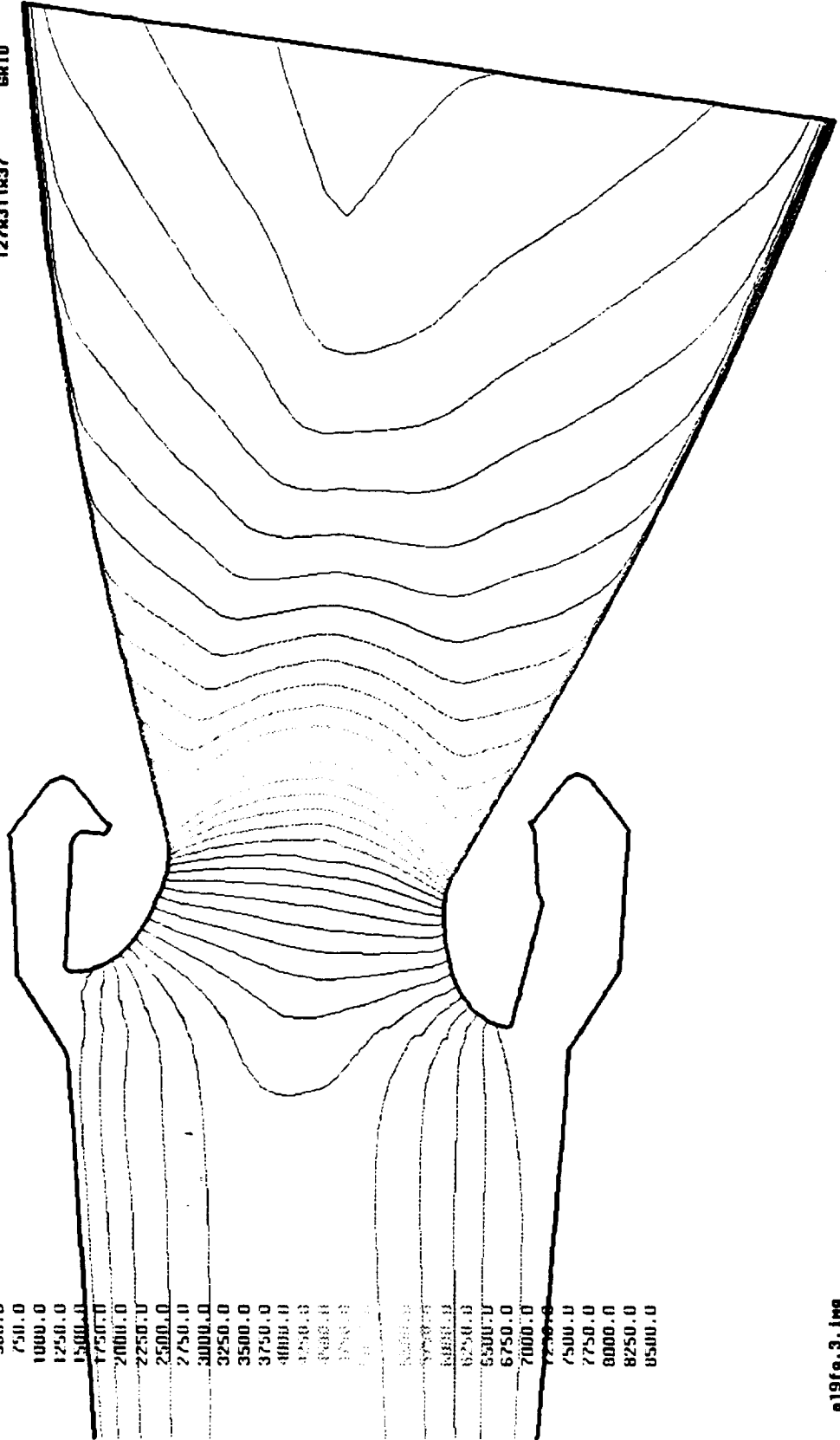


VELOCITY MAGNITUDE

Fine Grid Model for ASRM at 19 seconds with 8-degree Spherol Angle  
 Velocity in ft./sec. 4/21/93

CONTOUR LEVELS  
 0.0  
 250.0  
 500.0  
 750.0  
 1000.0  
 1250.0  
 1500.0  
 1750.0  
 2000.0  
 2250.0  
 2500.0  
 2750.0  
 3000.0  
 3250.0  
 3500.0  
 3750.0  
 4000.0  
 4250.0  
 4500.0  
 4750.0  
 5000.0  
 5250.0  
 5500.0  
 5750.0  
 6000.0  
 6250.0  
 6500.0  
 6750.0  
 7000.0  
 7250.0  
 7500.0  
 7750.0  
 8000.0  
 8250.0  
 8500.0

0.224 MACH  
 0.00 DEG ALPHA  
 4.56x10<sup>06</sup> Re  
 127x311x37 GRID



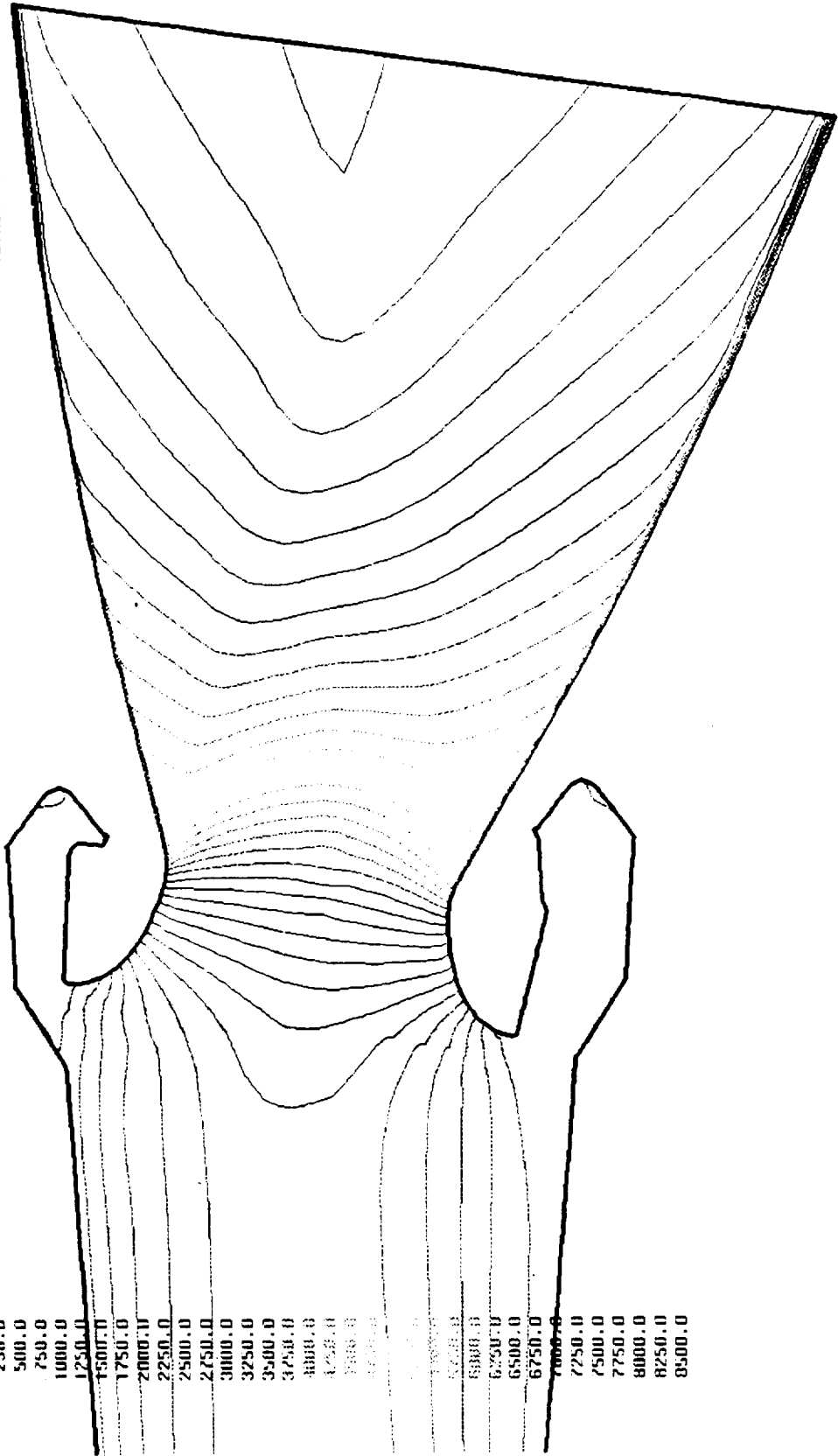
e19fg.3.img

U VELOCITY

Fine Grid Model for ASRM at 19 seconds with 8-degree Gimbal Angle  
Velocity in ft./sec. 4/21/93

0.224 MACH  
0.00 DEG ALPHA  
4.56x10<sup>06</sup> Re  
127x31x37 GRID

CONTOUR LEVELS  
-250.0  
0.0  
250.0  
500.0  
750.0  
1000.0  
1250.0  
1500.0  
1750.0  
2000.0  
2250.0  
2500.0  
2750.0  
3000.0  
3250.0  
3500.0  
3750.0  
4000.0  
4250.0  
4500.0  
4750.0  
5000.0  
5250.0  
5500.0  
5750.0  
6000.0  
6250.0  
6500.0  
6750.0  
7000.0  
7250.0  
7500.0  
7750.0  
8000.0  
8250.0  
8500.0

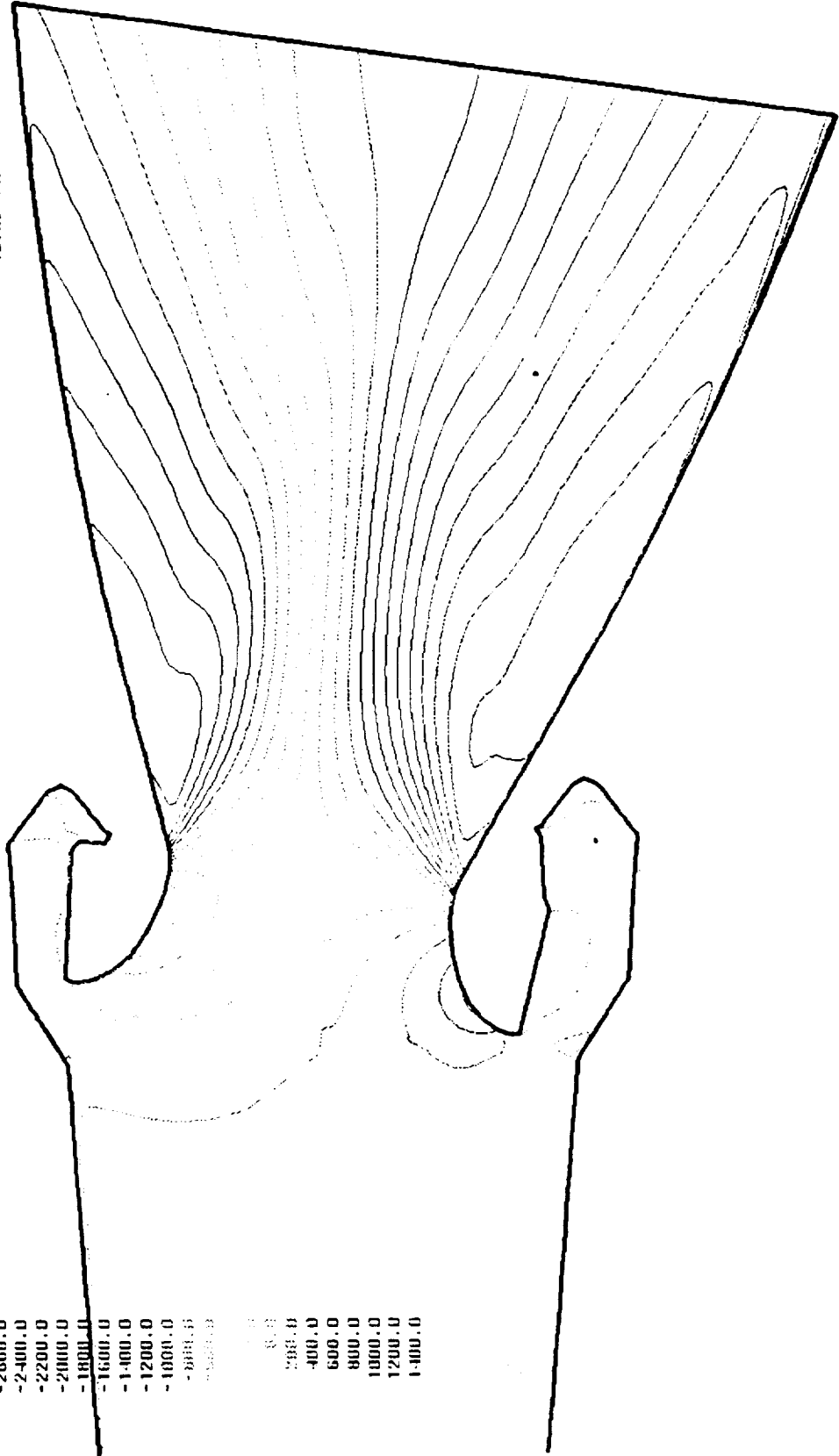


U VELOCITY

Fine Grid Model for ASRM at 19 seconds with 8-degree Gimbal Angle  
Velocity in ft./sec. 4/21/93

0.224 MACH  
0.00 DEG ALPHA  
4.56x10<sup>06</sup> Re  
127x311x37 GRID

CONTOUR LEVELS  
-3000.0  
-2800.0  
-2600.0  
-2400.0  
-2200.0  
-2000.0  
-1800.0  
-1600.0  
-1400.0  
-1200.0  
-1000.0  
-800.0  
-600.0  
-400.0  
-200.0  
0.0  
200.0  
400.0  
600.0  
800.0  
1000.0  
1200.0  
1400.0

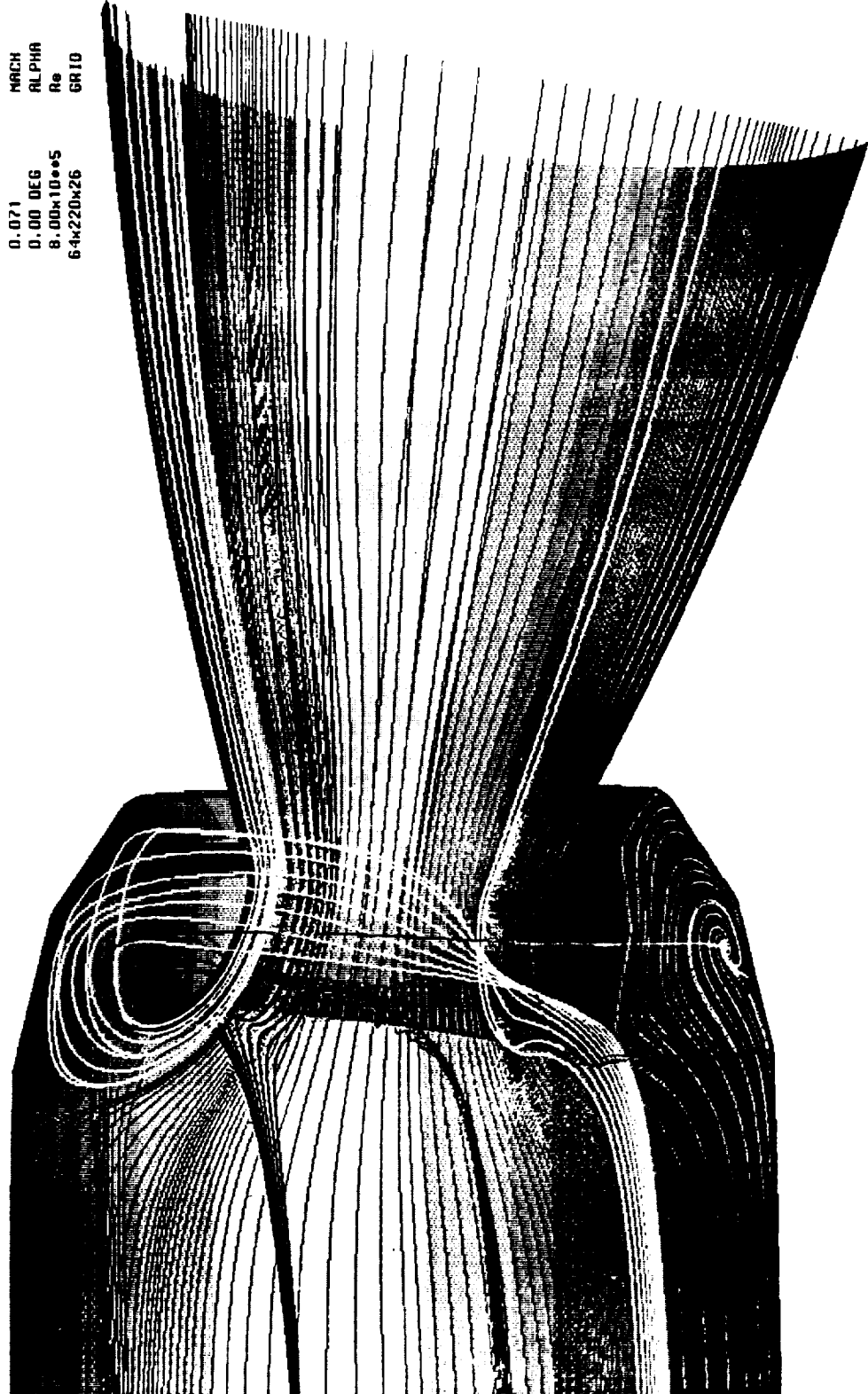


a19fg.5.1mg



PARTICLE TRACES

ASRM at 115 second burn time with nozzle gimballed at 8 degrees: 3/24/92  
Solution "d" (after 3400 iterations)



MACH 0.071  
ALPHA 0.00 DEG  
Re 8.00e+10  
GRID 64x220x26

f10nd.9.1mg

FIGURE 10

HSR at 11's second turn time with an isopotential at a distance of 37.7497  
Solution of the isopotential equation

0.0000  
0.0000  
0.0000  
0.0000

0.0000  
0.0000  
0.0000  
0.0000

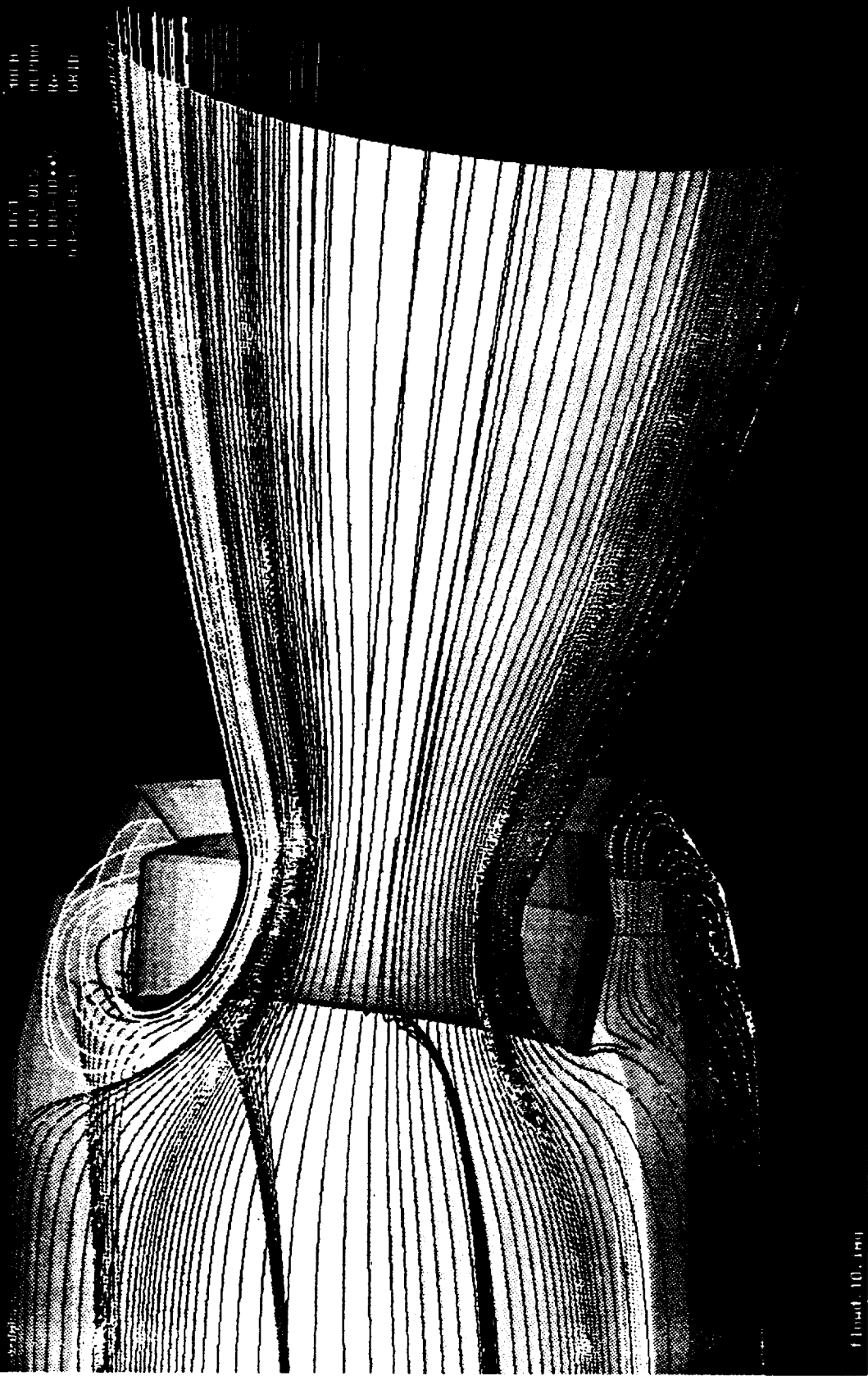
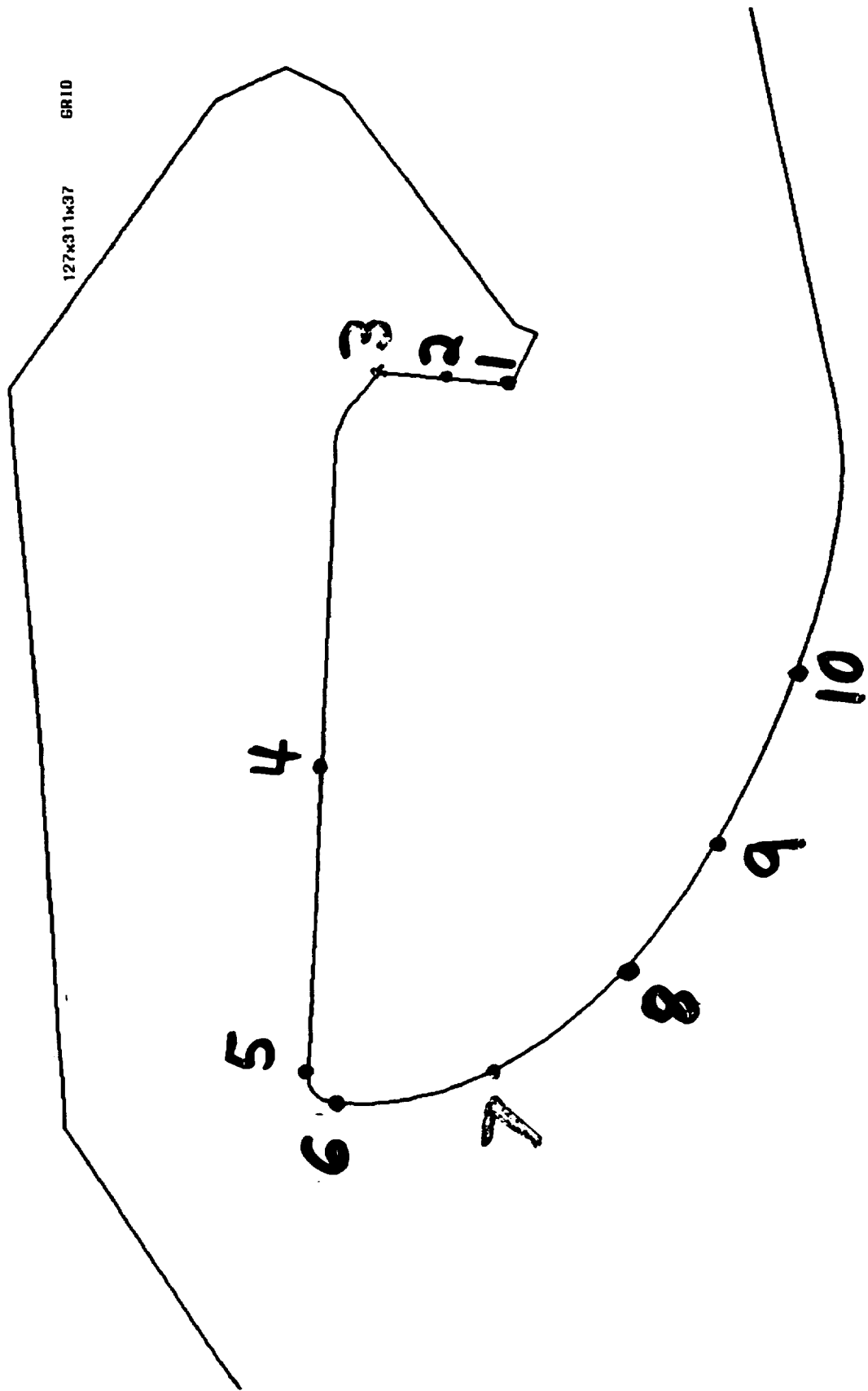


FIGURE 10, 1961

GEOMETRY

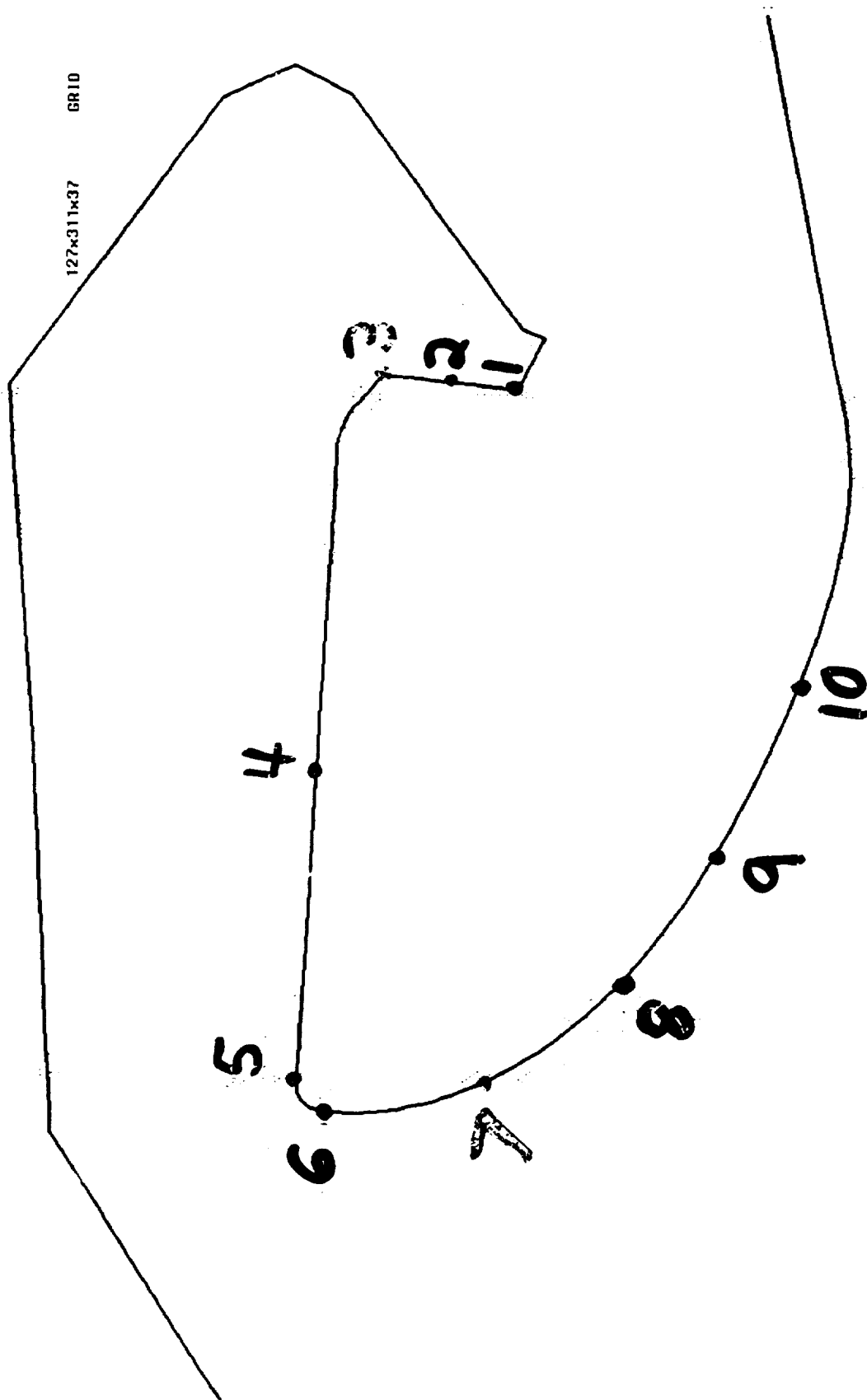
ASRM at 19 seconds with 8-degree Gimbel Angle  
Station Locations on Nozzle Nose in  $K = 1$  Plane



THE POOR QUALITY

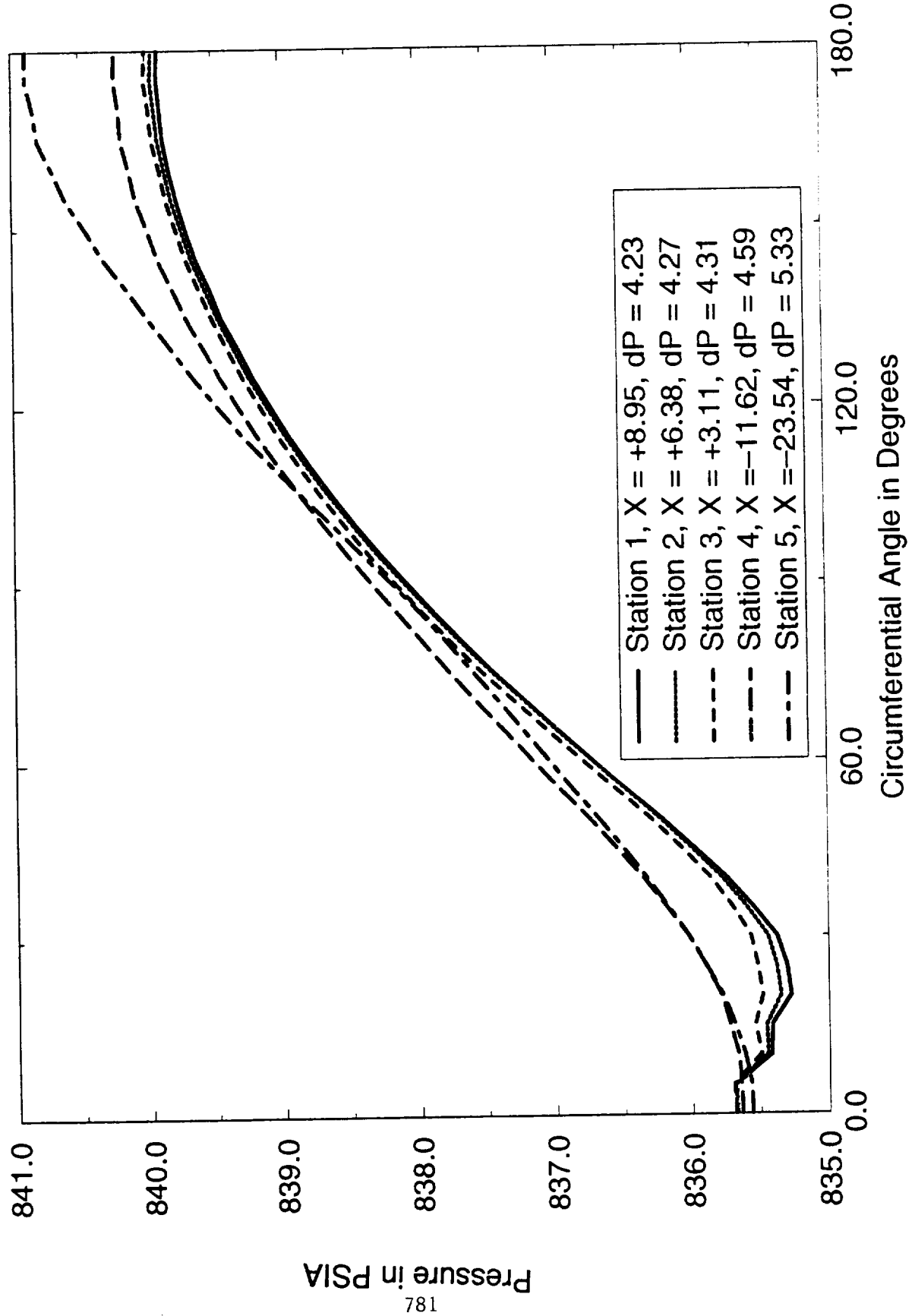
GEOMETRY

ASPH at 19 seconds with 8-degree Gimbale Angle  
Station Locations on Nozzle Nose in K = 1 Plane

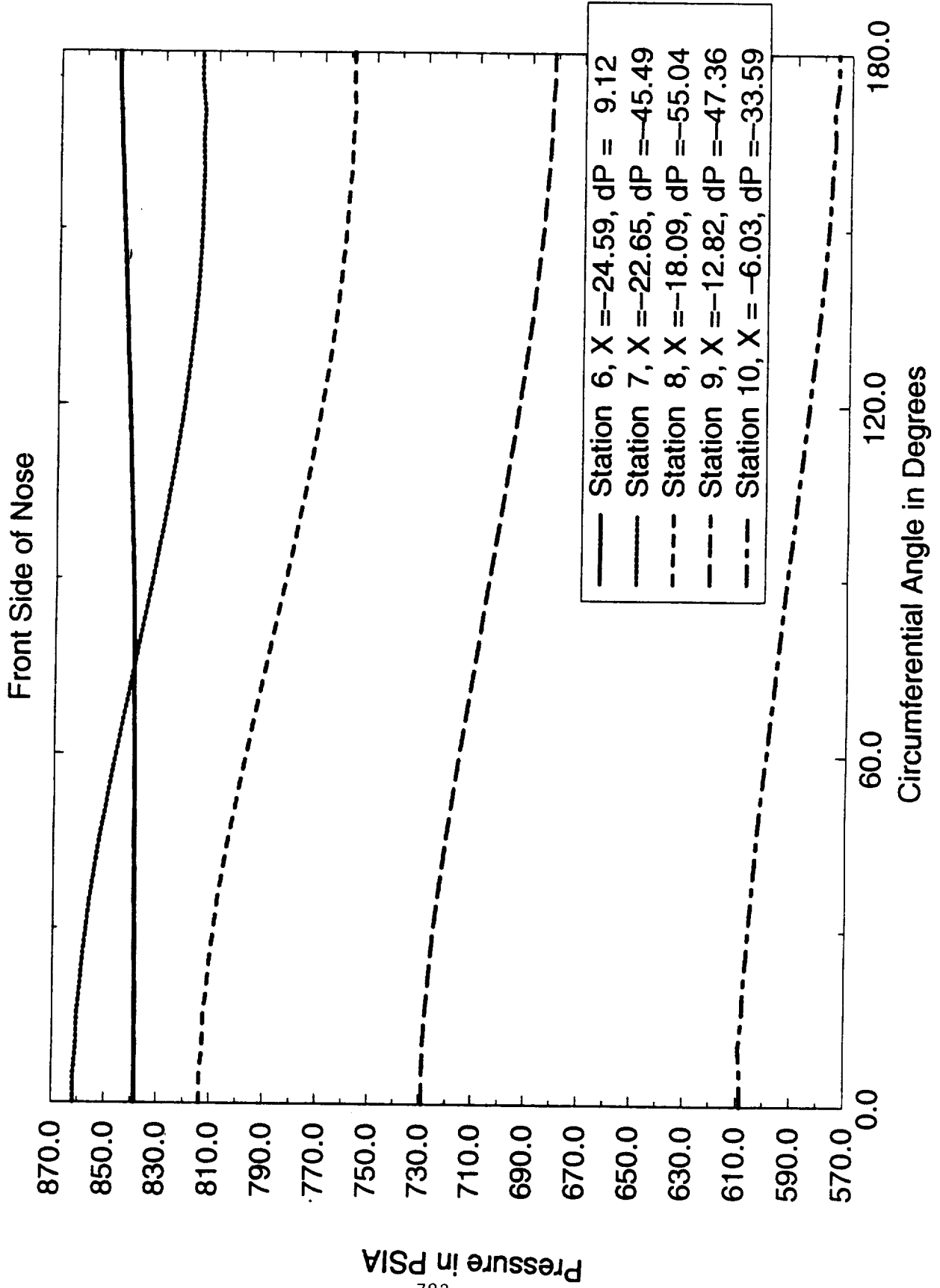


# Circumferential Pressure Variation

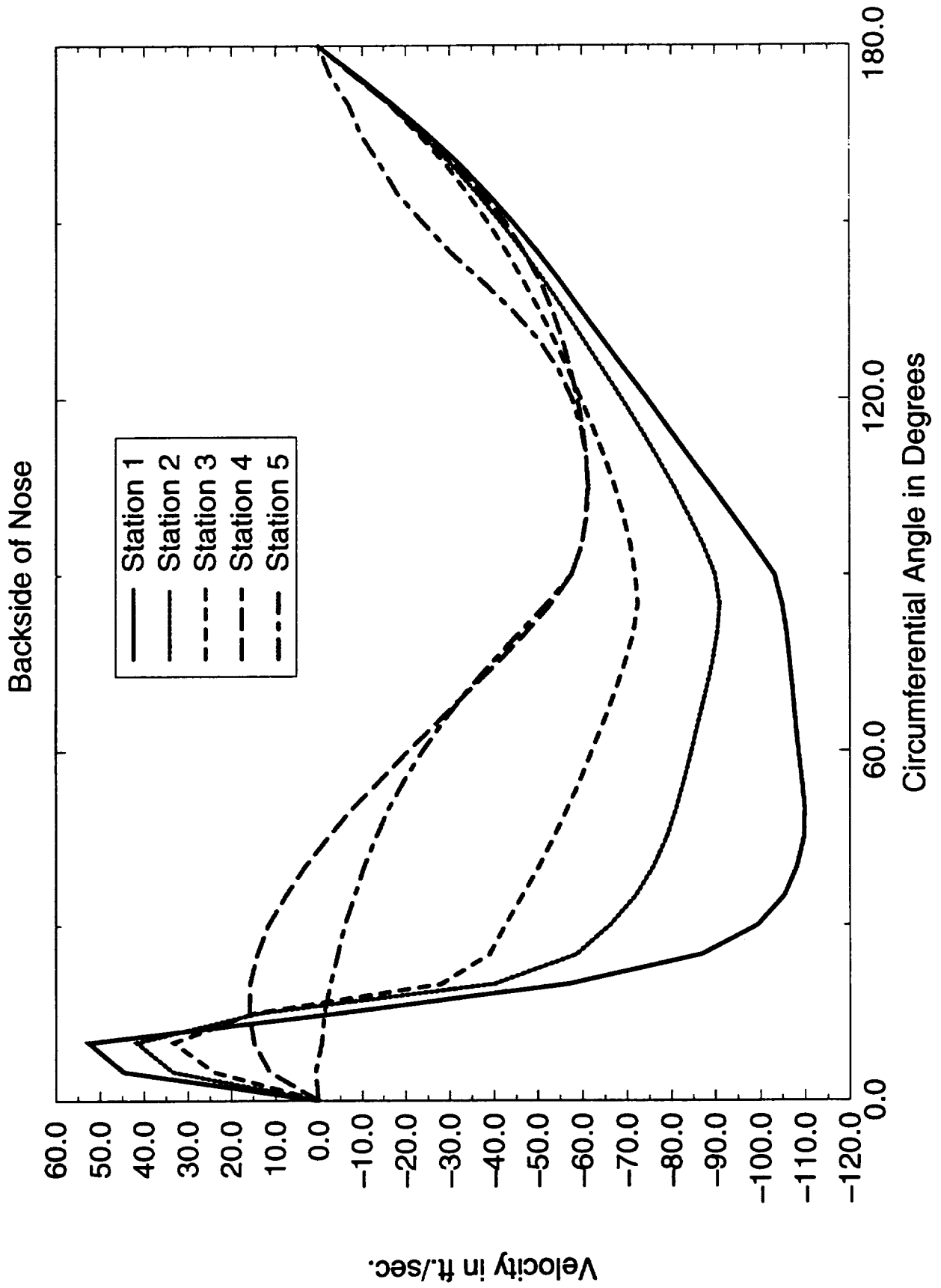
Backside of Nose



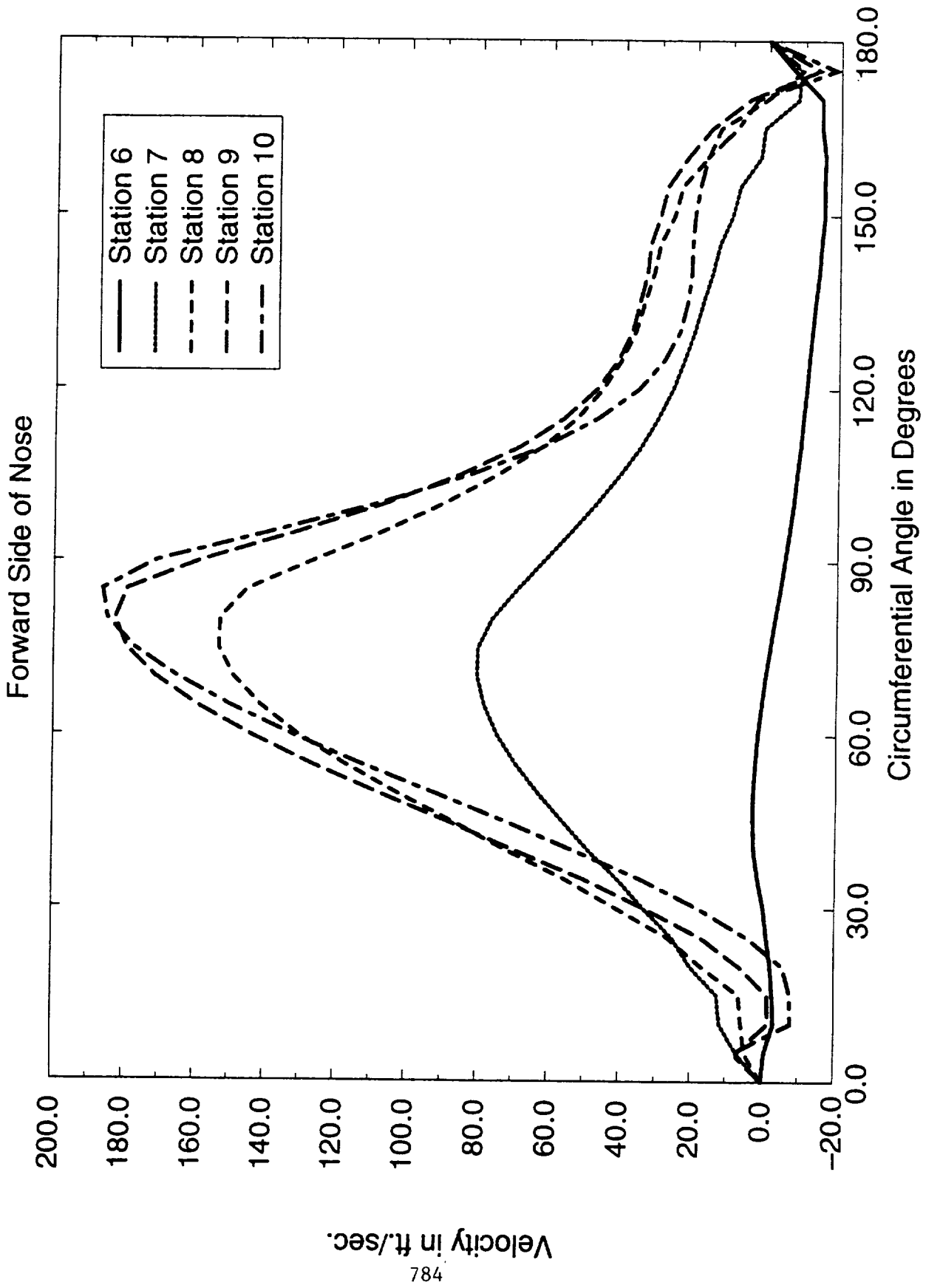
# Circumferential Pressure Variation



# Variation of Circumferential Velocity

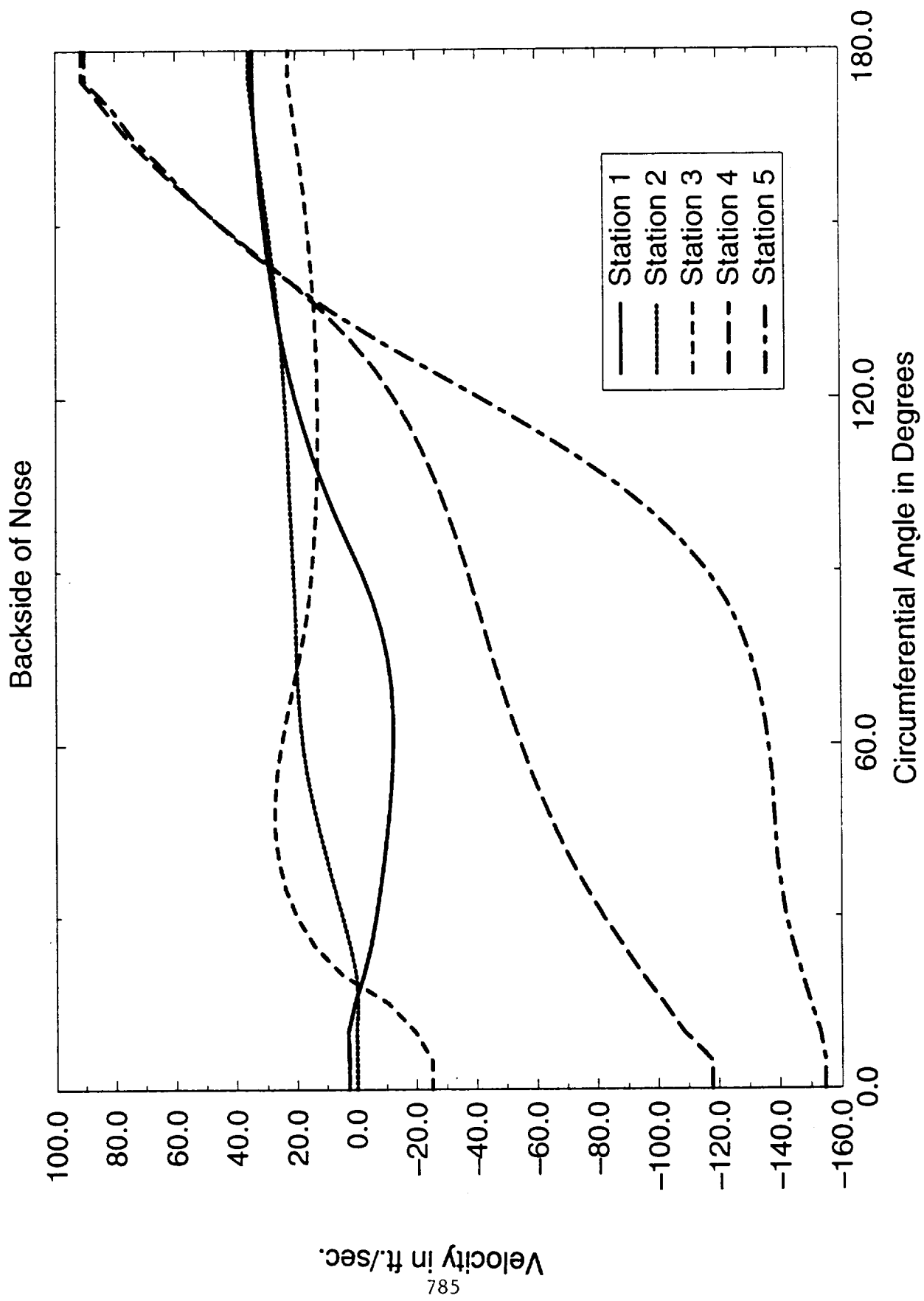


# Variation of Circumferential Velocity

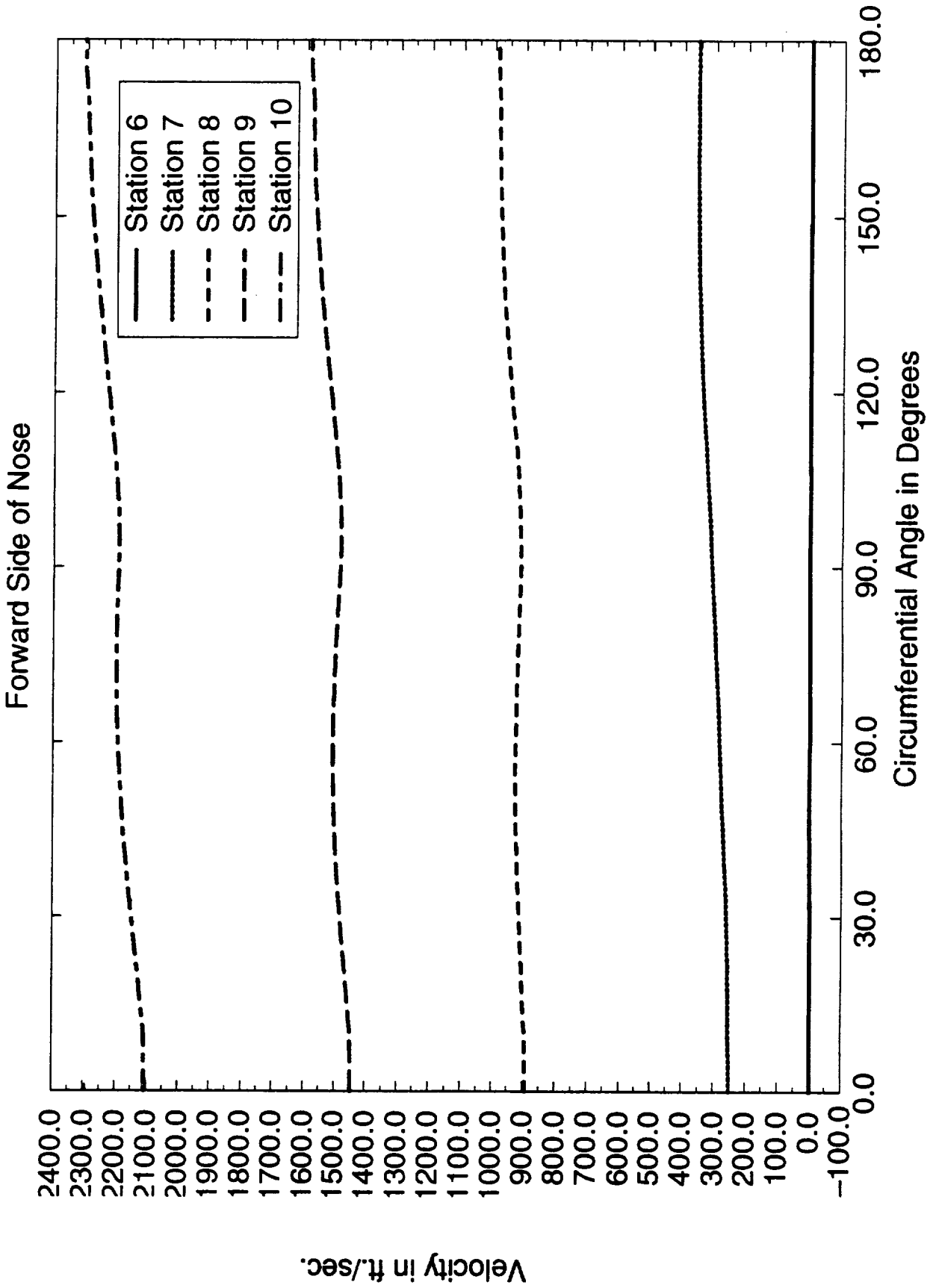




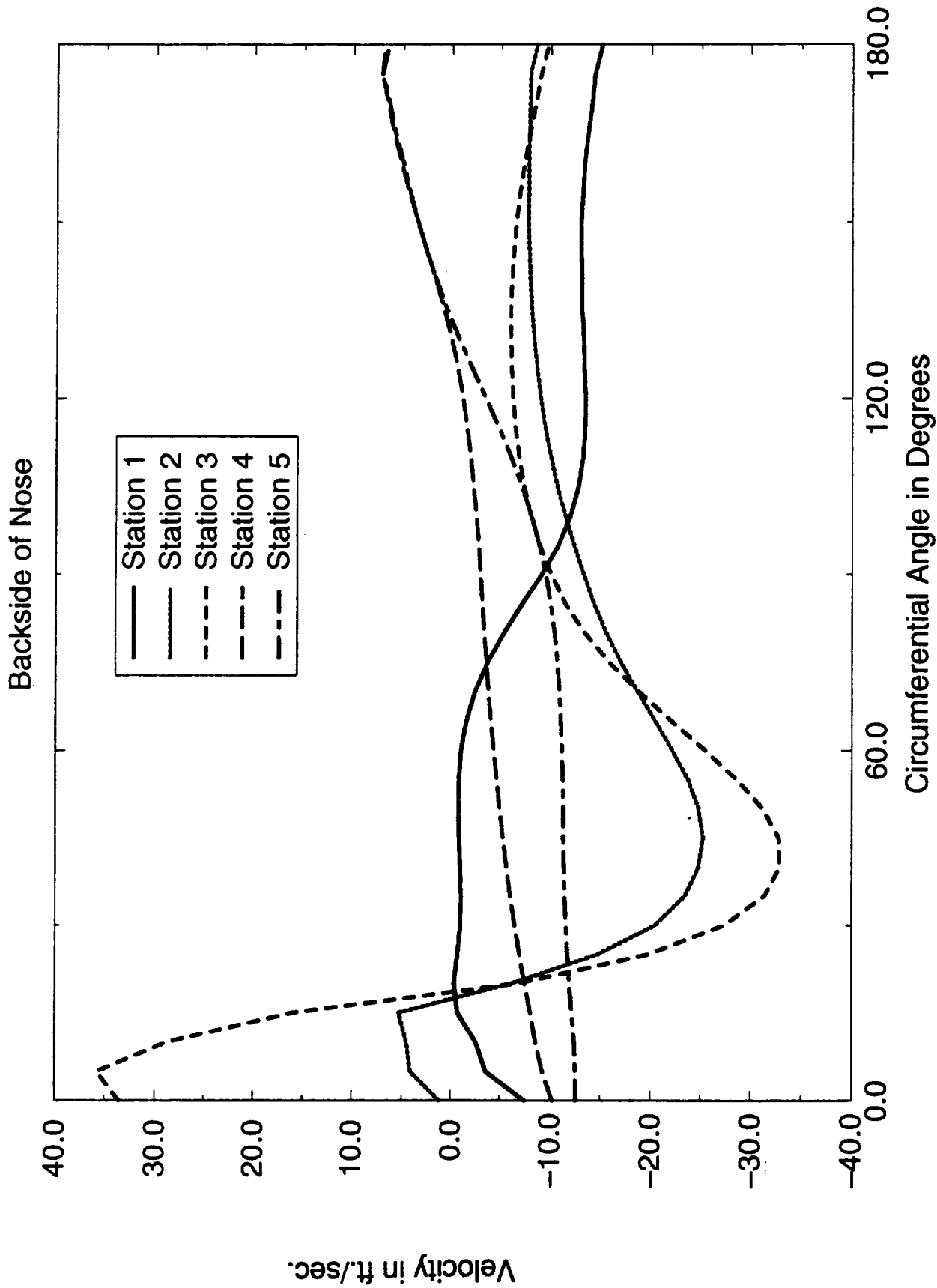
# Variation of Axial Velocity



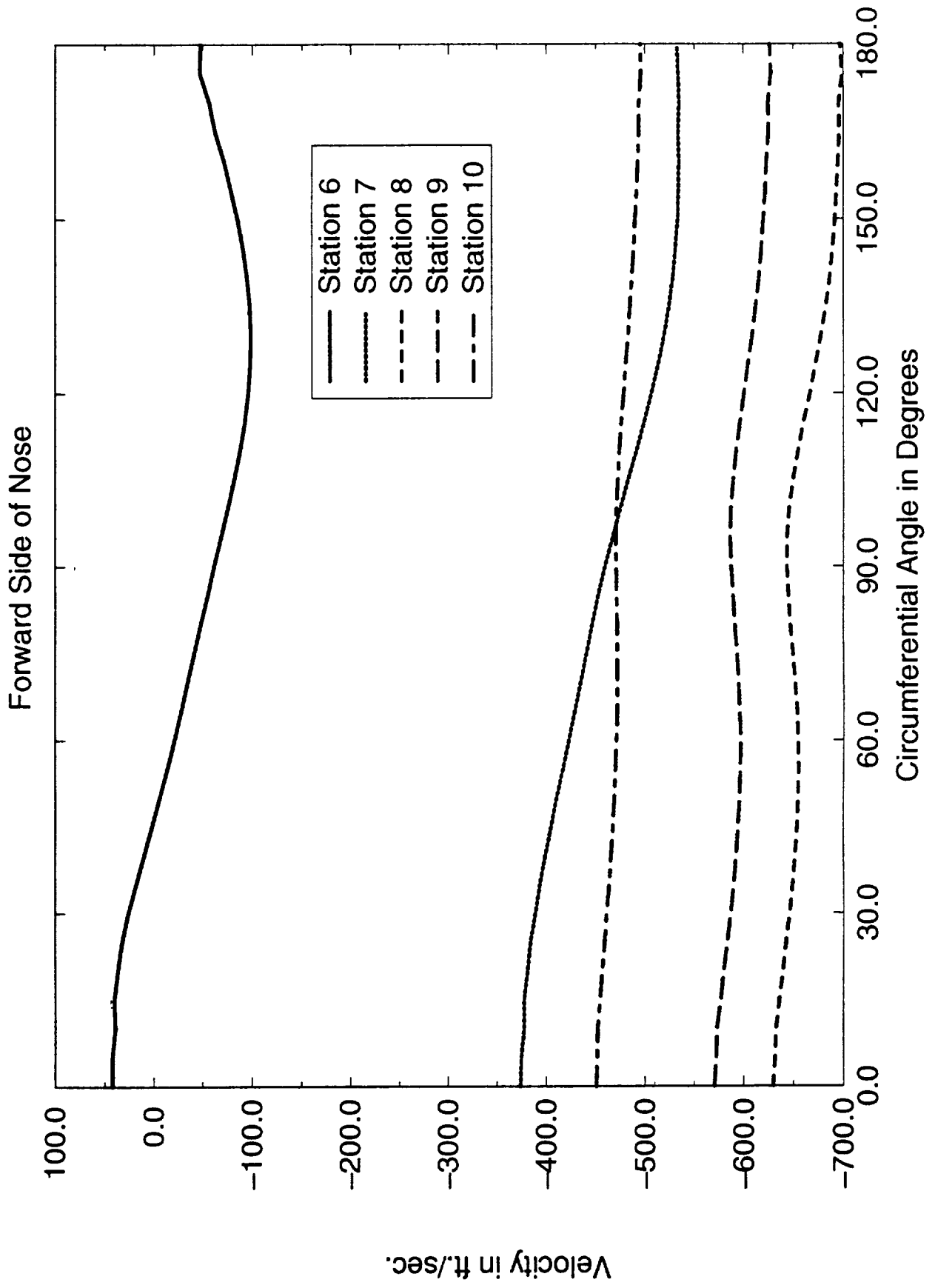
# Variation of Axial Velocity



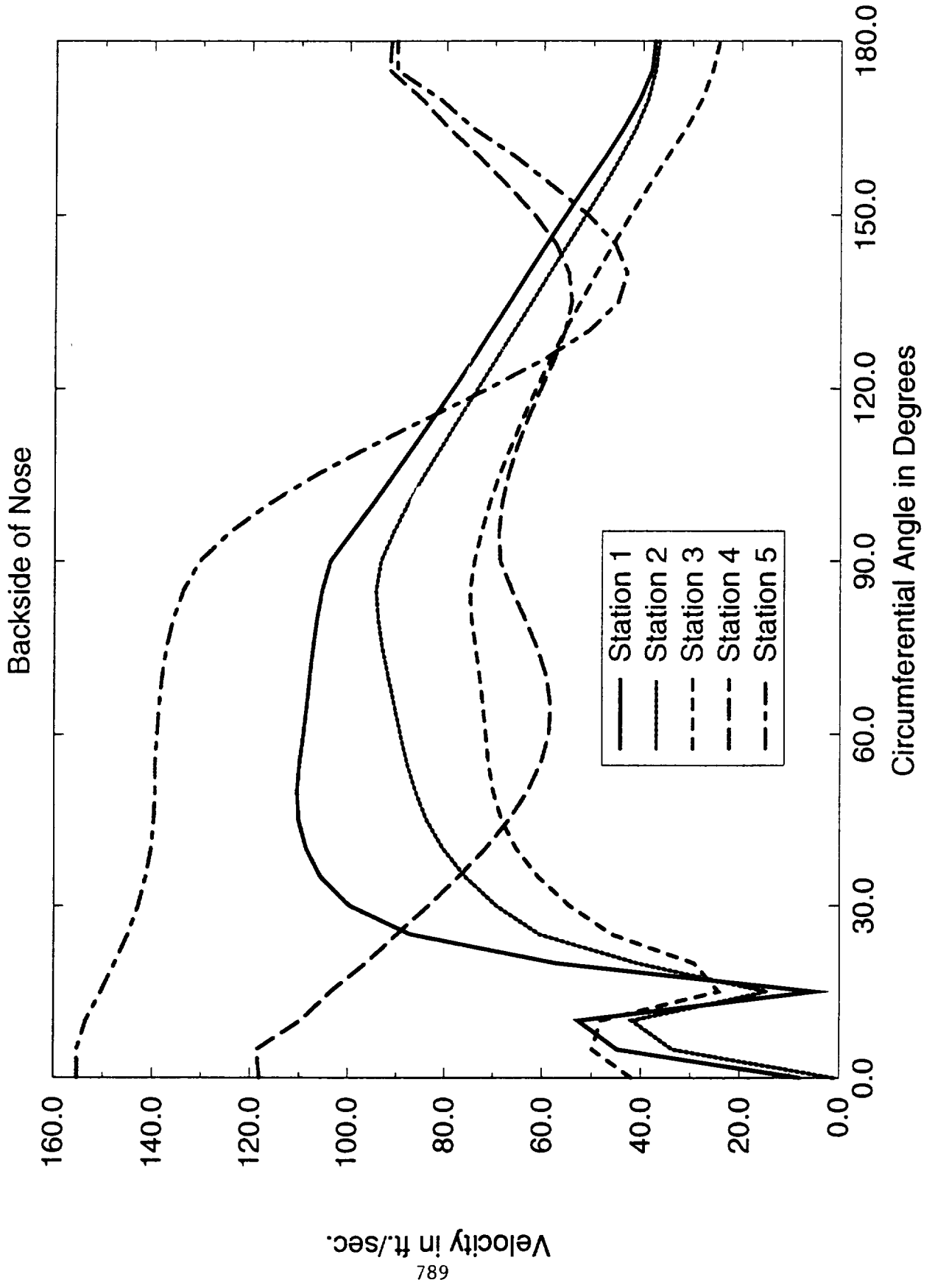
# Variation of Radial Velocity



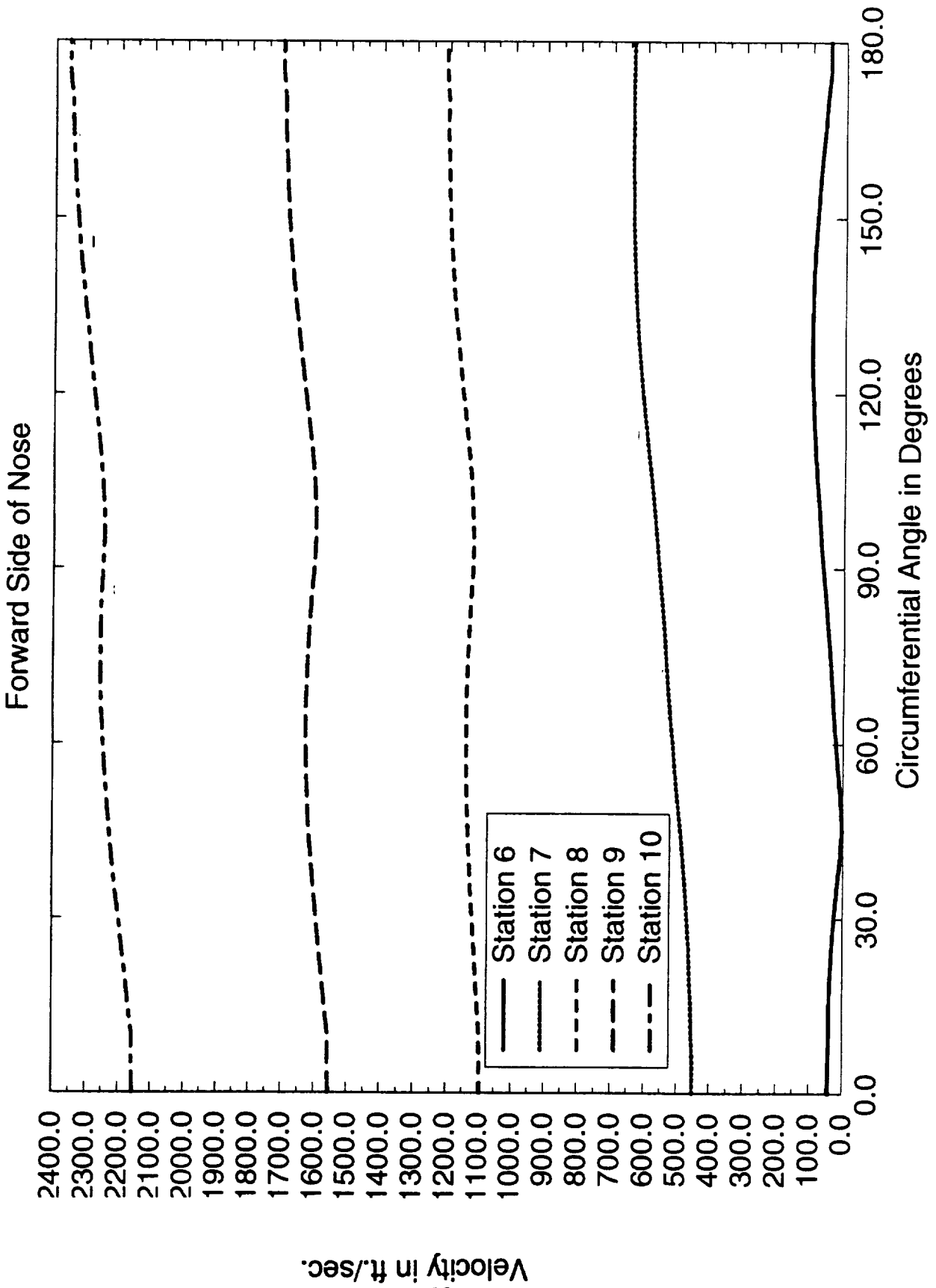
# Variation of Radial Velocity



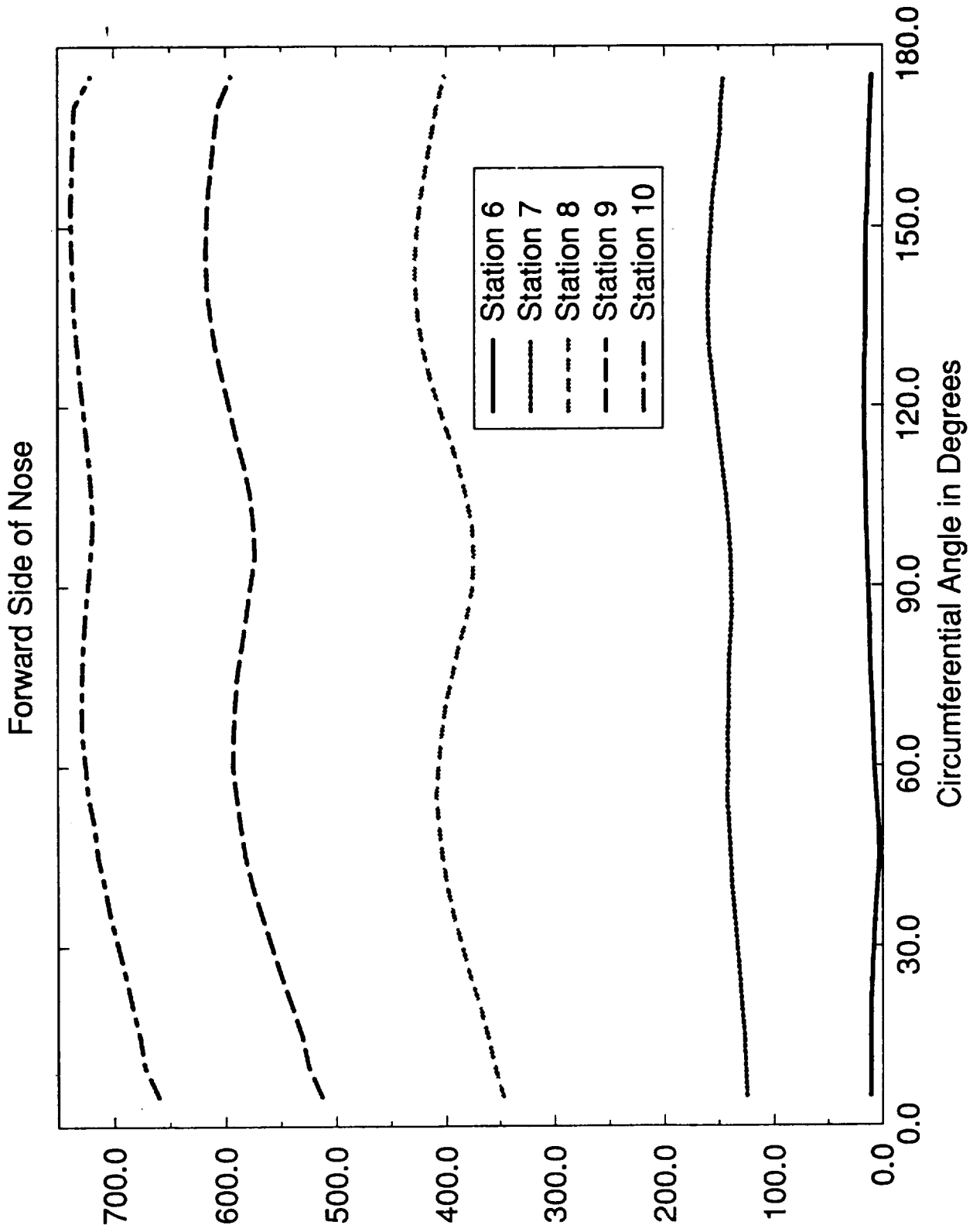
# Variation of Velocity Magnitude



# Variation of Velocity Magnitude



# Variation of Y+ Values



# Variation of Y+ Values

