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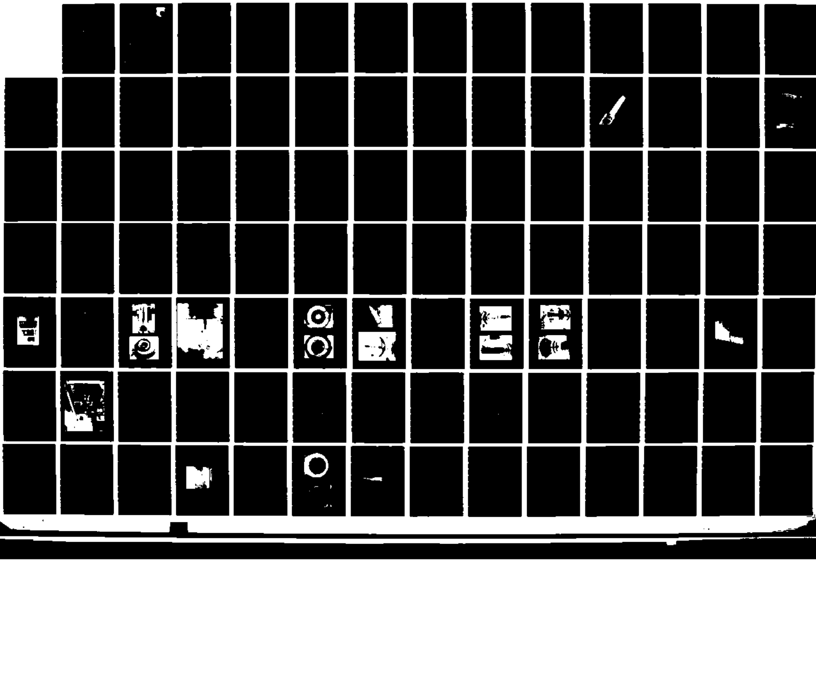

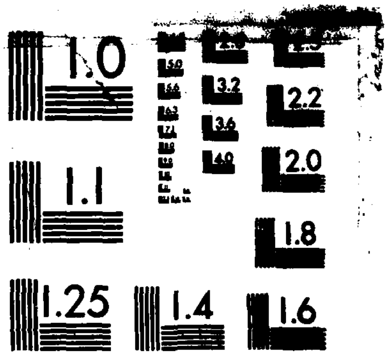

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COMPRESSOR RESEARCH FACILITY F100 HIGH PRESSURE COMPRESSOR INLET TOTAL PRESSURE AND SWIRL PROFILE SIMULATION

William W. Copenhaver

Technology Branch
Turbine Engine Division

~~September~~ October 1984

Report for Period December 1980 - November 1983

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A component test of the F100(3) high pressure compressor will be performed in the Compressor Research Facility (CRF) at Wright-Patterson Air Force Base. This report documents the efforts to obtain total pressure and swirl profiles for the test that corresponds to those that exist in an operational engine. The data acquisition methods and results of a test to obtain the engine profiles are detailed. The design and testing efforts to simulate these profiles through preswirl vanes and screens are also defined. The CRF F100 inlet hardware configuration detailed in this report provides adequate engine inlet profile

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TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Cont'd)

LIST OF ILLUSTRATIONS (Cont'd)

LIST OF ILLUSTRATIONS (Cont'd)

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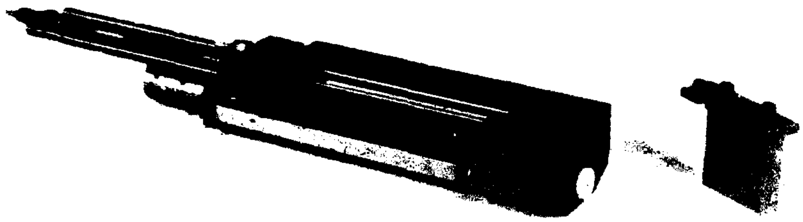


Figure 5. Traverse to Engine Interface Plate

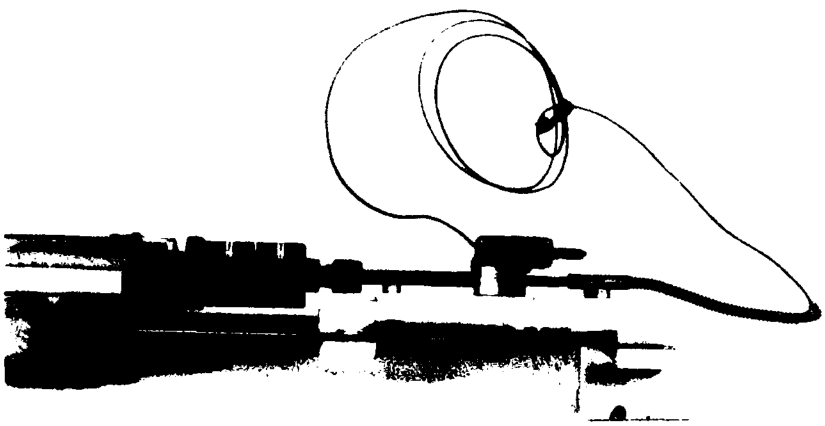


Figure 6. Probe to Traverse Alignment Plate

crews before it was tightened down onto the interface plate.

To assure the wedge probe was aligned with the traverse, two critical checks were made. First, the probe head was checked to assure it was perpendicular with the wedge edge. The procedure used to verify probe head alignment is detailed in Reference 4. Probe head-to-wedge alignment was assured to within $\pm$.1 minute. The second check involved aligning the probe head to the traverse. This was done through the use of another alignment bracket. This bracket slipped over the traverse slide guides and mated against the probe head, forcing it to the zero angle position, as shown in Figure 6. With these checks and procedures, overall flow angle measurement accuracy was $\pm$1 degree.

Pressure obtained from the wedge probe during testing were converted to DC voltages by Druck Model PDCR42 differential pressure transducers. Transducer pressure ranges were 0-1 psi, 0-15 psi and 0-50 psi for wedge probe measurements of P2-P3, P1-P2 and P1-PATM, respectively. The transducers were bench calibrated before testing to assure their characteristics were linear in the range of interest. The results of this bench calibration are shown in Table A-4, Appendix A. Excitation voltages for these transducers were maintained at 12 volts DC by Preston Model 8800 Universal Signal Conditioners. Amplification of transducer output signals were obtained through the use of Preston model 8300 XWB amplifiers. Gains were set to obtain output levels in the range of 0 to 5 volts DC.

To obtain on-line calibration of the pressure transducers, four Model J scanivalves were incorporated in the test system. Two transducers were referenced to atmospheric pressure, PATM, while one transducer was referenced to another scanivalve to measure differential pressure on the wedge probe. A schematic of the pressure measurement equipment is shown in Figure 7. A scanivalve solenoid controller, Model CTLR2/S2-S6, was used to control the common drive shaft of the four scanivalves. These valves were positioned to six different ports for each test condition. The order of sensing is shown in Table 1.

The calibration facility provided a 2-inch diameter free jet in the Mach number range of .17 to .50 at atmospheric static pressure. With the wedge probe set at a null position, the calibration results for CPT and CPS were 0.998 and 0.905, respectively, over the range of Mach numbers available. Details of the calibration results are shown in Table A-1, Appendix A. Results of the angle sensitivity calibration, shown in Table A-2, Appendix A, demonstrated that nulling of the probe during testing was obtained to within 0.5 degrees in the most severe misalignment case. In post test data reduction, the flow angle was corrected for this misalignment.

No calibrations were performed to determine the effects of probe-wall interactions or flow blockage by the probe. Although these errors do exist, as described in References 2 and 3, the ultimate test objective is to simulate the engine profiles in a compressor test where these interaction effects should be consistent.

The traversing and rotating of the wedge probe were remotely performed by a Northern Research and Engineering Corporation actuation system. Feed back signals from the system's potentiometers were used to record radial and angular positions of the probe. The probe actuator was calibrated to assure the accuracy of flow angle measurement and core duct radial position. Voltages from the potentiometer corresponding to traverse linear travel were correlated with the actual probe travel measured with a vernier caliper accurate to within .001 inch. The calibration results shown in Table A-3, Appendix A were linear within the range of travel; therefore, a straight line fit was used and calibration constants derived. The same procedure was followed for the traverse angular rotation. A protractor divided into .1 degree intervals provided for a calibration accuracy of $\pm$.1 degree. Through repetitive calibrations of the linear and angular potentiometers, repeatability was determined to be within $\pm$.0002 inch and $\pm$.5 degree, respectively. These accuracies were suitable for the program requirements.

Traverse to engine alignment methods were developed in an effort to maintain the accuracy required in flow angle measurement, as referenced to the engine axis. These methods required that an alignment plate, shown in Figure 5, be placed on the traverse to engine interface plate. The traverse was drawn up to this plate by cap

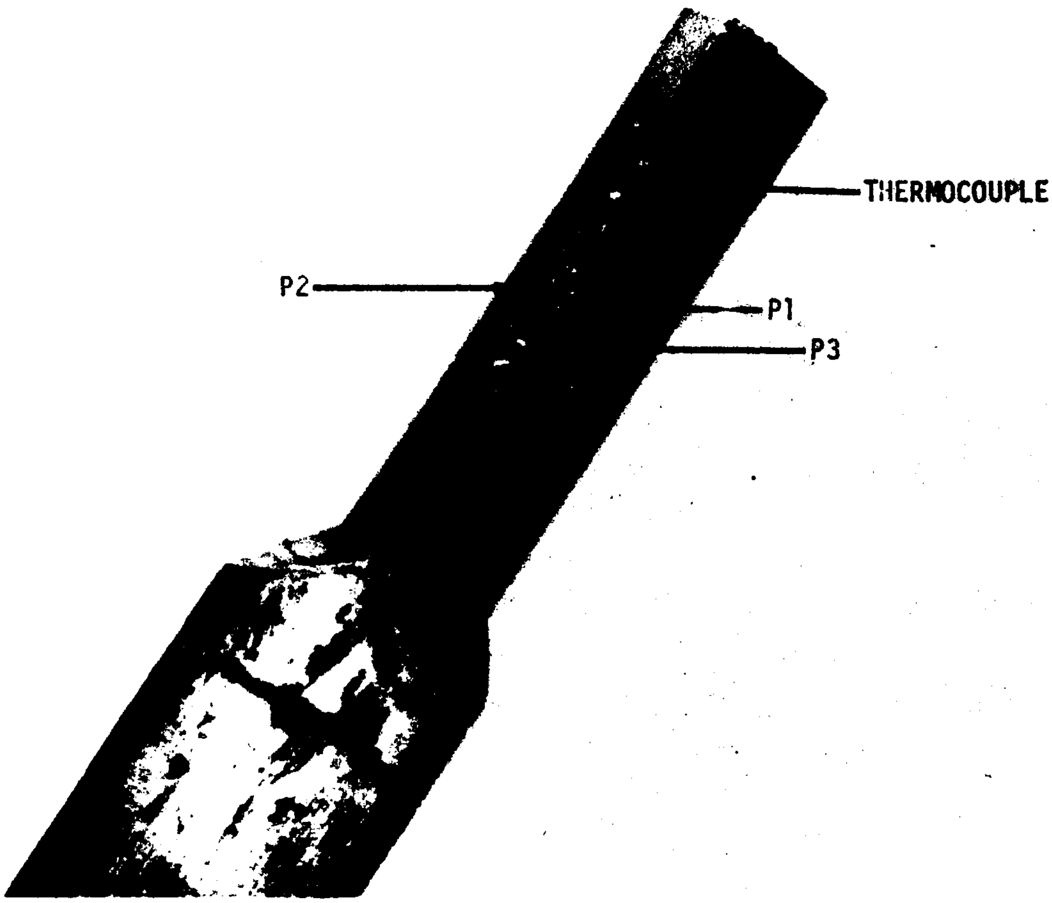


Figure 4. Wedge Probe Sensing Ports

connected to different channels of the scanner. These channels were read by the voltmeters by the scanner on command from the computer. Two digital channels were used to operate the scanivalve. The 3456A voltmeter is a six-digit integrating AC-DC digital voltmeter capable of storing up to 350 readings at a time. It also has a math option which allows it to determine maximum, minimum, average, and standard deviation of a given set of readings. This option was utilized in test data analysis. The 3456A was used for all pressure transducer calibrations and measurements. All data were printed out on-line by the HP 9871A printer.

The inlet profile pressures and temperatures were obtained thru a wedge probe sensing element. The probe used in the experiment was a .25-inch diameter United Sensor Model WT-250-25-Cu/C wedge probe. This probe senses one temperature and three pressures (P1, P2, and P3), as shown in Figure 4. The temperature was measured by a copper constantan thermocouple. P1 is proportional to the total pressure, while the average of P2 and P3 is proportional to the static pressure. The flow angle was determined by the nulling method. In this procedure, the probe was rotated so that each of the side ports read the same pressure. Flow direction is then determined from the physical position of the probe.

Prior to testing, the wedge probe was calibrated to determine its total and static pressure coefficients, CPT and CPS, which are defined as

$$CPT = \frac{P1 - PS}{PT - PS} \qquad (1)$$

and

$$CPS = \frac{(P1 - P2) + (P1-P3)}{2(PT - PS)} \qquad (2)$$

where PT and PS are the total and static pressure in the calibration nozzle. After engine testing, an additional calibration was performed to determine flow angle sensitivity, as there were difficulties in obtaining an absolute null position during portions of the test.

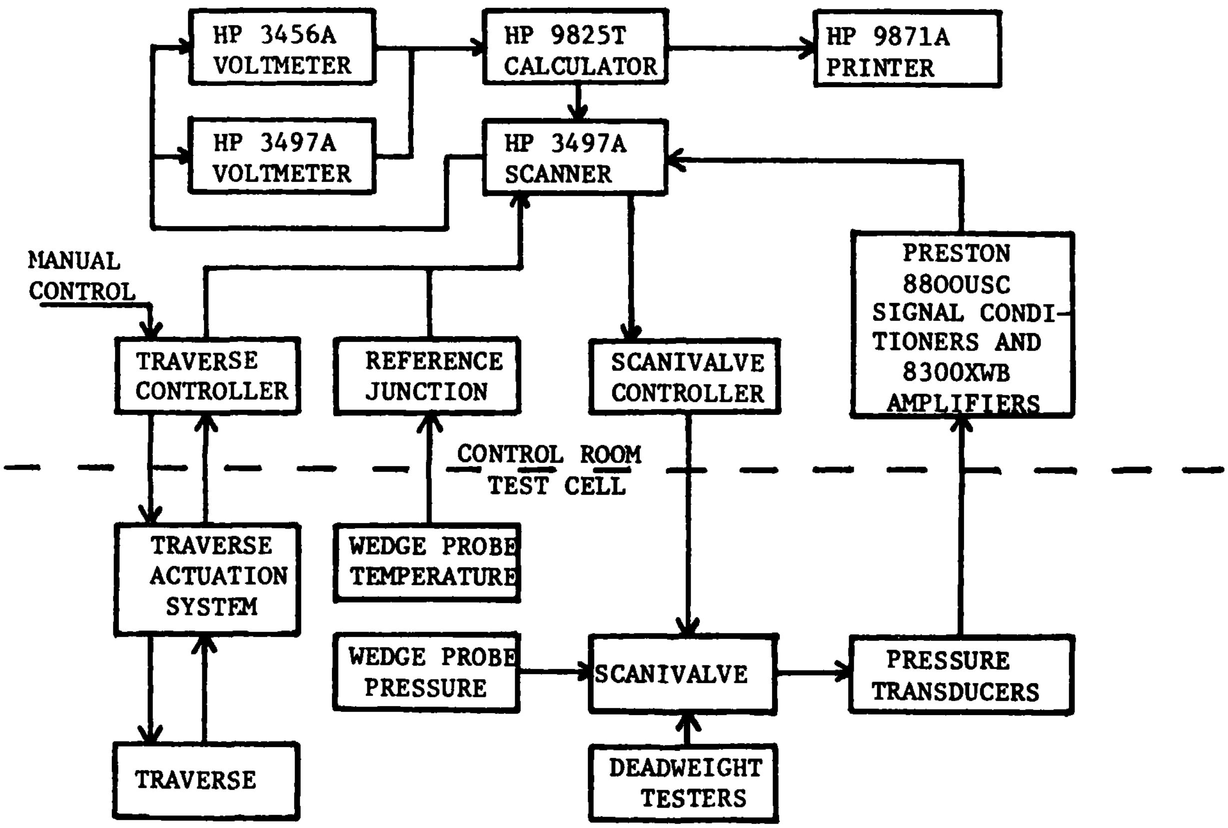


Figure 3. Schematic of Data Acquisition System

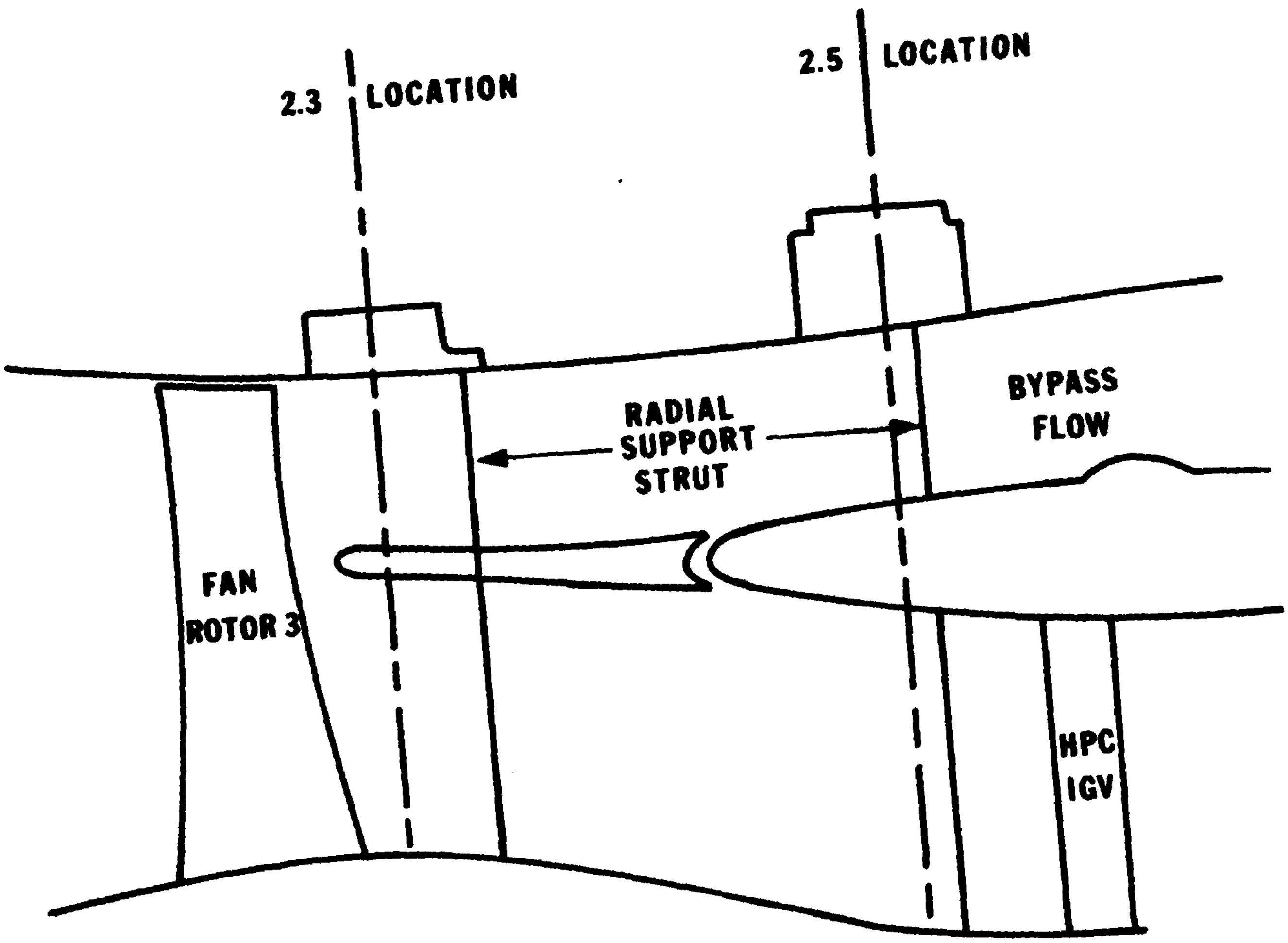


Figure 2. Schematic of Fan and Core Flow Path

SECTION II

ENGINE CORE INLET PROFILES

1. GENERAL REQUIREMENTS

This phase of the program involved the development of a transportable data acquisition system and measurement of F100(3) HPC inlet profiles with this system. (Ref. I) The test was performed at a test stand located at Pratt and Whitney Aircraft, Florida. The core compressor inlet profiles acquired were total pressure, static pressure, temperature and swirl angle. A cutaway of the F100 fan and core flow path investigated is presented in Figure 2. Shown in this figure are the two axial locations that were investigated. A wedge probe was traversed across the core flow to obtain the desired profiles at these two axial locations. Since the 2.5 location is further from the last rotor row of the fan (approximately four chord widths downstream), this position should have less time-varying pressure and temperature fluctuations associated with the rotating stages of the fan. For this reason, the 2.5 location was considered the primary position for measuring the time-averaged pressures and temperatures, while data obtained at station 2.3 were used for comparison.

2. DATA ACQUISITION SYSTEM

a. System Hardware

The data system hardware was selected for its high acquisition rate and modular design. These characteristics allowed for the required data to be obtained in a short period of time at a remote test site. A schematic of the data acquisition hardware is shown in Figure 3.

The data acquisition system consisted of a Hewlett Packard 9825T desk top computer, 3487A scanner, 3456A voltmeter, and a 9871A printer. The 9825T computer controlled the scanner and voltmeter by an IEEE 488 standard interface and the printer via a 16-bit parallel interface. In addition, the computer was used for on-line data reduction. The 3497A scanner has 20 analog data acquisition channels, 16 digital channels, an internal clock, and a built-in 5-1/2 digit integrating digital voltmeter. Four analog channels were used for data acquisition and two for measuring probe position. The three pressure transducers and the thermocouple were

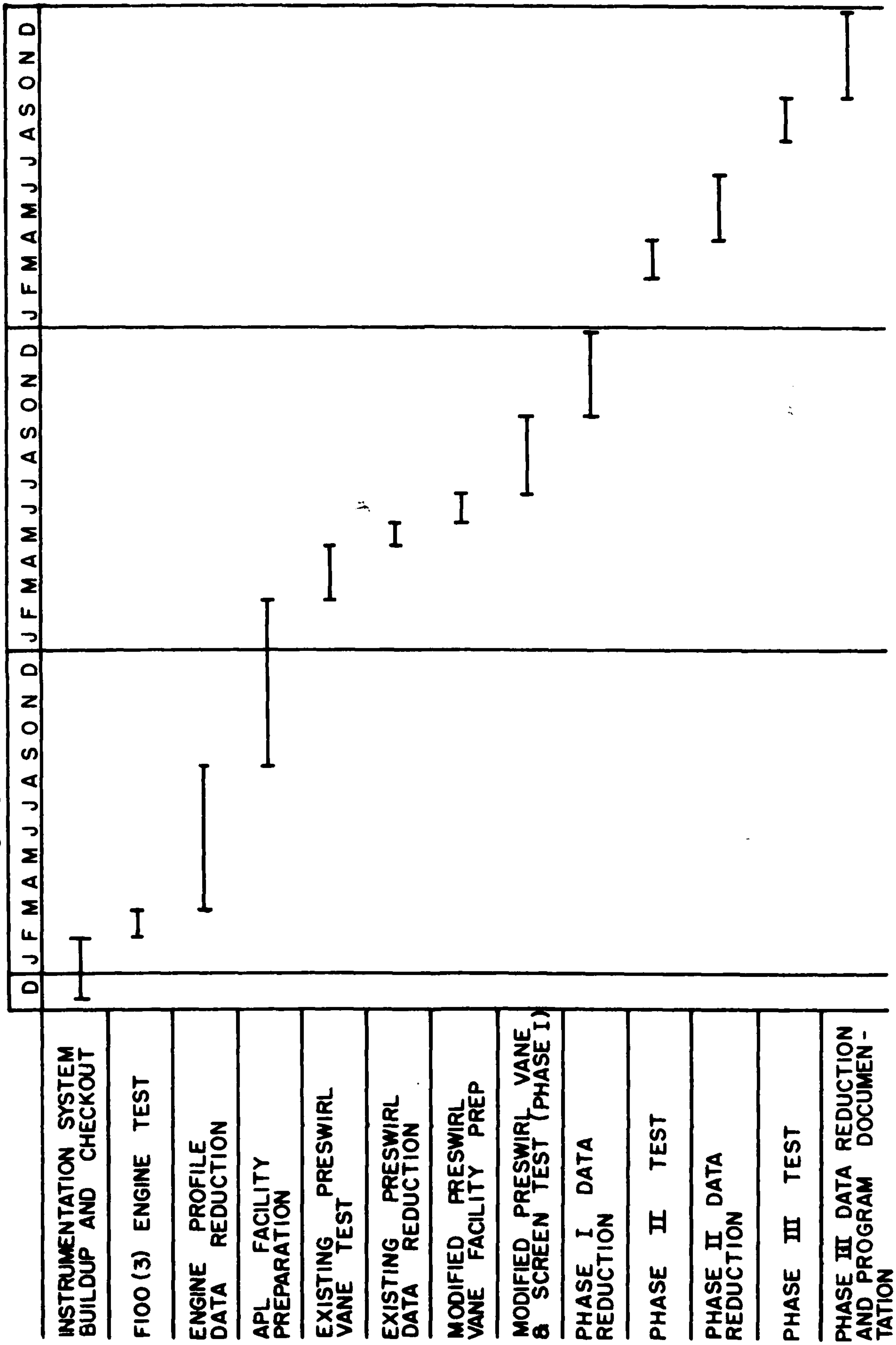


Figure 1. CRF/F100 Inlet Profile Verification Test Program Schedule

3. TEST SCHEDULE

The tests were completed over a period of 37 months, starting December 1980. The five tests progressed as shown in Figure 1.

SECTION I

INTRODUCTION

1. GENERAL

The F100 gas turbine engine currently powers the Air Force F-15 and F-16 aircraft. The compression section of this engine consists of a three-stage fan followed by a ten-stage High Pressure Compressor (HPC). A component test of the F100 HPC will be performed in the Compressor Research Facility (CRF) of the Aero Propulsion Laboratory (APL) at Wright-Patterson Air Force Base, to investigate its stall and post stall characteristics. This testing will require that the high pressure compressor entrance profiles be simulated to obtain results which correspond to actual engine operation. Since these entrance profiles had never been measured, a program was designed to experimentally measure the total and static pressure, temperature and flow angle profiles at the HPC entrance of an F100 Series 3 engine (F100 (3)), (S/N P072).

The measured profile data were then used as design data for a set of inlet screens and vanes. These vanes and screens will simulate the engine fan discharge profiles for the HPC test. The manufactured screens and vanes were tested in Room 24 of Building 18 of the Air Force Wright Aeronautical Laboratories to verify their simulation capabilities. Five separate test periods were necessary to achieve the program goals. These tests are described in Sections II thru VI. The program discussion and conclusions are presented in Section VII and VIII.

Additional keywords; F-100 engine; aerodynamic tests; Swirler vanes; inlet guide vanes; preswirl vanes

2. PROGRAM OBJECTIVES

The program objectives were to measure the actual F100 engine HPC inlet pressure profiles within ± 1 percent and swirl angle profiles within ± 1 degree. With these results as input data, a set of screens and vanes were designed and manufactured by Pratt & Whitney Aircraft (P&WA) as part of the overall CRF F100 contract. The screens and vanes designed were tested to determine if the profiles they produce meet the goal of the CRF F100 contract: to simulate actual engine HPC inlet profiles during the CRF component test. This will assure that test results can be compared to engine performance results.

LIST OF SYMBOLS (Concluded)

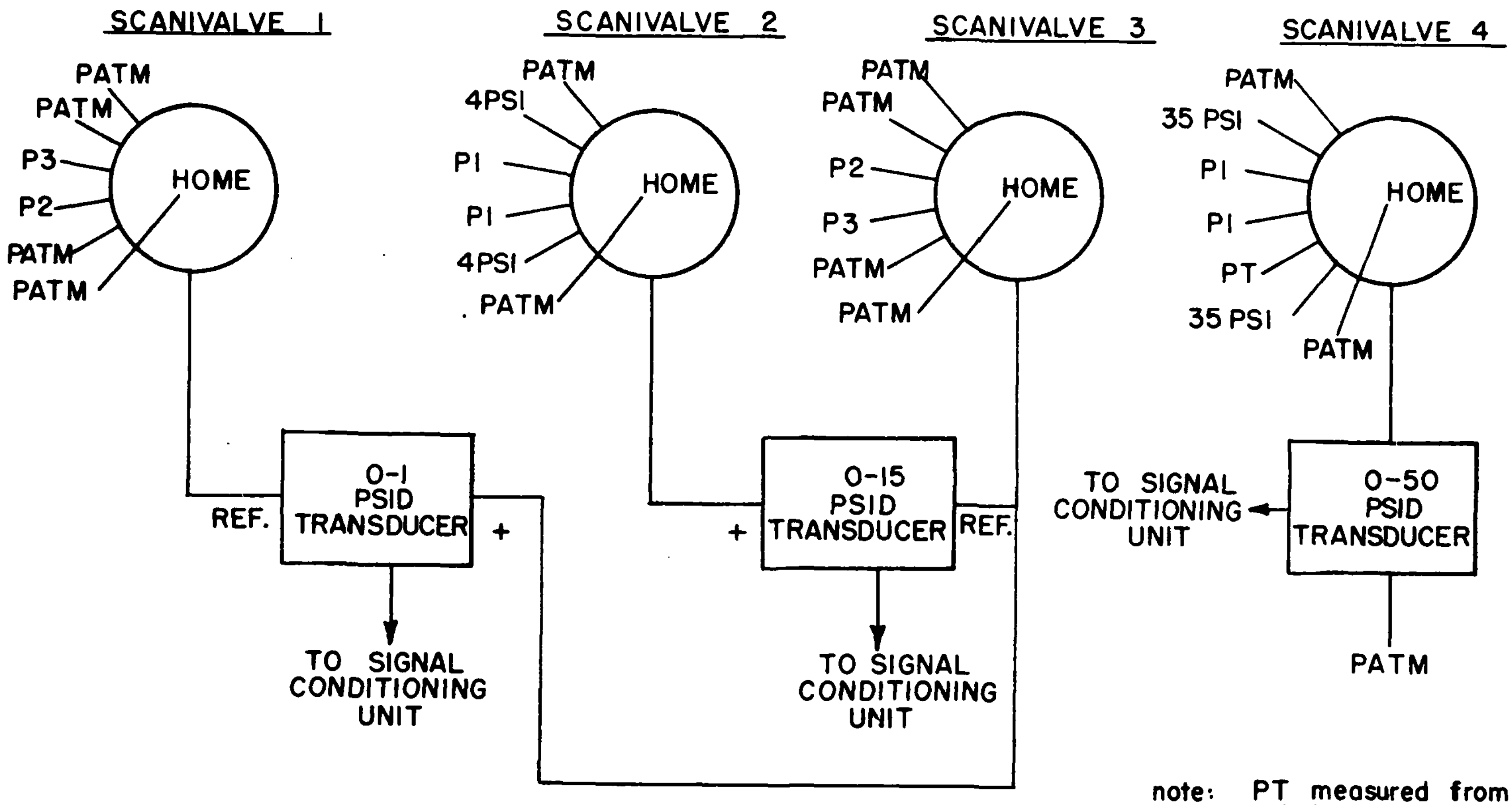
α_2^*	Blade Inlet Angle
α_3^*	Blade Outlet Angle
α_3'	Air Outlet Angle
α_{ch}	Blade Chord Angle
γ	Ratio of Specific Heats for Gas Mixture
θ^*	Blade Camber Angle
θ'	Turning

LIST OF SYMBOLS

A	Area
A_1	Amplifier Gain (Transducer 1)
b	Chord Length
CPS	Static Pressure Coefficient
CPT	Total Pressure Coefficient
E_o	Amplifier Output Voltage
$E_{o f}$	Amplifier Offset Voltage
E_s	Transducer Supply Voltage
E_t	Transducer Output Voltage
g_c	A Constant that Relates Force, Mass, Length, and Time
LER	Leading Edge Radius
M	Mach Number
$\dot{m}$	Mass Flow Rate
$\dot{m}_{corr}$	Corrected Mass Flow Rate
P1	Wedge Probe Total Pressure
P2	Wedge Probe Side Face Pressure (Left)
P3	Wedge Probe Side Face Pressure (Right)
P4	Bellmouth Wall Static Pressure
P5	Station 2.5 O.D. Wall Static Pressure
P6	Total Pressure at Station 2.5 (Rake)
PATM	Atmospheric Pressure
PS	Static Pressure
PT	Total Pressure
$P_{T_{avg}}$	Average Spanwise Total Pressure
R	Gas Constant for Air
S	Sensitivity of Transducer
t	Blade Thickness
TER	Trailing Edge Radius
TT	Total Temperature
U	Uncertainty
V	Volume

LIST OF ILLUSTRATIONS (Concluded)

LIST OF TABLES



note: PT measured from existing engine core flow probe.

Figure 7. Pressure Measurement Schematic

TABLE 1 - ORDER OF PRESSURE MEASUREMENT

Measurement Order	Transducer		
	0-1 psid	0-15 psid	0-50 psid
1	0 psid	0 psid	0 psid
2	0 psid	4 psid	35 psid
3	P3-P2	P1-P2	PT-PATM
4	P2-P3	P1-P3	P1-PATM
5	0 psid	4 psid	35 psid
6	0 psid	0 psid	0 psid

The scanivalve remained on a port for five seconds in order to stabilize the pressure in the system. After this stabilization time, 36 scans of the transducer output were recorded and averaged by the acquisition system. The scheme in Table 1 provided for a zero point calibration of the 0-1 psid transducer and a two-point calibration of the 0-15 and 0-50 psid transducers before and after the transducers were exposed to the test ports.

A zero point calibration of the 0-1 psid transducer was performed since this transducer was used to align the probe with the flow direction by nulling the pressure difference between the side ports of the wedge probe. A two-point calibration of the other two transducers was performed to eliminate bias due to transducer drift that might occur during testing. Calibration pressures of 4 and 35 psig were supplied by two Model MK100 pneumatic deadweight testers. Two of these calibrations were performed for each test condition to determine if a transducer drifted during the test measurement.

b. System Software and Data Reduction

The complete data acquisition process was preprogrammed on the HP 9825T calculator. The system software commanded opening and closing of relays necessary to convey information to and from the data acquisition hardware. The program measured traverse positions, transducer calibration values, probe pressures and probe temperatures. With this information, transducer calibration coefficients and reduced parameters of temperature, total pressure, static pressure, Mach number, and swirl angle were calculated. The program provided a printout of reduced data in engineering units as they were obtained during testing, thus minimizing the need for post test data reduction.

The first step of the reduction program was to obtain a straight line transducer calibration from the on-line calibration. Details of this procedure are shown in Appendix A. After the two calibrations (one before data acquisition and one after) were compared and no appreciable change was evident, the data reduction was continued. The raw data in volts were then reduced to actual probe pressures (P1-PATM, P1-P2, P1-P3, P2-P3) and temperatures. These pressures were then converted to profile pressures using calibration coefficients obtained in previous probe calibrations. The total and static pressures and Mach number of the free-stream airflow were calculated from the following relations.

Static Pressure

From Equation 2

$$\mathrm{PT-PS} = \frac{\mathrm{(P1-P2) + (P1-P3)}}{\mathrm{2(CPS)}} \tag{3}$$

where P1, P2, P3 are probe measured pressures indicated in Figure 4. Also from Equation 1:

$$\mathrm{PS = P1-CPT \times (PT-PS)} \tag{4}$$

Since P1 is not measured directly, the equation must be rewritten as follows:

$$\mathrm{PS = (P1-PATM) - CPT \times (PT-PS) + PATM} \tag{5}$$

The final form is found by substituting Equation 3 into Equation 5.

$$\mathrm{PS = (P1-PATM) - CPT \times \frac{(P1-P2) + (P1-P3)}{2(CPS)} + PATM} \tag{6}$$

Total Pressure:

$$\mathrm{PT = PS + (PT-PS)} \tag{7}$$

Substitute Equation 3 into this identity:

$$\mathrm{PT = PS + \frac{(P1-P2) + (P1-P3)}{2(CPS)}} \tag{8}$$

Combining this with Equation 6

$$PT = (P1-PATM) + \frac{(P1-P2) + (P1-P3)}{2(CPS)} (1-CPT) + PATM \tag{9}$$

Mach Number

The Mach number is calculated assuming isentropic ideal gas conditions from the following equation:

$$M = \left\{ \frac{2}{\gamma-1} \left[\left(\frac{PT}{PS} \right)^{\gamma-1/\gamma} - 1 \right] \right\}^{1/2} \tag{10}$$

The data acquisition software flow chart detailing the steps taken and decisions made during the test is shown in Figure 8. A complete program listing is shown in Appendix A.

c. Data System Uncertainty and Verification

The data system was optimized to obtain a theoretical acquisition uncertainty of ± 1 percent over the range of total and static pressures measured by the probe sensing ports. The total and static pressures measured by the wedge probe ranged from 18 to 46 psi and 17 to 34 psi, respectively. The data uncertainty analysis involved the development of uncertainty criteria for the system defined as a function of component uncertainties and weighting functions, as described in Reference 5. During the development of the data system, it was determined that an on-line calibration of the pressure transducers was required to reach the goal of ± 1 percent uncertainty over the complete range of measured pressures. Data uncertainty for the system described in Section VI.2.a is shown in Table 2 for pressures in the range of interest with an on-line calibration and a maximum of $2^{\circ}C$ change in temperature between calibration times. Details of the uncertainty analysis procedure are given in Appendix B.

The correct operation of the data system was verified by placing known pressures on the wedge probe tubing for P1 thru P3. These pressures were supplied by a dead-weight tester. The reduced data printed out were crosschecked with the pressure input to assure proper function of the data acquisition system. The system

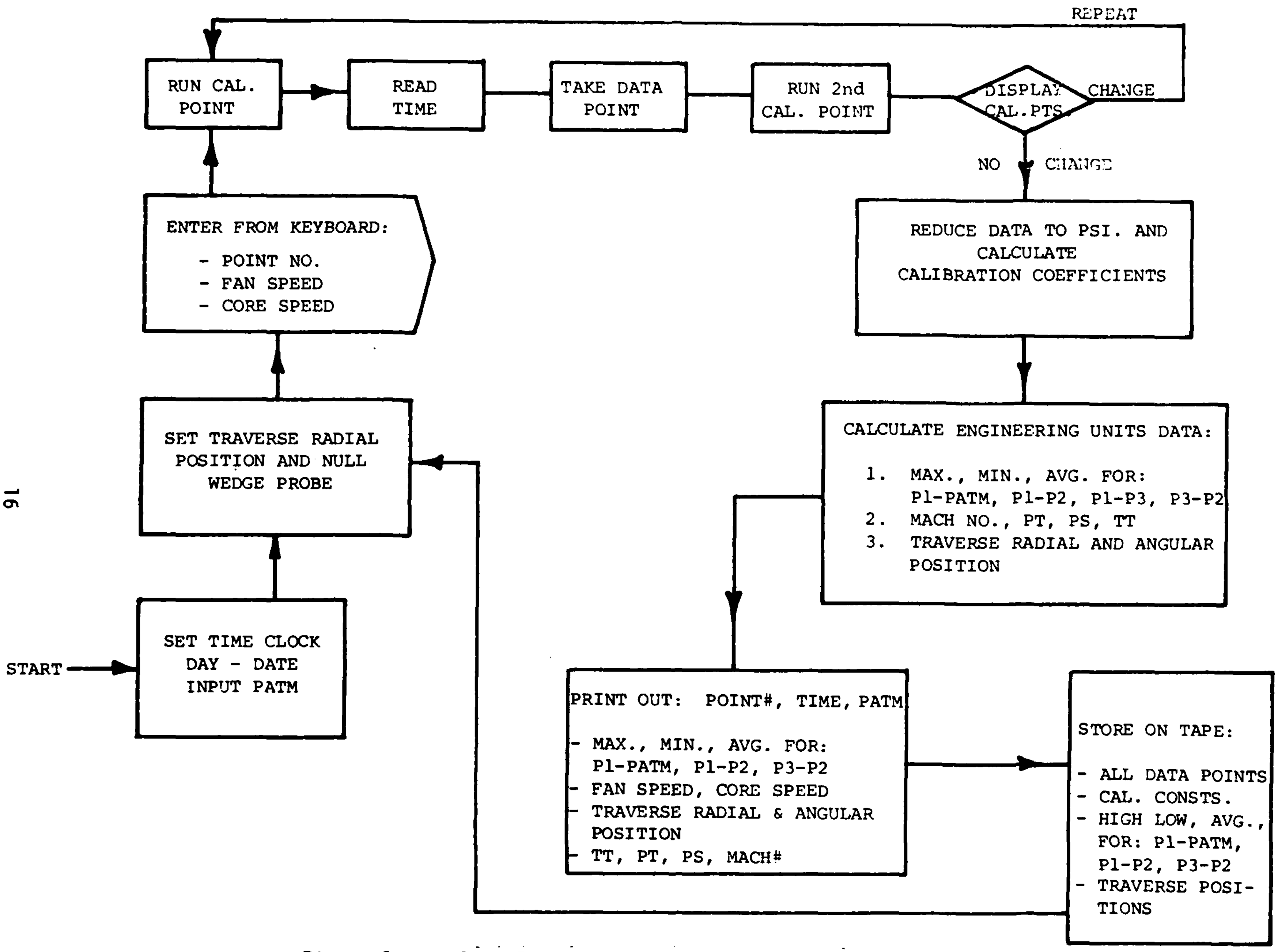


Figure 8. Hewlett Packard 9825T Data Acquisition System Flow Chart

TABLE 2

DATA ACQUISITION SYSTEM UNCERTAINTY

Total Pressure Psig	Uncertainty (Percent of Reading)	Static Pressure Psig	Uncertainty (Percent of Reading)
2.26	2.3	1.75	3.1
4.52	1.2	3.33	1.8
6.26	1.0	3.97	1.7
10.45	.7	6.95	1.2
12.91	.6	8.85	1.0
16.24	.5	11.52	.9
18.57	.5	13.05	.8
20.23	.4	14.40	.8
21.56	.4	14.85	.9
24.23	.5	15.74	1.0
26.89	.5	17.07	1.0
29.55	.5	18.40	1.0
30.88	.5	19.11	1.0
32.21	.4	20.18	1.0
33.55	.5	20.18	1.0
36.21	.5	21.73	1.0

produced reduced data for the dead-weight tester input pressure within the uncertainty of ±1 percent. This verification was performed over the complete range of pressures to be measured.

3. DATA ACQUISITION

The data acquisition system was transported to Pratt and Whitney Aircraft Group, Government Products Division. The test was undertaken at one of the sea level engine test stands at P&WA. The engine used in the test was an F100(3), Serial Number P072. The traverse actuation system was installed on the engine at the 2.5 station, and the wedge probe was inserted and aligned. The remainder of the data acquisition system was prepared for the test in a temporary data acquisition room next to the the test cell. After all data system preparations and engine check-outs were completed, testing began.

The test plan was to acquire 12 data points across the span of the core duct at the 2.3 and the 2.5 positions, as described in Figure 9 and Table 3. These traverses were duplicated for fan speeds of 9,500, 8,500, 6,500 and 4,500 RPM. When the engine had stabilized at the desired speed, the data taking process began by translating the wedge probe to the desired position. A schedule for these positions is shown in Table C-1, Appendix C. The wedge probe was then rotated until a zero difference was achieved between pressures P2 and P3. Nulling was performed with the use of a direct reading digital voltmeter. To initialize the data acquisition program, atmospheric pressure and temperature, engine fan and core speed were entered into the Hewlett Packard 9825T calculator. At the start of the program, the traverse positions and wedge probe total temperature were initially measured. The calculator then controlled the scanivalve to obtain the pressures shown in Table 1. After the pressure data were recorded, the traverse position and wedge probe temperature were again measured to determine if any changes had occurred during the data acquisition. The calibration constants obtained before and after the data measurements were compared to each other and to off-line calibration constants measured before the experiment. If this comparison was to within .05 percent of slope and intercept, the data were accepted and the calculator would reduce the data to engineering units. The following reduced data were printed out on-line after each point.

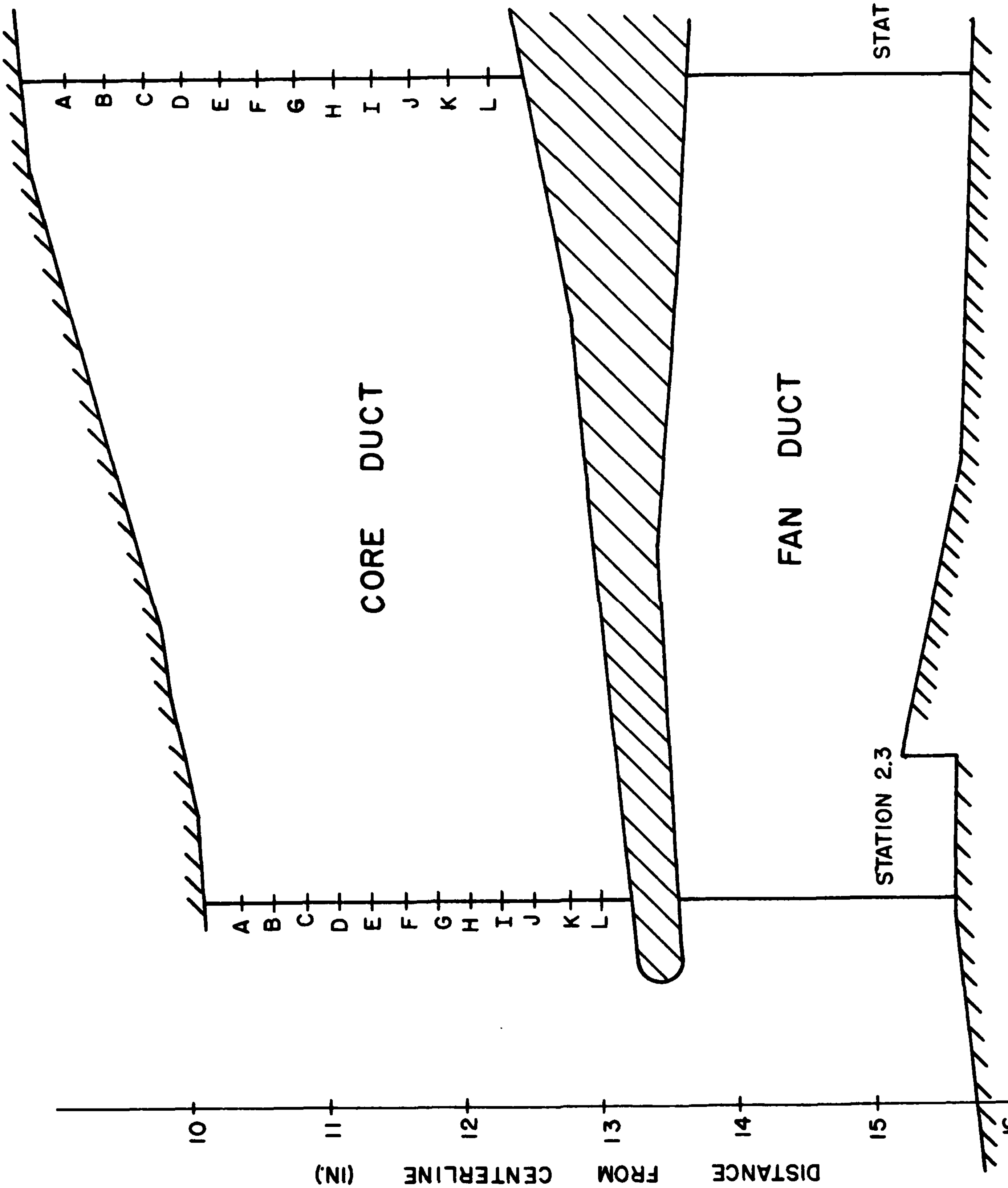


Figure 9. Spanwise Measurement Locations

TABLE 3

RADIAL LOCATION FOR TRAVERSE PROBE STOPS

	Station 2.3 Distance from Centerline in.	Station 2.5 Distance from Centerline in.
I.D.	10.09	8.75
"A"	10.332	9.034
"B"	10.575	9.318
"C"	10.817	9.602
"D"	11.059	9.885
"E"	11.302	10.169
"F"	11.544	10.453
"G"	11.786	10.737
"H"	12.028	11.021
"I"	12.271	11.305
"J"	12.513	11.588
"K"	12.755	11.872
"L"	12.998	12.156

- Time of day - obtained from internal clock
- Date
- Point Number
- Patm
- Maximum/minimum/average for P1-Patm, P1-P2, P1-P3 in psid
- Fan and core speed.
- Traverse radial position and degree of rotation and their respective percent changed during data taking
- TT, PT, PS, Mach Number, Swirl Angle

During each data point, the program stored the following on tape:

- All individual points
- Both sets of calibration constants
- Values printed out in the short form printout mentioned above

The procedure, starting with translating the wedge probe, was then duplicated for all 12 positions of the core inlet span. When a complete traverse was accomplished, the engine speed was changed and allowed to stabilize. The complete process of acquiring the traverse points was repeated. This was done for four engine speeds at the 2.5 position and two engine speeds at the 2.3 position. Time constraints forbid acquisition of data at the two other engine speeds for the 2.3 position.

The total time required to obtain the 72 data points was approximately six hours. No unforeseen problems were encountered during the data acquisition phase of this test.

4. RESULTS AND DISCUSSION

The high pressure compressor entrance profiles measured during the experimentation are shown in Figures 10 through 21. The tabular data obtained in this test are presented in Tables C-2 and C-3, Appendix C. For each plotted parameter, there are four profiles shown for measurements at the 2.5 location. In addition, two profiles taken at 2.3 location of that same parameter are shown for comparison.

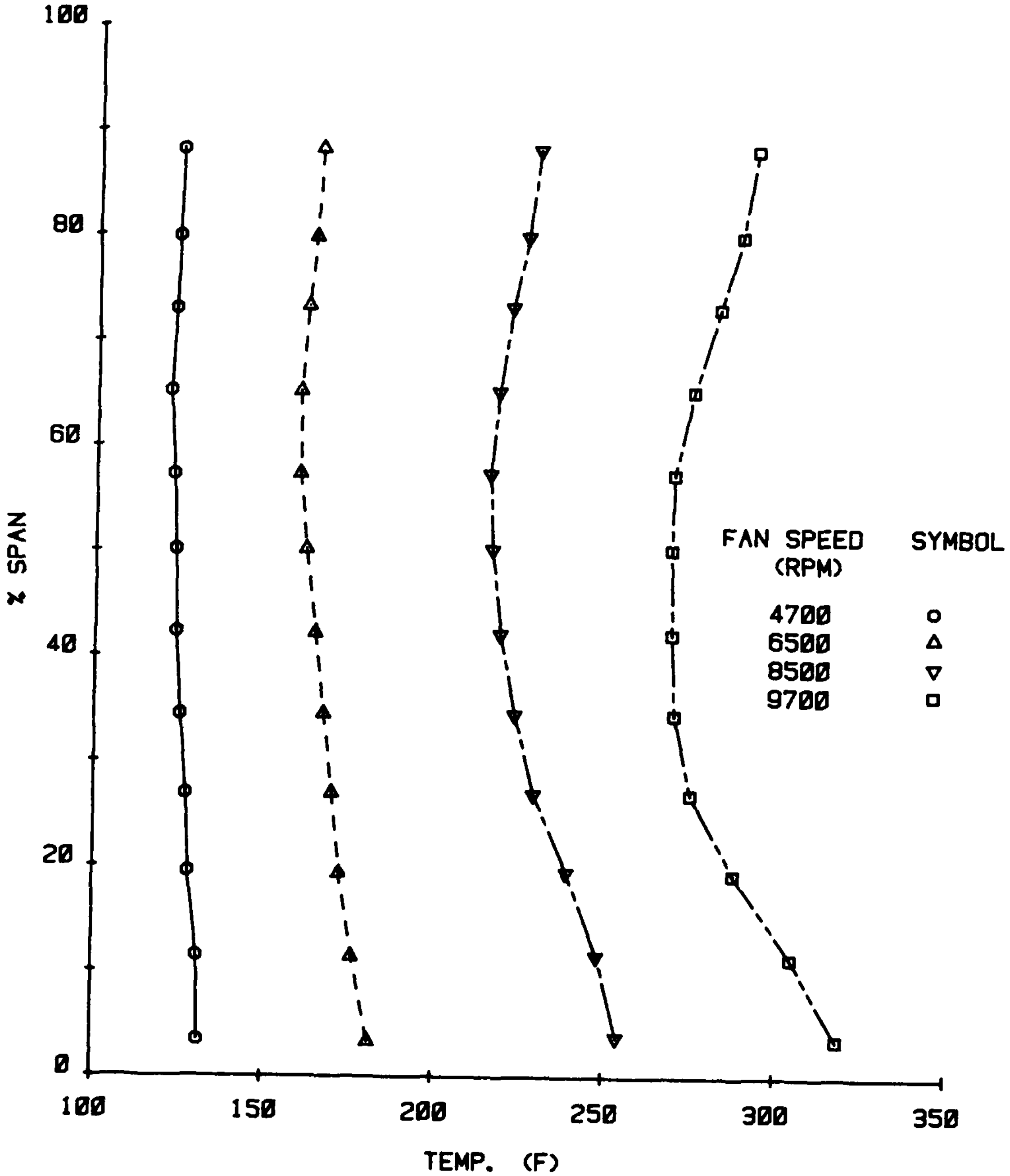
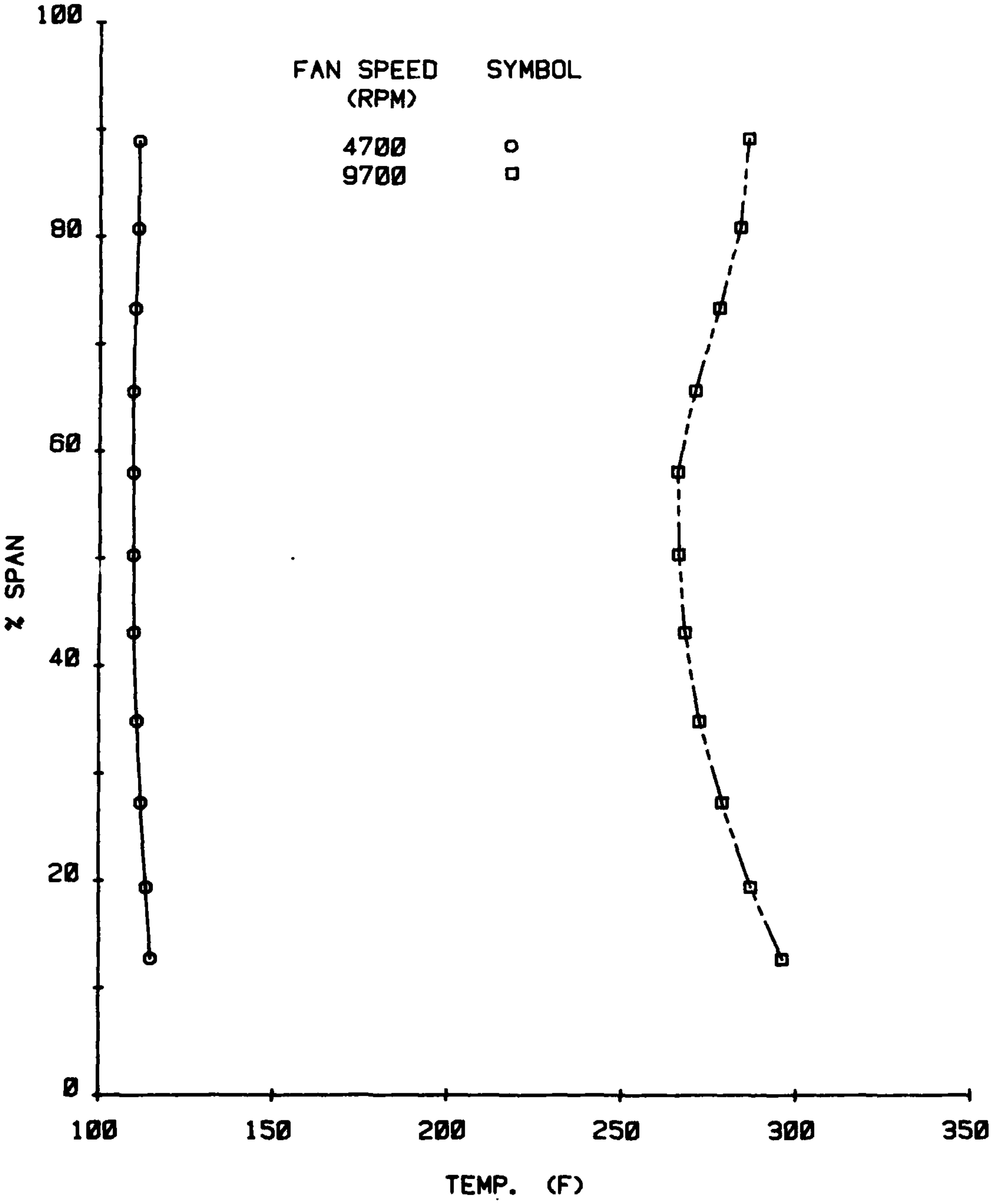
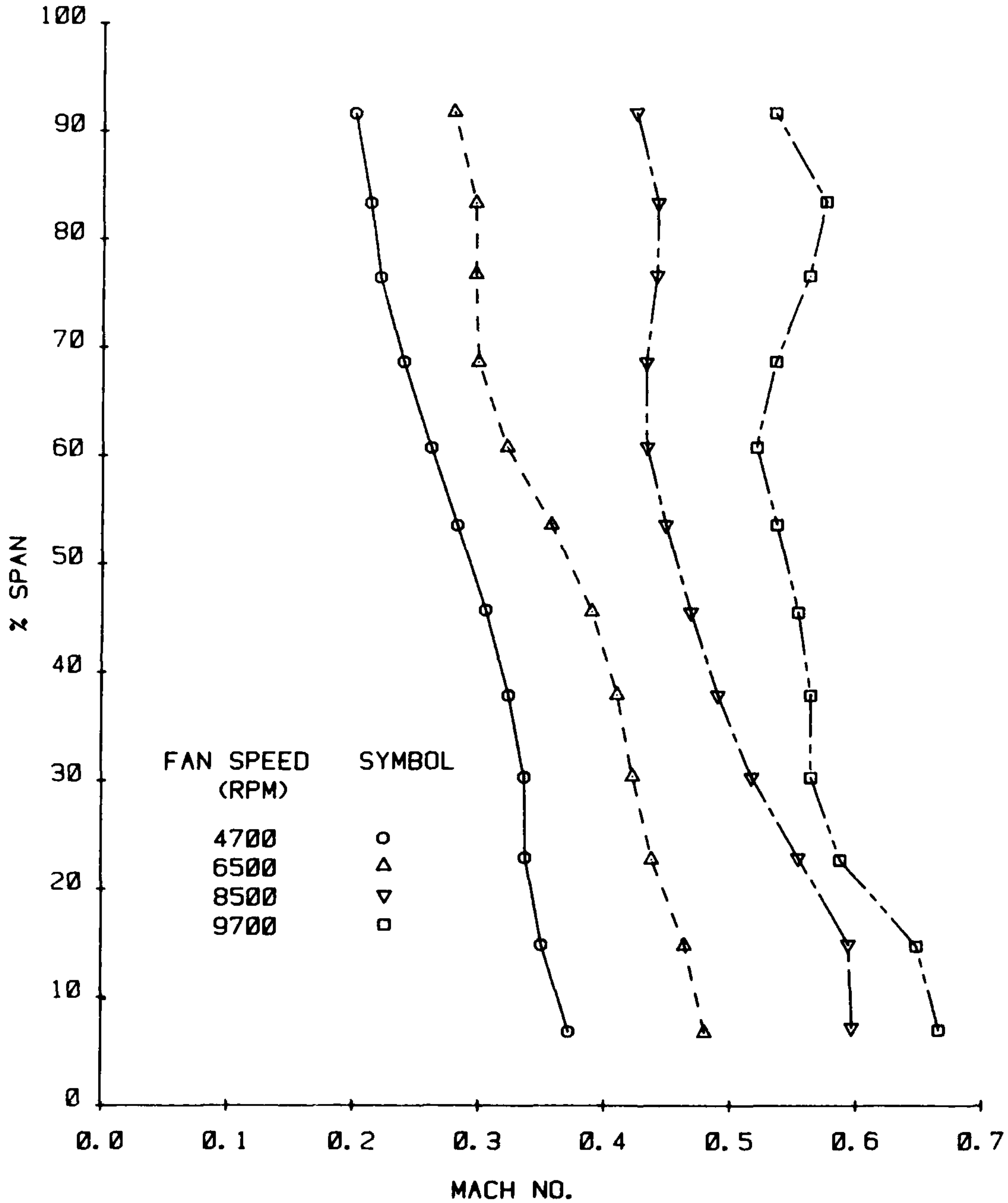


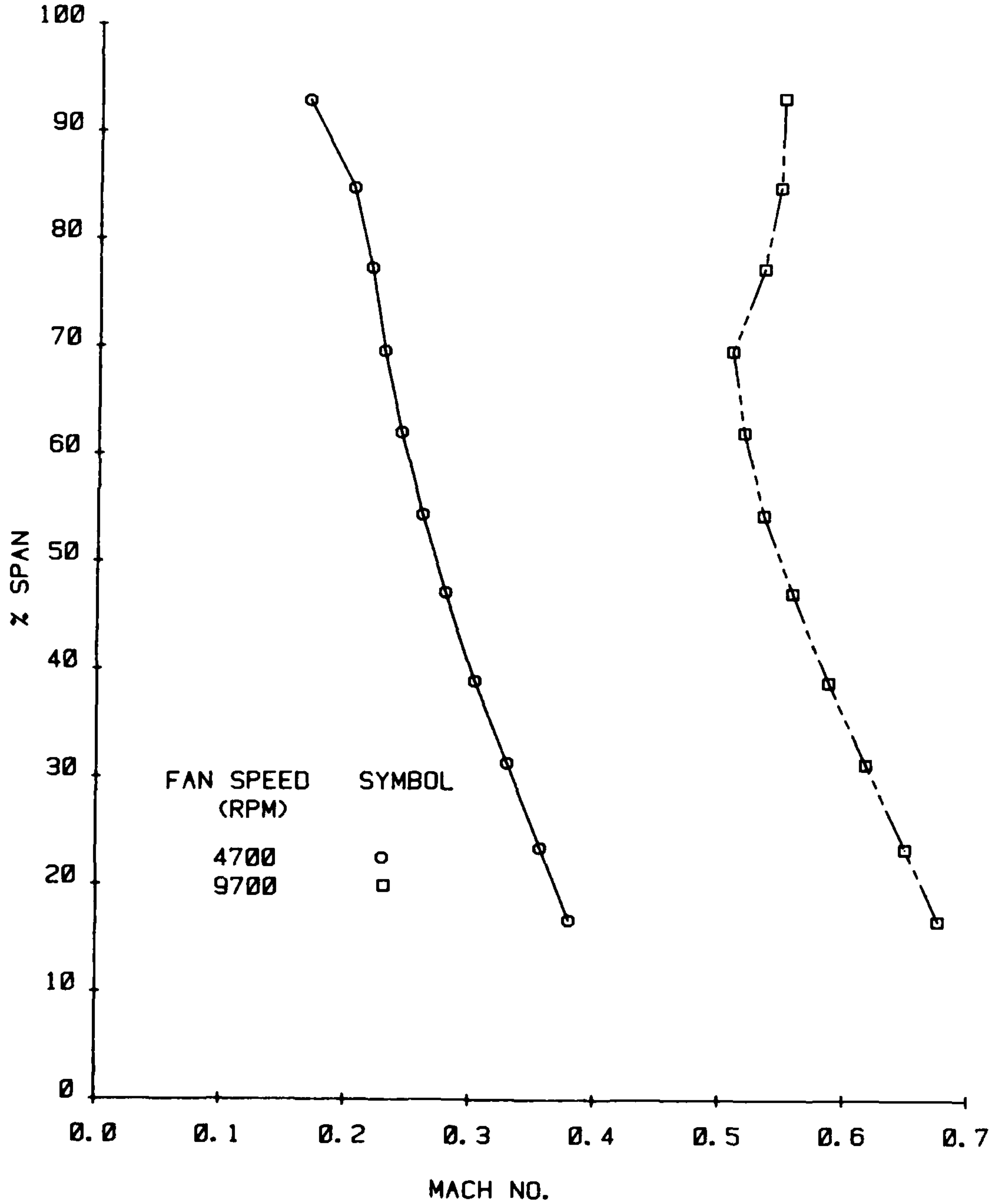
Figure 10. Core Entrance Profile of Temperature at Station 2.5 in F100(3) Engine P072



igure 11. Core Entrance Profile of Temperature at Station 2.3 in F100(3) Engine P072



gure 12. Core Entrance Profile of Mach Number at Station 2.5 in F100(3) Engine P072



jure 13. Core Entrance Profile of Mach Number at Station 2.3 in F100(3) Engine P072

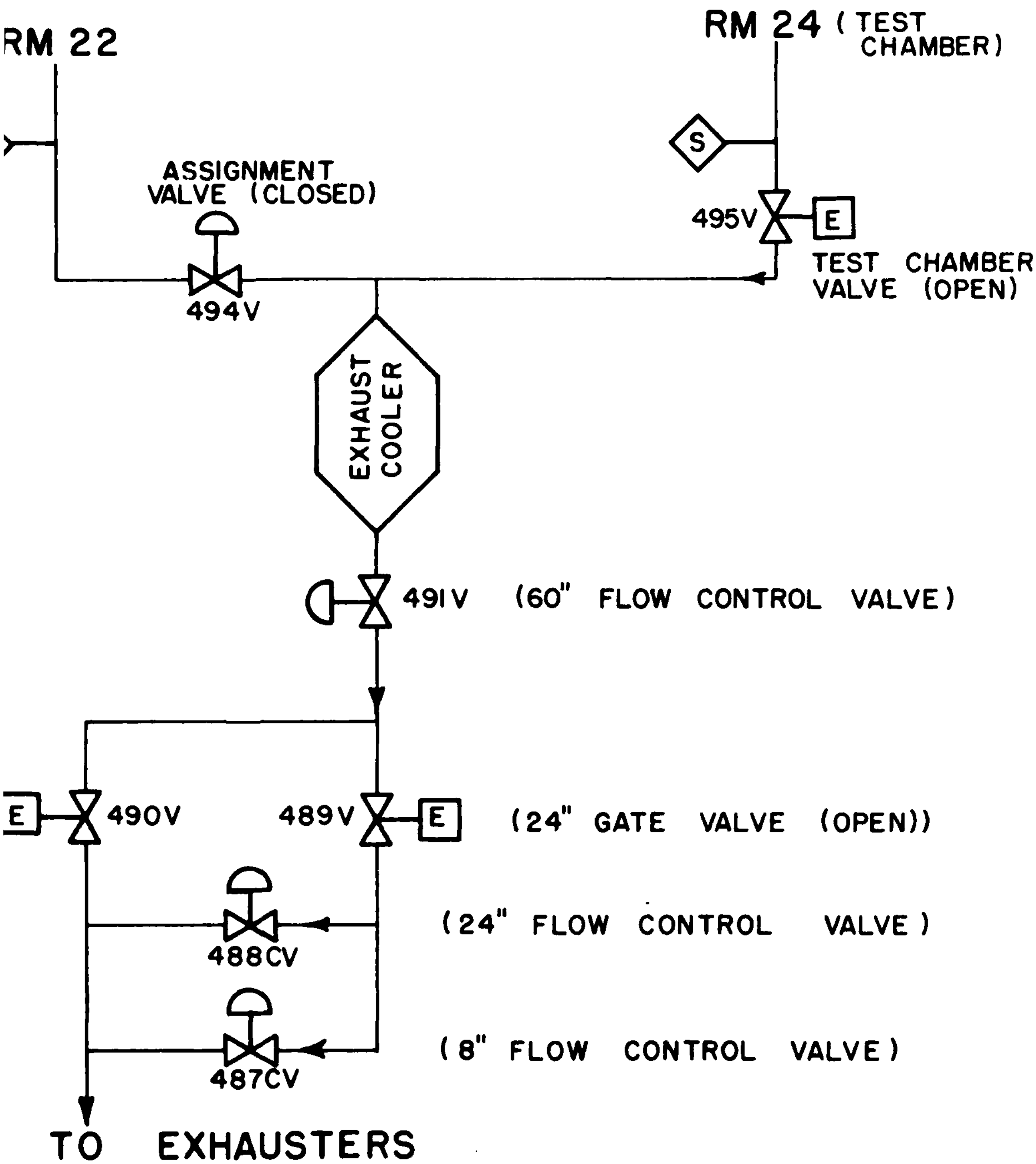


Figure 23. Airflow Control Schematic

ɜcting the inlet hardware to the exhauster facility in the basement of Building Preliminary test indicated that two Ingersol Rand exhausters connected in parallel ɉ draw airflows through the chamber up to approximately 60 lbm/sec. The flow s through the inlet hardware were controlled by three valves, as shown in Figure These valves were actuated pneumatically from the test cell control room by the uster control panel, shown in Figure 24. A filter house was provided at the t hardware bellmouth to reduce particulate build-up on the instrumentation.

TEST ARTICLE

The CRF/F100 inlet hardware utilized for this program was designed and manufactured ratt and Whitney Aircraft for the core compressor test program. During the inlet profile tests, the core compressor module was not connected to the inlet hardware. core was separated from the inlet at the rear flange of the intermediate case. efore, the test article, as defined for this program, consisted of the following:

(1) Bellmouth Nose Cone Assembly

(2) Screen Holder Assembly

(3) Preswirl Vane Row

(4) Inlet Adaptor Duct

(5) Intermediate Case

(6) Diffuser Cone

(7) Facility Adaptation Ring

:hematic of the hardware is shown in Figure 25. The hardware was designed and ıfactured early in the CRF/F100 contract effort so inlet profile verifications d be completed before compressor test article assembly.

a. Facility Adaptation Ring and Diffuser Cone

An adapting ring was required to connect the intermediate case rear flange .he test chamber. This ring was designed to minimize flow path distortion from intermediate case inlet guide vane (IGV) exit to the entrance of the chamber. ıas also designed to support the test article without the need of external supports. adaptation ring installed on the test article is shown in Figure 26. In another ırt to minimize losses from the intermediate case to the large test chamber opening, berglass diffuser cone was designed. The diffuser cone (shown in Figure 26) was ıched to the intermediate case bearing housing through an interface ring shown in ıre 27. With the adaptation hardware, the intermediate case and diffuser assembly d be installed on the front flange of the test chamber, as shown in Figure 28.

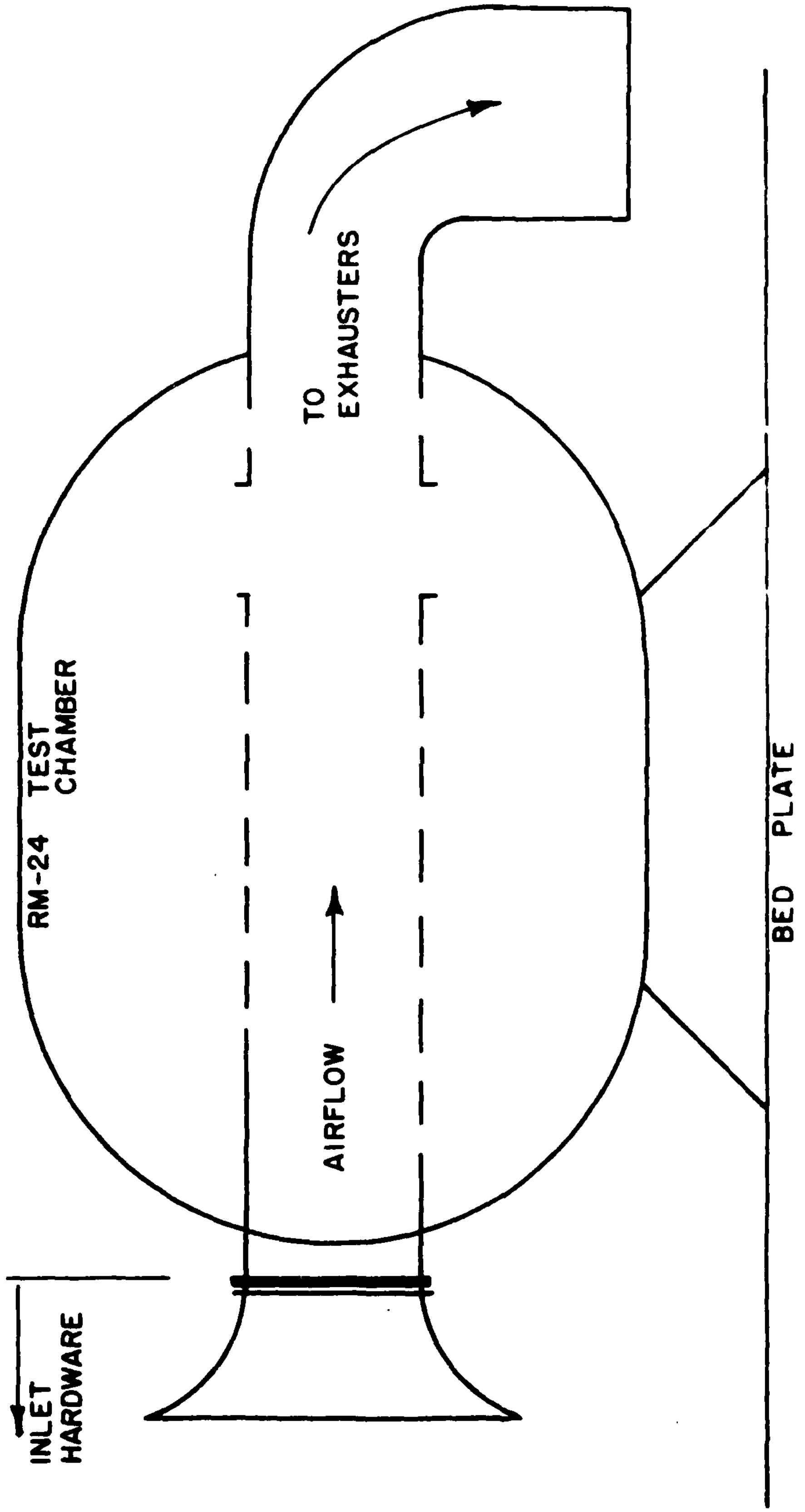


Figure 22. Test Chamber Schematic

SECTION III

EXISTING PRESWIRL VANE TEST

1. GENERAL REQUIREMENTS

Review of the F100(3) engine HPC inlet pressure and swirl angle profiles indicated a new preswirl vane (PSV) design would be required to obtain such profiles in the CRF/F100 inlet. Existing vanes available from a previous F100 core compressor test (described in Reference 7) would not provide the profiles detailed in Section II.4. The existing preswirl vanes were tested primarily to debug the data acquisition system and test method for the future modified vane tests. They were also tested to determine the swirl profiles they produced. The test required that the existing preswirl vanes be installed in inlet hardware designed for the CRF/F100. This hardware was then installed in a flow test cell in the Aero Propulsion laboratory at Wright-Patterson Air Force Base. The facility provided compressor corrected mass flow rates equivalent to those encountered in the engine test. With these airflows, swirl profiles resulting from the existing vanes were measured at station 2.5 and compared with those detailed in Section II.4. Section III defines the inlet hardware and test facility. It also details the changes required in the data acquisition system described in Section II.2 to accommodate this test.

2. TEST FACILITY

A facility that could provide 54 lbs/sec corrected mass flow through the CRF/F100 inlet hardware was necessary to determine the swirl angle and Mach number profiles generated by the existing vanes. Preliminary testing of an engine test cell in Room 24, Building 18E of the Aero Propulsion Laboratory indicated that it could provide the necessary flow capacity. Modifications to this engine test facility were required to accommodate the CRF/F100 inlet hardware. The facility was equipped with an altitude chamber that provided altitude and increased Mach number engine testing. The altitude chamber was not required for the CRF/F100 inlet duct test because the capability for ram air conditions do not currently exist in the CRF. Therefore, the inlet hardware was mounted on the inlet flange outside of the chamber to make easy access to the hardware, as shown in Figure 22. The chamber was used as a large diameter pipe

Inlet preswirl vanes will be used to simulate the entrance swirl angle profiles, while a series of screens will be used to simulate the total pressure profiles. Since the CRF currently has no temperature distortion capability, no attempt will be made to simulate the temperature profiles.

The largest change between the two axial locations occurred in the swirl angle profiles. Swirl angle is defined as 90 degrees minus the angle of flow with respect to the engine axis. This 10-15 degree change to a more axial flow at the 2.5 location is probably a result of the eight radial structural supports in the intermediate case between the 2.3 and 2.5 locations of the F100 engine. The swirl angle profile at the 2.5 location remained relatively constant throughout the speed range of the engine, varying only $\pm$2.5 degrees from an average swirl angle profile. However, across the flow path, the swirl angle varies as much as 13 degrees. It is possible that this spanwise variation is due to variable angle of attack on the struts at the different spanwise locations. The angle of attack variations can result in stalling of the intermediate case struts at different spanwise locations. This stalling would also result in an inlet distortion to the compressor thereby reducing performance. Stalling of the struts can be the reason for this spanwise swirl angle variations. The limited amount of data obtained prohibits conclusive proof of that phenomenon. It is, therefore, only suggested as a possible explanation of the phenomenon.

The mass average value of the plotted parameters in the other profiles should be the same for both the 2.3 and 2.5 locations since the flow area at each location is the same to within 1 percent and no energy is intentionally added or removed from the airflow. The variations in the 2.3 and 2.5 profiles that exist at the nominal 4,700 RPM engine speed are due to a slightly lower engine speed while the 2.3 location data were taken than when the 2.5 data were obtained. The variations between the two locations at the higher engine speed is probably a result of higher uncertainty in the pressure reading due to the fluctuation caused by the fan rotor, as indicated in References 3 and 5.

The engine profiles that were obtained in this experiment will be used as a design tool to obtain simulated profiles in a subsequent high pressure compressor test. Even though the effects of probe blockage and probe wall interactions do exist, these effects will be the same in both the engine test and the compressor test since the hardware is approximately the same. The significant effect that cannot be simulated will be the fluctuation effects of pressure, swirl angle and temperature resulti from the rotating fan blades. The profiles measured at the 2.5 location, approximately four mean chord diameters downstream from the last rotor row of the fan, should be relatively unaffected by these fluctuations, as indicated in Reference 6.

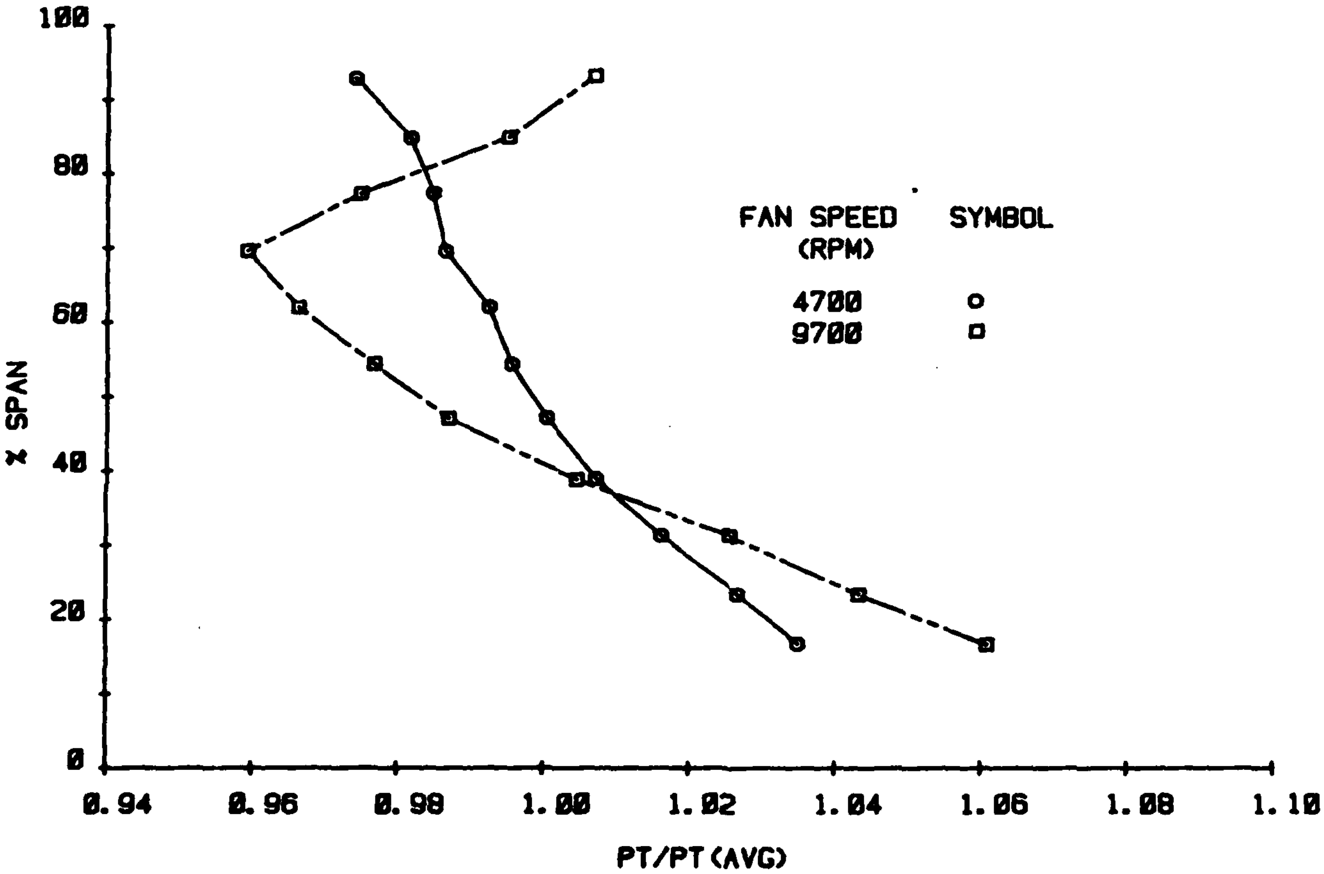


Figure 21. Core Entrance Profile of PT/PT(AVG) at Station 2.3 in F100(3) Engine P072

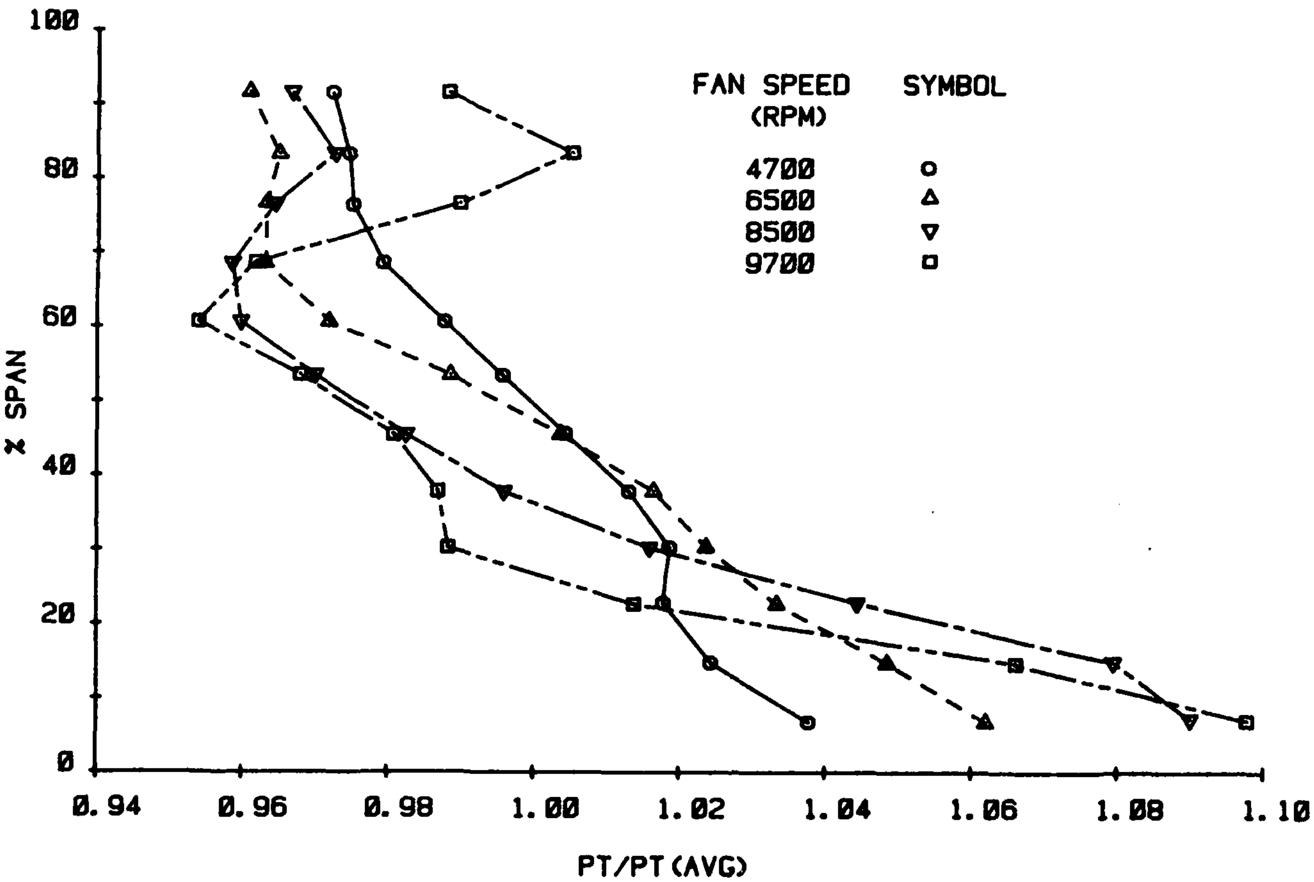


Figure 20. Core Entrance Profile of PT/PT(AVG) at Station 2.5 in F100(3) Engine P072

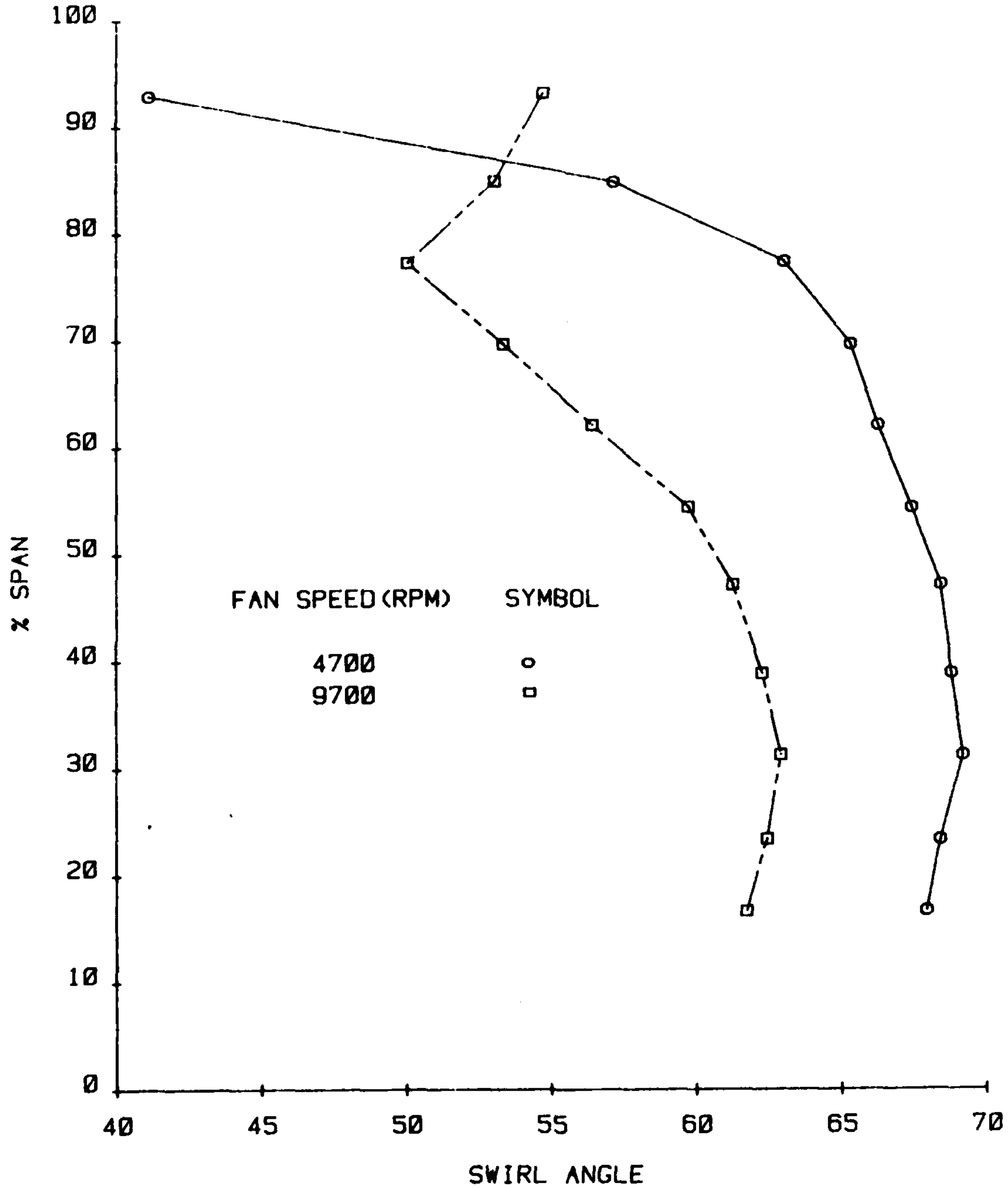


Figure 19. Core Entrance Profile of Swirl Angle at Station 2.3 in F100(3) Engine P072

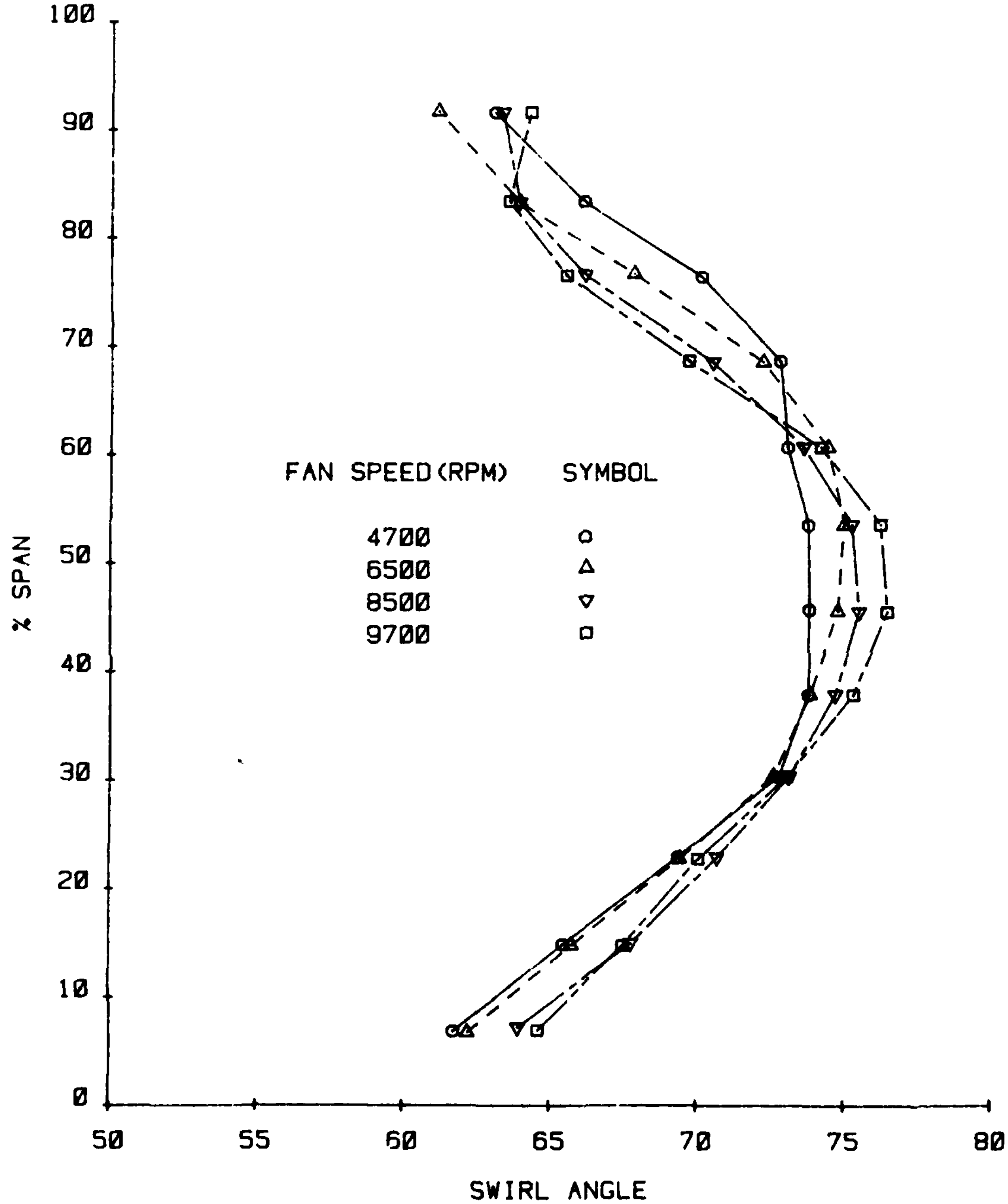


Figure 18. Core Entrance Profile of Swirl Angle at Station 2.5 in F100(3) Engine P072

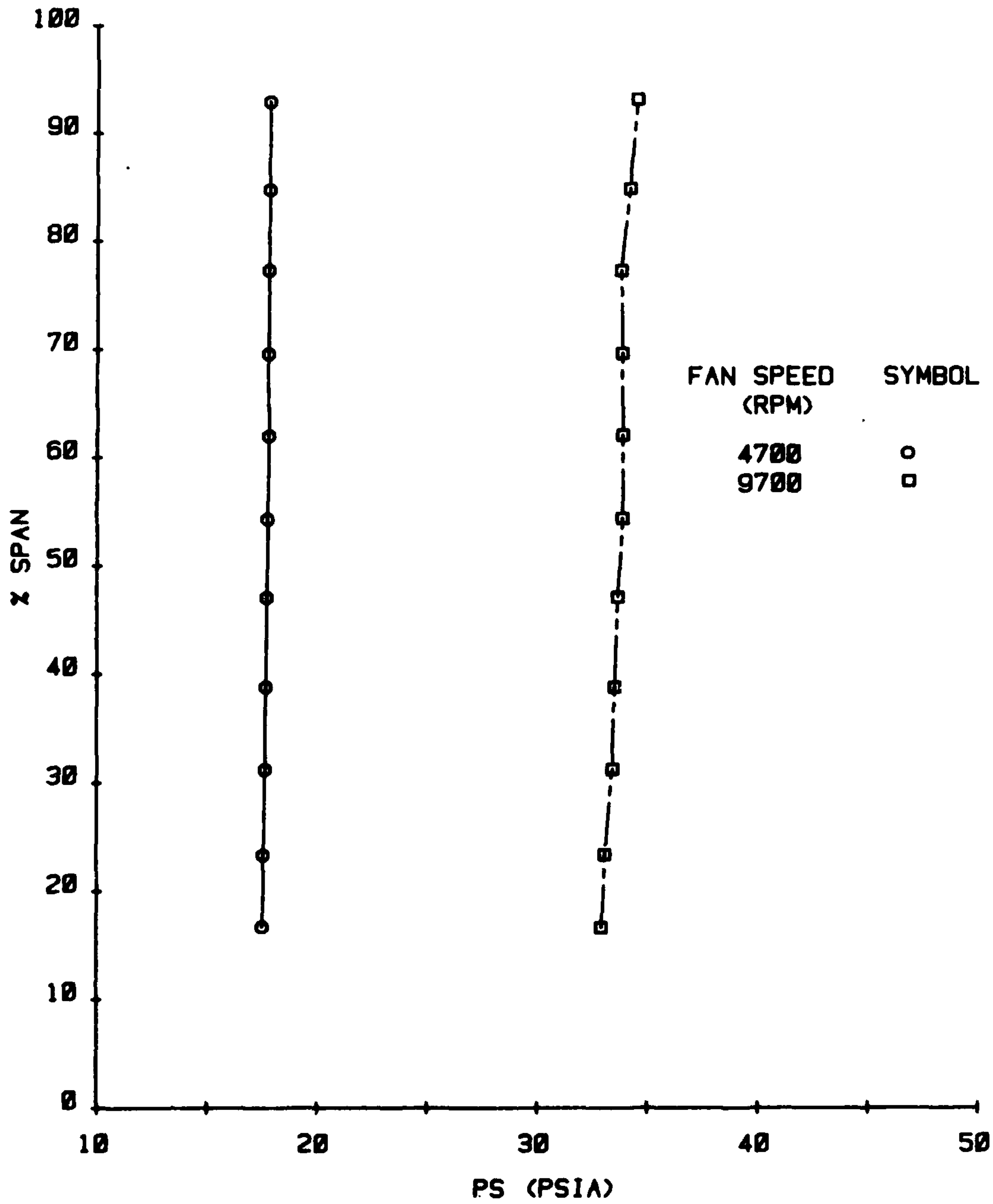


Figure 17. Core Entrance Profile of Static Pressure at Station 2.3 in F100(3) Engine P072

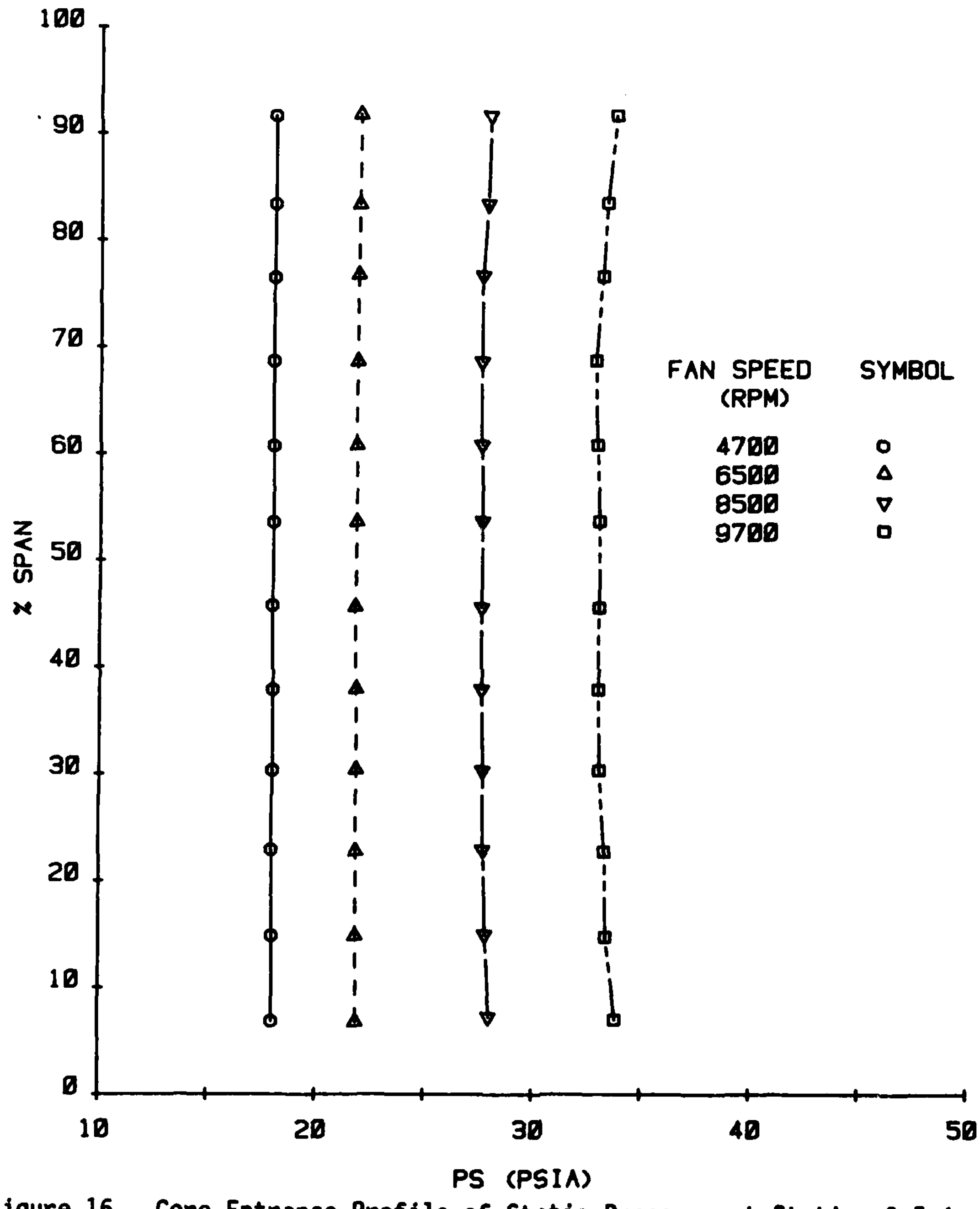


Figure 16. Core Entrance Profile of Static Pressure at Station 2.5 in F100(3) Engine P072

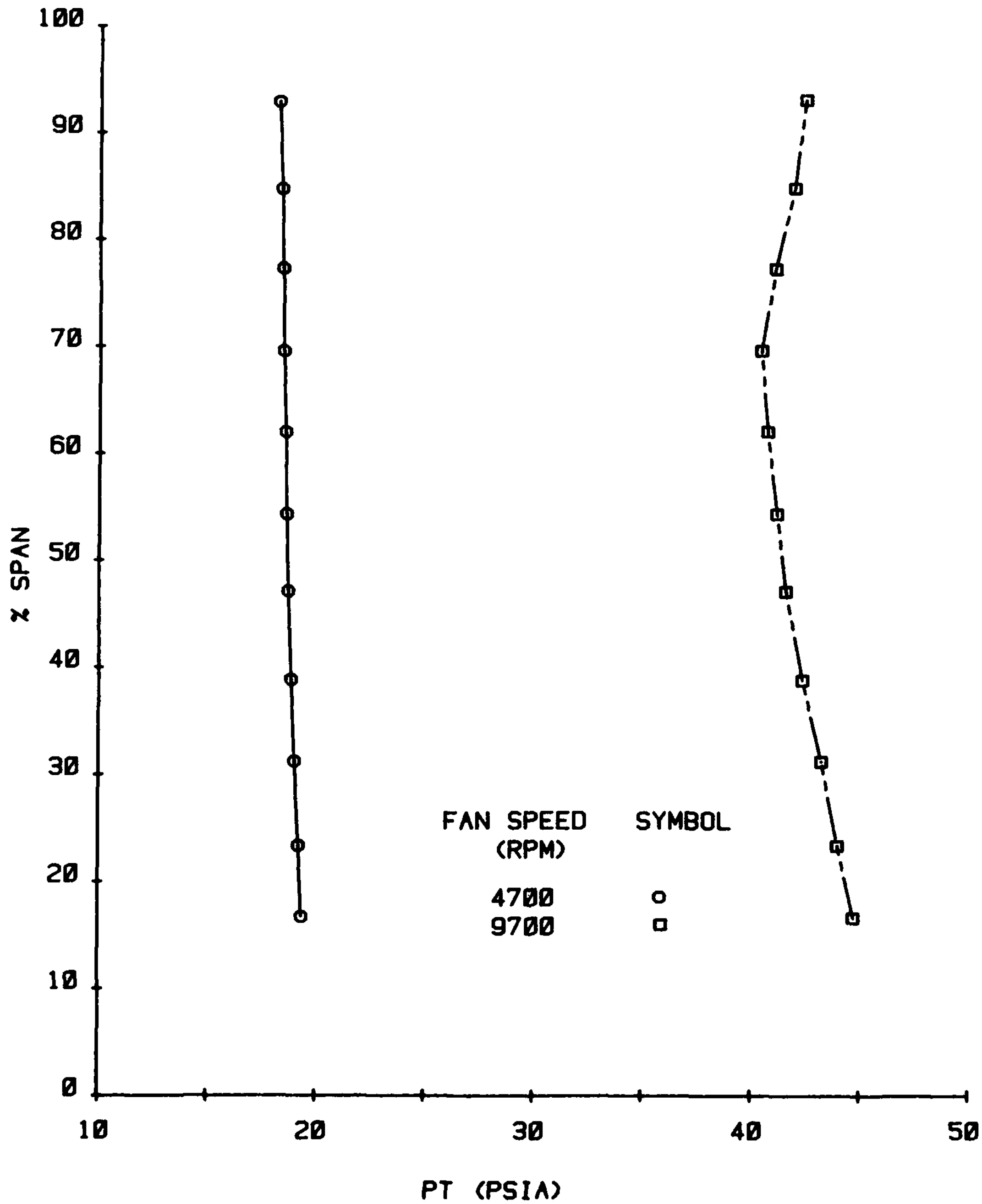


Figure 15. Core Entrance Profile of Total Pressure at Station 2.3 in F100(3) Engine P072

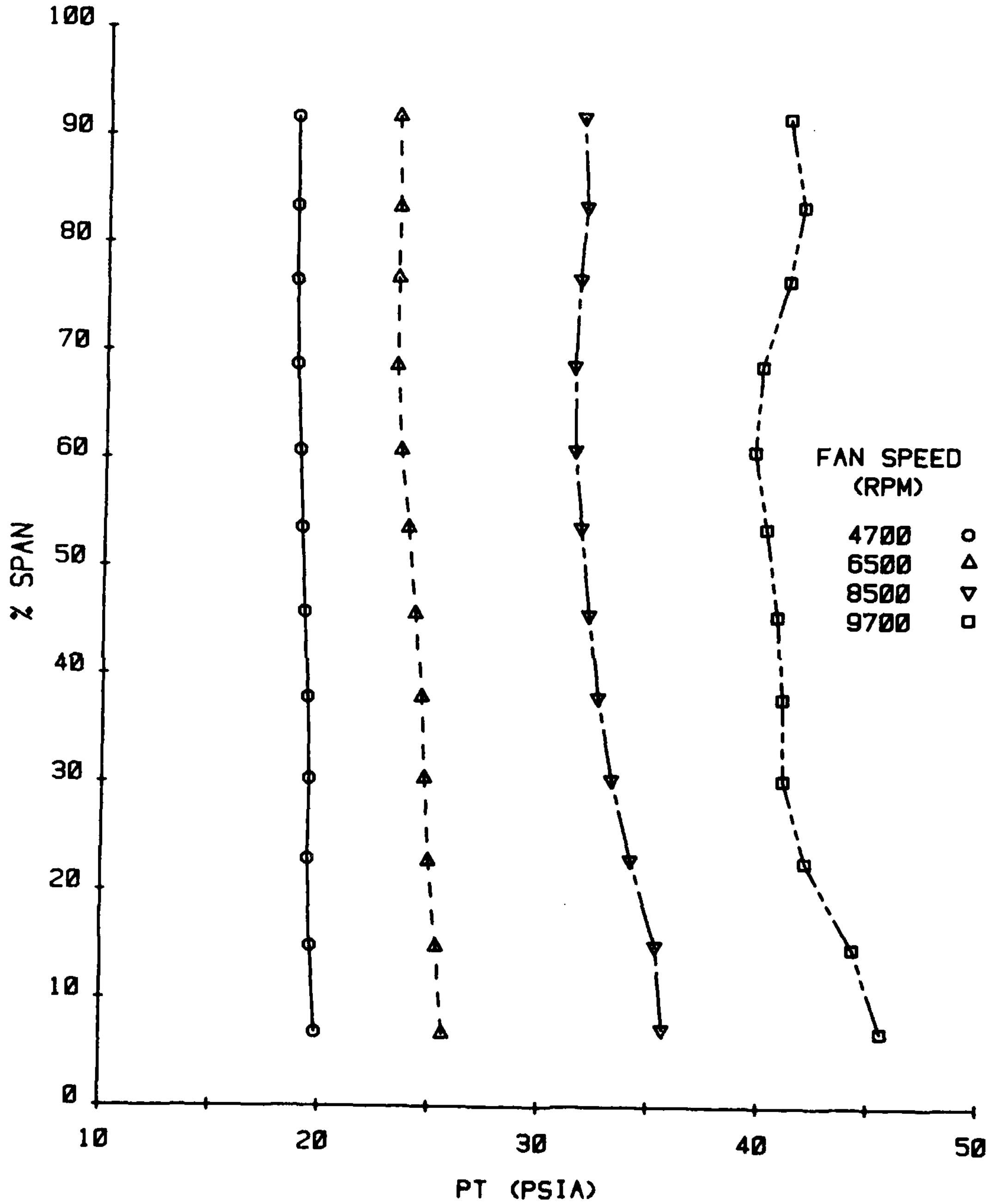


Figure 14. Core Entrance Profile of Total Pressure at Station 2.5 in F100(3) Engine P072

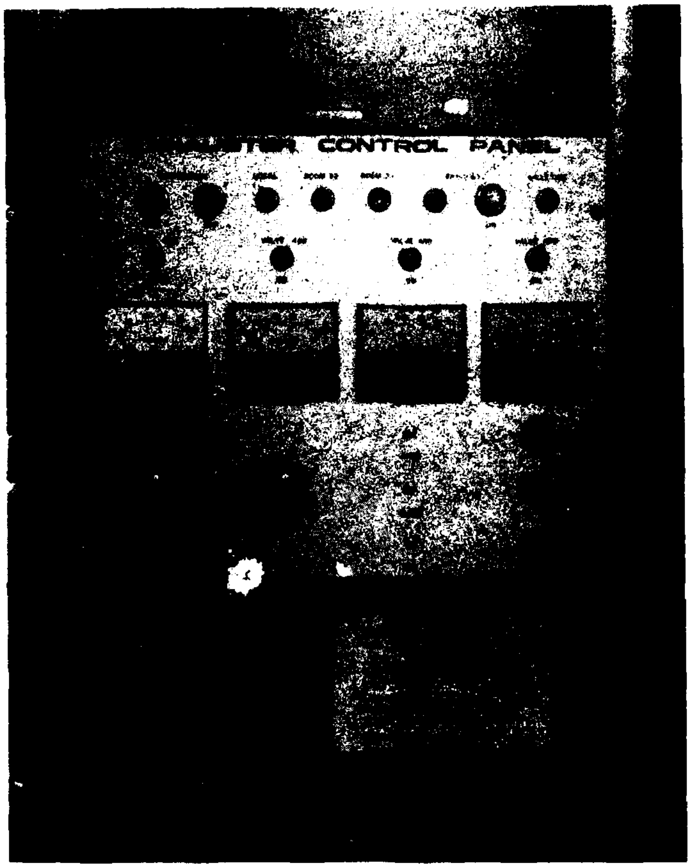


Figure 24. Exhauster Control Panel

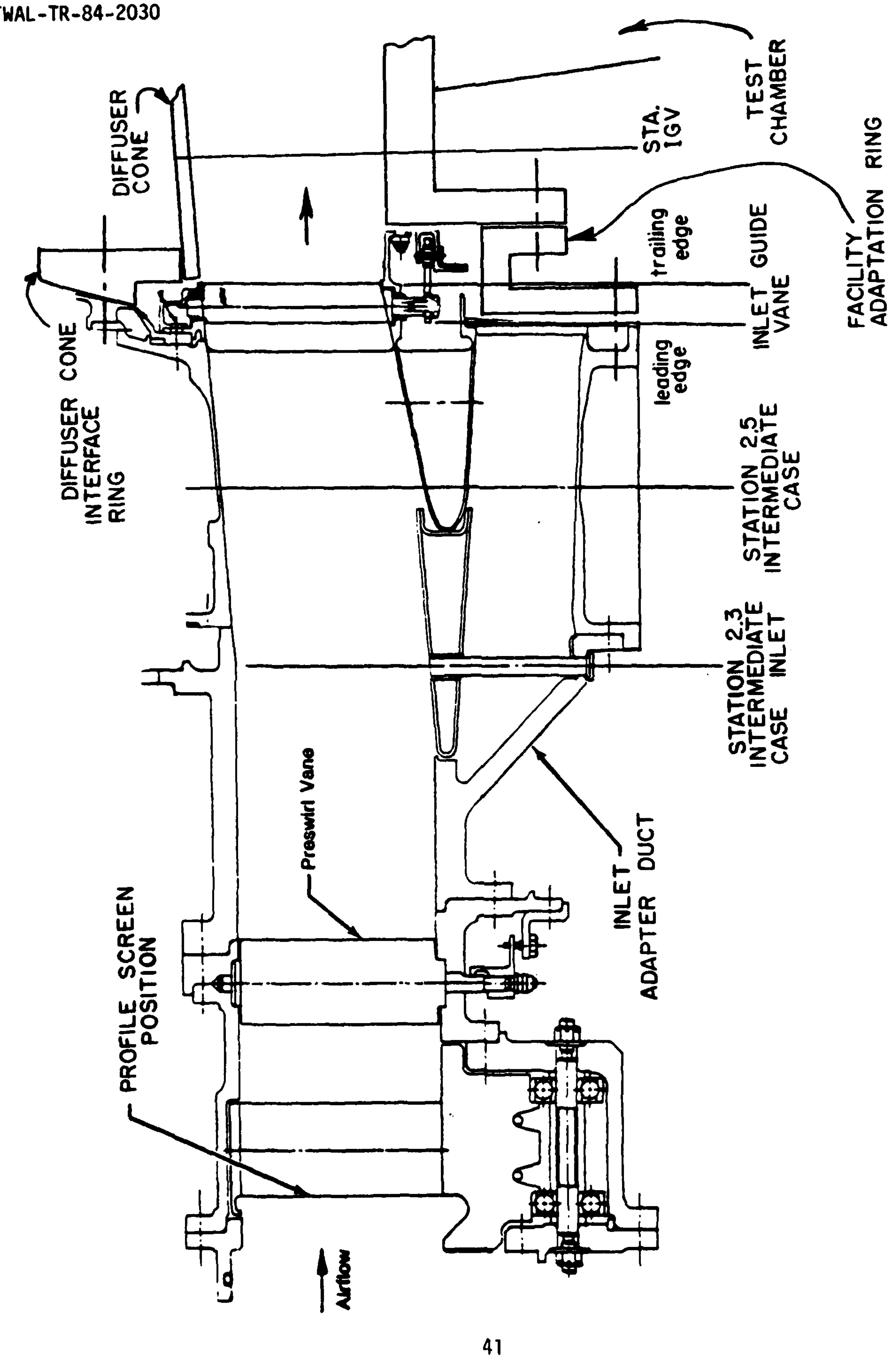
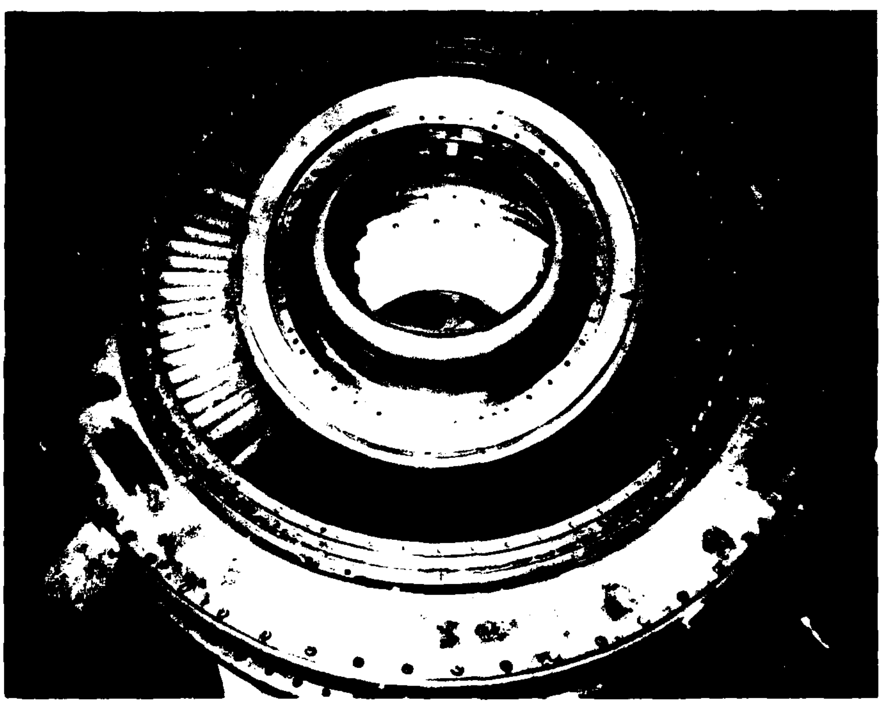


Figure 25. CRF/F100 Inlet hardware Schematic

DIFFUSER
CONE

ADAPTATION
RING

Figure 26. Diffuser Cone and Facility Adaptation Ring



INTERFACE
RING

Figure 27. Diffuser Cone Interface Ring

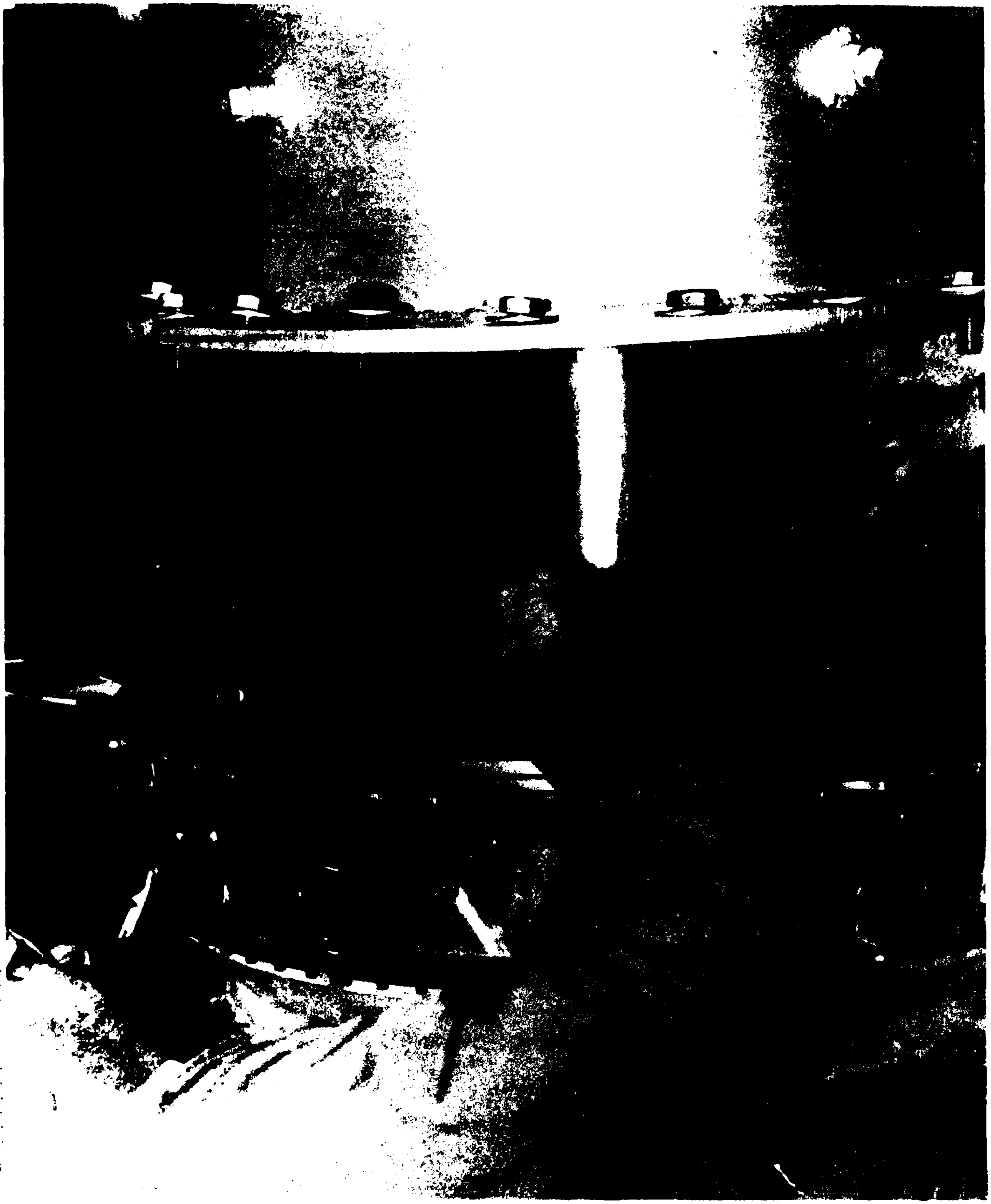


Figure 28. Inlet Hardware Installation

b. Intermediate Case and Inlet Adapter Duct

The intermediate case for the CRF/F100 test article is an F100 Series 2 intermediate case. This is not the same case as was on the engine (S/N P072) discussed in Section II. The differences between these two designs will be discussed later in this report.

The Series 2 intermediate case assembly consists of an 8 strut compressor shaft support ring and a 90 vane inlet guide vane assembly. The support struts are airfoil shapes positioned at a 20 degree angle of attack from the axial position. The intermediate case mounted to the test chamber is shown in Figure 29. Measurement locations were provided at axial station 2.5 for wedge probe traverse between all 8 support struts, defined as octants 1 through 8 clockwise looking forward. Three 2.3 traverse locations were also available. The inlet adapter duct provides for transition from the intermediate case splitter leading edge to the preswirl vane assembly.

c. Preswirl Vane Assembly and Screen Holder

The existing preswirl vanes (PSV) were installed in a support ring that allowed for simultaneous actuation of the vanes through a sync ring assembly. The vane row consisted of 40 rotatable vanes. The vanes installed in the support ring are shown in Figure 30. Vane position was determined for this test by a vernier angle indicator attached to one of the vanes. The PSV leading edge is axial for a 20 PSV setting. The detailed vane design is shown in Figure 31.

The button end is positioned at the flow path I.D. wall. The threaded end allows for attachment to the sync ring. The screen holder assembly was designed such that the screen pattern could be rotated for distortion testing if necessary. Circumferential distortion variations were not part of this program so this feature of the screen holder was not utilized. The screen holder assembly was designed with 12 screen support struts and attached to the vane assembly, as shown in Figure 32. The desired screen pattern was attached with wire to the screen holder struts. The preswirl vane and screen holder assemblies are attached to the inlet adapter duct described in Section III.3.b.

b. Bellmouth Nose Cone Assembly

To assure a smooth flow transition into the screen holder assembly, a bellmouth and nose cone were required. The nose cone, which provided for a smooth

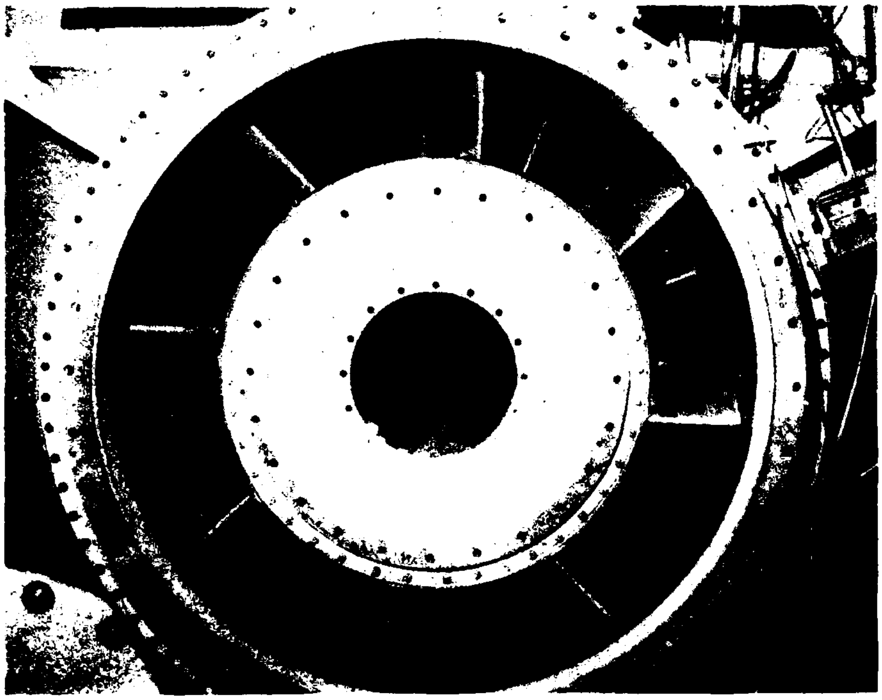


Figure 29. F100(2) Intermediate Case

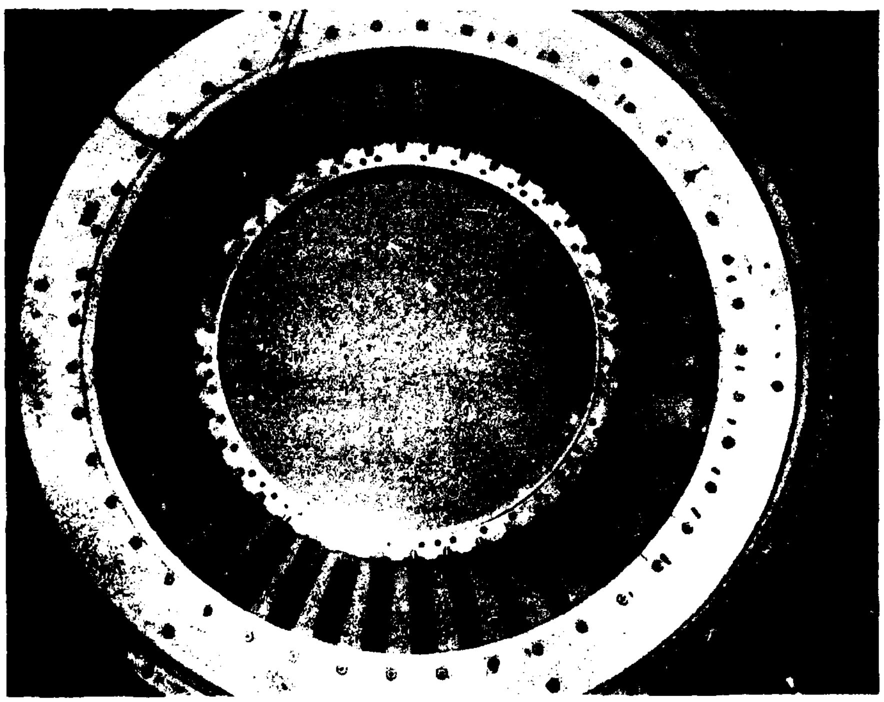


Figure 30. Preswirl Vane Assembly

Figure 31. Existing Preswirl Vane

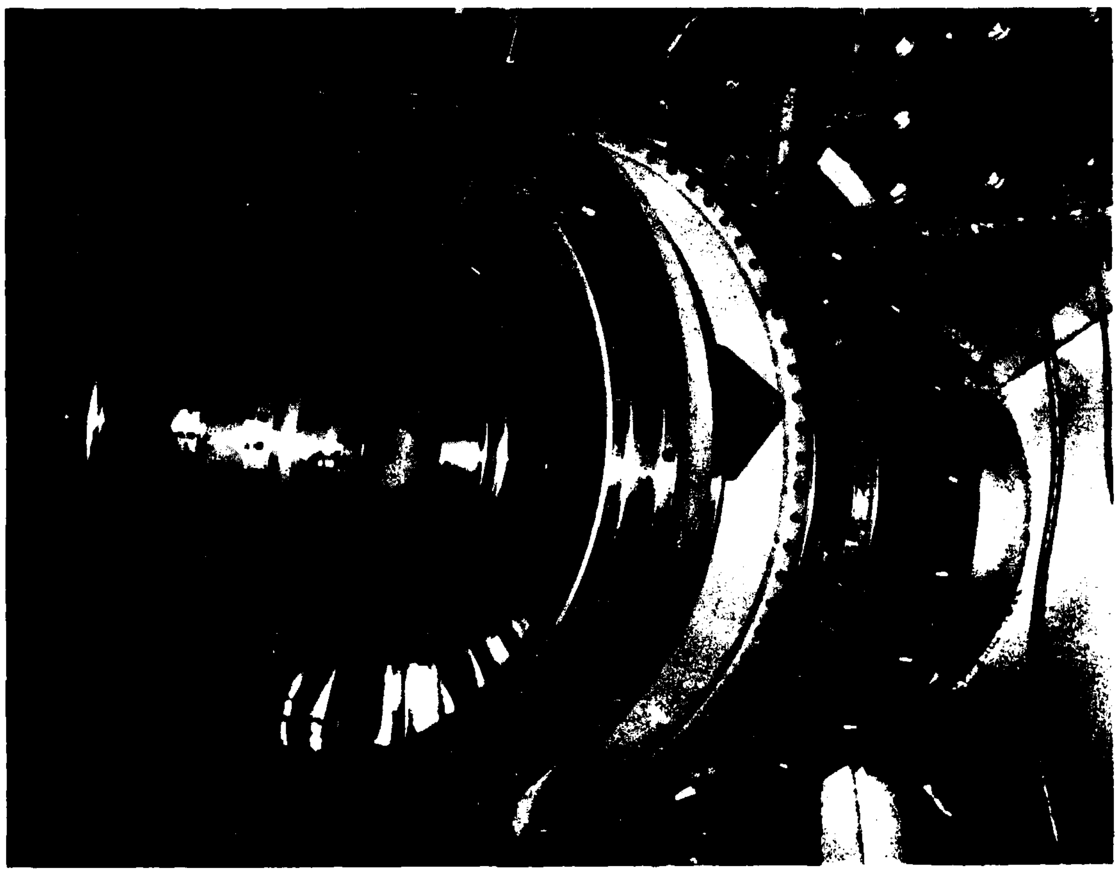


Figure 32. Screen Holder Assembly

inner flow path wall, was supported by the slip ring assembly mount shown in Figure 33. The slip ring was not required for this test as the compressor was not attached. The nose cone designed by P&WA was installed over the slip ring assembly mount, as shown in Figure 34. To provide the outer flow path inlet transition, a long throat elliptical fiberglass bellmouth was designed and manufactured by P&WA. The bellmouth was positioned to the nose cone through the use of four tie rods, as shown in Figure 35. These tie rods were not supporting members. They were for positioning and stability only during the test. The filter house was connected to the bellmouth entrance to complete the test set up. Figure 36 shows the entire inlet installed on the test chamber with the filter house attached. This test configuration was used for the remaining test programs. Minor changes were made between test periods and are detailed in their respective sections of this report.

4. DATA ACQUISITION SYSTEM

The data required for this test were the same as obtained in the engine test described in Section II. The magnitudes of the pressures and temperatures were reduced from the levels obtained in the engine test. Swirl measurements were not affected. The Room 24 test facility created absolute pressure measurements in the inlet hardware which were less than atmospheric because exhausters were used as the air flow source. The above atmospheric pressures encountered in the engine were due to the fan upstream of the core compressor. The reduced pressures encountered during this test required data acquisition system changes. Additional measurement requirements for this test also resulted in data acquisition system changes from the engine test system (Section II.2). Temperature measurements were obtained although no analysis or comparison with engine data were performed. Temperature distortion capabilities are not currently available in the CRF. All data acquisition system changes are detailed in the following subsections.

a. Hardware Modifications

All data acquisition hardware used during engine testing at Pratt and Whitney Aircraft was transferred back to Wright-Patterson Air Force Base and installed in the Room 24 test facility described in Section III.2. To accommodate the test at the facility, additions and changes were made to the data acquisition hardware previously described in Section II.2.a. A schematic of the Room 24 test facility data acquisition system is shown in Figure 37. Additions required to the original system are indicated by the dotted lines. A Hewlett Packard (Model 2804A) quartz

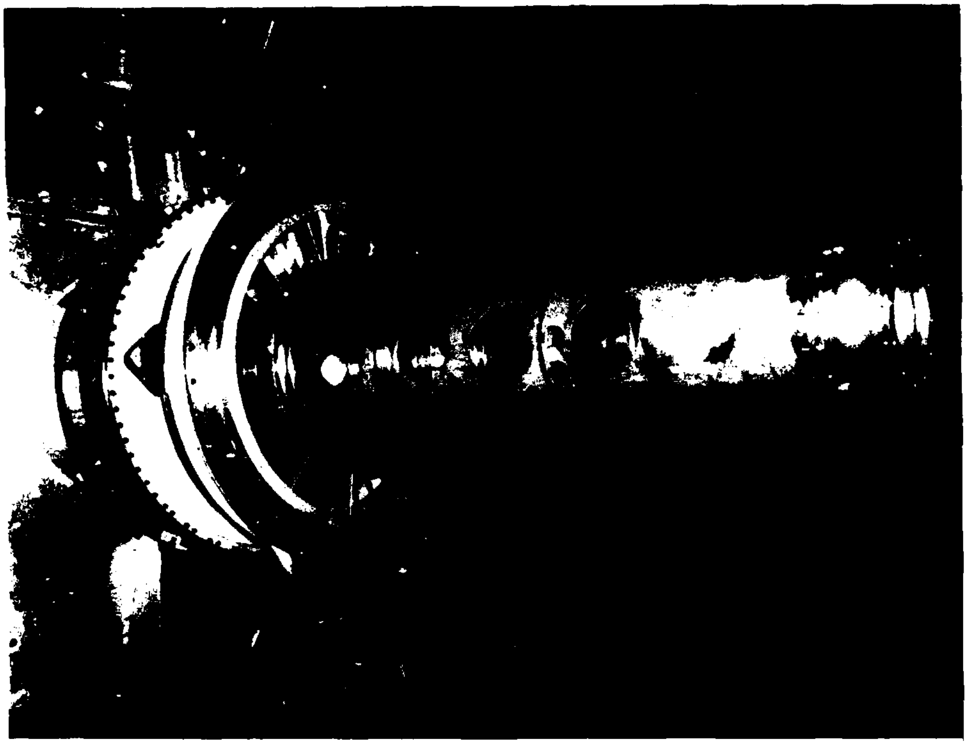


Figure 33. Slip Ring Support Assembly

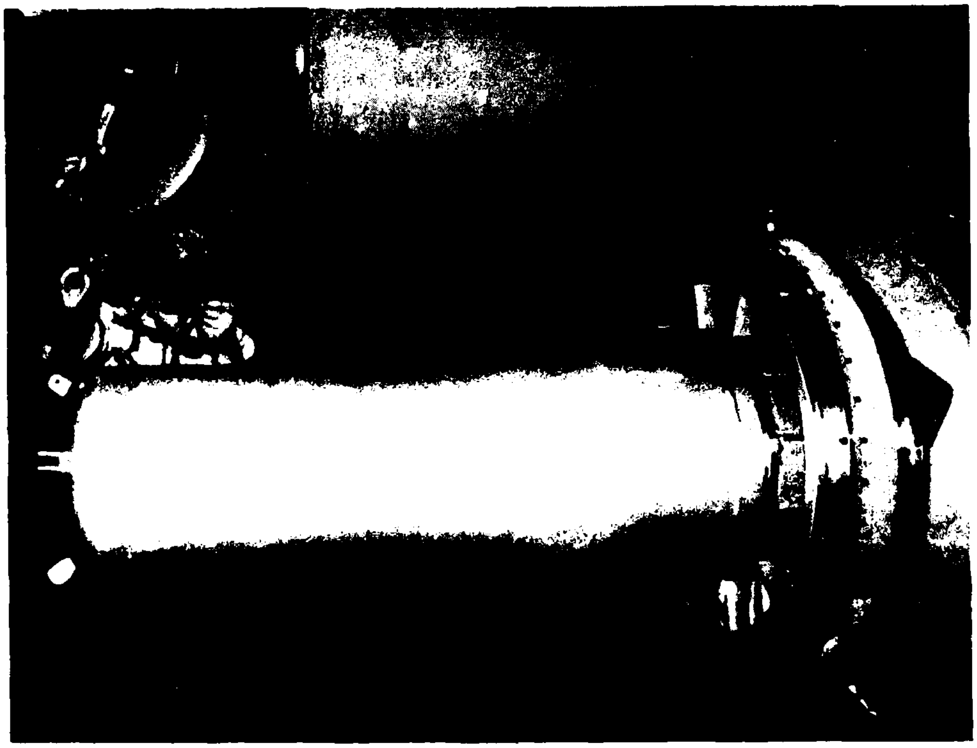


Figure 34. Nose Cone Installation

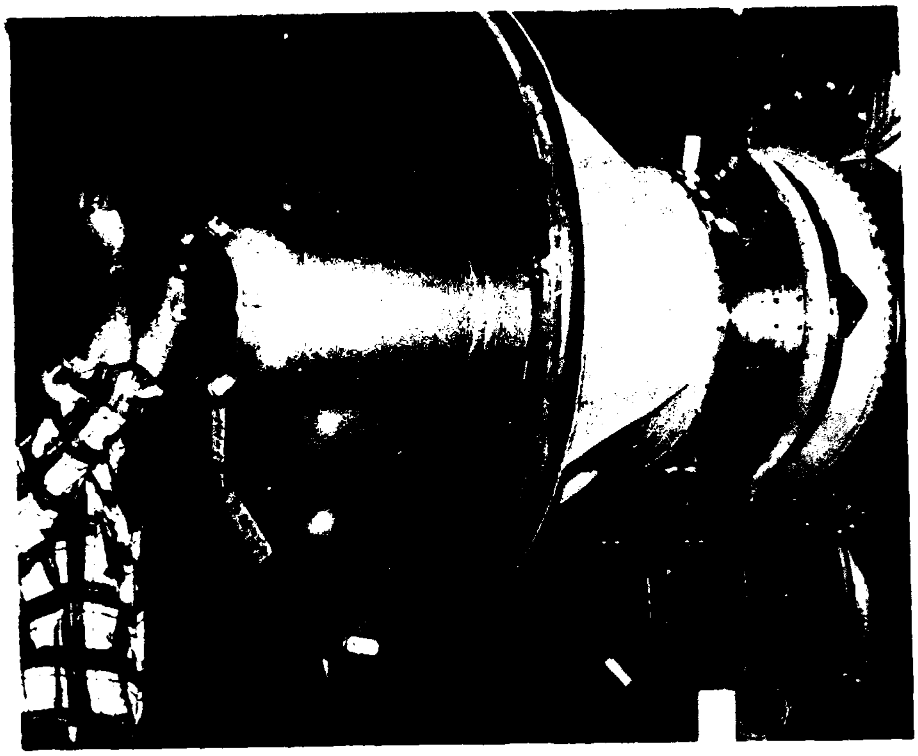


Figure 35. Bellmouth Tie Rod Installation

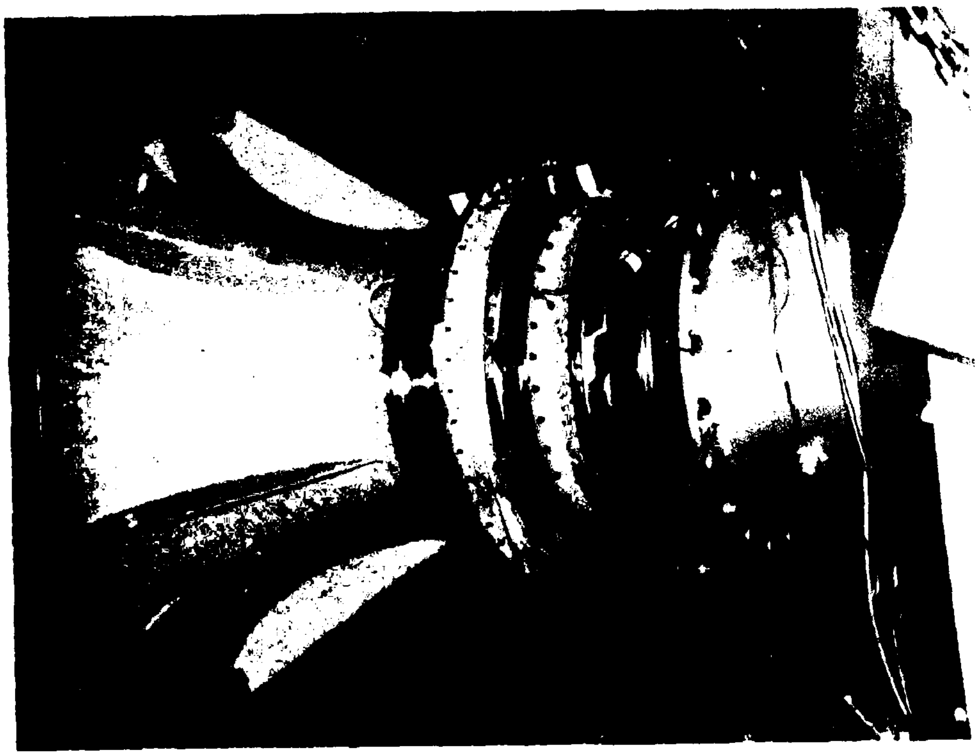


Figure 36. Test Article

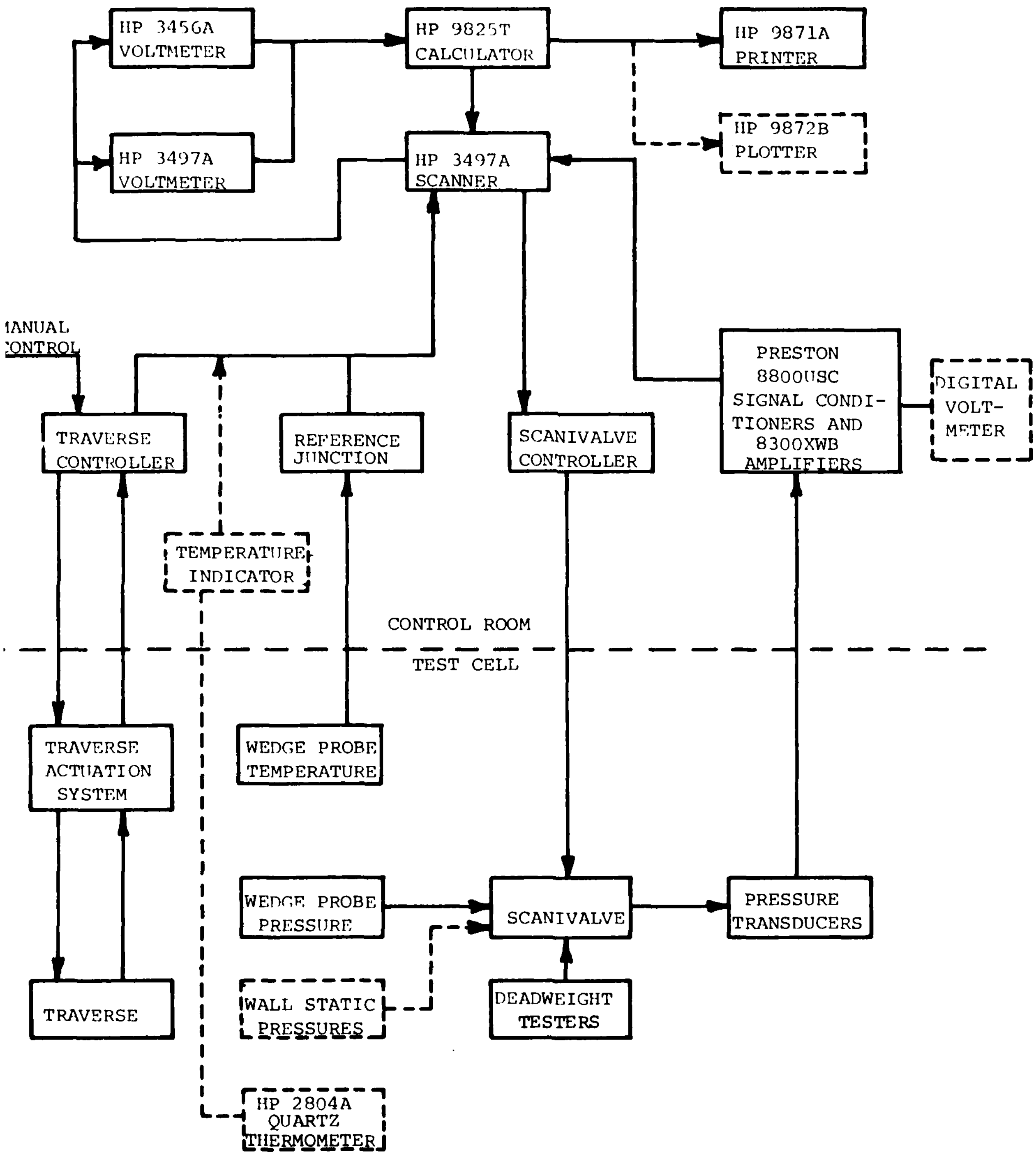


Figure 37. Schematic of Aero Propulsion Laboratory Test Facility Data Acquisition System

mometer was added to the system to provide additional temperature information use in corrected flow calculations. The quartz probe (Model 18110A) was mounted he positioning strut of the nose cone, as shown in Figure 38.

The output of the probe required amplification by a 1810A line amplifier, to the distance from the test article to the control room where the temperature recorded.

Wall static pressure measurements in addition to those obtained from the e probe were added to monitor test facility flow rates. A bellmouth wall static sure measurement (P4) and a station 2.5 O.D. wall static measurement (P5) were ched to the scanivalve. These measurements were necessary to assist in setting maintaining the required mass flow rates during data acquisition periods.

The pressure transducers used during Phase I of this program were replaced wo Druck model PDCR22 pressure transducers with ranges of 0-1 and 0-5 psid, ectively. This change was necessary due to the lower pressure differentials untered in this test facility as opposed to the engine test. Measurements of e low differentials on the transducers used in the engine test would have romised the uncertainty goals. The lower range transducers provided the ssary component uncertainty to maintain the ± 1 percent overall system rtainty. Bench calibrations for the new transducers are shown in Table D-1, ndix D. These indicate linear response in the range of pressures measured. sure measurements were connected to the scanivalves as shown in Figure 39.

The scanivalves were replaced by model J-9 scanivalves which provide for r pressure differential measurement capability. Initial testing in Room 24, at r pressure differentials than obtained in the engine test, indicated on-line bration errors. Differences in on-line calibration before and after a urement were noted. The problem was traced to the oil filled type scanivalve g used. The lubricating oil leaked into the pressure sensing channel, resulting lockage of the depressurization port. The low pressure differentials measured unable to keep this port clear, thus resulting in false readings. The model scanivalves were graphite lubricated and thus eliminated the problem.

The traverse actuation system was adjusted after the engine test to acquire er response. Due to this change, it was recalibrated by the same procedures iled in Section II.2. The results of this calibration are shown in Figures D-1 ugh D-4, Appendix D. The new calibration constants were incorporated into the acquisition software.

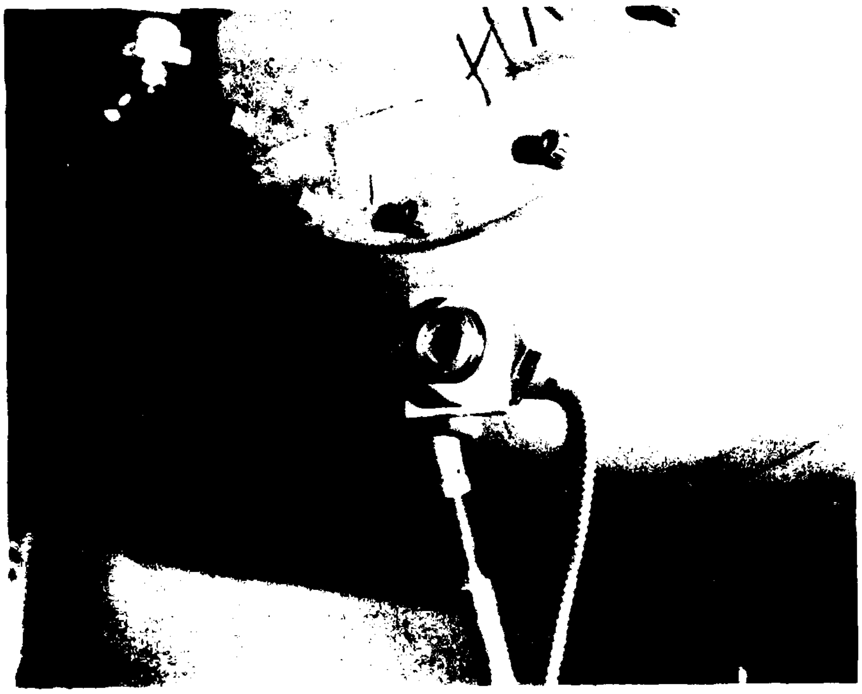


Figure 38. Quartz Thermometer Installation

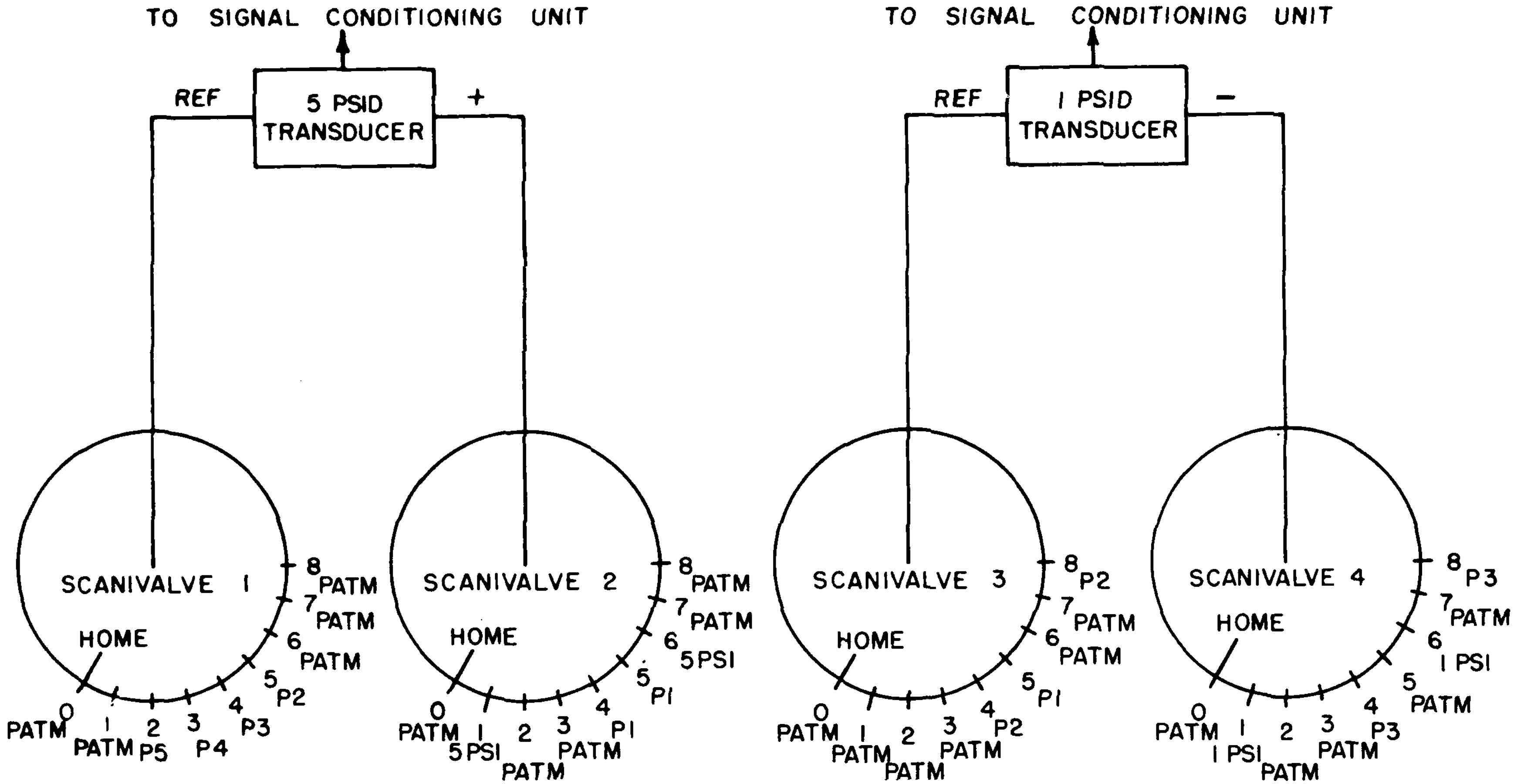


Figure 39. Scanivalve Pressure Measurement Schematic

SECTION IV

MODIFIED PRESWIRL VANE AND SCREEN TEST (PHASE I)

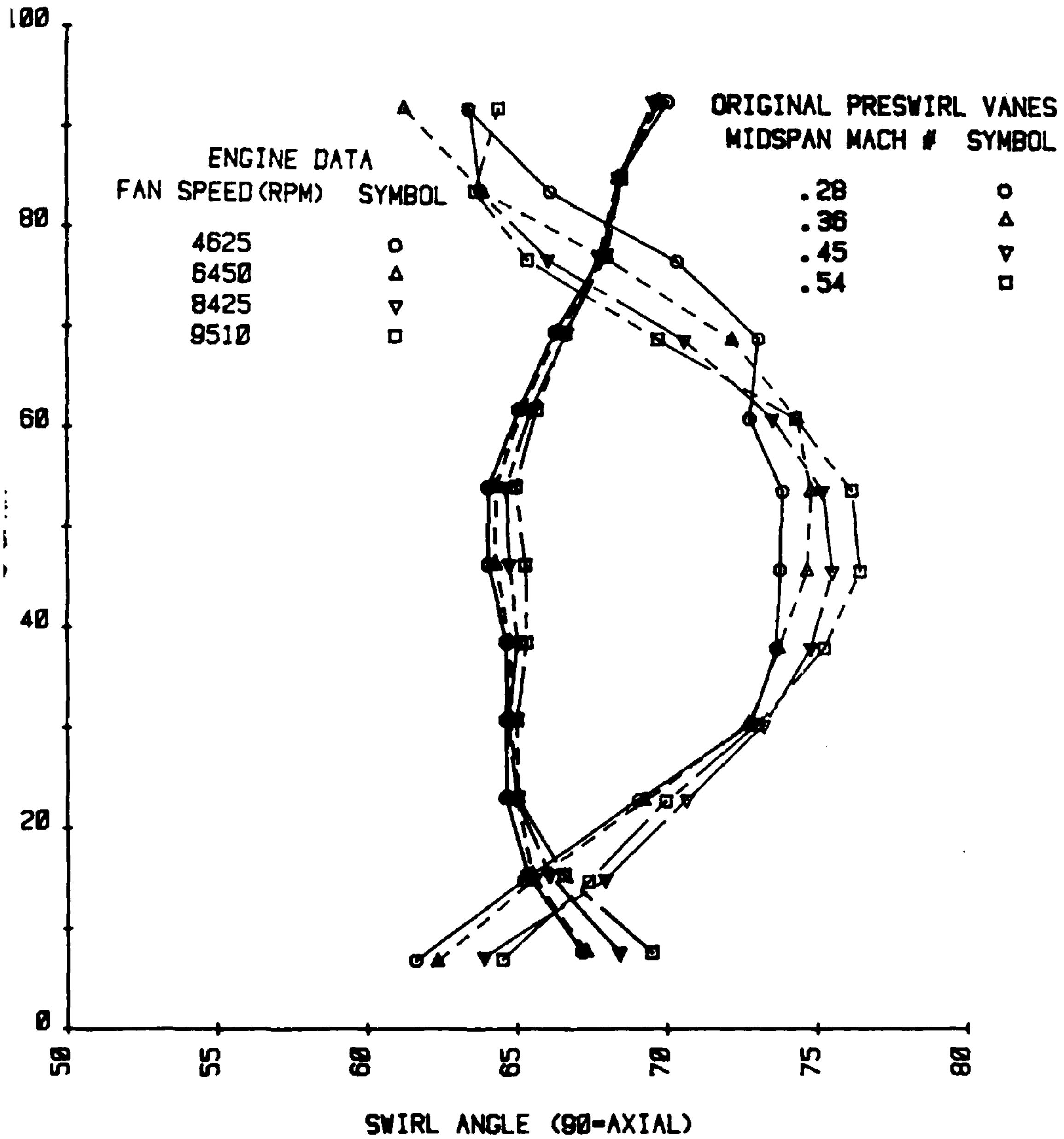
ERAL REQUIREMENTS

was previously indicated, a modified preswirl vane and screen design was to more accurately duplicate the total pressure and swirl angle profiles d in Section II.4. The vanes and screens to achieve these measured profiles igned by Pratt & Whitney Aircraft and tested in the CRF/F100 inlet duct test defined in Section III.3. The following subsections describe the preswirl screen design, the test procedures and test results.

SWIRL VANE AND SCREEN DESIGN

better simulate the fan discharge swirl profiles, a new preswirl vane row CRF/F100 was designed by Pratt & Whitney Aircraft, Government Products . The new vane design was compatible with existing inlet hardware defined ion III.3. Therefore, there are no changes to the flow path or the number of escribed. The modified preswirl vanes were designed from the total pressure l angle profiles measured at the 2.3 location in the F100 S/N P072 engine. suggested by P&WA that these profiles measured at the 2.3 location, which is n of the 8 intermediate case support struts, would provide a better design n than the profiles measured at station 2.5. It was assumed if the station iles could be duplicated in the inlet hardware, the station 2.5 profiles lso be duplicated. During the design process, factors were taken into to compensate for the fact that the engine station 2.5 profiles were d in a Series 3 intermediate case, and the CRF/F100 inlet hardware has a ? intermediate case. The difference between these cases is shown in Figure e Series 3 case has a slightly more bulged flow path than the Series 2 case. all program goal was to design preswirl vanes and screens that provide 2.5 (compressor entrance) profiles similar to those measured in the engine; e, the differences in intermediate cases required consideration.

e preswirl vanes were designed to generate a swirl distribution profile from those measured in the engine, as shown in Figure 50 (taken from e 8). Restaggering of the vanes with the sync ring assembly was anticipated eve the profiles at the low and high speed ranges.



·e 48. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 33^{0})

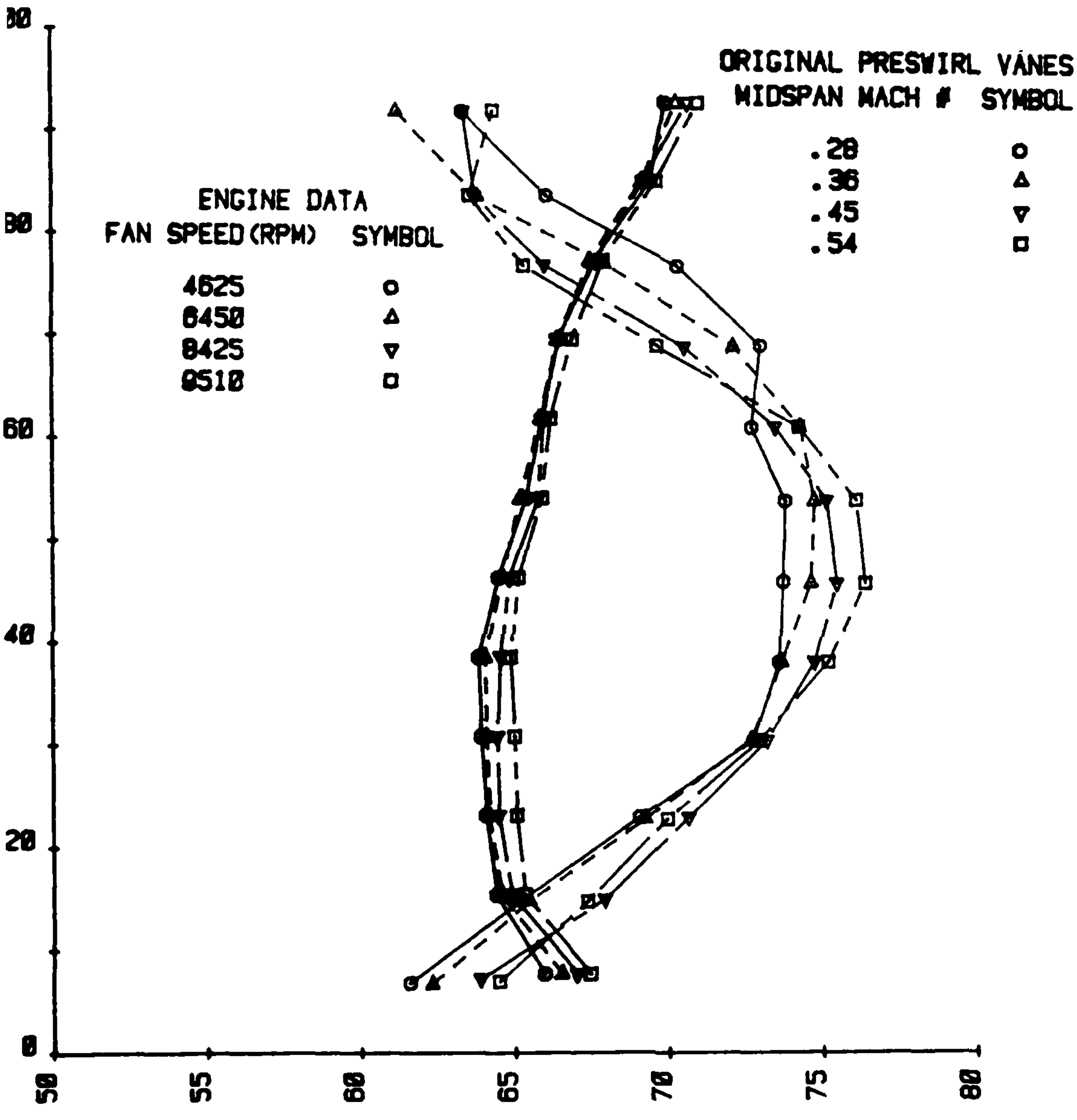
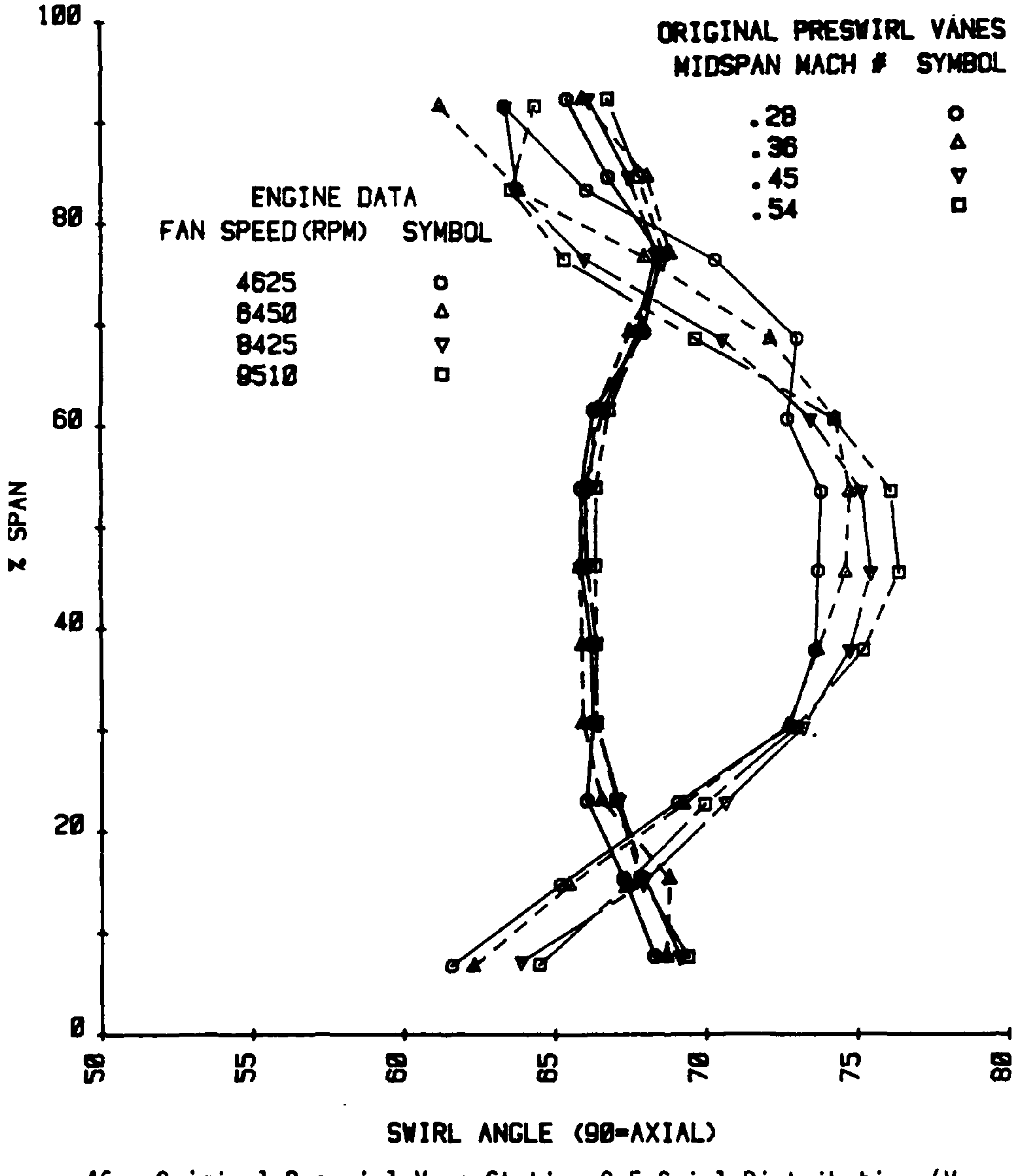


Figure 47. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 30^{0})



gure 46. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 25°)

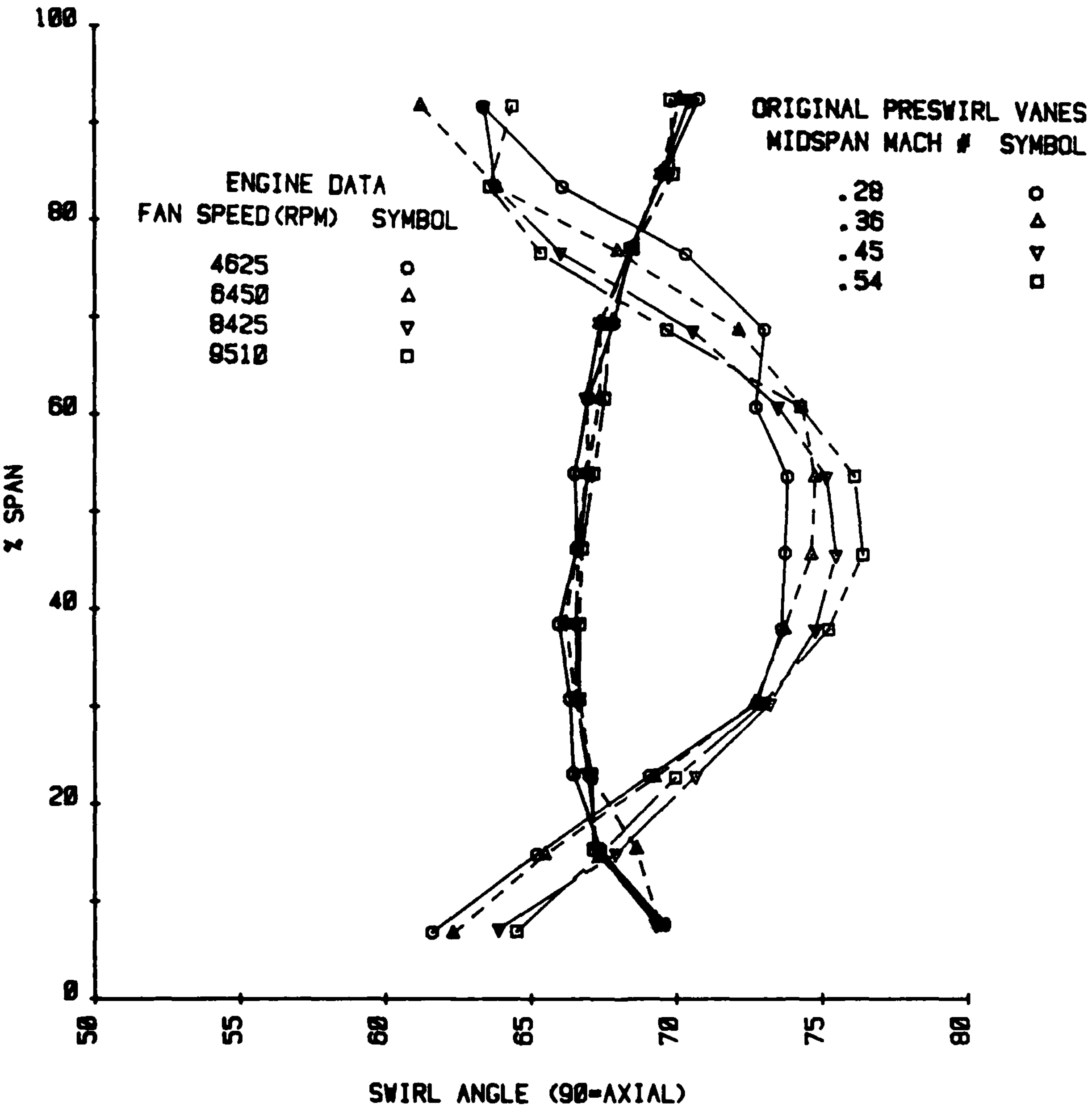


Figure 45. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 20^{o})

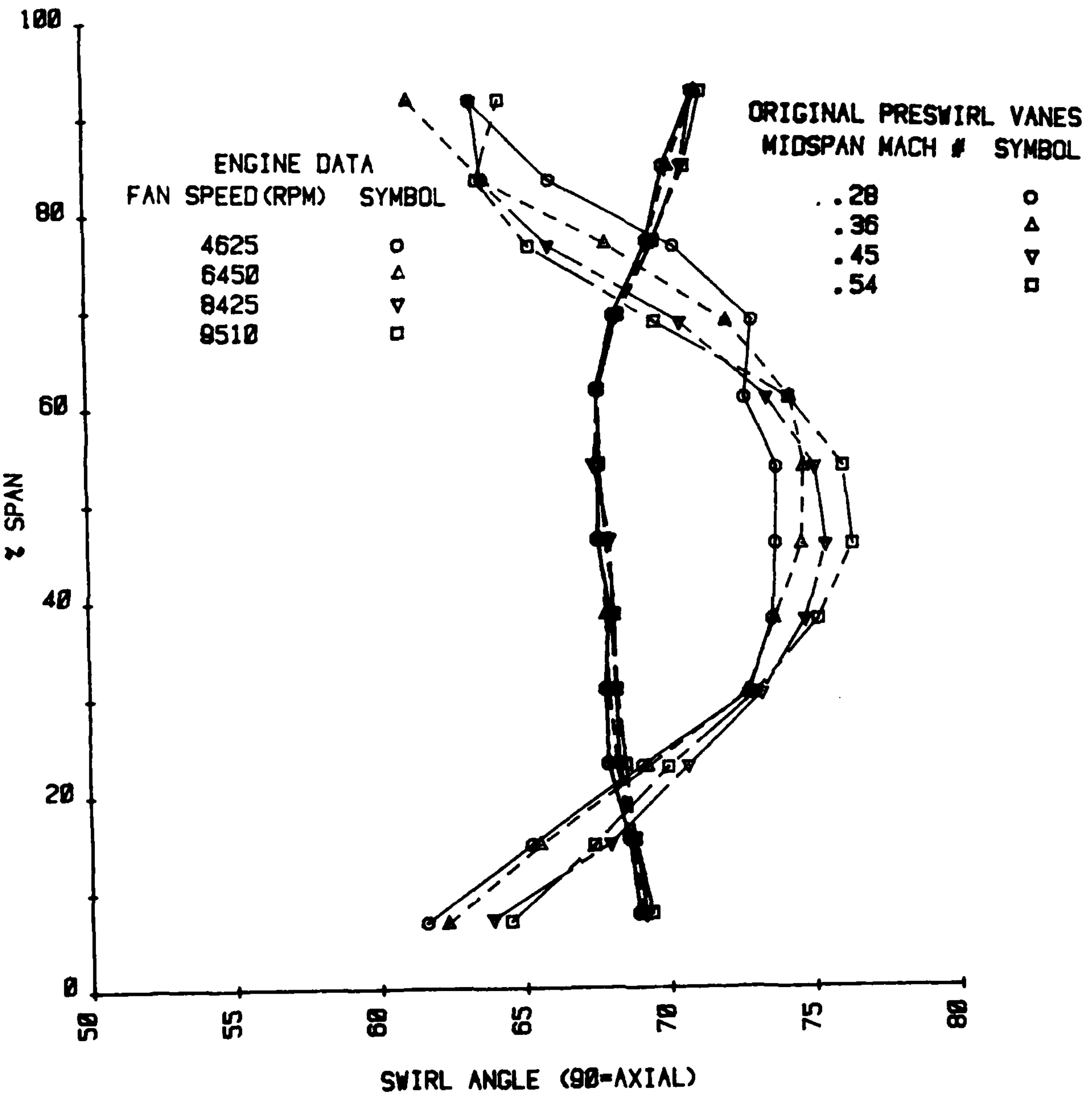


Figure 44. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 15^{O})

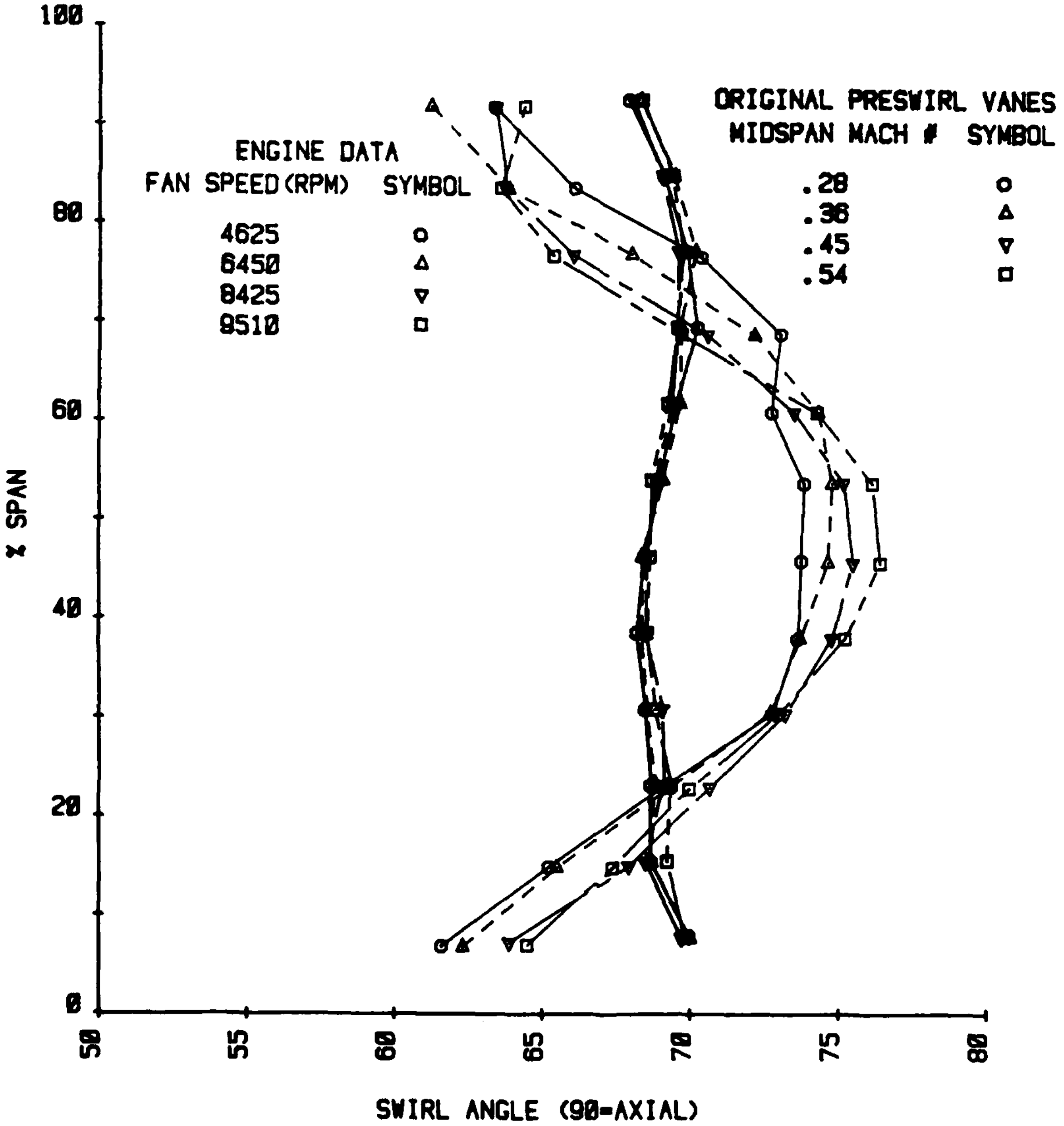


Figure 43. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 10^0)

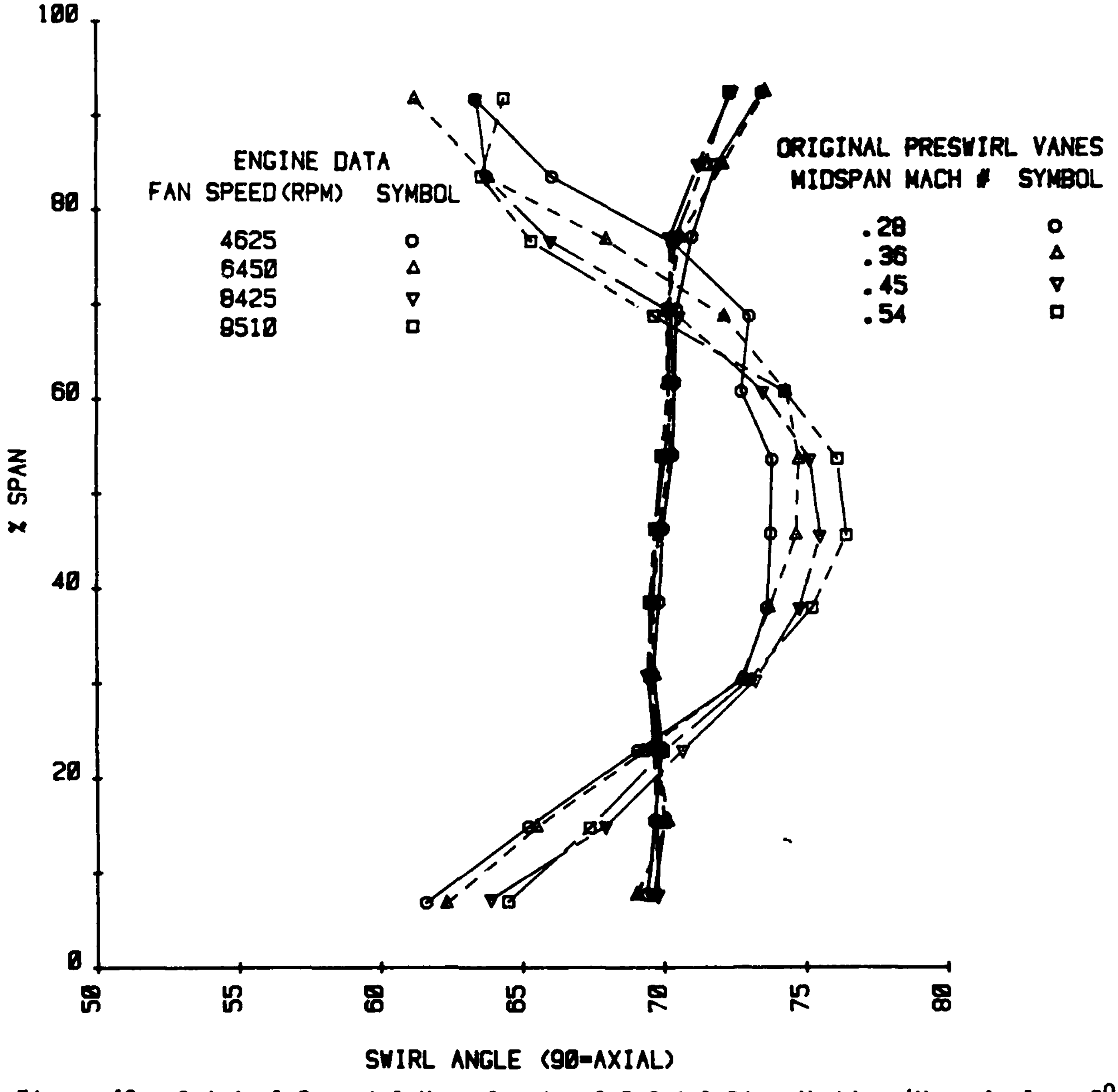


Figure 42. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 5^{0})

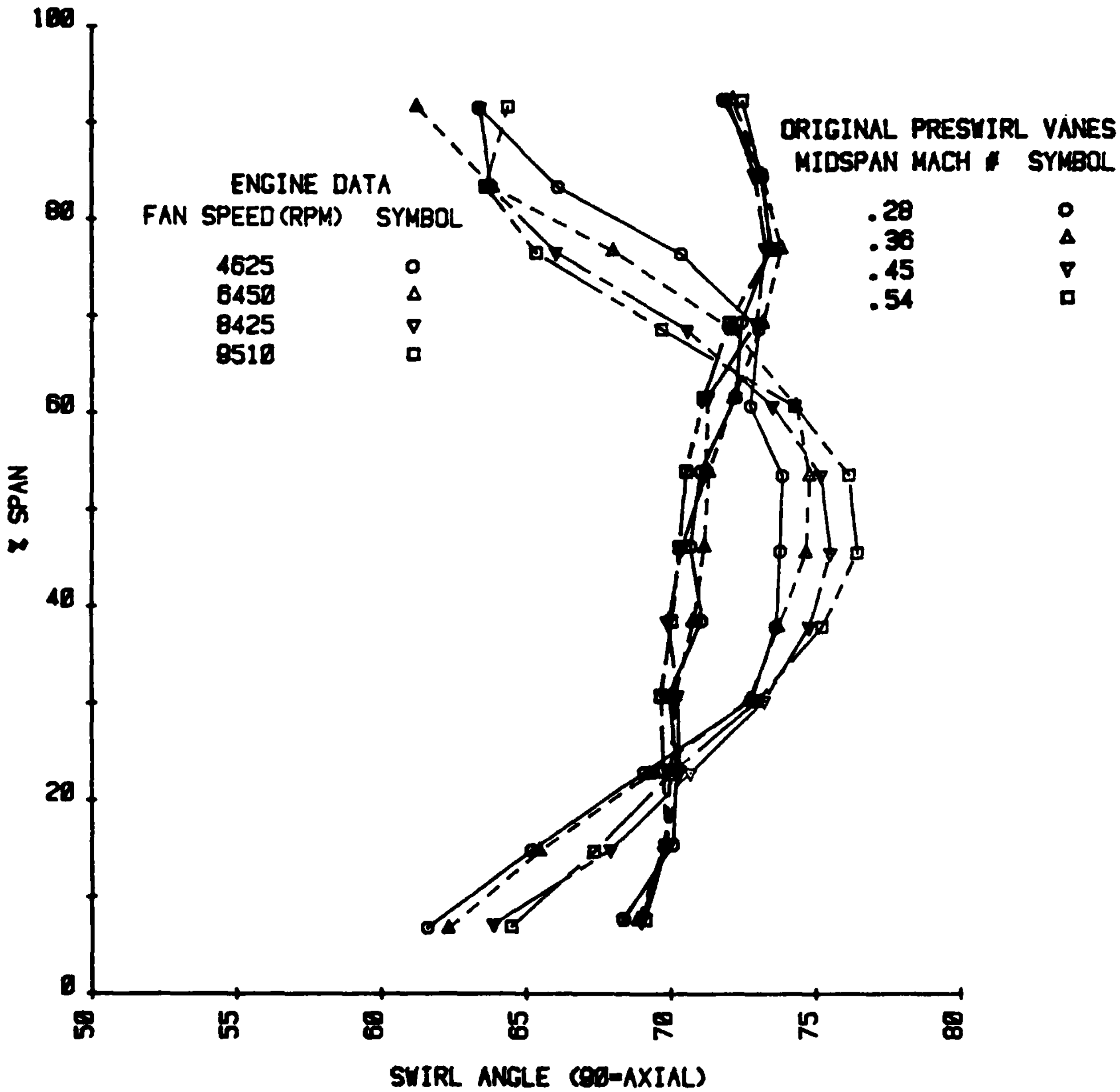


Figure 41. Original Preswirl Vane Station 2.5 Swirl Distribution (Vane Angle = 0^{o})

(9) During each data point, the program stored the following on tape:
- All individual average value points (raw data)
- Both sets of calibration constants
- Valves printed out in the short form printout mentioned above

6. RESULTS

The swirl angle profiles measured during this phase of testing are shown in Figures 41 through 48, the tabulated data is shown in Table D-2, Appendix D. Measured swirl profiles for the four selected midspan Mach number flow rates are superimposed with the swirl profiles, measured at the same location (Station 2.5) and respective flow rate, for the F100 engine S/N P072. All vane angle settings from 0 to 33 degrees indicate, as was previously anticipated, inadequate duplication of measured engine profiles.

They also indicate less than a three degree variation in swirl angle over the complete range of flows tested. Therefore, future testing of the modified preswirl vanes was accomplished without varying the flow rates over the complete range of engine operation.

The primary goal of this test phase of checking out the data acquisition process was accomplished, and the system was ready for future modified vane testing with little change.

TABLE 5

TRAVERSE CONTROL SETTINGS

	POSITION	PERCENT SPAN	TRAVERSE LINEAR VOLTS	TRAVERSE DEPTH (IN.)	MEASUREMENT PORT DEPTH (IN.)
	0	6.8	-.052	0.0	0.25
	1	7.7	-.134	.034	0.284
	2	15.4	-.819	0.318	0.568
	3	23.1	-1.505	0.602	0.852
	4	30.8	-2.187	0.885	1.135
	5	38.5	-2.873	1.169	1.419
	6	46.2	-3.558	1.453	1.703
	7	53.8	-4.243	1.737	1.987
	8	61.6	-4.928	2.021	2.271
	9	69.2	-5.614	2.305	2.555
	10	76.9	-6.297	2.588	2.838
	11	84.6	-6.982	2.872	3.122
	12	92.3	-7.667	3.156	3.406
AT SPLITTER	13	100.0	-8.352	3.440	3.69

(6) Option to either reduce printout and store the data, or return to step 2.

(7) Short form printout. Reduce data and print out the following in engineering units:

- Time of day - to be obtained from internal clock
- Date
- Point number
- Values for P1-PATM, P1-P2, P1-P3, P2-P3, P4-PATM, P5-PATM in psid
- T1, Tatm ^{O}F, traverse positions in percent span and degree of rotation.
- TT, PT, PS, Mach Number, swirl angle

(8) Plot Data

As the experiment proceeds, the following parameters were plotted as a function of percent span (traverse position)

- Mach number
- Swirl angle

test was position 2.5 midspan Mach number. With this continuous readout of Mach number, the exhauster control valves could be adjusted to obtain the flows matching the engine test.

A statement was added to the software which read the HP 2804A quartz thermometer through an IEEE interface. Provisions were also added to accommodate the measurement, calculation in engineering units, and printout of the bellmouth and station 2.5 wall static pressures for each data point. The output format for the on-line printout was also modified. An example of this printout is shown in Figure D-5, Appendix D.

5. DATA ACQUISITION

After completion of test article installation, data acquisition system changes and check-out, the traverse actuation system was mounted to the inlet hardware at Station 2.5. The alignment procedures followed are described in Section II.2.a.

The test plan was to acquire 12 data points across the span of the intermediate case at the 2.5 position. The spanwise locations and corresponding traverse control voltages are shown in Table 5. Four different midspan Mach number ranges were chosen to correspond to the engine fan speeds of 9,500, 8,500, 6,500 and 4,500 RPM. The corresponding station 2.5 midspan Mach numbers measured were .54, .45, .36 and .28. In addition to the flow rate variations, there were PSV setting variations. The vane angles of attack could be manually varied through a sync ring device described in Section III.3.c. The vanes could be varied over a range of 33 degrees. Eight different PSV settings were tested. The following is a list of steps that the data taking and recording system followed.

(1) Rotate wedge probe to null position.

(2) Calibrate transducers and store calibration constants for high/low calibration reference pressure.

(3) Take average, maximum, minimum, and deviation from 36 data points each of P5-PATM, P4-PATM, P1-P2, P1-P3, P2-P3. Take one data point of T1, Tatm, and traverse (radial and rotational) positions before and after taking the raw data points.

(4) Calibrate transducers for high/low pressure again.

(5) Print the calibration constants measured after the data taking and their respective percentage change from before to after data taking. Also, print out percentage change of traverse positions mean and maximum variation of all raw data.

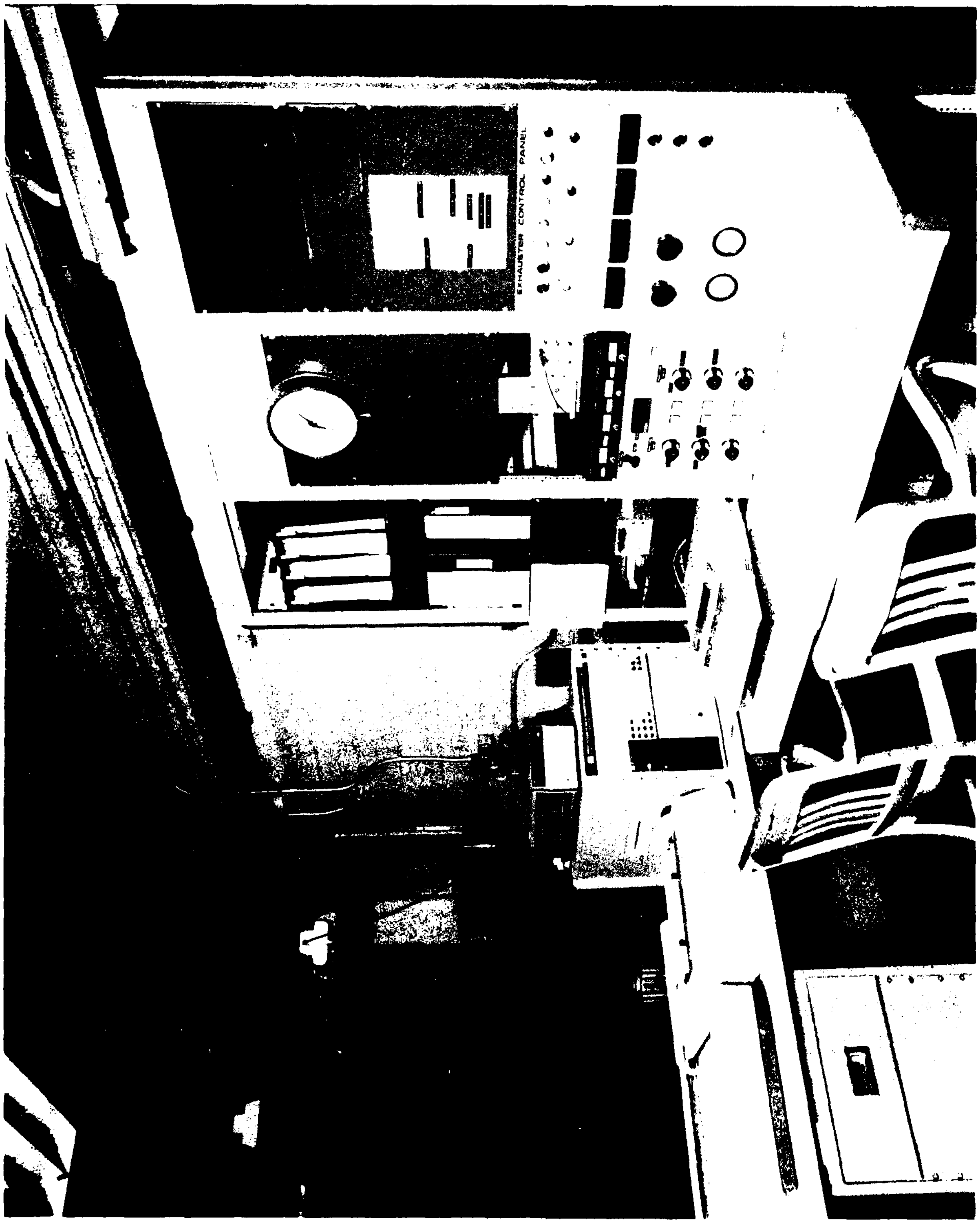


Figure 40. Data Acquisition Control Center

The order of pressure measurement shown in Table 1 was changed because only two transducers were required and additional wall static measurements were made. The revised order is shown in Table 4.

TABLE 4

PRESSURE SENSING ORDER

Measurement Order	Transducer 0-1 psid	Transducer 0-5 psid
1	0 psid	0 psid
2	1 psid	5 psid
3	0 psid	P5 - PATM
4	0 psid	P4 - PATM
5	P2 - P3	P3 - P1
6	P1 - PATM	P2 - P1
7	1 psid	5 psid
8	0 psid	0 psid
9	P2 - P3	0 psid

This scheme provided for a zero point and a full range point calibration of both transducers before and after each data point, as was the case in the previous test. Without this method of data acquisition, the scanivalve problem previously mentioned would have gone undetermined, resulting in erroneous measurements.

An HP 9872B plotter was also added to the data system to allow for plotting of selected measured parameters during the data acquisition process. The data acquisition system was installed in racks in the control room positioned in close proximity to the exhauster control panel, as shown in Figure 40. No other data acquisition hardware changes were required for the test.

b. Software Modifications

To accommodate the additional hardware and measurements added to perform this test, data acquisition computer program changes were required.

The basic data reduction equations remained the same as those defined in Section II.2.b. Provisions were made to calculate and display the mach number, determined from the wedge probe, continuously before each traverse. This was required because the parameter chosen to match the engine profile test and the inlet hardware

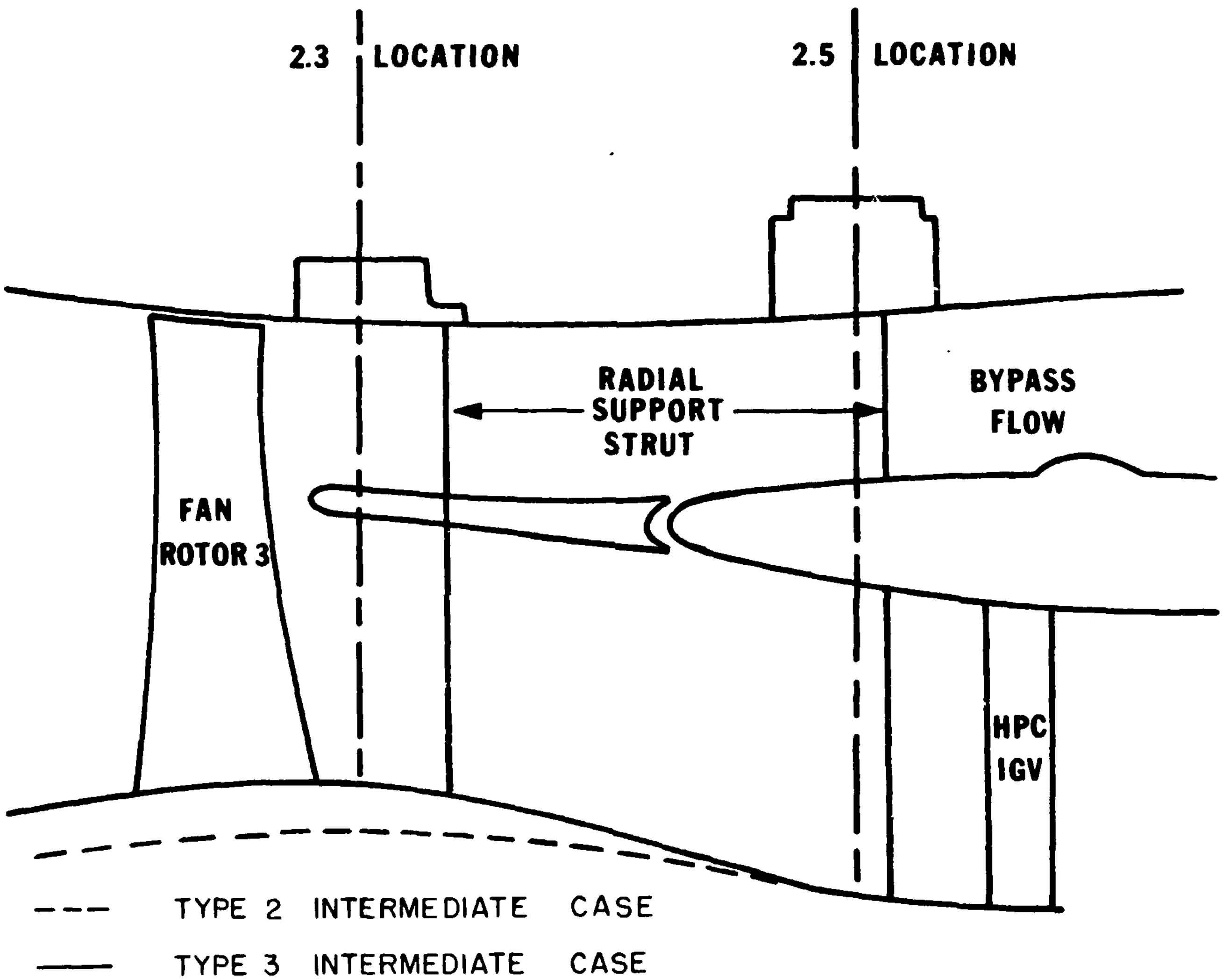


Figure 49. Intermediate Case Inner Diameter Flow Path Variations

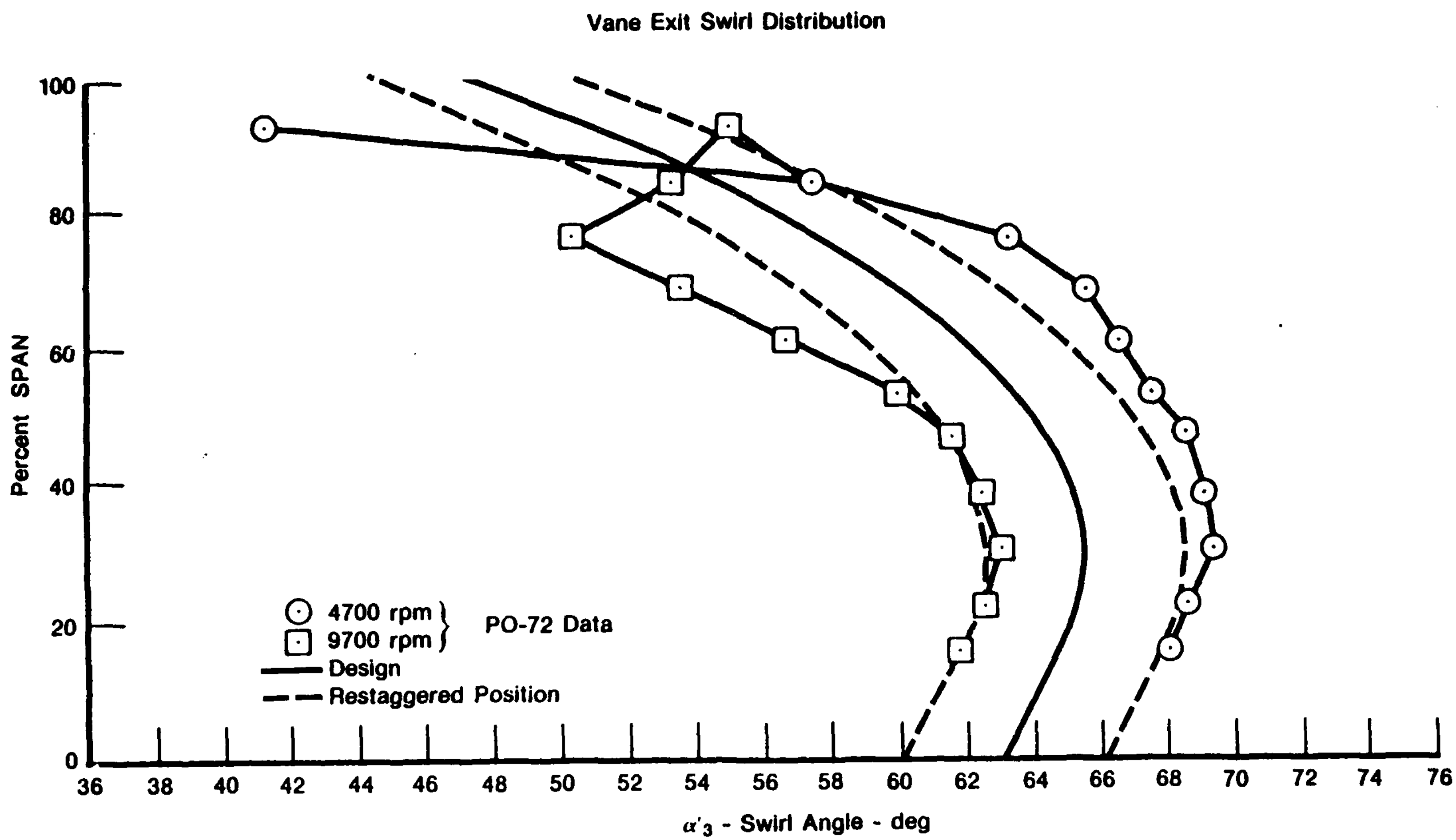


Figure 50. CRF/F100 Preswirl Vane, Vane Exit Swirl Distribution

The preswirl vane was designed using the test results defined in Reference 9 for 6 percent thick NACA 63 series guide vanes. A PSV setting of 20 degrees positions the vane leading edge axially. To accomplish the turning required at a minimum loss and maintain a reasonable vane camber distribution, increased cord was required. Details of vane geometry taken from Reference 8 are given in Appendix E. The final vane design is shown in Figure 51.

To simulate engine compressor inlet total pressure profile in the CRF/F100, a screen configuration was also designed by P&WA. The screen loss was defined in order to simulate the high engine speed profile shown in Figure 52. The screen discharge pressure profile was defined considering inlet end-wall boundary layer preswirl vane loss and swirl distribution to obtain the required pressure profile of station 2.5. Further details of this design can be found in Reference 8. The screens defined by this process are shown in Figure 53. The outer portion of the screen from 60 to 100 percent span was a .16 x .16 x .062 mesh, and the inner portion from 29 to 60 percent span was a .20 x .20 x .062 mesh.

3. DATA ACQUISITION SYSTEM

The data acquisition system utilized in this phase of testing is described in Section III.4. As a result of previous test experience, some minor modifications were performed to obtain more information. The changes are detailed in the following sections.

a. Hardware Modifications

During this phase of testing, the modified preswirl vanes described in Section IV.2 were installed in the inlet hardware sync ring assembly, as shown in Figure 54. The vanes were designed such that 20 degrees of actuation was available during testing. All traverse and instrumentation locations remained the same as the previous phase of testing. A station 2.5 engine total pressure rake (Figure 55) was installed in octant three of the intermediate case for use in calculating the station 2.5 corrected mass flow on-line. This was required for future data comparisons. The five compressor rake measurements were plumbed together to obtain an aerodynamic average total pressure at station 2.5. The fan duct portion of the rake was not utilized for this test. Due to the addition of this measurement, the scanivalve was reconfigured (as shown in Figure 56), where P6 is the station 2.5 rake average pressure.

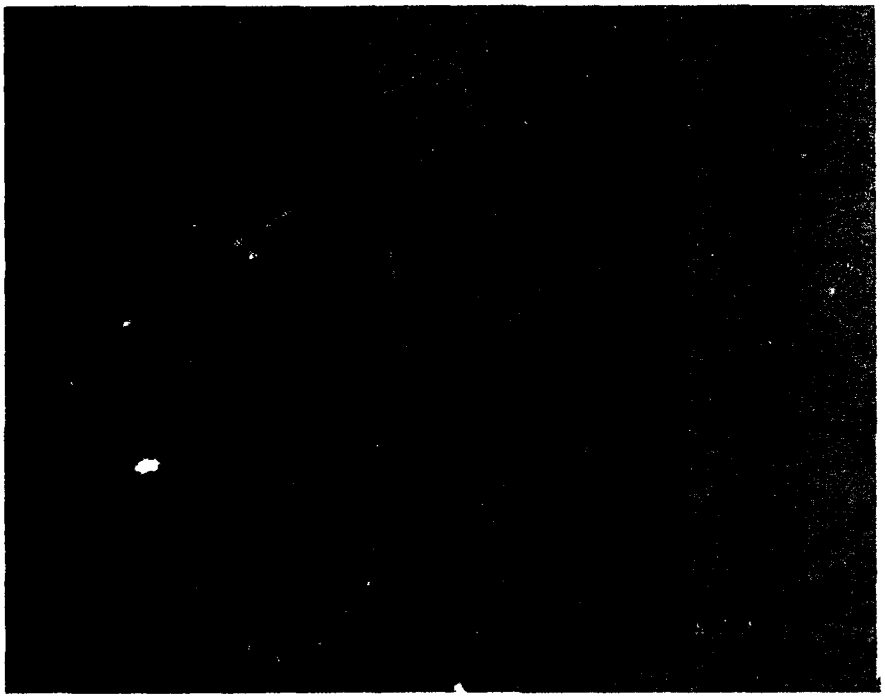


Figure 51. Modified Preswirl Vane

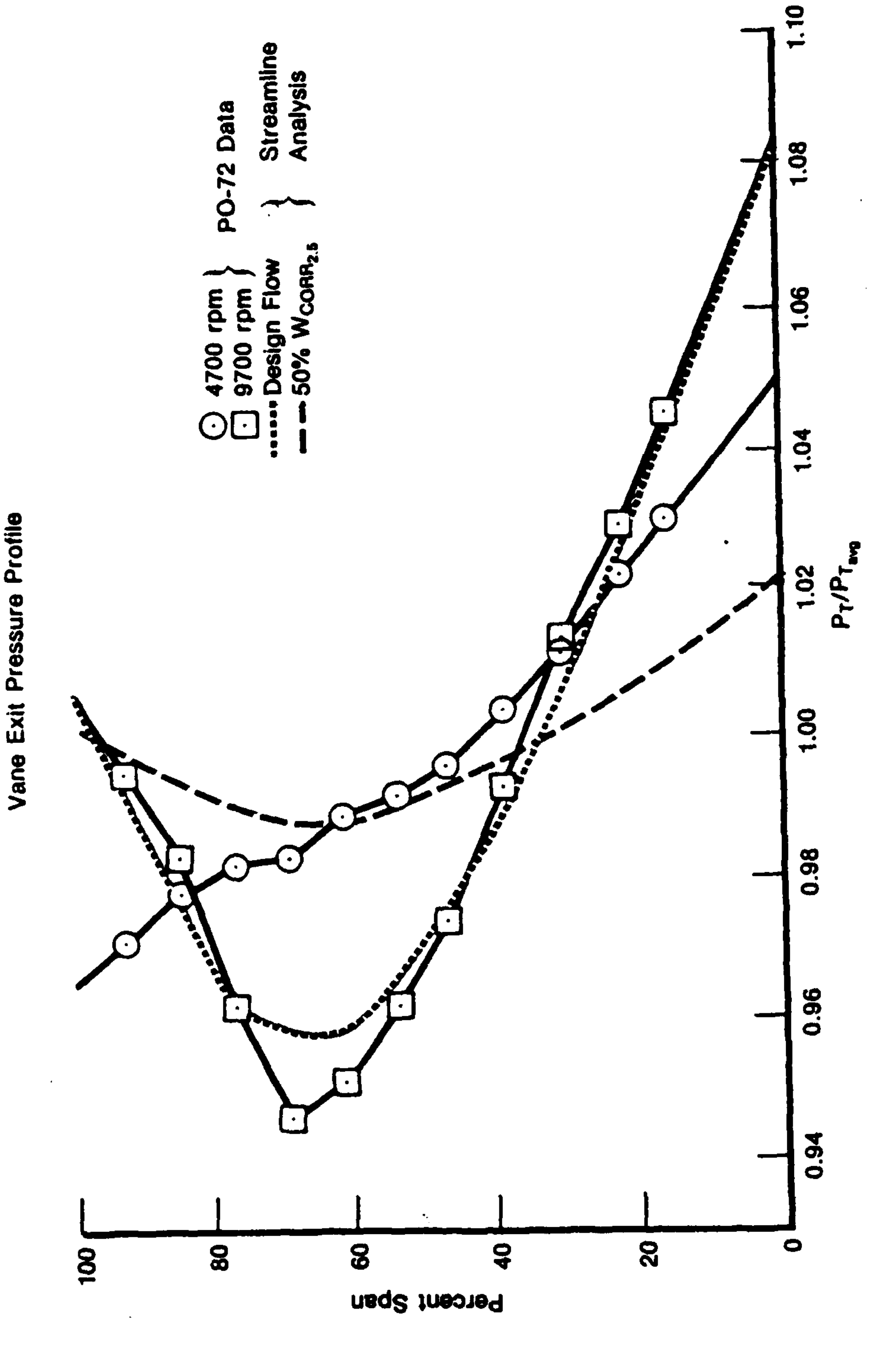


Figure 52. CRF/F100 Preswirl Vane, Vane Exit Pressure Profile

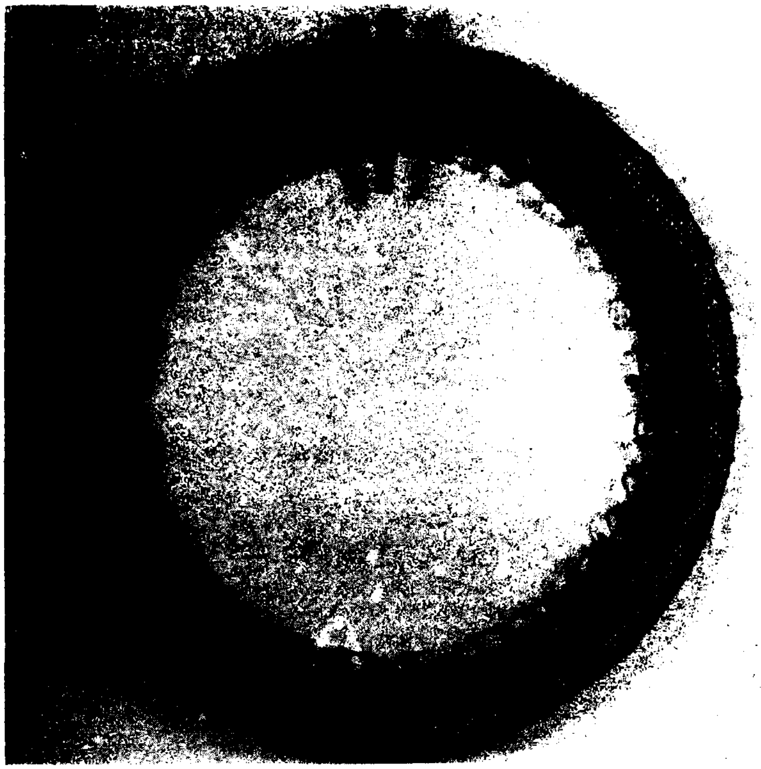


Figure 53. Phase I - Screen Configuration

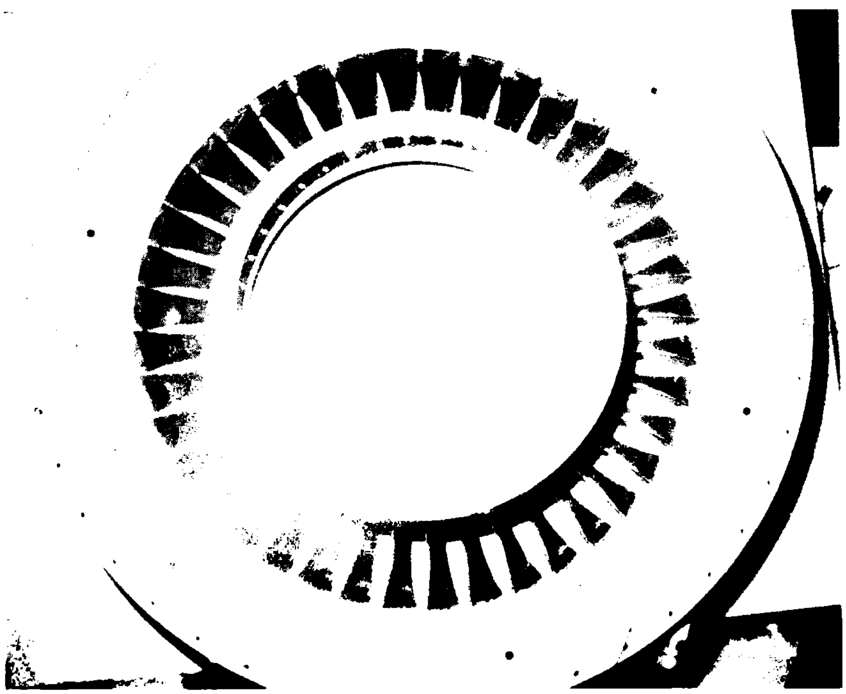


Figure 54. Modified Preswirl Vane Installation

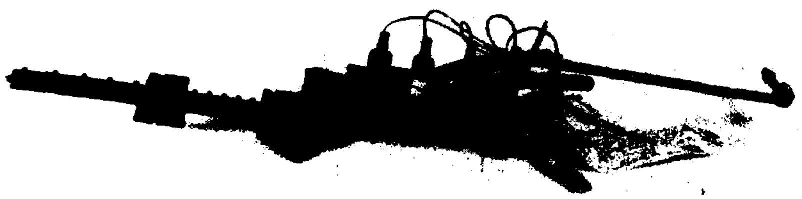


Figure 55. F100 Engine Total Pressure Probe

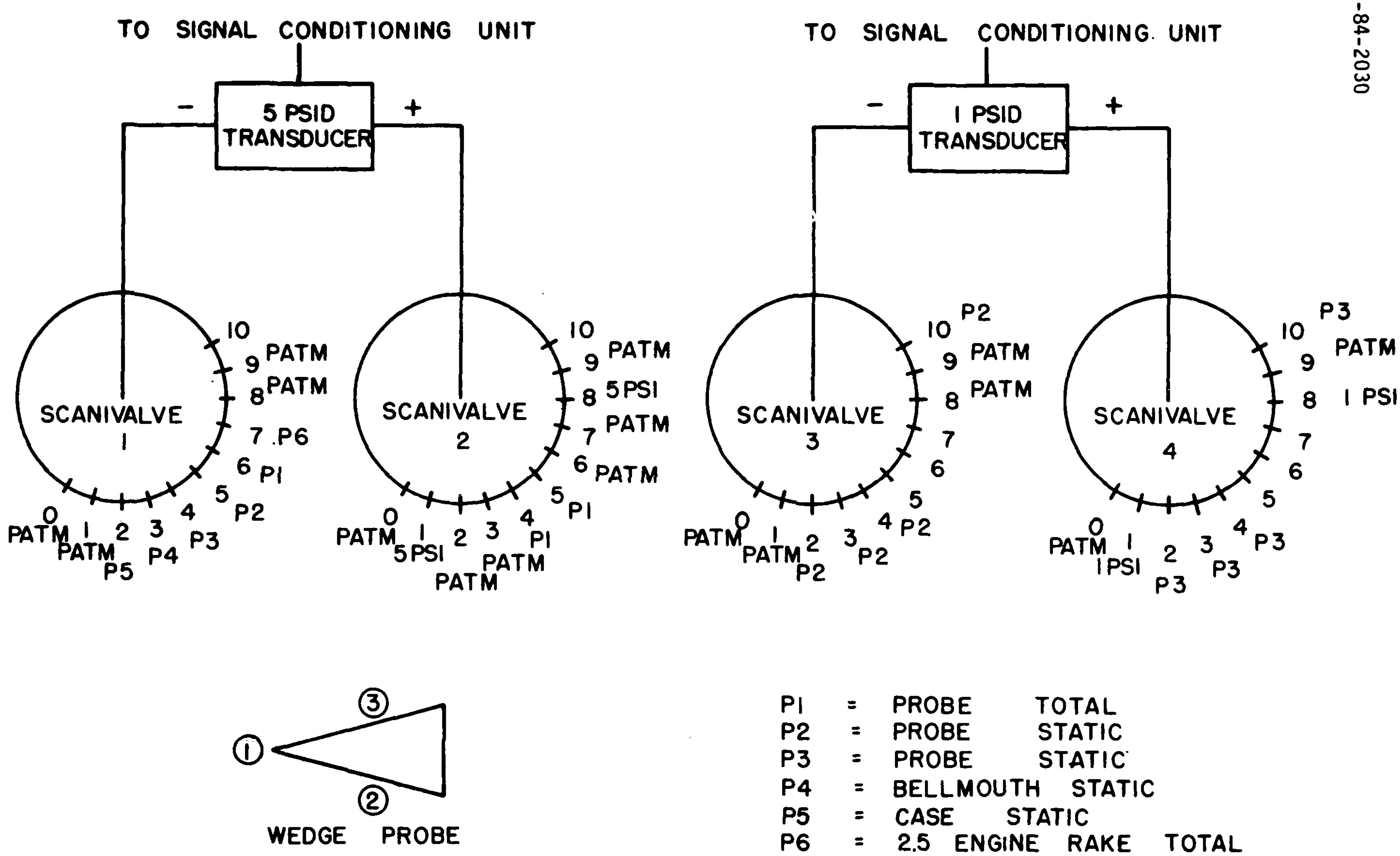


Figure 56. Modified Preswirl Vane Test (Phase I) Scanivalve Configuration

b. Software Modifications

The data acquisition software described in Section III.4.2 was modified to ommodate the additional measurement and associated corrected mass flow calculation. station 2.5 corrected mass flow was determined in the following manner.

s Flow

$$\dot{m} = \rho VA \tag{11}$$

For an ideal gas, this relation can be expressed in the following manner

$$\dot{m} = A \cdot PS \cdot \left[\frac{\gamma gc}{R} \cdot \frac{1}{TT} \left(\frac{PT}{PS}\right)^{\gamma-1/\gamma} \right]^{1/2} *M \tag{12}$$

Mach Number can also be expressed in terms of total and static pressure by the lationship defined in Equation 10. Therefore Equation 12 becomes the following

$$\dot{m} = A \cdot PS \cdot \left[\frac{\gamma gc}{R \cdot TT} \left(\frac{PT}{PS}\right)^{\gamma-1/\gamma} \right]^{1/2} * \left\{ \frac{2}{\gamma-1} \left[\left(\frac{PT}{PS}\right)^{\gamma-1/\gamma} -1 \right] \right\}^{1/2} \tag{13}$$

Rearranging Equation 13 the following relation is obtained

$$\dot{m} = A* \left(\frac{2 \cdot g_c}{R} \cdot \frac{\gamma}{\gamma-1}\right)^{1/2} * PS* \left\{ \left(\frac{PT}{PS}\right)^{\gamma-1/\gamma} * \left[\left(\frac{PT}{PS}\right)^{\gamma-1/\gamma} -1 \right] * \frac{1}{TT} \right\}^{1/2} \tag{14}$$

Using the bellmouth area at station 2.0 of 271.8 in^2 and the values of the onstants for air at room temperature the following relation is obtained

$$\dot{m} = 558.5 *PS* \left\{ \left(\frac{PT}{PS}\right)^{1/3.5} * \left[\left(\frac{PT}{PS}\right)^{1/3.5} -1 \right] \cdot \frac{1}{TT} \right\}^{1/2} \tag{15}$$

Equation 15 was used to determine the actual mass flow where

$$PS = PATM - P4 \tag{16}$$

$$PT = PATM \tag{17}$$

$$TT = \text{Quartz Thermometer Temp} \tag{18}$$

:ted Mass Flow

ne mass flow was corrected to station 2.5 conditions by the following relation

$$\dot{m}_{corr} = \left(\dot{m} \cdot \sqrt{\frac{TT}{519}}\right) / \left(\frac{PT2}{14.7}\right) \qquad (19)$$

Rearranging Equation 19, the corrected mass flow can be expressed as the wing

$$\dot{m}_{corr} = \dot{m}\ (.645)\ \sqrt{TT}/PT2 \qquad (20)$$

Equation 20 was used to determine the corrected mass flow for the test where

$$PT2 = PATM - P6 \qquad (21)$$

These equations were incorporated into the data acquisition software. The wing additional information was added to the on-line printout format:

(1) Vane angle

(2) Rake total pressure

(3) Mass flow

(4) Corrected mass flow

cample of the output is shown in Figure E-6, Appendix E.

Upon completion of all required changes, the data acquiaition hardware and vare was checked by an end-to-end verification as before. The process required that id-weight tester pressure be applied to the sensing tubing of P1 thru P5, ectively. Each time a pressure was applied, the data acquisition sequence was iated and the resulting pressure printed out was compared with the dead-weight sure setting. In all cases the pressure compared with less than the ± 1 percent defined by the uncertainty analysis. Therefore, the data acquisition system repared for the data acquisition phase of this test.

DATA ACQUISITION

The same data acquisition procedures described in Section III.5 were followed. were acquired for preswirl vane angle settings of 0, 5, 10, 15 and 20 degrees nidspan Mach number settings of .54 and .45. A midspan Mach number setting of was also obtained for vane settings of 10, 15 and 20 degrees. Plots of swirl e and Mach number versus percent span were obtained on-line to aid in data fication. For further data acquisition confidence, selected traverses were ated on different test days. These traverses indicated duplication of results in the prescribed accuracy. Additional traverses were obtained at a different umferential location by removing the traverse from octant eight, placing it into nt one, and re-establishing the required flow rate. The traverse and wedge e was then removed from the station 2.5 location and placed at the 2.3 location btain further information for comparison with design data. This information was ssary because the vanes were designed to produce the 2.3 profiles, as described ection IV.2. Data were obtained at the 2.3 location for vane angles 0, 5, 10, nd 20 degrees and flow rates corresponding to station 2.5 midspan Mach number of and .54. These corrected flow rates were approximately 45 lb/sec and 53 lb/sec, ectively. These flow rate settings were determined as noncritical in affecting l distributions from previous test results. Therefore, they were adjusted to in 1 lb/sec of the desired rate to conserve test time. The station 2.3 and 2.5 obtained during this phase of testing is presented in tabular form in Table Appendix E.

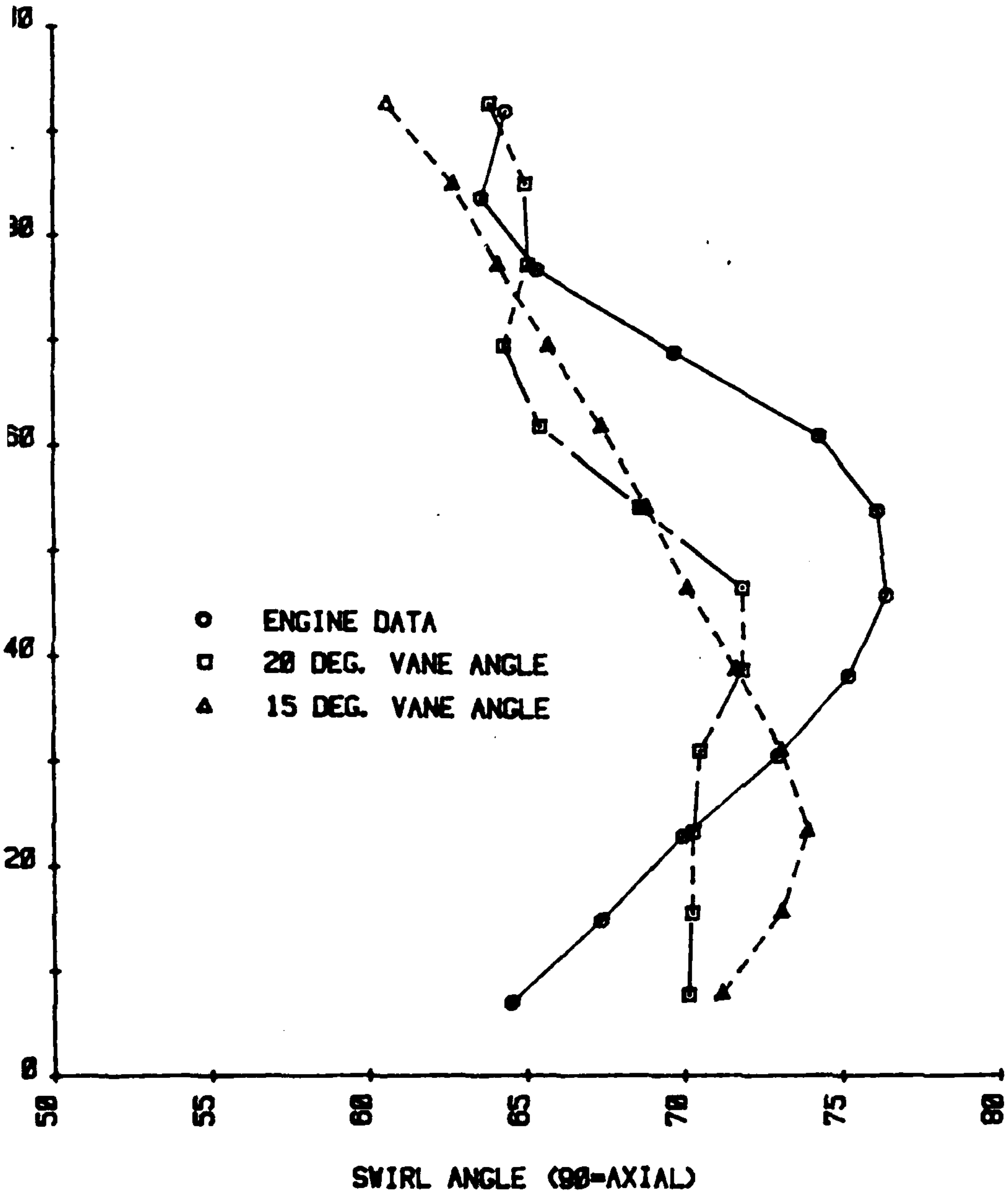
DATA REDUCTION AND ANALYSIS

Further post test data reduction was performed to obtain total pressure profile s at the 2.3 and 2.5 locations. These plots and selected swirl distribution s are presented in Figures E-7 thru E-23, Appendix E. These profiles were ared with the measured engine profiles to determine the adequacy of the screen gn.

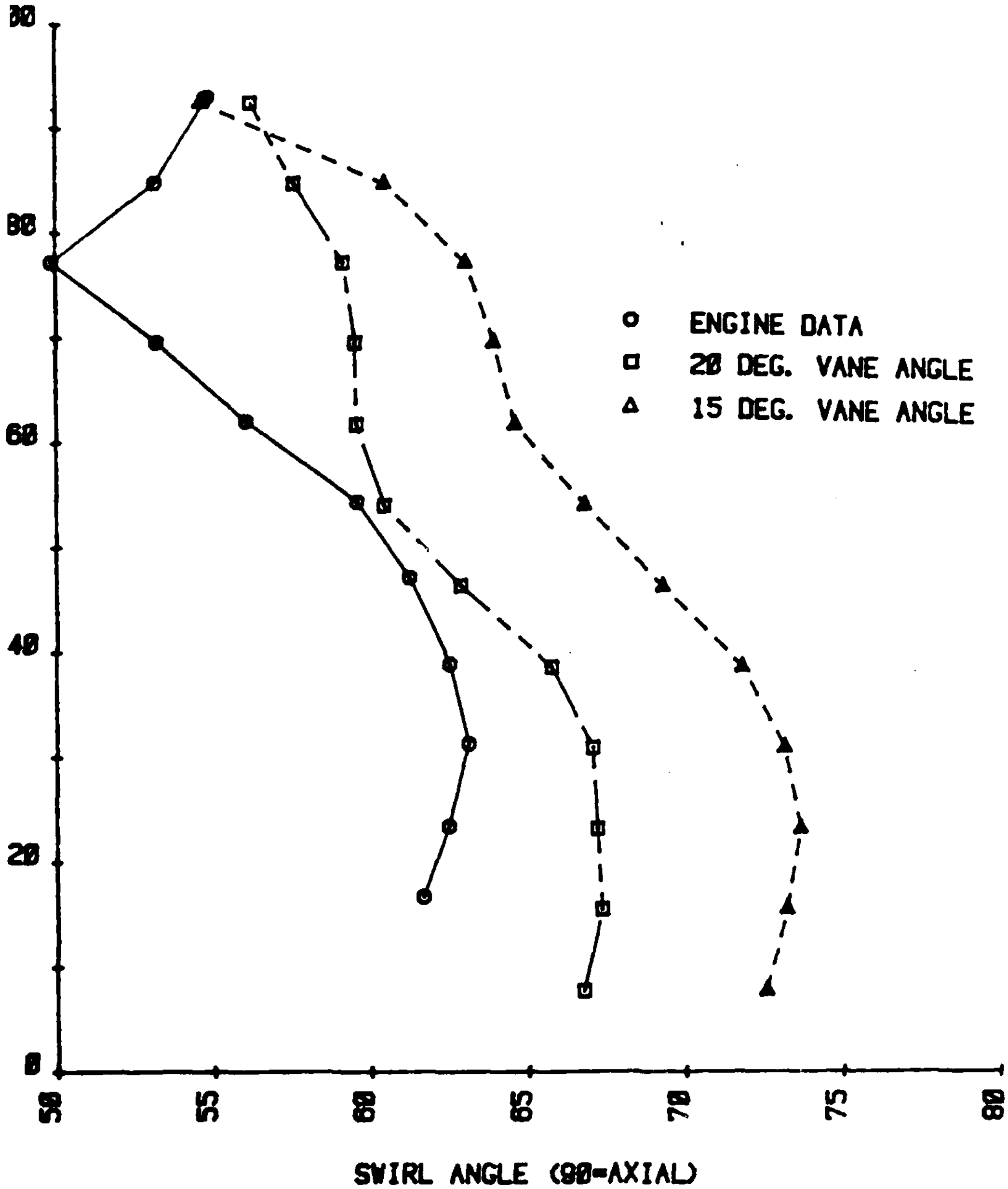
An investigation of the swirl distribution provided at station 2.5 indicates the modified preswirl vanes did provide a spanwise swirl distribution which es much more than the one produced by previous existing vanes although they l did not match the required engine profiles. Indications are that the swirl ribution varies insignificantly with flow rate; therefore, it was not considered analysis. Further investigation of the swirl data indicates the overall does not vary for vane angle settings of 0, 5, 10 and 15 degrees; the s appear to only be shifted. Comparison between the profiles obtained at a 15 degree PSV setting indicated a marked change in the overall profile, as n Figure 57. The profile that was obtained for a PSV setting of 20 degrees of the profiles that was duplicated, as previously mentioned, therefore ıg that this distribution existed. Further investigation of the station 2.3 ːs for these settings indicate that they approached the required engine shown in Figure 58, but did not achieve it. Streamline analysis performed predict this change in swirl distribution at station 2.5 for a 5 degree ıon in vane setting. This variation in profile was perceived to be due to ːparation on the eight support struts. Separation of flow could explain the ɾirl distribution discussed in Section II.4. The swirl profile measured at 2.5 for a vane setting of 20 degrees agreed more closely to the engine ːs than any other profile produced thus far.

tation 2.5 total pressure profiles also indicate a considerable change with ıgle variations from 15 to 20 degrees. A reduction in total pressure results lower 50 percent span and increases in total pressure results at the upper 50 t span. Figure 59 shows this variation, and it also indicates that the 20 s vane angle setting total pressure profile duplicates the engine data for the 50 percent span.

ith these results it was apparent that although the modified preswirl vanes eens did provide profiles with more variation than the original vanes, they t match the measured engine profiles. Specifically, the swirl profiles ed less turning in the midspan region and the total pressure profile required ation at the outer 50 percent span. As indicated in the above results, the rofiles became more like the engine swirl profiles when the vanes were ed from 15 to 20 degrees. It was anticipated that further actuation above 20 s may lead to profiles even more like those measured in the engine. The ıg inlet hardware configuration did not allow for actuation above 20 degrees vane O.D. edges binding on the screen holder rotator ring. A recommendation de for modifications to the vanes and screen holder assembly to allow for 35 of actuation. Also, to provide for corrections for the total pressure ions at the outer 50 percent span, it was recommended that a screen be added



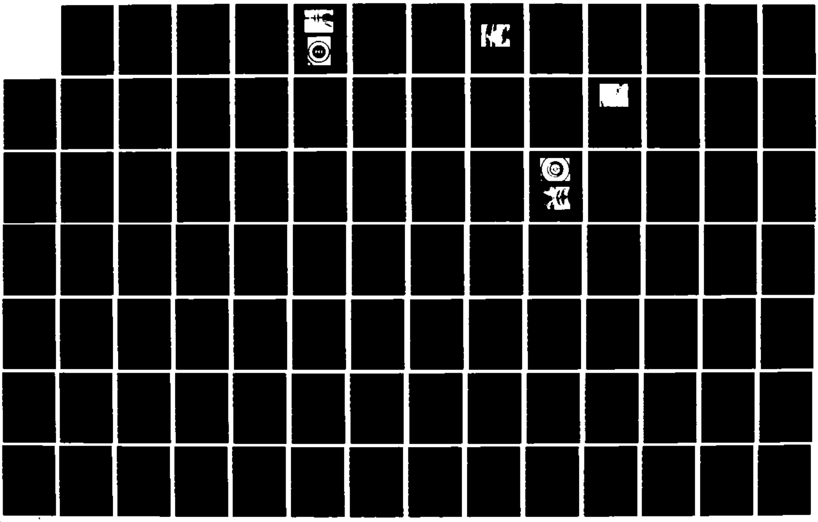
57. Station 2.5 Swirl Profile Comparisons (Modified Preswirl Vanes - Phase I)

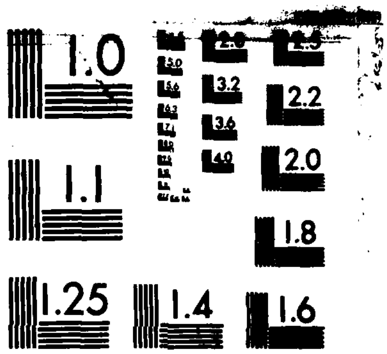


3. Station 2.3 Swirl Profile Comparisons (Modified Preswirl Vanes - Phase I)

AD-A157 108 COMPRESSOR RESEARCH FACILITY F100 HIGH PRESSURE COMPRESSOR INLET TOTAL PR..(U) AIR FORCE WRIGHT AERONAUTICAL LABS WRIGHT-PATTERSON AFB OH

UNCLASSIFIED W W COPENHAVER OCT 84 AFWAL-TR-84-2030 F/G 21/5 NL





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

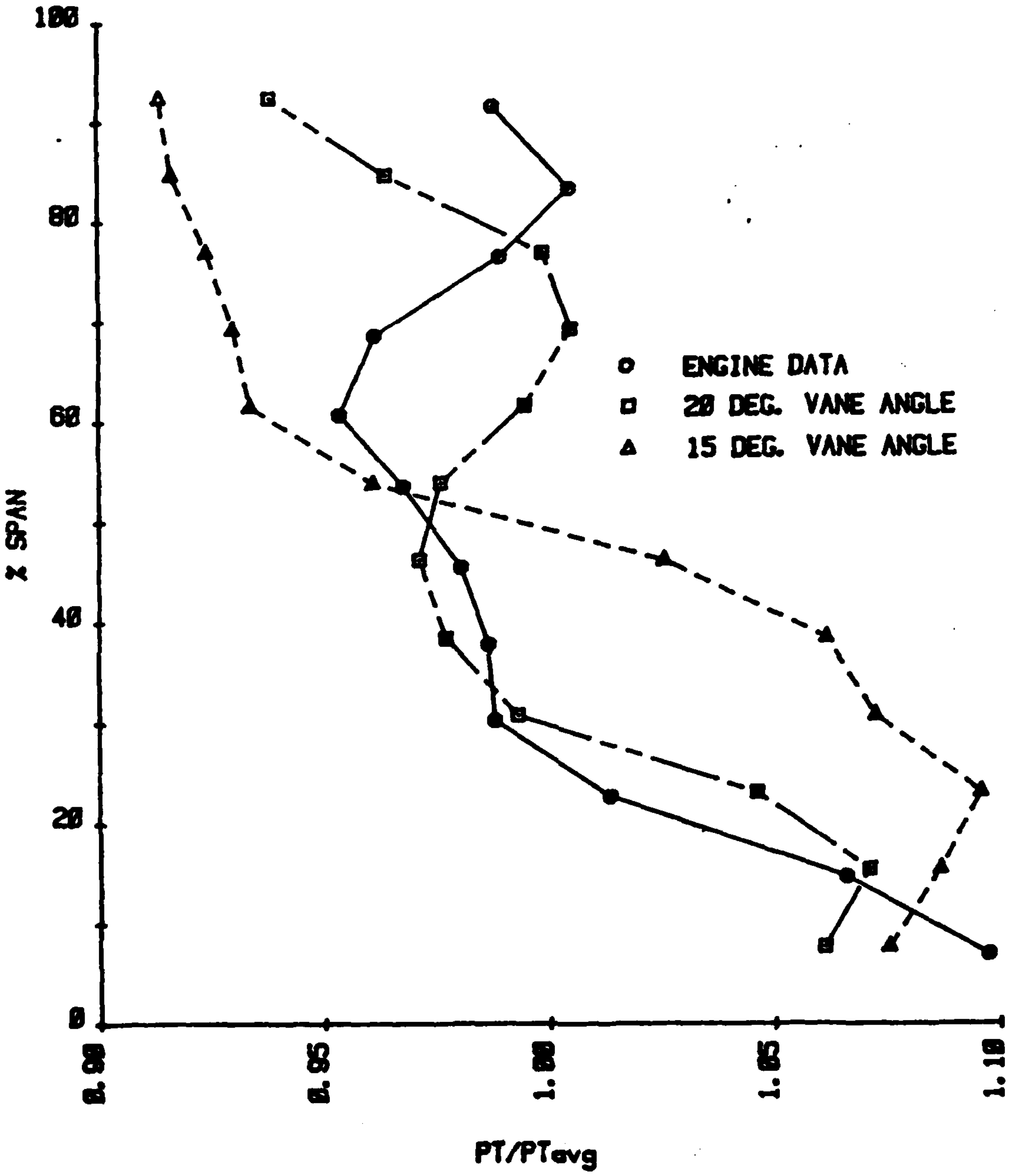


Figure 59. Station 2.5 Total Pressure Comparisons (Modified Preswirl Vanes - Phase I)

to the existing screen, thereby, reducing the total pressure at the area entering the preswirl vanes. It was anticipated that this would reduce the total pressure at the outer 50 percent span at station 2.5. With these recommendations, an additional phase of testing was undertaken to attempt to obtain improved profiles.

SECTION V

MODIFIED PRESWIRL VANE AND SCREEN TEST (PHASE II)

1. GENERAL REQUIREMENTS

In an attempt to better simulate the measured P072 engine profiles described in Section II.4, an additional test was undertaken. This test incorporated the recommendations for inlet hardware improvements (Section IV.5) to determine if their conclusion would result in improved results. Additionally, test procedures were modified to allow for improvements deemed necessary from previous test experience. The following subsections describe the modifications made to the inlet hardware and to the overall test procedures. They also detail results obtained from this phase of testing.

2. PRESWIRL VANE AND SCREEN MODIFICATIONS

As was recommended in the previous section, the preswirl vanes were modified by P&WA to allow for increased actuation. This was accomplished through two procedures. First, the O.D. vane edges were ground to eliminate binding when they are actuated above 20 degrees. Second, the rotating screen holder assembly described in Section III.3.c was replaced by a stationary holder shown in Figure 60. The clearance required for the bearings on the rotating holder was allowing the ring assemb' ' to drop down on the vanes positioned at the top of the test article resulting in additional binding. After completion of these two modifications, 35 degrees of vane actuation was available.

The inlet screen profile was modified by the addition of a screen (designed by P&WA) to the existing configuration, as shown in Figure 61. The additional screen was a .25 x .25 x .062 mesh between 50 and 90 percent span. This screen combination was defined in the data as Screens=3.

3. DATA ACQUISITION SYSTEM

The data acquisition system used during this phase of testing was modified from the previous tests to provide additional information and reduce test time. As was determined during the previous test, station 2.3 information was required to

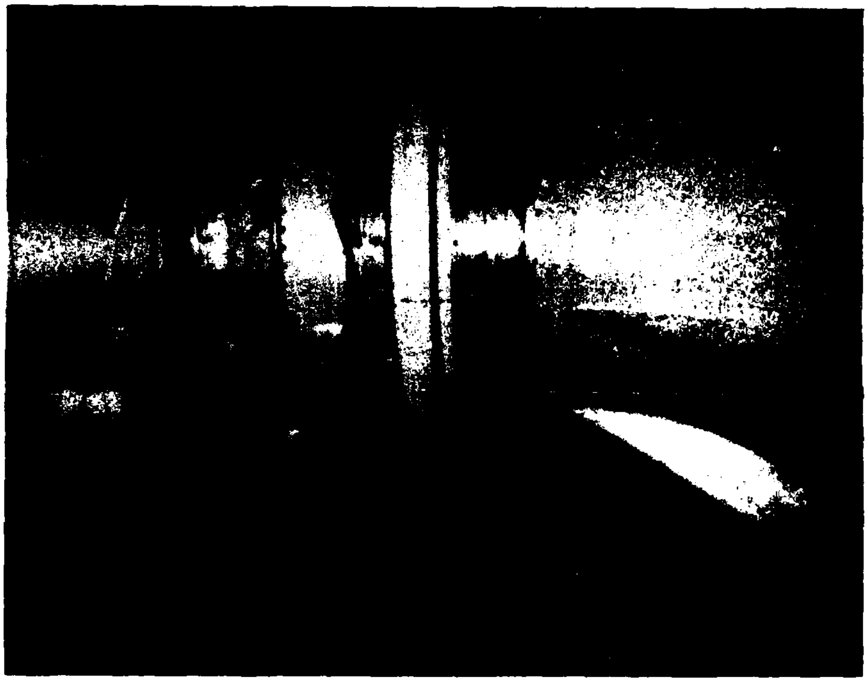
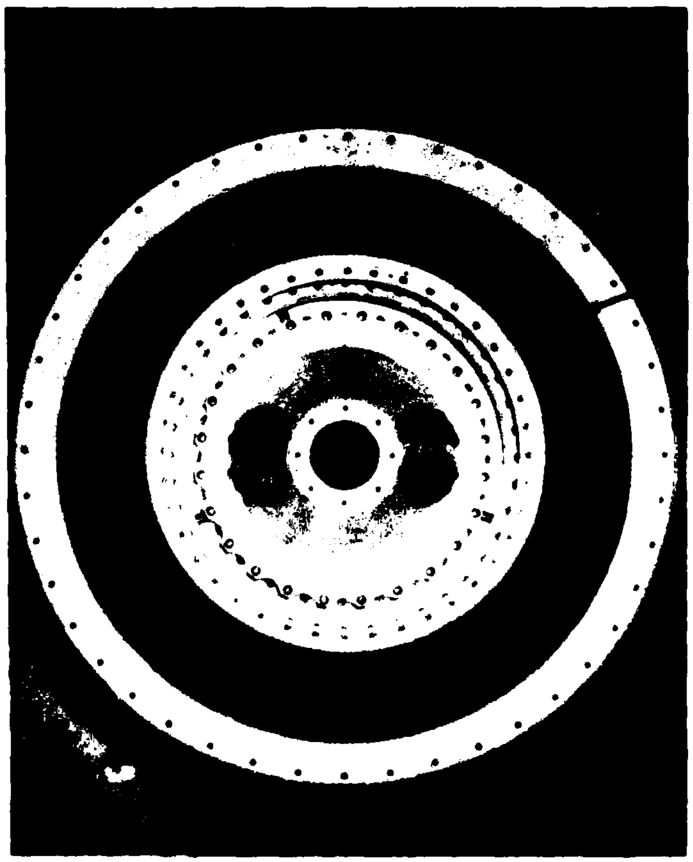


Figure 60. Stationary Screen Holder



ADDITIONAL
SCREEN

Figure 61. Phase II - Screen Configuration

determine a complete evaluation of design changes. Provisions were made to obtain data at station 2.3 and station 2.5 simultaneously and thereby reduce test time significantly. In addition, after discussion with P&WA, it was determined that information was required about the flow, swirl angle and total pressure, behind the compressor inlet guide vanes. These conditions are the compressor inlet conditions. Provisions were made to obtain this data. The changes required to the hardware and software to incorporate these additional requirements are detailed in the following paragraphs.

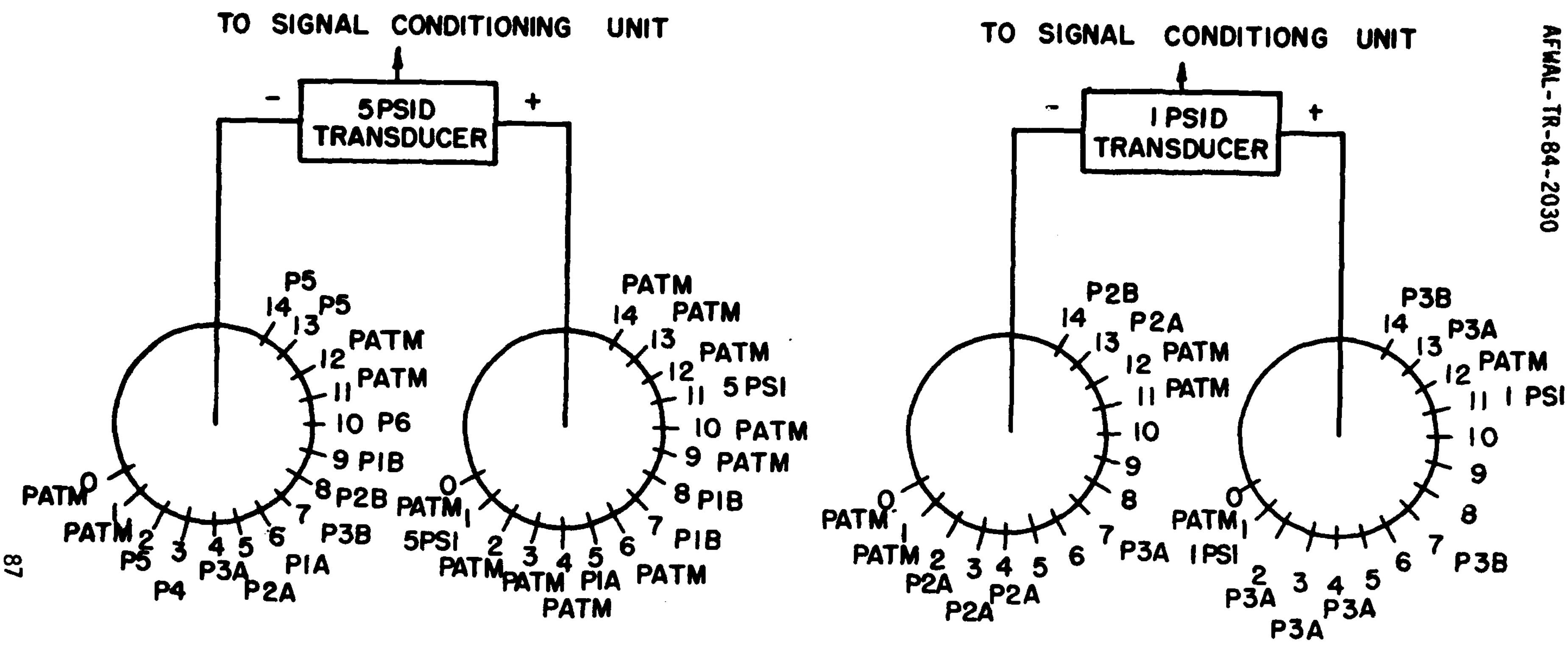
a. Hardware Modifications

The primary data acquisition hardware change required was to accommodate an additional traverse and wedge probe at station 2.3. This addition was made to reduce test time by obtaining both station 2.3 and station 2.5 information simultaneously. The addition of a traverse and wedge probe resulted in five additional measurements; three pressures from the station 2.3 wedge probe (probe B) and two traverse potentiometer signals from the additional traverse. To accommodate these measurements, the scanivalve was altered to the configuration defined in Figure 62. Wedge probe A is the station 2.5 probe.

In addition to this change, an alternate method for determining vane angle setting was required as the original indicator could not be attached to the new stationary screen holder. The modified vane position indicator was attached directly to a vane stem with a fixed pointer, as shown in Figure 63. All other data acquisition hardware remained the same as described in Section IV.3.a.

b. Software Modifications

Due to the additional measurements required from station 2.3, the data acquisition computer program was modified. Changes were made in the program to direct the scanivalve to the 14 different ports and acquire the data from the additional wedge probe. All data reduction procedures defined in Section II.2.b were followed for the station 2.3 probe. The Mach number at station 2.3 was determined as defined in Section IV.3.b. The on-line data output prints and plots were modified to provide for the additional information (example is shown in Figure F-1, Appendix F). Plotting was modified to produce the swirl profiles measured on a background of the engine design flow (54 lb/sec) swirl profile. This plotting



P1A	=	WEDGE PROBE A TOTAL
P2A	=	WEDGE PROBE A STATIC
P3A	=	WEDGE PROBE A STATIC
P1B	=	WEDGE PROBE B TOTAL
P2B	=	WEDGE PROBE B STATIC
P3B	=	WEDGE PROBE B STATIC
P4	=	BELLMOUTH STATIC
P5	=	INTERMEDIATE CASE STATIC
P6	=	2.5 RAKE TOTAL

Figure 62. Modified Preswirl Vane Test(Phase II) Scanivalve Configuration

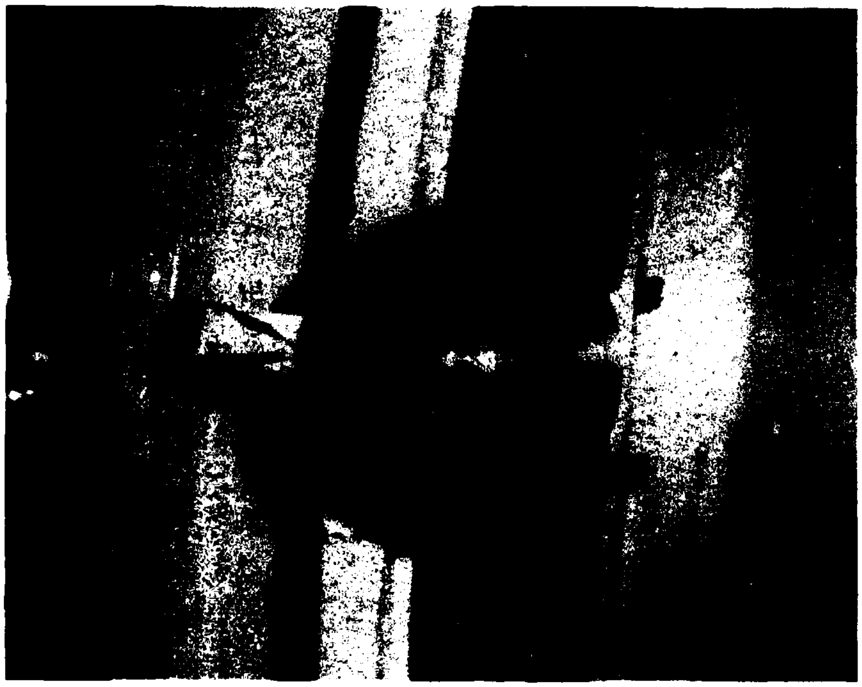


Figure 63. Modified Vane Position Indicator

option was added to allow for more direct comparison of the achievements of the preswirl vanes. The provision was also made in the program to produce total pressure profiles measured on the engine profile background after each traverse was completed. A listing of this modified program is shown in Appendix F.

4. DATA ACQUISITION

The goal of this test was to determine if the recommended modifications made in the screens and vanes would provide profiles that match profiles measured in F100(3) S/N P072 engine. The test plan was defined to obtain this information. The complete test plan for this phase of testing is shown in Appendix F. Before testing began, an end-to-end calibration of the data acquisition system was completed. This calibration indicated the desired data accuracy of ± 1 percent was achieved.

All traverses were obtained for a corrected mass flow of approximately 54 lb/sec or maximum exhauster capabilities. Some hardware configurations resulted in slightly reduced flow rates from the exhausters defined in Section III.2. This did not present a problem since previous test results indicated no appreciable change in profiles exists with a 2 lb/sec flow rate variation. Data were obtained at preswirl vane settings of 0, 10 and 15 degrees with the screen set defined in Section IV.2 without the additional screen for comparison with the results of the previous phase of this test. This data will indicate the profile variations due to PSV and screen holder changes defined in Section V.2 and the reinstallation of the hardware in the test facility.

5. DATA ANALYSIS

a. Swirl Angle Profiles

Tabular data obtained during this phase of testing is shown in Table F-1, Appendix F. As previously stated, one of the goals of this test was to determine the effects on the profiles of hardware modifications and reinstallation in the test facility.

The modifications made to the hardware described in Section V.2 should have had minimal effect on the profiles for vane angle settings of 0 to 20 degrees. Swirl data obtained in this phase of testing compared with that obtained under the same conditions (Section V.5) is shown in Figures 64 thru 67. Figure 64 indicates a

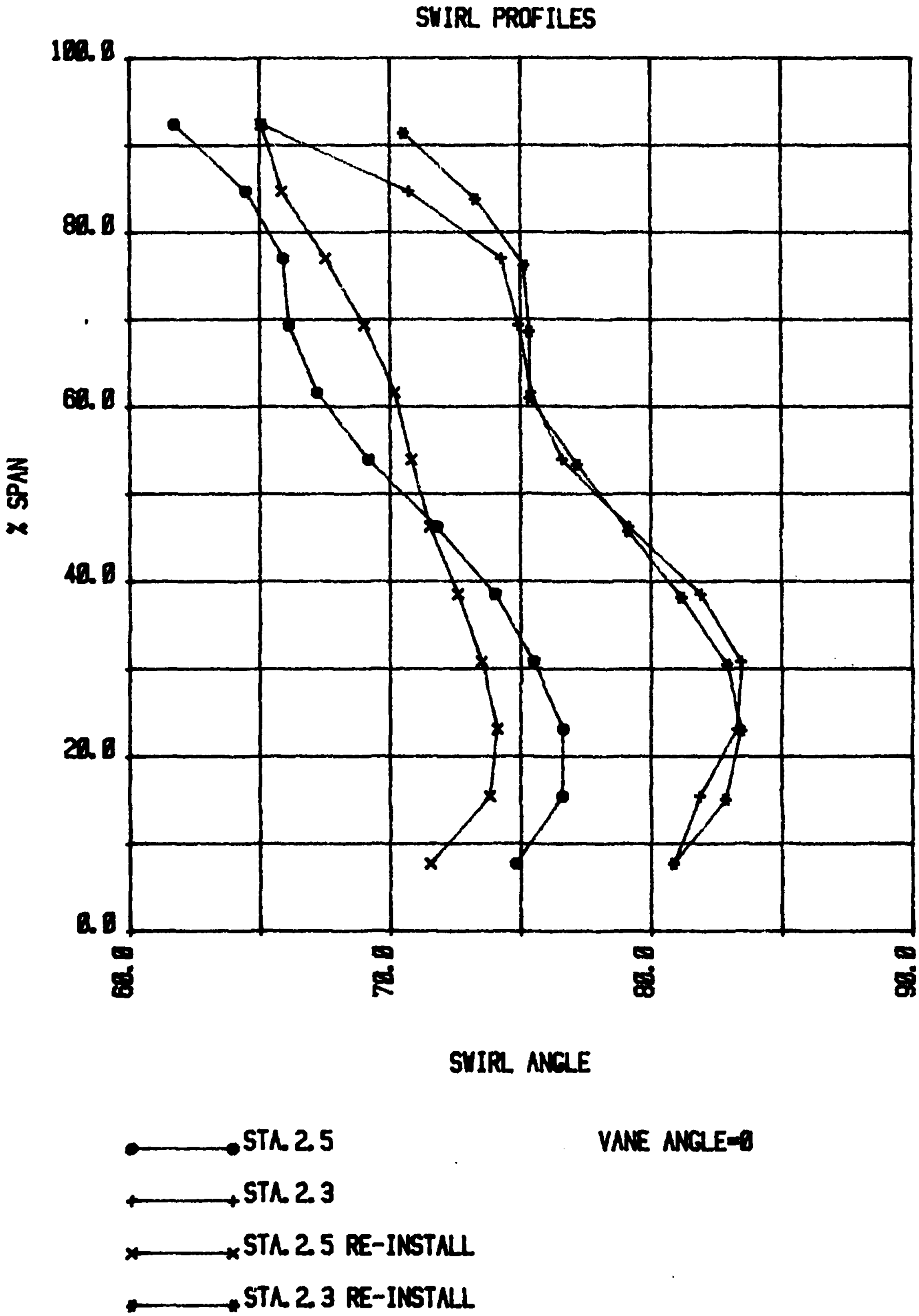


Figure 64. Re Installation Effects on Swirl Profiles, PSV = 0^0

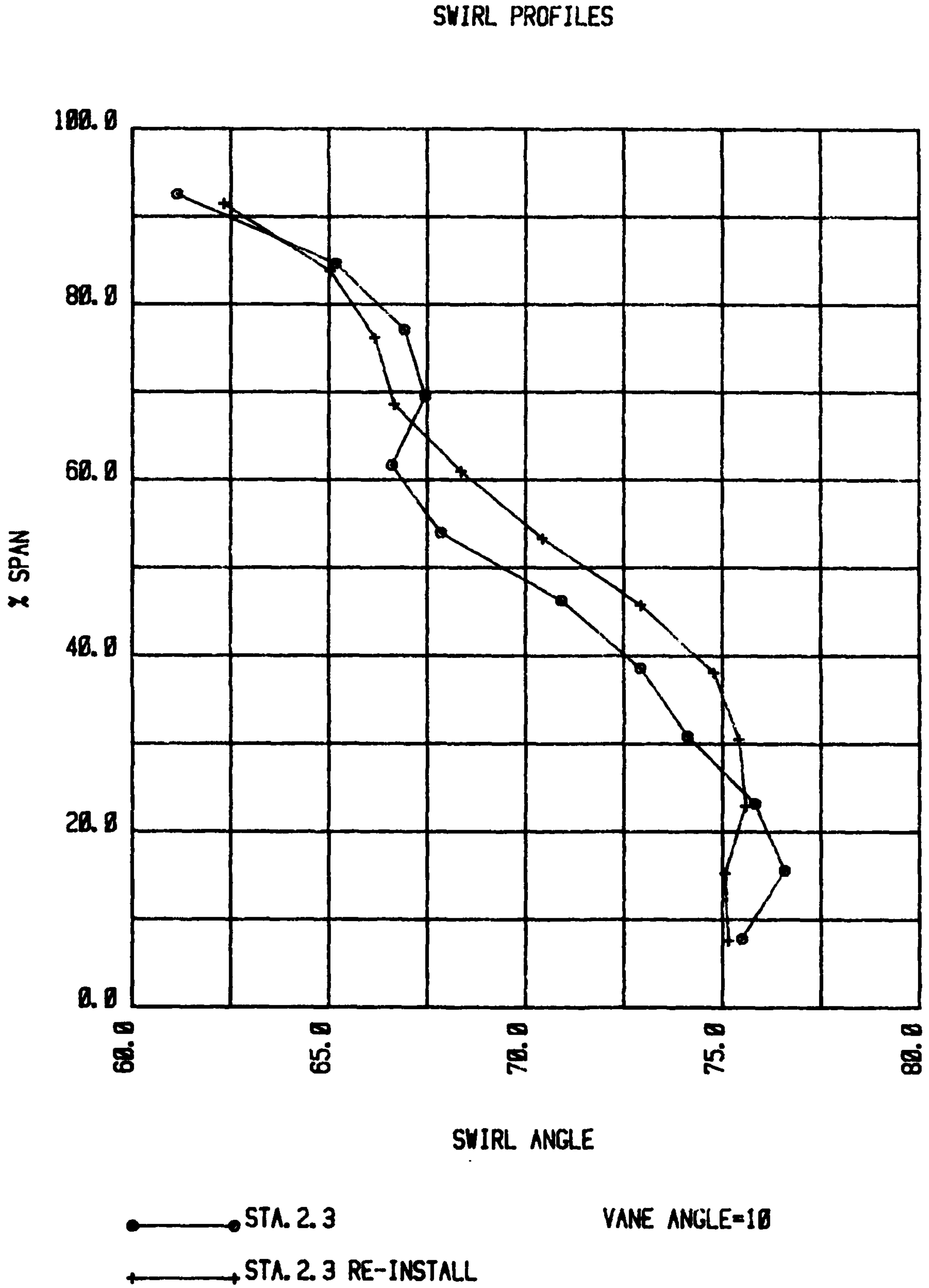


Figure 65a. Re Installation Effects on Swirl Profiles at Station 2.3, PSV = 10^0

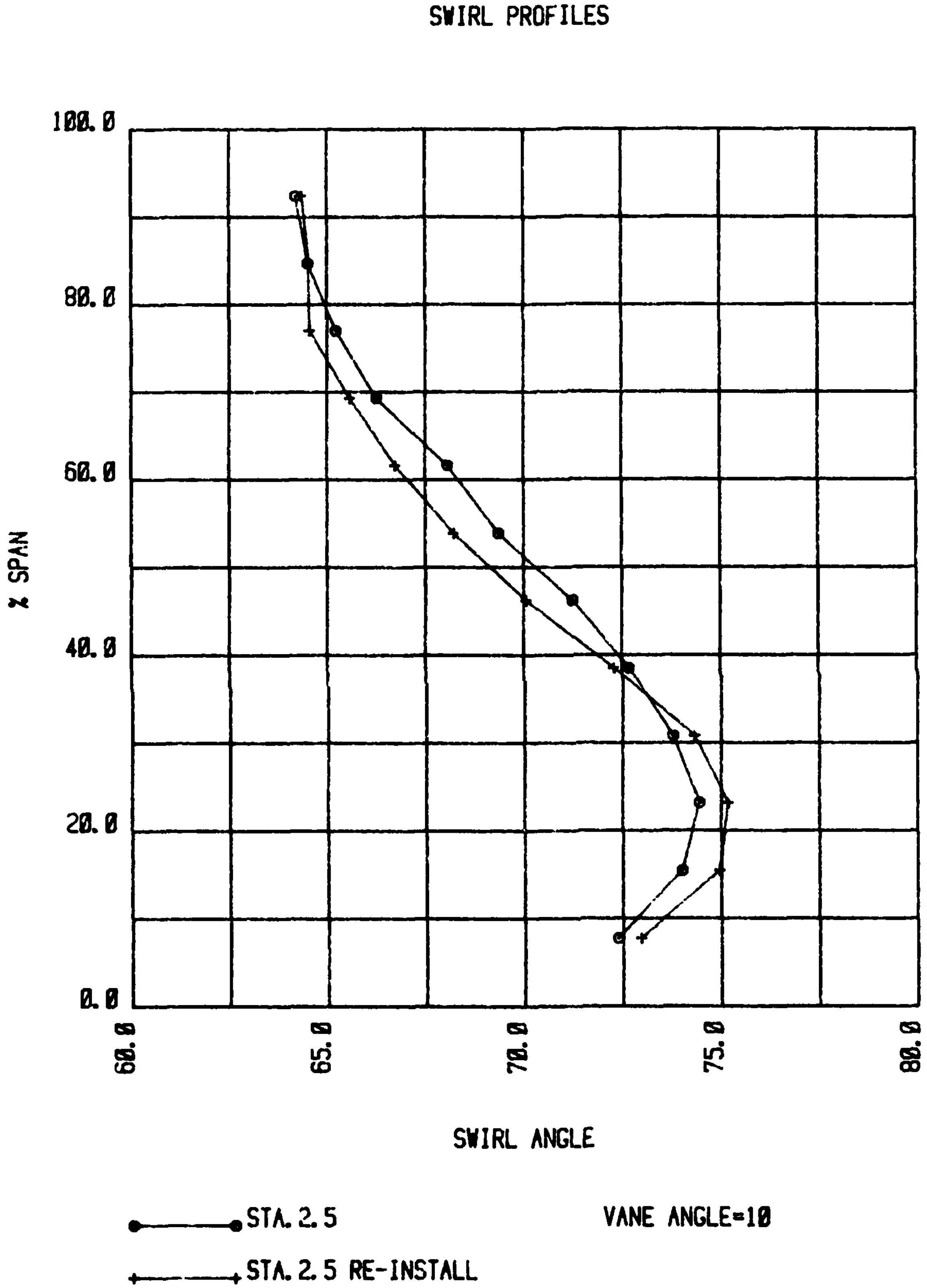
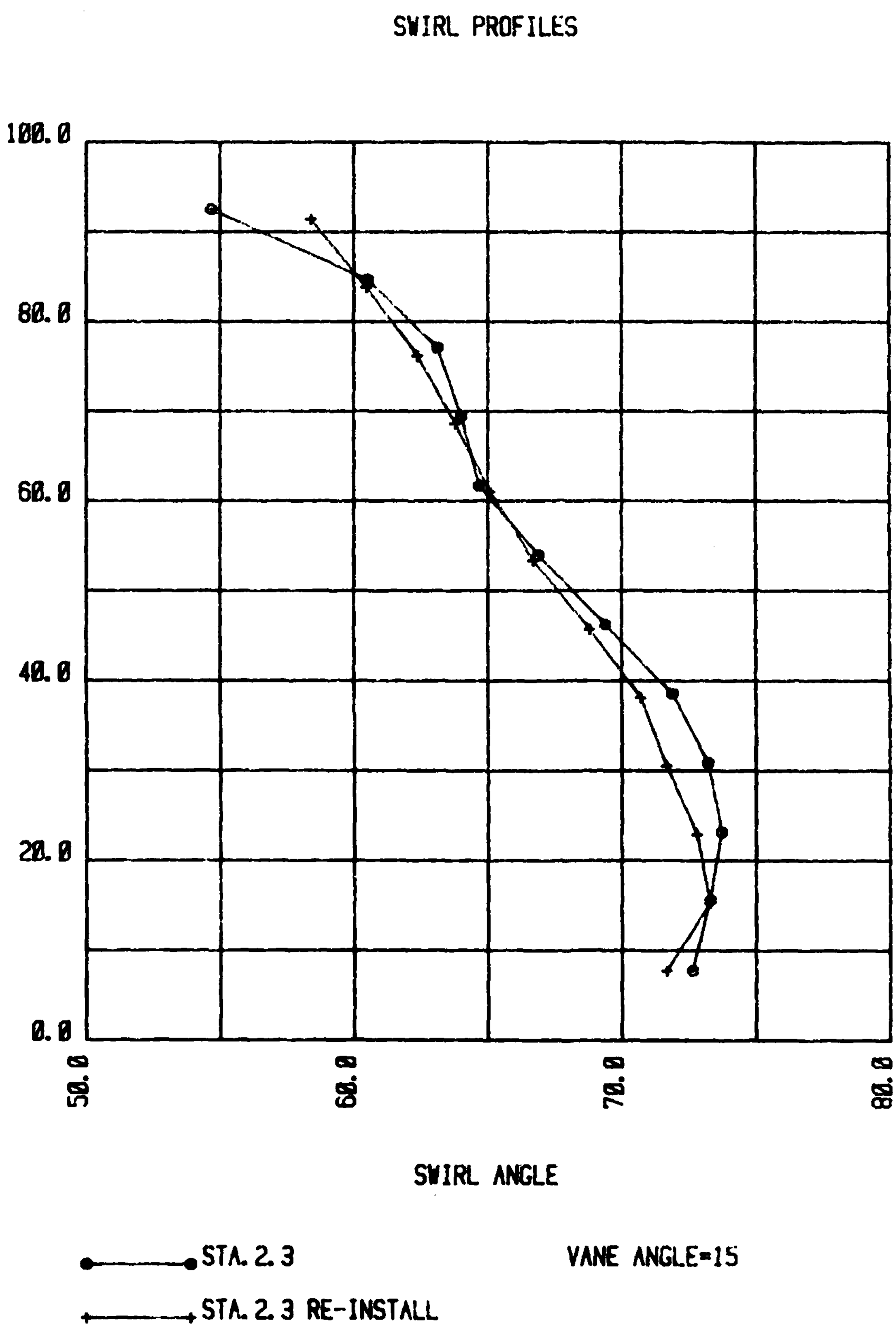
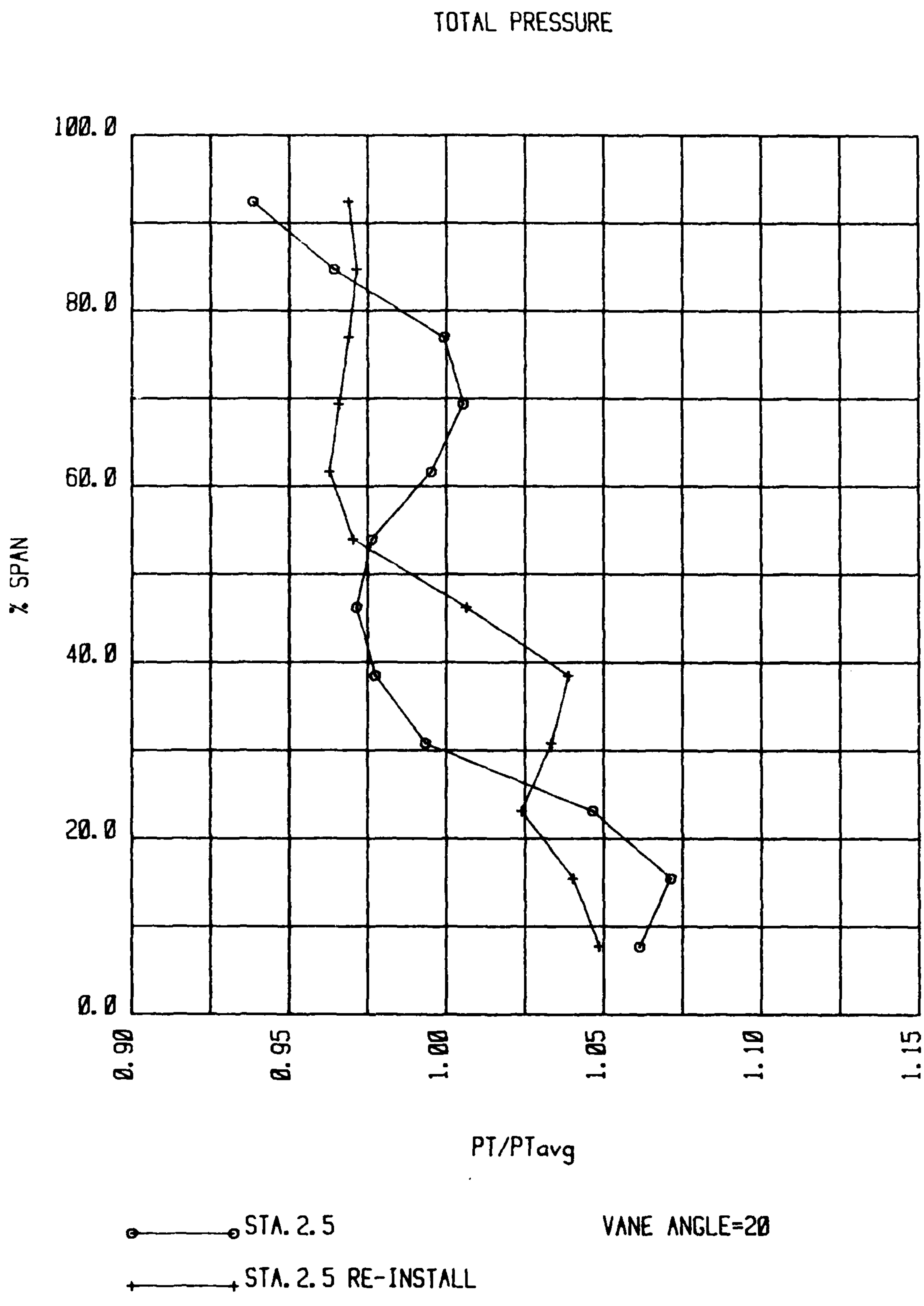


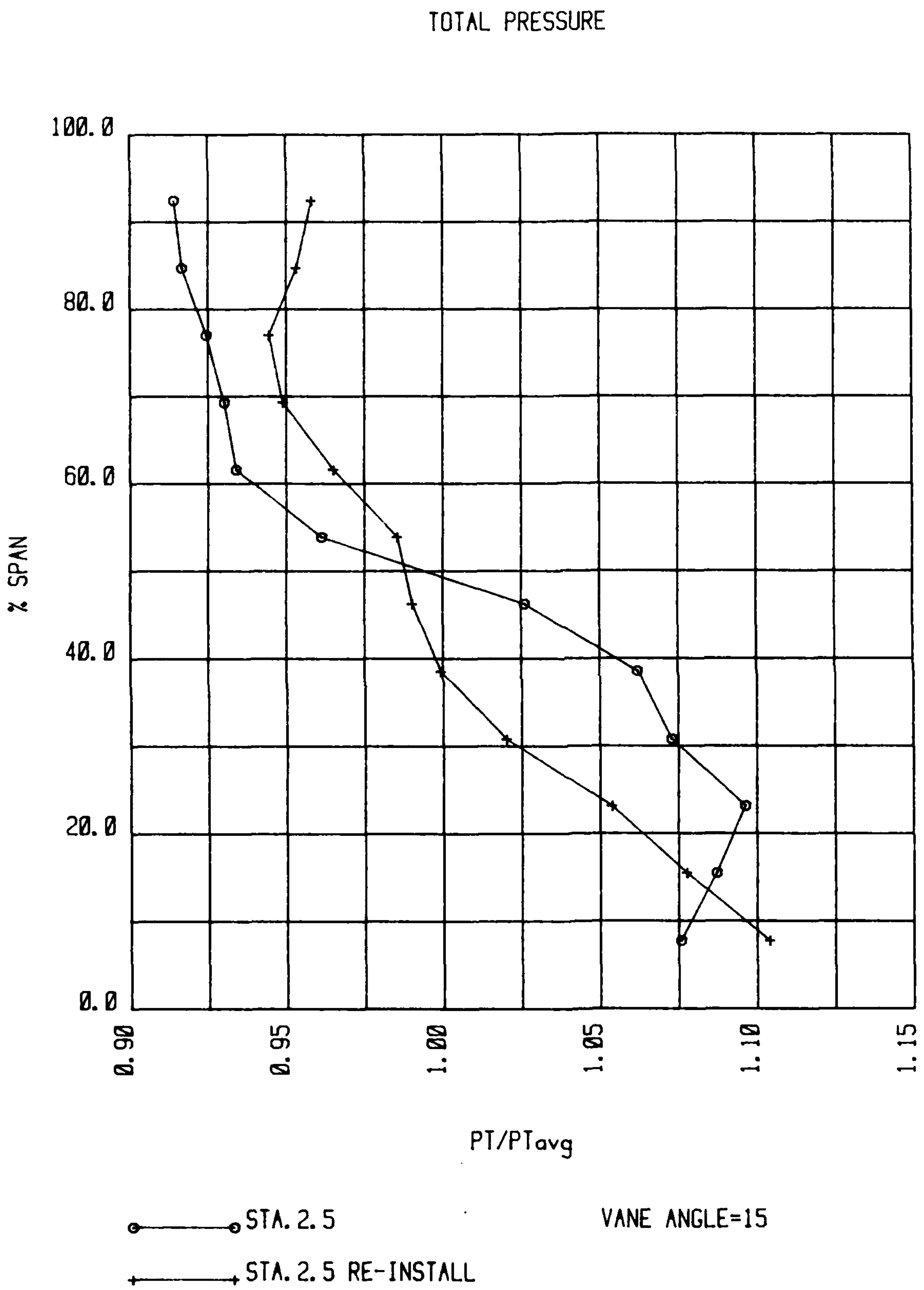
Figure 65b. Re Installation Effects of Swirl Profiles at Station 2.5, PSV = 10°



gure 66a. Re Installation Effects on Swirl Profiles at Station 2.3, PSV = 15^{0}



ure 91. Re Installation Effects on Station 2.5 Total Pressure Profiles, PSV = 20°



gure 90. Re Installation Effects on Station 2.5 Total Pressure Profiles, PSV = 15°

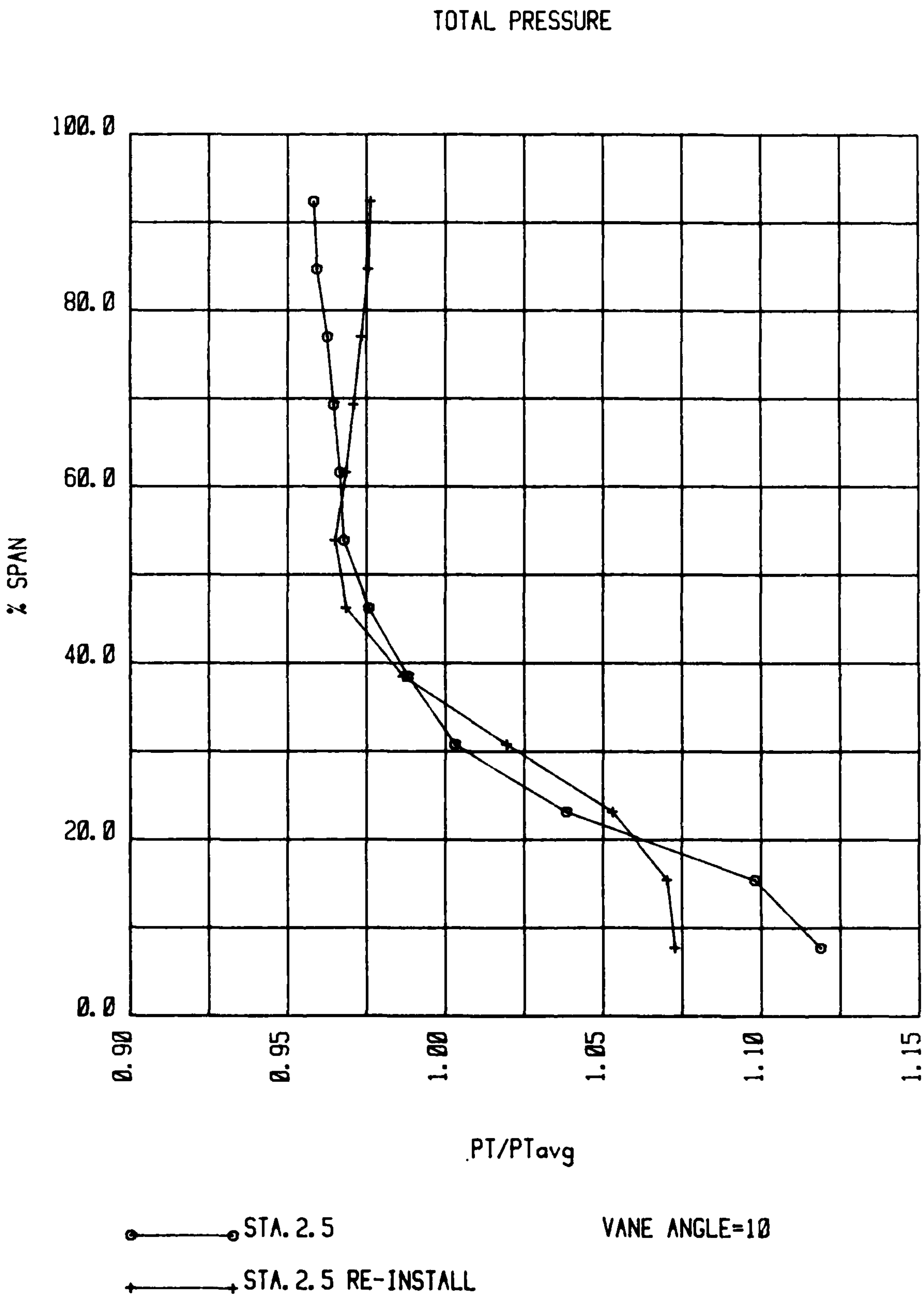


Figure 89. Re Installation Effects on Station 2.5 Total Pressure Profiles, PSV = 10°

Figure 87. Travese Location Behind Inlet Guide Vanes

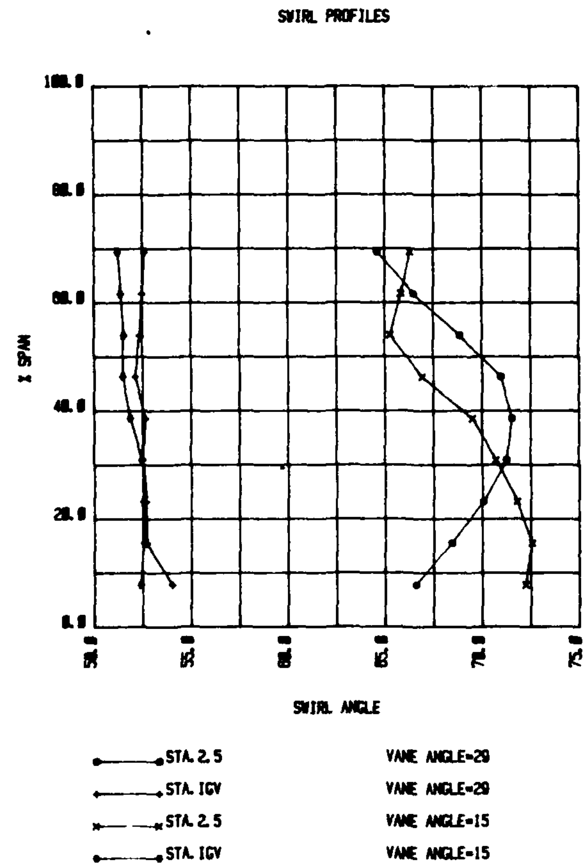


Figure 88. Swirl Profiles Behind Inlet Guide Vanes (Phase II), PSV = 15^{o} and 29^{o}

gure 84. Swirl Profiles (Phase II),
PSV = 29^{0}, Station 2.5, Octant 6

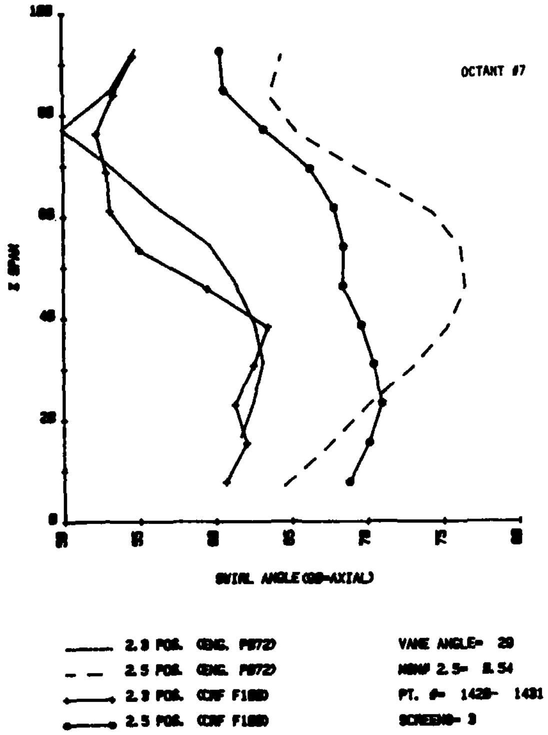
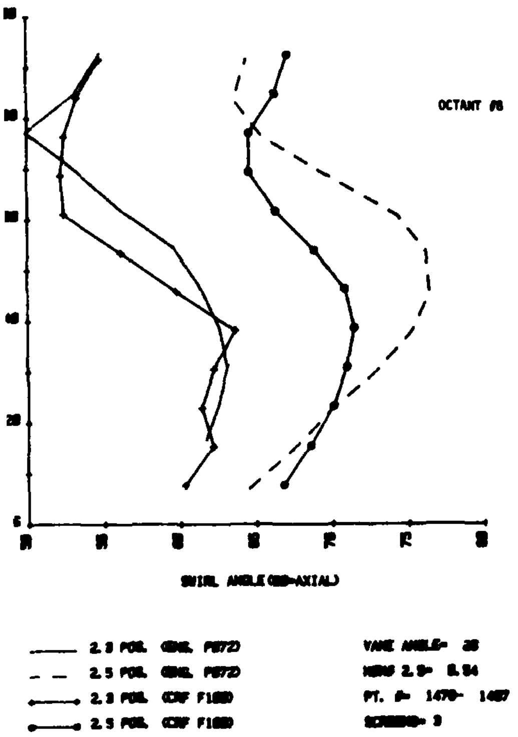


Figure 85. Swirl Profiles (Phase II),
PSV = 29^{0}, Station 2.5, Octant 7



gure 86. Swirl Profiles (Phase II),
PSV = 29^{0}, Station 2.5, Octant 8

Figure 81 and Figure 86 indicates that duplication was achieved and, therefore, assures that the measured circumferential variations were not due to traverse repositioning. These variations are primarily due to the intermediate case support struts creating 8 individual flow passages in the intermediate case. Each passage has its own characteristic since there are small variations in each due to strut variations.

Engine circumferential variations were not measured in the test described in Section II due to test article configuration and time limitations. Therefore, these results indicate additional uncertainty (in duplication of the engine conditions) may exist due to the circumferential variation of the swirl profiles. The results also showed that further investigation behind the IGV was required to determine if the profiles measured at station 2.5 will propogate to the inlet of the fourth stage rotor. A traverse was taken at the location shown in Figure 87. Results of the measurements taken behind the IGV's are shown in Figure 88. It indicates that the swirl distribution present at station 2.5 is substantially modified after transition thru the inlet guide vanes. The spanwise variation in swirl angle is eliminated and increased turning is added to the flow. It also indicated that the swirl distribution behind the IGV's is insensitive to PSV changes.

b. Total Pressure Profiles

As described in the previous section, data were obtained for the inlet hardware configuration of Section IV to determine removal, reinstallation and modification effects. Figure 89 indicates that good agreement in total pressure profile exists between installations at low vane angle settings, as was the case for the swirl profiles. Figures 90 and 91 show the increasing sensitivity to hardware installation changes with increases in vane angle settings. This variation also indicates the total pressure profile at station 2.5 is sensitive to swirl changes, as swirl profiles varied between installations for PSV angles above 15 degrees. It was apparent from these comparisons that when the final screen configuration is determined and full documentation obtained, care should be taken in assuring accurate screen positioning for the CRF F100 test. No further comparisons were made between installations with the knowledge of this sensitivity. Additional profiles for vane angle settings of 25, 27, 30 and 35 are shown in Figures 92 thru 95. These indicate the total pressure profile is sensitive to vane angle settings up to 25 degrees. Above that, little variation is noted in total pressure profile.

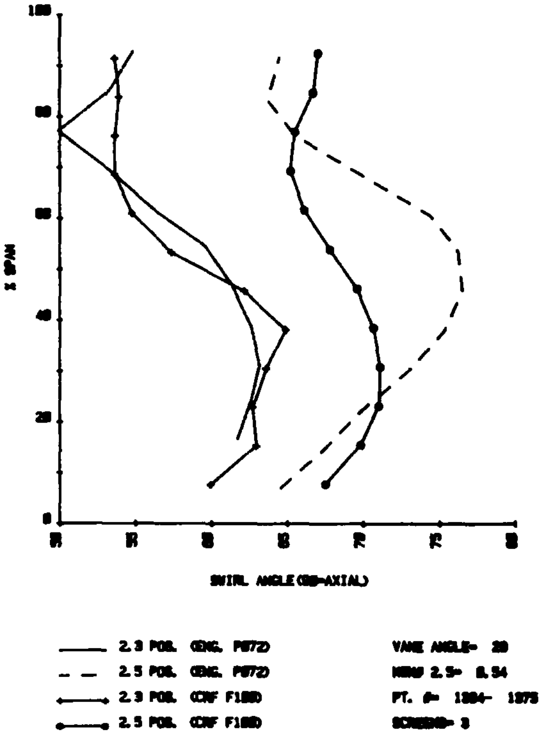


Figure 80. Swirl Profiles (Phase II), PSV = 28^{0}

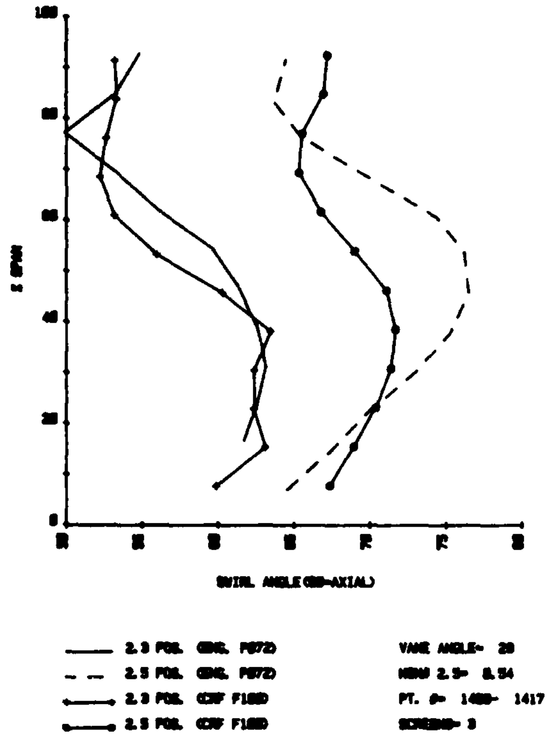


Figure 81. Swirl Profiles (Phase II), PSV = 29^{0}

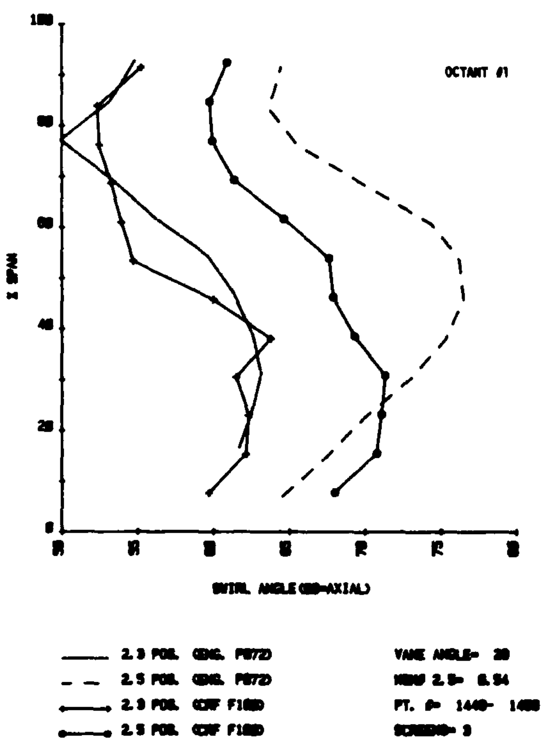


Figure 82. Swirl Profiles (Phase II), PSV = 29^{0}, Station 2.5, Octant 1

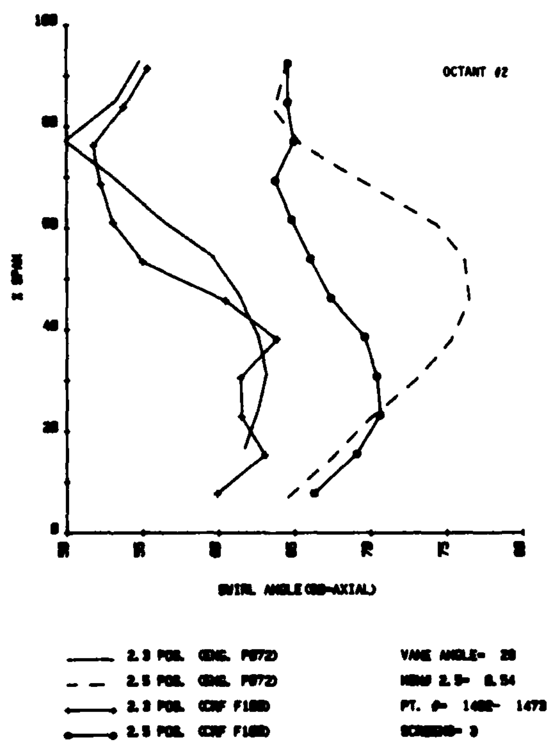


Figure 83. Swirl Profiles (Phase II), PSV = 29^{0}, Station 2.5, Octant 2

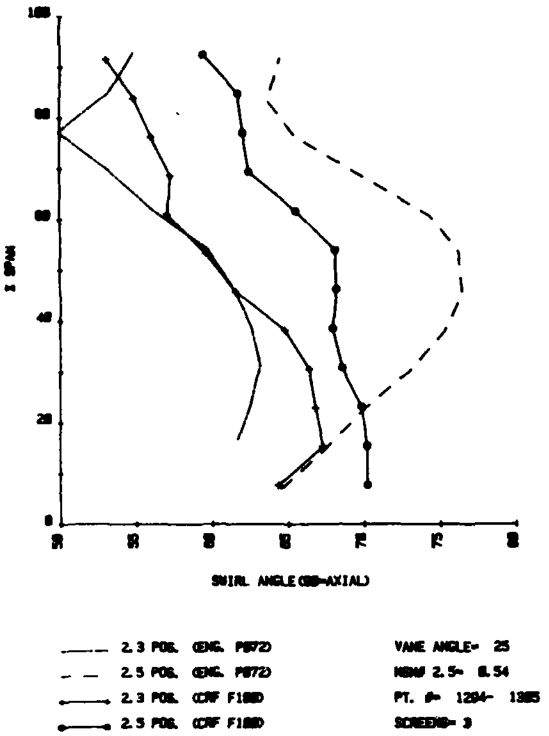


Figure 76. Swirl Profiles (Phase II), PSV = 25^{0}

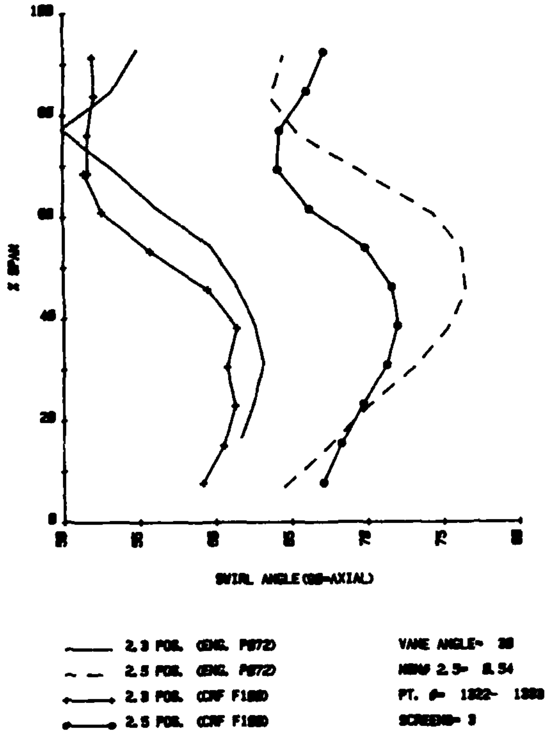


Figure 77. Swirl Profiles (Phase II), PSV = 30^{0}

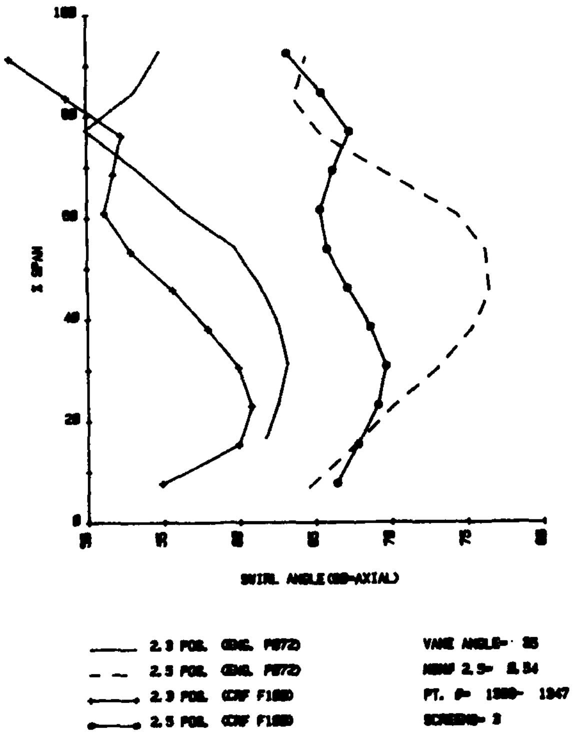


Figure 78. Swirl Profiles (Phase II), PSV = 35^{0}

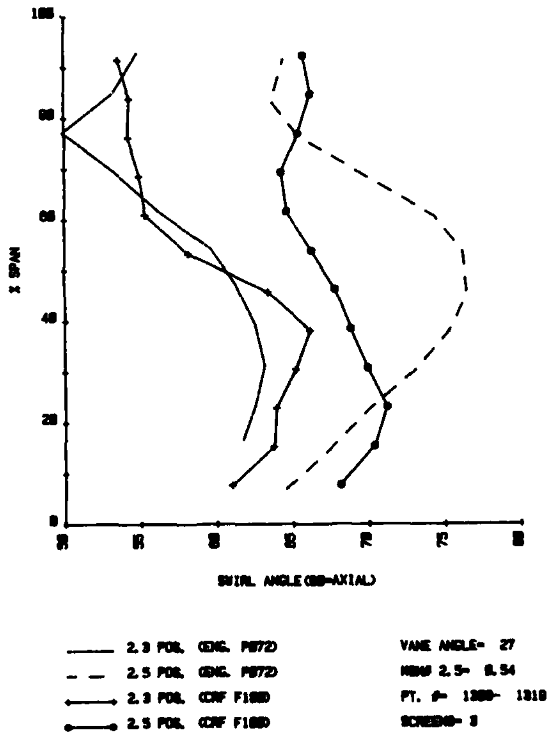


Figure 79. Swirl Profiles (Phase II), PSV = 27^{0}

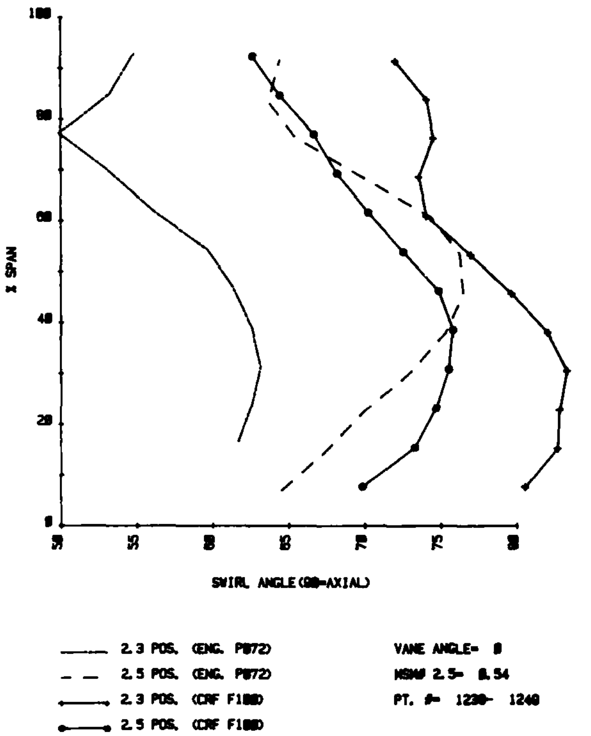


Figure 72. Swirl Profiles (Phase II), PSV = 0^{0}

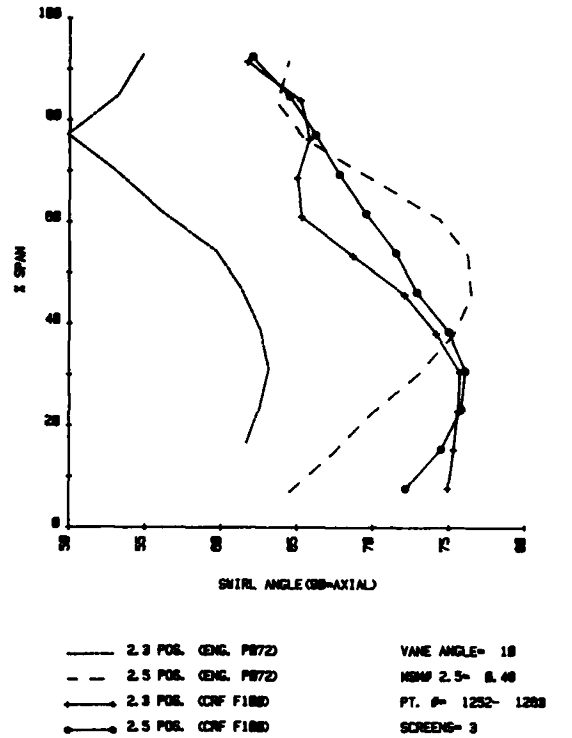


Figure 73. Swirl Profiles (Phase II), PSV = 10^{0}

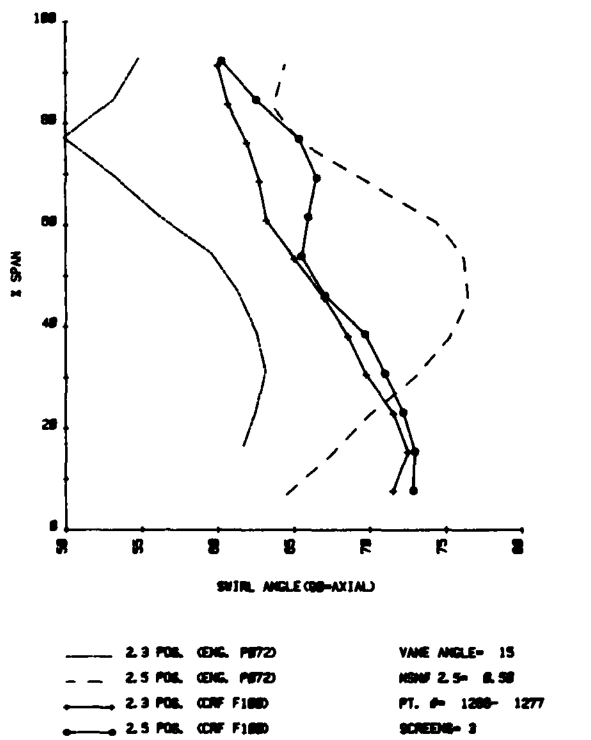


Figure 74. Swirl Profiles (Phase II), PSV = 15^{0}

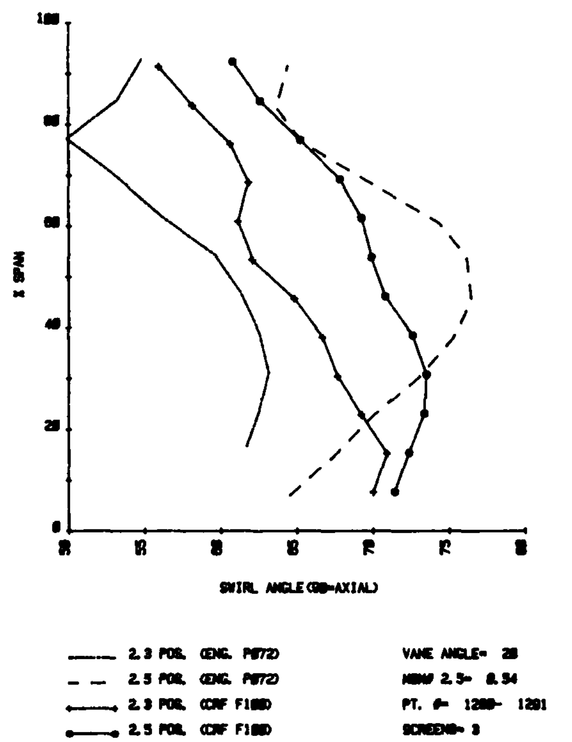


Figure 75. Swirl Profiles (Phase II), PSV = 20^{0}

testing results. Swirl angle profiles measured for vane angles of 0, 10, 15, 20, 25, 30 and 35 degrees are shown in Figures 72 thru 78, respectively. Figure 72 (PSV=0) indicates that swirl profiles at station 2.5, with screen set three, can simulate the measured engine profiles without the profiles at station 2.3 matching. This figure shows that the profile measured at station 2.5 has, with additional flow turning, the same relative shape as the 2.3 profile. This demonstrates that the eight support struts in the intermediate case impose little effect in altering the profile shape for low PSV settings. As air angles of attack on the struts increase by increasing the PSV turning, they become more critical in affecting the swirl profiles measured. This was apparent for vane settings above 15 degrees, as shown in Figures 74 thru 78. The profiles measured at the 2.5 location vary considerably. They also confirm that profiles obtained for PSV settings above 30 degrees result in poorer matches of engine profiles. From Figures 76 (PSV=25^{o}) and 77 (PSV=30^{o}), it is apparent that the profile undergoes a change into a configuration more characteristic of those measured in the engine. Also, the measured 2.3 profile for a PSV setting of 30 degrees duplicates the engine profiles within 5 degrees and has the same general shape. Due to the closeness of these profiles, traverses at additional settings of 27, 28 and 29 degrees were obtained to determine the optimum vane angle setting. These traverses are shown in Figures 79 thru 81. These figures demonstrate the progression of the station 2.5 swirl profile into one similar to the engine profile at the vane angle setting of 29 degrees. The swirl angle profiles measured with the vane angles set at 29 degrees represent the swirl profiles measured on the engine more accurately than all previous profiles measured. Therefore, this vane setting was selected for use during testing to determine circumferential variation in swirl distribution at station 2.5. The traverse at station 2.3 was used to assure conditions remained equal between station 2.5 traverse movements. Profiles were measured in octants one, two, six and seven, in addition to the previous measurements made at octant eight. Figure 82 thru 85 detail these additional profiles. These figures indicate that while maintaining constant 2.3 profiles and, therefore, consistent flow conditions, there is a substantial circumferential variation in swirl distribution at station 2.5. The swirl circumferential distribution indicates a maximum variation of 7 degrees at the 84 percent span location. The average of the maximum variations for all spanwise locations was four degrees. To assure that the movement of the station 2.5 traverse could not have caused these variations, the traverse actuator was installed back to the original octant eight position and the traverse duplicated. Comparison between

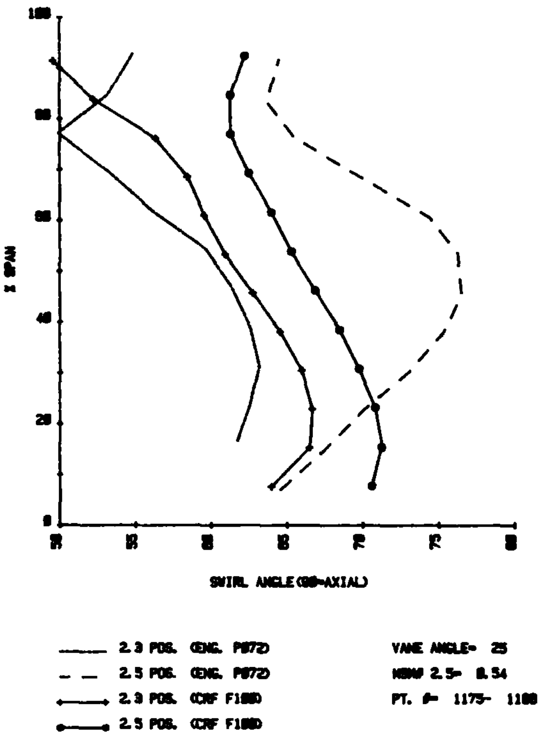


Figure 68. Phase I - Screen Configuration Swirl Profiles (PSV = 25^{0})

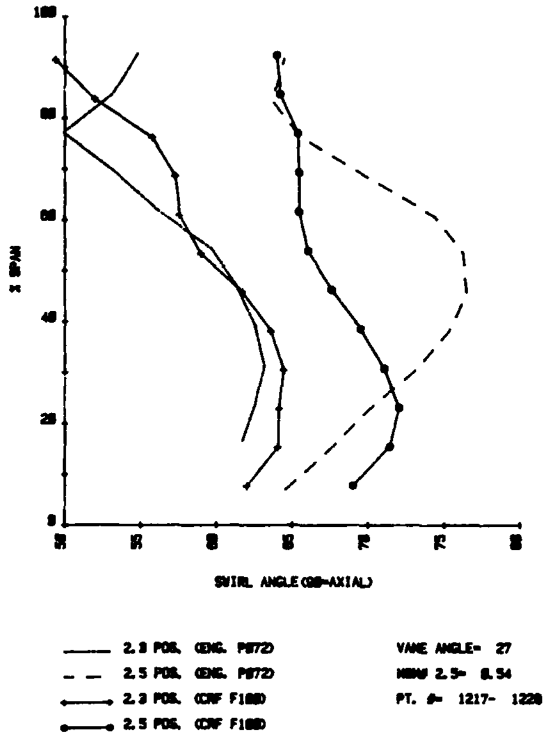


Figure 69. Phase I - Screen Configuration Swirl Profiles (PSV = 27^{0})

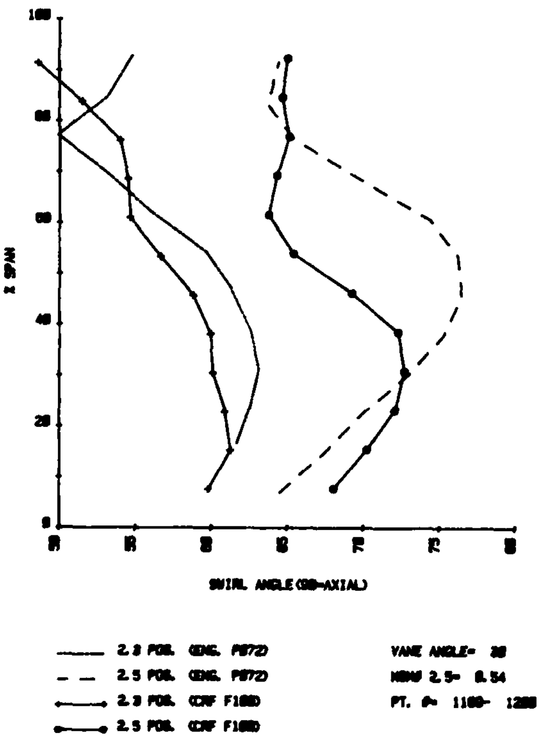


Figure 70. Phase I - Screen Configuration Swirl Profiles (PSV = 30^{0})

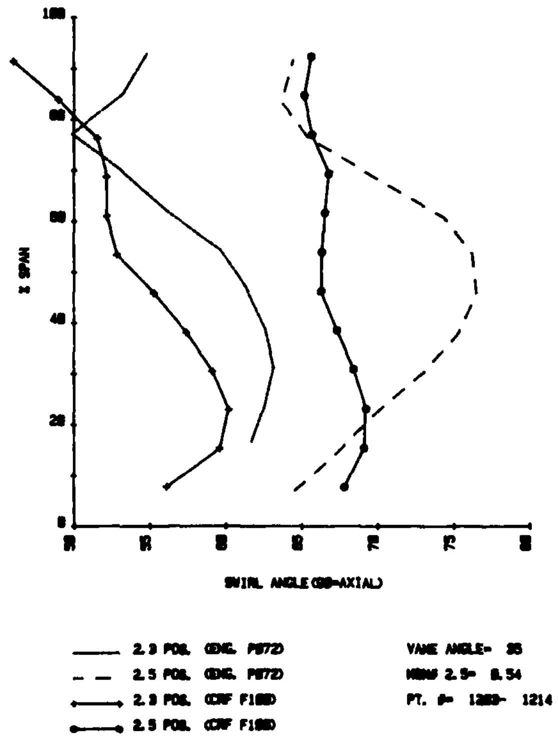


Figure 71. Phase I - Screen Configuration Swirl Profiles (PSV = 35^{0})

maximum variation of 6 degrees at the 92 percent span position between the station 2.3 profiles for a vane angle setting of 0 degrees. The reduced flow turning at the tip seen in this test is due to the increase in tip clearance of the vanes to reduce binding at the higher angles. The profiles indicate excellent comparison at all other spanwise locations. Figure 64 also indicates at station 2.5 a variation in profile between 0 and 3 degrees at almost all spanwise locations. Figure 65b, although, indicated less than a 1 degree swirl variation between test phases at this station for a 10 degree PSV setting. Also, the station 2.3 swirl profiles at a 10 degree PSV setting (Figure 65a) are again in good agreement. Figures 66a and 66b show the swirl angle variations between phases for a 15 degree PSV setting. They demonstrate swirl agreement within 1 degree of both station 2.3 and 2.5 profiles between test phases. The final comparison condition available is that one of the 20 degree PSV setting, as shown in Figure 67. Although at some spanwise locations differences of three degrees exist, both stations were duplicated within two degrees agreement at the majority of spanwise locations. From the four cases shown, it can be assumed that variations in swirl angle profiles (due to inlet hardware removal and changes) between test phases contributed to approximately a 2 degree uncertainty in profile duplication.

Additional swirl angle profile information, with the original screens described in Section IV.2, was obtained for vane settings of 25, 27, 30 and 35 degrees to determine the effects of the increased vane actuation capability on the swirl profiles. The results of these traverses are shown in Figures 68 thru 71. Review of these data indicates that good agreement was obtained between the P072 engine station 2.3 swirl profiles and the inlet hardware profiles for a vane angle setting of 27 or 30 degrees. The data also indicates that the station 2.5 swirl profile for a vane angle setting of 30 degrees matches the engine profiles at approximately 0 to 40 percent span and from 80 to 100 percent span. The profiles between 40 and 80 percent span still require reduced turning to match the engine profiles. Figure 71 indicates that increased vane actuation to 35 degrees resulted in a degradation of the station 2.5 swirl profile obtained at 30 degrees. Therefore, no further vane actuation data were recorded.

Data were obtained for the complete range of vane angle settings with the additional profile screen defined in Section V.2. This additional screen was recommended, as was the increase in vane actuation, after review of the Phase I

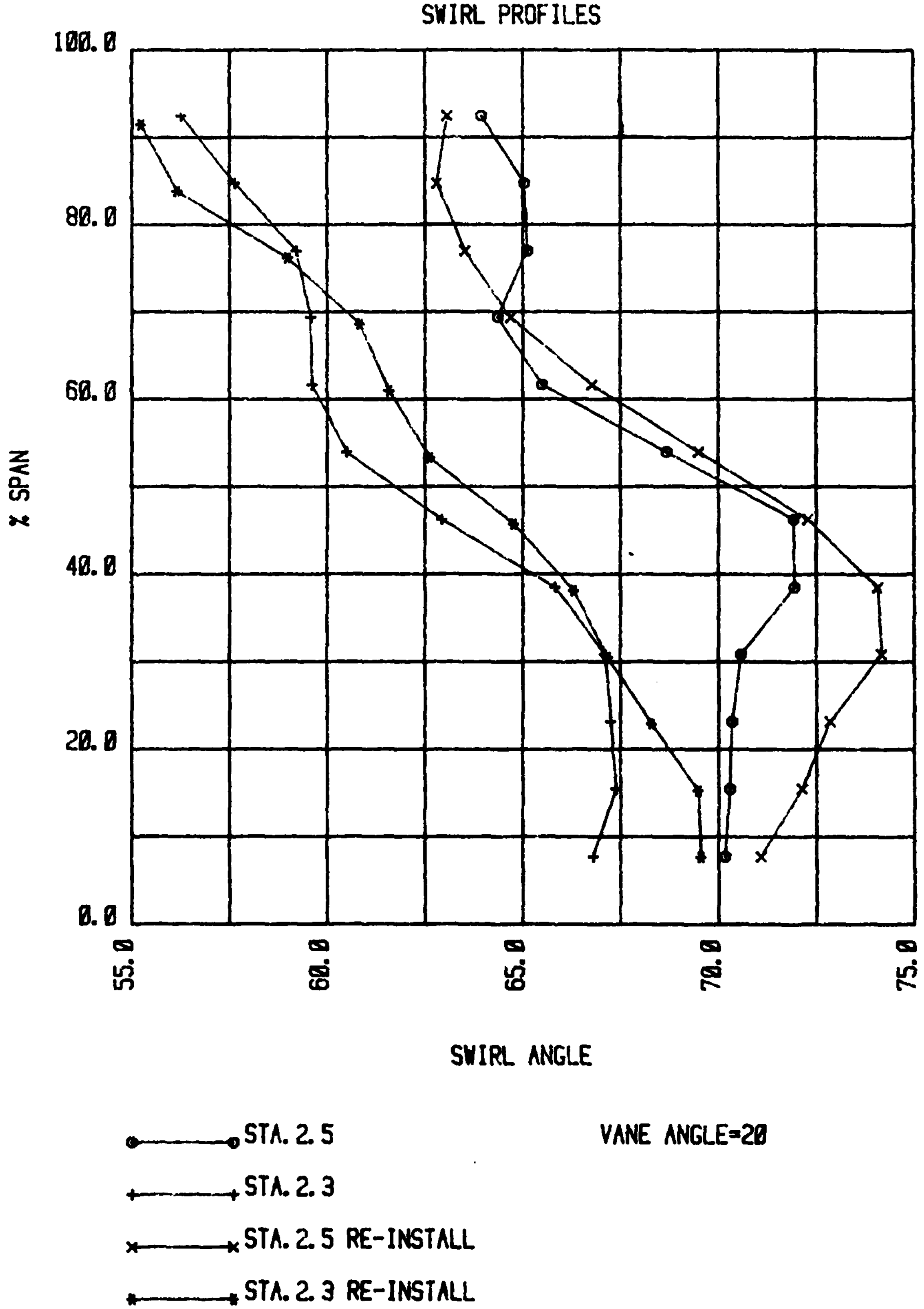


Figure 67. Re Installation Effects on Swirl Profiles, PSV = 20°

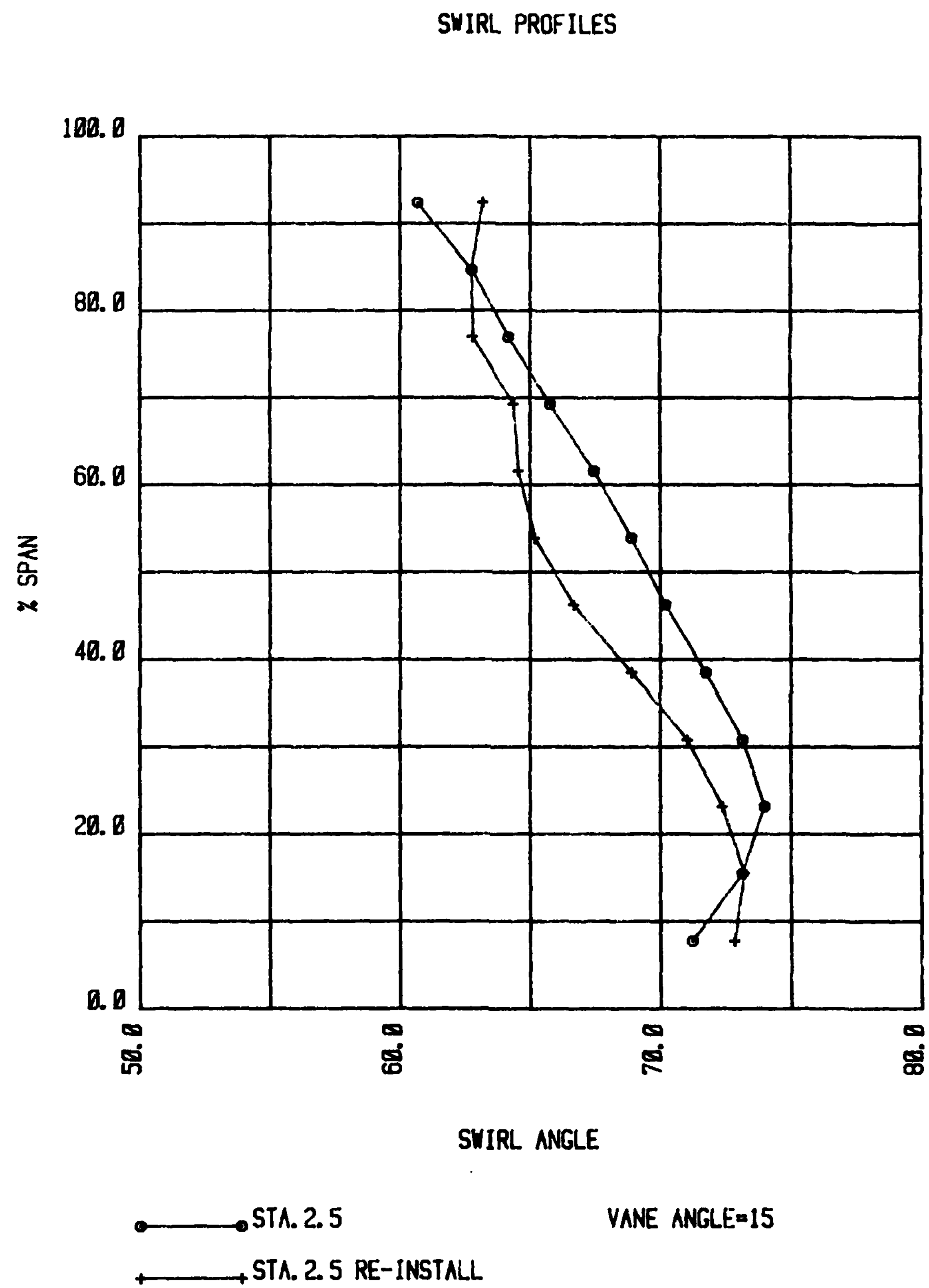


Figure 66b. Re Installation Effects on Swirl Profiles at Station 2.5, PSV = 15^{o}

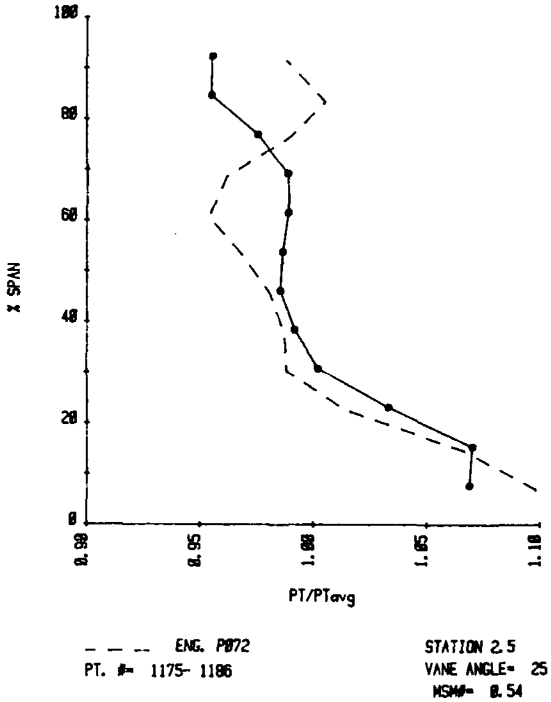


Figure 92. Phase I - Screen Configuration Total Pressure Profile (PSV = 25^0)

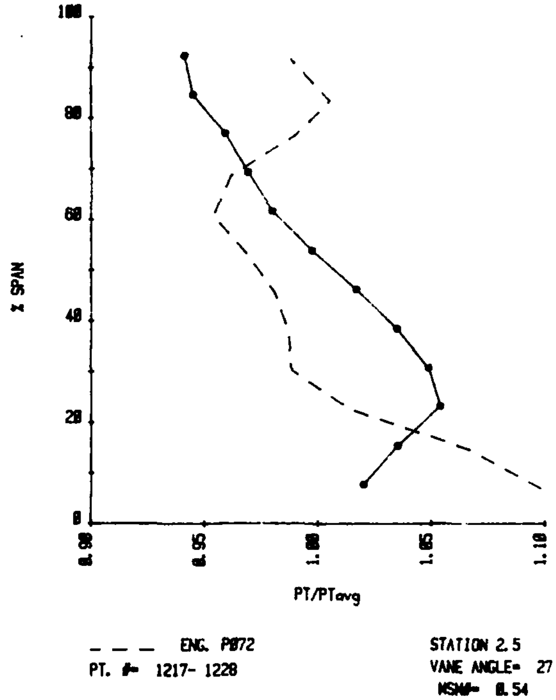


Figure 93. Phase I - Screen Configuration Total Pressure Profile (PSV = 27^0)

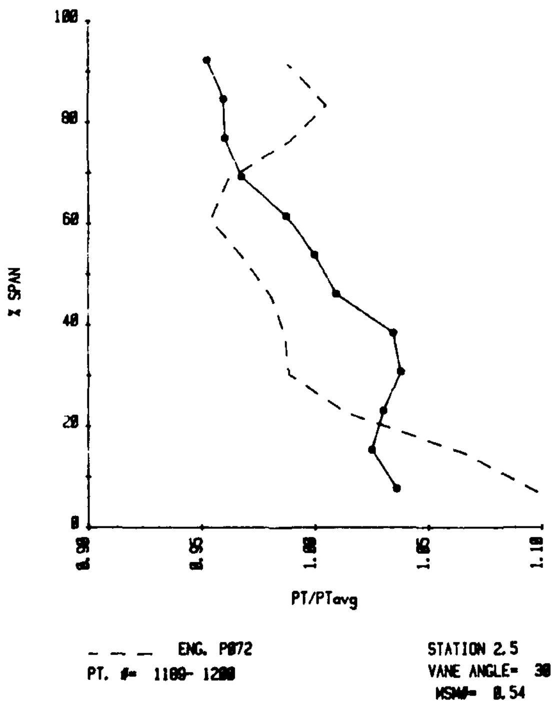


Figure 94. Phase I - Screen Configuration Total Pressure Profile (PSV = 30^0)

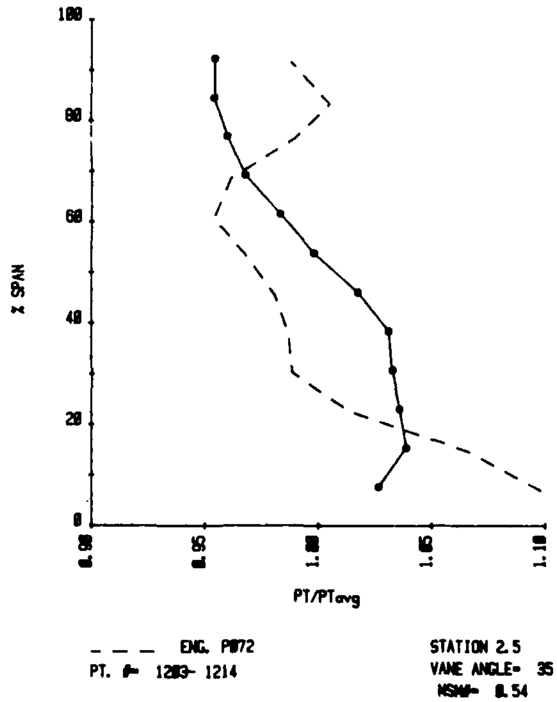


Figure 95. Phase I - Screen Configuration Total Pressure Profile (PSV = 35^0)

The total pressure profiles obtained for the screen configuration defined in Section V.2 for vane angles from 0 to 35 degrees are shown in Figures 96 thru 105. As was the case with the swirl profiles, little profile variation is noted for vane angle settings above 25 degrees. Figure 98 and 100 demonstrate that good agreement can be reached between measured engine and inlet hardware profiles for vane angle settings of 15 or 25 degrees. The engine spanwise gradient in total pressure was 15 percent. The 25 degree setting provided a maximum of 6 percent and average of 2.3 percent deviation from the desired profiles, although an increase in total pressure from 70 to 100 percent span is required to match engine profiles for these and all other vane settings. As was the case with the swirl angle profiles, circumferential variation in station 2.5 total pressure was determined, as shown in Figures 106 thru 110 for octants one, two, six, seven and eight, respectively. Data taken in octant eight was compared with the previous data taken in that octant for the same conditions to determine total pressure profile repeatability. Comparison of these profiles shown in Figure 111, indicate repeatability within the prescribed accuracy of ±1 percent. From Figures 106 thru 110, it can be seen that circumferential variations in total pressure at station 2.5 do exist, as was the case of swirl distribution. Further measurements downstream of the IGV (shown in Figure 112) when compared with the station 2.5 profile (shown in Figure 113) indicate that a nonuniform total pressure profile does exist downstream of the IGV's and that this profile takes on the same general gradient as those generated at station 2.5.

c. Discussion

Although the modification to the preswirl vanes did produce a more representative swirl distribution, the engine measured swirl profile was not matched. Measurements of the swirl distribution downstream of the IGV's indicate substantial spanwise swirl variation reduction. With this IGV spanwise flow straightening effect, the measured swirl distribution at station 2.5 is adequate for the CRF/F100 rig test as long as the total pressure profile at station 2.5 between engine and rig is matched. Measurements during this phase of testing indicated the total pressure profile present at station 2.5 is not substantially changed by the IGV's. Therefore, it is extremely important that the profile measured from the engine described in Section II is matched in the rig. The screen set number three, as described in this phase, required modification in the area between 70 and 100 percent span to increase the total pressure at that location. An additional phase of testing was required with the screen modification to achieve the F100 engine total pressure profile at station 2.5.

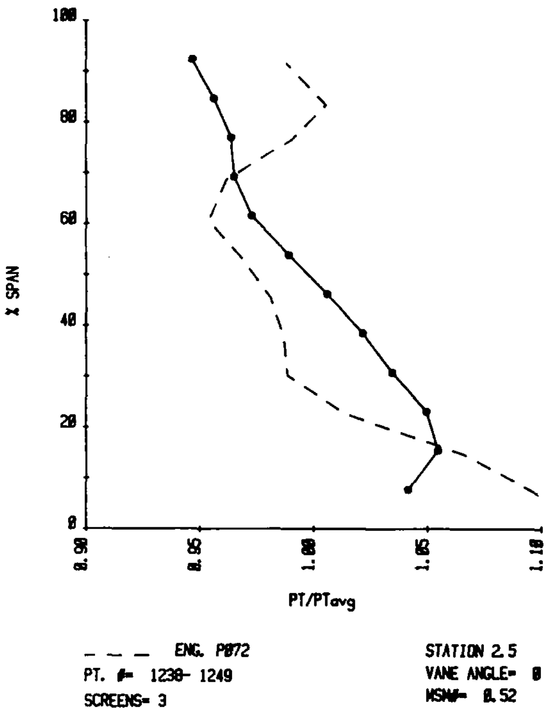


Figure 96. Total Pressure Profile (Phase II), PSV = 0°, Station 2.5

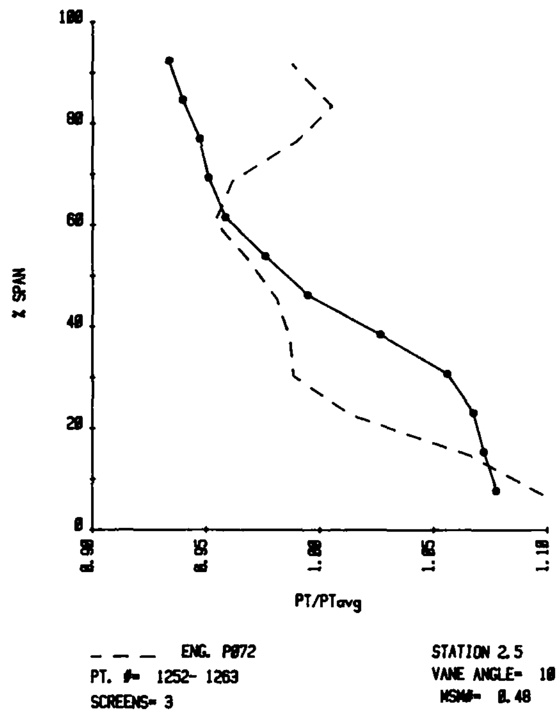


Figure 97. Total Pressure Profile (Phase II), PSV = 10°, Station 2.5

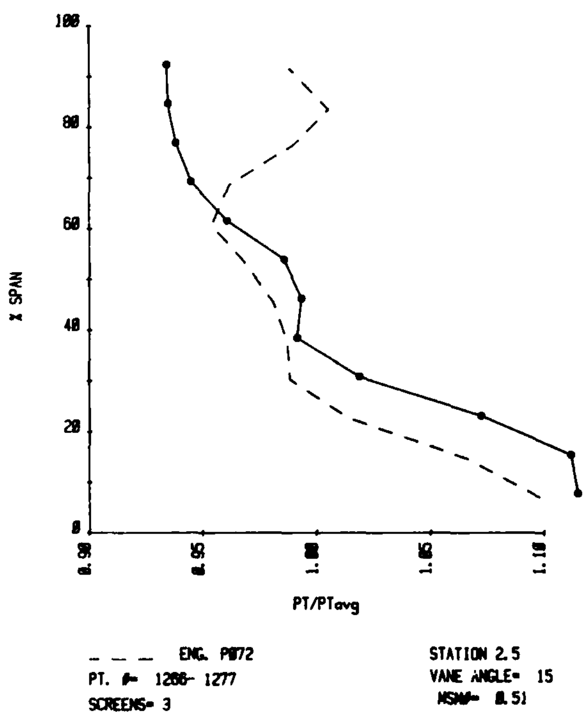


Figure 98. Total Pressure Profile (Phase II), PSV = 15°, Station 2.5

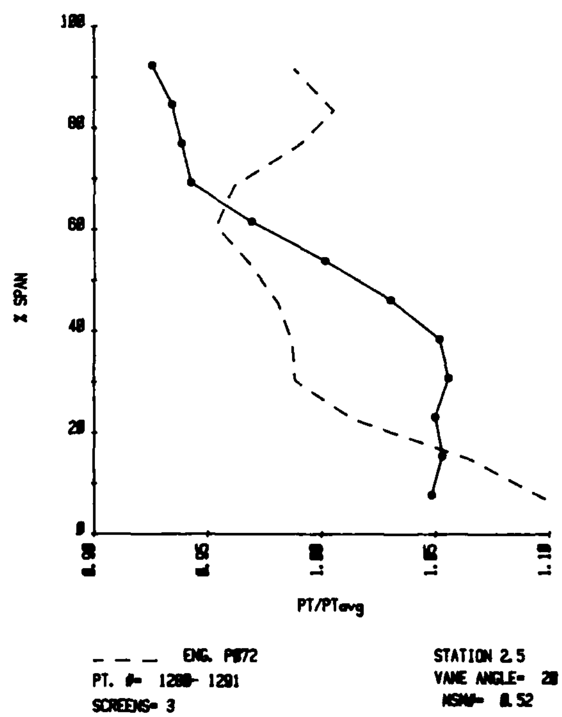


Figure 99. Total Pressure Profile (Phase II), PSV = 20°, Station 2.5

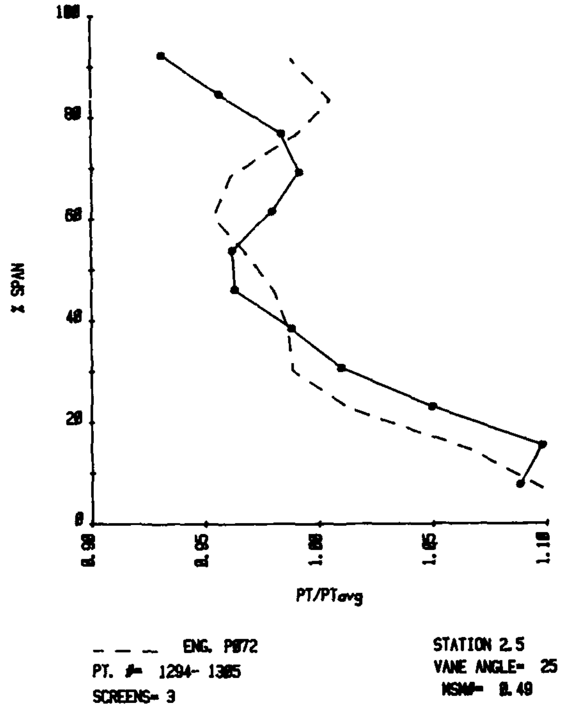


Figure 100. Total Pressure Profile (Phase II), PSV = 25^{0}, Station 2.5

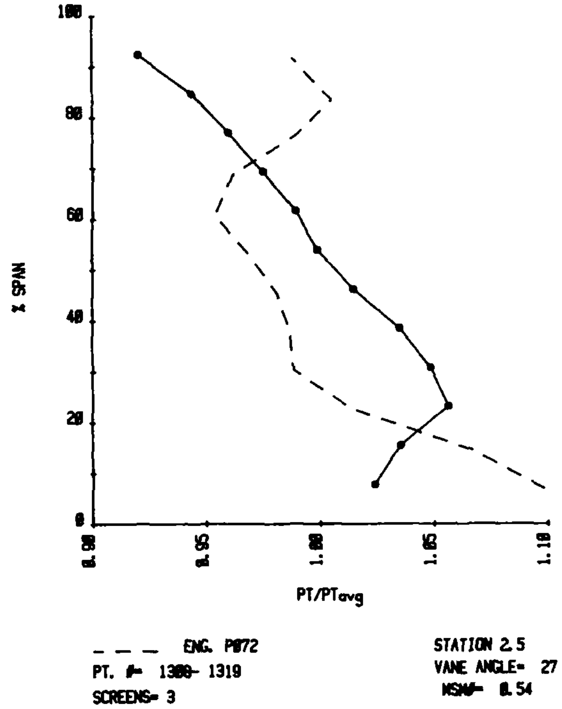


Figure 101. Total Pressure Profile (Phase II), PSV = 27^{0}, Station 2.5

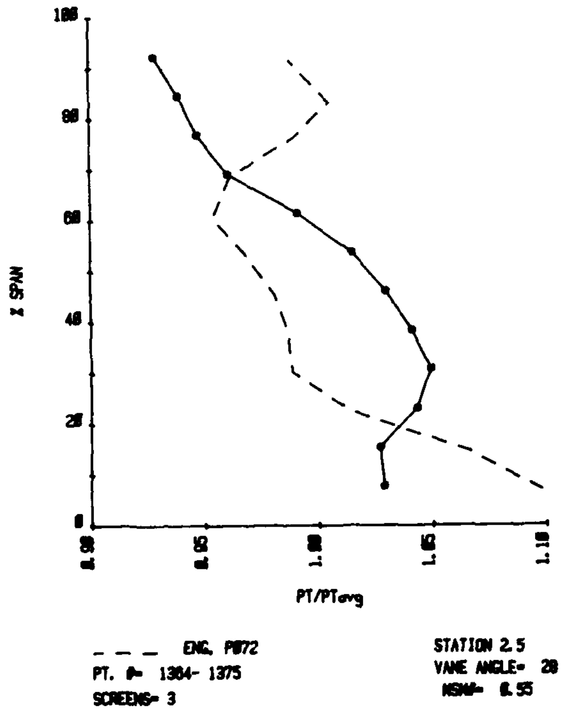


Figure 102. Total Pressure Profile (Phase II), PSV = 28^{0}, Station 2.5

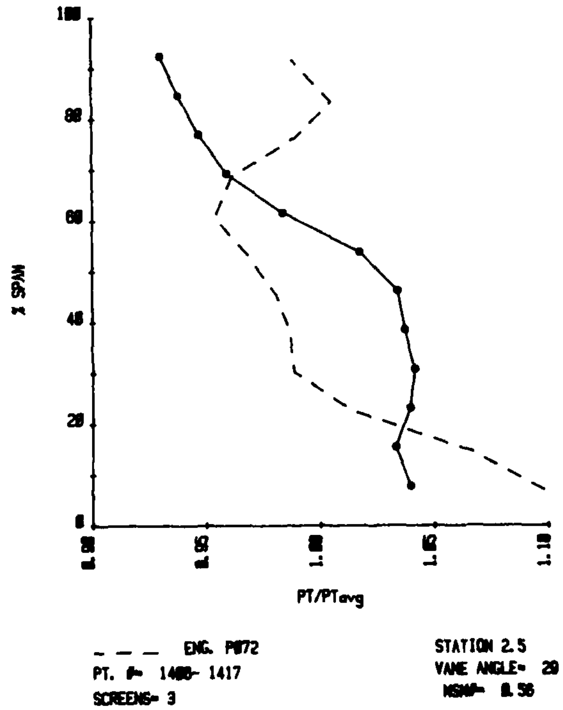


Figure 103. Total Pressure Profile (Phase II), PSV = 29^{0}, Station 2.5

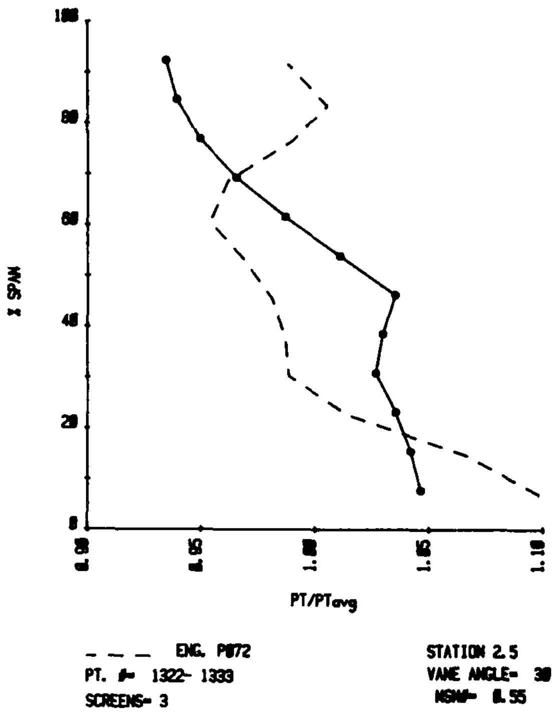


Figure 104. Total Pressure Profile (Phase II), PSV = 30°, Station 2.5

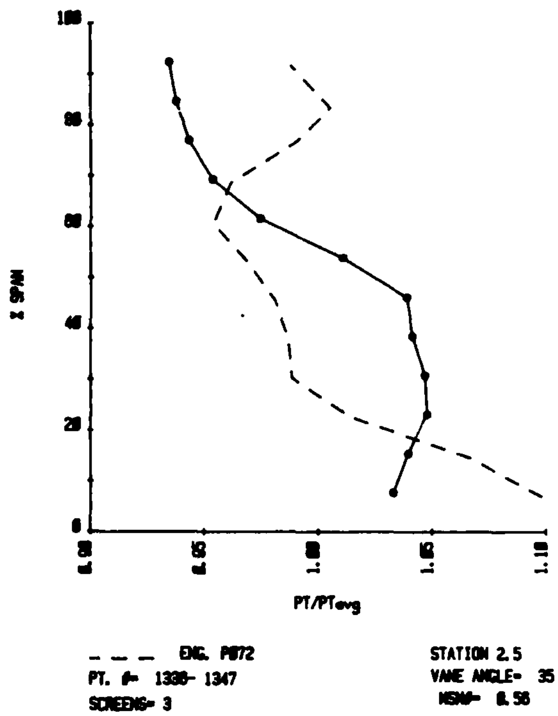


Figure 105. Total Pressure Profile (Phase II), PSV = 35°, Station 2.5

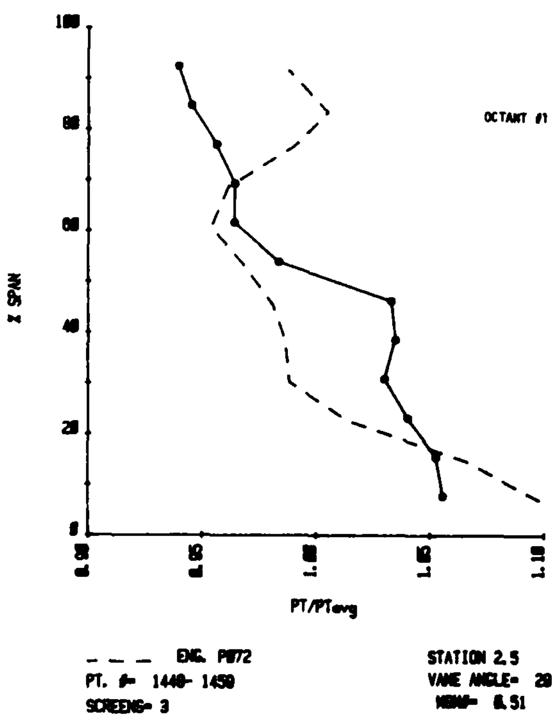


Figure 106. Total Pressure Profile (Phase II), PSV = 29°, Station 2.5, Octant 1

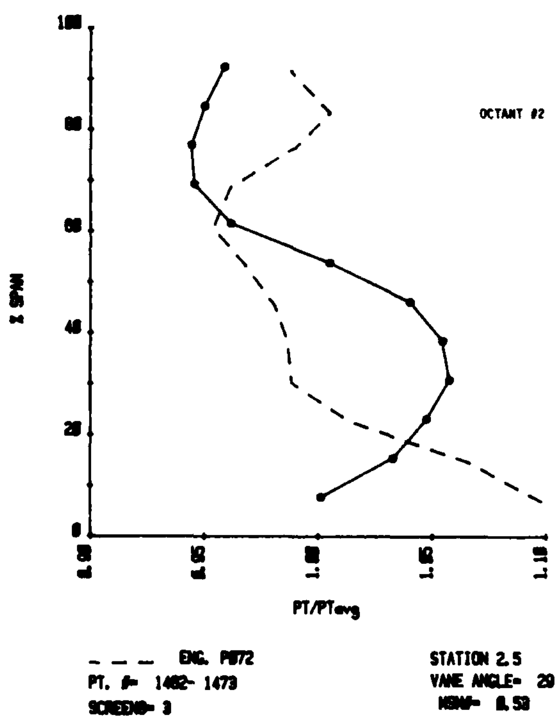


Figure 107. Total Pressure Profile (Phase II), PSV = 29°, Station 2.5, Octant 2

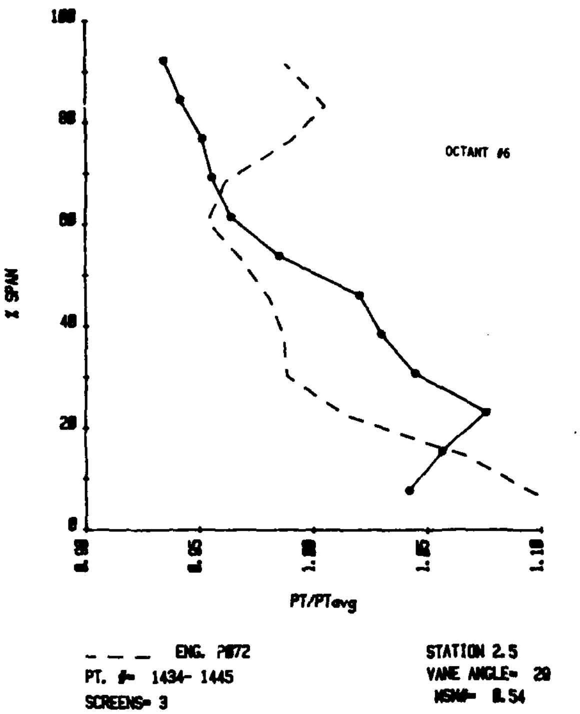


Figure 108. Total Pressure Profile (Phase II), PSV = 29°, Station 2.5, Octant 6

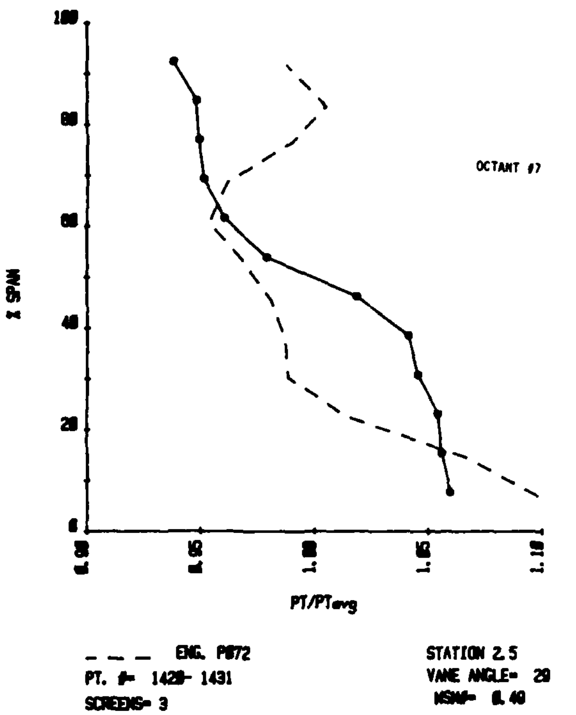


Figure 109. Total Pressure Profile (Phase II), PSV = 29°, Station 2.5, Octant 7

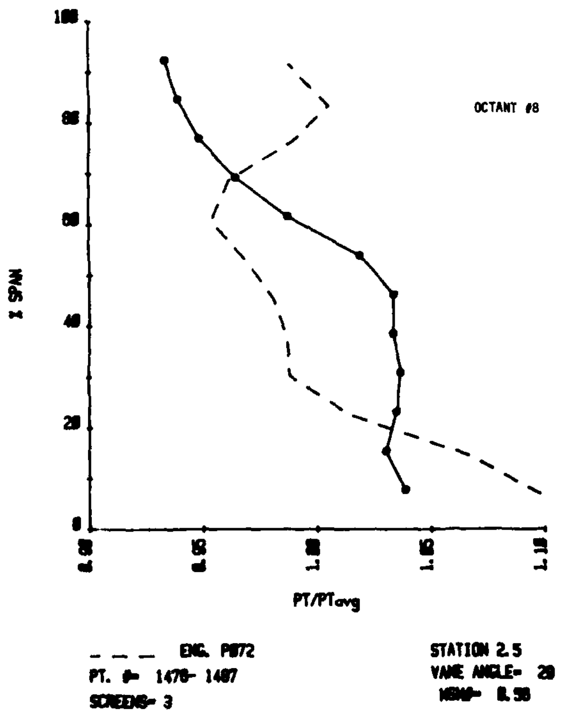


Figure 110. Total Pressure Profile (Phase II), PSV = 29°, Station 2.5, Octant 8

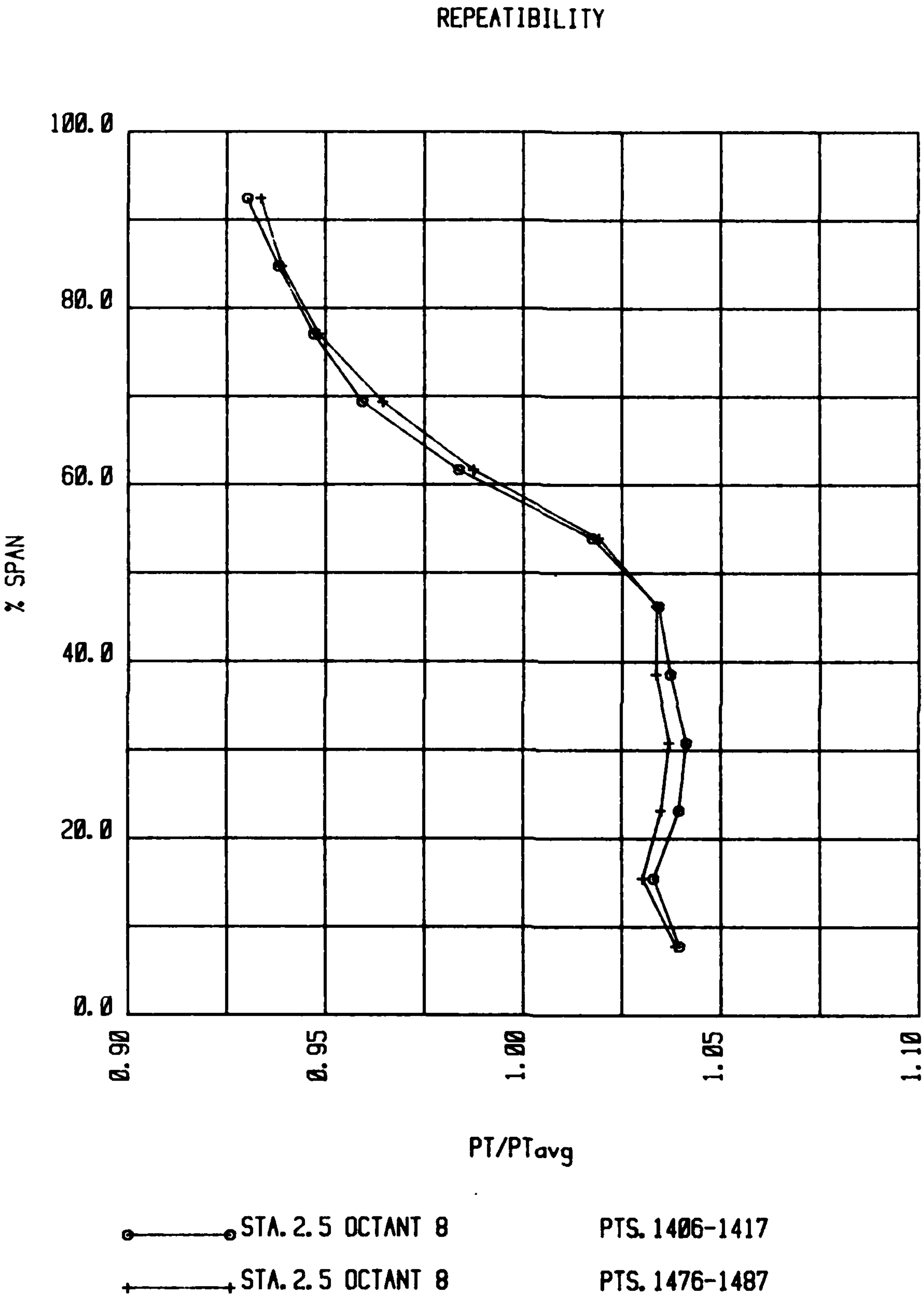


Figure 111. Octant 8, Total Pressure Repeatibility, PSV = 29^{0}

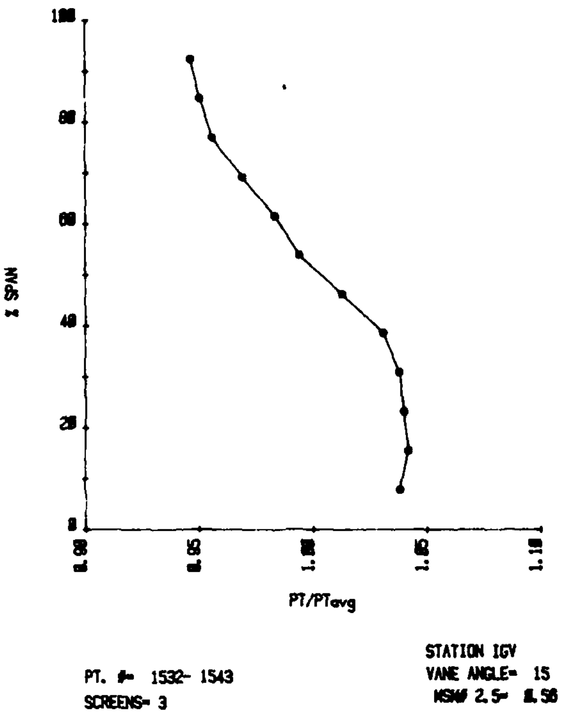


Figure 112. Total Pressure Profile Behind IGV (Phase II), PSV = 15°

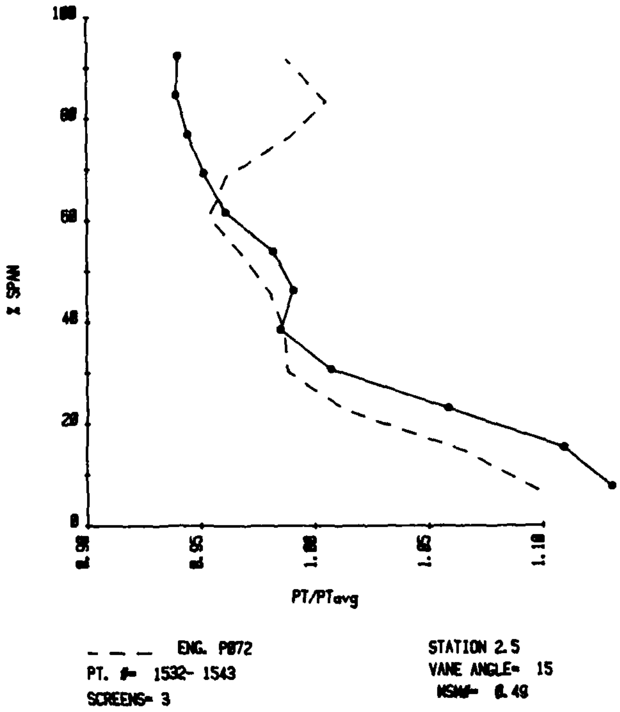


Figure 113. Total Pressure Profile (Phase II), PSV = 15°, Station 2.5

SECTION VI

MODIFIED PRESWIRL VANE AND SCREEN TEST (PHASE III)

1. GENERAL REQUIREMENTS

A final modification was required on the screen set provided by P&WA to increase the total pressure in the region of 70 percent to 100 percent span at station 2.5. In addition, circumferential variation of the swirl profiles and total pressure profiles behind the IGV's will be determined. After the desired station 2.5 total pressure profile was obtained, full documentation of the entrance profiles in the inlet hardware was made for future comparison during CRF testing. The following subsections describe this final phase of testing.

2. PRESWIRL VANE AND SCREEN MODIFICATIONS

No modifications were made to the preswirl vane configuration as swirl profiles obtained in the previous phase of testing were adequate. To increase the total pressure in the 70 percent to 100 percent span region, the outer portion of the screen set 3 was removed, as shown in Figure 114.

3. HARDWARE MODIFICATIONS

An additional traverse location behind the IGV's was added at octant two, as shown in Figure 115. This provided additional information to determine the circumferential total pressure and swirl variation at the entrance to the compressor. The filter house was not available for this phase of testing and, therefore, was not utilized.

4. DATA ACQUISITION (TESTING)

The test plan from the previous phase of testing was followed. Before testing began, an end-to-end calibration of the data acquisition system was completed. The results of this check (shown in Figures G-1 thru G-10, Appendix G) indicated that the desired accuracy of ± 1 percent was achieved. During the data acquisition process, it was noted that fluctuations in P2-P3 measured by the wedge probe were much greater than previously encountered. The fluctuations were presumed due to the absence of the filter house. In previous tests the filter house not only minimized particles in the flow, but also acted as a flow smoothing and straightening device. The testing

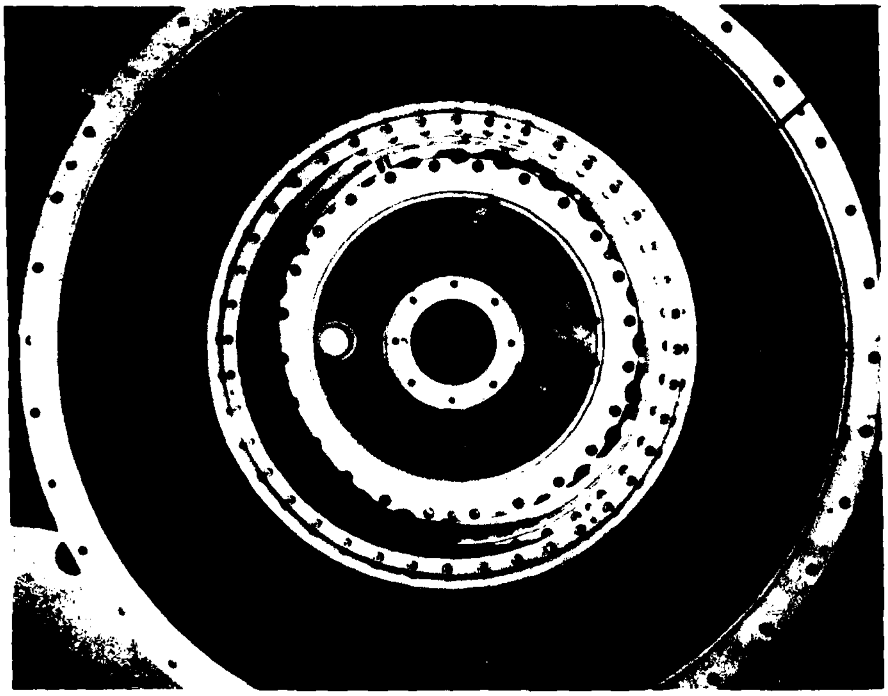


Figure 114. Screens with Outer Portion Removed

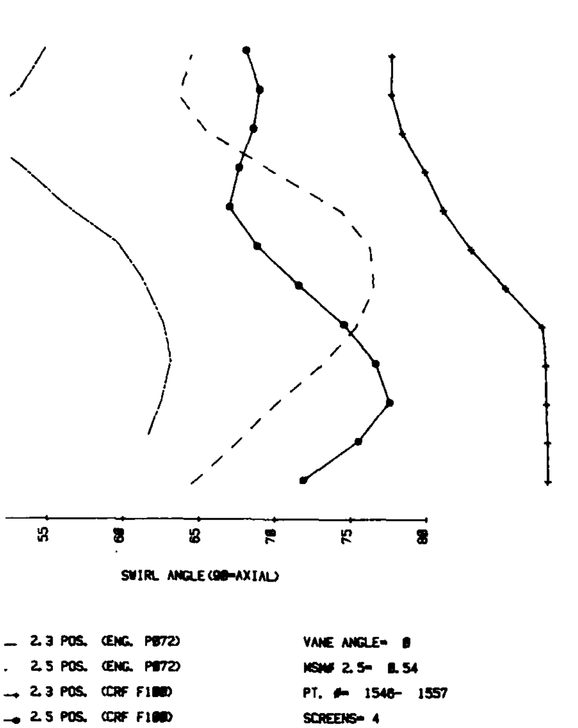
Figure 115. IGV Traverse Location, Octant 7

ontinued without the filter house because this configuration was more similar to he conditions that exist in the CRF. Data were obtained for vane angle settings of , 10, 15, 20, 25, 30 and 35. After reviewing these data, intermediate angles of 22 nd 23 were obtained. Data were also obtained for the optimum vane angle setting in ctants one, two, seven and eight at station 2.5 and octants two and seven at the ocation behind the IGV. The vane angle was varied and additional IGV data were aken to determine profile sensitivity behind the IGV to preswirl vane changes. A otal of 21 traverses were obtained during this phase of testing. All data obtained re presented in tabular form in Table G-1, Appendix G.

. DATA ANALYSIS

a. Swirl Angle Profiles

Profile data at stations 2.3 and 2.5, with screen set 4, for preswirl vane ngles of 0, 10, 15, 20, 25, 30 and 35 are shown in Figures 116 thru 122. These data indicate that while profiles at station 2.3 vary substantially as vane settings are changed, station 2.5 swirl has small variations. The station 2.5 swirl profiles most represent the engine profiles for vane angle settings of 20 to 30 degrees, as shown in Figures 119 thru 121. The station 2.3 profile shown in Figure 121 for the vane angle setting of 30 degrees matches the engine profile within 2 degrees between 60 and 100 percent span and 3 degrees for 0 thru 60 percent span. Therefore, vane settings between 20 and 30 degrees are acceptable for the CRF/F100 rig testing. Since the total pressure profile at station 2.5 is affected by preswirl vane setting, the final setting was determined when the desired total pressure profile was obtained. Intermediate preswirl vane angle settings of 22 and 23 degrees (shown in Figures 123 and 124) were obtained after review of the total pressure profiles for preswirl vane angles of 20, 25 and 35. Both plots indicate an average agreement of three degrees with the desired station 2.5 profile. This is the best agreement thus far in the test program. Documentation of circumferential variation of station 2.5 swirl profiles are shown in Figures 125 thru 130. The profiles were obtained for octants one, two, three, six, seven, and eight, respectively. The traverse at station 2.3 was not physically moved from its location on the case during these traverses. Therefore, the station 2.3 profiles are nearly identical in all figures. This indicates that the flow conditions were duplicated upstream of station 2.5 for all traverses. These figures again represent a variation circumferentially in swirl profile at station 2.5 as was found in the previous phase of testing. Measurements were obtained at two circumferentially locations at a station downstream of the inlet guide vane to



e 116. Swirl Profiles (Phase III), PSV = 0^{0}

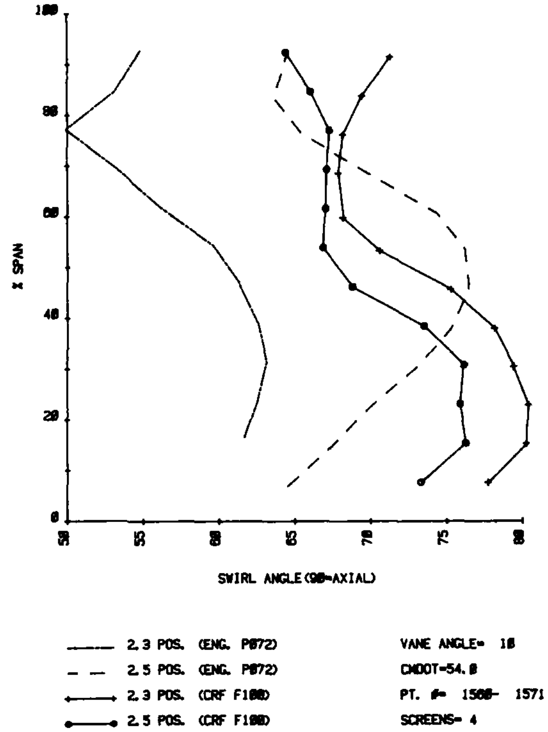
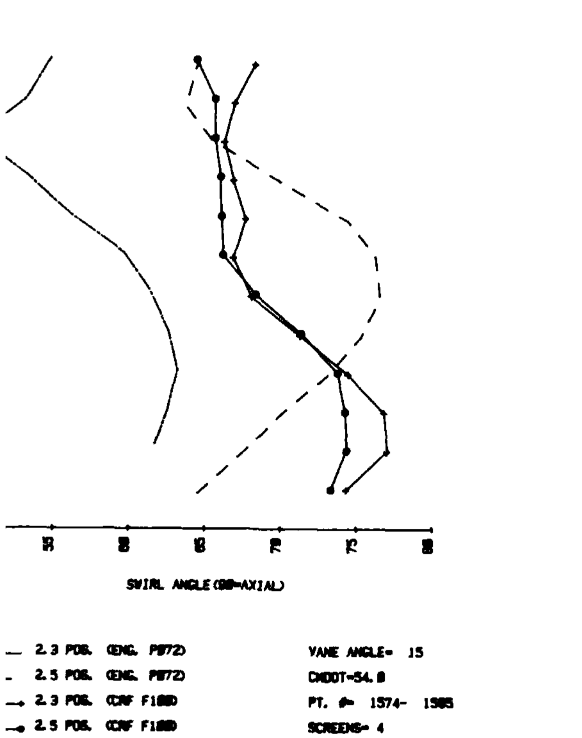


Figure 117. Swirl Profiles (Phase III), PSV = 10^{0}



re 118. Swirl Profiles (Phase III), PSV = 15^{0}

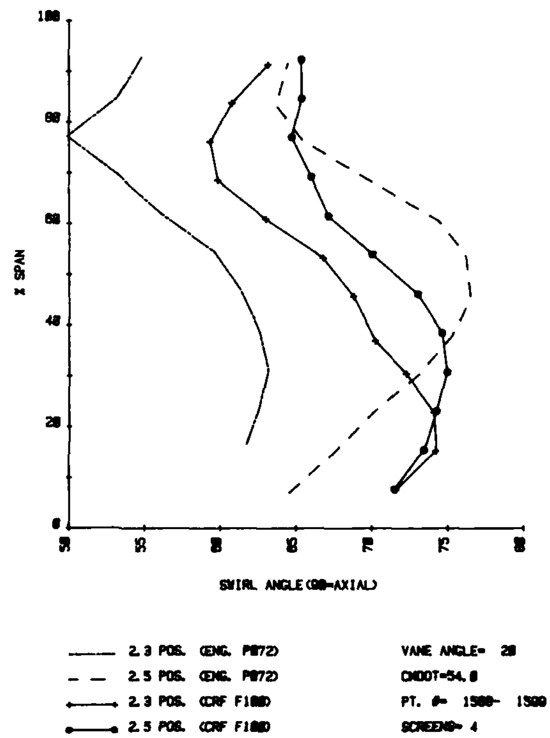
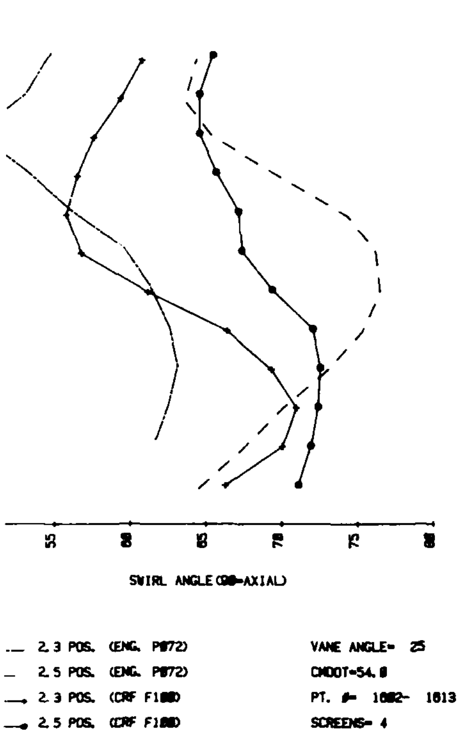


Figure 119. Swirl Profiles (Phase III), PSV = 20^{0}



e 120. Swirl Profiles (Phase III), PSV = 25^0

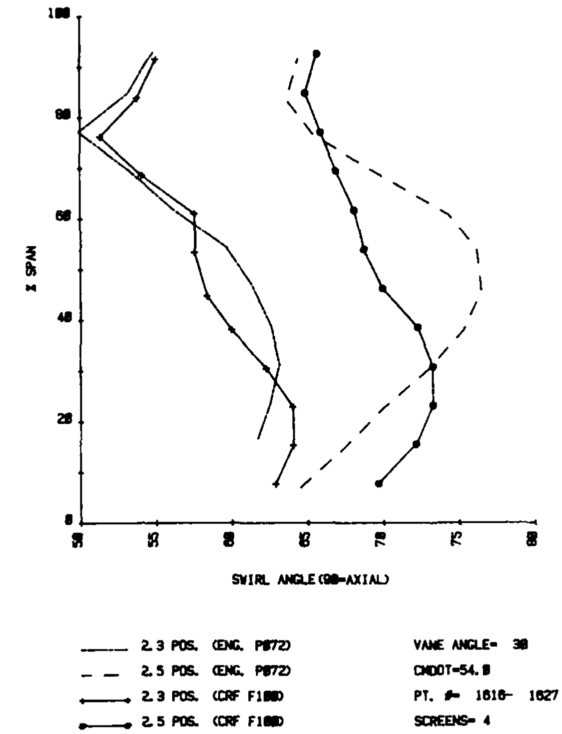
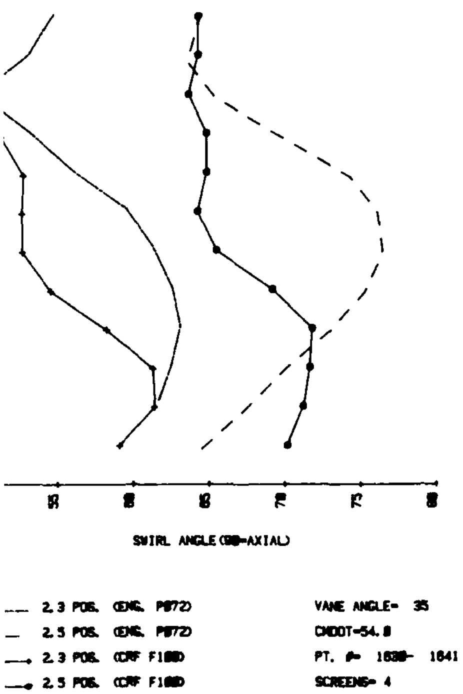


Figure 121. Swirl Profiles (Phase III), PSV = 30^0



: 122. Swirl Profiles (Phase III), PSV = 35^0

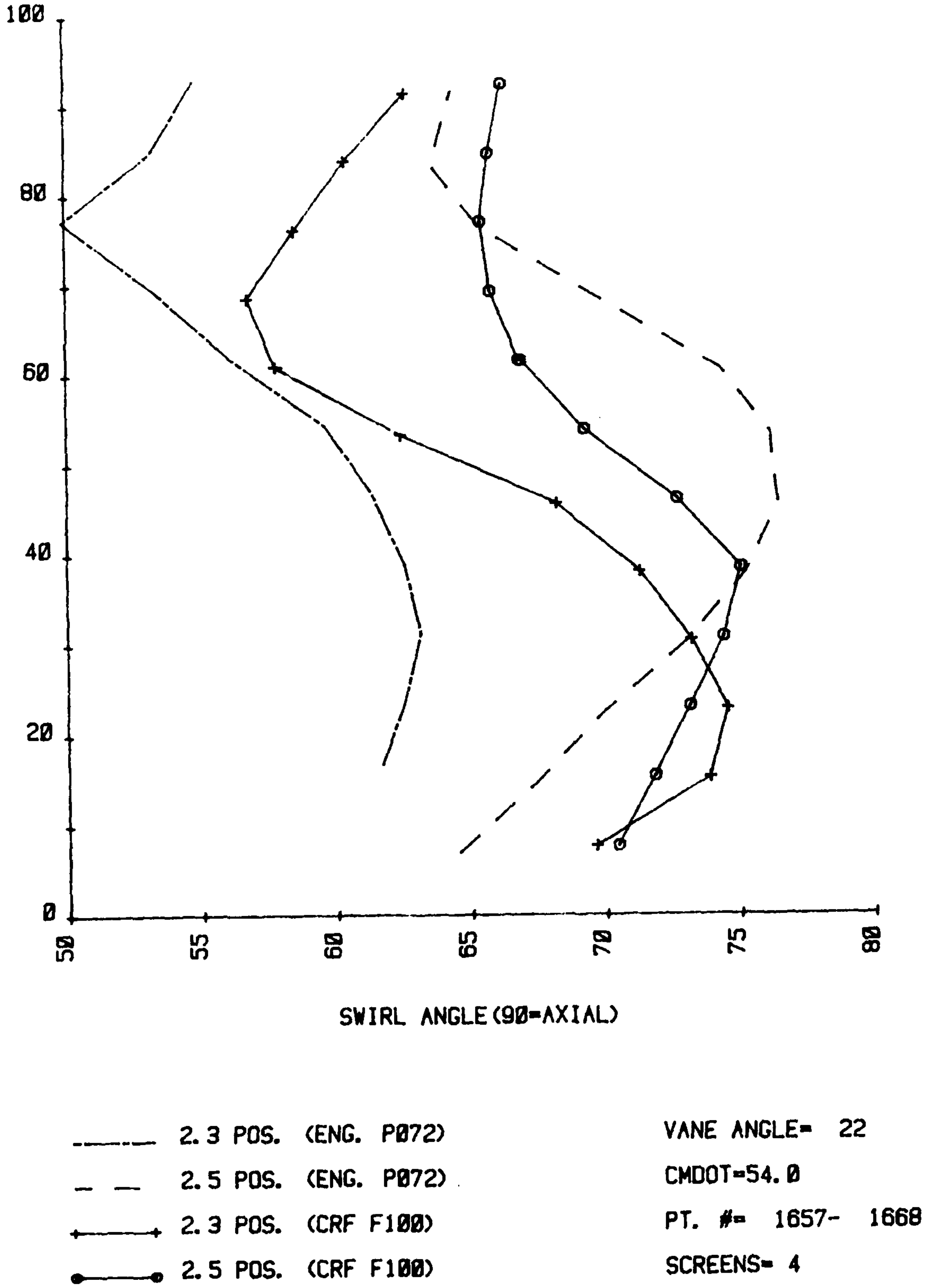


Figure 123. Swirl Profiles (Phase III), PSV = 22^{o}

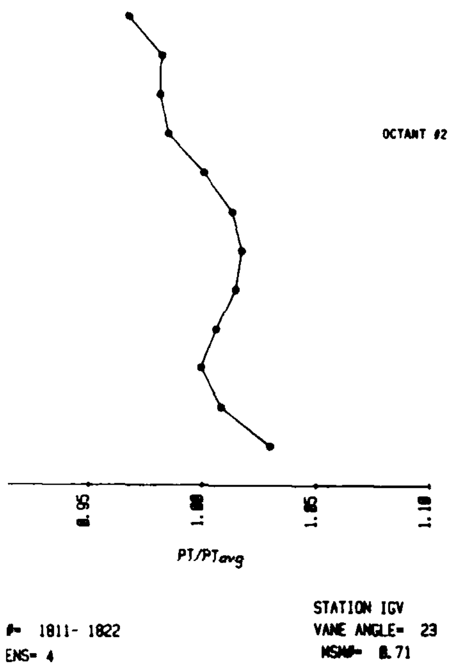
SECTION VII

DISCUSSION

objectives of this program were to determine the fan discharge total pressure l angle profiles from an operational F100(3) engine. Then define a configura- t would provide these profiles at the inlet of the CRF/F100 compressor rig. rimental measurements and verifications were undertaken by the Air Force OTX) and the analytical design and hardware development was performed by d Whitney Aircraft, Government Products Division. This report primarily ed the efforts of POTX in obtaining the engine profiles and verifying the compressor rig inlet preswirl vanes and inlet screen design. Information given on the method used by Pratt and Whitney Aircraft in designing these vanes and screens to provide the measured engine profiles.

lata acquisition system was defined and transported to Pratt and Whitney : to measure the engine profiles. This system was modified for installation \ir Force test facility. Additional data acquisition system hardware and software modifications were made as requirements in the verification increased. The test facility in which all inlet preswirl vane and screen ations were tested was defined. This facility provided for flow capacity :rol over the complete range of F100 engine core compressor operation.

)file data were obtained at station 2.3 and 2.5 at one circumferential ı of the F100(3) engine (SN P072) for core speeds of 9,700, 10,430, 11,550 780 RPM. The design speed data at 12,780 RPM indicated a swirl angle)n of 13 degrees from hub-to-tip at station 2.5. The data obtained from the :her speeds at this location indicated a swirl variation with engine speed of legrees maximum over the complete span. This indicates swirl profiles at 2.5 are not substantially affected by core flow rates. This was also proven equent CRF/F100 inlet tests. The swirl profile measured at station 2.3 for RPM and 9,700 RPM were utilized by Pratt and Whitney Aircraft in designing 'F100 preswirl vanes. The total pressure profiles measured at station 2.5 in ine at design speed indicate a maximum of 15 percent gradient of total from hub-to-tip. The design speed total pressure profile was designated as l for the CRF/F100 inlet. Total pressure profiles measured at station 2.3 ed as design parameters for the CRF/F100 inlet configuration specification.



150. Total Pressure Profile
IGV (Phase III), PSV = 23^{0},
2

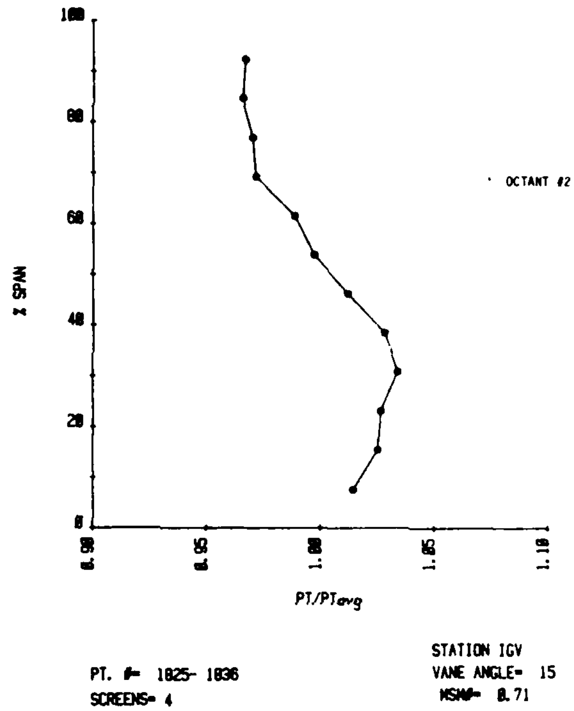
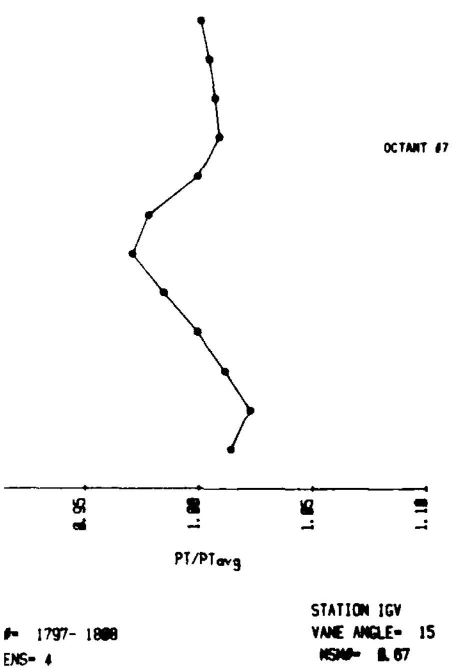


Figure 151. Total Pressure Profile Behind IGV (Phase III), PSV = 15^{0}, Octant 2



152. Total Pressure Behind IGV
se III), PSV = 23^{0}, Octant 7

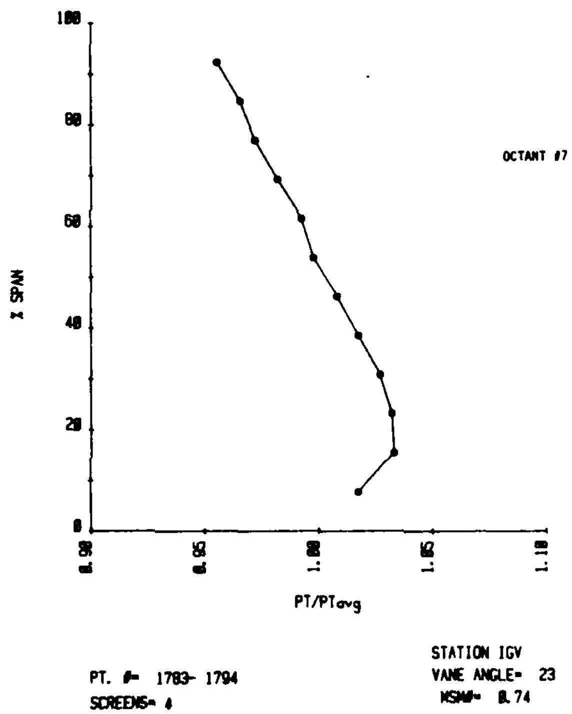


Figure 153. Total Pressure Behind IGV (Phase III), PSV = 15^{0}, Octant 7

ate the circumferential variation of the station 2.5 total pressure profile for ts one, two, three, six, seven and eight. The maximum circumferential variation percent and the average variation is 3 percent. The circumferential variation tal pressure is maximum in the hub region and the tip region. This circumferential iformity is due to the effect of the eight support stuts generating individual passages. Each flow passage has its own characteristics and, therefore, total ure profile. Measurements were made downstream of the IGV's to determine the t of this flow nonuniformity after transition through the inlet guide vanes. ›rofiles were measured in two different circumferential locations for vane angle ngs of 15 and 23 degrees. Figures 150 and 151 show total pressure profiles ıred at station IGV in octant two for vane angles of 15 and 23 degrees. These 'es indicate that the total pressure profile downstream of the IGV is affected ıe preswirl vane settings. The profile measured for vane angle setting of 23 compared with the profile measured at station 2.5 octant two (Figure 145) shows the overall profile is transmitted through the IGV. Some reduction in the spanwise ıtion can be seen. The profiles were measured for the same vane angles in octant ı, as shown in Figures 152 and 153. Comparison of these profiles and the profiles ıred in octant two indicated an average circumferential variation of three percent ; degree PSV setting and 1.5 percent for 23 degree PSV setting.

Discussion and conclusions with regard to this final phase of testing will ›vered in Sections VII and VIII.

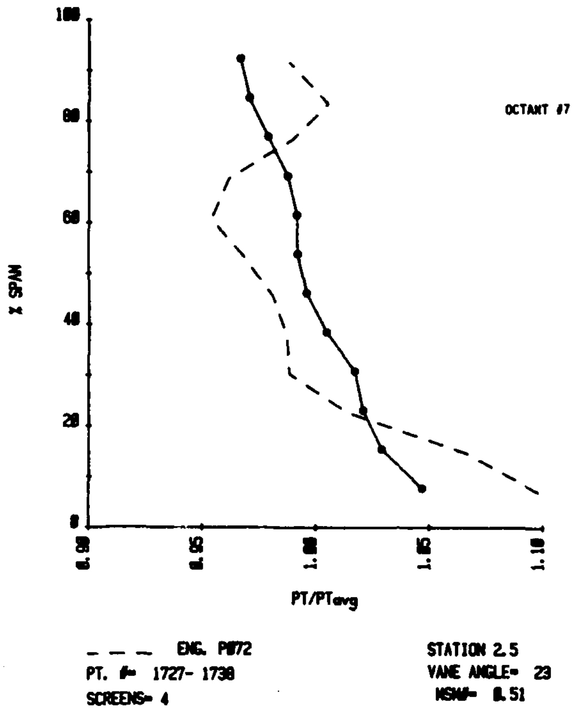


Figure 148. Total Pressure Profile (Phase III), PSV = 23^{O}, Station 2.5, Octant 7

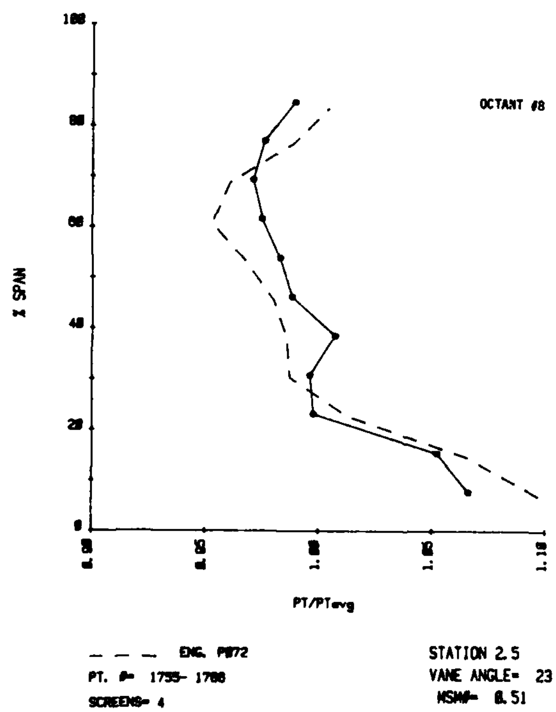
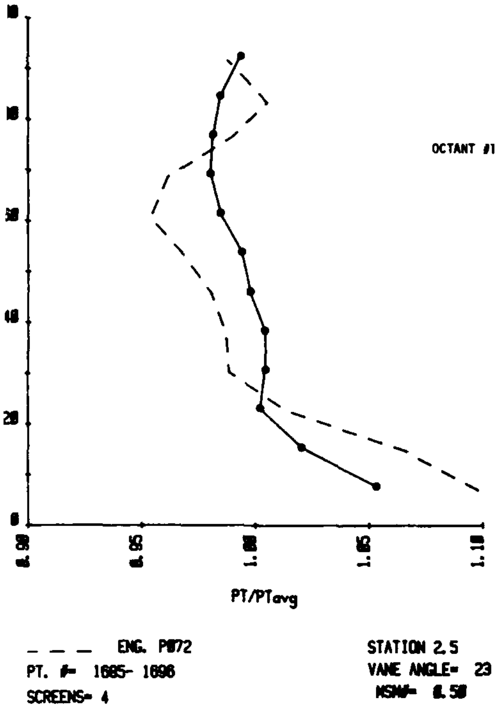


Figure 149. Total Pressure Profile (Phase III), PSV = 23^{O}, Station 2.5, Octant 8



ıre 144. Total Pressure Profile
se III), PSV = 23^{o}, Station 2.5,
ant 1

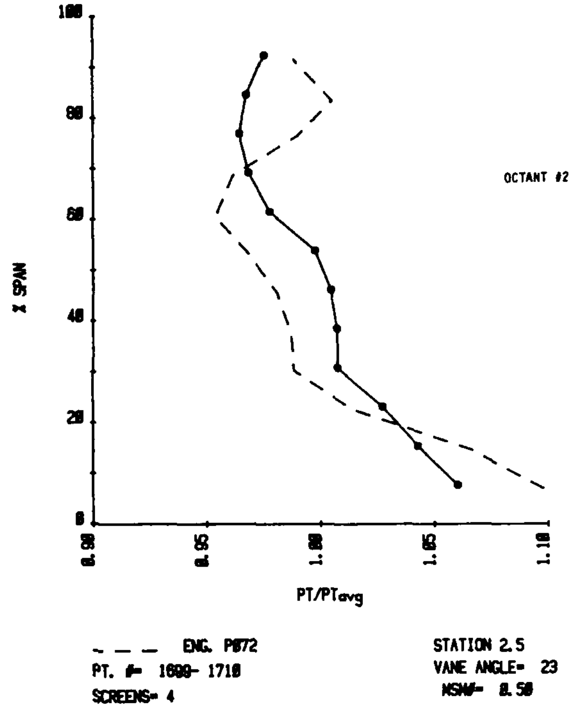
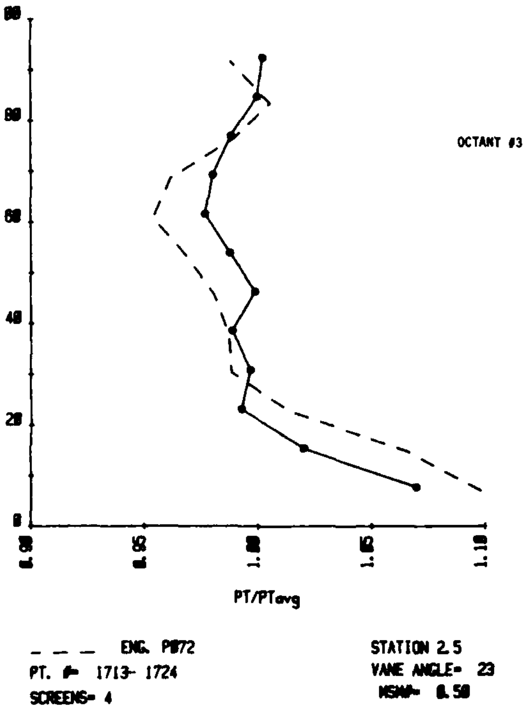


Figure 145. Total Pressure Profile
(Phase III), PSV = 23^{o}, Station 2.5,
Octant 2



ıre 146. Total Pressure Profile
ıse III), PSV = 23^{o}, Station 2.5,
ant 3

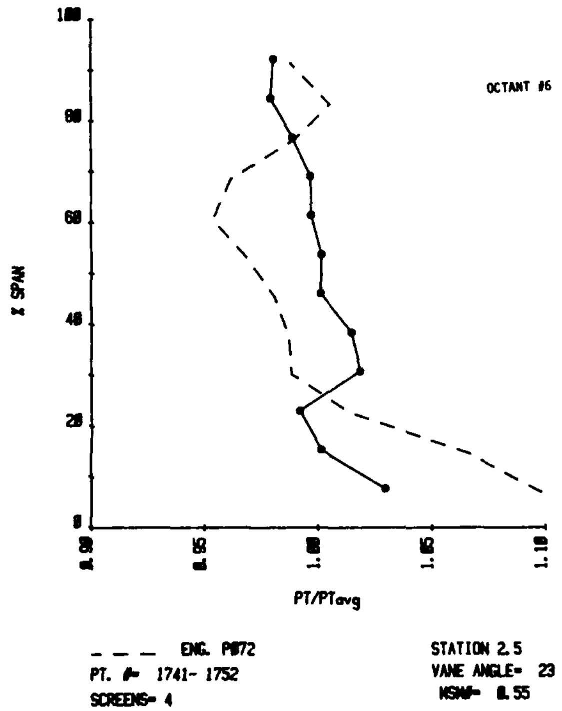


Figure 147. Total Pressure Profile
(Phase III), PSV = 23^{o}, Station 2.5,
Octant 6

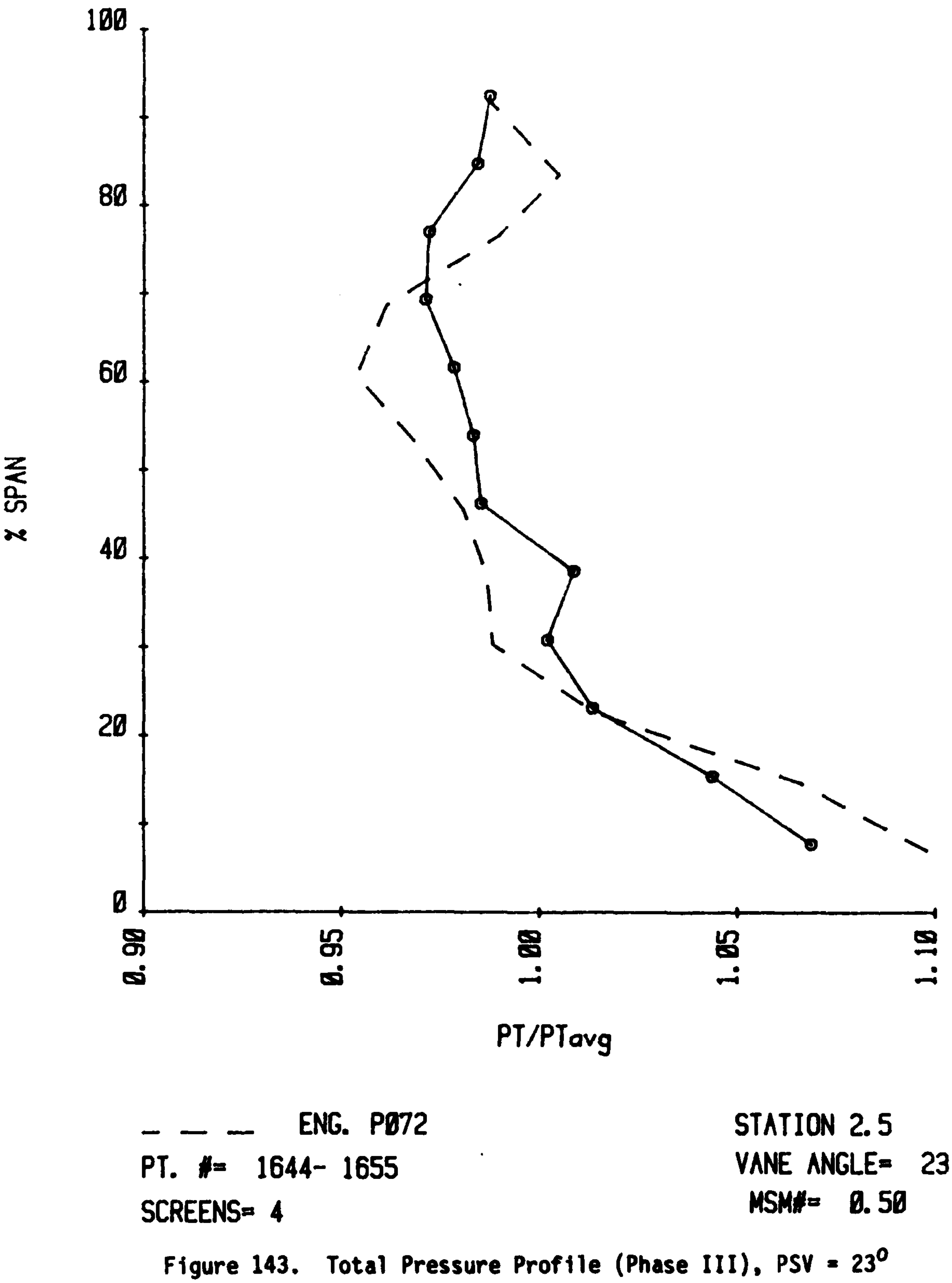


Figure 143. Total Pressure Profile (Phase III), PSV = 23°

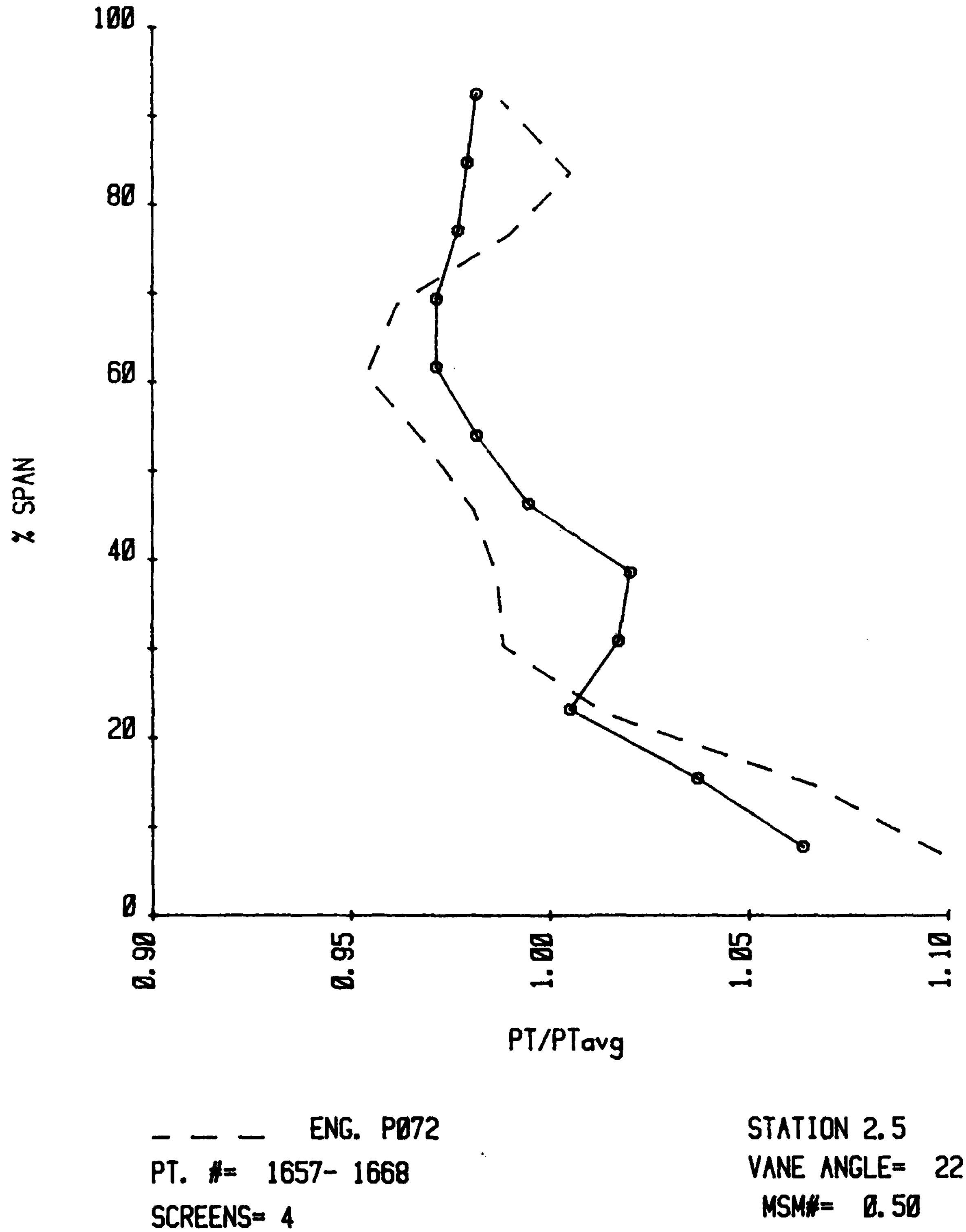


Figure 142. Total Pressure Profile (Phase III), PSV = 22°

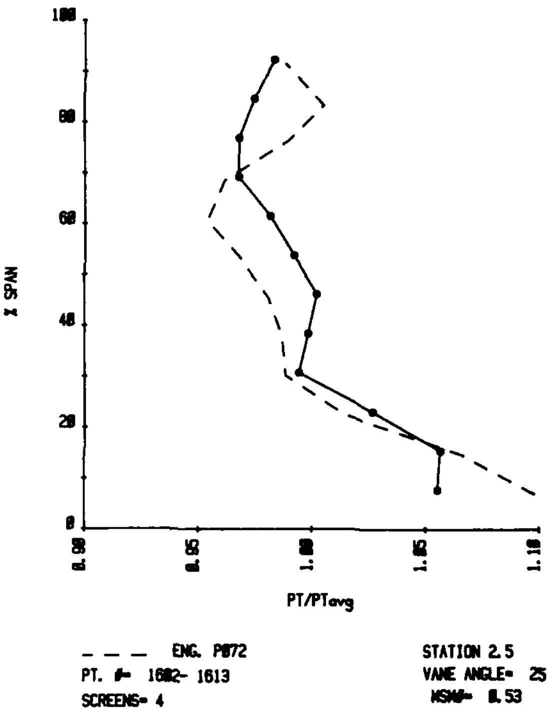


Figure 139. Total Pressure Profile (Phase III), PSV = 25^{0}

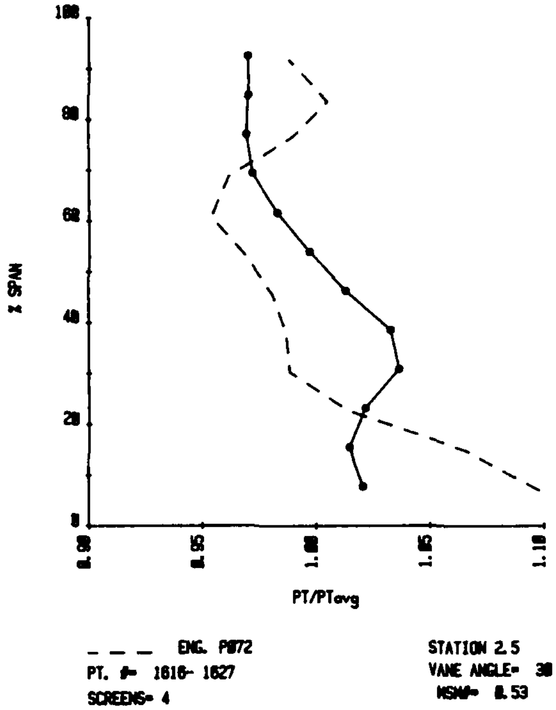


Figure 140. Total Pressure Profile (Phase III), PSV = 30^{0}

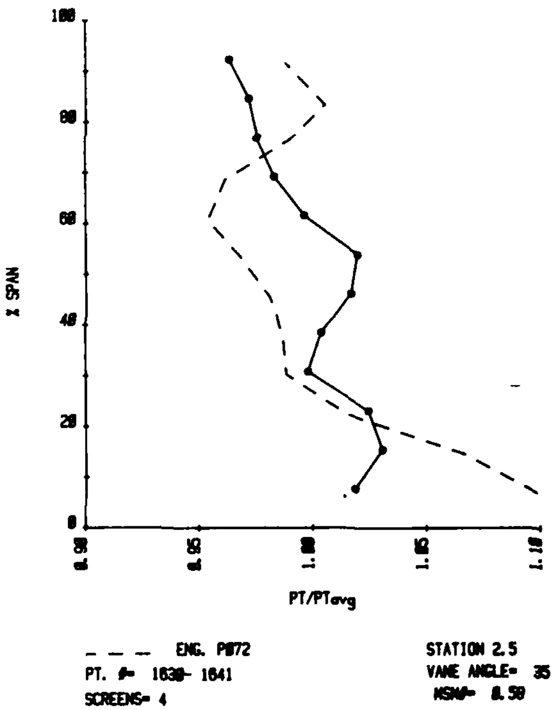


Figure 141. Total Pressure Profile (Phase III), PSV = 35^{0}

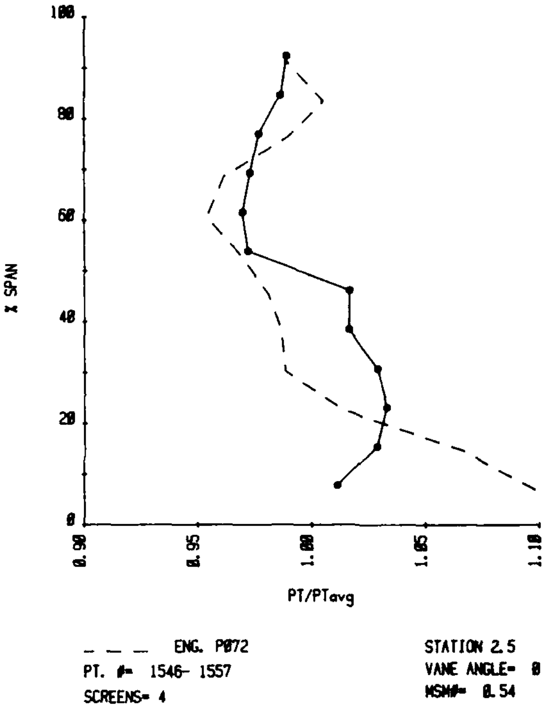


Figure 135. Total Pressure Profile (Phase III), PSV = 0^{o}

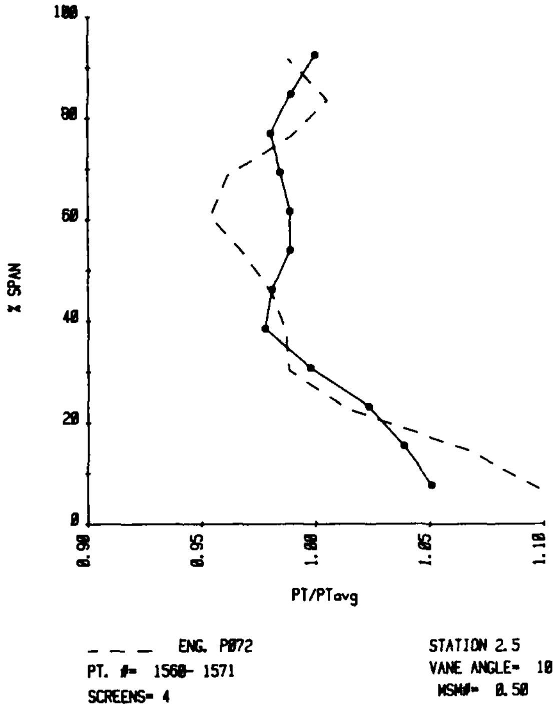


Figure 136. Total Pressure Profile (Phase III), PSV = 10^{o}

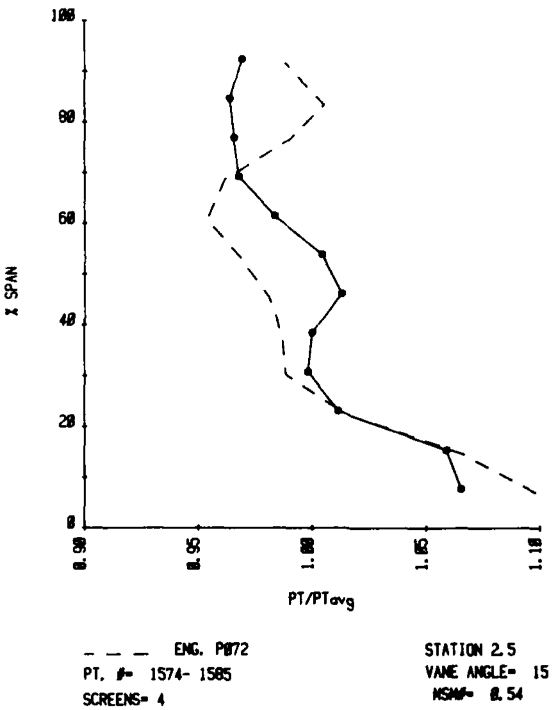


Figure 137. Total Pressure Profile (Phase III), PSV = 15^{o}

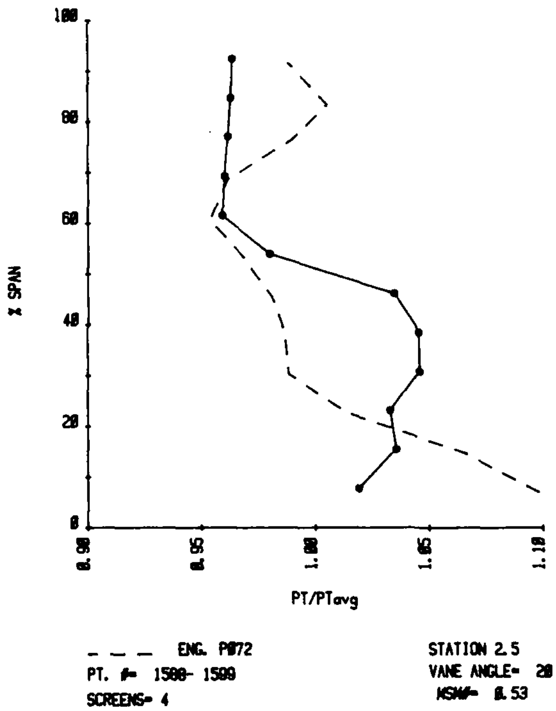


Figure 138. Total Pressure Profile (Phase III), PSV = 20^{o}

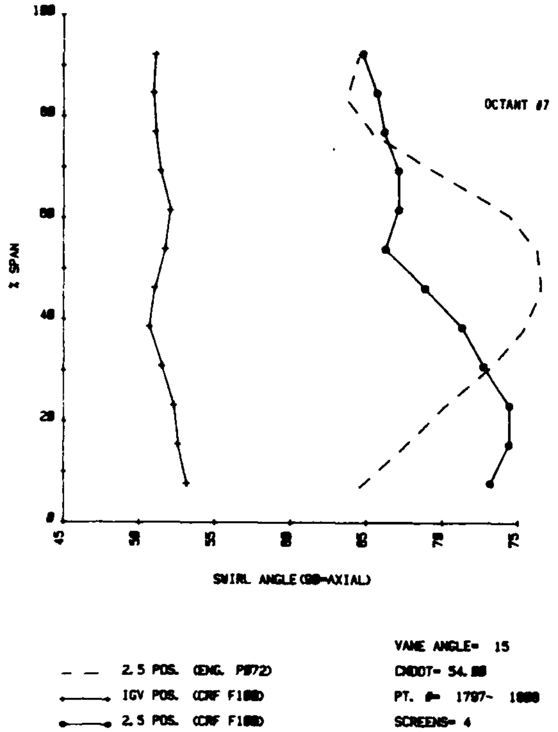


Figure 131. Swirl Profile Behind IGV (Phase III), PSV = 15°, Octant 7

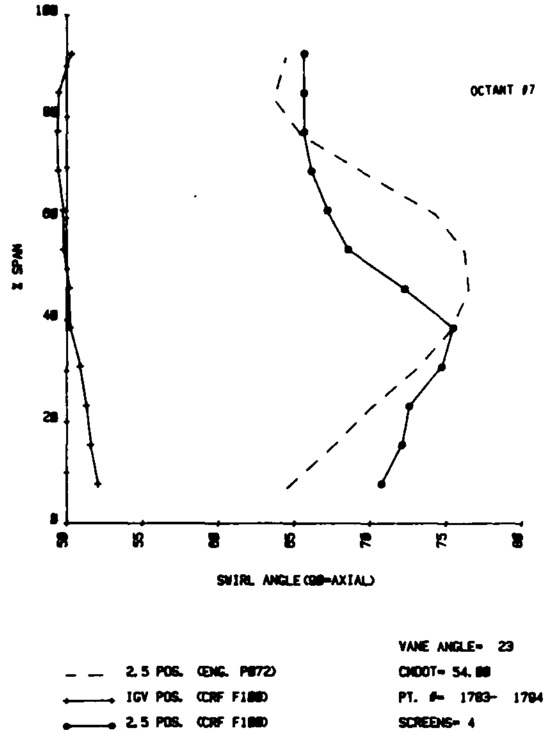


Figure 132. Swirl Profile Behind IGV (Phase III), PSV = 23°, Octant 7

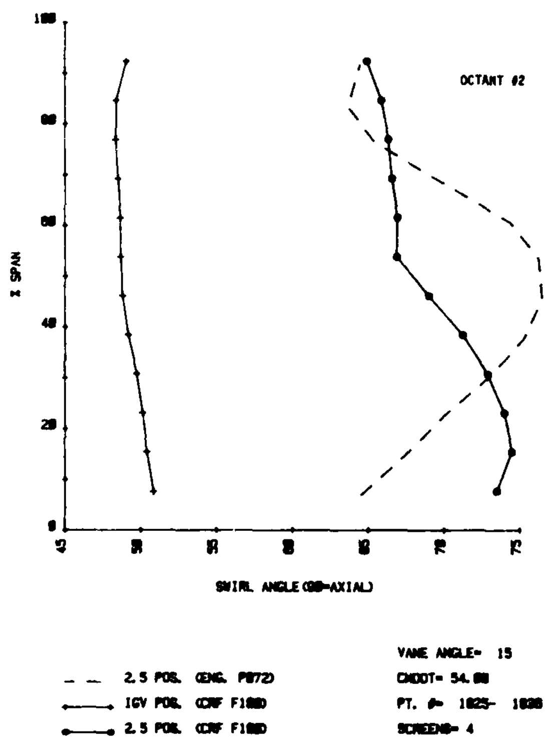


Figure 133. Swirl Profile Behind IGV (Phase III), PSV = 15°, Octant 2

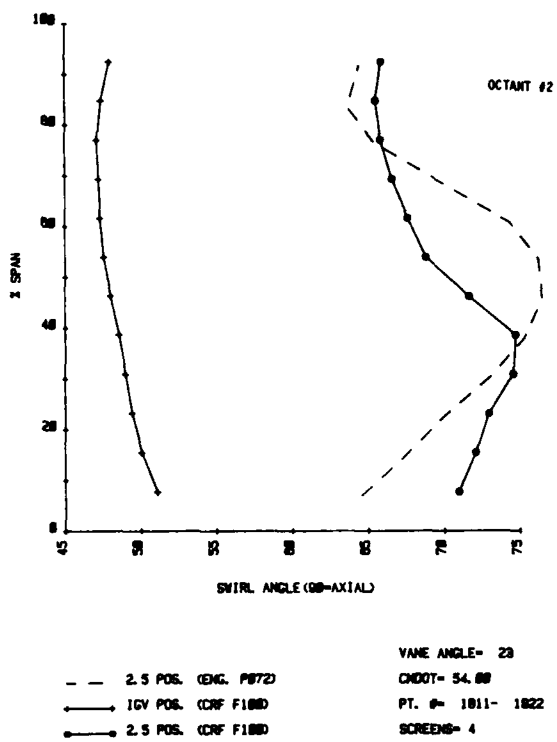


Figure 134. Swirl Profile Behind IGV (Phase III), PSV = 23°, Octant 2

determine the effects the inlet guide vanes had on the flow. Data were obtained for vane angle settings of 15 and 23 degrees in octants two and seven at this location. The traverse of station 2.5 was not moved circumferentially and used primarily for assurance of no flow variation between movements of the IGV traverse. Figures 131 and 132 show swirl distribution behind the IGV at octant seven for vane angle settings of 15 and 23. They indicate that the swirl distribution behind the IGV's is not affected by variation in preswirl vane setting within the ± 1 degree measurement accuracy. They also indicate that for both PSV settings a maximum variation of 2 degrees exists from hub-to-tip, while at stations 2.5 a 10 degree variation exists. These figures demonstrate the insensitivity of swirl profile behind the IGV's at octant two are shown in Figures 133 and 134. They indicate a shift of approximately 2 degrees from octant seven. This was due to a traverse to case alignment shift. The bosses behind the IGV did not have any convenient method of alignment with the axis of the inlet hardware. Therefore, it cannot be stated that this two degree shift is due to circumferential variation. Therefore, Figures 133 and 134 indicate no circumferential variation of the swirl profile downstream of the IGV within the accuracy of the measurement.

In summary, the measurements downstream of the IGV's indicate that the variation in distribution, radial and circumferential, at station 2.5, does not result in a variation of the profiles generated by the IGV's within the accuracy of the measurements.

b. Total Pressure Profiles

The total pressure data obtained for the inlet screen configuration described in Section VI.2 are shown in Figures 135 thru 141 for vane angles 0, 10, 15, 20, 25, 30 and 35 degrees. All profiles indicate an increase in total pressure between 70 and 100 percent span and a decrease from 0 to 20 percent from the previous screen configuration defined in Section V.2, as was desired. These figures also indicate the sensitivity of the total pressure profile at station 2.5, to a preswirl vane angle variation. The total pressure profile created for a vane angle setting of 25 degrees most closely approximated the desired engine profile. Therefore, a more detailed investigation was performed around this PSV setting. Figures 142 and 143 show the total pressure profiles for 22 and 23 degree PSV setting. The profile measured for a PSV setting of 23 degrees indicated a maximum variation from the desired profile of 3 percent and an average variation of 1.5 percent. No previously measured profiles agree with the desired profiles this accurately. Figures 144 thru 149

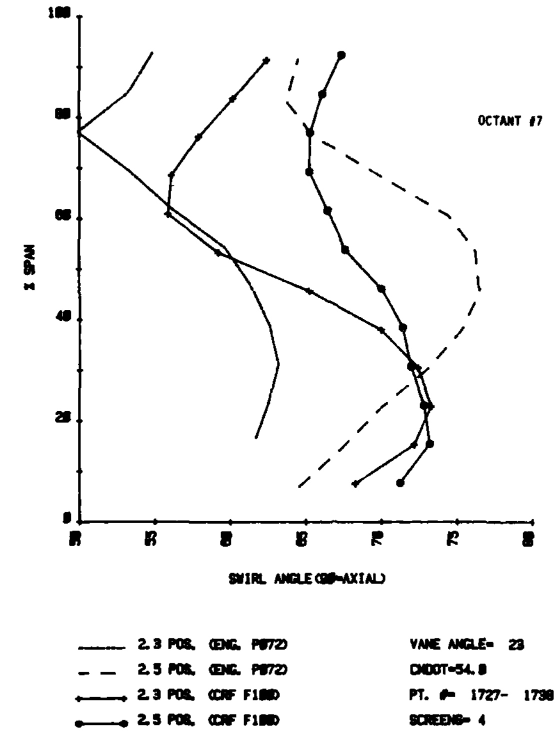


Figure 129. Swirl Profiles (Phase III), PSV = 23^{o}, Station 2.5, Octant 7

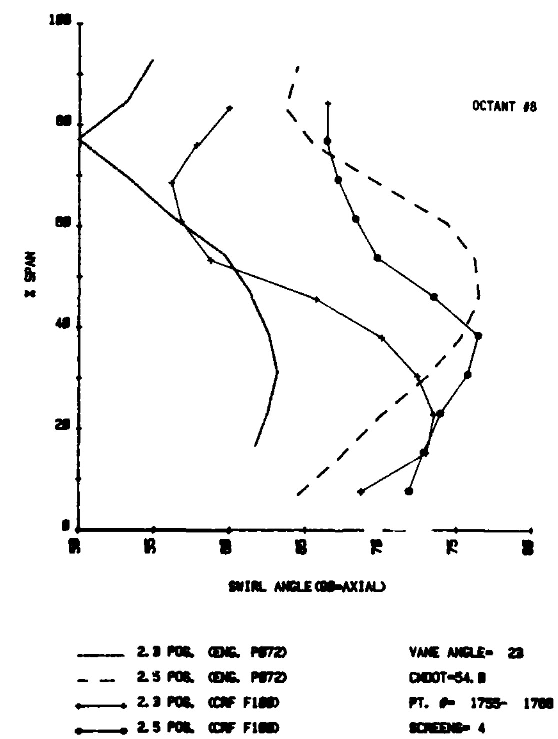


Figure 130. Swirl Profiles (Phase III), PSV = 23^{o}, Station 2.5, Octant 8

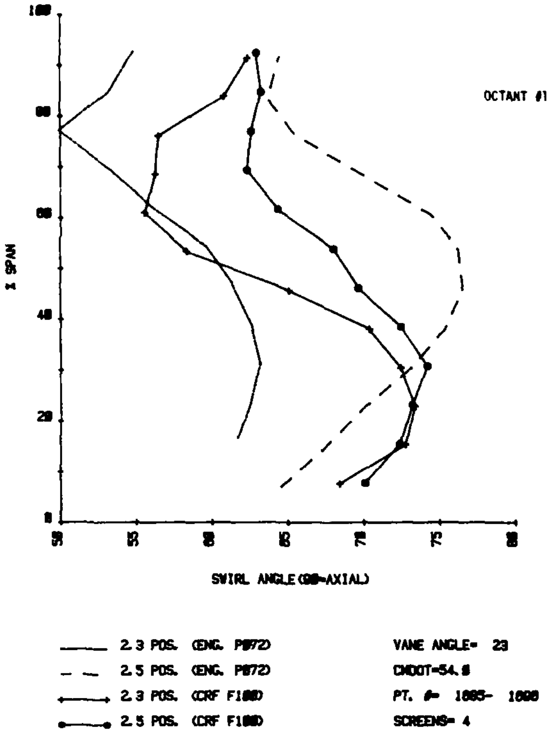


Figure 125. Swirl Profiles (Phase III), PSV = 23°, Station 2.5, Octant 1

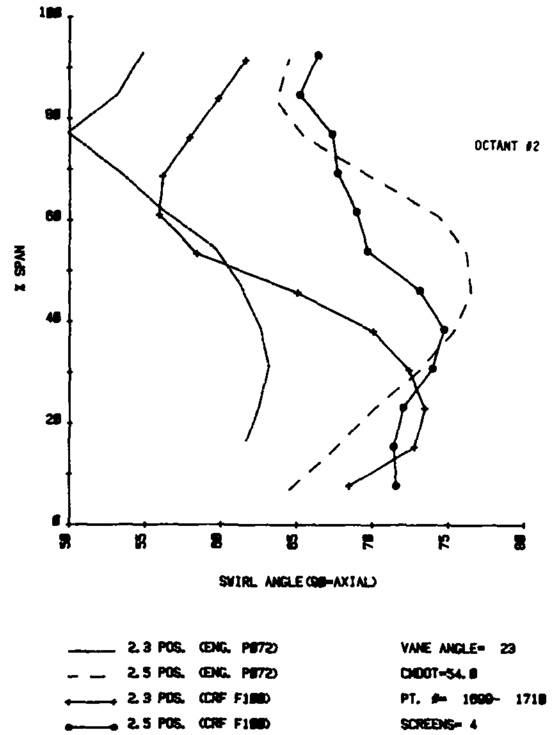


Figure 126. Swirl Profiles (Phase III), PSV = 23°, Station 2.5, Octant 2

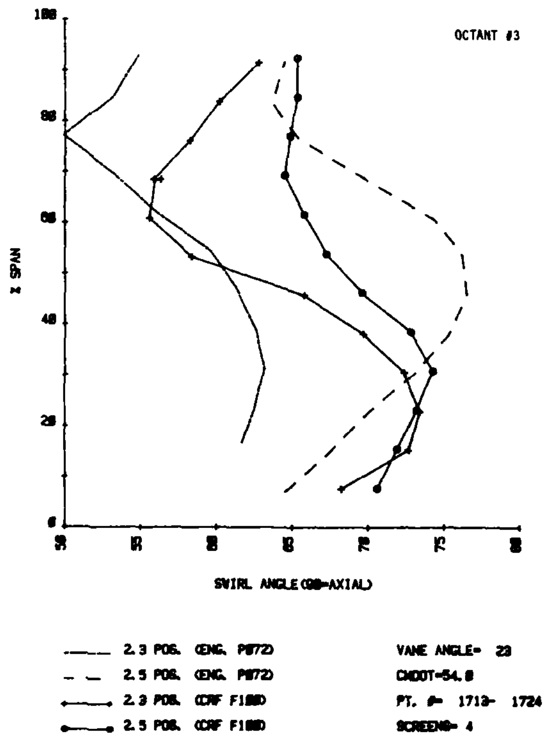


Figure 127. Swirl Profiles (Phase III), PSV = 23°, Station 2.5, Octant 3

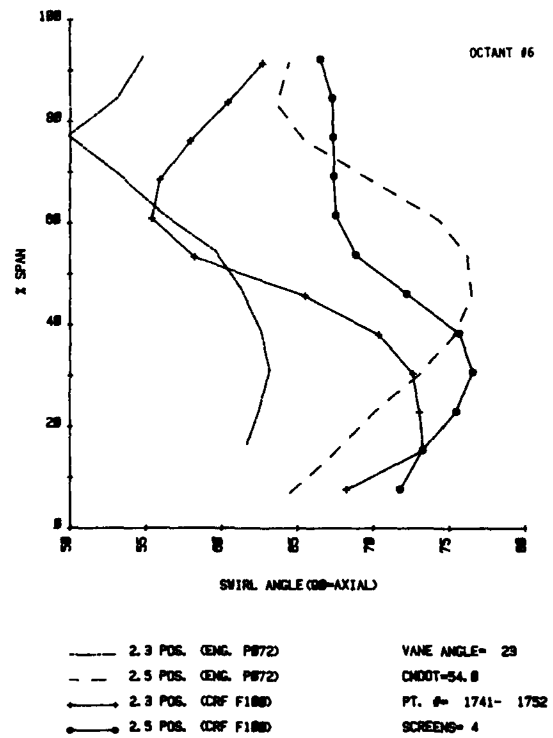


Figure 128. Swirl Profiles (Phase III), PSV = 23°, Station 2.5, Octant 6

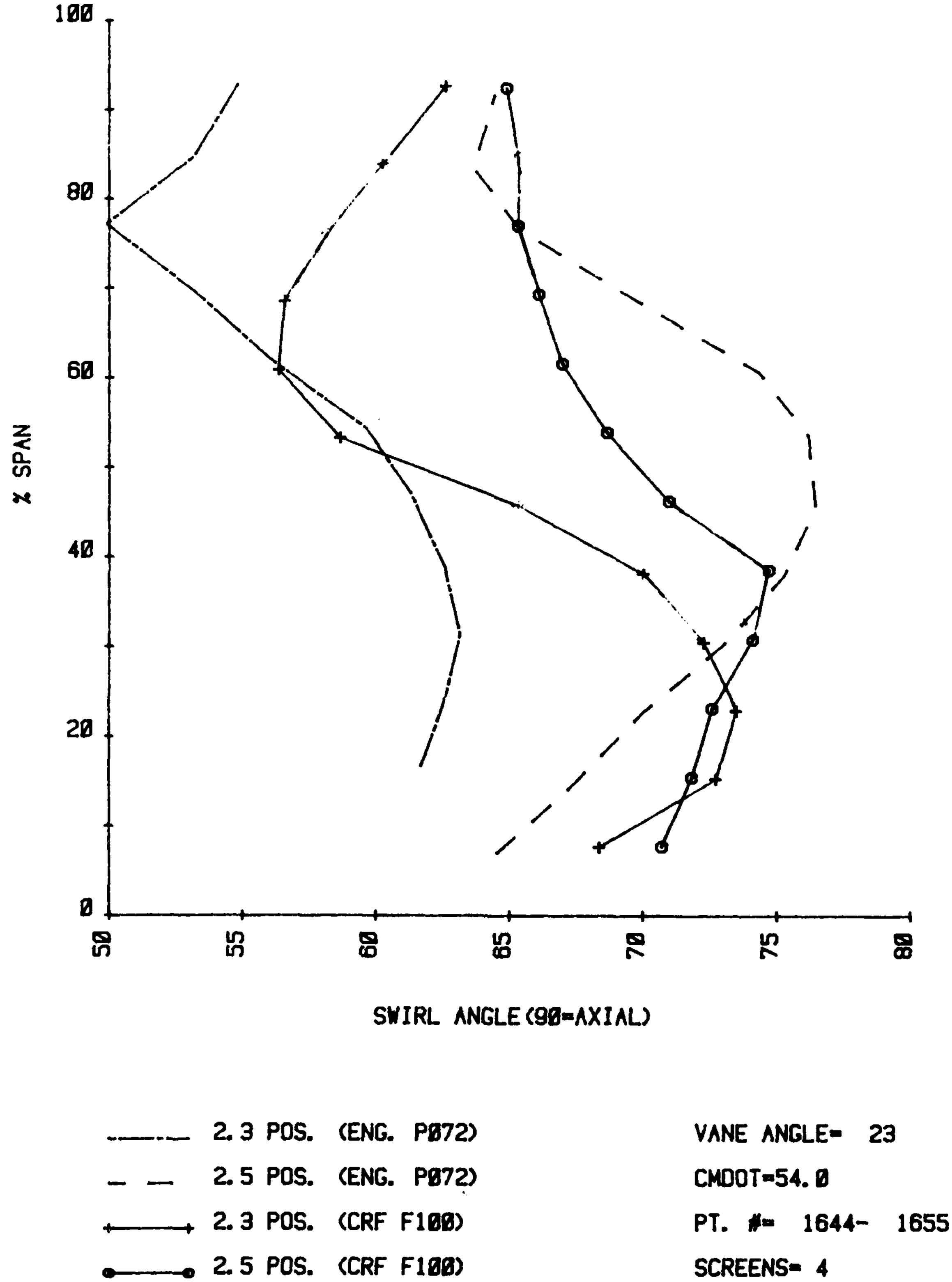


Figure 124. Swirl Profiles (Phase III), PSV = 23°

The design process involved a streamline analysis of a particular preswirl vane geometry with an inlet total pressure profile. The vane geometry and inlet total pressure profiles were iterated until the desired station 2.3 profiles were obtained. It was assumed that if the engine station 2.3 profiles were generated in the compressor rig, then the profiles measured at station 2.5 would also match the engine profiles. This assumption will be discussed in reference to the inlet hardware data obtained, later in this discussion.

The data acquisition system was improved and installed in the Air Force test facility as described. This facility provided for the necessary flow rates in the rig inlet hardware comparable to the engine flow rates. Data were obtained for an existing set of preswirl vanes utilized in previous F100 tests. This test was undertaken primarily to determine if the data acquisition system and method were adequate for future testing. A secondary desire was to determine the swirl distribution at station 2.5 provided by these vanes. Data were obtained for preswirl vane settings of 0 to 33. For vane angle settings from 0 to 25 at design flow conditions, a maximum of 3 degrees spanwise variation from 20 degrees was obtained at station 2.5. For vane angle settings of 25 to 33, a 6 degree spanwise variation was measured. As stated previously, engine profiles indicate a 13 degree spanwise variation in swirl angle at station 2.5. This data indicated what was already assumed, that the existing preswirl vane design would not provide the desired swirl profiles. The design of new preswirl vanes had begun before this test. The data also indicated that flow rate has little effect on swirl distribution at station 2.5, as was the case in the engine tests. This information was utilized in future tests to reduce test time. The test itself did verify that the data acquisition system and procedures would be acceptable for future testing with minor modifications.

The preswirl vanes and screens defined by the Pratt and Whitney Aircraft streamline analysis program were provided for installation in the CRF/F100 rig hardware set up in the Air Force test facility. These vanes were 6 percent thick NACA series 63 blading with increasing cord and turning from hub-to-tip. Total pressure, static pressure and swirl angle traverses were obtained for station 2.3 and 2.5. The station 2.3 data were obtained to assist Pratt and Whitney Aircraft in their design method verification. Data were acquired for preswirl vane settings of 0 to 20 degrees. No further actuation above 20 degrees was available. A preswirl vane setting of 20 degrees positioned the vane leading edge approximately parallel with the inlet hardware axis. The swirl and total pressure data most representative of the engine profile data were for 20 degrees PSV setting. The swirl angle variation from hub-to-tip was 8 degrees with a maximum and average deviation from the desired profile of 9 and 3 degrees, respectively. The swirl distribution measured at station 2.3 was within agreement of the desired profile by an average of 4 degrees. The measured profiles also indicated that more vane angle actuation would improve the agreement. The average and maximum total pressure profile variation from the engine profiles was 3 and 5 percent, respectively. This average 3 percent variation represents 20 percent of the hub-to-tip gradient of total pressure in the engine.

Although the improved preswirl vane and screen design did generate more representative profiles, it was envisioned that further improvements could be made through experimentally determined modifications. Streamline analysis was unable to predict the profiles at station 2.5 for a given vane angle setting. This is primarily due to the high angle of attack (of the flow generated at station 2.3) on the support struts at station 2.5. The struts are positioned at 70 degrees (90=axial) while station 2.3 flow angles range from 50 to 64 degrees. An additional reason for the failure of the profiles measured at station 2.5 to match engine profiles is the difference between engine and rig intermediate cases. The engine intermediate case was of an F100(3) while the rig intermediate case is of an F100(2). The F100(3) case station 2.5 ID wall protrudes farther into the flow path than the F100(2). The F100(2) intermediate case was selected for the rig test because it was anticipated that an F100(3) case would result in flow separation in the rig test. Therefore, a match of the inlet hardware station 2.3 profiles to the F100(3) engine station 2.3 profiles did not assure a station 2.5 match.

Due to these conditions, modifications to the screens and vanes were made and further experimental efforts were undertaken. Due to the difficulty in obtaining an accurate match of station 2.5 swirl and total pressure profiles on the first attempt, it was decided that measurements were required downstream of the IGV's to determine the flow sensitivity at this location to differences at station 2.5. After one preswirl modification and two screen changes, profiles determined adequate for the rig test were obtained. From measurements behind the IGV's, it was determined that the swirl profile, behind the IGV's, was insensitive to changes at station 2.5. It was also found that the total pressure profile, behind the IGV's, was sensitive to these changes, therefore, additional effort was taken to assure a match between engine and rig total pressure profiles at station 2.5. Swirl data obtained from the final configuration at station 2.5 deviated from the desired data by a maximum of 7.5 degrees and an average of 3.4 degrees for a PSV setting of 23 degrees. With the knowledge of the IGV's effect on swirl distribution, this profile match was acceptable. Agreement between engine and rig station 2.5 total pressure profiles for this PSV setting was obtained within 1.5 percent. This average variation is 11 percent of the total hub-to-tip total pressure gradient in the engine.

In addition, total pressure and swirl angle circumferential variation was determined. From measurements made in six of the eight locations, a maximum of five degrees swirl variation and an average of four degrees variation were determined. The average variation circumferentially in total pressure was 20 percent of the total hub-to-tip gradient. It should be noted that the circumferential variation measured in the inlet hardware test may differ from CRF/F100 rig variations. This is due to the inability to simulate the upstream effects the compressor will have on the inlet in our tests. It is anticipated that the compressor will lessen the circumferential variation and, in addition, have some effect on both the total and swirl absolute profiles. These effects will be determined during the CRF/F100 rig test since base line conditions have been generated in these tests.

A summary of the best results obtained for all test phases is shown in Table 6. This table indicates the difficulty in obtaining both swirl and total pressure profile matches in Phase II for the same preswirl vane setting. A setting of 25 degrees provided improved matching of total pressure profiles over Phase I, while resulting in a poorer match of swirl profiles. A 29 degree setting results in an improved swirl profile match and a poorer total pressure match over Phase I results. The table also indicates that Phase III results for a PSV setting of 23 degrees indicates improvements in both total pressure and swirl angle profile over all previous phases of testing. The profiles obtained from this phase of testing match the engine profiles more accurately than any previous F100 core engine test. With these profiles simulated, the CRF/F100 compressor performance data obtained can be transferred directly to engine configurations. Therefore, the efforts to simulate fan discharge conditions in the CRF/F100 rig inlet were successful.

TABLE 6

INLET HARDWARE TEST RESULTS

	EXISTING PRESWIRL VANES	MODIFIED PRESWIRL VANES AND SCREENS PHASE I	MODIFIED PRESWIRL VANES AND SCREENS PHASE II		MODIFIED PRESWIRL VANES AND SCREENS PHASE III
PRESWIRL VANE ANGLE	10^0	20^0	25^0	29^0	23^0
Average Swirl Variation From Desired (% of Total Engine Spanwise Variation 13°)	32	28	44	26	26
Maximum Swirl Variation From Desired (% of Total Engine Spanwise Variation 13°)	58	68	84	58	57
Average Total Pressure Variation From Desired (% of Total Engine Spanwise Gradient 15%)		20	15	28	11
Maximum Total Pressure Variation From Desired (% of Total Engine Spanwise Gradient 15%)		33	40	46	20

SECTION VIII

SUMMARY

a. A microprocessor based data acquisition system was utilized to provide swirl measurements at the inlet of an F100 core compressor with ± 1 degree accuracy and pressure measurements with ± 1 percent uncertainty.

b. Experimentally measured, swirl angle, total pressure, static pressure and total temperature profiles were documented for an F100 Series (3) engine at stations 2.3 and 2.5.

c. With the total pressure and swirl angle profiles as goals, a CRF/F100 rig inlet configuration was designed to provide these profiles.

SECTION IX

CONCLUSIONS

The following conclusions can be drawn from the results of this program.

a. Differences in F100(3) and F100(2) intermediate cases resulted in difficulty in obtaining exact duplication of the desired results.

b. The desired station 2.5 swirl angle profile for engine design speed of 12,700 RPM was matched within an average of 3 degrees in the CRF/F100 inlet hardware.

c. The desired station 2.5 total pressure profile for the engine at design speed was matched within 11 percent of the total hub-to-tip engine gradient.

d. Circumferential variations in both swirl angle and total pressure profiles do exist at station 2.5 due to the eight support struts creating individual flow passages. The magnitude of these variations may change due to the upstream effects by the compressor in the rig test.

e. Swirl distribution downstream of the inlet guide vanes is not affected (within the accuracy of the measurements made) by variations at station 2.5.

f. Total pressure distribution downstream of the IGV's is affected by variations at station 2.5. Therefore to assure the rig test results can be transferred to engine conditions these station 2.5 total pressure profiles must be matched.

SECTION X

RECOMMENDATIONS

The following recommendations are made for the CRF/F100 compressor component test performed in the Compressor Research Facility.

a. Obtain data detailing inlet profiles at station 2.5 with the compressor connected to the inlet hardware. Conclusions can be drawn from this information defining upstream effects resulting from the compressor downstream, thereby providing experimental information to assist in theoretical modeling of compressor effects on the upstream flow field.

b. Determine if the pressure of the compressor down stream reduces the circumferential swirl and total pressure variations measured in this test. These circumferential variations and possible separated flow distortions may reduce the performance of the compressor and, therefore, the F100 engine.

c. Determine the effect these simulated fan discharge profiles have on compressor performance by obtaining performance data with and without the screens and vanes defined in this report. This information will provide for a better understanding of effects of a fan on the performance of the high pressure compressor in the F100 engine.

APPENDIX A

ENGINE CORE INLET TEST PREPARATION

TABLE A-1

WEDGE PROBE CALIBRATION RESULTS (S/N B1625)

PT-PATM in. H_2O	P1-PATM in. H_2O	P1-P2 in. H_2O	P1-P3 in. H_2O	CPS	CPT	MACH#
70.73	70.20	63.50	63.25	.901	.999	.488
57.90	57.80	52.30	52.35	.904	.998	.445
48.70	48.60	44.15	44.15	.906	.998	.409
37.55	37.45	33.85	34.00	.903	.997	.361
27.10	27.05	24.55	24.65	.908	.998	.308
21.10	21.05	19.20	19.20	.910	.997	.273
17.30	17.30	16.00	15.85	.920	1.00	.247
14.55	14.55	13.35	13.35	.918	1.00	.227
10.90	10.95	10.15	10.15	.932	1.00	.197
7.80	7.85	7.30	7.30	.936	1.00	.167
			Average	.905	.998	

WEDGE PROBE ANGLE CALIBRATION RESULTS

P1 in. H_2O = 31.2 Nominally

*(deg)	-5	-4	-3	-2	-1	+1	+2	+3	+4	+5
P1 - P2 (in. H_2O)	31.1	30.5	29.7	28.9	28.1	26.75	26.10	25.40	24.60	23.70
P1 - P3 (in. H_2O)	24.3	24.7	25.6	26.3	27.0	28.3	28.85	29.45	30.15	30.70
P2 - P3 (in. H_2O)	6.8	5.8	4.1	2.6	1.1	-1.55	-2.75	-4.05	-5.55	-7.0

P1 in. H_2O = 58.7 Nominally

(deg)	-5.5	-4.5	-3.5	-2.5	-1.5	.5	1.5	2.5	3.5	4.5
P1 - P2 (in. H_2O)	58.0	56.6	55.5	54.45	53.2	51.1	49.6	48.4	46.7	45.1
P1 - P3 (in. H_2O)	42.3	44.4	46.5	48.1	49.5	51.6	53.15	54.3	55.5	56.35
P2 - P3 (in. H_2O)	15.7	12.2	9.0	6.35	3.7	-0.5	-3.55	-5.9	-8.8	-11.25

P1 in. H_2O = 84.4 Nominally

(deg)	-5.5	-4.5	-3.5	-2.5	-1.5	.5	1.5	2.5	3.5	4.5
P1 - P2 (in. H_2O)	83.4	81.2	80.1	79.0	77.1	73.4	71.5	69.0	67.3	64.5
P1 - P3 (in. H_2O)	60.0	62.8	65.4	67.6	70.6	74.0	75.9	78.0	79.3	80.7
P2 - P3 (in. H_2O)	23.4	18.4	14.7	11.4	6.5	-0.6	-4.4	-9.0	-12	-16.2

* Positive angle clockwise looking down on probe

TABLE A-3

TRAVERSE CALIBRATION

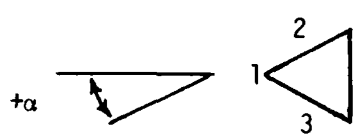
LINEAR

Position (Inches)	Potientometer Output (Volts)
0.000	-0.533
0.500	-1.888
1.000	-3.160
1.500	-4.494
2.000	-5.763
2.500	-7.101
3.000	-8.377
3.500	-9.736
4.000	-11.035
4.500	-12.398
5.000	-13.774
5.500	-15.243

ANGULAR

Position (Degrees)*	Potientometer Output (Volts)
35	-2.970
30	-3.445
25	-3.928
20	-4.444
15	-4.876
10	-5.430
8	-5.557
6	-5.775
4	-5.920
2	-6.135
0	-6.325
-2	-6.503
-4	-6.685
-6	-6.880
-8	-7.078
-10	-7.226
-15	-7.732
-20	-8.194
-25	-8.680
-30	-9.125
-35	-9.595

* Angle defined as follows



positive counter clockwise looking down on the probe.

TABLE A-4

TRANSDUCER BENCH CALIBRATIONS

0 - 1 PSID S/N 13006		0 - 15 PSID S/N 10135		0 - 50 PSID S/N 44041	
ressure (PSI)	Output (mV)	Pressure (PSI)	Output (mV)	Pressure (PSI)	Output (mV)
0.000	-0.53	0.000	-0.29	0.000	-0.400
0.200	3.50	3.000	14.70	10.00	14.64
0.400	7.53	6.000	29.70	20.00	29.65
0.600	11.54	9.000	44.80	30.00	44.68
0.800	15.55	12.000	59.85	40.00	59.72
1.000	19.58	15.000	74.85	50.00	74.76
0.800	15.54	12.000	59.84	40.00	59.81
0.600	11.54	9.000	44.78	30.00	44.69
0.400	7.52	6.000	29.70	20.00	29.66
0.200	3.50	3.000	14.70	10.00	14.64
0.000	-0.53	0.000	-0.30	0.00	-0.40

ON-LINE PRESSURE CALIBRATION PROCEDURES

From the four calibration pressures provided during the data taking ess, the output voltages are stored. The voltages correspond to the zero maximum pressure points for each transducer. The output voltages are ned in the program as follows:

R[I,K] where I and K are derived from the following table

K \ I	1	2	3
1	0 psid	0 psid	0 psid
2	0 psid	4 psid	35 psid
3	0 psid	4 psid	35 psid
4	0 psid	0 psid	0 psid

The transducer intercept is determined from the voltages stored in R for and I=4. The slopes are determined from the voltages stored in the R ·ix as follows:

$$Q[2,K] = MCP[K]/(R[2,K] - R[1,K])$$

$$Q[3,K] = MCP[K]/(R[3,K] - R[4,K])$$

re MCP[K] is the maximum calibration pressure for K transducer and Q[2,K] the first slope for the K transducer before data is obtained and Q[3,K] is second slope determined after the data was obtained.

The intercepts are defined as follows:

$$Q[1,K] = R[1,K] * Q[2,K]$$

$$Q[4,K] = R[4,K] * Q[3,K]$$

re Q[1,K] is the first intercept for the K transducer and Q[4,K] is the ›nd intercept for the K transducer after the data was obtained.

percent change from the first to the second calibration for both
and intercept is defined as follows:

$$r[K+2] = \frac{Q[2,K] - Q[3,K]}{Q[3,K]} \quad \text{(slope K=2,3)}$$

$$r[K] = \frac{Q[1,K] - Q[4,K]}{Q[1,K]} \quad \text{(intercept K=1,2,3)}$$

r is the percent change during data taking. These values are printed
d compared during the data taking process.

```
34 FORMAT(1HO,10X,*TOTAL PRESSURE PSIG*,10X,*UNCERTAINTY PERCENT*,10X
  C,*STATIC PRESSURE PSIG*,10X,*UNCERTAINTY PERCENT*)
   DO 50 K=1,N
   WRITE(6,35)PTT(K),UPTT(K),PST(K),UPST(K)
35 FORMAT(1HO,18X,F5.2,26X,F4.1,24X,F5.2,26X,F4.1)
50 CONTINUE
 9 CONTINUE
   END
```

Figure B-2 (Cont'd)

```
17 FORMAT(1H0,20X,*TRANSDUCER SENSITIVITY CHANNEL P1-P2 =*,F10.7,2X,*
  CVOLTS/SUPPLY VOLT / PSI +-*,F10.7,2X,*VOLTS/SUPPLY VOLT / PSI*)
18 FORMAT(1H0,20X,*TOTAL PRESSURE COEFFICIENT =*,F10.5,2X,*+-*,F10.5)
19 FORMAT(1H0,20X,*STATIC PRESSURE COEFFICIENT =*,F10.5,2X,*+-*,F10.5
  C)
   .
23 FORMAT(1H0,20X,*OUTPUT VOLTAGE CHANNEL P3-P2 =*,F10.5,2X,*VOLTS +-
  C*,F10.7,2X,*VOLTS*)
24 FORMAT(1H0,20X,*AMPLIFIER GAIN CHANNEL P3-P2 =*,F10.5,2X,*VOLTS/VO
  CLT +-*,F10.5,2X,*VOLTS/VOLT*)
25 FORMAT(1H0,20X,*SUPPLY VOLTAGE CHANNEL P3-P2 =*,F10.5,2X,*VOLTS +-
  C*,F10.5,2X,*VOLTS*)
26 FORMAT(1H0,20X,*TRANSDUCER SENSITIVITY CHANNEL P3-P2 =*,F10.7,2X,*
  CVOLTS/SUPPLY VOLT / PSI +-*,F10.7,2X,*VOLTS/SUPPLY VOLT / PSI*)
27 FORMAT(1H0,20X,*ANGLE CALIBRATION CONSTANT =*,F10.2,2X,*PSID/DEG.
  C+-*,F10.5,2X,*PSID/DEG.*)
   WRITE(6,20)
20 FORMAT(1H0,30X,*UNCERTAINTIES DUE TO COMPONENTS (PSI )*)
   WRITE(6,21)
21 FORMAT(1H0,7X,*EO1*,8X,*A1*,7X,*ES1*,15X,*S1*,16X,*EOD*,8X,*AD*,7X
  C,*ESD*,14X,*SD*,14X,*CPT*,7X,*CPS*)
   .
   WRITE(6,22)UPT1,UPT2,UPT3,UPT4,UPT42,UPT5,UPT8,UPT9,UPT10,UPT102,U
  CPT6,UPT7
22 FORMAT(1H0,12(F11.5))
   WRITE(6,30)
30 FORMAT(1H0)
   WRITE(6,31)PT,UPTA,UPT
31 FORMAT(1H0,10X,*TOTAL PRESSURE =*,F10.2,2X,*PSIG+-*,F10.2,2X,*PSI*
  C,5X,*UNCERTAINTY IN TOTAL PRESSURE =*,F10.1,2X,*PERCENT OF READING
  C*)
   WRITE(6,20)
   WRITE(6,21)
   WRITE(6,22)UPS1,UPS2,UPS3,UPS4,UPS42,UPS5,UPS8,UPS9,UPS10,UPS102,U
  CPS6,UPS7
   WRITE(6,32)PS,UPSA,UPS
32 FORMAT(1H0,10X,*STATIC PRESSURE =*,F10.2,2X,*PSIG+-*,F10.2,2X,*PSI
  C*,5X,*UNCERTAINTY IN STATIC PRESSURE =*,F10.1,2X,*PERCENT OF READI
  CNG*)
   .
   .
   WRITE(6,20)
   WRITE(6,28)
28 FORMAT(1H0,10X,*EOA*,7X,*AA*,13X,*ESA*,12X,*SA*,10X,*C*)
   WRITE(6,29)UA1,UA2,UA3,UA4,UA42,UA5
29 FORMAT(1H0,5X,6(F10.5))
   WRITE(6,30)
   WRITE(6,33)A,UAA,UA
33 FORMAT(1H0,10X,*ANGLE  =*,F10.2,2X,*DEGREES +-*,F10.5,2X,*DEG.*,5X
  C,*UNCERTAINTY IN ANGLE =*,F10.1,2X,*PERCENT OF READING*)
   PTT(I)=PT
   UPTT(I)=UPT
   PST(I)=PS
   UPST(I)=UPS
40 CONTINUE
```

Figure B-2 (Cont'd)

```
      UC=(BC+2*SC)
*
      DA1=C/(AA*ESA*SA)
      DA2=-EOA*C/(AA**2*ESA*SA)
      DA3=-EOA*C/(AA*ESA**2*SA)
      DA4=-EOAF*C/(AA*ESA*SA**2)
      DA42=-EOA*C/(AA*ESA*SA**2)
      DA5=EOA/(AA*ESA*SA)
*
      UA1=DA1*EOA*UEOA/100.0
      UA2=DA2*AA*UAA/100.0
      UA3=DA3*ESA*UESA/100.0
      UA4=DA4*USA
      UA42=DA42*USA2*SA/100.0
      UA5=DA5*UC*C/100.0
*
      AUEOA=(UEOA/100.0)*EOA
      AUAA=(UAA/100.0)*AA
      AUESA=(UESA/100.0)*ESA
      AUSA=USA+(USA2/100.0)*SA
      AUC=(UC/100.0)*C
*
      UAA=(UA1**2+UA2**2+UA3**2+(UA4+UA42)**2+UA5**2)**0.5
      UA=(UAA/A)*100.0
*
      WRITE(6,10)EO1,AUEO1
      WRITE(6,11)A1,AUA1
      WRITE(6,12)ES1,AUES1
      WRITE(6,13)S1,AUS1
      WRITE(6,14)EOD,AUEOD
      WRITE(6,15)AD,AUAD
      WRITE(6,16)ESD,AUESD
      WRITE(6,17)SD,AUSD
      WRITE(6,18)CPT,AUCPT
      WRITE(6,19)CPS,AUCPS
      WRITE(6,23)EOA,AUEOA
      WRITE(6,24)AA,AUAA
      WRITE(6,25)ESA,AUESA
      WRITE(6,26)SA,AUSA
      WRITE(6,27)C,AUC
*
    7 FORMAT(1H1)
    8 FORMAT(1H0,58X,*CASE NUMBER*,I5)
   10 FORMAT(1H1,20X,*OUTPUT VOLTAGE CHANNEL P1 =*,F10.5,2X,*VOLTS +-*,F
     C10.5,2X,*VOLTS*)
   11 FORMAT(1H0,20X,*AMPLIFIER GAIN CHANNEL P1 =*,F10.5,2X,*VOLTS/VOLT
     C +-*,F10.5,2X,*VOLTS/VOLT*)
   12 FORMAT(1H0,20X,*SUPPLY VOLTAGE CHANNEL P1 =*,F10.5,2X,*VOLTS +-*,F
     C10.5,2X,*VOLTS*)
   13 FORMAT(1H0,20X,*TRANSDUCER SENSITIVITY CHANNEL P1 =*,F10.7,2X,*VOL
     CTS/SUPPLY VOLT / PSI +-*,F10.7,2X,*VOLTS/SUPPLY VOLT / PSI*)
   14 FORMAT(1H0,20X,*OUTPUT VOLTAGE CHANNEL P1-P2 =*,F10.5,2X,*VOLTS +-
     C*,F10.7,2X,*VOLTS*)
   15 FORMAT(1H0,20X,*AMPLIFIER GAIN CHANNEL P1-P2 =*,F10.5,2X,*VOLTS/VO
     CLT +-*,F10.5,2X,*VOLTS/VOLT*)
```

Figure B-2 (Cont'd)

```
      UPT10=DPT10*USD
      UPT102=DPT102*USD2*SD/100.0
*
      AUE01=(UE01/100.0)*E01
      AUA1=(UA1/100.0)*A1
      AUES1=(UES1/100.0)*ES1
      AUS1=US1+(US12/100.0)*S1
      AUEOD=(UEOD/100.0)*EOD
      AUCPT=(UCPT/100.0)*CPT
      AUCPS=(UCPS/100.0)*CPS
      AUAD=(UAD/100.0)*AD
      AUESD=(UESD/100.0)*ESD
      AUSD=USD+(USD2/100.0)*SD
*
*
      UPTA=(UPT1**2+UPT2**2+UPT3**2+(UPT4+UPT42)**2+UPT5**2+UPT6**2+UPT7
     C**2+UPT8**2+UPT9**2+(UPT10+UPT102)**2)**0.5
*
      PT=((E01-OFF1)/(A1*ES1*S1))+((EOD-OFFD)*(1-CPT)/(CPS*AD*ESD*SD))
*
      UPT=(UPTA/PT)*100.0
*
      PS=-1.0*(EOD-OFFD)*CPT/(CPS*AD*ESD*SD)+((E01-OFF1)/(A1*ES1*S1))
      DPS1=DPT1
      DPS2=DPT2
      DPS3=DPT3
      DPS4=DPT4
      DPS42=DPT42
      DPS5=-CPT/(CPS*AD*ESD*SD)
      DPS6=DPT6
      DPS7=(-1.0*(EOD-OFFD)*CPT)/(CPS**2*AD*ESD*SD)
      DPS8=(-1.0*(EOD-OFFD)*CPT)/(CPS*AD**2*ESD*SD)
      DPS9=(-1.0*(EOD-OFFD)*CPT)/(CPS*AD*ESD**2*SD)
      DPS102=(-1.0*(EOD-OFFD)*CPT)/(CPS*AD*ESD*SD**2)
      DPS10=(-EODF*CPT)/(CPS*ESD*SD**2)
*
      UPS1=DPS1*(E01-OFF1)*UE01/100.0
      UPS2=DPS2*A1*UA1/100.0
      UPS3=DPS3*ES1*UES1/100.0
      UPS4=DPS4*US1
      UPS42=DPS42*US12*S1/100.0
      UPS5=DPS5*(EOD-OFFD)*UEOD/100.0
      UPS6=DPS6*CPT*UCPT/100.0
      UPS7=DPS7*CPS*UCPS/100.0
      UPS8=DPS8*AD*UAD/100.0
      UPS9=DPS9*ESD*UESD/100.0
      UPS10=DPS10*USD
      UPS102=DPS102*USD2*SD/100.0
*
      UPSA=(UPS1**2+UPS2**2+UPS3**2+(UPS4+UPS42)**2+UPS5**2+UPS6**2+UPS7
     C**2+UPS8**2+UPS9**2+(UPS10+UPS102)**2)**0.5
      UPS=(UPSA/PS)*100.0
      A=EOA*C/(AA*ESA*SA)
*
      UEOA=BEOA+2*SEOA
      UAA=BAA+2*SAA
      UESA=BESA+2*SESA
```

Figure B-2 (Cont'd)

```
      PROGRAM UNC (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      DIMENSION PTT(30),UPTT(30),PST(30),UPST(30)
      READ(5,*)NC
      DO 9 J=1,NC
      WRITE(6,7)
      WRITE(6,30)
      WRITE(6,30)
      WRITE(6,30)
      WRITE(6,30)
      WRITE(6,30)
      WRITE(6,30)
      WRITE(6,8)J
      READ(5,*)A1,ES1,S1,EO1F,CPT,CPS,AD,ESD,SD,EODF,OFF1,OFFD
      READ(5,*)BEO1,BA1,BES1,BS1,BS12,BEOD,BCPT,BCPS,BAD,BESD,BSD,BSD2
      READ(5,*)SEO1,SA1,SES1,SS1,SS12,SEOD,SCPT,SCPS,SAD,SESD,SSD,SSD2
      READ(5,*)C,AA,ESA,SA,BEOA,SEOA,BAA,SAA,BESA,SESA,BSA,SSA,BSA2,SSA2
     C,BC,SC,EOAF
*
      READ(5,*)N
      DO 40 I=1,N
      READ(5,*)EO1,EOD,EOA
      UEO1=BEO1+2*SEO1
      UA1=BA1+2*SA1
      UES1=BES1+2*SES1
      US1=(BS1+2*SS1)*S1/100.0
      UEOD=BEOD+2*SEOD
      UCPT=BCPT+2*SCPT
      UCPS=BCPS+2*SCPS
      UAD=BAD+2*SAD
      UESD=BESD+2*SESD
      USD=(BSD+2*SSD)*SD/100.0
      USD2=(BSD2+2*SSD2)
      US12=(BS12+2*SS12)
*
      DPT1=1/(A1*ES1*S1)
      DPT2=-(EO1-OFF1)/(A1**2*ES1*S1)
      DPT3=-(EO1-OFF1)/(A1*ES1**2*S1)
      DPT42=-(EO1-OFF1)/(A1*ES1*S1**2)
      DPT4=-(EO1F)/(ES1*S1**2)
      DPT5=(1-CPT)/(CPS*AD*ESD*SD)
      DPT6=-(EOD-OFFD)/(CPS*AD*ESD*SD)
      DPT7=-(EOD-OFFD)*(1-CPT)/(CPS**2*AD*ESD*SD)
      DPT8=-(EOD-OFFD)*(1-CPT)/(CPS*AD**2*ESD*SD)
      DPT9=-(EOD-OFFD)*(1-CPT)/(CPS*AD*ESD**2*SD)
      DPT102=-(EOD-OFFD)*(1-CPT)/(CPS*AD*ESD*SD**2)
      DPT10=-EODF*(1-CPT)/(CPS*ESD*SD**2)
*
      UPT1=DPT1*(EO1-OFF1)*UEO1/100.0
      UPT2=DPT2*A1*UA1/100.0
      UPT3=DPT3*ES1*UES1/100.0
      UPT4=DPT4*US1
      UPT42=DPT42*US12*S1/100.0
      UPT5=DPT5*(EOD-OFFD)*UEOD/100.0
      UPT6=DPT6*CPT*UCPT/100.0
      UPT7=DPT7*CPS*UCPS/100.0
      UPT8=DPT8*AD*UAD/100.0
      UPT9=DPT9*ESD*UESD/100.0
```

Figure B-2. Uncertainty Analysis Program Listing and Output

The uncertainty of the static pressure is defined as follows:

$$U_{PS} = \pm\left[\left(\frac{\partial PS}{\partial E_{01}} U_{E_{01}}\right)^2 + \left(\frac{\partial PS}{\partial A_1} U_{A_1}\right)^2 + \left(\frac{\partial PS}{\partial E_{S1}} U_{E_{S1}}\right)^2 + \left(\frac{\partial PS}{\partial S_1} U_{S_1}\right)^2 + \left(\frac{\partial PS}{\partial E_{0d}} U_{E_{0d}}\right)^2 + \left(\frac{\partial PS}{\partial CPT} U_{CPT}\right)^2 + \left(\frac{\partial PS}{\partial CPT} U_{CPS}\right)^2 + \left(\frac{\partial PS}{\partial A_d} U_{A_d}\right)^2 + \left(\frac{\partial PS}{\partial E_{Sd}} U_{E_{Sd}}\right)^2 + \left(\frac{\partial PS}{\partial S_d} U_{S_d}\right)^2\right]^{1/2} \quad (20)$$

The portions of Equation 20 that deal with U_{S_1} and U_{S_d} as before were broken :o two parts. Uncertainty in percent of full scale and percent of sensitivity.

Computer Program

Equations 16 and 20 were solved through the use of a computer program. The ›gram required input of all data system component uncertainties, $U_{E_{01}}$, U_{A_1}, (bias ł precision), etc., transducer sensitivities S_1 and S_d, amplifier gains A_1 and A_d, ›ply voltages E_{S1} and E_{Sd}, output voltages E_{01} and E_{0d}, transducer offset tages E_{01f} and E_{0df} and total static pressure coefficients CPT and CPS. The output tages input into the program corresponded to the range of pressures to be ısured during the test. All input values and their respective uncertainties are nted out for data input verification. The overall uncertainty in total and ıtic pressure and each component's contribution to that uncertainty is determined ł printed out. Theoretical angle measurement uncertainties were not considered, as ›se were determined through repetitive calibrations of the traverse system. The ›gram listing and output are shown in Figure B-2.

$$\frac{\partial PT}{\partial S_1} U_{S_1} = \left[\left(-E_{01F} - E_{01f}\right)/\left(A_1 \cdot E_{S1} \cdot S_1^2\right)\right] U_{S_{1F}} + \left[-\left(E_{01} - E_{01f}\right)/\left(A_1 \cdot E_{S1} \cdot S_1^2\right)\right] U_{S_{1S}} \tag{17}$$

d

$$\frac{\partial PT}{\partial S_d} U_{S_d} = \left[\left(E_{0dF} - E_{0df}\right)\left(1-CPT\right)/\left(CPS \cdot A_d \cdot E_{Sd} \cdot S_d^2\right)\right] U_{S_{dF}} + \left[-\left(E_{0d}-E_{0df}\right)\left(1-CPT\right)/\left(CPS \cdot A_d \cdot E_{Sd} \cdot S_d^2\right)\right] U_{S_{dS}} \tag{18}$$

where E_{01F} = P1 transducer full scale output voltage

U_{S1F} = P1 transducer full scale error

U_{S1S} = P1 transducer sensitivity error

E_{0df} = P1 - P2 transducer full scale output voltage

U_{SdF} = P1 - P2 transducer full scale error

$U_{S_{dS}}$ = P1 - P2 transducer sensitivity error

. Static Pressure Uncertainty

Equation 4 can be rewritten as the following

$$PS = - [(P1 - P2)/CPS) + PT$$

The following equation is obtained by substituting Equations 13 and 14 into e above equation.

$$PS = - \{([(E_{0d} - E_{0df}) * CPT]/(CPS * A_d * E_{Sd} * S_d)]\} + [(E_{01} - E_{01f})/(A_1 * E_{S1} * S_1)] \tag{19}$$

$$PT = [(E_{01} - E_{01f})/(A_1 * E_{S1} * S_1)] + [(E_{0d} - E_{0df})(1 - CPT)]/(CPS * A_d * E_{Sd} * S_d) \qquad (14)$$

III. Uncertainty Definition

A. From Kline and McClintock, square law of error Propogation, as defined in Reference 10, the uncertainty in a measurement can be defined as

$$U_R = \pm\left[\left(\frac{\partial R}{\partial M_1} U_{M_1}\right)^2 + \left(\frac{\partial R}{\partial M_2} U_{M_2}\right)^2 + \ldots\ldots + \left(\frac{\partial R}{\partial M_i} U_{M_i}\right)^2\right]^{1/2} \qquad (15)$$

B. For Equation 14 the uncertainty is defined as follows:

$$U_{PT} = \pm\left[\left(\frac{\partial PT}{\partial E_{01}} U_{E_{01}}\right)^2 + \left(\frac{\partial PT}{\partial A_1} U_{A_1}\right)^2 + \left(\frac{\partial PT}{\partial E_{S1}} U_{E_{S1}}\right)^2 + \left(\frac{\partial PT}{\partial S_1} U_{S_1}\right)^2 + \left(\frac{\partial PT}{\partial E_{0d}} U_{E_{0d}}\right)^2 + \left(\frac{\partial PT}{\partial CPT} U_{CPT}\right)^2 + \left(\frac{\partial PT}{\partial CPS} U_{CPS}\right)^2 + \left(\frac{\partial PT}{\partial A_d} U_{A_d}\right)^2 + \left(\frac{\partial PT}{\partial E_{Sd}} U_{E_{Sd}}\right)^2 + \left(\frac{\partial PT}{\partial S_d} U_{S_d}\right)^2\right]^{1/2} \qquad (16)$$

Where $U_{E_{01}}$, U_{A_1}, $U_{E_{S1}}$, U_{S_1}, $U_{E_{0d}}$, U_{CPT}, U_{CPS}, U_{A_d}, $U_{E_{Sd}}$, U_{S_d} are the data system component uncertainties. These are divided into bias and precision which are carried through the equations separately to determine the system overall bias and precision uncertainty components. The overall uncertainty in PT is defined as follows:

$$U_{PT} = \left(\underset{\uparrow\,\text{Bias}}{U_{PT_B}} + 2\,\underset{\uparrow\,\text{Precision}}{U_{PT_S}}\right)$$

Manufacturer's specifications for transducer accuracies are given in both percent of sensitivity and percent of full scale output, therefore, the following terms were used to define the transducers contribution to the overall system uncertainties.

where S_1 = Sensitivity of the P1 transducer

E_{t1} = P1 transducer output voltage

E_{S1} = P1 transducer supply voltage

also

$$S_d = E_{td}/[E_{Sd} * (P1 - P2)] \qquad (7)$$

where S_d = Sensitivity of the (P1-P2) transducer

E_{td} = P1 - P2 transducer output voltage

E_{Sd} = P1 - P2 transducer supply voltage

Rearranging both Equations 6 and 7

$$P1 = E_{t1}/(E_{S1} * S_1) \qquad (8)$$

and

$$(P1 - P2) = E_{td}/(E_{Sd} * S_d) \qquad (9)$$

2. For the amplifiers

$$E_{01} - E_{01f} = E_{t1} * A_1 \qquad (10)$$

where E_{01} = P1 amplifier output voltage

E_{01f} = P1 amplifier zero offset voltage

A_1 = P1 amplifier gain

and

$$E_{0d} - E_{odf} = E_{td} * A_d \qquad (11)$$

where E_{od} = P1 - P2 amplifier output voltage

E_{odf} = P1 - P2 amplifier zero offset voltage

A_d = P1 - P2 amplifier gain

P1 and P1 - P2 can be defined by substituting Equations 10 and 11 into 9 and 10.

$$P1 = (E_{0d} * E_{01f})/(A_1 * E_{S1} * S_1) \qquad (12)$$

and

$$(P1 - P2) = (E_{0d} - E_{0df})/(A_d * E_{Sd} * S_d) \qquad (13)$$

Therefore, by substituting Equations 12 and 13 into Equation 5, the following can be obtained.

II. Measurement Equations for Uncertainty Analysis

A. The following definitions are used to define the total and static pressure uncertainties as measured from the wedge probe.

$$CPT = \frac{P1-PS}{PT-PS} \tag{1}$$

where CPT = Wedge probe total pressure coefficient

P1 = Wedge probe total pressure

PS = "True" static pressure

PT = "True" total pressure

Equation 1 can be re-written as

$$PT = [(P1 - PS)/CPT] + PS \tag{2}$$

Also

$$CPS = (P1 - P2)/(PT - PS) \tag{3}$$

where CPS = Wedge probe static pressure coefficient

P1 - P2 = Wedge probe static pressure

Equation 3 can be rewirtten as

$$PS = -[(P1 - P2)/CPS] + PT \tag{4}$$

B. Total pressure measurement uncertainty

Combining Equations 2 and 4

$$PT = P1 + [(P1 - P2)/CPS] - [(CPT/CPS) * (P1 - P2)] \tag{5}$$

It is noted that P1 - P2 and P1 - P3 from the wedge probe are measured on the same transducer and averaged in the final analysis. Because the same transducer is used, only one value (P1-P2) is considered in the uncertainty analysis.

The data system equations can be defined as follows

1. For the transducers

$$S_1 = E_{t1}/(E_{S1} * P1) \tag{6}$$

UNCERTAINTY IN PRESSURE MEASUREMENT

I. Block Diagram

The system uncertainty was determined for the configuration shown in Figure B-1.

These functional blocks define the components whose uncertainties will be considered in determining the overall uncertainty.

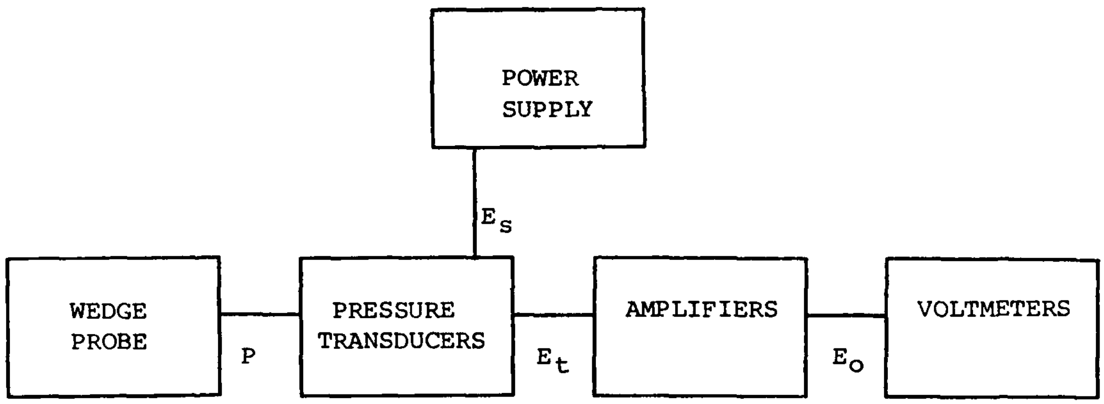


Figure B-1. Measurement Uncertainty Block Diagram

APPENDIX B

DATA SYSTEM UNCERTAINTY ANALYSIS

```
57: ret
58: "ELAVG":
59: for L=10 to 16;0→E;for J=1 to 5;E[A,L,J]+E→E
60: next J;E/5→F[A,L];next L
61: ret
62: 35/(R[2,3]-R[1,3])→Q[2,3];35/(R[3,3]-R[4,3])→Q[3,3]
63: 4/(R[2,2]-R[1,2])→Q[2,2];4/(R[3,2]-R[4,2])→Q[3,2]
64: -R[1,3]*Q[2,3]→Q[1,3];-R[4,3]*Q[3,3]→Q[4,3]
65: -R[1,2]*Q[2,2]→Q[1,2];-R[4,2]*Q[3,2]→Q[4,2]
66: -R[1,1]*Q[3,1]→Q[1,1];-R[4,1]*Q[3,1]→Q[4,1]
67: (Q[1,3]-Q[4,3])*2.8571→r1;(Q[1,2]-Q[4,2])*25→r2
68: 100*(Q[2,3]-Q[3,3])/Q[3,3]→r3;100*(Q[2,2]-Q[3,2])/Q[3,2]→r4
69: (Q[1,1]-Q[4,1])*100→r5
70: fmt 1,15x,"0-50 PSID",9x,"0-15 PSID",9x,"0-1 PSID",/
71: wrt 6.1;fxd 5
72: wrt 6,"Y-INT",Q[4,3],Q[4,2],Q[4,1];wrt 6,"% DIF",r1,r2,r5
73: wrt 6,"SLOPE",Q[3,3],Q[3,2];wrt 6,"% DIF",r3,r4
74: gto 76
75: wrt 6;wrt 6,"TIME:",T$[7]
76: ent "CONTINUE?",C$;if cap(C$)="N";gto 11
77: gto 79
78: rcf N,D[*],R[*],E[*],H[*],Z[*],P
79: gsb "step";wait 200
80: gsb "step";wait 200
81: "DATA RED.":
82: for A=1 to 2;gsb "ELAVG"
83: next A
84: M*C[1,8]+C[2,8]→G;M*C[1,9]+C[2,9]→H
85: .998→G;.905→H
86: for I=1 to 2;for K=1 to 3;for L=1 to 3
87: Z[I,K,L]*Q[3,K]+Q[4,K]→Y[I,K,L]
88: next L;next K;next I
89: for L=1 to 3
90: (Y[1,2,L]+Y[2,2,L])/(2*H)→O[L]
91: Y[2,3,L]-O[L]+P*G→S[L]
92: S[L]+O[L]→T[L];√(5((T[L]/S[L])^.2857-1))→M[L]
93: next L
94: for L=10 to 16
95: F[1,L]*C[1,L]+C[2,L]→F[3,L]
96: F[2,L]*C[1,L]+C[2,L]→F[4,L]
97: (F[2,L]-F[1,L])*100/F[2,L]→F[5,L]
98: next L
99: fmt 2,/,5x,"RUN NO.=",f4.0,8x,"Patm",f7.2,x,"PSIA",8x,"PTP",f7.2
100: wrt 6.2,N,P,Y[1,3,2]+P
101: fmt 3,/,10x,"P1-Patm",10x,"P1-P2",11x,"P3-P2",13x,"AC",14x,"DC",/
102: fmt 4,f14.3,7x,f8.3,8x,f8.3,10x,f8.5,8x,f8.4
103: fmt 8,f12.4,8x,f8.4,9x,f8.4,7x,f8.4
104: wrt 6.3
105: wrt 6.4,"MAX",Y[2,3,1],Y[2,2,1],Y[1,1,1],Z[1,5,1],Z[1,4,1]
106: wrt 6.4,"AVG",Y[2,3,2],Y[2,2,2],Y[1,1,2],Z[1,5,2],Z[1,4,2]
107: wrt 6.4,"MIN",Y[2,3,3],Y[2,2,3],Y[1,1,3],Z[1,5,3],Z[1,4,3]
108: fmt 5,/,10x,"WEDGE RAD",7x,"WEDGE ROT",10x,"HW RAD",9x,"HW ROT",/
109: wrt 6.5
110: wrt 6.8,"VALUE",F[4,13],F[4,14],F[4,15],F[4,16]
111: wrt 6.8,"% CHG",F[5,13],F[5,14],F[5,15],F[5,16]
112: fmt 6,/,10x,"TEMP(F)",5x,"FAN SPEED",5x,"CORE SPEED",/
113: fmt 9,f11.1,8x,f6.0,8x,f6.0
114: wrt 6.6
115: wrt 6.9,"VALUE",F[4,10],F[4,11],F[4,12]
116: wrt 6.9,"% CHG",F[5,10],F[5,11],F[5,12]
117: fmt 7,/,10x,"PT=",f7.2,3x,"PS=",f7.2,3x,"MACH NO=",f6.2,5/
118: wrt 6.7,T[2],S[2],M[2]
119: gto 9
120: end
121: for I=1 to 2;for J=1 to 36
122: wrt 6,D[I,1,J],D[I,2,J],D[I,3,J]
123: next J;wrt 6;next I
*27483
```

Figure A-1. (Cont'd)

```
0: dim T$[14],D[2,3,36],R[4,3],E[4,10:16,5],H[4:5,36],Z[2,5,3],P,F[5,10:16]
1: dim C$[1],S[3],Q[4,3],T[3],O[3],N[3],M[3],C[2,8:16],Y[2,5,3]
2: dsp "SET TIME(wrt 709,""TDMMDDHHMMSS"")";stp
3: 1+C[1,9];0+C[2,9]
4: 38788+C[1,10];45+C[2,10];100+C[1,11];0+C[2,11]
5: 100+C[1,12];0+C[2,12];-.38183+C[1,13];-.2104+C[2,13]
6: 10.582+C[1,14];66.77+C[2,14];-.40351+C[1,15];-.204+C[2,15]
7: 10.861+C[1,16];93.8+C[2,16];.24878+Q[3,1]
8: ent "Patm",P
9: ent "POINT NO.?",N;ldf N,D[*],R[*],E[*],H[*],Z[*],P;gto 62
10: fxd 0;gsb "home"
11: for I=1 to 2;if I=2;gsb "step"
12: wait 5000;1+F;gsb "scan"
13: next I
14: for I=1 to 2;gsb "step"
15: wait 5000;0+F;gsb "scan"
16: next I;wrt 709,"AC5";wrt 722,"HS0F2";gsb "step"
17: wait 2000;5+K;gsb "scanH"
18: wrt 722,"H";4+K;gsb "scanH"
19: for I=3 to 4;if I=4;gsb "step"
20: if I=4;wait 5000
21: 1+F;gsb "scan"
22: next I;gsb "home"
23: sfg 14;gto 62
24: "scan":
25: if F=1;if I#1;if I#4;jmp 2
26: wrt 709,"AC1";1+K;gsb "F?"
27: wrt 709,"AC2";2+K;gsb "F?"
28: wrt 709,"AC3";3+K;gsb "F?"
29: if I=1;if F=1;gsb "EE"
30: if I=4;gsb "EE"
31: ret
32: "F?":if F=1;gsb "scanC"
33: if F=0;gsb "scanD"
34: ret
35: "scanC":wrt 722,"HSM002L1RS130STN.1STIM2T3QX1"
36: rds(722)+S;if S#66;jmp 0
37: wrt 722,"REM";red 722,R[I,K]
38: ret
39: "scanD":wrt 722,"H.1STI36STNSO1M2T3"
40: for J=1 to 36;red 722,D[I,K,J];next J
41: "stat":wrt 722,"REM";red 722,Z[I,K,2];wrt 722,"REL";red 722,Z[I,K,3]
42: wrt 722,"REU";red 722,Z[I,K,1]
43: ret
44: "scanH":wrt 722,".1STI36STNSO1M2T3"
45: for J=1 to 36;red 722,H[K,J];next J;1+I
46: gsb "stat"
47: ret
48: "step":wrt 709,"DC1,1";wait 10;wrt 709,"DO1,1"
49: ret
50: "home":wrt 709,"DC1,2";wait 3000;wrt 709,"DO1,2"
51: ret
52: "EE":wrt 709,"SIARAF10AL16";if I=1;1+A
53: if I=4;2+A
54: for L=10 to 16;wrt 709,"ASVN5SO1VFJVS1VT3VS";for J=1 to 5
55: red 709,E[A,L,J];next J;next L
56: if I=1;wrt 709,"TD";red 709,T$
```

Figure A-1. P072 Engine Test Data Acquisition Program Listing

OUTPUT VOLTAGE CHANNEL P1 = .30000 VOLTS +- .00000 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = .20000 VOLTS +- .0000016 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .01000 VOLTS +- .0000014 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58060 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00002	-.00045	-.00009	-.04988	-.00181	.00000	-.00000	-.00000	-.00003	-.00000	-.00509	-.00001

TOTAL PRESSURE = 2.26 PSIG+- .05 PSI UNCERTAINTY IN TOTAL PRESSURE = 2.3 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00002	-.00045	-.00009	-.04988	-.00181	-.00000	-.00010	-.00002	-.01659	-.00041	-.00509	-.00611

STATIC PRESSURE = 1.75 PSIG+- .05 PSI UNCERTAINTY IN STATIC PRESSURE = 3.1 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00002	-.00019	-.00019	-.00069	-.00027	.00146

ANGLE = .13 DEGREES +- .00176 DEG. UNCERTAINTY IN ANGLE = 1.3 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1 = .63900 VOLTS +- .00001 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = .50800 VOLTS +- .0000041 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .02000 VOLTS +- .0000028 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		E0D	AD	ESD	SD		CPT	CPS
.00004	-.00090	-.00018	-.04988	-.00361	.00000	-.00000	-.00000	-.00003	-.00000	-.01190	-.00003

TOTAL PRESSURE = 4.52 PSIG+- .05 PSI UNCERTAINTY IN TOTAL PRESSURE = 1.2 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		E0D	AD	ESD	SD		CPT	CPS
.00004	-.00090	-.00018	-.04988	-.00361	-.00001	-.00024	-.00005	-.01659	-.00095	-.01190	-.01428

STATIC PRESSURE = 3.33 PSIG+- .06 PSI UNCERTAINTY IN STATIC PRESSURE = 1.8 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E0A	AA		ESA	SA	C
.00004	-.00037	-.00037	-.00069	-.00053	.00292

ANGLE = .27 DEGREES +- .00320 DEG. UNCERTAINTY IN ANGLE = 1.2 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1 = .90000 VOLTS +- .00001 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 1.00000 VOLTS +- .0000080 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .03000 VOLTS +- .0000042 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD		SD	CPT	CPS
.00005	-.00125	-.00025	-.04988	-.00500	.00000	-.00000	-.00000	-.00003	-.00000	-.02279	-.00005

TOTAL PRESSURE = 6.26 PSIG+- .06 PSI UNCERTAINTY IN TOTAL PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD		SD	CPT	CPS
.00005	-.00125	-.00025	-.04988	-.00500	-.00002	-.00046	-.00009	-.01659	-.00182	-.02279	-.02734

STATIC PRESSURE = 3.97 PSIG+- .07 PSI UNCERTAINTY IN STATIC PRESSURE = 1.7 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA		ESA	SA	C
.00006	-.00056	-.00056	-.00069	-.00080	.00437

ANGLE = .40 DEGREES +- .00469 DEG. UNCERTAINTY IN ANGLE = 1.2 PERCENT OF READING

Figure B-2 (Cont'd)

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OUTPUT VOLTAGE CHANNEL P1 =   1.53000  VOLTS +-     .00001  VOLTS
AMPLIFIER GAIN CHANNEL P1 = 100.00000  VOLTS/VOLT  +-    .02000  VOLTS/VOLT
SUPPLY VOLTAGE CHANNEL P1 =  12.00000  VOLTS +-     .00048  VOLTS
TRANSDUCER SENSITIVITY CHANNEL P1 =  .0001253  VOLTS/SUPPLY VOLT / PSI +-  .0000002  VOLTS/SUPPLY VOLT / PSI
OUTPUT VOLTAGE CHANNEL P1-P2 =   1.55000  VOLTS +-  .0000124  VOLTS
AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000  VOLTS/VOLT +-    .02000  VOLTS/VOLT
SUPPLY VOLTAGE CHANNEL P1-P2 =  12.00000  VOLTS +-    .00048  VOLTS
TRANSDUCER SENSITIVITY CHANNEL P1-P2 =  .0004177  VOLTS/SUPPLY VOLT / PSI +-  .000C008  VOLTS/SUPPLY VOLT / PSI
TOTAL PRESSURE COEFFICIENT =    .99800  +-    .00998
STATIC PRESSURE COEFFICIENT =    .90000  +-    .01080
OUTPUT VOLTAGE CHANNEL P3-P2 =    .04000  VOLTS +-  .0000056  VOLTS
AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000  VOLTS/VOLT +-    .28000  VOLTS/VOLT
SUPPLY VOLTAGE CHANNEL P3-P2 =  12.00000  VOLTS +-    .01680  VOLTS
TRANSDUCER SENSITIVITY CHANNEL P3-P2 =  .0016600  VOLTS/SUPPLY VOLT / PSI +-  .0000076  VOLTS/SUPPLY VOLT / PSI
ANGLE CALIBRATION CONSTANT =     52.80  PSID/DEG. +-    .58080  PSID/DEG.
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UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00008	-.00209	-.00042	-.04988	-.00835	.00000	-.00000	-.00000	-.00003	-.00001	-.03495	-.00008

TOTAL PRESSURE =   10.45 PSIG+-   .07 PSI   UNCERTAINTY IN TOTAL PRESSURE =   .7 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00008	-.00209	-.00042	-.04988	-.00835	-.00003	-.00070	-.00014	-.01659	-.00280	-.03495	-.04195

STATIC PRESSURE =   6.95 PSIG+-   .08 PSI   UNCERTAINTY IN STATIC PRESSURE =   1.2 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA		ESA	SA	C
.00007	-.00074	-.00074	-.00069	-.00106	.00583

ANGLE =   .53 DEGREES +-   .00618 DEG.   UNCERTAINTY IN ANGLE =   1.2 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1 = 1.90000 VOLTS +- .00002 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 1.80000 VOLTS +- .0000144 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .05000 VOLTS +- .0000070 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00010	-.00258	-.00052	-.04988	-.01032	.00000	-.00000	-.00000	-.00003	-.00001	-.04048	-.00010

TOTAL PRESSURE = 12.91 PSIG+- .07 PSI UNCERTAINTY IN TOTAL PRESSURE = .6 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00010	-.00258	-.00052	-.04988	-.01032	-.00003	-.00081	-.00016	-.01659	-.00324	-.04048	-.04858

STATIC PRESSURE = 8.85 PSIG+- .09 PSI UNCERTAINTY IN STATIC PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00009	-.00093	-.00093	-.00069	-.00133	.00729

ANGLE = .66 DEGREES +- .00768 DEG. UNCERTAINTY IN ANGLE = 1.2 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1 = 2.40000 VOLTS +- .00002 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .C2C00 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 2.10000 VOLTS +- .0000168 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .000C008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .06000 VOLTS +- .0000084 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .000C076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOI	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00013	-.00325	-.00065	-.04988	-.01298	.00000	-.00000	-.00000	-.00003	-.00001	-.04712	-.00011

TOTAL PRESSURE = 16.24 PSIG+- .08 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOI	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00013	-.00325	-.00065	-.04988	-.01298	-.00004	-.00094	-.00019	-.01659	-.00377	-.04712	-.05655

STATIC PRESSURE = 11.52 PSIG+- .10 PSI UNCERTAINTY IN STATIC PRESSURE = .9 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA		ESA	SA	C
.00011	-.00111	-.00111	-.00069	-.00159	.00875

ANGLE = .80 DEGREES +- .00918 DEG. UNCERTAINTY IN ANGLE = 1.2 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1 = 2.75000 VOLTS +- .00002 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 2.46000 VOLTS +- .0000197 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .07000 VOLTS +- .0000098 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00015	-.00371	-.00074	-.04988	-.01484	.00000	-.00000	-.00000	-.00003	-.00001	-.05509	-.00013

TOTAL PRESSURE = 18.57 PSIG+- .09 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00015	-.00371	-.00074	-.04988	-.01484	-.00004	-.00110	-.00022	-.01659	-.00441	-.05509	-.06610

STATIC PRESSURE = 13.05 PSIG+- .11 PSI UNCERTAINTY IN STATIC PRESSURE = .8 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00013	-.00130	-.00130	-.00069	-.00186	.01020

ANGLE = .93 DEGREES +- .01068 DEG. UNCERTAINTY IN ANGLE = 1.2 PERCENT OF READING

Figure B-2 (Cont'd)

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P' = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 2.60000 VOLTS +- .0000208 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .08000 VOLTS +- .0000112 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .000C076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00016	-.00404	-.00081	-.04988	-.01617	.00000	-.00000	-.00000	-.00003	-.00001	-.05818	-.00014

TOTAL PRESSURE = 20.23 PSIG+- .09 PSI UNCERTAINTY IN TOTAL PRESSURE = .4 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00016	-.00404	-.00081	-.04988	-.01617	-.00005	-.00116	-.00023	-.01659	-.00465	-.05818	-.06982

STATIC PRESSURE = 14.40 PSIG+- .11 PSI UNCERTAINTY IN STATIC PRESSURE = .8 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00015	-.00148	-.00148	-.00069	-.00212	.01166

ANGLE = 1.06 DEGREES +- .01218 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 3.00000 VOLTS +- .0000240 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .09000 VOLTS +- .0000126 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1		S1	EOD	AD	ESD		SD	CPT	CPS
.00017	-.00431	-.00086	-.04988	-.01724	.00000	-.00000	-.00000	-.00003	-.00001	-.06703	-.00016

TOTAL PRESSURE = 21.56 PSIG+- .09 PSI UNCERTAINTY IN TOTAL PRESSURE = .4 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1		S1	EOD	AD	ESD		SD	CPT	CPS
.00017	-.00431	-.00086	-.04988	-.01724	-.00005	-.00134	-.00027	-.01659	-.00536	-.06703	-.08044

STATIC PRESSURE = 14.85 PSIG+- .13 PSI UNCERTAINTY IN STATIC PRESSURE = .9 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00017	-.00167	-.00167	-.00069	-.00239	.01312

ANGLE = 1.19 DEGREES +- .01368 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 3.80000 VOLTS +- .0000304 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .10000 VOLTS +- .0000140 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1		S1	EOD	AD	ESD		SD	CPT	CPS
.00019	-.00484	-.00097	-.04988	-.01937	.00000	-.00000	-.00000	-.00003	-.00001	-.08473	-.00020

TOTAL PRESSURE = 24.23 PSIG+- .11 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1		S1	EOD	AD	ESD		SD	CPT	CPS
.00019	-.00484	-.00097	-.04988	-.01937	-.00007	-.00169	-.00034	-.01659	-.00678	-.08473	-.10168

STATIC PRESSURE = 15.74 PSIG+- .15 PSI UNCERTAINTY IN STATIC PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA		ESA	SA	C
.00019	-.00186	-.00186	-.00069	-.00265	.01458

ANGLE = 1.33 DEGREES +- .01519 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 4.40000 VOLTS +- .0000352 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .11000 VOLTS +- .0000154 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1		S1	EOD	AD	ESD		SD	CPT	CPS
.00021	-.00537	-.00107	-.04988	-.02150	.00000	-.00000	-.00000	-.00003	-.00002	-.09800	-.00024

TOTAL PRESSURE = 26.89 PSIG+- .12 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EO1	A1	ES1		S1	EOD	AD	ESD		SD	CPT	CPS
.00021	-.00537	-.00107	-.04988	-.02150	-.00008	-.00196	-.00039	-.01659	-.00784	-.09800	-.11761

STATIC PRESSURE = 17.07 PSIG+- .17 PSI UNCERTAINTY IN STATIC PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA		ESA	SA	C
.00020	-.00204	-.00204	-.00069	-.00292	.01604

ANGLE = 1.46 DEGREES +- .01669 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1-P2 = 5.00000 VOLTS +- .0000400 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = 12000 VOLTS +- .0000168 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

ED1	A1	ES1	S1	EOD	AD	ESD	SD	CPT	CPS		
.00024	-.00591	-.00118	-.04988	-.02362	.00000	-.00000	-.00000	-.00003	-.00002	-.11128	-.00027

TOTAL PRESSURE = 29.55 PSIG+- .13 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

ED1	A1	ES1	S1	EOD	AD	ESD	SD	CPT	CPS		
.00024	-.00591	-.00118	-.04988	-.02362	-.00009	-.00223	-.00045	-.01659	-.00890	-.11128	-.13353

STATIC PRESSURE = 18.40 PSIG+- .19 PSI UNCERTAINTY IN STATIC PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA	SA	C	
.00022	-.00223	-.00223	-.00069	-.00318	.01749

ANGLE = 1.59 DEGREES +- .01819 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 5.28000 VOLTS +- .0000422 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .13000 VOLTS +- .0000182 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		E0D	AD	ESD	SD		CPT	CPS
.00025	-.00617	-.00123	-.04988	-.02469	.00000	-.00000	-.00000	-.00003	-.00002	-.11747	-.00028

TOTAL PRESSURE = 30.88 PSIG+- .14 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		E0D	AD	ESD	SD		CPT	CPS
.00025	-.00617	-.00123	-.04988	-.02469	-.00009	-.00235	-.00047	-.01659	-.00940	-.11747	-.14097

STATIC PRESSURE = 19.11 PSIG+- .20 PSI UNCERTAINTY IN STATIC PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00024	-.00241	-.00241	-.00069	-.00345	.01895

ANGLE = 1.72 DEGREES +- .01970 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1-P2 = 5.40000 VOLTS +- .0000432 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .14000 VOLTS +- .0000196 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1		S1	E0D	AD	ESD	SD		CPT	CPS
.00026	-.00644	-.00129	-.04988	-.02575	.00000	-.00000	-.00000	-.00003	-.00002	-.12013	-.00029

TOTAL PRESSURE = 32.21 PSIG+- .14 PSI UNCERTAINTY IN TOTAL PRESSURE = .4 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1		S1	E0D	AD	ESD	SD		CPT	CPS
.00026	-.00644	-.00129	-.04988	-.02575	-.00010	-.00240	-.00048	-.01659	-.00961	-.12013	-.14415

STATIC PRESSURE = 20.18 PSIG+- .20 PSI UNCERTAINTY IN STATIC PRESSURE = 1.0 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

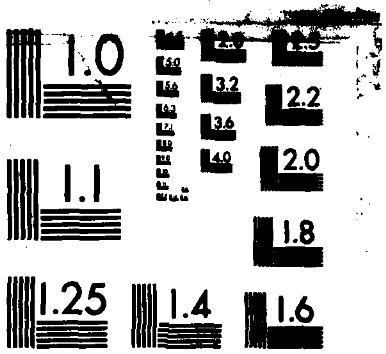
EOA	AA	ESA		SA	C
.00026	-.00260	-.00260	-.00069	-.00371	.02041

ANGLE = 1.86 DEGREES +- .02120 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

AD-A157 108   COMPRESSOR RESEARCH FACILITY F100 HIGH PRESSURE   3/3
COMPRESSOR INLET TOTAL PR..(U) AIR FORCE WRIGHT
AERONAUTICAL LABS WRIGHT-PATTERSON AFB OH
UNCLASSIFIED   W W COPENHAVER OCT 84 AFWAL-TR-84-2030   F/G 21/5   NL

END
FILMED



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

OUTPUT VOLTAGE CHANNEL P1 = 5.00000 VOLTS +- .00004 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 6.00000 VOLTS +- .0000480 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .15000 VOLTS +- .0000210 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00027	-.00670	-.00134	-.04988	-.02682	.00000	-.00001	-.00000	-.00003	-.00002	-.13340	-.00032

TOTAL PRESSURE = 33.55 PSIG+- .15 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00027	-.00670	-.00134	-.04988	-.02682	-.00011	-.00267	-.00053	-.01659	-.01067	-.13340	-.16008

STATIC PRESSURE = 20.18 PSIG+- .22 PSI UNCERTAINTY IN STATIC PRESSURE = 1.1 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E0A	AA		ESA	SA	C
.00028	-.00278	-.00278	-.00069	-.00398	.02187

ANGLE = 1.99 DEGREES +- .02271 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

OUTPUT VOLTAGE CHANNEL P1 = 5.40000 VOLTS +- .00004 VOLTS

AMPLIFIER GAIN CHANNEL P1 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1 = .0001253 VOLTS/SUPPLY VOLT / PSI +- .0000002 VOLTS/SUPPLY VOLT / PSI

OUTPUT VOLTAGE CHANNEL P1-P2 = 6.50000 VOLTS +- .0000520 VOLTS

AMPLIFIER GAIN CHANNEL P1-P2 = 100.00000 VOLTS/VOLT +- .02000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P1-P2 = 12.00000 VOLTS +- .00048 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P1-P2 = .0004177 VOLTS/SUPPLY VOLT / PSI +- .0000008 VOLTS/SUPPLY VOLT / PSI

TOTAL PRESSURE COEFFICIENT = .99800 +- .00998

STATIC PRESSURE COEFFICIENT = .90000 +- .01080

OUTPUT VOLTAGE CHANNEL P3-P2 = .16000 VOLTS +- .0000224 VOLTS

AMPLIFIER GAIN CHANNEL P3-P2 = 200.00000 VOLTS/VOLT +- .28000 VOLTS/VOLT

SUPPLY VOLTAGE CHANNEL P3-P2 = 12.00000 VOLTS +- .01680 VOLTS

TRANSDUCER SENSITIVITY CHANNEL P3-P2 = .0016600 VOLTS/SUPPLY VOLT / PSI +- .0000076 VOLTS/SUPPLY VOLT / PSI

ANGLE CALIBRATION CONSTANT = 52.80 PSID/DEG. +- .58080 PSID/DEG.

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00029	-.00724	-.00145	-.04988	-.02894	.00000	-.00001	-.00000	-.00003	-.00002	-.14446	-.00035

TOTAL PRESSURE = 36.21 PSIG+- .16 PSI UNCERTAINTY IN TOTAL PRESSURE = .5 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

E01	A1	ES1	S1		EOD	AD	ESD	SD		CPT	CPS
.00029	-.00724	-.00145	-.04988	-.02894	-.00012	-.00289	-.00058	-.01659	-.01156	-.14446	-.17336

STATIC PRESSURE = 21.73 PSIG+- .24 PSI UNCERTAINTY IN STATIC PRESSURE = 1.1 PERCENT OF READING

UNCERTAINTIES DUE TO COMPONENTS (PSI)

EOA	AA	ESA		SA	C
.00030	-.00297	-.00297	-.00069	-.00424	.02333

ANGLE = 2.12 DEGREES +- .02421 DEG. UNCERTAINTY IN ANGLE = 1.1 PERCENT OF READING

Figure B-2 (Cont'd)

TOTAL PRESSURE PSIG	UNCERTAINTY PERCENT	STATIC PRESSURE PSIG	UNCERTAINTY PERCENT
2.26	2.3	1.75	3.1
4.52	1.2	3.33	1.8
6.26	1.0	3.97	1.7
10.45	.7	6.95	1.2
12.91	.6	8.85	1.0
16.24	.5	11.52	.9
18.57	.5	13.05	.8
20.23	.4	14.40	.8
21.56	.4	14.85	.9
24.23	.5	15.74	1.0
26.89	.5	17.07	1.0
29.55	.5	18.40	1.0
30.88	.5	19.11	1.0
32.21	.4	20.18	1.0
33.55	.5	20.18	1.1
36.21	.5	21.73	1.1

Figure B-2 (Concluded)

APPENDIX C

ENGINE CORE INLET TEST DATA

TABLE C-1

TRAVERSE POSITIONING CHART

WEDGE PROBE CHANNEL 1

	Engine Distance From Center Line in.	Traverse Travel Outward in.	Voltage Setting Volts
ID	8.75	0.0	-.475
A	9.034	0.034	-0.55
B	9.318	0.318	-1.323
C	9.602	0.602	-2.098
D	9.885	0.885	-2.826
E	10.169	1.169	-3.556
F	10.453	1.453	-4.297
G	10.737	1.737	-5.070
H	11.021	2.021	-5.759
I	11.305	2.305	-6.524
J	11.588	2.588	-7.292
K	11.872	2.872	-7.942
L	12.156	3.156	-8.747
*M	12.440	3.440	-9.511

* Splitter Wall

TABLE C-2

F100(3) ENGINE P072 CORE INLET PROFILE DATA AT POSITION 2.5

PT. NO.	LINEAR POS. (INCHES)	% SPAN	SWIRL ANGLE (DEGREES)	90-SWIRL ANG. (DEGREES)	PT (PSIA)	PS (PSIA)	MACH NO.	TEMP. (F)	FAN SPEED (RPM)	CORE SPEED (RPM)
0	0.25	6.9	28.35	61.65	19.83	18.02	0.37	131.3	4730	9700
1	0.55	14.9	24.74	65.26	19.57	17.98	0.35	130.9	4720	9690
2	0.84	22.9	20.86	69.14	19.45	17.98	0.34	128.0	4723	9683
3	1.12	30.3	17.16	72.84	19.46	13.00	0.34	127.1	4733	9688
4	1.40	37.9	16.31	73.69	19.36	18.00	0.32	125.3	4721	9680
5	1.69	45.7	16.18	73.82	19.19	17.99	0.31	123.8	4725	9680
6	1.97	53.5	16.10	73.90	19.02	18.00	0.28	123.5	4727	9684
7	2.24	60.7	17.13	72.82	18.87	18.00	0.26	122.7	4731	9688
8	2.53	68.6	16.87	73.13	18.71	17.98	0.24	121.4	4731	9638
9	2.82	76.5	19.58	70.42	18.63	18.01	0.22	122.7	4732	9687
10	3.08	83.3	23.84	66.16	18.62	18.04	0.21	123.5	4730	9687
11	3.38	91.6	26.56	63.44	18.58	18.06	0.20	124.1	4732	9687
12	0.26	7.0	25.45	64.55	45.60	33.87	0.67	318.6	9729	12803
13	0.54	14.7	22.58	67.42	44.28	33.39	0.65	305.0	9707	12734
14	0.84	22.7	19.97	70.03	42.11	33.33	0.59	288.0	9690	12757
15	1.12	30.3	16.95	73.05	41.05	33.08	0.56	275.1	9698	12768
16	1.40	37.9	14.71	75.29	40.99	33.03	0.56	270.2	9704	12730
17	1.68	45.5	13.52	76.48	40.74	33.08	0.55	269.3	9696	12765
18	1.98	53.6	13.79	76.21	40.20	33.05	0.54	268.9	9709	12783
19	2.24	60.7	15.64	74.36	39.62	32.95	0.52	269.5	9715	12788
20	2.53	68.7	20.23	69.77	39.94	32.86	0.54	274.9	9711	12784
21	2.82	76.5	24.58	65.42	41.11	33.17	0.56	282.2	9750	12788
22	3.03	83.4	26.34	63.66	41.75	33.36	0.58	288.6	9731	12803
23	3.38	91.6	25.55	64.45	41.04	33.78	0.53	292.6	9715	12780
24	0.25	6.8	27.63	62.37	25.64	21.90	0.48	181.4	6554	10426
25	0.55	14.8	24.46	65.54	25.32	21.34	0.46	176.4	6566	10422
26	0.84	22.7	20.67	69.33	24.95	21.87	0.44	172.4	6566	10422
27	1.12	30.4	17.22	72.78	24.72	21.86	0.42	170.0	6558	10422
28	1.40	37.9	16.22	73.78	24.54	21.86	0.41	167.4	6562	10426
29	1.68	45.6	15.28	74.72	24.23	21.82	0.39	164.7	6568	10428
30	1.98	53.5	15.15	74.85	23.87	21.85	0.36	161.7	6568	10428
31	2.24	60.7	15.60	74.40	23.47	21.84	0.32	159.7	6568	10428
32	2.53	68.6	17.76	72.24	23.25	21.86	0.30	159.5	6565	10423
33	2.83	76.7	21.93	68.07	23.26	21.88	0.30	161.5	6576	10426
34	3.07	83.3	26.06	63.94	23.30	21.92	0.30	163.5	6576	10426
35	3.38	91.7	28.71	61.29	23.20	21.98	0.28	164.9	6576	10426
36	0.27	7.2	26.06	63.94	35.67	28.04	0.60	254.3	8579	11563
37	0.55	14.9	22.01	67.99	35.32	27.82	0.59	248.3	8579	11567
38	0.84	22.9	19.27	70.73	34.18	27.74	0.55	239.2	8577	11555
39	1.12	30.3	16.71	73.29	33.24	27.70	0.52	229.2	8532	11562
40	1.40	37.9	15.16	74.84	32.59	27.65	0.49	223.5	8580	11555
41	1.68	45.5	14.44	75.56	32.15	27.66	0.47	219.0	8577	11558
42	1.98	53.6	14.76	75.24	31.74	27.65	0.45	216.3	8582	11562
43	2.24	60.7	16.42	73.58	31.41	27.61	0.43	215.5	8553	11547
44	2.53	68.6	19.35	70.65	31.36	27.58	0.43	217.7	8582	11558
45	2.83	76.6	23.91	66.09	31.56	27.62	0.44	221.3	8573	11551
46	3.07	83.3	26.15	63.85	31.83	27.84	0.44	225.7	8565	11543
47	3.38	91.6	26.52	63.48	31.63	27.95	0.42	228.7	8582	11555
48	0.55	14.8	22.48	67	44.88	33.83	0.65	303.6	9719	12788
49	1.98	53.6	13.33	76.67	40.77	33.50	0.54	266.5	9723	12799
50	3.08	83.3	26.12	63.88	42.18	33.67	0.58	295.8	9727	12803

TABLE C-3

F100(3) ENGINE P072 CORE INLET PROFILE DATA AT POSITION 2.3

PT. NO	LINEAR POS. (INCHES)	% SPAN	SWIRL ANGLE (DEGREES)	90-SWIRL ANG. (DEGREES)	PT (PSIA)	PS (PSIA)	MACH NO.	TEMP. (F)	FAN SPEED (RPM)	CORE SPEED (RPM)
51	0.53	16.7	28.30	61.70	44.72	32.94	0.68	296.0	9714	12782
52	0.71	23.4	27.48	62.52	43.98	33.12	0.65	287.0	9727	12799
53	0.98	31.2	26.85	63.15	43.24	33.44	0.62	278.9	9715	12788
54	1.22	38.8	27.42	62.58	42.35	33.55	0.59	272.4	9719	12791
55	1.48	47.1	28.70	61.30	41.61	33.68	0.56	268.1	9723	12799
56	1.71	54.4	30.37	59.63	41.18	33.91	0.53	266.2	9713	12788
57	1.95	62.0	33.90	56.10	40.74	33.92	0.52	266.0	9725	12792
58	2.19	69.6	36.76	53.24	40.44	33.90	0.51	271.0	9721	12795
59	2.43	77.2	40.10	49.90	41.10	33.85	0.53	277.9	9731	12807
60	2.67	84.3	36.81	53.19	41.95	34.24	0.55	283.9	9731	12803
61	2.93	93.1	35.11	54.89	42.45	34.59	0.55	286.2	9721	12796
62	2.93	92.9	48.26	41.74	18.23	17.98	0.17	111.2	4567	9521
63	2.67	84.7	32.78	57.22	18.37	17.85	0.20	111.0	4553	9496
64	2.43	77.3	26.78	63.22	18.43	17.83	0.22	110.1	4536	9483
65	2.19	69.5	24.52	65.48	18.46	17.90	0.23	109.6	4536	9483
66	1.95	62.0	23.49	66.51	18.58	17.93	0.24	109.8	4534	9483
67	1.71	54.3	22.65	67.35	18.63	17.78	0.26	109.8	4548	9491
68	1.48	47.1	21.77	68.23	18.73	17.74	0.28	110.0	4542	9493
69	1.22	38.8	21.54	68.46	18.85	17.69	0.30	111.0	4540	9484
70	0.98	31.2	20.86	69.14	19.02	17.64	0.33	112.0	4540	9484
71	0.73	23.3	21.40	68.60	19.22	17.59	0.36	113.6	4534	9480
72	0.53	16.7	21.80	68.20	19.37	17.54	0.38	114.8	4534	9477

APPENDIX D

EXISTING PRESWIRL VANE TEST PREPARATION AND DATA

TABLE D-1

TRANSDUCER BENCH CALIBRATIONS

(Inlet Preswirl Vane Test)

0 - 1 PSID S/N 3004 Pressure (PSI)	0 - 1 PSID S/N 3004 Output (mV)	0 - 5 PSID S/N 46255 Pressure (PSI)	0 - 5 PSID S/N 46255 Output (mV)
0.000	-0.57	0.000	-0.19
0.200	3.45	1.000	10.00
0.400	7.47	2.000	20.19
0.600	11.50	3.000	30.30
0.800	15.49	4.000	40.46
1.000	19.47	5.000	50.59
0.800	15.49	4.000	40.46
0.600	11.45	3.000	30.36
0.400	7.48	2.000	20.17
0.200	3.46	1.000	10.02
0.000	-0.57	0.000	-0.17

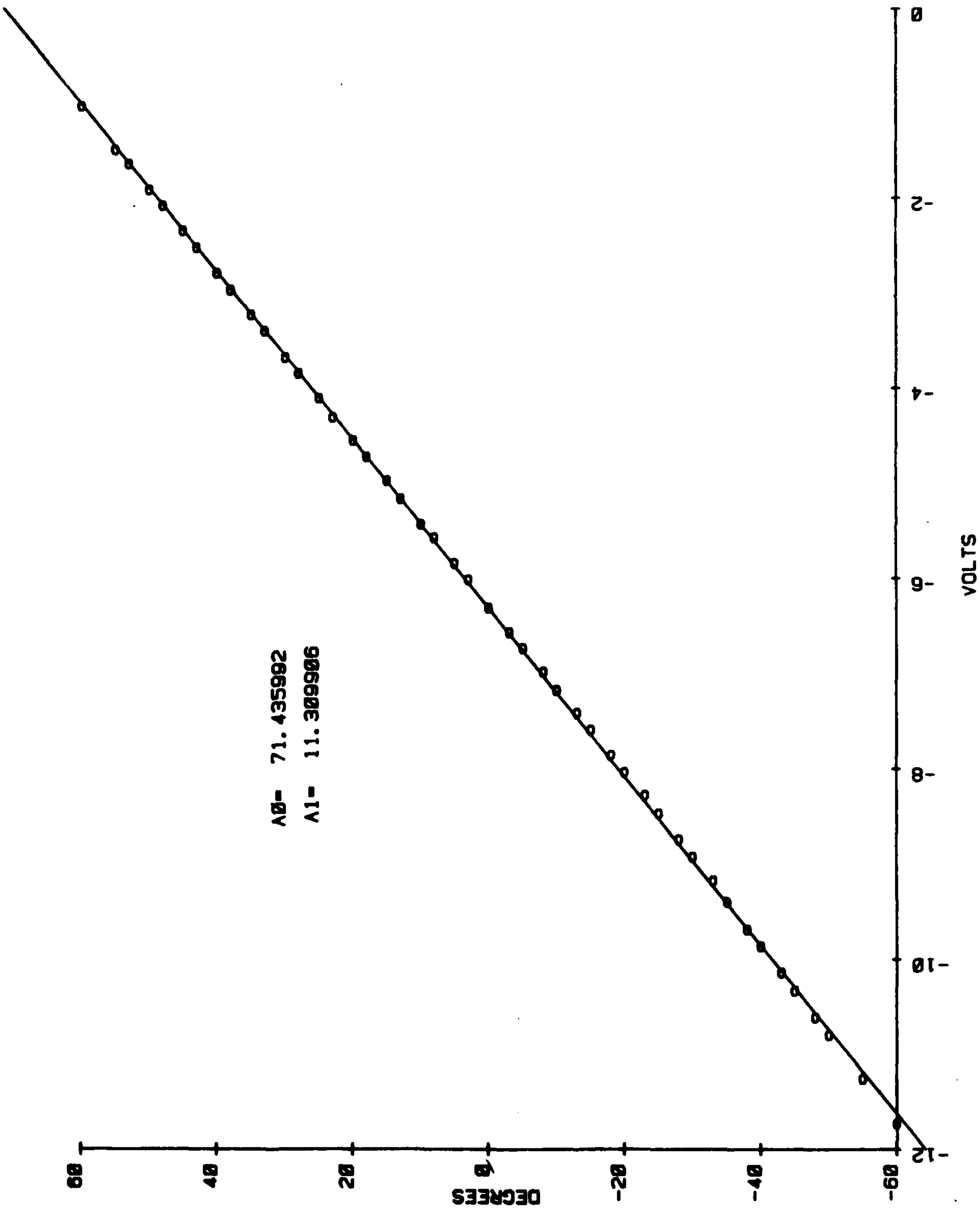


Figure D-1. Traverse Angular Calibration (S/N ER165263)

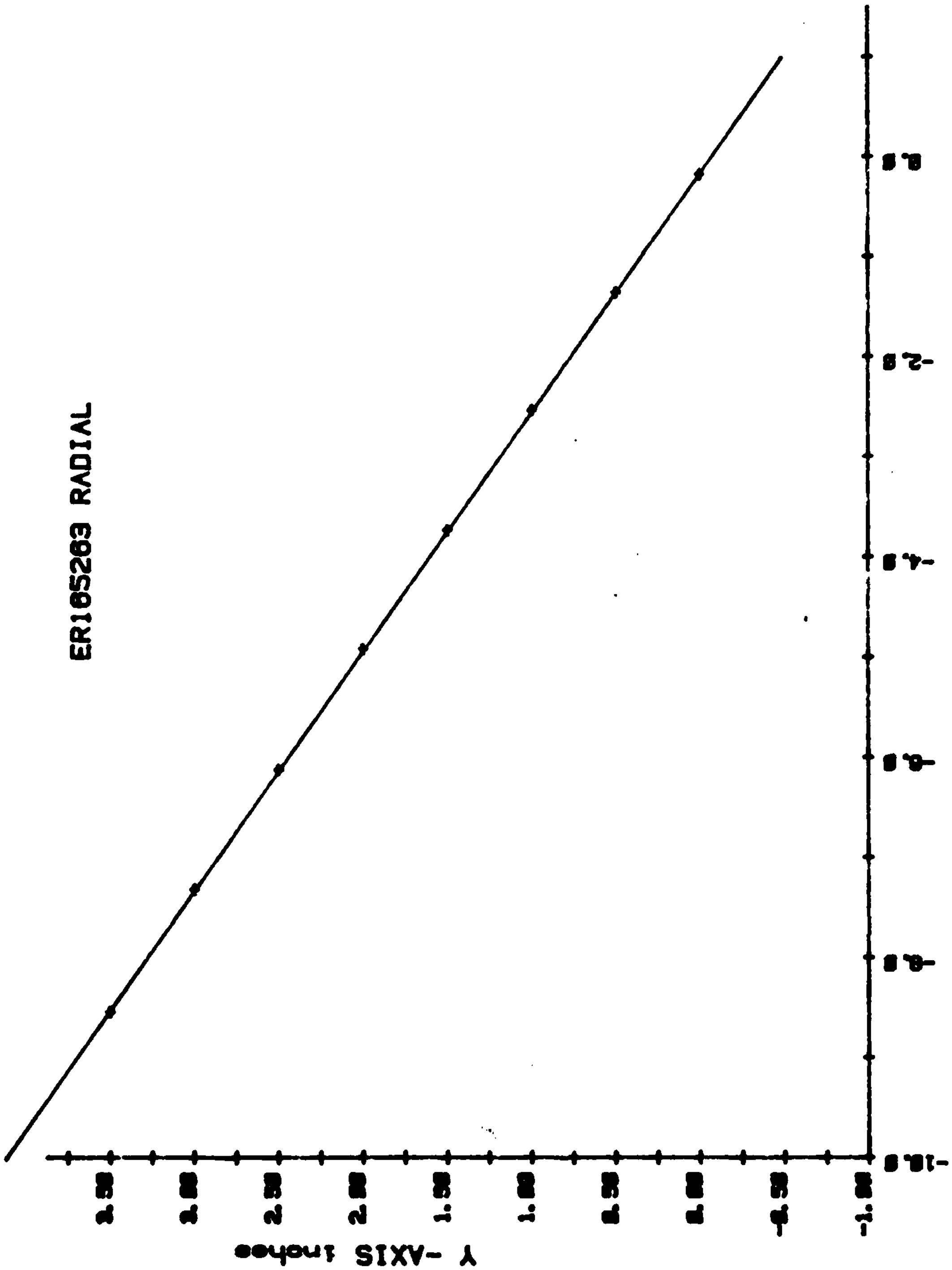


Figure D-2. Traverse Radial Calibration (S/N ER165263)

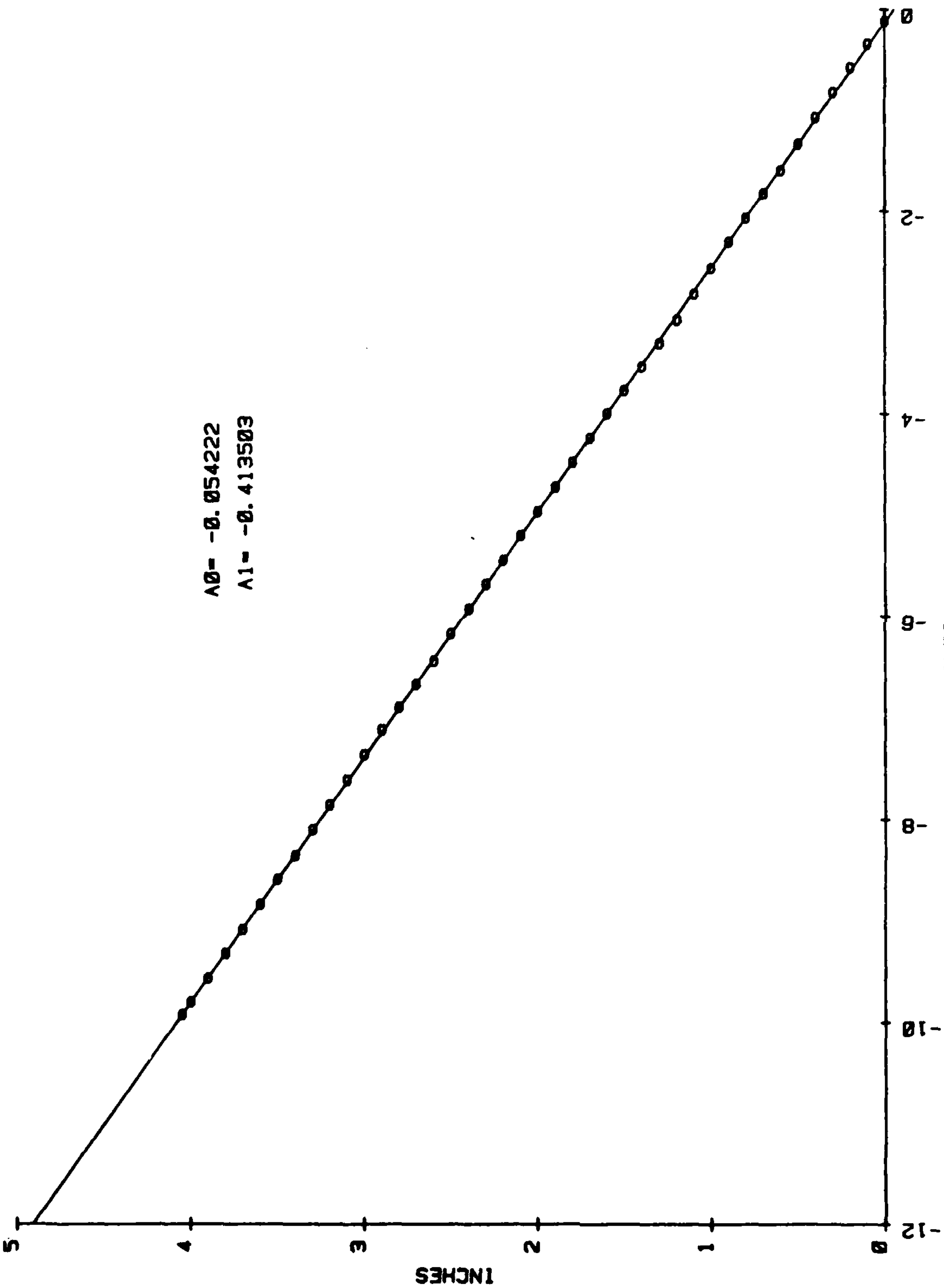


Figure D-3. Traverse Angular Calibration (S/N ER165262)

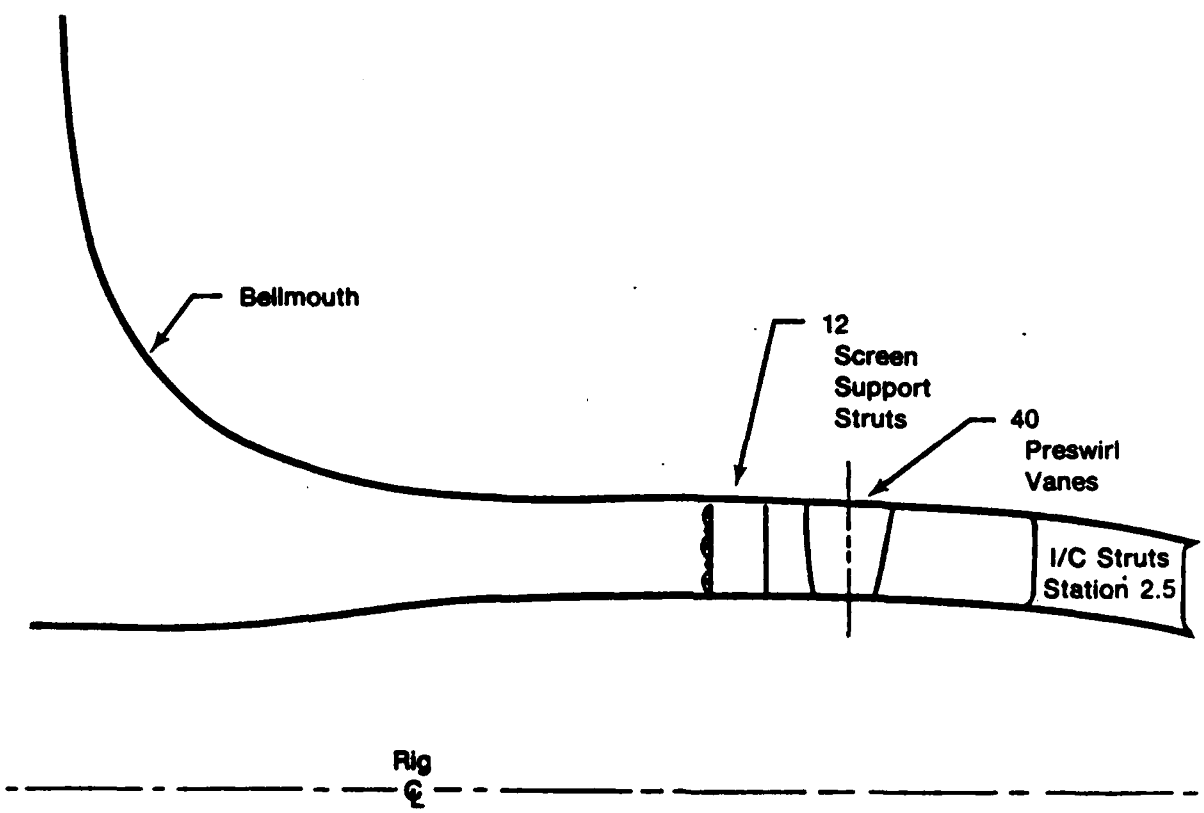


Figure E-1. CRF/F100 Compressor Rig Inlet Model

PRESWIRL VANE AND PRESSURE PROFILE SCREEN DETAILED DESIGN

The aerodynamic design of the inlet preswirl vane was based upon the profile data obtained at Station 2.3 from the PO-72 engine test. As shown in Figure E-1, a streamline model was made of the inlet system from the bellmouth to the intermediate case; profile screen loss, vane loss, and vane turning were iterated to produce the desired Station 2.3 profile. A summary of the synthesized vane geometry is presented in Figures E-2 and E-3. For this vane, the turning distribution, the exit swirl distribution, and the exit pressure profile is presented in Figure E-4. The required screen discharge pressure profile is presented in Figure E-5.

APPENDIX E

MODIFIED PRESWIRL VANE DESIGN AND PHASE I TEST DATA

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
440	33	0.28	14.21	81.5	53.9	26	79.9	14.12	13.38	0.28
441	33	0.28	14.21	81.6	7.7	23	81.0	14.14	13.32	0.29
442	33	0.28	14.21	81.2	15.4	25	80.2	14.19	13.31	0.30
443	33	0.28	14.21	81.1	23.1	25	80.2	14.20	13.33	0.30
444	33	0.28	14.21	81.2	30.8	25	79.9	14.19	13.35	0.30
445	33	0.28	14.21	81.3	38.5	25	80.5	14.14	13.36	0.29
446	33	0.28	14.21	81.6	46.2	26	80.9	14.11	13.36	0.28
447	33	0.28	14.21	81.7	53.9	26	80.5	14.13	13.38	0.28
448	33	0.28	14.21	81.8	61.6	25	80.9	14.17	13.39	0.29
449	33	0.28	14.21	82.0	69.3	24	81.3	14.16	13.40	0.28
450	33	0.28	14.21	82.2	77.0	22	81.9	14.11	13.43	0.27
451	33	0.28	14.21	82.5	84.7	22	82.5	14.09	13.46	0.26
452	33	0.28	14.21	82.8	92.4	20	82.6	14.12	13.51	0.25
453	33	0.28	14.21	82.8	53.9	26	82.4	14.13	13.37	0.28
454	30	0.28	14.33	73.8	53.9	25	73.4	14.32	13.56	0.28
455	0	0.00	0.00	0.0	0.0	0	0.0	0.00	0.00	0.00
456	0	0.00	0.00	0.0	0.0	0	0.0	0.00	0.00	0.00
457	0	0.00	0.00	0.0	0.0	0	0.0	0.00	0.00	0.00
458	0	0.00	0.00	0.0	0.0	0	0.0	0.00	0.00	0.00
459	0	0.00	0.00	0.0	0.0	0	0.0	0.00	0.00	0.00
460	0	0.00	0.00	0.0	0.0	0	0.0	0.00	0.00	0.00

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
385	30	0.28	14.33	73.8	7.7	24	71.2	14.25	13.52	0.27
386	30	0.28	14.33	74.2	15.4	26	72.6	14.31	13.52	0.29
387	30	0.28	14.33	74.2	23.1	26	73.0	14.29	13.52	0.28
388	30	0.28	14.33	74.5	30.8	26	73.1	14.30	13.54	0.28
389	30	0.28	14.33	74.9	38.5	26	73.7	14.25	13.55	0.27
390	30	0.28	14.33	74.5	46.2	25	73.9	14.27	13.55	0.27
391	30	0.28	14.33	75.0	53.9	25	74.2	14.32	13.56	0.28
392	30	0.28	14.33	74.8	61.6	24	74.3	14.33	13.58	0.28
393	30	0.28	14.33	75.0	69.3	23	74.5	14.30	13.60	0.27
394	30	0.28	14.33	74.1	77.0	22	74.5	14.25	13.62	0.25
395	30	0.28	14.33	74.8	84.7	20	74.3	14.26	13.66	0.25
396	30	0.28	14.33	74.6	92.4	20	74.7	14.32	13.70	0.25
397	30	0.28	14.33	74.9	53.9	25	75.0	14.32	13.56	0.28
398	33	0.54	14.23	73.4	53.8	25	67.7	13.90	11.40	0.54
399	33	0.54	14.23	73.3	7.7	20	68.6	13.97	11.21	0.57
400	33	0.54	14.23	73.4	15.4	23	67.5	14.03	11.26	0.57
401	33	0.54	14.23	73.2	23.1	25	68.1	14.13	11.26	0.58
402	33	0.54	14.23	73.1	30.8	25	66.7	14.21	11.31	0.58
403	33	0.54	14.23	73.1	38.5	25	67.1	14.11	11.29	0.57
404	33	0.54	14.23	73.3	46.2	25	68.4	13.91	11.33	0.55
405	33	0.54	14.23	73.3	53.9	25	67.9	13.91	11.38	0.54
406	33	0.54	14.23	73.5	61.6	24	68.5	14.06	11.48	0.55
407	33	0.54	14.23	73.6	69.3	23	69.3	14.12	11.52	0.55
408	33	0.54	14.23	73.8	77.0	22	68.9	13.86	11.54	0.52
409	33	0.54	14.23	73.9	84.7	21	70.8	13.81	11.68	0.50
410	33	0.54	14.23	73.8	92.3	20	71.8	13.78	11.81	0.47
411	33	0.54	14.23	73.7	53.9	25	68.6	13.92	11.39	0.54
412	33	0.45	14.23	74.0	53.9	25	70.0	13.99	12.16	0.45
413	33	0.45	14.23	74.2	7.7	22	70.2	14.07	12.01	0.48
414	33	0.45	14.23	74.5	15.4	24	71.8	14.11	11.99	0.49
415	33	0.45	14.23	74.1	23.1	25	69.1	14.18	12.04	0.49
416	33	0.45	14.23	74.1	30.8	25	71.2	14.21	12.08	0.49
417	33	0.45	14.23	74.4	38.5	25	70.6	14.12	12.10	0.48
418	33	0.45	14.23	74.4	46.2	25	71.4	13.98	12.09	0.46
419	33	0.45	14.23	74.3	53.9	25	70.6	14.00	12.14	0.46
420	33	0.45	14.23	74.3	61.6	24	71.9	14.10	12.20	0.46
421	33	0.45	14.23	74.5	69.3	23	71.7	14.14	12.22	0.46
422	33	0.45	14.23	74.4	77.0	22	72.3	13.96	12.25	0.44
423	33	0.45	14.23	74.7	84.7	22	72.2	13.92	12.35	0.42
424	33	0.45	14.23	75.1	92.4	20	74.1	13.94	12.49	0.40
425	33	0.45	14.23	75.4	53.9	25	72.1	13.99	12.14	0.45
426	33	0.36	14.21	80.2	53.9	26	78.2	14.07	12.85	0.36
427	33	0.36	14.21	80.5	7.7	23	79.0	14.11	12.76	0.38
428	33	0.36	14.21	80.7	15.4	24	78.9	14.16	12.75	0.39
429	33	0.36	14.21	80.6	23.2	25	77.6	14.20	12.77	0.39
430	33	0.36	14.21	80.4	30.8	25	79.4	14.19	12.81	0.39
431	33	0.36	14.21	80.9	38.5	25	78.8	14.11	12.81	0.37
432	33	0.36	14.21	80.5	46.2	26	77.8	14.04	12.82	0.36
433	33	0.36	14.21	80.9	53.9	26	79.9	14.05	12.82	0.36
434	33	0.36	14.21	81.4	61.6	25	80.5	14.15	12.88	0.37
435	33	0.36	14.21	81.3	69.3	24	79.6	14.13	12.89	0.36
436	33	0.36	14.21	81.0	77.0	22	79.4	14.03	12.92	0.34
437	33	0.36	14.21	80.9	84.7	22	80.4	14.01	12.99	0.33
438	33	0.36	14.21	81.0	92.4	20	79.4	14.03	13.06	0.32
439	33	0.36	14.21	81.1	53.9	26	79.6	14.07	12.84	0.36

TABLE D-2 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
329	25	0.28	14.30	80.6	53.9	24	80.0	14.29	13.55	0.28
330	25	0.28	14.30	80.6	7.7	22	79.3	14.25	13.49	0.28
331	25	0.28	14.30	80.6	15.4	23	80.0	14.27	13.49	0.28
332	25	0.28	14.30	80.8	23.1	24	79.4	14.29	13.50	0.29
333	25	0.23	14.30	80.7	30.8	24	79.3	14.30	13.51	0.29
334	25	0.28	14.30	80.9	38.5	24	80.0	14.30	13.51	0.29
335	25	0.28	14.30	81.2	46.2	24	80.4	14.29	13.52	0.28
336	25	0.28	14.30	81.1	53.9	24	81.1	14.28	13.54	0.28
337	25	0.28	14.30	81.4	61.6	24	80.6	14.27	13.55	0.27
338	25	0.28	14.30	81.3	69.3	22	80.7	14.28	13.57	0.27
339	25	0.28	14.30	81.7	77.0	21	81.1	14.26	13.60	0.26
340	25	0.28	14.30	81.6	84.7	23	81.3	14.22	13.64	0.24
341	25	0.28	14.30	81.6	92.4	25	81.2	14.25	13.66	0.25
342	25	0.28	14.30	81.5	53.9	24	80.3	14.29	13.54	0.28
343	30	0.54	14.34	64.7	53.9	24	59.1	14.27	11.70	0.54
344	30	0.54	14.34	64.7	7.7	23	59.0	14.06	11.55	0.54
345	30	0.54	14.34	64.5	15.4	25	58.4	14.29	11.55	0.56
346	30	0.54	14.34	65.0	23.1	25	58.6	14.27	11.61	0.55
347	30	0.54	14.34	65.2	30.8	25	58.0	14.32	11.63	0.55
348	30	0.54	14.34	65.3	38.5	25	58.8	14.20	11.67	0.54
349	30	0.54	14.34	65.4	46.2	25	59.8	14.10	11.67	0.53
350	30	0.54	14.34	65.7	53.9	24	61.1	14.29	11.71	0.54
351	30	0.54	14.34	65.5	61.6	24	59.7	14.32	11.76	0.54
352	30	0.54	14.34	65.5	69.3	23	60.2	14.29	11.83	0.53
353	30	0.54	14.34	65.3	77.0	22	60.4	14.08	11.88	0.50
354	30	0.54	14.34	65.3	84.7	20	61.1	14.03	11.98	0.48
355	30	0.54	14.34	65.7	92.4	19	63.1	14.26	12.11	0.49
356	30	0.54	14.34	65.8	53.9	24	60.0	14.26	11.70	0.54
357	30	0.45	14.34	66.0	53.9	24	62.0	14.30	12.44	0.45
358	30	0.45	14.34	66.4	7.7	23	60.9	14.13	12.34	0.44
359	30	0.45	14.34	65.8	15.4	25	61.1	14.29	12.33	0.46
360	30	0.45	14.34	66.2	23.1	25	61.1	14.27	12.37	0.46
361	30	0.45	14.34	65.4	30.8	25	62.0	14.31	12.39	0.46
362	30	0.45	14.34	66.0	38.5	25	61.2	14.19	12.38	0.45
363	30	0.45	14.34	65.9	46.2	25	62.6	14.16	12.40	0.44
364	30	0.45	14.34	66.0	53.9	24	62.3	14.30	12.45	0.45
365	30	0.45	14.34	66.1	61.6	24	62.8	14.33	12.51	0.45
366	30	0.45	14.34	66.2	69.3	23	62.8	14.31	12.54	0.44
367	30	0.45	14.34	65.9	77.0	22	62.6	14.16	12.53	0.42
368	30	0.45	14.34	66.1	84.7	21	63.7	14.13	12.67	0.40
369	30	0.45	14.34	66.5	92.4	19	64.8	14.29	12.75	0.41
370	30	0.45	14.34	66.0	53.9	24	63.7	14.30	12.43	0.45
371	30	0.36	14.33	74.6	53.9	25	72.6	14.31	13.09	0.36
372	30	0.36	14.33	74.2	7.7	23	71.6	14.19	13.02	0.35
373	30	0.36	14.33	74.4	15.4	25	72.7	14.29	13.00	0.37
374	30	0.36	14.33	74.7	23.1	26	71.9	14.28	13.03	0.36
375	30	0.36	14.33	74.0	30.8	26	70.6	14.30	13.04	0.37
376	30	0.36	14.33	73.8	38.5	26	71.9	14.20	13.02	0.35
377	30	0.36	14.33	74.4	46.2	25	72.2	14.21	13.04	0.35
378	30	0.36	14.33	73.8	53.9	25	72.6	14.31	13.08	0.36
379	30	0.36	14.33	74.3	61.6	24	71.7	14.33	13.14	0.35
380	30	0.36	14.33	74.1	69.3	23	72.5	14.28	13.11	0.35
381	30	0.36	14.33	74.1	77.0	22	72.1	14.20	13.14	0.34
382	30	0.36	14.33	73.6	84.7	21	72.1	14.21	13.23	0.32
383	30	0.36	14.33	73.9	92.4	20	72.4	14.31	13.28	0.33
384	30	0.36	14.33	73.5	53.9	24	71.4	14.31	13.08	0.36

TABLE D-2 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
273	20	0.28	14.37	82.3	53.9	23	81.5	14.37	13.60	0.28
274	20	0.28	14.37	82.6	7.7	20	81.1	14.19	13.54	0.26
275	20	0.28	14.37	82.4	15.4	23	80.6	14.25	13.53	0.27
276	20	0.28	14.37	82.4	23.1	23	81.5	14.33	13.55	0.28
277	20	0.28	14.37	82.4	30.8	24	81.5	14.35	13.55	0.29
278	20	0.28	14.37	82.5	38.5	24	81.6	14.33	13.56	0.28
279	20	0.28	14.37	82.5	46.2	23	81.5	14.36	13.59	0.28
280	20	0.28	14.37	82.4	53.9	23	81.4	14.37	13.60	0.28
281	20	0.28	14.37	82.4	61.6	23	81.5	14.36	13.62	0.28
282	20	0.28	14.37	82.4	69.3	22	81.9	14.30	13.63	0.26
283	20	0.28	14.37	82.5	77.0	21	81.2	14.23	13.63	0.25
284	20	0.28	14.37	82.6	84.7	20	81.9	14.26	13.68	0.25
285	20	0.28	14.37	82.5	92.4	19	81.8	14.30	13.72	0.24
286	20	0.28	14.37	82.4	53.9	23	81.2	14.37	13.60	0.28
287	25	0.54	14.38	75.8	53.9	23	72.0	14.36	11.78	0.54
288	25	0.54	14.38	76.1	7.7	21	70.9	14.24	11.62	0.55
289	25	0.54	14.38	76.8	15.4	22	71.5	14.32	11.62	0.56
290	25	0.54	14.38	76.3	23.1	23	71.9	14.37	11.62	0.56
291	25	0.54	14.38	76.6	30.8	24	72.4	14.38	11.67	0.55
292	25	0.54	14.38	76.7	38.5	24	71.7	14.38	11.71	0.55
293	25	0.54	14.38	77.3	46.2	24	71.7	14.38	11.75	0.55
294	25	0.54	14.38	77.5	53.9	24	73.4	14.36	11.78	0.54
295	25	0.54	14.38	77.6	61.6	23	72.8	14.30	11.84	0.53
296	25	0.54	14.38	78.2	69.3	22	73.2	14.32	11.88	0.52
297	25	0.54	14.38	78.2	77.0	21	74.6	14.29	11.97	0.51
298	25	0.54	14.38	78.7	84.7	22	74.5	14.20	12.08	0.49
299	25	0.54	14.38	79.1	92.4	23	75.8	14.33	12.18	0.49
300	25	0.54	14.38	78.7	53.9	24	73.1	14.36	11.79	0.54
301	25	0.45	14.37	85.5	53.9	24	81.8	14.35	12.51	0.45
302	25	0.45	14.37	85.2	7.7	21	82.0	14.27	12.41	0.45
303	25	0.45	14.37	84.8	15.4	22	81.1	14.34	12.38	0.46
304	25	0.45	14.37	84.4	23.1	23	81.8	14.37	12.40	0.46
305	25	0.45	14.37	85.2	30.8	24	81.8	14.37	12.43	0.46
306	25	0.45	14.37	85.8	38.5	24	81.7	14.37	12.45	0.46
307	25	0.45	14.37	85.8	46.2	24	82.1	14.37	12.49	0.45
308	25	0.45	14.37	85.6	53.9	24	81.3	14.35	12.52	0.45
309	25	0.45	14.37	86.0	61.6	23	83.4	14.32	12.54	0.44
310	25	0.45	14.37	85.8	69.3	22	83.0	14.32	12.59	0.43
311	25	0.45	14.37	65.8	77.0	22	83.3	14.29	12.64	0.42
312	25	0.45	14.37	85.1	84.7	22	81.3	14.21	12.74	0.40
313	25	0.45	14.37	85.5	92.4	24	83.6	14.33	12.81	0.40
314	25	0.45	14.37	85.6	53.9	24	82.6	14.36	12.51	0.45
315	25	0.36	14.31	74.0	53.9	24	72.8	14.29	13.08	0.36
316	25	0.36	14.31	74.3	7.7	21	72.8	14.23	13.01	0.35
317	25	0.36	14.31	74.0	15.4	21	71.8	14.27	13.01	0.37
318	25	0.36	14.31	74.0	23.1	23	72.1	14.30	13.01	0.37
319	25	0.36	14.31	74.0	30.8	24	72.0	14.31	13.03	0.37
320	25	0.36	14.31	73.5	38.5	24	72.0	14.31	13.04	0.37
321	25	0.36	14.31	74.2	46.2	24	72.3	14.31	13.08	0.36
322	25	0.36	14.31	74.3	53.9	24	72.3	14.30	13.09	0.36
323	25	0.36	14.31	74.0	61.6	24	72.6	14.27	13.10	0.35
324	25	0.36	14.31	74.0	69.3	22	72.9	14.28	13.15	0.35
325	25	0.36	14.31	74.2	77.0	21	73.3	14.23	13.18	0.33
326	25	0.36	14.31	74.4	84.7	22	73.6	14.15	13.24	0.31
327	25	0.36	14.31	74.8	92.4	24	74.1	14.24	13.29	0.32
328	25	0.36	14.31	74.4	53.9	24	72.8	14.30	13.09	0.36

TABLE D-2 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
217	5	0.45	14.39	81.8	53.9	20	78.6	14.38	12.49	0.45
218	5	0.45	14.39	81.8	7.7	20	78.3	14.36	12.41	0.46
219	5	0.45	14.39	81.4	15.4	20	78.3	14.38	12.36	0.47
220	5	0.45	14.39	81.5	23.1	20	78.4	14.38	12.36	0.47
221	5	0.45	14.39	81.4	30.8	21	78.3	14.38	12.41	0.46
222	5	0.45	14.39	81.4	38.5	20	78.2	14.38	12.42	0.46
223	5	0.45	14.39	81.4	46.2	20	77.9	14.38	12.46	0.46
224	5	0.45	14.39	81.1	53.9	20	77.8	14.38	12.50	0.45
225	5	0.45	14.39	81.5	61.6	20	78.6	14.37	12.53	0.45
226	5	0.45	14.39	81.6	69.3	20	78.6	14.33	12.58	0.44
227	5	0.45	14.39	81.6	77.0	20	78.7	14.15	12.56	0.42
228	5	0.45	14.39	81.5	84.7	19	79.3	14.11	12.69	0.39
229	5	0.45	14.39	81.4	92.4	17	80.3	14.18	12.77	0.39
230	5	0.45	14.39	81.4	53.9	20	78.6	14.38	12.51	0.45
231	20	0.54	14.39	71.1	53.9	23	68.1	14.37	11.78	0.54
232	20	0.54	14.39	71.4	7.7	20	66.1	13.80	11.63	0.50
233	20	0.54	14.39	71.4	15.4	23	66.3	14.03	11.55	0.53
234	20	0.54	14.39	71.7	23.1	23	68.0	14.24	11.63	0.55
235	20	0.54	14.39	72.1	30.8	23	68.8	14.35	11.66	0.55
236	20	0.54	14.39	71.9	38.5	23	68.1	14.30	11.71	0.54
237	20	0.54	14.39	72.5	46.2	23	68.8	14.35	11.76	0.54
238	20	0.54	14.39	72.6	53.9	23	69.1	14.38	11.80	0.54
239	20	0.54	14.39	72.8	61.6	22	69.1	14.31	11.82	0.53
240	20	0.54	14.39	73.1	69.3	22	69.2	14.03	11.82	0.50
241	20	0.54	14.39	73.1	77.0	21	69.4	13.96	11.85	0.49
242	20	0.54	14.39	73.4	84.7	20	71.3	14.11	11.99	0.49
243	20	0.54	14.39	73.6	92.4	20	72.2	14.15	12.16	0.47
244	20	0.54	14.39	73.8	53.9	23	70.7	14.38	11.61	0.54
245	20	0.45	14.38	77.4	53.9	23	74.6	14.37	12.51	0.45
246	20	0.45	14.38	77.2	7.7	21	73.3	13.95	12.38	0.42
247	20	0.45	14.38	77.6	15.4	23	74.5	14.13	12.34	0.44
248	20	0.45	14.38	77.4	23.1	23	74.8	14.27	12.37	0.46
249	20	0.45	14.38	77.8	30.8	23	75.4	14.34	12.41	0.46
250	20	0.45	14.38	78.0	38.5	23	74.8	14.32	12.45	0.45
251	20	0.45	14.38	78.0	46.2	23	75.3	14.36	12.50	0.45
252	20	0.45	14.38	77.9	53.9	23	75.3	14.37	12.51	0.45
253	20	0.45	14.38	78.1	61.6	23	75.4	14.32	12.52	0.44
254	20	0.45	14.38	78.4	69.3	23	75.5	14.15	12.57	0.42
255	20	0.45	14.38	78.4	77.0	21	75.6	14.07	12.59	0.40
256	20	0.45	14.38	78.4	84.7	20	76.3	14.18	12.68	0.40
257	20	0.45	14.38	78.7	92.4	19	77.0	14.23	12.80	0.39
258	20	0.45	14.38	78.7	53.9	23	75.5	14.37	12.51	0.45
259	20	0.36	14.37	81.5	53.9	23	79.7	14.37	13.11	0.36
260	20	0.36	14.37	81.4	7.7	21	78.9	14.08	13.01	0.34
261	20	0.36	14.37	81.4	15.4	21	79.3	14.20	12.99	0.36
262	20	0.36	14.37	81.2	23.1	23	79.3	14.31	13.00	0.37
263	20	0.36	14.37	81.5	30.8	23	79.8	14.33	13.01	0.37
264	20	0.36	14.37	81.6	38.5	24	79.6	14.33	13.05	0.37
265	20	0.36	14.37	81.9	46.2	23	80.1	14.34	13.07	0.37
266	20	0.36	14.37	81.8	53.9	23	80.0	14.36	13.11	0.36
267	20	0.36	14.37	81.8	61.6	23	80.5	14.34	13.12	0.36
268	20	0.36	14.37	82.3	69.3	23	80.6	14.23	13.13	0.34
269	20	0.36	14.37	82.2	77.0	21	80.1	14.15	13.14	0.33
270	20	0.36	14.37	81.9	84.7	20	80.7	14.22	13.21	0.33
271	20	0.36	14.37	82.0	92.4	20	81.0	14.25	13.28	0.32
272	20	0.36	14.37	82.1	53.9	23	80.0	14.36	13.09	0.37

TABLE D-2 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
160	15	0.36	14.43	68.1	53.9	22	65.8	14.36	13.11	0.36
161	15	0.36	14.43	67.9	7.7	21	66.0	14.43	13.05	0.38
162	15	0.36	14.43	68.1	15.4	21	66.4	14.43	13.05	0.38
163	15	0.36	14.43	68.0	23.1	22	66.5	14.42	13.04	0.38
164	15	0.36	14.43	68.9	30.8	22	67.3	14.41	13.06	0.38
165	15	0.36	14.43	69.0	38.5	22	67.3	14.40	13.08	0.37
166	15	0.36	14.43	68.9	46.2	22	67.6	14.37	13.09	0.37
167	15	0.36	14.43	70.0	53.9	22	68.5	14.35	13.11	0.36
168	15	0.36	14.43	69.9	61.6	22	68.2	14.36	13.14	0.36
169	15	0.36	14.43	70.1	69.3	22	68.7	14.37	13.16	0.36
170	15	0.36	14.43	70.0	77.0	20	69.1	14.38	13.20	0.35
171	15	0.36	14.43	70.4	84.7	20	69.8	14.41	13.29	0.34
172	15	0.36	14.43	71.2	92.3	19	70.6	14.43	13.34	0.34
173	15	0.36	14.43	71.8	53.9	22	70.3	14.36	13.11	0.36
174	15	0.45	14.42	66.8	53.9	22	64.2	14.30	12.41	0.45
175	15	0.45	14.42	67.0	7.7	21	63.3	14.42	12.36	0.47
176	15	0.45	14.42	67.1	15.4	21	63.9	14.41	12.31	0.48
177	15	0.45	14.42	67.2	23.1	22	65.5	14.41	12.34	0.48
178	15	0.45	14.42	68.1	30.8	22	65.4	14.39	12.36	0.47
179	15	0.45	14.42	68.4	38.5	22	65.7	14.36	12.37	0.47
180	15	0.45	14.42	68.5	46.2	22	66.1	14.33	12.41	0.46
181	15	0.45	14.42	68.8	53.9	22	66.6	14.30	12.40	0.46
182	15	0.45	14.42	69.1	61.6	22	67.0	14.30	12.46	0.45
183	15	0.45	14.42	69.3	69.3	22	67.4	14.33	12.51	0.45
184	15	0.45	14.42	69.9	77.0	20	68.3	14.35	12.56	0.44
185	15	0.45	14.42	69.9	84.7	19	68.1	14.40	12.67	0.43
186	15	0.45	14.42	70.0	92.4	19	69.0	14.42	12.75	0.42
187	15	0.45	14.42	70.3	53.9	22	67.3	14.30	12.42	0.45
188	15	0.28	14.41	76.1	53.9	22	74.5	14.36	13.57	0.28
189	15	0.28	14.41	75.8	7.7	21	75.1	14.40	13.55	0.30
190	15	0.28	14.41	75.9	15.4	21	75.1	14.39	13.54	0.30
191	15	0.28	14.41	76.2	23.1	22	74.8	14.40	13.55	0.30
193	15	0.28	14.41	76.0	30.8	22	73.8	14.40	13.56	0.29
194	15	0.28	14.41	75.3	38.5	22	74.7	14.38	13.56	0.29
195	15	0.28	14.41	75.7	46.2	22	74.5	14.38	13.58	0.29
196	15	0.28	14.41	76.1	53.9	22	74.6	14.37	13.59	0.28
197	15	0.28	14.41	76.5	61.6	22	75.6	14.36	13.60	0.28
198	15	0.28	14.41	76.1	69.3	22	75.0	14.37	13.62	0.28
199	15	0.28	14.41	75.7	77.0	21	74.0	14.38	13.64	0.27
200	15	0.28	14.41	76.1	84.7	20	75.6	14.40	13.69	0.27
201	15	0.28	14.41	76.4	92.4	19	75.2	14.40	13.72	0.26
202	15	0.28	14.41	76.3	53.9	22	74.8	14.36	13.58	0.28
203	5	0.54	14.40	74.9	53.9	20	71.8	14.39	11.80	0.54
204	5	0.54	14.40	75.2	7.7	20	70.9	14.36	11.68	0.55
205	5	0.54	14.40	75.6	15.4	20	71.9	14.38	11.64	0.56
206	5	0.54	14.40	75.8	23.1	20	71.9	14.38	11.65	0.56
207	5	0.54	14.40	76.0	30.8	20	71.8	14.39	11.66	0.56
208	5	0.54	14.40	76.1	38.5	20	72.5	14.39	11.74	0.55
209	5	0.54	14.40	76.6	46.2	20	72.9	14.39	11.76	0.54
210	5	0.54	14.40	76.6	53.9	20	73.0	14.39	11.78	0.54
211	5	0.54	14.40	76.7	61.6	20	72.1	14.39	11.81	0.54
212	5	0.54	14.40	77.0	69.3	20	74.1	14.33	11.88	0.52
213	5	0.54	14.40	77.2	77.0	19	74.1	14.18	11.92	0.50
214	5	0.54	14.40	77.2	84.7	18	74.3	14.05	12.03	0.48
215	5	0.54	14.40	77.6	92.4	18	76.0	14.14	12.17	0.47
216	5	0.54	14.40	77.7	53.9	20	73.7	14.39	11.79	0.54

TABLE D-2 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
103	10	0.36	14.29	72.9	53.9	21	71.2	14.28	13.06	0.36
104	10	0.36	14.29	72.7	7.7	20	71.0	14.05	13.02	0.33
105	10	0.36	14.29	72.6	15.4	21	70.1	14.06	12.98	0.34
106	10	0.36	14.29	72.7	23.1	21	70.7	14.16	12.98	0.35
107	10	0.36	14.29	72.7	30.8	21	70.7	14.23	12.98	0.36
108	10	0.36	14.29	72.9	38.5	22	71.4	14.24	13.00	0.36
109	10	0.36	14.29	72.9	46.2	22	71.7	14.26	13.02	0.36
110	10	0.36	14.29	72.7	53.9	21	71.7	14.28	13.05	0.36
111	10	0.36	14.29	72.8	61.6	20	71.5	14.29	13.10	0.35
112	10	0.36	14.29	72.5	69.3	20	71.0	14.28	13.09	0.35
113	10	0.36	14.29	72.7	77.0	20	71.6	14.25	13.13	0.34
114	10	0.36	14.29	72.8	84.7	20	72.9	14.23	13.21	0.33
115	10	0.36	14.29	73.1	92.4	22	72.9	14.22	13.23	0.32
116	10	0.36	14.29	72.7	53.9	21	71.2	14.28	13.04	0.36
117	10	0.45	14.31	69.1	53.9	21	66.8	14.29	12.42	0.45
118	10	0.45	14.31	68.9	7.7	20	64.9	13.93	12.33	0.42
119	10	0.45	14.31	68.6	15.4	21	64.5	13.99	12.32	0.43
120	10	0.45	14.31	68.4	23.1	21	65.1	14.13	12.31	0.45
121	10	0.45	14.31	68.4	30.8	21	66.0	14.22	12.34	0.45
122	10	0.45	14.31	68.4	38.5	21	66.0	14.23	12.36	0.45
123	10	0.45	14.31	68.5	46.2	21	65.6	14.26	12.40	0.45
124	10	0.45	14.31	68.2	53.9	21	65.5	14.29	12.43	0.45
125	10	0.45	14.31	68.2	61.6	21	66.1	14.30	12.44	0.45
126	10	0.45	14.31	68.2	69.3	20	65.2	14.30	12.51	0.44
127	10	0.45	14.31	68.1	77.0	20	66.3	14.28	12.56	0.43
128	10	0.45	14.31	68.1	84.7	21	66.0	14.23	12.66	0.41
129	10	0.45	14.31	68.1	92.4	22	66.6	14.25	12.72	0.41
130	10	0.45	14.31	67.8	53.9	21	65.9	14.29	12.43	0.45
131	10	0.54	14.31	67.9	53.9	21	64.3	14.27	11.72	0.54
132	10	0.54	14.31	68.1	7.7	20	63.8	13.80	11.63	0.50
133	10	0.54	14.31	68.2	15.4	21	63.2	13.87	11.55	0.52
134	10	0.54	14.31	68.3	23.1	21	63.9	14.05	11.57	0.53
135	10	0.54	14.31	67.8	30.8	21	64.6	14.18	11.60	0.54
136	10	0.54	14.31	68.1	38.5	21	65.2	14.20	11.64	0.54
137	10	0.54	14.31	68.1	46.2	21	64.7	14.23	11.68	0.54
138	10	0.54	14.31	68.2	53.9	21	64.9	14.27	11.72	0.54
139	10	0.54	14.31	68.1	61.6	21	65.0	14.30	11.77	0.53
140	10	0.54	14.31	68.0	69.3	20	64.8	14.30	11.83	0.53
141	10	0.54	14.31	68.0	77.0	20	65.0	14.26	11.90	0.52
142	10	0.54	14.31	68.1	84.7	21	66.2	14.19	12.01	0.49
143	10	0.54	14.31	68.2	92.4	22	66.5	14.22	12.12	0.48
144	10	0.54	14.31	68.2	53.9	21	65.6	14.27	11.72	0.54
145	10	0.54	14.42	66.9	53.9	21	61.4	14.39	11.54	0.57
146	15	0.54	14.44	60.7	53.9	22	55.5	14.26	11.67	0.54
147	15	0.54	14.44	60.7	7.7	21	56.3	14.43	11.60	0.57
148	15	0.54	14.44	61.1	15.4	21	56.5	14.43	11.56	0.57
149	15	0.54	14.44	61.1	23.1	21	56.6	14.42	11.59	0.57
150	15	0.54	14.44	60.9	30.8	22	57.0	14.40	11.60	0.56
151	15	0.54	14.44	61.4	38.5	22	56.2	14.35	11.63	0.56
152	15	0.54	14.44	61.2	46.2	22	55.4	14.29	11.64	0.55
153	15	0.54	14.44	61.4	53.9	22	56.1	14.27	11.67	0.54
154	15	0.54	14.44	61.4	61.6	22	57.9	14.26	11.70	0.54
155	15	0.54	14.44	61.2	69.3	22	58.0	14.30	11.78	0.53
156	15	0.54	14.44	61.4	77.0	20	58.4	14.33	11.88	0.52
157	15	0.54	14.44	61.9	84.7	19	59.3	14.40	12.00	0.52
158	15	0.54	14.44	62.3	92.4	19	60.5	14.43	12.13	0.50
159	15	0.54	14.44	62.2	53.9	22	56.7	14.26	11.66	0.54

TABLE D-2 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
56	0	0.54	14.47	36.2	53.9	~~19~~	30.8	14.32	11.79	0.53
57	0	0.54	14.47	35.7	7.7	22	28.5	14.02	11.56	0.53
58	0	0.54	14.47	35.5	23.1	20	31.2	14.34	11.68	0.55
59	0	0.54	14.47	36.1	38.5	20	31.4	14.29	11.70	0.54
60	0	0.54	14.47	35.9	69.3	18	32.1	14.40	11.88	0.53
61	0	0.54	14.47	36.0	84.6	17	33.4	14.18	12.01	0.49
62	5	0.36	14.46	38.6	53.9	20	35.9	14.46	13.20	0.36
63	5	0.36	14.46	38.7	7.7	21	35.2	14.45	13.15	0.37
64	5	0.36	14.46	39.0	15.4	20	36.1	14.45	13.13	0.37
65	5	0.36	14.46	38.9	23.1	20	36.1	14.46	13.13	0.37
66	5	0.36	14.46	39.0	30.8	20	36.4	14.46	13.15	0.37
67	5	0.36	14.46	38.9	38.5	20	36.4	14.46	13.17	0.37
68	5	0.36	14.46	38.8	46.2	20	36.3	14.46	13.18	0.37
69	5	0.36	14.46	39.0	53.9	20	36.7	14.46	13.22	0.36
70	5	0.36	14.46	39.0	61.6	20	35.7	14.46	13.25	0.36
71	5	0.36	14.46	39.1	69.3	20	36.6	14.44	13.28	0.35
72	5	0.36	14.46	38.8	77.0	19	37.6	14.31	13.28	0.33
73	5	0.36	14.46	38.8	84.7	18	37.6	14.28	13.34	0.31
74	5	0.36	14.46	38.8	92.4	16	38.6	14.38	13.41	0.32
75	5	0.36	14.46	38.9	53.9	20	36.7	14.46	13.23	0.36
76	5	0.28	14.46	39.2	53.9	20	38.0	14.46	13.71	0.28
77	5	0.28	14.46	38.9	7.7	21	36.7	14.44	13.65	0.29
78	5	0.28	14.46	39.1	15.5	20	37.5	14.46	13.65	0.29
79	5	0.28	14.46	39.2	23.1	20	37.2	14.46	13.67	0.28
80	5	0.28	14.46	39.1	30.8	20	37.2	14.46	13.66	0.29
81	5	0.28	14.46	39.2	38.5	20	37.9	14.45	13.66	0.29
82	5	0.28	14.46	39.0	46.2	20	35.9	14.46	13.69	0.28
83	5	0.28	14.46	39.1	53.9	20	37.1	14.46	13.72	0.28
84	5	0.28	14.46	39.2	61.6	20	37.7	14.44	13.72	0.27
85	5	0.28	14.46	39.2	69.3	19	37.2	14.45	13.74	0.27
86	5	0.28	14.46	39.0	77.0	19	37.1	14.40	13.79	0.25
87	5	0.28	14.46	38.9	84.7	18	37.8	14.41	13.80	0.25
88	5	0.28	14.46	38.9	92.4	16	37.6	14.42	13.83	0.24
89	10	0.28	14.32	68.1	53.9	21	67.0	14.32	13.53	0.28
90	10	0.28	14.32	68.0	7.9	20	66.6	14.17	13.49	0.27
91	10	0.28	14.32	68.1	15.4	21	66.9	14.17	13.47	0.27
92	10	0.28	14.32	68.3	23.1	21	67.0	14.23	13.48	0.28
93	10	0.28	14.32	68.3	30.8	21	67.0	14.28	13.48	0.29
94	10	0.28	14.32	68.2	38.5	22	68.0	14.29	13.49	0.29
95	10	0.28	14.32	68.1	46.2	21	68.0	14.30	13.50	0.29
96	10	0.28	14.32	68.2	53.9	21	68.5	14.32	13.53	0.29
97	10	0.28	14.32	68.4	61.6	20	67.9	14.32	13.54	0.28
98	10	0.28	14.32	68.4	69.3	20	67.9	14.31	13.56	0.28
99	10	0.28	14.32	68.2	77.0	20	67.4	14.27	13.56	0.27
100	10	0.28	14.32	68.0	84.7	21	68.2	14.27	13.62	0.26
101	10	0.28	14.32	68.0	92.4	22	68.0	14.28	13.64	0.26
102	10	0.28	14.32	68.0	53.9	21	68.6	14.32	13.52	0.29

TABLE D-2

EXISTING INLET PRESWIRL VANE DATA

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	TT	PT	PS	M#
0	0	0.28	14.19	46.7	53.9	19	48.1	14.14	13.38	0.28
1	0	0.28	14.19	46.4	54.6	19	49.4	14.15	13.41	0.28
2	0	0.28	14.19	46.4	7.7	22	47.9	14.06	13.36	0.27
3	0	0.28	14.19	46.5	15.4	20	47.7	14.13	13.38	0.28
4	0	0.28	14.19	46.5	23.1	20	48.0	14.16	13.37	0.29
5	0	0.28	14.19	46.4	30.8	20	48.0	14.14	13.37	0.28
6	0	0.28	14.19	46.3	38.5	19	48.5	14.14	13.37	0.28
7	0	0.28	14.19	46.2	46.2	19	48.0	14.14	13.37	0.28
8	0	0.28	14.19	46.2	54.0	19	48.5	14.15	13.42	0.28
9	0	0.28	14.19	46.2	61.6	18	48.0	14.16	13.41	0.28
10	0	0.28	14.19	46.2	69.3	17	48.8	14.17	13.42	0.28
11	0	0.28	14.19	46.2	77.0	16	48.7	14.18	13.46	0.27
12	0	0.28	14.19	46.2	84.7	17	48.9	14.12	13.49	0.26
13	0	0.28	14.19	46.2	92.4	18	49.5	14.07	13.53	0.24
14	0	0.54	14.47	33.2	53.9	19	27.2	14.29	11.70	0.54
15	0	0.54	14.47	33.1	7.7	21	26.7	14.07	11.62	0.53
16	0	0.54	14.47	32.8	15.4	20	27.7	14.28	11.61	0.55
17	0	0.54	14.47	33.1	23.1	20	28.0	14.32	11.67	0.55
18	0	0.54	14.47	33.1	30.8	20	27.4	14.31	11.69	0.55
19	0	0.54	14.47	33.2	38.5	20	27.3	14.31	11.71	0.54
20	0	0.54	14.47	32.8	46.1	20	28.5	14.28	11.75	0.53
21	0	0.54	14.47	33.1	54.0	19	27.5	14.29	11.75	0.54
22	0	0.54	14.47	33.3	61.6	19	29.0	14.42	11.92	0.53
23	0	0.54	14.47	32.8	69.3	18	28.3	14.41	11.92	0.53
24	0	0.54	14.47	32.6	76.9	16	28.3	14.35	11.95	0.52
25	0	0.54	14.47	33.1	84.6	17	30.4	14.14	12.05	0.48
26	0	0.54	14.47	33.2	92.3	17	29.8	13.99	12.13	0.46
27	0	0.54	14.47	33.4	53.9	19	28.0	14.28	11.80	0.53
28	0	0.45	14.47	33.7	53.9	19	29.8	14.33	12.42	0.46
29	0	0.45	14.47	34.4	7.7	21	30.4	14.20	12.39	0.45
30	0	0.45	14.47	33.9	15.4	20	30.6	14.34	12.37	0.46
31	0	0.45	14.47	34.1	23.1	20	30.2	14.35	12.39	0.46
32	0	0.45	14.47	34.0	30.8	20	29.0	14.35	12.40	0.46
33	0	0.45	14.47	33.6	38.4	20	28.1	14.34	12.45	0.45
34	0	0.45	14.47	33.7	46.1	20	30.1	14.32	12.44	0.45
35	0	0.45	14.47	34.0	53.9	19	30.2	14.36	12.53	0.45
36	0	0.45	14.47	34.1	61.6	19	31.9	14.40	12.58	0.44
37	0	0.45	14.47	34.5	69.3	17	31.9	14.43	12.65	0.44
38	0	0.45	14.47	34.6	77.0	17	30.3	14.42	12.63	0.44
39	0	0.45	14.47	34.5	84.6	17	31.6	14.19	12.63	0.41
40	0	0.45	14.47	33.9	92.4	18	31.2	14.16	12.83	0.38
41	0	0.45	14.47	34.2	53.9	19	30.7	14.32	12.50	0.45
42	0	0.36	14.47	35.2	53.9	19	32.9	14.39	13.18	0.36
43	0	0.36	14.47	35.3	7.7	21	32.6	14.28	13.14	0.35
44	0	0.36	14.47	35.4	15.5	20	32.9	14.37	13.12	0.36
45	0	0.36	14.47	35.4	23.1	20	31.8	14.40	13.12	0.37
46	0	0.36	14.47	35.7	30.8	20	32.9	14.39	13.13	0.36
47	0	0.36	14.47	35.8	38.5	19	33.1	14.38	13.15	0.36
48	0	0.36	14.47	36.0	46.2	19	33.8	14.38	13.17	0.36
49	0	0.36	14.47	35.8	53.9	19	32.7	14.40	13.18	0.36
50	0	0.36	14.47	35.6	61.6	18	33.2	14.41	13.22	0.35
51	0	0.36	14.47	35.8	69.3	17	32.9	14.45	13.27	0.35
52	0	0.36	14.47	36.1	77.0	16	34.5	14.45	13.29	0.35
53	0	0.36	14.47	36.4	84.7	17	34.8	14.35	13.33	0.32
54	0	0.36	14.47	36.5	92.4	18	36.5	14.25	13.38	0.30
55	0	0.36	14.47	36.5	53.9	19	33.8	14.39	13.21	0.35

*** CALIBRATION INFORMATION ***

	TRANSDUCERS 0-1 PSID	TRANSDUCERS 0-5 PSID
Y-INTERCEPT (PSI)	0.059	0.004
% CHANGE DURING DATA AQUISITION	0.014	0.004
SLOPE (PSI/VOLT)	0.397	0.791
% CHANGE DURING DATA AQUISITION	0.004	-0.016

	TRAVERSES WEDGE PROBE	TRAVERSES HOT WIRE
RADIAL POS. (% SPAN)	23.1	94.8
% CHANGE DURING DATA AQUISITION	-0.03	-0.00
ROTATIONAL ANGLE (0=AXIAL)	20	-64
% CHANGE DURING DATA AQUISITION	0.00	-0.03

*** INLET PROFILE DATA ***

2.5 POSITION MIDSPAN MACH #= 0.54

POINT #= 206 DATE: 05-05-82 TIME: 10:13:09

PATM= 14.40 PSIA TATM= 75.8 F

	WEDGE PROBE (PSID)			STATIC TAPS (PSID)		HOT WIRE (VOLTS)	
	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5	DC	AC
MAX.	0.023	2.493	0.023	1.297	2.781	0.000	0.001
MIN.	0.015	2.455	-0.004	1.267	2.736	-0.000	0.000
STD DEV.	0.001	0.009	0.005	0.007	0.012	0.000	0.000
AVG.	0.018	2.476	0.004	1.280	2.761	-0.000	0.000

REDUCED DATA

VANE ANGLE=	5.0
% SPAN	23.1
TT=	71.9
PT=	14.38
PS=	11.65
MACH #=	0.56
SWIRL ANGLE=	20

Figure D-5. Sample of Existing Inlet Preswirl Vane Test Output

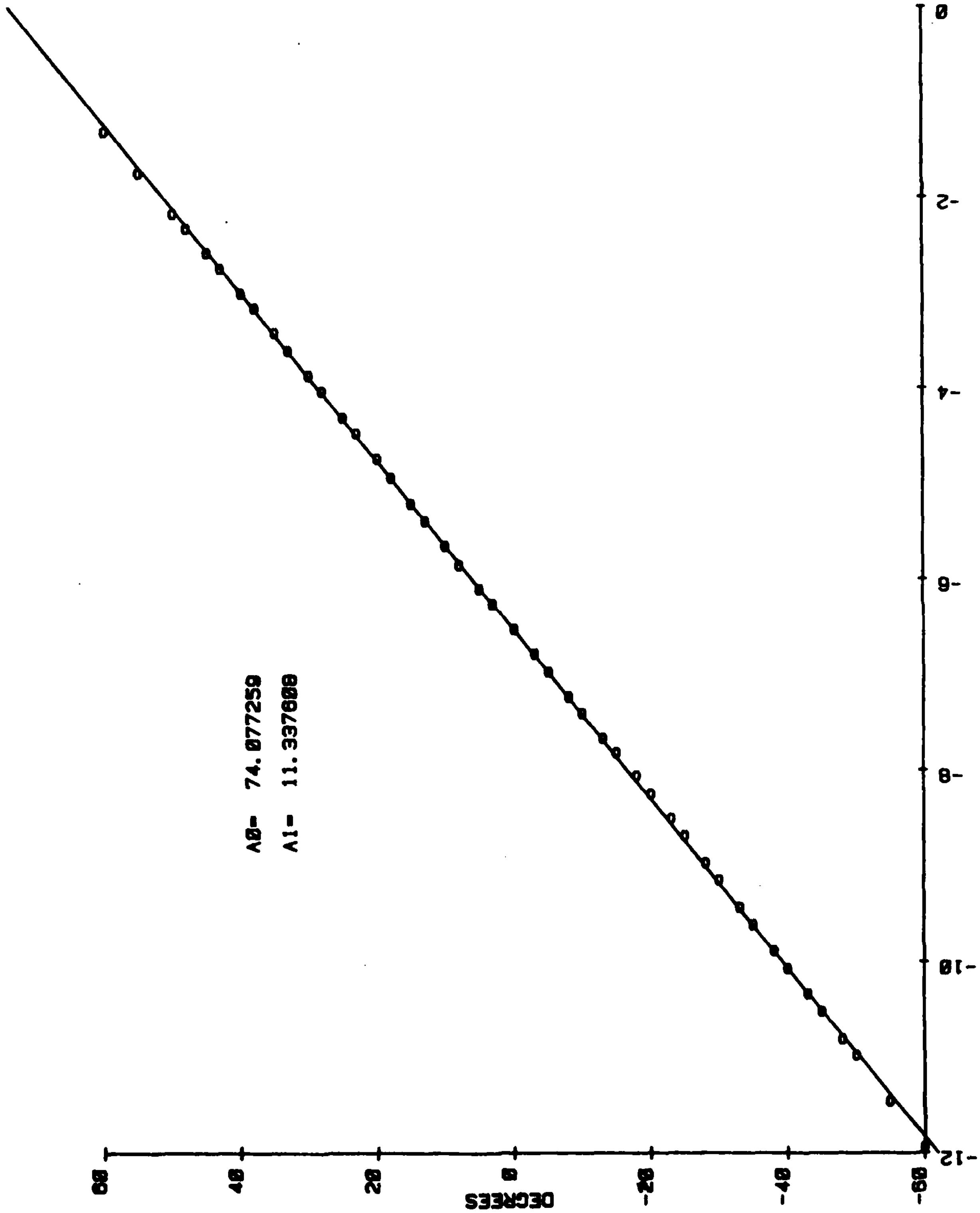


Figure D-4. Traverse Radial Calibration (S/N ER165262)

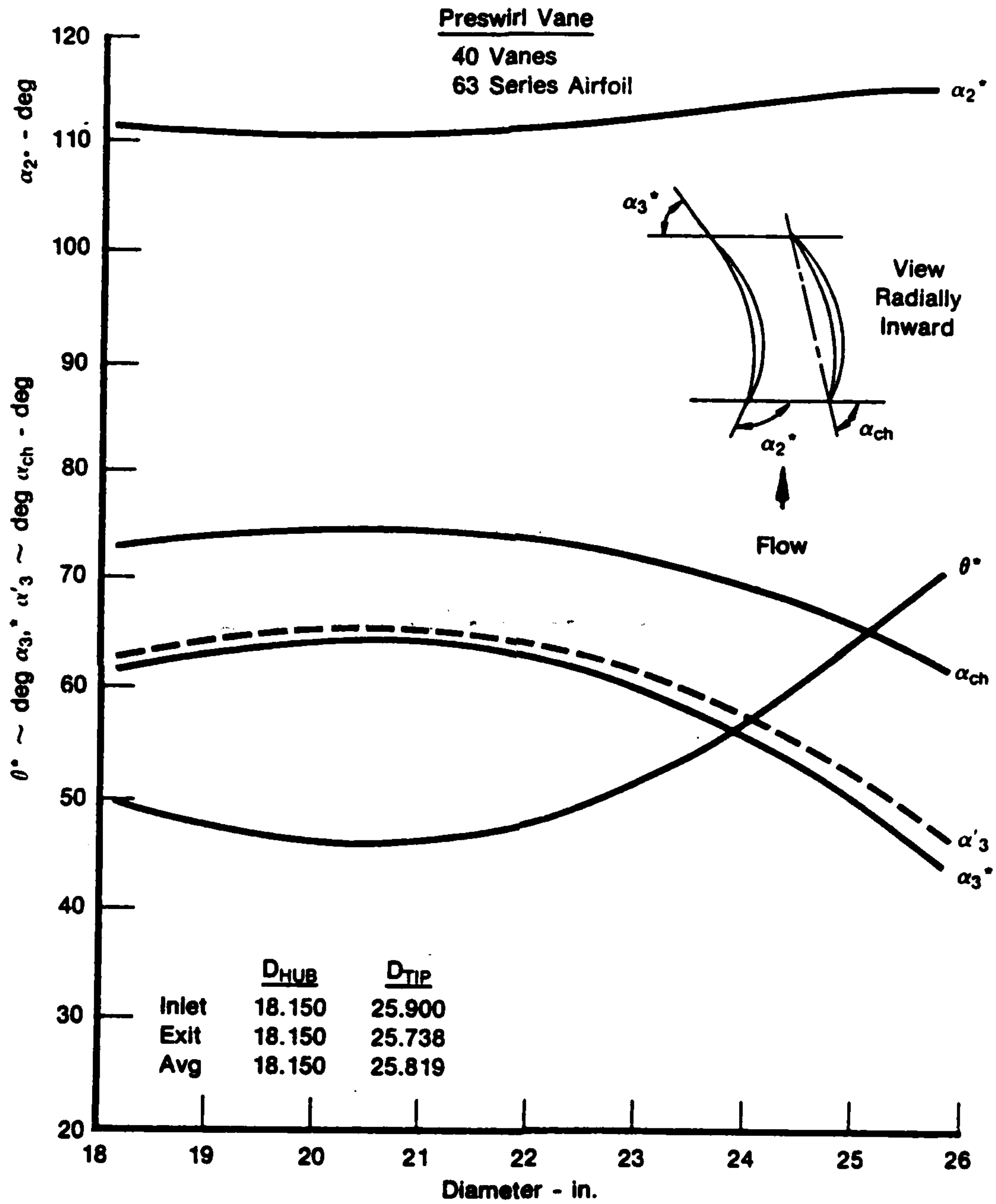


Figure E-2. CRF/F100 HPC Rig, Preswirl Vane Geometry (I)

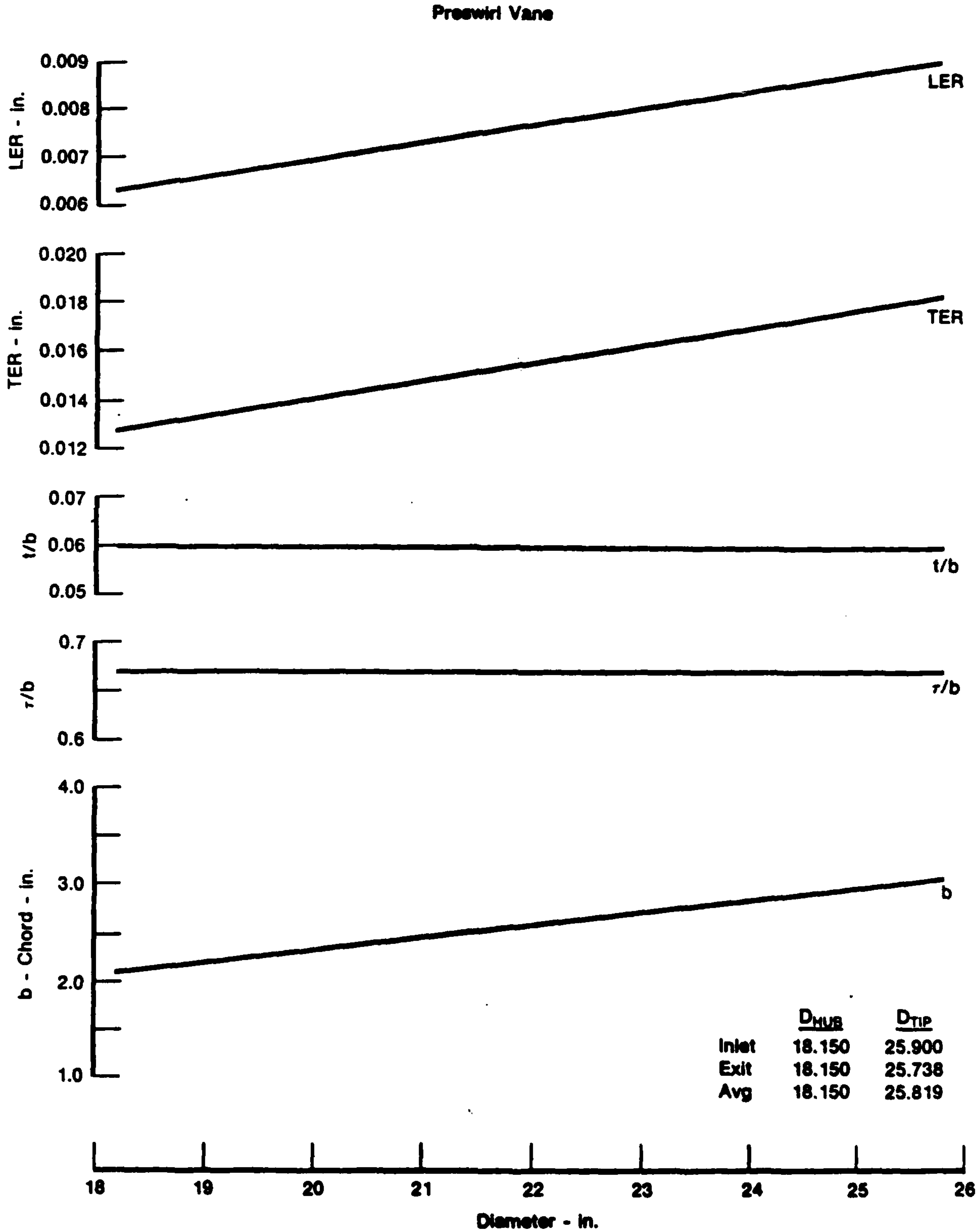


Figure E-3. CRF/F100 HPC Rig, Preswirl Vane Geometry (II)

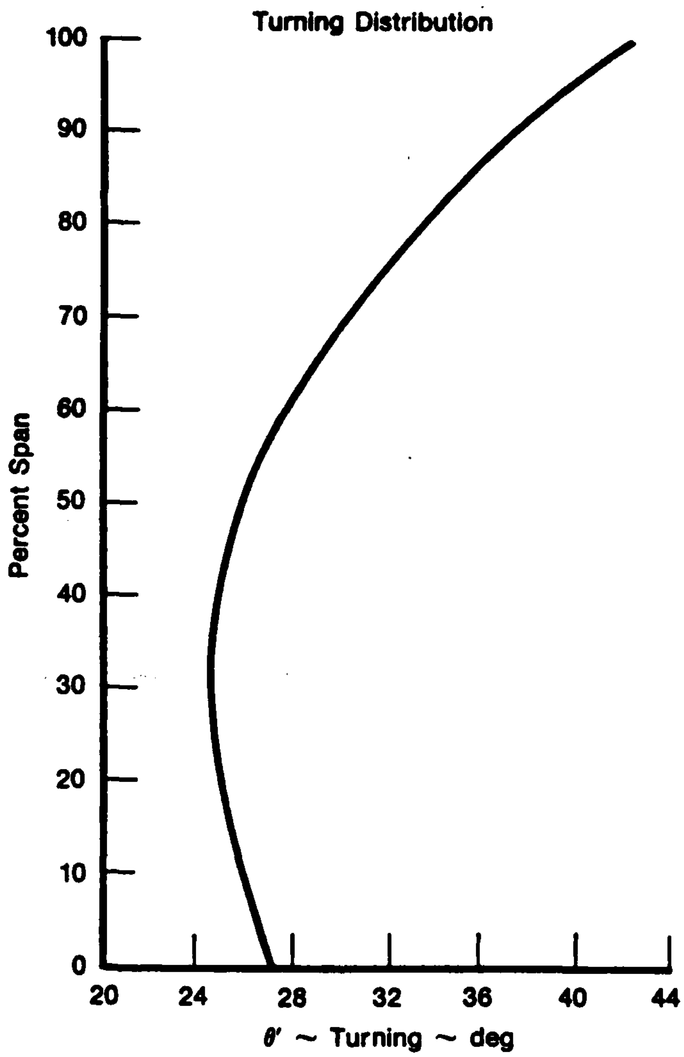


Figure E-4. CRF/F100 Preswirl Vane, Turning Distribution

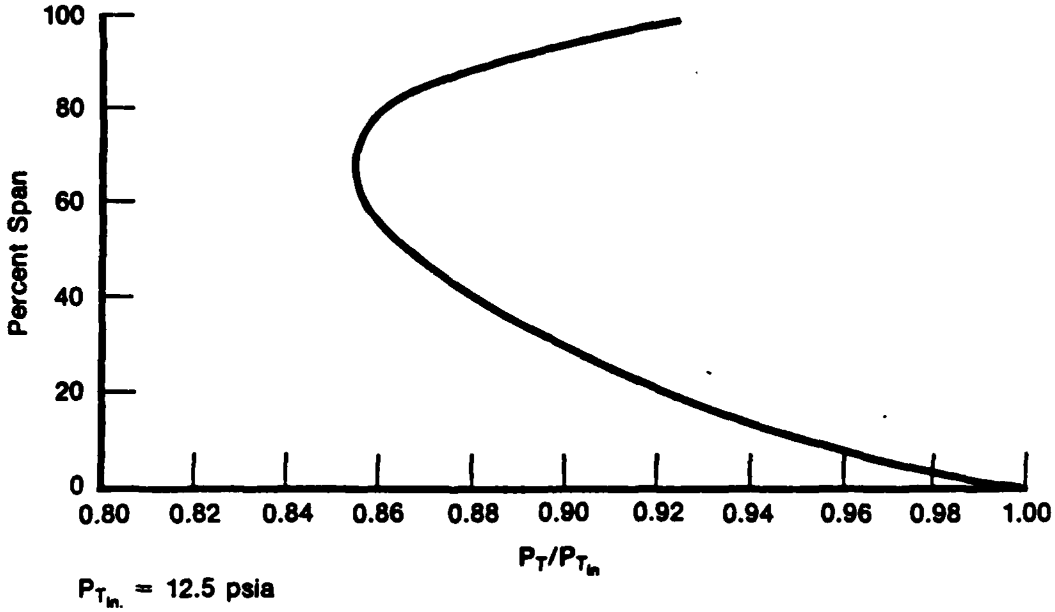


Figure E-5. CRF/F100 Compressor Rig Inlet, Screen Discharge Pressure Profile at Design Flow

*** CALIBRATION INFORMATION ***

	TRANSDUCERS			TRAVERSES	
	0-1 PSID	0-5 PSID		WEDGE PROBE	HOT WIRE
Y-INTERCEPT (PSI)	0.050	0.001	RADIAL POS. (% SPAN)	23.1	24.0
% CHANGE DURING DATA AQUISITION	-0.004	-0.001	% CHANGE DURING DATA AQUISITION	0.02	-0.02
SLOPE (PSI/VOLT)	0.398	0.789	ROTATIONAL ANGLE (0=AXIAL)	19.7	-42.7
% CHANGE DURING DATA AQUISITION	0.033	-0.093	% CHANGE DURING DATA AQUISITION	0.01	0.02

*** INLET PROFILE DATA ***

2.5 POSITION MIDSPAN MACH #= 0.54

POINT #= 686 DATE: 09-13-82 TIME: 09:25:24

PATM= 14.37 PSIA TATM= 75.7 F

	WEDGE PROBE(PSID)			STATIC TAPS(PSID)		HOT WIRE(VOLTS)	
	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5	DC	AC
MAX.	2.185	2.697	0.016	0.717	5.201	4.373	0.236
MIN.	2.096	2.617	0.008	0.713	5.180	4.295	0.207
STD DEV.	0.022	0.021	0.002	0.001	0.005	0.022	0.008
AVG.	2.142	2.665	0.013	0.715	5.193	4.330	0.220

REDUCED DATA

VANE ANGLE=	20.0	PT RAKE=	11.35
% SPAN	23.1	MDOT=	40.2
TT=	72.6	CMDOT=	52.9
PT=	12.24		
PS=	9.31		
MACH #=	0.64		
SWIRL ANGLE=	20		

Figure E-6. Modified Preswirl Vane Test (Phase I) Sample Output

TABLE E-1

MODIFIED PRESWIRL VANE TEST PHASE I DATA

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#
670	20	0.28	14.42	74.5	7.8	19.8	13.94	12.79	0.35
671	20	0.28	14.42	74.9	15.4	20.0	13.95	12.78	0.35
672	20	0.28	14.42	75.6	23.1	20.2	13.83	12.78	0.34
673	20	0.28	14.42	75.9	30.8	20.3	13.65	12.80	0.30
674	20	0.28	14.42	76.5	38.5	19.7	13.56	12.81	0.29
675	20	0.28	14.42	75.7	46.2	19.5	13.52	12.82	0.28
676	20	0.28	14.42	75.4	54.0	22.0	13.54	12.82	0.28
677	20	0.28	14.42	75.9	61.6	24.7	13.62	12.86	0.29
678	20	0.28	14.42	76.0	69.3	25.9	13.61	12.86	0.28
679	20	0.28	14.42	75.9	77.0	25.9	13.49	12.88	0.26
680	20	0.28	14.42	75.9	84.7	26.6	13.38	12.90	0.23
681	20	0.28	14.42	75.9	92.4	28.5	13.36	12.92	0.22
684	20	0.54	14.37	75.0	7.7	19.8	12.41	9.34	0.65
685	20	0.54	14.37	75.5	15.4	19.7	12.53	9.30	0.67
686	20	0.54	14.37	75.7	23.1	19.7	12.24	9.31	0.64
687	20	0.54	14.37	75.5	30.8	19.4	11.62	9.28	0.58
688	20	0.54	14.37	75.7	38.5	18.1	11.43	9.26	0.56
689	20	0.54	14.37	75.7	46.3	18.1	11.36	9.29	0.54
690	20	0.54	14.37	75.9	54.0	21.3	11.42	9.33	0.54
691	20	0.54	14.37	76.1	61.7	24.5	11.64	9.37	0.56
692	20	0.54	14.37	76.0	69.4	25.6	11.76	9.43	0.57
693	20	0.54	14.37	76.4	77.0	24.9	11.68	9.46	0.56
694	20	0.54	14.37	76.6	84.7	25.0	11.28	9.50	0.50
695	20	0.54	14.37	77.0	92.4	26.1	10.97	9.57	0.45
702	20	0.45	14.34	72.7	7.7	19.7	13.09	10.64	0.55
703	20	0.45	14.34	72.5	15.4	20.0	13.07	10.62	0.55
704	20	0.45	14.34	72.4	23.1	20.2	12.77	10.61	0.52
705	20	0.45	14.34	72.3	30.8	19.9	12.42	10.63	0.48
706	20	0.45	14.34	72.4	38.5	18.2	12.28	10.65	0.46
707	20	0.45	14.34	72.7	46.2	18.7	12.21	10.67	0.44
708	20	0.45	14.34	73.0	53.9	21.8	12.28	10.69	0.45
709	20	0.45	14.34	72.7	61.6	24.7	12.47	10.74	0.47
710	20	0.45	14.34	72.6	69.3	25.8	12.54	10.76	0.47
711	20	0.45	14.34	72.7	77.0	25.6	12.44	10.79	0.46
712	20	0.45	14.34	72.8	84.6	25.6	12.15	10.86	0.40
713	20	0.45	14.34	73.1	92.4	26.9	11.91	10.89	0.36
716	15	0.54	14.34	74.1	7.7	18.8	12.52	9.22	0.68
717	15	0.54	14.34	74.7	15.5	16.9	12.66	9.25	0.68
718	15	0.54	14.34	74.7	23.1	16.0	12.76	9.28	0.69
719	15	0.54	14.34	75.2	30.8	16.8	12.49	9.27	0.67
720	15	0.54	14.34	75.0	38.5	18.3	12.37	9.25	0.66
721	15	0.54	14.34	75.3	46.2	19.8	11.95	9.21	0.62
722	15	0.54	14.34	75.1	53.9	21.1	11.19	9.19	0.54
723	15	0.54	14.34	75.3	61.6	22.5	10.87	9.20	0.50
724	15	0.54	14.34	75.6	69.3	24.2	10.83	9.23	0.48
725	15	0.54	14.34	75.9	77.0	25.8	10.76	9.28	0.47
726	15	0.54	14.34	76.0	84.7	27.3	10.67	9.35	0.44
727	15	0.54	14.34	76.0	92.4	29.3	10.64	9.42	0.42

TABLE E-1 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
730	15	0.45	14.33	83.4	7.7	18.3	12.97	10.37	0.57	2.5
731	15	0.45	14.33	83.9	15.4	16.6	13.13	10.40	0.59	2.5
732	15	0.45	14.33	84.2	23.1	15.8	13.24	10.43	0.59	2.5
733	15	0.45	14.33	83.9	30.8	16.8	13.05	10.46	0.57	2.5
734	15	0.45	14.33	84.1	38.5	18.4	12.90	10.43	0.56	2.5
735	15	0.45	14.33	83.8	46.2	20.0	12.55	10.42	0.52	2.5
736	15	0.45	14.33	83.6	53.9	21.4	11.95	10.43	0.45	2.5
737	15	0.45	14.33	83.7	61.6	22.6	11.70	10.45	0.41	2.5
738	15	0.45	14.33	83.9	69.3	24.7	11.65	10.46	0.39	2.5
739	15	0.45	14.33	83.9	77.0	26.1	11.60	10.50	0.38	2.5
740	15	0.45	14.33	84.5	84.7	27.6	11.54	10.56	0.36	2.5
741	15	0.45	14.33	84.6	92.4	29.5	11.51	10.61	0.34	2.5
744	10	0.54	14.33	83.8	7.7	17.6	12.26	8.81	0.70	2.5
745	10	0.54	14.33	84.1	15.4	16.0	12.03	8.71	0.69	2.5
746	10	0.54	14.33	84.4	23.1	15.6	11.38	8.67	0.64	2.5
747	10	0.54	14.33	83.9	30.8	16.2	10.99	8.63	0.60	2.5
748	10	0.54	14.33	83.5	38.5	17.3	10.83	8.64	0.58	2.5
749	10	0.54	14.33	83.8	46.2	18.8	10.69	8.67	0.56	2.5
750	10	0.54	14.33	83.8	53.9	20.6	10.61	8.68	0.54	2.5
751	10	0.54	14.33	83.7	61.6	21.9	10.59	8.69	0.54	2.5
752	10	0.54	14.33	83.3	69.3	23.7	10.57	8.73	0.53	2.5
753	10	0.54	14.33	83.3	77.0	24.8	10.55	8.79	0.52	2.5
754	10	0.54	14.33	83.9	84.7	25.5	10.51	8.87	0.50	2.5
755	10	0.54	14.33	83.9	92.4	25.8	10.50	8.96	0.48	2.5
758	10	0.45	14.39	63.6	7.7	16.9	12.86	10.04	0.60	2.5
759	10	0.45	14.39	63.5	15.4	15.8	12.76	10.01	0.60	2.5
760	10	0.45	14.39	63.8	23.1	16.3	12.28	9.99	0.55	2.5
761	10	0.45	14.39	64.1	30.8	16.8	11.91	10.00	0.51	2.5
762	10	0.45	14.39	64.8	38.5	17.3	11.74	9.99	0.49	2.5
763	10	0.45	14.39	64.8	46.2	18.4	11.61	10.00	0.47	2.5
764	10	0.45	14.39	64.6	54.0	20.4	11.51	10.02	0.45	2.5
765	10	0.45	14.39	64.8	61.6	22.1	11.47	10.04	0.44	2.5
766	10	0.45	14.39	65.2	69.3	23.8	11.42	10.06	0.43	2.5
767	10	0.45	14.39	65.5	77.0	25.0	11.37	10.11	0.41	2.5
768	10	0.45	14.39	65.5	84.7	26.0	11.28	10.13	0.40	2.5
769	10	0.45	14.39	66.0	92.4	26.6	11.22	10.19	0.37	2.5
772	5	0.54	14.26	62.9	7.7	15.2	11.87	8.93	0.65	2.5
773	5	0.54	14.26	62.8	15.4	14.0	12.24	8.91	0.69	2.5
774	5	0.54	14.26	62.6	23.1	13.7	12.36	8.98	0.69	2.5
775	5	0.54	14.26	62.6	30.8	14.3	12.21	8.99	0.68	2.5
776	5	0.54	14.26	62.3	38.5	15.6	11.93	8.96	0.65	2.5
777	5	0.54	14.26	62.2	46.2	17.8	11.40	8.90	0.61	2.5
778	5	0.54	14.26	62.3	53.9	20.5	10.87	8.90	0.54	2.5
779	5	0.54	14.26	62.1	61.6	23.2	10.71	8.88	0.52	2.5
780	5	0.54	14.26	61.7	69.4	24.2	10.69	8.89	0.52	2.5
781	5	0.54	14.26	62.2	77.0	24.5	10.73	8.96	0.51	2.5
782	5	0.54	14.26	61.9	84.7	25.0	10.76	9.07	0.50	2.5
783	5	0.54	14.26	61.8	92.4	26.5	10.75	9.15	0.48	2.5

TABLE E-1 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
787	5	0.45	14.26	62.3	7.7	14.8	12.57	10.06	0.57	2.5
788	5	0.45	14.26	62.2	15.5	13.7	12.83	10.07	0.60	2.5
789	5	0.45	14.26	62.7	23.1	13.5	12.87	10.11	0.60	2.5
790	5	0.45	14.26	62.9	30.8	14.1	12.73	10.13	0.58	2.5
791	5	0.45	14.26	63.4	38.5	15.6	12.46	10.11	0.55	2.5
792	5	0.45	14.26	63.7	46.2	18.0	11.98	10.07	0.50	2.5
793	5	0.45	14.26	64.1	53.9	20.8	11.59	10.08	0.45	2.5
794	5	0.45	14.26	64.5	69.3	24.2	11.51	10.13	0.43	2.5
795	5	0.45	14.26	64.4	61.6	23.4	11.48	10.07	0.44	2.5
796	5	0.45	14.26	64.4	77.0	24.4	11.56	10.20	0.43	2.5
797	5	0.45	14.26	64.3	84.7	25.3	11.58	10.29	0.41	2.5
798	5	0.45	14.26	64.5	92.4	26.2	11.56	10.33	0.40	2.5
801	15	0.28	14.32	58.4	7.7	18.0	13.80	12.81	0.33	2.5
802	15	0.28	14.32	58.5	15.4	16.9	13.87	12.82	0.34	2.5
803	15	0.28	14.32	58.3	23.1	16.3	13.92	12.83	0.34	2.5
804	15	0.28	14.32	58.2	30.8	16.8	13.91	12.86	0.34	2.5
805	15	0.28	14.32	58.1	38.5	18.4	13.84	12.86	0.33	2.5
806	15	0.28	14.32	58.1	46.2	20.4	13.77	12.87	0.31	2.5
807	15	0.28	14.32	58.0	54.0	21.7	13.56	12.86	0.28	2.5
808	15	0.28	14.32	57.9	61.6	22.9	13.38	12.88	0.23	2.5
809	15	0.28	14.32	57.9	69.3	24.7	13.34	12.89	0.22	2.5
810	15	0.28	14.32	58.0	77.0	26.1	13.32	12.89	0.22	2.5
811	15	0.28	14.32	57.9	84.7	28.2	13.30	12.92	0.20	2.5
812	15	0.28	14.32	58.0	92.4	30.9	13.30	12.95	0.20	2.5
815	10	0.28	14.32	58.3	7.0	16.4	13.78	12.31	0.40	2.5
816	10	0.28	14.32	58.2	15.4	16.2	13.52	12.29	0.37	2.5
817	10	0.28	14.32	58.1	23.1	16.5	13.28	12.28	0.34	2.5
818	10	0.28	14.32	58.3	30.8	16.8	13.14	12.29	0.31	2.5
819	10	0.28	14.32	58.3	38.5	17.9	13.10	12.30	0.30	2.5
820	10	0.28	14.32	58.4	46.2	19.7	13.06	12.30	0.29	2.5
821	10	0.28	14.32	58.3	53.9	21.3	13.02	12.32	0.28	2.5
822	10	0.28	14.32	58.4	61.6	22.7	12.99	12.33	0.27	2.5
823	10	0.28	14.32	58.3	69.3	24.2	12.96	12.34	0.26	2.5
824	10	0.28	14.32	58.3	77.0	25.2	12.93	12.36	0.26	2.5
825	10	0.28	14.32	58.3	84.7	26.2	12.90	12.38	0.24	2.5
826	10	0.28	14.32	58.4	92.4	27.9	12.86	12.39	0.23	2.5
828	0	0.54	14.24	59.7	7.7	15.2	12.23	8.90	0.69	2.5
	0	0.54	14.24	59.8	15.4	13.4	12.47	8.91	0.71	2.5
829	0	0.54	14.24	59.8	23.1	13.4	12.19	8.84	0.69	2.5
830	0	0.54	14.24	59.9	30.8	14.5	11.57	8.80	0.64	2.5
831	0	0.54	14.24	59.9	38.5	16.0	11.15	8.77	0.60	2.5
832	0	0.54	14.24	59.9	46.2	18.2	10.87	8.76	0.56	2.5
833	0	0.54	14.24	59.9	53.9	20.9	10.71	8.77	0.54	2.5
834	0	0.54	14.24	60.0	61.6	22.8	10.64	8.79	0.53	2.5
835	0	0.54	14.24	59.8	69.3	23.9	10.61	8.79	0.53	2.5
836	0	0.54	14.24	59.9	77.0	24.1	10.65	8.85	0.52	2.5
837	0	0.54	14.24	59.9	84.7	25.5	10.62	8.95	0.50	2.5
838	0	0.54	14.24	60.1	92.4	28.3	10.64	9.05	0.49	2.5

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
841	0	0.45	14.24	60.0	7.8	14.6	12.79	9.99	0.60	2.5
842	0	0.45	14.24	60.2	15.4	12.9	12.88	10.00	0.61	2.5
843	0	0.45	14.24	60.2	23.1	13.0	12.61	10.00	0.59	2.5
844	0	0.45	14.24	60.3	30.8	14.0	12.08	9.95	0.53	2.5
845	0	0.45	14.24	60.2	38.5	15.6	11.76	9.96	0.49	2.5
846	0	0.45	14.24	60.3	46.2	18.2	11.56	9.95	0.47	2.5
847	0	0.45	14.24	60.4	53.9	21.0	11.44	9.94	0.45	2.5
848	0	0.45	14.24	60.6	61.6	23.1	11.38	9.96	0.44	2.5
849	0	0.45	14.24	60.6	69.3	23.8	11.36	9.97	0.44	2.5
850	0	0.45	14.24	60.7	77.0	24.2	11.42	10.03	0.43	2.5
851	0	0.45	14.24	60.6	84.7	25.2	11.38	10.11	0.41	2.5
852	0	0.45	14.24	60.7	92.4	28.3	11.39	10.18	0.40	2.5
855	20	0.54	14.39	71.1	7.7	23.2	12.82	9.55	0.66	2.3
856	20	0.54	14.39	71.7	15.5	22.6	12.45	9.58	0.62	2.3
857	20	0.54	14.39	71.7	23.2	22.8	11.81	9.59	0.55	2.3
858	20	0.54	14.39	71.6	30.9	22.9	11.40	9.62	0.50	2.3
859	20	0.54	14.39	72.0	38.6	24.2	11.30	9.65	0.48	2.3
860	20	0.54	14.39	72.1	46.3	27.1	11.27	9.69	0.47	2.3
861	20	0.54	14.39	71.9	54.0	29.5	11.20	9.71	0.46	2.3
862	20	0.54	14.39	71.6	61.7	30.4	11.18	9.74	0.45	2.3
863	20	0.54	14.39	71.7	69.5	30.4	11.19	9.79	0.44	2.3
864	20	0.54	14.39	71.5	77.1	30.8	11.23	9.85	0.44	2.3
865	20	0.54	14.39	71.3	84.7	32.4	11.27	9.92	0.43	2.3
866	20	0.54	14.39	71.3	92.5	33.7	11.12	9.94	0.40	2.3
869	20	0.45	14.39	71.8	7.7	22.7	13.41	10.83	0.56	2.3
870	20	0.45	14.39	71.7	15.5	22.3	12.92	10.86	0.50	2.3
871	20	0.45	14.39	71.7	23.2	22.8	12.45	10.89	0.44	2.3
872	20	0.45	14.39	71.6	30.9	22.7	12.19	10.91	0.40	2.3
873	20	0.45	14.39	71.5	38.6	24.4	12.16	10.93	0.39	2.3
874	20	0.45	14.39	71.5	46.3	27.4	12.13	10.97	0.38	2.3
875	20	0.45	14.39	71.5	54.0	29.8	12.09	10.99	0.37	2.3
876	20	0.45	14.39	71.4	61.7	30.6	12.07	11.02	0.36	2.3
877	20	0.45	14.39	71.2	69.5	30.4	12.08	11.05	0.36	2.3
878	20	0.45	14.39	71.0	77.1	30.5	12.11	11.09	0.36	2.3
879	20	0.45	14.39	71.0	84.7	32.1	12.14	11.15	0.35	2.3
880	20	0.45	14.39	71.0	92.5	33.4	12.05	11.16	0.33	2.3
883	15	0.54	14.39	70.3	7.7	17.4	12.15	9.44	0.61	2.3
884	15	0.54	14.39	70.1	15.5	16.7	12.39	9.50	0.63	2.3
885	15	0.54	14.39	70.1	23.2	16.3	12.49	9.58	0.63	2.3
886	15	0.54	14.39	70.0	30.9	16.8	12.59	9.61	0.63	2.3
887	15	0.54	14.39	69.9	38.6	18.1	12.47	9.59	0.62	2.3
888	15	0.54	14.39	69.8	46.2	20.6	11.91	9.59	0.56	2.3
889	15	0.54	14.39	69.8	54.0	23.1	11.15	9.61	0.46	2.3
890	15	0.54	14.39	69.7	61.7	25.3	10.84	9.66	0.41	2.3
891	15	0.54	14.39	69.5	69.5	26.0	10.84	9.67	0.41	2.3
892	15	0.54	14.39	69.4	77.1	26.9	10.89	9.69	0.41	2.3
893	15	0.54	14.39	69.2	84.7	29.5	10.74	9.75	0.38	2.3
894	15	0.54	14.39	69.0	92.5	35.3	10.97	9.81	0.40	2.3

TABLE E-1 (Cont'd)

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
897	15	0.54	14.39	74.5	7.7	17.3	12.14	9.42	0.61	2.3
898	15	0.54	14.39	74.3	15.5	17.1	12.42	9.52	0.63	2.3
899	15	0.54	14.39	74.4	22.6	16.6	12.48	9.57	0.63	2.3
900	15	0.54	14.39	74.4	30.9	16.8	12.59	9.59	0.64	2.3
901	15	0.54	14.39	74.5	38.5	18.1	12.48	9.62	0.62	2.3
902	15	0.54	14.39	74.5	46.3	20.7	11.90	9.62	0.56	2.3
903	15	0.54	14.39	74.4	54.0	23.2	11.11	9.59	0.46	2.3
904	15	0.54	14.39	74.6	61.7	25.0	10.82	9.64	0.41	2.3
905	15	0.54	14.39	74.7	69.5	26.1	10.83	9.66	0.41	2.3
906	15	0.54	14.39	74.6	77.1	26.9	10.93	9.71	0.41	2.3
907	15	0.54	14.39	74.7	84.7	29.5	10.75	9.76	0.37	2.3
908	15	0.54	14.39	75.0	92.5	35.2	10.94	9.78	0.40	2.3
911	15	0.45	14.39	76.4	7.8	17.2	12.82	10.53	0.54	2.3
912	15	0.45	14.39	76.8	15.5	16.9	12.98	10.57	0.55	2.3
913	15	0.45	14.39	76.8	23.2	16.5	13.02	10.64	0.54	2.3
914	15	0.45	14.39	76.7	30.8	16.9	13.07	10.68	0.55	2.3
915	15	0.45	14.39	76.7	38.6	18.6	12.90	10.69	0.53	2.3
916	15	0.45	14.39	76.9	46.3	21.0	12.48	10.72	0.47	2.3
917	15	0.45	14.39	76.7	54.0	23.3	11.90	10.74	0.39	2.3
918	15	0.45	14.39	76.5	61.7	24.8	11.66	10.73	0.35	2.3
919	15	0.45	14.39	76.6	69.5	25.9	11.71	10.79	0.34	2.3
920	15	0.45	14.39	76.9	77.1	26.6	11.73	10.80	0.35	2.3
921	15	0.45	14.39	76.9	84.7	29.8	11.58	10.80	0.32	2.3
922	15	0.45	14.39	76.9	92.5	35.4	11.77	10,88	0.34	2.3
925	10	0.54	14.39	76.7	7.8	14.5	13.07	9.38	0.70	2.3
926	10	0.54	14.39	76.9	15.6	13.4	12.70	9.35	0.68	2.3
927	10	0.54	14.39	77.2	23.2	14.2	12.03	9.33	0.61	2.3
928	10	0.54	14.39	77.2	30.9	15.9	11.48	9.35	0.55	2.3
929	10	0.54	14.39	77.3	38.6	17.1	11.18	9.37	0.51	2.3
930	10	0.54	14.39	77.1	46.3	19.1	10.96	9.38	0.48	2.3
931	10	0.54	14.39	77.0	54.0	22.2	10.79	9.37	0.45	2.3
932	10	0.54	14.39	77.3	61.7	23.4	10.63	9.38	0.43	2.3
933	10	0.54	14.39	77.1	69.5	22.6	10.64	9.40	0.42	2.3
934	10	0.54	14.39	77.0	77.1	23.1	10.64	9.48	0.41	2.3
935	10	0.54	14.39	77.0	84.7	24.8	10.39	9.50	0.36	2.3
936	10	0.54	14.39	77.1	92.5	28.9	10.26	9.54	0.32	2.3
939	10	0.45	14.39	76.6	7.8	14.4	13.39	10.32	0.62	2.3
940	10	0.45	14.39	76.5	15.5	13.4	13.02	10.31	0.59	2.3
941	10	0.45	14.39	76.5	23.2	14.3	12.48	10.35	0.52	2.3
942	10	0.45	14.39	76.5	30.9	15.6	12.11	10.38	0.47	2.3
943	10	0.45	14.39	76.5	38.6	17.0	11.86	10.37	0.44	2.3
944	10	0.45	14.39	76.4	46.3	19.6	11.69	10.37	0.42	2.3
945	10	0.45	14.39	76.3	54.0	22.7	11.60	10.46	0.39	2.3
946	10	0.45	14.39	76.2	61.7	23.5	11.44	10.43	0.37	2.3
947	10	0.45	14.39	76.2	69.5	22.3	11.47	10.45	0.37	2.3
948	10	0.45	14.39	76.1	77.1	22.7	11.48	10.54	0.35	2.3
949	10	0.45	14.39	75.9	84.7	24.2	11.15	10.48	0.30	2.3
950	10	0.45	14.39	75.7	92.5	28.6	11.12	10.55	0.28	2.3

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
952	5	0.54	14.38	60.9	7.7	10.2	12.56	9.25	0.68	2.3
953	5	0.54	14.38	60.8	15.5	9.9	12.72	9.36	0.68	2.3
954	5	0.54	14.38	60.9	23.1	9.9	12.18	9.34	0.63	2.3
955	5	0.54	14.38	61.2	30.9	10.2	11.58	9.34	0.56	2.3
956	5	0.54	14.38	61.2	38.5	11.0	11.16	9.32	0.51	2.3
957	5	0.54	14.38	61.3	46.3	13.7	10.85	9.35	0.47	2.3
958	5	0.54	14.38	61.6	53.9	16.8	10.63	9.37	0.43	2.3
959	5	0.54	14.38	61.8	61.7	18.7	10.54	9.36	0.42	2.3
960	5	0.54	14.38	62.2	69.5	18.7	10.60	9.39	0.42	2.3
961	5	0.54	14.38	62.2	77.1	19.4	10.69	9.43	0.43	2.3
962	5	0.54	14.38	62.5	84.7	22.0	10.68	9.49	0.41	2.3
963	5	0.54	14.38	62.8	92.5	24.2	10.48	9.51	0.37	2.3
966	5	0.45	14.38	63.5	7.8	10.3	13.04	10.29	0.59	2.3
967	5	0.45	14.38	63.7	15.5	10.1	13.08	10.40	0.58	2.3
968	5	0.45	14.38	64.0	23.1	9.9	12.66	10.46	0.53	2.3
969	5	0.45	14.38	64.2	30.9	10.1	12.23	10.45	0.48	2.3
970	5	0.45	14.38	64.5	38.6	11.3	11.89	10.43	0.44	2.3
971	5	0.45	14.38	64.7	46.3	13.8	11.64	10.46	0.39	2.3
972	5	0.45	14.38	64.9	54.0	17.0	11.48	10.47	0.36	2.3
973	5	0.45	14.38	65.2	61.7	18.7	11.42	10.48	0.35	2.3
974	5	0.45	14.38	65.5	69.5	18.7	11.46	10.50	0.36	2.3
975	5	0.45	14.38	65.7	77.1	19.1	11.53	10.54	0.36	2.3
976	5	0.45	14.38	66.0	84.7	22.0	11.55	10.59	0.35	2.3
977	5	0.45	14.38	66.3	92.5	24.1	11.45	10.64	0.33	2.3
980	0	0.54	14.38	69.1	7.7	9.1	12.46	9.30	0.66	2.3
981	0	0.54	14.38	69.3	15.5	8.1	12.22	9.40	0.62	2.3
982	0	0.54	14.38	69.5	23.2	6.7	12.05	9.48	0.60	2.3
983	0	0.54	14.38	69.6	30.8	6.6	11.73	9.48	0.56	2.3
984	0	0.54	14.38	69.8	38.5	8.1	11.26	9.44	0.51	2.3
985	0	0.54	14.38	70.0	46.3	10.8	10.92	9.43	0.46	2.3
986	0	0.54	14.38	70.1	54.0	13.4	10.80	9.44	0.44	2.3
987	0	0.54	14.38	70.4	61.7	14.6	10.73	9.46	0.43	2.3
988	0	0.54	14.38	70.3	69.5	15.1	10.76	9.48	0.43	2.3
989	0	0.54	14.38	70.6	77.1	15.8	10.75	9.52	0.42	2.3
990	0	0.54	14.38	70.7	84.7	19.3	10.53	9.56	0.37	2.3
991	0	0.54	14.38	70.8	92.5	24.9	10.51	9.61	0.36	2.3
994	20	0.54	14.35	81.2	7.7	20.2	12.56	9.51	0.64	2.5
995	20	0.54	14.35	80.7	15.4	19.1	12.17	9.47	0.61	2.5
996	20	0.54	14.35	80.9	23.2	18.3	11.57	9.41	0.55	2.5
997	20	0.54	14.35	81.0	30.8	16.0	11.43	9.42	0.53	2.5
998	20	0.54	14.35	80.7	38.5	16.8	11.32	9.43	0.52	2.5
999	20	0.54	14.35	79.9	46.2	22.1	11.36	9.47	0.52	2.5
1000	20	0.54	14.35	80.2	53.9	24.9	11.34	9.50	0.51	2.5
1001	20	0.54	14.35	80.8	61.6	23.9	11.26	9.52	0.49	2.5
1002	20	0.54	14.35	80.9	69.3	23.9	11.20	9.56	0.48	2.5
1003	20	0.54	14.35	80.9	77.0	24.9	11.14	9.60	0.46	2.5
1004	20	0.54	14.35	80.6	84.7	26.5	11.06	9.68	0.44	2.5
1005	20	0.54	14.35	80.5	92.3	28.0	11.05	9.75	0.43	2.5

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
1008	15	0.54	14.34	67.0	7.7	19.4	12.13	8.78	0.70	2.5
1009	15	0.54	14.34	67.0	15.4	17.6	12.37	8.79	0.72	2.5
1010	15	0.54	14.34	66.6	23.1	16.5	12.48	8.84	0.72	2.5
1011	15	0.54	14.34	66.6	30.8	15.9	12.57	8.85	0.73	2.5
1012	15	0.54	14.34	66.6	38.5	16.7	12.30	8.81	0.71	2.5
1013	15	0.54	14.34	66.6	46.2	18.7	11.55	8.75	0.64	2.5
1014	15	0.54	14.34	66.6	53.9	20.3	10.91	8.73	0.57	2.5
1015	15	0.54	14.34	66.6	61.6	21.6	10.70	8.76	0.54	2.5
1016	15	0.54	14.34	66.6	69.3	22.7	10.59	8.77	0.53	2.5
1017	15	0.54	14.34	66.5	77.0	24.1	10.58	8.82	0.52	2.5
1018	15	0.54	14.34	66.6	84.7	25.6	10.64	8.91	0.51	2.5
1019	15	0.54	14.34	66.6	92.4	25.6	10.64	8.99	0.50	2.5
1022	0	0.45	14.34	67.2	7.7	9.6	13.04	10.38	0.58	2.3
1023	0	0.45	14.34	67.2	15.5	9.0	12.79	10.46	0.54	2.3
1024	0	0.45	14.34	67.4	23.2	8.3	12.58	10.52	0.51	2.3
1025	0	0.45	14.34	67.3	30.8	8.3	12.23	10.53	0.47	2.3
1026	0	0.45	14.34	67.3	38.5	9.6	11.87	10.51	0.42	2.3
1027	0	0.45	14.34	67.6	46.3	12.2	11.69	10.53	0.39	2.3
1028	0	0.45	14.34	67.7	54.0	14.4	11.59	10.54	0.37	2.3
1029	0	0.45	14.34	67.8	61.6	15.4	11.53	10.54	0.36	2.3
1030	0	0.45	14.34	67.9	69.5	16.0	11.55	10.58	0.36	2.3
1031	0	0.45	14.34	68.0	77.1	16.9	11.53	10.60	0.35	2.3
1032	0	0.45	14.34	68.0	84.7	19.8	11.37	10.64	0.31	2.3
1033	0	0.45	14.34	68.2	92.5	24.8	11.35	10.67	0.30	2.3
1036	20	0.54	14.33	73.4	7.8	20.2	12.53	9.14	0.69	2.5
1037	20	0.54	14.33	73.4	15.4	19.9	12.36	9.09	0.68	2.5
1038	20	0.54	14.33	73.3	23.1	19.8	11.70	9.05	0.62	2.5
1039	20	0.54	14.33	73.7	30.8	18.0	11.37	9.06	0.58	2.5
1040	20	0.54	14.33	73.1	38.5	16.6	11.53	9.09	0.59	2.5
1041	20	0.54	14.33	73.4	46.2	14.7	11.40	9.10	0.58	2.5
1042	20	0.54	14.33	73.5	53.9	19.7	11.12	9.14	0.54	2.5
1043	20	0.54	14.33	73.8	61.6	25.0	11.31	9.19	0.55	2.5
1044	20	0.54	14.33	73.8	69.3	27.7	11.47	9.23	0.57	2.5
1045	20	0.54	14.33	73.8	77.0	26.0	11.42	9.25	0.56	2.5
1046	20	0.54	14.33	73.9	84.7	26.0	11.13	9.33	0.51	2.5
1047	20	0.54	14.33	73.9	92.4	27.6	10.76	9.38	0.45	2.5
1050	20	0.51	14.33	74.6	7.7	19.9	12.70	9.43	0.67	2.5
1051	20	0.51	14.33	74.8	15.4	19.8	12.43	9.34	0.65	2.5
1052	20	0.51	14.33	75.2	23.1	19.9	11.84	9.32	0.59	2.5
1053	20	0.51	14.33	75.5	30.8	18.1	11.59	9.33	0.57	2.5
1054	20	0.51	14.33	75.5	38.5	15.1	11.74	9.36	0.58	2.5
1055	20	0.51	14.33	75.2	46.2	15.2	11.54	9.37	0.55	2.5
1056	20	0.51	14.33	75.2	53.9	19.1	11.29	9.40	0.52	2.5
1057	20	0.51	14.33	75.4	61.6	24.8	11.50	9.47	0.53	2.5
1058	20	0.51	14.33	75.3	69.3	27.8	11.65	9.52	0.55	2.5
1059	20	0.51	14.33	75.2	77.1	26.3	11.61	9.56	0.53	2.5
1060	20	0.51	14.33	75.3	84.6	26.1	11.28	9.58	0.49	2.5
1061	20	0.51	14.33	75.6	92.4	27.4	10.94	9.66	0.43	2.5

PT #	VANE ANGLE	MIDSPAN M#	PATM	TATM	% SPAN	SWIRL ANGLE	PT	PS	M#	STA
1064	15	0.54	14.35	66.6	7.8	19.1	12.50	9.35	0.66	2.5
1065	15	0.54	14.35	66.8	15.4	16.6	12.73	9.37	0.68	2.5
1066	15	0.54	14.35	66.7	23.2	16.6	12.71	9.37	0.68	2.5
1067	15	0.54	14.35	66.6	30.8	17.7	12.25	9.35	0.63	2.5
1068	15	0.54	14.35	66.7	38.5	18.6	12.07	9.33	0.62	2.5
1069	15	0.54	14.35	66.7	46.2	20.4	12.01	9.29	0.62	2.5
1070	15	0.54	14.35	66.8	53.9	22.2	11.31	9.29	0.54	2.5
1071	15	0.54	14.35	67.0	61.7	24.0	10.90	9.30	0.48	2.5
1072	15	0.54	14.35	66.9	69.4	26.1	10.85	9.34	0.47	2.5
1073	15	0.54	14.35	67.3	77.0	27.0	10.80	9.38	0.45	2.5
1074	15	0.54	14.35	67.3	84.7	27.6	10.72	9.44	0.43	2.5
1075	15	0.54	14.35	67.4	92.4	28.5	10.66	9.50	0.41	2.5

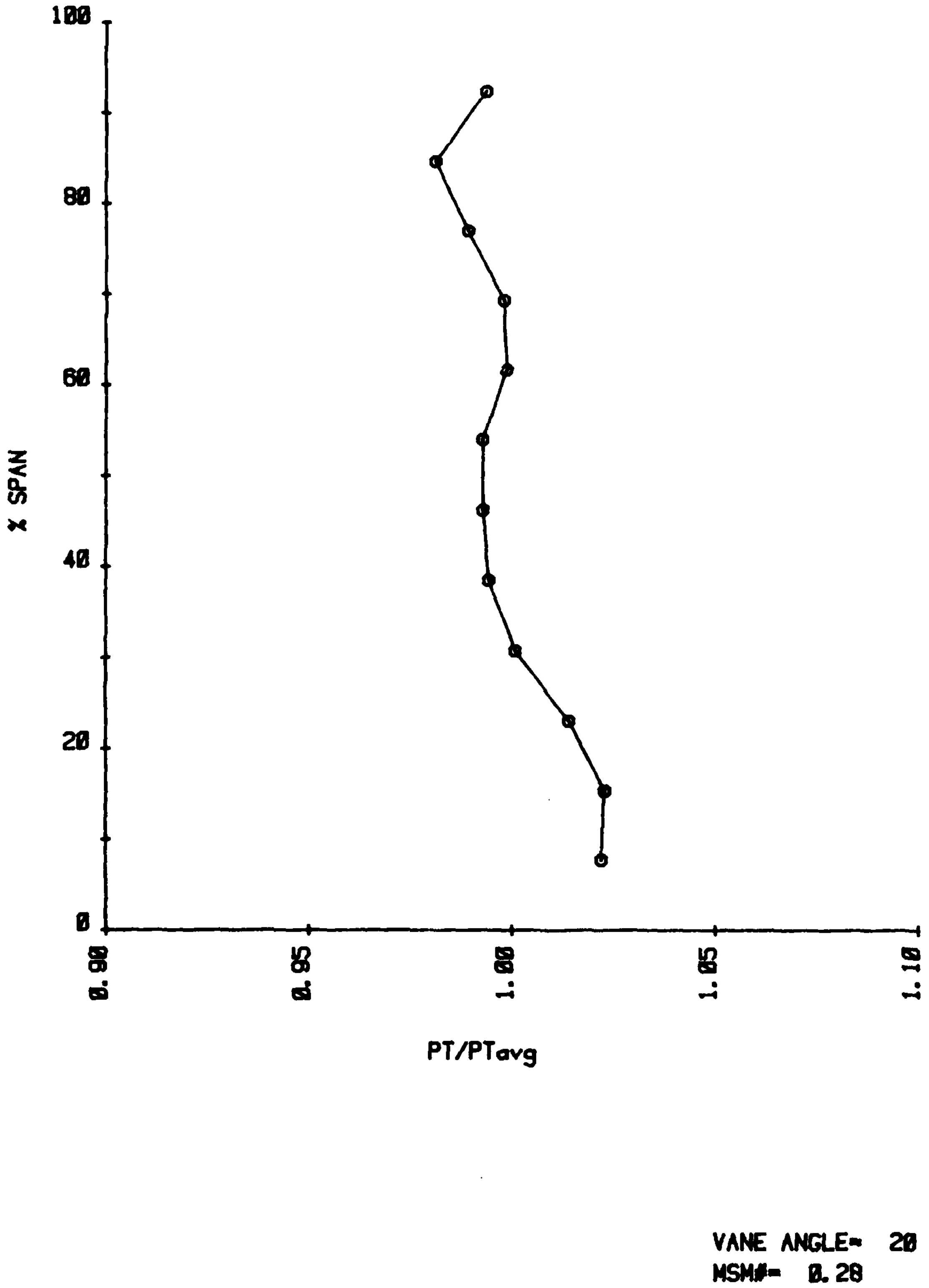
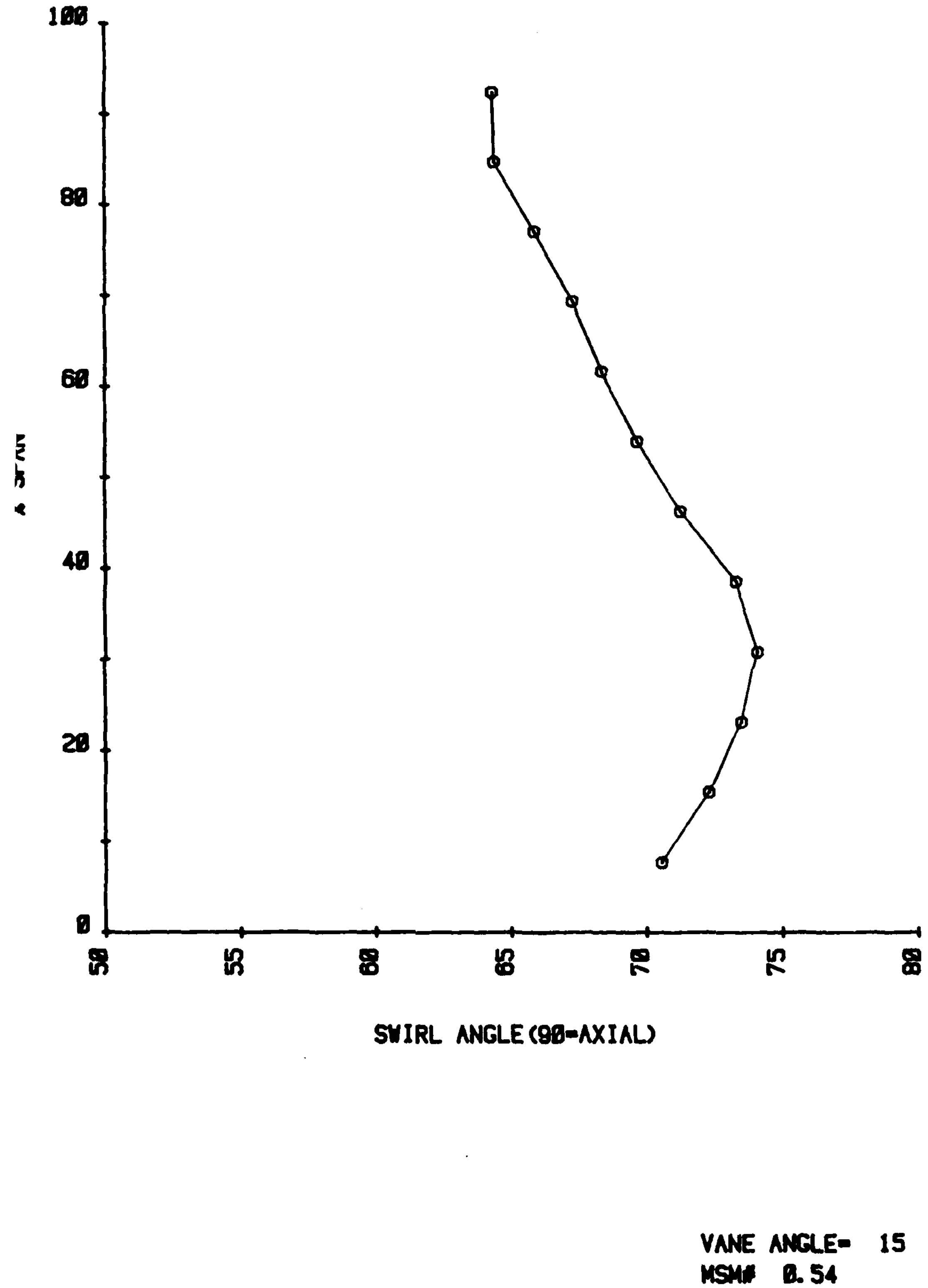


Figure E-7. Total Pressure Profile, Station 2.5 (Phase I), PSV=20^{0}, Low Flow



re E-21. Swirl Profile, Station 2.5 (Phase I), PSV=15^{o}, Mach Number = .54, Octant 1

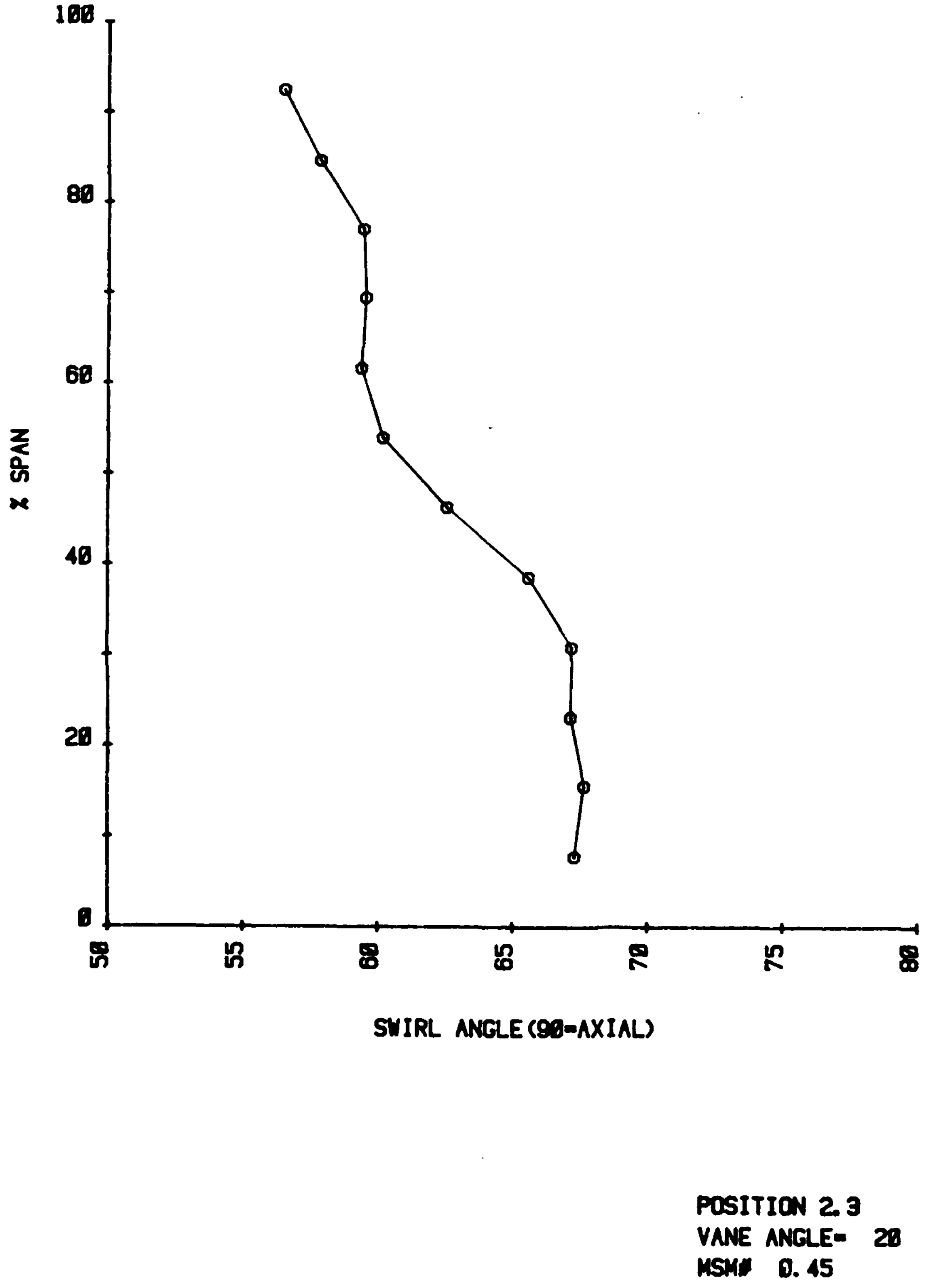


Figure E-20. Swirl Profile, Station 2.3 (Phase I), PSV=20^{0}, Mach Number = .45

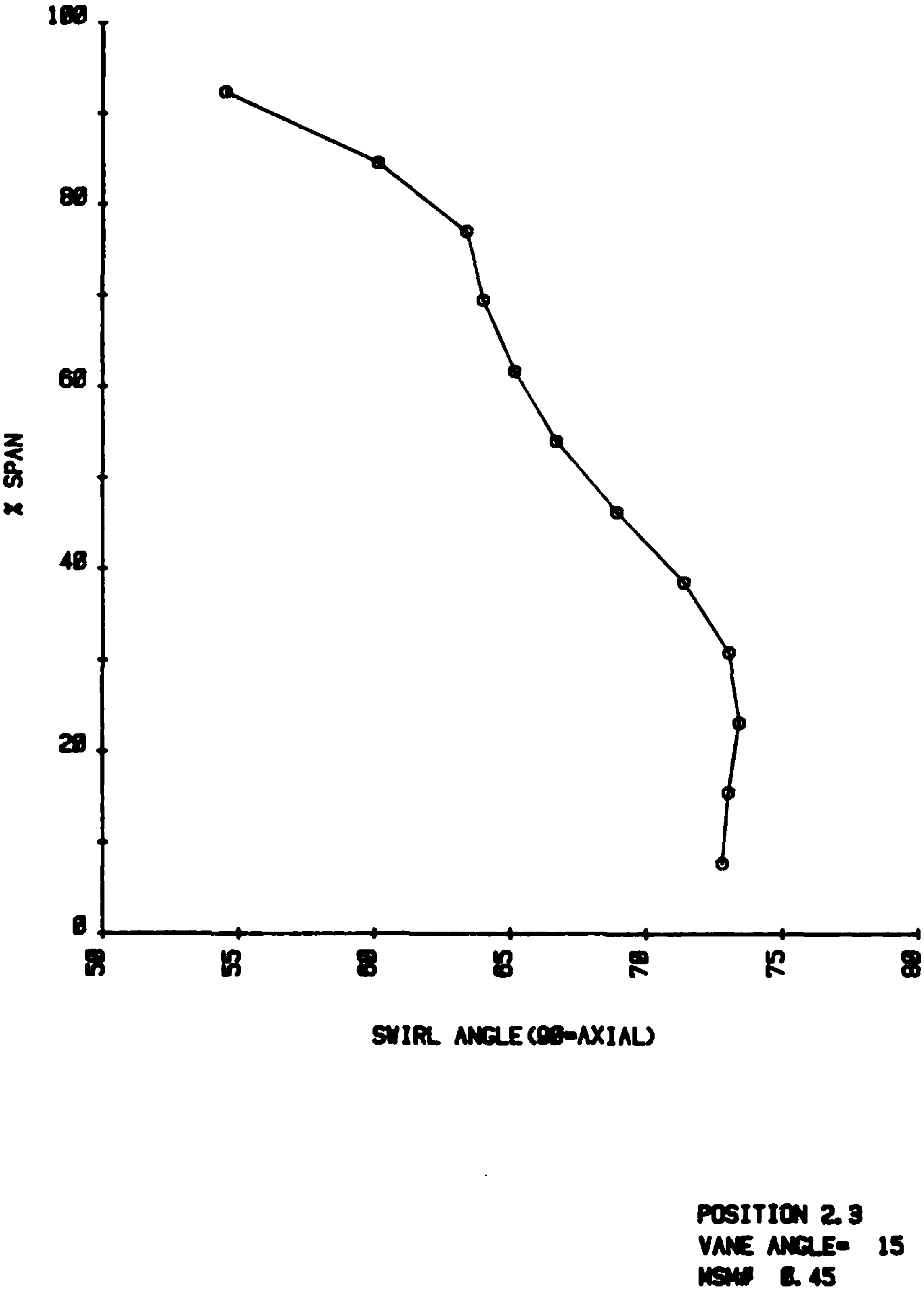


Figure E-19. Swirl Profile, Station 2.3 (Phase I), PSV=15^{O}, Mach Number = .45

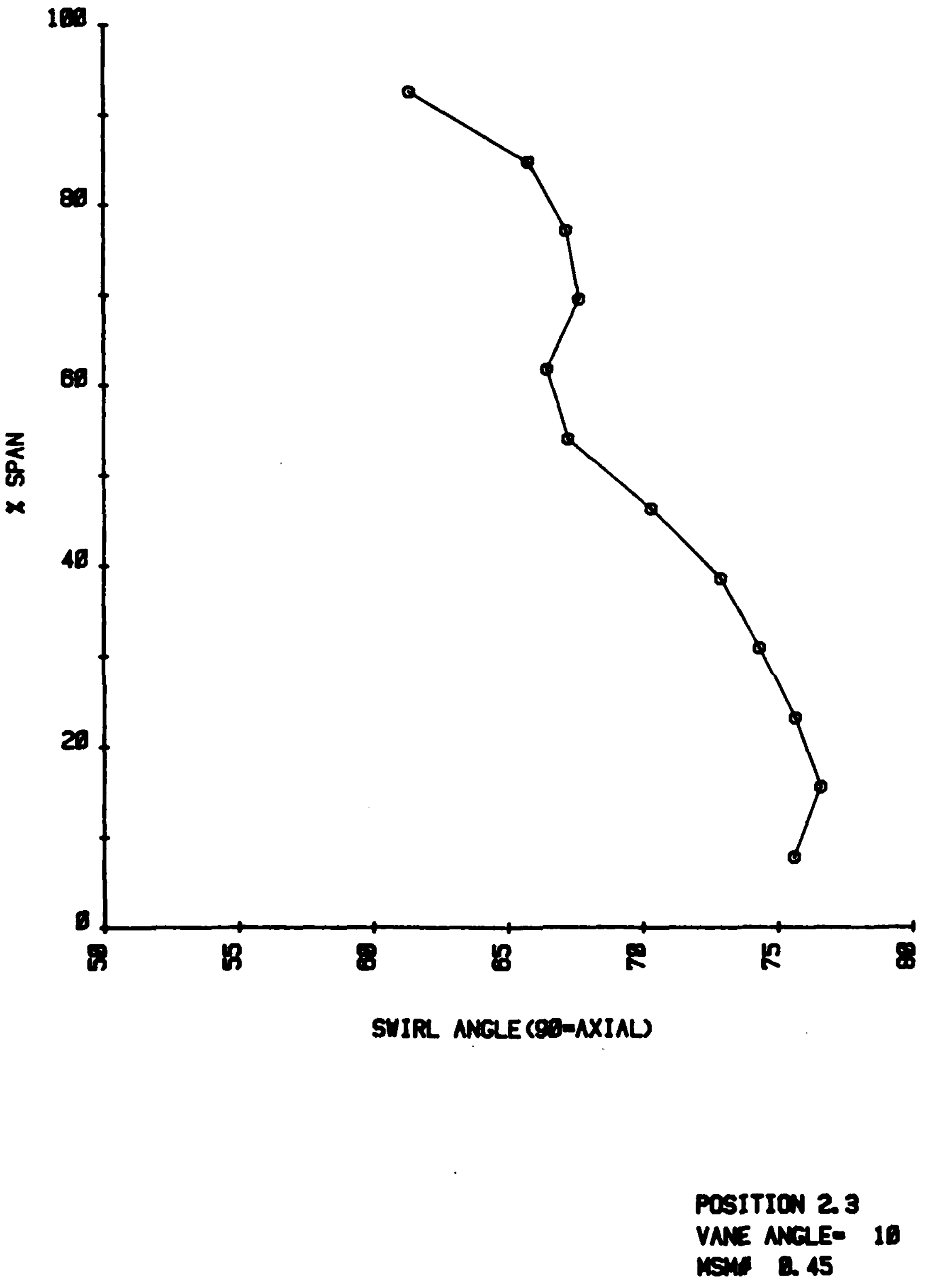


Figure E-18. Swirl Profile, Station 2.3 (Phase I), PSV=10°, Mach Number = .45

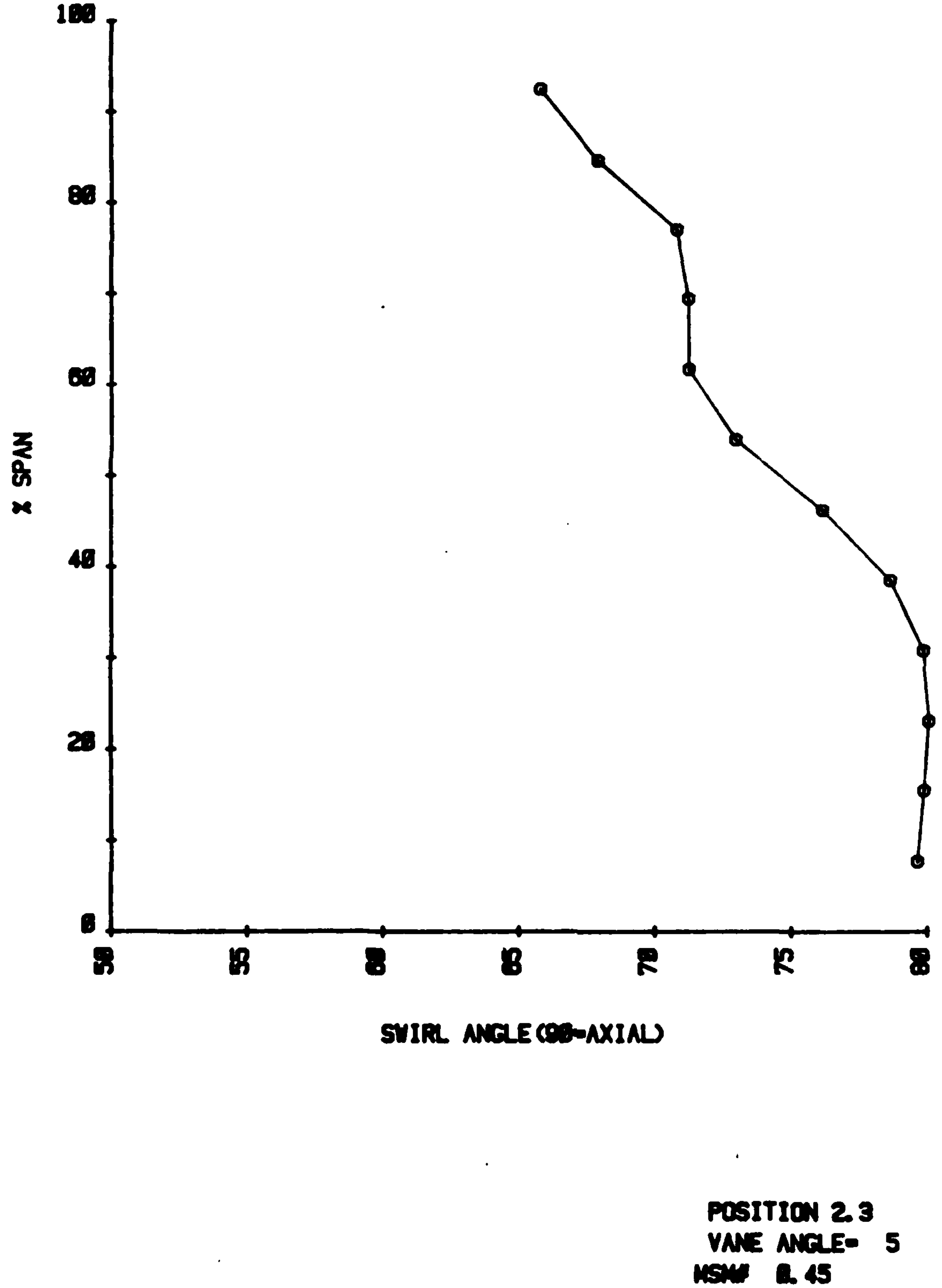


Figure E-17. Swirl Profile, Station 2.3 (Phase I), PSV=5°, Mach Number = .45

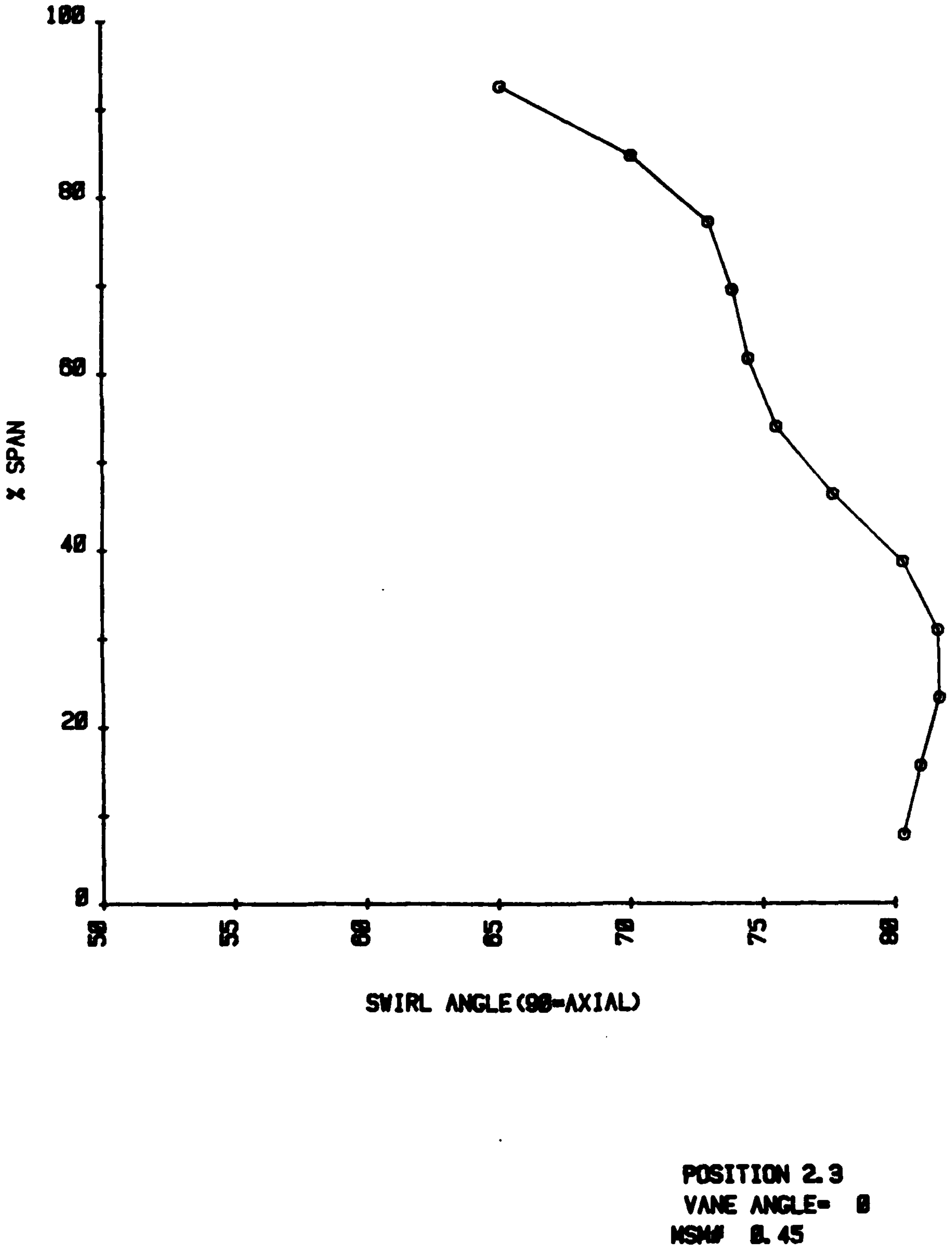


Figure E-16. Swirl Profile, Station 2.3 (Phase I), PSV=0°, Mach Number = .45

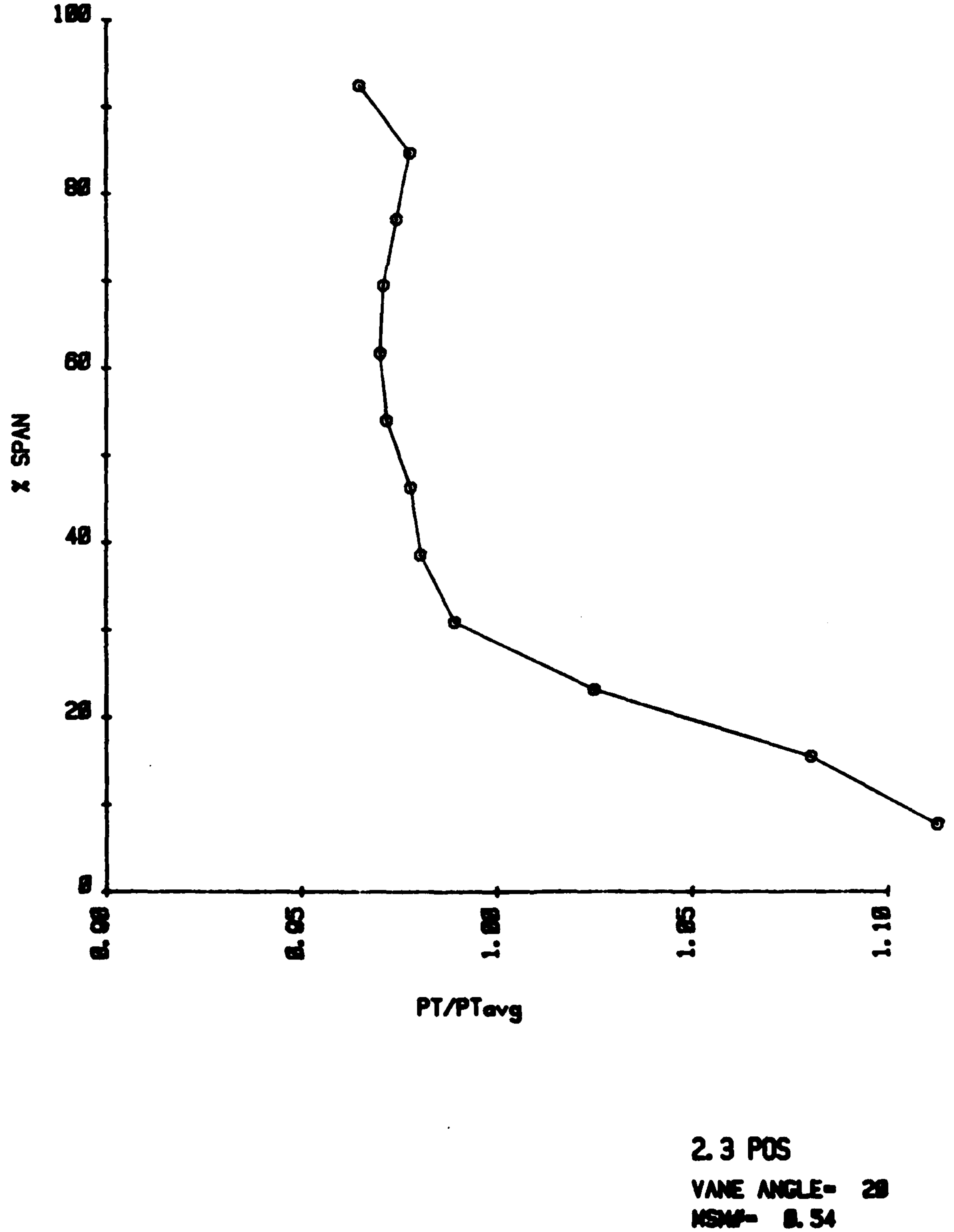


Figure E-15. Total Pressure Profile, Station 2.3 (Phase I), PSV=20°, Mach Number = .54

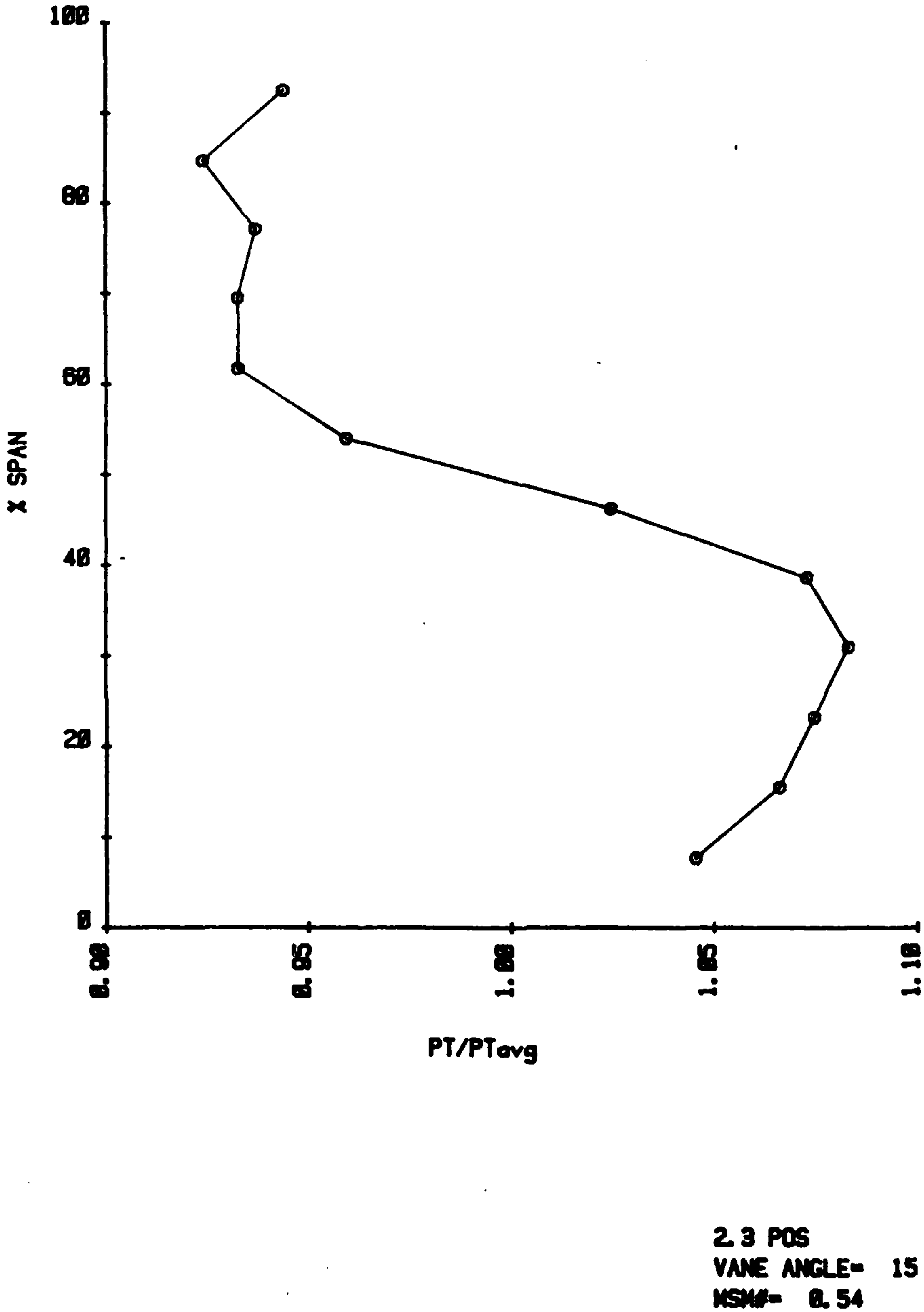


Figure E-14. Total Pressure Profile, Station 2.3 (Phase I), PSV=15°, Mach Number = .54

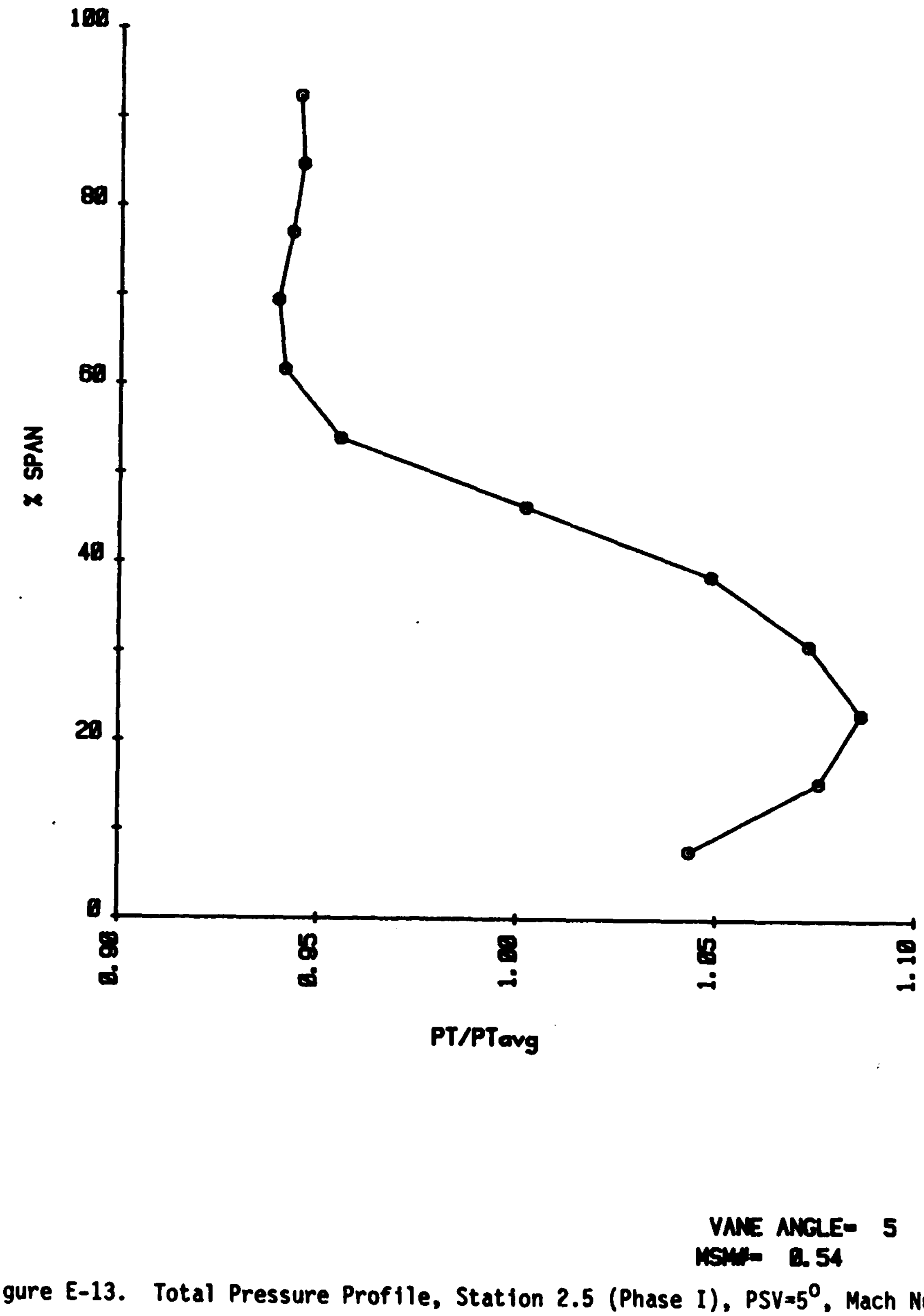


Figure E-13. Total Pressure Profile, Station 2.5 (Phase I), PSV=5°, Mach Number = .54

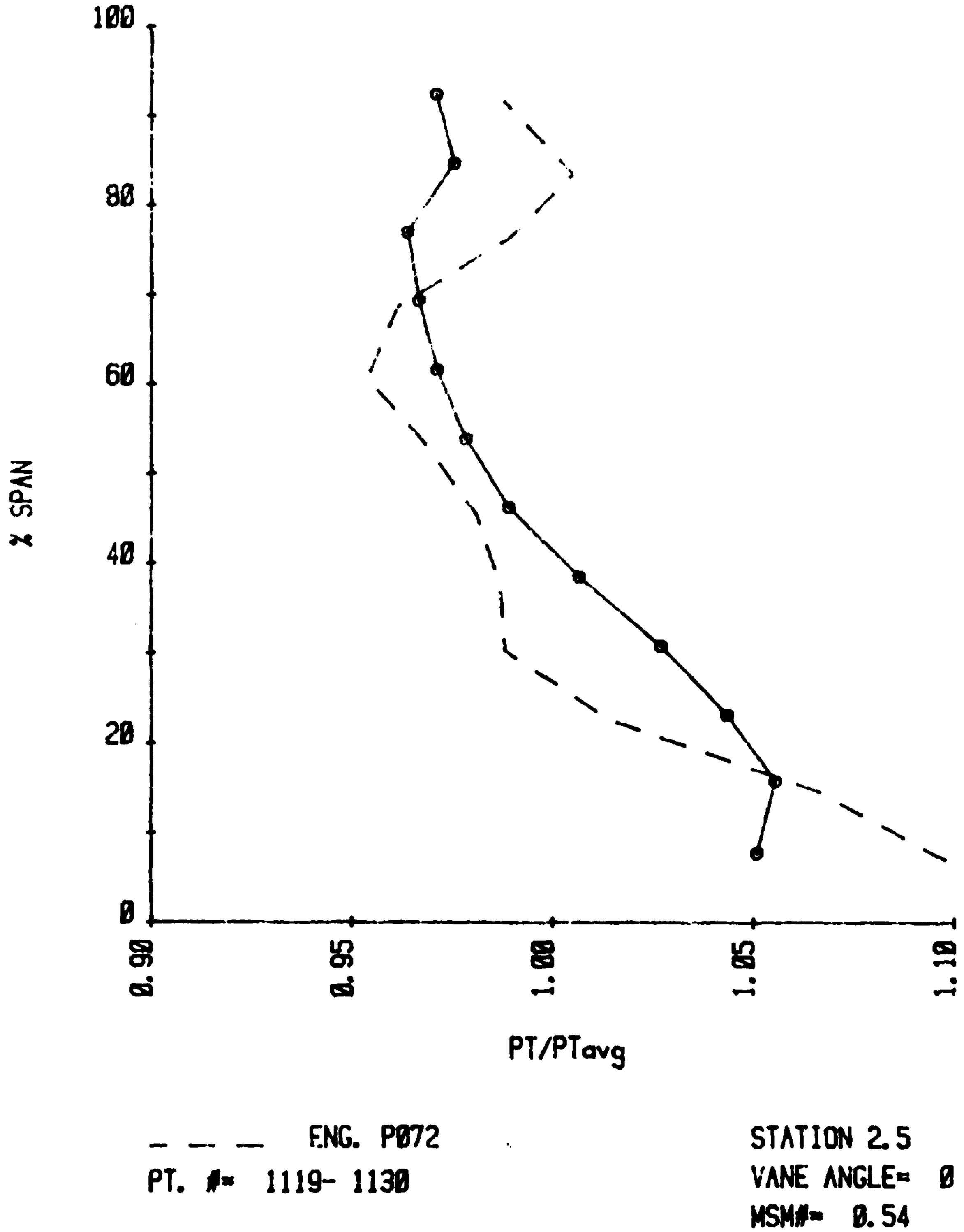


Figure E-12. Total Pressure Profile, Station 2.5 (Phase I), PSV=0^{0}, Mach Number = .45

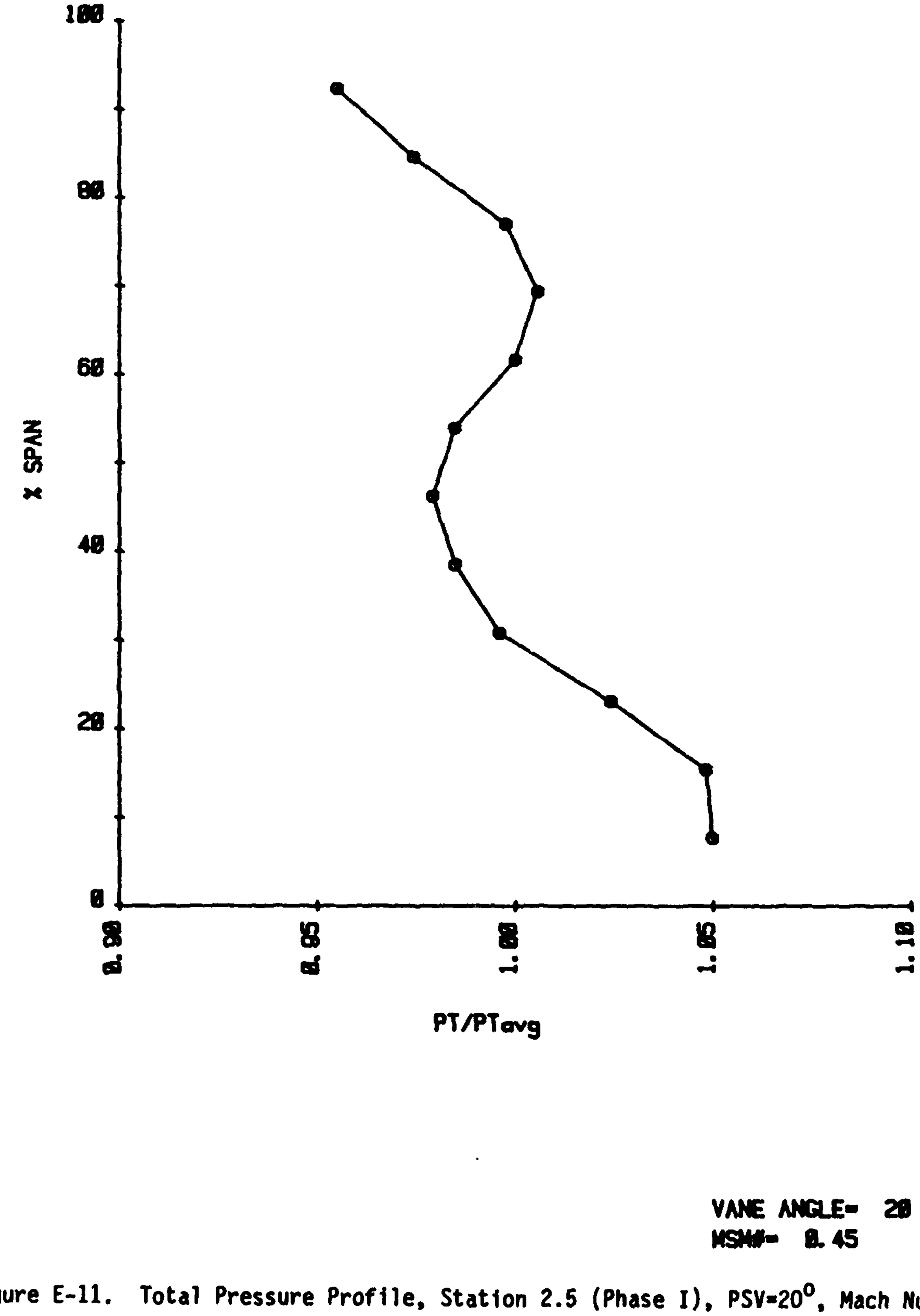


Figure E-11. Total Pressure Profile, Station 2.5 (Phase I), PSV=20^{o}, Mach Number = .45

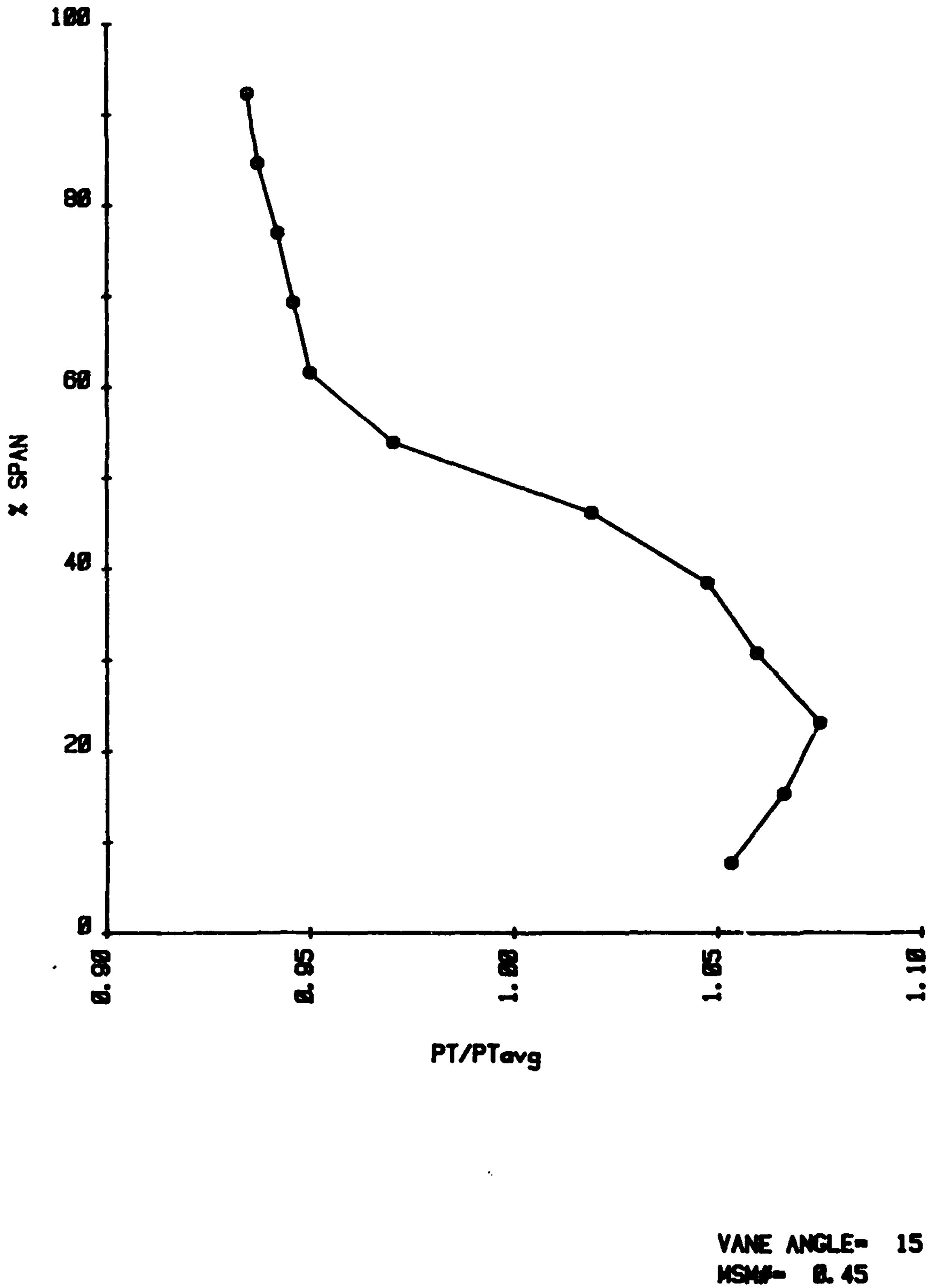


Figure E-10. Total Pressure Profile, Station 2.5 (Phase I), PSV=15^{o}, Mach Number = .45

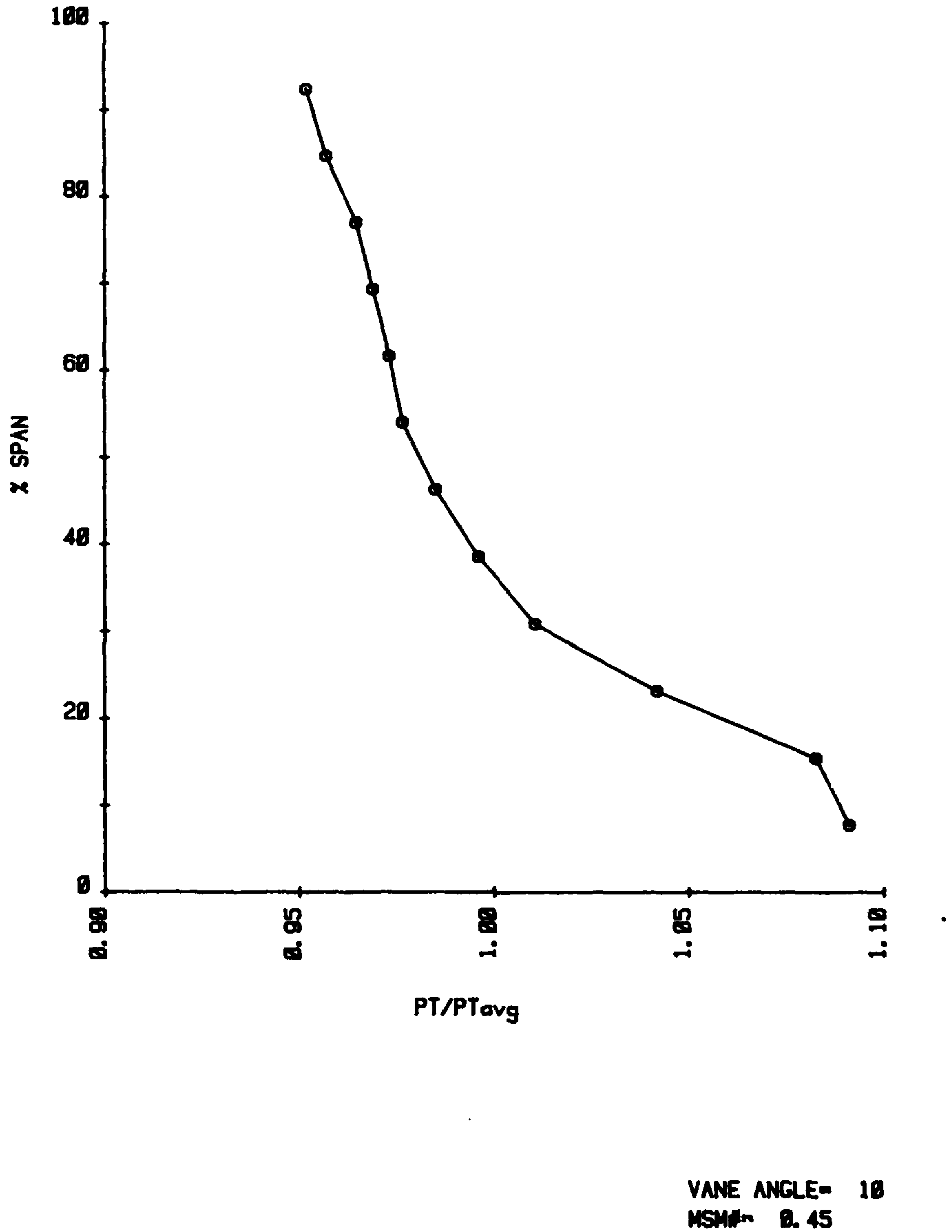


Figure E-9. Total Pressure Profile, Station 2.5 (Phase I), PSV=10^{O}, Mach Number = .45

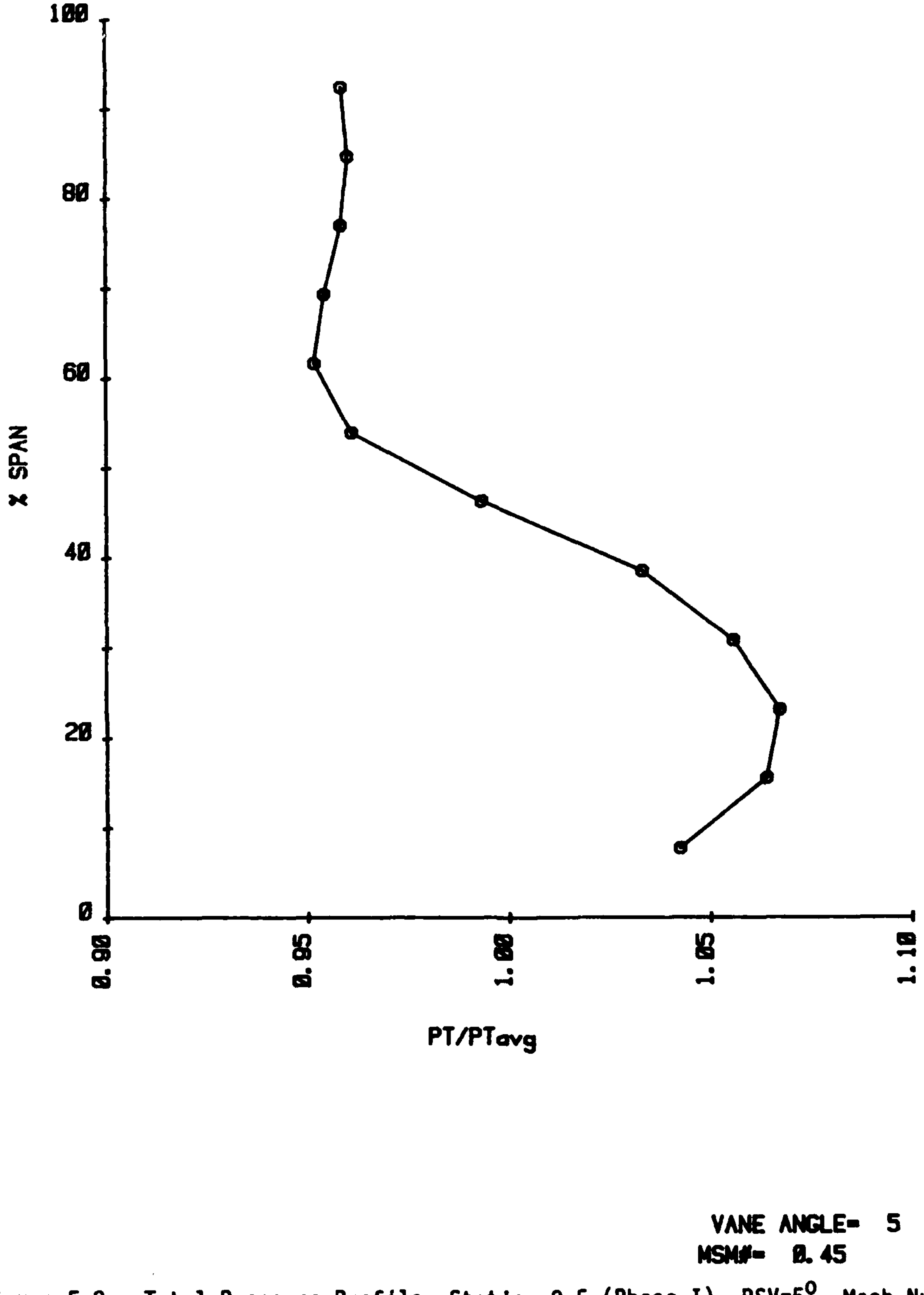


Figure E-8. Total Pressure Profile, Station 2.5 (Phase I), PSV=5°, Mach Number = .45

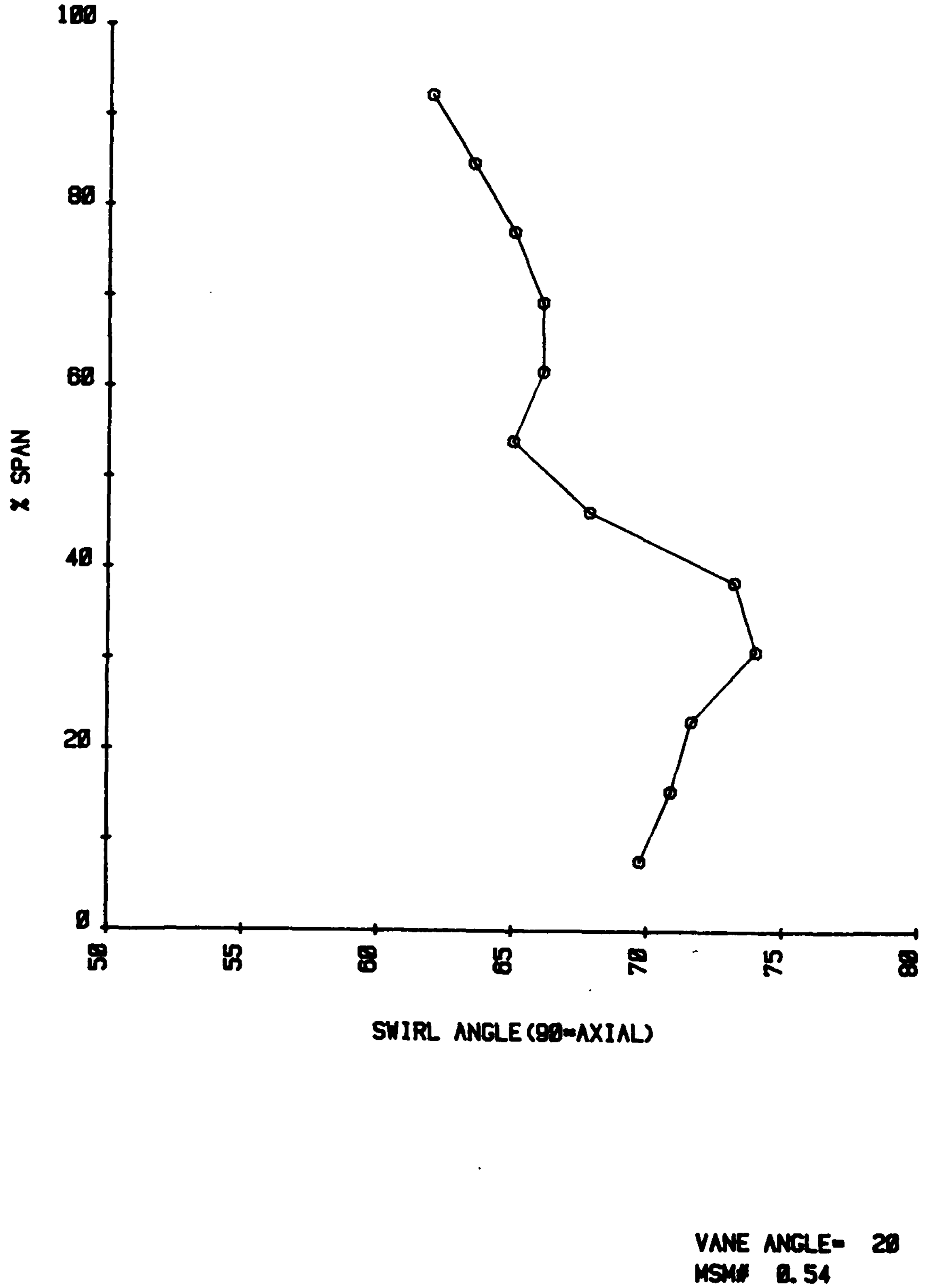


Figure E-22. Swirl Profile, Station 2.5 (Phase I), PSV=20^{0}, Mach Number = .54, Octant 1

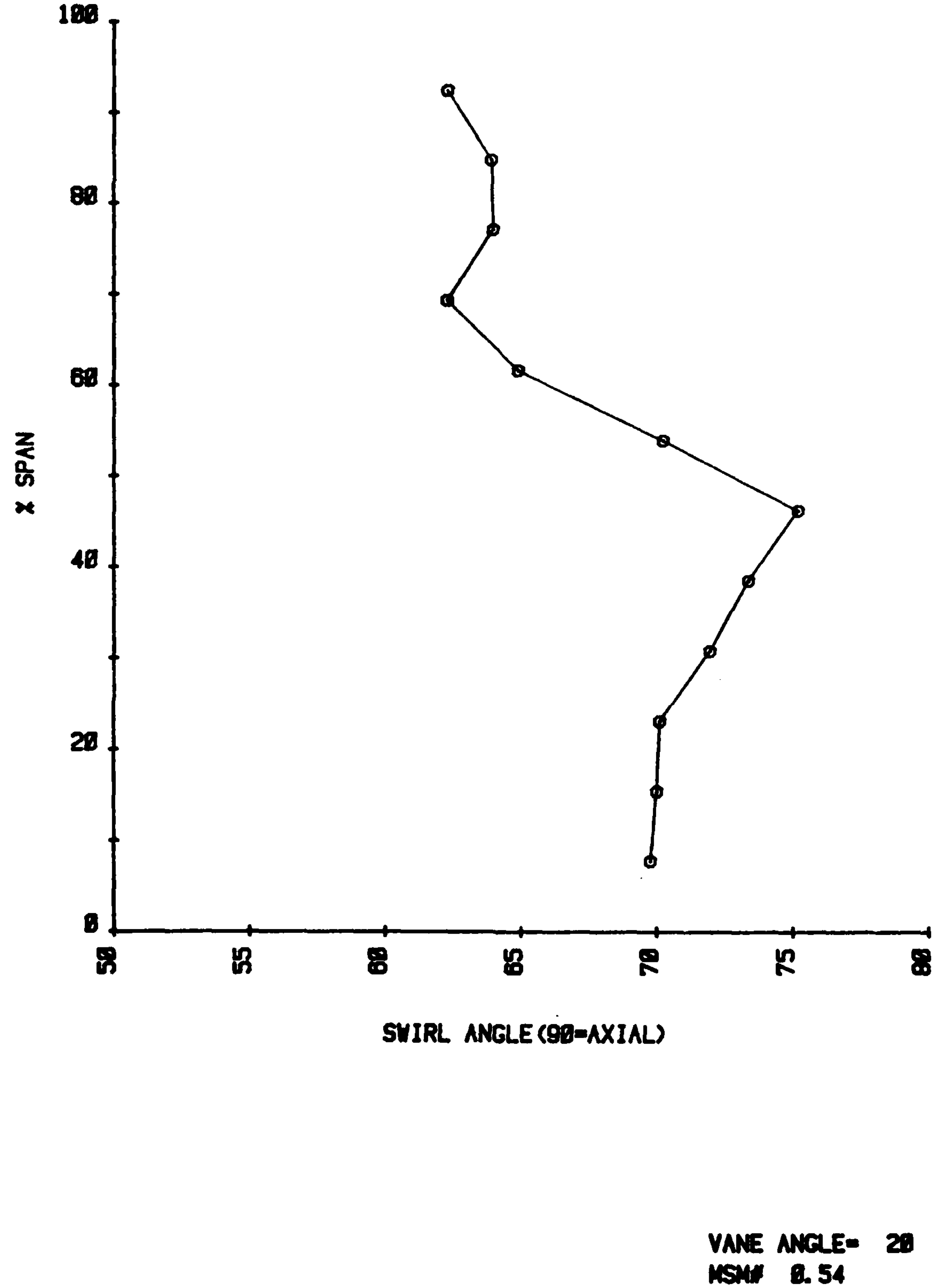


Figure E-23. Swirl Profile, Station 2.5 (Phase I), PSV=20^{0}, Mach Number = .54, Duplication

APPENDIX F

MODIFIED PRESWIRL VANE TEST PHASE II PREPARATION AND DATA

*** CALIBRATION INFORMATION ***

	TRANSDUCERS 0-1 PSID	TRANSDUCERS 0-5 PSID
Y-INTERCEPT (PSI)	0.043	-0.004
% CHANGE DURING DATA AQUISITION	-0.008	0.004
SLOPE (PSI/VOLT)	0.395	0.790
% CHANGE DURING DATA AQUISITION	-0.133	-0.058

	TRAVERSES WEDGE PROBE A	TRAVERSES WEDGE PROBE B
RADIAL POS. (% SPAN)	30.8	30.5
% CHANGE DURING DATA AQUISITION	-0.01	0.00
ROTATIONAL ANGLE (0=AXIAL)	18.6	27.6
% CHANGE DURING DATA AQUISITION	-0.01	0.03

*** INLET PROFILE DATA ***

VANE ANGLE= 29 MIDSPAN MACH #= 0.54

POINT #=1409 DATE: 03-28-83 TIME: 08:33:57

PATM= 14.17 PSIA TATM= 45.6 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	2.084	2.375	0.001	2.849	1.848	0.015	0.727	4.809
MIN.	2.041	2.344	-0.008	2.822	1.829	-0.004	0.713	4.775
STD DEV.	0.011	0.008	0.002	0.006	0.006	0.005	0.003	0.011
AVG.	2.060	2.358	-0.003	2.836	1.837	0.006	0.723	4.795

REDUCED DATA:

% SPAN	30.8	% SPAN	30.5
PT=	12.12	PT=	11.34
PS=	9.50	PS=	9.31
MACH #=	0.60	MACH #=	0.54
SWIRL ANGLE=	19	SWIRL ANGLE=	28

PT RAKE= 11.28
MDOT= 41.3
CMDOT= 53.1

Figure F-1. Modified Preswirl Vane Test (Phase II), Sample Output

FINAL TEST PLAN FOR

F100 HPC INLET DUCT TEST

(Modified Vanes with Increased Actuation Modified Screens)

7 March 1983

I. TEST OBJECTIVE

An F100 Series 3 High Pressure Compressor Test Article is being designed for experimentation in the Compressor Research Facility (CRF) of the Aero Propulsion Laboratory.

To perform these experiments without the fan and use the results for comparison to actual engine parameters, the entrance profiles to the high pressure compressor must be simulated. This program is designed to experimentally measure the pressure, temperature, and flow angle profiles at the exit of the test article inlet duct for comparison to measured engine profiles. In this test program, two 0.25-inch diameter wedge probes will be used to measure the temperature, total and static pressure, and flow angle profiles. They will also be used to determine the sensitivity of the flow downstream of the IGV to changes made at the 2.3 location. This test will be conducted in Building 18, Room 24, since previous experiments have shown adequate flow capacity in this facility.

II. HARDWARE

A cutaway of the inlet flow path is shown in Figure F-2. Shown in this figure are two axial locations that are available for investigation. The location shown at 2.5 duplicates station 2.5 measured in engine P072. For this reason, the primary location of profile measurements will be the 2.5 locations. Measurements will also be made at station 2.3 through the use of a second wedge probe. If time permits, the probes will be moved downstream of the IGV. The wedge probe to be used in the experiment is a United Sensor Model WT-150-24-CU/C. A schematic of the probe is shown in Figure F-3.

The wedge probe senses three pressures and one temperature. The temperature is measured by a copper constantan thermocouple from the position shown in Figure 2. P1 is proportional to the total pressure, while (P2 + P3)/2 is proportional to the static pressure. The flow angle will be determined by rotating the probe to a position where P2 - P3 = 0 and then measuring the probe's physical position (angle).

The pressures P1-Patm, P1 - P2, P1 - P3, and P3 - P2 will be recorded. The range of these readings is 0-1 psid, 0-5 psid, 0-5 psid and 0-1 psid, respectively. These same pressures will be recorded from the wedge probe positioned at the 2.3 location.

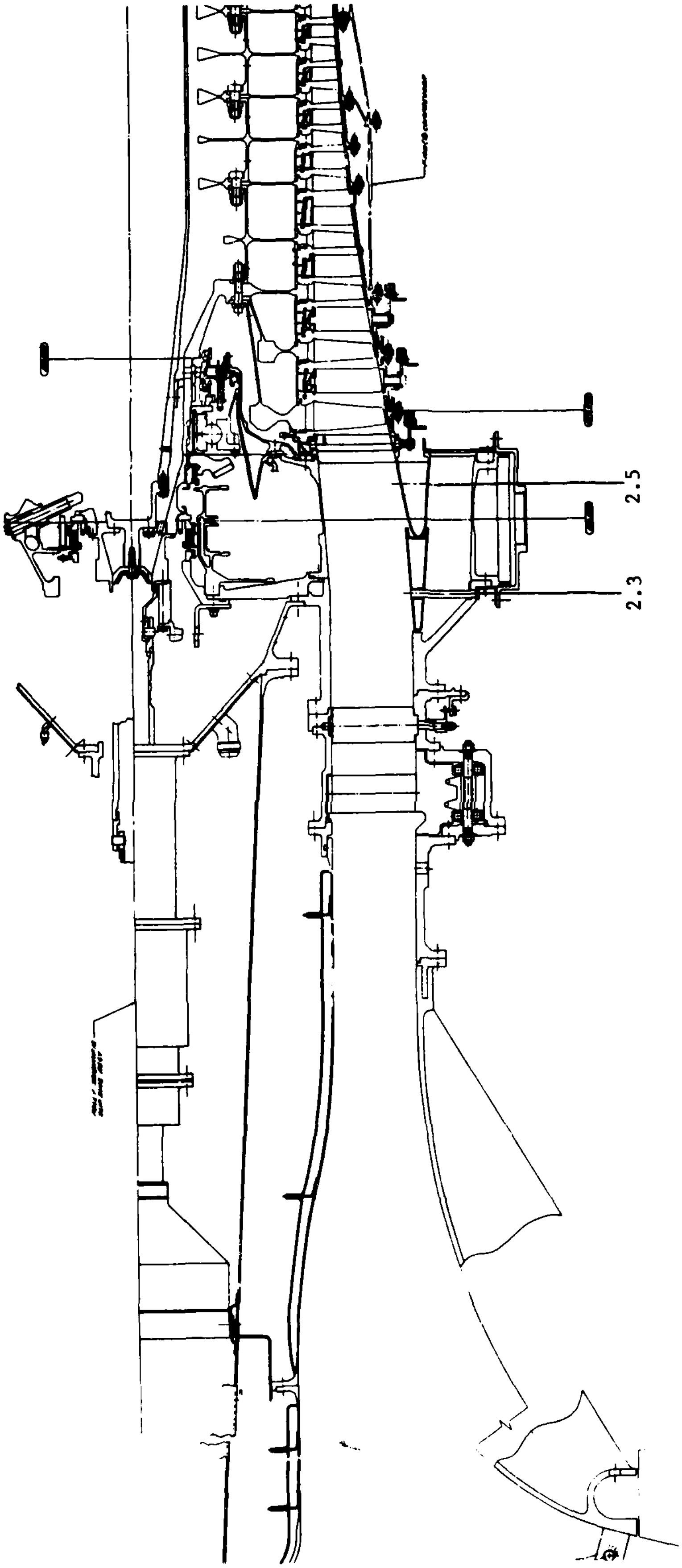


Figure F-2. CRF/F100 Inlet Flow Path

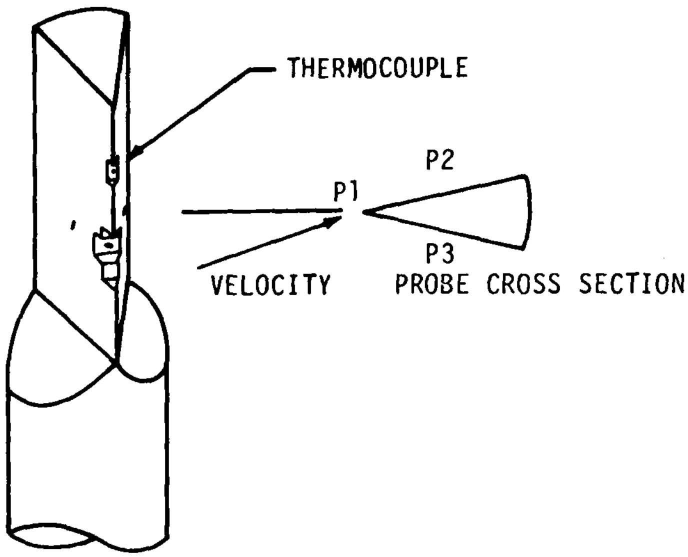


Figure F-3. Wedge Probe Schematic

During the test, the probes will be translated radially and rotated to the required positions. This operation will be controlled through a Northern Research and Engineering Corporation TEMI-3 Traversing Actuation System. Two ER1-4 traverse actuators will be used simultaneously to translate and/or rotate both wedge probes.

Additional data obtained will be Tatm and flow path ID wall static pressure (P4-Patm) and OD wall static pressure (P5-Patm).

DATA TAKING AND RECORDING REQUIREMENTS

The following is a list of steps that the data taking and recording system should follow:

a. Rotate both wedge probes to null position.

b. Calibrate transducers and store calibration constants for high/low calibration reference pressure.

c. Take average, maximum, minimum, and deviation from 36 data points each of P5-Patm, P4-Patm, P1 - P2, P1 - P3, P2 - P3, P1A - P2A, P1A - P3A, and P2A - P3A. Take one data point of T1, Tatm, and traverses (radial and rotational) position before and after taking the raw data points.

d. Calibrate transducers for high/low pressure again.

e. Print the calibration constants measured after the data taking and their respective percent change from before to after data taking. Also, print out percent change of traverse positions, mean values and maximum variation of all raw data.

f. Option to reduce printout and store the data or return to the cal-data-cal cycle above.

g. Short form printout. Reduce data and print out the following in engineering Units:

- Time of day - to be obtained from internal clock.
- Date - have the program keep the input date until turned off.
- Point Number
- Values for P1-Patm, P3 - P2, P1 - P2, P1 - P3, P1A - Patm, P3A - P2A, P1A - P3A, P4 - Patm, P5 - Patm in psid
- T1, Tatm ^{O}F, traverse positions, percent span and degree of rotation
- TT, PT, PS, Mach No., swirl angle, PT/PS

h. Plot Data

As the experiment proceeds, plot out the following parameters as a function of percent span (traverse position).

Swirl angle (Station 2.5 and Station 2.3) after the traverse, plot PT/(PT average) as a function of percent span. After the test, this program will be able to access the files desired and plot out one of the curves above, or possibly plot four color-coded curves at one time.

i. During each data point, the program must store the following on tape:

- All individual average value points (raw data)
- Both sets of calibration constants
- The values printed out in the short form printout mentioned above

F100 HPC INLET DUCT TEST

TEST PLAN

It is currently estimated that four minutes will be required for each data point. The following steps are required for each data point:

a. Set stator angle on all vanes

b. Set flow rate to approximately 54 lb/sec and position probe at midspan. Take data point.

c. Position the probes to the desired radial position.

d. Rotate both wedge probes to P2 - P3 and P2A - P3A = 0.

e. Take data.

f. Print out and store data.

g. Take 12 data points across the duct

h. Return to midspan position and duplicate point

i. Stop air flow

j. Change vane angle and repeat steps b-i for each vane angle.

<u>Vane angles to be tested</u>

0
10
15
20
30
35
40 (if required)
50 (if required)

k. Change screens and repeat steps a-j.

<u>Screens to be tested</u>

Existing screens
Existing screen with add-on (screens=3)
Existing screen with cutout and with add-on (screens=4)

l. Move traverse to different circumferential location and repeat selected vane setting (as time permits).

m. Move traverse downstream of IGV and determine swirl profiles for selected vane settings (as time permits)

1079	15	0.49	14.20	45.0	7.5	15.7	12.11	9.82	0.56	7.0	16.8	12.55	9.60	0.63
1080	15	0.49	14.20	44.7	15.3	12.2	12.37	9.90	0.57	15.4	15.1	12.20	9.63	0.59
1081	15	0.49	14.20	44.7	22.9	12.5	12.39	9.98	0.56	22.5	15.9	11.98	9.62	0.57
1082	15	0.49	14.20	44.4	30.4	15.4	12.19	9.98	0.54	30.8	17.4	11.81	9.56	0.56
1083	15	0.49	14.20	44.4	38.1	17.0	11.85	10.01	0.50	38.5	19.6	10.43	8.19	0.60
1084	15	0.49	14.20	44.4	45.6	17.6	11.45	10.00	0.44	46.3	21.2	11.47	9.59	0.51
1085	15	0.49	14.20	44.0	53.4	19.5	11.22	10.00	0.41	53.9	23.1	11.38	9.67	0.49
1086	15	0.49	14.20	44.5	60.9	21.0	11.35	9.98	0.43	61.6	22.0	11.23	9.66	0.47
1087	15	0.49	14.20	44.0	68.6	22.1	11.49	10.03	0.45	69.3	22.1	11.14	9.70	0.45
1088	15	0.49	14.20	43.5	76.2	22.9	11.44	10.03	0.44	77.0	26.2	11.10	9.71	0.44
1089	15	0.49	14.20	43.4	83.8	22.7	11.64	10.09	0.46	84.7	25.6	11.15	9.82	0.43
1090	15	0.49	14.20	43.5	91.4	21.6	11.74	10.16	0.46	92.4	25.7	11.27	9.90	0.43
1092	15	0.51	14.20	43.9	8.5	15.9	12.55	9.83	0.60	6.8	18.8	12.52	9.55	0.63
1093	15	0.51	14.19	43.3	16.2	14.1	12.41	9.91	0.58	14.5	17.9	12.32	9.49	0.62
1094	15	0.51	14.19	43.1	23.8	13.6	11.91	9.91	0.52	22.2	18.7	12.04	9.48	0.59
1095	15	0.51	14.19	43.2	31.4	16.4	11.47	9.93	0.46	29.9	20.2	11.94	9.49	0.58
1096	15	0.51	14.19	43.0	39.0	38.1	11.18	9.94	0.41	37.6	22.1	11.73	9.48	0.56
1097	15	0.51	14.19	42.7	46.7	41.7	11.19	9.90	0.42	45.3	24.5	11.55	9.49	0.54
1098	15	0.51	14.19	42.9	54.3	45.1	11.13	9.96	0.40	52.9	26.0	11.41	9.51	0.52
1099	15	0.51	14.19	42.6	62.0	43.1	11.13	9.97	0.40	60.6	26.0	11.21	9.53	0.49
1100	15	0.51	14.19	42.8	69.6	43.3	11.16	10.00	0.40	68.3	26.3	11.06	9.54	0.46
1101	15	0.51	14.19	42.7	77.2	43.2	11.18	10.03	0.40	76.0	28.6	11.03	9.59	0.45
1102	15	0.51	14.19	42.6	84.9	45.5	11.14	10.14	0.37	83.6	29.6	11.07	9.66	0.44
1103	15	0.51	14.19	42.6	92.5	49.6	11.11	10.15	0.36	91.3	29.3	11.16	9.74	0.44
1106	0	0.53	14.19	42.7	54.3	70.2	10.82	10.19	0.29	6.9	21.1	12.05	9.45	0.60
1107	0	0.53	14.19	42.6	54.3	70.0	10.83	10.19	0.30	14.5	18.4	12.21	9.45	0.62
1108	0	0.53	14.19	42.4	54.3	70.0	10.80	10.17	0.29	22.2	17.8	12.10	9.47	0.60
1109	0	0.53	14.19	42.8	54.3	70.1	10.82	10.18	0.30	29.8	17.8	11.88	9.47	0.58
1110	0	0.53	14.19	42.6	54.3	70.0	10.82	10.19	0.29	37.6	18.2	11.68	9.47	0.56
1111	0	0.53	14.19	42.7	54.3	70.0	10.82	10.19	0.29	45.3	18.6	11.56	9.49	0.54
1112	0	0.53	14.19	42.4	54.3	70.0	10.81	10.19	0.29	52.9	19.2	11.49	9.50	0.53
1113	0	0.53	14.19	42.5	54.3	70.1	10.81	10.18	0.29	60.6	20.5	11.43	9.52	0.52
1114	0	0.53	14.19	42.8	54.3	70.0	10.82	10.19	0.29	68.3	22.4	11.31	9.56	0.50
1115	0	0.53	14.19	42.5	54.3	70.0	10.80	10.18	0.29	76.0	24.6	11.24	9.60	0.48
1116	0	0.53	14.19	42.6	54.3	70.1	10.82	10.19	0.29	83.6	26.3	11.19	9.66	0.46
1117	0	0.53	14.19	42.6	54.3	70.0	10.81	10.19	0.29	91.3	28.0	11.14	9.75	0.44
1119	0	0.54	14.26	45.3	7.7	9.1	12.60	10.19	0.56	7.8	18.5	12.12	9.35	0.62
1120	0	0.54	14.26	45.6	15.0	7.1	12.76	10.27	0.57	15.7	16.2	12.17	9.33	0.63
1121	0	0.54	14.26	46.8	22.9	6.6	12.83	10.33	0.57	23.2	15.9	12.03	9.34	0.61
1122	0	0.54	14.26	46.8	30.5	7.1	12.29	10.29	0.51	30.8	16.5	11.84	9.37	0.59
1123	0	0.54	14.26	47.9	38.1	8.9	11.69	10.29	0.43	38.5	17.4	11.61	9.33	0.57
1124	0	0.54	14.26	48.8	45.7	10.9	11.42	10.30	0.39	46.2	18.5	11.41	9.35	0.54
1125	0	0.54	14.26	48.7	53.4	12.8	11.20	10.30	0.35	53.9	19.2	11.28	9.36	0.52
1126	0	0.54	14.26	49.4	61.0	14.7	11.10	10.31	0.33	61.6	19.8	11.20	9.38	0.51
1127	0	0.54	14.26	48.7	68.6	14.7	11.09	10.30	0.33	69.3	21.0	11.15	9.41	0.50
1128	0	0.54	14.26	49.0	76.2	14.9	11.19	10.36	0.33	77.0	22.5	11.12	9.45	0.49
1129	0	0.54	14.26	49.5	83.8	16.7	11.33	10.55	0.32	84.7	24.1	11.25	9.80	0.45
1130	0	0.54	14.26	49.6	91.4	19.5	11.22	10.57	0.29	92.4	24.9	11.20	9.85	0.43

PT#	VANE ANGLE	MIDSPAN M#	PAIM	TAIM	%SPAN	SWIRL ANGLE									
1133	10	0.48	14.28	50.3	7.6	14.9	12.15	9.86	0.55	8.1	17.0	12.29	9.44	0.62
1134	10	0.48	14.28	51.0	15.3	14.9	12.58	10.03	0.58	15.5	15.0	12.26	9.43	0.62
1135	10	0.48	14.28	51.0	22.9	14.4	12.60	10.09	0.57	23.2	14.8	12.06	9.42	0.61
1136	10	0.48	14.28	50.7	30.5	14.6	12.46	10.12	0.55	30.8	15.7	11.67	9.42	0.56
1137	10	0.48	14.28	50.9	38.1	15.2	12.15	10.11	0.52	38.5	17.7	11.30	9.42	0.52
1138	10	0.48	14.28	51.5	45.8	17.1	11.74	10.08	0.47	46.2	19.9	11.09	9.42	0.49
1139	10	0.48	14.28	52.5	53.4	19.6	11.23	10.08	0.40	54.0	21.8	11.05	9.41	0.48
1140	10	0.48	14.28	52.7	61.0	21.6	11.03	10.09	0.36	61.6	23.3	11.09	9.43	0.49
1141	10	0.48	14.28	52.0	68.6	23.3	11.03	10.10	0.36	69.3	24.4	11.12	9.46	0.49
1142	10	0.48	14.28	52.3	76.2	23.8	11.06	10.14	0.35	77.0	25.5	11.15	9.52	0.48
1143	10	0.48	14.28	50.3	83.8	25.0	11.02	10.17	0.34	84.7	25.5	11.17	9.61	0.47
1144	10	0.48	14.28	51.5	91.4	27.7	10.89	10.20	0.31	92.4	25.6	11.18	9.69	0.46
1147	15	0.52	14.28	56.9	7.7	18.3	12.63	9.84	0.61	7.7	17.2	12.87	9.57	0.66
1148	15	0.52	14.28	55.9	15.3	16.7	12.64	9.89	0.60	15.4	16.8	12.56	9.53	0.64
1149	15	0.52	14.28	56.6	22.9	17.2	12.06	9.94	0.53	23.1	17.6	12.29	9.55	0.61
1150	15	0.52	14.28	56.6	30.5	18.3	11.63	9.94	0.48	30.8	19.0	11.89	9.49	0.58
1151	15	0.52	14.28	56.2	38.1	19.3	11.41	9.96	0.45	38.5	21.1	11.65	9.48	0.55
1152	15	0.52	14.28	57.1	45.7	21.2	11.23	9.97	0.42	46.3	23.3	11.54	9.51	0.53
1153	15	0.52	14.28	58.1	53.4	23.3	11.13	10.00	0.39	53.9	24.8	11.49	9.55	0.52
1154	15	0.52	14.28	57.6	61.0	24.9	11.07	10.01	0.38	61.6	25.5	11.25	9.60	0.48
1155	15	0.52	14.28	57.4	68.6	26.2	11.05	10.03	0.37	69.3	25.6	11.06	9.57	0.46
1156	15	0.52	14.28	56.6	76.2	27.6	11.03	10.05	0.37	77.0	27.2	11.01	9.60	0.45
1157	15	0.52	14.28	56.9	83.8	29.5	11.02	10.10	0.36	84.7	27.3	11.11	9.70	0.44
1158	15	0.52	14.28	57.1	91.4	31.6	11.03	10.14	0.35	92.4	26.8	11.17	9.78	0.44
1161	20	0.49	14.26	57.6	7.6	20.4	12.71	9.70	0.63	7.7	18.9	12.16	9.51	0.60
1162	20	0.49	14.26	58.7	15.3	20.5	12.42	9.77	0.60	15.4	17.9	12.06	9.51	0.59
1163	20	0.49	14.26	59.2	22.9	21.7	12.11	9.78	0.56	23.1	17.2	11.87	9.51	0.57
1164	20	0.49	14.26	57.7	30.5	22.8	11.91	9.79	0.54	30.8	15.8	11.98	9.52	0.58
1165	20	0.49	14.26	58.9	38.1	23.7	11.61	9.82	0.50	38.5	15.9	12.05	9.56	0.58
1166	20	0.49	14.26	58.5	45.7	25.2	11.30	9.81	0.45	46.2	17.7	11.67	9.54	0.54
1167	20	0.49	14.26	58.9	53.3	27.4	11.09	9.83	0.42	53.9	20.5	11.25	9.55	0.49
1168	20	0.49	14.26	58.7	61.0	28.4	11.03	9.86	0.40	61.6	23.2	11.16	9.55	0.48
1169	20	0.49	14.26	58.1	68.6	29.2	11.02	9.89	0.40	69.3	25.3	11.20	9.57	0.48
1170	20	0.49	14.26	59.5	76.2	31.0	10.90	9.91	0.37	77.0	26.5	11.24	9.63	0.48
1171	20	0.49	14.26	59.9	83.8	33.8	10.75	9.94	0.34	85.8	27.2	11.26	9.74	0.46
1172	20	0.49	14.26	60.4	91.4	34.8	10.74	10.01	0.32	92.4	26.9	11.23	9.80	0.45
1175	25	0.54	14.30	45.4	7.6	26.1	11.88	9.35	0.59	7.8	19.4	12.53	9.51	0.64
1176	25	0.54	14.30	45.5	15.3	23.5	11.98	9.42	0.60	15.4	18.8	12.54	9.49	0.64
1177	25	0.54	14.30	45.3	22.9	23.3	12.34	9.53	0.62	23.2	19.2	12.11	9.48	0.60
1178	25	0.54	14.30	45.2	30.5	24.1	12.53	9.60	0.63	30.8	20.3	11.75	9.47	0.56
1179	25	0.54	14.30	45.3	38.1	25.5	12.18	9.59	0.59	38.5	21.5	11.62	9.46	0.55
1180	25	0.54	14.30	45.3	45.7	27.3	11.76	9.58	0.55	46.2	23.2	11.55	9.48	0.54
1181	25	0.54	14.30	45.2	53.3	29.1	11.30	9.60	0.49	53.9	24.7	11.56	9.51	0.54
1182	25	0.54	14.30	45.2	61.0	30.4	11.14	9.64	0.46	61.6	26.0	11.59	9.56	0.53
1183	25	0.54	14.30	44.9	68.6	31.6	11.07	9.64	0.45	69.4	27.5	11.59	9.60	0.53
1184	25	0.54	14.30	45.4	76.2	33.7	11.08	9.69	0.44	77.0	28.8	11.43	9.61	0.50
1185	25	0.54	14.30	45.5	83.8	37.7	11.07	9.75	0.43	84.7	28.7	11.19	9.70	0.46
1186	25	0.54	14.30	45.7	91.4	40.5	11.02	9.80	0.41	92.4	27.8	11.20	9.78	0.44

PT#	VANE ANGLE	MIDSPAN M#	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	M#	%SPAN	SWIRL ANGLE	PT	PS	M#
1189	30	0.54	14.30	47.0	7.6	30.2	12.43	9.22	0.67	7.7	21.9	12.17	9.46	0.61
1190	30	0.54	14.30	47.4	15.2	28.7	12.25	9.25	0.65	15.4	19.8	12.05	9.48	0.60
1191	30	0.54	14.30	47.5	22.9	29.1	12.28	9.30	0.64	23.1	17.9	12.11	9.50	0.60
1192	30	0.54	14.30	47.5	30.5	29.9	12.01	9.33	0.61	30.8	17.3	12.19	9.53	0.60
1193	30	0.54	14.30	47.1	38.1	30.0	11.62	9.36	0.56	38.5	17.7	12.16	9.57	0.60
1194	30	0.54	14.30	47.7	45.7	31.2	11.40	9.37	0.54	46.2	20.7	11.86	9.58	0.56
1195	30	0.54	14.30	47.6	53.3	33.3	11.30	9.43	0.52	53.9	24.6	11.75	9.62	0.54
1196	30	0.54	14.30	48.0	60.9	35.3	11.25	9.47	0.50	61.6	26.2	11.60	9.64	0.52
1197	30	0.54	14.30	48.1	68.6	35.5	11.26	9.53	0.49	69.3	25.7	11.37	9.66	0.49
1198	30	0.54	14.30	48.5	76.2	36.0	11.25	9.58	0.48	77.0	24.9	11.29	9.70	0.47
1199	30	0.54	14.30	49.1	83.8	38.5	11.13	9.63	0.46	84.7	25.4	11.28	9.78	0.46
1200	30	0.54	14.30	48.8	91.4	41.4	10.94	9.69	0.42	92.4	25.0	11.19	9.84	0.43
1203	35	0.54	14.30	49.9	7.6	33.9	11.80	8.73	0.67	7.7	22.2	11.92	9.32	0.60
1204	35	0.54	14.30	49.8	15.3	30.4	12.25	8.80	0.70	15.4	20.9	12.06	9.35	0.62
1205	35	0.54	14.30	50.6	22.9	29.8	12.64	8.95	0.72	23.1	20.8	12.03	9.37	0.61
1206	35	0.54	14.30	51.5	30.5	30.9	12.46	8.97	0.70	30.8	21.6	11.99	9.43	0.60
1207	35	0.54	14.30	50.9	38.1	32.6	12.12	8.98	0.67	38.5	22.7	11.97	9.44	0.59
1208	35	0.54	14.30	50.2	45.7	34.7	11.99	9.03	0.65	46.2	23.7	11.82	9.45	0.57
1209	35	0.54	14.30	51.7	53.4	37.2	11.80	9.04	0.63	53.9	23.7	11.59	9.48	0.54
1210	35	0.54	14.30	51.6	60.9	37.8	11.37	9.08	0.58	61.6	23.5	11.42	9.49	0.52
1211	35	0.54	14.30	52.0	68.6	37.8	11.18	9.13	0.55	69.3	23.2	11.24	9.53	0.49
1212	35	0.54	14.30	52.6	76.2	38.4	11.09	9.22	0.52	77.0	24.3	11.15	9.59	0.47
1213	35	0.54	14.30	51.7	83.8	41.0	11.12	9.29	0.51	84.7	24.8	11.08	9.67	0.45
1214	35	0.54	14.30	52.6	91.4	44.0	11.07	9.37	0.49	92.4	24.4	11.08	9.75	0.43
1217	27	0.54	14.30	58.5	7.7	28.0	12.17	9.54	0.60	7.8	21.0	12.34	9.69	0.60
1218	27	0.54	14.30	58.5	15.3	26.0	12.02	9.58	0.58	15.4	18.6	12.52	9.71	0.61
1219	27	0.54	14.30	58.2	22.9	25.9	12.08	9.66	0.57	23.1	18.0	12.75	9.75	0.63
1220	27	0.54	14.30	57.9	30.5	25.6	12.00	9.73	0.55	30.8	19.0	12.69	9.81	0.62
1221	27	0.54	14.30	59.2	38.1	26.4	11.71	9.73	0.52	38.5	20.5	12.52	9.80	0.60
1222	27	0.54	14.30	60.2	45.8	28.3	11.49	9.77	0.49	46.3	22.4	12.30	9.80	0.58
1223	27	0.54	14.30	58.9	53.3	31.0	11.41	9.78	0.47	53.9	24.0	12.06	9.83	0.55
1224	27	0.54	14.30	59.2	61.0	32.4	11.38	9.82	0.46	61.6	24.6	11.85	9.86	0.52
1225	27	0.54	14.30	59.7	68.6	32.7	11.40	9.88	0.46	69.3	24.6	11.72	9.88	0.50
1226	27	0.54	14.30	60.1	76.2	34.2	11.40	9.92	0.45	77.0	24.7	11.60	9.92	0.48
1227	27	0.54	14.30	59.3	83.8	38.0	11.33	9.96	0.43	84.7	25.8	11.43	10.00	0.44
1228	27	0.54	14.30	58.9	91.4	40.6	11.19	10.02	0.40	92.4	26.0	11.39	10.07	0.42
1231	20	0.48	14.30	60.9	7.6	20.8	12.77	9.80	0.63	7.8	19.0	12.26	9.61	0.60
1232	20	0.48	14.30	58.5	15.3	26.0	12.02	9.58	0.58	15.4	18.6	12.52	9.71	0.61
1233	20	0.48	14.30	60.5	22.9	21.9	12.22	9.90	0.56	23.1	17.5	11.89	9.61	0.56
1234	20	0.48	14.30	57.9	30.5	25.6	12.00	9.73	0.55	30.8	19.0	12.69	9.81	0.62
1235	20	0.48	14.30	59.8	38.1	23.8	11.71	9.93	0.49	38.5	15.8	12.06	9.66	0.57
1236	20	0.48	14.30	60.2	45.8	28.3	11.49	9.77	0.49	46.3	22.4	12.30	9.80	0.58
1237	20	0.48	14.30	60.6	53.4	27.5	11.21	9.97	0.41	53.9	20.2	11.34	9.68	0.48

1238	0	0.52	14.09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1239	0	0.52	14.09	53.6	15.3	7.3	12.70	10.18	0.57	15.4	16.7	12.00	9.29	0.62
1240	0	0.52	14.09	53.3	22.9	7.2	12.69	10.22	0.56	23.1	15.3	11.94	9.33	0.60
1241	0	0.52	14.09	53.4	30.5	6.7	12.28	10.19	0.52	30.6	14.5	11.77	9.35	0.58
1242	0	0.52	14.09	53.3	38.1	8.0	11.68	10.19	0.45	38.5	14.2	11.62	9.35	0.57
1243	0	0.52	14.09	53.8	45.7	10.4	11.26	10.20	0.38	46.2	15.2	11.45	9.38	0.54
1244	0	0.52	14.09	53.4	53.3	13.1	11.01	10.21	0.33	53.9	17.5	11.26	9.39	0.52
1245	0	0.52	14.09	53.1	61.0	15.9	10.84	10.18	0.30	61.6	19.8	11.07	9.38	0.49
1246	0	0.52	14.09	53.7	68.6	16.4	10.88	10.20	0.31	69.3	21.8	10.98	9.40	0.48
1247	0	0.52	14.09	53.1	76.2	15.5	11.00	10.21	0.33	77.0	23.3	10.96	9.44	0.47
1248	0	0.52	14.09	53.6	83.8	15.9	11.09	10.26	0.33	84.7	25.6	10.88	9.51	0.44
1249	0	0.52	14.09	53.2	91.4	18.0	10.99	10.29	0.31	92.4	27.4	10.77	9.58	0.41
1252	10	0.48	14.09	52.6	7.7	15.1	11.95	9.80	0.54	7.7	17.8	12.24	9.45	0.62
1253	10	0.48	14.09	52.2	15.3	14.7	12.39	9.96	0.57	15.4	15.5	12.18	9.44	0.61
1254	10	0.48	14.09	52.3	22.9	14.4	12.45	10.03	0.56	23.1	14.2	12.13	9.46	0.61
1255	10	0.48	14.09	52.8	30.5	14.3	12.25	10.01	0.54	30.8	13.9	11.99	9.48	0.59
1256	10	0.48	14.09	52.8	38.1	15.8	11.82	9.98	0.50	38.5	15.0	11.66	9.47	0.55
1257	10	0.48	14.09	52.7	45.7	17.9	11.26	9.95	0.42	46.2	17.1	11.30	9.46	0.51
1258	10	0.48	14.09	52.8	53.3	21.3	10.78	9.97	0.34	53.9	18.5	11.09	9.47	0.48
1259	10	0.48	14.09	52.8	61.0	24.7	10.87	10.01	0.35	61.6	20.5	10.89	9.46	0.45
1260	10	0.48	14.09	52.9	68.6	25.0	10.87	10.02	0.34	69.3	22.2	10.80	9.49	0.43
1261	10	0.48	14.09	52.9	76.2	24.2	10.91	10.04	0.35	77.0	23.8	10.76	9.50	0.43
1262	10	0.48	14.09	52.9	83.8	24.8	10.95	10.08	0.35	84.7	25.6	10.67	9.57	0.40
1263	10	0.48	14.09	52.6	91.4	28.3	10.80	10.10	0.31	92.4	28.0	10.61	9.63	0.37
1266	15	0.51	14.08	55.6	7.6	18.5	12.74	9.72	0.63	7.7	17.1	12.72	9.49	0.66
1267	15	0.51	14.08	56.1	15.3	17.5	12.50	9.74	0.61	15.4	17.0	12.69	9.48	0.66
1268	15	0.51	14.08	56.1	22.9	18.4	11.85	9.76	0.53	23.1	17.8	12.24	9.45	0.62
1269	15	0.51	14.08	56.7	30.5	20.2	11.43	9.75	0.48	30.8	19.0	11.63	9.38	0.56
1270	15	0.51	14.08	56.2	38.1	21.4	11.26	9.76	0.46	38.5	20.3	11.31	9.37	0.53
1271	15	0.51	14.08	56.4	45.7	23.0	11.16	9.77	0.44	46.2	22.9	11.34	9.37	0.53
1272	15	0.51	14.08	57.1	53.3	25.2	10.99	9.75	0.42	53.9	24.4	11.25	9.41	0.51
1273	15	0.51	14.08	56.3	61.0	26.8	10.88	9.82	0.39	61.6	24.0	10.96	9.42	0.47
1274	15	0.51	14.08	56.6	68.6	27.2	10.85	9.83	0.38	69.3	23.5	10.78	9.44	0.44
1275	15	0.51	14.08	56.7	76.2	28.0	10.84	9.86	0.37	77.0	24.6	10.71	9.47	0.42
1276	15	0.51	14.08	57.3	83.8	29.3	10.83	9.90	0.36	84.7	27.4	10.67	9.55	0.40
1277	15	0.51	14.08	56.8	91.4	30.0	10.81	9.94	0.35	92.4	29.7	10.66	9.60	0.39
1280	20	0.52	14.02	41.1	7.6	20.0	12.57	9.65	0.63	7.7	18.6	12.00	9.41	0.60
1281	20	0.52	14.02	40.4	15.2	19.1	12.30	9.68	0.59	15.4	17.6	12.05	9.44	0.60
1282	20	0.52	14.02	40.2	22.9	20.7	11.90	9.70	0.55	23.1	16.6	12.01	9.47	0.59
1283	20	0.52	14.02	39.2	30.5	22.3	11.60	9.72	0.51	30.8	16.5	12.08	9.50	0.60
1284	20	0.52	14.02	39.6	38.1	23.3	11.24	9.72	0.46	38.5	17.4	12.04	9.53	0.59
1285	20	0.52	14.02	39.1	45.7	25.1	11.05	9.73	0.43	46.2	19.2	11.79	9.50	0.56
1286	20	0.52	14.02	38.9	53.3	27.9	10.89	9.76	0.40	53.9	20.1	11.46	9.52	0.52
1287	20	0.52	14.02	39.1	60.9	28.8	10.87	9.80	0.39	61.6	20.7	11.09	9.54	0.47
1288	20	0.52	14.02	38.5	68.6	28.2	10.87	9.83	0.38	69.3	22.2	10.79	9.55	0.42
1289	20	0.52	14.02	39.0	76.2	29.3	10.76	9.85	0.36	77.0	24.7	10.74	9.57	0.41
1290	20	0.52	14.02	38.9	83.8	31.8	10.59	9.86	0.32	84.7	27.4	10.69	9.63	0.39
1291	20	0.52	14.02	38.5	91.4	34.0	10.57	9.92	0.30	92.4	29.2	10.59	9.70	0.36

(PSI)			(% SPAN)		
% CHANGE DURING DATA AQUISITION	-0.010	0.001	% CHANGE DURING DATA AQUISITION	-0.00	0.00
SLOPE (PSI/VOLT)	0.398	0.791	ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.004	0.007	% CHANGE DURING DATA AQUISITION	-0.00	-0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 09-01-83 TIME: 10:07:15

PATM= 14.59 PSIA TATM= 80.5 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	0.000	0.000	0.000	-1.005	1.005	0.000	0.000	0.000
MIN.	-0.000	-0.000	-0.000	-1.006	1.004	-0.000	-0.000	0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	-0.000	0.000	-0.000	-1.005	1.004	-0.000	0.000	0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	14.59	PT=	15.60
PS=	14.59	PS=	14.49
MACH #=	0.00	MACH #=	0.33
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.3
CMDOT= 0.3

Figure G-5. Data System End-to-End Check, 1 Psi on P1B

(PSI)			(% SPAN)		
% CHANGE DURING DATA AQUISITION	0.005	0.005	% CHANGE DURING DATA AQUISITION	0.00	0.00
SLOPE (PSI/VOLT)	0.398	0.791	ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	-0.014	0.022	% CHANGE DURING DATA AQUISITION	0.00	0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 08-31-83 TIME: 15:37:48

PATM= 14.59 PSIA TATM= 83.0 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	-5.036	5.004	0.000	0.000	0.000	0.000	0.000	0.000
MIN.	-5.036	5.003	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	-5.036	5.004	0.000	0.000	0.000	0.000	0.000	0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	19.64	PT=	14.59
PS=	14.11	PS=	14.59
MACH #=	0.70	MACH #=	0.00
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.4
CMDOT= 0.4

Figure G-4. Data System End-to-End Check, 5 Psi on P1A

Y-INTERCEPT (PSI)	0.052	-0.003	RADIAL PCS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.002	0.002	% CHANGE DURING DATA AQUISITION	-0.00	-0.02
SLOPE (PSI/VOLT)	0.398	0.791	ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.010	0.019	% CHANGE DURING DATA AQUISITION	-0.00	-0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 09-01-83 TIME: 09:55:55

PATM= 14.59 PSIA TATM= 80.4 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	-3.019	3.009	0.000	0.000	0.000	0.000	0.000	0.000
MIN.	-3.020	3.008	-0.000	-0.000	-0.000	-0.000	0.000	0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	-3.019	3.008	0.000	-0.000	-0.000	0.000	0.000	0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	17.61	PT=	14.59
PS=	14.29	PS=	14.59
MACH #=	0.55	MACH #=	0.00
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.5
CMDOT= 0.5

Figure G-3. Data System End-to-End Check, 3 Psi on P1A

Y-INTERCEPT (PSI)	0.052	-0.003	RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.003	0.001	% CHANGE DURING DATA AQUISITION	-0.00	0.01
SLOPE (PSI/VOLT)	0.398	0.791	ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	-0.004	0.014	% CHANGE DURING DATA AQUISITION	-0.00	-0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 09-01-83 TIME: 10:00:22

PATM= 14.59 PSIA TATM= 80.4 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	-1.005	1.005	0.000	-0.000	0.000	0.000	0.000	0.000
MIN.	-1.006	1.004	-0.000	-0.000	-0.000	-0.000	0.000	-0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	-1.005	1.004	0.000	-0.000	-0.000	-0.000	0.000	0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	15.60	PT=	14.59
PS=	14.49	PS=	14.59
MACH #=	0.33	MACH #=	0.00
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.4
CMDOT= 0.4

Figure G-2. Data System End to End Check, 1 Psi on P1A

	0-1 PSID	0-5 PSID
Y-INTERCEPT (PSI)	0.057	-0.001
% CHANGE DURING DATA AQUISITION	0.011	0.004
SLOPE (PSI/VOLT)	0.398	0.791
% CHANGE DURING DATA AQUISITION	-0.008	0.012

	WEDGE PROBE A	WEDGE PROBE B
RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.01	0.01
ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.00	0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 01-01-83 TIME: 00:00:00

PATM= 14.43 PSIA TATM= 82.7 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MIN.	-0.000	0.000	-0.000	-0.000	-0.000	0.000	0.000	-0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	14.43	PT=	14.43
PS=	14.43	PS=	14.43
MACH #=	[illegible]	MACH #=	0.00
SWIRL ANGLE=	34	SWIRL ANGLE=	20

Figure 6-1. Data System Zero Point End-to-End Check

APPENDIX G

MODIFIED PRESWIRL VANE TEST PHASE III PREPARATION AND DATA

```
192: wrt 705,"SM";plt r52,r51,1;wrt 705,"SMo"
193: plt M[2],P[1],2;M[2]+r52;P[1]+r51;pen# ;gto 134
194: "RAW CAL. DATA PRINTOUT":
195: fxd 0 prt "POINT",N;for I=1 to 4;for K=1 to 2
196: fmt 1,"R[",f1.0,",",f1.0,"]=",f9.5;wrt 16.1,I,K,R[I,K]
197: next K;next I;spc 4;stp
198: "ON LINE MACH #":
199: ent "MIDSPAN M#",B,"Patm-Pl",r22
200: fmt 0;gsb "home"
201: for I=1 to 4;gsb "step"
202: next I;wrt 709,"SIAC2";fxd 3;wrt 722,"H"
203: red 722,r20;r20Q[2,2]+Q[1,2]+r21
204: -r22-r21/H*G+P+Y;Y+r21/H+X
205: √(5((X/Y)^.2857-1))+M;dsp M;wait 200;jmp -2
206: "PLOT PT/PTavg":ent "VA",C,"MSM#",B
207: 0+P;for I=1 to 12;A[1,I]+P+P;next I;P/12+P
208: scl .9,1.1,0,100;wrt 705,"SM";pen# 1
209: fxd 2;xax 0,.05,.9,1.1,1
210: fxd 0;yax .9,10,0,100,2
211: 45.6+L[1,1];7+L[2,1];44.28+L[1,2];14.7+L[2,2];42.11+L[1,3]
212: 22.7+L[2,3];41.05+L[1,4];30.3+L[2,4];40.99+L[1,5];37.9+L[2,5]
213: 40.74+L[1,6];45.5+L[2,6];40.2+L[1,7];53.6+L[2,7];39.62+L[1,8]
214: 60.7+L[2,8];39.94+L[1,9];68.7+L[2,9];41.11+L[1,10];76.5+L[2,10]
215: 41.75+L[1,11];83.4+L[2,11];41.04+L[1,12];91.6+L[2,12]
216: 0+L[1,13]
217: for I=1 to 12;L[1,I]+L[1,13]+L[1,13];next I;L[1,13]/12+L[1,13];pen
218: line 2;plt L[1,1]/L[1,13],L[2,1],-2
219: for I=2 to 12;plt L[1,I]/L[1,13],L[2,I],0;next I;pen
220: plt .9,-25,-2;plt .93,-25,-1;plt .94,-25,0;lbl "ENG. P072"
221: ent "START PT. #?",L[2,13];pen
222: plt .9,-30,0;lbl "PT. #= ",L[2,13],"-",L[2,13]+11;line
223: pen;plt .9,-35,1;lbl "SCREENS= 3"
224: wrt 705,"SMo";for I=1 to 12;2+A;if I=1;1+A
225: plt A[1,I]/P,A[5,I],A;next I;wrt 705,"SM"
226: plt .99,-15,1;lbl "PT/PTavg"
227: plt .87,42,1;csiz 2.2,1.8,1,90;lbl "% SPAN"
228: csiz 2.2,1.8;plt 1.05,-25,1;lbl "STATION 2.5";cplt -11,-1
229: fxd 0;lbl "VANE ANGLE= ",C;cplt -14,-1
230: fxd 2;lbl "MSM#= ",B;pen# 0
231: fxd 0;prt "VANE ANGLE=",C
232: fxd 2;prt "MSM#=",B;spc
233: prt "% SPAN        PT"
234: fmt 1,f5.1,f11.2;for I=1 to 12;wrt 16.1,A[5,I],A[1,I];next I
235: spc ;fxd 2;prt "AVG.=",P
*28321
```

```
127: fmt 24x,"SWIRL ANGLE=",f4.0,22x,"SWIRL ANGLE=",f4.0,/
128: wrt 6,F[3,6],F[3,8]
129: fmt 1,3x,"PT RAKE=",f7.2;wrt 6.1,P-Y[9,2]
130: fmt 1,3x,"MDOT=",f9.1;wrt 6.1,r55
131: fmt 1,3x,"CMDOT=",f8.1,11/;wrt 6.1,r56
132: fmt 0;dsp "CONTINUE TO STORE";stp
133: N→r100;trk 0;N-1377→O;rcf O,R[*],Z[*],F[*],P,N,T,B,C;gto 141
134: "ON LINE STATIC TAP PRESS.":
135: fmt 0;gsb "home"
136: for I=1 to 3;gsb "step"
137: next I;wrt 709,"SIAC2";wrt 722,"H";fxd 3
138: red 722,r30;r30Q[2,2]+Q[1,2]→r31;P-r31→r32
139: 558.4r32(P/r32)^(1/7)√(((P/r32)^.2857-1)/(T+460))→r33
140: dsp r31,r33;wait 200;jmp -2
141: dsp "CONTINUE TO PLOT";stp
142: "BCKGRD PLOT DATA":
143: 25.45→L[1,1];7→L[2,1];22.58→L[1,2];14.7→L[2,2];19.97→L[1,3];22.7→L[2,3]
144: 16.95→L[1,4];30.3→L[2,4];14.71→L[1,5];37.9→L[2,5];13.52→L[1,6]
145: 45.5→L[2,6];13.79→L[1,7];53.6→L[2,7];15.64→L[1,8];60.7→L[2,8]
146: 20.23→L[1,9];68.7→L[2,9];24.58→L[1,10];76.5→L[2,10]
147: 26.34→L[1,11];83.4→L[2,11];25.55→L[1,12];91.6→L[2,12]
148: 28.3→L[1,13];16.7→L[2,13];27.48→L[1,14];23.4→L[2,14]
149: 26.85→L[1,15];31.2→L[2,15];27.42→L[1,16];38.8→L[2,16]
150: 28.7→L[1,17];47.1→L[2,17];30.37→L[1,18];54.4→L[2,18]
151: 33.9→L[1,19];62→L[2,19];36.76→L[1,20];69.6→L[2,20]
152: 40.1→L[1,21];77.2→L[2,21];36.81→L[1,22];84.8→L[2,22]
153: 35.11→L[1,23];93.1→L[2,23]
154: int(P[1]/7.7+.5)→I
155: T[1]→A[1,I];S[1]→A[2,I];M[1]→A[3,I];F[3,6]→A[4,I];P[1]→A[5,I]
156: Y[9,2]→A[6,I];Y[2,2]→A[7,I];Y[1,2]→A[8,I];P→A[9,I];T→A[10,I]
157: T[2]→A[11,I];S[2]→A[12,I];M[2]→A[13,I];F[3,8]→A[14,I];P[2]→A[15,I]
158: fmt 0;wrt 705,"ip1256,3480,6629,9451"
159: scl 50,80,0,100;if flg1;gto 182
160: wrt 705,"SM";pen# 1
161: csiz 1.7,1.5;wrt 705,"VS5";fxd 0;xax 0,5,50,80,1;yax 50,10,0,100,2
162: "BACKGROUND PLOTS":
163: for I=1 to 23;90-L[1,I]→L[1,I];next I
164: line 2;plt L[1,1],L[2,1],1
165: for I=2 to 12;plt L[1,I],L[2,I],2;next I;pen
166: plt 50,-30,-2;plt 53,-30,-1;plt 54,-30,0;lbl "2.5 POS. (ENG. P072)";pen
167: line 5;plt L[1,13],L[2,13],1
168: for I=14 to 23;plt L[1,I],L[2,I],2;next I;pen
169: plt 50,-25,-2;plt 53,-25,-1;plt 54,-25,0;lbl "2.3 POS. (ENG. P072)"
170: line ;pen;wrt 705,"SM+";plt 50,-35,-2;plt 53,-35,-1
171: wrt 705,"SM";plt 54,-35,1;lbl "2.3 POS. (CRF F100)";pen
172: wrt 705,"SMo";plt 50,-40,-2;plt 53,-40,-1;wrt 705,"SM"
173: plt 54,-40,1;lbl "2.5 POS. (CRF F100)";wrt 705,"SM"
174: plt 60,-12,1;lbl "SWIRL ANGLE(90=AXIAL)"
175: csiz 1.7,1.5,1,90;plt 47,46,1;lbl "% SPAN";csiz 1.7,1.5
176: plt 72,-25,1;fxd 0;lbl "VANE ANGLE= ",C
177: plt 72,-30,1;fxd 2;lbl "MSM# 2.5= ",B
178: plt 72,-35,1;fxd 0;lbl "PT. #= ",N,"- ",N+11;fxd 2;pen
179: plt 72,-40,1;lbl "SCREENS= 3";wrt 705,"SMo";csiz 2.2,1.8
180: 90-F[3,6]→r50;plt r50,P[1],1
181: wrt 705,"SM+";90-F[3,8]→r60;plt r60,P[2],1;jmp 5
182: pen# 1;wrt 705,"SM";plt r50,r51,1;wrt 705,"SMo"
183: 90-F[3,6]→r50;plt r50,P[1],2
184: wrt 705,"SM";plt r60,r61,1;wrt 705,"SM+"
185: 90-F[3,8]→r60;plt r60,P[2],2
186: P[1]→r51;P[2]→r61;pen# ;sfg 1;gto 134
187: scl 0,.7,0,100;ofs 1.129,0
188: if flg1;jmp 4
189: wrt 705,"SM";csiz 1.7,1.5;pen# 1;fxd 1;xax 0,.1,0,.7,1
190: fxd 0;yax 0,10,0,100,2;sfg 1;csiz 2.2,1.8;pen# 3
```

```
60: (F[2,L]-F[1,L])*100/F[1,L]→F[5,L]
61: next L
62: 1/(R[2,1]-R[1,1])→Q[2,1];1/(R[3,1]-R[4,1])→Q[3,1]
63: 5/(R[2,2]-R[1,2])→Q[2,2];5/(R[3,2]-R[4,2])→Q[3,2]
64: -R[1,1]*Q[2,1]→Q[1,1];-R[4,1]*Q[3,1]→Q[4,1]
65: -R[1,2]*Q[2,2]→Q[1,2];-R[4,2]*Q[3,2]→Q[4,2]
66: (Q[1,1]-Q[4,1])*100→r1;(Q[1,2]-Q[4,2])*20→r2
67: 100*(Q[2,1]-Q[3,1])/Q[2,1]→r3;100*(Q[2,2]-Q[3,2])/Q[2,2]→r4
68: 100(F[3,5]+.25)/3.69→P[1]
69: 100(F[3,7]+.25)/3.73→P[2]
70: fmt 2/,45x,"*** CALIBRATION INFORMATION ***",/;wrt 6
71: fmt 30x,"TRANSDUCERS",50x,"TRAVERSES",/;wrt 6
72: fmt z,25x,"0-1 PSID",7x,"0-5 PSID";wrt 6
73: fmt 36x,"WEDGE PROBE A",3x,"WEDGE PROBE B",/;wrt 6
74: fmt "Y-INTERCEPT",f20.3,f15.3,18x,"RADIAL POS.",f17.1,f15.1
75: wrt 6,Q[1,1],Q[1,2],P[1],P[2]
76: fmt "(PSI)",59x,"(% SPAN)",/;wrt 6
77: fmt 3x,"% CHANGE DURING",f13.3,f15.3,21x,"% CHANGE DURING",f11.2,f15.2
78: wrt 6,r1,r2,F[5,5],F[5,7]
79: fmt 3x,"DATA AQUISITION",49x,"DATA AQUISITION",/;wrt 6
80: fmt "SLOPE",f26.3,f15.3,18x,"ROTATIONAL ANGLE",f12.1,f15.1
81: wrt 6,Q[2,1],Q[2,2],F[3,6],F[3,8]
82: fmt "(PSI/VOLT)",54x,"(0=AXIAL)",/;wrt 6
83: fmt 3x,"% CHANGE DURING",f13.3,f15.3,21x,"% CHANGE DURING",f11.2,f15.2
84: wrt 6,r3,r4,F[5,6],F[5,8]
85: fmt 3x,"DATA AQUISITION",49x,"DATA AQUISITION",5/;wrt 6
86: fmt 0
87: dsp "CONTINUE?";stp
88: "DATA RED.":
89: .998→G;.905→H
90: for L=1 to 3;for I=1 to 9
91: Z[I,L]Q[2,2]+Q[1,2]→Y[I,L];next I
92: for I=10 to 11
93: Z[I,L]Q[2,1]+Q[1,1]→Y[I,L];next I;next L
94: for I=1 to 9;√Z[I,4]Q[2,2]→Y[I,4];next I
95: for I=10 to 11;√Z[I,4]Q[2,1]→Y[I,4];next I
96: (Y[3,2]+Y[4,2])/2H→O[1];(Y[6,2]+Y[7,2])/2H→O[2]
97: -Y[5,2]-O[1]G+P→S[1];-Y[8,2]-O[2]G+P→S[2]
98: for L=1 to 2;S[L]+O[L]→T[L];√(5((T[L]/S[L])^.2857-1))→M[L]
99: next L;P-Y[2,2]→r57
100: 558.4r57(P/r57)^(1/7)√(((P/r57)^.2857-1)/(T+460))→r55
101: .6451r55√(T+460)/(P-Y[9,2])→r56
102: fmt 47x,"*** INLET PROFILE DATA ***",2/;wrt 6
103: fmt 40x,"VANE ANGLE=",f4.0,11x,"MIDSPAN MACH #=",f5.2;wrt 6,C,B
104: fmt /,35x,"POINT #=",f4.0,5x,"DATE:",c6,"-83",5x,"TIME:",c9
105: "-"→T$[3,3];wrt 6,N,T$[1,5],T$[7]
106: fmt /,40x,"PATM=",f6.2," PSIA",10x,"TATM=",f6.1," F",2/
107: wrt 6,P,T
108: fmt 25x,"WEDGE PROBE A(PSID)",19x,"WEDGE PROBE B(PSID)",z;wrt 6
109: fmt 14x,"STATIC TAPS(PSID)";wrt 6
110: fmt 30x,"STA. 2.5",30x,"STA. 2.3";wrt 6
111: fmt /,19x,"PATM-P1",6x,"P1-P2",7x,"P3-P2",8x,"PATM-P1",z;wrt 6
112: fmt 6x,"P1-P2",7x,"P3-P2",8x,"PATM-P4",5x,"PATM-P5",/;wrt 6
113: fmt 1,3x,c4,f18.3,2f12.3,2x,3f12.3,2x,2f12.3
114: "MAX."→A$
115: wrt 6.1,A$,Y[5,3],Y[4,3],Y[10,3],Y[8,3],Y[7,3],Y[11,3],Y[2,3],Y[1,3]
116: "MIN."→A$
117: wrt 6.1,A$,Y[5,1],Y[4,1],Y[10,1],Y[8,1],Y[7,1],Y[11,1],Y[2,1],Y[1,1]
118: fmt 2,z,3x,"STD DEV.",f14.3,2f12.3;wrt 6.2,Y[5,4],Y[4,4],Y[10,4]
119: fmt 2,2x,3f12.3,2x,2f12.3;wrt 6.2,Y[8,4],Y[7,4],Y[11,4],Y[2,4],Y[1,4]
120: "AVG."→A$
121: wrt 6.1,A$,Y[5,2],Y[4,2],Y[10,2],Y[8,2],Y[7,2],Y[11,2],Y[2,2],Y[1,2]
122: fmt /,3x,"REDUCED DATA:",/;wrt 6
123: fmt 24x,"% SPAN",f12.1,20x,"% SPAN",f12.1;wrt 6,P[1],P[2]
124: fmt 24x,"PT=",f16.2,19x,"PT=",f16.2;wrt 6,T[1],T[2]
```

APPENDIX F

PHASE II COMPUTER PROGRAM LISTING

```
0: "CRF F100 PSV TEST IN RM 24,3rd SET SCREENS; 3/18/83":
1: dim E[2,4:8,5],H[3:4,36],R[4,3],Z[11,4],F[5,4:8],P,N,T,B,C
2: dim C$[1],S[2],Q[4,2],T[2],O[2],N[3],M[2],C[0:1,5:8],Y[11,4]
3: dim P[2],A$[4],T$[14],B$[12],A[15,12],L[2,24]
4: "TD"+B$;ent "DATE & TIME",B$[3];wrt 709,B$
5: -.0678+C[0,7];-.4188+C[1,7];71.426+C[0,8];11.3099+C[1,8]
6: -.054222+C[0,5];-.413503+C[1,5];74.077+C[0,6];11.338+C[1,6];7000+W
7: cfg 1;ent "Patm?",Q,"MIDSPAN MACH #?",B,"VANE ANGLE?",C
8: ent "POINT NO.?",N;dsp r100,N
9: fmt 0;Q*.49118+P
10: fxd 0;gsb "home"
11: red 713,T;if T<32;beep;ent T
12: for I=1 to 2;if I=2;gsb "step"
13: if I=2;wait W-3000
14: wait 3000;gsb "scanC"
15: next I
16: for J=1 to 9;J+I;gsb "step"
17: wait w;wrt 709,"AC2";gsb "scanD"
18: if J=3;10+I;wrt 709,"AC1";gsb "scanD"
19: if J=6;11+I;wrt 709,"AC1";gsb "scanD"
20: next J
21: for I=3 to 4;gsb "step"
22: wait W
23: gsb "scanC"
24: next I;gsb "step"
25: sfg 14;gto 54
26: "scanC":
27: wrt 709,"AC1";1+K;jmp 2
28: wrt 709,"AC2";2+K
29: wrt 722,"HSM002L1RS130STN.1STIM2T3QX1"
30: rds(722)+S;if S#66;jmp 0
31: wrt 722,"REM";red 722,R[I,K];if K=1;jmp -3
32: if I=1;1+A;gsb "EE"
33: if I=4;2+A;gsb "EE"
34: ret
35: "scanD":wrt 722,"HSM002L1RS136STN.1STIM2T3QX1"
36: rds(722)+S;if S#66;jmp 0
37: "stat":wrt 722,"REM";red 722,Z[I,2];wrt 722,"REL";red 722,Z[I,1]
38: wrt 722,"REU";red 722,Z[I,3];wrt 722,"REV";red 722,Z[I,4]
39: ret
40: gsb "stat"
41: ret
42: "step":wrt 709,"DC1,3";wait 50;wrt 709,"DO1,3";V+1+V;wait 200;jmp 2
43: "home":wrt 709,"SI","DC1,4";wait 100;wrt 709,"DO1,4";wait 9000;0+V
44: red 3,U,D;if U=480;0+U
45: if V#U/10;dsp "SCANIVALVE ERROR";stp
46: if U=0;dsp "HOME";ret
47: if U>0;dsp U/10;ret
48: "EE":wrt 709,"SIARAF4AL8"
49: for L=4 to 8;wrt 709,"ASVN5SO1VF1VS1VT3VS";for J=1 to 5
50: red 709,E[A,L,J];next J;next L
51: if I=1;wrt 709,"TD";red 709,T$
52: ret
53: "RERUN":fmt 1,38/;wrt 6.1;gto 9
54: "EEAVG":
55: for A=1 to 2;for L=4 to 8;0+E;for J=1 to 5;E[A,L,J]+E+E
56: next J;E/5+F[A,L];next L;next A
57: for L=5 to 8
58: F[1,L]*C[1,L]+C[0,L]+F[3,L]
```

TABLE F-1 (Concluded)

						STATION 2.3					STATION 2.5				
PT#	STA.2.5 OCTANT#	VANE ANGLE	CORRECTED MASS FLOW	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	M#	%SPAN	SWIRL ANGLE	PT	PS	M#
1462	2	29	54.0	14.44	48.0	7.8	30.1	12.44	9.44	0.64	7.8	23.7	11.73	9.57	0.55
1463	2	29	54.0	14.44	46.9	15.3	27.0	12.20	9.48	0.61	15.5	20.9	12.10	9.65	0.58
1464	2	29	54.0	14.44	47.4	22.9	28.5	12.09	9.48	0.60	23.2	19.4	12.27	9.70	0.59
1465	2	29	54.0	14.44	47.4	30.5	28.5	11.58	9.53	0.54	30.8	19.6	12.39	9.76	0.59
1466	2	29	54.0	14.44	46.8	38.1	26.2	11.47	9.55	0.52	38.6	20.4	12.35	9.78	0.59
1467	2	29	54.0	14.44	47.3	45.7	29.6	11.45	9.60	0.51	46.3	22.6	12.19	9.77	0.57
1468	2	29	54.0	14.44	47.8	53.4	35.0	11.43	9.65	0.50	53.9	24.0	11.78	9.75	0.53
1469	2	29	54.0	14.44	47.0	61.0	36.9	11.29	9.68	0.47	61.7	25.2	11.27	9.79	0.45
1470	2	29	54.0	14.44	47.0	68.6	37.8	11.20	9.72	0.45	69.3	26.3	11.08	9.80	0.42
1471	2	29	54.0	14.44	47.6	76.2	38.2	11.13	9.76	0.44	77.0	25.0	11.06	9.81	0.42
1472	2	29	54.0	14.44	47.9	83.8	36.2	11.06	9.82	0.42	84.7	25.4	11.13	9.89	0.41
1473	2	29	54.0	14.44	47.3	91.5	34.6	11.14	9.88	0.42	92.4	25.4	11.24	9.96	0.42
1476	8	29	54.0	14.44	49.1	7.7	29.7	12.48	9.46	0.64	7.8	23.2	12.35	9.61	0.61
1477	8	29	54.0	14.44	47.6	15.3	27.8	12.22	9.48	0.61	15.5	21.4	12.25	9.65	0.59
1478	8	29	54.0	14.44	50.6	22.9	28.6	12.14	9.51	0.60	23.2	19.9	12.31	9.68	0.60
1479	8	29	54.0	14.44	49.7	30.5	27.8	11.61	9.55	0.53	30.8	19.0	12.34	9.73	0.59
1480	8	29	54.0	14.44	47.9	38.1	26.3	11.50	9.58	0.52	38.6	18.5	12.29	9.74	0.59
1481	8	29	54.0	14.44	47.6	45.8	30.2	11.49	9.64	0.51	46.2	19.1	12.30	9.78	0.58
1482	8	29	54.0	14.44	47.6	53.4	33.9	11.45	9.68	0.50	54.0	21.1	12.12	9.80	0.56
1483	8	29	54.0	14.44	46.9	61.0	37.6	11.33	9.74	0.47	61.7	23.7	11.75	9.83	0.51
1484	8	29	54.0	14.44	47.4	68.6	37.8	11.22	9.76	0.45	69.4	25.4	11.47	9.87	0.47
1485	8	29	54.0	14.44	48.4	76.2	37.6	11.16	9.80	0.44	77.0	25.4	11.28	9.86	0.44
1486	8	29	54.0	14.44	48.4	83.8	36.7	11.11	9.87	0.41	84.8	23.7	11.17	9.92	0.42
1487	8	29	54.0	14.44	47.3	91.5	35.2	11.15	9.91	0.41	92.5	22.9	11.10	9.99	0.39

TABLE F-1 (Cont'd)

						STATION 2.3					STATION 2.5				
PT#	STA.2.5 OCTANT#	VANE ANGLE	CORRECTED MASS FLOW	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	M#	%SPAN	SWIRL ANGLE	PT	PS	M#
1406	8	29	54.0	14.17	48.1	7.7	30.1	12.17	9.25	0.64	7.8	22.6	12.10	9.41	0.61
1407	8	29	54.0	14.17	47.1	15.3	26.9	11.93	9.27	0.61	15.5	21.1	12.02	9.44	0.60
1408	8	29	54.0	14.17	48.1	22.9	27.6	11.85	9.30	0.60	23.2	19.6	12.10	9.46	0.60
1409	8	29	54.0	14.17	45.6	30.5	27.6	11.34	9.31	0.54	30.8	18.6	12.12	9.50	0.60
1410	8	29	54.0	14.17	46.0	38.1	26.5	11.26	9.35	0.52	38.5	18.3	12.07	9.52	0.59
1411	8	29	54.0	14.17	44.9	45.7	29.7	11.22	9.39	0.51	46.2	18.9	12.03	9.53	0.59
1412	8	29	54.0	14.17	44.3	53.4	34.0	11.20	9.43	0.50	53.9	21.0	11.84	9.56	0.56
1413	8	29	54.0	14.17	44.6	61.0	36.8	11.08	9.48	0.48	61.6	23.2	11.45	9.56	0.51
1414	8	29	54.0	14.17	44.4	68.6	37.8	10.98	9.50	0.46	69.4	24.7	11.16	9.59	0.47
1415	8	29	54.0	14.17	44.4	76.2	37.4	10.93	9.54	0.45	77.0	24.5	11.02	9.61	0.45
1416	8	29	54.0	14.17	43.9	83.8	36.7	10.84	9.62	0.42	84.7	23.1	10.92	9.67	0.42
1417	8	29	54.0	14.17	44.4	91.4	36.8	10.85	9.65	0.41	92.4	22.8	10.82	9.74	0.39
1420	7	29	54.0	14.17	45.0	7.7	29.3	12.15	9.22	0.64	7.8	21.2	12.04	9.37	0.61
1421	7	29	54.0	14.17	45.3	15.3	27.9	11.92	9.26	0.61	15.5	19.9	12.00	9.38	0.60
1422	7	29	54.0	14.17	45.1	22.9	28.7	11.83	9.26	0.60	23.2	19.0	11.98	9.41	0.60
1423	7	29	54.0	14.17	46.8	30.6	27.5	11.36	9.31	0.54	30.9	19.6	11.88	9.45	0.58
1424	7	29	54.0	14.17	45.4	38.1	26.5	11.24	9.35	0.52	38.6	20.4	11.83	9.45	0.58
1425	7	29	54.0	14.17	45.1	45.7	30.5	11.22	9.40	0.51	46.3	21.6	11.58	9.45	0.55
1426	7	29	54.0	14.17	44.6	53.3	35.0	11.20	9.44	0.50	54.0	21.5	11.13	9.45	0.49
1427	7	29	54.0	14.17	44.3	61.0	36.9	11.08	9.48	0.48	61.7	22.1	10.92	9.47	0.46
1428	7	29	54.0	14.17	44.2	68.6	37.2	10.99	9.51	0.46	69.4	23.7	10.81	9.50	0.43
1429	7	29	54.0	14.17	44.2	76.2	37.8	10.93	9.56	0.44	77.0	26.8	10.79	9.52	0.43
1430	7	29	54.0	14.17	43.8	83.8	36.7	10.85	9.62	0.42	84.7	29.4	10.77	9.59	0.41
1431	7	29	54.0	14.17	43.8	91.4	35.3	10.87	9.66	0.41	92.4	29.6	10.66	9.63	0.38
1434	6	29	54.0	14.44	38.3	7.7	30.3	12.46	9.43	0.64	7.8	22.5	12.25	9.41	0.63
1435	6	29	54.0	14.44	38.6	15.3	27.0	12.21	9.46	0.61	15.4	20.3	12.42	9.45	0.64
1436	6	29	54.0	14.44	38.4	22.9	29.0	12.12	9.47	0.60	23.2	19.1	12.65	9.55	0.65
1437	6	29	54.0	14.44	38.5	30.5	28.5	11.59	9.52	0.54	30.8	19.4	12.28	9.55	0.61
1438	6	29	54.0	14.44	38.5	38.1	26.5	11.48	9.54	0.52	38.5	21.1	12.11	9.53	0.60
1439	6	29	54.0	14.44	38.4	45.7	30.2	11.47	9.61	0.51	46.2	23.3	12.00	9.52	0.58
1440	6	29	54.0	14.44	38.2	53.3	34.8	11.44	9.64	0.50	54.0	25.3	11.58	9.52	0.54
1441	6	29	54.0	14.44	38.5	61.0	36.8	11.30	9.68	0.47	61.6	26.0	11.34	9.58	0.50
1442	6	29	54.0	14.44	38.1	68.6	38.6	11.21	9.72	0.46	69.4	26.3	11.23	9.62	0.48
1443	6	29	54.0	14.44	38.2	76.2	36.8	11.15	9.76	0.44	77.0	25.9	11.18	9.64	0.47
1444	6	29	54.0	14.44	38.1	83.8	38.0	11.06	9.81	0.42	84.7	25.0	11.08	9.71	0.44
1445	6	29	54.0	14.44	38.9	91.4	35.4	11.09	9.86	0.41	92.4	23.5	10.99	9.80	0.41
1448	1	29	54.0	14.44	41.2	7.7	30.3	12.46	9.40	0.65	7.8	22.0	12.46	9.68	0.61
1449	1	29	54.0	14.44	41.1	15.3	27.9	12.21	9.44	0.62	15.5	19.3	12.42	9.67	0.61
1450	1	29	54.0	14.44	41.3	22.9	27.7	12.13	9.44	0.61	23.2	18.9	12.27	9.68	0.59
1451	1	29	54.0	14.44	41.5	30.5	28.5	11.58	9.49	0.54	30.8	18.7	12.15	9.74	0.57
1452	1	29	54.0	14.44	41.8	38.1	26.2	11.48	9.54	0.52	38.5	20.7	12.21	9.73	0.58
1453	1	29	54.0	14.44	41.1	45.8	30.0	11.46	9.59	0.51	46.2	22.1	12.19	9.73	0.58
1454	1	29	54.0	14.44	41.5	53.3	35.3	11.43	9.62	0.50	53.9	22.4	11.61	9.71	0.51
1455	1	29	54.0	14.44	41.8	61.0	36.1	11.30	9.68	0.48	61.6	25.4	11.37	9.75	0.47
1456	1	29	54.0	14.44	41.3	68.7	36.7	11.19	9.71	0.46	69.3	28.6	11.38	9.82	0.46
1457	1	29	54.0	14.44	42.6	76.2	37.6	11.14	9.76	0.44	77.0	30.1	11.28	9.85	0.44
1458	1	29	54.0	14.44	43.3	83.8	37.7	11.05	9.80	0.42	84.7	30.2	11.15	9.90	0.42
1459	1	29	54.0	14.44	42.3	91.5	34.8	11.09	9.87	0.41	92.4	29.1	11.09	9.96	0.40

TABLE F-1 (Cont'd)

					STATION 2.3					STATION 2.5				
PT#	VANE ANGLE	MIDSPAN M#	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	M#	%SPAN	SWIRL ANGLE	PT	PS	M#
1350	29	0.54	14.41	33.8	7.6	30.9	12.58	9.42	0.66	7.8	23.1	12.33	9.59	0.61
1351	29	0.54	14.41	33.8	15.3	28.7	12.33	9.45	0.63	15.4	21.8	12.26	9.62	0.60
1352	29	0.54	14.41	34.7	22.9	28.9	12.30	9.48	0.62	23.1	20.6	12.16	9.64	0.59
1353	29	0.54	14.41	35.1	30.5	28.4	11.72	9.49	0.56	30.8	19.1	12.04	9.68	0.57
1354	29	0.54	14.41	34.9	38.1	28.6	11.41	9.51	0.52	38.5	18.1	12.08	9.71	0.57
1355	29	0.54	14.41	34.4	45.7	29.2	11.46	9.55	0.52	46.2	18.4	12.15	9.72	0.57
1356	29	0.54	14.41	34.8	53.4	34.3	11.43	9.57	0.51	53.9	20.9	11.92	9.74	0.54
1357	29	0.54	14.41	35.7	61.0	36.9	11.31	9.63	0.48	61.6	24.1	11.63	9.77	0.50
1358	29	0.54	14.41	35.0	68.6	38.4	11.21	9.68	0.46	69.4	25.9	11.42	9.80	0.47
1359	29	0.54	14.41	36.3	76.2	38.1	11.08	9.70	0.44	77.0	25.9	11.22	9.82	0.44
1360	29	0.54	14.41	34.2	83.8	37.5	10.94	9.76	0.41	84.7	23.9	11.09	9.89	0.41
1361	29	0.54	14.41	35.7	91.4	37.9	10.95	9.85	0.39	92.4	22.6	11.05	9.95	0.39
1364	28	0.55	14.41	40.8	7.6	30.1	12.51	9.85	0.59	7.7	22.5	12.56	9.95	0.59
1365	28	0.55	14.41	40.8	15.3	27.1	12.30	9.89	0.57	15.4	20.2	12.54	9.98	0.58
1366	28	0.55	14.41	39.9	22.9	27.3	12.22	9.90	0.56	23.1	19.0	12.74	10.03	0.59
1367	28	0.55	14.41	40.7	30.5	26.4	11.86	9.92	0.51	30.8	18.9	12.81	10.05	0.60
1368	28	0.55	14.41	38.7	38.1	25.1	11.87	9.92	0.51	38.5	19.4	12.71	10.07	0.59
1369	28	0.55	14.41	40.5	45.7	27.9	11.66	9.98	0.48	46.2	20.5	12.57	10.09	0.57
1370	28	0.55	14.41	40.6	53.4	32.5	11.59	10.01	0.46	53.9	22.0	12.39	10.12	0.55
1371	28	0.55	14.41	38.8	61.0	35.2	11.51	10.05	0.44	61.6	23.9	12.10	10.12	0.51
1372	28	0.55	14.41	39.7	68.6	36.4	11.45	10.06	0.43	69.3	24.8	11.73	10.11	0.47
1373	28	0.55	14.41	40.4	76.2	36.4	11.46	10.12	0.43	77.0	24.5	11.57	10.15	0.44
1374	28	0.55	14.41	40.2	83.8	36.1	11.43	10.16	0.41	84.7	23.3	11.47	10.22	0.41
1375	28	0.55	14.41	40.6	91.4	36.4	11.43	10.24	0.40	92.4	23.0	11.34	10.29	0.37
1378	25	0.49	14.42	37.0	7.6	25.6	11.89	9.46	0.58	7.7	20.5	12.29	9.56	0.61
1379	25	0.49	14.42	35.7	15.3	22.8	12.04	9.51	0.59	15.4	19.4	12.60	9.57	0.64
1380	25	0.49	14.42	36.9	22.9	23.5	12.03	9.58	0.58	23.1	19.2	12.37	9.58	0.62
1381	25	0.49	14.42	37.3	30.5	23.5	12.28	9.62	0.60	30.8	20.0	11.78	9.58	0.55
1382	25	0.49	14.42	37.4	38.1	25.1	12.32	9.64	0.60	38.5	20.7	11.32	9.52	0.50
1383	25	0.49	14.42	37.2	45.7	27.6	11.83	9.64	0.55	46.2	21.0	11.15	9.52	0.48
1384	25	0.49	14.42	36.6	53.4	31.7	11.14	9.67	0.45	53.9	23.9	11.28	9.55	0.49
1385	25	0.49	14.42	35.5	61.0	33.3	11.06	9.68	0.44	61.6	26.7	11.43	9.60	0.51
1386	25	0.49	14.42	36.3	68.6	34.4	11.09	9.72	0.44	69.3	26.6	11.39	9.64	0.49
1387	25	0.49	14.42	35.4	76.2	33.6	11.11	9.75	0.43	77.0	25.7	11.05	9.66	0.44
1388	25	0.49	14.42	36.4	83.8	36.0	11.11	9.82	0.42	84.7	26.1	10.78	9.72	0.39
1389	25	0.49	14.42	35.5	91.4	37.9	11.12	9.87	0.42	92.4	29.9	10.77	9.77	0.38
1392	30	0.54	14.42	36.4	7.7	30.9	12.25	9.00	0.68	7.7	23.5	11.88	9.19	0.62
1393	30	0.54	14.42	37.3	15.3	28.4	11.99	9.05	0.65	15.4	21.9	11.76	9.21	0.60
1394	30	0.54	14.42	36.7	22.9	29.1	11.96	9.05	0.64	23.1	20.0	11.58	9.22	0.58
1395	30	0.54	14.42	37.2	30.5	31.1	11.52	9.12	0.59	30.8	18.0	11.64	9.26	0.58
1396	30	0.54	14.42	37.0	38.1	30.6	11.26	9.15	0.55	38.5	17.9	11.76	9.29	0.59
1397	30	0.54	14.42	37.1	45.7	33.4	11.25	9.19	0.55	46.2	19.7	11.61	9.32	0.57
1398	30	0.54	14.42	37.0	53.4	35.7	11.14	9.22	0.53	53.9	23.7	11.45	9.36	0.54
1399	30	0.54	14.42	36.2	61.0	37.3	10.95	9.20	0.51	61.7	26.7	11.42	9.33	0.55
1400	30	0.54	14.42	35.8	68.6	36.0	10.83	9.22	0.48	69.3	26.8	11.21	9.35	0.52
1401	30	0.54	14.42	37.5	76.2	38.4	10.72	9.27	0.46	77.0	25.3	10.90	9.37	0.47
1402	30	0.54	14.42	36.5	83.8	38.6	10.55	9.33	0.42	84.7	23.5	10.74	9.44	0.43
1403	30	0.54	14.42	36.3	90.3	38.4	10.58	9.40	0.41	92.4	22.5	10.72	9.50	0.42

TABLE F-1 (Cont'd)

					STATION 2.3					STATION 2.5				
PT#	VANE ANGLE	MIDSPAN M#	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	M#	%SPAN	SWIRL ANGLE	PT	PS	M#
1294	25	0.49	14.02	38.6	7.6	25.7	11.61	9.15	0.59	7.7	19.8	12.33	9.30	0.65
1295	25	0.49	14.02	38.4	15.3	22.7	11.80	9.22	0.60	15.4	19.8	12.44	9.30	0.66
1296	25	0.49	14.02	38.8	22.9	23.2	11.93	9.30	0.61	23.1	20.2	11.89	9.28	0.61
1297	25	0.49	14.02	38.0	30.5	23.6	12.19	9.38	0.62	30.8	21.5	11.44	9.26	0.56
1298	25	0.49	14.02	38.0	38.1	25.2	12.08	9.41	0.61	38.5	22.1	11.20	9.26	0.53
1299	25	0.49	14.02	38.1	45.7	28.4	11.80	9.40	0.58	46.2	21.8	10.91	9.26	0.49
1300	25	0.49	14.02	38.2	53.3	30.1	11.15	9.40	0.50	53.9	21.6	10.90	9.26	0.49
1301	25	0.49	14.02	37.9	61.0	32.9	10.76	9.43	0.44	61.6	24.4	11.10	9.32	0.51
1302	25	0.49	14.02	37.7	68.6	32.7	10.75	9.45	0.43	69.3	27.5	11.23	9.38	0.51
1303	25	0.49	14.02	38.1	76.2	34.0	10.77	9.50	0.43	77.0	28.0	11.15	9.39	0.50
1304	25	0.49	14.02	38.0	83.8	35.1	10.75	9.54	0.42	84.7	28.3	10.84	9.49	0.44
1305	25	0.49	14.02	37.9	91.4	37.0	10.81	9.59	0.42	92.4	30.6	10.55	9.51	0.39
1308	27	0.54	14.07	39.6	7.6	29.0	12.02	9.49	0.59	7.7	21.9	12.20	9.57	0.60
1309	27	0.54	14.07	39.9	15.2	26.2	11.84	9.51	0.57	15.4	19.7	12.33	9.59	0.61
1310	27	0.54	14.07	39.7	22.9	26.1	11.78	9.55	0.56	23.1	18.8	12.58	9.66	0.63
1311	27	0.54	14.07	39.5	30.5	24.8	11.63	9.58	0.53	30.8	20.1	12.49	9.69	0.61
1312	27	0.54	14.07	39.2	38.1	23.8	11.76	9.60	0.55	38.5	21.2	12.33	9.71	0.59
1313	27	0.54	14.07	39.1	45.7	26.6	11.36	9.60	0.50	46.2	22.2	12.09	9.71	0.57
1314	27	0.54	14.07	38.9	53.3	31.9	11.21	9.67	0.46	53.9	23.8	11.90	9.74	0.54
1315	27	0.54	14.07	38.6	61.0	34.7	11.15	9.71	0.45	61.6	25.4	11.79	9.73	0.53
1316	27	0.54	14.07	38.4	68.6	35.1	11.13	9.74	0.44	69.4	25.7	11.61	9.77	0.50
1317	27	0.54	14.07	38.4	76.2	35.8	11.13	9.78	0.43	77.0	24.6	11.44	9.80	0.47
1318	27	0.54	14.07	38.5	83.8	35.7	11.15	9.84	0.43	84.7	23.8	11.24	9.84	0.44
1319	27	0.54	14.07	38.4	91.4	36.4	11.13	9.89	0.41	92.4	24.2	10.96	9.89	0.39
1322	30	0.55	14.07	38.3	7.7	30.8	12.27	9.07	0.67	7.7	22.9	11.97	9.26	0.62
1323	30	0.55	14.07	38.4	15.0	29.4	12.07	9.14	0.64	15.4	21.7	11.92	9.30	0.61
1324	30	0.55	14.07	38.5	22.9	28.7	12.03	9.14	0.64	23.1	20.3	11.84	9.30	0.60
1325	30	0.55	14.07	38.4	30.5	29.2	11.47	9.16	0.58	30.8	18.7	11.75	9.33	0.58
1326	30	0.55	14.07	38.1	38.1	28.6	11.07	9.17	0.53	38.5	18.0	11.78	9.37	0.58
1327	30	0.55	14.07	38.0	45.7	30.5	11.12	9.20	0.53	46.2	18.4	11.84	9.39	0.59
1328	30	0.55	14.07	38.8	53.3	34.3	11.12	9.25	0.52	53.9	20.2	11.56	9.40	0.55
1329	30	0.55	14.07	38.3	61.0	37.4	10.99	9.29	0.50	61.6	23.8	11.29	9.47	0.51
1330	30	0.55	14.07	38.2	68.6	38.4	10.87	9.33	0.47	69.3	25.9	11.04	9.46	0.48
1331	30	0.55	14.07	38.5	76.1	38.4	10.71	9.37	0.44	77.0	25.7	10.86	9.49	0.44
1332	30	0.55	14.07	37.9	83.8	38.0	10.55	9.41	0.41	84.7	24.0	10.75	9.55	0.41
1333	30	0.55	14.07	38.0	91.4	38.1	10.60	9.51	0.40	92.4	22.8	10.69	9.60	0.40
1336	35	0.56	14.41	33.5	7.6	35.1	11.82	8.73	0.67	7.7	23.6	11.96	9.33	0.61
1337	35	0.56	14.41	32.7	15.2	30.1	12.34	8.79	0.71	15.4	22.2	12.04	9.33	0.61
1338	35	0.56	14.41	32.3	22.8	29.2	12.69	8.92	0.73	23.1	20.9	12.13	9.39	0.62
1339	35	0.56	14.41	33.0	30.4	30.1	12.62	8.96	0.72	30.8	20.4	12.12	9.43	0.61
1340	35	0.56	14.41	32.7	38.1	32.1	12.43	9.00	0.70	38.5	21.4	12.06	9.43	0.60
1341	35	0.56	14.41	32.8	45.7	34.4	12.15	9.05	0.66	46.2	22.9	12.03	9.44	0.60
1342	35	0.56	14.41	33.3	53.4	37.3	11.92	9.02	0.64	53.9	24.3	11.70	9.43	0.56
1343	35	0.56	14.41	32.7	60.9	38.9	11.41	9.05	0.58	61.6	24.6	11.28	9.51	0.50
1344	35	0.56	14.41	32.4	68.5	38.3	11.13	9.08	0.55	69.3	23.8	11.04	9.51	0.47
1345	35	0.56	14.41	32.5	76.1	37.8	10.97	9.15	0.52	77.0	22.7	10.92	9.55	0.44
1346	35	0.56	14.41	32.9	83.8	41.3	11.01	9.24	0.51	84.7	24.5	10.86	9.62	0.42
1347	35	0.56	14.41	33.1	91.4	45.1	11.06	9.31	0.50	92.4	26.8	10.82	9.67	0.40

*** CALIBRATION INFORMATION ***

TRANSDUCERS	0-1 PSID	0-5 PSID
Y-INTERCEPT (PSI)	0.053	-0.000
% CHANGE DURING DATA AQUISITION	0.004	0.005
SLOPE (PSI/VOLT)	0.398	0.791
% CHANGE DURING DATA AQUISITION	-0.006	0.013

TRAVERSES	WEDGE PROBE A	WEDGE PROBE B
RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.00	0.00
ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.00	0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 08-31-83 TIME: 15:42:25

PATM= 14.59 PSIA TATM= 83.0 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	0.000	0.000	0.000	-5.035	5.003	0.000	0.000	0.000
MIN.	-0.000	-0.000	-0.000	-5.036	5.002	-0.000	-0.000	0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	0.000	0.000	-0.000	-5.036	5.003	-0.000	0.000	0.000

REDUCED DATA:

	Probe A		Probe B
% SPAN	17.1	% SPAN	20.4
PT=	14.59	PT=	19.63
PS=	14.59	PS=	14.11
MACH #=	0.00	MACH #=	0.70
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.5
CMDOT= 0.5

Figure G-6. Data System End-to-End Check, 5 Psi on P1B

*** CALIBRATION INFORMATION ***

	TRANSDUCERS 0-1 PSID	TRANSDUCERS 0-5 PSID
Y-INTERCEPT (PSI)	0.053	-0.000
% CHANGE DURING DATA AQUISITION	0.004	0.005
SLOPE (PSI/VOLT)	0.398	0.791
% CHANGE DURING DATA AQUISITION	-0.001	0.022

	TRAVERSES WEDGE PROBE A	TRAVERSES WEDGE PROBE B
RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.00	-0.00
ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.00	0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 08-31-83 TIME: 16:05:53

PATM= 14.59 PSIA TATM= 83.1 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
MIN.	-0.000	-0.000	1.000	0.000	0.000	-0.000	0.000	0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000

REDUCED DATA:

	Probe A		Probe B
% SPAN	17.1	% SPAN	20.4
PT=	14.59	PT=	14.59
PS=	15.14	PS=	14.59
MACH #=	0.23	MACH #=	0.00
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.5
CMDOT= 0.5

Figure G-7. Data System End-to-End Check, 1 Psi on P3A

*** CALIBRATION INFORMATION ***

TRANSDUCERS	0-1 PSID	0-5 PSID
Y-INTERCEPT (PSI)	0.053	-0.000
% CHANGE DURING DATA AQUISITION	0.004	0.003
SLOPE (PSI/VOLT)	0.398	0.791
% CHANGE DURING DATA AQUISITION	0.003	0.024

TRAVERSES	WEDGE PROBE A	WEDGE PROBE B
RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.00	0.01
ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.00	0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 08-31-83 TIME: 15:51:20

PATM= 14.59 PSIA TATM= 83.1 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSI	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	P7 -P5
MAX.	0.000	0.000	0.000	0.000	0.000	0.998	0.000	0.000
MIN.	-0.000	-0.000	-0.000	-0.000	-0.000	0.998	0.000	0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	-0.000	-0.000	0.000	0.000	-0.000	0.998	0.000	0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	14.59	PT=	14.59
PS=	14.59	PS=	15.14
MACH #=	0.00	MACH #=	0.23
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 14.59
MDOT= 0.6
CMDOT= 0.6

Figure G-8. Data System End-to-End Check, 1 Psi on P3B

*** CALIBRATION INFORMATION ***

TRANSDUCERS	0-1 PSID	0-5 PSID
Y-INTERCEPT (PSI)	0.052	-0.002
% CHANGE DURING DATA AQUISITION	-0.000	0.003
SLOPE (PSI/VOLT)	0.398	0.791
% CHANGE DURING DATA AQUISITION	0.005	0.004

TRAVERSES	WEDGE PROBE A	WEDGE PROBE B
RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.00	-0.02
ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	-0.00	-0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 09-01-83 TIME: 10:32:37

PATM= 14.59 PSIA TATM= 80.7 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MIN.	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	0.000	0.000	0.000	-0.000	0.000	0.000	0.000	0.000

REDUCED DATA:

	WEDGE PROBE A	WEDGE PROBE B
% SPAN	17.1	20.4
PT=	14.59	14.59
PS=	14.59	14.59
MACH #=	0.00	0.00
SWIRL ANGLE=	34	20

PT RAKE= 15.59
MDOT= 0.4
CMDOT= 0.4

Figure G-9. Data System End-to-End Check, 1 Psi on PT Rake

*** CALIBRATION INFORMATION ***

TRANSDUCERS	0-1 PSID	0-5 PSID
Y-INTERCEPT (PSI)	0.052	-0.002
% CHANGE DURING DATA AQUISITION	0.001	0.001
SLOPE (PSI/VOLT)	0.397	0.791
% CHANGE DURING DATA AQUISITION	-0.008	0.003

TRAVERSES	WEDGE PROBE A	WEDGE PROBE B
RADIAL POS. (% SPAN)	17.1	20.4
% CHANGE DURING DATA AQUISITION	0.00	-0.01
ROTATIONAL ANGLE (0=AXIAL)	33.8	20.1
% CHANGE DURING DATA AQUISITION	0.00	0.00

*** INLET PROFILE DATA ***

VANE ANGLE= 0 MIDSPAN MACH #= 0.54

POINT #= 0 DATE: 09-01-83 TIME: 10:37:46

PATM= 14.59 PSIA TATM= 80.8 F

	WEDGE PROBE A(PSID) STA. 2.5			WEDGE PROBE B(PSID) STA. 2.3			STATIC TAPS(PSID)	
	PATM-P1	P1-P2	P3-P2	PATM-P1	P1-P2	P3-P2	PATM-P4	PATM-P5
MAX.	0.000	0.000	0.000	-0.000	0.000	0.000	0.000	0.000
MIN.	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
STD DEV.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVG.	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000

REDUCED DATA:

% SPAN	17.1	% SPAN	20.4
PT=	14.59	PT=	14.59
PS=	14.59	PS=	14.59
MACH #=	0.00	MACH #=	0.00
SWIRL ANGLE=	34	SWIRL ANGLE=	20

PT RAKE= 17.61
MDOT= 0.2
CMDOT= 0.1

Figure G-10. Data System End-to-End Check, 3 Psi on PT Rake

TABLE G-7

~~MODIFIED PRESWIRL VANE TEST PHASE III DATA~~

PT#	STA.2.5 OCTANT#	VANE ANGLE	CORRECTED MASS FLOW	PATM	TATM	STATION 2.3 %SPAN	STATION 2.3 SWIRL ANGLE	STATION 2.3 PT	STATION 2.3 PS	STATION 2.3 M#	STATION 2.5 %SPAN	STATION 2.5 SWIRL ANGLE	STATION 2.5 PT	STATION 2.5 PS	STATION 2.5 M#
1546	8	0	54.0	14.34	79.9	7.6	2.0	11.98	9.69	0.56	7.8	18.1	12.08	9.51	0.59
1547	8	0	54.0	14.34	80.2	15.3	2.0	12.33	10.10	0.54	15.4	14.5	12.28	9.55	0.61
1548	8	0	54.0	14.34	80.8	22.9	2.1	12.21	10.14	0.52	23.2	12.5	12.34	9.60	0.61
1549	8	0	54.0	14.34	80.4	30.5	2.1	12.30	10.16	0.53	30.8	13.4	12.29	9.67	0.59
1550	8	0	54.0	14.34	81.0	38.1	2.5	12.18	10.20	0.51	38.5	15.5	12.14	9.63	0.59
1551	8	0	54.0	14.34	80.3	45.7	4.8	11.68	10.16	0.45	46.2	18.5	12.14	9.81	0.56
1552	8	0	54.0	14.34	82.3	53.4	7.1	11.33	10.16	0.40	53.9	21.2	11.61	9.65	0.52
1553	8	0	54.0	14.34	81.6	61.0	9.0	11.24	10.19	0.38	61.6	23.1	11.58	9.63	0.52
1554	8	0	54.0	14.34	82.0	68.6	10.2	11.40	10.16	0.41	69.3	22.4	11.62	9.63	0.53
1555	8	0	54.0	14.34	82.5	76.2	11.7	11.56	10.17	0.43	77.0	21.5	11.67	9.72	0.52
1556	8	0	54.0	14.34	82.3	83.8	12.4	11.56	10.27	0.41	84.7	21.1	11.78	9.85	0.51
1557	8	0	54.0	14.34	82.0	91.4	12.4	11.70	10.33	0.43	92.4	22.0	11.81	9.96	0.50
1560	8	10	54.0	14.37	68.3	7.6	12.3	12.09	10.10	0.51	7.7	16.7	12.47	9.89	0.59
1561	8	10	54.0	14.37	69.7	15.3	9.7	12.59	10.16	0.56	15.4	13.7	12.32	9.78	0.58
1562	8	10	54.0	14.37	71.0	22.9	9.6	12.35	10.18	0.53	23.1	14.1	12.14	9.82	0.56
1563	8	10	54.0	14.37	71.6	30.5	10.6	11.97	10.41	0.45	30.8	13.9	11.83	9.83	0.52
1564	8	10	54.0	14.37	71.8	38.1	11.8	11.54	10.25	0.41	38.5	16.5	11.60	9.85	0.49
1565	8	10	54.0	14.37	71.9	45.7	14.7	11.36	10.30	0.38	46.2	21.2	11.63	9.84	0.50
1566	8	10	54.0	14.37	72.1	53.3	19.4	11.37	10.31	0.38	53.9	23.1	11.73	9.89	0.50
1567	8	10	54.0	14.37	72.5	59.8	21.8	11.38	10.32	0.38	61.6	23.0	11.73	9.90	0.50
1568	8	10	54.0	14.37	72.6	68.6	22.1	11.41	10.31	0.38	69.3	22.9	11.68	9.88	0.49
1569	8	10	54.0	14.37	72.9	76.2	21.8	11.53	10.24	0.41	77.0	22.7	11.63	9.96	0.48
1570	8	10	54.0	14.37	73.3	83.8	20.5	11.84	10.39	0.44	84.7	23.9	11.73	10.11	0.47
1571	8	10	54.0	14.37	73.3	91.4	18.7	12.04	10.52	0.44	92.4	25.6	11.86	10.21	0.47
1574	8	15	54.0	14.37	75.5	7.6	15.7	12.69	10.21	0.57	7.7	16.7	12.88	10.00	0.61
1575	8	15	54.0	14.37	75.7	15.3	13.0	12.73	10.16	0.58	15.4	15.7	12.80	10.25	0.57
1576	8	15	54.0	14.37	76.2	22.9	13.2	12.52	10.38	0.52	23.1	15.8	12.23	10.03	0.54
1577	8	15	54.0	14.37	76.3	30.5	15.6	12.10	10.39	0.47	30.8	16.3	12.07	9.90	0.54
1578	8	15	54.0	14.37	76.9	38.1	18.8	11.80	10.28	0.45	38.5	18.7	12.09	9.97	0.53
1579	8	15	54.0	14.37	77.5	45.7	22.0	11.92	10.32	0.46	46.2	21.7	12.25	10.02	0.54
1580	8	15	54.0	14.37	78.0	53.3	23.2	12.01	10.33	0.47	53.9	23.9	12.14	10.04	0.53
1581	8	15	54.0	14.37	78.3	61.0	22.4	11.98	10.33	0.46	61.6	24.0	11.89	10.07	0.49
1582	8	15	54.0	14.37	78.7	68.6	23.2	11.79	10.36	0.43	69.3	24.0	11.70	10.08	0.47
1583	8	15	54.0	14.37	79.6	76.2	23.8	11.68	10.42	0.41	77.0	24.4	11.67	10.11	0.46
1584	8	15	54.0	14.37	79.8	83.8	23.1	11.68	10.42	0.41	84.7	24.4	11.65	10.19	0.44
1585	8	15	54.0	14.37	80.0	91.4	21.7	11.80	10.54	0.41	92.4	25.6	11.72	10.30	0.43
1588	8	20	54.0	14.37	86.0	7.6	18.4	12.17	9.88	0.55	7.7	18.5	12.38	9.75	0.59
1589	8	20	54.0	14.37	86.1	15.3	15.8	12.93	9.99	0.62	15.4	16.6	12.57	9.82	0.60
1590	8	20	54.0	14.37	86.7	22.9	15.9	13.16	10.14	0.62	23.1	15.8	12.54	9.84	0.60
1591	8	20	54.0	14.37	86.7	30.5	17.8	12.96	10.05	0.61	30.8	15.1	12.70	9.90	0.61
1592	8	20	54.0	14.37	86.8	37.0	19.8	12.91	10.12	0.60	38.5	15.4	12.70	9.90	0.61
1593	8	20	54.0	14.37	87.0	45.7	21.2	12.17	9.88	0.55	46.2	17.0	12.56	9.89	0.59
1594	8	20	54.0	14.37	87.1	53.3	23.2	11.73	10.14	0.46	54.0	20.0	11.90	9.93	0.52
1595	8	20	54.0	14.37	87.1	61.0	27.0	11.52	10.18	0.42	61.6	22.9	11.65	9.88	0.49
1596	8	20	54.0	14.37	87.1	68.6	30.2	11.38	10.22	0.39	69.3	24.0	11.66	9.95	0.48
1597	8	20	54.0	14.37	87.0	76.2	30.7	11.29	10.22	0.38	77.1	25.3	11.68	10.01	0.48
1598	8	20	54.0	14.37	87.5	83.8	29.2	11.36	10.28	0.38	84.7	24.6	11.70	10.10	0.46
1599	8	20	54.0	14.37	87.8	91.4	26.8	11.33	10.33	0.37	92.4	24.6	11.70	10.13	0.46

TABLE G-1 (Cont'd)

PT#	STA.2.5 OCTANT#	VANE ANGLE	CORRECTED MASS FLOW	PATM	TATM	STATION 2.3 %SPAN	STATION 2.3 SWIRL ANGLE	STATION 2.3 PT	STATION 2.3 PS	STATION 2.3 M#	STATION 2.5 %SPAN	STATION 2.5 SWIRL ANGLE	STATION 2.5 PT	STATION 2.5 PS	STATION 2.5 M#
1602	8	25	54.0	14.34	67.1	7.6	23.7	12.23	9.91	0.56	7.7	18.9	12.62	9.88	0.60
1603	8	25	54.0	14.34	67.1	15.2	1° 9	12.09	10.07	0.52	15.4	18.1	12.63	9.91	0.60
1604	8	25	54.0	14.34	66.9	22.9	19.0	11.97	10.00	0.51	23.1	17.6	12.27	10.07	0.54
1605	8	25	54.0	14.34	67.4	30.5	20.7	11.77	10.10	0.47	30.8	17.5	11.89	9.82	0.53
1606	8	25	54.0	14.34	67.1	38.1	23.6	11.60	10.09	0.45	38.5	18.0	11.94	9.98	0.51
1607	8	25	54.0	14.34	67.0	45.7	28.8	11.70	10.15	0.46	46.2	20.6	11.98	10.02	0.51
1608	8	25	54.0	14.34	68.2	53.4	33.2	11.85	10.10	0.48	53.9	22.6	11.86	9.96	0.51
1609	8	25	54.0	14.34	68.5	61.0	34.2	12.06	10.16	0.50	61.6	22.8	11.73	10.01	0.48
1610	8	25	54.0	14.34	68.6	68.6	33.4	12.11	10.18	0.51	69.3	24.3	11.57	10.00	0.46
1611	8	25	54.0	14.34	69.4	76.2	32.4	11.95	10.24	0.47	77.0	25.4	11.57	10.04	0.45
1612	8	25	54.0	14.34	69.1	83.8	30.6	11.85	10.29	0.45	84.7	25.4	11.65	10.14	0.45
1613	8	25	54.0	14.34	69.7	91.4	29.1	11.77	10.39	0.43	92.4	24.5	11.75	10.15	0.46
1616	8	30	54.0	14.34	67.1	7.6	23.7	12.23	9.91	0.56	7.7	18.9	12.62	9.88	0.60
1617	8	30	54.0	14.35	71.5	15.3	25.9	12.73	9.75	0.63	15.5	17.8	12.18	9.73	0.58
1618	8	30	54.0	14.35	71.8	22.9	26.0	12.61	9.83	0.61	23.1	16.7	12.26	9.61	0.60
1619	8	30	54.0	14.35	71.7	30.4	27.7	12.60	9.89	0.60	30.8	16.7	12.44	9.80	0.59
1620	8	30	54.0	14.35	71.9	38.1	30.0	12.61	9.96	0.59	38.5	17.7	12.40	9.80	0.59
1621	8	30	54.0	14.35	72.0	44.7	31.6	12.44	10.01	0.57	46.2	20.0	12.16	9.86	0.56
1622	8	30	54.0	14.35	72.4	53.4	32.4	12.07	9.91	0.54	53.9	21.3	11.97	9.90	0.53
1623	8	30	54.0	14.35	72.6	61.0	32.4	11.72	9.95	0.49	61.6	21.9	11.80	9.91	0.51
1624	8	30	54.0	14.35	73.3	68.6	35.9	11.44	9.99	0.44	69.3	23.1	11.67	9.89	0.49
1625	8	30	54.0	14.35	72.7	76.2	38.7	11.53	10.05	0.45	77.0	24.1	11.64	9.98	0.47
1626	8	30	54.0	14.35	73.2	83.8	36.2	11.69	10.13	0.46	84.7	25.1	11.65	10.04	0.47
1627	8	30	54.0	14.35	73.2	91.4	35.0	11.70	10.17	0.45	92.5	24.3	11.64	10.11	0.45
1630	8	35	54.0	14.35	75.4	7.7	30.9	12.17	9.32	0.63	7.7	19.8	12.07	9.51	0.59
1631	8	35	54.0	14.35	75.6	15.2	28.6	12.04	9.35	0.61	15.4	18.7	12.21	9.50	0.61
1632	8	35	54.0	14.35	76.3	22.9	28.7	11.92	9.37	0.60	23.1	18.3	12.14	9.53	0.60
1633	8	35	54.0	14.35	76.2	30.5	31.7	12.01	9.46	0.59	30.8	18.2	11.82	9.50	0.57
1634	8	35	54.0	14.35	76.5	38.1	35.4	12.19	9.51	0.61	38.5	20.8	11.89	9.60	0.56
1635	8	35	54.0	14.35	75.8	45.8	37.3	11.95	9.43	0.59	46.2	24.5	12.05	9.56	0.58
1636	8	35	54.0	14.35	75.6	53.4	37.3	11.85	9.60	0.56	53.9	25.7	12.08	9.65	0.58
1637	8	35	54.0	14.35	75.5	60.9	37.2	11.78	9.67	0.54	61.6	25.1	11.80	9.68	0.54
1638	8	35	54.0	14.35	76.0	68.6	38.7	11.73	9.70	0.53	69.3	25.1	11.65	9.72	0.52
1639	8	35	54.0	14.35	76.7	76.2	40.3	11.62	9.74	0.51	77.0	26.3	11.56	9.77	0.50
1640	8	35	54.0	14.35	76.3	83.8	40.8	11.50	9.78	0.49	84.7	25.6	11.51	9.89	0.47
1641	8	35	54.0	14.35	76.3	91.4	40.3	11.45	9.88	0.46	92.4	25.6	11.41	9.91	0.45
1644	8	23	54.0	14.43	56.9	7.7	21.6	12.18	9.96	0.54	7.7	19.3	12.87	9.89	0.62
1645	8	23	54.0	14.43	57.4	15.2	17.3	12.28	10.02	0.55	15.4	18.2	12.57	10.03	0.58
1646	8	23	54.0	14.43	58.3	22.8	16.5	12.50	10.14	0.56	23.1	17.4	12.21	10.05	0.53
1647	8	23	54.0	14.43	61.3	30.5	17.7	12.05	10.02	0.52	30.8	15.9	12.07	9.96	0.53
1648	8	23	54.0	14.43	63.0	38.1	20.0	11.96	10.30	0.47	38.5	15.3	12.15	9.95	0.54
1649	8	23	54.0	14.43	63.6	45.8	24.7	11.55	10.17	0.43	46.2	19.0	11.87	9.92	0.51
1650	8	23	54.0	14.43	63.8	53.4	31.3	11.72	10.21	0.45	53.9	21.3	11.84	9.97	0.50
1651	8	23	54.0	14.43	64.2	60.9	33.7	11.79	10.16	0.47	61.6	23.0	11.78	9.99	0.49
1652	8	23	54.0	14.43	64.2	68.6	33.4	11.81	10.20	0.46	69.3	23.9	11.70	9.97	0.48
1653	8	23	54.0	14.43	64.5	76.2	31.8	11.75	10.26	0.45	77.0	24.7	11.71	9.98	0.48
1654	8	23	54.0	14.43	64.5	83.9	29.7	11.71	10.30	0.43	84.7	24.7	11.86	10.13	0.48
1655	8	23	54.0	14.43	64.8	92.6	27.4	11.62	10.39	0.40	92.4	25.1	11.89	10.22	0.47

						STATION 2.3					[illegible]				
PT#	STA.2.5 OCTANT#	VANE ANGLE	CORRECTED MASS FLOW	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	M#	%SPAN	SWIRL ANGLE	PT	PS	M#
1657	8	22	54.0	14.39	70.3	7.7	20.4	12.15	9.93	0.54	7.7	19.6	12.82	9.96	0.61
1658	8	22	54.0	14.39	69.9	15.2	16.1	12.53	10.07	0.57	15.4	18.2	12.50	9.91	0.59
1659	8	22	54.0	14.39	70.1	22.9	15.4	12.91	10.20	0.59	23.1	16.9	12.12	9.87	0.55
1660	8	22	54.0	14.39	70.2	30.5	16.8	12.64	10.16	0.57	30.8	15.6	12.27	9.89	0.56
1661	8	22	54.0	14.39	70.4	38.1	18.7	12.18	10.18	0.51	38.5	14.9	12.30	10.00	0.55
1662	8	22	54.0	14.39	70.5	45.7	21.8	11.70	10.28	0.43	46.2	17.3	11.99	9.99	0.52
1663	8	22	54.0	14.39	69.9	53.3	27.5	11.58	10.25	0.42	53.9	20.7	11.84	10.02	0.49
1664	8	22	54.0	14.39	70.6	61.0	32.2	11.54	10.20	0.42	61.6	23.1	11.71	9.86	0.50
1665	8	22	54.0	14.39	70.6	68.6	33.2	11.49	10.13	0.43	69.3	24.2	11.71	9.90	0.50
1666	8	22	54.0	14.39	70.3	76.1	31.5	11.50	10.19	0.42	77.0	24.5	11.78	9.98	0.49
1667	8	22	54.0	14.39	70.4	83.8	29.6	11.52	10.25	0.41	84.7	24.2	11.81	10.07	0.48
1668	8	22	54.0	14.39	70.2	91.4	27.3	11.50	10.31	0.40	92.4	23.7	11.83	10.16	0.47
1671	8	10	54.0	14.27	66.3	7.6	12.1	12.07	10.14	0.51	7.7	16.6	12.44	9.87	0.58
1672	8	10	54.0	14.27	66.0	15.3	9.6	12.53	10.12	0.56	15.4	14.7	12.33	9.86	0.57
1673	8	10	54.0	14.27	66.6	22.9	9.7	12.43	10.30	0.53	23.1	13.6	12.15	9.87	0.55
1674	8	10	54.0	14.27	66.4	30.5	11.0	11.87	10.20	0.47	30.8	14.0	11.74	9.75	0.52
1675	8	10	54.0	14.27	66.3	38.1	12.0	11.53	10.25	0.41	38.5	16.2	11.59	9.86	0.49
1676	8	10	54.0	14.27	66.4	45.7	14.6	11.41	10.27	0.39	46.2	20.3	11.52	9.80	0.49
1677	8	10	54.0	14.27	65.9	53.3	19.4	11.34	10.29	0.37	53.9	22.9	11.62	9.83	0.50
1678	8	10	54.0	14.27	66.0	61.0	22.0	11.33	10.25	0.38	61.6	23.4	11.69	9.83	0.50
1679	8	10	54.0	14.27	65.9	68.6	21.9	11.34	10.25	0.38	69.3	23.0	11.68	9.89	0.49
1680	8	10	54.0	14.27	66.5	76.2	21.6	11.48	10.27	0.40	77.0	23.1	11.69	9.98	0.48
1681	8	10	54.0	14.27	66.7	83.8	20.3	11.76	10.34	0.43	84.7	24.1	11.73	10.03	0.48
1682	8	10	54.0	14.27	67.0	91.4	18.8	11.94	10.43	0.44	92.4	25.3	11.82	10.19	0.47
1685	1	23	54.0	14.28	55.5	7.7	21.6	12.10	9.90	0.54	7.7	19.9	12.38	9.88	0.58
1686	1	23	54.0	14.28	55.2	15.3	17.3	12.14	9.84	0.56	15.5	17.6	11.99	9.82	0.54
1687	1	23	54.0	14.28	55.8	23.0	16.7	12.24	9.85	0.56	23.1	16.8	11.78	9.71	0.53
1688	1	23	54.0	14.28	57.1	30.5	17.6	11.91	9.93	0.52	30.8	15.9	11.80	9.81	0.52
1689	1	23	54.0	14.28	56.6	38.1	19.7	11.59	9.99	0.47	38.5	17.6	11.80	9.79	0.52
1690	1	23	54.0	14.28	56.9	45.7	24.9	11.42	9.98	0.44	46.1	20.4	11.72	9.77	0.52
1691	1	23	54.0	14.28	56.9	53.4	31.6	11.57	10.08	0.45	53.9	22.0	11.68	9.88	0.50
1692	1	23	54.0	14.28	57.0	61.0	34.4	11.72	10.08	0.47	61.6	25.7	11.57	9.86	0.48
1693	1	23	54.0	14.28	57.4	68.6	33.7	11.64	10.03	0.47	69.4	27.7	11.52	9.87	0.48
1694	1	23	54.0	14.28	57.9	76.2	33.5	11.66	10.14	0.45	77.0	27.4	11.53	9.92	0.47
1695	1	23	54.0	14.28	57.8	83.9	29.2	11.55	10.17	0.43	84.7	26.8	11.57	10.01	0.46
1696	1	23	54.0	14.28	57.9	91.4	27.7	11.44	10.25	0.40	92.4	27.1	11.68	10.18	0.45
1699	2	23	54.0	14.32	60.3	7.7	21.5	12.15	9.92	0.55	7.7	18.4	12.64	9.83	0.61
1700	2	23	54.0	14.32	60.0	15.3	17.2	12.23	9.95	0.55	15.5	18.6	12.43	9.79	0.59
1701	2	23	54.0	14.32	60.5	22.9	16.6	12.35	9.95	0.56	23.1	18.0	12.24	9.90	0.56
1702	2	23	54.0	14.32	60.5	30.5	17.6	12.00	9.98	0.52	30.8	16.1	12.01	9.89	0.53
1703	2	23	54.0	14.32	61.2	38.1	20.0	11.55	9.88	0.48	38.6	15.3	12.00	9.86	0.54
1704	2	23	54.0	14.32	60.9	45.7	24.9	11.44	10.05	0.43	46.2	16.9	11.97	9.91	0.53
1705	2	23	54.0	14.32	60.0	53.4	31.6	11.58	10.05	0.45	53.9	20.3	11.89	9.98	0.51
1706	2	23	54.0	14.32	60.3	61.0	34.1	11.77	10.13	0.47	61.6	21.1	11.65	9.97	0.48
1707	2	23	54.0	14.32	60.1	68.6	33.9	11.79	10.17	0.47	69.3	22.3	11.54	9.99	0.46
1708	2	23	54.0	14.32	60.2	76.2	32.1	11.68	10.16	0.45	77.0	22.7	11.49	9.99	0.45
1709	2	23	54.0	14.32	60.8	83.8	30.2	11.56	10.21	0.42	84.7	24.8	11.53	10.13	0.43
1710	2	23	54.0	14.32	60.7	91.4	28.4	11.63	10.34	0.41	92.4	23.6	11.62	10.20	0.44

PT#	OCTANT#	ANGLE	MASS FLOW	PATM	TATM	%SPAN	SWIRL ANGLE	PT	PS	MN	%SPAN	SWIRL ANGLE	PT	PS	MN
1713	3	23	54.0	14.43	50.6	7.6	21.8	12.35	10.20	0.53	7.7	19.4	12.86	10.04	0.61
1714	3	23	54.0	14.43	50.5	15.2	17.3	12.34	10.05	0.5[illegible]	15.4	18.1	12.26	9.82	0.57
1715	3	23	54.0	14.43	49.8	22.8	16.6	12.49	10.16	0.55	23.1	16.8	11.93	9.90	0.52
1716	3	23	54.0	14.43	49.6	30.5	17.6	11.94	10.01	0.51	30.8	15.8	11.98	9.93	0.53
1717	3	23	54.0	14.43	50.0	38.1	20.3	11.72	10.01	0.48	38.5	17.2	11.88	9.84	0.53
1718	3	23	54.0	14.43	51.0	45.7	24.2	11.58	10.21	0.43	46.2	20.4	12.01	10.04	0.51
1719	3	23	54.0	14.43	50.5	53.3	31.6	11.77	10.27	0.45	53.9	22.7	11.87	10.03	0.50
1720	3	23	54.0	14.43	50.9	60.9	34.4	11.81	10.12	0.48	61.6	24.2	11.74	9.99	0.49
1721	3	23	54.0	14.43	52.2	68.6	33.7	11.92	10.27	0.47	69.3	25.5	11.78	10.03	0.48
1722	3	23	54.0	14.43	53.4	76.1	31.8	11.83	10.28	0.45	77.0	25.2	11.88	10.07	0.49
1723	3	23	54.0	14.43	53.8	83.8	29.8	11.73	10.33	0.43	84.7	24.7	12.02	10.22	0.49
1724	3	23	54.0	14.43	54.0	91.4	27.2	11.64	10.43	0.40	92.4	24.7	12.05	10.30	0.48
1727	7	23	54.0	14.47	59.2	7.6	21.7	12.23	10.10	0.53	7.7	18.8	12.56	9.90	0.59
1728	7	23	54.0	14.47	58.2	15.2	17.8	12.38	10.12	0.54	15.4	16.8	12.34	9.82	0.58
1729	7	23	54.0	14.47	58.9	22.9	16.7	12.51	10.20	0.55	23.1	17.2	12.24	9.82	0.57
1730	7	23	54.0	14.47	58.7	30.5	17.6	12.20	10.25	0.51	30.8	18.1	12.20	9.87	0.56
1731	7	23	54.0	14.47	58.9	38.1	20.1	11.97	10.33	0.46	38.5	18.6	12.05	9.87	0.54
1732	7	23	54.0	14.47	58.6	45.7	24.8	11.60	10.23	0.43	46.2	20.0	11.94	9.91	0.52
1733	7	23	54.0	14.47	58.6	53.3	30.8	11.77	10.31	0.44	53.9	22.4	11.90	9.93	0.51
1734	7	23	54.0	14.47	58.4	60.9	34.1	11.83	10.29	0.45	61.6	23.6	11.89	9.98	0.51
1735	7	23	54.0	14.47	58.6	68.6	33.9	11.95	10.35	0.46	69.3	24.8	11.84	10.01	0.50
1736	7	23	54.0	14.47	58.5	76.2	32.1	11.86	10.34	0.45	77.0	24.7	11.74	10.14	0.46
1737	7	23	54.0	14.47	58.6	83.8	29.8	11.79	10.44	0.42	84.7	23.9	11.64	10.19	0.44
1738	7	23	54.0	14.47	58.7	91.4	27.6	11.73	10.58	0.39	92.4	22.7	11.59	10.26	0.42
1741	6	23	54.0	14.44	62.4	7.6	21.7	12.32	10.06	0.55	7.7	18.2	12.48	9.77	0.60
1742	6	23	54.0	14.44	62.5	15.2	16.7	12.34	10.10	0.54	15.4	16.7	12.14	9.73	0.57
1743	6	23	54.0	14.44	61.9	22.9	16.9	12.46	10.13	0.55	23.1	14.5	12.02	9.72	0.56
1744	6	23	54.0	14.44	61.7	30.5	17.4	12.18	10.17	0.51	30.8	13.5	12.35	9.87	0.58
1745	6	23	54.0	14.44	61.6	38.1	19.6	11.71	10.09	0.47	38.5	14.4	12.30	9.84	0.57
1746	6	23	54.0	14.44	61.8	45.7	24.5	11.61	10.28	0.42	46.2	17.8	12.14	9.84	0.56
1747	6	23	54.0	14.44	61.5	53.4	31.8	11.72	10.21	0.45	53.9	21.2	12.14	9.84	0.56
1748	6	23	54.0	14.44	61.6	60.9	34.6	11.84	10.18	0.47	61.6	22.4	12.09	9.83	0.55
1749	6	23	54.0	14.44	62.2	68.6	34.1	11.88	10.25	0.46	69.3	22.6	12.08	9.88	0.54
1750	6	23	54.0	14.44	62.5	76.2	32.0	11.81	10.28	0.45	77.0	22.6	11.99	9.92	0.53
1751	6	23	54.0	14.44	62.4	83.8	29.6	11.71	10.33	0.43	84.7	22.7	11.87	10.03	0.50
1752	6	23	54.0	14.44	62.2	91.4	27.3	11.64	10.43	0.40	92.4	23.5	11.89	10.15	0.48
1755	8	23	54.0	14.44	68.8	7.6	21.3	12.17	9.97	0.54	7.7	18.1	12.86	9.92	0.62
1756	8	23	54.0	14.44	68.7	15.2	16.9	12.34	10.07	0.55	15.4	17.1	12.69	10.14	0.58
1757	8	23	54.0	14.44	68.7	22.9	16.5	12.53	10.11	0.56	23.1	16.0	12.04	9.87	0.54
1758	8	23	54.0	14.44	68.7	30.5	17.6	12.21	10.18	0.52	30.8	14.2	12.02	9.82	0.55
1759	8	23	54.0	14.44	68.7	38.1	19.9	11.83	10.13	0.48	38.5	13.5	12.15	9.90	0.55
1760	8	23	54.0	14.44	68.8	45.7	24.2	11.63	10.25	0.43	46.2	16.5	11.92	9.92	0.52
1761	8	23	54.0	14.44	68.9	53.4	31.3	11.70	10.24	0.44	53.9	20.2	11.86	9.94	0.51
1762	8	23	54.0	14.44	68.9	60.9	33.2	11.75	10.24	0.45	61.6	21.7	11.76	9.99	0.49
1763	8	23	54.0	14.44	68.8	68.6	33.8	11.85	10.27	0.46	69.3	22.8	11.71	10.01	0.48
1764	8	23	54.0	14.44	68.9	76.2	32.2	11.80	10.33	0.44	77.0	23.6	11.77	10.08	0.48
1765	8	23	54.0	14.45	56.6	83.8	30.0	11.77	10.40	0.42	84.7	23.5	11.94	10.23	0.48
1766	8	23	54.0	14.44	62.2	91.4	27.3	11.64	10.43	0.40	92.4	23.5	11.89	10.15	0.48

1783	7	23	54.0	14.46	74.6	7.7	37.9	12.09	7.97	0.79	7.8	19.2	12.88	10.01	0.61
1784	7	23	54.0	14.46	74.7	15.4	38.4	12.28	7.98	0.81	15.4	17.9	12.51	9.94	0.58
1785	7	23	54.0	14.46	74.6	23.2	38.7	12.27	8.10	0.79	23.1	17.4	12.08	9.93	0.54
1786	7	23	54.0	14.46	74.6	30.9	39.1	12.21	8.20	0.78	30.8	15.3	12.07	9.86	0.55
1787	7	23	54.0	14.46	74.9	38.6	39.8	12.09	8.19	0.77	38.5	14.5	12.03	9.81	0.55
1788	7	23	54.0	14.46	74.9	46.3	39.9	11.98	8.33	0.74	46.2	17.8	11.95	9.97	0.52
1789	7	23	54.0	14.46	75.2	53.9	40.2	11.86	8.37	0.72	53.9	21.5	11.85	9.96	0.50
1790	7	23	54.0	14.46	75.6	61.6	40.2	11.80	8.42	0.71	61.6	22.8	11.73	9.96	0.49
1791	7	23	54.0	14.46	75.4	69.3	40.6	11.67	8.54	0.68	69.3	23.9	11.74	10.06	0.48
1792	7	23	54.0	14.46	75.7	77.0	40.6	11.55	8.51	0.68	77.0	24.4	11.83	10.06	0.49
1793	7	23	54.0	14.46	75.0	84.7	40.5	11.48	8.59	0.66	84.7	24.4	11.93	10.21	0.48
1794	7	23	54.0	14.46	75.1	92.4	39.7	11.36	8.39	0.67	92.4	24.4	11.91	10.18	0.48
1797	7	15	54.0	14.14	65.3	7.7	36.9	11.21	7.86	0.73	7.7	16.9	12.66	9.91	0.60
1798	7	15	54.0	14.14	65.2	15.4	37.4	11.30	7.80	0.75	15.4	15.6	12.47	9.60	0.62
1799	7	15	54.0	14.14	65.2	23.2	37.7	11.18	7.87	0.73	23.1	15.6	12.31	10.01	0.55
1800	7	15	54.0	14.14	65.3	30.9	38.5	11.05	7.90	0.71	30.8	17.3	12.09	10.01	0.53
1801	7	15	54.0	14.14	64.8	38.6	39.3	10.88	7.90	0.69	38.5	18.7	12.12	9.81	0.56
1802	7	15	54.0	14.14	64.8	46.3	39.0	10.73	7.89	0.68	46.2	21.2	11.98	9.74	0.55
1803	7	15	54.0	14.14	64.7	53.9	38.3	10.81	7.99	0.67	53.9	23.8	11.88	9.77	0.54
1804	7	15	54.0	14.14	64.6	61.5	37.9	11.05	8.21	0.67	61.6	22.9	11.65	9.87	0.49
1805	7	15	54.0	14.14	65.1	69.3	38.6	11.15	8.30	0.66	69.3	22.9	11.51	9.89	0.47
1806	7	15	54.0	14.14	64.5	77.0	38.9	11.13	8.34	0.66	77.0	23.9	11.50	9.96	0.46
1807	7	15	54.0	14.14	64.9	84.7	39.1	11.10	8.37	0.65	84.7	24.4	11.40	10.04	0.43
1808	7	15	54.0	14.14	64.9	92.2	38.9	11.06	8.36	0.64	92.4	25.3	11.51	10.14	0.43
1811	2	23	54.0	14.22	68.6	7.7	38.9	12.02	7.98	0.79	7.7	19.1	12.72	9.86	0.61
1812	2	23	54.0	14.22	69.2	15.5	39.9	11.77	8.07	0.75	15.4	17.9	12.25	9.74	0.58
1813	2	23	54.0	14.22	69.8	23.2	40.6	11.66	8.13	0.74	23.2	17.1	11.87	9.73	0.54
1814	2	23	54.0	14.22	69.6	30.9	41.0	11.74	8.21	0.73	30.8	15.4	11.90	9.83	0.53
1815	2	23	54.0	14.22	69.9	38.6	41.4	11.83	8.31	0.73	38.5	15.3	11.85	9.72	0.54
1816	2	23	54.0	14.22	70.1	46.3	42.0	11.87	8.39	0.72	46.2	18.3	11.76	9.86	0.51
1817	2	23	54.0	14.22	69.5	53.9	42.4	11.82	8.51	0.70	53.9	21.2	11.69	9.89	0.50
1818	2	23	54.0	14.22	69.6	61.6	42.7	11.67	8.51	0.69	61.6	22.4	11.58	9.87	0.48
1819	2	23	54.0	14.22	69.4	69.3	42.8	11.49	8.55	0.66	69.3	23.4	11.54	9.89	0.47
1820	2	23	54.0	14.22	69.9	77.0	42.9	11.45	8.59	0.65	77.0	24.2	11.62	9.99	0.47
1821	2	23	54.0	14.22	70.0	84.7	42.6	11.45	8.64	0.65	84.7	24.5	11.72	10.05	0.47
1822	2	23	54.0	14.22	70.0	92.4	42.0	11.28	8.66	0.63	92.4	24.1	11.77	10.15	0.46
1825	2	15	54.0	14.26	64.1	7.6	39.2	11.90	8.06	0.77	7.7	16.5	12.83	10.00	0.61
1826	2	15	54.0	14.26	64.0	15.4	39.6	12.03	8.26	0.75	15.4	15.5	12.65	9.98	0.59
1827	2	15	54.0	14.26	63.9	23.1	39.9	12.04	8.20	0.76	23.1	16.0	12.55	10.08	0.57
1828	2	15	54.0	14.26	63.8	30.8	40.3	12.13	8.30	0.76	30.8	17.1	12.08	9.88	0.54
1829	2	15	54.0	14.26	64.2	38.5	40.8	12.06	8.39	0.74	38.5	18.8	12.46	10.30	0.53
1830	2	15	54.0	14.26	63.7	46.2	41.2	11.87	8.41	0.72	46.2	21.0	12.11	10.01	0.53
1831	2	15	54.0	14.26	64.6	53.9	41.3	11.69	8.34	0.71	53.9	22.7	11.97	9.97	0.52
1832	2	15	54.0	14.26	64.6	61.6	41.3	11.60	8.52	0.68	61.6	23.1	11.73	9.95	0.49
1833	2	15	54.0	14.26	64.5	69.3	41.5	11.40	8.44	0.67	69.3	23.4	11.69	10.02	0.48
1834	2	15	54.0	14.26	64.6	77.0	41.6	11.38	8.51	0.66	77.0	23.6	11.54	9.98	0.46
1835	2	15	54.0	14.26	64.6	84.7	41.6	11.33	8.52	0.65	84.7	24.1	11.45	10.03	0.44
1836	2	15	54.0	14.26	64.8	92.4	40.9	11.34	8.51	0.65	92.4	25.1	11.53	10.16	0.43

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