NASA CR-54588
~~GE~~-R68AEG287

EXPERIMENTAL EVALUATION OF OUTER CASE BLOWING OR BLEEDING OF SINGLE STAGE AXIAL FLOW COMPRESSOR

PART II - PERFORMANCE OF PLAIN CASING INSERT CONFIGURATION WITH UNDISTORTED INLET FLOW AND BOUNDARY LAYER TRIP

by

C.C. KOCH and L.H. SMITH, JR.

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONTRACT NAS 3-7618

AIRCRAFT ENGINE TECHNICAL DIVISION
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GENERAL ELECTRIC
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August 14, 1968

CONTRACT NO. NAS3-7618

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ABSTRACT

A 1120 feet per second tip speed rotor having an aspect ratio of 4.5 and an inlet hub-tip radius ratio of 0.5 was tested with undistorted inlet flow and also with a thickened inlet casing boundary layer produced by a trip ring. Overall performance, stall performance and blade element data were obtained. The rotor was designed to produce a total-pressure ratio of 1.47 at a weight flow of 187 lbs/sec and an adiabatic efficiency of 0.905. The peak efficiency attained at design speed was 0.900, occurring at a total-pressure ratio of 1.458 and a weight flow of 181 lbs/sec. Evidence was obtained indicating that rotating stalls initiated in the vicinity of the part-span shroud rather than at the tip.

SUMMARY

The objective of this program is to investigate the potential of outer casing blowing and bleeding as means of increasing the weight flow range of high aspect-ratio transonic rotors. This report documents the basic performance of the rotor without casing boundary layer control devices. The rotor had a design tip speed of 1120 feet per second, an aspect ratio of 4.5 and an inlet hub-tip radius ratio of 0.5; the design tip diffusion factor was 0.45.

Tests were conducted with undistorted inlet flow and also with the inlet casing boundary layer thickened by means of a trip ring. Overall performance and stall performance were obtained on both configurations. Blade element data were obtained at seven radial positions during undistorted inlet tests at each of five speeds from 50% to 110% of design. The condition where rotating stall first appeared was determined at each speed, and overall performance data were obtained while in stall and also at the point where stall cleared.

The rotor was designed to produce a total pressure of 1.47 at a flow of 187 lbs/sec and an adiabatic efficiency of 0.905. Peak adiabatic efficiency obtained at design speed was 0.900, occurring at a total-pressure ratio of 1.458 and a flow of 181 lbs/sec. Stall at 100% speed was at 172.2 lbs/sec flow and a total pressure ratio of 1.48.

The installation of the boundary layer trip caused the displacement thickness of the casing boundary layer to increase from 0.035 in to 0.29 in. About 2 percentage points in adiabatic efficiency were lost at all conditions as a result; also the stall line was lowered somewhat at 100% speed but was improved at 90% speed.

Evidence was obtained from hot-wire anemometers to indicate that rotating stalls initiated in the vicinity of the part-span shroud in both configurations rather than at the tip.

INTRODUCTION

It is recognized that the use of high-aspect-ratio blading in aircraft gas turbine compressors offers the potential of designing lighter, more compact units. The performance of such stages has not always been satisfactory, however, in that they have generally been found to have less weight flow range than similar stages with lower aspect-ratio blading (refs. 1 and 2). Reduced weight flow range typically results in reduced stall margin, especially in cases where the compressor must operate with inlet flow distortions.

The objective of this test series is to investigate methods of increasing the flow range of high-aspect-ratio compressors under conditions of distorted as well as undistorted inlet flow. It is believed that the flow at the tip of the first rotor of fans and multistage compressors generally breaks down first and causes stage stall. Accordingly, outer casing boundary layer control methods (blowing and bleeding) are being investigated in this program to determine their effectiveness in extending the weight flow range of an isolated, high-aspect-ratio rotor. The design of the rotor and of the blowing and bleeding devices is presented in reference 3.

This report presents the basic performance of the rotor when tested without casing boundary layer control; a conventional solid casing was installed over the rotor tip. Overall performance and blade element data are presented for tests with undistorted inlet flow. In addition, overall performance is documented for tests in which the inlet casing boundary layer was increased by using a boundary layer trip to better simulate installed engine conditions.

SYMBOLS

The following symbols are used in this report:

A — flow area, in^2

A_j — area represented by each discharge rake element. This is the area of an annulus bounded either by radii midway between those of two adjacent elements or by the hub or casing, in^2

C_h — enthalpy-equivalent static-pressure-rise coefficient,

$$C_h = \frac{2gJc_p t_1 \left[\left(\frac{p_2}{p_1} \right)^{\frac{\gamma}{\gamma-1}} -1 \right] - (U_2^2 - U_1^2)}{V_1'^2}$$

C_p — static-pressure-rise coefficient,

$$C_p = \frac{p_2 - p_1}{P_1' - p_1}$$

c_p — specific heat at constant pressure, Btu/lb-°R

D — diffusion factor

$$D = 1 - \frac{V_2'}{V_1'} + \frac{r_2 V_{\theta 2} - r_1 V_{\theta 1}}{2 \bar{r} \sigma V_1'}$$

g — acceleration due to gravity, 32.174 ft/sec^2

i — incidence angle, difference between air angle and camber line angle at leading edge in cascade projection, deg

J — mechanical equivalent of heat, 778.161 ft-lb/Btu

M — Mach number

P — total or stagnation pressure, psia

P_j — arithmetic average total pressure at j immersion, psia

p — static or stream pressure, psi

r — radius, in

$\bar{r}$ — Mean radius, average of streamline leading-edge and trailing-edge radii, in

T — total or stagnation temperature, °R

T_j — arithmetic average total temperature at j immersion, °R

t — static or stream temperature, °R

U — rotor speed, ft/sec

V — air velocity, ft/sec

V_{zj} — average axial velocity at j immersion, ft/sec

W — weight flow, lb/sec

z — displacement along compressor axis, in

β — air angle, angle whose tangent is the ratio of tangential to axial velocity, deg

γ — ratio of specific heats

δ — ratio: - $\frac{\text{total pressure}}{\text{standard pressure}}$, $\frac{\text{psia}}{14.696\text{ psia}}$

δ° — deviation angle, difference between air angle and camber line angle at trailing edge in cascade projection, deg

ε° — meridional angle, angle between tangent to streamline projected on meridional plane and axial direction, deg

θ — ratio: - $\frac{\text{total temperature}}{\text{standard temperature}}$, $\frac{^\circ\text{R}}{518.688^\circ\text{R}}$

θ° — angular displacement about compressor axis, deg

η — efficiency

κ° — angle between cylindrical projection of the blade camber line at the leading and trailing edge and the axial direction, deg

ρ — static or stream density, $\text{lb-sec}^2/\text{ft}^4$

σ — solidity, ratio of chord to spacing

ψ — stream function; $\psi_h = 0$, $\psi_c = 1$

$\bar{\omega}$ total-pressure-loss coefficient

Subscripts:

ad adiabatic

an annulus value

avg arithmetic average at any plane

c casing at any plane

d downstream

h hub at any plane

in inlet

j immersion number

m meridional direction

p polytropic

s suction surface

u upstream

z with respect to axial displacement

θ with respect to tangential displacement

1 leading edge

2 trailing edge

0.05, 0.65, 0.90, 1.54, 1.90, 3.50 instrumentation plane designations (figs. 5 & 6)

superscripts:

$*$ critical flow condition

$'$ relative to rotor

APPARATUS AND PROCEDURE

Test Rotor Design

A high aspect-ratio transonic rotor was designed as an instrument for evaluating the effects on performance and operating range of casing blow and bleed devices on stages of this type. The overall characteristics of the rotor design are contained in the following list.

1. Rotor tip speed, 1120 ft/sec.
2. Inlet hub-tip radius ratio, 0.50.
3. Total-pressure ratio, 1.47, radially constant.
4. Corrected weight flow per unit annulus area, 39.32 lb/sec.-sq.ft.
5. Rotor tip solidity, 1.0.
6. Rotor tip relative Mach number, 1.2.
7. Rotor tip diffusion factor, 0.45.
8. Rotor blade aspect ratio, 4.5.
9. Rotor blade section; double-circular-arc on cylindrical sections.
10. Rotor chord, 1.772 in. radially constant.
11. Rotor maximum thickness - chord ratio, 0.085 at hub, 0.03 at tip.
12. Number of rotor blades, 60.
13. Rotor tip diameter, 34 in.
14. Corrected weight flow, 187 lbs/sec.

The rotor tip diffusion factor of 0.45 is somewhat higher than is common practice for stages with a radius ratio of 0.5. This moderately large tip loading was selected with the expectation that the boundary layer control devices to be investigated would permit operation at loading levels that exceed those given by conventional design criteria. The remaining items were selected as being typical of a compressor front stage, the most likely application of a boundary layer control device. Full details of the methods employed in the design of this rotor and the resulting design parameters are presented in reference 3.

Figure 1 is a photograph of this rotor. A notable feature is the part-span shroud, which is located 39.5% of the span from the tip, (80.8% of the tip radius). The shroud is roughly elliptical in cross section, with a length (parallel to the local blade chord) of 43% of the blade chord, and a thickness of 19% of the shroud length. The relative inlet Mach number at the shroud radius is 1.045 at the rotor design point. The shroud blockage is approximately 1.25% of the total passage throat area. The throat area was set to be 8% greater than choke at each section, not accounting for the shroud. The shroud's major axis was aligned with the local design streamline meridional angle of 5° from axial.

After manufacture, the blading was inspected by means of contour layouts at several sections. For this rotor blade, five of the 13 manufacturing sections along the blade height were inspected for four blades selected at random from the batch. At each manufacturing section an average blade section of these four was obtained and was compared with the design intent. A meridional view of the rotor appears in figure 2 and the inspected sections are identified by asterisks. The results of the comparisons of the average blade sections with design intent appear in figures 3(a) through 3(e). A rather good correspondence exists between the average blade section and design intent for most sections; it is accordingly judged that the design intent was achieved.

The average running tip clearance at 100% speed was 0.027 inch.

Test Facility

Performance tests of this rotor were made in General Electric's House Compressor Test Facility at Lynn, Massachusetts. The general aspects of the test set-up are shown in figure 4. The test rotor draws air from the atmosphere through two banks of filters. The first filter bank is intended to remove 22% of the particles larger than 3-5 microns (dust spot test). The second and final filter bank is intended to remove 90-95% of the remaining particles down to the same size. The air then passes through a coarse wire inlet screen and into the bellmouth. The flow straightener described in reference 3 was not installed because experience on a previous similar configuration showed it was unnecessary (reference 4). Downstream of the test rotor, outlet guide vanes are used to remove most of the swirl. In the exit assembly the air is split into two streams. The inner air stream is passed into an exit pipe containing a flow straightener and a venturi flow meter and then exhausted to atmosphere. The outer air stream passes through a slide cylindrical throttle valve and into a collector, then into pipes, each of which has installed a flow straightener and a venturi flow meter, and is finally discharged to atmosphere.

Power to drive the test rotor is provided by a high-pressure non-condensing steam turbine rated at 15,000 horsepower.

Instrumentation

Schematic views of the instrumentation provided for the testing are shown in figures 5 and 6. Inlet total temperature was measured by 24 thermocouples distributed on the inlet screen. During all the testing described in this report, the inlet total and static pressures were measured at plane 0.05 by six pitot-static rakes having 7 elements each, these 7 elements being placed radially at centers of equal annulus area. A 15-element boundary layer rake was immersed from the outer casing at plane 0.65 ahead of the rotor.

Traverse probes used for obtaining blade element data were located at planes 1.54 behind the rotor and 0.9 ahead of the rotor. At plane 1.54 there were 2 static pressure wedge probes and one cobra probe; one wedge and one cobra were located ahead of the rotor at plane 0.9. The immersions used for recording blade element data were 5%, 10%, 20%, 30%, 50%, 70% and 90% of the annulus height from the tip at plane 1.54, the rotor exit measuring station; at plane 0.9, the rotor inlet measuring station, the 7 immersions were chosen so that the same design streamline sensed at the exit station would be sensed by the corresponding immersion at the inlet station.

Hot wire anemometer data were taken with 5 probes located at plane 1.54 behind the rotor. Three of these probes were shielded units used to determine the number, rotative speed, and radial extent of the rotating stall cells. The remaining two were unshielded and were provided to obtain blade-wake data. However, because of probe vibrations and damage to the exposed wires of these unshielded units, meaningful blade-wake data were not obtained.

Outlet total pressure and temperatures were measured at plane 1.9 by 4 fixed rakes of each type. Immersions of the 5 elements on each rake corresponded to the design streamlines sensed at the 10%, 30%, 50%, 70% and 90% annulus height traverse positions at plane 1.54. The discharge rakes at plane 1.9 are ahead of the outlet guide vanes, and thus must measure swirling flow. These rakes were therefore rotated 37.5° from the axial direction to match the pitchline swirl angle of the flow at the design condition.

The general construction of the traverse probes and fixed rakes is shown in figures 7 and 8. The thermocouple rakes, cobra probes, and static pressure wedge probes were calibrated for Mach number effects, and these calibrations were used in the data reduction calculations. Pressure and temperature measurements from the fixed rakes were found to be sufficiently insensitive to small pitch and yaw angle variations to justify the omission of corrections for these effects; pitch angle effects on the traversing probes could similarly be neglected.

A generous number of static pressure taps were located on the hub and casing throughout the flowpath. At measuring planes where the traverse probes or fixed rakes were located, static pressures at the hub and casing were measured at more than one circumferential position (figure 6).

An exception to this was that, due to an oversight, only one static tap was installed at the hub at plane 1.90 instead of the five called for. To establish the hub Mach number at this plane, the pressure from this tap was averaged with the pressures from two other hub taps immediately upstream and downstream at the same circumferential position.

Boundary Layer Trip

The boundary layer trip shown in figure 9 was used to thicken the inlet casing boundary layer during part of the testing. It was a sharp-edged annular ring which protruded 0.30 inch into the airstream from the outer casing at plane 0.10. The objective in designing the boundary layer trip was to raise the momentum thickness of the casing boundary layer to 0.16 inch and produce a displacement thickness of approximately 0.30 inch.

Test Procedure

For the first runs, the boundary layer trip was not installed. The vehicle was stalled at 50%, 70%, 90%, 100% and 110% speeds as early as possible in order to determine any mechanical limits on operation; none were found. Overall performance data from the fixed instrumentation were obtained at each speed at various discharge valve settings between maximum flow and the limit of stall-free operation. Blade element data from the traverse instrumentation were obtained at 5 of the operating points per speed where overall performance had been recorded. With the complete stall-free performance defined, overall performance data were then recorded while in stall and at the point where the stalls cleared. These rotating-stall and stall-removal overall performance readings completed the performance testing on the undistorted inlet flow configuration.

The boundary layer trip was then installed ahead of the rotor. As before, the stall line was determined first. For these tests, data were taken at 70%, 90% and 100% speeds only, and no blade element data were taken. Overall performance from fixed instrumentation was determined at a minimum of 5 operating points per speed between maximum flow and the limit of stall-free operation. Rotating-stall and stall-removal overall performance readings were also taken.

<u>Testing in the Unstalled Region</u> For all speeds the throttle settings at which data were recorded in the stall-free region of operation were selected to give an approximately even spacing of the points on the compressor performance map. Some repeat overall performance readings were taken, usually at the start of a new day's running in order to assure that data were repeatable.

When taking blade element data, an overall performance reading from the fixed instrumentation was taken before traversing the probes. At the rotor inlet traverse location, the static pressure wedge was set at zero flow angle and the cobra probe was allowed to seek its nulled angle position. At the rotor exit traverse location, the static pressure wedge probe was manually rotated to the angle established by the nulled position of the cobra probe; since stationary vane rows and struts were relatively far removed from this plane, circumferential variations of angle were presumed to be sufficiently small not to affect the pressures read by the static pressure wedge probes. All temperatures and pressures from fixed and traversing instrumentation were recorded in digitized form on punched paper tape for computerized data reduction.

Stall Testing During all testing, both with and without the boundary layer trip installed, the limit of stall-free performance at each speed was reached when rotating stall cells formed in the rotor. The rotor was stalled twice at each speed, the stall point being established by slowly closing the throttle valve until strain gage and hot wire signals indicated the formation of rotating stall cells.

For the first stall at each speed, 3 hot-wire anemometer probes were immersed to the 10%, 50% and 90% positions. In some instances, the vehicle was held in the stalled mode of operation while a single anemometer was immersed to the 10%, 30%, 50%, 70% and 90% immersions. Examination of the data, which were plotted on a high-speed paper tape, showed the radial extent of the rotating stall cells. When the vehicle was stalled the second time, the 3 hot wires were set at the immersion where the stall cells were strongest in the first stall. From the resulting tapes, information on the number and speed of rotating stall cells could be obtained. While throttling into and out of this second stall, an ICPAC* trace was obtained. Conditions were stabilized in stall and a rotating-stall overall performance reading taken. When this was completed, the speed was maintained and the discharge throttle valve slowly opened until the stall cleared; at this condition a stall-removal overall performance reading was taken.

The discharge throttle valve was geared for a fast opening-closing rate for the first stall testing and was closed in a stepwise fashion by the operator. During the second stalls the discharge valve was geared to move very slowly and was actuated by the operator at a constant rate in order that the stall line would always be obtained in a fully consistent manner.

*Instantaneous Compressor Performance Analysis Computer. This is an analogue circuit which senses weight flow and pressure ratio, and which plots these quantities nearly instantaneously to provide an approximate on-line compressor performance map.

RESULTS AND DISCUSSION

The testing reported herein was conducted on Configuration 1, plain casing insert, to establish the basic performance of the rotor. It was done in two phases: undistorted inlet flow (that is, without inlet distortion screens or boundary layer trip), and boundary layer trip testing. The overall and stall performance of each is presented and discussed separately in the following sections, as well as blade element performance data obtained during the undistorted inlet flow testing.

Performance with Undistorted Inlet

Overall Performance A tabulation of all overall performance data points taken during undistorted inlet flow testing is given in Table 1 (a), and the compressor performance map based on these data is shown in figure 10. The rotor exit total-temperature and total-pressure ratios were established on the basis of fixed rake readings by a mass weighting routine, as follows: At each immersion, measurements from all circumferential locations were arithmetically averaged. The static pressure was assumed to vary linearly from hub to casing between the averages of the measured hub and casing values. With static pressure, total pressure and total temperature determined at each rotor exit immersion, the local values of static density and absolute velocity were computed. The tangential velocity was then obtained from the total-temperature rise and the Euler turbomachinery equation, with the assumption of zero inlet tangential velocity. This, when combined with the absolute velocity and the design meridional streamline angle, gave the axial velocity. The discharge total-temperature and total-pressure ratios were then obtained from the following equations:

$$\frac{T}{T_{in}} = \frac{\sum_{j=1}^{5} \frac{T_j}{T_{in}} \rho_j V_{zj} A_j}{\sum_{j=1}^{5} \rho_j V_{zj} A_j} , \qquad (1)$$

$$\frac{P}{P_{in}} = \left\{ \frac{\sum_{j=1}^{5} \left[\left(\frac{P_j}{P_{in}} \right)^{\frac{\gamma-1}{\gamma}} -1 \right] \rho_j V_{zj} A_j}{\sum_{j=1}^{5} \rho_j V_{zj} A_j} +1 \right\}^{\frac{\gamma}{\gamma-1}} \qquad (2)$$

These quantities were used with the real gas properties of dry air to compute the rotor adiabatic and polytropic efficiencies. The weight flow was obtained from the calibrated venturi flow nozzles and was corrected by the ratio of the average inlet total pressure at plane 0.05 to the standard-day value of 14.696 psia and the square root of the ratio of average inlet total temperature to 518.688°R.

The performance at 100% corrected speed, shown in figure 10, should be compared to the design intent of 1.47 total-pressure ratio and 187 lbs/sec corrected flow. The design pressure ratio was actually achieved at 176 lbs/sec flow, close to the stall point; peak adiabatic efficiency at 0.900 was achieved at 181 lbs/sec flow. The pressure ratio at design flow, 1.425, was less than design intent probably because the hub deviation angles were several degrees greater than estimated when selecting the blade sections.

Some scatter in measured efficiency exists at the lower speeds; all recorded values were plotted in figure 10 and the best curve drawn between points. On this basis, the highest efficiency reached by the rotor was 0.943 at 70% corrected speed. Peak efficiencies drop off rapidly above 90% speed and also occur closer to stall at the three higher speeds. This is not unexpected in view of the rather low tip solidity of 1.0 and the double-circular arc blade shape combined with tip relative Mach numbers ranging from 1.05 at 90% speed close to stall up to 1.31 at the 110% speed-maximum flow condition. Since there is substantial camber on the suction surface of these blades, and since the low solidity allows the shock to intersect the suction surface rather near the trailing edge, the Mach number on this part of the blade can build up to fairly high levels before the shock. The resulting high shock losses and the possibility of separation after the shock are the most probable sources for the efficiency changes noted above.

Stall Performance The stall line shown on the performance map (figure 10) is based on the rotating stall testing in which the slow-acting discharge throttle valve was used. The stall points and stall mode were generally very repeatable. The stalling flow was determined from the ICPAC system at the instant that stall was detected. The ICPAC values of stalling flow were then corrected using a correlation of ICPAC and actual flow obtained during unstalled performance testing. Stalling total-pressure ratio was obtained by extrapolating the speed lines on the performance map using the ICPAC traces as a guide.

The overall performance data points which were recorded while the rotor was operating with rotating stall present appear as solid symbols in figure 10. Since conditions are quite unsteady when in stall, the accuracy of these readings is open to question. These data do, however, indicate an appreciable decrease in pressure ratio and efficiency when stall occurs at the higher speeds. After each rotating stall overall performance reading was taken, the discharge throttle valve was slowly opened until the stall cleared. At this latter valve setting, a stall removal overall performance reading was taken;

these points appear as half-shaded symbols in figure 10. In general there is some hysteresis in this process: the stall does not clear until the flow increases above that at which stall first appeared. There was more of this hysteresis at the higher speeds than at the lower.

In order to determine if discharge de-swirl vane position had any effect on stall performance, these vanes were closed 15° from nominal and the rotor was stalled at 90% speed. The effect was negligible; stalling flow appeared to be about 1.5 lbs/sec less based on ICPAC measurements, with a similar reduction in flow at the stall removal point. The stall line in figure 10 is based only on stalls with these vanes in their nominal position.

Samples of the shielded hot-wire anemometer data appear in figure 11. These are copies of oscillograph traces obtained while in stall. In figure 11 (a) a single anemometer was immersed to the 10%, 30%, 50%, 70% and 90% positions at 100% design speed. It can be seen that the rotating stall cells extend from the tip inward to about the 70% immersion and are generally strongest near the 30% immersion. At 90% design speed similar traces indicated that the stall cells were very weak at the tip and hub and were most pronounced at the 30% and 50% immersions. During stall testing the strain gages on the blades did not indicate any abrupt increase in tip stresses at the onset of stall. Because of the severity of the stall cells in the region of the part-span shroud (40% span from the tip) and the low tip stresses, it was considered very probable that stalls were originating in the vicinity of the part-span shroud rather than at the outer casing. Design conditions giving a relative inlet Mach number of 1.045 and a diffusion factor of 0.50 at the shroud location are rather severe; these plus the blockage of the shroud itself could have combined to make the flow past the shroud more prone to stall than that at the tip. In order to establish the number and speed of the rotating stall cells, the phase difference between any two hot wires gives certain options and the use of a third anemometer eliminates all integral numbers except one. A knowledge of the paper speed of the trace and the number of cells permits deduction of the stall speed/rotor speed ratio. This method generally follows the method given in reference 5. Another method is available to check the number and speed of the rotating stall cells by utilizing the traces from a rotor strain gage and a hot wire. The number of stall cells can be calculated by adding the number of pulses per unit time of the strain gage and the hot wire and dividing the total by the number of rotor revolutions for the same unit of time. The ratio of stall cell speed to rotor speed is calculated by dividing the number of pulses per unit time on the hot-wire trace by the product of the rotor revolutions per unit time and the number of stall cells. The number and speed of the rotating stall cells determined by both methods were in good agreement. These data and other stalling performance information are presented in figure 11 (b).

Blade Element Performance For presentation of the data from traverse probes located upstream and downstream of the rotor, a method of adjusting the data to obtain conditions at the blade edges was used. Knowing the measured total pressure, total temperature, static pressure and flow angle at each immersion and using the design meridional streamline angle, the meridional Mach number and all velocity components at each measurement plane may be calculated. Application of the condition of constant angular momentum along design streamlines yields the tangential velocity at each blade edge. It is assumed that the convergence of each meridional stream tube, between a measurement plane and its adjacent blade edge, remains fixed at the design value for all data conditions. The meridional Mach number at a measurement plane may then be used to determine the meridional Mach number at the blade edge by use of the relationship shown in figure 12. This method is not strictly correct at the trailing edge where there may be an appreciable swirl velocity together with a change in radius between the edge and the measurement plane. Nevertheless, since the radius changes are not large, the method should be a very good approximation. With the tangential velocities and the meridional Mach numbers at the edges thus obtained, and with measured stagnation conditions assumed to be constant along the design streamlines, the velocities, Mach numbers, and all of their components may be determined at the blade edges. The constant physical quantities used in these computations, at the measurement planes and at the edges, are given in table 2.

In order to check out this procedure and to determine small differences due to calculation technique, design values of total pressure, total temperature, static pressure and flow angle were used in a sample calculation. Treating this information as though it were test data, the calculation routine was used to give design point blade element performance, yielding the data listed in table 3. Table 4 is included to give a more complete description of the abbreviations used. Some indication of the small differences which can occur is given in table 3 by the comparison of the integrated flows, at the upstream and downstream measurement planes, with the nozzle flow. In this case the nozzle flow was set equal to the design flow.

Complete listings of blade element data are given in table 5, and graphs of deviation angle, diffusion factor and loss coefficient, plotted as a function of incidence angle are presented in figure 13.

In NASA contract NAS3-7617 (reference 4) it was found that more reliable values of blade element loss coefficients could be obtained by using total pressure and temperatures obtained from the fixed rakes rather than from the cobra probes. The data obtained from fixed rakes in the present program gave loss coefficients generally higher at the tip and lower at the hub as compared to the traverse probe values, with the differences being greatest at the higher speeds. Loss coefficients calculated from the fixed instrumentation appear as solid symbols in figure 13 and are tabulated as supplementary data in table 5. Fixed instrumentation was not included at the 5 and 20 percent span radial stations. Therefore, only traverse data are shown in figures 13 (a) and 13 (c).

Figure 14 presents a more complete picture of the radial variations of the total-temperature ratio, total-pressure ratio, absolute air angle, and adiabatic efficiency as obtained from continuous traverses taken at points as close as possible to the stall line at 90% and 100% speeds. The influence of the part-span shroud's wake can be seen in figure 14 and was also observable in direct plots made during blade element traverses. The wake does not change radial position with speed or throttle setting, and generally lies between the 30% and 50% blade element immersions. Thus the blade element data at these two immersions could have been affected only very slightly by the shroud wake.

Performance with Boundary Layer Trip

Overall Performance   Results of testing configuration 1, plain casing insert, with the boundary layer trip installed are tabulated in Table 1 (b) and presented as a performance map in figure 15. The instrumentation and the data analysis methods used in these tests were identical to those used in undistorted inlet overall performance testing.

Overall performance was recorded at 70%, 90% and 100% speeds. Although there was considerable scatter in the efficiency measurements, it appears as if roughly 2 points in efficiency were lost at all conditions as compared to the undistorted inlet configuration. However, because the inlet total pressure is measured ahead of the boundary layer trip, the loss produced by the trip ring appears as a rotor loss in the efficiency calculations.

At the two higher speeds there was some reduction in choked, or maximum, flow. At 100% speed the pressure rise at any flow was less than obtained in undistorted inlet testing; this effect was not observed at lower speeds.

Stall Performance   Thickening the inlet boundary layer by installing the trip ring had only a minor effect on the stall line. At 90% speed the stalling flow was actually reduced by about 5 lbs/sec; at 100% speed, however, the stall line was lowered slightly. Despite these changes, the radial position where stall initiated did not appear to change. The hot wires still indicated that the rotating stall cells were concentrated in the outer portion of the blade and were most severe near the 30% immersion. The rotor stresses remained moderate in the outer part of the blade during stall.

Figure 16 presents hot wire traces and a tabulation of the number and rotative speed of the stall cells. These are seen to be of the same character as given in figure 11 for undistorted inlet, except that three stall cells have formed rather than a single cell. No stalls were performed with the outlet guide vanes in non-standard positions during boundary layer trip testing. Thus it is not known if outlet guide vane position affects the number of stall cells for this case as it did in undistorted inlet testing. The hysteresis effect which exists when attempting to clear the stalls is more pronounced with the boundary layer trip installed, in that the discharge valve had to be opened farther before the stalls could be cleared. As with the undistorted inlet performance map (figure 10), the solid symbols in figure 15 are the performance in stall while the half-shaded symbols indicate the points where the stalls cleared.

Figure 17 compares the inlet casing boundary layer with and without the boundary layer trip installed. The objective momentum thickness of 0.16 in. was obtained at a flow of 176.7 lbs/sec in boundary layer trip test reading 3; the displacement thickness at this condition was 0.29 in., or about equal to the depth of the trip ring. Also shown in figure 17 is the inlet pressure profile for undistorted inlet test reading 6. For this condition the flow was 177.8 lb/sec; the displacement thickness was 0.035 in., and the momentum thickness was 0.023 in.

In summation, the installation of the boundary layer trip, while greatly enlarging the inlet casing boundary layer, did not change the radial variations of stall cell strength and resulted in no consistent change in the point of stall inception on the performance map. The absence of any consistent major reduction in stall performance due to the thick inlet boundary layer reinforces the belief that the part-span shroud, rather than the blade tip region, is responsible for initiation of stall in this rotor.

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Table 1 (a). - Overall Performance Based on Fixed Instrumentation for Undistorted Inlet Flow Testing

Rdg.	Total Pressure Ratio	Rotor Adiabatic Efficiency	Corrected Weight Flow lb/sec	Corrected Speed, Percent Design	Throttle Valve Setting	Inlet Dist'n	Type* Data
1	1.083	.939	107.10	50.32	18.0	none	OP
2	1.084	.960	107.12	50.04	18.0	none	OP
3	1.198	.920	124.50	70.00	6.2	none	BE & HW
4	1.356	.957	165.58	89.95	7.2	none	BE & HW
5	1.200	.913	125.83	70.11	6.2	none	OP
6	1.469	.895	177.77	100.08	6.3	none	BE & HW
7	1.293	.810	191.62	100.00	20.0	none	BE & HW
8	1.384	.869	189.22	100.05	10.5	none	BE
9	1.423	.884	187.10	100.08	8.5	none	BE
10	1.547	.844	188.48	110.21	7.0	none	BE
11	1.549	.846	188.12	110.05	7.0	none	OP
12	1.234	.758	191.68	100.14	50.0	none	OP
15	1.212	.816	185.38	90.08	50.0	none	BE & HW
16	1.363	.931	167.97	90.04	7.2	none	OP
17	1.254	.868	184.58	90.07	21.0	none	BE
18	1.307	.901	179.73	90.02	12.0	none	BE
19	1.339	.929	174.06	90.01	8.8	none	BE & HW
20	1.447	.895	183.63	100.01	7.4	none	BE & HW
21	1.287	.741	198.58	110.20	30.0	none	OP
22	1.333	.764	198.58	110.11	20.0	none	BE
23	1.442	.815	196.59	110.17	11.0	none	BE
24	1.494	.836	195.53	110.02	9.0	none	BE
25	1.534	.848	192.38	110.23	7.8	none	BE
26	1.074	.934	120.45	50.05	55.0	none	BE
27	1.083	.926	110.33	50.07	20.0	none	BE
28	1.089	.937	102.63	50.05	13.0	none	BE
29	1.094	.924	96.92	50.08	9.0	none	BE
30	1.099	.897	88.33	50.05	5.5	none	BE

* Letter code indicates type of data taken, as follows: OP - overall performance from fixed instrumentation; BE - blade element traverse taken concurrently with OP data; HW - hot wire survey of rotor wakes; RS - overall performance in stall with hot wire investigation of stall cells; SR - overall performance at point where stall cleared; CT - continuous traverse taken concurrently with OP data.

Table 1 (a) . (Continued)

Rdg.	Total Pressure Ratio	Rotor Adiabatic Efficiency	Corrected Weight Flow lb/sec	Corrected Speed, Percent Design	Throttle Valve Setting	Inlet Dist'n	Type* Data
31	1.142	.922	162.94	70.11	60.0	none	BE
32	1.166	.942	151.43	70.08	19.0	none	BE
33	1.184	.940	141.90	70.11	12.0	none	BE
34	1.194	.920	133.81	70.09	8.5	none	BE
35	1.448	.900	183.24	100.03	7.4	none	CT
36	1.339	.932	173.85	90.12	8.8	none	CT
37	1.192	.903	133.36	70.14	8.5	none	OP
38	1.193	.914	133.23	70.08	8.5	none	OP & HW
39	1.142	.982	161.41	70.13	60.0	none	OP & HW
40	1.099	.841	80.18	50.07	3.5	none	RS
41	1.099	.861	83.17	50.09	3.9	none	SR
42	1.198	.865	118.19	70.08	5.5	none	RS
43	1.201	.894	121.99	70.06	5.7	none	SR
44	1.354	.884	157.31	90.06	6.5	none	RS
45	1.367	.934	162.23	90.07	6.7	none	SR
46 **	1.360	.882	154.26	90.06	3.8	none	RS
47 **	1.366	.918	159.83	90.08	4.8	none	SR
48	1.430	.818	164.26	100.09	5.4	none	RS
49	1.455	.902	181.01	100.09	7.0	none	SR
50	1.515	.796	175.77	110.08	5.9	none	RS
51	1.555	.846	183.75	110.10	6.3	none	SR

* Letter code indicates type of data taken, as follows: OP - overall performance from fixed instrumentation; BE - blade element traverse taken concurrently with OP data; HW - hot wire survey of rotor wakes; RS - overall performance in stall with hot wire investigation of stall cells; SR - overall performance at point where stall cleared; CT - continuous traverse taken concurrently with OP data.

** Outlet de-swirl vanes closed 15° during Readings 46 & 47.

Table 1 (b). - Overall Performance Based on Fixed Instrumentation for Testing with Boundary Layer Trip

Rdg.	Total Pressure Ratio	Rotor Adiabatic Efficiency	Corrected Weight Flow, lb/sec	Corrected Speed, Percent Design	Throttle Valve Setting	Inlet Dist'n	Type* Data
1	1.200	.874	121.77	70.03	5.2	BLT	OP & HW
2	1.364	.926	163.33	90.07	6.4	BLT	OP & HW
3	1.461	.888	176.72	100.09	6.2	BLT	OP & HW
4	1.285	.792	190.18	100.07	20.0	BLT	OP
5	1.377	.852	187.20	100.07	10.5	BLT	OP
6	1.413	.864	184.15	100.10	8.5	BLT	OP
7	1.437	.879	181.60	100.10	7.4	BLT	OP & HW
8	1.345	.922	170.99	90.11	8.0	BLT	OP & HW
9	1.192	.904	132.26	70.07	8.0	BLT	OP & HW
10	1.300	.756	147.20	90.08	5.5	BLT	RS
11	1.340	.961	171.70	90.08	8.3	BLT	SR
12	1.370	.727	157.53	100.08	5.5	BLT	RS
13	1.414	.882	183.68	100.07	8.4	BLT	SR
14	1.184	.808	116.41	70.04	4.5	BLT	RS
15	1.199	.886	123.88	70.04	5.7	BLT	SR
16	1.181	.912	141.48	70.05	12.0	BLT	OP
17	1.181	.941	142.26	70.06	12.0	BLT	OP
18	1.142	.981	161.02	70.03	60.0	BLT	OP
19	1.165	.961	150.53	70.09	19.0	BLT	OP
20	1.251	.879	183.21	90.09	21.0	BLT	OP
21	1.201	.800	183.32	90.10	50.0	BLT	OP
22	1.306	.927	179.30	90.10	12.0	BLT	OP

* Letter code indicates type of data taken, as follows: OP - overall performance from fixed instrumentation; HW - hot wire survey of rotor wakes; RS - overall performance in stall with hot wire investigation of stall cells; SR - overall performance at point where stall cleared.

Table 2. - Constants Used in Blade Element Data Reduction

Parameter	Plane 0.9	Edge 1	Edge 2	Plane 1.54	Plane 1.9	% imm.
A_j (ft^2)	.4308			.3966		5
	.4344			.3854	1.0641	10
	.5560			.4908		20
	.7839			.6908	.9558	30
	.9692			.8446	.8587	50
	.9186			.7532	.7635	70
	.8750			.6615	.6759	90
r_j (in.)	17.07	17.00	16.91	16.91	17.43	0
	16.69	16.58	16.55	16.55		5
	16.27	16.21	16.20	16.19	16.69	10
	15.46	15.43	15.45	15.46		20
	14.62	14.66	14.71	14.74	15.24	30
	12.97	13.08	13.22	13.29	13.82	50
	11.19	11.44	11.75	11.83	12.39	70
	9.19	9.62	10.21	10.37	11.00	90
	7.98	8.50	9.48	9.63	10.29	100
ε°_j	-1.55	-2.95	-1.57	1.87		5
	-0.96	-1.64	-0.80	1.92	6.27	10
	0.78	0.82	0.75	2.41		20
	2.55	2.73	2.37	3.11	5.36	30
	6.33	6.64	5.80	5.31	4.71	50
	11.12	12.07	10.00	8.38	4.16	70
	19.16	22.12	15.92	12.39	3.50	90
$\kappa'^\circ_j(\kappa'^\circ_{sj})$		56.87 (59.94)	46.94			5
		56.02 (59.49)	45.93			10
		54.42 (58.64)	43.46			20
		52.77 (57.90)	40.32			30
		49.75 (56.16)	31.67			50
		46.61 (53.55)	18.61			70
		45.05 (52.41)	-0.60			90

Parameter	% imm.	
$\dfrac{\left(\frac{w}{w*}\right)_1}{\left(\frac{w}{w*}\right)_u}$	5	1.08790
	10	1.08092
	20	1.05833
	30	1.04935
	50	1.04709
	70	1.06531
	90	1.09794
$\dfrac{\left(\frac{w}{w*}\right)_2}{\left(\frac{w}{w*}\right)_d}$	5	.99509
	10	.99354
	20	.98891
	30	.98586
	50	.98164
	70	.97944
	90	.99043
$\bar{r}_j$ (Used for Diffusion Factor)	5	16.575
	10	16.205
	20	15.440
	30	14.680
	50	13.140
	70	11.585
	90	9.905
σ_j (Used for Diffusion Factor)	5	1.0209
	10	1.0442
	20	1.0959
	30	1.1527
	50	1.2878
	70	1.4606
	90	1.7084

Table 3. - Listing of Check Case for Blade Element Results Using Design Data.

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	58.024	1.154	-1.916	1.1992	1288.277	1092.395	682.883	0.636	681.978
2	57.277	1.257	-2.213	1.1823	1269.641	1068.017	686.532	0.639	686.251
3	56.387	1.967	-2.253	1.1354	1220.784	1016.626	675.859	0.629	675.790
4	55.321	2.551	-2.579	1.0919	1174.981	965.894	669.052	0.622	668.293
5	52.890	3.140	-3.270	1.0053	1083.315	861.793	656.417	0.609	652.014
6	50.183	3.573	-3.367	0.9177	990.474	753.740	642.585	0.595	628.379
7	49.492	4.442	-2.918	0.7940	862.208	633.827	584.523	0.538	541.500

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.500	3.560	7.524	0.7809	898.180	1090.419	696.082	0.605	571.229
2	49.679	3.749	7.598	0.7625	876.290	1067.359	693.516	0.603	566.995
3	47.638	4.178	8.748	0.7215	827.904	1017.944	690.106	0.601	557.829
4	45.079	4.759	10.242	0.6818	781.127	969.188	691.251	0.603	551.345
5	37.804	6.134	15.086	0.6091	694.939	871.017	708.478	0.621	547.324
6	26.928	8.318	23.255	0.5565	631.230	774.164	748.694	0.660	555.963
7	10.518	11.118	38.973	0.5606	628.496	672.699	836.007	0.746	594.981

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.1175	0.454	0.35389	0.4321	0.	397.469	1092.395	692.949	0.838
2	0.1079	0.460	0.37225	0.4477	0.	399.273	1068.017	668.085	0.826
3	0.0922	0.474	0.40516	0.4738	0.	406.226	1016.626	611.718	0.825
4	0.0787	0.489	0.43852	0.5000	0.	416.325	965.894	552.863	0.825
5	0.0569	0.519	0.50069	0.5437	0.	446.416	861.793	424.601	0.839
6	0.0449	0.535	0.54053	0.5559	0.	491.770	753.740	282.395	0.885
7	0.0426	0.468	0.45648	0.4251	0.	562.232	633.827	110.468	1.099

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS. T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.037	0.8336	0.8424	1.467	1.139	1.0020	0.	34.831
2	0.033	0.8479	0.8560	1.467	1.137	1.0022	0.	35.153
3	0.028	0.8734	0.8801	1.467	1.133	1.0016	0.	36.063
4	0.024	0.8952	0.9007	1.467	1.129	1.0017	0.	37.057
5	0.017	0.9302	0.9339	1.467	1.125	1.0029	0.	39.202
6	0.014	0.9508	0.9534	1.467	1.122	1.0038	0.	41.494
7	0.012	0.9623	0.9643	1.467	1.120	1.0092	0.	43.379

TRAVERSE PRESSURE RATIO = 1.4670
TRAVERSE ADIABATIC EFF. = 0.9077
TRAVERSE POLYTROPIC EFF. = 0.9125
FLOW COEFFICIENT L.E. = 0.988
FLOW COEFFICIENT T.E. = 0.958
PERCENT CORRECTED SPEED = 100.00

FIXED INSTRUMENTATION PRESSURE RATIO = 1.4600
ADIABATIC EFF. = 0.9065
POLYTROPIC EFF. = 0.9102
NOZZLE WEIGHT FLOW = 187.00
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00298
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00255

Table 4. - Symbolic Identification of Blade Element Data Column Headings.

RADIAL POSITION 1 2 3 4 5 6 7	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
	β'_1	i	$\beta'_1 - \kappa'_{s1}$	M'_1	V'_1	U_1	V_1	$\overline{M}_1$	V_{z1}

RADIAL POSITION 1 2 3 4 5 6 7	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
	β'_2	$\delta°$	$\Delta\beta'$	M'_2	V'_2	U_2	V_2	M_2	V_{z2}

RADIAL POSITION 1 2 3 4 5 6 7	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
	$\overline{\omega}'$	D	C_p	C_h	$V_{\theta 1}$	$V_{\theta 2}$	$V'_{\theta 1}$	$V'_{\theta 2}$	$\frac{V_{z2}}{V_{z1}}$

RADIAL POSITION 1 2 3 4 5 6 7	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
	$\frac{\overline{\omega}'\cos\beta'_2}{2\sigma}$	η_{ad}	η_p	$\frac{P_{1.54}}{P_{0.90}}$	$\frac{T_{1.54}}{T_{0.90}}$		β_1	β_2

TRAVERSE PRESSURE RATIO =
TRAVERSE ADIABATIC EFF. =
TRAVERSE POLYTROPIC EFF. =
FLOW COEFFICIENT L.E. =
FLOW COEFFICIENT T.E. =
PERCENT CORRECTED SPEED =

FIXED INSTRUMENTATION PRESSURE RATIO =
ADIABATIC EFF. =
POLYTROPIC EFF. =
NOZZLE WEIGHT FLOW =
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW =
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW =

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION 2 4 5 6 7	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
	$\frac{\overline{\omega}'\cos\beta'_2}{2\sigma}$	η_{ad}	$\overline{\omega}'$	$\frac{P_{1.90}}{P_{0.05}}$	$\frac{T_{1.90}}{T_{0.05}}$

Table 5. - Listing of Blade Element Performance.

CONFIG. 1 = PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 2 READING NUMBER 3 DATE 10/18/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	61.967	5.097	2.027	0.7840	866.631	764.731	407.720	0.369	407.180
2	61.308	5.288	1.818	0.7718	852.399	747.665	409.368	0.371	409.200
3	60.428	6.008	1.788	0.7410	818.303	711.689	403.880	0.366	403.838
4	59.460	6.690	1.560	0.7113	785.317	676.173	399.390	0.362	398.937
5	57.289	7.539	1.129	0.6503	718.429	603.298	390.092	0.353	387.476
6	54.228	7.618	0.678	0.5934	655.404	527.655	388.760	0.352	380.166
7	53.137	8.087	0.727	0.5160	570.835	443.710	359.129	0.325	332.696

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	49.899	2.959	12.068	0.5921	672.596	763.347	499.759	0.440	433.176
2	50.232	4.302	11.076	0.5824	659.269	747.204	485.490	0.429	421.704
3	49.425	5.965	11.003	0.5390	609.558	712.611	468.541	0.414	396.467
4	48.450	8.130	11.010	0.4971	562.238	678.479	453.543	0.401	372.779
5	42.705	11.035	14.584	0.4315	487.541	609.755	455.382	0.403	357.280
6	33.057	14.447	21.171	0.3758	423.698	541.953	474.780	0.421	351.297
7	11.070	11.670	42.067	0.3680	413.167	470.923	566.146	0.504	390.469

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.0835	0.364	0.35481	0.3917	0.	248.951	764.731	514.396	1.064
2	0.0255	0.362	0.36980	0.4043	0.	240.483	747.665	506.721	1.031
3	0.0164	0.394	0.40013	0.4299	0.	249.634	711.689	462.977	0.982
4	0.0357	0.427	0.42778	0.4525	0.	257.874	676.173	420.606	0.934
5	0.0395	0.474	0.48223	0.4924	0.	280.012	603.298	329.743	0.922
6	0.0405	0.520	0.53933	0.5247	0.	313.320	527.655	228.633	0.924
7	0.0346	0.485	0.51715	0.4569	0.	394.526	443.710	76.397	1.174

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.026	0.8738	0.8774	1.225	1.068	0.8890	0.	29.886
2	0.008	0.9580	0.9592	1.217	1.060	0.9547	0.	29.695
3	0.005	0.9734	0.9741	1.207	1.057	1.0028	0.	32.196
4	0.010	0.9444	0.9458	1.196	1.056	1.0081	0.	34.674
5	0.011	0.9453	0.9466	1.189	1.054	1.0195	0.	38.087
6	0.012	0.9515	0.9527	1.188	1.053	1.0277	0.	41.730
7	0.010	0.9715	0.9723	1.220	1.060	0.9895	0.	45.296

TRAVERSE PRESSURE RATIO = 1.2034
TRAVERSE ADIABATIC EFF. = 0.9448
TRAVERSE POLYTROPIC EFF. = 0.9463
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 70.00

FIXED INSTRUMENTATION PRESSURE RATIO = 1.1980
ADIABATIC EFF. = 0.9197
POLYTROPIC EFF. = 0.9218
NOZZLE WEIGHT FLOW = 124.50
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.01060
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98878

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0197	0.8978	0.0643	1.211	1.063
4	0.0189	0.9020	0.0657	1.191	1.057
5	0.0203	0.9062	0.0711	1.182	1.054
6	0.0138	0.9432	0.0480	1.188	1.054
7	0.0140	0.9594	0.0489	1.216	1.060

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 = PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 3 READING NUMBER 4 DATE 10/18/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SLCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.258	2.388	-0.682	1.0496	1143.685	982.628	585.199	0.537	584.423
2	58.712	2.692	-0.778	1.0331	1124.319	960.700	584.079	0.537	583.840
3	57.904	3.484	-0.736	0.9916	1079.494	914.473	573.627	0.527	573.568
4	56.903	4.133	-0.997	0.9522	1037.459	868.838	566.958	0.520	566.315
5	54.803	5.053	-1.357	0.8716	950.764	775.198	550.474	0.505	546.781
6	51.983	5.373	-1.567	0.7948	858.030	678.002	542.024	0.496	530.042
7	50.427	5.377	-1.983	0.6978	754.056	570.138	508.650	0.465	471.212

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	48.828	1.888	10.430	0.7178	824.913	980.850	651.652	0.567	542.973
2	49.065	3.135	9.647	0.7225	825.744	960.107	637.075	0.557	541.011
3	47.809	4.349	10.094	0.6792	775.089	915.658	622.541	0.546	520.531
4	46.911	6.591	9.993	0.6447	734.546	871.801	603.858	0.530	501.595
5	42.733	11.063	12.070	0.5520	627.732	783.495	585.046	0.514	459.809
6	33.240	14.630	18.743	0.4808	545.377	696.374	608.663	0.537	451.263
7	11.348	11.948	39.079	0.4720	531.685	605.105	725.888	0.644	502.030

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.1053	0.433	0.37419	0.4370	0.	360.012	982.628	620.838	0.929
2	0.0450	0.409	0.39103	0.4510	0.	336.325	960.700	623.782	0.927
3	0.0341	0.426	0.42283	0.4764	0.	341.407	914.473	574.251	0.908
4	0.0203	0.433	0.45093	0.4979	0.	335.583	868.838	536.218	0.886
5	0.0372	0.487	0.49976	0.5292	0.	358.711	775.198	424.784	0.841
6	0.0551	0.532	0.54346	0.5462	0.	400.626	678.002	295.748	0.851
7	0.0575	0.503	0.52315	0.4815	0.	504.356	570.138	100.749	1.065

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.034	0.8557	0.8625	1.408	1.120	0.9389	0.	33.546
2	0.014	0.9345	0.9375	1.400	1.108	0.9564	0.	31.868
3	0.010	0.9512	0.9535	1.388	1.103	0.9685	0.	33.260
4	0.006	0.9709	0.9721	1.366	1.096	0.9738	0.	33.784
5	0.011	0.9495	0.9515	1.329	1.089	1.0084	0.	37.959
6	0.016	0.9340	0.9365	1.317	1.088	1.0186	0.	41.598
7	0.016	0.9502	0.9524	1.370	1.099	0.9863	0.	45.132

TRAVERSE PRESSURE RATIO = 1.3619
TRAVERSE ADIABATIC EFF. = 0.9371
TRAVERSE POLYTROPIC EFF. = 0.9398
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 89.95

FIXED INSTRUMENTATION PRESSURE RATIO = 1.3560
ADIABATIC EFF. = 0.9567
POLYTROPIC EFF. = 0.9586
NOZZLE WEIGHT FLOW = 165.58
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00968
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99035

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0155	0.9274	0.0493	1.391	1.107
4	0.0064	0.9693	0.0216	1.355	1.094
5	0.0102	0.9544	0.0357	1.326	1.088
6	0.0101	0.9575	0.0353	1.323	1.087
7	0.0052	0.9839	0.0181	1.370	1.096

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 = PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 2 READING NUMBER 6 DATE 10/19/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.953	3.083	0.013	1.1635	1263.417	1093.268	633.235	0.583	632.395
2	59.241	3.221	-0.249	1.1473	1243.978	1068.871	636.394	0.587	636.133
3	58.240	3.820	-0.400	1.1050	1196.653	1017.439	629.919	0.582	629.854
4	57.339	4.569	-0.561	1.0598	1148.610	966.666	620.373	0.572	619.669
5	54.774	5.024	-1.386	0.9765	1058.199	862.482	613.114	0.566	609.802
6	51.888	5.278	-1.662	0.8920	967.053	754.342	605.111	0.558	591.734
7	51.146	6.096	-1.264	0.7708	840.626	634.333	551.610	0.506	511.010

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.077	3.137	9.876	0.7299	833.779	1091.290	700.710	0.599	547.839
2	50.120	4.190	9.121	0.7535	873.816	1068.212	687.093	0.593	560.253
3	48.274	4.814	9.966	0.6924	801.044	1018.757	679.303	0.587	533.126
4	46.120	5.800	11.219	0.6711	772.631	969.962	676.668	0.588	535.333
5	41.400	9.730	13.374	0.5839	669.712	871.713	662.180	0.577	500.905
6	31.913	13.303	19.975	0.5257	599.769	774.783	688.564	0.604	503.505
7	13.757	14.357	37.388	0.4985	554.958	673.237	773.363	0.682	528.829

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.2000	0.493	0.37695	0.4523	0.	436.626	1093.268	654.664	0.866
2	0.1156	0.451	0.39502	0.4674	0.	397.683	1068.871	670.529	0.881
3	0.1127	0.491	0.43018	0.4958	0.	420.928	1017.439	597.830	0.846
4	0.0648	0.484	0.46373	0.5216	0.	413.288	966.666	556.675	0.864
5	0.0584	0.526	0.53446	0.5730	0.	430.103	862.482	441.610	0.823
6	0.0634	0.545	0.58339	0.5933	0.	461.217	754.342	313.566	0.851
7	0.0746	0.523	0.58056	0.5419	0.	543.762	634.333	129.475	1.035

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.063	0.7604	0.7740	1.514	1.166	0.9164	0.	38.555
2	0.036	0.8513	0.8597	1.507	1.146	0.9273	0.	35.368
3	0.034	0.8595	0.8673	1.501	1.143	0.9584	0.	38.293
4	0.019	0.9191	0.9236	1.496	1.133	0.9655	0.	37.669
5	0.017	0.9305	0.9342	1.463	1.124	0.9731	0.	40.651
6	0.018	0.9318	0.9352	1.444	1.119	0.9640	0.	42.490
7	0.021	0.9382	0.9415	1.468	1.124	0.9492	0.	45.798

TRAVERSE PRESSURE RATIO = 1.4795
TRAVERSE ADIABATIC EFF. = 0.8909
TRAVERSE POLYTROPIC EFF. = 0.8968
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 100.08

FIXED INSTRUMENTATION PRESSURE RATIO = 1.4690
ADIABATIC EFF. = 0.8950
POLYTROPIC EFF. = 0.9006
NOZZLE WEIGHT FLOW = 177.77
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00554
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00460

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0469	0.8077	0.1527	1.495	1.151
4	0.0271	0.8915	0.0902	1.476	1.132
5	0.0181	0.9322	0.0621	1.462	1.123
6	0.0123	0.9532	0.0422	1.438	1.115
7	0.0166	0.9507	0.0584	1.463	1.121

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 3 READING NUMBER 7 DATE 10/19/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SLCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	57.579	0.709	-2.361	1.2029	1295.973	1093.560	695.467	0.646	694.545
2	56.743	0.723	-2.747	1.1895	1278.720	1069.156	701.449	0.652	701.162
3	56.226	1.806	-2.414	1.1380	1224.373	1017.710	680.702	0.633	680.632
4	55.224	2.454	-2.676	1.0946	1177.615	966.923	672.188	0.625	671.425
5	52.400	2.650	-3.760	1.0148	1091.634	862.712	668.874	0.622	664.387
6	48.884	2.274	-4.666	0.9415	1011.396	754.543	673.489	0.627	658.600
7	47.436	2.386	-4.974	0.8280	893.451	634.502	629.017	0.583	582.719

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	53.042	6.102	4.538	0.9544	1077.439	1091.581	687.808	0.609	647.705
2	52.599	6.669	4.144	0.9441	1062.603	1068.496	683.354	0.607	645.398
3	50.643	7.183	5.582	0.8932	1004.981	1019.029	681.731	0.606	637.282
4	47.773	7.453	7.451	0.8671	971.941	970.221	699.990	0.624	652.962
5	41.472	9.802	10.928	0.7504	843.494	871.946	707.414	0.629	630.192
6	28.475	9.865	20.409	0.6666	746.492	774.990	782.761	0.699	648.442
7	10.726	11.326	36.710	0.6798	752.599	673.416	915.557	0.827	712.017

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.1366	0.256	0.19230	0.2516	0.	230.745	1093.560	860.836	0.933
2	0.1132	0.253	0.20711	0.2661	0.	224.395	1069.156	844.101	0.920
3	0.1162	0.269	0.22615	0.2806	0.	241.990	1017.710	777.038	0.936
4	0.0824	0.267	0.24611	0.2962	0.	250.791	966.923	719.429	0.973
5	0.1602	0.340	0.27805	0.3150	0.	314.952	862.712	556.994	0.949
6	0.1121	0.407	0.35632	0.3742	0.	423.278	754.543	351.711	0.985
7	0.0926	0.339	0.27932	0.2496	0.	538.544	634.502	134.872	1.222

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.040	0.7092	0.7179	1.239	1.089	0.9014	0.	19.608
2	0.033	0.7529	0.7603	1.242	1.085	0.9034	0.	19.172
3	0.034	0.7653	0.7727	1.253	1.087	0.9074	0.	20.793
4	0.024	0.8404	0.8458	1.276	1.086	0.9105	0.	21.011
5	0.047	0.7389	0.7475	1.265	1.094	0.9368	0.	26.555
6	0.034	0.8545	0.8607	1.355	1.106	0.9930	0.	33.135
7	0.027	0.9123	0.9167	1.442	1.121	0.9665	0.	37.103

TRAVERSE PRESSURE RATIO = 1.3060
TRAVERSE ADIABATIC EFF. = 0.8145
TRAVERSE POLYTROPIC EFF. = 0.8214
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 100.00

FIXED INSTRUMENTATION PRESSURE RATIO = 1.2930
ADIABATIC EFF. = 0.8095
POLYTROPIC EFF. = 0.8164
NOZZLE WEIGHT FLOW = 191.62
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99566
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.01954

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0420	0.6891	0.1445	1.225	1.087
4	0.0286	0.8154	0.0983	1.262	1.084
5	0.0636	0.6390	0.2188	1.203	1.085
6	0.0294	0.8706	0.0977	1.353	1.104
7	0.0081	0.9723	0.0282	1.449	1.115

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 = PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 4 READING NUMBER 8 DATE 10/19/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	57.885	1.015	-2.055	1.1966	1290.859	1092.928	686.897	0.637	685.986
2	57.143	1.123	-2.347	1.1812	1272.183	1068.538	690.417	0.641	690.135
3	56.512	2.092	-2.128	1.1323	1219.606	1017.122	672.980	0.625	672.911
4	55.536	2.766	-2.364	1.0886	1172.520	966.364	664.035	0.616	663.282
5	52.770	3.020	-3.390	1.0076	1085.573	862.213	659.588	0.612	655.164
6	49.486	2.876	-4.064	0.9307	1001.444	754.107	658.948	0.612	644.380
7	48.062	3.012	-4.348	0.8171	883.381	634.135	615.007	0.569	569.741

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.469	4.529	6.416	0.8679	996.245	1090.950	694.617	0.605	620.507
2	51.610	5.680	5.533	0.8429	963.506	1067.879	675.164	0.591	598.323
3	49.168	5.708	7.344	0.7920	903.841	1018.440	679.143	0.595	590.951
4	46.606	6.286	8.929	0.7657	870.383	969.660	686.844	0.604	597.719
5	41.261	9.591	11.509	0.6568	746.154	871.442	678.970	0.598	559.263
6	27.590	8.980	21.897	0.6090	687.305	774.542	764.931	0.678	601.845
7	12.723	13.323	35.339	0.5986	670.121	673.027	842.996	0.753	629.746

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.1447	0.346	0.29296	0.3660	0.	311.729	1092.928	779.221	0.905
2	0.1105	0.360	0.30838	0.3796	0.	312.707	1068.538	755.171	0.867
3	0.1085	0.384	0.33587	0.4011	0.	334.593	1017.122	683.847	0.878
4	0.0749	0.383	0.36327	0.4225	0.	337.453	966.364	632.207	0.901
5	0.1067	0.450	0.41533	0.4587	0.	380.786	862.213	490.656	0.854
6	0.0709	0.473	0.47545	0.4939	0.	460.044	754.107	314.498	0.934
7	0.0928	0.423	0.43029	0.4039	0.	530.845	634.135	142.182	1.105

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.044	0.7733	0.7834	1.379	1.125	0.8706	0.	26.674
2	0.033	0.8172	0.8251	1.365	1.114	0.9354	0.	27.593
3	0.032	0.8316	0.8391	1.378	1.116	0.9451	0.	29.518
4	0.022	0.8862	0.8914	1.388	1.111	0.9466	0.	29.448
5	0.031	0.8502	0.8566	1.362	1.109	0.9799	0.	34.250
6	0.022	0.9181	0.9222	1.432	1.118	0.9730	0.	37.394
7	0.026	0.9145	0.9189	1.447	1.122	0.9445	0.	40.129

TRAVERSE PRESSURE RATIO = 1.3964
TRAVERSE ABIABATIC EFF. = 0.8659
TRAVERSE POLYTROPIC EFF. = 0.8721
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 100.00

FIXED INSTRUMENTATION PRESSURE RATIO = 1.3840
ADIABATIC EFF. = 0.8694
POLYTROPIC EFF. = 0.8753
NOZZLE WEIGHT FLOW = 189.22
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99798
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.01066

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0415	0.7734	0.1397	1.355	1.117
4	0.0294	0.8552	0.0988	1.370	1.110
5	0.0368	0.8326	0.1260	1.340	1.105
6	0.0146	0.9551	0.0378	1.434	1.114
7	0.0144	0.9517	0.0503	1.440	1.115

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 = PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 5 READING NUMBER 9 DATE 10/19/1967

RADIAL POSITION	REL.INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	58.410	1.540	-1.530	1.1877	1283.876	1093.231	673.190	0.623	672.298
2	57.641	1.621	-1.849	1.1733	1265.471	1068.834	677.503	0.628	677.225
3	57.018	2.598	-1.622	1.1248	1212.910	1017.403	660.334	0.612	660.266
4	55.954	3.184	-1.946	1.0814	1167.017	966.632	653.874	0.606	653.132
5	53.276	3.526	-2.884	0.9998	1076.617	862.452	647.758	0.600	643.413
6	50.055	3.445	-3.495	0.9218	993.129	754.316	645.997	0.600	631.716
7	48.790	3.740	-3.620	0.8062	872.864	634.311	599.618	0.554	555.484

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.241	4.301	7.169	0.8184	947.166	1091.253	690.095	0.596	592.887
2	51.566	5.636	6.075	0.8050	926.390	1068.175	670.066	0.582	575.838
3	49.059	5.599	7.959	0.7516	862.720	1018.722	674.064	0.587	565.307
4	47.061	6.741	8.893	0.7306	835.613	969.929	672.913	0.588	569.014
5	41.155	9.485	12.121	0.6376	726.439	871.683	675.665	0.593	545.366
6	28.755	10.145	21.299	0.5795	655.950	774.756	739.793	0.654	568.309
7	12.908	13.508	35.882	0.5592	628.797	673.214	816.323	0.726	590.508

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.1530	0.397	0.33957	0.4156	0.	352.778	1093.231	738.474	0.882
2	0.1088	0.398	0.35524	0.4289	0.	342.541	1068.834	725.634	0.850
3	0.1017	0.427	0.38532	0.4522	0.	367.864	1017.403	651.658	0.856
4	0.0652	0.417	0.41551	0.4756	0.	358.442	966.632	611.487	0.871
5	0.0754	0.470	0.46435	0.5071	0.	395.807	862.452	476.677	0.848
6	0.0573	0.501	0.52043	0.5368	0.	462.901	754.316	311.856	0.900
7	0.0947	0.466	0.49116	0.4624	0.	537.879	634.311	135.335	1.063

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.047	0.7854	0.7961	1.440	1.140	0.8749	0.	30.753
2	0.032	0.8379	0.8458	1.425	1.127	0.9191	0.	30.747
3	0.030	0.8563	0.8635	1.435	1.127	0.9433	0.	32.996
4	0.019	0.9079	0.9125	1.432	1.119	0.9353	0.	32.208
5	0.022	0.9001	0.9048	1.407	1.114	0.9711	0.	35.916
6	0.017	0.9351	0.9384	1.443	1.118	0.9763	0.	39.164
7	0.027	0.9157	0.9201	1.456	1.124	0.9422	0.	42.330

TRAVERSE PRESSURE RATIO = 1.4332
TRAVERSE ADIABATIC EFF. = 0.8851
TRAVERSE POLYTROPIC EFF. = 0.8908
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 100.10

FIXED INSTRUMENTATION PRESSURE RATIO = 1.4230
ADIABATIC EFF. = 0.8841
POLYTROPIC EFF. = 0.8898
NOZZLE WEIGHT FLOW = 187.10
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99774
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00536

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0422	0.7943	0.1419	1.417	1.132
4	0.0302	0.8631	0.1023	1.415	1.121
5	0.0256	0.8932	0.0877	1.401	1.113
6	0.0093	0.9642	0.0309	1.444	1.115
7	0.0168	0.9454	0.0589	1.446	1.118

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 = PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 6 READING NUMBER 10 DATE 10/19/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	60.431	3.561	0.491	1.2827	1384.698	1203.972	683.988	0.634	683.081
2	59.696	3.676	0.206	1.2655	1363.536	1177.104	688.228	0.639	687.946
3	58.963	4.543	0.323	1.2130	1307.718	1120.464	674.306	0.625	674.237
4	57.921	5.151	0.021	1.1666	1256.783	1064.549	668.012	0.620	667.253
5	55.456	5.706	-0.704	1.0725	1155.634	949.816	658.285	0.611	653.869
6	52.067	5.457	-1.483	0.9866	1062.311	830.726	662.118	0.615	647.480
7	50.729	5.679	-1.681	0.8615	931.734	698.565	616.550	0.570	571.171

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.801	3.861	9.630	0.7912	935.532	1201.793	759.736	0.642	591.182
2	50.603	4.673	9.093	0.8118	947.336	1176.378	747.657	0.641	601.238
3	49.005	5.545	9.957	0.7509	874.686	1121.916	736.531	0.632	573.764
4	45.364	5.044	12.557	0.7229	838.229	1068.180	754.915	0.651	588.691
5	42.579	10.909	12.877	0.6005	693.998	959.982	710.045	0.614	509.598
6	27.860	9.250	24.207	0.5690	651.902	853.237	799.581	0.698	569.464
7	13.052	13.652	37.678	0.5633	637.692	741.409	866.367	0.765	598.542

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.2754	0.493	0.33174	0.4182	0.	476.907	1203.972	724.886	0.865
2	0.1609	0.461	0.35034	0.4343	0.	444.335	1177.104	732.043	0.874
3	0.1580	0.492	0.38233	0.4589	0.	461.754	1120.464	660.162	0.851
4	0.1368	0.496	0.41279	0.4819	0.	471.961	1064.549	596.220	0.882
5	0.1664	0.566	0.46660	0.5161	0.	491.727	949.816	468.256	0.779
6	0.0974	0.567	0.55273	0.5723	0.	552.231	830.726	301.006	0.880
7	0.0931	0.511	0.53247	0.5037	0.	602.654	698.565	138.754	1.048

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.085	0.6846	0.7041	1.578	1.204	0.8970	0.	38.893
2	0.049	0.7997	0.8122	1.579	1.175	0.9562	0.	36.466
3	0.047	0.8087	0.8205	1.570	1.170	0.9736	0.	38.826
4	0.042	0.8408	0.8509	1.586	1.168	0.9639	0.	38.720
5	0.048	0.8100	0.8206	1.501	1.152	0.9971	0.	43.978
6	0.029	0.9045	0.9105	1.585	1.156	0.9724	0.	44.120
7	0.027	0.9233	0.9281	1.575	1.150	0.9572	0.	45.196

TRAVERSE PRESSURE RATIO = 1.5651
TRAVERSE ADIABATIC EFF. = 0.8313
TRAVERSE POLYTROPIC EFF. = 0.8417
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 110.20

FIXED INSTRUMENTATION PRESSURE RATIO = 1.5470
ADIABATIC EFF. = 0.8441
POLYTROPIC EFF. = 0.8534
NOZZLE WEIGHT FLOW = 188.48
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00295
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.02378

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0637	0.7447	0.2097	1.557	1.181
4	0.0479	0.8220	0.1571	1.550	1.162
5	0.0451	0.8337	0.1576	1.497	1.147
6	0.0187	0.9362	0.0619	1.566	1.146
7	0.0174	0.9480	0.0610	1.564	1.144

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 3 READING NUMBER 15 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	56.278	-0.592	-3.662	1.0927	1132.555	983.178	657.113	0.607	656.242
2	55.632	-0.388	-3.858	1.0781	1164.681	961.238	657.650	0.609	657.381
3	55.041	0.621	-3.599	1.0329	1116.464	914.984	639.761	0.592	639.696
4	53.915	1.145	-3.985	0.9940	1076.135	869.324	634.304	0.586	633.585
5	50.990	1.240	-5.170	0.9265	1000.865	775.632	632.555	0.586	628.312
6	47.238	0.628	-6.312	0.8664	933.689	678.381	641.540	0.595	627.358
7	45.579	0.529	-6.831	0.7674	830.415	570.457	603.463	0.558	559.047

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	54.260	7.320	2.018	0.9400	1047.597	981.399	625.962	0.562	611.828
2	52.921	6.991	2.711	0.9221	1028.148	960.645	635.627	0.570	619.864
3	50.329	6.869	4.712	0.8786	977.491	916.170	645.177	0.580	623.985
4	48.210	7.890	5.704	0.8551	950.409	872.289	654.518	0.589	633.113
5	39.329	7.659	11.662	0.7475	833.948	783.934	695.631	0.624	643.096
6	27.778	9.168	19.460	0.6637	739.362	696.764	746.796	0.670	646.343
7	10.619	11.219	34.960	0.6670	735.725	605.443	865.896	0.785	696.280

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.0988	0.168	0.14638	0.1875	0.	131.197	983.178	850.202	0.932
2	0.1204	0.175	0.15761	0.1981	0.	140.412	961.238	820.233	0.943
3	0.0836	0.191	0.17901	0.2171	0.	163.798	914.984	752.372	0.975
4	0.0561	0.183	0.19480	0.2295	0.	163.939	869.324	708.350	0.999
5	0.1498	0.267	0.23510	0.2606	0.	257.027	775.632	526.907	1.024
6	0.1197	0.341	0.32323	0.3341	0.	356.310	678.381	340.454	1.030
7	0.1037	0.287	0.22439	0.1904	0.	474.896	570.457	130.547	1.245

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.028	0.6796	0.6849	1.124	1.050	0.8225	0.	12.103
2	0.035	0.6572	0.6633	1.136	1.056	0.7649	0.	12.763
3	0.024	0.7776	0.7823	1.163	1.057	0.8491	0.	14.708
4	0.016	0.8548	0.8581	1.174	1.055	0.8322	0.	14.517
5	0.045	0.7374	0.7444	1.210	1.076	0.8520	0.	21.785
6	0.036	0.8352	0.8409	1.281	1.088	0.9110	0.	28.867
7	0.030	0.8948	0.8992	1.346	1.099	0.9341	0.	34.296

TRAVERSE PRESSURE RATIO = 1.2197
TRAVERSE ADIABATIC EFF. = 0.8063
TRAVERSE POLYTROPIC EFF. = 0.8117
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 90.08

FIXED INSTRUMENTATION PRESSURE RATIO = 1.2120
ADIABATIC EFF. = 0.8163
POLYTROPIC EFF. = 0.8213
NOZZLE WEIGHT FLOW = 185.38
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99582
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00911

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0353	0.6423	0.1224	1.129	1.055
4	0.0219	0.8175	0.0757	1.173	1.057
5	0.0620	0.6124	0.2065	1.148	1.066
6	0.0214	0.8963	0.0705	1.278	1.081
7	0.0001	0.9998	0.0002	1.361	1.092

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 5 READING NUMBER 17 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN. CMBR. LN	INCID ANG SUCT. SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	56.315	-0.555	-3.625	1.0930	1182.994	983.966	656.724	0.607	655.854
2	55.698	-0.322	-3.792	1.0783	1164.693	962.008	656.545	0.608	656.276
3	55.090	0.670	-3.550	1.0324	1116.693	915.718	639.112	0.591	639.046
4	53.995	1.225	-3.905	0.9943	1075.891	870.021	632.934	0.585	632.216
5	51.051	1.301	-5.109	0.9259	1000.797	776.253	631.685	0.584	627.448
6	47.379	0.769	-6.171	0.8633	932.267	678.925	638.892	0.592	624.768
7	46.034	0.984	-6.376	0.7603	824.180	570.914	594.415	0.548	550.664

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	52.932	5.992	3.383	0.8927	1003.362	982.186	631.628	0.562	604.705
2	52.345	6.415	3.353	0.8727	980.016	961.414	626.825	0.558	598.672
3	49.700	6.240	5.390	0.8270	927.947	916.905	635.628	0.566	600.160
4	47.538	7.218	6.458	0.8036	897.859	872.988	642.052	0.575	605.914
5	38.598	6.928	12.453	0.6941	778.632	784.562	679.695	0.606	606.622
6	26.528	7.918	20.851	0.6312	706.127	697.322	741.892	0.663	624.065
7	11.569	12.169	34.465	0.6236	692.234	605.929	827.228	0.745	653.149

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.0998	0.227	0.20995	0.2621	0.	181.691	983.966	800.495	0.922
2	0.1018	0.235	0.22595	0.2774	0.	185.558	962.008	775.857	0.912
3	0.0855	0.255	0.24723	0.2944	0.	209.210	915.718	707.695	0.939
4	0.0247	0.251	0.26985	0.3131	0.	210.878	870.021	662.111	0.958
5	0.1038	0.339	0.32527	0.3577	0.	300.330	776.253	484.232	0.967
6	0.0678	0.386	0.39745	0.4107	0.	385.795	678.925	311.527	0.999
7	0.0947	0.333	0.31428	0.2842	0.	472.223	570.914	133.706	1.186

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.029	0.7590	0.7650	1.193	1.068	0.8340	0.	16.724
2	0.030	0.7625	0.7685	1.198	1.069	0.8221	0.	17.221
3	0.025	0.8153	0.8204	1.216	1.071	0.8689	0.	19.218
4	0.007	0.9451	0.9467	1.228	1.064	0.9208	0.	19.190
5	0.031	0.8329	0.8383	1.262	1.083	0.9163	0.	26.339
6	0.021	0.9113	0.9148	1.324	1.092	0.9422	0.	31.724
7	0.027	0.9056	0.9096	1.351	1.099	0.9266	0.	35.867

TRAVERSE PRESSURE RATIO = 1.2648
TRAVERSE ADIABATIC EFF. = 0.8667
TRAVERSE POLYTROPIC EFF. = 0.8711
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 90.07

FIXED INSTRUMENTATION PRESSURE RATIO = 1.2540
ADIABATIC EFF. = 0.8683
POLYTROPIC EFF. = 0.8725
NOZZLE WEIGHT FLOW = 184.58
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99551
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00706

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0327	0.7342	0.1118	1.186	1.068
4	0.0174	0.8777	0.0595	1.222	1.067
5	0.0455	0.7533	0.1501	1.212	1.075
6	0.0101	0.9552	0.0330	1.324	1.088
7	0.0045	0.9835	0.0156	1.354	1.092

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 6 READING NUMBER 18 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	56.976	0.106	-2.964	1.0823	1173.335	983.387	640.050	0.590	639.202
2	56.286	0.266	-3.204	1.0686	1155.982	961.442	641.813	0.593	641.550
3	55.696	1.276	-2.944	1.0238	1107.925	915.179	624.457	0.577	624.393
4	54.709	1.939	-3.191	0.9839	1065.677	869.509	616.135	0.569	615.435
5	52.016	2.266	-4.144	0.9113	986.812	775.796	609.867	0.563	605.777
6	49.474	2.864	-4.076	0.8321	901.244	678.525	593.164	0.548	580.051
7	48.140	3.090	-4.270	0.7303	793.793	570.578	551.859	0.508	511.241

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.112	4.172	5.865	0.8061	918.761	981.608	635.545	0.558	576.718
2	50.287	4.357	5.999	0.7993	906.449	960.849	636.362	0.561	579.148
3	47.755	4.295	7.941	0.7544	854.583	916.365	640.814	0.566	574.514
4	46.565	6.245	8.144	0.7242	818.471	872.474	628.038	0.556	562.492
5	40.170	8.500	11.846	0.6443	726.983	784.100	640.409	0.568	553.848
6	28.519	9.909	20.955	0.5715	642.444	696.912	689.876	0.614	557.834
7	14.634	15.234	33.506	0.5920	659.931	605.572	779.470	0.699	615.512

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.1170	0.328	0.30640	0.3685	0.	266.578	983.387	715.030	0.902
2	0.0731	0.325	0.32219	0.3824	0.	263.588	961.442	697.260	0.903
3	0.0724	0.346	0.34802	0.4025	0.	283.760	915.179	632.605	0.920
4	0.0429	0.346	0.37398	0.4228	0.	278.374	869.509	594.100	0.914
5	0.0541	0.389	0.42748	0.4617	0.	316.562	775.796	467.538	0.914
6	0.0718	0.439	0.46144	0.4707	0.	393.795	678.525	303.117	0.962
7	0.0798	0.338	0.39060	0.3560	0.	444.854	570.578	160.718	1.204

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.036	0.7994	0.8068	1.301	1.098	0.8524	0.	24.808
2	0.022	0.8703	0.8751	1.308	1.092	0.8844	0.	24.472
3	0.022	0.8807	0.8853	1.318	1.094	0.8932	0.	26.285
4	0.013	0.9282	0.9309	1.308	1.086	0.9054	0.	26.331
5	0.016	0.9195	0.9226	1.309	1.087	0.9164	0.	29.751
6	0.022	0.9125	0.9160	1.330	1.093	0.9483	0.	35.220
7	0.023	0.9250	0.9282	1.356	1.099	0.8830	0.	35.857

TRAVERSE PRESSURE RATIO = 1.3205
TRAVERSE ADIABATIC EFF. = 0.8995
TRAVERSE POLYTROPIC EFF. = 0.9034
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 90.02

FIXED INSTRUMENTATION PRESSURE RATIO = 1.3070
ADIABATIC EFF. = 0.9008
POLYTROPIC EFF. = 0.9045
NOZZLE WEIGHT FLOW = 179.73
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99403
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.01247

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0299	0.8281	0.0977	1.296	1.093
4	0.0191	0.8957	0.0639	1.293	1.085
5	0.0197	0.9057	0.0663	1.294	1.084
6	0.0141	0.9395	0.0468	1.317	1.087
7	0.0131	0.9543	0.0463	1.346	1.093

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 7 READING NUMBER 19 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN. CMBR. LN	INCID ANG SUCT. SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	57.940	1.070	-2.000	1.0674	1160.626	983.253	616.659	0.567	615.842
2	57.317	1.297	-2.173	1.0536	1142.286	961.310	617.008	0.569	616.756
3	56 577	2.157	-2.063	1.0097	1096.397	915.054	603.956	0.556	603.894
4	55.558	2.788	-2.342	0.9703	1054.575	869.390	596.900	0.549	596.223
5	53.162	3.412	-2.998	0.8941	971.564	775.690	585.015	0.538	581.091
6	50.320	3.710	-3.230	0.8186	889.689	678.432	575.567	0.530	562.842
7	49.706	4.656	-2.704	0.7078	773.378	570.500	522.153	0.478	483.721

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.175	3.235	7.764	0.7635	875.947	981.474	640.495	0.558	560.905
2	50.085	4.155	7.231	0.7632	871.587	960.717	631.029	0.553	559.227
3	47.829	4.369	8.748	0.7185	818.724	916.240	630.808	0.554	549.630
4	46.289	5.969	9.269	0.6802	772.557	872.355	619.635	0.546	533.636
5	40.980	9.310	12.182	0.5959	675.292	783.993	615.068	0.543	508.312
6	29.671	11.061	20.649	0.5191	587.609	696.817	655.848	0.579	504.675
7	12.710	13.310	36.996	0.5167	579.855	605.489	744.316	0.663	544.944

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.1261	0.375	0.34479	0.4080	0.	308.842	983.253	672.632	0.911
2	0.0998	0.359	0.36151	0.4224	0.	292.236	961.310	668.481	0.907
3	0.0650	0.382	0.39169	0.4465	0.	309.474	915.054	606.766	0.910
4	0.0204	0.397	0.42141	0.4700	0.	314.154	869.390	558.201	0.895
5	0.0328	0.443	0.47784	0.5102	0.	342.435	775.690	441.557	0.875
6	0.0977	0.499	0.51385	0.5207	0.	409.294	678.432	287.522	0.897
7	0.0603	0.438	0.46982	0.4308	0.	482.578	570.500	122.911	1.127

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.040	0.8108	0.8188	1.354	1.112	0.8651	0.	28.838
2	0.031	0.8471	0.8535	1.351	1.106	0.8468	0.	27.590
3	0.020	0.9020	0.9061	1.356	1.101	0.8998	0.	29.382
4	0.006	0.9685	0.9699	1.346	1.092	0.9572	0.	30.485
5	0.010	0.9537	0.9556	1.330	1.089	0.9676	0.	33.967
6	0.029	0.8869	0.8916	1.332	1.096	0.9508	0.	39.042
7	0.017	0.9460	0.9483	1.363	1.098	0.9572	0.	41.527

TRAVERSE PRESSURE RATIO = 1.3456
TRAVERSE ADIABATIC EFF. = 0.9091
TRAVERSE POLYTROPIC EFF. = 0.9128
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 90.01

FIXED INSTRUMENTATION PRESSURE RATIO = 1.3390
ADIABATIC EFF. = 0.9295
POLYTROPIC EFF. = 0.9324
NOZZLE WEIGHT FLOW = 174.06
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99670
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99405

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0268	0.8625	0.0874	1.346	1.103
4	0.0139	0.9316	0.0464	1.336	1.093
5	0.0100	0.9551	0.0340	1.327	1.088
6	0.0110	0.9541	0.0368	1.326	1.088
7	0.0098	0.9685	0.0343	1.361	1.095

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

NASA. 8?A; COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 8 READING NUMBER 20 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.080	2.210	-0.860	1.1788	1273.986	1092.555	655.259	0.606	654.391
2	58.221	2.201	-1.269	1.1648	1256.697	1068.174	662.037	0.614	661.765
3	57.539	3.119	-1.101	1.1175	1205.085	1016.775	646.838	0.600	646.772
4	56.659	3.889	-1.241	1.0720	1156.753	966.035	636.282	0.590	635.559
5	54.045	4.295	-2.115	0.9891	1067.269	861.919	629.411	0.583	625.189
6	51.983	5.373	-1.567	0.8927	965.138	753.850	602.662	0.557	589.339
7	50.281	5.231	-2.129	0.7844	851.486	633.919	568.485	0.524	526.643

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.631	5.691	8.449	0.7759	901.970	1090.978	694.432	0.597	572.044
2	50.690	4.760	7.531	0.7834	903.934	1067.515	680.818	0.590	572.640
3	48.370	4.910	9.169	0.7270	837.363	1018.893	680.672	0.591	556.253
4	46.418	6.098	10.241	0.7067	810.322	969.330	677.283	0.591	558.401
5	40.321	8.651	13.724	0.6126	698.706	871.145	679.508	0.596	531.127
6	29.470	10.860	22.513	0.5604	635.894	774.278	724.590	0.639	547.209
7	12.537	13.137	37.744	0.5400	607.581	672.798	806.749	0.717	571.359

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.1908	0.443	0.35717	0.4333	0.	393.391	1092.555	697.187	0.874
2	0.1169	0.421	0.37593	0.4496	0.	368.146	1068.174	699.368	0.865
3	0.1258	0.454	0.40594	0.4726	0.	392.229	1016.775	625.864	0.860
4	0.0854	0.443	0.43629	0.4955	0.	382.579	966.035	586.751	0.879
5	0.0715	0.499	0.49069	0.5318	0.	420.386	861.919	450.758	0.850
6	0.0710	0.508	0.53785	0.5493	0.	465.862	753.850	309.215	0.929
7	0.1022	0.480	0.48939	0.4554	0.	545.741	633.919	127.057	1.085

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.059	0.7558	0.7688	1.475	1.156	0.8814	0.	34.516
2	0.035	0.8393	0.8478	1.468	1.138	0.9103	0.	32.737
3	0.038	0.8365	0.8452	1.470	1.139	0.9220	0.	35.189
4	0.026	0.8891	0.8949	1.465	1.130	0.9191	0.	34.416
5	0.021	0.9115	0.9159	1.441	1.121	0.9774	0.	38.362
6	0.021	0.9252	0.9290	1.454	1.122	0.9911	0.	40.361
7	0.029	0.9129	0.9174	1.455	1.124	0.9543	0.	43.686

TRAVERSE PRESSURE RATIO = 1.4586
TRAVERSE ADIABATIC EFF. = 0.8751
TRAVERSE POLYTROPIC EFF. = 0.8816
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 100.01

FIXED INSTRUMENTATION PRESSURE RATIO = 1.4470
ADIABATIC EFF. = 0.8949
POLYTROPIC EFF. = 0.9003
NOZZLE WEIGHT FLOW = 183.63
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99292
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.01248

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0436	0.8050	0.1436	1.456	1.141
4	0.0284	0.8793	0.0949	1.445	1.126
5	0.0222	0.9139	0.0751	1.435	1.119
6	0.0076	0.9721	0.0253	1.451	1.115
7	0.0142	0.9558	0.0497	1.451	1.117

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 10 READING NUMBER 22 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN,CMBR,LN	INCID ANG SUCT,SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.151	2.281	-0.789	1.3065	1401.571	1202.859	719.398	0.671	718.444
2	58.043	2.023	-1.447	1.2955	1386.245	1176.016	733.936	0.686	733.635
3	57.318	2.898	-1.322	1.2428	1330.033	1119.428	718.240	0.671	718.166
4	56.289	3.519	-1.611	1.1944	1279.011	1063.565	710.421	0.663	709.614
5	53.619	3.869	-2.541	1.1036	1181.484	948.938	703.862	0.657	699.141
6	50.344	3.734	-3.206	1.0174	1088.010	829.958	703.516	0.658	687.963
7	48.639	3.589	-3.771	0.8963	962.817	697.919	663.269	0.617	614.450

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	53.609	6.669	5.542	1.0321	1170.970	1200.682	741.308	0.653	694.632
2	53.013	7.083	5.030	1.0250	1156.562	1175.290	739.917	0.656	695.798
3	51.278	7.818	6.040	0.9601	1083.476	1120.879	731.678	0.648	677.736
4	48.415	8.095	7.874	0.9354	1053.051	1067.193	753.189	0.669	698.677
5	43.879	12.209	9.739	0.8042	906.440	959.095	734.528	0.652	651.619
6	30.661	12.051	19.683	0.7062	792.662	852.448	820.743	0.731	674.139
7	8.149	8.749	40.490	0.7992	875.813	740.723	1067.109	0.974	834.348

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.2045	0.255	0.15923	0.2208	0.	258.189	1202.859	942.493	0.967
2	0.1466	0.253	0.17957	0.2433	0.	251.491	1176.016	923.800	0.948
3	0.1482	0.280	0.20391	0.2648	0.	275.588	1119.428	845.291	0.944
4	0.1331	0.272	0.22048	0.2766	0.	279.836	1063.565	787.357	0.985
5	0.2272	0.343	0.22958	0.2691	0.	332.481	948.938	626.614	0.932
6	0.2070	0.416	0.28691	0.3064	0.	452.798	829.958	399.650	0.980
7	0.0974	0.285	0.15694	0.1177	0.	621.246	697.919	119.477	1.358

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.059	0.6137	0.6264	1.267	1.114	0.8673	0.	20.390
2	0.042	0.7063	0.7165	1.281	1.104	0.9088	0.	19.872
3	0.042	0.7214	0.7314	1.294	1.106	0.9347	0.	22.128
4	0.038	0.7643	0.7733	1.317	1.107	0.8953	0.	21.827
5	0.064	0.6292	0.6410	1.257	1.107	0.9559	0.	27.032
6	0.061	0.7343	0.7454	1.353	1.123	1.0130	0.	33.888
7	0.028	0.9151	0.9203	1.572	1.151	0.9833	0.	36.671

TRAVERSE PRESSURE RATIO = 1.3446
TRAVERSE ADIABATIC EFF. = 0.7489
TRAVERSE POLYTROPIC EFF. = 0.7592
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 110.11

FIXED INSTRUMENTATION PRESSURE RATIO = 1.3330
ADIABATIC EFF. = 0.7645
POLYTROPIC EFF. = 0.7739
NOZZLE WEIGHT FLOW = 198.58
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99099
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.02952

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0474	0.6648	0.1646	1.260	1.103
4	0.0404	0.7592	0.1405	1.306	1.104
5	0.0786	0.5541	0.2807	1.205	1.099
6	0.0529	0.7565	0.1797	1.338	1.115
7	0.0045	0.9859	0.0156	1.580	1.142

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 11 READING NUMBER 23 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN,CMBR,LN	INCID ANG SUCT,SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	58.702	1.832	-1.238	1.3129	1408.252	1202.886	732.284	0.683	731.313
2	57.977	1.957	-1.513	1.2953	1387.275	1176.043	735.838	0.687	735.536
3	57.461	3.041	-1.179	1.2384	1327.943	1119.453	714.323	0.666	714.250
4	56.521	3.751	-1.379	1.1894	1275.587	1063.589	704.202	0.657	703.402
5	54.055	4.305	-2.105	1.0954	1174.896	948.960	692.717	0.646	688.071
6	51.588	4.978	-1.962	0.9954	1068.544	829.977	672.997	0.627	658.119
7	49.552	4.502	-2.858	0.8807	948.493	697.935	642.282	0.596	595.008

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.942	5.002	6.760	0.9457	1091.668	1200.710	754.695	0.654	672.875
2	52.148	6.218	5.829	0.9144	1052.097	1175.317	731.850	0.636	645.572
3	50.904	7.444	6.557	0.8565	984.620	1120.904	716.157	0.623	620.905
4	46.435	6.115	10.087	0.8333	952.337	1067.217	757.379	0.663	656.066
5	43.786	12.116	10.268	0.6998	801.147	959.117	707.937	0.618	576.818
6	28.425	9.815	23.163	0.6302	715.013	852.468	815.180	0.719	621.385
7	9.097	9.697	40.455	0.6890	766.057	740.740	981.236	0.882	728.094

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.1800	0.343	0.26319	0.3458	0.	341.269	1202.886	859.441	0.920
2	0.1562	0.361	0.27901	0.3599	0.	344.616	1176.043	830.701	0.878
3	0.1664	0.381	0.29955	0.3736	0.	356.780	1119.453	764.125	0.869
4	0.1270	0.382	0.32119	0.3887	0.	377.444	1063.589	689.773	0.933
5	0.2209	0.453	0.35453	0.4047	0.	406.229	948.960	552.888	0.838
6	0.1796	0.499	0.39965	0.4219	0.	516.134	829.977	336.334	0.944
7	0.1033	0.391	0.30956	0.2815	0.	624.157	697.935	116.583	1.224

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.054	0.7339	0.7473	1.443	1.151	0.8669	0.	26.893
2	0.046	0.7600	0.7718	1.426	1.141	0.9200	0.	28.094
3	0.048	0.7526	0.7644	1.413	1.138	0.9272	0.	29.882
4	0.038	0.8213	0.8305	1.455	1.138	0.9377	0.	29.912
5	0.062	0.7049	0.7177	1.367	1.133	0.9438	0.	35.155
6	0.054	0.8053	0.8156	1.464	1.143	0.9912	0.	39.714
7	0.030	0.9122	0.9177	1.570	1.151	0.9878	0.	40.605

TRAVERSE PRESSURE RATIO = 1.4508
TRAVERSE ADIABATIC EFF. = 0.7926
TRAVERSE POLYTROPIC EFF. = 0.8032
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 110.17

FIXED INSTRUMENTATION PRESSURE RATIO = 1.4420
ADIABATIC EFF. = 0.8148
POLYTROPIC EFF. = 0.8242
NOZZLE WEIGHT FLOW = 196.59
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98952
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.02476

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0530	0.7244	0.1805	1.409	1.142
4	0.0416	0.8081	0.1392	1.427	1.132
5	0.0608	0.7225	0.2169	1.347	1.123
6	0.0402	0.8506	0.1335	1.469	1.137
7	0.0080	0.9755	0.0277	1.574	1.142

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 12 READING NUMBER 24 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN. CMBR. LN	INCID ANG SUCT. SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.158	2.288	-0.782	1.3054	1400.318	1201.877	718.597	0.670	717.644
2	58.373	2.353	-1.117	1.2885	1380.171	1175.056	723.958	0.676	723.662
3	57.703	3.283	-0.937	1.2340	1323.266	1118.514	707.078	0.659	707.006
4	56.749	3.979	-1.151	1.1855	1271.184	1062.697	697.556	0.651	696.764
5	54.196	4.446	-1.964	1.0943	1171.809	948.164	688.566	0.643	683.947
6	50.836	4.226	-2.714	1.0089	1079.273	829.281	690.741	0.646	675.471
7	49.351	4.301	-3.059	0.8848	950.793	697.350	646.306	0.601	598.736

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.673	4.733	7.486	0.9006	1049.495	1199.702	752.035	0.645	650.752
2	51.618	5.688	6.755	0.8789	1016.431	1174.331	735.470	0.636	631.080
3	50.957	7.497	6.747	0.8168	943.953	1119.964	709.396	0.614	594.584
4	47.350	7.030	9.399	0.7914	909.144	1066.322	733.541	0.639	615.718
5	43.537	11.867	10.658	0.6546	751.551	958.312	702.605	0.612	543.346
6	28.063	9.453	22.773	0.5976	680.438	851.752	806.016	0.708	593.301
7	11.568	12.168	37.783	0.6300	706.308	740.119	919.088	0.820	666.430

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.2169	0.382	0.30139	0.3878	0.	376.511	1201.877	823.191	0.907
2	0.1484	0.395	0.31922	0.4035	0.	377.592	1175.056	796.739	0.872
3	0.1559	0.420	0.34670	0.4240	0.	386.850	1118.514	733.114	0.841
4	0.1111	0.421	0.37580	0.4461	0.	397.901	1062.697	668.420	0.884
5	0.1955	0.506	0.41392	0.4659	0.	442.020	948.164	516.292	0.794
6	0.1450	0.542	0.48677	0.5115	0.	535.454	829.281	316.299	0.878
7	0.1010	0.449	0.44509	0.4222	0.	603.705	697.350	136.414	1.113

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.066	0.7160	0.7319	1.508	1.174	0.8290	0.	30.053
2	0.044	0.7924	0.8039	1.500	1.155	0.9143	0.	30.893
3	0.045	0.7858	0.7972	1.476	1.150	0.9265	0.	33.049
4	0.033	0.8518	0.8601	1.504	1.145	0.9387	0.	32.872
5	0.055	0.7553	0.7673	1.427	1.142	0.9640	0.	39.129
6	0.044	0.8483	0.8571	1.525	1.151	0.9754	0.	42.086
7	0.029	0.9144	0.9197	1.577	1.152	0.9494	0.	42.173

TRAVERSE PRESSURE RATIO	= 1.5024	FIXED INSTRUMENTATION PRESSURE RATIO	= 1.4940
TRAVERSE ADIABATIC EFF.	= 0.8156	ADIABATIC EFF.	= 0.8360
TRAVERSE POLYTROPIC EFF.	= 0.8259	POLYTROPIC EFF.	= 0.8451
FLOW COEFFICIENT L.E.	= 0.980	NOZZLE WEIGHT FLOW	= 195.53
FLOW COEFFICIENT T.E.	= 0.950	L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW	= 0.99704
PERCENT CORRECTED SPEED	= 110.02	T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW	= 1.01854

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0519	0.7588	0.1746	1.487	1.158
4	0.0421	0.8188	0.1432	1.483	1.146
5	0.0521	0.7839	0.1853	1.423	1.135
6	0.0297	0.8938	0.0983	1.528	1.144
7	0.0134	0.9582	0.0468	1.563	1.142

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 13 READING NUMBER 25 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.624	2.754	-0.316	1.2982	1396.276	1204.194	706.755	0.657	705.818
2	58.911	2.891	-0.579	1.2808	1374.938	1177.321	710.189	0.662	709.898
3	58.323	3.903	-0.317	1.2254	1316.889	1120.671	691.589	0.644	691.518
4	57.429	4.659	-0.471	1.1750	1263.872	1064.746	680.947	0.633	680.174
5	55.029	5.279	-1.131	1.0793	1161.896	949.992	668.968	0.621	664.480
6	52.176	5.566	-1.374	0.9853	1060.880	830.880	659.626	0.613	645.044
7	50.591	5.541	-1.819	0.8638	933.928	698.694	619.717	0.573	574.104

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.865	3.925	8.759	0.8416	989.594	1202.015	760.987	0.647	624.487
2	50.900	4.970	8.011	0.8393	976.205	1176.595	744.777	0.640	615.646
3	49.631	6.171	8.692	0.7804	906.562	1122.123	728.677	0.627	587.166
4	46.002	5.682	11.427	0.7509	868.453	1068.377	749.196	0.648	603.009
5	42.346	10.676	12.683	0.6194	714.360	960.160	714.672	0.620	526.495
6	27.389	8.779	24.787	0.5887	672.897	853.395	811.844	0.710	590.277
7	12.400	13.000	38.190	0.6023	679.208	741.545	896.010	0.795	639.030

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.2482	0.443	0.32564	0.4134	0.	434.540	1204.194	767.476	0.885
2	0.1557	0.436	0.34323	0.4285	0.	419.045	1177.321	757.550	0.867
3	0.1640	0.461	0.37006	0.4476	0.	431.448	1120.671	690.675	0.849
4	0.1370	0.466	0.39565	0.4654	0.	443.904	1064.746	624.473	0.887
5	0.1710	0.547	0.44277	0.4932	0.	480.312	949.992	479.848	0.792
6	0.1262	0.545	0.50580	0.5266	0.	547.568	830.880	305.827	0.915
7	0.0980	0.467	0.47213	0.4446	0.	601.042	698.694	140.503	1.113

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.077	0.7020	0.7200	1.561	1.194	0.8607	0.	34.832
2	0.047	0.7982	0.8104	1.555	1.169	0.9344	0.	34.242
3	0.048	0.7935	0.8057	1.537	1.165	0.9409	0.	36.308
4	0.041	0.8334	0.8434	1.552	1.161	0.9458	0.	36.359
5	0.049	0.7981	0.8089	1.477	1.148	1.0012	0.	42.374
6	0.038	0.8753	0.8829	1.560	1.155	0.9697	0.	42.850
7	0.028	0.9190	0.9240	1.573	1.151	0.9527	0.	43.245

TRAVERSE PRESSURE RATIO = 1.5427
TRAVERSE ADIABATIC EFF. = 0.8237
TRAVERSE POLYTROPIC EFF. = 0.8341
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 110.23

FIXED INSTRUMENTATION PRESSURE RATIO = 1.5340
ADIABATIC EFF. = 0.8483
POLYTROPIC EFF. = 0.8572
NOZZLE WEIGHT FLOW = 192.38
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99177
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.02503

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0572	0.7583	0.1893	1.540	1.173
4	0.0444	0.8262	0.1475	1.529	1.156
5	0.0459	0.8260	0.1601	1.478	1.143
6	0.0222	0.9251	0.0729	1.561	1.147
7	0.0133	0.9601	0.0464	1.567	1.143

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 14 READING NUMBER 26 DATE 10/30/1967

RADIAL POSITION	REL.INLET FLOW ANG.	INCID ANG MN.CMBR,LN	INCID ANG SUCT,SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	55.319	-1.551	-4.621	0.6013	665.183	546.770	378.829	0.342	378.327
2	54.464	-1.556	-5.026	0.5945	657.010	534.568	381.967	0.346	381.810
3	53.480	-0.940	-5.160	0.5733	633.190	508.846	376.836	0.341	376.798
4	52.254	-0.516	-5.646	0.5539	611.659	483.453	374.699	0.339	374.274
5	49.282	-0.468	-6.878	0.5169	570.756	431.348	373.766	0.339	371.259
6	45.939	-0.671	-7.611	0.4807	530.769	377.265	373.346	0.338	365.092
7	44.677	-0.373	-7.733	0.4250	469.674	317.245	346.337	0.313	320.845

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.094	4.154	4.225	0.5412	603.808	545.781	386.837	0.347	379.160
2	50.590	4.660	3.874	0.5333	594.003	534.238	384.582	0.345	377.098
3	48.248	4.788	5.233	0.5069	564.153	509.505	386.011	0.347	375.663
4	45.678	5.358	6.576	0.4797	534.357	485.102	387.446	0.348	373.193
5	38.719	7.049	10.562	0.4298	479.094	435.965	398.894	0.358	372.630
6	25.957	7.347	19.982	0.3912	435.736	387.488	440.490	0.396	386.947
7	10.813	11.413	33.864	0.3797	421.938	336.702	489.971	0.441	399.079

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.0419	0.148	0.18551	0.2017	0.	75.978	546.770	469.802	1.002
2	0.0030	0.151	0.20290	0.2181	0.	75.316	534.568	458.922	0.988
3	-0.0119	0.173	0.22995	0.2428	0.	88.646	508.846	420.859	0.997
4	0.0164	0.200	0.25800	0.2684	0.	102.968	483.453	382.133	0.997
5	0.0340	0.255	0.31203	0.3140	0.	137.225	431.348	298.740	1.004
6	0.0227	0.309	0.34445	0.3296	0.	199.118	377.265	188.370	1.060
7	0.0221	0.269	0.27085	0.2221	0.	260.480	317.245	76.222	1.244

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.013	0.8496	0.8508	1.054	1.018	0.7503	0.	11.331
2	0.001	0.9881	0.9883	1.055	1.016	0.8304	0.	11.295
3	-0.004	1.0428	1.0425	1.060	1.016	0.8960	0.	13.277
4	0.005	0.9522	0.9527	1.064	1.019	0.8524	0.	15.425
5	0.010	0.9240	0.9248	1.072	1.022	0.8813	0.	20.217
6	0.007	0.9625	0.9630	1.090	1.026	0.9574	0.	27.230
7	0.006	0.9748	0.9752	1.106	1.030	0.9413	0.	33.133

TRAVERSE PRESSURE RATIO = 1.0750
TRAVERSE ADIABATIC EFF. = 0.9567
TRAVERSE POLYTROPIC EFF. = 0.9572
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 50.05

FIXED INSTRUMENTATION PRESSURE RATIO = 1.0740
ADIABATIC EFF. = 0.9345
POLYTROPIC EFF. = 0.9352
NOZZLE WEIGHT FLOW = 120.45
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00014
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.96740

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0128	0.8510	0.0420	1.053	1.018
4	0.0092	0.9138	0.0302	1.062	1.019
5	0.0149	0.8914	0.0492	1.069	1.022
6	0.0062	0.9664	0.0201	1.089	1.026
7	-0.0022	1.0089	-0.0075	1.106	1.029

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 15 READING NUMBER 27 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	57.896	1.026	-2.044	0.5828	646.513	547.448	343.919	0.310	343.464
2	57.047	1.027	-2.443	0.5754	637.927	535.231	347.101	0.313	346.959
3	56.088	1.668	-2.552	0.5539	613.926	509.476	342.548	0.309	342.513
4	55.019	2.249	-2.881	0.5335	591.003	484.052	339.085	0.306	338.700
5	52.333	2.583	-3.827	0.4934	546.975	431.883	335.647	0.303	333.395
6	49.390	2.780	-4.160	0.4533	502.363	377.732	331.191	0.299	323.869
7	48.354	3.304	-4.056	0.3969	440.303	317.638	304.915	0.275	282.472

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.384	3.444	7.512	0.4988	559.056	546.457	374.910	0.334	356.424
2	50.134	4.204	6.913	0.4931	552.208	534.900	370.996	0.331	353.945
3	48.396	4.936	7.691	0.4686	524.362	510.137	367.649	0.329	348.149
4	45.933	5.613	9.086	0.4402	492.541	485.703	367.239	0.328	342.423
5	39.358	7.688	12.975	0.3883	434.597	436.505	373.552	0.334	334.996
6	27.585	8.975	21.805	0.3529	394.579	387.968	407.597	0.365	345.530
7	10.677	11.277	37.677	0.3474	387.326	337.119	465.922	0.418	366.495

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.0449	0.223	0.25182	0.2704	0.	115.864	547.448	430.593	1.038
2	0.0248	0.218	0.26587	0.2828	0.	111.070	535.231	423.830	1.020
3	0.0052	0.234	0.29334	0.3073	0.	118.056	509.476	392.081	1.016
4	0.0285	0.264	0.31761	0.3283	0.	131.948	484.052	353.755	1.011
5	0.0168	0.321	0.36688	0.3674	0.	161.743	431.883	274.763	1.005
6	0.0397	0.358	0.38309	0.3640	0.	207.442	377.732	180.525	1.067
7	0.0291	0.304	0.28502	0.2272	0.	268.023	317.638	69.096	1.297

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.014	0.8874	0.8887	1.077	1.024	0.8396	0.	18.008
2	0.008	0.9350	0.9357	1.076	1.023	0.8435	0.	17.422
3	0.002	0.9869	0.9871	1.077	1.022	0.8851	0.	18.732
4	0.009	0.9367	0.9374	1.078	1.023	0.8830	0.	21.073
5	0.005	0.9677	0.9681	1.081	1.023	0.9710	0.	25.772
6	0.012	0.9424	0.9431	1.090	1.027	0.9729	0.	30.979
7	0.008	0.9706	0.9711	1.105	1.030	0.9705	0.	36.179

TRAVERSE PRESSURE RATIO = 1.0848
TRAVERSE ADIABATIC EFF. = 0.9507
TRAVERSE POLYTROPIC EFF. = 0.9513
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 50.07

FIXED INSTRUMENTATION PRESSURE RATIO = 1.0830
ADIABATIC EFF. = 0.9261
POLYTROPIC EFF. = 0.9270
NOZZLE WEIGHT FLOW = 110.33
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98840
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.97718

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0143	0.8806	0.0466	1.073	1.023
4	0.0140	0.9167	0.0378	1.076	1.023
5	0.0152	0.9079	0.0569	1.079	1.024
6	0.0183	0.9432	0.0390	1.090	1.026
7	0.0078	0.9722	0.0271	1.103	1.029

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 16   READING NUMBER 28   DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN. CMBR. LN	INCID ANG SUCT. SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	59.607	2.737	-0.333	0.5714	634.053	546.731	321.106	0.289	320.680
2	58.908	2.888	-0.582	0.5629	624.270	534.530	322.476	0.291	322.344
3	57.973	3.553	-0.667	0.5411	600.168	508.809	318.300	0.287	318.268
4	56.860	4.090	-1.040	0.5208	577.522	483.418	315.972	0.285	315.614
5	54.396	4.646	-1.764	0.4795	531.702	431.317	310.922	0.280	308.836
6	51.286	4.676	-2.264	0.4401	487.773	377.238	309.215	0.279	302.380
7	50.560	5.510	-1.850	0.3823	424.229	317.223	281.674	0.254	260.942

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.408	3.468	9.199	0.4761	534.515	545.742	366.100	0.326	340.604
2	50.109	4.179	8.799	0.4652	521.702	534.200	360.408	0.321	334.567
3	48.398	4.938	9.575	0.4394	492.614	509.469	356.228	0.318	327.057
4	46.327	6.007	10.533	0.4149	464.900	485.067	354.033	0.316	320.902
5	40.121	8.451	14.275	0.3595	402.772	435.934	355.882	0.318	307.069
6	29.059	10.449	22.227	0.3225	360.830	387.460	382.229	0.342	311.729
7	11.101	11.701	39.459	0.3115	347.707	336.678	436.854	0.391	328.573

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.0558	0.260	0.29524	0.3148	0.	133.906	546.731	411.835	1.062
2	0.0362	0.267	0.31009	0.3278	0.	133.930	534.530	400.271	1.038
3	0.0248	0.287	0.33602	0.3503	0.	141.116	508.809	368.352	1.028
4	0.0181	0.307	0.36253	0.3732	0.	148.945	483.418	336.122	1.017
5	0.0365	0.373	0.41196	0.4115	0.	177.165	431.317	258.769	0.994
6	0.0290	0.413	0.44977	0.4287	0.	214.249	377.238	173.212	1.031
7	0.0417	0.374	0.37318	0.3110	0.	272.209	317.223	64.469	1.259

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.017	0.8841	0.8855	1.090	1.028	0.8285	0.	21.462
2	0.011	0.9225	0.9235	1.088	1.027	0.8625	0.	21.817
3	0.008	0.9488	0.9494	1.088	1.026	0.8959	0.	23.339
4	0.005	0.9645	0.9649	1.088	1.025	0.9201	0.	24.898
5	0.011	0.9393	0.9400	1.087	1.026	0.9663	0.	29.983
6	0.009	0.9605	0.9611	1.093	1.027	0.9957	0.	34.500
7	0.012	0.9611	0.9617	1.105	1.030	0.9788	0.	39.640

TRAVERSE PRESSURE RATIO = 1.0915
TRAVERSE ADIABATIC EFF. = 0.9437
TRAVERSE POLYTROPIC EFF. = 0.9445
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 50.05

FIXED INSTRUMENTATION PRESSURE RATIO = 1.0890
ADIABATIC EFF. = 0.9367
POLYTROPIC EFF. = 0.9375
NOZZLE WEIGHT FLOW = 102.63
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99559
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98122

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0138	0.9021	0.0450	1.085	1.026
4	0.0113	0.9274	0.0377	1.085	1.025
5	0.0125	0.9310	0.0419	1.085	1.025
6	0.0098	0.9549	0.0328	1.091	1.027
7	0.0118	0.9607	0.0411	1.102	1.029

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 17 READING NUMBER 29 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN. CMBR. LN	INCID ANG SUCT. SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	61.189	4.319	1.249	0.5619	624.528	547.054	301.276	0.271	300.877
2	60.389	4.369	0.899	0.5540	615.254	534.846	304.100	0.274	303.976
3	59.508	5.088	0.868	0.5321	590.836	509.110	299.823	0.270	299.792
4	58.503	5.733	0.603	0.5112	567.459	483.704	296.715	0.267	296.378
5	56.185	6.435	0.025	0.4688	520.529	431.572	291.024	0.262	289.072
6	53.281	6.671	-0.269	0.4276	474.728	377.461	287.906	0.259	281.542
7	52.442	7.392	0.032	0.3711	412.504	317.410	263.458	0.237	244.067

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.030	3.090	11.159	0.4506	507.102	546.064	361.891	0.322	325.703
2	50.132	4.202	10.257	0.4419	496.961	534.516	353.461	0.314	318.551
3	48.521	5.061	10.987	0.4179	469.615	509.770	348.867	0.310	311.037
4	46.530	6.210	11.973	0.3887	436.479	485.354	344.556	0.307	300.166
5	39.877	8.207	16.308	0.3393	380.900	436.192	350.635	0.312	291.426
6	29.895	11.285	23.386	0.3004	336.776	387.689	367.513	0.328	288.612
7	10.946	11.546	41.496	0.2964	331.487	336.877	427.238	0.382	313.399

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.0680	0.311	0.32353	0.3434	0.	157.490	547.054	388.574	1.083
2	0.0595	0.311	0.33958	0.3575	0.	153.103	534.846	381.413	1.048
3	0.0499	0.327	0.36666	0.3809	0.	157.949	509.110	351.821	1.038
4	0.0489	0.360	0.39161	0.4020	0.	168.716	483.704	316.638	1.013
5	0.0537	0.413	0.43489	0.4334	0.	192.717	431.572	243.474	1.008
6	0.0599	0.453	0.47204	0.4485	0.	221.764	377.461	165.925	1.025
7	0.0477	0.398	0.39147	0.3248	0.	276.265	317.410	60.613	1.284

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T. RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.021	0.8762	0.8780	1.100	1.032	0.8734	0.	25.806
2	0.018	0.8898	0.8912	1.097	1.030	0.8718	0.	25.670
3	0.015	0.9111	0.9123	1.096	1.029	0.8883	0.	26.922
4	0.015	0.9167	0.9178	1.093	1.028	0.9298	0.	29.339
5	0.016	0.9205	0.9215	1.092	1.028	0.9707	0.	33.476
6	0.018	0.9255	0.9265	1.093	1.028	0.9896	0.	37.538
7	0.014	0.9581	0.9587	1.105	1.030	0.9858	0.	41.397

TRAVERSE PRESSURE RATIO = 1.0963
TRAVERSE ADIABATIC EFF. = 0.9169
TRAVERSE POLYTROPIC EFF. = 0.9180
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 50.08

FIXED INSTRUMENTATION PRESSURE RATIO = 1.0940
ADIABATIC EFF. = 0.9237
POLYTROPIC EFF. = 0.9247
NOZZLE WEIGHT FLOW = 96.92
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99128
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98522

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0182	0.8880	0.0592	1.094	1.029
4	0.0159	0.9086	0.0533	1.091	1.028
5	0.0144	0.9276	0.0483	1.089	1.027
6	0.0126	0.9461	0.0424	1.093	1.027
7	0.0157	0.9520	0.0545	1.104	1.030

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 18 READING NUMBER 30 DATE 10/30/1967

RADIAL POSITION	REL.INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	63.193	6.323	3.253	0.5510	612.781	546.776	276.653	0.249	276.286
2	62.423	6.403	2.933	0.5427	603.146	534.574	279.312	0.251	279.198
3	61.544	7.124	2.904	0.5211	578.791	508.852	275.806	0.248	275.777
4	60.562	7.792	2.662	0.4998	555.287	483.458	273.151	0.246	272.841
5	58.373	8.623	2.213	0.4570	507.538	431.353	267.449	0.241	265.655
6	55.589	8.979	2.039	0.4147	460.623	377.269	264.275	0.238	258.433
7	54.741	9.691	2.331	0.3591	399.075	317.249	242.103	0.218	224.284

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.524	3.584	12.669	0.4286	483.347	545.787	352.583	0.313	307.246
2	50.732	4.802	11.691	0.4173	469.790	534.245	342.809	0.304	297.344
3	49.329	5.869	12.215	0.3923	441.441	509.511	336.599	0.299	287.684
4	47.425	7.105	13.137	0.3618	407.060	485.107	332.137	0.295	275.292
5	41.928	10.258	16.445	0.3146	353.606	435.970	331.170	0.295	262.331
6	31.729	13.119	23.860	0.2758	309.515	387.492	348.135	0.310	260.346
7	9.928	10.528	44.813	0.2710	303.281	336.706	414.065	0.370	287.603

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.0988	0.349	0.35566	0.3757	0.	172.754	546.776	373.033	1.112
2	0.0618	0.356	0.37426	0.3922	0.	170.552	534.574	363.693	1.065
3	0.0758	0.375	0.39917	0.4132	0.	174.707	508.852	334.804	1.043
4	0.0762	0.412	0.42518	0.4350	0.	185.471	483.458	299.637	1.009
5	0.0976	0.458	0.47122	0.4684	0.	200.365	431.353	235.605	0.987
6	0.0801	0.499	0.51520	0.4889	0.	226.519	377.269	160.973	1.007
7	0.0887	0.457	0.45889	0.3869	0.	286.365	317.249	50.341	1.282

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.031	0.8448	0.8471	1.109	1.036	0.8514	0.	29.348
2	0.019	0.8973	0.8988	1.105	1.032	0.9012	0.	29.838
3	0.023	0.8814	0.8831	1.102	1.032	0.8921	0.	31.270
4	0.022	0.8858	0.8873	1.099	1.031	0.9318	0.	33.969
5	0.028	0.8715	0.8731	1.094	1.030	0.9374	0.	37.372
6	0.023	0.9086	0.9098	1.094	1.029	0.9809	0.	41.026
7	0.026	0.9311	0.9321	1.109	1.032	0.9611	0.	44.876

TRAVERSE PRESSURE RATIO = 1.1010
TRAVERSE ADIABATIC EFF. = 0.8887
TRAVERSE POLYTROPIC EFF. = 0.8902
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 50.05

FIXED INSTRUMENTATION PRESSURE RATIO = 1.0990
ADIABATIC EFF. = 0.8971
POLYTROPIC EFF. = 0.8986
NOZZLE WEIGHT FLOW = 88.33
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00607
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99801

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0268	0.8558	0.0886	1.103	1.033
4	0.0237	0.8778	0.0807	1.096	1.030
5	0.0243	0.8879	0.0842	1.092	1.029
6	0.0188	0.9249	0.0647	1.094	1.028
7	0.0167	0.9536	0.0578	1.108	1.031

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 19 READING NUMBER 31 DATE 10/30/1967

RADIAL POSITION	REL.INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	54.535	-2.335	-5.405	0.8605	940.708	765.837	546.282	0.500	545.558
2	53.754	-2.266	-5.736	0.8503	928.538	748.747	549.146	0.503	548.921
3	52.884	-1.536	-5.756	0.8188	893.817	712.718	539.390	0.494	539.335
4	51.654	-1.116	-6.246	0.7916	863.784	677.152	536.272	0.491	535.664
5	48.740	-1.010	-7.420	0.7393	806.078	604.171	533.610	0.489	530.031
6	45.286	-1.324	-8.264	0.6899	751.963	528.419	534.997	0.491	523.170
7	44.426	-0.624	-7.984	0.6044	661.006	444.352	489.368	0.447	453.349

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	51.566	4.626	2.969	0.7701	854.812	764.452	539.904	0.486	531.289
2	50.813	4.883	2.941	0.7516	834.185	748.285	536.844	0.484	527.063
3	48.402	4.942	4.482	0.7202	799.357	713.642	543.227	0.489	530.676
4	45.938	5.618	5.716	0.6815	756.478	679.461	543.619	0.490	525.860
5	39.198	7.528	9.542	0.6013	668.535	610.638	552.629	0.497	516.493
6	26.448	7.838	18.838	0.5502	610.786	542.738	613.145	0.552	540.170
7	11.712	12.312	32.713	0.5400	597.427	471.604	684.950	0.619	563.425

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.0154	0.141	0.17160	0.2008	0.	94.957	765.837	669.495	0.974
2	0.0091	0.154	0.19285	0.2221	0.	101.744	748.747	646.541	0.960
3	0.0080	0.165	0.21691	0.2438	0.	115.891	712.718	597.751	0.984
4	0.0063	0.193	0.24425	0.2689	0.	136.086	677.152	543.375	0.982
5	0.0440	0.262	0.30101	0.3172	0.	189.424	604.171	421.214	0.974
6	0.0292	0.314	0.34458	0.3438	0.	274.029	528.419	268.709	1.032
7	0.0464	0.258	0.26249	0.2230	0.	354.797	444.352	116.807	1.243

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.005	0.9392	0.9400	1.097	1.029	0.8110	0.	10.133
2	0.003	0.9658	0.9663	1.103	1.029	0.8301	0.	10.926
3	0.002	0.9744	0.9749	1.117	1.033	0.8058	0.	12.319
4	0.002	0.9819	0.9822	1.124	1.035	0.8585	0.	14.509
5	0.013	0.9040	0.9057	1.138	1.042	0.8956	0.	20.140
6	0.009	0.9528	0.9539	1.178	1.051	0.9491	0.	26.899
7	0.013	0.9488	0.9502	1.212	1.060	0.9054	0.	32.199

TRAVERSE PRESSURE RATIO = 1.1456
TRAVERSE ADIABATIC EFF. = 0.9490
TRAVERSE POLYTROPIC EFF. = 0.9500
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 70.11

FIXED INSTRUMENTATION PRESSURE RATIO = 1.1420
ADIABATIC EFF. = 0.9223
POLYTROPIC EFF. = 0.9238
NOZZLE WEIGHT FLOW = 162.94
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99606
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98207

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0120	0.8607	0.0395	1.099	1.032
4	0.0078	0.9278	0.0259	1.119	1.035
5	0.0268	0.8099	0.0891	1.120	1.041
6	0.0063	0.9662	0.0207	1.178	1.050
7	0.0002	0.9991	0.0008	1.212	1.057

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 20 READING NUMBER 32 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	56.665	-0.205	-3.275	0.8355	916.673	765.544	504.214	0.460	503.546
2	55.798	-0.222	-3.692	0.8261	905.079	748.460	508.897	0.465	508.689
3	54.994	0.574	-3.646	0.7934	869.826	712.445	499.018	0.455	498.967
4	53.979	1.209	-3.921	0.7642	837.234	676.892	492.724	0.450	492.165
5	51.299	1.549	-4.861	0.7079	775.913	603.939	487.132	0.444	483.865
6	48.254	1.644	-5.296	0.6525	715.108	528.216	482.045	0.440	471.388
7	47.476	2.426	-4.934	0.5688	625.029	444.182	439.732	0.400	407.367

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	50.220	3.280	6.444	0.6982	782.502	764.159	526.611	0.470	500.598
2	49.983	4.053	5.815	0.6858	767.723	747.998	518.984	0.464	493.638
3	47.937	4.477	7.057	0.6484	725.602	713.369	516.576	0.462	486.098
4	46.147	5.827	7.832	0.6122	685.061	679.201	509.739	0.456	474.424
5	39.932	8.262	11.367	0.5459	610.683	610.403	518.107	0.463	466.862
6	27.483	8.873	20.771	0.4871	544.056	542.529	566.727	0.507	476.859
7	10.915	11.515	36.560	0.4824	536.280	471.424	646.251	0.581	507.066

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CHI	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.0279	0.233	0.25796	0.2936	0.	162.890	765.544	601.269	0.994
2	0.0182	0.236	0.27521	0.3097	0.	160.059	748.460	587.939	0.970
3	0.0023	0.258	0.29954	0.3302	0.	174.698	712.445	538.671	0.974
4	0.0177	0.278	0.32418	0.3510	0.	185.394	676.892	493.807	0.964
5	0.0135	0.324	0.37423	0.3897	0.	219.604	603.939	390.800	0.965
6	0.0313	0.382	0.40274	0.3977	0.	294.473	528.216	248.057	1.012
7	0.0542	0.322	0.30001	0.2530	0.	373.639	444.182	97.784	1.245

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.009	0.9327	0.9341	1.157	1.046	0.8700	0.	18.024
2	0.006	0.9554	0.9564	1.155	1.044	0.8704	0.	17.965
3	0.001	0.9946	0.9947	1.159	1.043	0.9217	0.	19.768
4	0.005	0.9618	0.9626	1.157	1.044	0.9111	0.	21.344
5	0.004	0.9746	0.9752	1.162	1.045	0.9560	0.	25.191
6	0.010	0.9548	0.9559	1.183	1.052	0.9944	0.	31.696
7	0.016	0.9457	0.9472	1.209	1.059	0.9606	0.	36.385

TRAVERSE PRESSURE RATIO = 1.1710
TRAVERSE ADIABATIC EFF. = 0.9597
TRAVERSE POLYTROPIC EFF. = 0.9606
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 70.08

FIXED INSTRUMENTATION PRESSURE RATIO = 1.1660
ADIABATIC EFF. = 0.9420
POLYTROPIC EFF. = 0.9433
NOZZLE WEIGHT FLOW = 151.43
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99650
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.98863

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0102	0.9180	0.0333	1.148	1.044
4	0.0079	0.9439	0.0264	1.153	1.044
5	0.0149	0.9128	0.0500	1.157	1.047
6	0.0097	0.9535	0.0319	1.181	1.051
7	0.0089	0.9680	0.0310	1.207	1.057

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 21 READING NUMBER 33 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN.CMBR.LN	INCID ANG SUCT.SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	58.575	1.705	-1.365	0.8165	897.824	765.862	468.556	0.426	467.935
2	57.795	1.775	-1.695	0.8057	885.022	748.771	471.811	0.430	471.618
3	56.906	2.486	-1.734	0.7748	850.778	712.741	464.568	0.423	464.520
4	55.858	3.088	-2.042	0.7458	818.482	677.173	459.728	0.419	459.206
5	53.397	3.647	-2.763	0.6877	754.429	604.190	451.793	0.412	448.762
6	50.404	3.794	-3.146	0.6312	692.125	528.435	446.983	0.408	437.101
7	49.669	4.619	-2.741	0.5483	602.747	444.366	407.238	0.370	377.264

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	49.773	2.833	8.802	0.6550	737.928	764.476	517.378	0.459	476.491
2	49.945	4.015	7.850	0.6497	730.596	748.309	506.788	0.451	470.135
3	48.290	4.830	8.616	0.6125	687.848	713.665	499.556	0.445	457.651
4	46.786	6.466	9.072	0.5710	640.933	679.483	487.810	0.435	438.689
5	40.858	9.188	12.538	0.5013	562.163	610.657	491.014	0.438	423.930
6	29.778	11.168	20.626	0.4441	496.886	542.755	526.009	0.470	426.311
7	11.105	11.705	38.564	0.4325	481.870	471.619	608.541	0.546	455.348

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG.VEL	INLET REL TANG. VEL	EXIT REL TANG.VEL	AXIAL VEL.RATIO
1	0.0400	0.288	0.30507	0.3423	0.	201.162	765.862	563.314	1.018
2	0.0169	0.277	0.32111	0.3565	0.	189.113	748.771	559.196	0.997
3	0.0006	0.299	0.34796	0.3792	0.	200.192	712.741	513.473	0.985
4	0.0078	0.330	0.37455	0.4014	0.	212.559	677.173	466.924	0.955
5	0.0234	0.381	0.42657	0.4407	0.	243.975	604.190	366.682	0.945
6	0.0333	0.432	0.46604	0.4579	0.	298.820	528.435	243.935	0.975
7	0.0563	0.392	0.38436	0.3331	0.	382.245	444.366	89.374	1.207

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS.INLET FLOW ANG.	ABS.EXIT FLOW ANG.
1	0.013	0.9225	0.9244	1.191	1.056	0.8843	0.	22.888
2	0.005	0.9658	0.9666	1.186	1.052	0.8751	0.	21.913
3	0.000	0.9989	0.9990	1.185	1.050	0.9221	0.	23.626
4	0.002	0.9852	0.9856	1.178	1.049	0.9533	0.	25.852
5	0.007	0.9616	0.9625	1.176	1.050	0.9706	0.	29.921
6	0.010	0.9553	0.9564	1.187	1.053	0.9964	0.	35.028
7	0.016	0.9476	0.9490	1.211	1.060	0.9778	0.	40.012

TRAVERSE PRESSURE RATIO = 1.1873
TRAVERSE ADIABATIC EFF. = 0.9601
TRAVERSE POLYTROPIC EFF. = 0.9611
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 70.11

FIXED INSTRUMENTATION PRESSURE RATIO = 1.1840
ADIABATIC EFF. = 0.9403
POLYTROPIC EFF. = 0.9418
NOZZLE WEIGHT FLOW = 141.90
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 1.00369
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99328

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0130	0.9166	0.0420	1.181	1.053
4	0.0125	0.9251	0.0421	1.175	1.051
5	0.0115	0.9394	0.0390	1.174	1.050
6	0.0098	0.9554	0.0331	1.186	1.052
7	0.0193	0.9637	0.0380	1.209	1.058

Table 5. - Listing of Blade Element Performance (continued).

CONFIG. 1 - PLAIN CASING

N.A.S.A. COMPRESSOR OUTPUT DATA
BLADE ELEMENT PERFORMANCE RESULTS
POINT NUMBER 22 READING NUMBER 34 DATE 10/30/1967

RADIAL POSITION	REL. INLET FLOW ANG.	INCID ANG MN. CMBR. LN	INCID ANG SUCT. SURF	INLET REL MACH NO.	INLET REL VELOCITY	ROTOR SPD AT INLET	INLET ABS VELOCITY	INLET ABS MACH NO.	INLET AX. VELOCITY
1	60.153	3.283	0.213	0.8006	883.033	765.652	439.914	0.399	439.331
2	59.340	3.320	-0.150	0.7898	870.309	748.566	443.946	0.403	443.764
3	58.520	4.100	-0.120	0.7582	835.537	712.546	436.349	0.396	436.305
4	57.590	4.820	-0.310	0.7277	802.155	676.988	430.280	0.390	429.791
5	55.343	5.593	-0.817	0.6676	735.918	604.025	420.392	0.381	417.572
6	52.533	5.923	-1.017	0.6087	671.211	528.291	414.045	0.375	404.892
7	51.846	6.796	-0.564	0.5273	582.479	444.244	376.734	0.341	349.006

RADIAL POSITION	REL. EXIT FLOW ANG.	REL. DEV. ANG. T.E.	REL. TURN ANGLE	EXIT REL. MACH NO.	EXIT REL. VELOCITY	ROTOR SPD AT EXIT	EXIT ABS VELOCITY	EXIT ABS MACH NO.	EXIT AX. VELOCITY
1	49.301	2.361	10.852	0.6185	700.264	764.267	512.933	0.453	456.559
2	49.639	3.709	9.700	0.6150	694.550	748.104	500.244	0.443	449.769
3	48.263	4.803	10.257	0.5702	643.721	713.469	487.867	0.432	428.519
4	47.155	6.835	10.436	0.5331	601.797	679.297	473.692	0.420	409.072
5	41.084	9.414	14.260	0.4620	521.038	610.490	476.790	0.423	391.587
6	30.502	11.892	22.031	0.4086	459.756	542.606	505.400	0.449	391.638
7	10.544	11.144	41.302	0.4066	455.237	471.490	594.900	0.531	430.928

RADIAL POSITION	LOSS COEFFICIENT	DIFFUSION FACTOR	ST. PRESS RISE COEFF	CH1	INLET ABS TANG. VEL	EXIT ABS TANG. VEL	INLET REL TANG. VEL	EXIT REL TANG. VEL	AXIAL VEL. RATIO
1	0.0641	0.336	0.33329	0.3707	0.	233.448	765.652	530.818	1.039
2	0.0245	0.322	0.35041	0.3858	0.	218.890	748.566	529.214	1.014
3	0.0259	0.357	0.37680	0.4076	0.	233.139	712.546	480.330	0.982
4	0.0342	0.379	0.40241	0.4283	0.	238.239	676.988	441.058	0.952
5	0.0531	0.435	0.45071	0.4628	0.	269.083	604.025	341.406	0.938
6	0.0445	0.476	0.49231	0.4806	0.	311.898	528.291	230.709	0.967
7	0.0720	0.421	0.41169	0.3547	0.	391.279	444.244	80.212	1.235

RADIAL POSITION	TOT. PRESS LOSS PARAM	ADIABATIC EFFICIENCY	POLYTROPIC EFFICIENCY	TOT. PRESS RATIO	TOT. TEMP RATIO	MOMEN RISE/ MEAS T.RISE	ABS. INLET FLOW ANG.	ABS. EXIT FLOW ANG.
1	0.020	0.8931	0.8961	1.212	1.064	0.8983	0.	27.082
2	0.008	0.9564	0.9575	1.206	1.058	0.9103	0.	25.951
3	0.008	0.9554	0.9566	1.199	1.056	0.9548	0.	28.549
4	0.010	0.9430	0.9444	1.189	1.054	0.9619	0.	30.216
5	0.016	0.9227	0.9245	1.184	1.054	0.9836	0.	34.495
6	0.013	0.9447	0.9461	1.188	1.054	1.0147	0.	38.534
7	0.021	0.9387	0.9403	1.214	1.061	0.9728	0.	42.239

TRAVERSE PRESSURE RATIO = 1.1971
TRAVERSE ADIABATIC EFF. = 0.9351
TRAVERSE POLYTROPIC EFF. = 0.9368
FLOW COEFFICIENT L.E. = 0.980
FLOW COEFFICIENT T.E. = 0.950
PERCENT CORRECTED SPEED = 70.09

FIXED INSTRUMENTATION PRESSURE RATIO = 1.1940
ADIABATIC EFF. = 0.9201
POLYTROPIC EFF. = 0.9221
NOZZLE WEIGHT FLOW = 133.81
L.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99913
T.E. CHECK WEIGHT FLOW/NOZ. WEIGHT FLOW = 0.99175

PARAMETERS DETERMINED FROM FIXED INSTRUMENTATION

RADIAL POSITION	TOT. PRESS LOSS PARAM.	ADIABATIC EFFICIENCY	LOSS COEFFICIENT	TOT. PRESS RATIO	TOT. TEMP RATIO
2	0.0193	0.8935	0.0622	1.201	1.060
4	0.0196	0.8958	0.0663	1.187	1.056
5	0.0161	0.9228	0.0551	1.182	1.053
6	0.0141	0.9408	0.0478	1.188	1.054
7	0.0155	0.9533	0.0538	1.213	1.060

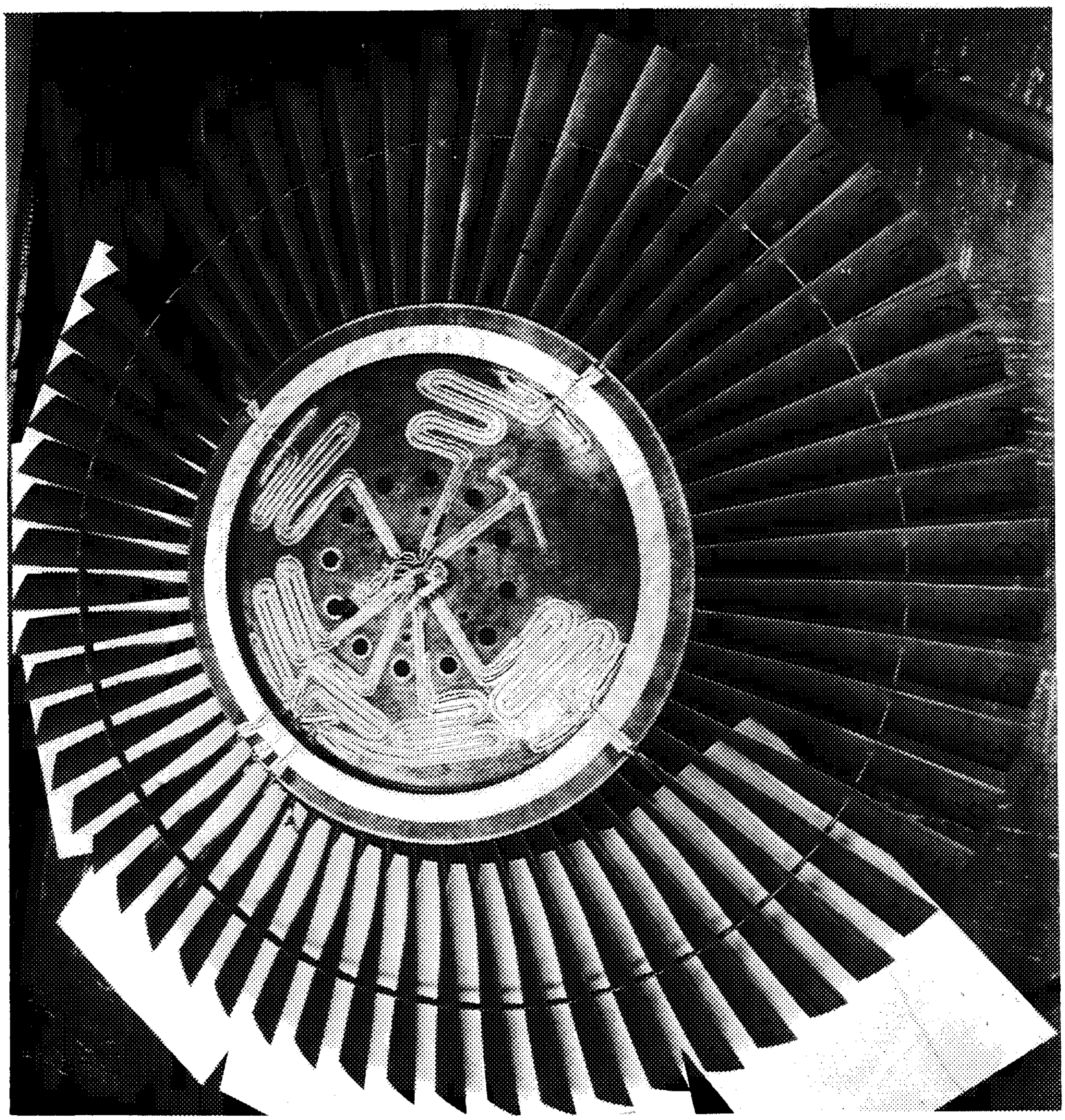


Figure 1. - Photograph of rotor.

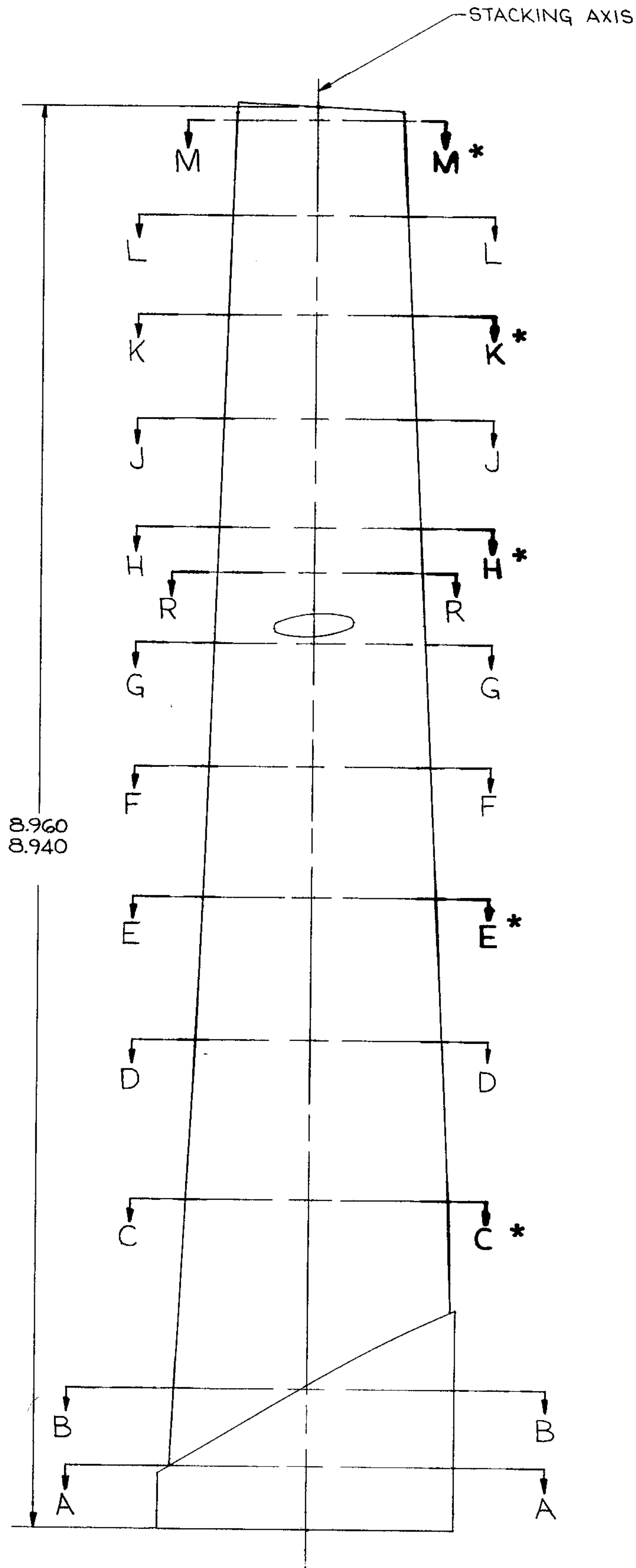


Figure 2. - Meridional view of rotor. Probograph inspection stations are indicated by asterisks.

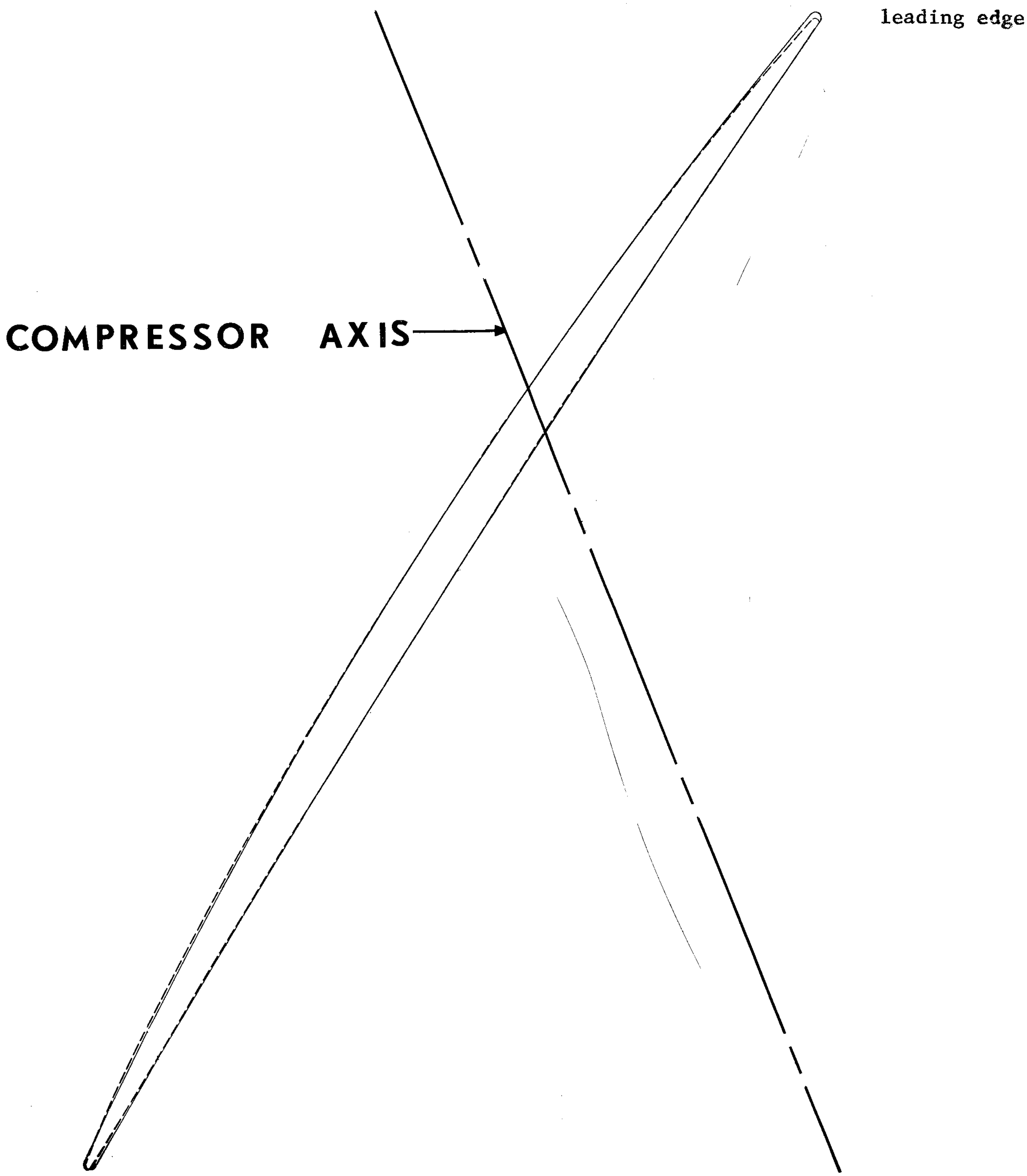


Figure 3(a). - Cylindrical cut of blade at section MM. The solid line represents design intent and the dashed line represents the average of four measured samples.

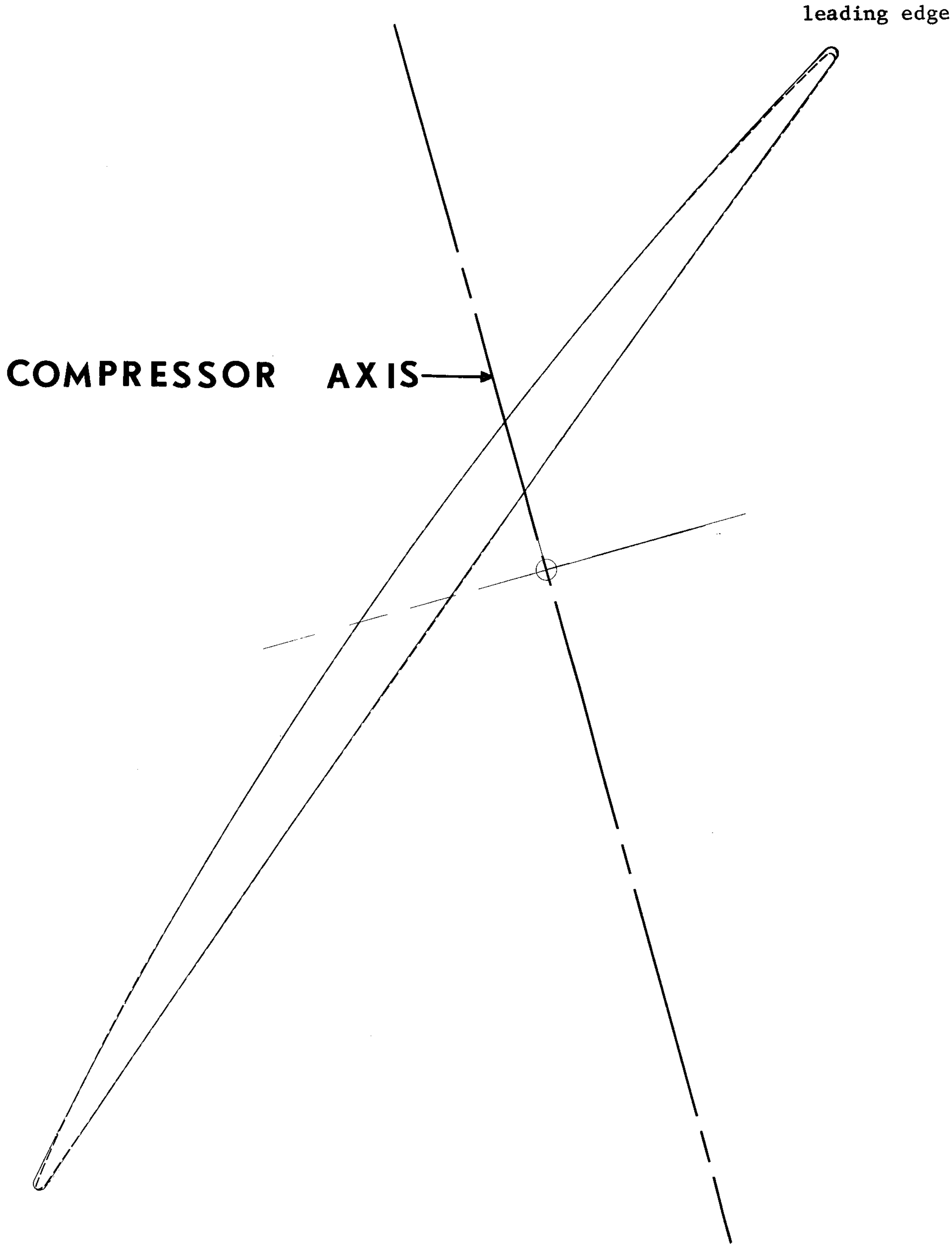


Figure 3(b). - Cylindrical cut of blade at section KK. The solid line represents design intent and the dashed line represents the average of four measured samples.

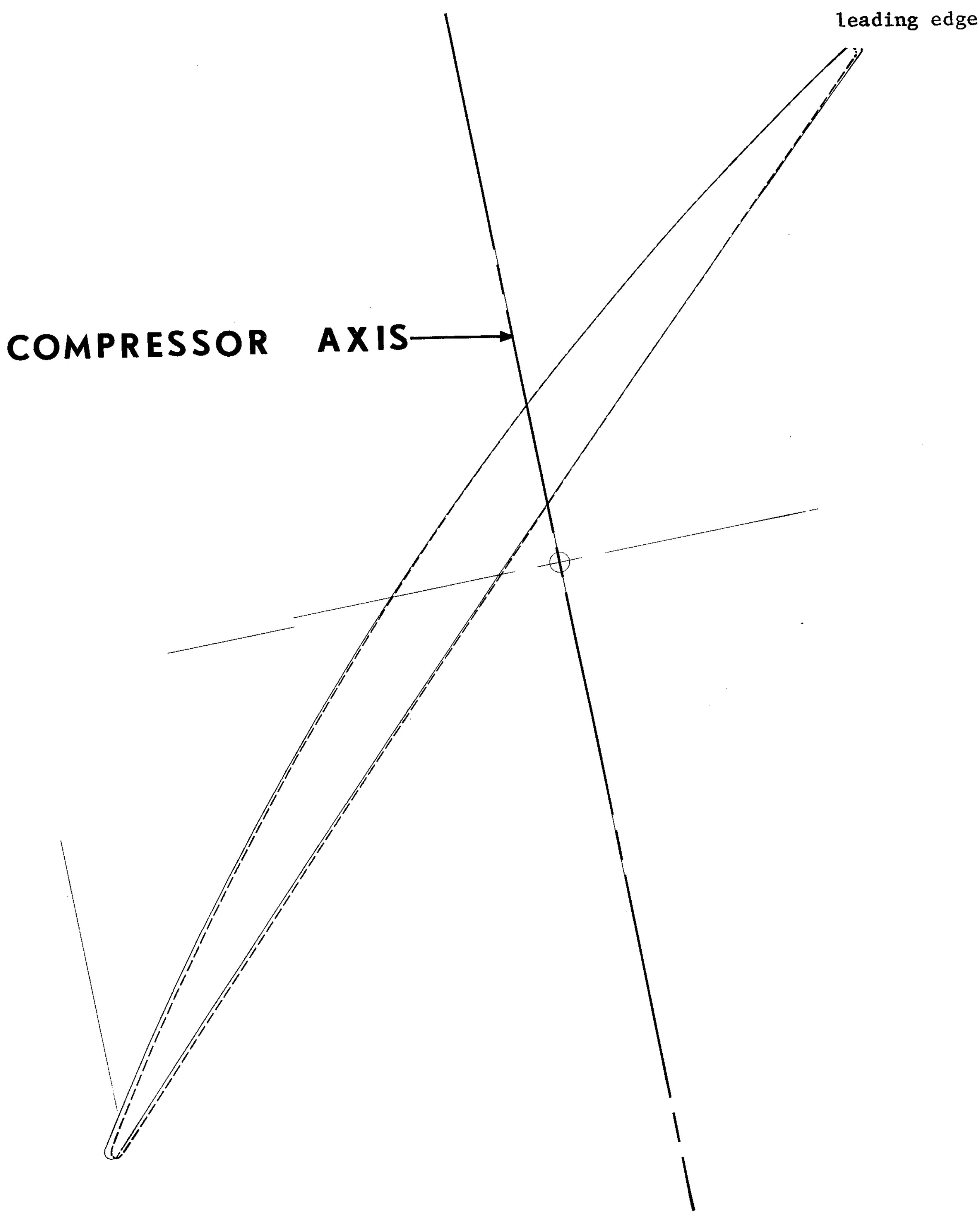


Figure 3(c). - Cylindrical cut of blade at section HH. The solid line represents design intent and the dashed line represents the average of four measured samples.

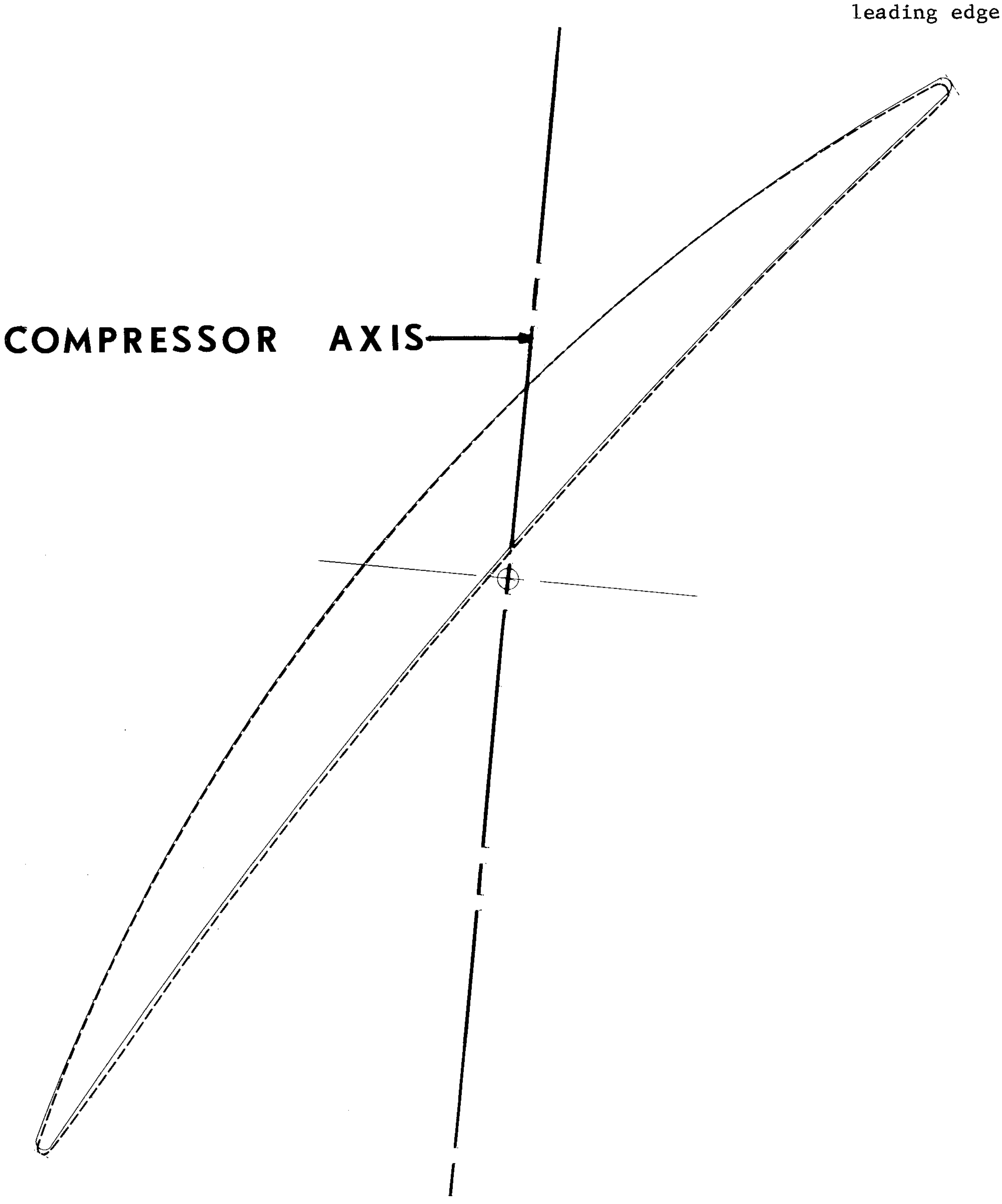


Figure 3(d). - Cylindrical cut of blade at section EE. The solid line represents design intent and the dashed line represents the average of four measured samples.

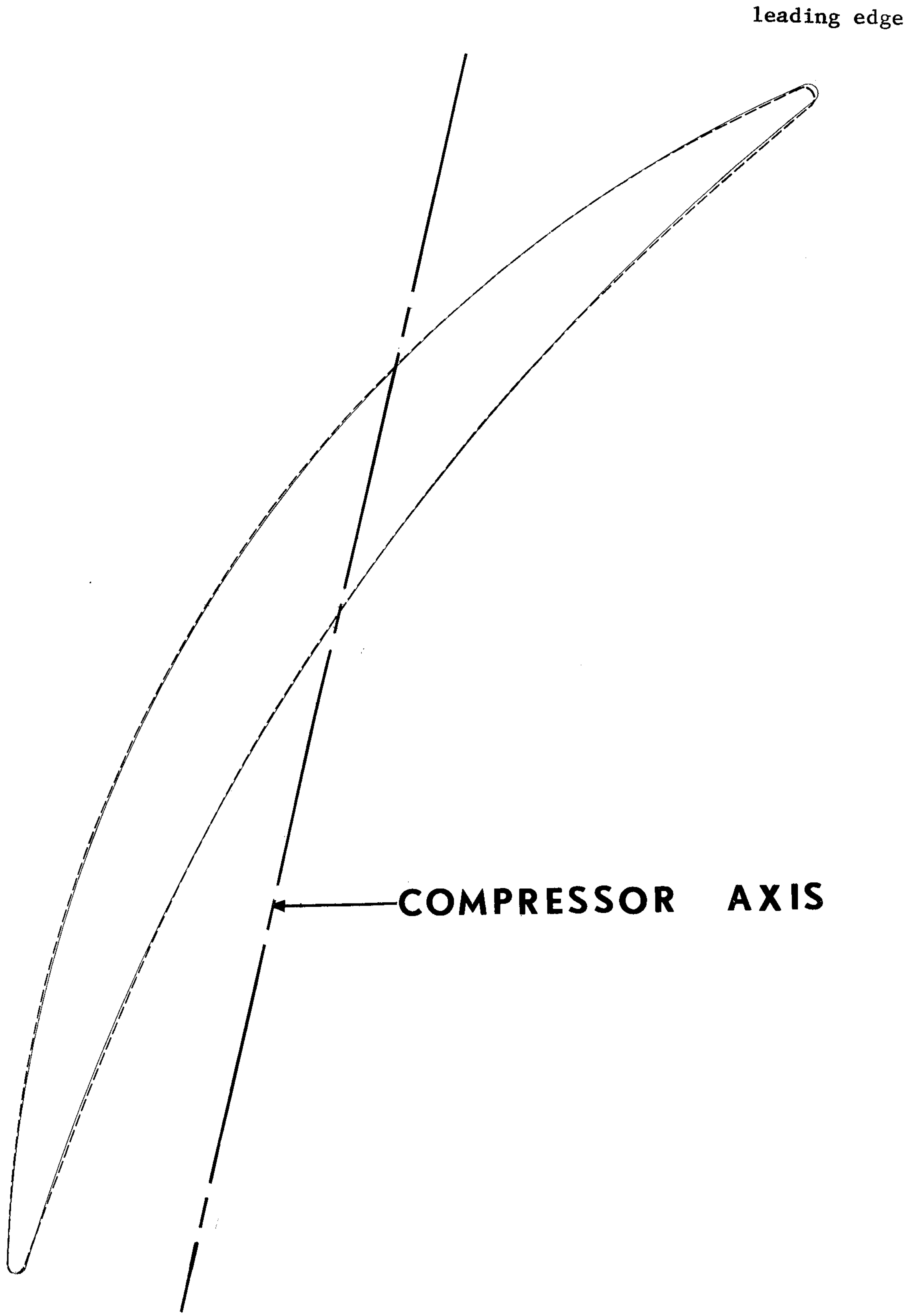


Figure 3(e). - Cylindrical cut of blade at section CC. The solid line represents design intent and the dashed line represents the average of four measured samples.

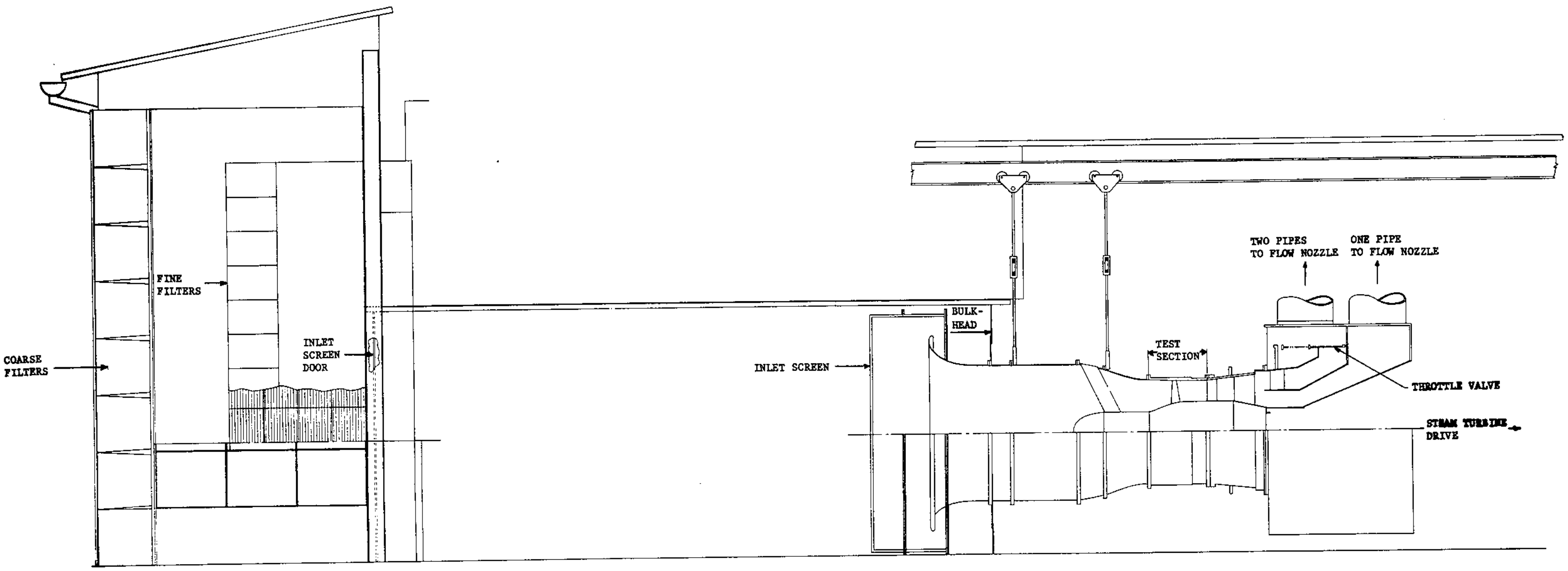
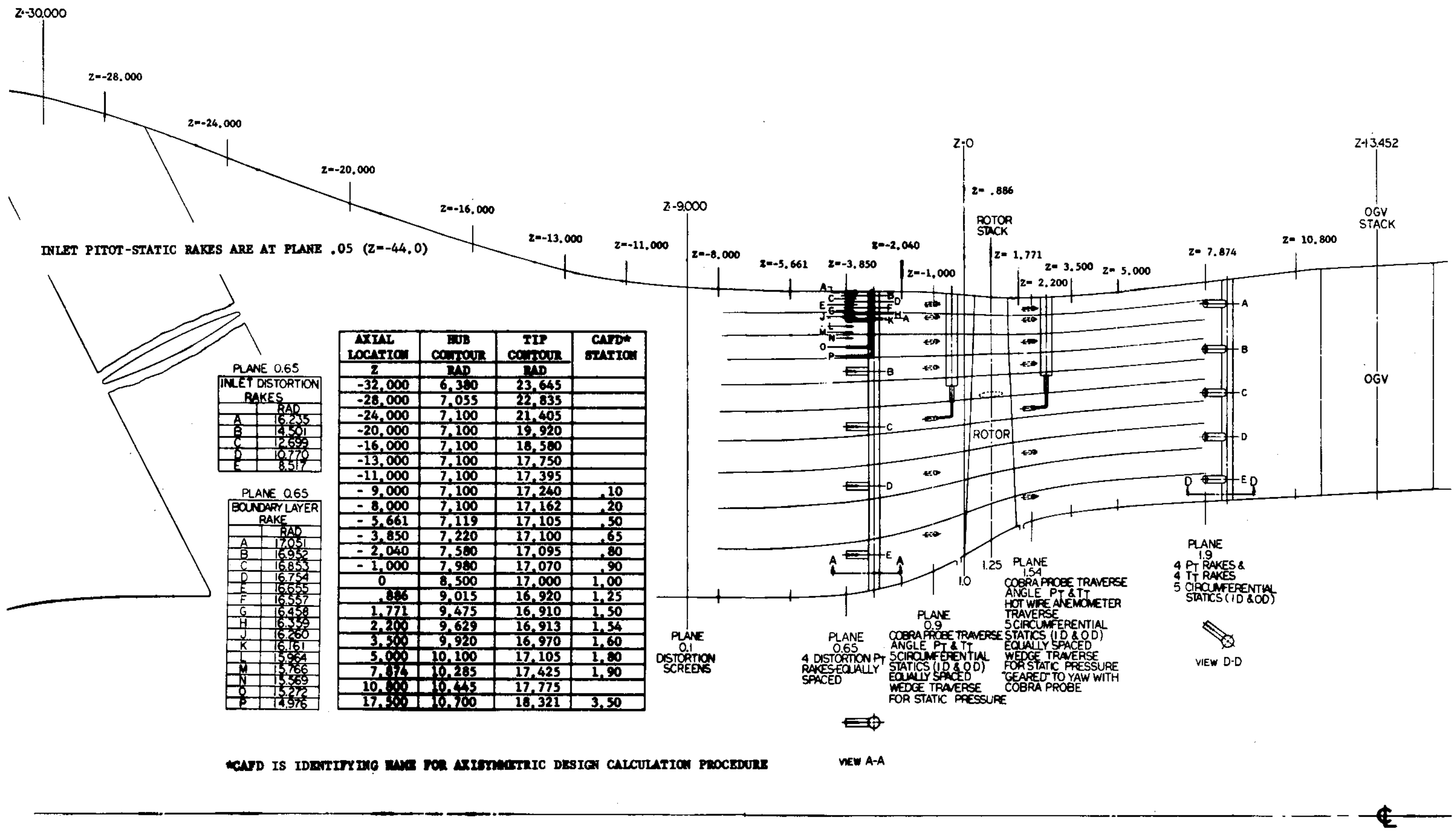


Figure 4. - House Compressor Test Facility.



PLANE 0.65

INLET DISTORTION RAKES	RAD
A	16.235
B	14.501
C	12.699
D	10.770
E	8.517

PLANE 0.65

BOUNDARY LAYER RAKE	RAD
A	17.051
B	16.952
C	16.853
D	16.754
E	16.655
F	16.557
G	16.458
H	16.359
J	16.260
K	16.161
L	15.964
M	15.766
N	15.569
O	15.272
P	14.976

AXIAL LOCATION Z	HUB CONTOUR RAD	TIP CONTOUR RAD	CAFD* STATION
-32,000	6,380	23,645	
-28,000	7,055	22,835	
-24,000	7,100	21,405	
-20,000	7,100	19,920	
-16,000	7,100	18,580	
-13,000	7,100	17,750	
-11,000	7,100	17,395	
- 9,000	7,100	17,240	.10
- 8,000	7,100	17,162	.20
- 5,661	7,119	17,105	.50
- 3,850	7,220	17,100	.65
- 2,040	7,580	17,095	.80
- 1,000	7,980	17,070	.90
0	8,500	17,000	1,00
.886	9,015	16,920	1,25
1,771	9,475	16,910	1,50
2,200	9,629	16,913	1,54
3,500	9,920	16,970	1,60
5,000	10,100	17,105	1,80
7,874	10,285	17,425	1,90
10,800	10,445	17,775	
17,500	10,700	18,321	3,50

*CAFD IS IDENTIFYING NAME FOR AXISYMMETRIC DESIGN CALCULATION PROCEDURE

Figure 5. - Meridional view showing location of instrumentation.

QTY	SYM	DESCRIPTION	PLANE
76	○	STATIC PRESSURE TAPS	-
3	□	STATIC PRESSURE PROBES	0.9&1.54
2	◇	COBRA PROBE TRAVERSE	0.9&1.54
4	△	OUTLET P_t RAKES	1.9
4	⊿	OUTLET T_t RAKES	1.9
4	⊿	INLET DISTORTION P_t RAKES	0.65
1	⌂	INLET BOUNDARY LAYER RAKE	0.65
6	▽	INLET PITOT STATIC RAKES	0.05
5	⌂	HOT WIRE ANEMOMETER TRAVERSE	1.54
3	⬡	P_t WAKE RAKES	3.5

24 INLET T_t THERMOCOUPLES DISTRIBUTED ON INLET SCREEN
24 ADDITIONAL THERMOCOUPLES FOR IN-TEST CHECK (NOT SHOWN)

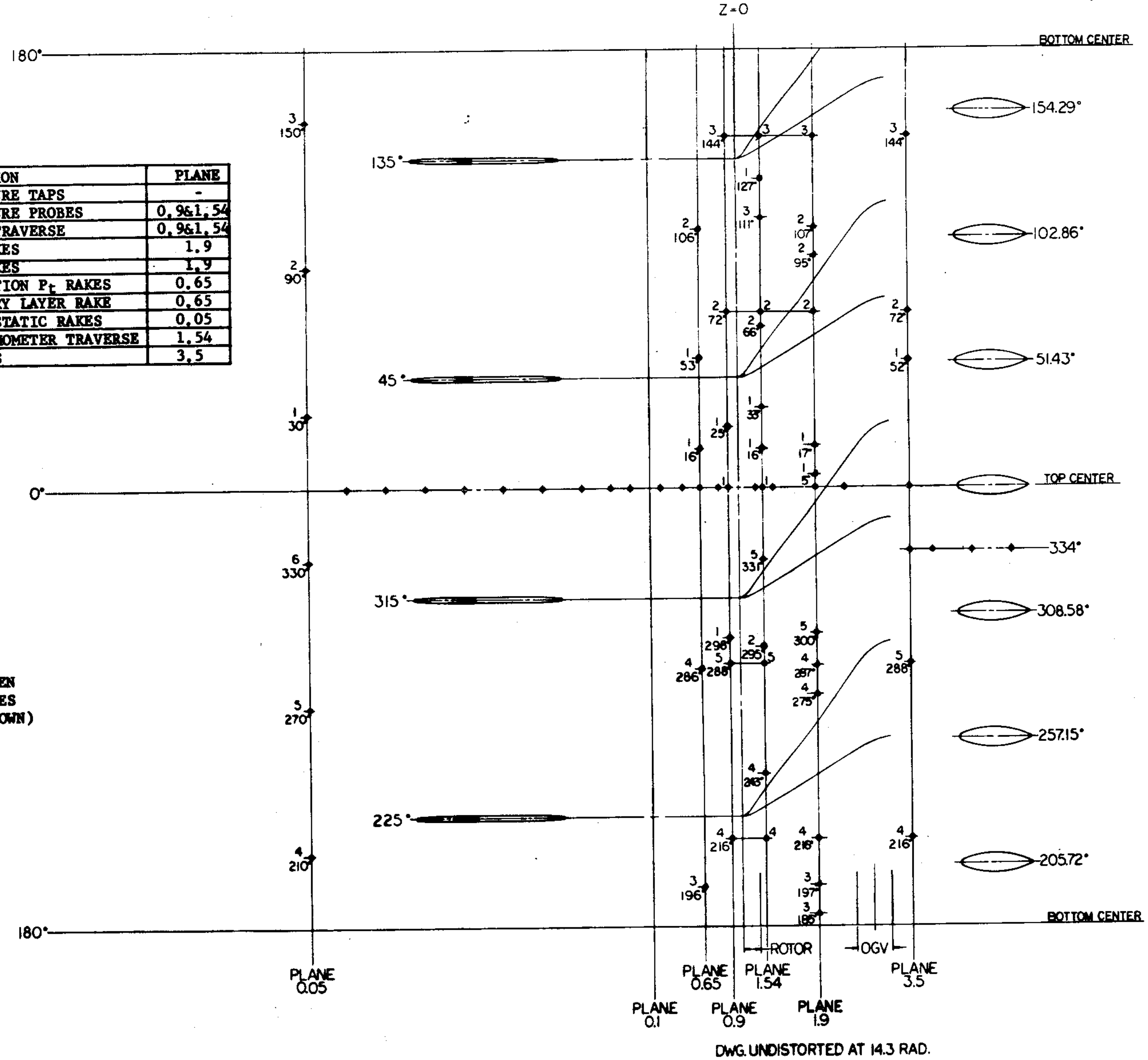
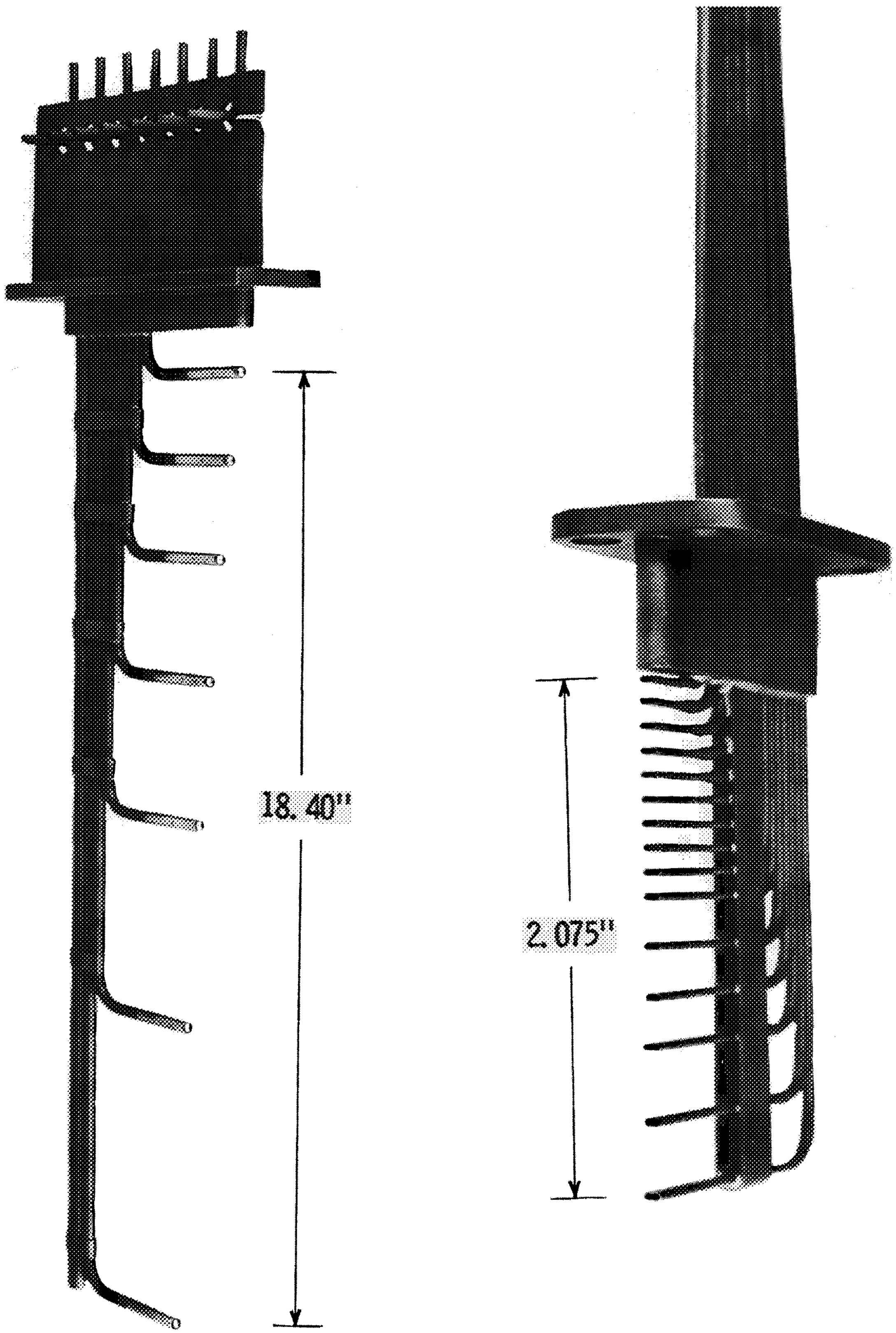
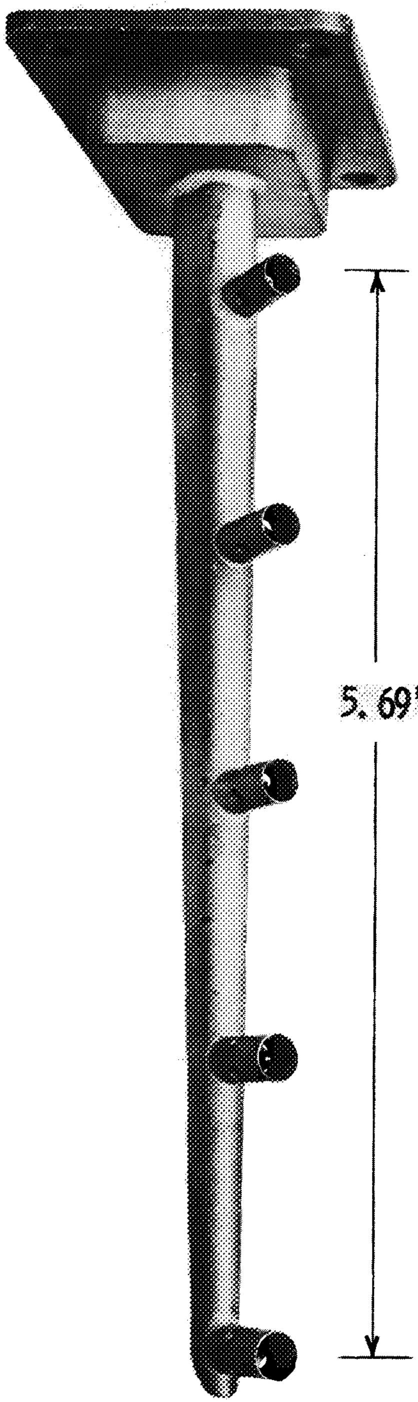


Figure 6. - Development showing circumferential location of instrumentation.

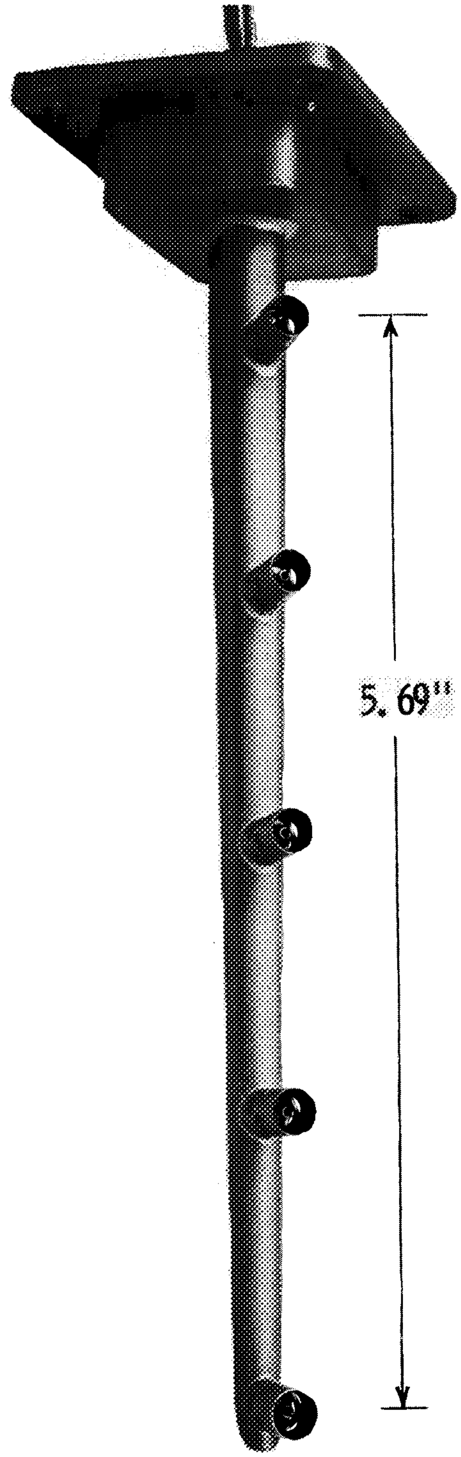


(a). - **Inlet pitot-static rake.** (b). - Casing boundary layer rake.

Figure 7. - Photographs of fixed instrumentation.

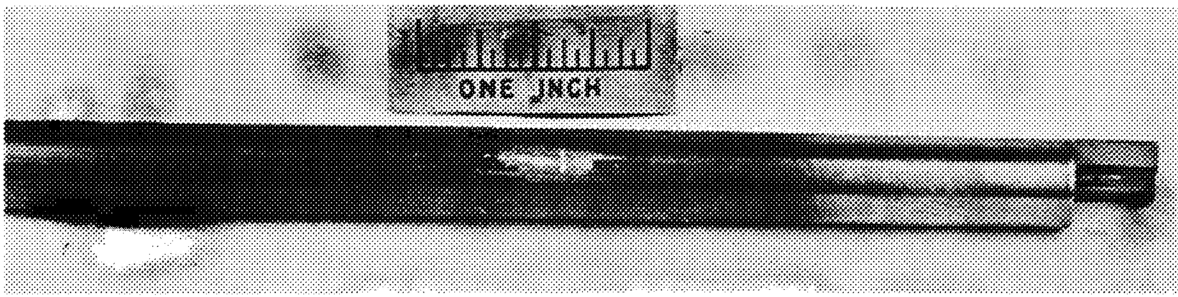


(c). - Discharge total temperature rake.

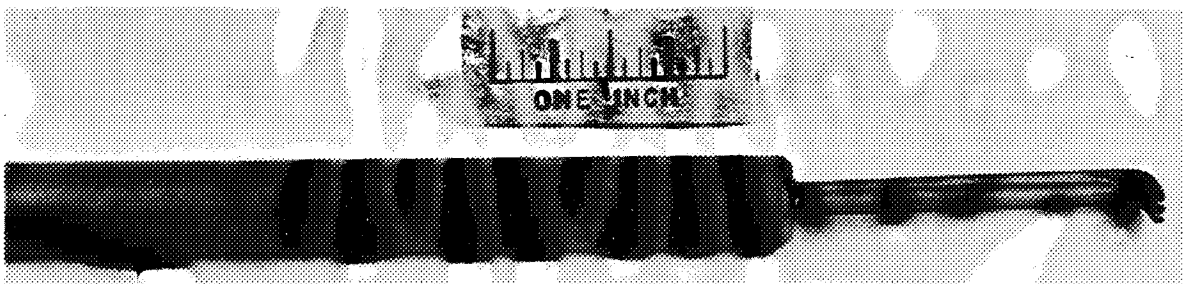


(d). - Discharge total pressure rake.

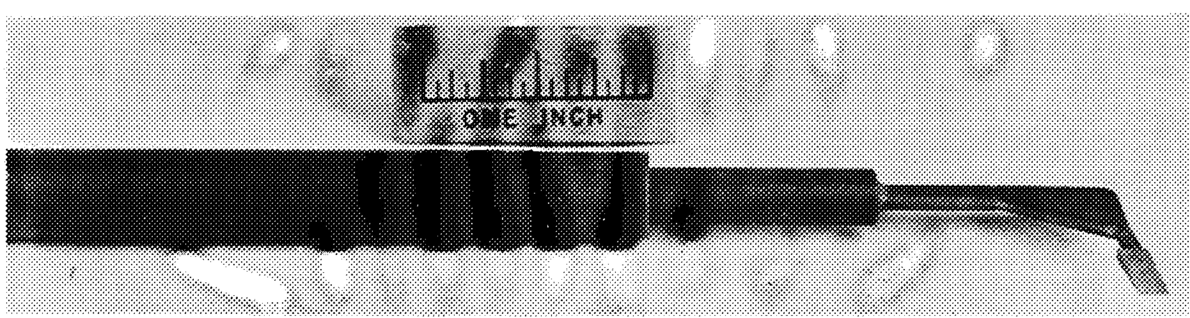
Figure 7. - Photographs of fixed instrumentation.



(a). - Shielded hot wire probe.



(b). - Cobra probe for sensing flow angle, total pressure and total temperature.



(c). - Wedge probe for sensing static pressure.

Figure 8. - Photographs of traverse instrumentation.

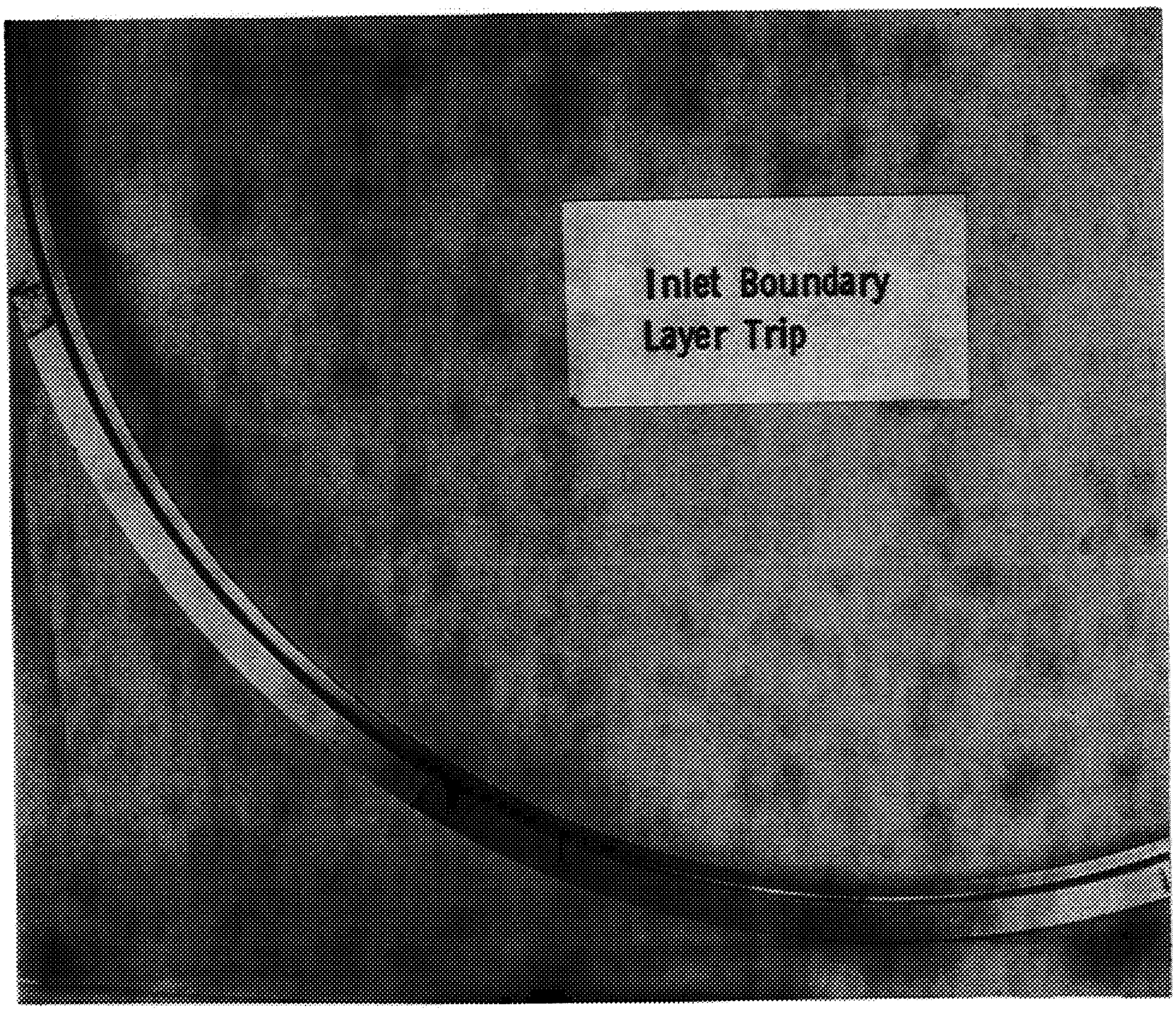


Figure 9. Photograph of inlet boundary layer trip.

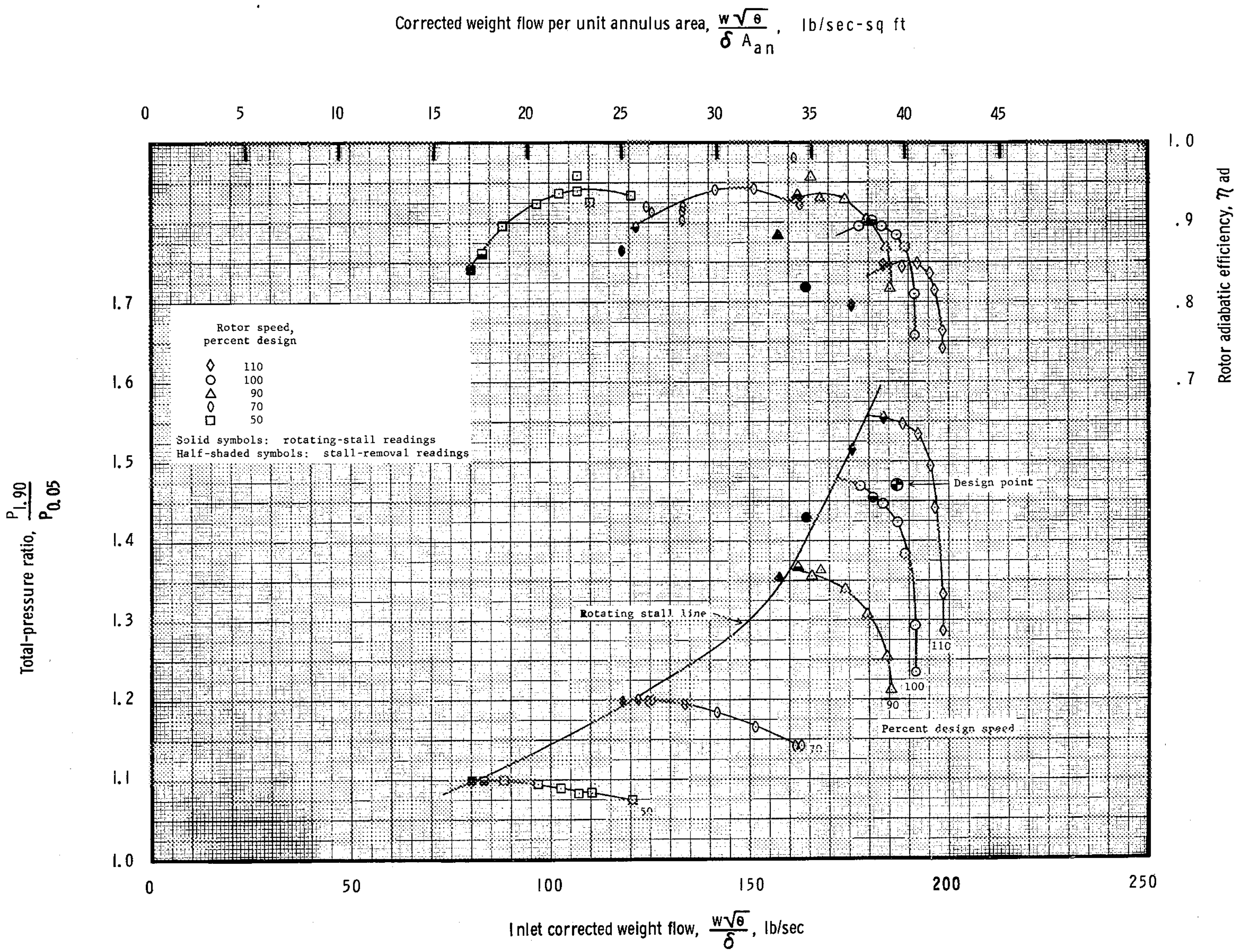
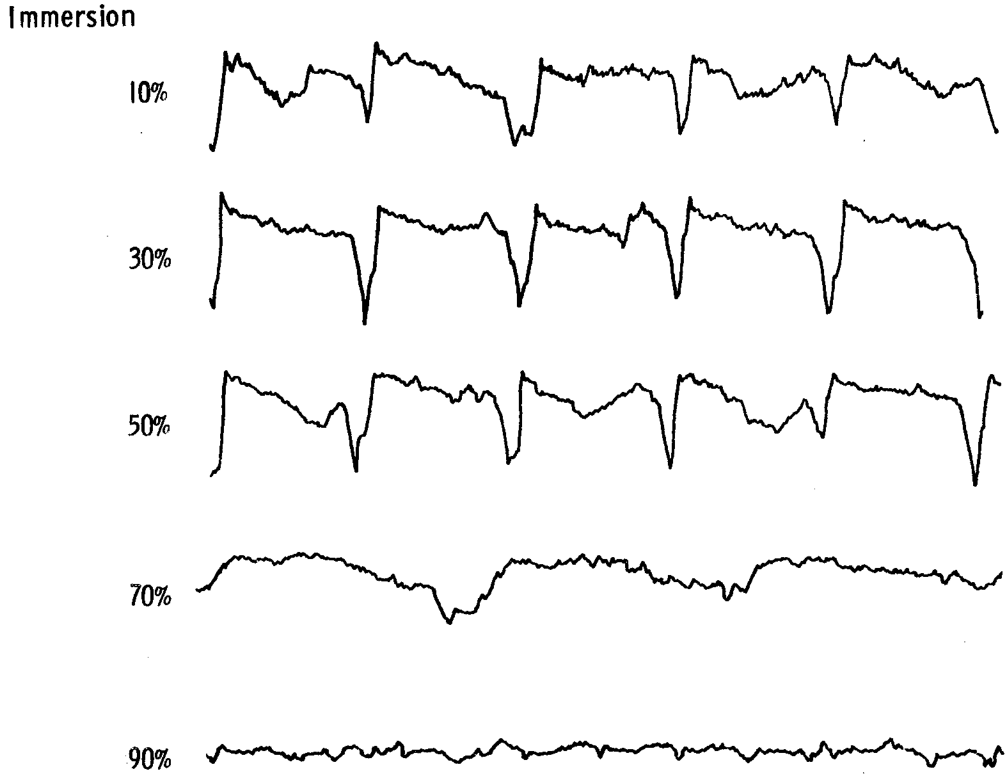


Figure 10. - Rotor performance map for undistorted inlet flow



(a) Sample hot wire anemometer traces at design rotor speed.

Rotor speed, percent design	Throttle setting at stall	Number of stall cells	Stall cell speed / Rotor speed	Radial extent of stall cell
50	3.50	1	.279	outer 50%+
70	5.40	1	.286	full span
90	6.46	1	.364	outer 50%+
90*	3.76	3	.708	outer 50%+
100	5.28	1	.565	outer 70%
110	5.9	1	.305	outer 50%+

* Outlet de-swirl vanes closed 15°

(b) Tabulation of stall data

Figure 11. - Undistorted inlet hot wire traces and tabulation of stall data.

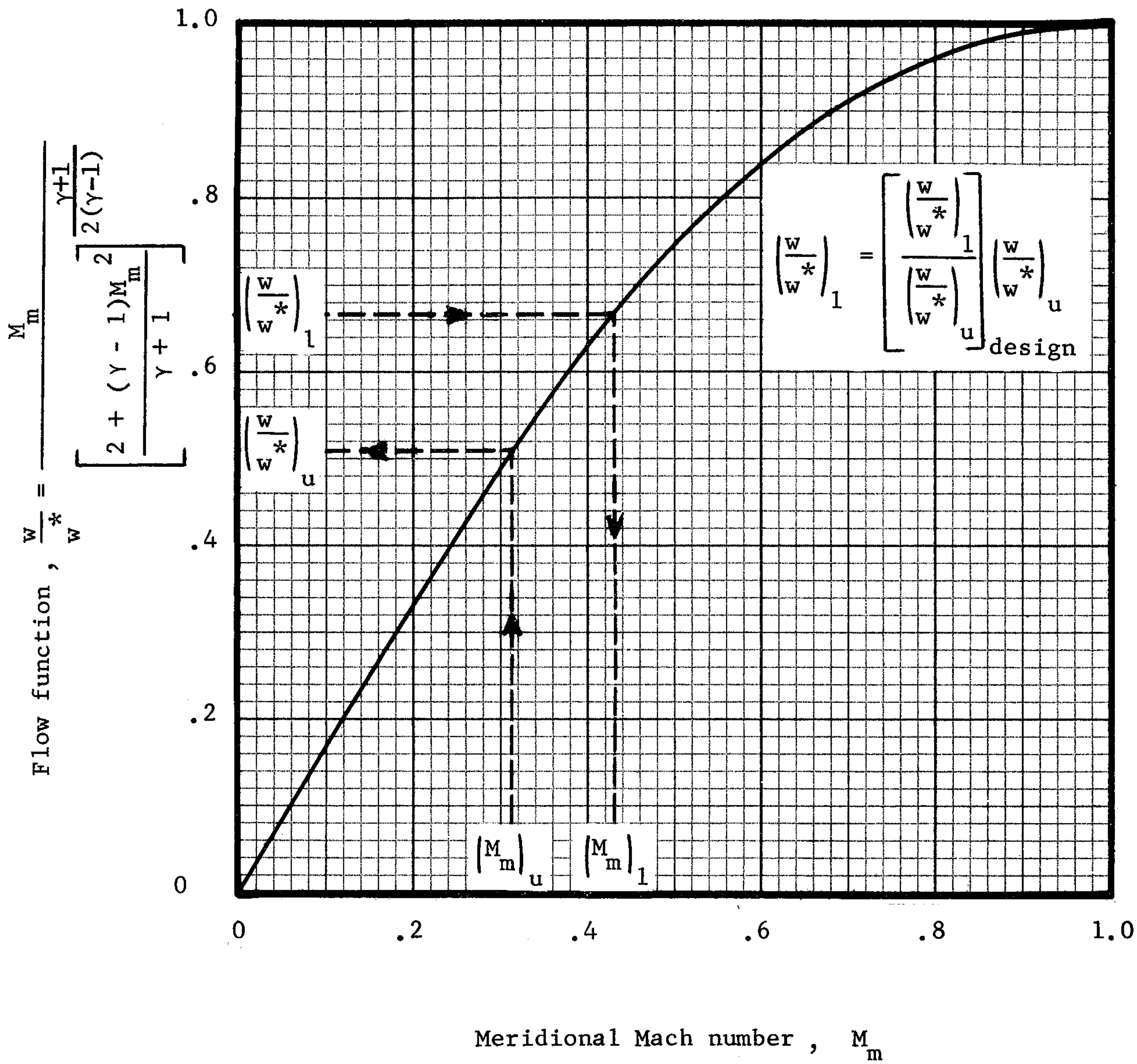


Figure 12. - **Relationship between** flow function and meridional **Mach number** - **used for transferring** traverse measurements to **blade edges. Dashed** lines with arrows and inset formulas indicate **calculation** sequence for sample case at leading edge.

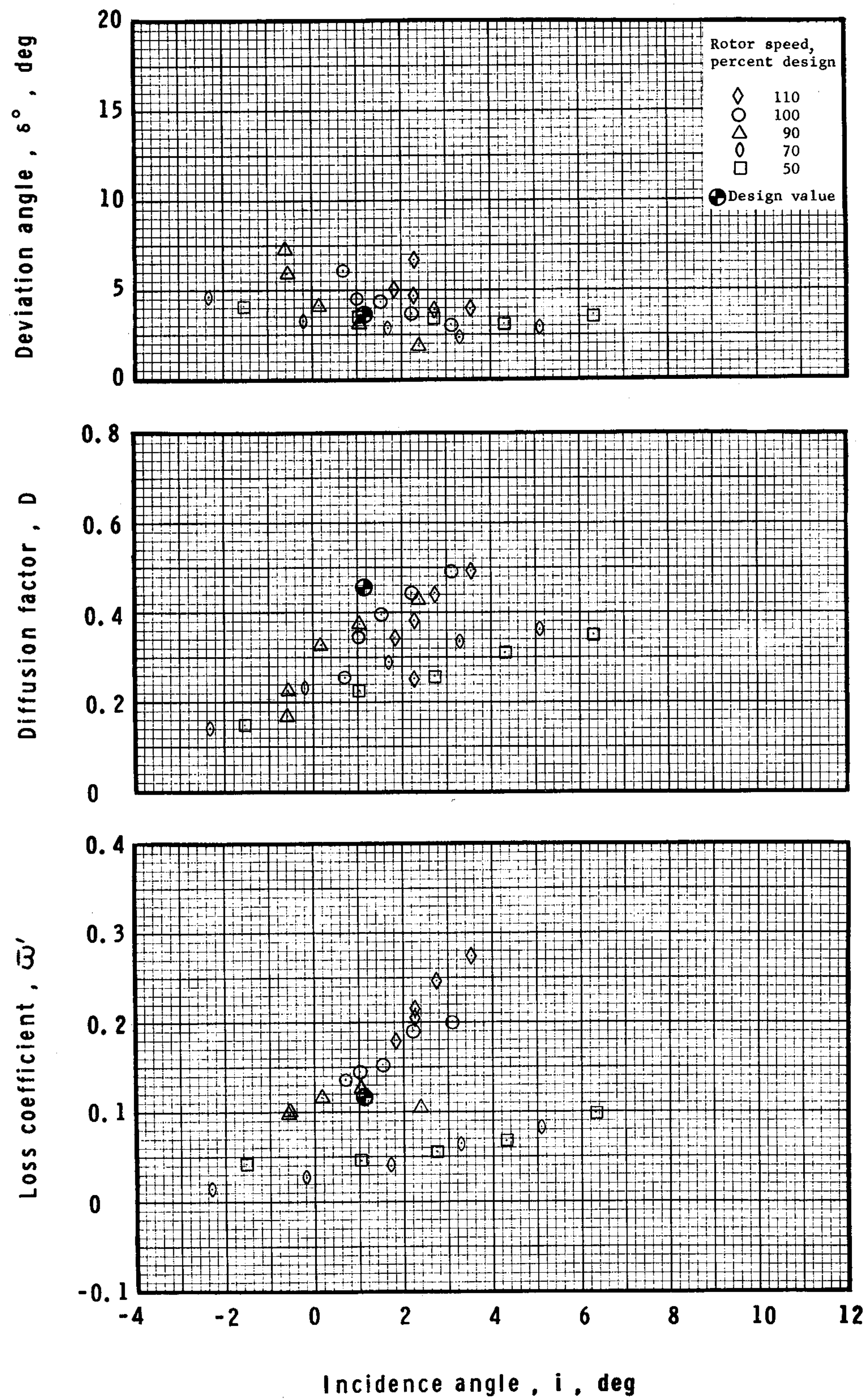


Figure 13(a). - Blade element data measured at 5% immersion from tip.

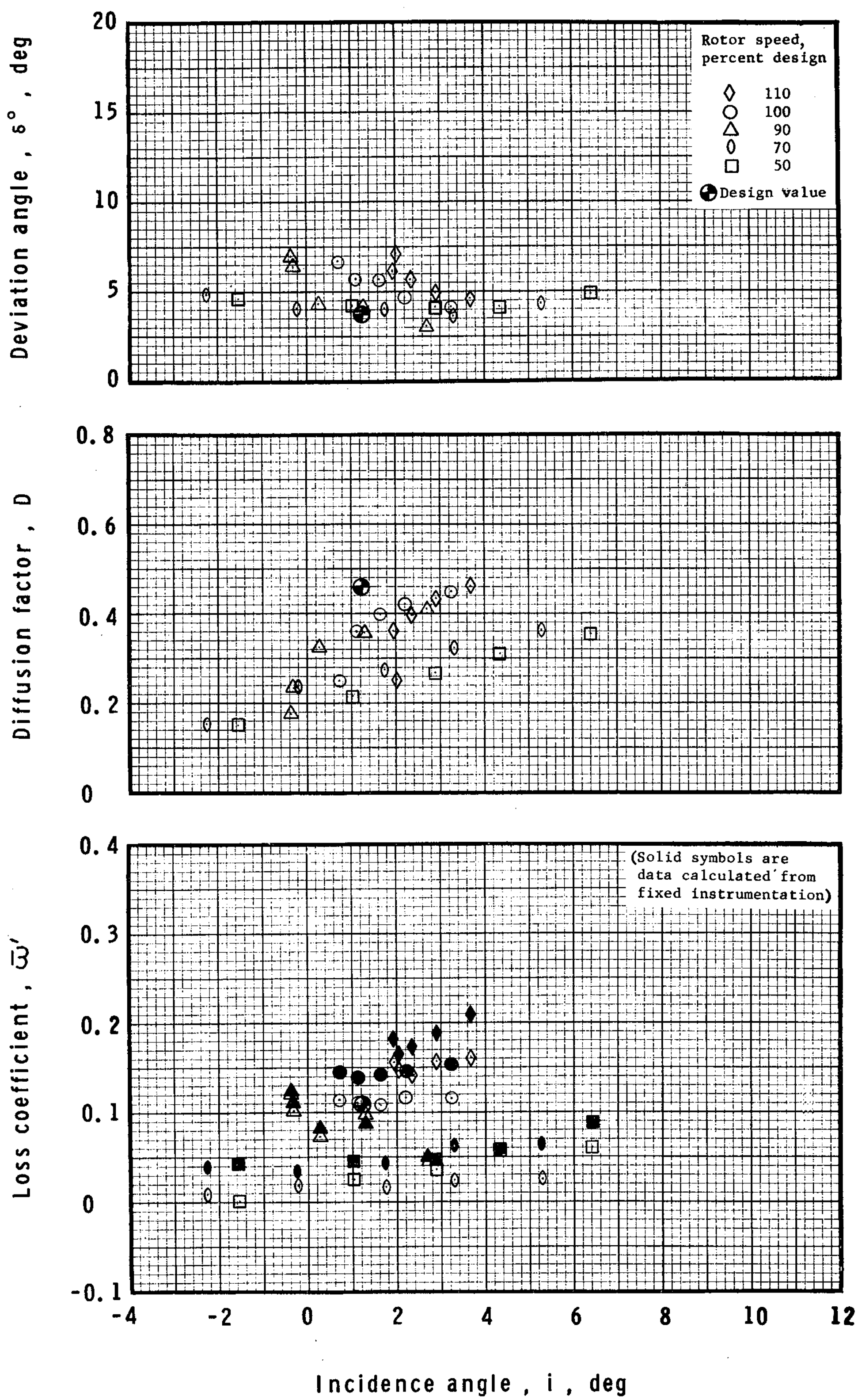


Figure 13(b). - Blade element data measured at 10% immersion from tip.

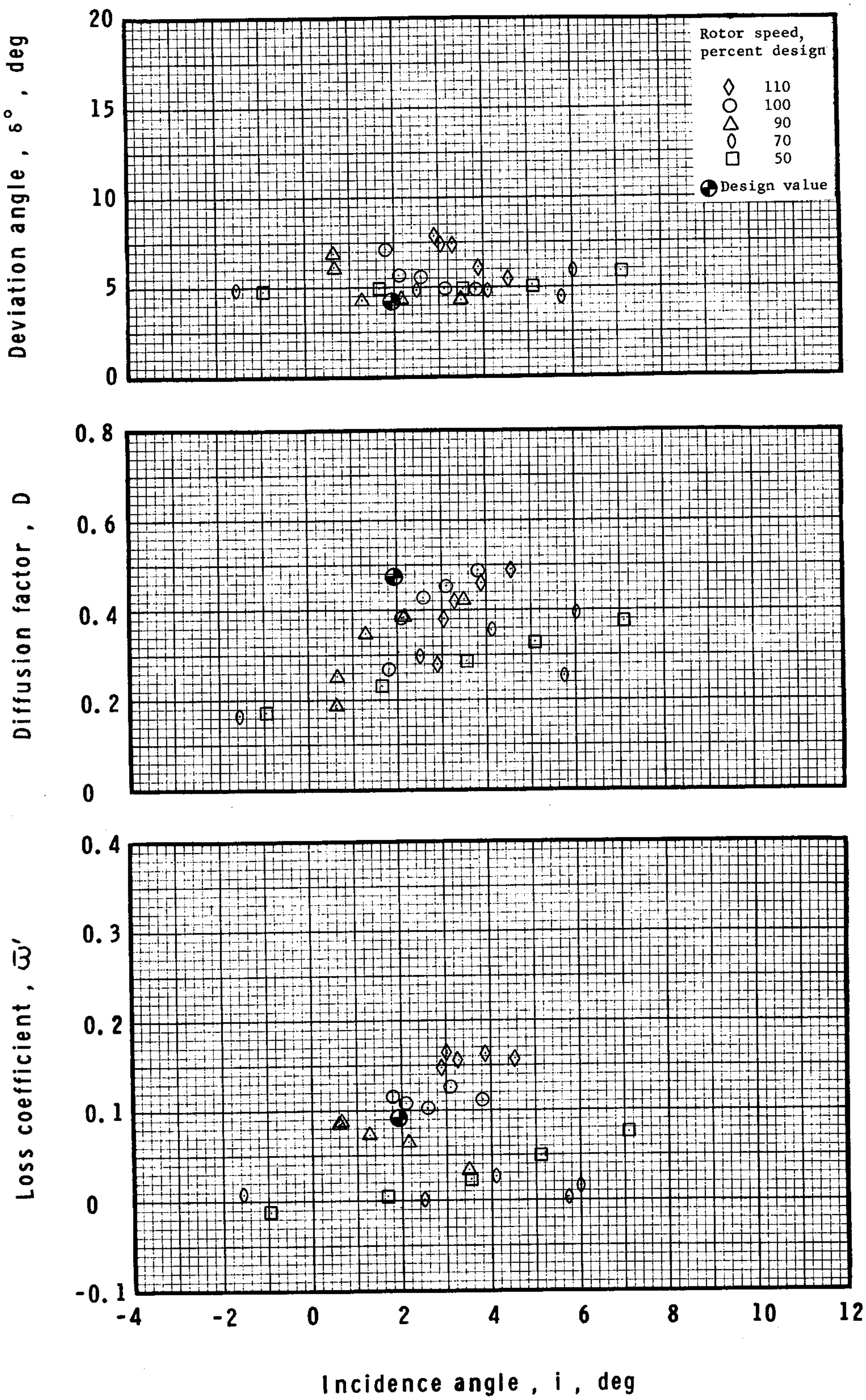


Figure 13(c). - **Blade element data measured at 20% immersion from tip.**

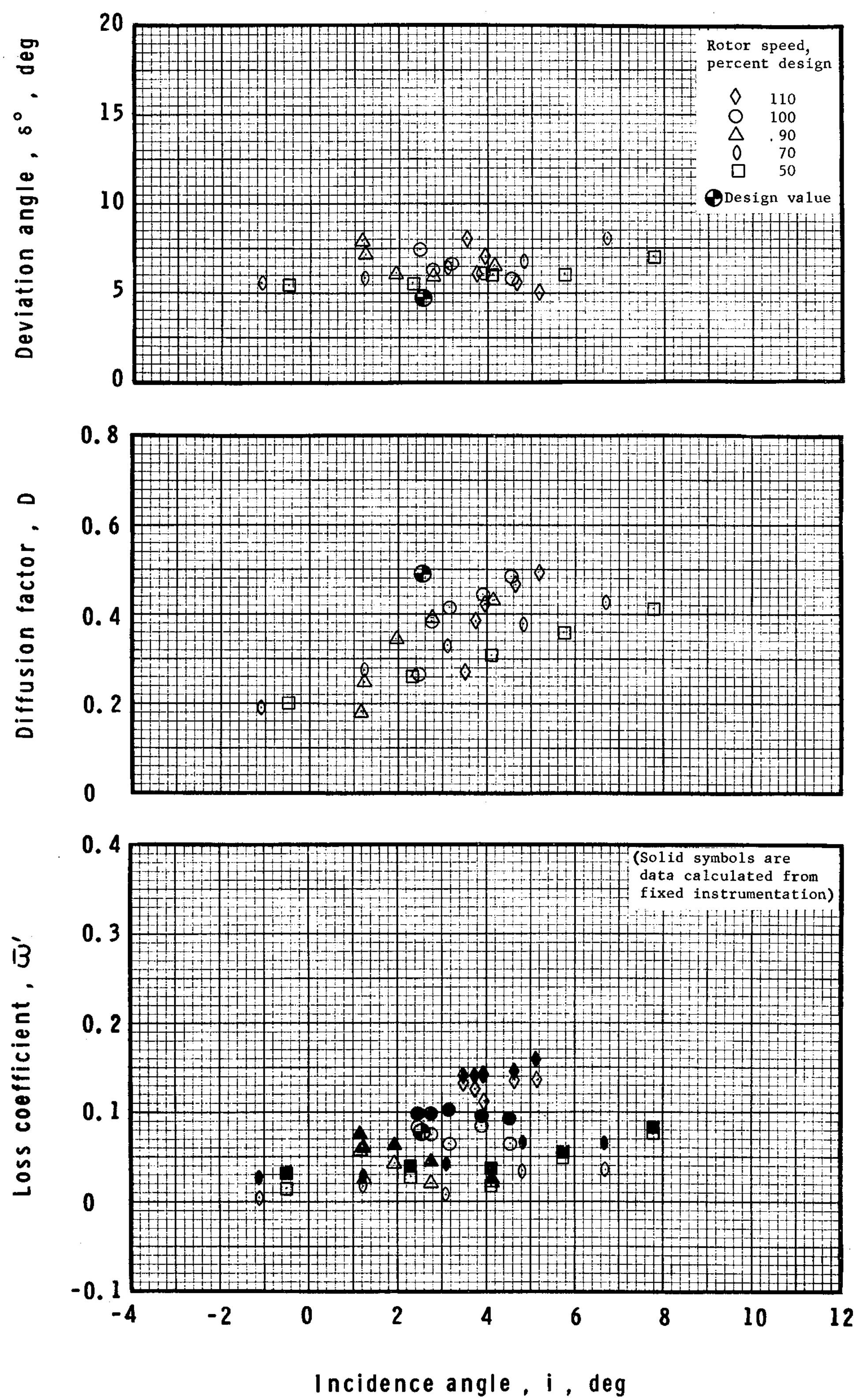


Figure 13(d). - Blade element data measured at 30% immersion from tip.

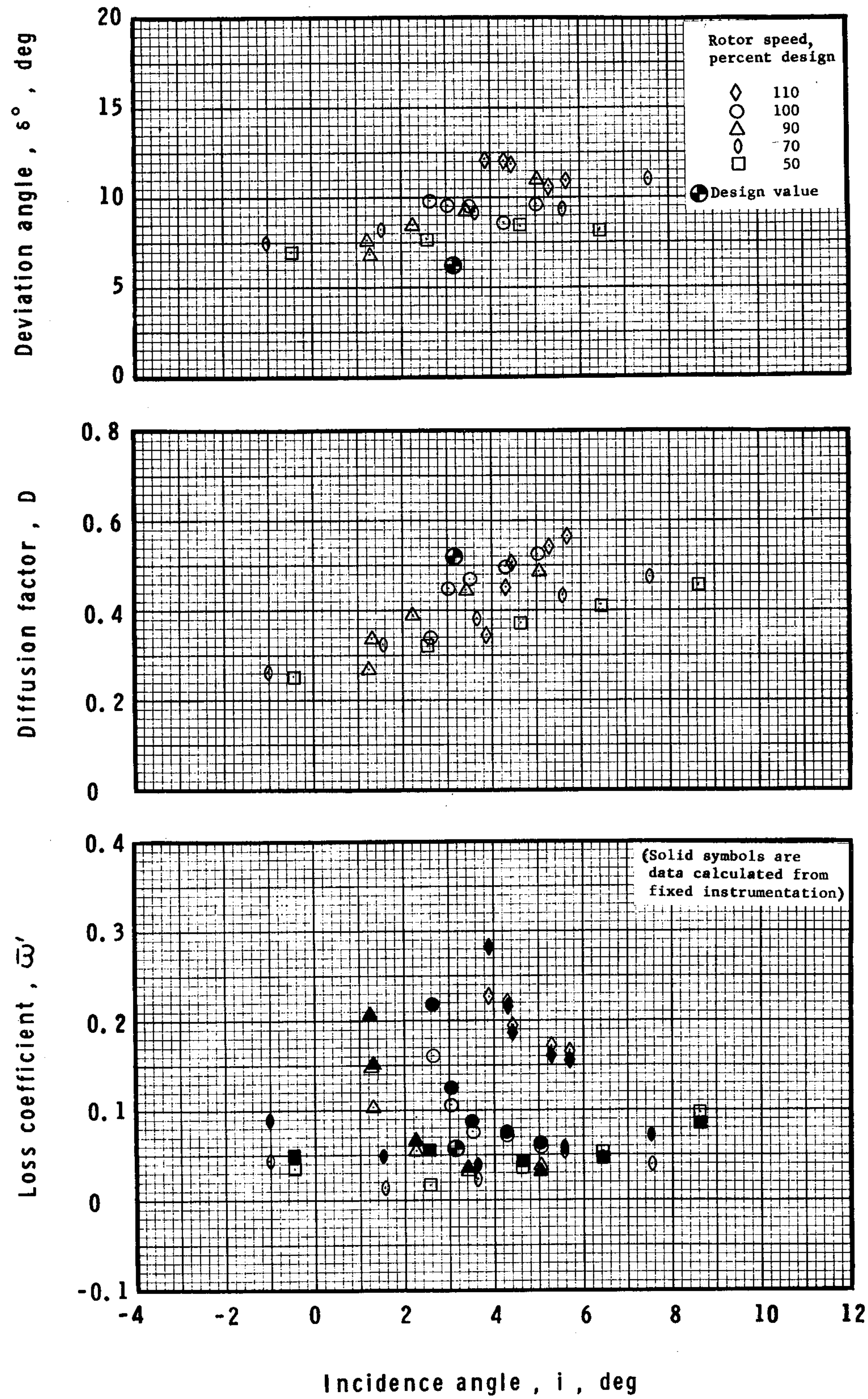


Figure 13(e). - Blade element data measured at 50% immersion from tip.

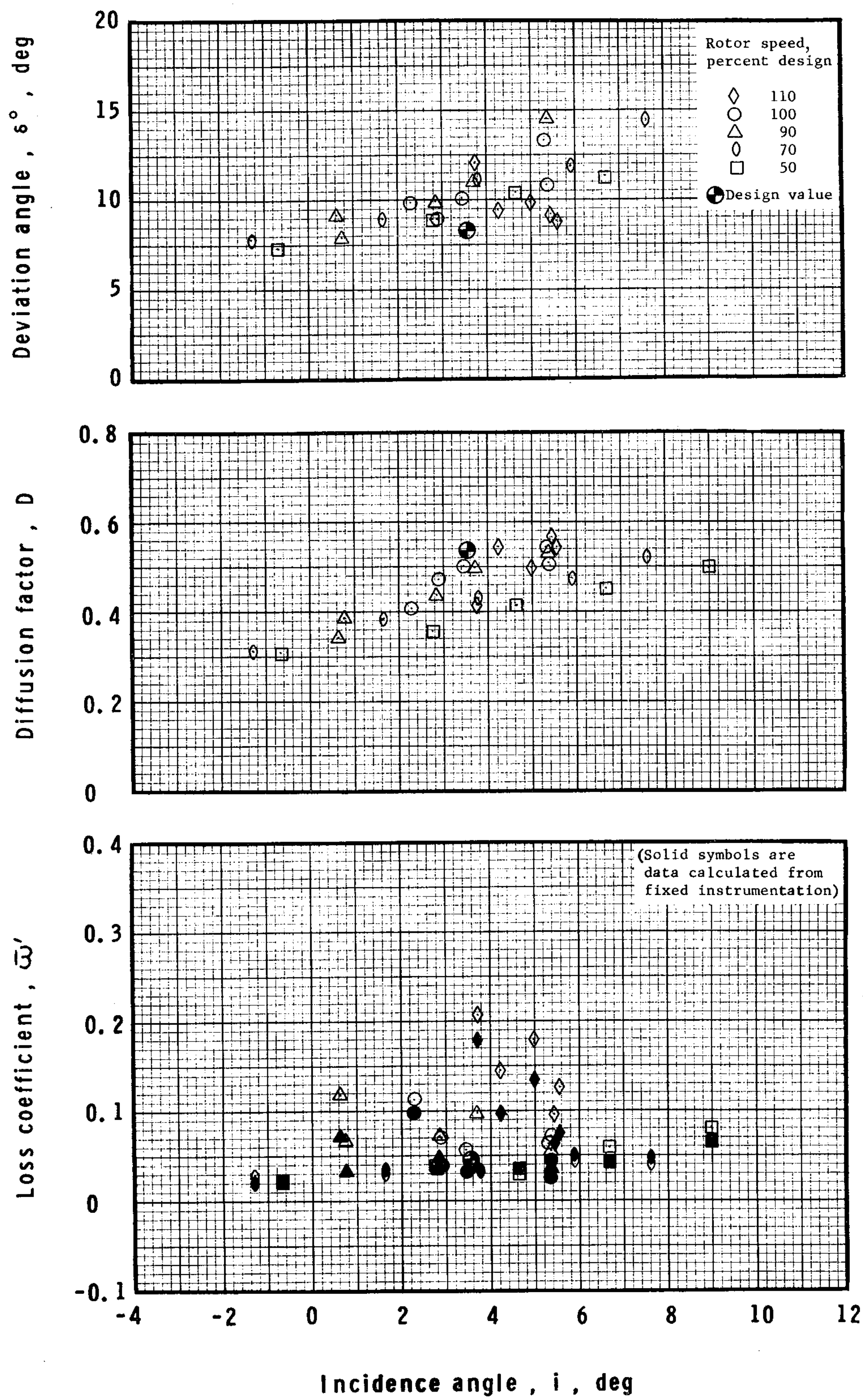


Figure 13(f). - Blade element data measured at 70% immersion from tip.

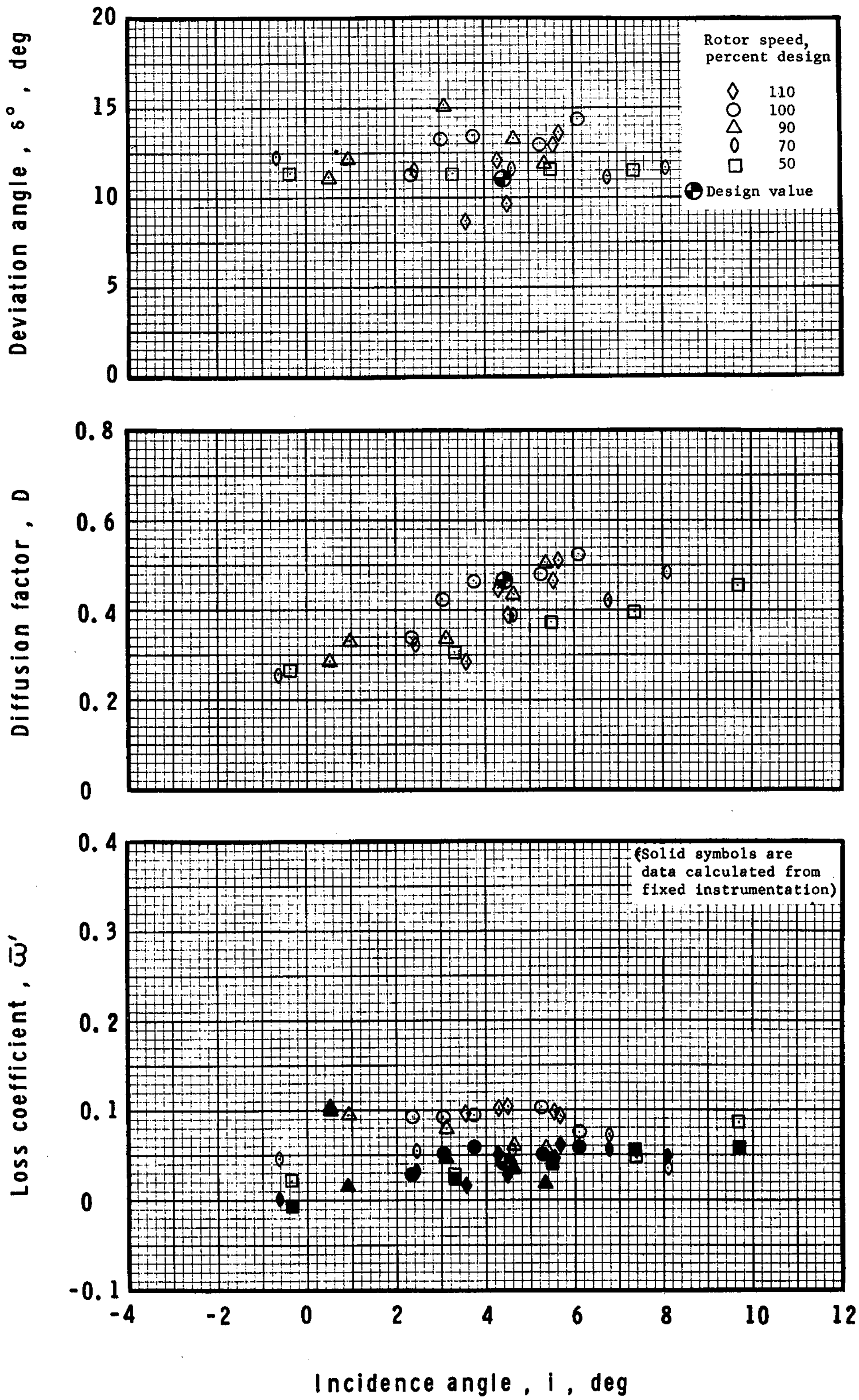


Figure 13(g). - Blade element data measured at 90% immersion from tip.

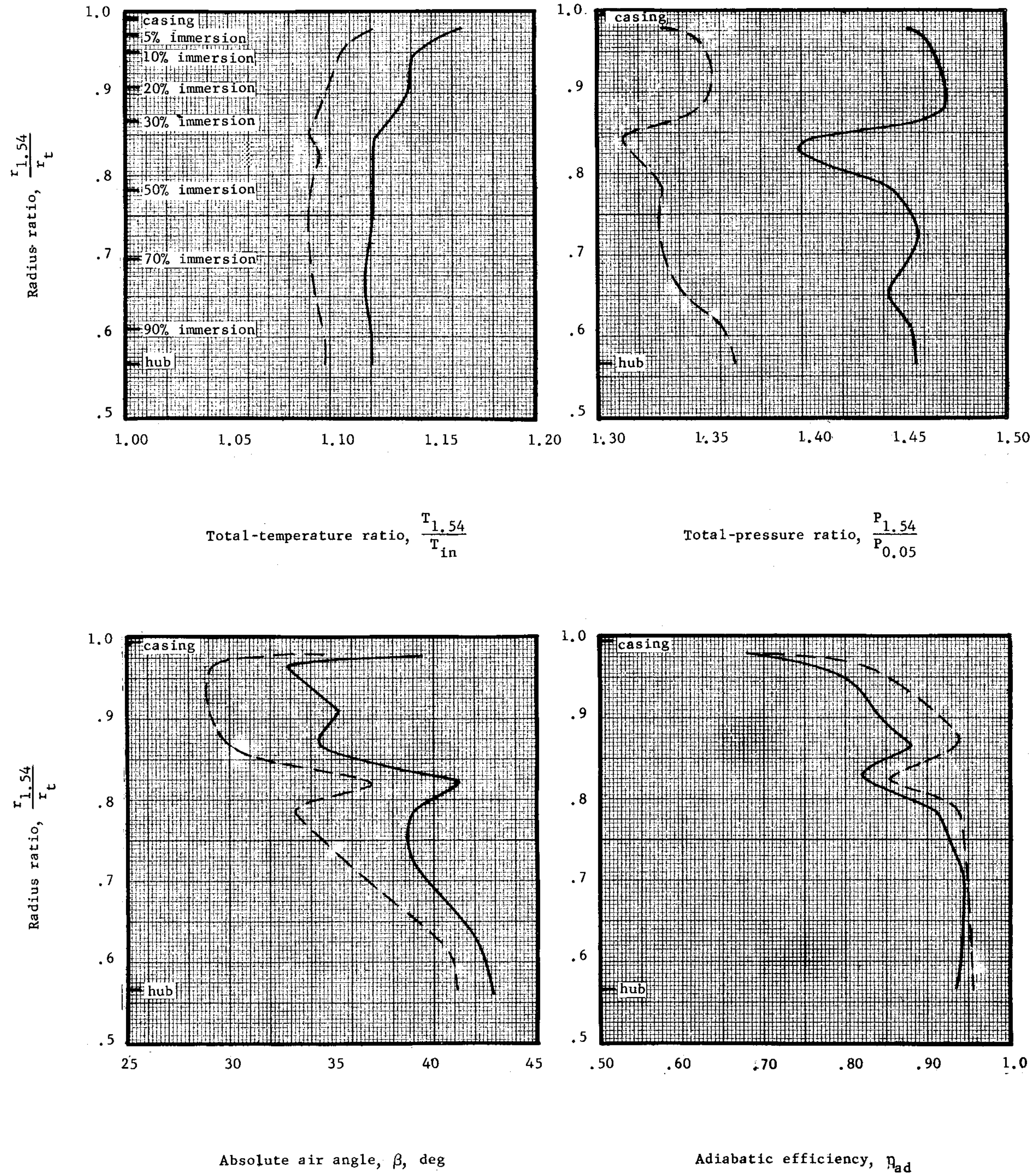


Figure 14. - Continuous traverses at rotor exit plane 1.54. Solid lines are reading 35, 100% speed. Dashed lines are reading 36, 90% speed.

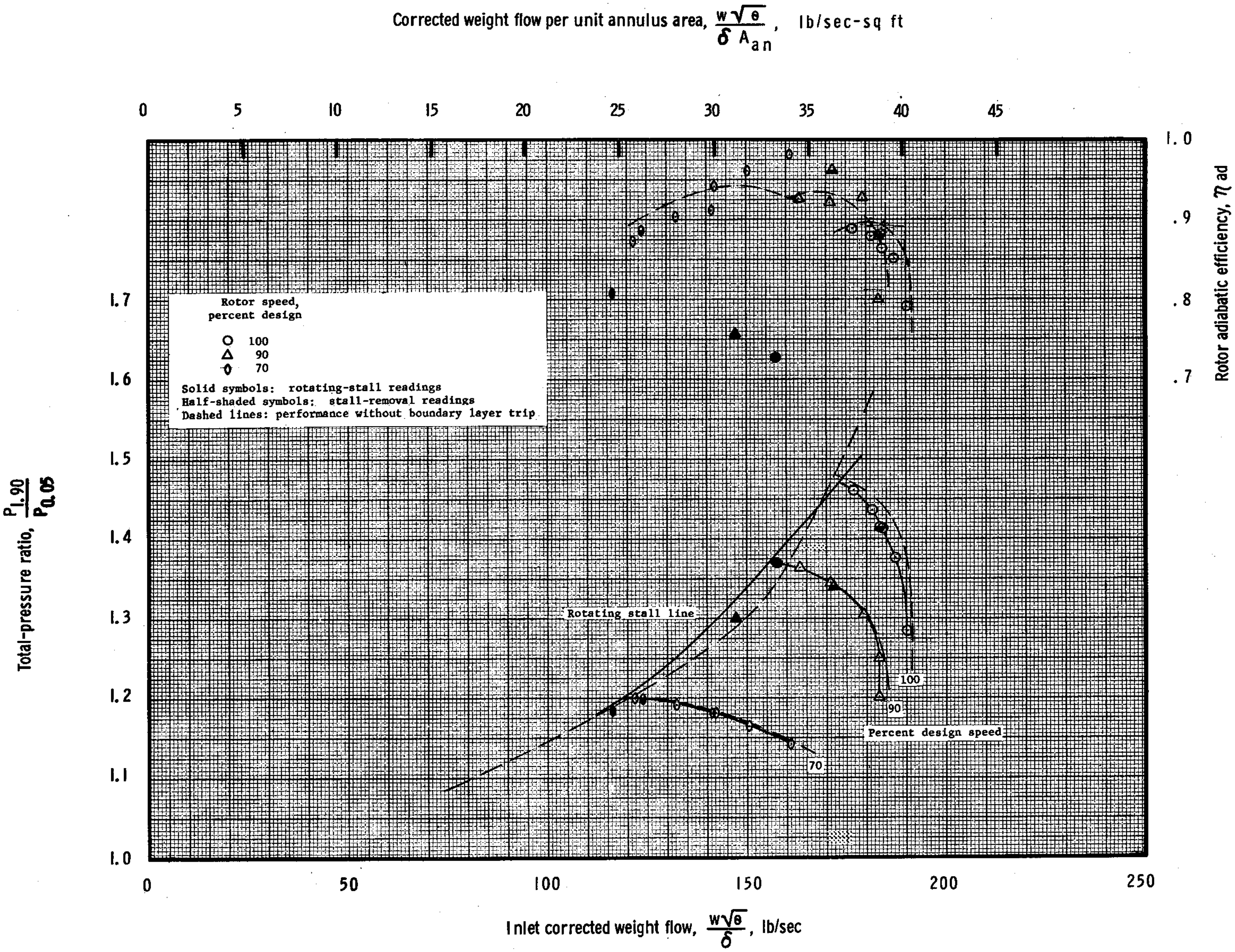
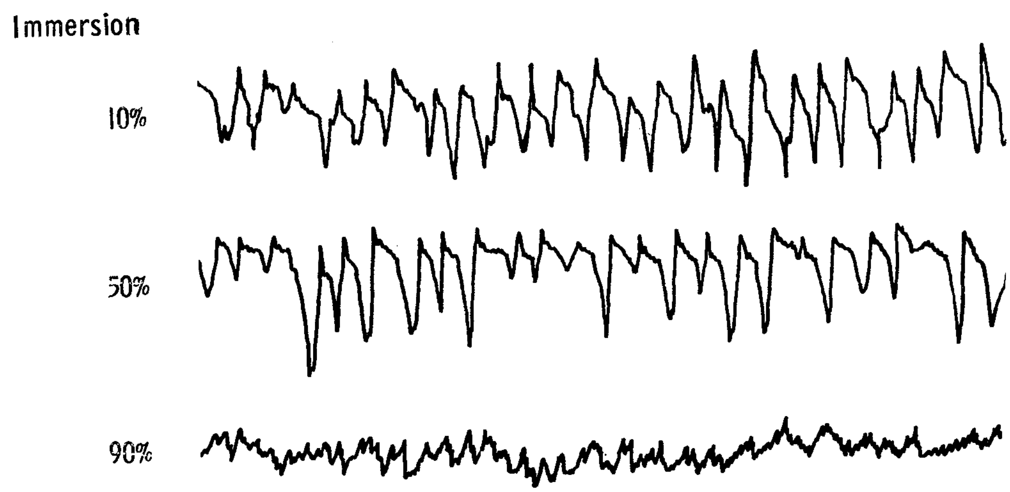
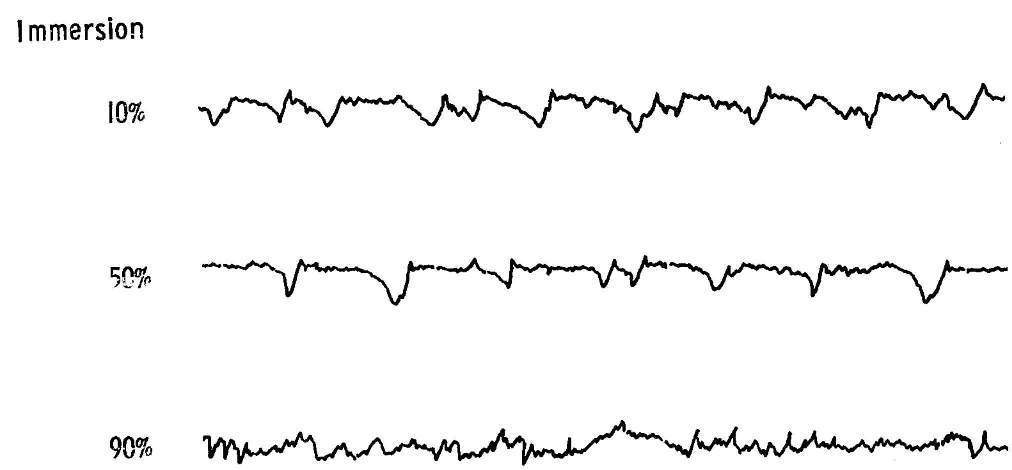


Figure 15. - Rotor performance map with boundary layer trip



(a) Sample hot wire anemometer traces at design rotor speed.



(b) Sample hot wire anemometer traces at 70% design rotor speed.

Rotor speed, percent design	Throttle setting at stall	Number of stall cells	Stall cell speed / Rotor speed	Radial extent of stall cell
70	4.54	3	.580	outer 50%+
90	5.54	3	.570	outer 50%+
100	5.50	3	.576	outer 50%+

(c) Tabulation of stall data

Figure 16. - Boundary layer trip hot wire traces and tabulation of stall data.

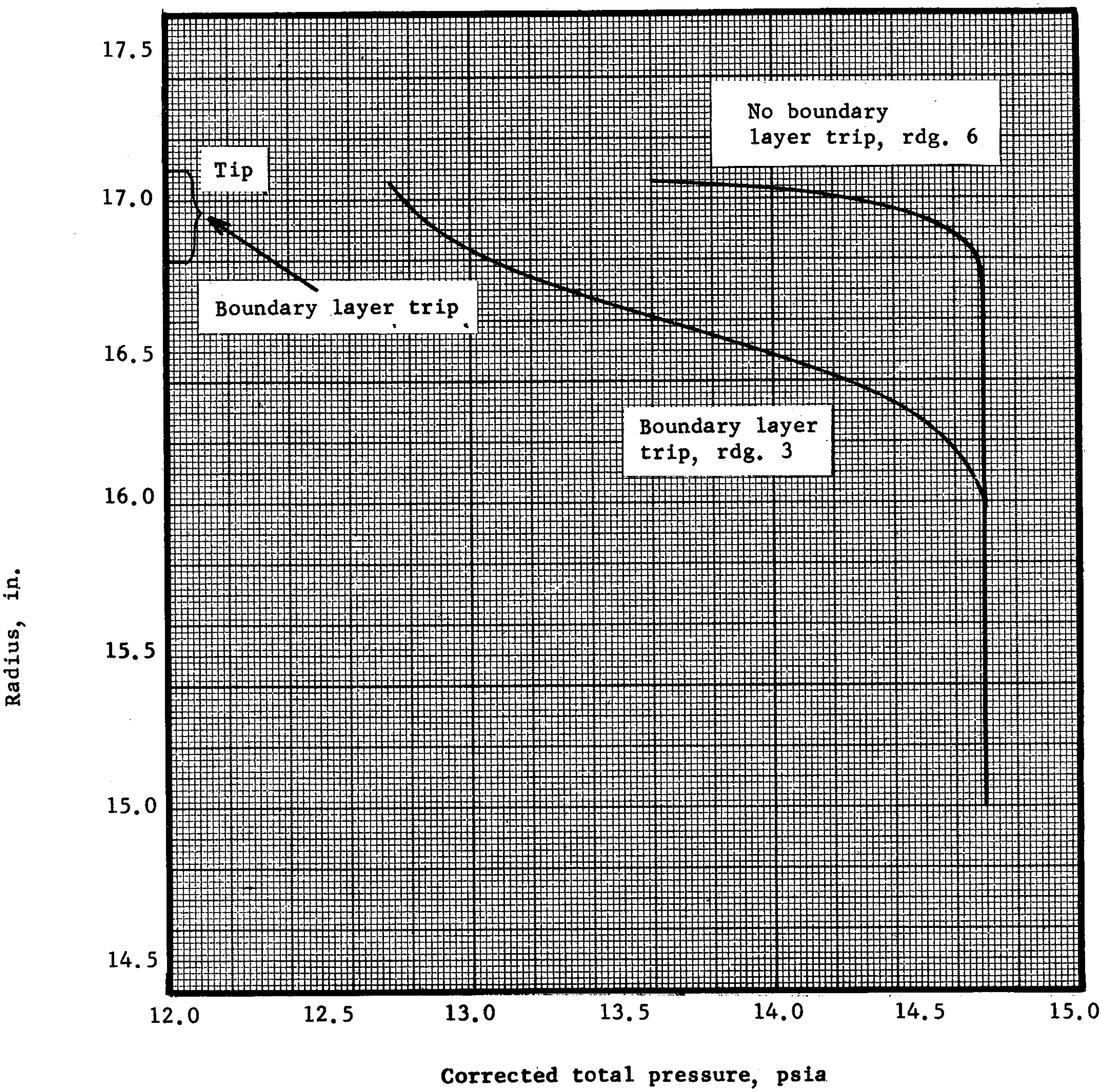


Figure 17 - Inlet boundary layers at plane 0.65

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