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NASA CR-54566
JUNE 1968
Allison EDR 5759

Single-Stage Experimental Evaluation of Boundary Layer Blowing Techniques for High Lift Stator Blades

III — Data and Performance of Single-Slotted 0.65 Hub Diffusion Factor Stator

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Contract NAS3-7619

FACILITY FORM 602
N69-11526 (ACCESSION NUMBER)
(THRU)
130 (PAGES)
(CODE)
CR-54566 (NASA CR OR TMX OR AD NUMBER)
01 (CATEGORY)



Allison Division • General Motors

Indianapolis, Indiana

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M. L. Miller and G. Seren

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ABSTRACT

The test described in this report is part of an overall program to establish experimentally the extent to which it is feasible to increase compressor stator loading and stall-free flow margin by employing suction surface boundary layer blowing techniques. A secondary objective was to obtain blade element data for design use.

In this test, overall and blade element performance of a row of 0.65 diffusion factor single-slotted stators with self-energized blowing boundary layer control was measured. In addition, the vane static pressure distribution was obtained at three radial locations. Overall and blade element performance was also obtained for the rotor and compared to data previously obtained for this rotor without stator vanes. Preliminary discussion of test results and correlations of data are presented.

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SINGLE-STAGE EXPERIMENTAL EVALUATION OF BOUNDARY LAYER BLOWING TECHNIQUES FOR HIGH LIFT STATOR BLADES

III—DATA AND PERFORMANCE OF SINGLE SLOTTED 0.65 HUB DIFFUSION FACTOR STATOR

By

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SUMMARY

To establish the feasibility of increasing compressor stator loading and stall-free flow margin by the use of a boundary layer blowing technique and to determine the extent to which such concepts may be employed, an investigation was made of a single-stage compressor provided with a single-slotted stator row. The stator was designed with NACA 65-series airfoils and a hub diffusion factor of 0.65.

The single blowing slot was designed to reenergize the boundary layer air on the suction surface with the slot located at about 42% chord. For this purpose, the air is inducted into the vane core through a full-span slot near the leading edge of the vane pressure surface and is discharged through a single full-span blowing slot upstream of the point on the suction surface where flow separation is estimated to take place on the unslotted vane. The orientation of the blowing slot relative to the suction surface is as nearly tangential as mechanically feasible. To ensure an attached stator end wall boundary layer and to minimize secondary flows, annulus wall bleeding was employed during all stator testing from a point forward of to a point behind the stator. The flow into this stator row was generated by a state-of-the-art flow generation rotor, with prewhirl established by a row of inlet guide vanes.

Overall performance of the rotor and inlet guide vanes was evaluated separately for this stage test. Compared with rotor design values of 1.37 pressure ratio, 88.2 lb/sec inlet flow, and 88.8% overall adiabatic efficiency, at design pressure ratio, the corrected inlet flow was 95.4 lb/sec with an adiabatic efficiency of 92.4%. In general, this performance was similar to the flow generation rotor performance without stators in Reference 1. Overall performance for the slotted stator stage had a pressure ratio of 1.323 at the 95.4 lb/sec airflow corresponding to the flow generation rotor design pressure ratio. Stage design values consisted of a 1.355 pressure ratio at 88.2 lb/sec flow rate.

Blade element performance was measured for the rotor blade and stator vane row. Experimental values are presented herein in terms of diffusion factor, deviation angle, and loss coefficient as a function of incidence for various annulus heights with rotative speed as a parameter. Minimum loss values are compared with the NACA loss parameter versus diffusion factor correlation curves. Radial variations of the experimental rotor and stator blade element performance near their design inlet flow conditions are also compared to the design values.

A hysteresis test with acquisition of rotating stall characteristics was also obtained at 60% corrected speed for the slotted stator stage. Hysteresis effects for the slotted stator stage could exist; however, the data recorded were insufficient to establish any existence. Onset of stall was found to be abrupt at all speeds with stall cells first appearing in the hub region.

The single-slotted blowing 0.65 diffusion factor stator performance did not meet the design flow turning values at the end walls and had total pressure losses higher than expected at these high loadings. Blade element performance loss correlations for these stators at the end wall were above an extension of the existing NACA correlations.

Surface pressure distribution and wake surveys were obtained for the slotted stator.

Suction surface static pressure distributions indicated a boundary layer separation at 55 to 70% chord throughout the entire range of tests. The pressure distributions did not indicate boundary layer reattachment. The deviation angles tend to confirm the flow separation but the loss coefficients do not.

The experimental flow rates through the blowing slots at the suction surface of the slotted stators were found to be approximately 45% of the design values at 100% corrected speed.

INTRODUCTION

Advanced airbreathing propulsion systems require lightweight compact compressors capable of high levels of performance. These compressors should have a broad range of operation and a large stall margin. High reliability and relative insensitivity to inlet flow distortion are generally required of all compressors. In meeting the more demanding compressor design requirements, compromises must be made that are strongly dependent on the particular application. New applications are steadily increasing the range of requirements which the compressor must meet.

Compressor technology has been advanced by extending, among other parameters, the usable rotational speeds, by increasing stage loadings or diffusion factors, and by reducing stage length through the use of high blade aspect ratios. Whereas, further advancements can be made through optimizations and improved combinations of these parameters; severe aerodynamic limitations such as increasing losses and decreased stall margin are being encountered. Significant advancements in compressor technology require the application of advanced concepts in terms of improved blading for high flow Mach numbers and application of high lift devices to extend the stall-free flow range for compressor rotors and stators. Advanced concepts in these areas may result in sizable reductions in the number of compressor stages and improved compressor performance.

Airfoils, designed to provide high lift, experience steep blade surface pressure gradients which become steeper as the angle of incidence is increased. As a result, the suction surface boundary layer separates, resulting in high total pressure losses and a decrease in stall-free flow margin. To some extent, however, separation of the suction surface boundary layer can be delayed by energizing it with high energy air. In view of these considerations, an experimental single-stage compressor rig was designed and constructed to test highly loaded stators using internal blowing concepts to reduce losses and to improve stall-free flow margin.

The objectives of this program are to establish experimentally the feasibility of increasing blade loading and stall-free flow margin by boundary layer blowing and the extent to which it may be employed. A secondary objective is to obtain blade element data for design use. The stator designs were to be representative of those for middle and latter stages of highly loaded axial-flow compressors. Stator inlet flow was to be generated by a state-of-the-art flow generation rotor. This report presents the test results for the single-slot 0.65 hub diffusion factor stator. Previous test results on the flow generation rotor performance, the mid-span suction surface pressure distribution for an unslotted 0.75 hub diffusion factor stator, and the single-slot 0.75 hub diffusion factor stator performance are presented in Reference 1.

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SYMBOLS

A_a	Annulus area, ft^2
c	Airfoil chord, in.
C_W	Flow coefficient
D_f	Diffusion factor
g	Gravitational constant, 32.2 ft-lb_m/lb_f-sec^2
H	Hysteresis loop data point
h	Height of blowing slot, in.
i	Incidence angle based on mean camber line, degrees
L	Net slot length
M	Mach number
$\dot{m}$	Blowing mass flow rate in blowing slot per blade, lb_m/sec
n	Number of blades per row
N	Rotational speed, rpm
P_t	Total pressure, psia
p	Static pressure, psia
q	Dynamic pressure, psia
R	Radius, in.
$\mathcal{R}$	Gas constant, 53.35 lb_f-ft/lb_m-°R
R_c	Pressure ratio
S	Airfoil surface pressure coefficient, Equation (A13)
T_t	Total temperature, °R
t	Static temperature, °R
t/c	Thickness-to-chord ratio

V	Air velocity, ft/sec
W_a	Compressor airflow, lb_m/sec
W_{BL}	Annulus wall bleed flow, lb_m/sec
x	Distance from blade leading edge, in.

Greek

β	Air angle measured from axial direction, degrees
γ	Ratio of specific heats
γ°	Blade chord angle, degrees
δ	Ratio of total pressure to standard sea level pressure of 2116.2 psfa
δ°	Deviation angle, degrees
Δ	Incremental value
η	Efficiency
θ	Ratio of total temperature to standard sea level temperature of 518.6°R
κ	Blade metal angle measured from axial direction, degrees
ρ	Density, lb_m/ft^3
ψ	Slot angle with respect to chord
σ	Blade row solidity
ϕ	Camber angle, degrees
ω	Angular velocity of rotor, radians/sec
$\bar{\omega}$	Total pressure loss coefficient
$\bar{\omega} \cos \beta / 2\sigma$	Loss parameter

Subscripts

0	Guide vane inlet
1	Rotor inlet
2	Stator inlet or rotor exit
3	Stator exit
θ	Tangential direction
ma	Mass averaged
ad	Adiabatic
m	Mean or 50% streamline
z	Axial direction

Superscripts

'	Relative value, rotor property

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APPARATUS AND PROCEDURES

TEST FACILITY

A general arrangement of the test facility is shown in Figure 1. Air enters the test compressor after passing through the test facility filter house, an inlet duct, plenum, and bell-mouth and is exhausted to atmosphere through a diffuser. Provisions exist for maintaining compressor inlet pressures above or below atmospheric if necessary.

Two power units can be used simultaneously to drive the test compressor. One is a T56 power turbine with combustors which burn fuel mixed with high pressure air from test facility compressors; the other is a complete T56 power section. The two units are coupled by a primary gearbox whose output shaft drives a secondary gearbox which in turn drives the test compressor. Control of the test compressor speed is effected by throttling the turbine air supply with a hydraulically-operated valve and by independent fuel controls for each unit.

COMPRESSOR TEST RIG

The mechanical arrangement of the test compressor is shown in Figure 2. It consists of a cylindrical inlet section, the test compressor section, and an exhaust diffuser. The single-stage rotor is supported on two bearings whose housings are linked by a vertically-split compressor case. The compressor case houses the inlet guide vanes, the rotor tip abradable coating, the stator vanes, and the case and hub bleed manifolds. The design of the rig allows the rapid exchange of inlet guide vanes, if necessary, without dismantling the remainder of the compressor, and the exchange of stator vanes without disassembly of the entire test rig.

Airflow rate and pressure ratio are varied by throttle plates located in the exhaust diffuser. The throttles are linked by a ring and operated by a common actuator.

Provision is made in the rig for bleeding the wall boundary layers at stator tip and hub. This is accomplished by fabricating the stator flow passage walls from perforated sheet metal. Manifolds behind the perforated metal surfaces are connected by multiple tubes to separate vacuum headers for tip and hub wall bleeds.

BLADING

The design of the stator vanes, rotor blade, and design inlet guide vanes is described in detail in Reference 2. Selected types of airfoil sections are: (1) 63-006 series for the inlet guide vanes, (2) double circular arc for the

rotor blade, and (3) 65-series thickness distribution with circular arc mean-line for the stator vane. For convenience, the principal geometric details of these components are repeated in Table I. Only the design inlet guide vanes (Reference 2) were used in this test. Basic details of the slot configuration of the single-slotted 0.65 diffusion factor stator are shown in Figure 3.

INSTRUMENTATION

Instrumentation was provided to obtain blade element performance for the rotor and stator row and to measure overall performance. The locations of instrumentation planes are shown in Figure 4, while Figure 5 shows schematically the circumferential location of the instruments installed at each plane. The radial element locations at each plane were selected along streamlines passing through the 10, 30, 50, 70, and 90% annulus height stations from the tip at the stator inlet measurement plane. The streamline locations are shown schematically in Figure 6. Dimensional sketches of the probes used are shown in Figure 7. Instrumentation was distributed to minimize area blockage and prevent immersion in upstream instrument wakes. Duplicate instrumentation was distributed to average out any inlet guide vane effects.

Compressor Inlet Conditions

Weight flow was measured with an ASME thin plate orifice located in each branch of the triple inlet header. Six total pressure probes and two 6-element temperature rakes were located in the cylindrical section 3 ft upstream of the test compressor inlet to measure inlet total pressure and temperature. See Figure 5a. Inlet static pressure was measured at the same axial station by two static taps in the inlet wall.

Rotor Inlet—Station 1

Four approximately equally spaced static pressure taps were located on both the inner and outer walls as shown in Figure 5b. An 8-degree wedge static pressure traverse probe was also installed to measure the radial static pressure distribution. Three radial traverse combination total pressure and yaw angle probes were used to measure the distribution of these parameters across the annulus. Total temperature was obtained from plenum thermocouples.

Stator Inlet or Rotor Exit—Station 2

Four approximately equally spaced static pressure taps were located on both the inner and outer walls, and the radial distribution of static pressure was measured by two 8-degree wedge static pressure traverse probes as shown in Figure 5c. Three radial traverse combination probes were installed at this station to measure the radial distribution of total pressure, total temperature, and flow angle.

Stator Exit—Station 3

Four approximately equally spaced static pressure taps were located on both inner and outer walls and two 8-degree wedge traverse probes were installed to measure the radial static pressure distribution as shown in Figure 5d. One traverse combination total pressure, total temperature, and yaw probe was installed primarily to measure flow angle. A 16-element total pressure circumferential rake, shown in Figure 7d, was installed at this station to measure discharge total pressure and stator vane wake. This rake spanned 1.08 vane spaces at the 10% streamline and 1.43 vane spaces at the 90% streamline. Total temperature was measured by four 5-element radial rakes. Inner and outer wall boundary layers were surveyed by fixed 5-element total pressure probes. All taps, probes, and radial rakes were located on extensions of mid-channel streamlines.

Special Instrumentation

In addition to the instrumentation previously enumerated for blade element and overall performance, the following special instrumentation was installed. At the rotor exit, two fixed and one traverse hot wire anemometers were installed to signal the onset of compressor stall and to provide rotating stall data. Shaft whip was monitored by means of a whip pickup mounted in the plane of the rotor blades, and strain gages were mounted on eight rotor blades to monitor blade stresses.

The 10, 50, and 90% streamline sections of the slotted vanes were each provided with 11 suction surface and 7 pressure surface static pressure taps as indicated in Figure 8. One blowing discharge slot static tap and one core static pressure tap were provided at each section to measure blowing flow rate. The 20 static pressure taps for each streamline section were distributed among 4 vanes.

DETERMINATION OF ANNULUS WALL BLEED FLOW FOR STATOR VANE TESTS

With the compressor operating at design speed and stage pressure ratio, the circumferential total pressure rake at the stator exit was set at the streamline station 10% from the tip. Hub and tip wall bleeds were set at a nominal flow of less than 1% of compressor flow. The stator wake pattern at this bleed flow was noted, and the tip wall bleed was then increased until no further improvement in wake pattern was visually observed on a manometer bank. This bleed flow rate was defined as the "optimum" bleed rate. One limiting consideration set as a reasonable upper value, however, was to extract no more than 2.5% of the compressor inlet flow per wall at design conditions.

The circumferential rake was then set at the streamline station 90% from the tip. The tip wall bleed flow rate was reset at its original low value, and the procedure described was repeated for the hub bleed.

After hub and outer wall bleed flows were optimized, the circumferential rake was moved to the mean position. Hub and outer wall bleeds were varied simultaneously in increments from the original nominal flow rate to optimum flow. The effects on the stator wake at mean depth were studied to check that optimum hub and tip wall bleeds coincided with an optimum wake at mid-span. The valve settings for these optimum bleed flow rates were left unchanged for all subsequent speed and flow conditions.

HYSTERESIS TEST WITH SLOTTED 0.65 HUB DIFFUSION FACTOR STATOR

The following method was employed to determine the characteristics of this stage at entry to and when recovering from stall. With corrected speed set at 60%, the throttle was closed until stall cells were indicated by the three hot-wire anemometers (two of which were at the 10% and one at the 90% station from the tip) thus signalling the onset of stall. At this stalled condition (taken as the first hysteresis data point setting), a partial data recording, which consisted of data required for airflow and pressure ratio calculation, was obtained. The throttle was then closed further and a second partial data recording was made at an intermediate point. With further throttle closure the stage pressure ratio reached a minimum value and a third partial data recording was obtained. The throttle was then gradually opened in steps and a fourth partial recording was made, again at an intermediate point. When indications of stall, as signalled by the hot-wire anemometers, disappeared a fifth short data cycle was recorded.

Rotor blade stresses were monitored continuously during the hysteresis test to ensure that excessive vibratory stresses were not encountered.

OVERALL AND BLADE ELEMENT PERFORMANCE DATA

Overall and blade element performance data were obtained at a sufficient number of points per speed line to define rotor or stage performance between choke and stall. The near-stall test point was taken as close to the rotating stall condition as could be set without actually being in rotating stall. This type of near-stall setting permitted a full data point recording. The stage stall point is defined as the onset of a steady stall cell indication on the hot-wire anemometers. At each full data point, fixed and traverse pressure and temperature data were recorded at five radial locations corresponding to streamlines passing through the 10, 30, 50, 70, and 90% span stations at the stator inlet measurement plane.

DATA REDUCTION

Overall performance and blade element data reduction is accomplished in one program. A second program is used to calculate pressure coefficients and slot blowing flow rates for the stator vanes.

In the first program, raw data from the test stand is read in and printed. The program converts wedge probe static pressure transducer readings to inches of mercury absolute and applies a Mach number correction. All yaw units are converted to degrees. Data recording system, wire calibration, and Mach number corrections are applied to all temperatures. Pressures recorded on the data recording system are corrected to standard inlet total pressure. The corrected data is then printed.

Circumferential arithmetic averages of total pressures, static pressures, total temperatures, and yaw angles are calculated and printed. Individual data readings were compared with the averages to validate the data. Any individual reading which differs by more than a prescribed deviation (0.5 in. Hg for pressures, 3 degrees for yaw angles, 1.5°R, 2°R, and 3°R, respectively, for reference, inlet, and all other temperatures) is not used in the final calculations. Mass-averaged values required for performance calculations are determined.

The program provides a choice of two radial distributions of static pressure: (1) distributions measured by the wedge probes and (2) a linear distribution across the flow annulus calculated from the arithmetically-averaged hub and case wall static pressure taps. Overall and blade element performance are calculated and printed using the two static pressure distributions previously mentioned. If a continuity check at any data measurement station is not satisfied within 5%, a simple radial equilibrium solution is provided to give an indication of the problem.

Overall performance values are calculated for the inlet guide vane and rotor and for the complete stage. The following operations were performed to determine these values.

At the inlet plenum station, two total temperatures are arithmetically averaged at each radial station. Mass flow is integrated radially, assuming that averaged wall static pressure exists over the entire cross section. Total pressure and temperature are then mass-averaged. Behind the rotor, all total pressures, total temperatures, and wall statics are arithmetically averaged circumferentially at each radial station. Mass flow is radially integrated and total pressures and temperatures are mass averaged.

At the stator exit, four total temperatures are arithmetically averaged circumferentially at each radial station. Mass flow is computed using an arithmetic average of the circumferential rake total pressure readings spanning a stator vane passage at each radial station. A radial integration is made for weight flow. For performance calculations, the total pressures at each radial station are mass averaged circumferentially and the total pressures and temperatures are mass averaged radially. The overall pressure ratio and efficiencies are obtained using the radially mass averaged values of total pressure and temperature.

The calculation of performance variables, as programmed in the data reduction programs, are delineated in the Appendix.

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PRESENTATION OF RESULTS

Experimental results obtained during the test program are summarized for the single-slotted 0.65 hub diffusion factor stator vane and flow generation rotor and the design inlet guide vane set. The reduced data presented were based on a linear static pressure distribution across the annulus at each axial survey station rather than on the static wedge survey values. Comparison of results using both linear and wedge static data (Reference 1) showed that, when the wedge data were considered reliable, differences in reduced data were small; there was a tendency, however, for the wedge static data to be erratic for some test points. Use of the linear static data gives a consistent basis for comparison over the test range and with the data from other tests.

OVERALL PERFORMANCE OF FLOW GENERATION ROTOR AND STAGE

Overall pressure ratio and adiabatic efficiency are each plotted versus corrected inlet flow with corrected speed as a parameter. Figures 9 and 10 present data for the flow generation rotor during this stage test, and Figures 11 and 12 present data for the stage.

To indicate whether the rotor or the single-slotted stator caused the stage to choke or stall, rotor incidence range is summarized in Table II for the flow generation rotor test of Reference 1 and the flow generation rotor of the single-slotted 0.65 D_f stator stage test. Stage rotating stall characteristics at the single-slotted stall points and hysteresis points are summarized in Table III.

BLADE ELEMENT PERFORMANCE

Rotor blade and stator vane blade element characteristics were computed on the five streamline positions previously defined. The blade element characteristics chosen to present the detailed performance of each blade row are listed as follows:

Incidence angle, i
Total pressure loss coefficient, $\bar{\omega}'$ or $\bar{\omega}$
Diffusion factor, D_f
Deviation angle, $\delta°$
Inlet flow angle, β' or β
Flow turning, $\Delta\beta'$ or $\Delta\beta$
Inlet axial velocity, V_z
Inlet Mach number, M' or M

Rotor blade element data are plotted as a function of incidence with corrected speed as a parameter for each of the streamline stations. The blade element data obtained during the stage test are shown in Figure 13. For comparison and to aid the analysis of the rotor blade performance, blade element data for the rotor blade are plotted versus percent annulus height in Figure 14 for the flow, providing the best approximation of the design incidence angle at design speed. Design values are also plotted for comparison. Mass flux distribution out of the rotor corresponding to the design flow rate is plotted and compared with the design flow distribution in Figure 15. Rotor blade element performance is evaluated in Figure 16 by comparing the loss parameter versus diffusion factor at the 10, 50, and 90% streamline stations from the tip with the NACA correlation curve from Reference 3.

Stator vane blade element data are also plotted as a function of incidence with corrected speed as a parameter for each streamline station. The blade element data for the single-slotted stator are plotted in Figure 17. The annulus wall bleed rates and the single-slotted stator slot blowing flow rates are also presented in Figures 18 through 20. Blade element data of the slotted stator vane for conditions nearest the design incidence angle are plotted against the percent annulus height in Figure 21 to aid stator vane performance analysis and comparison. Stator vane blade element performance is also presented in Figure 22 where the loss parameter versus diffusion factor for 10, 50, and 90% streamline stations from tip is compared with the NACA correlation curve from Reference 3.

The slotted stator static pressure distributions are presented in Figures 23 through 27 for all the speed lines. The wake surveys of the slotted stator tests are plotted in Figure 28. The variation of the stator wake during wall bleed optimization is presented in Figure 29.

To enable compressor designers to evaluate and apply the results of this test, a detailed summary of vector diagrams, blade element characteristics, and loss data at each streamline station is provided. These summaries are presented in Table IV.

DISCUSSION OF RESULTS

The method of presentation using the overall and blade element parameters for evaluating the performance are described in detail. Since the figures and tables are self explanatory, only general observations are made.

OVERALL PERFORMANCE

Flow Generation Rotor

Flow generation rotor pressure ratio and adiabatic efficiency with the design inlet guide vanes are shown in Figures 9 and 10. The adiabatic efficiency was based on the mass averaged temperature measured by the stator vane exit station radial temperature rakes.

In general, the performance data for the flow generation rotor from this stage test agreed favorably with the data obtained from the flow generation rotor test of Reference 1. The design point pressure ratio and efficiency are 1.365 and 88.8%, respectively, at a design flow rate of 88.2 lb/sec with the design inlet guide vanes. At the design equivalent rotor speed, maximum efficiency was 94% with a corresponding pressure ratio of 1.445 and a flow rate of 89 lb/sec. At the design pressure ratio of 1.365, the flow rate was 8.4% higher than design at 95.6 lb/sec and the adiabatic efficiency was 92.4%. The excess flow was attributed to the effective overcambering of the blades as evidenced by the measured deviation angles compared to the design deviation angles discussed in Reference 1.

Flow generation rotor pressure ratio and adiabatic efficiency with the design inlet guide vanes and no stators are shown in Figures 10 and 11 of Reference 1. The pressure-ratio results are in good agreement with the rotor test results without stator vanes. When the maximum values of the adiabatic efficiencies are examined at 100% corrected speed, a value of 94.0% is obtained from the results of the stage test (Figure 10) compared with 92.5% from the flow generation rotor test. Both values were taken at the same measured airflow rate. Since the accuracy of the thermocouple is $\pm$ 0.75°F, the possible error in the adiabatic efficiency, corresponding to a pressure ratio of 1.4, would be $\pm$ 1.2%. The values of the adiabatic efficiencies should, therefore, be considered to compare favorably within the limits of experimental accuracy.

A prime concern during the design phase of the flow generation rotor discussed in Reference 2 was that sufficient flow range would be available to avoid excessive limitations on the stator operating range by the rotor or facility. Table II gives a summary of rotor incidence angles near stall and choke at hub, mean, and tip streamlines. The stall incidence angles correspond to the minimum flow rate because of rotor or stator stall. The choke incidence angles correspond to the maximum flow rate because of rotor choke, stator choke, or facility pressure loss limitations.

Rotor incidence angle differences at stall observed between slotted stator test and flow generation rotor test of Reference 1 are small, and stage stall may be primarily caused by rotor stall rather than stator stall. The comparison of incidence angles at maximum flows indicates that the stator limited the maximum flow at 60 and 80% corrected speed. At 100% corrected speed, the approximately equal rotor incidence angles for both tests indicate that either the rotor or stator are choked at nearly the same flow or the facility pressure loss was controlling. It is believed that the facility exit duct pressure loss was controlling at these relatively low pressure ratios with high flow rate conditions.

Single-Slotted Stator Stage

The overall stage pressure ratio and adiabatic efficiency are shown in Figures 11 and 12, respectively. During these tests, only the design inlet guide vanes were employed.

Stage design pressure ratio and adiabatic efficiency are, as indicated in Reference 2, 1.355 and 86.4% at a design flow rate of 88.2 lb/sec. At the design equivalent rotor speed, a maximum stage adiabatic efficiency of 85.5% was obtained with a pressure ratio of 1.38 and a flow rate of 91.0 lb/sec. At the flow generation rotor condition of 95.4 lb/sec corrected flow rate, the stage pressure ratio was 1.328 and the adiabatic efficiency was 83.4%. For simplicity, the stage adiabatic efficiency, presented herein, is not penalized by the case and hub wall bleed flows. Since the rotor loading is not compatible with the stator loading, the stage efficiency is of secondary interest.

The design average total pressure recovery of the slotted stator is 0.989 (1.355/1.37) and the measured "design" total pressure recovery is 0.970 (1.328/1.37). Since the stator inlet flow conditions are equivalent to a 1.45 pressure ratio rotor without inlet guide vanes, the stage efficiency of 83.4% would be increased by 1.5-2.0 points because of the additional work with the same average pressure recovery of 0.970 and rotor efficiency of 92.4%.

Annulus Wall Bleed for Stator Test

Annulus wall bleed over the stator row at tip and hub surface was defined at 100% corrected speed and rotor pressure ratio of 1.37 by monitoring visually the circumferential rake and boundary layer total pressure rakes at tip

and hub. Except at very low wall bleed flows of about 0.5% where stator wakes are relatively large, the boundary layer total pressure rakes indicated an attached boundary layer—total pressures increased away from the wall. Once the wall boundary layer was attached, additional wall bleed essentially affected only the 10 and 90% streamline stator wakes. When the stator wake reduction showed negligible improvement with increased wall bleeds, the tip and hub bleed values were held fixed throughout all remaining test points. The optimized hub and tip bleed values at the reference operating point were 1.83 and 1.79%, respectively.

The tip and hub wall bleed rates experienced throughout this test with the fixed bleed line valve settings are summarized in Figure 18.

Hysteresis and Rotating Stall Results—Slotted Stator Stage

This test was made to determine whether the stall of this stage was gradual or abrupt, and whether the stall would disappear and the stage recover smoothly. The onset of rotating stall at each corrected speed is indicated by the hot-wire anemometer located at the 90% streamline. Rotor stall was abrupt at all speeds as indicated by stall zone progression to the tip of the rotor with only a slight increase in back pressure.

At 60% corrected speed, a five-point hysteresis loop test was conducted. The pressure ratio-flow rate points are shown in Figure 11. A hysteresis effect in terms of pressure ratio and flow rate was observed from measurements defining the path from point H_1 to H_5. The path from H_4 to H_5 could not be established from the recorded data.

The maximum transient blade stresses encountered during the hysteresis test were 15,200 psi.

There were indications, from the frequent recurrence of stress peaks, that these maximum transient stresses prevailed for a significant period during the hysteresis test. This made the determination of steady-state values difficult. The blade stresses experienced were also considered to be at a potentially damaging level.

Rotating stall results in terms of rotative speed, frequency, and number of stall zones are summarized in Table III. Following the onset of stall, one stall zone was recorded in both the hub and tip regions. The rotative speeds of the cells in both span regions ranged from 26 to 42% rotor speed in the direction of rotation, with frequencies varying from 30 to 52 cps, depending on the corrected speeds run. In deep stall, rotative speed was approximately 36% rotor speed in the direction of rotation with a frequency of 30 cps. High rotor blade transient stresses prevented radial traversing of the hot-wire probe. It appears, however, that the stall zone extended across the blade span.

BLADE ELEMENT PERFORMANCE

An extensive study of the inlet guide vanes, both at design and off design conditions, was made as reported in Reference 1. Investigation into the possible persistence of the inlet guide vane wakes through the rotor at the design flow rate condition indicated the attenuation of these wakes before entering the stator rows. Because of these results, repeated study of inlet guide vane flow for each test was found unnecessary.

Rotor

Diffusion factor, deviation angle, and loss coefficient data throughout the rotor operating range for the slotted stator stage test are summarized in Figure 13. In general, the measured loss coefficients are found to be about equal to design values at the 0-degree design incidence value at the 50, 70, and 90% streamline stations and are less than design values at the 10 and 30% streamline stations.

Primary rotor blade element performance for the double circular arc blade during the stator test is sh wn in Figure 14. Rotor blade measured data for both the flow generation rotor and slotted stator stage tests operating near the design incidence angle at corrected speed are compared to the design values. The selection of measured data was based on the best agreement with the design incidence angle values, since the rotor exceeded its design pressure ratio. In general, the measured and design values of the incidence angle compare favorably.

Significant differences occur in the deviation angle and diffusion factor as also evidenced in Reference 1. The effect of lower than design deviation angle results in an effective overcambering of the rotor blade, providing more work into the flow. The combination of higher work input and lower axial exit velocity results in the higher than design values of diffusion factors.

The radial distribution of mass flux at the rotor outlet for the flow generation rotor and slotted stator stage test are compared to the design values in Figure 15. A flow shift to the tip occurred experimentally with respect to the design distribution. This can be attributed to the low deviation angles in the tip region of the rotor. An additional mass flow shift was observed between the measured test values of the flow generation rotor test (Reference 1) and the 0.65 diffusion factor slotted stator stage test. This additional mass flow shift at the rotor outlet could be due to an effective blockage in the hub region caused by the separation of the boundary layer at the stator suction surface, inducing a secondary flow and end wall effects. The stator exit hub wall boundary layer rake, however, did not indicate any wall boundary layer separation.

Rotor loss parameter data at the 10, 50, and 90% streamlines are shown in Figure 16. Minimum loss coefficient values are indicated as filled symbols when they could be defined. The minimum values are selected as the data point nearest to the minimum value of the curve drawn through data points in Figure 13. Minimum loss data for the tip region or 10% streamline are found to lie on the lower band of the data scatter. Loss data for the mid-span and hub region are found to agree well with the NACA correlation curves.

Stator

Measured results of lower flow turning and greater losses than design values are shown in Figure 17, presenting diffusion factor, deviation angle, and loss coefficient over the entire test operating range for a given annulus height. A study of these results also indicates that the choke or minimum incidence angle limit may not be clearly defined except at the 90% streamline. Further study also shows, however, that the loss coefficient versus incidence angle curve is quite flat over a wide range except at the 90% streamline height. It is indicated that the operating range of this stator with self-energized boundary layer control is comparable to the operating range of the stator reported in Reference 1.

The radial variation of blade element data for the slotted stator near the design incidence angles is compared with the design values in Figure 21. Inlet axial velocity and incidence angle plots of this figure indicate a mass flow shift with respect to the design value. Other significant results, as shown in Figure 21, are that flow turning was less than expected or deviation angles were greater than design values over the entire span of the blades, with an especially high value at the tip. This deviation angle result is contrary to measured deviation angles for the single-slot 0.75 diffusion factor stator of Reference 1. Measured losses were found to be greater than the design values.

Loss parameter values calculated from the data of Figure 17 are compared with the NACA loss parameter versus diffusion factor correlation (Reference 3) in Figure 22 for the 10, 50, and 90% streamlines from the tip. The minimum loss values (filled symbols) for the 0.65 hub diffusion factor slotted stator for each streamline are generally in reasonable agreement with an extension of the NACA correlation. Comparing these data with 0.75 hub diffusion factor single-slotted blowing stator results (Reference 1) indicates that within experimental accuracy the present correlation curves are satisfactory for this type airfoil. The flow turning and loss performance of this stator, however, are not as good as the apparent performance of the single-slotted 0.75 hub diffusion factor stator reported in Reference 1.

Typical slotted stator wake distributions are shown in Figure 28. Figures 28d through 28h illustrate the effects of incidence angle at an inlet Mach number near 0.7. The wake surveys at high positive incidence angles in Figures 28g and 28h show that the hub region is experiencing a strong secondary flow or wall effect as indicated by the relatively low total pressures at rake elements 12 and 13. Also, the low pressures indicated by elements 5 through 8 obtained at the 90% streamline may be caused by flow separation at the wall in the hub region.

Wake survey data were recorded during the wall bleed optimization runs at a design stage pressure ratio of 1.355 and 100% corrected speed. The effect of reduced stator losses with increasing wall bleed rate is shown in Figure 29. Increased wall bleed reduced the end wall region flow disturbances and stator losses at the tip. This indicates that wall bleed reduced the mass flow shift to the center and resulted in greater stator loading due to reduced outlet velocities near midspan. Higher wall bleed rates above the 30- and 29-in. H_2O orifice pressure differential at tip and hub, respectively, had little effect on increasing wake total pressure at these depth locations.

Stator Static Pressure Distributions

Suction surface static pressure distributions for the slotted stator indicate a boundary layer separation at 55 to 70% chord throughout the entire range of tests as shown in Figures 23 through 27. The blowing slot was located at 42.0% chord. The pressure distribution did not indicate boundary layer reattachment. The deviation angles tend to confirm flow separation, but the loss coefficients do not.

Stator Slot Blowing Flow

The variation of slot blowing flow along the span of the stator is given in Figure 20. The test point representing design incidence angle at each corrected speed was selected to give the best approximation over the blade span. Experimental flow rates are found to be about 45% of the design values at 100% corrected speed. This deficiency in the blowing flow rate may have been one of the factors causing the relatively poor performance of the slotted stator. The flow rates are calculated from a measured static pressure in the core of the stator which was assumed equal to the core total pressure, and a static tap located in the slot. Design values for the hub, mean, and tip section slots (i.e., separated by slot bridges) taken as an average for each slot section are 0.00604, 0.00558, and 0.00517 $lb_m/sec\text{-}in.$, respectively. Experimental blowing flow spanwise gradients were greater than experienced on the 0.75 diffusion factor single-slotted stator test presented in Reference 1. Figure 20b shows that the variation in blowing rates from the value at design incidence to either test extreme on the speed line characteristics was within 25% of the value at design incidence.

CONCLUDING REMARKS

Discussion of the experimental results is based on analysis work completed to date. Considerably more effort is required in addition to the beneficial experience to be obtained on continuing stator tests before final conclusions can be drawn. Analysis of the data to date, however, indicates the following points.

- The overall performance of the flow generation rotor in this stage test agreed well with the performance of the flow generation rotor without stators reported in Reference 1. At the flow rate corresponding to the flow generation rotor design pressure ratio, the stage pressure ratio was lower than the design value.
- The performance of the single-slotted 0.65 hub diffusion factor stators in flow turning and total pressure loss was not as good as the single-slotted 0.75 hub diffusion factor stator. The deviation angles were greater than the design, and the losses were higher at the hub and tip regions.
- A hysteresis effect in terms of pressure ratio and flow rate was indicated. The data recorded, however, were insufficient to establish this with certainty. The onset of stall was abrupt with stall cells first appearing in the hub region and extending throughout the span.
- Rotor blade stresses exceeded the prescribed steady-state limit but remained below the transient limit during the hysteresis and stall point tests. The occurrence of stress peaks during stall point tests prevented the determination of steady-state values at these points.
- The results of the loss parameter versus diffusion factor curves were generally in good agreement with the extension of the NACA correlation curves.
- Based on the pressure distributions, boundary layer separation appeared to occur at 55 to 70% chord, indicating an inability on the part of the slots to effectively control the boundary layer. There was no indication of reattachment of the flow further downstream. The reason for this may be the location of the slot being placed too far downstream along the suction surface. The relatively poor performance of the stator may also be caused by the flow deficiency through the suction surface blowing slot.

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REFERENCES

1. Miller, M. L. and Beck, T. E. Single-Stage Experimental Evaluation of Boundary Layer Blowing Techniques for High Lift Stator Blades, II—Data and Performance of Flow Generation Rotor and Single-Slotted 0.75 Hub Diffusion Factor Stator. National Aeronautics and Space Administration. NASA CR-54565 (Allison Division EDR 5691). February 1968.

2. Chapman, D. C. and Miller, M. L. Single-Stage Experimental Evaluation of Boundary Layer Blowing Techniques for High Lift Stator Blades, I—Compressor Design. National Aeronautics and Space Administration. NASA CR-54564 (Allison Division EDR 5636). July 1967.

3. Aerodynamic Design of Axial Flow Compressors. NASA SP-36, 1965.

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APPENDIX

PERFORMANCE EQUATIONS

The following overall and blade element performance parameters were calculated for the analysis of test data and the evaluation of the slotted and unslotted stator performance.

WEIGHT FLOW

Overall performance is presented as a function of corrected weight flow, defined as

$$\frac{W_a\sqrt{\theta}}{\delta} \tag{A1}$$

ADIABATIC EFFICIENCY

Adiabatic efficiency for the inlet guide vane and rotor combination is

$$\eta_{ad_2} = \frac{\left[\left(\frac{P_{t_{2,ma}}}{P_{t_0}}\right)^{(\gamma-1)/\gamma} - 1\right]}{\frac{T_{t_{3,ma}}}{T_{t_0}} - 1} \tag{A2}$$

and for the guide vane, rotor and stator is

$$\eta_{ad_3} = \frac{\left[\left(\frac{P_{t_{3,ma}}}{P_{t_0}}\right)^{(\gamma-1)/\gamma} - 1\right]}{\frac{T_{t_{3,ma}}}{T_{t_0}} - 1} \tag{A3}$$

DIFFUSION FACTOR

For the rotor, diffusion factor is defined as

$$D_{f_2} = 1 - \frac{V_2'}{V_1'} + \frac{V_{\theta_2} - V_{\theta_1}}{2\sigma V_1'} \tag{A4}$$

and for the stator as

$$Df_3 = 1 - \frac{V_3}{V_2} + \frac{V_{\theta 2} - V_{\theta 3}}{2\sigma V_2} \qquad (A5)$$

These quantities are calculated using the appropriate velocity triangle values previously computed by the program.

DEVIATION ANGLE

Rotor blade deviation is defined as

$$\delta_2^\circ = \beta_2' - \kappa_2' \qquad (A6)$$

and stator deviation as

$$\delta_3^\circ = \beta_3 - \kappa_3 \qquad (A7)$$

where κ_2' is the rotor blade exit metal angle based on the mean camber line for a double circular arc airfoil and κ_3 is the stator vane exit metal angle based on the circular arc camber line for the 65-series airfoil.

INCIDENCE ANGLE

Rotor blade incidence is defined as

$$i_1' = \beta_1' - \kappa_1' \qquad (A8)$$

and stator incidence as

$$i_2 = \beta_2 - \kappa_2 \qquad (A9)$$

where κ_1' is the rotor blade inlet metal angle based on the mean camber line for a double-circular arc airfoil and κ_2 is the stator vane inlet metal angle based on the circular arc camber line.

TOTAL PRESSURE LOSS COEFFICIENT

Total pressure loss coefficient for the rotor is defined as

$$\bar{\omega}' = \frac{\left[1 + \frac{\gamma-1}{2}\frac{(\omega R_2)^2}{\gamma g \mathcal{R} T'_{t_1}}\left(1-\frac{R_1^2}{R_2^2}\right)\right]^{\gamma/(\gamma-1)}\left[1 - \frac{(P_{t_2}/P_{t_1})}{(T_{t_2}/T_{t_1})^{\gamma/(\gamma-1)}}\right]}{1 - \left[1 + \frac{\gamma-1}{2}(M'_1)^2\right]^{-\gamma/(\gamma-1)}} \tag{A10}$$

and for the inlet guide vane as

$$\bar{\omega} = \frac{1 - \frac{P_{t_1}}{P_{t_0}}}{1 - \left[1 + \frac{\gamma-1}{2}(M_0)^2\right]^{-\gamma/(\gamma-1)}} \tag{A11}$$

and stator as

$$\bar{\omega} = \frac{1 - \frac{P_{t_3}}{P_{t_2}}}{1 - \left[1 + \frac{\gamma-1}{2}(M_2)^2\right]^{-\gamma/(\gamma-1)}} \tag{A12}$$

PRESSURE COEFFICIENT

Pressure coefficient (S) is defined by

$$S = \frac{P_{t_2} - p}{q_2} \tag{A13}$$

where:

P_{t_2} = total pressure at stator inlet
p = static pressure at a given point on the vane surface
$q_2 = \frac{1}{2}\gamma\, p_2\, M_2^2$ = dynamic pressure at stator inlet

VANE BLOWING FLOW

Vane blowing flow per unit slot length is first calculated at each station at which surface static pressure taps exist and is defined as

$$\dot{m} = C_W \rho_{slot} h V_{slot} \quad \text{(A14)}$$

where:

C_W = slot flow coefficient = 0.82

$$\rho_{slot} = \frac{p_{slot}}{\mathcal{R} t_{slot}}$$

Slot flow conditions were based on stator inlet free stream total temperature, the core measured pressure taken as total pressure at the streamline in question, and the measured slot static pressure. The values obtained are used to calculate blowing flow through each segment of the slot and then total blowing flow taking account of the blockage introduced by the interruption between slot segments.

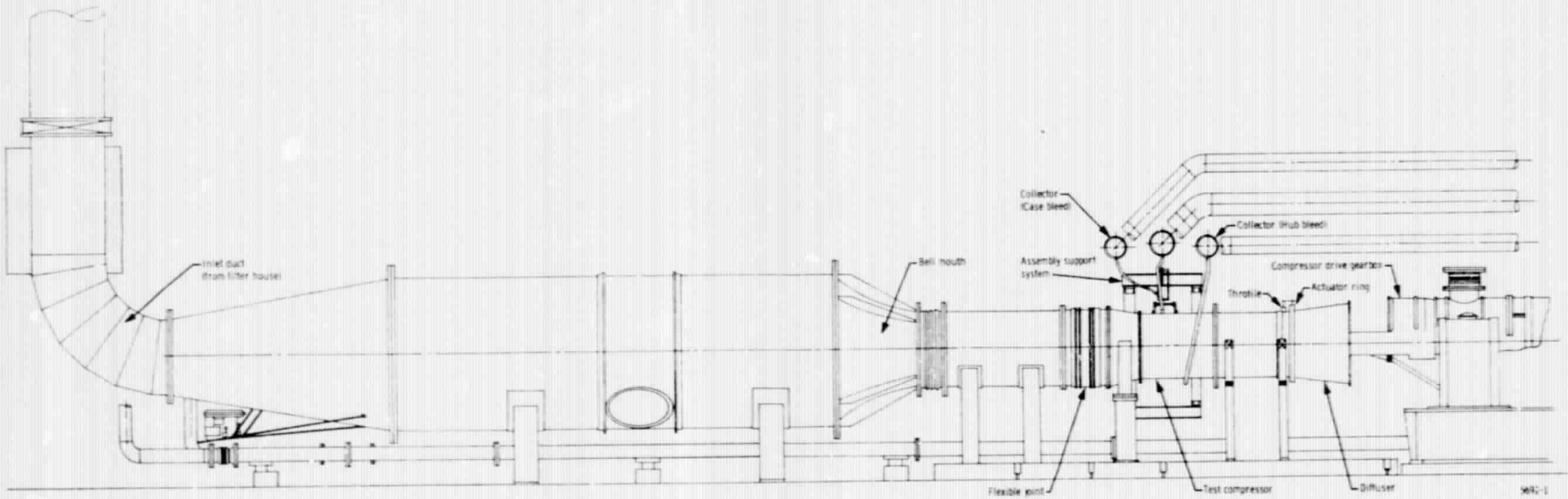


Figure 1. Compressor test facility.

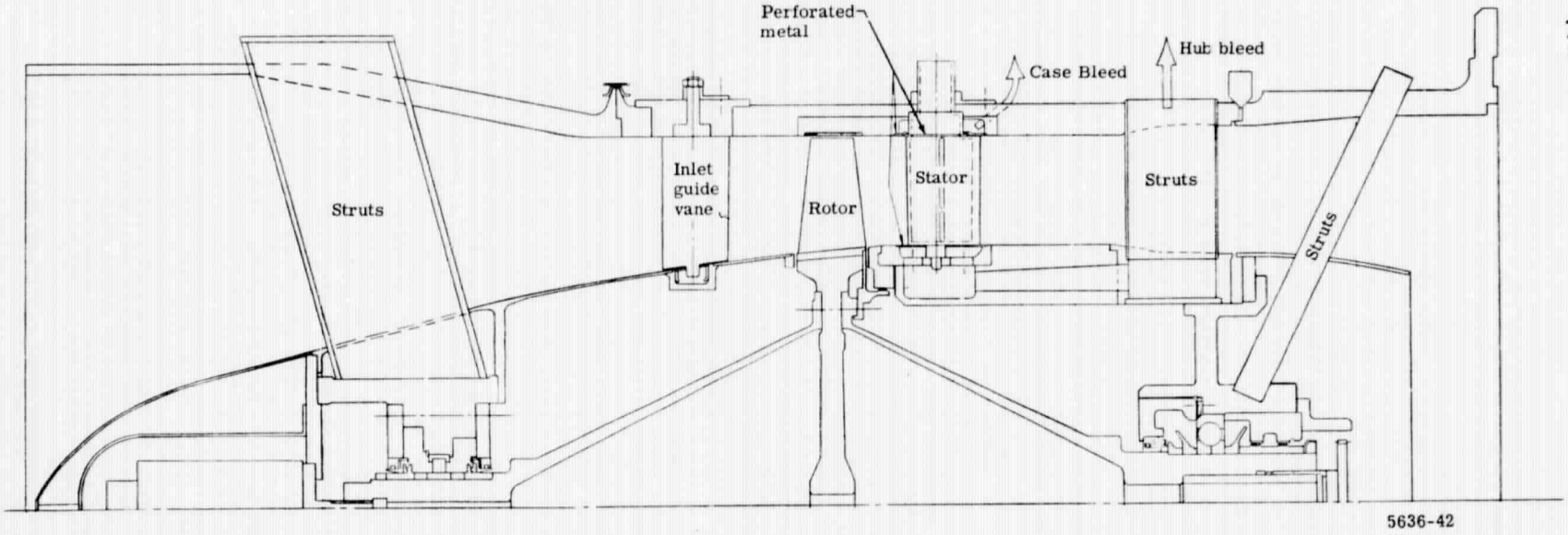
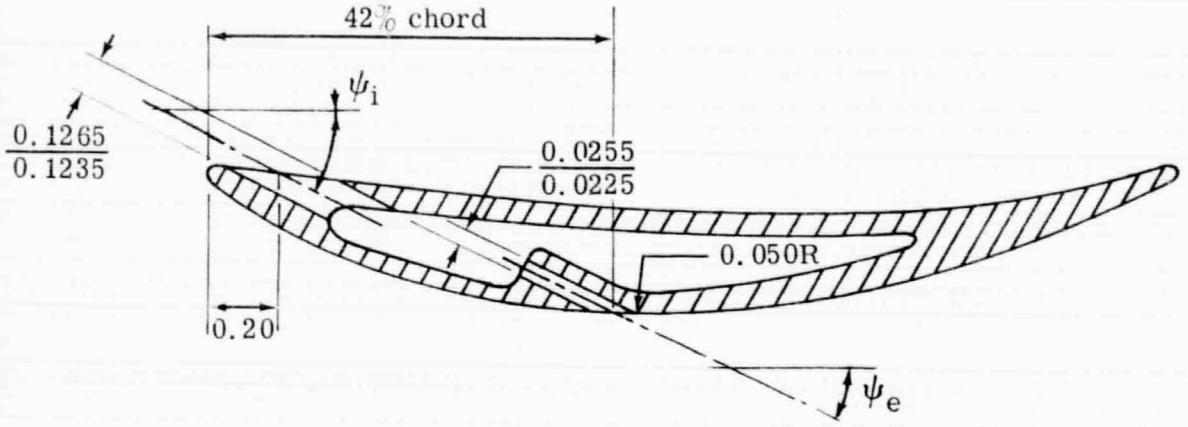
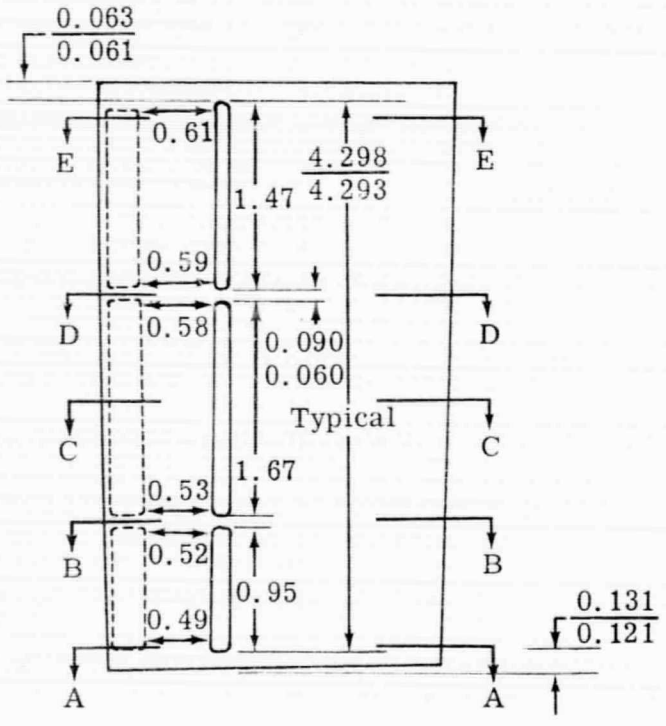


Figure 2. Layout of compressor test rig.

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Note: Dimensions are in inches.



Section	ψ_i	ψ_e
A-A	20° 45'	16° 00'
B-B	23° 15'	18° 30'
C-C	24° 57'	19° 45'
D-D	26° 08'	21° 23'
E-E	27° 38'	22° 53'

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Figure 3. Single-slotted 0.65 hub diffusion factor stator slot configuration.

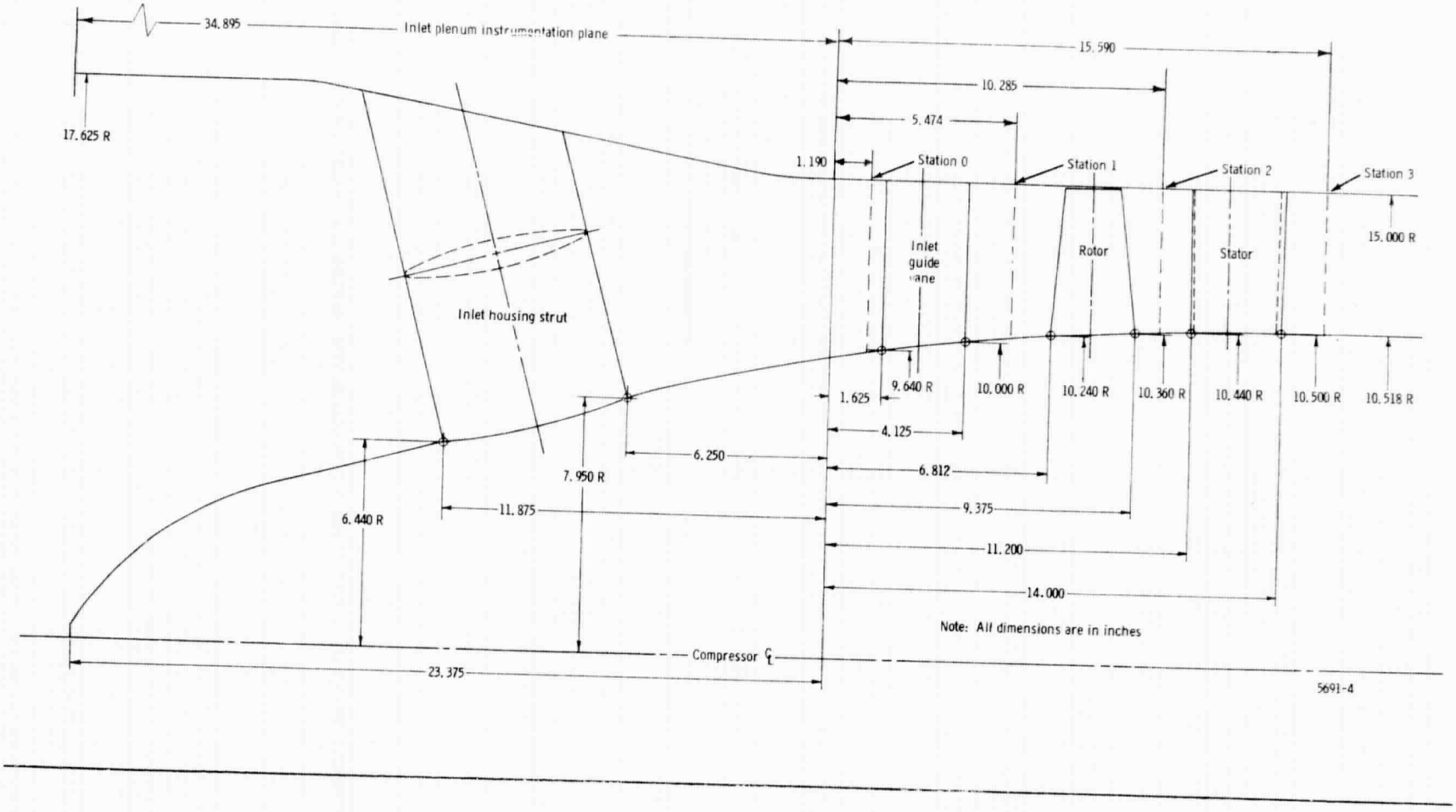


Figure 4. Test rig flow path.

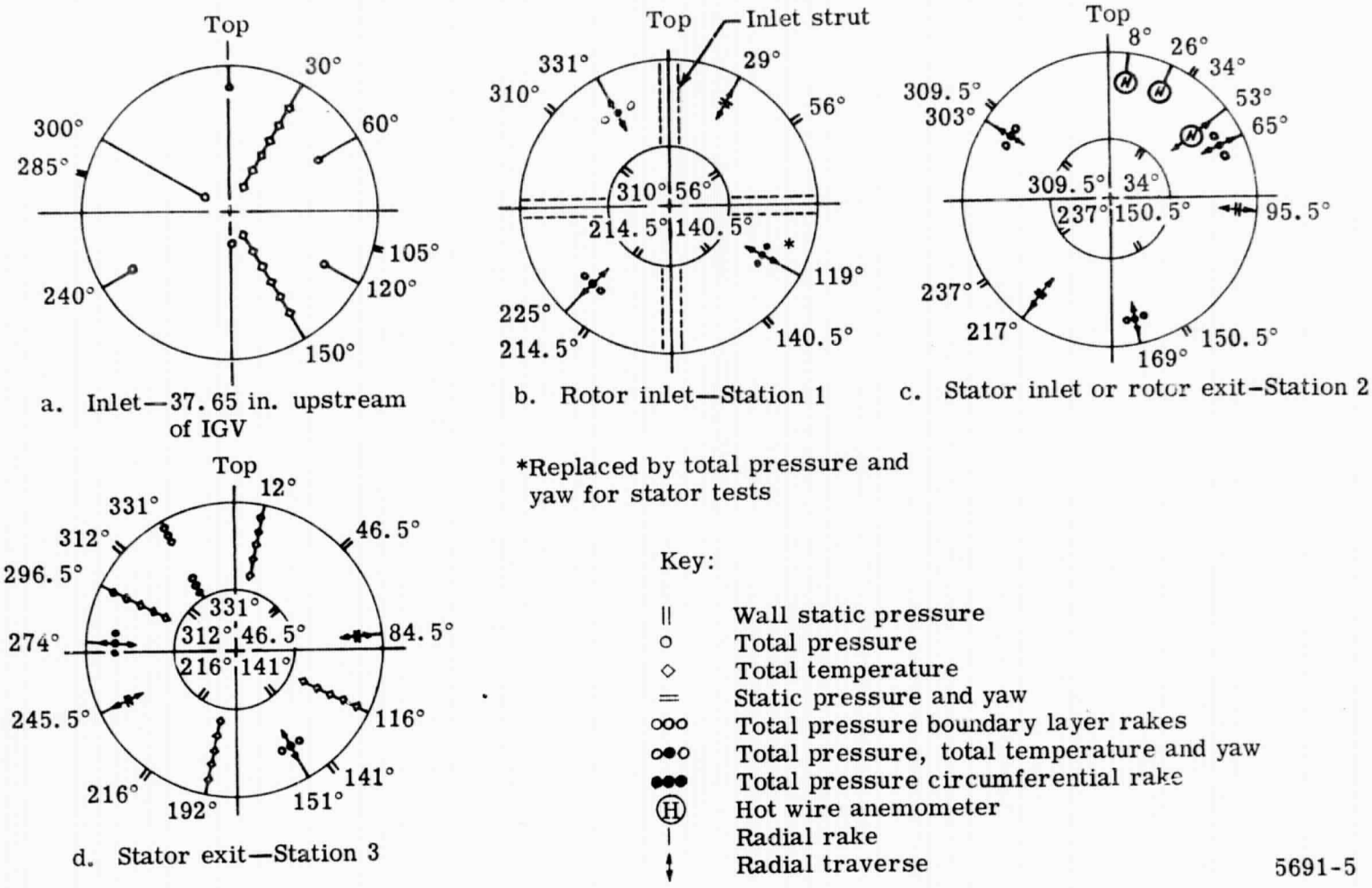


Figure 5. Circumferential location of instrumentation viewed downstream.

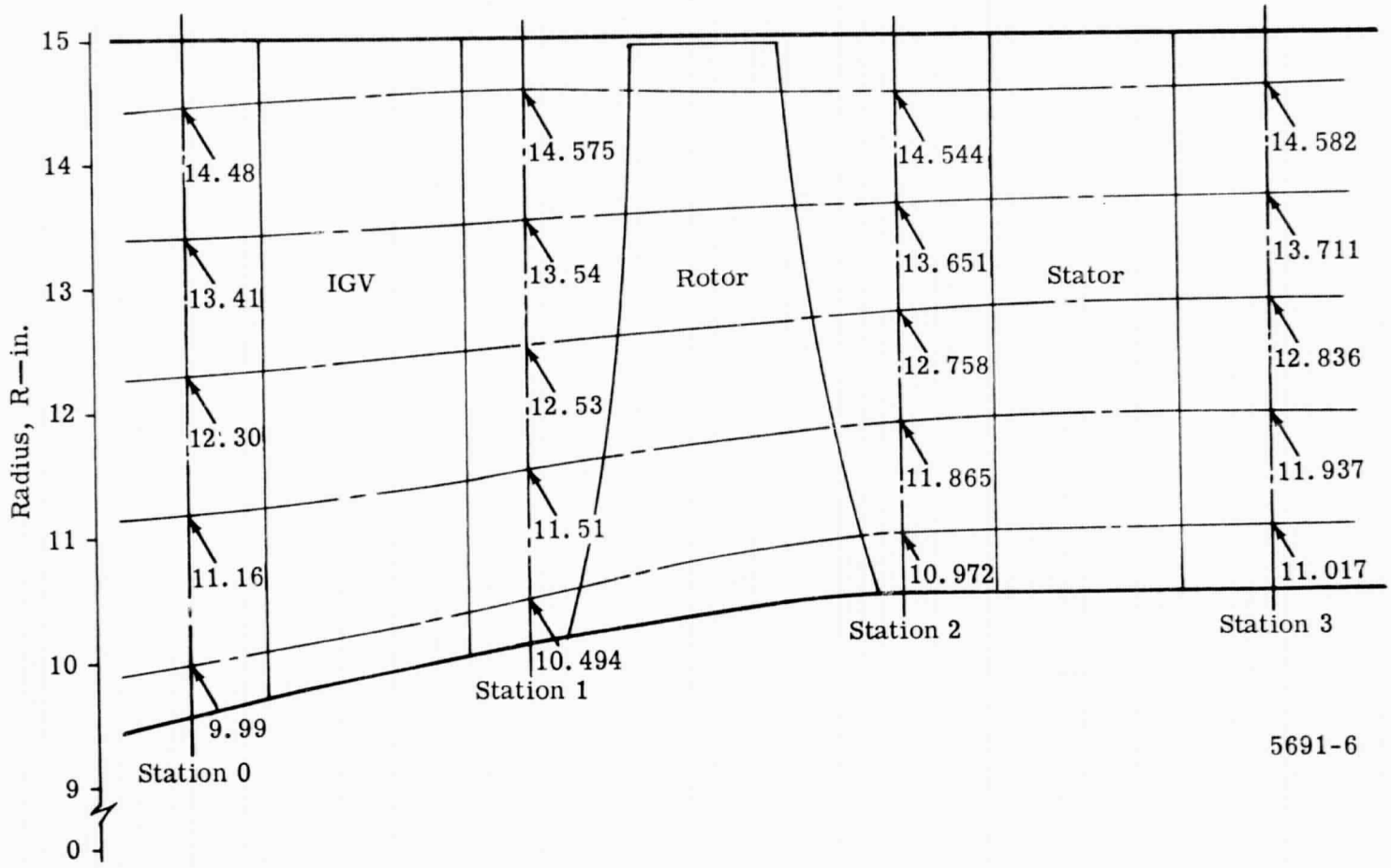
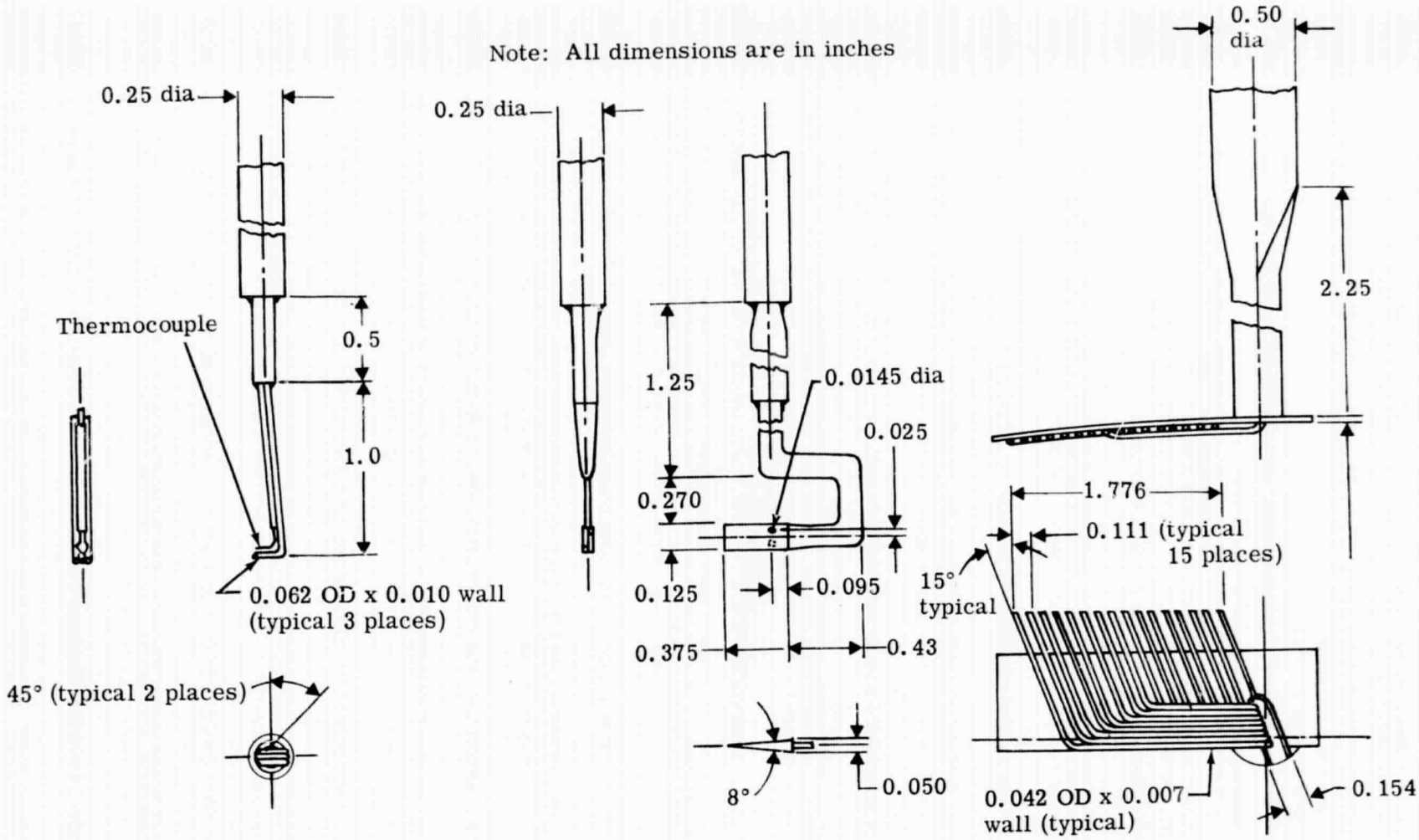


Figure 6. Radial location of streamlines for instrumentation positions.



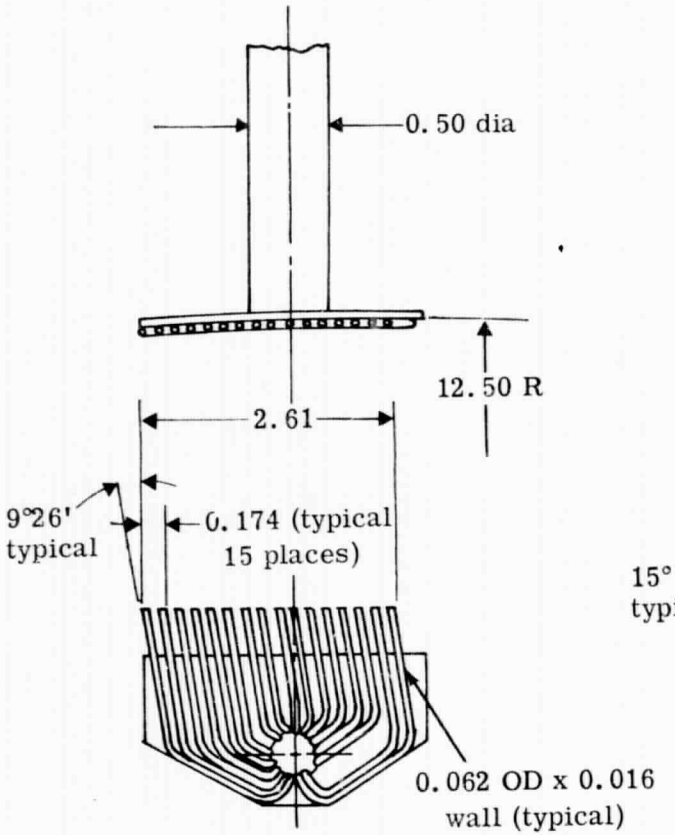
a. Total pressure, total temperature, and yaw probe

b. Static pressure and yaw probe

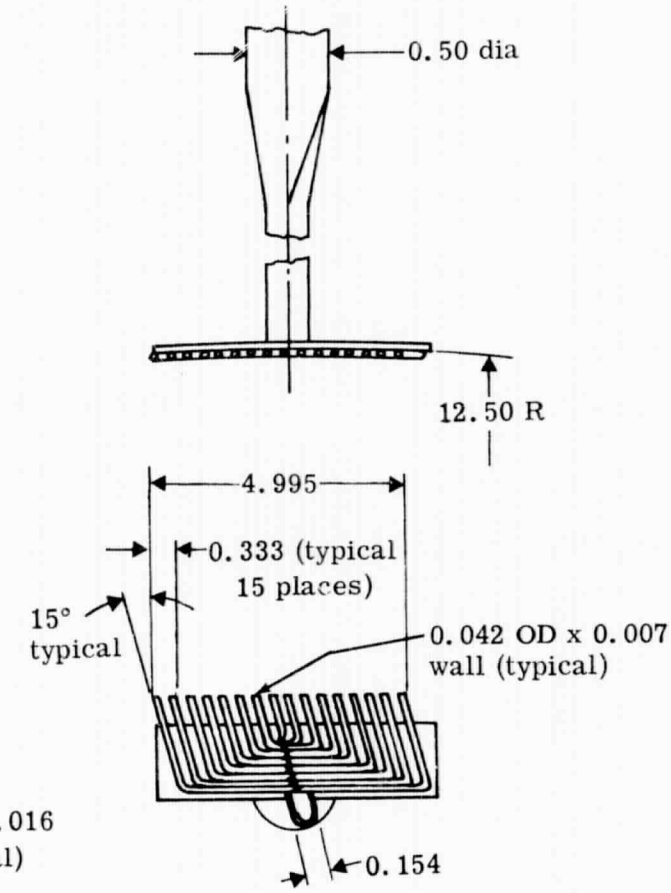
c. IGV circumferential rake

Figure 7. Schematics of survey instrumentation.

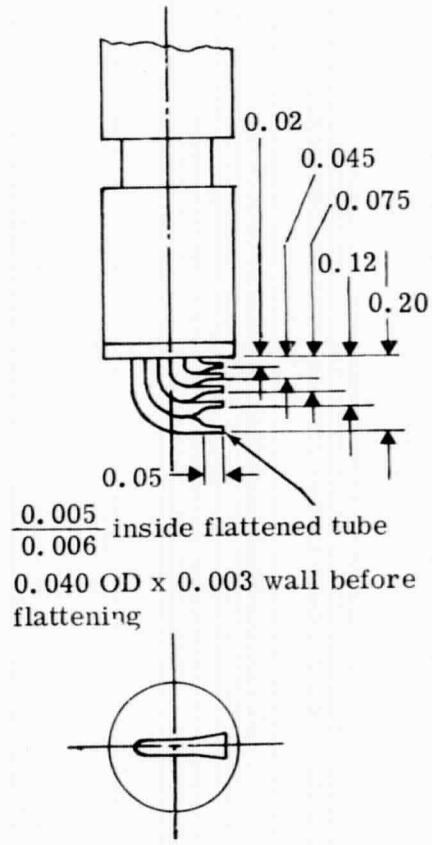
Note: All dimensions are in inches



d. Stator circumferential rake



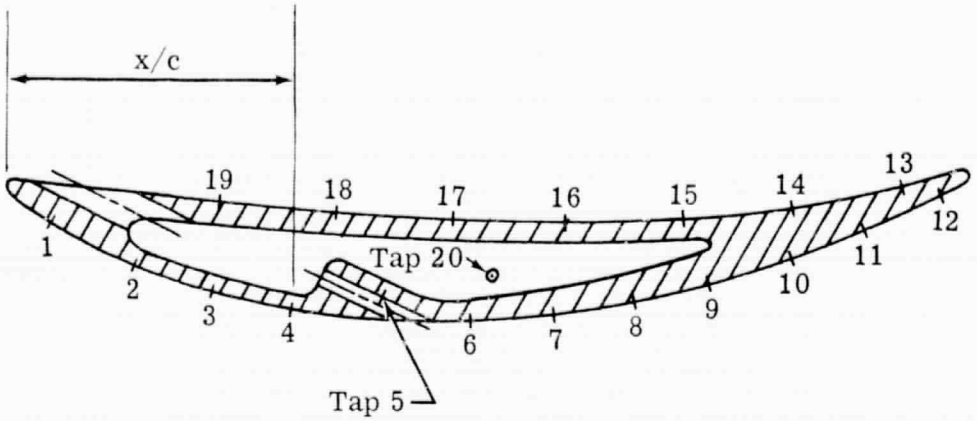
e. IGV wake persistence circumferential rake



f. Boundary layer probe for tip and hub

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Figure 7. Schematics of survey instrumentation.

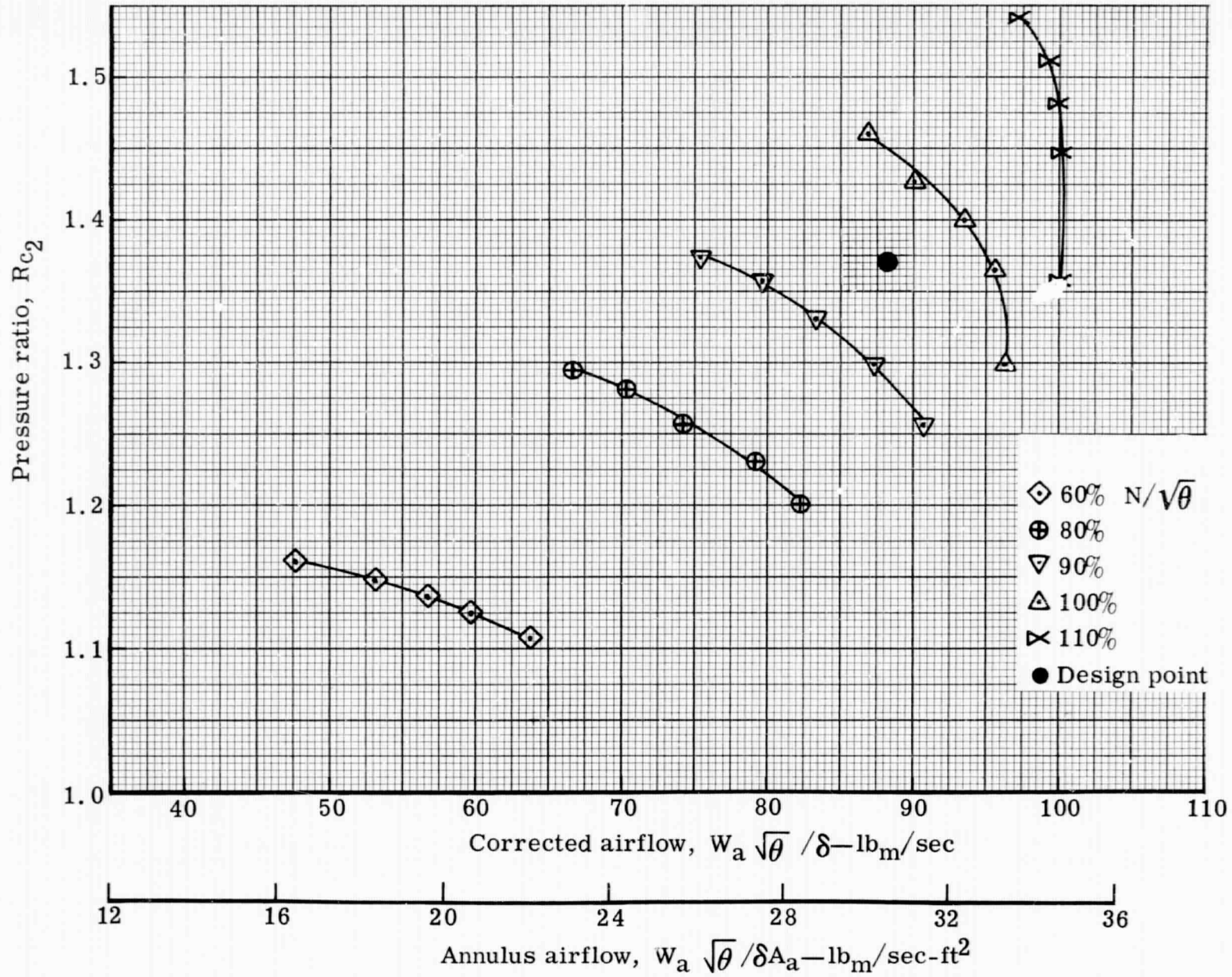


Tap	1	2	3	4	5	6	7	8	9	10	11	12
x/c—%	4.98	13.28	21.58	29.55	—	47.81	56.44	65.07	73.37	81.67	89.31	97.28
Vane No.	1	2	3	4	1	2	3	4	1	2	3	4

Tap	13	14	15	16	17	18	19	20
x/c—%	93.63	81.34	70.05	58.10	46.48	34.53	22.58	—
Vane No.	1	2	3	4	1	2	3	4

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Figure 8. Slotted stator vane static pressure tap locations at 10, 50, and 90% streamlines.



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Figure 9. Flow generation rotor overall performance in stage test—pressure ratio.

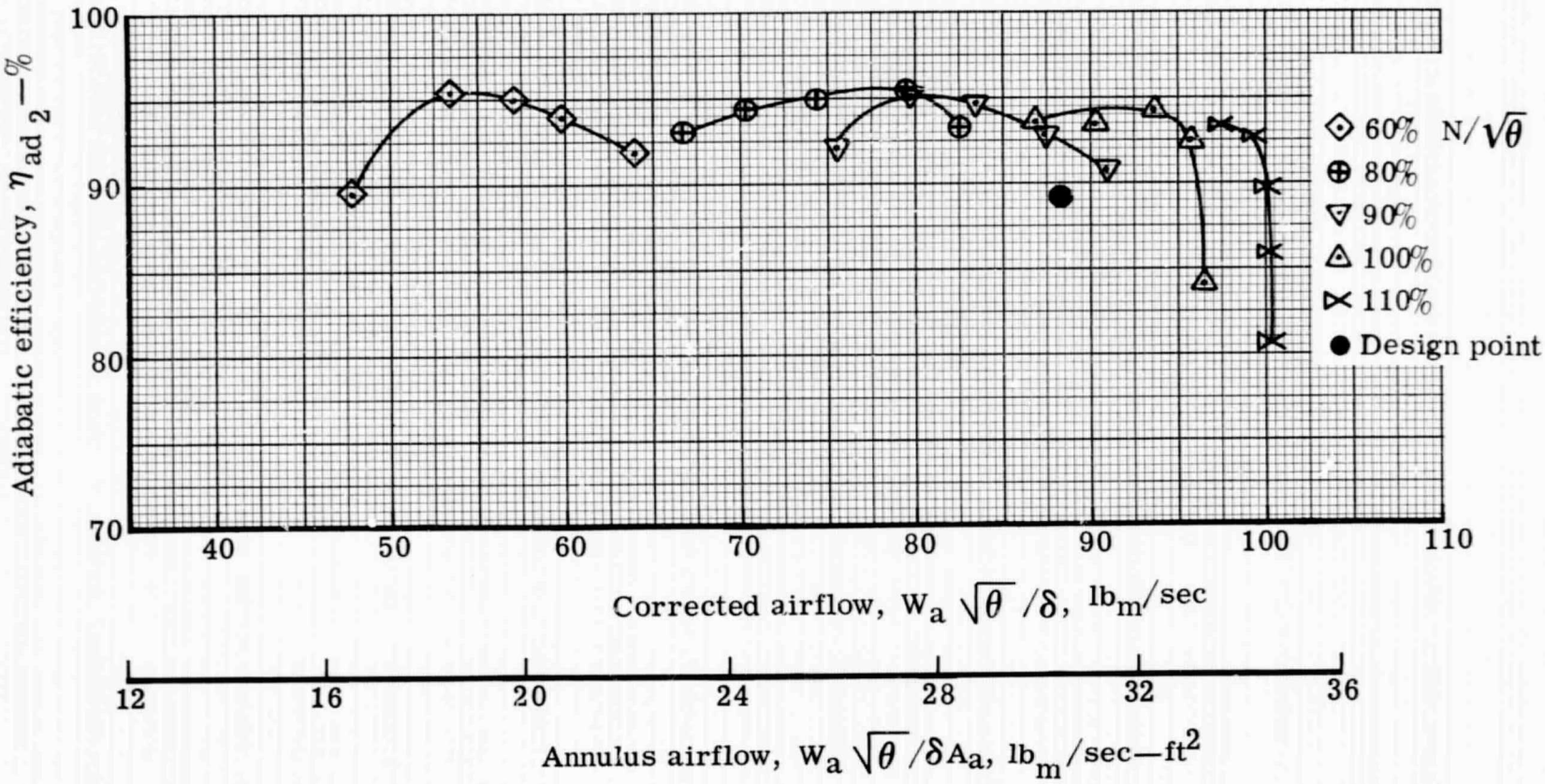


Figure 10. Flow generation rotor overall performance in stage test—adiabatic efficiency.

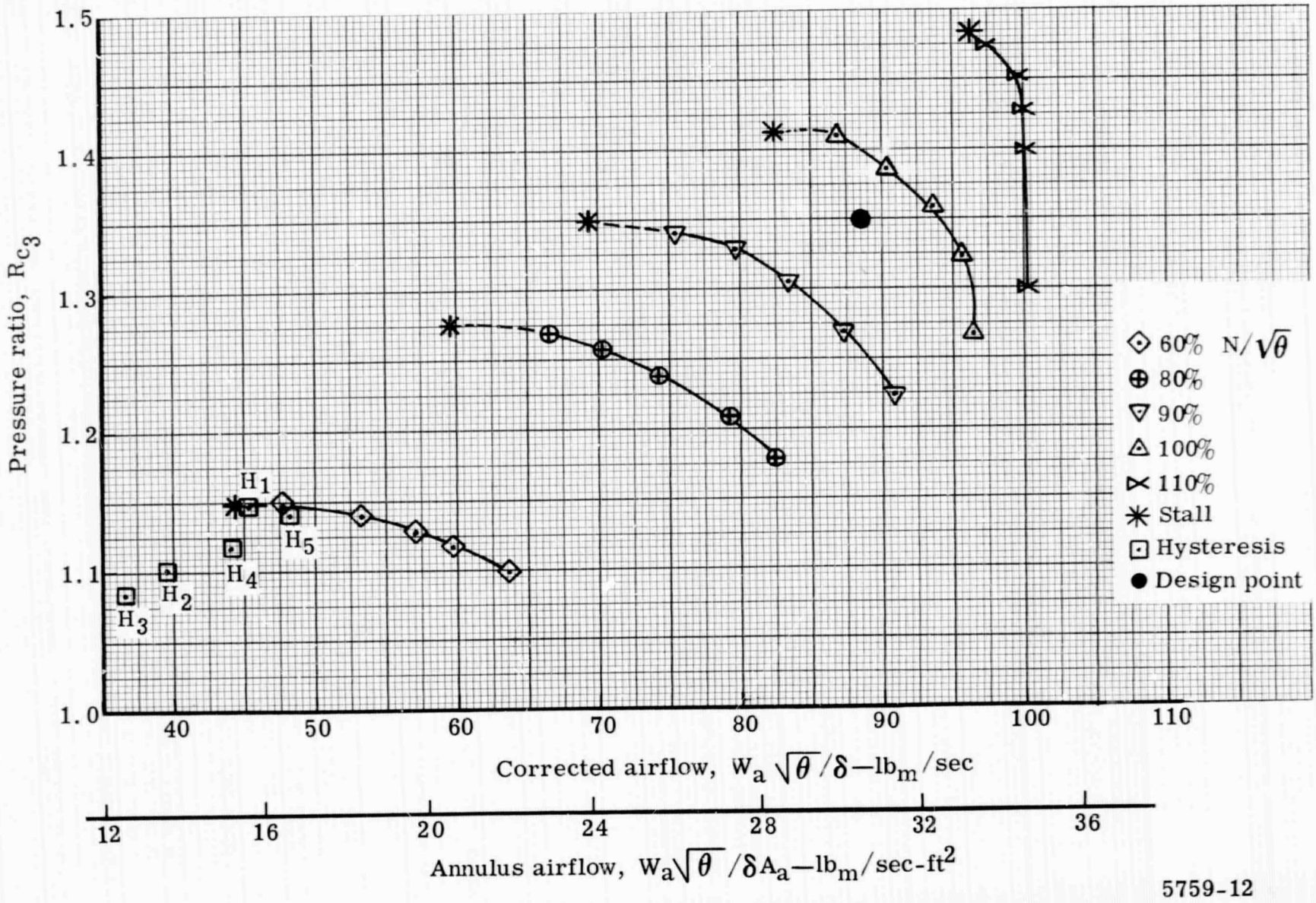


Figure 11. Stage overall performance—pressure ratio.

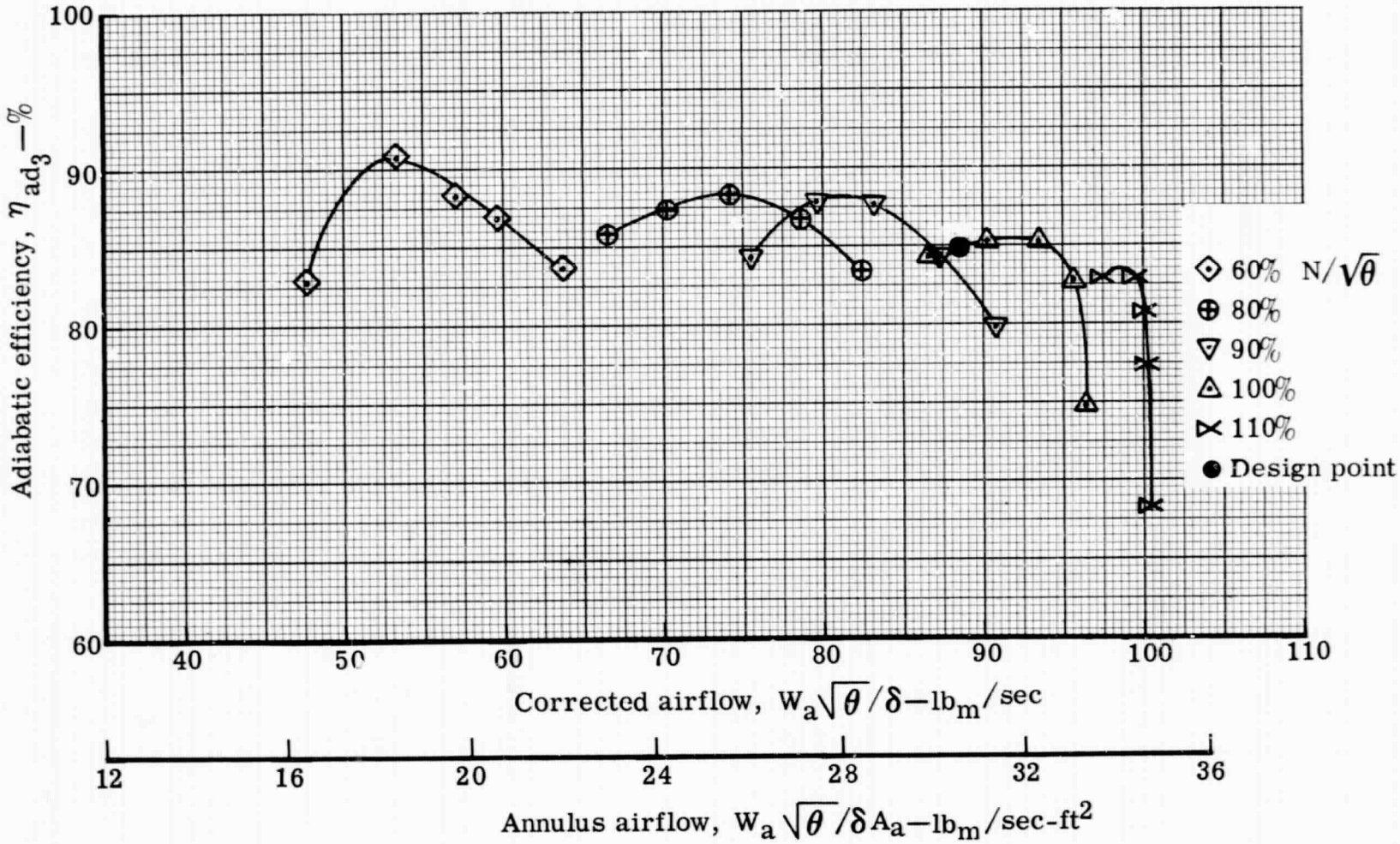


Figure 12. Stage overall performance—adiabatic efficiency.

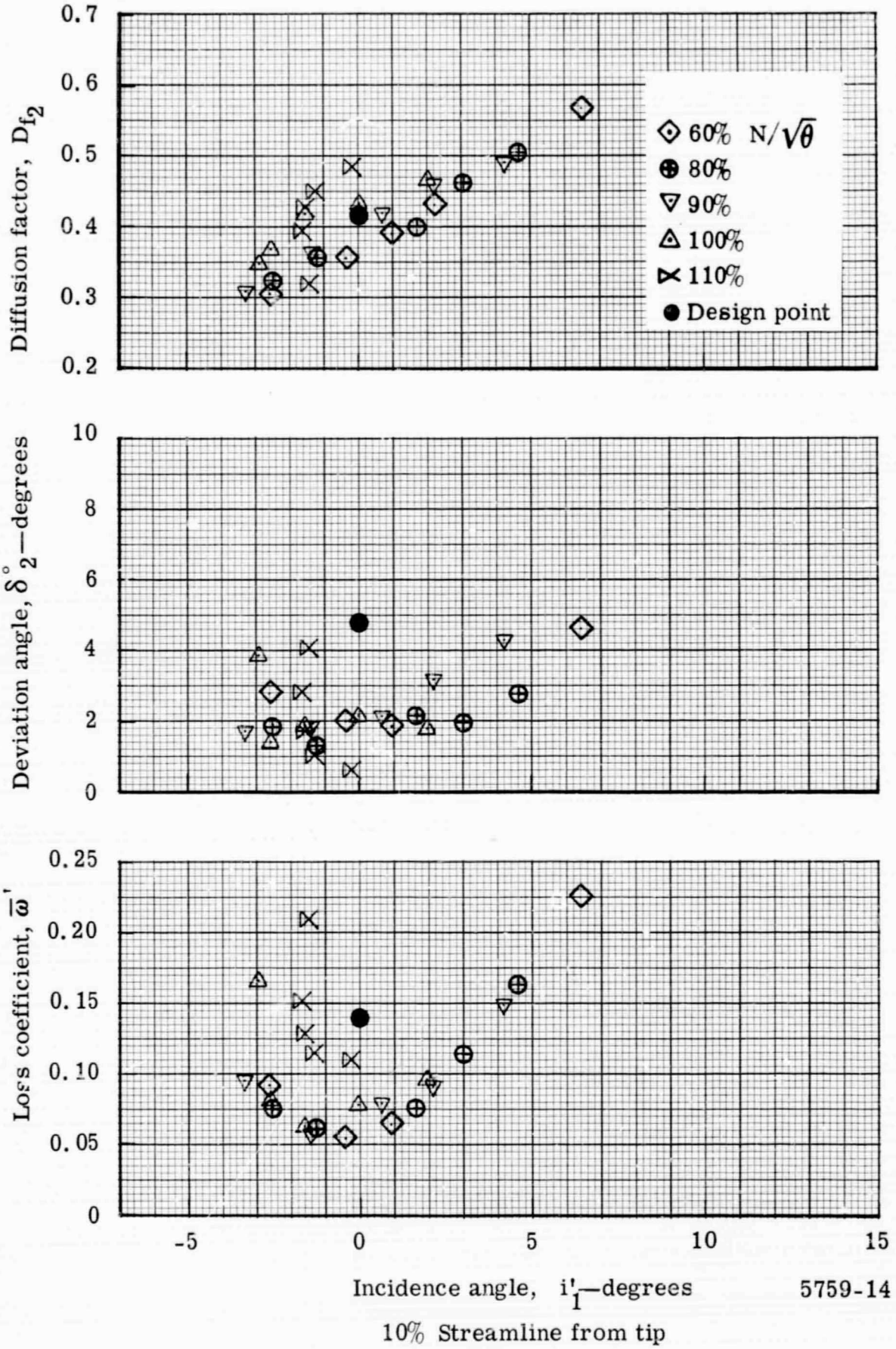


Figure 13a. Rotor blade element performance—stage test.

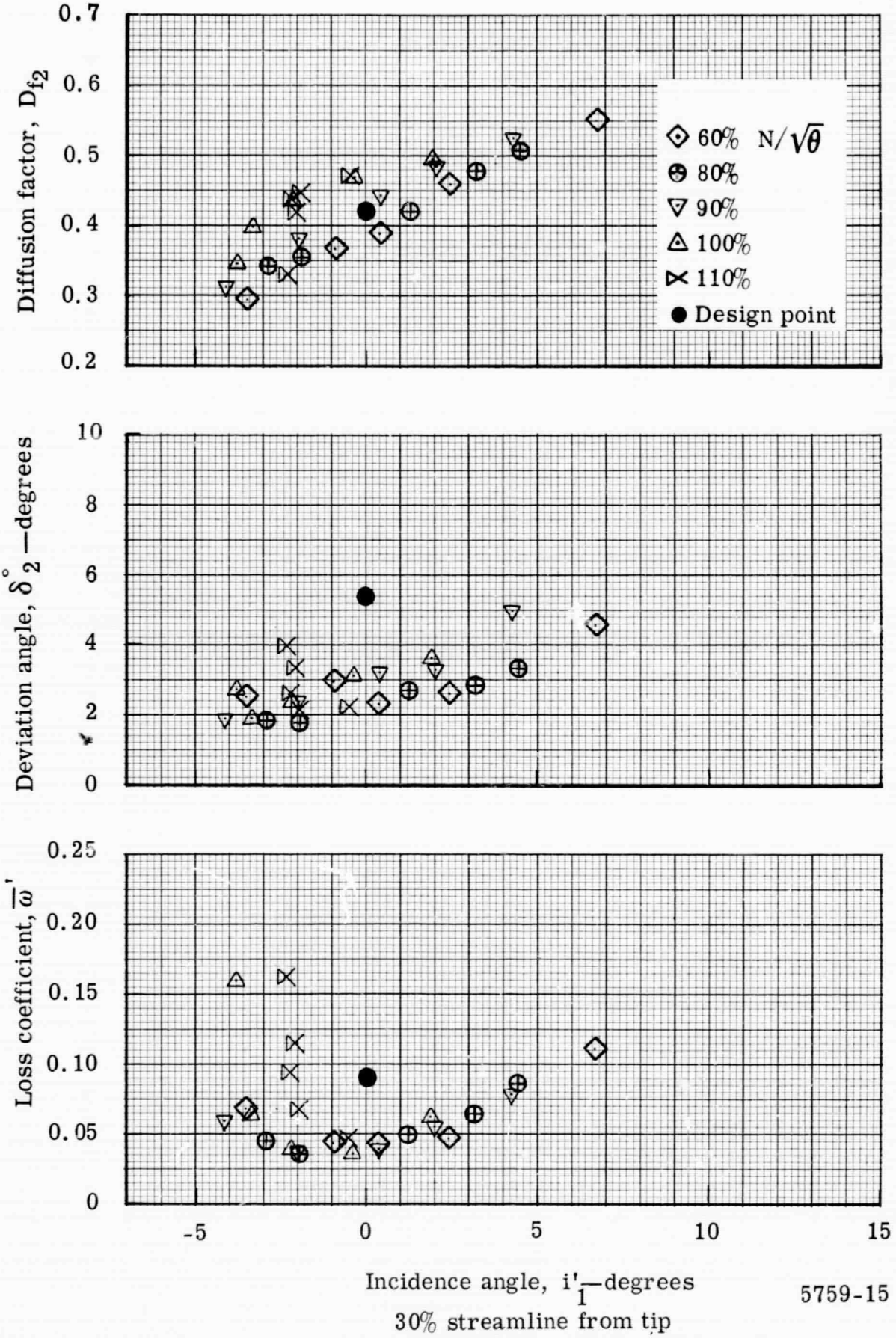


Figure 13b. Rotor blade element performance—stage test.

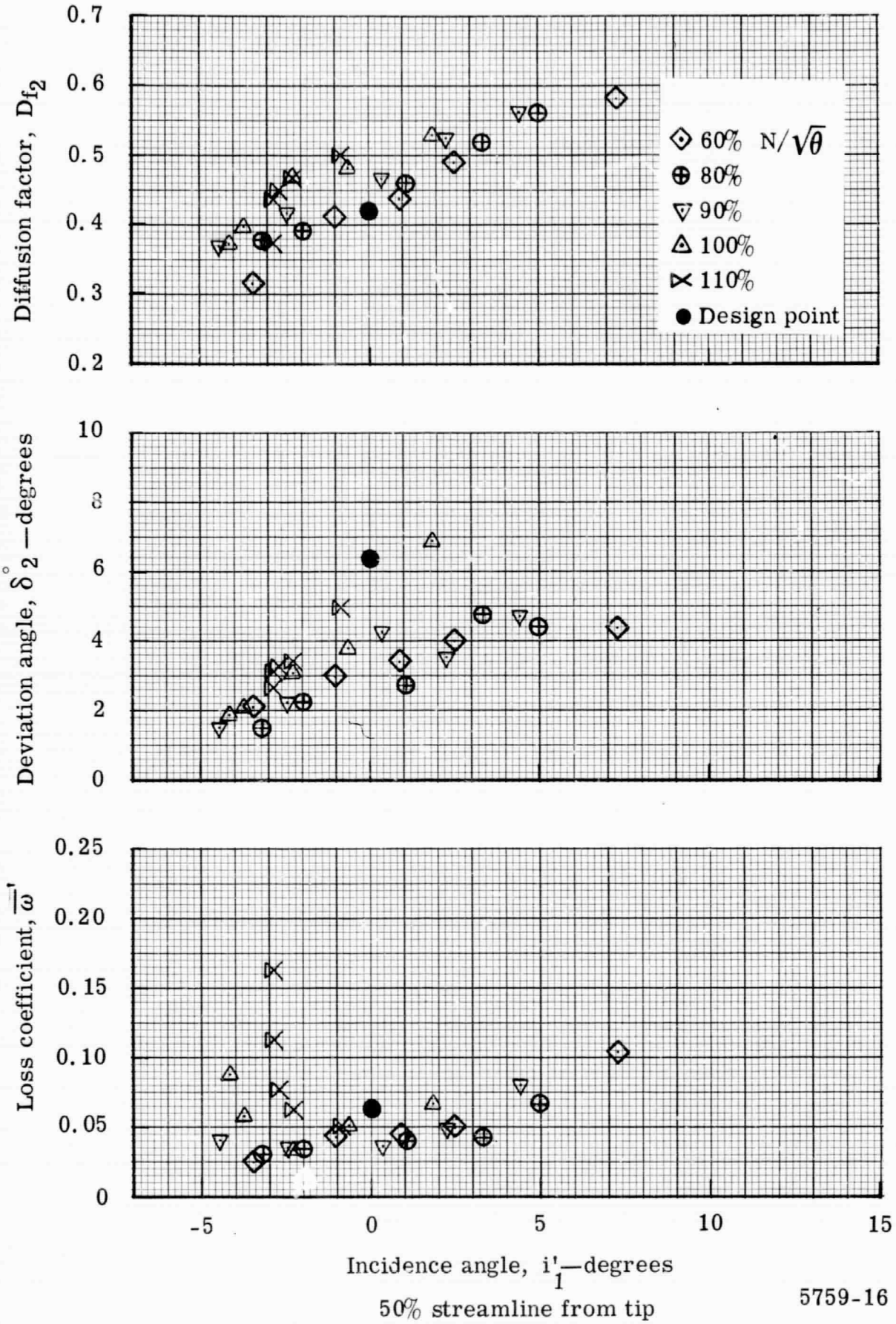


Figure 13c. Rotor blade element performance—stage test.

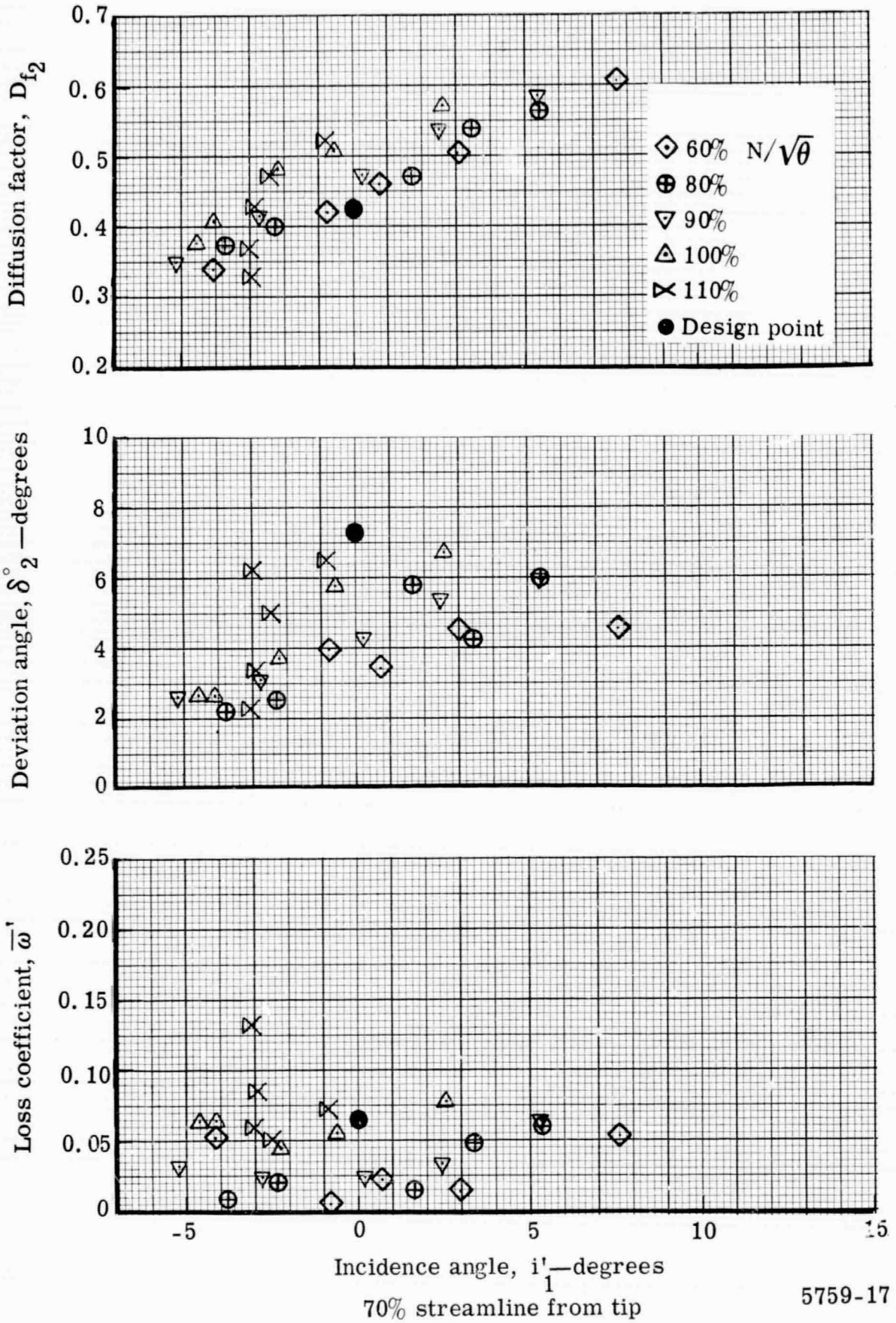


Figure 13d. Rotor blade element performance—stage test.

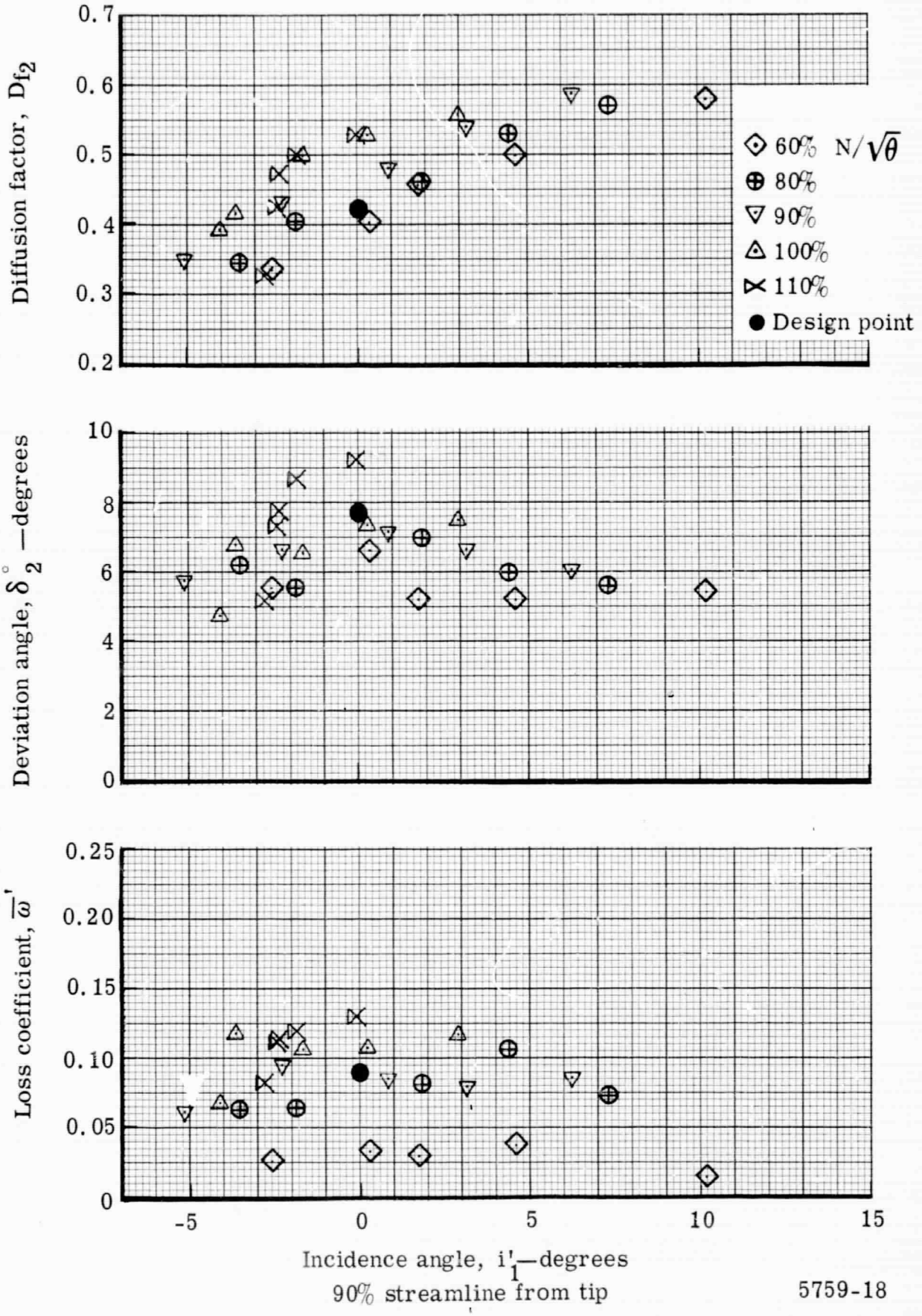
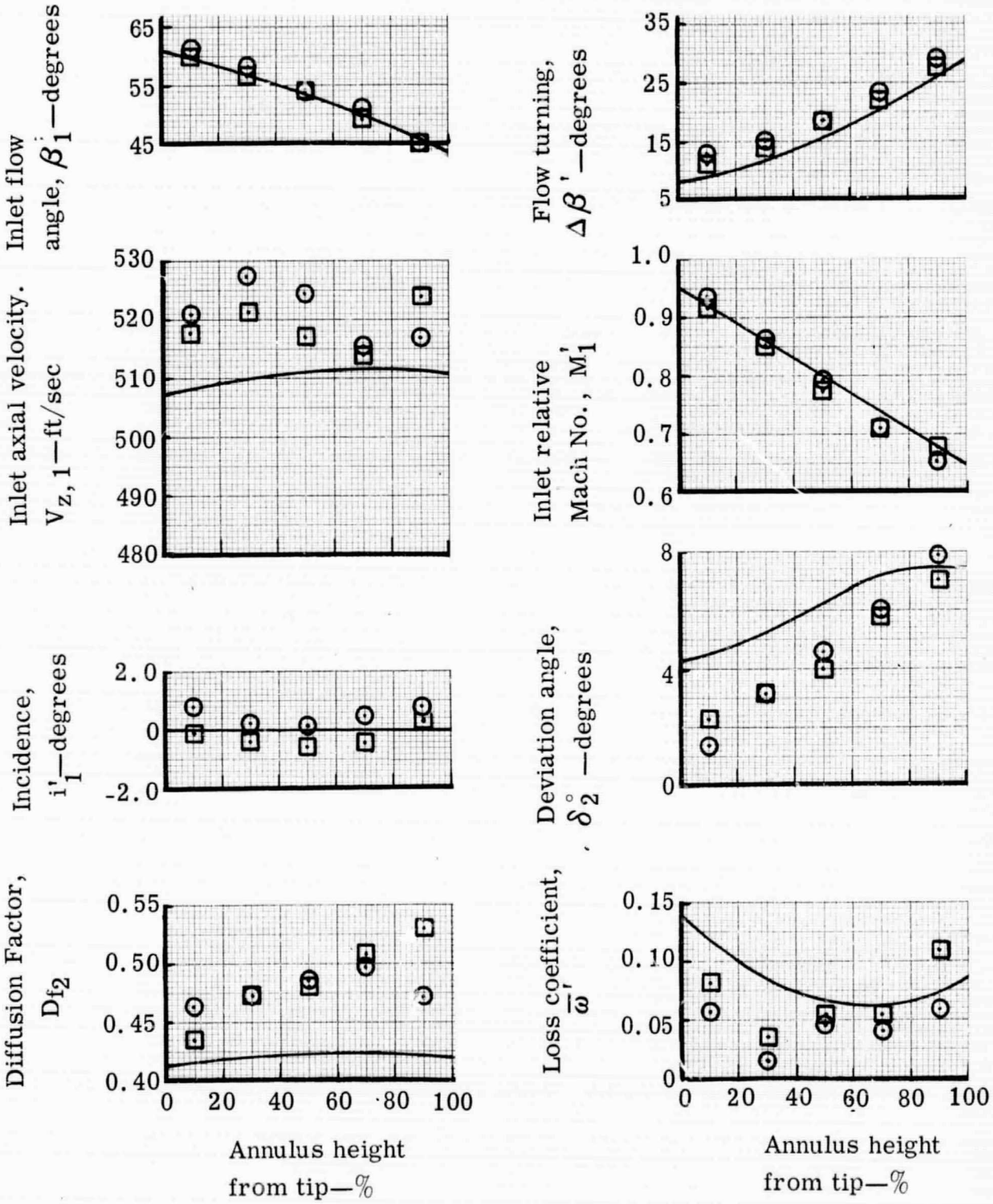


Figure 13e. Rotor blade element performance—stage test.

— Design, $W_a\sqrt{\theta}/\delta$ = 88.2 lb_m/sec , $N/\sqrt{\theta}$ = 100%

⊙ Flow generation rotor test, $W_a\sqrt{\theta}/\delta$ = 89.3 lb_m/sec, $N/\sqrt{\theta}$ = 99.3%

⊡ Slotted stator test, $W_a\sqrt{\theta}/\delta$ = 90.2 lb_m/sec, $N/\sqrt{\theta}$ = 99.8%



5759-19

Figure 14. Radial variation of rotor blade element performance.

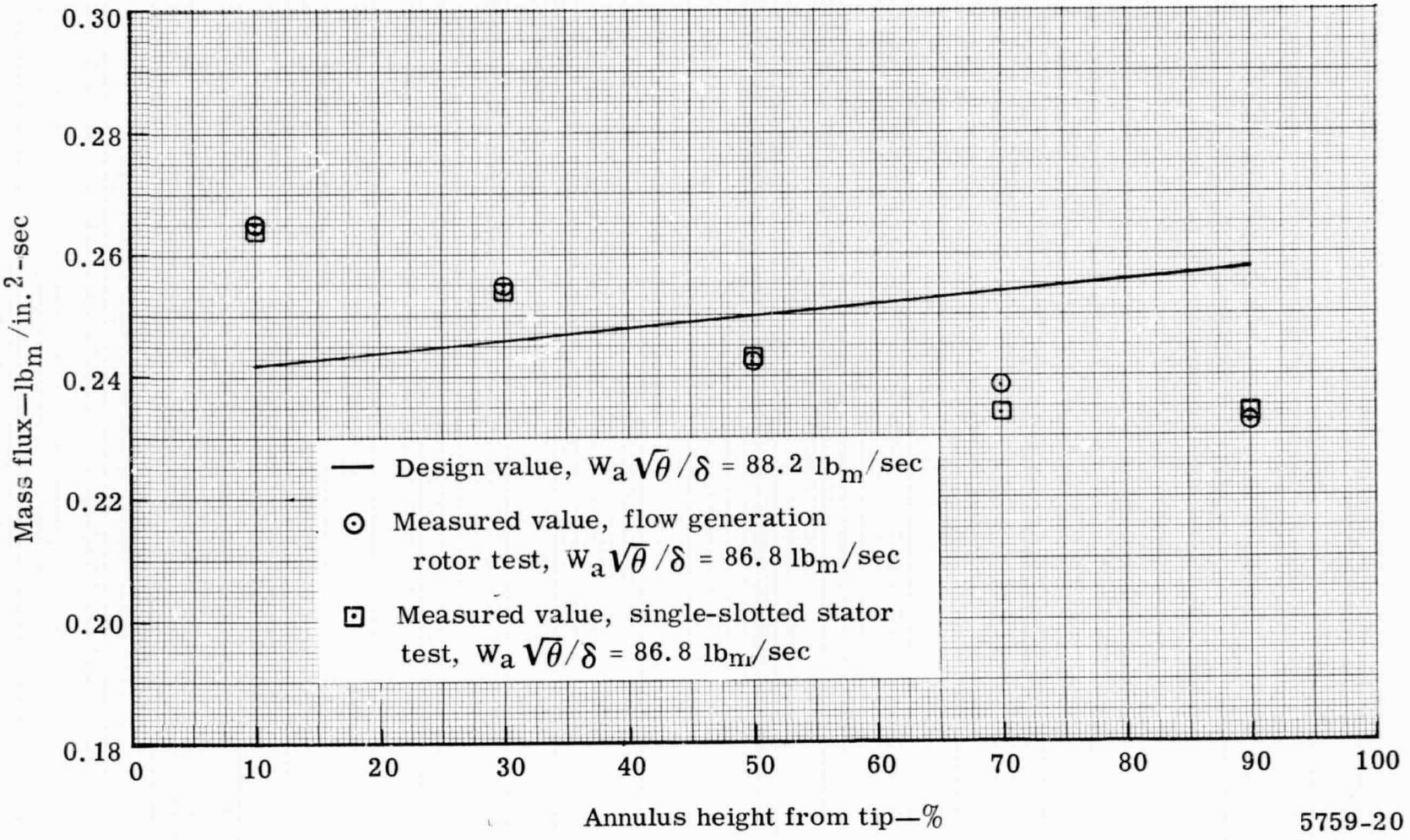
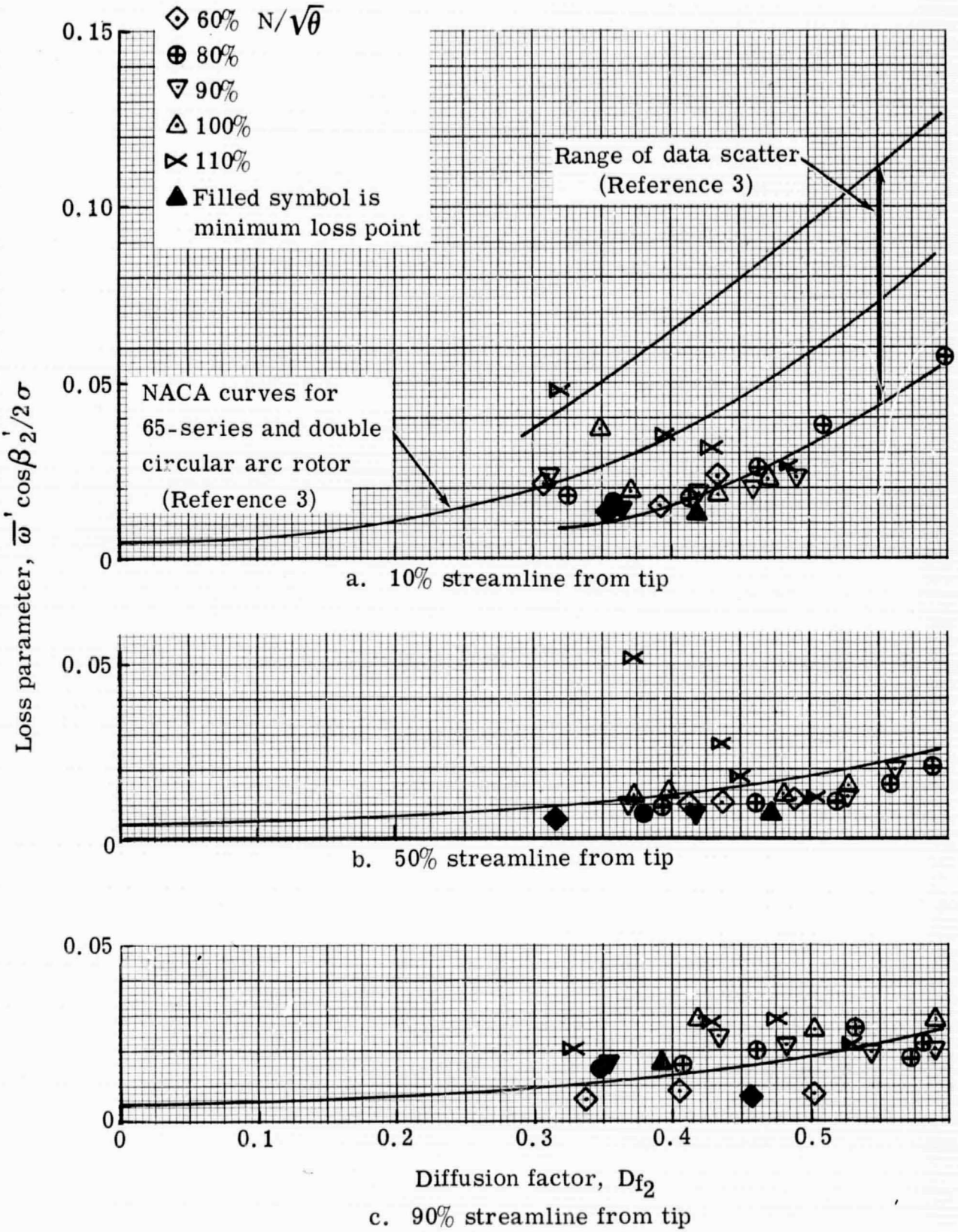


Figure 15. Rotor out radial mass flux distribution at design speed.



a. 10% streamline from tip

b. 50% streamline from tip

c. 90% streamline from tip

Figure 16. Rotor loss parameter versus diffusion factor.

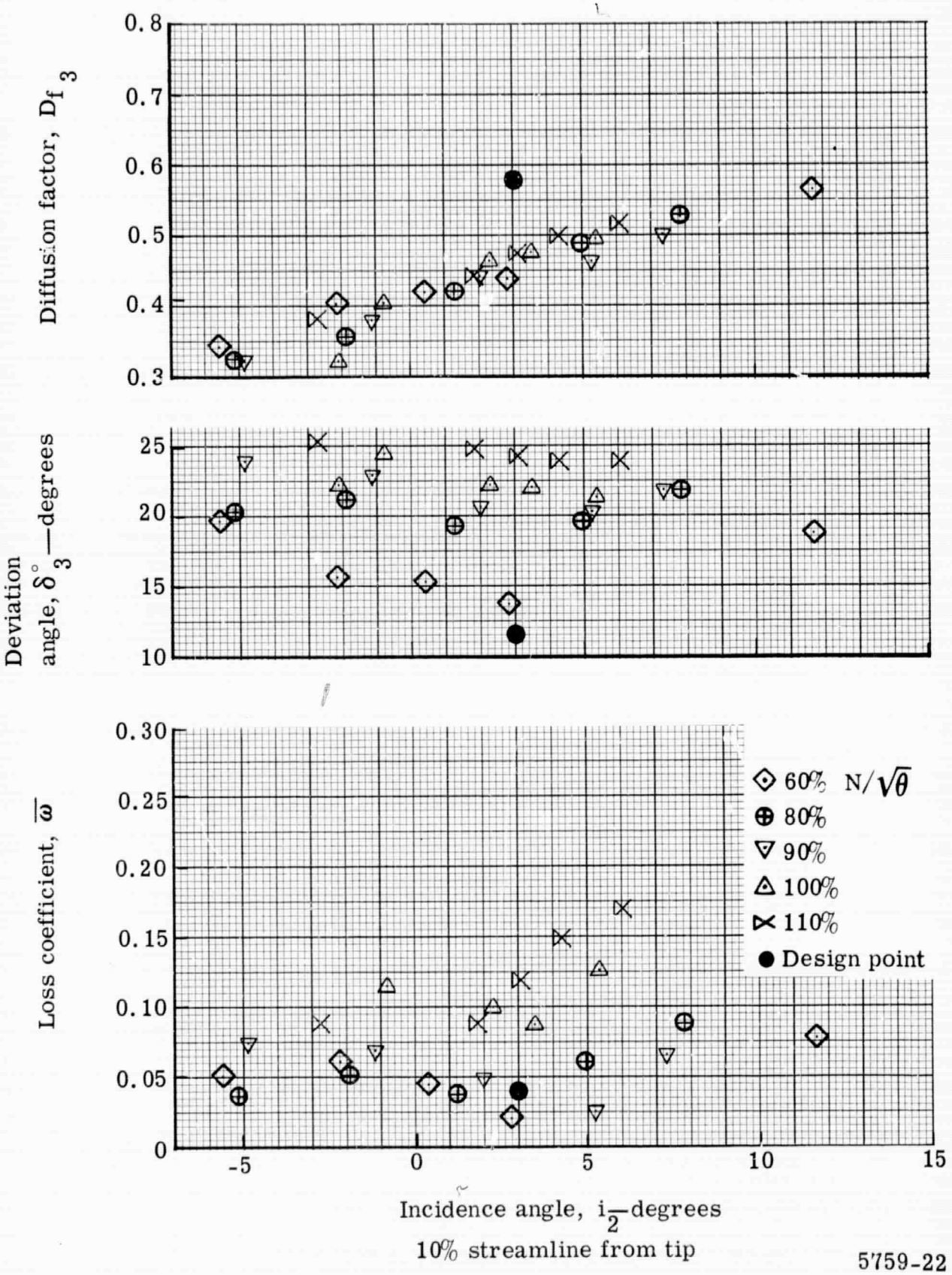


Figure 17a. Slotted stator blade element performance.

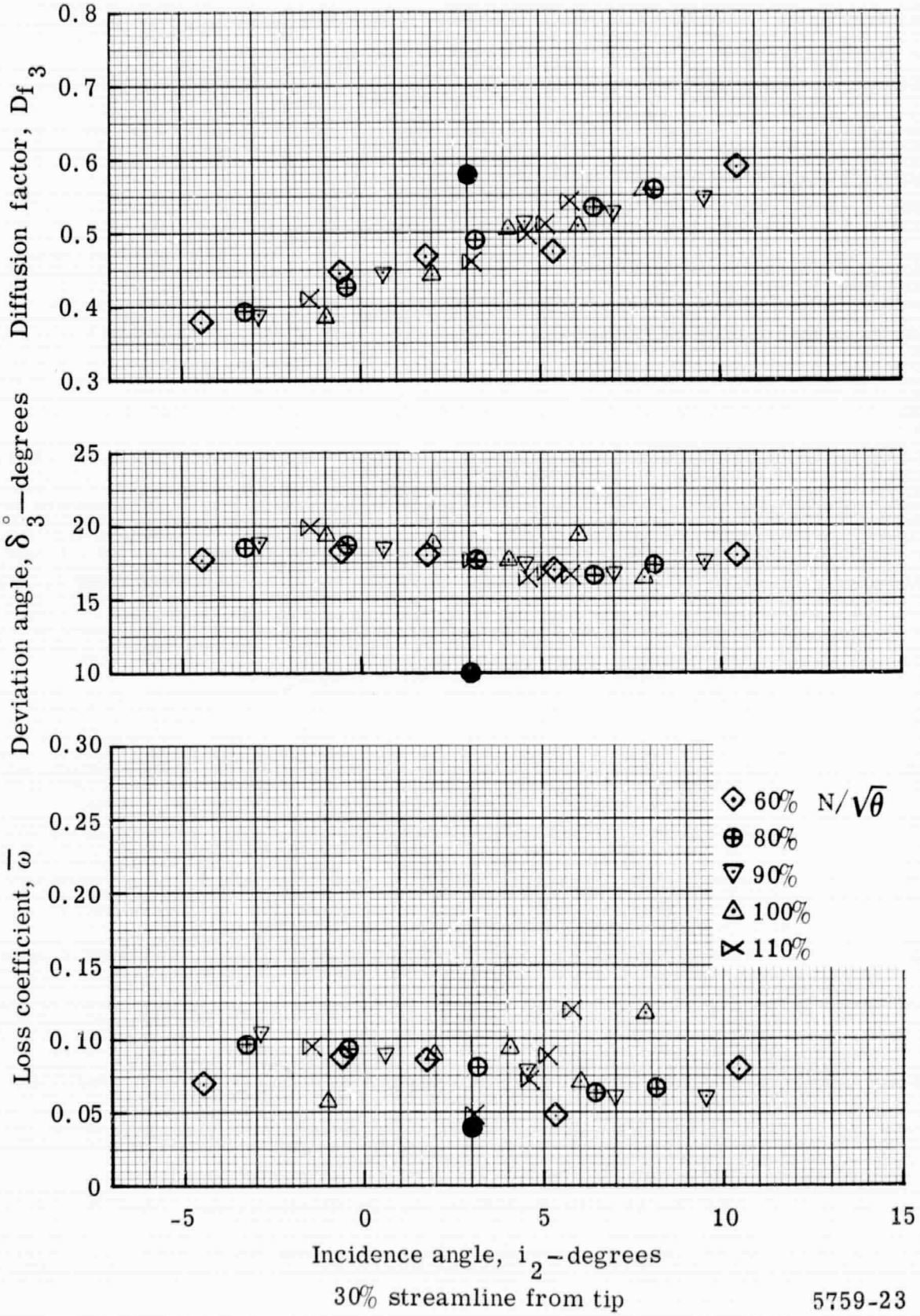


Figure 17b. Slotted stator blade element performance.

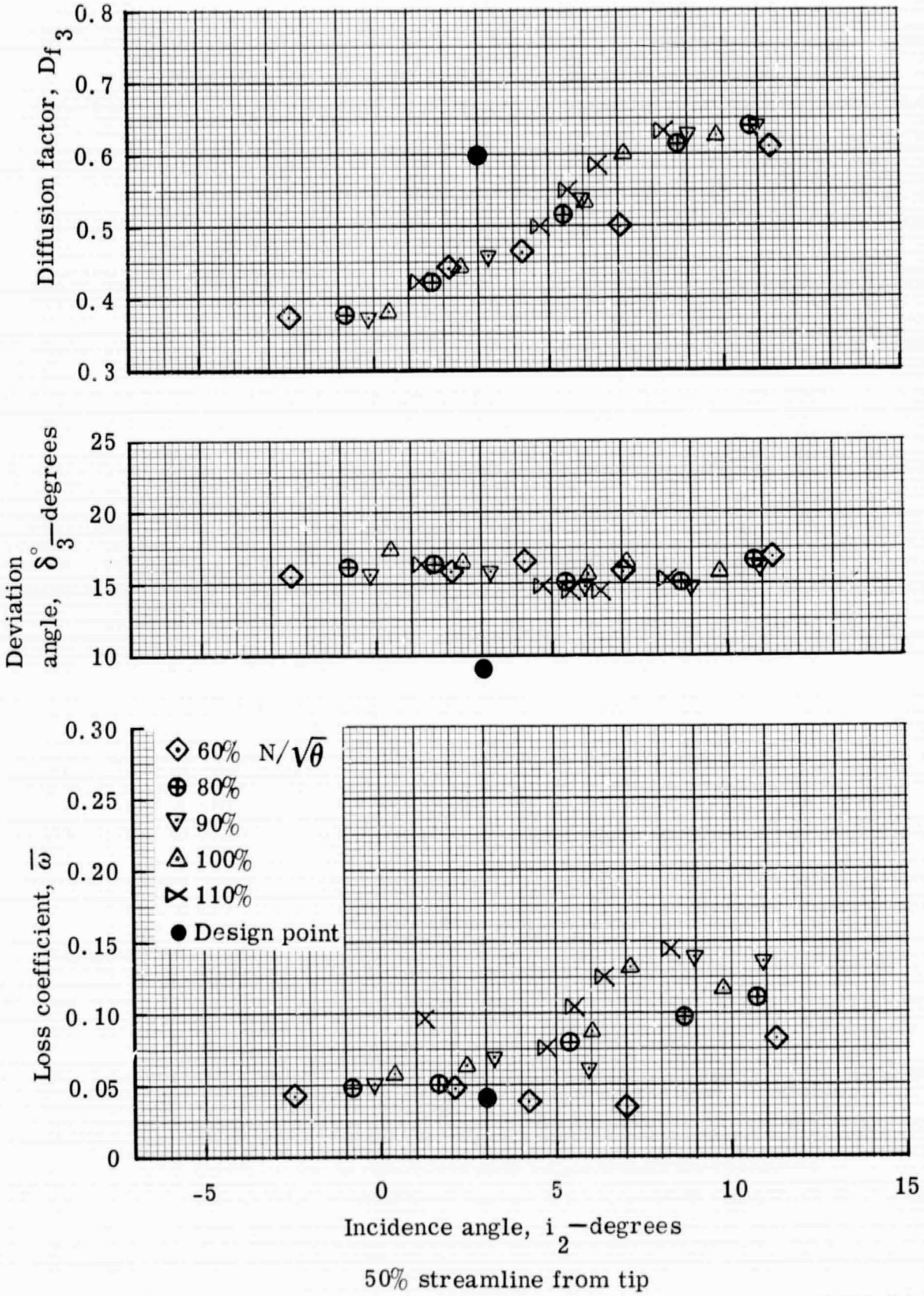


Figure 17c. Slotted stator blade element performance.

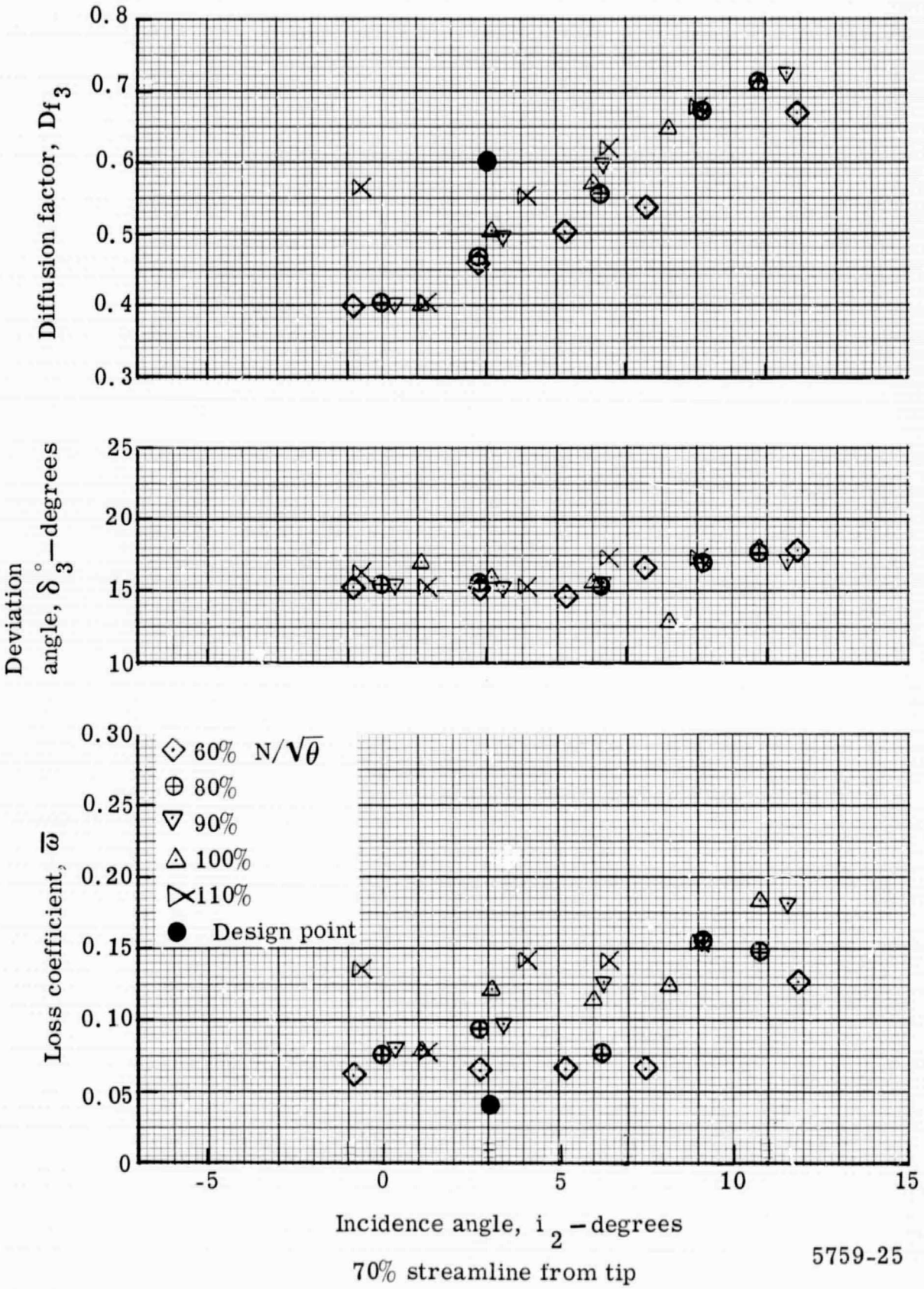


Figure 17d. Slotted stator blade element performance.

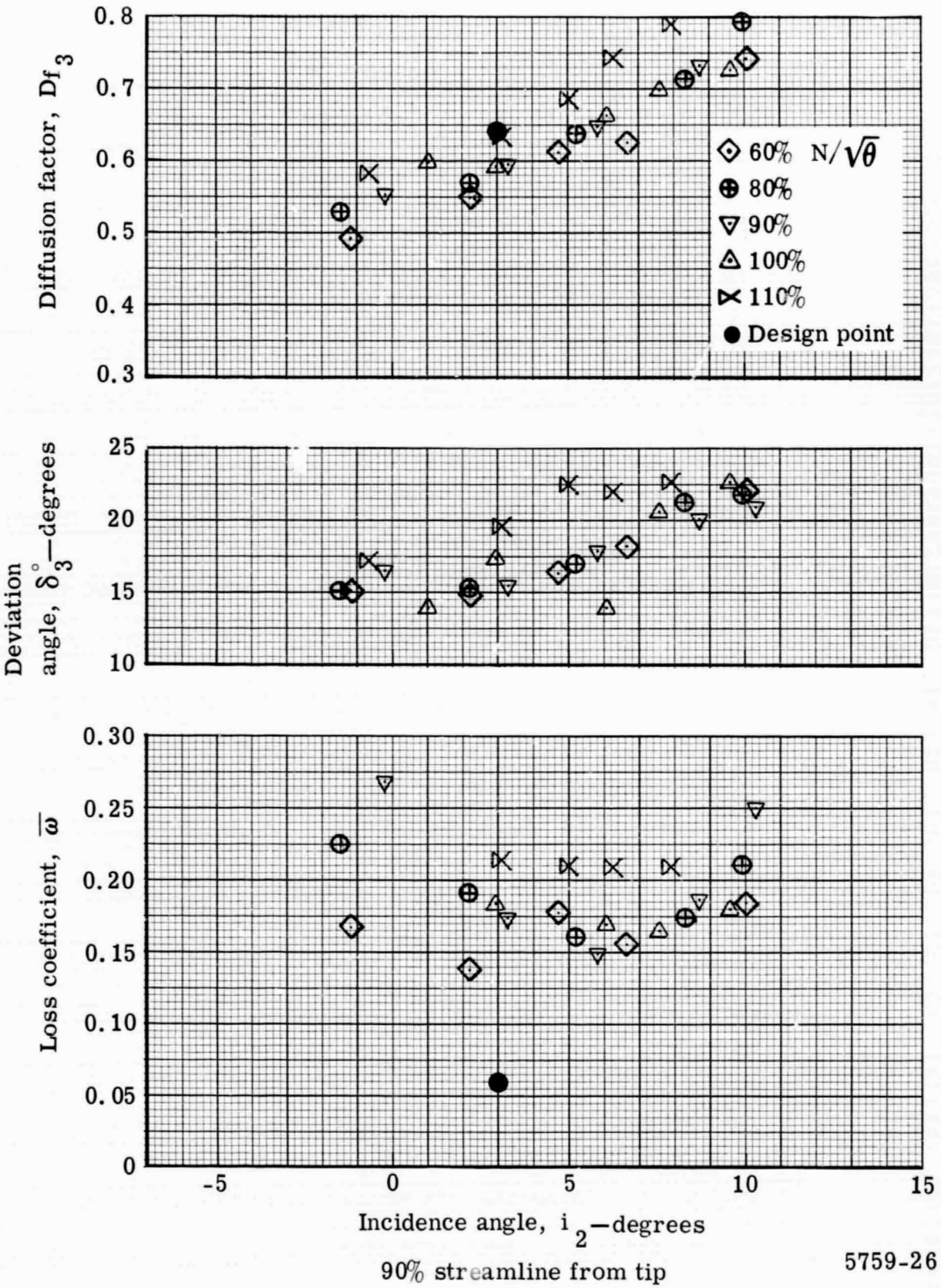


Figure 17e. Slotted stator blade element performance.

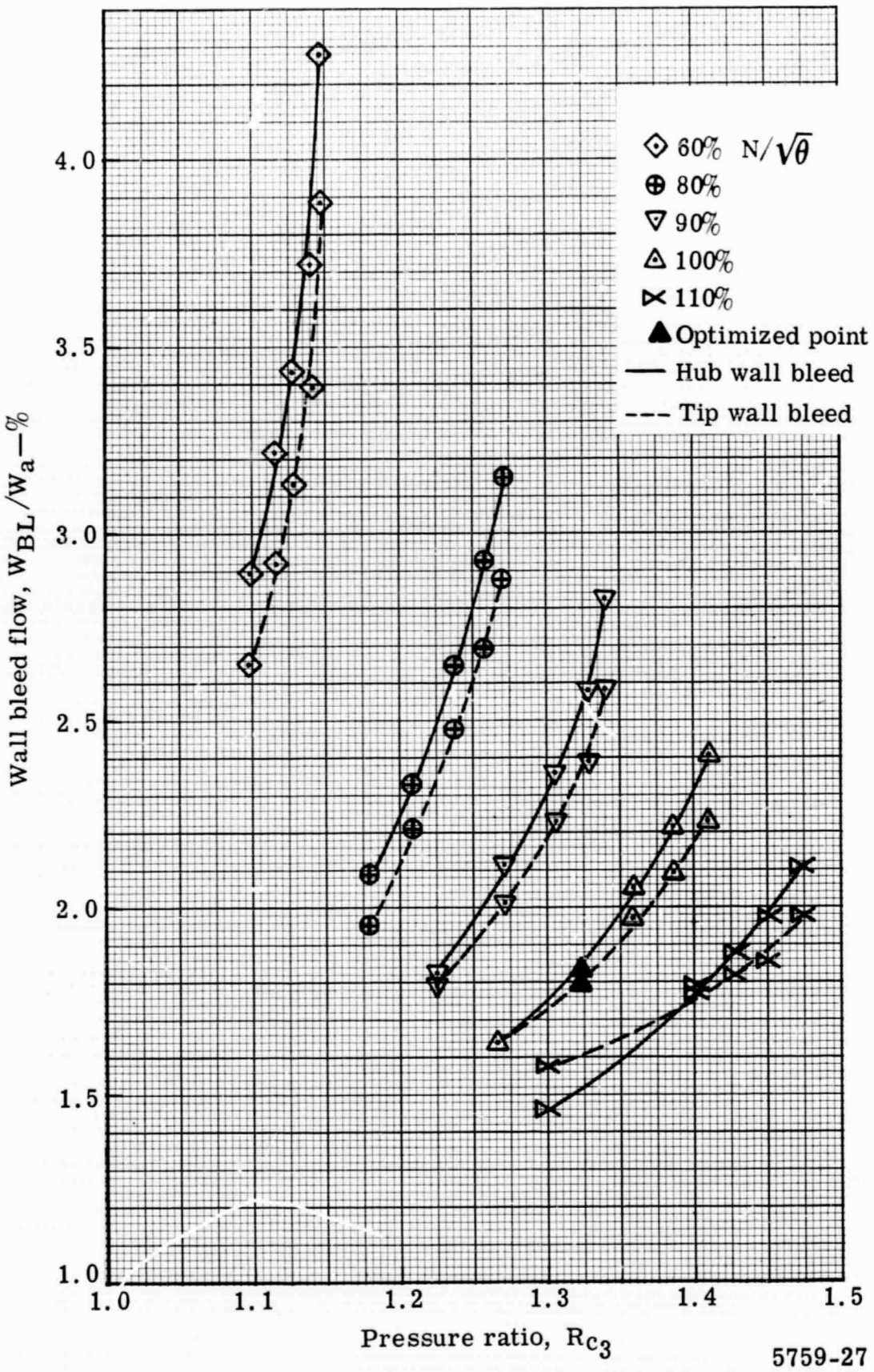


Figure 18. Variation of wall bleed flows with stage pressure ratio.

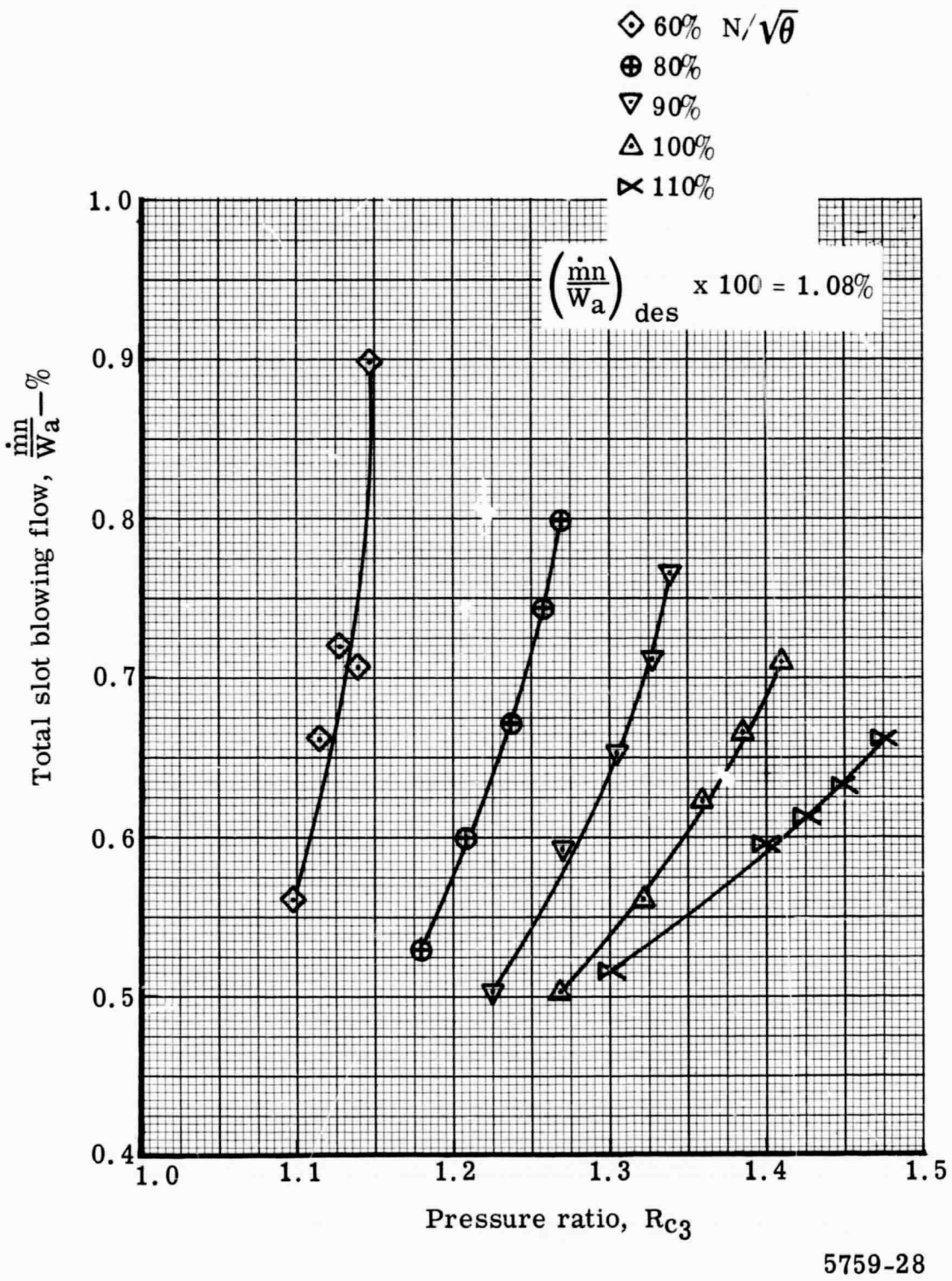
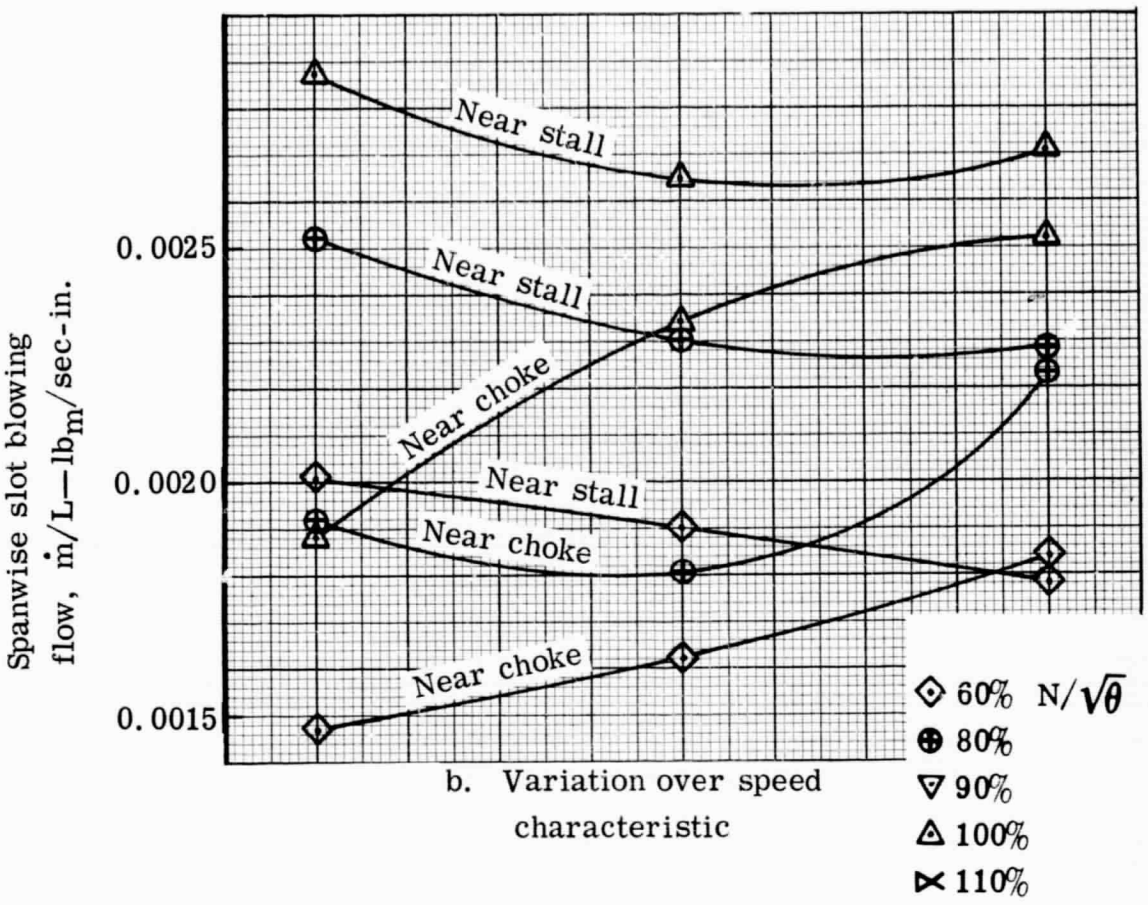
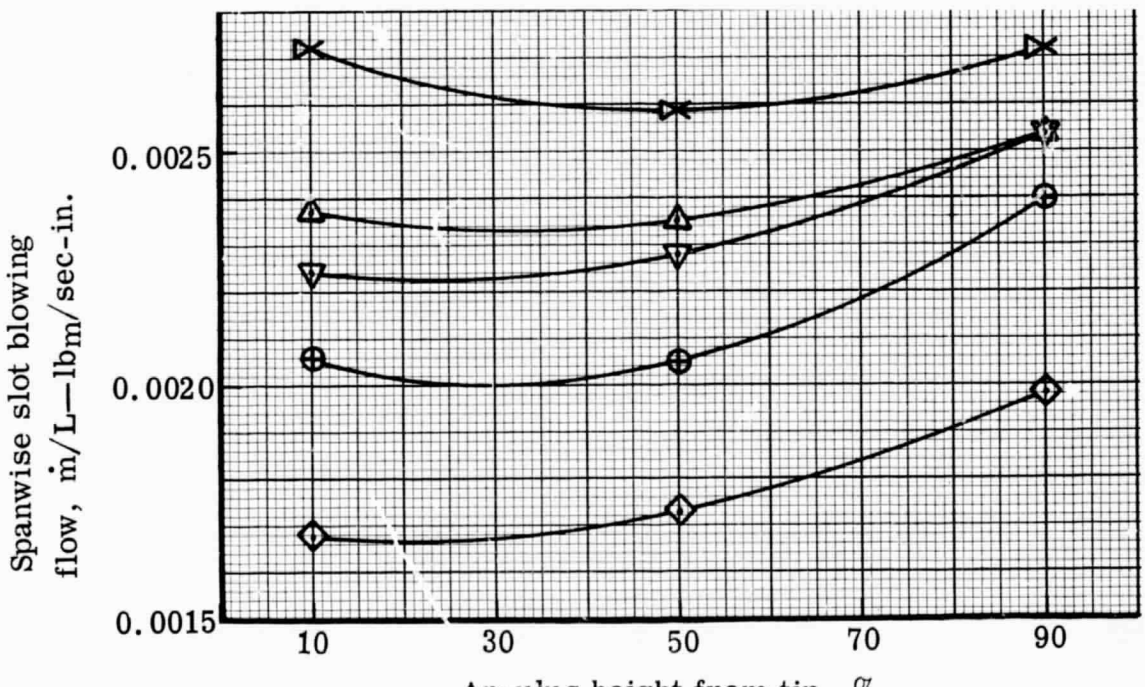


Figure 19. Stator slot blowing flow versus stage pressure ratio.



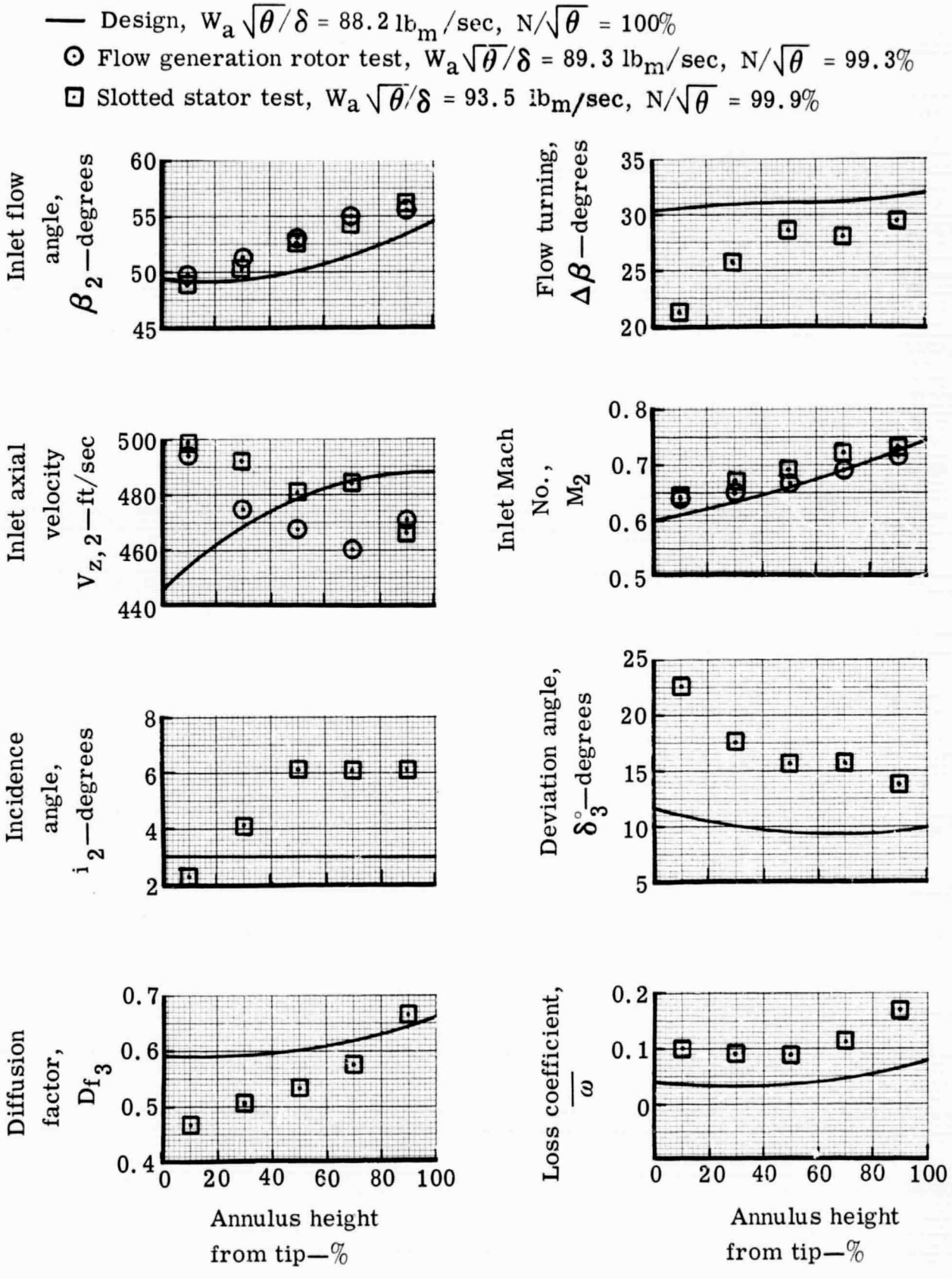
b. Variation over speed characteristic



a. At stator design incidence

5759-29

Figure 20. Stator slot blowing flow spanwise distribution.



5759-30

Figure 21. Radial variation of 0.65 D_f slotted stator blade element performance.

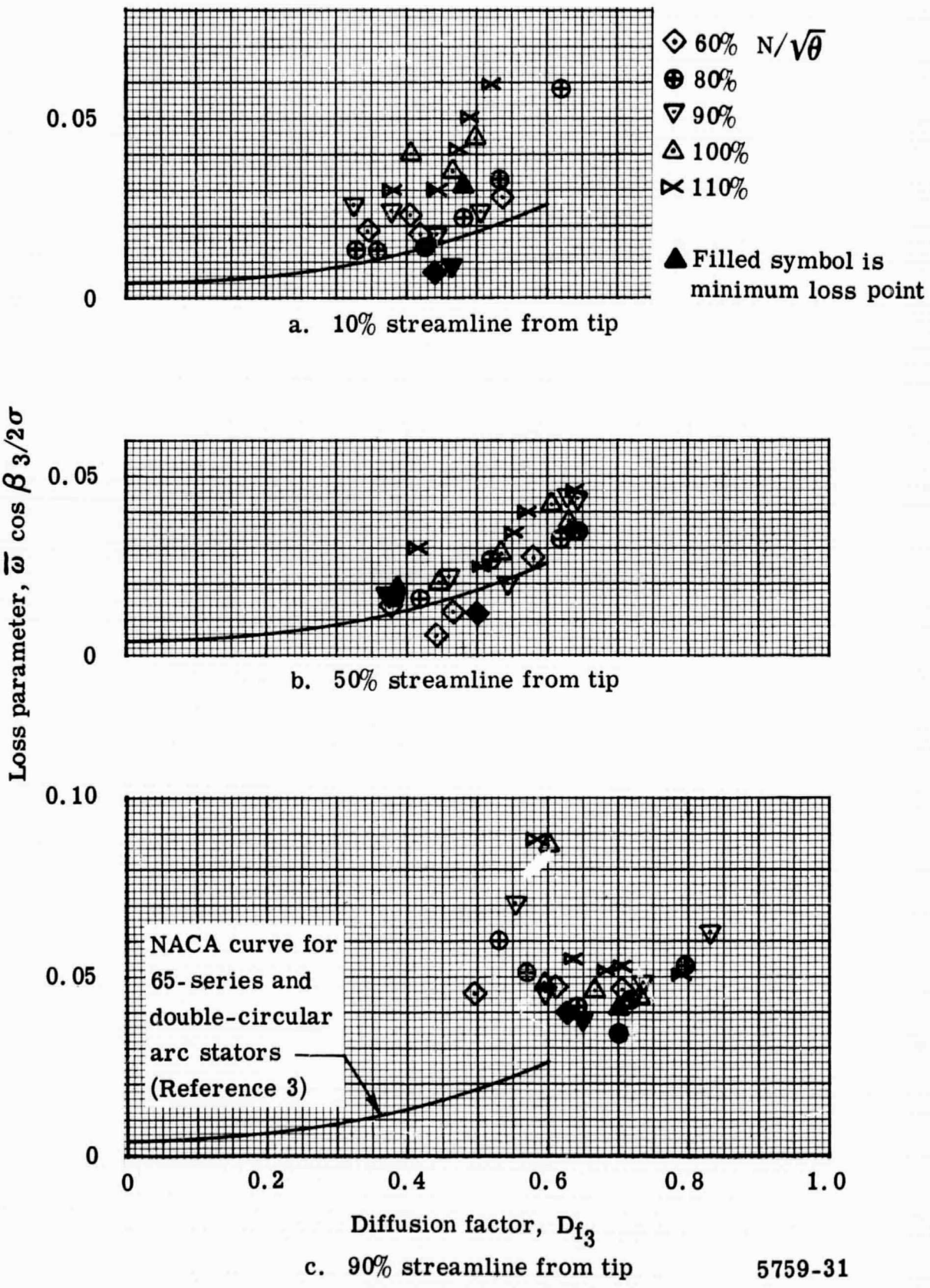
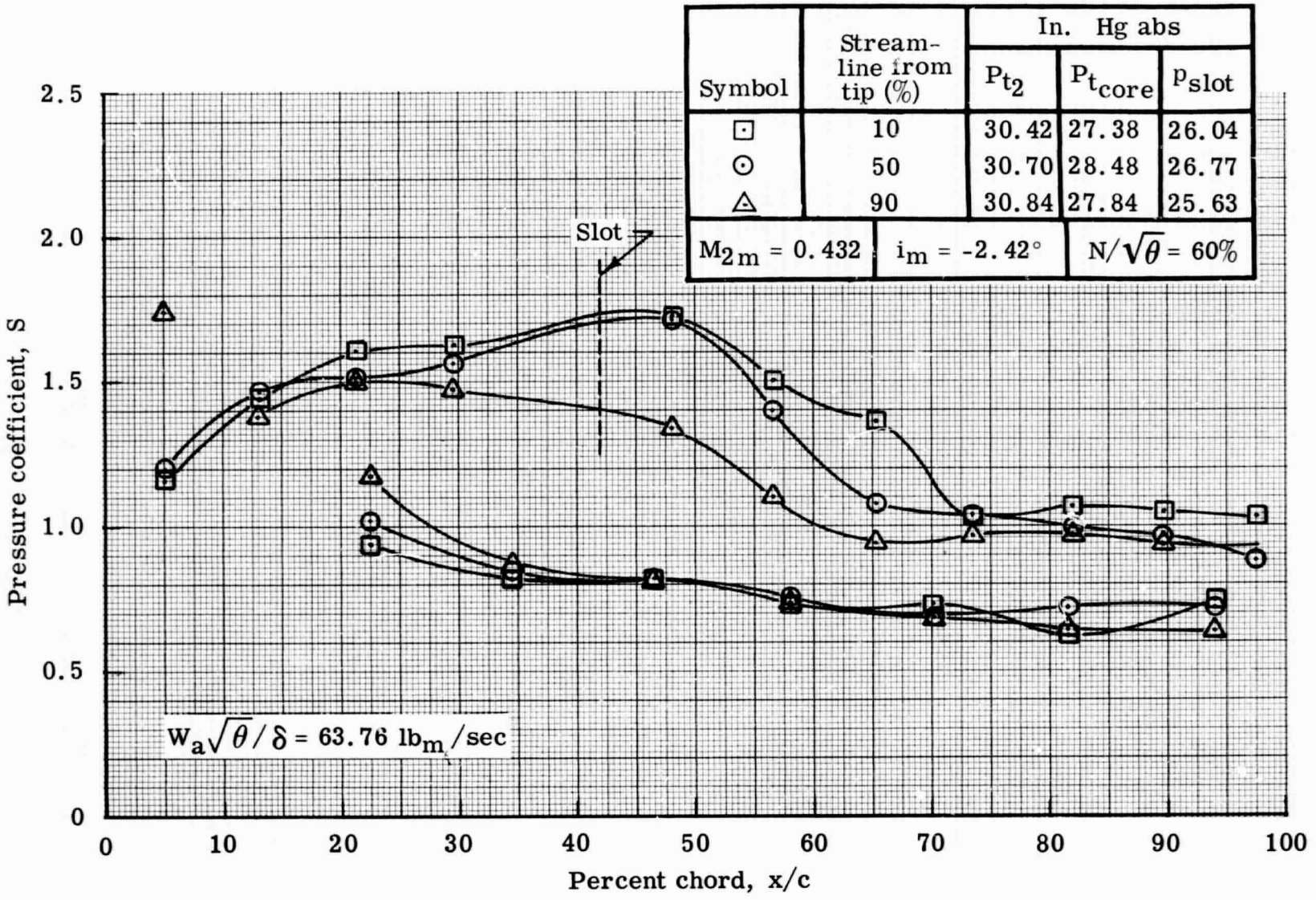


Figure 22. Stator loss parameter versus diffusion factor.



5759-32

Figure 23a. Slotted stator static pressure distribution at 60% speed.

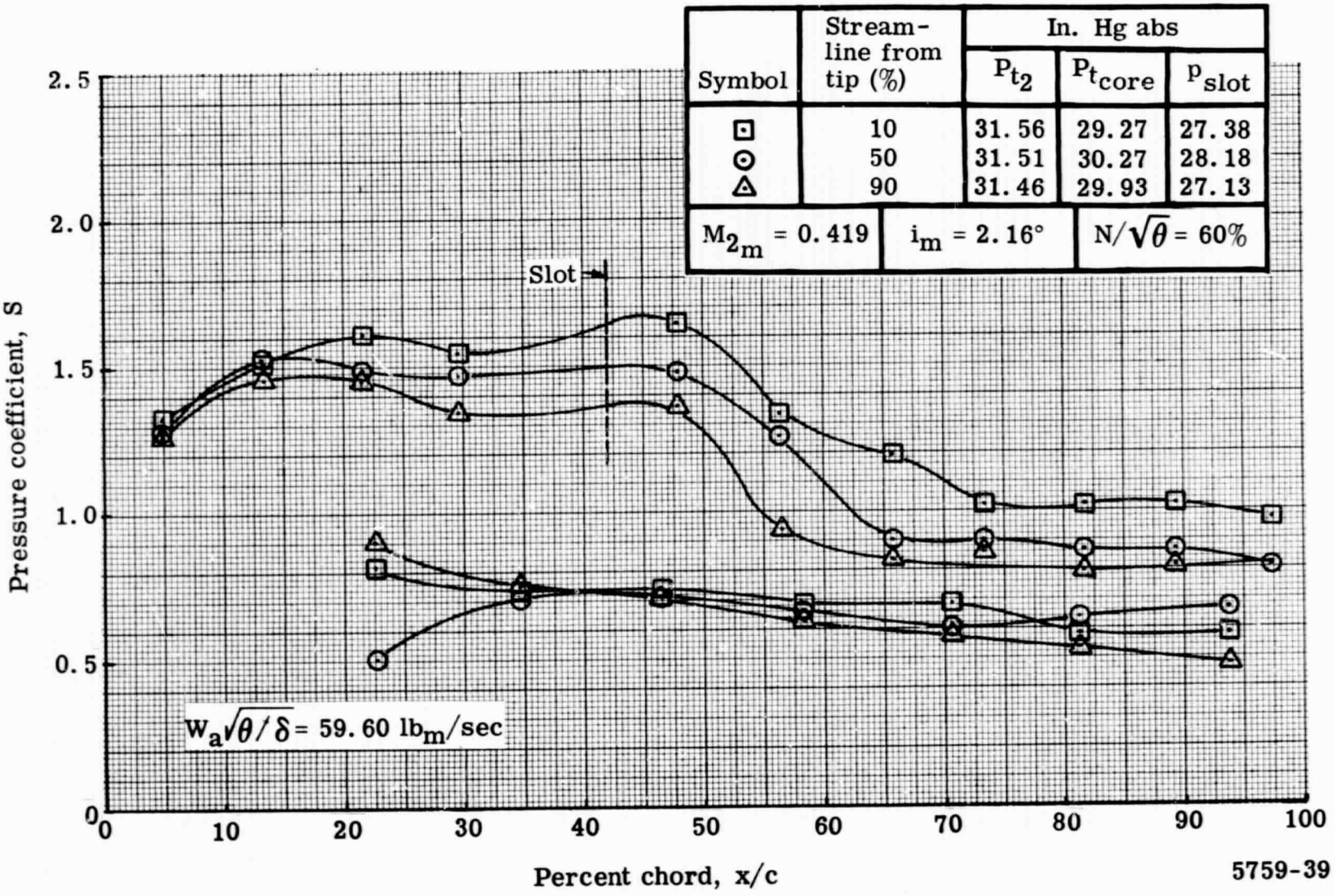


Figure 23b. Slotted stator static pressure distribution at 60% speed.

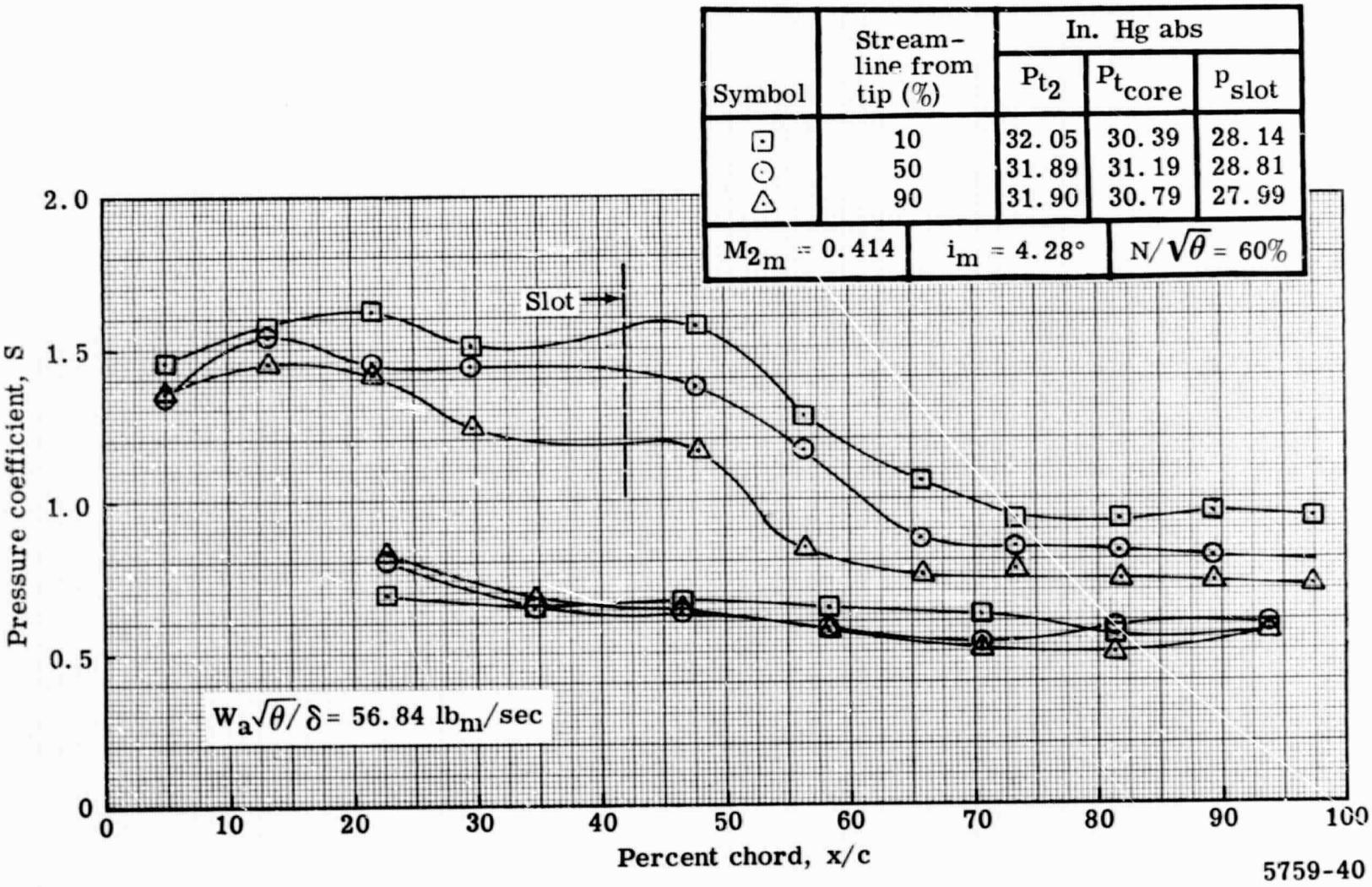


Figure 23c. Slotted stator static pressure distribution at 60% speed.

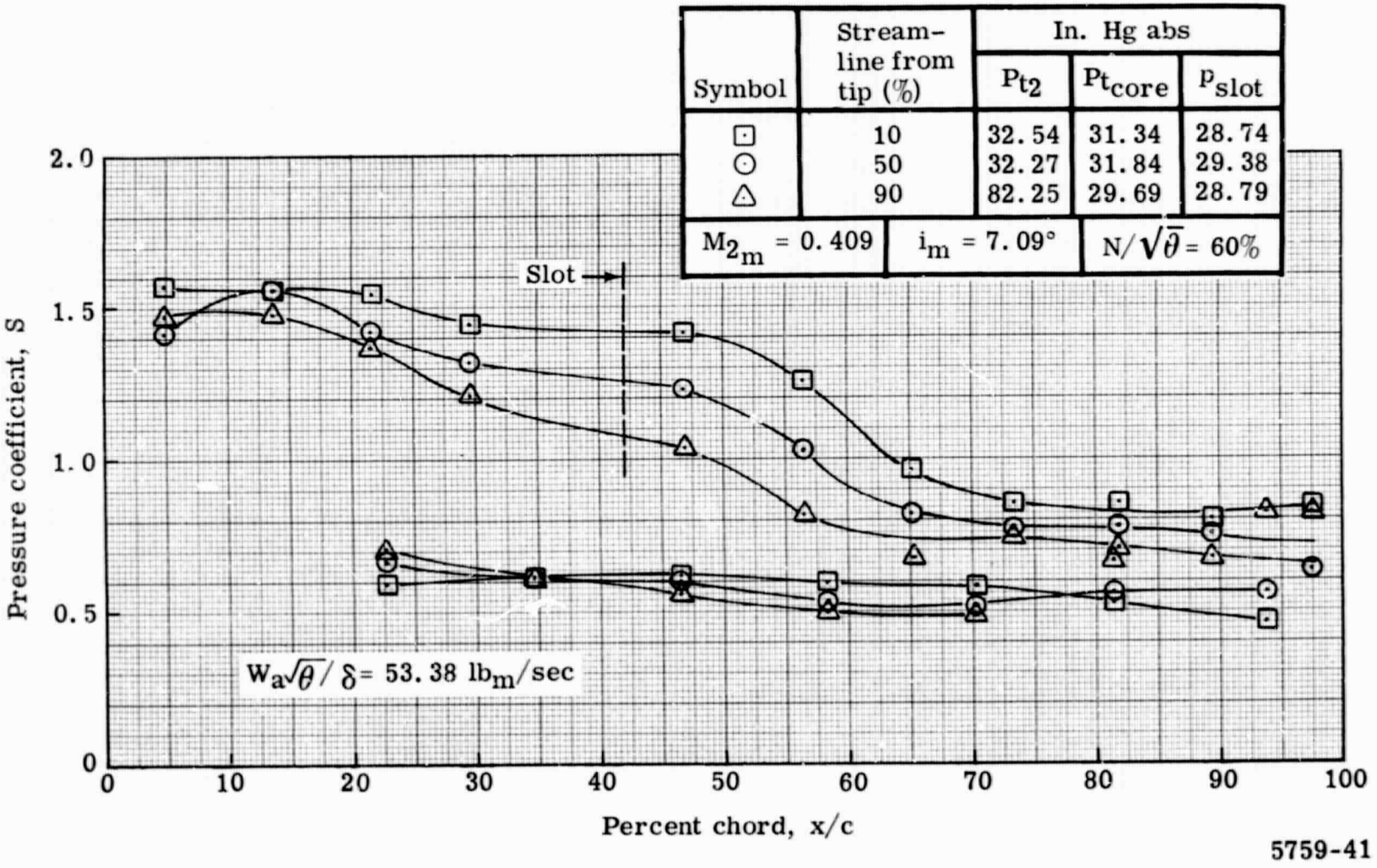


Figure 23d. Slotted stator static pressure distribution at 60% speed.

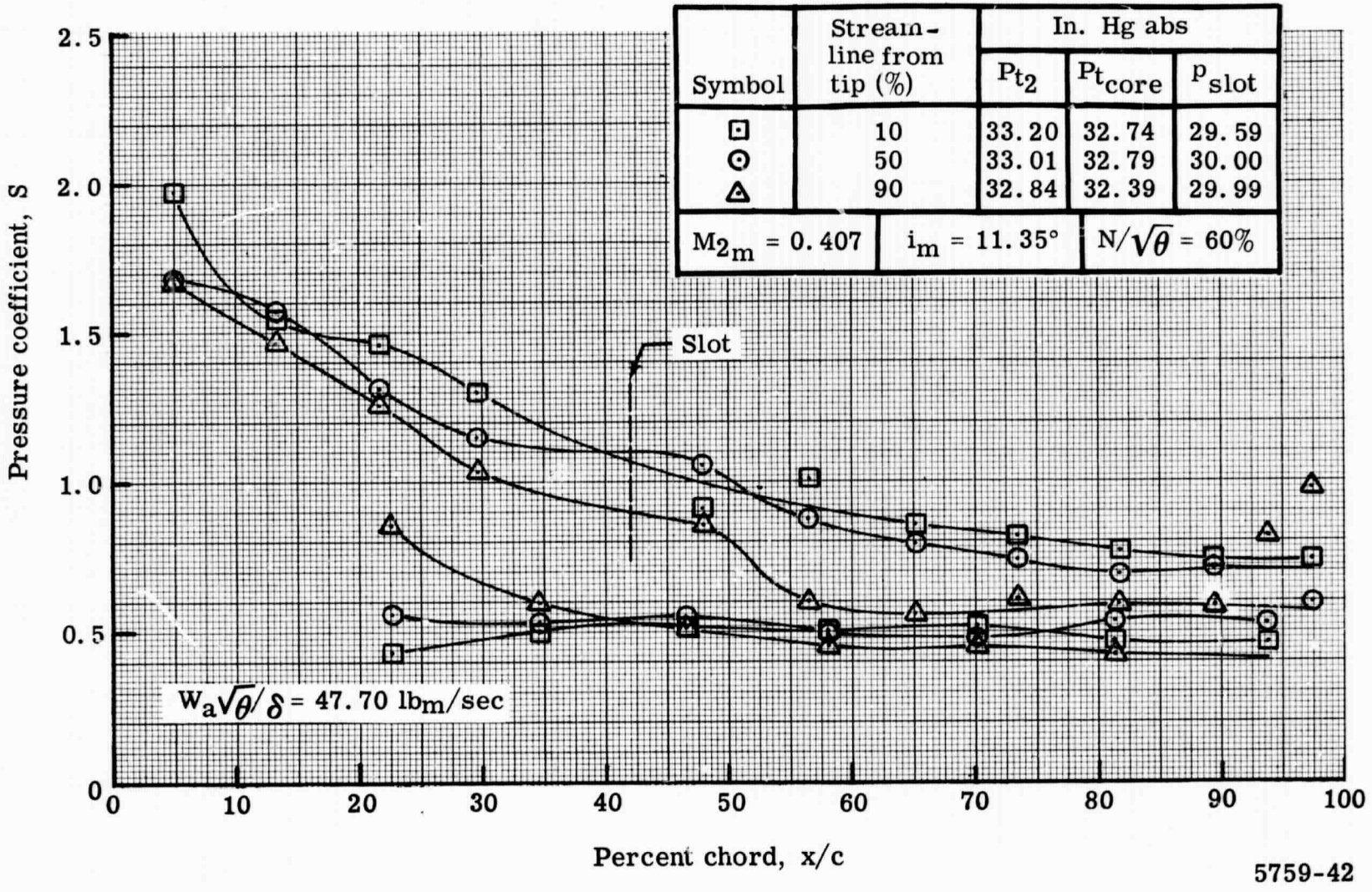


Figure 23e. Slotted stator static pressure distribution at 60% speed.

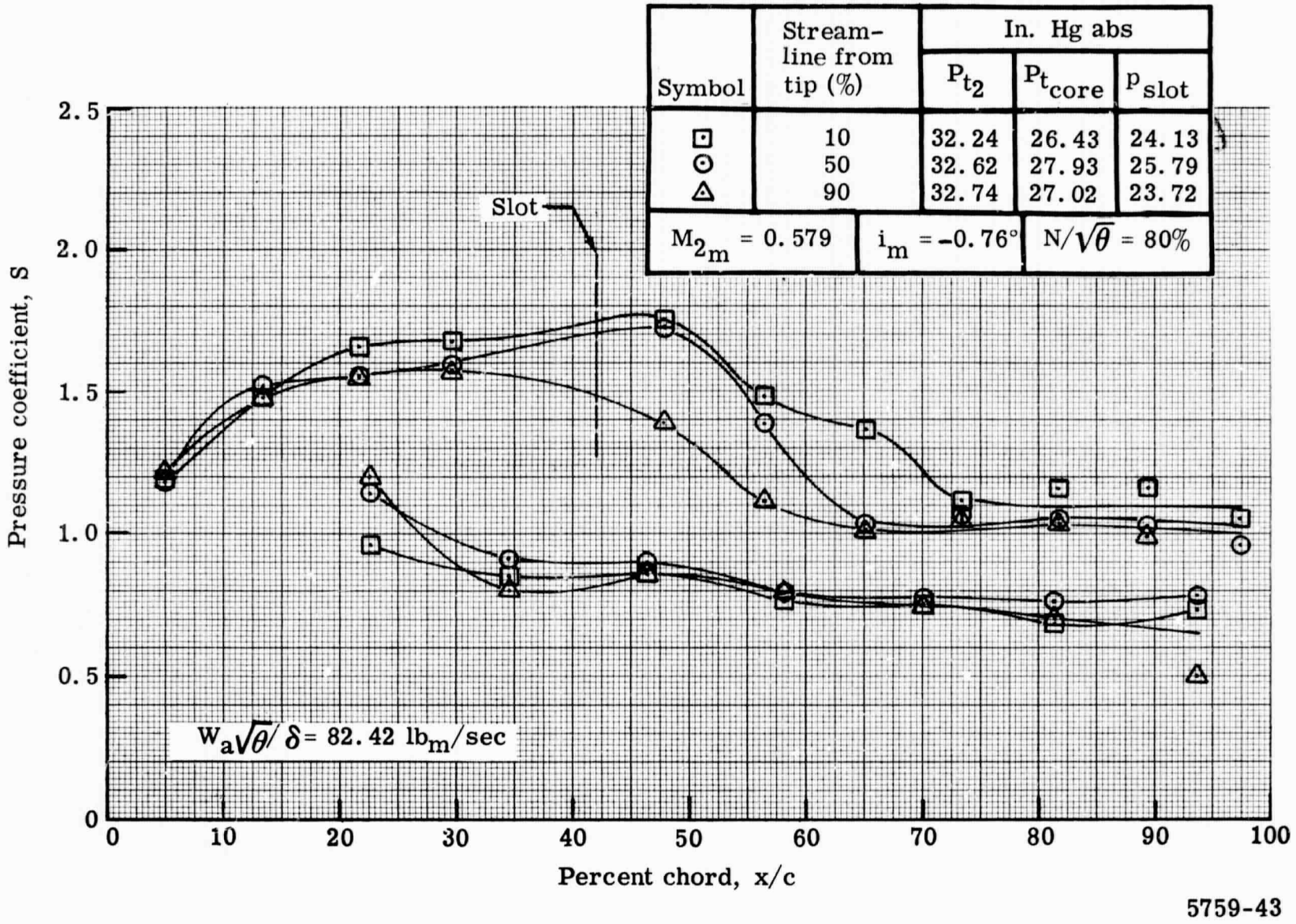


Figure 24a. Slotted stator static pressure distribution at 80% speed.

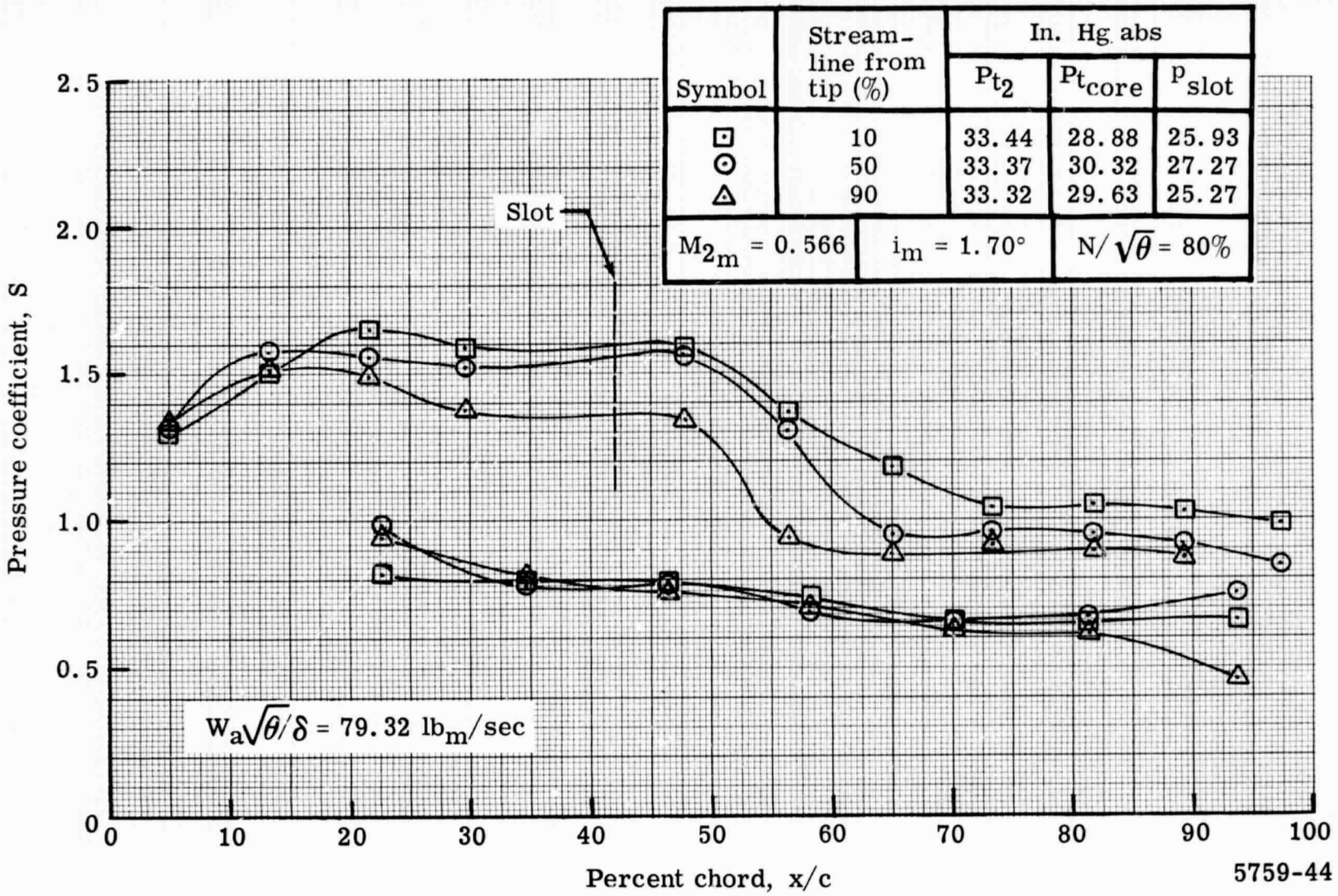


Figure 24b. Slotted stator static pressure distribution at 80% speed.

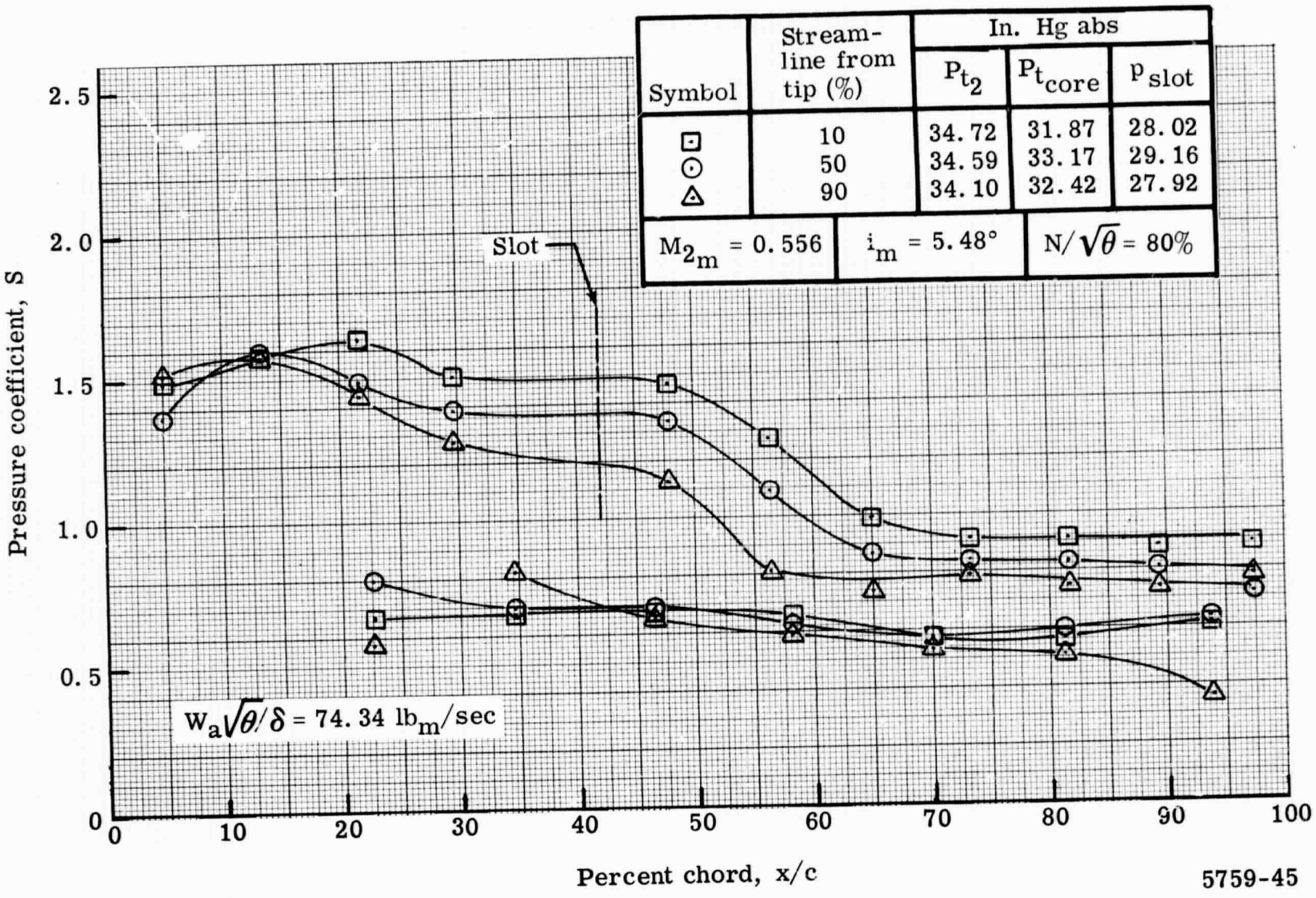


Figure 24c. Slotted stator static pressure distribution at 80% speed.

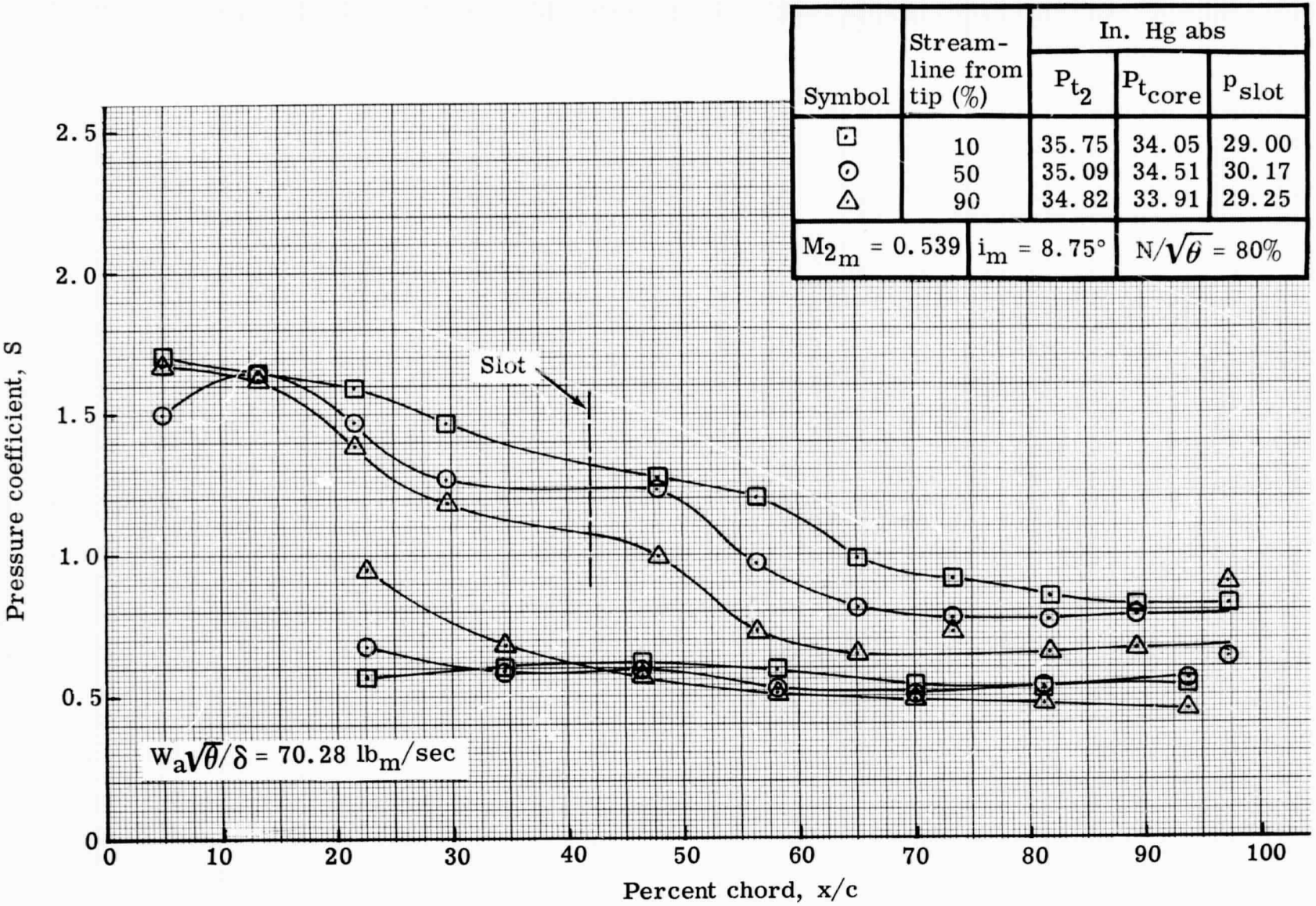


Figure 24d. Slotted stator static pressure distribution at 80% speed. 5759-46

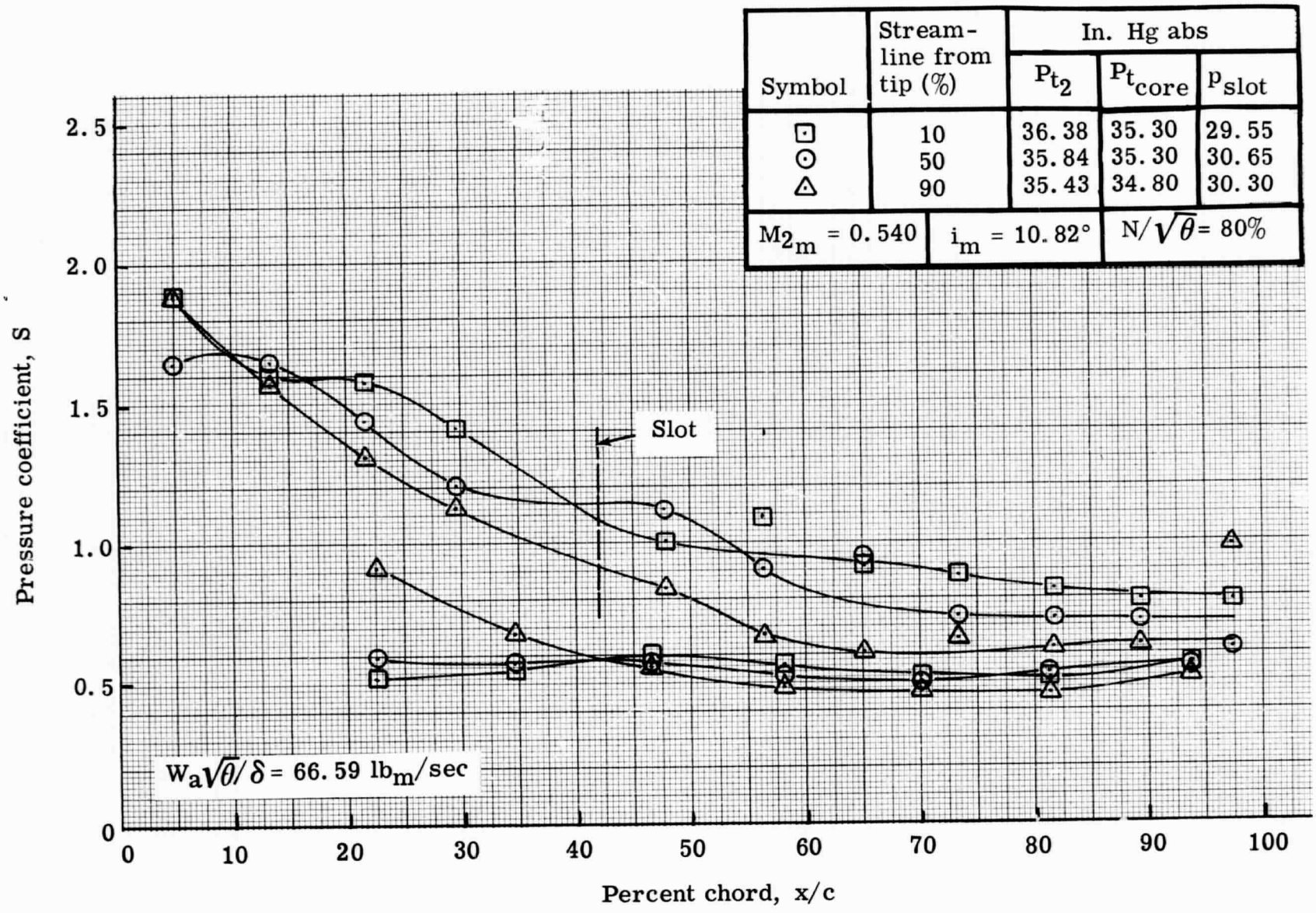


Figure 24e. Slotted stator static pressure distribution at 80% speed.

5759-47

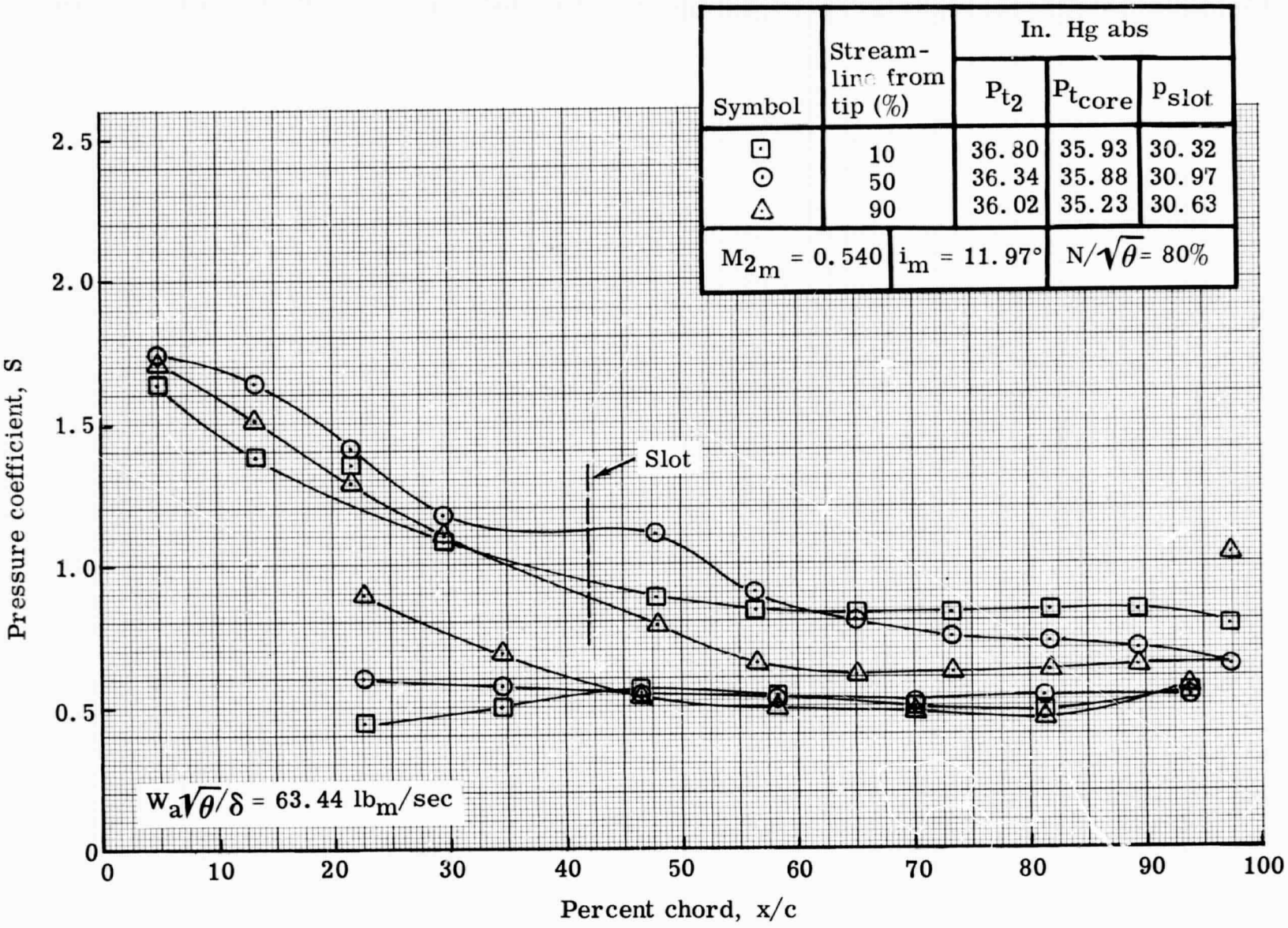


Figure 24f. Slotted stator static pressure distribution at 80% speed. 5759-48

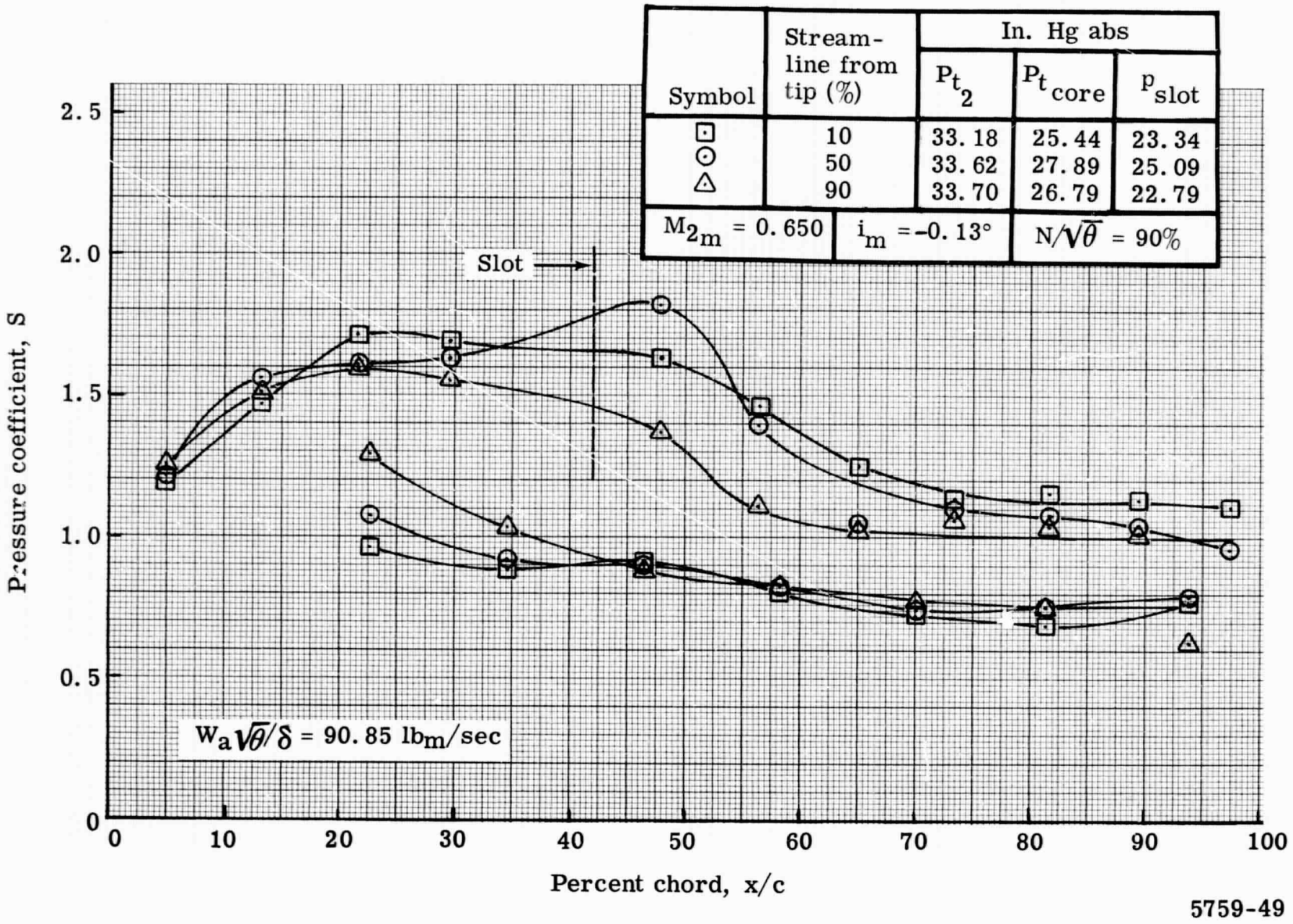


Figure 25a. Slotted stator static pressure distribution at 90% speed.

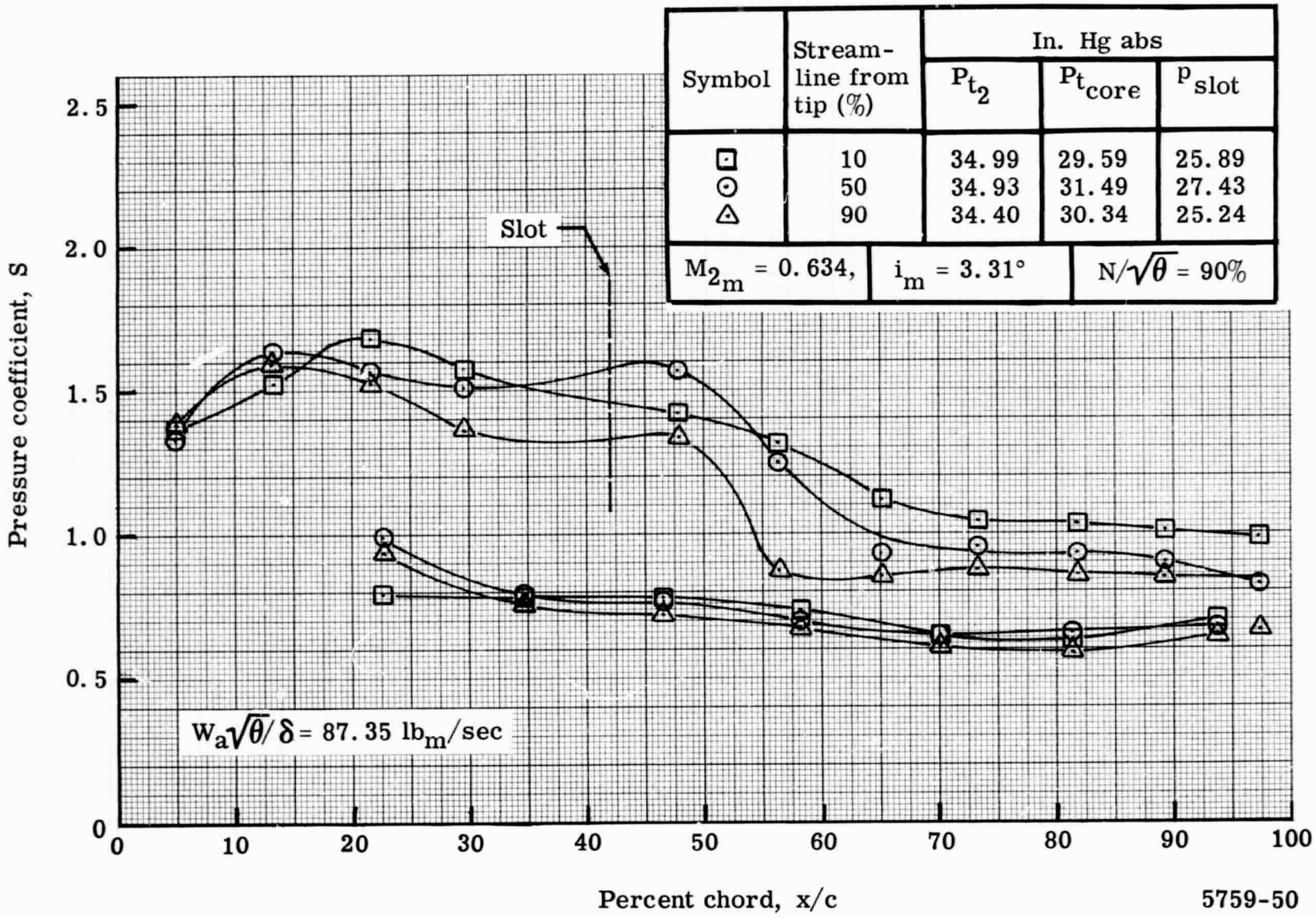


Figure 25b. Slotted stator static pressure distribution at 90% speed.

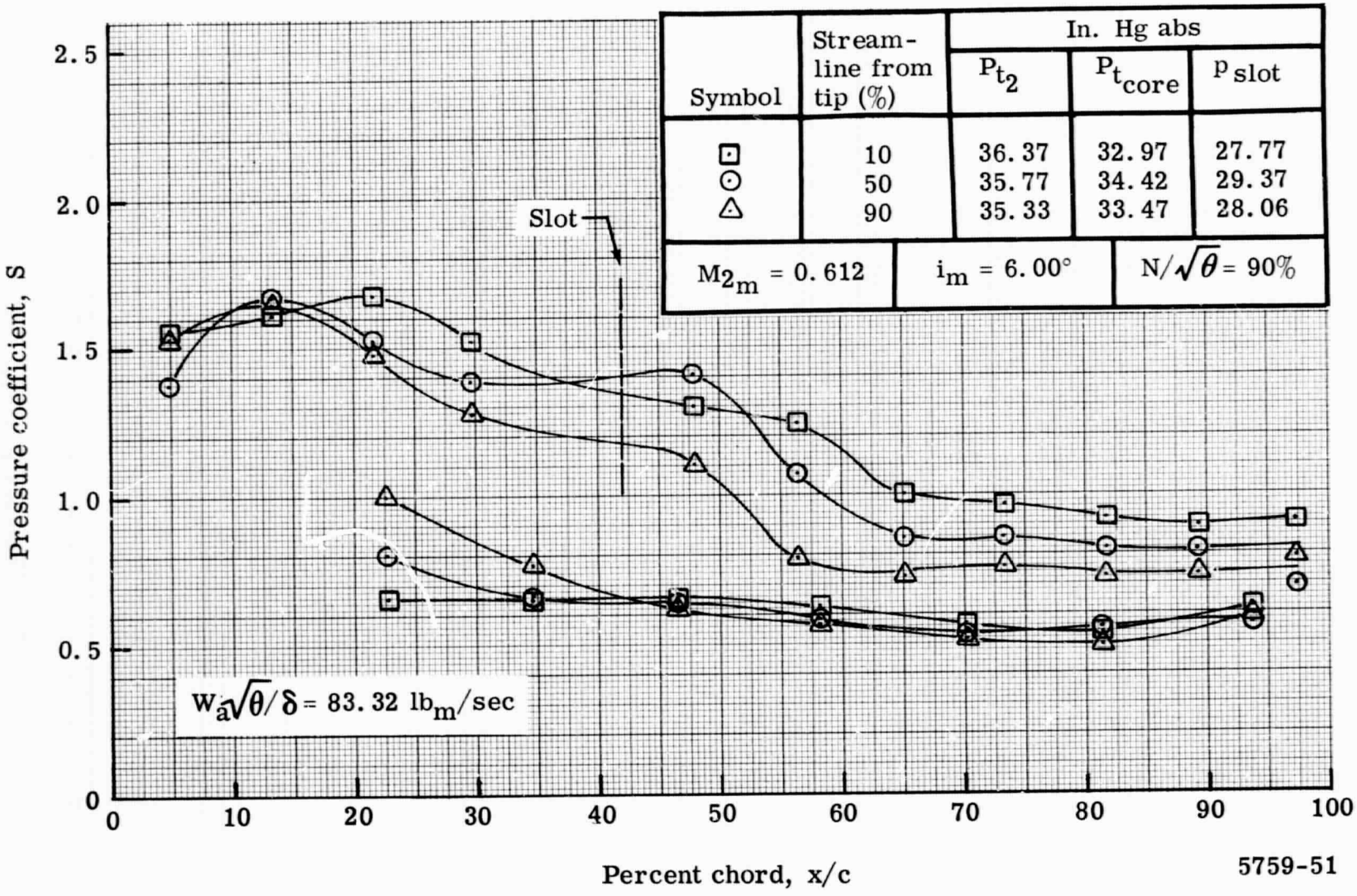


Figure 25c. Slotted stator static pressure distribution at 90% speed.

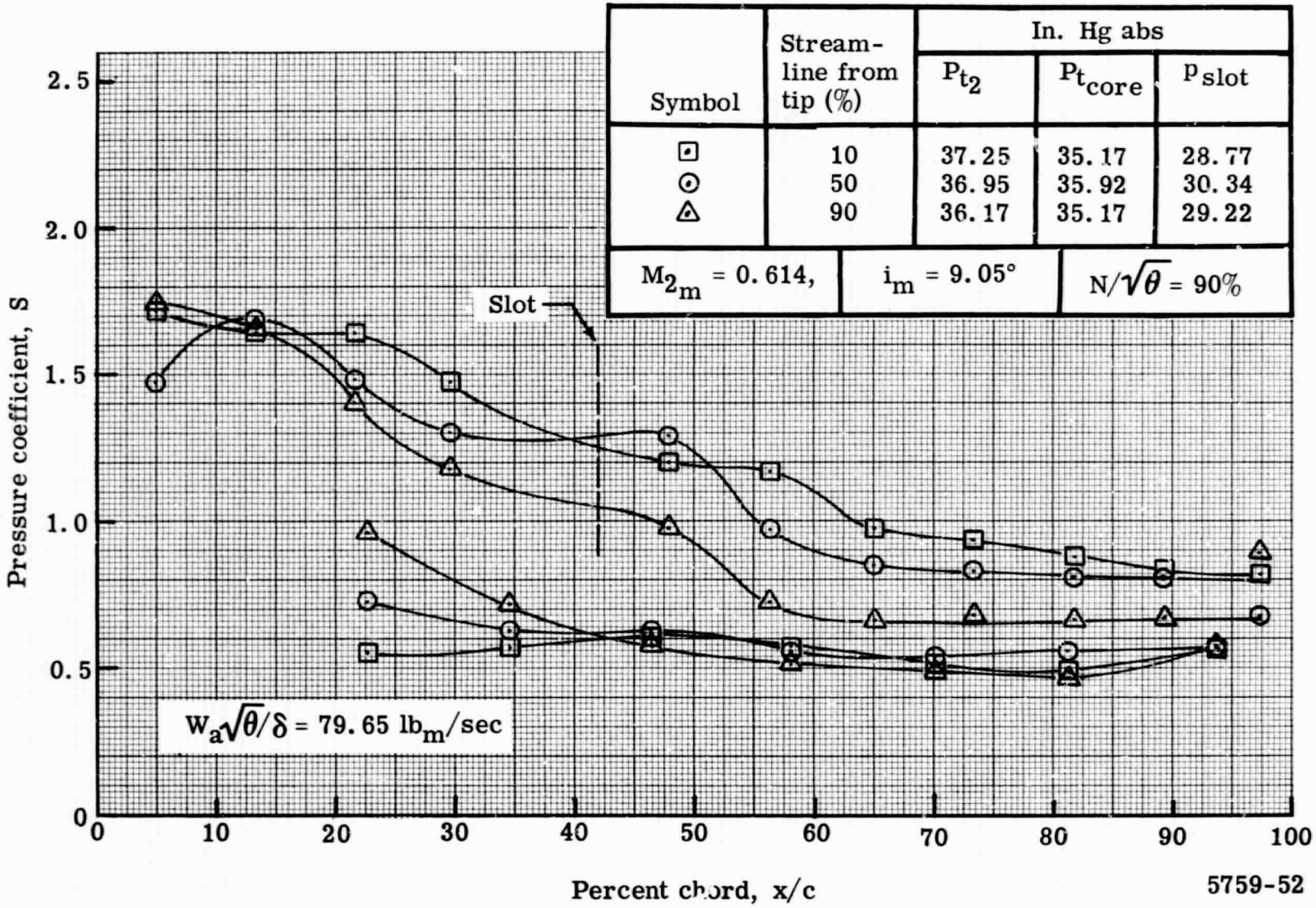


Figure 25d. Slotted stator static pressure distribution at 90% speed.

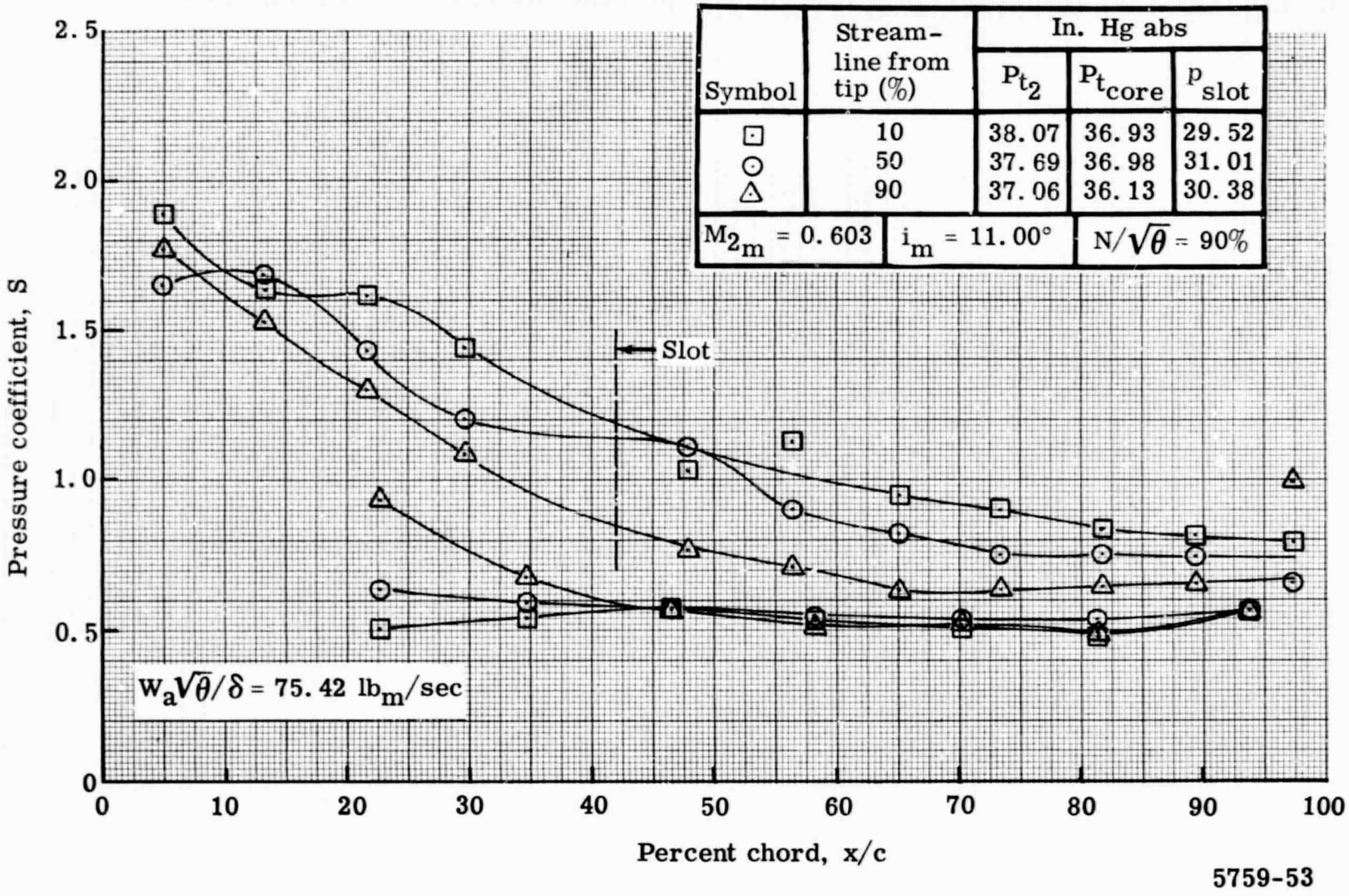


Figure 25e. Slotted stator static pressure distribution at 90% speed.

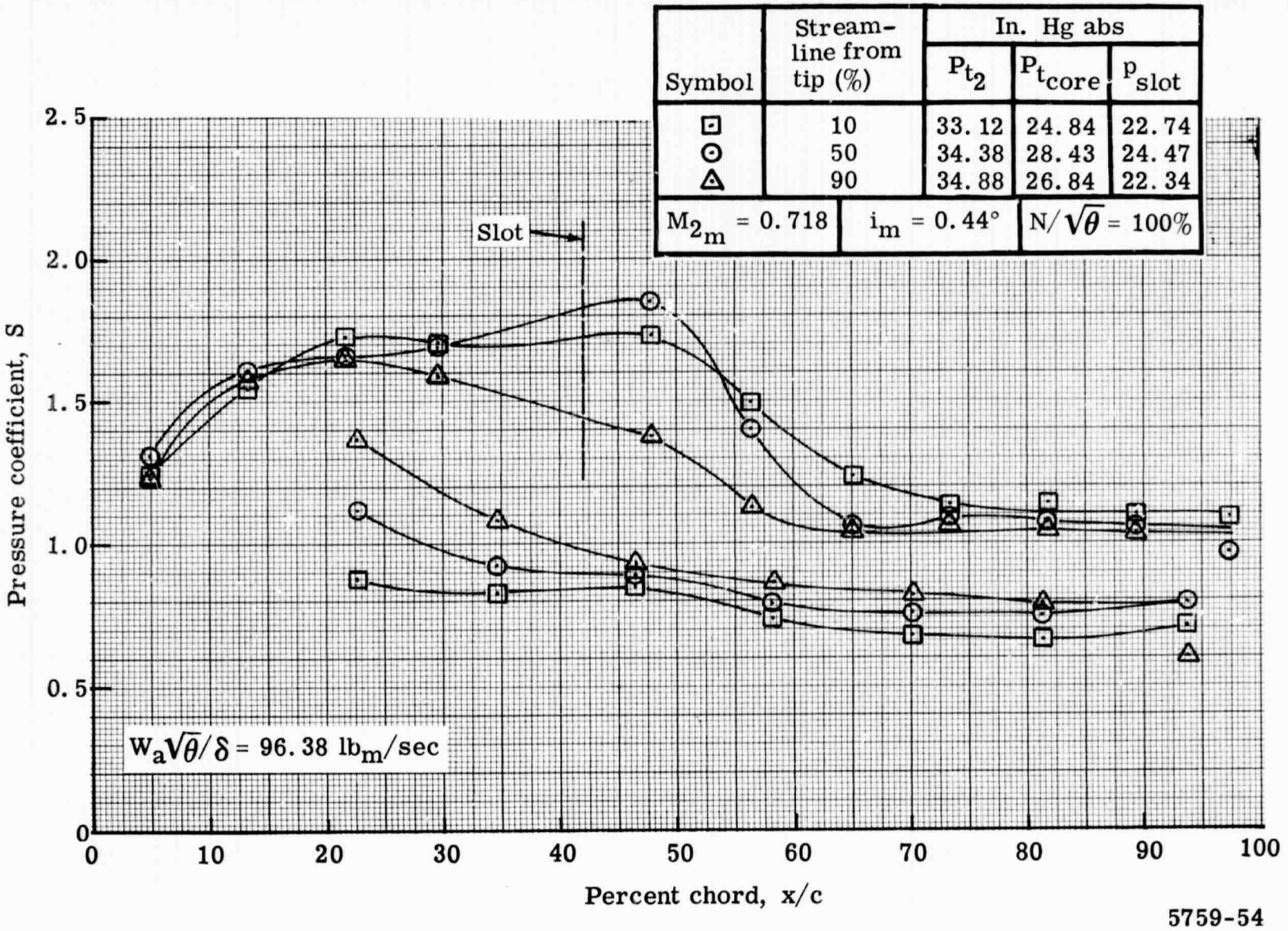


Figure 26a. Slotted stator static pressure distribution at 100% speed.

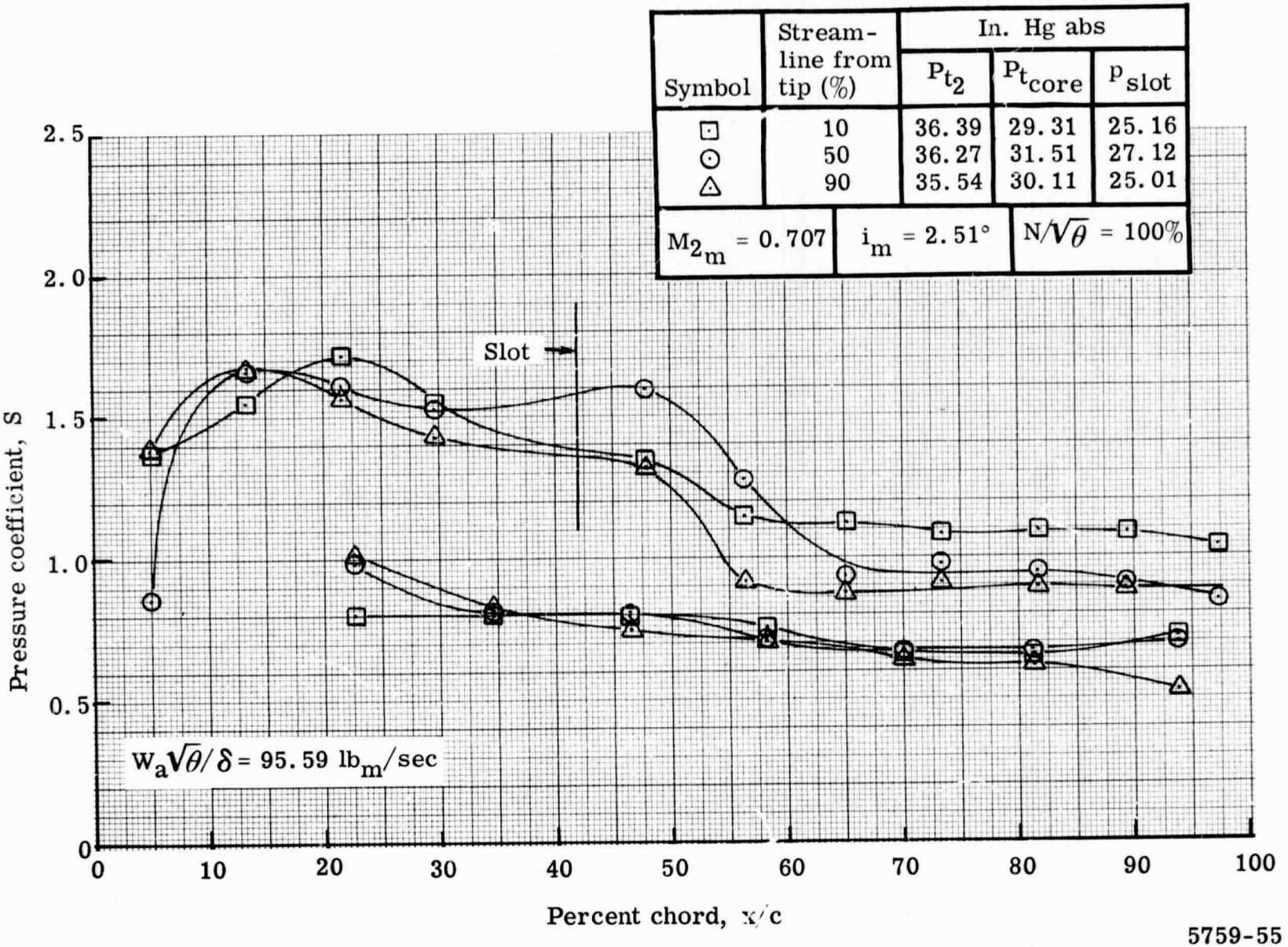


Figure 26b. Slotted stator static pressure distribution at 100% speed.

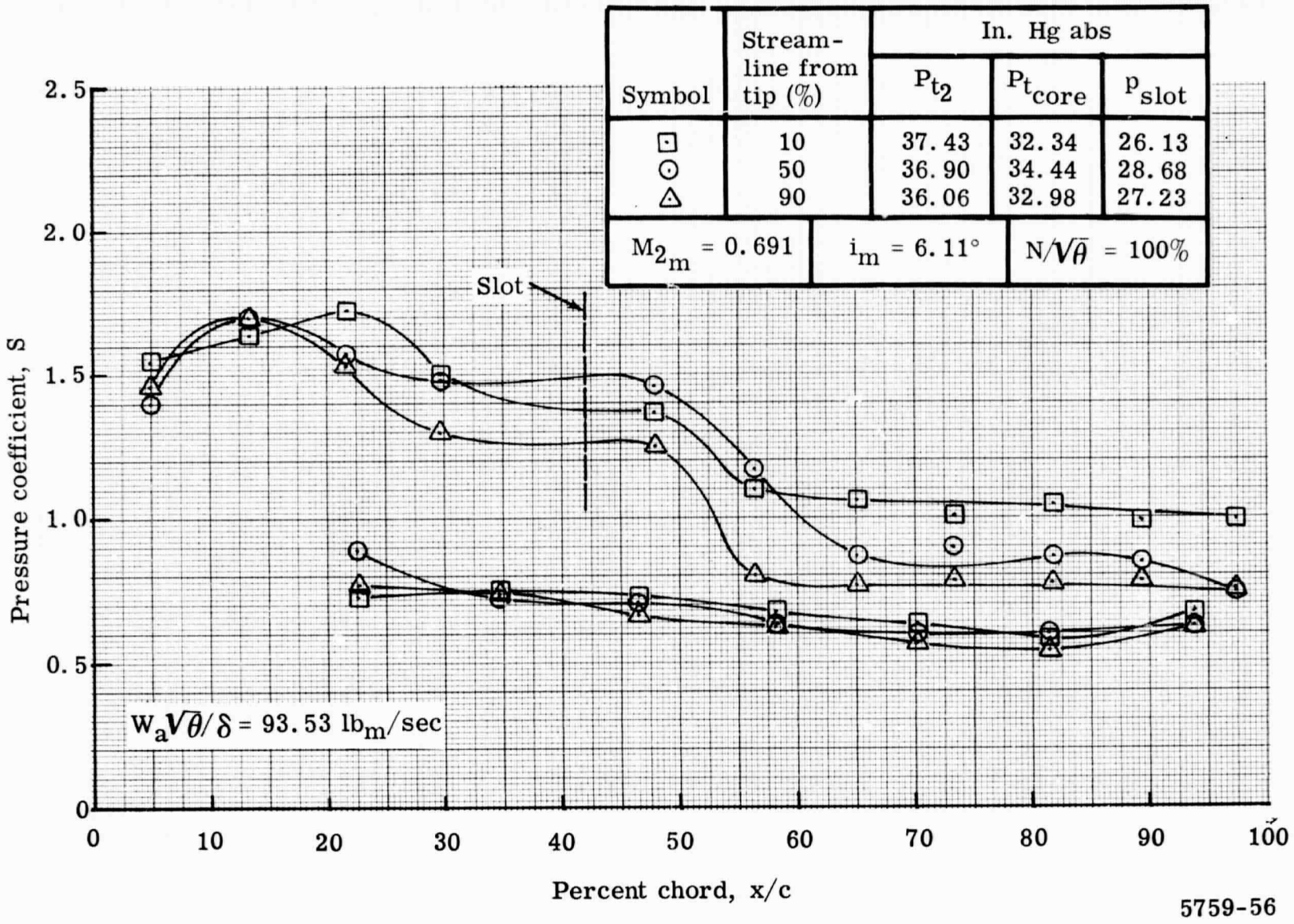


Figure 26c. Slotted stator static pressure distribution at 100% speed.

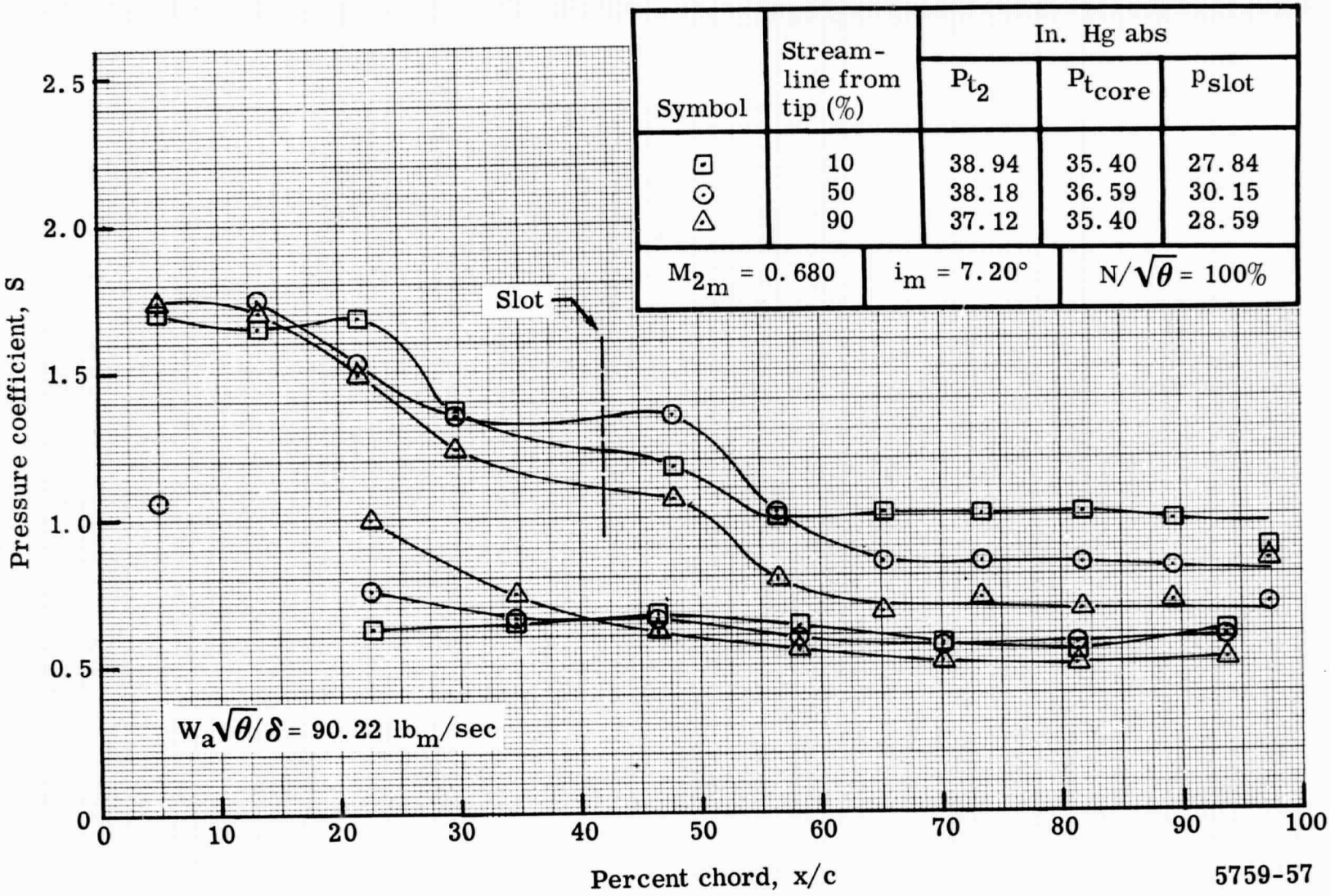


Figure 26d. Slotted stator static pressure distribution at 100% speed.

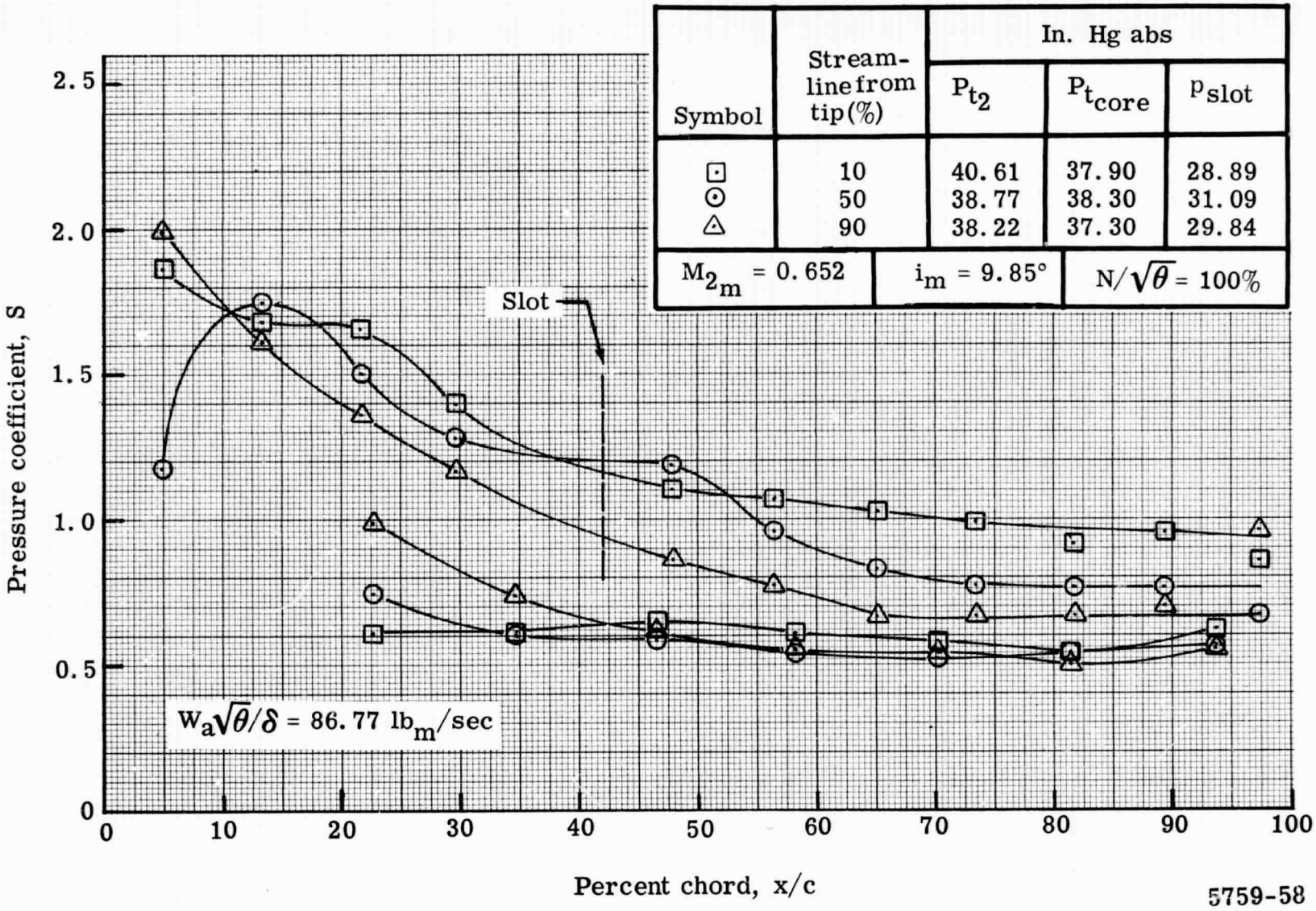
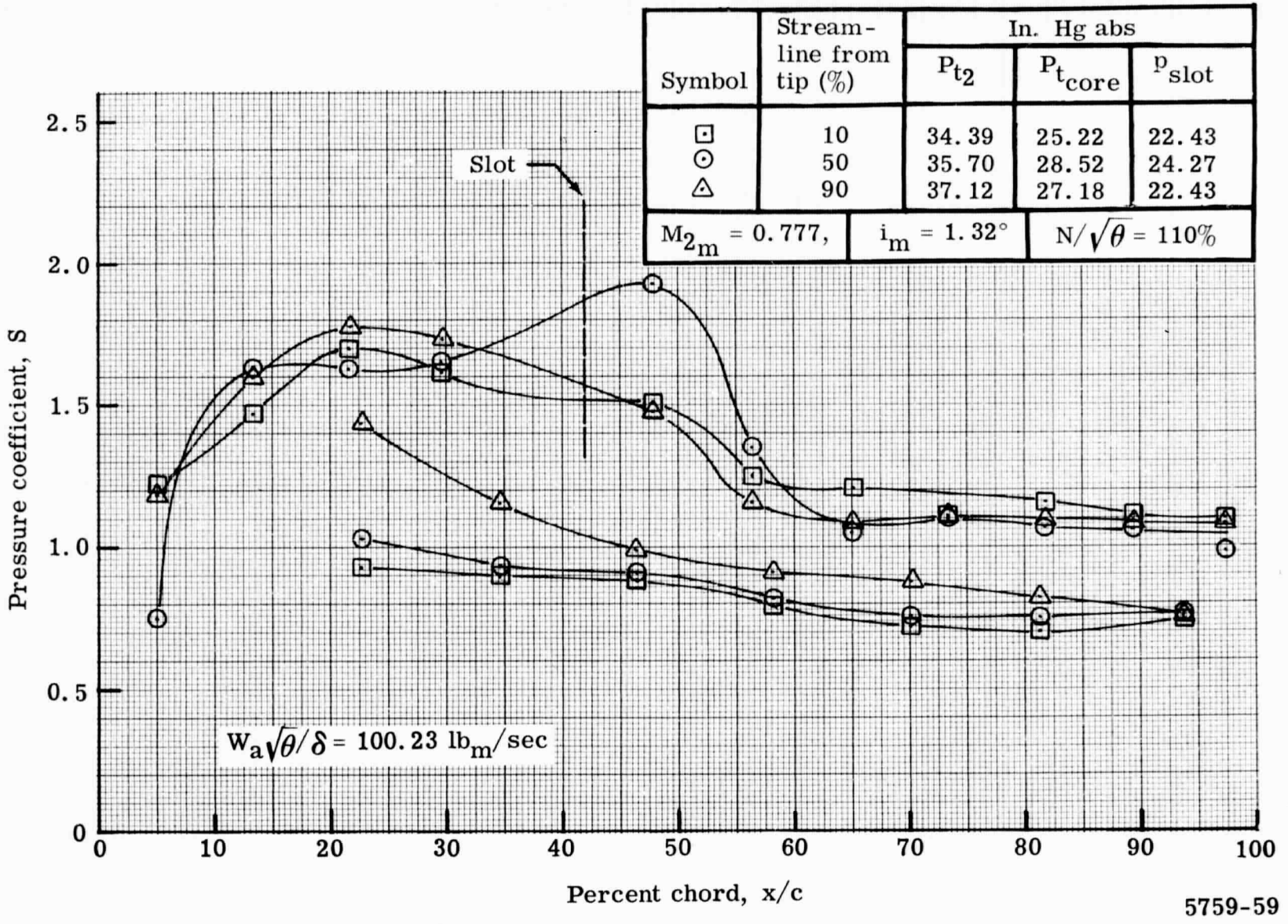


Figure 26e. Slotted stator static pressure distribution at 100% speed.



5759-59

Figure 27a. Slotted stator static pressure distribution at 110% speed.

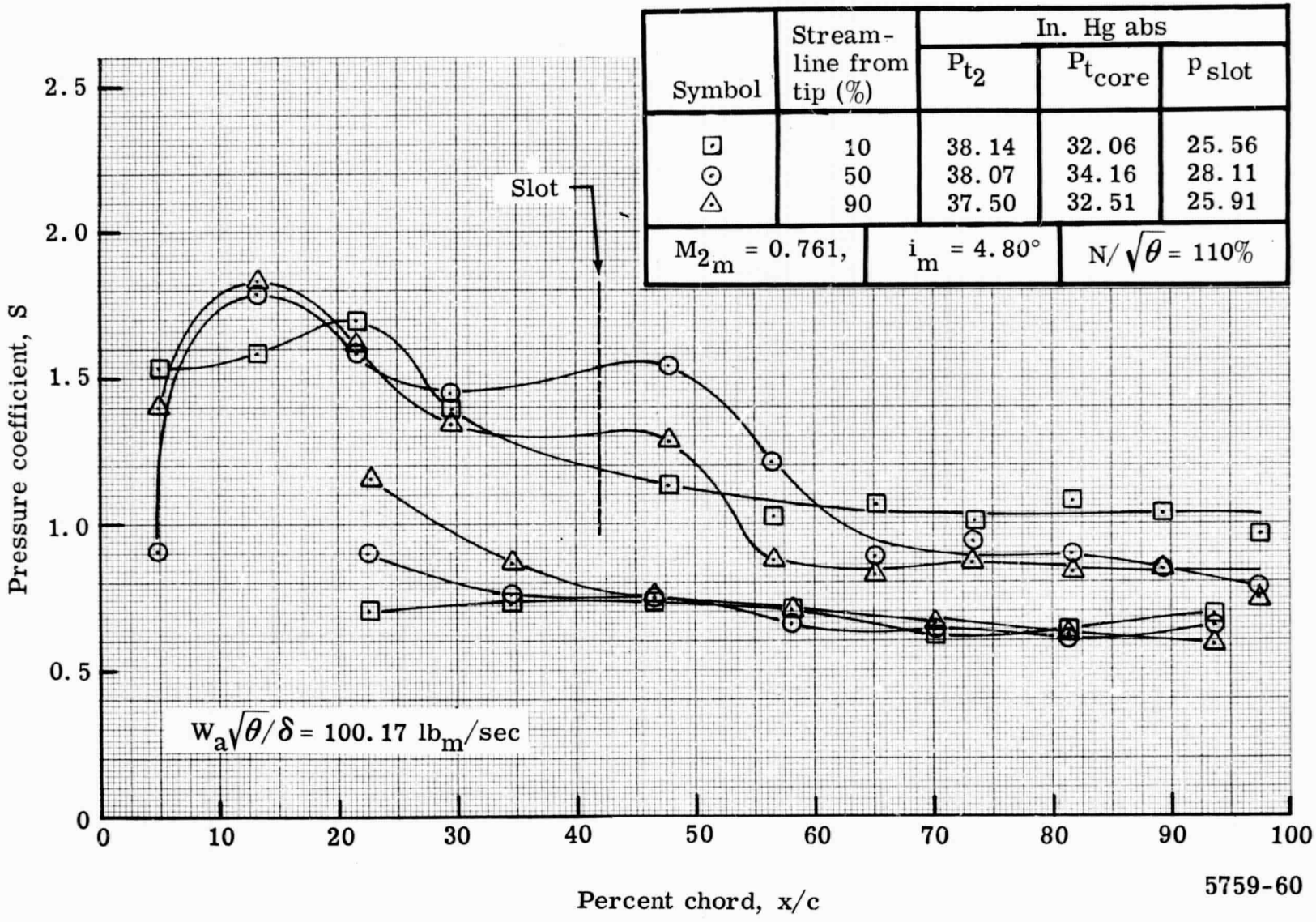


Figure 27b. Slotted stator static pressure distribution at 110% speed.

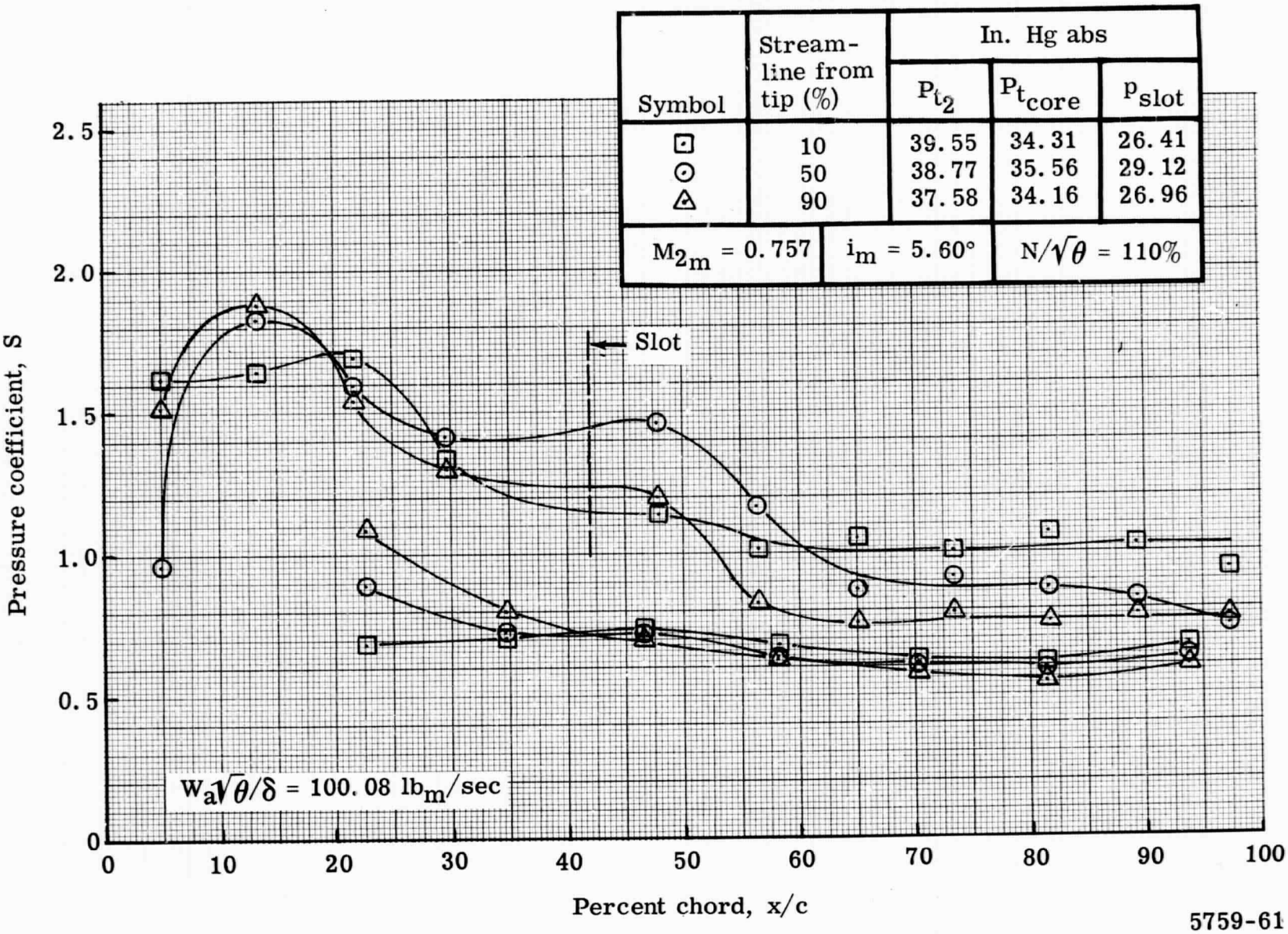


Figure 27c. Slotted stator static pressure distribution at 110% speed.

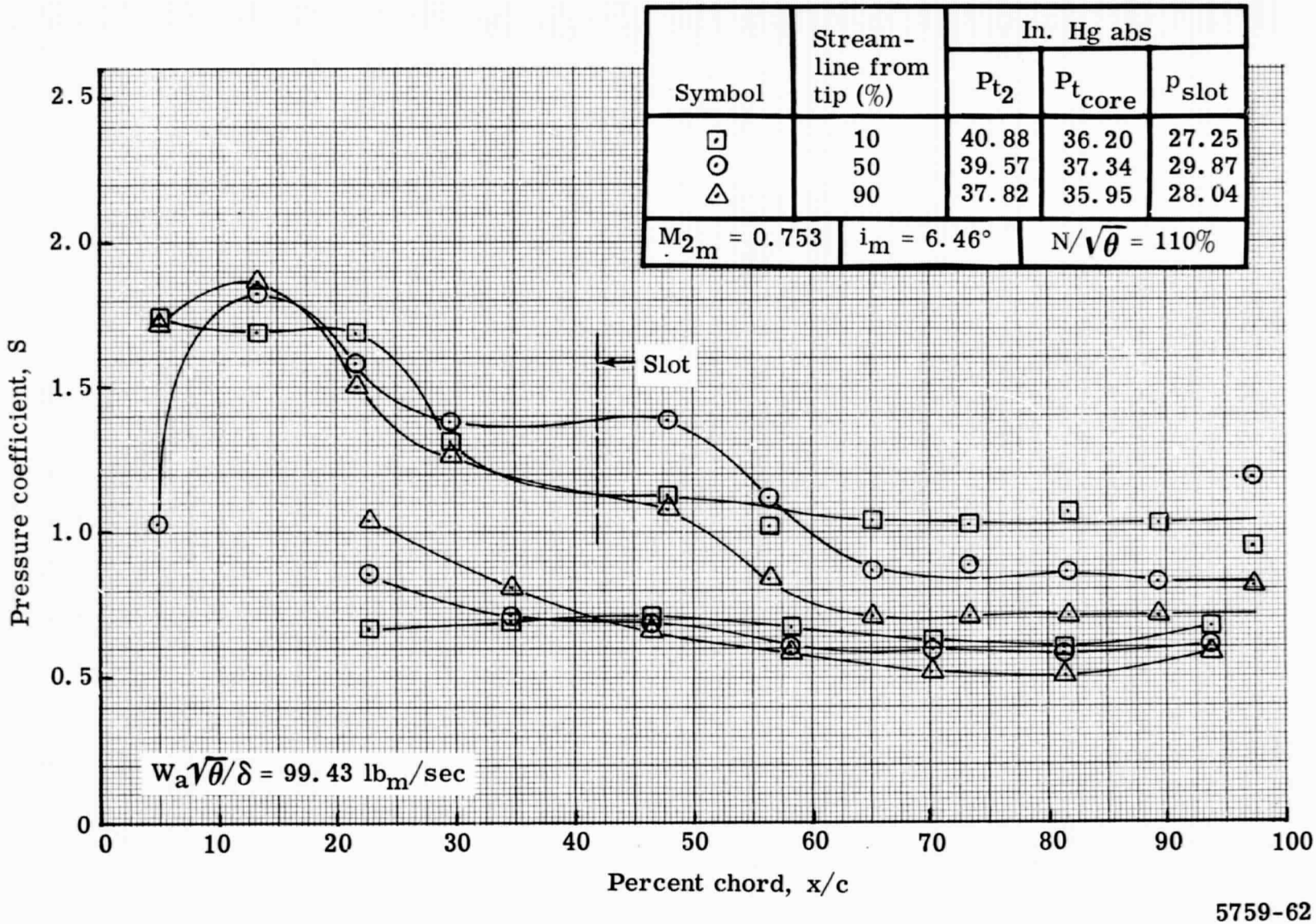
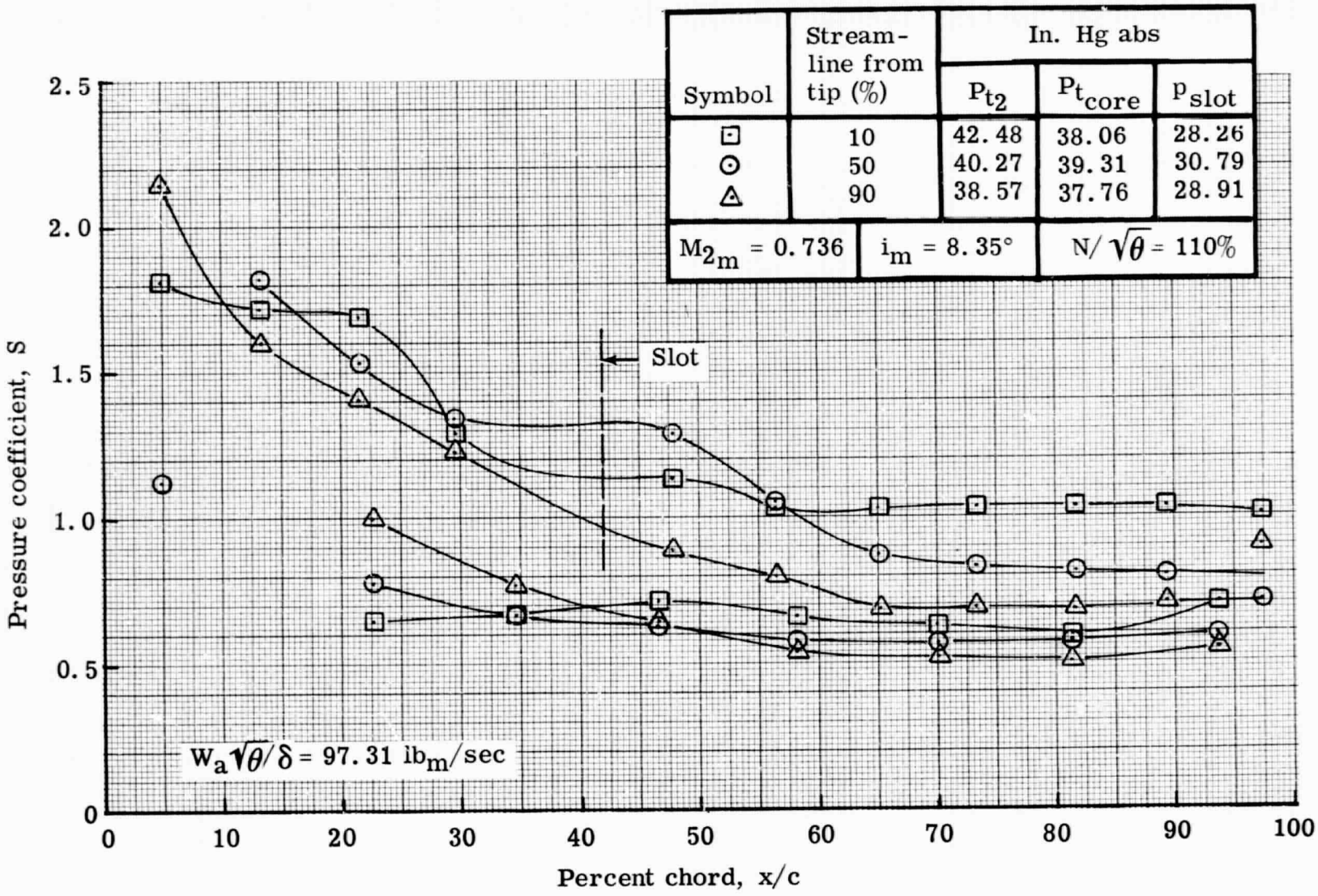


Figure 27d. Slotted stator static pressure distribution at 110% speed.



5759-63

Figure 27e. Slotted stator static pressure distribution at 110% speed.

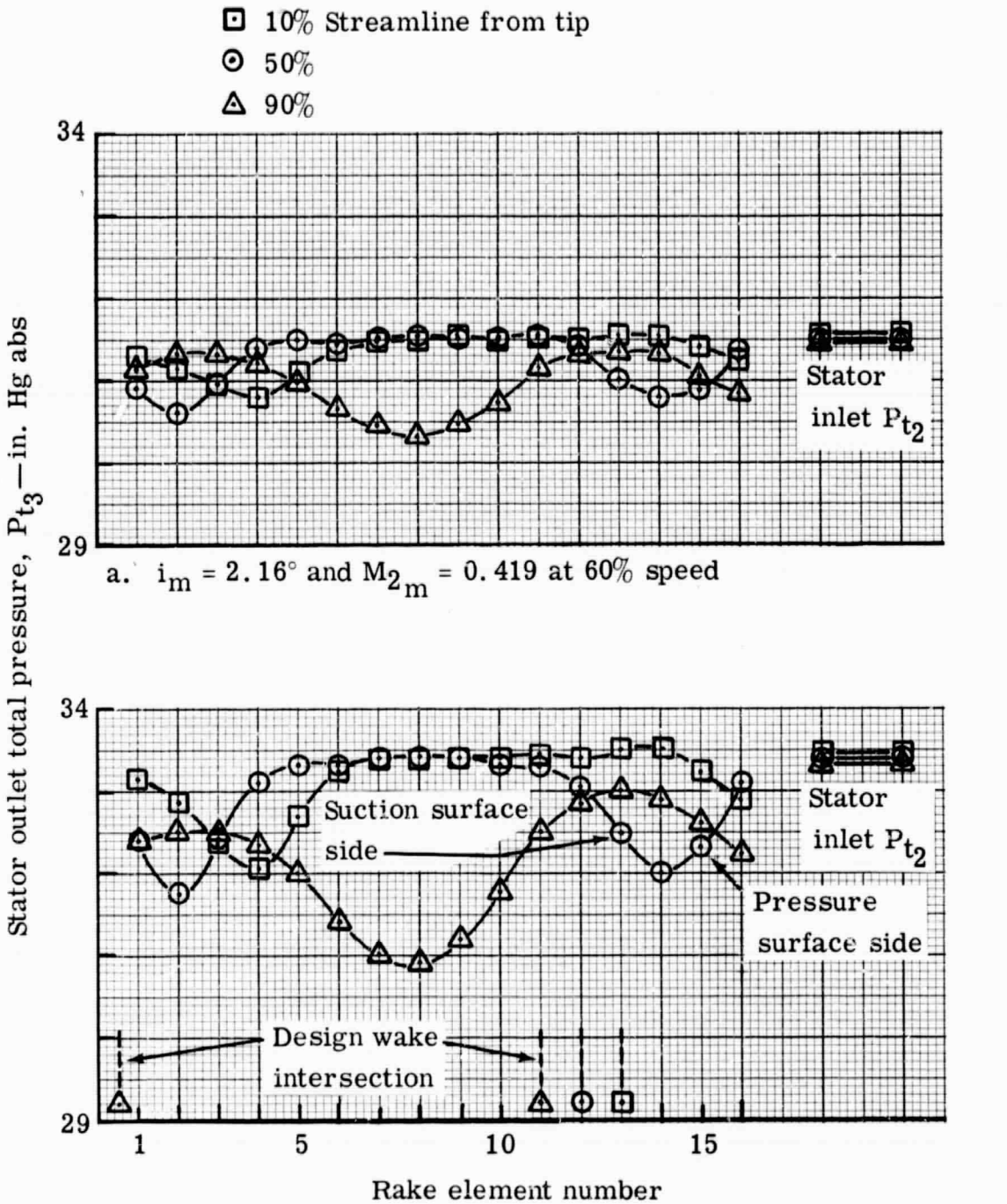
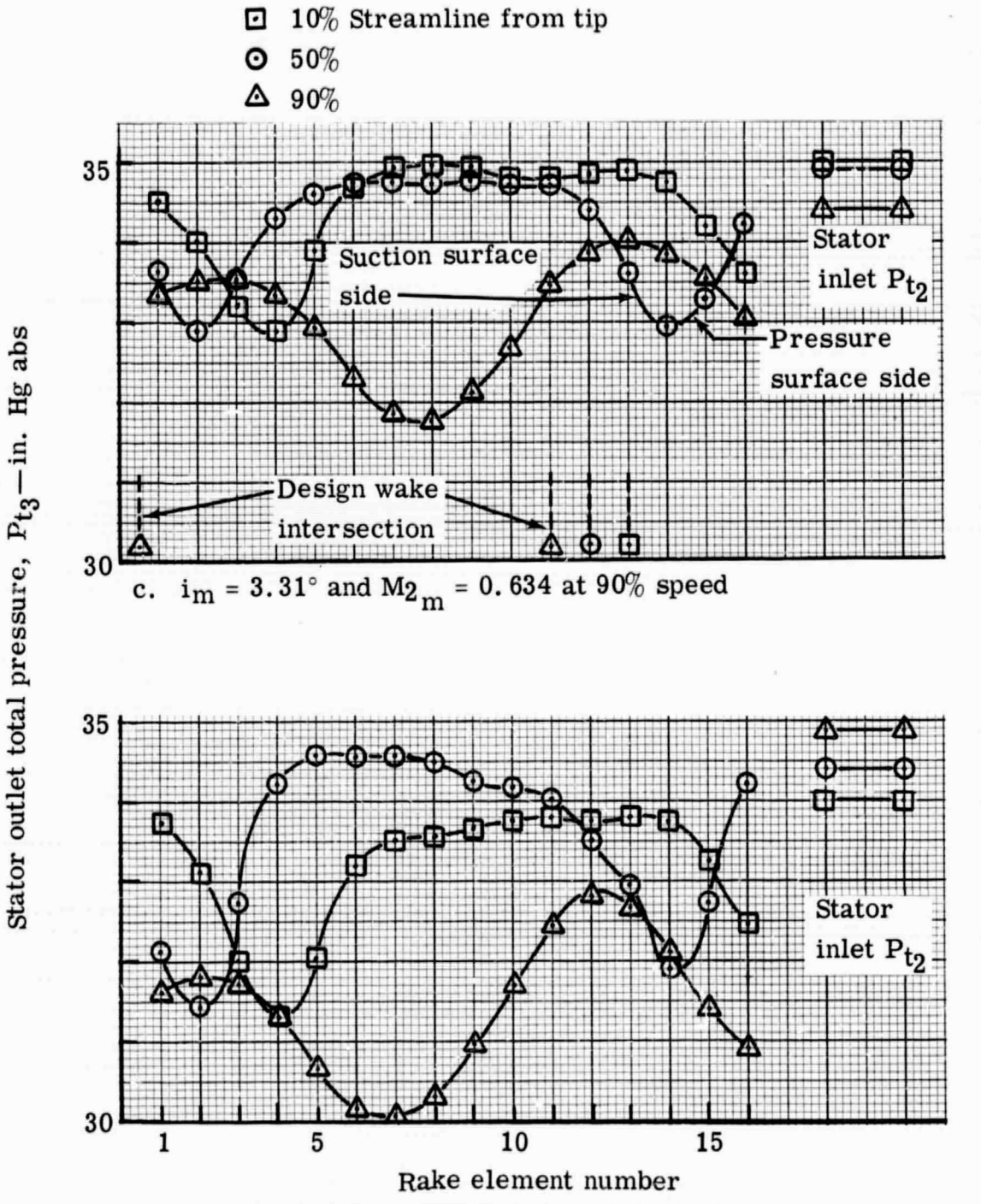


Figure 28. Single-slotted stator wake surveys.

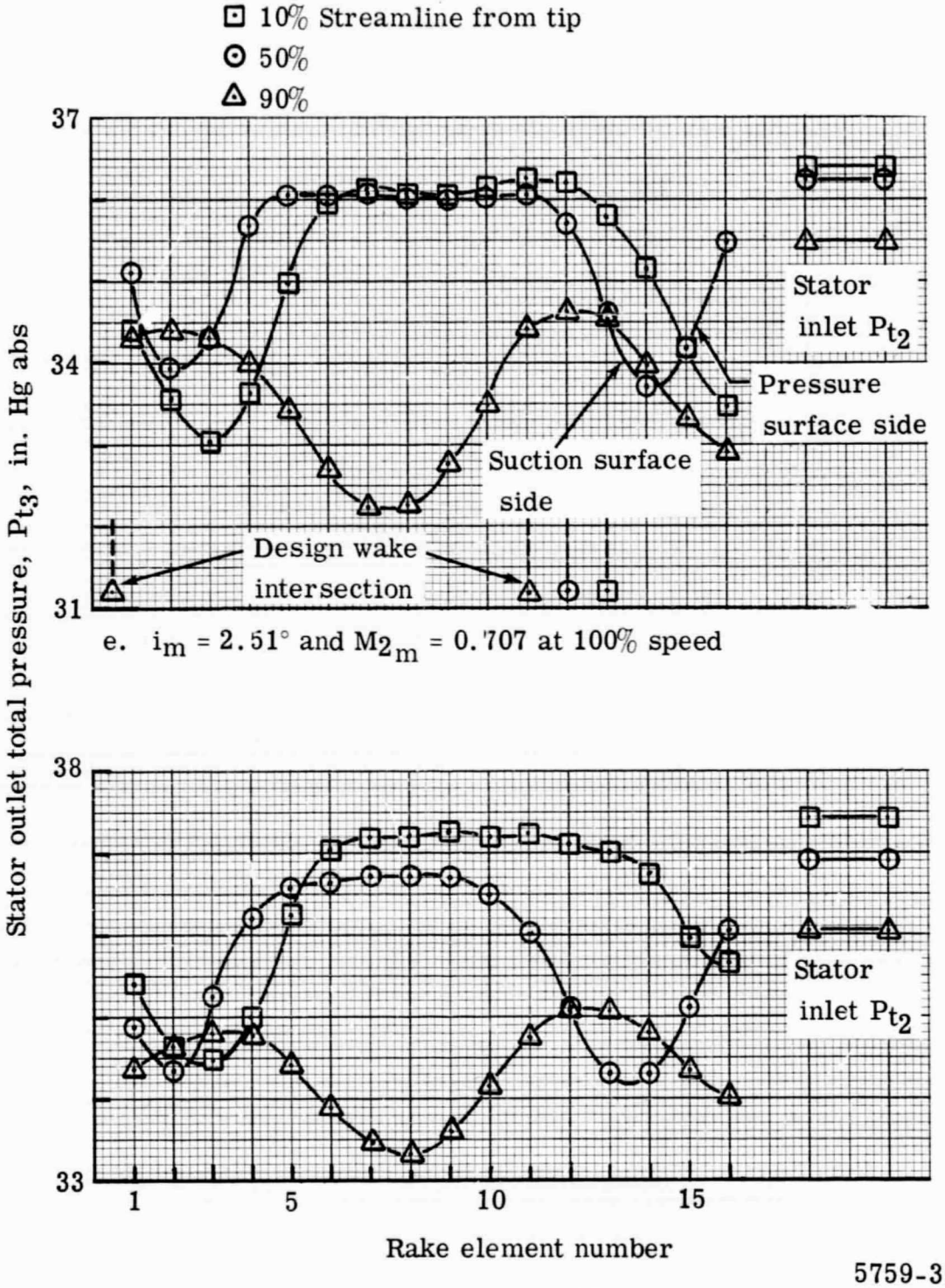


c. $i_m = 3.31°$ and $M_{2_m} = 0.634$ at 90% speed

d. $i_m = 0.44°$ and $M_{2_m} = 0.717$ at 100% speed

5759-34

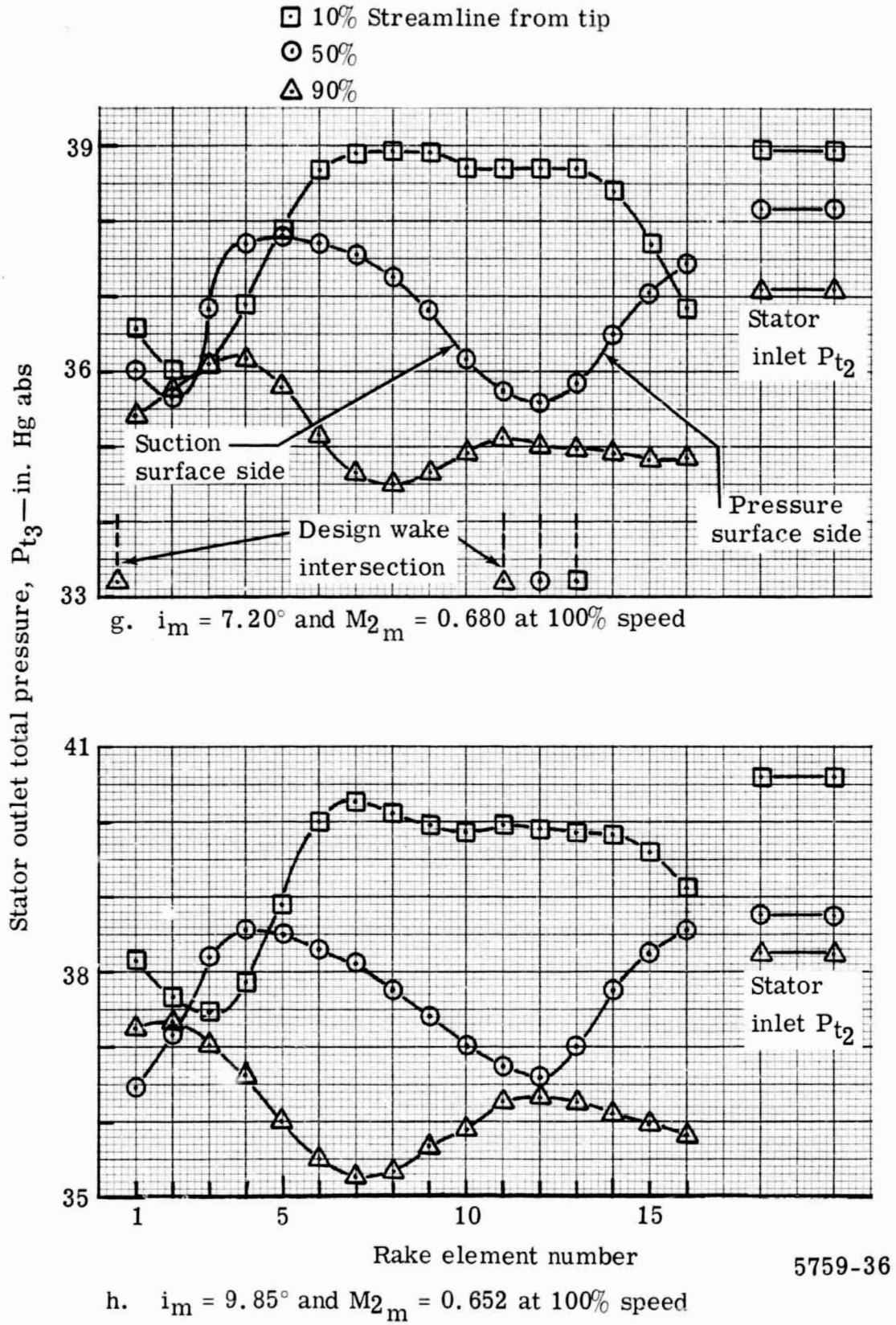
Figure 28. Single-slotted stator wake surveys.



e. $i_m = 2.51°$ and $M_{2_m} = 0.707$ at 100% speed

f. $i_m = 6.11$ and $M_{2_m} = 0.691$ at 100% speed

Figure 28. Single-slotted stator wake surveys.



g. $i_m = 7.20°$ and $M2_m = 0.680$ at 100% speed

h. $i_m = 9.85°$ and $M2_m = 0.652$ at 100% speed

Figure 28. Single-slotted stator wake surveys.

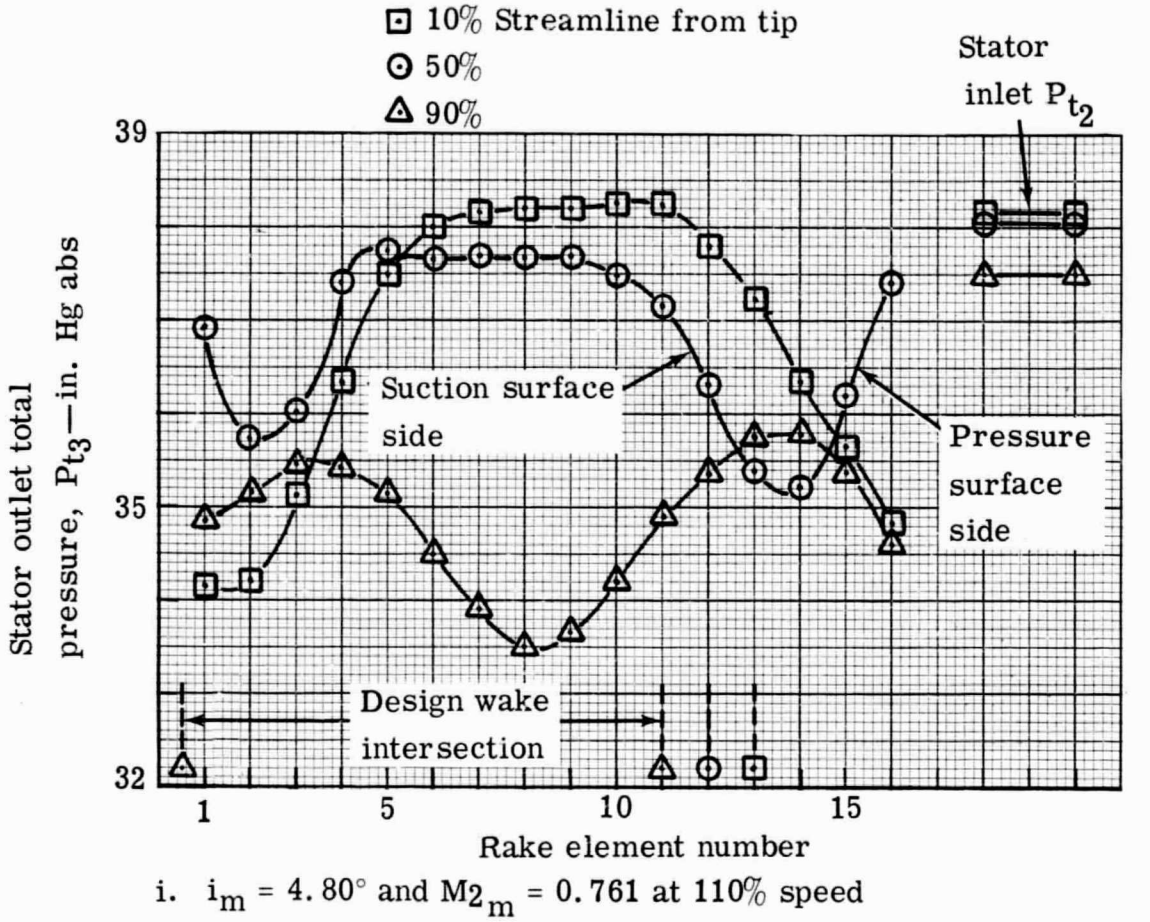


Figure 28. Single-slotted stator wake surveys.

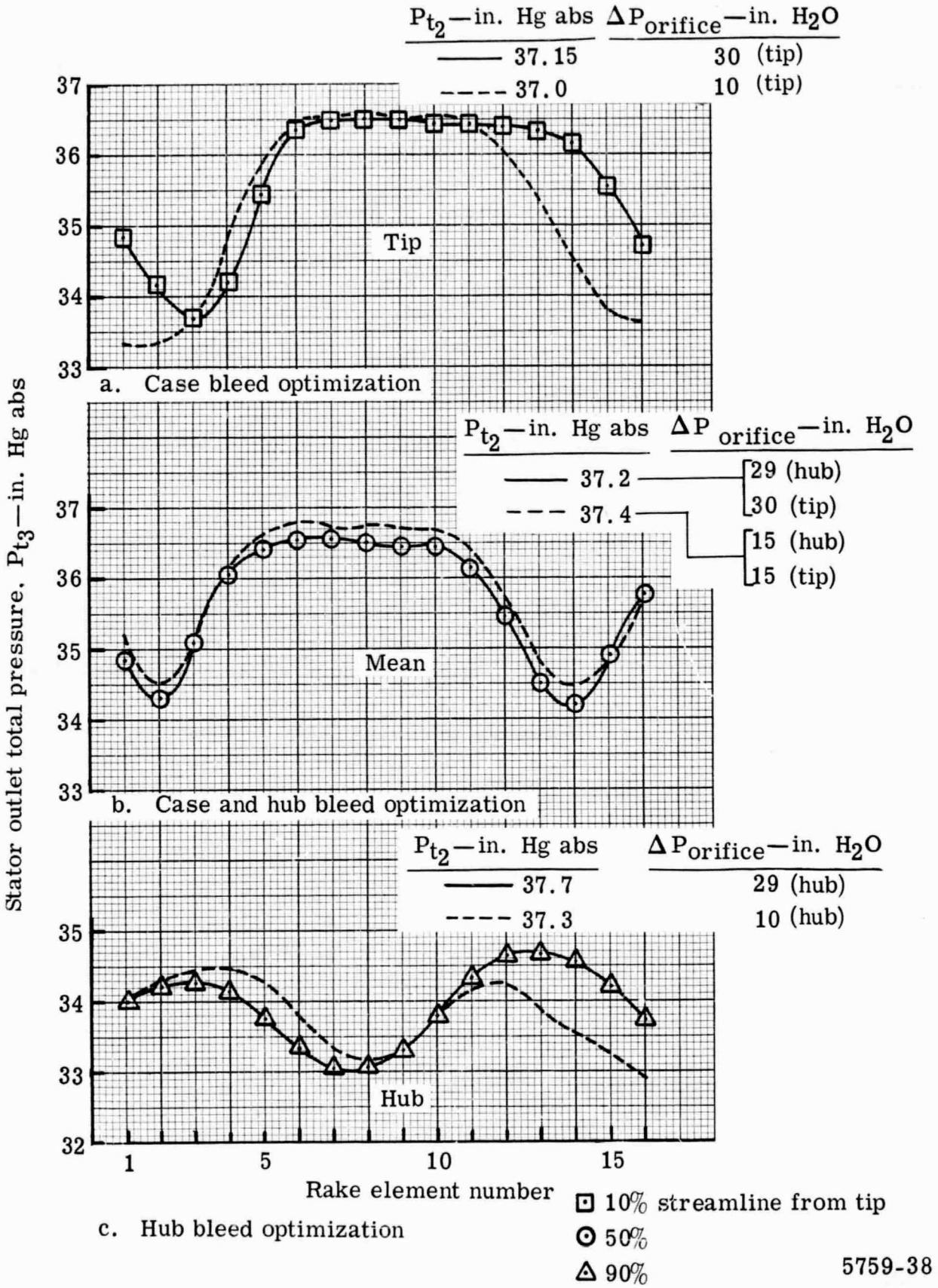


Figure 29. Variation in stator wake at 10, 50, and 90% streamlines from tip during wall bleed optimization.

Table I.
Blade and vane geometry summary.

Blade row	Exit radius (in.)*	κ_1 (degrees)	κ_2 (degrees)	ϕ $\Delta\kappa$ ($\kappa_1 - \kappa_2$)	c (in.)	$\bar{\sigma}$ —	t/c —	δ° (degrees)	i_{des} (degrees)	α_{des} (degrees)	n —
Design inlet guide vanes (63-006 series)	10.49	—	—	—	2.733	1.41	0.06	—	—	17.80	34
	11.51	—	—	—	2.733	1.29	0.06	—	—	16.25	
	12.53	—	—	—	2.733	1.18	0.06	—	—	15.16	
	13.54	—	—	—	2.733	1.09	0.06	—	—	14.36	
	14.58	—	—	—	2.733	1.02	0.06	—	—	13.30	
Rotor blade (double circular arc)	10.97	43.1	9.1	34.0	2.875	1.89	0.078	7.81	0	—	45
	11.86	49.2	21.0	28.2	2.875	1.74	0.052	7.38	0	—	
	12.76	53.4	31.2	22.2	2.875	1.61	0.039	6.34	0	—	
	13.65	56.7	39.1	17.6	2.875	1.51	0.033	5.52	0	—	
	14.54	59.6	44.4	15.2	2.875	1.42	0.032	4.85	0	—	
Stator blade 0.65 Df_H (65 series— circular arc meanline)	11.02	50.18	12.60	37.58	3.0	1.653	0.10	9.27	+3	—	38
	11.94	48.20	10.35	37.85	3.0	1.524	0.10	9.36	+3	—	
	12.84	46.67	8.73	37.94	3.0	1.416	0.10	9.65	+3	—	
	13.71	45.34	7.92	37.42	3.0	1.326	0.10	10.11	+3	—	
	14.58	45.53	5.65	39.88	3.0	1.247	0.10	10.92	+3	—	

*Radii listed represents those for instrumentation (See Figure 6).

Table II.
Rotor incidence at minimum and maximum flow for flow generation rotor and slotted stator stage tests.

		Flow generation rotor test		Slotted stator stage test	
Corrected speed (%)	Streamline from tip (%)	i_{max} (stall) (degrees)	i_{min} (choke) (degrees)	i_{max} (stall) (degrees)	i_{min} (choke) (degrees)
60	10	6.2	- 8.0	6.3	-5.6
	50	6.0	-12.0	7.2	-2.4
	90	7.6	-13.0	10.0	-1.2
80	10	5.4	- 8.0	4.5	-5.2
	50	5 4	- 7.5	5.0	-0.8
	90	8.0	- 8.0	7.2	-1.4
100	10	4.0	- 3.0	4.3	-3.0
	50	4.0	- 4.3	4.3	-4.1
	90	4.7	- 5.0	6.1	-4.1

Table III.
Rotating stall results for single-slotted stator stage test.

Corrected speed (%)	Corrected airflow (lb_m/sec)	Number of stall cells at streamline from tip		Rotative cell speed (% rpm)	Stall cell frequency (cps)	Comment
		10%	90%			
60	44.2	1	1	39	33	Stall point; throttle closing; both cells abrupt.
60	45.3	—	—	36	30	Hysteresis point H_1; throttle fixed; one cell.
60	36.5	—	1	36	30	Hysteresis point H_3; throttle fixed.
60	48.1	—	1	36	30	Hysteresis point H_5; stage unloaded; throttle fixed.
90	69.4	1	1	40	52	Stall point; throttle closing.
100	82.4	1	1	41	30	Stall point; throttle closing.
110	91.2	1	—	26	40	Stall point; fixed throttle.
80	59.9	1	1	42	47	Stall point; throttle closing.

Table IVa.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 59.94

CORRECTED WEIGHT FLOW = 63.76

CORRECTED ROTOR SPEED = 5015.15

PRESSURE RATIO = 1.0983

ADIABATIC EFFICIENCY = 83.7019

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	19.696	22.503	24.066	25.188	25.188
BETA 2	40.471	41.679	44.263	47.175	48.838
BETA(PR) 1	56.971	53.384	50.249	45.672	42.416
BETA(PR) 2	47.884	41.337	32.898	23.211	14.268
V 1	366.63	373.96	373.73	382.31	376.29
V 2	438.19	463.72	493.39	519.86	535.43
VZ 1	345.18	345.48	341.24	345.96	340.51
VZ 2	333.35	346.35	353.34	353.38	352.41
V-THETA 1	123.57	143.12	152.40	162.71	160.15
V-THETA 2	284.41	308.36	344.36	381.28	403.10
V(PR) 1	633.3	579.2	533.6	495.1	461.2
V(PR) 2	497.1	461.3	420.8	384.5	363.6
VTHETA PR1	531.0	464.9	410.3	354.2	311.1
VTHETA PR2	368.7	304.7	226.6	151.5	89.6
U 1	654.52	608.04	562.69	516.88	471.26
U 2	653.13	613.03	572.93	532.82	492.72
M 1	0.3236	0.3302	0.3299	0.3377	0.3323
M 2	0.3821	0.4053	0.4322	0.4559	0.4702
M(PR) 1	0.5589	0.5114	0.4711	0.4373	0.4073
M(PR) 2	0.4334	0.4032	0.3686	0.3372	0.3193
TURN(PR)	9.088	12.047	17.351	22.461	28.148
UUBAR	0.0921	0.0685	0.0244	0.0522	0.0258
DFAC	0.3054	0.2949	0.3159	0.3397	0.3367
EFFP	0.8420	0.8965	0.9691	0.9446	0.9766
EFF	0.8399	0.8951	0.9686	0.9438	0.9762
LOSS PARAM.	0.0218	0.0170	0.0063	0.0136	0.0065
INCID	-2.63	-3.52	-3.45	-4.13	-2.58
DEV	2.784	2.537	2.098	2.511	5.568

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	63.76
UPSTREAM OF STATOR	63.76
DOWNSTREAM OF STATOR	60.24

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	40.471	41.679	44.263	47.175	48.838
BETA 3	24.720	24.720	24.032	25.580	27.644
V 2	438.19	463.72	493.39	519.86	535.43
V 3	344.24	349.09	375.47	383.34	344.60
VZ 2	333.35	346.35	353.34	353.38	352.41
VZ 3	312.70	317.10	342.93	345.77	305.26
V-THETA 2	284.41	308.36	344.36	381.28	403.10
V-THETA 3	143.96	145.99	152.91	165.52	159.88
M 2	0.3821	0.4053	0.4322	0.4559	0.4702
M 3	0.2986	0.3029	0.3262	0.3332	0.2985
TURN	15.751	16.359	20.231	21.595	21.194
UUBAR	0.0504	0.0688	0.0424	0.0610	0.1672
DFAC	0.3431	0.3791	0.3754	0.3983	0.4934
LOSS PARAM.	0.0184	0.0236	0.0136	0.0180	0.0447
INCID	-5.61	-4.45	-2.42	-0.81	-1.16
DEV	19.690	17.720	15.582	15.300	15.144

Table IVb.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 59.90

CORRECTED WEIGHT FLOW = 59.60

CORRECTED ROTOR SPEED = 5012.05

PRESSURE RATIO = 1.1148

ADIABATIC EFFICIENCY = 86.8143

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.136	21.630	23.026	24.500	25.962
BETA 2	43.914	45.576	48.842	50.790	52.226
BETA(PR) 1	59.194	55.974	52.685	49.023	45.312
BETA(PR) 2	47.101	41.771	33.777	24.685	15.363
V 1	338.78	346.00	349.60	351.06	347.55
V 2	441.63	454.58	476.93	496.72	510.44
VZ 1	318.07	321.63	321.74	319.45	312.48
VZ 2	318.14	318.18	313.89	314.01	312.67
V-THETA 1	116.62	127.54	136.74	145.58	152.15
V-THETA 2	306.31	324.65	359.08	384.87	403.47
V(PR) 1	621.1	574.8	530.8	487.1	444.3
V(PR) 2	467.4	426.6	377.6	345.6	324.3
VTHETA PR1	533.4	476.4	422.1	367.8	315.9
VTHETA PR2	342.4	284.2	209.9	144.3	85.9
U 1	650.07	603.91	558.86	513.36	468.05
U 2	648.69	608.86	569.03	529.20	489.37
M 1	0.3004	0.3069	0.3102	0.3115	0.3083
M 2	0.3867	0.3988	0.4191	0.4374	0.4497
M(PR) 1	0.5507	0.5099	0.4709	0.4323	0.3942
M(PR) 2	0.4092	0.3743	0.3318	0.3043	0.2857
TURN(PR)	12.093	14.202	18.907	24.339	29.949
UUBAR	0.0543	0.0438	0.0427	0.0049	0.0333
DFAC	0.3560	0.3681	0.4111	0.4209	0.4051
EFFP	0.9219	0.9424	0.9517	0.9960	0.9733
EFF	0.9206	0.9414	0.9509	0.9960	0.9728
LOSS PARAM.	0.0130	0.0108	0.0109	0.0013	0.0084
INCID	-0.41	-0.93	-1.02	-0.78	0.31
DEV	2.001	2.971	2.977	3.985	6.663

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	59.60
UPSTREAM OF STATOR	59.60
DOWNSTREAM OF STATOR	55.98

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	43.914	45.576	48.842	50.790	52.226
BETA 3	20.731	25.408	24.376	25.924	27.644
V 2	441.63	454.58	476.93	496.72	510.44
V 3	337.94	321.94	342.19	340.09	308.33
VZ 2	318.14	318.18	313.89	314.01	312.67
VZ 3	316.06	290.80	311.68	305.87	273.14
V-THETA 2	306.31	324.65	359.08	384.87	403.47
V-THETA 3	119.63	138.13	141.23	148.68	143.06
M 2	0.3867	0.3988	0.4191	0.4374	0.4497
M 3	0.2941	0.2801	0.2980	0.2964	0.2680
TURN	23.183	20.168	24.466	24.866	24.582
UUBAR	0.0611	0.0885	0.0478	0.0645	0.1375
DFAC	0.4046	0.4464	0.4431	0.4708	0.5501
LOSS PARAM.	0.0230	0.0301	0.0153	0.0190	0.0368
INCID	-2.17	-0.55	2.16	2.80	2.23
DEV	15.701	18.408	15.926	15.644	15.144

Table IVc.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 59.92

CORRECTED WEIGHT FLOW = 56.85

CORRECTED ROTOR SPEED = 5013.72

PRESSURE RATIO = 1.1269

ADIABATIC EFFICIENCY = 88.2497

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.926	23.882	24.324	25.445	25.962
BETA 2	46.493	47.986	50.962	53.250	54.744
BETA(PR) 1	60.524	57.277	54.592	50.529	46.736
BETA(PR) 2	46.964	41.133	34.198	24.146	13.939
V 1	323.85	330.77	330.35	336.77	336.38
V 2	444.03	459.17	472.88	495.40	510.44
VZ 1	302.49	302.45	301.02	304.10	302.43
VZ 2	305.69	307.33	297.84	296.41	294.64
V-THETA 1	115.67	133.91	136.07	144.69	147.26
V-THETA 2	322.05	341.15	367.30	396.94	416.82
V(PR) 1	614.7	559.5	519.5	478.4	441.3
V(PR) 2	447.9	408.0	360.1	324.8	303.6
VTHETA PR1	535.2	470.7	423.4	369.3	321.3
VTHETA PR2	327.4	268.4	202.4	132.9	73.1
U 1	650.63	604.61	559.51	513.97	468.60
U 2	649.45	609.57	569.70	529.82	489.94
M 1	0.2867	0.2929	0.2925	0.2983	0.2980
M 2	0.3877	0.4019	0.4144	0.4350	0.4488
M(PR) 1	0.5442	0.4955	0.4601	0.4238	0.3909
M(PR) 2	0.3911	0.3571	0.3156	0.2852	0.2669
TURN(PR)	13.560	16.144	20.394	26.382	32.797
UUBAR	0.0642	0.0435	0.0445	0.0221	0.0301
DFAC	0.3905	0.3900	0.4374	0.4613	0.4585
EFFP	0.9183	0.9509	0.9556	0.9813	0.9780
EFF	0.9168	0.9500	0.9548	0.9809	0.9775
LOSS PARAM.	0.0154	0.0108	0.0113	0.0057	0.0076
INCID	0.92	0.38	0.89	0.73	1.74
DEV	1.864	2.333	3.398	3.446	5.239

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	56.85
UPSTREAM OF STATOR	56.85
DOWNSTREAM OF STATOR	53.14

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	46.493	47.986	50.962	53.250	54.744
BETA 3	20.381	25.064	25.064	24.892	28.848
V 2	444.03	459.17	472.88	495.40	510.44
V 3	339.07	321.23	332.28	330.15	282.32
VZ 2	305.69	307.33	297.84	296.41	294.64
VZ 3	317.84	290.98	300.99	299.48	247.29
V-THETA 2	322.05	341.15	367.30	396.94	416.82
V-THETA 3	118.08	136.08	140.76	138.96	136.22
M 2	0.3877	0.4019	0.4144	0.4350	0.4488
M 3	0.2944	0.2788	0.2886	0.2869	0.2446
TURN	26.112	22.922	25.898	28.358	25.896
UUBAR	0.0445	0.0873	0.0385	0.0653	0.1776
DFAC	0.4209	0.4687	0.4658	0.5039	0.6130
LOSS PARAM.	0.0168	0.0298	0.0123	0.0194	0.0470
INCID	0.41	1.86	4.28	5.26	4.74
DEV	15.351	18.064	16.614	14.612	16.348

Table IVd.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 59.92

CORRECTED WEIGHT FLOW = 53.38

CORRECTED ROTOR SPEED = 5013.60

PRESSURE RATIO = 1.1403

ADIABATIC EFFICIENCY = 90.7657

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.040	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.840	22.940	24.235	25.790	26.048
BETA 2	48.906	51.535	53.773	55.551	56.702
BETA(PR) 1	61.760	59.329	56.198	52.801	49.594
BETA(PR) 2	46.795	41.436	34.807	25.272	13.935
V 1	310.90	311.61	316.03	317.37	313.90
V 2	447.35	458.15	468.46	485.89	504.63
VZ 1	290.56	286.97	288.18	285.76	282.02
VZ 2	294.04	284.99	276.86	274.86	277.04
V-THETA 1	110.60	121.45	129.72	138.08	137.84
V-THETA 2	337.14	358.72	377.90	400.68	421.78
V(PR) 1	614.1	562.6	518.0	472.7	435.1
V(PR) 2	429.5	380.1	337.2	303.9	285.4
VTHETA PR1	541.0	483.9	430.4	376.5	331.3
VTHETA PR2	313.1	251.6	192.5	129.8	68.7
U 1	651.59	605.32	560.17	514.57	469.15
U 2	650.21	610.29	570.36	530.44	490.52
M 1	0.2747	0.2754	0.2793	0.2805	0.2774
M 2	0.3893	0.3998	0.4094	0.4255	0.4422
M(PR) 1	0.5426	0.4971	0.4578	0.4178	0.3845
M(PR) 2	0.3738	0.3317	0.2947	0.2662	0.2502
TURN(PR)	14.965	17.893	21.392	27.529	35.659
UUBAR	0.0975	0.0471	0.0403	0.0139	0.0377
DFAC	0.4314	0.4606	0.4900	0.5052	0.5011
EFFP	0.8885	0.9507	0.9540	0.9894	0.9750
EFF	0.8863	0.9497	0.9531	0.9892	0.9745
LOSS PARAM.	0.0235	0.0116	0.0124	0.0036	0.0095
INCID	2.16	2.43	2.50	3.00	4.59
DEV	1.695	2.636	4.007	4.572	5.235

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	53.38
UPSTREAM OF STATOR	53.38
DOWNSTREAM OF STATOR	49.59

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	48.906	51.535	53.773	55.551	56.702
BETA 3	18.801	24.032	24.376	26.956	30.740
V 2	447.35	458.15	468.46	485.89	504.63
V 3	341.85	325.53	319.70	309.82	273.57
VZ 2	294.04	284.99	276.86	274.86	277.04
VZ 3	323.61	297.31	291.20	276.16	235.13
V-THETA 2	337.14	358.72	377.90	400.68	421.78
V-THETA 3	110.17	132.57	131.95	140.44	139.83
M 2	0.3893	0.3998	0.4094	0.4255	0.4422
M 3	0.2960	0.2818	0.2769	0.2684	0.2364
TURN	30.105	27.503	29.397	28.595	25.962
UUBAR	0.0200	0.0473	0.0347	0.0653	0.1554
DFAC	0.4396	0.4754	0.5021	0.5375	0.6267
LOSS PARAM.	0.0076	0.0163	0.0111	0.0190	0.0404
INCID	2.83	5.40	7.09	7.56	6.79
DEV	13.771	17.032	15.926	16.676	18.240

Table IVe.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 59.99

CORRECTED WEIGHT FLOW = 47.70

CORRECTED ROTOR SPEED = 5019.60

PRESSURE RATIO = 1.1484

ADIABATIC EFFICIENCY = 82.9213

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.394	22.067	22.940	24.321	25.704
BETA 2	57.801	56.636	58.030	59.913	60.087
BETA(PR) 1	66.024	63.609	61.008	57.454	55.199
BETA(PR) 2	49.741	43.393	35.188	25.281	14.158
V 1	265.97	270.51	273.72	280.42	271.85
V 2	441.80	451.49	468.06	482.55	495.44
VZ 1	249.30	250.70	252.08	255.53	244.95
VZ 2	235.42	248.30	247.83	241.91	247.07
V-THETA 1	92.68	101.	106.69	115.49	117.91
V-THETA 2	373.85	377.06	397.06	417.53	429.44
V(PR) 1	613.5	564.0	520.1	475.0	429.2
V(PR) 2	364.3	341.7	303.2	267.5	254.8
VTHETA PR1	560.6	505.2	454.9	400.4	352.4
VTHETA PR2	278.0	234.8	174.7	114.3	62.3
U 1	653.25	606.86	561.59	515.88	470.34
U 2	651.86	611.84	571.81	531.79	491.76
M 1	0.2342	0.2383	0.2411	0.2471	0.2395
M 2	0.3816	0.3919	0.4070	0.4208	0.4327
M(PR) 1	0.5403	0.4968	0.4582	0.4186	0.3781
M(PR) 2	0.3147	0.2966	0.2637	0.2333	0.2225
TURN(PR)	16.283	20.216	25.820	32.172	41.041
UUBAR	0.2256	0.1119	0.1041	0.0534	0.0147
DFAC	0.5686	0.5524	0.5822	0.6079	0.5823
EFFP	0.7907	0.8976	0.9158	0.9615	0.9918
EFF	0.7860	0.8954	0.9139	0.9607	0.9916
LOSS PARAM.	0.0514	0.0268	0.0261	0.0137	0.0037
INCID	6.42	6.71	7.31	7.65	10.20
DEV	4.641	4.593	4.388	4.581	5.458

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	47.70
UPSTREAM OF STATOR	47.70
DOWNSTREAM OF STATOR	43.84

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	57.801	56.636	58.030	59.913	60.087
BETA 3	23.860	25.064	25.408	28.160	34.524
V 2	441.80	451.49	468.06	482.55	495.44
V 3	293.59	281.71	278.56	255.74	219.09
VZ 2	235.42	248.30	247.83	241.91	247.07
VZ 3	268.49	255.18	251.62	225.47	180.50
V-THETA 2	373.85	377.08	397.06	417.53	429.44
V-THETA 3	118.76	119.34	119.52	120.69	124.17
M 2	0.3816	0.3919	0.4070	0.4208	0.4327
M 3	0.2520	0.2424	0.2399	0.2201	0.1882
TURN	33.941	31.572	32.622	31.753	25.563
UUBAR	0.0777	0.0792	0.0826	0.1267	0.1845
DFAC	0.5674	0.5911	0.6134	0.6712	0.7439
LOSS PARAM.	0.0285	0.0270	0.0262	0.0365	0.0459
INCID	11.72	10.51	11.35	11.92	10.09
DEV	18.830	18.064	16.958	17.880	22.024

Table IVf.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 79.92

CORRECTED WEIGHT FLOW = 82.42

CORRECTED ROTOR SPEED = 6686.83

PRESSURE RATIO = 1.1790

ADIABATIC EFFICIENCY = 83.4691

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	18.753	19.981	21.205	23.632	24.320
BETA 2	40.933	42.884	45.916	47.977	48.558
BETA(PR) 1	57.068	54.006	50.543	46.026	41.476
BETA(PR) 2	46.946	40.654	32.297	22.924	14.935
V 1	485.80	492.10	498.41	506.65	512.41
V 2	590.61	619.54	654.85	687.42	704.20
VZ 1	460.01	462.48	464.66	464.16	466.94
VZ 2	446.19	453.96	455.59	460.17	466.08
V-THETA 1	156.18	168.16	180.28	203.09	211.03
V-THETA 2	386.95	421.61	470.39	510.67	527.88
V(PR) 1	846.2	786.9	731.2	668.5	623.2
V(PR) 2	653.6	598.4	539.0	499.6	482.4
VTHETA PR1	710.2	636.7	564.5	481.1	412.8
VTHETA PR2	477.6	389.8	288.0	194.6	124.3
U 1	866.38	804.85	744.82	684.18	623.79
U 2	864.53	811.45	758.37	705.29	652.20
M 1	0.4354	0.4413	0.4472	0.4549	0.4602
M 2	0.5185	0.5460	0.5789	0.6097	0.6251
M(PR) 1	0.7584	0.7057	0.6560	0.6002	0.5598
M(PR) 2	0.5738	0.5274	0.4765	0.4432	0.4282
TURN(PR)	10.122	13.352	18.246	23.102	26.541
UUBAR	0.0752	0.0453	0.0301	0.0084	0.0433
DFAC	0.3245	0.3431	0.3789	0.3743	0.3465
EFFP	0.8790	0.9336	0.9622	0.9918	0.9411
EFF	0.8760	0.9319	0.9612	0.9916	0.9395
LOSS PARAM.	0.0181	0.0113	0.0078	0.0022	0.0159
INCID	-2.53	-2.89	-3.16	-3.77	-3.52
DEV	1.846	1.854	1.497	2.224	6.235

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	82.42
UPSTREAM OF STATOR	82.42
DOWNSTREAM OF STATOR	79.10

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	40.933	42.884	45.916	47.977	48.558
BETA 3	25.408	25.580	24.720	25.752	27.644
V 2	590.61	619.54	654.85	687.42	704.20
V 3	472.18	458.82	499.08	504.85	429.77
VZ 2	446.19	453.96	455.59	460.17	466.08
VZ 3	426.50	413.85	453.34	454.71	380.71
V-THETA 2	386.95	421.61	470.39	510.67	527.88
V-THETA 3	202.59	198.11	208.71	219.34	199.40
M 2	0.5185	0.5460	0.5789	0.6097	0.6251
M 3	0.4108	0.3987	0.4350	0.4404	0.3720
TURN	15.525	17.304	21.196	22.225	20.914
UUBAR	0.0362	0.0967	0.0484	0.0755	0.2247
DFAC	0.3259	0.3953	0.3784	0.4042	0.5306
LOSS PARAM.	0.0131	0.0329	0.0155	0.0223	0.0601
INCID	-5.15	-3.25	-0.76	-0.01	-1.44
DEV	20.378	18.580	16.270	15.472	15.144

Table IVg.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 79.94

CORRECTED WEIGHT FLOW = 79.32

CORRECTED ROTOR SPEED = 6688.37

PRESSURE RATIO = 1.2085

ADIABATIC EFFICIENCY = 86.8039

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.814	23.453	24.150	26.400	25.883
BETA 2	44.198	45.752	48.381	50.786	52.222
BETA(PR) 1	58.341	54.991	51.749	47.491	43.133
BETA(PR) 2	46.405	40.581	33.054	23.260	14.274
V 1	485.85	474.20	478.38	484.17	490.57
V 2	599.85	621.36	646.77	678.08	693.50
VZ 1	435.45	435.03	436.50	433.68	441.36
Z 2	430.06	433.57	429.56	428.69	424.84
V-THETA 1	165.53	188.73	195.72	215.28	214.15
V-THETA 2	418.18	445.09	483.51	525.37	548.14
V(PR) 1	829.6	758.3	705.1	641.8	604.8
V(PR) 2	623.7	570.9	512.5	466.6	438.4
VTHETA PR1	706.2	621.1	553.7	473.1	413.5
VTHETA PR2	451.7	371.4	279.5	184.3	108.1
U 1	871.72	809.82	749.41	688.40	627.64
U 2	869.87	816.46	763.05	709.64	656.23
M 1	0.4144	0.4220	0.4259	0.4312	0.4372
M 2	0.5215	0.5423	0.5660	0.5952	0.6097
M(PR) 1	0.7379	0.6749	0.6277	0.5717	0.5389
M(PR) 2	0.5422	0.4982	0.4485	0.4096	0.3854
TURN(PR)	11.936	14.410	18.696	24.231	28.858
UUBAR	0.0615	0.0359	0.0342	0.0203	0.0646
DFAC	0.3564	0.3558	0.3924	0.4008	0.4067
EFFP	0.9180	0.9570	0.9638	0.9824	0.9475
EFF	0.9155	0.9557	0.9627	0.9818	0.9460
LOSS PARAM.	0.0149	0.0090	0.0088	0.0053	0.0163
INCID	-1.26	-1.91	-1.95	-2.31	-1.87
DEV	1.305	1.781	2.254	2.560	5.574

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	79.32
UPSTREAM OF STATOR	79.32
DOWNSTREAM OF STATOR	75.74

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	44.198	45.752	48.381	50.786	52.222
BETA 3	26.268	25.752	24.892	25.924	27.816
V 2	599.85	621.36	646.77	678.08	693.50
V 3	469.91	450.23	472.71	464.97	405.91
VZ 2	430.06	433.57	429.56	428.69	424.84
VZ 3	421.39	405.52	428.80	418.18	359.00
V-THETA 2	418.18	445.09	483.51	525.37	548.14
V-THETA 3	207.97	195.61	198.97	203.28	189.41
M 2	0.5215	0.5423	0.5660	0.5952	0.6097
M 3	0.4043	0.3874	0.4073	0.4012	0.3482
TURN	17.930	20.000	23.489	24.862	24.406
UUBAR	0.0512	0.0931	0.0506	0.0936	0.1913
DFAC	0.3574	0.4247	0.4238	0.4696	0.5710
LOSS PARAM.	0.0184	0.0316	0.0161	0.0275	0.0511
INCID	-1.88	-0.38	1.70	2.80	2.22
DEV	21.238	18.752	16.442	15.644	15.316

Table IVh.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 79.95

CORRECTED WEIGHT FLOW = 74.34

CORRECTED ROTOR SPEED = 6689.58

PRESSURE RATIO = 1.2379

ADIABATIC EFFICIENCY = 88.3986

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.168	22.928	24.324	26.400	26.898
BETA 2	47.359	49.359	52.164	54.287	55.262
BETA(PR) 1	61.252	58.169	54.802	51.471	46.854
BETA(PR) 2	47.262	41.532	33.524	26.523	15.718
V 1	423.58	432.95	440.50	439.25	447.73
V 2	593.12	612.15	638.86	644.15	669.14
VZ 1	395.00	398.75	401.40	393.44	399.29
VZ 2	401.79	398.71	391.88	376.00	381.30
V-THETA 1	152.96	168.67	181.44	195.31	202.56
V-THETA 2	436.31	464.50	504.55	523.02	549.88
V(PR) 1	821.3	756.0	696.4	631.6	583.9
V(PR) 2	592.0	532.6	470.1	420.2	396.1
VTHETA PR1	720.0	642.3	569.1	494.1	426.0
VTHETA PR2	434.8	353.1	259.6	187.7	107.3
U 1	872.99	811.00	750.50	689.41	628.55
U 2	871.14	817.65	764.16	710.67	657.18
M 1	0.3751	0.3837	0.3906	0.3894	0.3972
M 2	0.5120	0.5306	0.5555	0.5618	0.5844
M(PR) 1	0.7274	0.6700	0.6175	0.5600	0.5180
M(PR) 2	0.5111	0.4617	0.4088	0.3665	0.3459
TURN(PR)	13.990	16.637	21.278	24.948	31.135
UUBAR	0.0761	0.0500	0.0400	0.0147	0.0820
DFAC	0.4016	0.4218	0.4613	0.4725	0.4637
EFFP	0.9134	0.9479	0.9635	0.9886	0.9425
EFF	0.9104	0.9462	0.9623	0.9882	0.9407
LOSS PARAM.	0.0182	0.0124	0.0102	0.0037	0.0206
INCID	1.65	1.27	1.10	1.67	1.85
DEV	2.162	2.732	2.724	5.823	7.018

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	74.34
UPSTREAM OF STATOR	74.34
DOWNSTREAM OF STATOR	70.54

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	47.359	49.359	52.164	54.287	55.262
BETA 3	24.376	24.720	23.688	25.580	29.536
V 2	593.12	612.15	638.86	644.15	669.14
V 3	444.20	420.06	425.00	399.56	354.54
VZ 2	401.79	398.71	391.88	376.00	381.30
VZ 3	404.60	381.57	389.19	360.40	308.47
V-THETA 2	436.31	464.50	504.55	523.02	549.88
V-THETA 3	183.33	175.66	170.75	172.52	174.78
M 2	0.5120	0.5306	0.5555	0.5618	0.5844
M 3	0.3794	0.3589	0.3636	0.3419	0.3022
TURN	22.983	24.639	28.476	28.707	25.726
UUBAR	0.0376	0.0806	0.0800	0.0759	0.1607
DFAC	0.4224	0.4916	0.5185	0.5576	0.6395
LOSS PARAM.	0.0138	0.0276	0.0258	0.0224	0.0422
INCID	1.28	3.23	5.48	6.30	5.26
DEV	19.346	17.720	15.238	15.300	17.036

Table IVi.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 79.97

CORRECTED WEIGHT FLOW = 70.28

CORRECTED ROTOR SPEED = 6690.99

PRESSURE RATIO = 1.2578

ADIABATIC EFFICIENCY = 87.2438

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.168	22.928	24.150	25.711	26.898
BETA 2	51.079	52.673	55.434	57.212	58.366
BETA(PR) 1	62.615	60.096	57.053	53.226	49.402
BETA(PR) 2	47.075	41.676	35.584	24.974	14.727
V 1	404.46	407.87	413.57	421.09	421.56
V 2	600.12	613.28	622.38	651.11	665.18
VZ 1	377.16	375.65	377.38	379.40	375.96
VZ 2	377.03	371.87	353.11	352.60	348.88
V-THETA 1	146.05	158.90	169.21	182.68	190.72
V-THETA 2	466.90	487.67	512.51	547.38	566.34
V(PR) 1	820.0	753.5	693.9	633.7	577.7
V(PR) 2	553.6	497.9	434.2	389.0	360.7
VTHETA PR1	728.1	653.2	582.3	507.6	438.7
VTHETA PR2	405.4	331.0	252.7	164.2	91.7
U 1	874.14	812.06	751.49	690.31	629.38
U 2	872.28	818.72	765.16	711.60	658.05
M 1	0.3574	0.3605	0.3656	0.3725	0.3729
M 2	0.5151	0.5291	0.5389	0.5654	0.5783
M(PR) 1	0.7245	0.6659	0.6134	0.5606	0.5110
M(PR) 2	0.4752	0.4295	0.3759	0.3377	0.3136
TURN(PR)	15.540	18.420	21.469	28.252	34.674
UUBAR	0.1147	0.0648	0.0423	0.0484	0.1074
DFAC	0.4636	0.4803	0.5200	0.5402	0.5320
EFFP	0.8841	0.9390	0.9634	0.9642	0.9319
EFF	0.8797	0.9367	0.9621	0.9630	0.9296
LOSS PARAM.	0.0275	0.0160	0.0105	0.0125	0.0271
INCID	3.01	3.20	3.35	3.43	4.40
DEV	1.975	2.876	4.784	4.274	6.027

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	70.28
UPSTREAM OF STATOR	70.28
DOWNSTREAM OF STATOR	66.36

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	51.079	52.673	55.434	57.212	58.366
BETA 3	24.720	23.688	23.688	27.300	33.836
V 2	600.12	613.28	622.38	651.11	665.18
V 3	422.21	406.60	366.78	340.17	308.31
VZ 2	377.03	371.87	353.11	352.60	348.88
VZ 3	383.52	372.34	335.88	302.28	256.09
V-THETA 2	466.90	487.67	512.51	547.38	566.34
V-THETA 3	176.56	163.35	147.36	156.02	171.67
M 2	0.5151	0.5291	0.5389	0.5654	0.5783
M 3	0.3583	0.3458	0.3117	0.2888	0.2612
TURN	26.359	28.985	31.746	29.912	24.530
UUBAR	0.0606	0.0631	0.0979	0.1553	0.1740
DFAC	0.4968	0.5363	0.6170	0.6741	0.7158
LOSS PARAM.	0.0221	0.0218	0.0315	0.0451	0.0437
INCID	5.00	6.54	8.75	9.22	8.37
DEV	19.690	16.688	15.238	17.020	21.336

Table IVj.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 79.93

CORRECTED WEIGHT FLOW = 66.59

CORRECTED ROTOR SPEED = 6687.70

PRESSURE RATIO = 1.2706

ADIABATIC EFFICIENCY = 85.7336

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.521	22.928	24.150	26.566	26.400
BETA 2	53.949	54.346	57.503	58.819	59.978
BETA(PR) 1	64.215	61.378	58.717	55.194	52.337
BETA(PR) 2	47.877	42.155	35.227	26.705	14.343
V 1	381.74	391.38	393.73	398.61	392.57
V 2	598.44	611.58	626.48	638.39	662.94
VZ 1	355.13	360.46	359.27	356.52	351.63
VZ 2	352.18	356.48	336.58	330.53	331.69
V-THETA 1	140.04	152.47	161.09	178.27	174.55
V-THETA 2	483.83	496.94	528.38	546.16	574.00
V(PR) 1	816.4	752.5	691.9	624.6	575.5
V(PR) 2	525.1	480.9	412.0	370.0	342.4
VTHETA PR1	735.1	660.5	591.3	512.8	455.6
VTHETA PR2	389.5	322.7	237.7	166.3	84.8
U 1	875.15	813.01	752.36	691.12	630.11
U 2	873.29	819.67	766.05	712.43	658.81
M 1	0.3363	0.3449	0.3471	0.3515	0.3460
M 2	0.5107	0.5254	0.5401	0.5521	0.5744
M(PR) 1	0.7191	0.6632	0.6099	0.5507	0.5072
M(PR) 2	0.4481	0.4131	0.3552	0.3200	0.2967
TURN(PR)	16.338	19.223	23.489	28.489	37.994
UUBAR	0.1639	0.0868	0.0667	0.0602	0.0736
DFAC	0.5061	0.5091	0.5612	0.5653	0.5729
EFFP	0.8485	0.9227	0.9464	0.9578	0.9559
EFF	0.8425	0.9198	0.9444	0.9563	0.9544
LOSS PARAM.	0.0388	0.0212	0.0167	0.0153	0.0186
INCID	4.62	4.48	5.02	5.39	7.34
DEV	2.777	3.355	4.427	6.005	5.643

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	66.59
UPSTREAM OF STATOR	66.59
DOWNSTREAM OF STATOR	62.59

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	53.949	54.346	57.503	58.819	59.978
BETA 3	26.956	24.376	25.236	27.988	34.352
V 2	598.44	611.58	626.48	638.39	662.94
V 3	401.54	395.18	356.80	312.58	264.21
VZ 2	352.18	356.48	336.58	330.53	331.69
VZ 3	357.92	359.96	322.75	276.02	218.12
V-THETA 2	483.83	496.94	528.38	546.16	574.00
V-THETA 3	182.02	163.10	152.12	146.69	149.08
M 2	0.5107	0.5254	0.5401	0.5521	0.5744
M 3	0.3385	0.3345	0.3020	0.2642	0.2226
TURN	26.993	29.970	32.267	30.831	25.626
UUBAR	0.0882	0.0660	0.1114	0.1475	0.2106
DFAC	0.5316	0.5595	0.6416	0.7150	0.7951
LOSS PARAM.	0.0316	0.0227	0.0354	0.0426	0.0525
INCID	7.87	8.22	10.82	10.83	9.98
DEV	21.926	17.376	16.786	17.708	21.852

Table IVk.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 89.91

CORRECTED WEIGHT FLOW = 90.85

CORRECTED ROTOR SPEED = 7522.69

PRESSURE RATIO = 1.2239

ADIABATIC EFFICIENCY = 79.7806

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.814	23.453	23.278	26.566	26.400
BETA 2	41.222	43.289	46.546	48.379	49.809
BETA(PR) 1	56.260	52.770	49.256	44.606	39.846
BETA(PR) 2	46.816	40.700	32.304	23.338	14.477
V 1	558.11	566.76	576.09	581.76	591.49
V 2	669.19	699.26	738.53	770.96	792.31
VZ 1	521.69	519.94	529.19	520.33	529.81
VZ 2	503.34	508.99	507.94	512.07	511.30
V-THETA 1	198.32	225.57	227.67	260.18	263.00
V-THETA 2	440.98	479.47	536.12	576.33	605.25
V(PR) 1	939.3	859.4	810.8	730.9	690.1
V(PR) 2	735.5	671.4	601.0	557.7	528.1
VTHETA PR1	781.0	684.2	614.3	513.2	442.1
VTHETA PR2	536.3	437.8	321.2	220.9	132.0
U 1	979.36	909.82	841.95	773.41	705.14
U 2	977.28	917.28	857.27	797.27	737.26
M 1	0.5008	0.5089	0.5177	0.5231	0.5324
M 2	0.5837	0.6132	0.6504	0.6813	0.7018
M(PR) 1	0.8427	0.7717	0.7287	0.6572	0.6211
M(PR) 2	0.6416	0.5888	0.5292	0.4928	0.4678
TURN(PR)	9.444	12.070	16.952	21.269	25.369
UUBAR	0.0953	0.0596	0.0402	0.0318	0.0618
DFAC	0.3088	0.3134	0.3697	0.3505	0.3518
EFFP	0.8600	0.9206	0.9521	0.9689	0.9446
EFF	0.8556	0.9180	0.9505	0.9678	0.9427
LOSS PARAM.	0.0230	0.0149	0.0104	0.0083	0.0156
INCID	-3.34	-4.13	-4.44	-5.19	-5.15
DEV	1.716	1.900	1.504	2.638	5.777

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	90.85
UPSTREAM OF STATOR	90.85
DOWNSTREAM OF STATOR	87.58

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	41.222	43.289	46.546	48.379	49.809
BETA 3	29.020	25.924	24.204	25.752	29.020
V 2	669.19	699.26	738.53	770.96	792.31
V 3	527.12	521.89	568.56	567.89	467.56
VZ 2	503.34	508.99	507.94	512.07	511.30
VZ 3	460.94	469.38	518.57	511.49	408.86
V-THETA 2	440.98	479.47	536.12	576.33	605.25
V-THETA 3	255.71	228.16	233.10	246.74	226.82
M 2	0.5837	0.6132	0.6504	0.6813	0.7018
M 3	0.4537	0.4495	0.4919	0.4923	0.4006
TURN	12.202	17.365	22.342	22.627	20.789
UUBAR	0.0742	0.1048	0.0513	0.0804	0.2684
DFAC	0.3235	0.3891	0.3744	0.4032	0.5542
LOSS PARAM.	0.0261	0.0355	0.0165	0.0237	0.0709
INCID	-4.86	-2.84	-0.13	0.39	-0.19
DEV	23.990	18.924	15.754	15.472	16.520

Table IVl.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 89.95

CORRECTED WEIGHT FLOW = 87.35

CORRECTED ROTOR SPEED = 7525.78

PRESSURE RATIO = 1.2686

ADIABATIC EFFICIENCY = 84.4179

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.991	22.402	24.672	26.400	25.883
BETA 2	44.952	46.781	49.986	51.473	53.310
BETA(PR) 1	58.193	54.923	51.280	47.026	42.725
BETA(PR) 2	46.958	41.206	33.026	23.821	15.381
V 1	525.19	535.56	542.54	549.70	555.97
V 2	666.96	690.09	723.66	753.56	762.52
VZ 1	490.33	495.14	493.01	492.37	500.20
VZ 2	472.01	472.57	465.29	469.38	455.59
V-THETA 1	188.13	204.10	226.47	244.42	242.70
V-THETA 2	471.22	502.90	554.25	589.52	611.45
V(PR) 1	930.3	861.6	788.2	722.3	680.9
V(PR) 2	691.6	628.1	555.0	513.1	472.5
VTHETA PR1	790.6	705.1	614.9	528.5	462.0
VTHETA PR2	505.4	413.8	302.5	207.2	125.3
U 1	978.73	909.23	841.40	772.91	704.68
U 2	976.65	916.68	856.71	796.75	736.78
M 1	0.4704	0.4801	0.4867	0.4934	0.4993
M 2	0.5794	0.6024	0.6340	0.6628	0.6715
M(PR) 1	0.8332	0.7724	0.7070	0.6483	0.6115
M(PR) 2	0.6000	0.5483	0.4862	0.4513	0.4161
TURN(PR)	11.234	13.718	18.254	23.205	27.344
UUBAR	0.0571	0.0378	0.0349	0.0241	0.0957
DFAC	0.3647	0.3826	0.4175	0.4160	0.4348
EFFP	0.9278	0.9560	0.9651	0.9794	0.9224
EFF	0.9250	0.9543	0.9638	0.9786	0.9197
LOSS PARAM.	0.0138	0.0094	0.0090	0.0063	0.0240
INCID	-1.41	-1.98	-2.42	-2.77	-2.27
DEV	1.858	2.406	2.226	3.121	6.681

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	87.35
UPSTREAM OF STATOR	87.35
DOWNSTREAM OF STATOR	83.78

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	44.952	46.781	49.986	51.473	53.310
BETA 3	27.988	25.580	24.376	25.580	27.988
V 2	666.96	690.09	723.66	753.56	762.52
V 3	506.74	491.15	511.29	500.72	431.58
VZ 2	472.01	472.57	465.29	469.38	455.59
VZ 3	447.48	443.01	465.71	451.64	381.11
V-THETA 2	471.22	502.90	554.25	589.52	611.45
V-THETA 3	237.81	212.06	211.02	216.20	202.54
M 2	0.5794	0.6024	0.6340	0.6628	0.6715
M 3	0.4336	0.4208	0.4386	0.4306	0.3685
TURN	16.964	21.201	25.610	25.893	25.322
UUBAR	0.0687	0.0900	0.0696	0.0971	0.1737
DFAC	0.3808	0.4471	0.4602	0.4975	0.5960
LOSS PARAM.	0.0244	0.0306	0.0223	0.0286	0.0463
INCID	-1.13	0.65	3.31	3.48	3.31
DEV	22.958	18.580	15.926	15.300	15.488

Table IVm.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 89.94

CORRECTED WEIGHT FLOW = 83.32

CORRECTED ROTOR SPEED = 7525.42

PRESSURE RATIO = 1.3051

ADIABATIC EFFICIENCY = 87.6757

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.282	22.753	24.324	26.400	26.400
BETA 2	48.102	50.729	52.682	54.349	55.860
BETA(PR) 1	60.245	57.304	54.075	50.027	45.855
BETA(PR) 2	47.248	42.034	35.068	25.016	15.890
V 1	492.07	498.25	503.57	510.41	514.91
V 2	665.36	681.13	701.19	734.05	745.58
VZ 1	461.56	459.47	458.87	457.18	461.21
VZ 2	444.33	431.15	425.09	427.84	418.43
V-THETA 1	170.57	192.70	207.42	226.95	228.95
V-THETA 2	495.25	527.30	557.65	596.48	617.09
V(PR) 1	930.0	850.6	782.1	711.6	662.2
V(PR) 2	654.6	580.5	519.4	472.1	435.1
VTHETA PR1	807.4	715.8	633.3	545.4	475.2
VTHETA PR2	480.6	388.7	298.4	199.7	119.1
U 1	977.96	908.52	840.75	772.31	704.13
U 2	975.88	915.97	856.05	796.13	736.21
M 1	0.4399	0.4456	0.4506	0.4569	0.4611
M 2	0.5750	0.5919	0.6116	0.6429	0.6540
M(PR) 1	0.8314	0.7607	0.6998	0.6371	0.5931
M(PR) 2	0.5656	0.5045	0.4530	0.4135	0.3816
TURN(PR)	12.997	15.270	19.008	25.010	29.965
UUBAR	0.0793	0.0396	0.0361	0.0242	0.0860
DFAC	0.4201	0.4445	0.4673	0.4746	0.4830
EFFP	0.9114	0.9592	0.9667	0.9812	0.9383
EFF	0.9076	0.9575	0.9653	0.9804	0.9359
LOSS PARAM.	0.0190	0.0097	0.0091	0.0062	0.0215
INCID	0.64	0.40	0.38	0.23	0.86
DEV	2.148	3.234	4.268	4.316	7.190

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	83.32
UPSTREAM OF STATOR	83.32
DOWNSTREAM OF STATOR	79.50

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	48.102	50.729	52.682	54.349	55.860
BETA 3	25.752	24.548	23.344	25.924	30.396
V 2	665.36	681.13	701.19	734.05	745.58
V 3	484.39	456.63	454.86	427.90	388.47
VZ 2	444.33	431.15	425.09	427.84	418.43
VZ 3	436.28	415.36	417.62	384.84	335.07
V-THETA 2	495.25	527.30	557.65	596.48	617.09
V-THETA 3	210.46	189.71	180.24	187.07	196.55
M 2	0.5750	0.5919	0.6116	0.6429	0.6540
M 3	0.4125	0.3891	0.3882	0.3652	0.3303
TURN	22.350	26.181	29.338	28.425	25.464
UUBAR	0.0490	0.0789	0.0616	0.1264	0.1490
DFAC	0.4439	0.5163	0.5406	0.5995	0.6494
LOSS PARAM.	0.0177	0.0270	0.0199	0.0372	0.0388
INCID	2.02	4.60	6.00	6.36	5.86
DEV	20.722	17.548	14.894	15.644	17.896

Table IVn.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 89.92

CORRECTED WEIGHT FLOW = 79.65

CORRECTED ROTOR SPEED = 7523.37

PRESSURE RATIO = 1.3284

ADIABATIC EFFICIENCY = 87.8155

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.168	22.928	24.498	25.538	26.732
BETA 2	51.358	53.196	55.725	57.159	58.761
BETA(PR) 1	61.736	58.930	55.979	52.270	48.164
BETA(PR) 2	48.288	42.115	34.332	26.118	15.398
V 1	466.19	473.16	476.47	483.01	485.96
V 2	657.97	681.68	706.18	719.04	737.03
VZ 1	434.73	435.77	433.58	435.82	434.02
VZ 2	410.87	408.38	397.69	389.94	382.23
V-THETA 1	168.34	184.33	197.58	208.23	218.59
V-THETA 2	513.92	545.81	583.55	604.12	630.17
V(PR) 1	918.1	844.4	774.9	712.2	650.7
V(PR) 2	617.5	550.5	481.6	434.3	396.5
VTHETA PR1	808.6	723.2	642.3	563.3	484.8
VTHETA PR2	461.0	369.2	271.6	191.2	105.3
U 1	976.95	907.57	839.87	771.50	703.40
U 2	974.87	915.01	855.16	795.30	735.44
M 1	0.4162	0.4227	0.4258	0.4318	0.4346
M 2	0.5668	0.5905	0.6140	0.6278	0.6449
M(PR) 1	0.8197	0.7543	0.6925	0.6367	0.5819
M(PR) 2	0.5319	0.4769	0.4187	0.3792	0.3469
TURN(PR)	13.448	16.814	21.647	26.152	32.766
UUBAR	0.0916	0.0556	0.0488	0.0337	0.0803
DFAC	0.4609	0.4864	0.5253	0.5386	0.5426
EFFP	0.9056	0.9477	0.9595	0.9748	0.9472
EFF	0.9013	0.9453	0.9577	0.9737	0.9450
LOSS PARAM.	0.0215	0.0136	0.0124	0.0086	0.0202
INCID	2.14	2.03	2.28	2.47	3.16
DEV	3.188	3.315	3.532	5.418	6.698

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	79.65
UPSTREAM OF STATOR	79.65
DOWNSTREAM OF STATOR	75.71

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	51.358	53.196	55.725	57.159	58.761
BETA 3	25.408	23.860	23.344	27.300	32.632
V 2	657.97	681.68	706.18	719.04	737.03
V 3	476.17	456.47	408.55	374.56	332.36
VZ 2	410.87	408.38	397.69	389.94	382.23
VZ 3	430.11	417.46	375.11	332.84	279.89
V-THETA 2	513.92	545.81	583.55	604.12	630.17
V-THETA 3	204.30	184.64	161.89	171.79	179.22
M 2	0.5668	0.5905	0.6140	0.6278	0.6449
M 3	0.4041	0.3881	0.3474	0.3180	0.2813
TURN	25.950	29.336	32.381	29.859	26.129
UUBAR	0.0252	0.0611	0.1400	0.1556	0.1866
DFAC	0.4653	0.5300	0.6314	0.6757	0.7339
LOSS PARAM.	0.0091	0.0210	0.0452	0.0452	0.0475
INCID	5.28	7.07	9.05	9.17	8.76
DEV	20.378	16.560	14.894	17.020	20.132

Table IVo.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 89.85

CORRECTED WEIGHT FLOW = 75.42

CORRECTED ROTOR SPEED = 7517.62

PRESSURE RATIO = 1.3396

ADIABATIC EFFICIENCY = 84.2903

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.014	22.764	24.150	25.870	25.274
BETA 2	53.434	55.727	57.681	59.622	60.368
BETA(PR) 1	63.800	61.173	58.145	55.142	51.269
BETA(PR) 2	49.412	43.805	35.530	26.686	14.815
V 1	436.82	443.84	451.14	450.27	456.41
V 2	656.14	675.36	703.02	718.18	741.77
VZ 1	407.77	409.27	411.66	405.15	412.73
VZ 2	390.89	380.33	375.86	363.18	366.75
V-THETA 1	156.64	171.74	184.58	196.47	194.86
V-THETA 2	526.99	558.09	594.11	619.58	644.76
V(PR) 1	923.6	848.8	780.0	708.9	659.7
V(PR) 2	600.8	527.0	461.9	406.5	379.4
VTHETA PR1	828.7	743.6	662.5	581.7	514.6
VTHETA PR2	456.3	364.8	268.4	182.6	97.0
U 1	985.34	915.37	847.09	778.13	709.45
U 2	983.25	922.88	862.51	802.13	741.76
M 1	0.3855	0.3919	0.3985	0.3977	0.4033
M 2	0.5565	0.5772	0.6032	0.6187	0.6410
M(PR) 1	0.8150	0.7494	0.6890	0.6261	0.5829
M(PR) 2	0.5096	0.4504	0.3963	0.3501	0.3278
TURN(PR)	14.388	17.368	22.815	28.455	36.454
UUBAR	0.1495	0.0788	0.0803	0.0644	0.0868
DFAC	0.4917	0.5265	0.5629	0.5865	0.5898
EFFP	0.8596	0.9300	0.9369	0.9554	0.9461
EFF	0.8529	0.9267	0.9340	0.9534	0.9437
LOSS PARAM.	0.0343	0.0188	0.0200	0.0163	0.0218
INCID	4.20	4.27	4.45	5.34	6.27
DEV	4.312	5.005	4.730	5.986	6.115

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	75.42
UPSTREAM OF STATOR	75.42
DOWNSTREAM OF STATOR	71.34

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	53.434	55.727	57.681	59.622	60.368
BETA 3	26.956	24.720	24.720	27.472	33.492
V 2	656.14	675.36	703.02	718.18	741.77
V 3	454.83	444.18	401.27	346.70	276.25
VZ 2	390.89	380.33	375.86	363.18	366.75
VZ 3	405.41	403.48	364.50	307.61	230.38
V-THETA 2	526.99	558.09	594.11	619.58	644.76
V-THETA 3	206.18	185.75	167.81	159.94	152.44
M 2	0.5565	0.5772	0.6032	0.6187	0.6410
M 3	0.3799	0.3728	0.3369	0.2903	0.2304
TURN	26.478	31.007	32.961	32.150	26.876
UUBAR	0.0661	0.0608	0.1368	0.1817	0.2503
DFAC	0.5032	0.5500	0.6424	0.7265	0.8281
LOSS PARAM.	0.0237	0.0208	0.0437	0.0527	0.0631
INCID	7.35	9.60	11.00	11.63	10.37
DEV	21.926	17.720	16.270	17.192	20.992

Table IVp.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 99.89

CORRECTED WEIGHT FLOW = 96.38

CORRECTED ROTOR SPEED = 8358.07

PRESSURE RATIO = 1.2656

ADIABATIC EFFICIENCY = 74.8174

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	20.401	23.201	23.894	25.617	24.938
BETA 2	43.972	45.170	47.124	49.123	51.038
BETA(PR) 1	56.653	53.105	49.559	45.201	40.889
BETA(PR) 2	48.964	41.544	32.674	23.378	13.471
V 1	615.56	626.46	634.88	642.96	651.62
V 2	715.91	766.28	817.03	855.06	885.12
VZ 1	576.95	575.80	580.47	579.76	591.34
VZ 2	515.22	540.23	555.92	559.58	556.57
V-THETA 1	214.58	246.80	257.16	277.99	273.72
V-THETA 2	497.06	543.45	598.75	646.52	688.23
V(PR) 1	1049.6	959.1	894.9	822.8	782.2
V(PR) 2	784.8	721.8	660.4	609.6	572.3
VTHETA PR1	876.8	767.0	681.1	583.8	512.0
VTHETA PR2	592.0	478.7	356.5	241.9	133.3
U 1	1091.34	1013.84	938.21	861.84	785.76
U 2	1089.01	1022.15	955.28	888.42	821.55
M 1	0.5536	0.5640	0.5721	0.5798	0.5882
M 2	0.6204	0.6676	0.7175	0.7547	0.7841
M(PR) 1	0.9439	0.8635	0.8064	0.7420	0.7061
M(PR) 2	0.6801	0.6268	0.5800	0.5381	0.5070
TURN(PR)	7.689	11.561	16.835	21.824	27.419
UUBAR	0.1659	0.1601	0.0877	0.0635	0.0681
DFAC	0.3480	0.3466	0.3732	0.3771	0.3944
EFFP	0.7582	0.7992	0.8996	0.9370	0.9385
EFF	0.7500	0.7920	0.8956	0.9345	0.9360
LOSS PARAM.	0.0384	0.0396	0.0226	0.0166	0.0172
INCID	-2.95	-3.79	-4.14	-4.60	-4.11
DEV	3.864	2.744	1.874	2.678	4.771

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	96.38
UPSTREAM OF STATOR	96.38
DOWNSTREAM OF STATOR	93.22

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	43.972	45.170	47.124	49.123	51.038
BETA 3	27.300	26.440	25.924	27.300	26.440
V 2	715.91	766.28	817.03	855.06	885.12
V 3	578.39	577.99	619.60	628.99	495.91
VZ 2	515.22	540.23	555.92	559.58	556.57
VZ 3	513.97	517.53	557.25	558.93	444.04
V-THETA 2	497.06	543.45	598.75	646.52	688.23
V-THETA 3	265.28	257.36	270.87	288.49	220.81
M 2	0.6204	0.6676	0.7175	0.7547	0.7841
M 3	0.4945	0.4940	0.5312	0.5417	0.4209
TURN	16.672	18.730	21.200	21.823	24.598
UUBAR	-0.0222	0.0574	0.0580	0.0786	0.3201
DFAC	0.3221	0.3864	0.3828	0.4013	0.5993
LOSS PARAM.	-0.0079	0.0194	0.0183	0.0228	0.0866
INCID	-2.11	-0.96	0.44	1.13	1.04
DEV	22.270	19.440	17.474	17.020	13.940

Table IVq.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 99.82

CORRECTED WEIGHT FLOW = 95.59

CORRECTED ROTOR SPEED = 8352.34

PRESSURE RATIO = 1.3230

ADIABATIC EFFICIENCY = 82.7651

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.362	25.516	23.730	21.944
BETA 1	21.345	23.278	25.192	26.566	26.896
BETA 2	45.296	48.154	49.190	51.137	52.973
BETA(PR) 1	57.007	53.551	49.975	45.689	41.351
BETA(PR) 2	46.506	40.710	32.892	23.372	15.514
V 1	600.98	612.68	618.22	626.06	628.99
V 2	742.75	767.55	802.12	838.17	842.77
VZ 1	559.75	562.81	559.42	559.96	560.94
VZ 2	522.48	512.06	524.23	525.92	507.51
V-THETA 1	218.74	242.13	263.15	279.99	284.56
V-THETA 2	527.91	571.78	607.11	652.64	672.82
V(PR) 1	1027.9	947.3	869.8	811.6	747.3
V(PR) 2	759.1	675.5	624.3	572.9	526.7
VTHETA PR1	862.2	762.0	666.1	573.6	493.7
VTHETA PR2	550.7	446.6	359.0	227.3	148.9
U 1	1080.90	1004.14	929.24	853.60	778.25
U 2	1078.60	1012.38	946.15	879.92	813.71
M 1	0.5448	0.5561	0.5614	0.5696	0.5718
M 2	0.6476	0.6731	0.7066	0.7415	0.7471
M(PR) 1	0.9319	0.8598	0.7899	0.7286	0.6794
M(PR) 2	0.6618	0.5924	0.5500	0.5069	0.4669
TURN(PR)	16.506	12.841	17.183	22.317	25.838
UUBAR	0.0815	0.0638	0.0576	0.0764	0.1183
DFAC	0.3684	0.3989	0.3976	0.4085	0.4181
EFFP	0.8999	0.9275	0.9427	0.9447	0.9055
EFF	0.8953	0.9242	0.9401	0.9422	0.9014
LOSS PARAM.	0.0198	0.0167	0.0148	0.0167	0.0297
INCID	-2.59	-3.35	-3.72	-4.11	-3.65
DEV	1.406	1.915	2.092	2.672	6.814

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	95.59
UPSTREAM OF STATOR	95.59
DOWNSTREAM OF STATOR	92.11

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	45.296	48.154	49.190	51.137	52.973
BETA 3	29.536	25.924	25.064	26.268	29.880
V 2	742.75	767.55	802.12	838.17	842.77
V 3	545.70	550.95	572.78	548.91	474.74
VZ 2	522.48	512.06	524.23	525.92	507.51
VZ 3	474.78	495.51	518.84	492.23	411.64
V-THETA 2	527.91	571.78	607.11	652.64	672.82
V-THETA 3	269.01	240.86	242.65	242.93	236.51
M 2	0.6476	0.6731	0.7065	0.7415	0.7471
M 3	0.4659	0.4727	0.4926	0.4728	0.4654
TURN	15.760	22.230	24.126	24.869	23.093
UUBAR	0.1150	0.0895	0.0638	0.1214	0.1836
DFAC	0.4053	0.4446	0.4457	0.5050	0.5931
LOSS PARAM.	0.0462	0.0303	0.0203	0.0356	0.0481
INCID	-0.78	2.02	2.51	3.15	2.97
DEV	24.506	16.924	16.614	15.988	17.380

Table IVr.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 99.91

CORRECTED WEIGHT FLOW = 93.53

CORRECTED ROTOR SPEED = 8359.53

PRESSURE RATIO = 1.3578

ADIABATIC EFFICIENCY = 85.3169

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.[illegible]20	2[illegible].988
DIA 2	29.088	27.[illegible]62	25.516	23.730	21.944
BETA 1	21.015	22.936	24.499	25.[illegible]02	25.36[illegible]
BETA 2	48.381	50.270	52.788	54.[illegible]58	56.119
BETA(PR) 1	58.004	54.735	51.438	47.[illegible]71	43.331
BETA(PR) 2	46.980	41.197	33.875	24.436	15.277
V 1	589.58	599.73	603.48	6[illegible].68	614.[illegible]8
V 2	746.94	770.08	795.22	826.19	837.[illegible]
VZ 1	550.36	552.31	549.15	552.1[illegible]	554.9[illegible]
VZ 2	496.10	492.22	480.92	484.94	466.6[illegible]
V-THETA 1	211.44	233.72	252.25	258.64	263.[illegible]1
V-THETA 2	558.40	592.24	633.32	668.90	694.87
V(PR) 1	1038.[illegible]	956.6	88[illegible].9	818.3	762.9
V(PR) 2	727.1	654.2	579.2	532.7	483.7
VTHETA PR1	880.9	781.1	688.8	6[illegible]4.[illegible]	523.5
VTHETA PR2	531.6	430.9	322.9	220.3	127.4
U 1	1092.35	1014.78	939.[illegible]9	862.64	786.49
U 2	1096.[illegible]3	1023.10	956.17	889.25	822.32
M 1	0.5285	0.5381	0.5416	0.5475	0.5517
M 2	0.6424	0.6664	0.6912	0.7209	0.7318
M(PR) 1	0.9310	0.8583	0.7967	0.7349	0.6854
M(PR) 2	0.6254	0.5061	0.5034	0.4648	0.4229
TURN(PR)	11.024	13.538	17.563	23.134	28.054
OOBAR	0.0628	0.0395	0.0332	0.0443	0.1071
DFAC	0.4185	0.4370	0.4699	0.4823	0.5011
EFFP	0.9283	0.9584	0.9688	0.9627	0.9171
EFF	0.9247	0.9564	0.9673	0.9609	0.9133
LOSS PARAM.	0.0151	0.0098	0.0085	0.0115	0.0269
INCID	-1.66	-2.17	-2.26	-2.23	-1.67
DEV	1.885	2.397	3.075	3.736	6.577

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	93.53
UPSTREAM OF STATOR	93.53
DOWNSTREAM OF STATOR	89.76

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.[illegible]74	22.[illegible]34
BETA 2	48.381	50.270	52.788	54.[illegible]58	56.119
BETA 3	27.300	24.720	24.264	25.924	26.440
V 2	746.94	770.[illegible]8	795.[illegible]2	826.19	837.[illegible]0
V 3	526.59	520.76	517.[illegible]1	500.48	432.67
VZ 2	496.10	492.22	480.92	484.94	466.[illegible]0
VZ 3	467.93	473.04	471.56	450.12	387.59
V-THETA 2	558.40	592.24	633.32	668.90	694.87
V-THETA 3	241.52	217.77	211.97	218.80	192.74
M 2	0.6424	0.6664	0.6912	0.7209	0.7318
M 3	0.4429	0.4396	0.4372	0.4238	0.3645
TURN	21.081	25.550	28.584	28.134	29.679
OOBAR	0.0999	0.0939	0.[illegible]877	0.1141	0.1694
DFAC	0.4654	0.5070	0.5362	0.5724	0.6641
LOSS PARAM.	0.0357	0.0321	0.0281	0.0336	0.0458
INCID	2.30	4.14	6.11	6.07	6.12
DEV	22.270	17.720	15.754	15.644	13.940

Table IVs.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 99.77

CORRECTED WEIGHT FLOW = 90.22

CORRECTED ROTOR SPEED = 8347.94

PRESSURE RATIO = 1.3863

ADIABATIC EFFICIENCY = 85.2885

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.521	22.753	25.192	26.732	25.538
BETA 2	49.597	52.229	53.885	56.233	57.616
BETA(PR) 1	59.566	56.537	53.084	49.211	45.253
BETA(PR) 2	47.254	41.936	34.594	26.497	16.078
V 1	555.71	565.03	571.57	576.40	581.74
V 2	739.37	757.14	781.25	796.02	816.84
VZ 1	516.97	521.06	517.21	514.79	524.90
VZ 2	479.23	463.76	460.48	442.44	437.49
V-THETA 1	203.86	218.53	243.29	259.28	250.79
V-THETA 2	563.03	598.49	631.12	661.74	689.81
V(PR) 1	1020.6	945.0	861.1	788.0	745.6
V(PR) 2	706.0	623.4	559.4	494.4	455.3
VTHETA PR1	880.0	788.3	688.5	596.6	529.6
VTHETA PR2	518.5	416.6	317.6	220.6	126.1
U 1	1083.83	1006.86	931.76	855.91	780.36
U 2	1081.52	1015.12	948.71	882.31	815.90
M 1	0.4999	0.5087	0.5149	0.5195	0.5246
M 2	0.6365	0.6564	0.6799	0.6958	0.7159
M(PR) 1	0.9181	0.8508	0.7758	0.7103	0.6724
M(PR) 2	0.6078	0.5405	0.4868	0.4321	0.3990
TURN(PR)	12.313	14.601	18.490	22.714	29.175
UUBAR	0.0782	0.0364	0.0510	0.0555	0.1083
DFAC	0.4331	0.4701	0.4825	0.5082	0.5303
EFFP	0.9193	0.9646	0.9561	0.9569	0.9221
EFF	0.9149	0.9627	0.9539	0.9548	0.9184
LOSS PARAM.	0.0187	0.0089	0.0129	0.0141	0.0271
INCID	-0.03	-0.36	-0.62	-0.59	0.25
DEV	2.154	3.156	3.794	5.797	7.378

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	90.22
UPSTREAM OF STATOR	90.22
DOWNSTREAM OF STATOR	86.34

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	49.597	52.229	53.885	56.233	57.616
BETA 3	27.128	26.440	25.064	23.172	33.148
V 2	739.37	757.14	781.25	796.02	816.84
V 3	517.62	510.68	462.44	439.32	389.25
VZ 2	479.23	463.76	460.48	442.44	437.49
VZ 3	460.68	457.26	418.90	403.88	325.90
V-THETA 2	563.03	598.49	631.12	661.74	689.81
V-THETA 3	236.03	227.39	195.90	172.87	212.64
M 2	0.6365	0.6564	0.6799	0.6958	0.7159
M 3	0.4362	0.4322	0.3912	0.3715	0.3280
TURN	22.469	25.789	28.821	33.161	24.468
UUBAR	0.0876	0.0716	0.1326	0.1241	0.1649
DFAC	0.4775	0.5102	0.6049	0.6489	0.6999
LOSS PARAM.	0.0313	0.0246	0.0423	0.0373	0.0417
INCID	3.52	6.10	7.20	8.24	7.62
DEV	22.098	19.440	16.614	12.892	20.648

Table IVt.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 99.85

CORRECTED WEIGHT FLOW = 86.77

CORRECTED ROTOR SPEED = 8354.05

PRESSURE RATIO = 1.4101

ADIABATIC EFFICIENCY = 84.4459

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.680	25.860	23.920	21.988
DIA 2	29.088	27.302	25.516	23.732	21.944
BETA 1	21.521	23.278	24.498	25.192	27.065
BETA 2	51.483	54.051	56.532	58.832	59.629
BETA(PR) 1	61.553	58.815	55.564	52.374	47.906
BETA(PR) 2	46.898	42.452	37.688	27.449	16.233
V 1	519.52	525.81	534.36	534.52	541.07
V 2	746.20	753.05	752.01	783.80	806.99
VZ 1	483.30	483.69	486.25	483.68	481.82
VZ 2	464.69	442.09	414.71	405.65	408.01
V-THETA 1	190.58	207.80	221.58	227.52	246.18
V-THETA 2	583.84	669.62	627.33	670.67	696.25
V(PR) 1	1014.6	932.8	859.9	792.3	718.8
V(PR) 2	680.1	599.2	524.1	457.1	425.7
VTHETA PR1	892.1	798.0	709.2	627.5	533.3
VTHETA PR2	496.5	404.4	322.4	214.7	118.8
U 1	1082.68	1005.80	930.77	855.08	779.53
U 2	1080.38	1014.65	947.71	881.37	815.64
M 1	0.4668	0.4727	0.4807	0.4809	0.4870
M 2	0.6400	0.6561	0.6523	0.6824	0.7051
M(PR) 1	0.9116	0.8385	0.7736	0.7127	.647
M(PR) 2	0.5832	0.5173	0.4545	0.3980	.3713
TURN(PR)	14.655	16.363	17.876	24.926	31.673
OOBAR	0.0965	0.0828	0.0668	0.0779	0.1178
DFAC	0.4672	0.4969	0.5293	0.5725	0.5590
EFFP	0.9100	0.9448	0.9443	0.9431	0.9255
EFF	0.9046	0.9417	0.9414	0.9401	0.9217
LOSS PARAM.	0.0232	0.0153	0.0102	0.0197	0.0295
INCID	1.95	1.91	1.86	2.57	2.91
DEV	1.798	3.652	6.888	6.749	7.533

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	86.77
UPSTREAM OF STATOR	86.77
DOWNSTREAM OF STATOR	82.74

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	51.483	54.051	56.532	58.832	59.629
BETA 3	26.440	23.516	24.376	28.332	35.212
V 2	746.20	753.05	752.01	783.80	806.99
V 3	517.20	487.81	436.53	386.34	366.29
VZ 2	464.69	442.09	414.71	405.65	408.01
VZ 3	463.10	447.30	397.61	340.66	299.27
V-THETA 2	583.84	669.62	627.33	670.67	696.25
V-THETA 3	230.29	194.64	180.17	183.35	211.26
M 2	0.6400	0.6561	0.6523	0.6824	0.7051
M 3	0.4347	0.4116	0.3685	0.3254	0.3080
TURN	25.043	31.535	32.156	30.540	24.417
OOBAR	0.1263	0.1178	0.1175	0.1837	0.1799
DFAC	0.4972	0.5599	0.6286	0.7104	0.7277
LOSS PARAM.	0.0454	0.0467	0.0376	0.0529	0.0444
INCID	5.40	7.92	9.85	10.84	9.63
DEV	21.410	16.516	15.926	18.652	22.712

Table IVu.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 109.89

CORRECTED WEIGHT FLOW = 100.23

CORRECTED ROTOR SPEED = 9194.36

PRESSURE RATIO = 1.2998

ADIABATIC EFFICIENCY = 88.3345

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.[illegible]	[illegible]
DIA 2	29.088	27.312	25.516	23.737	21.944
BETA 1	22.226	23.628	25.192	26.[illegible]	28.732
BETA 2	43.350	44.721	47.998	49.[illegible]	49.353
BETA(PR) 1	58.125	54.585	50.858	46.729	42.2[illegible]
BETA(PR) 2	49.179	42.789	33.449	23.[illegible]	13.9[illegible]
V 1	639.29	656.36	667.37	67[illegible].11	682.13
V 2	779.30	821.12	881.50	938.73	976.61
VZ 1	591.79	61[illegible].34	603.9[illegible]	6[illegible]4.7[illegible]	6[illegible]9.22
VZ 2	566.68	583.44	589.86	612.11	636.15
V-THETA 1	241.82	263.[illegible]6	284.[illegible]7	3[illegible].18	3[illegible]6.84
V-THETA 2	534.95	577.79	655.[illegible]6	711.71	74[illegible].99
V(PR) 1	1120.7	1[illegible].37.7	956.7	8[illegible]2.2	822.4
V(PR) 2	865.9	795.[illegible]	7[illegible]6.9	6[illegible]5.[illegible]	655.4
VTHETA PR1	951.7	845.7	742.[illegible]	[illegible]42.3	552.5
VTHETA PR2	656.0	54[illegible].1	389.7	259.9	157.[illegible]
U 1	1193.51	11[illegible]8.76	1[illegible]20.[illegible]5	942.52	859.33
U 2	1196.97	1117.84	1[illegible]44.72	971.59	898.47
M 1	[illegible].5799	[illegible].5965	[illegible].6[illegible]73	0.6148	[illegible].6217
M 2	0.6771	[illegible].72[illegible]2	[illegible].7774	0.8333	[illegible].8729
M(PR) 1	1.0166	[illegible].9431	[illegible].87[illegible]5	0.8[illegible]34	[illegible].749[illegible]
M(PR) 2	0.7532	[illegible].6974	[illegible].6234	0.5903	[illegible].5858
TURN(PR)	8.947	11.796	17.4[illegible]9	23.725	28.3[illegible]
UUBAR	[illegible].2096	[illegible].1629	[illegible].1628	0.1328	[illegible].[illegible]829
DFAC	0.3195	[illegible].3311	[illegible].3749	0.3694	[illegible].3282
EFFP	0.7254	[illegible].7942	[illegible].8266	0.8801	[illegible].933
EFF	0.7094	0.7859	[illegible].8190	0.8743	[illegible].9296
LOSS PARAM.	[illegible].[illegible]483	[illegible].[illegible]394	[illegible].[illegible]417	0.[illegible]347	[illegible].21
INCID	-1.47	-2.32	-2.84	-3.[illegible]7	-2.8
DEV	4.079	3.969	2.649	2.[illegible]3[illegible]4	5.[illegible]24

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	1[illegible].23
UPSTREAM OF STATOR	100.23
DOWNSTREAM OF STATOR	97.19

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	43.350	44.721	47.998	49.303	49.353
BETA 3	30.396	26.956	24.892	25.580	29.708
V 2	779.30	821.12	881.50	938.73	976.61
V 3	578.36	598.55	642.36	693.53	548.44
VZ 2	566.68	583.44	589.86	612.11	636.15
VZ 3	498.87	533.52	582.69	625.55	476.35
V-THETA 2	534.95	577.79	655.06	711.71	740.99
V-THETA 3	292.64	271.33	270.38	299.44	271.79
M 2	0.6771	0.7202	0.7774	0.8333	0.8729
M 3	0.4924	0.5119	0.5508	0.5974	0.4646
TURN	12.954	17.765	23.106	23.723	19.645
UUBAR	0.0882	0.0950	0.0968	0.0772	0.3375
DFAC	0.3827	0.4117	0.4247	0.4048	0.5836
LOSS PARAM.	0.0306	0.0319	0.0309	0.0228	0.0886
INCID	-2.73	-1.41	1.32	1.31	-[illegible].65
DEV	25.366	19.956	16.442	15.300	17.208

Table IVv.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = [illegible]

CORRECTED WEIGHT FLOW = [illegible]

CORRECTED ROTOR SPEED = 4197.95

PRESSURE RATIO = 1.3991

ADIABATIC EFFICIENCY = 77.3951

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.15[illegible]	27.[illegible]	25.66	23.[illegible]	[illegible]
DIA 2	29.088	27.[illegible]	25.516	23.73[illegible]	21.944
BETA 1	22.462	22.577	25.365	26.565	26.4[illegible]
BETA 2	47.934	49.252	51.481	52.166	53.142
BETA(PR) 1	57.925	56.840	5[illegible].867	46.898	42.571
BETA(PR) 2	47.929	42.16[illegible]	33.922	24.[illegible]93	16.051
V 1	641.77	653.01	665.51	67[illegible].63	676.77
V 2	8[illegible].75	827.38	868.13	911.44	922.[illegible]1
VZ 1	593.34	6[illegible].96	6[illegible].35	599.82	6[illegible].19
VZ 2	536.49	54[illegible].5	54[illegible].65	559.[illegible]6	553.[illegible]6
V-THETA 1	244.58	250.71	285[illegible].9	299.92	3[illegible].42
V-THETA 2	594.46	626.81	679.22	719.84	737.72
V(PR) 1	1117.3	1[illegible]47.1	95[illegible]	877.8	823.1
V(PR) 2	6[illegible].7	728.5	69[illegible]	612.4	575.[illegible]
VTHETA PR1	946.8	85[illegible].[illegible]	739.[illegible]	64[illegible].9	556.[illegible]
VTHETA PR2	594.3	489.[illegible]	363.6	25[illegible].[illegible]	159.1
U 1	1191.35	1196.75	1[illegible]24.19	94[illegible].82	857.77
U 2	1188.81	1195.82	1[illegible]42.83	969.83	896.84
M 1	[illegible].5837	.5947	[illegible].6[illegible]69	0.6119	[illegible].6179
M 2	[illegible].6916	.72[illegible]5	[illegible].75[illegible]7	0.8[illegible]4[illegible]	.8165
M(PR) 1	1.[illegible]162	[illegible].9535	[illegible].8689	0.8[illegible]09	[illegible].7515
M(PR) 2	[illegible].6916	[illegible].6345	.5710	[illegible].54[illegible]2	.5097
TURN(PR)	9.996	12.66[illegible]	16.945	22.8[illegible]3	26.519
UUBAR	[illegible].1519	[illegible].1155	[illegible].1129	0.[illegible]854	[illegible].1122
DFAC	0.3946	[illegible].4199	[illegible].4371	0.4288	[illegible].4267
EFFP	[illegible].831[illegible]	[illegible].8769	[illegible].8944	0.9299	[illegible].9133
EFF	[illegible].8727	[illegible].87[illegible]4	[illegible].8887	[illegible].9266	.[illegible]88
LOSS PARAM.	[illegible].0359	[illegible].0283	[illegible].0287	[illegible].[illegible]221	[illegible].[illegible]281
INCID	-1.68	-2.[illegible]6	-2.83	-2.9[illegible]	-2.43
DEV	2.829	3.36[illegible]	3.122	3.393	7.351

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 2	29.164	27.422	25.672	23.874	22.[illegible]34
BETA 2	47.934	49.252	51.481	52.166	53.142
BETA 3	29.880	24.720	23.344	25.580	32.116
V 2	8[illegible].76	827.38	868.13	911.44	922.[illegible]1
V 3	569.81	588.94	588.95	562.44	482.26
VZ 2	536.49	54[illegible].65	54[illegible].65	559.[illegible]6	553.[illegible]6
VZ 3	494.06	534.97	54[illegible].74	5[illegible]7.32	408.46
V-THETA 2	594.46	626.81	679.22	719.84	737.72
V-THETA 3	263.87	246.29	233.37	242.85	256.39
M 2	[illegible].6916	[illegible].7205	[illegible].7667	[illegible].8[illegible]40	[illegible].8165
M 3	[illegible].4792	[illegible].4990	[illegible].4998	[illegible].4785	[illegible].4[illegible]73
TURN	18.[illegible]54	24.532	28.137	26.586	21.[illegible]26
UUBAR	[illegible].[illegible]884	[illegible].0481	[illegible].[illegible]762	[illegible].1417	[illegible].2140
DFAC	[illegible].4442	[illegible].4615	[illegible].5022	[illegible].554[illegible]	[illegible].6347
LOSS PARAM.	[illegible].03[illegible]8	[illegible].[illegible]165	[illegible].[illegible]246	[illegible].[illegible]418	[illegible].[illegible]548
INCID	1.85	3.12	4.80	4.18	3.14
DEV	24.850	17.720	14.894	15.3[illegible]0	19.616

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	10[illegible].17
UPSTREAM OF STATOR	10[illegible].17
DOWNSTREAM OF STATOR	96.61

Table IVw.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 109.83

CORRECTED WEIGHT FLOW = 100.08

CORRECTED ROTOR SPEED = 9189.86

PRESSURE RATIO = 1.4272

ADIABATIC EFFICIENCY = 89.7584

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.521	23.628	25.538	26.732	25.883
BETA 2	49.195	50.799	52.281	47.419	55.043
BETA(PR) 1	58.011	54.699	51.625	46.802	42.638
BETA(PR) 2	46.813	41.438	34.068	26.953	16.487
V 1	641.04	652.30	661.54	670.77	677.30
V 2	817.14	836.16	864.59	896.61	905.61
VZ 1	596.35	597.62	596.91	599.08	609.36
VZ 2	533.99	528.49	528.94	606.67	518.87
V-THETA 1	235.16	261.44	285.20	301.73	295.67
V-THETA 2	618.52	647.97	683.91	660.20	742.22
V(PR) 1	1125.7	1034.2	949.0	875.2	828.3
V(PR) 2	780.2	705.0	638.5	680.6	541.1
VTHETA PR1	954.8	844.0	737.8	638.0	561.1
VTHETA PR2	568.9	466.5	357.7	308.5	153.6
U 1	1189.95	1105.45	1022.99	939.71	856.76
U 2	1167.42	1114.51	1041.60	968.69	895.79
M 1	0.5832	0.5942	0.6032	0.6122	0.6186
M 2	0.7043	0.7268	0.7566	0.7898	0.8001
M(PR) 1	1.0241	0.9420	0.8653	0.7988	0.7566
M(PR) 2	0.6725	0.6128	0.5588	0.5996	0.4781
TURN(PR)	11.199	13.261	16.957	19.848	26.152
UUBAR	0.1287	0.0944	0.0768	0.0593	0.1148
DFAC	0.4278	0.4388	0.4510	0.3293	0.4749
EFFP	0.8653	0.9065	0.9306	0.9517	0.9108
EFF	0.8572	0.9010	0.9267	0.9496	0.9061
LOSS PARAM.	0.0311	0.0234	0.0195	0.0150	0.0287
INCID	-1.59	-2.20	-2.67	-3.00	-2.36
DEV	1.713	2.638	3.268	6.253	7.787

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	100.08
UPSTREAM OF STATOR	100.08
DOWNSTREAM OF STATOR	96.38

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	49.195	50.799	52.281	47.419	55.043
BETA 3	29.364	23.516	23.000	26.612	35.040
V 2	817.14	836.16	864.59	896.61	905.61
V 3	565.09	576.79	551.52	527.92	432.70
VZ 2	533.99	528.49	528.94	606.67	518.87
VZ 3	492.49	528.89	507.68	472.00	354.28
V-THETA 2	618.52	647.97	683.91	660.20	742.22
V-THETA 3	277.09	230.14	215.50	236.48	248.44
M 2	0.7043	0.7268	0.7566	0.7898	0.8001
M 3	0.4739	0.4873	0.4673	0.4480	0.3643
TURN	19.831	27.283	29.281	26.857	26.603
UUBAR	0.1192	0.0721	0.1049	0.1355	0.2100
DFAC	0.4763	0.4585	0.5526	0.5657	0.6869
LOSS PARAM.	0.0417	0.0249	0.0340	0.0396	0.0526
INCID	3.11	4.67	5.60	-0.57	5.04
DEV	24.334	16.516	14.550	16.332	22.540

Table IVx.

Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 109.9%

CORRECTED WEIGHT FLOW = 99.43

CORRECTED ROTOR SPEED = 9195.58

PRESSURE RATIO = 1.459

ADIABATIC EFFICIENCY = 82.6971

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.521	23.812	25.365	26.898	25.833
BETA 2	50.397	51.310	53.141	54.519	56.307
BETA(PR) 1	58.292	54.969	51.445	47.338	43.151
BETA(PR) 2	46.133	46.959	34.212	25.732	17.469
V 1	635.54	647.01	654.94	661.90	669.45
V 2	828.32	842.40	862.38	885.51	894.62
VZ 1	591.23	591.98	591.81	592.29	592.29
VZ 2	528.02	526.59	517.30	513.99	494.07
V-THETA 1	233.19	261.12	288.57	299.45	292.24
V-THETA 2	638.21	657.53	696.08	721.08	741.01
V(PR) 1	1124.8	1031.3	949.5	887.9	825.6
V(PR) 2	702.0	697.3	625.3	571.6	517.8
VTHETA PR1	956.9	844.4	742.5	647.4	564.6
VTHETA PR2	549.3	457.1	351.7	247.7	154.9
U 1	1190.07	1115.56	1023.10	939.81	858.45
U 2	1187.54	1114.63	1041.71	968.8	895.88
M 1	0.5782	0.5893	0.5971	0.6039	0.6113
M 2	0.7127	0.7315	0.7554	0.7784	0.7849
M(PR) 1	1.0233	0.9393	0.8656	0.7946	0.7538
M(PR) 2	0.6556	0.6355	0.5465	0.5115	0.4563
TURN(PR)	12.157	14.009	17.233	21.597	25.746
UUBAR	0.1156	0.0678	0.0622	0.0651	0.1201
DFAC	0.4554	0.4478	0.4675	0.4729	0.5021
EFFP	0.8862	0.938	0.9459	0.9598	0.9285
EFF	0.8788	0.932	0.9427	0.9575	0.9037
LOSS PARAM.	0.0281	0.0169	0.0158	0.0131	0.0298
INCID	-1.31	-1.93	-2.26	-2.47	-1.85
DEV	1.033	2.159	3.412	5.132	8.704

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	99.43
UPSTREAM OF STATOR	99.43
DOWNSTREAM OF STATOR	95.63

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 2	29.164	27.422	25.672	23.874	22.034
BETA 2	50.397	51.310	53.141	54.519	56.307
BETA 3	29.020	25.860	23.000	27.644	34.524
V 2	828.32	842.40	862.38	885.51	894.62
V 3	560.52	571.10	525.96	495.73	385.83
VZ 2	528.02	526.59	517.30	513.99	494.07
VZ 3	490.14	502.30	484.15	439.14	317.88
V-THETA 2	638.21	657.53	696.08	721.08	741.01
V-THETA 3	271.91	231.01	265.51	230.01	218.67
M 2	0.7127	0.7315	0.7554	0.7784	0.7849
M 3	0.4693	0.4823	0.4447	0.4191	0.3240
TURN	21.377	27.450	36.141	26.875	21.783
UUBAR	0.1489	0.0886	0.1258	0.1414	0.2098
DFAC	0.5069	0.5128	0.5876	0.6215	0.7440
LOSS PARAM.	0.0523	0.0365	0.0467	0.0409	0.1520
INCID	4.32	5.18	6.46	6.53	6.31
DEV	23.993	16.860	14.550	17.364	22.024

Table IVy.
Blade element performance—slotted stator stage.

PERCENT DESIGN SPEED = 109.92

CORRECTED WEIGHT FLOW = 97.31

CORRECTED ROTOR SPEED = 9197.28

PRESSURE RATIO = 1.4742

ADIABATIC EFFICIENCY = 82.8495

ROTOR 1

STATION 1 - STATION 2

	10	30	50	70	90
DIA 1	29.150	27.080	25.060	23.020	20.988
DIA 2	29.088	27.302	25.516	23.730	21.944
BETA 1	21.168	22.402	25.192	26.898	26.400
BETA 2	52.171	51.996	55.032	57.103	57.961
BETA(PR) 1	59.363	56.407	52.874	48.960	44.918
BETA(PR) 2	45.722	41.047	35.763	27.229	17.962
V 1	616.47	625.22	632.84	638.06	642.21
V 2	839.24	844.06	847.63	867.99	880.95
VZ 1	574.88	578.04	572.65	569.03	575.23
VZ 2	514.71	519.70	485.79	471.43	467.35
V-THETA 1	222.61	238.27	269.37	288.66	285.55
V-THETA 2	662.87	665.09	694.61	728.80	746.77
V(PR) 1	1128.1	1044.7	948.8	866.6	812.3
V(PR) 2	737.3	689.1	598.7	530.2	491.3
VTHETA PR1	970.6	870.2	756.5	653.7	573.6
VTHETA PR2	527.9	452.5	349.9	242.6	151.5
U 1	1193.25	1108.52	1025.83	942.32	859.14
U 2	1190.72	1117.61	1044.50	971.39	898.28
M 1	0.5582	0.5667	0.5740	0.5791	0.5831
M 2	0.7178	0.7292	0.7363	0.7574	0.7711
M(PR) 1	1.0215	0.9469	0.8606	0.7865	0.7376
M(PR) 2	0.6306	0.5954	0.5201	0.4626	0.4300
TURN(PR)	13.641	15.360	17.111	21.731	26.956
UUBAR	0.1104	0.0473	0.0506	0.0726	0.1308
DFAC	0.4849	0.4724	0.5004	0.5230	0.5305
EFFP	0.8970	0.9569	0.9572	0.9449	0.9075
EFF	0.8899	0.9540	0.9546	0.9417	0.9024
LOSS PARAM.	0.0272	0.0118	0.0126	0.0183	0.0324
INCID	-0.24	-0.49	-0.83	-0.84	-0.08
DEV	0.622	2.247	4.963	6.529	9.262

CORRECTED WEIGHT FLOW

UPSTREAM OF ROTOR	97.31
UPSTREAM OF STATOR	97.31
DOWNSTREAM OF STATOR	93.34

STATOR 1

STATION 2 - STATION 3

	10	30	50	70	90
DIA 3	29.164	27.422	25.672	23.874	22.034
BETA 2	52.171	51.996	55.032	57.103	57.961
BETA 3	29.020	23.688	23.860	27.644	35.212
V 2	839.24	844.06	847.63	867.99	880.95
V 3	566.83	551.91	484.86	448.87	349.25
VZ 2	514.71	519.70	485.79	471.43	467.35
VZ 3	490.42	505.41	443.42	397.63	285.35
V-THETA 2	662.87	665.09	694.61	728.80	746.77
V-THETA 3	272.07	221.73	196.13	208.27	201.38
M 2	0.7178	0.7292	0.7363	0.7574	0.7711
M 3	0.4669	0.4631	0.4069	0.3763	0.2911
TURN	23.151	28.308	31.172	29.459	22.749
UUBAR	0.1698	0.1199	0.1451	0.1542	0.2093
DFAC	0.5187	0.5446	0.6348	0.6790	0.7906
LOSS PARAM.	0.0596	0.0414	0.0466	0.0447	0.0517
INCID	6.09	5.87	8.35	9.11	7.96
DEV	23.990	16.688	15.410	17.364	22.712