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CORE COMPRESSOR EXIT STAGE STUDY

Volume IV - Data and Performance Report for the Best Stage Configuration

by

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16. Abstract

The objective of the Core Compressor Exit Stage Study Program is to develop rear stage blading designs that have lower losses in their endwall boundary layer regions. This report describes the test data and performance results for the Best Stage configuration consisting of Rotor B running with Stator B. The overall technical approach in this efficiency improvement program utilizes General Electric's Low Speed Research Compressor as the principal investigation tool. Tests were conducted in two ways: (1) using four identical stages of blading so that test data would be obtained in a true multistage environment and (2) using a single stage of blading so that comparison with the multistage test results could be made. The effects of increased rotor tip clearances and circumferential groove casing treatment were also evaluated.

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1.0 SUMMARY

The Core Compressor Exit Stage Study Program has the primary objective of developing rear stage blade designs that have improved efficiency by virtue of having lower losses in their endwall boundary layer regions. Blading concepts that offer promise of reducing endwall losses have been evaluated in a multistage environment. This report describes the test data and the performance results for the Best Stage Configuration, consisting of Rotor B/Stator B, that was tested in the General Electric Low Speed Research Compressor. The aerodynamic design of this stage is described in Volume I of this report (Reference 1).

Overall performance data and various types of detailed performance data are presented for the Rotor B/Stator B configuration along with the resulting vector diagrams, loss coefficients, and diffusion factors. Both multistage and single-stage configurations were tested. Also the effects of increased rotor tip clearance and casing treatment on compressor performance were evaluated. The following test results were obtained:

- Rotor B tested with Stator B showed a 0.3 to 0.4 point improvement in efficiency at the design point and a significant improvement in the pressure-flow characteristic near stall relative to the baseline Rotor A/Stator A.

- Increasing the rotor tip clearance from 1.38% clearance-to-blade-height to 2.80% costs 1.49 points in peak efficiency, 9.7% in peak pressure rise, and 11% in stalling flow coefficient.

- Adding casing treatment to all stages at the increased rotor tip clearance gave a slight increase in peak efficiency and peak pressure rise at the design point but gave a 3.0% decrease in pressure rise at stall.

- Using single-stage test results to evaluate multistage compressor performance can prevent some difficulties.

Evaluation and comparisons of these data will be presented in the final report.

2.0 INTRODUCTION

Recent preliminary design studies of advanced turbofan core compressors (Reference 2) have indicated that such compressors must have very high efficiencies, as well as the advantages of compactness, light weight, and low cost, in order for advanced overall engine/aircraft systems to have an improved economic payoff. Loss mechanism assessments, such as those of Reference 3, suggest that approximately half of the total loss in a multistage compressor rear stage is associated with the endwall boundary layers. Since only a relatively small amount of past research has been dedicated to the problem of finding improved airfoil shapes for operation in multistage compressor endwall boundary layers, it is believed that substantial improvements in that area are likely. Accordingly, a goal of a 15% reduction in rear stage endwall boundary layer losses, compared to current technology levels, has been set. The Core Compressor Exit Stage Study Program is directed toward achieving this goal. Blading concepts that offer a promise of reducing endwall losses relative to a baseline design have been evaluated in a multistage environment. The test data and performance results for this Best-Stage Configuration are described in this report.

3.0 TEST APPARATUS AND PROCEDURE

3.1 LOW SPEED RESEARCH COMPRESSOR

The General Electric Low Speed Research Compressor (LSRC) facility, described in more detail in Volume II (Reference 4), was used for this test program. The LSRC configuration, used in the test program and shown schematically in Figure 1, consisted of four identical compressor stages having a constant casing diameter of 1.524 m (60 in.) and a radius ratio of 0.85. A photograph of the LSRC is shown in Figure 2. A detailed cross section of one stage is shown in Figure 3. The airfoils are 11.43 cm (4.5 in.) in span and approximately 9 cm (3.5 in.) in chord; large enough that blade edge and surface contours can be closely controlled during manufacture. The blade and vane construction described in Volume II (Reference 4) resulted in hydraulically smooth surfaces at the Reynolds numbers necessary to simulate high-speed compressor performance. A single-stage configuration was also tested.

The average rotor tip-clearance-to-blade-height was 1.36% and the average stator seal-clearance-to-blade-height was 0.78%. Circumferential groove casing treatment was applied over the tip of only the first rotor to assure that Stage 1 would not be the stall limiting blading.

3.2 TEST STAGE

The test stage consisted of Rotor B and Stator B. The Rotor B/Stator B designs are presented in Volume I (Reference 1). A brief summary of these designs is given below.

Rotor B was designed to the same set of vector diagrams as Rotor A but uses a type of meanline in the tip region that unloads the leading edge and loads the trailing edge relative to Rotor A. The modification to the tip region of Rotor B was blended into the pitchline so that Rotor A and Rotor B are identical from the pitchline to the hub. Stator B embodies blade sections twisted closed locally in the endwall regions similar to those used in a highly loaded NASA single stage that had rather good performance for its loading level (Reference 6).

3.3 INSTRUMENTATION

The instrumentation used at various locations in the compressor for the Rotor B/Stator B test series is presented in Table 1. Standard total pressure rakes and wall static pressure taps were used. In addition, static pressure taps located on the blade and vane surfaces were used to determine the distribution of static pressure on the suction and pressure surfaces. For rotors, the pressures measured with a rotating rake were read by a pressure transducer/slipring device.

Details about the instrumentation and the data recording equipment are given in Volume II (Reference 4).

3.4 TEST PROCEDURE

The overall test program was divided into four parts as outlined in Table 2. The first part involved extensive testing of the baseline blading, Stage A (Rotor A/Stator A), in both four-stage and single-stage configurations. The test results can be found in Volume II (Reference 4) of this series. The second part involved a series of short screening tests to select the best rotor design and the best stator design based on tests in four-stage configurations. These test results can be found in Volume III (Reference 5). The third part, described in this report, involves extensive testing of the best rotor and best stator designs in combination using a four-stage compressor configuration. The final part of the test program will consist of extensive testing of a new Rotor C design in a four-stage configuration with Stator B and will be presented in Volume V.

Six types of data were taken during the Rotor B/Stator B tests: preview data, stall determination data, standard data, blade element data, blade surface pressure data, and detailed wall boundary layer data. A brief description of each of these types of data is presented in Volume II (Reference 4).

3.5 DATA REDUCTION AND ANALYSIS METHODS

The data analysis procedures used in processing test data are described in Volume II (Reference 4).

4.0 RESULTS AND DISCUSSION

Based on the Screening Test results presented in Reference 5, the Rotor B/Stator B Configuration was selected as the "Best Stage" to undergo detailed testing because of the possible beneficial effect of the Rotor B tip section at higher Mach numbers. In the detailed testing, the following four configurations were tested: (1) a four-stage configuration at a nominal rotor tip clearance having the third stage as the test stage, (2) a four-stage configuration with increased rotor tip clearance, (3) a four-stage configuration with both increased rotor tip clearance and circumferential groove casing treatment on all stages, and (4) a single-stage configuration at nominal clearance. The average rotor tip-clearance-to-blade-height ratio for the nominal clearance configurations was 1.36% and that for the increased clearance configuration was 2.80%. The average stator seal-clearance-to-blade-height ratio for all tests was 0.78%. The test Reynolds number was 3.6×10^5. As discussed in Reference 4, casing treatment was applied over the tip of the first rotor only for Tests (1) and (2) above to assure that Stage 1 would not be the limiting blading. No casing treatment was used for Test (4) above in order to make comparisons with the test stage (third stage) of the four-stage configuration.

4.1 OVERALL PERFORMANCE

The overall performance of the Best Stage Configuration, which consisted of Rotor B running with Stator B, was determined from Preview Data and Standard Data. These test data are presented as graphs of pressure coefficient, work coefficient, and torque efficiency plotted as a function of flow coefficient.

4.1.1 Four-Stage Configuration (Third Stage as Test Stage)

The overall performance data from the four-stage Rotor B/Stator B configuration is shown in Figure 4 and tabulated in Table 3. The data show a peak efficiency of 0.9047, an efficiency at the design point of 0.9033, a peak pressure coefficient of 0.6335, and a stalling flow coefficient of 0.338.

When compared with tha Rotor A/Stator A baseline, Rotor B/Stator B showed: (1) a 0.3 to 0.4 point improvement in efficiency at the design point and (2) a significant improvement in the pressure-flow characteristic near stall. The 2.8% improvement in peak pressure coefficient and the 5.4% improvement in flow range from the design point to the peak pressure point result from a more faborable pressure distribution on the airfoil, especially near the hub.

4.1.2 Four-Stage Configuration, Increased Rotor Tip Clearance

Overall performance of the Rotor B/Stator B Four-Stage Configuration was obtained at an increased tip-clearance-to-blade-height ratio of 2.80%; the results are presented in Figure 5 and Table 4. Peak efficiency is 0.8898, peak pressure coefficient is 0.572, and stalling flow coefficient is 0.372. The increase in tip clearance costs 1.49 points in peak efficiency, 11.0% loss in stalling flow coefficient and 9.70% loss in peak pressure rise relative to the nominal clearance.

4.1.3 Four-Stage Configuration, Increased Rotor Tip Clearance and Casing Treatment on All Stages

Overall performance was obtained with both increased tip clearance and casing treatment on all four stages. The results, presented in Figure 6 and Table 4, show a peak efficiency of 0.8915, a peak pressure coefficient of 0.563, and a stalling flow coefficient of 0.3708. This gives a loss of 1.32 points in peak efficiency, a loss of 10.7% in stalling flow coefficient, and a loss of 11.1% in peak pressure rise relative to the nominal Rotor B/Stator B configuration described in Section 4.1.1. Apparently casing treatment at open clearances gave a small performance improvement at the design point but hurt performance near stall.

4.1.4 Single-Stage Configuration

The overall performance of the single-stage Rotor B/Stator B Configuration is presented in Figures 7 and 8 and in Table 4. This configuration was tested without casing treatment over the rotor tip in order to make comparisons with the test stage (third stage) of the four-stage configuration. The data in Figure 7 show a peak efficiency of 0.8934, a peak pressure coefficient of 0.660, and a stalling flow coefficient of 0.353. The single-stage configuration is pumping more flow and achieves a higher peak pressure coefficient than the four-stage average. However, the peak efficiency of the single-stage configuration is 1.13 points lower than that of the four-stage configuration.

It is somewhat surprising that the single-stage efficiency should be so low compared to the four-stage efficiency. Much of this difference is probably due to inaccuracies in measurement/evaluation of the tare torque of the single-stage configuration relative to that of the four-stage configuration. Typical values of measured torque and tare torque for the single-stage configuration are 2050 in.-lb and 160 in.-lb, respectively. Thus 20 in.-lb of tare torque is worth about one point in efficiency. For comparison, typical values of torque and tare torque for the four-stage configuration are 8200 in.-lb and 60 in.-lb, respectively; 20 in.-lb of tare torque is worth a quarter of a point in efficiency.

The individual characteristics of the single-stage and four-stage configurations are compared in Figure 8. The single-stage characteristic is not quite so steep as the first-stage characteristic. Compared to the Stage 3 characteristic of the four-stage configuration, the single-stage characteristic has about the same slope but is operating at about 2% higher flow and about 4% higher pressure coefficients. Both the single stage and the first stage of the multistage configuration achieve higher peak pressures than those of the other stages. This difference probably results from the cleaner, more constant inlet conditions at the first rotor inlet. During throttling, the first rotor inlet is not subjected to the thickened wakes, increased deviation angles, and separated flow that the downstream stages feel. Perhaps even more striking is the higher pressure achieved by the first stage of the four-stage configuration compared to that of the single-stage configuration. This could result from the casing treatment or from the stabilizing influence of the downstream stages pulling on the first stage of a multistage configuration.

4.2 BLADE AND VANE SURFACE STATIC PRESSURE TEST RESULTS

The measurements of static pressure on the blade and vane surfaces are presented in Figures 9 through 16 and in Tables 5 through 12 for (1) the four-stage configuration with the third stage as test stage, (2) the four-stage configuration with increased rotor tip clearance, (3) the four-stage configuration with both increased rotor tip clearance and casing treatment on all stages, and (4) the single-stage configuration. The measured pressures have been normalized by the dynamic head based on tip speed, $1/2\ \rho_{ref}\ U_t^2$. Suction surface measurements are presented as solid lines and pressure surface measurements as dashed lines.

4.2.1 Four-Stage Configuration (Third Stage as Test Stage)

The pressure measurements on the blade and vane surfaces are presented in Figures 9 and 10 and in Tables 5 and 6. These figures have been discussed in detail in Section 4.2 of Reference 5 and will be discussed only briefly here.

The rotor data in Figure 9 indicate that the principal feature of Rotor B, its increased diffusion rate at the trailing edge near the tip, was successfully accomplished. The continuous diffusion from the location of the peak suction surface velocity (minimum static pressure) to the trailing edge for all blade sections from the pitchline to the tip and for all throttle settings indicates that the trailing edge region was able to take this increased aft loading without flow separation (Figure 9a, b, c). Evidence of flow separation near the hub can be seen in the distinct change in slope of the static pressure distribution on the suction surface at 70% chord for the peak pressure rise throttle (Figure 9e).

There is evidence of the effects of secondary flow and tip leakage on the suction surface pressure distribution over the first 25% of chord (Figure 9a). This is seen as an increase in static pressure on the suction surface from zero to about 8% chord followed by a decrease in static pressure from 8% to about 40% chord.

The stator data in Figure 10 indicate: (1) a Stator B leading edge loading that is slightly lower than that obtained for Stator A, and (2) a diffusion pattern on the suction surface of Stator B which is more favorable near the hub than that obtained for Stator A, although strong evidence of flow separation at the hub still exists for the peak pressure rise throttle (Figures 10d and 10e).

4.2.2 Four-Stage Configuration, Increased Rotor Tip Clearance

The pressure measurements on the blade and vane surfaces which incorporate the effects of increased rotor tip clearance are presented in Figures 11 and 12 and Tables 7 and 8. The qualitative look of the data is similar to that seen in Figures 9 and 10, although the loading levels are somewhat lower. Comparisons showing the effects of clearance will be presented in Section 4.2.5.

4.2.3 Four-Stage Configuration - Increased Rotor Tip Clearance and Casing Treatment on All Stages

The static pressure measurements on the blade and vane surfaces which incorporate the effects of increased rotor tip clearance and casing treatment on all stages are presented in Figures 13 and 14 and Tables 9 and 10. The qualitative look of the data is again similar to that shown in Figures 9 and 10. Further comparisons will be presented in Section 4.2.5.

4.2.4 Single-Stage Configuration

The normalized static pressure measurements on the blade and vane surfaces are shown in Figures 15 and 16 and Tables 11 and 12, respectively, for the single-stage configuration. This configuration was run without casing treatment over the rotor tip so that the stage geometry of the single stage matched that of the third stage of the four-stage configuration as closely as possible.

The rotor data in Figure 15 show a uniform diffusion from about 40% chord to the trailing edge for all throttles at 5%, 20%, and 50% immersions (Figures 15a, b, and c). No evidence of flow separation is apparent. However, for

80% and 90% immersions, Figures 15d and e, there is a decrease in the rate of diffusion for all throttles beginning at about 70% immersion in Figure 15d and from 50% to 70% immersion, depending upon throttle, in Figure 15e.

There is again evidence in Figure 15a of the effects of secondary flow and tip leakage on the suction surface pressure distribution of the rotor over the first 30% of the chord.

The stator data in Figure 16 indicate that, for all throttles and all immersions, there is a continuous diffusion from the point of minimum static pressure on the suction surface to the trailing edge, although there is a change in the rate of diffusion near the hub.

4.2.5 Comparison of Rotor Tip Clearance Effects

A comparison showing the effects of rotor tip clearance and casing treatment on the blade surface static pressures is shown in Figure 17 for the tip section. There is a reduction in blade loading over the first 40% of chord, a rearward shift of peak suction surface velocity and a reduced pressure on the pressure surface for both the increased clearance configuration and the increased clearance with casing treatment configuration. At increased clearance, casing treatment does appear to give a larger blade loading from 50% chord to the trailing edge.

4.2.6 Comparisons With Potential Flow (CASC) Solutions

The comparisons of the experimentally determined surface velocities with the CASC velocities for Rotor B are shown in Figure 18. The tests are in quantitative agreement with CASC except at the tip section. The peak suction surface velocities occur about as intended.

The significant differences that are observed on the suction surface near the tip in Figure 18 are attributed to secondary flow/tip leakage effects. The suction surface velocity tends to be low from 5% to about 30% chord and high from 30% to 60%. These velocity perturbations are probably induced by the tip clearance vortex which moves away from the suction surface and away from the casing as percent chord increases.

The comparisons of the experimentally determined surface velocities with the CASC velocities for Stator B are shown in Figure 19. The test results for the velocity distribution on the pressure surface are in qualitative agreement with CASC. The leading edge loadings for Stator B are lower than those for Stator A, especially near the hub, although they are still somewhat larger than intended. This could explain the improvement in the pressure-flow characteristic near stall obtained with Stator B. Airfoil loading is again less than predicted on the aft portion of the vane.

4.3 BLADE ELEMENT AND WALL BOUNDARY LAYER TEST RESULTS

Blade element data and wall boundary layer data provide vector diagram quantities from measured values of total pressure, static pressure, and flow angles in a matrix of circumferential and radial locations across a blade pitch. The radial surveys of pressure and flow angle, taken between adjacent stators, are used to fix the shape of the radial distribution; circumferential surveys are used to fix the absolute level of the distribution. The measurements are taken at the rotor inlet and at the rotor and stator discharges of the test stage. The bars in the figures indicate the variation of measured values across the circumferential blade spacing. The detailed wall boundary layer data are included in the radial profiles.

4.3.1 Four-Stage Configuration (Third Stage As Test Stage) Pressures

Detailed surveys of normalized absolute total and static pressures at the third rotor inlet (Plane 3.0), third rotor exit (Plane 3.5), and third stator exit (Plane 4.0) are presented in Figures 20 through 23 and in Table 13 for open throttle, the design point throttle, the peak efficiency throttle, and the peak pressure rise/near stall throttle. The difference between the total pressure at Plane 3.5 and 3.0 represents the total pressure rise across the rotor. The difference between the total pressures at Plane 3.5 and 4.0 represents the loss across the stator. The region of end-wall loss in the stator from 0% to 20% immersion and from 80% to 100% immersion is evident.

The static pressure rise across the rotor is seen as the difference between the measured pressures in Planes 3.0 and 3.5 and that across the stator as the difference between Planes 3.5 and 4.0. This gives a pitch-line reaction at the design point throttle of about 64%.

Flow Angles

Detailed surveys of absolute air angles at the third rotor inlet, third rotor exit, and third stator exit are presented in Figures 24 through 29 and in Table 13 for the design point throttle, the peak efficiency throttle, the peak pressure rise and the near stall throttles. A small correction factor to the flow angles, which is needed because of the geometry of the measuring system, was used in the data analysis. This correction would yield true flow angles that were about 0.5° larger than observed at 100% immersion and about 1.1° larger at zero percent immersion. The correction factor to the flow angles has not been incorporated into the data shown in the figures but has been incorporated in the data shown in the tables. The leading and trailing edge metal angles for the stator are shown in the figures so that the incidence and deviation angles are easily seen.

The data in Figure 25 indicate that the design intent swirl distribution has been achieved at the exit plane of the third stator. The increase in incidence and deviation angles as the compressor is throttled to stall is evident in Figures 24 through 27.

Total Pressure Circumferential Surveys and Loss Coefficients

Relative total pressure measurements across a circumferential blade spacing were obtained at 11 radial immersions using the rotating rake. The results are presented in Figures 30 through 33 for the various throttles. The rotor wake is clearly evident as is the increased size of this wake near stall, particularly near the hub (Figure 33). An interesting feature of these circumferential surveys is the shape of the distribution near the tip of the blade. Both the loss region due to the wake and the loss region due to tip clearance/secondary flow effects can be seen.

Absolute total pressure measurements across a circumferential stator vane spacing were obtained at 19 radial immersions, including the immersions for the boundary layer surveys. Representative samples of these measurements are shown in Figures 34 through 37 for 11 of the 19 immersions. The distribution of static and total pressures shown in Figures 20 through 23 were obtained by computing the average, minimum, and maximum value of pressure shown in Figures 34 through 37 at each radial immersion. The large stator wakes in the vicinity of the hub near stall are clearly evident.

These detailed measurements were used to determine rotor and stator loss coefficients. The rotor loss coefficients computed from the relative total pressure measurements are presented in Figure 38 and Table 14. The stator loss coefficients computed from absolute total pressure measurements are presented in Figure 39. Both are in reasonable agreement with design intent. The total loss shown is the sum of the wake loss, the tip clearance vortex loss, free-stream loss, and miscellaneous losses.

Vector Diagram Quantities

Complete vector diagram quantities as well as loss coefficients, loss parameters, diffusion factors, incidence and deviation angles were computed from the quantities measured in the absolute frame of reference. The results are tabulated in Tables 15 through 23 for the various throttle settings. Several of these performance parameters have been plotted as a function of percent immersion in Figures 40 through 46. The design point intent is also plotted on each figure for reference. In most cases over the midportion of the span, the vector diagram quantities computed from measurements are in reasonable agreement with design intent for the design point throttle setting. The rotor loss coefficients and D-factors and the stator incidence angles are somewhat larger than those used in designing the stage. In the end-wall region (particularly the outer diameter) the velocities are lower, and air angles, incidence angles, deviation angles, losses, and D-factors are larger than the design values.

The rotor total loss coefficients, computed from measurements made in the absolute frame of reference (Figure 42), are smaller at the design point than the design intent and the loss coefficients computed from measurements made in the relative frame using the rotating rake (Figure 38). Since the rotor loss coefficients obtained from the relative frame measurements do not depend upon inaccuracies in flow angle measurements (particularly in the end-wall regions) and in vector diagram calculations, it is believed that they are the more reliable of the two.

As the compressor is throttled toward stall, there is a general decrease in velocity levels and an increase in air angles, flow turning, incidence angles, deviation angles, and D-factors. The region of end-wall flow is distinctly defined by the data.

4.3.2 Four-Stage Configuration (Increased Rotor Tip Clearance)

Pressures

Detailed surveys of normalized total and static pressures at the rotor inlet (Plane 3.0), rotor exit (Plane 3.5), and the stator exit (Plane 4.0) are presented in Figures 47 through 49 and in Table 24 for the open throttle, the design point throttle, and the peak pressure rise/near stall throttle. A description of these figures is qualitatively the same as that for the four-stage configuration in Section 4.3.1.

Flow Angles

Detailed surveys of absolute air angles at the rotor inlet, rotor exit, and stator exit are presented in Figures 50 through 54 and in Table 24 for the open, the design point, and the peak pressure rise/near stall throttle. Again, the description of these figures is similar to that for the four-stage configuration in Section 4.3.1.

Total Pressure Circumferential Surveys and Loss Coefficients

Relative total pressure measurements across a circumferential blade spacing were obtained at 11 immersions using the rotating rake. These results are shown in Figures 55 through 57 for the various throttles. The loss region due to the rotor wake and the loss region due to tip clearance/secondary flow effects can be seen.

Absolute total pressure measurements across a circumferential vane spacing were obtained and the results, including boundary layer surveys, are presented in Figures 58 through 60.

These detailed measurements were used to determine the rotor and stator loss coefficients presented in Figures 61 and 62 and in Table 25.

Vector Diagram Quantities

Complete vector diagram quantities, loss coefficients, loss parameters, diffusion factors, incidence angles, and deviation angles were computed from the measured quantities; the results are given in Tables 26 through 31 for the various throttle settings. Several of the performance parameters have been plotted as a function of percent immersion in Figures 63 through 69.

Comparisons showing the effects of increased rotor tip clearance on blade element performance are presented in Figure 70. An increase in rotor tip clearance from 1.4% tip-clearance-to-blade-height ratio to 2.8% produces increases in absolute air angles at the rotor exit, in stator incidence angles, and in rotor D-factors and loss coefficients from a 0% to 10% immersion. Increases of 5° in absolute air angles and incidence angles were observed. D-factors increased slightly to values over 0.70 and total pressure loss coefficients increased from about 0.125 to 0.2.

4.3.3 Four-Stage Configuration (Increased Rotor Tip Clearance and Casing Treatment on All Stages)

Pressures

Detailed surveys of normalized total and static pressures at the rotor inlet (Plane 3.0), rotor exit (Plane 3.5), and the stator exit (Plane 4.0) are presented in Figures 71 through 73 and in Table 32 for the open throttle, the design point throttle, and the peak pressure rise/near stall throttle. A description of these figures is qualitatively the same as that for the four-stage configuration in Section 4.3.1.

Flow Angles

Detailed surveys of absolute air angles at the rotor inlet, rotor exit, and stator exit are presented in Figures 74 through 78 and in Table 32 for the same throttles. Again, the description of these figures is similar to that for the four-stage configuration in Section 4.3.1.

Total Pressure Circumferential Surveys and Loss Coefficients

Relative total pressure measurements across a circumferential blade spacing were obtained for the single-stage configuration at 11 immersions using the rotating rake. These results are shown in Figures 79 through 81 for the various throttles. The loss region due to the rotor wake and the loss region due to tip clearance/secondary flow effects can be seen.

Absolute total pressure measurements across a circumferential vane spacing were obtained and the results, including boundary layer surveys, are presented in Figures 82 through 84.

These detailed measurements were used to determine the rotor and stator loss coefficients presented in Figures 85 and 86 and in Table 33.

Vector Diagram Quantities

Complete vector diagram quantities, loss coefficients, loss parameters, diffusion factors, incidence angles, and deviation angles were computed from the measured quantities; the results are given in Tables 34 through 39 for the various throttle settings. Several of the performance parameters have been plotted as a function of percent immersion in Figures 87 through 93.

Comparisons showing the effects of increased rotor tip clearance and casing treatment are shown in Figure 94. The addition of casing treatment at increased clearance produces a significant increase of 13° in absolute air angle and stator incidence angle relative to the nominal clearance case. Near the tip the flow is nearly tangential with air angles of about 83°. Increases in D-factor and loss coefficient were also observed. Generally, the effects are observed from 0% to 10% immersion.

4.3.4 Single-Stage Configuration

Pressures

Detailed surveys of normalized total and static pressures at the rotor inlet (Plane 1.0), rotor exit (Plane 1.5), and the stator exit (Plane 2.0) are presented in Figures 95 through 97 and in Table 40 for the design point throttle, the peak efficiency throttle, and the peak pressure rise/near stall throttle. A description of these figures is qualitatively the same as that for the four-stage configuration discussed in Section 4.3.1.

Flow Angles

Detailed surveys of absolute air angles are presented in Figures 98 through 100 and in Table 40 for the design point, the peak efficiency point, and the peak pressure rise/near stall throttles.

Total Pressure Circumferential Surveys and Loss Coefficients

Circumferential surveys of total pressure, including boundary layer surveys, are presented in Figures 101 through 103. The loss coefficients determined from these measurements are shown in Figure 104.

Vector Diagram Quantities

Complete vector diagram quantities, loss coefficients, loss parameters, diffusion factors, incidence angles, and deviation angles were computed from the measured quantities; the results are given in Table 41 through 46 for the various throttle settings. Several of the performance parameters have been plotted as a function of percent immersion in Figures 105 through 111.

The rotor loss coefficients shown in Figure 110 should be compared with those shown in Figure 42. Although these loss coefficients are computed from fixed rake data and the levels may therefore be somewhat suspect, the radial profile comparisons should be meaningful.

Generally, the discussion follows that of Section 4.3.1, vector diagram quantities for the four-stage configuration, and is not repeated here. It should be noted that a single stage reacts differently to throttling than an embedded stage. This can be seen by comparing the differences in axial velocities shown in Figures 40 and 105.

5.0 CONCLUSIONS

The Rotor B/Stator B, Best Stage Configuration was tested in General Electric's Low Speed Research Compressor test facility. Four configurations were tested: (1) the four-stage configuration with the third stage as test stage, (2) the four-stage configuration with increased rotor tip clearance, (3) the four-stage configuration with both increased rotor tip clearance and casing treatment on all stages, and (4) the single-stage configuration.

Overall performance data and various types of detailed performance data are presented for the Rotor B/Stator B configuration along with the resulting vector diagrams, loss coefficients, and diffusion factors. These data provide the basis for the evaluation and comparisons of the configurations which will be presented in the Final Report.

Several overall test results are discussed below:

- Rotor B tested with Stator B showed a 0.3 to 0.4 point improvement in efficiency at the design point and a significant improvement in the pressure-flow characteristic near stall relative to the baseline Rotor A/Stator A.
- Increasing the rotor tip clearance from 1.38% clearance-to-blade-height to 2.80% costs 1.49 points in peak efficiency, 9.7% in peak pressure rise, and 11% in stalling flow coefficient.
- Adding casing treatment to all stages at the increased rotor tip clearance gave a slight increase in peak efficiency and peak pressure rise at the design point but gave a 3.0% decrease in pressure rise at stall.
- Using data from single-stage tests to evaluate multistage performance can present some difficulties as will be discussed in the final report.

6.0 LIST OF SYMBOLS AND ACRONYMS

Symbol	Definition
A	Annulus area of the compressor
Alpha	Absolute air angle
AMAC	Advanced multistage axial flow compressor
Beta	Relative air angle
c	Stator shroud seal clearance
C	Absolute velocity
CU	Absolute tangential velocity
CZ	Axial velocity
CAFD	Circumferential average flow determination
Δ CAM	Changing Camber
CASC	Cascade analysis by streamline curvature
F_c	Compressibility correction factor
h	Annulus height
ID	Inside diameter
IGV	Inlet guide vane
LSRC	Low speed research compressor
OD	Outside diameter
P	Pressure
P_s	Blade surface static pressure $\equiv P_{surface} - (P_B + P_{ref})$
P_{S_1}	Upstream static pressure
P_{T_1}	Total Pressure
QU	Normalizing quantity = $1/2\ \rho_{ref}\ U_t^2$

6.0 LIST OF SYMBOLS AND ACRONYMS Continued)

Symbol	Definition
R	Radius
Re	Reynolds number
T	Measured torque corrected for windage/bearing friction
U_t	Wheel speed at tip
V	Air velocity
W	Relative velocity
WU	Relative tangential velocity
ε	Rotor tip clearance
η	Torque efficiency
ρ	Density
$\bar{\rho}$	Average density across annulus
ϕ	Flow coefficient
ψ	Work coefficient
ψ'	Pressure coefficient
$\bar{\omega}$	Loss coefficient

Subscript

B	Barometer
C	Casing
H	Hub
ref	Reference
S	Static properties
T	Total properties

6.0 LIST OF SYMBOLS AND ACRONYMS (Concluded)

Symbol	Definition
t	Tip
1	Upstream conditions
2	Downstream conditions
β_1^*	Inlet metal angle
β_2^*	Exit metal angle

7.0 FIGURES

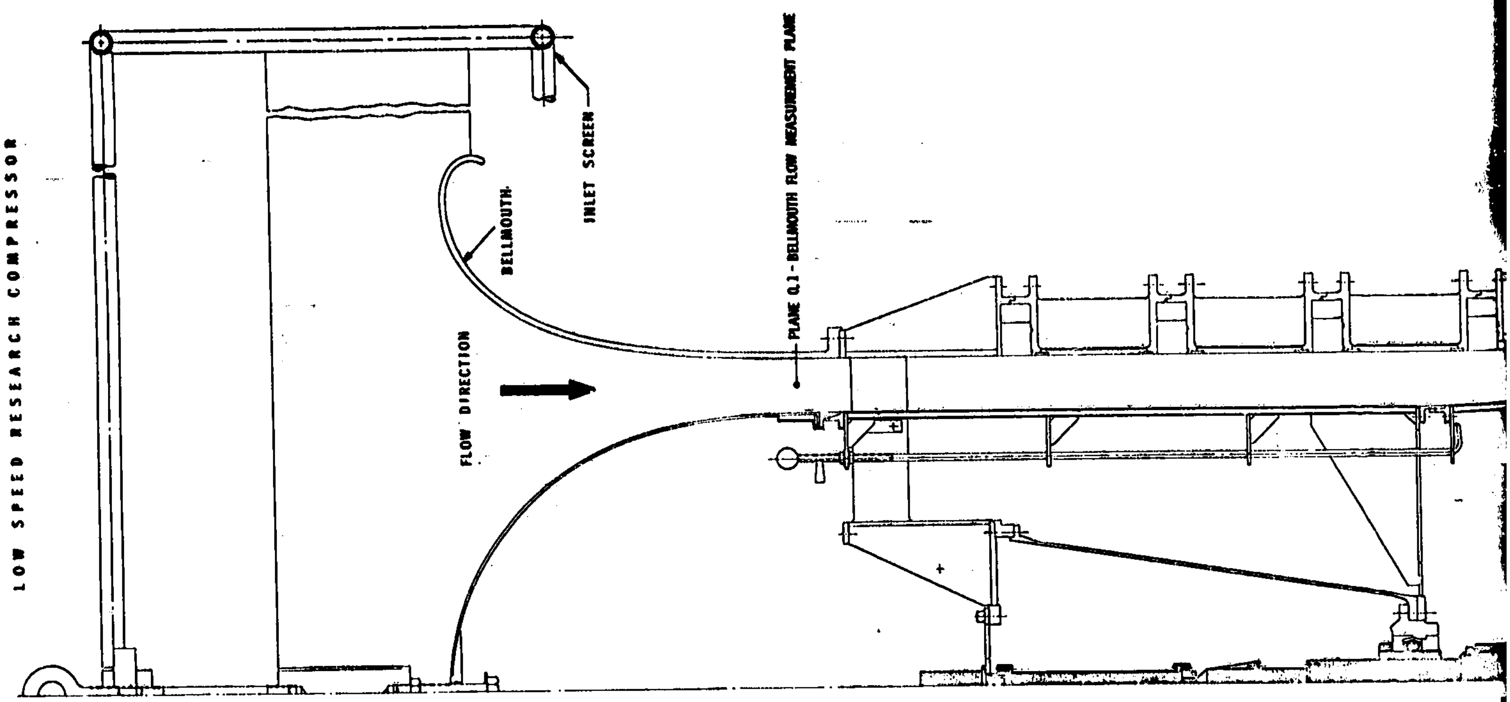
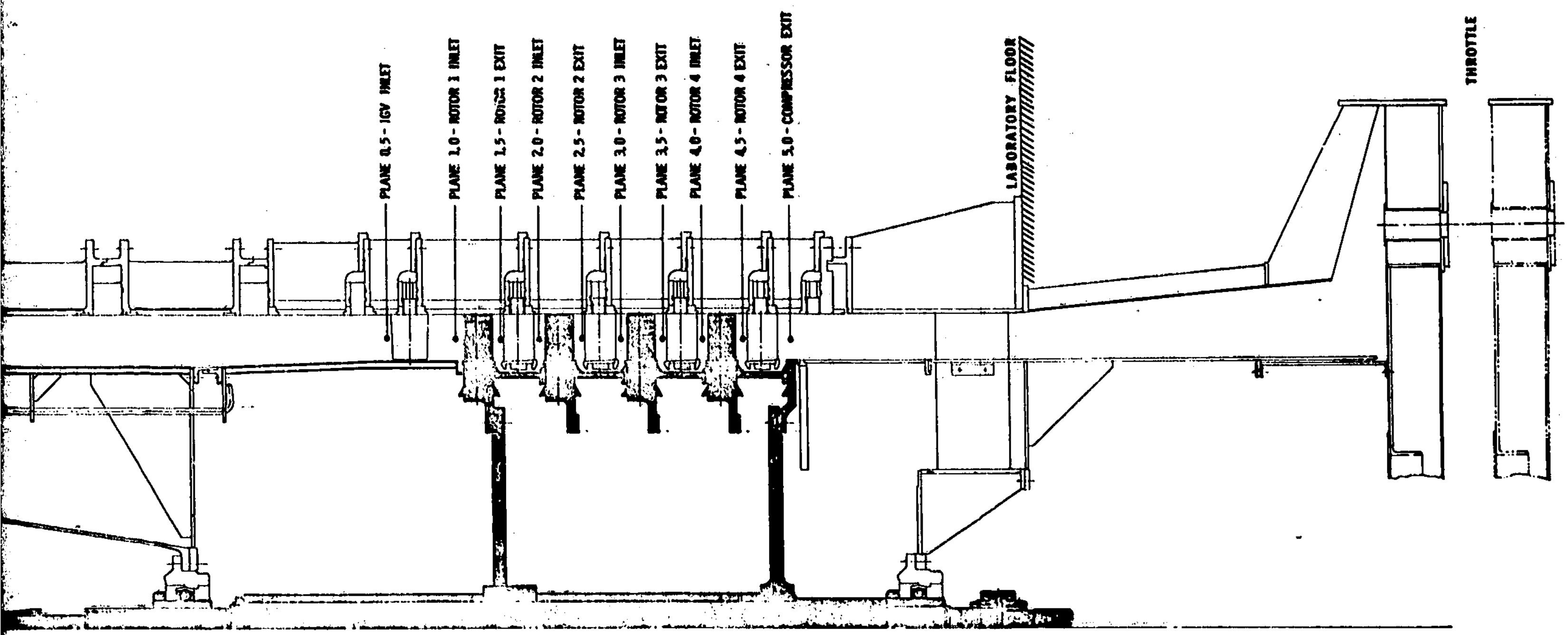


Figure 1. Four-Stage Compressor Configuration



or Configuration Tested in the NASA-GE Core Compressor Exit Stage Study.

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Figure 2. Photograph of the Low Speed Research Compressor.

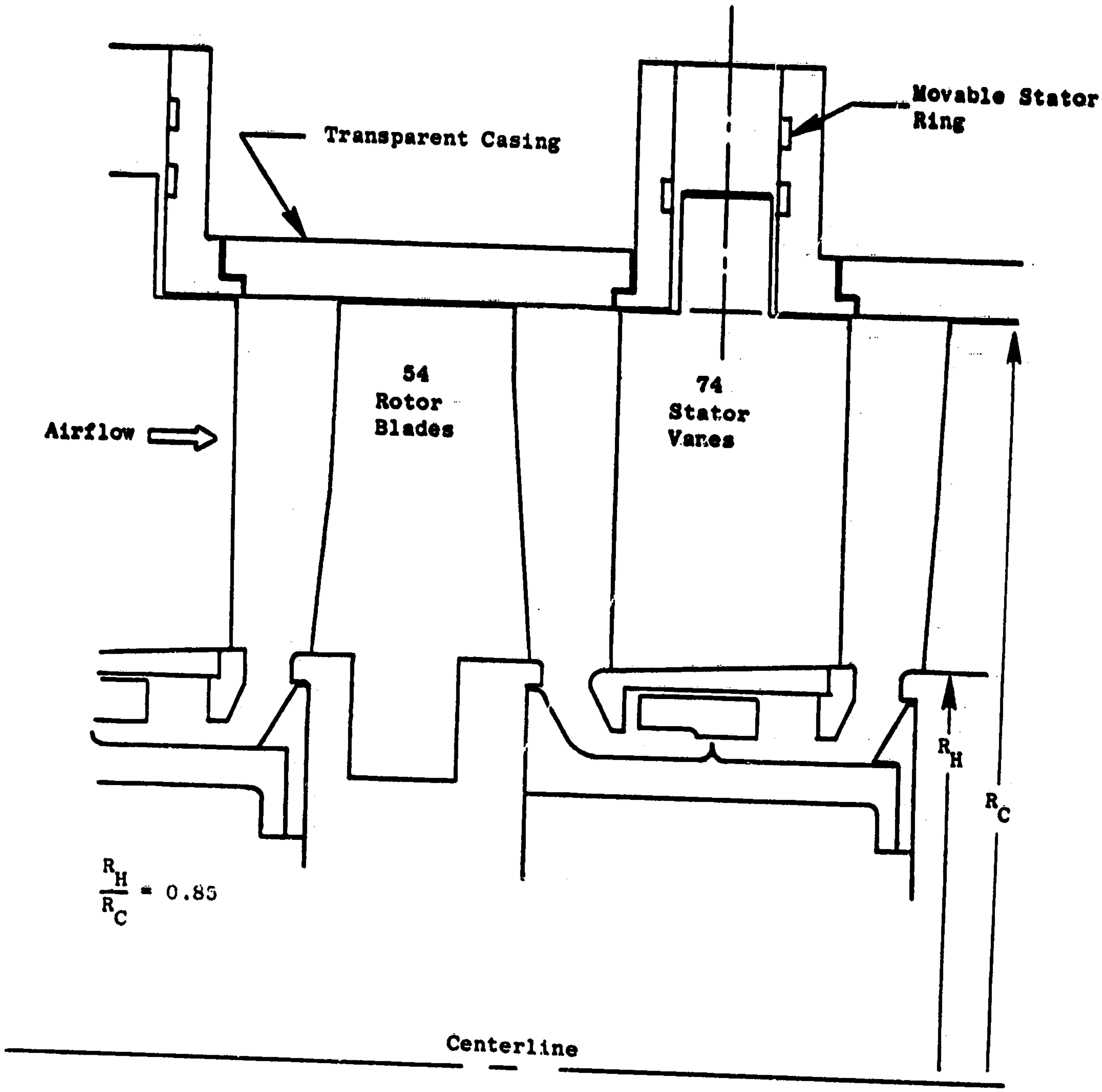

Figure 3. Cross Section of 0.85 Radius Ratio Compressor Stage.

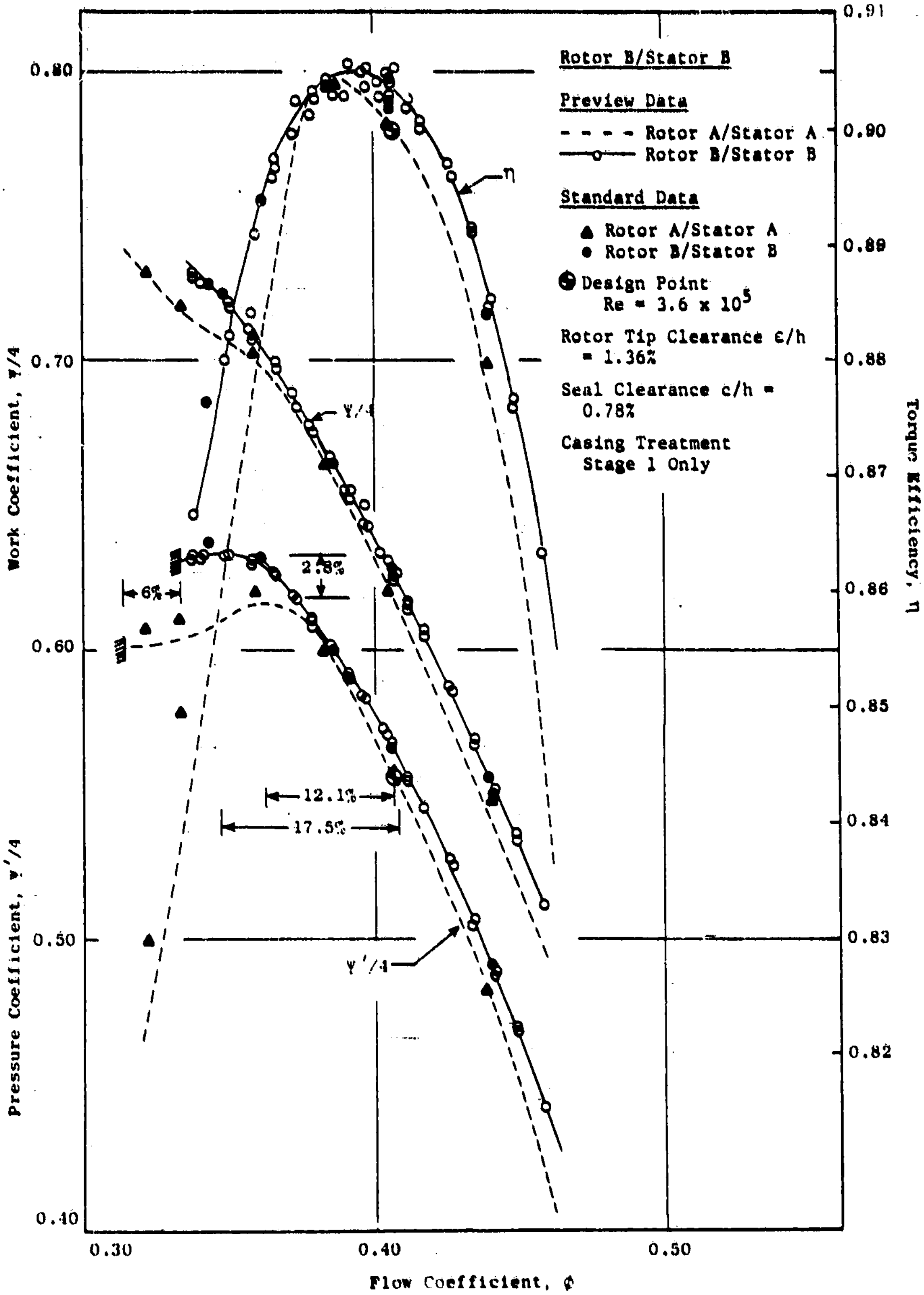

Figure 4. Overall Performance of Rotor B/Stator B Four-Stage Configuration Compared with that of Rotor A/Stator A.

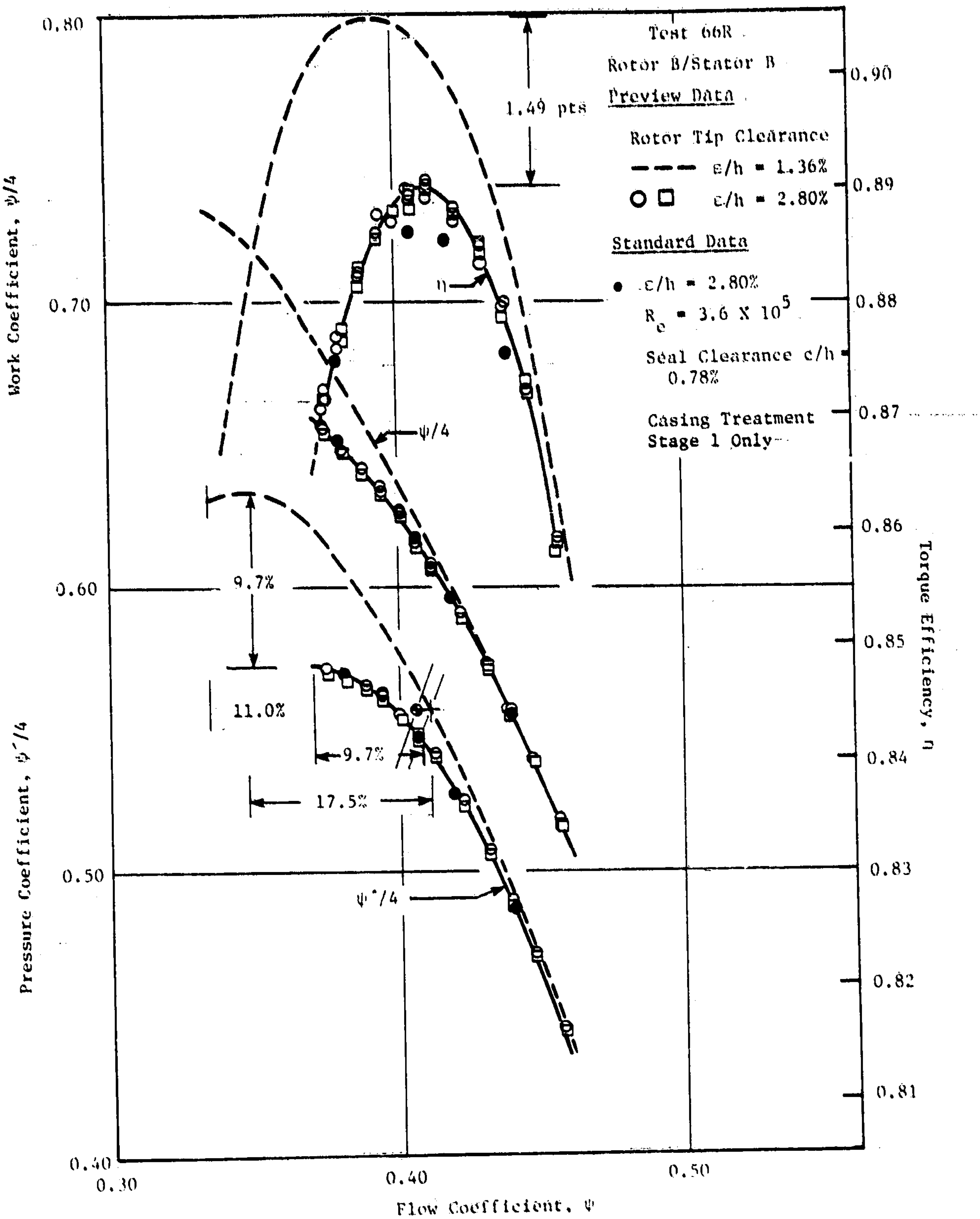

Figure 5. Comparison Showing the Effects of Increased Rotor Tip Clearance on Overall Compressor Performance, Rotor B/Stator B Four-Stage Configuration.

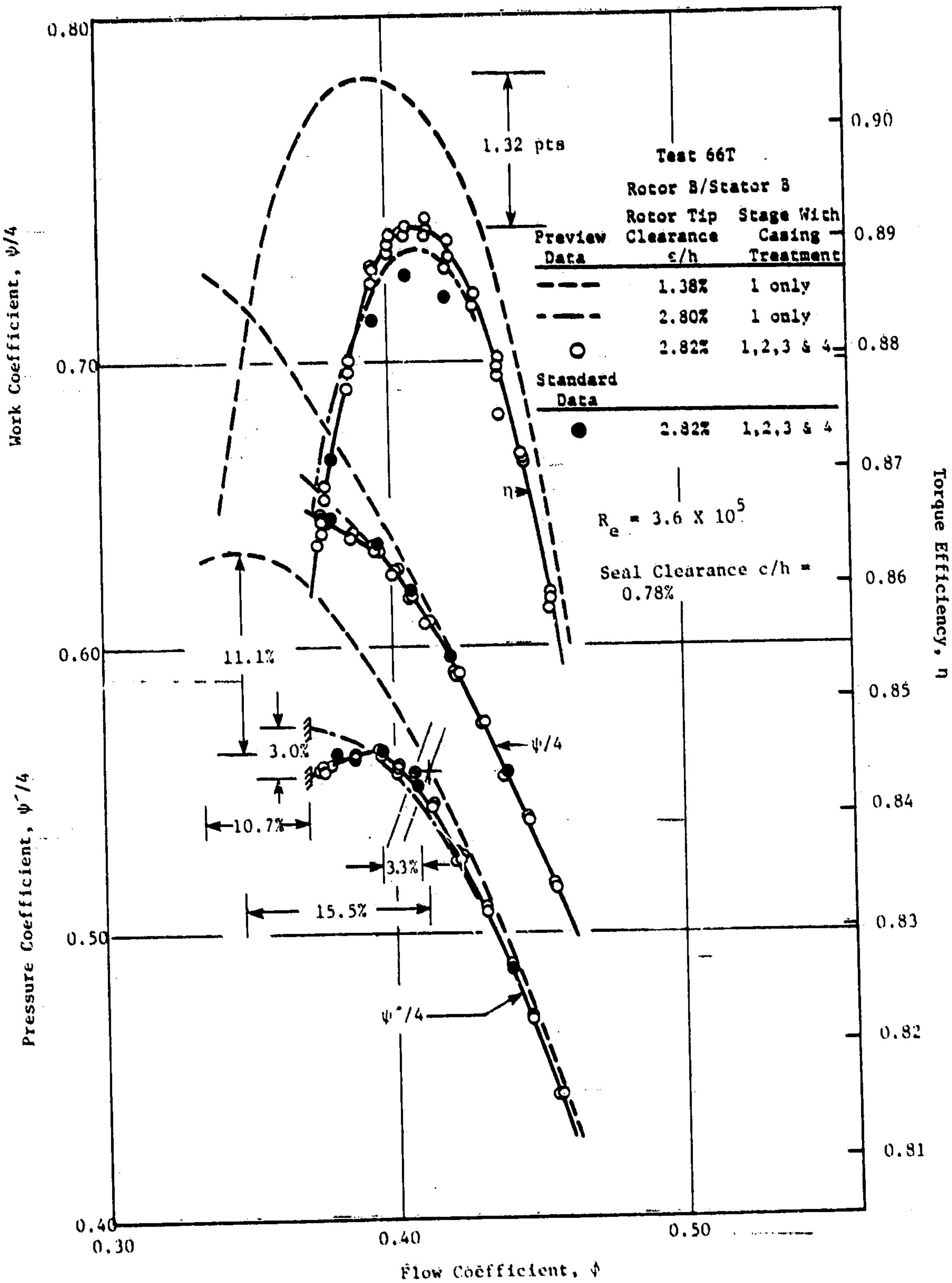

Figure 6. Comparison Showing the Effects of Increased Rotor Tip Clearance and Casing Treatment on Overall Compressor Performance, Rotor B/ Stator B Four-Stage Configuration.

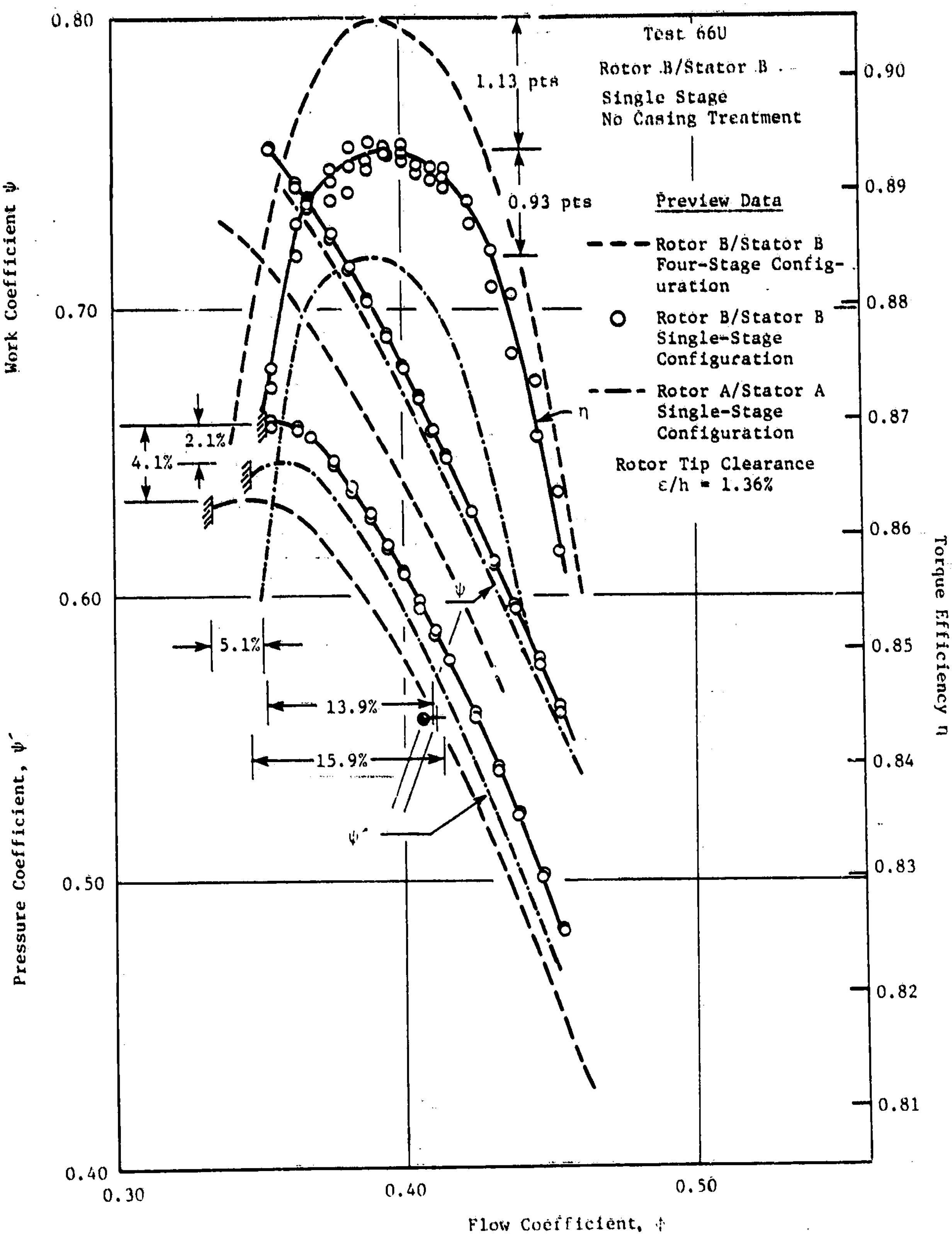

Figure 7. Overall Performance of the Single-Stage Rotor B/Stator B Configuration.

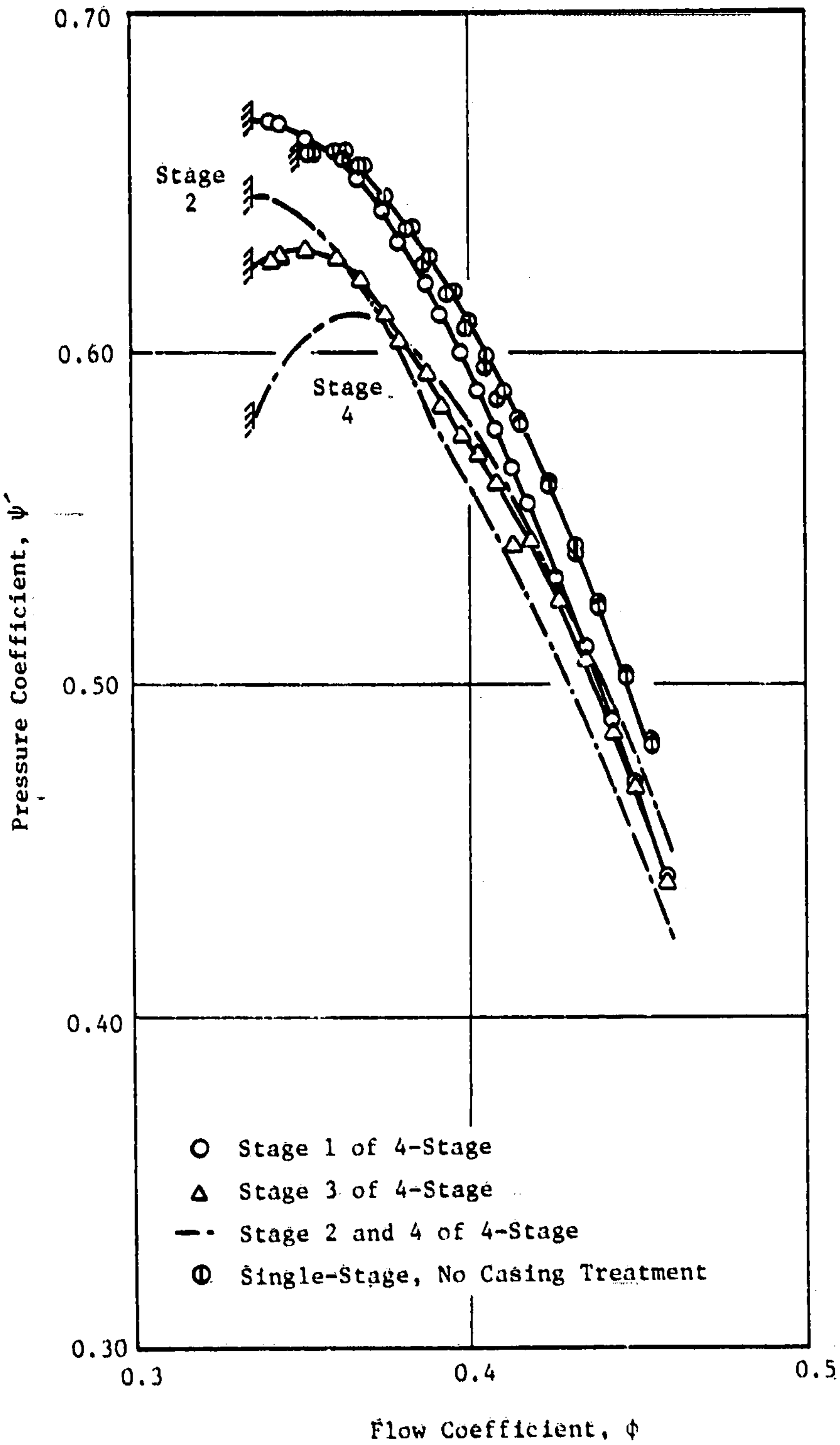

Figure 8. Comparison of Individual Stage Characteristics for the Single-Stage and Four-Stage Configurations, Rotor B Running with Stator B.

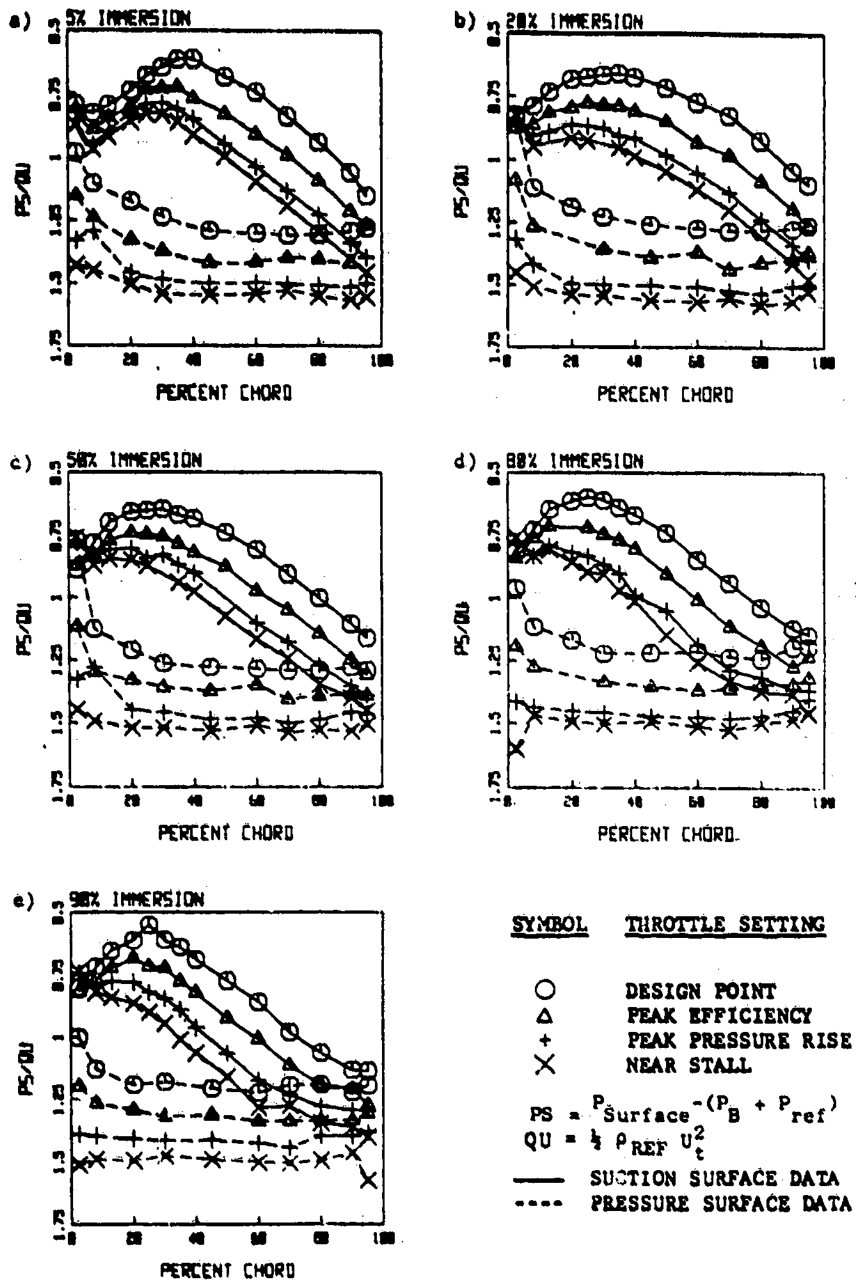

Figure 9. Rotor Blade Surface Static Pressure Measurements for the Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

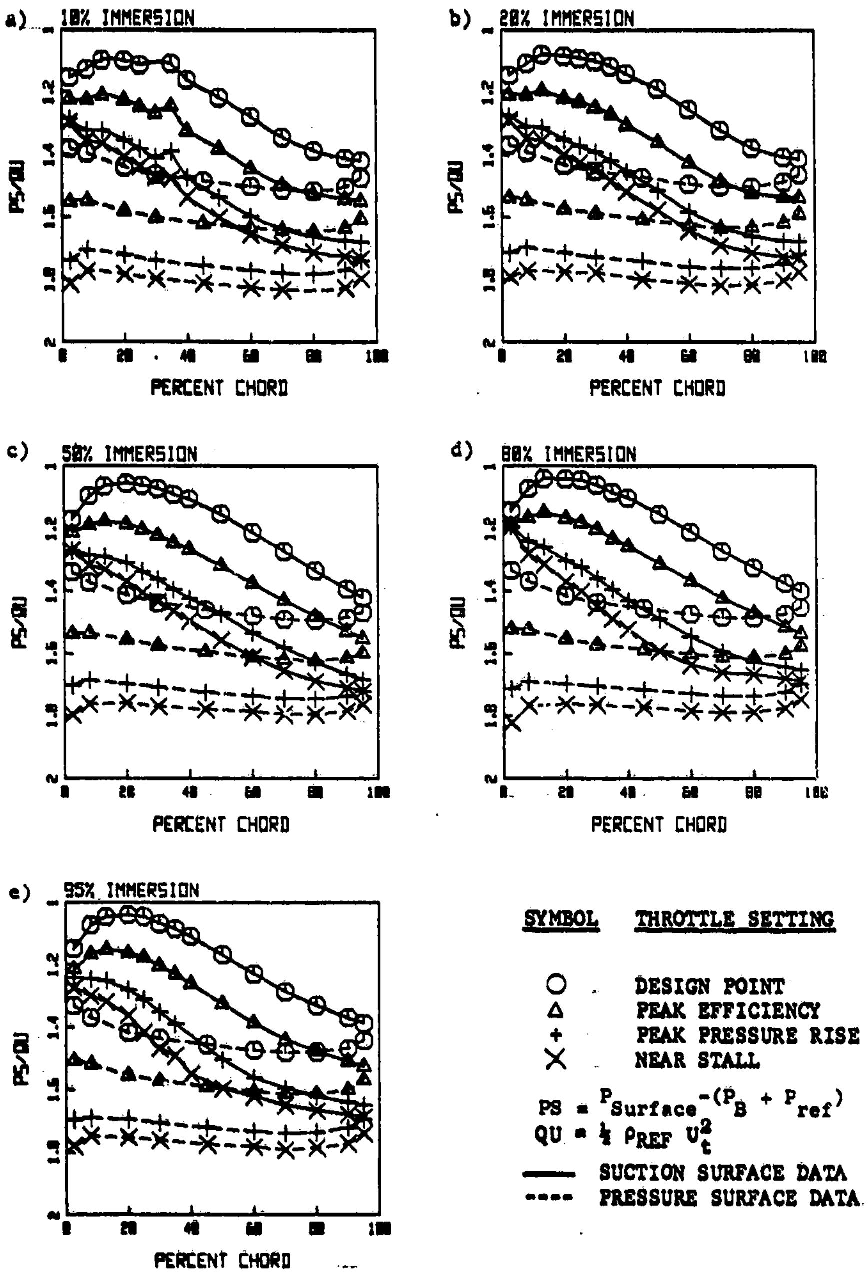

Figure 10. Stator Vane Surface Static Pressure Measurements for the Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

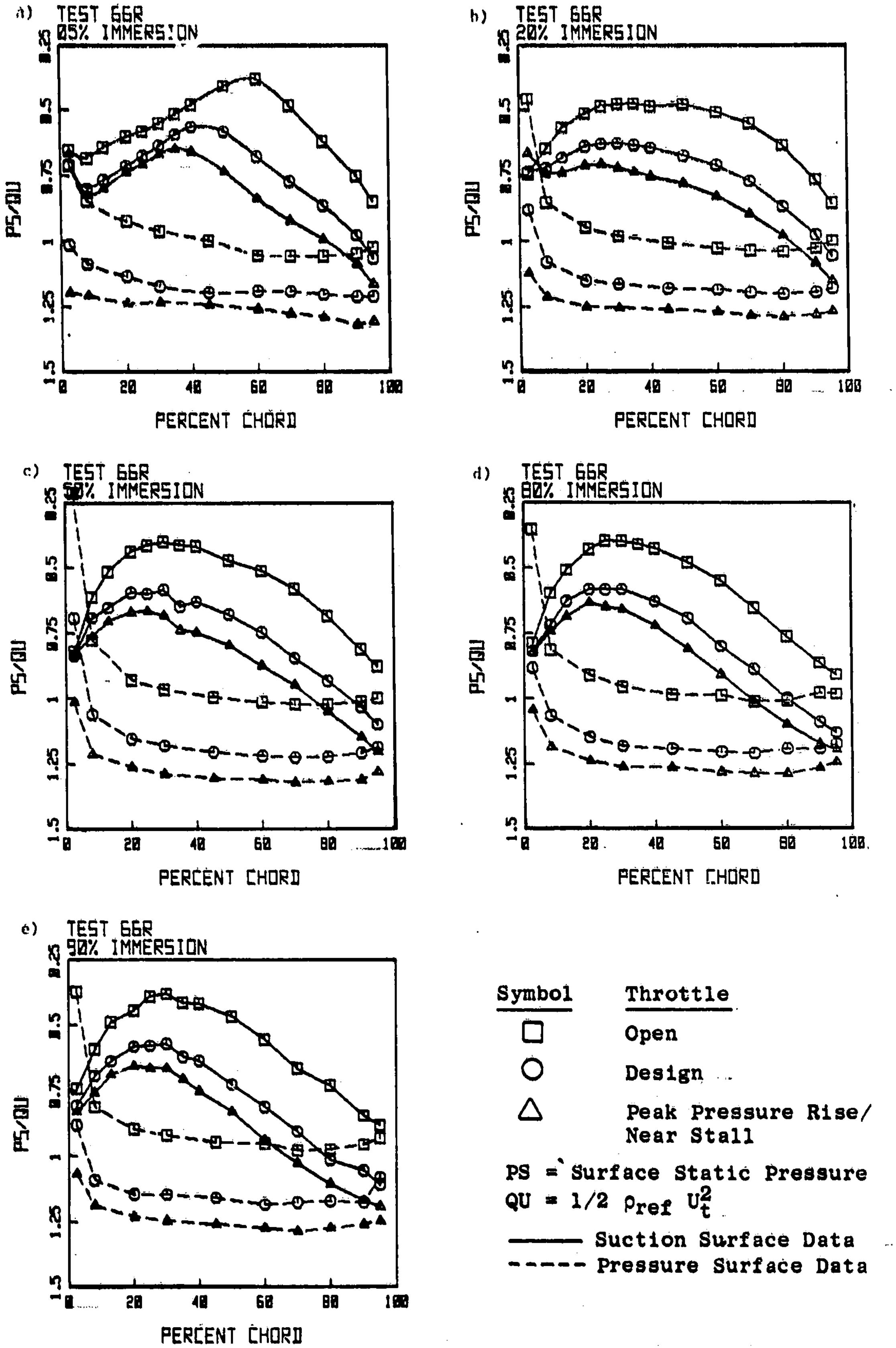

Figure 11. Rotor Blade Surface Static Pressure Measurements for the Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

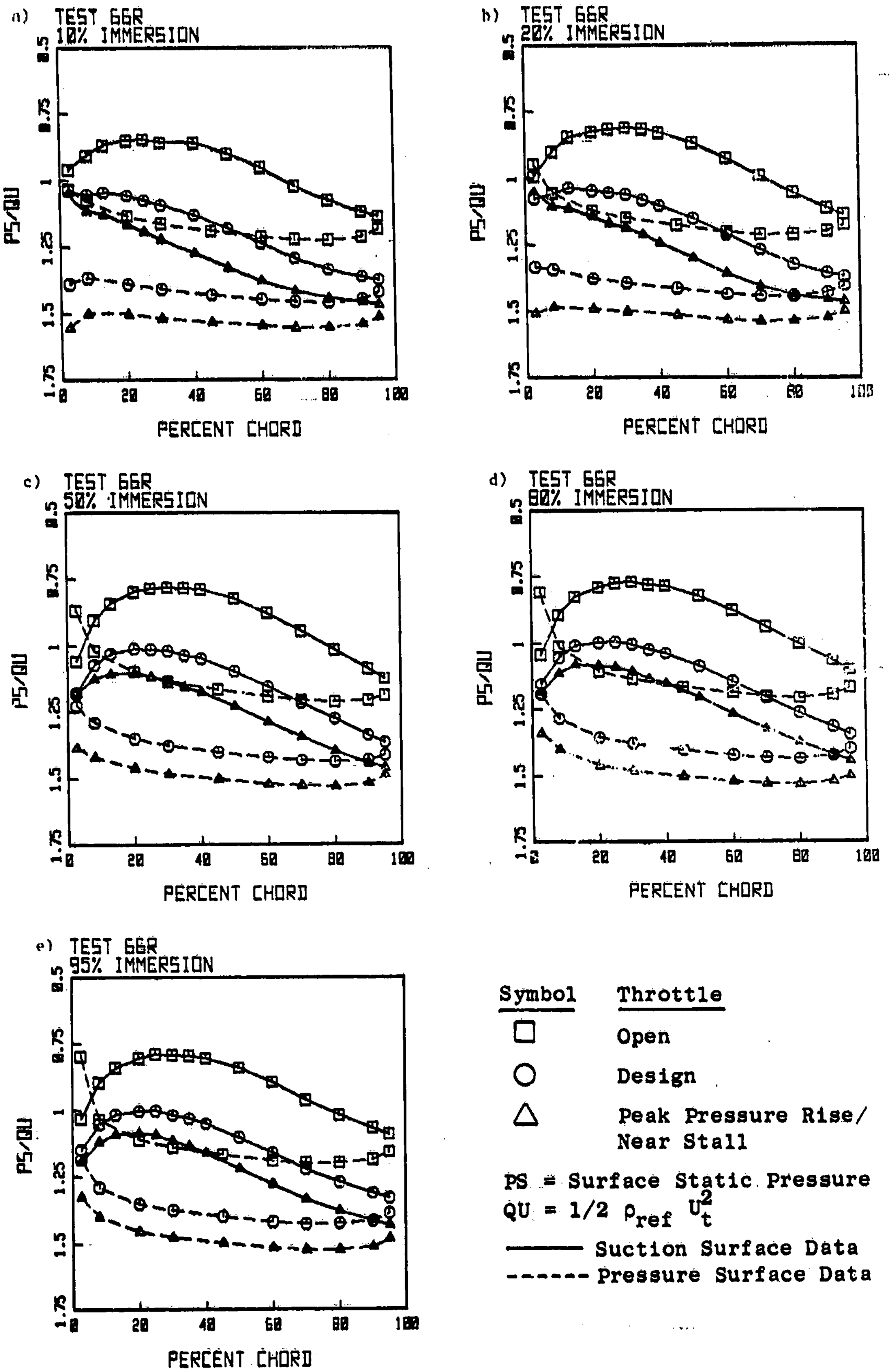

Figure 12. Stator Vane Surface Static Pressure Measurements for the Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

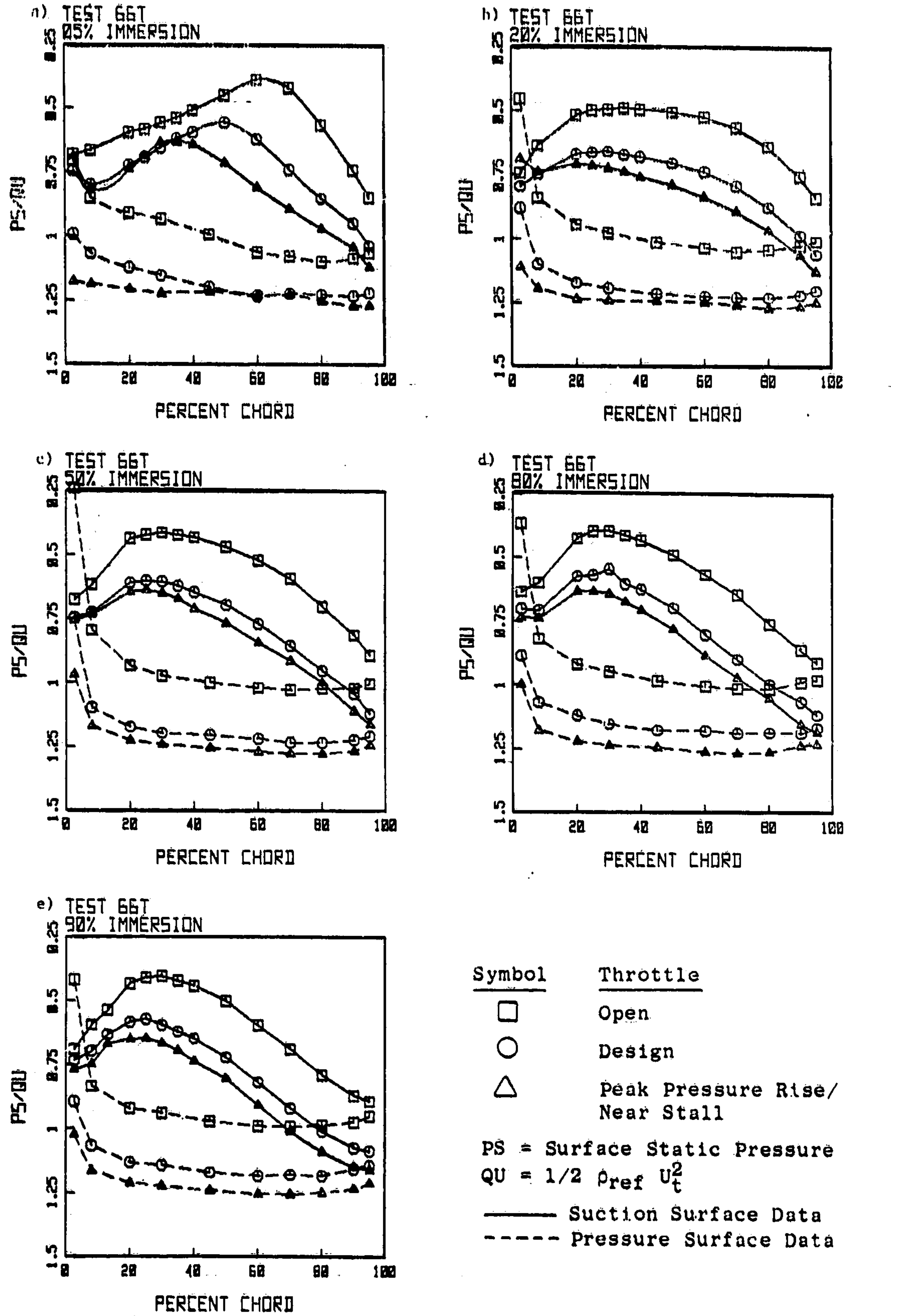

Figure 13. Rotor Blade Surface Static Pressure Measurements for the Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment on All Stages.

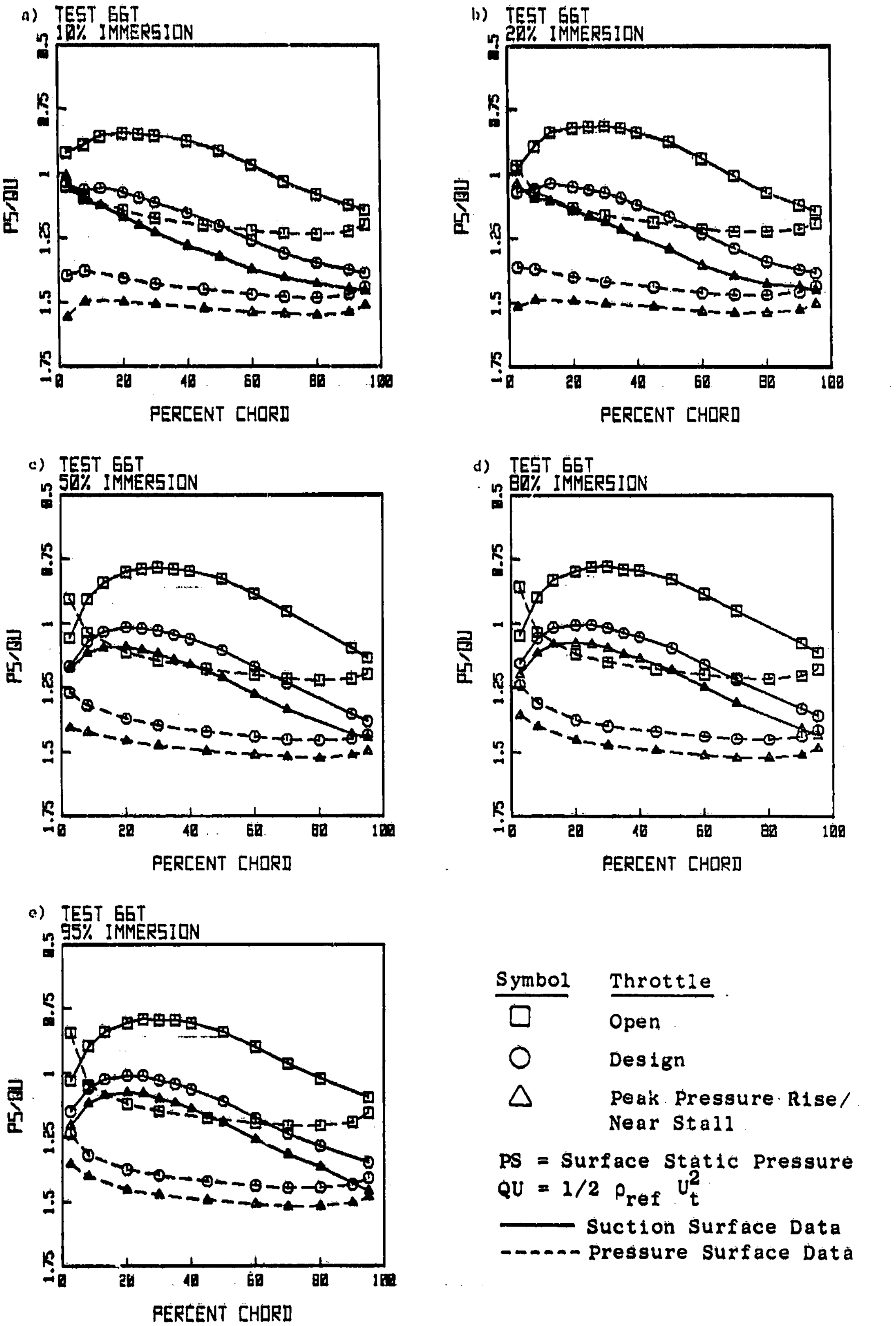

Figure 14. Stator Vane Surface Static Pressure Measurements for the Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment on All Stages.

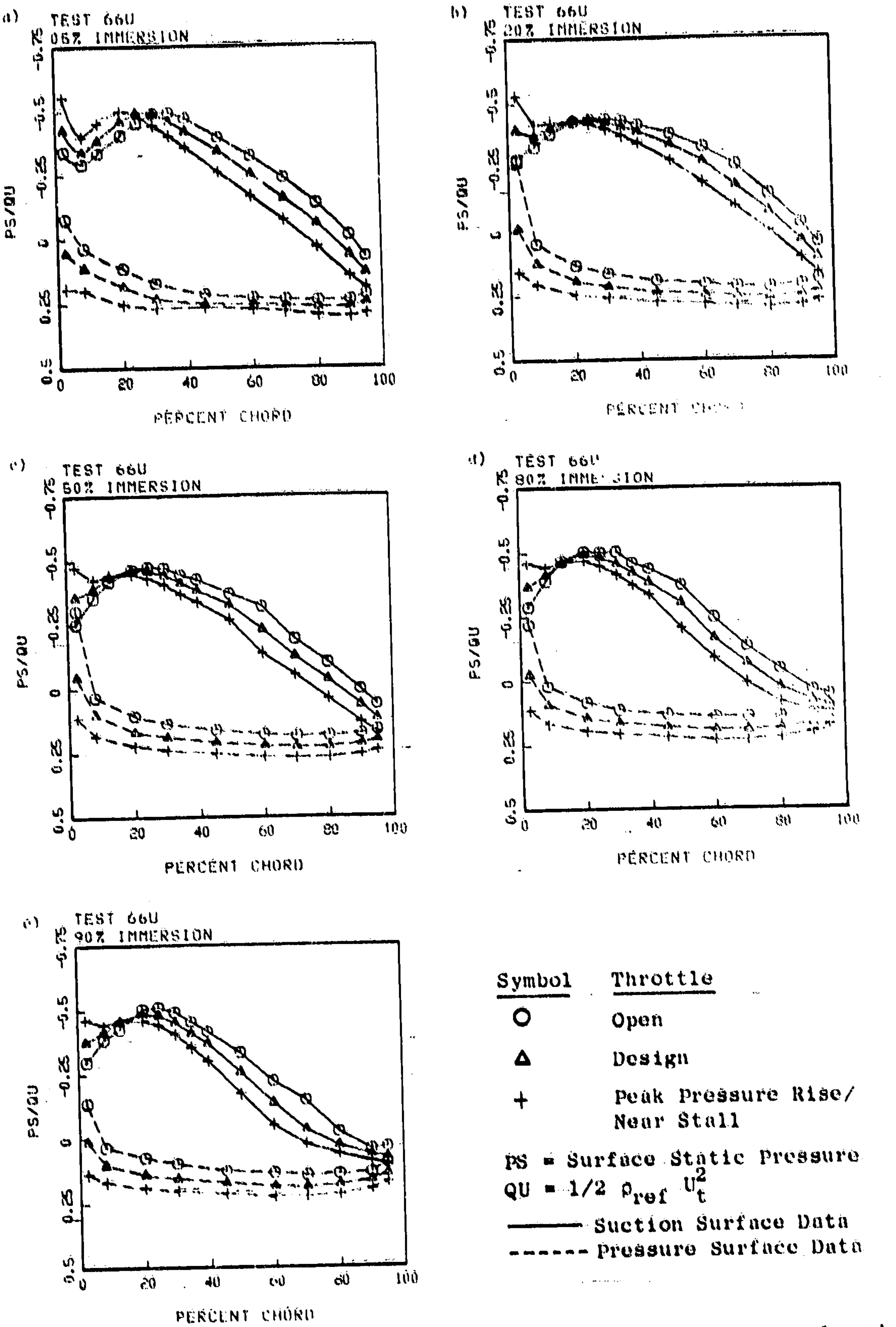

Figure 15. Rotor Blade Surface Static Pressure Measurements for the Rotor B/Stator B Single-Stage Configuration.

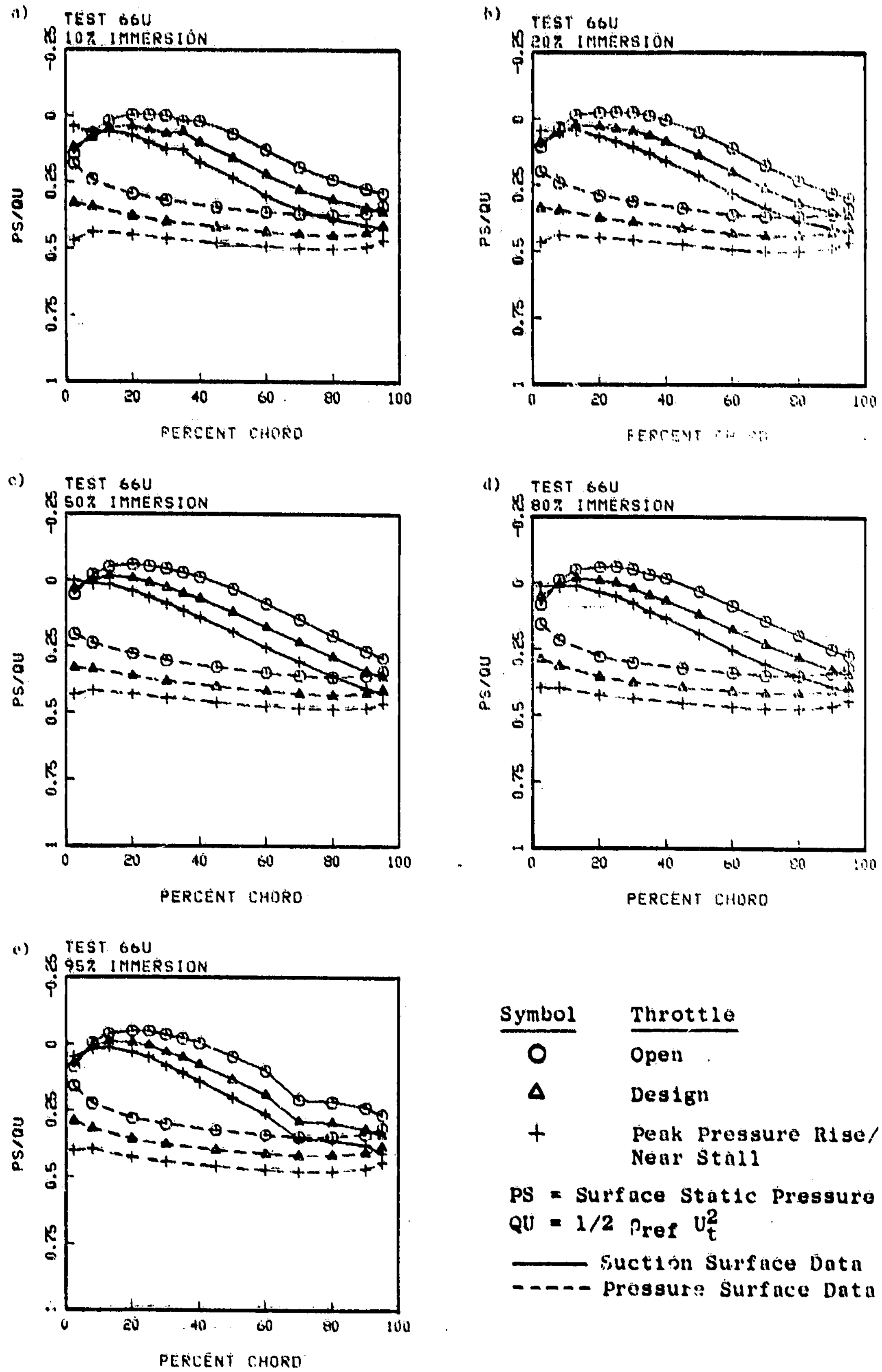

Figure 16. Stator Vane Surface Static Pressure Measurements for the Rotor B/Stator B Single-Stage Configuration.

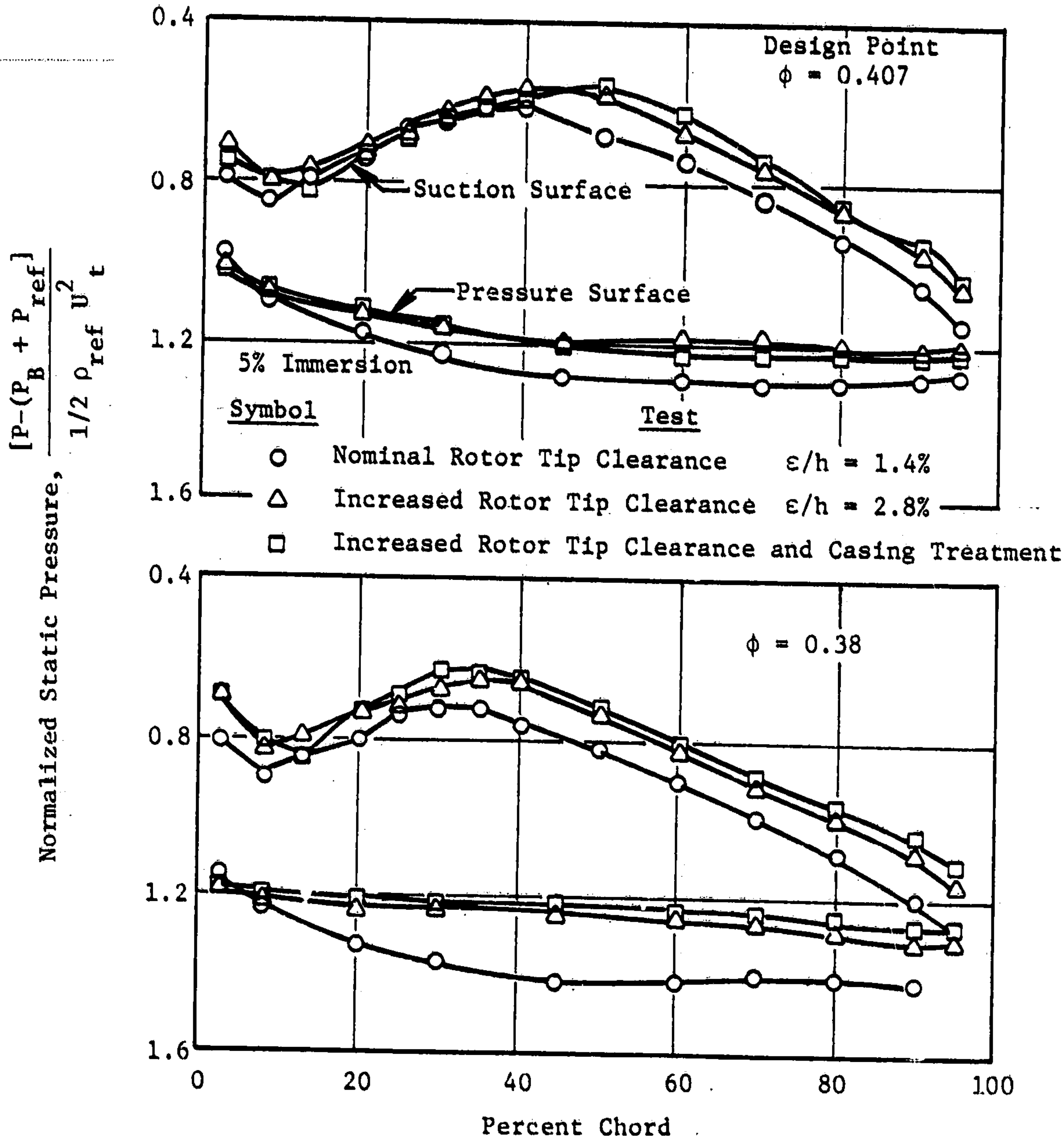

Figure 17. Static Pressure Measurements on the Blade Surface Near the Tip of Rotor B, Four-Stage Configuration, Third Stage Tested.

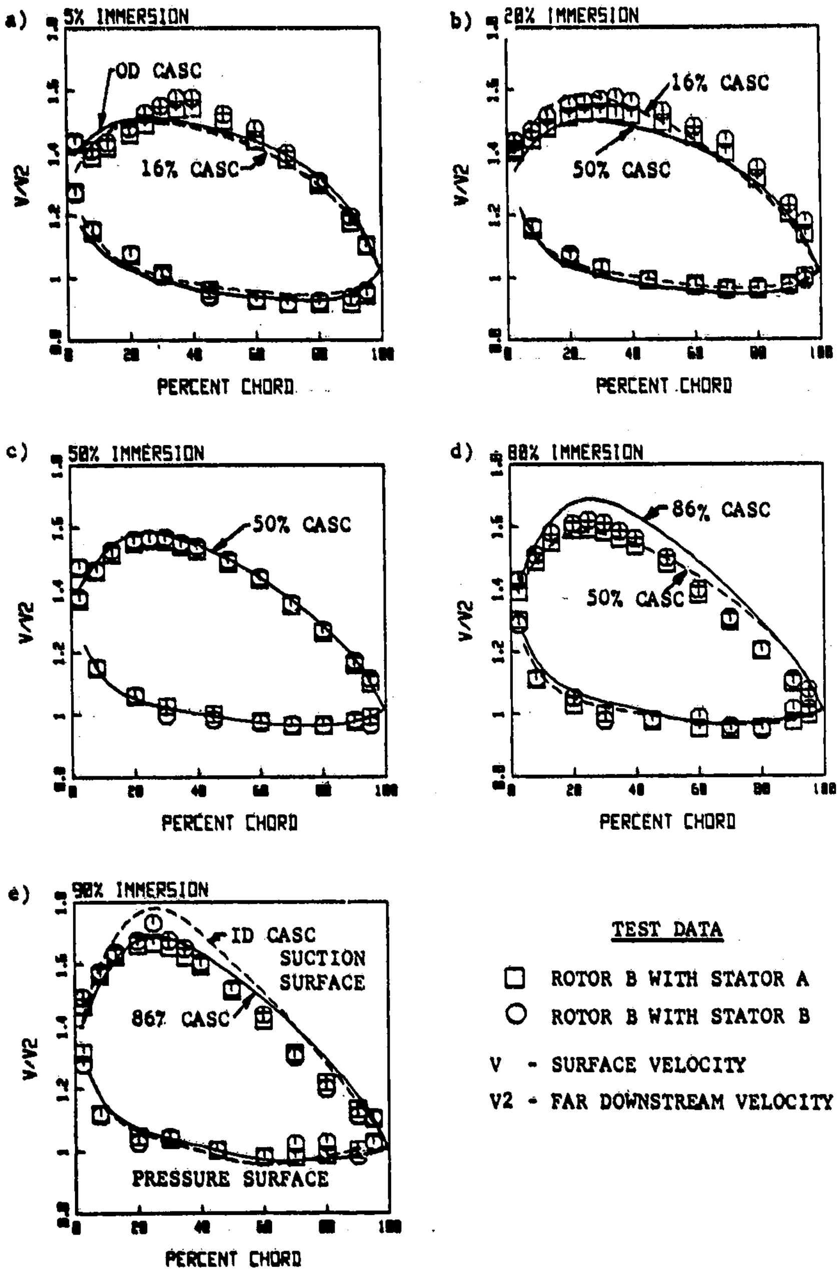

Figure 18. Rotor Blade Surface Velocity Distributions for Rotor B Operating Near the Design Point - Measurements Compared with Potential Flow CASC Solutions.

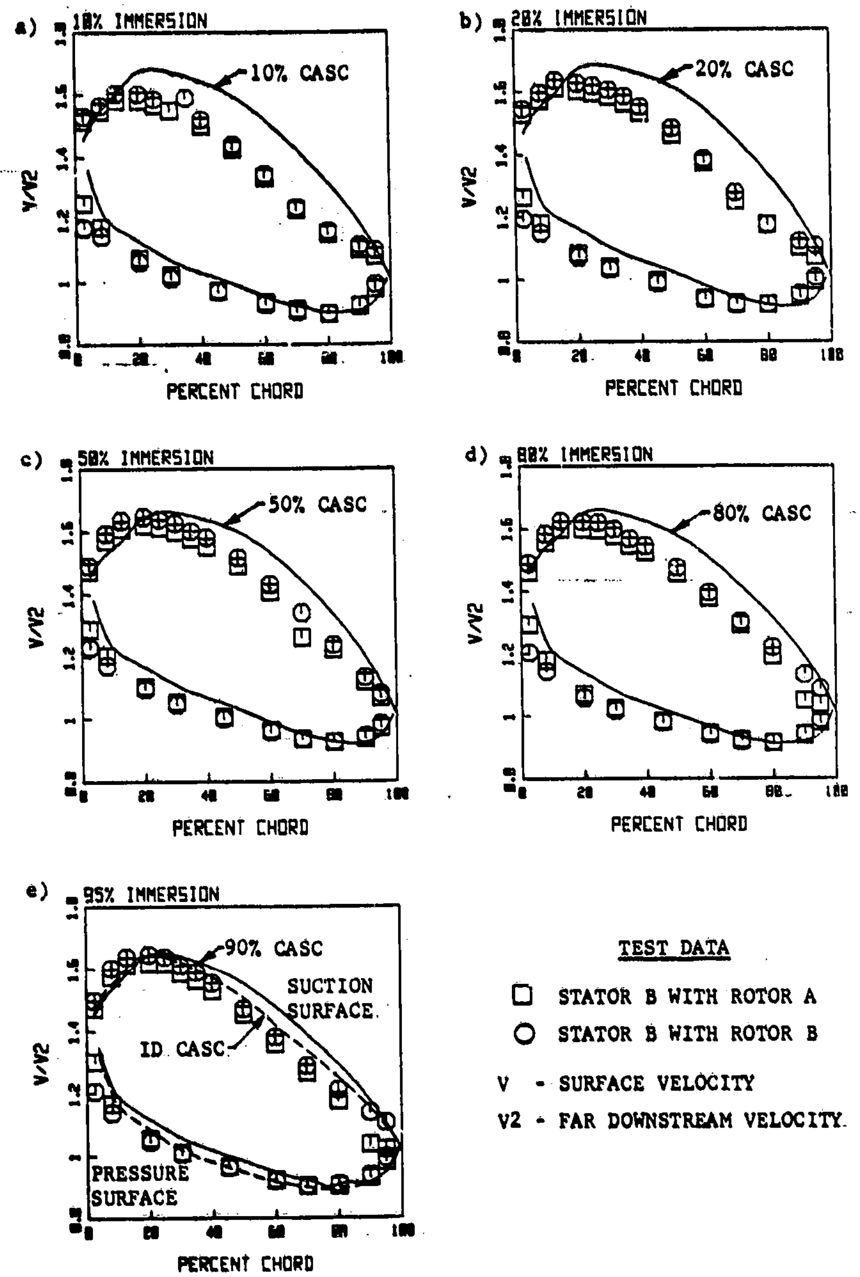

Figure 19. Stator Vane Surface Velocity Distributions for Stator B Operating Near the Design Point - Measurements Compared with Potential Flow CASC Solutions.

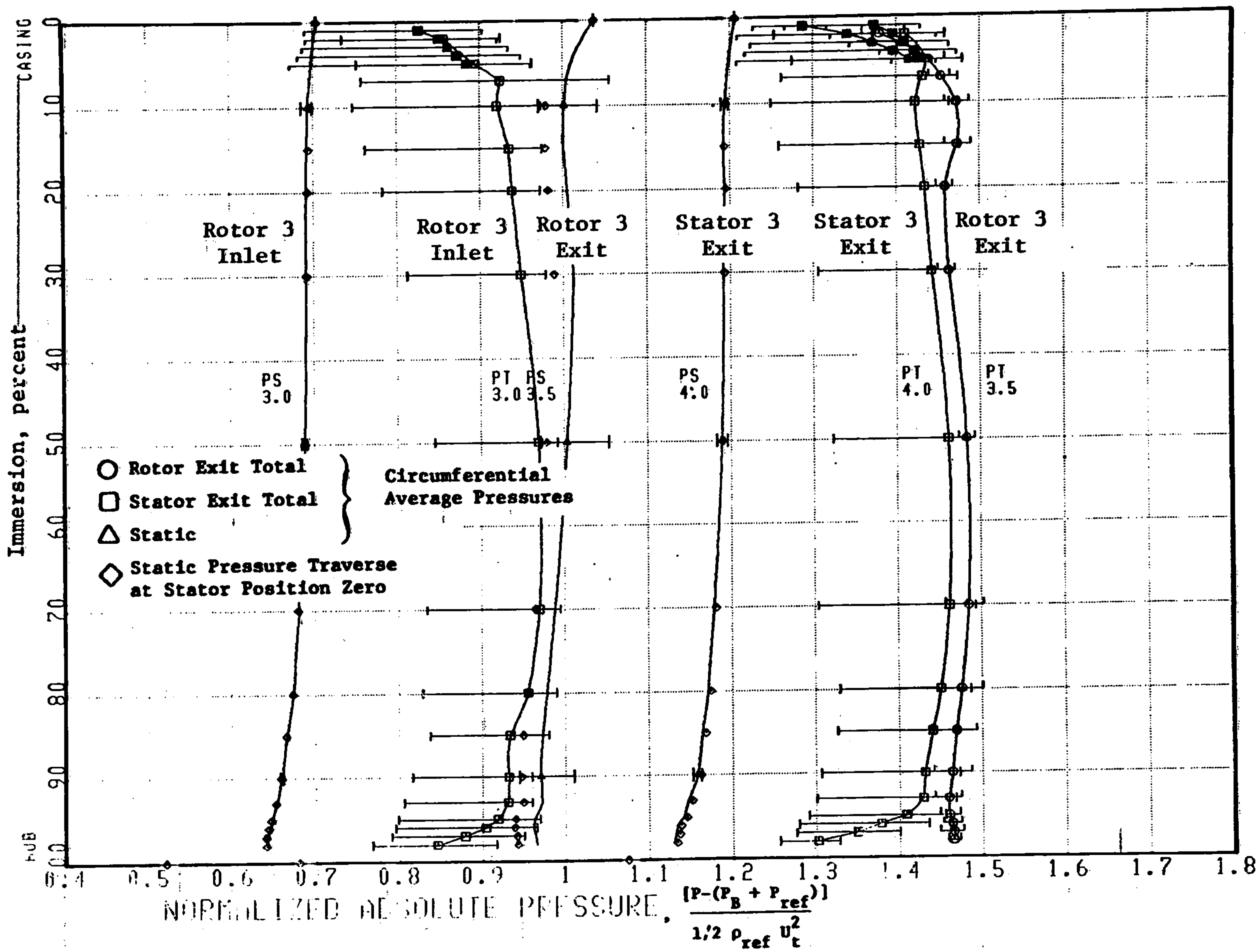

Figure 20. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Open Throttle.

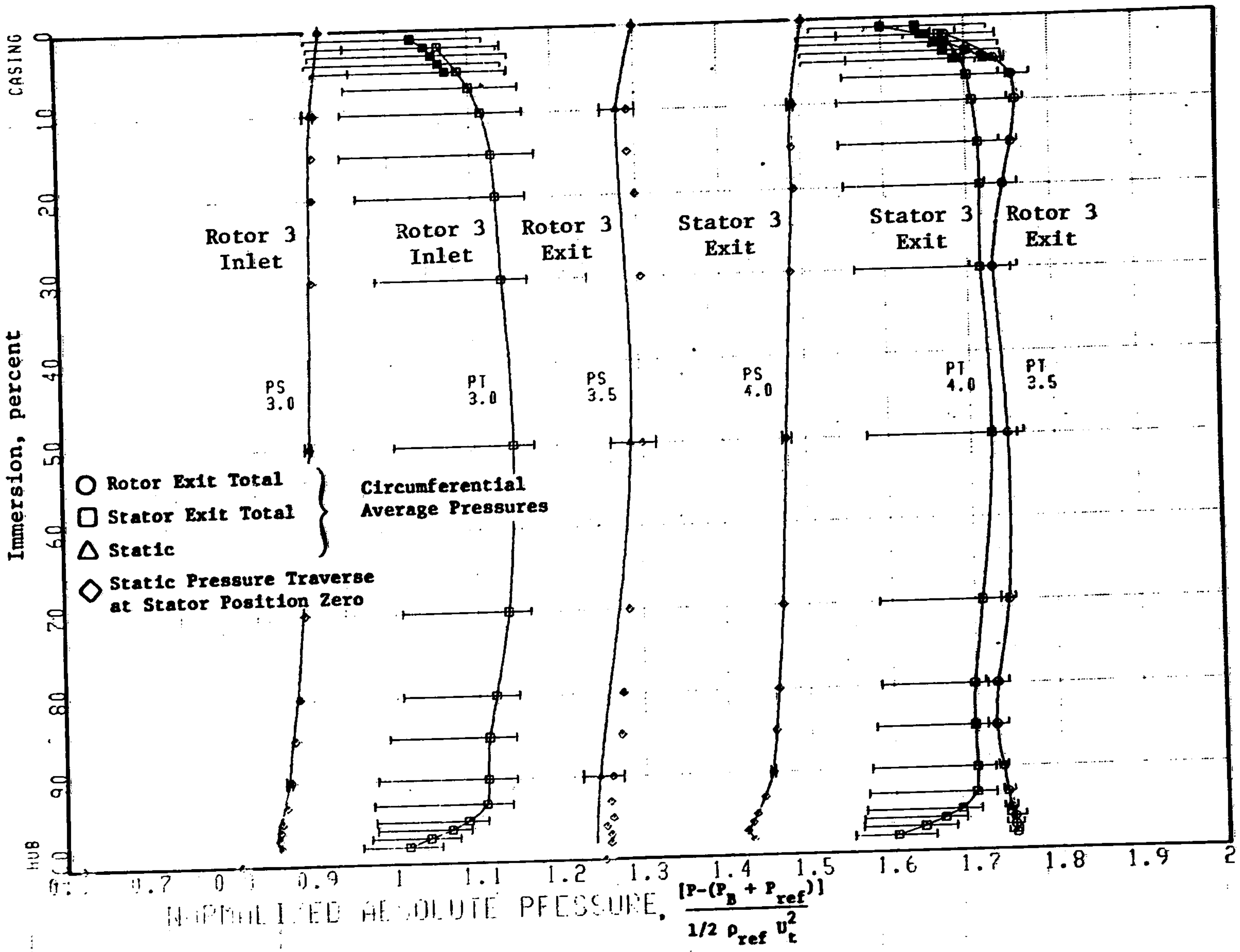

Figure 21. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Design Point Throttle.

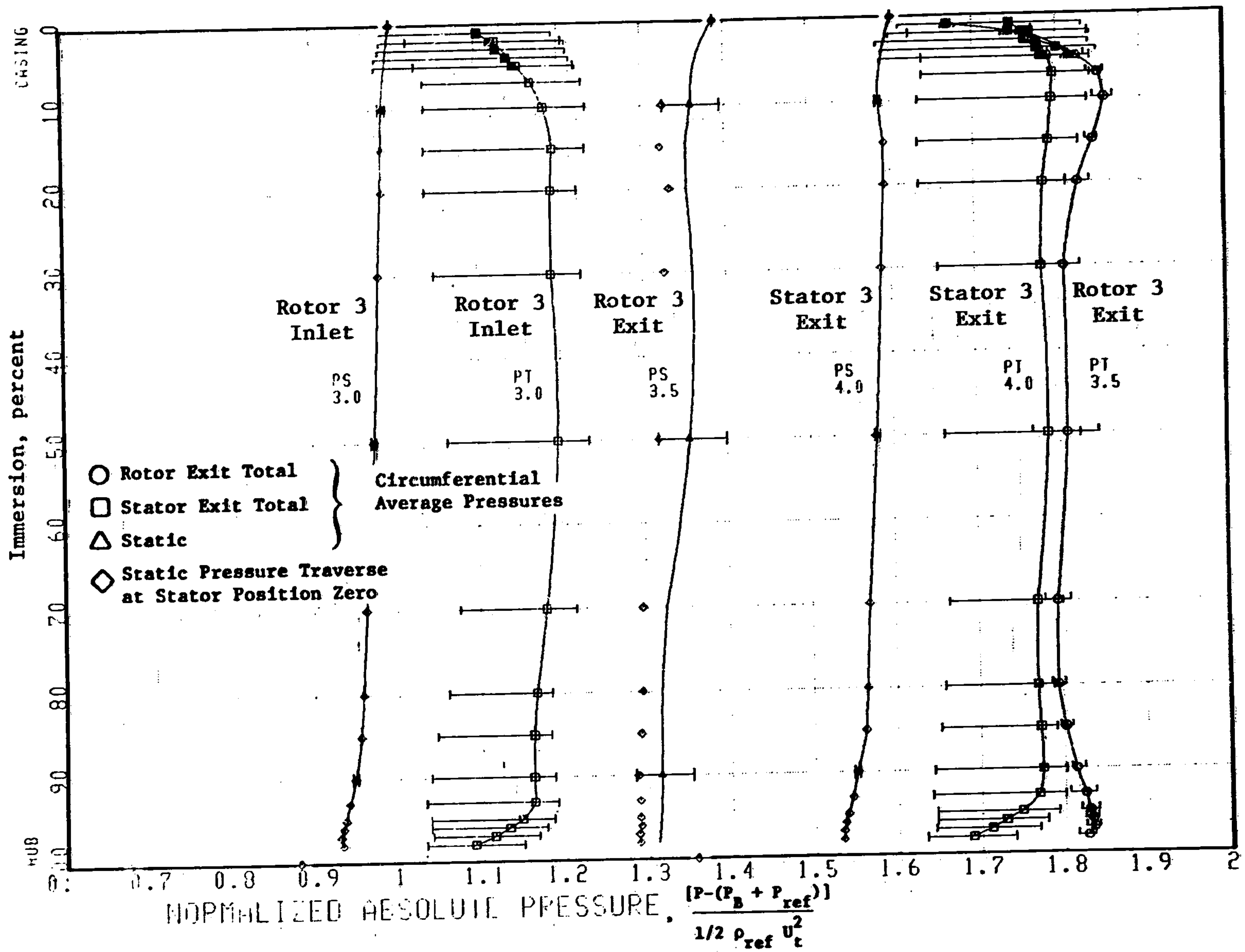

Figure 22. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Efficiency Throttle.

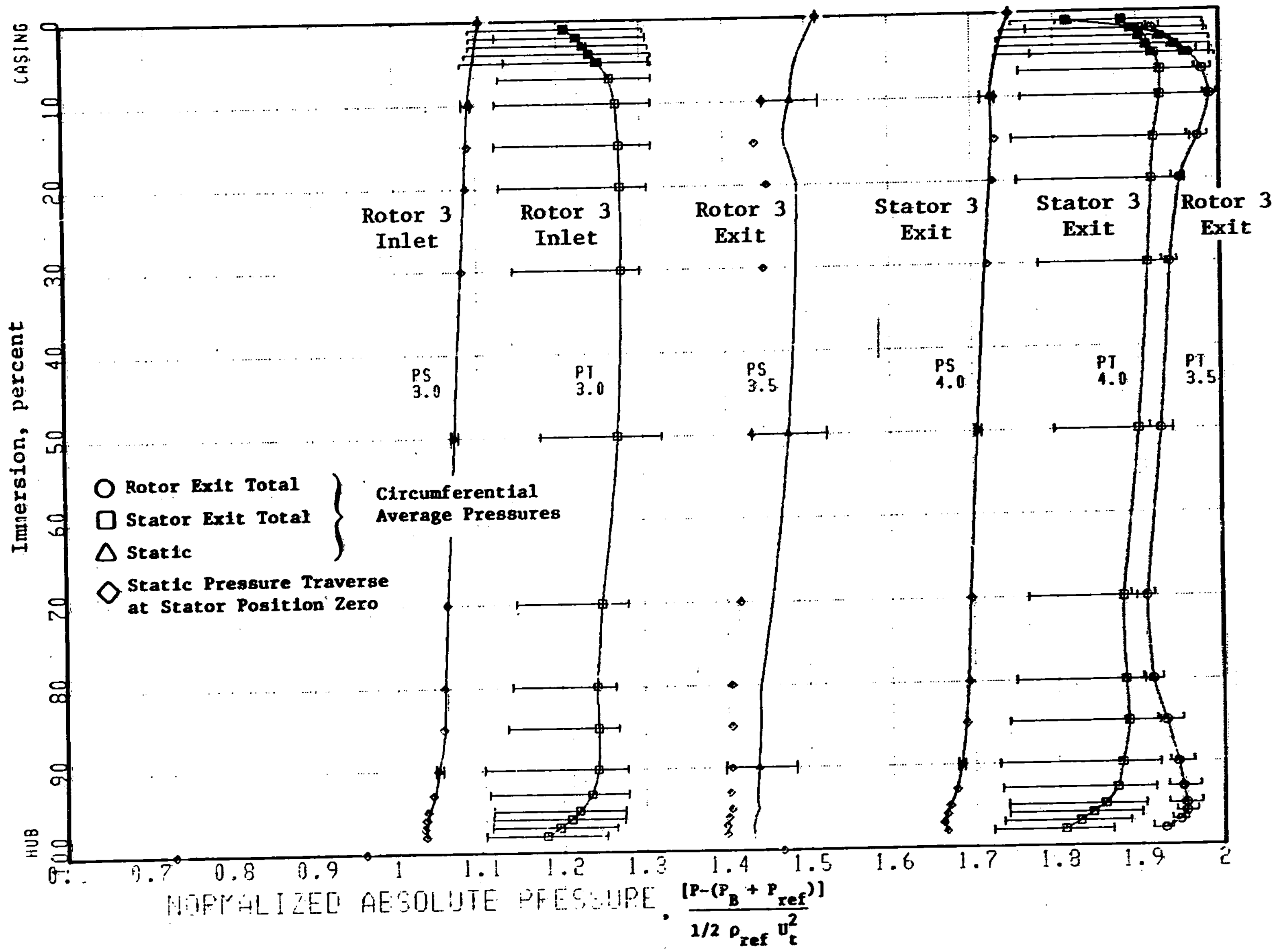

Figure 23. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Pressure Rise/Near Stall Throttle.

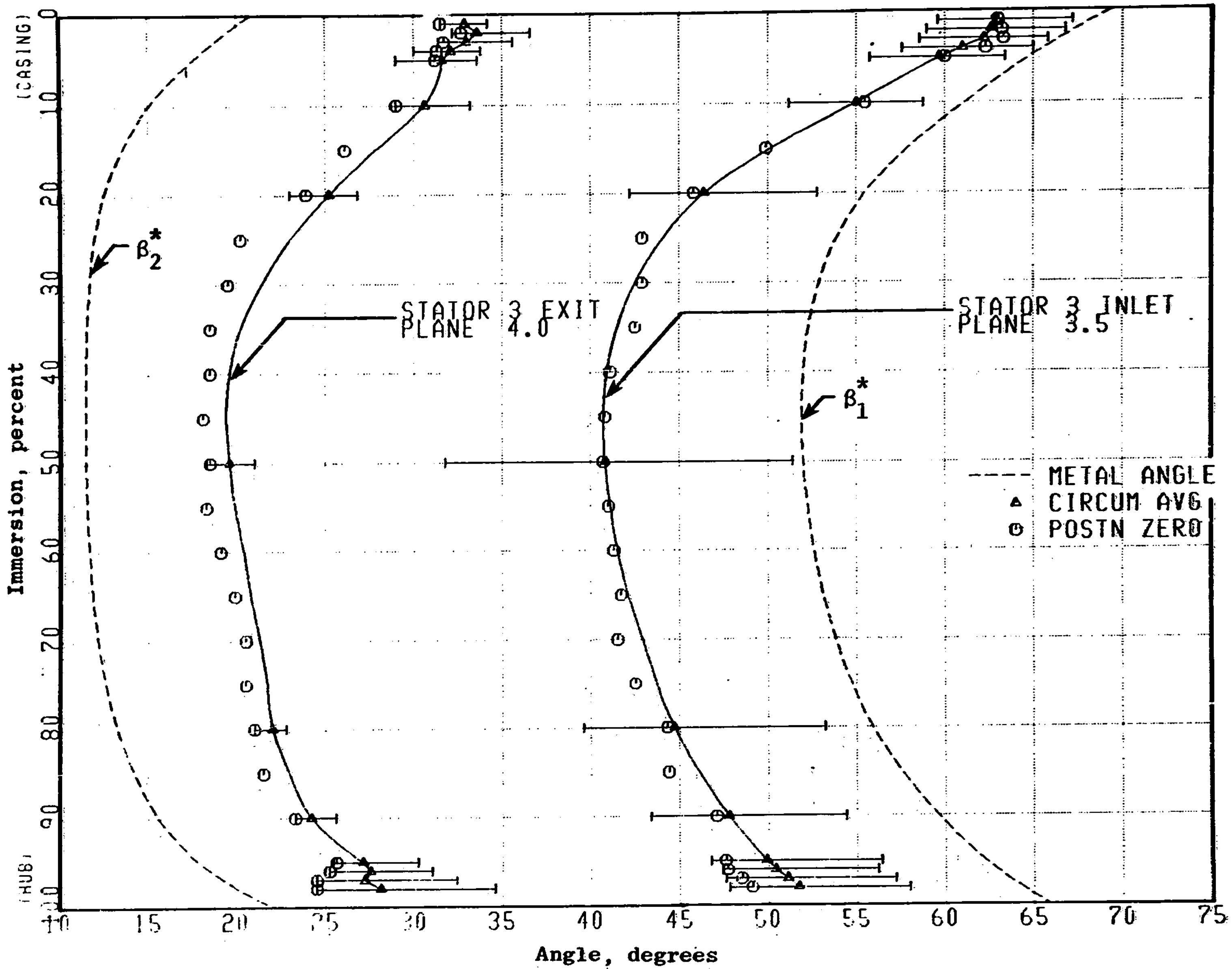

Figure 24. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Open Throttle.

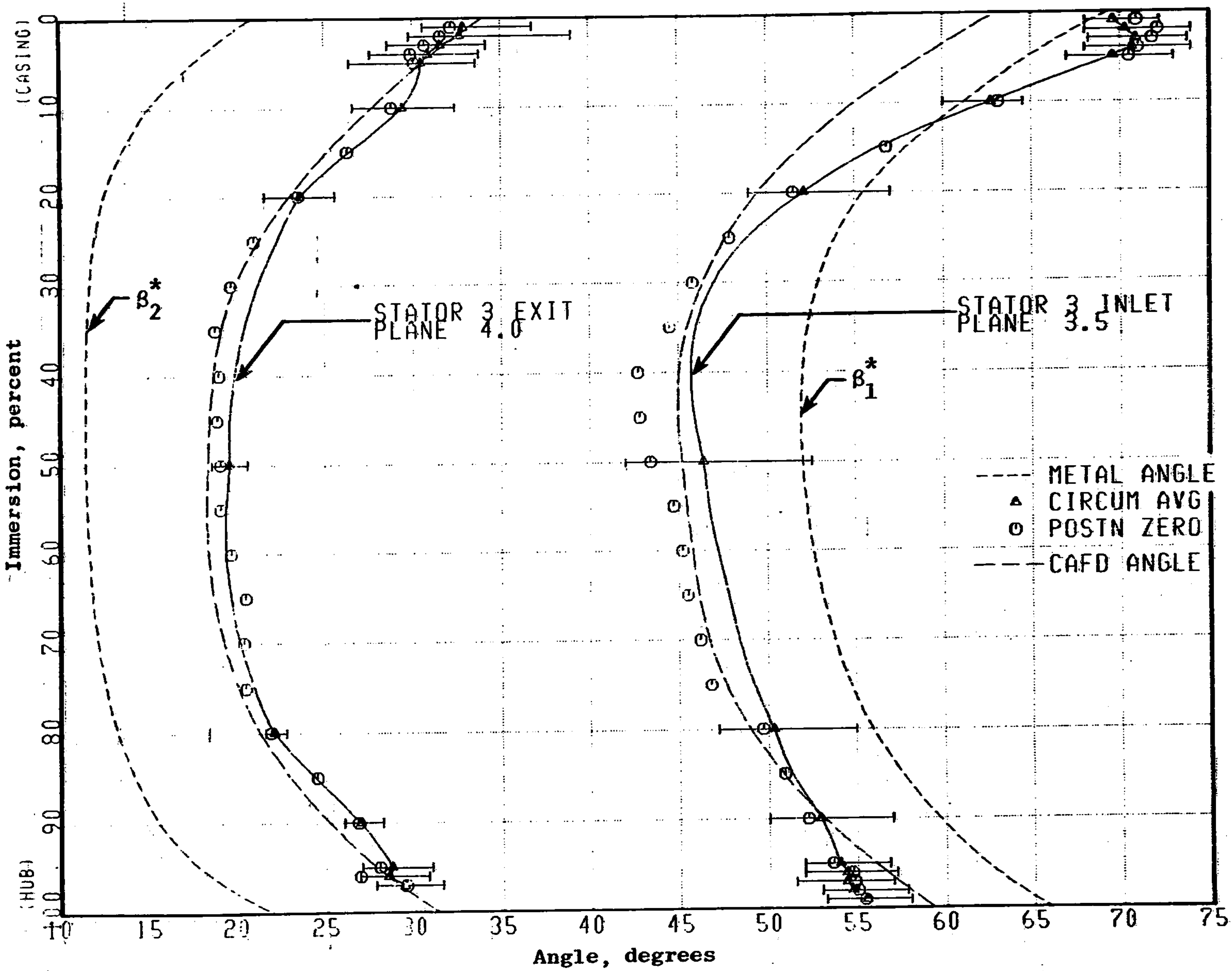

Figure 25. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Design Point Throttle.

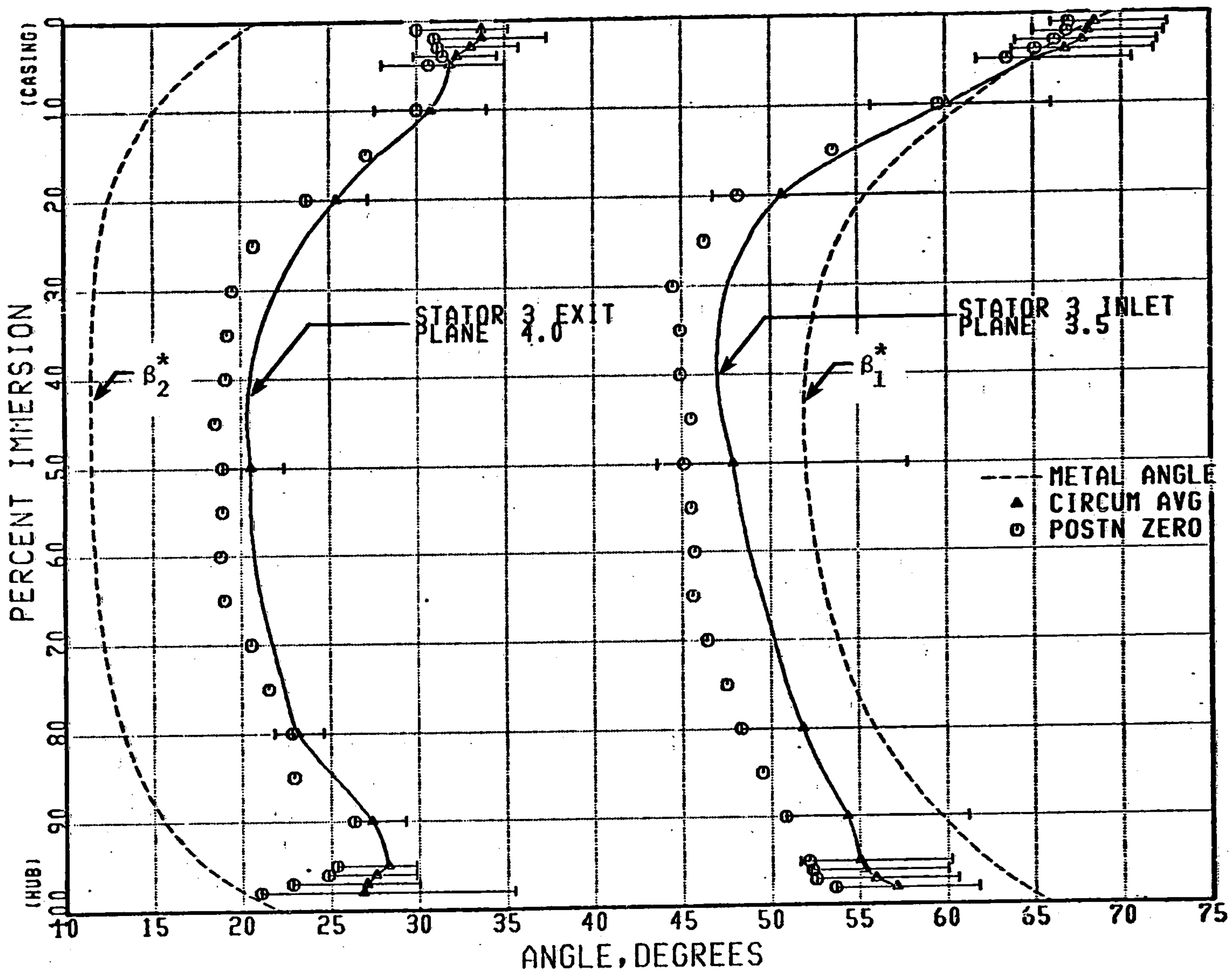

Figure 26. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Efficiency Throttle.

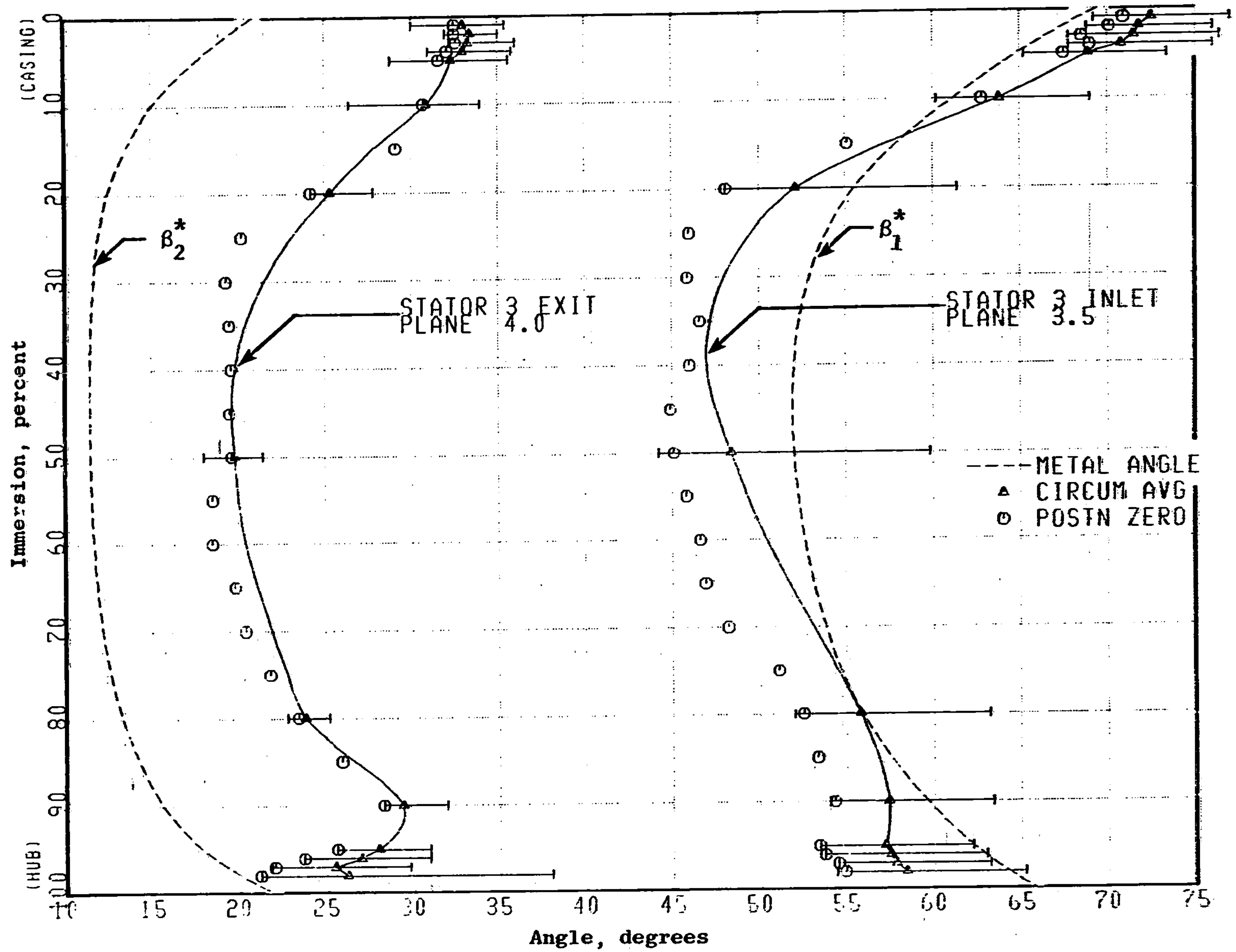

Figure 27. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Pressure Rise/Near Stall Throttle.

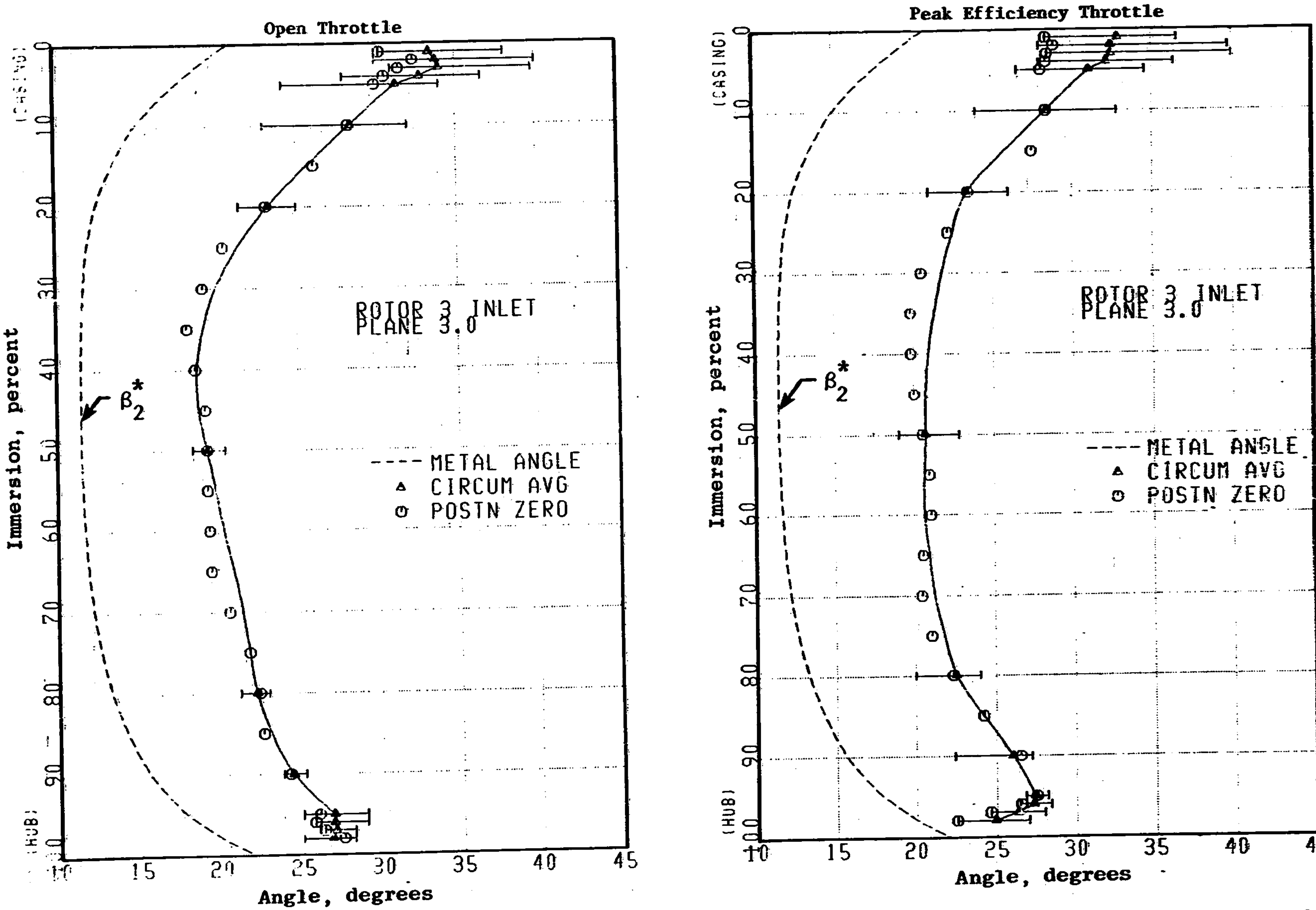

Figure 28. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

Peak Pressure Rise/Near Stall Throttle

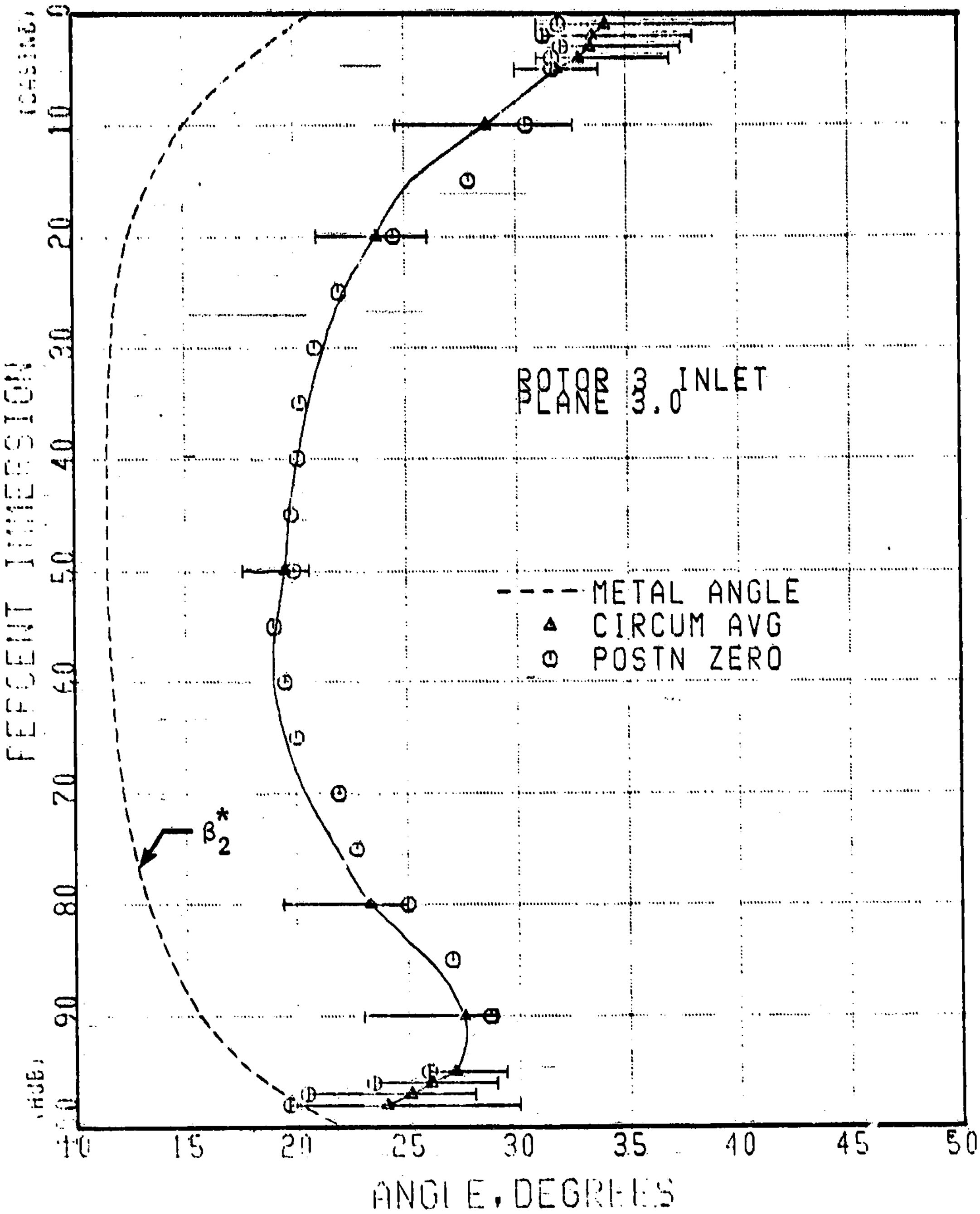

Figure 29. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

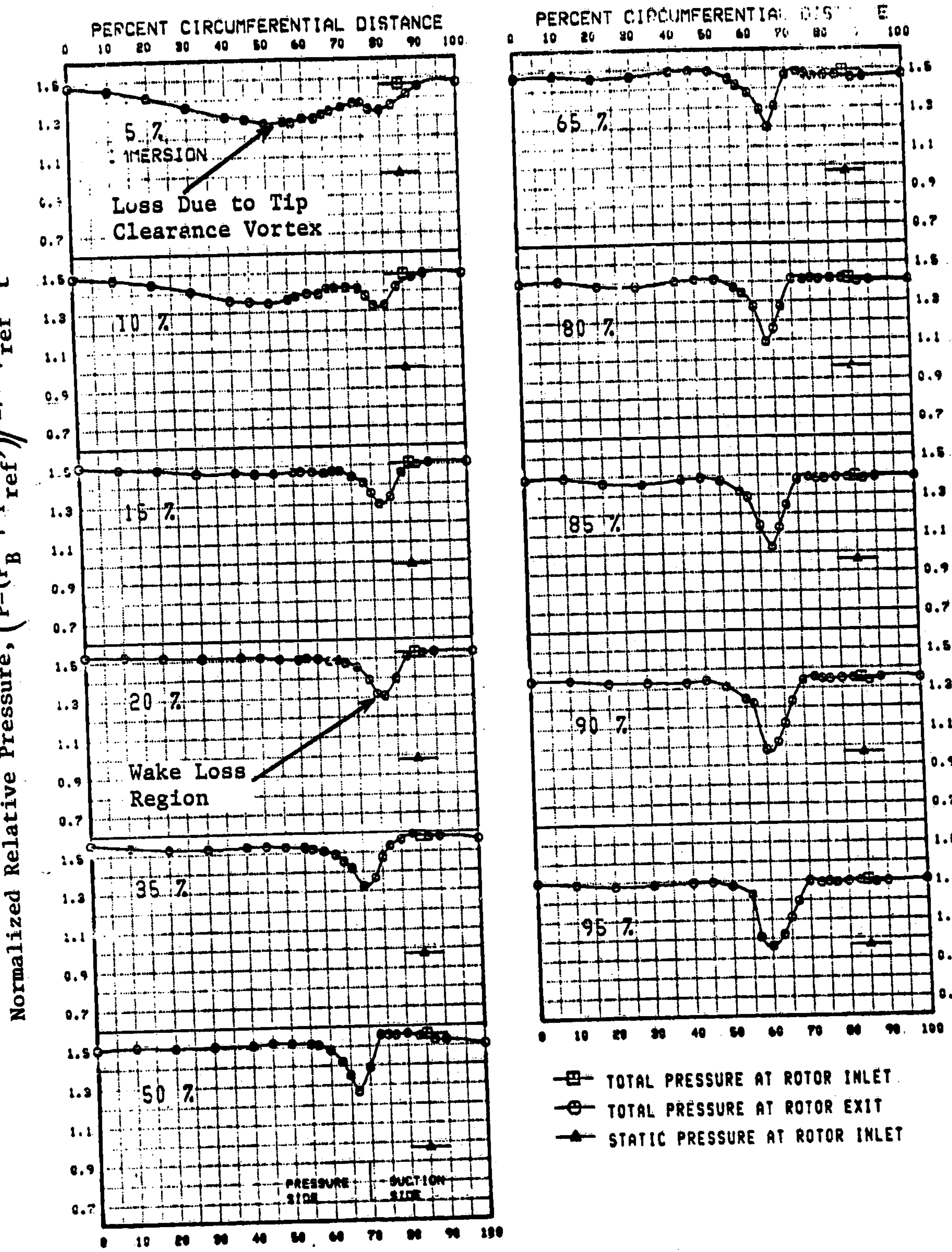

Figure 30. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Open Throttle.

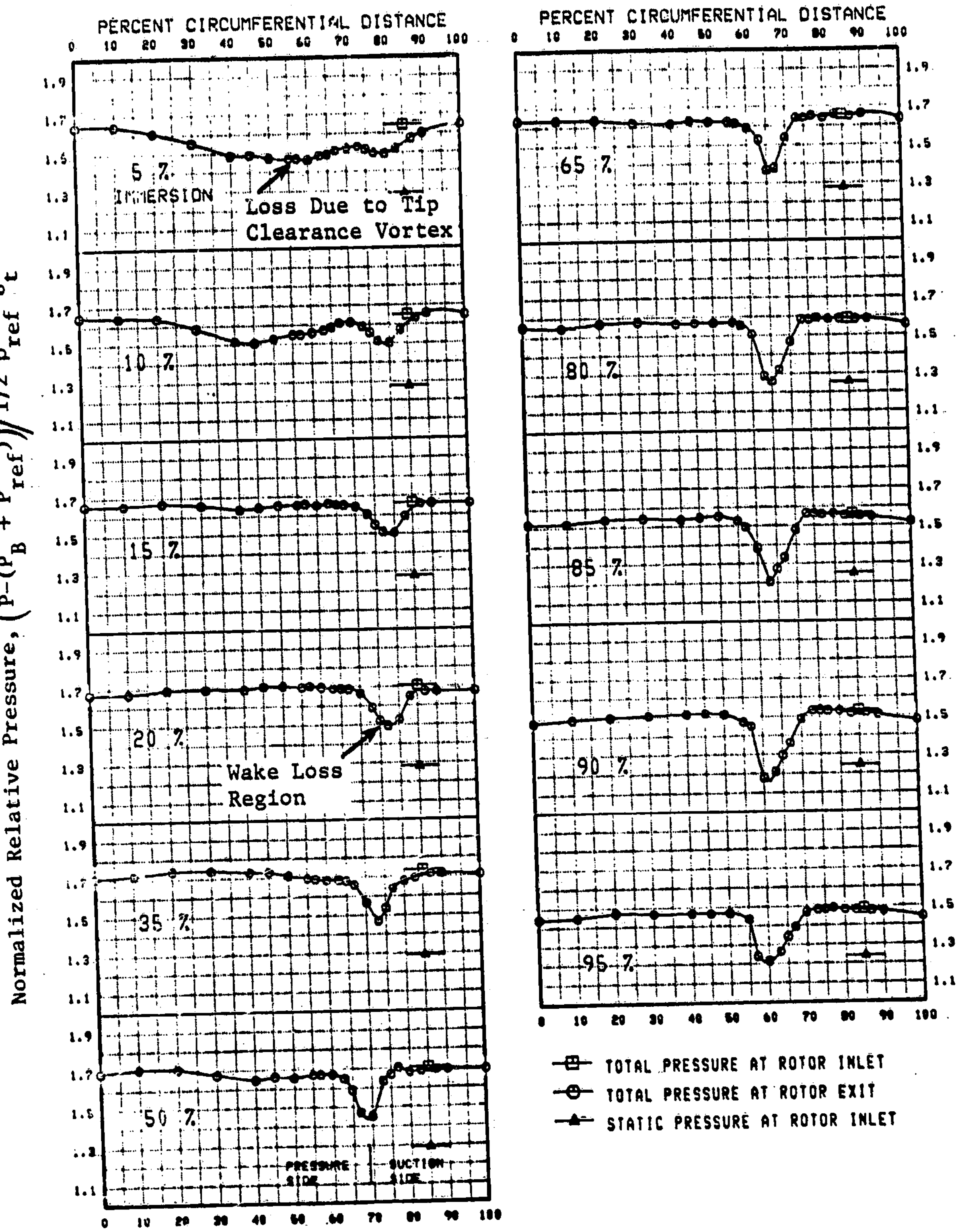

Figure 31. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Design Point Throttle.

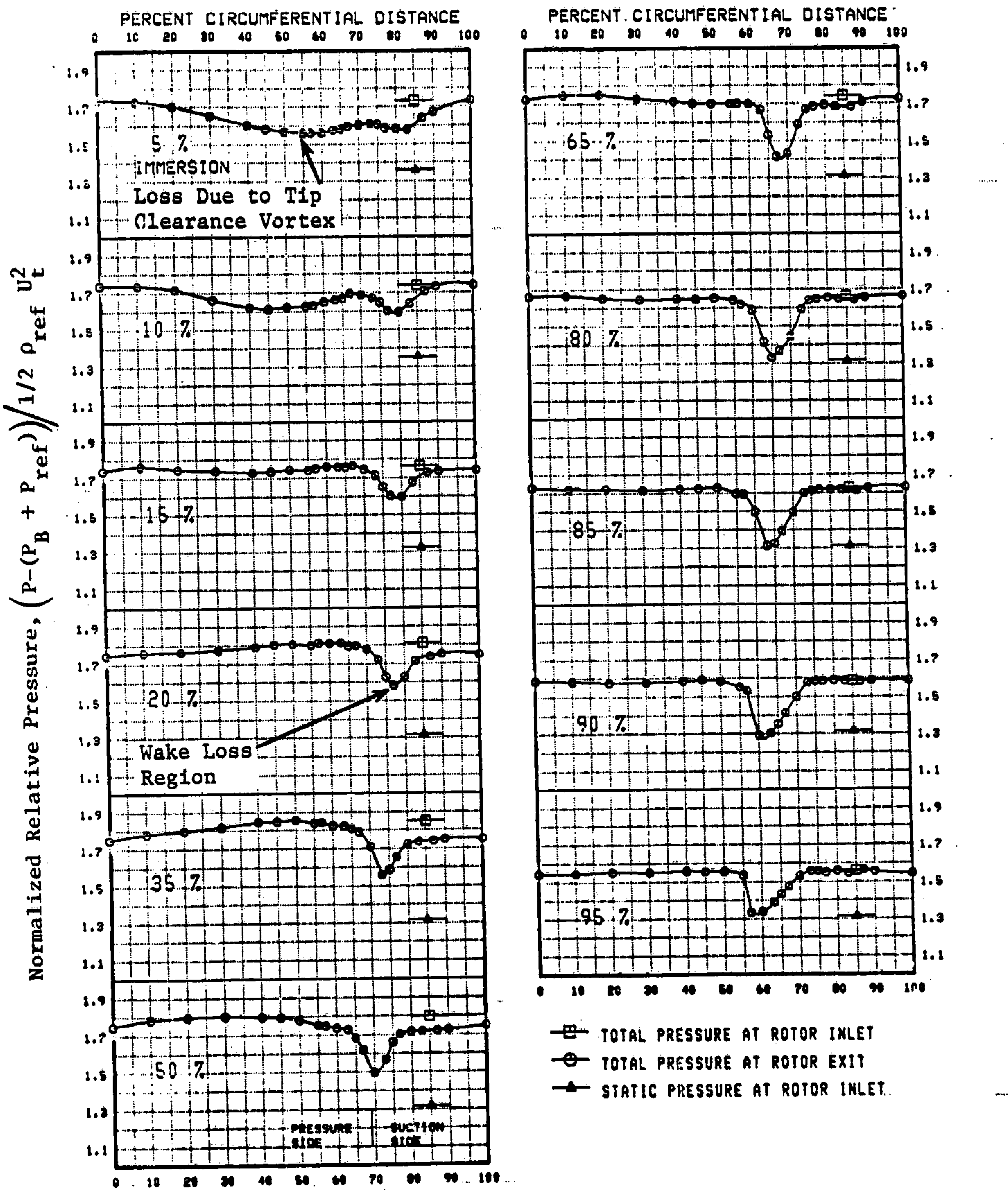

Figure 32. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Efficiency Throttle.

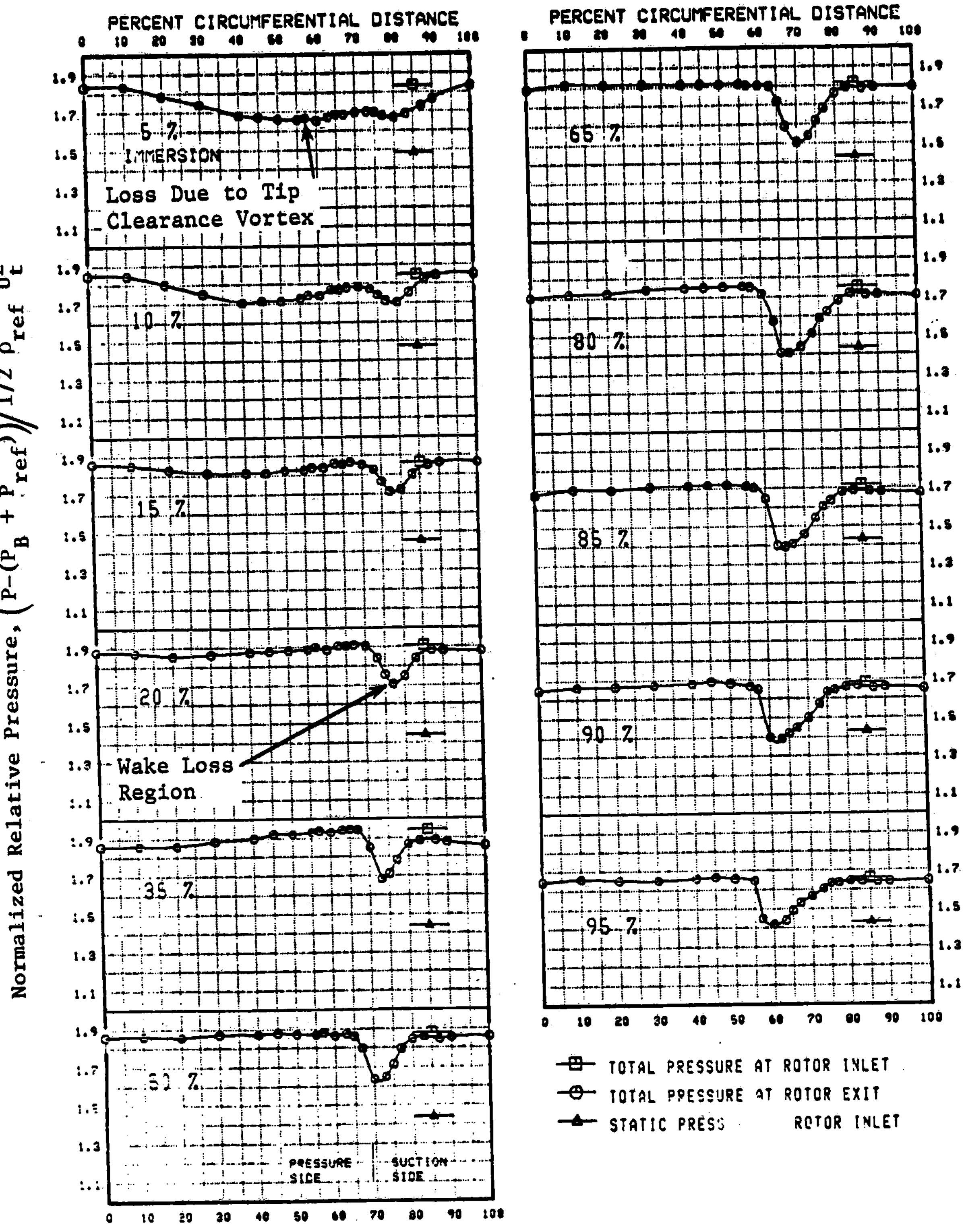

Figure 33. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Pressure Rise/Near Stall Throttle.

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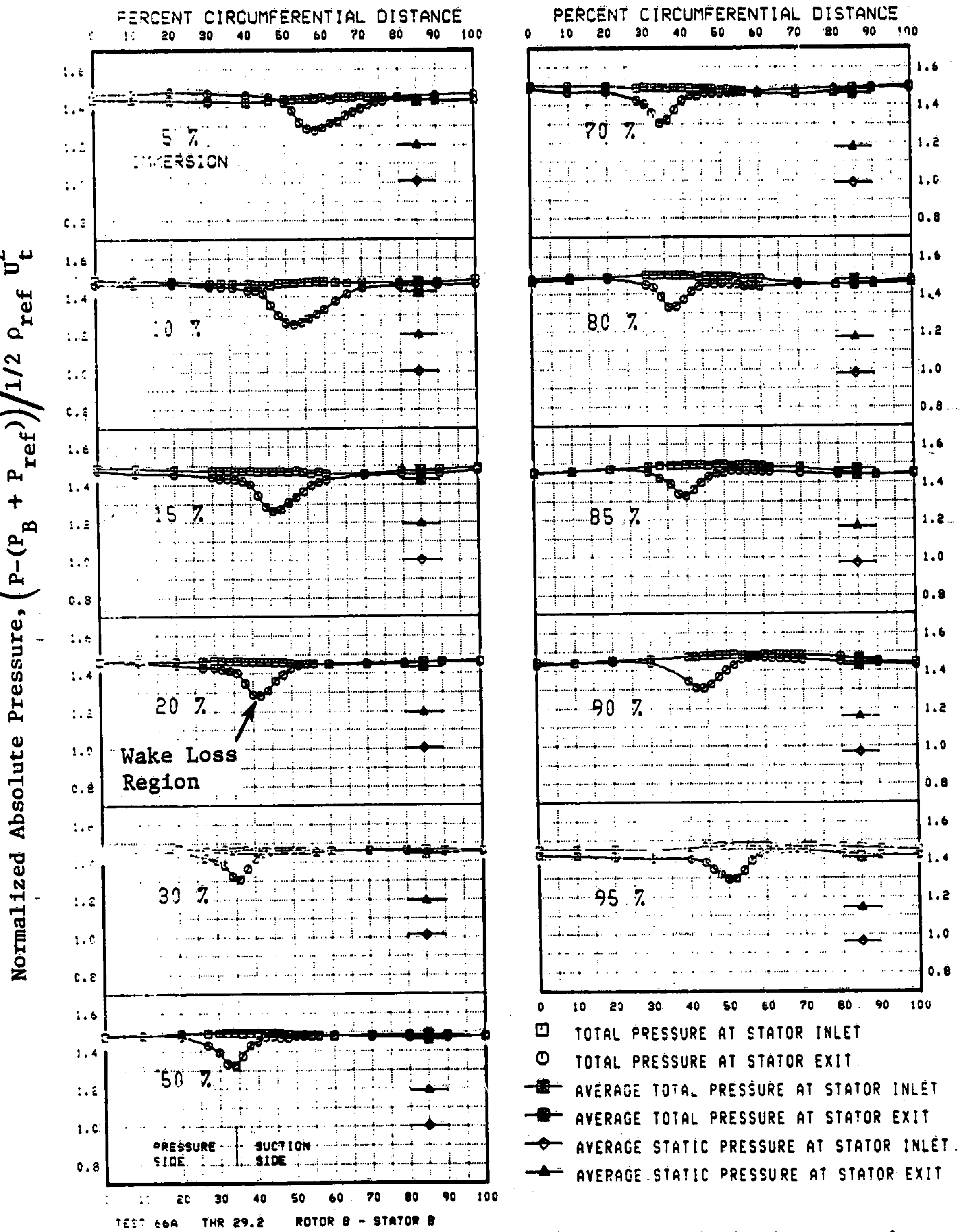


Figure 34. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Open Throttle.

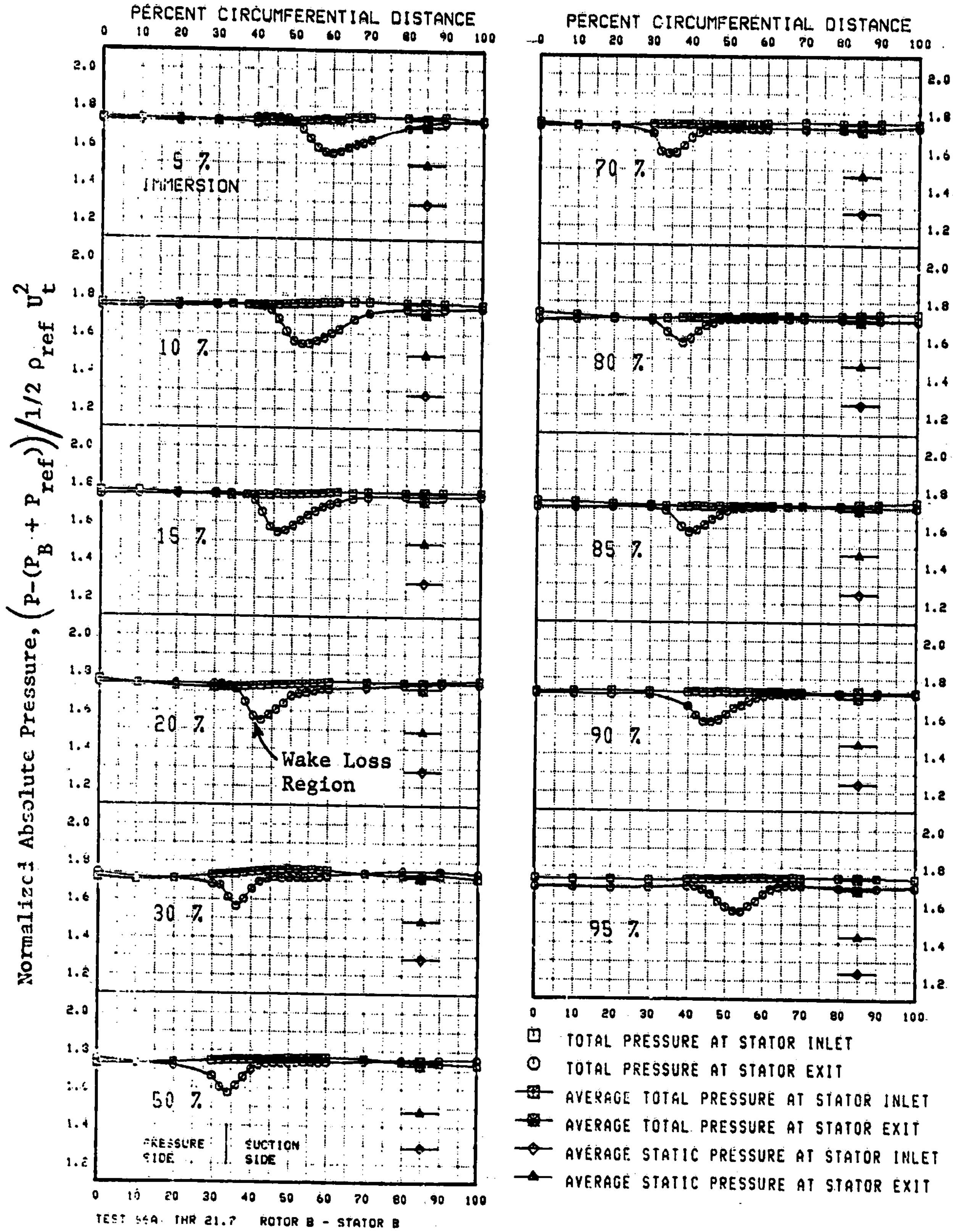


Figure 35. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Design Point Throttle.

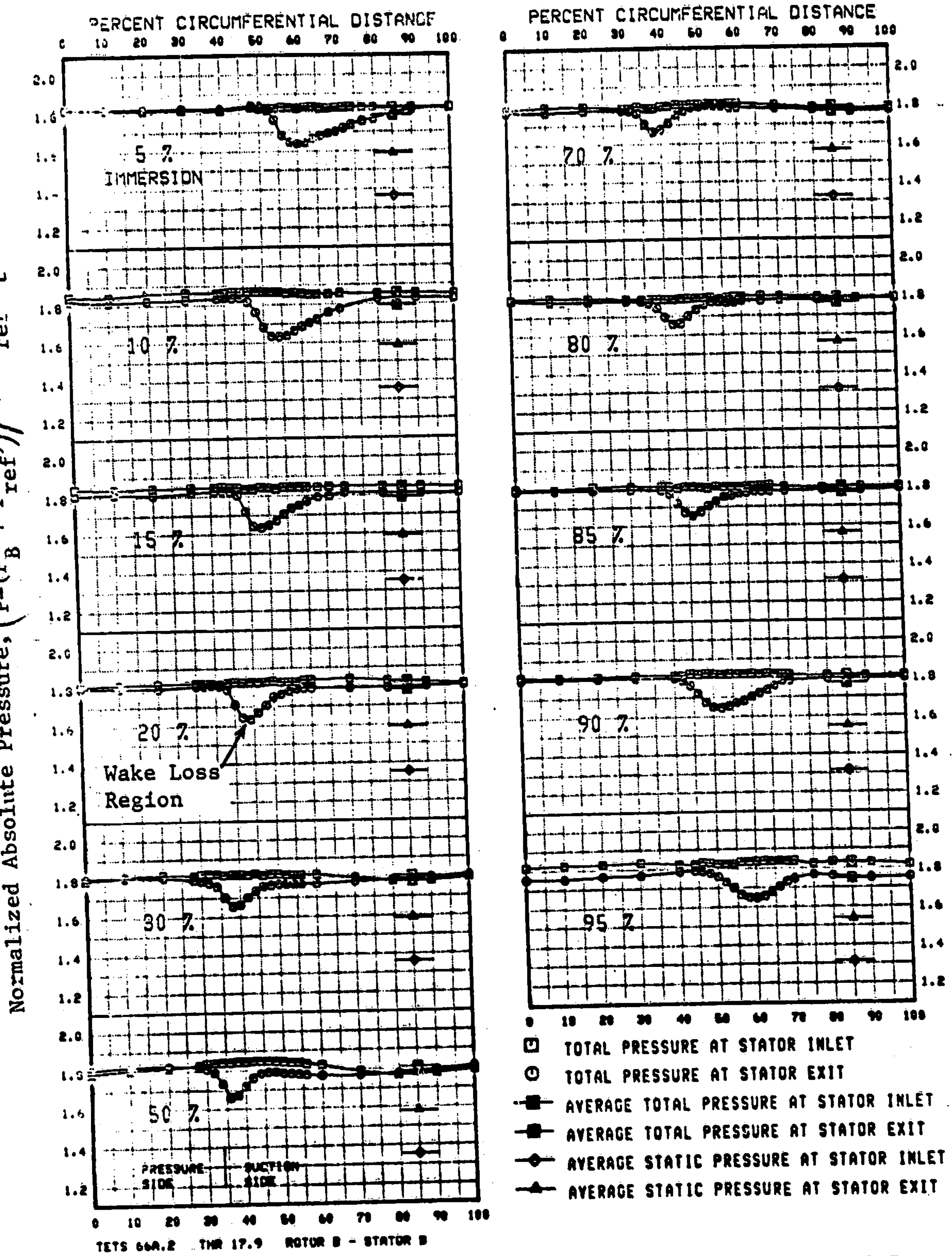


Figure 36. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Efficiency Throttle.

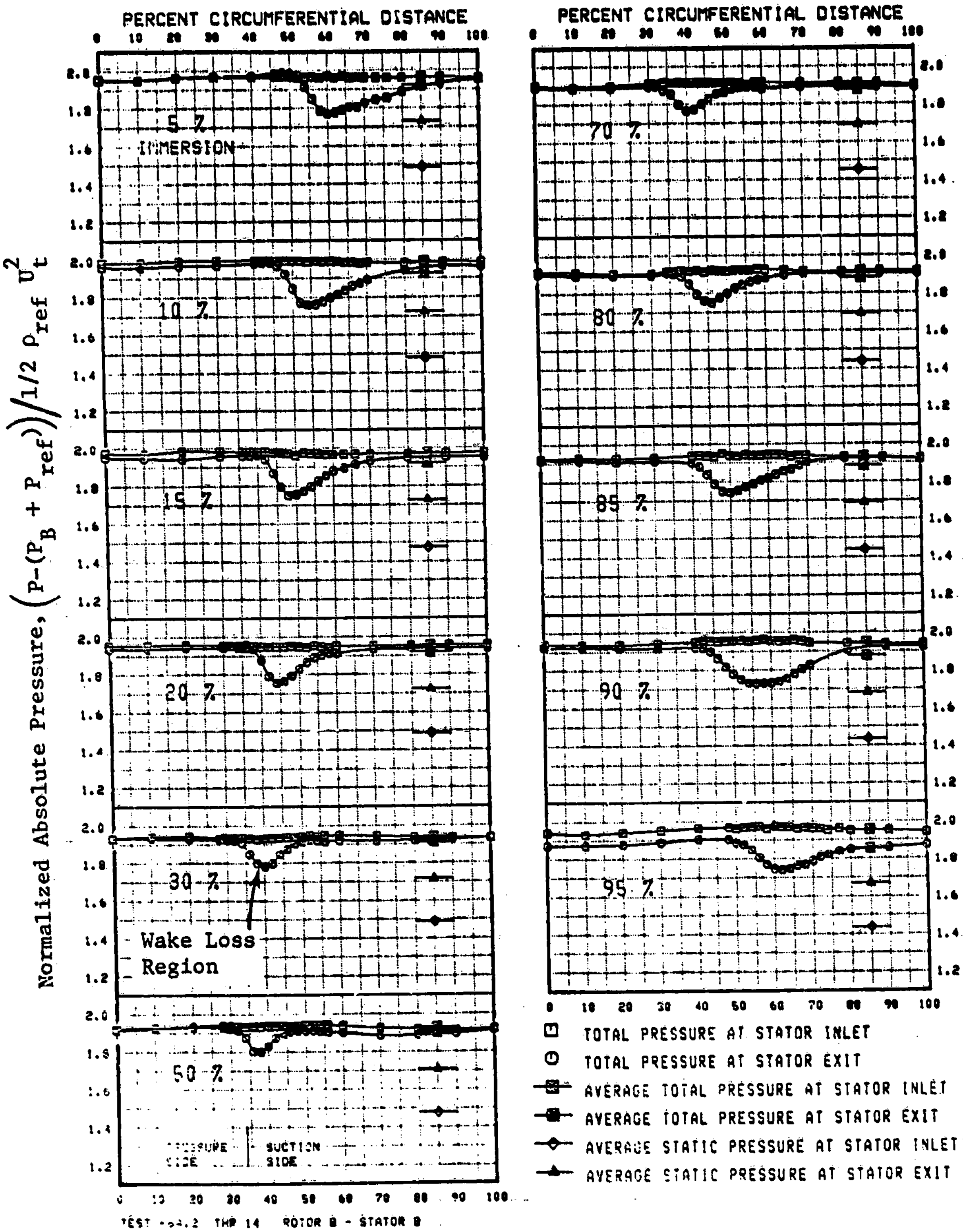
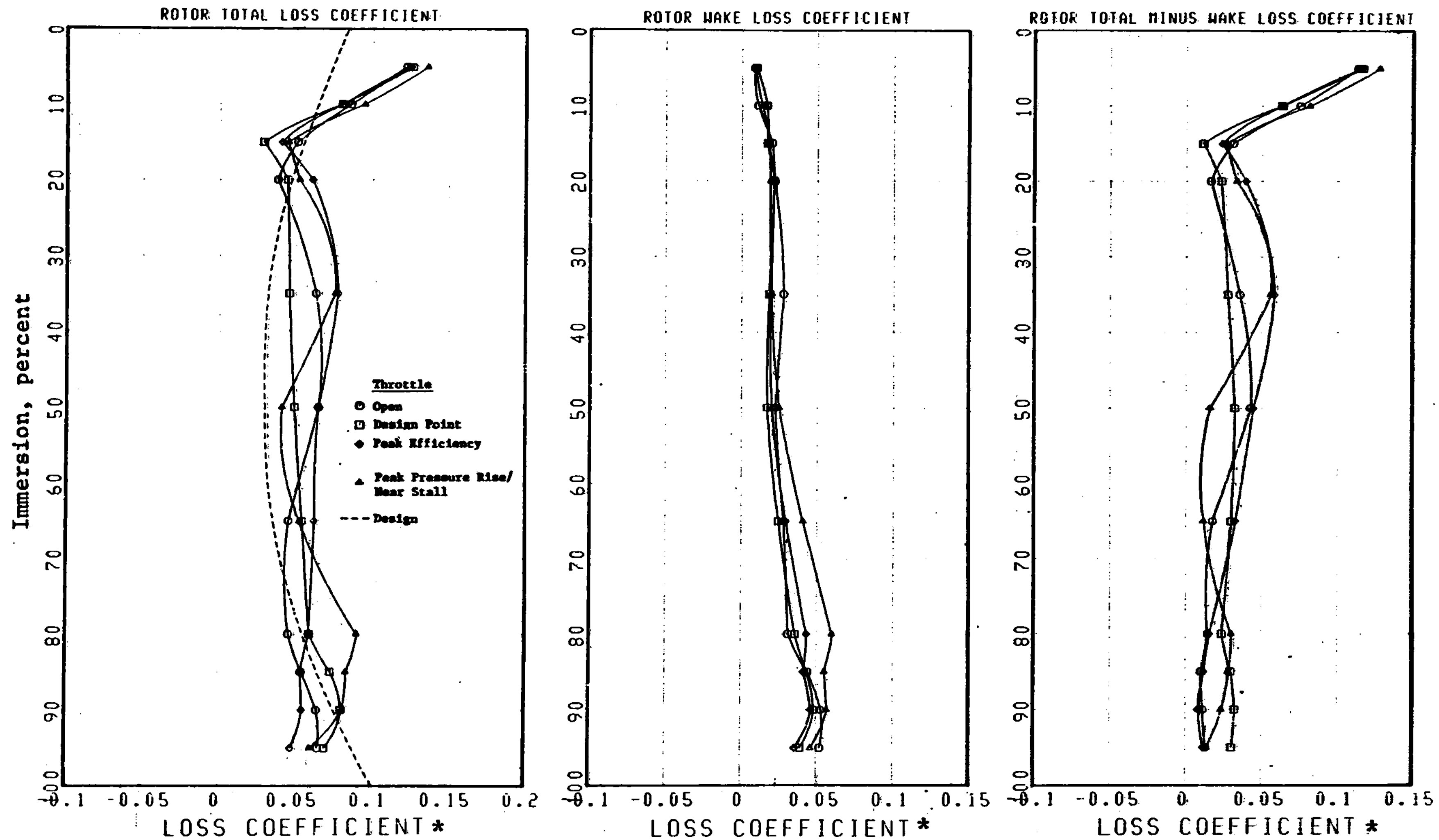


Figure 37. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Pressure Rise/Near Stall Throttle.



*Computed from Rotating Rake Data

Figure 38. Rotor Total Loss Coefficients, Wake Loss Coefficients, and Total Minus Wake Loss Coefficients for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

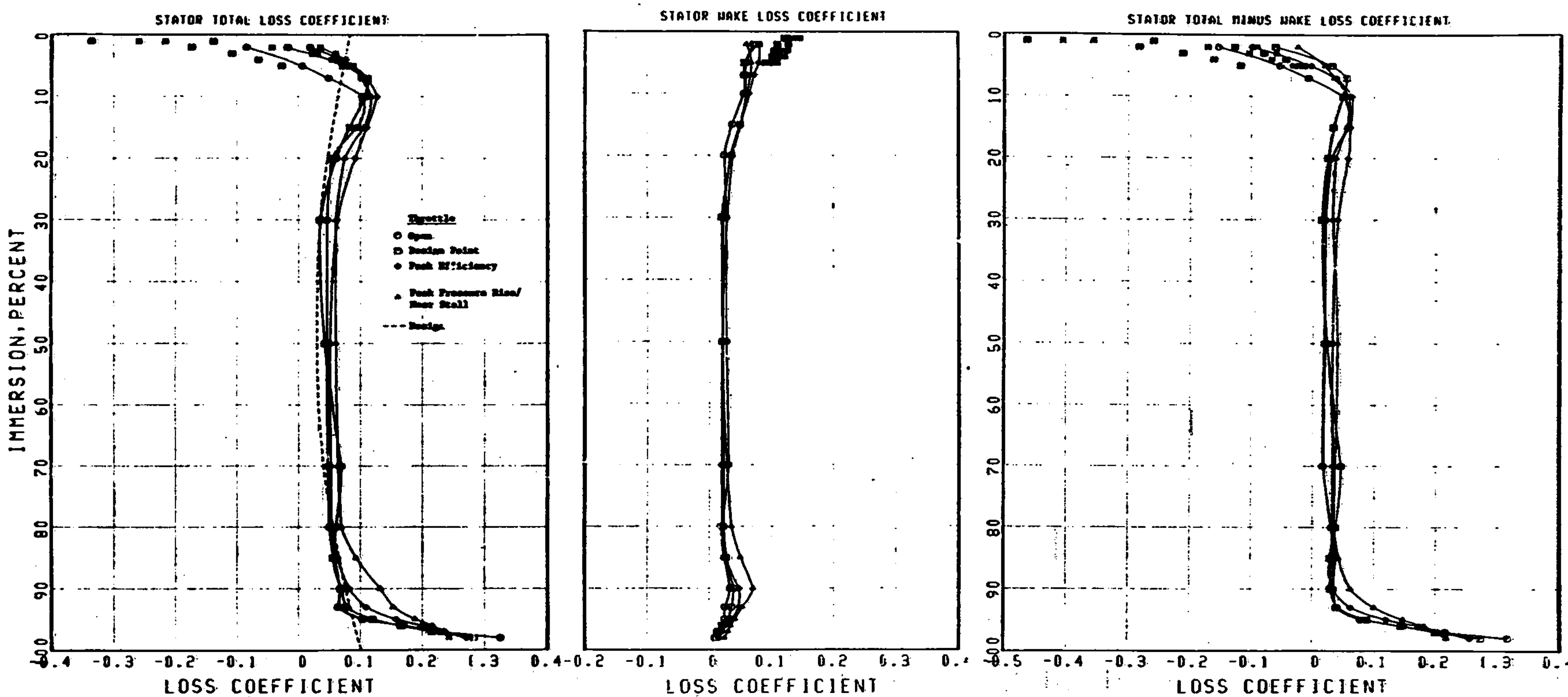


Figure 39. Stator Total Loss Coefficients, Wake Loss Coefficients, and Total Minus Wake Loss Coefficients for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

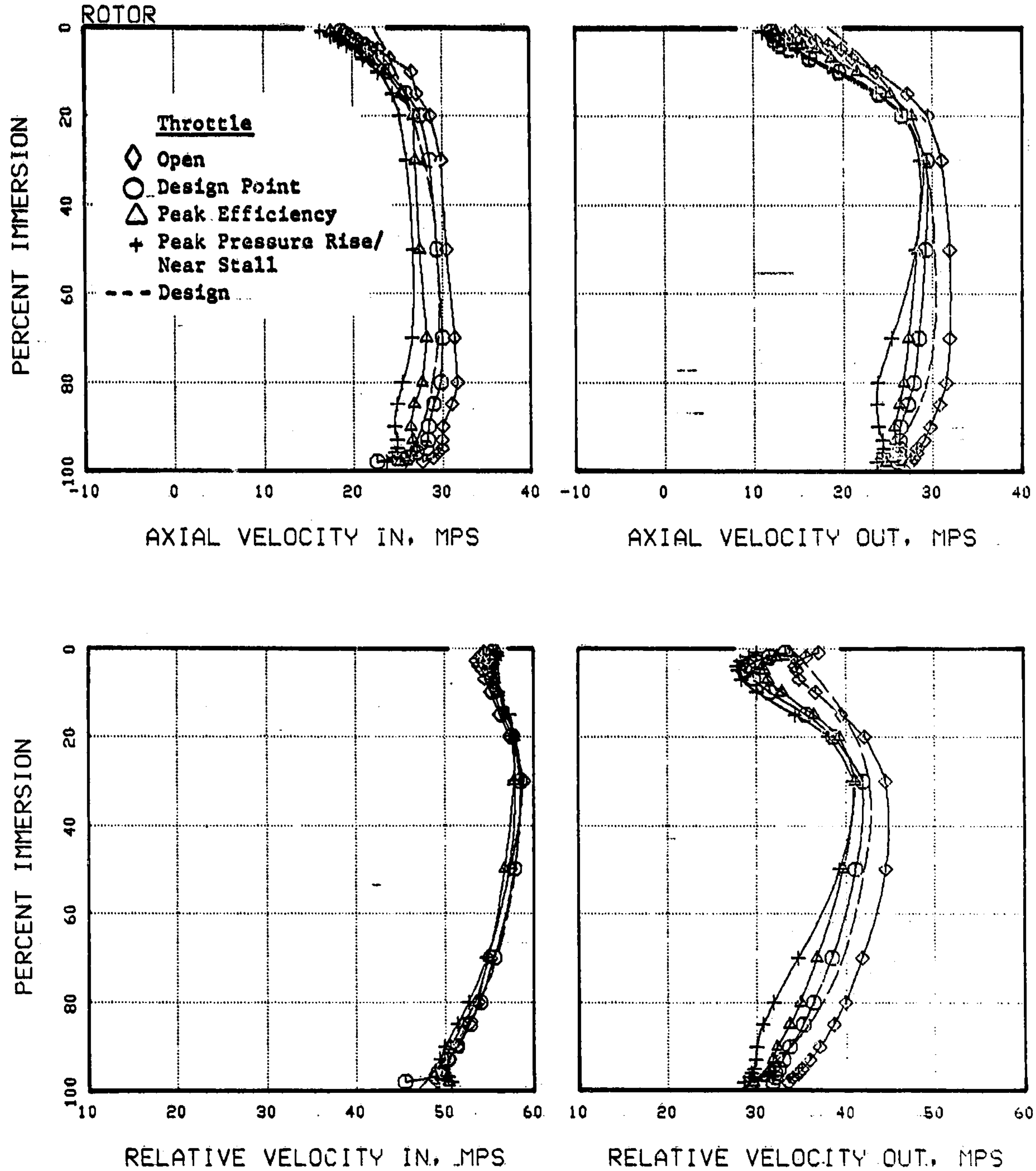


Figure 40. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

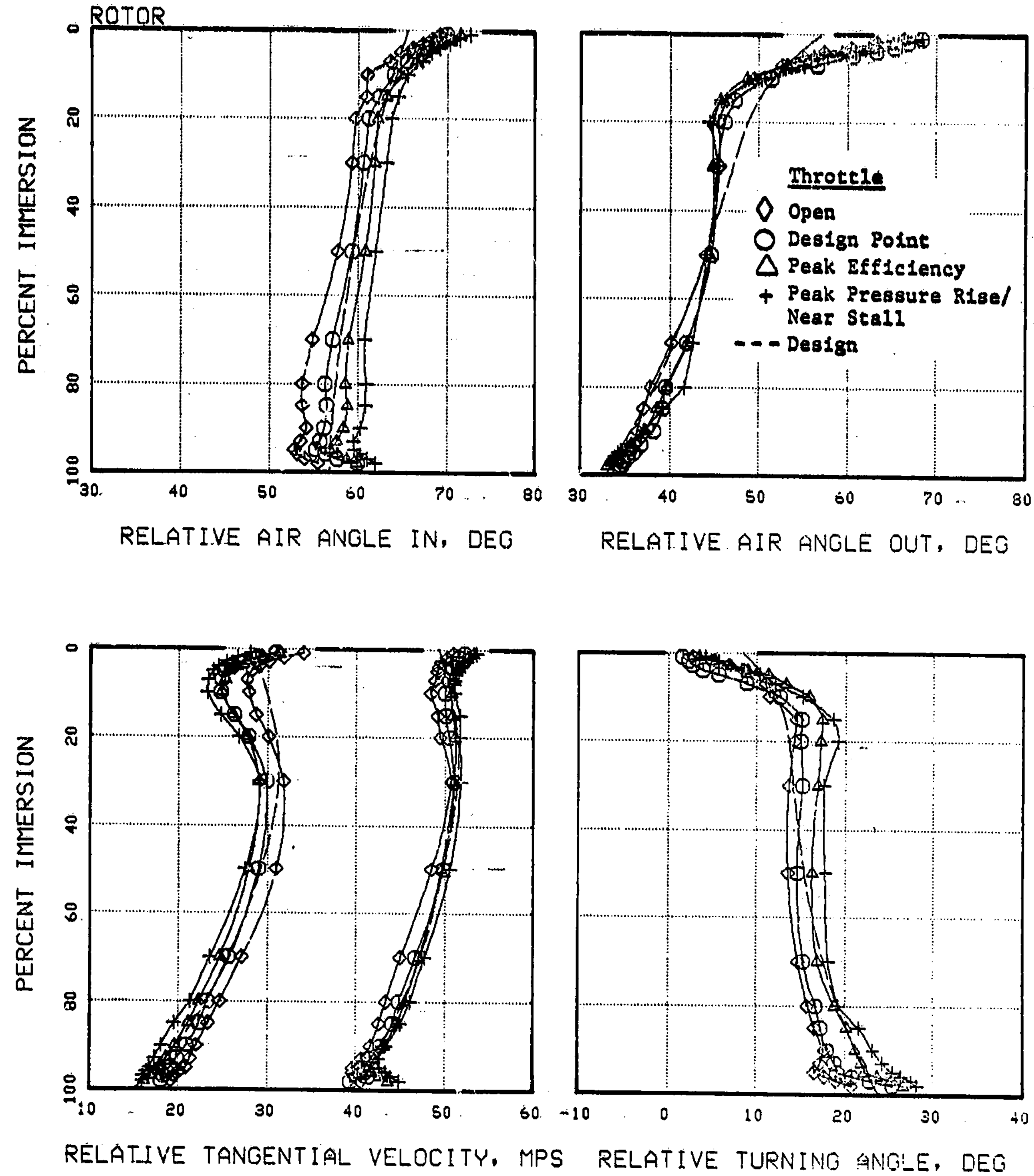
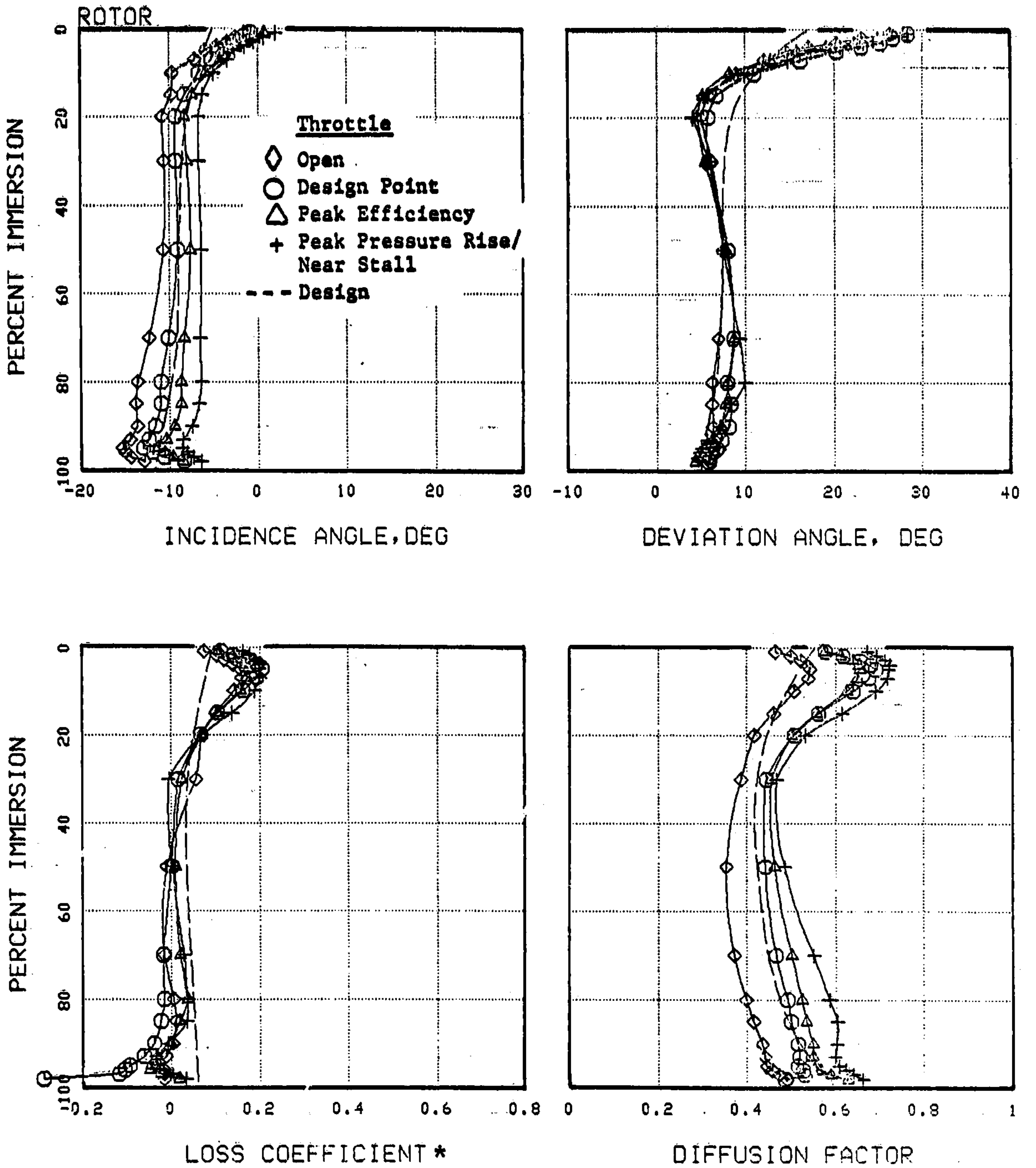


Figure 41. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.



*Computed from Stationary Rake Data

Figure 42. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

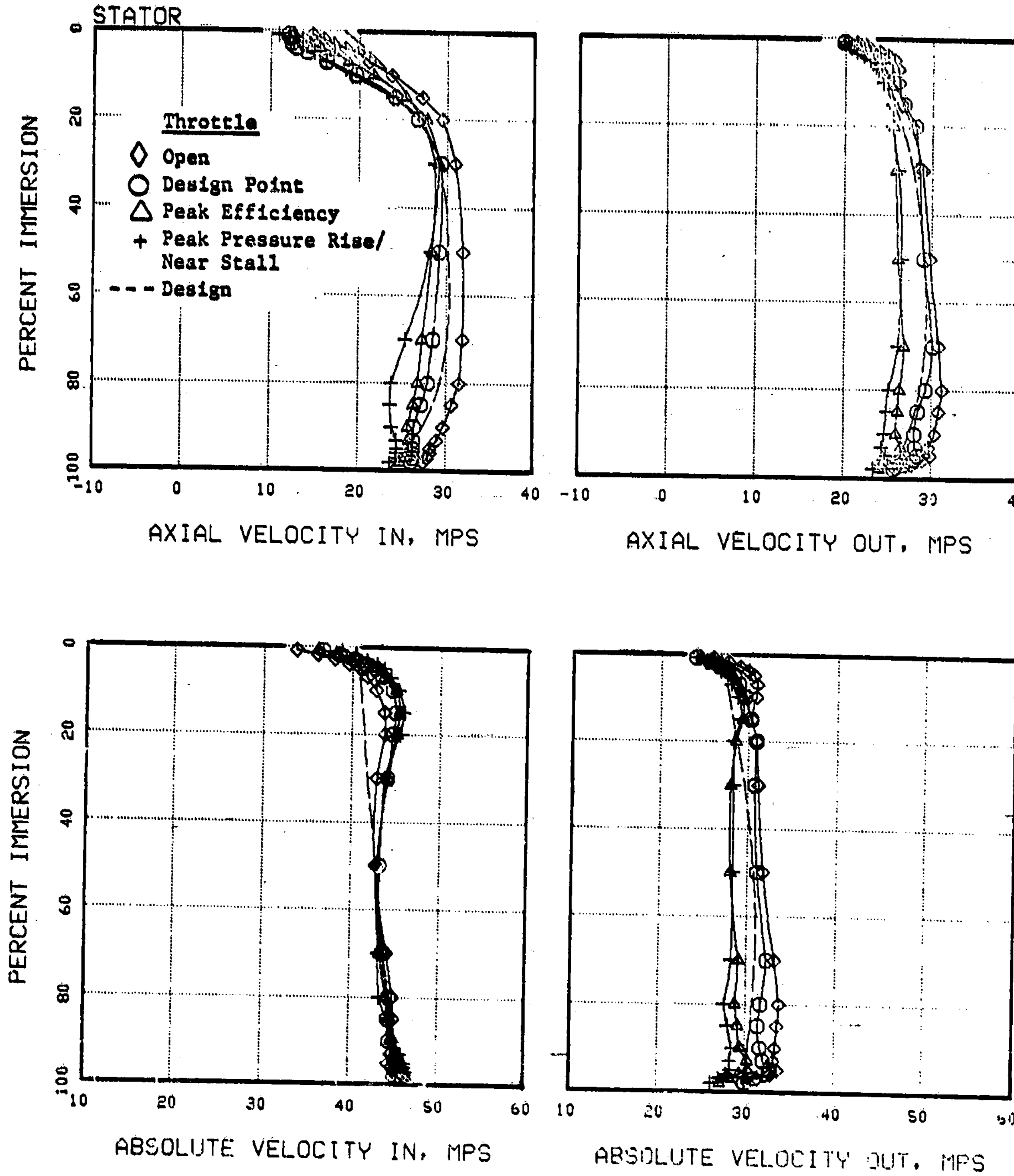


Figure 43. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

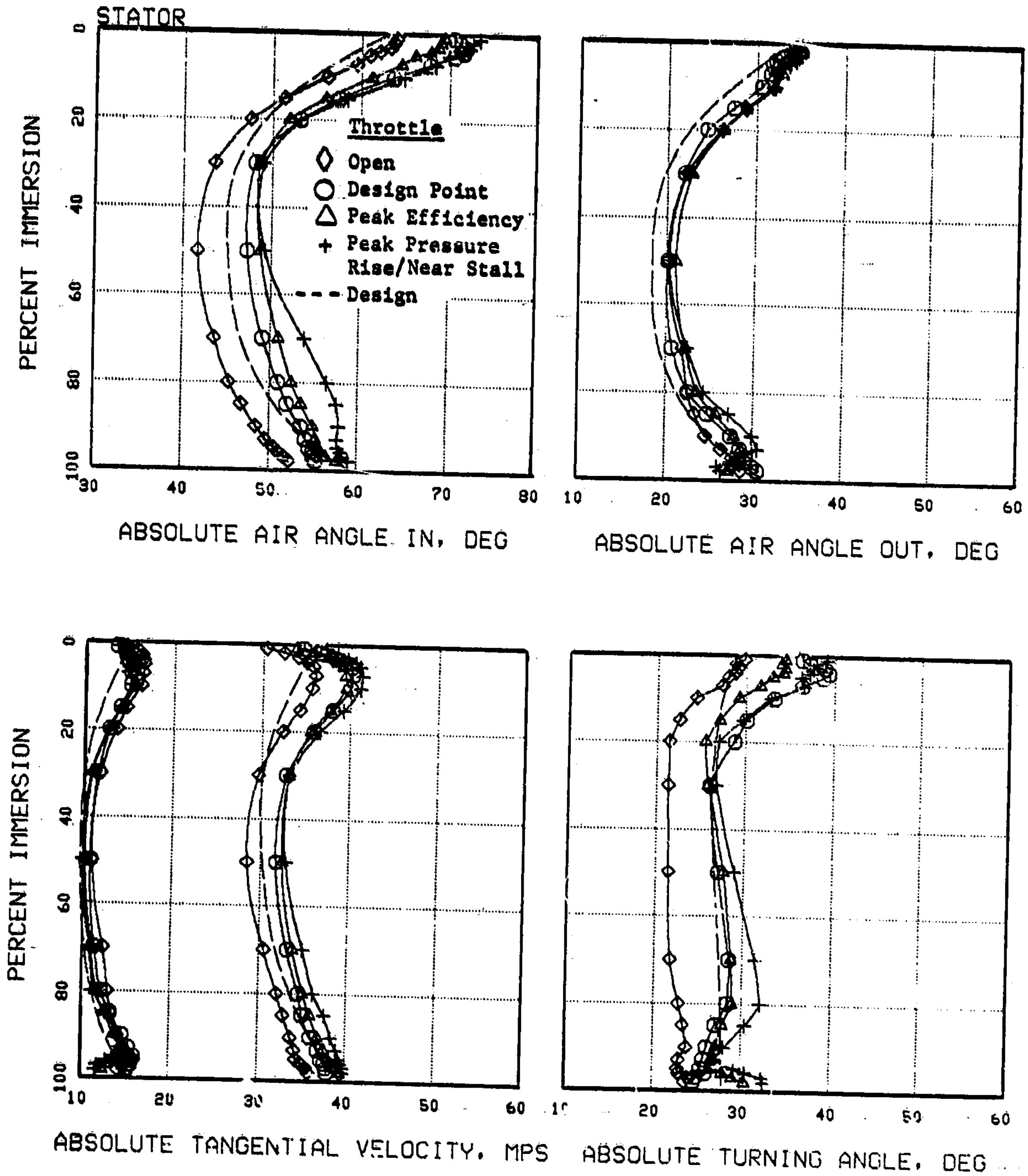


Figure 44. Stator Vector Diagram Quantities Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

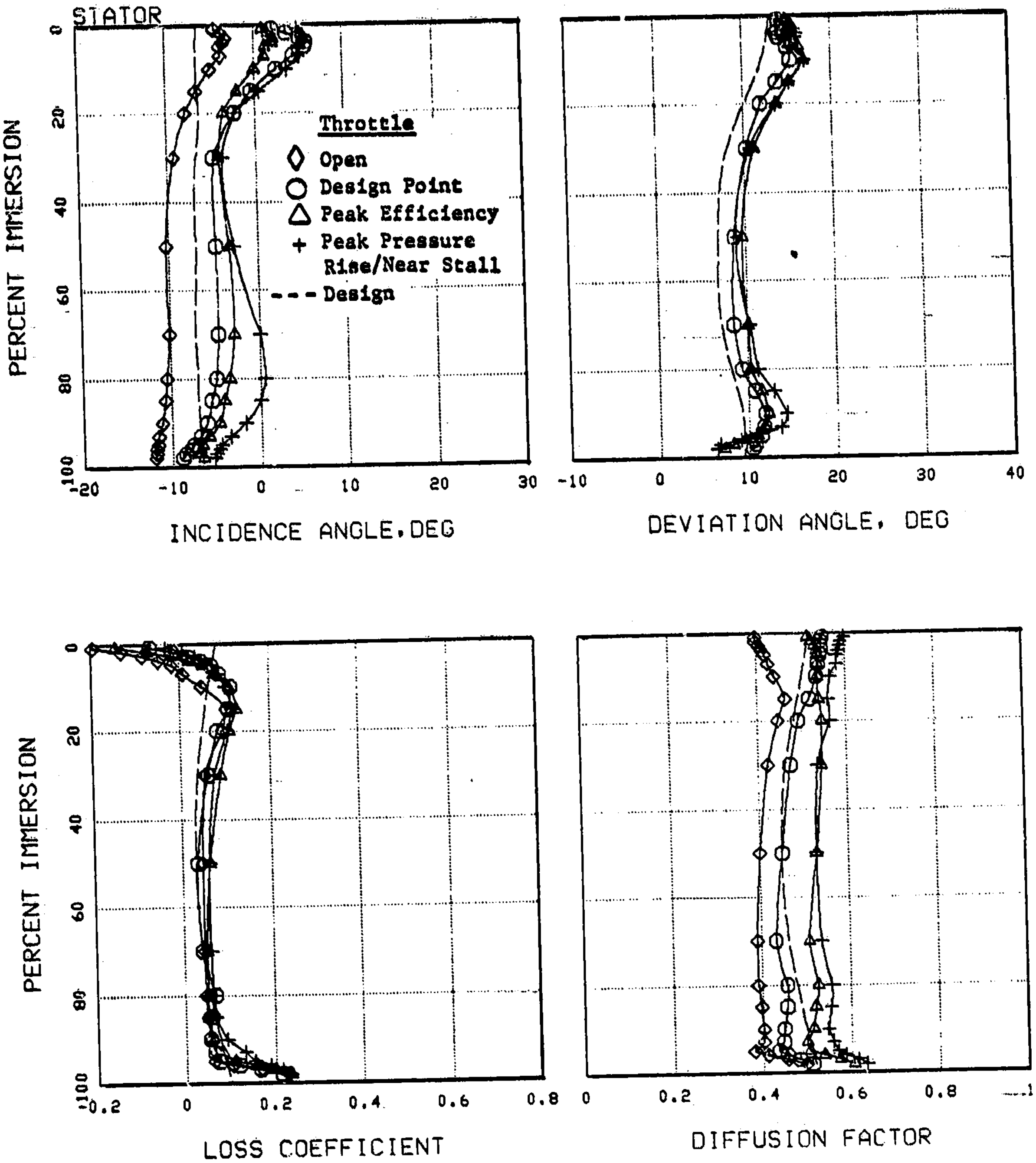


Figure 45. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

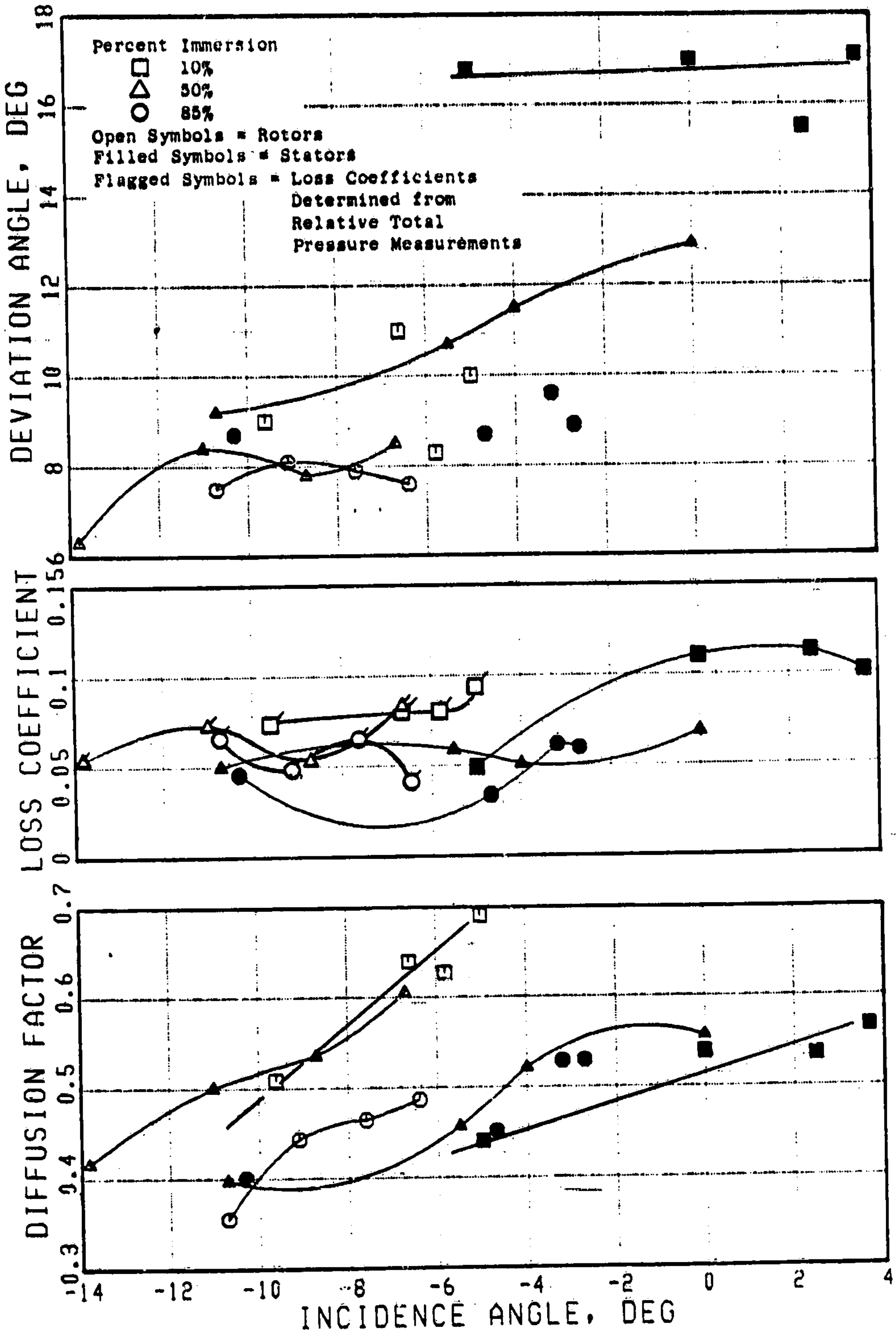


Figure 46. Diffusion Factor, Loss Coefficient and Deviation Angle Versus Incidence Angle, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

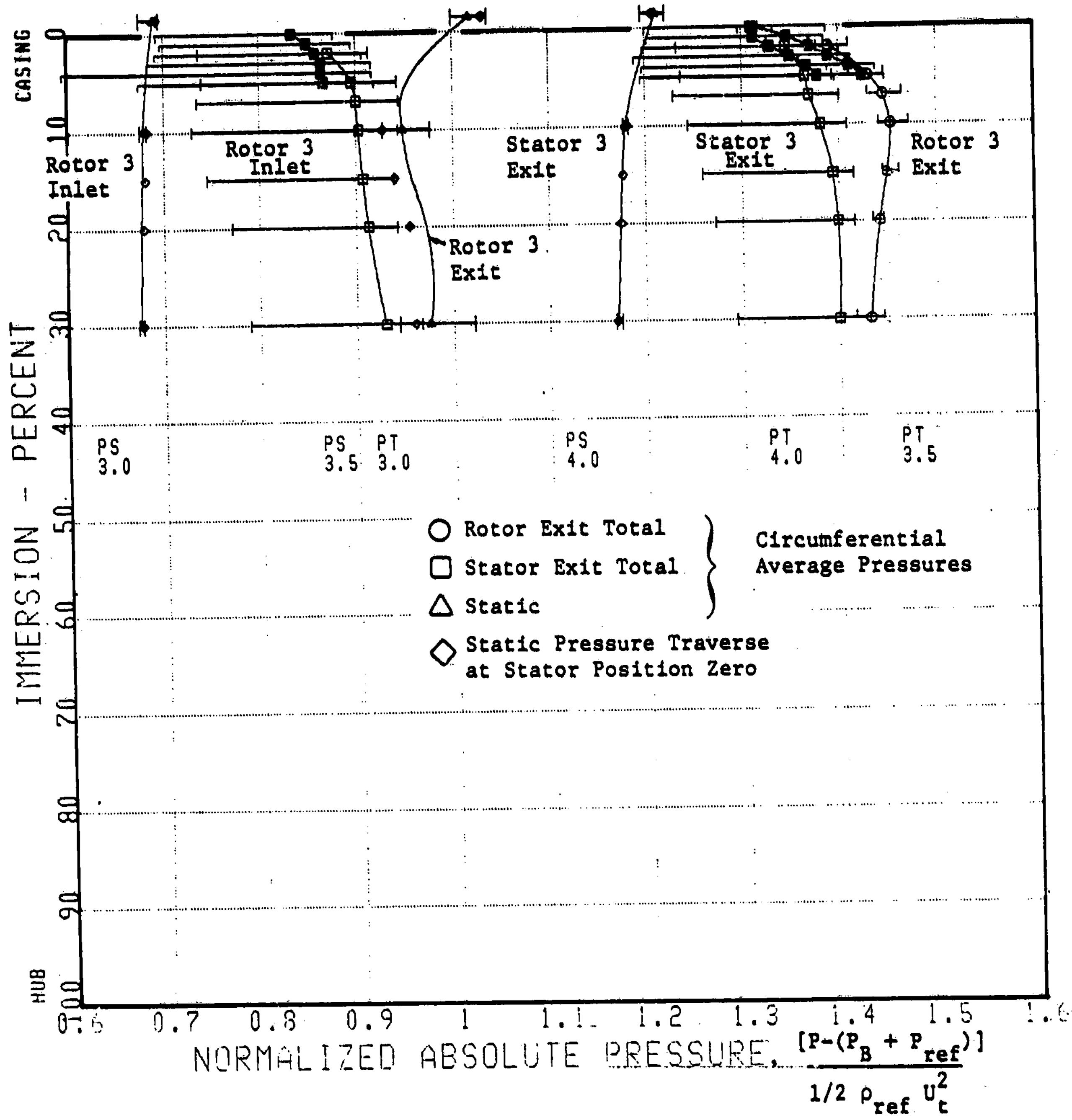


Figure 47. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Open Throttle.

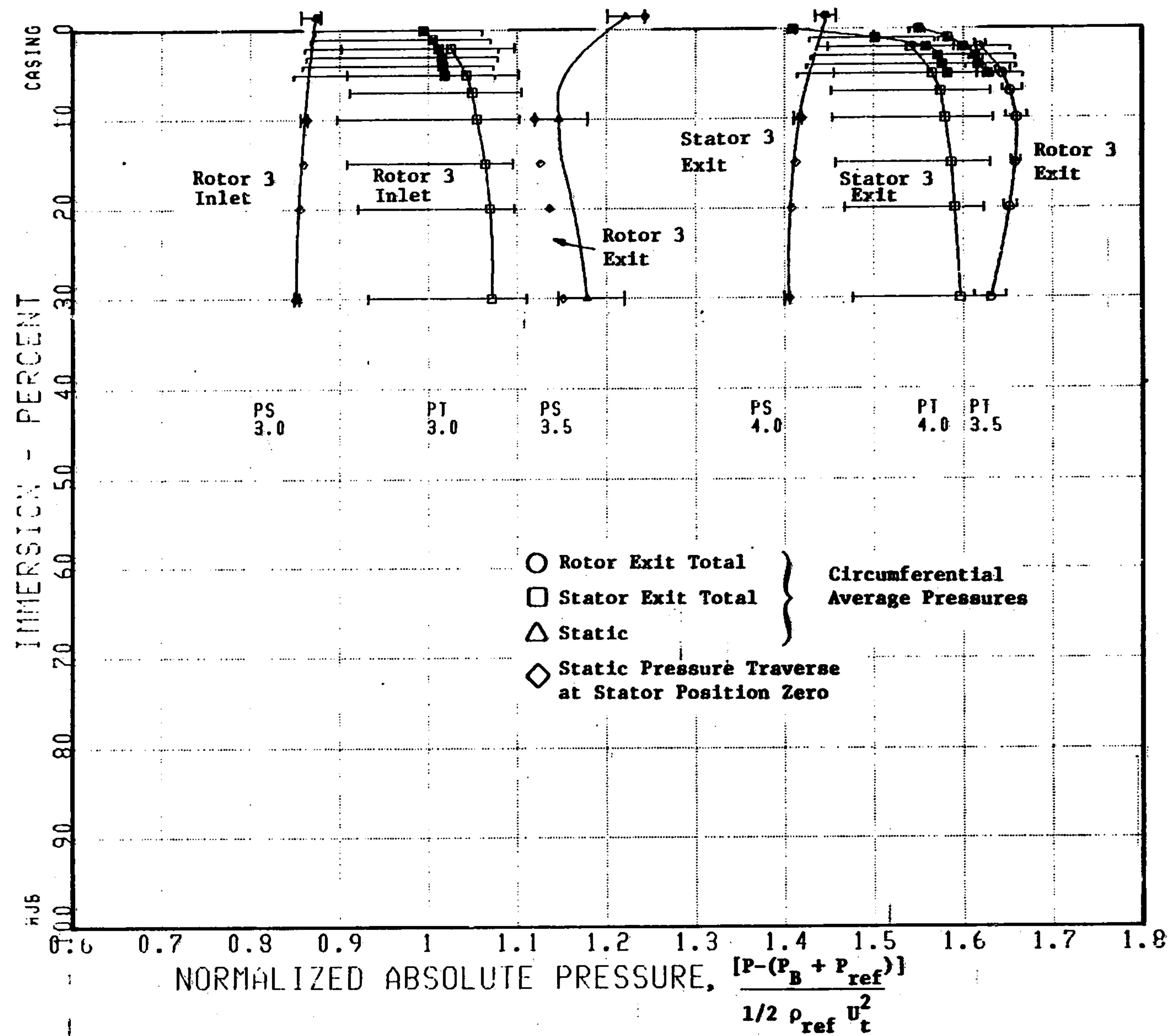


Figure 48. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Design Point Throttle.

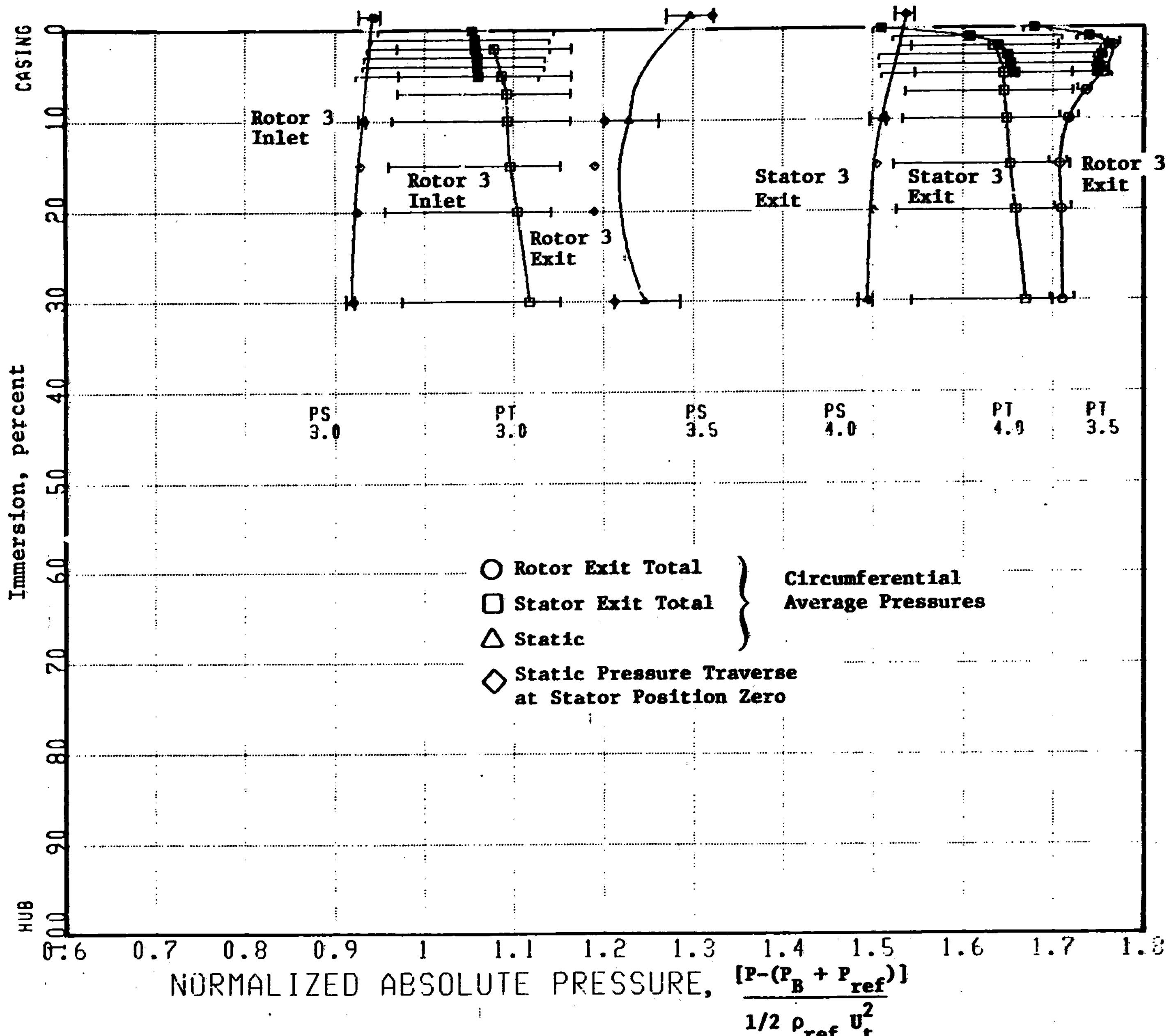


Figure 49. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Peak Pressure Rise/Near Stall Throttle.

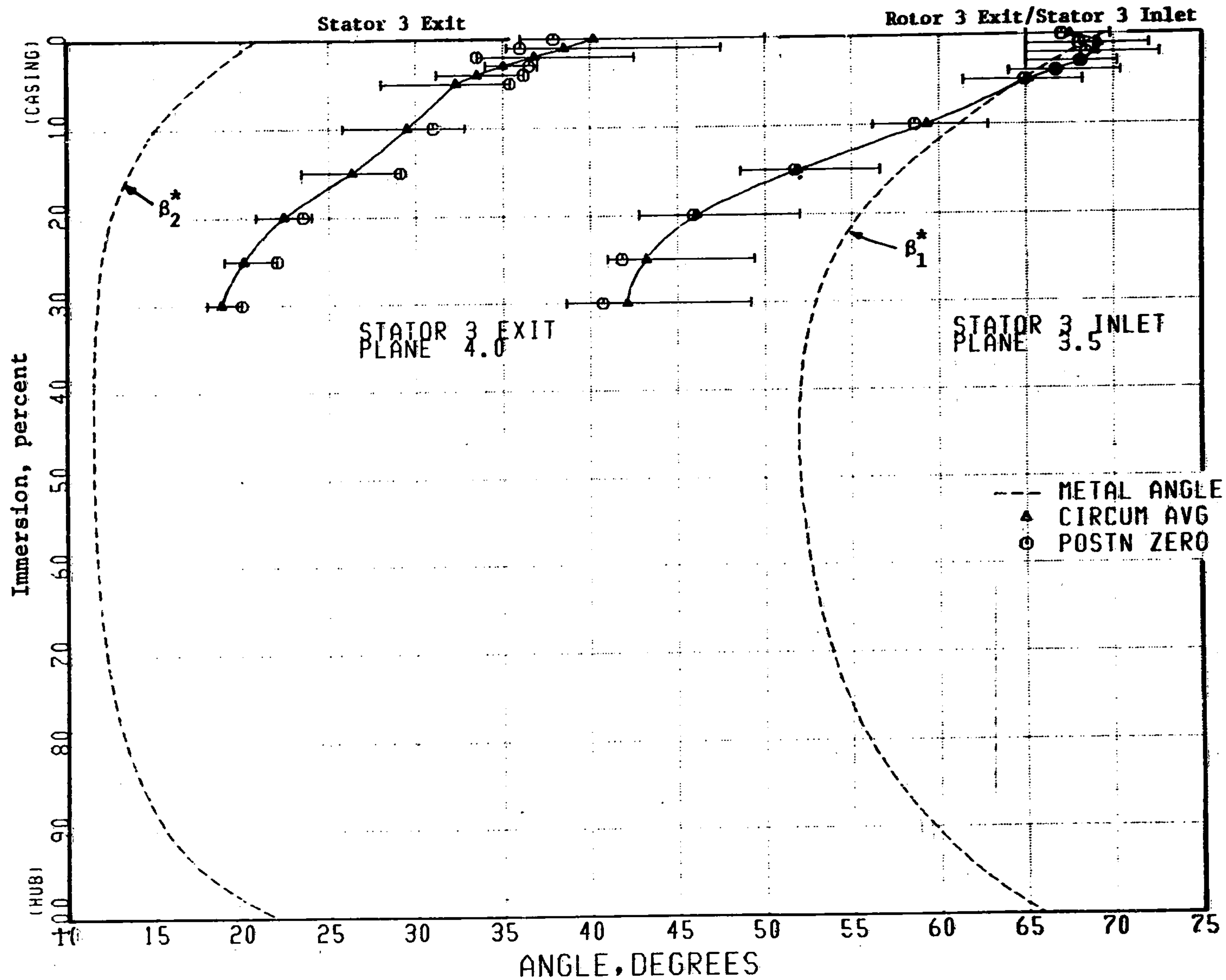


Figure 50. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Open Throttle.

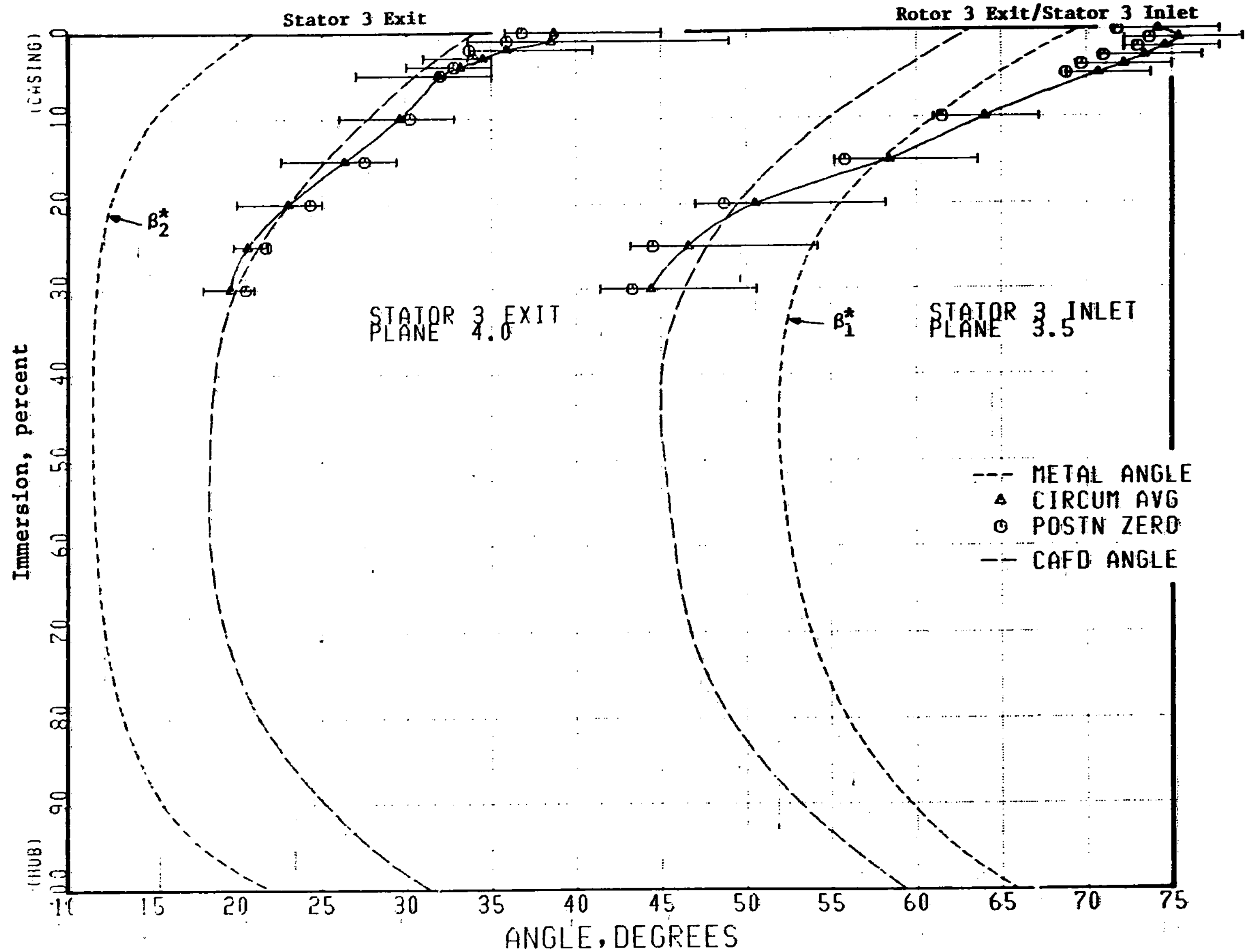


Figure 51. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Design Point Throttle.

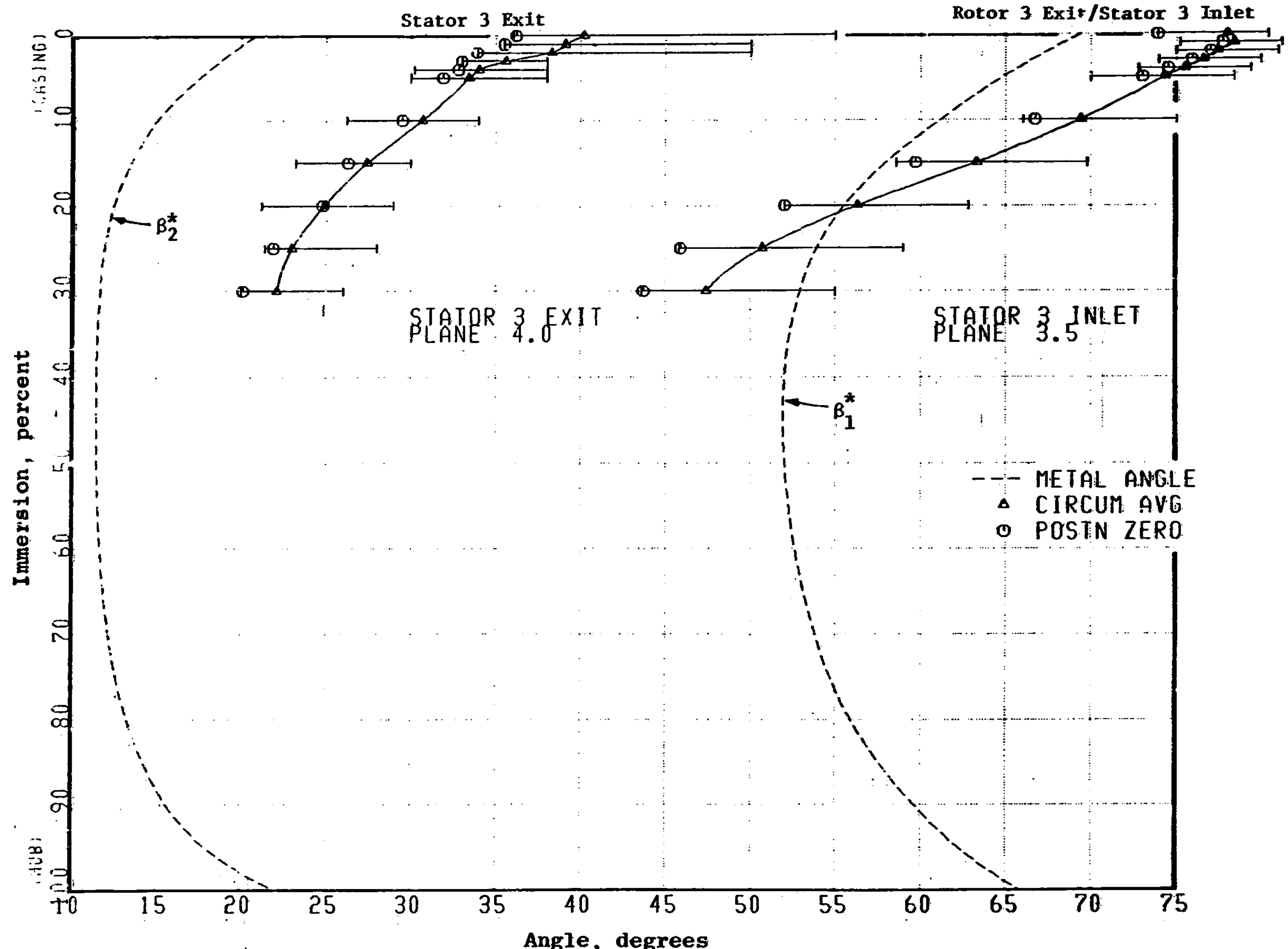


Figure 52. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Peak Pressure Rise/Near Stall Throttle.

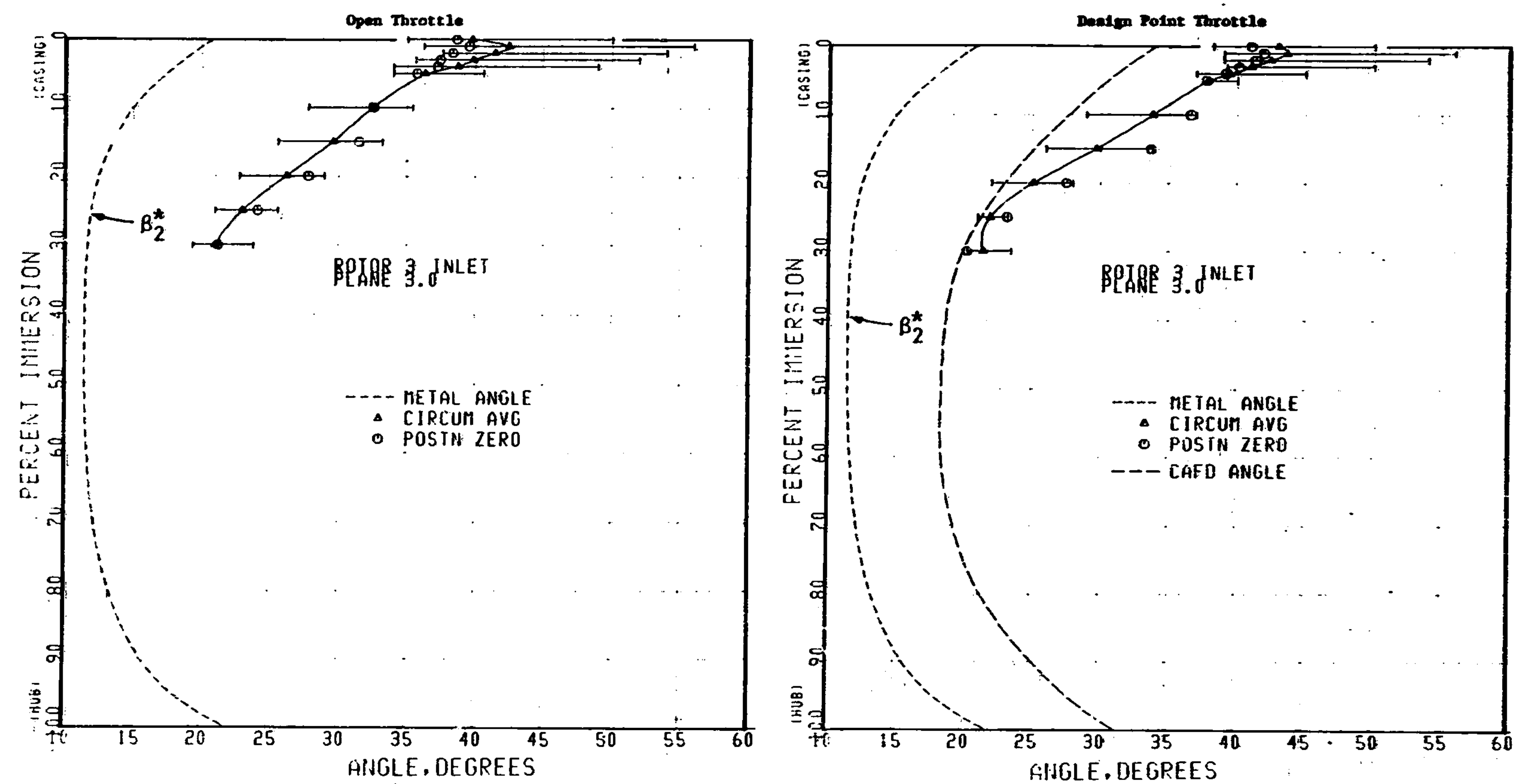


Figure 53. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

Peak Pressure Rise/Near Stall Throttle

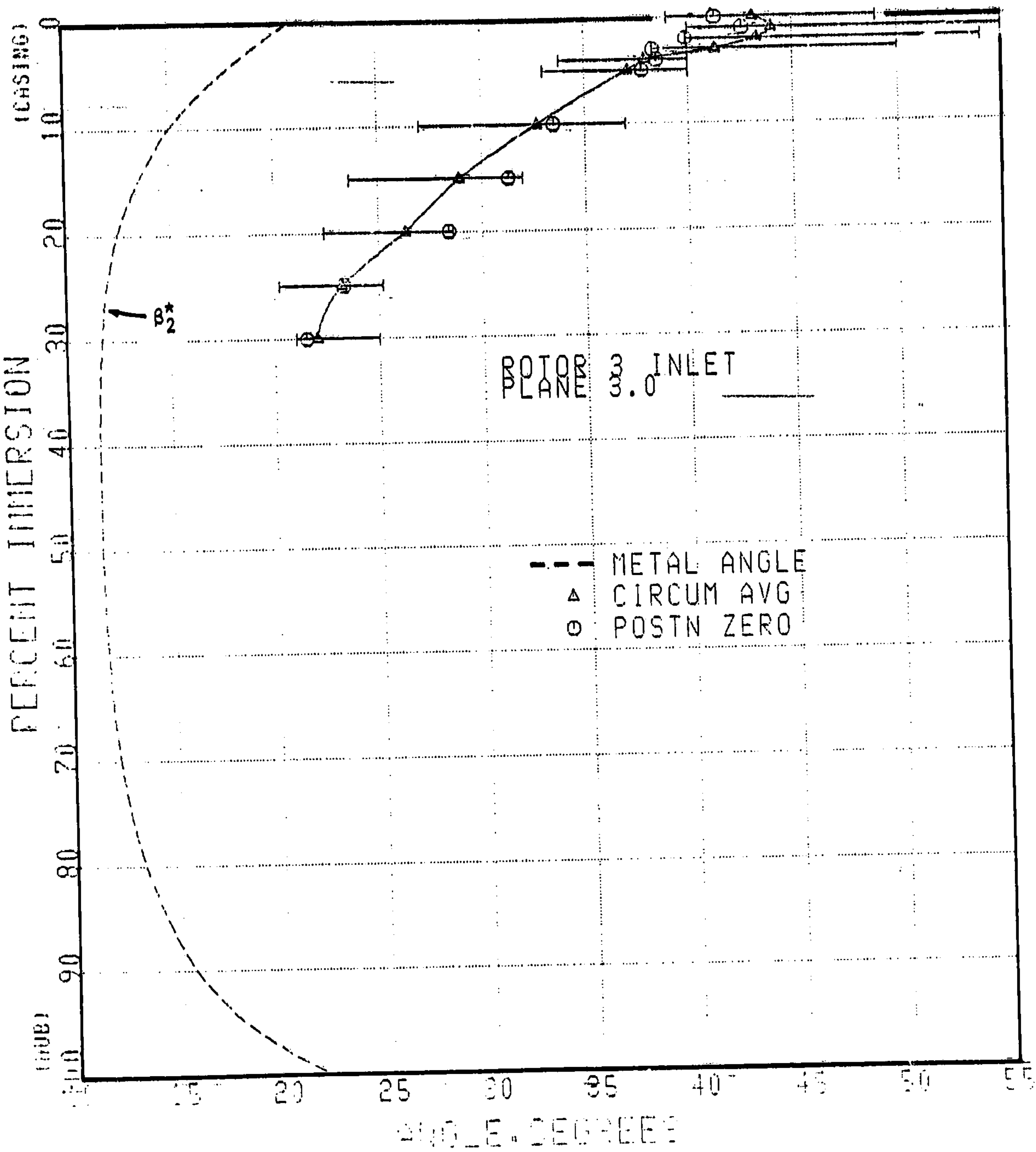


Figure 54. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

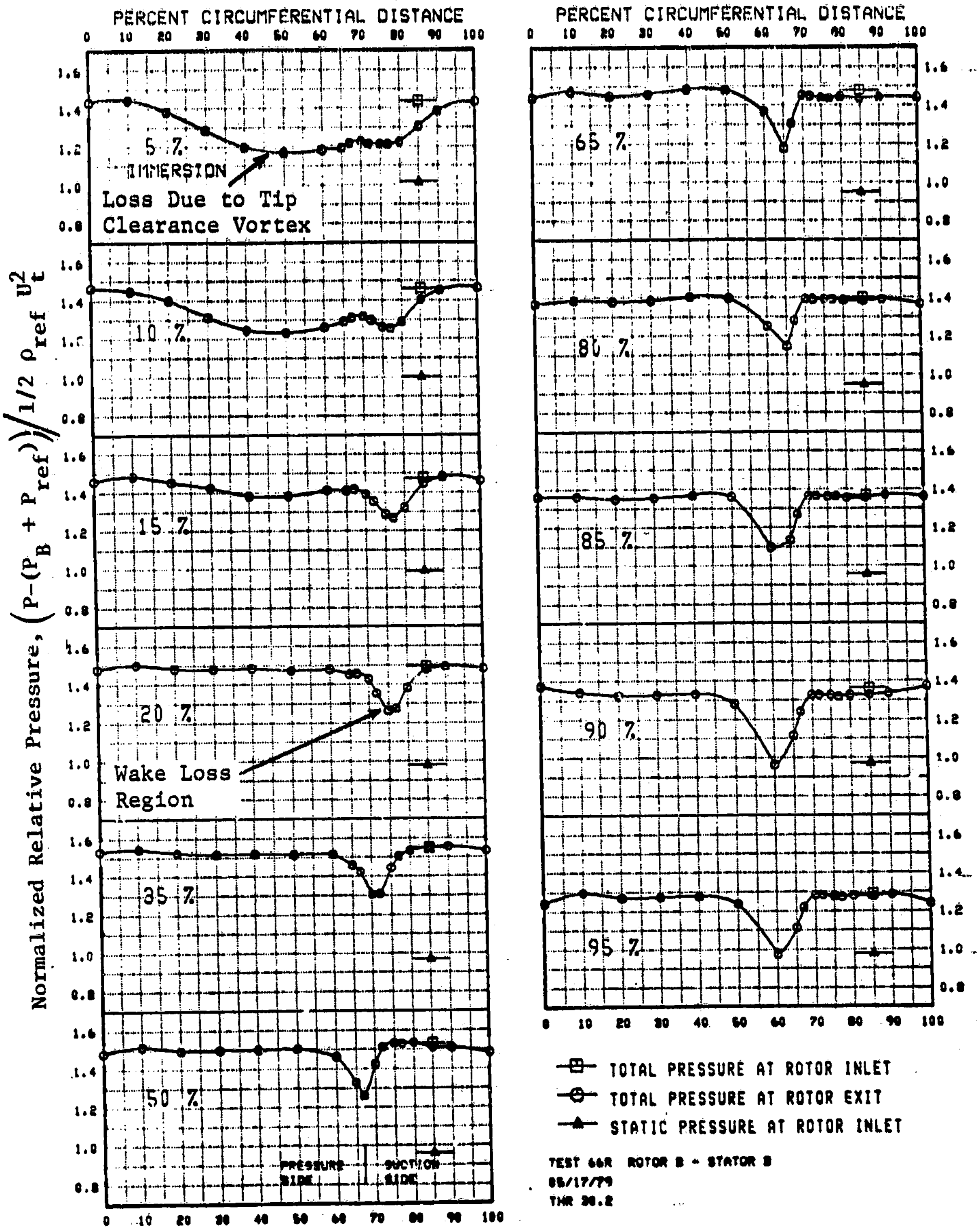


Figure 55. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Open Throttle.

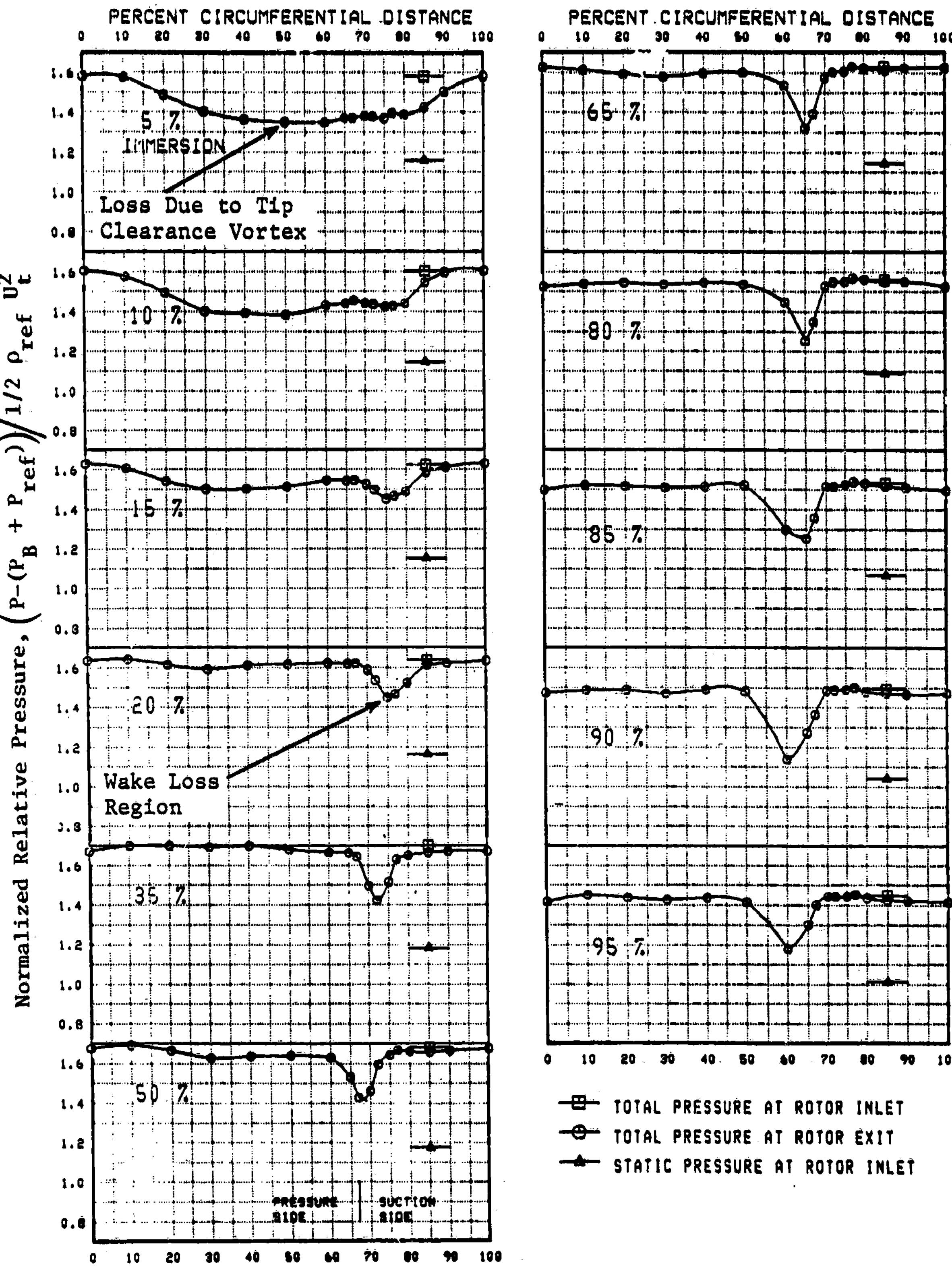


Figure 56. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Tip Clearance, Design Point Throttle.

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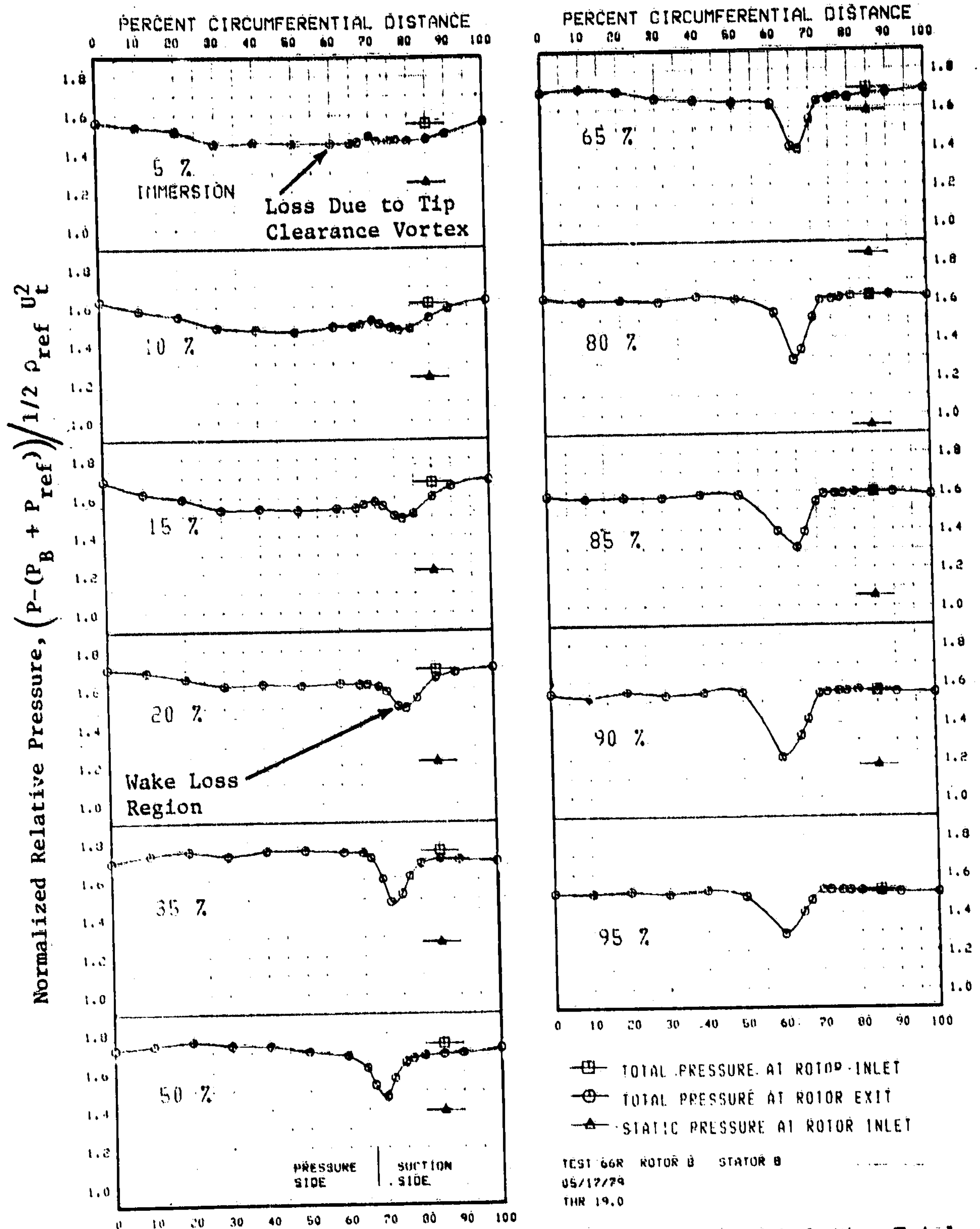


Figure 57. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Peak Pressure Rise/Near Stall Throttle.

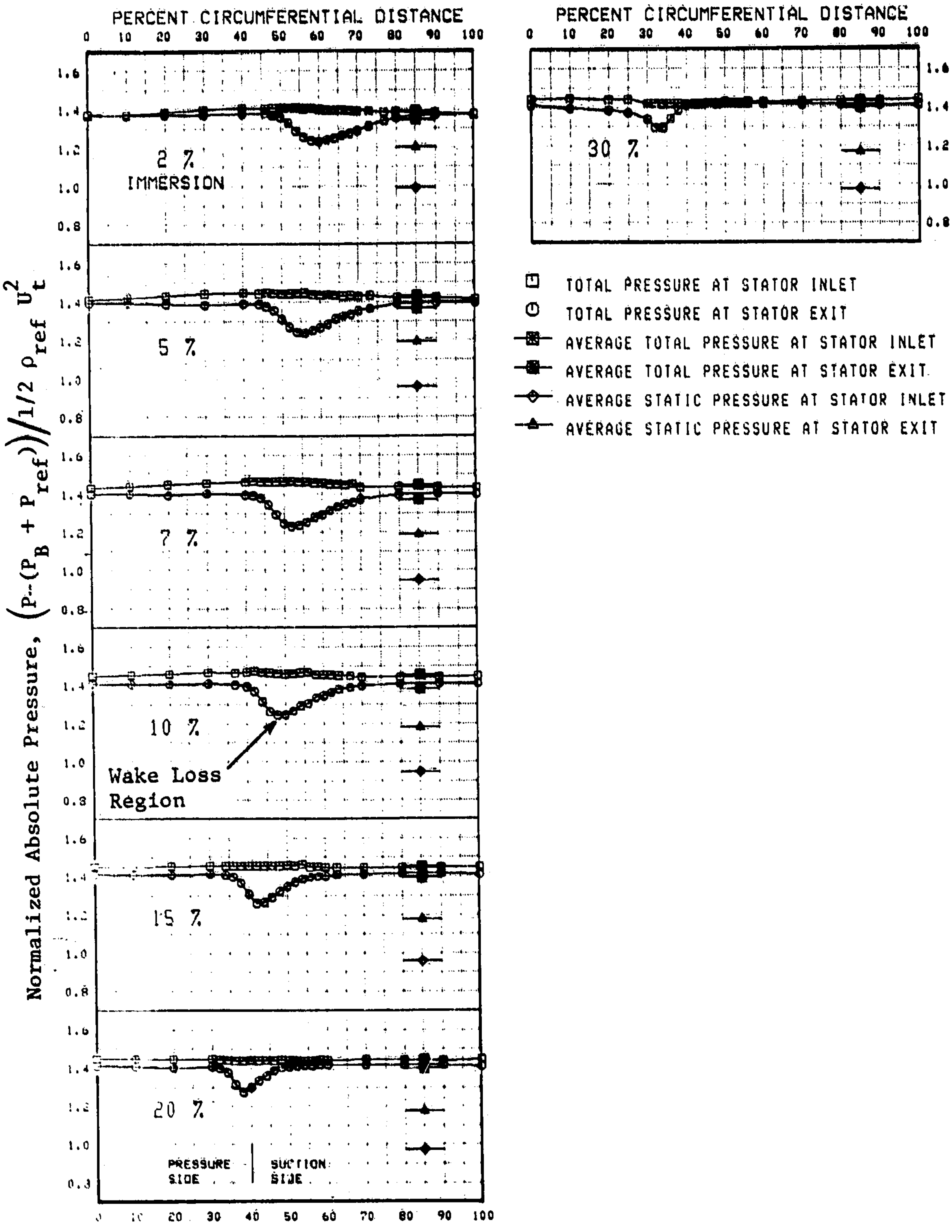


Figure 58. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Open Throttle.

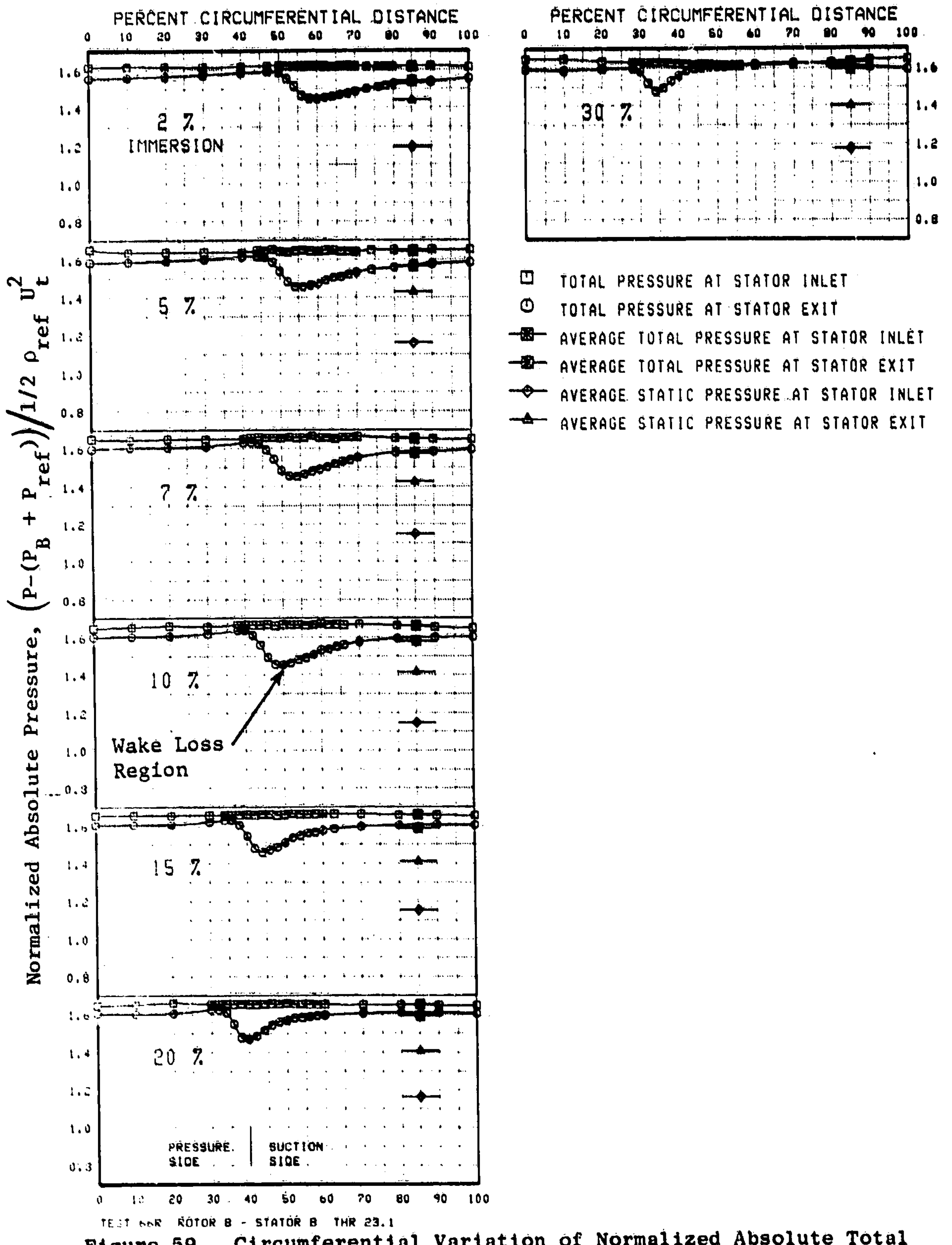


Figure 59. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Design Point Throttle.

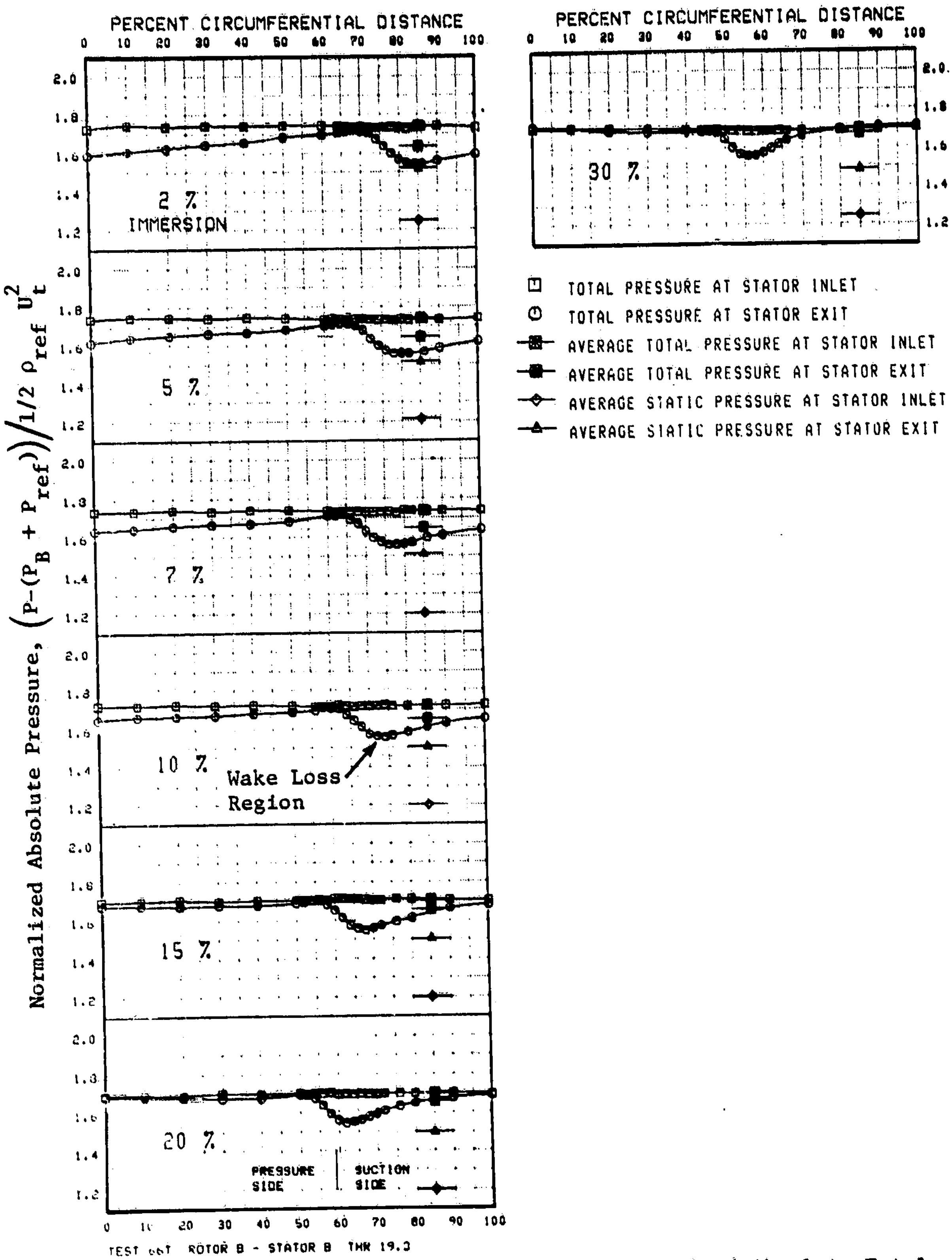
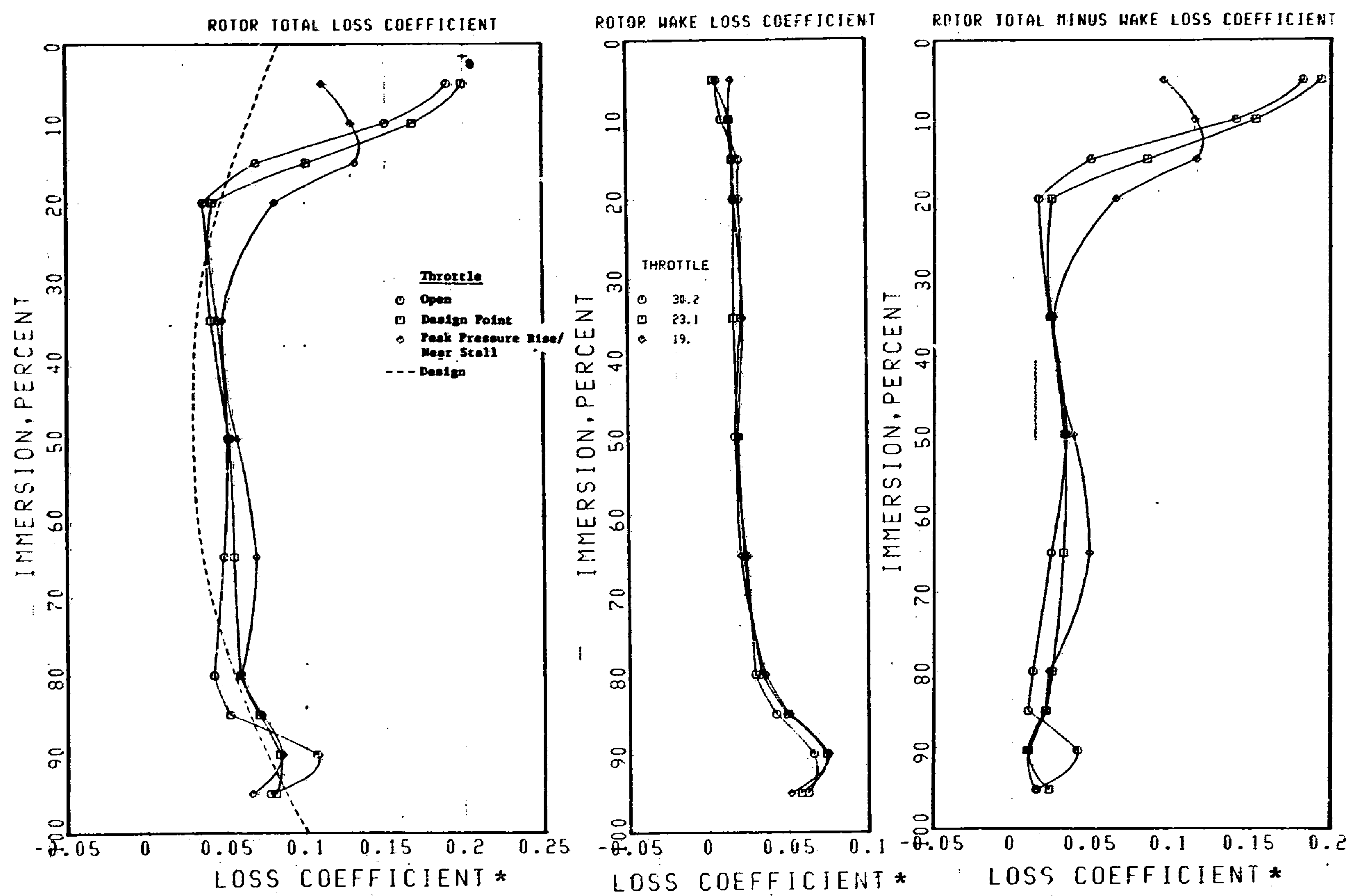


Figure 60. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Peak Pressure Rise/Near Stall Throttle.



*Computed from Rotating Rake Data

Figure 61. Rotor Total Loss Coefficients, Wake Loss Coefficients, and Total Minus Wake Loss Coefficients for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

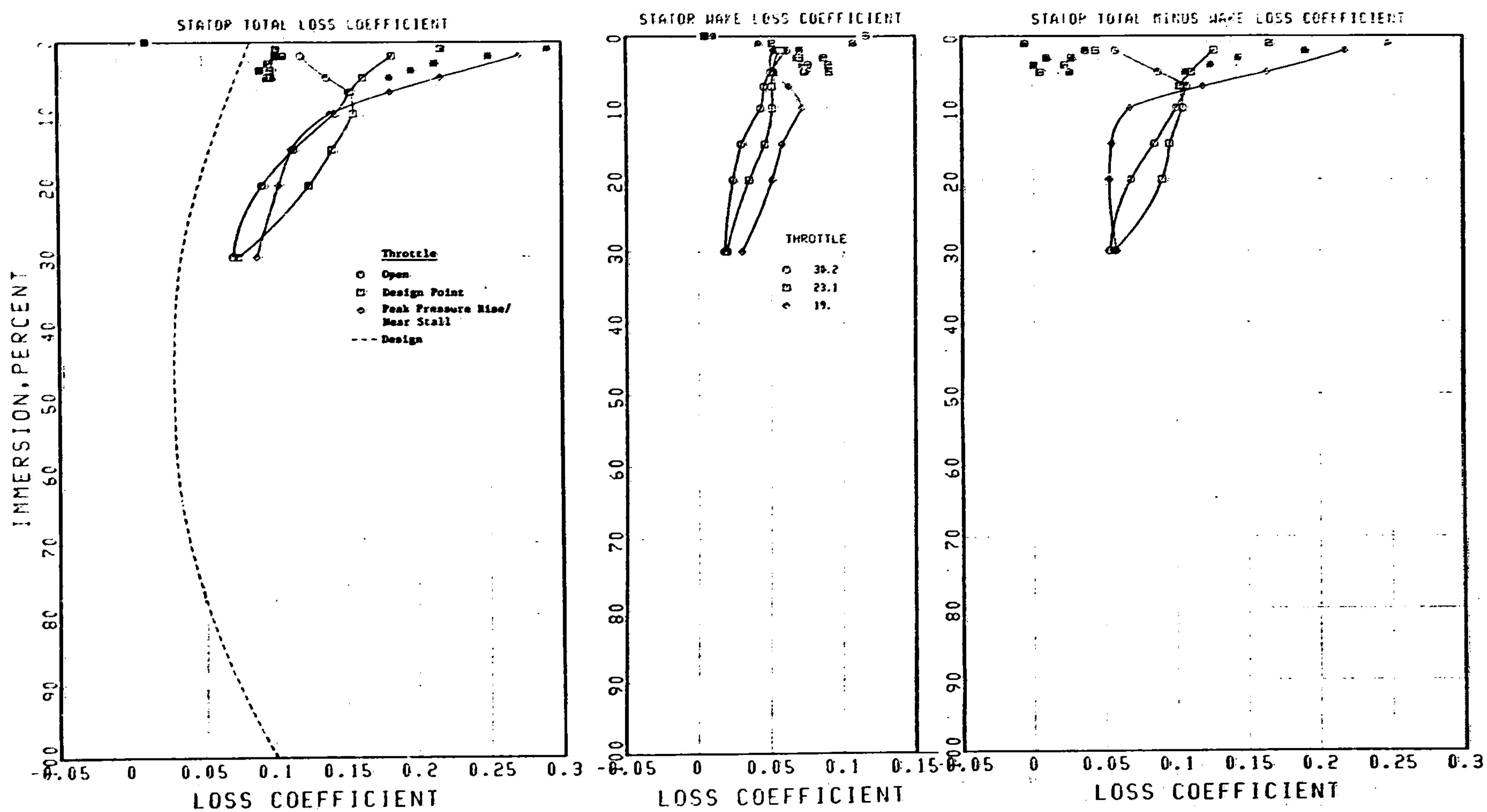


Figure 62. Stator Total Loss Coefficients, Wake Loss Coefficients and Total Minus Wake Loss Coefficients for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

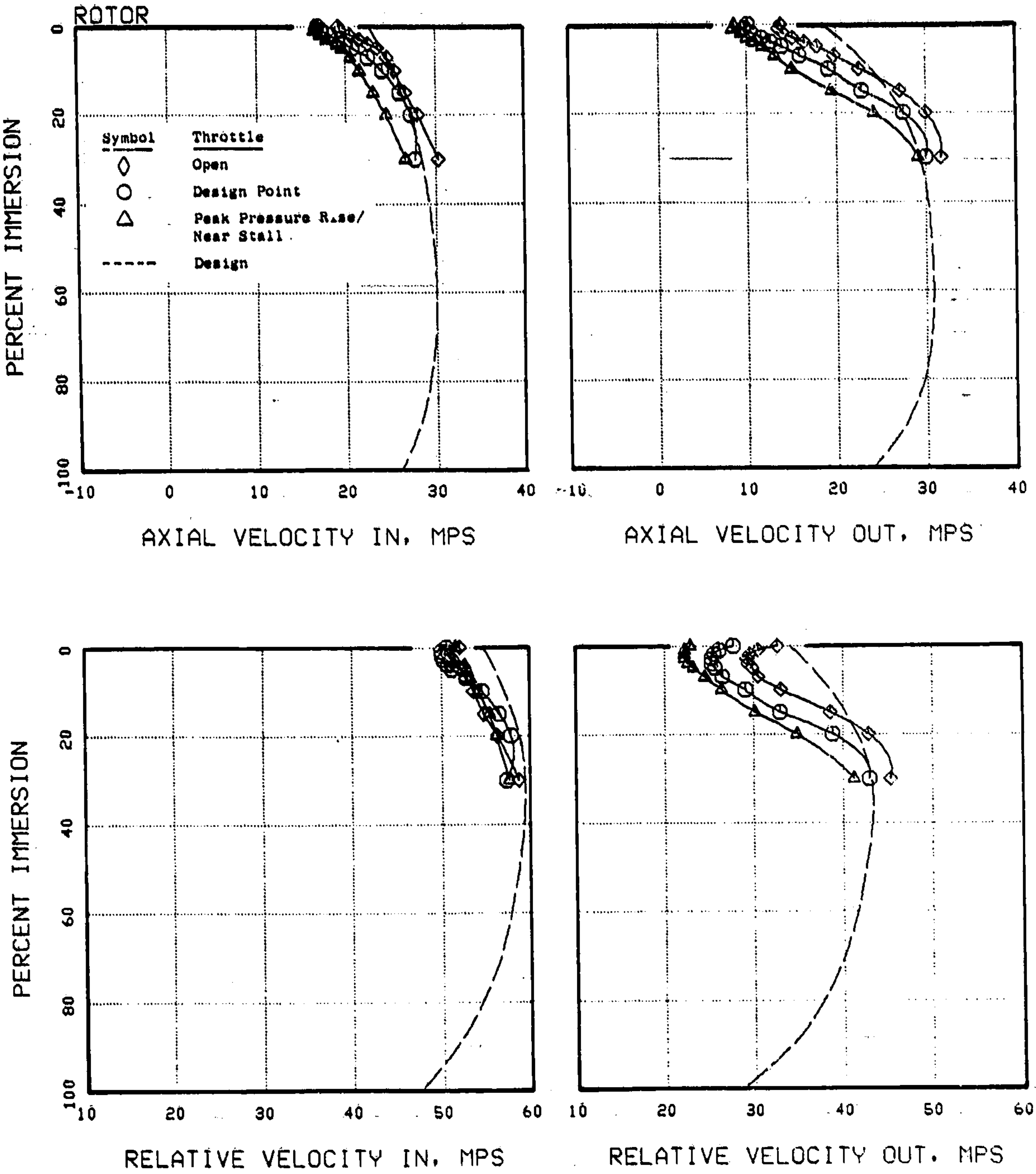


Figure 63. **Rotor Vector Diagram Quantities Versus Percent Immersion Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.**

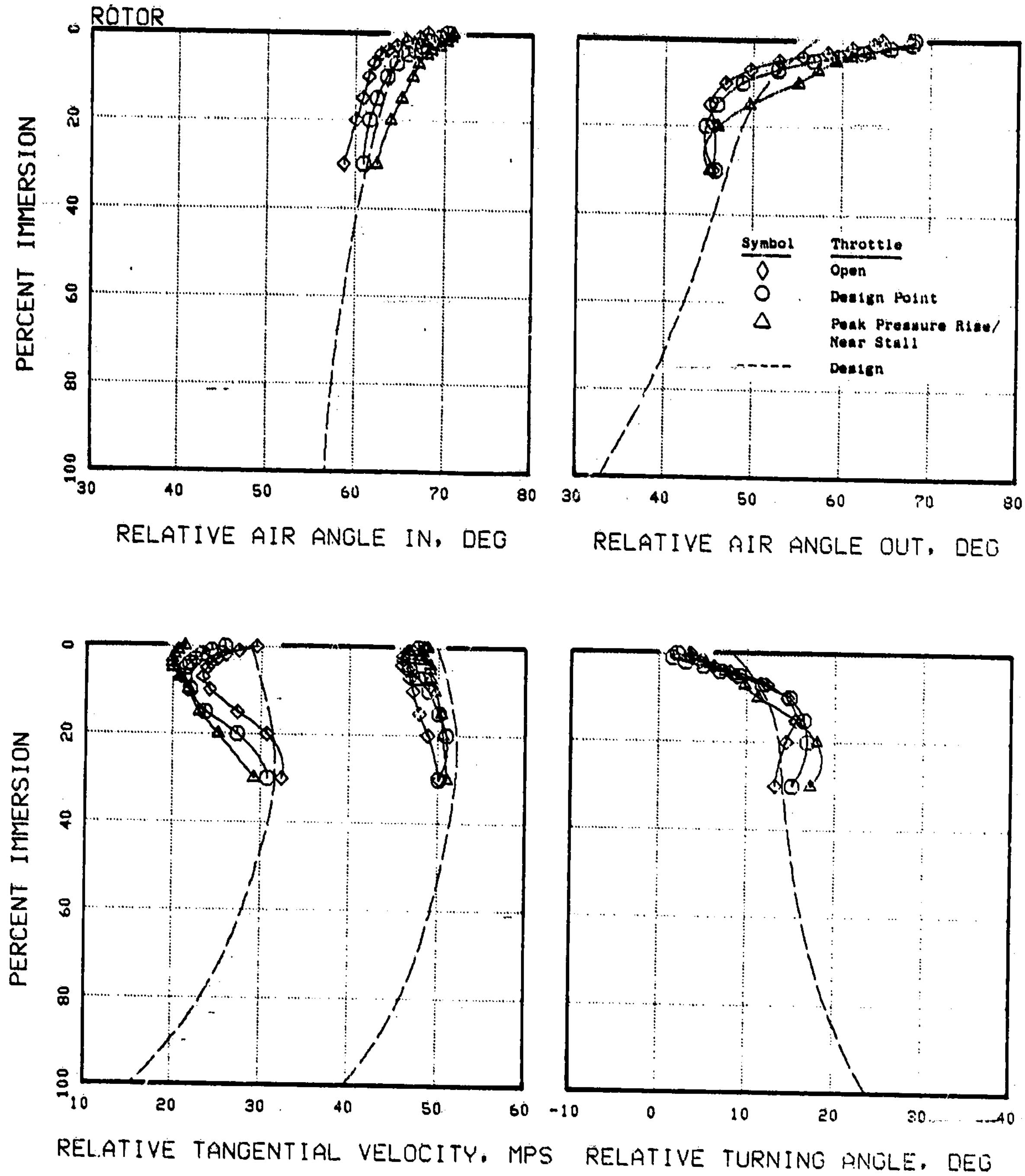
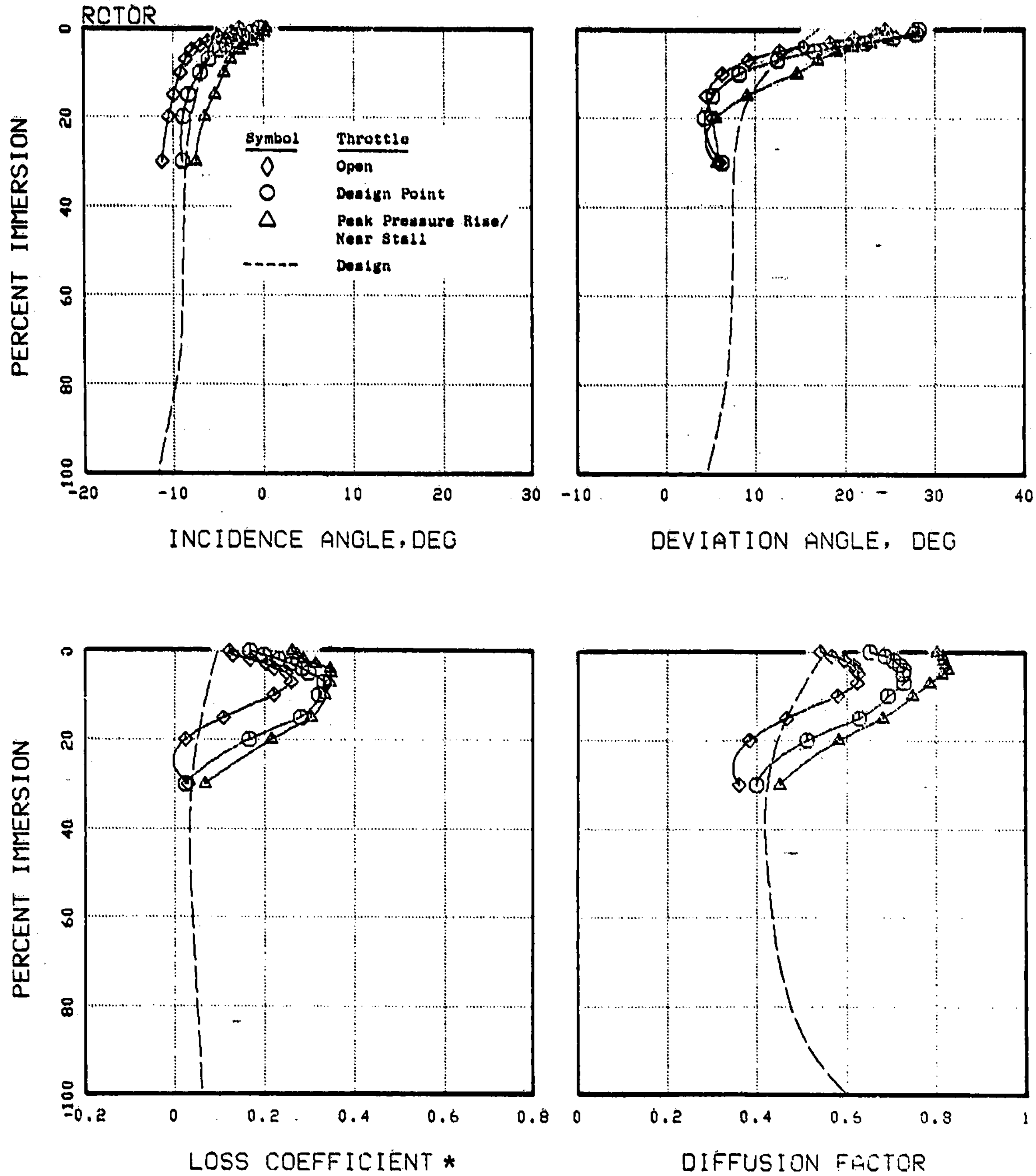


Figure 64. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.



*Computed from Stationary Rake Data

Figure 65. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

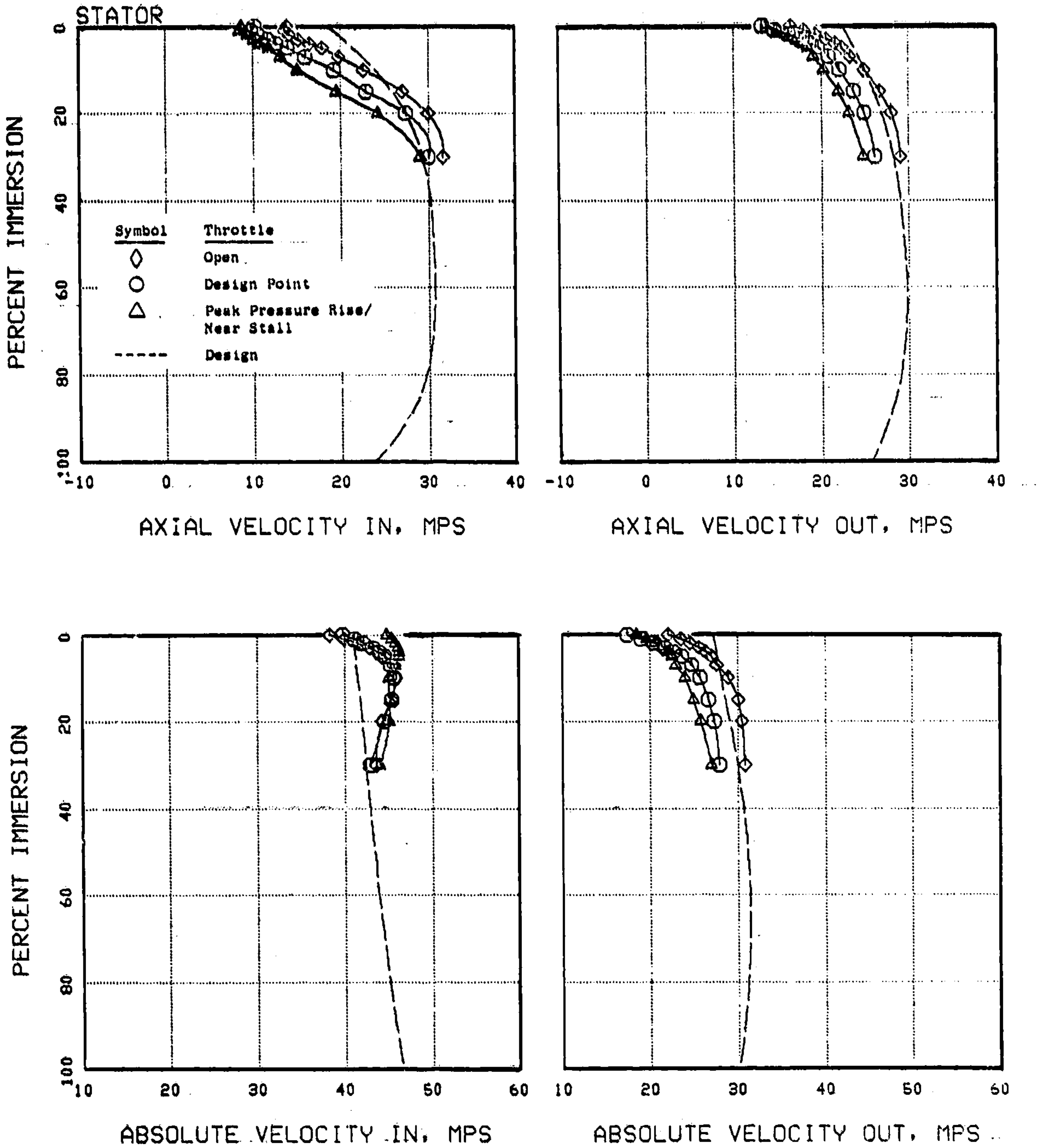


Figure 66. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearnace.

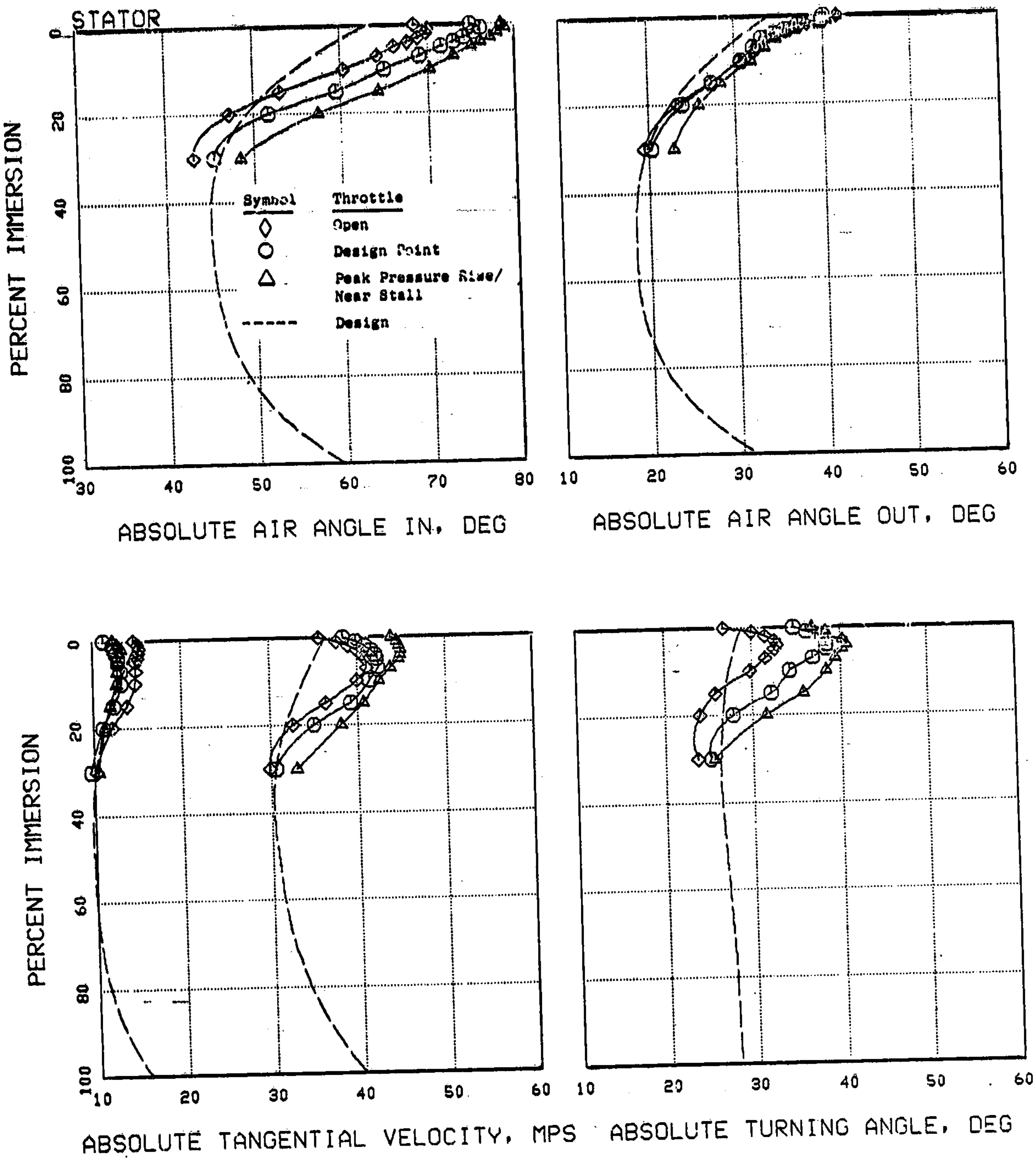


Figure 67. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration Third Stage Tested, Increased Rotor Tip Clearance.

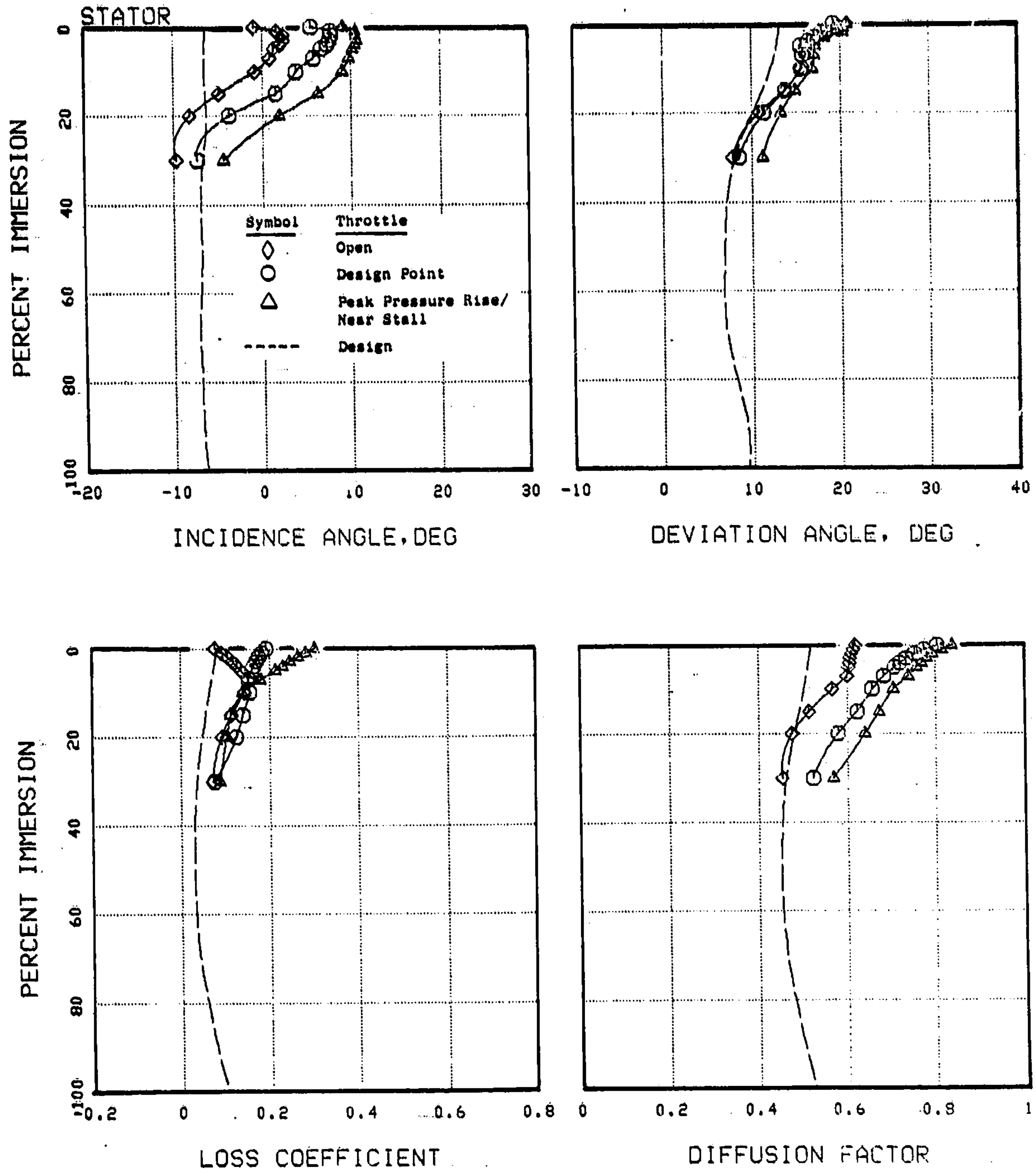


Figure 68. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

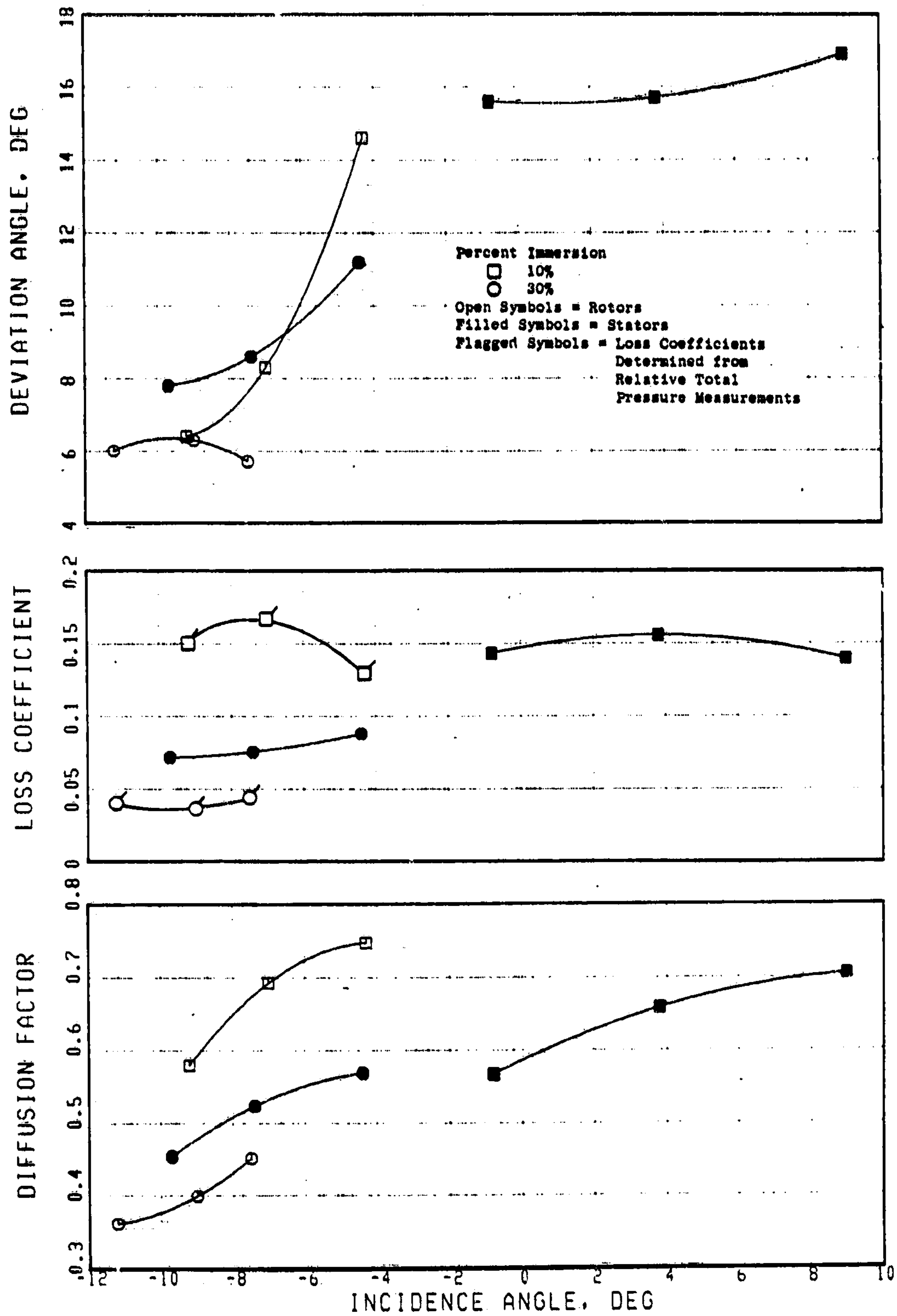


Figure 69. Diffusion Factor, Loss Coefficient and Deviation Angle Versus Incidence Angle, Rotor B/Stator B Four-Stage Configuration, Increased Rotor Tip Clearance.

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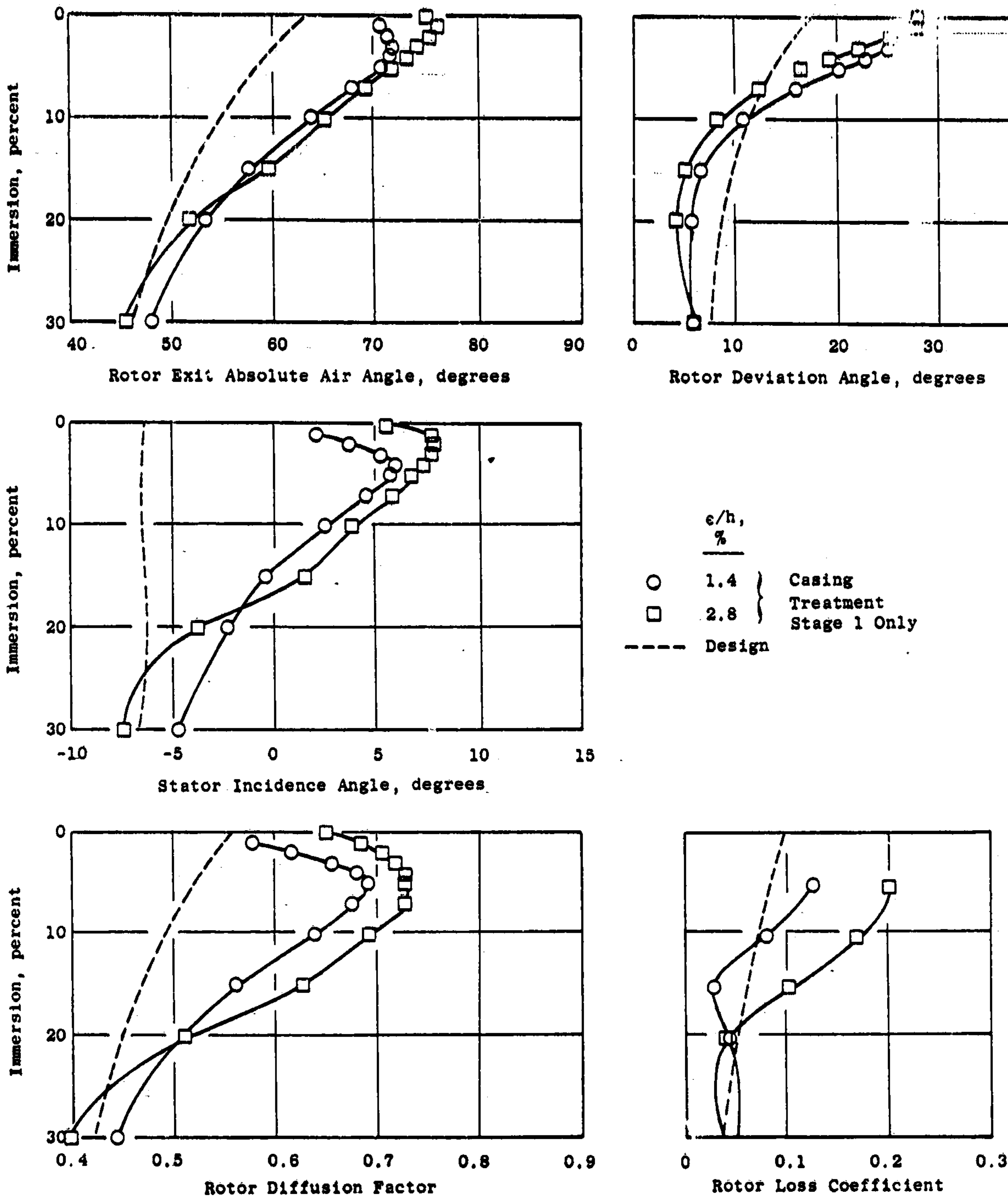

Figure 70. Comparison Showing the Effects of Increased Rotor Tip Clearance on Blade Element Performance.

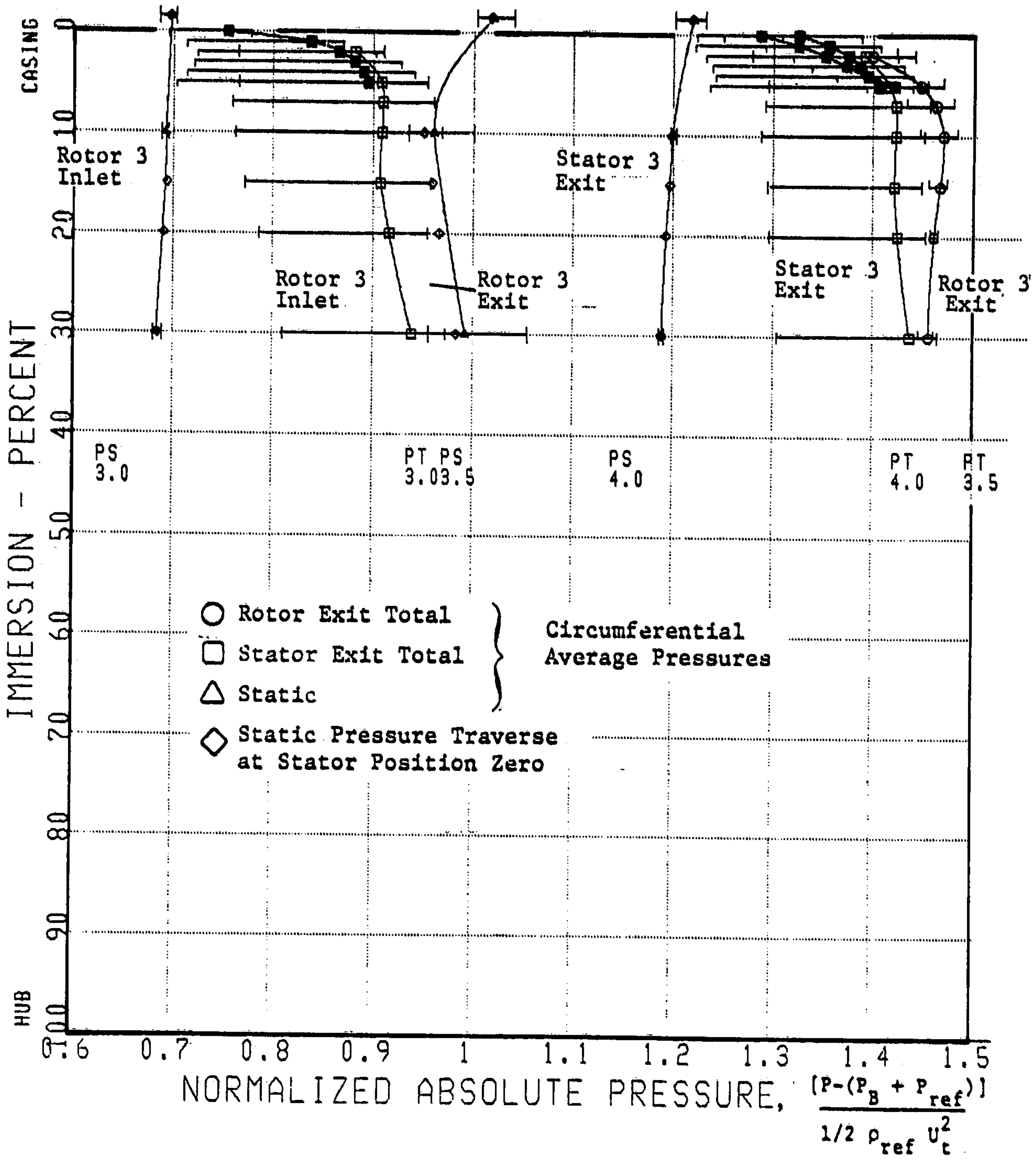

Figure 71. Normalized Absolute Total Pressures and Static Pressures for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Open Throttle.

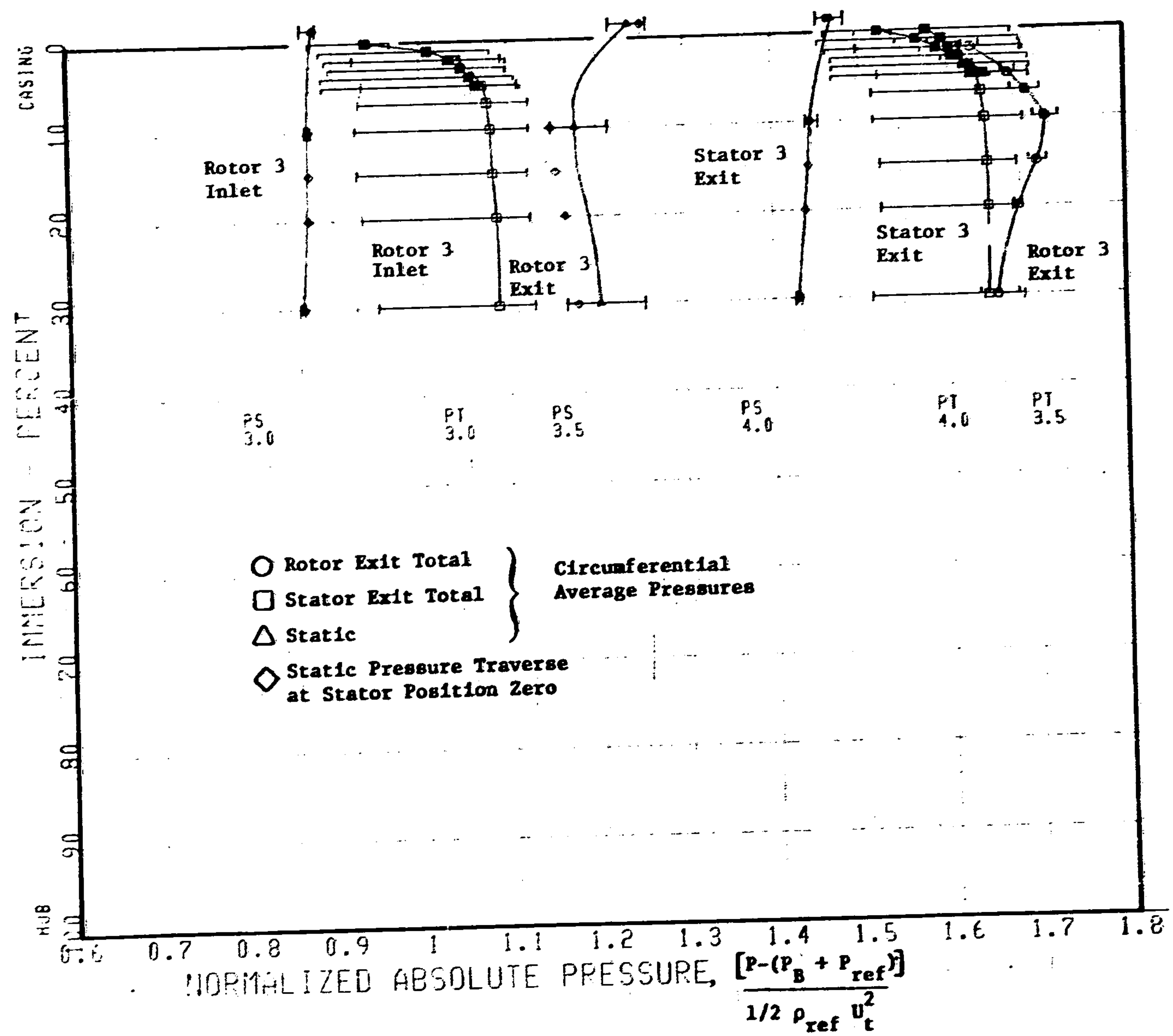

Figure 72. Normalized Absolute Total Pressures and Static Pressures for Rotor B/ Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Design Point Throttle.

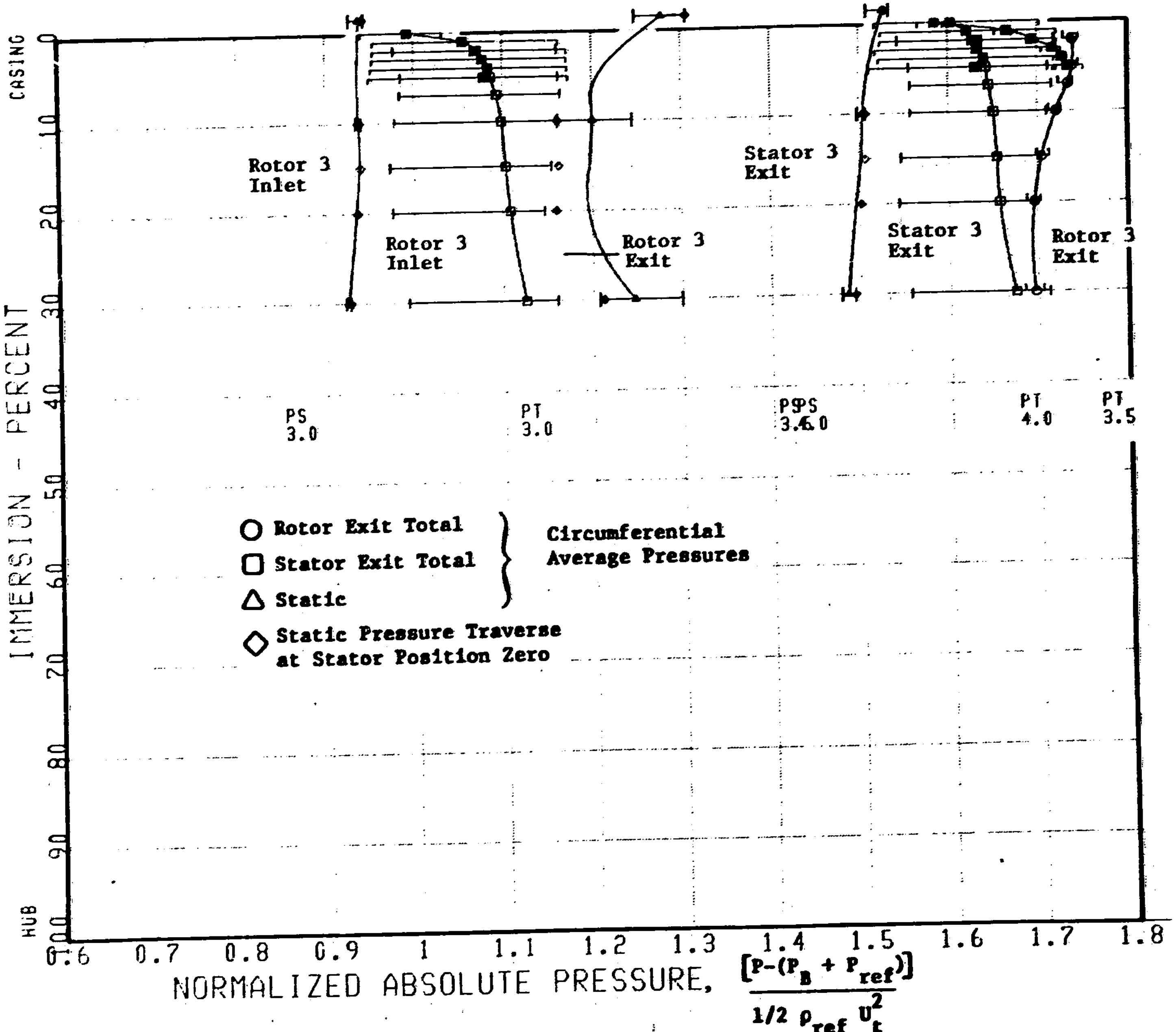

Figure 73. Normalized Absolute Total Pressure and Static Pressures for Rotor B/ Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Peak Pressure Rise/Near Stall Throttle.

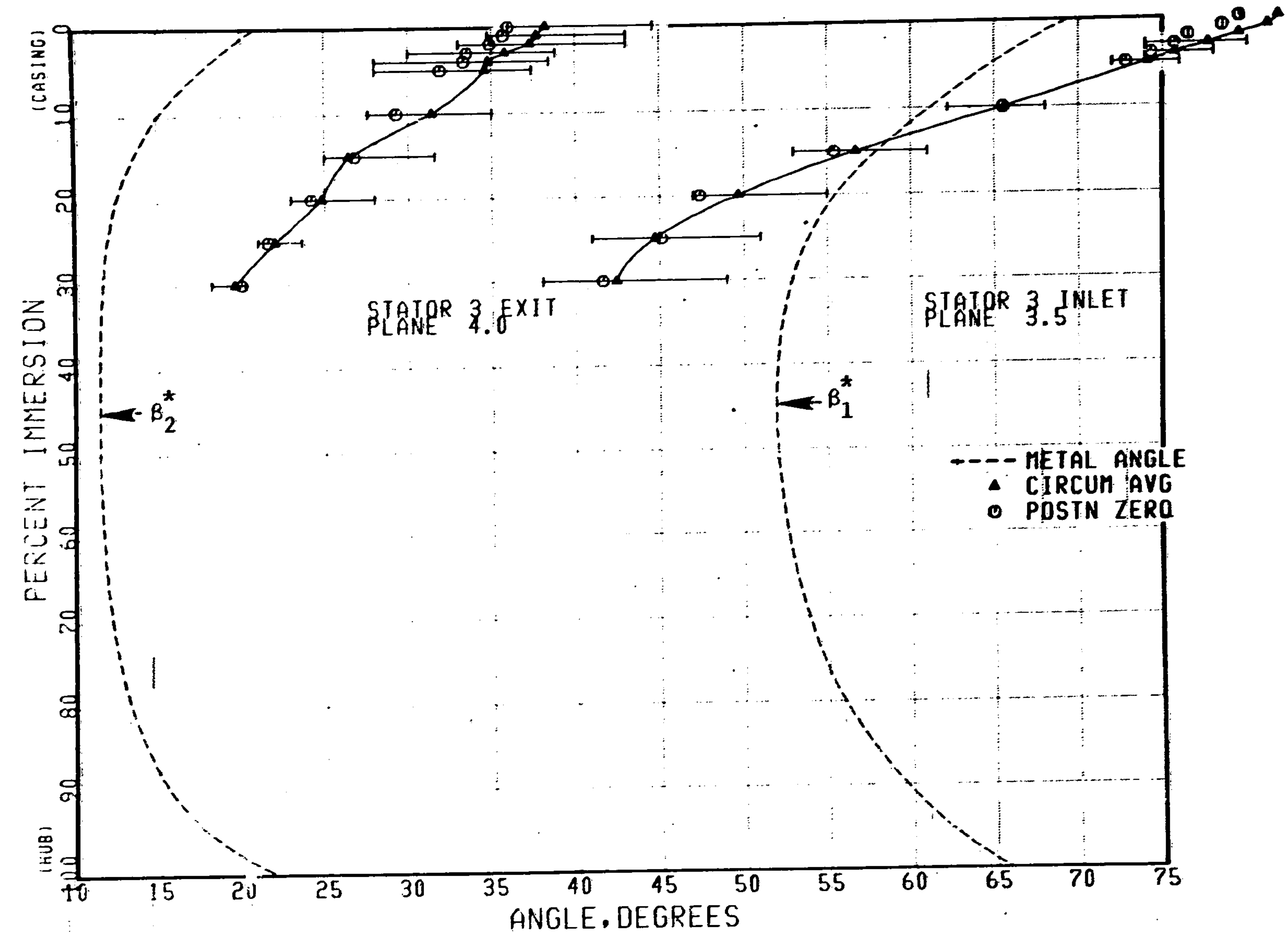

Figure 74. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Open Throttle.

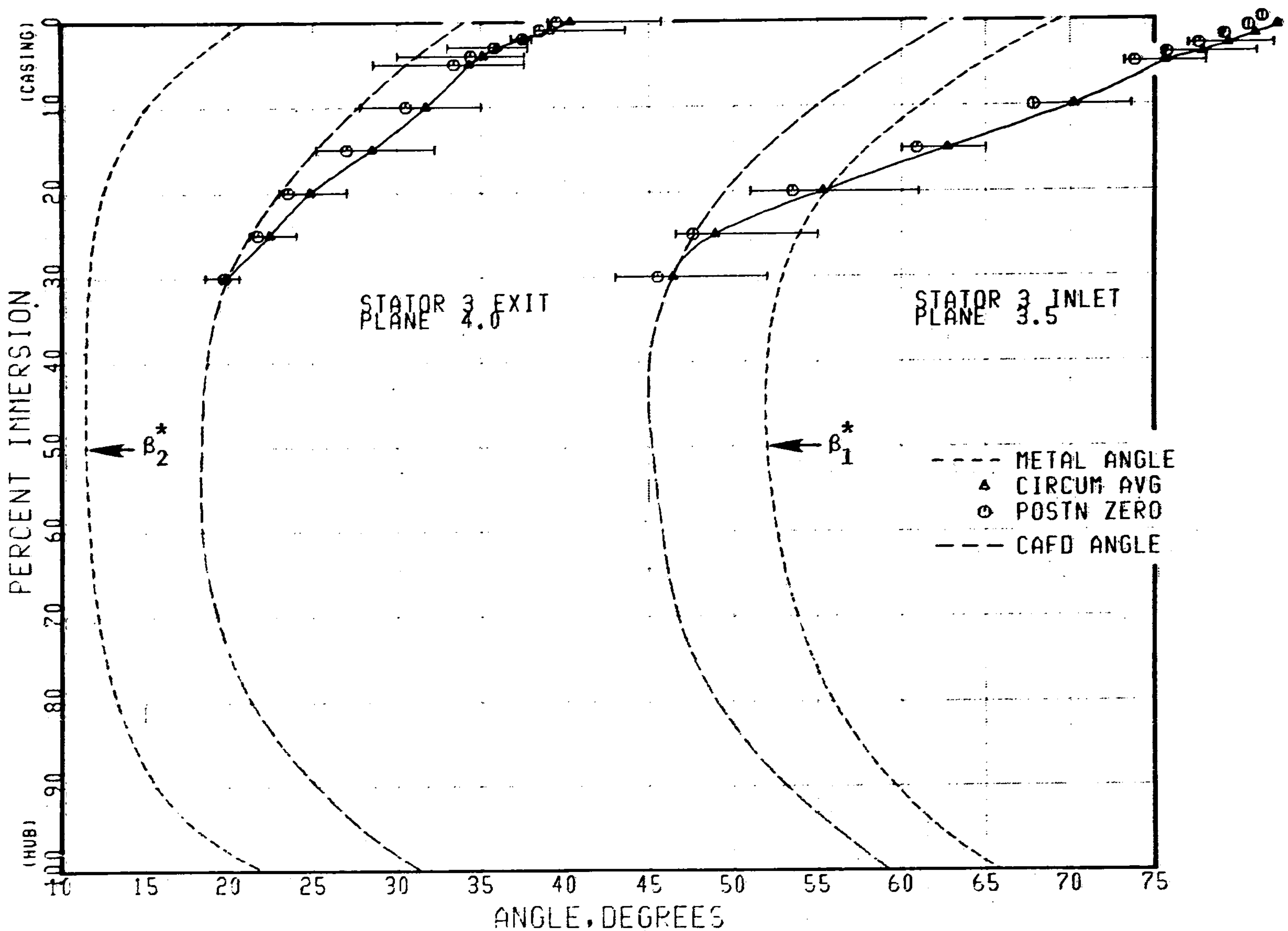

Figure 75. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third State Tested, Increased Rotor Tip Clearance and Casing Treatment, Design Point Throttle.

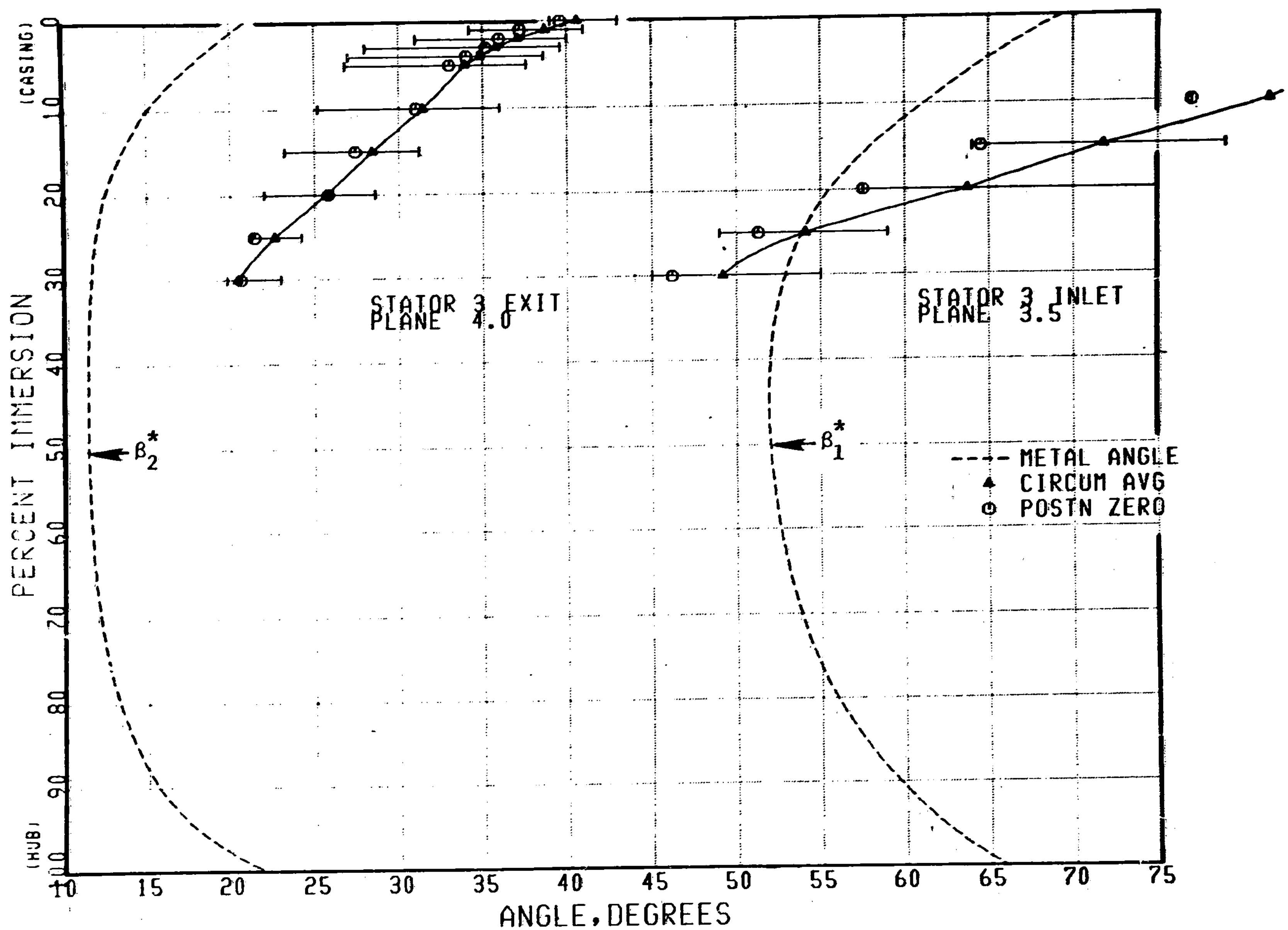

Figure 76. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Peak Pressure Rise/Near Stall Throttle.

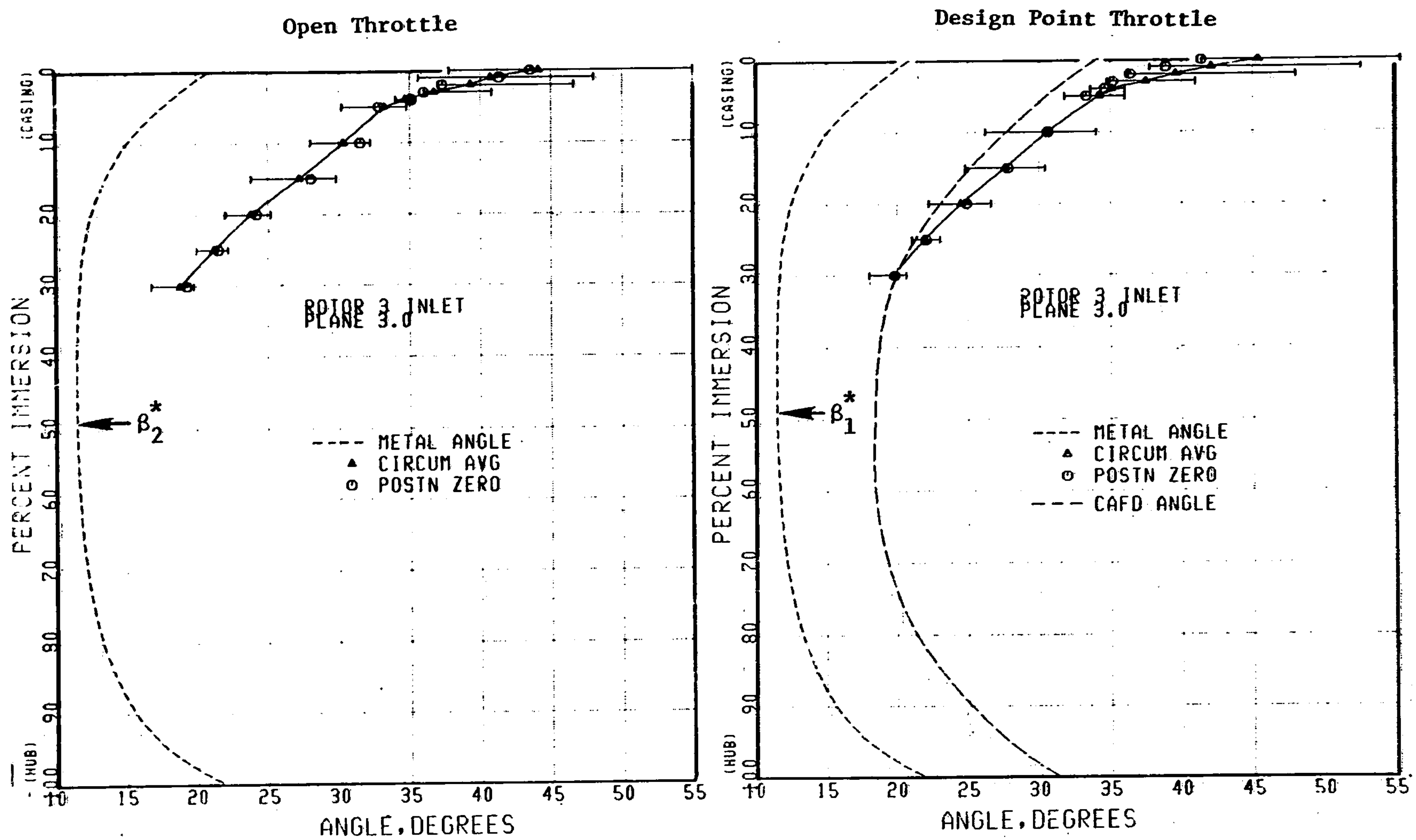

Figure 77. Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

Peak Pressure Rise/Near Stall Throttle

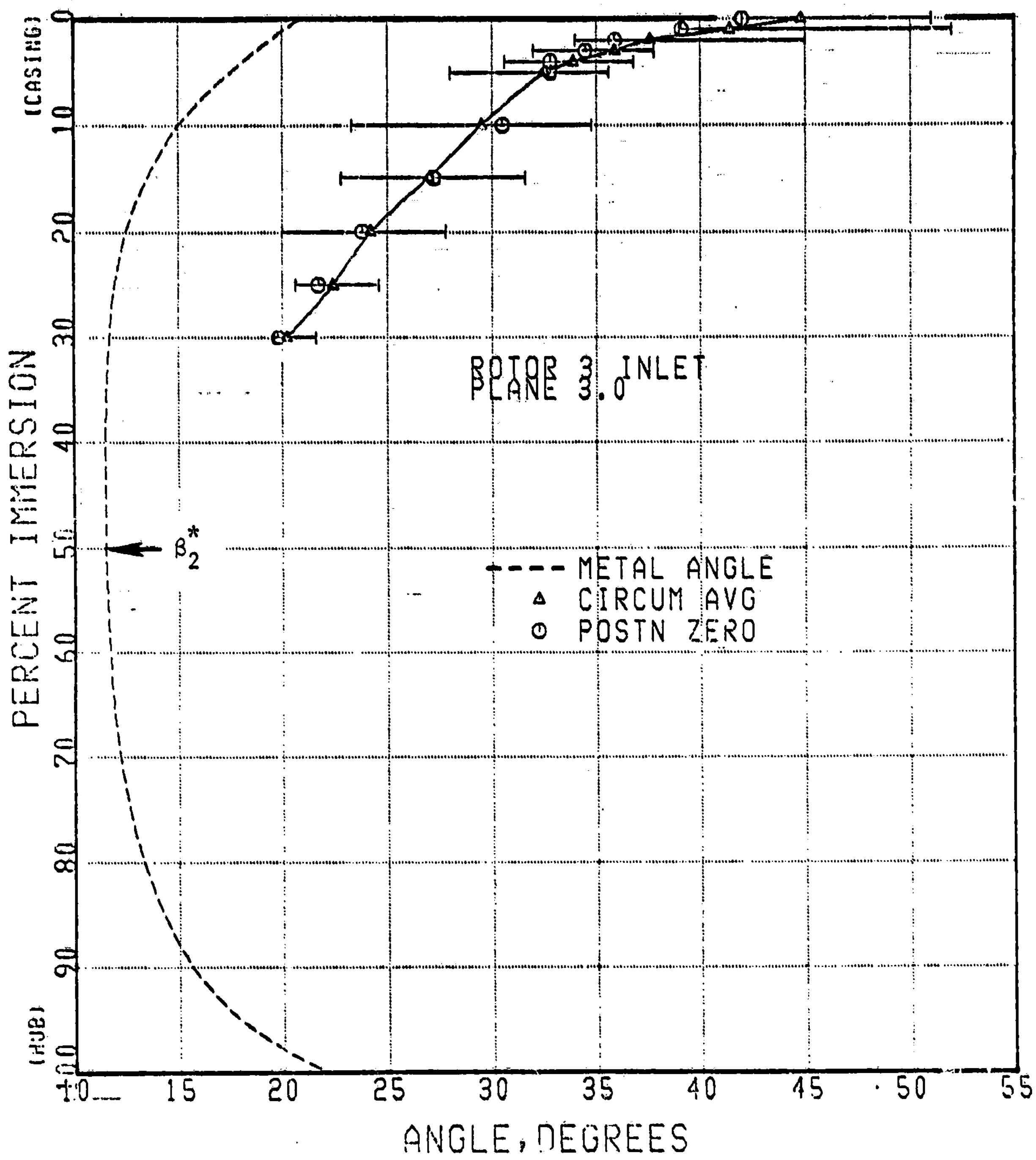

Figure 78. **Absolute Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Stage Clearance, and Casing Treatment.**

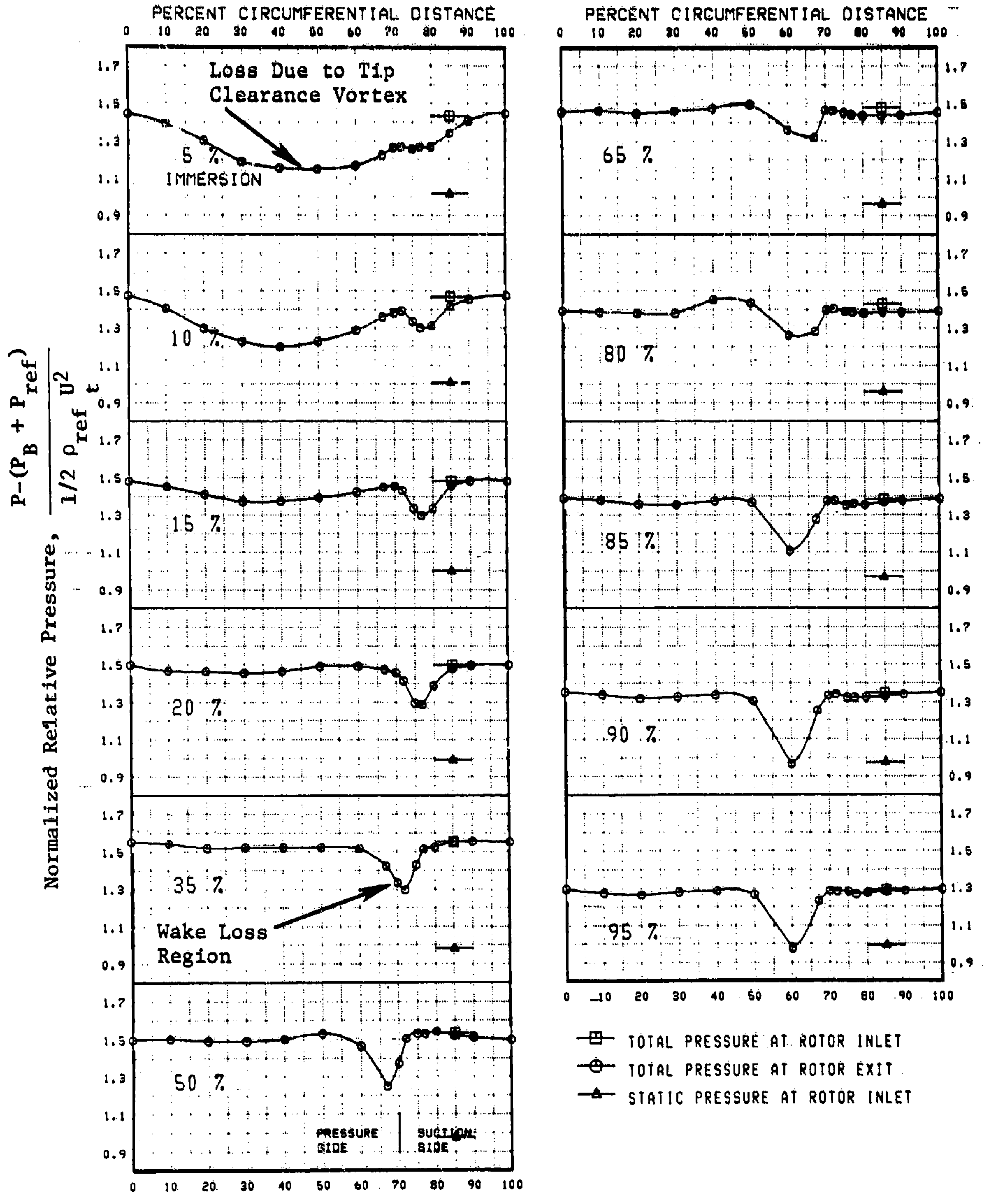

Figure 79. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance Casing Treatment. Open Throttle.

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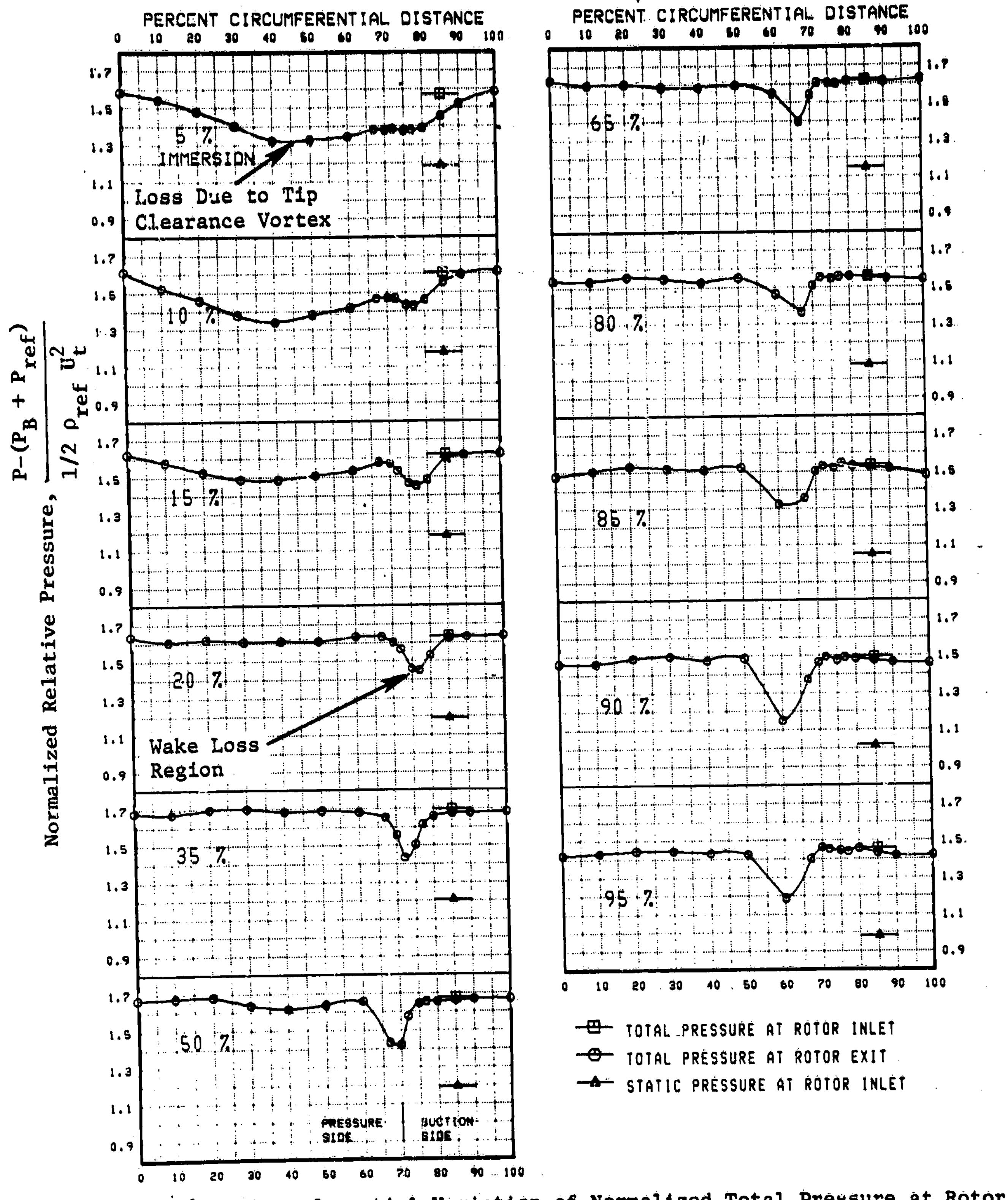

Figure 80. Circumferential Variation of Normalized Total Pressure at Rotor Exit, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Design Point Throttle.

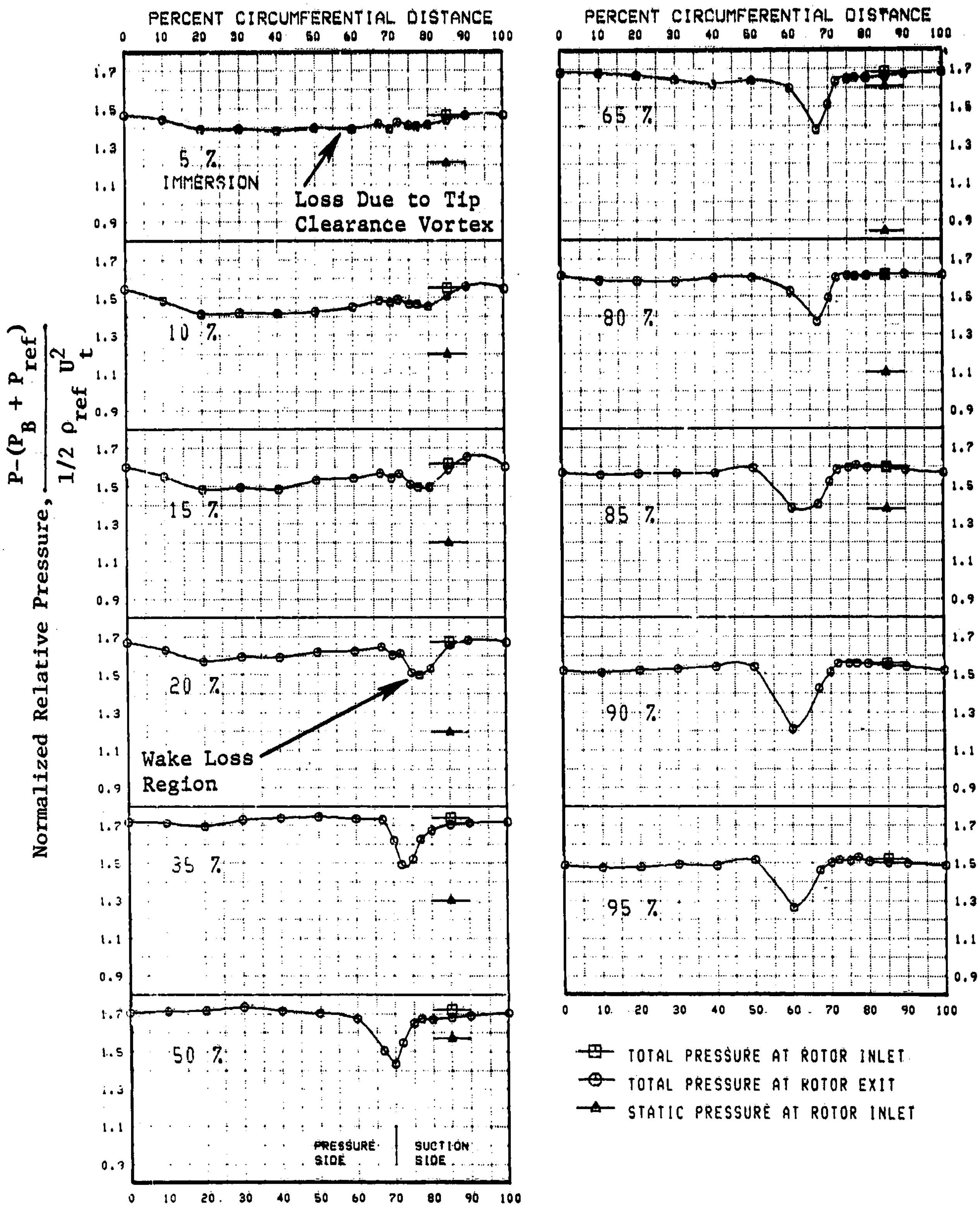

Figure 81. Circumferential Variation of Normalized Relative Total Pressure at Rotor Exit Rotor B/Stator B Four-Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Peak Pressure Rise/ Near Stall Throttle.

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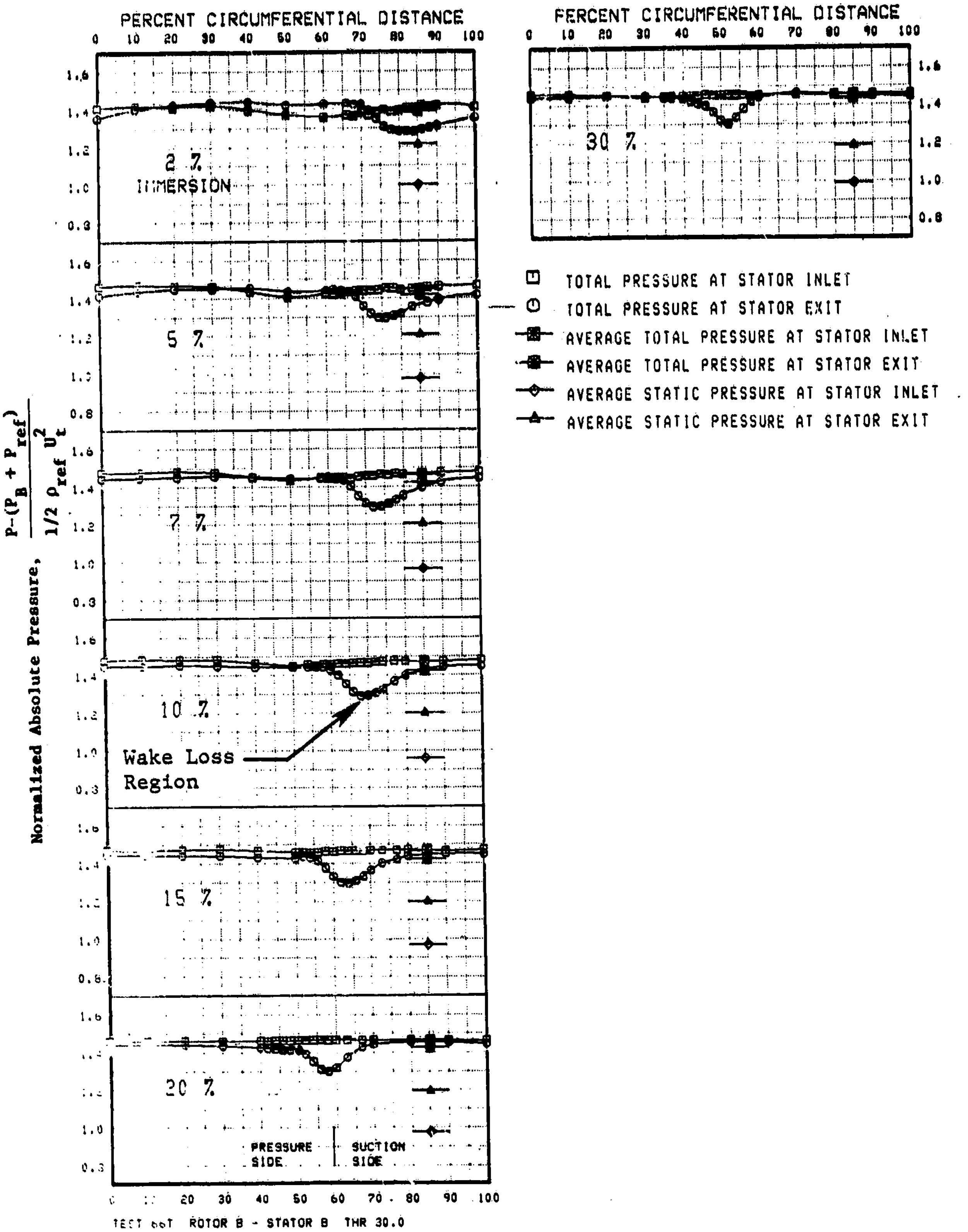


Figure 82. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Open Throttle.

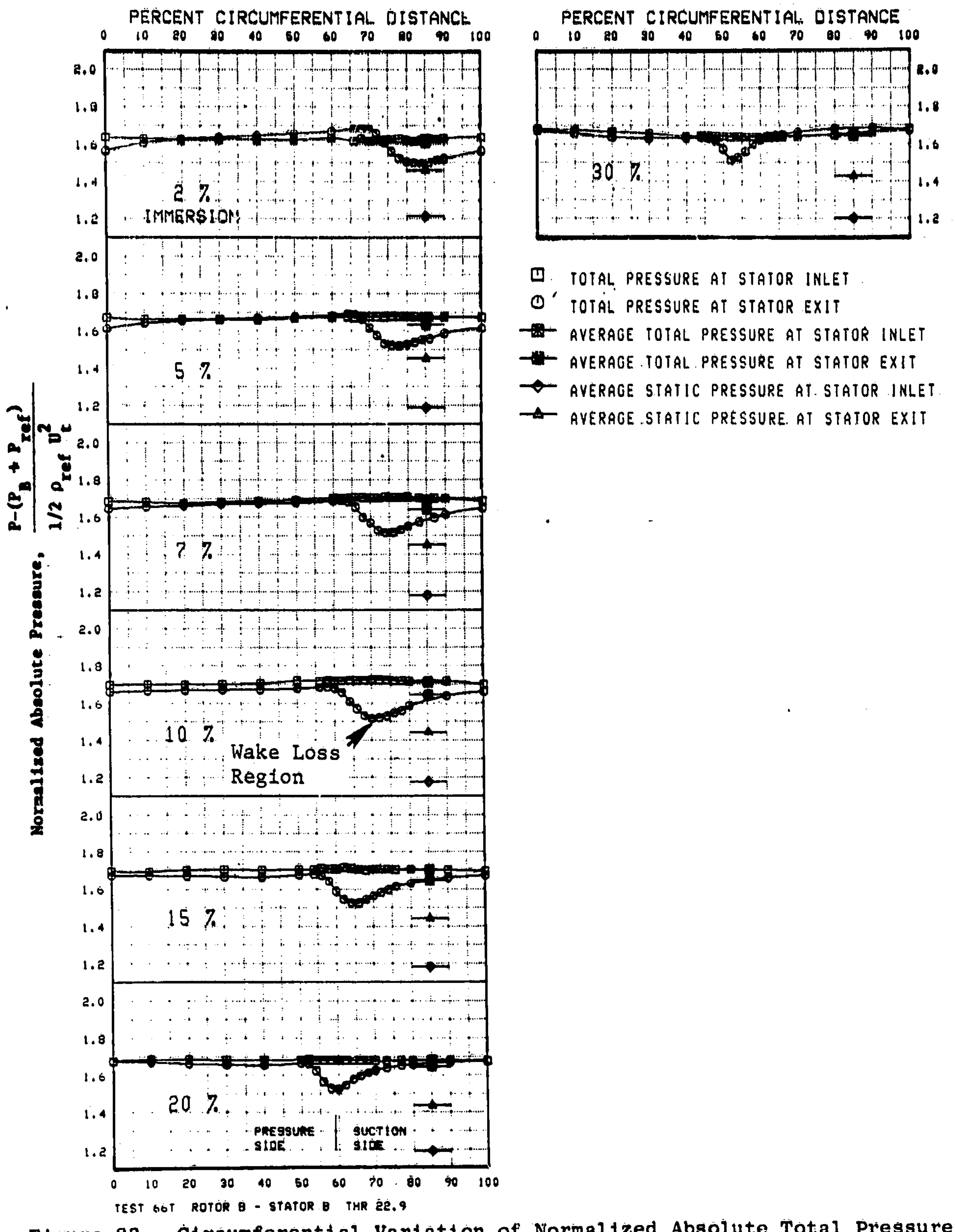


Figure 83. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Design Point Throttle.

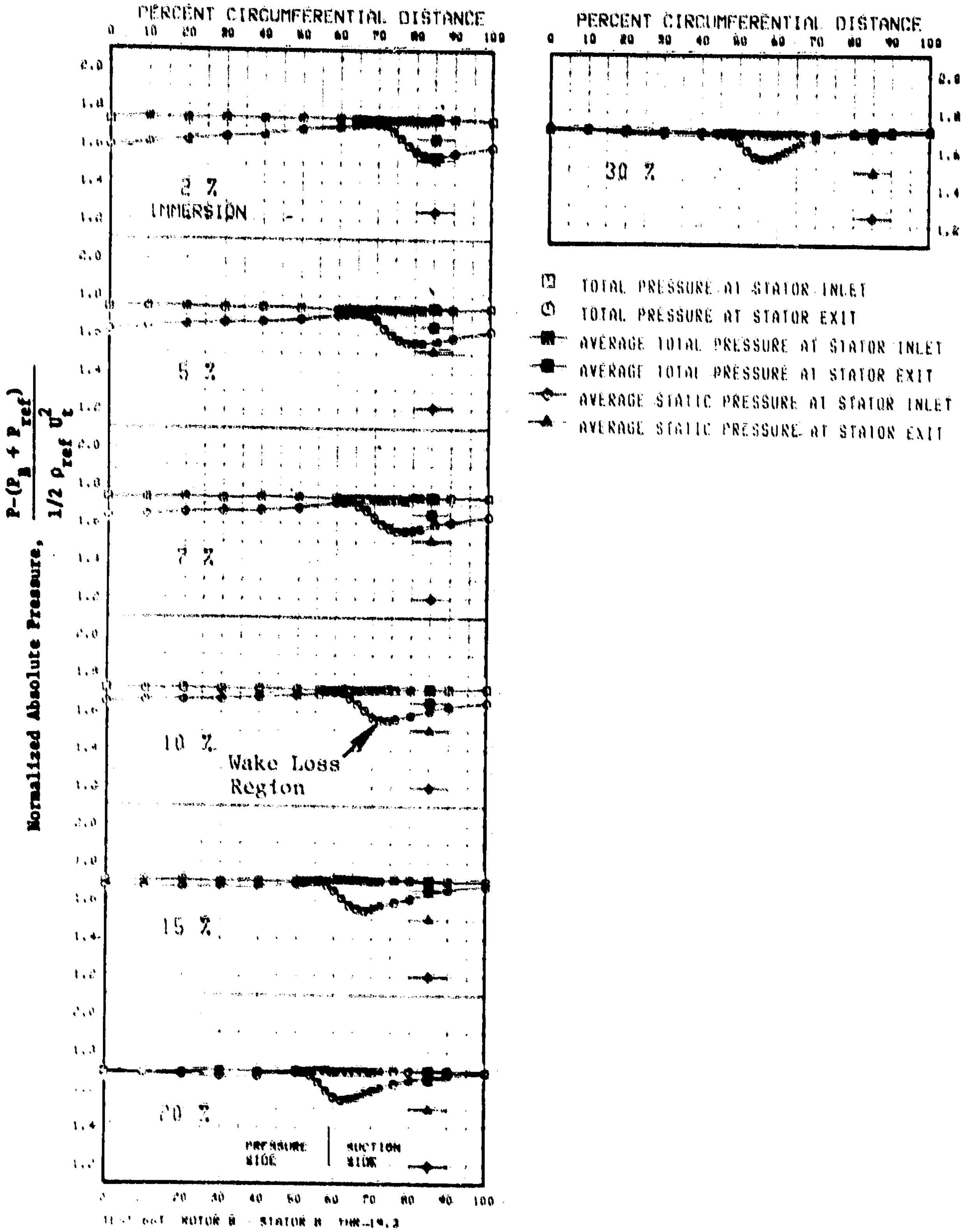
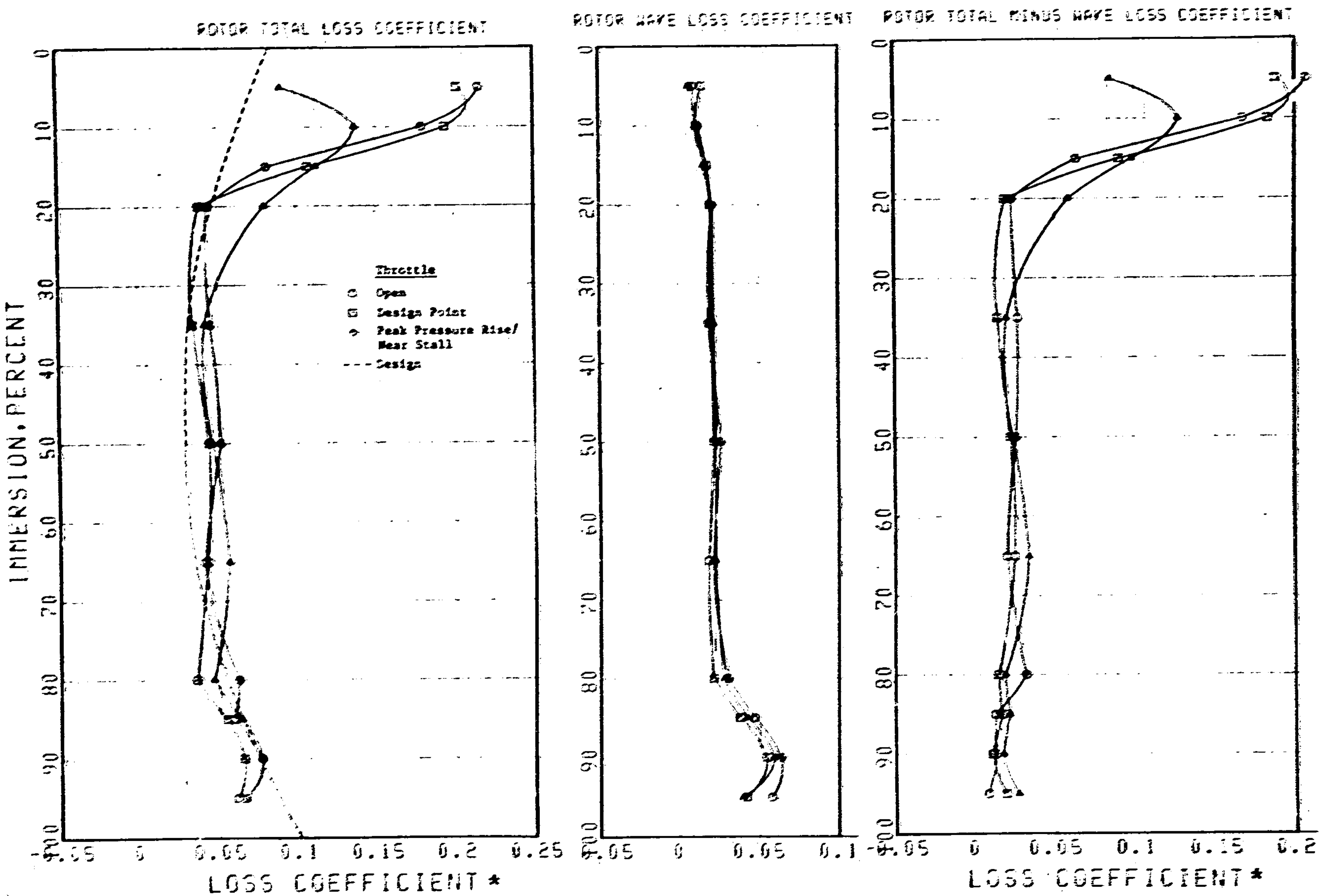


Figure 84. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Peak Pressure Rise/Near Stall Throttle.



*Computed from Rotating Rake Data

Figure 85. Rotor Total Loss Coefficients, Wake Loss Coefficients, and Total Minus Wake Loss Coefficients for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

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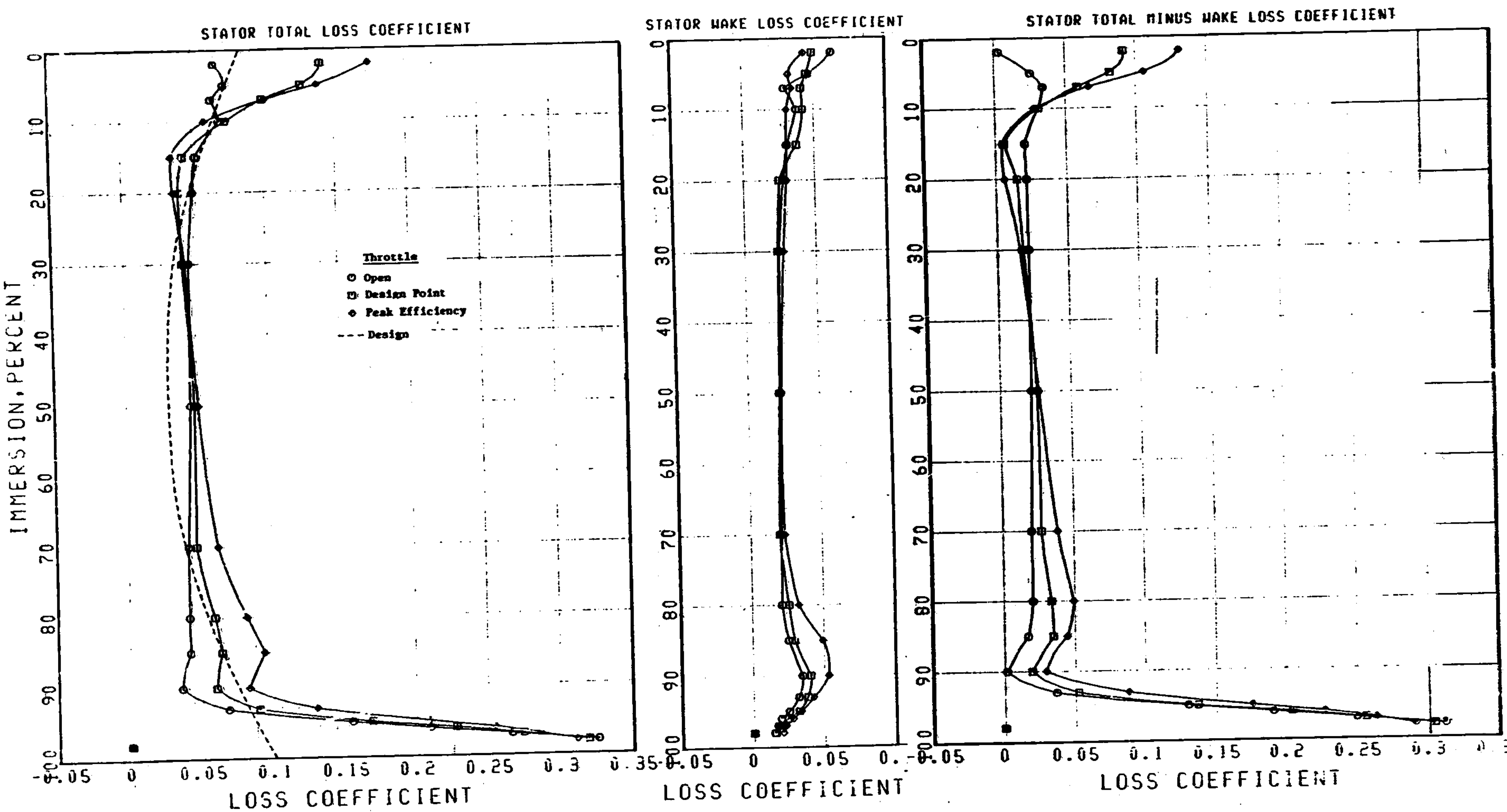


Figure 86. Stator Total Loss Coefficients, Wake Loss Coefficients, and Total Minus Wake Loss Coefficients for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

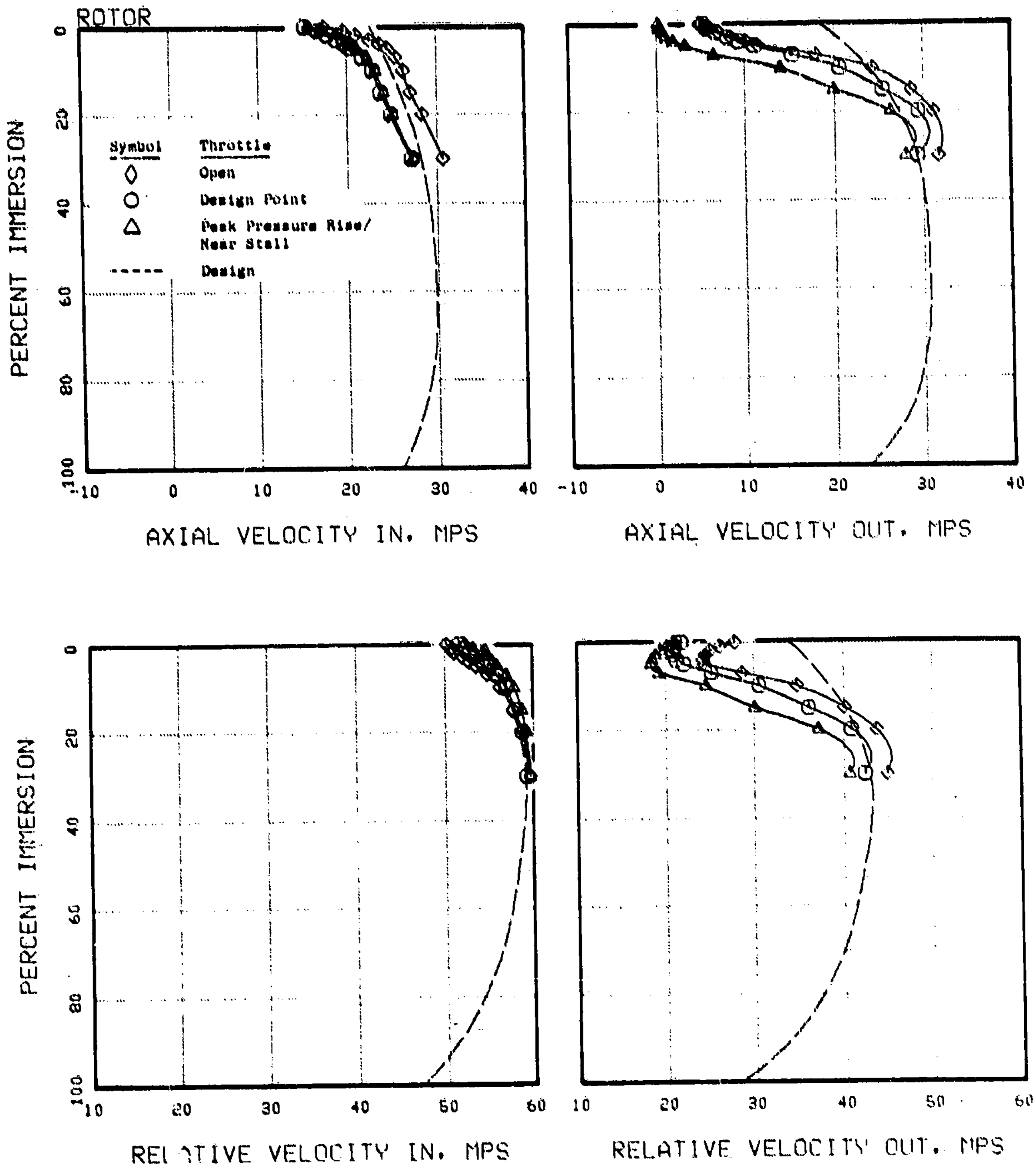


Figure 87. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

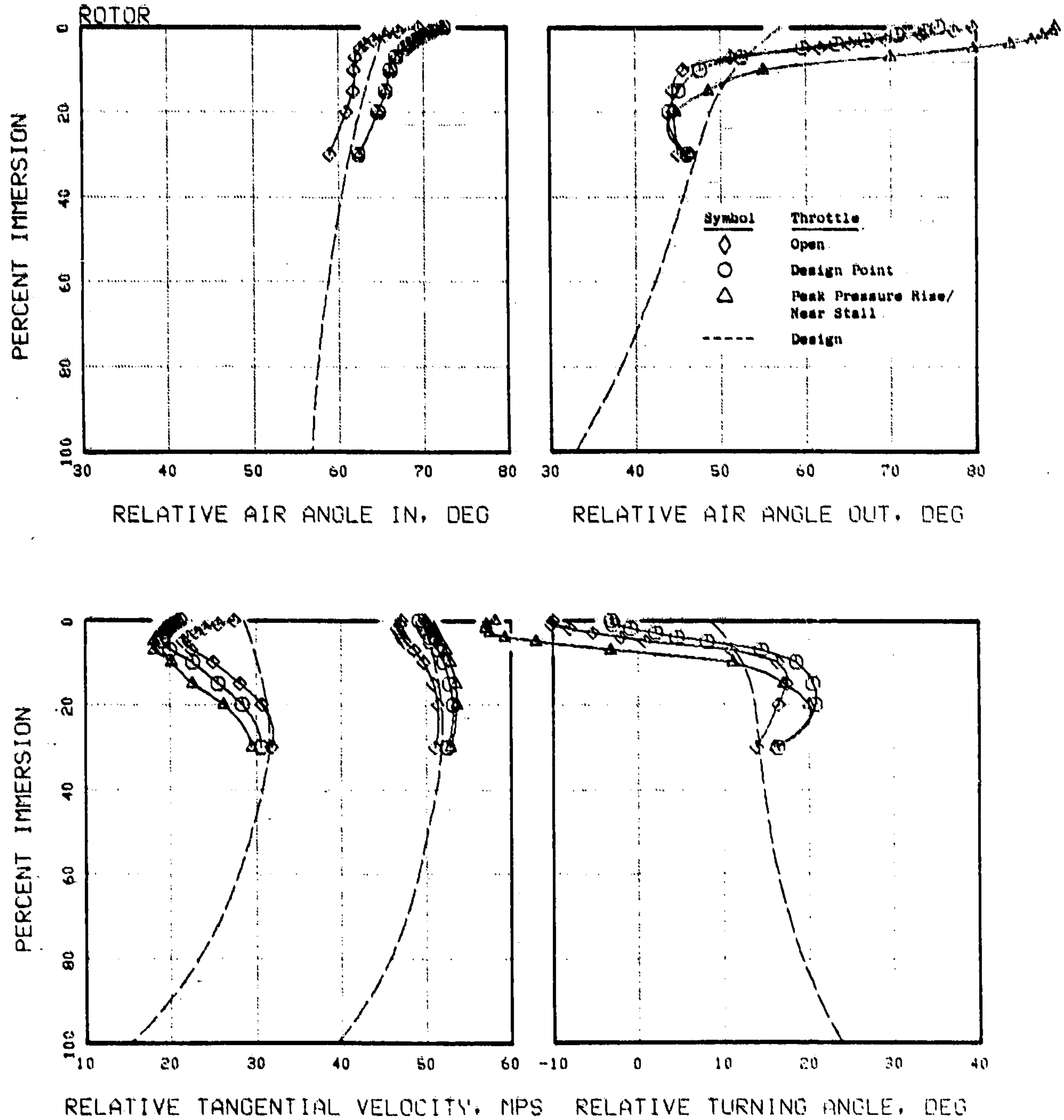
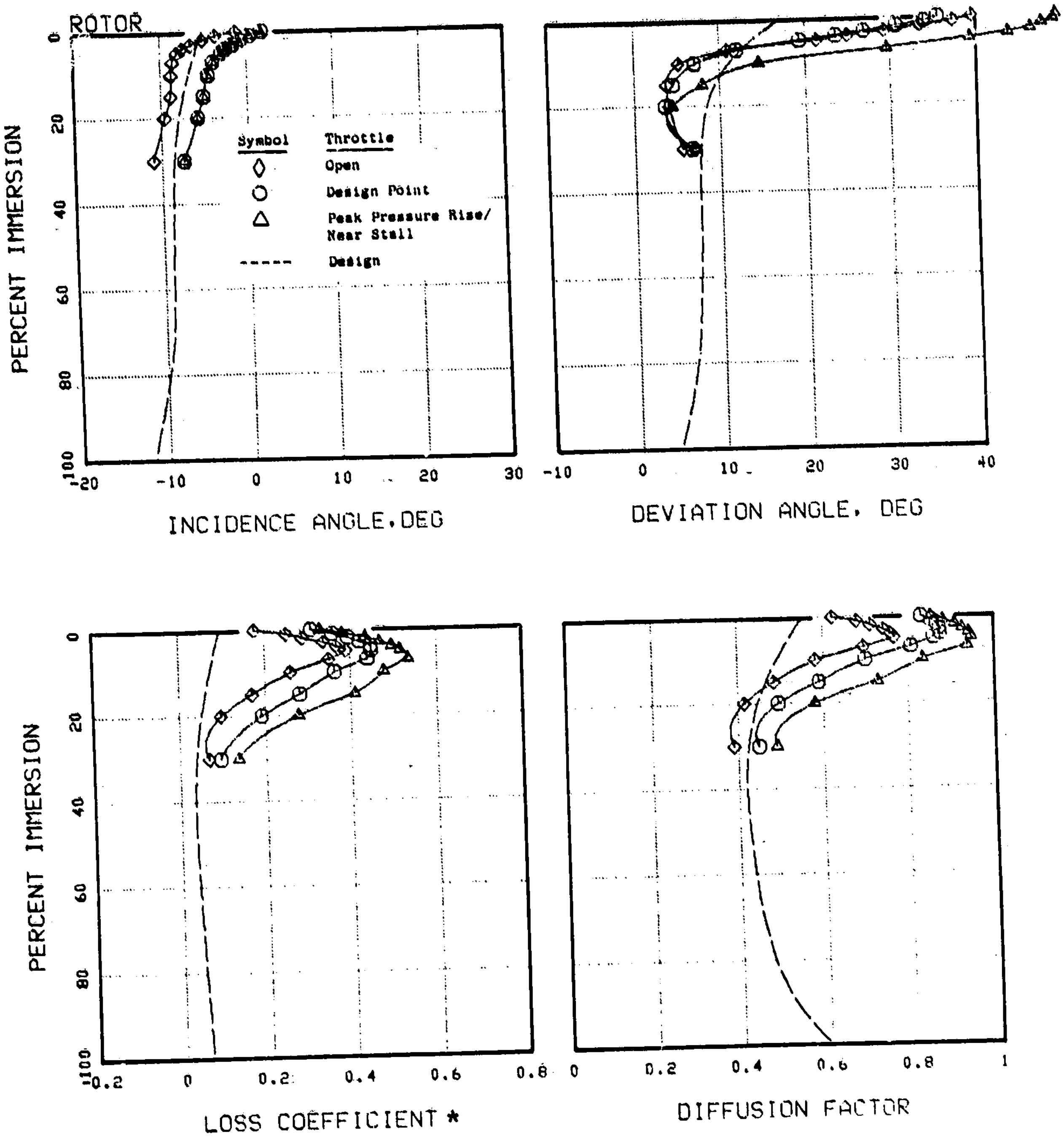


Figure 88. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.



*Computed from Stationary Rake Data

Figure 89. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

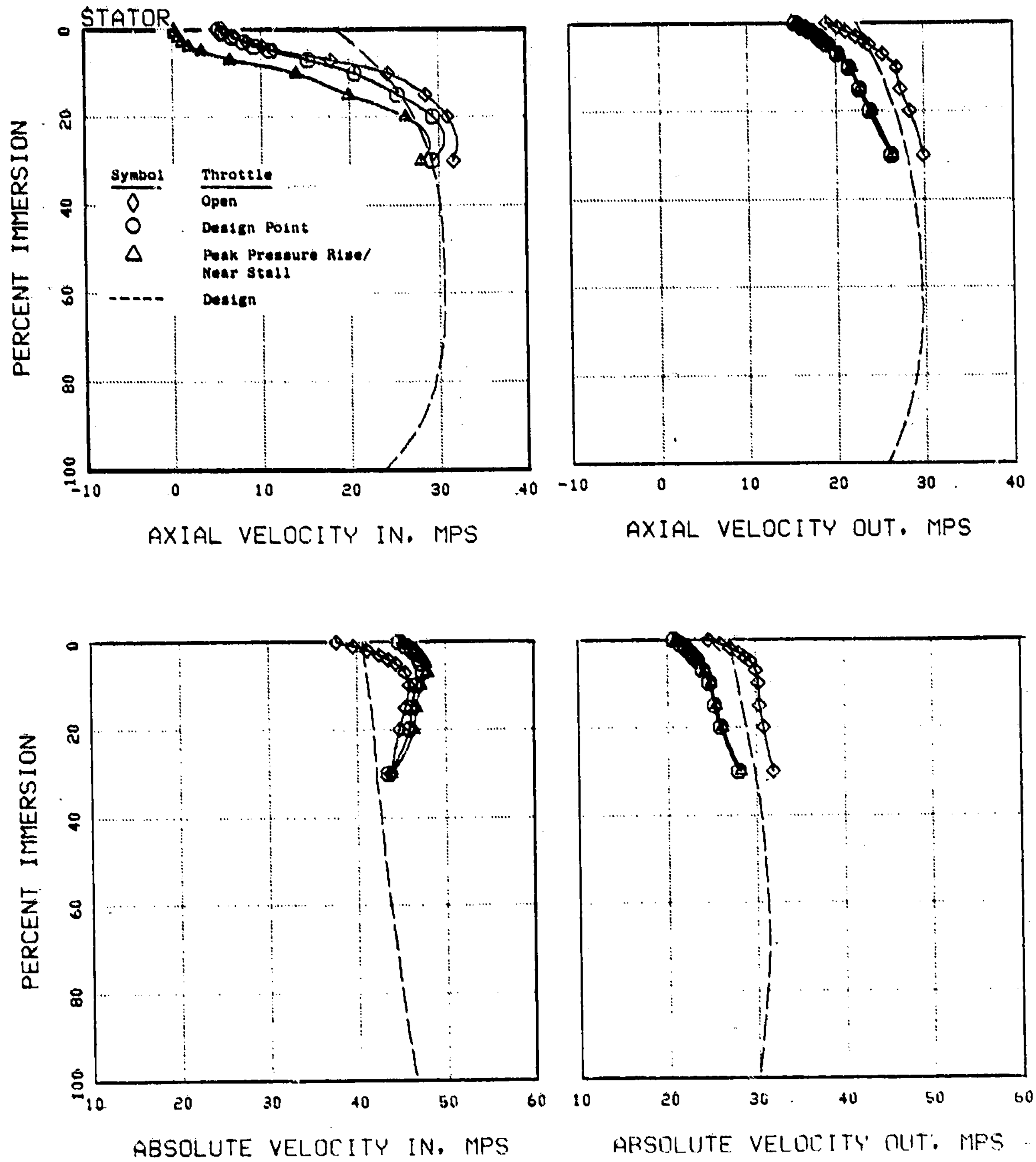


Figure 90. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance Treatment.

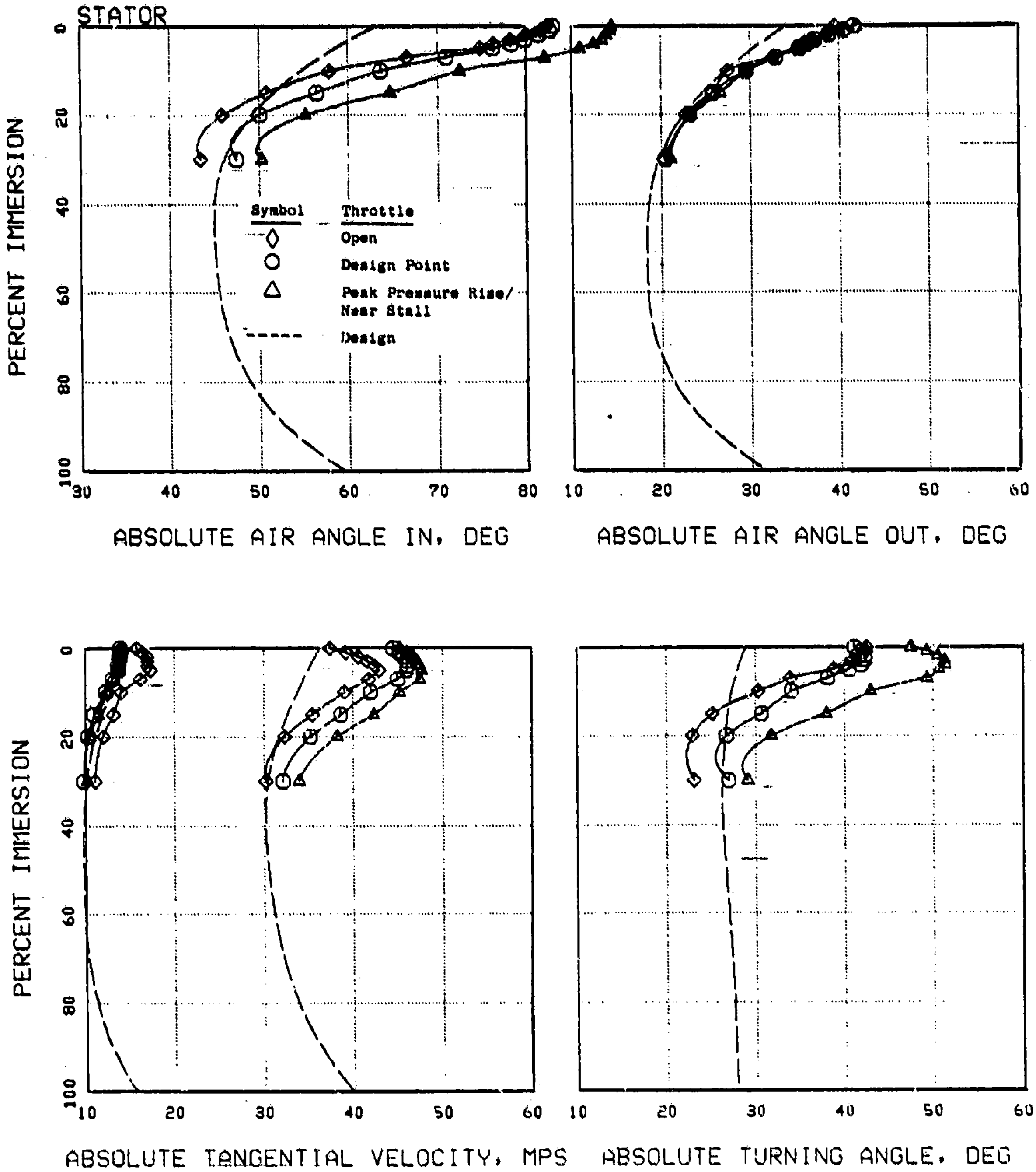


Figure 91. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

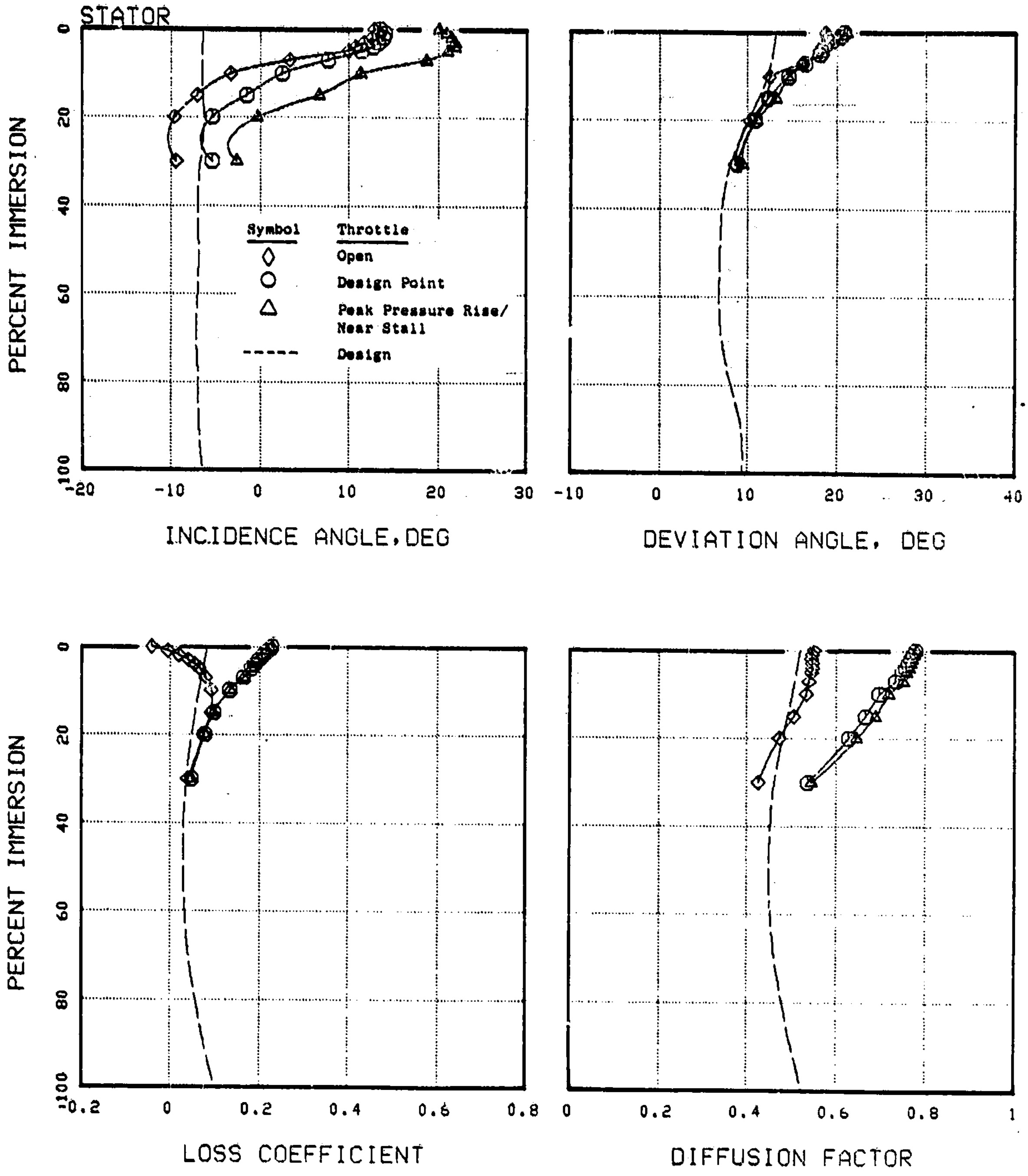


Figure 92. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

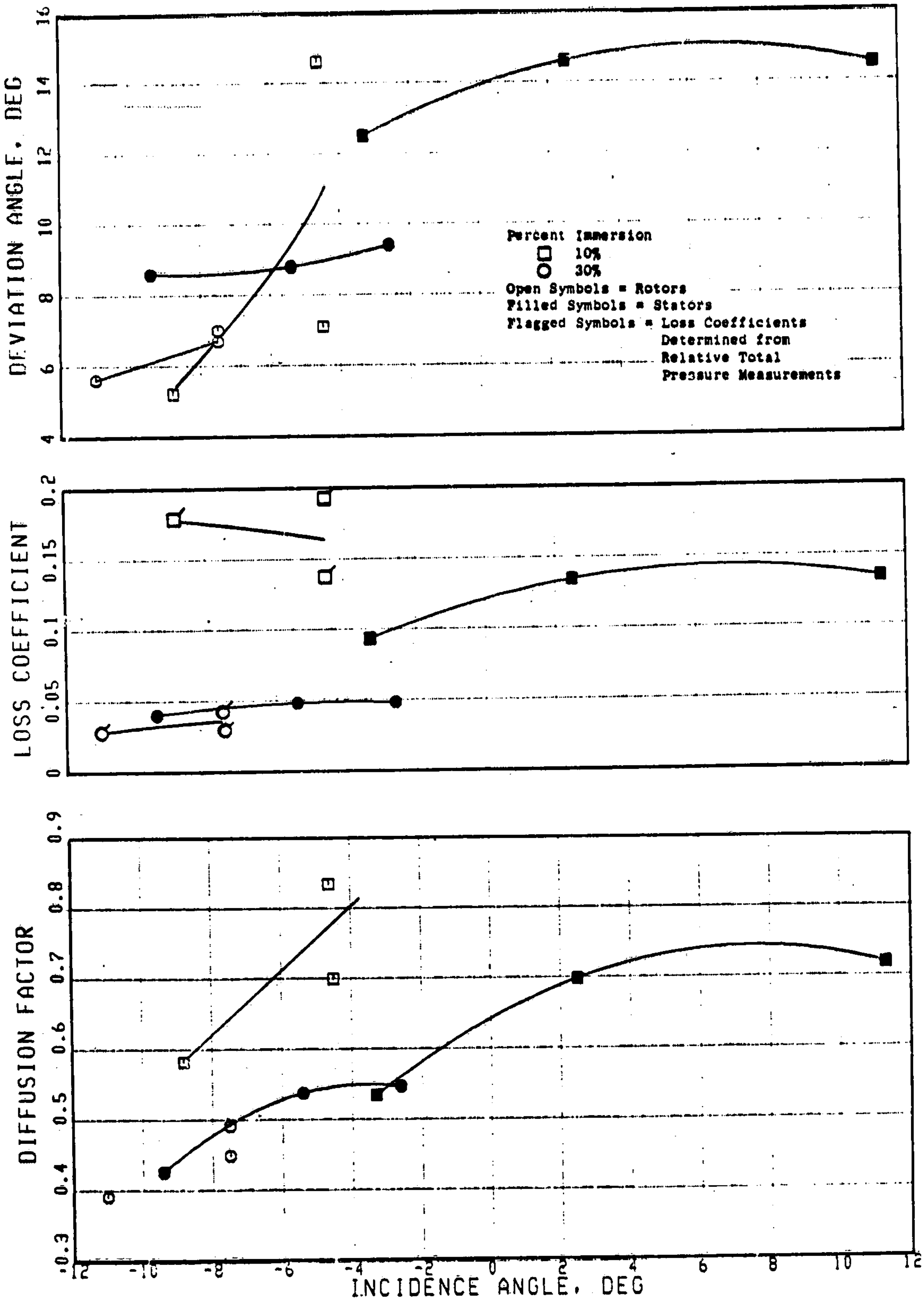


Figure 93. Diffusion Factor, Loss Coefficient, and Deviation Angle Versus Incidence Angle, Rotor B/Stator B Four-Stage Configuration, Increased Tip Clearance and Casing Treatment.

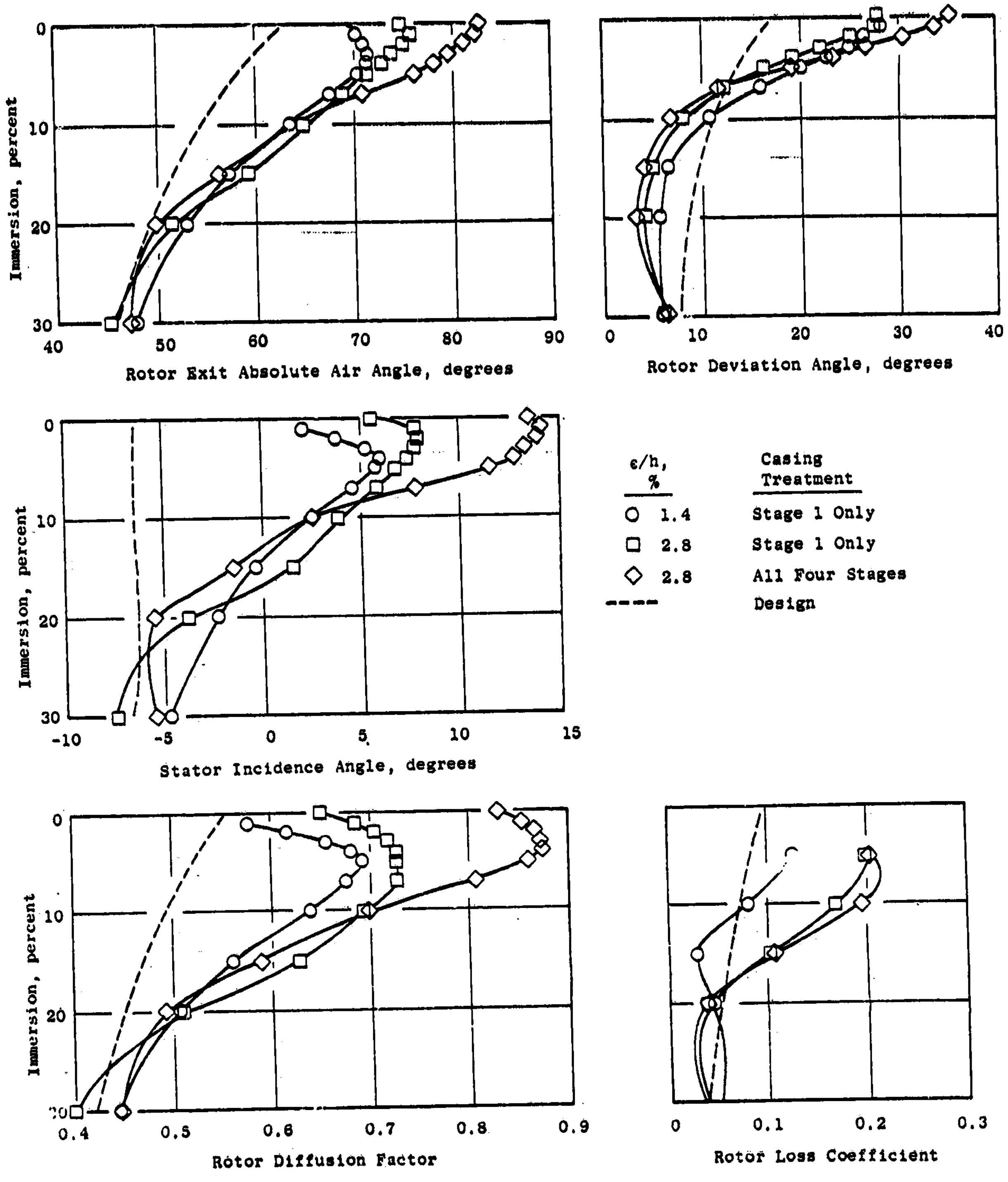


Figure 94. Comparison Showing the Effects of Increased Rotor Tip Clearance and Casing Treatment on Blade Element Performance.

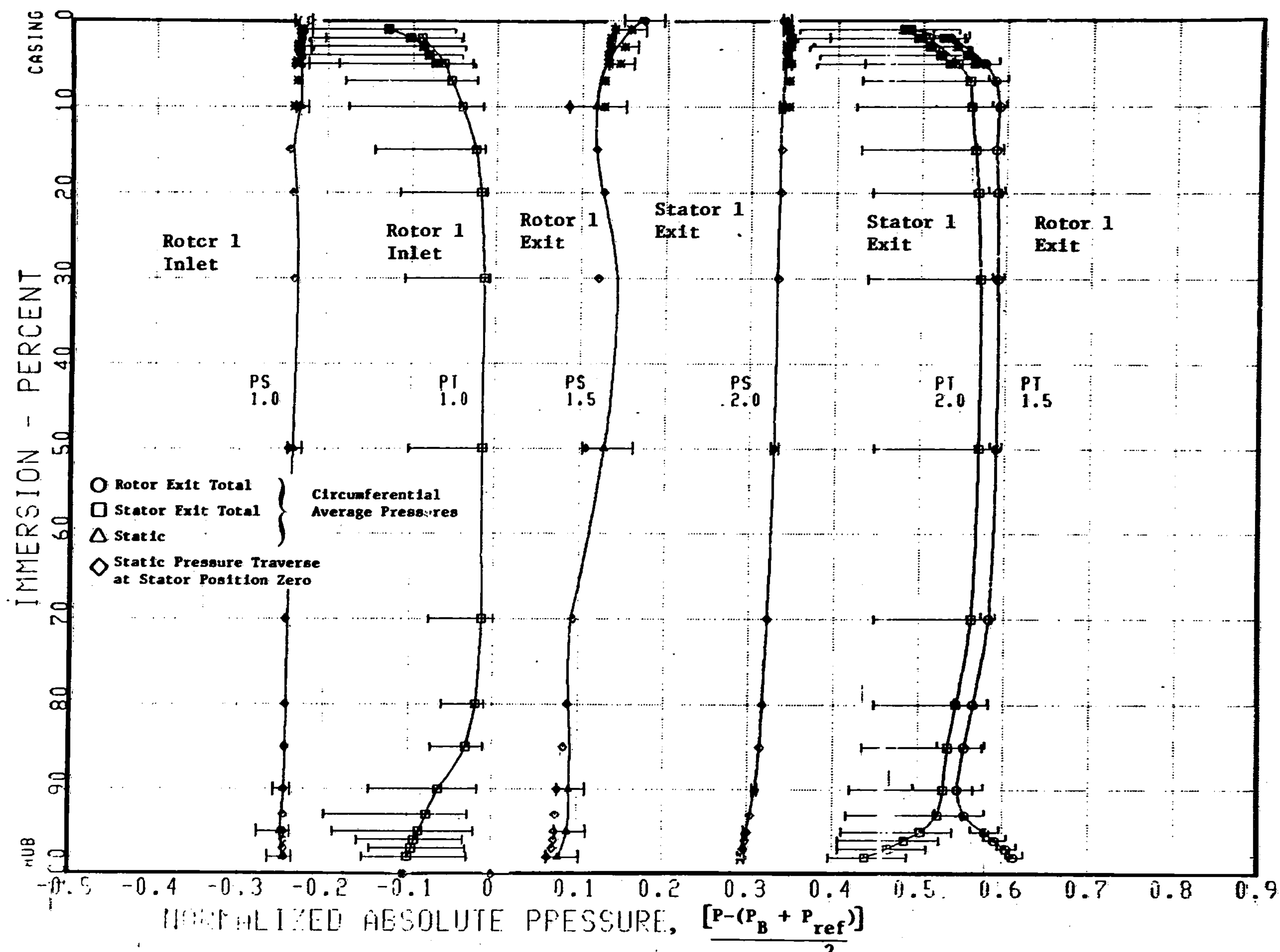


Figure 95. Normalized Absolute Total Pressure and Static Pressure for Rotor B/Stator B Single-Stage Configuration, Design Point Throttle.

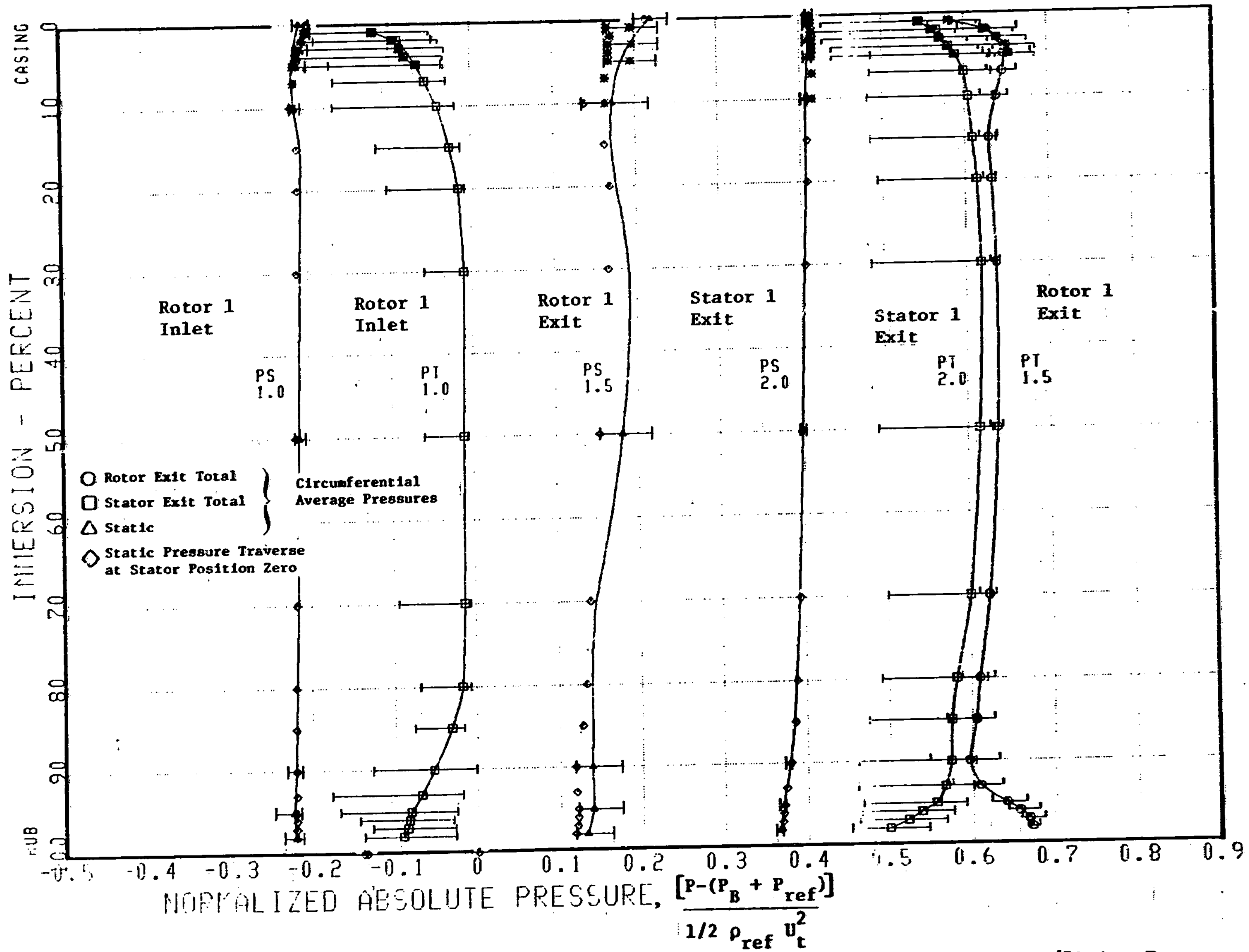


Figure 96. Normalized Absolute Total Pressure and Static Pressure for Rotor B/Stator B Single-Stage Configuration, Peak Efficiency Throttle.

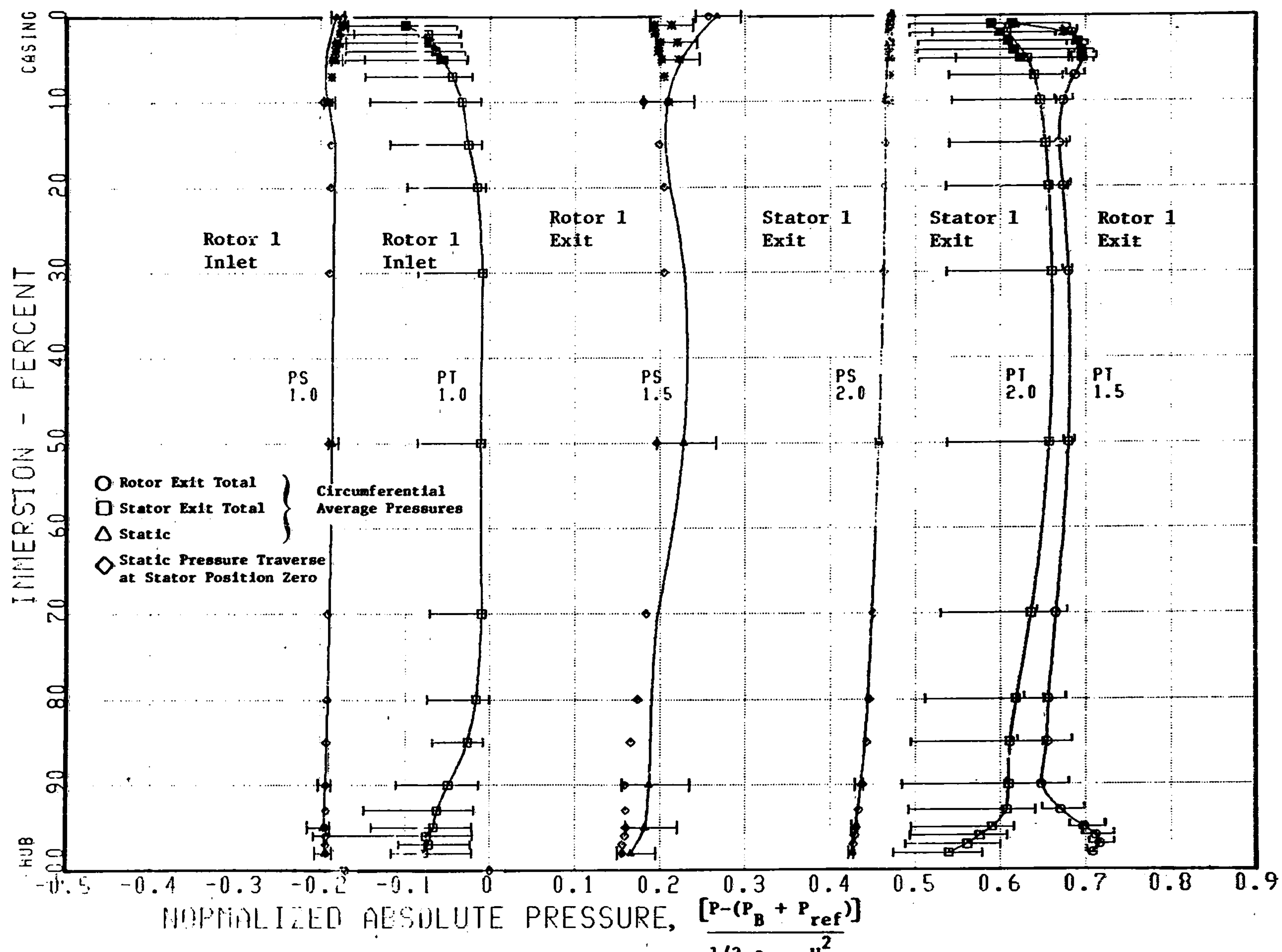


Figure 97. Normalized Absolute Total Pressure and Static Pressure for Rotor B/Stator B Single-Stage Configuration, Peak Pressure Rise/Near Stall Throttle.

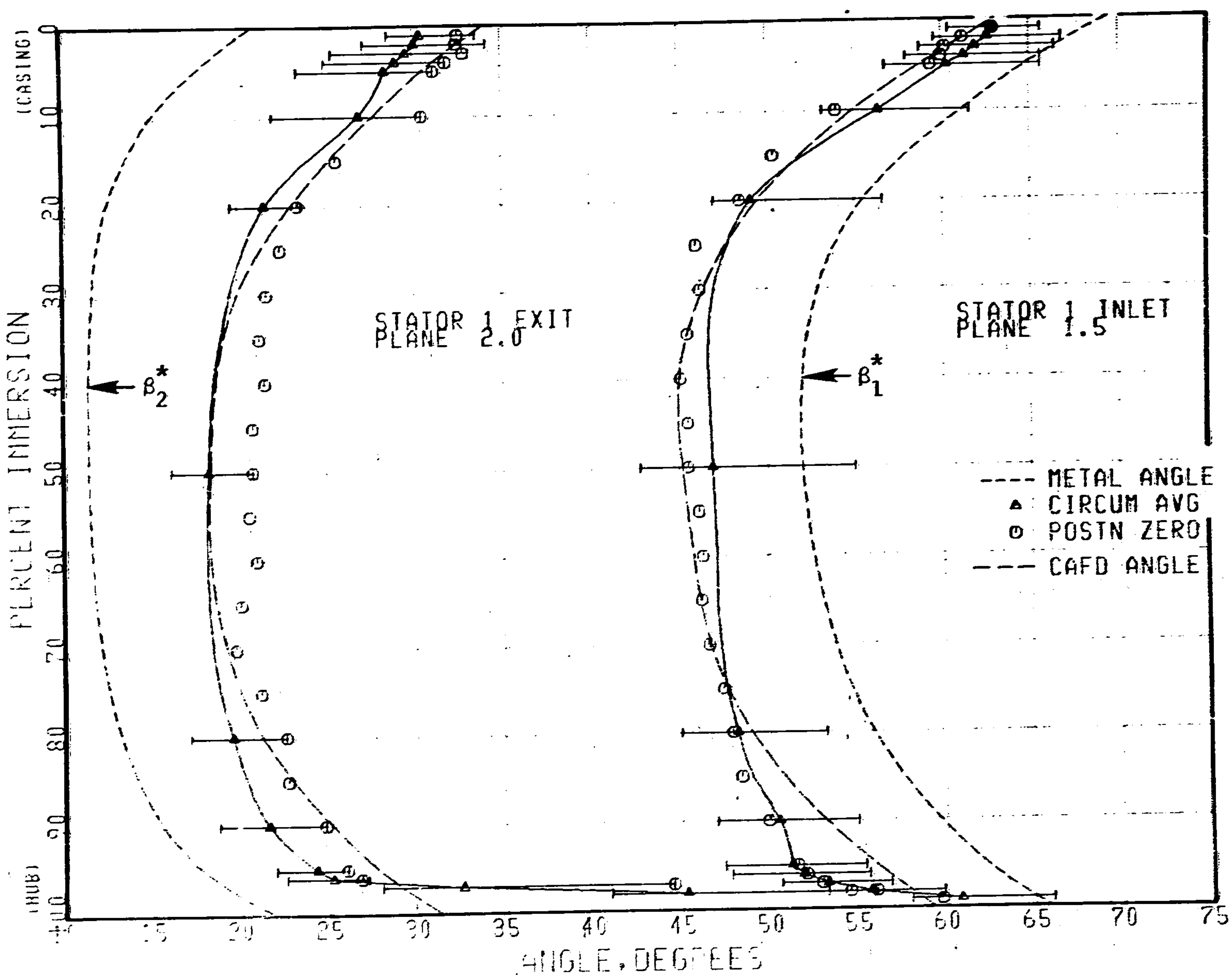


Figure 98. Absolute Flow Angles for Rotor B/Stator B Single-Stage Configuration, Design Point Throttle.

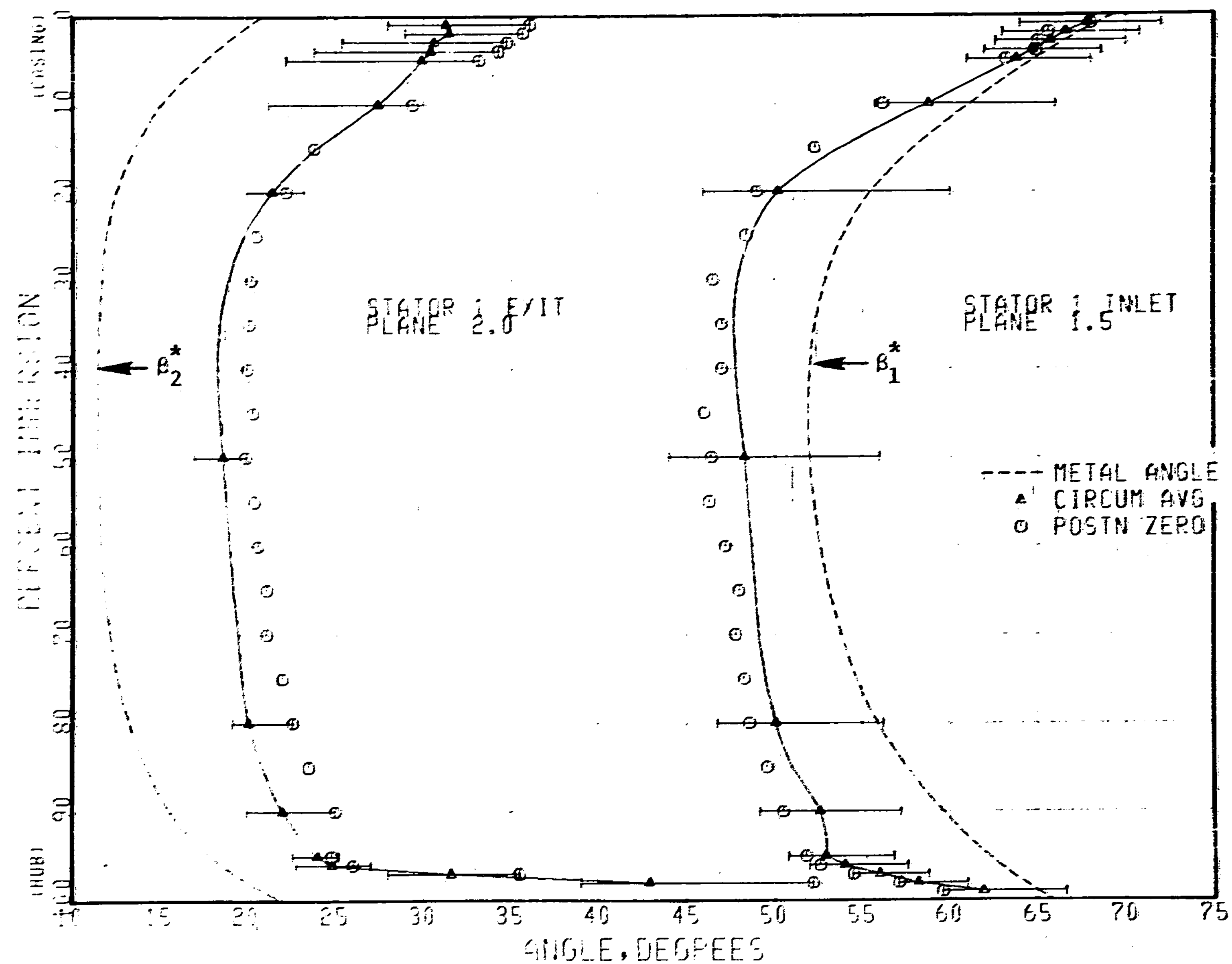


Figure 99. Absolute Flow Angles for Rotor B/Stator B Single-Stage Configuration, Peak Efficiency Throttle.

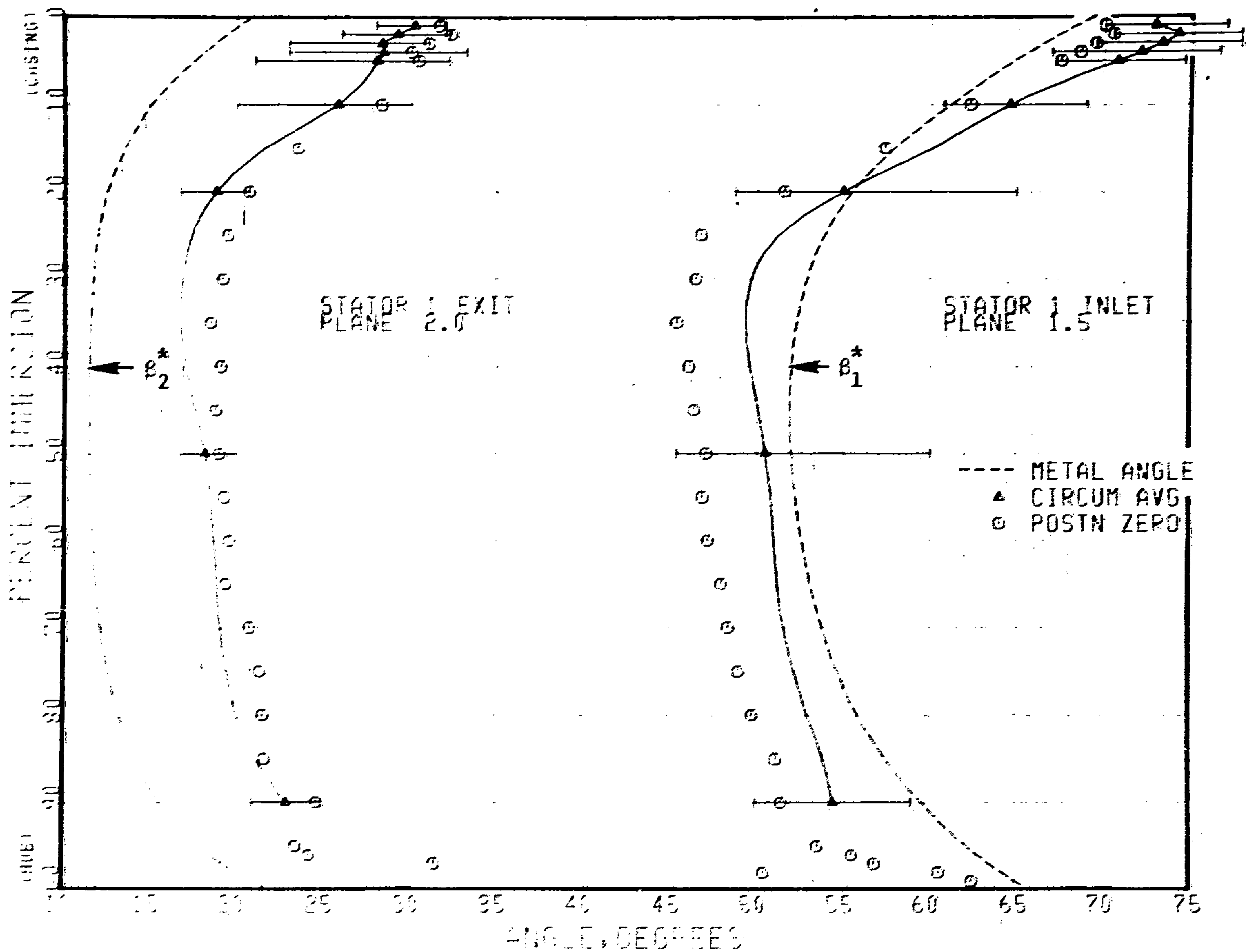


Figure 100. Absolute Flow Angles for Rotor B/Stator B Single-Stage Configuration, Peak Pressure Rise/Near Stall Throttle.

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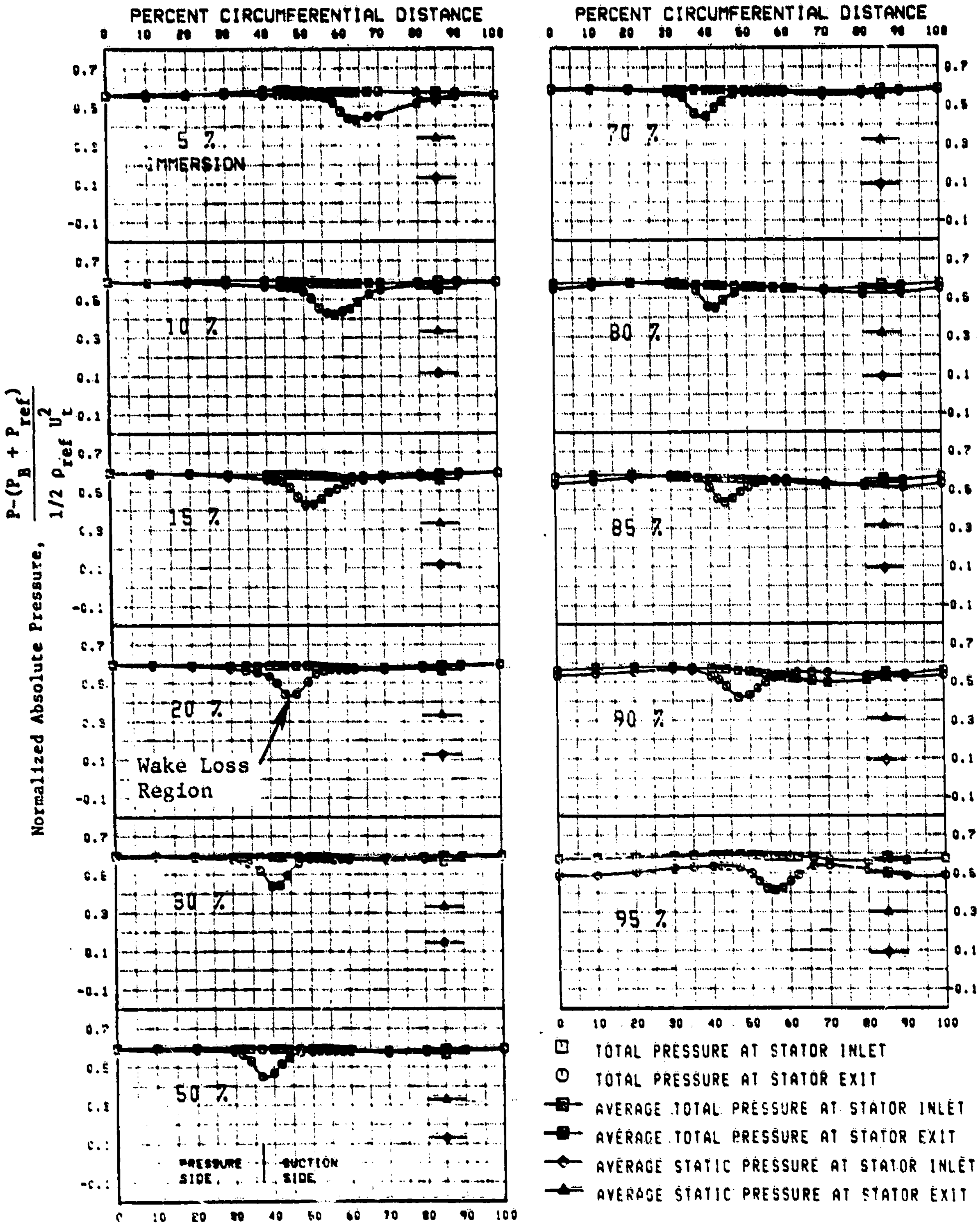

Figure 101. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Single-Stage Configuration, Design Point Throttle.

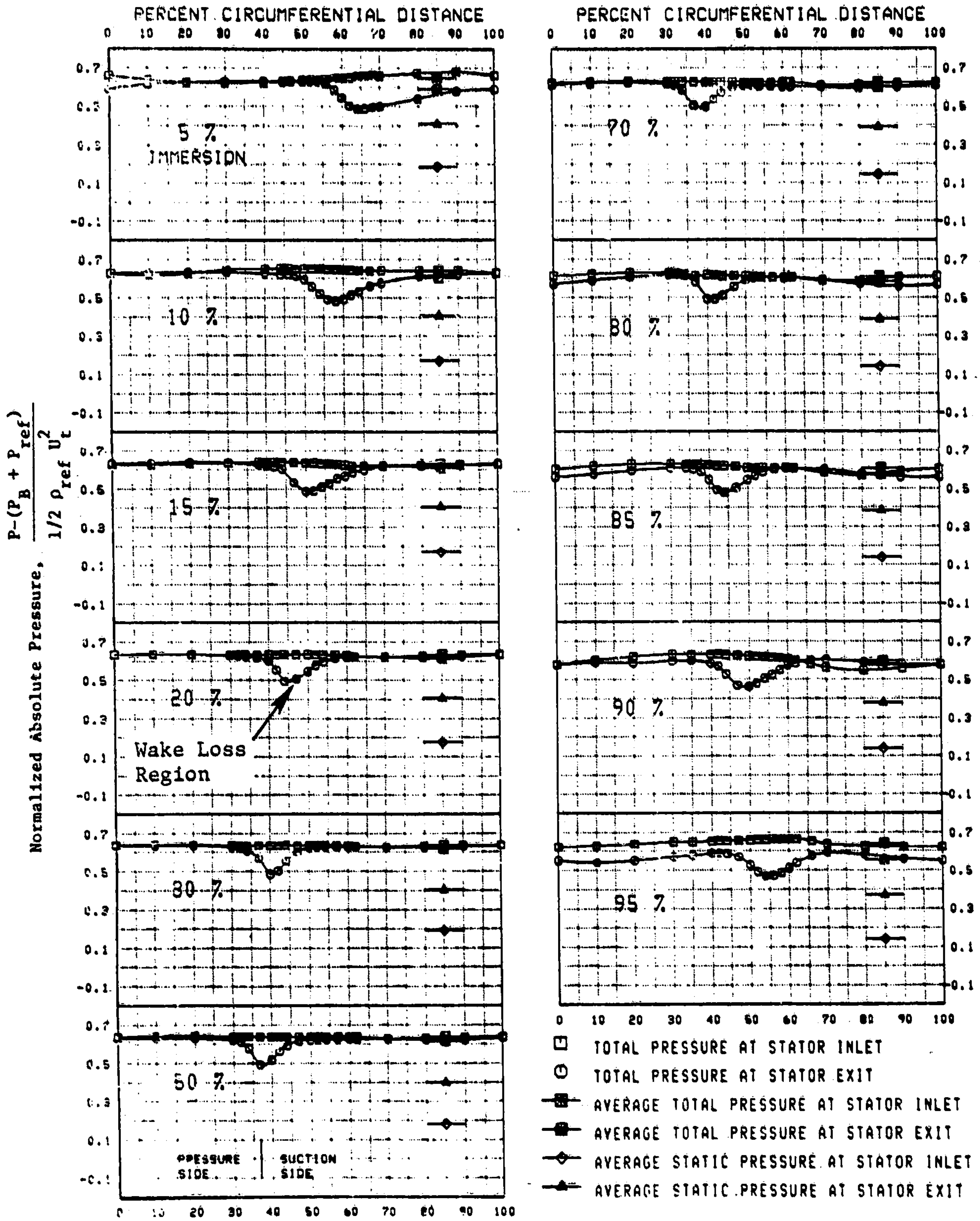

Figure 102. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Single-Stage Configuration, Peak Efficiency Throttle.

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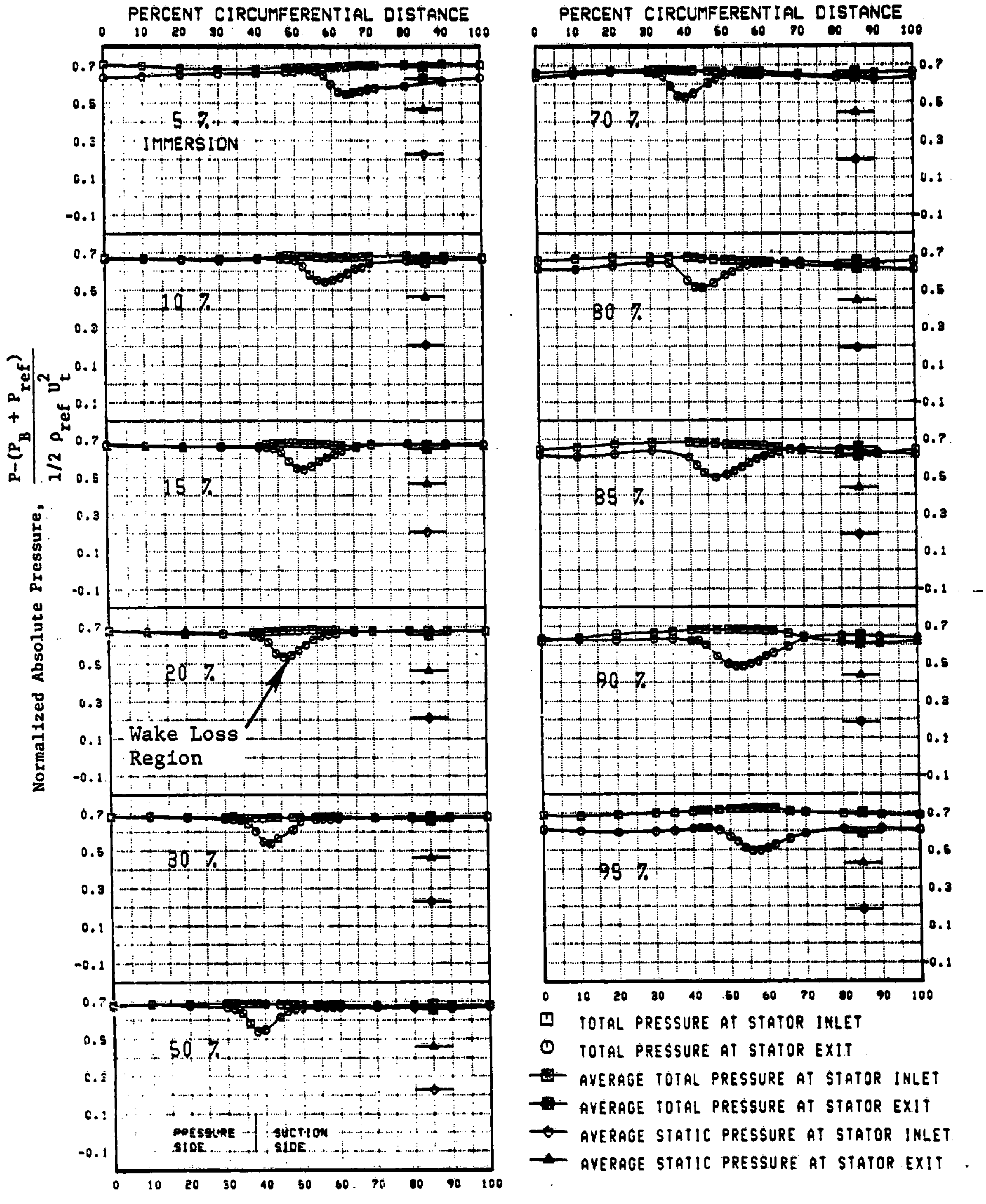

Figure 103. Circumferential Variation of Normalized Absolute Total Pressure and Static Pressure, Rotor B/Stator B Single-Stage Configuration, Peak Pressure Rise/Near Stall Throttle.

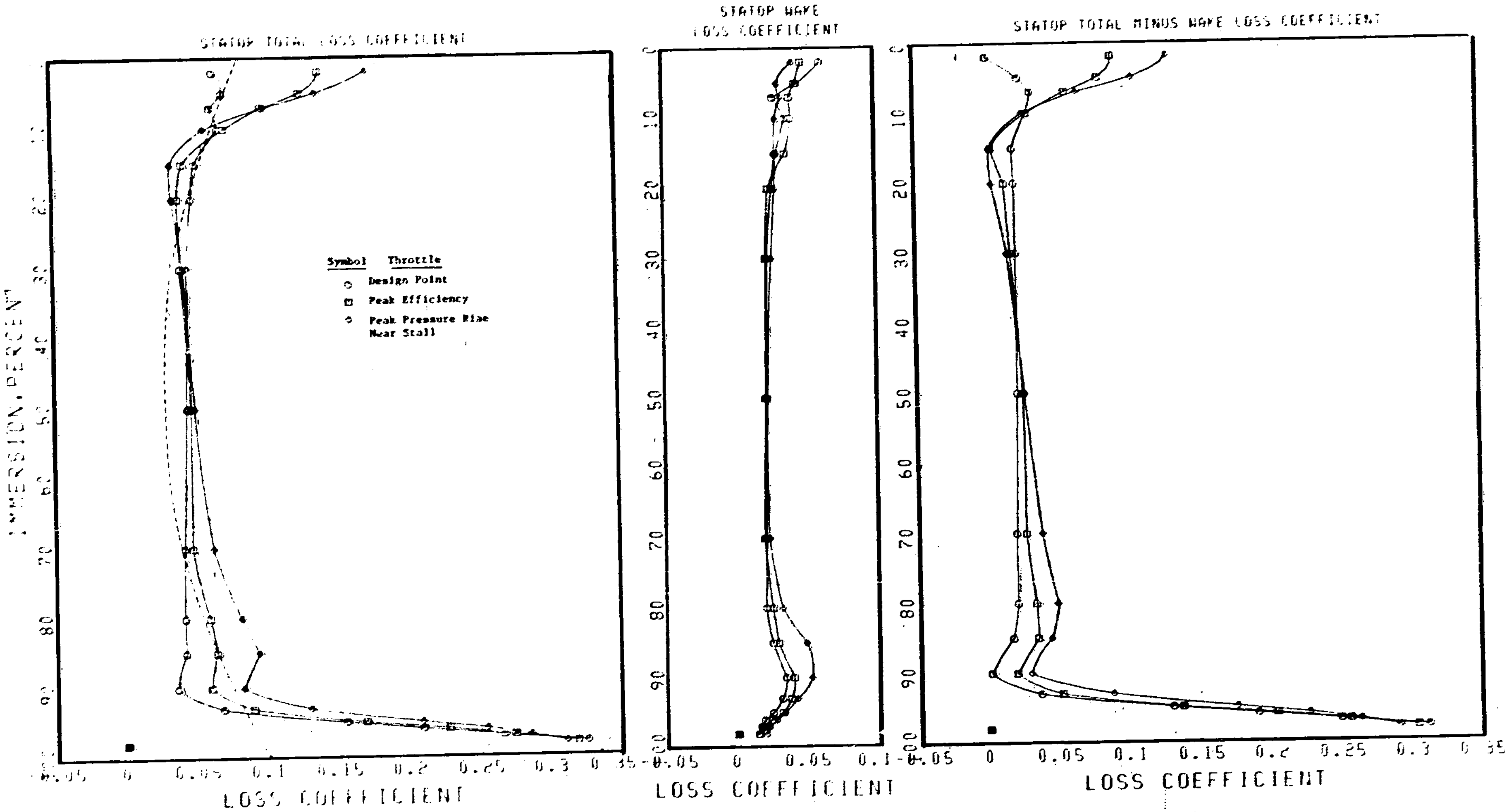

Figure 104. Stator Total Loss Coefficients, Wake Loss Coefficients, and Total Minus Wake Loss Coefficients for Rotor B/Stator B Single-Stage Configuration.

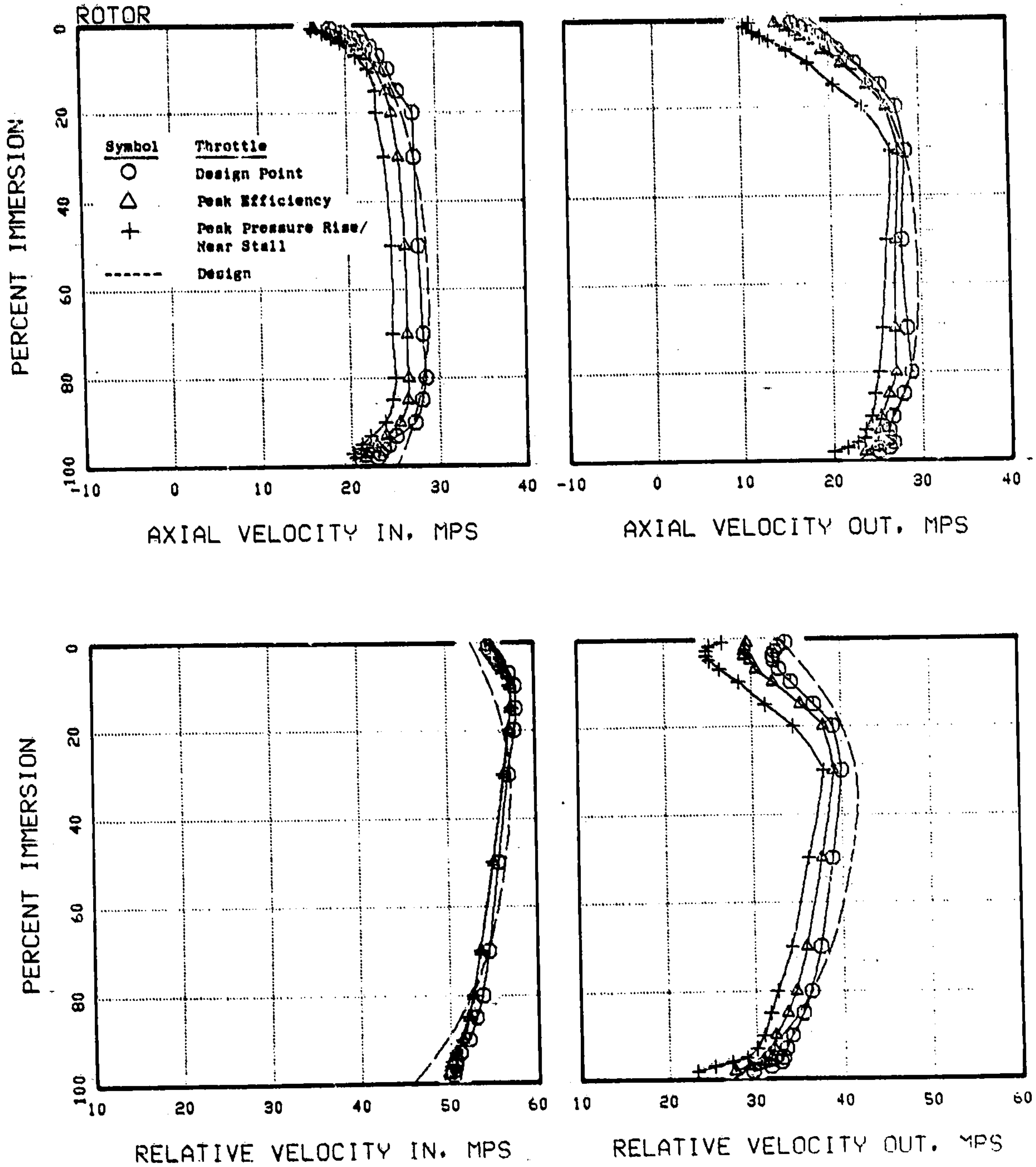

Figure 105. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Single-Stage Configuration.

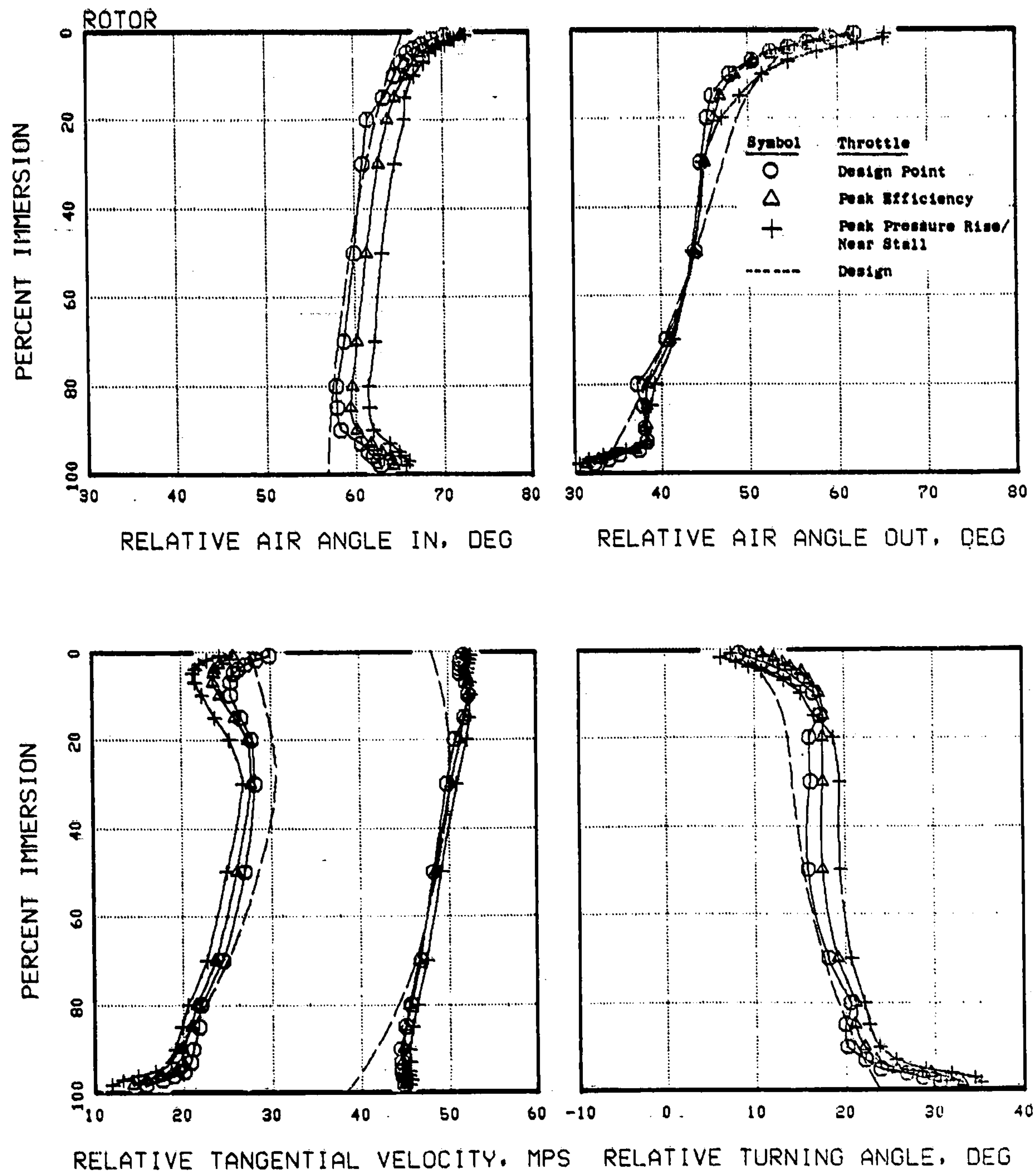

Figure 106. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Single-Stage Configuration.

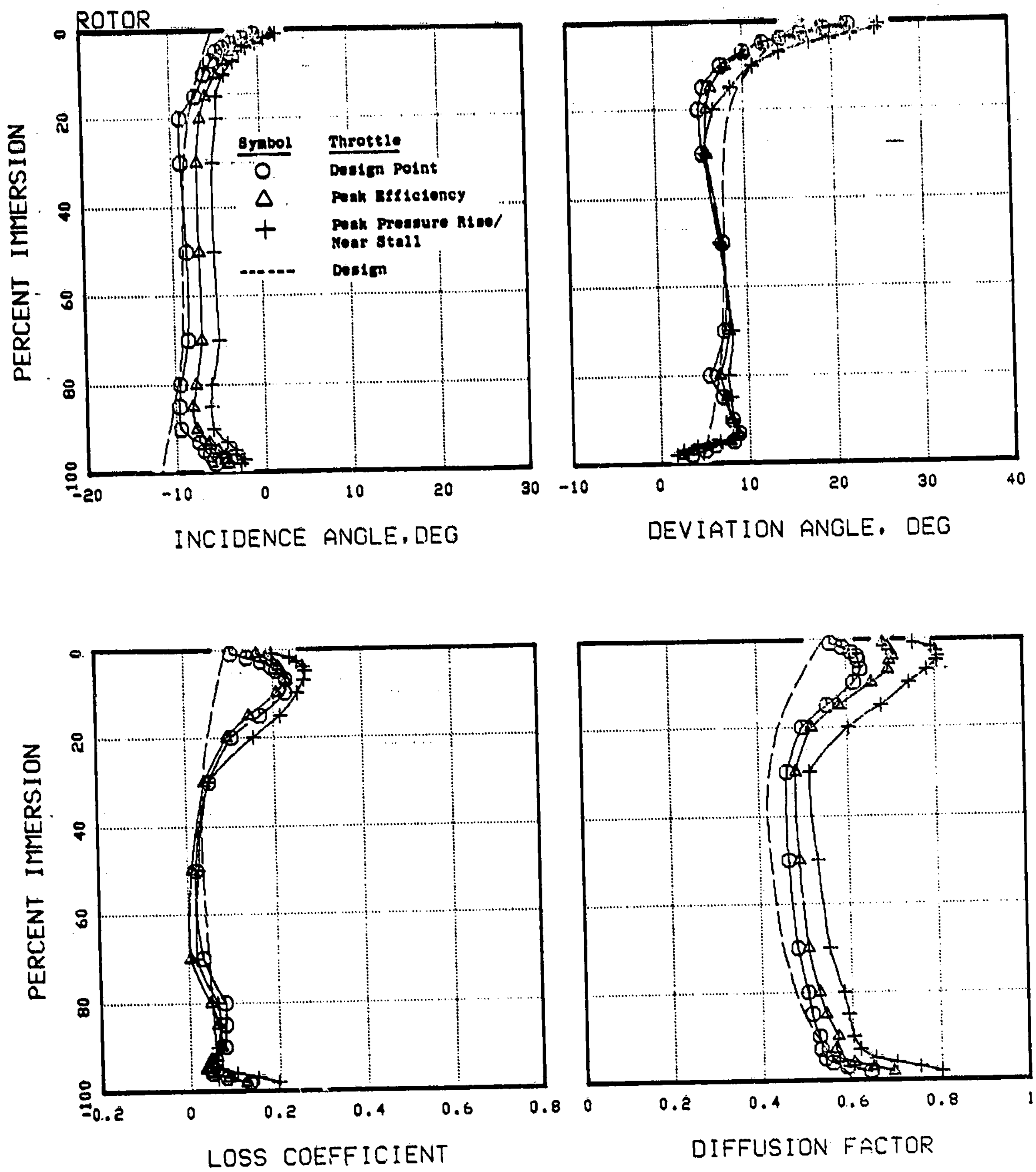

Figure 107. Rotor Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Single-Stage Configuration.

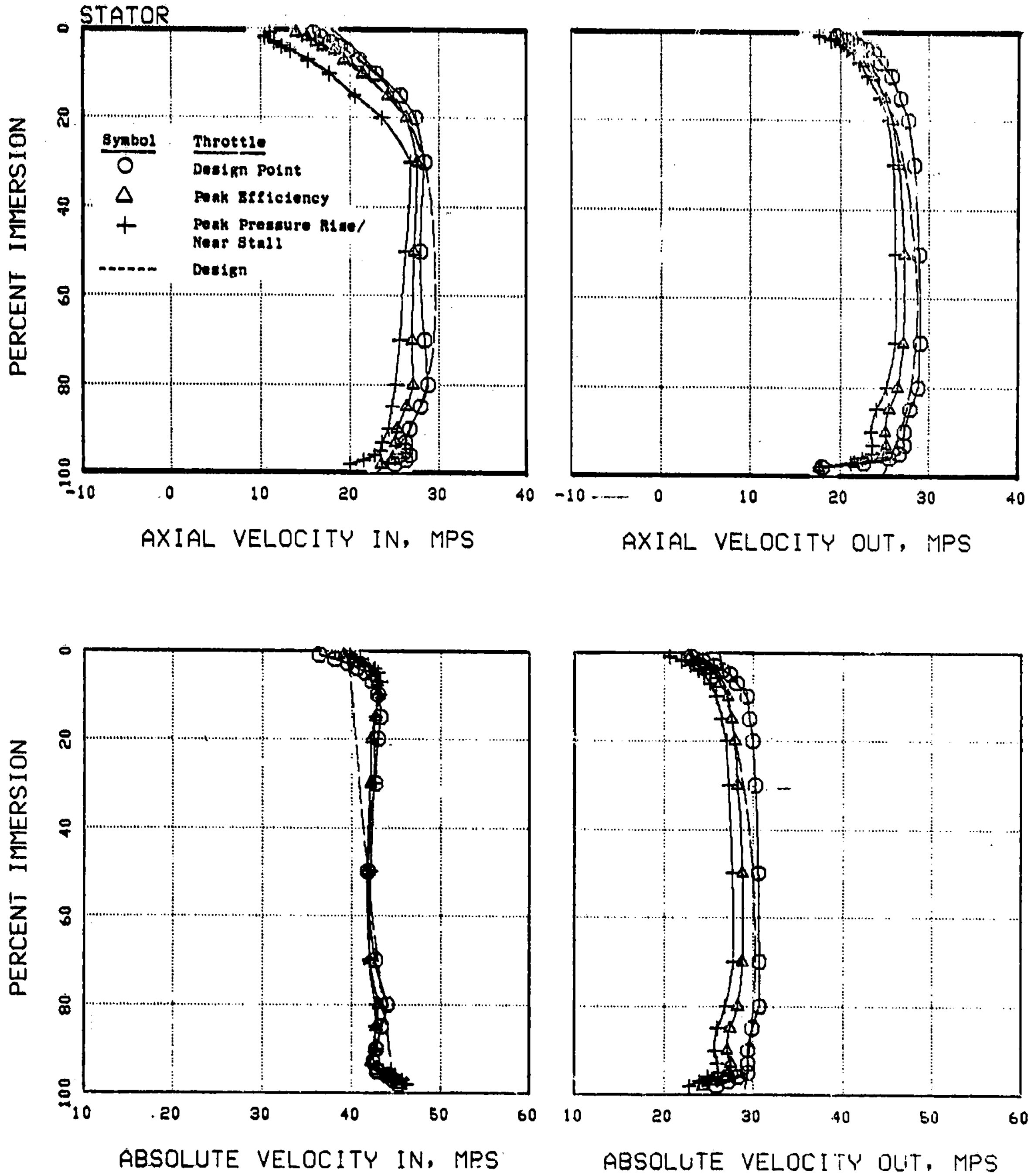

Figure 108. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Single-Stage Configuration.

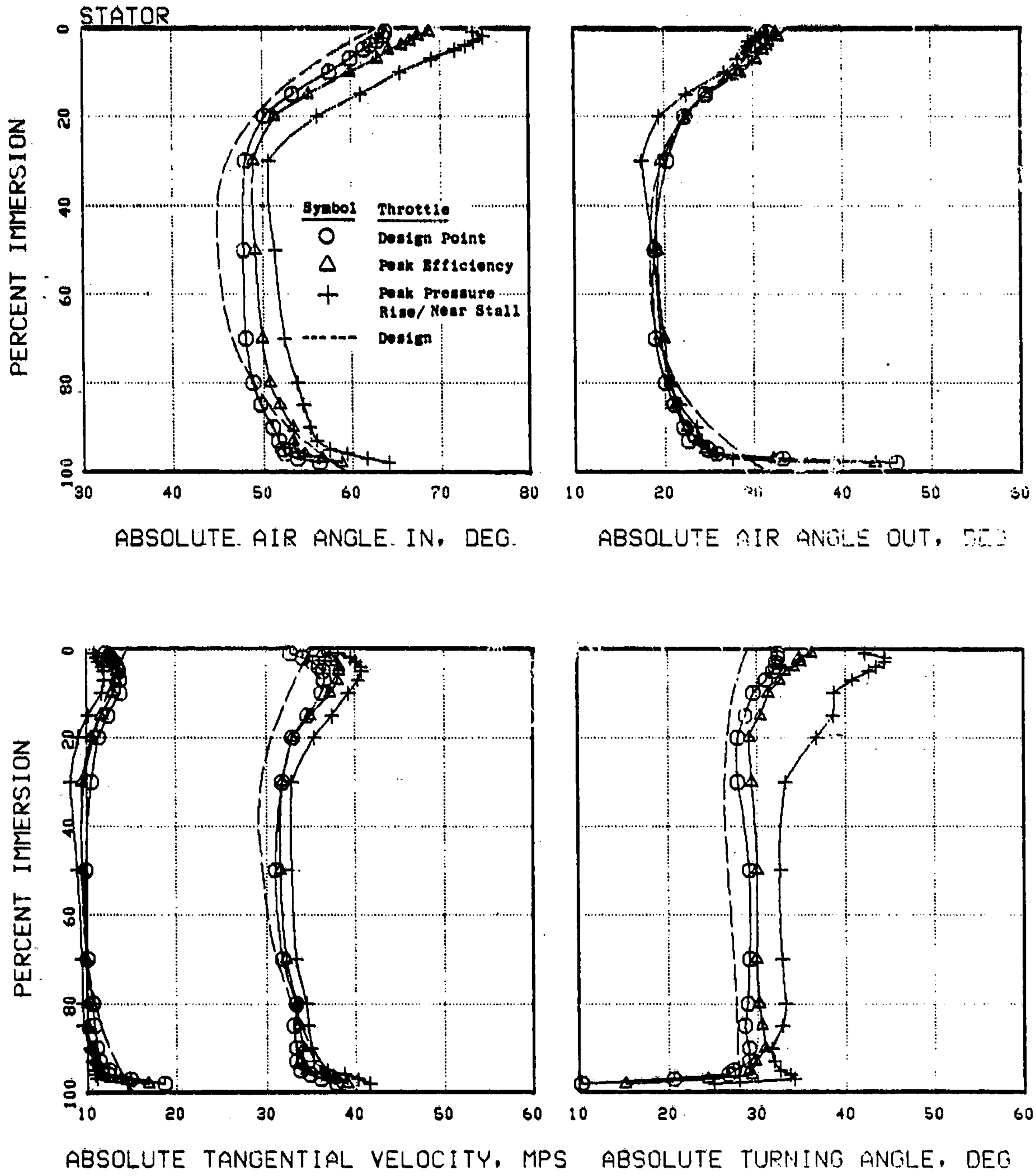

Figure 109. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Single-Stage Configuration.

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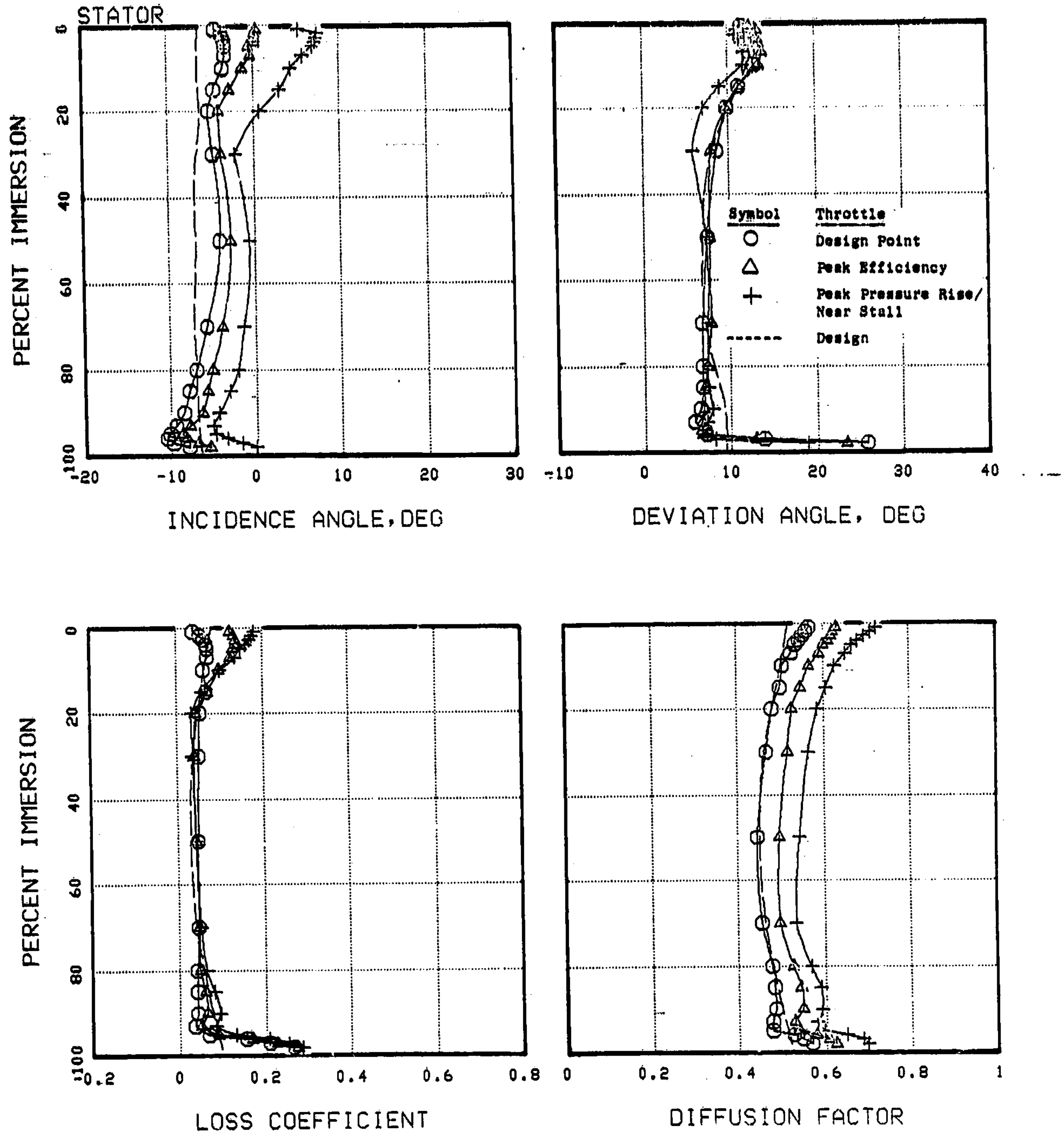

Figure 110. Stator Vector Diagram Quantities Versus Percent Immersion, Rotor B/Stator B Single-Stage Configuration.

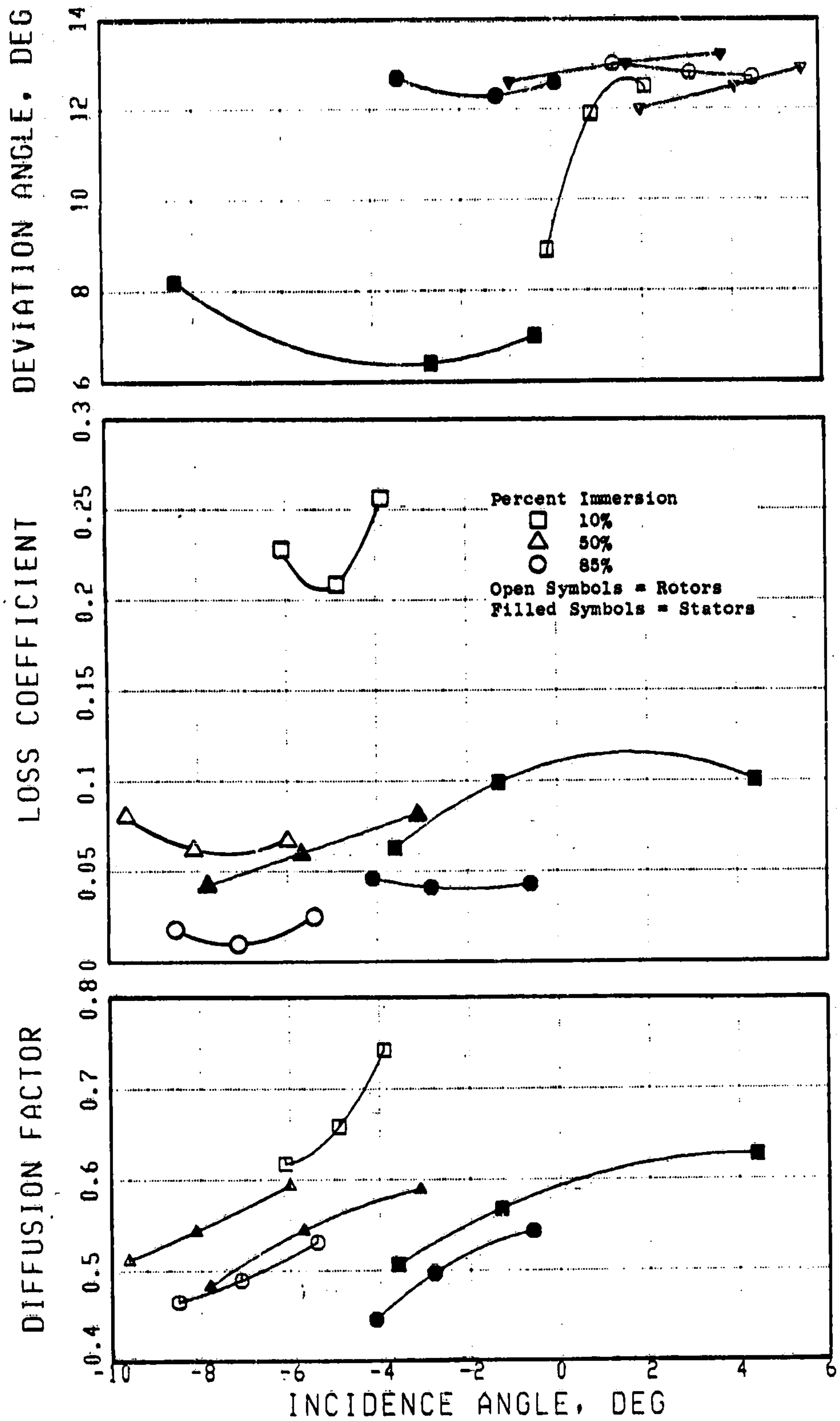

Figure 111. Diffusion Factor, Loss Coefficient and Deviation Angle Versus Incidence Angle, Rotor B/Stator B Single-Stage Configuration.

8.0 TABLES

Table 1. Instrumentation for the Test Program.

Instrumentation	Plane Location										
	0.1 Bellmouth	0.5 IGV Inlet	1.0 R1 Inlet	1.5 S1 Inlet	2.0 R2 Inlet	2.5 S2 Inlet	3.0 R3 Inlet	3.5 S3 Inlet	4.0 R4 Inlet	4.5 S4 Inlet	5.0 Compressor Discharge
Static Pressure											
1. Casing Statics 11 Equally-Spaced Taps	X	X	X	X	X	X	X	X	X	X	X
2. Hub Statics 11 Equally-Spaced Taps	X	X	X								X
3. Hub Seal Cavity Static Pressures				X	X	X	X	X	X	X	
4. Single Element Traverse Probe*											
5. Blade or Vane Surface Static Pressure Taps							R3	S3			
Total Pressure											
1. 11 Element Radial Rake			X				X	X	X		X
2. Single Element Traverse Probe*							X	X	X		
3. Rotating Radial Rake								X			
Flow Angle											
1. Single Element Traverse Probe*											
Hot Film Probe*											

*Provisions for this instrumentation have been made at the planes indicated. However, the instrumentation was not in place for the screening tests.

Table 2. Overall Test Plan Outline for Complete Program.

I. Tests Using Stage A Blading (Reported in Ref. 1)	
A. Shakedown Test	5 data points
B. 4-Stage Configuration (Third Stage as Test Stage)	
1. Preview Data	15 data points
2. Stall Determination	As Appropriate
3. Casing Treatment Data	15 data points
4. Reynolds Number Data	30 data points
5. Standard Data	4 data points
6. Blade Element Data	4 data points
7. Blade Surface Pressure Data	2 data points
8. Detailed Wall Boundary Layer Data	2 data points
C. 1-Stage Configuration	
1. Preview Data	15 data points
2. Stall Determination	As Appropriate
3. Standard Data	4 data points
4. Blade Element Data	4 data points
5. Blade Surface Pressure Data	4 data points
6. Detailed Wall Boundary Layer Data	2 data points
D. 4-Stage Configuration (First Stage as Test Stage)	
1. Blade Element Data	4 data points
2. Blade Surface Pressure Data	4 data points
3. Detailed Wall Boundary Layer Data	2 data points
II. Screen Tests	
A. 4-Stage Configuration with Rotor B and Stator A	
1. Preview Data	15 data points
2. Stall Determination	As Appropriate
3. Standard Data	4 data points
4. Blade Surface Pressure Data	4 data points
B. 4-Stage Configuration with Stator B and Rotor A (Same Data as II.A.)	
C. 4-Stage Configuration with Stator C and Rotor A (Same Data as II.A.)	
D. 4-Stage Configuration with Rotor B and Stator B (Same Data as II.A.)	
III. Tests Using Rotor B and Stator B Designs	
A. 4-Stage Configuration, Third Stage as Test Stage	
1. Same Data as I.B., Except Delete I.B.3. and 4.	
2. Rotor Tip Clearance Data, Casement Treatment 4 Stages	
3. Rotor Tip Clearance Data, Casing Treatment Stage 1.	
B. 1-Stage Configuration	
1. Same Data as I.C., Except Delete I.C.4. (Rotor Tip Clearance Data)	
IV. Tests Using Rotor C/Stator B Designs	
A. 4-Stage Configuration, Third Stage as Test Stage	
1. Same Data as I.B., Except Delete I.B.3. and 4.	

Table 3. Preview Data for Rotor B/ Stator B, Four-Stage Configuration.

Test 66A.2 Four-Stage Configuration

FLOW COEF	P COEF CASING	WORK, COEF	TORQUE EFFICI
0.45895	0.44056	0.51058	0.86285
0.44975	0.46727	0.53303	0.87662
0.44289	0.48467	0.54861	0.88345
0.43570	0.50421	0.56549	0.89164
0.42765	0.52337	0.58308	0.89758
0.41852	0.54276	0.60229	0.90115
0.41417	0.55137	0.61068	0.90288
0.40893	0.56076	0.62045	0.90379
0.40437	0.56931	0.62991	0.90381
0.39893	0.57875	0.63969	0.90473
0.39322	0.58892	0.65035	0.90554
0.38801	0.59761	0.66041	0.90491
0.38186	0.60761	0.67227	0.90381
0.37615	0.61596	0.68228	0.90280
0.36939	0.62467	0.69369	0.90050
0.36253	0.63039	0.70464	0.89462
0.35373	0.63335	0.71612	0.88442
0.34520	0.63210	0.72413	0.87291
0.34246	0.63166	0.72566	0.87046
0.43867	0.49290	0.55736	0.88436
0.40490	0.56500	0.62751	0.90038
0.38516	0.59872	0.66470	0.90073
0.35938	0.62865	0.70826	0.88760
0.44011	0.49388	0.55618	0.88799
0.40627	0.56722	0.62756	0.90386
0.38662	0.59908	0.66368	0.90267
0.36097	0.63014	0.70690	0.89140

Table 4. Preview Data for Rotor B/Stator B, (a) Four-Stage Configuration Increased Rotor Tip Clearance, (b) Four-Stage Configuration, Increased Rotor Tip Clearance and Casing Treatment, (c) Single-Stage Configuration.

(a) Four-Stage Configuration Increased Rotor Tip Clearance

FLOW COEF	P COEF CASING	WORK, COEF	TORQUE EFFICI
0.45706	0.44116	0.51729	0.85863
0.44711	0.47066	0.53958	0.87225
0.44012	0.48921	0.55600	0.87987
0.43192	0.50595	0.57284	0.88497
0.42289	0.52418	0.59014	0.88823
0.41289	0.54094	0.60788	0.88988
0.40725	0.54378	0.61716	0.88920
0.40156	0.55539	0.62630	0.88678
0.39574	0.56157	0.63376	0.88609
0.38690	0.56629	0.64194	0.88216
0.38187	0.56965	0.64964	0.87687
0.37553	0.57146	0.65642	0.87057
0.42236	0.52427	0.59112	0.88691
0.41219	0.54097	0.60855	0.88895
0.40719	0.54873	0.61732	0.88890
0.40140	0.55572	0.62659	0.88639
0.39530	0.56206	0.63473	0.88551
0.45650	0.44312	0.51642	0.85806
0.44676	0.46926	0.53819	0.87193
0.43934	0.48737	0.55470	0.87862
0.43147	0.50520	0.57081	0.88506
0.42240	0.52260	0.58801	0.88876
0.41261	0.53905	0.60581	0.88980
0.40746	0.54626	0.61511	0.88806
0.40153	0.55408	0.62409	0.88782
0.39581	0.55986	0.63194	0.88594
0.38913	0.56137	0.64038	0.88130
0.38241	0.56758	0.64755	0.87650
0.37634	0.56988	0.65592	0.87149
0.45707	0.44296	0.51553	0.85923
0.44712	0.46983	0.53812	0.87308
0.43996	0.48735	0.55473	0.87854
0.43167	0.50689	0.57222	0.88409
0.42263	0.52304	0.58897	0.88806
0.41294	0.53913	0.60598	0.88968
0.40777	0.54580	0.61347	0.88969
0.40204	0.55315	0.62311	0.88772
0.39538	0.56065	0.63313	0.88554
0.38947	0.56463	0.63959	0.88280
0.38273	0.56748	0.64651	0.87776
0.37670	0.56949	0.65362	0.87128

(b) Four-Stage Configuration Increased Rotor Tip Clearance and Casing Treatment

FLOW COEF	P COEF CASING	WORK, COEF	TORQUE EFFICI
0.45604	0.44292	0.51544	0.85930
0.44653	0.46961	0.53902	0.87123
0.43934	0.48918	0.55625	0.87943
0.43163	0.50767	0.57317	0.88571
0.42308	0.52518	0.59073	0.88904
0.41304	0.54270	0.60885	0.89136
0.40766	0.55039	0.61781	0.89088
0.40187	0.55760	0.62654	0.88996
0.39610	0.56309	0.63413	0.88797
0.38727	0.56168	0.63913	0.87882
0.37837	0.55835	0.64349	0.86769
0.37611	0.55778	0.64491	0.86490
0.45586	0.44365	0.51680	0.85846
0.44643	0.46986	0.53920	0.87140
0.43956	0.48894	0.55545	0.88025
0.43189	0.50831	0.57386	0.88577
0.42298	0.52647	0.59117	0.89055
0.41291	0.54367	0.60921	0.89240
0.40808	0.55112	0.61799	0.89179
0.40236	0.55883	0.62726	0.89090
0.39594	0.56325	0.63424	0.88806
0.38769	0.56249	0.63922	0.87995
0.37821	0.55907	0.64335	0.86900
0.37654	0.55877	0.64490	0.86644
0.45618	0.44311	0.51546	0.85964
0.44633	0.47096	0.54010	0.87199
0.43846	0.48767	0.55501	0.87867
0.43100	0.50715	0.57330	0.88462
0.42188	0.52484	0.59109	0.88792
0.41220	0.54220	0.60859	0.89091
0.40725	0.54975	0.61684	0.89123
0.40132	0.55605	0.62515	0.88945
0.39508	0.56128	0.63294	0.88678
0.38633	0.56007	0.63831	0.87742
0.37678	0.55698	0.64286	0.86641
0.37536	0.55677	0.64452	0.86385

(c) Single-Stage Configuration

FLOW COEF	P COEF CASING	WORK, COEF	TORQUE EFFICI
0.45461	0.48245	0.58492	0.82482
0.44764	0.50192	0.60136	0.83464
0.43968	0.52347	0.62139	0.84242
0.43276	0.53989	0.63784	0.84644
0.42523	0.55838	0.65608	0.85108
0.41650	0.57652	0.67553	0.85344
0.41209	0.58654	0.68644	0.85447
0.40694	0.59672	0.69810	0.85479
0.40151	0.60633	0.70893	0.85527
0.39606	0.61662	0.72045	0.85588
0.39007	0.62699	0.73179	0.85678
0.38360	0.63776	0.74477	0.85632
0.37691	0.64664	0.75675	0.85450
0.36926	0.65468	0.76874	0.85163
0.36440	0.65819	0.77472	0.84958
0.35548	0.66036	0.78866	0.83731
0.45464	0.48360	0.58735	0.82335
0.44769	0.50167	0.60327	0.83158
0.43984	0.52319	0.62230	0.84074
0.43323	0.54089	0.63932	0.84603
0.42574	0.55871	0.65610	0.85156
0.41732	0.57792	0.67437	0.85698
0.41243	0.58702	0.68508	0.85687
0.40768	0.59713	0.69598	0.85797
0.40254	0.60816	0.70656	0.86074
0.39685	0.61787	0.71910	0.85923
0.39087	0.62727	0.73074	0.85840
0.38439	0.63612	0.74117	0.85827
0.37783	0.64569	0.75325	0.85721
0.37052	0.65487	0.76651	0.85435
0.36572	0.65861	0.77140	0.85379
0.35682	0.65989	0.78284	0.84294
0.45424	0.48146	0.58692	0.82032
0.44747	0.50156	0.60399	0.83041
0.43928	0.52223	0.62333	0.83781
0.43255	0.53877	0.63859	0.84370
0.42504	0.55725	0.65605	0.84940
0.41649	0.57664	0.67488	0.85443
0.41178	0.58493	0.68535	0.85348
0.40671	0.59539	0.69703	0.85419
0.40143	0.60639	0.70779	0.85674
0.39580	0.61614	0.71949	0.85636
0.38995	0.62571	0.73209	0.85470
0.38343	0.63585	0.74563	0.85277
0.37676	0.64555	0.75750	0.85222
0.36928	0.65445	0.76802	0.85213
0.36434	0.65733	0.77578	0.84731
0.35530	0.65882	0.78815	0.83591

Table 5. Blade Surface Static Pressures, Rotor B/Stator B Four-Stage Configuration, Third Stage Is Test Stage.

IMMERSION(%)= 5

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	[illegible]	0.9619	1.1516	1.3280	1.4268
8.00	[illegible]	1.1011	1.2372	1.2938	1.4495
20.00	[illegible]	[illegible]	1.3242	1.4587	1.5053
30.00	[illegible]	[illegible]	1.3692	1.4846	1.5419
45.00	[illegible]	[illegible]	1.4176	1.5013	1.5478
60.00	[illegible]	[illegible]	1.4136	1.4981	1.5425
70.00	1.0835	1.3078	1.3973	1.5040	1.5299
80.00	1.0928	1.3026	1.4021	1.5089	1.5526
90.00	1.0916	1.2918	1.4157	1.5137	1.5668
95.00	1.0647	1.2766	1.2664	1.5007	1.5563

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	[illegible]	0.7913	0.8085	0.8513	0.8725
8.00	0.6902	0.8200	0.8897	0.9514	0.9672
13.00	0.6461	0.7959	0.8437	0.8955	0.9180
20.00	0.5971	0.7380	0.8006	0.8286	0.8585
25.00	0.5671	0.6795	0.7345	0.7918	0.8285
30.00	0.5200	0.6466	0.7268	0.7877	0.8320
35.00	0.4883	0.6150	0.7226	0.8108	0.8588
40.00	0.4538	0.6127	0.7669	0.8502	0.9113
50.00	0.4378	0.6816	0.8263	0.9457	0.9965
60.00	0.4970	0.7424	0.9083	1.0344	1.0964
70.00	0.5719	0.8373	0.9900	1.1315	1.1913
80.00	0.6598	0.9392	1.0917	1.2262	1.2968
90.00	0.7935	1.0588	1.2133	1.3384	1.4016
95.00	0.8899	1.1504	1.2668	1.3338	1.4556

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.2914	0.8249	1.0819	1.3161	1.4515
8.00	0.8245	1.1114	1.2655	1.4188	1.5099
20.00	0.9518	1.1893	1.4702	1.4966	1.5419
30.00	0.9795	1.2262	1.3559	1.4993	1.5447
45.00	1.0036	1.2583	1.3895	1.5043	1.5641
60.00	1.0495	1.2732	1.3687	1.5105	1.5691
70.00	1.0637	1.2825	1.4400	1.5259	1.5564
80.00	1.0623	1.2784	1.4095	1.5358	1.5825
90.00	1.0650	1.2732	1.3951	1.5058	1.5680

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.7934	0.8284	0.8760	0.8633	0.8240
8.00	0.6627	0.7877	0.8623	0.9047	0.9479
13.00	0.5909	0.7312	0.8143	0.8893	0.8038
20.00	0.5257	0.6832	0.7944	0.8626	0.9155
25.00	0.4962	0.6743	0.7737	0.8670	0.9240
30.00	0.4780	0.6644	0.7840	0.8754	0.7719
35.00	0.4789	0.6587	0.7852	0.9052	0.9533
40.00	0.4828	0.6731	0.8070	0.9155	0.9864
50.00	0.5003	0.7145	0.8468	0.9833	1.0450
60.00	0.5241	0.7722	0.9316	1.0522	1.1184
70.00	0.5800	0.8230	0.9818	1.1313	1.1997
80.00	0.6812	0.9233	1.0847	1.2360	1.4209
90.00	0.8334	1.0433	1.1949	1.3359	1.4125
95.00	0.8602	1.0972	1.2618	1.3959	1.4768

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.1933	0.7655	1.1169	1.3259	1.4464
8.00	0.7614	1.1258	1.2984	1.2811	1.4928
20.00	0.9195	1.2103	1.3303	1.4493	1.5202
30.00	0.9563	1.2653	1.3584	1.4592	1.5209
45.00	0.9890	1.2777	1.3743	1.4851	1.5319
60.00	1.0294	1.2859	1.3508	1.4822	1.5114
70.00	1.0244	1.2927	1.4078	1.5029	1.5391
80.00	1.0093	1.2936	1.3949	1.4869	1.5310
90.00	1.0090	1.2797	1.3889	1.4586	1.5329
95.00	0.9843	1.2922	1.3925	1.4661	1.5076

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.7879	0.8870	0.8748	0.7828	0.7578
8.00	0.6087	0.7804	0.8354	0.8416	0.8704
13.00	0.5116	0.7002	0.7740	0.8106	0.8476
20.00	0.4336	0.6567	0.7408	0.8039	0.8505
25.00	0.4145	0.6517	0.7471	0.8429	0.8736
30.00	0.3959	0.6457	0.7553	0.8296	0.7955
35.00	0.4056	0.6698	0.7851	0.8697	0.9409
40.00	0.4112	0.6837	0.8210	0.9019	0.9780
50.00	0.4465	0.7405	0.8776	0.8918	1.0751
60.00	0.4978	0.8093	0.9751	1.1027	1.1665
70.00	0.5753	0.9076	1.0507	1.1805	1.2443
80.00	0.6761	1.0039	1.1481	1.2736	1.3482
90.00	0.7979	1.1071	1.2502	1.3547	1.4031
95.00	0.8791	1.1625	1.3099	1.3825	1.4503

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.3663	0.9611	1.1937	1.4145	1.6025
8.00	0.8185	1.1168	1.2771	1.4366	1.4708
20.00	0.9351	1.1681	1.4323	1.4506	1.4937
30.00	0.9256	1.2223	1.3369	1.4589	1.5025
45.00	0.9611	1.2209	1.3547	1.4725	1.4928
60.00	1.0030	1.2158	1.3703	1.4765	1.5134
70.00	1.0231	[illegible]	1.3653	1.4814	1.5279
80.00	1.0188	1.2452	1.3471	1.4720	1.4996
90.00	0.9945	1.1974	1.3465	1.4510	1.4857
95.00	0.9479	1.1961	1.3206	1.4044	1.4548

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.7667	0.8173	0.8420	0.7759	0.7580
8.00	0.6203	0.7295	0.7609	0.8318	0.8308
13.00	0.4966	0.6456	0.7139	0.7928	0.8069
20.00	0.4209	0.6133	0.5812	0.8193	0.8595
25.00	0.3974	0.5981	0.7197	0.8342	0.8978
30.00	0.3990	0.6092	0.7469	0.8685	0.9072
35.00	[illegible]	0.6407	0.7708	0.9046	0.9718
40.00	0.4226	0.6667	0.8049	0.9931	1.0135
50.00	0.4913	0.7398	0.9074	1.0525	1.1499
60.00	0.5572	0.8489	1.0090	1.1871	1.2589
70.00	0.6168	0.9419	1.1161	1.2905	1.3327
80.00	0.7601	1.0403	1.1922	1.3187	1.3744
90.00	0.8667	1.1221	1.2771	1.3655	1.3835
95.00	0.9167	1.1483	1.2353	1.3702	1.4612

IMMERSION(%)= 90

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.4692	0.9980	1.1986	1.4055	1.5184
8.00	0.8372	1.1257	1.2651	1.4113	1.4960
20.00	0.9150	1.1877	1.2933	1.4235	1.5011
30.00	0.9396	1.1772	1.3188	1.4303	1.4824
45.00	0.9669	1.2039	1.3141	1.4275	1.4969
60.00	0.9858	1.2196	1.3381	1.4411	1.5080
70.00	0.9907	1.1913	1.3380	1.4581	1.5119
80.00	0.9887	1.1889	1.3371	1.4107	1.5012
90.00	0.9746	1.2167	1.3348	1.4130	1.4712
95.00	0.9583	1.1905	1.3076	1.3951	1.5807

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.7413	0.8015	0.8181	0.7602	0.7453
8.00	0.5820	0.7174	0.7717	0.8183	0.8283
13.00	0.4879	0.6520	0.7246	0.7947	0.8497
20.00	0.4172	0.6098	0.6858	0.7965	0.8722
25.00	0.3975	0.5478	0.7180	0.8362	0.9065
30.00	0.3940	0.6091	0.7241	0.8814	0.9528
35.00	0.4164	0.6378	0.7781	0.9049	1.0161
40.00	0.4385	0.6868	0.8222	0.9774	1.0693
50.00	0.5027	0.7722	0.9252	1.0800	1.1661
60.00	0.5924	0.8551	1.0092	1.1899	1.2903
70.00	0.6991	0.9787	1.1150	1.2487	1.2845
80.00	0.8021	1.0615	1.1914	1.2947	1.3513
90.00	0.8740	1.1290	1.2081	1.3097	1.3682
95.00	0.8968	1.1330	1.2727	1.3105	1.4062

Table 6. Vane Surface Static Pressures, Rotor B/Stator B Four-Stage Configuration, Third Stage Is Test Stage.

IMMERSION(%)= 10

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.9591	1.3800	1.5505	1.7393	1.8129
8.00	1.0654	1.3950	1.5469	1.7053	1.7729
20.00	1.1370	1.4381	1.5792	1.7209	1.7826
30.00	1.1714	1.4637	1.5998	1.7386	1.7969
45.00	1.2014	1.4835	1.6191	1.7652	1.8107
60.00	1.2213	1.5017	1.6338	1.7694	1.8256
70.00	1.2324	1.5119	1.6409	1.7791	1.8315
80.00	1.2366	1.5145	1.6442	1.7804	1.7368
90.00	1.2252	1.5039	1.6333	1.7688	1.8260
95.00	1.1996	1.4736	1.6052	1.7393	1.7961

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.9910	1.1523	1.2227	1.2848	1.2954
8.00	0.9246	1.1262	1.2231	1.3222	1.3547
13.00	0.8768	1.0972	1.2092	1.3225	1.3645
20.00	0.8531	1.0982	1.2238	1.3534	1.4067
25.00	0.8494	1.1118	1.2453	1.3812	1.4367
30.00	0.8502	1.1258	1.2675	1.4094	1.4698
35.00	0.7791	1.1074	1.2424	1.3894	1.4738
40.00	0.8632	1.1604	1.3230	1.4715	1.5351
50.00	0.9068	1.2169	1.3795	1.5356	1.6008
60.00	0.9636	1.2787	1.4453	1.5976	1.6551
70.00	1.0351	1.3441	1.4963	1.6364	1.6885
80.00	1.0950	1.3866	1.5240	1.6612	1.7128
90.00	1.1345	1.4139	1.5408	1.6741	1.7253
95.00	1.1516	1.4199	1.5479	1.6804	1.7321

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.9694	1.3682	1.5360	1.7134	1.7905
8.00	1.0700	1.3914	1.5428	1.6965	1.7707
20.00	1.1402	1.4315	1.5716	1.7134	1.7748
30.00	1.1684	1.4506	1.5871	1.7272	1.7765
45.00	1.1966	1.4717	1.6064	1.7401	1.7994
60.00	1.2198	1.4943	1.6265	1.7602	1.8126
70.00	1.2284	1.5016	1.6339	1.7635	1.8190
80.00	1.2299	1.5022	1.6306	1.7621	1.8158
90.00	1.2165	1.4878	1.6167	1.7478	1.8023

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	1.0230	1.1456	1.2072	1.2763	1.2893
8.00	0.9234	1.1081	1.2079	1.3110	1.3481
13.00	0.8635	1.0785	1.1933	1.3129	1.3543
20.00	0.8411	1.0839	1.2172	1.3504	1.3992
25.00	0.8296	1.0905	1.2294	1.3712	1.4245
30.00	0.8233	1.0998	1.2469	1.3901	1.4492
35.00	0.8275	1.1165	1.2691	1.4181	1.4831
40.00	0.8432	1.1411	1.3039	1.4532	1.5183
50.00	0.8779	1.1887	1.3594	1.5150	1.5769
60.00	1.0209	1.2552	1.4253	1.5835	1.6430
70.00	1.0074	1.3210	1.4649	1.6329	1.6896
80.00	1.0751	1.3765	1.5234	1.6614	1.7133
90.00	1.1308	1.4072	1.5350	1.6750	1.7260
95.00	1.1557	1.4142	1.5375	1.6781	1.7303

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.9341	1.3392	1.5369	1.7024	1.7864
8.00	1.0510	1.3723	1.5349	1.6849	1.7624
20.00	1.1252	1.4116	1.5545	1.6971	1.7581
30.00	1.1558	1.4377	1.5746	1.7075	1.7691
45.00	1.1867	1.4594	1.5939	1.7242	1.7791
60.00	1.2105	1.4783	1.6118	1.7358	1.7859
70.00	1.2246	1.4897	1.6178	1.7447	1.7946
80.00	1.2303	1.4937	1.6235	1.7459	1.7957
90.00	1.2239	1.4852	1.6151	1.7373	1.7839
95.00	1.2069	1.4684	1.5986	1.7216	1.7629

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	1.0619	1.1719	1.2117	1.2705	1.2707
8.00	0.9144	1.0954	1.1877	1.2859	1.3177
13.00	0.8565	1.0639	1.1761	1.2896	1.3318
20.00	0.8140	1.0544	1.1845	1.3098	1.3595
25.00	0.8027	1.0612	1.2015	1.3376	1.4055
30.00	0.8001	1.0711	1.2207	1.3624	1.4330
35.00	0.8068	1.0898	1.2437	1.3949	1.4641
40.00	0.8108	1.1052	1.2869	1.4240	1.4946
50.00	0.8470	1.1527	1.3179	1.4723	1.5572
60.00	0.9013	1.2124	1.3755	1.5335	1.6109
70.00	0.9679	1.2723	1.4299	1.5805	1.6543
80.00	1.0385	1.3350	1.4807	1.6267	1.6889
90.00	1.1100	1.3930	1.5280	1.6666	1.7096
95.00	1.1463	1.4217	1.5519	1.6841	1.7207

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.8970	1.3340	1.5215	1.7135	1.8220
8.00	1.0489	1.3685	1.5231	1.6906	1.7665
20.00	1.1312	1.4153	1.5531	1.6970	1.7621
30.00	1.1622	1.4357	1.5707	1.7043	1.7640
45.00	1.1872	1.4548	1.5873	1.7161	1.7725
60.00	1.2090	1.4735	1.6014	1.7291	1.7848
70.00	1.2221	1.4834	1.6113	1.7348	1.7893
80.00	1.2250	1.4854	1.6118	1.7365	1.7881
90.00	1.2131	1.4732	1.6013	1.7239	1.7755
95.00	1.1904	1.4515	1.5765	1.6978	1.7463

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	1.0373	1.1434	1.1865	1.1930	1.1954
8.00	0.8959	1.0719	1.1643	1.2412	1.2817
13.00	0.8314	1.0395	1.1475	1.2586	1.3142
20.00	0.8030	1.0410	1.1656	1.3026	1.3706
25.00	0.7862	1.0431	1.1799	1.3246	1.3998
30.00	0.7866	1.0600	1.2016	1.3596	1.4494
35.00	0.7990	1.0837	1.2335	1.3941	1.4884
40.00	0.8043	1.1013	1.2555	1.4307	1.5225
50.00	0.8461	1.1541	1.3129	1.4900	1.5933
60.00	0.9012	1.2108	1.3668	1.5455	1.6368
70.00	0.9655	1.2724	1.4235	1.5944	1.6611
80.00	1.0281	1.3238	1.4686	1.6262	1.6680
90.00	1.0921	1.3753	1.5155	1.6436	1.6799
95.00	1.1225	1.4009	1.5350	1.6530	1.6878

IMMERSION(%)= 95

PRESSURE SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	0.9119	1.3319	1.5076	1.6964	1.7803
8.00	1.0642	1.3692	1.5185	1.6900	1.7487
20.00	1.1349	1.4166	1.5530	1.6945	1.7533
30.00	1.1595	1.4364	1.5715	1.7072	1.7622
45.00	1.1879	1.4554	1.5905	1.7214	1.7748
60.00	1.2073	1.4737	1.6060	1.7336	1.7829
70.00	1.2151	1.4809	1.6131	1.7399	1.7932
80.00	1.2139	1.4789	1.6118	1.7359	1.7858
90.00	1.2037	1.4676	1.6002	1.7224	1.7728
95.00	1.1781	1.4417	1.5693	1.6952	1.7405

SUCTION SURFACE

%CHORD	OP	DP	PE	PPR	NS
2.50	1.0274	1.1490	1.2140	1.2431	1.2752
8.00	0.9012	1.0740	1.1669	1.2453	1.2993
13.00	0.8490	1.0461	1.1506	1.2606	1.3191
20.00	0.8191	1.0405	1.1619	1.2800	1.3625
25.00	0.8065	1.0457	1.1760	1.3106	1.4168
30.00	0.8113	1.0681	1.2040	1.3513	1.4691
35.00	0.8157	1.0841	1.2297	1.3894	1.4907
40.00	0.8260	1.1092	1.2608	1.3303	1.5510
50.00	0.8695	1.1682	1.3252	1.5036	1.5957
60.00	0.9231	1.2284	1.3855	1.5609	1.6222
70.00	0.9875	1.2857	1.4398	1.5957	1.6494
80.00	1.0427	1.3297	1.4766	1.6215	1.6670
90.00	1.0892	1.3698	1.5097	1.6396	1.6800
95.00	1.1122	1.3872	1.5281	1.6495	1.6857

Table 7. Blade Surface Static Pressures, Rotor B/Stator B Four-Stage Configuration, Increased Rotor Tip Clearance.

IMMERSION(%)= 5

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.7144	1.0153	1.1965
8.00	[illegible]	1.0878	[illegible]
20.00	0.9245	1.1344	1.2360
30.00	0.9623	1.1726	1.2329
45.00	0.9978	1.1967	1.2427
60.00	[illegible]	1.1905	1.2514
70.00	1.0572	1.1972	1.2758
80.00	1.0574	1.2040	1.2695
90.00	1.0180	1.2117	1.3178
95.00	1.0292	1.2106	1.3056

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	[illegible]	0.7114	0.6665
8.00	0.6823	0.6008	0.6256
13.00	0.6134	0.7675	0.7990
20.00	0.6019	0.7124	0.7549
25.00	[illegible]	0.6755	0.7046
30.00	0.5516	0.6372	0.6682
35.00	0.5154	0.5940	0.6474
40.00	0.4798	0.5644	0.6579
50.00	0.4073	0.5819	0.7327
60.00	0.3763	0.6779	0.8164
70.00	0.4317	0.7732	0.9207
80.00	0.6189	0.8648	0.9926
90.00	0.7516	0.9785	1.0876
95.00	0.8492	1.0661	1.1642

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.4579	0.8814	1.1218
8.00	0.8537	1.0803	1.2123
20.00	0.9480	1.1511	1.2509
30.00	0.9818	1.1644	1.2514
45.00	1.0070	1.1809	1.2608
60.00	1.0280	1.1860	1.2697
70.00	1.0374	1.1961	1.2832
80.00	1.0409	1.2026	1.2904
90.00	1.0292	1.1963	1.2823

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.7430	0.7366	0.6640
8.00	0.6467	0.7225	0.7440
13.00	0.5675	0.6827	0.7375
20.00	0.5131	0.6393	0.7112
25.00	0.4857	0.6292	0.7051
30.00	0.4778	0.6261	0.7206
35.00	0.4757	0.6342	0.7364
40.00	0.4863	0.6437	0.7550
50.00	0.4779	0.6744	0.7794
60.00	0.5083	0.7109	0.8288
70.00	0.5563	0.7715	0.8964
80.00	0.6356	0.8668	0.9783
90.00	0.7655	0.9767	1.0840
95.00	0.8565	1.0576	1.1520

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.2124	0.6925	1.0145
8.00	0.7767	1.0612	1.2117
20.00	0.9288	1.1540	1.2613
30.00	0.9648	1.1756	1.2856
45.00	0.9944	1.2041	1.3046
60.00	1.0133	1.2193	1.3098
70.00	1.0215	1.2247	1.3205
80.00	1.0223	1.2226	1.3163
90.00	1.0128	1.2086	1.3124
95.00	0.9977	1.1655	1.2802

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.8201	0.8362	0.8318
8.00	0.6134	0.6913	0.7630
13.00	0.5148	0.6527	0.7033
20.00	0.4381	0.5949	0.6688
25.00	0.4141	0.5593	0.6656
30.00	0.4003	0.5835	0.6814
35.00	0.4125	0.6479	0.7367
40.00	0.4175	0.6295	0.7468
50.00	0.4711	0.6782	0.7948
60.00	0.5106	0.7462	0.8740
70.00	0.5601	0.8452	0.9483
80.00	0.6841	0.9319	1.0486
90.00	0.8112	1.0339	1.1481
95.00	0.8770	1.0995	1.2020

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.5524	0.8929	1.0438
8.00	0.8137	1.0662	1.1853
20.00	0.9109	1.1135	1.2388
30.00	0.9558	1.1623	1.2623
45.00	0.9651	1.1924	1.2646
60.00	0.9583	1.2051	1.2818
70.00	1.0127	1.2105	1.2875
80.00	1.0086	1.1938	1.2884
90.00	0.9805	1.1948	1.2673
95.00	0.9844	1.1755	1.2445

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.7877	0.8183	0.8252
8.00	0.5963	0.7193	0.7408
13.00	0.5074	0.6270	0.6846
20.00	0.4302	0.5325	0.6316
25.00	0.3965	0.5829	0.6491
30.00	0.3972	0.5818	0.6587
35.00	0.4164	0.6230	0.6951
40.00	0.4261	0.6289	0.7213
50.00	0.4791	0.6925	0.8100
60.00	0.5496	0.8008	0.9088
70.00	[illegible]	0.8887	1.0109
80.00	[illegible]	1.0010	1.0998
90.00	0.8604	1.0915	1.1751
95.00	0.9168	1.1322	1.1983

IMMERSION(%)= 90

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.3727	0.8925	1.0676
8.00	0.8121	1.0914	1.1876
20.00	0.8976	1.1456	1.2317
30.00	0.9204	1.1470	1.2463
45.00	0.9478	1.1587	1.2569
60.00	0.9536	1.1659	1.2743
70.00	0.9792	1.1774	1.2858
80.00	0.9749	1.1722	1.2746
90.00	0.9574	1.1775	1.2605
95.00	0.9318	1.0817	1.2477

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.7435	0.8031	0.8310
8.00	0.5920	0.6938	0.7560
13.00	0.4874	0.6380	0.6889
20.00	0.4441	0.5819	0.6555
25.00	0.3903	0.5786	0.6639
30.00	0.3804	0.5712	0.6648
35.00	0.4149	0.6207	0.7055
40.00	0.4176	0.6363	0.7524
50.00	0.4670	0.7268	0.8297
60.00	0.5559	0.8137	0.9395
70.00	0.6661	0.9074	1.0272
80.00	0.7310	1.0166	1.1072
90.00	0.8477	1.0563	1.1716
95.00	0.8848	1.1100	1.1929

Table 8. Vane Surface Static Pressures, Rotor B/Stator B Four-Stage Configuration, Increased Rotor Tip Clearance.

IMMERSION(%)= 10

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	1.0328	1.3897	1.5537
8.00	1.0773	1.3663	1.5004
20.00	1.1336	1.3891	1.5029
30.00	1.1630	1.4074	1.5171
45.00	1.1900	1.4298	1.5319
60.00	1.2121	1.4471	1.5447
70.00	1.2213	1.4554	1.5527
80.00	1.2249	1.4581	1.5518
90.00	1.2124	1.4467	1.5405
95.00	1.1843	1.4196	1.5133

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.9614	1.0374	1.0478
8.00	0.9078	1.0547	1.1147
13.00	0.8687	1.0453	1.1267
20.00	0.8503	1.0574	1.1653
25.00	0.8468	1.0752	1.1926
30.00	0.8589	1.0930	1.2220
35.00	0.8036	1.0689	1.2122
40.00	0.8603	1.1313	1.2733
50.00	0.9022	1.1814	1.3275
60.00	0.9525	1.2364	1.3772
70.00	1.0223	1.2934	1.4154
80.00	1.0765	1.3348	1.4415
90.00	1.1188	1.3622	1.4568
95.00	1.1371	1.3738	1.4677

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.9494	1.3340	1.5065
8.00	1.0552	1.3425	1.4839
20.00	1.1229	1.3763	1.4906
30.00	1.1492	1.3938	1.4996
45.00	1.1771	1.4147	1.5143
60.00	1.2025	1.4358	1.5330
70.00	1.2131	1.4432	1.5390
80.00	1.2116	1.4442	1.5364
90.00	1.2014	1.4314	1.5254

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.9931	1.0764	1.0516
8.00	0.9011	1.0592	1.1051
13.00	0.8461	1.0367	1.1122
20.00	0.8263	1.0464	1.1436
25.00	0.8159	1.0543	1.1685
30.00	0.8109	1.0613	1.1866
35.00	0.8152	1.0817	1.2110
40.00	0.8301	1.1048	1.2437
50.00	0.8684	1.1526	1.2998
60.00	0.9265	1.2115	1.3583
70.00	0.9914	1.2702	1.4073
80.00	1.0560	1.3245	1.4405
90.00	1.1141	1.3584	1.4576
95.00	1.1385	1.3719	1.4644

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.8686	1.2265	1.3849
8.00	1.0206	1.2906	1.4197
20.00	1.0985	1.3507	1.4613
30.00	1.1352	1.3776	1.4928
45.00	1.1655	1.4018	1.5031
60.00	1.1913	1.4213	1.5212
70.00	1.2050	1.4323	1.5265
80.00	1.2112	1.4375	1.5304
90.00	1.2054	1.4314	1.5192
95.00	1.1881	1.4132	1.4881

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	1.0598	1.1794	1.1776
8.00	0.9043	1.0723	1.1246
13.00	0.8416	1.0308	1.1055
20.00	0.7967	1.0114	1.1041
25.00	0.7842	1.0138	1.1174
30.00	0.7809	1.0196	1.1327
35.00	0.7838	1.0369	1.1561
40.00	0.7887	1.0490	1.1756
50.00	0.8230	1.0967	1.2287
60.00	0.8782	1.1559	1.2878
70.00	0.9453	1.2154	1.3439
80.00	1.0158	1.2759	1.3978
90.00	1.0876	1.3377	1.4434
95.00	1.1252	1.3652	1.4606

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.8078	1.1929	1.3391
8.00	1.0143	1.2844	1.4010
20.00	1.1064	1.3556	1.4606
30.00	1.1369	1.3789	1.4319
45.00	1.1662	1.4034	1.5023
60.00	1.1872	1.4231	1.5211
70.00	1.2020	1.4321	1.5295
80.00	1.2073	1.4356	1.5321
90.00	1.1950	1.4241	1.5200
95.00	1.1678	1.3987	1.5012

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	1.0437	1.1542	1.1841
8.00	0.8943	1.0552	1.1138
13.00	0.8256	1.0104	1.0813
20.00	0.7905	0.9989	1.0856
25.00	0.7732	0.9958	1.0909
30.00	0.7696	1.0054	1.1072
35.00	0.7808	1.0252	1.1347
40.00	0.7848	1.0385	1.1518
50.00	0.8217	1.0877	1.2050
60.00	0.8771	1.1447	1.2671
70.00	0.9391	1.2058	1.3232
80.00	1.0023	1.2625	1.3745
90.00	1.0655	1.3161	1.4219
95.00	1.1012	1.3445	1.4453

IMMERSION(%)= 95

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.7981	1.1839	1.3246
8.00	1.0345	1.2892	1.3990
20.00	1.1107	1.3516	1.4515
30.00	1.1394	1.3751	1.4755
45.00	1.1664	1.3992	1.4980
60.00	1.1890	1.4197	1.5152
70.00	1.1978	1.4271	1.5231
80.00	1.1970	1.4214	1.5237
90.00	1.1859	1.4155	1.5127
95.00	1.1574	1.3674	1.4811

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	1.0317	1.1479	1.1927
8.00	0.8950	1.0524	1.1181
13.00	0.8389	1.0150	1.0900
20.00	0.8034	1.0029	1.0858
25.00	0.7888	1.0011	1.0930
30.00	0.7920	1.0181	1.1118
35.00	0.7947	1.0304	1.1352
40.00	0.8052	1.0503	1.1599
50.00	0.8404	1.1029	1.2202
60.00	0.8934	1.1612	1.2777
70.00	0.9623	1.2217	1.3318
80.00	1.0190	1.2711	1.3779
90.00	1.0673	1.3108	1.4145
95.00	1.0914	1.3300	1.4312

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Table 9. Blade Surface Static Pressures, Rotor B/Stator B Four-Stage Configuration, Increased Rotor Tip Clearance and Casing Treatment.

IMMERSION(%)= 5

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.7061	0.9941	1.1758
8.00	0.8510	1.0671	1.1865
20.00	0.9687	1.1230	1.2070
30.00	0.9337	1.1543	1.2226
45.00	0.9939	1.1991	1.2166
60.00	1.0629	1.2316	1.2333
70.00	1.0786	1.2246	1.2282
80.00	1.0978	1.2283	1.2533
90.00	1.0851	1.2326	1.2701
95.00	1.0622	1.2202	1.2695

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.6809	0.7448	0.6913
8.00	0.6653	0.8004	0.8133
13.00	0.7286	0.8208	0.8470
20.00	0.5545	0.7208	0.7350
25.00	0.5827	0.6920	0.6872
30.00	0.5575	0.6543	0.6345
35.00	0.5395	0.6193	0.6367
40.00	0.5079	0.5949	0.6414
50.00	0.4493	0.5563	0.7145
60.00	0.3894	0.6216	0.8085
70.00	0.4208	0.7355	0.8930
80.00	0.5660	0.8516	0.9698
90.00	0.7596	0.9479	1.0429
95.00	0.8469	1.0360	1.1184

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.4527	0.8802	1.1089
8.00	0.8396	1.0943	1.1938
20.00	0.9137	1.1709	1.2347
30.00	0.9769	1.1935	1.2410
45.00	1.0124	1.2149	1.2423
60.00	1.0345	1.2254	1.2476
70.00	1.0519	1.2298	1.2592
80.00	1.0431	1.2308	1.2711
90.00	1.0281	1.2219	1.2654

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.7436	0.7955	0.6880
8.00	0.6353	0.7477	0.7380
13.00	0.6395	0.7504	0.7744
20.00	0.5157	0.6691	0.7067
25.00	0.4969	0.6616	0.7125
30.00	0.4938	0.6591	0.7223
35.00	0.4884	0.6710	0.7366
40.00	0.4938	0.6788	0.7565
50.00	0.5052	0.7030	0.7879
60.00	0.5248	0.7374	0.8352
70.00	0.5662	0.7937	0.8916
80.00	0.6408	0.8782	0.9668
90.00	0.7587	0.9872	1.0652
95.00	0.8409	1.0615	1.1284

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.2381	0.7475	0.9686
8.00	0.7948	1.0961	1.1694
20.00	0.9332	1.1738	1.2260
30.00	0.9733	1.1979	1.2420
45.00	0.9997	1.2056	1.2560
60.00	1.0196	1.2194	1.2703
70.00	1.0280	1.2352	1.2773
80.00	1.0226	1.2341	1.2775
90.00	1.0200	1.2231	1.2676
95.00	1.0025	1.2079	1.2136

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.5758	0.7457	0.7571
8.00	0.6161	0.7259	0.7314
13.00	0.6627	0.7451	0.7599
20.00	0.4361	0.6089	0.6442
25.00	0.4206	0.6011	0.6368
30.00	0.4125	0.6040	0.6489
35.00	0.4214	0.6209	0.6711
40.00	0.4307	0.6458	0.7103
50.00	0.4680	0.6954	0.7666
60.00	0.5202	0.7694	0.8423
70.00	0.5926	0.8563	0.9146
80.00	0.7013	0.9531	0.9989
90.00	0.8124	1.0420	1.1100
95.00	0.8904	1.1214	1.1622

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.3673	0.8861	0.9978
8.00	0.8186	1.0690	1.1780
20.00	0.9187	1.1199	1.2199
30.00	0.9471	1.1536	1.2360
45.00	0.9837	1.1771	1.2441
60.00	1.0042	1.1785	1.2613
70.00	1.0128	1.1879	1.2662
80.00	1.0145	1.1854	1.2636
90.00	0.9882	1.1872	1.2372
95.00	0.9804	1.1689	1.2324

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.6348	0.7024	0.7364
8.00	0.5998	0.7079	0.7391
13.00	0.5658	0.6479	0.6900
20.00	0.4247	0.5729	0.6313
25.00	0.3958	0.5693	0.6322
30.00	0.3957	0.5454	0.6424
35.00	0.4128	0.6032	0.6732
40.00	0.4329	0.6253	0.7064
50.00	0.4897	0.6974	0.7801
60.00	0.5667	0.8015	0.8844
70.00	0.6461	0.8985	0.9706
80.00	0.7604	0.9964	1.0513
90.00	0.8615	1.0649	1.1536
95.00	0.9127	1.1176	1.1849

IMMERSION(%)= 90

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.4172	0.8938	1.0222
8.00	0.8330	1.0652	1.1636
20.00	0.9210	1.1314	1.2107
30.00	0.9374	1.1417	1.2234
45.00	0.9699	1.1704	1.2401
60.00	0.9880	1.1834	1.2538
70.00	0.9916	1.1792	1.2560
80.00	0.9847	1.1830	1.2487
90.00	0.9735	1.1564	1.2329
95.00	0.9503	1.1433	1.2127

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.6896	0.7331	0.7686
8.00	0.5930	0.6956	0.7461
13.00	0.5358	0.6317	0.6666
20.00	0.4317	0.5820	0.6498
25.00	0.4077	0.5705	0.6465
30.00	0.4031	0.5941	0.6644
35.00	0.4209	0.6195	0.6940
40.00	0.4406	0.6470	0.7357
50.00	0.4997	0.7208	0.8040
60.00	0.5952	0.8187	0.9068
70.00	0.6894	0.9202	1.0103
80.00	0.7900	1.0101	1.0697
90.00	0.8692	1.0742	1.1491
95.00	0.8928	1.0865	1.1602

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Table 10. Vane Surface Static Pressures, Rotor B/Stator B Four-Stage Configuration, Increased Rotor Tip Clearance and Casing Treatment.

IMMERSION(%)= 10

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	1.0503	1.3967	1.5573
8.00	1.0910	1.3781	1.4974
20.00	1.1437	1.4062	1.4989
30.00	1.1737	1.4288	1.5070
45.00	1.1998	1.4494	1.5234
60.00	1.2219	1.4691	1.5382
70.00	1.2319	1.4784	1.5440
80.00	1.2354	1.4622	1.5483
90.00	1.2242	1.4666	1.5369
95.00	1.1985	1.4404	1.5103

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.9185	1.0354	1.0089
8.00	0.8888	1.0650	1.1031
13.00	0.8568	1.0570	1.1230
20.00	0.8448	1.0752	1.1678
25.00	0.8492	1.0946	1.1994
30.00	0.8551	1.1135	1.2285
35.00	0.7849	1.0508	1.1987
40.00	0.8743	1.1542	1.2806
50.00	0.9118	1.2029	1.3227
60.00	0.9678	1.2596	1.3718
70.00	1.0311	1.3107	1.4035
80.00	1.0819	1.3469	1.4272
90.00	1.1225	1.3735	1.4460
95.00	1.1427	1.3868	1.4554

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.9705	1.3628	1.5166
8.00	1.0685	1.3689	1.4892
20.00	1.1329	1.4008	1.4921
30.00	1.1599	1.4178	1.5030
45.00	1.1862	1.4371	1.5136
60.00	1.2134	1.4606	1.5326
70.00	1.2223	1.4674	1.5387
80.00	1.2232	1.4687	1.5377
90.00	1.2138	1.4579	1.5270

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	0.9829	1.0720	1.0390
8.00	0.8924	1.0568	1.0955
13.00	0.8374	1.0359	1.1027
20.00	0.8212	1.0494	1.1367
25.00	0.8160	1.0603	1.1623
30.00	0.8138	1.0711	1.1844
35.00	0.8204	1.0916	1.2130
40.00	0.8379	1.1196	1.2431
50.00	0.8737	1.1643	1.2902
60.00	0.9391	1.2297	1.3541
70.00	1.0068	1.2878	1.3951
80.00	1.0718	1.3401	1.4261
90.00	1.1203	1.3709	1.4353
95.00	1.1428	1.3835	1.4512

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.9059	1.2701	1.4657
8.00	1.0356	1.3197	1.4231
20.00	1.1125	1.3703	1.4565
30.00	1.1456	1.3970	1.4759
45.00	1.1773	1.4220	1.4973
60.00	1.2011	1.4409	1.5109
70.00	1.2148	1.4521	1.5191
80.00	1.2217	1.4557	1.5242
90.00	1.2158	1.4494	1.5135
95.00	1.1973	1.4325	1.4963

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	1.0563	1.1680	1.1745
8.00	0.9055	1.0707	1.1145
13.00	0.8430	1.0326	1.0933
20.00	0.8003	1.0148	1.0912
25.00	0.7880	1.0204	1.1035
30.00	0.7829	1.0281	1.1179
35.00	0.7889	1.0451	1.1420
40.00	0.7959	1.0605	1.1609
50.00	0.8256	1.1040	1.2098
60.00	0.8852	1.1696	1.2768
70.00	0.9535	1.2325	1.3352
80.00	1.0885	1.3495	1.4301
90.00	1.0956	1.3524	1.4299
95.00	1.1334	1.3804	1.4452

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.8578	1.2376	1.3565
8.00	1.0328	1.3098	1.4000
20.00	1.1184	1.3741	1.4532
30.00	1.1483	1.3983	1.4736
45.00	1.1759	1.4188	1.4926
60.00	1.1979	1.4382	1.5111
70.00	1.2103	1.4474	1.5211
80.00	1.2136	1.4508	1.5207
90.00	1.2019	1.4380	1.5100
95.00	1.1757	1.4123	1.4836

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	1.0456	1.1543	1.1972
8.00	0.8958	1.0562	1.1116
13.00	0.8298	1.0144	1.0753
20.00	0.7964	1.0056	1.0755
25.00	0.7782	1.0034	1.0787
30.00	0.7760	1.0151	1.0933
35.00	0.7681	1.0359	1.1180
40.00	0.7919	1.0506	1.1348
50.00	0.8257	1.0929	1.1736
60.00	0.8842	1.1571	1.2461
70.00	0.9488	1.2190	1.3075
80.00	1.0675	1.3487	1.4324
90.00	1.0742	1.3304	1.4085
95.00	1.1097	1.3569	1.4340

IMMERSION(%)= 95

PRESSURE SURFACE

%CHORD	OP	DP	PPR
2.50	0.8434	1.2365	1.3535
8.00	1.0482	1.3191	1.4002
20.00	1.1203	1.3750	1.4531
30.00	1.1487	1.3969	1.4728
45.00	1.1749	1.4211	1.4933
60.00	1.1956	1.4368	1.5082
70.00	1.2041	1.4461	1.5179
80.00	1.2044	1.4445	1.5165
90.00	1.1915	1.4333	1.5035
95.00	1.1550	1.4072	1.4803

SUCTION SURFACE

%CHORD	OP	DP	PPR
2.50	1.0295	1.1495	1.2034
8.00	0.8952	1.0595	1.1177
13.00	0.8401	1.0236	1.0861
20.00	0.8063	1.0111	1.0767
25.00	0.7908	1.0109	1.0787
30.00	0.7951	1.0284	1.0995
35.00	0.7954	1.0429	1.1162
40.00	0.8054	1.0633	1.1392
50.00	0.8399	1.1095	1.1918
60.00	0.8996	1.1761	1.2577
70.00	0.9650	1.2360	1.3157
80.00	1.0221	1.2838	1.3640
90.00	1.1497	1.3971	1.4598
95.00	1.0950	1.3474	1.4577

Table 11. Blade Surface Static Pressures, Rotor B/Stator B Single-Stage Configuration.

IMMERSION(%)= 5

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	-0.0802	0.0522	0.1900
8.00	0.0325	0.1100	0.1981
20.00	0.1135	0.1829	0.2527
30.00	0.1702	0.2309	0.2683
45.00	0.2125	0.2499	0.2647
60.00	0.2276	0.2522	0.2731
70.00	0.2333	0.2563	0.2815
80.00	0.2391	0.2636	0.2957
90.00	0.2353	0.2630	0.3023
95.00	0.2165	0.2476	0.2899

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	-0.3407	-0.4257	-0.5503
8.00	-0.2929	-0.3378	-0.3986
13.00	-0.3355	-0.3847	-0.4507
20.00	-0.4045	-0.4584	-0.4976
25.00	-0.4527	-0.4902	-0.4794
30.00	-0.4877	-0.4881	-0.4436
35.00	-0.4926	-0.4590	-0.4016
40.00	-0.4695	-0.4194	-0.3564
50.00	-0.3947	-0.3423	-0.2597
60.00	-0.3222	-0.2518	-0.1678
70.00	-0.2384	-0.1595	-0.0738
80.00	-0.1393	-0.0603	0.0301
90.00	-0.0149	0.0625	0.1444
95.00	0.0698	0.1314	0.1876

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	-0.2725	-0.0155	0.1566
8.00	0.0459	0.1215	0.2065
20.00	0.1307	0.1919	0.2444
30.00	0.1613	0.2125	0.2552
45.00	0.1905	0.2350	0.2711
60.00	0.2034	0.2432	0.2813
70.00	0.2125	0.2518	0.2895
80.00	0.2159	0.2552	0.2944
90.00	0.2065	0.2466	0.2863

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	-0.2847	-0.3958	-0.5296
8.00	-0.3317	-0.3718	-0.4167
13.00	-0.3823	-0.4044	-0.4227
20.00	-0.4286	-0.4342	-0.4293
25.00	-0.4391	-0.4344	-0.4185
30.00	-0.4392	-0.4243	-0.3998
35.00	-0.4316	-0.4087	-0.3735
40.00	-0.4158	-0.3891	-0.3451
50.00	-0.3792	-0.3380	-0.2767
60.00	-0.3282	-0.2734	-0.1913
70.00	-0.2596	-0.1780	-0.0972
80.00	-0.1448	-0.0768	-0.0000
90.00	-0.0290	0.0376	0.1069
95.00	0.0449	0.1044	0.1654

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	-0.3054	-0.0473	0.1108
8.00	0.0322	0.0982	0.1817
20.00	0.1052	0.1674	0.2219
30.00	0.1354	0.1878	0.2384
45.00	0.1601	0.2080	0.2523
60.00	0.1782	0.2214	0.2646
70.00	0.1842	0.2263	0.2689
80.00	0.1830	0.2259	0.2671
90.00	0.1762	0.2156	0.2567
95.00	0.1625	0.2011	0.2415

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	-0.2534	-0.3574	-0.4759
8.00	-0.3551	-0.3902	-0.4251
13.00	-0.4200	-0.4379	-0.4430
20.00	-0.4649	-0.4627	-0.4477
25.00	-0.4736	-0.4581	-0.4295
30.00	-0.4709	-0.4439	-0.4068
35.00	-0.4455	-0.4123	-0.3680
40.00	-0.4254	-0.3836	-0.3375
50.00	-0.3702	-0.3273	-0.2691
60.00	-0.3203	-0.2309	-0.1382
70.00	-0.1925	-0.1265	-0.0540
80.00	-0.1005	-0.0346	0.0395
90.00	0.0043	0.0651	0.1320
95.00	0.0641	0.1170	0.1738

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	-0.2205	-0.0258	0.1124
8.00	0.0198	0.0904	0.1656
20.00	0.0828	0.1438	0.1942
30.00	0.1120	0.1608	0.2057
45.00	0.1308	0.1784	0.2182
60.00	0.1415	0.1921	0.2319
70.00	0.1423	0.1926	0.2323
80.00	0.1432	0.1858	0.2226
90.00	0.1280	0.1692	0.2022
95.00	0.1074	0.1442	0.1756

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	-0.2891	-0.3686	-0.4601
8.00	-0.3907	-0.4121	-0.4423
13.00	-0.4678	-0.4620	-0.4650
20.00	-0.5046	-0.4921	-0.4701
25.00	-0.5013	-0.4814	-0.4471
30.00	-0.5032	-0.4580	-0.4146
35.00	-0.4600	-0.4216	-0.3741
40.00	-0.4365	-0.3845	-0.3353
50.00	-0.3733	-0.3042	-0.2049
60.00	-0.2447	-0.1644	-0.0876
70.00	-0.1319	-0.0665	0.0101
80.00	-0.0424	0.0278	0.0877
90.00	0.0405	0.0831	0.1189
95.00	0.0548	0.0941	0.1258

IMMERSION(%)= 90

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	-0.1379	0.0113	0.1357
8.00	0.0326	0.1007	0.1688
20.00	0.0735	0.1399	0.1911
30.00	0.0968	0.1544	0.2018
45.00	0.1262	0.1723	0.2137
60.00	0.1356	0.1883	0.2284
70.00	0.1454	0.1904	0.2259
80.00	0.1412	0.1824	0.2204
90.00	0.1360	0.1654	0.2003
95.00	0.0980	0.1408	0.1730

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	-0.2985	-0.3766	-0.4628
8.00	-0.3861	-0.4165	-0.4418
13.00	-0.4263	-0.4597	-0.4591
20.00	-0.5030	-0.4853	-0.4613
25.00	-0.5107	-0.4785	-0.4431
30.00	-0.4913	-0.4525	-0.4062
35.00	-0.4539	-0.4099	-0.3530
40.00	-0.4160	-0.3689	-0.3017
50.00	-0.3311	-0.2569	-0.1718
60.00	-0.2215	-0.1360	-0.0496
70.00	-0.1464	-0.0302	0.0250
80.00	-0.0223	0.0299	0.0636
90.00	0.0447	0.0659	0.0944
95.00	0.0370	0.0775	0.1050

Table 12. Vane Surface Static Pressures, Rotor B/Stator B Single-Stage Configuration.

IMMERSION(%)= 10

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	0.1612	0.3294	0.4702
8.00	0.2403	0.3416	0.4377
20.00	0.2926	0.3762	0.4474
30.00	0.3167	0.3964	0.4618
45.00	0.3426	0.4172	0.4772
60.00	0.3618	0.4357	0.4901
70.00	0.3678	0.4432	0.4972
80.00	0.3729	0.4481	0.4958
90.00	0.3632	0.4368	0.4905
95.00	0.3377	0.4105	0.4652

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	0.1446	0.1220	0.0407
8.00	0.0681	0.0816	0.0625
13.00	0.0209	0.0480	0.0590
20.00	-0.0027	0.0423	0.0764
25.00	-0.0034	0.0520	0.1004
30.00	-0.0005	0.0671	0.1247
35.00	0.0211	0.0612	0.1275
40.00	0.0216	0.0954	0.1756
50.00	0.0680	0.1568	0.2324
60.00	0.1273	0.2188	0.2994
70.00	0.1920	0.2768	0.3520
80.00	0.2379	0.3141	0.3848
90.00	0.2716	0.3430	0.4093
95.00	0.2693	0.3587	0.4207

IMMERSION(%)= 20

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	0.1994	0.3371	0.4657
8.00	0.2433	0.3460	0.4508
20.00	0.2996	0.3733	0.4490
30.00	0.3126	0.3697	0.4581
45.00	0.3372	0.4114	0.4734
60.00	0.3606	0.4316	0.4920
70.00	0.3675	0.4384	0.4992
80.00	0.3675	0.4391	0.4971
90.00	0.3573	0.4276	0.4859

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	0.1078	0.0918	0.0444
8.00	0.0342	0.0540	0.0529
13.00	-0.0121	0.0253	0.0440
20.00	-0.0208	0.0236	0.0689
25.00	-0.0232	0.0392	0.0874
30.00	-0.0228	0.0471	0.1074
35.00	-0.0103	0.0639	0.1308
40.00	0.0065	0.0879	0.1600
50.00	0.0505	0.1363	0.2147
60.00	0.1103	0.2004	0.2798
70.00	0.1752	0.2608	0.3349
80.00	0.2324	0.3153	0.3826
90.00	0.2780	0.3497	0.4109
95.00	0.2947	0.3624	0.4223

IMMERSION(%)= 50

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	0.2041	0.3307	0.4302
8.00	0.2369	0.3352	0.4150
20.00	0.2766	0.3599	0.4281
30.00	0.3018	0.3755	0.4431
45.00	0.3266	0.3993	0.4551
60.00	0.3470	0.4167	0.4742
70.00	0.3591	0.4271	0.4822
80.00	0.3633	0.4327	0.4855
90.00	0.3575	0.4252	0.4796
95.00	0.3412	0.4085	0.4536

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	0.0548	0.0320	0.0011
8.00	-0.0207	-0.0013	0.0145
13.00	-0.0509	-0.0154	0.0154
20.00	-0.0600	-0.0065	0.0407
25.00	-0.0536	0.0064	0.0644
30.00	-0.0444	0.0263	0.0879
35.00	-0.0288	0.0484	0.1146
40.00	-0.0127	0.0686	0.1399
50.00	0.0317	0.1191	0.1934
60.00	0.0885	0.1762	0.2529
70.00	0.1472	0.2324	0.3077
80.00	0.2072	0.2880	0.3602
90.00	0.2664	0.3410	0.4062
95.00	0.2913	0.3629	0.4247

IMMERSION(%)= 80

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	0.1567	0.2894	0.3959
8.00	0.2164	0.3134	0.3975
20.00	0.2794	0.3558	0.4242
30.00	0.3012	0.3755	0.4370
45.00	0.3218	0.3940	0.4534
60.00	0.3362	0.4081	0.4672
70.00	0.3498	0.4160	0.4756
80.00	0.3494	0.4161	0.4755
90.00	0.3396	0.4067	0.4643
95.00	0.3200	0.3857	0.4439

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	0.0833	0.0523	0.0144
8.00	-0.0088	0.0061	0.0140
13.00	-0.0490	-0.0169	0.0120
20.00	-0.0576	-0.0066	0.0371
25.00	-0.0599	0.0002	0.0529
30.00	-0.0499	0.0212	0.0791
35.00	-0.0299	0.0479	0.1122
40.00	-0.0163	0.0683	0.1356
50.00	0.0322	0.1186	0.1918
60.00	0.0860	0.1760	0.2517
70.00	0.1433	0.2313	0.3057
80.00	0.1965	0.2794	0.3513
90.00	0.2496	0.3257	0.3886
95.00	0.2730	0.3453	0.4045

IMMERSION(%)= 95

PRESSURE SURFACE

%CHORD	DP	PE	PPR
2.50	0.1579	0.2900	0.4008
8.00	0.2242	0.3171	0.3955
20.00	0.2793	0.3581	0.4260
30.00	0.3012	0.3777	0.4423
45.00	0.3237	0.3968	0.4591
60.00	0.3419	0.4127	0.4741
70.00	0.3502	0.4201	0.4811
80.00	0.3488	0.4194	0.4799
90.00	0.3402	0.4089	0.4700
95.00	0.3156	0.3851	0.4469

SUCTION SURFACE

%CHORD	DP	PE	PPR
2.50	0.0673	0.0727	0.0480
8.00	-0.0048	0.0096	0.0187
13.00	-0.0396	-0.0093	0.0126
20.00	-0.0494	-0.0060	0.0314
25.00	-0.0493	0.0042	0.0494
30.00	-0.0353	0.0305	0.0811
35.00	-0.0216	0.0495	0.1091
40.00	-0.0034	0.0770	0.1414
50.00	0.0465	0.1324	0.2016
60.00	0.1003	0.1912	0.2634
70.00	0.2111	0.2919	0.3568
80.00	0.2182	0.2963	0.3626
90.00	0.2390	0.3202	0.3812
95.00	0.2670	0.3424	0.4111

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Table 13. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

Open Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	0.8370	1.3173	1.3719	0.7036	1.0373	1.2059
1.0	0.8463	1.3500	1.3920	0.7023	1.0302	1.2042
2.0	0.8567	1.3797	1.4096	0.7010	1.0239	1.2027
3.0	0.8682	1.4038	1.4222	0.6998	1.0184	1.2012
4.0	0.8807	1.4232	1.4307	0.6986	1.0137	1.1999
5.0	0.8943	1.4380	1.4350	0.6976	1.0097	1.1986
7.0	0.9245	1.4534	1.4313	0.6956	1.0040	1.1964
10.0	0.9206	1.4718	1.4226	0.6932	1.0011	1.1938
15.0	0.9350	1.4728	1.4280	0.6920	1.0010	1.1921
20.0	0.9389	1.4580	1.4339	0.6909	1.0044	1.1937
30.0	0.9485	1.4622	1.4417	0.6902	1.0117	1.1916
50.0	0.9689	1.4828	1.4610	0.6881	1.0030	1.1889
70.0	0.9691	1.4841	1.4609	0.6800	0.9877	1.1783
80.0	0.9550	1.4752	1.4504	0.6728	0.9770	1.1709
85.0	0.9335	1.4685	1.4402	0.6653	0.9722	1.1639
90.0	0.9318	1.4634	1.4305	0.6589	0.9698	1.1580
93.0	0.9306	1.4590	1.4280	0.6524	0.9718	1.1468
95.0	0.9186	1.4594	1.4001	0.6468	0.9622	1.1408
96.0	0.9039	1.4627	1.3778	0.6435	0.9610	1.1335
97.0	0.8791	1.4646	1.3498	0.6406	0.9637	1.1319
98.0	0.8455	1.4642	1.3018	0.6411	0.9650	1.1292

Design Point Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	1.0461	1.6197	1.6413	0.9199	1.2990	1.5031
1.0	1.0550	1.6497	1.6561	0.9186	1.2964	1.5012
2.0	1.0635	1.6762	1.6680	0.9173	1.2938	1.4995
3.0	1.0717	1.6991	1.6795	0.9160	1.2914	1.4979
4.0	1.0795	1.7184	1.6882	0.9147	1.2891	1.4963
5.0	1.0869	1.7342	1.6948	0.9134	1.2870	1.4949
7.0	1.1005	1.7552	1.7020	0.9110	1.2830	1.4922
10.0	1.1143	1.7596	1.7075	0.9073	1.2778	1.4887
15.0	1.1262	1.7535	1.7142	0.9044	1.2787	1.4865
20.0	1.1299	1.7432	1.7156	0.9040	1.2807	1.4885
30.0	1.1356	1.7292	1.7143	0.9026	1.2860	1.4836
50.0	1.1470	1.7435	1.7244	0.8991	1.2805	1.4758
70.0	1.1376	1.7408	1.7086	0.8880	1.2705	1.4682
80.0	1.1200	1.7250	1.6974	0.8799	1.2565	1.4614
85.0	1.1113	1.7228	1.6960	0.8730	1.2497	1.4569
90.0	1.1095	1.7301	1.6986	0.8678	1.2437	1.4521
93.0	1.1071	1.7345	1.6971	0.8617	1.2410	1.4416
95.0	1.0847	1.7384	1.6793	0.8551	1.2395	1.4316
96.0	1.0645	1.7424	1.6580	0.8532	1.2390	1.4272
97.0	1.0386	1.7429	1.6347	0.8522	1.2385	1.4201
98.0	1.0129	1.7448	1.6019	0.8547	1.2382	1.4279

Peak Efficiency Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	1.1059	1.7019	1.7470	0.9969	1.3880	1.6020
1.0	1.1155	1.7329	1.7582	0.9956	1.3816	1.5988
2.0	1.1248	1.7606	1.7680	0.9944	1.3763	1.5960
3.0	1.1338	1.7850	1.7764	0.9933	1.3718	1.5936
4.0	1.1426	1.8061	1.7833	0.9922	1.3681	1.5914
5.0	1.1511	1.8238	1.7888	0.9912	1.3652	1.5896
7.0	1.1673	1.8493	1.7954	0.9893	1.3615	1.5870
10.0	1.1824	1.8567	1.7935	0.9869	1.3603	1.5857
15.0	1.1922	1.8426	1.7891	0.9854	1.3539	1.5914
20.0	1.1900	1.8235	1.7819	0.9842	1.3540	1.5912
30.0	1.1894	1.8058	1.7785	0.9799	1.3601	1.5872
50.0	1.1953	1.8079	1.7849	0.9738	1.3542	1.5795
70.0	1.1796	1.7936	1.7695	0.9627	1.3240	1.5683
80.0	1.1663	1.7931	1.7689	0.9571	1.3169	1.5640
85.0	1.1627	1.8015	1.7714	0.9538	1.3159	1.5615
90.0	1.1621	1.8136	1.7733	0.9462	1.3151	1.5504
93.0	1.1624	1.8241	1.7687	0.9390	1.3147	1.5444
95.0	1.1476	1.8290	1.7484	0.9343	1.3138	1.5384
96.0	1.1320	1.8323	1.7290	0.9316	1.3131	1.5351
97.0	1.1144	1.8340	1.7118	0.9281	1.3121	1.5330
98.0	1.0908	1.8273	1.6888	0.9308	1.3109	1.5328

Peak Pressure Rise/Near Stall Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	1.2035	1.8749	1.8860	1.1057	1.5133	1.7464
1.0	1.2141	1.8979	1.8951	1.1041	1.5073	1.7427
2.0	1.2239	1.9182	1.9032	1.1024	1.5019	1.7394
3.0	1.2331	1.9358	1.9103	1.1009	1.4971	1.7364
4.0	1.2417	1.9506	1.9164	1.0994	1.4930	1.7336
5.0	1.2495	1.9627	1.9215	1.0979	1.4895	1.7312
7.0	1.2633	1.9786	1.9285	1.0952	1.4844	1.7271
10.0	1.2704	1.9878	1.9281	1.0916	1.4815	1.7233
15.0	1.2739	1.9732	1.9201	1.0884	1.4736	1.7251
20.0	1.2750	1.9512	1.9169	1.0861	1.4809	1.7221
30.0	1.2752	1.9305	1.9116	1.0811	1.4870	1.7157
50.0	1.2694	1.9263	1.8994	1.0718	1.4763	1.7040
70.0	1.2488	1.9075	1.8790	1.0622	1.4548	1.6948
80.0	1.2419	1.9143	1.8818	1.0581	1.4400	1.6918
85.0	1.2430	1.9301	1.8846	1.0568	1.4387	1.6882
90.0	1.2421	1.9437	1.8766	1.0492	1.4365	1.6821
93.0	1.2344	1.9495	1.8706	1.0437	1.4342	1.6759
95.0	1.2192	1.9530	1.8556	1.0367	1.4357	1.6672
96.0	1.2695	1.9529	1.8404	1.0349	1.4320	1.5635
97.0	1.1952	1.9457	1.8255	1.0327	1.4297	1.6598
98.0	1.1798	1.9282	1.8073	1.0348	1.4303	1.6638

Table 13. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested (Concluded).

Open Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
1.0	33.4	62.9	32.9	34.7	64.0	34.2
2.0	33.0	62.6	33.6	35.1	63.7	34.9
3.0	34.0	62.2	33.0	35.3	63.3	34.3
4.0	32.8	61.0	32.1	34.1	62.2	33.4
5.0	31.3	59.7	31.6	32.5	60.9	32.8
10.0	28.4	55.0	30.6	29.5	56.2	31.8
15.0*	25.7	50.2	27.8	26.7	51.4	28.9
20.0	23.2	46.4	25.2	24.1	47.6	26.1
25.0*	21.3	44.1	23.0	22.1	45.3	23.9
30.0*	19.9	42.5	21.4	20.6	43.6	22.1
35.0*	19.1	41.5	20.2	19.7	42.6	20.9
40.0*	18.7	40.9	19.6	19.4	42.0	20.2
45.0*	18.8	40.7	19.4	19.5	41.7	20.0
50.0	13.3	40.8	19.6	19.9	41.7	20.2
55.0*	19.8	41.1	19.9	20.3	42.0	20.5
60.0*	20.3	41.5	20.4	20.9	42.4	20.9
65.0*	20.9	42.1	20.8	21.4	43.0	21.4
70.0*	21.4	42.9	21.3	21.9	43.7	21.8
75.0*	21.8	43.7	21.7	22.3	44.5	22.2
80.0	22.2	44.7	22.0	22.7	45.5	22.5
85.0*	23.1	46.1	23.0	23.6	46.9	23.5
90.0	24.4	47.8	24.2	24.9	48.5	24.7
95.0	26.9	49.9	27.1	27.5	50.6	27.7
96.0	26.9	50.4	27.5	27.5	51.1	28.1
97.0	27.0	51.1	27.2	27.6	51.8	27.8
98.0	26.8	51.7	28.1	27.3	52.4	28.7

* CURVE FIT VALUES USING ZERO STATOR POSITION DATA

Design Point Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
1.0	34.1	69.6	32.9	35.4	70.5	34.2
2.0	34.3	70.3	32.7	35.6	71.2	34.0
3.0	33.4	70.9	31.6	34.7	71.0	32.9
4.0	32.9	70.7	30.9	34.2	71.6	32.1
5.0	32.0	69.6	30.5	33.2	70.5	31.7
10.0	30.2	62.7	29.4	31.4	63.8	30.5
15.0	27.4	56.4	26.4	28.4	57.6	27.4
20.0	24.6	52.1	23.6	25.5	53.3	24.5
30.0*	21.4	47.0	21.2	22.2	48.1	22.0
50.0	19.9	46.4	19.6	20.5	47.3	20.2
70.0*	21.4	48.4	20.2	22.0	49.2	20.8
80.0	22.8	50.3	22.1	23.3	51.0	22.6
85.0*	24.0	51.3	24.4	24.5	52.0	24.9
90.0	25.7	52.9	26.9	26.3	53.6	27.5
95.0	28.5	54.0	28.7	29.1	54.6	29.3
96.0	28.7	54.4	28.5	29.3	55.0	29.1
97.0	28.9	54.4	29.4	29.5	55.0	30.0
98.0	35.6	54.7	30.0	36.2	55.3	30.5

Peak Efficiency Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
1.0	32.9	68.5	33.7	34.2	69.5	35.0
2.0	32.5	68.1	33.7	33.8	69.1	35.0
3.0	32.5	67.8	33.1	33.8	68.8	34.4
4.0	32.2	66.8	32.3	33.5	67.8	33.6
5.0	31.1	65.1	31.9	32.3	66.1	33.2
10.0	28.4	60.1	30.8	29.5	61.2	32.0
15.0*	25.8	54.8	27.8	26.8	56.0	28.9
20.0	23.4	50.7	25.4	24.3	51.9	26.3
25.0	22.5	48.8	23.4	23.4	49.9	24.3
30.0*	21.8	47.6	22.0	22.6	48.7	22.8
35.0*	21.3	47.1	21.0	22.0	48.1	21.8
40.0*	20.9	47.0	20.5	21.6	48.0	21.2
45.0*	20.7	47.3	20.3	21.4	48.3	21.0
50.0	20.7	47.9	20.5	21.3	48.8	21.1
55.0	20.6	48.3	20.5	21.2	49.2	21.1
60.0*	20.6	48.8	20.7	21.2	49.7	21.3
65.0	20.9	49.5	21.1	21.4	50.3	21.7
70.0	21.2	50.2	21.7	21.8	50.9	22.3
75.0*	21.8	50.9	22.4	22.3	51.7	22.9
80.0	22.5	51.3	23.1	23.0	52.5	23.7
85.0*	24.2	52.9	25.2	24.7	53.7	25.8
90.0	25.0	54.3	27.3	26.6	55.0	27.9
95.0	27.4	55.0	28.2	28.0	55.6	23.8
96.0	27.3	55.3	27.5	27.9	55.9	28.1
97.0	25.3	55.9	27.0	26.8	56.5	27.6
98.0	24.9	57.1	26.8	25.4	57.7	27.3

Peak Pressure Rise/Near Stall Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
1.0	34.1	72.5	33.0	35.4	73.3	34.3
2.0	33.5	71.8	33.4	34.8	72.6	34.7
3.0	33.4	71.5	33.3	34.7	72.3	34.6
4.0	32.9	70.8	33.0	34.2	71.7	34.3
5.0	31.9	68.9	32.3	33.2	69.8	33.6
10.0	23.7	63.8	30.9	29.0	54.8	32.1
15.0*	25.3	57.4	27.8	26.3	58.5	28.0
20.0	23.7	52.1	25.3	24.6	53.3	26.2
25.0	22.2	49.6	23.1	23.0	50.8	23.9
30.0*	21.3	48.0	21.5	22.1	49.1	22.3
35.0*	20.6	47.2	20.4	21.3	48.3	21.1
40.0*	20.1	47.9	19.8	20.8	48.1	20.5
45.0*	19.7	47.5	19.6	20.3	48.5	20.2
50.0	19.5	48.4	19.8	20.1	49.3	20.4
55.0	19.1	49.3	20.0	19.6	50.1	20.6
60.0*	19.0	50.4	20.4	19.6	51.2	21.0
65.0	19.5	51.7	21.1	20.0	52.5	21.6
70.0	20.4	53.1	21.9	21.0	53.9	22.4
75.0*	21.8	54.5	22.8	22.3	55.3	23.4
80.0	21.3	55.8	23.8	23.9	56.5	24.4
85.0*	25.9	56.8	26.6	26.4	57.4	27.2
90.0	27.5	57.4	29.4	28.1	58.0	30.0
95.0	27.1	57.2	28.0	27.7	57.8	28.6
96.0	25.0	57.5	27.0	26.5	58.1	27.6
97.0	25.1	57.8	25.5	25.6	58.4	25.0
98.0	24.0	58.4	26.2	24.5	59.0	26.7

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Table 14. Rotor Loss Coefficients Determined from Relative Total Pressure Measurements, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested.

Open Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.4688	1.3747	5.0	0.1219	0.0085	0.1135
10.0	1.4871	1.4191	10.0	0.0857	0.0106	0.0752
15.0	1.5081	1.4567	15.0	0.0508	0.0200	0.0308
20.0	1.5290	1.4974	20.0	0.0377	0.0216	0.0162
35.0	1.5786	1.5226	35.0	0.0630	0.0276	0.0354
50.0	1.5564	1.5000	50.0	0.0649	0.0221	0.0428
65.0	1.4910	1.4543	65.0	0.0455	0.0279	0.0176
80.0	1.4172	1.3830	80.0	0.0459	0.0311	0.0147
85.0	1.3910	1.3515	85.0	0.0544	0.0440	0.0104
90.0	1.3505	1.3059	90.0	0.0645	0.0531	0.0114
95.0	1.3009	1.2580	95.0	0.0655	0.0524	0.0131

Design Point Throttl?

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.6437	1.5518	5.0	0.1259	0.0094	0.1165
10.0	1.6499	1.5905	10.0	0.0799	0.0164	0.0635
15.0	1.6623	1.6407	15.0	0.0285	0.0172	0.0113
20.0	1.7038	1.6685	20.0	0.0441	0.0210	0.0230
35.0	1.7358	1.6978	35.0	0.0457	0.0182	0.0275
50.0	1.7048	1.6654	50.0	0.0489	0.0168	0.0321
65.0	1.6589	1.6172	65.0	0.0544	0.0245	0.0298
80.0	1.5877	1.5455	80.0	0.0596	0.0356	0.0240
85.0	1.5631	1.5125	85.0	0.0734	0.0435	0.0299
90.0	1.5294	1.4760	90.0	0.0806	0.0483	0.0324
95.0	1.4860	1.4419	95.0	0.0699	0.0394	0.0305

Peak Pressure Rise/Near Stall Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.8351	1.7349	5.0	0.1359	0.0081	0.1278
10.0	1.8481	1.7767	10.0	0.0944	0.0132	0.0812
15.0	1.8637	1.8293	15.0	0.0444	0.0180	0.0264
20.0	1.9067	1.8641	20.0	0.0519	0.0187	0.0333
35.0	1.9424	1.8771	35.0	0.0756	0.0195	0.0561
50.0	1.8764	1.8435	50.0	0.0409	0.0249	0.0160
65.0	1.8154	1.7760	65.0	0.0525	0.0408	0.0117
80.0	1.7536	1.6906	80.0	0.0906	0.0602	0.0304
85.0	1.7155	1.6605	85.0	0.0836	0.0551	0.0284
90.0	1.6823	1.6310	90.0	0.0810	0.0570	0.0240
95.0	1.6598	1.6222	95.0	0.0603	0.0463	0.0140

Peak Effeciency Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.7331	1.6407	5.0	0.1245	0.0089	0.1156
10.0	1.7372	1.6772	10.0	0.0800	0.0165	0.0635
15.0	1.7626	1.7313	15.0	0.0403	0.0165	0.0238
20.0	1.8091	1.7591	20.0	0.0606	0.0212	0.0393
35.0	1.8477	1.7806	35.0	0.0773	0.0191	0.0582
50.0	1.7960	1.7431	50.0	0.0643	0.0199	0.0445
65.0	1.7427	1.6943	65.0	0.0622	0.0294	0.0328
80.0	1.6654	1.6236	80.0	0.0590	0.0434	0.0156
85.0	1.6283	1.5922	85.0	0.0537	0.0416	0.0121
90.0	1.5876	1.5522	90.0	0.0551	0.0463	0.0087
95.0	1.5597	1.5298	95.0	0.0479	0.0358	0.0121

Table 15. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Open Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER %	W MPS	W FPS	WU MPS	WU FPS	BETA DEG	CZ MPS	CZ FPS	CU MPS	CU FPS	C MPS	C FPS	ALPHA DEG
1.0	54.6	179.7	51.0	167.3	69.2	19.1	62.8	13.3	43.7	23.3	76.5	34.7
2.0	54.0	177.2	50.2	164.9	68.3	19.8	64.9	14.0	46.8	24.2	79.5	35.1
3.0	53.6	175.9	49.5	162.5	67.3	20.5	67.4	14.6	47.9	26.2	82.6	35.3
4.0	53.9	176.7	49.3	161.8	66.1	21.7	71.1	14.7	48.3	26.2	86.0	34.1
5.0	54.3	178.2	49.2	161.5	64.8	22.9	75.3	14.7	48.2	27.2	89.4	32.5
7.0	54.6	179.1	48.9	160.6	63.6	24.2	79.2	14.8	48.5	28.3	92.9	31.4
10.0	55.2	181.2	48.4	158.8	61.0	26.6	87.3	15.0	49.3	30.6	100.2	29.4
15.0	56.2	184.4	49.2	161.4	60.9	27.2	89.1	13.8	45.2	30.5	99.9	26.8
20.0	57.3	187.9	49.5	162.6	59.7	28.7	94.2	12.9	42.4	31.5	103.3	24.2
30.0	58.9	193.4	50.8	166.6	59.3	29.9	98.2	10.7	35.2	31.8	104.3	19.7
50.0	57.3	188.0	48.5	159.1	57.7	30.5	100.1	11.1	36.3	32.5	106.5	19.9
70.0	54.8	179.9	45.0	147.5	54.9	31.4	103.0	12.7	41.6	33.8	111.0	22.0
80.0	53.7	176.2	43.4	142.3	53.7	31.7	103.9	13.3	43.6	34.3	112.7	22.7
85.0	52.7	172.9	42.6	139.6	53.7	31.1	101.9	13.6	44.7	33.9	111.3	23.6
90.0	51.4	168.6	41.7	136.9	54.2	30.0	98.4	14.0	45.9	33.1	108.5	24.9
93.0	50.5	165.5	40.6	133.3	53.5	29.9	98.1	14.8	48.5	33.4	109.5	26.2
95.0	49.7	162.9	39.7	130.1	52.9	29.9	98.0	15.6	51.1	33.7	110.5	27.4
96.0	49.5	162.5	39.7	130.4	53.2	29.5	96.9	15.4	50.5	33.3	109.2	27.4
97.0	49.3	161.7	39.9	131.0	54.0	28.9	94.7	15.1	49.6	32.6	106.9	27.5
98.0	49.1	161.2	40.6	133.2	55.5	27.7	90.8	14.4	47.1	31.2	102.3	27.3

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER %	W MPS	W FPS	WU MPS	WU FPS	BETA DEG	CZ MPS	CZ FPS	CU MPS	CU FPS	C MPS	C FPS	ALPHA DEG
1.0	37.0	121.4	34.0	111.4	66.4	14.7	48.1	30.4	99.6	33.7	110.6	64.0
2.0	35.6	116.7	31.8	104.4	63.3	15.9	52.1	32.4	106.3	36.1	118.4	63.7
3.0	34.6	113.4	30.1	98.7	60.4	17.0	55.7	34.0	111.6	38.0	124.7	63.3
4.0	34.3	112.6	29.0	95.1	57.4	18.4	60.3	35.0	115.0	39.6	129.8	62.1
5.0	34.5	113.1	28.2	92.6	54.9	19.8	64.8	35.7	117.1	40.8	133.8	60.9
7.0	34.8	114.3	27.7	91.0	52.6	21.1	69.2	36.0	118.1	41.7	136.9	59.5
10.0	36.6	119.9	27.9	91.4	49.5	23.7	77.7	35.6	116.8	42.7	140.2	56.2
15.0	39.5	129.7	28.7	94.1	46.4	27.2	89.2	34.3	112.4	43.7	143.5	51.4
20.0	42.1	138.1	30.1	98.7	45.5	29.5	96.7	32.4	106.3	43.8	143.7	47.6
30.0	44.5	145.9	31.8	104.5	45.6	31.0	101.8	29.7	97.4	42.9	140.9	43.6
50.0	44.5	146.0	31.0	101.8	44.1	31.9	104.6	28.5	93.7	42.8	142.4	41.7
70.0	41.8	137.2	27.1	88.8	40.2	31.9	104.6	30.6	100.3	44.2	144.9	43.7
80.0	39.9	131.0	24.6	80.7	37.9	31.5	103.2	32.1	105.3	44.9	147.4	45.4
85.0	38.6	126.5	23.3	76.6	37.1	30.7	100.7	32.9	107.8	45.0	147.6	46.8
90.0	37.0	121.3	22.0	72.2	36.4	29.7	97.4	33.7	110.6	44.9	147.4	48.5
93.0	35.9	117.9	21.3	69.7	36.2	29.0	95.1	34.2	112.1	44.8	147.0	49.6
95.0	35.0	114.9	20.8	68.2	36.3	28.2	92.5	34.4	113.0	44.5	146.0	50.6
96.0	34.6	113.6	20.1	65.9	35.4	28.2	92.5	35.0	115.0	45.0	147.5	51.1
97.0	34.0	111.6	19.5	64.0	34.9	27.9	91.5	35.5	116.6	45.2	148.2	51.7
98.0	33.5	109.9	19.1	62.8	34.8	27.5	90.2	35.8	117.4	45.1	148.1	52.3

BLADE ELEMENT DATA STATOR OUTLET

IMMER %	W MPS	W FPS	WU MPS	WU FPS	BETA DEG	CZ MPS	CZ FPS	CU MPS	CU FPS	C MPS	C FPS	ALPHA DEG
1.0	54.1	177.6	49.7	163.1	66.5	21.4	70.2	14.6	47.9	25.9	85.0	34.2
2.0	53.4	175.2	48.4	158.7	64.7	22.6	74.2	15.8	52.0	27.6	90.6	34.9
3.0	53.4	175.2	47.8	156.8	63.3	23.9	78.3	16.3	53.6	28.9	94.9	34.3
4.0	53.7	176.1	47.5	156.0	62.1	24.9	81.9	16.5	54.1	29.9	98.1	33.4
5.0	53.8	176.6	47.3	155.2	61.4	25.6	84.2	16.6	54.5	30.6	100.3	32.8
7.0	54.0	177.1	47.2	154.9	60.8	26.1	85.8	16.5	54.2	30.9	101.5	32.2
10.0	54.0	177.0	47.2	154.8	58.8	26.2	85.9	16.3	53.4	30.0	101.1	31.8
15.0	55.1	180.8	48.2	158.3	60.9	26.6	87.4	14.7	48.3	30.4	99.8	28.8
20.0	56.2	184.2	48.8	160.2	60.2	27.7	90.9	13.6	44.0	30.9	101.4	26.1
30.0	57.5	188.6	49.7	163.1	59.7	28.9	94.7	11.8	38.7	31.2	102.3	22.2
50.0	57.0	187.0	48.6	159.3	58.3	29.8	97.9	11.0	36.1	31.8	104.4	20.2
70.0	54.7	179.6	45.3	148.5	55.6	30.8	101.0	12.4	40.6	33.2	108.9	21.9
80.0	53.7	176.2	43.7	143.3	54.3	31.2	102.5	13.0	42.6	33.8	111.0	22.5
85.0	52.8	173.1	42.8	140.4	54.1	30.8	101.2	13.4	44.0	33.6	110.4	23.4
90.0	51.6	169.2	41.7	136.8	53.8	30.4	99.6	14.0	46.0	33.4	109.7	24.7
93.0	50.3	164.9	40.5	133.0	53.6	29.7	97.4	14.9	48.8	33.2	109.0	26.5
95.0	49.5	162.6	39.5	129.7	52.8	29.9	98.0	15.7	51.5	33.7	110.7	27.7
96.0	49.1	161.1	39.6	130.0	53.6	29.0	95.2	15.3	50.9	32.9	107.9	28.1
97.0	49.0	160.8	40.4	132.4	55.3	27.8	91.2	14.7	48.1	31.4	103.2	27.7
98.0	48.3	158.4	40.7	133.4	57.2	26.0	85.4	14.3	46.8	29.7	97.4	28.7

Table 16. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Design Point Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	55.5	182.1	52.2	171.3	70.0	18.8	61.6	13.4	44.0	23.1	75.7	35.4
2.0	55.1	180.7	51.5	169.0	69.1	19.5	63.9	14.0	46.0	24.0	78.7	35.6
3.0	55.2	181.0	51.3	168.2	68.1	20.4	66.9	14.2	46.5	24.8	81.5	34.7
4.0	55.1	180.9	50.9	167.0	67.2	21.2	69.5	14.4	47.4	25.6	84.1	34.2
5.0	55.3	181.5	50.7	166.5	66.3	22.0	72.3	14.5	47.6	26.4	86.5	33.2
7.0	55.4	181.8	50.5	165.7	65.5	22.8	74.9	14.5	47.7	27.1	88.8	32.4
10.0	55.5	182.1	50.0	164.0	64.0	24.1	79.2	14.8	48.4	28.3	92.8	31.4
15.0	56.5	185.3	50.1	164.5	62.4	26.0	85.2	14.1	46.3	29.6	97.0	28.4
20.0	57.6	188.9	50.5	165.8	61.2	27.6	90.6	13.2	43.4	30.6	100.4	25.5
30.0	58.5	192.1	51.1	167.6	60.6	28.6	93.8	11.7	38.3	30.9	101.3	22.2
50.0	57.8	189.6	49.8	163.3	59.3	29.4	96.4	11.0	36.1	31.4	102.9	20.5
70.0	55.5	182.1	46.7	153.2	57.1	30.0	98.4	12.1	39.8	32.4	106.2	22.0
80.0	53.9	176.9	44.9	147.4	56.3	29.8	97.8	12.9	42.3	32.5	106.5	23.3
85.0	52.8	173.1	44.1	144.6	56.5	29.0	95.2	13.3	43.6	31.9	104.7	24.5
90.0	51.4	168.6	42.8	140.4	56.2	28.4	93.3	14.1	46.2	31.7	104.1	26.3
93.0	50.3	165.1	41.6	136.6	55.7	28.3	92.7	14.9	49.0	32.0	104.8	27.8
95.0	49.5	162.2	40.7	133.5	55.2	28.1	92.3	15.7	51.5	32.2	105.6	29.1
96.0	49.2	161.3	41.0	134.5	56.3	27.1	89.1	15.3	50.1	31.1	102.2	29.3
97.0	48.9	160.5	41.4	135.9	57.7	26.0	85.3	14.7	48.3	29.9	98.0	29.5
98.0	45.5	149.2	39.4	129.4	60.0	22.6	74.2	16.6	54.5	28.1	92.0	36.2

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	33.3	109.2	31.0	101.7	68.4	12.1	39.8	34.6	113.6	36.7	120.4	70.5
2.0	31.5	103.4	29.0	95.2	66.8	12.3	40.4	36.5	119.8	38.5	126.4	71.2
3.0	30.0	98.5	27.3	89.6	65.3	12.4	40.8	38.1	125.0	40.1	131.5	71.7
4.0	29.1	95.4	26.0	85.4	63.3	13.0	42.6	39.3	129.0	41.4	135.8	71.5
5.0	28.8	94.5	25.1	82.5	60.6	14.1	46.2	40.1	131.5	42.5	139.4	70.5
7.0	29.7	97.5	24.8	81.5	56.6	16.3	53.5	40.2	131.9	43.4	142.3	67.7
10.0	31.5	103.5	24.7	81.1	51.4	19.6	64.3	40.0	131.3	44.6	146.2	63.7
15.0	35.6	116.7	26.2	86.0	47.3	24.1	78.9	38.0	124.8	45.0	147.7	57.5
20.0	38.6	126.5	27.9	91.5	46.2	26.7	87.4	35.9	117.7	44.7	146.6	53.2
30.0	41.9	137.5	29.9	98.0	45.3	29.4	96.4	32.9	107.9	44.1	144.7	48.1
50.0	41.1	135.0	29.0	95.1	44.7	29.2	95.8	31.8	104.4	43.2	141.6	47.3
70.0	38.4	125.8	25.6	84.2	41.9	28.5	93.5	33.2	108.8	43.7	143.5	49.2
80.0	36.3	119.0	23.2	76.1	39.6	27.9	91.5	34.6	113.7	44.5	145.9	51.0
85.0	35.2	115.5	22.3	73.2	39.2	27.2	89.4	35.0	115.0	44.4	145.6	52.0
90.0	33.7	110.5	20.9	68.6	38.2	26.4	86.6	36.0	118.0	44.6	146.4	53.6
93.0	32.9	108.1	19.8	64.9	36.8	26.3	86.4	36.8	120.7	45.2	148.4	54.2
95.0	32.5	106.7	19.1	62.8	36.0	26.3	86.2	37.2	122.1	45.6	149.5	54.6
96.0	32.1	105.4	18.7	61.2	35.4	26.2	85.8	37.6	123.4	45.8	150.3	55.0
97.0	32.1	105.2	18.4	60.3	34.9	26.3	86.2	37.8	123.9	46.0	151.0	55.0
98.0	31.8	104.3	18.1	59.4	34.6	26.1	85.7	37.9	124.5	46.1	151.1	55.3

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	55.7	182.9	52.1	170.9	68.9	19.9	65.1	13.5	44.4	24.0	78.9	34.2
2.0	55.4	181.9	51.3	168.2	67.5	21.1	69.1	14.3	46.8	25.5	83.5	34.0
3.0	55.6	182.5	51.0	167.2	66.1	22.3	73.3	14.5	47.5	26.6	87.3	32.9
4.0	55.7	182.9	50.6	166.1	65.1	23.3	76.5	14.7	48.2	27.6	90.4	32.1
5.0	55.8	183.0	50.3	165.0	64.2	24.1	79.0	14.9	49.0	28.3	93.0	31.7
7.0	55.6	182.6	49.9	163.7	63.5	24.6	80.8	15.1	49.7	28.9	94.9	31.5
10.0	55.8	183.1	49.7	162.9	62.6	25.5	83.6	15.1	49.5	29.6	97.2	30.6
15.0	57.0	187.0	50.3	165.0	61.7	26.8	88.1	14.0	45.8	30.3	99.3	27.4
20.0	58.2	190.8	50.9	167.1	61.0	28.1	92.1	12.8	42.1	30.9	101.3	24.5
30.0	58.6	192.4	51.2	168.0	60.7	28.6	93.8	11.6	37.9	30.8	101.1	22.0
50.0	57.9	190.0	50.0	164.2	59.6	29.1	95.6	10.8	35.3	31.1	101.9	20.2
70.0	56.2	184.3	47.4	155.4	57.4	30.2	98.9	11.4	37.5	32.3	105.8	20.7
80.0	54.2	177.8	45.6	149.6	57.1	29.3	96.0	12.2	40.1	31.7	104.1	22.6
85.0	52.5	172.1	44.1	144.5	57.0	28.5	93.4	13.3	43.6	31.4	103.1	24.9
90.0	50.7	166.3	42.2	138.5	56.2	28.1	92.2	14.7	48.1	31.7	103.9	27.5
93.0	49.9	163.7	41.2	135.0	55.4	28.2	92.5	15.4	50.5	32.1	105.4	28.6
95.0	49.4	162.0	40.3	132.3	54.6	28.5	93.5	16.0	52.6	32.7	107.3	29.3
96.0	49.4	162.0	40.6	133.1	55.1	28.1	92.3	15.7	51.4	32.2	105.6	29.1
97.0	48.7	159.8	40.6	133.1	56.2	26.9	88.4	15.6	51.1	31.1	102.1	30.0
98.0	48.2	158.3	40.8	133.8	57.5	25.8	84.6	15.3	50.1	30.0	98.3	30.6

Table 17. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Efficiency Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	56.0	183.7	53.2	174.4	71.5	17.6	57.8	12.0	39.4	21.3	69.9	34.2
2.0	55.8	183.0	52.6	172.6	70.4	18.6	60.9	12.5	40.9	22.4	73.3	33.8
3.0	55.5	182.0	52.0	170.6	69.4	19.4	63.5	13.0	42.6	23.3	76.5	33.8
4.0	55.3	181.5	51.5	169.0	68.4	20.2	66.2	13.4	43.9	24.2	79.4	33.5
5.0	55.5	182.2	51.4	168.5	67.4	21.1	69.3	13.4	44.0	25.0	82.1	32.3
7.0	55.6	182.4	51.1	167.6	66.5	22.0	72.2	13.5	44.4	25.8	84.7	31.5
10.0	56.1	184.0	50.8	166.8	64.8	23.7	77.7	13.5	44.1	27.2	89.4	29.5
15.0	56.9	186.7	50.9	167.0	63.2	25.5	83.6	12.9	42.3	28.6	93.7	26.8
20.0	57.8	189.5	51.2	168.0	62.2	26.8	87.8	12.1	39.7	29.4	96.3	24.3
30.0	57.8	189.6	51.1	167.5	61.9	27.0	88.7	11.3	37.0	29.3	96.1	22.6
50.0	56.7	186.1	49.6	162.7	60.8	27.5	90.3	10.8	35.4	29.6	97.0	21.3
70.0	54.9	180.2	47.1	154.6	58.9	28.2	92.6	11.3	37.0	30.4	99.7	21.7
80.0	53.4	175.1	45.6	149.7	58.6	27.7	90.8	11.8	38.7	30.1	98.7	23.0
85.0	52.0	170.6	44.6	146.2	58.8	26.8	88.0	12.4	40.7	29.5	96.9	24.7
90.0	50.6	165.2	43.2	141.8	58.4	26.4	86.6	13.2	43.4	29.5	96.8	26.6
93.0	49.9	163.6	42.2	138.5	57.6	26.6	87.1	14.0	45.8	30.0	98.4	27.7
95.0	49.6	162.7	41.6	136.6	56.9	26.9	88.4	14.3	47.1	30.5	100.1	28.0
96.0	49.5	162.4	41.9	137.5	57.7	26.4	86.5	14.0	45.8	29.8	97.9	27.9
97.0	49.9	163.6	42.7	140.1	58.7	25.8	84.6	13.1	42.9	28.9	94.8	26.8
98.0	50.4	165.4	43.7	143.3	59.9	25.2	82.5	12.0	39.3	27.9	91.4	25.4

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	33.8	110.8	31.3	102.8	68.0	12.6	41.2	33.8	111.0	36.1	118.4	69.4
2.0	32.3	106.1	29.4	96.4	65.1	13.5	44.4	35.7	117.1	38.2	125.3	69.0
3.0	31.2	102.4	27.7	90.9	62.4	14.4	47.1	37.3	122.3	39.9	131.0	68.7
4.0	30.7	100.8	26.5	86.9	59.4	15.5	51.0	38.4	126.0	41.4	135.9	67.8
5.0	30.9	101.4	25.7	84.4	56.2	17.1	56.3	39.1	128.1	42.7	139.9	66.1
7.0	31.3	102.8	25.2	82.5	53.2	18.7	61.4	39.4	129.4	43.6	143.2	64.5
10.0	32.9	107.8	24.8	81.3	48.8	21.6	70.8	39.5	129.7	45.0	147.7	61.2
15.0	36.4	119.3	26.1	85.6	45.7	25.3	83.1	37.7	123.7	45.4	149.0	56.0
20.0	39.3	128.9	27.8	91.2	44.9	27.7	91.0	35.5	116.5	45.1	147.8	51.9
30.0	41.1	135.0	29.1	95.5	44.9	29.1	95.4	33.2	109.1	44.2	144.9	48.7
50.0	39.7	130.3	27.9	91.6	44.5	28.3	92.7	32.5	106.5	43.0	141.2	48.6
70.0	36.7	120.5	24.6	80.8	42.0	27.3	89.4	33.8	110.9	43.4	142.4	51.0
80.0	34.9	114.4	22.3	73.2	39.7	26.8	87.9	35.1	115.2	44.2	144.9	52.5
85.0	33.7	110.6	21.1	69.2	38.6	26.3	86.3	35.9	117.7	44.5	145.9	53.6
90.0	32.3	106.1	19.6	64.4	37.3	25.7	84.3	36.8	120.9	44.9	147.4	55.0
93.0	31.8	104.4	18.7	61.2	35.8	25.8	84.6	37.5	123.0	45.5	149.3	55.3
95.0	31.5	103.3	17.9	58.8	34.6	25.9	84.9	38.0	124.8	46.0	151.0	55.6
96.0	31.2	102.3	17.5	57.3	34.0	25.8	84.7	38.4	126.0	46.3	151.8	55.9
97.0	30.7	100.6	17.0	55.7	33.5	25.5	83.8	38.8	127.3	46.5	152.4	56.5
98.0	29.6	97.2	16.2	53.3	33.1	24.8	81.3	39.4	129.4	46.6	152.8	57.7

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	54.9	180.0	51.1	167.6	68.4	20.0	65.6	14.1	46.2	24.5	80.3	35.0
2.0	54.5	178.9	50.3	165.1	67.2	21.0	68.8	14.8	48.4	25.7	84.2	35.0
3.0	54.5	178.8	49.9	163.7	66.0	22.0	72.1	15.1	49.5	26.6	87.4	34.4
4.0	54.7	179.4	49.7	162.9	65.1	22.9	75.0	15.2	50.0	27.5	90.1	33.6
5.0	54.7	179.4	49.4	161.9	64.3	23.5	77.2	15.4	50.6	28.1	92.4	33.1
7.0	54.6	179.1	49.0	160.8	63.6	24.1	79.0	15.6	51.1	28.7	94.1	32.8
10.0	54.7	179.5	48.7	159.9	62.8	24.9	81.6	15.6	51.1	29.3	96.3	32.0
15.0	55.9	183.3	49.6	162.8	62.5	25.6	84.1	14.2	46.5	29.3	96.1	28.8
20.0	56.7	186.0	50.6	166.0	63.0	25.6	84.0	12.7	41.7	28.6	93.7	26.3
30.0	57.6	188.9	51.4	168.8	63.1	25.9	84.8	10.9	35.7	28.1	92.0	22.8
50.0	56.7	185.9	50.2	164.8	62.3	26.2	86.0	10.2	33.3	28.1	92.2	21.1
70.0	54.5	178.8	47.4	155.4	60.2	26.9	88.4	11.1	36.3	29.1	95.6	22.3
80.0	52.9	173.6	45.8	150.4	59.9	26.4	86.6	11.6	38.0	28.8	94.6	23.6
85.0	51.4	168.8	44.3	145.3	59.2	26.2	85.9	12.7	41.6	29.1	95.4	25.8
90.0	50.0	163.9	42.7	140.0	58.5	26.0	85.3	13.8	45.3	29.4	96.6	27.9
93.0	49.4	161.9	41.6	136.4	57.2	26.6	87.3	14.6	47.9	30.3	99.5	26.7
95.0	49.1	161.2	41.3	135.5	57.0	26.7	87.5	14.7	48.2	30.4	99.9	28.8
96.0	49.4	162.0	42.0	137.8	58.1	26.0	85.2	13.9	45.6	29.4	96.6	28.1
97.0	49.5	162.3	42.7	140.0	59.4	25.1	82.3	13.1	43.0	28.3	92.8	27.5
98.0	49.5	162.2	43.2	141.6	60.6	24.1	79.1	12.5	41.0	27.2	89.1	27.3

Table 18. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Peak Pressure Rise/ Near Stall Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.Ø	55.9	183.5	53.5	175.4	72.7	16.4	53.9	11.7	38.5	2Ø.2	66.2	35.4
2.Ø	55.7	182.7	52.8	173.4	71.4	17.6	57.6	12.2	4Ø.2	21.4	7Ø.2	34.8
3.Ø	55.3	181.6	52.2	171.1	7Ø.3	18.5	6Ø.6	12.8	42.1	22.5	73.8	34.7
4.Ø	55.2	181.1	51.7	169.6	69.2	19.4	63.6	13.2	43.4	23.5	77.Ø	34.2
5.Ø	55.3	181.6	51.5	168.8	68.2	2Ø.4	66.8	13.3	43.8	24.3	79.9	33.1
7.Ø	55.4	181.7	51.1	167.8	67.3	21.2	69.6	13.5	44.2	25.1	82.5	32.3
1Ø.Ø	56.Ø	183.8	51.1	167.7	65.6	22.9	75.3	13.2	43.3	26.5	86.8	29.8
15.Ø	57.2	187.7	51.7	169.6	64.5	24.5	8Ø.2	12.1	39.8	27.3	89.6	26.3
2Ø.Ø	57.6	188.9	51.7	169.7	63.8	25.3	82.9	11.6	38.1	27.8	91.2	24.6
3Ø.Ø	57.9	19Ø.1	51.8	169.9	63.2	26.Ø	85.3	1Ø.6	34.7	28.1	92.1	22.1
5Ø.Ø	57.2	187.7	5Ø.6	166.Ø	62.Ø	26.7	87.6	9.8	32.1	28.4	93.3	2Ø.1
7Ø.Ø	54.7	179.3	47.7	156.6	6Ø.7	26.6	87.4	1Ø.7	35.1	28.7	94.2	21.9
8Ø.Ø	52.7	172.8	46.1	151.3	6Ø.9	25.5	83.6	11.3	37.2	27.9	91.5	24.Ø
85.Ø	51.4	168.7	45.Ø	147.5	6Ø.8	24.9	81.8	12.Ø	39.4	27.7	9Ø.8	25.7
9Ø.Ø	49.9	163.6	43.4	142.3	6Ø.3	24.6	8Ø.7	13.1	43.Ø	27.9	91.4	28.Ø
93.Ø	49.4	162.Ø	42.6	139.9	59.5	24.9	81.7	13.6	44.5	28.4	93.Ø	28.5
95.Ø	49.5	162.3	42.7	14Ø.2	59.6	24.9	81.6	13.2	43.5	28.2	92.5	28.Ø
96.Ø	49.8	163.5	43.4	142.3	6Ø.3	24.6	8Ø.6	12.5	41.1	27.6	9Ø.5	26.9
97.Ø	5Ø.3	164.9	44.Ø	144.4	61.Ø	24.3	79.6	11.8	38.6	27.Ø	88.5	25.8
98.Ø	5Ø.7	166.5	44.9	147.2	62.Ø	23.7	77.6	1Ø.8	35.5	26.Ø	85.4	24.5

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.Ø	3Ø.1	98.8	28.Ø	92.Ø	68.5	11.Ø	35.9	37.1	121.9	38.7	127.1	73.4
2.Ø	29.2	95.7	26.6	87.4	65.7	11.9	39.1	38.5	126.2	4Ø.3	132.1	72.6
3.Ø	28.3	92.9	25.4	83.3	63.5	12.6	41.2	39.6	13Ø.Ø	41.6	136.4	72.2
4.Ø	27.9	91.4	24.4	8Ø.1	61.Ø	13.5	44.1	4Ø.5	132.9	42.7	14Ø.Ø	71.4
5.Ø	28.1	92.3	23.9	78.3	57.8	14.9	49.Ø	41.Ø	134.4	43.6	143.Ø	69.8
7.Ø	28.4	93.2	23.3	76.6	55.1	16.2	53.1	41.3	135.4	44.3	145.4	68.4
1Ø.Ø	3Ø.1	98.6	23.2	76.2	5Ø.4	19.1	62.6	41.1	134.8	45.3	148.6	64.9
15.Ø	34.3	112.5	24.7	8Ø.9	45.8	23.8	78.2	39.2	128.5	45.9	15Ø.4	58.5
2Ø.Ø	38.1	125.1	26.8	87.8	44.5	27.2	89.1	36.6	12Ø.Ø	45.5	149.4	53.2
3Ø.Ø	4Ø.9	134.1	29.2	95.7	45.4	28.6	93.9	33.2	1Ø8.8	43.8	143.7	49.1
5Ø.Ø	39.3	129.1	27.5	9Ø.2	44.2	28.1	92.3	32.9	1Ø7.9	43.3	142.Ø	49.3
7Ø.Ø	34.6	113.5	23.5	77.Ø	42.6	25.4	83.3	35.Ø	114.7	43.2	141.8	53.9
8Ø.Ø	31.9	1Ø4.8	21.3	69.7	41.6	23.8	78.2	36.2	118.8	43.4	142.2	56.5
85.Ø	3Ø.7	1ØØ.6	19.5	63.8	39.3	23.7	77.8	37.5	123.1	44.4	145.6	57.6
9Ø.Ø	3Ø.Ø	98.4	18.1	59.5	37.1	23.9	78.4	38.3	125.8	45.2	148.2	57.9
93.Ø	29.9	98.2	17.3	56.8	35.3	24.4	8Ø.1	38.9	127.5	45.9	15Ø.6	57.7
95.Ø	29.7	97.5	16.8	55.Ø	34.3	24.5	8Ø.5	39.2	128.7	46.3	151.8	57.8
96.Ø	29.4	96.6	16.5	54.Ø	33.9	24.4	8Ø.Ø	39.4	129.3	46.4	152.1	58.1
97.Ø	29.1	95.6	16.1	52.9	33.5	24.3	79.6	39.7	13Ø.2	46.5	152 6	58.4
98.Ø	28.6	93.9	16.Ø	52.4	33.8	23.7	77.9	39.7	13Ø.4	46.3	151.9	59.Ø

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.Ø	55.3	181.4	51.6	169.4	68.8	19.8	64.9	13.6	44.5	24.Ø	78.7	34.3
2.Ø	54.8	179.8	5Ø.8	166.6	67.7	2Ø.6	67.5	14.3	47.Ø	25.1	82.3	34.7
3.Ø	54.6	179.Ø	5Ø.2	164.7	66.7	21.4	7Ø.1	14.8	48.5	26.Ø	85.3	34.6
4.Ø	54.5	178.7	49.8	163.3	65.9	22.1	72.5	15.1	49.6	26.8	87.9	34.3
5.Ø	54.6	179.2	49.6	162.7	65.1	22.9	75.Ø	15.2	49.9	27.5	9Ø.1	33.6
7.Ø	55.2	18Ø.9	49.8	163.3	64.3	23.8	78.Ø	14.8	48.7	28.Ø	91.9	31.9
1Ø.Ø	54.7	179.5	49.Ø	16Ø.7	63.3	24.4	8Ø.1	15.3	5Ø.3	28.8	94.6	32.1
15.Ø	55.9	183.4	49.8	163.3	62.7	25.4	83.5	14.1	46.1	29.1	95.4	28.8
2Ø.Ø	56.8	186.3	5Ø.8	166.5	63.2	25.4	83.4	12.6	41.2	28.4	93.1	26.2
3Ø.Ø	57.9	189.9	51.6	169.3	62.9	26.2	86.Ø	1Ø.8	35.3	28.4	93.Ø	22.3
5Ø.Ø	57.1	187.2	5Ø.5	165.5	62.Ø	26.6	87.4	9.9	32.6	28.4	93.3	2Ø.4
7Ø.Ø	54.3	178.2	47.6	156.1	61.Ø	26.2	85.9	1Ø.9	35.6	28.3	93.Ø	22.5
8Ø.Ø	52.5	172.1	46.1	151.1	61.2	25.1	82.4	11.4	37.4	27.6	9Ø.4	24.4
85.Ø	5Ø.7	166.3	44.1	144.8	6Ø.4	24.9	81.7	12.8	42.1	28.Ø	91.9	27.2
9Ø.Ø	48.9	16Ø.5	42.3	138.6	59.6	24.7	8Ø.9	14.2	46.7	28.5	93.4	29.9
93.Ø	48.3	158.5	41.7	136.9	59.5	24.4	79.9	14.5	47.4	28.3	92.9	3Ø.6
95.Ø	49.2	161.3	42.4	139.1	59.4	24.9	81.6	13.6	44.6	28.3	93.Ø	28.6
96.Ø	49.6	162.6	43.Ø	141.Ø	59.9	24.7	81.Ø	12.9	42.4	27.9	91.5	27.5
97.Ø	5Ø.2	164.6	43.9	144.1	6Ø.9	24.3	79.6	11.9	39.Ø	27.Ø	88.6	26.Ø
98.Ø	49.8	163.4	44.Ø	144.3	61.8	23.4	76.7	11.7	38.4	26.1	85.8	26.5

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Table 19. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Open Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.Ø	64.3	211.ØØ	2.8	Ø.Ø75	Ø.Ø64	Ø.156	Ø.466	Ø.1Ø6	-1.5	25.4
2.Ø	64.2	21Ø.69	5.Ø	Ø.1Ø3	Ø.Ø89	Ø.155	Ø.5ØØ	Ø.1Ø2	-2.4	23.2
3.Ø	64.1	21Ø.37	6.9	Ø.121	Ø.1Ø7	Ø.154	Ø.523	Ø.Ø99	-3.4	2Ø.3
4.Ø	64.Ø	21Ø.Ø5	8.6	Ø.141	Ø.126	Ø.155	Ø.537	Ø.Ø98	-4.6	17.2
5.Ø	63.9	2Ø9.74	1Ø.Ø	Ø.157	Ø.142	Ø.156	Ø.544	Ø.Ø99	-5.9	14.6
7.Ø	63.7	2Ø9.1Ø	11.Ø	Ø.16Ø	Ø.146	Ø.157	Ø.54Ø	Ø.1ØØ	-7.1	12.2
1Ø.Ø	63.4	2Ø8.15	11.5	Ø.144	Ø.133	Ø.158	Ø.5Ø8	Ø.1Ø5	-9.6	9.Ø
15.Ø	63.Ø	2Ø6.57	14.5	Ø.1Ø2	Ø.Ø95	Ø.161	Ø.462	Ø.113	-9.7	5.9
2Ø.Ø	62.5	2Ø4.98	14.3	Ø.Ø69	Ø.Ø65	Ø.164	Ø.413	Ø.121	-1Ø.8	5.1
3Ø.Ø	61.5	2Ø1.81	13.7	Ø.Ø56	Ø.Ø53	Ø.169	Ø.388	Ø.127	-1Ø.6	6.2
5Ø.Ø	59.6	195.47	13.6	-.ØØ9	-.ØØ8	Ø.164	Ø.355	Ø.127	-1Ø.7	7.5
7Ø.Ø	57.6	189.13	14.7	-.Ø15	-.Ø14	Ø.157	Ø.373	Ø.12Ø	-12.3	7.Ø
8Ø.Ø	56.7	185.96	15.8	Ø.ØØ6	Ø.ØØ6	Ø.154	Ø.4ØØ	Ø.114	-13.6	6.3
85.Ø	56.2	184.38	16.6	Ø.Ø11	Ø.Ø1Ø	Ø.151	Ø.416	Ø.11Ø	-13.8	6.3
9Ø.Ø	55.7	182.79	17.7	Ø.ØØ3	Ø.ØØ3	Ø.147	Ø.435	Ø.1Ø6	-13.6	6.4
93.Ø	55.4	181.84	17.3	-.Ø11	-.Ø1Ø	Ø.145	Ø.442	Ø.1Ø3	-14.5	5.6
95.Ø	55.2	181.21	16.6	-.Ø31	-.Ø3Ø	Ø.142	Ø.446	Ø.1ØØ	-15.3	7.1
96.Ø	55.1	18Ø.89	17.8	-.Ø18	-.Ø18	Ø.142	Ø.459	Ø.Ø99	-15.Ø	6.3
97.Ø	55.Ø	18Ø.57	19.1	-.Ø15	-.Ø15	Ø.141	Ø.474	Ø.Ø97	-14.4	6.Ø
98.Ø	54.9	18Ø.26	2Ø.8	-.Ø16	-.Ø16	Ø.141	Ø.491	Ø.Ø96	-12.9	5.Ø

TORQUE = 7929.14 IN.-LB.

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.Ø	64.3	211.ØØ	29.8	Ø.Ø97	Ø.Ø74	-4.4	14.1	-.195Ø	-.19Ø6	Ø.3984
2.Ø	64.2	21Ø.69	28.8	Ø.1Ø3	Ø.Ø79	-3.7	15.5	-.131Ø	-.1279	Ø.3935
3.Ø	64.1	21Ø.37	29.Ø	Ø.1Ø9	Ø.Ø83	-3.2	15.6	-.Ø84Ø	-.Ø821	Ø.4Ø52
4.Ø	64.Ø	21Ø.Ø5	28.8	Ø.113	Ø.Ø86	-3.5	15.3	-.Ø477	-.Ø467	Ø.412Ø
5.Ø	63.9	2Ø9.74	28.Ø	Ø.117	Ø.Ø87	-3.9	15.3	-.Ø183	-.Ø179	Ø.4131
7.Ø	63.7	2Ø9.1Ø	27.3	Ø.12Ø	Ø.Ø89	-3.8	15.8	Ø.ØØ7Ø	Ø.ØØ69	Ø.4255
1Ø.Ø	63.4	2Ø8.15	24.5	Ø.122	Ø.Ø88	-5.Ø	16.3	Ø.Ø492	Ø.Ø48[illegible]	Ø.44Ø1
15.Ø	63.Ø	2Ø6.57	22.6	Ø.125	Ø.Ø87	-6.6	15.3	Ø.1Ø45	Ø.1Ø2[illegible]	Ø.46[illegible]
2Ø.Ø	62.5	2Ø4.98	21.5	Ø.125	Ø.Ø88	-7.9	13.6	Ø.Ø95Ø	Ø.Ø937	Ø.4[illegible]74
3Ø.Ø	61.5	2Ø1.81	21.4	Ø.123	Ø.Ø89	-9.3	1Ø.5	Ø.Ø531	Ø.Ø52[illegible]	Ø.4[illegible]
5Ø.Ø	59.6	195.47	21.5	Ø.123	Ø.Ø91	-1Ø.3	8.7	Ø.Ø455	Ø.Ø45[illegible]	Ø.4[illegible]
7Ø.Ø	57.6	189.13	21.8	Ø.127	Ø.Ø95	-1Ø.1	9.7	Ø.Ø4[illegible]4	Ø.Ø45[illegible]	Ø.3[illegible]
8Ø.Ø	56.7	185.96	22.9	Ø.129	Ø.Ø97	-1Ø.5	9.2	Ø.Ø467	Ø.Ø46[illegible]	Ø.3[illegible]
85.Ø	56.2	184.38	23.4	Ø.129	Ø.Ø96	-1Ø.7	9.2	Ø.Ø499	Ø.Ø49[illegible]	Ø.3[illegible]75
9Ø.Ø	55.7	182.79	23.8	Ø.129	Ø.Ø96	-11.1	9.1	Ø.Ø57Ø	Ø.Ø56[illegible]	Ø.4[illegible]7
93.Ø	55.4	181.84	23.Ø	Ø.128	Ø.Ø95	-11.5	9.7	Ø.Ø667	Ø.Ø65[illegible]	Ø.4[illegible]16
95.Ø	55.2	181.21	22.9	Ø.128	Ø.Ø97	-11.6	9.3	Ø.Ø636	Ø.Ø62[illegible]	Ø.3[illegible]
96.Ø	55.1	[illegible].89	23.Ø	Ø.129	Ø.Ø94	-11.3	9.3	Ø.1Ø32	Ø.1Ø1[illegible]	Ø.[illegible]
97.Ø	55.Ø	[illegible].57	24.Ø	Ø.129	Ø.Ø9Ø	-11.3	8.1	Ø.1332	Ø.1[illegible]7[illegible]	Ø.4[illegible]
98.Ø	54.9	[illegible].26	23.7	Ø.129	Ø.Ø85	-11.9	8.5	Ø.1292	Ø.[illegible]26[illegible]	Ø.4Ø91

Table 20. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Design Point Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.Ø	65.6	215.32	1.6	Ø.114	Ø.Ø97	Ø.158	Ø.578	Ø.Ø95	-Ø.7	28.4
2.Ø	65.5	214.99	2.3	Ø.141	Ø.121	Ø.157	Ø.617	Ø.Ø9Ø	-1.6	25.7
3.Ø	65.4	214.67	2.8	Ø.176	Ø.152	Ø.157	Ø.656	Ø.Ø86	-2.6	25.2
4.Ø	65.3	214.35	3.9	Ø.195	Ø.17Ø	Ø.157	Ø.681	Ø.Ø83	-3.5	23.1
5.Ø	65.2	214.Ø2	5.7	Ø.2Ø7	Ø.183	Ø.158	Ø.692	Ø.Ø82	-4.4	2Ø.3
7.Ø	65.Ø	213.38	8.9	Ø.193	Ø.174	Ø.158	Ø.676	Ø.Ø85	-5.2	16.2
1Ø.Ø	64.7	212.41	12.6	Ø.162	Ø.148	Ø.158	Ø.64Ø	Ø.Ø9Ø	-6.6	11.Ø
15.Ø	64.2	21Ø.79	15.1	Ø.1Ø6	Ø.Ø99	Ø.161	Ø.562	Ø.1Ø1	-8.2	6.8
2Ø.Ø	63.8	2Ø9.17	15.Ø	Ø.Ø68	Ø.Ø63	Ø.164	Ø.5Ø7	Ø.11Ø	-9.3	5.8
3Ø.Ø	62.8	2Ø5.94	15.2	Ø.Ø16	Ø.Ø15	Ø.167	Ø.445	Ø.119	-9.3	5.9
5Ø.Ø	6Ø.8	199.47	14.6	Ø.ØØ1	Ø.ØØ1	Ø.165	Ø.443	Ø.117	-9.1	8.1
7Ø.Ø	58.8	193.ØØ	15.3	-.Ø18	-.Ø17	Ø.158	Ø.467	Ø.1Ø9	-1Ø.1	8.7
8Ø.Ø	57.8	189.75	16.7	-.Ø15	-.Ø14	Ø.154	Ø.492	Ø.1Ø3	-11.Ø	8.Ø
85.Ø	57.3	188.15	17.3	-.Ø23	-.Ø22	Ø.151	Ø.5ØØ	Ø.1ØØ	-11.Ø	8.4
9Ø.Ø	56.9	186.53	18.Ø	-.Ø38	-.Ø37	Ø.147	Ø.516	Ø.Ø96	-11.6	9.2
93.Ø	56.6	185.55	18.9	-.Ø61	-.Ø59	Ø.144	Ø.519	Ø.Ø94	-12.4	7.3
95.Ø	56.4	184.91	19.2	-.Ø93	-.Ø9Ø	Ø.141	Ø.516	Ø.Ø93	-13.Ø	6.8
96.Ø	56.3	184.59	2Ø.9	-.1Ø4	-.1Ø1	Ø.14Ø	Ø.527	Ø.Ø92	-11.9	6.3
97.Ø	56.2	184.26	22.9	-.117	-.114	Ø.14Ø	Ø.531	Ø.Ø91	-1Ø.6	6.Ø
98.Ø	56.1	183.94	25.4	-.284	-.276	Ø.13Ø	Ø.487	Ø.Ø91	-8.4	5.9

TORQUE = 8179.19 IN.-LB.

*Loss Coefficients Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.Ø	65.6	215.32	36.3	Ø.1Ø5	Ø.Ø68	2.1	14.1	-.Ø674	-.Ø658	Ø.55Ø4
2.Ø	65.5	214.99	37.2	Ø.11Ø	Ø.Ø72	3.7	14.6	-.Ø181	-.Ø177	Ø.5458
3.Ø	65.4	214.67	38.9	Ø.114	Ø.Ø76	5.2	14.1	Ø.Ø194	Ø.Ø189	Ø.5479
4.Ø	65.3	214.35	39.4	Ø.118	Ø.Ø79	5.9	14.Ø	Ø.Ø481	Ø.Ø471	Ø.5463
5.Ø	65.2	214.Ø2	38.7	Ø.121	Ø.Ø81	5.7	14.2	Ø.Ø7Ø3	Ø.Ø69Ø	Ø.5448
7.Ø	65.Ø	213.38	36.3	Ø.124	Ø.Ø82	4.5	15.1	Ø.Ø9Ø1	Ø.Ø864	Ø.5396
1Ø.Ø	64.7	212.41	33.2	Ø.127	Ø.Ø84	2.5	15.5	Ø.1127	Ø.11Ø6	Ø.5351
15.Ø	64.2	21Ø.79	3Ø.1	Ø.128	Ø.Ø86	-Ø.4	13.9	Ø.1Ø31	Ø.1Ø6[illegible]	Ø.51Ø9
2Ø.Ø	63.8	2Ø9.17	28.8	Ø.127	Ø.Ø88	-2.3	12.Ø	Ø.Ø828	Ø.Ø819	[illegible]
3Ø.Ø	62.8	2Ø5.94	26.1	Ø.126	Ø.Ø88	-4.3	1Ø.3	Ø.Ø597	Ø.Ø591	Ø.4739
5Ø.Ø	6Ø.8	199.47	27.1	Ø.123	Ø.Ø89	-4.7	8.7	Ø.Ø336	Ø.Ø331	[illegible]
7Ø.Ø	58.8	193.ØØ	28.5	Ø.125	Ø.Ø92	-4.6	8.5	Ø.Ø42Ø	Ø.Ø417	[illegible]
8Ø.Ø	57.8	189.75	28.4	Ø.127	Ø.Ø9Ø	-4.9	9.3	Ø.Ø635	Ø.Ø579	Ø.4574
85.Ø	57.3	188.15	27.Ø	Ø.127	Ø.Ø9Ø	-5.5	1Ø.7	Ø.Ø589	Ø.Ø581	[illegible]
9Ø.Ø	56.9	[illegible]	26.1	Ø.127	Ø.Ø9Ø	-6.Ø	11.9	Ø.Ø55Ø	Ø.Ø542	[illegible]
93.Ø	56.6	[illegible]	25.7	Ø.129	Ø.Ø91	-6.8	11.7	Ø.Ø648	[illegible]	[illegible]
95.Ø	56.4	[illegible]	25.4	Ø.13Ø	Ø.Ø93	-7.6	11.4	Ø.Ø753	Ø.Ø74[illegible]	[illegible]
96.Ø	56.3	[illegible]	23.Ø	Ø.131	Ø.Ø92	-7.3	1Ø.5	Ø.1135	[illegible]	[illegible]
97.Ø	56.2	[illegible]	[illegible]	Ø.131	Ø.Ø89	-8.5	1Ø.7	Ø.1361	[illegible]	[illegible]
98.Ø	56.1	[illegible]	21.7	Ø.131	Ø.Ø85	-8.9	1Ø.4	Ø.2145	Ø.211[illegible]	[illegible]

Table 21. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Peak Efficiency Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.Ø	65.2	213.83	3.5	Ø.11Ø	Ø.Ø94	Ø.16Ø	Ø.578	Ø.Ø97	Ø.8	27.9
2.Ø	65.1	213.51	5.3	Ø.141	Ø.122	Ø.16Ø	Ø.613	Ø.Ø93	-Ø.3	25.Ø
3.Ø	65.Ø	213.19	7.Ø	Ø.16Ø	Ø.14Ø	Ø.159	Ø.64Ø	Ø.Ø89	-1.3	22.3
4.Ø	64.9	212.87	9.Ø	Ø.17Ø	Ø.151	Ø.153	Ø.653	Ø.Ø88	-2.3	19.2
5.Ø	64.8	212.54	11.3	Ø.176	Ø.159	Ø.159	Ø.656	Ø.Ø88	-3.3	15.9
7.Ø	64.6	211.9Ø	13.3	Ø.172	Ø.157	Ø.159	Ø.65Ø	Ø.Ø9Ø	-4.2	12.9
1Ø.Ø	64.3	21Ø.94	16.Ø	Ø.158	Ø.146	Ø.161	Ø.627	Ø.Ø94	-5.8	8.3
15.Ø	63.8	2Ø9.33	17.5	Ø.1Ø5	Ø.Ø98	Ø.163	Ø.559	Ø.1Ø4	-7.4	5.2
2Ø.Ø	63.3	2Ø7.73	17.3	Ø.Ø71	Ø.Ø66	Ø.166	Ø.5Ø3	Ø.112	-8.3	1.6
3Ø.Ø	62.3	2Ø4.51	17.Ø	Ø.Ø24	Ø.Ø23	Ø.166	Ø.457	Ø.118	-8.Ø	5.5
5Ø.Ø	6Ø.4	198.Ø9	16.3	Ø.Ø1Ø	Ø.ØØ9	Ø.163	Ø.464	Ø.114	-7.6	7.9
7Ø.Ø	58.4	191.66	16.9	Ø.Ø21	Ø.Ø2Ø	Ø.157	Ø.5Ø2	Ø.1Ø5	-8.3	8.8
8Ø.Ø	57.4	188.45	18.9	Ø.Ø38	Ø.Ø37	Ø.153	Ø.525	Ø.1ØØ	-8.7	9.1
85.Ø	57.Ø	186.85	2Ø.2	Ø.Ø19	Ø.Ø18	Ø.149	Ø.535	Ø.Ø96	-8.7	7.8
9Ø.Ø	56.5	185.24	21.2	-.ØØ2	-.ØØ2	Ø.145	Ø.549	Ø.Ø93	-9.4	7.3
93.Ø	56.2	184.2Ø	21.9	-.Ø32	-.Ø31	Ø.143	Ø.55Ø	Ø.Ø91	-1Ø.4	6.3
95.Ø	56.Ø	183.63	22.3	-.Ø46	-.Ø45	Ø.142	Ø.556	Ø.Ø9Ø	-11.3	5.4
96.Ø	55.9	183.31	23.7	-.Ø48	-.Ø47	Ø.142	Ø.566	Ø.Ø89	-1Ø.6	4.9
97.Ø	55.8	182.99	25.2	-.Ø23	-.Ø22	Ø.143	Ø.59Ø	Ø.Ø88	-9.6	4.6
98.Ø	55.7	182.67	26.7	Ø.Ø19	Ø.Ø19	Ø.144	Ø.625	Ø.Ø85	-8.5	4.4

TORQUE = 8575.7Ø IN.-LB.

*Loss Coefficients Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.Ø	65.2	213.83	34.4	Ø.1Ø3	Ø.Ø7Ø	1.Ø	15.Ø	-.1437	-.14Ø2	Ø.5177
2.Ø	65.1	213.51	34.Ø	Ø.1Ø9	Ø.Ø73	1.5	15.6	-.Ø72Ø	-.Ø7Ø3	Ø.5242
3.Ø	65.Ø	213.19	34.4	Ø.114	Ø.Ø76	2.2	15.7	-.Ø193	-.Ø188	Ø.5313
4.Ø	64.9	212.87	34.2	Ø.119	Ø.Ø79	2.1	15.5	Ø.Ø2Ø8	[illegible]	Ø.5367
5.Ø	64.8	212.54	33.Ø	Ø.122	Ø.Ø8Ø	1.3	15.6	Ø.Ø521	Ø.Ø5Ø9	[illegible]
7.Ø	64.6	211.9Ø	31.6	Ø.125	Ø.Ø82	1.2	16.4	Ø.Ø763	[illegible]	Ø.5[illegible]
1Ø.Ø	64.3	21Ø.94	29.2	Ø.129	Ø.Ø84	Ø.Ø	17.Ø	Ø.1165	[illegible]	[illegible]
15.Ø	63.8	2Ø9.33	27.1	Ø.13Ø	Ø.Ø84	-2.Ø	15.3	Ø.1273	[illegible]	[illegible]
2Ø.Ø	63.3	2Ø7.73	25.5	Ø.129	Ø.Ø82	-3.6	13.8	Ø.1Ø95	[illegible]	[illegible]
3Ø.Ø	62.3	2Ø4.51	25.9	Ø.126	Ø.Ø8Ø	-4.2	11.1	Ø.Ø938	[illegible]	[illegible]
5Ø.Ø	6Ø.4	198.Ø9	27.7	Ø.123	Ø.Ø8Ø	-3.2	9.6	Ø.Ø613	[illegible]	[illegible]
7Ø.Ø	58.4	191.66	28.7	Ø.124	Ø.Ø83	-2.8	1Ø.1	[illegible]	[illegible]	[illegible]
8Ø.Ø	57.4	188.45	28.9	Ø.126	Ø.Ø82	-3.4	1Ø.3	Ø.Ø513	[illegible]	[illegible]
85.Ø	57.Ø	[illegible]	27.8	Ø.127	Ø.Ø83	-4.Ø	11.6	[illegible]	[illegible]	[illegible]
9Ø.Ø	56.5	[illegible]	27.1	Ø.129	Ø.Ø84	-4.6	12.3	[illegible]	[illegible]	[illegible]
93.Ø	56.2	[illegible]	26.7	Ø.13Ø	Ø.Ø87	-5.8	11.8	[illegible]	[illegible]	[illegible]
95.Ø	56.Ø	[illegible]	26.9	Ø.132	Ø.Ø87	-6.6	1Ø.9	[illegible]	[illegible]	[illegible]
96.Ø	55.9	[illegible]	27.9	Ø.132	Ø.Ø84	-6.9	9.5	Ø.1531	[illegible]	[illegible]
97.Ø	55.8	[illegible]	29.Ø	Ø.133	Ø.Ø81	-7.Ø	8.2	[illegible]	[illegible]	[illegible]
98.Ø	55.7	[illegible]	[illegible]	Ø.123	Ø.Ø78	-6.5	7.2	[illegible]	[illegible]	[illegible]

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Figure 22. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Peak Pressure Rise/Near Stall Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.0	65.2	213.90	4.2	0.162	0.137	0.160	0.672	0.096	2.0	28.4
2.0	65.1	213.53	5.7	0.178	0.153	0.159	0.694	0.083	0.7	25.6
3.0	65.0	213.26	6.8	0.139	0.165	0.158	0.712	0.081	-0.4	23.3
4.0	64.9	212.93	8.3	0.198	0.175	0.158	0.723	0.080	-1.5	20.8
5.0	64.8	212.61	10.4	0.201	0.179	0.158	0.721	0.080	-2.5	17.8
7.0	64.6	211.97	12.1	0.200	0.180	0.158	0.718	0.081	-3.4	[illegible]
10.0	64.3	211.01	15.2	0.190	0.175	0.160	0.691	0.086	-5.[illegible]	[illegible]
15.0	63.8	209.40	18.7	0.138	0.129	0.163	0.615	0.098	-6.2	5.3
20.0	63.3	207.79	19.3	0.070	0.066	0.165	0.533	0.109	-6.7	4.1
30.0	62.4	204.58	17.7	-.005	-.004	0.166	0.468	0.117	-6.7	5.0
50.0	60.4	198.15	17.8	0.003	0.003	0.163	0.485	0.112	-6.4	7.6
70.0	58.4	191.73	18.1	0.029	0.027	0.156	0.552	0.099	-6.5	9.4
80.0	57.5	188.51	19.3	0.037	0.035	0.151	0.587	0.091	-6.4	10.0
85.0	57.0	186.91	21.6	0.036	0.035	0.147	0.605	0.088	-6.7	3.5
90.0	56.5	185.30	23.2	-.008	-.007	0.142	0.602	0.086	-7.5	7.1
93.0	56.2	184.34	24.3	-.035	-.034	0.141	0.599	0.085	-8.5	5.7
95.0	56.0	183.69	25.4	-.032	-.031	0.141	0.608	0.085	-8.6	5.1
96.0	55.9	183.37	26.4	-.024	-.023	0.142	0.624	0.084	-8.0	4.9
97.0	55.8	183.05	27.5	0.003	0.003	0.144	0.641	0.083	-7.4	4.6
98.0	55.7	182.73	28.2	0.034	0.033	0.145	0.662	0.082	-6.4	5.1

TORQUE = 8353.58 IN.-LB.

*Loss Coefficient Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.0	65.2	213.90	39.1	0.110	0.068	5.0	14.2	-.0307	-.0300	0.5980
2.0	65.1	213.53	37.9	0.115	0.071	5.2	15.3	0.0072	0.0073	0.5915
3.0	65.0	213.26	37.6	0.119	0.074	5.7	15.9	0.0360	0.0352	0.5[illegible]
4.0	64.9	212.93	37.2	0.122	0.076	5.8	16.2	0.0581	0.0569	0.5[illegible]
5.0	64.8	212.61	36.2	0.124	0.078	5.0	16.1	0.0747	0.0731	0.5[illegible]
7.0	64.6	211.97	36.5	0.126	0.080	3.1	15.5	0.0871	0.0853	0.5[illegible]
10.0	64.3	[illegible]	32.8	0.129	0.082	3.7	17.1	0.1014	0.0993	0.5[illegible]
15.0	63.8	[illegible]	29.7	0.131	0.083	0.5	15.3	0.1179	0.116[illegible]	0.5[illegible]
20.0	63.3	[illegible].79	27.0	0.130	0.081	-2.3	13.7	0.1063	0.1040	0.5[illegible]
30.0	62.4	[illegible].58	26.9	0.125	0.081	-3.8	10.6	0.0742	0.0733	0.5[illegible]
50.0	60.4	[illegible].15	28.0	0.124	0.081	-2.7	3.9	0.0596	0.059[illegible]	[illegible]
70.0	58.4	[illegible].73	31.4	0.123	0.081	0.1	10.3	0.0598	0.059[illegible]	[illegible]
80.0	57.5	[illegible].51	32.1	0.124	0.079	0.6	11.1	0.0630	0.062[illegible]	[illegible]
85.0	57.0	[illegible].91	30.4	0.127	0.080	0.0	12.0	0.0685	0.067[illegible]	[illegible]
90.0	56.5	[illegible]	28.0	0.129	0.081	-1.7	14.3	0.0926	0.091[illegible]	[illegible]
93.0	56.2	[illegible]	27.1	0.131	0.081	-3.4	13.7	0.1325	[illegible]	[illegible]
95.0	56.0	[illegible]	29.2	0.132	0.081	-4.1	10.7	0.1331	0.151[illegible]	[illegible]
96.0	55.9	[illegible]	30.5	0.132	0.079	-4.7	[illegible]	[illegible]	[illegible]	[illegible]
97.0	55.8	[illegible]	32.1	0.133	0.077	-5.1	[illegible]	[illegible]	[illegible]	[illegible]
98.0	55.7	[illegible]	32.5	0.132	0.075	-5.3	6.1	[illegible]	[illegible]	[illegible]

Table 23. Design Intent Performance for Rotor B/Stator B Computed for U_t = 65.73 mps (215.64).

BLADE ELEMENT DATA ROTOR INLET

IMMER %	W MPS	W FPS	WU MPS	WU FPS	BETA DEG	CZ MPS	CZ FPS	CU MPS	CU FPS	C MPS	C FPS	ALPHA DEG
0.	55.3	181.3	50.3	165.1	65.6	22.8	75.0	15.4	50.5	27.5	90.4	34.0
11.5	57.9	189.9	51.9	170.1	63.7	25.7	84.2	12.8	42.0	28.7	94.0	26.5
21.6	59.3	194.6	52.5	172.4	62.3	27.6	90.5	11.1	36.5	29.7	97.8	22.0
31.2	59.8	196.4	52.4	172.1	61.2	28.8	94.5	10.3	33.7	30.6	100.3	19.6
40.5	59.6	195.7	51.8	170.0	60.3	29.6	97.0	9.9	32.6	31.2	102.3	18.6
49.8	59.1	193.7	50.8	166.8	59.5	30.0	98.4	10.0	32.7	31.6	103.6	18.4
59.1	58.3	191.1	49.8	163.4	58.8	30.2	99.1	10.1	33.2	31.9	104.5	18.5
68.6	57.1	187.5	48.5	159.0	58.1	30.2	99.0	10.5	34.3	31.9	104.7	19.1
78.3	55.3	181.4	46.7	153.1	57.6	29.6	97.2	11.3	37.1	31.7	104.1	20.9
88.6	52.4	172.1	44.0	144.4	57.1	28.5	93.4	12.9	42.4	31.3	102.7	24.4
100.0	47.7	156.5	39.9	131.0	56.8	26.1	85.7	15.9	52.3	30.6	100.3	31.4

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER %	W MPS	W FPS	WU MPS	WU FPS	BETA DEG	CZ MPS	CZ FPS	CU MPS	CU FPS	C MPS	C FPS	ALPHA DEG
0.	34.5	113.2	29.0	95.0	57.1	18.7	61.4	36.8	120.6	41.2	135.3	63.0
11.5	39.5	129.6	30.7	100.9	51.1	24.8	81.3	33.8	110.9	41.9	137.6	53.7
21.6	42.4	139.0	31.8	104.2	48.5	28.1	92.1	31.8	104.3	42.4	139.1	48.6
31.2	43.6	143.1	31.9	104.5	47.0	29.8	97.7	30.7	100.9	42.8	140.3	45.9
40.5	43.6	143.2	31.1	102.1	45.5	30.6	100.3	30.6	100.3	43.2	141.8	45.0
49.8	42.9	140.9	29.9	98.0	44.1	30.8	101.2	30.9	101.4	43.7	143.3	45.1
59.1	42.0	137.8	28.4	93.2	42.5	31.0	101.7	31.5	103.3	44.2	144.9	45.5
68.5	40.7	133.6	26.6	87.3	40.7	30.8	101.2	32.4	106.2	44.7	146.7	46.4
78.3	38.5	126.4	24.1	79.1	38.7	30.1	98.7	33.9	111.4	45.3	148.8	48.5
88.6	35.1	115.0	20.7	67.9	36.1	28.3	92.9	36.3	119.2	46.1	151.2	52.1
100.0	28.6	93.7	15.5	50.8	32.9	24.0	78.6	40.4	132.5	46.9	154.0	59.3

BLADE ELEMENT DATA STATOR OUTLET

IMMER %	W MPS	W FPS	WU MPS	WU FPS	BETA DEG	CZ MPS	CZ FPS	CU MPS	CU FPS	C MPS	C FPS	ALPHA DEG
0.	55.3	181.4	50.4	165.4	65.8	22.7	74.5	15.3	50.2	27.4	89.8	34.0
11.5	57.9	189.9	51.9	170.3	63.9	25.5	83.6	12.7	41.8	28.5	93.4	26.5
21.6	59.3	194.5	52.6	172.6	62.5	27.4	89.8	11.1	36.3	29.5	96.8	22.0
31.2	59.8	196.2	52.5	172.3	61.5	28.6	93.8	10.2	33.4	30.3	99.5	19.6
40.5	59.6	195.6	51.9	170.2	60.5	29.3	96.2	9.9	32.4	31.0	101.5	18.6
49.8	59.0	193.5	51.0	167.3	59.7	29.7	97.6	9.9	32.4	31.3	102.8	18.4
59.1	58.2	190.9	49.9	163.7	59.0	30.0	98.4	10.0	32.9	31.6	103.7	18.5
68.6	57.1	187.2	48.6	159.4	58.3	29.9	98.2	10.4	34.0	31.7	103.9	19.1
78.3	55.2	181.2	46.8	153.5	57.8	29.4	96.5	11.2	36.9	31.5	103.3	20.9
88.6	52.4	171.9	44.2	144.9	57.4	28.2	92.6	12.8	42.0	31.0	101.8	24.4
100.0	47.7	156.5	40.0	131.3	57.1	25.9	85.0	15.8	51.9	30.4	99.6	31.4

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
0.	57.6	189.00	8.5	0.096	0.086	0.142	0.555	0.088	-5.1	17.1
11.5	56.6	185.74	12.6	0.068	0.062	0.149	0.483	0.101	-7.0	10.6
21.6	55.7	182.88	13.8	0.048	0.045	0.152	0.442	0.109	-8.1	8.3
31.2	54.9	180.15	14.2	0.037	0.035	0.154	0.423	0.112	-8.6	7.7
40.5	54.1	177.52	14.8	0.034	0.032	0.153	0.419	0.112	-8.8	7.5
49.8	53.3	174.88	15.4	0.035	0.033	0.152	0.425	0.110	-8.9	7.5
59.1	52.5	172.25	16.3	0.039	0.037	0.150	0.434	0.108	-9.0	7.4
68.6	51.7	169.55	17.4	0.044	0.042	0.147	0.447	0.104	-9.1	7.2
78.3	50.8	166.80	18.9	0.049	0.047	0.142	0.471	0.099	-9.6	6.8
88.6	50.0	163.88	21.0	0.055	0.053	0.135	0.512	0.090	-10.6	5.9
100.0	49.0	160.65	23.9	0.061	0.059	0.122	0.604	0.073	-11.7	4.5

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
0.	57.6	189.00	29.0	0.106	0.070	-6.4	13.2	0.0840	0.0821	0.5210
11.5	56.6	185.74	27.2	0.107	0.073	-6.5	12.0	0.0620	0.0612	0.5000
21.6	55.7	182.88	26.6	0.109	0.076	-6.3	9.7	0.0460	0.0456	0.4780
31.2	54.9	180.15	26.3	0.110	0.078	-6.8	7.9	0.0350	0.0347	0.4610
40.5	54.1	177.52	26.4	0.111	0.079	-7.0	7.1	0.0300	0.0298	0.4530
49.8	53.3	174.88	26.7	0.112	0.080	-6.9	6.9	0.0300	0.0298	0.4510
59.1	52.5	172.25	27.0	0.113	0.081	-7.0	6.8	0.0320	0.0318	0.4530
68.5	51.7	169.55	27.3	0.115	0.081	-7.2	7.0	0.0390	0.0387	0.4610
78.3	50.8	166.80	27.6	0.116	0.081	-7.0	7.9	0.0540	0.0536	0.4760
88.6	50.0	163.88	27.7	0.118	0.079	-6.9	9.2	0.0740	0.0732	0.4970
100.0	49.0	160.65	27.9	0.120	0.078	-6.5	9.4	0.1010	0.0994	0.5250

Table 24. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

Open Throttle

PERCENT IMMERSION	TOTAL PRESSURE ROTOR 3 INLET	TOTAL PRESSURE ROTOR 3 EXIT	TOTAL PRESSURE STATOR 3 EXIT	STATIC PRESSURE ROTOR 3 INLET	STATIC PRESSURE ROTOR 3 EXIT	STATIC PRESSURE STATOR 3 EXIT
0.	0.8442	1.3499	1.3230	0.6878	0.9981	1.2057
1.0	0.8591	1.3707	1.3351	0.6865	0.9867	1.2023
2.0	0.8716	1.3891	1.3454	0.6853	0.9763	1.1991
3.0	0.8819	1.4051	1.3539	0.6842	0.9672	1.1960
4.0	0.8899	1.4187	1.3605	0.6831	0.9596	1.1931
5.0	0.8956	1.4299	1.3653	0.6822	0.9536	1.1904
7.0	0.9002	1.4452	1.3694	0.6805	0.9467	1.1855
10.0	0.9025	1.4531	1.3809	0.6786	0.9481	1.1795
15.0	0.9069	1.4495	1.3934	7.6778	0.9571	1.1757
20.0	0.9128	1.4414	1.3984	0.6767	0.9725	1.1741
30.0	0.9298	1.4314	1.3989	0.6760	0.9760	1.1705

Design Point Throttle

PERCENT IMMERSION	TOTAL PRESSURE ROTOR 3 INLET	TOTAL PRESSURE ROTOR 3 EXIT	TOTAL PRESSURE STATOR 3 EXIT	STATIC PRESSURE ROTOR 3 INLET	STATIC PRESSURE ROTOR 3 EXIT	STATIC PRESSURE STATOR 3 EXIT
0.	1.0082	1.5929	1.5175	0.8701	1.2018	1.4418
1.0	1.0171	1.6063	1.5296	0.8690	1.1895	1.4387
2.0	1.0250	1.6181	1.5404	0.8679	1.1782	1.4357
3.0	1.0319	1.6282	1.5499	0.8668	1.1684	1.4328
4.0	1.0377	1.6366	1.5581	0.8658	1.1601	1.4300
5.0	1.0425	1.6435	1.5650	0.8648	1.1536	1.4273
7.0	1.0490	1.6521	1.5747	0.8629	1.1457	1.4223
10.0	1.0542	1.6596	1.5797	0.8603	1.1462	1.4156
15.0	1.0638	1.6582	1.5868	0.8569	1.1506	1.4099
20.0	1.0692	1.6516	1.5907	0.8536	1.1626	1.4059
30.0	1.0709	1.6305	1.5964	0.8505	1.1775	1.4034

Peak Pressure Rise/Near Stall Throttle

PERCENT IMMERSION	TOTAL PRESSURE ROTOR 3 INLET	TOTAL PRESSURE ROTOR 3 EXIT	TOTAL PRESSURE STATOR 3 EXIT	STATIC PRESSURE ROTOR 3 INLET	STATIC PRESSURE ROTOR 3 EXIT	STATIC PRESSURE STATOR 3 EXIT
0.	1.0710	1.7621	1.6166	0.9398	1.2806	1.5336
1.0	1.0741	1.7652	1.6255	0.9389	1.2709	1.5313
2.0	1.0771	1.7661	1.6328	0.9380	1.2621	1.5289
3.0	1.0801	1.7647	1.6386	0.9371	1.2543	1.5265
4.0	1.0831	1.7610	1.6427	0.9362	1.2472	1.5241
5.0	1.0860	1.7551	1.6452	0.9353	1.2414	1.5218
7.0	1.0918	1.7365	1.6455	0.9335	1.2331	1.5170
10.0	1.0927	1.7169	1.6489	0.9306	1.2205	1.5099
15.0	1.0958	1.7076	1.6527	0.9254	1.2178	1.5011
20.0	1.1037	1.7091	1.6585	0.9216	1.2195	1.4974
30.0	1.1170	1.7106	1.6698	0.9179	1.2460	1.4938

Table 24. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance (Concluded).

Open Throttle

PERCENT IMMERSION	MEASURED ROTOR 3 INLET	MEASURED STATOR 3 INLET	MEASURED STATOR 3 EXIT	CORRECTED ROTOR 3 INLET	CORRECTED STATOR 3 INLET	CORRECTED STATOR 3 EXIT
0.	39.7	67.5	40.2	41.1	68.5	41.6
1.0	42.4	69.1	38.5	43.8	70.0	39.9
2.0	41.4	68.9	36.8	42.8	69.8	38.2
3.0	39.8	68.0	35.0	41.2	69.0	36.3
4.0	38.7	66.7	33.5	40.1	67.7	34.8
5.0	36.3	65.1	32.3	37.6	66.1	33.6
10.0	32.5	59.3	29.5	33.7	60.4	30.6
15.0	29.6	51.9	26.3	30.7	53.1	27.3
20.0	26.2	46.1	22.4	27.2	47.3	23.3
25.0	23.0	43.2	20.1	23.8	44.4	20.9
30.0	21.0	42.1	18.8	21.8	43.2	19.5

• CURVE FIT VALUES USING ZERO STATOR POSITION DATA

Design Point Throttle

PERCENT IMMERSION	MEASURED ROTOR 3 INLET	MEASURED STATOR 3 INLET	MEASURED STATOR 3 EXIT	CORRECTED ROTOR 3 INLET	CORRECTED STATOR 3 INLET	CORRECTED STATOR 3 EXIT
0.	43.0	74.2	38.7	44.5	74.9	40.1
1.0	43.6	75.4	38.5	45.0	76.1	39.9
2.0	42.4	74.6	35.9	43.8	75.3	37.3
3.0	41.0	73.4	34.5	42.4	74.2	35.8
4.0	39.4	72.2	33.2	40.8	73.0	34.5
5.0	37.8	70.7	31.9	39.1	71.5	33.2
10.0	33.8	64.0	29.6	35.0	65.0	30.7
15.0	29.7	58.4	26.3	30.8	59.5	27.3
20.0	25.1	50.5	23.0	26.0	51.7	23.9
25.0	21.9	46.6	20.6	22.7	47.8	21.4
30.0	21.4	44.4	19.6	22.2	45.5	20.3

Peak Pressure Rise/Near Stall Throttle

PERCENT IMMERSION	MEASURED ROTOR 3 INLET	MEASURED STATOR 3 INLET	MEASURED STATOR 3 EXIT	CORRECTED ROTOR 3 INLET	CORRECTED STATOR 3 INLET	CORRECTED STATOR 3 EXIT
0.	43.1	78.0	40.2	44.6	78.6	41.6
1.0	44.0	78.4	39.1	45.4	79.0	40.5
2.0	43.3	77.4	38.3	44.7	78.0	39.7
3.0	41.3	76.6	35.6	42.7	77.2	36.9
4.0	37.9	75.5	34.0	39.3	76.2	35.3
5.0	37.1	74.3	33.4	38.4	75.0	34.7
10.0	32.7	69.4	30.7	33.9	70.3	31.9
15.0	28.9	63.3	27.4	30.0	64.3	28.4
20.0	26.3	56.3	24.9	27.3	57.4	25.8
25.0	23.2	50.7	23.0	24.0	51.8	23.8
30.0	22.0	47.4	22.1	22.8	48.5	22.9

Table 25. Rotor Loss Coefficients Determined from Relative Total Pressure Measurements, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance.

Open Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.4370	1.2940	5.0	0.1896	0.0066	0.1830
10.0	1.4606	1.3426	10.0	0.1509	0.0098	0.1411
15.0	1.4729	1.4177	15.0	C 0694	0.0202	0.0492
20.0	1.4919	1.4628	20.0	0.0358	0.0199	0.0159
35.0	1.5492	1.5101	35.0	0.0448	0.0211	0.0237
50.0	1.5305	1.4871	50.0	0.0511	0.0169	0.0342
65.0	1.4789	1.4407	65.0	0.0483	0.0239	0.0244
80.0	1.3973	1.3682	80.0	0.0418	0.0290	0.0128
85.0	1.3660	1.3317	85.0	0.0520	0.0421	0.0099
90.0	1.3627	1.2930	90.0	0.1069	0.0656	0.0413
95.0	1.2875	1.2433	95.0	0.0774	0.0621	0.0153

Design Point Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.5806	1.4382	5.0	0.1991	0.0049	0.1942
10.0	1.6021	1.4775	10.0	0.1680	0.0147	0.1534
15.0	1.6231	1.5456	15.0	0.1012	0.0164	0.0848
20.0	1.6373	1.6047	20.0	0.0416	0.0173	0.0243
35.0	1.7003	1.6657	35.0	0.0407	0.0166	0.0242
50.0	1.6802	1.6376	50.0	0.0518	0.0190	0.0328
65.0	1.6287	1.5875	65.0	0.0548	0.0227	0.0322
80.0	1.5598	1.5218	80.0	0.0582	0.0332	0.0251
85.0	1.5306	1.4875	85.0	0.0705	0.0494	0.0212
90.0	1.4921	1.4456	90.0	0.0832	0.0735	0.0097
95.0	1.4488	1.4083	95.0	0.0808	0.0576	0.0232

Peak Pressure Rise/Near Stall Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.4650	1.4168	5.0	0.1112	0.0158	0.0954
10.0	1.5499	1.4656	10.0	0.1293	0.0144	0.1150
15.0	1.6165	1.5397	15.0	0.1319	0.0159	0.1160
20.0	1.6723	1.6133	20.0	0.0811	0.0164	0.0648
35.0	1.7373	1.7030	35.0	0.0477	0.0222	0.0255
50.0	1.7203	1.6817	50.0	0.0569	0.0187	0.0382
65.0	1.6822	1.6360	65.0	0.0688	0.0204	0.0484
80.0	1.6162	1.5797	80.0	0.0587	0.0354	0.0233
85.0	1.5969	1.5470	85.0	0.0719	0.0503	0.0216
90.0	1.5573	1.4994	90.0	0.0852	0.0749	0.0102
95.0	1.5199	1.4711	95.0	0.0660	0.0514	0.0147

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Table 26. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Open Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	52.1	17Ø.8	48.4	158.7	68.1	19.2	63.1	16.9	55.3	25.6	84.Ø	41.1
1.Ø	5Ø.4	165.2	46.5	152.5	67.2	19.4	63.5	18.7	61.2	26.9	88.2	43.8
2.Ø	5Ø.4	165.2	46.Ø	151.Ø	65.8	2Ø.5	67.1	19.Ø	62.4	27.9	91.6	42.8
3.Ø	5Ø.8	166.6	46.Ø	15Ø.8	64.6	21.6	7Ø.9	19.Ø	62.3	28.8	94.4	41.2
4.Ø	51.1	167.6	45.9	15Ø.5	63.7	22.5	73.8	19.Ø	62.3	29.4	96.6	[illegible]
5.Ø	52.1	171.Ø	46.5	152.4	62.8	23.6	77.6	18.3	6Ø.Ø	29.9	98.1	37.6
7.Ø	52.8	173.4	46.8	153.5	62.1	24.6	8Ø.7	17.8	58.3	3Ø.3	99.5	35.8
1Ø.Ø	53.6	176.Ø	47.2	154.9	61.5	25.5	83.5	17.Ø	55.9	3Ø.6	1ØØ.5	33.7
15.Ø	54.8	179.8	47.9	157.2	6Ø.8	26.6	87.3	15.8	52.Ø	31.Ø	1Ø1.6	3Ø.7
2Ø.Ø	55.3	184.Ø	48.9	16Ø.4	6Ø.1	28.Ø	91.7	14.4	47.2	31.5	1Ø3.2	27.2
3Ø.Ø	58.6	192.3	5Ø.2	164.6	58.7	3Ø.3	99.3	12.1	39.7	32.6	1Ø7.Ø	21.7

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	32.7	1Ø7.1	29.5	96.9	64.5	13.9	45.7	35.7	117.1	38.3	125.7	68.5
1.Ø	3Ø.6	1ØØ.5	27.5	9Ø.1	63.5	13.6	44.5	37.7	123.6	4Ø.Ø	131.4	7Ø.Ø
2.Ø	29.6	97.2	26.Ø	85.3	61.2	14.2	46.6	39.Ø	128.Ø	41.5	136.2	69.8
3.Ø	29.3	96.Ø	25.Ø	81.9	58.4	15.2	5Ø.Ø	4Ø.Ø	131.1	42.8	14Ø.3	68.9
4.Ø	29.4	96.3	24.3	79.6	55.6	16.5	54.2	4Ø.6	133.1	43.8	143.7	67.7
5.Ø	29.9	98.Ø	23.9	78.4	52.9	17.9	58.9	4Ø.9	134.Ø	44.6	146.4	66.1
7.Ø	3Ø.6	1ØØ.5	23.4	76.8	49.7	19.8	64.9	41.1	135.Ø	45.7	149.8	64.2
1Ø.Ø	33.1	1Ø8.6	24.2	79.5	46.9	22.6	74.Ø	4Ø.Ø	131.3	45.9	15Ø.8	6Ø.4
15.Ø	38.6	126.6	27.4	89.9	45.1	27.1	89.1	36.4	119.3	45.4	148.9	53.1
2Ø.Ø	42.9	14Ø.7	3Ø.7	1ØØ.7	45.6	3Ø.Ø	98.3	32.6	1Ø6.9	44.3	145.2	47.3
3Ø.Ø	45.3	148.8	32.4	1Ø6.2	45.4	31.7	1Ø4.2	29.9	98.2	43.6	143.1	43.2

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	53.2	174.4	5Ø.5	165.8	71.7	16.5	54.Ø	14.7	48.2	22.1	72.4	41.6
1.Ø	53.2	174.5	5Ø.Ø	164.2	7Ø.Ø	18.Ø	59.Ø	15.1	49.5	23.5	77.Ø	39.9
2.Ø	53.4	175.2	49.8	163.3	68.6	19.4	63.5	15.3	5Ø.1	24.6	8Ø.9	[illegible]
3.Ø	53.3	175.6	49.7	163.2	67.3	2Ø.6	67.6	15.2	49.9	25.6	84.Ø	[illegible]
4.Ø	54.3	[illegible]	49.8	163.3	66.3	21.6	71.Ø	15.1	49.5	26.4	86.5	[illegible]
5.Ø	54.6	179.2	49.8	163.4	65.6	22.4	73.6	14.9	49.Ø	27.Ø	[illegible]	[illegible]
7.Ø	54.8	179.9	49.7	162.9	64.7	23.3	76.4	14.9	48.9	27.6	9Ø.7	[illegible]
1Ø.Ø	55.4	181.7	49.5	162.3	63.1	24.9	81.6	14.8	48.5	28.9	94.9	[illegible]
15.Ø	56.6	185.8	49.9	163.8	61.7	26.7	87.6	13.8	45.4	3Ø.1	98.7	[illegible]
2Ø.Ø	58.4	191.5	51.2	167.9	61.1	28.Ø	92.Ø	12.1	39.7	3Ø.5	1ØØ.2	[illegible]
3Ø.Ø	59.6	195.4	[illegible]	[illegible]	6Ø.8	29.Ø	96.3	[illegible]	33.8	3Ø.8	1Ø1.1	[illegible]

Table 27. **Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Design Point Throttle.**

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	5Ø.6	166.1	47.7	156.6	7Ø.3	16.9	55.4	16.6	54.5	23.7	77.7	44.4
1.Ø	5Ø.Ø	163.9	46.9	153.8	69.5	17.3	56.8	17.4	57.1	24.5	8Ø.5	45.Ø
2.Ø	5Ø.1	164.2	46.6	153.Ø	68.5	18.2	59.7	17.5	57.5	25.3	82.9	43.8
3.Ø	5Ø.3	165.1	46.6	152.8	67.5	19.1	62.7	17.5	57.4	25.9	85.Ø	42.4
4.Ø	5Ø.8	166.6	46.7	153.1	66.6	2Ø.Ø	65.6	17.3	56.8	26.4	86.7	4Ø.8
5.Ø	51.2	168.Ø	46.8	153.5	65.9	2Ø.8	68.1	17.1	56.Ø	26.9	88.2	39.3
7.Ø	52.9	173.5	47.8	157.Ø	64.6	22.5	73.8	15.8	52.Ø	27.5	9Ø.2	35.1
1Ø.Ø	54.6	179.Ø	49.Ø	16Ø.6	63.6	24.1	79.Ø	14.4	47.3	28.1	92.1	3Ø.8
15.Ø	56.5	185.3	5Ø.1	164.5	62.4	26.Ø	85.4	12.8	41.9	29.Ø	95.2	26.1
2Ø.Ø	57.8	189.6	51.Ø	167.2	61.6	27.3	89.6	11.5	37.7	29.6	97.2	22.7
3Ø.Ø	57.3	188.Ø	5Ø.1	164.5	6Ø.9	27.7	9Ø.9	11.3	37.1	29.9	98.2	22.2

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	27.8	91.3	25.9	84.9	68.2	1Ø.2	33.6	38.5	126.3	39.8	13Ø.7	74.9
1.Ø	26.2	86.Ø	24.3	79.8	67.9	9.8	32.Ø	39.9	131.Ø	41.1	134.9	76.1
2.Ø	25.6	83.9	23.3	76.4	65.4	1Ø.6	34.7	4Ø.9	134.2	42.2	138.6	75.3
3.Ø	25.3	83.1	22.5	73.8	62.4	11.7	38.3	41.6	136.4	43.2	141.7	74.1
4.Ø	25.3	83.1	21.9	71.8	59.6	12.7	41.8	42.1	138.1	44.Ø	144.3	73.Ø
5.Ø	25.7	84.3	21.5	7Ø.7	56.8	14.Ø	45.9	42.3	138.9	44.6	146.3	71.5
7.Ø	26.6	87.4	21.3	69.8	52.8	16.Ø	52.6	42.4	139.1	45.3	148.7	69.1
1Ø.Ø	29.1	95.6	22.Ø	72.1	48.8	19.2	62.9	41.4	135.9	45.7	149.8	65.Ø
15.Ø	33.Ø	1Ø8.3	23.7	77.9	45.9	22.9	75.2	39.2	128.5	45.4	148.9	59.5
2Ø.Ø	38.9	127.5	27.4	9Ø.Ø	44.7	27.5	9Ø.4	35.Ø	114.9	44.5	146.2	51.7
3Ø.Ø	43.Ø	141.1	3Ø.3	1Ø1.1	45.7	3Ø.Ø	98.4	3Ø.6	1ØØ.5	42.9	14Ø.7	45.5

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	54.7	179.6	53.1	174.2	75.7	13.3	43.7	11.3	37.Ø	17.5	57.3	4Ø.1
1.Ø	54.Ø	177.1	52.Ø	17Ø.5	74.Ø	14.7	48.1	12.3	4Ø.4	19.1	62.8	39.5
2.Ø	54.2	177.9	51.7	169.6	72.3	16.3	53.6	12.5	4Ø.9	2Ø.5	67.4	37.3
3.Ø	54.3	178.Ø	51.3	168.4	7Ø.9	17.6	57.7	12.7	41.3	21.7	71.3	35.8
4.Ø	54.4	178.5	51.1	167.6	69.7	18.7	61.4	12.9	42.3	22.7	74.5	34.5
5.Ø	54.6	179.3	51.Ø	167.2	68.7	19.7	64.6	12.9	42.4	23.6	77.3	33.1
7.Ø	54.6	179.2	5Ø.4	165.5	67.3	2Ø.9	68.7	13.2	43.4	24.8	81.3	32.2
1Ø.Ø	54.9	18Ø.Ø	5Ø.2	164.8	66.1	22.1	72.5	13.2	43.2	25.7	84.4	3Ø.7
15.Ø	55.9	183.4	5Ø.6	166.1	64.7	23.7	77.8	12.3	4Ø.3	26.7	87.6	27.3
2Ø.Ø	57.1	187.3	51.4	168.5	63.9	24.9	81.8	11.1	36.3	27.3	89.5	23.9
3Ø.Ø	58.Ø	19Ø.3	51.8	169.8	[illegible]	26.1	85.8	9.7	31.8	27.9	91.5	[illegible]

Table 28. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Peak Pressure Rise/Near Stall Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	51.6	169.1	48.8	160.1	71.Ø	16.6	54.6	16.4	53.9	23.4	76.7	44.5
1.Ø	51.Ø	167.2	48.2	158.1	7Ø.8	16.6	54.5	16.9	55.6	23.7	77.9	45.4
2.Ø	51.Ø	167.3	48.1	157.7	7Ø.2	17.1	56.Ø	17.Ø	55.7	24.1	79.Ø	44.7
3.Ø	51.6	169.2	48.3	158.6	69.5	17.9	58.8	16.6	54.4	24.4	8Ø.1	42.7
4.Ø	52.7	173.Ø	49.1	161.2	68.5	19.1	62.8	15.7	51.5	24.7	81.2	39.3
5.Ø	52.9	173.5	49.1	161.2	68.Ø	19.6	64.3	15.6	51.2	25.1	82.2	38.4
7.Ø	53.3	175.Ø	49.2	161.4	67.1	2Ø.6	67.6	15.3	5Ø.3	25.7	84.3	36.6
1Ø.Ø	54.2	177.8	49.7	163.1	66.4	21.6	7Ø.7	14.5	47.7	26.Ø	85.3	33.9
15.Ø	55.4	181.9	5Ø.4	165.4	65.2	23.1	75.7	13.3	43.8	26.7	87.5	3Ø.Ø
2Ø.Ø	56.2	184.5	5Ø.6	166.1	64.Ø	24.5	8Ø.3	12.7	41.5	27.6	9Ø.4	27.3
3Ø.Ø	57.6	189.Ø	51.1	167.7	62.4	26.6	87.1	11.2	36.7	28.8	94.5	22.8

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	23.Ø	75.6	21.3	7Ø.Ø	67.6	8.7	28.6	43.9	144.Ø	44.8	146.9	78.5
1.Ø	22.3	73.1	2Ø.6	67.6	67.3	8.5	28.Ø	44.5	146.1	45.4	148.8	78.9
2.Ø	22.3	73.1	2Ø.2	66.3	64.9	9.4	3Ø.8	44.8	147.1	45.8	15Ø.3	78.Ø
3.Ø	22.3	72.3	19.9	65.4	63.1	1Ø.1	33.Ø	45.Ø	147.6	46.1	151.3	77.2
4.Ø	22.7	74.5	19.9	65.3	61.1	1Ø.9	35.8	44.9	147.4	46.2	151.7	76.1
5.Ø	23.3	76.3	2Ø.Ø	65.7	59.3	11.8	38.8	44.7	146.7	46.2	151.7	75.Ø
7.Ø	24.6	8Ø.6	2Ø.7	68.Ø	57.3	13.2	43.3	43.8	143.8	45.8	15Ø.2	73.Ø
1Ø.Ø	26.5	87.Ø	21.8	71.4	55.1	15.1	49.6	42.5	139.4	45.1	147.9	7Ø.2
15.Ø	3Ø.2	98.9	23.Ø	75.6	49.6	19.5	63.9	4Ø.7	133.6	45.2	148.1	64.3
2Ø.Ø	34.9	114.7	25.2	82.6	46.Ø	24.2	79.5	38.1	125.Ø	45.1	148.1	57.4
3Ø.Ø	41.3	135.4	29.3	96.2	45.1	29.1	95.4	33.Ø	1Ø8.2	44.Ø	144.3	48.5

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	54.7	179.4	52.9	173.6	75.2	13.8	45.3	12.3	4Ø.4	18.5	6Ø.7	41.6
1.Ø	54.4	178.5	52.3	171.6	73.8	15.Ø	49.1	12.8	42.1	19.7	64.7	4Ø.5
2.Ø	54.2	177.7	51.8	169.9	72.7	15.9	52.2	13.3	43.5	2Ø.7	68.Ø	39.7
3.Ø	54.7	179.6	52.Ø	17Ø.5	71.5	17.2	56.3	13.Ø	42.5	21.5	7Ø.6	36.9
4.Ø	55.1	18Ø.7	52.Ø	17Ø.7	7Ø.7	18.Ø	59.2	12.8	42.1	22.1	72.6	35.3
5.Ø	55.1	18Ø.7	51.9	17Ø.2	7Ø.1	18.5	6Ø.8	12.9	42.2	22.6	74.1	34.7
7.Ø	55.2	181.2	51.8	169.9	69.5	19.2	62.9	12.8	41.8	23.Ø	75.6	33.5
1Ø.Ø	55.4	181.9	51.5	169.2	68.3	2Ø.3	66.7	12.7	41.6	24.Ø	78.6	31.9
15.Ø	56.3	184.7	51.8	17Ø.Ø	66.8	22.Ø	72.1	11.9	39.2	25.Ø	82.1	28.4
2Ø.Ø	57.Ø	[illegible]	52.Ø	17Ø.6	65.8	23.2	76.1	11.3	37.Ø	25.8	84.6	[illegible]
3Ø.Ø	57.4	[illegible]	51.8	169.9	64.2	24.8	81.5	1Ø.5	34.5	27.Ø	88.5	22.9

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Table 29. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Open Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
Ø.	65.2	214.Ø2	3.6	Ø.122	Ø.1Ø6	Ø.148	Ø.541	Ø.Ø93	-2.6	24.5
1.Ø	65.1	213.7Ø	3.7	Ø.13Ø	Ø.113	Ø.144	Ø.567	Ø.Ø37	-3.5	23.5
2.Ø	65.Ø	213.38	4.7	Ø.169	Ø.148	Ø.144	Ø.595	Ø.Ø84	-4.9	21.1
3.Ø	64.9	213.Ø6	6.2	Ø.2Ø4	Ø.182	Ø.145	Ø.615	Ø.Ø83	-6.1	18.3
4.Ø	64.8	212.74	8.1	Ø.222	Ø.2Ø9	Ø.146	Ø.62Ø	Ø.Ø84	-7.Ø	15.4
5.Ø	64.7	212.41	9.9	Ø.249	Ø.227	Ø.149	Ø.626	Ø.Ø86	-7.9	12.7
7.Ø	64.5	211.77	12.4	Ø.26Ø	Ø.24Ø	Ø.151	Ø.623	Ø.Ø87	-8.6	9.3
1Ø.Ø	64.3	21Ø.81	14.6	Ø.222	Ø.2Ø7	Ø.153	Ø.579	Ø.Ø94	-9.2	6.4
15.Ø	63.8	2Ø9.2Ø	15.6	Ø.11Ø	Ø.1Ø3	Ø.156	Ø.466	Ø.11Ø	-9.9	4.6
2Ø.Ø	63.3	2Ø7.6Ø	14.5	Ø.Ø24	Ø.Ø22	Ø.161	Ø.384	Ø.122	-1Ø.5	5.2
3Ø.Ø	62.3	2Ø4.39	13.3	Ø.Ø3Ø	Ø.Ø28	Ø.167	Ø.361	Ø.129	-11,2	6.Ø

TORQUE = 43[illegible].7Ø IN.-LB.

*Loss Coefficients Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
Ø.	65.2	214.Ø2	26.9	Ø.1Ø9	Ø.Ø63	-Ø.9	2Ø.3	Ø.Ø765	Ø.Ø739	[illegible]
1.Ø	65.1	213.7Ø	3Ø.1	Ø.114	Ø.Ø67	1.6	19.8	Ø.Ø927	[illegible]	Ø.6152
2.Ø	65.Ø	213.38	31.6	Ø.118	Ø.Ø7Ø	2.4	18.8	Ø.1Ø59	[illegible]	[illegible]
3.Ø	64.9	213.Ø6	32.6	Ø.122	Ø.Ø73	2.4	17.6	Ø.1159	[illegible]	[illegible]
4.Ø	64.8	212.74	32.9	Ø.125	Ø.Ø75	2.Ø	16.7	Ø.1238	[illegible]	[illegible]
5.Ø	64.7	[illegible]	32.6	Ø.127	Ø.Ø77	1.3	16.1	Ø.1356	[illegible]	[illegible]
7.Ø	64.5	211.77	31.6	Ø.13Ø	Ø.Ø79	Ø.9	16.1	Ø.1521	[illegible]	[illegible]
1Ø.Ø	64.3	21Ø.81	29.8	Ø.131	Ø.Ø82	-Ø.3	15.3	[illegible]	[illegible]	[illegible]
15.Ø	63.8	[illegible]	26.8	Ø.129	Ø.Ø86	-4.9	13.[illegible]	Ø.1139	[illegible]	[illegible]
2Ø.Ø	63.3	[illegible]	24.Ø	Ø.126	Ø.Ø87	-8.2	1Ø.3	Ø.Ø917	[illegible]	[illegible]
3Ø.Ø	[illegible]	[illegible]	23.7	Ø.124	Ø.Ø88	-9.7	7.8	Ø.Ø714	[illegible]	[illegible]

Table 30. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Design Point Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
Ø.	64.4	211.16	2.1	Ø.168	Ø.143	Ø.145	Ø.651	Ø.Ø79	-Ø.4	28.2
1.Ø	64.3	21Ø.84	1.6	Ø.199	Ø.169	Ø.143	Ø.685	Ø.Ø75	-1.2	27.9
2.Ø	64.2	21Ø.53	3.1	Ø.232	Ø.2ØØ	Ø.143	Ø.7Ø5	Ø.Ø73	-2.2	25.3
3.Ø	64.1	21Ø.21	5.1	Ø.259	Ø.227	Ø.144	Ø.718	Ø.Ø72	-3.2	22.2
4.Ø	64.Ø	2Ø9.89	7.Ø	Ø.283	Ø.251	Ø.145	Ø.727	Ø.Ø72	-4.1	19.4
5.Ø	63.9	2Ø9.53	9.1	Ø.297	Ø.266	Ø.146	Ø.726	Ø.Ø73	-4.8	15.6
7.Ø	63.7	2Ø8.94	11.8	Ø.331	Ø.3Ø1	Ø.151	Ø.727	Ø.Ø76	-6.Ø	12.5
1Ø.Ø	63.4	2Ø7.99	14.9	Ø.32Ø	Ø.296	Ø.156	Ø.692	Ø.Ø83	-7.Ø	8.3
15.Ø	62.9	2Ø6.41	16.5	Ø.28Ø	Ø.261	Ø.161	Ø.628	Ø.Ø94	-8.3	5.3
2Ø.Ø	62.4	2Ø4.83	16.9	Ø.166	Ø.156	Ø.165	Ø.511	Ø.111	-8.9	4.4
3Ø.Ø	61.5	2Ø1.66	15.2	Ø.Ø25	Ø.Ø24	Ø.164	Ø.399	Ø.123	-9.Ø	3.3

TORQUE = 4Ø37.33 IN.-LB.

*Loss Coefficient Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
Ø.	64.4	211.16	34.8	Ø.114	Ø.Ø5Ø	5.5	19.3	Ø.1928	Ø.1863	Ø.8Ø57
1.Ø	64.3	21Ø.84	36.2	Ø.117	Ø.Ø55	7.7	19.8	Ø.184Ø	Ø.1783	Ø.7748
2.Ø	64.2	21Ø.53	38.Ø	Ø.121	Ø.Ø59	7.8	17.9	Ø.1766	Ø.171[illegible]	Ø.7544
3.Ø	64.1	21Ø.21	38.3	Ø.123	Ø.Ø62	7.6	17.1	Ø.17Ø3	Ø.166[illegible]	[illegible]
4.Ø	64.Ø	[illegible]	38.5	Ø.126	Ø.Ø65	7.3	16.4	Ø.1647	[illegible]	[illegible]
5.Ø	63.9	[illegible]	38.4	Ø.127	Ø.Ø67	6.7	15.6	Ø.15Ø2	[illegible]	[illegible]
7.Ø	63.7	[illegible]	36.9	Ø.129	Ø.Ø71	5.3	15.8	Ø.1528	[illegible]	[illegible]
1Ø.Ø	63.4	[illegible]	34.3	Ø.13Ø	Ø.Ø73	3.3	15.7	Ø.1566	[illegible]	[illegible]
15.Ø	62.9	[illegible]	32.2	Ø.13Ø	Ø.Ø76	1.5	13.[illegible]	Ø.14Ø7	[illegible]	[illegible]
2Ø.Ø	62.4	[illegible]	27.8	Ø.127	Ø.Ø78	-3.8	11.4	Ø.1245	Ø.123[illegible]	[illegible]
3Ø.Ø	61.5	[illegible]	25.2	Ø.122	Ø.Ø8Ø	-7.4	8.5	Ø.Ø753	Ø.Ø74[illegible]	[illegible]

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Table 31. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance, Peak Pressure Rise/Near Stall Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
Ø.	65.2	214.Ø2	3.4	Ø.262	Ø.223	Ø.147	Ø.8Ø1	Ø.Ø66	Ø.3	27.6
1.Ø	65.1	213.7Ø	3.5	Ø.272	Ø.233	Ø.145	Ø.814	Ø.Ø63	Ø.1	27.2
2.Ø	65.Ø	213.33	5.3	Ø.286	Ø.247	Ø.145	Ø.816	Ø.Ø63	-Ø.5	24.8
3.Ø	64.9	213.Ø6	6.4	Ø.312	Ø.272	Ø.147	Ø.821	Ø.Ø64	-1.2	22.9
4.Ø	64.8	212.74	7.5	Ø.345	Ø.3Ø4	Ø.15Ø	Ø.826	Ø.Ø65	-2.2	2Ø.9
5.Ø	64.7	212.41	8.8	Ø.347	Ø.3Ø8	Ø.151	Ø.814	Ø.Ø66	-2.6	19.Ø
7.Ø	64.5	211.77	9.8	Ø.345	Ø.3Ø9	Ø.152	Ø.785	Ø.Ø7Ø	-3.6	17.Ø
1Ø.Ø	64.3	21Ø.81	11.3	Ø.334	Ø.3Ø2	Ø.155	Ø.747	Ø.Ø75	-4.3	14.6
15.Ø	63.8	2Ø9.2Ø	15.6	Ø.3Ø3	Ø.28Ø	Ø.158	Ø.68Ø	Ø.Ø86	-5.4	9.1
2Ø.Ø	63.3	2Ø7.6Ø	18.Ø	Ø.216	Ø.2Ø2	Ø.16Ø	Ø.582	Ø.1ØØ	-6.5	5.6
3Ø.Ø	62.3	2Ø4.39	17.3	Ø.Ø68	Ø.Ø64	Ø.164	Ø.451	Ø.118	-7.5	3.7

TORQUE = 4935.91 IN.-LB.

*Loss Coefficient Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
Ø.	65.2	214.Ø2	36.9	Ø.127	Ø.Ø53	9.1	2Ø.8	Ø.3Ø22	Ø.292Ø	Ø.8365
1.Ø	65.1	213.7Ø	38.4	Ø.129	Ø.Ø56	1Ø.5	2Ø.4	Ø.2826	Ø.2733	Ø.815Ø
2.Ø	65.Ø	213.33	38.3	Ø.13Ø	Ø.Ø59	1Ø.5	2Ø.3	Ø.2645	Ø.2561	Ø.7841
3.Ø	64.9	213.Ø6	4Ø.3	Ø.131	Ø.Ø61	1Ø.7	18.2	Ø.247Ø	Ø.24Ø[illegible]	Ø.7[illegible]7
4.Ø	64.8	212.74	4Ø.8	Ø.132	Ø.Ø63	1Ø.5	17.2	Ø.23Ø2	Ø.224[illegible]	Ø.7587
5.Ø	64.7	212.41	4Ø.3	Ø.132	Ø.Ø64	1Ø.2	17.2	Ø.2139	Ø.2Ø8[illegible]	Ø.7379
7.Ø	64.5	211.77	39.5	Ø.13Ø	Ø.Ø66	9.8	17.1	Ø.19Ø8	Ø.176[illegible]	Ø.7[illegible]
1Ø.Ø	64.3	21Ø.81	38.4	Ø.128	Ø.Ø68	9.Ø	16.9	Ø.1392	Ø.138[illegible]	Ø.7[illegible]
15.Ø	63.8	2Ø9.2Ø	35.8	Ø.129	Ø.Ø71	6.3	14.9	Ø.1121	Ø.11Ø[illegible]	Ø.6[illegible]
2Ø.Ø	63.3	2Ø7.6Ø	31.6	Ø.129	Ø.Ø73	1.9	13.3	Ø.1Ø34	Ø.1Ø2[illegible]	[illegible]
3Ø.Ø	62.3	2Ø4.39	25.6	Ø.125	Ø.Ø77	-4.4	11.2	Ø.Ø878	Ø.Ø8[illegible]	[illegible]

Table 32. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

Open Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	0.8475	1.3505	1.3647	0.6972	1.0057	1.2164
1.0	0.8662	1.3766	1.3790	0.6967	0.9969	1.2141
2.0	0.8816	1.3993	1.3913	0.6962	0.9888	1.2119
3.0	0.8938	1.4186	1.4016	0.6958	0.9815	1.2099
4.0	0.9027	1.4347	1.4100	0.6953	0.9752	1.2080
5.0	0.9083	1.4474	1.4163	0.6949	0.9700	1.2063
7.0	0.9099	1.4627	1.4229	0.6940	0.9631	1.2032
10.0	0.9089	1.4705	1.4230	0.6928	0.9606	1.1995
15.0	0.9075	1.4671	1.4213	0.6923	0.9672	1.1967
20.0	0.9164	1.4610	1.4245	0.6893	0.9751	1.1932
30.0	0.9390	1.4555	1.4369	0.6837	0.9922	1.1892

Design Point Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	1.0101	1.5919	1.5868	0.8761	1.2213	1.4643
1.0	1.0281	1.6103	1.5998	0.8753	1.2112	1.4616
2.0	1.0433	1.6271	1.6109	0.8746	1.2021	1.4589
3.0	1.0557	1.6424	1.6202	0.8739	1.1941	1.4565
4.0	1.0652	1.6562	1.6275	0.8734	1.1874	1.4541
5.0	1.0719	1.6685	1.6329	0.8729	1.1821	1.4519
7.0	1.0767	1.6865	1.6380	0.8721	1.1758	1.4479
10.0	1.0803	1.7100	1.6421	0.8715	1.1766	1.4430
15.0	1.0823	1.7005	1.6446	0.8717	1.1797	1.4403
20.0	1.0862	1.6791	1.6455	0.8708	1.1909	1.4365
30.0	1.0878	1.6545	1.6444	0.8649	1.2034	1.4277

Peak Pressure Rise/Near Stall Throttle

	TOTAL PRESSURE			STATIC PRESSURE		
PERCENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT	ROTOR 3 INLET	ROTOR 3 EXIT	STATOR 3 EXIT
0.	1.0571	1.7354	1.6264	0.9375	1.2577	1.5223
1.0	1.0643	1.7377	1.6304	0.9371	1.2447	1.5194
2.0	1.0709	1.7393	1.6340	0.9368	1.2327	1.5168
3.0	1.0767	1.7399	1.6371	0.9366	1.2222	1.5146
4.0	1.0818	1.7397	1.6399	0.9365	1.2134	1.5123
5.0	1.0862	1.7387	1.6422	0.9365	1.2065	1.5103
7.0	1.0929	1.7340	1.6455	0.9366	1.1987	1.5070
10.0	1.0987	1.7205	1.6507	0.9374	1.2004	1.5037
15.0	1.1031	1.7041	1.6544	0.9386	1.1971	1.5017
20.0	1.1079	1.6955	1.6571	0.9345	1.1957	1.4957
30.0	1.1248	1.6956	1.6740	0.9243	1.2466	1.4859

Table 32. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment (Concluded).

Open Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
0.	44.1	81.8	38.2	45.6	82.2	39.6
1.0	40.7	81.2	37.7	42.1	81.6	39.1
2.0	39.3	79.5	37.3	40.7	80.0	38.7
3.0	36.7	77.7	35.8	38.1	78.3	37.1
4.0	34.7	75.7	34.8	36.0	76.4	36.1
5.0	33.2	74.1	34.6	34.5	74.8	35.9
10.0	30.3	65.6	31.4	31.5	66.6	32.6
15.0*	27.2	56.7	26.4	28.2	57.8	27.4
20.0*	23.8	49.7	24.8	24.7	50.9	25.7
25.0*	21.2	44.7	22.0	22.0	45.9	22.8
30.0*	18.8	42.4	19.6	19.5	43.5	20.3

* CURVE FIT VALUES USING ZERO STATOR POSITION DATA

Design Point Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
0.	45.4	82.6	40.3	46.9	83.0	41.7
1.0	42.1	82.2	39.1	43.5	82.6	40.5
2.0	39.6	80.9	37.5	41.0	81.3	38.9
3.0	37.5	79.3	36.0	38.9	79.8	37.4
4.0	35.1	77.8	35.1	36.4	78.4	36.4
5.0	34.2	75.6	34.3	35.5	76.3	35.6
10.0	30.6	70.2	31.7	31.8	71.0	32.9
15.0*	27.6	62.7	28.5	28.7	63.7	29.6
20.0*	24.5	55.3	24.8	25.4	56.4	25.7
25.0*	21.9	48.9	22.4	22.7	50.0	23.2
30.0*	19.7	46.4	19.8	20.4	47.5	20.5

Peak Pressure Rise/Near Stall Throttle

	MEASURED			CORRECTED		
PERCENT IMMERSION	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT	ROTOR 3 INLET	STATOR 3 INLET	STATOR 3 EXIT
0.	44.8	89.8	40.6	46.3	89.8	42.0
1.0	41.4	89.4	38.7	42.8	89.4	40.1
2.0	37.6	88.9	37.1	39.0	89.0	38.5
3.0	35.9	88.4	35.8	37.3	88.5	37.1
4.0	33.9	87.4	34.8	35.2	87.5	36.1
5.0	32.5	85.7	33.9	33.8	85.9	35.2
10.0	29.5	81.6	31.4	30.6	82.0	32.6
15.0*	27.0	71.8	28.4	28.0	72.5	29.5
20.0*	24.2	63.7	25.7	25.1	64.6	25.7
25.0*	22.4	54.1	22.6	23.2	55.2	23.4
30.0*	20.2	49.2	20.4	20.9	50.3	21.1

Table 33. Rotor Loss Coefficients Determined from Relative Total Pressure Measurements, Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment.

Open Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.4332	1.2742	5.0	0.2155	0.0088	0.2066
10.0	1.4663	1.3274	10.0	0.1795	0.0124	0.1671
15.0	1.4794	1.4151	15.0	0.0817	0.0179	0.0638
20.0	1.4967	1.4613	20.0	0.0438	0.0207	0.0231
35.0	1.5511	1.5114	35.0	0.0456	0.0186	0.0270
50.0	1.5311	1.4867	50.0	0.0518	0.0259	0.0259
65.0	1.4779	1.4444	65.0	0.0414	0.0213	0.0200
80.0	1.4290	1.3811	80.0	0.0624	0.0304	0.0320
85.0	1.3831	1.3401	85.0	0.0594	0.0468	0.0126
90.0	1.3462	1.2935	90.0	0.0766	0.0634	0.0132
95.0	1.2899	1.2480	95.0	0.0661	0.0579	0.0082

Design Point Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.5715	1.4304	5.0	0.2021	0.0146	0.1876
10.0	1.6065	1.4638	10.0	0.1942	0.0115	0.1827
15.0	1.6206	1.5399	15.0	0.1077	0.0176	0.0901
20.0	1.6346	1.6048	20.0	0.0389	0.0198	0.0191
35.0	1.6929	1.6641	35.0	0.0346	0.0203	0.0143
50.0	1.6731	1.6361	50.0	0.0443	0.0218	0.0225
65.0	1.6239	1.5883	65.0	0.0432	0.0184	0.0248
80.0	1.5587	1.5298	80.0	0.0359	0.0213	0.0146
85.0	1.5337	1.4899	85.0	0.0548	0.0379	0.0169
90.0	1.4943	1.4434	90.0	0.0653	0.0546	0.0107
95.0	1.4564	1.4095	95.0	0.0615	0.0420	0.0195

Peak Pressure Rise/Near Stall Throttle

TOTAL PRESSURE			ROTOR LOSS COEFFICIENT			
PRECENT IMMERSION	ROTOR 3 INLET	ROTOR 3 EXIT	PERCENT IMMERSION	TOTAL LOSS	WAKE LOSS	TOTAL MINUS WAKE LOSS
5.0	1.4650	1.4168	5.0	0.0911	0.0064	0.0847
10.0	1.5499	1.4656	10.0	0.1376	0.0104	0.1272
15.0	1.6165	1.5397	15.0	0.1133	0.0154	0.0979
20.0	1.6723	1.6133	20.0	0.0799	0.0213	0.0587
35.0	1.7373	1.7030	35.0	0.0418	0.0219	0.0199
50.0	1.7203	1.6817	50.0	0.0468	0.0230	0.0238
65.0	1.6822	1.6360	65.0	0.0566	0.0229	0.0337
80.0	1.6162	1.5797	80.0	0.0465	0.0278	0.0187
85.0	1.5969	1.5470	85.0	0.0640	0.0423	0.0218
90.0	1.5573	1.4994	90.0	0.0768	0.0594	0.0174
95.0	1.5199	1.4711	95.0	0.0666	0.0396	0.0270

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Table 34. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Open Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	5Ø.2	164.6	47.1	154.4	69.5	17.4	57.2	17.8	58.5	24.9	81.8	45.5
1.Ø	5Ø.9	167.1	47.Ø	154.2	67.1	19.6	64.4	17.8	58.4	26.5	86.9	42.1
2.Ø	51.1	167.7	46.6	152.9	65.6	21.Ø	68.8	18.1	59.4	27.7	9Ø.9	4Ø.7
3.Ø	52.Ø	17Ø.7	46.9	153.9	64.2	22.5	73.9	17.7	58.Ø	28.6	94.Ø	38.1
4.Ø	52.8	173.4	47.2	155.Ø	63.2	23.7	77.7	17.3	56.7	29.3	96.2	36.Ø
5.Ø	53.5	175.5	47.5	156.Ø	62.6	24.5	8Ø.3	16.9	55.3	29.7	97.6	34.5
7.Ø	54.8	179.9	48.6	159.3	62.1	25.5	83.6	15.7	51.4	29.9	98.1	31.5
1Ø.Ø	56.3	184.6	49.7	163.1	61.9	26.3	86.4	14.2	46.6	29.9	98.2	[illegible]
15.Ø	57.7	[illegible]	5Ø.9	167.Ø	61.8	27.1	88.9	12.5	41.1	29.9	98.Ø	24.7
2Ø.Ø	58.8	192.8	51.4	168.7	6Ø.9	28.4	93.3	11.5	37.8	3Ø.7	1ØØ.6	22.Ø
3Ø.Ø	59.6	195.5	51.1	167.7	58.9	3Ø.7	1ØØ.6	1Ø.9	35.7	32.5	1Ø6.7	19.5

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	27.9	91.7	27.5	9Ø.2	79.5	5.Ø	16.4	37.4	122.7	37.7	123.8	82.2
1.Ø	26.2	86.Ø	25.6	84.Ø	77.4	5.6	18.5	39.2	128.6	39.6	129.9	81.6
2.Ø	25.1	82.4	24.1	79.1	73.6	7.Ø	23.Ø	4Ø.6	133.1	41.2	135.1	8Ø.Ø
3.Ø	24.5	8Ø.3	23.Ø	75.3	69.5	8.5	27.9	41.6	136.6	42.5	139.4	78.2
4.Ø	24.3	79.9	22.1	72.6	65.2	1Ø.2	33.3	42.4	139.1	43.6	143.Ø	76.3
5.Ø	24.4	8Ø.Ø	21.5	7Ø.5	61.7	11.5	37.8	42.9	14Ø.8	44.4	145.8	74.8
7.Ø	28.7	94.3	22.5	73.7	51.2	17.9	58.8	41.8	137.Ø	45.5	149.1	66.6
1Ø.Ø	34.8	114.3	25.Ø	81.9	45.6	24.3	79.8	39.Ø	127.8	45.9	15Ø.7	57.9
15.Ø	4Ø.1	131.4	28.1	92.1	44.4	28.6	93.7	35.4	116.Ø	45.5	149.2	5Ø.9
2Ø.Ø	43.7	143.4	3Ø.7	1ØØ.7	44.5	31.1	1Ø2.1	32.3	1Ø5.8	44.8	147.1	45.9
3Ø.Ø	44.9	147.3	31.8	1Ø4.3	45.Ø	31.7	1Ø4.Ø	3Ø.2	99.Ø	43.8	143.6	43.5

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	52.7	172.3	49.1	161.2	68.7	19.Ø	62.3	15.8	51.7	24.7	81.Ø	39.6
1.Ø	52.4	171.9	48.4	158.6	67.2	2Ø.2	66.2	16.4	54.Ø	26.Ø	85.4	39.1
2.Ø	52.2	171.2	47.7	156.5	65.9	21.2	69.4	17.Ø	55.8	27.1	89.1	[illegible]
3.Ø	52.6	172.6	47.6	156.2	64.7	22.3	73.3	17.Ø	55.7	28.1	92.1	37.1
4.Ø	52.9	173.5	47.5	155.8	63.7	23.2	76.3	17.Ø	55.8	28.8	94.5	36.1
5.Ø	52.8	173.2	47.1	154.7	63.1	23.8	78.Ø	17.3	56.6	29.4	96.4	[illegible]
7.Ø	54.2	177.9	48.Ø	157.4	62.Ø	25.3	83.Ø	16.2	53.3	3Ø.Ø	98.6	[illegible]
1Ø.Ø	56.7	[illegible]	49.9	163.8	61.5	26.9	88.2	14.Ø	46.Ø	3Ø.3	99.4	[illegible]
15.Ø	57.2	[illegible]	5Ø.2	164.7	61.2	27.3	89.7	13.2	43.4	3Ø.1	98.7	[illegible]
2Ø.Ø	58.3	[illegible]	5Ø.9	167.2	6Ø.7	28.4	93.2	12.Ø	39.4	3Ø.8	1Ø1.2	[illegible]
3Ø.Ø	59.Ø	[illegible]	5Ø.9	166.9	59.4	29.9	98.1	11.1	36.4	31.9	1Ø4.7	[illegible]

Table 35. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Design Point Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	51.6	169.2	49.2	161.5	72.5	15.3	5Ø.3	16.4	53.8	22.4	73.6	46.8
1.Ø	52.3	171.7	49.6	162.6	71.1	16.8	55.Ø	16.Ø	52.4	23.2	76.Ø	43.5
2.Ø	52.9	173.7	49.8	163.5	7Ø.Ø	17.9	58.8	15.6	51.3	23.8	78.Ø	41.Ø
3.Ø	53.5	175.6	5Ø.1	164.3	69.1	18.9	62.Ø	15.3	5Ø.1	24.3	79.7	38.9
4.Ø	54.3	178.2	5Ø.5	165.8	68.3	19.9	65.2	14.7	48.3	24.7	81.2	36.4
5.Ø	54.5	178.8	5Ø.5	165.8	67.8	2Ø.4	67.Ø	14.6	48.Ø	25.1	82.4	35.5
7.Ø	55.3	183.2	51.4	168.6	66.8	21.8	71.5	13.6	44.5	25.7	84.2	31.8
1Ø.Ø	56.9	186.7	52.1	171.Ø	66.1	22.9	75.Ø	12.5	41.2	26.1	85.5	28.7
15.Ø	57.9	19Ø.Ø	52.8	173.3	65.6	23.8	78.Ø	11.3	37.2	26.3	86.4	25.5
2Ø.Ø	58.7	192.7	53.2	174.5	64.7	24.9	81.8	1Ø.5	34.4	27.Ø	88.7	22.7
3Ø.Ø	59.2	194.1	52.5	172.3	62.4	27.2	89.4	1Ø.2	33.4	29.1	95.4	2Ø.4

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	21.8	71.5	21.1	69.3	75.6	5.3	17.5	44.5	146.1	44.8	147.1	82.9
1.Ø	21.1	69.4	2Ø.4	66.8	74.Ø	5.7	18.8	45.2	148.3	45.6	149.5	82.5
2.Ø	2Ø.9	68.6	19.8	64.9	7Ø.8	6.8	22.3	45.7	149.9	46.2	151.5	81.3
3.Ø	21.Ø	68.9	19.4	63.6	67.1	8.1	26.6	46.Ø	15Ø.8	46.7	153.2	79.8
4.Ø	21.3	69.8	19.1	62.7	63.7	9.3	3Ø.7	46.1	151.4	47.1	154.5	78.3
5.Ø	22.1	72.6	19.1	62.8	59.7	11.1	36.4	46.Ø	151.Ø	47.3	155.3	76.2
7.Ø	25.2	82.6	2Ø.Ø	65.6	52.5	15.3	5Ø.2	45.Ø	147.5	47.5	155.8	71.Ø
1Ø.Ø	3Ø.6	1ØØ.4	22.6	74.2	47.6	2Ø.6	67.5	42.Ø	137.9	46.8	153.5	63.7
15.Ø	36.1	118.4	25.6	84.Ø	45.1	25.4	83.4	38.6	126.6	46.2	151.6	56.5
2Ø.Ø	4Ø.9	134.1	28.4	93.3	44.Ø	29.4	96.3	35.2	115.6	45.9	15Ø.5	5Ø.1
3Ø.Ø	42.4	138.9	3Ø.6	1ØØ.3	46.1	29.3	96.1	32.1	1Ø5.3	43.5	142.6	47.5

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	54.Ø	177.2	51.7	169.8	73.1	15.5	51.Ø	13.9	45.6	2Ø.8	68.4	41.7
1.Ø	54.1	177.4	51.5	169.1	72.2	16.3	53.6	14.Ø	46.Ø	21.5	7Ø.6	4Ø.5
2.Ø	54.3	178.2	51.5	169.1	71.3	17.2	56.4	13.9	45.6	22.1	72.6	38.9
3.Ø	54.6	179.2	51.6	169.3	7Ø.6	18.Ø	58.9	13.8	45.1	22.6	74.2	37.3
4.Ø	54.8	179.6	51.5	169.Ø	7Ø.Ø	18.5	6Ø.9	13.7	45.1	23.1	75.7	36.4
5.Ø	54.9	18Ø.1	51.5	168.8	69.5	19.1	62.5	13.7	44.9	23.5	77.Ø	35.6
7.Ø	55.6	182.5	51.9	17Ø.1	68.6	2Ø.2	66.2	13.1	43.Ø	24.Ø	78.9	32.9
1Ø.Ø	56.6	185.8	52.4	171.9	67.5	21.5	7Ø.6	12.3	4Ø.3	24.8	81.3	29.6
15.Ø	57.8	189.7	53.2	174.4	66.7	22.7	74.6	11.Ø	36.1	25.3	83.8	25.8
2Ø.Ø	58.5	191.9	53.4	175.2	65.8	23.8	78.2	1Ø.3	33.7	25.Ø	85.2	23.3
3Ø.Ø	59.Ø	193.6	52.8	173.4	63.4	26.2	86.1	9.8	32.3	28.Ø	92.Ø	2Ø.5

Table 36. Vector Diagram Parameters for Rotor B/Stator B Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Peak Pressure Rise/Near Stall Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	52.3	171.7	49.9	163.8	72.4	15.7	51.4	16.4	53.9	22.7	74.4	46.2
1.Ø	53.2	174.4	5Ø.3	165.1	71.Ø	17.1	56.2	15.9	52.3	23.4	76.8	42.8
2.Ø	54.3	178.2	51.Ø	167.4	69.7	18.7	61.2	15.1	49.7	24.Ø	78.8	39.Ø
3.Ø	54.8	179.7	51.2	167.9	68.9	19.5	64.1	14.9	48.9	24.6	8Ø.6	37.2
4.Ø	55.4	181.8	51.5	169.Ø	68.2	2Ø.4	67.Ø	14.4	47.4	25.Ø	82.1	35.2
5.Ø	55.9	183.3	51.7	169.7	67.6	21.1	69.2	14.1	46.4	25.4	83.3	33.8
7.Ø	56.9	186.8	52.4	171.9	66.8	22.3	73.1	13.3	43.5	25.9	85.1	3Ø.7
1Ø.Ø	57.8	189.7	52.9	173.7	66.1	23.2	76.2	12.4	4Ø.8	26.4	86.5	28.1
15.Ø	58.7	192.6	53.5	175.6	65.6	24.1	79.Ø	11.3	37.2	26.6	87.3	25.2
2Ø.Ø	59.1	194.Ø	53.6	175.7	64.7	25.1	82.3	1Ø.8	35.5	27.3	89.7	23.3
3Ø.Ø	59.6	195.4	52.9	173.4	62.4	27.4	9Ø.Ø	1Ø.5	34.5	29.4	96.4	2Ø.9

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	21.Ø	69.Ø	21.Ø	69.Ø	89.2	Ø.2	Ø.7	45.3	148.7	45.3	148.7	89.5
1.Ø	2Ø.2	66.3	2Ø.2	66.3	88.9	Ø.3	1.Ø	46.Ø	151.1	46.Ø	151.1	89.4
2.Ø	19.5	64.Ø	19.5	63.9	87.7	Ø.7	2.2	46.7	153.1	46.7	153.2	88.9
3.Ø	18.9	62.Ø	18.9	61.9	86.5	1.1	3.6	47.2	154.8	47.2	154.8	88.4
4.Ø	18.5	6Ø.7	18.4	6Ø.4	83.9	1.9	6.2	47.5	156.Ø	47.6	156.1	87.5
5.Ø	18.4	6Ø.4	18.1	59.5	79.6	3.3	1Ø.7	47.7	156.6	47.9	157.Ø	85.9
7.Ø	19.3	63.2	18.1	59.4	7Ø.Ø	6.5	21.4	47.5	156.Ø	48.Ø	157.5	82.Ø
1Ø.Ø	21.6	7Ø.7	2Ø.2	66.2	55.Ø	14.Ø	46.1	45.2	148.2	47.3	155.2	72.5
15.Ø	3Ø.1	98.7	22.6	74.1	48.6	19.9	65.1	42.3	138.7	46.7	153.2	64.7
2Ø.Ø	37.2	121.9	26.2	86.Ø	44.7	26.3	86.4	38.2	125.2	46.4	152.1	55.2
3Ø.Ø	4Ø.7	133.5	29.5	96.8	46.4	28.Ø	91.9	33.9	111.1	43.9	144.2	5Ø.3

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
Ø.	54.5	178.8	52.2	171.3	73.1	15.6	51.3	14.1	46.4	21.1	69.1	42.Ø
1.Ø	54.8	179.8	52.2	171.3	72.1	16.6	54.5	14.Ø	46.1	21.8	71.4	4Ø.1
2.Ø	55.1	18Ø.7	52.2	171.3	71.3	17.5	57.3	13.9	45.7	22.4	73.3	38.5
3.Ø	55.3	181.5	52.2	171.3	7Ø.6	18.2	59.7	13.8	45.4	22.9	75.Ø	37.1
4.Ø	55.5	182.Ø	52.2	171.2	7Ø.Ø	18.8	61.8	13.8	45.2	23.3	76.5	36.1
5.Ø	55.6	182.6	52.2	171.1	69.4	19.4	63.5	13.7	44.9	23.7	77.8	35.2
7.Ø	56.4	185.Ø	52.5	172.4	68.5	2Ø.5	67.1	13.1	43.1	24.3	79.7	32.6
1Ø.Ø	57.3	188.Ø	53.Ø	173.9	67.5	21.8	71.4	12.1	4Ø.6	25.Ø	82.2	29.5
15.Ø	58.Ø	19Ø.4	53.4	175.1	66.7	22.8	74.8	11.5	37.7	25.5	83.7	26.7
2Ø.Ø	59.Ø	193.6	53.9	176.8	65.8	24.1	78.9	1Ø.5	34.4	26.2	86.1	23.5
3Ø.Ø	59.3	194.7	53.1	174.3	63.4	26.4	86.7	1Ø.2	33.6	28.3	93.Ø	21.1

Table 37. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Open Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS COEF.*	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
Ø.	64.9	212.92	-1Ø.Ø	Ø.178	Ø.142	Ø.143	Ø.624	Ø.Ø8Ø	-1.2	39.5
1.Ø	64.8	212.6Ø	-1Ø.2	Ø.252	Ø.2Ø4	Ø.146	Ø.68Ø	Ø.Ø75	-3.6	37.3
2.Ø	64.7	212.28	-8.Ø	Ø.29Ø	Ø.24Ø	Ø.146	Ø.712	Ø.Ø72	-5.1	33.5
3.Ø	64.6	211.96	-5.3	Ø.338	Ø.286	Ø.149	Ø.742	Ø.Ø7Ø	-6.5	29.3
4.Ø	64.5	211.64	-2.Ø	Ø.369	Ø.319	Ø.151	Ø.759	Ø.Ø69	-7.5	25.Ø
5.Ø	64.4	211.32	Ø.9	Ø.39Ø	Ø.343	Ø.153	Ø.768	Ø.Ø7Ø	-8.1	21.4
7.Ø	64.2	21Ø.6Ø	1Ø.9	Ø.351	Ø.321	Ø.157	Ø.695	Ø.Ø82	-8.6	14.9
1Ø.Ø	63.9	2Ø9.73	16.3	Ø.261	Ø.244	Ø.161	Ø.582	Ø.Ø99	-8.8	5.2
15.Ø	63.4	2Ø8.13	17.4	Ø.17Ø	Ø.159	Ø.165	Ø.485	Ø.114	-8.9	3.8
2Ø.Ø	63.Ø	2Ø6.53	16.4	Ø.Ø97	Ø.Ø92	Ø.168	Ø.413	Ø.125	-9.6	4.1
3Ø.Ø	62.Ø	2Ø3.34	13.9	Ø.Ø67	Ø.Ø63	Ø.17Ø	Ø.391	Ø.128	-11.Ø	3.6

TORQUE = 5Ø32.83 IN.-LB.

*Loss Coefficient Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
Ø.	64.9	212.92	42.6	Ø.1Ø8	Ø.Ø7Ø	12.8	18.8	-.Ø412	-.Ø399	Ø.55Ø8
1.Ø	64.8	212.6Ø	42.5	Ø.113	Ø.Ø74	13.2	19.Ø	-.ØØ63	-.ØØ6[illegible]	Ø.5831
2.Ø	64.7	212.28	41.3	Ø.118	Ø.Ø77	12.5	19.3	Ø.Ø195	Ø.Ø18[illegible]	Ø.5434
3.Ø	64.6	211.96	41.1	Ø.121	Ø.Ø8Ø	11.7	18.4	Ø.Ø389	Ø.Ø37[illegible]	Ø.547[illegible]
4.Ø	64.5	211.64	4Ø.2	Ø.124	Ø.Ø82	1Ø.7	18.Ø	Ø.Ø53Ø	Ø.Ø52[illegible]	Ø.547[illegible]
5.Ø	64.4	211.32	38.9	Ø.127	Ø.Ø84	1Ø.Ø	18.4	Ø.Ø651	Ø.Ø63[illegible]	Ø.5651
7.Ø	64.2	21Ø.6Ø	34.Ø	Ø.13Ø	Ø.Ø86	3.3	16.2	Ø.Ø797	Ø.Ø78[illegible]	Ø.5496
1Ø.Ø	63.9	2Ø9.73	3Ø.4	Ø.131	Ø.Ø86	-3.3	12.5	Ø.Ø932	Ø.Ø91[illegible]	[illegible]
15.Ø	63.4	2Ø8.13	25.2	Ø.13Ø	Ø.Ø87	-7.1	12.3	Ø.Ø916	Ø.Ø9Ø[illegible]	[illegible]
2Ø.Ø	63.Ø	2Ø6.53	23.Ø	Ø.128	Ø.Ø88	-9.6	1Ø.5	Ø.Ø751	Ø.Ø74[illegible]	[illegible]
3Ø.Ø	62.Ø	2Ø3.34	23.2	Ø.125	Ø.Ø91	-9.4	8.6	Ø.Ø4Ø1	Ø.Ø39[illegible]	[illegible]

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Table 38. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Design Point Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
Ø.	65.6	215.37	-3.1	Ø.31Ø	Ø.254	Ø.147	Ø.831	Ø.Ø62	1.8	35.6
1.Ø	65.5	215.Ø5	-2.9	Ø.36Ø	Ø.297	Ø.149	Ø.855	Ø.Ø5Ø	Ø.4	34.Ø
2.Ø	65.4	214.72	-Ø.8	Ø.396	Ø.332	Ø.151	Ø.868	Ø.Ø59	-Ø.7	3Ø.7
3.Ø	65.3	214.4Ø	2.1	Ø.422	Ø.362	Ø.152	Ø.873	Ø.Ø6Ø	-1.6	26.9
4.Ø	65.3	214.Ø8	4.6	Ø.448	Ø.389	Ø.155	Ø.875	Ø.Ø6Ø	-2.4	23.6
5.Ø	65.2	213.75	8.1	Ø.449	Ø.398	Ø.155	Ø.86Ø	Ø.Ø63	-2.9	19.4
7.Ø	65.Ø	213.11	14.4	Ø.439	Ø.4ØØ	Ø.159	Ø.8Ø7	Ø.Ø72	-3.9	12.1
1Ø.Ø	64.7	212.14	18.5	Ø.364	Ø.338	Ø.162	Ø.699	Ø.Ø87	-4.5	7.1
15.Ø	64.2	21Ø.62	2Ø.5	Ø.282	Ø.264	Ø.165	Ø.59Ø	Ø.1Ø3	-5.1	4.5
2Ø.Ø	63.7	2Ø8.91	2Ø.3	Ø.192	Ø.18Ø	Ø.167	Ø.494	Ø.116	-5.8	3.6
3Ø.Ø	62.7	2Ø5.68	16.3	Ø.Ø94	Ø.Ø88	Ø.168	Ø.449	Ø.12Ø	-7.5	6.7

TORQUE = 5232.52 IN.-LB.

*Loss Coefficient Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
Ø.	65.6	215.37	41.2	Ø.127	Ø.Ø59	13.5	2Ø.9	Ø.2282	Ø.22Ø5	Ø.779Ø
1.Ø	65.5	215.Ø5	42.Ø	Ø.13Ø	Ø.Ø61	14.1	2Ø.4	Ø.2176	Ø.21Ø7	Ø.772Ø
2.Ø	65.4	214.72	42.4	Ø.131	Ø.Ø63	13.9	19.5	Ø.2Ø79	Ø.2Ø17	Ø.7[illegible]
3.Ø	65.3	214.4Ø	42.4	Ø.133	Ø.Ø64	13.3	18.6	Ø.1986	Ø.1932	Ø.7[illegible]
4.Ø	65.3	214.Ø8	41.9	Ø.134	Ø.Ø66	12.7	18.3	Ø.1896	Ø.1847	Ø.7[illegible]
5.Ø	65.2	213.75	4Ø.6	Ø.135	Ø.Ø67	11.4	18.1	Ø.1813	Ø.1768	Ø.7[illegible]
7.Ø	65.Ø	213.11	38.1	Ø.135	Ø.Ø68	7.7	16.5	Ø.1653	Ø.1618	Ø.7[illegible]
1Ø.Ø	64.7	212.14	34.1	Ø.133	Ø.Ø7Ø	2.5	14.6	Ø.1342	Ø.1318	Ø.6977
15.Ø	64.2	21Ø.62	3Ø.7	Ø.131	Ø.Ø72	-1.5	12.3	Ø.Ø983	Ø.Ø961	Ø.6[illegible]
2Ø.Ø	63.7	2Ø8.91	26.3	Ø.13Ø	Ø.Ø74	-5.[illegible]	1Ø.3	Ø.Ø758	Ø.Ø76[illegible]	Ø.6[illegible]
3Ø.Ø	62.7	2Ø5.68	27.Ø	Ø.124	Ø.Ø8Ø	-5.4	8.3	Ø.Ø481	Ø.Ø477	Ø.5[illegible]2

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Table 39. Blade and Vane Element Performance for Rotor B/Stator B, Four-Stage Configuration, Third Stage Tested, Increased Rotor Tip Clearance and Casing Treatment, Peak Pressure Rise/Near Stall Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS* COEF.	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
Ø.	66.4	217.72	-16.8	Ø.332	Ø.248	Ø.148	Ø.855	Ø.Ø6Ø	1.7	[illegible]
1.Ø	66.3	217.39	-17.9	Ø.383	Ø.288	Ø.151	Ø.882	Ø.Ø57	Ø.3	48.9
2.Ø	66.2	217.Ø7	-18.Ø	Ø.436	Ø.331	Ø.154	Ø.91Ø	Ø.Ø55	-1.Ø	[illegible]
3.Ø	66.1	216.74	-17.5	Ø.468	Ø.358	Ø.155	Ø.927	Ø.Ø54	-1.8	[illegible]
4.Ø	66.Ø	216.41	-15.7	Ø.497	Ø.387	Ø.157	Ø.942	Ø.Ø52	-2.5	[illegible]
5.Ø	65.9	216.Ø9	-12.Ø	Ø.515	Ø.413	Ø.158	Ø.948	Ø.Ø52	-3.1	[illegible]
7.Ø	65.7	215.43	-3.2	Ø.535	Ø.452	Ø.161	Ø.938	Ø.Ø55	-3.9	[illegible]
1Ø.Ø	65.4	214.45	11.1	Ø.477	Ø.431	Ø.164	Ø.834	Ø.Ø7Ø	-4.6	[illegible]
15.Ø	64.9	212.82	17.Ø	Ø.41Ø	Ø.38Ø	Ø.166	Ø.727	Ø.Ø85	-5.1	[illegible]
2Ø.Ø	64.4	211.19	2Ø.Ø	Ø.278	Ø.261	Ø.168	Ø.58Ø	Ø.1Ø5	-5.8	[illegible]
3Ø.Ø	63.4	2Ø7.92	16.Ø	Ø.136	Ø.128	Ø.169	Ø.491	Ø.115	-7.5	7.Ø

TORQUE = 5247.89 IN.-LB.

*Loss Coefficient Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
Ø.	66.4	217.72	47.5	Ø.128	Ø.Ø6Ø	2Ø.1	21.2	Ø.2282	Ø.22Ø4	[illegible]
1.Ø	66.3	217.39	49.3	Ø.13Ø	Ø.Ø62	21.Ø	2Ø.Ø	Ø.2176	Ø.21Ø8	Ø.7758
2.Ø	66.2	217.Ø7	5Ø.5	Ø.132	Ø.Ø63	21.5	19.1	Ø.2Ø79	[illegible]	Ø.7717
3.Ø	66.1	216.74	51.3	Ø.134	Ø.Ø65	21.9	18.4	Ø.1986	[illegible]	[illegible]
4.Ø	66.Ø	216.41	51.4	Ø.135	Ø.Ø66	21.9	18.Ø	Ø.1895	[illegible]	[illegible]
5.Ø	65.9	216.Ø9	5Ø.7	Ø.136	Ø.Ø67	21.1	17.7	Ø.1813	[illegible]	[illegible]
7.Ø	65.7	215.43	49.3	Ø.136	Ø.Ø69	18.7	16.2	Ø.1653	[illegible]	[illegible]
1Ø.Ø	65.4	214.45	43.Ø	Ø.134	Ø.Ø71	11.3	14.5	Ø.1342	[illegible]	[illegible]
15.Ø	64.9	[illegible]	38.Ø	Ø.132	Ø.Ø72	6.7	[illegible]	Ø.Ø98Ø	[illegible]	[illegible]
2Ø.Ø	64.4	211.19	31.3	Ø.121	Ø.Ø74	-Ø.3	11.Ø	Ø.Ø768	[illegible]	[illegible]
3Ø.Ø	63.4	[illegible]	29.1	Ø.124	[illegible]	-2.6	9.4	Ø.Ø131	[illegible]	[illegible]

Table 40. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Single-Stage Configuration.

Design Point Throttle

PERCENT IMMERSION	TOTAL PRESSURE ROTOR 3 INLET	TOTAL PRESSURE ROTOR 3 EXIT	TOTAL PRESSURE STATOR 3 EXIT	STATIC PRESSURE ROTOR 3 INLET	STATIC PRESSURE ROTOR 3 EXIT	STATIC PRESSURE STATOR 3 EXIT
0.	-.1164	0.4891	0.4756	-.2319	0.1514	0.3392
1.0	-.1023	0.5117	0.4916	-.2317	0.1425	0.3390
2.0	-.0901	0.5313	0.5040	-.2315	0.1350	0.3300
3.0	-.0795	0.5480	0.5150	-.2314	0.1290	0.3304
4.0	-.0700	0.5617	0.5284	-.2314	0.1242	0.3280
5.0	-.0539	0.5724	0.5403	-.2314	0.1206	0.3376
7.0	-.0553	0.5849	0.5554	-.2317	0.1165	0.3365
10.0	-.0417	0.5900	0.5575	-.2325	0.1166	0.3343
15.0	-.0252	0.5670	0.5626	-.2407	0.1189	0.3326
20.0	-.0187	0.5894	0.5665	-.2352	0.1204	0.3325
30.0	-.0130	0.5903	0.5609	-.2337	0.1466	0.3306
50.0	-.0107	0.5890	0.5591	-.2342	0.1205	0.3294
70.0	-.0141	0.5820	0.5614	-.2426	0.0900	0.3212
80.0	-.0146	0.5640	0.5442	-.2436	0.0889	0.3161
85.0	-.0320	0.5539	0.5344	-.2443	0.0989	0.3134
90.0	-.0643	0.5463	0.5299	-.2456	0.0900	0.3083
93.0	-.0770	0.5549	0.5237	-.2479	0.0904	0.3021
95.0	-.0866	0.5793	0.5032	-.2488	0.0881	0.2981
96.0	-.0919	0.5902	0.4845	-.2479	0.0856	0.2959
97.0	-.0951	0.6035	0.4649	-.2474	0.0822	0.2934
98.0	-.0998	0.6123	0.4380	-.2455	0.0781	0.2920

Peak Efficiency Throttle

PERCENT IMMERSION	TOTAL PRESSURE ROTOR 3 INLET	TOTAL PRESSURE ROTOR 3 EXIT	TOTAL PRESSURE STATOR 3 EXIT	STATIC PRESSURE ROTOR 3 INLET	STATIC PRESSURE ROTOR 3 EXIT	STATIC PRESSURE STATOR 3 EXIT
0.	-.1105	0.5972	0.5482	-.2060	0.2048	0.4116
1.0	-.0995	0.6136	0.5580	-.2096	0.1971	0.4111
2.0	-.0896	0.6269	0.5670	-.2120	0.1905	0.4106
3.0	-.0808	0.6370	0.5751	-.2140	0.1951	0.4101
4.0	-.0732	0.6439	0.5823	-.2155	0.1808	0.4096
5.0	-.0667	0.6477	0.5888	-.2166	0.1773	0.4090
7.0	-.0569	0.6459	0.5931	-.2176	0.1730	0.4075
10.0	-.0418	0.6378	0.6038	-.2150	0.1717	0.4060
15.0	-.0268	0.6283	0.6086	-.2085	0.1699	0.4055
20.0	-.0166	0.6312	0.6132	-.2086	0.1750	0.4053
30.0	-.0106	0.6357	0.6174	-.2106	0.1805	0.4031
50.0	-.0122	0.6354	0.6137	-.2131	0.1803	0.3985
70.0	-.0138	0.6227	0.5959	-.2163	0.1465	0.3922
80.0	-.0177	0.6094	0.5814	-.2140	0.1404	0.3852
85.0	-.0313	0.6046	0.5740	-.2200	0.1298	0.3838
90.0	-.0539	0.5954	0.5732	-.2209	0.1384	0.3777
93.0	-.0690	0.6002	0.5662	-.2224	0.1396	0.3725
95.0	-.0819	0.6401	0.5555	-.2240	0.1390	0.3698
96.0	-.0843	0.6555	0.5377	-.2232	0.1372	0.3681
97.0	-.0864	0.6672	0.5212	-.2226	0.1349	0.3667
98.0	-.0917	0.6710	0.4591	-.2217	0.1322	0.3649

Peak Pressure Rise/Near Stall Throttle

PERCENT IMMERSION	TOTAL PRESSURE ROTOR 3 INLET	TOTAL PRESSURE ROTOR 3 EXIT	TOTAL PRESSURE STATOR 3 EXIT	STATIC PRESSURE ROTOR 3 INLET	STATIC PRESSURE ROTOR 3 EXIT	STATIC PRESSURE STATOR 3 EXIT
0.	-.0808	0.6567	0.5832	-.1805	0.2510	0.4721
1.0	-.0815	0.6718	0.5960	-.1839	0.2424	0.4711
2.0	-.0746	0.6833	0.6072	-.1860	0.2350	0.4702
3.0	-.0680	0.6913	0.6160	-.1892	0.2287	0.4693
4.0	-.0619	0.6956	0.6249	-.1912	0.2234	0.4685
5.0	-.0561	0.6964	0.6314	-.1926	0.2190	0.4670
7.0	-.0458	0.6872	0.6395	-.1940	0.2125	0.4665
10.0	-.0339	0.6735	0.6462	-.1923	0.2001	0.4650
15.0	-.0266	0.6685	0.6525	-.1834	0.2058	0.4647
20.0	-.0158	0.6727	0.6563	-.1841	0.2107	0.4642
30.0	-.0093	0.6750	0.6596	-.1855	0.2259	0.4624
50.0	-.0111	0.6794	0.6567	-.1863	0.2276	0.4571
70.0	-.0101	0.6642	0.6351	-.1895	0.1986	0.4486
80.0	-.0165	0.6555	0.6175	-.1915	0.1989	0.4436
85.0	-.0270	0.6539	0.6104	-.1927	0.1891	0.4424
90.0	-.0520	0.6472	0.6092	-.1930	0.1868	0.4355
93.0	-.0631	0.6700	0.6062	-.1951	0.1846	0.4312
95.0	-.0659	0.6975	0.5900	-.1965	0.1822	0.4290
96.0	-.0753	0.7109	0.5757	-.1952	0.1771	0.4268
97.0	-.0726	0.7162	0.5680	-.1948	0.1716	0.4252
98.0	-.0783	0.7050	0.5293	-.1945	0.1650	0.4248

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Table 40. Normalized Absolute Total Pressure, Static Pressure, and Flow Angles for Rotor B/Stator B Single-Stage Configuration (Concluded).

Design Point Throttle

	Measured			Corrected		
PERCENT IMMERSION	ROTOR 1 INLET	STATOR 1 INLET	STATOR 1 EXIT	ROTOR 1 INLET	STATOR 1 INLET	STATOR 1 EXIT
1.0	29.9	62.9	30.4	31.2	64.0	31.7
2.0	28.6	62.6	30.1	29.8	53.7	31.4
3.0	27.1	61.9	29.6	28.3	63.1	30.8
4.0	25.8	61.3	29.0	26.9	62.5	30.2
5.0	24.9	60.3	28.4	26.0	61.5	29.6
10.0	20.4	56.4	26.9	21.3	57.6	28.0
15.0*	19.6	52.2	23.9	20.4	53.4	24.9
20.0	19.6	49.1	21.5	20.4	50.3	22.3
30.0*	19.6	47.0	19.5	20.3	48.1	20.2
50.0	19.0	46.9	18.3	19.6	47.8	18.9
70.0*	18.2	47.3	18.5	18.7	48.1	19.0
80.0	18.4	48.2	19.6	18.9	49.0	20.1
85.0*	18.8	49.0	20.4	19.2	49.7	20.9
90.0	19.6	50.5	21.6	20.0	51.2	22.1
95.0	20.8	51.2	24.3	21.3	51.9	24.8
96.0	20.8	51.8	25.2	21.3	52.5	25.7
97.0	20.6	53.2	32.6	21.0	53.8	33.2
98.0	20.5	55.7	45.3	20.9	56.3	46.0

Peak Efficiency Throttle

	Measured			Corrected		
PERCENT IMMERSION	ROTOR 1 INLET	STATOR 1 INLET	STATOR 1 EXIT	ROTOR 1 INLET	STATOR 1 INLET	STATOR 1 EXIT
1.0	30.5	67.8	31.3	31.8	68.8	32.6
2.0	28.4	66.6	31.5	29.6	67.6	32.8
3.0	26.9	65.7	30.6	28.0	66.7	31.9
4.0	25.6	64.7	30.4	26.7	65.8	31.6
5.0	24.0	63.8	29.9	25.0	64.9	31.1
10.0	20.5	58.8	27.4	21.4	60.0	28.5
15.0*	19.8	53.8	23.9	20.6	55.0	24.9
20.0	19.5	50.2	21.4	20.3	51.4	22.2
30.0*	19.2	47.9	18.9	19.9	49.0	19.6
50.0	19.0	48.3	18.6	19.6	49.2	19.2
70.0*	19.0	49.1	19.5	19.5	49.9	20.0
80.0	19.2	50.1	20.1	19.7	50.8	20.6
85.0*	19.3	51.0	20.9	19.8	51.7	21.4
90.0	19.6	52.6	22.0	20.0	53.3	22.5
95.0	20.6	52.9	24.0	21.1	53.6	24.5
96.0	20.6	54.0	24.8	21.0	54.6	25.3
97.0	20.7	56.0	31.6	21.1	56.6	32.2
98.0	20.8	58.2	42.9	21.2	58.8	43.6

Peak Pressure Rise/Near Stall Throttle

	Measured			Corrected		
PERCENT IMMERSION	ROTOR 1 INLET	STATOR 1 INLET	STATOR 1 EXIT	ROTOR 1 INLET	STATOR 1 INLET	STATOR 1 EXIT
1.0	30.3	72.9	30.2	31.6	73.7	31.5
2.0	28.4	74.2	29.2	29.6	74.9	30.4
3.0	27.1	73.3	28.3	28.3	74.1	29.5
4.0	25.9	72.1	28.4	27.0	72.9	29.6
5.0	25.0	70.8	28.0	26.1	71.6	29.2
10.0	21.1	64.6	25.8	22.0	65.6	26.9
15.0	19.8	60.2	21.6	20.6	61.3	22.5
20.0	19.6	55.0	18.8	20.4	56.1	19.5
30.0*	19.4	49.7	16.9	20.1	50.8	17.5
50.0	19.0	50.5	18.2	19.6	51.4	18.8
70.0*	18.6	51.6	19.1	19.1	52.4	19.6
80.0*	18.8	53.0	20.1	19.3	53.8	20.6
85.0*	19.2	53.9	21.2	19.7	54.6	21.7
90.0	19.7	54.5	23.0	20.1	55.2	23.5
95.0*	20.8	56.8	24.4	21.3	57.4	24.9
96.0*	20.8	58.8	25.2	21.3	59.4	25.7
97.0*	20.8	61.2	27.0	21.2	61.7	27.5
98.0*	20.9	63.2	38.4	21.3	64.1	39.0

* CURVE FIT VALUES USING ZERO STATOR POSITION DATA

Table 41. Vector Diagram Parameters for Rotor B/Stator B Single-Stage Configuration, Design Point Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	54.8	179.8	51.7	169.5	70.3	18.3	60.0	11.1	36.4	21.4	70.1	31.2
2.0	55.0	180.5	51.4	168.6	68.9	19.6	64.4	11.3	37.0	22.6	74.2	29.8
3.0	55.4	181.8	51.3	168.4	67.7	20.8	68.3	11.2	36.8	23.7	77.6	28.3
4.0	55.8	183.1	51.3	168.5	66.8	21.8	71.7	11.1	36.5	24.5	80.4	26.9
5.0	56.1	184.0	51.3	168.3	66.0	22.7	74.3	11.1	36.3	25.2	82.7	26.0
7.0	57.1	187.4	52.0	170.5	65.4	23.6	77.6	10.2	33.4	25.7	84.5	23.3
10.0	57.8	189.6	52.3	171.6	64.6	24.6	80.7	9.6	31.5	26.4	86.7	21.3
15.0	57.9	189.9	51.8	170.0	63.4	25.7	84.5	9.6	31.5	27.5	90.2	20.4
20.0	57.7	189.2	50.8	166.6	61.5	27.4	89.8	10.2	33.4	29.2	95.8	20.4
30.0	56.9	186.7	49.8	163.4	60.9	27.5	90.3	10.2	33.5	29.3	96.3	20.3
50.0	55.7	182.6	48.2	158.2	59.9	27.8	91.2	9.9	32.5	29.5	96.8	19.6
70.0	54.5	178.9	46.7	153.2	58.7	28.2	92.4	9.6	31.3	29.7	97.6	18.7
80.0	53.7	176.2	45.6	149.5	57.8	28.5	93.4	9.7	32.0	30.1	98.7	18.9
85.0	53.0	174.0	45.0	147.7	57.9	28.0	92.0	9.8	32.2	29.7	97.5	19.2
90.0	52.1	170.9	44.4	145.7	58.3	27.2	89.3	10.0	32.7	29.0	95.1	20.0
93.0	51.1	167.6	44.5	146.1	60.5	25.0	82.1	9.6	31.4	26.8	87.9	20.9
95.0	50.6	166.0	44.5	145.9	61.3	24.2	79.3	9.4	30.9	25.9	85.1	21.3
96.0	50.5	165.5	44.6	146.3	61.9	23.6	77.4	9.2	30.2	25.3	83.1	21.3
97.0	50.4	165.4	44.8	146.8	62.4	23.2	76.0	8.9	29.3	24.8	81.5	21.0
98.0	50.3	165.1	44.8	147.0	62.7	22.9	75.2	8.8	28.9	24.5	80.5	20.9

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	33.9	111.2	29.9	98.2	61.9	15.9	52.0	32.8	107.7	36.4	119.6	64.0
2.0	33.0	108.7	28.4	93.3	59.3	16.8	55.0	34.2	112.3	38.1	125.0	63.7
3.0	32.6	107.0	27.3	89.6	56.7	17.8	58.4	35.3	115.7	39.5	129.6	63.0
4.0	32.4	106.3	26.4	86.8	54.5	18.7	61.5	36.0	118.2	40.6	133.2	62.3
5.0	32.5	106.7	25.9	84.8	52.5	19.7	64.7	36.5	119.8	41.5	136.2	61.5
7.0	33.1	108.7	25.6	84.0	50.5	21.0	68.9	36.6	120.0	42.2	138.4	60.0
10.0	34.4	112.7	25.6	83.9	48.0	22.9	75.2	36.3	119.2	42.9	140.9	57.6
15.0	37.0	121.5	26.7	87.6	46.0	25.7	84.2	34.7	113.9	43.2	141.7	53.4
20.0	39.1	128.4	27.9	91.6	45.4	27.4	90.0	33.0	108.4	42.9	140.9	50.2
30.0	40.0	131.4	28.2	92.7	44.7	28.4	93.1	31.8	104.2	42.6	139.8	48.1
50.0	38.9	127.6	27.0	88.7	43.9	27.9	91.7	31.1	102.0	41.8	137.1	47.9
70.0	37.5	123.0	24.5	80.3	40.6	28.4	93.2	31.8	104.3	42.6	139.8	48.1
80.0	36.3	119.1	22.0	72.3	37.3	28.8	94.6	33.3	109.1	44.0	144.4	48.9
85.0	35.4	116.1	21.8	71.4	37.9	27.9	91.5	33.1	108.5	43.3	141.9	49.7
90.0	34.1	111.7	21.1	69.2	38.1	26.7	87.7	33.3	109.2	42.7	140.1	51.1
93.0	33.4	109.7	20.8	68.1	38.3	26.2	86.0	33.3	109.3	42.4	139.1	51.7
95.0	33.0	108.4	20.1	65.9	37.4	26.2	86.0	33.8	110.9	42.8	140.3	52.1
96.0	32.7	107.3	18.9	61.9	35.1	26.7	87.7	34.9	114.6	44.0	144.3	52.4
97.0	31.6	103.7	17.6	57.9	33.8	26.2	86.0	36.1	118.3	44.6	146.3	53.8
98.0	29.6	97.2	15.8	51.9	32.2	25.0	82.2	37.8	123.9	45.3	148.7	56.3

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	54.3	178.1	50.6	166.0	68.6	19.6	64.4	12.2	39.9	23.1	75.8	31.7
2.0	54.1	177.5	49.9	163.8	67.1	20.8	68.4	12.7	41.8	24.4	80.1	31.3
3.0	54.1	177.4	49.4	162.2	65.9	21.9	72.0	13.1	43.1	25.6	83.9	30.8
4.0	54.2	177.7	49.1	161.0	64.7	23.0	75.3	13.4	44.0	26.6	87.2	30.2
5.0	54.3	178.2	48.8	160.1	63.8	23.8	78.2	13.6	44.5	27.4	90.0	29.6
7.0	54.4	178.6	48.5	159.2	62.9	24.6	80.8	13.7	44.8	28.2	92.4	28.9
10.0	54.6	179.2	48.1	157.9	61.6	25.0	84.7	13.8	45.1	29.3	96.0	28.0
15.0	55.9	183.4	49.0	160.9	61.1	26.8	88.0	12.4	40.7	29.6	97.0	24.7
20.0	56.8	136.3	49.5	162.5	60.6	27.7	91.0	11.4	37.5	30.0	98.4	22.3
30.0	57.0	187.2	49.5	162.4	60.0	28.4	93.1	10.5	34.5	30.3	99.3	20.3
50.0	56.2	184.5	48.2	158.2	58.8	28.9	95.0	9.9	32.5	30.6	100.4	18.9
70.0	54.6	179.1	46.2	151.7	57.7	29.0	95.2	10.0	32.9	30.7	100.7	19.0
80.0	53.2	174.6	44.8	146.8	57.1	28.8	94.4	10.6	34.6	30.7	100.6	20.1
85.0	52.1	171.0	44.1	144.6	57.5	27.9	91.4	10.8	35.3	29.9	98.0	21.1
90.0	51.1	167.8	43.3	142.0	57.6	27.2	89.4	11.1	36.4	29.4	96.5	22.1
93.0	50.6	166.0	42.7	140.1	57.4	27.2	89.1	11.4	37.4	29.4	96.6	22.7
95.0	49.4	161.9	41.5	136.2	57.1	26.7	87.5	12.4	40.6	29.4	96.5	24.8
96.0	48.7	159.7	41.5	136.1	58.2	25.5	83.7	12.3	40.4	28.3	92.9	25.7
97.0	44.9	147.5	38.8	127.3	59.5	22.7	74.5	14.9	48.9	27.2	89.1	33.2
98.0	39.3	128.9	35.0	114.7	62.6	18.0	58.9	18.7	61.2	25.9	85.0	46.0

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Table 42. Vector Diagram Parameters for Rotor B/Stator B Single-Stage Configuration, Peak Efficiency Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	54.6	[illegible]	[illegible]	170.9	72.2	16.5	54.0	10.2	33.6	19.4	63.6	31.8
2.0	55.0	180.5	52.0	170.5	70.7	18.0	59.1	10.3	33.7	20.7	68.0	29.6
3.0	55.3	181.5	51.8	170.1	69.4	19.3	63.3	10.3	33.8	21.9	71.7	28.0
4.0	55.6	182.6	51.8	169.9	68.3	20.4	66.9	10.3	33.7	22.8	74.8	26.7
5.0	56.2	184.3	52.0	170.5	67.5	21.3	70.0	10.0	32.8	23.6	77.4	25.0
7.0	56.9	186.5	52.3	171.6	66.7	22.3	73.1	9.5	31.0	24.2	79.4	23.0
10.0	57.3	188.0	52.3	171.7	65.8	23.3	76.5	9.2	30.0	25.1	82.2	21.4
15.0	57.3	187.9	51.8	170.0	64.6	24.4	80.0	9.2	30.2	26.1	85.5	20.6
20.0	57.1	187.2	51.3	168.3	63.8	25.0	82.0	9.3	30.4	26.6	87.4	20.3
30.0	56.5	185.3	50.3	164.9	62.7	25.7	84.5	9.3	30.7	27.4	89.9	19.9
50.0	55.1	180.6	48.4	158.6	61.3	26.3	86.4	9.4	30.8	28.0	91.7	19.6
70.0	53.5	175.4	46.5	152.5	60.2	26.4	86.6	9.4	30.8	28.0	91.9	19.5
80.0	52.6	172.6	45.4	149.1	59.6	26.5	86.9	9.5	31.1	28.1	92.3	19.7
85.0	52.1	171.0	45.0	147.5	59.4	26.4	86.5	9.5	31.2	28.0	92.0	19.8
90.0	51.4	168.8	44.7	146.6	60.1	25.5	83.7	9.3	30.6	27.2	89.1	20.0
93.0	50.6	166.1	44.6	146.5	61.7	23.9	78.3	9.1	29.8	25.5	83.8	20.8
95.0	50.2	164.7	44.7	146.7	62.8	22.8	74.9	8.8	28.9	24.5	80.3	21.1
96.0	50.0	164.2	45.0	147.5	63.8	22.0	72.1	8.5	27.8	23.6	77.3	21.0
97.0	49.9	163.7	44.9	147.4	64.0	21.7	71.2	8.4	27.6	23.3	76.4	21.1
98.0	49.8	163.2	44.9	147.2	64.2	21.5	70.5	8.4	27.5	23.1	75.7	21.2

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	29.5	96.6	25.9	85.0	61.4	14.0	46.0	36.4	119.5	39.0	128.1	68.8
2.0	29.3	96.0	25.0	82.1	58.5	15.2	49.9	37.2	122.2	40.2	132.0	67.6
3.0	29.2	95.7	24.3	79.7	56.2	16.2	53.0	37.9	124.2	41.2	135.1	66.7
4.0	29.2	95.9	23.8	78.0	54.2	17.0	55.9	38.3	125.6	41.9	137.5	65.8
5.0	29.9	98.2	23.7	77.7	52.2	18.3	60.0	38.3	125.6	42.4	139.2	64.3
7.0	30.5	100.1	23.6	77.5	50.6	19.3	63.3	38.1	125.2	42.8	140.3	63.0
10.0	32.4	106.2	24.3	79.8	48.6	21.4	70.1	37.2	121.9	42.9	140.6	59.9
15.0	35.5	116.6	26.0	85.4	46.9	24.2	79.4	35.0	114.8	42.6	139.6	55.2
20.0	38.0	124.8	27.5	90.3	46.2	26.3	86.2	33.0	108.4	42.2	138.5	51.4
30.0	39.1	128.4	27.8	91.2	45.1	27.6	90.4	31.8	104.4	42.1	138.1	49.0
50.0	37.7	123.6	26.1	85.7	43.8	27.2	89.1	31.6	103.8	41.7	136.7	49.2
70.0	35.9	117.8	23.7	77.6	41.1	27.0	88.6	32.2	105.7	42.0	138.0	49.9
80.0	34.6	113.5	21.5	70.6	38.4	27.1	88.9	33.4	109.6	43.0	141.1	50.8
85.0	33.6	110.2	20.9	68.4	38.3	26.3	86.3	33.6	110.3	42.7	140.1	51.8
90.0	32.2	105.6	19.9	65.2	38.0	25.3	83.1	34.1	111.9	42.5	139.4	53.3
93.0	32.0	105.1	19.9	65.3	38.3	25.1	82.4	33.8	111.0	42.1	138.2	53.3
95.0	31.7	104.0	19.2	62.8	37.0	25.3	82.9	34.4	112.8	42.7	140.0	53.5
96.0	30.8	101.1	17.4	57.1	34.2	25.5	83.5	36.1	118.3	44.1	144.8	54.6
97.0	29.2	95.9	15.8	51.9	32.6	24.6	80.7	37.5	123.2	44.9	147.3	56.6
98.0	27.5	90.1	14.3	46.9	31.2	23.5	77.0	39.0	127.8	45.5	149.2	58.8

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
X	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	53.6	175.7	49.9	163.9	68.7	19.3	63.4	12.4	40.6	23.0	75.3	32.6
2.0	53.2	174.6	49.3	161.8	67.7	20.0	65.6	12.9	42.4	23.8	78.1	32.8
3.0	53.4	175.2	49.2	161.3	66.8	20.8	68.4	13.0	42.6	24.6	80.6	31.8
4.0	53.3	174.9	48.8	160.1	66.1	21.5	70.4	13.3	43.5	25.2	82.8	31.6
5.0	53.4	175.1	48.6	159.4	65.4	22.1	72.4	13.4	43.9	25.8	84.7	31.1
7.0	53.5	175.5	48.4	158.9	64.7	22.7	74.5	13.3	43.8	26.3	86.4	30.4
10.0	54.0	177.2	48.5	159.0	63.6	23.8	78.2	13.0	42.7	27.2	89.1	28.6
15.0	55.4	181.9	49.4	162.2	62.9	25.1	82.3	11.6	38.0	27.6	90.6	24.7
20.0	56.3	184.6	49.9	163.9	62.4	25.9	84.9	10.6	34.8	28.0	91.8	22.2
30.0	56.8	186.2	50.1	164.4	61.8	26.6	87.4	9.5	31.2	28.3	92.8	19.6
50.0	55.4	181.7	48.3	158.4	60.5	27.2	89.1	9.5	31.1	28.0	94.3	19.2
70.0	53.4	175.1	46.0	150.9	59.3	27.1	88.8	9.9	32.4	28.8	94.5	20.0
80.0	52.2	171.2	45.0	147.5	59.3	26.5	86.9	10.0	32.7	28.3	92.5	20.6
85.0	51.3	168.3	44.5	146.0	60.0	25.5	83.7	10.0	32.7	27.4	89.9	21.3
90.0	50.3	165.0	43.6	143.0	59.9	25.1	82.3	10.4	34.2	27.1	89.1	22.5
93.0	49.6	162.6	42.7	140.1	59.3	25.2	82.5	11.0	36.2	27.5	90.1	23.6
95.0	48.9	160.6	42.2	138.3	59.3	24.9	81.6	11.4	37.3	27.3	89.7	24.5
96.0	48.4	158.9	42.0	137.7	59.9	24.2	79.3	11.5	37.6	26.8	87.8	25.3
97.0	45.2	148.3	39.7	130.2	61.2	21.6	70.9	13.7	44.8	25.6	83.9	32.2
98.0	40.5	132.7	36.4	119.4	63.9	17.7	57.9	16.9	55.3	24.4	80.1	43.6

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Table 43. Vector Diagram Parameters for Rotor B/Stator B Single-Stage Configuration, Peak Pressure Rise and Near Stall Throttle.

BLADE ELEMENT DATA ROTOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	55.0	180	52.6	172.5	72.7	16.2	53.0	10.0	32.7	19.0	62.3	31.6
2.0	55.3	181.5	52.5	172.3	71.4	17.4	57.2	9.9	32.6	20.1	65.8	29.6
3.0	55.5	182.2	52.4	171.9	70.4	18.5	60.6	10.0	32.7	21.0	68.9	28.3
4.0	55.8	183.1	52.3	171.6	69.4	19.4	63.7	9.9	32.6	21.8	71.6	27.0
5.0	56.0	183.8	52.2	171.4	68.6	20.2	66.4	9.9	32.6	22.5	73.9	26.1
7.0	56.5	185.5	52.5	172.1	67.9	21.1	69.3	9.5	31.2	23.2	76.0	24.2
10.0	57.2	187.6	52.6	172.7	66.8	22.4	73.4	9.1	29.7	24.1	79.2	22.0
15.0	57.4	188.2	52.4	172.0	65.8	23.3	76.5	8.8	28.9	24.9	81.8	20.6
20.0	57.0	187.2	52.1	170.9	65.7	23.3	76.3	8.7	28.4	24.8	81.4	20.4
30.0	56.4	185.0	50.9	167.2	64.5	24.1	79.2	8.9	29.1	25.7	84.4	20.1
50.0	55.0	180.4	49.1	161.0	63.0	24.8	81.3	8.8	29.0	26.3	86.3	19.6
70.0	53.5	175.6	47.4	155.7	62.2	24.8	81.3	8.6	28.2	26.2	86.1	19.1
80.0	52.7	172.8	46.3	152.0	61.4	25.1	82.2	8.8	28.8	26.6	87.1	19.3
85.0	52.0	170.7	45.8	150.3	61.5	24.7	81.0	8.8	29.0	26.2	86.0	19.7
90.0	51.3	168.3	45.4	148.8	62.0	23.9	78.6	8.8	28.9	25.5	83.7	20.1
93.0	50.6	166.1	45.5	149.2	63.8	22.2	72.9	8.4	27.6	23.8	78.0	20.6
95.0	50.1	164.5	45.4	149.0	64.8	21.2	69.6	8.3	27.2	22.8	74.7	21.3
96.0	50.0	164.2	45.4	149.0	65.0	21.0	69.0	8.2	26.9	22.6	74.0	21.3
97.0	49.9	163.7	45.6	149.7	65.9	20.2	66.3	7.9	25.9	21.7	71.2	21.2
98.0	49.8	163.4	45.4	149.0	65.6	20.4	66.9	8.0	26.2	21.9	71.9	21.3

BLADE ELEMENT DATA ROTOR OUTLET / STATOR INLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	26.7	87.6	24.3	79.7	65.3	11.1	36.3	38.2	125.4	39.8	130.5	73.7
2.0	25.2	82.6	22.9	75.0	65.1	10.5	34.5	39.6	129.8	40.9	134.3	74.9
3.0	24.9	81.8	22.1	72.6	62.3	11.5	37.7	40.2	132.0	41.8	137.3	73.8
4.0	24.9	81.6	21.6	70.8	60.0	12.4	40.6	40.7	133.4	42.5	139.5	72.9
5.0	25.2	82.5	21.3	70.0	57.8	13.3	43.8	40.8	133.9	42.9	140.9	71.7
7.0	26.4	86.7	21.6	70.8	54.5	15.3	50.1	40.4	132.5	43.2	141.7	69.1
10.0	28.6	93.7	22.4	73.6	51.6	17.7	58.0	39.3	128.8	43.1	141.3	65.6
15.0	31.5	103.2	23.8	78.2	49.1	20.5	67.3	37.4	122.6	42.6	139.9	61.1
20.0	34.6	113.5	25.4	83.2	47.0	23.6	77.3	35.4	116.1	42.5	139.5	56.2
30.0	38.0	124.6	26.9	88.2	44.9	26.8	88.1	32.9	108.0	42.5	139.4	50.7
50.0	36.2	118.7	25.0	82.0	43.6	26.2	85.8	32.9	108.1	42.1	138.0	51.4
70.0	34.2	112.2	22.7	74.5	41.5	25.6	83.9	33.3	109.4	42.0	137.8	52.4
80.0	32.5	106.6	20.6	67.7	39.3	25.1	82.3	34.5	113.1	42.6	139.9	53.8
85.0	31.7	104.0	19.9	65.3	38.8	24.7	80.9	34.7	114.0	42.6	139.8	54.5
90.0	30.9	101.4	19.1	62.8	38.2	24.3	79.6	35.0	114.9	42.6	139.8	55.2
93.0	30.1	98.7	18.7	61.2	38.2	23.6	77.4	35.2	115.6	42.4	139.1	56.0
95.0	28.9	94.7	16.9	55.6	35.9	23.4	76.6	36.8	120.6	43.5	142.9	57.4
96.0	27.2	89.3	14.9	49.0	33.2	22.7	74.6	38.7	126.9	44.9	147.2	59.4
97.0	25.2	82.8	13.2	43.4	31.5	21.5	70.6	40.3	132.2	45.7	149.9	61.7
98.0	23.3	76.3	11.9	38.9	30.5	20.0	65.7	41.6	136.4	46.1	151.4	64.1

BLADE ELEMENT DATA STATOR OUTLET

IMMER	W		WU		BETA	CZ		CU		C		ALPHA
%	MPS	FPS	MPS	FPS	DEG	MPS	FPS	MPS	FPS	MPS	FPS	DEG
1.0	54.6	179.2	51.7	169.5	70.9	17.7	58.0	10.9	35.6	20.7	68.1	31.5
2.0	54.7	179.3	51.3	168.2	69.5	19.0	62.2	11.2	36.6	22.0	72.2	30.4
3.0	54.8	179.7	51.0	167.2	68.3	20.0	65.8	11.4	37.3	23.0	75.6	29.5
4.0	54.6	179.1	50.5	165.5	67.4	20.8	68.2	11.8	38.7	23.9	78.5	29.5
5.0	54.6	179.1	50.2	164.6	66.6	21.5	70.6	12.0	39.3	24.6	80.8	29.1
7.0	54.7	179.4	50.0	164.0	65.9	22.2	72.7	12.0	39.3	25.2	82.6	28.3
10.0	55.0	180.6	50.0	163.9	65.0	23.1	75.8	11.7	38.5	25.9	85.0	26.8
15.0	56.6	185.8	51.1	167.5	64.2	24.5	80.3	10.2	33.3	26.5	87.0	22.5
20.0	57.6	189.0	51.7	169.6	63.6	25.4	83.4	9.1	29.7	27.0	88.5	19.5
30.0	57.8	189.5	51.6	169.2	63.0	26.0	85.4	8.2	27.0	27.3	89.5	17.5
50.0	55.6	182.3	49.0	160.8	61.7	26.2	85.9	8.9	29.3	27.7	90.7	18.8
70.0	53.5	175.7	46.7	153.2	60.5	26.2	86.0	9.4	30.7	27.8	91.3	19.6
80.0	52.1	171.0	45.6	149.7	60.9	25.2	82.6	9.5	31.1	26.9	88.2	20.6
85.0	51.1	167.6	45.0	147.7	61.6	24.1	79.1	9.6	31.6	26.0	85.2	21.7
90.0	49.8	163.4	43.9	144.0	61.6	23.5	77.2	10.3	33.7	25.7	84.2	23.5
93.0	49.3	161.8	43.3	141.9	61.1	23.7	77.7	10.6	34.9	26.0	85.1	24.1
95.0	48.8	160.1	42.7	140.0	60.8	23.6	77.6	11.0	36.1	26.1	85.6	24.9
96.0	48.3	158.5	42.7	140.2	62.1	22.5	73.8	10.9	35.7	25.0	82.0	25.7
97.0	47.4	155.6	42.4	139.1	63.2	21.3	69.7	11.1	36.5	24.0	78.7	27.5
98.0	42.8	140.5	39.0	127.8	65.3	17.8	58.3	14.5	47.5	22.9	75.2	39.0

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Table 44. Blade and Vane Element Performance for Rotor B/Stator B, Single-Stage Configuration, Design Point Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS COEF.*	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.Ø	62.8	2Ø5.88	8.4	Ø.1Ø6	Ø.Ø93	Ø.158	Ø.566	Ø.Ø98	-Ø.4	21.9
2.Ø	62.7	2Ø5.57	9.6	Ø.144	Ø.128	Ø.159	Ø.593	Ø.Ø95	-1.8	19.2
3.Ø	62.6	2Ø5.26	11.Ø	Ø.175	Ø.157	Ø.16Ø	Ø.612	Ø.Ø94	-3.Ø	16.6
4.Ø	62.5	2Ø4.95	12.2	Ø.198	Ø.179	Ø.161	Ø.625	Ø.Ø94	-3.9	14.3
5.Ø	62.4	2Ø4.64	13.5	Ø.21Ø	Ø.192	Ø.162	Ø.629	Ø.Ø94	-4.7	12.3
7.Ø	62.2	2Ø4.Ø3	14.9	Ø.23Ø	Ø.212	Ø.165	Ø.632	Ø.Ø96	-5.3	1Ø.1
1Ø.Ø	61.9	2Ø3.1Ø	16.6	Ø.228	Ø.211	Ø.167	Ø.617	Ø.Ø99	-6.1	7.5
15.Ø	61.4	2Ø1.55	17.4	Ø.171	Ø.16Ø	Ø.167	Ø.557	Ø.1Ø7	-7.2	5.5
2Ø.Ø	61.Ø	2ØØ.ØØ	16.1	Ø.1Ø4	Ø.Ø98	Ø.167	Ø.5ØØ	Ø.113	-9.Ø	5.Ø
3Ø.Ø	6Ø.Ø	196.91	16.2	Ø.Ø51	Ø.Ø48	Ø.164	Ø.464	Ø.116	-9.Ø	5.3
5Ø.Ø	58.1	19Ø.73	15.9	Ø.Ø18	Ø.Ø17	Ø.161	Ø.465	Ø.112	-8.5	7.3
7Ø.Ø	56.2	184.54	18.1	Ø.Ø32	Ø.Ø31	Ø.157	Ø.482	Ø.1Ø8	-8.5	7.4
8Ø.Ø	55.3	181.45	2Ø.6	Ø.Ø8Ø	Ø.Ø77	Ø.155	Ø.5Ø3	Ø.1Ø5	-9.5	5.7
85.Ø	54.8	179.9Ø	2Ø.Ø	Ø.Ø8Ø	Ø.Ø77	Ø.153	Ø.511	Ø.1Ø2	-9.6	7.1
9Ø.Ø	54.4	178.35	2Ø.2	Ø.Ø77	Ø.Ø74	Ø.15Ø	Ø.526	Ø.Ø98	-9.5	8.1
93.Ø	54.1	177.43	22.2	Ø.Ø55	Ø.Ø53	Ø.147	Ø.531	Ø.Ø97	-7.5	8.8
95.Ø	53.9	176.81	23.9	Ø.Ø45	Ø.Ø43	Ø.146	Ø.539	Ø.Ø95	-6.9	8.2
96.Ø	53.8	176.5Ø	26.8	Ø.Ø49	Ø.Ø48	Ø.146	Ø.555	Ø.Ø94	-6.3	6.1
97.Ø	53.7	176.19	28.6	Ø.Ø81	Ø.Ø79	Ø.146	Ø.587	Ø.Ø91	-5.9	5.Ø
98.Ø	53.6	175.83	3Ø.5	Ø.133	Ø.13Ø	Ø.145	Ø.64Ø	Ø.Ø86	-5.7	3.5

TORQUE = 22Ø2.21 IN.-LB.

*Loss Coefficients Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.Ø	62.8	2Ø5.88	32.4	Ø.1Ø5	Ø.Ø67	-4.4	11.6	Ø.Ø4ØØ	Ø.Ø392	Ø.5689
2.Ø	62.7	2Ø5.57	32.4	Ø.11Ø	Ø.Ø71	-3.7	12.Ø	Ø.Ø544	Ø.Ø534	Ø.55Ø5
3.Ø	62.6	2Ø5.26	32.2	Ø.114	Ø.Ø74	-3.5	12.1	Ø.Ø638	Ø.Ø627	Ø.5526
4.Ø	62.5	2Ø4.95	32.2	Ø.117	Ø.Ø77	-3.3	12.1	Ø.Ø692	Ø.Ø68Ø	Ø.5447
5.Ø	62.4	2Ø4.64	31.9	Ø.12Ø	Ø.Ø79	-3.3	12.1	Ø.Ø715	Ø.Ø7Ø3	Ø.5366
7.Ø	62.2	2Ø4.Ø3	31.Ø	Ø.122	Ø.Ø81	-3.3	12.5	Ø.Ø71Ø	Ø.Ø699	Ø.5265
1Ø.Ø	61.9	2Ø3.1Ø	29.6	Ø.124	Ø.Ø84	-3.6	13.Ø	Ø.Ø63Ø	Ø.Ø62Ø	Ø.5Ø62
15.Ø	61.4	2Ø1.55	28.7	Ø.125	Ø.Ø85	-4.6	11.2	Ø.Ø687	Ø.Ø678	Ø.5Ø32
2Ø.Ø	61.Ø	2ØØ.ØØ	27.8	Ø.124	Ø.Ø87	-5.3	9.8	Ø.Ø521	Ø.Ø516	Ø.4898
3Ø.Ø	6Ø.Ø	196.91	27.8	Ø.123	Ø.Ø87	-4.8	8.6	Ø.Ø497	Ø.Ø493	Ø.467Ø
5Ø.Ø	58.1	19Ø.73	29.1	Ø.121	Ø.Ø88	-4.1	7.4	Ø.Ø46Ø	Ø.Ø457	Ø.4454
7Ø.Ø	56.2	184.54	29.1	Ø.123	Ø.Ø89	-5.7	6.3	Ø.Ø449	Ø.Ø446	Ø.4551
8Ø.Ø	55.3	181.45	28.9	Ø.127	Ø.Ø88	-7.Ø	6.8	Ø.Ø419	Ø.Ø416	Ø.47ØØ
85.Ø	54.8	179.9Ø	28.6	Ø.125	Ø.Ø86	-7.8	6.8	Ø.Ø417	Ø.Ø414	Ø.4824
9Ø.Ø	54.4	178.35	29.Ø	Ø.123	Ø.Ø85	-8.5	6.5	Ø.Ø421	Ø.Ø418	Ø.4846
93.Ø	54.1	177.43	29.Ø	Ø.122	Ø.Ø85	-9.4	5.8	Ø.Ø359	Ø.Ø356	Ø.4769
95.Ø	53.9	176.81	27.2	Ø.123	Ø.Ø85	-1Ø.1	6.9	Ø.Ø682	Ø.Ø675	Ø.4779
96.Ø	53.8	176.5Ø	26.7	Ø.127	Ø.Ø82	-1Ø.4	7.1	Ø.1549	Ø.1532	Ø.5257
97.Ø	53.7	176.19	2Ø.6	Ø.129	Ø.Ø78	-9.7	13.9	Ø.2Ø93	Ø.2Ø54	Ø.5469
98.Ø	53.6	175.83	1Ø.3	Ø.131	Ø.Ø75	-7.9	25.8	Ø.266Ø	Ø.2567	Ø.5574

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Table 45. Blade and Vane Element Performance for Rotor B/Stator B, Single-Stage Configuration, Peak Efficiency Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS COEF.	* LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.0	62.3	204.51	10.8	0.165	0.145	0.158	0.683	0.085	1.5	21.3
2.0	62.2	204.21	12.2	0.186	0.165	0.159	0.695	0.085	-0.0	18.4
3.0	62.1	203.90	13.2	0.202	0.181	0.160	0.703	0.084	-1.3	16.0
4.0	62.1	203.59	14.1	0.214	0.194	0.161	0.707	0.085	-2.4	14.0
5.0	62.0	203.28	15.[illegible]	0.219	0.200	0.163	0.699	0.087	-3.2	11.9
7.0	61.8	202.67	16.[illegible]	0.230	0.211	0.165	0.695	0.088	-3.9	10.3
10.0	61.5	201.75	17.2	0.209	0.194	0.166	0.658	0.094	-4.9	8.1
15.0	61.0	200.21	17.7	0.146	0.136	0.166	0.584	0.103	-6.0	6.4
20.0	60.6	198.68	17.6	0.094	0.088	0.165	0.521	0.110	-6.7	5.8
30.0	59.6	195.60	17.6	0.042	0.040	0.164	0.484	0.113	-7.2	5.7
50.0	57.7	189.46	17.5	0.010	0.009	0.159	0.489	0.109	-7.1	7.2
70.0	55.9	183.31	19.2	0.004	0.004	0.155	0.506	0.104	-7.0	7.9
80.0	54.9	180.24	21.2	0.048	0.046	0.152	0.528	0.100	-7.7	6.8
85.0	54.5	178.71	21.1	0.062	0.060	0.151	0.543	0.097	-8.1	7.5
90.0	54.0	177.17	22.1	0.070	0.068	0.149	0.568	0.093	-7.7	8.0
93.0	53.7	176.25	23.4	0.045	0.044	0.147	0.563	0.093	-6.3	8.7
95.0	53.5	175.63	25.7	0.034	0.033	0.145	0.572	0.092	-5.4	7.8
96.0	53.4	175.33	29.5	0.048	0.046	0.145	0.603	0.089	-4.5	5.2
97.0	53.3	175.02	31.4	0.085	0.083	0.144	0.646	0.085	-4.3	3.7
98.0	53.3	174.71	33.0	0.125	0.122	0.144	0.692	0.080	-4.2	2.5

TORQUE = 2192.59 IN.-LB.

*Loss Coefficients Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.0	62.3	204.51	36.2	0.113	0.066	0.4	12.5	0.1249	0.1223	0.6320
2.0	62.2	204.21	34.8	0.116	0.069	0.2	13.4	0.1335	0.1307	0.6242
3.0	62.1	203.90	34.9	0.119	0.071	0.2	13.1	0.1373	0.1345	0.6194
4.0	62.1	203.59	34.2	0.121	0.073	0.2	13.5	0.1370	0.1343	0.6113
5.0	62.0	203.28	33.2	0.123	0.075	-0.5	13.6	0.1330	0.1305	0.6013
7.0	61.8	202.67	32.6	0.124	0.076	-0.3	14.0	0.1252	0.1230	0.5912
10.0	61.5	201.75	31.3	0.124	0.079	-1.3	13.6	0.0990	0.0974	0.5674
15.0	61.0	200.21	30.4	0.123	0.080	-2.8	11.2	0.0729	0.0721	0.5472
20.0	60.6	198.68	29.1	0.122	0.081	-4.1	9.7	0.0430	0.0426	0.5268
30.0	59.6	195.60	29.4	0.122	0.082	-3.9	7.9	0.0395	0.0392	0.5165
50.0	57.7	189.46	30.0	0.121	0.083	-2.8	7.7	0.0409	0.0406	0.4964
70.0	55.9	183.31	29.9	0.122	0.083	-3.9	7.3	0.0477	0.0473	0.4968
80.0	54.9	180.24	30.2	0.125	0.082	-5.1	7.3	0.0479	0.0475	0.5262
85.0	54.5	178.71	30.5	0 .24	0.079	-5.7	7.0	0.0597	0.0592	0.5441
90.0	54.0	177.17	30.8	0.123	0.079	-6.3	6.9	0.0641	0.0636	0.5472
93.0	53.7	176.25	29.7	0.122	0.079	-7.8	6.7	0.0486	0.0481	0.5277
95.0	53.5	175.63	29.0	0.124	0.079	-8.7	6.6	0.0896	0.0887	0.5377
96.0	53.4	175.33	29.3	0.128	0.077	-8.2	6.7	0.1688	0.1670	0.5773
97.0	53.3	175.02	24.4	0.130	0.074	-6.9	12.9	0.2273	0.2234	0.6055
98.0	53.3	174.71	15.2	0.132	0.071	-5.5	23.4	0.2743	0.2557	0.6253

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Table 46. Blade and Vane Element Performance for Rotor B/Stator B, Single-Stage Configuration, Peak Pressure Rise and Near Stall Throttle.

ROTOR BLADE ELEMENT PERFORMANCE

IMMER (%)	WHEEL SPEED MPS	WHEEL SPEED FPS	REL. TURNING ANGLE DEG	LOSS COEF.*	LOSS PARA.	REL. MACH NO. IN	DIFF. FACT.	REL. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG
1.Ø	62.5	2Ø5.16	7.4	Ø.198	Ø.171	Ø.159	Ø.753	Ø.Ø77	2.Ø	25.3
2.Ø	62.4	2Ø4.85	6.3	Ø.24Ø	Ø.2Ø8	Ø.16Ø	Ø.793	Ø.Ø73	Ø.7	25.Ø
3.Ø	62.3	2Ø4.55	8.Ø	Ø.256	Ø.224	Ø.16Ø	Ø.8Ø3	Ø.Ø72	-Ø.3	22.2
4.Ø	62.3	2Ø4.24	9.4	Ø.269	Ø.238	Ø.161	Ø.8Ø8	Ø.Ø72	-1.3	19.8
5.Ø	62.2	2Ø3.93	1Ø.8	Ø.274	Ø.244	Ø.162	Ø.8Ø5	Ø.Ø73	-2.1	17.6
7.Ø	62.Ø	2Ø3.31	13.3	Ø.27Ø	Ø.244	Ø.163	Ø.783	Ø.Ø76	-2.8	14.2
1Ø.Ø	61.7	2Ø2.39	15.2	Ø.256	Ø.235	Ø.165	Ø.742	Ø.Ø82	-3.9	11.1
15.Ø	61.2	2ØØ.85	16.7	Ø.215	Ø.199	Ø.166	Ø.678	Ø.Ø91	-4.8	8.6
2Ø.Ø	6Ø.7	199.31	18.8	Ø.155	Ø.144	Ø.165	Ø.6Ø4	Ø.1ØØ	-4.8	6.6
3Ø.Ø	59.8	196.22	19.5	Ø.Ø5Ø	Ø.Ø47	Ø.163	Ø.516	Ø.11Ø	-5.4	5.5
5Ø.Ø	57.9	19Ø.Ø6	19.5	Ø.Ø25	Ø.Ø24	Ø.159	Ø.531	Ø.1Ø4	-5.4	7.Ø
7Ø.Ø	56.1	183.9Ø	2Ø.7	Ø.Ø17	Ø.Ø16	Ø.155	Ø.553	Ø.Ø99	-5.Ø	8.3
8Ø.Ø	55.1	18Ø.81	22.1	Ø.Ø63	Ø.Ø61	Ø.152	Ø.583	Ø.Ø94	-5.9	7.7
85.Ø	54.6	179.27	22.7	Ø.Ø67	Ø.Ø65	Ø.15Ø	Ø.593	Ø.Ø91	-6.Ø	8.Ø
9Ø.Ø	54.2	177.73	23.8	Ø.Ø6Ø	Ø.Ø58	Ø.148	Ø.6Ø3	Ø.Ø89	-5.8	8.2
93.Ø	53.9	176.81	25.6	Ø.Ø57	Ø.Ø55	Ø.146	Ø.618	Ø.Ø87	-4.3	8.7
95.Ø	53.7	176.19	28.9	Ø.Ø69	Ø.Ø67	Ø.145	Ø.651	Ø.Ø83	-3.4	6.7
96.Ø	53.6	175.88	31.8	Ø.1Ø4	Ø.1Ø2	Ø.144	Ø.699	Ø.Ø78	-3.3	4.1
97.Ø	53.5	175.57	34.4	Ø.152	Ø.148	Ø.144	Ø.752	Ø.Ø73	-2.4	2.6
98.Ø	53.4	175.27	35.1	Ø.196	Ø.192	Ø.144	Ø.8ØØ	Ø.Ø67	-2.8	1.8

TORQUE = 22ØØ.88 IN.-LB.

*Loss Coefficients Computed from Fixed Rake Data

STATOR VANE ELEMENT PERFORMANCE

IMMER %	WHEEL SPEED MPS	WHEEL SPEED FPS	ABS. TURNING ANGLE DEG	ABS. MACH NO. IN	ABS. MACH NO. OUT	INCID. ANGLE DEG	DEV. ANGLE DEG	LOSS COEF.	LOSS PARA.	DIFF. FACT.
1.Ø	62.5	2Ø5.16	42.2	Ø.115	Ø.Ø6Ø	5.3	11.4	Ø.1812	Ø.1777	Ø.7244
2.Ø	62.4	2Ø4.85	44.5	Ø.118	Ø.Ø63	7.5	11.Ø	Ø.1765	Ø.1733	Ø.71Ø6
3.Ø	62.3	2Ø4.55	44.4	Ø.121	Ø.Ø66	7.3	1Ø.8	Ø.1698	Ø.1669	Ø.6958
4.Ø	62.3	2Ø4.24	43.4	Ø.123	Ø.Ø69	7.2	11.4	Ø.161Ø	Ø.1583	Ø.68Ø2
5.Ø	62.2	2Ø3.93	42.7	Ø.124	Ø.Ø71	6.9	11.6	Ø.1497	Ø.1473	Ø.6667
7.Ø	62.Ø	2Ø3.31	4Ø.8	Ø.125	Ø.Ø73	5.8	11.9	Ø.1362	Ø.134Ø	Ø.652Ø
1Ø.Ø	61.7	2Ø2.39	38.7	Ø.124	Ø.Ø75	4.4	11.8	Ø.1ØØ5	Ø.Ø991	Ø.6269
15.Ø	61.2	2ØØ.85	38.6	Ø.123	Ø.Ø76	3.1	9.Ø	Ø.Ø587	Ø.Ø581	Ø.6Ø62
2Ø.Ø	6Ø.7	199.31	36.7	Ø.123	Ø.Ø78	Ø.7	7.Ø	Ø.Ø346	Ø.Ø343	Ø.5862
3Ø.Ø	59.8	196.22	33.2	Ø.123	Ø.Ø79	-2.2	5.8	Ø.Ø355	Ø.Ø353	Ø.564Ø
5Ø.Ø	57.9	19Ø.Ø6	32.6	Ø.121	Ø.Ø8Ø	-Ø.6	7.3	Ø.Ø428	Ø.Ø425	Ø.5429
7Ø.Ø	56.1	183.9Ø	32.8	Ø.121	Ø.Ø8Ø	-1.4	7.4	Ø.Ø5Ø2	Ø.Ø499	Ø.5334
8Ø.Ø	55.1	18Ø.81	33.2	Ø.123	Ø.Ø78	-2.1	7.3	Ø.Ø625	Ø.Ø62Ø	Ø.5677
85.Ø	54.6	179.27	32.8	Ø.123	Ø.Ø75	-3.1	7.4	Ø.Ø818	Ø.Ø811	Ø.5885
9Ø.Ø	54.2	177.73	31.6	Ø.123	Ø.Ø74	-4.4	7.9	Ø.Ø936	Ø.Ø927	Ø.5912
93.Ø	53.9	176.81	31.9	Ø.122	Ø.Ø75	-5.1	7.2	Ø.Ø825	Ø.Ø817	Ø.58Ø5
95.Ø	53.7	176.19	32.5	Ø.126	Ø.Ø75	-4.8	7.Ø	Ø.13Ø2	Ø.1289	Ø.5964
96.Ø	53.6	175.88	33.7	Ø.129	Ø.Ø72	-3.5	7.1	Ø.2ØØ6	Ø.1963	Ø.6479
97.Ø	53.5	175.57	34.2	Ø.132	Ø.Ø69	-1.3	3.2	Ø.2542	Ø.2517	Ø.6855
98.Ø	53.4	175.27	25.1	Ø.133	Ø.Ø66	-Ø.1	18.9	Ø.2853	Ø.2782	Ø.6966

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