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ROTOR REDESIGN FOR A HIGHLY LOADED 1800 FT/SEC TIP SPEED FAN

I. AERODYNAMIC AND MECHANICAL DESIGN REPORT

by

J. M. Norton, U. Tari and R. M. Weber

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SUMMARY

A highly loaded, high tip-speed fan rotor was designed under NASA Contract NAS3-20591 as a replacement for a marginally successful precompression (PC) airfoil design and a less successful multiple-circular-arc (MCA) airfoil design. A quasi three-dimensional (quasi 3-D) design system was used to design the rotor using Four-Part MCA airfoil sections. The redesigned rotor is the only change to the original stage design.

The rotor has a tip-speed of 548.6 m/sec (1800 ft/sec), axial inlet flow, a hub-tip ratio of 0.5, and an aspect ratio of 2.87 (based on average blade length and axially projected chord at the hub). Design corrected flow is 78.8 kg/sec (173.8 lbm/sec); rotor design pressure ratio is 2.34; and rotor design adiabatic efficiency is 0.868. Design adiabatic efficiency for the stage is 0.838 which is two percentage points higher than the measured PC efficiency.

The rotor aerodynamic design was performed by using a quasi 3-D analysis consisting of an axisymmetric intrablade flowfield calculation, which models the shroud as an isolated splitter, coupled with blade-to-blade calculations along conical surfaces. The procedure is iterative with output from one calculation providing input for the other until convergence of a number of physical parameters is achieved. The advantages of the quasi 3-D design approach include improved shroud modeling, improved modeling of radial flow distribution, and definition of chordwise and radial distributions of work, loss, and blockage. The definition of the intrablade flowfield and the resolution of total loss into calculated increments should enable the quasi 3-D design system to produce a more efficient fan blade.

The rotor design uses standard MCA sections from the hub to 20 percent span and Four-Part MCA sections from 34 percent span to the tip. The Four-Part MCA sections provide increased control over suction surface camber to provide better alignment of the blade with the free-stream flow and improved axial distribution of channel areas between airfoils.

The structural analysis, which considered stage vibratory characteristics, airfoil static stresses and fatigue life, airfoil flutter characteristics, and rig critical speeds, established that the design is satisfactory to evaluate aerodynamic performance in a research test facility.

INTRODUCTION

Advanced aircraft powerplants require compact lightweight fans that are efficient and operate stably over a wide range of operating conditions. Increased wheel speed and loadings result in increased stage pressure ratio. However, in order to achieve high levels of pressure ratio per stage while maintaining acceptable levels of efficiency, careful consideration must be given to the blade element design in order to avoid high aerodynamic losses.

A 548.6 m/sec (1800 ft/sec) tip-speed fan program was undertaken in an attempt to significantly increase stage pressure ratio through the use of higher rotor speed while maintaining useful levels of efficiency and stall margin. Two previous rotors had been designed for the same conditions. The original rotor was designed with a precompression (PC) blade (Reference 1). This design achieved a rotor adiabatic efficiency of 84.8 percent (Reference 2). A second rotor, designed with multiple-circular-arc (MCA) sections (Reference 3), exhibited high partspan shroud losses and achieved only 80 percent efficiency.

In an effort to better understand and correct for design deficiencies in the previous PC and MCA rotor designs, a newly developed quasi 3-D design method was employed in the present redesign. Ths quasi 3-D method involves an iterative process incorporating "time-marching" procedures for calculating mixed subsonic and supersonic flows (Reference 4) and is a valuable tool for analysis of flow between adjacent airfoils (blade-to-blade) and for the optimization of airfoil shapes. These calculations, performed for individual streamtubes, must be consistent with radial equilibrium. Thus the quasi 3-D method involves iterations to link the blade-to-blade flowfield calculations (time-marching) with radial equilibrium calculated by the more conventional axisymmetric calculations which include intrablade stations and a partspan shroud modeled as an isolated solid body in a split flow. Full span radial equilibrium was satisfied both upstream and downstream of the shroud, but a pressure discontinuity was allowed across the shroud. A priori knowledge of the flow split around the shroud is required.

The quasi 3-D method was checked by applying it to the two previous rotor designs. From an analysis of data obtained for the PC rotor, quasi 3-D results at the tip were found to agree reasonably well with data taken from an array of wall static taps over the rotor blade tips. Quasi 3-D analysis of the MCA design predicted the MCA rotor losses to be higher than design estimates and worse than those of the PC rotor. The higher losses were predicted in the region of the partspan shroud where measured losses were much higher for the MCA rotor. On the basis of this comparison, it is believed that the quasi 3-D system can identify the effects of design changes on performance.

This report describes the detailed aerodynamic and mechanical design of the redesigned 548.6 m/sec (1800 ft/sec) tip speed rotor.

AERODYNAMIC DESIGN

The 548.6 m/sec (1800 ft/sec) tip-speed rotor was redesigned to improve efficiency. Design pressure ratio and flow are the same as for the original design. The predicted performance parameters for the redesigned rotor and the stage are presented in Table I. All symbols used in this report are defined in Appendix A.

TABLE I

DESIGN PARAMETERS

Corrected Speed, rpm	12,464
Rotor Tip Speed, m/sec (ft/sec)	548.6 (1800)
Corrected Flow, kg/sec (lbm/sec)	78.8 (173.8)
Specific Flow, kg/m^2-sec (lbm/ft^2-sec)	188.9 (38.7)
Rotor Pressure Ratio	2.34
Stage Pressure Ratio	2.280
Rotor Adiabatic Efficiency	0.868
Stage Adiabatic Efficiency	0.838

The redesign was made to be compatible with the existing flowpath and stator. The basic stage configuration shown in Figure 1 has a hub-tip ratio of 0.5 at the rotor inlet, a rotor aspect ratio of 2.87, a rotor tip solidity of 1.635, a stator aspect ratio of 2.22, and no inlet guide vanes. Within these constraints, optimum performance is sought through the use of a quasi 3-D design system and Four-Part MCA airfoils. Each airfoil section is optimized to reduce the increment of calculated loss attributed to shock losses. The partspan shroud is recontoured to match the calculated intrablade flow field.

PRELIMINARY ANALYSES

Checkout of Rotor With Precompression Blading

The quasi 3-D method (described in Appendix B) was used to analyze rotor blade element data measured during testing of the PC design. A peak efficiency point near the design operating line at design speed (point 908-10-05 reported in Reference 2) was chosen for analysis. The iterative procedure utilized in the quasi 3-D method was continued until reasonably good agreement was obtained between the axisymmetric and blade-to-blade solutions.

Recovery predicted by the system was slightly lower than the measured recovery near the hub and higher than the measured recovery near the tip. Figure 2 shows a spanwise profile of recovery for each calculated increment and compares the resulting overall predicted recovery profile to the measured profile. One checkout goal was to determine the amount of residual recovery (actual recovery divided by calculated recovery) to be expected in the redesign of the rotor. The level and radial distribution of residual recovery determined from this checkout was directly applied in the redesign, since this recovery is presumed to be due to physical processes not yet properly modeled, such as shock-boundary layer interaction and the radial transport of boundary layers.

Axial distributions of static pressure calculated by both the blade-to-blade program and the axisymmetric program are compared in Figure 3 at three radial locations and show good convergence. In addition, the calculated static pressure distribution at the 95 percent span location shows good agreement with the measured outer wall static pressures shown. Figure 4 shows that the individual intrablade solutions yield radially continous shock waves. Comparisons of radial profiles of inlet relative flow angle (Figure 5) show good agreement between the axisymmetric and blade-to-blade solutions.

The flow split around the shroud was adjusted to keep the splitting streamline smooth and also to balance the velocities above and below the shroud. Figure 6 shows a meridional view of the splitting streamline and the shroud meanline for the final pass of the checkout, and Figure 7 shows the resulting meridional velocity distribution. These figures indicate a good solution of the intrablade flowfield around the shroud.

Calculations using both the conventional, non intrablade, and quasi 3-D methods showed significant differences in radial flow distributions, especially within the rotor, with resulting large changes in calculated choke margins for the PC rotor blading. Calculated choke margins predicted by the two methods are compared in Figure 8. The conventional calculation results in a minimum A/A* of less than 1.0 for the lower 40 percent of span from the hub while the quasi 3-D calculation yields minimum A/A* values greater than 1.0 everywhere except locally at the endwalls where viscous endwall boundary layer effects, modeled as a fullspan blockage in both calculations, would afford relief. In addition, the conventional calculation shows an increase in minimum A/A* in the vicinity of the shroud at 65 percent span while the quasi 3-D calculation shows a decrease in minimum A/A* due to the local flow acceleration around the shroud. These results indicate the quasi 3-D calculation models the actual flowfield better than the conventional, non-intrablade axisymmetric calculation.

Checkout of Rotor With MCA Blading

A point on the operating line at design speed was chosen for the checkout analysis of the MCA blading. Complete convergence was not obtained. One major difficulty was that the flow for this data point was six percent below the design value and the blade-to-blade calculations, which satisfy unique incidence, gave inlet flow angles that did not agree with test values. The use of blockages equivalent to residual recovery reduced the angle disagreement, but did not produce convergence. Despite this problem, the resulting predicted pressure recovery profile is in fair agreement with the measured profile, as shown in Figure 9. An important result is that the analysis predicted lower recovery for the MCA rotor than for the PC rotor over practically the entire blade span and particularly in the region of 45 to about 80 percent span. This is shown in Figure 10 which compares the predicted and measured recovery for both the PC and MCA rotors. The measured recovery for the MCA rotor was in fact lower over the entire blade span with the greatest decrease in measured recovery occurring in the region of about 50 to 80 percent span.

An effort was also made to predict the MCA rotor performance at design flow where the incidence problem should be minimized. Design flow at design speed corresponded to the wide open throttle test point and thus represented a pressure ratio lower than design (Rotor Pr = 1.99 vs. 2.34). This prediction used the radial distribution of residual recovery obtained in the checkout of the PC rotor. This was an attempt to predict performance with no influence of test data from the rotor whose performance was being predicted. The iteration did not converge, but reasonable agreement with measured recovery was obtained. Profiles of predicted recovery increments and the resulting total recovery from this analysis are shown in Figure 11. Measured recovery for the open-throttle data point at design speed is shown for comparison. Qualitative agreement is very good, but measured recovery is below the predicted recovery between the hub and 60 percent span.

The degree of disagreement between the blade-to-blade and axisymmetric calculations for the MCA design is perhaps best illustrated by the difference in relative inlet angles at the blade tip, as shown in Figure 12. The MCA design cannot satisfy both the unique incidence solution of the blade-to-blade calculation and the radial equilibrium solution of the axisymmetric calculation.

The quasi 3-D method, therefore, does not accurately predict the intrablade flow patterns of a poor design, which is not unexpected. The important result is that the quasi 3-D method can distinquish between designs by predicting a lower recovery for a poor design.

The quasi 3-D analyses of the PC and MCA rotors leads to the following conclusions about the method:

1) The quasi 3-D method is capable of modeling the flowfield in a high tip speed fan operating at near-design conditions.

2) It can identify a poor design.

3) It models the intrablade flow distribution better than the conventional method.

FINAL DESIGN

Rotor Design

The rotor was designed to produce a total pressure ratio of 2.34:1 with an adiabatic efficiency of 0.868 at a tip speed of 548.6 m/sec (1800 ft/sec). The rotor incorporates 38 blades with an aspect ratio of 2.87 (based on average blade length and axially projected chord at the hub).

The radial distribution of losses for the redesigned rotor is shown in Figure 13 as total pressure recovery versus span. The design rotor exit total pressure profile, shown in Figure 14, is similar to that measured for the original rotor (Reference 2).The resulting spanwise efficiency profile is shown in Figure 15. The measured values of efficiency for the original PC design are also shown for comparison.

The radial profiles of rotor inlet and exit relative Mach number are shown in Figure 16. The inlet relative Mach number is subsonic from the hub to 7 percent span, is 1.55 at the shroud splitting streamline, and reaches a maximum of 1.76 at the tip. Rotor exit relative Mach number is subsonic throughout the span. The radial distributions of rotor inlet and exit relative air angles are presented in Figure 17.

Design velocity vector data along streamlines at the rotor leading and trailing edges are tabulated in Appendix C.

High solidity is used to control loadings, as in the previous PC and MCA designs. The solidity for the redesigned rotor, shown in Figure 18, is similar to that of the previous designs.

Analysis of the PC and MCA test data indicates that the blade tips initiate instabilities that limit the flow range (surge margin) at design speed. Based on the average of the rotor loading characteristics of the previous two designs, the redesigned blade is estimated to provide about seven percent surge margin at the design point. The rotor blade element loadings (diffusion factors) are shown in Figure 19.

Compatibility of the rotor aerodynamics with the existing stator can be illustrated by the data presented in Figure 20. Predicted stator incidence angles from rotor redesign calculations (arrows) are shown on plots of measured stator loss versus incidence angle (data from reference 2). The plots show that the predicted incidence angles fall in the low loss operating range at 10, 50, and 90 percent of span with the stator at its nominal stagger angle. Stator inlet absolute Mach numbers for both the redesigned rotor and the original PC rotor are in very close agreement as shown in Figure 21, further substantiating that the existing stator is satisfactory.

The rotor blade was designed using the quasi 3-D method described in Appendix B. The final rotor design is the result of matching an intrablade axisymmetric flow calculation to the time-marching blade-to-blade calculation. Blade design was optimized by adjusting airfoil section geometry to minimize the shock losses calculated in the blade-to-blade calculations. This optimization was affected by mechanical design constraints: structural analyses of preliminary designs were used to indicate mechanical design weaknesses and to guide subsequent design iterations.

The calculation of recovery, as amplified in Appendix B, is as follows. The main increment of recovery, shock recovery, is calculated in the final blade-to-blade solutions along conical design sections. The recovery due to the shroud is based on experience and is essentially the same as the shroud recovery measured in the test of the original (PC) blade. Tip recovery is calculated using the tip clearance model of Reference 6 and a tip clearance of 0.762 mm (0.030 in.). Blade surface boundary layers are calculated based on velocities from the blade-to-blade solutions using the boundary layer program described in Reference 5. The results are mixed to obtain the boundary layer recovery shown in Figure 13. The final total recovery profile is calculated using the sum of the above increments and the residual recovery increment determined in the checkout of the original (PC) blade, presumed to be losses due to physical processes not yet properly modeled.

In the axisymmetric calculations, blockages used to account for end-wall boundary layers (shown in Table II) are based on data from tests of the original rotor (Reference 2), and are similar to those used in the MCA redesign (Reference 3). Additional blockages are used in the quasi 3-D intrablade design to account for the blade, the boundary layer, non-uniform gapwise flow, and all non-shock recoveries.

TABLE II

END WALL BLOCKAGES IN AXISYMMETRIC CALCULATION

	PERCENT FLOW AREA		
Axial Location	PC Blade	MCA Blade	Redesign
Rotor Inlet	2.0	2.0	2.6
Rotor Exit	3.0	2.5	3.3
Stator Inlet	3.0	2.5	3.3
Stator Exit	4.0	4.0	4.0

A comparison of static pressure distributions at three radial locations (Figure 22) and inlet relative flow angles (Figure 23) calculated on the final iteration shows that the axisymmetric calculation agrees well with the blade-to-blade solution indicating satisfactory convergence. The quasi 3-D iteration resulted in radially continuous shock waves. The chordwise locations of shock waves calculated by the blade-to-blade program for individual airfoil sections give smooth shock surfaces radially (Figure 24). The spanwise distribution of meridional velocity at the rotor inlet as calculated by the axisymmetric calculation is smooth and is shown in Figure 25.

The rotor blade consists of MCA sections from the hub to 20 percent span and Four-Part MCA sections from 34 percent span to the tip with the region from 20 percent to 34 percent span providing a transition area to permit radially smooth airfoil shapes. The Four-Part MCA sections are used in regions of higher inlet Mach number because these sections permit better control of passage area distribution and provide greater potential for reducing shock losses. All airfoil sections were designed on conical surfaces approximating stream surfaces of revolution.

Standard MCA airfoil sections are defined by total chord, front chord, maximum thickness and its chordwise location, total camber, front camber, and leading and trailing edge radii, as shown in Figure 26. Both pressure and suction surfaces, as well as the mean camber line, are constructed with circular arcs. The Four-Part MCA airfoil sections used in the present redesign are constructed by first defining the suction surface and then adding a thickness distribution to define the pressure surface coordinates. The suction surface is made up of four curve segments which, in conjunction with the thickness distribution, allows simultaneous satisfaction of incidence, turning, and choke margin criteria while providing the freedom to design the passage for minimum strength shocks. Figure 27 illustrates the construction of a Four-Part MCA airfoil.

The radial distribution of total chord on conical surfaces for the redesigned airfoil is similar to that of the previous two designs, as shown in Figure 28. The changes in the distribution were made in order to keep the airfoil on the existing platform and to maintain necessary blade resonance margins. The front chord of each section was initially set equal to the distance from the leading edge to a point on the suction surface where a normal shock at the channel entrance would impinge, but was allowed to vary during airfoil section optimization. The front chord distribution is compared in Figure 29 with the previous PC and MCA designs.

In general, airfoil thickness is set at the minimum value compatible with mechanical design criteria. Chordwise locations of maximum thickness are varied in the optimization process, but must also meet mechanical design and blade smoothness constraints. Figure 30 shows the section maximum thickness-to-chord ratio, and Figure 31 shows the location as a function of percent span.

Stagger and camber of front segments control both the incidence angle to the relative inlet flow and the throat area in the blade passage. The metal angle at the trailing edge is adjusted to give the desired exit relative flow angle by changing rear camber.

Rotor suction surface incidence angle for the subsonic sections is set at the leading edge and is based on minimum loss data from previous experience. In the supersonic portion of conventional MCA sections, the incidence angle is set at the a' point, which is approximately halfway between the leading edge and the origin of the first captured Mach line on the suction surface. For the Four-Part MCA sections the entire surface from the leading edge to the Mach line origin is set at the desired incidence angle. The supersonic sections are set at +1.25 degrees of incidence based on previous experience. Both leading edge suction surface incidence angle and incidence angle at the a' point are plotted as a function of span in Figure 32.

Deviation angles were calculated using Carter's Rule with modifications based on experience and are shown by Figure 33. Rotor inlet and exit metal angles on conical sections are presented in Figure 34 and 35, respectively.

The ratio of minimum blade channel flow area to critical area $(A/A^*)_{min.}$ was set at 1.02 over most of the span (Figure 36) in order to prevent choking, and was decreased locally at the endwalls to account for endwall effects. The actual area (A) is calculated from the channel width and the streamtube annulus height ratio. The critical area (A^*) is determined from the inlet relative Mach number with corrections for shock loss (based on an assumed normal shock at the first covered section), streamline slope, and a distribution of profile loss (total loss minus shock loss).

Appendix D contains the blade airfoil geometry on aerodynamic conical sections. For manufacturing purposes, the sections are also defined on planes normal to a radial line which passes through the center of gravity of the blade hub conical airfoil section. Coordinates for these sections are tabulated in Appendix E, and reflect a leading edge overcamber in the tip region, compensating for the predicted mechanical uncambering.

Partspan Shroud

The objective of the aerodynamic design of the partspan shroud was to align the shroud with the adjacent streamlines to minimize the meridional velocity acceleration and subsequent diffusion along the shroud and to eliminate any radial lift force in either direction. Two operations were required to reduce lift and its associated drag: 1) a shroud bypass ratio was found that minimized radial discontinuities in meridional velocities, and 2) the shape of the shroud itself was altered to reduce shroud incidence and deviation angles as well as minimize meridional velocity diffusion on the shroud surfaces. The final shroud contour is shown in Figure 37. The axial distribution of the axisymmetric meridional velocity around the shroud is shown in Figure 38. Figure 39 depicts the details of the shroud geometry.

The shroud was positioned in a rearward location on the blade (like the PC) rather than at the center of the blade (like the MCA) in order to minimize the incident flow velocity on the shroud and position the shroud in the region of maximum blade to blade distance normal to the flow. The lower shroud loss of the PC blade relative to the MCA blade shows the validity of this concept.

The previous MCA rotor (Reference 3) was designed using an increase in (A/A*)min. in the region of the partspan shroud. This conventional method of relieving the local choking problem increases the A/A* through the entire blade passage, especially at the leading edge. The quasi 3-D design method, however, accounts for the flow area occupied by the shroud as an integral part of the axisymmetric intrablade calculation, and the shroud blockage is reflected by the streamtube height ratios determined by the axisymmetric calculation and is used in the blade-to-blade calculation. Streamtube height ratios calculated using the quasi 3-D method are compared with those calculated for a blade designed using the non-intrablade method with the same overall work and loss levels in Figure 40, showing the effect of the shroud on the intrablade flowfield. Since the blade shape of a four-part MCA depends on the blade passage area distribution and A/A*min, and A/A*min is a function of streamtube height, the quasi 3-D design method produces a blade which intrinsically accounts for the presence of a shroud, without the arbitrary opening involved in a conventional shroud blade design. The quasi 3-D method clearly models the shroud effects better than the conventional method and results in a blade tailored to the shroud.

STRUCTURAL AND VIBRATION ANALYSIS

Mechanical design of the redesigned rotor blade was guided by experience gained from the PC and MCA blade tests in which the respective blade designs demonstrated good mechanical and aeroelastic behavior. The structural analysis included investigation of stage vibratory characteristics, airfoil static stresses and fatigue life, airfoil flutter characteristics, and the rig critical speeds. Rig critical speed analysis was performed to evaluate the effect of testing the present fan in the X-204 stand instead of the previously used X-202 stand.

Rotor Blade, Blade Attachment and Disk Stress

A NASTRAN finite element stress analysis was conducted at 105 percent design speed and 366°K (200°F) to determine the maximum static stresses in the airfoil. The maximum steady stress location was determined to be below the partspan shroud, as indicated in Table III. The low cycle fatigue (LCF) life for this location is predicted to be 1400 cycles (Ti-8Al-1Mo-1V). The next most limiting steady stress on the blade occurs at the airfoil root fillet. The calculated limiting fatigue life at this location is 1800 cycles. These stress levels and the resultant LCF lives are comparable with stresses and LCF lives calculated for the PC and MCA blades. No static stress limitation exists for the intended rig test program. The maximum steady stress locations are shown schematically in Figure 41.

TABLE III

SUMMARY OF AIRFOIL MAXIMUM LOCAL CONCENTRATED STRESS FOR THE MCA, PC AND REDESIGNED ROTOR BLADE

	MCA	PC	Redesign
Maximum Rotational Speed	13,115 rpm	13,115 rpm	13,115 rpm
Maximum Nominal Local Stress at Airfoil Root	70.3×10^7 N/m² 102×10^3 lbf/in.²)	104.8×10^7 N/m² (152×10^3 lbf/in.²)	92.39×10^7 N/m² (134×10^3 lbf/in.²)
Maximum Concentrated Local Stress at Airfoil Root	97.2×10^7 N/m² (141×10^3 lbf/in.²)	133.1×10^7 N/m² (193×10^3 lbf/in.²)	110.4×10^7 N/m² 160×10^3 lbf/in.²)
LCF Life at Airfoil Root	2,700 cycles	600 cycles*	1,800 cycles*
Maximum Nominal Local Stress Below the Shroud	100.0×10^7 N/m² (145×10^3 lbf/in.²)	60.7×10^7 N/m² (88×10^3 lbf/in.²)	93.8×10^7 N/m² (136×10^3 lbf/in.²)
Maximum Concentrated Local Stress Below the Shroud	110.4×10^7 N/m² (160×10^3 lbf/in.²)	65.2×10^7 N/m² (95×10^3 lbf/in.²)	115.8×10^7 N/m² (168×10^3 lbf/in.²)
LCF Life for Airfoil Below the Shroud	1,800 cycles	10,000 cycles	1,400 cycles*

*The calculated LCF life for the redesigned rotor blades is found to be higher than the successfully tested PC blades of 600 cycles.

The blade attachment and disk design are unchanged from the previous MCA and PC configurations. The airfoil will be positioned on the attachment so as to maintain the same root balance conditions as the prior blades. Blade pull has been reduced by four percent from the PC blade, and thus the blade root and disk stresses are lower than the levels of the PC design. The rotor blade attachment and disk stresses are therefore considered to be acceptable.

Rotor Blade Resonances

The resonance diagram for the redesigned blade is shown in Figure 42. Frequency predictions for the coupled blade-disk spanwise modes of vibration (Modes 1 and 2 in Figure 42) were made using a well substantiated rotor-frequency analysis program. Chordwise bending modes (Modes 3 through 5) were obtained using the NASTRAN finite element program. Avoiding low order, first mode resonances (1E, 2E, and 3E) at high speed was of prime concern in the resonance tuning of the airfoil. Also of concern was the possibility for inlet strut excited resonant conditions, 10E, at continuous operation. Results of the calculations, shown in Figure 41, indicate a 6.1 percent 3E, 1st mode frequency margin at 105 percent of design speed and a 4E, first mode resonance condition predicted at 9200 rpm low in the operation range. Adequate second mode 6E frequency margin is also indicated (6.4 percent at 105 percent of design speed).

Previous tests of the MCA and PC blade configurations have shown significant dynamic response only in the first and second modes. For the redesigned blade, the maximum vibratory stress locations were determined from a coupled disk/blade vibration analysis. For 4E 1st bending mode and 7E 2nd bending mode resonances, the points of maximum vibration stress were located above the shroud at 60 percent chord and at the trailing edge, respectively (Figure 41). The steady stresses at these locations and predicted resonance speeds were determined from the NASTRAN analysis and these were used to determine the allowable vibratory stress by use of the modified Goodman diagram shown in Figure 42. The allowable vibratory stress is $\pm 1.17 \times 10^8$ N/m^2 (17000 lbf/in.^{2}) for both modes of vibration.

Based on a correlation of measured and predicted chordwise bending frequencies, tenth order vibratory resonances for tip chordwise bending Modes 3 and 4 are expected to occur high in the running range for the redesigned blade. These resonances are a potential concern since they can be excited by the inlet strut passing at high flow conditions where the viscous wakes from the ten inlet struts have the greatest strength; however, the previous PC and MCA blades operated successfully, and dynamic strain gage data taken during prior testing (with identical inlet) revealed no significant tenth order resonance stress.

The allowable vibratory stress for the 10E tip resonance has been determined to be $\pm 1.45 \times 10^8$ N/m^2 ($\pm$21000 lbf/in^2), Figure 43.

Blade frequencies and nodal stress distributions will be determined before test by means of holographic techniques used to position strain gages. These gages will be monitored during shakedown running of the rig. This strain gage information will be used to avoid critical resonance speeds, if any, during aerodynamic performance testing.

Rotor Blade Flutter

The supersonic unstalled flutter results are presented in Table IV. These results show that the redesigned PC blade will not flutter over the intended operating range.

Rig Critical Speed

The two previous 1800 fps fan rigs operated successfully in X-202 stand to 13,115 rpm. The rig in the X-202 stand had a high strain energy rotor pitch mode predicted to occur at 11,800 rpm and a fan rig second bending mode predicted to occur at 16,500 rpm.

Installation of rig in X-204 stand is predicted to lower the pitch mode to 11,300 rpm and the second bending mode to 15,153 rpm (15 percent speed margin over maximum intended operating speed). The rotor strain energy content and distribution remains essentially unchanged as the result of the stand change, and damper effectiveness at the 1st bearing will be unaffected. Consequently, no linear vibration problems are anticipated in X-204 stand rig testing.

TABLE IV

SUPERSONIC UNSTALLED FLUTTER PARAMETERS

A. Original PC Blade at Design Speed (N = 12,464 rpm)

	Mode	Min. Log Decrement	Excitation Order	Allowable Log Decrement
Forward Wave	1	0.030	2E	0
	2	0.0056	3E	0.002
	3	0.007	2E	0
Backward Wave	1	0.0025	2E	0
	2	0.0038	2E	0.002
	3	0.004	7E	0

B. Redesigned Blade at 105 percent Design Speed (N = 13,087 rpm)

	Mode	Min. Log Decrement	Excitation Order	Allowable Log Decrement
Forward Wave	1	0.024	2E	0
	2	0.0034	3E	0.002
	3	0.002	2E	0
Backward Wave	1	0.005	2E	0
	2	0.0029	2E	0.002
	3	0.0013	2E	0

Blade Uncamber

Analysis of the redesigned blade predicts an uncamber of the airfoil leading edge of 2.3° at 100 percent span which diminishes to less than one quarter of a degree at the shroud location. A comparison was made to similar predictions for the TS22 fan blade where local airfoil untwist was determined by measuring the deviations of a light beam reflected from small mirrors installed on the rotating airfoil (NASA Contract NAS3-20606). Uncamber predictions were found to agree very well with TS22 data, thus verifying the prediction technique employed for the present redesigned blade.

Partspan Shroud

The size, geometry, and position of the partspan shroud were established by aerodynamic and structural requirements. The spanwise location was optimized to achieve maximum first mode vibration margin. The thickness and cross sectional shape were chosen to be consistent with the successful experience of previous designs. Shroud design parameters are summarized in Table V. These values fall within the range of previous successful experience.

TABLE V

Partspan Shroud Parameters

(105 percent of Design Speed)

Spanwise Location	66.4 percent span from hub
Contact Angle	65°
Bearing Stress	5.2×10^7 N/m^2 (7600 lbf/in.^{2})
Bending Stress	3.0×10^8 N/m^2 (43300 lbf/in.^{2})
Thickness	0.00457m (0.180 in.)

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3. Halle, J. E. and Ruschak, J. T. :"Redesigned Rotor for a Highly Loaded, 1800 ft/sec Tip Speed Compressor Fan Stage-I. Aerodynamic and Mechanical Design", NASA CR-134835, PWA-5266, 1975.

4. McDonald, P. W. :"The Computation of Transonic Flow Through Two Dimensional Gas Turbine Cascades", ASME Paper No. 71-GT-89, 1971.

5. McNally, W. D. "Fortran Program for Calculating Compressible Laminar and Turbulent Boundary Layers in Arbitrary Pressures", NASA TN D-5681, 1970.

6. Lakshminarayana, B. "Methods of Predicting the Tip Clearance Effects in Axial Flow Machinery", ASME Paper No. 69-Wa/FE-26, 1969.

	DIAMETER (meters)		AXIAL LOCATION (meters)		DIAMETER (inches)		AXIAL LOCATION (inches)	
	HUB	TIP	HUB	TIP	HUB	TIP	HUB	TIP
ROTOR INLET	0.4191	0.8402	0.0	0.0090	16.500	33.079	0.0	0.355
ROTOR EXIT	0.5109	0.8139	0.0625	0.0474	20.114	32.042	2.460	1.865
STATOR INLET	0.5274	0.7949	0.0749	0.0749	20.820	31.28	3.000	3.000
STATOR EXIT	0.5627	0.7701	0.5627	0.1334	22.150	30.360	5.100	5.100

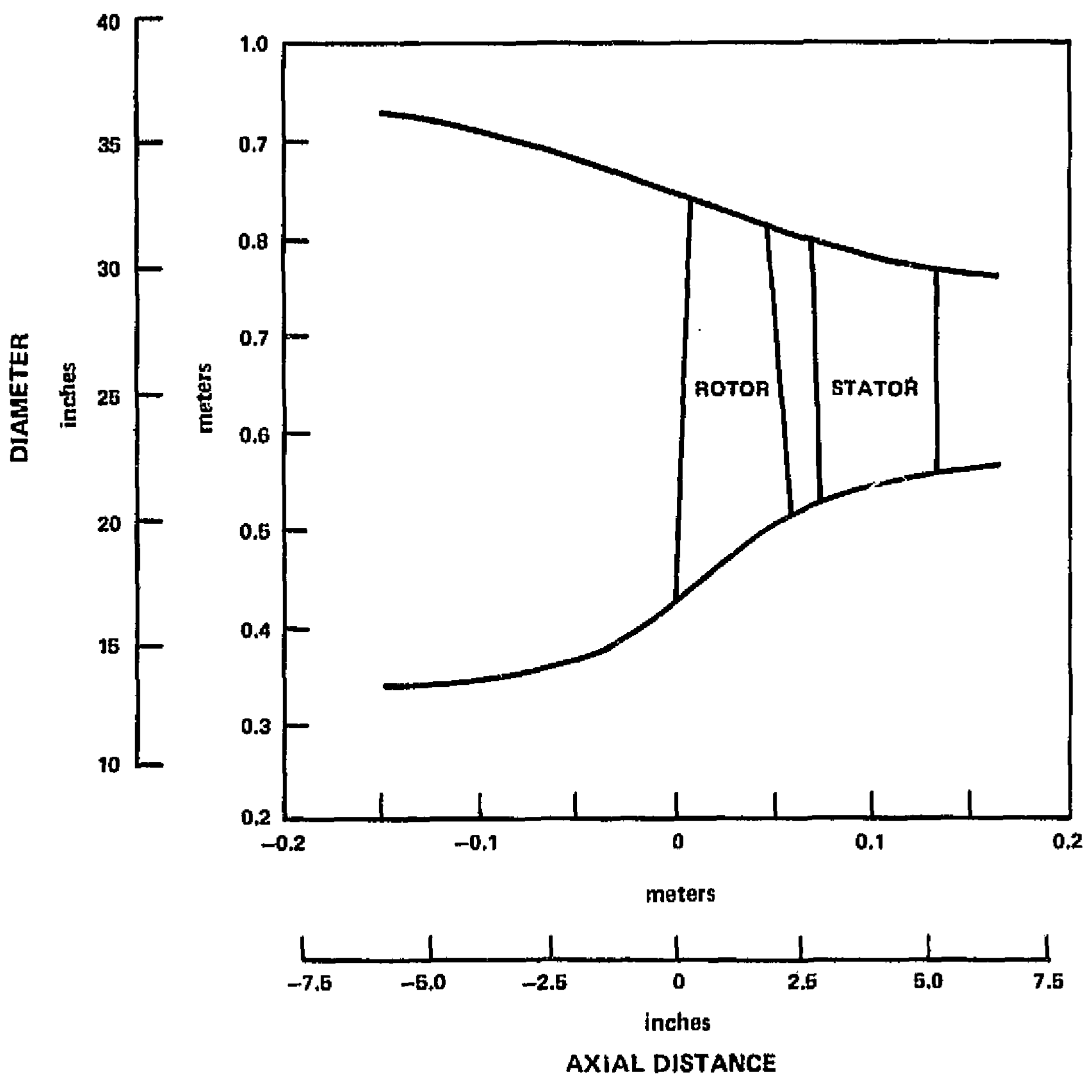


Figure 1 Fan Flowpath With Redesigned Rotor

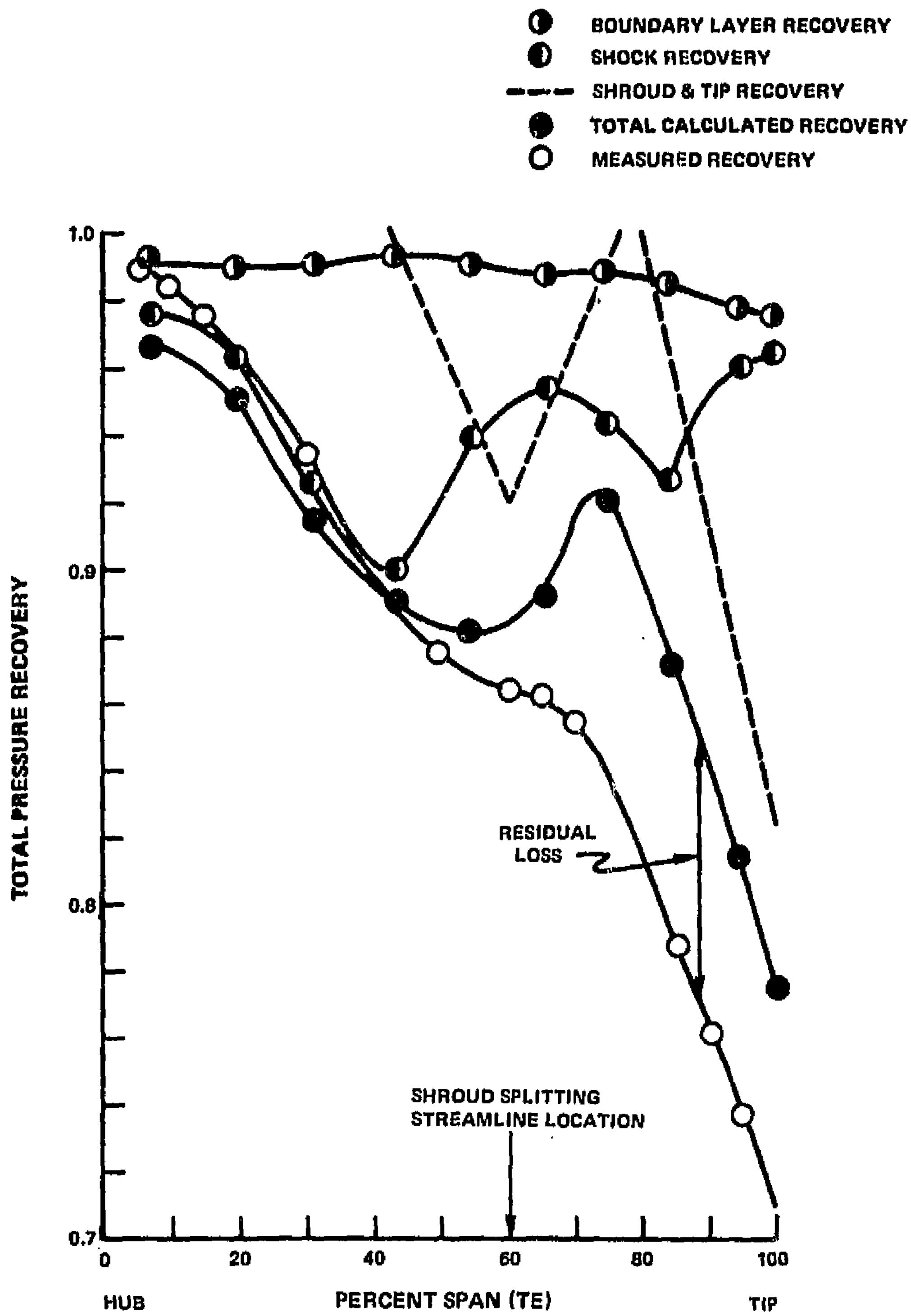


Figure 2 Radial Profiles of Calculated Recovery Increments and Resulting Total Recovery, Compared With Measured Recovery for Precompression Rotor

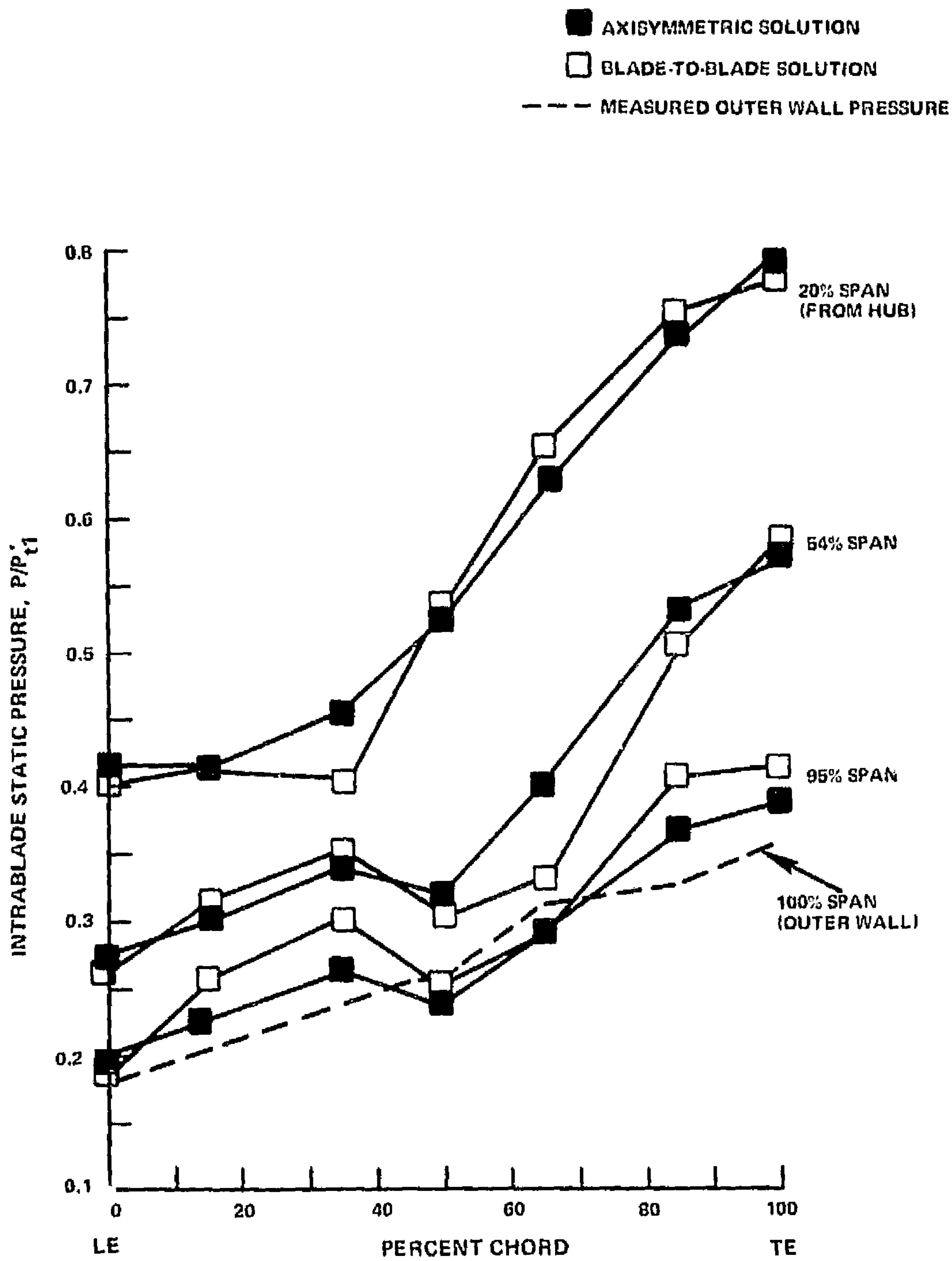


Figure 3 Calculated Intrablade Axial Distributions of Static Pressure for Precompression Rotor Analysis (Including Comparison With Measured Outer Wall Static Pressures)

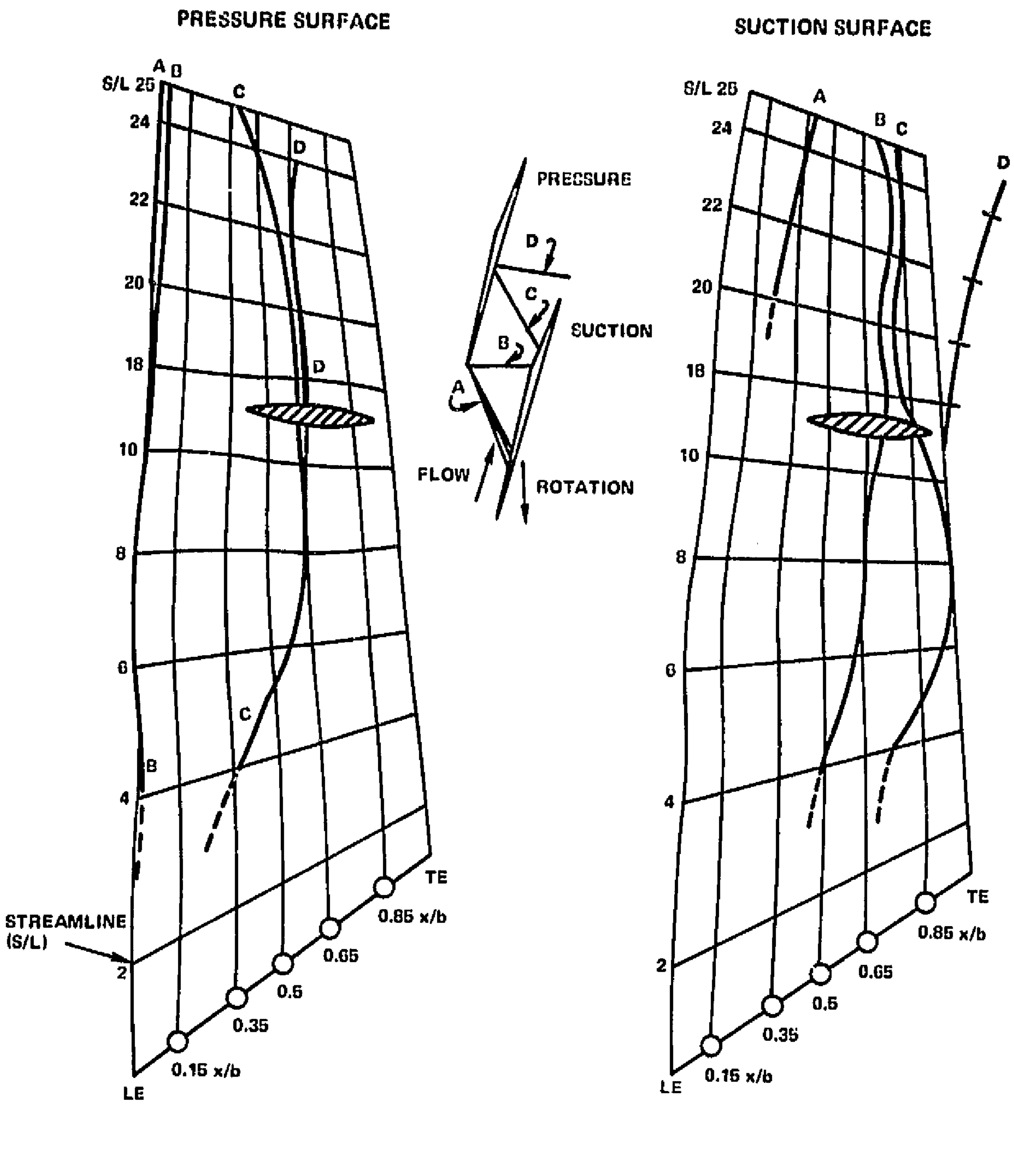


Figure 4 Calculated Loci of Shock Impingement Points On Precompression Blade Surfaces

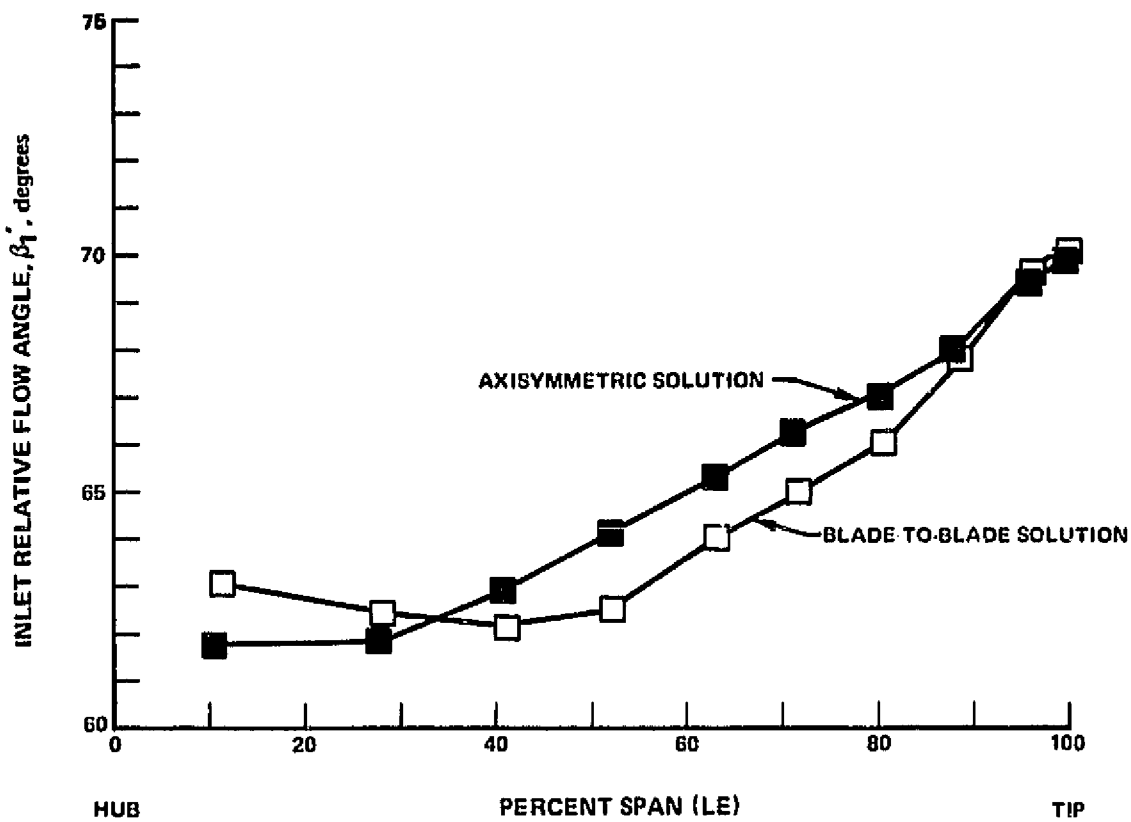


Figure 5 Radial Profiles of Inlet Relative Flow Angles for Precompression Rotor Blading, Comparing Blade-to-Blade Solutions With Axisymmetric Solution

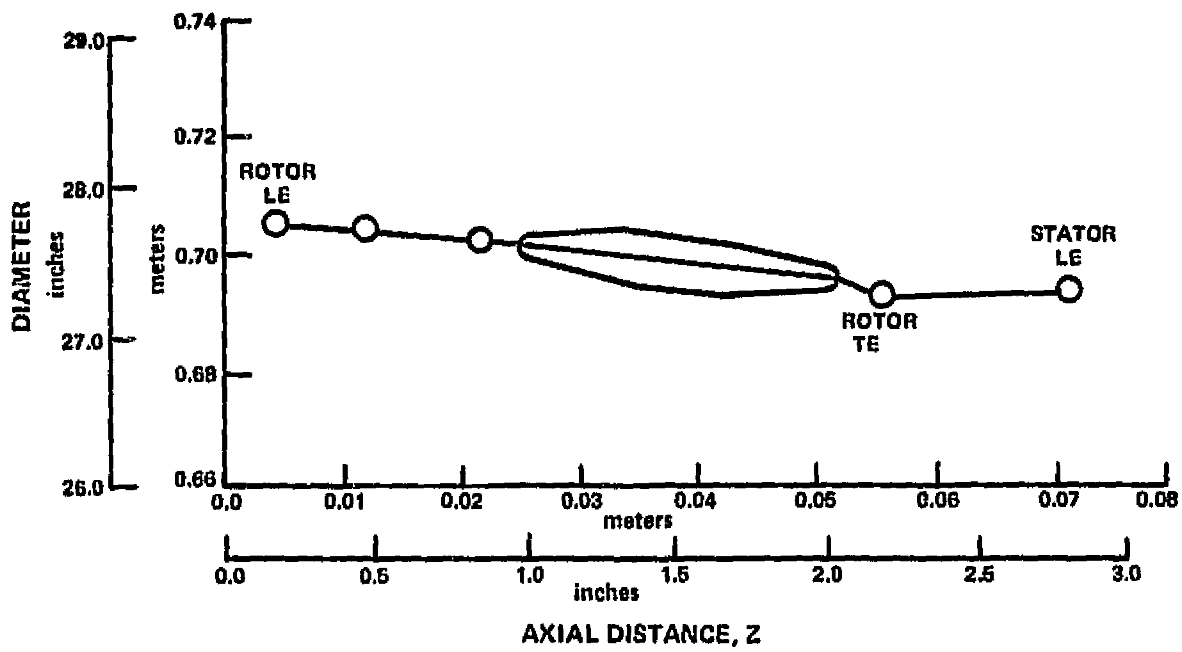


Figure 6 Partspan Shroud Splitting Streamline for Precompression Rotor Analysis

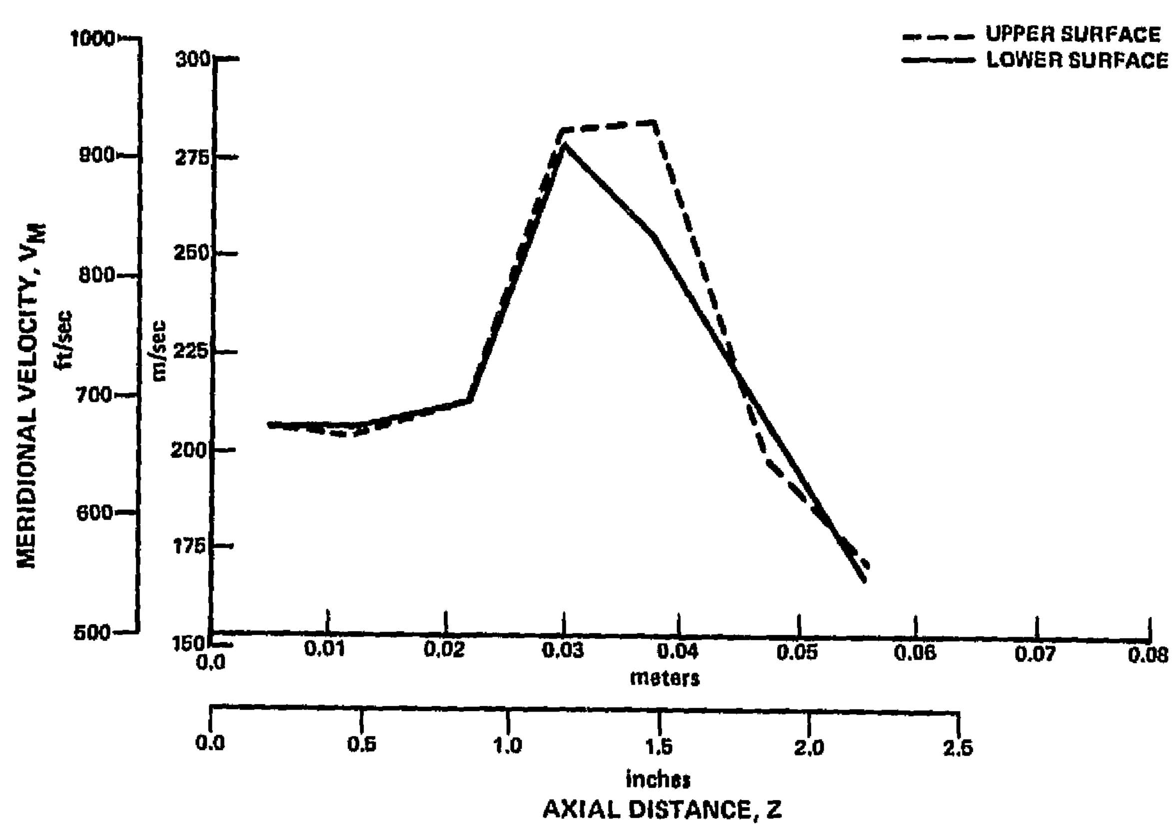


Figure 7 Axial Distribution of Calculated Velocities Near Partspan Shroud for Precompression Rotor Analysis

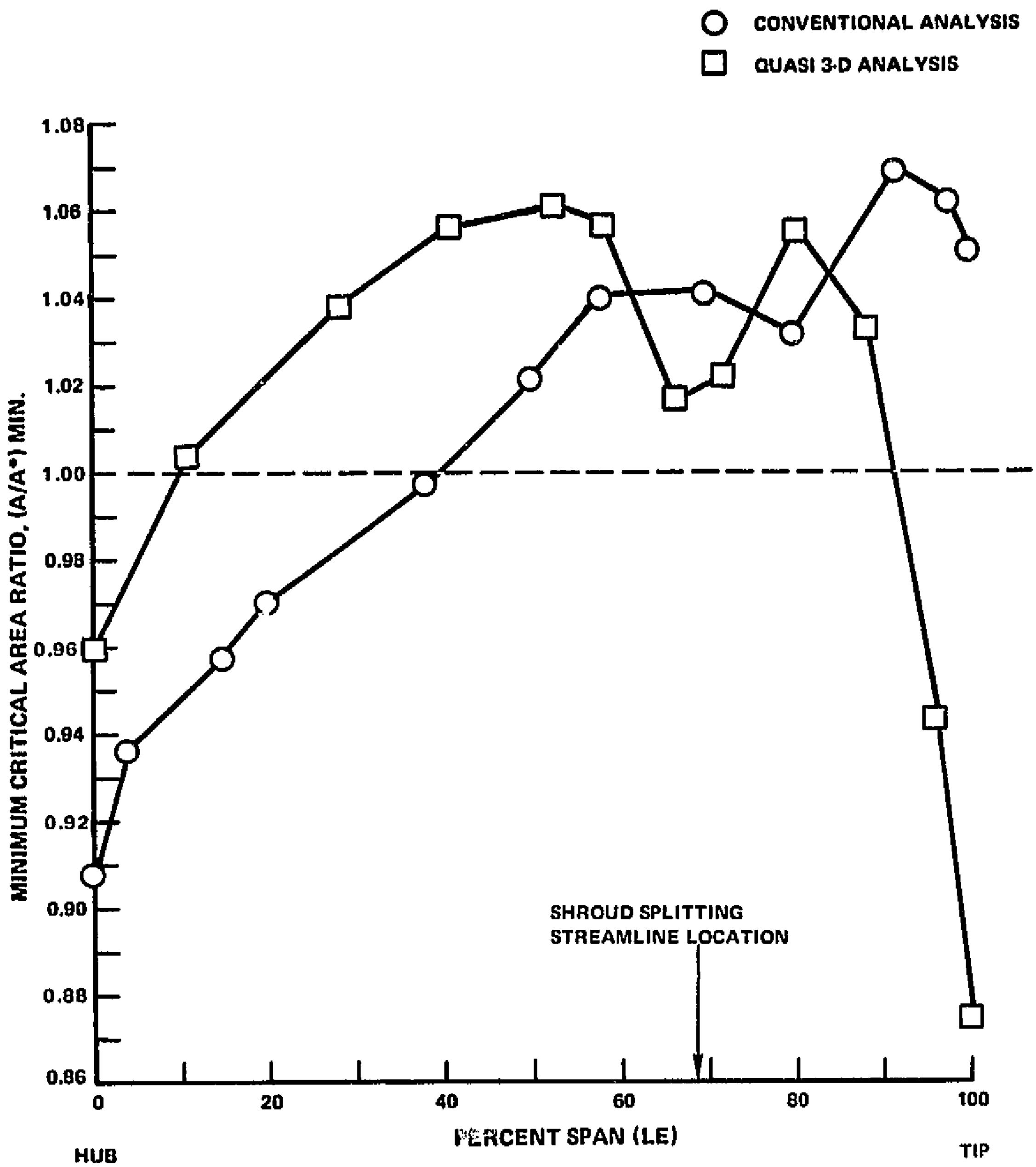


Figure 8 Minimum Critical Area Ratio (A/A* min) Versus Span for the Precompression Rotor, Comparing Quasi 3-D Analysis With Conventional Analysis

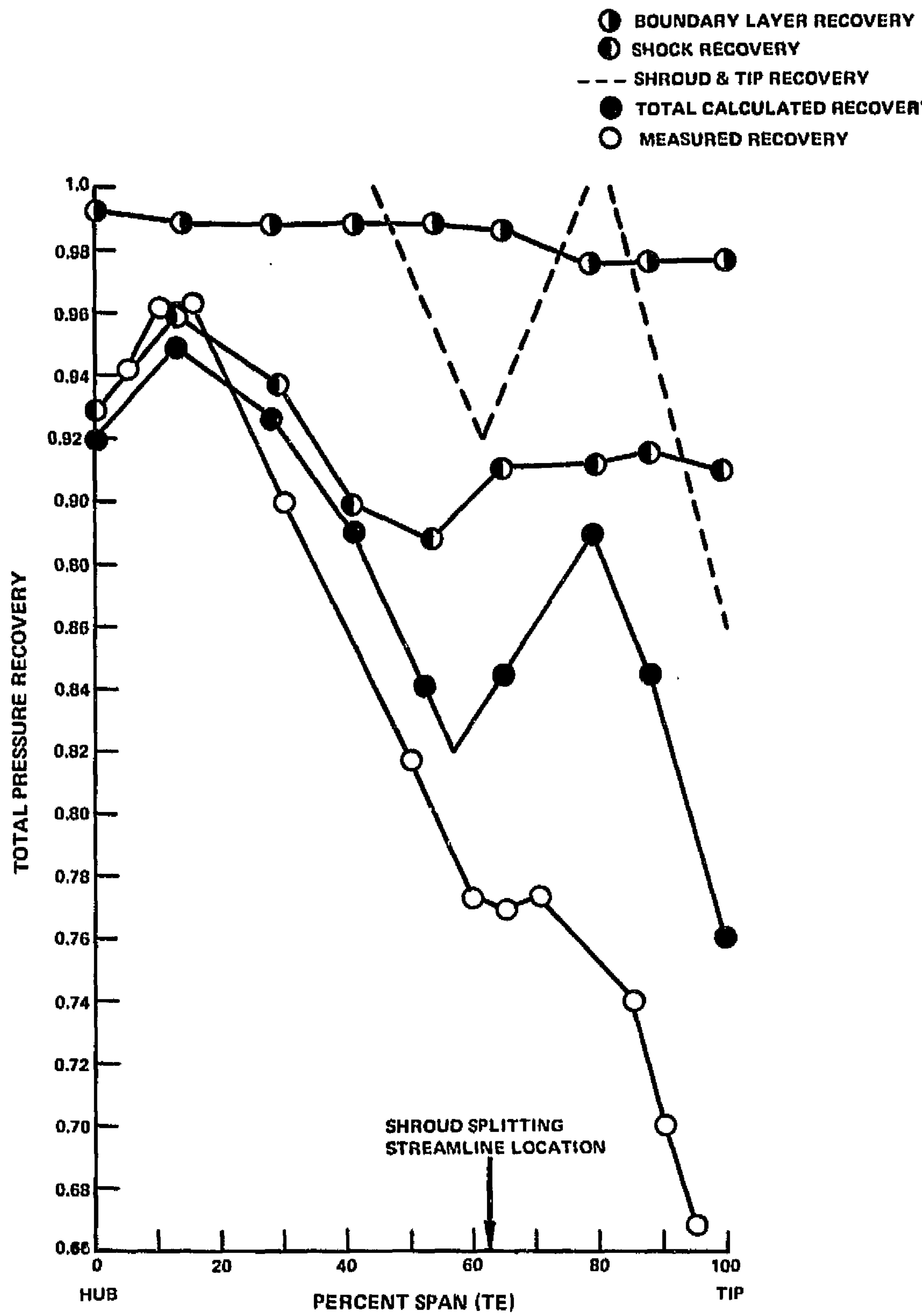


Figure 9 Radial Profiles of Calculated Recovery Increments and Resulting Total Recovery, Compared With Measured Recovery, for MCA Rotor Analysis

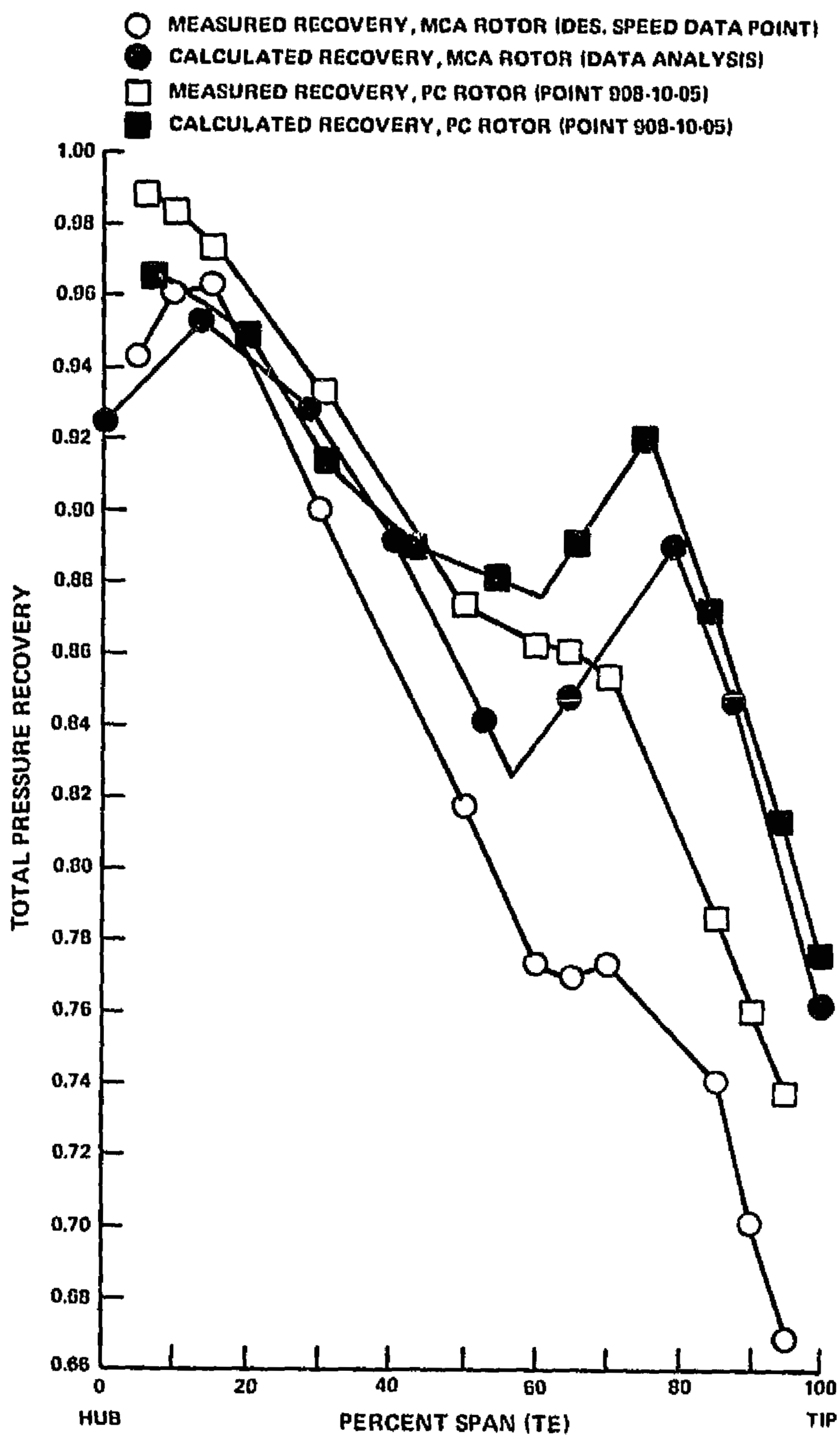


Figure 10 Radial Profiles of Recovery, Comparing Measured and Calculated Recovery for the Precompression and MCA Rotors

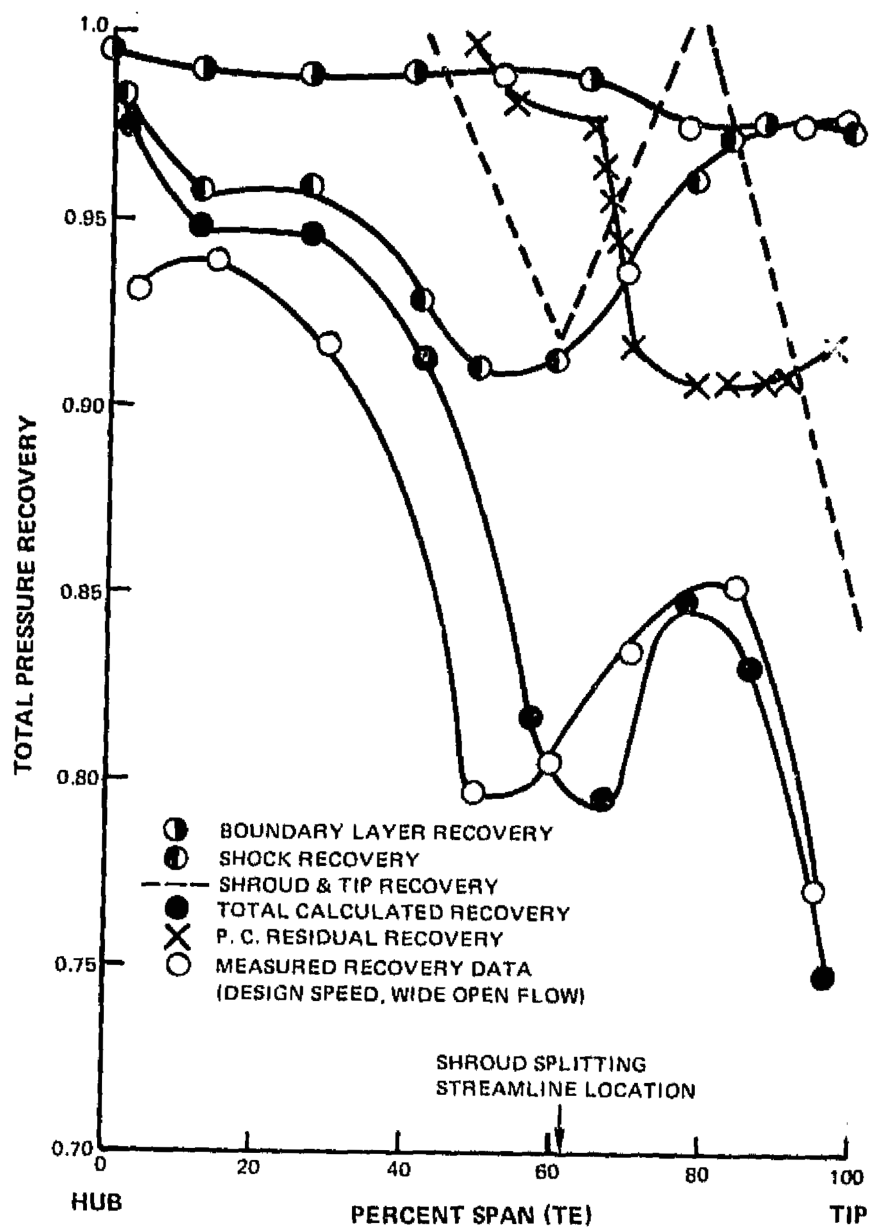


Figure 11 Radial Profiles of Calculated Recovery Increments and Resulting Total Recovery for MCA Analysis at Design Point Speed, Wide Open Flow

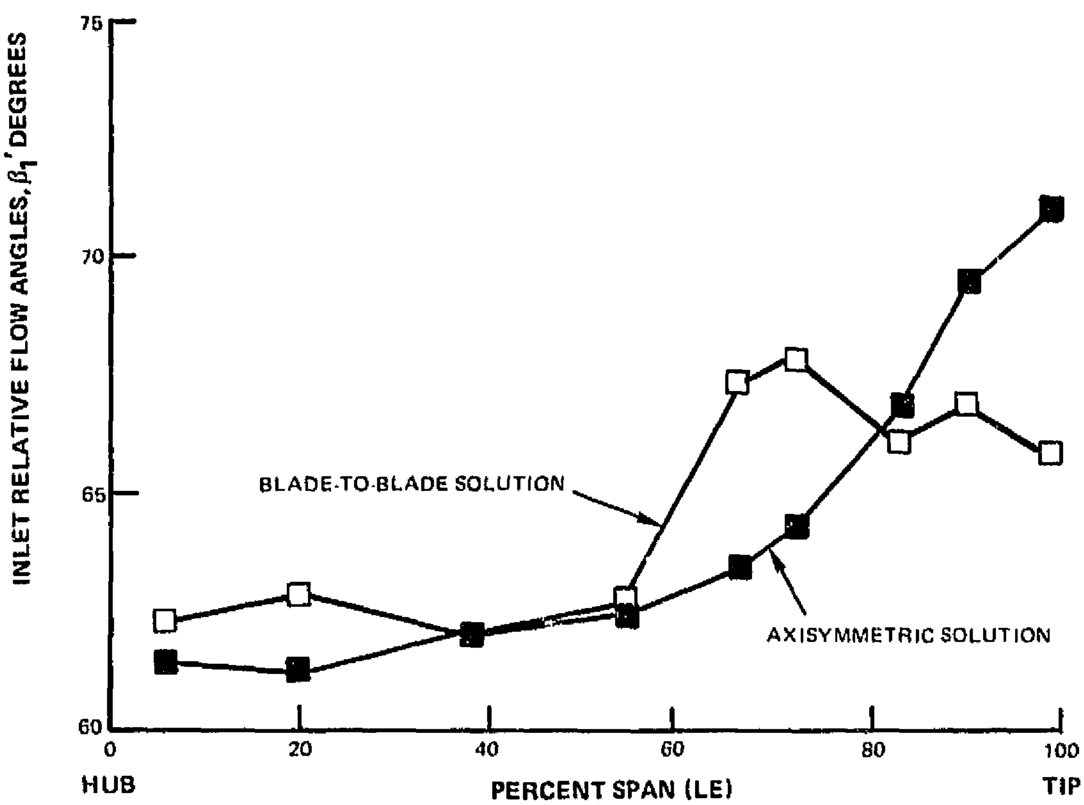


Figure 12 Calculated Radial Profiles of Inlet Relative Flow Angles for MCA Analysis at Design Speed, Wide Open Flow, Comparing Blade-to-Blade Solutions With the Axisymmetric Solution

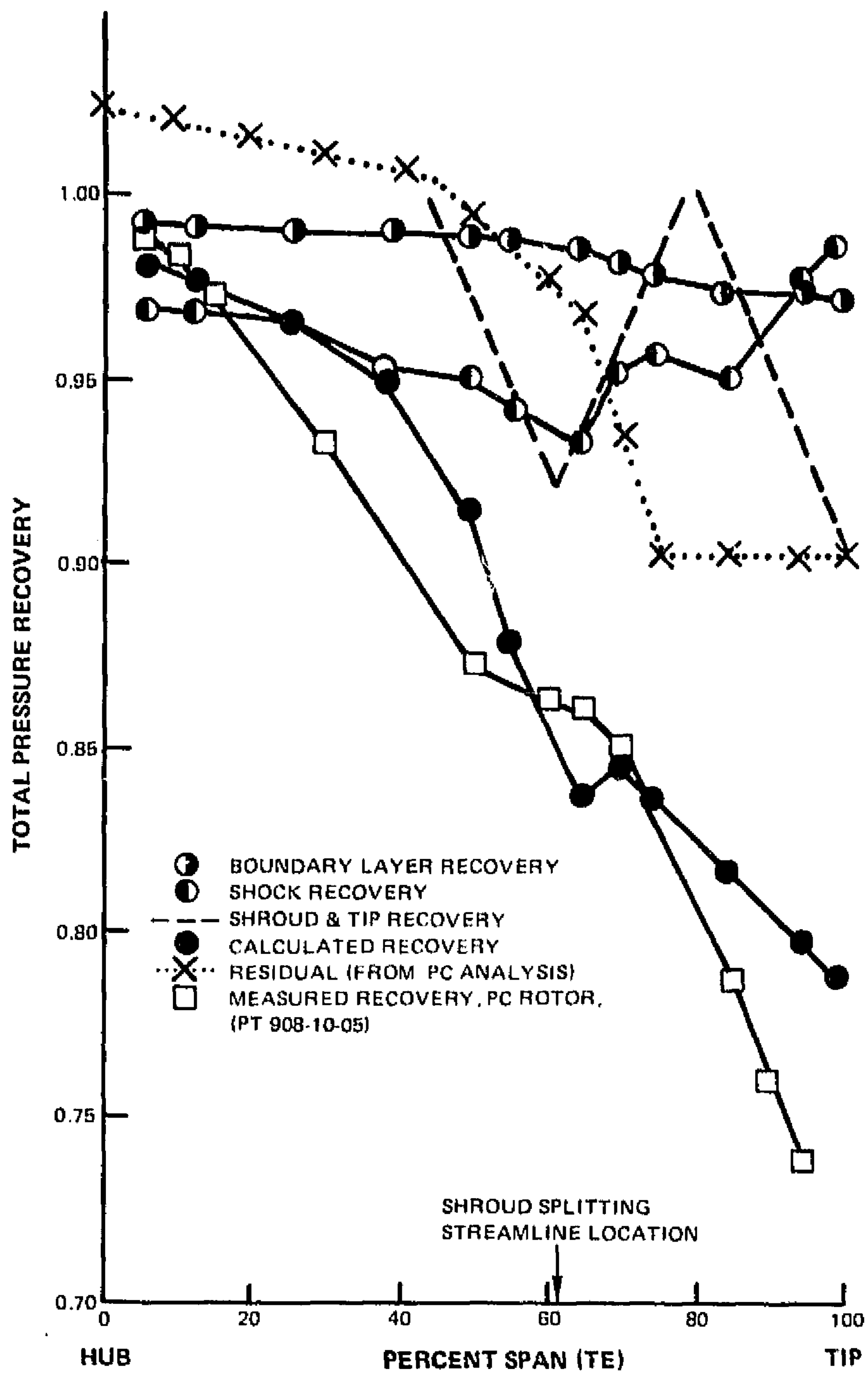


Figure 13 Radial Profiles of Predicted Recovery Increments and Resulting Total Recovery for the Redesigned Rotor

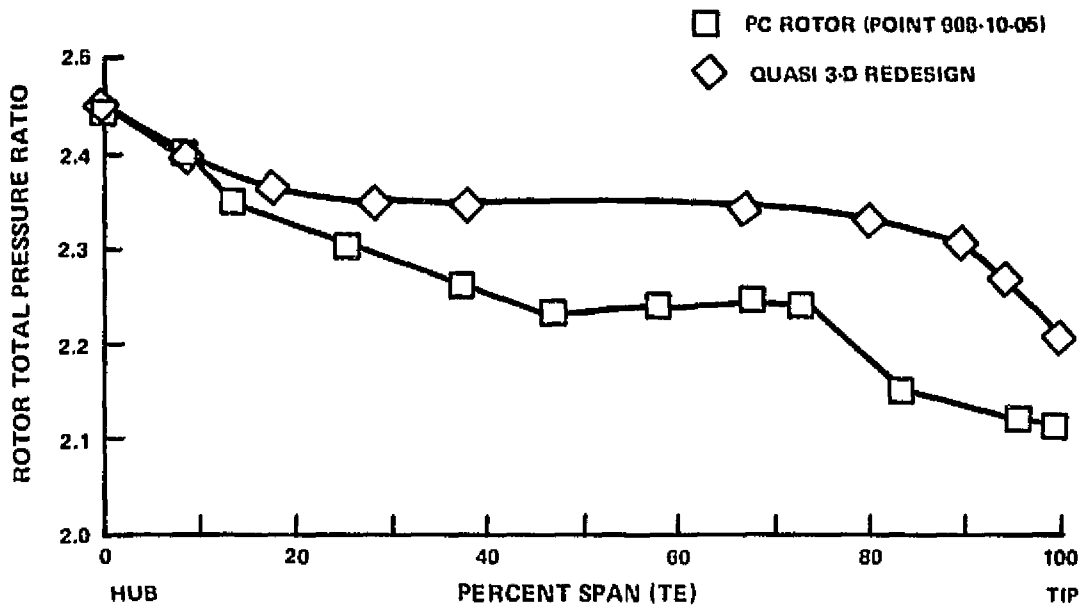


Figure 14 Radial Profiles of Pressure Ratio, Comparing Predicted Values for the Redesigned Rotor With Measured Values for the Precompression Rotor

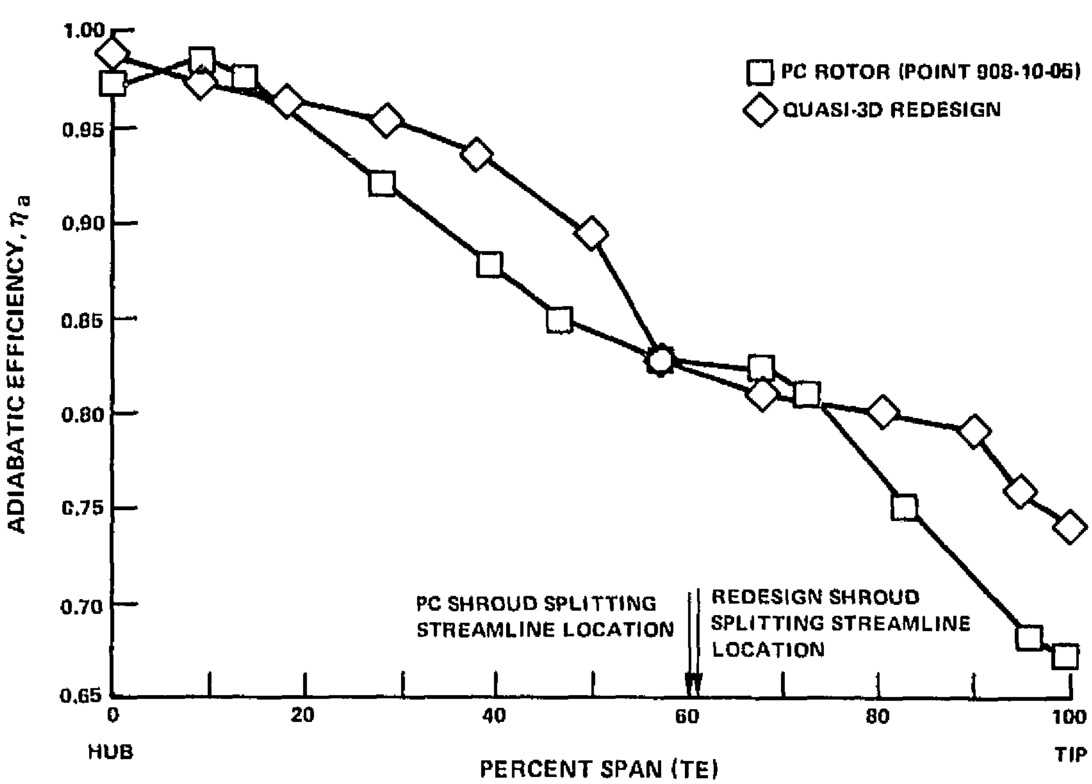


Figure 15 Radial Profiles of Adiabatic Efficiency for the Redesigned Rotor and Original Precompression Rotor

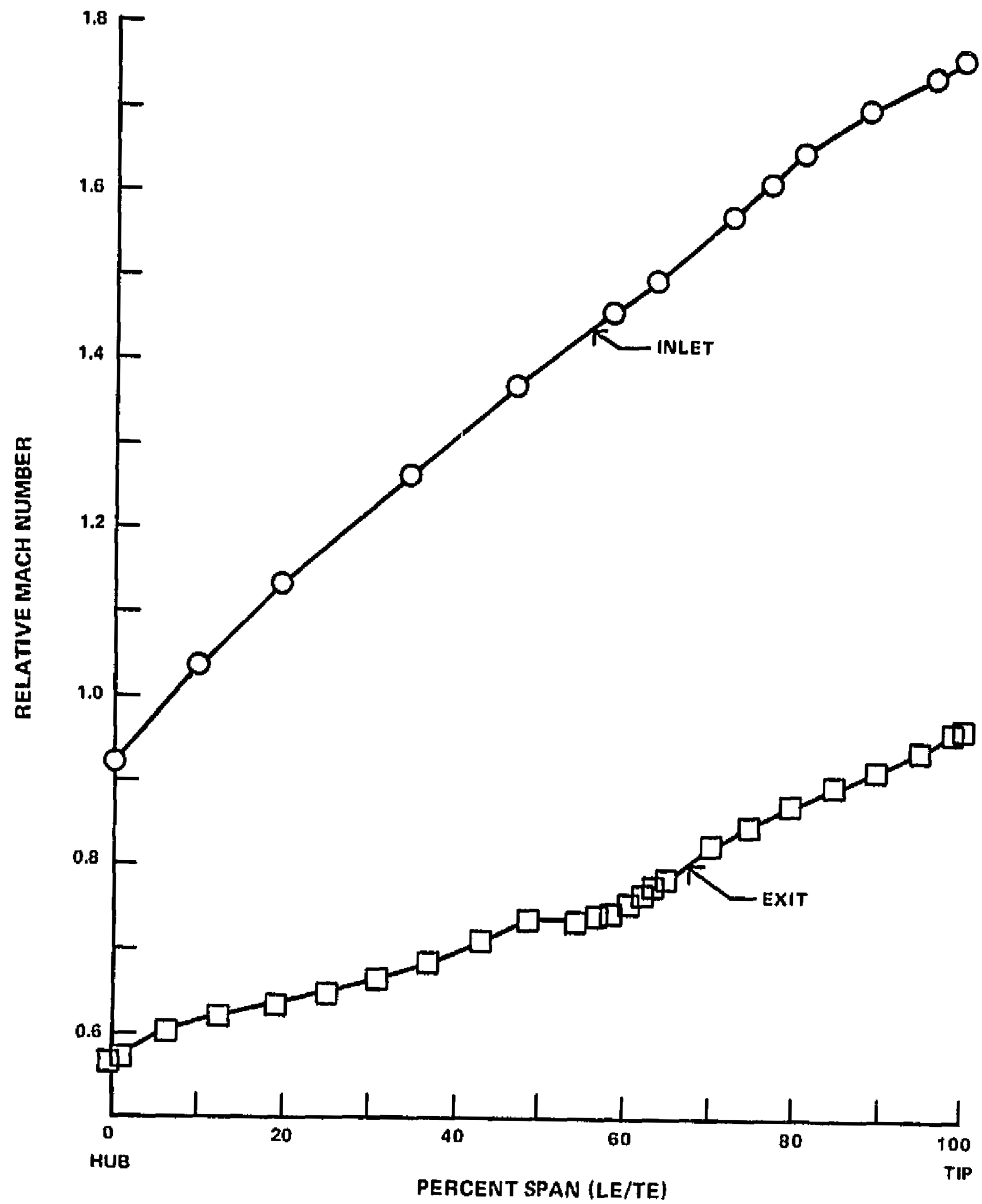


Figure 16 Radial Profiles of Relative Mach Number at Rotor Inlet and Exit for the Redesigned Rotor

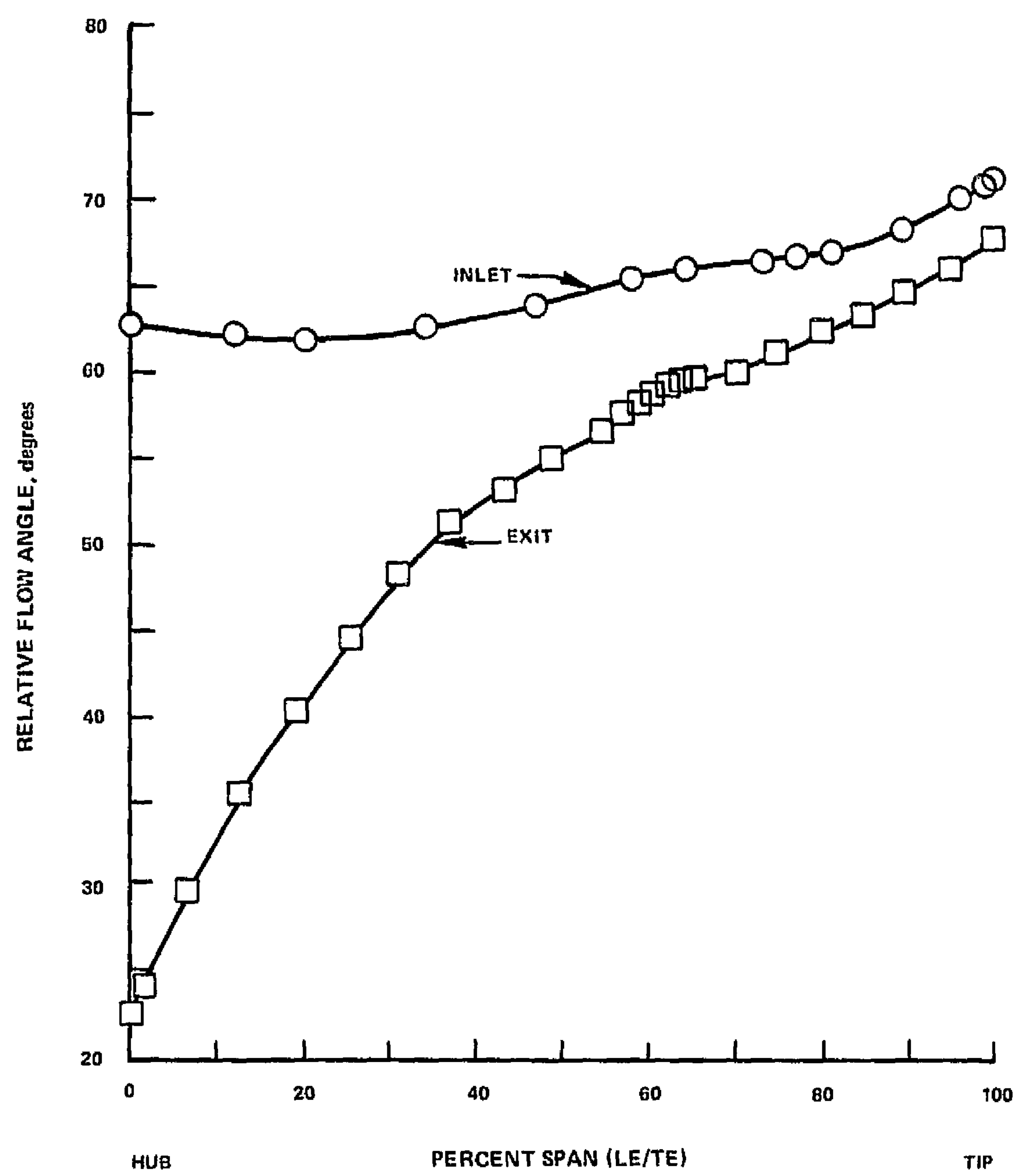


Figure 17 Radial Profiles of Relative Flow Angle at Rotor Inlet and Exit for the Redesigned Rotor

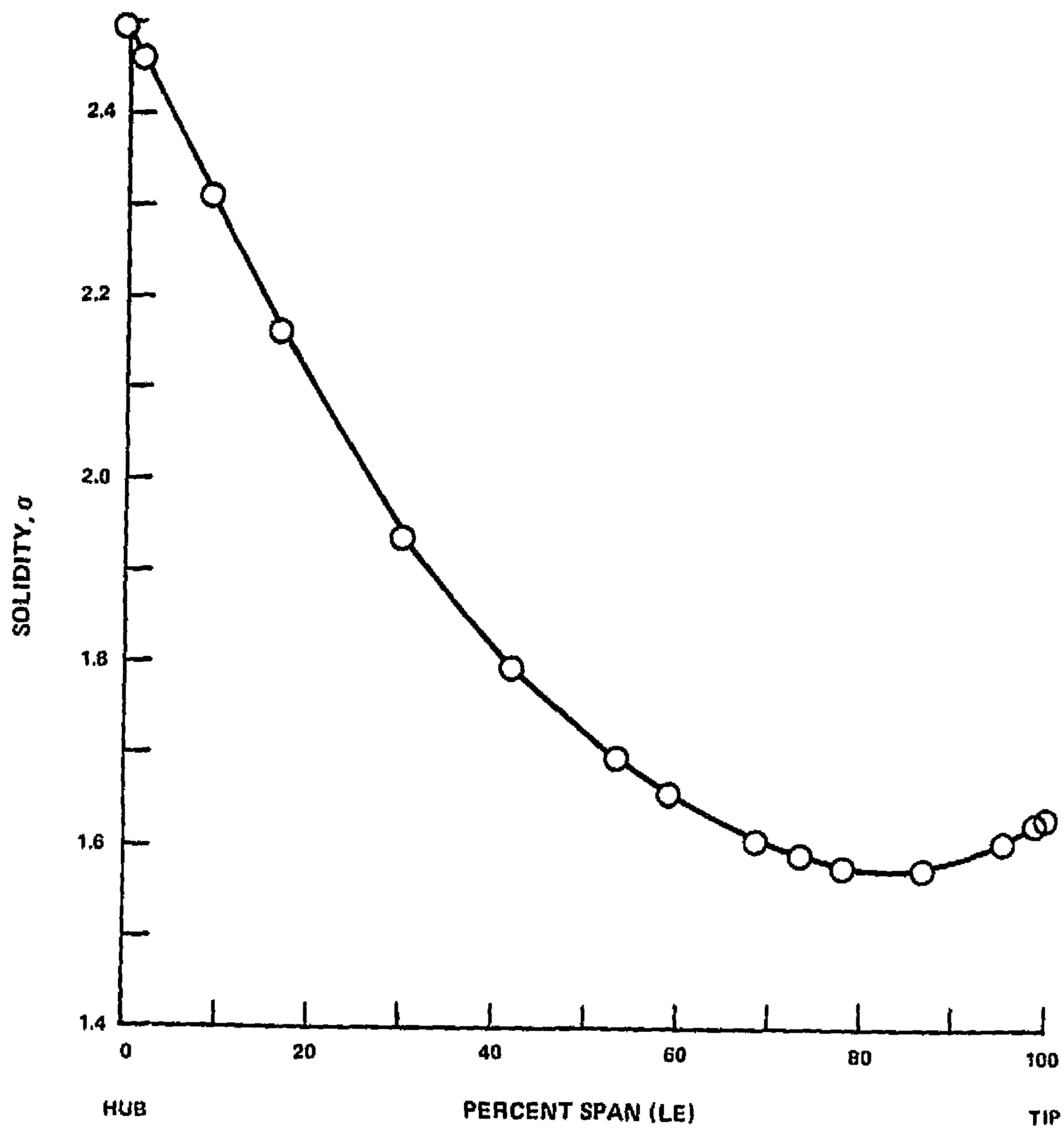


Figure 18 Radial Profile of Solidity for the Redesigned Rotor

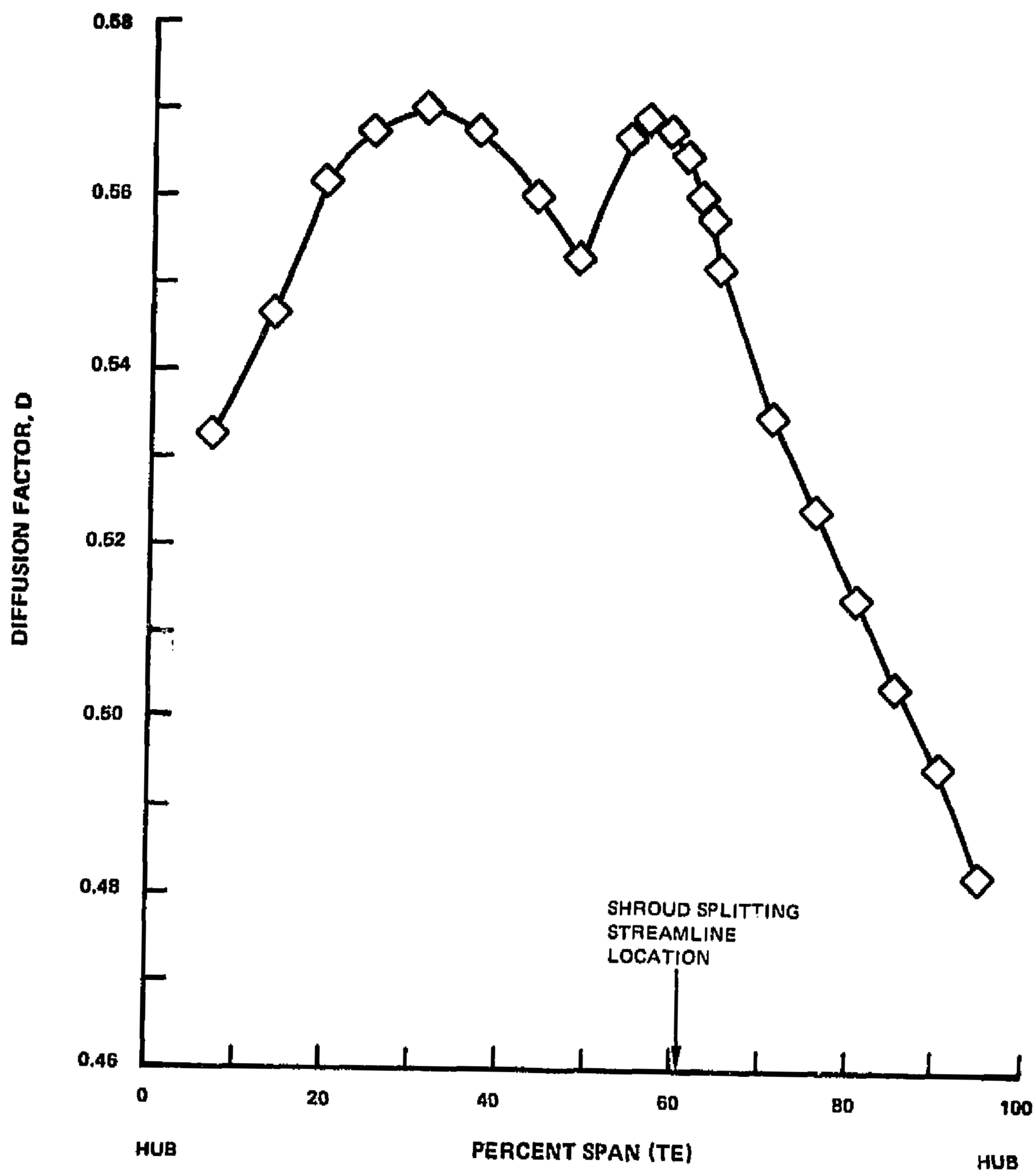


Figure 19 Radial Profile of Diffusion Factor for the Redesigned Rotor

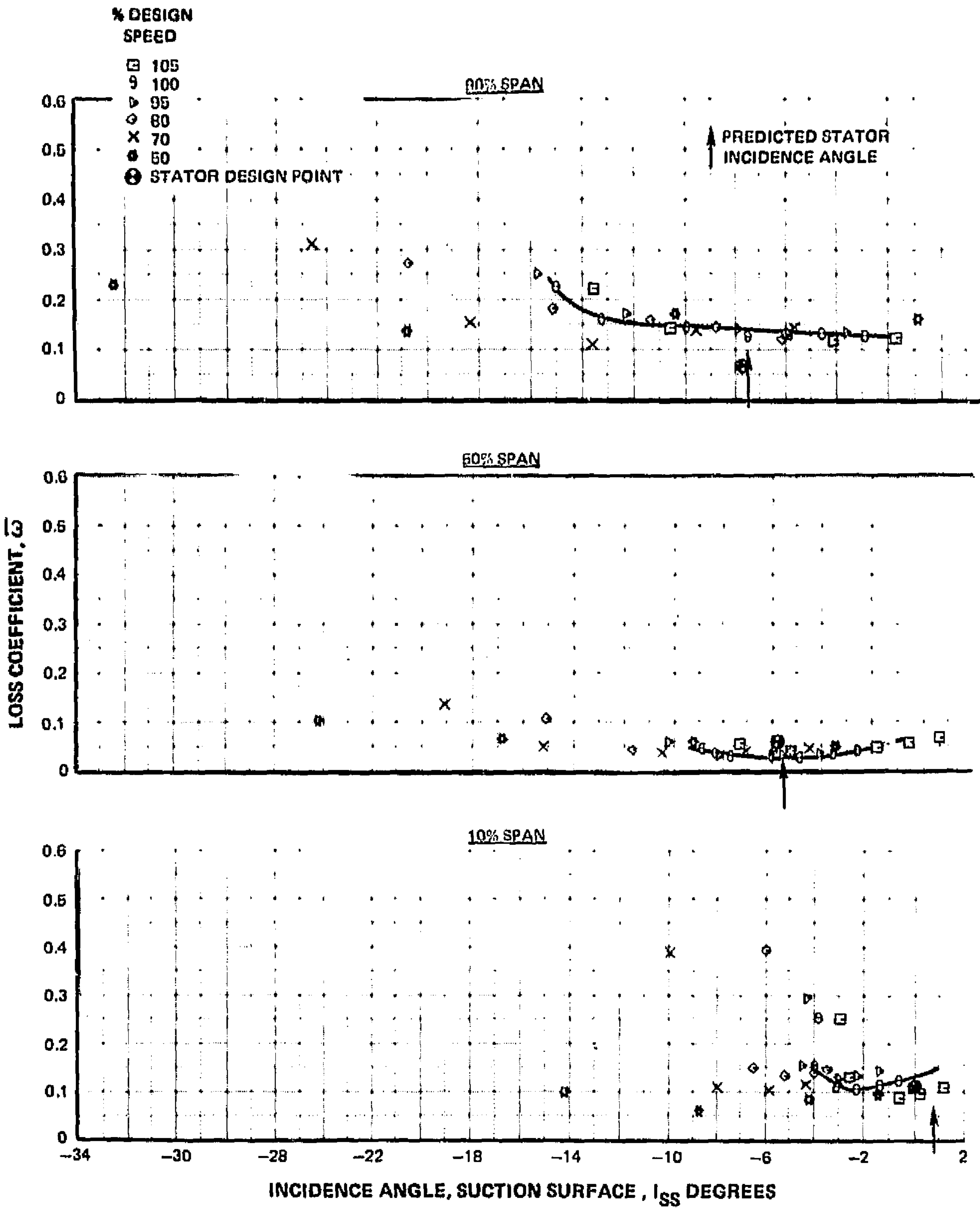


Figure 20 Measured Stator Loss Coefficient ($\bar{\omega}$) as a Function of Suction Surface Incidence Angle Showing the Stator Compatibility With Present Redesigned Rotor

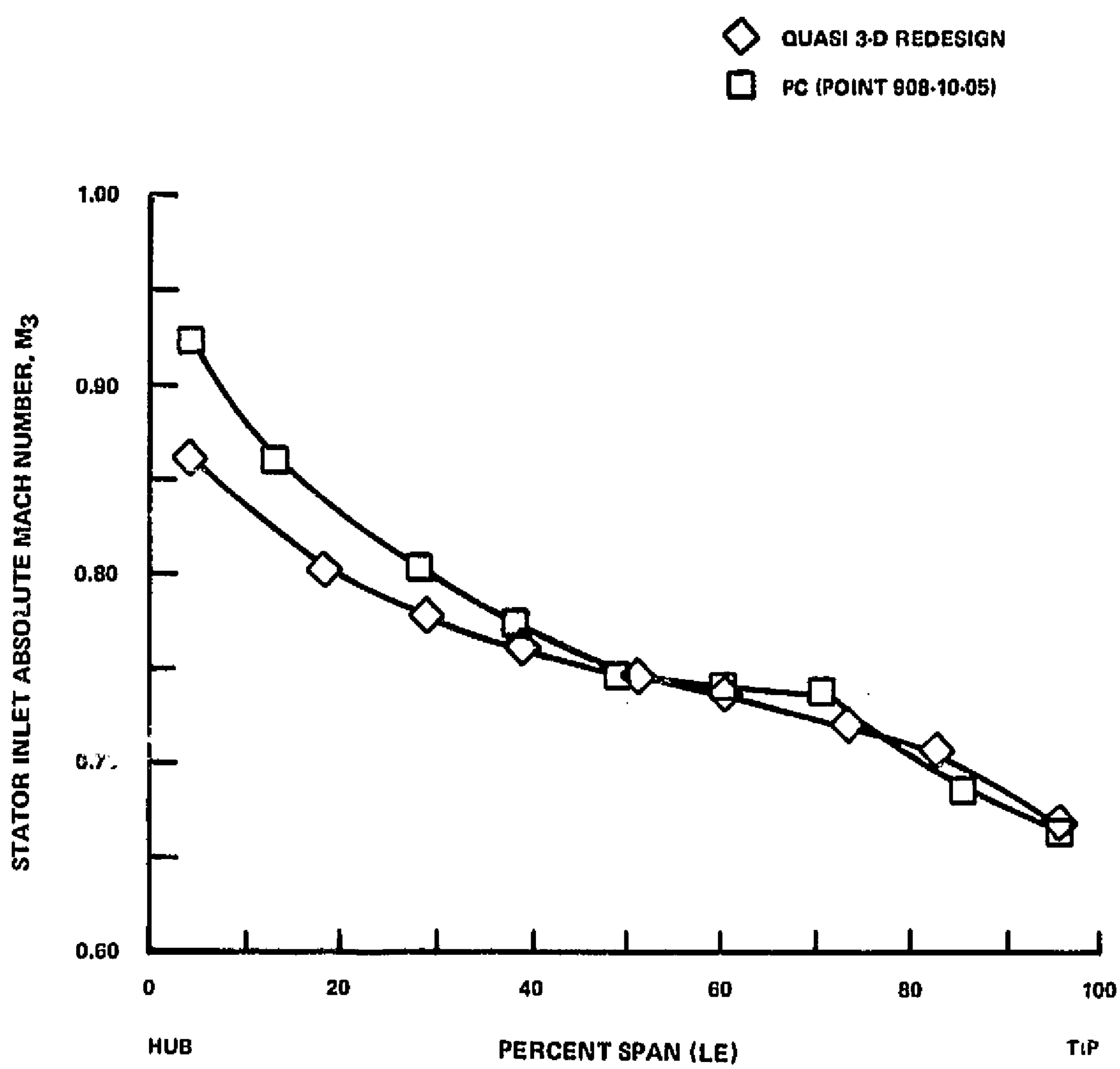


Figure 21 Comparison of Radial Profiles of Inlet Absolute Mach Number at Stator Inlet, for the Redesigned and Precompression Rotors

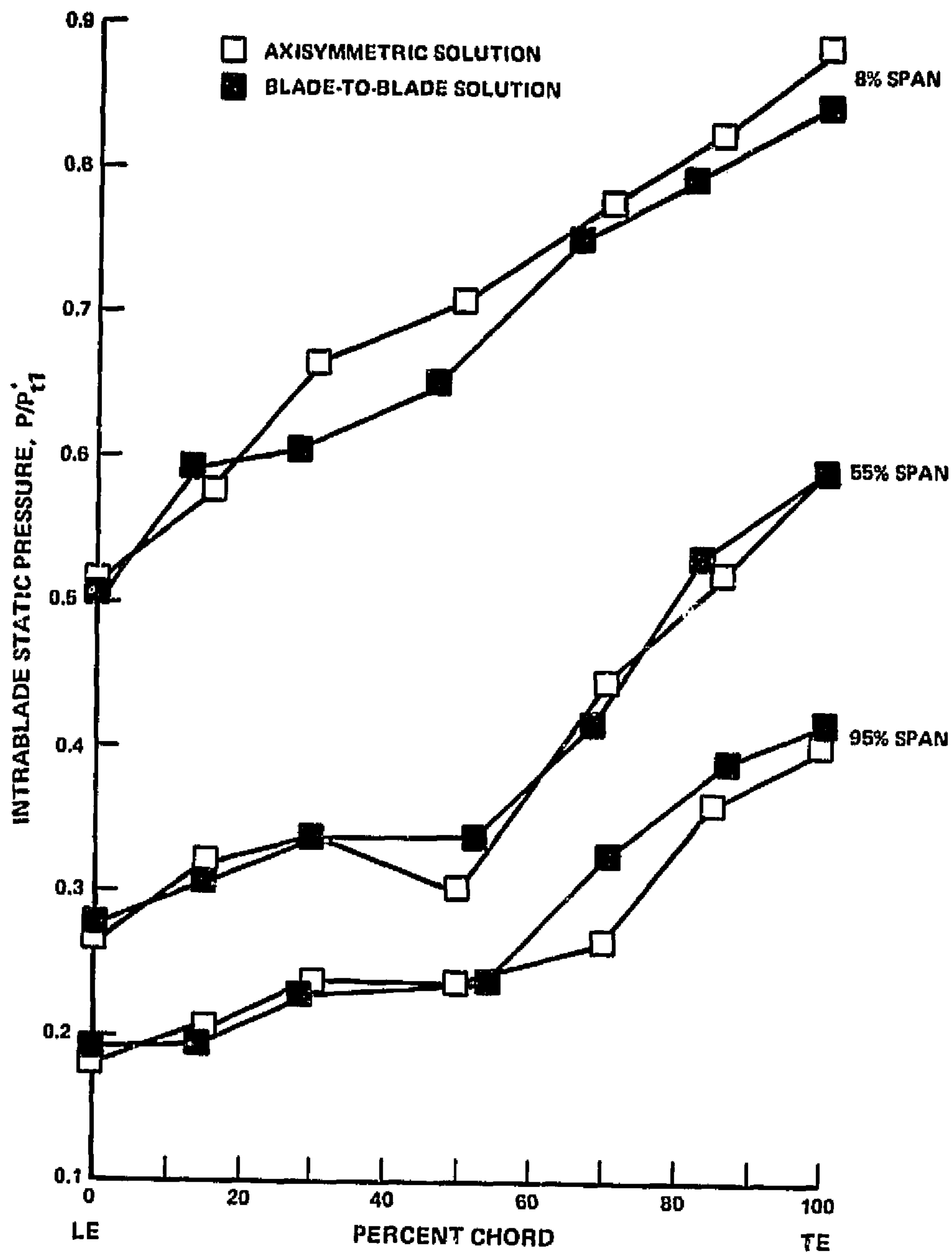


Figure 22 Calculated Intrablade Axial Distributions of Static Pressure for the Redesigned Rotor, Comparing Blade-To-Blade Solutions With the Axisymmetric Solution

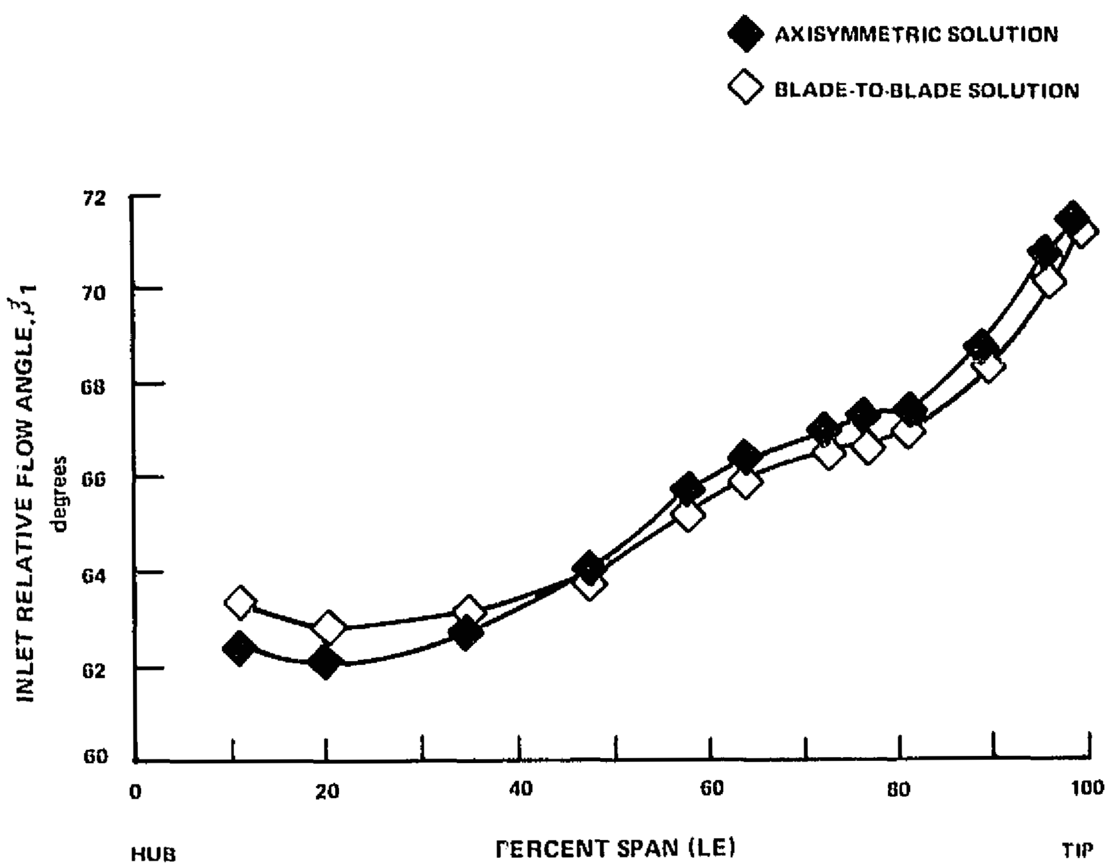


Figure 23 Radial Profiles of Inlet Relative Flow Angle for the Redesigned Rotor, Comparing Blade-To-Blade Solutions With the Axisymmetric Solution

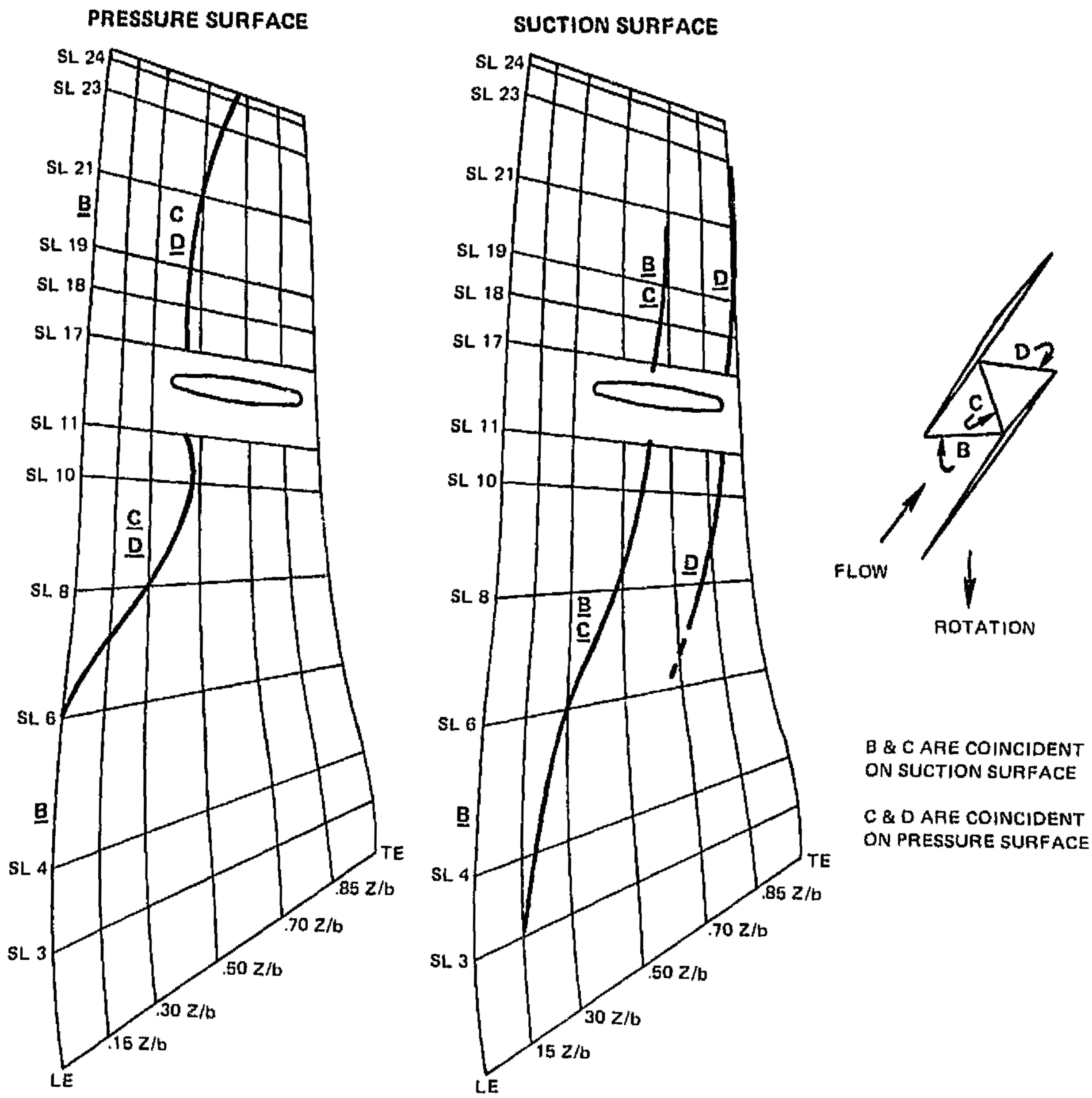


Figure 24 Predicted Loci of Shock Impingement Points on Redesigned Blade Surfaces

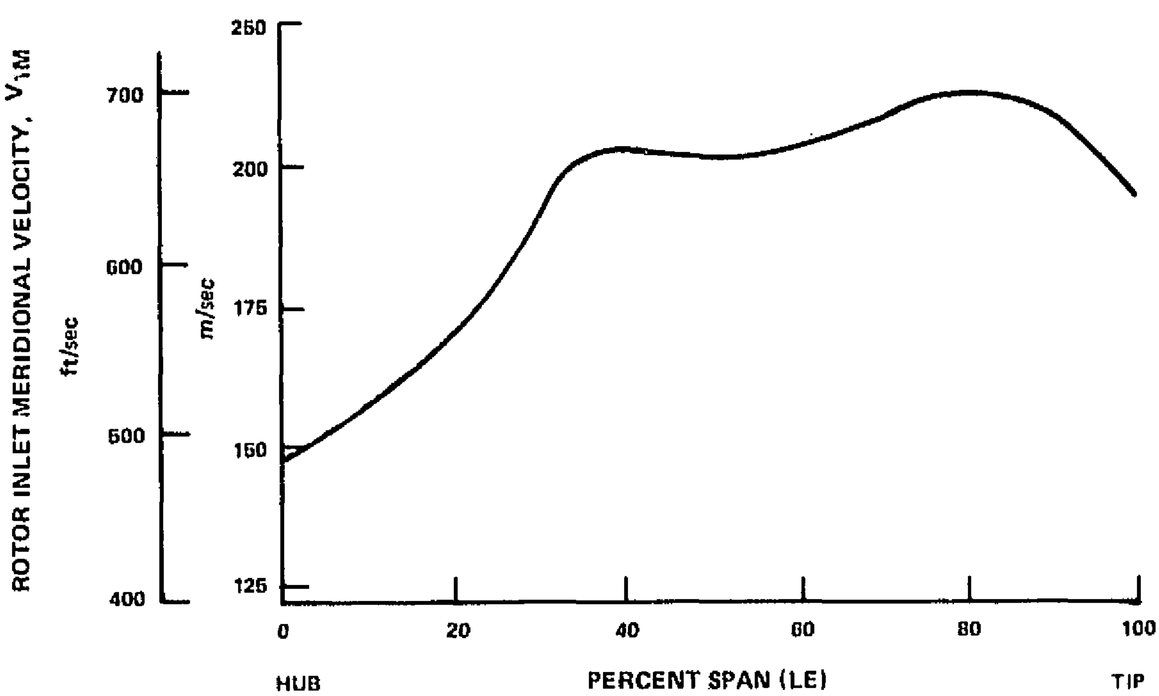
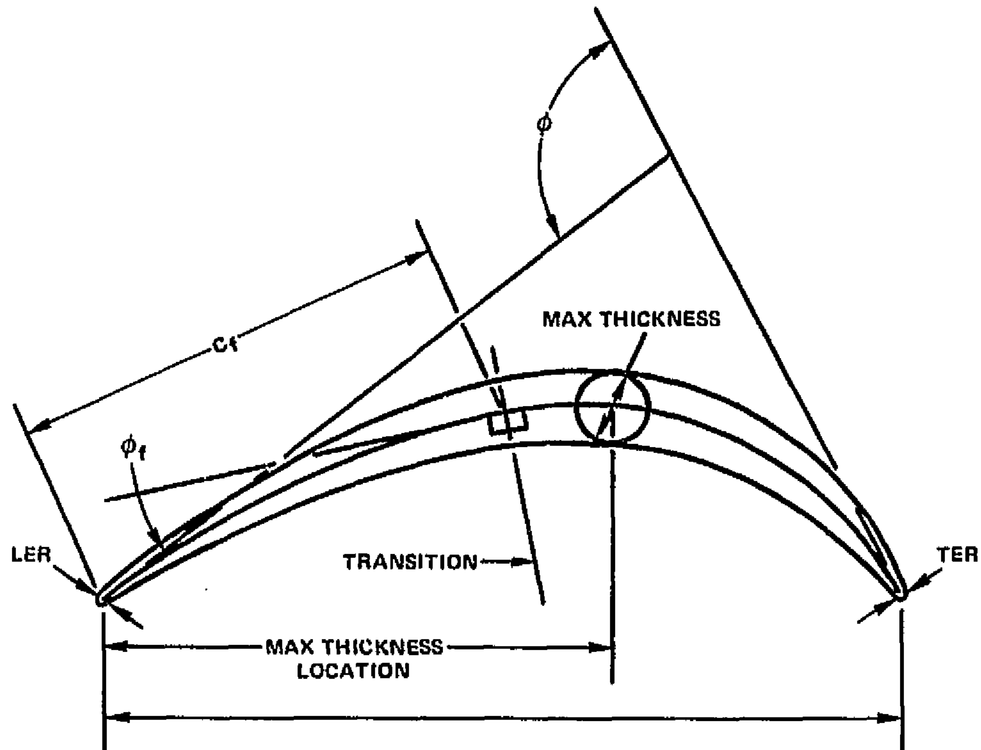
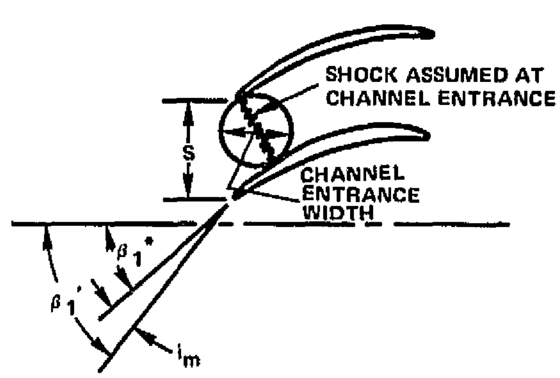


Figure 25 Predicted Radial Profile of Meridional Velocity at the Inlet of the Redesigned Rotor



A. AIRFOIL DEFINITIONS



B. CASCADE RELATIONSHIPS

Figure 26 Definitions for Conventional MCA Airfoils and Cascade Relationships

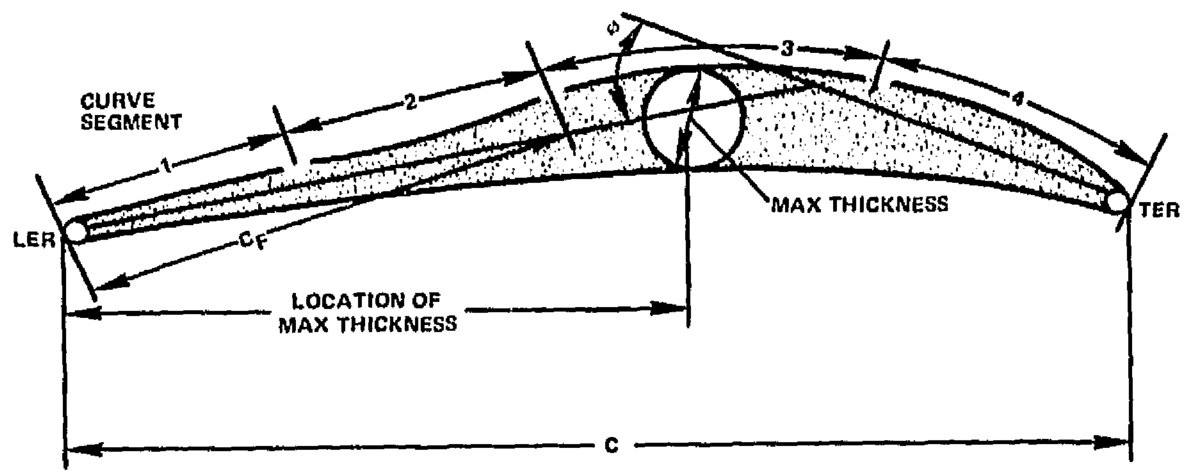


Figure 27 Four-Part MCA Airfoil Definitions

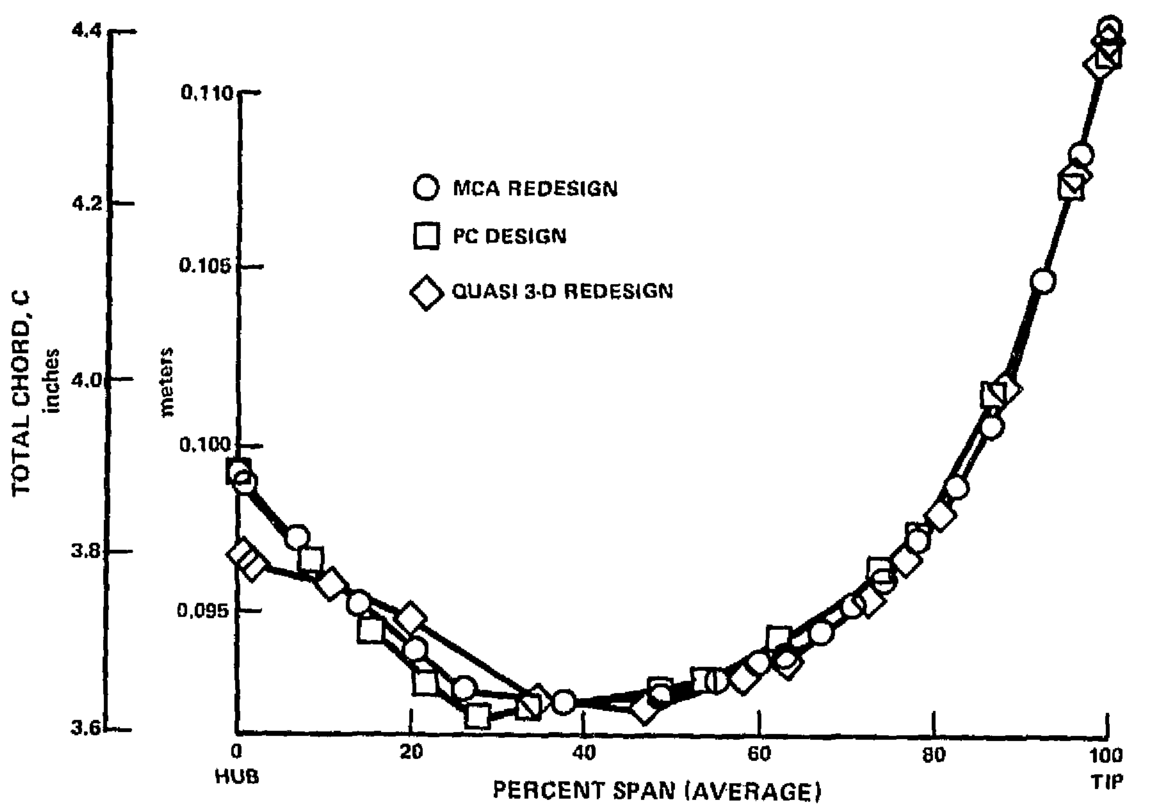


Figure 28 Rotor Chord on Conical Surfaces, Comparing the Redesigned Rotor with the Precompression and MCA Rotors

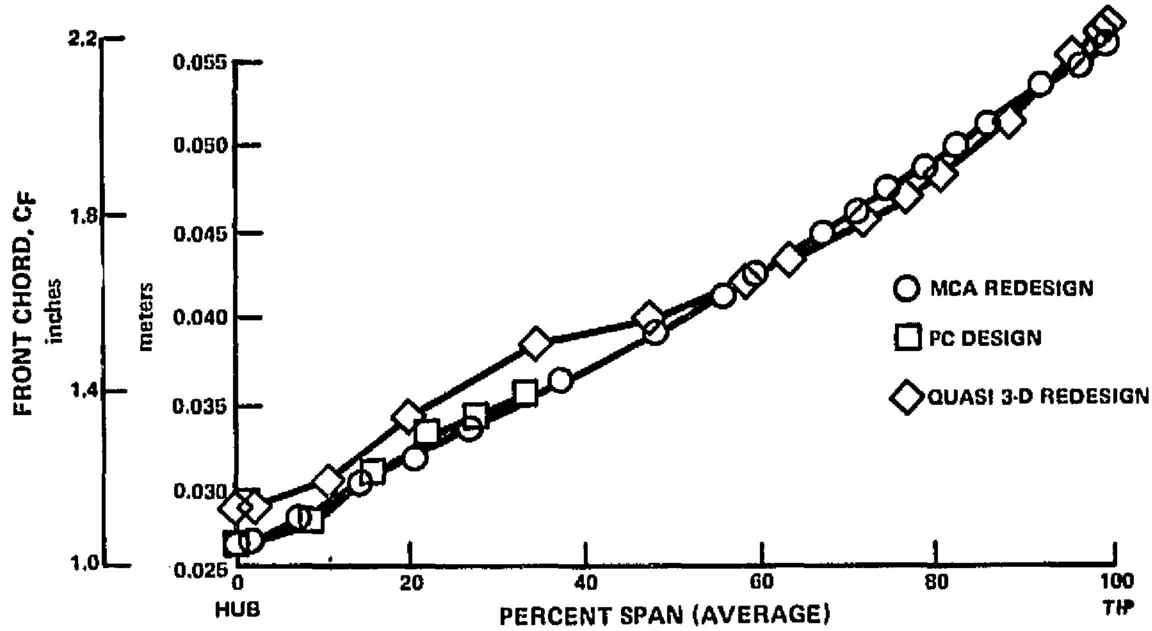


Figure 29 Front Chord on Conical Surfaces, Comparing the Redesigned Rotor with the Precompression and MCA Rotors

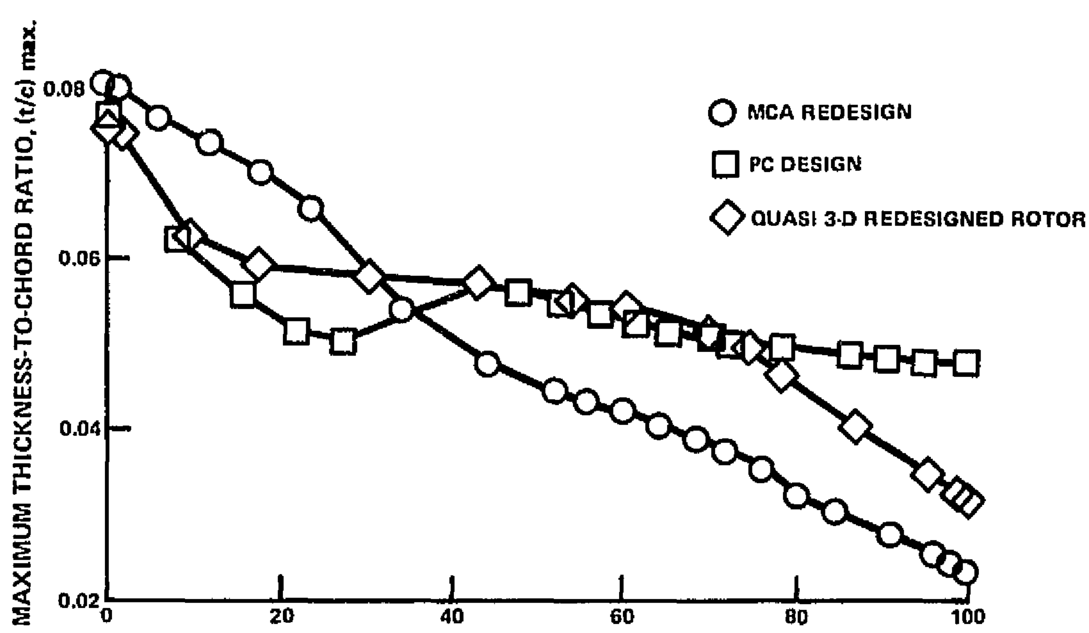


Figure 30 Maximum Thickness to Chord Ratio, Comparing the Redesigned Rotor with the Precompression and MCA Rotors

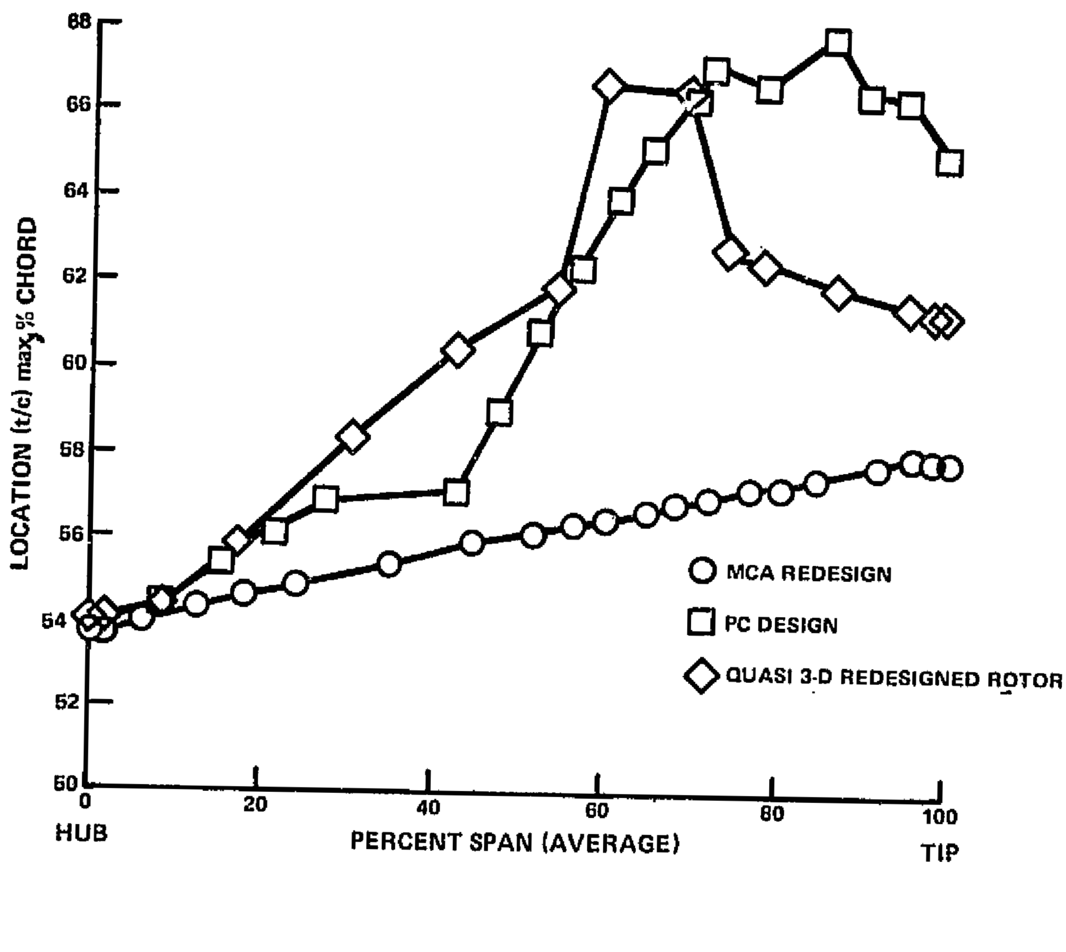


Figure 31 Chordwise Location of Airfoil Maximum Thickness, Comparing the Redesigned Rotor With the Precompression and MCA Rotors

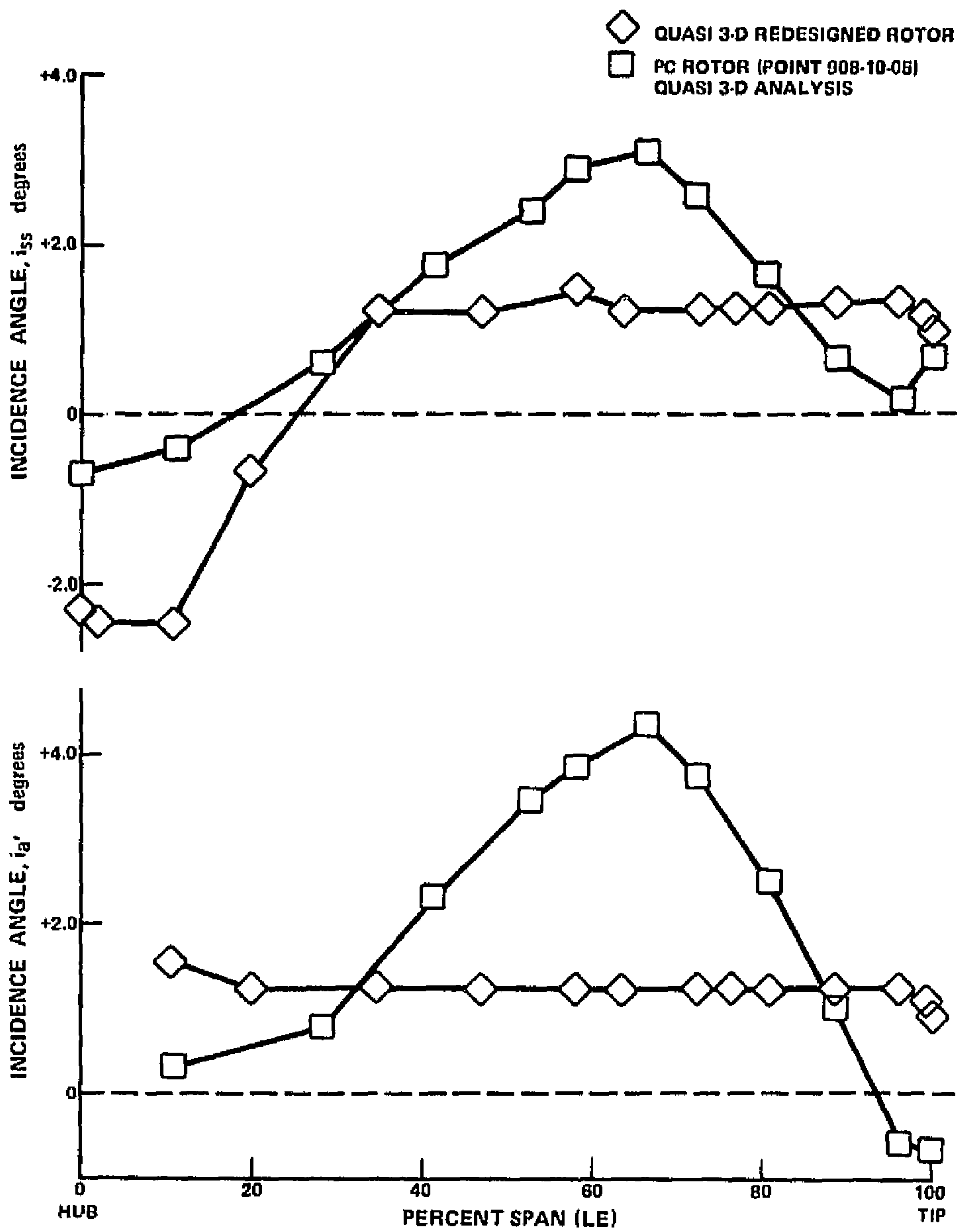


Figure 32 Rotor Incidence Angle to the Suction Surface and to the a' Point, Comparing the Redesigned Rotor to the Precompression Rotor

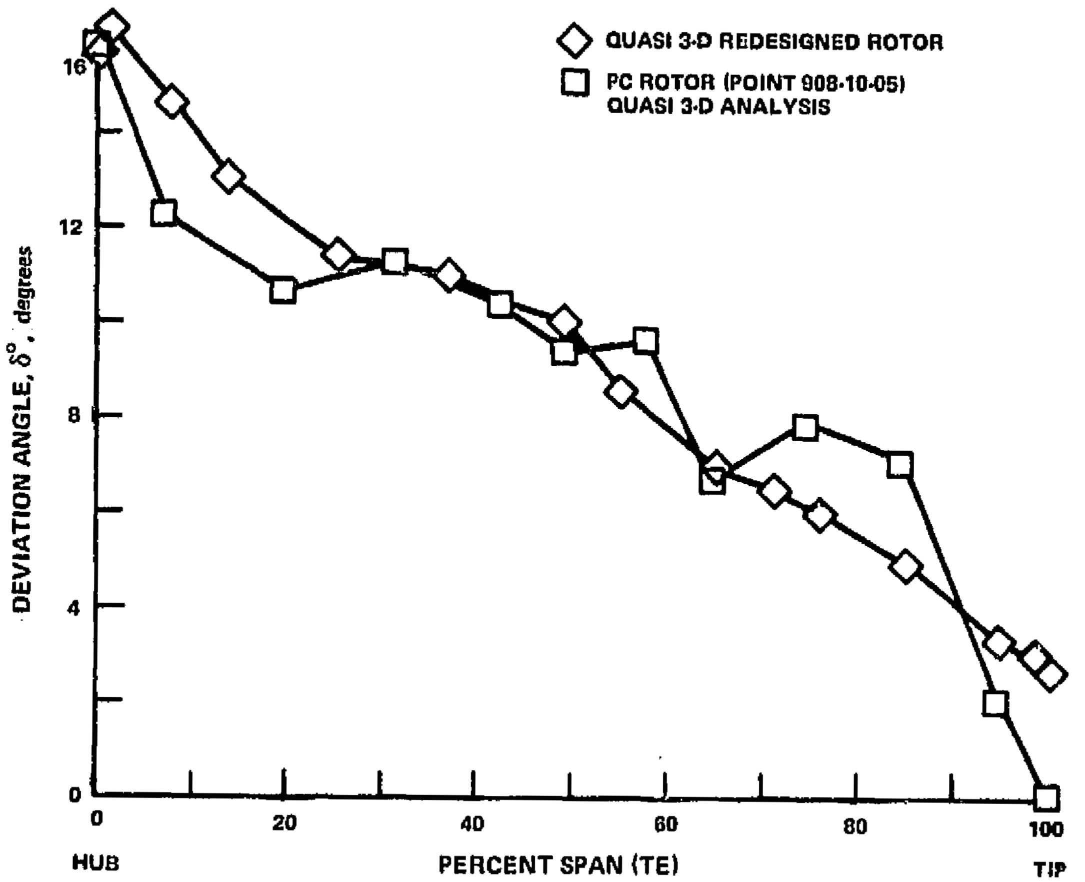


Figure 33 Rotor Deviation Angle, Comparing the Redesigned Rotor to the Precompression Rotor

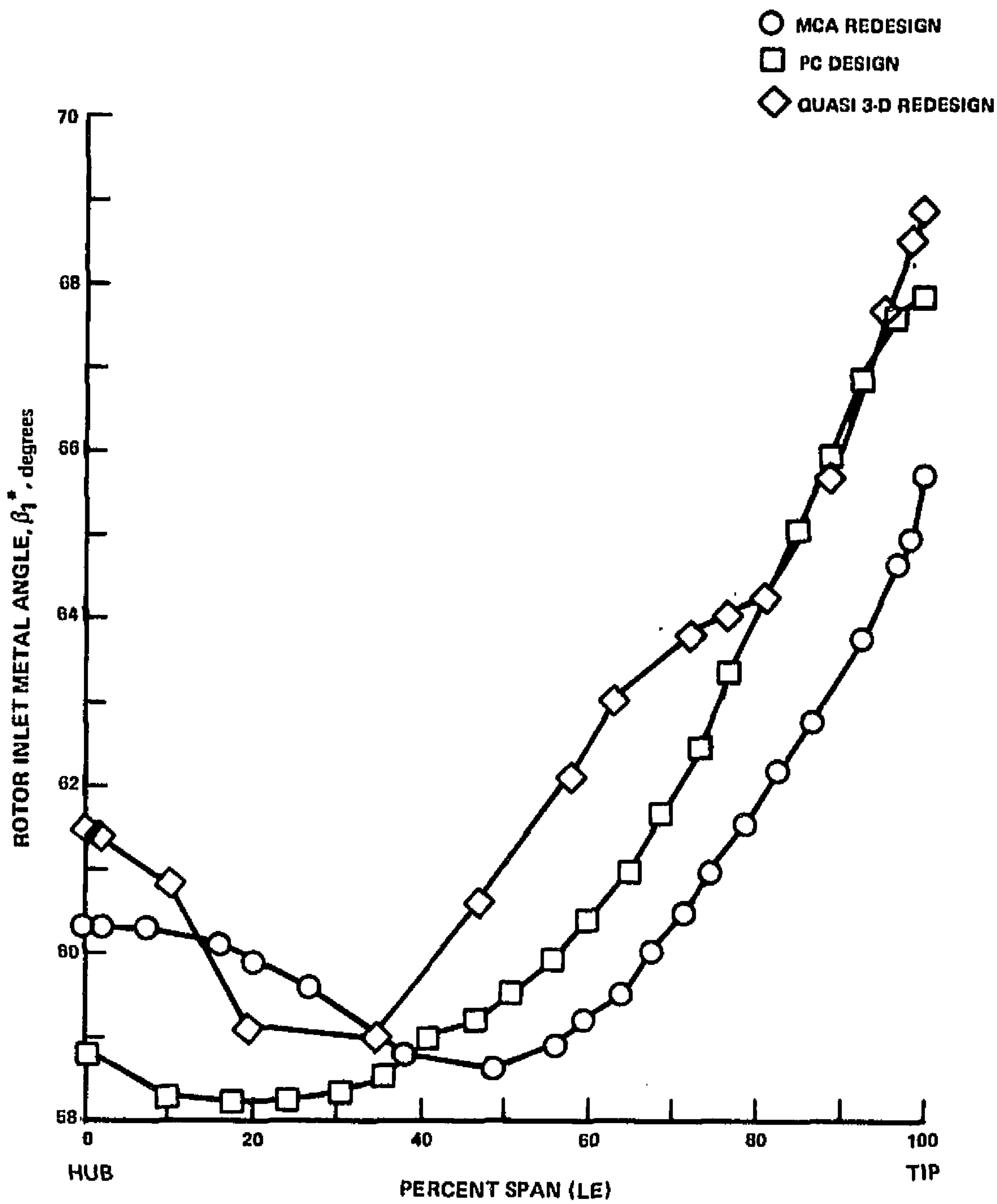


Figure 34 Rotor Leading Edge Metal Angles, Comparing the Redesigned Rotor With the Precompression and MCA Rotors

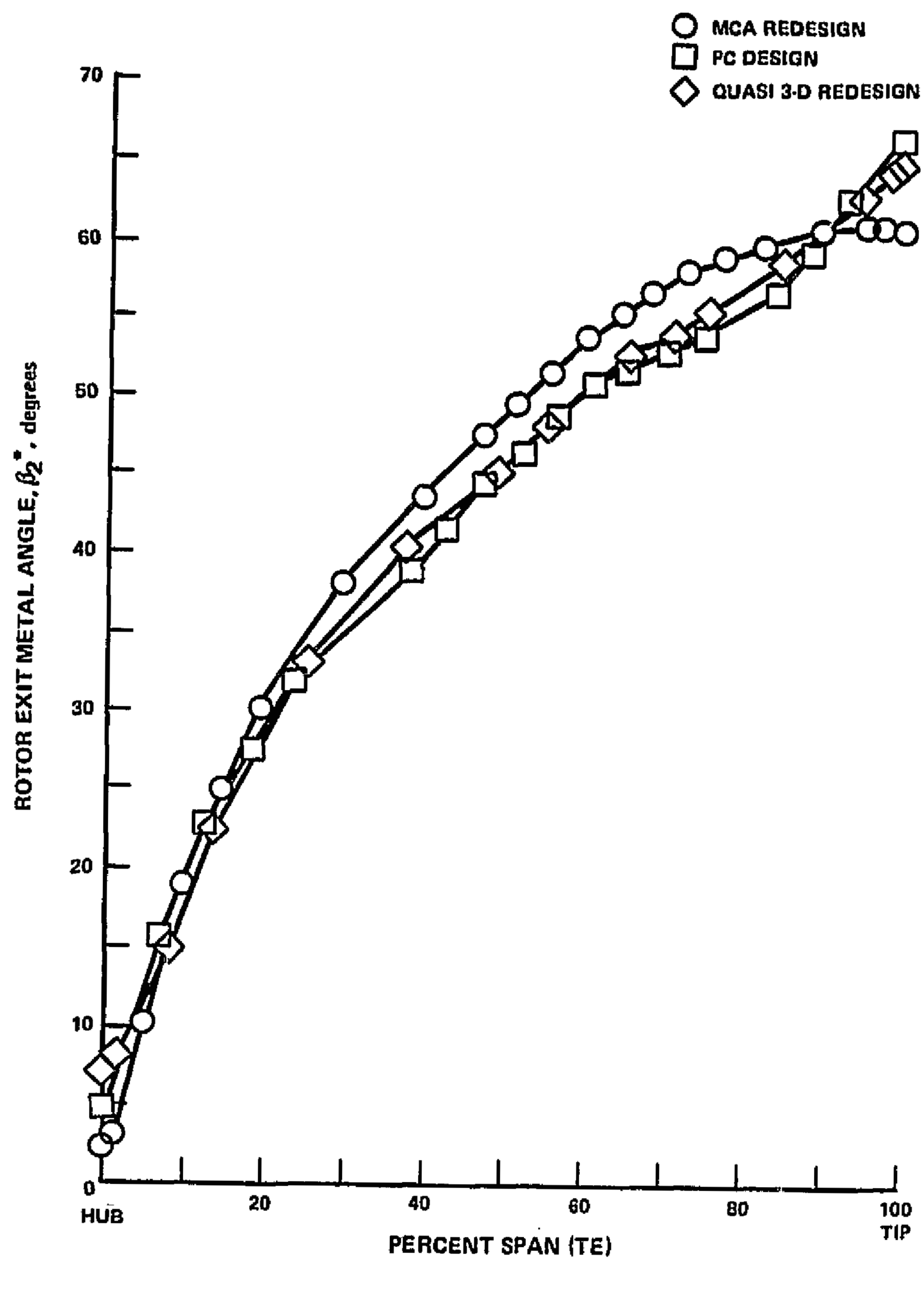


Figure 35 Rotor Trailing Edge Metal Angles, Comparing the Redesigned Rotor With the Precompression and MCA Rotors

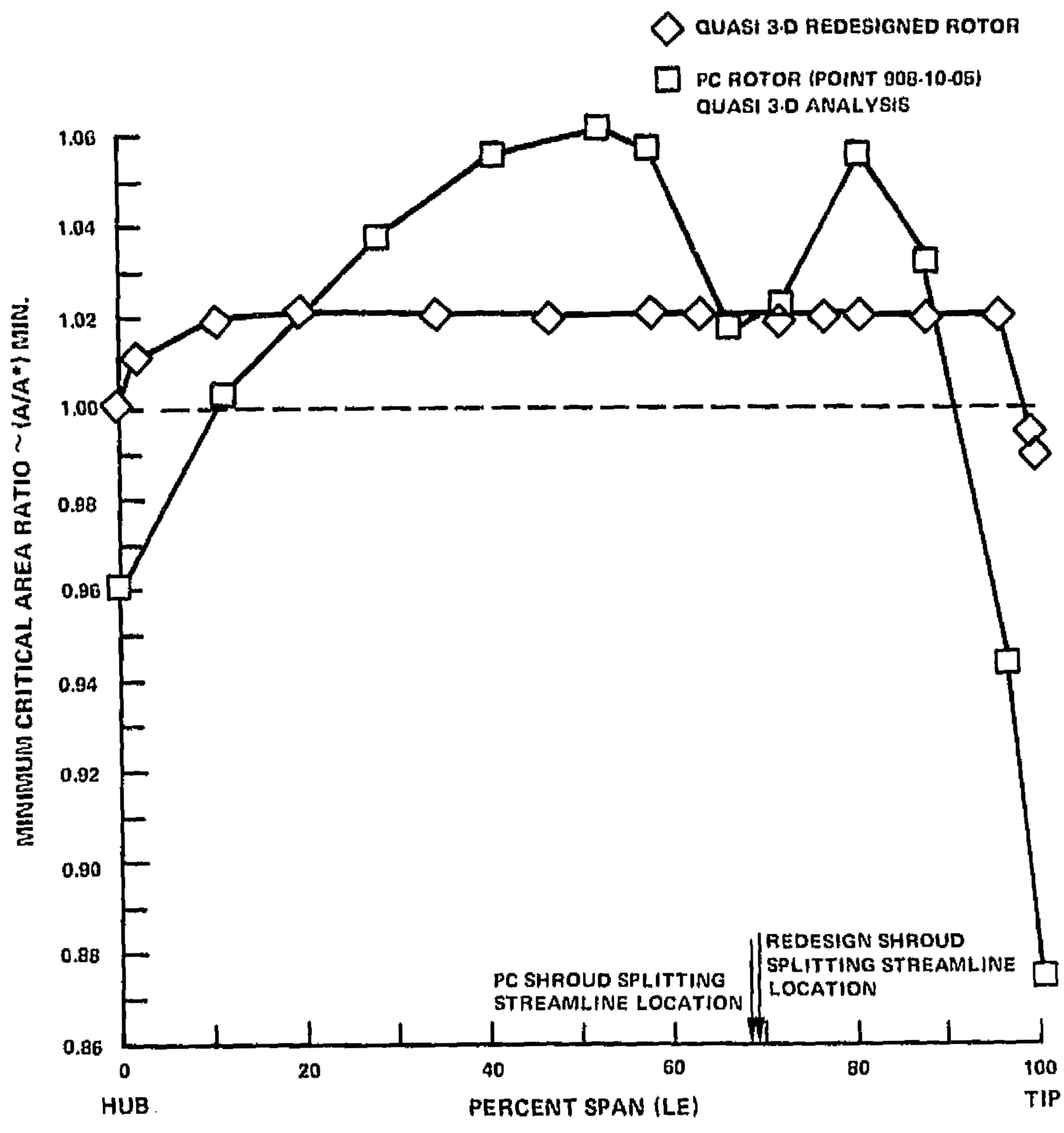


Figure 36 Minimum Critical Area Ratios, Comparing the Redesigned Rotor With the Precompression Rotor

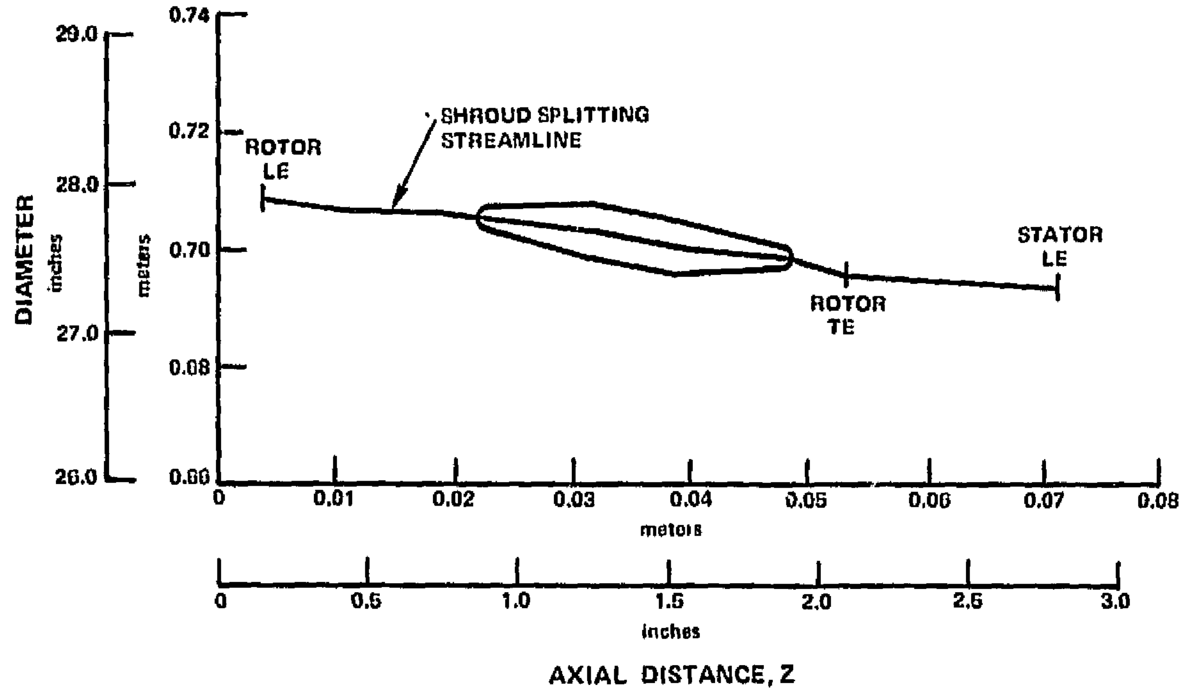


Figure 37 Partspan Shroud Contour and Splitting Streamline for Quasi 3-D Redesigned Rotor

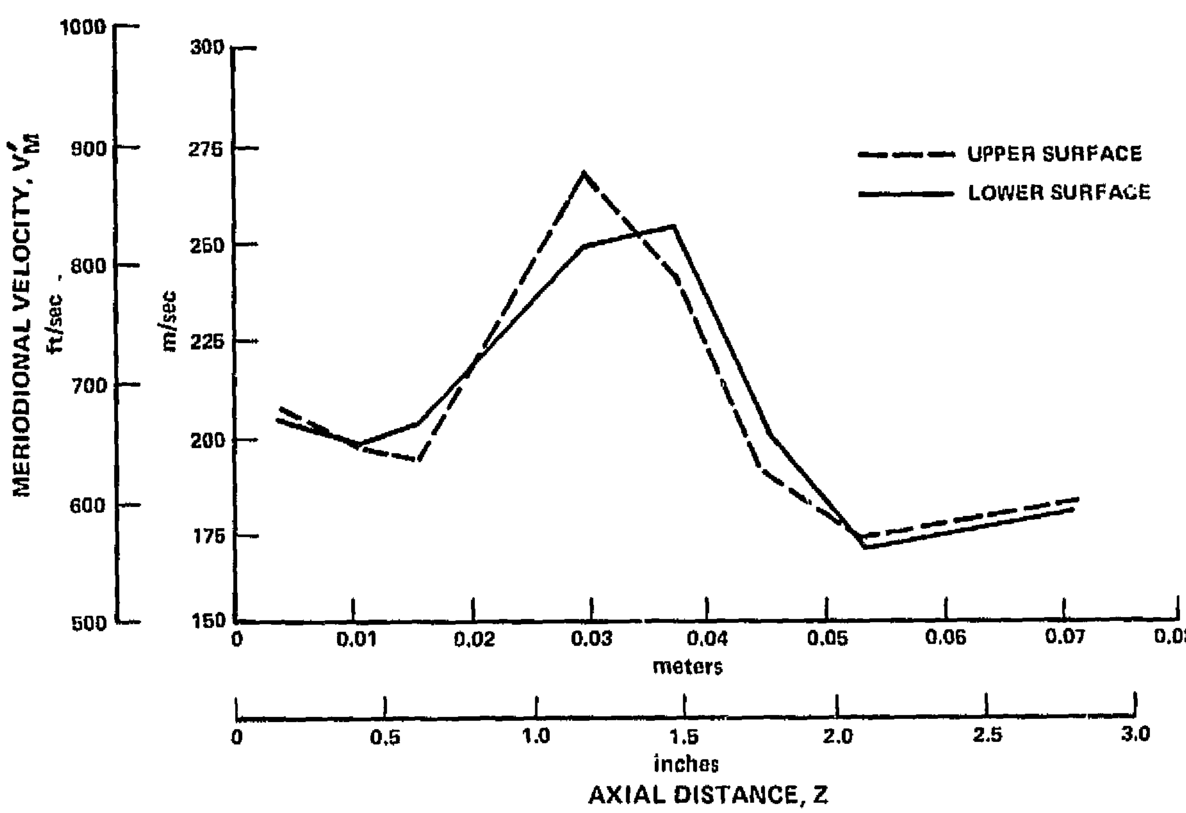


Figure 38 Axial Distribution of Calculated Velocities Near Partspan Shroud for the Quasi 3-D Redesigned Rotor

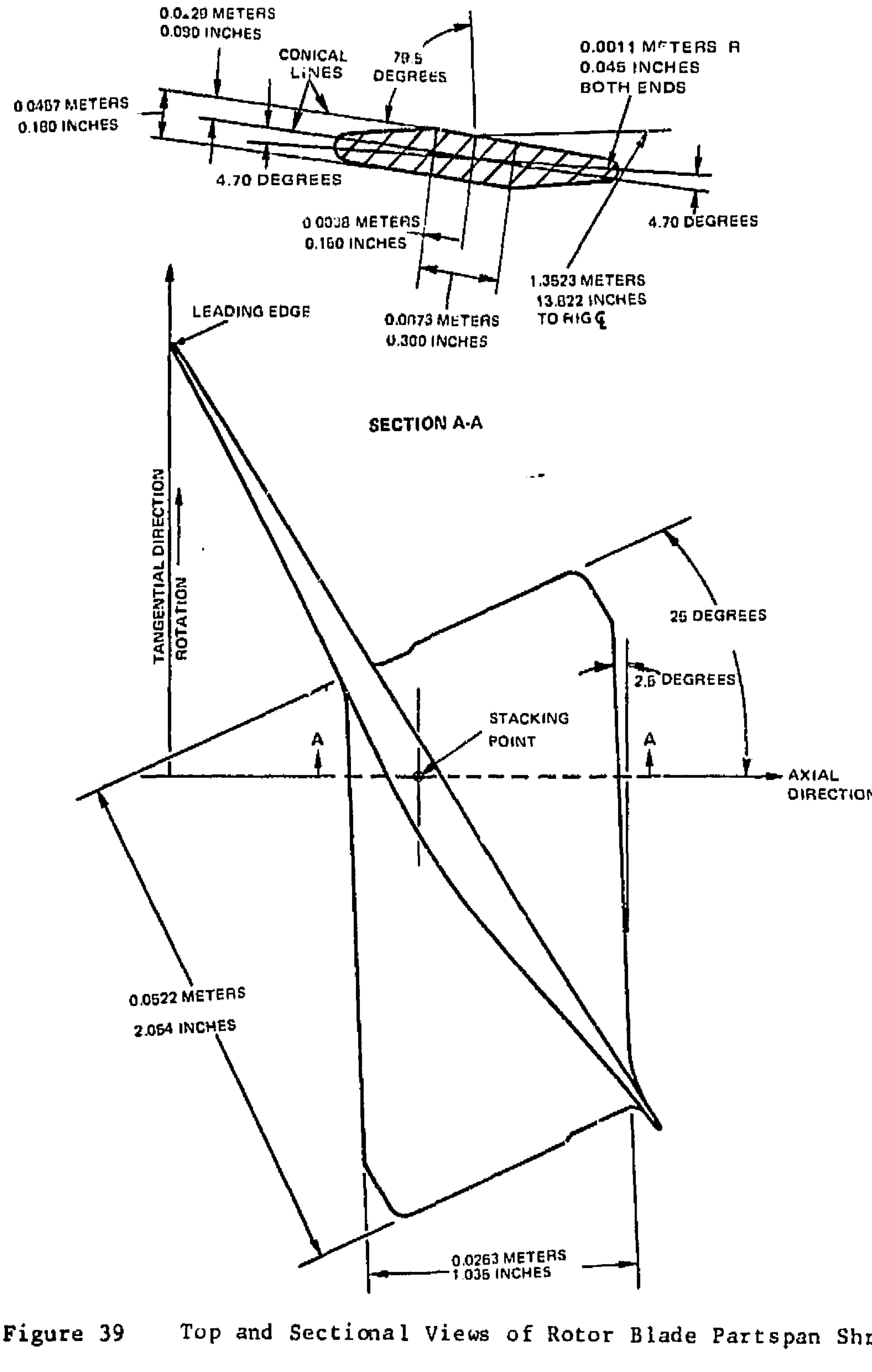


Figure 39 Top and Sectional Views of Rotor Blade Partspan Shroud

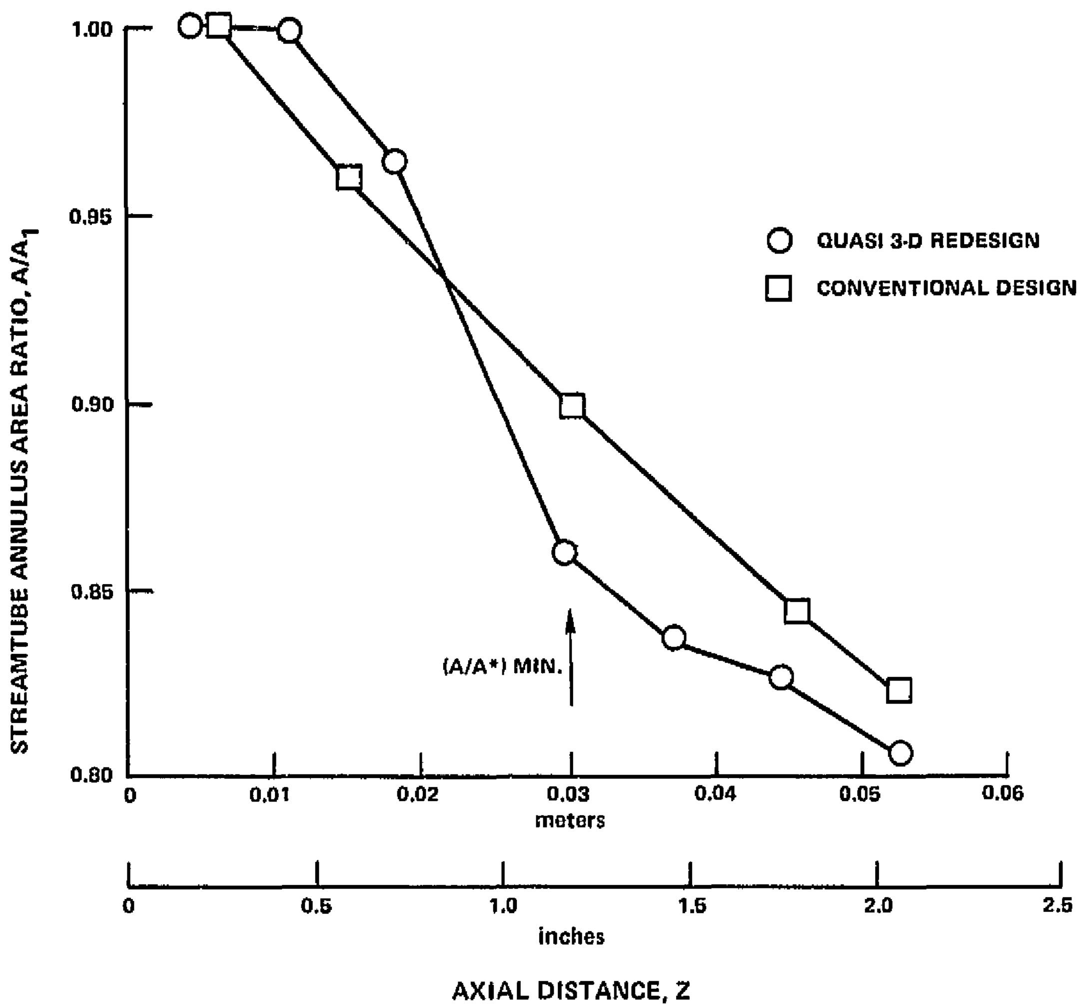


Figure 40 Streamtube Annulus Area Ratio vs. Axial Location, Comparing Shroud Effects for Quasi 3-D and Conventional Design Procedures

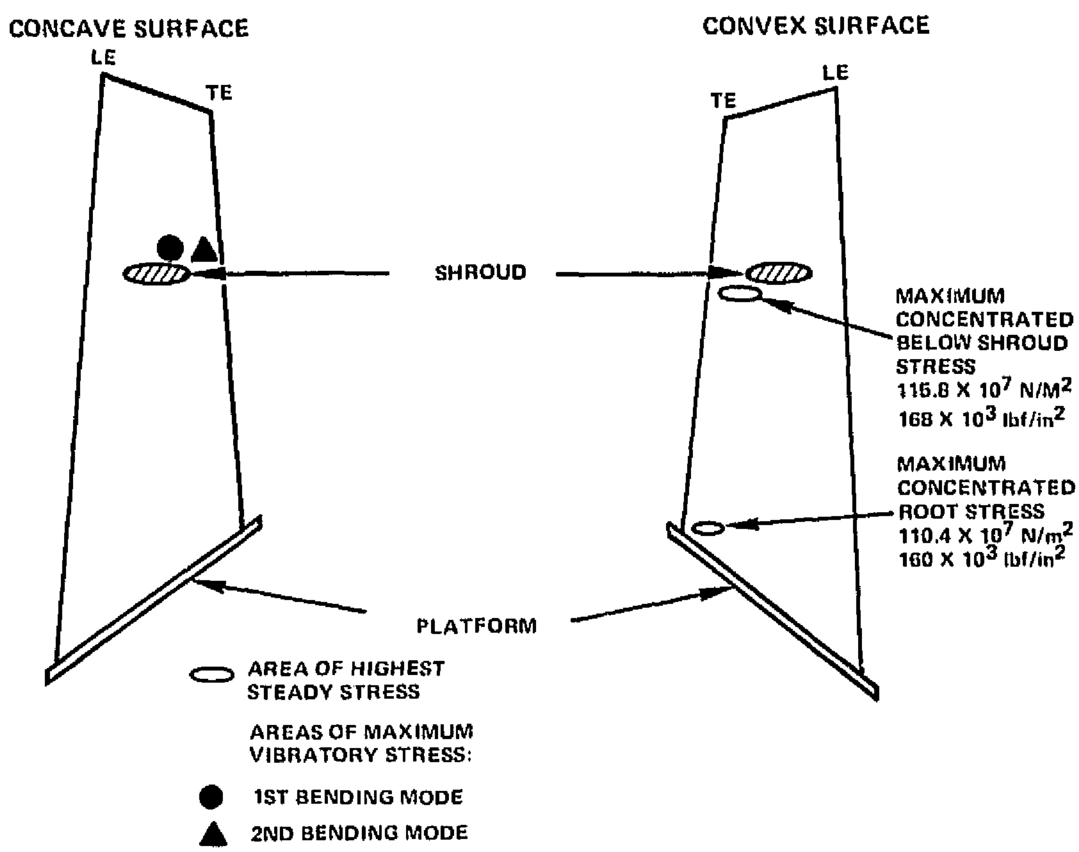


Figure 41 Rotor Blade Maximum Stress Locations Showing the Predicted Concentrated Stress Values.

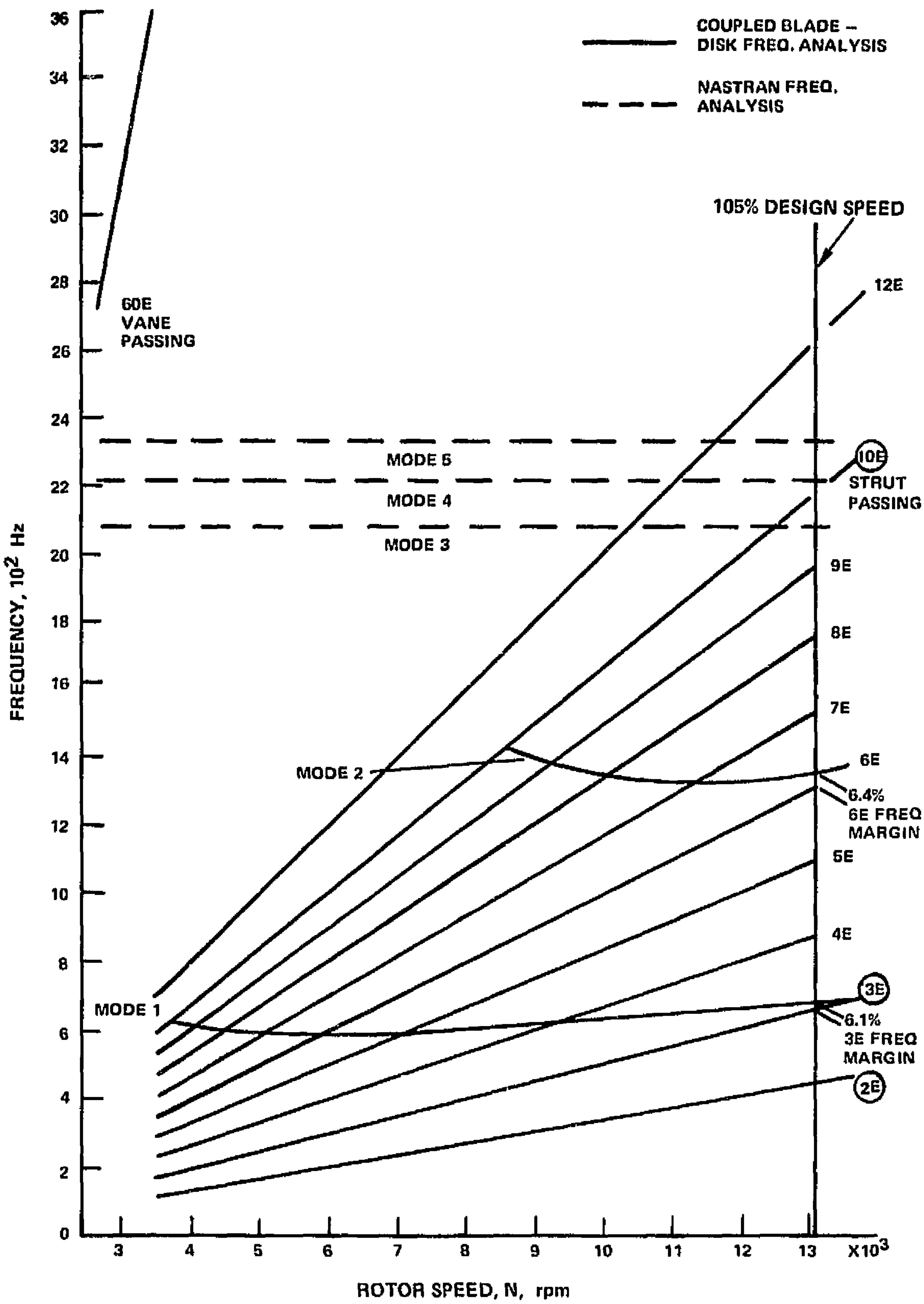


Figure 42 Rotor Blade Resonance Diagram

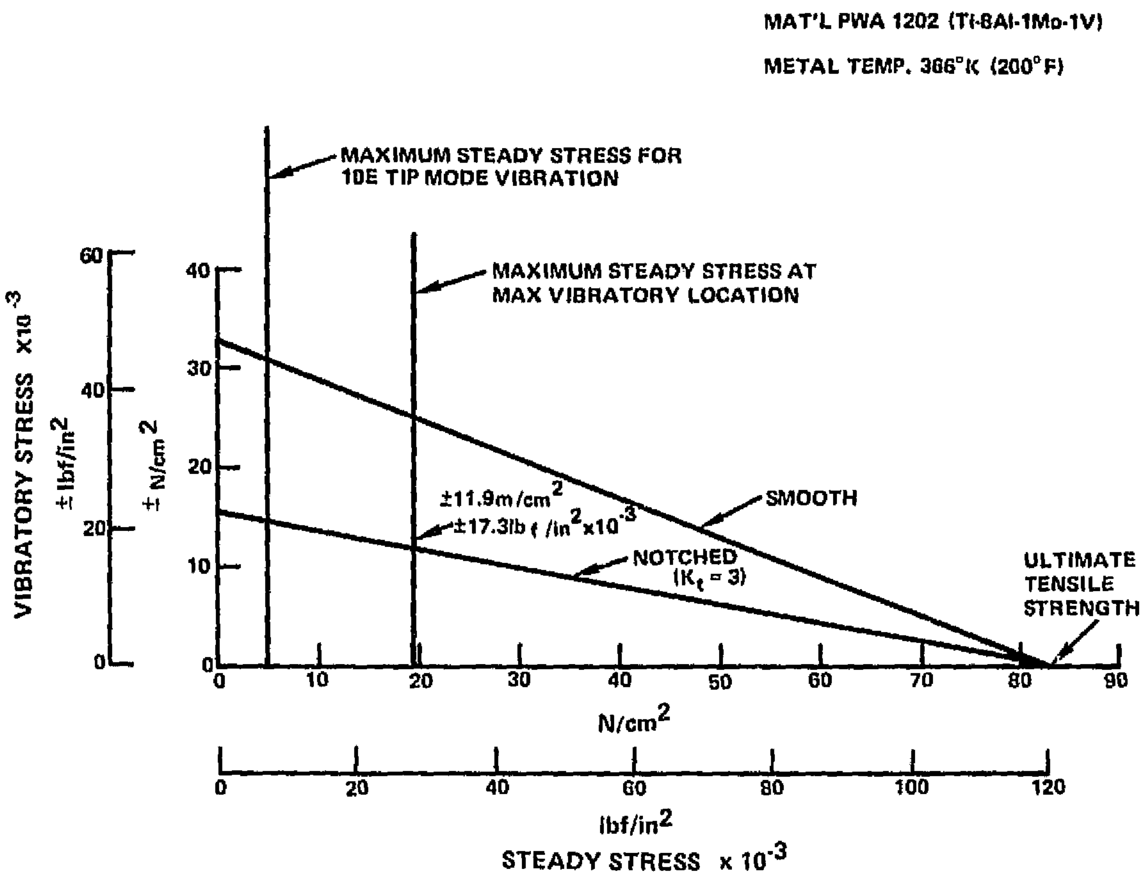


Figure 43 Modified Goodman Diagram

APPENDIX A

NOMENCLATURE

Symbol	Definition
A	area
A/A*	(area)/(sonic flow area)
a	distance along chord line to maximum camber point from leading edge
c	aerodynamic chord, i.e., along the flow surface
D	diffusion factor

$$\text{for rotor} = 1 - \frac{V'_2}{V'_1} + \frac{r_2 V_{\theta 2} - r_1 V_{\theta 1}}{(r_1 + r_2)\,\sigma V'_1}$$

$$\text{for stator} = 1 - \frac{V_4}{V_3} + \frac{r_3 V_{\theta 3} - r_4 V_{\theta 4}}{(r_3 + r_4)\,\sigma V_3}$$

E	excitations per rotor revolution
i_m	incidence angle between inlet air direction and line tangent to blade mean camber line at leading edge, degrees
i_{ss}	incidence angle between inlet air direction and line tangent to blade suction surface at leading edge, degrees
$\overline{K}$	blockage factor, effective/actual flow area
LCF	low cycle fatigue

NOMENCLATURE (Cont'd)

Symbol	Definition
LE	leading edge
M	Mach number
MCA	multiple-circular-arc
N	rotor speed, rpm
O/S	overshoot angle
p	pressure
PC	precompression blade
r	radius
R	distance along conical surface from apex to blade (see Figure 44)
R_c	streamline radius of curvature
RLE	radius at blade leading edge
RTE	radius at blade trailing edge
s	blade spacing
T	temperature
t	blade maximum thickness
TE	trailing edge
U	rotor tangential speed
V	air velocity
W	weight flow
x conical	distance in unwrapped conical plane
YP	airfoil coordinate of pressure surface normal to chord line
YS	airfoil coordinate of suction surface normal to chord line

NOMENCLATURE (Cont'd)

Symbol	Definition
YCSL	vertical distance to airfoil stacking line from chord line
y	length along calculation station
y conical	distance normal to x conical
Z	axial distance
ZC	airfoil coordinate parallel to chord line
ZCSL	horizontal distance to airfoil stacking line from leading edge along chord line
β	absolute air angle = COT^{-1} (V_m/V'_θ)
β'	relative air angle = COT^{-1} (V_m/V_θ)
β^*	metal angle, angle between tangent to mean camber line and meridional direction
γ	blade chord angle, angle between chord and axial direction
δ^o	deviation angle - exit air angle minus metal angle at trailing edge
E	angle on conical surface of revolution (see Figure 44)
ϵ	angle between tangent to streamline projected on meridional plane and axial direction
$\bar{\epsilon}$	cone angle = TAN^{-1} $\dfrac{(r_{te} - r_{le})}{(Z_{te} - Z_{le})}$
η_{ad}	adiabatic efficiency
λ	angle of calculation station measured from axial direction
ρ	density
σ	solidity or stress
ϕ	camber angle, difference between blade angles at leading and trailing edges on conical surface

NOMENCLATURE (Cont'd)

Symbol	Definition
ϕ_E	camber angle, difference between blade angles at leading and trailing edges on the unwrapped conical surface
ϕ_{Ef}	front camber angle, difference between blade angles at leading edge and MCA transition point on the unwrapped conical surface
ω	angular velocity
ω_t	torsional frequency
$\bar{\omega}$	total pressure loss coefficient, mass average defect in relative total pressure divided by difference between inlet stagnation and static pressures

Subscripts

av	average
f	front
le	leading edge
m	meridional direction (r-z plane)
p	profile
r	radial direction
ss	suction surface
t	total or stagnation
te	trailing edge
z	axial direction
θ	circumferential direction
1	station into rotor along leading edge
2	station out of rotor along trailing edge
3	station into stator along leading edge
4	station out of stator along trailing edge

Superscripts

'	relative to rotor
*	designates blade metal angle
o	degrees of arc or temperature

APPENDIX B

QUASI 3-D ANALYSIS METHOD

A quasi 3-D analysis was developed for calculating the intrablade transonic flowfield. This method is an iteration between a set of blade-to-blade calculations of the flowfields on average stream surfaces of revolution and a core flow axisymmetric intrablade calculation which satisfies radial equilibrium. The core flow solution is used because the static pressure field in the core flow controls shock location.

Loss Resolution

The quasi 3-D analysis resolves the total loss into shock and non-shock losses. The increment of loss attributed to shock waves is calculated in the blade-to-blade solution and is the increment which was optimized in the present redesign. Increments of non-shock losses are calculated for blade boundary layers, tip clearance and for the partspan shroud. Losses in excess of these calculated losses are designated as residual loss.

Axisymmetric Flowfield Calculation

Conventional streamline analysis is used to obtain a solution for the steady, compressible, inviscid, axisymmetric flowfield. The intrablade flowfield is calculated from axial and radial distributions of work, loss, blade blockage, and boundary layer blockage on the airfoil and end wall surfaces. Thus, the solution is a "core flow" or unmixed solution which yields a physically meaningful static pressure distribution for determination of shock strength. Axial distributions of work, loss, and blockage are obtained from the blade-to-blade solutions.

The partspan shroud is modeled in the axisymmetric intrablade analysis as an isolated body in a split flow. Full-span radial equilibrium is satisfied both upstream and downstream of the shroud, but discontinuities are allowed across the shroud. A priori knowledge of the flow split around the shroud is needed. The flow split is adjusted to keep the splitting streamline smooth and also balance the velocities above and below the shroud. In the design, diffusion on the shroud was minimized. The effects of this body appear in the calculated velocities because of its blockage and because of the streamline curvature it causes. The shroud influences the blade-to-blade calculation primarily through its effects on streamtube heights.

The axisymmetric solution satisfies radial equilibrium for the specified input and gives blade inlet and exit flow conditions and intrablade streamtube height ratio distributions for input into the blade-to-blade calculation.

Blade-to-Blade Calculations

The blade-to-blade program (a time-marching finite area calculation procedure, Reference 4) calculates the transonic flowfield between adjacent airfoils. Aerodynamic input in the form of blade inlet and exit conditions and the axial schedule of streamtube convergence are determined from the axisymmetric calculation. Conical section blade geometry is supplied either by a blade design geometry generator or an interpolation of known geometry.

The solution includes blade surface velocity profiles which are used as input into the boundary layer program (Reference 5). The boundary layer program generates a boundary layer thickness distribution which is added to the blade geometry for subsequent blade-to-blade solutions.

The blade-to-blade solution is used to generate gap averaged distributions of work, loss and blockage for use in the axisymmetric calculation. The amount of shock loss calculated by this program distinguishes good designs from bad. The blade design is then optimized by modifying the blade geometry to minimize shock loss. Iterations are performed until satisfactory convergence between the blade-to-blade and axisymmetric streamline analysis is achieved as discussed in the following section.

Convergence Criteria

Convergence of the quasi 3-D analysis is assessed primarily by comparing axial distributions of static pressure calculated by the intrablade streamline solution with gap-averaged values calculated by the blade-to-blade solution. Other criteria are: 1) continuous radial pattern of shock waves calculated by the blade-to-blade solutions, 2) smooth radial profiles of meridional velocity, and 3) a radial distribution of flow which satisfies both the unique incidence condition of the blade-to-blade solution and the radial equilibrium condition of the axisymmetric solution.

APPENDIX C

AERODYNAMIC SUMMARY FOR REDESIGNED ROTOR

NOMENCLATURE USED IN APPENDIX C PRINTOUTS

ESPI	ϵ
INCS	i_{ss}
INCM	i_m
DEV	δ^o
TURN	$\beta_1' - \beta_2'$
RHOVM	$\rho_1 V_{m1}/\rho_2 V_{m2}$
D-FAC	D
OMEGA-B	$\overline{\omega}$
LOSS-P	$\overline{\omega} \cos \beta'_2/2\sigma$
EFF-P	η_p
EFF-A	η_a

AERODYNAMIC SUMMARY

SL	V-1 M/SEC	V-2 M/SEC	VM-1 M/SEC	VM-2 M/SEC	Vθ-1 M/SEC	Vθ-2 M/SEC	U-1 M/SEC	U-2 M/SEC	V'-1 M/SEC	V'-2 M/SEC	Vθ'-1 M/SEC	Vθ'-2 M/SEC	RHOVM-1 KG/M2 SEC	RHOVM-2 KG/M2 SEC	EPSI-1 RADIAN	EPSI-2 RADIAN	PO/PO INLET
1	157.5	310.2	157.5	188.9	0.0	246.1	298.5	344.7	337.5	213.1	-298.5	-98.6	172.98	307.27	0.4802	0.5260	2.4216
2	168.5	301.7	168.5	186.6	0.0	237.1	316.8	354.5	358.8	220.4	-316.8	-117.4	182.07	306.31	0.3911	0.4567	2.3926
3	178.6	292.7	178.6	181.8	0.0	229.4	335.0	364.3	379.6	226.4	-335.0	-134.9	189.87	302.19	0.3096	0.3930	2.3719
4	196.7	268.3	196.7	163.1	0.0	213.0	383.6	393.8	431.1	243.6	-383.6	-180.9	202.73	281.96	0.0958	0.2309	2.3440
5	198.0	258.5	198.0	155.4	0.0	206.6	436.8	433.2	475.6	274.7	-436.8	-226.6	203.56	270.18	-0.0346	-0.0081	2.3400
6	200.6	259.7	200.6	147.8	0.0	213.5	461.9	452.8	503.6	281.3	-461.9	-239.4	205.26	252.79	-0.0872	-0.1266	2.3400
7	203.6	259.8	203.6	150.3	0.0	211.9	473.2	462.7	515.1	292.4	-473.2	-250.8	207.15	256.32	-0.1057	-0.2462	2.3400
8	207.4	258.0	207.4	153.4	0.0	207.4	484.6	472.5	527.1	306.3	-484.6	-265.1	209.47	262.41	-0.1340	-0.2773	2.3385
9	204.7	250.4	204.7	151.0	0.0	199.7	519.4	502.0	558.3	337.9	-519.4	-302.3	207.02	257.95	-0.2741	-0.3183	2.3144
10	198.7	245.6	198.7	146.8	0.0	196.9	530.7	511.9	566.7	347.5	-530.7	-315.0	204.01	250.71	-0.3050	-0.3349	2.2979
11	192.8	240.2	192.8	143.1	0.0	192.9	540.2	521.7	573.5	358.6	-540.2	-328.8	200.09	243.44	-0.3217	-0.3397	2.2679

SL	B-1 DEGREE	B-2 DEGREE	B'-1 DEGREE	B'-2 DEGREE	M-1	M-2	M'-1	M'-2	INCS DEGREE	INCM DEGREE	DEV DEGREE	TURN DEGREE	D FAC	OMEGA-B TOTAL	LOSS-P TOTAL	PO2/ PO1	%EFF-A TOTAL	%EFF-P TOTAL
1	0.0	52.5	62.18	27.56	0.4733	0.8591	1.0141	0.5900	-2.81	1.23	15.61	34.62	0.5312	0.0361	0.0068	2.4216	98.11	98.33
2	0.0	51.8	61.99	32.17	0.5080	0.8332	1.0815	0.6088	-1.67	2.04	14.39	29.81	0.5396	0.0432	0.0081	2.3926	97.47	97.76
3	0.0	51.6	61.94	36.59	0.5399	0.8055	1.1479	0.6230	-0.48	2.89	13.14	25.36	0.5505	0.0473	0.0089	2.3719	96.93	97.28
4	0.0	52.5	62.85	47.95	0.5986	0.7305	1.3118	0.6632	0.93	3.21	12.15	14.90	0.5673	0.0614	0.0110	2.3440	95.09	95.64
5	0.0	53.1	65.62	55.56	0.6027	0.6955	1.4600	0.7392	1.49	3.35	10.00	10.06	0.5533	0.1228	0.0205	2.3400	89.92	90.16
6	0.0	55.3	66.52	58.31	0.6113	0.6917	1.5344	0.7494	1.40	3.13	8.01	8.22	0.5691	0.1908	0.0307	2.3400	82.31	84.28
7	0.0	54.7	66.72	59.07	0.6211	0.6908	1.5713	0.7774	1.28	2.96	6.69	7.65	0.5579	0.1994	0.0319	2.3400	81.17	83.26
8	0.0	53.5	66.83	59.94	0.6335	0.6856	1.6103	0.8141	1.32	2.88	6.35	6.89	0.5390	0.1948	0.0306	2.3385	81.13	83.23
9	0.0	52.9	68.49	63.45	0.6246	0.6616	1.7038	0.8928	1.35	2.77	4.98	5.04	0.5048	0.2128	0.0302	2.3144	78.20	80.59
10	0.0	53.3	69.48	65.02	0.6050	0.6472	1.7255	0.9159	1.31	2.68	4.49	4.46	0.4922	0.2205	0.0292	2.2979	77.06	79.56
11	0.0	53.4	70.36	66.49	0.5858	0.6320	1.7427	0.9435	1.31	2.64	3.07	3.87	0.4765	0.2303	0.0285	2.2679	75.80	78.39

SL	V-1 ft/sec	V-2 ft/sec	VM-1 ft/sec	VM-2 ft/sec	Vθ-1 ft/sec	Vθ-2 ft/sec	U-1 ft/sec	U-2 ft/sec	V'-1 ft/sec	V'-2 ft/sec	Vθ'-1 ft/sec	Vθ'-2 ft/sec	RHOVM-1 LBM/FT2SEC	RHOVM-2 LBM/FT2SEC	EPSI-1 DEGREE	EPSI-2 DEGREE	PCT TE SPAN
1	516.9	1017.8	516.9	619.7	0.0	807.3	979.4	1130.7	1107.4	699.0	-979.4	-323.4	35.43	62.93	27.513	30.137	0.0500
2	552.9	989.9	552.9	612.2	0.0	777.9	1039.3	1163.0	1177.2	723.2	-1039.3	-385.1	37.29	62.74	22.408	26.166	0.1000
3	585.8	960.2	585.8	596.4	0.0	752.6	1099.1	1195.3	1245.5	742.7	-1099.1	-442.7	38.89	61.89	17.736	22.515	0.1500
4	645.4	880.2	645.4	535.2	0.0	698.7	1258.6	1292.1	1414.4	799.1	-1258.6	-593.4	41.52	57.75	5.491	13.232	0.3000
5	649.6	848.1	649.6	509.8	0.0	677.8	1433.2	1421.2	1573.6	901.4	-1433.2	-743.4	41.69	55.34	-1.981	-0.462	0.5000
6	658.2	851.9	658.2	484.9	0.0	700.4	1515.4	1485.7	1652.1	922.9	-1515.4	-785.3	42.04	51.78	-4.998	-7.253	0.6000
7	668.0	852.3	668.0	493.1	0.0	695.2	1552.4	1518.0	1690.0	959.2	-1552.4	-822.8	42.43	52.50	-6.055	-14.105	0.6500
8	680.4	846.4	680.4	503.4	0.0	680.4	1589.9	1550.3	1729.4	1005.0	-1589.9	-869.8	42.90	53.74	-7.679	-15.886	0.7000
9	671.5	821.6	671.5	495.5	0.0	655.3	1704.2	1647.1	1831.7	1108.7	-1704.2	-991.8	42.56	52.83	-15.703	-18.236	0.8500
10	651.8	805.7	651.8	481.5	0.0	645.9	1741.2	1679.4	1859.2	1140.1	-1741.2	-1033.4	41.78	51.35	-17.474	-19.191	0.9000
11	632.6	788.0	632.6	469.3	0.0	633.0	1772.2	1711.6	1881.7	1176.4	-1772.2	-1078.7	40.98	49.86	-18.431	-19.466	0.9500

WC1/A1 LBM/SEC SQFT	WC1/A1 KG/SEC SQM	TO/TO INLET	PO/PO INLET	EFF-AD INLET %	EFF-P INLET %	TO2/TO1	PO2/PO1	EFF-AD ROTOR %	EFF-P ROTOR %
38.70	188.9	1.3163	2.3409	86.80	88.28	1.3163	2.3409	86.80	88.28

APPENDIX D

BLADE AIRFOIL GEOMETRY ON CONICAL SURFACES

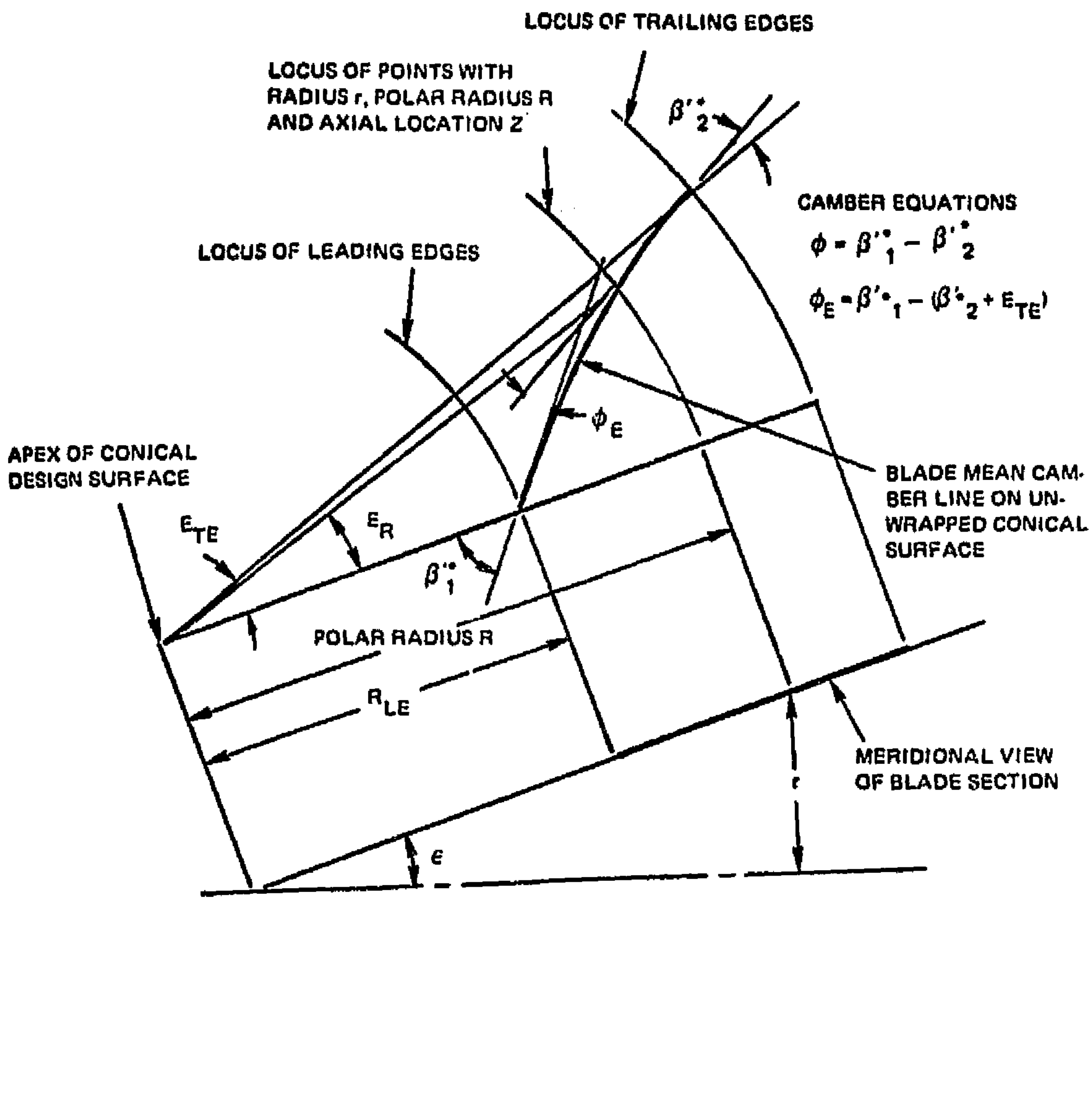


Figure 44   Unwrapped Conical Surface Definitions

ROTOR BLADE GEOMETRY ON CONICAL SURFACES
38 BLADES

S.I. UNITS : METERS (M) AND RADIANS (RAD)

D_1 (M)	D_2 (M)	%SPAN LE	C (M)	C_f (M)	LER (MM)	TER (MM)	β_1^* (RAD)	β_2^* (RAD)	ϕ_E (RAD)	ϕ_{EP} (RAD)	$\bar{\epsilon}$ (RAD)	O/S (RAD)	A/C	σ
0.4204	0.5130	0.0	0.0967	0.0289	0.2972	0.2591	1.0725	0.1222	0.8052	0.1644	0.6339	0.0	0.5166	2.4975
0.4285	0.5170	1.9	0.0964	0.0291	0.2946	0.2591	1.0708	0.1369	0.7962	0.1731	0.6054	0.0	0.5151	2.4606
0.4663	0.5359	10.9	0.0958	0.0305	0.2794	0.2540	1.0616	0.2618	0.6857	0.1612	0.4888	0.0	0.5163	2.3111
0.5041	0.5544	19.9	0.0947	0.0341	0.2616	0.2438	1.0309	0.3904	0.5491	0.0827	0.3768	0.0	0.5439	2.1654
0.5653	0.5898	34.5	0.0925	0.0383	0.2388	0.2206	1.0288	0.5773	0.4000	0.0255	0.2099	-0.0843	0.5910	1.9361
0.6176	0.6255	47.0	0.0922	0.0397	0.2104	0.2159	1.0572	0.7044	0.3338	-0.0233	0.0769	-0.0932	0.6800	1.7947
0.6646	0.6608	58.1	0.0931	0.0420	0.2057	0.2057	1.0838	0.7872	0.3059	-0.0206	-0.0392	-0.0770	0.6587	1.6987
0.6869	0.6784	63.5	0.0936	0.0432	0.2032	0.2032	1.0989	0.8412	0.2783	-0.0508	-0.0880	-0.0029	0.5975	1.6592
0.7244	0.7102	72.4	0.0953	0.0456	0.2032	0.2032	1.1127	0.9180	0.2296	-0.0324	-0.1517	0.0266	0.5885	1.6080
0.7431	0.7265	76.8	0.0966	0.0468	0.2032	0.2032	1.1163	0.9390	0.2187	-0.0686	-0.1803	0.0335	0.6417	1.5903
0.7597	0.7409	80.8	0.0978	0.0482	0.2032	0.2032	1.1203	0.9639	0.2035	-0.1002	-0.2058	0.0348	0.6711	1.5770
0.7922	0.7699	88.5	0.1016	0.0512	0.2032	0.2032	1.1434	1.0226	0.1798	-0.0875	-0.2545	0.0314	0.0678	1.5741
0.8246	0.7983	96.2	0.1078	0.0550	0.2032	0.2032	1.1785	1.0910	0.1610	-0.0265	-0.3068	0.0314	0.6395	1.6067
0.8375	0.8105	99.3	0.1110	0.0567	0.2032	0.2032	1.1945	1.1235	0.1508	-0.0151	-0.3254	0.0314	0.6310	1.6289
0.8404	0.8133	100.0	0.1117	0.0571	0.2032	0.2032	1.2003	1.1303	•0.1513	-0.0138	-0.3303	0.0314	0.6290	1.6332

U.S. CUSTOMARY UNITS : INCHES (IN) AND DEGREES (DEG)

D_1 (IN)	D_2 (IN)	%SPAN TE	C (IN)	C_f (IN)	LER (IN)	TER (IN)	β_1^* (DEG)	β_2^* (DEG)	ϕ_E (DEG)	ϕ_{EP} (DEG)	$\bar{\epsilon}$ (DEG)	O/S (DEG)	T/C MAX	LOC TMAX % C
16.55	20.20	0.0	3.807	1.136	0.0117	0.0102	61.45	7.00	46.13	9.42	36.32	0.0	0.0757	54.0430
16.87	20.35	1.3	3.794	1.145	0.0116	0.0102	61.35	7.85	45.62	9.92	34.69	0.0	0.0751	54.0741
18.36	21.10	7.6	3.771	1.200	0.0110	0.0100	60.82	15.00	39.29	9.24	28.01	0.0	0.0630	54.4245
19.85	21.83	13.8	3.730	1.343	0.0103	0.0096	59.07	22.37	31.46	4.74	21.59	0.0	0.0593	55.8591
22.26	23.22	25.6	3.641	1.508	0.0094	0.0090	58.95	33.08	22.92	1.46	12.03	-4.83	0.0583	58.3915
24.31	24.62	37.4	3.630	1.562	0.0086	0.0085	60.57	40.36	19.12	-1.34	4.41	-5.34	0.0572	60.4394
26.17	26.02	49.2	3.664	1.652	0.0081	0.0081	62.09	45.10	17.53	-1.18	-2.25	-4.41	0.0553	61.9024
27.05	26.71	55.1	3.687	1.700	0.0080	0.0080	62.96	48.20	15.95	-2.91	-5.04	-0.16	0.0541	66.6784
28.52	27.96	65.7	3.754	1.794	0.0080	0.0080	63.75	52.60	13.15	-1.86	-8.69	1.53	0.0517	66.5733
29.25	28.60	71.1	3.804	1.844	0.0080	0.0080	63.96	53.80	12.53	-3.93	-10.33	1.92	0.0490	62.7952
29.91	29.17	75.9	3.852	1.897	0.0080	0.0080	64.19	55.23	11.66	-5.74	-11.79	1.99	0.0461	62.4807
31.19	30.31	85.5	4.002	2.017	0.0080	0.0080	65.51	58.59	10.30	-5.02	-14.58	1.80	0.0403	61.9158
32.46	31.43	95.0	4.245	2.164	0.0060	0.0080	67.52	62.51	9.22	-1.52	-17.58	1.80	0.0345	61.4783
32.97	31.91	99.1	4.371	2.234	0.0080	0.0080	68.44	64.37	8.64	-0.87	-18.64	1.80	0.0321	61.3404
33.09	32.02	100.0	4.399	2.248	0.0080	0.0080	68.77	64.76	8.67	-0.79	-18.92	1.80	0.031[illegible]	[illegible]1.3091

APPENDIX E

MANUFACTURING COORDINATES FOR BLADE SECTIONS
NORMAL TO STACKING LINE

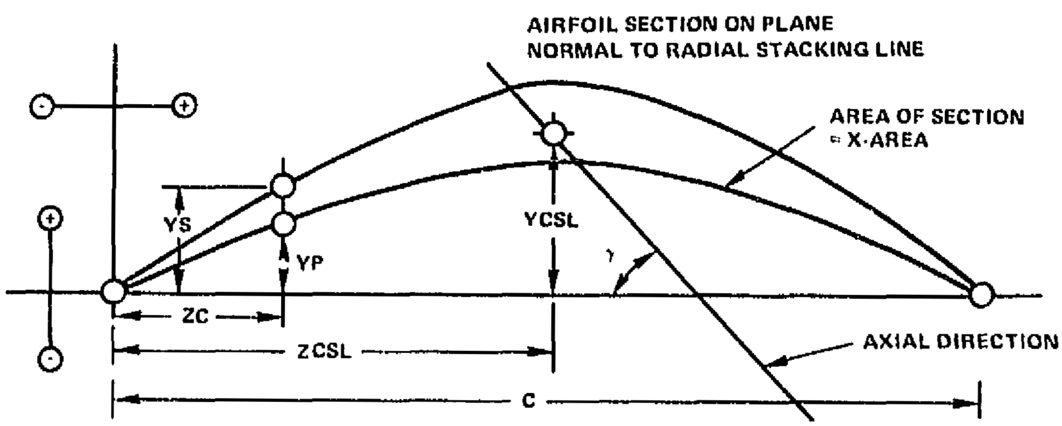


Figure 45 Airfoil Designations for Manufacturing Coordinates

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0003	0.0003	0.0	-0.0109	0.0121
0.0025	0.0003	0.0014	0.1001	0.0128	0.0550
0.0051	0.0009	0.0024	0.2003	0.0355	0.0962
0.0076	0.0014	0.0034	0.3004	0.0566	0.1353
0.0102	0.0019	0.0044	0.4006	0.0765	0.1732
0.0127	0.0024	0.0053	0.5007	0.0952	0.2099
0.0153	0.0029	0.0062	0.6008	0.1126	0.2446
0.0178	0.0033	0.0071	0.7010	0.1291	0.2784
0.0203	0.0037	0.0079	0.8011	0.1444	0.3119
0.0229	0.0040	0.0087	0.9013	0.1589	0.3444
0.0254	0.0044	0.0095	1.0014	0.1719	0.3733
0.0280	0.0047	0.0102	1.1016	0.1837	0.4001
0.0305	0.0049	0.0108	1.2017	0.1939	0.4244
0.0331	0.0052	0.0113	1.3018	0.2029	0.4446
0.0356	0.0053	0.0118	1.4020	0.2100	0.4631
0.0382	0.0055	0.0121	1.5021	0.2159	0.4772
0.0407	0.0056	0.0124	1.6023	0.2199	0.4890
0.0432	0.0056	0.0126	1.7024	0.2222	0.4969
0.0458	0.0057	0.0128	1.8025	0.2229	0.5020
0.0483	0.0056	0.0128	1.9027	0.2217	0.5035
0.0509	0.0056	0.0127	2.0028	0.2186	0.5017
0.0534	0.0054	0.0126	2.1030	0.2133	0.4966
0.0560	0.0052	0.0124	2.2031	0.2057	0.4871
0.0585	0.0050	0.0120	2.3033	0.1957	0.4734
0.0610	0.0047	0.0116	2.4034	0.1832	0.4549
0.0636	0.0043	0.0109	2.5035	0.1676	0.4311
0.0661	0.0038	0.0102	2.6037	0.1486	0.4009
0.0687	0.0032	0.0092	2.7038	0.1256	0.3630
0.0712	0.0025	0.0080	2.8040	0.0979	0.3153
0.0738	0.0016	0.0064	2.9041	0.0646	0.2539
0.0763	0.0006	0.0044	3.0042	0.0241	0.1718
0.0789	-0.0007	0.0013	3.1044	-0.0260	0.0510

RADIUS (METERS) = 0.2024	RADIUS (INCHES) = 7.9700
CHORD (METERS) = 0.0789	CHORD (INCHES) = 3.1044
ZCSL (METERS) = 0.0437	ZCSL (INCHES) = 1.7223
YCSL (METERS) = 0.0079	YCSL (INCHES) = 0.3110
RLE (METERS) =0.000301	RLE (INCHES) = 0.0119
RTE (METERS) =0.000891	RTE (INCHES) = 0.0351
X-AREA(SQ.METERS)=0.000407	X-AREA (SQ. IN.) = 0.6315
GAMMA-CHORD(RAD.)= 0.7343	GAMMA-CHORD(DEG.)= 42.07

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0003	0.0003	0.0	-0.0104	0.0117
0.0026	0.0004	0.0014	0.1030	0.0144	0.0552
0.0052	0.0010	0.0025	0.2060	0.0380	0.0984
0.0078	0.0015	0.0035	0.3090	0.0594	0.1388
0.0105	0.0020	0.0045	0.4119	0.0788	0.1764
0.0131	0.0025	0.0054	0.5149	0.0967	0.2121
0.0157	0.0029	0.0063	0.6179	0.1138	0.2463
0.0183	0.0033	0.0071	0.7209	0.1295	0.2792
0.0209	0.0037	0.0079	0.8239	0.1442	0.3111
0.0235	0.0040	0.0087	0.9269	0.1576	0.3420
0.0262	0.0043	0.0094	1.0299	0.1701	0.3712
0.0288	0.0046	0.0101	1.1328	0.1811	0.3970
0.0314	0.0048	0.0107	1.2358	0.1909	0.4205
0.0340	0.0051	0.0112	1.3388	0.1992	0.4405
0.0366	0.0052	0.0116	1.4418	0.2061	0.4578
0.0392	0.0054	0.0120	1.5448	0.2117	0.4713
0.0419	0.0055	0.0123	1.6477	0.2153	0.4823
0.0445	0.0055	0.0124	1.7507	0.2176	0.4894
0.0471	0.0055	0.0125	1.8537	0.2181	0.4935
0.0497	0.0055	0.0126	1.9567	0.2168	0.4941
0.0523	0.0054	0.0125	2.0597	0.2137	0.4913
0.0549	0.0053	0.0123	2.1627	0.2085	0.4850
0.0575	0.0051	0.0121	2.2657	0.2011	0.4745
0.0602	0.0049	0.0117	2.3687	0.1915	0.4596
0.0628	0.0046	0.0112	2.4716	0.1793	0.4402
0.0654	0.0042	0.0105	2.5746	0.1641	0.4153
0.0680	0.0037	0.0098	2.6776	0.1458	0.3840
0.0706	0.0031	0.0088	2.7806	0.1238	0.3452
0.0732	0.0025	0.0075	2.8836	0.0972	0 2966
0.0759	0.0017	0.0060	2.9866	0.0655	0.2350
0.0785	0.0007	0.0039	3.0895	0.0270	0.1536
0.0811	-0.0005	0.0009	3.1925	-0.0203	0.0366

RADIUS (METERS) = 0.2129	RADIUS (INCHES) = 8.3835
CHORD (METERS) = 0.0811	CHORD (INCHES) = 3.1925
ZCSL (METERS) = 0.0451	ZCSL (INCHES) = 1.7764
YCSL (METERS) = 0.0075	YCSL (INCHES) = 0.2952
RLE (METERS) =0.000289	RLE (INCHES) = 0.0114
RTE (METERS) =0.000677	RTE (INCHES) = 0.0266
X-AREA(SQ.METERS)=0.000408	X-AREA (SQ. IN.) = 0.6317
GAMMA-CHORD(RAD.)= 0.7144	GAMMA-CHORD(DEG.)= 40.93

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0096	0.0104
0.0027	0.0006	0.0016	0.1070	0.0254	0.0624
0.0054	0.0015	0.0028	0.2140	0.0576	0.1110
0.0082	0.0022	0.0040	0.3210	0.0875	0.1569
0.0109	0.0029	0.0051	0.4281	0.1151	0.2006
0.0136	0.0036	0.0061	0.5351	0.1402	0.2419
0.0163	0.0041	0.0071	0.6421	0.1627	0.2807
0.0190	0.0046	0.0081	0.7491	0.1826	0.3170
0.0217	0.0051	0.0089	0.8561	0.1998	0.3510
0.0245	0.0054	0.0097	0.9631	0.2141	0.3824
0.0272	0.0057	0.0104	1.0701	0.2255	0.4114
0.0299	0.0059	0.0111	1.1772	0.2341	0.4369
0.0326	0.0061	0.0116	1.2842	0.2398	0.4584
0.0353	0.0062	0.0121	1.3912	0.2426	0.4760
0.0381	0.0062	0.0124	1.4982	0.2425	0.4897
0.0408	0.0061	0.0127	1.6052	0.2412	0.4994
0.0435	0.0061	0.0128	1.7122	0.2412	0.5052
0.0462	0.0061	0.0129	1.8193	0.2401	0.5072
0.0489	0.0060	0.0129	1.9263	0.2373	0.5063
0.0516	0.0059	0.0128	2.0333	0.2330	0.5023
0.0544	0.0058	0.0126	2.1403	0.2271	0.4948
0.0571	0.0056	0.0123	2.2473	0.2193	0.4838
0.0598	0.0053	0.0119	2.3543	0.2096	0.4690
0.0625	0.0050	0.0114	2.4613	0.1978	0.4499
0.0652	0.0047	0.0108	2.5683	0.1838	0.4264
0.0680	0.0042	0.0101	2.6754	0.1673	0.3978
0.0707	0.0038	0.0092	2.7824	0.1479	0.3632
0.0734	0.0032	0.0082	2.8894	0.1252	0.3216
0.0761	0.0025	0.0069	2.9964	0.0987	0.2710
0.0788	0.0017	0.0053	3.1034	0.0678	0.2088
0.0815	0.0008	0.0033	3.2104	0.0311	0.1293
0.0843	-0.0003	0.0005	3.3174	-0.0130	0.0207

RADIUS (METERS) = 0.2306	RADIUS (INCHES) = 9.0769
CHORD (METERS) = 0.0843	CHORD (INCHES) = 3.3175
ZCSL (METERS) = 0.0470	ZCSL (INCHES) = 1.8496
YCSL (METERS) = 0.0075	YCSL (INCHES) = 0.2967
RLE (METERS) =0.000251	RLE (INCHES) = 0.0099
RTE (METERS) =0.000418	RTE (INCHES) = 0.0164
X-AREA(SQ.METERS)=0.000394	X-AREA (SQ. IN.) = 0.6114
GAMMA-CHORD(RAD.)= 0.7049	GAMMA-CHORD(DEG.)= 40.39

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0095	0.0100
0.0028	0.0006	0.0015	0.1096	0.0233	0.0585
0.0056	0.0014	0.0027	0.2191	0.0557	0.1063
0.0083	0.0022	0.0039	0.3287	0.0870	0.1525
0.0111	0.0030	0.0050	0.4383	0.1171	0.1973
0.0139	0.0037	0.0061	0.5478	0.1458	0.2405
0.0167	0.0044	0.0072	0.6574	0.1731	0.2819
0.0195	0.0050	0.0082	0.7670	0.1987	0.3216
0.0223	0.0057	0.0091	0.8765	0.2225	0.3593
0.0250	0.0062	0.0100	0.9861	0.2444	0.3949
0.0278	0.0067	0.0109	1.0956	0.2640	0.4282
0.0306	0.0071	0.0116	1.2052	0.2808	0.4584
0.0334	0.0074	0.0123	1.3148	0.2922	0.4845
0.0362	0.0076	0.0128	1.4243	0.3006	0.5054
0.0390	0.0078	0.0132	1.5339	0.3061	0.5211
0.0417	0.0078	0.0135	1.6435	0.3085	0.5328
0.0445	0.0078	0.0137	1.7530	0.3080	0.5401
0.0473	0.0077	0.0138	1.8626	0.3042	0.5433
0.0501	0.0076	0.0138	1.9722	0.2973	0.5421
0.0529	0.0073	0.0136	2.0817	0.2868	0.5364
0.0557	0.0069	0.0134	2.1913	0.2728	0.5260
0.0584	0.0065	0.0130	2.3009	0.2549	0.5106
0.0612	0.0059	0.0124	2.4104	0.2329	0.4897
0.0640	0.0054	0.0118	2.5200	0.2131	0.4628
0.0668	0.0050	0.0109	2.6296	0.1963	0.4284
0.0696	0.0045	0.0100	2.7391	0.1770	0.3941
0.0724	0.0039	0.0091	2.8487	0.1550	0.3563
0.0751	0.0033	0.0079	2.9583	0.1301	0.3115
0.0779	0.0026	0.0066	3.0678	0.1019	0.2585
0.0807	0.0018	0.0050	3.1774	0.0697	0.1950
0.0835	0.0008	0.0030	3.2870	0.0328	0.1167
0.0863	-0.0003	0.0004	3.3965	-0.0102	0.0147

RADIUS (METERS) = 0.2420	RADIUS (INCHES) = 9.5269
CHORD (METERS) = 0.0863	CHORD (INCHES) = 3.3965
ZCSL (METERS) = 0.0482	ZCSL (INCHES) = 1.8967
YCSL (METERS) = 0.0082	YCSL (INCHES) = 0.3214
RLE (METERS) =0.000246	RLE (INCHES) = 0.0097
RTE (METERS) =0.000316	RTE (INCHES) = 0.0125
X-AREA(SQ.METERS)=0.000370	X-AREA (SQ. IN.) = 0.5737
GAMMA-CHORD(RAD.)= 0.7173	GAMMA-CHORD(DEG.)= 41.10

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0095	0.0102
0.0028	0.0005	0.0014	0.1114	0.0190	0.0535
0.0057	0.0012	0.0024	0.2228	0.0470	0.0963
0.0085	0.0019	0.0035	0.3341	0.0739	0.1380
0.0113	0.0025	0.0045	0.4455	0.0997	0.1787
0.0141	0.0032	0.0055	0.5569	0.1248	0.2181
0.0170	0.0038	0.0065	0.6683	0.1503	0.2569
0.0198	0.0045	0.0075	0.7796	0.1755	0.2957
0.0226	0.0051	0.0085	0.8910	0.1995	0.3332
0.0255	0.0056	0.0094	1.0024	0.2222	0.3694
0.0283	0.0062	0.0103	1.1138	0.2435	0.4039
0.0311	0.0067	0.0111	1.2251	0.2632	0.4364
0.0339	0.0071	0.0118	1.3365	0.2811	0.4660
0.0368	0.0075	0.0125	1.4479	0.2967	0.4915
0.0396	0.0079	0.0130	1.5593	0.3097	0.5125
0.0424	0.0081	0.0134	1.6706	0.3199	0.5293
0.0453	0.0083	0.0138	1.7820	0.3273	0.5416
0.0481	0.0084	0.0140	1.8934	0.3317	0.5495
0.0509	0.0085	0.0140	2.0048	0.3328	0.5529
0.0537	0.0084	0.0140	2.1161	0.3307	0.5516
0.0566	0.0083	0.0139	2.2275	0.3252	0.5455
0.0594	0.0080	0.0136	2.3389	0.3163	0.5346
0.0622	0.0077	0.0132	2.4503	0.3030	0.5185
0.0651	0.0073	0.0126	2.5616	0.2856	0.4970
0.0679	0.0067	0.0119	2.6730	0.2639	0.4693
0.0707	0.0060	0.0111	2.7844	0.2375	0.4351
0.0736	0.0052	0.0100	2.8958	0.2059	0.3931
0.0764	0.0043	0.0087	3.0071	0.1682	0.3418
0.0792	0.0031	0.0071	3.1185	0.1235	0.2786
0.0820	0.0018	0.0050	3.2299	0.0693	0.1985
0.0849	0.0008	0.0026	3.3413	0.0307	0.1018
0.0877	-0.0002	0.0003	3.4527	-0.0090	0.0119

RADIUS (METERS) = 0.2537	RADIUS (INCHES) = 9.9874
CHORD (METERS) = 0.0877	CHORD (INCHES) = 3.4527
ZCSL (METERS) = 0.0487	ZCSL (INCHES) = 1.9162
YCSL (METERS) = 0.0085	YCSL (INCHES) = 0.3353
RLE (METERS) =0.000251	RLE (INCHES) = 0.0099
RTE (METERS) =0.000270	RTE (INCHES) = 0.0106
X-AREA(SQ.METERS)=0.000348	X-AREA (SQ. IN.) = 0.5389
GAMMA-CHORD(RAD.)= 0.7254	GAMMA-CHORD(DEG.)= 41.56

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0094	0.0102
0.0028	0.0005	0.0014	0.1117	0.0192	0.0533
0.0057	0.0012	0.0024	0.2233	0.0473	0.0959
0.0085	0.0019	0.0035	0.3350	0.0743	0.1374
0.0113	0.0025	0.0045	0.4467	0.1004	0.1778
0.0142	0.0032	0.0055	0.5583	0.1254	0.2171
0.0170	0.0038	0.0065	0.6700	0.1494	0.2553
0.0199	0.0044	0.0074	0.7816	0.1724	0.2924
0.0227	0.0049	0.0083	0.8933	0.1944	0.3283
0.0255	0.0055	0.0092	1.0050	0.2172	0.3638
0.0284	0.0061	0.0101	1.1166	0.2388	0.3982
0.0312	0.0066	0.0110	1.2283	0.2590	0.4312
0.0340	0.0070	0.0117	1.3399	0.2775	0.4614
0.0369	0.0075	0.0124	1.4516	0.2937	0.4874
0.0397	0.0078	0.0129	1.5633	0.3076	0.5092
0.0425	0.0081	0.0134	1.6749	0.3188	0.5267
0.0454	0.0083	0.0137	1.7866	0.3273	0.5399
0.0482	0.0085	0.0139	1.8983	0.3329	0.5487
0.0511	0.0085	0.0140	2.0099	0.3355	0.5531
0.0539	0.0085	0.0140	2.1216	0.3350	0.5530
0.0567	0.0084	0.0139	2.2332	0.3311	0.5481
0.0596	0.0082	0.0137	2.3449	0.3238	0.5383
0.0624	0.0079	0.0133	2.4566	0.3130	0.5235
0.0652	0.0076	0.0128	2.5682	0.2986	0.5033
0.0681	0.0071	0.0121	2.6799	0.2796	0.4774
0.0709	0.0065	0.0113	2.7916	0.2559	0.4453
0.0737	0.0058	0.0103	2.9032	0.2272	0.4057
0.0766	0.0049	0.0091	3.0149	0.1928	0.3576
0.0794	0.0039	0.0076	3.1265	0.1520	0.2987
0.0823	0.0026	0.0057	3.2382	0.1033	0.2255
0.0851	0.0011	0.0033	3.3499	0.0445	0.1305
0.0879	-0.0002	0.0003	3.4615	-0.0090	0.0116

RADIUS (METERS) = 0.2562	RADIUS (INCHES) =10.0871
CHORD (METERS) = 0.0879	CHORD (INCHES) = 3.4615
ZCSL (METERS) = 0.0487	ZCSL (INCHES) = 1.9168
YCSL (METERS) = 0.0086	YCSL (INCHES) = 0.3375
RLE (METERS) =0.000251	RLE (INCHES) = 0.0099
RTE (METERS) =0.000249	RTE (INCHES) = 0.0098
X-AREA(SQ.METERS)=0.000343	X-AREA (SQ. IN.) = 0.5323
GAMMA-CHORD(RAD.)= 0.7270	GAMMA-CHORD(DEG.)= 41.65

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0094	0.0102
0.0028	0.0005	0.0014	0.1118	0.0192	0.0532
0.0057	0.0012	0.0024	0.2235	0.0473	0.0957
0.0085	0.0019	0.0035	0.3353	0.0744	0.1371
0.0114	0.0025	0.0045	0.4470	0.1004	0.1775
0.0142	0.0032	0.0055	0.5588	0.1254	0.2167
0.0170	0.0038	0.0065	0.6705	0.1494	0.2548
0.0199	0.0044	0.0074	0.7823	0.1723	0.2918
0.0227	0.0049	0.0083	0.8940	0.1943	0.3277
0.0255	0.0055	0.0092	1.0058	0.2158	0.3627
0.0284	0.0060	0.0101	1.1175	0.2375	0.3967
0.0312	0.0065	0.0109	1.2293	0.2577	0.4296
0.0341	0.0070	0.0117	1.3410	0.2763	0.4599
0.0369	0.0074	0.0123	1.4528	0.2926	0.4860
0.0397	0.0078	0.0129	1.5646	0.3066	0.5079
0.0426	0.0081	0.0133	1.6763	0.3180	0.5255
0.0454	0.0083	0.0137	1.7881	0.3268	0.5390
0.0483	0.0084	0.0139	1.8998	0.3327	0.5480
0.0511	0.0085	0.0140	2.0116	0.3356	0.5526
0.0539	0.0085	0.0140	2.1233	0.3353	0.5526
0.0568	0.0084	0.0139	2.2351	0.3318	0.5480
0.0596	0.0083	0.0137	2.3468	0.3248	0.5385
0.0624	0.0080	0.0133	2.4586	0.3144	0.5240
0.0653	0.0076	0.0128	2.5703	0.3003	0.5040
0.0681	0.0072	0.0122	2.6821	0.2825	0.4784
0.0710	0.0066	0.0113	2.7938	0.2593	0.4468
0.0738	0.0059	0.0104	2.9056	0.2313	0.4079
0.0766	0.0050	0.0092	3.0174	0.1977	0.3603
0.0795	0.0040	0.0077	3.1291	0.1577	0.3024
0.0823	0.0028	0.0059	3.2409	0.1101	0.2306
0.0852	0.0013	0.0035	3.3526	0.0530	0.1381
0.0880	-0.0002	0.0003	3.4644	-0.0095	0.0129

RADIUS (METERS) = 0.2568	RADIUS (INCHES) =10.1120
CHORD (METERS) = 0.0880	CHORD (INCHES) = 3.4644
ZCSL (METERS) = 0.0487	ZCSL (INCHES) = 1.9170
YCSL (METERS) = 0.0086	YCSL (INCHES) = 0.3375
RLE (METERS) =0.000251	RLE (INCHES) = 0.0099
RTE (METERS) =0.000256	RTE (INCHES) = 0.0101
X-AREA(SQ.METERS)=0.000342	X-AREA (SQ. IN.) = 0.5307
GAMMA-CHORD(RAD.)= 0.7277	GAMMA-CHORD(DEG.)= 41.70

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0094	0.0102
0.0028	0.0005	0.0013	0.1119	0.0192	0.0530
0.0057	0.0012	0.0024	0.2238	0.0472	0.0954
0.0085	0.0019	0.0035	0.3357	0.0742	0.1366
0.0114	0.0025	0.0045	0.4475	0.1001	0.1768
0.0142	0.0032	0.0055	0.5594	0.1250	0.2158
0.0171	0.0038	0.0064	0.6713	0.1489	0.2538
0.0199	0.0044	0.0074	0.7832	0.1718	0.2906
0.0227	0.0049	0.0083	0.8951	0.1936	0.3263
0.0256	0.0054	0.0092	1.0070	0.2145	0.3612
0.0284	0.0060	0.0100	1.1189	0.2354	0.3947
0.0313	0.0065	0.0109	1.2307	0.2556	0.4273
0.0341	0.0070	0.0116	1.3426	0.2742	0.4574
0.0369	0.0074	0.0123	1.4545	0.2905	0.4835
0.0398	0.0077	0.0128	1.5664	0.3046	0.5055
0.0426	0.0080	0.0133	1.6783	0.3161	0.5232
0.0455	0.0083	0.0136	1.7902	0.3250	0.5368
0.0483	0.0084	0.0139	1.9021	0.3310	0.5458
0.0512	0.0085	0.0140	2.0139	0.3341	0.5506
0.0540	0.0085	0.0140	2.1258	0.3341	0.5508
0.0568	0.0084	0.0139	2.2377	0.3308	0.5463
0.0597	0.0082	0.0136	2.3496	0.3241	0.5369
0.0625	0.0080	0.0133	2.4615	0.3139	0.5225
0.0654	0.0076	0.0128	2.5734	0.3001	0.5028
0.0682	0.0072	0.0121	2.6853	0.2826	0.4773
0.0710	0.0066	0.0113	2.7971	0.2605	0.4459
0.0739	0.0059	0.0104	2.9090	0.2330	0.4075
0.0767	0.0051	0.0092	3.0209	0.2000	0.3605
0.0796	0.0041	0.0077	3.1328	0.1607	0.3033
0.0824	0.0029	0.0059	3.2447	0.1140	0.2326
0.0853	0.0015	0.0036	3.3566	0.0579	0.1421
0.0881	-0.0003	0.0004	3.4685	-0.0104	0.0144

RADIUS (METERS) = 0.2575	RADIUS (INCHES) =10.1369
CHORD (METERS) = 0.0881	CHORD (INCHES) = 3.4685
ZCSL (METERS) = 0.0487	ZCSL (INCHES) = 1.9176
YCSL (METERS) = 0.0085	YCSL (INCHES) = 0.3361
RLE (METERS) =0.000250	RLE (INCHES) = 0.0099
RTE (METERS) =0.000274	RTE (INCHES) = 0.0108
X-AREA(SQ.METERS)=0.000341	X-AREA (SQ. IN.) = 0.5287
GAMMA-CHORD(RAD.)= 0.7293	GAMMA-CHORD(DEG.)= 41.79

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0093	0.0102
0.0029	0.0005	0.0013	0.1128	0.0184	0.0518
0.0057	0.0012	0.0024	0.2256	0.0455	0.0929
0.0086	0.0018	0.0034	0.3383	0.0716	0.1329
0.0115	0.0025	0.0044	0.4511	0.0966	0.1719
0.0143	0.0031	0.0053	0.5639	0.1206	0.2097
0.0172	0.0036	0.0063	0.6767	0.1436	0.2465
0.0201	0.0042	0.0072	0.7895	0.1655	0.2820
0.0229	0.0047	0.0080	0.9023	0.1863	0.3165
0.0258	0.0052	0.0089	1.0150	0.2061	0.3501
0.0286	0.0057	0.0097	1.1278	0.2249	0.3822
0.0315	0.0062	0.0105	1.2406	0.2427	0.4132
0.0344	0.0066	0.0112	1.3534	0.2596	0.4418
0.0372	0.0070	0.0119	1.4662	0.2750	0.4668
0.0401	0.0073	0.0124	1.5790	0.2886	0.4882
0.0430	0.0076	0.0128	1.6917	0.2997	0.5055
0.0458	0.0078	0.0132	1.8045	0.3083	0.5186
0.0487	0.0080	0.0134	1.9173	0.3143	0.5274
0.0516	0.0081	0.0135	2.0301	0.3174	0.5318
0.0544	0.0081	0.0135	2.1429	0.3175	0.5318
0.0573	0.0080	0.0134	2.2557	0.3145	0.5271
0.0602	0.0078	0.0131	2.3685	0.3081	0.5176
0.0630	0.0076	0.0128	2.4812	0.2982	0.5030
0.0659	0.0072	0.0123	2.5940	0.2846	0.4830
0.0688	0.0068	0.0116	2.7068	0.2672	0.4573
0.0716	0.0062	0.0108	2.8196	0.2460	0.4255
0.0745	0.0056	0.0098	2.9324	0.2209	0.3871
0.0773	0.0048	0.0087	3.0451	0.1896	0.3411
0.0802	0.0039	0.0072	3.1579	0.1519	0.2852
0.0831	0.0027	0.0055	3.2707	0.1071	0.2166
0.0859	0.0014	0.0033	3.3835	0.0536	0.1302
0.0888	-0.0003	0.0004	3.4963	-0.0109	0.0142

RADIUS (METERS) = 0.2600　　RADIUS (INCHES) =10.2366
CHORD (METERS) = 0.0888　　CHORD (INCHES) = 3.4963
ZCSL (METERS) = 0.0488　　ZCSL (INCHES) = 1.9215
YCSL (METERS) = 0.0081　　YCSL (INCHES) = 0.3205
RLE (METERS) =0.000250　　RLE (INCHES) = 0.0098
RTE (METERS) =0.000285　　RTE (INCHES) = 0.0112
X-AREA(SQ.METERS)=0.000336　　X-AREA (SQ. IN.) = 0.5215
GAMMA-CHORD(RAD.)= 0.7411　　GAMMA-CHORD(DEG.)= 42.46

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0092	0.0102
0.0029	0.0004	0.0013	0.1137	0.0173	0.0501
0.0058	0.0011	0.0023	0.2274	0.0433	0.0896
0.0087	0.0017	0.0033	0.3411	0.0682	0.1281
0.0116	0.0023	0.0042	0.4549	0.0921	0.1655
0.0144	0.0029	0.0051	0.5686	0.1149	0.2017
0.0173	0.0035	0.0060	0.6823	0.1366	0.2369
0.0202	0.0040	0.0069	0.7960	0.1573	0.2710
0.0231	0.0045	0.0077	0.9097	0.1768	0.3038
0.0260	0.0050	0.0085	1.0234	0.1951	0.3358
0.0289	0.0054	0.0093	1.1371	0.2122	0.3663
0.0318	0.0058	0.0100	1.2508	0.2282	0.3956
0.0347	0.0062	0.0107	1.3646	0.2429	0.4224
0.0375	0.0065	0.0113	1.4783	0.2562	0.4460
0.0404	0.0068	0.0118	1.5920	0.2681	0.4660
0.0433	0.0071	0.0122	1.7057	0.2785	0.4822
0.0462	0.0073	0.0126	1.8194	0.2873	0.4948
0.0491	0.0074	0.0128	1.9331	0.2932	0.5036
0.0520	0.0075	0.0129	2.0468	0.2962	0.5085
0.0549	0.0075	0.0129	2.1606	0.2965	0.5082
0.0578	0.0075	0.0128	2.2743	0.2938	0.5034
0.0607	0.0073	0.0125	2.3880	0.2879	0.4938
0.0635	0.0071	0.0122	2.5017	0.2785	0.4792
0.0664	0.0067	0.0117	2.6154	0.2654	0.4592
0.0693	0.0063	0.0110	2.7291	0.2486	0.4336
0.0722	0.0058	0.0102	2.8428	0.2279	0.4019
0.0751	0.0052	0.0092	2.9565	0.2032	0.3637
0.0780	0.0044	0.0081	3.0703	0.1741	0.3180
0.0809	0.0036	0.0067	3.1840	0.1400	0.2636
0.0838	0.0025	0.0050	3.2977	0.0988	0.1987
0.0866	0.0012	0.0030	3.4114	0.0489	0.1179
0.0895	-0.0003	0.0003	3.5251	-0.0108	0.0134

RADIUS (METERS) = 0.2631 RADIUS (INCHES) =10.3566
CHORD (METERS) = 0.0895 CHORD (INCHES) = 3.5251
ZCSL (METERS) = 0.0489 ZCSL (INCHES) = 1.9264
YCSL (METERS) = 0.0077 YCSL (INCHES) = 0.3014
RLE (METERS) =0.000247 RLE (INCHES) = 0.0097
RTE (METERS) =0.000283 RTE (INCHES) = 0.0111
X-AREA(SQ.METERS)=0.000331 X-AREA (SQ. IN.) = 0.5131
GAMMA-CHORD(RAD.)= 0.7562 GAMMA-CHORD(DEG.)= 43.33

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0090	0.0101
0.0029	0.0004	0.0012	0.1146	0.0159	0.0479
0.0058	0.0010	0.0022	0.2292	0.0402	0.0852
0.0087	0.0016	0.0031	0.3438	0.0635	0.1216
0.0116	0.0022	0.0040	0.4584	0.0857	0.1568
0.0146	0.0027	0.0049	0.5730	0.1069	0.1910
0.0175	0.0032	0.0057	0.6876	0.1270	0.2241
0.0204	0.0037	0.0065	0.8022	0.1460	0.2560
0.0233	0.0042	0.0073	0.9167	0.1638	0.2869
0.0262	0.0046	0.0080	1.0313	0.1802	0.3166
0.0291	0.0050	0.0088	1.1459	0.1952	0.3451
0.0320	0.0053	0.0095	1.2605	0.2088	0.3722
0.0349	0.0056	0.0101	1.3751	0.2211	0.3970
0.0378	0.0059	0.0106	1.4897	0.2316	0.4189
0.0407	0.0061	0.0111	1.6043	0.2410	0.4373
0.0437	0.0063	0.0115	1.7189	0.2492	0.4519
0.0466	0.0065	0.0118	1.8335	0.2562	0.4631
0.0495	0.0066	0.0120	1.9481	0.2616	0.4708
0.0524	0.0067	0.0121	2.0627	0.2651	0.4747
0.0553	0.0068	0.0121	2.1773	0.2665	0.4748
0.0582	0.0067	0.0120	2.2919	0.2655	0.4707
0.0611	0.0066	0.0117	2.4065	0.2611	0.4622
0.0640	0.0064	0.0114	2.5210	0.2527	0.4489
0.0669	0.0061	0.0109	2.6356	0.2408	0.4299
0.0699	0.0057	0.0103	2.7502	0.2252	0.4049
0.0728	0.0052	0.0095	2.8648	0.2058	0.3739
0.0757	0.0046	0.0085	2.9794	0.1825	0.3365
0.0786	0.0039	0.0074	3.0940	0.1550	0.2921
0.0815	0.0031	0.0061	3.2086	0.1229	0.2395
0.0844	0.0022	0.0045	3.3232	0.0854	0.1773
0.0873	0.0010	0.0026	3.4378	0.0413	0.1026
0.0902	-0.0003	0.0003	3.5524	-0.0103	0.0122

RADIUS (METERS) = 0.2668	RADIUS (INCHES) =10.5056
CHORD (METERS) = 0.0902	CHORD (INCHES) = 3.5524
ZCSL (METERS) = 0.0491	ZCSL (INCHES) = 1.9327
YCSL (METERS) = 0.0070	YCSL (INCHES) = 0.2771
RLE (METERS) =0.000247	RLE (INCHES) = 0.0097
RTE (METERS) =0.000274	RTE (INCHES) = 0.0108
X-AREA(SQ.METERS)=0.000325	X-AREA (SQ. IN.) = 0.5036
GAMMA-CHORD(RAD.)= 0.7760	GAMMA-CHORD(DEG.)= 44.46

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0088	0.0099
0.0029	0.0003	0.0011	0.1152	0.0136	0.0445
0.0059	0.0009	0.0020	0.2304	0.0354	0.0786
0.0088	0.0014	0.0028	0.3457	0.0561	0.1116
0.0117	0.0019	0.0037	0.4609	0.0759	0.1437
0.0146	0.0024	0.0044	0.5761	0.0946	0.1748
0.0176	0.0029	0.0052	0.6913	0.1122	0.2048
0.0205	0.0033	0.0059	0.8066	0.1288	0.2337
0.0234	0.0037	0.0066	0.9218	0.1441	0.2615
0.0263	0.0040	0.0073	1.0370	0.1579	0.2882
0.0293	0.0043	0.0080	1.1522	0.1700	0.3137
0.0322	0.0046	0.0086	1.2674	0.1805	0.3379
0.0351	0.0048	0.0091	1.3827	0.1895	0.3600
0.0380	0.0050	0.0096	1.4979	0.1967	0.3798
0.0410	0.0052	0.0101	1.6131	0.2028	0.3962
0.0439	0.0053	0.0104	1.7283	0.2084	0.4092
0.0468	0.0054	0.0106	1.8435	0.2131	0.4190
0.0498	0.0055	0.0108	1.9588	0.2167	0.4255
0.0527	0.0056	0.0109	2.0740	0.2192	0.4286
0.0556	0.0056	0.0109	2.1892	0.2201	0.4283
0.0585	0.0056	0.0108	2.3044	0.2193	0.4243
0.0615	0.0055	0.0106	2.4197	0.2163	0.4164
0.0644	0.0054	0.0103	2.5349	0.2110	0.4044
0.0673	0.0052	0.0099	2.6501	0.2031	0.3881
0.0702	0.0049	0.0093	2.7653	0.1921	0.3667
0.0732	0.0045	0.0086	2.8806	0.1772	0.3395
0.0761	0.0040	0.0078	2.9958	0.1577	0.3055
0.0790	0.0034	0.0067	3.1110	0.1331	0.2641
0.0819	0.0027	0.0054	3.2262	0.1044	0.2144
0.0849	0.0018	0.0040	3.3414	0.0716	0.1572
0.0878	0.0009	0.0023	3.4567	0.0337	0.0903
0.0907	-0.0002	0.0003	3.5719	-0.0098	0.0113

RADIUS (METERS) = 0.2722	RADIUS (INCHES) =10.7148
CHORD (METERS) = 0.0907	CHORD (INCHES) = 3.5719
ZCSL (METERS) = 0.0493	ZCSL (INCHES) = 1.9417
YCSL (METERS) = 0.0062	YCSL (INCHES) = 0.2434
RLE (METERS) =0.000242	RLE (INCHES) = 0.0095
RTE (METERS) =0.000267	RTE (INCHES) = 0.0105
X-AREA(SQ.METERS)=0.000318	X-AREA (SQ. IN.) = 0.4934
GAMMA-CHORD(RAD.)= 0.8056	GAMMA-CHORD(DEG.)= 46.16

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0084	0.0094
0.0029	0.0003	0.0010	0.1158	0.0113	0.0408
0.0059	0.0007	0.0018	0.2316	0.0290	0.0697
0.0088	0.0012	0.0025	0.3475	0.0457	0.0977
0.0118	0.0016	0.0032	0.4633	0.0615	0.1249
0.0147	0.0019	0.0038	0.5791	0.0763	0.1512
0.0177	0.0023	0.0045	0.6949	0.0902	0.1766
0.0206	0.0026	0.0051	0.8107	0.1030	0.2009
0.0235	0.0029	0.0057	0.9265	0.1144	0.2241
0.0265	0.0032	0.0063	1.0424	0.1242	0.2463
0.0294	0.0034	0.0068	1.1582	0.1323	0.2675
0.0324	0.0035	0.0073	1.2740	0.1386	0.2875
0.0353	0.0036	0.0078	1.3898	0.1431	0.3061
0.0382	0.0037	0.0082	1.5056	0.1460	0.3229
0.0412	0.0038	0.0086	1.6215	0.1481	0.3369
0.0441	0.0038	0.0088	1.7373	0.1501	0.3479
0.0471	0.0039	0.0090	1.8531	0.1518	0.3559
0.0500	0.0039	0.0092	1.9689	0.1532	0.3611
0.0530	0.0039	0.0092	2.0847	0.1542	0.3633
0.0559	0.0039	0.0092	2.2005	0.1544	0.3624
0.0588	0.0039	0.0091	2.3164	0.1536	0.3585
0.0618	0.0039	0.0089	2.4322	0.1518	0.3513
0.0647	0.0038	0.0087	2.5480	0.1488	0.3408
0.0677	0.0037	0.0083	2.6638	0.1444	0.3269
0.0706	0.0035	0.0079	2.7796	0.1388	0.3094
0.0735	0.0033	0.0073	2.8954	0.1309	0.2870
0.0765	0.0030	0.0066	3.0113	0.1191	0.2590
0.0794	0.0026	0.0057	3.1271	0.1030	0.2246
0.0824	0.0021	0.0047	3.2429	0.0823	0.1832
0.0853	0.0014	0.0034	3.3587	0.0560	0.1342
0.0883	0.0006	0.0019	3.4745	0.0244	0.0753
0.0912	-0.0002	0.0003	3.5904	-0.0094	0.0111

RADIUS (METERS) = 0.2800	RADIUS (INCHES) =11.0236
CHORD (METERS) = 0.0912	CHORD (INCHES) = 3.5904
ZCSL (METERS) = 0.0496	ZCSL (INCHES) = 1.9544
YCSL (METERS) = 0.0049	YCSL (INCHES) = 0.1941
RLE (METERS) =0.000232	RLE (INCHES) = 0.0091
RTE (METERS) =0.000269	RTE (INCHES) = 0.0106
X-AREA(SQ.METERS)=0.000309	X-AREA (SQ. IN.) = 0.4793
GAMMA-CHORD(RAD.)= 0.8533	GAMMA-CHORD(DEG.)= 48.89

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0085	0.0094
0.0029	0.0002	0.0009	0.1160	0.0073	0.0359
0.0059	0.0006	0.0016	0.2320	0.0226	0.0619
0.0088	0.0009	0.0022	0.3480	0.0372	0.0872
0.0118	0.0013	0.0028	0.4640	0.0510	0.1117
0.0147	0.0016	0.0034	0.5800	0.0640	0.1355
0.0177	0.0019	0.0040	0.6960	0.0762	0.1584
0.0206	0.0022	0.0046	0.8120	0.0874	0.1803
0.0236	0.0025	0.0051	0.9280	0.0972	0.2012
0.0265	0.0027	0.0056	1.0440	0.1055	0.2212
0.0295	0.0028	0.0061	1.1599	0.1119	0.2402
0.0324	0.0030	0.0066	1.2759	0.1163	0.2583
0.0354	0.0030	0.0070	1.3919	0.1184	0.2751
0.0383	0.0030	0.0074	1.5079	0.1182	0.2904
0.0412	0.0030	0.0077	1.6239	0.1176	0.3027
0.0442	0.0030	0.0079	1.7399	0.1171	0.3124
0.0471	0.0030	0.0081	1.8559	0.1168	0.3193
0.0501	0.0030	0.0082	1.9719	0.1165	0.3236
0.0530	0.0030	0.0083	2.0879	0.1162	0.3250
0.0560	0.0029	0.0082	2.2039	0.1156	0.3237
0.0589	0.0029	0.0081	2.3199	0.1147	0.3196
0.0619	0.0029	0.0079	2.4359	0.1134	0.3127
0.0648	0.0028	0.0077	2.5519	0.1114	0.3029
0.0678	0.0028	0.0074	2.6679	0.1089	0.2901
0.0707	0.0027	0.0070	2.7839	0.1062	0.2746
0.0737	0.0026	0.0065	2.8998	0.1016	0.2548
0.0766	0.0024	0.0058	3.0159	0.0940	0.2300
0.0795	0.0021	0.0051	3.1318	0.0824	0.1993
0.0825	0.0017	0.0041	3.2478	0.0665	0.1625
0.0854	0.0012	0.0030	3.3638	0.0461	0.1192
0.0884	0.0005	0.0017	3.4798	0.0196	0.0676
0.0913	-0.0002	0.0003	3.5958	-0.0087	0.0104

RADIUS (METERS) = 0.2863	RADIUS (INCHES) =11.2726
CHORD (METERS) = 0.0913	CHORD (INCHES) = 3.5958
ZCSL (METERS) = 0.0498	ZCSL (INCHES) = 1.9617
YCSL (METERS) = 0.0042	YCSL (INCHES) = 0.1665
RLE (METERS) =0.000233	RLE (INCHES) = 0.0092
RTE (METERS) =0.000254	RTE (INCHES) = 0.0100
X-AREA(SQ.METERS)=0.000303	X-AREA (SQ. IN.) = 0.4689
GAMMA-CHORD(RAD.)= 0.8946	GAMMA-CHORD(DEG.)= 51.26

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0083	0.0092
0.0030	0.0001	0.0008	0.1162	0.0031	0.0308
0.0059	0.0004	0.0013	0.2325	0.0141	0.0520
0.0089	0.0006	0.0018	0.3487	0.0246	0.0728
0.0118	0.0009	0.0024	0.4650	0.0345	0.0929
0.0148	0.0011	0.0029	0.5812	0.0439	0.1125
0.0177	0.0013	0.0033	0.6975	0.0525	0.1315
0.0207	0.0015	0.0038	0.8137	0.0605	0.1497
0.0236	0.0017	0.0042	0.9300	0.0674	0.1672
0.0266	0.0019	0.0047	1.0462	0.0732	0.1842
0.0295	0.0020	0.0051	1.1625	0.0776	0.2007
0.0325	0.0020	0.0055	1.2787	0.0804	0.2169
0.0354	0.0021	0.0059	1.3950	0.0817	0.2326
0.0384	0.0021	0.0063	1.5112	0.0815	0.2477
0.0413	0.0021	0.0066	1.6274	0.0807	0.2612
0.0443	0.0020	0.0069	1.7437	0.0800	0.2721
0.0472	0.0020	0.0071	1.8599	0.0796	0.2801
0.0502	0.0020	0.0073	1.9762	0.0793	0.2855
0.0531	0.0020	0.0073	2.0924	0.0793	0.2881
0.0561	0.0020	0.0073	2.2087	0.0793	0.2880
0.0591	0.0020	0.0072	2.3249	0.0793	0.2852
0.0620	0.0020	0.0071	2.4412	0.0792	0.2796
0.0650	0.0020	0.0069	2.5574	0.0791	0.2714
0.0679	0.0020	0.0066	2.6737	0.0789	0.2605
0.0709	0.0020	0.0063	2.7899	0.0790	0.2469
0.0738	0.0020	0.0058	2.9062	0.0776	0.2296
0.0768	0.0019	0.0053	3.0224	0.0736	0.2076
0.0797	0.0017	0.0046	3.1386	0.0657	0.1801
0.0827	0.0014	0.0037	3.2549	0.0537	0.1468
0.0856	0.0009	0.0027	3.3711	0.0373	0.1074
0.0886	0.0004	0.0016	3.4874	0.0168	0.0616
0.0915	-0.0002	0.0002	3.6036	-0.0079	0.0097

RADIUS (METERS) = 0.2937 RADIUS (INCHES) =11.5616
CHORD (METERS) = 0.0915 CHORD (INCHES) = 3.6036
ZCSL (METERS) = 0.0501 ZCSL (INCHES) = 1.9721
YCSL (METERS) = 0.0035 YCSL (INCHES) = 0.1377
RLE (METERS) =0.000229 RLE (INCHES) = 0.0090
RTE (METERS) =0.000236 RTE (INCHES) = 0.0093
X-AREA(SQ.METERS)=0.000298 X-AREA (SQ. IN.) = 0.4617
GAMMA-CHORD(RAD.)= 0.9375 GAMMA-CHORD(DEG.)= 53.71

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0080	0.0088
0.0030	-0.0000	0.0006	0.1167	-0.0010	0.0254
0.0059	0.0001	0.0011	0.2334	0.0057	0.0419
0.0089	0.0003	0.0015	0.3501	0.0120	0.0579
0.0119	0.0005	0.0019	0.4668	0.0180	0.0736
0.0148	0.0006	0.0023	0.5835	0.0236	0.0890
0.0178	0.0007	0.0026	0.7002	0.0287	0.1039
0.0207	0.0008	0.0030	0.8169	0.0334	0.1182
0.0237	0.0010	0.0034	0.9336	0.0374	0.1322
0.0267	0.0010	0.0037	1.0503	0.0406	0.1460
0.0296	0.0011	0.0041	1.1670	0.0427	0.1599
0.0326	0.0011	0.0044	1.2837	0.0435	0.1739
0.0356	0.0011	0.0048	1.4004	0.0432	0.1880
0.0385	0.0011	0.0051	1.5171	0.0416	0.2025
0.0415	0.0010	0.0055	1.6338	0.0397	0.2155
0.0445	0.0010	0.0058	1.7505	0.0380	0.2264
0.0474	0.0009	0.0060	1.8672	0.0369	0.2347
0.0504	0.0009	0.0061	1.9839	0.0364	0.2407
0.0534	0.0009	0.0062	2.1006	0.0364	0.2440
0.0563	0.0009	0.0062	2.2173	0.0370	0.2450
0.0593	0.0010	0.0062	2.3340	0.0381	0.2435
0.0622	0.0010	0.0061	2.4507	0.0395	0.2396
0.0652	0.0011	0.0059	2.5674	0.0415	0.2333
0.0682	0.0011	0.0057	2.6841	0.0439	0.2247
0.0711	0.0012	0.0054	2.8008	0.0472	0.2138
0.0741	0.0013	0.0051	2.9175	0.0500	0.1997
0.0771	0.0013	0.0046	3.0342	0.0504	0.1813
0.0800	0.0012	0.0040	3.1509	0.0471	0.1578
0.0830	0.0010	0.0033	3.2676	0.0396	0.1287
0.0860	0.0007	0.0024	3.3843	0.0281	0.0942
0.0889	0.0003	0.0014	3.5010	0.0116	0.0534
0.0919	-0.0002	0.0002	3.6177	-0.0071	0.0086

RADIUS (METERS) = 0.3030 RADIUS (INCHES) =11.9294
CHORD (METERS) = 0.0919 CHORD (INCHES) = 3.6177
ZCSL (METERS) = 0.0505 ZCSL (INCHES) = 1.9870
YCSL (METERS) = 0.0026 YCSL (INCHES) = 0.1017
RLE (METERS) =0.000220 RLE (INCHES) = 0.0087
RTE (METERS) =0.000213 RTE (INCHES) = 0.0084
X-AREA(SQ.METERS)=0.000292 X-AREA (SQ. IN.) = 0.4527
GAMMA-CHORD(RAD.)= 0.9844 GAMMA-CHORD(DEG.)= 56.40

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0078	0.0086
0.0030	-0.0001	0.0006	0.1167	-0.0033	0.0225
0.0059	0.0000	0.0009	0.2334	0.0012	0.0363
0.0089	0.0001	0.0013	0.3500	0.0055	0.0499
0.0119	0.0002	0.0016	0.4667	0.0096	0.0634
0.0148	0.0003	0.0019	0.5834	0.0133	0.0765
0.0178	0.0004	0.0023	0.7001	0.0167	0.0893
0.0207	0.0005	0.0026	0.8167	0.0197	0.1017
0.0237	0.0006	0.0029	0.9334	0.0222	0.1137
0.0267	0.0006	0.0032	1.0501	0.0239	0.1257
0.0296	0.0006	0.0035	1.1668	0.0245	0.1379
0.0326	0.0006	0.0038	1.2835	0.0241	0.1506
0.0356	0.0006	0.0042	1.4001	0.0226	0.1636
0.0385	0.0005	0.0045	1.5168	0.0200	0.1773
0.0415	0.0004	0.0048	1.6335	0.0173	0.1898
0.0445	0.0004	0.0051	1.7502	0.0151	0.2006
0.0474	0.0004	0.0053	1.8669	0.0138	0.2091
0.0504	0.0003	0.0055	1.9835	0.0132	0.2154
0.0533	0.0003	0.0056	2.1002	0.0132	0.2193
0.0563	0.0004	0.0056	2.2169	0.0141	0.2210
0.0593	0.0004	0.0056	2.3336	0.0156	0.2203
0.0622	0.0005	0.0055	2.4502	0.0178	0.2173
0.0652	0.0005	0.0054	2.5669	0.0206	0.2121
0.0682	0.0006	0.0052	2.6836	0.0242	0.2046
0.0711	0.0007	0.0050	2.8003	0.0289	0.1952
0.0741	0.0009	0.0046	2.9170	0.0335	0.1829
0.0771	0.0009	0.0042	3.0336	0.0366	0.1668
0.0800	0.0009	0.0037	3.1503	0.0360	0.1456
0.0830	0.0008	0.0030	3.2670	0.0313	0.1195
0.0859	0.0006	0.0022	3.3837	0.0226	0.0879
0.0889	0.0002	0.0013	3.5004	0.0097	0.0510
0.0919	-0.0002	0.0002	3.6170	-0.0072	0.0086

RADIUS (METERS) = 0.3100　　RADIUS (INCHES) =12.2034
CHORD (METERS) = 0.0919　　CHORD (INCHES) = 3.6170
ZCSL (METERS) = 0.0505　　ZCSL (INCHES) = 1.9897
YCSL (METERS) = 0.0021　　YCSL (INCHES) = 0.0811
RLE (METERS) =0.000216　　RLE (INCHES) = 0.0085
RTE (METERS) =0.000215　　RTE (INCHES) = 0.0085
X-AREA(SQ.METERS)=0.000288　　X-AREA (SQ. IN.) = 0.4462
GAMMA-CHORD(RAD.)= 1.0079　　GAMMA-CHORD(DEG.)= 57.75

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0077	0.0084
0.0030	-0.0001	0.0005	0.1173	-0.0043	0.0208
0.0060	-0.0000	0.0008	0.2345	-0.0008	0.0333
0.0089	0.0001	0.0012	0.3518	0.0027	[illegible]
0.0119	0.0002	0.0015	0.4691	0.0060	[illegible]
0.0149	0.0002	0.0018	0.5864	0.0090	0.0701
0.0179	0.0003	0.0021	0.7036	0.0118	0.0818
0.0209	0.0004	0.0024	0.8209	0.0140	0.0930
0.0238	0.0004	0.0026	0.9382	0.0158	0.1039
0.0268	0.0004	0.0029	1.0555	0.0166	0.1145
0.0298	0.0004	0.0032	1.1727	0.0162	0.1254
0.0328	0.0004	0.0035	1.2900	0.0143	0.1364
0.0357	0.0003	0.0037	1.4073	0.0110	0.1476
0.0387	0.0002	0.0040	1.5246	0.0060	0.1592
0.0417	0.0000	0.0043	1.6418	0.0005	0.1698
0.0447	-0.0001	0.0046	1.7591	-0.0043	0.1793
0.0477	-0.0002	0.0047	1.8764	-0.0075	0.1869
0.0506	-0.0002	0.0049	1.9936	-0.0090	0.1926
0.0536	-0.0002	0.0050	2.1109	-0.0091	0.1964
0.0566	-0.0002	0.0050	2.2282	-0.0076	0.1983
0.0596	-0.0001	0.0050	2.3455	-0.0047	0.1982
0.0626	-0.0000	0.0050	2.4627	-0.0008	0.1963
0.0655	0.0001	0.0049	2.5800	0.0041	0.1924
0.0685	0.0003	0.0047	2.6973	0.0103	0.1867
0.0715	0.0004	0.0046	2.8146	0.0175	0.1792
0.0745	0.0006	0.0043	2.9318	0.0254	0.1692
0.0774	0.0008	0.0040	3.0491	0.0312	0.1555
0.0804	0.0008	0.0035	3.1664	0.0328	0.1368
0.0834	0.0008	0.0029	3.2837	0.0298	0.1129
0.0864	0.0006	0.0021	3.4009	0.0220	0.0835
0.0894	0.0002	0.0012	3.5182	0.0088	0.0489
0.0923	-0.0002	0.0002	3.6355	-0.0077	0.0091

RADIUS (METERS) = 0.3167	RADIUS (INCHES) =12.4685
CHORD (METERS) = 0.0923	CHORD (INCHES) = 3.6355
ZCSL (METERS) = 0.0507	ZCSL (INCHES) = 1.9966
YCSL (METERS) = 0.0017	YCSL (INCHES) = 0.0651
RLE (METERS) =0.000212	RLE (INCHES) = 0.0083
RTE (METERS) =0.000227	RTE (INCHES) = 0.0089
X-AREA(SQ.METERS)=0.000283	X-AREA (SQ. IN.) = 0.4380
GAMMA-CHORD(RAD.)= 1.0250	GAMMA-CHORD(DEG.)= 58.73

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0074	0.0081
0.0030	-0.0001	0.0005	0.1181	-0.0035	0.0202
0.0060	0.0000	0.0008	0.2362	0.0003	0.0321
0.0090	0.0001	0.0011	0.3544	0.0039	0.0439
0.0120	0.0002	0.0014	0.4725	0.0073	0.0554
0.0150	0.0003	0.0017	0.5906	0.0104	0.0667
0.0180	0.0003	0.0020	0.7088	0.0131	0.0776
0.0210	0.0004	0.0022	0.8269	0.0152	0.0878
0.0240	0.0004	0.0025	0.9450	0.0168	0.0978
0.0270	0.0005	0.0027	1.0631	0.0181	0.1076
0.0300	0.0005	0.0030	1.1812	0.0188	0.1182
0.0330	0.0005	0.0033	1.2994	0.0190	0.1295
0.0360	0.0005	0.0036	1.4175	0.0186	0.1414
0.0390	0.0004	0.0039	1.5356	0.0177	0.1546
0.0420	0.0004	0.0043	1.6537	0.0162	0.1681
0.0450	0.0004	0.0046	1.7719	0.0143	0.1807
0.0480	0.0003	0.0049	1.8900	0.0124	0.1912
0.0510	0.0003	0.0051	2.0081	0.0108	0.1990
0.0540	0.0002	0.0052	2.1262	0.0094	0.2044
0.0570	0.0002	0.0053	2.2444	0.0081	0.2073
0.0600	0.0002	0.0053	2.3625	0.0071	0.2076
0.0630	0.0002	0.0052	2.4806	0.0064	0.2053
0.0660	0.0002	0.0051	2.5987	0.0064	0.2004
0.0690	0.0002	0.0049	2.7169	0.0071	0.1928
0.0720	0.0002	0.0046	2.8350	0.0087	0.1824
0.0750	0.0003	0.0043	2.9531	0.0109	0.1689
0.0780	0.0003	0.0039	3.0712	0.0131	0.1521
0.0810	0.0003	0.0033	3.1894	0.0135	0.1312
0.0840	0.0003	0.0027	3.3075	0.0116	0.1063
0.0870	0.0002	0.0020	3.4256	0.0074	0.0773
0.0900	0.0000	0.0011	3.5437	0.0014	0.0444
0.0930	-0.0002	0.0002	3.6619	-0.0063	0.0078

RADIUS (METERS) = 0.3344	RADIUS (INCHES) =13.1664
CHORD (METERS) = 0.0930	CHORD (INCHES) = 3.6619
ZCSL (METERS) = 0.0524	ZCSL (INCHES) = 2.0633
YCSL (METERS) = 0.0017	YCSL (INCHES) = 0.0663
RLE (METERS) =0.000204	RLE (INCHES) = 0.0080
RTE (METERS) =0.000199	RTE (INCHES) = 0.0078
X-AREA(SQ.METERS)=0.000278	X-AREA (SQ. IN.) = 0.4314
GAMMA-CHORD(RAD.)= 1.0357	GAMMA-CHORD(DEG.)= 59.34

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0074	0.0080
0.0030	-0.0001	0.0005	0.1191	-0.0030	0.0205
0.0060	0.0000	0.0008	0.2381	0.0011	0.0326
0.0091	0.0001	0.0011	0.3572	0.0050	0.0446
0.0121	0.0002	0.0014	0.4763	0.0086	0.0562
0.0151	0.0003	0.0017	0.5954	0.0119	0.0676
0.0181	0.0004	0.0020	0.7144	0.0148	0.0784
0.0212	0.0004	0.0023	0.8335	0.0171	0.0887
0.0242	0.0005	0.0025	0.9526	0.0189	0.0986
0.0272	0.0005	0.0028	1.0716	0.0204	0.1085
0.0302	0.0006	0.0030	1.1907	0.0217	0.1192
0.0333	0.0006	0.0033	1.3098	0.0228	0.1309
0.0363	0.0006	0.0036	1.4289	0.0239	0.1436
0.0393	0.0006	0.0040	1.5479	0.0249	0.1577
0.0423	0.0007	0.0044	1.6670	0.0256	0.1725
0.0454	0.0007	0.0047	1.7861	0.0259	0.1865
0.0484	0.0006	0.0050	1.9051	0.0253	0.1980
0.0514	0.0006	0.0052	2.0242	0.0240	0.2064
0.0544	0.0006	0.0054	2.1433	0.0217	0.2117
0.0575	0.0005	0.0054	2.2624	0.0186	0.2140
0.0605	0.0004	0.0054	2.3814	0.0145	0.2132
0.0635	0.0002	0.0053	2.5005	0.0098	0.2095
0.0665	0.0001	0.0051	2.6196	0.0056	0.2026
0.0696	0.0001	0.0049	2.7386	0.0022	0.1928
0.0726	-0.0000	0.0046	2.8577	-0.0003	0.1799
0.0756	-0.0000	0.0042	2.9768	-0.0015	0.1638
0.0786	-0.0000	0.0037	3.0958	-0.0017	0.1447
0.0817	-0.0000	0.0031	3.2149	-0.0016	0.1226
0.0847	-0.0000	0.0025	3.3340	-0.0019	0.0977
0.0877	-0.0001	0.0018	3.4531	-0.0029	0.0700
0.0907	-0.0001	0.0010	3.5721	-0.0041	0.0397
0.0938	-0.0001	0.0002	3.6912	-0.0058	0.0072

RADIUS (METERS) = 0.3420	RADIUS (INCHES) =13.4657
CHORD (METERS) = 0.0938	CHORD (INCHES) = 3.6912
ZCSL (METERS) = 0.0531	ZCSL (INCHES) = 2.0887
YCSL (METERS) = 0.0017	YCSL (INCHES) = 0.0683
RLE (METERS) =0.000203	RLE (INCHES) = 0.0080
RTE (METERS) =0.000185	RTE (INCHES) = 0.0073
X-AREA(SQ.METERS)=0.000280	X-AREA (SQ. IN.) = 0.4340
GAMMA-CHORD(RAD.)= 1.0412	GAMMA-CHORD(DEG.)= 59.66

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0074	0.0080
0.0031	-0.0001	0.0005	0.1202	-0.0037	0.0196
0.0061	-0.0000	0.0008	0.2403	-0.0002	0.0311
0.0092	0.0001	0.0011	0.3605	0.0033	0.0425
0.0122	0.0002	0.0014	0.4806	0.0066	0.0538
0.0153	0.0003	0.0016	0.6008	0.0098	0.0649
0.0183	0.0003	0.0019	0.7209	0.0127	0.0758
0.0214	0.0004	0.0022	0.8411	0.0153	0.0862
0.0244	0.0004	0.0024	0.9612	0.0174	0.0962
0.0275	0.0005	0.0027	1.0814	0.0192	0.1064
0.0305	0.0005	0.0030	1.2015	0.0206	0.1170
0.0336	0.0005	0.0033	1.3217	0.0216	0.1281
0.0366	0.0006	0.0036	1.4418	0.0221	0.1399
0.0397	0.0006	0.0039	1.5620	0.0223	0.1526
0.0427	0.0006	0.0042	1.6821	0.0219	0.1657
0.0458	0.0005	0.0045	1.8023	0.0210	0.1786
0.0488	0.0005	0.0048	1.9225	0.0192	0.1889
0.0519	0.0004	0.0050	2.0426	0.0165	0.1960
0.0549	0.0003	0.0051	2.1628	0.0129	0.2002
0.0580	0.0002	0.0051	2.2829	0.0084	0.2014
0.0610	0.0001	0.0051	2.4031	0.0031	0.1998
0.0641	-0.0001	0.0050	2.5232	-0.0026	0.1953
0.0671	-0.0002	0.0048	2.6434	-0.0075	0.1880
0.0702	-0.0003	0.0045	2.7635	-0.0110	0.1779
0.0732	-0.0003	0.0042	2.8837	-0.0132	0.1649
0.0763	-0.0004	0.0038	3.0038	-0.0139	0.1490
0.0793	-0.0003	0.0033	3.1240	-0.0131	0.1303
0.0824	-0.0003	0.0028	3.2442	-0.0115	0.1094
0.0855	-0.0003	0.0022	3.3643	-0.0099	0.0864
0.0885	-0.0002	0.0016	3.4845	-0.0086	0.0617
0.0916	-0.0002	0.0009	3.6046	-0.0073	0.0353
0.0946	-0.0002	0.0002	3.7248	-0.0062	0.0074

RADIUS (METERS) = 0.3500	RADIUS (INCHES) =13.7809
CHORD (METERS) = 0.0946	CHORD (INCHES) = 3.7248
ZCSL (METERS) = 0.0533	ZCSL (INCHES) = 2.0972
YCSL (METERS) = 0.0015	YCSL (INCHES) = 0.0606
RLE (METERS) =0.000200	RLE (INCHES) = 0.0079
RTE (METERS) =0.000195	RTE (INCHES) = 0.0077
X-AREA(SQ.METERS)=0.000278	X-AREA (SQ. IN.) = 0.4314
GAMMA-CHORD(RAD.)= 1.0542	GAMMA-CHORD(DEG.)= 60.40

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0074	0.0080
0.0031	-0.0001	0.0005	0.1208	-0.0043	0.0189
0.0061	-0.0000	0.0008	0.2416	-0.0014	0.0297
0.0092	0.0000	0.0010	0.3624	0.0015	0.0404
0.0123	0.0001	0.0013	0.4832	0.0043	0.0511
0.0153	0.0002	0.0016	0.6040	0.0070	0.0617
0.0184	0.0002	0.0018	0.7248	0.0094	0.0719
0.0215	0.0003	0.0021	0.8456	0.0114	0.0817
0.0245	0.0003	0.0023	0.9664	0.0129	0.0911
0.0276	0.0004	0.0026	1.0872	0.0142	0.1007
0.0307	0.0004	0.0028	1.2080	0.0150	0.1106
0.0338	0.0004	0.0031	1.3288	0.0153	0.1211
0.0368	0.0004	0.0034	1.4496	0.0152	0.1322
0.0399	0.0004	0.0037	1.5704	0.0148	0.1440
0.0430	0.0004	0.0040	1.6912	0.0138	0.1564
0.0460	0.0003	0.0043	1.8120	0.0124	0.1687
0.0491	0.0003	0.0045	1.9328	0.0101	0.1785
0.0522	0.0002	0.0047	2.0536	0.0071	0.1854
0.0552	0.0001	0.0048	2.1744	0.0034	0.1894
0.0583	-0.0000	0.0048	2.2952	-0.0010	0.1905
0.0614	-0.0001	0.0048	2.4160	-0.0059	0.1828
0.0644	-0.0003	0.0047	2.5368	-0.0109	0.1843
0.0675	-0.0004	0.0045	2.6576	-0.0148	0.1770
0.0706	-0.0004	0.0042	2.7784	-0.0175	0.1670
0.0736	-0.0005	0.0039	2.8992	-0.0188	0.1542
0.0767	-0.0005	0.0035	3.0200	-0.0186	0.1387
0.0798	-0.0004	0.0031	3.1408	-0.0171	0.1206
0.0828	-0.0004	0.0026	3.2616	-0.0151	0.1005
0.0859	-0.0003	0.0020	3.3824	-0.0130	0.0788
0.0890	-0.0003	0.0014	3.5032	-0.0106	0.0558
0.0921	-0.0002	0.0008	3.6240	-0.0084	0.0323
0.0951	-0.0002	0.0002	3.7448	-0.0067	0.0078

RADIUS (METERS) = 0.3537	RADIUS (INCHES) =13.9257
CHORD (METERS) = 0.0951	CHORD (INCHES) = 3.7448
ZCSL (METERS) = 0.0534	ZCSL (INCHES) = 2.1004
YCSL (METERS) = 0.0013	YCSL (INCHES) = 0.0523
RLE (METERS) =0.000201	RLE (INCHES) = 0.0079
RTE (METERS) =0.000203	RTE (INCHES) = 0.0080
X-AREA(SQ.METERS)=0.000275	X-AREA (SQ. IN.) = 0.4265
GAMMA-CHORD(RAD.)= 1.0633	GAMMA-CHORD(DEG.)= 60.92

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0074	0.0080
0.0031	-0.0002	0.0004	0.1230	-0.0065	0.0161
0.0062	-0.0001	0.0006	0.2459	-0.0057	0.0240
0.0094	-0.0001	0.0008	0.3689	-0.0053	0.0318
0.0125	-0.0001	0.0010	0.4918	-0.0050	0.0392
0.0156	-0.0001	0.0012	0.6148	-0.0052	0.0463
0.0187	-0.0002	0.0013	0.7377	-0.0060	0.0528
0.0219	-0.0002	0.0015	0.8607	-0.0074	0.0586
0.0250	-0.0002	0.0016	0.9837	-0.0094	0.0641
0.0281	-0.0003	0.0018	1.1066	-0.0118	0.0699
0.0312	-0.0004	0.0019	1.2296	-0.0142	0.0767
0.0344	-0.0004	0.0022	1.3525	-0.0165	0.0846
0.0375	-0.0005	0.0024	1.4755	-0.0186	0.0938
0.0406	-0.0005	0.0026	1.5984	-0.0206	0.1042
0.0437	-0.0006	0.0030	1.7214	-0.0223	0.1165
0.0468	-0.0006	0.0033	1.8443	-0.0239	0.1291
0.0500	-0.0006	0.0036	1.9673	-0.0251	0.1403
0.0531	-0.0007	0.0038	2.0903	-0.0258	0.1492
0.0562	-0.0007	0.0039	2.2132	-0.0259	0.1551
0.0593	-0.0006	0.0040	2.3362	-0.0254	0.1582
0.0625	-0.0006	0.0040	2.4591	-0.0242	0.1586
0.0656	-0.0006	0.0040	2.5821	-0.0227	0.1561
0.0687	-0.0005	0.0038	2.7050	-0.0207	0.1509
0.0718	-0.0005	0.0036	2.8280	-0.0184	0.1431
0.0750	-0.0004	0.0034	2.9509	-0.0157	0.1326
0.0781	-0.0003	0.0030	3.0739	-0.0124	0.1194
0.0812	-0.0002	0.0026	3.1969	-0.0093	0.1042
0.0843	-0.0002	0.0022	3.3198	-0.0070	0.0874
0.0874	-0.0001	0.0018	3.4428	-0.0057	0.0693
0.0906	-0.0001	0.0013	3.5657	-0.0053	0.0499
0.0937	-0.0001	0.0007	3.6887	-0.0058	0.0292
0.0968	-0.0002	0.0002	3.8116	-0.0068	0.0076

RADIUS (METERS) = 0.3662	RADIUS (INCHES) =14.4187
CHORD (METERS) = 0.0968	CHORD (INCHES) = 3.8117
ZCSL (METERS) = 0.0534	ZCSL (INCHES) = 2.1006
YCSL (METERS) = 0.0007	YCSL (INCHES) = 0.0278
RLE (METERS) =0.000201	RLE (INCHES) = 0.0079
RTE (METERS) =0.000198	RTE (INCHES) = 0.0078
X-AREA(SQ.METERS)=0.000258	X-AREA (SQ. IN.) = 0.4005
GAMMA-CHORD(RAD.)= 1.0925	GAMMA-CHORD(DEG.)= 62.60

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0074	0.0080
0.0032	-0.0002	0.0004	0.1242	-0.0078	0.0145
0.0063	-0.0002	0.0005	0.2484	-0.0090	0.0204
0.0095	-0.0003	0.0006	0.3726	-0.0109	0.0256
0.0126	-0.0003	0.0008	0.4968	-0.0137	0.0299
0.0158	-0.0004	0.0008	0.6210	-0.0175	0.0333
0.0189	-0.0006	0.0009	0.7452	-0.0223	0.0355
0.0221	-0.0007	0.0009	0.8694	-0.0279	0.0372
0.0252	-0.0009	0.0010	0.9936	-0.0335	0.0392
0.0284	-0.0010	0.0011	1.1178	-0.0386	0.0424
0.0315	-0.0011	0.0012	1.2420	-0.0430	0.0471
0.0347	-0.0012	0.0014	1.3661	-0.0466	0.0534
0.0379	-0.0013	0.0016	1.4903	-0.0493	0.0613
0.0410	-0.0013	0.0018	1.6145	-0.0511	0.0707
0.0442	-0.0013	0.0021	1.7387	-0.0518	0.0824
0.0473	-0.0013	0.0024	1.8629	-0.0515	0.0951
0.0505	-0.0013	0.0027	1.9871	-0.0506	0.1072
0.0536	-0.0012	0.0030	2.1113	-0.0491	0.1172
0.0568	-0.0012	0.0032	2.2355	-0.0470	0.1243
0.0599	-0.0011	0.0033	2.3597	-0.0444	0.1287
0.0631	-0.0011	0.0033	2.4839	-0.0413	0.1307
0.0662	-0.0010	0.0033	2.6081	-0.0380	0.1300
0.0694	-0.0009	0.0032	2.7323	-0.0345	0.1267
0.0726	-0.0008	0.0031	2.8565	-0.0307	0.1209
0.0757	-0.0007	0.0029	2.9807	-0.0268	0.1125
0.0789	-0.0006	0.0026	3.1049	-0.0225	0.1016
0.0820	-0.0005	0.0023	3.2291	-0.0184	0.0890
0.0852	-0.0004	0.0019	3.3533	-0.0148	0.0749
0.0883	-0.0003	0.0015	3.4775	-0.0119	0.0597
0.0915	-0.0002	0.0011	3.6017	-0.0097	0.0432
0.0946	-0.0002	0.0007	3.7259	-0.0081	0.0258
0.0978	-0.0002	0.0002	3.8501	-0.0067	0.0075

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RADIUS (METERS)   =  0.3739    RADIUS  (INCHES) =14.7201
CHORD  (METERS)   =  0.0978    CHORD   (INCHES) = 3.8501
ZCSL   (METERS)   =  0.0537    ZCSL    (INCHES) = 2.1151
YCSL   (METERS)   =  0.0001    YCSL    (INCHES) = 0.0050
RLE    (METERS)   =0.000201    RLE     (INCHES) = 0.0079
RTE    (METERS)   =0.000195    RTE     (INCHES) = 0.0077
X-AREA(SQ.METERS)=0.000250     X-AREA (SQ. IN.) = 0.3876
GAMMA-CHORD(RAD.)= 1.1078      GAMMA-CHORD(DEG.)= 63.47
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METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0076	0.0082
0.0032	-0.0002	0.0004	0.1278	-0.0085	0.0143
0.0065	-0.0003	0.0005	0.2556	-0.0102	0.0198
0.0097	-0.0003	0.0006	0.3834	-0.0127	0.0242
0.0130	-0.0004	0.0007	0.5112	-0.0162	0.0278
0.0162	-0.0005	0.0008	0.6390	-0.0207	0.0302
0.0195	-0.0007	0.0008	0.7667	-0.0262	0.0317
0.0227	-0.0008	0.0008	0.8945	-0.0329	0.0319
0.0260	-0.0010	0.0008	1.0223	-0.0396	0.0324
0.0292	-0.0012	0.0009	1.1501	-0.0456	0.0342
0.0325	-0.0013	0.0010	1.2779	-0.0503	0.0378
0.0357	-0.0014	0.0011	1.4057	-0.0538	0.0430
0.0390	-0.0014	0.0013	1.5335	-0.0560	0.0500
0.0422	-0.0015	0.0015	1.6613	-0.0571	0.0588
0.0454	-0.0014	0.0018	1.7891	-0.0568	0.0695
0.0487	-0.0014	0.0021	1.9169	-0.0551	0.0820
0.0519	-0.0013	0.0024	2.0447	-0.0525	0.0947
0.0552	-0.0013	0.0027	2.1725	-0.0494	0.1053
0.0584	-0.0012	0.0029	2.3002	-0.0459	0.1132
0.0617	-0.0011	0.0030	2.4280	-0.0418	0.1184
0.0649	-0.0010	0.0031	2.5558	-0.0375	0.1211
0.0682	-0.0008	0.0031	2.6836	-0.0334	0.1211
0.0714	-0.0007	0.0030	2.8114	-0.0292	0.1186
0.0747	-0.0006	0.0029	2.9392	-0.0252	0.1136
0.0779	-0.0005	0.0027	3.0670	-0.0211	0.1063
0.0811	-0.0004	0.0025	3.1948	-0.0172	0.0968
0.0844	-0.0004	0.0022	3.3226	-0.0142	0.0859
0.0876	-0.0003	0.0018	3.4504	-0.0125	0.0722
0.0909	-0.0003	0.0014	3.5782	-0.0111	0.0570
0.0941	-0.0003	0.0010	3.7059	-0.0100	0.0411
0.0974	-0.0002	0.0006	3.8337	-0.0087	0.0246
0.1006	-0.0002	0.0002	3.9615	-0.0071	0.0080

RADIUS (METERS) = 0.3852	RADIUS (INCHES) =15.1634
CHORD (METERS) = 0.1006	CHORD (INCHES) = 3.9615
ZCSL (METERS) = 0.0548	ZCSL (INCHES) = 2.1561
YCSL (METERS) = -0.0001	YCSL (INCHES) =-0.0023
RLE (METERS) =0.000208	RLE (INCHES) = 0.0082
RTE (METERS) =0.000205	RTE (INCHES) = 0.0081
X-AREA(SQ.METERS)=0.000243	X-AREA (SQ. IN.) = 0.3767
GAMMA-CHORD(RAD.)= 1.1354	GAMMA-CHORD(DEG.)= 65.05

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0077	0.0084
0.0034	-0.0002	0.0004	0.1332	-0.0085	0.0146
0.0068	-0.0002	0.0005	0.2664	-0.0098	0.0202
0.0101	-0.0003	0.0006	0.3996	-0.0120	0.0250
0.0135	-0.0004	0.0007	0.5327	-0.0151	0.0289
0.0169	-0.0005	0.0008	0.6659	-0.0193	0.0317
0.0203	-0.0006	0.00[illegible]	0.7991	-0.0245	0.0333
0.0237	-0.0008	0.0009	0.9323	-0.0306	0.0340
0.0271	-0.0009	0.0009	1.0655	-0.0367	0.0348
0.0304	-0.0011	0.0009	1.1986	-0.0424	0.0364
0.0338	-0.0012	0.0010	1.3318	-0.0471	0.0392
0.0372	-0.0013	0.0011	1.4650	-0.0509	0.0435
0.0406	-0.0014	0.0012	1.5982	-0.0539	0.0489
0.0440	-0.0014	0.0014	1.7314	-0.0560	0.0556
0.0474	-0.0014	0.0016	1.8646	-0.0570	0.0640
0.0507	-0.0015	0.0019	1.9977	-0.0572	0.0734
0.0541	-0.0014	0.0021	2.1309	-0.0567	0.0825
0.0575	-0.0014	0.0023	2.2641	-0.0558	0.0896
0.0609	-0.0014	0.0024	2.3973	-0.0544	0.0943
0.0643	-0.0013	0.0025	2.5305	-0.0524	0.0966
0.0677	-0.0013	0.0025	2.6636	-0.0503	0.0965
0.0710	-0.0012	0.0024	2.7968	-0.0481	0.0942
0.0744	-0.0012	0.0023	2.9300	-0.0459	0.0899
0.0778	-0.0011	0.0021	3.0632	-0.0436	0.0835
0.0812	-0.0010	0.0019	3.1964	-0.0411	0.0756
0.0846	-0.0010	0.0017	3.3296	-0.0384	0.0661
0.0880	-0.0009	0.0014	3.4628	-0.0351	0.0560
0.0913	-0.0008	0.0012	3.5959	-0.0313	0.0457
0.0947	-0.0007	0.0009	3.7291	-0.0267	0.0354
0.0981	-0.0005	0.0006	3.8623	-0.0212	0.0254
0.1015	-0.0004	0.0004	3.9955	-0.0146	0.0156
0.1049	-0.0002	0.0002	4.1287	-0.0065	0.0073

RADIUS (METERS) = 0.3959	RADIUS (INCHES) =15.5871
CHORD (METERS) = 0.1049	CHORD (INCHES) = 4.1287
ZCSL (METERS) = 0.0562	ZCSL (INCHES) = 2.2119
YCSL (METERS) = -0.0002	YCSL (INCHES) =-0.0087
RLE (METERS) =0.000210	RLE (INCHES) = 0.0083
RTE (METERS) =0.000187	RTE (INCHES) = 0.0074
X-AREA(SQ.METERS)=0.000239	X-AREA (SQ. IN.) = 0.3709
GAMMA-CHORD(RAD.)= 1.1678	GAMMA-CHORD(DEC.)= 66.91

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0078	0.0084
0.0035	-0.0002	0.0004	0.1390	-0.0084	0.0147
0.0071	-0.0002	0.0005	0.2780	-0.0098	0.0203
0.0106	-0.0003	0.0006	0.4170	-0.0120	0.0251
0.0141	-0.0004	0.0007	0.5560	-0.0151	0.0290
0.0177	-0.0005	0.0008	0.6950	-0.0192	0.0318
0.0212	-0.0006	0.0009	0.8340	-0.0240	0.0337
0.0247	-0.0007	0.0009	0.9730	-0.0293	0.0351
0.0282	-0.0009	0.0009	1.1121	-0.0350	0.0362
0.0318	-0.0010	0.0010	1.2511	-0.0404	0.0375
0.0353	-0.0012	0.0010	1.3901	-0.0454	0.0395
0.0388	-0.0013	0.0011	1.5291	-0.0500	0.0422
0.0424	-0.0014	0.0012	1.6681	-0.0538	0.0458
0.0459	-0.0014	0.0013	1.8071	-0.0570	0.0501
0.0494	-0.0015	0.0014	1.9461	-0.0594	0.0556
0.0530	-0.0015	0.0016	2.0851	-0.0610	0.0619
0.0565	-0.0016	0.0017	2.2241	-0.0617	0.0680
0.0600	-0.0016	0.0019	2.3631	-0.0617	0.0730
0.0636	-0.0015	0.0019	2.5021	-0.0609	0.0760
0.0671	-0.0015	0.0020	2.6412	-0.0594	0.0773
0.0706	-0.0015	0.0020	2.7802	-0.0574	0.0768
0.0741	-0.0014	0.0019	2.9192	-0.0552	0.0748
0.0777	-0.0013	0.0018	3.0582	-0.0527	0.0713
0.0812	-0.0013	0.0017	3.1972	-0.0500	0.0663
0.0847	-0.0012	0.0015	3.3362	-0.0471	0.0601
0.0883	-0.0011	0.0013	3.4752	-0.0438	0.0527
0.0918	-0.0010	0.0011	3.6142	-0.0399	0.0449
0.0953	-0.0009	0.0009	3.7532	-0.0351	0.0371
0.0989	-0.0008	0.0007	3.8922	-0.0296	0.0294
0.1024	-0.0006	0.0006	4.0312	-0.0230	0.0218
0.1059	-0.0004	0.0004	4.1702	-0.0153	0.0144
0.1095	-0.0002	0.0002	4.3092	-0.0066	0.0073

RADIUS (METERS) = 0.4061	RADIUS (INCHES) =15.9867
CHORD (METERS) = 0.1095	CHORD (INCHES) = 4.3092
ZCSL (METERS) = 0.0581	ZCSL (INCHES) = 2.2859
YCSL (METERS) = -0.0004	YCSL (INCHES) =-0.0168
RLE (METERS) =0.000209	RLE (INCHES) = 0.0082
RTE (METERS) =0.000186	RTE (INCHES) = 0.0073
X-AREA(SQ.METERS)=0.000236	X-AREA (SQ. IN.) = 0.3660
GAMMA-CHORD(RAD.)= 1.2077	GAMMA-CHORD(DEG.)= 69.19

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0073	0.0083
0.0036	-0.0002	0.0004	0.1409	-0.0086	0.0146
0.0072	-0.0003	0.0005	0.2818	-0.0101	0.0201
0.0107	-0.0003	0.0006	0.4227	-0.0123	0.0248
0.0143	-0.0004	0.0007	0.5636	-0.0151	0.0288
0.0179	-0.0005	0.0008	0.7045	-0.0187	0.0320
0.0215	-0.0006	0.0009	0.8454	-0.0229	0.0345
0.0251	-0.0007	0.0009	0.9863	-0.0275	0.0363
0.0286	-0.0008	0.0010	1.1272	-0.0325	0.0380
0.0322	-0.0010	0.0010	1.2681	-0.0375	0.0397
0.0358	-0.0011	0.0011	1.4090	-0.0421	0.0417
0.0394	-0.0012	0.0011	1.5499	-0.0461	0.0445
0.0429	-0.0013	0.0012	1.6908	-0.0495	0.0480
0.0465	-0.0013	0.0013	1.8317	-0.0523	0.0522
0.0501	-0.0014	0.0015	1.9726	-0.0546	0.0575
0.0537	-0.0014	0.0016	2.1135	-0.0560	0.0636
0.0573	-0.0014	0.0018	2.2544	-0.0566	0.0696
0.0608	-0.0014	0.0019	2.3953	-0.0564	0.0745
0.0644	-0.0014	0.0020	2.5362	-0.0556	0.0774
0.0680	-0.0014	0.0020	2.6771	-0.0541	0.0786
0.0716	-0.0013	0.0020	2.8180	-0.0523	0.0782
0.0752	-0.0013	0.0019	2.9589	-0.0503	0.0762
0.0787	-0.0012	0.0018	3.0998	-0.0481	0.0726
0.0823	-0.0012	0.0017	3.2407	-0.0459	0.0675
0.0859	-0.0011	0.0016	3.3815	-0.0436	0.0611
0.0895	-0.0010	0.0014	3.5225	-0.0410	0.0536
0.0930	-0.0010	0.0012	3.6634	-0.0378	0.0457
0.0966	-0.0009	0.0010	3.8042	-0.0337	0.0378
0.1002	-0.0007	0.0008	3.9451	-0.0286	0.0299
0.1038	-0.0006	0.0006	4.0860	-0.0225	0.0222
0.1074	-0.0004	0.0004	4.2269	-0.0152	0.0148
0.1109	-0.0002	0.0002	4.3678	-0.0069	0.0075

RADIUS (METERS) = 0.4095	RADIUS (INCHES) =16.1216
CHORD (METERS) = 0.1109	CHORD (INCHES) = 4.3678
ZCSL (METERS) = 0.0588	ZCSL (INCHES) = 2.3153
YCSL (METERS) = -0.0003	YCSL (INCHES) =-0.0135
RLE (METERS) =0.000210	RLE (INCHES) = 0.0083
RTE (METERS) =0.000192	RTE (INCHES) = 0.0076
X-AREA(SQ.METERS)=0.000235	X-AREA (SQ. IN.) = 0.3638
GAMMA-CHORD(RAD.)= 1.2217	GAMMA-CHORD(DEG.)= 70.00

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0078	0.0082
0.0036	-0.0002	0.0004	0.1430	-0.0083	0.0145
0.0073	-0.0002	0.0005	0.2860	-0.0094	0.0203
0.0109	-0.0003	0.0006	0.4290	-0.0109	0.0255
0.0145	-0.0003	0.0008	0.5720	-0.0130	0.0301
0.0182	-0.0004	0.0009	0.7150	-0.0158	0.0340
0.0218	-0.0005	0.0009	0.8580	-0.0193	0.0371
0.0254	-0.0006	0.0010	1.0010	-0.0232	0.0397
0.0291	-0.0007	0.0011	1.1440	-0.0274	0.0419
0.0327	-0.0008	0.0011	1.2871	-0.0318	0.0441
0.0363	-0.0009	0.0012	1.4301	-0.0360	0.0464
0.0400	-0.0010	0.0013	1.5731	-0.0397	0.0492
0.0436	-0.0011	0.0013	1.7161	-0.0428	0.0527
0.0472	-0.0012	0.0014	1.8591	-0.0454	0.0569
0.0509	-0.0012	0.0016	2.0021	-0.0471	0.0620
0.0545	-0.0012	0.0017	2.1451	-0.0482	0.0678
0.0581	-0.0012	0.0019	2.2881	-0.0488	0.0735
0.0618	-0.0012	0.0020	2.4311	-0.0487	0.0780
0.0654	-0.0012	0.0021	2.5741	-0.0480	0.0807
0.0690	-0.0012	0.0021	2.7171	-0.0467	0.0817
0.0726	-0.0012	0.0021	2.8601	-0.0453	0.0810
0.0763	-0.0011	0.0020	3.0031	-0.0438	0.0787
0.0799	-0.0011	0.0019	3.1461	-0.0422	0.0749
0.0835	-0.0010	0.0018	3.2892	-0.0407	0.0696
0.0872	-0.0010	0.0016	3.4321	-0.0391	0.0630
0.0908	-0.0009	0.0014	3.5752	-0.0373	0.0553
0.0944	-0.0009	0.0012	3.7182	-0.0350	0.0472
0.0981	-0.0008	0.0010	3.8612	-0.0317	0.0391
0.1017	-0.0007	0.0008	4.0042	-0.0273	0.0310
0.1053	-0.0006	0.0006	4.1472	-0.0219	0.0231
0.1090	-0.0004	0.0004	4.2902	-0.0153	0.0155
0.1126	-0.0002	0.0002	4.4332	-0.0074	0.0080

RADIUS (METERS) = 0.4134	RADIUS (INCHES) =16.2766
CHORD (METERS) = 0.1126	CHORD (INCHES) = 4.4332
ZCSL (METERS) = 0.0597	ZCSL (INCHES) = 2.3498
YCSL (METERS) = -0.0002	YCSL (INCHES) =-0.0087
RLE (METERS) =0.000208	RLE (INCHES) = 0.0082
RTE (METERS) =0.000206	RTE (INCHES) = 0.0081
X-AREA(SQ.METERS)=0.000233	X-AREA (SQ. IN.) = 0.3609
GAMMA-CHORD(RAD.)= 1.2373	GAMMA-CHORD(DEG.)= 70.89

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0078	0.0083
0.0037	-0.0002	0.0004	0.1454	-0.0074	0.0155
0.0074	-0.0002	0.0006	0.2909	-0.0073	0.0223
0.0111	-0.0002	0.0007	0.4363	-0.0077	0.0285
0.0148	-0.0002	0.0009	0.5818	-0.0087	0.0340
0.0185	-0.0003	0.0010	0.7272	-0.0111	0.0382
0.0222	-0.0004	0.0011	0.8727	-0.0140	0.0419
0.0259	-0.0004	0.0011	1.0181	-0.0173	0.0451
0.0296	-0.0005	0.0012	1.1635	-0.0208	0.0478
0.0332	-0.0006	0.0013	1.3090	-0.0246	0.0503
0.0369	-0.0007	0.0013	1.4544	-0.0285	0.0527
0.0406	-0.0008	0.0014	1.5999	-0.0322	0.0554
0.0443	-0.0009	0.0015	1.7453	-0.0351	0.0586
0.0480	-0.0009	0.0016	1.8908	-0.0373	0.0626
0.0517	-0.0010	0.0017	2.0362	-0.0382	0.0676
0.0554	-0.0010	0.0019	2.1817	-0.0390	0.0730
0.0591	-0.0010	0.0020	2.3271	-0.0396	0.0781
0.0628	-0.0010	0.0021	2.4725	-0.0398	0.0822
0.0665	-0.0010	0.0021	2.6180	-0.0391	0.0845
0.0702	-0.0010	0.0022	2.7634	-0.0382	0.0852
0.0739	-0.0009	0.0021	2.9089	-0.0372	0.0842
0.0776	-0.0009	0.0021	3.0543	-0.0362	0.0816
0.0813	-0.0009	0.0020	3.1997	-0.0352	0.0776
0.0850	-0.0009	0.0018	3.3452	-0.0344	0.0721
0.0887	-0.0009	0.0017	3.4906	-0.0337	0.0653
0.0924	-0.0008	0.0015	3.6361	-0.0329	0.0575
0.0961	-0.0008	0.0012	3.7815	-0.0316	0.0490
0.0997	-0.0007	0.0010	3.9270	-0.0292	0.0407
0.1034	-0.0007	0.0008	4.0724	-0.0259	0.0325
0.1071	-0.0005	0.0006	4.2178	-0.0213	0.0243
0.1108	-0.0004	0.0004	4.3633	-0.0155	0.0165
0.1145	-0.0002	0.0002	4.5087	-0.0085	0.0089

RADIUS (METERS) = 0.4185	RADIUS (INCHES) =16.4765
CHORD (METERS) = 0.1145	CHORD (INCHES) = 4.5087
ZCSL (METERS) = 0.0607	ZCSL (INCHES) = 2.3895
YCSL (METERS) = -0.0001	YCSL (INCHES) =-0.0033
RLE (METERS) =0.000208	RLE (INCHES) = 0.0082
RTE (METERS) =0.000234	RTE (INCHES) = 0.0092
X-AREA(SQ.METERS)=0.000231	X-AREA (SQ. IN.) = 0.3583
GAMMA-CHORD(RAD.)= 1.2555	GAMMA-CHORD(DEG.)= 71.94

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0083	0.0091
0.0037	-0.0002	0.0004	0.1472	-0.0069	0.0170
0.0075	-0.0002	0.0006	0.2945	-0.0059	0.0243
0.0112	-0.0001	0.0008	0.4417	-0.0055	0.0314
0.0150	-0.0002	0.0009	0.5889	-0.0062	0.0369
0.0187	-0.0002	0.0011	0.7362	-0.0084	0.0414
0.0224	-0.0003	0.0012	0.8834	-0.0108	0.0455
0.0262	-0.0003	0.0012	1.0307	-0.0134	0.0490
0.0299	-0.0004	0.0013	1.1779	-0.0164	0.0520
0.0337	-0.0005	0.0014	1.3251	-0.0198	0.0546
0.0374	-0.0006	0.0015	1.4724	-0.0235	0.0572
0.0411	-0.0007	0.0015	1.6196	-0.0269	0.0596
0.0449	-0.0007	0.0016	1.7668	-0.0295	0.0628
0.0486	-0.0008	0.0017	1.9141	-0.0311	0.0668
0.0524	-0.0008	0.0018	2.0613	-0.0314	0.0716
0.0561	-0.0008	0.0019	2.2085	-0.0318	0.0767
0.0598	-0.0008	0.0021	2.3558	-0.0325	0.0814
0.0636	-0.0008	0.0022	2.5030	-0.0327	0.0850
0.0673	-0.0008	0.0022	2.6503	-0.0321	0.0870
0.0711	-0.0008	0.0022	2.7975	-0.0313	0.0873
0.0748	-0.0008	0.0022	2.9447	-0.0306	0.0861
0.0785	-0.0008	0.0021	3.0920	-0.0300	0.0834
0.0823	-0.0007	0.0020	3.2392	-0.0294	0.0793
0.0860	-0.0007	0.0019	3.3864	-0.0291	0.0737
0.0898	-0.0007	0.0017	3.5337	-0.0291	0.0668
0.0935	-0.0007	0.0015	3.6809	-0.0291	0.0591
0.0972	-0.0007	0.0013	3.8281	-0.0286	0.0504
0.1010	-0.0007	0.0011	3.9754	-0.0272	0.0420
0.1047	-0.0006	0.0009	4.1226	-0.0247	0.0337
0.1085	-0.0005	0.0006	4.2698	-0.0210	0.0255
0.1122	-0.0004	0.0004	4.4171	-0.0160	0.0175
0.1159	-0.0002	0.0002	4.5643	-0.0098	0.0098

RADIUS (METERS) = 0.4236	RADIUS (INCHES) =16.6765
CHORD (METERS) = 0.1159	CHORD (INCHES) = 4.5643
ZCSL (METERS) = 0.0613	ZCSL (INCHES) = 2.4137
YCSL (METERS) = 0.0000	YCSL (INCHES) = 0.0005
RLE (METERS) =0.000221	RLE (INCHES) = 0.0087
RTE (METERS) =0.000269	RTE (INCHES) = 0.0106
X-AREA(SQ.METERS)=0.000230	X-AREA (SQ. IN.) = 0.3559
GAMMA-CHORD(RAD.)= 1.2717	GAMMA-CHORD(DEG.)= 72.86