NASA CR-165500
PWA-5698-28

NASA-CR-165500
19820008208

NASA

STUDY OF CONTROLLED DIFFUSION STATOR BLADING

I. AERODYNAMIC AND MECHANICAL DESIGN REPORT

by

E. Canal, B.C. Chisholm, D. Lee and D.A. Spear

January 1981

UNITED TECHNOLOGIES CORPORATION
Pratt & Whitney Aircraft Group
Commercial Products Division

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NASA-Lewis Research Center
Contract NAS3-22008

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR-165500		

4. Title and Subtitle	5. Report Date
Study of Controlled Diffusion Stator Blading I. Aerodynamics and Mechanical Design Report	January 1981
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
E. Canal, B.C. Chisholm, D. Lee and D.A. Spear	PWA-5698-28
	10. Work Unit No.
9. Performing Organization Name and Address	11. Contract or Grant No.
United Technologies Corporation Pratt & Whitney Aircraft Group (CPD) East Hartford, CT 06108	NAS3-22008
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Aeronautics and Space Administration Washington D.C. 20546	14. Sponsoring Agency Code

15. Supplementary Notes

NASA Project Manager: Mr. L.J. Herrig, Fluid Mechanics and Acoustic Division - Fan and Compressor Branch, NASA-Lewis Research Center

16. Abstract

Pratt & Whitney Aircraft is conducting a test program for NASA under Contract NAS3-22008 in order to demonstrate that a controlled-diffusion stator provides low losses at high loadings and Mach numbers. The technology has shown great promise in wind tunnel tests. This report presents details of the design of the controlled diffusion stator vanes and the multiple-circular-arc rotor blades. The stage, including stator and rotor, was designed to be suitable for the first-stage of an advanced multistage, high-pressure compressor.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Controlled-diffusion Front stage High pressure ratio Low aspect ratio	Unclassified-Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	102	

* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-C-168 (Rev. 10-75)

FOREWORD

The work described herein was performed under NASA Contract NAS3-22008 by the United Technologies Corporation, Pratt & Whitney Aircraft Group, Commercial Products Division, Hartford, Connecticut under the direction of Mr. N. T. Monsarrat, Program Manager. The NASA Project Manager was Mr. L. J. Herrig, NASA-Lewis Research Center, Fluid Mechanics and Acoustics Division.

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Pratt & Whitney Aircraft Group

1.0 SUMMARY

Pratt & Whitney Aircraft is conducting a test program, Contract NAS3-22008, for the National Aeronautics and Space Administration; the purpose, to demonstrate that a controlled-diffusion compressor stator provides low losses at high loadings and high Mach numbers.

Two-dimensional wind tunnel tests have shown that the controlled-diffusion design method, a nascent technology for custom designing cascade airfoils, could significantly reduce compressor stator vane losses. This technology will be tested in a three-dimensional flowfield during the NAS3-22008 program. The stator, which was designed to be suitable for the first stage of an advanced multistage, high-pressure compressor, will be tested in a rig employing an inlet guide vane and a rotor designed and tested during an earlier NASA program, Contract NAS3-20809.

This report presents the details of the design of the controlled-diffusion stator airfoil and the modification of the multiple-circular-arc sections of the NAS3-20809 low aspect ratio rotor blade.

The design parameters are typical of an advanced high-pressure compressor front stage and are compatible with the hardware of the existing rig, which accurately simulates engine conditions. The hardware includes an offset inlet transition duct incorporating a preswirl vane that simulates the exit flow from a fan stator root or low-pressure compressor, engine type intermediate case struts, and a variable inlet guide vane.

The design pressure ratio is 1.81 at the goal adiabatic efficiency of 88.5 percent. The design flow per unit annulus area at the rotor inlet is 195.3 kg/sec-m^2 (40.0 lbm/sec-ft^2) at the design tip speed of 442.0 m/sec (1450 ft/sec). The hub/tip ratio is 0.597; the tip diameter, 0.691 m (27.2 in.); and the rotor aspect ratio, 1.3.

The high tip speed and inlet specific flow of the rotor is required to achieve the 1.81 stage pressure ratio, which although aggressive is representative of front stages of advanced core compressors. The stator exit specific flow and the absolute air angle are realistic values chosen to match downstream high-pressure compressor stages. The spacing between rotor and stator has been reduced relative to the NAS3-20809 rig in order to make the spacing typical of the front end of high-pressure compressors.

The stator vane, its absolute Mach number varies from 0.88 at the hub to 0.69 at the tip, has been designed to a prescribed pressure distribution using controlled-diffusion technology. Both rotor and stator losses are estimates based on a combination of fan, high-pressure compressor, and Pratt & Whitney Aircraft controlled-diffusion airfoil experience.

2.0 INTRODUCTION

Commercial aircraft powerplants of the future in order to reduce fuel consumption will require compressors with higher pressure ratios and efficiencies than currently in use, implying higher tip speeds and higher stage loadings to achieve a higher stage pressure ratio. However, high speed fan and compressor stages designed for high flow capacity and high loading tend to have very high flow Mach numbers entering the stator, especially in the hub region. This results in a tendency for strong shocks in the stator channels, followed by boundary layer separation in the subsonic region behind the shock due to shock-boundary layer interaction. The result is excessive stator pressure loss, which reduces stage efficiency and operating range at a given speed.

An emerging theoretical design method has the potential to design stator channels that control diffusion in such a way as to eliminate shocks, or radically reduce shock strength, thus significantly reducing stator pressure loss to improve stage efficiency. Stator airfoil shapes designed by these methods have been subjected to limited testing in a two-dimensional cascade tunnel, with encouraging results (ref. 1).

The objective of this program is to evaluate the controlled-diffusion stator design technique in a three-dimensional flowfield. The effort covers the design, procurement, and testing of a controlled-diffusion stator. The inlet guide vane and rotor designed and tested under Contract NAS3-20809 (ref. 2) will be used to form a complete stage for testing under the current program. The original rotor blade from Contract NAS3-20809 will be modified to correct deficiencies that had been identified during testing (ref. 3).

3.0 AERODYNAMIC DESIGN

3.1 FLOWPATH AND VELOCITY VECTOR DIAGRAM DESIGN

The compressor flowpath was designed to utilize the existing inlet case with the exit ducting, which has been modified from the original NAS3-20809 configuration. This hardware includes inlet prerotation vanes that simulate flow from a fan stator or low-pressure compressor exit stator, intermediate case struts, and variable inlet guide vanes (IGV) located in a curved duct typical of an engine intermediate case (Figure 1). Contract requirements established the design parameters, listed in Table I, for rotor inlet hub-tip ratio, rotor tip speed, inlet specific flow, pressure ratio, and approximate blade and vane aspect ratios.

The original flowpath has been retained with the exception of the rotor-to-stator axial spacing and the annulus area downstream of the stator. Streamline analysis iterations were started using the existing flowpath shape, test flow blockages (ref. 3), and estimated efficiency profiles. The aerodynamics of the design are shown in Figures 2 through 24.

TABLE I

DESIGN PARAMETERS

Corrected Speed, rpm	12210
Rotor Tip Speed, m/sec (ft/sec)	442.0 (1450)
Inlet Corrected Flow, kg/sec (lbm/sec)	47.28 (104.24)
Rotor Inlet Corrected Weight Flow Per Unit Annulus Area, kg/m^2-sec (lbm/ft^2-sec)	195.3 (40.0)
Rotor Pressure Ratio	1.845
Stage Pressure Ratio	1.81
Rotor Adiabatic Efficiency, %	92.1
Stage Adiabatic Efficiency, %	88.5
Tip Diameter, meters (inches)	0.6901 (27.2)
Hub/Tip Ratio at Rotor Inlet	0.597
Rotor Tip Solidity	1.26
Rotor Aspect Ratio*	1.30
Stator Hub Solidity	1.429
Stator Aspect Ratio*	1.446
Stator Average Exit Flow Angle, Degrees	22.0
Number of Rotor Blades	24
Number of Stator Vanes	27

*Aspect Ratio = average-airfoil-length/midspan-chord.

With the required rotor tip speed of 442.0 m/sec (1450 ft/sec), the design speed corrected to standard inlet conditions is 12,210 rpm. Specific weight flow at the rotor inlet is 195.3 kg/m^2-sec (40 lbm/ft^2-sec), consistent with advanced high-pressure compressor front stage technology. This yields an inlet corrected flow of 47.28 kg/sec (104.24 lbm/sec) to the rotor and 46.53 kg/sec (102.6 lbm/sec) into the rig inlet case.

Flowpath convergence and wall curvatures were chosen to control blade and wall loadings and to be compatible with typical downstream high-pressure compressor stages. The stage average exit axial Mach number is 0.56, and the stator average exit flow angle is 22 degrees, which is representative of exit conditions of typical front stages of advanced technology high-pressure compressors. Mach number levels and blade loading balance are a result of reaction selection as controlled by the inlet-guide-vane exit air angle, Figure 2. A relatively high reaction level of 0.71 was chosen in order to keep stator inlet Mach number levels below 0.9 across the span. The resulting rotor loadings are within experience levels. Inlet and exit Mach number profiles for the rotor and stator are shown in Figure 3.

Rotor losses were estimated by extrapolating data from the previous test of this rig (ref. 3) to design flow and pressure ratio values at minimum loss. Controlled-diffusion stator losses were estimated from the previous test of this rig and Pratt & Whitney Aircraft's controlled-diffusion airfoil experience (ref. 1).

The radial distributions of rotor and stator loss coefficients are shown in Figures 4 and 5 . Details of the rotor and stator loss system are provided in Appendix B.

Blockages were included in the aerodynamic design to account for boundary layer growth along casing walls and for airfoil wakes. The blockage distribution through the compressor was estimated from the data obtained during the previous test of this rig (ref. 3). The blockages for this design are summarized and compared with the previous design values in Table II and Figure 6.

TABLE II

AERODYNAMIC DESIGN ANNULUS BLOCKAGES

Location	Redesign Endwall Blockage, %	Original Design Endwall Blockage, %
Rotor Leading Edge	3.0	4.5
Rotor Trailing Edge	6.5	2.5
Stator Leading Edge	6.5	1.5
Stator Trailing Edge	7.0	1.5

The total inlet pressure loss relative to the plenum, the diffusion factors for rotor and stator, and the final flowpath design are shown in Figures 7, 8, and 9, respectively. The close spacing between rotor and stator (Figure 9), which is less than in the original rig, is representative of first-stage spacing of typical high-pressure compressors. The exit duct has been opened up relative to the original (ref. 2) because the original duct is believed to have been choked as a result of instrumentation blockage. The rotor and stator inlet and exit meridional velocity profiles are shown in Figure 10, and the relative and absolute air angle for which the blades and vanes were designed are shown in Figure 11.

A complete summary of the design velocity vector data calculated along streamlines at the rotor and stator leading and trailing edges is tabulated in Appendix C.

3.2 ROTOR BLADE REDESIGN

The NAS3-20809 rotor, which was deficient, has been redesigned to achieve its original goals and will be used in the current test program. The redesign will be effected by modifying the original blades by a reforming process. Thus only the front and total camber and their location in space (and hence blade stagger) are being changed. The rotor, designed to provide a pressure ratio of 1.845 at a tip speed of 441.96 m/sec (1450 ft/sec), has 24 blades with a tip solidity of 1.26 and an aspect ratio of 1.3 based on average blade length and absolute chord length at midspan.

The rotor redesign employed actual measured blockages and recorrelated deviations. The modified rotor airfoil is specified by 21 multiple-circular-arc sections on conical surfaces that approximate stream surfaces of revolution at 0, 5, 10, 16, 21, 27, 32, 37, 42, 47, 52, 57, 62, 67, 72, 76, 81, 86, 91, 96, and 100 percent of span. Airfoil sections are defined by specifying total and front chord, total and front camber, stagger, maximum thickness and its chordwise location, and leading and trailing edge radii, as defined in Figure 12.

The front-to-total-camber ratio and stagger angle were changed to achieve the required incidence and critical channel area margin (A/A* min.) established from multiple-circular-arc fan rotor and stator experience. Because many combinations of these parameters satisfy the incidence and area margin criteria, an additional analysis technique, a time-marching finite-area procedure (ref. 4), was used to ensure an optimized blade shape.

With this procedure a blade channel flowfield was calculated for streamlines at approximately 20, 50, and 80 percent of span, which yielded pressure distribitions throughout the channel for each selected blade shape. The front camber level selected from the above criteria was shown to minimize the shock loss calculated by the time-marching finite area program and to achieve a smooth diffusion of pressure on the blade surfaces.

Rotor maximum-thickness-to-chord ratio (t/c), unchanged from the original design, is 0.085 at the hub and 0.035 at the tip. The chordwise location of maximum thickness varies linearly from 55 to 65 percent from root to tip.

Incidence angles for all supersonic inlet sections were chosen at a point (termed the a' point) on the suction surface halfway between the leading edge and the point from which a Mach wave emanates that meets the leading edge of the adjacent blade. This incidence, together with the entrance region and channel area considèrations, determines the leading edge incidence. For the midsection the a' incidence was set at approximately 1.5 degrees based on fan experience. This incidence angle is intended to account for blockage at the blade leading edge, development of the suction surface boundary layer, and bow-wave loss. Near the tip the a' incidence was reduced to about one degree in order to improve the pressure distribution predicted from the time-marching finite area program.

For sections near the root where the inlet Mach number was only slightly greater than one, higher values of incidence to the a' point were required to provide adequate flow area while maintaining a smooth distribution of leading edge incidence. Streamline 1 has a suction surface incidence of -5 degrees, which fairs smoothly with the rest of the span and is consistent with hub sections of similar high-pressure compressor rotors.

The resulting spanwise distribution of suction surface, mean camber line, and a' incidence is shown in Figure 13.

Deviation angles from 20 to 80 percent of span were calculated using Carter's rule plus adjustments based on the test of the original blade. The resulting design deviation versus span for the rotor is shown in Figure 14, and the rotor inlet and exit metal angles resulting from the incidence and deviation selection are shown in Figure 15. The ratio of front camber to total camber was chosen to provide a minimum channel flow critical area ratio of approximately 1.03 for most of the span. In the outer 15 percent span the area was larger in order to keep the front camber from becoming negative. These margins above choke have been shown to give good performance for many fans (ref. 5 to 7).

Rotor geometry on design conical surfaces is summarized in Appendix D. For manufacturing purposes the airfoil sections were redefined on planes normal to the stacking line, a radial line through the center of gravity of the root conical section. The resultant blade coordinates are presented in Appendix E.

Because of the method of modification, the root section of the blade (from zero to ten percent span) could not be changed; thus the redesign was confined to outboard of ten percent span. The modification was accomplished by adding approximately three degrees of total camber to the trailing edge (Figure 16), with minimal changes to front camber and none to the leading edge metal angle.

3.3 STATOR VANE DESIGN

The stator row has 27 vanes with controlled-diffusion airfoil sections designed on conical surfaces approximating stream surfaces of revolution. The original stator had 30 vanes and was located further downstream of the rotor trailing edge than in the current design in order to provide room for instrumentation not incorporated in the redesigned stage. The current spacing is more in keeping with engine practice. In order to provide a sound basis for comparing performance, the stator solidity, aspect ratio, thickness-to-chord ratio, and taper ratio were not changed.

The vanes have a constant chord of 0.748 meters (2.948 in.) and solidities of 1.455, 1.167, and 0.975 respectively at the root, mean, and tip. The aspect ratio based on average length and actual chord is 1.446 and is 1.58 based on average length and axially projected chord at the hub. Maximum-thickness-to-chord ratio (0.05 at the hub to 0.07 at the tip), midspan solidity, aspect ratio, and diffusion factor are the same as in the original design (ref. 2).

3.3.1 Controlled-Diffusion Airfoil Design Concept

In the controlled-diffusion concept the airfoil is contoured to yield an unseparated boundary layer at the airfoil trailing edge throughout the incidence and Mach number range of interest. The contoured airfoil produces a pressure distribution such as shown in Figure 17. The design criteria for a controlled-diffusion airfoil are:

1) Peak Mach number controlled to low supersonic levels to preclude formation of strong shock waves.

2) Suction surface leading edge region maintains a continuous acceleration up to peak Mach number in order to provide a favorable pressure gradient for maintaining a laminar boundary layer.

3) Diffusion from peak Mach number is controlled to provide a relatively constant boundary layer shape factor (skin friction) over the rear portion of the airfoil to ensure an unseparated boundary layer.

4) Pressure surface peak velocity controlled to ensure that the airfoil has choke margin and that the airfoil is not in negative stall.

5) Pressure distribution closes at the blade trailing edge.

These criteria provide blades with unseparated boundary layers, good incidence range, high Mach number capability, and low losses.

The controlled-diffusion design process relies on a "direct" solution technique in which airfoil surface curvatures are varied to provide sections on conical surfaces that satisfy the above criteria. The section properties are also developed to be smooth in the spanwise direction. Further details of the design process can be found in ref. 1.

A typical section of the designed airfoil is shown in Figure 18, and spanwise examples of resulting design pressure distributions are shown in Figures 19, 20, and 21.

Incidence angle and deviation were set by pressure distribution and Pratt & Whitney Aircraft controlled-diffusion airfoil experience. Incidence varies from -3 degrees to the leading edge mean camber line at 20 percent span to -5 degrees at 80 percent span as shown by Figure 22. Because controlled-diffusion airfoils have a low camber toward the rear and are designed to avoid separation, the airfoil deviations relative to the trailing edge mean camber line are low, as shown in Figure 23. These deviation levels, which vary from about 5 degrees at 20 percent span to about 4 degrees at 80 percent span, are consistent with Pratt & Whitney Aircraft controlled-diffusion airfoil experience. Root to tip stator leading and trailing edge metal angles are shown in Figure 24.

Figure 20 shows the design midspan pressure distribution. This section is well behaved and is operating unseparated. The stator is predicted to have a $\pm 2^{o}$ incidence capability at design inlet Mach number, and +0.02 Mach number capability at design incidence from root to tip.

A complete summary of stator geometry on conical surfaces is presented in Appendix D. The airfoil sections were redefined on planes normal to the stacking line for manufacturing purposes. The resultant airfoil coordinates are presented in Appendix E.

4.0 STRUCTURAL AND VIBRATIONAL ANALYSIS

The structural, vibrational analysis involved tuning the blade and vane geometries to avoid undesirable resonant conditions, stability calculations to ensure stable and flutter-free operation of blades and vanes, and a steady-stress analysis to satisfy overspeed and low cycle fatigue criteria. A rotor frame critical-speed analysis was also performed to investigate the vibrational characteristics of the overall rig assembly.

No structural limitations are anticipated. The rig design is capable of operating to 110 percent of design speed (13,431 rpm). Strain gages will be placed on the blades and vanes and accelerometers on the case in order to ensure rig safety.

4.1 BLADE RESONANCE TUNING

Coupled blade-disk resonances that may be excited in the operating range are of major importance in the design of a compressor stage. Circumferential and radial distortion exist in the inlet airstream and normally contain strong components of first through fourth order harmonics. The airfoil hub/tip ratio, aspect ratio, and spanwise thickness distribution have been adjusted to avoid natural system modes at frequencies close to one, two, and three (1E, 2E, and 3E) excitations per revolution during high speed operation.

For stages behind major support structures--such as the nine inlet struts immediately upstream of the rotor stage--strut passing and twice strut passing frequency can be encountered in the first four coupled spanwise modes of vibration. Other major sources of excitation are the vanes immediately upstream (inlet guide vane) or downstream (stator) of the stage and such periodic obstructions in the flowpath as instrumentation probes.

All adjustments to the blade were made from the previous program (NAS3-20809) such that natural modes will not occur at frequencies close to one, two, and three (1E, 2E, and 3E) excitations. The standard rotor frequency and bending frequency analyses made during the earlier study are applicable to this test.

The redesigned blade was analyzed for natural frequencies and resonant crossings; the results are shown in Figure 25. A 2E first mode frequency margin of 15 percent exists at the 13,431 rpm maximum anticipated rotor speed, and a 3E first mode resonance is predicted at 8900 rpm. Second and third mode (coupled bending and first torsion modes, respectively) frequencies are adequately high to avoid low order resonances yet low enough to avoid vane or strut passing excitations at high rotor speeds. Vane passing and probe excited resonant conditions, which occur low in the operating range, are not expected to be a concern.

4.2 VANE RESONANCE TUNING

Both inlet guide vane and exit stators are variable. The stator vane frequencies were calculated assuming that the vanes are pinned at the inner and outer diameter bushings. Modeling of the circular end caps, extensions, and activating arms were included to accurately predict resonant frequencies. The stator were designed so that the first mode frequency is sufficiently high to avoid low order (2E and 3E) and blade passing (24E) resonance at high speed.

The inlet guide vane, which is the same as tested during the previous program, has been run to 13,000 rpm. No excessive vibratory stresses were observed during the previous test. Analysis indicates the first mode frequency is 28 percent greater than the 2E excitation frequency at redline speed. A 3E first mode resonance was calculated to occur at 11,500 rpm.

The exit stator, which has a controlled-diffusion design, is new for this study. It was structurally designed so that the first mode frequencies would be sufficiently high to avoid low order (2E and 3E) resonance, yet low enough to avoid blade passing (24E) resonance at high speed. Analysis of the stator showed a first mode 3E frequency margin of 16 percent at the maximum anticipated 13,431 rpm rotor speed and a 4E resonant crossing at 11,985 rpm. The results of the analysis are shown in Figure 26.

4.3 ROTOR BLADE AND STATOR VANE FLUTTER

A supersonic, unstalled flutter analysis was performed on the blade at 110 percent of the 13,431 rpm aerodynamic design point in order to ensure that flutter will not be a problem during operation. The minimum log decrement (a measure of the aerodynamic damping in the system) for each of the first three vibration modes is shown in Table III and compared with the previous test, NAS3-20809.

Each of these values being above the minimum allowable log decrement, the design is acceptable.

The stator vane bending flutter and torsional flutter parameters were calculated for both the inlet and exit stators. The calculated values are well within the range of successful experience.

TABLE III

ROTOR BLADE FLUTTER ANALYSIS

	Mode	Minumum Log Decrement	Excitation Order	Allowable Log Decrement
Forward Wave	1	0.02286 (0.02417)	2E (2E)	>0 (>0)
	2	0.01976 (0.01343)	2E (2E)	>0 (>0.002)
	3	0.01053 (0.01109)	3E (4E)	>0 (>0)
Backward Wave	1	0.0079 (0.0096)	2E (2E)	>0 (>0)
	2	0.0071 (0.00614)	4E (2E)	>0 (>0.002)
	3	0.0008 (0.00052)	6E (6E)	>0 (>0)

Speed = 12,210 rpm (Design Speed)

The parenthetic data are from the NAS3-20809 tests

4.4 ROTOR BLADE AND DISK STEADY STRESS

Rotor blade and disk steady stress analyses were not performed as part of the current program, because a complete analysis had been made during the earlier contract, NAS3-20809, and the blade and disk were used without problems. The previous-program analysis is included for completeness of the report.

Blade root stresses were minimized by circumferentially tilting the airfoil 0.889 mm (0.035 in.) at the tip in order to counteract the blade pressure loading. Combined centrifugal, untwist, gas bending, and counteracting tilt stresses were calculated at 13,431 rpm. Predicted airfoil root stresses are shown in Table IV together with the allowable stresses for AMS 4928 titanium alloy at 366K (200°F). The maximum stress in the airfoil of 226 X 10^6 N/m^2 (32,800 lbf/in.^{2}) occurs near the trailing edge of the airfoil root and is well below the allowable stress of 448 x 10^6 N/m^2 (65,000 lbf/in.^{2}).

Calculated blade attachment tension (P/A), contact surface bearing stress, and tooth bending and shear are also compared in Table IV with stress allowables.

The limiting stress in the blade attachment is the average bearing stress of 481 X 10^6 N/m^2 (69,700 lbf/in.^{2}). The bearing stress limit of 448 X 10^6 N/m^2 (65,000 lbf/in.^{2}) was established to minimize galling on the contact surface during long term service and is not a relevent limit for the intended rig testing. Minor broach refinement would be required to satisfy the service stress limit.

TABLE IV

STATIC BLADE STRESSES
N/m^2 (lbf/in.^{2})

	Maximum	Allowable
Blade Root (0.035 Tilt)		
Leading Edge	215 X 10^6 (31,200)	448 X 10^6 (65,000)
Trailing Edge	226 X 10^6 (32,800)	448 X 10^6 (65,000)
Maximum Thickness	225 X 10^6 (32,600)	448 X 10^6 (65,000)
Blade Attachment		
Tension	199 X 10^6 (28,800)	276 X 10^6 (40,000
Bearing	481 X 10^6 (69,700)	448 X 10^6* (65,000)
Bending	217 X 10^6 (31,400)	276 X 10^6 (40,000)
Shear	150 X 10^6 (21,700)	276 X 10^6 (40,000)

*Applied to long term service.

A modified Goodman Diagram (Figure 27) indicates that at the maximum steady state stress level in the blade root of 226 X 10^6 N/m^2 (32,800 lbf/in.^{2}), the maximum allowable vibratory stress is 103 X 10^6 N/m^2 (15,000 lbf/ in.^{2}).

Maximum allowable vibratory stress limits for the stator vanes were established based upon test experience with similar stator vane and attachment design. For the entrance and exit stators, a vibratory stress limit of 69 X 10^6 N/m^2 (10,000 lbf/in.^{2}) was established.

4.5 RIG CRITICAL SPEED

A critical-speed analysis was not performed for this program because a complete study had been made during the previous contract, the rig configuration being the same and no critical-speed problems having been encountered. The NAS3-20809 analysis is included in this report for completeness.

Existing rig hardware--the rotor drive system, bearings, dampers, and primary rotor support structure--will be used in this program. This hardware has been employed without linear vibration problems in tests of a Pratt & Whitney Aircraft research fan to a speed of 12,400 rpm in the same test facility. Inner and outer cases downstream of the inlet guide vane will be new, but an existing inlet case from an advanced compressor will be used forward of the inlet guide vane.

An existing rotor-frame critical-speed analysis was modified to reflect the new blade, disk, and cases. Predicted rotor critical speeds and the total strain energy in the rotor system are shown in Table V. The first mode rotor critical speed at 8065 rpm is essentially a cantilevered rotor and number one bearing support structure mode pivoting about the exit strut case.

TABLE V

CRITICAL SPEED ANALYSIS
ROTOR MODES

Critical Speed (rpm)	Rotor Strain Energy (%)
8,065	10.7
12,477	9.8
15,274	67.1

Design Speed - 12,210 rpm
Running Range - 6,105 rpm to 13,431 rpm

Significant relative motion exists at the number one bearing location, but the viscous damper will suppress response in this mode. The second rotor critical speed of interest is a rotor pitch mode about the number two bearing. Again the viscous damper in the number one location will be effective in suppressing response in this mode. The third mode, predicted at fifteen percent above redline speed, is a fundamental drive shaft and coupling bending mode. Little case participation was noted, and no relative motion was present at the bearing. This mode is sufficiently beyond the intended operating speed to be of no concern.

4.6 PROBE ANALYSIS

A frequency analysis of the probes was made by means of a simple beam analysis. Each probe was assumed to be a cantilevered beam with a weight that included the probe and the kiel heads and tubing. This analysis (Figure 28) showed that three of the probe frequencies are well above the 2E excitation frequency at redline speed (13,341 rpm) and that the remaining probe has a 26 percent 2E margin at the redline speed. The difference in number of inlet guide vanes and blades creates a natural 4E excitation for the probe system but, as seen in Figure 28, the 4E resonant conditions were tuned to occur at a low speed and above the redline speed. Blade passing resonances (24E) were also avoided by tuning the first mode frequencies of each probe.

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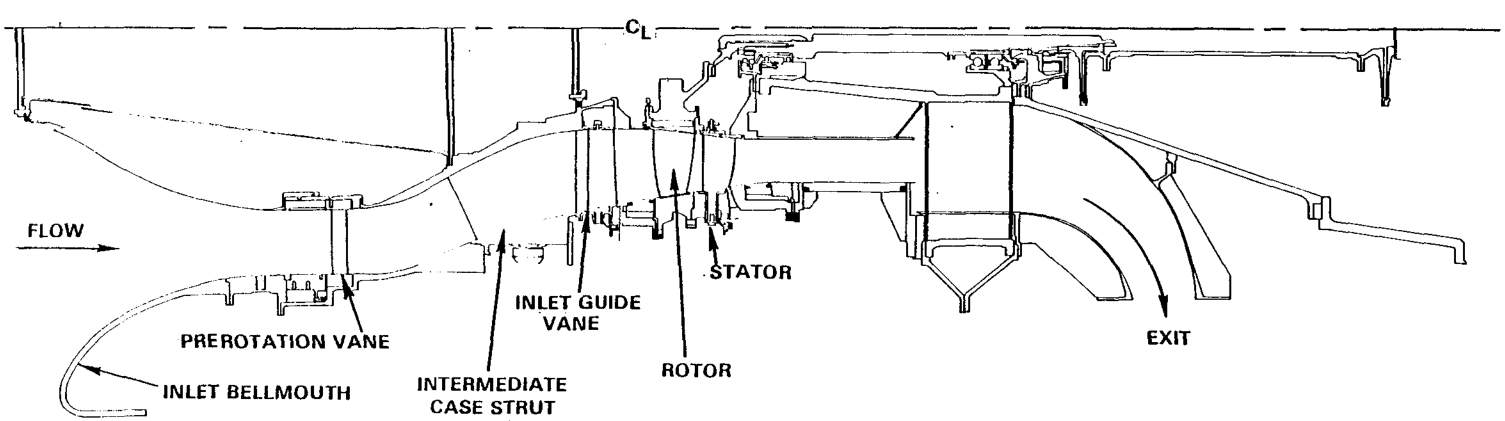


Figure 1 Flowpath of Controlled-Diffusion, Front Stage Rig

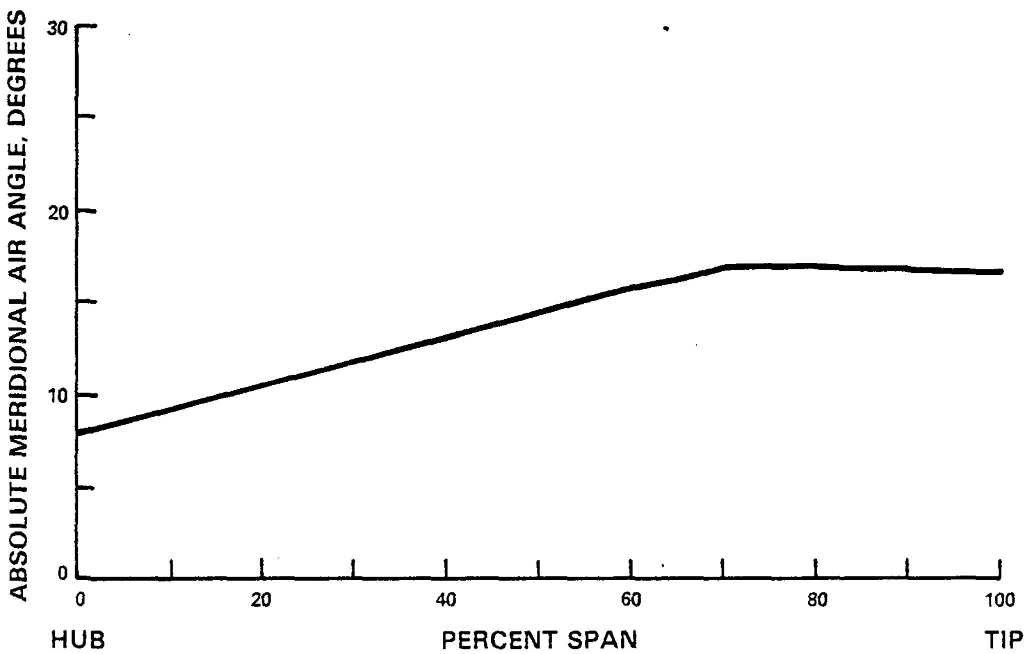


Figure 2 Inlet Guide Vane Absolute Exit Air Angle

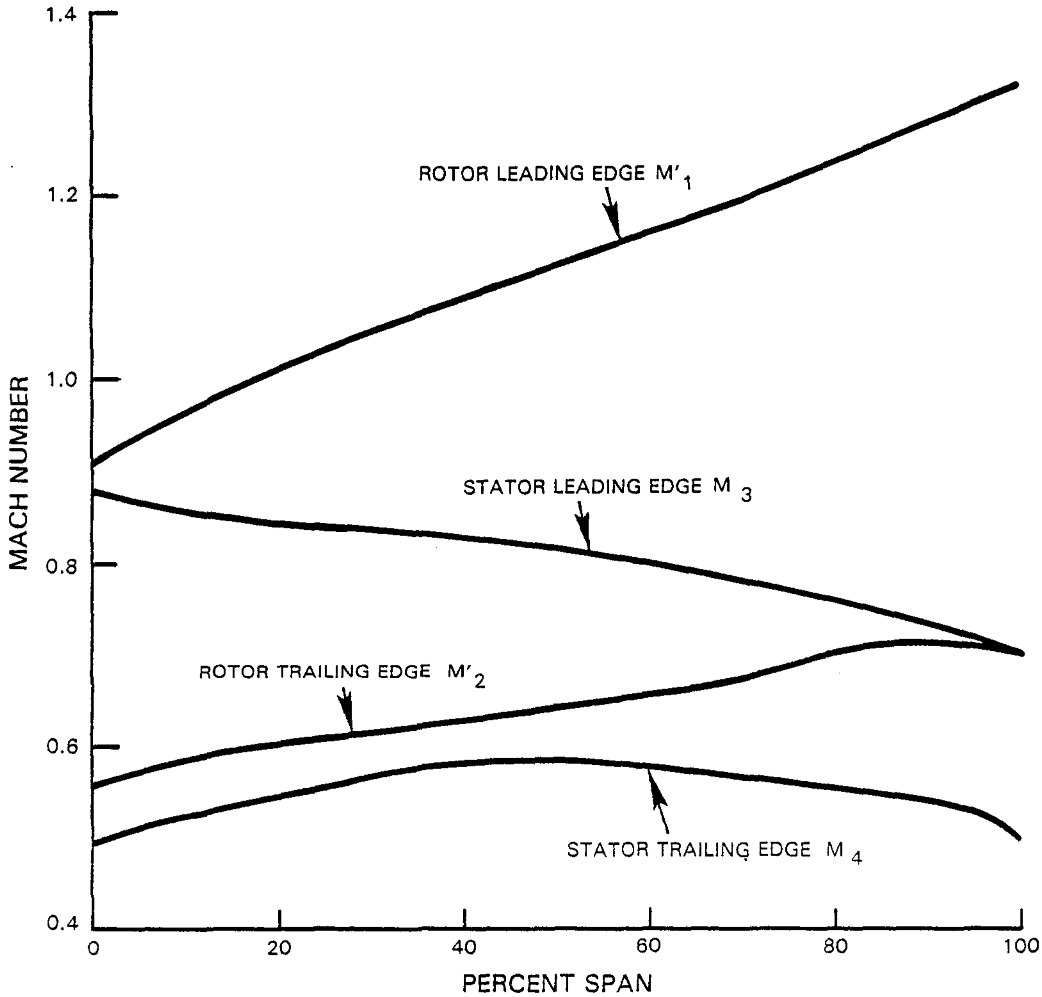


Figure 3 Inlet and Exit Mach Numbers for the Rotor and Stator as a Function of Percent Span From the Hub

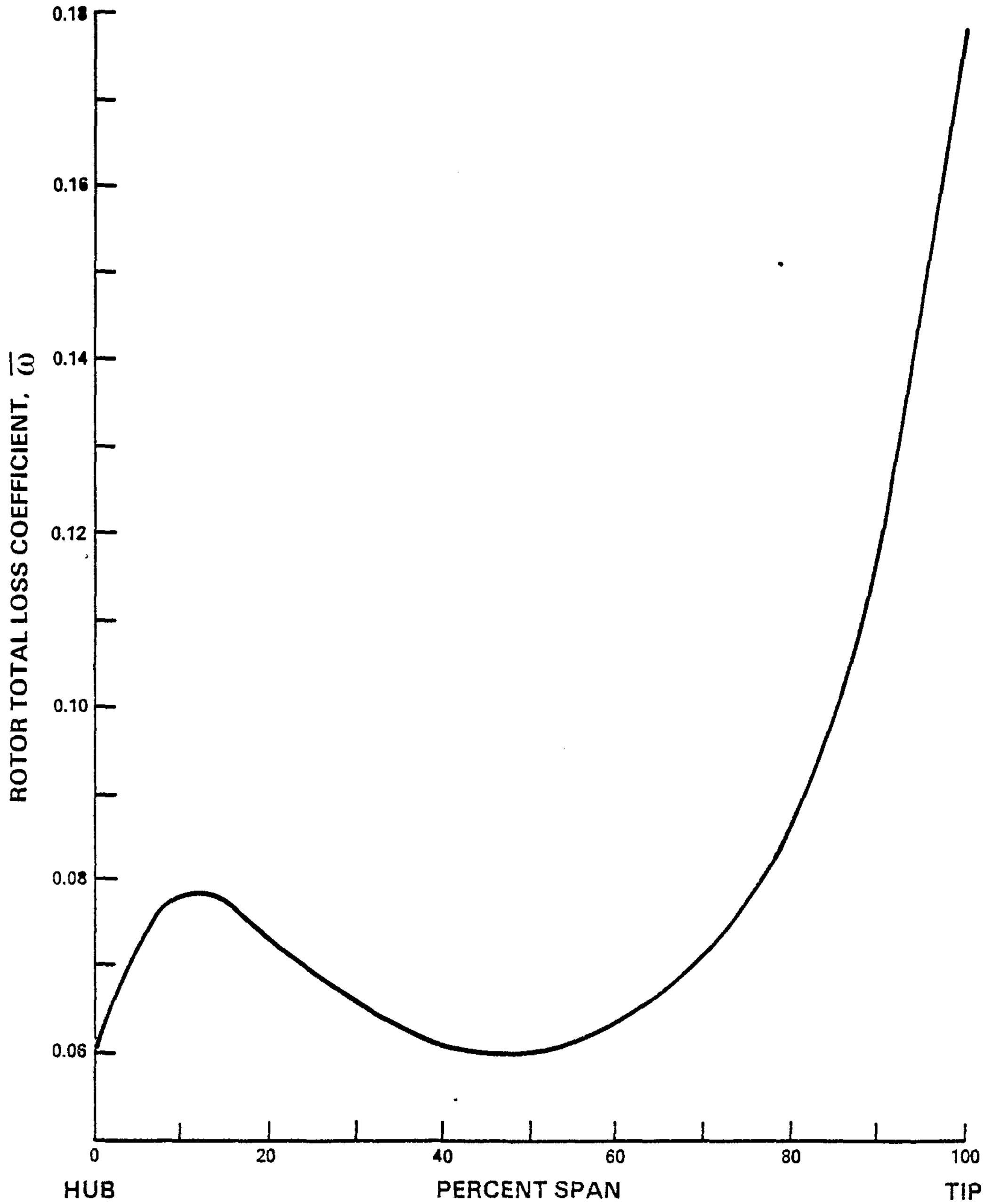


Figure 4 Radial Distribution of Rotor Loss Coefficient

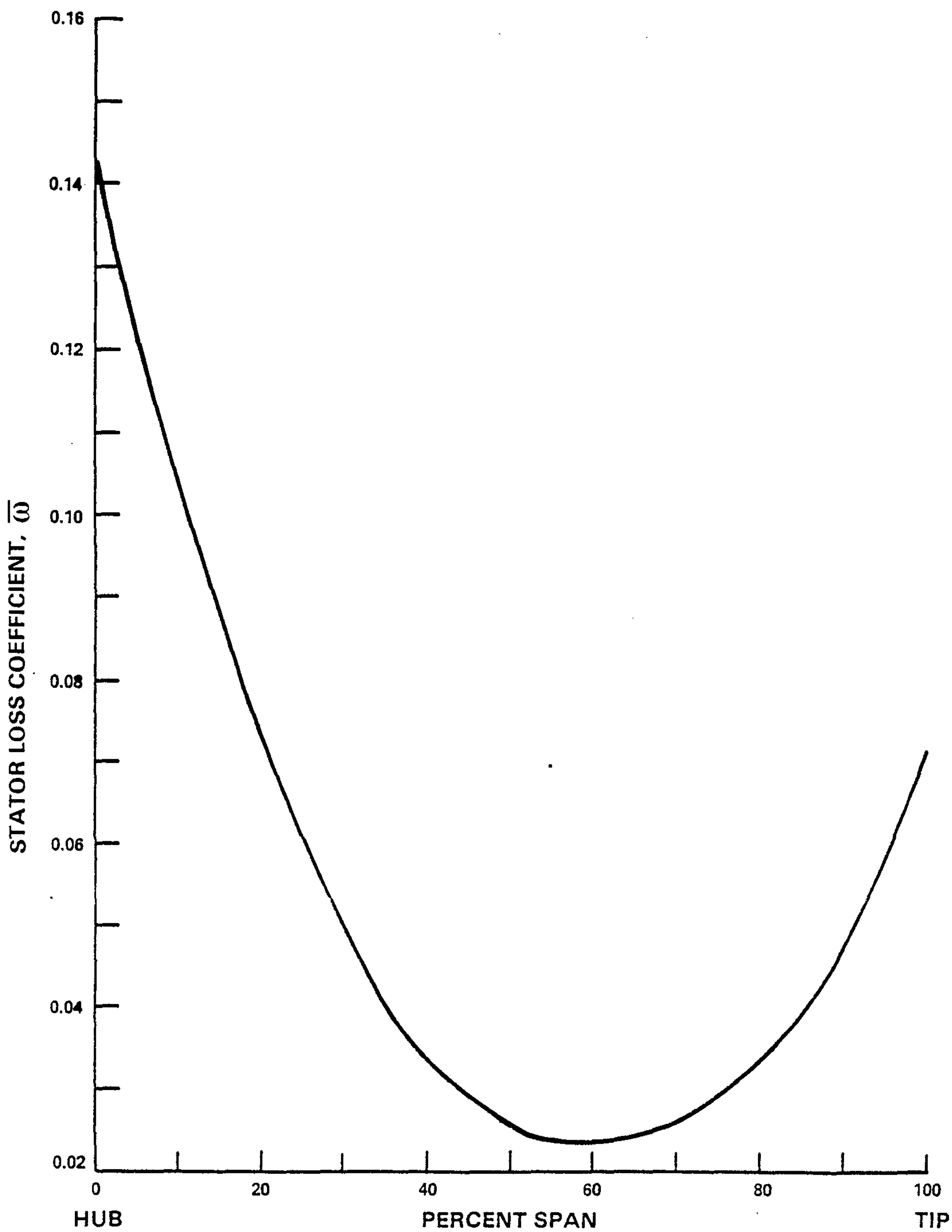


Figure 5 Radial Distribution of Stator Loss Coefficient

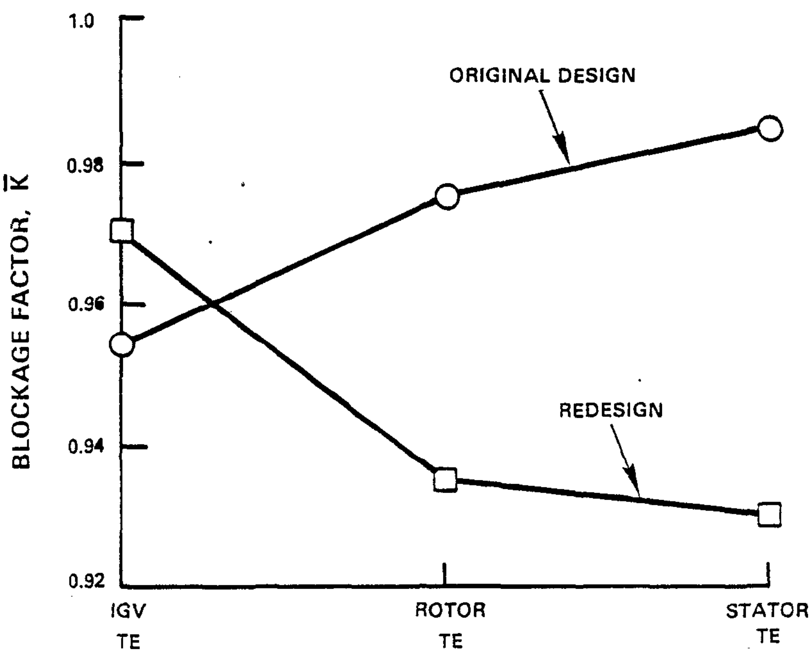


Figure 6 Trailing Edge Blockage Distribution - Incorrect blockages resulted in an undercambered blade in original design

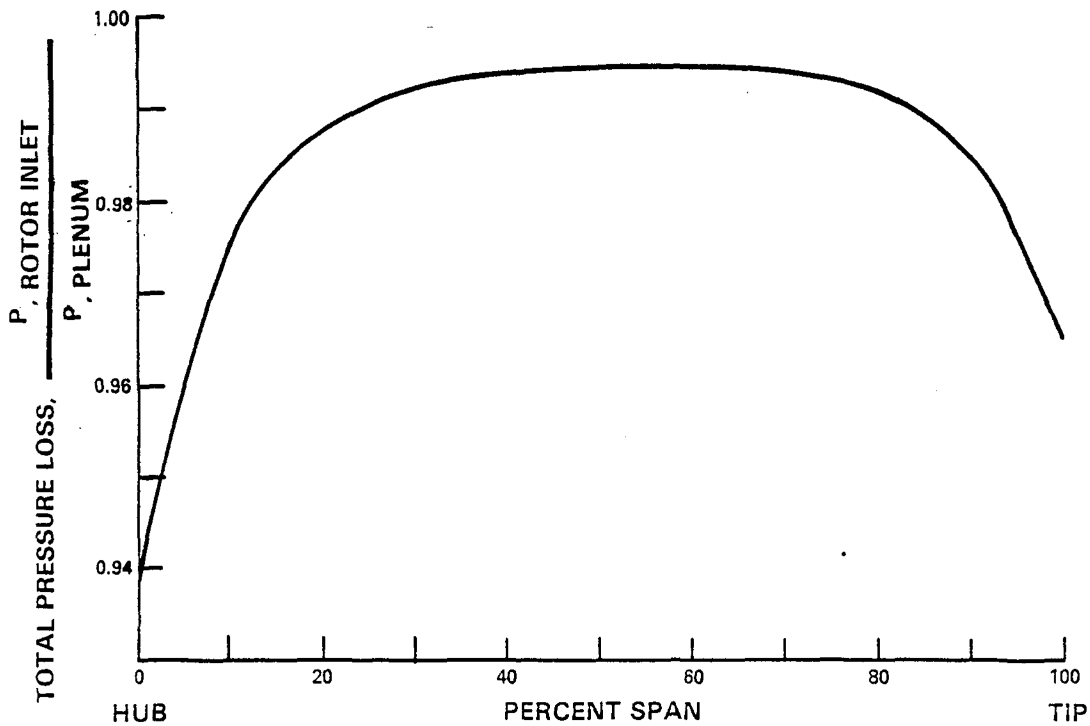


Figure 7 Inlet and Inlet-Guide-Vane Total Pressure Loss as a Function of Percent Span From the Hub

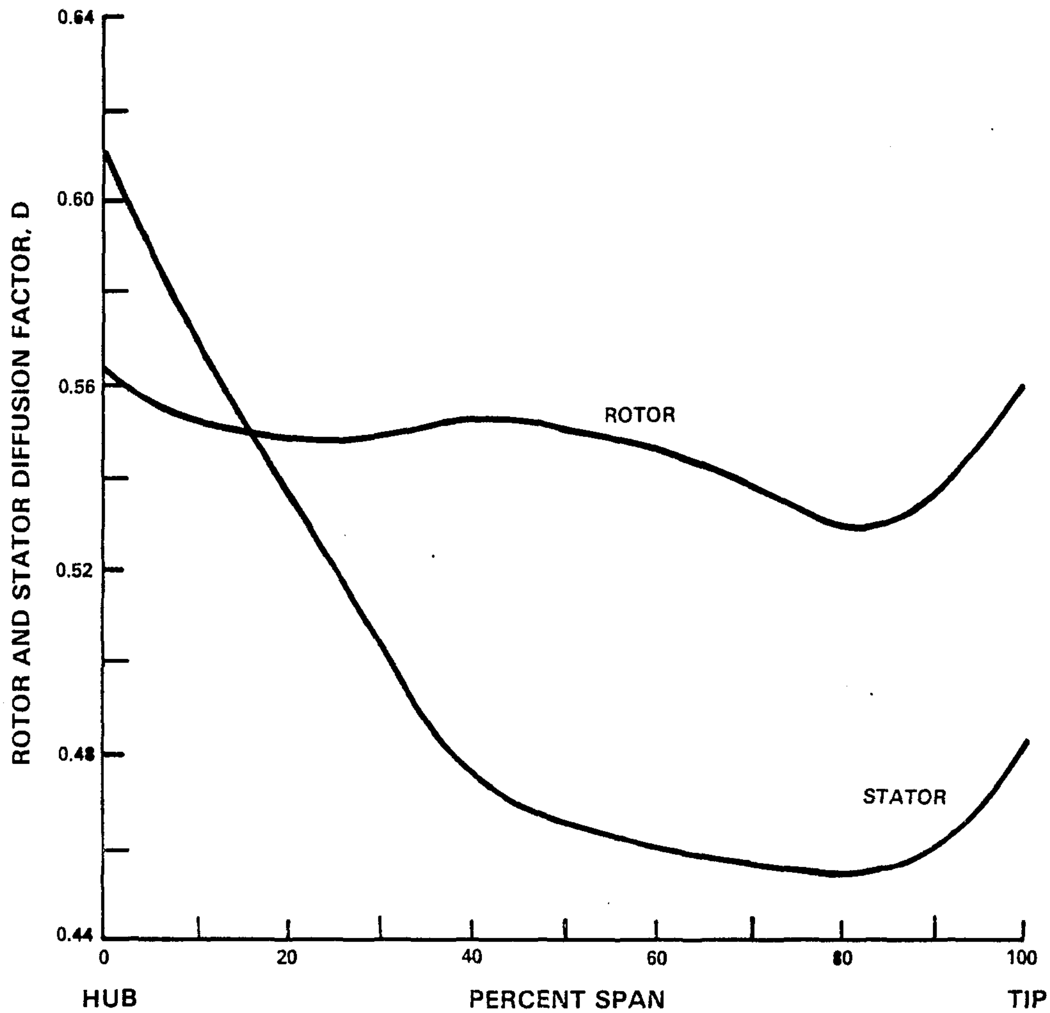


Figure 8 Design Diffusion Factor for Rotor and Stator as Functions of Percent Span From the Hub

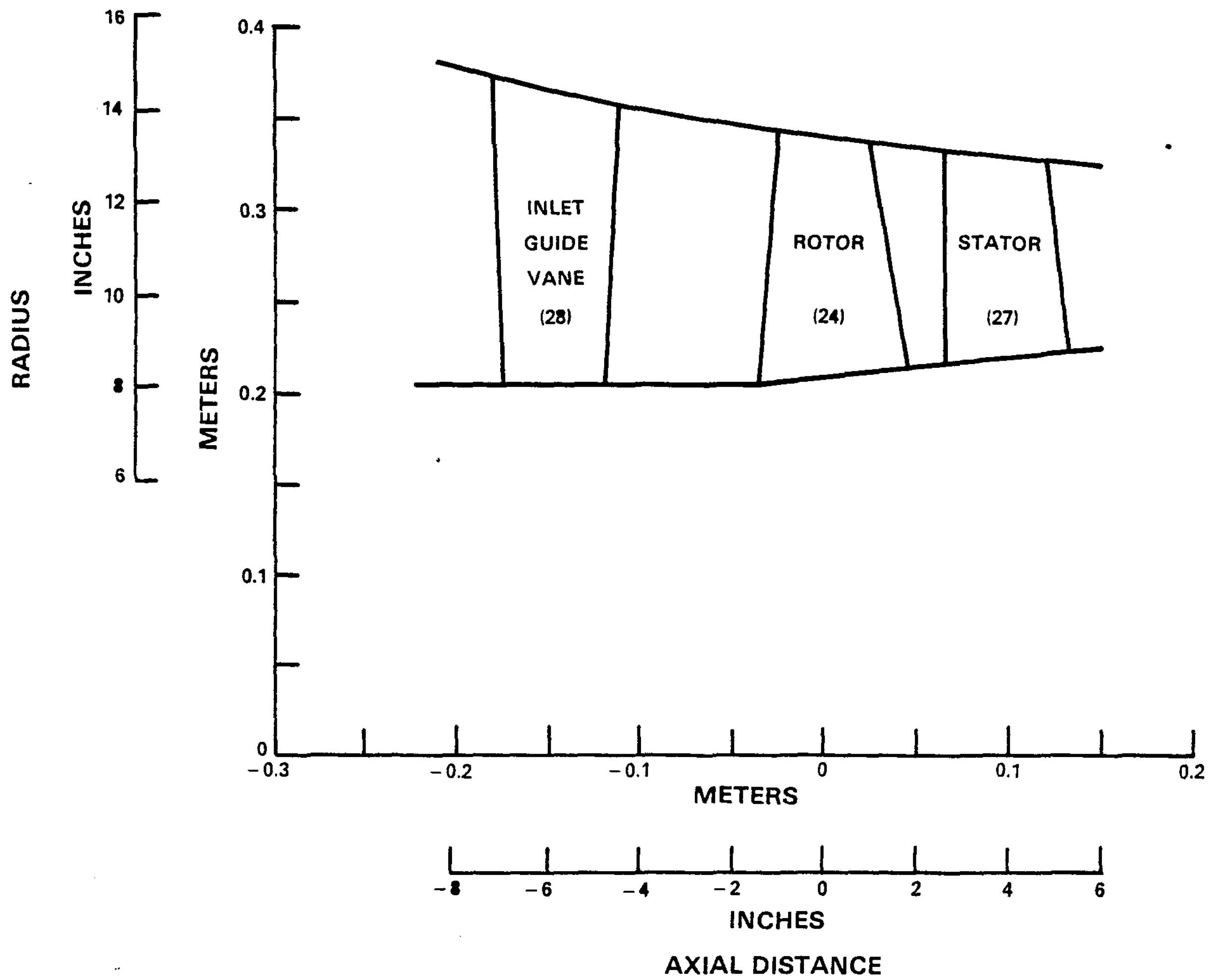


Figure 9 Compressor Stage Flowpath

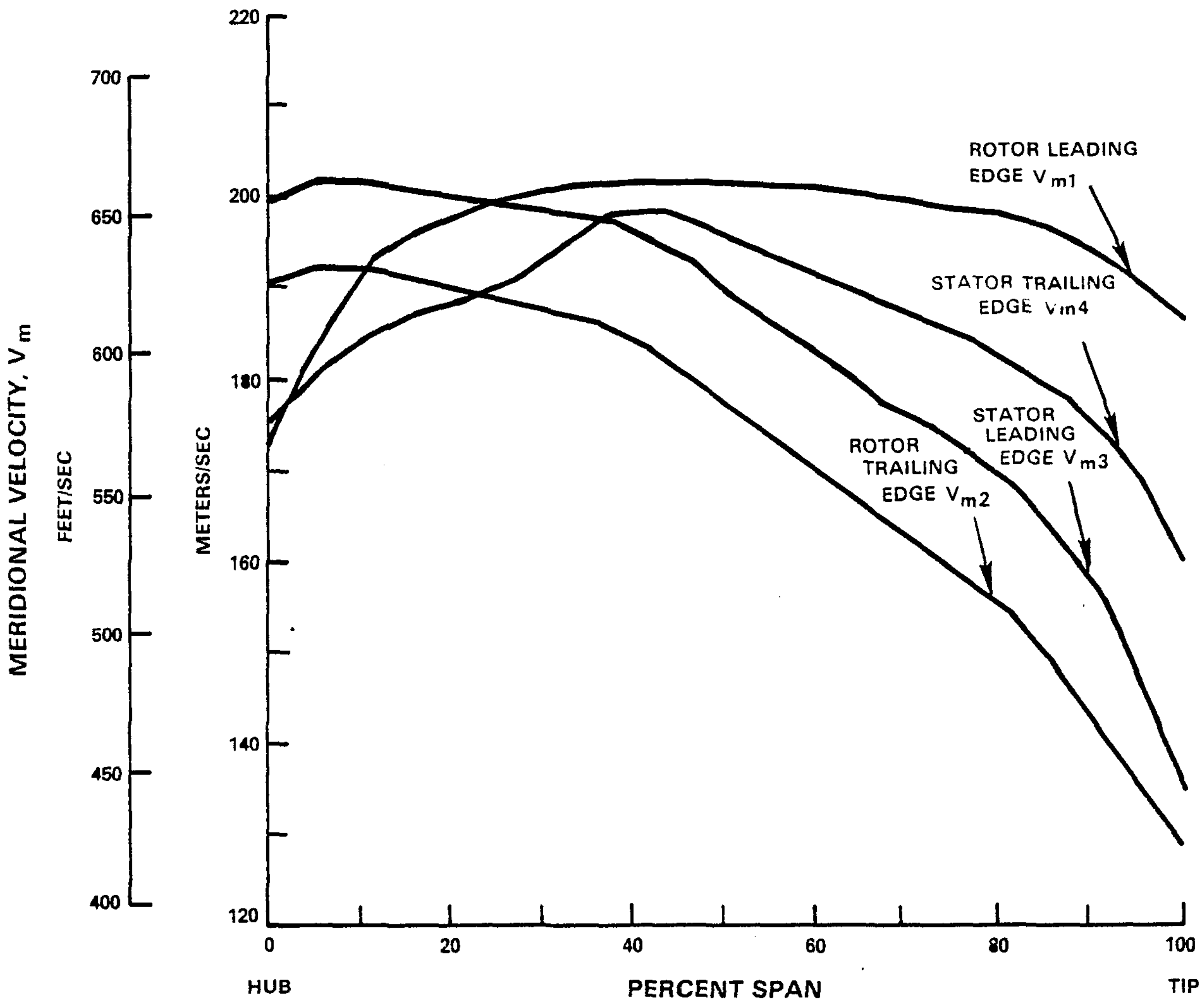


Figure 10 Meridional Velocity Profiles of Rotor and Stator Inlet and Exit

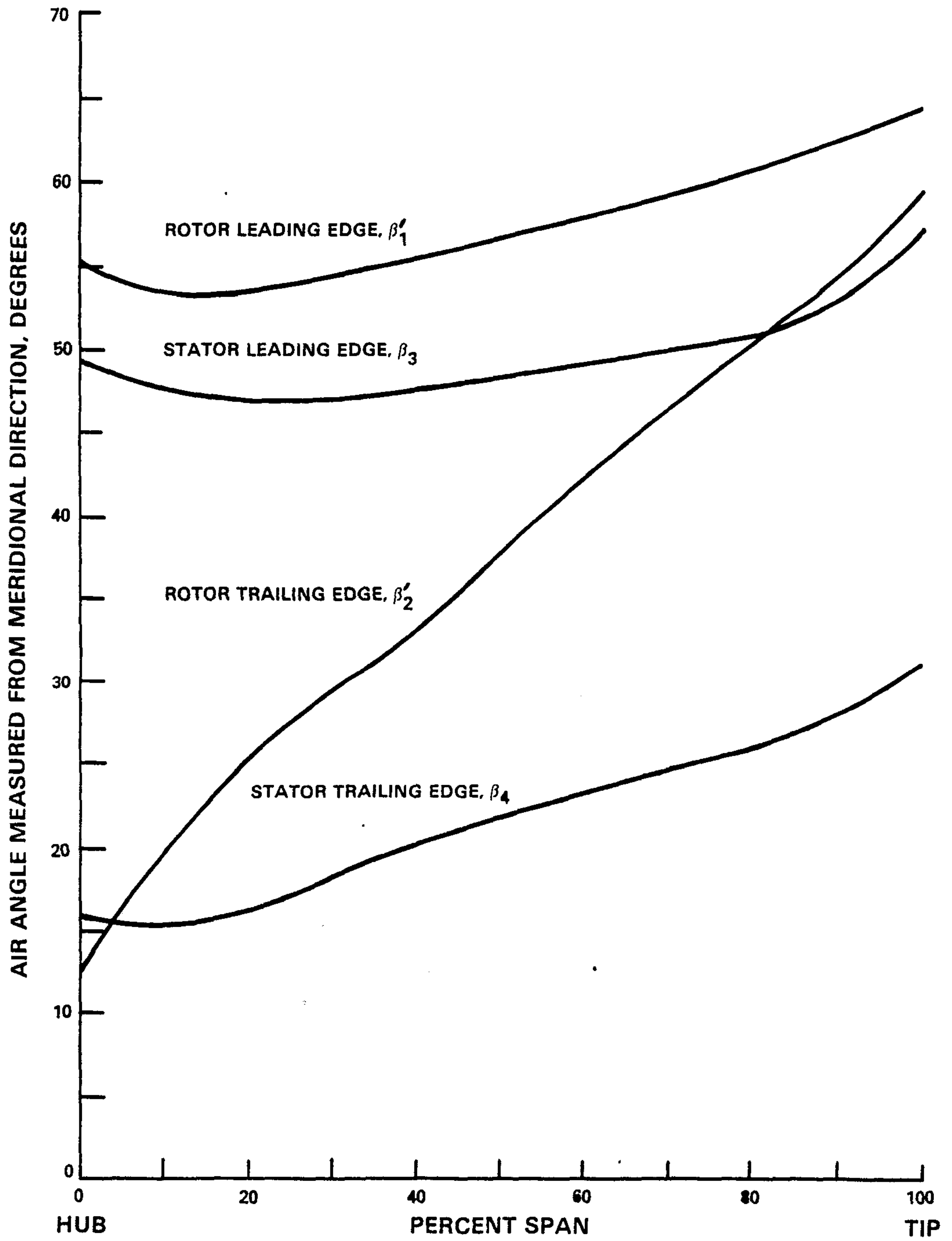


Figure 11 Design Air Angle for Rotor (relative) and Stator (absolute)

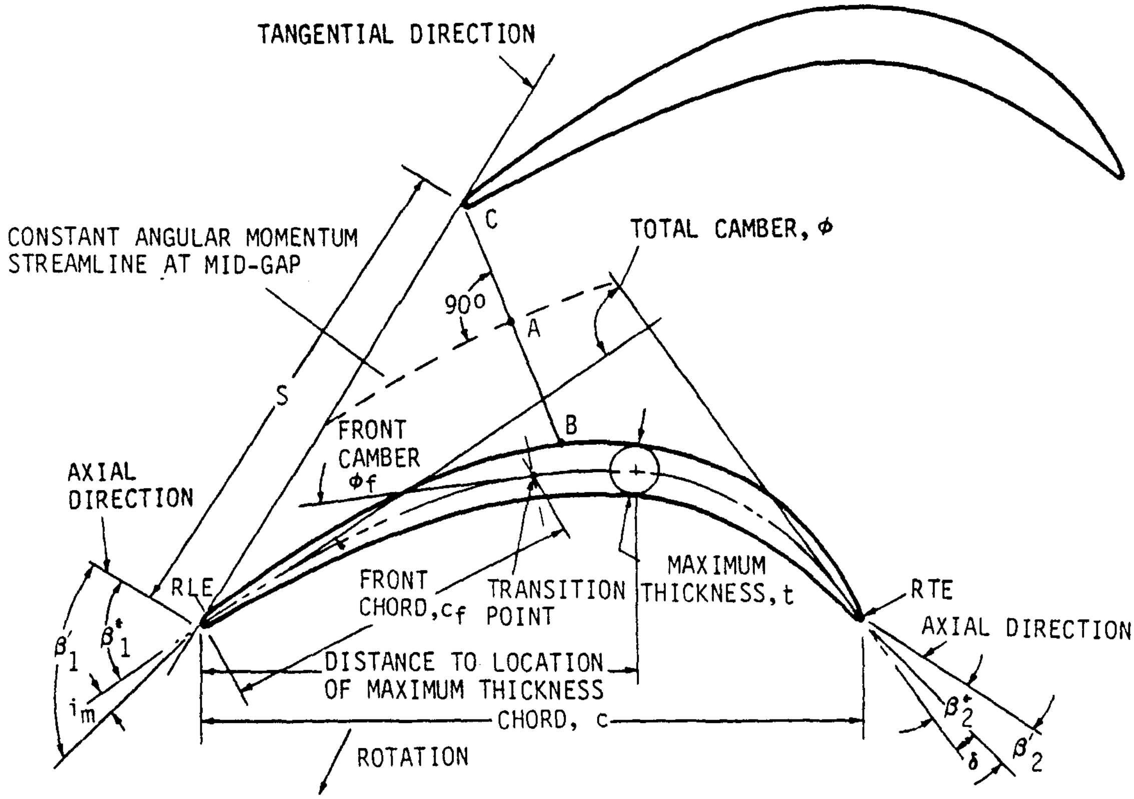


Figure 12 Multiple-Circular-Arc Airfoil Definitions and Cascade Relationship

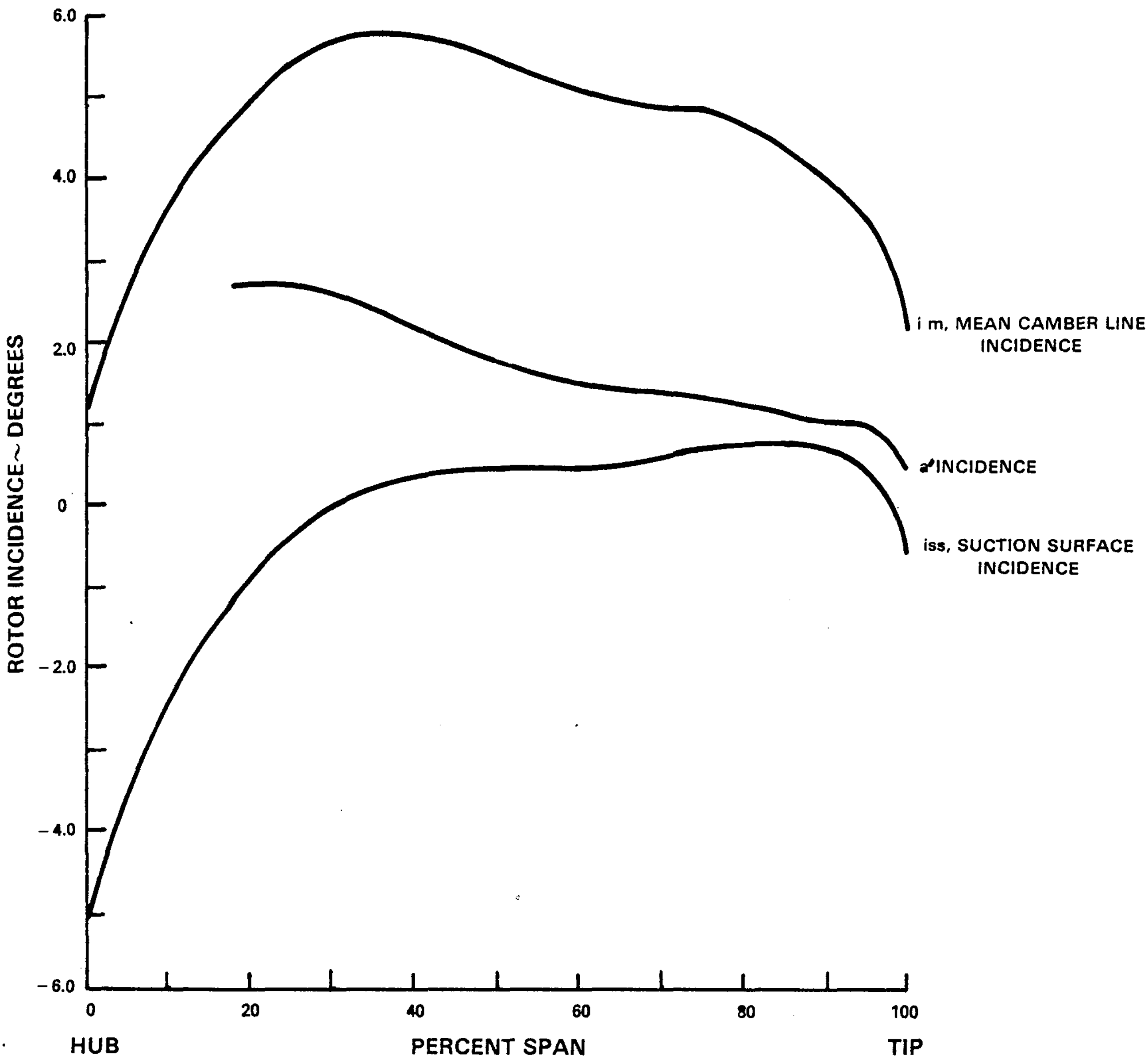


Figure 13 Rotor Incidence Angle as a Function of Percent Span From the Hub

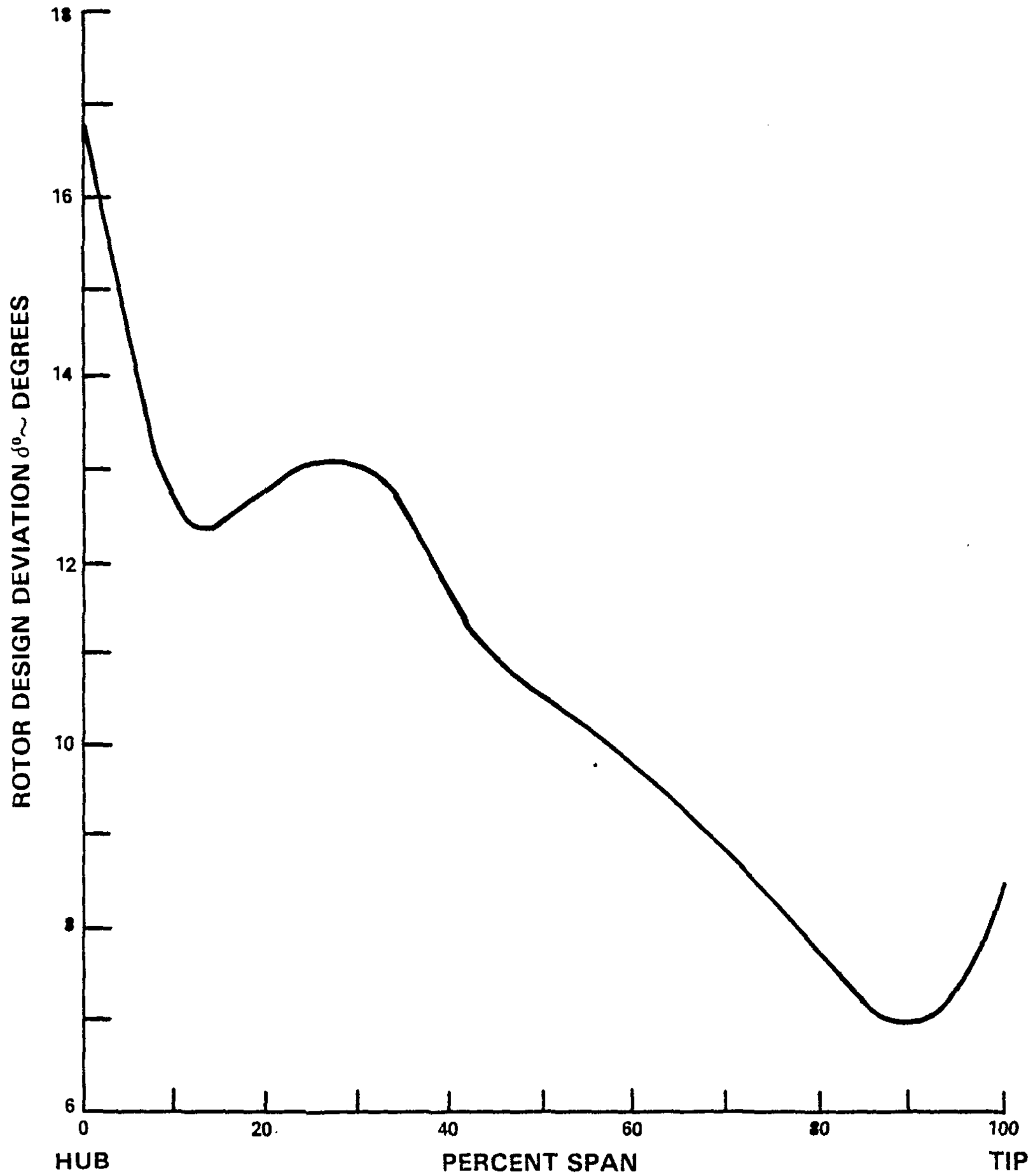


Figure 14 Rotor Deviation as a Function of Percent Span From the Hub

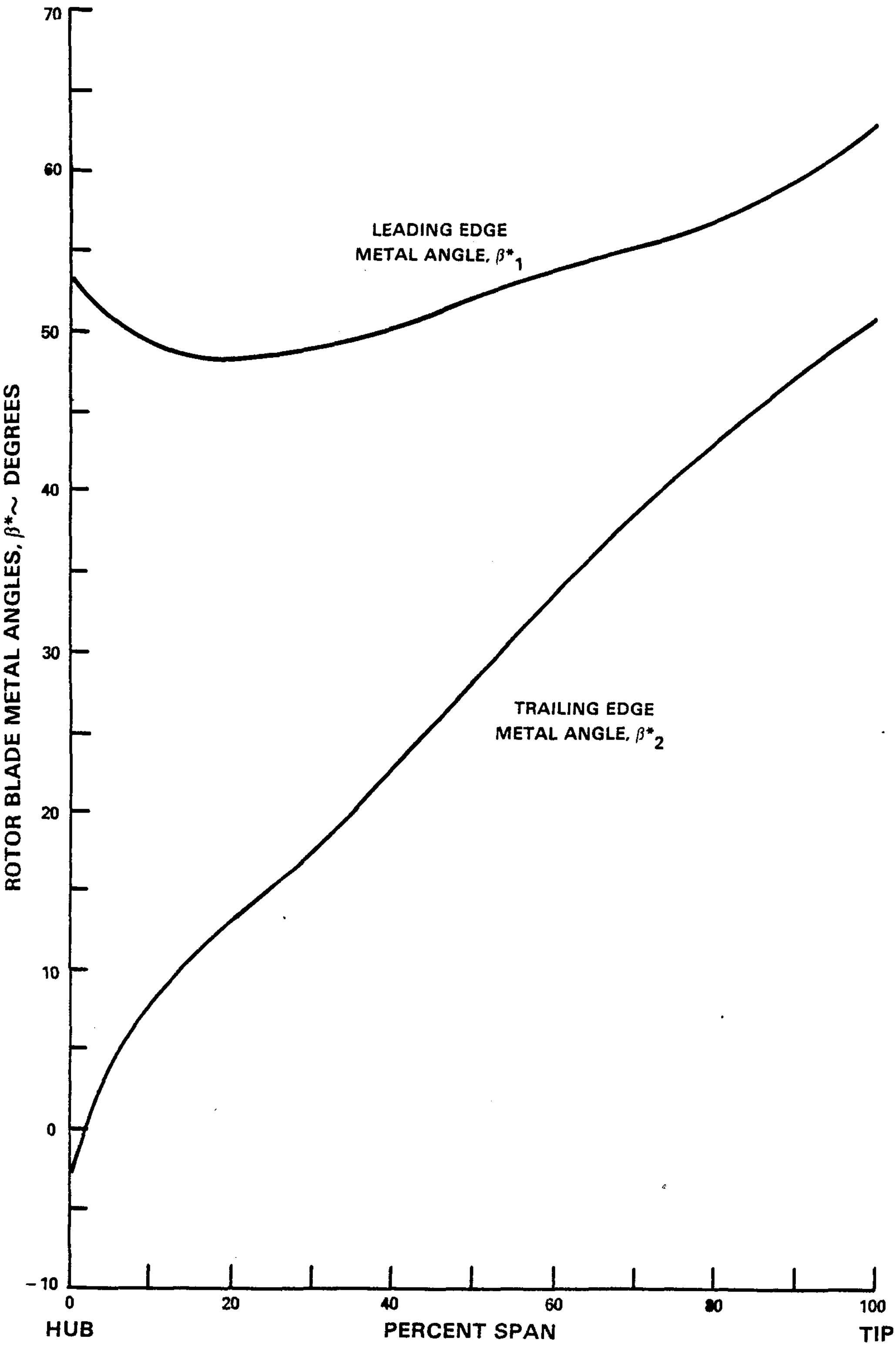


Figure 15 Inlet and Exit Rotor Metal Angle as a Function of Percent Span From the Hub

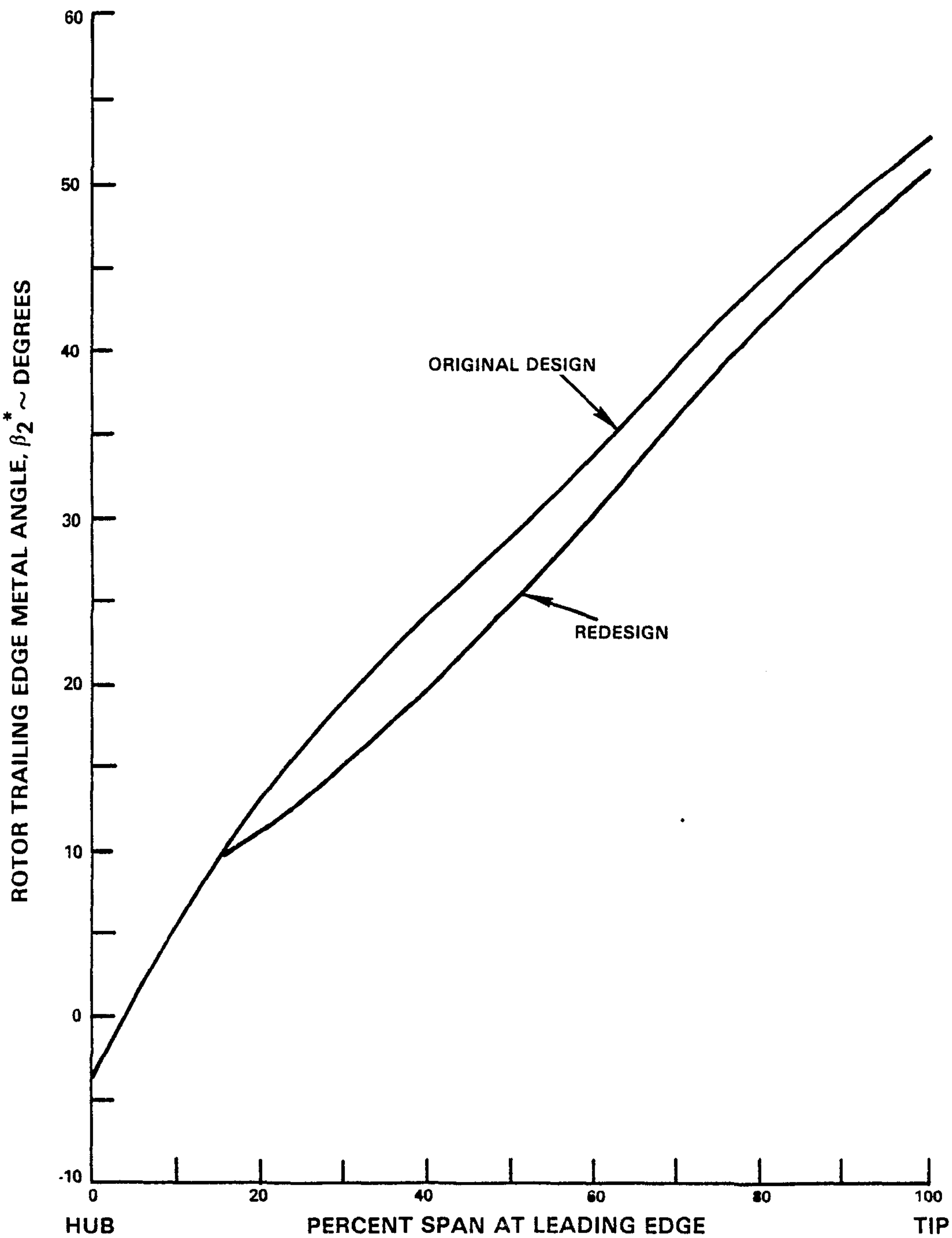


Figure 16 Comparison of Redesign With Original Design Trailing Edge Rotor Metal Angle

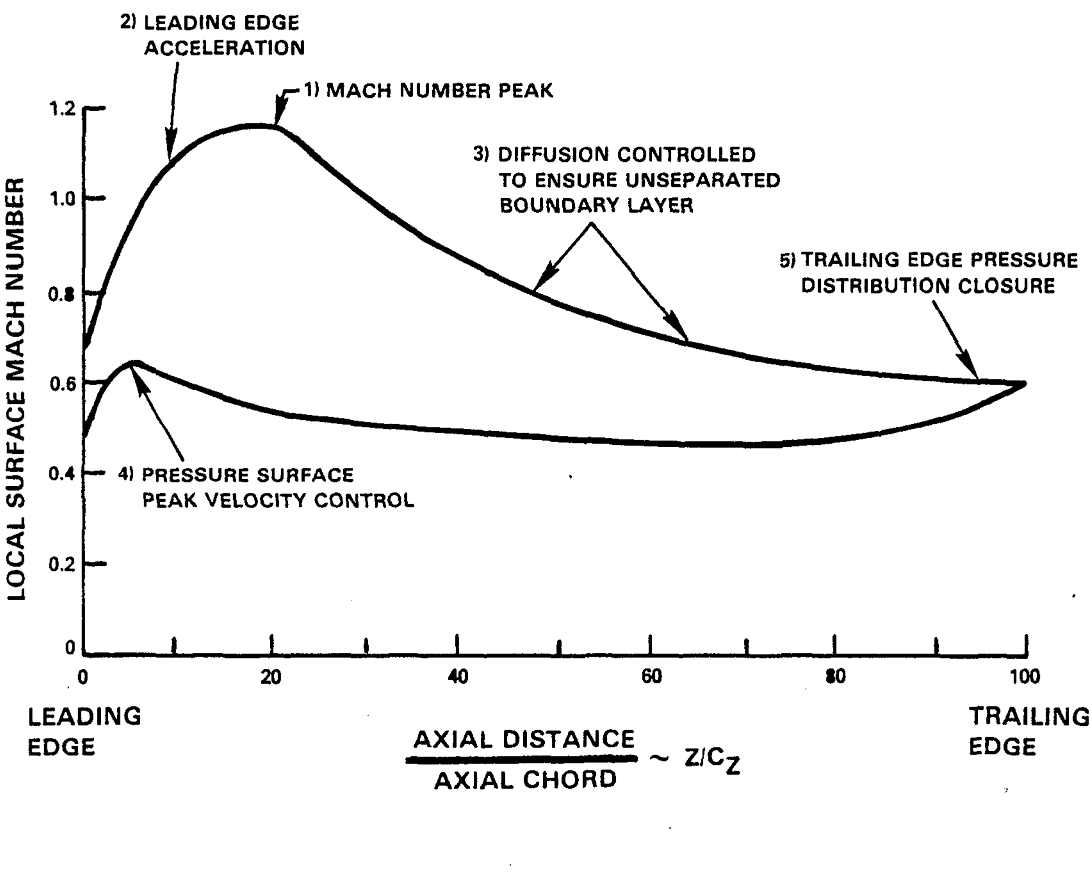


Figure 17 Design Criteria for Controlled-Diffusion Stator Airfoil

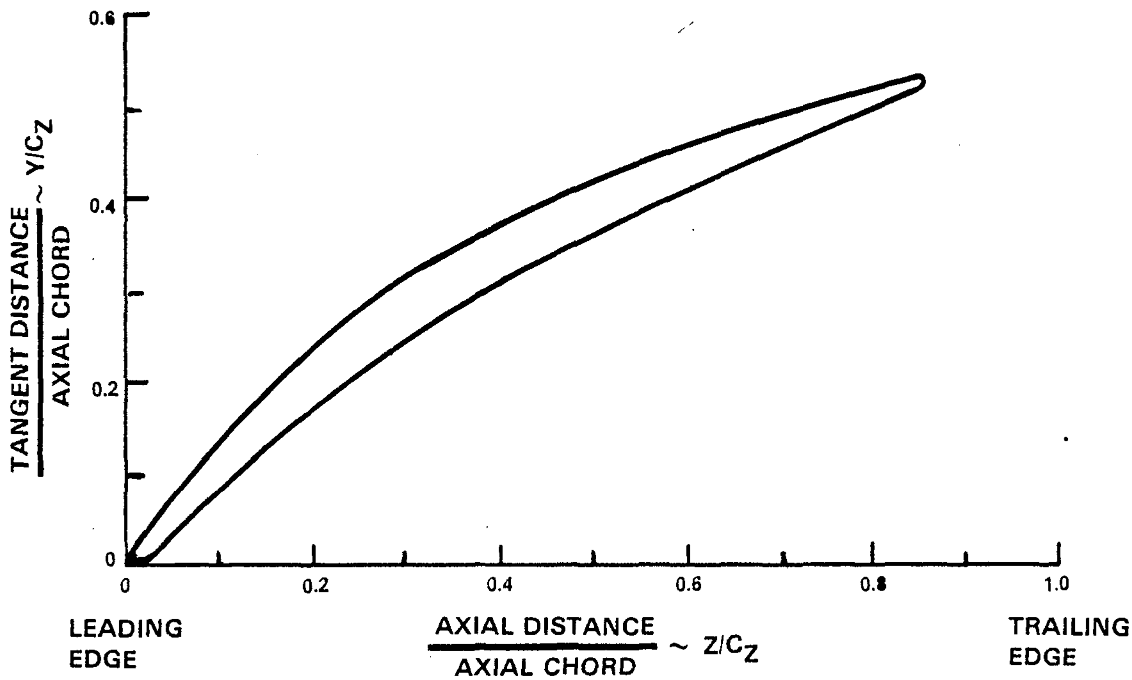


Figure 18 Typical Design Airfoil Section at 47 Percent Span From Hub

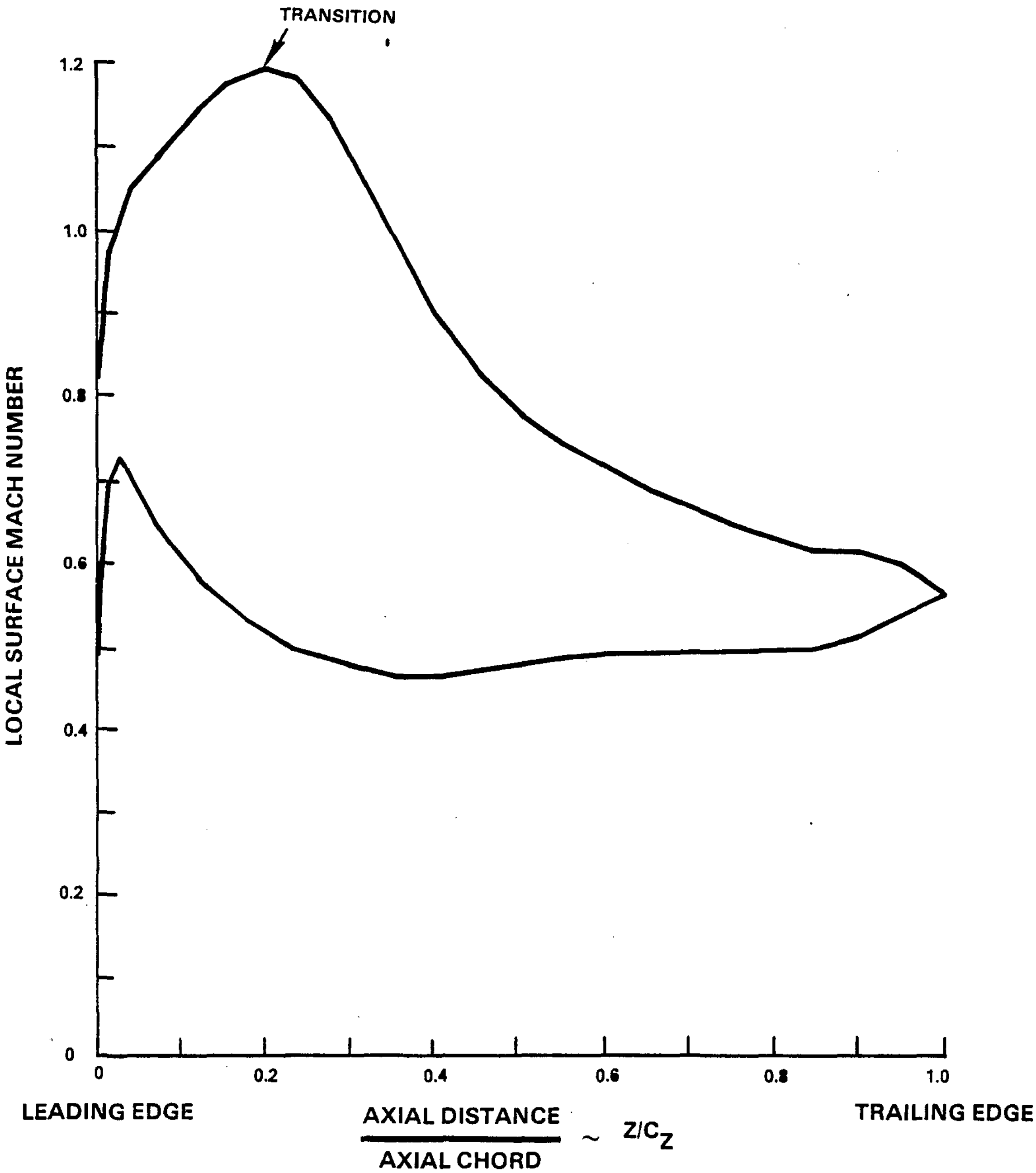


Figure 19 Airfoil Local Surface Mach Number Distribution at 100 Percent Design Speed at 16 Percent Span From Hub

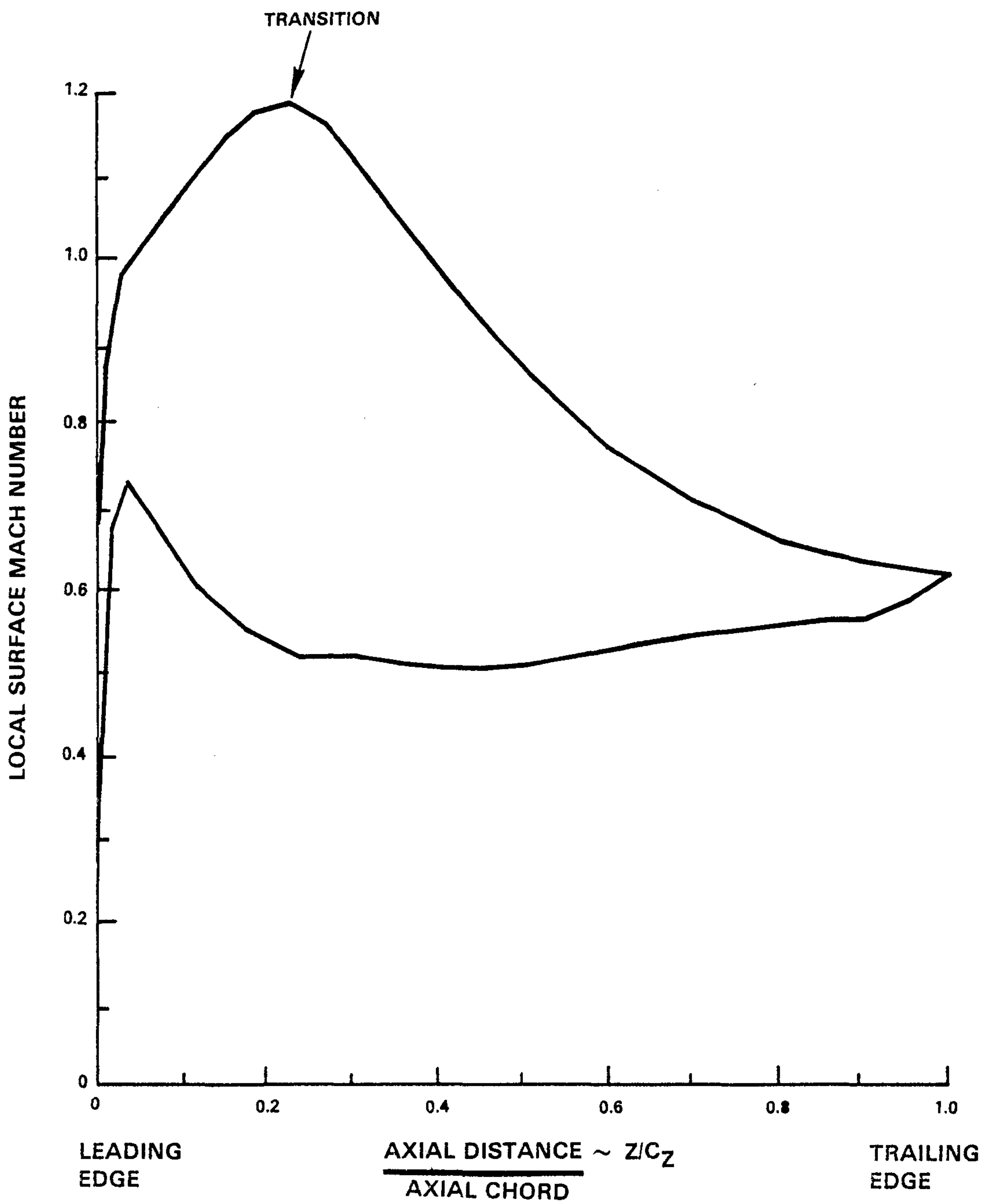


Figure 20 Airfoil Local Surface Mach Number Distribution at 100 Percent Design Speed at 47 Percent Span From Hub

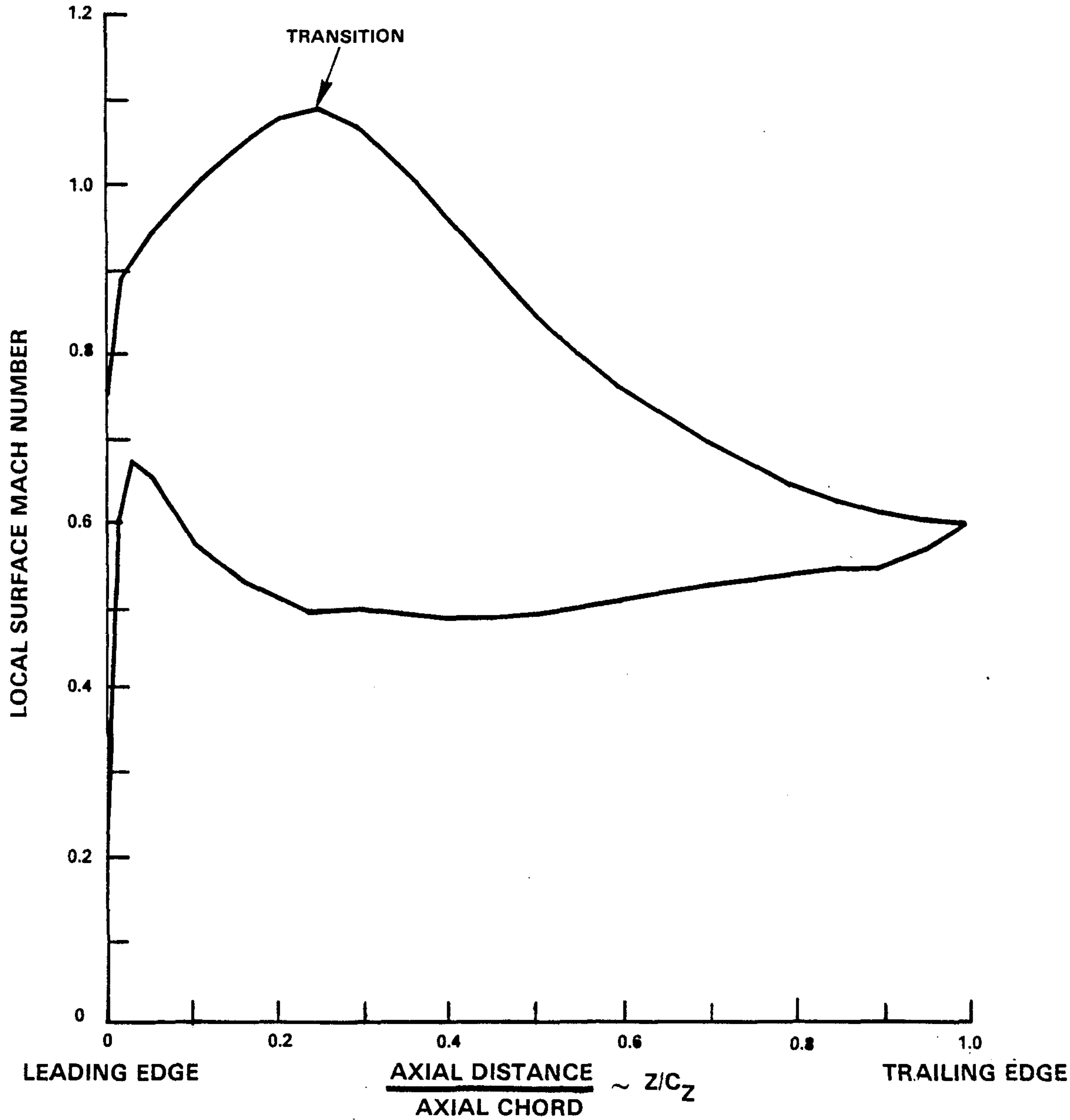


Figure 21 Airfoil Local Surface Mach Number Distribution at 100 Percent Design Speed at 76 Percent Span From Hub

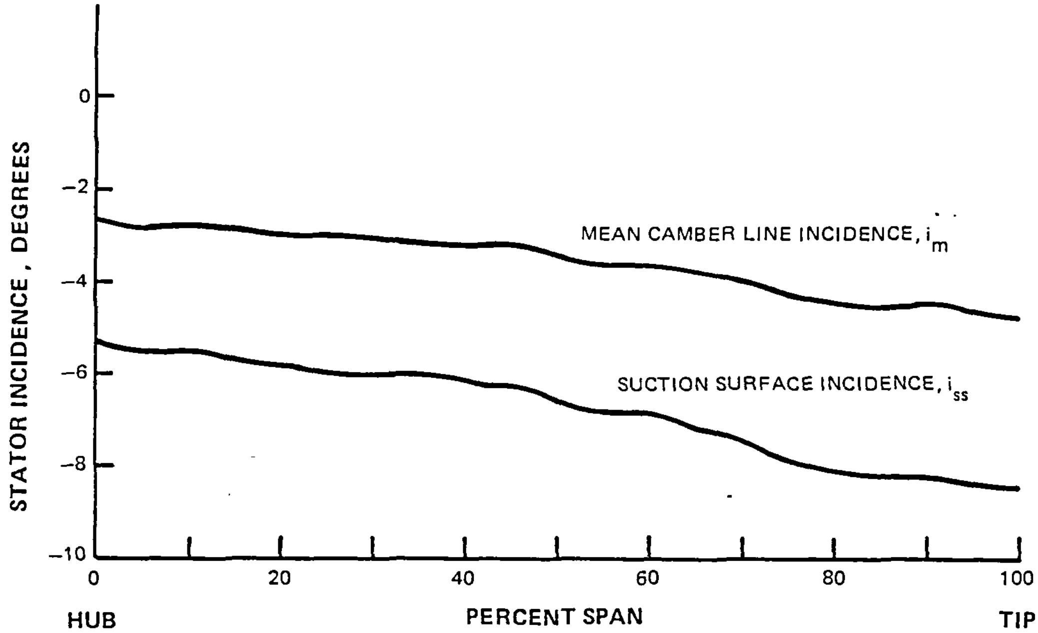


Figure 22 Stator Incidence as a Function of Percent Span From Hub

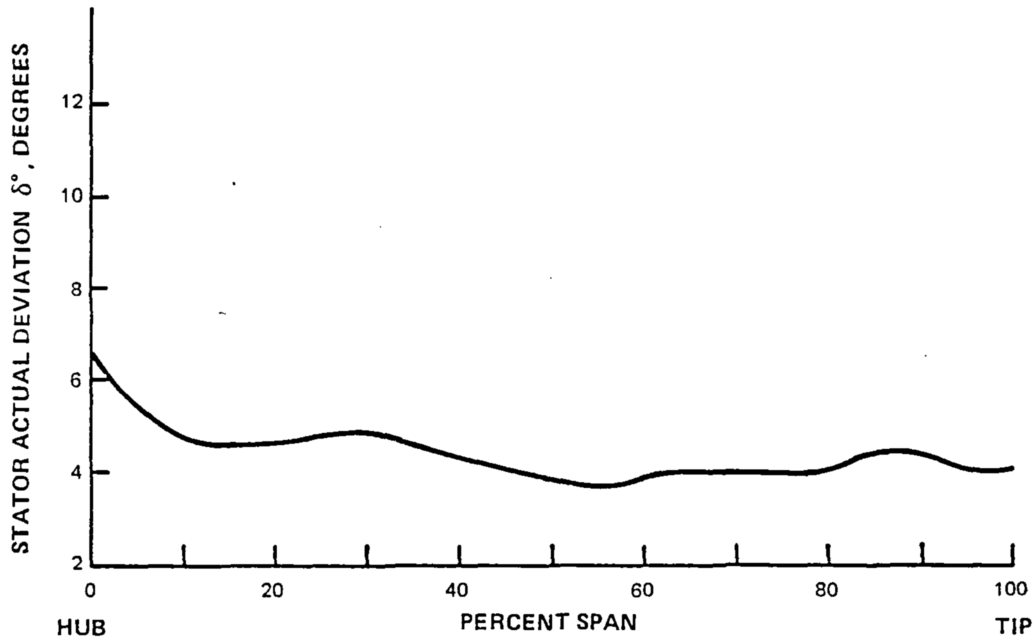


Figure 23 Stator Deviation as a Function of Percent Span From Hub

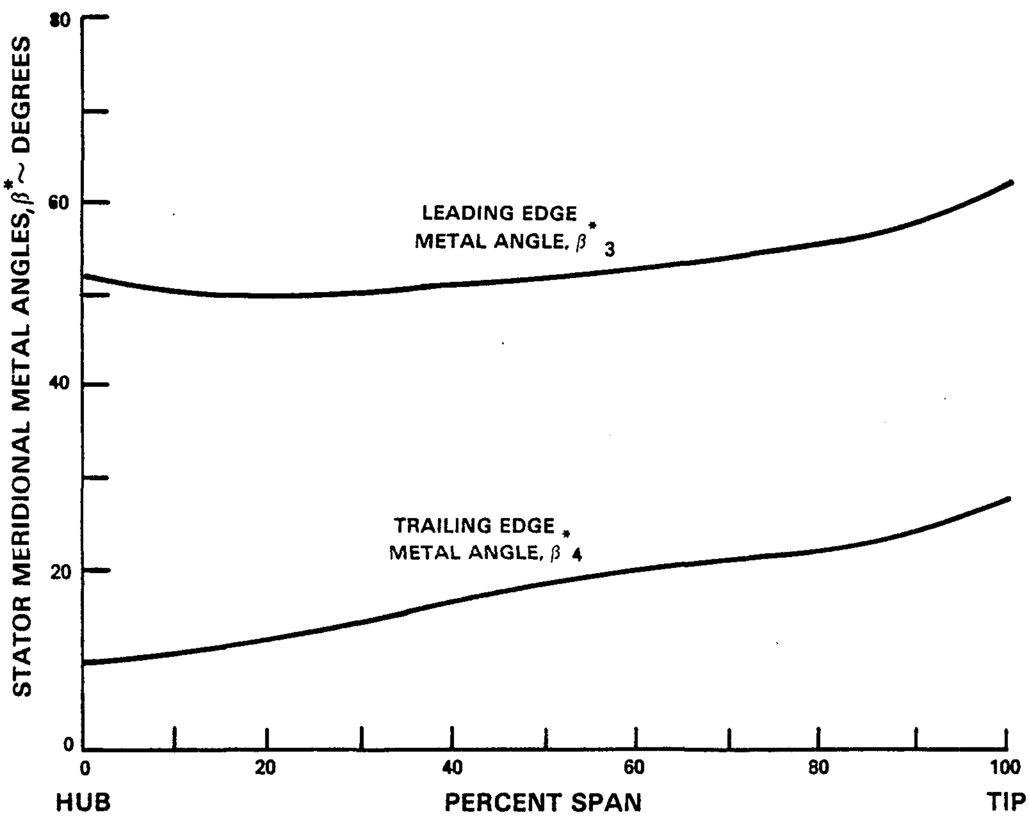


Figure 24 Inlet and Exit Stator Metal Angle as a Function of Percent Span From Hub

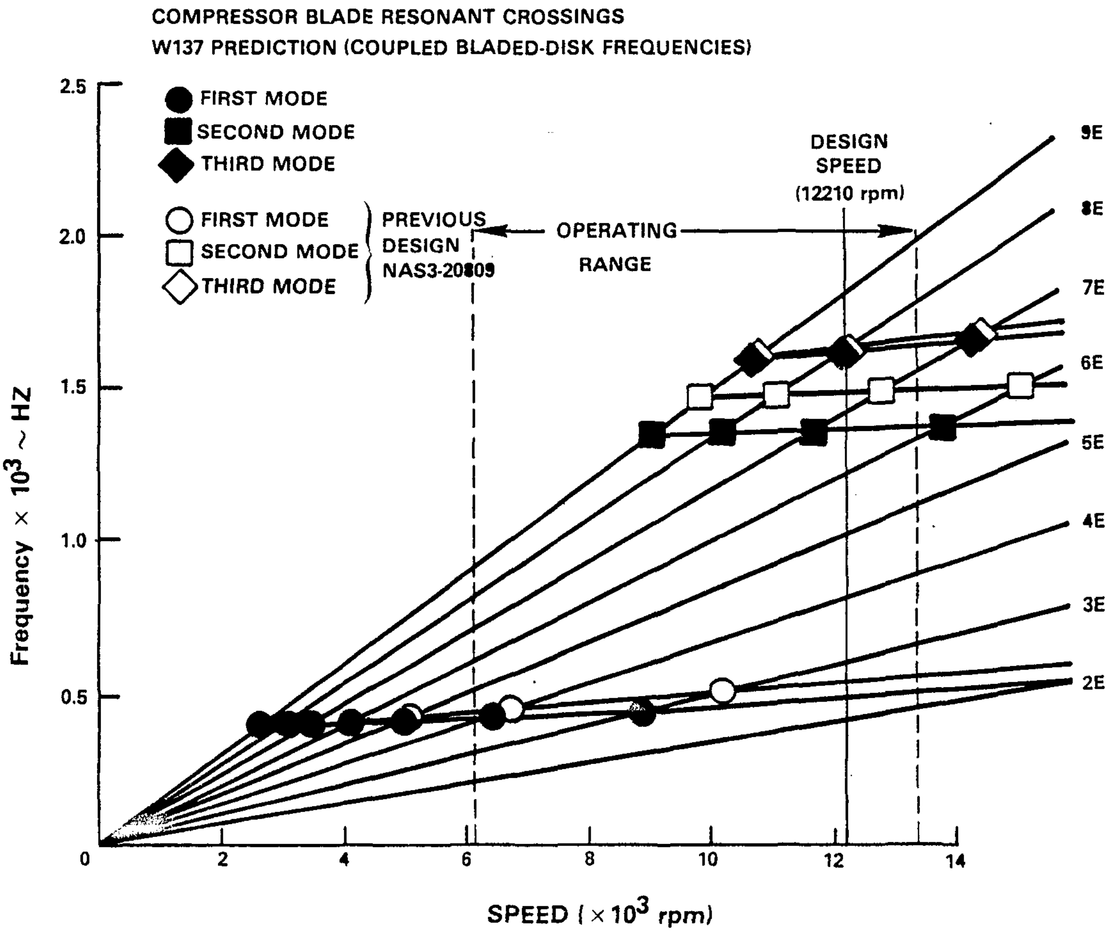


Figure 25 Blade-Disk Frequency Analysis

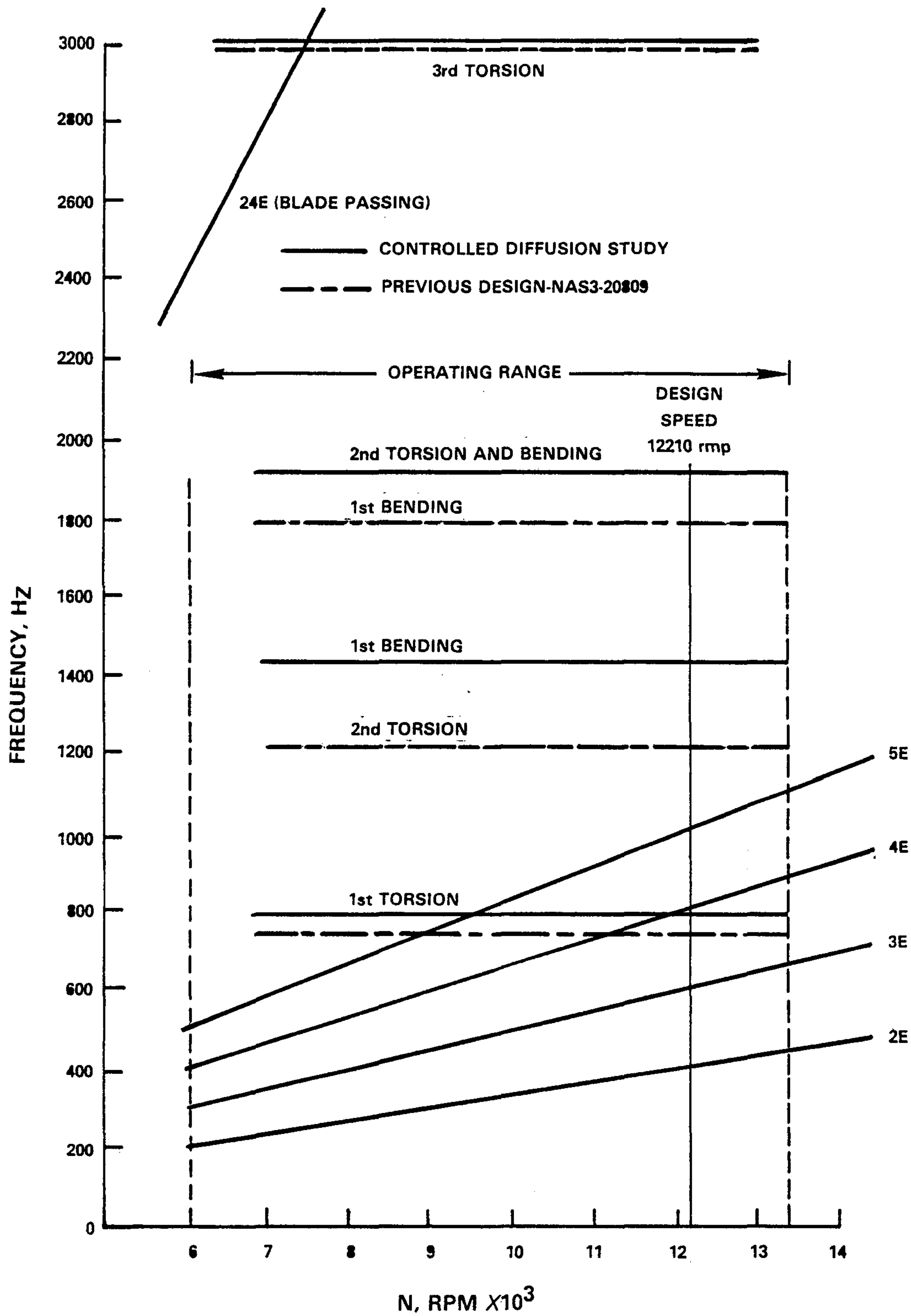


Figure 26 Stator Vane Vibration Analysis

MODIFIED GOODMAN DIAGRAM
AMS 4928 at 93°C
(200°F)

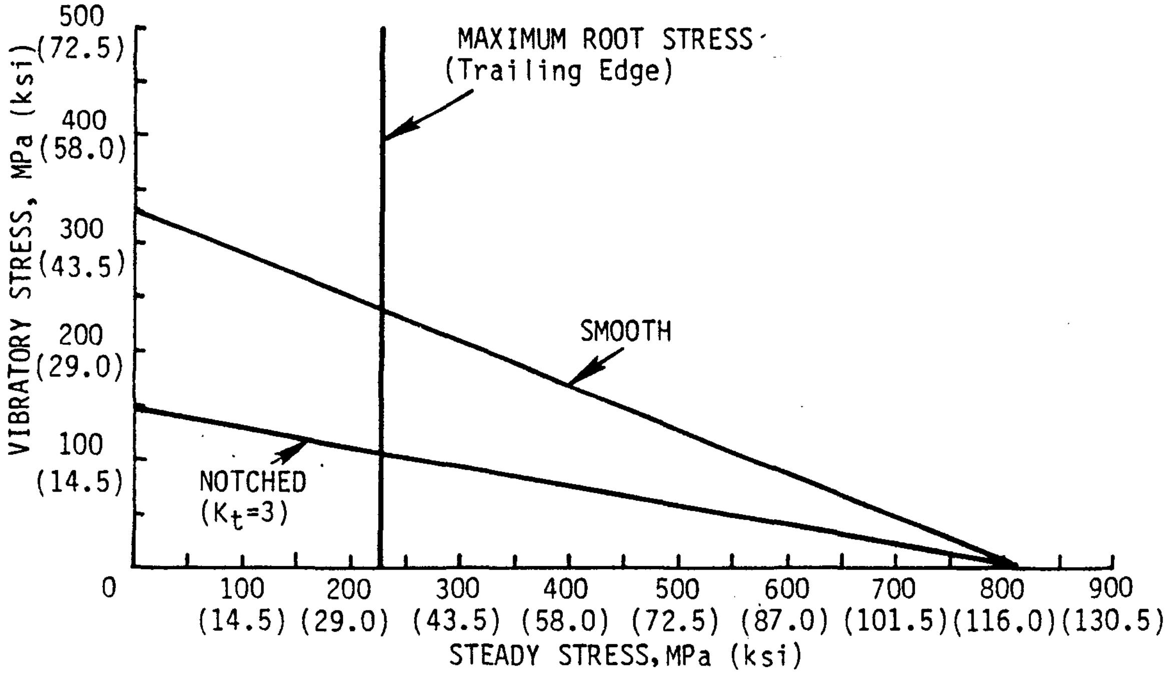


Figure 27 Modified Goodman Diagram

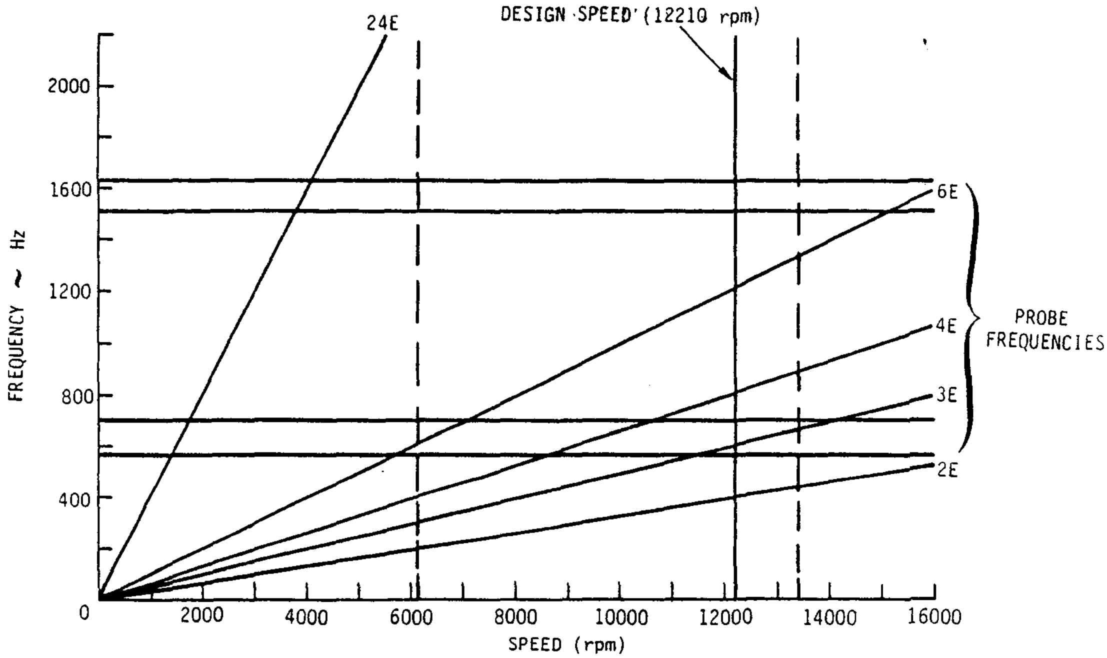


Figure 28 Probe Analysis

APPENDIX A

FLOWFIELD CALCULATION PROCEDURES

The aerodynamic flowfield calculation used in this design assumes axisymmetric flow and uses solutions of continuity, energy, and radial equilibrium equations. These equations account for streamline curvature and radial gradients of enthalpy and entropy but neglect viscous terms. Calculations were performed on stations oriented at an angle with respect to the axial direction.

$$\frac{1}{2}\ \frac{\partial V^2_m}{\partial m} \cos(\lambda - \epsilon) - \frac{V^2_m}{R_C} \sin(\lambda - \epsilon)\ \frac{V^2_\theta}{r} + \frac{1}{\rho}\ \frac{\partial P}{\partial r} = 0$$

$$R_c = \frac{\partial \epsilon}{\partial m} = \text{streamline radius of curvature}$$

Enthalpy rise across a rotor for a streamline, ψ, is given by the Euler relationship:

$$H_{Rotor} = (U_2 V_{\theta 2}) - (U_1 V_{\theta 1})\psi$$

Weight flow is calculated by the continuity equation:

$$W = 2\pi \int_{y\ root}^{y\_tip} \frac{1}{\overline{K}}\ \rho V_m \frac{\sin(\lambda - \epsilon)}{\sin\lambda}\ y\ dy$$

where $\overline{K}$ is the local blockage factor and y is the length along the calculation station from the centerline to the point of interest. Values of K are determined from the continuity equation and experimentally determined values of an endwall blockage parameter, $\overline{XK}$ defined as:

$$\overline{XK} = \frac{W}{\int_{root}^{tip} \overline{\rho C_m}\ dA}$$

where $\overline{\rho C_m}$ is the mass average value in the free stream flow.

APPENDIX B

LOSS SYSTEM

Rotor

The redesigned rotor loss was estimated using the data from the NAS3-20809 test (ref. 3) and extrapolating incidence and loss data to the desired operating incidence from the root to the tip. Figure 4 shows the resulting spanwise total loss.

Stator

Stator loss was estimated using the data from the NAS3-20809 test (ref. 3) for multiple-circular-arc airfoil adjusted to minimum loss incidence. This in turn was compared with multiple-circular-arc sections versus controlled- diffusion cascade results (ref. 1). The root-to-tip loss value was adjusted from approximately midspan to tip in order to account for the controlled- diffusion cascade benefit. Figure 5 shows the resulting spanwise total loss.

APPENDIX C

AERODYNAMIC SUMMARY

ROTOR AIRFOIL AERODYNAMIC SUMMARY PRINT

RUN NO 0 SPEED CODE 0 POINT NO 0

SL	V-1 M/SEC	V-2 M/SEC	VM-1 M/SEC	VM-2 M/SEC	VO-1 M/SEC	VO-2 M/SEC	U-1 M/SEC	U-2 M/SEC	V'-1 M/SEC	V'-2 M/SEC	VO'-1 M/SEC	VO'-2 M/SEC	RHOVM-1 KG/M2 SEC	RHOVM-2 KG/M2 SEC	EPSI-1 RADIAN	EPSI-2 RADIAN	PO/PO INLET
1	172.5	300.9	171.5	190.4	18.7	233.0	263.7	274.9	299.0	195.0	-245.0	-41.9	172.15	239.38	0.0567	0.1118	1.7727
2	183.5	297.0	182.2	192.4	22.2	226.2	272.6	282.7	309.7	200.5	-250.5	-56.5	183.67	245.92	0.0408	0.0958	1.7806
3	192.0	293.3	190.3	192.2	25.7	221.6	281.6	290.5	318.8	204.2	-255.8	-68.9	192.43	249.23	0.0266	0.0812	1.7868
4	200.3	287.7	197.8	190.1	31.4	216.0	299.3	306.1	333.0	210.4	-267.9	-90.1	200.17	251.97	0.0016	0.0536	1.8007
5	203.6	285.6	200.4	187.9	35.7	215.1	317.1	321.7	345.5	216.0	-281.4	-106.6	202.39	253.52	-0.0217	0.0270	1.8277
6	205.5	284.7	201.5	184.6	40.5	216.7	334.8	337.3	356.7	220.5	-294.3	-120.6	203.02	253.31	-0.0443	0.0011	1.8593
7	206.6	279.1	201.6	178.3	45.2	214.7	352.7	352.8	367.7	225.5	-307.5	-138.1	202.82	248.15	-0.0665	-0.0242	1.8638
8	206.8	273.0	200.9	171.3	48.9	212.6	370.5	368.6	379.3	231.7	-321.7	-156.0	202.06	241.46	-0.0882	-0.0487	1.8638
9	206.4	267.3	199.6	164.8	52.4	210.4	388.2	384.2	390.7	239.5	-335.9	-173.7	200.82	234.83	-0.1085	-0.0714	1.8636
10	204.9	261.8	198.1	159.4	52.3	207.6	407.2	399.8	406.4	249.7	-354.9	-192.1	199.38	228.95	-0.1289	-0.0922	1.8616
11	201.5	256.3	194.9	149.8	51.4	208.0	423.8	415.4	420.3	255.8	-372.4	-207.3	195.97	215.35	-0.1452	-0.1100	1.8553
12	197.6	252.9	191.2	141.2	50.1	209.9	432.7	423.2	427.7	255.8	-382.6	-213.3	191.86	202.30	-0.1520	-0.1169	1.8469
13	193.1	247.3	186.9	129.0	48.6	211.0	441.7	431.0	435.3	255.0	-393.1	-219.9	187.01	184.15	-0.1556	-0.1215	1.8292

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	6.2	50.8	54.90	12.41	0.5203	0.8640	0.9021	0.5598	-5.47	0.89	16.61	42.49	0.5648	0.0593	0.0	1.8717	96.01	96.34
2	6.9	49.6	53.87	16.36	0.5556	0.8529	0.9376	0.5758	-3.84	2.45	13.81	37.51	0.5571	0.0723	0.0	1.8317	94.65	95.08
3	7.7	49.0	53.27	19.72	0.5831	0.8423	0.9681	0.5864	-2.62	3.54	12.33	33.55	0.5535	0.0800	0.0	1.8044	93.66	94.16
4	9.0	48.6	53.49	25.34	0.6100	0.8247	1.0141	0.6030	-1.11	4.76	13.01	28.16	0.5493	0.0735	0.0	1.7964	93.70	94.20
5	10.1	48.9	54.51	29.55	0.6208	0.8165	1.0534	0.6174	-0.07	5.62	12.85	24.97	0.5493	0.0660	0.0	1.8170	94.09	94.56
6	11.4	49.6	55.63	33.14	0.6271	0.8116	1.0884	0.6287	0.37	5.80	11.22	22.49	0.5522	0.0613	0.0	1.8460	94.34	94.81
7	12.7	50.3	56.81	37.77	0.6307	0.7932	1.1225	0.6409	0.51	5.55	10.45	19.04	0.5505	0.0604	0.0	1.8502	94.18	94.66
8	13.7	51.2	58.11	42.36	0.6312	0.7733	1.1578	0.6563	0.59	5.25	9.70	15.75	0.5462	0.0641	0.0	1.8502	93.57	94.10
9	14.8	52.0	59.39	46.55	0.6299	0.7544	1.1926	0.6759	0.66	5.00	8.72	12.84	0.5397	0.0718	0.0	1.8520	92.56	93.18
10	14.9	52.5	60.93	50.31	0.6250	0.7356	1.2399	0.7016	0.77	4.65	7.66	10.62	0.5311	0.0870	0.0	1.8544	90.74	91.50
11	14.8	54.2	62.47	54.14	0.6141	0.7153	1.2807	0.7137	0.68	4.02	7.24	8.33	0.5361	0.1194	0.0	1.8645	87.26	88.32
12	14.7	56.0	63.50	56.44	0.6013	0.7020	1.3013	0.7100	0.46	3.51	7.51	7.06	0.5474	0.1461	0.0	1.8720	84.58	85.87
13	14.6	58.4	64.56	59.48	0.5864	0.6826	1.3221	0.7038	-0.50	2.23	8.56	5.09	0.5596	0.1755	0.0	1.8706	81.63	83.17

SL	V-1 FT/SEC	V-2 FT/SEC	VM-1 FT/SEC	VM-2 FT/SEC	VO-1 FT/SEC	VO-2 FT/SEC	U-1 FT/SEC	U-2 FT/SEC	V'-1 FT/SEC	V'-2 FT/SEC	VO'-1 FT/SEC	VO'-2 FT/SEC	RHOVM-1 LBM/FT2SEC	RHOVM-2 LBM/FT2SEC	EPSI-1 DEGREE	EPSI-2 DEGREE	PCT TE SPAN
1	565.9	987.4	562.6	624.8	61.4	764.5	865.2	902.0	981.2	639.7	-803.8	-137.4	35.26	49.03	3.250	6.407	0.0000
2	602.1	974.4	597.7	631.2	72.8	742.3	894.5	927.5	1016.1	657.8	-821.8	-185.3	37.62	50.37	2.336	5.491	0.0498
3	630.0	962.5	624.3	630.8	84.5	727.0	923.8	953.1	1046.1	670.1	-839.3	-226.2	39.41	51.05	1.522	4.654	0.0997
4	657.2	944.1	649.1	623.8	103.0	708.7	981.9	1004.3	1092.5	690.3	-878.8	-295.6	41.00	51.61	0.094	3.070	0.1994
5	668.0	937.0	657.7	616.3	117.3	705.8	1040.5	1055.4	1133.5	708.6	-923.2	-349.6	41.45	51.92	-1.243	1.549	0.2991
6	674.2	934.1	661.0	605.8	132.8	711.0	1098.6	1106.5	1170.3	723.6	-965.8	-395.6	41.58	51.88	-2.536	0.062	0.3988
7	677.8	915.8	661.4	584.9	148.2	704.6	1157.2	1157.7	1206.4	739.9	-1009.0	-453.1	41.54	50.82	-3.812	-1.386	0.4984
8	678.4	895.7	659.2	561.9	160.4	697.5	1215.8	1209.4	1244.3	760.1	-1055.4	-511.9	41.38	49.45	-5.055	-2.791	0.5992
9	677.1	877.0	654.9	540.7	171.9	690.5	1273.8	1260.5	1281.9	785.7	-1102.0	-570.0	41.13	48.10	-6.215	-4.093	0.6989
10	672.2	858.9	649.9	523.1	171.7	681.3	1336.2	1311.7	1333.5	819.2	-1164.5	-630.4	40.83	46.89	-7.387	-5.280	0.7985
11	661.2	841.1	639.4	491.5	168.6	682.5	1390.5	1362.8	1379.1	839.2	-1221.9	-680.3	40.14	44.11	-8.317	-6.301	0.8982
12	648.4	829.8	627.2	463.1	164.4	688.5	1419.8	1388.4	1403.4	839.2	-1255.4	-699.9	39.29	41.43	-8.708	-6.696	0.9481
13	633.4	811.4	613.1	423.2	159.3	692.3	1449.1	1413.9	1428.1	836.6	-1289.8	-721.6	38.30	37.72	-8.913	-6.959	0.9979

WC1/A1 LBM/SEC SOFT	WC1/A1 KG/SEC SQM	TO/TO INLET	PO/PO INLET	EFF-AD INLET %	EFF-P INLET %
40.19	196.10	1.2068	1.8412	92.09	92.74

TO2/TO1	PO2/PO1	EFF-AD ROTOR %	EFF-P ROTOR %
1.2068	1.8412	92.09	92.74

ROTOR AIRFOIL AERODYNAMIC SUMMARY PRINT

RUN NO 0 SPEED CODE 0 POINT NO 0

SL	V-1 M/SEC	V-2 M/SEC	VM-1 M/SEC	VM-2 M/SEC	VO-1 M/SEC	VO-2 M/SEC	U-1 M/SEC	U-2 M/SEC	V'-1 M/SEC	V'-2 M/SEC	VO'-1 M/SEC	VO'-2 M/SEC	RHOVM-1 KG/M2 SEC	RHOVM-2 KG/M2 SEC	EPSI-1 RADIAN	EPSI-2 RADIAN	PO/PO INLET
1																	
2																	
3																	
4																	
5																	
6	V_1	V_2	V_{m1}	V_{m2}	$V_{\theta 1}$	$V_{\theta 2}$	U_1	U_2	V'_1	V'_2	$V_{\theta 1}$	$V'_{\theta 2}$	$\rho_1 V_{m1}$	$\rho_2 V_{m2}$	ϵ_1	ϵ_2	P_2/P_{in}
7																	
8																	
9																	
10																	
11																	
12																	
13																	

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																		
2																		
3																		
4																		
5																		
6	β_1	β_2	β'_1	β'_2	M_1	M_2	M'_1	M'_2	i_{ss1}	i_{m1}	δ^*_2	$\Delta\beta'$	D	$\bar{\omega}$	$\frac{\bar{\omega}\cos\beta'_2}{2\sigma}$	P_2/P_1	$\eta_{ad2/1}$	$\eta_{p2/1}$
7																		
8																		
9																		
10																		
11																		
12																		
13																		

SL	V-1 FT/SEC	V-2 FT/SEC	VM-1 FT/SEC	VM-2 FT/SEC	VO-1 FT/SEC	VO-2 FT/SEC	U-1 FT/SEC	U-2 FT/SEC	V'-1 FT/SEC	V'-2 FT/SEC	VO'-1 FT/SEC	VO'-2 FT/SEC	RHOVM-1 LBM/FT2SEC	RHOVM-2 LBM/FT2SEC	EPSI-1 DEGREE	EPSI-2 DEGREE	PCT TE SPAN
1																	
2																	
3																	
4																	
5																	
6	V_1	V_2	V_{m1}	V_{m2}	$V_{\theta 1}$	$V_{\theta 2}$	U_1	U_2	V'_1	V'_2	$V'_{\theta 1}$	$V'_{\theta 2}$	$\rho_1 V_{m1}$	$\rho_2 V_{m2}$	ϵ_1	ϵ_2	$\%\ SPAN_2$
7																	
8																	
9																	
10																	
11																	
12																	
13																	

spanwise mass average	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 %
	$W_1\sqrt{\theta_1}/\delta_1 A_1$		T_2/T_{in}	P_2/P_{in}	$\eta_{ad2/1}$	$\eta_{p2/1}$	T_2/T_1	P_2/P_1	$\eta_{ad1/2}$	$\eta_{p2/1}$

STATOR AIRFOIL AERODYNAMIC SUMMARY PRINT

RUN NO 0 SPEED CODE 0 POINT NO 0

SL	V-1 M/SEC	V-2 M/SEC	VM-1 M/SEC	VM-2 M/SEC	VO-1 M/SEC	VO-2 M/SEC	RHOVM-1 KG/M2 SEC	RHOVM-2 KG/M2 SEC	PO/PO INLET	TO/TO INLET	%EFF-A TOT-INLET	%EFF-P TOT-INLET	EPSI-1 RADIAN	EPSI-2 RADIAN
1	305.3	182.0	200.0	174.9	230.7	50.3	248.66	259.63	1.6705	1.2048	77.07	78.65	0.1152	0.0677
2	301.9	186.4	202.0	179.7	224.3	49.5	255.13	269.59	1.6924	1.2001	81.06	82.40	0.1028	0.0608
3	298.7	190.3	202.1	183.7	220.0	49.9	258.60	277.99	1.7129	1.1966	84.52	85.64	0.0909	0.0538
4	294.1	196.3	200.7	188.4	214.9	55.2	261.92	288.86	1.7479	1.1943	88.99	89.81	0.0675	0.0394
5	292.6	203.7	199.1	193.2	214.4	64.5	264.19	299.28	1.7892	1.1969	91.78	92.42	0.0442	0.0239
6	292.4	211.8	196.6	198.5	216.4	73.8	264.79	310.02	1.8345	1.2025	93.43	93.96	0.0207	0.0075
7	287.4	211.5	190.7	196.2	215.0	79.0	260.39	308.24	1.8467	1.2039	93.89	94.39	-0.0024	-0.0099
8	281.5	209.1	183.7	191.6	213.3	83.7	254.13	302.30	1.8485	1.2052	93.46	94.00	-0.0254	-0.0284
9	275.5	206.5	176.5	187.3	211.6	86.8	247.06	296.06	1.8473	1.2078	92.21	92.85	-0.0481	-0.0478
10	269.5	203.2	169.9	182.3	209.1	89.6	240.10	287.77	1.8416	1.2125	89.63	90.48	-0.0697	-0.0684
11	263.1	198.6	158.5	175.2	209.9	93.6	224.85	274.18	1.8279	1.2236	84.07	85.35	-0.0904	-0.0903
12	259.0	194.5	148.8	168.8	212.0	96.7	210.64	261.94	1.8135	1.2329	79.55	81.17	-0.1013	-0.1025
13	252.7	187.3	135.4	159.1	213.4	98.8	191.22	244.60	1.7885	1.2414	74.76	76.72	-0.1130	-0.1162

SL	B-1 DEGREE	B-2 DEGREE	M-1	M-2	INCS DEGREE	INCM DEGREE	DEV DEGREE	TURN DEGREE	D-FAC	OMEGA-B TOTAL	LOSS-P TOTAL	PO2/ PO1	PO/PO STAGE	TO/TO STAGE	%EFF-A TOT-STG	%EFF-P TOT-STG
1	49.1	16.0	0.8785	0.4993	-5.23	-2.62	6.56	33.10	0.6129	0.1444	0.0	0.9429	1.7693	1.2048	86.44	87.47
2	48.0	15.3	0.8691	0.5133	-5.50	-2.88	5.49	32.64	0.5913	0.1253	0.0	0.9511	1.7480	1.2001	86.42	87.43
3	47.4	15.2	0.8600	0.5254	-5.59	-2.89	4.71	32.25	0.5719	0.1061	0.0	0.9592	1.7354	1.1966	86.72	87.71
4	47.0	16.3	0.8453	0.5434	-5.86	-3.01	4.45	30.66	0.5390	0.0758	0.0	0.9716	1.7449	1.1943	88.69	89.53
5	47.1	18.4	0.8393	0.5644	-6.14	-3.16	4.67	28.67	0.5045	0.0503	0.0	0.9814	1.7792	1.1969	90.82	91.53
6	47.7	20.4	0.8366	0.5869	-6.26	-3.16	4.41	27.36	0.4750	0.0337	0.0	0.9876	1.8216	1.2025	92.24	92.87
7	48.4	21.9	0.8198	0.5857	-6.59	-3.37	3.88	26.49	0.4651	0.0257	0.0	0.9908	1.8331	1.2039	92.66	93.26
8	49.3	23.6	0.8003	0.5783	-6.89	-3.55	3.96	25.68	0.4599	0.0239	0.0	0.9918	1.8349	1.2052	92.24	92.88
9	50.2	24.9	0.7805	0.5699	-7.29	-3.82	3.93	25.31	0.4573	0.0264	0.0	0.9913	1.8357	1.2077	91.17	91.89
10	50.9	26.2	0.7596	0.5591	-8.02	-4.44	3.97	24.73	0.4554	0.0340	0.0	0.9892	1.8344	1.2125	89.01	89.90
11	52.9	28.1	0.7360	0.5431	-8.19	-4.48	4.13	24.83	0.4610	0.0485	0.0	0.9854	1.8377	1.2236	84.88	86.11
12	54.9	29.8	0.7206	0.5293	-8.36	-4.61	3.91	25.11	0.4699	0.0602	0.0	0.9825	1.8400	1.2329	81.66	83.15
13	57.6	31.8	0.6989	0.5067	-8.46	-4.74	3.69	25.75	0.4867	0.0728	0.0	0.9799	1.8324	1.2414	78.16	79.93

SL	V-1 FT/SEC	V-2 FT/SEC	VM-1 FT/SEC	VM-2 FT/SEC	VO-1 FT/SEC	VO-2 FT/SEC	RHOVM-1 LBM/FT2SEC	RHOVM-2 LBM/FT2SEC	PCT TE SPAN	TO/TO INLET	%EFF-A TOT-INLET	%EFF-P TOT-INLET	EPSI-1 DEGREE	EPSI-2 DEGREE
1	1001.8	597.0	656.2	573.7	756.9	165.0	50.93	53.17	-0.0063	1.2048	77.07	78.65	6.598	3.879
2	990.4	611.7	662.9	589.7	735.9	162.5	52.25	55.21	0.0444	1.2001	81.06	82.40	5.889	3.484
3	980.1	624.5	663.1	602.7	721.7	163.8	52.96	56.93	0.0952	1.1966	84.52	85.64	5.206	3.084
4	964.8	644.0	658.4	618.1	705.2	181.0	53.64	59.16	0.1967	1.1943	88.99	89.81	3.869	2.255
5	960.0	668.3	653.3	633.9	703.4	211.5	54.11	61.30	0.2982	1.1969	91.78	92.42	2.532	1.371
6	959.4	694.9	645.0	651.3	710.1	242.1	54.23	63.49	0.3997	1.2025	93.43	93.96	1.189	0.429
7	942.9	693.9	625.6	643.6	705.5	259.3	53.33	63.13	0.5013	1.2039	93.89	94.39	-0.136	-0.567
8	923.5	686.0	602.7	628.7	699.7	274.5	52.05	61.91	0.6028	1.2052	93.46	94.00	-1.456	-1.626
9	904.1	677.4	579.1	614.6	694.2	284.8	50.60	60.63	0.7030	1.2078	92.21	92.85	-2.755	-2.737
10	884.1	666.6	557.5	598.2	686.2	294.1	49.17	58.94	0.8046	1.2125	89.63	90.48	-3.994	-3.916
11	863.1	651.5	520.2	574.7	688.7	307.0	46.05	56.15	0.9061	1.2236	84.07	85.35	-5.181	-5.172
12	849.7	638.2	488.1	553.7	695.5	317.4	43.14	53.65	0.9569	1.2329	79.55	81.17	-5.804	-5.870
13	829.2	614.5	444.3	522.0	700.1	324.2	39.16	50.10	1.0076	1.2414	74.76	76.72	-6.472	-6.660

NCORR INLET RPM	WCORR INLET LBM/SEC	WCORR INLET KG/SEC	TO/TO INLET	PO/PO INLET	EFF-AD INLET %	EFF-P INLET %	TO/TO STAGE	PO2/PO1	PO/PO STAGE	EFF-AD STAGE %	EFF-P STAGE %
12210.00	102.90	46.67	1.2068	1.8095	89.24	90.09	1.2068	0.9828	1.8095	89.24	90.09

STATOR AIRFOIL AERODYNAMIC SUMMARY PRINT

RUN NO 0 SPEED CODE 0 POINT NO 0

SL	V-1 M/SEC	V-2 M/SEC	VM-1 M/SEC	VM-2 M/SEC	VO-1 M/SEC	VO-2 M/SEC	RHOVM-1 KG/M2 SEC	RHOVM-2 KG/M2 SEC	PO/PO INLET	TO/TO INLET	%EFF-A TOT-INLET	%EFF-P TOT-INLET	EPSI-1 RADIAN	EPSI-2 RADIAN
1														
2														
3														
4														
5														
6	V_3	V_4	V_{m3}	V_{m4}	$V_{\theta 3}$	$V_{\theta 4}$	$\rho_3 V_{m3}$	$\rho_4 V_{m4}$	P_4/P_{in}	T_4/T_{in}	$\eta_{ad4/ln}$	$\eta_{p4/in}$	ϵ_3	ϵ_4
7														
8														
9														
10														
11														
12														
13														

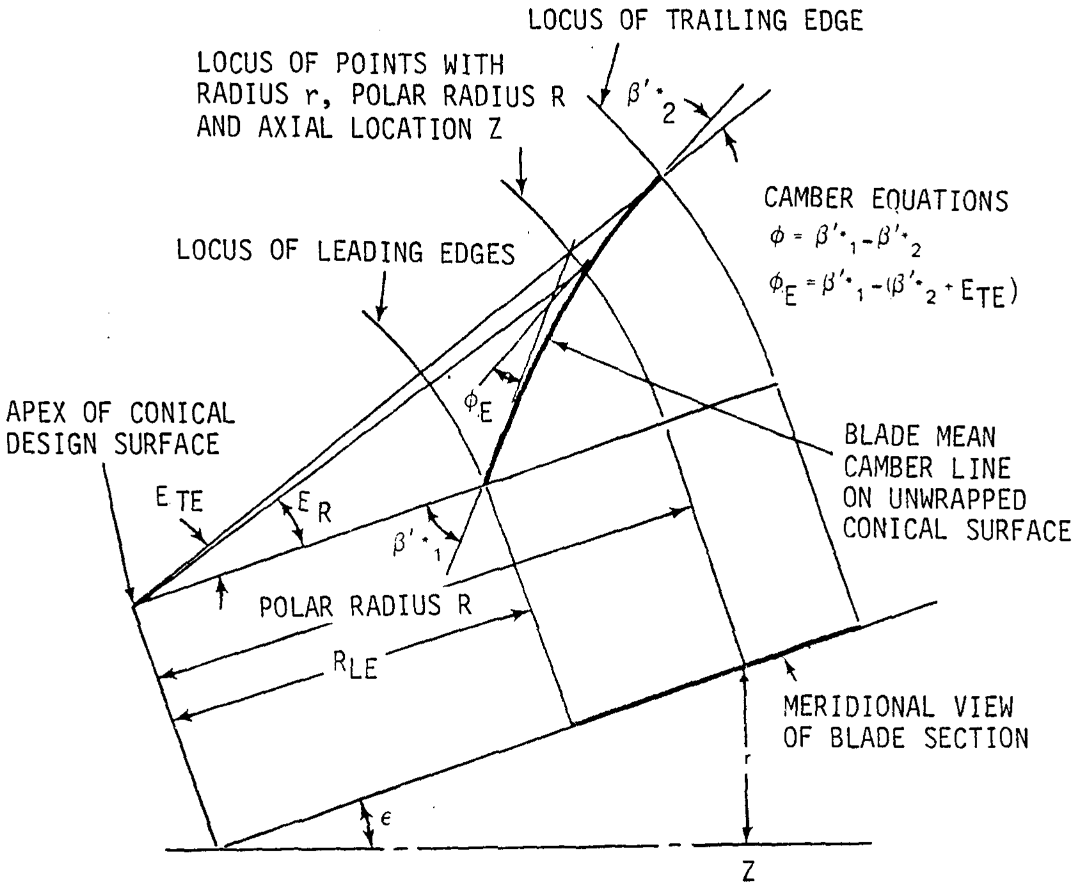
SL	B-1 DEGREE	B-2 DEGREE	M-1	M-2	INCS DEGREE	INCM DEGREE	DEV DEGREE	TURN DEGREE	D-FAC	OMEGA-B TOTAL	LOSS-P TOTAL	PO2/ PO1	PO/PO STAGE	TO/TO STAGE	%EFF-A TOT-STG	%EFF-P TOT-STG
1																
2																
3																
4																
5																
6	β_3	β_4	M_3	M_4	i_{ss3}	i_{m3}	$\delta^o{}_4$	$\Delta\beta$	D	ϖ	$\frac{\varpi \cos\beta_4}{2\sigma}$	P_4/P_3	P_4/P_1	T_4/T_1	$\eta_{ad4/1}$	$\eta_{p4/1}$
7																
8																
9																
10																
11																
12																
13																

SL	V-1 FT/SEC	V-2 FT/SEC	VM-1 FT/SEC	VM-2 FT/SEC	VO-1 FT/SEC	VO-2 FT/SEC	RHOVM-1 LBM/FT2SEC	RHOVM-2 LBM/FT2SEC	PCT TE SPAN	TO/TO INLET	%EFF-A TOT-INLET	%EFF-P TOT-INLET	EPSI-1 DEGREE	EPSI-2 DEGREE
1														
2														
3														
4														
5														
6	V_3	V_4	V_{m3}	V_{m4}	$V_{\theta 3}$	$V_{\theta 4}$	$\rho_3 V_{m3}$	$\rho_4 V_{m4}$	% $SPAN_4$	T_4/T_{in}	$\eta_{ad4/in}$	$\eta_{p4/in}$	ϵ_3	ϵ_4
7														
8														
9														
10														
11														
12														
13														

spanwise mass average	NCORR INLET RPM	WCORR INLET LBM/SEC	WCORR INLET KG/SEC	TO/TO INLET	PO/PO INLET	EFF-AD INLET %	EFF-P INLET %	TO/TO STAGE	PO2/PO1	PO/PO STAGE	EFF-AD STAGE %	EFF-P STAGE %
	$N/\sqrt{\theta}_{in}$	$W\sqrt{\theta}_{in}/\delta_{in}$		T_4/T_{in}	P_4/P_{in}	$\rho_{ad4/in}$	$\rho_{p4/in}$	T_4/T_3	P_4/P_3	P_4/P_1	$\rho_{ad4/1}$	$\rho_{p4/1}$

APPENDIX D

AIRFOIL GEOMETRY ON CONICAL SURFACES



MERIDIONAL VIEW AND POLAR REPRESENTATION OF BLADE MEAN-CAMBER-LINE

ROTOR BLADE GEOMETRY ON CONICAL SURFACES
24 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_{Ef} (rad)	$\bar{\epsilon}$ (rad)	W.A. (rad)	A/c	σ	t/c MAX	LOC tMAX % c
0.4125	0.4300	0.0	0.0934	0.0389	0.2896	0.2769	0.9426	-0.0733	0.9927	0.2461	0.1074	0.22794	0.5436	1.6935	0.0850	55.0047
0.4300	0.4430	6.3	0.0946	0.0406	0.2718	0.2616	0.8860	0.0518	0.8164	0.2033	0.0800	0.22310	0.5495	1.6551	0.0832	55.6518
0.4466	0.4560	12.3	0.0957	0.0423	0.2540	0.2438	0.8587	0.1410	0.7047	0.1835	0.0578	0.21606	0.5525	1.6202	0.0815	56.2635
0.4627	0.4689	18.1	0.0968	0.0440	0.2438	0.2362	0.8511	0.1887	0.6536	0.1639	0.0384	0.20955	0.5602	1.5863	0.0799	56.8544
0.4785	0.4818	23.7	0.0979	0.0458	0.2337	0.2286	0.8483	0.2265	0.6171	0.1489	0.0204	0.20361	0.5687	1.5550	0.0783	57.4350
0.4939	0.4944	29.3	0.0990	0.0478	0.2311	0.2286	0.8523	0.2603	0.5912	0.1371	0.0033	0.20159	0.5788	1.5253	0.0767	58.0026
0.5090	0.5070	34.7	0.1000	0.0500	0.2286	0.2286	0.8588	0.3041	0.5579	0.1267	-0.0132	0.19771	0.5881	1.4990	0.0751	58.5490
0.5238	0.5193	40.0	0.1010	0.0520	0.2286	0.2286	0.8694	0.3498	0.5268	0.1153	-0.0292	0.19064	0.5980	1.4745	0.0722	59.0815
0.5383	0.5315	45.2	0.1020	0.0540	0.2286	0.2286	0.8814	0.3975	0.4950	0.1067	-0.0446	0.18340	0.6065	1.4518	0.0690	59.6062
0.5526	0.5436	50.4	0.1029	0.0559	0.2286	0.2286	0.8954	0.4433	0.4672	0.0980	-0.0593	0.17532	0.6144	1.4306	0.0660	60.1164
0.5666	0.5558	55.4	0.1039	0.0577	0.2286	0.2286	0.9097	0.4918	0.4369	0.0903	-0.0732	0.16851	0.6226	1.4104	0.0629	60.6204
0.5804	0.5678	60.4	0.1048	0.0599	0.2286	0.2286	0.9233	0.5400	0.4060	0.0844	-0.0862	0.16249	0.6315	1.3912	0.0599	61.1142
0.5939	0.5799	65.2	0.1057	0.0621	0.2286	0.2286	0.9366	0.5825	0.3802	0.0771	-0.0986	0.15710	0.6419	1.3731	0.0569	61.6011
0.6073	0.5920	70.0	0.1066	0.0643	0.2286	0.2286	0.9492	0.6282	0.3505	0.0694	-0.1099	0.15171	0.6522	1.3556	0.0539	62.0797
0.6203	0.6040	74.7	0.1075	0.0665	0.2286	0.2286	0.9621	0.6719	0.3228	0.0626	-0.1203	0.14654	0.6632	1.3389	0.0509	62.5517
0.6331	0.6159	79.3	0.1083	0.0688	0.2286	0.2286	0.9776	0.7102	0.3029	0.0571	-0.1301	0.13997	0.6754	1.3228	0.0480	63.0116
0.6456	0.6276	83.8	0.1092	0.0711	0.2286	0.2286	0.9934	0.7539	0.2780	0.0521	-0.1395	0.13004	0.6862	1.3079	0.0452	63.4570
0.6577	0.6393	88.2	0.1100	0.0732	0.2286	0.2286	1.0122	0.7903	0.2629	0.0476	-0.1476	0.12084	0.6976	1.2933	0.0424	63.8864
0.6694	0.6509	92.4	0.1107	0.0752	0.2286	0.2286	1.0318	0.8236	0.2510	0.0421	-0.1533	0.11178	0.7088	1.2794	0.0398	64.2978
0.6805	0.6625	96.4	0.1114	0.0771	0.2286	0.2286	1.0566	0.8572	0.2433	0.0376	-0.1556	0.10317	0.7199	1.2660	0.0372	64.6758
0.6906	0.6739	100.0	0.1120	0.0790	0.2286	0.2286	1.0878	0.8888	0.2425	0.0348	-0.1525	0.09531	0.7312	1.2536	0.0350	65.0004

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_{Ef} (deg)	$\bar{\epsilon}$ (deg)	W.A. (deg)
16.24	16.93	0.0	3.676	1.530	0.0114	0.0109	54.01	-4.20	56.88	14.10	6.15	13.060
16.93	17.44	5.3	3.724	1.599	0.0107	0.0103	50.76	2.97	46.77	11.65	4.58	12.782
17.58	17.95	10.7	3.769	1.665	0.0100	0.0096	49.20	8.08	40.38	10.51	3.31	12.379
18.22	18.46	16.0	3.812	1.733	0.0096	0.0093	48.77	10.81	37.45	9.39	2.20	12.007
18.84	18.97	21.2	3.855	1.802	0.0092	0.0090	48.61	12.98	35.36	8.53	1.17	11.666
19.45	19.47	26.4	3.897	1.883	0.0091	0.0090	48.83	14.91	33.88	7.86	0.19	11.547
20.04	19.96	31.6	3.937	1.967	0.0090	0.0090	49.20	17.42	31.96	7.26	-0.75	11.328
20.62	20.44	36.6	3.976	2.049	0.0090	0.0090	49.82	20.04	30.18	6.61	-1.67	10.923
21.19	20.92	41.6	4.015	2.128	0.0090	0.0090	50.50	22.78	28.36	6.11	-2.55	10.509
21.76	21.40	46.6	4.052	2.202	0.0090	0.0090	51.30	25.40	26.77	5.62	-3.40	10.095
22.31	21.88	51.6	4.089	2.274	0.0090	0.0090	52.12	28.18	25.03	5.17	-4.19	9.655
22.85	22.36	56.5	4.125	2.359	0.0090	0.0090	52.90	30.94	23.26	4.84	-4.94	9.310
23.38	22.83	61.5	4.161	2.444	0.0090	0.0090	53.66	33.38	21.79	4.42	-5.65	9.001
23.91	23.31	66.4	4.196	2.531	0.0090	0.0090	54.39	35.99	20.08	3.98	-6.30	8.692
24.42	23.78	71.4	4.231	2.616	0.0090	0.0090	55.12	38.50	18.49	3.59	-6.89	8.396
24.93	24.25	76.2	4.265	2.709	0.0090	0.0090	56.01	40.69	17.36	3.27	-7.45	8.020
25.42	24.71	81.0	4.298	2.798	0.0090	0.0090	56.92	43.19	15.93	2.99	-8.00	7.451
25.89	25.17	85.8	4.329	2.881	0.0090	0.0090	57.99	45.28	15.06	2.73	-8.46	6.924
26.35	25.63	90.6	4.359	2.960	0.0090	0.0090	59.12	47.19	14.38	2.41	-8.78	6.410
26.79	26.08	95.3	4.387	3.034	0.0090	0.0090	60.54	49.11	13.94	2.15	-8.91	5.911
27.19	26.53	100.0	4.411	3.110	0.0090	0.0090	62.33	50.92	13.90	2.00	-8.74	5.461

STATOR VANE GEOMETRY ON CONICAL SURFACES
27 VANES

S.I. UNITS: METERS (m) AND RADIANS (rad)

D_3 (m)	D_4 (m)	%SPAN LE	c (m)	LER (mm)	TER (mm)	β_3^* (rad)	β_4^* (rad)	ϕ_E (rad)	$\bar{\epsilon}$ (rad)	A/c	σ	t/c MAX	LOC tMAX % c
0.4343	0.4501	0.0	0.0749	0.6934	0.4140	0.9055	0.1644	0.7195	0.1234	0.5053	1.4552	0.0500	50.0000
0.4469	0.4616	5.4	0.0749	0.6985	0.4216	0.8868	0.1731	0.6943	0.1151	0.5034	1.4166	0.0501	50.0000
0.4593	0.4730	10.7	0.0749	0.7061	0.4293	0.8767	0.1849	0.6745	0.1059	0.5017	1.3806	0.0511	50.0000
0.4718	0.4841	16.1	0.0749	0.7214	0.4369	0.8727	0.1977	0.6597	0.0957	0.5004	1.3466	0.0523	50.0000
0.4841	0.4950	21.4	0.0749	0.7341	0.4470	0.8713	0.2119	0.6461	0.0849	0.4990	1.3146	0.0534	50.0000
0.4962	0.5056	26.6	0.0749	0.7518	0.4547	0.8732	0.2286	0.6332	0.0735	0.4977	1.2847	0.0546	50.0000
0.5083	0.5161	31.8	0.0749	0.7696	0.4623	0.8784	0.2490	0.6198	0.0614	0.4962	1.2564	0.0558	50.0000
0.5201	0.5263	36.8	0.0749	0.7874	0.4724	0.8845	0.2699	0.6071	0.0487	0.4948	1.2300	0.0569	50.0000
0.5319	0.5363	41.9	0.0749	0.8026	0.4801	0.8906	0.2888	0.5964	0.0356	0.4934	1.2050	0.0580	50.0000
0.5435	0.5463	46.9	0.0749	0.8179	0.4877	0.8983	0.3069	0.5880	0.0223	0.4924	1.1809	0.0592	50.0000
0.5551	0.5562	51.9	0.0749	0.8331	0.4953	0.9075	0.3232	0.5829	0.0089	0.4917	1.1581	0.0603	50.0000
0.5667	0.5661	56.8	0.0749	0.8509	0.5029	0.9174	0.3379	0.5802	-0.0046	0.4913	1.1361	0.0614	50.0000
0.5783	0.5760	61.8	0.0749	0.8661	0.5105	0.9253	0.3476	0.5804	-0.0183	0.4913	1.1151	0.0625	50.0000
0.5898	0.5859	66.7	0.0749	0.8839	0.5207	0.9366	0.3604	0.5811	-0.0323	0.4914	1.0948	0.0636	50.0000
0.6012	0.5957	71.7	0.0749	0.8966	0.5283	0.9457	0.3694	0.5834	-0.0464	0.4917	1.0754	0.0647	50.0000
0.6126	0.6055	76.5	0.0749	0.9119	0.5359	0.9573	0.3805	0.5859	-0.0604	0.4921	1.0566	0.0658	50.0000
0.6238	0.6151	81.4	0.0749	0.9296	0.5436	0.9689	0.3905	0.5895	-0.0741	0.4926	1.0389	0.0669	50.0000
0.6349	0.6247	86.1	0.0749	0.9423	0.5512	0.9832	0.4014	0.5950	-0.0879	0.4933	1.0218	0.0680	50.0000
0.6460	0.6343	90.9	0.0749	0.9576	0.5588	1.0053	0.4208	0.6000	-0.1023	0.4939	1.0053	0.0690	50.0000
0.6568	0.6439	95.5	0.0749	0.9703	0.5639	1.0434	0.4557	0.6059	-0.1176	0.4946	0.9896	0.0699	50.0000
0.6673	0.6531	100.0	0.0749	0.9830	0.5715	1.0877	0.4911	0.6179	-0.1340	0.4960	0.9748	0.0700	50.0000

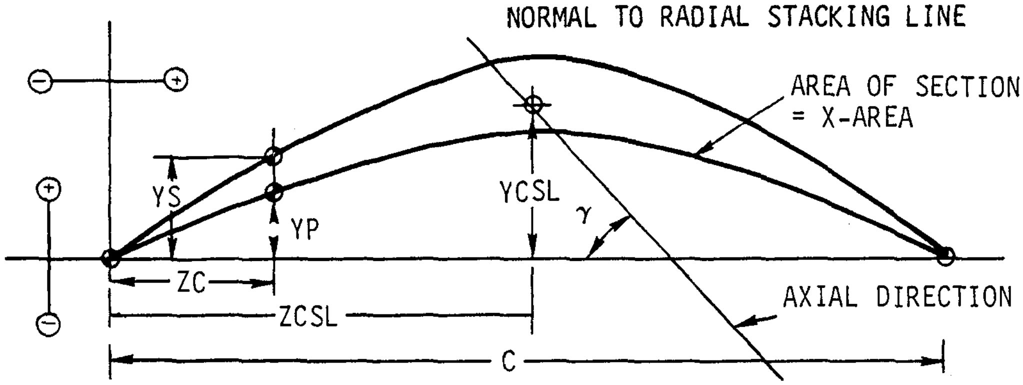
U.S. CUSTOMARY UNITS: INCHES (in.) AND DEGREES (deg)

D_3 (in.)	D_4 (in.)	%SPAN TE	c (in.)	LER (in.)	TER (in.)	β_3^* (deg)	β_4^* (deg)	ϕ_E (deg)	$\bar{\epsilon}$ (deg)
17.10	17.72	0.0	2.948	0.0273	0.0163	51.88	9.42	41.23	7.07
17.59	18.17	5.7	2.948	0.0275	0.0166	50.81	9.92	39.78	6.59
18.08	18.62	11.3	2.948	0.0278	0.0169	50.23	10.60	38.65	6.07
18.57	19.06	16.7	2.948	0.0284	0.0172	50.00	11.32	37.80	5.49
19.06	19.49	22.1	2.948	0.0289	0.0176	49.92	12.14	37.02	4.86
19.54	19.91	27.4	2.948	0.0296	0.0179	50.03	13.10	36.28	4.21
20.01	20.32	32.5	2.948	0.0303	0.0182	50.33	14.27	35.51	3.52
20.48	20.72	37.5	2.948	0.0310	0.0186	50.68	15.46	34.78	2.79
20.94	21.12	42.5	2.948	0.0316	0.0189	51.03	16.54	34.17	2.04
21.40	21.51	47.4	2.948	0.0322	0.0192	51.47	17.58	33.69	1.28
21.86	21.90	52.3	2.948	0.0328	0.0195	51.99	18.52	33.40	0.51
22.31	22.29	57.2	2.948	0.0335	0.0198	52.56	19.36	33.24	-0.26
22.77	22.68	62.0	2.948	0.0341	0.0201	53.01	19.92	33.26	-1.05
23.22	23.07	66.9	2.948	0.0348	0.0205	53.67	20.65	33.29	-1.85
23.67	23.45	71.7	2.948	0.0353	0.0208	54.19	21.16	33.42	-2.66
24.12	23.84	76.5	2.948	0.0359	0.0211	54.85	21.80	33.57	-3.46
24.56	24.22	81.3	2.948	0.0366	0.0214	55.52	22.38	33.78	-4.25
25.00	24.60	86.0	2.948	0.0371	0.0217	56.33	23.00	34.09	-5.04
25.43	24.97	90.7	2.948	0.0377	0.0220	57.60	24.11	34.38	-5.86
25.86	25.35	95.4	2.948	0.0382	0.0222	59.78	26.11	34.71	-6.74
26.27	25.71	100.0	2.948	0.0387	0.0225	62.32	28.14	35.40	-7.68

APPENDIX E

AIRFOIL MANUFACTURING COORDINATES FOR

SECTIONS NORMAL TO THE STACKING LINE



AIRFOIL COORDINATE DEFINITIONS FOR MANUFACTURING SECTIONS

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0003	0.0003	0.0	-0.0100	0.0115
0.0030	0.0006	0.0019	0.1176	0.0235	0.0750
0.0060	0.0014	0.0035	0.2351	0.0566	0.1372
0.0090	0.0023	0.0050	0.3527	0.0887	0.1964
0.0119	0.0030	0.0064	0.4702	0.1197	0.2531
0.0149	0.0038	0.0078	0.5878	0.1497	0.3069
0.0179	0.0045	0.0091	0.7054	0.1783	0.3579
0.0209	0.0052	0.0103	0.8229	0.2058	0.4059
0.0239	0.0059	0.0115	0.9405	0.2318	0.4510
0.0269	0.0065	0.0125	1.0580	0.2565	0.4931
0.0299	0.0071	0.0135	1.1756	0.2797	0.5324
0.0328	0.0077	0.0145	1.2932	0.3014	0.5690
0.0358	0.0082	0.0153	1.4107	0.3215	0.6021
0.0388	0.0086	0.0160	1.5283	0.3396	0.6310
0.0418	0.0090	0.0166	1.6458	0.3548	0.6545
0.0448	0.0093	0.0171	1.7634	0.3666	0.6721
0.0478	0.0095	0.0174	1.8810	0.3750	0.6839
0.0508	0.0096	0.0175	1.9985	0.3797	0.6899
0.0537	0.0097	0.0175	2.1161	0.3807	0.6901
0.0567	0.0096	0.0174	2.2336	0.3781	0.6844
0.0597	0.0094	0.0171	2.3512	0.3717	0.6728
0.0627	0.0092	0.0166	2.4688	0.3614	0.6551
0.0657	0.0088	0.0160	2.5863	0.3470	0.6309
0.0687	0.0083	0.0152	2.7039	0.3284	0.6001
0.0717	0.0078	0.0143	2.8214	0.3054	0.5623
0.0747	0.0071	0.0131	2.9390	0.2776	0.5167
0.0776	0.0062	0.0118	3.0566	0.2448	0.4627
0.0806	0.0053	0.0101	3.1741	0.2068	0.3992
0.0836	0.0041	0.0083	3.2917	0.1628	0.3249
0.0866	0.0029	0.0060	3.4092	0.1123	0.2380
0.0896	0.0014	0.0035	3.5268	0.0545	0.1359
0.0926	-0.0003	0.0004	3.6444	-0.0110	0.0148

RADIUS (METERS) = 0.2103	RADIUS (INCHES) = 8.2788
CHORD (METERS) = 0.0926	CHORD (INCHES) = 3.6444
ZCSL (METERS) = 0.0487	ZCSL (INCHES) = 1.9164
YCSL (METERS) = 0.0105	YCSL (INCHES) = 0.4143
RLE (METERS) =0.000281	RLE (INCHES) = 0.0111
RTE (METERS) =0.000295	RTE (INCHES) = 0.0116
X-AREA(SQ.METERS)=0.000513	X-AREA (SQ. IN.) = 0.7947
GAMMA-CHORD(RAD.)= 0.4672	GAMMA-CHORD(DEG.)= 26.77

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0093	0.0102
0.0030	0.0004	0.0016	0.1198	0.0164	0.0641
0.0061	0.0011	0.0030	0.2396	0.0414	0.1163
0.0091	0.0017	0.0042	0.3594	0.0653	0.1660
0.0122	0.0022	0.0054	0.4792	0.0881	0.2132
0.0152	0.0028	0.0066	0.5990	0.1099	0.2580
0.0183	0.0033	0.0076	0.7188	0.1305	0.3003
0.0213	0.0038	0.0086	0.8386	0.1500	0.3401
0.0243	0.0043	0.0096	0.9584	0.1684	0.3774
0.0274	0.0047	0.0105	1.0782	0.1857	0.4122
0.0304	0.0051	0.0113	1.1980	0.2017	0.4446
0.0335	0.0055	0.0121	1.3178	0.2165	0.4745
0.0365	0.0058	0.0128	1.4376	0.2302	0.5023
0.0396	0.0062	0.0134	1.5574	0.2426	0.5270
0.0426	0.0064	0.0139	1.6772	0.2531	0.5474
0.0456	0.0066	0.0143	1.7970	0.2613	0.5630
0.0487	0.0068	0.0146	1.9168	0.2669	0.5733
0.0517	0.0069	0.0147	2.0366	0.2699	0.5784
0.0548	0.0069	0.0147	2.1564	0.2702	0.5782
0.0578	0.0068	0.0145	2.2762	0.2678	0.5728
0.0609	0.0067	0.0143	2.3960	0.2625	0.5622
0.0639	0.0065	0.0139	2.5158	0.2544	0.5462
0.0669	0.0062	0.0133	2.6356	0.2433	0.5245
0.0700	0.0058	0.0126	2.7554	0.2293	0.4971
0.0730	0.0054	0.0118	2.8752	0.2120	0.4636
0.0761	0.0049	0.0108	2.9950	0.1915	0.4237
0.0791	0.0043	0.0096	3.1148	0.1676	0.3770
0.0822	0.0036	0.0082	3.2346	0.1401	0.3228
0.0852	0.0028	0.0066	3.3544	0.1089	0.2605
0.0882	0.0019	0.0048	3.4742	0.0737	0.1888
0.0913	0.0009	0.0027	3.5940	0.0342	0.1065
0.0943	-0.0002	0.0003	3.7138	-0.0094	0.0122

RADIUS (METERS) = 0.2188	RADIUS (INCHES) = 8.6132
CHORD (METERS) = 0.0943	CHORD (INCHES) = 3.7138
ZCSL (METERS) = 0.0497	ZCSL (INCHES) = 1.9569
YCSL (METERS) = 0.0084	YCSL (INCHES) = 0.3294
RLE (METERS) =0.000262	RLE (INCHES) = 0.0103
RTE (METERS) =0.000278	RTE (INCHES) = 0.0109
X-AREA(SQ.METERS)=0.000507	X-AREA (SQ. IN.) = 0.7858
GAMMA-CHORD(RAD.)= 0.5266	GAMMA-CHORD(DEG.)= 30.17

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0088	0.0095
0.0031	0.0003	0.0015	0.1217	0.0133	0.0589
0.0062	0.0009	0.0027	0.2435	0.0346	0.1064
0.0093	0.0014	0.0038	0.3652	0.0548	0.1515
0.0124	0.0019	0.0049	0.4869	0.0740	0.1942
0.0155	0.0023	0.0060	0.6087	0.0920	0.2346
0.0186	0.0028	0.0069	0.7304	0.1090	0.2726
0.0216	0.0032	0.0078	0.8521	0.1248	0.3082
0.0247	0.0035	0.0087	0.9738	0.1394	0.3414
0.0278	0.0039	0.0095	1.0956	0.1529	0.3723
0.0309	0.0042	0.0102	1.2173	0.1653	0.4009
0.0340	0.0045	0.0108	1.3390	0.1764	0.4271
0.0371	0.0047	0.0115	1.4607	0.1864	0.4513
0.0402	0.0050	0.0120	1.5825	0.1952	0.4728
0.0433	0.0051	0.0125	1.7042	0.2026	0.4914
0.0464	0.0053	0.0128	1.8259	0.2081	0.5055
0.0495	0.0054	0.0131	1.9477	0.2114	0.5145
0.0526	0.0054	0.0132	2.0694	0.2126	0.5186
0.0557	0.0054	0.0132	2.1911	0.2115	0.5179
0.0587	0.0053	0.0130	2.3128	0.2082	0.5121
0.0618	0.0052	0.0127	2.4346	0.2028	0.5014
0.0649	0.0050	0.0123	2.5563	0.1951	0.4857
0.0680	0.0047	0.0118	2.6780	0.1852	0.4649
0.0711	0.0044	0.0111	2.7998	0.1731	0.4388
0.0742	0.0040	0.0103	2.9215	0.1587	0.4074
0.0773	0.0036	0.0094	3.0432	0.1421	0.3704
0.0804	0.0031	0.0083	3.1650	0.1231	0.3275
0.0835	0.0026	0.0071	3.2867	0.1018	0.2784
0.0866	0.0020	0.0057	3.4084	0.0779	0.2228
0.0897	0.0013	0.0041	3.5301	0.0516	0.1599
0.0928	0.0006	0.0023	3.6519	0.0228	0.0892
0.0958	-0.0002	0.0003	3.7736	-0.0084	0.0100

RADIUS (METERS)	= 0.2266	RADIUS (INCHES)	= 8.9212
CHORD (METERS)	= 0.0958	CHORD (INCHES)	= 3.7736
ZCSL (METERS)	= 0.0506	ZCSL (INCHES)	= 1.9917
YCSL (METERS)	= 0.0072	YCSL (INCHES)	= 0.2841
RLE (METERS)	=0.000247	RLE (INCHES)	= 0.0097
RTE (METERS)	=0.000250	RTE (INCHES)	= 0.0098
X-AREA(SQ.METERS)	=0.000504	X-AREA (SQ. IN.)	= 0.7815
GAMMA-CHORD(RAD.)	= 0.5607	GAMMA-CHORD(DEG.)	= 32.13

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0084	0.0090
0.0032	0.0002	0.0013	0.1244	0.0091	0.0526
0.0063	0.0007	0.0024	0.2489	0.0259	0.0945
0.0095	0.0011	0.0034	0.3733	0.0418	0.1344
0.0126	0.0014	0.0044	0.4977	0.0570	0.1722
0.0158	0.0018	0.0053	0.6222	0.0713	0.2079
0.0190	0.0022	0.0061	0.7466	0.0847	0.2416
0.0221	0.0025	0.0069	0.8710	0.0972	0.2732
0.0253	0.0028	0.0077	0.9955	0.1089	0.3028
0.0284	0.0030	0.0084	1.1199	0.1196	0.3305
0.0316	0.0033	0.0090	1.2443	0.1295	0.3561
0.0348	0.0035	0.0096	1.3687	0.1384	0.3798
0.0379	0.0037	0.0102	1.4932	0.1465	0.4017
0.0411	0.0039	0.0107	1.6176	0.1537	0.4215
0.0442	0.0041	0.0112	1.7421	0.1603	0.4400
0.0474	0.0042	0.0116	1.8665	0.1654	0.4548
0.0506	0.0043	0.0118	1.9909	0.1689	0.4653
0.0537	0.0043	0.0120	2.1153	0.1704	0.4710
0.0569	0.0043	0.0120	2.2398	0.1701	0.4718
0.0601	0.0043	0.0119	2.3642	0.1678	0.4677
0.0632	0.0042	0.0117	2.4886	0.1635	0.4588
0.0664	0.0040	0.0113	2.6131	0.1573	0.4450
0.0695	0.0038	0.0108	2.7375	0.1493	0.4263
0.0727	0.0035	0.0102	2.8619	0.1394	0.4026
0.0759	0.0032	0.0095	2.9864	0.1275	0.3737
0.0790	0.0029	0.0086	3.1108	0.1138	0.3395
0.0822	0.0025	0.0076	3.2352	0.0983	0.2998
0.0853	0.0021	0.0065	3.3597	0.0808	0.2544
0.0885	0.0016	0.0052	3.4841	0.0615	0.2030
0.0917	0.0010	0.0037	3.6085	0.0403	0.1452
0.0948	0.0004	0.0020	3.7330	0.0172	0.0806
0.0980	-0.0002	0.0002	3.8574	-0.0076	0.0090

RADIUS (METERS) = 0.2411	RADIUS (INCHES) = 9.4916
CHORD (METERS) = 0.0980	CHORD (INCHES) = 3.8574
ZCSL (METERS) = 0.0519	ZCSL (INCHES) = 2.0447
YCSL (METERS) = 0.0063	YCSL (INCHES) = 0.2485
RLE (METERS) =0.000236	RLE (INCHES) = 0.0093
RTE (METERS) =0.000232	RTE (INCHES) = 0.0091
X-AREA(SQ.METERS)=0.000503	X-AREA (SQ. IN.) = 0.7789
GAMMA-CHORD(RAD.)= 0.6110	GAMMA-CHORD(DEG.)= 35.01

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0085	0.0088
0.0032	0.0001	0.0012	0.1270	0.0051	0.0476
0.0064	0.0005	0.0022	0.2539	0.0180	0.0849
0.0097	0.0008	0.0031	0.3809	0.0302	0.1203
0.0129	0.0011	0.0039	0.5078	0.0418	0.1538
0.0161	0.0013	0.0047	0.6348	0.0526	0.1855
0.0193	0.0016	0.0055	0.7618	0.0628	0.2154
0.0226	0.0018	0.0062	0.8887	0.0723	0.2435
0.0258	0.0021	0.0069	1.0157	0.0812	0.2698
0.0290	0.0023	0.0075	1.1427	0.0895	0.2944
0.0322	0.0025	0.0081	1.2696	0.0971	0.3171
0.0355	0.0026	0.0086	1.3966	0.1041	0.3382
0.0387	0.0028	0.0091	1.5235	0.1105	0.3576
0.0419	0.0030	0.0095	1.6505	0.1163	0.3753
0.0451	0.0031	0.0099	1.7775	0.1216	0.3915
0.0484	0.0032	0.0103	1.9044	0.1264	0.4062
0.0516	0.0033	0.0106	2.0314	0.1303	0.4182
0.0548	0.0034	0.0108	2.1583	0.1327	0.4257
0.0580	0.0034	0.0109	2.2853	0.1333	0.4284
0.0613	0.0034	0.0108	2.4123	0.1321	0.4263
0.0645	0.0033	0.0107	2.5392	0.1293	0.4194
0.0677	0.0032	0.0104	2.6662	0.1248	0.4078
0.0709	0.0030	0.0099	2.7932	0.1186	0.3914
0.0742	0.0028	0.0094	2.9201	0.1108	0.3702
0.0774	0.0026	0.0087	3.0471	0.1014	0.3440
0.0806	0.0023	0.0079	3.1740	0.0903	0.3128
0.0838	0.0020	0.0070	3.3010	0.0778	0.2764
0.0871	0.0016	0.0060	3.4280	0.0636	0.2346
0.0903	0.0012	0.0048	3.5549	0.0480	0.1872
0.0935	0.0008	0.0034	3.6819	0.0308	0.1340
0.0967	0.0003	0.0019	3.8089	0.0122	0.0746
0.1000	-0.0002	0.0002	3.9358	-0.0077	0.0087

RADIUS (METERS) = 0.2547	RADIUS (INCHES) =10.0288
CHORD (METERS) = 0.1000	CHORD (INCHES) = 3.9358
ZCSL (METERS) = 0.0531	ZCSL (INCHES) = 2.0911
YCSL (METERS) = 0.0055	YCSL (INCHES) = 0.2162
RLE (METERS) =0.000237	RLE (INCHES) = 0.0093
RTE (METERS) =0.000232	RTE (INCHES) = 0.0091
X-AREA(SQ.METERS)=0.000501	X-AREA (SQ. IN.) = 0.7761
GAMMA-CHORD(RAD.)= 0.6670	GAMMA-CHORD(DEG.)= 38.21

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0085	0.0087
0.0033	0.0000	0.0011	0.1295	0.0012	0.0421
0.0066	0.0003	0.0019	0.2589	0.0103	0.0741
0.0099	0.0005	0.0027	0.3883	0.0189	0.1045
0.0132	0.0007	0.0034	0.5178	0.0271	0.1333
0.0164	0.0009	0.0041	0.6472	0.0348	0.1604
0.0197	0.0011	0.0047	0.7767	0.0420	0.1860
0.0230	0.0012	0.0053	0.9061	0.0487	0.2100
0.0263	0.0014	0.0059	1.0356	0.0551	0.2324
0.0296	0.0015	0.0064	1.1650	0.0610	0.2534
0.0329	0.0017	0.0069	1.2945	0.0665	0.2728
0.0362	0.0018	0.0074	1.4239	0.0716	0.2908
0.0395	0.0019	0.0078	1.5534	0.0764	0.3074
0.0427	0.0021	0.0082	1.6828	0.0809	0.3225
0.0460	0.0022	0.0085	1.8123	0.0850	0.3363
0.0493	0.0023	0.0089	1.9417	0.0891	0.3492
0.0526	0.0024	0.0092	2.0712	0.0928	0.3603
0.0559	0.0024	0.0094	2.2006	0.0959	0.3689
0.0592	0.0025	0.0095	2.3301	0.0976	0.3735
0.0625	0.0025	0.0095	2.4595	0.0979	0.3735
0.0658	0.0025	0.0094	2.5890	0.0965	0.3689
0.0690	0.0024	0.0091	2.7184	0.0936	0.3597
0.0723	0.0023	0.0088	2.8479	0.0893	0.3461
0.0756	0.0021	0.0083	2.9773	0.0836	0.3277
0.0789	0.0019	0.0077	3.1067	0.0766	0.3049
0.0822	0.0017	0.0070	3.2362	0.0682	0.2774
0.0855	0.0015	0.0062	3.3657	0.0584	0.2451
0.0888	0.0012	0.0053	3.4951	0.0475	0.2081
0.0921	0.0009	0.0042	3.6245	0.0353	0.1661
0.0954	0.0006	0.0030	3.7540	0.0221	0.1189
0.0986	0.0002	0.0017	3.8834	0.0076	0.0665
0.1019	-0.0002	0.0002	4.0129	-0.0077	0.0087

RADIUS (METERS) = 0.2678	RADIUS (INCHES) =10.5436
CHORD (METERS) = 0.1019	CHORD (INCHES) = 4.0129
ZCSL (METERS) = 0.0541	ZCSL (INCHES) = 2.1311
YCSL (METERS) = 0.0046	YCSL (INCHES) = 0.1805
RLE (METERS) =0.000235	RLE (INCHES) = 0.0093
RTE (METERS) =0.000233	RTE (INCHES) = 0.0092
X-AREA(SQ.METERS)=0.000479	X-AREA (SQ. IN.) = 0.7424
GAMMA-CHORD(RAD.)= 0.7291	GAMMA-CHORD(DEG.)= 41.77

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0085	0.0086
0.0033	-0.0001	0.0009	0.1319	-0.0024	0.0369
0.0067	0.0001	0.0016	0.2637	0.0034	0.0641
0.0100	0.0002	0.0023	0.3956	0.0088	0.0897
0.0134	0.0004	0.0029	0.5275	0.0139	0.1140
0.0167	0.0005	0.0035	0.6593	0.0188	0.1370
0.0201	0.0006	0.0040	0.7912	0.0233	0.1585
0.0234	0.0007	0.0045	0.9231	0.0276	0.1787
0.0268	0.0008	0.0050	1.0549	0.0316	0.1977
0.0301	0.0009	0.0055	1.1868	0.0354	0.2153
0.0335	0.0010	0.0059	1.3187	0.0390	0.2316
0.0368	0.0011	0.0063	1.4505	0.0424	0.2468
0.0402	0.0012	0.0066	1.5824	0.0457	0.2607
0.0435	0.0012	0.0069	1.7142	0.0488	0.2735
0.0469	0.0013	0.0072	1.8461	0.0518	0.2851
0.0502	0.0014	0.0075	1.9780	0.0547	0.2957
0.0536	0.0015	0.0078	2.1098	0.0578	0.3052
0.0569	0.0015	0.0080	2.2417	0.0609	0.3138
0.0603	0.0016	0.0081	2.3736	0.0632	0.3193
0.0636	0.0016	0.0082	2.5054	0.0643	0.3209
0.0670	0.0016	0.0081	2.6373	0.0642	0.3181
0.0703	0.0016	0.0079	2.7692	0.0627	0.3111
0.0737	0.0015	0.0076	2.9010	0.0601	0.2999
0.0770	0.0014	0.0072	3.0329	0.0564	0.2844
0.0804	0.0013	0.0067	3.1648	0.0515	0.2648
0.0837	0.0012	0.0061	3.2966	0.0456	0.2410
0.0871	0.0010	0.0054	3.4285	0.0388	0.2130
0.0904	0.0008	0.0046	3.5604	0.0310	0.1808
0.0938	0.0006	0.0037	3.6922	0.0224	0.1442
0.0971	0.0003	0.0026	3.8241	0.0130	0.1034
0.1005	0.0001	0.0015	3.9559	0.0030	0.0582
0.1038	-0.0002	0.0002	4.0878	-0.0076	0.0086

RADIUS (METERS)	= 0.2804	RADIUS (INCHES)	=11.0406
CHORD (METERS)	= 0.1038	CHORD (INCHES)	= 4.0878
ZCSL (METERS)	= 0.0551	ZCSL (INCHES)	= 2.1688
YCSL (METERS)	= 0.0037	YCSL (INCHES)	= 0.1462
RLE (METERS)	=0.000234	RLE (INCHES)	= 0.0092
RTE (METERS)	=0.000231	RTE (INCHES)	= 0.0091
X-AREA(SQ.METERS)	=0.000455	X-AREA (SQ. IN.)	= 0.7056
GAMMA-CHORD(RAD.)	= 0.7901	GAMMA-CHORD(DEG.)	= 45.27

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0087	0.0086
0.0034	-0.0001	0.0008	0.1341	-0.0058	0.0325
0.0068	-0.0001	0.0014	0.2682	-0.0032	0.0554
0.0102	-0.0000	0.0020	0.4024	-0.0007	0.0770
0.0136	0.0000	0.0025	0.5365	0.0018	0.0974
0.0170	0.0001	0.0030	0.6706	0.0040	0.1166
0.0204	0.0002	0.0034	0.8047	0.0061	0.1346
0.0238	0.0002	0.0038	0.9389	0.0081	0.1514
0.0273	0.0003	0.0042	1.0730	0.0101	0.1671
0.0307	0.0003	0.0046	1.2071	0.0120	0.1816
0.0341	0.0004	0.0050	1.3412	0.0138	0.1951
0.0375	0.0004	0.0053	1.4754	0.0157	0.2074
0.0409	0.0004	0.0056	1.6095	0.0175	0.2188
0.0443	0.0005	0.0058	1.7436	0.0195	0.2292
0.0477	0.0005	0.0061	1.8777	0.0215	0.2385
0.0511	0.0006	0.0063	2.0118	0.0236	0.2469
0.0545	0.0007	0.0065	2.1460	0.0260	0.2546
0.0579	0.0007	0.0066	2.2801	0.0285	0.2613
0.0613	0.0008	0.0068	2.4142	0.0315	0.2671
0.0647	0.0009	0.0069	2.5483	0.0340	0.2705
0.0681	0.0009	0.0069	2.6825	0.0353	0.2700
0.0715	0.0009	0.0067	2.8166	0.0356	0.2655
0.0749	0.0009	0.0065	2.9507	0.0349	0.2569
0.0784	0.0008	0.0062	3.0848	0.0331	0.2445
0.0818	0.0008	0.0058	3.2189	0.0305	0.2282
0.0852	0.0007	0.0053	3.3531	0.0269	0.2081
0.0886	0.0006	0.0047	3.4872	0.0227	0.1842
0.0920	0.0005	0.0040	3.6213	0.0177	0.1565
0.0954	0.0003	0.0032	3.7554	0.0122	0.1251
0.0988	0.0002	0.0023	3.8896	0.0060	0.0900
0.1022	-0.0000	0.0013	4.0237	-0.0007	0.0511
0.1056	-0.0002	0.0002	4.1578	-0.0075	0.0086

RADIUS (METERS) = 0.2927	RADIUS (INCHES) =11.5232
CHORD (METERS) = 0.1056	CHORD (INCHES) = 4.1578
ZCSL (METERS) = 0.0558	ZCSL (INCHES) = 2.1970
YCSL (METERS) = 0.0029	YCSL (INCHES) = 0.1150
RLE (METERS) =0.000237	RLE (INCHES) = 0.0093
RTE (METERS) =0.000229	RTE (INCHES) = 0.0090
X-AREA(SQ.METERS)=0.000432	X-AREA (SQ. IN.) = 0.6691
GAMMA-CHORD(RAD.)= 0.8451	GAMMA-CHORD(DEG.)= 48.42

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0087	0.0087
0.0035	-0.0002	0.0007	0.1362	-0.0089	0.0284
0.0069	-0.0002	0.0012	0.2724	-0.0092	0.0471
0.0104	-0.0002	0.0016	0.4087	-0.0095	0.0648
0.0138	-0.0003	0.0021	0.5449	-0.0099	0.0814
0.0173	-0.0003	0.0025	0.6811	-0.0101	0.0970
0.0208	-0.0003	0.0028	0.8174	-0.0104	0.1115
0.0242	-0.0003	0.0032	0.9536	-0.0107	0.1250
0.0277	-0.0003	0.0035	1.0898	-0.0108	0.1375
0.0311	-0.0003	0.0038	1.2261	-0.0108	0.1491
0.0346	-0.0003	0.0041	1.3623	-0.0107	0.1597
0.0381	-0.0003	0.0043	1.4985	-0.0103	0.1694
0.0415	-0.0002	0.0045	1.6347	-0.0098	0.1783
0.0450	-0.0002	0.0047	1.7710	-0.0090	0.1863
0.0484	-0.0002	0.0049	1.9072	-0.0080	0.1935
0.0519	-0.0002	0.0051	2.0434	-0.0066	0.2000
0.0554	-0.0001	0.0052	2.1796	-0.0049	0.2057
0.0588	-0.0001	0.0054	2.3159	-0.0027	0.2107
0.0623	-0.0000	0.0055	2.4521	-0.0001	0.2155
0.0657	0.0001	0.0056	2.5883	0.0030	0.2191
0.0692	0.0001	0.0056	2.7246	0.0059	0.2206
0.0727	0.0002	0.0056	2.8608	0.0080	0.2187
0.0761	0.0002	0.0054	2.9970	0.0093	0.2132
0.0796	0.0002	0.0052	3.1332	0.0097	0.2041
0.0830	0.0002	0.0049	3.2695	0.0095	0.1916
0.0865	0.0002	0.0045	3.4057	0.0085	0.1755
0.0900	0.0002	0.0040	3.5419	0.0069	0.1561
0.0934	0.0001	0.0034	3.6781	0.0047	0.1332
0.0969	0.0001	0.0027	3.8144	0.0021	0.1070
0.1003	-0.0000	0.0020	3.9506	-0.0010	0.0774
0.1038	-0.0001	0.0011	4.0868	-0.0044	0.0445
0.1073	-0.0002	0.0002	4.2231	-0.0078	0.0085

RADIUS (METERS) = 0.3046
CHORD (METERS) = 0.1073
ZCSL (METERS) = 0.0564
YCSL (METERS) = 0.0021
RLE (METERS) =0.000236
RTE (METERS) =0.000230
X-AREA(SQ.METERS)=0.000407
GAMMA-CHORD(RAD.)= 0.8968

RADIUS (INCHES) =11.9938
CHORD (INCHES) = 4.2231
ZCSL (INCHES) = 2.2212
YCSL (INCHES) = 0.0844
RLE (INCHES) = 0.0093
RTE (INCHES) = 0.0091
X-AREA (SQ. IN.) = 0.6314
GAMMA-CHORD(DEG.)= 51.38

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0086	0.0086
0.0035	-0.0003	0.0006	0.1378	-0.0110	0.0245
0.0070	-0.0003	0.0010	0.2757	-0.0135	0.0395
0.0105	-0.0004	0.0014	0.4135	-0.0160	0.0536
0.0140	-0.0005	0.0017	0.5514	-0.0183	0.0667
0.0175	-0.0005	0.0020	0.6892	-0.0206	0.0789
0.0210	-0.0006	0.0023	0.8271	-0.0227	0.0902
0.0245	-0.0006	0.0026	0.9649	-0.0247	0.1007
0.0280	-0.0007	0.0028	1.1028	-0.0265	0.1103
0.0315	-0.0007	0.0030	1.2406	-0.0281	0.1192
0.0350	-0.0007	0.0032	1.3785	-0.0294	0.1272
0.0385	-0.0008	0.0034	1.5163	-0.0304	0.1346
0.0420	-0.0008	0.0036	1.6542	-0.0311	0.1411
0.0455	-0.0008	0.0037	1.7920	-0.0314	0.1471
0.0490	-0.0008	0.0039	1.9298	-0.0314	0.1524
0.0525	-0.0008	0.0040	2.0677	-0.0309	0.1572
0.0560	-0.0008	0.0041	2.2055	-0.0299	0.1614
0.0595	-0.0007	0.0042	2.3434	-0.0284	0.1652
0.0630	-0.0007	0.0043	2.4812	-0.0264	0.1685
0.0665	-0.0006	0.0044	2.6191	-0.0236	0.1715
0.0700	-0.0005	0.0044	2.7569	-0.0203	0.1745
0.0735	-0.0004	0.0044	2.8948	-0.0170	0.1752
0.0770	-0.0004	0.0044	3.0326	-0.0142	0.1729
0.0805	-0.0003	0.0042	3.1705	-0.0120	0.1673
0.0840	-0.0003	0.0040	3.3083	-0.0103	0.1583
0.0875	-0.0002	0.0037	3.4462	-0.0092	0.1463
0.0910	-0.0002	0.0033	3.5840	-0.0083	0.1311
0.0945	-0.0002	0.0029	3.7219	-0.0078	0.1127
0.0980	-0.0002	0.0023	3.8597	-0.0076	0.0912
0.1015	-0.0002	0.0017	3.9976	-0.0075	0.0666
0.1050	-0.0002	0.0010	4.1354	-0.0076	0.0389
0.1085	-0.0002	0.0002	4.2732	-0.0077	0.0085

RADIUS (METERS) = 0.3164	RADIUS (INCHES) =12.4572
CHORD (METERS) = 0.1085	CHORD (INCHES) = 4.2732
ZCSL (METERS) = 0.0571	ZCSL (INCHES) = 2.2488
YCSL (METERS) = 0.0015	YCSL (INCHES) = 0.0576
RLE (METERS) =0.000234	RLE (INCHES) = 0.0092
RTE (METERS) =0.000228	RTE (INCHES) = 0.0090
X-AREA(SQ.METERS)=0.000379	X-AREA (SQ. IN.) = 0.5878
GAMMA-CHORD(RAD.)= 0.9487	GAMMA-CHORD(DEG.)= 54.35

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0089	0.0088
0.0036	-0.0003	0.0005	0.1399	-0.0124	0.0215
0.0071	-0.0004	0.0008	0.2799	-0.0160	0.0333
0.0107	-0.0005	0.0011	0.4198	-0.0197	0.0442
0.0142	-0.0006	0.0014	0.5597	-0.0232	0.0542
0.0178	-0.0007	0.0016	0.6997	-0.0267	0.0635
0.0213	-0.0008	0.0018	0.8396	-0.0301	0.0720
0.0249	-0.0008	0.0020	0.9796	-0.0333	0.0797
0.0284	-0.0009	0.0022	1.1195	-0.0362	0.0867
0.0320	-0.0010	0.0024	1.2594	-0.0389	0.0931
0.0355	-0.0011	0.0025	1.3994	-0.0415	0.0988
0.0391	-0.0011	0.0026	1.5393	-0.0436	0.1040
0.0427	-0.0012	0.0028	1.6792	-0.0453	0.1086
0.0462	-0.0012	0.0029	1.8192	-0.0466	0.1128
0.0498	-0.0012	0.0030	1.9591	-0.0475	0.1166
0.0533	-0.0012	0.0030	2.0990	-0.0478	0.1199
0.0569	-0.0012	0.0031	2.2390	-0.0476	0.1230
0.0604	-0.0012	0.0032	2.3789	-0.0467	0.1259
0.0640	-0.0011	0.0033	2.5188	-0.0451	0.1285
0.0675	-0.0011	0.0033	2.6588	-0.0428	0.1311
0.0711	-0.0010	0.0034	2.7987	-0.0396	0.1338
0.0746	-0.0009	0.0035	2.9386	-0.0356	0.1363
0.0782	-0.0008	0.0035	3.0786	-0.0318	0.1371
0.0818	-0.0007	0.0034	3.2185	-0.0283	0.1346
0.0853	-0.0006	0.0033	3.3584	-0.0252	0.1290
0.0889	-0.0006	0.0031	3.4984	-0.0223	0.1203
0.0924	-0.0005	0.0028	3.6383	-0.0197	0.1088
0.0960	-0.0004	0.0024	3.7782	-0.0173	0.0944
0.0995	-0.0004	0.0020	3.9182	-0.0149	0.0771
0.1031	-0.0003	0.0014	4.0581	-0.0125	0.0571
0.1066	-0.0003	0.0009	4.1981	-0.0102	0.0342
0.1102	-0.0002	0.0002	4.3380	-0.0077	0.0087

RADIUS (METERS) = 0.3283	RADIUS (INCHES) =12.9242
CHORD (METERS) = 0.1102	CHORD (INCHES) = 4.3380
ZCSL (METERS) = 0.0581	ZCSL (INCHES) = 2.2879
YCSL (METERS) = 0.0009	YCSL (INCHES) = 0.0360
RLE (METERS) =0.000237	RLE (INCHES) = 0.0094
RTE (METERS) =0.000229	RTE (INCHES) = 0.0090
X-AREA(SQ.METERS)=0.000348	X-AREA (SQ. IN.) = 0.5389
GAMMA-CHORD(RAD.)= 1.0035	GAMMA-CHORD(DEG.)= 57.50

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0091	0.0091
0.0036	-0.0003	0.0005	0.1407	-0.0129	0.0202
0.0071	-0.0004	0.0008	0.2815	-0.0170	0.0305
0.0107	-0.0005	0.0010	0.4222	-0.0211	0.0399
0.0143	-0.0006	0.0012	0.5630	-0.0253	0.0484
0.0179	-0.0007	0.0014	0.7037	-0.0294	0.0561
0.0214	-0.0009	0.0016	0.8444	-0.0335	0.0630
0.0250	-0.0010	0.0018	0.9852	-0.0374	0.0692
0.0286	-0.0010	0.0019	1.1259	-0.0412	0.0748
0.0322	-0.0011	0.0020	1.2666	-0.0447	0.0797
0.0357	-0.0012	0.0021	1.4074	-0.0479	0.0840
0.0393	-0.0013	0.0022	1.5481	-0.0507	0.0879
0.0429	-0.0014	0.0023	1.6888	-0.0531	0.0913
0.0465	-0.0014	0.0024	1.8296	-0.0551	0.0944
0.0500	-0.0014	0.0025	1.9703	-0.0566	0.0971
0.0536	-0.0015	0.0025	2.1110	-0.0575	0.0996
0.0572	-0.0015	0.0026	2.2518	-0.0577	0.1019
0.0608	-0.0015	0.0026	2.3925	-0.0573	0.1042
0.0643	-0.0014	0.0027	2.5333	-0.0560	0.1064
0.0679	-0.0014	0.0028	2.6740	-0.0538	0.1088
0.0715	-0.0013	0.0028	2.8147	-0.0507	0.1113
0.0751	-0.0012	0.0029	2.9555	-0.0464	0.1146
0.0786	-0.0011	0.0030	3.0962	-0.0417	0.1166
0.0822	-0.0009	0.0030	3.2369	-0.0369	0.1165
0.0858	-0.0008	0.0029	3.3777	-0.0325	0.1133
0.0894	-0.0007	0.0027	3.5184	-0.0283	0.1072
0.0929	-0.0006	0.0025	3.6592	-0.0245	0.0981
0.0965	-0.0005	0.0022	3.7999	-0.0207	0.0862
0.1001	-0.0004	0.0018	3.9406	-0.0172	0.0713
0.1037	-0.0003	0.0014	4.0814	-0.0138	0.0534
0.1072	-0.0003	0.0008	4.2221	-0.0105	0.0326
0.1108	-0.0002	0.0002	4.3628	-0.0077	0.0087

RADIUS (METERS) = 0.3343	RADIUS (INCHES) =13.1632
CHORD (METERS) = 0.1108	CHORD (INCHES) = 4.3628
ZCSL (METERS) = 0.0585	ZCSL (INCHES) = 2.3021
YCSL (METERS) = 0.0006	YCSL (INCHES) = 0.0245
RLE (METERS) =0.000243	RLE (INCHES) = 0.0096
RTE (METERS) =0.000228	RTE (INCHES) = 0.0090
X-AREA(SQ.METERS)=0.000330	X-AREA (SQ. IN.) = 0.5113
GAMMA-CHORD(RAD.)= 1.0375	GAMMA-CHORD(DEG.)= 59.44

AIRFOIL MANUFACTURING COORDINATES

ROTOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0092	0.0091
0.0036	-0.0003	0.0005	0.1416	-0.0112	0.0208
0.0072	-0.0004	0.0008	0.2833	-0.0139	0.0313
0.0108	-0.0004	0.0010	0.4249	-0.0169	0.0406
0.0144	-0.0005	0.0012	0.5666	-0.0202	0.0489
0.0180	-0.0006	0.0014	0.7082	-0.0236	0.0562
0.0216	-0.0007	0.0016	0.8499	-0.0272	0.0627
0.0252	-0.0008	0.0017	0.9915	-0.0307	0.0684
0.0288	-0.0009	0.0019	1.1332	-0.0342	0.0734
0.0324	-0.0010	0.0020	1.2748	-0.0375	0.0777
0.0360	-0.0010	0.0021	1.4164	-0.0405	0.0815
0.0396	-0.0011	0.0022	1.5581	-0.0433	0.0848
0.0432	-0.0012	0.0022	1.6997	-0.0457	0.0879
0.0468	-0.0012	0.0023	1.8414	-0.0476	0.0905
0.0504	-0.0012	0.0024	1.9830	-0.0489	0.0930
0.0540	-0.0013	0.0024	2.1247	-0.0497	0.0954
0.0576	-0.0013	0.0025	2.2663	-0.0497	0.0977
0.0612	-0.0012	0.0025	2.4080	-0.0491	0.1000
0.0648	-0.0012	0.0026	2.5496	-0.0476	0.1025
0.0684	-0.0012	0.0027	2.6912	-0.0455	0.1051
0.0720	-0.0011	0.0027	2.8329	-0.0425	0.1077
0.0756	-0.0010	0.0028	2.9745	-0.0382	0.1113
0.0792	-0.0008	0.0029	3.1162	-0.0332	0.1145
0.0827	-0.0007	0.0029	3.2578	-0.0282	0.1158
0.0863	-0.0006	0.0029	3.3995	-0.0237	0.1143
0.0899	-0.0005	0.0028	3.5411	-0.0198	0.1094
0.0935	-0.0004	0.0026	3.6827	-0.0165	0.1014
0.0971	-0.0004	0.0023	3.8244	-0.0139	0.0898
0.1007	-0.0003	0.0019	3.9660	-0.0117	0.0751
0.1043	-0.0003	0.0014	4.1077	-0.0101	0.0570
0.1079	-0.0002	0.0009	4.2493	-0.0092	0.0353
0.1115	-0.0002	0.0003	4.3910	-0.0090	0.0100

RADIUS (METERS) = 0.3411	RADIUS (INCHES) =13.4290
CHORD (METERS) = 0.1115	CHORD (INCHES) = 4.3910
ZCSL (METERS) = 0.0592	ZCSL (INCHES) = 2.3294
YCSL (METERS) = 0.0007	YCSL (INCHES) = 0.0274
RLE (METERS) =0.000244	RLE (INCHES) = 0.0096
RTE (METERS) =0.000262	RTE (INCHES) = 0.0103
X-AREA(SQ.METERS)=0.000311	X-AREA (SQ. IN.) = 0.4821
GAMMA-CHORD(RAD.)= 1.0794	GAMMA-CHORD(DEG.)= 61.84

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0001	0.0002	0.0	-0.0056	0.0088
0.0024	0.0001	0.0018	0.0948	0.0057	0.0709
0.0048	0.0009	0.0028	0.1897	0.0352	0.1108
0.0072	0.0016	0.0038	0.2845	0.0633	0.1480
0.0096	0.0023	0.0046	0.3794	0.0896	0.1826
0.0120	0.0029	0.0055	0.4742	0.1139	0.2147
0.0145	0.0035	0.0062	0.5691	0.1362	0.2442
0.0169	0.0040	0.0069	0.6639	0.1567	0.2714
0.0193	0.0045	0.0075	0.7587	0.1754	0.2964
0.0217	0.0049	0.0081	0.8536	0.1924	0.3186
0.0241	0.0052	0.0086	0.9484	0.2062	0.3372
0.0265	0.0055	0.0089	1.0433	0.2166	0.3515
0.0289	0.0057	0.0092	1.1381	0.2234	0.3613
0.0313	0.0057	0.0093	1.2329	0.2256	0.3658
0.0337	0.0057	0.0093	1.3278	0.2245	0.3664
0.0361	0.0056	0.0092	1.4226	0.2213	0.3641
0.0385	0.0055	0.0091	1.5175	0.2154	0.3585
0.0410	0.0053	0.0089	1.6123	0.2076	0.3500
0.0434	0.0051	0.0086	1.7071	0.1988	0.3395
0.0458	0.0048	0.0083	1.8020	0.1890	0.3269
0.0482	0.0045	0.0079	1.8968	0.1782	0.3124
0.0506	0.0042	0.0075	1.9917	0.1662	0.2959
0.0530	0.0039	0.0070	2.0865	0.1532	0.2774
0.0554	0.0035	0.0065	2.1813	0.1392	0.2569
0.0578	0.0031	0.0060	2.2762	0.1240	0.2343
0.0602	0.0027	0.0053	2.3710	0.1077	0.2096
0.0626	0.0023	0.0046	2.4659	0.0903	0.1829
0.0650	0.0018	0.0039	2.5607	0.0718	0.1540
0.0675	0.0013	0.0031	2.6556	0.0521	0.1228
0.0699	0.0008	0.0023	2.7504	0.0310	0.0893
0.0723	0.0002	0.0014	2.8452	0.0088	0.0535
0.0747	-0.0004	0.0004	2.9401	-0.0146	0.0154

RADIUS (METERS) = 0.2196	RADIUS (INCHES) = 8.6469
CHORD (METERS) = 0.0747	CHORD (INCHES) = 2.9401
ZCSL (METERS) = 0.0365	ZCSL (INCHES) = 1.4382
YCSL (METERS) = 0.0055	YCSL (INCHES) = 0.2149
RLE (METERS) =0.000213	RLE (INCHES) = 0.0084
RTE (METERS) =0.000389	RTE (INCHES) = 0.0153
X-AREA(SQ.METERS)=0.000207	X-AREA (SQ. IN.) = 0.3213
GAMMA-CHORD(RAD.)= 0.5144	GAMMA-CHORD(DEG.)= 29.47

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0001	0.0002	0.0	-0.0058	0.0088
0.0024	0.0001	0.0018	0.0949	0.0049	0.0707
0.0048	0.0009	0.0028	0.1897	0.0338	0.1101
0.0072	0.0016	0.0037	0.2846	0.0613	0.1468
0.0096	0.0022	0.0046	0.3795	0.0869	0.1809
0.0120	0.0028	0.0054	0.4743	0.1105	0.2124
0.0145	0.0034	0.0061	0.5692	0.1322	0.2414
0.0169	0.0039	0.0068	0.6641	0.1520	0.2679
0.0193	0.0043	0.0074	0.7589	0.1699	0.2923
0.0217	0.0047	0.0080	0.8538	0.1861	0.3140
0.0241	0.0051	0.0084	0.9487	0.1993	0.3319
0.0265	0.0053	0.0088	1.0435	0.2091	0.3457
0.0289	0.0055	0.0090	1.1384	0.2153	0.3551
0.0313	0.0055	0.0091	1.2333	0.2169	0.3591
0.0337	0.0055	0.0091	1.3281	0.2154	0.3593
0.0361	0.0054	0.0091	1.4230	0.2118	0.3566
0.0386	0.0052	0.0089	1.5179	0.2057	0.3507
0.0410	0.0050	0.0087	1.6127	0.1978	0.3418
0.0434	0.0048	0.0084	1.7076	0.1890	0.3310
0.0458	0.0046	0.0081	1.8025	0.1792	0.3184
0.0482	0.0043	0.0077	1.8973	0.1685	0.3040
0.0506	0.0040	0.0073	1.9922	0.1569	0.2876
0.0530	0.0037	0.0068	2.0871	0.1443	0.2693
0.0554	0.0033	0.0063	2.1819	0.1307	0.2492
0.0578	0.0029	0.0058	2.2768	0.1161	0.2272
0.0602	0.0026	0.0052	2.3717	0.1005	0.2031
0.0626	0.0021	0.0045	2.4665	0.0840	0.1771
0.0651	0.0017	0.0038	2.5614	0.0664	0.1491
0.0675	0.0012	0.0030	2.6563	0.0477	0.1190
0.0699	0.0007	0.0022	2.7511	0.0279	0.0867
0.0723	0.0002	0.0013	2.8460	0.0071	0.0524
0.0747	-0.0004	0.0004	2.9409	-0.0148	0.0157

RADIUS (METERS)	= 0.2258	RADIUS (INCHES)	= 8.8881
CHORD (METERS)	= 0.0747	CHORD (INCHES)	= 2.9409
ZCSL (METERS)	= 0.0365	ZCSL (INCHES)	= 1.4377
YCSL (METERS)	= 0.0053	YCSL (INCHES)	= 0.2086
RLE (METERS)	=0.000216	RLE (INCHES)	= 0.0085
RTE (METERS)	=0.000398	RTE (INCHES)	= 0.0157
X-AREA(SQ.METERS)	=0.000210	X-AREA (SQ. IN.)	= 0.3247
GAMMA-CHORD(RAD.)	= 0.5036	GAMMA-CHORD(DEG.)	= 28.85

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0060	0.0090
0.0024	0.0001	0.0018	0.0949	0.0042	0.0710
0.0048	0.0008	0.0028	0.1898	0.0327	0.1103
0.0072	0.0015	0.0037	0.2847	0.0598	0.1469
0.0096	0.0022	0.0046	0.3796	0.0848	0.1808
0.0121	0.0027	0.0054	0.4745	0.1080	0.2121
0.0145	0.0033	0.0061	0.5694	0.1292	0.2409
0.0169	0.0038	0.0068	0.6643	0.1485	0.2672
0.0193	0.0042	0.0074	0.7592	0.1660	0.2914
0.0217	0.0046	0.0079	0.8541	0.1816	0.3126
0.0241	0.0049	0.0084	0.9491	0.1944	0.3304
0.0265	0.0052	0.0087	1.0440	0.2038	0.3439
0.0289	0.0053	0.0090	1.1389	0.2096	0.3531
0.0313	0.0054	0.0091	1.2338	0.2109	0.3569
0.0337	0.0053	0.0091	1.3287	0.2092	0.3570
0.0362	0.0052	0.0090	1.4236	0.2055	0.3543
0.0386	0.0051	0.0088	1.5185	0.1992	0.3482
0.0410	0.0049	0.0086	1.6134	0.1912	0.3392
0.0434	0.0046	0.0083	1.7083	0.1824	0.3284
0.0458	0.0044	0.0080	1.8032	0.1727	0.3158
0.0482	0.0041	0.0077	1.8981	0.1621	0.3014
0.0506	0.0038	0.0072	1.9930	0.1506	0.2852
0.0530	0.0035	0.0068	2.0879	0.1382	0.2671
0.0554	0.0032	0.0063	2.1828	0.1250	0.2470
0.0579	0.0028	0.0057	2.2777	0.1108	0.2251
0.0603	0.0024	0.0051	2.3726	0.0957	0.2013
0.0627	0.0020	0.0045	2.4675	0.0797	0.1756
0.0651	0.0016	0.0038	2.5624	0.0626	0.1478
0.0675	0.0011	0.0030	2.6573	0.0446	0.1180
0.0699	0.0007	0.0022	2.7522	0.0256	0.0862
0.0723	0.0001	0.0013	2.8472	0.0056	0.0523
0.0747	-0.0004	0.0004	2.9421	-0.0154	0.0162

RADIUS (METERS) = 0.2318	RADIUS (INCHES) = 9.1251
CHORD (METERS) = 0.0747	CHORD (INCHES) = 2.9421
ZCSL (METERS) = 0.0366	ZCSL (INCHES) = 1.4407
YCSL (METERS) = 0.0052	YCSL (INCHES) = 0.2055
RLE (METERS) =0.000224	RLE (INCHES) = 0.0088
RTE (METERS) =0.000414	RTE (INCHES) = 0.0163
X-AREA(SQ.METERS)=0.000215	X-AREA (SQ. IN.) = 0.3335
GAMMA-CHORD(RAD.)= 0.4980	GAMMA-CHORD(DEG.)= 28.54

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0060	0.0093
0.0024	0.0001	0.0018	0.0950	0.0033	0.0713
0.0048	0.0008	0.0028	0.1899	0.0312	0.1103
0.0072	0.0015	0.0037	0.2849	0.0578	0.1467
0.0096	0.0021	0.0046	0.3798	0.0824	0.1803
0.0121	0.0027	0.0054	0.4747	0.1051	0.2114
0.0145	0.0032	0.0061	0.5697	0.1258	0.2400
0.0169	0.0037	0.0068	0.6647	0.1446	0.2660
0.0193	0.0041	0.0074	0.7596	0.1617	0.2899
0.0217	0.0045	0.0079	0.8546	0.1769	0.3109
0.0241	0.0048	0.0083	0.9495	0.1893	0.3285
0.0265	0.0050	0.0087	1.0444	0.1983	0.3418
0.0289	0.0052	0.0089	1.1394	0.2039	0.3510
0.0314	0.0052	0.0090	1.2344	0.2050	0.3548
0.0338	0.0052	0.0090	1.3293	0.2032	0.3550
0.0362	0.0051	0.0089	1.4242	0.1994	0.3523
0.0386	0.0049	0.0088	1.5192	0.1930	0.3461
0.0410	0.0047	0.0086	1.6142	0.1849	0.3371
0.0434	0.0045	0.0083	1.7091	0.1760	0.3262
0.0458	0.0042	0.0080	1.8041	0.1663	0.3136
0.0482	0.0040	0.0076	1.8990	0.1558	0.2993
0.0506	0.0037	0.0072	1.9939	0.1445	0.2831
0.0531	0.0034	0.0067	2.0889	0.1324	0.2650
0.0555	0.0030	0.0062	2.1838	0.1194	0.2452
0.0579	0.0027	0.0057	2.2788	0.1057	0.2235
0.0603	0.0023	0.0051	2.3737	0.0910	0.1998
0.0627	0.0019	0.0044	2.4687	0.0755	0.1743
0.0651	0.0015	0.0037	2.5636	0.0591	0.1469
0.0675	0.0011	0.0030	2.6586	0.0417	0.1174
0.0699	0.0006	0.0022	2.7535	0.0235	0.0859
0.0724	0.0001	0.0013	2.8485	0.0043	0.0524
0.0748	-0.0004	0.0004	2.9434	-0.0158	0.0167

RADIUS (METERS) = 0.2377	RADIUS (INCHES) = 9.3592
CHORD (METERS) = 0.0748	CHORD (INCHES) = 2.9434
ZCSL (METERS) = 0.0367	ZCSL (INCHES) = 1.4439
YCSL (METERS) = 0.0051	YCSL (INCHES) = 0.2024
RLE (METERS) =0.000228	RLE (INCHES) = 0.0090
RTE (METERS) =0.000427	RTE (INCHES) = 0.0168
X-AREA(SQ.METERS)=0.000221	X-AREA (SQ. IN.) = 0.3424
GAMMA-CHORD(RAD.)= 0.4979	GAMMA-CHORD(DEG.)= 28.53

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS ZC	METERS YP	METERS YS	INCHES ZC	INCHES YP	INCHES YS
0.0	-0.0002	0.0002	0.0	-0.0060	0.0094
0.0024	0.0001	0.0018	0.0950	0.0023	0.0715
0.0048	0.0008	0.0028	0.1900	0.0297	0.1103
0.0072	0.0014	0.0037	0.2850	0.0557	0.1464
0.0097	0.0020	0.0046	0.3800	0.0799	0.1798
0.0121	0.0026	0.0053	0.4750	0.1020	0.2105
0.0145	0.0031	0.0061	0.5700	0.1222	0.2388
0.0169	0.0036	0.0067	0.6650	0.1405	0.2646
0.0193	0.0040	0.0073	0.7599	0.1571	0.2882
0.0217	0.0044	0.0078	0.8550	0.1718	0.3089
0.0241	0.0047	0.0083	0.9499	0.1837	0.3263
0.0265	0.0049	0.0086	1.0449	0.1926	0.3396
0.0290	0.0050	0.0089	1.1399	0.1982	0.3489
0.0314	0.0051	0.0090	1.2349	0.1998	0.3533
0.0338	0.0050	0.0090	1.3299	0.1985	0.3541
0.0362	0.0050	0.0089	1.4249	0.1951	0.3518
0.0386	0.0048	0.0088	1.5199	0.1884	0.3456
0.0410	0.0046	0.0085	1.6149	0.1800	0.3363
0.0434	0.0043	0.0083	1.7099	0.1709	0.3252
0.0458	0.0041	0.0079	1.8049	0.1610	0.3124
0.0483	0.0038	0.0076	1.8999	0.1504	0.2979
0.0507	0.0035	0.0072	1.9949	0.1392	0.2815
0.0531	0.0032	0.0067	2.0899	0.1271	0.2635
0.0555	0.0029	0.0062	2.1849	0.1144	0.2436
0.0579	0.0026	0.0056	2.2799	0.1008	0.2219
0.0603	0.0022	0.0050	2.3749	0.0865	0.1984
0.0627	0.0018	0.0044	2.4698	0.0714	0.1730
0.0651	0.0014	0.0037	2.5648	0.0555	0.1457
0.0676	0.0010	0.0030	2.6598	0.0388	0.1165
0.0700	0.0005	0.0022	2.7548	0.0214	0.0854
0.0724	0.0001	0.0013	2.8498	0.0030	0.0523
0.0748	-0.0004	0.0004	2.9448	-0.0161	0.0171

RADIUS (METERS)	= 0.2436	RADIUS (INCHES)	= 9.5895
CHORD (METERS)	= 0.0748	CHORD (INCHES)	= 2.9448
ZCSL (METERS)	= 0.0367	ZCSL (INCHES)	= 1.4463
YCSL (METERS)	= 0.0051	YCSL (INCHES)	= 0.1996
RLE (METERS)	=0.000231	RLE (INCHES)	= 0.0091
RTE (METERS)	=0.000438	RTE (INCHES)	= 0.0173
X-AREA(SQ.METERS)	=0.000227	X-AREA (SQ. IN.)	= 0.3511
GAMMA-CHORD(RAD.)	= 0.5007	GAMMA-CHORD(DEG.)	= 28.69

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0061	0.0095
0.0024	0.0000	0.0018	0.0950	0.0011	0.0717
0.0048	0.0007	0.0028	0.1901	0.0279	0.1101
0.0072	0.0014	0.0037	0.2851	0.0533	0.1458
0.0097	0.0020	0.0045	0.3801	0.0769	0.1789
0.0121	0.0025	0.0053	0.4752	0.0984	0.2092
0.0145	0.0030	0.0060	0.5702	0.1180	0.2371
0.0169	0.0034	0.0067	0.6652	0.1358	0.2625
0.0193	0.0039	0.0073	0.7603	0.1517	0.2857
0.0217	0.0042	0.0078	0.8553	0.1658	0.3061
0.0241	0.0045	0.0082	0.9503	0.1773	0.3232
0.0266	0.0047	0.0085	1.0454	0.1859	0.3366
0.0290	0.0049	0.0088	1.1404	0.1915	0.3461
0.0314	0.0049	0.0089	1.2354	0.1936	0.3512
0.0338	0.0049	0.0090	1.3305	0.1929	0.3527
0.0362	0.0048	0.0089	1.4255	0.1898	0.3509
0.0386	0.0047	0.0088	1.5205	0.1833	0.3448
0.0410	0.0044	0.0085	1.6156	0.1748	0.3355
0.0434	0.0042	0.0082	1.7106	0.1657	0.3244
0.0459	0.0040	0.0079	1.8056	0.1558	0.3115
0.0483	0.0037	0.0075	1.9007	0.1452	0.2968
0.0507	0.0034	0.0071	1.9957	0.1340	0.2804
0.0531	0.0031	0.0067	2.0907	0.1220	0.2623
0.0555	0.0028	0.0062	2.1858	0.1094	0.2424
0.0579	0.0024	0.0056	2.2808	0.0961	0.2207
0.0603	0.0021	0.0050	2.3758	0.0821	0.1973
0.0628	0.0017	0.0044	2.4709	0.0675	0.1721
0.0652	0.0013	0.0037	2.5659	0.0522	0.1449
0.0676	0.0009	0.0029	2.6609	0.0361	0.1160
0.0700	0.0005	0.0022	2.7560	0.0192	0.0851
0.0724	0.0000	0.0013	2.8510	0.0016	0.0522
0.0748	-0.0004	0.0004	2.9460	-0.0167	0.0174

RADIUS (METERS)	= 0.2493	RADIUS (INCHES)	= 9.8157
CHORD (METERS)	= 0.0748	CHORD (INCHES)	= 2.9460
ZCSL (METERS)	= 0.0368	ZCSL (INCHES)	= 1.4491
YCSL (METERS)	= 0.0050	YCSL (INCHES)	= 0.1966
RLE (METERS)	=0.000238	RLE (INCHES)	= 0.0094
RTE (METERS)	=0.000452	RTE (INCHES)	= 0.0178
X-AREA(SQ.METERS)	=0.000233	X-AREA (SQ. IN.)	= 0.3604
GAMMA-CHORD(RAD.)	= 0.5078	GAMMA-CHORD(DEG.)	= 29.10

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0002	0.0	-0.0062	0.0098
0.0024	-0.0000	0.0018	0.0951	-0.0003	0.0716
0.0048	0.0006	0.0028	0.1901	0.0256	0.1093
0.0072	0.0013	0.0037	0.2852	0.0502	0.1444
0.0097	0.0019	0.0045	0.3802	0.0728	0.1768
0.0121	0.0024	0.0052	0.4753	0.0936	0.2066
0.0145	0.0029	0.0059	0.5704	0.1125	0.2339
0.0169	0.0033	0.0066	0.6654	0.1295	0.2586
0.0193	0.0037	0.0071	0.7605	0.1446	0.2812
0.0217	0.0040	0.0076	0.8555	0.1579	0.3011
0.0241	0.0043	0.0081	0.9506	0.1688	0.3179
0.0266	0.0045	0.0084	1.0456	0.1772	0.3312
0.0290	0.0046	0.0087	1.1407	0.1828	0.3408
0.0314	0.0047	0.0088	1.2358	0.1855	0.3466
0.0338	0.0047	0.0089	1.3308	0.1857	0.3490
0.0362	0.0047	0.0088	1.4259	0.1834	0.3479
0.0386	0.0045	0.0087	1.5210	0.1775	0.3425
0.0410	0.0043	0.0085	1.6160	0.1695	0.3338
0.0435	0.0041	0.0082	1.7111	0.1606	0.3231
0.0459	0.0038	0.0079	1.8061	0.1507	0.3103
0.0483	0.0036	0.0075	1.9012	0.1399	0.2954
0.0507	0.0033	0.0071	1.9963	0.1286	0.2789
0.0531	0.0030	0.0066	2.0913	0.1166	0.2606
0.0555	0.0026	0.0061	2.1864	0.1041	0.2407
0.0579	0.0023	0.0056	2.2814	0.0911	0.2191
0.0604	0.0020	0.0050	2.3765	0.0775	0.1957
0.0628	0.0016	0.0043	2.4715	0.0633	0.1707
0.0652	0.0012	0.0037	2.5666	0.0485	0.1438
0.0676	0.0008	0.0029	2.6617	0.0330	0.1151
0.0700	0.0004	0.0021	2.7567	0.0169	0.0846
0.0724	0.0000	0.0013	2.8518	0.0003	0.0522
0.0748	-0.0004	0.0005	2.9468	-0.0171	0.0178

RADIUS (METERS) = 0.2550	RADIUS (INCHES) =10.0379
CHORD (METERS) = 0.0748	CHORD (INCHES) = 2.9468
ZCSL (METERS) = 0.0369	ZCSL (INCHES) = 1.4514
YCSL (METERS) = 0.0049	YCSL (INCHES) = 0.1925
RLE (METERS) =0.000245	RLE (INCHES) = 0.0097
RTE (METERS) =0.000465	RTE (INCHES) = 0.0183
X-AREA(SQ.METERS)=0.000238	X-AREA (SQ. IN.) = 0.3688
GAMMA-CHORD(RAD.)= 0.5199	GAMMA-CHORD(DEG.)= 29.79

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0062	0.0100
0.0024	-0.0000	0.0018	0.0951	-0.0018	0.0713
0.0048	0.0006	0.0027	0.1902	0.0231	0.1082
0.0072	0.0012	0.0036	0.2852	0.0467	0.1425
0.0097	0.0017	0.0044	0.3803	0.0684	0.1741
0.0121	0.0022	0.0052	0.4754	0.0882	0.2032
0.0145	0.0027	0.0058	0.5705	0.1062	0.2297
0.0169	0.0031	0.0064	0.6655	0.1223	0.2539
0.0193	0.0035	0.0070	0.7606	0.1366	0.2757
0.0217	0.0038	0.0075	0.8557	0.1490	0.2949
0.0241	0.0040	0.0079	0.9507	0.1593	0.3113
0.0266	0.0042	0.0082	1.0458	0.1672	0.3242
0.0290	0.0044	0.0085	1.1409	0.1726	0.3337
0.0314	0.0045	0.0086	1.2360	0.1755	0.3397
0.0338	0.0045	0.0087	1.3310	0.1760	0.3425
0.0362	0.0044	0.0087	1.4261	0.1741	0.3419
0.0386	0.0043	0.0086	1.5212	0.1689	0.3372
0.0411	0.0041	0.0084	1.6163	0.1616	0.3292
0.0435	0.0039	0.0081	1.7114	0.1533	0.3191
0.0459	0.0036	0.0078	1.8064	0.1436	0.3066
0.0483	0.0034	0.0074	1.9015	0.1330	0.2917
0.0507	0.0031	0.0070	1.9966	0.1218	0.2752
0.0531	0.0028	0.0065	2.0917	0.1101	0.2571
0.0555	0.0025	0.0060	2.1867	0.0980	0.2374
0.0580	0.0022	0.0055	2.2818	0.0854	0.2160
0.0604	0.0018	0.0049	2.3769	0.0723	0.1930
0.0628	0.0015	0.0043	2.4719	0.0587	0.1683
0.0652	0.0011	0.0036	2.5670	0.0444	0.1418
0.0676	0.0008	0.0029	2.6621	0.0298	0.1135
0.0700	0.0004	0.0021	2.7572	0.0146	0.0835
0.0724	-0.0000	0.0013	2.8523	-0.0011	0.0518
0.0749	-0.0004	0.0005	2.9473	-0.0174	0.0181

RADIUS (METERS)	= 0.2605	RADIUS (INCHES)	=10.2555
CHORD (METERS)	= 0.0749	CHORD (INCHES)	= 2.9473
ZCSL (METERS)	= 0.0369	ZCSL (INCHES)	= 1.4524
YCSL (METERS)	= 0.0047	YCSL (INCHES)	= 0.1870
RLE (METERS)	=0.000251	RLE (INCHES)	= 0.0099
RTE (METERS)	=0.000475	RTE (INCHES)	= 0.0187
X-AREA(SQ.METERS)	=0.000243	X-AREA (SQ. IN.)	= 0.3760
GAMMA-CHORD(RAD.)	= 0.5341	GAMMA-CHORD(DEG.)	= 30.60

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0064	0.0100
0.0024	-0.0001	0.0018	0.0951	-0.0032	0.0710
0.0048	0.0005	0.0027	0.1901	0.0208	0.1073
0.0072	0.0011	0.0036	0.2852	0.0436	0.1408
0.0097	0.0016	0.0044	0.3803	0.0644	0.1718
0.0121	0.0021	0.0051	0.4754	0.0833	0.2002
0.0145	0.0026	0.0057	0.5704	0.1004	0.2261
0.0169	0.0029	0.0063	0.6655	0.1158	0.2496
0.0193	0.0033	0.0069	0.7606	0.1293	0.2708
0.0217	0.0036	0.0074	0.8556	0.1409	0.2895
0.0241	0.0038	0.0078	0.9507	0.1505	0.3054
0.0266	0.0040	0.0081	1.0458	0.1579	0.3181
0.0290	0.0041	0.0083	1.1409	0.1630	0.3275
0.0314	0.0042	0.0085	1.2359	0.1659	0.3337
0.0338	0.0042	0.0086	1.3310	0.1666	0.3366
0.0362	0.0042	0.0085	1.4261	0.1651	0.3364
0.0386	0.0041	0.0084	1.5211	0.1607	0.3324
0.0411	0.0039	0.0083	1.6162	0.1543	0.3251
0.0435	0.0037	0.0080	1.7113	0.1466	0.3156
0.0459	0.0035	0.0077	1.8063	0.1372	0.3034
0.0483	0.0032	0.0073	1.9014	0.1267	0.2886
0.0507	0.0029	0.0069	1.9965	0.1157	0.2722
0.0531	0.0026	0.0065	2.0916	0.1043	0.2542
0.0555	0.0023	0.0060	2.1866	0.0925	0.2347
0.0580	0.0020	0.0054	2.2817	0.0802	0.2135
0.0604	0.0017	0.0048	2.3768	0.0675	0.1907
0.0628	0.0014	0.0042	2.4718	0.0544	0.1662
0.0652	0.0010	0.0036	2.5669	0.0409	0.1402
0.0676	0.0007	0.0029	2.6620	0.0269	0.1124
0.0700	0.0003	0.0021	2.7570	0.0126	0.0828
0.0724	-0.0001	0.0013	2.8521	-0.0023	0.0516
0.0749	-0.0004	0.0005	2.9472	-0.0176	0.0185

RADIUS (METERS)	= 0.2660	RADIUS (INCHES)	=10.4709
CHORD (METERS)	= 0.0749	CHORD (INCHES)	= 2.9472
ZCSL (METERS)	= 0.0369	ZCSL (INCHES)	= 1.4531
YCSL (METERS)	= 0.0046	YCSL (INCHES)	= 0.1820
RLE (METERS)	=0.000255	RLE (INCHES)	= 0.0100
RTE (METERS)	=0.000484	RTE (INCHES)	= 0.0190
X-AREA(SQ.METERS)	=0.000247	X-AREA (SQ. IN.)	= 0.3832
GAMMA-CHORD(RAD.)	= 0.5476	GAMMA-CHORD(DEG.)	= 31.37

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0067	0.0101
0.0024	-0.0001	0.0018	0.0950	-0.0045	0.0709
0.0048	0.0005	0.0027	0.1901	0.0187	0.1065
0.0072	0.0010	0.0035	0.2851	0.0408	0.1395
0.0097	0.0015	0.0043	0.3802	0.0609	0.1700
0.0121	0.0020	0.0050	0.4753	0.0791	0.1979
0.0145	0.0024	0.0057	0.5703	0.0956	0.2234
0.0169	0.0028	0.0063	0.6653	0.1101	0.2464
0.0193	0.0031	0.0068	0.7604	0.1230	0.2671
0.0217	0.0034	0.0072	0.8554	0.1341	0.2854
0.0241	0.0036	0.0076	0.9505	0.1431	0.3009
0.0266	0.0038	0.0080	1.0455	0.1500	0.3133
0.0290	0.0039	0.0082	1.1406	0.1548	0.3224
0.0314	0.0040	0.0083	1.2356	0.1575	0.3285
0.0338	0.0040	0.0084	1.3307	0.1580	0.3314
0.0362	0.0040	0.0084	1.4257	0.1565	0.3311
0.0386	0.0039	0.0083	1.5208	0.1522	0.3273
0.0410	0.0037	0.0081	1.6158	0.1460	0.3202
0.0435	0.0035	0.0079	1.7109	0.1386	0.3109
0.0459	0.0033	0.0076	1.8059	0.1295	0.2990
0.0483	0.0030	0.0072	1.9010	0.1193	0.2845
0.0507	0.0028	0.0068	1.9960	0.1087	0.2685
0.0531	0.0025	0.0064	2.0911	0.0979	0.2508
0.0555	0.0022	0.0059	2.1861	0.0866	0.2316
0.0579	0.0019	0.0054	2.2812	0.0749	0.2109
0.0604	0.0016	0.0048	2.3762	0.0628	0.1884
0.0628	0.0013	0.0042	2.4713	0.0503	0.1643
0.0652	0.0010	0.0035	2.5663	0.0375	0.1386
0.0676	0.0006	0.0028	2.6614	0.0242	0.1112
0.0700	0.0003	0.0021	2.7564	0.0106	0.0821
0.0724	-0.0001	0.0013	2.8515	-0.0034	0.0513
0.0748	-0.0005	0.0005	2.9465	-0.0178	0.0187

RADIUS (METERS) = 0.2714	RADIUS (INCHES) =10.6851
CHORD (METERS) = 0.0748	CHORD (INCHES) = 2.9465
ZCSL (METERS) = 0.0369	ZCSL (INCHES) = 1.4535
YCSL (METERS) = 0.0045	YCSL (INCHES) = 0.1772
RLE (METERS) =0.000263	RLE (INCHES) = 0.0104
RTE (METERS) =0.000493	RTE (INCHES) = 0.0194
X-AREA(SQ.METERS)=0.000252	X-AREA (SQ. IN.) = 0.3904
GAMMA-CHORD(RAD.)= 0.5612	GAMMA-CHORD(DEG.)= 32.15

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0067	0.0102
0.0024	-0.0001	0.0018	0.0950	-0.0055	0.0709
0.0048	0.0004	0.0027	0.1900	0.0169	0.1061
0.0072	0.0010	0.0035	0.2850	0.0383	0.1387
0.0097	0.0015	0.0043	0.3800	0.0578	0.1686
0.0121	0.0019	0.0050	0.4750	0.0755	0.1962
0.0145	0.0023	0.0056	0.5701	0.0913	0.2213
0.0169	0.0027	0.0062	0.6651	0.1053	0.2439
0.0193	0.0030	0.0067	0.7601	0.1176	0.2643
0.0217	0.0033	0.0072	0.8551	0.1283	0.2824
0.0241	0.0035	0.0076	0.9501	0.1368	0.2976
0.0265	0.0036	0.0079	1.0451	0.1433	0.3097
0.0290	0.0038	0.0081	1.1401	0.1479	0.3187
0.0314	0.0038	0.0082	1.2351	0.1503	0.3247
0.0338	0.0038	0.0083	1.3301	0.1507	0.3276
0.0362	0.0038	0.0083	1.4251	0.1491	0.3274
0.0386	0.0037	0.0082	1.5202	0.1449	0.3236
0.0410	0.0035	0.0080	1.6152	0.1388	0.3167
0.0434	0.0033	0.0078	1.7102	0.1316	0.3075
0.0459	0.0031	0.0075	1.8052	0.1228	0.2958
0.0483	0.0029	0.0072	1.9002	0.1130	0.2816
0.0507	0.0026	0.0068	1.9952	0.1028	0.2658
0.0531	0.0023	0.0063	2.0902	0.0922	0.2484
0.0555	0.0021	0.0058	2.1852	0.0814	0.2295
0.0579	0.0018	0.0053	2.2802	0.0702	0.2090
0.0603	0.0015	0.0047	2.3752	0.0586	0.1869
0.0627	0.0012	0.0041	2.4703	0.0467	0.1631
0.0652	0.0009	0.0035	2.5653	0.0344	0.1377
0.0676	0.0006	0.0028	2.6603	0.0218	0.1106
0.0700	0.0002	0.0021	2.7553	0.0089	0.0817
0.0724	-0.0001	0.0013	2.8503	-0.0045	0.0513
0.0748	-0.0005	0.0005	2.9453	-0.0181	0.0190

RADIUS (METERS) = 0.2768	RADIUS (INCHES) =10.8978
CHORD (METERS) = 0.0748	CHORD (INCHES) = 2.9453
ZCSL (METERS) = 0.0369	ZCSL (INCHES) = 1.4539
YCSL (METERS) = 0.0044	YCSL (INCHES) = 0.1734
RLE (METERS) =0.000269	RLE (INCHES) = 0.0106
RTE (METERS) =0.000502	RTE (INCHES) = 0.0198
X-AREA(SQ.METERS)=0.000257	X-AREA (SQ. IN.) = 0.3978
GAMMA-CHORD(RAD.)= 0.5750	GAMMA-CHORD(DEG.)= 32.95

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0068	0.0106
0.0024	-0.0002	0.0018	0.0950	-0.0063	0.0713
0.0048	0.0004	0.0027	0.1899	0.0158	0.1064
0.0072	0.0009	0.0035	0.2849	0.0369	0.1389
0.0096	0.0014	0.0043	0.3798	0.0562	0.1689
0.0121	0.0019	0.0050	0.4748	0.0736	0.1964
0.0145	0.0023	0.0056	0.5697	0.0893	0.2214
0.0169	0.0026	0.0062	0.6647	0.1031	0.2440
0.0193	0.0029	0.0067	0.7597	0.1152	0.2644
0.0217	0.0032	0.0072	0.8546	0.1256	0.2824
0.0241	0.0034	0.0076	0.9496	0.1341	0.2976
0.0265	0.0036	0.0079	1.0445	0.1405	0.3099
0.0289	0.0037	0.0081	1.1395	0.1450	0.3190
0.0314	0.0037	0.0083	1.2344	0.1476	0.3250
0.0338	0.0038	0.0083	1.3294	0.1481	0.3279
0.0362	0.0037	0.0083	1.4244	0.1467	0.3278
0.0386	0.0036	0.0082	1.5193	0.1426	0.3241
0.0410	0.0035	0.0081	1.6143	0.1367	0.3174
0.0434	0.0033	0.0078	1.7092	0.1297	0.3083
0.0458	0.0031	0.0075	1.8042	0.1211	0.2967
0.0482	0.0028	0.0072	1.8991	0.1115	0.2826
0.0507	0.0026	0.0068	1.9941	0.1015	0.2668
0.0531	0.0023	0.0063	2.0891	0.0911	0.2495
0.0555	0.0020	0.0059	2.1840	0.0804	0.2306
0.0579	0.0018	0.0053	2.2790	0.0694	0.2100
0.0603	0.0015	0.0048	2.3739	0.0580	0.1878
0.0627	0.0012	0.0042	2.4689	0.0462	0.1640
0.0651	0.0009	0.0035	2.5638	0.0341	0.1385
0.0675	0.0005	0.0028	2.6588	0.0215	0.1112
0.0699	0.0002	0.0021	2.7538	0.0086	0.0823
0.0724	-0.0001	0.0013	2.8487	-0.0047	0.0516
0.0748	-0.0005	0.0005	2.9437	-0.0182	0.0191

RADIUS (METERS)	= 0.2822	RADIUS (INCHES)	=11.1103
CHORD (METERS)	= 0.0748	CHORD (INCHES)	= 2.9437
ZCSL (METERS)	= 0.0369	ZCSL (INCHES)	= 1.4518
YCSL (METERS)	= 0.0044	YCSL (INCHES)	= 0.1728
RLE (METERS)	=0.000278	RLE (INCHES)	= 0.0109
RTE (METERS)	=0.000506	RTE (INCHES)	= 0.0199
X-AREA(SQ.METERS)	=0.000260	X-AREA (SQ. IN.)	= 0.4037
GAMMA-CHORD(RAD.)	= 0.5862	GAMMA-CHORD(DEG.)	= 33.59

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0069	0.0108
0.0024	-0.0002	0.0018	0.0949	-0.0075	0.0714
0.0048	0.0004	0.0027	0.1898	0.0141	0.1061
0.0072	0.0009	0.0035	0.2847	0.0346	0.1382
0.0096	0.0014	0.0043	0.3795	0.0532	0.1678
0.0121	0.0018	0.0050	0.4744	0.0702	0.1949
0.0145	0.0022	0.0056	0.5693	0.0854	0.2196
0.0169	0.0025	0.0061	0.6642	0.0987	0.2419
0.0193	0.0028	0.0067	0.7591	0.1104	0.2620
0.0217	0.0031	0.0071	0.8540	0.1203	0.2796
0.0241	0.0033	0.0075	0.9488	0.1284	0.2946
0.0265	0.0034	0.0078	1.0437	0.1345	0.3066
0.0289	0.0035	0.0080	1.1386	0.1386	0.3156
0.0313	0.0036	0.0082	1.2335	0.1408	0.3215
0.0337	0.0036	0.0082	1.3284	0.1410	0.3244
0.0362	0.0035	0.0082	1.4233	0.1395	0.3244
0.0386	0.0034	0.0081	1.5182	0.1355	0.3209
0.0410	0.0033	0.0080	1.6131	0.1297	0.3143
0.0434	0.0031	0.0078	1.7079	0.1229	0.3055
0.0458	0.0029	0.0075	1.8028	0.1145	0.2941
0.0482	0.0027	0.0071	1.8977	0.1052	0.2802
0.0506	0.0024	0.0067	1.9926	0.0956	0.2647
0.0530	0.0022	0.0063	2.0875	0.0856	0.2476
0.0554	0.0019	0.0058	2.1824	0.0753	0.2290
0.0578	0.0016	0.0053	2.2772	0.0647	0.2087
0.0603	0.0014	0.0047	2.3721	0.0538	0.1868
0.0627	0.0011	0.0041	2.4670	0.0426	0.1632
0.0651	0.0008	0.0035	2.5619	0.0310	0.1380
0.0675	0.0005	0.0028	2.6568	0.0191	0.1110
0.0699	0.0002	0.0021	2.7517	0.0069	0.0823
0.0723	-0.0001	0.0013	2.8465	-0.0057	0.0518
0.0747	-0.0005	0.0005	2.9414	-0.0186	0.0196

RADIUS (METERS) = 0.2876	RADIUS (INCHES) =11.3222
CHORD (METERS) = 0.0747	CHORD (INCHES) = 2.9414
ZCSL (METERS) = 0.0369	ZCSL (INCHES) = 1.4529
YCSL (METERS) = 0.0043	YCSL (INCHES) = 0.1692
RLE (METERS) =0.000283	RLE (INCHES) = 0.0111
RTE (METERS) =0.000519	RTE (INCHES) = 0.0204
X-AREA(SQ.METERS)=0.000265	X-AREA (SQ. IN.) = 0.4114
GAMMA-CHORD(RAD.)= 0.5985	GAMMA-CHORD(DEG.)= 34.29

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0069	0.0109
0.0024	-0.0002	0.0018	0.0948	-0.0081	0.0720
0.0048	0.0003	0.0027	0.1896	0.0133	0.1067
0.0072	0.0009	0.0035	0.2844	0.0337	0.1389
0.0096	0.0013	0.0043	0.3792	0.0523	0.1686
0.0120	0.0018	0.0050	0.4740	0.0691	0.1958
0.0144	0.0021	0.0056	0.5688	0.0842	0.2207
0.0169	0.0025	0.0062	0.6636	0.0976	0.2432
0.0193	0.0028	0.0067	0.7584	0.1093	0.2635
0.0217	0.0030	0.0071	0.8532	0.1192	0.2813
0.0241	0.0032	0.0075	0.9480	0.1274	0.2965
0.0265	0.0034	0.0078	1.0428	0.1336	0.3088
0.0289	0.0035	0.0081	1.1376	0.1378	0.3179
0.0313	0.0036	0.0082	1.2324	0.1403	0.3241
0.0337	0.0036	0.0083	1.3272	0.1408	0.3272
0.0361	0.0035	0.0083	1.4220	0.1394	0.3272
0.0385	0.0034	0.0082	1.5168	0.1355	0.3238
0.0409	0.0033	0.0081	1.6116	0.1298	0.3172
0.0433	0.0031	0.0078	1.7064	0.1230	0.3084
0.0458	0.0029	0.0075	1.8012	0.1147	0.2970
0.0482	0.0027	0.0072	1.8960	0.1054	0.2831
0.0506	0.0024	0.0068	1.9908	0.0958	0.2675
0.0530	0.0022	0.0064	2.0856	0.0858	0.2503
0.0554	0.0019	0.0059	2.1804	0.0755	0.2315
0.0578	0.0016	0.0054	2.2752	0.0649	0.2110
0.0602	0.0014	0.0048	2.3700	0.0539	0.1889
0.0626	0.0011	0.0042	2.4648	0.0426	0.1651
0.0650	0.0008	0.0035	2.5596	0.0310	0.1395
0.0674	0.0005	0.0029	2.6544	0.0191	0.1122
0.0698	0.0002	0.0021	2.7492	0.0068	0.0832
0.0722	-0.0001	0.0013	2.8440	-0.0058	0.0524
0.0746	-0.0005	0.0005	2.9388	-0.0188	0.0197

RADIUS (METERS)	= 0.2930	RADIUS (INCHES)	=11.5338
CHORD (METERS)	= 0.0746	CHORD (INCHES)	= 2.9388
ZCSL (METERS)	= 0.0369	ZCSL (INCHES)	= 1.4510
YCSL (METERS)	= 0.0043	YCSL (INCHES)	= 0.1701
RLE (METERS)	=0.000286	RLE (INCHES)	= 0.0113
RTE (METERS)	=0.000526	RTE (INCHES)	= 0.0207
X-AREA(SQ.METERS)	=0.000269	X-AREA (SQ. IN.)	= 0.4175
GAMMA-CHORD(RAD.)	= 0.6092	GAMMA-CHORD(DEG.)	= 34.91

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0069	0.0111
0.0024	-0.0002	0.0018	0.0947	-0.0090	0.0722
0.0048	0.0003	0.0027	0.1894	0.0119	0.1067
0.0072	0.0008	0.0035	0.2841	0.0319	0.1387
0.0096	0.0013	0.0043	0.3788	0.0501	0.1681
0.0120	0.0017	0.0050	0.4735	0.0666	0.1951
0.0144	0.0021	0.0056	0.5682	0.0813	0.2197
0.0168	0.0024	0.0061	0.6629	0.0943	0.2420
0.0192	0.0027	0.0067	0.7576	0.1056	0.2621
0.0216	0.0029	0.0071	0.8523	0.1152	0.2798
0.0241	0.0031	0.0075	0.9470	0.1231	0.2949
0.0265	0.0033	0.0078	1.0417	0.1290	0.3069
0.0289	0.0034	0.0080	1.1364	0.1331	0.3160
0.0313	0.0034	0.0082	1.2311	0.1352	0.3221
0.0337	0.0034	0.0083	1.3258	0.1355	0.3251
0.0361	0.0034	0.0083	1.4205	0.1339	0.3252
0.0385	0.0033	0.0082	1.5152	0.1300	0.3218
0.0409	0.0032	0.0080	1.6099	0.1243	0.3153
0.0433	0.0030	0.0078	1.7046	0.1177	0.3066
0.0457	0.0028	0.0075	1.7992	0.1095	0.2954
0.0481	0.0026	0.0072	1.8940	0.1005	0.2816
0.0505	0.0023	0.0068	1.9887	0.0911	0.2662
0.0529	0.0021	0.0063	2.0834	0.0814	0.2492
0.0553	0.0018	0.0059	2.1780	0.0714	0.2305
0.0577	0.0016	0.0053	2.2727	0.0611	0.2103
0.0601	0.0013	0.0048	2.3674	0.0505	0.1883
0.0625	0.0010	0.0042	2.4621	0.0397	0.1646
0.0649	0.0007	0.0035	2.5568	0.0286	0.1392
0.0673	0.0004	0.0028	2.6515	0.0171	0.1121
0.0698	0.0001	0.0021	2.7462	0.0053	0.0833
0.0722	-0.0002	0.0013	2.8409	-0.0067	0.0526
0.0746	-0.0005	0.0005	2.9356	-0.0192	0.0201

RADIUS (METERS) = 0.2983	RADIUS (INCHES) =11.7441
CHORD (METERS) = 0.0746	CHORD (INCHES) = 2.9356
ZCSL (METERS) = 0.0369	ZCSL (INCHES) = 1.4510
YCSL (METERS) = 0.0043	YCSL (INCHES) = 0.1675
RLE (METERS) =0.000290	RLE (INCHES) = 0.0114
RTE (METERS) =0.000536	RTE (INCHES) = 0.0211
X-AREA(SQ.METERS)=0.000274	X-AREA (SQ. IN.) = 0.4244
GAMMA-CHORD(RAD.)= 0.6215	GAMMA-CHORD(DEG.)= 35.61

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0070	0.0112
0.0024	-0.0002	0.0018	0.0946	-0.0097	0.0725
0.0048	0.0003	0.0027	0.1892	0.0108	0.1069
0.0072	0.0008	0.0035	0.2838	0.0305	0.1388
0.0096	0.0012	0.0043	0.3783	0.0485	0.1681
0.0120	0.0016	0.0050	0.4729	0.0647	0.1951
0.0144	0.0020	0.0056	0.5675	0.0792	0.2197
0.0168	0.0023	0.0061	0.6621	0.0921	0.2420
0.0192	0.0026	0.0067	0.7567	0.1033	0.2621
0.0216	0.0029	0.0071	0.8513	0.1129	0.2799
0.0240	0.0031	0.0075	0.9459	0.1206	0.2951
0.0264	0.0032	0.0078	1.0404	0.1265	0.3073
0.0288	0.0033	0.0080	1.1350	0.1305	0.3165
0.0312	0.0034	0.0082	1.2296	0.1328	0.3227
0.0336	0.0034	0.0083	1.3242	0.1331	0.3258
0.0360	0.0033	0.0083	1.4188	0.1317	0.3260
0.0384	0.0032	0.0082	1.5134	0.1278	0.3227
0.0408	0.0031	0.0080	1.6080	0.1221	0.3162
0.0432	0.0029	0.0078	1.7025	0.1155	0.3075
0.0456	0.0027	0.0075	1.7971	0.1074	0.2963
0.0480	0.0025	0.0072	1.8917	0.0983	0.2825
0.0505	0.0023	0.0068	1.9863	0.0890	0.2671
0.0529	0.0020	0.0064	2.0809	0.0794	0.2500
0.0553	0.0018	0.0059	2.1755	0.0695	0.2314
0.0577	0.0015	0.0054	2.2701	0.0593	0.2110
0.0601	0.0012	0.0048	2.3646	0.0489	0.1890
0.0625	0.0010	0.0042	2.4592	0.0382	0.1653
0.0649	0.0007	0.0036	2.5538	0.0272	0.1399
0.0673	0.0004	0.0029	2.6484	0.0160	0.1127
0.0697	0.0001	0.0021	2.7430	0.0045	0.0837
0.0721	-0.0002	0.0013	2.8376	-0.0073	0.0530
0.0745	-0.0005	0.0005	2.9321	-0.0194	0.0204

RADIUS (METERS) = 0.3036	RADIUS (INCHES) =11.9534
CHORD (METERS) = 0.0745	CHORD (INCHES) = 2.9322
ZCSL (METERS) = 0.0368	ZCSL (INCHES) = 1.4501
YCSL (METERS) = 0.0042	YCSL (INCHES) = 0.1668
RLE (METERS) =0.000296	RLE (INCHES) = 0.0117
RTE (METERS) =0.000545	RTE (INCHES) = 0.0215
X-AREA(SQ.METERS)=0.000278	X-AREA (SQ. IN.) = 0.4307
GAMMA-CHORD(RAD.)= 0.6340	GAMMA-CHORD(DEG.)= 36.32

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0072	0.0114
0.0024	-0.0003	0.0018	0.0945	-0.0107	0.0727
0.0048	0.0002	0.0027	0.1889	0.0094	0.1066
0.0072	0.0007	0.0035	0.2834	0.0287	0.1382
0.0096	0.0012	0.0043	0.3778	0.0462	0.1674
0.0120	0.0016	0.0049	0.4723	0.0620	0.1941
0.0144	0.0019	0.0055	0.5667	0.0762	0.2185
0.0168	0.0023	0.0061	0.6612	0.0886	0.2406
0.0192	0.0025	0.0066	0.7557	0.0995	0.2606
0.0216	0.0028	0.0071	0.8501	0.1088	0.2783
0.0240	0.0030	0.0075	0.9446	0.1164	0.2933
0.0264	0.0031	0.0078	1.0390	0.1221	0.3054
0.0288	0.0032	0.0080	1.1335	0.1259	0.3146
0.0312	0.0033	0.0081	1.2280	0.1280	0.3207
0.0336	0.0033	0.0082	1.3224	0.1283	0.3238
0.0360	0.0032	0.0082	1.4169	0.1267	0.3239
0.0384	0.0031	0.0081	1.5113	0.1227	0.3206
0.0408	0.0030	0.0080	1.6058	0.1168	0.3141
0.0432	0.0028	0.0078	1.7003	0.1100	0.3053
0.0456	0.0026	0.0075	1.7947	0.1019	0.2940
0.0480	0.0024	0.0071	1.8892	0.0928	0.2802
0.0504	0.0021	0.0067	1.9836	0.0835	0.2648
0.0528	0.0019	0.0063	2.0781	0.0740	0.2477
0.0552	0.0016	0.0058	2.1726	0.0642	0.2291
0.0576	0.0014	0.0053	2.2670	0.0543	0.2089
0.0600	0.0011	0.0047	2.3615	0.0442	0.1870
0.0624	0.0009	0.0042	2.4559	0.0339	0.1635
0.0648	0.0006	0.0035	2.5504	0.0234	0.1383
0.0672	0.0003	0.0028	2.6448	0.0128	0.1115
0.0696	0.0001	0.0021	2.7393	0.0021	0.0830
0.0720	-0.0002	0.0013	2.8338	-0.0087	0.0527
0.0744	-0.0005	0.0005	2.9282	-0.0197	0.0208

RADIUS (METERS)	= 0.3089	RADIUS (INCHES)	=12.1601
CHORD (METERS)	= 0.0744	CHORD (INCHES)	= 2.9282
ZCSL (METERS)	= 0.0368	ZCSL (INCHES)	= 1.4497
YCSL (METERS)	= 0.0042	YCSL (INCHES)	= 0.1638
RLE (METERS)	=0.000303	RLE (INCHES)	= 0.0119
RTE (METERS)	=0.000557	RTE (INCHES)	= 0.0219
X-AREA(SQ.METERS)	=0.000282	X-AREA (SQ. IN.)	= 0.4370
GAMMA-CHORD(RAD.)	= 0.6486	GAMMA-CHORD(DEG.)	= 37.16

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0073	0.0115
0.0024	-0.0003	0.0018	0.0943	-0.0125	0.0716
0.0048	0.0002	0.0026	0.1886	0.0061	0.1043
0.0072	0.0006	0.0034	0.2829	0.0240	0.1346
0.0096	0.0010	0.0041	0.3772	0.0402	0.1625
0.0120	0.0014	0.0048	0.4715	0.0548	0.1881
0.0144	0.0017	0.0054	0.5658	0.0677	0.2115
0.0168	0.0020	0.0059	0.6601	0.0791	0.2326
0.0192	0.0023	0.0064	0.7544	0.0889	0.2516
0.0216	0.0025	0.0068	0.8487	0.0972	0.2684
0.0240	0.0026	0.0072	0.9431	0.1037	0.2827
0.0263	0.0028	0.0075	1.0374	0.1084	0.2942
0.0287	0.0028	0.0077	1.1317	0.1115	0.3027
0.0311	0.0029	0.0078	1.2260	0.1128	0.3083
0.0335	0.0029	0.0079	1.3203	0.1125	0.3110
0.0359	0.0028	0.0079	1.4146	0.1103	0.3107
0.0383	0.0027	0.0078	1.5089	0.1058	0.3071
0.0407	0.0025	0.0076	1.6032	0.0996	0.3002
0.0431	0.0023	0.0074	1.6975	0.0925	0.2912
0.0455	0.0021	0.0071	1.7918	0.0841	0.2799
0.0479	0.0019	0.0068	1.8861	0.0748	0.2659
0.0503	0.0017	0.0064	1.9804	0.0655	0.2505
0.0527	0.0014	0.0059	2.0747	0.0562	0.2336
0.0551	0.0012	0.0055	2.1690	0.0470	0.2153
0.0575	0.0010	0.0050	2.2633	0.0376	0.1956
0.0599	0.0007	0.0044	2.3576	0.0284	0.1745
0.0623	0.0005	0.0039	2.4519	0.0194	0.1520
0.0647	0.0003	0.0033	2.5462	0.0106	0.1282
0.0671	0.0001	0.0026	2.6405	0.0020	0.1031
0.0695	-0.0002	0.0019	2.7348	-0.0064	0.0766
0.0719	-0.0004	0.0013	2.8292	-0.0140	0.0493
0.0743	-0.0005	0.0005	2.9235	-0.0201	0.0214

RADIUS	(METERS)	= 0.3141	RADIUS	(INCHES)	=12.3648
CHORD	(METERS)	= 0.0743	CHORD	(INCHES)	= 2.9235
ZCSL	(METERS)	= 0.0369	ZCSL	(INCHES)	= 1.4512
YCSL	(METERS)	= 0.0039	YCSL	(INCHES)	= 0.1516
RLE	(METERS)	=0.000310	RLE	(INCHES)	= 0.0122
RTE	(METERS)	=0.000580	RTE	(INCHES)	= 0.0228
X-AREA(SQ.METERS)		=0.000286	X-AREA (SQ. IN.)		= 0.4434
GAMMA-CHORD(RAD.)		= 0.6737	GAMMA-CHORD(DEG.)		= 38.60

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0074	0.0112
0.0024	-0.0004	0.0017	0.0941	-0.0156	0.0687
0.0048	0.0000	0.0025	0.1882	0.0002	0.0987
0.0072	0.0004	0.0032	0.2823	0.0154	0.1263
0.0096	0.0007	0.0039	0.3765	0.0290	0.1517
0.0120	0.0010	0.0044	0.4706	0.0411	0.1750
0.0143	0.0013	0.0050	0.5647	0.0516	0.1960
0.0167	0.0015	0.0055	0.6588	0.0606	0.2150
0.0191	0.0017	0.0059	0.7529	0.0683	0.2321
0.0215	0.0019	0.0063	0.8470	0.0746	0.2470
0.0239	0.0020	0.0066	0.9411	0.0792	0.2598
0.0263	0.0021	0.0069	1.0352	0.0823	0.2698
0.0287	0.0021	0.0070	1.1293	0.0838	0.2770
0.0311	0.0021	0.0071	1.2234	0.0837	0.2814
0.0335	0.0021	0.0072	1.3176	0.0821	0.2832
0.0359	0.0020	0.0072	1.4117	0.0790	0.2822
0.0382	0.0019	0.0071	1.5058	0.0741	0.2784
0.0406	0.0017	0.0069	1.5999	0.0676	0.2715
0.0430	0.0015	0.0067	1.6940	0.0606	0.2628
0.0454	0.0013	0.0064	1.7881	0.0529	0.2521
0.0478	0.0011	0.0061	1.8822	0.0446	0.2392
0.0502	0.0009	0.0057	1.9763	0.0366	0.2250
0.0526	0.0007	0.0053	2.0704	0.0290	0.2098
0.0550	0.0006	0.0049	2.1646	0.0218	0.1933
0.0574	0.0004	0.0045	2.2587	0.0149	0.1758
0.0598	0.0002	0.0040	2.3528	0.0083	0.1571
0.0622	0.0001	0.0035	2.4469	0.0023	0.1373
0.0645	-0.0001	0.0030	2.5410	-0.0033	0.1164
0.0669	-0.0002	0.0024	2.6351	-0.0083	0.0944
0.0693	-0.0003	0.0018	2.7292	-0.0129	0.0713
0.0717	-0.0004	0.0012	2.8233	-0.0169	0.0470
0.0741	-0.0005	0.0005	2.9175	-0.0203	0.0215

RADIUS (METERS) = 0.3192	RADIUS (INCHES) =12.5673
CHORD (METERS) = 0.0741	CHORD (INCHES) = 2.9175
ZCSL (METERS) = 0.0369	ZCSL (INCHES) = 1.4516
YCSL (METERS) = 0.0033	YCSL (INCHES) = 0.1298
RLE (METERS) =0.000312	RLE (INCHES) = 0.0123
RTE (METERS) =0.000589	RTE (INCHES) = 0.0232
X-AREA(SQ.METERS)=0.000289	X-AREA (SQ. IN.) = 0.4480
GAMMA-CHORD(RAD.)= 0.7173	GAMMA-CHORD(DEG.)= 41.10

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0075	0.0109
0.0024	-0.0005	0.0017	0.0939	-0.0181	0.0664
0.0048	-0.0001	0.0024	0.1879	-0.0045	0.0944
0.0072	0.0002	0.0031	0.2818	0.0087	0.1201
0.0095	0.0005	0.0037	0.3758	0.0205	0.1438
0.0119	0.0008	0.0042	0.4698	0.0309	0.1654
0.0143	0.0010	0.0047	0.5637	0.0400	0.1851
0.0167	0.0012	0.0052	0.6577	0.0478	0.2030
0.0191	0.0014	0.0056	0.7516	0.0544	0.2191
0.0215	0.0015	0.0059	0.8456	0.0598	0.2333
0.0239	0.0016	0.0062	0.9395	0.0638	0.2455
0.0263	0.0017	0.0065	1.0335	0.0663	0.2551
0.0286	0.0017	0.0067	1.1274	0.0673	0.2619
0.0310	0.0017	0.0068	1.2214	0.0667	0.2660
0.0334	0.0016	0.0068	1.3153	0.0645	0.2673
0.0358	0.0015	0.0068	1.4093	0.0610	0.2660
0.0382	0.0014	0.0066	1.5032	0.0554	0.2617
0.0406	0.0012	0.0065	1.5972	0.0482	0.2539
0.0430	0.0010	0.0062	1.6911	0.0411	0.2449
0.0453	0.0009	0.0060	1.7851	0.0340	0.2344
0.0477	0.0007	0.0056	1.8790	0.0269	0.2224
0.0501	0.0005	0.0053	1.9730	0.0202	0.2093
0.0525	0.0004	0.0050	2.0669	0.0140	0.1953
0.0549	0.0002	0.0046	2.1609	0.0084	0.1802
0.0573	0.0001	0.0042	2.2548	0.0032	0.1642
0.0597	-0.0000	0.0037	2.3488	-0.0013	0.1473
0.0620	-0.0001	0.0033	2.4427	-0.0054	0.1295
0.0644	-0.0002	0.0028	2.5367	-0.0089	0.1104
0.0668	-0.0003	0.0023	2.6306	-0.0124	0.0900
0.0692	-0.0004	0.0017	2.7246	-0.0156	0.0684
0.0716	-0.0005	0.0012	2.8186	-0.0182	0.0455
0.0740	-0.0005	0.0005	2.9125	-0.0204	0.0215

RADIUS (METERS) = 0.3243 RADIUS (INCHES) =12.7674
CHORD (METERS) = 0.0740 CHORD (INCHES) = 2.9125
ZCSL (METERS) = 0.0368 ZCSL (INCHES) = 1.4479
YCSL (METERS) = 0.0030 YCSL (INCHES) = 0.1168
RLE (METERS) =0.000313 RLE (INCHES) = 0.0123
RTE (METERS) =0.000591 RTE (INCHES) = 0.0233
X-AREA(SQ.METERS)=0.000290 X-AREA (SQ. IN.) = 0.4493
GAMMA-CHORD(RAD.)= 0.7662 GAMMA-CHORD(DEG.)= 43.90

AIRFOIL MANUFACTURING COORDINATES

STATOR

METERS			INCHES		
ZC	YP	YS	ZC	YP	YS
0.0	-0.0002	0.0003	0.0	-0.0076	0.0109
0.0024	-0.0005	0.0017	0.0940	-0.0193	0.0657
0.0048	-0.0002	0.0024	0.1880	-0.0066	0.0928
0.0072	0.0001	0.0030	0.2821	0.0058	0.1176
0.0096	0.0004	0.0036	0.3761	0.0168	0.1405
0.0119	0.0007	0.0041	0.4701	0.0267	0.1616
0.0143	0.0009	0.0046	0.5641	0.0353	0.1807
0.0167	0.0011	0.0050	0.6582	0.0428	0.1982
0.0191	0.0012	0.0054	0.7522	0.0491	0.2139
0.0215	0.0014	0.0058	0.8462	0.0545	0.2281
0.0239	0.0015	0.0061	0.9402	0.0585	0.2401
0.0263	0.0015	0.0063	1.0342	0.0610	0.2495
0.0287	0.0016	0.0065	1.1283	0.0619	0.2562
0.0310	0.0015	0.0066	1.2223	0.0609	0.2598
0.0334	0.0015	0.0066	1.3163	0.0582	0.2605
0.0358	0.0014	0.0066	1.4103	0.0543	0.2587
0.0382	0.0012	0.0065	1.5043	0.0484	0.2541
0.0406	0.0010	0.0062	1.5984	0.0412	0.2461
0.0430	0.0009	0.0060	1.6924	0.0343	0.2370
0.0454	0.0007	0.0058	1.7864	0.0277	0.2268
0.0478	0.0005	0.0055	1.8804	0.0214	0.2155
0.0502	0.0004	0.0052	1.9744	0.0154	0.2031
0.0525	0.0002	0.0048	2.0685	0.0098	0.1897
0.0549	0.0001	0.0045	2.1625	0.0046	0.1753
0.0573	0.0000	0.0041	2.2565	0.0000	0.1599
0.0597	-0.0001	0.0036	2.3505	-0.0042	0.1434
0.0621	-0.0002	0.0032	2.4445	-0.0081	0.1258
0.0645	-0.0003	0.0027	2.5386	-0.0115	0.1071
0.0669	-0.0004	0.0022	2.6326	-0.0146	0.0873
0.0693	-0.0004	0.0017	2.7266	-0.0171	0.0665
0.0716	-0.0005	0.0011	2.8206	-0.0190	0.0446
0.0740	-0.0005	0.0005	2.9146	-0.0205	0.0215

RADIUS (METERS) = 0.3292	RADIUS (INCHES) =12.9608
CHORD (METERS) = 0.0740	CHORD (INCHES) = 2.9147
ZCSL (METERS) = 0.0367	ZCSL (INCHES) = 1.4465
YCSL (METERS) = 0.0028	YCSL (INCHES) = 0.1118
RLE (METERS) =0.000318	RLE (INCHES) = 0.0125
RTE (METERS) =0.000592	RTE (INCHES) = 0.0233
X-AREA(SQ.METERS)=0.000289	X-AREA (SQ. IN.) = 0.4484
GAMMA-CHORD(RAD.)= 0.8131	GAMMA-CHORD(DEG.)= 46.59

APPENDIX F

SYMBOLS AND DEFINITIONS

A - area - meters^2 (inches^2) or location of maximum camber, measured from leading edge

A/A* - ratio of actual area to critical area (where local Mach number is 1.0)

a' - a point on the suction surface of a blade halfway between the leading edge and the point from which a Mach wave emanates that meets the leading edge of the following blade

b - rotor semi-chord at 75 percent of span from root

c - aerodynamic chord along the flow surface - meters (inches)

CDA - controlled diffusion airfoil

D - diffusion factor

for rotor:

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

for stator:

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

D - diameter - meters (inches)

E - excitations per rotor revolution

E - angle between rays drawn to a conical design surface: one ray to the leading edge of an airfoil, the second to some points on the airfoil (see Appendix D)

H - stagnation enthalpy

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
IGV	-	inlet guide vane
$\bar{K}$	-	blockage factor, effective/actual flow area
LE	-	leading edge
LER	-	leading edge airfoil radius - meters (inches)
m	-	unit length along meridional projection of streamline
M	-	Mach number
MCA	-	multiple-circular-arc blade
N	-	rotor speed, rpm
p	-	static pressure, N/m^2 (lbf/ft^2)
P	-	total or stagnation pressure, N/m^2 (lbf/ft^2)
R	-	distance from apex of design conical surface to point on blade - meters (inches)
R_C	-	streamline radius of curvature - meters (inches)
r	-	radius - meters (inches)
s	-	blade spacing
T	-	temperature, K (^oR)
t	-	blade maximum thickness, meters (inches)
TE	-	trailing edge
TER	-	trailing edge airfoil radius - meters (inches)
U	-	rotor tangential speed, m/sec (ft/sec)
V	-	air velocity, m/sec (ft/sec)
W	-	weight flow, kg/sec (lbm/sec)
WA	-	leading edge wedge angle

x conical	-	distance in unwrapped conical plane
Y_p	-	airfoil coordinate of pressure surface normal to chord line
Y_s	-	airfoil coordinate of suction surface normal to chord line
Y_{ccg}	-	vertical distance to airfoil center of gravity from chord line
Y	-	length along calculation station or tangential distance
$Y_{conical}$	-	distance normal to x conical
Z	-	axial distance
Z*ratio	-	shroud modulus/airfoil modulus
Z_c	-	airfoil coordinate parallel to chord line
Z_{ccg}	-	horizontal distance to airfoil center of gravity from leading edge along chord line
β		absolute air angle = COT^{-1} (Vm/V_θ)
β'		relative air angle = COT^{-1} $(V'm/V'_\theta)$
β^*	-	metal angle, angle between tangent to mean camber line and meridional direction
γ	-	blade chord angle, angle between chord and axial direction, or ratio of specific heats
$\delta°$	-	deviation angle - exit air angle minus metal angle at trailing edge
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
θ	-	circumferential direction
λ	-	angle of calculation station measured from axial direction
ρ	-	mass density, kg/m^3 (lbm/ft^3)
σ	-	solidity: ratio of aerodynamic chord to gap between blades; or stress, N/m^2 (lbf/in^2)
ϕ	-	camber angle, difference between blade angles at leading and trailing edges on conical surface
ϕ_E	-	camber angle, difference between blade angles at leading and trailing edges on the unwrapped conical surface
ϕ_f	-	front camber angle, difference between blade angles at leading edge and MCA transition point on the unwrapped conical surface
ψ	-	total amount of chord line twist displacement, degrees (radians)
$\bar{\omega}$	-	total pressure loss coefficient,

$$\frac{P'_1 \left[\frac{T'_2}{T'_1}\right]^{\frac{\gamma}{\gamma-1}} - P'_2}{P'_1 - p_1} \text{ (rotors)}$$

$$\frac{P_3 - P_4}{P_3 - p_3} \text{ (stators)}$$

Subscripts

av	-	average
ad	-	adiabatic
E	-	refers to camber definition which includes angle E

APPENDIX F (Cont'd)

Ef	-	refers to front camber definitions which include epsilon angle E
f	-	front
in	-	inlet
LE	-	leading edge
m	-	meridional (velocity); mean camber line (angle)
o	-	out
p	-	profile (loss); polytropic (efficiency)
ss	-	suction surface
sh	-	shock
t	-	transition
TE	-	trailing edge
z	-	axial component
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

<u>Superscripts</u>

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

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