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SINGLE STAGE, LOW NOISE, ADVANCED TECHNOLOGY FAN

VOLUME I AERODYNAMIC DESIGN

BY: T.J. SULLIVAN, J.L. YOUNGHANS AND D.R. LITTLE

ADVANCED ENGINEERING AND TECHNOLOGY
PROGRAMS DEPARTMENT
GENERAL ELECTRIC COMPANY
CINCINNATI, OHIO

PREPARED FOR

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16. Abstract

The aerodynamic design for a half-scale fan vehicle, which would have application on an advanced transport aircraft, is described. The single stage advanced technology fan was designed to a pressure ratio of 1.8 at a tip speed of 503 m/sec (1650 ft/sec).

The fan and booster components are designed in a scale model flow size convenient for testing with existing facility and vehicle hardware. The design corrected flow per unit annulus area at the fan face is 215 kg/sec m^2 (44.0 lb m/sec ft^2) with a hub-tip ratio of 0.38 at the leading edge of the fan rotor. This results in an inlet corrected airflow of 117.9 kg/sec (259.9 lb m/sec) for the selected rotor tip diameter of 90.37 cm (35.58 in.).

The variable geometry inlet is designed utilizing a combination of high throat Mach number and acoustic treatment in the inlet diffuser for noise suppression (hybrid inlet). A variable fan exhaust nozzle was assumed in conjunction with the variable inlet throat area to limit the required area change of the inlet throat at approach and hence limit the overall diffusion and inlet length.

The fan exit duct design was primarily influenced by acoustic requirements, including length of suppressor wall treatment; length, thickness and position on a duct splitter for additional suppressor treatment; and duct surface Mach numbers.

This report, entitled Volume I - Aerodynamic Design, is one of three in a series of design reports for the advanced technology fan. Other reports in this series include: Volume II - Structural Design and Volume III - Acoustic Design.

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SECTION I

SUMMARY

A high speed, low noise, high bypass ratio single-stage research fan with two booster stages and a variable-geometry inlet has been designed by the General Electric Company under the sponsorship of NASA (Contract No. NAS3-16813). This report, entitled Volume I - Aerodynamic Design, is one of three in a series of design reports for the advanced technology fan. It presents the aerodynamic design of this low radius-ratio fan and booster, and the aerodynamic design of the inlet and bypass exit ducts suitable for an advanced transport aircraft engine. Other reports in this series include: Volume II - Structural Design and Volume III - Acoustic Design, which are References 1 and 2, respectively.

The fan and booster components are designed in a scale-model flow size convenient for testing with existing facility and vehicle hardware. The design corrected flow per unit annulus area at the fan face is 215 kg/sec m^2 (44.0 lbm/sec ft^2) with a hub-tip ratio of 0.38 at the leading edge of the fan rotor. This results in an inlet corrected airflow of 117.9 kg/sec (259.9 lbm/sec) for the selected rotor tip diameter of 90.37 cm (35.58 in.).

The flow splitter is located immediately downstream of the fan rotor separating the fan bypass flow from the core/booster flow. The design bypass ratio is 6:1. The design average total pressure ratio in the bypass duct downstream of the outlet guide vane is 1.80. The core flow has an average pressure ratio of 1.69 at Stator 1 exit and is supercharged by the two booster stages to a pressure ratio of 2.75.

The design corrected rotor tip speed is 503 m/sec (1650 ft/sec) resulting in a tip relative Mach number of 1.64. The 44 medium-high aspect ratio (3.34) blades have an integral tip shroud to provide safe aeromechanical operation at all operating conditions.

The axial spacing between the fan rotor trailing edge and the bypass outlet guide vanes is approximately two rotor tip chords to minimize fan noise generation. The axial spacing is 0.9 rotor hub chord lengths between the rotor hub trailing edge and the core inlet stator leading edge.

The variable-geometry inlet is designed utilizing a combination of high throat Mach number and acoustic treatment in the inlet diffuser, for noise suppression (hybrid inlet). A variable fan exhaust nozzle was assumed in conjunction with the variable inlet throat area to limit the required area change of the inlet throat at approach and hence limit the overall diffusion and inlet length. The inlet selected from the design studies for construction has a length, with a flight lip, of approximately 1.4 fan diameters. The inlet forebody geometry is compatible with a cruise Mach number of 0.90 and consistent with an advanced transport aircraft. The actual hybrid test hardware utilized a modified bellmouth lip rather than a flight lip and the test

inlet with the bellmouth lip actually had a length of approximately 1.5 fan diameters. The purpose of the bellmouth was to simulate flight in-flow conditions during static testing.

The fan exit duct design was primarily influenced by acoustic requirements. The following acoustic requirements were specified: (1) total length of wall treatment, (2) a single splitter, (3) radial position of splitter and the axial location of its leading edge, (4) thickness of acoustic material, and (5) an objective of duct wall and splitter surface Mach number 0.35.

SECTION II

INTRODUCTION

Low noise and exhaust emissions and economical operation are the primary requirements for advanced transport aircraft. The successful development and acceptance of a subsonic, long-range transport for the next generation are greatly dependent upon technological improvements in the areas of fan aerodynamics and acoustic suppression. To help provide this fan technology, the General Electric Company was contracted to design a high speed, low noise, single stage research fan with two booster stages (hereafter referred to as an advanced technology fan), a variable inlet and an acoustically treated fan exit duct, all applicable for an advanced high bypass, low noise engine. To utilize existing hardware and facilities, the subject fan was designed to be half scale.

Under a separate and earlier contract with NASA (Contract NAS3-15544, References 3 and 4), parametric studies were performed to optimize the engine cycle for a typical advanced transport aircraft. Based on these studies, plus the current contract Statement of Work, an engine cycle was selected for an advanced transport designed to cruise between 0.85 and 0.90 Mach number. A fan pressure ratio of 1.8 to 1.9 and a bypass ratio of approximately 6:1 were desirable. Furthermore, it is desirable to raise the pressure ratio of the flow entering the core compressor to about 2.5 to 3.0 by the addition of booster stages. This then provides an overall cycle pressure ratio of 30:1 or greater and still uses only a single-stage turbine to drive the high pressure compressor. Fan tip speeds of 488 to 518 m/sec (1600 to 1700 ft/sec) are required to achieve the desired pressure ratio in a single, low radius ratio stage with adequate stall margin. A high specific flow rate of 215 kg/sec m^2 (44.0 lbm/sec ft^2) was chosen to minimize the fan diameter.

The blade row spacing and vane-to-blade number ratio were other acoustic considerations incorporated in the design of the advanced technology fan. Since the rotor/stator interaction noise is reduced as both the vane/blade ratio and vane-blade spacing are increased, the number of core and bypass outlet guide vanes (OGV) and their distance from the fan rotor blades were selected as high as possible from an aerodynamic and mechanical standpoint. The number of OGV's selected was 90 in the bypass duct and 82 in the core duct for vane/blade ratios of 2.045 and 1.86, respectively. The rotor-bypass OGV spacing, in true rotor tip chords, was set at 2.06 and the rotor-core OGV spacing, in rotor hub chords, was 0.90.

Another acoustic consideration employed in the aerodynamic design of the rotor blading was to have the shock "swallowed" at takeoff speed (92% of design speed) to reduce the multiple pure tone (MPT) noise level at this critical operating condition.

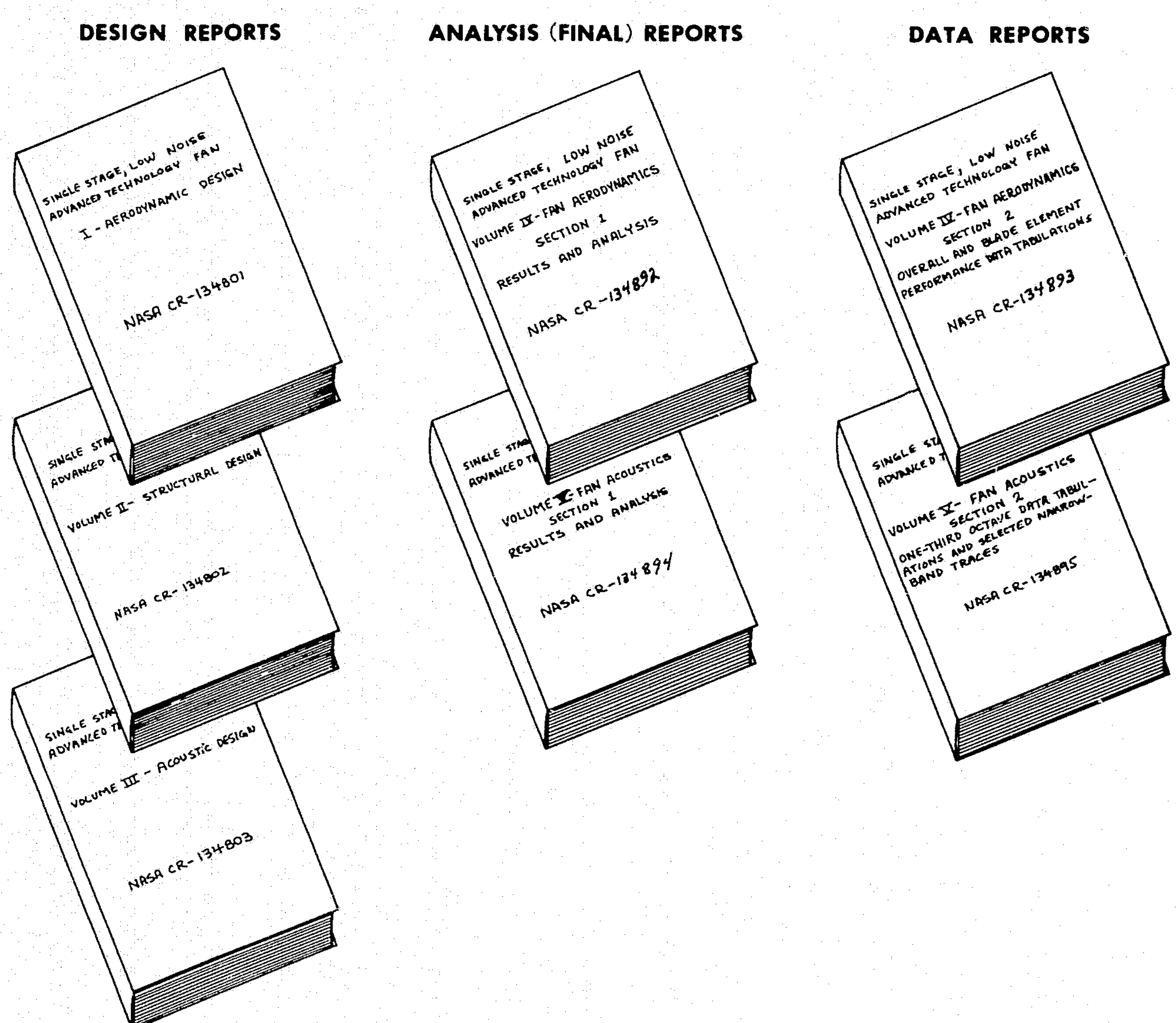
The variable-geometry inlet was designed with 36.4% throat area variability relative to the cruise area position. This provides the capability to induce a relatively high throat Mach number (0.79) at approach, takeoff, and cutback to produce (in conjunction with the acoustic wall treatment) the required inlet suppression. A contoured inlet lip was designed for static testing with the demonstrator fan which will duplicate, during the static testing, the inlet velocity peak that would occur if this inlet was actually flown at the approach and takeoff conditions. The static-test inlet length that results (1.5 fan diameters) is an integration of mechanical, acoustic, and aerodynamic considerations.

The exhaust duct was aerodynamically designed to accommodate the acoustic considerations necessary to meet the ambitious noise goals for the system. Low surface Mach number requirements plus extensive acoustic treatment on the duct walls and on a splitter resulted in a large, long, unconventional flowpath.

The present volume first discusses the aerodynamic design of the fan and booster stages, then the inlet design, and finally the fan exit duct design. Other reports in this series include: Volume II - Structural Design and Volume III - Acoustic Design, which are References 1 and 2, respectively.

A visual representation of the overall program and report organization is shown on the following page.

DESCRIPTION OF ADVANCED TECHNOLOGY FAN REPORTS



SECTION III

FAN AND BOOSTER AERODYNAMIC DESIGN

A. Design Parameters and Flowpath

The significant aerodynamic parameters for the fan and booster are presented in Table I and their flowpath is presented in Figure 1. The flowpath coordinates of the fan and booster design are tabulated in Appendix A. Symbols are defined either in each appendix or in Appendix F. Selection of the parameters in Table I is discussed below.

Table I. Aerodynamic Design Parameters.

Fan	
Corrected Tip Speed	503 m/sec (1650 ft/sec)
Corrected Airflow	117.9 kg/sec (259.9 lbm/sec)
Inlet Specific Flow Rate	215 kg/sec m^2 (44.0 lbm/sec ft^2)
Predicted Stall Margin (Const. Speed)	13%
Objective Adiabatic Efficiency (Bypass)	84%
Bypass Pressure Ratio	1.80
Core Pressure Ratio	1.69
Bypass Ratio	6.0
Inlet Hub/Tip Ratio	0.38
Tip Diameter	90.37 cm 35.58 in.
Rotor Aspect Ratio	3.34
OGV Aspect Ratio	3.94
Rotor Tip/Hub Solidity	1.50/2.74
OGV Tip/Hip Solidity	1.37/2.05

Table I. Aerodynamic Design Parameters (concluded).

Booster	
Corrected Tip Speed	262 m/sec (858 ft/sec)
Corrected Airflow (R2 Inlet)	11 kg/sec (24.0 lbm/sec)
Pressure Ratio	1.63
Predicted Stall Margin (const. speed)	13%
Rotor Aspect Ratio (R2/R3)	2.05/2.02
Rotor Pitchline Solidity (R2/R3)	1.27/1.35
Stator Aspect Ratio (S1/S2/S3)	1.60/1.99/2.20
Stator Pitchline Solidity (S1/S2/S3)	1.52/1.79/1.69

The inlet hub/tip radius ratio of 0.38 and the high specific flow rate of 215 kg/sec m^2 (44.0 lbm/sec ft^2) of inlet annulus area were selected to minimize the required fan size and nacelle diameter. The low inlet radius ratio approaches the practical structural limit for tip shrouded rotor blades at the design tip speed of 503 m/sec (1650 ft/sec) using current titanium alloys. The integral tip shroud was chosen in preference to a part span shroud because of its lower aerodynamic penalty and possible benefits from an acoustic standpoint. A shroud is necessary to provide satisfactory aero-mechanical operation over the entire operating regime for blading aspect ratios compatible with low weight.

The fan rotor inlet tip diameter of 90.37 centimeters (35.58 inches) was selected to permit the use of existing inlet and frame hardware. The selected diameter results in a design point corrected airflow of 117.9 kg/sec (259.9 lbm/sec.).

The flow is split immediately downstream of the rotor, dividing the bypass flow and the booster/core flow by the design bypass ratio of 6:1.

A large axial spacing between the fan rotor and the bypass outlet stator vanes (approximately two rotor tip chords) was provided to minimize turbo-machinery noise generation. The bypass outlet stator vanes were swept 8.5 degrees to provide a constant axial distance between their trailing edges and the swept leading edges of an existing stator casing and rear frame. (Utilizing this existing hardware was later deemed impossible because the required rotor tip axial lengths were incompatible with it.) At their inner ends, the axial distance from the rotor trailing edge is also about two local rotor chord lengths. The axial spacing between the rotor hub and the booster inlet stator is 0.9 rotor hub chord lengths.

The increase in radius across the fan rotor hub was selected to provide a good balance between the Stator 1 hub inlet Mach number, the severity of the "gooseneck" required in the transition duct connecting the booster discharge and the core compressor inlet, and the amount of axial velocity drop across the fan rotor. The hub contour through the fan rotor was made slightly concave in the vicinity of the maximum blade blockage to reduce the peak meridional Mach number and to avoid large diffusion rates on the hub and the adjacent airfoil surfaces.

The flow splitter was contoured similar to a NACA 65-209 airfoil section with the leading edge aligned to provide essentially a zero degree incidence angle relative to the design stagnation streamline. The upper surface followed the airfoil shape for approximately 75% chord or 7.6 cm (3 in.). Small departures from the 65-series airfoil were made on the lower surface of the splitter to improve the meridional Mach number distribution ahead of the stator.

The hub flowpath through the booster stages was made nearly cylindrical to obtain as much hub blade speed as possible and still provide a reasonable transition duct. The booster outlet guide vanes were tilted aft eliminating any significant aerodynamic sweep.

The radial variation of total pressure behind the fan rotor as a function of percent flow from the tip was specified as shown in Figure 2. The values of percent flow for this and other figures can be related to radius and percent immersion by referencing the tabulation of the circumferential-average flow solution appearing in Appendix B. The lower than average tip total pressure was specified to reduce the aerodynamic loading at the tip. The hub pressure ratio was limited by the maximum level of absolute Mach number ($\approx$ 0.85) desired at the core stator inlet to avoid excessive stator losses. An average pressure ratio, behind the rotor, of 1.83 in the bypass portion and 1.73 in the core sector results. The radial variation of rotor adiabatic efficiency resulting from the input total pressure profile and assumed blade loss coefficients is also shown in Figure 2.

The fan rotor total pressure loss coefficients used are shown in Figure 3, as are the calculated diffusion factors. Preliminary test results of the lower aerodynamically loaded 488 m/sec (1600 ft/sec) tip speed stage of Reference 5 became available during the early design phase of the advanced technology fan. These very encouraging test results led to the selection of lower loss coefficients for the outer 50% span than those measured on the 488 m/sec (1600 ft/sec) stage reported in Reference 6 and slightly lower than those measured on the 457 m/sec (1500 ft/sec) tip speed fan reported in Reference 7. The Reference 6 fan had a higher loading than the present design and was designed for a normal shock, rather than an oblique shock. The rather large loss coefficients assumed for the lower 20% of the advanced technology fan blade stemmed from early concern for the effect of the higher than normal through-flow velocity in the hub region where the blade blockage is the greatest.

The booster rotor exit total pressure profiles were selected to be non-uniform radially with the highest pressure at the hub, as shown in Figure 4. This results in a higher velocity in the hub region, which tends to reduce the hub axial diffusion or aerodynamic loading on subsequent blade rows and steepens the slope of the hub characteristic when throttling. Accumulative adiabatic efficiency at the booster rotor exit stations is also shown in Figure 4. The split in total pressure ratio for the two booster rotors was determined from preliminary design studies which assessed the loading capabilities of each stage. Booster loss coefficients and diffusion factors for both rotors and stators were selected based on previous General Electric experience from similar designs and are shown in Figures 5 and 6.

Booster stator 1 was set to reduce the fan hub exit whirl to 20 degrees at the tip and 16 degrees at the hub. The swirl exiting stator 2 is 13 degrees at the tip and 9 degrees at the hub and subsequently is reduced to a radially constant 2 degrees at stator 3 exit. Leaving the small amount of swirl results in a small reduction of the aerodynamic loading on the last stator. The transition duct downstream of the booster contains long chord, fairly high solidity struts which are capable of removing the remaining 2 degrees of swirl. These swirl angle distributions were specified to maintain equally balanced rotor-stator aerodynamic loadings.

The bypass OGV loss coefficients are consistent with previous test experience and with those calculated from an empirical loss model. These coefficients are presented in Figure 7 along with diffusion factors resulting from the final flow solution.

The final design circumferential-average flow solution is tabulated in Appendix B. The calculated circumferential-average meridional Mach numbers and streamlines are superimposed on the fan flowpath in Figure 8. The high design specific flow rate chosen for the advanced technology fan leads to higher than usual meridional Mach numbers at the fan face. Also, the calculated meridional Mach numbers indicate that the rotor hub loss coefficients chosen earlier in the design process may be somewhat pessimistic since the accelerating wall curvature at the rotor hub exit causes the local Mach numbers to be higher than average thus resulting in less hub axial diffusion. The local hub flow aft of the rotor then diffuses somewhat as it approaches the core Stator 1. This was done intentionally to limit the absolute Mach number entering the stator. The peak meridional Mach number of 0.79 occurs at the fan rotor leading edge near the 65 percent design flow streamline.

The calculation procedure utilized to obtain the circumferential-average flow solution is described next.

B. Design Calculation Procedure

Cycle studies resulted in selection of an optimum total-pressure ratio of 1.8, a specific flow rate of 215 kg/sec m^2 (44.0 lbm/sec ft^2) and a bypass ratio of 6.0 for the design of this advanced technology fan. The total flow of 117.9 kg/sec (259.9 lbm/sec) was set such that existing hardware from another advanced research program could be utilized with the selected rotor hub/tip radius ratio of 0.38. The fan and booster flowpath selection was influenced by the desire to reduce rotor/stator interaction noise and thus the blade-to-vane spacing of two rotor tip chords in the outer portion and 0.9 rotor hub chords (approximately) in the core portion was established. With the flowpath, flow rate and operating line total-pressure ratio now determined, the corrected rotor tip speed was calculated by an empirical correlation method consistent with the goal of 13% stall margin (constant speed). The total-pressure loss coefficients were selected as described in Section III.A, above.

The General Electric Compressor Axisymmetric Flow Determination (CAFD) computer program was then employed to determine the circumferential-average aerodynamic design point flow properties for the advanced technology fan and booster vehicle. The calculation procedure of this program is outlined in detail in Reference 8. Briefly, the flow solution is a radial equilibrium solution including the effects of streamline curvature together with gradients of enthalpy and entropy. The velocity vector diagrams and flow conditions for the fan and booster stages were calculated at several streamlines from tip to hub throughout the entire flowpath. The design streamlines are shown in Figure 8. Calculation stations were used at the leading and trailing edges of each blade row and in the upstream and downstream duct areas to assure an accurate representation of the flow. In addition to the leading and trailing edge stations, ten equally spaced calculation stations were located within the fan rotor blade. The intrablade stations, although not included in the Appendix B tabulation, were included to improve the overall accuracy of the flow solution by accounting for detailed effects of blade blockage and radial blade forces as well as the chordwise energy input along each streamline. The location of all the calculation stations is shown in the cross-sectional view of the flowpath in Figure 9.

After the initial calculation pass, several iterations were made on the flowpath contour, loss coefficients and total-pressure distributions to exact the optimum aerodynamic loadings and velocity diagrams for the fan and booster blade rows.

Inspection of the measured static pressure contours of rotor tip sections of high transonic Mach number stages such as is reported in Reference 6 shows that the chordwise distribution of energy addition through the rotor is dependent upon the speed and the degree of throttling. A linear distribution of rV_θ versus percent axial chord length was assumed for the tip streamline of the fan. This is generally consistent with observed test data for operation near the design point. Furthermore, the assumed distribution does not greatly influence the blade shape for a relatively high aspect ratio blade such as the advanced technology fan. For streamlines where the inlet Mach number is not greatly above 1.0, it is believed that, the first quarter cycle of a sine curve more nearly represents the true axial distribution of energy input. Hence, the quarter sine wave distribution was assumed for streamlines 9 through 12 (the hub region). A smooth variation of the rV_θ distribution was used between streamlines 1 and 9 with the 5th streamline being the mean distribution. The distributions of rV_θ are shown in Figure 10. The losses were distributed through the blade such that the blade efficiency varies linearly from the leading edge to the trailing edge at each streamline.

Effective-area coefficients were used at all stations in the axisymmetric flow calculation to account for annulus wall boundary layer displacement thickness and the wakes from upstream blade rows. At the stations through the fan blade, the blockage due to the presence of the rotor blades was also included. The assumed axial distribution and level of effective area coefficients are shown in Figure 11. The coefficient value diminishes from 0.989 at the rotor leading edge to 0.965 at the trailing edge. It then diminishes to 0.940 through the booster and to 0.955 at the fan OGV exit.

C. Blade-to-Blade Flow Analysis

The General Electric Transonic Unsteady Flow Cascade Analysis Program (TUFCAP) was employed to assist in determining the final blade profile shapes. This procedure was developed for the computation of inviscid transonic flow-through turbomachinery cascades. The procedure employs a finite difference solution to the time-dependent fluid dynamic equations. The steady-state solution is obtained asymptotically for large times as a transient solution of the flow field from an arbitrary initial condition. The procedure employs an "artificial viscosity" shock modeling scheme, whereby the shocks appear as rapid, but continuous changes in flow properties over an interval of two to four mesh spacings. This spreading of the shock is necessary to obtain a stable numerical procedure. The procedure includes the effect of streamtube convergence and the change in relative stagnation properties due to changes in streamline radius in a rotating coordinate system.

Since the calculation procedure is inviscid, the effect of losses was taken into account in an approximate manner by modifications to the input streamtube thickness distribution.

D. Airfoil Design

1. Fan Rotor Blade

The fan rotor blade profile shapes were specifically tailored for each streamline section. In the outer portion of the blade, where the inlet Mach number is supersonic, the profiles were shaped so as to attempt to minimize shock losses. In the hub region where the relative Mach numbers are subsonic, profiles similar to a double-circular arc were used.

The considerations which guide and influence the design of high transonic Mach Number cascades are presented and discussed in References 18, 8, and 9. Relative Mach Numbers at design for the advanced technology fan rotor are shown in Figure 12. For the blade inlet region, which establishes the maximum flow the cascade can pass, provided the throat is not limiting, the suction surface was offset a small amount from the "free-flow" streamline to account for the finite leading edge thickness bow-wave loss, and surface boundary layer growth. The flowfield which would exist if there were no disturbances of blade forces defines the "free-flow" streamline. Figure 13 shows the location of the "free-flow" streamline relative to the blade suction surface for a streamline near the tip. The average angle which the "free-flow" streamline makes with the blade suction surface in the region ahead of the first captured Mach wave is the suction surface incidence angle, calculated in this case to be a negative 0.3 degrees. Other streamline sections in the tip region have comparably small negative suction surface incidence angles. These angles are in the order of magnitude of general practice since boundary layer growth along the suction surface will give an effective surface that is a negative incidence with respect to the physical blade surface. Other information shown in Figure 13 will be discussed in the following paragraphs.

The passage throat area in the outer portion represents a compromise among the desires to have as small a throat area as possible to help achieve design speed efficiency, to provide sufficient throat area to assure a "started" mode of operation at takeoff speed (92% of design speed) and thusly to permit acceptable aerodynamic and acoustic performance at part-speed operating conditions. The fan rotor throat-to-capture area ratios were selected to give approximately 6% margin above the critical area ratio after allowances for losses equal to those of a normal shock at the upstream Mach number. The values of throat-to-capture area ratios are plotted versus inlet Mach number in Figure 14. The change in choke flow area that occurs along a streamline as a result of a change in radius in the rotating coordinate system is accounted for. It should be noted that for supersonic flow, the capture area is generally different from the mouth area as shown by the sketches in Figures 13 and 14.

The throat location for the sections near the tip was positioned near the exit of the covered passage as it is expected that these sections will operate with an oblique leading edge shock drawn well back into the passage. The passage exit area was set as close to the throat value as practical while still satisfying conventional deviation angle rules. This was done to prevent reacceleration of supersonic flow from the throat to the passage exit and then incurring a stronger than necessary shock at the passage exit.

The profile maximum thickness was located at 70% chord at the tip to facilitate positioning the throat well aft in the passage and to avoid accelerating surface curvatures ahead of the anticipated location of the intersection of the leading edge shock with the suction surface. In order to achieve this, the thickness in the leading edge region was maintained as thin as is structurally acceptable, then building to the maximum thickness at 70% chord and then thinning out rapidly in the last 30% chord. The point of maximum thickness moves forward at lower radii until the hub streamlines (lower 12.5% flow) are reached where the maximum thickness occurs at 50% chord. For these hub streamline sections, the thickness varies from leading edge to maximum thickness according to a quarter sine wave distribution and then reverses in a mirror image from the point of maximum thickness to the trailing edge.

It is expected that the leading edge shock (not shown on Figures 13 and 14) will become progressively less oblique for sections removed from the tip where the inlet Mach number is smaller. Consequently, both the throat location and the point of maximum profile thickness move forward as the inlet Mach number decreases. For the lower part of the blade, the throat was located near the cascade mouth and a smooth diverging passage area was provided for subsonic diffusion from the throat to the exit.

The blade trailing edge angle was established by applying a deviation angle to the circumferential-average relative flow angle at the blade exit. The deviation angle was calculated using a modified form of Carter's Rule for circular arc meanlines and then adding an empirical adjustment. An equivalent two-dimensional cascade having the same circulation as the actual cascade was defined as presented in Reference 8. The deviation angle of the equivalent cascade was then calculated using Carter's Rule. The empirical adder is approximately zero in the outer half of the blade increasing to 6 degrees at the hub.

The meanline incidence angles for the outer portion of the blade were largely determined by suction surface flow induction considerations. The incidence angles in the lower portion of the blade were selected consistent with past successful practice and were influenced by throat area considerations.

The radial distribution of incidence angle, Carter's rule deviation angle and the adjusted deviation angle are shown in Figure 15. The resulting meanline blade angles for all streamline sections are shown in Figure 16.

The final blade shape for Streamline 2 (SL2) was shown in Figure 13. The free-flow streamline, the first captured Mach wave from the suction surface, the approximate suction surface Mach number, the passage area distribution referenced to the mouth area and throat location are also shown. On the graph, the passage area distribution (Passage Area/Mouth Area) is read at the midpoint of the passage from the mouth (Area Ratio = 1.0) to the exit of the covered portion. The suction surface Mach number plot also superimposed in Figure 13 is read where the vertical scale intersects the suction surface of the blade.

In order to establish operation with an oblique leading edge shock, the ratio of the contraction from the cascade mouth to the throat must not exceed the critical contraction ratio including normal shock losses at the mouth Mach number. The amount by which the passage area exceeds the limiting contraction ratio is referred to as "starting margin". The mouth Mach number was obtained from a one-dimensional isentropic Mach number change in going from the inlet, or capture area, to the cascade mouth area. The change in streamtube contraction and the effect of a radius change in the rotating coordinate system were accounted for. The calculated internal contraction ratio for each streamline section is plotted versus mouth Mach number in Figure 17.

To calculate the speed at which the blade is operating in a "started" condition, it was assumed that Streamline 5 (40% flow) was representative of the average of the portion of the blade which operates with supersonic inlet conditions at the design point. It was further assumed that the radial distribution of flow at the rotor inlet and the streamtube contraction remained the same at the design condition as when the stage is operated at part speed and sufficiently unthrottled such that Streamline 5 operates as its design flow coefficient, V_Z/U, and hence, at its design inlet air angle. It can only do this if the cascade throat is not limiting the flow.

With these assumptions, V_Z is proportional to speed, and it is a simple calculation to define the inlet relative Mach number for Streamline 5 as a function of percent design speed.

The design internal contraction (throat-to-mouth area ratio) for Streamline 5 is 0.9563 (Figure 17). For zero starting margin, a started mode of operation can theoretically be established at a mouth Mach number of 1.304. A cross plot of the calculated mouth Mach number as a function of percent design speed indicates that Streamline 5 reaches this Mach number at 86.1% speed. However, bow-wave losses and blade boundary layer growth are not separately accounted for and margin allowances must be made. Experience with the other similar stages (Reference 6) indicates that these, and perhaps additional differences, require approximately 2% margin. If the throat-to-mouth area ratio is reduced 2%, this raises the mouth Mach number required to establish a started mode of operation to 1.39. This Mach number will occur at 92.6% design speed or approximately takeoff speed, for the conditions assumed.

A tabulation of the final blade camber, stagger and maximum thickness to chord ratio for manufacturing sections on a plane surface is contained in Appendix C. The blade and vane coordinates for several manufacturing sections are tabulated in Appendix D.

The blade-to-blade flow analysis program (TUFCAP), described in Section III C. above, was used to analyze the flowfield around preliminary blade sections for Streamlines 2 and 6. The results of this analysis were used as a guide in determining the final profile shapes. An isobar plot of the calculated flowfield for Streamline 2 and the final blade section is presented in Figure 18. To approximately account for losses, the streamtube thickness distribution for Streamline 2 was reduced about 3% in the throat area and about 6.8% at the blade trailing edge.

The calculated leading edge shock is quite weak followed by a much stronger, near-normal shock at the passage exit. It is believed that the flow pattern shown is qualitatively correct, but it is expected that the actual blade will operate with a stronger leading edge shock and a less strong second shock. This trend has been observed for cases where both data from high response pressure pick-ups over the rotor tip and TUFCAP calculations have been available. The actual case very probably has regions of flow separation present as a result of shock boundary layer interactions which are not accounted for in the TUFCAP calculations.

The flowfield around a preliminary blade section of Streamline 2 was analyzed in the early stages of blade selection. This preliminary blade used a chordwise thickness distribution which was somewhat different from the final blade and also incorporated a modest amount of precompression ahead of the leading edge shock. The TUFCAP calculated surface Mach number shown in Figure 19, indicated a reacceleration of the flow on the pressure surface of the airfoil from about 1.25 Mach number near the leading edge to about 1.57 Mach number at the exit of the covered portion of the cascade. The flow then underwent a shock down to the discharge Mach number.

For this preliminary blade, the precompression was accomplished by increasing the meanline angle aft of the first captured wave. This meanline angle change introduced a surface angle change on the pressure surface at about 15% chord as well as on the suction surface. Compression waves from the suction surface raised the pressure on the pressure surface just downstream of the leading edge. The flow was then reaccelerated at about 15% chord by the pressure surface angle change previously described. The reexpansion was intensified by expansion waves emanating from the suction surface near the mouth of the cascade. The blade curvature in the region of the cascade mouth was necessary to avoid an unacceptably small throat. The final blade does not incorporate any significant external compression of the flow. Also, modifications were made to the chordwise thickness distribution as a result of the TUFCAP analysis of the preliminary blade.

A plot of the calculated surface Mach numbers for both the preliminary and final blade is shown in Figure 19. The calculation procedure matches the required exit static pressure; however, the calculated exit Mach number is higher than will exist since the TUFCAP solution does not include losses.

TUFCAP calculations were also carried out for Streamline 6 (50% design stream function). The surface Mach numbers for the preliminary and final airfoil design are shown in Figure 20. It is believed, however, that the differences between the calculated flowfield and the actual flowfield will be greater for this streamline than for Streamline 2. The TUFCAP solution indicated a quite weak leading edge shock with supersonic flow throughout the enclosed part of the cascade passage. A strong, near-normal shock then occurred at the exit of the covered portion. It is anticipated that the actual blade will operate with a much stronger leading edge shock with supersonic diffusion downstream of the throat. It appears that, when the flow Mach number is not greatly larger than sonic, the inviscid TUFCAP solution predicts a supersonic flowfield under conditions where the actual flow, including losses and possible regions of separation, would be subsonic.

2. <u>Bypass Outlet Guide Vane (OGV)</u>

The bypass OGV airfoil sections are modified NACA 65-series thickness distributions on circular-arc meanlines. There are 90 vanes resulting in a vane-to-blade ratio slightly greater than 2 which is desirable from acoustic considerations. The vanes are moderately high aspect ratio (3.94) and have a solidity of 1.37 at the O.D. and 2.05 at the I.D.

The incidence angles were selected using NACA low-speed cascade data and other correlations as a guide. The design incidence angles are slightly smaller than the NACA low-speed cascade "design" values. Throat margins for all streamlines were calculated to assure sufficient operating range on the choke side of the loss-incidence curve.

Deviation angles were determined from Carter's Rule with no empirical adjustment. The incidence and deviation angles were defined in the projection which views the flow streamline cut looking down the tilted blade stacking axis and are shown in Figure 21.

The airfoil sections and meanlines were defined normal to the tilted blade axis for manufacture. Pertinent vane geometry parameters are tabulated in Appendix C, along with a sketch orientation of airfoil sections relative to blade axis.

3. Booster Rotors and Stator Vanes

The booster rotor blade airfoil sections are modified NACA 65-series thickness distributions on circular-arc meanlines. The booster blade and vane aspect ratios and solidities were selected on the basis of pressure rise capacity as well as for mechanical considerations.

Incidence angles were selected based on cascade correlations which include the effects of blade thickness and inlet Mach number. The blade ends used a somewhat smaller incidence angle than indicated by the correlations in expectation that the local end wall flow angles will be larger than calculated by the CAFD (reference Section III, B. above) since this calculation procedure assumed end-wall losses which were not intended to account for gross boundary layer separation and other end-wall effects. Choke checks were made to assure that there was adequate operating margin on the choke side of the loss-incidence angle curve.

The deviation angles were calculated using a modified version of Carter's Rule with a 3 degree empirical adjustment added to the hub. No adder was used outboard of the pitch line.

The radial distributions of incidence angle and deviation angle are shown in Figure 22. The booster rotor blade camber, stagger, etc. for cylindrical sections are tabulated in Appendix C. These blades were laid out on cylindrical sections normal to the radial stacking axes.

Stator 1 (fan hub stator) used a double-circular-arc airfoil while the remaining stators employ NACA 65-series thickness distributions on circular-arc meanlines. The stator vanes were laid out similar to the booster rotors, i.e., on cylindrical sections normal to the radial stacking axes. The incidence and deviation angles were selected using the same procedures as for the rotors except that the additive factor to Carter's Rule deviation angle was somewhat different.

The radial variations of stator incidence angle and deviation angle are shown in Figure 23. The booster stator vane geometry is tabulated in Appendix C. All stator airfoil sections were laid out on cylindrical sections with the exception of stator 3. Stator 3 vanes were defined by flat plane sections normal to the tilted vane axis as shown in the sketch in Appendix C.

SECTION IV

INLET AERODYNAMIC DESIGN

A. Design Requirements and Flowpath

A "hybrid" inlet design concept was chosen to meet the FAR 36-20 EPNdB noise objectives of the advanced technology fan. The "hybrid" concept refers to combining relatively high subsonic inlet throat Mach number and extensive acoustic suppression material on the inlet walls. Selection of this concept is described in detail in References 10 and 11.

The specific acoustic design requirement called for a one-dimensional throat Mach number of $M_{TH} = 0.79$* at takeoff, cutback, and approach. The corresponding length of treatment required on the inlet duct walls was equal to or less than the aerodynamic diffuser length required, and did not, therefore control the inlet length.

Table II summarizes the cycle parameters and the resulting inlet parameters, as well as the fan nozzle area at each of the three acoustic design conditions (takeoff, cutback, and approach). The same information is presented for cruise since it is the fan aerodynamic design point, as well as a very important performance operating condition.

The exhaust nozzle area was chosen to be variable during earlier propulsion system studies (Reference 10 and 11). This variability makes the required inlet variations physically manageable, although the 36.4% throat area reduction required at approach is still quite large.

The desired $M_{TH} = 0.79$ condition at approach power was attained by a combination of increased fan exhaust nozzle area (opened 40%) and reduced throat area (closed 36.4%). At cutback power $M_{TH} = 0.79$ was attained by increased fan exhaust nozzle area (opened 15%), with the same throat area as takeoff, and high flowing the fan to match the takeoff corrected airflow.

The inlet throat areas were determined as follows:

$$A_{TH} = \frac{\eta_R \left[\dfrac{w\sqrt{\theta}}{\delta}\right]_1}{\left[\dfrac{w\sqrt{\theta}}{\delta A}\right]_{TH}}$$

---

*One-dimensional throat Mach number means that the physical throat area was selected at each corrected inlet throat air flow to yield 0.79 from standard Mach tables.

Table II. Engine Cycle Parameters at Key Inlet Design Operating Conditions.

Parameter	Takeoff	Cutback	Cruise	Approach
$N/\sqrt{\theta_1}$ (%)	92.0	85.0	100.0	58.0
$\left(\frac{w\sqrt{\theta}}{\delta}\right)_1$ (kg/sec)	107.7	107.7	117.9	81.5
(lb/sec)	237.4	237.4	259.9	179.7
w_{BYP} (kg/sec)	87.3	87.3	-	75.5
(lb/sec)	192.5	192.5	-	166.5
$P_{T_{BYP}}$ (N/m^2)	101.1	101.1	-	122.5
(psia)	23.8	23.8	-	17.8
$T_{T_{BYP}}$ (° K)	363.1	363.1	-	320.2
(° R)	653.0	653.0	-	575.9
A_{28}	nominal	open (nominal + 15%)	nominal	open (nominal + 40%)
η_R	0.98	0.98	0.99	0.96
λ_{TH}	0.998	0.998	0.998	0.998
M_{TH}	0.79	0.79	0.695	0.79
A_{TH} (M^2)	0.457	0.457	0.532	0.339
(ft^2)	4.92	4.92	5.73	3.65

where, in English units, for example: $\left[\frac{W\sqrt{\theta}}{\delta A}\right]_{TH} = \frac{85.377\ M_{TH}}{(1+.2\ M_{TH}^2)^3}, \quad \frac{lb}{sec\ ft^2}$

The actual design of the demonstrator vehicle inlet centered around 3 basic demonstration points - takeoff, cutback, and approach. The cruise geometry was not tested statically and was a requirement only in that the demonstrator hardware mechanical design for approach, takeoff and cutback was compatible with operation at cruise.

After the inlet throat areas were determined, the overall inlet length was determined such that the shortest satisfactory diffuser length (as determined in Section IVB, below) would be utilized between the inlet throat and fan entrance plane. The limiting configuration is that for the approach condition, which has the smallest throat area, and hence requires the longest diffuser length. The geometry from the inlet throat forward to the inlet leading edge or highlite was selected based on providing flow attachment at angles of attack up to 20 degrees. The external inlet contour was selected utilizing the data from Reference 12 and a desire to keep the drag divergence Mach number greater than 0.90.

An inlet flowpath drawing is contained in Figure 24 and the internal area distributions for the three operating modes are contained in Figure 25.

B. Boundary Layer Separation Evaluations

An assessment of boundary layer separation potential was obtained by several different methods. Figure 26 contains a separation analysis of the inlet for the takeoff and approach condition based on an empirical technique of Stratford and Beavers, modified for compressibility by General Electric (Reference 13). This was accomplished by analyzing the cowl wall pressure distribution obtained from a computerized streamtube curvature analysis of the flowfield. Based on this analysis, the inlet does not appear to be in danger of separating at either the approach or takeoff conditions. Discontinuities in the curves occur as a result of local flow accelerations and the fact that this analysis applied only in the regions of adverse pressure gradients.

Figure 27 contains a Mach number and skin friction distribution along the cowl wall of the inlet at the approach condition, which is the most critical condition from a boundary layer separation standpoint. The proprietary General Electric Aero Boundary Layer program, which is similar to the boundary layer techniques described in Reference 14, was utilized to calculate the skin friction coefficient. A C_f of zero indicates the flow is at or near separation. The C_f distributions of Figure 27 reaches a value of zero approximately 13 cm upstream of the fan rotor and indicates a potential inlet diffuser separation. However, the separation would not cause large pressure fluctuations if it did occur since it is at the end of the diffusion process. This potential separation was not considered unfavorable for the following reasons:

(1) In the event of separation, the pressure fluctuations would not be severe and shouldn't offer operational problems for a turbofan engine.

(2) Past experience with the Aero Boundary Layer Program indicates that results are sometimes conservative i.e. separation is predicted and it does not occur.

A third form of separation analysis consisted of plotting the cumulative diffuser area ratio and comparing it with conical diffuser experience. The results of this are contained in Figure 28, which was plotted from information in Reference 15 and indicate the diffuser is marginal at the approach condition near the end of the diffuser exit which minimizes the amplitude of the pressure fluctuations in the event separation would occur. This method is considered to be the least precise of the three methods for assessing separation.

None of the methods utilized accounts for the location of the acoustic treatment contained in the diffuser. The only criteria utilized in accounting for the treatment effects is to place it in regions where the local Mach number is less than 0.7. This approach was developed based on some unfavorable results Boeing experienced during a scale-model sonic inlet effort where treatment was placed in regions of near-sonic velocity. (Reference 16).

C. Inlet Recovery Evaluations

Inlet recovery was estimated utilizing 2 basic techniques.

The first method employs the integration of the differential equation for pressure loss in a one-dimensional axisymmetric flow with no total temperature change, mass additions or internal drags. The resulting Fanno line equation is:

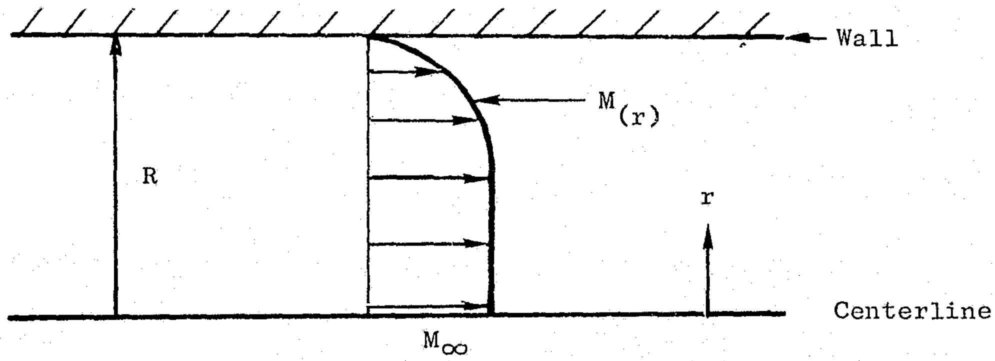
$$\frac{dP_T}{P_T} = - \frac{\gamma M^2}{2} \; 4C_f \; \frac{dx}{DH}$$

Integrating and evaluating between the inlet highlite and rotor leading edge yields

$$\frac{P_{T_1}}{P_{T_\infty}} = (e)^{-2\gamma \int_{\text{Highlite}}^{1} \frac{M^2 C_f dx}{DH}}$$

This equation was numerically integrated utilizing boundary layer computer program output.

The second method utilized consisted of an area-weighted integration of the total pressure profile in the boundary layer.



$$P_{T_1}/P_{T_\infty} = \frac{1}{A} \int_0^R \frac{P_{T(r)}\,dr}{P_{T_\infty}}$$

where:

$$\frac{P_{T(r)}}{P_{T_\infty}} = \left[\frac{1 + \frac{\gamma-1}{2} M(r)^2}{1 + \frac{\gamma-1}{2} M_\infty^2} \right]^{\frac{\gamma}{\gamma-1}}$$

Assuming

- No radial pressure gradient exists at Station 1
- $M_{(r)}$ can be evaluated from boundary layer velocity profile considerations

A comparison of these results is contained in Table III and indicates that the inlet should operate at high recovery levels at takeoff and approach. These levels are somewhat higher than would actually occur since no mixing losses are accounted for. These recoveries are inconsistent with the pre-design estimates used in Table II, but this merely means that the design throat Mach number will be reached at a slightly lower fan speed and airflow. Incorporation of Table III results into slight contour adjustments of the inlet was not considered to be a meaningful iteration and therefore was not performed.

Table III. Flight Condition - Calculated Inlet Pressure Recovery at Important Flight Operating Conditions.

	Takeoff	Cutback	Approach
Recovery Level as determined by Method I (Fanno Line)	0.9953	0.9953	0.9956
Recovery Level as determined by Method II (Profile Integration)	0.9930	0.9930	0.9928

SECTION V

FAN EXIT DUCT AERODYNAMIC DESIGN

A. Design Requirements and Flowpath

The fan exit duct design was primarily influenced by acoustics requirements (Reference 2). From these the following were specified: (1) total length of wall treatment, (2) a single splitter, (3) radial position of splitter and the axial location of its leading edge, (4) thickness of acoustic material, and (5) an objective of duct wall and splitter surface Mach number of 0.35.

Four basic cycle operating points were considered in the analysis and design of the advanced technology fan exit duct. The cycle information associated with these points - takeoff, power cutback, cruise, and approach for the half-scale test vehicle was previously presented in Table II. Estimated temperature and pressure profiles entering the fan exit duct at the OGV exit (Station 12.9 on Figure 9), for the four operating points, are shown in Figure 29.

The initial attempt at sizing the bypass duct considered cruise airflow, the specified (acoustic requirement) duct Mach number, and the fan exit profiles shown in Figure 29. For simplicity, the diffusion walls were made straight with circular-arc blends. The nozzle (which begins at 393.7 cm axial distance, see Figure 30) was sized using an estimated 2% $\Delta P_T/P_T$ loss, and was also made with straight walls for simplicity.

This first trial geometry was analyzed using the General Electric potential flow computer program (Stream Tube Curvature) linked to a boundary layer analysis program. This procedure was identical to that employed in the design of the inlet and is described as the first boundary layer analysis method in Section IVB of this report. The results showed a feasible location for the single acoustic splitter (2.18 cm thick) along one of the potential flow streamlines.

To maintain high performance of the splitter at large angle of attack variations caused by off-design fan exit profiles, a NACA series 64 leading edge contour was chosen. The splitter was defined using straight line conical and cylindrical sections to be consistent with the duct wall design, and incorporated circular-arc blends and a standard cubic contour trailing edge. The final design geometry is illustrated in Figure 30, while tabulated coordinates are presented in Appendix E.

B. Results

Initial analytical study with the potential flow program on the trial geometry for the cruise point revealed regions on the duct outer wall where the adverse pressure gradient was sufficient to cause separation. The outer wall at the entrance to the diffuser section was modified with a rapid-turn corner which forces diffusion quickly over a short distance when the boundary layer has more energy, followed by a decreased diffusion rate (see Reference 17). This method reduced boundary layer losses and avoided separation.

The final results of the design analysis of the fan exit duct are presented in Figures 31, 32, 33, and 34 for the cruise-, takeoff-, power cutback-, and approach-point operation, respectively. Each of these figures has four parts: (a) surface Mach number distribution, (b) surface static pressure distribution, (c) streamlines, and (d) a flow separation parameter.

In order to high-flow the engine for engine cycle considerations, the conical convergent section of the nozzle was opened to approximately 15% and 40% greater than the design cruise nominal area for the power cutback- and approach-point operations, respectively. This will also benefit inlet noise. The simple baseline geometry that was chosen allowed this variability without harming the flowfield.

On Figure 31 (b) the sharp drop in the outer wall static pressure at a distance of 265.4 cm is typical of the rapid-turn corner employed. The sharp upward spike at this station and also at 281.9 cm is a characteristic of the potential flow program technique only, and not an actual flow phenomenon.

From the separation parameter plots of Figures 31 - 34 (d), marginal regions where possible separation might occur are noted, and indicated separation occurs only at the trailing edge of the splitter. This wake separation occurs just ahead of the convergent area section of the nozzle and will decay rapidly.

Total pressure losses were calculated using the boundary layer program referred to in Section VA above, and estimating the losses by:

$$\frac{\Delta P_T}{P_{T_1}} = \frac{DRG}{P_{s1} A_1}$$

Where DRG is the body friction drag from the boundary layer program, A_1 is the initial flow area and P_{s1} is the initial static pressure. Table IV gives the calculated pressure losses for the four operating points.

Table IV. Calculated Fan Exit Duct Pressure Losses, $\Delta P_T/P_T$ at Key Operating Conditions.

Engine Power	Lower Channel*		Upper Channel**		Total Loss $\Delta P_T/P_T$
	To 393.7 cm	Aft 393.7 cm	To 393.7 cm	Aft 393.7 cm	
Take Off	0.00790	0.00046	0.00773	0.00069	1.7%
Cruise	0.00065	0.00043	0.00830	0.00076	1.6%
Cut Back	0.01290	0.00050	0.00913	0.00081	2.3%
Approach	0.01299	0.00045	0.00736	0.00042	2.1%

* Lower Channel is considered the streamtube below the splitter.

** Upper Channel is considered the streamtube above the splitter.

SECTION VI

RESUMÉ

The aerodynamic design for a half-scale fan vehicle which would have application on an advanced transport aircraft is described. The single stage, low noise and advanced technology fan was designed to a pressure ratio of 1.8 at a tip speed of 503 m/sec (1650 ft/sec). The design corrected flow per unit annulus area at the fan face is 215 kg/sec m^2 (44.0 lbm/sec ft^2) with a hub-tip ratio of 0.38. A flow splitter is located immediately downstream of the fan rotor, separating the fan bypass flow from the core/booster flow for a design bypass ratio of 6:1.

The variable-geometry inlet was designed utilizing a combination of high throat Mach and acoustic treatment in the inlet diffuser, for noise suppression (hybrid inlet). A variable fan exhaust nozzle was assumed in conjunction with the variable inlet throat area to limit the required area change and thus the overall diffusion and inlet length required. The final inlet design has a flight length of 1.4 fan diameters (although the test version of the hybrid inlet was 1.5 fan diameters long due to utilization of a bellmouth lip).

The fan exit duct design was primarily influenced by acoustic requirements, including length of suppressor wall treatment; length, thickness and position on a duct splitter of additional suppressor treatment; and duct surface Mach numbers.

APPENDIX A. ADVANCED TECHNOLOGY FAN AND BOOSTER FLOWPATH COORDINATES.

APPENDIX A NOMENCLATURE

Z = Axial Distance

R_1 = Outer Radius

R_2 = Flow Splitter Radius, Bypass Duct

R_3 = Flow Splitter Radius, Core Duct

R_4 = Inner Radius

(1) Fan Rotor Inlet

(2) Fan Rotor Exit

(3) Core Stator 1 Inlet

(4) Core Stator 1 Exit

(5) Core Rotor 2 Inlet

(6) Core Rotor 2 Exit

(7) Core Stator 2 Inlet

(8) Core Stator 2 Exit

(9) Core Rotor 3 Inlet

(10) Core Rotor 3 Exit

(11) Core Stator 3 Inlet

(12) Core Stator 3 Exit

(13) Bypass OGV Inlet

(14) Bypass OGV Exit

VEHICLE FLOWPATH TABULATION

Station	Z cm (in)	R_1 cm (in)	R_2 cm (in)	R_3 cm (in)	R_4 cm (in)
.08	-38.10 (-15.00)	42.67 (16.80)			0 (0)
.10	-26.67 (-10.50)	43.38 (17.08)			0 (0)
.20	-17.78 (- 7.00)	44.07 (17.35)			9.25 (3.64)
.40	-12.70 (- 5.00)	44.45 (17.50)			12.29 (4.84)
.60	- 7.62 (- 3.00)	44.83 (17.65)			14.43 (5.68)
.80	- 3.81 (- 1.50)	45.09 (17.75)			15.85 (6.24)
(1) 1.00	0 (0)	45.19 (17.79)			17.17 (6.76)
1.05	.64 (.25)	45.15 (17.775)			17.39 (6.848)
1.10	1.27 (.50)	45.09 (17.75)			17.63 (6.941)
1.15	1.91 (.75)	45.01 (17.72)			17.88 (7.04)
1.20	2.54 (1.00)	44.89 (17.675)			18.10 (7.125)
1.25	3.18 (1.25)	44.81 (17.64)			18.38 (7.236)
1.30	3.81 (1.50)	44.68 (17.59)			18.64 (7.34)
1.35	4.45 (1.75)	44.58 (17.55)			18.93 (7.452)
1.40	5.08 (2.00)	44.48 (17.51)			19.23 (7.57)
1.425	5.72 (2.25)	44.40 (17.48)			19.56 (7.70)
1.45	6.35 (2.50)	44.30 (17.44)			19.89 (7.83)
(2) 1.50	7.50 (2.954)	44.25 (17.42)			20.45 (8.05)
1.54	10.16 (4.00)			25.86 (10.18)	21.01 (8.27
1.56	12.07 (4.75)			26.02 (10.245)	21.15 (8.325)
(3) 1.60	14.22 (5.60)			26.11 (10.28)	21.29 (8.38)
1.75	15.34 (6.04)			25.93 (10.21)	21.41 (8.43)
(4) 1.90	16.69 (6.57)			25.73 (10.13)	21.56 (8.49)
(5) 2.00	17.27 (6.80)			25.63 (10.091)	21.56 (8.49)
2.25	18.01 (7.09)			25.49 (10.034)	21.56 (8.49)
(6) 2.50	19.02 (7.49)			25.29 (9.956)	21.56 (8.49)
(7) 2.60	19.69 (7.75)			25.16 (9.906)	21.53 (8.475)
2.75	20.39 (8.028)			25.02 (9.852)	21.46 (8.45)
(8) 2.90	21.34 (8.40)			24.84 (9.779)	21.37 (8.415)
(9) 3.00	21.80 (8.583)			24.74 (9.74)	21.34 (8.40)
3.25	22.57 (8.884)			24.57 (9.675)	21.21 (8.35)
(10) 3.50	23.27 (9.16)			24.39 (9.602)	21.11 (8.31)

VEHICLE FLOWPATH TABULATION

Station	Z cm (in)	R_1 cm (in)	R_2 cm (in)	R_3 cm (in)	R_4 cm (in)
(11) 3.60	23.90 (9.41)			24.23 (9.54)	20.98 (8.26)
3.75	24.47 (9.635)			24.07 (9.478)	20.85 (8.21)
(12) 3.90	25.48 (10.03)			23.77 (9.360)	20.52 (8.08)
4.00	26.67 (10.50)			23.42 (9.22)	19.99 (7.872)
5.00	29.21 (11.50)			22.66 (8.922)	18.45 (7.264)
6.00	31.75 (12.50)			21.69 (8.54)	16.61 (6.54)
7.00	35.56 (14.00)			19.96 (7.86)	14.00 (5.51)
8.00	39.37 (15.50)			18.29 (7.20)	12.29 (4.84)
9.00	43.18 (17.00)			16.81 (6.62)	11.38 (4.48)
10.00	45.97 (18.10)			16.10 (6.34)	11.25 (4.43)
12.00	9.60 (3.78)	44.25 (17.42)	26.26 (10.34)		
12.20	13.28 (5.23)	44.25 (17.42)	27.12 (10.678)		
12.30	16.76 (6.60)	44.25 (17.42)	27.33 (10.76)		
(13) 12.60	21.89 (8.62)	44.25 (17.42)	27.51 (10.83)		
12.80	25.78 (10.15)	44.04 (17.338)	27.81 (10.95)		
(14) 12.90	28.45 (11.20)	43.89 (17.28)	27.81 (10.95)		
13.00	30.10 (11.85)	43.85 (17.264)	27.81 (10.95)		

APPENDIX B. CIRCUMFERENTIAL-AVERAGE FLOW SOLUTION AT DESIGN POINT.

NOMENCLATURE FOR TABULATION

HEADING	IDENTIFICATION	METRIC UNITS
GENERAL		
SL	STREAMLINE NUMBER	-
PSI	STREAM FUNCTION	-
RADIUS	STREAMLINE RADIUS	CM.
% IMM	PERCENT IMMERSION FROM OUTER WALL	%
Z	AXIAL DIMENSION	CM.
BLKAGE	ANNULUS BLOCKAGE FACTOR	-
FLOW	WEIGHT FLOW	KG/SEC
ANGLES AND MACH NUMBERS		
PHI	MERIDIONAL FLOW ANGLE	DEG.
ALPHA	ABSOLUTE FLOW ANGLE =ARCTAN (CU/CZ)	DEG.
BETA	RELATIVE FLOW ANGLE =ARCTAN (-WU/CZ)	DEG.
M-ABS	ABSOLUTE MACH NUMBER	-
M-REL	RELATIVE MACH NUMBER	-
VELOCITIES		
C	ABSOLUTE VELOCITY	M/SEC
W	RELATIVE VELOCITY	M/SEC
CZ	AXIAL VELOCITY	M/SEC
U	BLADE SPEED	M/SEC
CU	TANGENTIAL COMPONENT OF C	M/SEC
WU	TANGENTIAL COMPONENT OF W	M/SEC
FLUID PROPERTIES		
PT	ABSOLUTE TOTAL PRESSURE	N/SQ.CM.
TT	ABSOLUTE TOTAL TEMPERATURE	DEG-K
TT-REL	RELATIVE TOTAL TEMPERATURE	DEG-K
PS	STATIC PRESSURE	N/SQ.CM.
TS	STATIC TEMPERATURE	DEG-K
RHO	STATIC DENSITY	KG/CU.METER
EFF	CUMULATIVE ADIABATIC EFFICIENCY REFERENCED TO PTI, TTI	-
PTI	INLET ABSOLUTE TOTAL PRESSURE	N/SQ.CM.
TTI	INLET ABSOLUTE TOTAL TEMPERATURE	DEG-K
AERODYNAMIC BLADING PARAMETERS		
TPLC	TOTAL PRESSURE LOSS COEFFICIENT	-
PR-ROW	TOTAL PRESSURE RATIO ACROSS BLADE ROW	-
DEL-T	TOTAL TEMPERATURE RISE ACROSS ROTOR	DEG-K
D	DIFFUSION FACTOR	-
DP/Q	STATIC PRESSURE RISE COEFFICIENT	-
CZ/CZ	AXIAL VELOCITY RATIO ACROSS BLADE ROW	-
SOLDTY	SOLIDITY	-
R-AVG	AVERAGE STREAMLINE RADIUS ACROSS BLADE ROW	CM.
F-TAN	TANGENTIAL BLADE FORCE PER UNIT BLADE LENGTH	N/CM
F-AXL	AXIAL BLADE FORCE PER UNIT BLADE LENGTH	N/CM
F-COEF	FLOW COEFFICIENT =CZ1/U1	-
T-COEF	WORK COEFFICIENT =(2*G*J*CP*DEL-T)/(U2*U2)	-

NOMENCLATURE FOR TABULATION

HEADING	IDENTIFICATION	ENGLISH UNITS
GENERAL		
SL	STREAMLINE NUMBER	-
PSI	STREAM FUNCTION	-
RADIUS	STREAMLINE RADIUS	IN.
% IMM	PERCENT IMMERSION FROM OUTER WALL	%
Z	AXIAL DIMENSION	IN.
ELKAGE	ANNULUS BLOCKAGE FACTOR	-
FLOW	WEIGHT FLOW	LBM/SEC
ANGLES AND MACH NUMBERS		
PHI	MERIDIONAL FLOW ANGLE	DEG.
ALPHA	ABSOLUTE FLOW ANGLE =ARCTAN (CU/CZ)	DEG.
BETA	RELATIVE FLOW ANGLE =ARCTAN (-WU/CZ)	DEG.
M_ABS	ABSOLUTE MACH NUMBER	-
M-REL	RELATIVE MACH NUMBER	-
VELOCITIES		
C	ABSOLUTE VELOCITY	FT/SEC
W	RELATIVE VELOCITY	FT/SEC
CZ	AXIAL VELOCITY	FT/SEC
U	BLADE SPEED	FT/SEC
CU	TANGENTIAL COMPONENT OF C	FT/SEC
WU	TANGENTIAL COMPONENT OF W	FT/SEC
FLUID PROPERTIES		
PT	ABSOLUTE TOTAL PRESSURE	LBF/SQ.IN.
TT	ABSOLUTE TOTAL TEMPERATURE	DEG-R
TT-REL	RELATIVE TOTAL TEMPERATURE	DEG-R
PS	STATIC PRESSURE	LBF/SQ.IN.
TS	STATIC TEMPERATURE	DEG-R
RHO	STATIC DENSITY	LBM/CU.FT.
EFF	CUMULATIVE ADIABATIC EFFICIENCY REFERENCED TO PTI, TTI	-
PTI	INLET ABSOLUTE TOTAL PRESSURE	LBF/SQ.IN.
TTI	INLET ABSOLUTE TOTAL TEMPERATURE	DEG-R
AERODYNAMIC BLADING PARAMETERS		
TPLC	TOTAL PRESSURE LOSS COEFFICIENT	-
PR-ROW	TOTAL PRESSURE RATIO ACROSS BLADE ROW	-
DEL-T	TOTAL TEMPERATURE RISE ACROSS ROTOR	DEG-R
D	DIFFUSION FACTOR	-
DP/Q	STATIC PRESSURE RISE COEFFICIENT	-
CZ/CZ	AXIAL VELOCITY RATIO ACROSS BLADE ROW	-
SOLDTY	SOLIDITY	-
R-AVG	AVERAGE STREAMLINE RADIUS ACROSS BLADE ROW	IN.
F-TAN	TANGENTIAL BLADE FORCE PER UNIT BLADE LENGTH	LBF/IN
F-AXL	AXIAL BLADE FORCE PER UNIT BLADE LENGTH	LBF/IN
F-COEF	FLOW COEFFICIENT =CZ1/U1	-
T-COEF	WORK COEFFICIENT =(2*G*J*CP*DEL-T)/(J2*U2)	-

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.00000 Z 0. ROTOR 1 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	45.1867	0.	-2.50	0.	60.91	0.590	1.638	194.2	539.1	194.0	502.9	0.	-502.9	1
2	0.1000	43.0989	7.5	-1.55	0.	66.43	0.640	1.600	209.3	523.4	209.2	479.7	0.	-479.7	2
3	0.2000	40.9929	15.0	-0.35	0.	64.12	0.680	1.558	221.4	507.1	221.4	456.2	0.	-456.2	3
4	0.3000	38.8295	22.7	1.08	0.	61.76	0.710	1.510	230.2	489.6	230.1	432.2	0.	-432.2	4
5	0.4000	36.5758	30.7	2.79	0.	59.37	0.731	1.456	236.6	470.8	236.3	407.1	0.	-407.1	5
6	0.5000	34.1953	39.2	4.72	0.	57.79	0.745	1.395	240.6	450.3	239.8	380.6	0.	-380.6	6
7	0.6500	30.2834	53.2	8.11	0.	54.54	0.752	1.287	242.5	415.2	240.1	337.1	0.	-337.1	7
8	0.7500	27.3434	63.7	10.84	0.	52.12	0.747	1.203	241.1	388.2	236.8	304.3	0.	-304.3	8
9	0.8750	23.0478	79.0	14.64	0.	49.24	0.696	1.052	226.1	341.9	218.7	256.5	0.	-256.5	9
10	0.9200	21.1988	85.6	16.99	0.	48.89	0.660	0.979	215.3	319.4	205.9	235.9	0.	-235.9	10
11	0.9650	19.0787	93.2	19.34	0.	47.96	0.619	0.895	202.9	293.7	191.4	212.3	0.	-212.3	11
12	1.0000	17.1704	100.0	19.50	0.	46.12	0.593	0.830	194.9	273.0	183.7	191.1	0.	-191.1	12

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	45.1867	10.132	288.16	414.04	8.005	269.40	1.03520	1.0000	1.00000		0.98900	1
2	0.1000	43.0989	10.132	288.16	402.68	7.693	266.36	1.00623	1.0000	1.00000		0.98900	2
3	0.2000	40.9929	10.132	288.16	391.76	7.435	263.77	0.98201	1.0000	1.00000		0.98900	3
4	0.3000	38.8295	10.132	288.16	381.11	7.242	261.79	0.96367	1.0000	1.00000		0.98900	4
5	0.4000	36.5758	10.132	288.16	370.63	7.099	260.31	0.95007	1.0000	1.00000		0.98900	5
6	0.5000	34.1953	10.132	288.16	360.25	7.008	259.35	0.94139	1.0000	1.00000		0.98900	6
7	0.6500	30.2834	10.132	288.16	344.70	6.965	258.90	0.93727	1.0000	1.00000		0.98900	7
8	0.7500	27.3434	10.132	288.16	334.25	6.997	259.24	0.94033	1.0000	1.00000		0.98900	8
9	0.8750	23.0478	10.132	288.16	320.91	7.332	262.72	0.97225	1.0000	1.00000		0.98900	9
10	0.9200	21.1988	10.132	288.16	315.86	7.566	265.09	0.99434	1.0000	1.00000		0.98900	10
11	0.9650	19.0787	10.132	288.16	310.60	7.828	267.68	1.01674	1.0000	1.00000		0.98900	11
12	1.0000	17.1704	10.132	288.16	306.34	7.990	269.25	1.03378	1.0000	1.00000		0.98900	12

MASS AVERAGED VALUES

$P_T/P_T{}^I$ 1.0000 EFF P_T 10.132 T_T 288.16 $T_T/T_T{}^I$ 1.00000 CZ 225.10

CORR. FLOW 117.902 CORR. RPM 10628.2 CORR. U-TIP 502.9

PTI 10.132
TTI 288.160
GAMMA 1.4000

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.00000 Z 0. ROTOR 1 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	17.7900	0.	-2.50	0.	68.91	0.590	1.638	637.0	1768.7	636.4	1650.0	0.	-1650.0	1
2	0.1000	16.9681	7.5	-1.55	0.	66.53	0.640	1.600	686.7	1717.1	686.5	1573.8	0.	-1573.8	2
3	0.2000	16.1389	15.0	-0.35	0.	64.12	0.680	1.558	726.3	1663.7	726.2	1496.9	0.	-1496.9	3
4	0.3000	15.2872	22.7	1.08	0.	61.96	0.710	1.510	755.2	1606.4	755.0	1417.9	0.	-1417.9	4
5	0.4000	14.3999	30.7	2.79	0.	59.87	0.731	1.456	776.1	1544.7	775.2	1335.6	0.	-1335.6	5
6	0.5000	13.4627	39.2	4.72	0.	57.79	0.745	1.395	789.3	1477.2	786.6	1248.6	0.	-1248.6	6
7	0.6500	11.9226	53.2	8.11	0.	54.54	0.752	1.287	795.5	1362.2	787.6	1105.8	0.	-1105.8	7
8	0.7500	10.7651	63.7	10.34	0.	52.12	0.747	1.203	790.9	1273.8	776.8	998.5	0.	-998.5	8
9	0.8750	9.0739	79.0	14.64	0.	49.24	0.696	1.052	741.8	1121.8	717.7	841.6	0.	-841.6	9
10	0.9200	8.3460	85.6	16.99	0.	48.59	0.660	0.979	706.3	1047.9	675.5	774.1	0.	-774.1	10
11	0.9650	7.5113	93.2	19.34	0.	47.96	0.619	0.895	665.6	963.5	628.1	696.7	0.	-696.7	11
12	1.0000	6.7600	100.0	19.50	0.	46.12	0.593	0.830	639.5	895.6	602.8	627.0	0.	-627.0	12

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	17.7900	14.696	518.69	745.27	11.611	484.92	0.06463	1.0000	1.00000		0.98900	1
2	0.1000	16.9681	14.696	518.69	724.82	11.158	479.44	0.06282	1.0000	1.00000		0.98900	2
3	0.2000	16.1389	14.696	518.69	705.16	10.784	474.79	0.06131	1.0000	1.00000		0.98900	3
4	0.3000	15.2872	14.696	518.69	686.00	10.503	471.22	0.06016	1.0000	1.00000		0.98900	4
5	0.4000	14.3999	14.696	518.69	667.14	10.296	468.55	0.05931	1.0000	1.00000		0.98900	5
6	0.5000	13.4627	14.696	518.69	648.45	10.165	466.84	0.05877	1.0000	1.00000		0.98900	6
7	0.6500	11.9226	14.696	518.69	620.46	10.103	466.02	0.05851	1.0000	1.00000		0.98900	7
8	0.7500	10.7651	14.696	518.69	601.66	10.149	466.62	0.05870	1.0000	1.00000		0.98900	8
9	0.8750	9.0739	14.696	518.69	577.64	10.634	472.90	0.06070	1.0000	1.00000		0.98900	9
10	0.9200	8.3460	14.696	518.69	568.56	10.774	477.17	0.06208	1.0000	1.00000		0.98900	10
11	0.9650	7.5113	14.696	518.69	559.08	11.353	481.62	0.06360	1.0000	1.00000		0.98900	11
12	1.0000	6.7600	14.696	518.69	551.40	11.598	484.65	0.06454	1.0000	1.00000		0.98900	12

MASS AVERAGED VALUES

P_T/P_{TI} 1.0000 EFF P_T 14.696 T_T 518.69 T_T/T_{TI} 1.00000 CZ 738.53

CORR. FLOW 259.930 CORR. RPM 10628.2 CORR. U-TIP 1650.0

PTI 14.696
TTI 518.688
GAMMA 1.4000

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.50000 Z 7.503175 ROTOR 1 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	44.2469	0.	0.	42.03	65.91	0.576	1.047	211.3	384.5	157.0	492.5	141.5	-351.0	1
2	0.1000	42.4095	7.7	-1.76	40.63	63.10	0.604	1.010	220.6	368.7	167.4	472.0	143.6	-328.4	2
3	0.2000	40.6137	15.3	-0.88	39.96	60.42	0.625	0.970	226.9	352.2	173.9	452.0	145.7	-306.3	3
4	0.3000	38.7881	22.9	0.61	40.56	58.18	0.636	0.917	230.3	331.8	174.9	431.7	149.7	-282.0	4
5	0.4000	36.8712	31.0	2.49	41.49	55.32	0.644	0.859	232.5	310.0	174.1	410.4	154.0	-256.4	5
6	0.5000	34.8259	39.6	4.67	42.42	52.09	0.654	0.800	235.3	287.7	173.4	387.6	158.4	-229.2	6
7	0.6500	31.4167	53.9	8.33	44.66	46.56	0.675	0.699	241.3	250.0	170.7	349.7	168.7	-180.9	7
8	0.7500	28.8139	64.8	11.33	47.24	40.71	0.690	0.619	245.5	220.4	165.2	320.7	178.6	-142.1	8
9	0.8750	24.9223	81.2	10.37	49.42	24.38	0.753	0.541	265.0	190.5	171.1	277.4	199.8	-77.5	9
10	0.9200	23.3924	87.6	12.14	49.50	15.25	0.803	0.547	280.4	190.9	180.4	260.4	211.2	-49.2	10
11	0.9650	21.7708	94.4	15.51	49.05	5.19	0.874	0.588	302.3	203.1	194.9	242.3	224.6	-17.7	11
12	1.0000	20.4470	100.0	20.00	47.85	-2.75	0.972	0.675	330.4	229.5	215.4	227.6	237.9	10.4	12

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	44.2469	18.036	357.50	408.86	14.408	335.28	1.49706	1.7800	1.24063	0.7443	0.96500	1
2	0.1000	42.4095	18.543	355.61	399.04	14.484	331.40	1.52296	1.8300	1.23408	0.8052	0.96500	2
3	0.2000	40.6137	18.856	353.72	389.85	14.494	328.10	1.53889	1.8610	1.22752	0.8535	0.96500	3
4	0.3000	38.7881	18.948	352.50	380.91	14.430	326.11	1.54156	1.8700	1.22328	0.8771	0.96500	4
5	0.4000	36.8712	18.887	351.06	371.97	14.286	324.14	1.53541	1.8640	1.21827	0.8922	0.96500	5
6	0.5000	34.8259	18.735	349.28	362.93	14.053	321.73	1.52168	1.8490	1.21210	0.9051	0.96500	6
7	0.6500	31.4167	18.390	346.89	349.01	13.550	317.90	1.48486	1.8150	1.20381	0.9110	0.96500	7
8	0.7500	28.8139	18.137	345.17	339.35	13.195	315.17	1.45845	1.7900	1.19783	0.9149	0.96500	8
9	0.8750	24.9223	17.742	343.33	326.45	12.186	308.39	1.37661	1.7510	1.19147	0.9066	0.96500	9
10	0.9200	23.3924	17.600	342.89	321.90	11.516	303.75	1.32074	1.7370	1.18993	0.8998	0.96500	10
11	0.9650	21.7708	17.438	342.33	317.38	10.593	296.85	1.24260	1.7210	1.18800	0.8925	0.96500	11
12	1.0000	20.4470	17.326	342.06	313.93	9.459	287.73	1.14520	1.7100	1.18703	0.8857	0.96500	12

SL	PSI	IPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.	0.20065	1.7800	69.34	0.373	0.228	0.809	1.5075	44.7168	845.26	1585.60	0.386	0.574	1
2	0.1000	0.15645	1.8300	67.45	0.387	0.272	0.800	1.4930	42.7542	875.81	1582.36	0.436	0.603	2
3	0.2000	0.12051	1.8610	65.56	0.401	0.317	0.786	1.4987	40.8033	883.93	1536.80	0.485	0.642	3
4	0.3000	0.10419	1.8700	64.34	0.423	0.365	0.760	1.5124	38.8086	875.50	1443.01	0.533	0.693	4
5	0.4000	0.09419	1.8640	62.90	0.448	0.414	0.737	1.5404	36.7235	852.66	1323.32	0.580	0.750	5
6	0.5000	0.08545	1.8490	61.12	0.472	0.466	0.723	1.5935	34.5106	820.66	1190.18	0.630	0.817	6
7	0.6500	0.08541	1.8150	58.73	0.518	0.549	0.711	1.7172	30.8501	764.02	965.31	0.712	0.962	7
8	0.7500	0.08653	1.7900	57.01	0.560	0.618	0.698	1.8427	28.0787	713.06	808.20	0.778	1.113	8
9	0.8750	0.10875	1.7510	55.17	0.568	0.653	0.782	2.0911	23.9850	659.05	575.65	0.853	1.441	9
10	0.9200	0.12792	1.7370	54.73	0.559	0.617	0.676	2.2143	22.2956	639.58	478.20	0.873	1.622	10
11	0.9650	0.15484	1.7210	54.17	0.481	0.516	1.018	2.3678	20.4247	614.90	367.20	0.902	1.853	11
12	1.0000	0.18477	1.7100	53.90	0.348	0.322	1.172	2.5097	18.8087	598.80	255.67	0.961	2.094	12

MASS AVERAGED VALUES

$P_T/P_T I$ 1.8162 EFF 0.8760 P_T 18.403 TT 349.31 TT/TTI 1.21220 CZ 172.23 ROW P_T2/P_T1 1.8162

CORR. FLOW 71.473 CORR. RPM 9653.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.50000 Z 2.654060 ROTOR 1 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	17.4200	0.	0.	42.03	65.91	0.576	1.047	693.2	1261.5	514.9	1615.7	464.1	-1151.6	1
2	0.1000	16.6966	7.7	-1.76	40.63	63.00	0.604	1.010	723.6	1209.5	549.1	1548.6	471.0	-1077.6	2
3	0.2000	15.9896	15.3	-0.88	39.96	60.42	0.625	0.970	744.4	1155.6	570.5	1483.0	478.1	-1004.9	3
4	0.3000	15.2709	22.9	0.61	40.56	58.18	0.636	0.917	755.5	1088.7	573.9	1416.4	491.2	-925.1	4
5	0.4000	14.5162	31.0	2.49	41.49	55.82	0.644	0.859	762.9	1017.1	571.2	1346.4	505.2	-841.2	5
6	0.5000	13.7109	39.6	4.67	42.42	52.89	0.654	0.800	771.9	944.0	568.8	1271.7	519.7	-751.9	6
7	0.6500	12.3698	53.9	8.33	44.66	46.66	0.675	0.699	791.8	820.3	560.2	1147.2	553.6	-593.6	7
8	0.7500	11.3440	64.8	11.33	47.24	40.71	0.690	0.619	805.4	723.0	541.8	1052.1	565.9	-466.2	8
9	0.8750	9.8119	81.2	10.37	49.42	24.38	0.753	0.541	869.3	624.9	561.5	910.0	655.6	-254.4	9
10	0.9200	9.2096	87.6	12.14	49.50	15.25	0.803	0.547	920.0	626.4	591.8	854.2	692.9	-161.3	10
11	0.9650	8.5711	94.4	15.51	49.05	5.19	0.875	0.588	991.8	666.3	639.6	795.0	736.9	-58.0	11
12	1.0000	8.0500	100.0	20.00	47.85	-2.75	0.972	0.675	1083.9	752.8	706.7	746.6	780.6	34.0	12

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	17.4200	26.159	643.50	735.94	20.897	603.51	0.09346	1.7800	1.24063	0.7443	0.96500	1
2	0.1000	16.6966	26.894	640.10	718.27	21.013	596.52	0.09508	1.8300	1.23408	0.8052	0.96500	2
3	0.2000	15.9896	27.349	636.70	701.73	21.021	590.59	0.09607	1.8610	1.22752	0.8535	0.96500	3
4	0.3000	15.2709	27.482	634.50	685.64	20.930	587.00	0.09624	1.8700	1.22328	0.8771	0.96500	4
5	0.4000	14.5162	27.393	631.90	669.55	20.721	583.46	0.09586	1.8640	1.21827	0.8922	0.96500	5
6	0.5000	13.7109	27.173	628.70	653.28	20.382	579.11	0.09500	1.8490	1.21210	0.9051	0.96500	6
7	0.6500	12.3698	26.673	624.40	628.22	19.653	572.22	0.09270	1.8150	1.20381	0.9110	0.96500	7
8	0.7500	11.3440	26.306	621.30	610.82	19.137	567.31	0.09105	1.7900	1.19783	0.9149	0.96500	8
9	0.8750	9.8119	25.733	618.00	587.61	17.675	555.11	0.08594	1.7510	1.19147	0.9066	0.96500	9
10	0.9200	9.2096	25.527	617.20	579.41	16.702	546.75	0.08245	1.7370	1.18993	0.8998	0.96500	10
11	0.9650	8.5711	25.292	616.20	571.28	15.357	534.34	0.07750	1.7210	1.18800	0.8925	0.96500	11
12	1.0000	8.0500	25.130	615.70	565.08	13.719	517.92	0.07149	1.7100	1.18703	0.8857	0.96500	12

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP7Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.	0.20065	1.7800	124.81	0.373	0.228	0.809	1.5075	17.6050	482.66	905.41	0.386	0.574	1
2	0.1000	0.15645	1.8300	121.41	0.387	0.272	0.800	1.4930	16.8323	500.10	903.56	0.436	0.608	2
3	0.2000	0.12051	1.8610	118.01	0.401	0.317	0.786	1.4987	16.0642	504.74	877.54	0.485	0.642	3
4	0.3000	0.10419	1.8700	115.81	0.423	0.365	0.760	1.5124	15.2790	499.93	823.98	0.533	0.69[illegible]	4
5	0.4000	0.09419	1.8640	113.21	0.448	0.414	0.737	1.5404	14.4580	466.89	755.64	0.580	0.75[illegible]	5
6	0.5000	0.08545	1.8490	110.01	0.472	0.466	0.723	1.5935	13.5868	468.62	679.62	0.630	0.817	6
7	0.6500	0.08541	1.8150	105.71	0.518	0.549	0.711	1.7172	12.1457	436.27	551.21	0.712	0.962	7
8	0.7500	0.09653	1.7900	102.61	0.560	0.618	0.698	1.8427	11.0546	407.17	461.49	0.778	1.113	8
9	0.6750	0.10675	1.7510	99.31	0.588	0.653	0.782	2.0911	9.4429	376.33	328.71	0.853	1.441	9
10	0.9200	0.12792	1.7370	98.51	0.559	0.617	0.876	2.2143	8.7778	365.21	273.06	0.873	1.625	10
11	0.9650	0.15484	1.7210	97.51	0.481	0.516	1.018	2.3678	8.0412	351.12	209.68	0.902	1.855	11
12	1.0000	0.18477	1.7100	97.01	0.348	0.322	1.172	2.5097	7.4050	341.92	145.99	0.961	2.094	12

MASS AVERAGED VALUES

P_T/P_TI 1.8162 EFF 0.8760 P_T 26.691 T_T 626.76 T_T/T_TI 1.21220 CZ 565.23 ROW P_T2/P_T1 1.8162
CORR. FLOW 157.570 CORR. RPM 9053.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.60000 Z 14.224028 STATOR 1 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	26.1113	0.	-5.00	50.43	32.00	0.702	0.528	249.0	187.3	158.4	290.6	191.6	-99.0	1
2	0.8750	25.5249	12.1	-3.69	49.00	27.58	0.733	0.544	258.8	191.8	169.6	284.1	195.1	-89.0	2
3	0.9200	24.0799	42.1	-0.77	47.39	18.42	0.797	0.569	278.8	198.9	188.7	268.0	205.2	-62.8	3
4	0.9650	22.5713	73.4	2.18	48.24	10.13	0.836	0.566	290.5	196.7	193.5	251.2	216.6	-34.6	4
5	1.0000	21.2852	100.0	5.00	50.51	2.54	0.857	0.547	296.6	189.3	188.4	236.9	228.6	-8.3	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	26.1113	17.798	343.60	330.19	12.804	312.74	1.42628	1.7566	1.19238	0.9078	0.96000	1
2	0.8750	25.5249	17.742	343.33	328.33	12.411	310.01	1.39469	1.7510	1.19147	0.9066	0.96000	2
3	0.9200	24.0799	17.600	342.89	323.91	11.577	304.22	1.32579	1.7370	1.18993	0.8998	0.96000	3
4	0.9650	22.5713	17.438	342.33	319.57	11.028	300.32	1.27919	1.7210	1.18800	0.8925	0.96000	4
5	1.0000	21.2852	17.326	342.06	316.09	10.727	298.26	1.25287	1.7100	1.18703	0.8857	0.96000	5

MASS AVERAGED VALUES

P_T/P_TI 1.7335 EFF 0.8981 P_T 17.564 T_T 342.77 TT/TTI 1.18952 CZ 184.58
CORR. FLOW 10.600 CORR. RPM 9744.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.60000 Z 5.600000 STATOR 1 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	10.2800	0.	-5.00	50.43	32.00	0.702	0.528	817.0	614.4	519.6	953.5	628.7	-324.7	1
2	0.8750	10.0492	12.1	-3.69	49.00	27.58	0.733	0.544	849.0	629.4	556.5	932.0	640.1	-291.9	2
3	0.9200	9.4803	42.1	-0.77	47.39	18.42	0.797	0.569	914.6	652.6	619.1	879.3	673.1	-206.2	3
4	0.9650	8.8863	73.4	2.18	48.24	10.13	0.836	0.566	953.2	645.2	634.7	824.2	710.8	-113.4	4
5	1.0000	8.3800	100.0	5.00	50.51	2.54	0.857	0.547	973.2	621.0	618.0	777.2	749.9	-27.4	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	10.2800	25.814	618.47	594.35	18.570	562.93	0.08904	1.7566	1.19238	0.9078	0.96000	1
2	0.8750	10.0492	25.733	618.00	590.99	18.001	558.02	0.08707	1.7510	1.19147	0.9066	0.96000	2
3	0.9200	9.4803	25.527	617.20	583.03	16.792	547.59	0.08277	1.7370	1.18993	0.8998	0.96000	3
4	0.9650	8.8863	25.292	616.20	575.22	15.994	540.58	0.07986	1.7210	1.18800	0.8925	0.96000	4
5	1.0000	8.3800	25.130	615.70	568.96	15.558	536.87	0.07822	1.7100	1.18703	0.8857	0.96000	5

MASS AVERAGED VALUES

P_T/P_TI 1.7335 EFF 0.8981 P_T 25.475 T_T 616.99 TT/TTI 1.18952 CZ 605.58
CORR. FLOW 23.370 CORR. RPM 9744.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.90000 Z 16.687833 STATOR 1 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	25.7303	0.	-9.00	20.00	51.27	0.529	0.790	191.3	285.6	177.8	286.4	64.7	-221.7	1
2	0.8750	25.2309	12.0	-7.96	19.47	49.96	0.539	0.786	194.6	283.9	181.9	280.8	64.3	-216.5	2
3	0.9200	23.9595	42.5	-4.55	18.21	47.12	0.556	0.775	200.3	279.2	189.7	266.7	62.4	-204.3	3
4	0.9650	22.6356	74.3	-0.62	16.96	44.45	0.570	0.764	204.8	274.5	195.9	251.9	59.8	-192.2	4
5	1.0000	21.5646	100.0	2.50	16.00	41.66	0.593	0.762	212.4	273.2	204.0	240.0	58.5	-181.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	25.7303	17.390	343.60	365.96	14.372	325.38	1.53876	1.7163	1.19238	0.8674	0.95600	1
2	0.8750	25.2309	17.386	343.33	364.60	14.267	324.48	1.53177	1.7158	1.19147	0.8711	0.95600	2
3	0.9200	23.9595	17.254	342.89	361.72	13.987	322.93	1.50693	1.7028	1.18993	0.8649	0.95600	3
4	0.9650	22.6356	16.925	342.33	359.94	13.579	321.45	1.47159	1.6704	1.18800	0.8398	0.95600	4
5	1.0000	21.5646	16.667	342.06	356.75	13.141	319.60	1.43245	1.6449	1.18703	0.8170	0.95600	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP2Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.08171	0.9771		0.414	0.314	1.123	1.4195	25.9208	494.50	333.32			1
2	0.8750	0.05686	0.9799		0.424	0.343	1.073	1.4509	25.3779	514.62	346.31			2
3	0.9200	0.05747	0.9803		0.449	0.409	1.005	1.5329	24.0197	553.50	369.04			3
4	0.9650	0.08003	0.9706		0.460	0.398	1.013	1.6284	22.6034	571.78	373.32			4
5	1.0000	0.09936	0.9620		0.449	0.366	1.083	1.7174	21.4249	579.15	381.93			5

MASS AVERAGED VALUES

P_T/P_TI 1.6902 EFF 0.8537 P_T 17.126 TT 342.77 TT/TTI 1.18952 CZ 190.58 ROW P_T2/P_T1 0.9751

CORR. FLOW 10.872 CORR. RPM 9744.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 1.90000 Z 6.570000 STATOR 1 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	10.1300	0.	-9.00	20.00	51.27	0.529	0.790	627.6	936.8	583.3	939.5	212.3	-727.2	1
2	0.8750	9.9334	12.0	-7.96	19.47	49.96	0.539	0.786	638.6	931.5	596.9	921.3	211.1	-710.3	2
3	0.9200	9.4328	42.5	-4.55	18.21	47.12	0.556	0.775	657.0	915.9	622.3	874.9	204.7	-670.1	3
4	0.9650	8.9116	74.3	-0.62	16.96	44.45	0.570	0.764	672.1	900.4	642.8	826.5	196.0	-630.5	4
5	1.0000	8.4900	100.0	2.50	16.00	41.66	0.593	0.762	696.9	896.4	669.3	787.4	191.9	-595.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	10.1300	25.223	618.47	658.74	20.845	585.69	0.09606	1.7163	1.19233	0.8674	0.95600	1
2	0.8750	9.9334	25.216	618.00	656.28	20.693	584.06	0.09563	1.7158	1.19147	0.8711	0.95600	2
3	0.9200	9.4328	25.025	617.20	651.09	20.287	581.27	0.09420	1.7028	1.18993	0.8649	0.95600	3
4	0.9650	8.9116	24.548	616.20	646.09	19.694	578.61	0.09187	1.6704	1.18800	0.8398	0.95600	4
5	1.0000	8.4900	24.174	615.70	642.15	19.060	575.28	0.08943	1.6449	1.18703	0.8170	0.95600	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP?Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.08171	0.9771		0.414	0.314	1.123	1.4195	10.2050	282.37	190.33			1
2	0.8750	0.06686	0.9799		0.424	0.348	1.073	1.4509	9.9913	293.86	197.75			2
3	0.9200	0.05747	0.9803		0.449	0.400	1.005	1.5329	9.4566	316.06	210.73			3
4	0.9650	0.08003	0.9706		0.460	0.398	1.013	1.6284	8.8990	326.50	213.17			4
5	1.0000	0.09986	0.9620		0.449	0.366	1.083	1.7174	8.4350	330.70	218.09			5

MASS AVERAGED VALUES

P_T/P_TI 1.6902 EFF 0.8537 P_T 24.840 TT 616.99 TT/TTI 1.18952 CZ 625.26 ROW P_T2/P_T1 0.9751

CORR. FLOW 23.968 CORR. RPM 9744.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.00000 Z 17.272034 ROTOR 2 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	25.6312	0.	-10.70	19.27	49.85	0.554	0.805	200.0	290.4	185.8	285.3	65.0	-220.3	1
2	0.8750	25.1450	12.0	-8.75	18.77	48.58	0.563	0.801	202.7	288.6	189.9	279.9	64.5	-215.3	2
3	0.9200	23.9080	42.4	-5.53	17.52	45.78	0.581	0.792	208.6	284.7	198.1	266.1	62.5	-203.6	3
4	0.9650	22.6194	74.1	-2.42	16.45	43.47	0.589	0.778	211.3	279.1	202.5	251.8	59.8	-192.0	4
5	1.0000	21.5646	100.0	2.50	15.84	41.36	0.599	0.767	214.5	274.8	206.2	240.0	58.5	-181.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	25.6312	17.390	343.60	365.65	14.113	323.69	1.51886	1.7163	1.19233	0.8674	0.95600	1
2	0.8750	25.1450	17.386	343.33	364.33	14.023	322.88	1.51300	1.7158	1.19147	0.8711	0.95600	2
3	0.9200	23.9080	17.254	342.89	361.56	13.732	321.24	1.48922	1.7028	1.18993	0.8649	0.95600	3
4	0.9650	22.6194	16.923	342.33	358.89	13.383	320.12	1.45638	1.6704	1.18800	0.8398	0.95600	4
5	1.0000	21.5646	16.667	342.06	356.75	13.078	319.16	1.42750	1.6449	1.18703	0.8170	0.95600	5

MASS AVERAGED VALUES

P_T/P_{TI} 1.6902 EFF 0.8537 P_T 17.126 T_T 342.77 T_T/T_{TI} 1.18952 CZ 197.70
CORR. FLOW 10.872 CORR. RPM 9744.8 CORR. U-TIP 261.6

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.00000 Z 6.800000 ROTOR 2 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	10.0910	0.	-10.70	19.27	49.35	0.554	0.805	656.1	952.6	609.7	935.9	213.1	-722.8	1
2	0.8750	9.8996	12.0	-8.75	18.77	48.58	0.563	0.801	665.1	946.8	623.1	918.2	211.8	-706.4	2
3	0.9200	9.4126	42.4	-5.53	17.52	45.78	0.581	0.792	684.3	933.9	649.8	873.0	205.2	-667.8	3
4	0.9650	8.9053	74.1	-2.42	16.45	43.47	0.589	0.778	693.2	915.8	664.2	826.0	196.2	-629.8	4
5	1.0000	8.4900	100.0	2.50	15.84	41.36	0.599	0.767	703.8	901.7	676.4	787.4	191.9	-595.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	10.0910	25.223	618.47	658.17	20.469	582.65	0.09482	1.7163	1.19238	0.8674	0.95600	1
2	0.8750	9.8996	25.216	618.00	655.80	20.339	581.19	0.09446	1.7158	1.19147	0.8711	0.95600	2
3	0.9200	9.4126	25.025	617.20	650.81	19.917	578.23	0.09297	1.7028	1.18993	0.8649	0.95600	3
4	0.9650	8.9053	24.548	616.20	646.01	19.410	576.21	0.09092	1.6704	1.18800	0.8398	0.95600	4
5	1.0000	8.4900	24.174	615.70	642.15	18.768	574.48	0.08912	1.6449	1.18703	0.8170	0.95600	5

MASS AVERAGED VALUES

P_T/P_{TI} 1.6902 EFF 0.8537 P_T 24.840 T_T 616.99 T_T/T_{TI} 1.18952 CZ 648.63
CORR. FLOW 23.368 CORR. RPM 9744.8 CORR. U-TIP 858.1

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.50000 Z 19.624637 ROTOR 2 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	25.2883	0.	-10.70	41.36	32.55	0.675	0.602	249.4	222.7	185.3	281.5	163.1	-118.3	1
2	0.8750	24.8392	12.1	-10.42	40.71	31.46	0.678	0.604	250.1	222.8	187.8	276.5	161.6	-114.9	2
3	0.9200	23.6917	42.9	-8.06	40.23	26.94	0.697	0.598	256.5	220.1	194.7	263.7	164.7	-99.0	3
4	0.9650	22.5132	74.5	-4.70	41.42	18.71	0.745	0.591	273.3	216.9	204.6	250.6	180.5	-70.1	4
5	1.0000	21.5646	100.0	-3.50	44.30	8.93	0.809	0.587	296.3	214.8	211.8	240.0	206.7	-33.3	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	25.2883	22.253	370.86	364.57	16.402	339.90	1.68110	2.1962	1.26694	0.8783	0.95200	1
2	0.8750	24.8392	22.192	369.81	363.39	16.314	338.68	1.67804	2.1902	1.28336	0.8861	0.95200	2
3	0.9200	23.6917	22.212	369.56	360.93	16.053	336.81	1.66036	2.1922	1.28240	0.8899	0.95200	3
4	0.9650	22.5132	22.456	372.37	358.60	15.539	335.18	1.61503	2.2162	1.29222	0.8736	0.95200	4
5	1.0000	21.5646	22.946	377.46	356.75	14.920	333.78	1.55719	2.2646	1.30991	0.8489	0.95200	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.05826	1.2796	27.26	0.374	0.305	0.997	1.1857	25.4597	444.86	364.84	0.651	0.691	1
2	0.8750	0.04541	1.2765	26.48	0.365	0.311	0.989	1.2100	24.9921	437.74	350.59	0.679	0.692	2
3	0.9200	0.02795	1.2674	26.67	0.367	0.330	0.983	1.2688	23.7998	450.58	332.84	0.744	0.774	3
4	0.9650	0.03479	1.3268	30.03	0.384	0.327	1.010	1.3363	22.5663	510.34	315.60	0.804	0.961	4
5	1.0000	0.07665	1.3767	35.41	0.411	0.296	1.027	1.4003	21.5646	597.85	273.13	0.859	1.232	5

MASS AVERAGED VALUES

P_T/P_{TI} 2.2073 EFF 0.8783 P_T 22.365 TT 371.44 TT/TTI 1.28900 CZ 197.24 ROW P_{T2}/P_{T1} 1.3059

CORR. FLOW 8.666 CORR. RPM 9361.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.50000 Z 7.490000 ROTOR 2 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.9560	0.	-10.70	41.36	32.55	0.675	0.602	818.2	730.5	608.1	923.4	535.3	-388.1	1
2	0.8750	9.7792	12.1	-10.42	40.71	31.46	0.678	0.604	820.5	731.0	616.0	907.0	530.1	-376.9	2
3	0.9200	9.3274	42.9	-8.06	40.23	26.94	0.697	0.598	841.6	722.2	638.8	865.1	540.4	-324.7	3
4	0.9650	8.8634	74.5	-4.70	41.42	18.91	0.745	0.591	896.8	711.6	671.2	822.1	592.2	-229.9	4
5	1.0000	8.4900	100.0	-3.50	44.30	8.93	0.809	0.587	972.0	704.8	695.0	787.4	678.2	-109.2	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.9560	32.275	667.54	656.23	23.790	611.82	0.10495	2.1962	1.26698	0.8783	0.95200	1
2	0.8750	9.7792	32.188	665.66	654.10	23.661	609.63	0.10476	2.1902	1.28336	0.8861	0.95200	2
3	0.9200	9.3274	32.216	665.21	649.67	23.282	606.26	0.10366	2.1922	1.28249	0.8499	0.95200	3
4	0.9650	8.8634	32.569	670.26	645.47	22.537	603.33	0.10083	2.2162	1.29222	0.8736	0.95200	4
5	1.0000	8.4900	33.281	679.43	642.15	21.639	600.80	0.09722	2.2646	1.30991	0.8489	0.95200	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.05826	1.2796	49.07	0.374	0.305	0.997	1.1857	10.0235	254.03	208.33	0.651	0.691	1
2	0.8750	0.04541	1.2765	47.66	0.305	0.311	0.989	1.2100	9.8394	249.96	200.20	0.679	0.699	2
3	0.9200	0.02795	1.2874	48.01	0.367	0.330	0.983	1.2688	9.3700	257.29	190.06	0.744	0.771	3
4	0.9650	0.03479	1.3268	54.06	0.384	0.327	1.010	1.3363	8.8844	291.41	180.21	0.804	0.961	4
5	1.0000	0.07665	1.3767	63.73	0.411	0.296	1.027	1.4003	8.4900	341.39	155.96	0.859	1.232	5

MASS AVERAGED VALUES

P_T/P_{TI} 2.2073 EFF 0.8783 P_T 32.438 TT 668.59 TT/TTI 1.28900 CZ 647.11 ROW P_{T2}/P_{T1} 1.3059

CORR. FLOW 19.106 CORR. RPM 9361.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.60000 Z 19.685039 STATOR 2 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	25.1613	0.	-10.70	40.67	31.31	0.689	0.613	254.2	226.3	190.8	280.0	164.0	-116.1	1
2	0.8750	24.7191	12.2	-10.31	39.95	30.19	0.693	0.616	255.3	227.0	193.8	275.1	162.4	-112.8	2
3	0.9200	23.5963	43.1	-8.45	39.14	25.57	0.719	0.620	263.8	227.3	203.2	262.6	165.4	-97.2	3
4	0.9650	22.4487	74.6	-6.46	40.17	17.80	0.770	0.619	281.6	226.5	214.4	249.9	181.0	-68.8	4
5	1.0000	21.5265	100.0	-4.00	43.05	8.34	0.832	0.615	303.8	224.6	221.7	239.6	207.1	-32.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	25.1613	22.253	370.86	364.18	16.201	338.70	1.66632	2.1962	1.28698	0.8783	0.95200	1
2	0.8750	24.7191	22.192	369.81	363.02	16.095	337.38	1.66192	2.1902	1.28336	0.8861	0.95200	2
3	0.9200	23.5963	22.212	369.56	360.65	15.742	334.94	1.63735	2.1922	1.28248	0.8899	0.95200	3
4	0.9650	22.4487	22.456	372.37	358.42	15.170	332.89	1.58756	2.2162	1.29222	0.8736	0.95200	4
5	1.0000	21.5265	22.946	377.46	356.65	14.572	331.54	1.53121	2.2646	1.30991	0.8489	0.95200	5

MASS AVERAGED VALUES

P_T/P_TI 2.2073 EFF 0.8783 P_T 22.365 T_T 371.44 T_T/T_TI 1.28900 CZ 205.63
CORR. FLOW 8.566 CORR. RPM 9361.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.60000 Z 7.750000 STATOR 2 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.9060	0.	-10.70	40.67	31.31	0.689	0.613	833.9	742.3	626.1	918.8	538.0	-380.8	1
2	0.8750	9.7319	12.2	-10.31	39.95	30.19	0.693	0.616	837.5	744.7	635.9	902.6	532.7	-370.0	2
3	0.9200	9.2899	43.1	-8.45	39.14	25.57	0.719	0.620	865.3	745.8	666.8	861.6	542.6	-319.0	3
4	0.9650	8.8381	74.6	-6.46	40.17	17.80	0.770	0.619	924.0	743.0	703.4	819.7	593.9	-225.9	4
5	1.0000	8.4750	100.0	-4.00	43.05	8.34	0.832	0.615	996.6	736.9	727.3	786.0	679.4	-106.7	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.9060	32.275	667.54	655.52	23.497	609.67	0.10403	2.1962	1.28698	0.8783	0.95200	1
2	0.8750	9.7319	32.188	665.66	653.44	23.344	607.28	0.10375	2.1902	1.28336	0.8861	0.95200	2
3	0.9200	9.2899	32.216	665.21	649.17	22.832	602.89	0.10222	2.1922	1.28248	0.8899	0.95200	3
4	0.9650	8.8381	32.569	670.26	645.15	22.002	599.20	0.09911	2.2162	1.29222	0.8736	0.95200	4
5	1.0000	8.4750	33.281	679.43	641.97	21.136	596.77	0.09559	2.2646	1.30991	0.8489	0.95200	5

MASS AVERAGED VALUES

P_T/P_TI 2.2073 EFF 0.8783 P_T 32.438 T_T 668.59 T_T/T_TI 1.28900 CZ 674.65
CORR. FLOW 19.106 CORR. RPM 9361.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.90000 Z 21.336042 STATOR 2 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	24.8387	0.	-11.00	12.97	51.91	0.509	0.796	191.7	299.7	183.6	276.5	42.3	-234.2	1
2	0.8750	24.4104	12.4	-11.10	12.46	50.99	0.518	0.796	194.6	298.8	186.6	271.7	41.3	-230.4	2
3	0.9200	23.3315	43.5	-9.02	11.26	48.53	0.538	0.791	201.7	296.5	195.1	259.7	38.9	-220.8	3
4	0.9650	22.2393	75.0	-7.49	10.05	46.03	0.556	0.786	208.8	294.9	203.9	247.5	36.1	-211.4	4
5	1.0000	21.3741	100.0	-6.20	9.00	43.86	0.574	0.784	216.4	295.7	212.5	237.9	33.7	-204.2	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	24.8387	21.918	370.86	397.26	18.361	352.56	1.81429	2.1631	1.28698	0.8594	0.94800	1
2	0.8750	24.4104	21.962	369.81	395.39	18.287	350.96	1.81522	2.1675	1.28336	0.8729	0.94800	2
3	0.9200	23.3315	22.062	369.56	393.07	18.114	349.31	1.80649	2.1774	1.28248	0.8814	0.94800	3
4	0.9650	22.2393	22.152	372.37	393.95	17.952	350.66	1.78347	2.1862	1.29222	0.8569	0.94800	4
5	1.0000	21.3741	22.220	377.46	397.66	17.777	354.15	1.74869	2.1930	1.30991	0.8116	0.94800	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.05537	0.9849		0.380	0.357	0.962	1.8039	25.0000	591.16	304.23			1
2	0.8750	0.03778	0.9896		0.371	0.360	0.963	1.7985	24.5648	586.75	303.78			2
3	0.9200	0.02314	0.9933		0.370	0.367	0.960	1.7909	23.4639	607.15	311.05			3
4	0.9650	0.04173	0.9865		0.404	0.382	0.951	1.7813	22.3440	680.15	341.84			4
5	1.0000	0.08665	0.9684		0.449	0.383	0.959	1.7754	21.4503	789.42	391.03			5

MASS AVERAGED VALUES

P_T/P_TI 2.1785 EFF 0.8621 P_T 22.075 T_T 371.44 T_T/T_TI 1.28900 CZ 197.08 BOW P_T2/P_T1 0.9870

CORR. FLOW 8.781 CORR. RPM 9361.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 2.90000 Z 8.400000 STATOR 2 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.7790	0.	-11.00	12.97	51.91	0.509	0.796	629.0	983.2	602.3	907.0	138.7	-768.3	1
2	0.8750	9.6104	12.4	-11.10	12.46	50.99	0.518	0.796	638.5	980.3	612.3	891.3	135.3	-756.0	2
3	0.9200	9.1856	43.5	-9.62	11.26	48.53	0.538	0.791	661.7	972.9	640.2	852.0	127.5	-724.5	3
4	0.9650	8.7556	75.0	-7.49	10.05	46.03	0.556	0.786	685.2	967.7	669.1	812.1	118.6	-693.5	4
5	1.0000	8.4150	100.0	-6.20	9.00	43.86	0.574	0.784	710.0	970.0	697.3	780.5	110.4	-670.0	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.7790	31.789	667.54	715.07	26.631	634.61	0.11327	2.1631	1.28698	0.8594	0.94800	1
2	0.8750	9.6104	31.854	665.66	711.70	26.523	631.73	0.11332	2.1675	1.28336	0.8729	0.94800	2
3	0.9200	9.1856	31.999	665.21	707.53	26.272	628.76	0.11278	2.1774	1.28248	0.8814	0.94800	3
4	0.9650	8.7556	32.128	670.26	709.11	25.037	631.19	0.11134	2.1862	1.29222	0.8569	0.94800	4
5	1.0000	8.4150	32.228	679.43	715.78	25.784	637.47	0.10917	2.1930	1.30991	0.8116	0.94800	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP7Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.05537	0.9649		0.380	0.357	0.962	1.8039	9.8425	337.56	173.72			1
2	0.8750	0.03778	0.9696		0.371	0.369	0.963	1.7985	9.6711	335.05	173.46			2
3	0.9200	0.02314	0.9933		0.370	0.367	0.960	1.7909	9.2377	346.69	177.61			3
4	0.9650	0.04173	0.9865		0.404	0.382	0.951	1.7813	8.7968	388.38	195.20			4
5	1.0000	0.08665	0.9684		0.449	0.383	0.959	1.7754	8.4450	450.77	223.28			5

MASS AVERAGED VALUES

P_T/P_TI 2.1785 EFF 0.8621 P_T 32.015 TT 668.59 TT/TTI 1.28900 CZ 646.59 BOW P_{T2}/P_{T1} 0.9870

CORR. FLOW 19.358 CORR. RPM 9361.2

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.00000 Z 21.800863 ROTOR 3 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	24.7396	0.	-12.50	12.73	51.11	0.524	0.804	197.1	302.1	187.9	275.3	42.4	-232.9	1
2	0.8750	24.3177	12.4	-11.34	12.18	50.08	0.533	0.804	200.0	301.4	191.8	270.7	41.4	-229.2	2
3	0.9200	23.2516	43.7	-9.91	11.07	47.51	0.550	0.798	206.0	298.7	199.2	258.8	39.0	-219.8	3
4	0.9650	22.1755	75.3	-8.34	9.68	44.74	0.582	0.803	217.8	300.8	212.5	246.8	36.2	-210.6	4
5	1.0000	21.3360	100.0	-8.50	3.56	42.30	0.609	0.811	228.9	304.6	223.9	237.5	33.7	-203.7	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	24.7396	21.918	370.86	396.96	18.173	351.52	1.80098	2.1631	1.28698	0.8594	0.94800	1
2	0.8750	24.3177	21.962	369.81	395.11	18.095	349.91	1.80162	2.1675	1.28336	0.8729	0.94800	2
3	0.9200	23.2516	22.062	369.56	392.84	17.956	348.44	1.79525	2.1774	1.28248	0.8814	0.94800	3
4	0.9650	22.1755	22.152	372.37	393.78	17.614	348.76	1.75943	2.1862	1.29222	0.8569	0.94800	4
5	1.0000	21.3360	22.220	377.46	397.56	17.296	351.39	1.71477	2.1930	1.30991	0.8116	0.94800	5

MASS AVERAGED VALUES

$P_T/P_T I$ 2.1785 EFF 0.8521 P_T 22.073 T_T 371.44 $T_T/T_T I$ 1.28900 CZ 203.46
CORR. FLOW 8.781 CORR. RPM 9361.2 CORR. U-TIP 242.5

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.00000 Z 8.583000 ROTOR 3 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.7400	0.	-12.50	12.73	51.11	0.524	0.804	646.6	991.3	616.5	903.4	139.2	-764.1	1
2	0.8750	9.5739	12.4	-11.34	12.18	50.08	0.533	0.804	656.1	988.8	629.4	888.0	135.9	-752.1	2
3	0.9200	9.1542	43.7	-9.91	11.07	47.81	0.550	0.798	675.8	980.0	653.7	849.0	127.9	-721.1	3
4	0.9650	8.7305	75.3	-8.34	9.68	44.74	0.582	0.803	714.5	986.7	697.1	809.7	118.9	-690.8	4
5	1.0000	8.4000	100.0	-8.50	8.56	42.30	0.609	0.811	751.0	999.3	734.6	779.1	110.6	-668.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.7400	31.789	667.54	714.52	26.358	632.74	0.11243	2.1631	1.28698	0.8594	0.94800	1
2	0.8750	9.5739	31.854	665.66	711.20	26.246	629.83	0.11247	2.1675	1.28336	0.8729	0.94800	2
3	0.9200	9.1542	31.999	665.21	707.12	26.043	627.19	0.11206	2.1774	1.28248	0.8814	0.94800	3
4	0.9650	8.7305	32.128	670.26	708.80	25.547	627.77	0.10984	2.1862	1.29222	0.8569	0.94800	4
5	1.0000	8.4000	32.228	679.43	715.60	25.086	632.50	0.10705	2.1930	1.30991	0.8116	0.94800	5

MASS AVERAGED VALUES

$P_T/P_T I$ 2.1785 EFF 0.8521 P_T 32.012 T_T 668.59 $T_T/T_T I$ 1.28900 CZ 667.53
CORR. FLOW 19.358 CORR. RPM 9361.2 CORR. U-TIP 795.7

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.50000 Z 23.266446 ROTOR 3 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	24.3891	0.	-15.00	41.85	34.57	0.605	0.550	234.5	213.0	171.3	271.4	153.4	-118.0	1
2	0.8750	23.9773	12.5	-14.51	40.97	32.47	0.620	0.557	239.3	215.2	177.3	266.9	154.0	-112.9	2
3	0.9200	22.9472	43.9	-13.35	39.05	29.31	0.633	0.566	243.6	217.9	186.1	255.4	150.9	-104.5	3
4	0.9650	21.9146	75.4	-11.49	37.51	24.37	0.657	0.577	252.9	222.0	198.1	243.9	152.1	-91.8	4
5	1.0000	21.1074	100.0	-11.00	37.38	19.18	0.697	0.589	269.1	227.5	211.3	234.9	161.4	-73.5	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	24.3891	28.072	400.67	395.90	21.916	373.31	2.04519	2.7705	1.39045	0.8656	0.94400	1
2	0.8750	23.9773	28.229	399.56	394.10	21.787	371.06	2.04552	2.7860	1.38661	0.8797	0.94400	2
3	0.9200	22.9472	28.240	397.89	391.98	21.558	368.34	2.03890	2.7871	1.38078	0.8936	0.94400	3
4	0.9650	21.9146	28.228	400.38	393.07	21.121	368.54	1.99651	2.7859	1.38944	0.8733	0.94400	4
5	1.0000	21.1074	28.437	407.24	396.96	20.562	371.21	1.92971	2.8065	1.41324	0.8298	0.94400	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.06544	1.2808	29.82	0.430	0.388	0.912	1.2627	24.5644	557.90	494.37	0.682	0.813	1
2	0.8750	0.05606	1.2854	29.75	0.430	0.385	0.924	1.2834	24.1475	572.38	486.69	0.709	0.837	2
3	0.9200	0.03339	1.2500	28.33	0.409	0.385	0.934	1.3409	23.0994	566.43	456.91	0.770	0.873	3
4	0.9650	0.03278	1.2743	28.01	0.398	0.376	0.932	1.4028	22.0450	583.75	413.51	0.861	0.949	4
5	1.0000	0.03354	1.2798	29.78	0.395	0.349	0.944	1.4623	21.2217	637.64	372.95	0.943	1.083	5

MASS AVERAGED VALUES

P_T/P_TI 2.7878 EFF 0.8748 P_T 28.247 TT 400.27 TT/TTI 1.38907 CZ 189.39 BOW P_T2/P_T1 1.2797

CORR. FLOW 7.123 CORR. RPM 9017.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.50000 Z 9.160000 ROTOR 3 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.6020	0.	-15.00	41.85	34.57	0.605	0.550	769.3	698.9	562.0	890.6	503.3	-387.3	1
2	0.8750	9.4399	12.5	-14.51	40.97	32.47	0.620	0.557	785.2	705.9	581.8	875.5	505.3	-370.3	2
3	0.9200	9.0343	43.9	-13.35	39.05	29.31	0.633	0.566	799.3	714.9	610.5	837.9	495.2	-342.7	3
4	0.9650	8.6278	75.4	-11.49	37.51	24.87	0.657	0.577	829.9	728.4	649.9	800.2	498.9	-301.3	4
5	1.0000	8.3100	100.0	-11.00	37.38	19.18	0.697	0.589	882.8	746.3	693.3	770.7	529.6	-241.1	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.6020	40.716	721.21	712.61	31.786	671.96	0.12768	2.7705	1.39045	0.8656	0.94400	1
2	0.8750	9.4399	40.943	719.22	709.38	31.600	667.91	0.12770	2.7860	1.38661	0.8797	0.94400	2
3	0.9200	9.0343	40.959	716.19	705.56	31.267	663.02	0.12729	2.7871	1.38078	0.8936	0.94400	3
4	0.9650	8.6278	40.941	720.68	707.52	30.633	663.37	0.12464	2.7859	1.38944	0.8733	0.94400	4
5	1.0000	8.3100	41.245	733.03	714.53	29.823	668.17	0.12047	2.8065	1.41324	0.8298	0.94400	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.06544	1.2608	53.67	0.438	0.388	0.912	1.2627	9.6710	318.57	282.29	0.682	0.813	1
2	0.8750	0.05606	1.2854	53.55	0.430	0.385	0.924	1.2834	9.5069	326.84	277.91	0.709	0.889	2
3	0.9200	0.03339	1.2800	50.99	0.409	0.385	0.934	1.3409	9.0942	323.44	260.68	0.770	0.879	3
4	0.9650	0.03278	1.2743	50.43	0.398	0.376	0.932	1.4028	8.6791	333.33	236.12	0.861	0.947	4
5	1.0000	0.05354	1.2798	53.60	0.395	0.349	0.944	1.4623	8.3550	364.10	212.96	0.943	1.081	5

MASS AVERAGED VALUES

P_T/P_TI 2.7878 EFF 0.8748 P_T 40.969 TT 720.49 TT/TTI 1.38907 CZ 621.37 ROW P_T2/P_T1 1.2797

CORR. FLOW 15.703 CORR. RPM 9017.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.60000 Z 23.901447 STATOR 3 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	24.2316	0.	-15.80	42.28	34.18	0.605	0.544	234.5	210.8	169.8	269.7	154.4	-115.3	1
2	0.8750	23.8159	12.8	-14.25	40.94	31.61	0.624	0.556	241.0	214.8	178.8	265.1	155.1	-110.0	2
3	0.9200	22.7961	44.2	-13.54	38.37	27.94	0.649	0.578	249.1	222.1	191.9	253.7	151.9	-101.8	3
4	0.9650	21.7787	75.4	-12.72	36.83	23.63	0.676	0.593	259.4	227.7	204.3	242.4	153.0	-89.4	4
5	1.0000	20.9804	100.0	-13.00	36.89	18.19	0.714	0.605	275.1	233.2	216.4	233.5	162.4	-71.1	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	24.2316	28.072	400.67	395.42	21.916	373.31	2.04517	2.7705	1.39045	0.8656	0.94400	1
2	0.8750	23.8159	28.229	399.56	393.62	21.707	370.67	2.04010	2.7860	1.38661	0.8797	0.94400	2
3	0.9200	22.7961	28.240	397.89	391.55	21.286	367.01	2.02050	2.7871	1.38078	0.8936	0.94400	3
4	0.9650	21.7787	28.228	400.38	392.70	20.793	366.69	1.97433	2.7859	1.38944	0.8733	0.94400	4
5	1.0000	20.9804	28.437	407.24	396.63	20.247	369.57	1.90856	2.8065	1.41324	0.8298	0.94400	5

MASS AVERAGED VALUES

P_T/P_TI 2.7878 EFF 0.8748 P_T 28.247 T_T 400.27 TT/TTI 1.38907 CZ 193.96

CORR. FLOW 7.123 CORR. RPM 9017.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.60000 Z 9.410000 STATOR 3 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.5400	0.	-15.80	42.28	34.18	0.605	0.544	769.3	691.6	557.1	884.8	506.6	-378.3	1
2	0.8750	9.3763	12.8	-14.25	40.94	31.61	0.624	0.556	790.6	704.6	586.5	869.6	508.7	-360.9	2
3	0.9200	8.9748	44.2	-13.54	38.37	27.94	0.649	0.578	817.2	728.5	629.5	832.4	498.5	-333.9	3
4	0.9650	8.5743	75.4	-12.72	36.83	23.63	0.676	0.593	851.0	747.1	670.3	795.3	502.0	-293.2	4
5	1.0000	8.2600	100.0	-13.00	36.89	18.19	0.714	0.605	902.6	765.0	709.9	766.1	532.8	-233.3	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.5400	40.716	721.21	711.76	31.786	671.95	0.12768	2.7705	1.39045	0.8656	0.94400	1
2	0.8750	9.3763	40.943	719.22	708.52	31.483	667.20	0.12736	2.7860	1.38661	0.8797	0.94400	2
3	0.9200	8.9748	40.959	716.19	704.79	30.873	660.62	0.12614	2.7871	1.38078	0.8936	0.94400	3
4	0.9650	8.5743	40.941	720.68	706.86	30.158	660.41	0.12326	2.7859	1.38944	0.8733	0.94400	4
5	1.0000	8.2600	41.245	733.03	713.93	29.366	665.23	0.11915	2.8065	1.41324	0.8298	0.94400	5

MASS AVERAGED VALUES

P_T/P_TI 2.7878 EFF 0.8748 P_T 40.969 T_T 720.49 TT/TTI 1.38907 CZ 636.35

CORR. FLOW 15.703 CORR. RPM 9017.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.90000 Z 25.476250 STATOR 3 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	23.7744	0.	-16.00	2.00	56.55	0.452	0.798	177.9	313.8	170.9	264.6	6.0	-258.6	1
2	0.8750	23.3743	12.3	-16.73	2.00	55.22	0.470	0.800	184.3	313.8	176.4	260.2	6.2	-254.0	2
3	0.9200	22.3670	43.3	-17.02	2.00	53.27	0.485	0.787	189.4	307.7	181.0	248.9	6.3	-242.6	3
4	0.9650	21.3329	75.1	-18.60	2.00	51.04	0.504	0.776	197.1	303.5	186.7	237.4	6.5	-230.9	4
5	1.0000	20.5232	100.0	-15.00	2.00	46.97	0.544	0.783	213.9	307.6	206.5	228.4	7.2	-221.2	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	23.7744	27.644	400.67	433.95	24.025	384.93	2.17435	2.7283	1.39045	0.8506	0.94000	1
2	0.8750	23.3743	27.943	399.56	431.65	24.018	382.65	2.18665	2.7578	1.38661	0.8596	0.94000	2
3	0.9200	22.3670	28.059	397.89	427.16	23.893	380.03	2.19032	2.7692	1.38078	0.8871	0.94000	3
4	0.9650	21.3329	27.950	400.38	426.90	23.503	381.04	2.14879	2.7585	1.38944	0.8636	0.94000	4
5	1.0000	20.5232	27.938	407.24	431.57	22.843	384.47	2.06979	2.7573	1.41324	0.8134	0.94000	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP70	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.06953	0.9647		0.423	0.343	1.006	1.7623	24.0030	757.89	323.95			1
2	0.8750	0.04386	0.9899		0.414	0.354	0.987	1.7455	23.5951	780.22	330.66			2
3	0.9200	0.02607	0.9936		0.414	0.375	0.943	1.6953	22.5615	763.09	313.11			3
4	0.9650	0.03736	0.9902		0.414	0.364	0.914	1.6370	21.5558	751.96	276.83			4
5	1.0000	0.06090	0.9825		0.402	0.317	0.954	1.5896	20.7518	800.86	287.92			5

MASS AVERAGED VALUES

P_T/P_{TI} 2.7596 EFF 0.8648 P_T 27.961 T_T 400.27 T_T/T_{TI} 1.38987 C_Z 183.70 RO_W P_{T2}/P_{T1} 0.9899

CORR. FLOW 7.196 CORR. RPM 9017.8

FAN AND BOOSTER STAGES - FINAL DESIGN

STATION 3.90000 Z 10.030000 STATOR 3 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.8571	9.3600	0.	-16.00	2.00	56.55	0.452	0.798	583.6	1029.7	560.6	868.1	19.6	-848.5	1
2	0.8750	9.2025	12.3	-16.73	2.00	55.22	0.470	0.800	604.8	1029.4	578.8	853.5	20.2	-833.3	2
3	0.9200	8.8059	43.3	-17.02	2.00	53.27	0.485	0.787	621.4	1009.6	593.9	816.7	20.7	-796.0	3
4	0.9650	8.3988	75.1	-18.60	2.00	51.04	0.504	0.776	646.8	995.9	612.6	779.0	21.4	-757.6	4
5	1.0000	8.0800	100.0	-15.00	2.00	46.97	0.544	0.783	701.7	1009.3	677.4	749.4	23.7	-725.8	5

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.8571	9.3600	40.095	721.21	781.10	34.846	692.87	0.13574	2.7283	1.39045	0.8506	0.94000	1
2	0.8750	9.2025	40.528	719.22	776.97	34.836	688.78	0.13651	2.7578	1.38661	0.8696	0.94000	2
3	0.9200	8.8059	40.696	716.19	768.89	34.655	684.05	0.13674	2.7692	1.38078	0.8871	0.94000	3
4	0.9650	8.3988	40.538	720.68	768.41	34.088	685.87	0.13415	2.7585	1.38944	0.8636	0.94000	4
5	1.0000	8.0800	40.521	733.03	776.82	33.131	692.05	0.12922	2.7573	1.41324	0.8134	0.94000	5

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.8571	0.06953	0.9847		0.423	0.343	1.006	1.7623	9.4500	432.77	184.98			1
2	0.8750	0.04388	0.9899		0.414	0.354	0.987	1.7455	9.2894	445.52	188.81			2
3	0.9200	0.02607	0.9936		0.414	0.375	0.943	1.6953	8.8904	435.74	178.79			3
4	0.9650	0.03736	0.9902		0.414	0.364	0.914	1.6370	8.4865	429.38	158.07			4
5	1.0000	0.06090	0.9825		0.402	0.317	0.954	1.5896	8.1700	457.31	164.18			5

MASS AVERAGED VALUES

P_T/P_TI 2.7596 EFF 0.8648 P_T 40.555 T_T 720.49 T_T/T_TI 1.38907 CZ 602.67 $BOW\ P_T2/P_T1$ 0.9899

CORR. FLOW 15.864 CORR. RPM 9017.8

FAN AND BOOSTER STAGES - FINAL DESIGN

(BY-PASS OGV)

STATION 12.60000 Z 21.894843 STATOR 12 INLET METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	44.2469	0.	-1.50	43.42	66.93	0.560	1.038	205.8	381.5	149.5	492.5	141.5	-351.0	1
2	0.1000	42.4042	11.0	-1.11	39.72	62.24	0.617	1.018	224.7	371.1	172.8	472.0	143.6	-328.4	2
3	0.2000	40.6815	21.3	-1.04	37.94	58.74	0.654	0.994	236.6	359.5	186.6	452.8	145.5	-307.3	3
4	0.3000	38.9756	31.5	-1.02	37.66	55.86	0.677	0.955	243.9	344.1	193.1	433.8	149.0	-284.8	4
5	0.4000	37.2244	42.0	-0.83	37.84	53.12	0.693	0.912	248.7	327.3	196.4	414.3	152.5	-261.8	5
6	0.5000	35.3925	52.9	-0.44	38.18	50.22	0.706	0.867	252.2	309.8	198.2	393.9	155.9	-238.0	6
7	0.6500	32.4093	70.7	0.52	39.66	44.97	0.721	0.785	256.3	278.9	197.3	360.7	163.6	-197.1	7
8	0.7500	30.1977	83.9	1.60	41.16	40.37	0.732	0.723	259.0	255.9	194.9	336.1	170.4	-165.7	8
9	0.8571	27.5083	100.0	4.00	44.36	33.74	0.738	0.665	260.5	224.1	186.0	306.2	181.9	-124.3	9

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	44.2469	18.036	357.50	408.86	14.579	336.41	1.50974	1.7800	1.24063	0.7443	0.96500	1
2	0.1000	42.4042	18.543	355.61	399.01	14.347	330.48	1.51241	1.8300	1.23408	0.8052	0.96500	2
3	0.2000	40.6815	18.856	353.72	390.19	14.150	325.86	1.51273	1.8610	1.22752	0.8535	0.96500	3
4	0.3000	38.9756	18.948	352.56	381.81	13.938	322.89	1.50380	1.8700	1.22328	0.8771	0.96500	4
5	0.4000	37.2244	18.887	351.06	373.59	13.699	320.28	1.49010	1.8640	1.21827	0.8922	0.96500	5
6	0.5000	35.3925	18.735	349.28	365.38	13.437	317.63	1.47373	1.8490	1.21210	0.9051	0.96500	6
7	0.6500	32.4093	18.390	346.89	352.91	13.005	314.19	1.44198	1.8150	1.20381	0.9110	0.96500	7
8	0.7500	30.1977	18.137	345.17	344.38	12.706	311.79	1.41966	1.7900	1.19733	0.9149	0.96500	8
9	0.8571	27.5083	17.798	343.60	334.81	12.390	309.82	1.39320	1.7566	1.19238	0.9078	0.96500	9

MASS AVERAGED VALUES

P_T/P_TI 1.8303 EFF 0.8728 P_T 18.545 T_T 350.40 T_T/T_TI 1.21598 CZ 189.06

CORR. FLOW 60.883 CORR. RPM 9638.2

FAN AND BOOSTER STAGES - FINAL DESIGN
(BY-PASS OGV)

STATION 12.60000 Z 8.620000 STATOR 12 INLET ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	17.4200	0.	-1.50	43.42	66.93	0.560	1.038	675.3	1251.7	490.4	1615.7	464.1	-1151.6	1
2	0.1000	16.6945	11.0	-1.11	39.72	62.24	0.617	1.018	737.2	1217.5	567.0	1548.4	471.1	-1077.3	2
3	0.2000	16.0163	21.3	-1.04	37.94	58.74	0.654	0.994	776.3	1179.5	612.1	1485.5	477.3	-1008.2	3
4	0.3000	15.3447	31.5	-1.02	37.66	55.86	0.677	0.955	800.2	1128.9	633.5	1423.2	488.9	-934.3	4
5	0.4000	14.6553	42.0	-0.83	37.84	53.12	0.693	0.912	815.8	1073.7	644.3	1359.3	500.4	-858.9	5
6	0.5000	13.9340	52.9	-0.44	38.18	50.22	0.706	0.867	827.3	1016.2	650.2	1292.4	511.4	-781.0	6
7	0.6500	12.7595	70.7	0.52	39.66	44.77	0.721	0.785	840.9	915.1	647.4	1183.4	536.7	-646.8	7
8	0.7500	11.8888	83.9	1.60	41.16	40.37	0.732	0.723	849.6	839.5	639.5	1102.7	559.1	-543.6	8
9	0.8571	10.8300	100.0	4.00	44.36	33.74	0.738	0.635	854.7	735.2	610.4	1004.5	596.8	-407.7	9

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	17.4200	26.159	643.50	735.94	21.146	605.55	0.09425	1.7800	1.24063	0.7443	0.96500	1
2	0.1000	16.6945	26.894	640.10	718.22	20.809	594.87	0.09442	1.8300	1.23408	0.8052	0.96500	2
3	0.2000	16.0163	27.349	636.70	702.34	20.523	586.55	0.09444	1.8610	1.22752	0.8535	0.96500	3
4	0.3000	15.3447	27.482	634.50	687.26	20.216	581.20	0.09388	1.8700	1.22328	0.8771	0.96500	4
5	0.4000	14.6553	27.393	631.90	672.45	19.870	576.51	0.09303	1.8640	1.21827	0.8922	0.96500	5
6	0.5000	13.9340	27.173	628.70	657.69	19.489	571.74	0.09200	1.8490	1.21210	0.9051	0.96500	6
7	0.6500	12.7595	26.673	624.40	635.25	18.862	565.55	0.09002	1.8150	1.20381	0.9110	0.96500	7
8	0.7500	11.8888	26.306	621.30	619.88	18.429	561.23	0.08863	1.7900	1.19783	0.9149	0.96500	8
9	0.8571	10.8300	25.814	618.47	602.66	17.970	557.67	0.08696	1.7566	1.19238	0.9078	0.96500	9

MASS AVERAGED VALUES

$P_T/P_T{}^I$ 1.8303 EFF 0.8728 P_T 26.898 T_T 630.72 $T_T/T_T{}^I$ 1.21598 CZ 620.28

CORR. FLOW 134.225 CORR. RPM 9638.2

FAN AND BOOSTER STAGES - FINAL DESIGN

(BY-PASS OGV)

STATION 12.90000 Z 28.446056 STATOR 12 EXIT METRIC UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	43.8913	0.	-5.50	0.	71.27	0.448	1.369	166.4	516.1	165.7	488.5	0.	-488.5	1
2	0.1000	42.2155	10.4	-1.35	0.	69.21	0.483	1.360	178.5	502.6	178.4	469.9	0.	-469.9	2
3	0.2000	40.6066	20.4	0.31	0.	67.53	0.508	1.330	186.9	489.1	186.9	451.9	0.	-451.9	3
4	0.3000	38.9947	30.5	1.85	0.	66.38	0.516	1.292	189.9	473.7	189.8	434.0	0.	-434.0	4
5	0.4000	37.3271	40.8	3.08	0.	65.52	0.518	1.248	189.4	456.6	189.1	415.4	0.	-415.4	5
6	0.5000	35.5653	51.8	3.88	0.	64.78	0.512	1.199	186.8	437.7	186.4	395.8	0.	-395.8	6
7	0.6500	32.6585	69.9	4.01	0.	63.73	0.493	1.112	179.8	405.5	179.4	363.5	0.	-363.5	7
8	0.7500	30.4800	83.4	2.98	0.	62.91	0.477	1.046	173.8	381.2	173.6	339.2	0.	-339.2	8
9	0.8571	27.8131	100.0	0.	0.	62.44	0.443	0.958	161.6	349.2	161.6	309.6	0.	-309.6	9

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	43.8913	17.821	357.50	476.27	15.530	343.71	1.57400	1.75[illegible]	1.24063	0.7275	0.95500	1
2	0.1000	42.2155	18.380	355.61	465.48	15.669	339.76	1.60661	1.8140	1.23408	0.7924	0.95500	2
3	0.2000	40.6066	18.706	353.72	455.38	15.680	336.33	1.62414	1.8462	1.22752	0.8415	0.95500	3
4	0.3000	38.9947	18.794	352.50	446.24	15.654	334.56	1.63000	1.8548	1.22328	0.8646	0.95500	4
5	0.4000	37.3271	18.722	351.06	436.95	15.596	333.20	1.63056	1.8477	1.21827	0.8784	0.95500	5
6	0.5000	35.5653	18.556	349.28	427.26	15.521	331.90	1.62915	1.8313	1.21210	0.8898	0.95500	6
7	0.6500	32.6585	18.184	346.89	412.64	15.399	330.80	1.62172	1.7947	1.20381	0.8923	0.95500	7
8	0.7500	30.4800	17.898	345.17	402.44	15.315	330.13	1.61611	1.7664	1.19783	0.8922	0.95500	8
9	0.8571	27.8131	17.475	343.60	391.29	15.269	330.60	1.60896	1.7246	1.19238	0.8759	0.95500	9

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.	0.05209	0.9881		0.461	0.275	1.108	1.3536	44.0691	914.21	369.05			1
2	0.1000	0.03867	0.9912		0.442	0.315	1.032	1.3805	42.3098	1003.86	391.09			2
3	0.2000	0.03189	0.9920		0.434	0.325	1.002	1.4639	40.6440	1044.51	393.80			3
4	0.3000	0.03082	0.9919		0.435	0.342	0.983	1.5628	38.9852	1050.43	397.14			4
5	0.4000	0.03182	0.9913		0.445	0.366	0.963	1.6747	37.2757	1030.38	395.34			5
6	0.5000	0.03377	0.9905		0.455	0.393	0.941	1.7844	35.4789	993.63	389.64			6
7	0.6500	0.03825	0.9888		0.465	0.445	0.909	1.8986	32.5339	923.51	388.07			7
8	0.7500	0.04408	0.9868		0.476	0.489	0.890	2.0041	30.3389	868.75	388.51			8
9	0.8571	0.05983	0.9818		0.465	0.532	0.869	2.0986	27.6607	787.90	394.39			9

MASS AVERAGED VALUES

P_T/P_TI 1.8113 EFF 0.8565 R_T 16.353 TT 350.40 TT/TTI 1.21598 CZ 180.89 ROW P_T2/P_T1 0.9896

CORR. FLOW 61.521 CORR. RPM 9638.2

FAN AND BOOSTER STAGES - FINAL DESIGN
(BY-PASS OGV)

STATION 12.90000 Z 11.200000 STATOR 12 EXIT ENGLISH UNITS

SL	PSI	RADIUS	% IMM	PHI	ALPHA	BETA	M-ABS	M-REL	C	W	CZ	U	CU	WU	SL
1	0.	17.2800	0.	-5.50	0.	71.27	0.446	1.389	546.1	1693.2	543.5	1602.7	0.	-1602.7	1
2	0.1000	16.6202	10.4	-1.35	0.	69.21	0.483	1.360	585.5	1649.0	585.4	1541.5	0.	-1541.5	2
3	0.2000	15.9868	20.4	0.31	0.	67.53	0.508	1.330	613.3	1604.6	613.3	1482.8	0.	-1482.8	3
4	0.3000	15.3522	30.5	1.85	0.	66.38	0.518	1.292	622.9	1554.2	622.5	1423.9	0.	-1423.9	4
5	0.4000	14.6957	40.8	3.08	0.	65.52	0.518	1.248	621.4	1498.0	620.5	1363.0	0.	-1363.0	5
6	0.5000	14.0021	51.8	3.68	0.	64.78	0.512	1.199	613.0	1436.1	611.6	1298.7	0.	-1298.7	6
7	0.6500	12.8577	69.9	4.01	0.	63.73	0.493	1.112	590.0	1330.5	588.5	1192.5	0.	-1192.5	7
8	0.7500	12.0000	83.4	2.98	0.	62.91	0.477	1.046	570.2	1250.5	569.4	1113.0	0.	-1113.0	8
9	0.8571	10.9500	100.0	0.	0.	62.44	0.443	0.958	530.2	1145.6	530.2	1015.6	0.	-1015.6	9

SL	PSI	RADIUS	PT	TT	TT-REL	PS	TS	RHO	PT/PTI	TT/TTI	EFF	BLKAGE	SL
1	0.	17.2800	25.848	643.50	857.28	22.524	618.68	0.09826	1.7588	1.24063	0.7275	0.95500	1
2	0.1000	16.6202	26.659	640.10	837.86	22.726	611.56	0.10030	1.8140	1.23408	0.7924	0.95500	2
3	0.2000	15.9868	27.131	636.70	819.68	22.742	605.39	0.10139	1.8462	1.22752	0.8415	0.95500	3
4	0.3000	15.3522	27.258	634.50	803.24	22.704	602.21	0.10176	1.8548	1.22328	0.8646	0.95500	4
5	0.4000	14.6957	27.154	631.90	786.52	22.620	599.76	0.10180	1.8477	1.21827	0.8784	0.95500	5
6	0.5000	14.0021	26.913	628.70	769.06	22.512	597.43	0.10171	1.8313	1.21210	0.8898	0.95500	6
7	0.6500	12.8577	26.374	624.40	742.76	22.335	595.43	0.10124	1.7947	1.20381	0.8923	0.95500	7
8	0.7500	12.0000	25.959	621.30	724.39	22.213	594.24	0.10089	1.7664	1.19783	0.8922	0.95500	8
9	0.8571	10.9500	25.345	618.47	704.32	22.146	595.08	0.10045	1.7246	1.19238	0.8759	0.95500	9

SL	PSI	TPLC	PR-ROW	DEL-T	D	DP/Q	CZ/CZ	SOLDTY	R-AVG	F-TAN	F-AXL	F-COEF	T-COEF	SL
1	0.	0.06209	0.9881		0.461	0.275	1.108	1.3536	17.3500	522.03	210.73			1
2	0.1000	0.03867	0.9912		0.442	0.315	1.032	1.3605	16.6574	573.23	223.32			2
3	0.2000	0.03189	0.9920		0.434	0.325	1.002	1.4639	16.0016	596.44	224.87			3
4	0.3000	0.03082	0.9919		0.435	0.342	0.983	1.5628	15.3485	599.81	226.78			4
5	0.4000	0.03182	0.9913		0.445	0.366	0.963	1.6747	14.6755	588.37	225.74			5
6	0.5000	0.03377	0.9905		0.455	0.393	0.941	1.7844	13.9680	567.38	222.49			6
7	0.6500	0.03825	0.9888		0.465	0.445	0.909	1.8986	12.8086	527.34	221.59			7
8	0.7500	0.04408	0.9868		0.476	0.480	0.890	2.0041	11.9444	496.07	221.85			8
9	0.8571	0.05983	0.9818		0.465	0.532	0.869	2.0086	10.8900	449.91	225.20			9

MASS AVERAGED VALUES

P_T/P_{T1} 1.8113 EFF. 0.8565 P_T 26.619 T_T 630.72 TT/TT1 1.21598 CZ 593.47 BOW P_{T2}/P_{T1} 0.9896
CORR. FLOW 135.630 CORR. RPM 9638.2

APPENDIX C. BLADE AND VANE AIRFOIL SECTION GEOMETRY.

FAN ROTOR HORIZONTAL PLANE SECTION GEOMETRY

Radius Inches	Radius Cm	% Blade Height	Camber Deg.	Stagger Deg.	t_{max}/C	Chord In	Chord Cm	Blade Edge Angles β^*_{LE} Deg.	Blade Edge Angles β^*_{TE} Deg.	Solidity
17.72	45.01	101.4	-1.95	66.00	.0433	3.825	9.716	65.35	67.30	1.512
17.66	44.86	100.8	-1.82	65.80	.0429	3.808	9.672	65.18	67.00	1.510
17.60	44.70	100.3	-1.68	65.60	.0425	3.791	9.629	65.01	66.69	1.508
17.52	44.50	99.5	-1.49	65.33	.0420	3.769	9.573	64.78	66.27	1.506
17.46	44.35	98.9	-1.34	65.13	.0415	3.752	9.530	64.60	65.94	1.505
17.00	43.18	94.4	0	63.54	.0386	3.627	9.213	63.24	63.24	1.494
16.00	40.64	84.6	1.40	60.31	.0365	3.417	8.679	60.49	59.09	1.496
15.00	38.10	74.9	2.15	56.88	.0361	3.245	8.242	57.48	55.33	1.515
14.00	35.56	65.1	3.30	53.89	.0374	3.153	8.009	54.70	51.40	1.577
13.00	33.02	55.3	5.87	50.28	.0411	3.080	7.823	52.16	46.28	1.659
12.00	30.48	45.5	10.30	45.87	.0468	3.029	7.694	49.73	39.43	1.768
11.00	27.94	35.8	18.03	40.04	.0551	2.977	7.562	47.66	29.63	1.895
10.00	25.40	26.0	31.12	32.37	.0662	2.927	7.435	46.11	14.99	2.050
9.00	22.86	16.2	50.05	23.53	.0789	2.912	7.396	44.58	-5.47	2.266
8.05	20.47	7.0	69.72	14.49	.0930	2.889	7.338	43.28	-26.43	2.513
7.70	19.56	3.5	76.05	11.05	.0985	2.885	7.329	43.05	-32.99	2.624
7.34	18.64	0	81.41	7.49	.1041	2.893	7.348	42.56	-38.86	2.760
7.05	17.91	-2.8	84.86	4.63	.1082	2.908	7.386	41.89	-42.98	2.889
6.76	17.17	-5.6	87.69	1.81	.1120	2.931	7.445	41.08	-46.61	3.036

Rotor Stacking Axis:

Axial Location Z = 3.84 cm (5.51 in) Ref. Z = 0 at rotor hub LE
Radius (O.D.) R = 44.65 cm (17.574 in)
Radius (I.D.) R = 18.63 cm (7.338 in)

Aspect Ratio = 3.34
No. of Blades= 44

BOOSTER ROTORS CYLINDRICAL SECTION GEOMETRY

Rotor 2

Radius Inches	Radius Cm	% Blade Height	Camber Deg.	Stagger Deg.	t_{max}/C	Chord In	Chord Cm	Blade Edge Angles β^*_{LE} Deg.	Blade Edge Angles β^*_{TE} Deg.	Solidity
10.036	25.491	100	23.35	38.31	.0396	0.747	1.897	49.99	26.64	1.185
10.024	25.461	99.2	23.21	38.22	.0400			49.82	26.61	1.187
9.839	24.951	87.3	21.43	36.94	.0453			47.66	26.23	1.207
9.370	23.800	56.9	23.02	33.69	.0549			45.20	22.18	1.268
8.884	22.565	25.5	32.35	28.19	.0635			44.37	12.02	1.338
8.490	21.565	0	47.25	20.54	.0700			44.17	-3.08	1.400

Aspect Ratio = 2.054
No. of Blades= 100

Rotor 3

Radius Inches	Radius Cm	% Blade Height	Camber Deg.	Stagger Deg.	t_{max}/C	Chord In	Chord Cm	Blade Edge Angles β^*_{LE} Deg.	Blade Edge Angles β^*_{TE} Deg.	Solidity
9.683	24.595	100	21.02	40.38	.0396	0.651	1.654	50.89	29.87	1.263
9.671	24.565	99.1	21.03	40.23	.0400			50.74	29.72	1.264
9.507	24.148	86.7	21.26	38.24	.0457			48.87	27.61	1.285
9.094	23.099	55.4	20.91	34.91	.0557			45.36	24.45	1.346
8.679	22.044	23.9	21.80	31.41	.0643			42.31	20.51	1.413
8.363	21.242	0	29.17	26.84	.0700			41.42	12.25	1.464

Aspect Ratio = 2.018
No. of Blades= 118

BOOSTER STATORS 1 AND 2 CYLINDRICAL GEOMETRY

Stator 1

Radius Inches	Cm	% Blade Height	Camber Deg.	Stagger Deg.	t_{max} / C	Chord In	Chord Cm	Blade Edge Angles β^*_{LE} Deg.	Blade Edge Angles β^*_{TE} Deg.	Solidity
10.213	25.94	100	42.49	30.11	.0701	1.110	2.819	51.35	8.86	1.418
10.205	25.92	99.6	42.37	30.11	.0700			51.29	8.92	1.420
9.991	25.38	87.6	39.16	30.01	.0660			49.59	10.43	1.449
9.456	24.02	57.6	36.08	28.64	.0565			46.67	10.60	1.531
8.899	22.60	26.3	39.10	27.72	.0470			47.28	8.17	1.627
8.435	21.42	0.3	47.84	26.91	.0400			50.83	2.99	1.717
8.429	21.41	0	47.96	26.90	.0399			50.88	2.92	1.719

Aspect Ratio = 1.596
No. Vanes = 82

Stator 2

Radius Inches	Cm	% Blade Height	Camber Deg.	Stagger Deg.	t_{max} / C	Chord In	Chord Cm	β^*_{LE} Deg.	β^*_{TE} Deg.	Solidity
9.846	25.01	100	34.13	22.09	.0701	.765	1.943	39.16	5.03	1.805
9.843	25.00	99.8	34.11	22.10	.0700	.764	1.941	39.16	5.03	1.804
9.671	24.56	87.5	33.05	22.44	.0675	.749	1.902	38.97	5.91	1.799
9.238	23.46	56.5	33.10	21.88	.0611	.712	1.808	38.43	5.34	1.791
8.797	22.34	25.0	36.80	21.42	.0548	.674	1.712	39.82	3.02	1.781
8.447	21.46	0	43.89	20.53	.0500	.645	1.638	42.48	-1.42	1.775

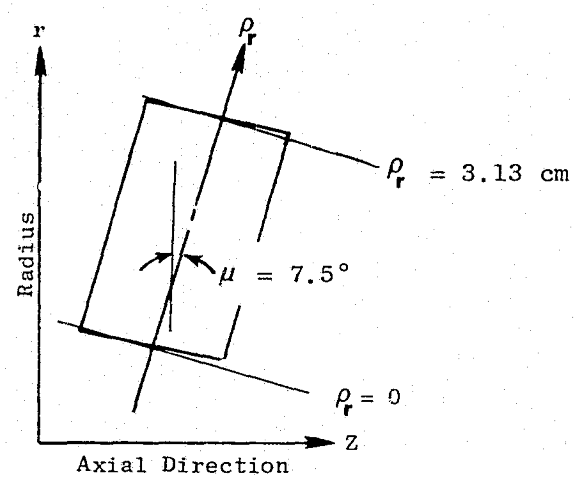
Aspect Ratio = 1.985
No. Vanes = 146

BOOSTER STATOR 3

HORIZONTAL PLANE SECTION GEOMETRY

Section Height (ρ_r) Inches	Section Height (ρ_r) Cm	% Blade Height	Camber Deg.	Stagger Deg.	$\frac{t_{max}}{C}$	Chord In	Chord Cm	Blade Edge Angles *LE Deg.	Blade Edge Angles *TE Deg.	Solidity
1.30	3.30	105.5	50.94	19.09	.0731	.641	1.628	43.24	-7.70	1.718
1.20	3.05	97.5	50.58	18.81	.0716	.630	1.600	42.94	-7.65	1.707
1.00	2.54	81.2	49.81	18.39	.0683	.609	1.547	42.24	-7.56	1.685
0.80	2.03	65.0	49.02	18.14	.0649	.588	1.494	41.43	-7.54	1.663
0.60	1.52	48.8	48.15	17.87	.0615	.567	1.440	40.84	-7.31	1.640
0.40	1.02	32.5	47.44	17.64	.0580	.547	1.389	40.56	-6.88	1.618
0.20	.51	16.2	47.77	17.79	.0548	.526	1.336	40.82	-6.95	1.593
0	0	0	49.20	18.34	.0519	.503	1.278	41.45	-7.76	1.560
-0.1	-.25	-8.1	50.02	18.66	.0505	.492	1.250	41.78	-8.24	1.545

Aspect Ratio = 2.20
No. Vanes = 160

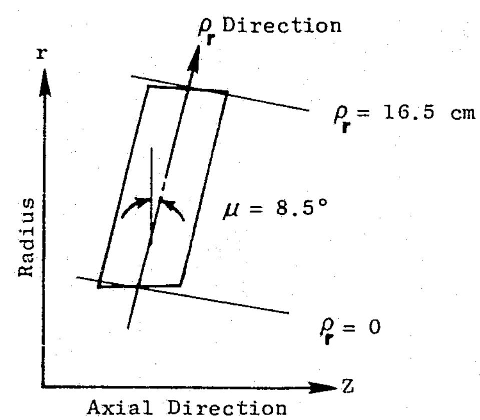


TABULATED HORIZONTAL PLANE SECTION DATA

BYPASS OGV - 90 65-SERIES AIRFOILS

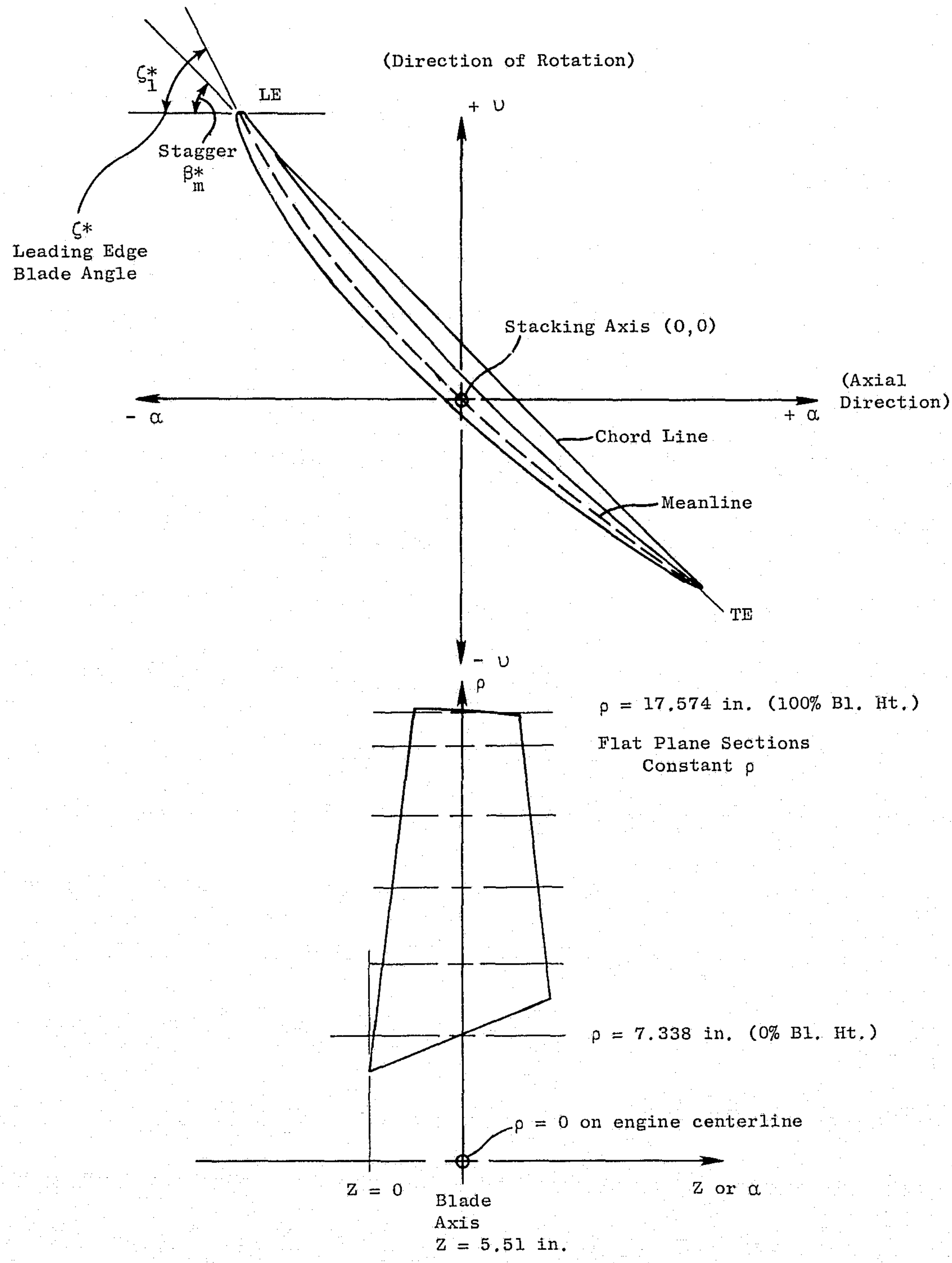
Aspect Ratio = 3.94

Section No.	Section Height (ρ_r) cm	Section Height (ρ_r) (in)	Chord cm	Chord (in)	$t_{m/c}$	Camber Deg.	Stagger Deg.	Solidity	% Height
1	-0.64	(-0.25)	3.858	(1.519)	.0496	53.63	19.94	2.041	- 3.9
2	-0.25	(-0.10)	3.879	(1.527)	.0503	53.07	19.62	2.025	- 1.5
3	0	(0)	3.894	(1.533)	.0508	52.70	19.41	2.013	0
4	.25	(0.10)	3.909	(1.539)	.0513	52.32	19.20	2.004	1.5
5	1.02	(0.40)	3.967	(1.562)	.0531	50.88	18.42	1.963	7.7
6	2.54	(1.00)	4.028	(1.586)	.0554	49.47	17.67	1.911	15.4
7	5.08	(2.00)	4.107	(1.617)	.0612	48.23	16.95	1.797	30.8
8	7.62	(3.00)	4.153	(1.635)	.0671	47.97	16.47	1.687	46.2
9	10.16	(4.00)	4.155	(1.636)	.0736	48.99	16.61	1.576	61.6
10	12.70	(5.00)	4.150	(1.634)	.0804	51.26	16.88	1.476	77.0
11	15.24	(6.00)	4.163	(1.639)	.0871	56.93	18.71	1.393	92.4
12	16.26	(6.40)	4.150	(1.634)	.0899	60.36	20.02	1.357	98.6
13	16.56	(6.52)	4.150	(1.632)	.0908	61.39	20.43	1.346	100.5
14	17.02	(6.70)	4.138	(1.629)	.0921	62.89	21.05	1.330	103.2



APPENDIX D. BLADE AND VANE AIRFOIL SECTION COORDINATES.

Dimensions are in inches, angles in degrees, and areas in square inches.



Fan Rotor Blade Coordinate Orientation.

STAGE 1, ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 3 SECTION CC R_{HO} 17.6000

CHORD	STAGGER	CAMBER
3.7914	65.602	-1.682

AREA 0.388139 SURFACE ARC LENGTH 7.60648

	ALPHA	UPSILON
SECTION C.G.	-0.00111	0.00233
STREAMSURFACE SECTION C.G.	-0.00388	0.01524
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

PT	T/C	UPPER ALPHA	UPPER UPSILON	LOWER ALPHA	LOWER UPSILON
1	0.00448	-0.88626	1.92551	-0.88626	1.92551
2	0.00448	-0.88813	1.92344	-0.88466	1.92568
3	0.00448	-0.88903	1.91943	-0.88265	1.92490
4	0.00448	-0.88887	1.91353	-0.88030	1.92312
5	0.00448	-0.88747	1.90581	-0.87770	1.92031
6	0.00448	-0.88472	1.89633	-0.87494	1.91644
7	0.00448	-0.88057	1.88511	-0.87204	1.91147
8	0.00448	-0.87516	1.87209	-0.86892	1.90547
9	0.00619	-0.85962	1.83541	-0.83834	1.84531
10	0.00788	-0.82333	1.74985	-0.79623	1.76247
11	0.00955	-0.78698	1.66444	-0.75417	1.67975
12	0.01118	-0.75058	1.57916	-0.71217	1.59711
13	0.01279	-0.71413	1.49400	-0.67021	1.51453
14	0.01437	-0.67764	1.40892	-0.62830	1.43201
15	0.01595	-0.64115	1.32388	-0.58638	1.34952
16	0.01756	-0.60471	1.23883	-0.54442	1.26703
17	0.01949	-0.56100	1.13669	-0.49404	1.16798
18	0.02141	-0.51726	1.03443	-0.44370	1.06875
19	0.02328	-0.47344	0.93205	-0.39344	0.96932
20	0.02509	-0.42952	0.82956	-0.34327	0.86967
21	0.02687	-0.38555	0.72693	-0.29315	0.76983
22	0.02864	-0.34157	0.62415	-0.24305	0.66983
23	0.03041	-0.29757	0.52125	-0.19296	0.56969
24	0.03214	-0.25352	0.41823	-0.14292	0.46936
25	0.03385	-0.20945	0.31505	-0.09291	0.36882
26	0.03556	-0.16538	0.21164	-0.04289	0.26798
27	0.03723	-0.12126	0.10794	0.00708	0.16673
28	0.03881	-0.07699	0.00388	0.05689	0.06490
29	0.04020	-0.03242	-0.10058	0.10640	-0.03770
30	0.04131	0.01262	-0.20549	0.15545	-0.14124
31	0.04209	0.05822	-0.31087	0.20394	-0.24578
32	0.04250	0.10448	-0.41668	0.25176	-0.35132
33	0.04239	0.15164	-0.52276	0.29868	-0.45785
34	0.04161	0.20000	-0.62885	0.34441	-0.56534
35	0.03998	0.24984	-0.73466	0.38866	-0.67374
36	0.03740	0.30136	-0.83992	0.43122	-0.78297
37	0.03401	0.35429	-0.94461	0.47238	-0.89280
38	0.03004	0.40823	-1.04879	0.51253	-1.00300
39	0.02555	0.46307	-1.15253	0.55177	-1.11360
40	0.02053	0.51882	-1.25591	0.59011	-1.22464
41	0.01492	0.57560	-1.35889	0.62741	-1.33617
42	0.00977	0.62373	-1.44444	0.65769	-1.42961
43	0.00439	0.66821	-1.52338	0.68506	-1.51610
44	0.00439	0.67280	-1.52742	0.68487	-1.52217
45	0.00439	0.67991	-1.52733	0.67991	-1.52733

LE RAD 0.00225 CENTER AT ALPHA -0.88532 UPSILON 1.92349
TE RAD 0.00925 CENTER AT ALPHA 0.67626 UPSILON -1.51886

STAGE 1. ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 6. SECTION FP R_{HO} 17.0000

CHORD	STAGGER	CAMBER
3.6267	63.544	0.004

AREA 0.321679 SURFACE ARC LENGTH 7.27537

	ALPHA	UPSILON
SECTION C.G.	-0.00032	0.00074
STREAMSURFACE SECTION C.G.	-0.00208	0.00959
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

PT	T/C	UPPER ALPHA	UPPER UPSILON	LOWER ALPHA	LOWER UPSILON
1	0.00484	-0.90983	1.82563	-0.90983	1.82563
2	0.00484	-0.91166	1.82345	-0.90819	1.82586
3	0.00484	-0.91245	1.81930	-0.90610	1.82510
4	0.00484	-0.91205	1.81323	-0.90364	1.82334
5	0.00484	-0.91033	1.80532	-0.90088	1.82052
6	0.00484	-0.90714	1.79565	-0.89793	1.81659
7	0.00484	-0.90243	1.78424	-0.89480	1.81155
8	0.00484	-0.89635	1.77101	-0.89143	1.80543
9	0.00626	-0.88149	1.73927	-0.86120	1.74948
10	0.00769	-0.84335	1.65780	-0.81845	1.67033
11	0.00910	-0.80519	1.57632	-0.77572	1.59115
12	0.01050	-0.76702	1.49482	-0.73301	1.51194
13	0.01187	-0.72880	1.41334	-0.69034	1.43269
14	0.01320	-0.69052	1.33188	-0.64774	1.35341
15	0.01453	-0.65222	1.25043	-0.60515	1.27412
16	0.01587	-0.61394	1.16897	-0.56254	1.19483
17	0.01750	-0.56805	1.07115	-0.51137	1.09966
18	0.01914	-0.52219	0.97327	-0.46017	1.00443
19	0.02077	-0.47631	0.87530	-0.40899	0.90908
20	0.02236	-0.43037	0.77723	-0.35787	0.81355
21	0.02392	-0.38438	0.67903	-0.30678	0.71785
22	0.02549	-0.33840	0.58069	-0.25571	0.62198
23	0.02705	-0.29241	0.48219	-0.20463	0.52597
24	0.02861	-0.24642	0.38358	-0.15356	0.42983
25	0.03014	-0.20039	0.28486	-0.10252	0.33355
26	0.03164	-0.15431	0.18606	-0.05154	0.23711
27	0.03311	-0.10819	0.08714	-0.00060	0.14050
28	0.03457	-0.06204	-0.01193	0.05032	0.04368
29	0.03596	-0.01581	-0.11117	0.10114	-0.05343
30	0.03722	0.03065	-0.21054	0.15174	-0.15092
31	0.03816	0.07763	-0.30992	0.20183	-0.24892
32	0.03859	0.12543	-0.40913	0.25109	-0.34752
33	0.03841	0.17425	-0.50799	0.29934	-0.44669
34	0.03754	0.22421	-0.60631	0.34644	-0.54636
35	0.03599	0.27528	-0.70398	0.39243	-0.64639
36	0.03381	0.32740	-0.80088	0.43738	-0.74663
37	0.03106	0.38045	-0.89695	0.48139	-0.84697
38	0.02777	0.43436	-0.99218	0.52454	-0.94733
39	0.02394	0.48914	-1.08654	0.56683	-1.04775
40	0.01954	0.54485	-1.18002	0.60818	-1.14826
41	0.01448	0.60159	-1.27257	0.64850	-1.24897
42	0.00976	0.64968	-1.34902	0.68129	-1.33309
43	0.00479	0.69351	-1.41784	0.71057	-1.40924
44	0.00479	0.69851	-1.42177	0.71075	-1.41560
45	0.00479	0.70593	-1.42125	0.70593	-1.42125

LE RAD 0.00227 CENTER AT ALPHA -0.90880 UPSILON 1.82361
TE RAD 0.00961 CENTER AT ALPHA 0.70160 UPSILON -1.41267

STAGE 1. ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 7 SECTION GG $R_H O$ 16.0000

CHORD	STAGGER	CAMBER
3.4167	60.313	1.398

AREA 0.275564 SURFACE ARC LENGTH 6.85503

	ALPHA	UPSILON
SECTION C.G.	-0.00053	0.00026
STREAMSURFACE SECTION C.G.	0.00046	0.00077
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

PT	T/C	UPPER ALPHA	UPPER UPSILON	LOWER ALPHA	LOWER UPSILON
1	0.00542	-0.93226	1.65264	-0.93226	1.65264
2	0.00542	-0.93408	1.65026	-0.93055	1.65296
3	0.00542	-0.93468	1.64584	-0.92831	1.65227
4	0.00542	-0.93395	1.63947	-0.92562	1.65053
5	0.00542	-0.93172	1.63122	-0.92258	1.64769
6	0.00542	-0.92784	1.62120	-0.91927	1.64370
7	0.00542	-0.92227	1.60942	-0.91573	1.63853
8	0.00542	-0.91516	1.59579	-0.91188	1.63225
9	0.00676	-0.90197	1.57097	-0.88186	1.58234
10	0.00810	-0.86161	1.49496	-0.83752	1.50858
11	0.00944	-0.82125	1.41891	-0.79316	1.43478
12	0.01080	-0.78092	1.34281	-0.74878	1.36096
13	0.01217	-0.74060	1.26668	-0.70440	1.28712
14	0.01352	-0.70026	1.19055	-0.66002	1.21325
15	0.01486	-0.65990	1.11438	-0.61568	1.13934
16	0.01617	-0.61949	1.03824	-0.57138	1.06539
17	0.01772	-0.57097	0.94686	-0.51825	0.97661
18	0.01926	-0.52244	0.85547	-0.46512	0.88780
19	0.02082	-0.47393	0.76403	-0.41198	0.79896
20	0.02239	-0.42545	0.67255	-0.35881	0.71010
21	0.02395	-0.37696	0.58103	-0.30565	0.62120
22	0.02548	-0.32841	0.48952	-0.25255	0.53223
23	0.02696	-0.27979	0.39800	-0.19952	0.44319
24	0.02839	-0.23110	0.30650	-0.14656	0.35407
25	0.02981	-0.18238	0.21499	-0.09362	0.26494
26	0.03125	-0.13369	0.12346	-0.04065	0.17583
27	0.03266	-0.08496	0.03200	0.01226	0.08676
28	0.03397	-0.03607	-0.05930	0.06503	-0.00227
29	0.03511	0.01308	-0.15032	0.11752	-0.09128
30	0.03598	0.06265	-0.24091	0.16961	-0.18028
31	0.03645	0.11283	-0.33090	0.22108	-0.26933
32	0.03640	0.16378	-0.42014	0.27178	-0.35848
33	0.03578	0.21557	-0.50855	0.32164	-0.44772
34	0.03462	0.26819	-0.59608	0.37068	-0.53702
35	0.03296	0.32153	-0.68275	0.41898	-0.62632
36	0.03086	0.37552	-0.76859	0.46664	-0.71555
37	0.02831	0.43017	-0.85359	0.51365	-0.80476
38	0.02528	0.48550	-0.93774	0.55997	-0.89398
39	0.02180	0.54148	-1.02109	0.60564	-0.98323
40	0.01789	0.59810	-1.10368	0.65068	-1.07252
41	0.01352	0.65536	-1.18550	0.69506	-1.16188
42	0.00955	0.70356	-1.25312	0.73157	-1.23640
43	0.00540	0.74659	-1.31286	0.76380	-1.30256
44	0.00540	0.75213	-1.31668	0.76455	-1.30927
45	0.00540	0.75992	-1.31560	0.75992	-1.31560

LE RAD 0.00238 CENTER AT ALPHA -0.93108 UPSILON 1.65057
TE RAD 0.01007 CENTER AT ALPHA 0.75475 UPSILON -1.30696

STAGE 1. ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MO 0. ETA 0.

SECTION NO 9 SECTION JJ $R_H O$ 14.0000

CHORD	STAGGER	CAMBER
3.1525	53.885	3.300

AREA 0.251314 SURFACE ARC LENGTH 6.32891

	ALPHA	UPSILON
SECTION C.G.	0.08024	-0.00011
STREAMSURFACE SECTION C.G.	-0.08096	-0.00052
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00655	-0.98426	1.38157	-0.98426	1.38157
2	0.00655	-0.98603	1.37870	-0.98240	1.38211
3	0.00655	-0.98623	1.37372	-0.97983	1.38161
4	0.00655	-0.98472	1.36672	-0.97664	1.37999
5	0.00655	-0.98136	1.35781	-0.97294	1.37719
6	0.00655	-0.97598	1.34710	-0.96880	1.37315
7	0.00655	-0.96853	1.33462	-0.96428	1.36783
8	0.00655	-0.95918	1.32026	-0.95926	1.36132
9	0.00816	-0.95036	1.30692	-0.92937	1.32178
10	0.00978	-0.90594	1.23974	-0.88077	1.25757
11	0.01141	-0.86153	1.17259	-0.83218	1.19338
12	0.01301	-0.81708	1.10548	-0.78362	1.12919
13	0.01459	-0.77260	1.03841	-0.73508	1.06499
14	0.01614	-0.72810	0.97139	-0.68657	1.00080
15	0.01768	-0.68356	0.90436	-0.63809	0.93660
16	0.01919	-0.63901	0.83738	-0.58964	0.87238
17	0.02098	-0.58550	0.75704	-0.53153	0.79530
18	0.02274	-0.53195	0.67673	-0.47347	0.71818
19	0.02445	-0.47834	0.59644	-0.41546	0.64102
20	0.02611	-0.42468	0.51620	-0.35751	0.56380
21	0.02773	-0.37095	0.43599	-0.29963	0.48656
22	0.02932	-0.31718	0.35585	-0.24178	0.40934
23	0.03091	-0.26339	0.27577	-0.18395	0.33222
24	0.03250	-0.20959	0.19582	-0.12614	0.25525
25	0.03400	-0.15567	0.11612	-0.06844	0.17840
26	0.03531	-0.10150	0.03681	-0.01100	0.10164
27	0.03636	-0.04697	-0.04199	0.04608	0.02492
28	0.03706	0.00801	-0.12018	0.10271	-0.05178
29	0.03741	0.06345	-0.19770	0.15889	-0.12841
30	0.03742	0.11933	-0.27451	0.21462	-0.20494
31	0.03706	0.17571	-0.35052	0.26986	-0.28134
32	0.03629	0.23262	-0.42565	0.32457	-0.35760
33	0.03509	0.29006	-0.49982	0.37874	-0.43368
34	0.03349	0.34801	-0.57301	0.43241	-0.50956
35	0.03154	0.40638	-0.64526	0.48564	-0.58520
36	0.02929	0.46512	-0.71662	0.53852	-0.66058
37	0.02673	0.52422	-0.78712	0.59103	-0.73575
38	0.02386	0.58370	-0.85679	0.64317	-0.81075
39	0.02069	0.64352	-0.92568	0.69497	-0.88559
40	0.01724	0.70366	-0.99380	0.74644	-0.96026
41	0.01348	0.76417	-1.06114	0.79754	-1.03480
42	0.01010	0.81490	-1.11663	0.83983	-1.09685
43	0.00658	0.85870	-1.16404	0.87613	-1.15015
44	0.00658	0.86538	-1.16752	0.87803	-1.15748
45	0.00658	0.87387	-1.16518	0.87387	-1.16518

LE RAD 0.00269 CENTER AT ALPHA -0.98271 UPSILON 1.37937
TE RAD 0.01118 CENTER AT ALPHA 0.86690 UPSILON -1.15644

STAGE I, ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 11 SECTION LL R_{HO} 12.0000

CHORD	STAGGER	CAMBER
3.0290	45.867	10.300

AREA 0.289355 SURFACE ARC LENGTH 6.09485

	ALPHA	UPSILON
SECTION C.G.	0.00024	-0.00019
STREAMSURFACE SECTION C.G.	-0.01000	0.00349
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

PT	T/C	UPPER ALPHA	UPPER UPSILON	LOWER ALPHA	LOWER UPSILON
1	0.00764	-1.05807	1.17268	-1.05807	1.17268
2	0.00764	-1.05983	1.16925	-1.05601	1.17350
3	0.00764	-1.05964	1.16362	-1.05306	1.17321
4	0.00764	-1.05736	1.15588	-1.04930	1.17175
5	0.00764	-1.05283	1.14618	-1.04484	1.16903
6	0.00764	-1.04591	1.13463	-1.03977	1.16497
7	0.00764	-1.03655	1.12129	-1.03411	1.15956
8	0.00764	-1.02491	1.10601	-1.02776	1.15287
9	0.01015	-1.01921	1.09863	-0.99577	1.11854
10	0.01260	-0.96924	1.03416	-0.94018	1.05892
11	0.01500	-0.91919	0.96992	-0.88465	0.99944
12	0.01736	-0.86910	0.90590	-0.82918	0.94014
13	0.01973	-0.81899	0.84210	-0.77371	0.88108
14	0.02211	-0.76890	0.77850	-0.71823	0.82231
15	0.02448	-0.71877	0.71518	-0.66279	0.76381
16	0.02679	-0.66856	0.65220	-0.60743	0.70558
17	0.02950	-0.60821	0.57709	-0.54110	0.63608
18	0.03213	-0.54774	0.50252	-0.47488	0.56702
19	0.03465	-0.48714	0.42853	-0.40879	0.49837
20	0.03704	-0.42636	0.35517	-0.34289	0.43013
21	0.03924	-0.36535	0.28250	-0.27722	0.36226
22	0.04123	-0.30406	0.21059	-0.21182	0.29480
23	0.04301	-0.24249	0.13950	-0.14671	0.22780
24	0.04455	-0.18062	0.06930	-0.08190	0.16129
25	0.04576	-0.11834	0.00018	-0.01748	0.09523
26	0.04655	-0.05557	-0.06777	0.04643	0.02956
27	0.04681	0.00780	-0.13434	0.10975	-0.03579
28	0.04650	0.07181	-0.19945	0.17242	-0.10087
29	0.04566	0.13639	-0.26311	0.23452	-0.16562
30	0.04438	0.20146	-0.32538	0.29614	-0.22995
31	0.04275	0.26687	-0.38635	0.35741	-0.29375
32	0.04087	0.33254	-0.44611	0.41843	-0.35694
33	0.03878	0.39841	-0.50468	0.47924	-0.41947
34	0.03649	0.46445	-0.56209	0.53989	-0.48130
35	0.03403	0.53064	-0.61832	0.60038	-0.54242
36	0.03138	0.59699	-0.67335	0.66072	-0.60284
37	0.02852	0.66349	-0.72716	0.72090	-0.66261
38	0.02543	0.73017	-0.77975	0.78091	-0.72179
39	0.02210	0.79702	-0.83115	0.84074	-0.78047
40	0.01850	0.86406	-0.88141	0.90038	-0.83872
41	0.01465	0.93130	-0.93059	0.95983	-0.89660
42	0.01126	0.98745	-0.97080	1.00925	-0.94457
43	0.00778	1.03400	-1.00365	1.05014	-0.98407
44	0.00778	1.04222	-1.00593	1.05395	-0.99180
45	0.00778	1.05113	-1.00132	1.05113	-1.00132

LE RAD 0.00314 CENTER AT ALPHA -1.05604 UPSILON 1.17028
TE RAD 0.01278 CENTER AT ALPHA 1.04131 UPSILON -0.99323

STAGE 1. ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 13 SECTION NN $R_H O$ 10.0000

CHORD	STAGGER	CAMBER
2.9273	32.373	31.122

AREA 0.385241 SURFACE ARC LENGTH 5.96972

	ALPHA	UPSILON
SECTION C.G.	-0.00101	0.00086
STREAMSURFACE SECTION C.G.	-0.02588	0.00188
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00885	-1.19472	0.95051	-1.19472	0.95051
2	0.00885	-1.19656	0.94646	-1.19243	0.95162
3	0.00885	-1.19605	0.94007	-1.18906	0.95156
4	0.00885	-1.19308	0.93147	-1.18471	0.95025
5	0.00885	-1.18750	0.92080	-1.17945	0.94761
6	0.00885	-1.17915	0.90820	-1.17338	0.94354
7	0.00885	-1.16799	0.89373	-1.16653	0.93803
8	0.00885	-1.15419	0.87720	-1.15877	0.93119
9	0.01315	-1.14894	0.87101	-1.12144	0.89793
10	0.01739	-1.09132	0.80394	-1.05532	0.83992
11	0.02154	-1.03351	0.73817	-0.98940	0.78320
12	0.02557	-0.97548	0.67372	-0.92370	0.72776
13	0.02951	-0.91725	0.61060	-0.85820	0.67366
14	0.03340	-0.85884	0.54880	-0.79267	0.62095
15	0.03722	-0.80026	0.48834	-0.72772	0.56964
16	0.04095	-0.74147	0.42926	-0.66277	0.51967
17	0.04521	-0.67058	0.36026	-0.58518	0.46135
18	0.04916	-0.59924	0.29338	-0.50804	0.40468
19	0.05277	-0.52744	0.22865	-0.43136	0.34960
20	0.05604	-0.45517	0.16607	-0.35515	0.29609
21	0.05895	-0.38242	0.10569	-0.27942	0.24413
22	0.06145	-0.30918	0.04757	-0.20417	0.19363
23	0.06348	-0.23542	-0.00818	-0.12945	0.14447
24	0.06496	-0.16111	-0.06148	-0.05529	0.09651
25	0.06586	-0.08624	-0.11230	0.01833	0.04968
26	0.06617	-0.01084	-0.16060	0.09141	0.00390
27	0.06588	0.06505	-0.20637	0.16400	-0.04085
28	0.06501	0.14138	-0.24963	0.23616	-0.08462
29	0.06358	0.21807	-0.29040	0.30794	-0.12743
30	0.06164	0.29507	-0.32877	0.37942	-0.16925
31	0.05926	0.37231	-0.36482	0.45067	-0.21005
32	0.05650	0.44973	-0.39862	0.52173	-0.24974
33	0.05338	0.52728	-0.43020	0.59266	-0.28826
34	0.04993	0.60490	-0.45952	0.66352	-0.32563
35	0.04614	0.68255	-0.48661	0.73435	-0.36187
36	0.04203	0.76016	-0.51150	0.80522	-0.39702
37	0.03763	0.83770	-0.53430	0.87616	-0.43109
38	0.03300	0.91511	-0.55516	0.94723	-0.46406
39	0.02817	0.99237	-0.57418	1.01846	-0.49597
40	0.02316	1.06946	-0.59149	1.[illegible]984	-0.52681
41	0.01800	1.14639	-0.60713	1.16140	-0.55662
42	0.01360	1.21035	-0.61896	1.22117	-0.58066
43	0.00914	1.26081	-0.62758	1.26621	-0.59821
44	0.00914	1.27041	-0.62594	1.27561	-0.60449
45	0.00914	1.27763	-0.61683	1.27763	-0.61683

LE RAD 0.00372 CENTER AT ALPHA -1.19215 UPSILON 0.94784
TE RAD 0.01495 CENTER AT ALPHA 1.26324 UPSILON -0.61285

STAGE 1. ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 14 SECTION PR R_HO 9.0000

CHORD	STAGGER	CAMBER
2.9120	23.534	50.045

AREA 0.457945 SURFACE ARC LENGTH 6.05926

	ALPHA	UPSILON
SECTION C.G.	0.00178	-0.00081
STREAMSURFACE SECTION C.G.	-0.03344	-0.00332
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00946	-1.28706	0.83816	-1.28706	0.83816
2	0.00946	-1.28893	0.83376	-1.28463	0.83943
3	0.00946	-1.28825	0.82694	-1.28103	0.83948
4	0.00946	-1.28489	0.81784	-1.27633	0.83824
5	0.00946	-1.27869	0.80661	-1.27063	0.83562
6	0.00946	-1.26950	0.79340	-1.26401	0.83152
7	0.00946	-1.25728	0.77827	-1.25649	0.82594
8	0.00946	-1.24219	0.76105	-1.24795	0.81899
9	0.01458	-1.23732	0.75559	-1.20802	0.78632
10	0.01969	-1.17529	0.68725	-1.13644	0.72941
11	0.02475	-1.11302	0.62090	-1.06510	0.67475
12	0.02976	-1.05048	0.55655	-0.99403	0.62230
13	0.03467	-0.98765	0.49421	-0.92325	0.57196
14	0.03945	-0.92450	0.43385	-0.85278	0.52362
15	0.04408	-0.86101	0.37548	-0.78266	0.47715
16	0.04851	-0.79715	0.31907	-0.71291	0.43245
17	0.05358	-0.72006	0.25390	-0.62966	0.38106
18	0.05835	-0.64243	0.19148	-0.54696	0.33204
19	0.06275	-0.56420	0.13189	-0.46486	0.28525
20	0.06671	-0.48533	0.07522	-0.38339	0.24059
21	0.07020	-0.40581	0.02153	-0.30258	0.19796
22	0.07316	-0.32565	-0.02910	-0.22241	0.15726
23	0.07556	-0.24485	-0.07657	-0.14287	0.11839
24	0.07734	-0.16345	-0.12081	-0.06394	0.08122
25	0.07845	-0.08146	-0.16175	0.01441	0.04562
26	0.07888	0.00104	-0.19935	0.09224	0.01147
27	0.07861	0.08400	-0.23359	0.16962	-0.02130
28	0.07765	0.16738	-0.26450	0.24657	-0.05270
29	0.07604	0.25111	-0.29207	0.32317	-0.08269
30	0.07383	0.33512	-0.31632	0.39950	-0.11120
31	0.07104	0.41932	-0.33721	0.47564	-0.13815
32	0.06772	0.50358	-0.35474	0.55171	-0.16348
33	0.06390	0.58783	-0.36888	0.62779	-0.18715
34	0.05961	0.67200	-0.37965	0.70396	-0.20904
35	0.05490	0.75599	-0.38704	0.78030	-0.22902
36	0.04984	0.83968	-0.39104	0.85694	-0.24695
37	0.04444	0.92297	-0.39169	0.93399	-0.26276
38	0.03874	1.00571	-0.38906	1.01159	-0.27641
39	0.03278	1.08785	-0.38335	1.08978	-0.28790
40	0.02663	1.16942	-0.37475	1.16854	-0.29721
41	0.02032	1.25041	-0.36337	1.24788	-0.30425
42	0.01498	1.31746	-0.35183	1.31445	-0.30831
43	0.00961	1.37032	-0.34140	1.36753	-0.31030
44	0.00961	1.37894	-0.33636	1.37738	-0.31411
45	0.00961	1.38276	-0.32457	1.38276	-0.32457

LE RAD 0.00405 CENTER AT ALPHA -1.28418 UPSILON 0.83532
TE RAD 0.01572 CENTER AT ALPHA 1.36711 UPSILON -0.32601

STAGE 1. ROTOR N B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 15 SECTION 00 RHO 8.0500

CHORD	STAGGER	CAMBER
2.8885	14.485	69.717

AREA 0.538430 SURFACE ARC LENGTH 6.22392

	ALPHA	UPSILON
SECTION C.G.	-0.00223	-0.00003
STREAMSURFACE SECTION C.G.	-0.04348	-0.01300
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.01013	-1.37081	0.73284	-1.37081	0.73284
2	0.01013	-1.37273	0.72807	-1.36823	0.73426
3	0.01013	-1.37189	0.72080	-1.36438	0.73443
4	0.01013	-1.36816	0.71115	-1.35933	0.73326
5	0.01013	-1.36137	0.69931	-1.35318	0.73065
6	0.01013	-1.35138	0.68543	-1.34600	0.72652
7	0.01013	-1.33814	0.66956	-1.33781	0.72085
8	0.01013	-1.32181	0.65153	-1.32848	0.71377
9	0.01608	-1.31890	0.64838	-1.28776	0.68283
10	0.02200	-1.25416	0.57965	-1.21254	0.62766
11	0.02787	-1.18906	0.51333	-1.13768	0.57528
12	0.03366	-1.12359	0.44945	-1.06319	0.52565
13	0.03938	-1.05774	0.38798	-0.98908	0.47868
14	0.04500	-0.99148	0.32890	-0.91537	0.43426
15	0.05045	-0.92480	0.27220	-0.84209	0.39219
16	0.05571	-0.85764	0.21785	-0.76929	0.35234
17	0.06173	-0.77639	0.15573	-0.68259	0.30736
18	0.06740	-0.69436	0.09701	-0.59666	0.26540
19	0.07266	-0.61150	0.04183	-0.51157	0.22638
20	0.07744	-0.52781	-0.00967	-0.42731	0.19018
21	0.08170	-0.44329	-0.05737	-0.34388	0.15666
22	0.08537	-0.35798	-0.10117	-0.26123	0.12564
23	0.08839	-0.27194	-0.14099	-0.17932	0.09695
24	0.09071	-0.18518	-0.17672	-0.09813	0.07041
25	0.09225	-0.09775	-0.20825	-0.01760	0.04587
26	0.09297	-0.00971	-0.23547	0.06231	0.02323
27	0.09285	0.07887	-0.25830	0.14169	0.00244
28	0.09190	0.16784	-0.27666	0.22067	-0.01650
29	0.09017	0.25708	-0.29052	0.29939	-0.03352
30	0.08768	0.34643	-0.29986	0.37799	-0.04857
31	0.08446	0.43575	-0.30464	0.45662	-0.06156
32	0.08056	0.52497	-0.30483	0.53536	-0.07236
33	0.07603	0.61394	-0.30037	0.61435	-0.08075
34	0.07091	0.70255	-0.29116	0.69368	-0.08652
35	0.06523	0.79065	-0.27703	0.77353	-0.08938
36	0.05902	0.87804	-0.25784	0.85410	-0.08904
37	0.05236	0.96452	-0.23353	0.93558	-0.08509
38	0.04532	1.04978	-0.20423	1.01827	-0.07718
39	0.03799	1.13374	-0.17026	1.10226	-0.06516
40	0.03044	1.21689	-0.13147	1.18707	-0.04874
41	0.02276	1.29912	-0.08685	1.27280	-0.02661
42	0.01629	1.36620	-0.04542	1.34567	-0.00309
43	0.00979	1.42042	-0.01011	1.40630	0.01822
44	0.00979	1.42665	-0.00220	1.41702	0.01822
45	0.00979	1.42592	0.01032	1.42592	0.01032

LE RAD 0.00440 CENTER AT ALPHA -1.36760 UPSILON 0.72982
TE RAD 0.01596 CENTER AT ALPHA 1.41165 UPSILON 0.00321

STAGE 2, ROTOR N_B 44

COORD SYSTEM ORIGIN Z 1.50981 R 0. MU 0. ETA 0.

SECTION NO 17 SECTION S8 RHO 7.3400

CHORD	STAGGER	CAMBER
2.8931	7.493	81.414

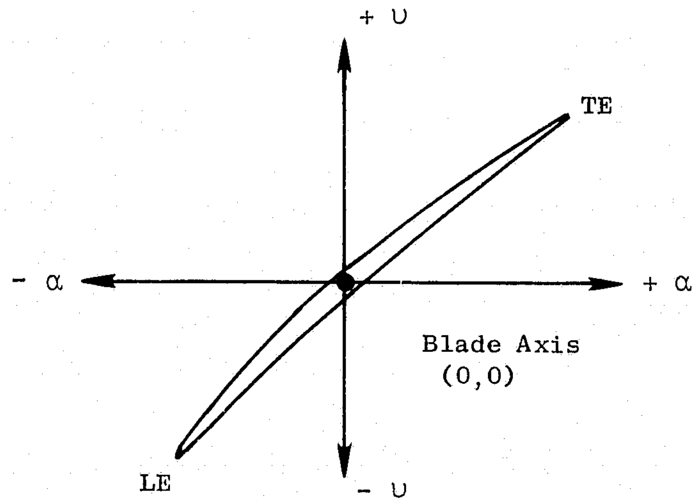
AREA 0.613345 SURFACE ARC LENGTH 6.43520

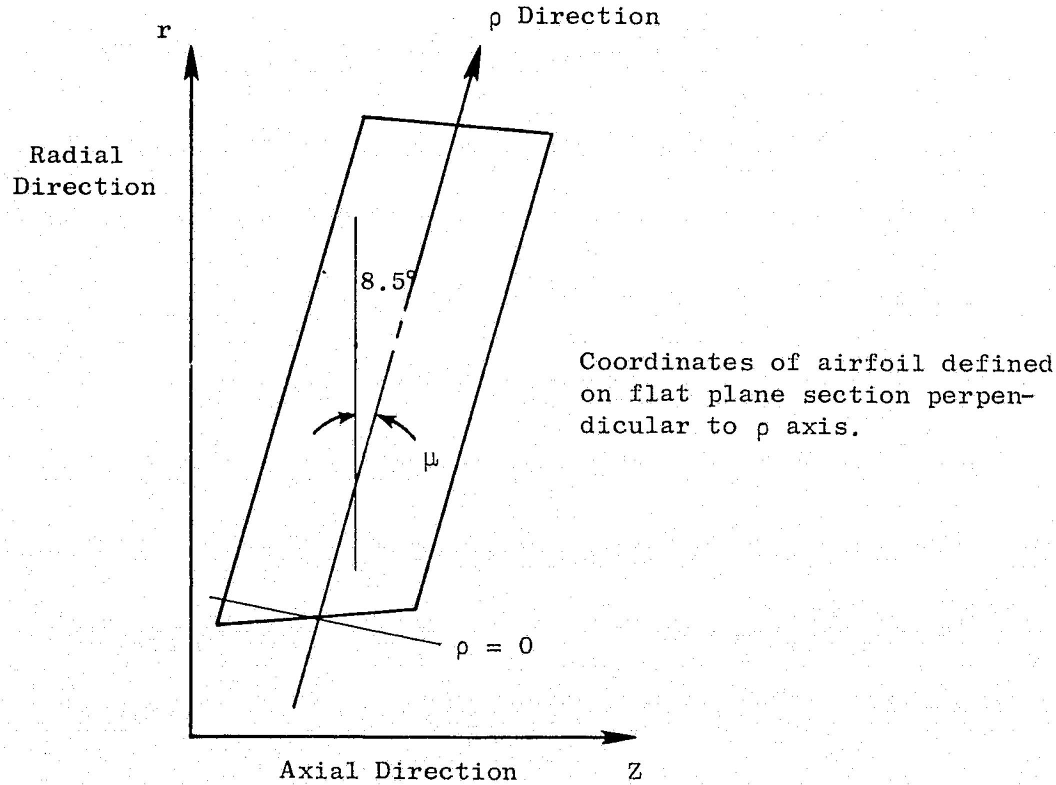
	ALPHA	UPSILON
SECTION C.G.	-0.00399	-0.00222
STREAMSURFACE SECTION C.G.	-0.05845	-0.02347
BLADE AXIS	0.	0.
STACKING AXIS (RADIAL)	0.	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.01048	-1.42732	0.64410	-1.42732	0.64410
2	0.01048	-1.42931	0.63908	-1.42465	0.64564
3	0.01048	-1.42838	0.63150	-1.42064	0.64588
4	0.01048	-1.42444	0.62150	-1.41537	0.64477
5	0.01048	-1.41730	0.60925	-1.40892	0.64218
6	0.01048	-1.40683	0.59492	-1.40137	0.63805
7	0.01048	-1.39298	0.57855	-1.39273	0.63235
8	0.01048	-1.37589	0.55998	-1.38288	0.62529
9	0.01712	-1.37440	0.55839	-1.34183	0.59571
10	0.02375	-1.30825	0.48956	-1.26443	0.54246
11	0.03032	-1.24166	0.42361	-1.18747	0.49261
12	0.03682	-1.17459	0.36050	-1.11100	0.44598
13	0.04324	-1.10705	0.30013	-1.03499	0.40240
14	0.04956	-1.03902	0.24241	-0.95946	0.36169
15	0.05571	-0.97046	0.18732	-0.88447	0.32364
16	0.06164	-0.90128	0.13486	-0.81011	0.28813
17	0.06844	-0.81735	0.07543	-0.72178	0.24886
18	0.07486	-0.73245	0.02001	-0.63442	0.21312
19	0.08082	-0.64659	-0.03138	-0.54802	0.18071
20	0.08627	-0.55984	-0.07847	-0.46252	0.15137
21	0.09114	-0.47225	-0.12139	-0.37785	0.12481
22	0.09534	-0.38372	-0.16003	-0.29412	0.10084
23	0.09880	-0.29425	-0.19422	-0.21133	0.07934
24	0.10145	-0.20392	-0.22374	-0.12940	0.06015
25	0.10322	-0.11285	-0.24842	-0.04822	0.04313
26	0.10408	-0.02116	-0.26813	0.03236	0.02818
27	0.10399	0.07098	-0.28275	0.11247	0.01524
28	0.10297	0.16348	-0.29219	0.19223	0.00432
29	0.10103	0.25617	-0.29638	0.27180	-0.00450
30	0.09819	0.34897	-0.29513	0.35126	-0.01106
31	0.09451	0.44168	-0.28837	0.43081	-0.01514
32	0.09004	0.53429	-0.27582	0.51045	-0.01641
33	0.08484	0.62654	-0.25718	0.59046	-0.01440
34	0.07894	0.71795	-0.23222	0.67131	-0.00864
35	0.07238	0.80821	-0.20080	0.75330	0.00126
36	0.06520	0.89716	-0.16282	0.83661	0.01582
37	0.05755	0.98463	-0.11826	0.92141	0.03576
38	0.04954	1.07023	-0.06739	1.00806	0.06174
39	0.04125	1.15405	-0.01066	1.09650	0.09388
40	0.03275	1.23685	0.05258	1.18596	0.13250
41	0.02415	1.31847	0.12410	1.27659	0.18001
42	0.01695	1.38475	0.18938	1.35386	0.22748
43	0.00975	1.44008	0.24583	1.42028	0.27020
44	0.00975	1.44448	0.25492	1.43063	0.27259
45	0.00975	1.44108	0.26684	1.44108	0.26684

LE RAD 0.00468 CENTER AT ALPHA -1.42389 UPSILON 0.64095
TE RAD 0.01580 CENTER AT ALPHA 1.42880 UPSILON 0.25690





Fan Bypass OGV Airfoil Coordinate Orientation.

FAN BYPASS OGV NB .90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 2 SECTION BB RHO 0.

CHORD	STAGGER	CAMBER
1.5331	19.405	52.696

AREA 0.097029 SURFACE ARC LENGTH 3.19952

	ALPHA	UPSILON
SECTION C.G.	-0.06221	-0.06853
STREAMSURFACE SECTION C.G.	-0.05633	-0.06742
BLADE AXIS	0.00000	0
STACKING AXIS (RADIAL)	0.97002	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00261	-0.69775	-0.44168	-0.69775	-0.44168
2	0.00261	-0.69818	-0.44107	-0.69716	-0.44214
3	0.00261	-0.69844	-0.44031	-0.69641	-0.44244
4	0.00261	-0.69853	-0.43942	-0.69552	-0.44256
5	0.00261	-0.69842	-0.43841	-0.69450	-0.44251
6	0.00261	-0.69812	-0.43727	-0.69335	-0.44226
7	0.00261	-0.69764	-0.43601	-0.69206	-0.44184
8	0.00814	-0.69481	-0.43028	-0.68623	-0.43934
9	0.00981	-0.69207	-0.42592	-0.68174	-0.43686
10	0.01230	-0.68612	-0.41771	-0.67323	-0.43148
11	0.01643	-0.67013	-0.39855	-0.65307	-0.41709
12	0.02258	-0.63692	-0.36224	-0.61398	-0.38815
13	0.02736	-0.60289	-0.32785	-0.57571	-0.35979
14	0.03136	-0.56835	-0.29507	-0.53795	-0.33231
15	0.03769	-0.49815	-0.23402	-0.46355	-0.28028
16	0.04246	-0.42686	-0.17862	-0.39025	-0.23245
17	0.04602	-0.35471	-0.12870	-0.31779	-0.18883
18	0.04855	-0.28189	-0.08409	-0.24602	-0.14930
19	0.05014	-0.20853	-0.04464	-0.17479	-0.11371
20	0.05081	-0.13475	-0.01020	-0.10396	-0.08175
21	0.05049	-0.06066	0.01936	-0.03345	-0.05310
22	0.04923	0.01362	0.04430	0.03686	-0.02751
23	0.04696	0.08804	0.06469	0.10704	-0.00474
24	0.04385	0.16245	0.08081	0.17723	0.01522
25	0.04011	0.23676	0.09285	0.24752	0.03230
26	0.03586	0.31090	0.10095	0.31798	0.04644
27	0.03122	0.38478	0.10521	0.38870	0.05750
28	0.02638	0.45835	0.10577	0.45973	0.06535
29	0.02149	0.53156	0.10277	0.53111	0.06983
30	0.01680	0.60443	0.09643	0.60284	0.07072
31	0.01268	0.67700	0.08703	0.67487	0.06771
32	0.01200	0.69149	0.08484	0.68930	0.06657
33	0.01140	0.70597	0.08257	0.70373	0.06524
34	0.01088	0.72046	0.08023	0.71817	0.06371
35	0.01016	0.74175	0.07669	0.73941	0.06106
36	0.01016	0.74652	0.07392	0.74486	0.06236
37	0.01016	0.74823	0.06768	0.74823	0.06768

LE RAD 0.00245 CENTER AT ALPHA -0.69598 UPSILON -0.43999
TE RAD 0.00790 CENTER AT ALPHA 0.74043 UPSILON 0.06890

FAN BYPASS OGV NB 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 5 SECTION EE RHO 1.0000

CHORD	STAGGER	CAMBER
1.5864	17.668	49.469

AREA 0.100660 SURFACE ARC LENGTH 3.29637

	ALPHA	UPSILON
SECTION C.G.	-0.06364	-0.06393
STREAMSURFACE SECTION C.G.	-0.05881	-0.06284
BLADE AXIS	0.00000	0.
STACKING AXIS (RADIAL)	0.82057	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

PT	T/C	UPPER ALPHA	UPPER UPSILON	LOWER ALPHA	LOWER UPSILON
1	0.00283	-0.72918	-0.41867	-0.72918	-0.41867
2	0.00283	-0.72965	-0.41794	-0.72853	-0.41924
3	0.00283	-0.72992	-0.41706	-0.72769	-0.41964
4	0.00283	-0.72999	-0.41602	-0.72668	-0.41985
5	0.00283	-0.72985	-0.41486	-0.72550	-0.41988
6	0.00283	-0.72948	-0.41357	-0.72417	-0.41970
7	0.00283	-0.72891	-0.41213	-0.72266	-0.41935
8	0.00884	-0.72620	-0.40683	-0.71705	-0.41746
9	0.01067	-0.72335	-0.40247	-0.71234	-0.41532
10	0.01337	-0.71716	-0.39436	-0.70342	-0.41052
11	0.01786	-0.70047	-0.37564	-0.68231	-0.39739
12	0.02456	-0.66580	-0.34038	-0.64141	-0.37077
13	0.02977	-0.63023	-0.30715	-0.60140	-0.34456
14	0.03414	-0.59411	-0.27556	-0.56194	-0.31914
15	0.04106	-0.52067	-0.21695	-0.48422	-0.27093
16	0.04630	-0.44608	-0.16393	-0.40765	-0.22654
17	0.05022	-0.37061	-0.11626	-0.33196	-0.18593
18	0.05301	-0.29445	-0.07370	-0.25696	-0.14897
19	0.05478	-0.21778	-0.03602	-0.18247	-0.11542
20	0.05554	-0.14069	-0.00305	-0.10840	-0.08504
21	0.05521	-0.06325	0.02526	-0.03408	-0.05754
22	0.05383	0.01443	0.04907	0.03880	-0.03278
23	0.05131	0.09227	0.06836	0.11212	-0.01057
24	0.04785	0.17012	0.08335	0.18543	0.00900
25	0.04366	0.24786	0.09422	0.25885	0.02584
26	0.03889	0.32538	0.10114	0.33249	0.03986
27	0.03368	0.40260	0.10425	0.40643	0.05095
28	0.02824	0.47948	0.10373	0.48071	0.05896
29	0.02272	0.55598	0.09976	0.55537	0.06373
30	0.01742	0.63210	0.09259	0.63041	0.06500
31	0.01276	0.70790	0.08256	0.70577	0.06243
32	0.01199	0.72303	0.08028	0.72087	0.06138
33	0.01131	0.73817	0.07793	0.73597	0.06013
34	0.01072	0.75330	0.07552	0.75107	0.05866
35	0.00991	0.77581	0.07187	0.77354	0.05607
36	0.00991	0.78065	0.06911	0.77904	0.05741
37	0.00991	0.78241	0.06282	0.78241	0.06282

LE RAD 0.00294 CENTER AT ALPHA -0.72696 UPSILON -0.41675
TE RAD 0.00798 CENTER AT ALPHA 0.77452 UPSILON 0.06399

BYPASS OGV NB 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU -8.5000 ETA 0.

SECTION NO. 6 SECTION FF RHO 2.0000

CHORD	STAGGER	CAMBER
1.6165	16.949	48.231

AREA 0.114133 SURFACE ARC LENGTH 3.35303

	ALPHA	UPSILON
SECTION C.G.	-0.06600	-0.06204
STREAMSURFACE SECTION C.G.	-0.06193	-0.06106
BLADE AXIS	0.00000	0.
STACKING AXIS (RADIAL)	0.67112	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00311	-0.74552	-0.40882	-0.74552	-0.40882
2	0.00311	-0.74604	-0.40797	-0.74477	-0.40949
3	0.00311	-0.74635	-0.40695	-0.74382	-0.40998
4	0.00311	-0.74643	-0.40576	-0.74267	-0.41027
5	0.00311	-0.74627	-0.40443	-0.74132	-0.41036
6	0.00311	-0.74587	-0.40295	-0.73979	-0.41024
7	0.00311	-0.74524	-0.40131	-0.73806	-0.40993
8	0.00970	-0.74277	-0.39636	-0.73280	-0.40847
9	0.01170	-0.73992	-0.39192	-0.72791	-0.40655
10	0.01467	-0.73368	-0.38372	-0.71870	-0.40211
11	0.01961	-0.71675	-0.36494	-0.69697	-0.38970
12	0.02697	-0.68146	-0.32977	-0.65495	-0.36437
13	0.03270	-0.64519	-0.29676	-0.61390	-0.33937
14	0.03752	-0.60833	-0.26548	-0.57345	-0.31509
15	0.04514	-0.53329	-0.20760	-0.49387	-0.26902
16	0.05094	-0.45701	-0.15540	-0.41552	-0.22652
17	0.05527	-0.37981	-0.10851	-0.33808	-0.18751
18	0.05836	-0.30191	-0.06661	-0.26136	-0.15180
19	0.06033	-0.22344	-0.02949	-0.18520	-0.11920
20	0.06119	-0.14451	0.00300	-0.10950	-0.08951
21	0.06084	-0.06520	0.03087	-0.03419	-0.06245
22	0.05929	0.01439	0.05421	0.04085	-0.03791
23	0.05645	0.09415	0.07299	0.11571	-0.01569
24	0.05256	0.17393	0.08743	0.19056	0.00410
25	0.04785	0.25357	0.09774	0.26554	0.02133
26	0.04247	0.33299	0.10410	0.34076	0.03589
27	0.03661	0.41209	0.10665	0.41628	0.04762
28	0.03047	0.49082	0.10557	0.49218	0.05634
29	0.02425	0.56912	0.10102	0.56851	0.06183
30	0.01828	0.64701	0.09326	0.64525	0.06376
31	0.01302	0.72453	0.08266	0.72235	0.06172
32	0.01216	0.74001	0.08028	0.73780	0.06075
33	0.01139	0.75548	0.07784	0.75325	0.05957
34	0.01073	0.77095	0.07535	0.76871	0.05815
35	0.00981	0.79408	0.07157	0.79180	0.05559
36	0.00981	0.79896	0.06878	0.79735	0.05696
37	0.00981	0.80075	0.06244	0.80075	0.06244

LE RAD 0.00351 CENTER AT ALPHA -0.74282 UPSILON -0.40657
TE RAD 0.00807 CENTER AT ALPHA 0.79277 UPSILON 0.06360

BYPASS OGV   NB 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 7   SECTION GG   RHO 3.0000

CHORD	STAGGER	CAMBER
1.6350	16.474	47.974

AREA 0.127356   SURFACE ARC LENGTH 3.39398

	ALPHA	UPSILON
SECTION C.G.	-0.06866	-0.06245
STREAMSURFACE SECTION C.G.	-0.06524	-0.06150
BLADE AXIS	0.00000	0.
STACKING AXIS (RADIAL)	0.52166	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00339	-0.75532	-0.40704	-0.75532	-0.40704
2	0.00339	-0.75592	-0.40607	-0.75448	-0.40781
3	0.00339	-0.75627	-0.40491	-0.75341	-0.40839
4	0.00339	-0.75638	-0.40357	-0.75211	-0.40876
5	0.00339	-0.75622	-0.40205	-0.75059	-0.40890
6	0.00339	-0.75580	-0.40038	-0.74886	-0.40883
7	0.00339	-0.75513	-0.39852	-0.74690	-0.40854
8	0.01062	-0.75296	-0.39390	-0.74200	-0.40737
9	0.01281	-0.75015	-0.38931	-0.73697	-0.40558
10	0.01606	-0.74395	-0.38089	-0.72749	-0.40135
11	0.02145	-0.72698	-0.36174	-0.70526	-0.38928
12	0.02952	-0.69148	-0.32599	-0.66237	-0.36449
13	0.03581	-0.65490	-0.29251	-0.62055	-0.33992
14	0.04108	-0.61766	-0.26083	-0.57939	-0.31603
15	0.04945	-0.54175	-0.20231	-0.49852	-0.27064
16	0.05581	-0.46447	-0.14961	-0.41900	-0.22874
17	0.06058	-0.38617	-0.10236	-0.34051	-0.19026
18	0.06398	-0.30707	-0.06027	-0.26282	-0.15507
19	0.06615	-0.22734	-0.02314	-0.18576	-0.12299
20	0.06710	-0.14711	0.00916	-0.10920	-0.09380
21	0.06671	-0.06646	0.03663	-0.03306	-0.06721
22	0.06499	0.01447	0.05936	0.04280	-0.04306
23	0.06183	0.09558	0.07733	0.11848	-0.02113
24	0.05749	0.17668	0.09081	0.19416	-0.00155
25	0.05223	0.25763	0.10004	0.27001	0.01555
26	0.04623	0.33831	0.10520	0.34612	0.03002
27	0.03968	0.41862	0.10648	0.42260	0.04172
28	0.03283	0.49849	0.10409	0.49951	0.05041
29	0.02589	0.57790	0.09824	0.57690	0.05592
30	0.01924	0.65683	0.08927	0.65476	0.05789
31	0.01337	0.73537	0.07762	0.73302	0.05589
32	0.01240	0.75104	0.07507	0.74870	0.05493
33	0.01154	0.76672	0.07246	0.76438	0.05374
34	0.01080	0.78240	0.06983	0.78006	0.05232
35	0.00978	0.80588	0.06586	0.80353	0.04973
36	0.00978	0.81079	0.06303	0.80914	0.05110
37	0.00978	0.81259	0.05662	0.81259	0.05662

LE RAD 0.00413 CENTER AT ALPHA -0.75213 UPSILON -0.40441
TE RAD 0.00816 CENTER AT ALPHA 0.80452 UPSILON 0.05782

BYPASS OGV NB 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 8 SECTION HH RHO 4.0000

CHORD	STAGGER	CAMBER
1.6363	16.606	48.992

AREA 0.139459 SURFACE ARC LENGTH 3.40318

	ALPHA	UPSILON
SECTION C.G.	-0.07101	-0.06352
STREAMSURFACE SECTION C.G.	-0.06850	-0.06293
BLADE AXIS	0.00000	0.
STACKING AXIS (RADIAL)	0.37221	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00372	-0.75435	-0.41203	-0.75435	-0.41203
2	0.00372	-0.75504	-0.41094	-0.75340	-0.41290
3	0.00372	-0.75547	-0.40964	-0.75219	-0.41355
4	0.00372	-0.75563	-0.40814	-0.75073	-0.41398
5	0.00372	-0.75550	-0.40644	-0.74903	-0.41416
6	0.00372	-0.75510	-0.40456	-0.74709	-0.41411
7	0.00372	-0.75443	-0.40246	-0.74490	-0.41382
8	0.01165	-0.75259	-0.39816	-0.74043	-0.41283
9	0.01405	-0.74991	-0.39339	-0.73527	-0.41111
10	0.01761	-0.74389	-0.38466	-0.72561	-0.40694
11	0.02353	-0.72722	-0.36488	-0.70308	-0.39488
12	0.03238	-0.69215	-0.32800	-0.65975	-0.36994
13	0.03928	-0.65588	-0.29348	-0.61762	-0.34513
14	0.04508	-0.61887	-0.26081	-0.57622	-0.32098
15	0.05426	-0.54322	-0.20050	-0.49506	-0.27509
16	0.06124	-0.46600	-0.14634	-0.41547	-0.23287
17	0.06648	-0.38761	-0.09800	-0.33706	-0.19432
18	0.07021	-0.30832	-0.05522	-0.25954	-0.15923
19	0.07259	-0.22836	-0.01771	-0.18269	-0.12735
20	0.07362	-0.14788	0.01472	-0.10636	-0.09837
21	0.07318	-0.06697	0.04212	-0.03047	-0.07193
22	0.07127	0.01423	0.06463	0.04514	-0.04781
23	0.06773	0.09561	0.08223	0.12057	-0.02575
24	0.06290	0.17697	0.09525	0.19601	-0.00590
25	0.05704	0.25816	0.10394	0.27163	0.01159
26	0.05036	0.33905	0.10853	0.34754	0.02656
27	0.04308	0.41954	0.10919	0.42386	0.03883
28	0.03546	0.49956	0.10617	0.50065	0.04815
29	0.02775	0.57906	0.09965	0.57796	0.05426
30	0.02035	0.65804	0.08996	0.65578	0.05673
31	0.01384	0.73659	0.07751	0.73405	0.05501
32	0.01277	0.75226	0.07478	0.74973	0.05405
33	0.01181	0.76793	0.07201	0.76542	0.05285
34	0.01099	0.78361	0.06921	0.78111	0.05139
35	0.00986	0.80203	0.06500	0.80456	0.04871
36	0.00986	0.81196	0.06210	0.81021	0.05007
37	0.00986	0.81372	0.05561	0.81372	0.05561

LE RAD 0.00481 CENTER AT ALPHA -0.75066 UPSILON -0.40894
TE RAD 0.00624 CENTER AT ALPHA 0.80558 UPSILON 0.05689

BYPASS OGV — NB 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 9 SECTION JJ RHO 5.0000

CHORD	STAGGER	CAMBER
1.6337	16.879	51.262

AREA 0.151692 SURFACE ARC LENGTH 3.41212

	ALPHA	UPSILON
SECTION C.G.	-0.07340	-0.06695
STREAMSURFACE SECTION C.G.	-0.07144	-0.06617
BLADE AXIS	-0.00000	0.
STACKING AXIS (RADIAL)	0.22276	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00405	-0.75085	-0.42546	-0.75085	-0.42546
2	0.00405	-0.75165	-0.42427	-0.74976	-0.42641
3	0.00405	-0.75218	-0.42284	-0.74841	-0.42711
4	0.00405	-0.75242	-0.42118	-0.74678	-0.42755
5	0.00405	-0.75237	-0.41930	-0.74490	-0.42774
6	0.00405	-0.75202	-0.41720	-0.74276	-0.42766
7	0.00405	-0.75139	-0.41486	-0.74035	-0.42733
8	0.01271	-0.74988	-0.41077	-0.73618	-0.42638
9	0.01532	-0.74736	-0.40572	-0.73089	-0.42458
10	0.01921	-0.74158	-0.39649	-0.72103	-0.42022
11	0.02567	-0.72532	-0.37561	-0.69821	-0.40761
12	0.03534	-0.69065	-0.33680	-0.65451	-0.38166
13	0.04287	-0.65502	-0.30059	-0.61218	-0.35599
14	0.04920	-0.61837	-0.26642	-0.57067	-0.33111
15	0.05923	-0.54323	-0.20363	-0.48948	-0.28410
16	0.06686	-0.46638	-0.14745	-0.40999	-0.24100
17	0.07258	-0.38826	-0.09739	-0.33178	-0.20166
18	0.07667	-0.30913	-0.05310	-0.25458	-0.16584
19	0.07927	-0.22923	-0.01429	-0.17815	-0.13330
20	0.08041	-0.14870	0.01916	-0.10235	-0.10375
21	0.07992	-0.06765	0.04726	-0.02707	-0.07684
22	0.07779	0.01375	0.07009	0.04786	-0.05234
23	0.07388	0.09537	0.08759	0.12257	-0.03000
24	0.06653	0.17695	0.10012	0.19733	-0.00998
25	0.06206	0.25829	0.10796	0.27231	0.00755
26	0.05468	0.33925	0.11136	0.34768	0.02244
27	0.04664	0.41972	0.11062	0.42354	0.03452
28	0.03823	0.49961	0.10599	0.49998	0.04354
29	0.02971	0.57889	0.09774	0.57703	0.04924
30	0.02154	0.65758	0.08629	0.65468	0.05122
31	0.01435	0.73577	0.07218	0.73281	0.04893
32	0.01317	0.75137	0.06916	0.74848	0.04784
33	0.01212	0.76698	0.06610	0.76414	0.04651
34	0.01121	0.78258	0.06302	0.77980	0.04492
35	0.00996	0.80584	0.05846	0.80312	0.04202
36	0.00996	0.81077	0.05546	0.80884	0.04333
37	0.00996	0.81246	0.04889	0.81246	0.04889

LE RAD 0.00551 CENTER AT ALPHA -0.74672 UPSILON -0.42181
TE RAD 0.00833 CENTER AT ALPHA 0.80424 UPSILON 0.05028

BYPASS OGV NB 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 10 SECTION KK RHO 6.0000

CHORD	STAGGER	CAMBER
1.6386	18,715	56,927

AREA 0,165959 SURFACE ARC LENGTH 3.45396

	ALPHA	UPSILON
SECTION C.G.	-0.07854	-0.07692
STREAMSURFACE SECTION C.G,	-0,07782	-0,07611
BLADE AXIS	0,00000	0.
STACKING AXIS (RADIAL)	0,07331	0,

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00437	-0.74290	-0.47605	-0.74290	-0.47605
2	0.00437	-0.74388	-0.47483	-0.74165	-0.47699
3	0.00437	-0.74457	-0.47332	-0.74012	-0,47765
4	0.00437	-0.74498	-0.47154	-0.73832	-0.47801
5	0.00437	-0.74509	-0.46949	-0.73626	-0.47806
6	0.00437	-0.74490	-0.46718	-0.73395	-0.47782
7	0.00437	-0,74442	-0,46459	-0.73136	-0,47728
8	0.01376	-0.74319	-0.46021	-0.72710	-0.47599
9	0.01658	-0.74094	-0.45462	-0.72159	-0.47368
10	0.02079	-0.73558	-0.44430	-0.71143	-0.46832
11	0.02777	-0.72004	-0.42080	-0.68817	-0,45328
12	0.03826	-0.68670	-0.37698	-0.64391	-0.42279
13	0.04642	-0.65176	-0.33610	-0.60126	-0.39298
14	0.05328	-0.61585	-0.29759	-0.55957	-0,36433
15	0.06415	-0.54188	-0.22698	-0.47834	-0.31073
16	0.07243	-0,46587	-0.16401	-0.39915	-0.26216
17	0.07663	-0.38832	-0.10813	-0.32151	-0.21830
18	0.08305	-0.30956	-0.05892	-0.24508	-0,17876
19	0.08587	-0.22987	-0.01602	-0.16957	-0.14315
20	0.08708	-0.14943	0.02078	-0.09481	-0.11105
21	0.08653	-0.06838	0.05155	-0.02067	-0.08196
22	0.08417	0.01308	0.07640	0.05307	-0.05560
23	0.07986	0.09478	0.09532	0.12656	-0.03162
24	0.07400	0.17643	0.10874	0.20011	-0.01018
25	0.06691	0.25780	0.11699	0.27394	0.00855
26	0.05884	0.33871	0.12036	0.34822	0.02442
27	0.05005	0.41903	0.11912	0.42310	0.03721
28	0.04086	0.49865	0.11358	0.49867	0,04663
29	0.03156	0.57752	0.10405	0.57499	0.05239
30	0,02265	0,65567	0.09098	0.65205	0.05405
31	0.01480	0.73322	0.07500	0.72969	0.05101
32	0.01351	0.74869	0.07159	0.74526	0,04971
33	0.01236	0.76416	0.06813	0.76083	0.04815
34	0.01138	0.77963	0.06466	0.77639	0.04630
35	0.01001	0.80261	0.05953	0.79947	0.04298
36	0.01001	0.80750	0.05639	0.80528	0.04419
37	0.01001	0.80905	0.04971	0.80905	0.04971

LE RAD 0,00676 CENTER AT ALPHA -0.73868 UPSILON -0.47170

TE RAD 0.00842 CENTER AT ALPHA 0.80078 UPSILON 0,05131

BYPASS OGV NR 90

COORD SYSTEM ORIGIN Z 9.40041 R 10.90727 MU 8.5000 ETA 0.

SECTION NO 13 SECTION NN RHO 6.6000

CHORD	STAGGER	CAMBER
1.6307	20.705	62.060

AREA 0.173827 SURFACE ARC LENGTH 3.47311

	ALPHA	UPSILON
SECTION C.G.	-0.08481	-0.08871
STREAMSURFACE SECTION C.G.	-0.08466	-0.08817
BLADE AXIS	-0.00000	0.
STACKING AXIS (RADIAL)	-0.01636	0.

SURFACE COORDINATES WITH ORIGIN AT SECTION AXIS

		UPPER		LOWER	
PT	T/C	ALPHA	UPSILON	ALPHA	UPSILON
1	0.00458	-0.72976	-0.52849	-0.72976	-0.52849
2	0.00458	-0.73085	-0.52729	-0.72839	-0.52938
3	0.00458	-0.73167	-0.52576	-0.72676	-0.52995
4	0.00458	-0.73221	-0.52396	-0.72487	-0.53019
5	0.00458	-0.73246	-0.52185	-0.72273	-0.53011
6	0.00456	-0.73241	-0.51944	-0.72034	-0.52968
7	0.00458	-0.73206	-0.51673	-0.71769	-0.52894
8	0.01442	-0.73104	-0.51191	-0.71322	-0.52725
9	0.01737	-0.72904	-0.50590	-0.70760	-0.52441
10	0.02178	-0.72408	-0.49470	-0.69730	-0.51804
11	0.02910	-0.70934	-0.46894	-0.67391	-0.50052
12	0.04010	-0.67739	-0.42061	-0.62959	-0.46522
13	0.04865	-0.64370	-0.37526	-0.58702	-0.43078
14	0.05585	-0.60894	-0.33237	-0.54550	-0.39771
15	0.06727	-0.53701	-0.25344	-0.46490	-0.33610
16	0.07596	-0.46268	-0.18300	-0.38669	-0.28082
17	0.08248	-0.38644	-0.12071	-0.31039	-0.23164
18	0.08713	-0.30870	-0.06627	-0.23560	-0.18810
19	0.09010	-0.22982	-0.01933	-0.16193	-0.14963
20	0.09139	-0.15013	0.02044	-0.08909	-0.11550
21	0.09361	-0.06983	0.05331	-0.01685	-0.08498
22	0.08834	0.01086	0.07959	0.05500	-0.0[illegible]754
23	0.08361	0.09173	0.09942	0.12666	-0.03270
24	0.07763	0.17250	0.11336	0.19843	-0.01055
25	0.07016	0.25294	0.12184	0.27052	0.00878
26	0.06166	0.33289	0.12515	0.34311	0.02512
27	0.05238	0.41220	0.12354	0.41634	0.03822
28	0.04269	0.49072	0.11734	0.49035	0.04773
29	0.03287	0.56839	0.10683	0.56522	0.05332
30	0.02346	0.64522	0.09251	0.64093	0.05450
31	0.01517	0.72138	0.07503	0.71731	0.05063
32	0.01381	0.73657	0.07129	0.73263	0.04911
33	0.01260	0.75175	0.06750	0.74795	0.04731
34	0.01156	0.76695	0.06369	0.76326	0.04521
35	0.01011	0.78937	0.05809	0.78583	0.04151
36	0.01011	0.79421	0.05481	0.79170	0.04259
37	0.01011	0.79561	0.04805	0.79561	0.04805

LE RAD 0.00624 CENTER AT ALPHA -0.72572 UPSILON -0.52373
TE RAD 0.00848 CENTER AT ALPHA 0.78732 UPSILON 0.04986

BYPASS OGV

NB 90

SECT	NO	RHO	CHORD	STAGGER	CAMBER	TM/C	ZETA1*	ZETA2*
AA	1	-0.10000	1.5272	19.62	53.07	0.05034	44.01	-9.06
BB	2	0.	1.5331	19.41	52.70	0.05081	43.69	-9.01
CC	3	0.10000	1.5389	19.20	52.32	0.05127	43.36	-8.96
DD	4	0.50000	1.5618	18.42	50.88	0.05311	42.12	-8.76
EE	5	1.00000	1.5864	17.67	49.47	0.05554	40.91	-8.56
FF	6	2.00000	1.6165	16.95	48.23	0.06119	39.80	-8.44
GG	7	3.00000	1.6350	16.47	47.97	0.06710	39.41	-8.57
HH	8	4.00000	1.6363	16.61	48.99	0.07362	39.98	-9.01
JJ	9	5.00000	1.6337	16.88	51.26	0.08041	41.53	-9.73
KK	10	6.00000	1.6386	18.71	56.93	0.08708	45.84	-11.09
LL	11	6.40000	1.6338	20.02	60.36	0.08993	48.43	-11.93
MM	12	6.52000	1.6319	20.43	61.39	0.09081	49.18	-12.20
NN	13	6.60000	1.6307	20.70	62.06	0.09139	49.67	-12.39

APPENDIX E. FAN EXHAUST DUCT FLOWPATH COORDINATES.

FAN EXHAUST DUCT FLOWPATH COORDINATES

Fan Duct Outer Wall		Fan Duct Inner Wall		Splitter Outer Wall		Splitter Inner Wall	
Axial Distance	Radius	Axial Distance	Radius	Axial Distance	Radius	Axial Distance	Radius
265.10	43.82	265.10	27.19	281.94	36.60	281.94	36.60
303.86	51.37	284.48	27.19	282.06	36.81	282.07	36.42
321.77	53.28	288.45	27.24	282.13	36.86	282.13	36.39
326.39	53.34	293.75	27.49	282.57	37.07	282.25	36.35
355.6	53.34	299.04	27.93	283.20	37.31	282.57	36.30
370.84	52.32	304.33	28.50	283.82	37.52	283.20	36.25
386.08	49.54	309.62	29.08	284.45	37.71	283.82	36.22
393.7	47.50	314.78	29.63	285.71	38.04	284.45	36.21
432.08	34.29	320.21	30.17	286.97	38.35	285.71	36.23
	(TO/CR)*	326.82	30.47	288.29	38.61	286.97	36.28
	36.83	359.90	30.47	316.18	42.58	288.29	36.40
	(P.Cut)**	365.20	30.22	321.26	42.94	316.18	40.37
	39.37	370.49	29.75	359.41	42.94	321.26	40.73
	(App.)***	375.78	29.23	368.3	41.02	359.41	40.73
		381.07	28.64			368.30	41.02
		386.37	27.97				
		392.98	27.06				
		396.95	26.47				
		402.24	25.60				
		407.54	24.58				
		412.83	23.45				
		418.12	22.23				
		423.42	20.79				
		430.03	18.44				

* Takeoff/Cruise
** Power Cut
*** Approach

Note: Dimensions are given in centimeters. See Figure 30 for axial distance reference location.

APPENDIX F

LIST OF SYMBOLS AND NOMENCLATURE

Symbol	Description	Units
A	Area	m^2 or cm^2
C	Blade Chord	cm
C_f	Skin Friction Coefficient $\equiv \tau_W/q$	-
D or	Diffusion Factor:	
D-Factor	$D_{rotor} = 1 - (V_2'/V_1') + (r_2 V_{\theta 2} - r_1 V_{\theta 1})/(2 \bar{r} \sigma V_1')$	
	$D_{stator} = 1 - (V_2/V_1) + (r_1 V_{\Theta 1} - r_2 V_{\theta 2})/(2 \bar{r} \sigma V_1)$	
d	Diameter	m
DH	Hydraulic Diameter $\equiv$ 4A/Wetted Perimeter	cm
DRG	Body Friction Drag	N
dx	Incremental Inlet Length	cm
f	Friction Factor	-
F_{sep*}	Separation Parameter (See Reference 11)	-
i	Incidence Angle	degrees
L	Length (inlet)	m
L/D_F	Ratio of Inlet Length vs Fan Diameter	-
M	Mach Number	-
N	Engine Speed	rpm
n	Power Law Exponent	-
N_B	Number of Blades or Vanes	-
P	Pressure	N/m^2
q	Dynamic Pressure (Total Pressure - Static Pressure, Incompressible)	N/m^2
R or r	Radius	cm
R1,R2,R3...	Rotor 1, Rotor 2, Rotor 3 etc Respectively	-
$\bar{r}$	Mean Radius	cm
S1, S2, S3...	Stator 1, Stator 2, Stator 3 etc Respectively	-
SL	Streamline	-

LIST OF SYMBOLS AND NOMENCLATURE (Continued)

Symbol	Description	Units
T	Temperature	° K
t	Thickness (Blade)	cm
U	Rotor Speed	m/sec
V	Velocity	m/sec
W	Airflow	kg/sec
Z	Axial Distance	cm
β	Flow Angle	degrees
γ	Specific Heat Ratio	-
δ	Pressure Correction ($P_T/5422$)	-
$\delta°$	Deviation Angle	degrees
η_R	Inlet Recovery (P_{T_1}/P_{T_∞})	-
θ	Temperature Correction ($T_{T_1}/518.67$)	-
$\theta°$	Equivalent Conical Diffusion Angle: $\theta° = \tan^{-1}[(R_2 - R_{TH})/L]$	degrees
λ	Effective Area Coefficient: $A_{effective}/A_{physical}$	-
μ	Angle of Tilt in the Axial Direction from a Radial Line	degrees
ρ	Air Density	kg/m^3
ρ_r	Dimension along Axis Tilted in the Axial Direction from a Radial Line	cm
σ	Solidity	-
τ_W	Shear Stress	N/m^2
ψ	Percent Flow	-
$\bar{\omega}$	Total Pressure Loss Coefficient: $(P_{T_2} - P_{T_1})/(0.5\ \rho\ V_1^2)$	-

LIST OF SYMBOLS AND NOMENCLATURE (Concluded)

Subscripts

amb	Ambient Condition
AVG	Average Value Based on a Mass-Weighted Technique
BYP	Bypass or Fan Exit
F	Fan
I	Cascade Inlet Capture
m or max	Maximum
r	Radial
S or s	Static Condition
T	Total
TH	Throat
Z	Axial Direction
θ	Tangential Direction
∞	Free Stream
0	Total or Stagnation Conditions
1	Entrance Station
2	Exit Station
28	Fan Duct Exit

Superscripts

*	β^* – Metal Angle
	A^* – Area at Mach 1.0
' (Prime)	Relative Property

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ILLUSTRATIONS

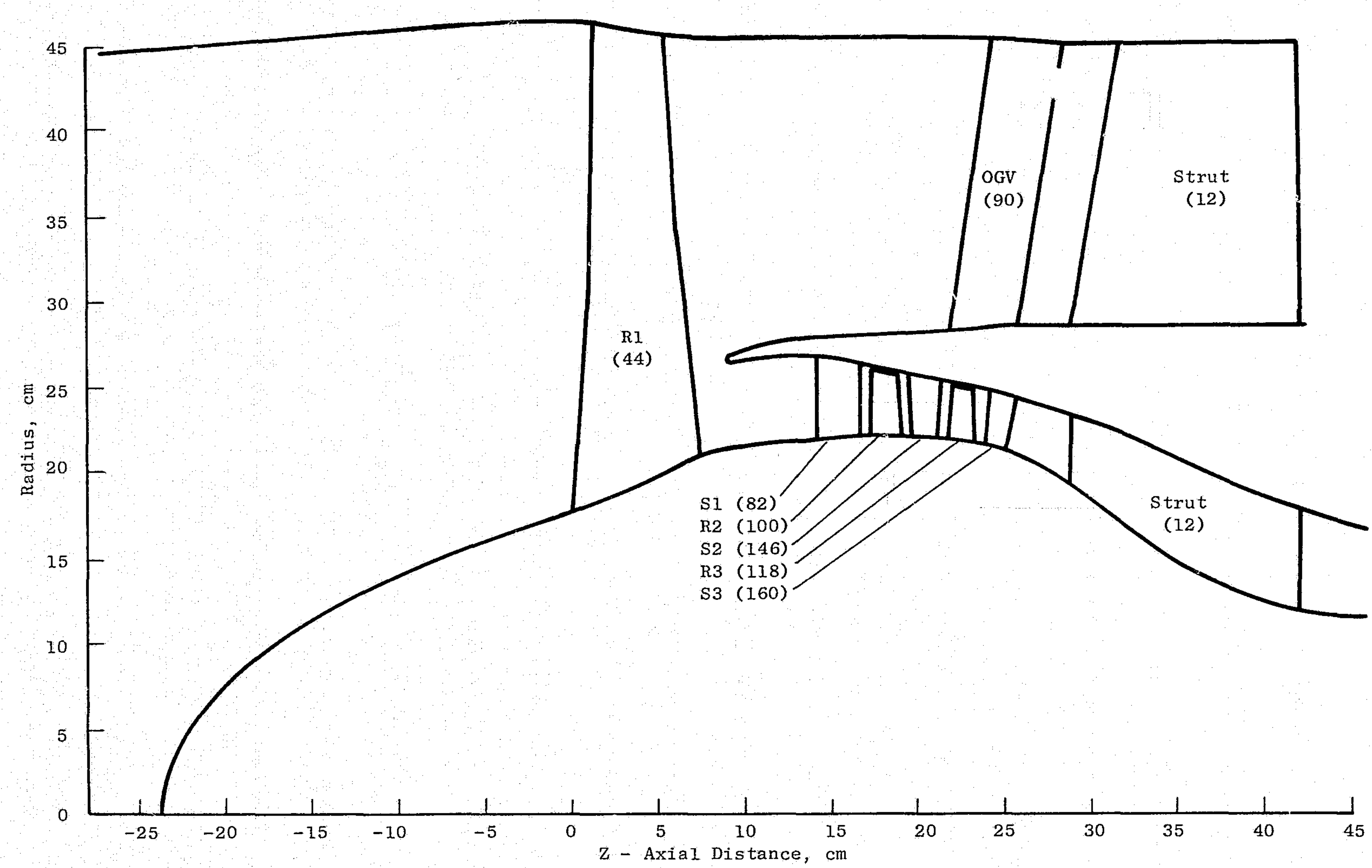
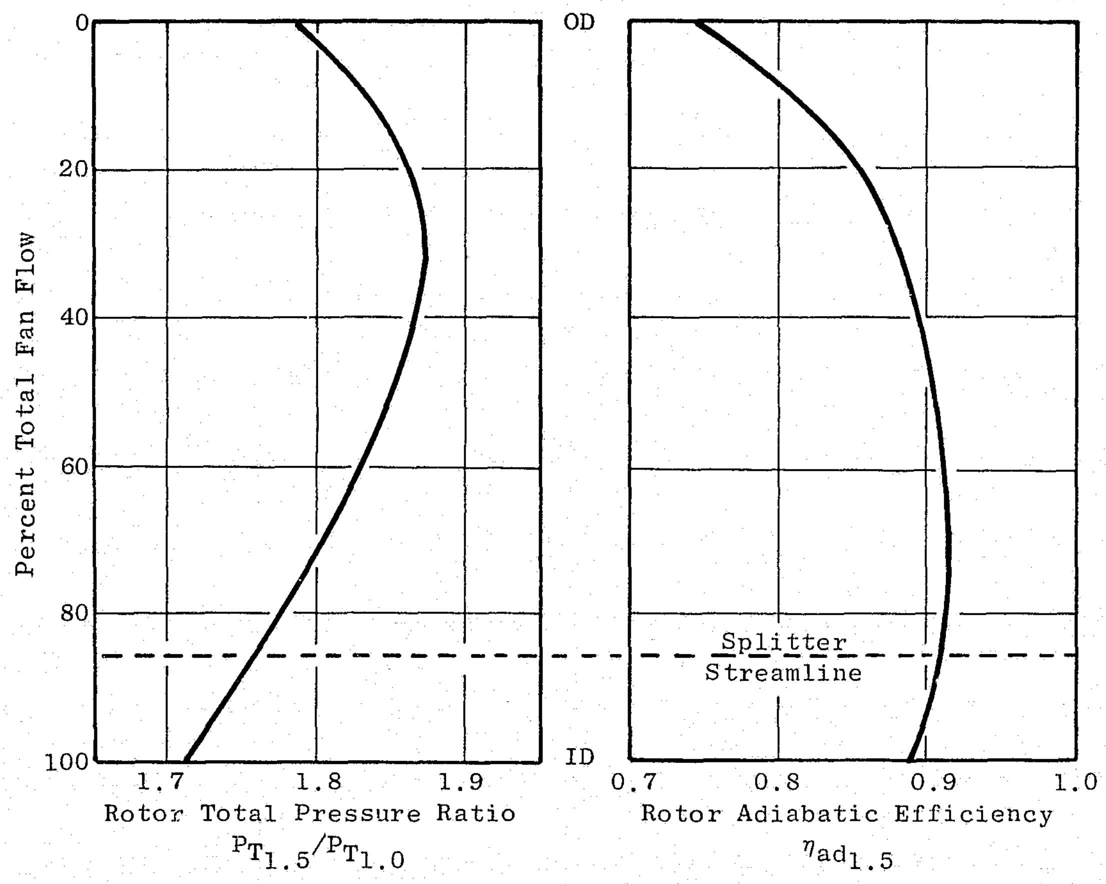


Figure 1. Advanced Technology Fan and Booster Flowpath.



(See Figure 9 for Station Locations)

Figure 2. Fan Rotor Pressure Ratio and Efficiency Radial Distributions.

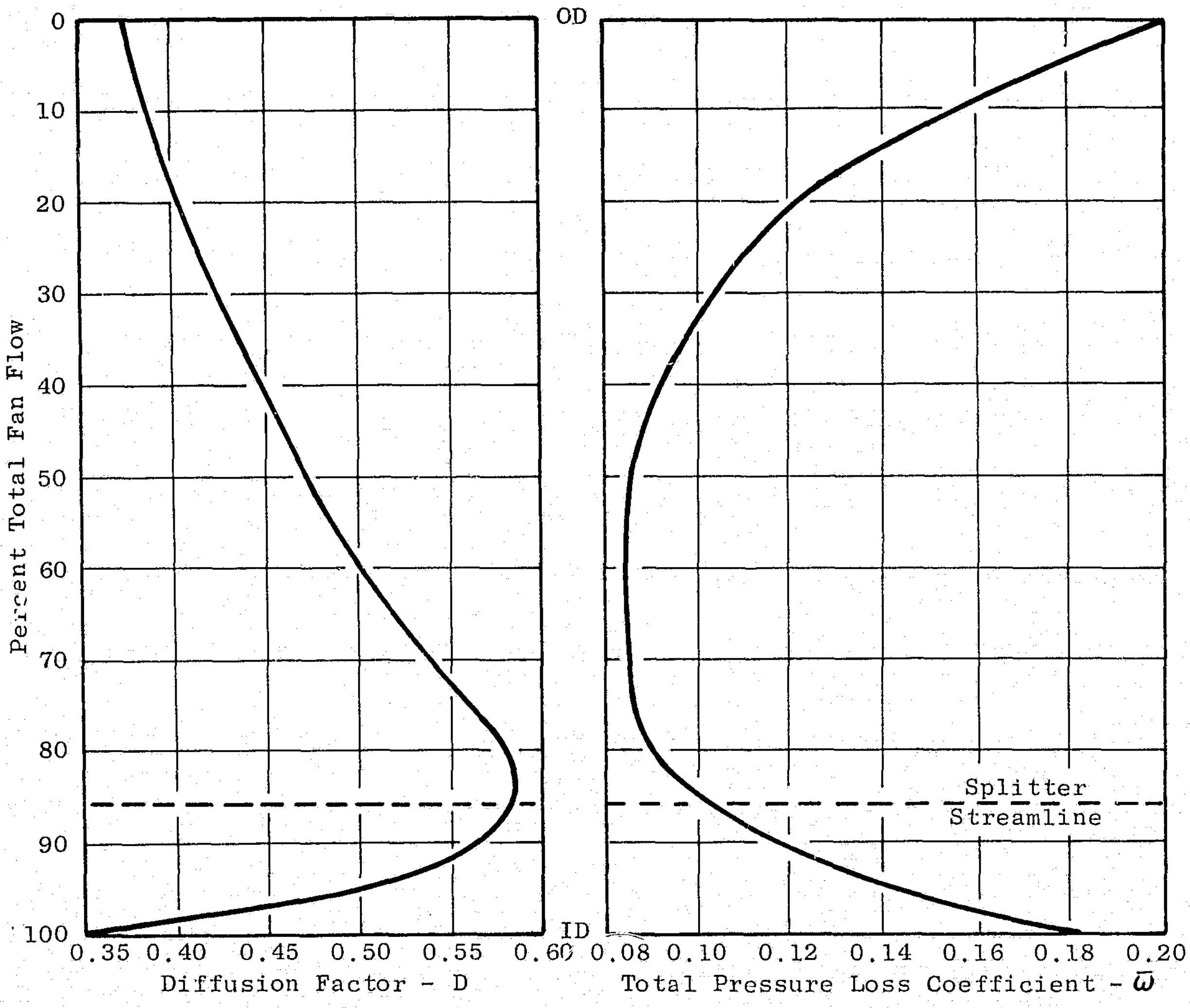


Figure 3. Fan Rotor Diffusion Factor and Loss Coefficient Radial Distributions.

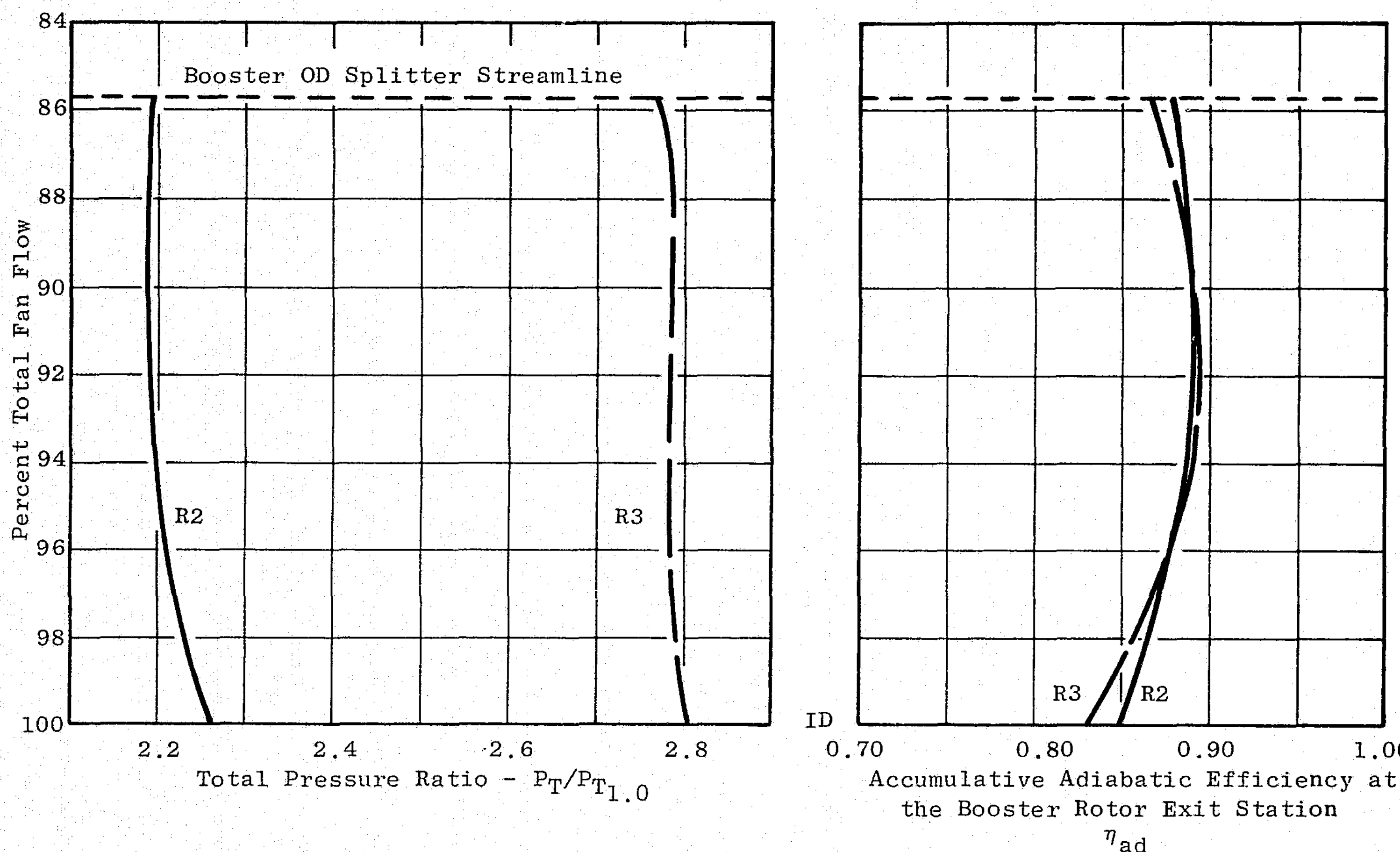


Figure 4. Fan Booster Rotors - Total Pressure Ratio and Efficiency Radial Distributions.

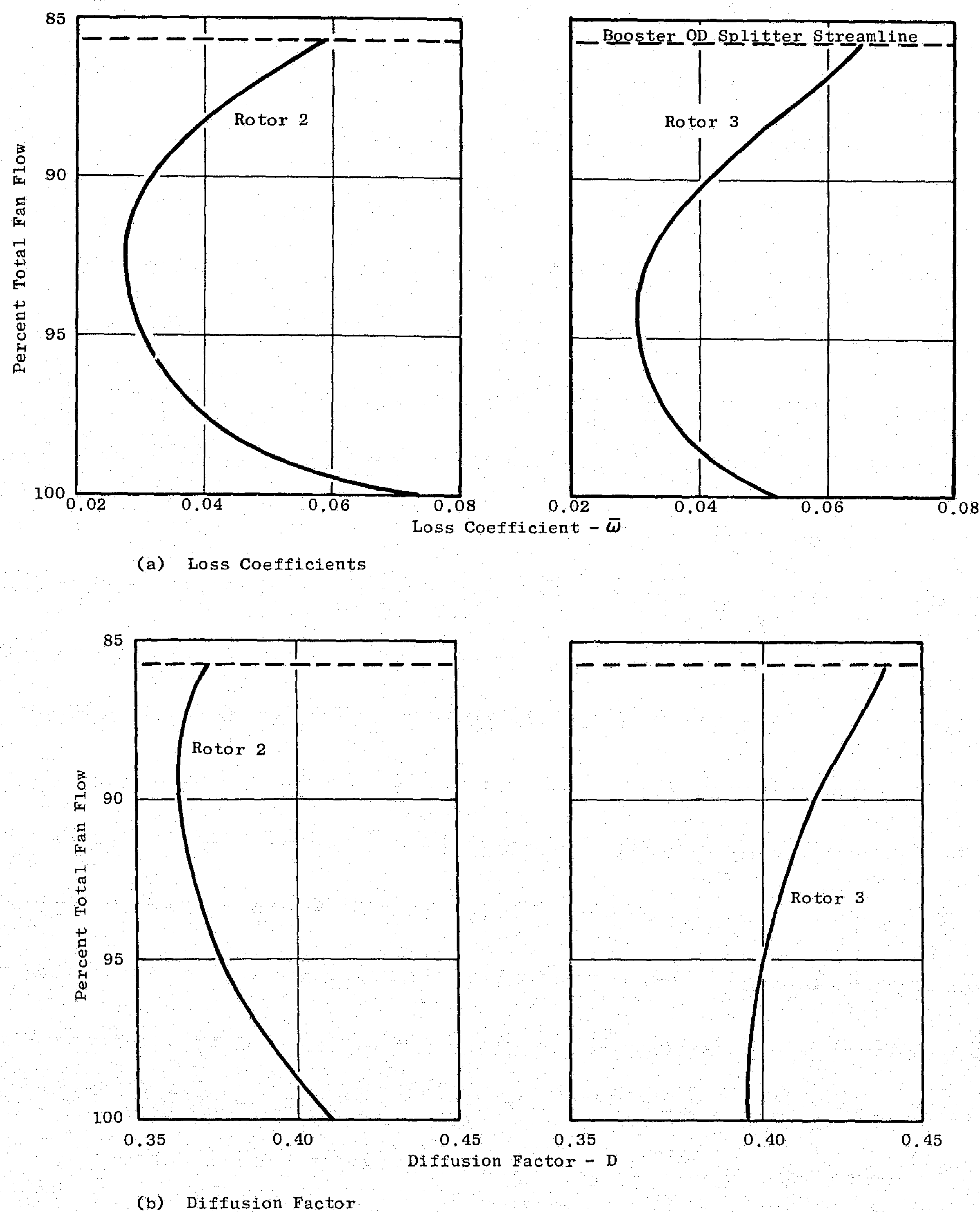


Figure 5. Fan Booster Rotors - Loss Coefficient and Diffusion Factor Radial Distributions.

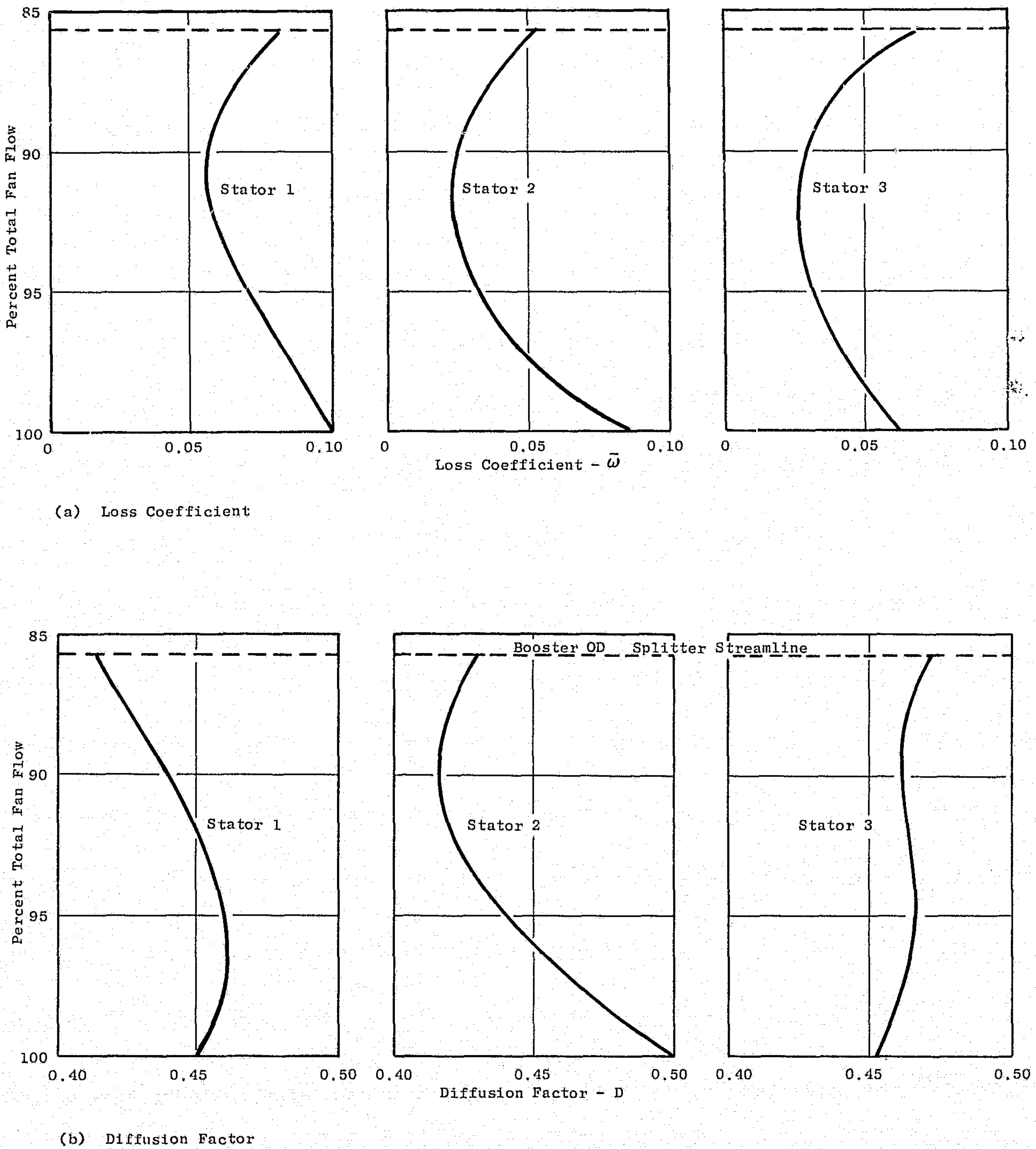


Figure 6. Fan Booster Stators - Loss Coefficient and Diffusion Factor Radial Distributions.

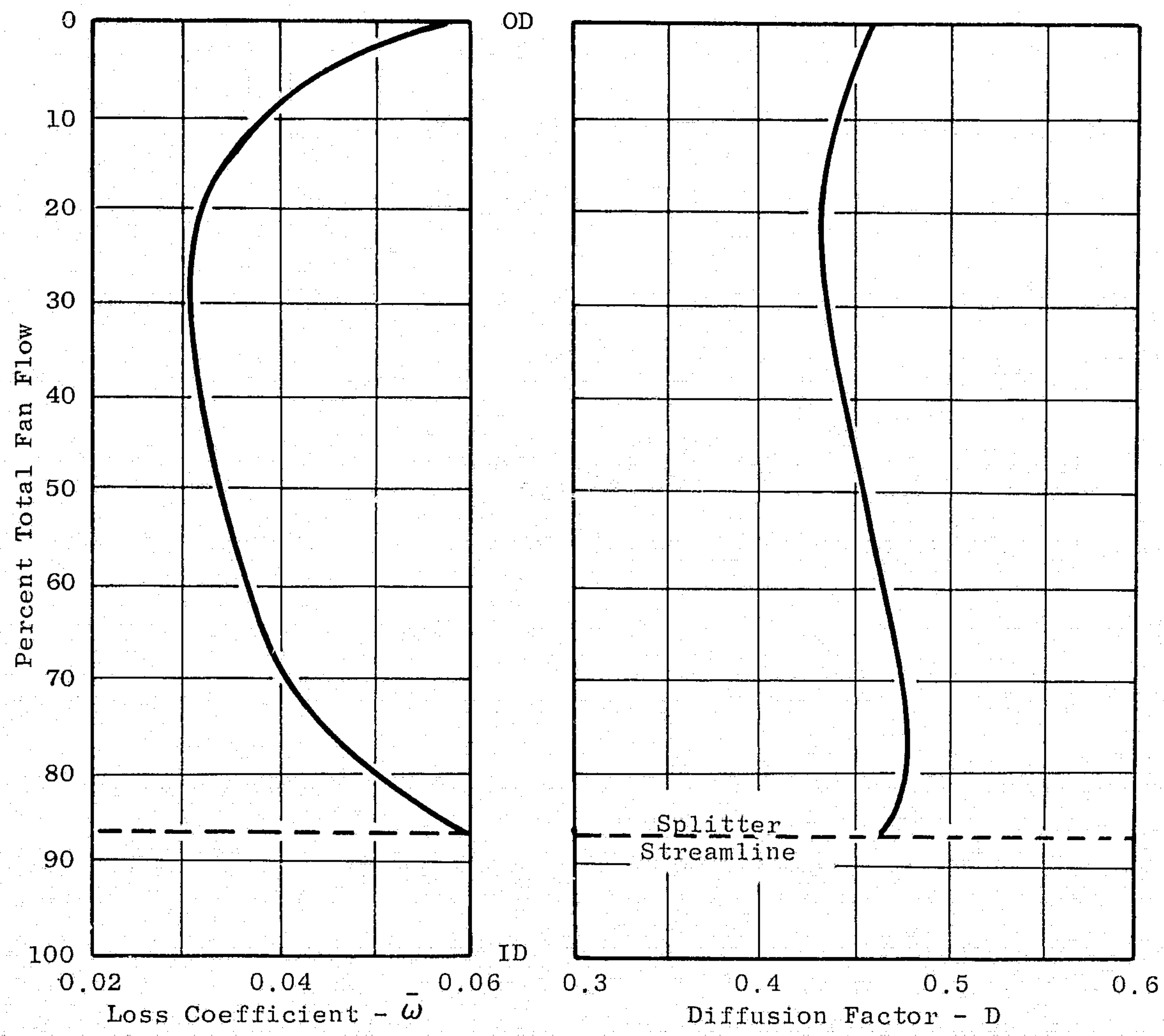


Figure 7. Fan Bypass OGV Loss Coefficient and Diffusion Factor Radial Distributions.

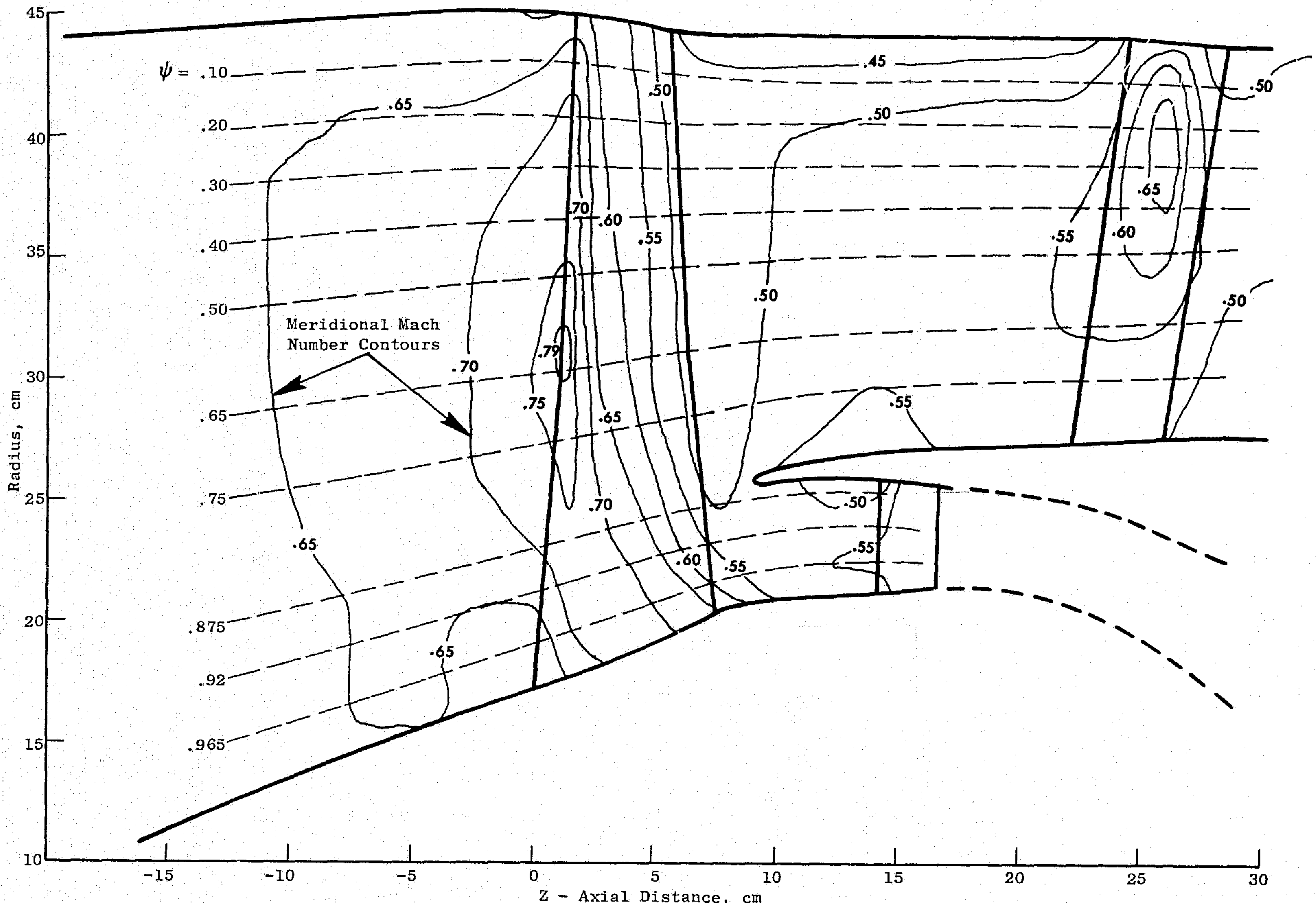


Figure 8. Fan Meridional Mach Number Contours and Streamlines at Design Point.

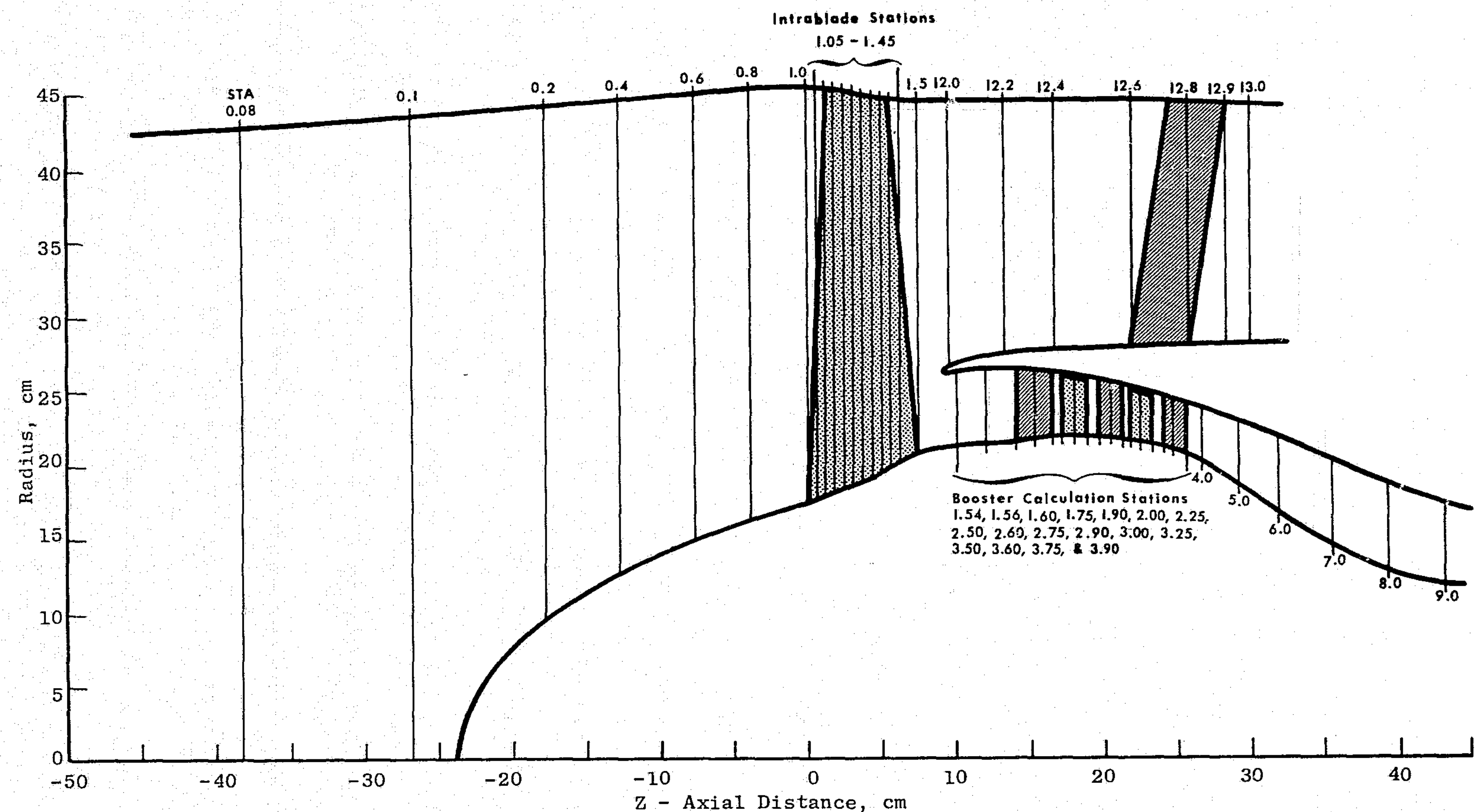


Figure 9. Fan and Booster Flowpath - Design Calculation Stations.

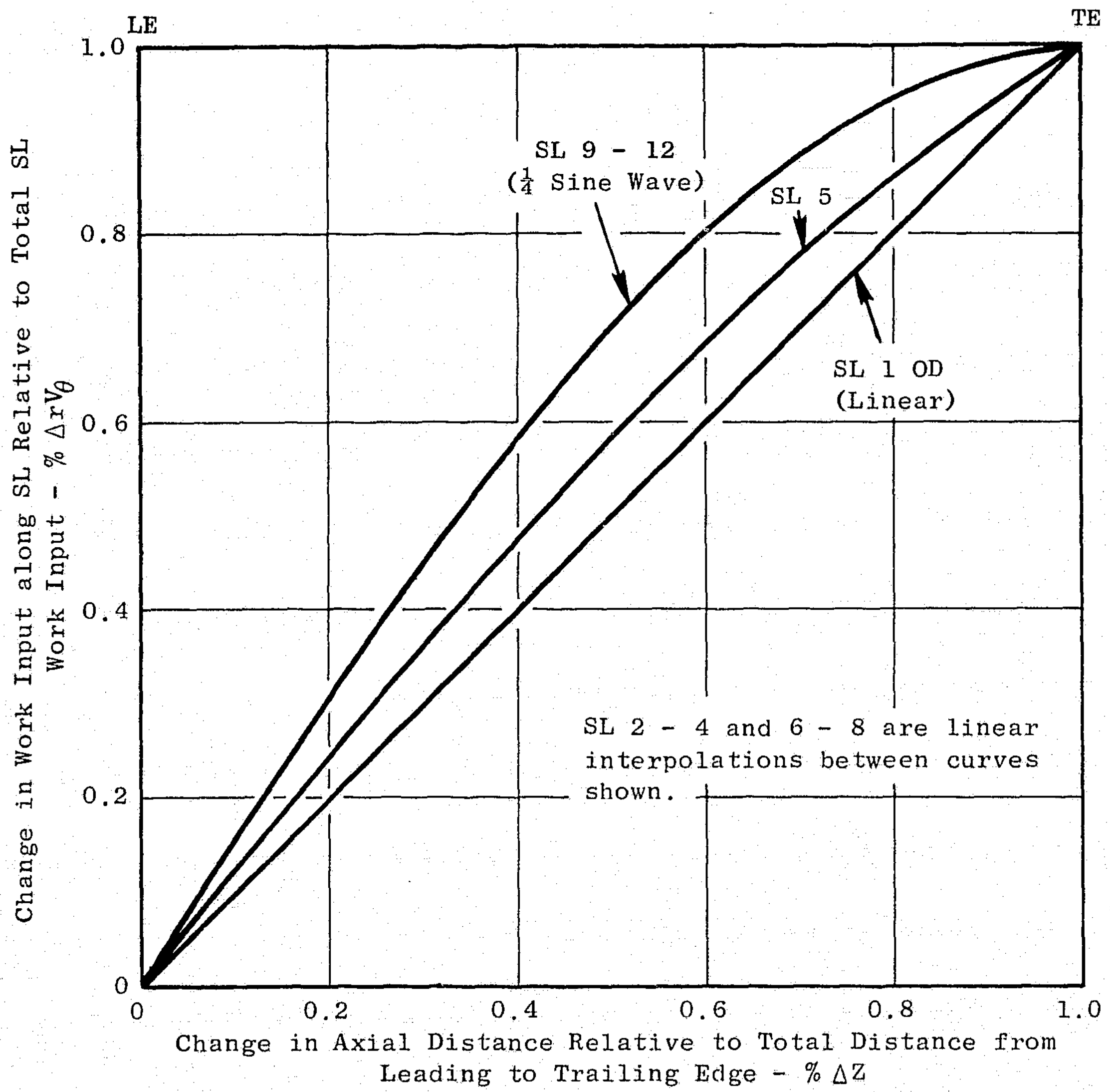


Figure 10. Fan Rotor Intrablade Energy Distribution Assumptions Along Streamlines.

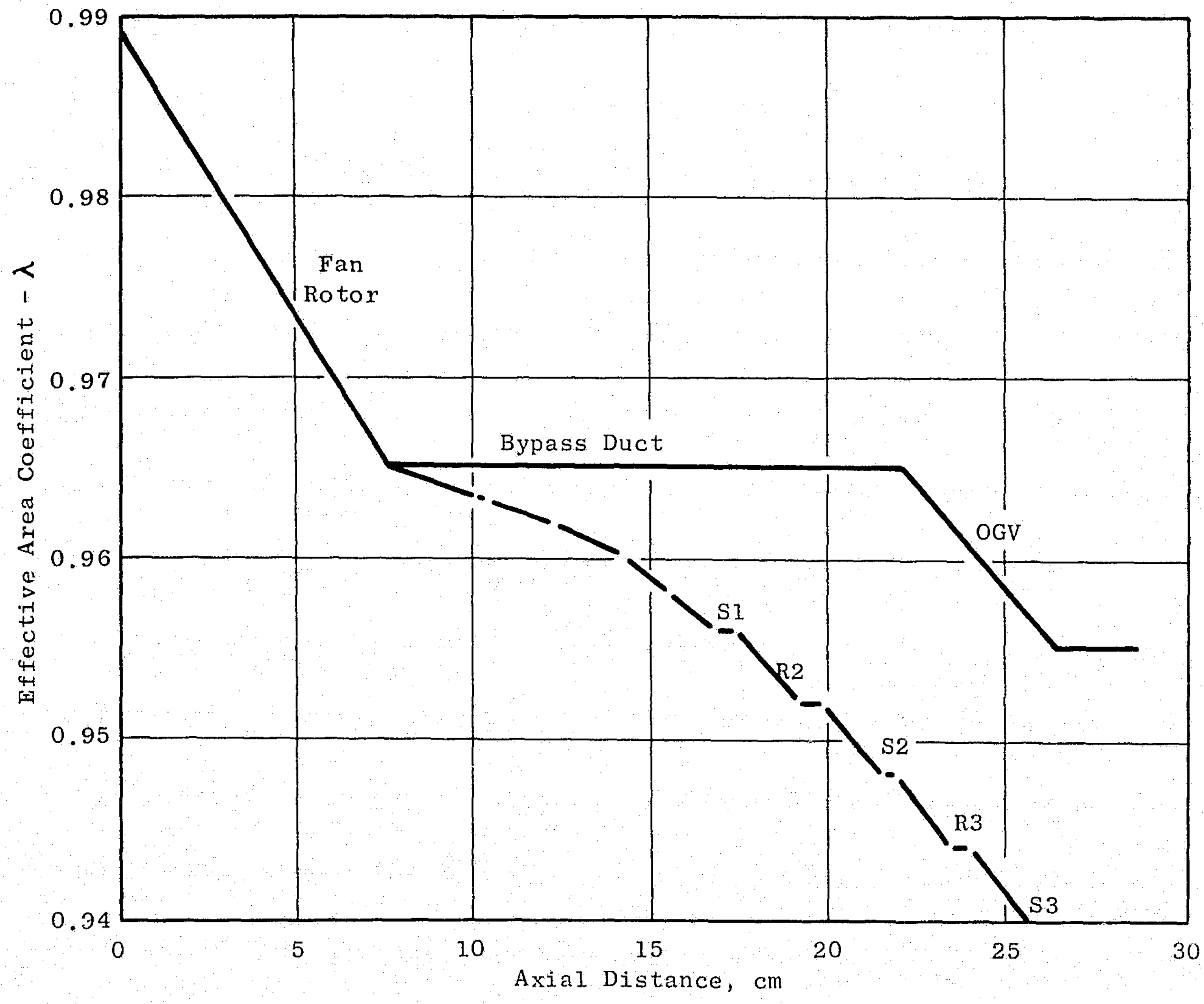


Figure 11. Fan and Booster Flowpath Effective Area Coefficients.

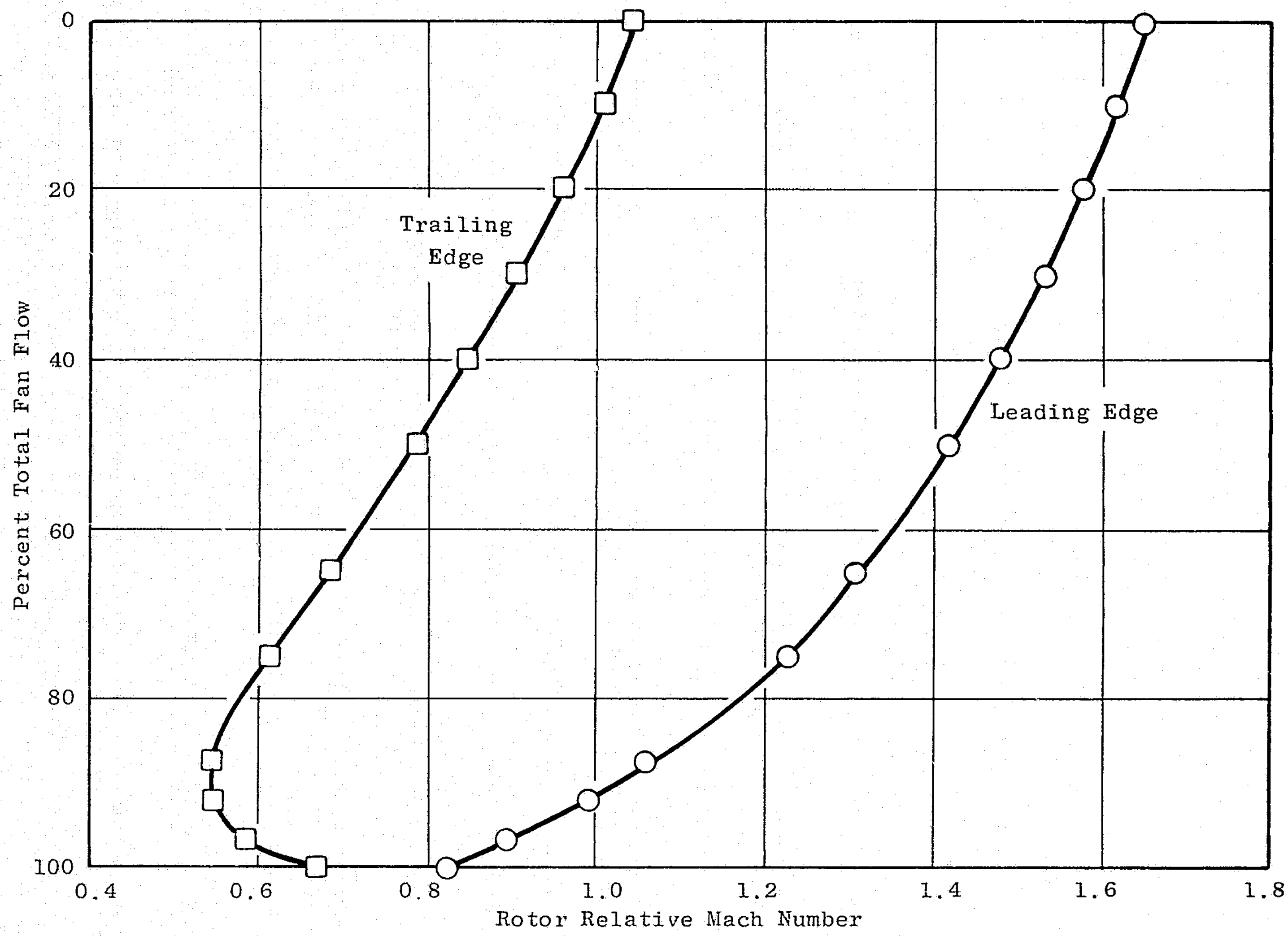


Figure 12. Fan Rotor Relative Mach Number Radial Distributions at Design Point.

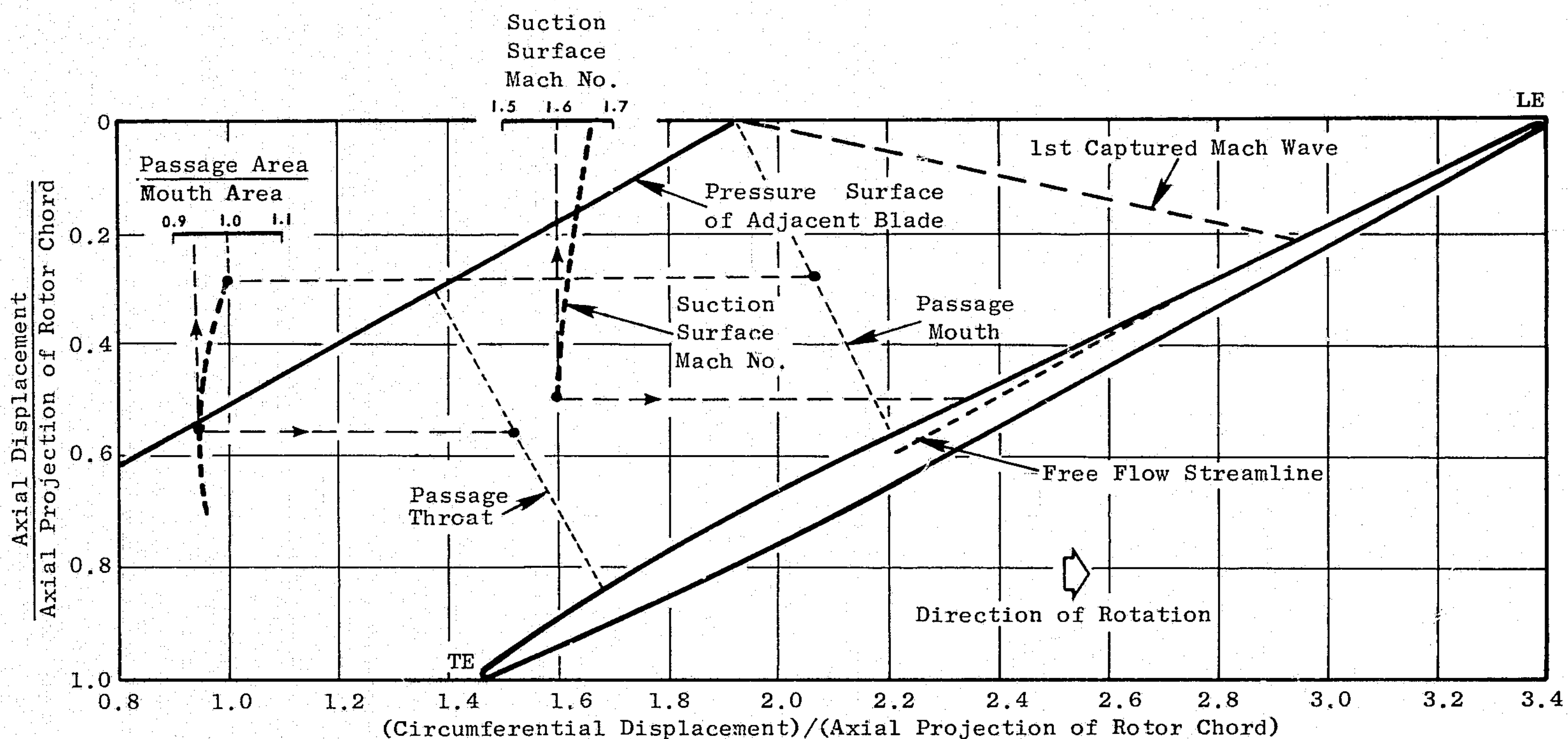


Figure 13. Fan Rotor Blade Shape Along a Streamline Near the Tip (SL2).

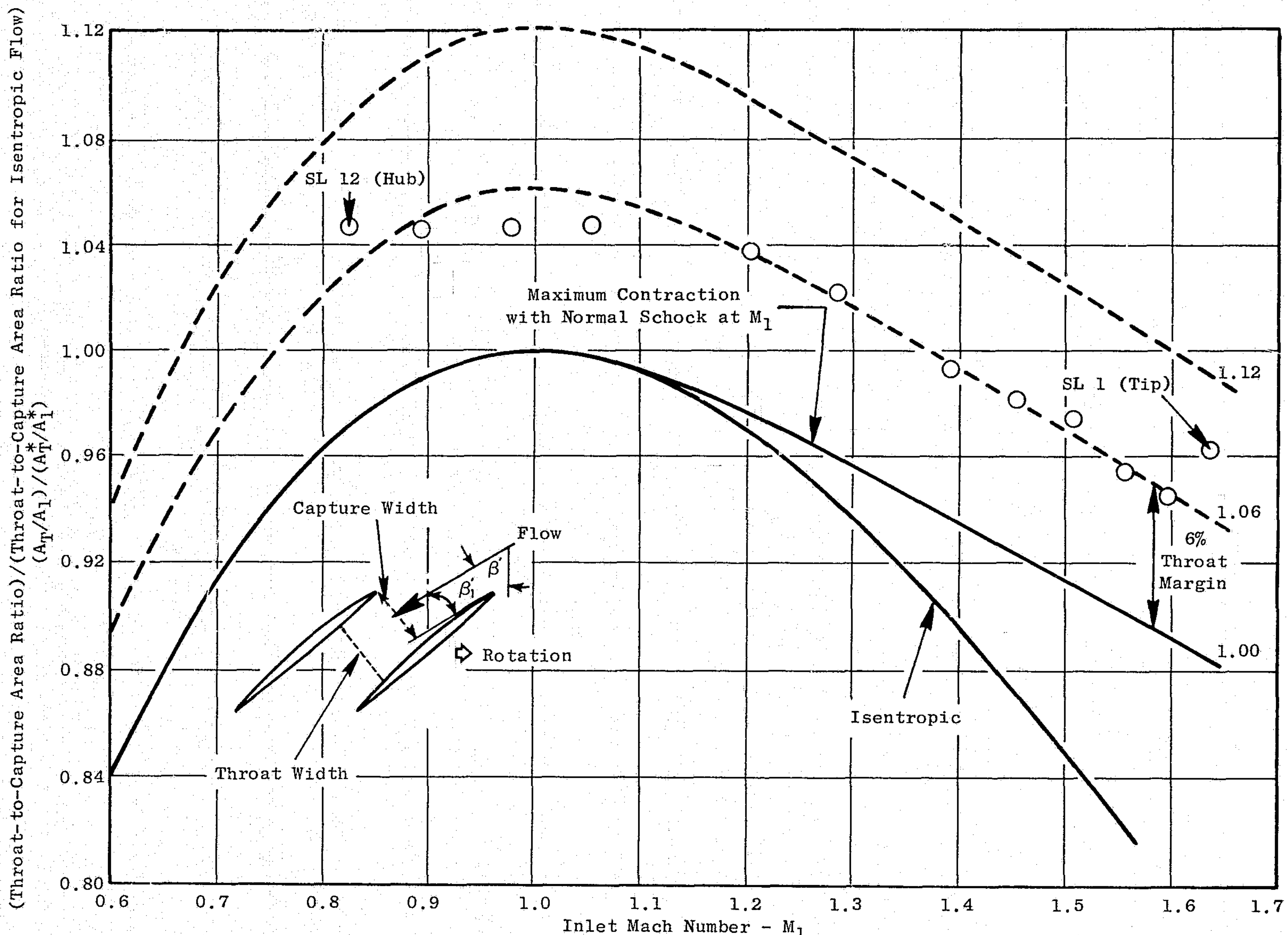


Figure 14. Fan Rotor Throat-to-Capture Area Ratios.

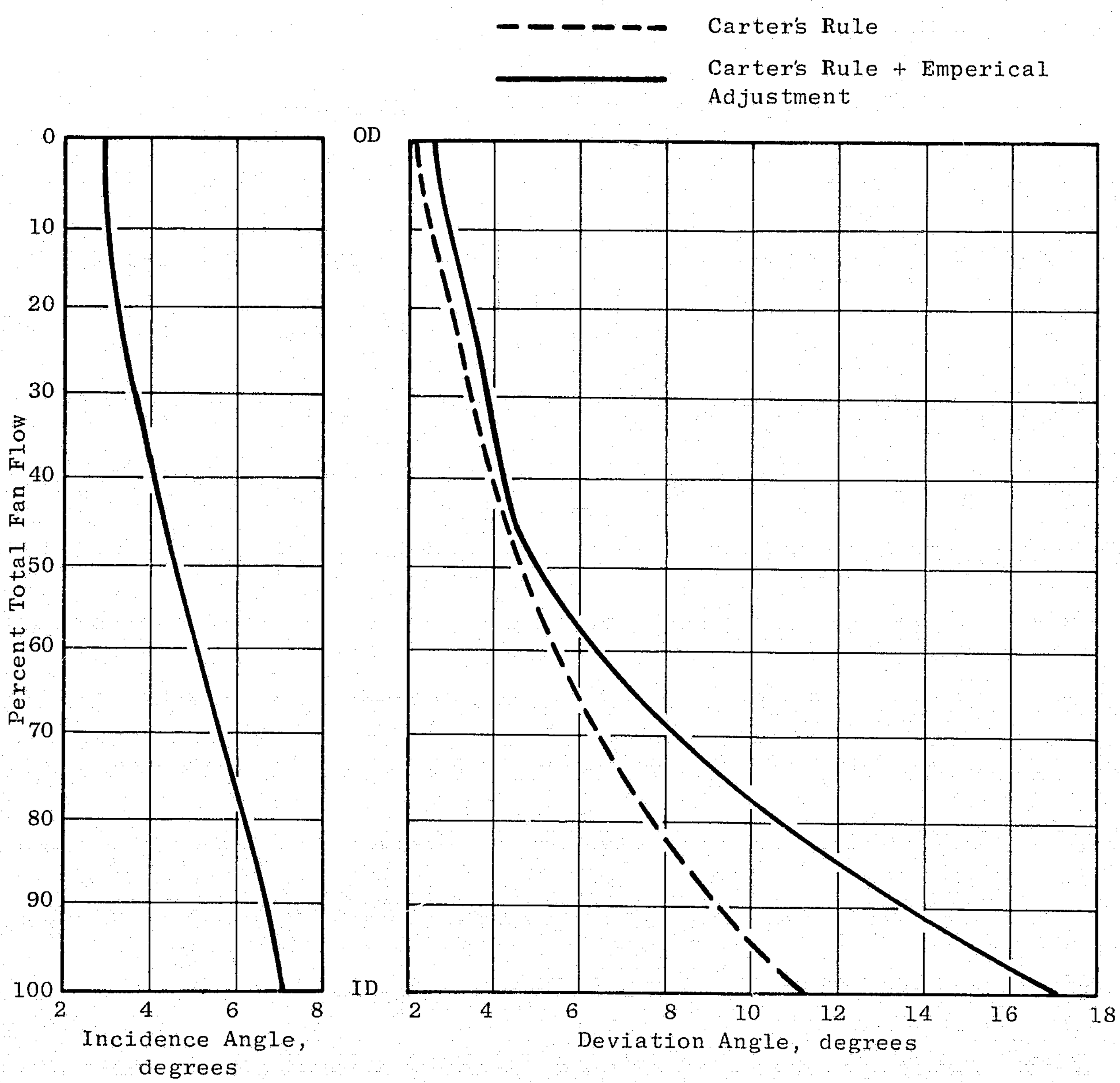


Figure 15. Fan Rotor Incidence and Deviation Angle Radial Distributions.

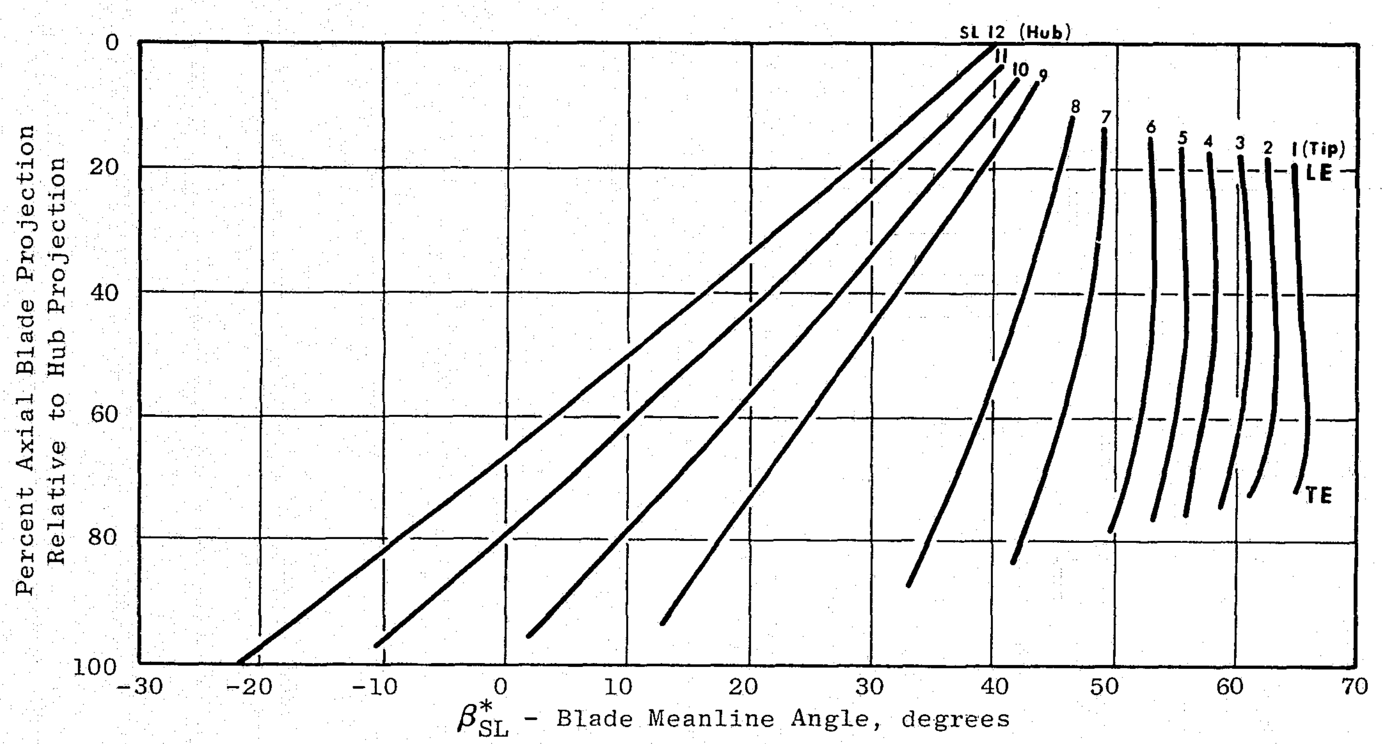


Figure 16. Fan Rotor Blade Stream Surface Meanline Angles.

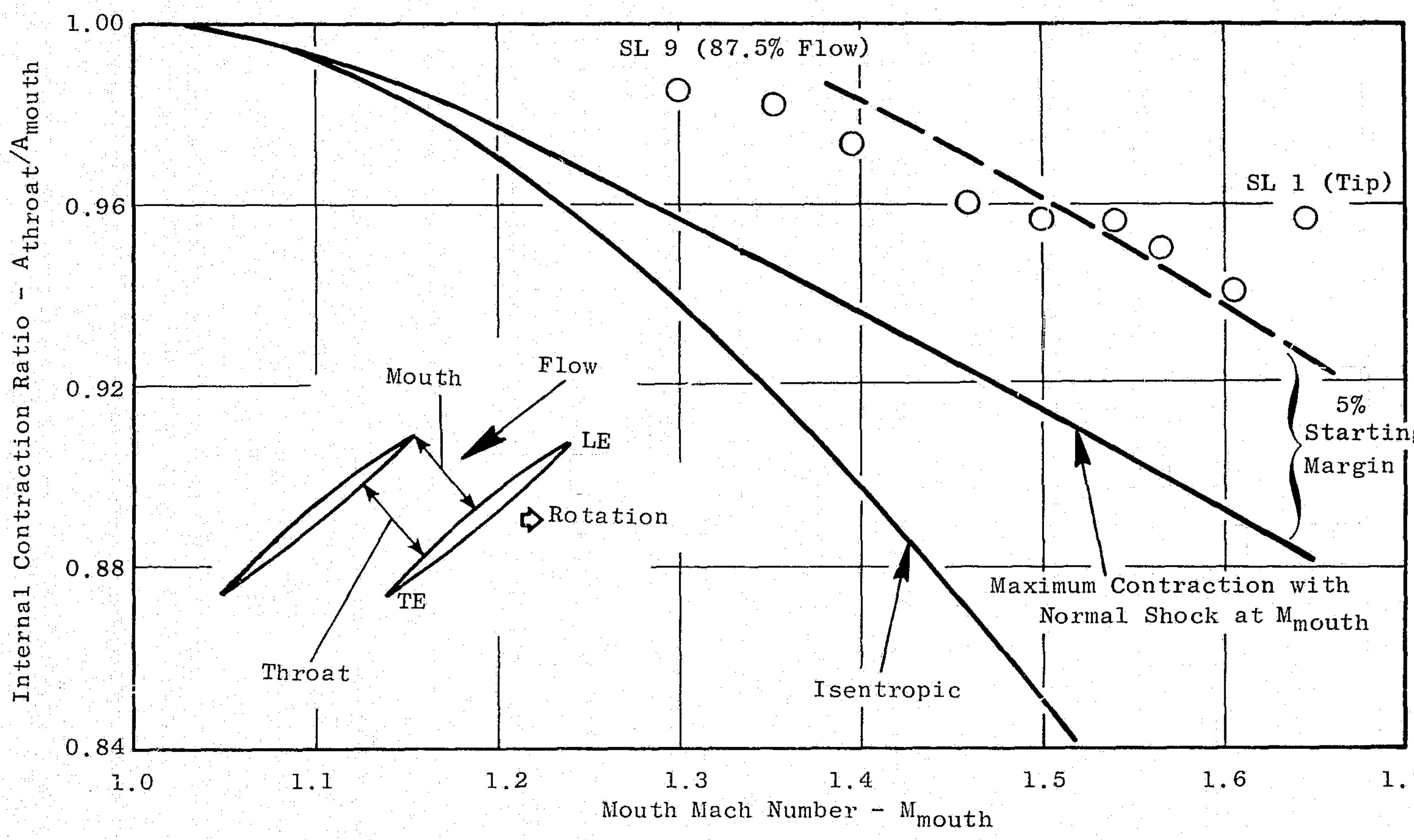


Figure 17. Fan Rotor Blade Internal Contraction Ratio.

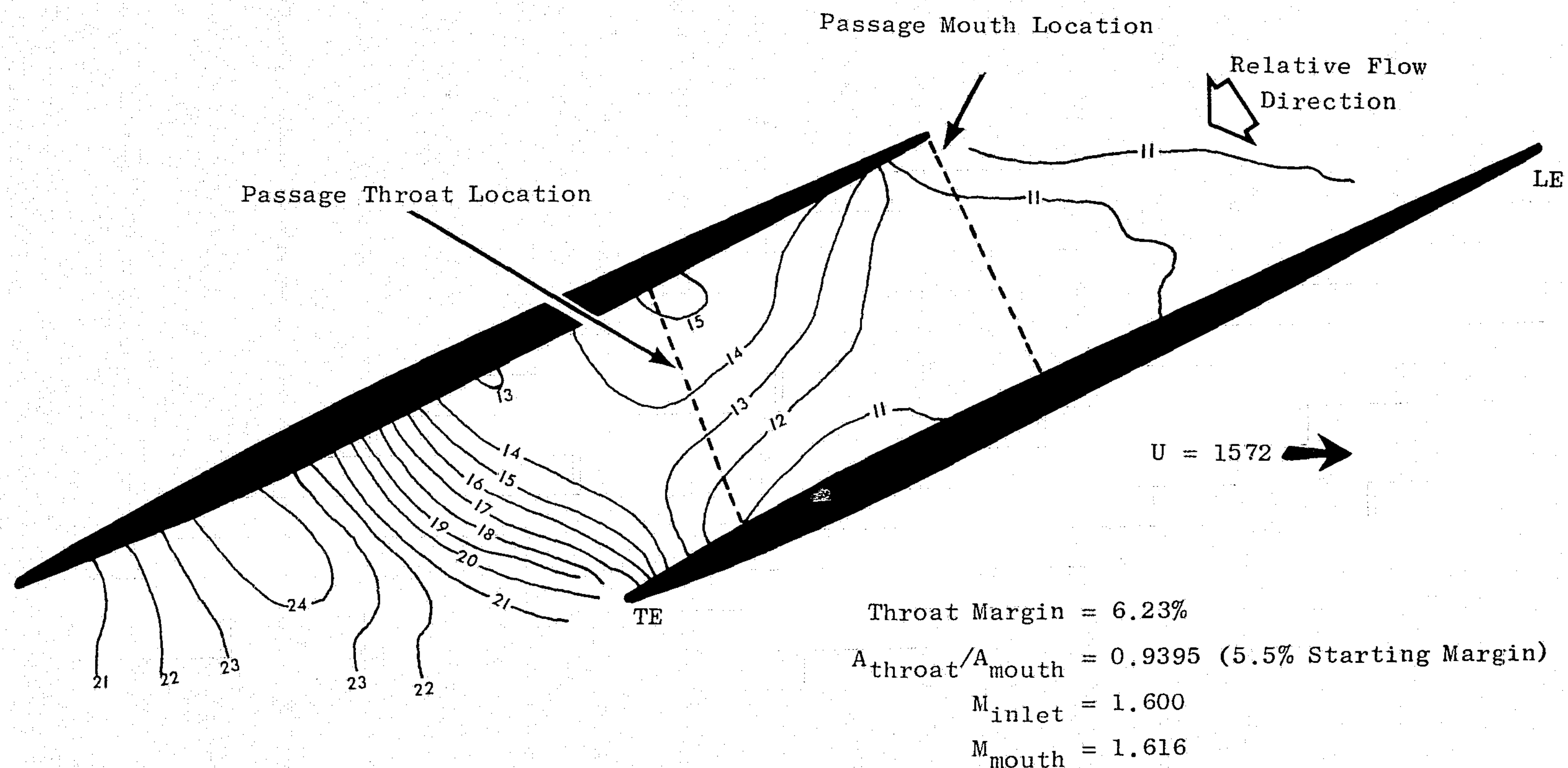


Figure 18. Fan Rotor Blade Static Pressure Isobars Along a Streamline Near the Tip (SL2) from Blade-to-Blade Analysis.

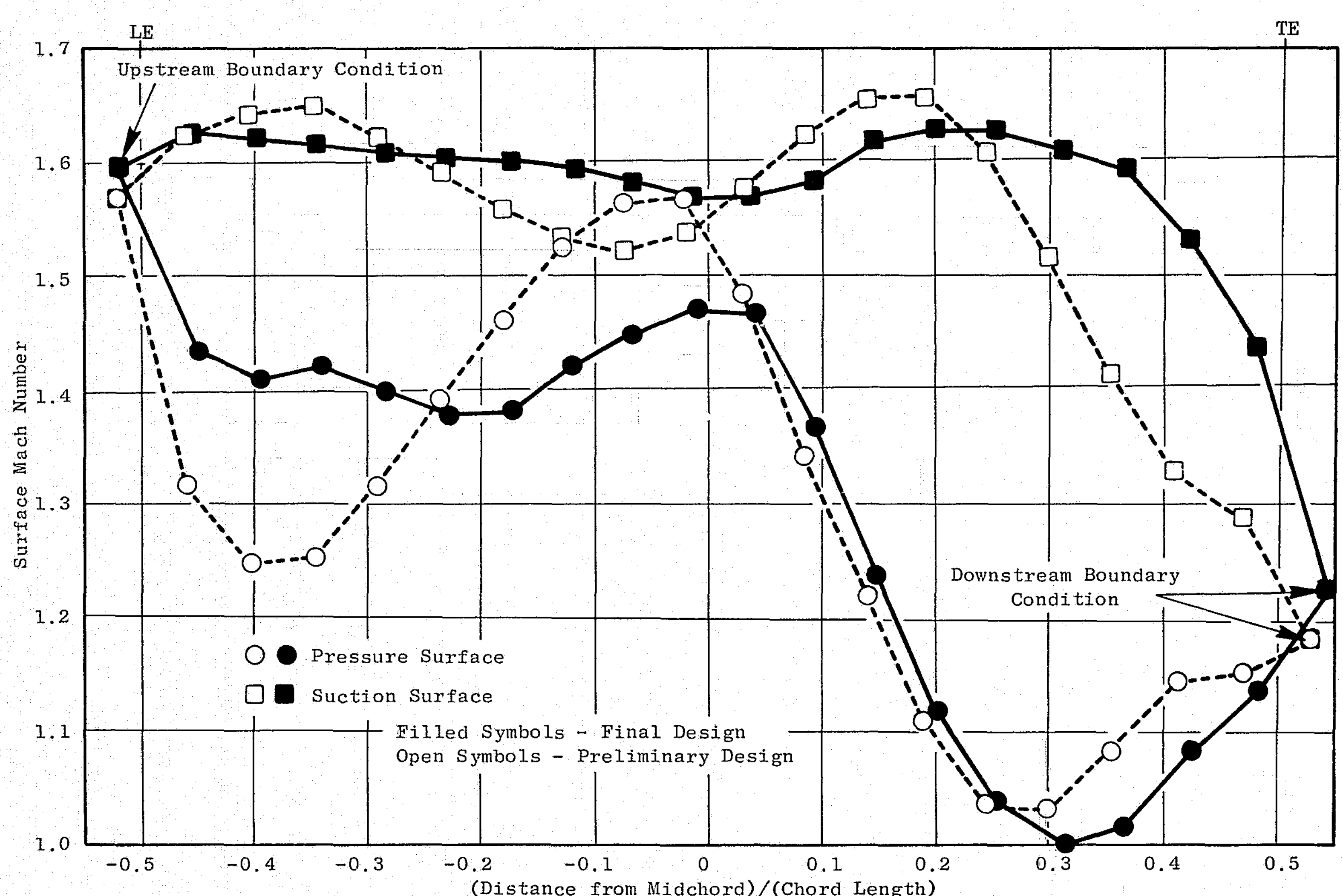


Figure 19. Fan Rotor Blade Surface Mach Numbers Along a Streamline Near the Tip (SL2) from Blade-to-Blade Analysis.

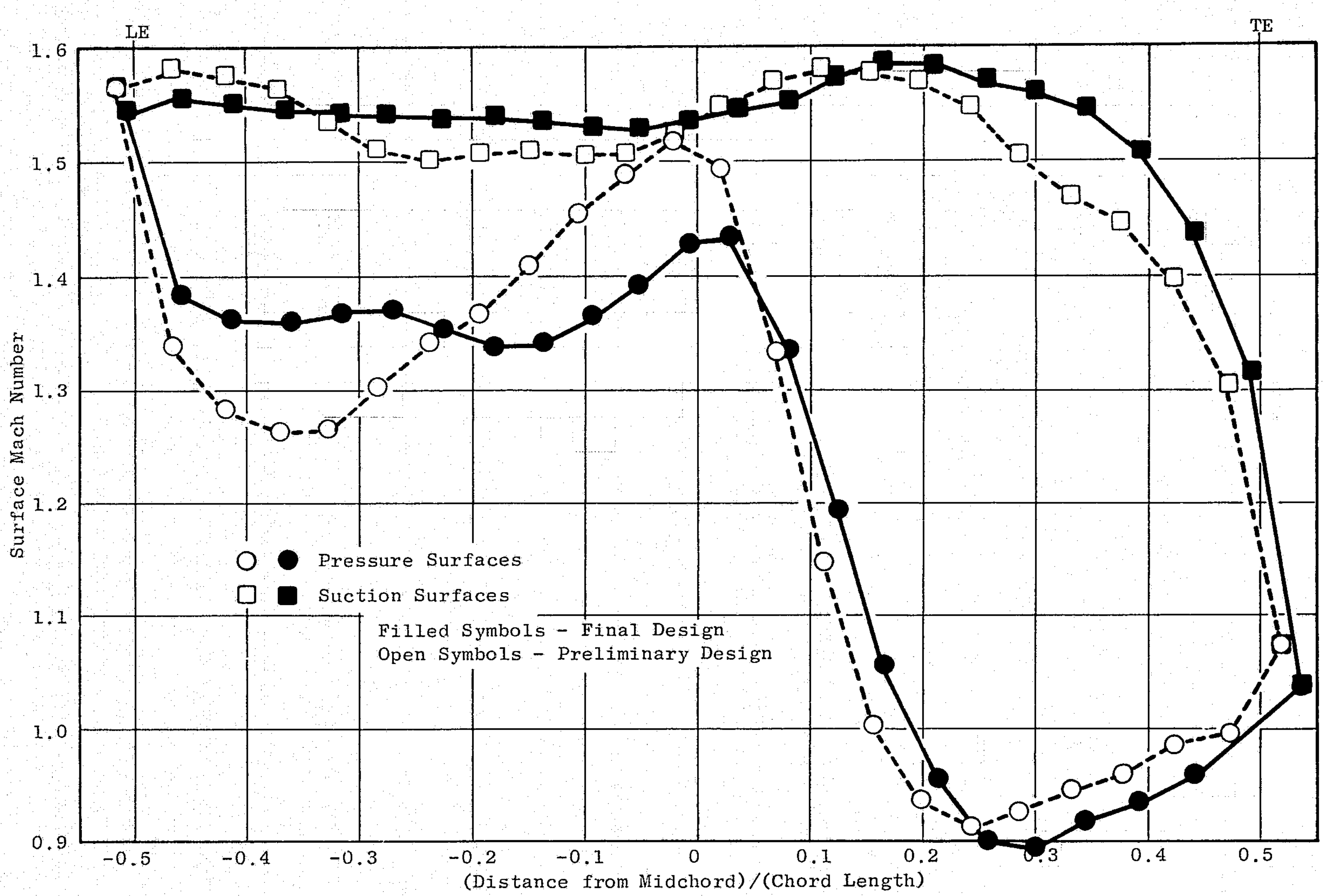


Figure 20. Fan Rotor Blade Surface Mach Numbers Along a Streamline Near the Pitch (SL6) from Blade-to-Blade Analysis.

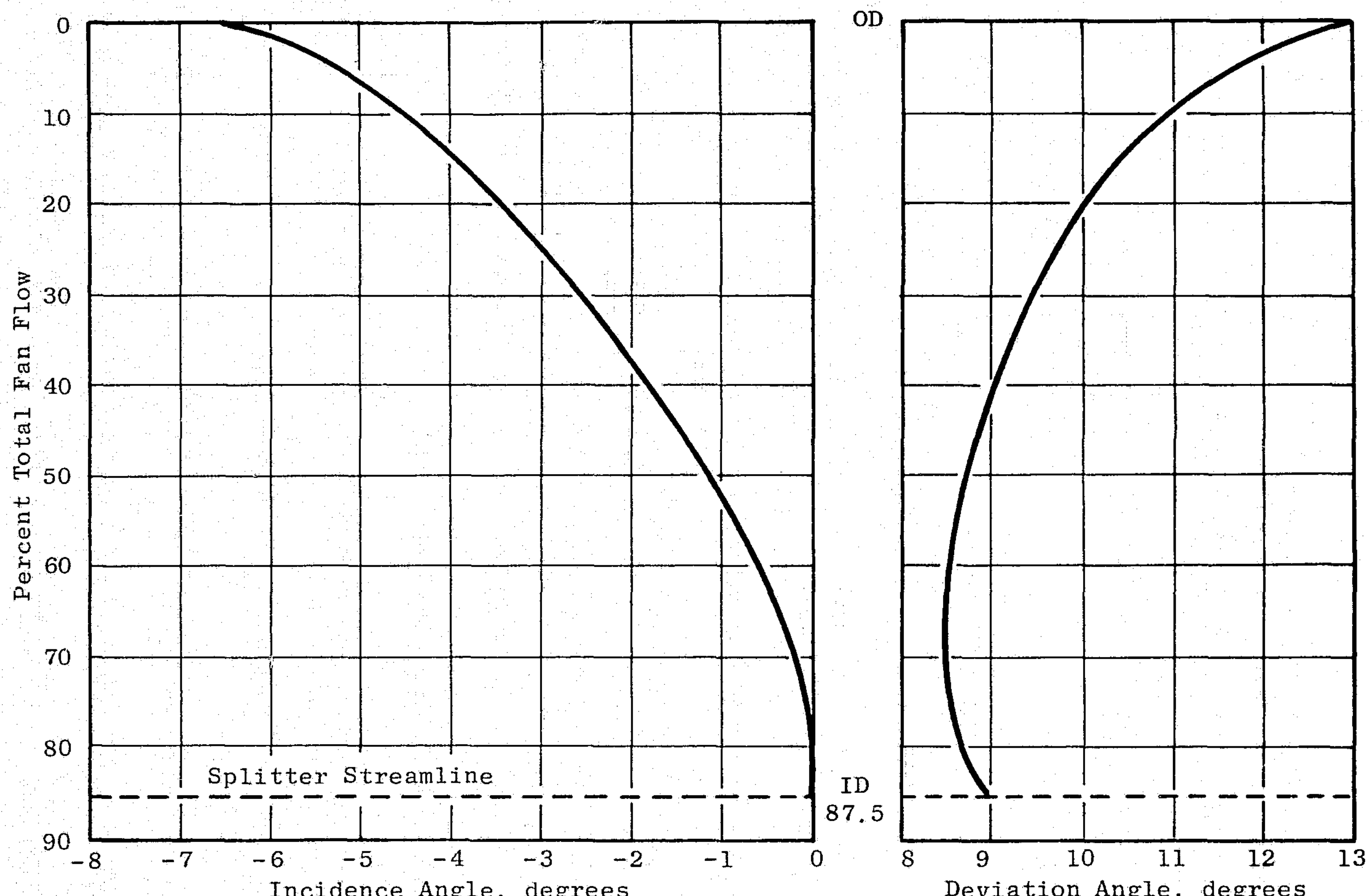


Figure 21. Fan Bypass Outlet Guide Vane (OGV) Incidence and Deviation Angles Radial Distributions.

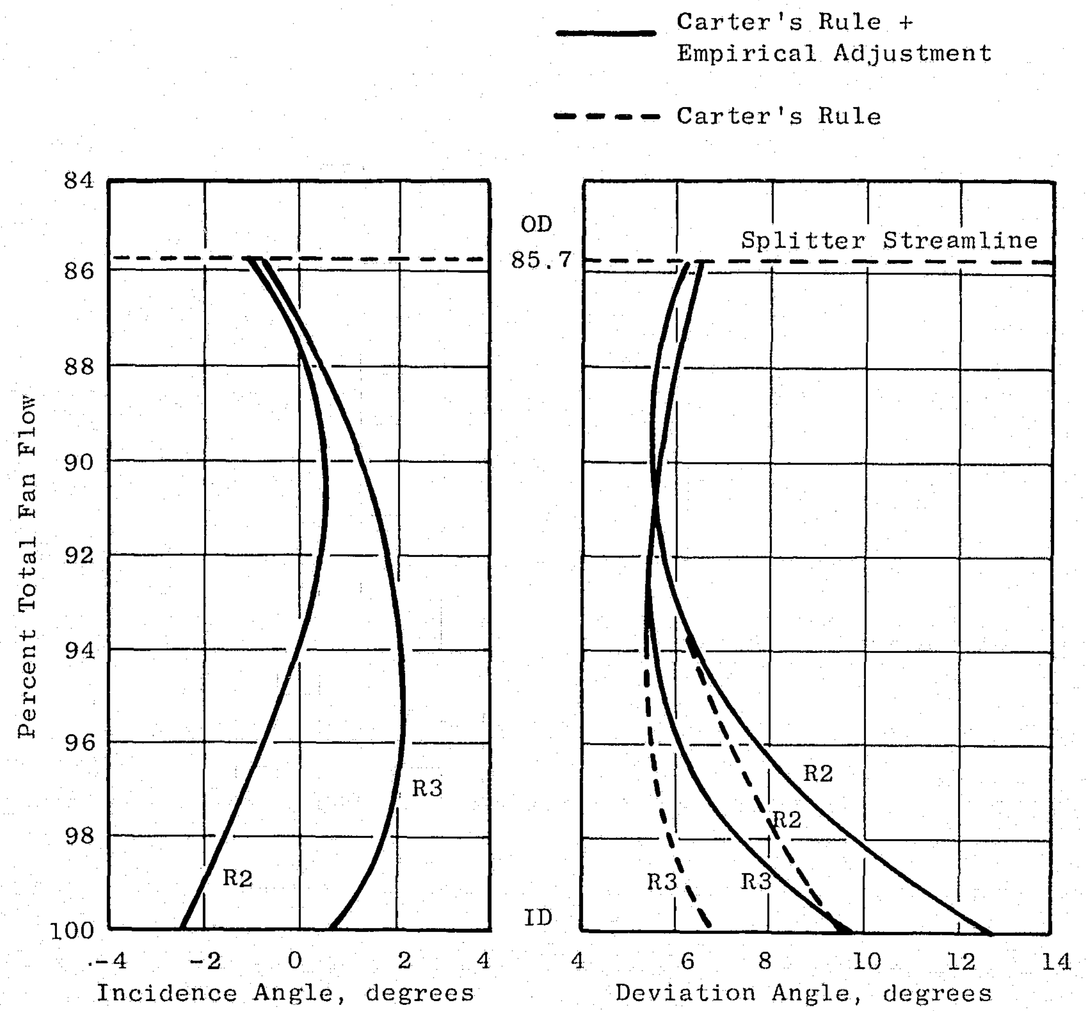


Figure 22. Fan Booster Rotors Incidence and Deviation Angles Radial Distributions.

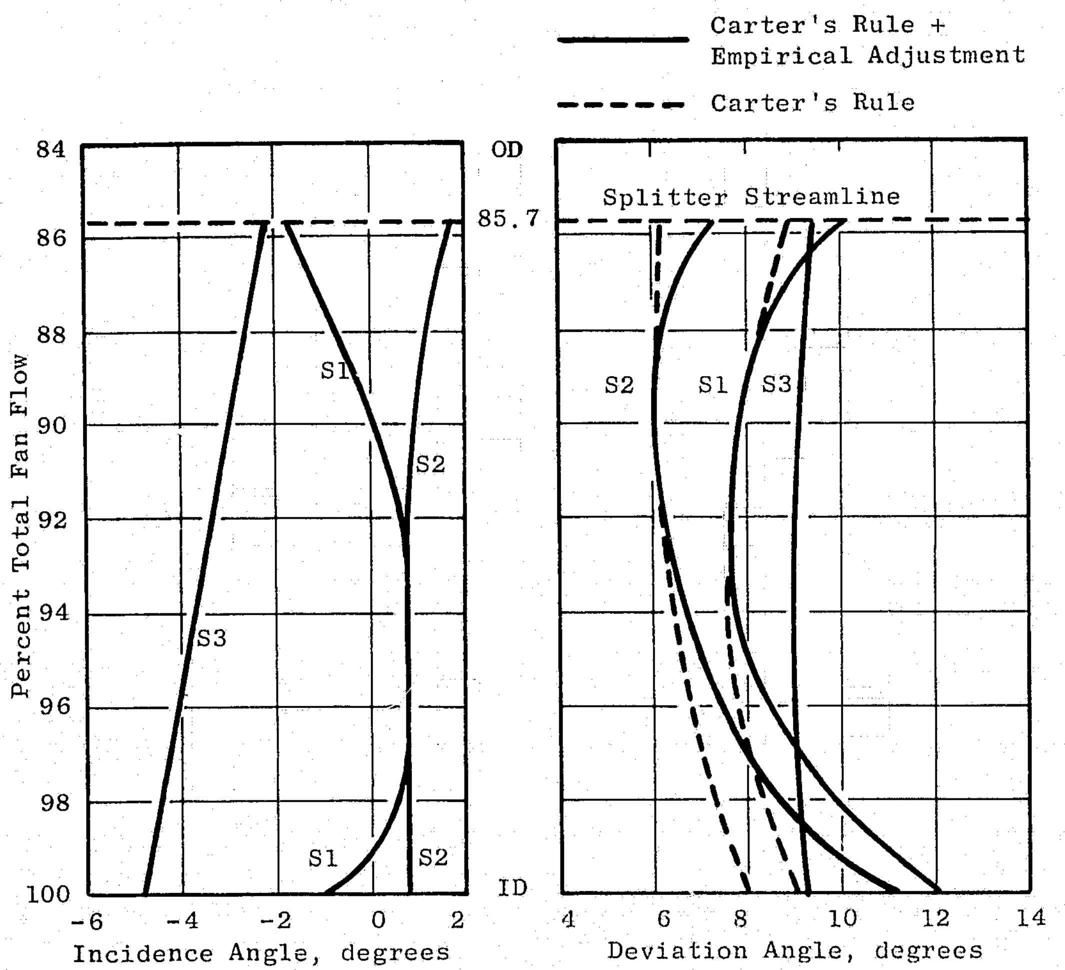


Figure 23. Fan Booster Stators Incidence and Deviation Angles Radial Distributions.

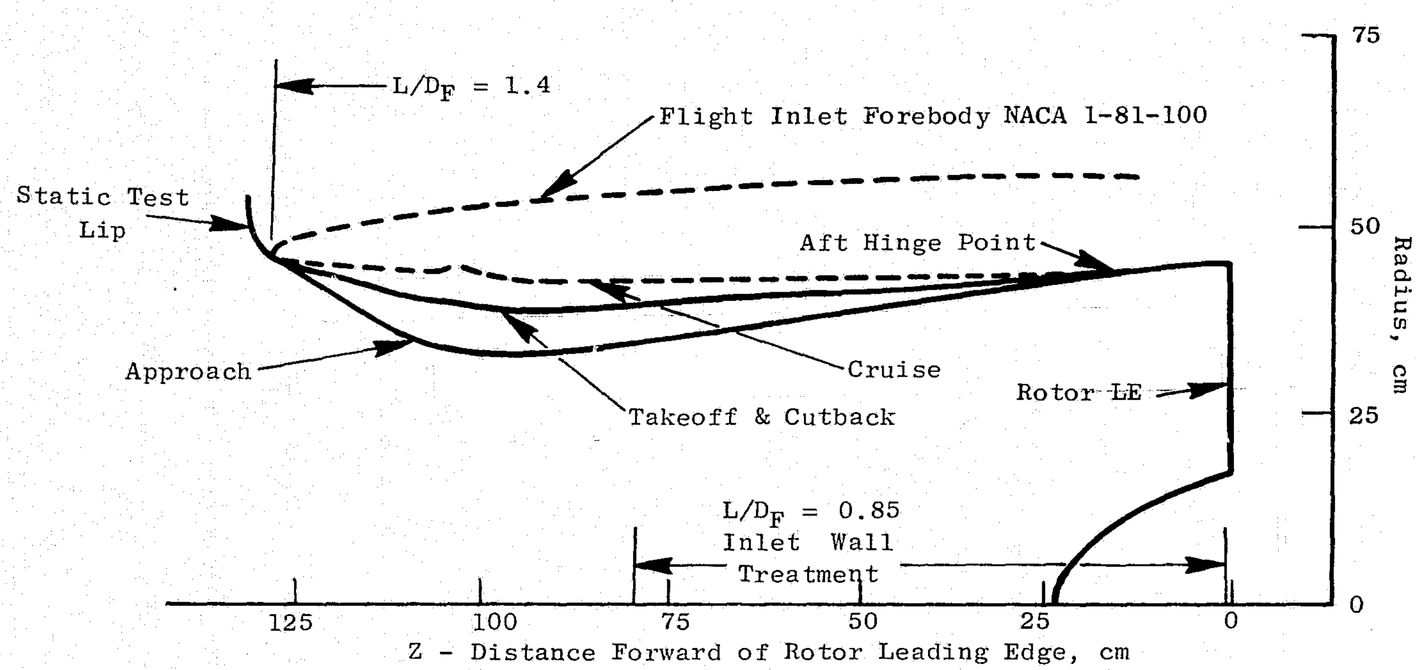


Figure 24. Advanced Technology Fan Inlet Flowpath.

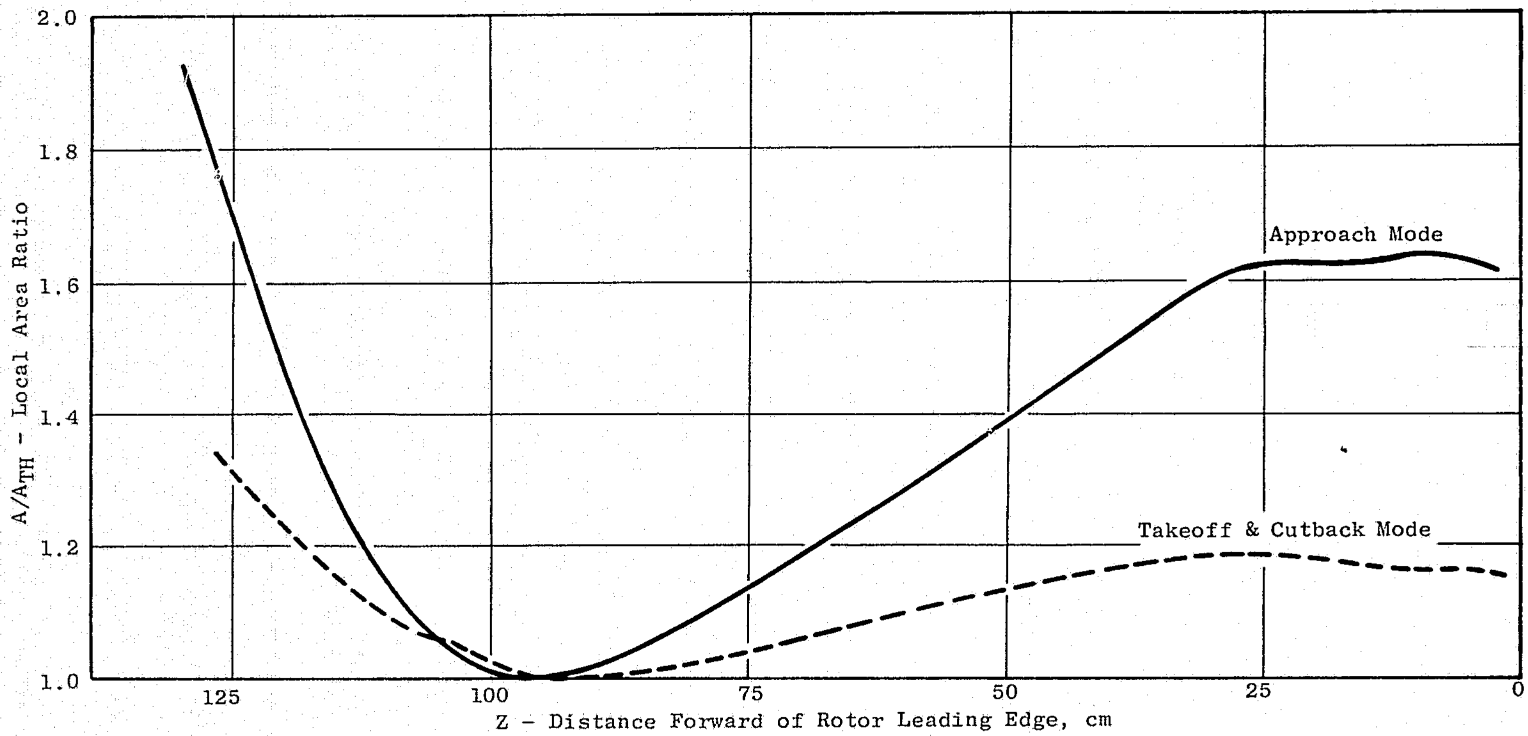


Figure 25. **Fan Inlet Area Distribution.**

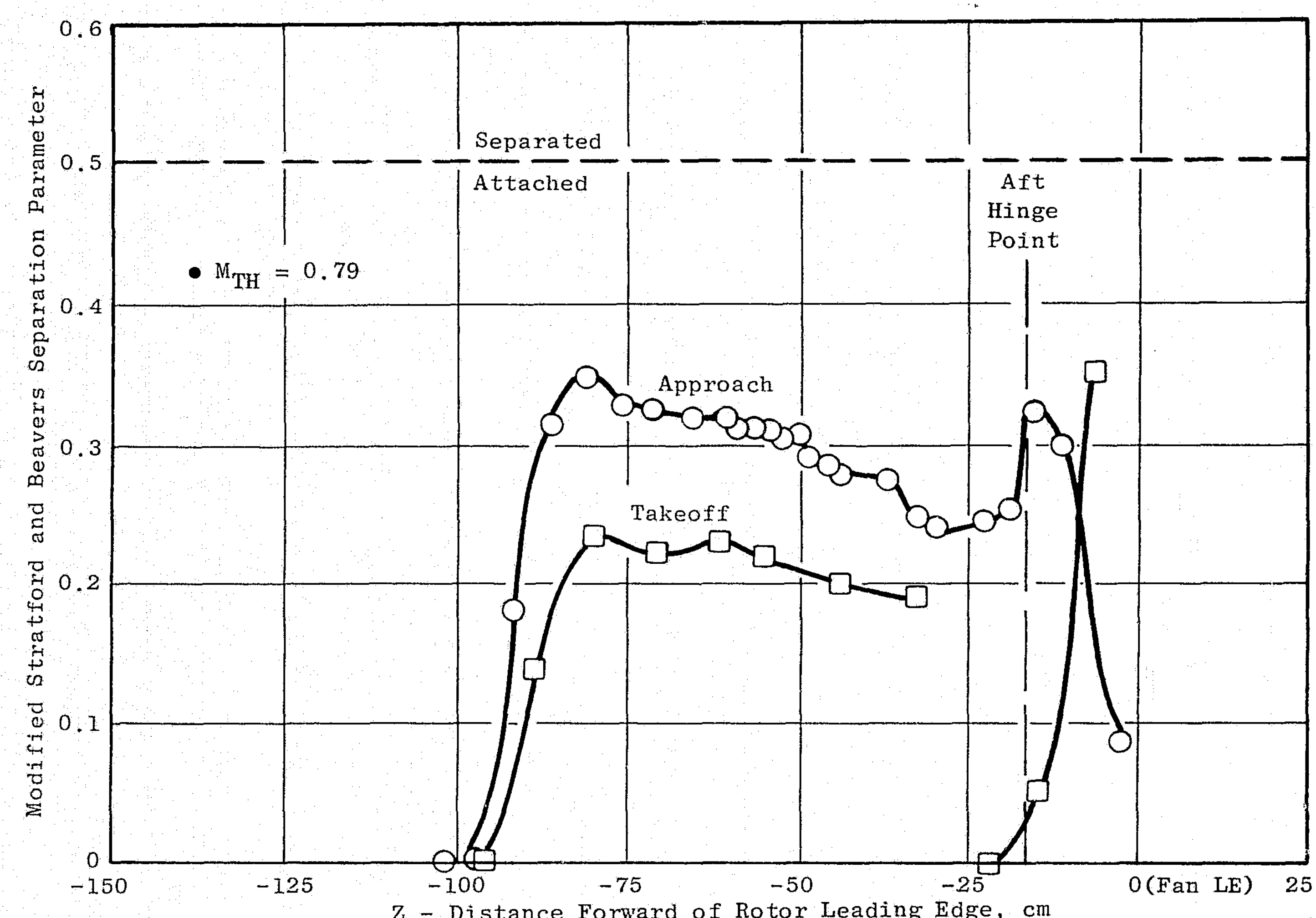


Figure 26. Fan Inlet Separation Parameter Along the Cowl Wall at Takeoff and Approach Conditions.

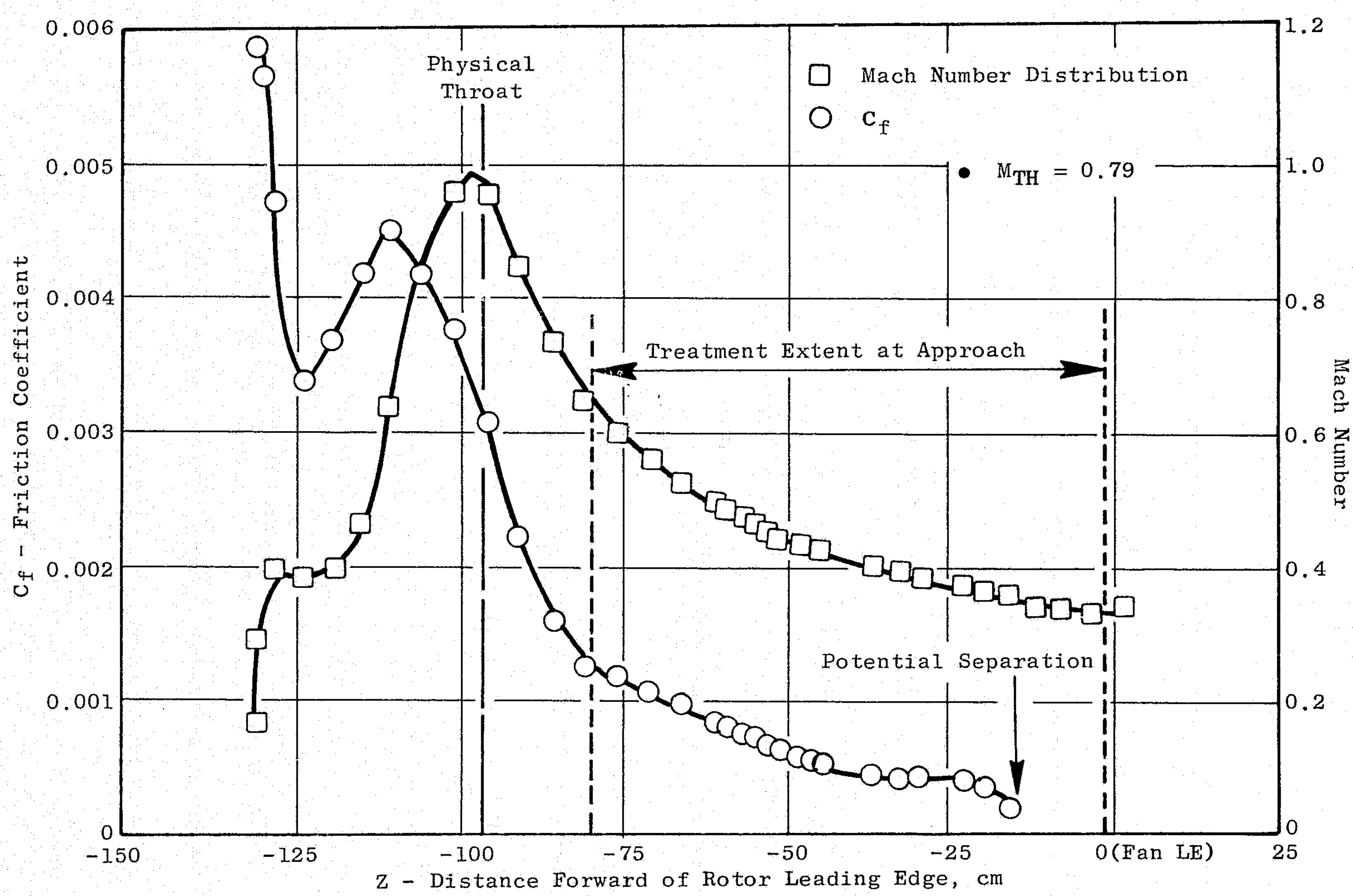


Figure 27. Fan Inlet Friction Coefficient and Mach No. Along the Cowl Wall at Approach Conditions.

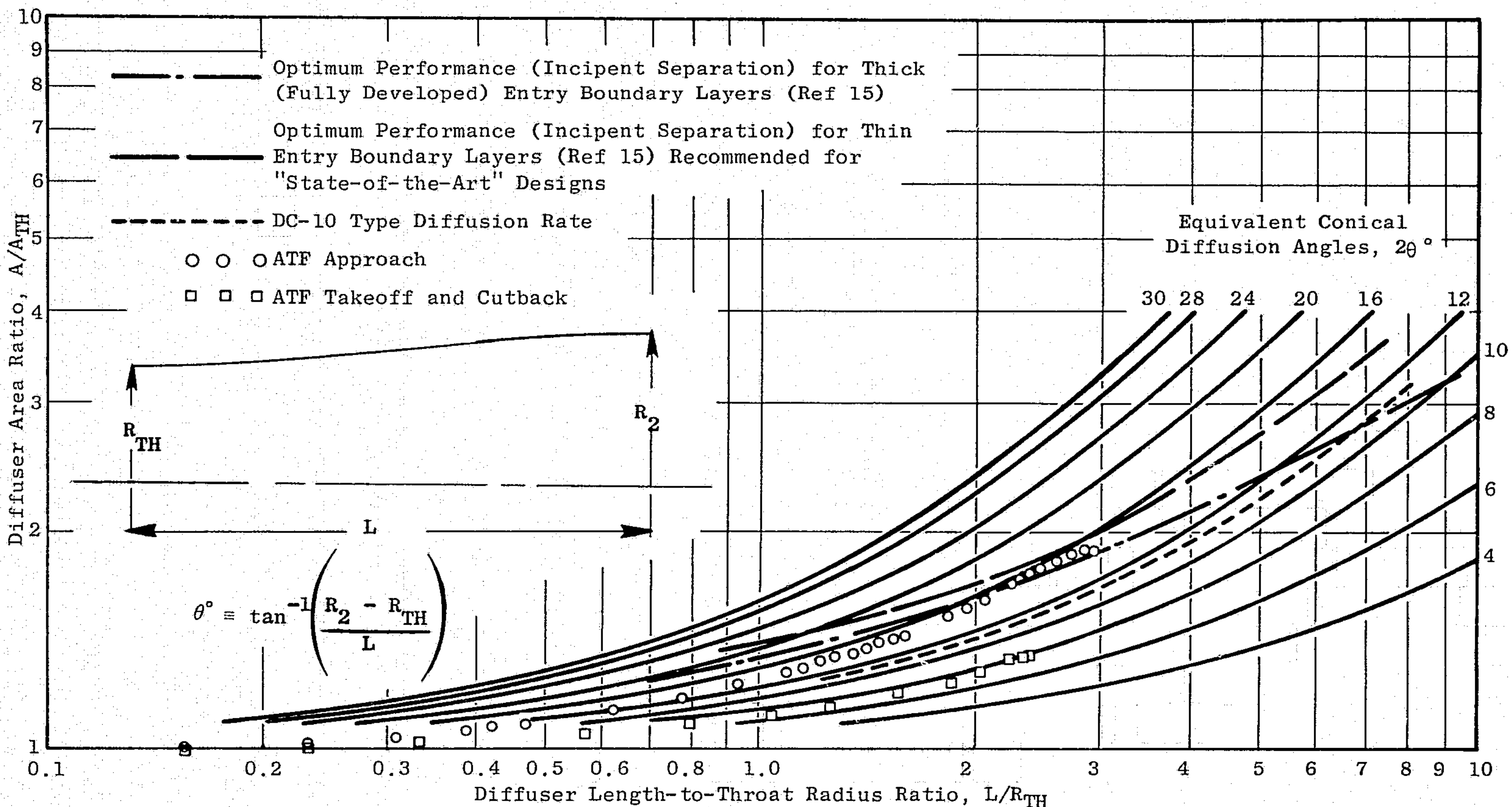


Figure 28. Fan Inlet Separation Analysis Based on an Equivalent Conical Diffuser.

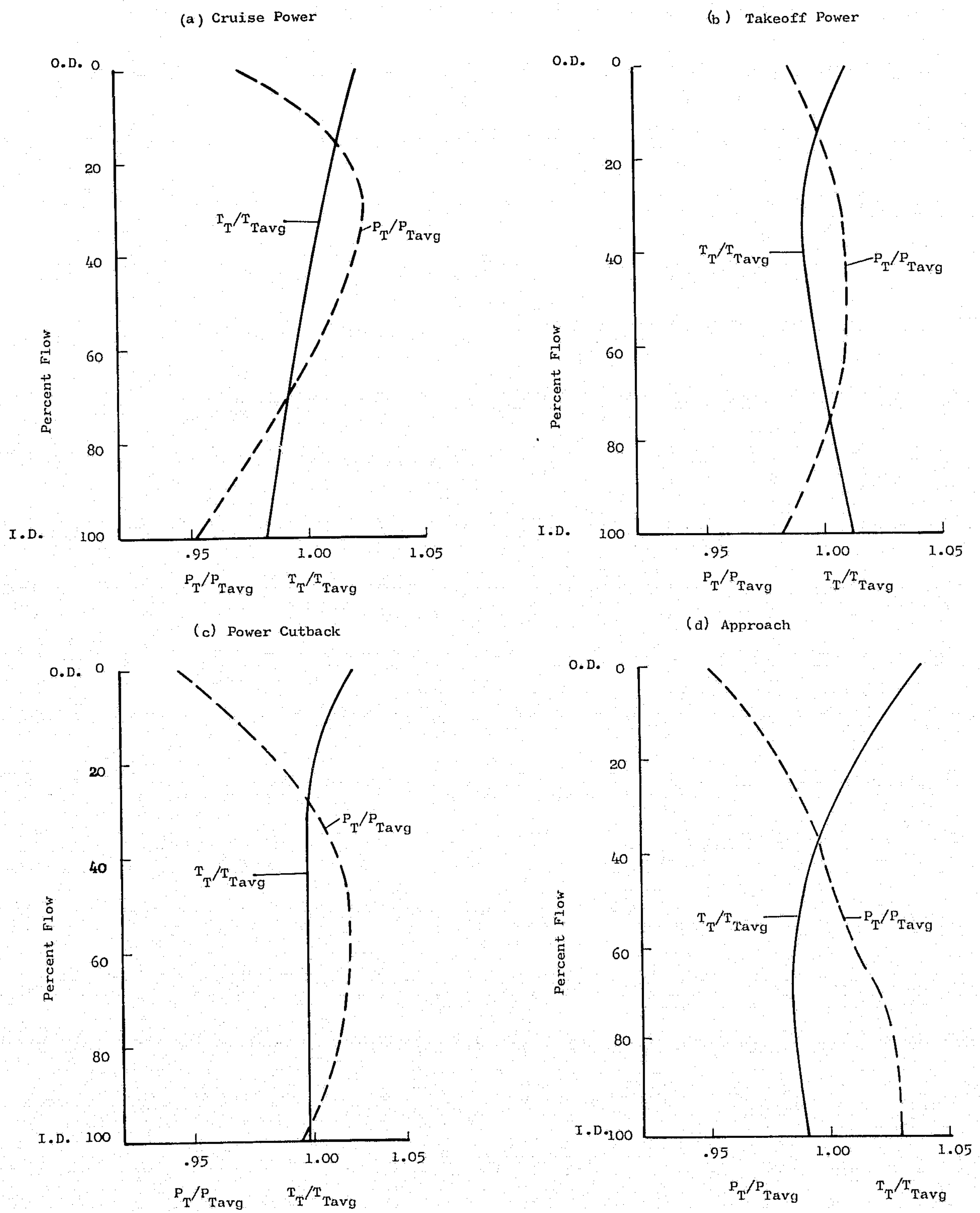


Figure 29. Estimated Pressure and Temperature Radial Profiles Entering the Fan Exit Duct at Four Operating Points.

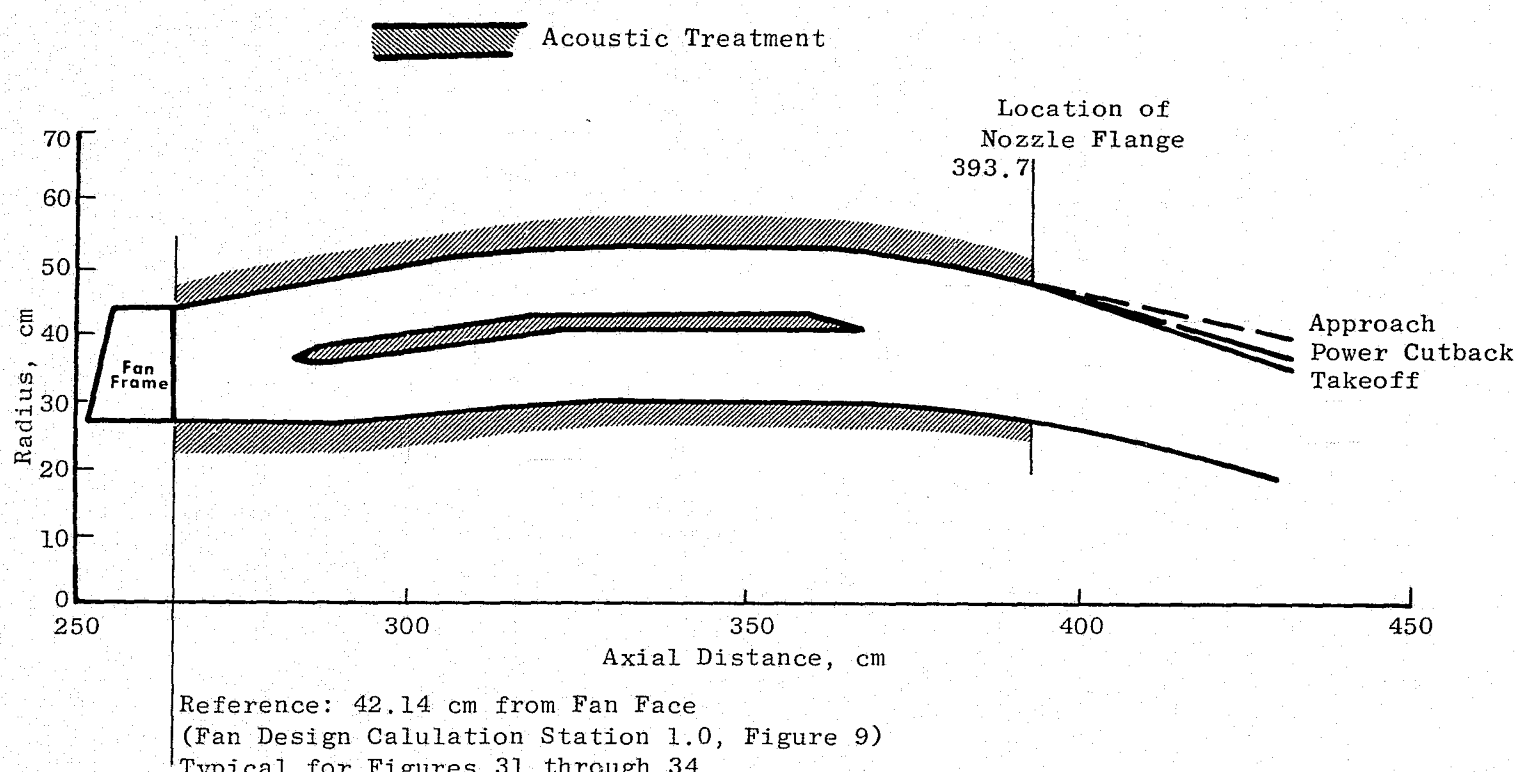
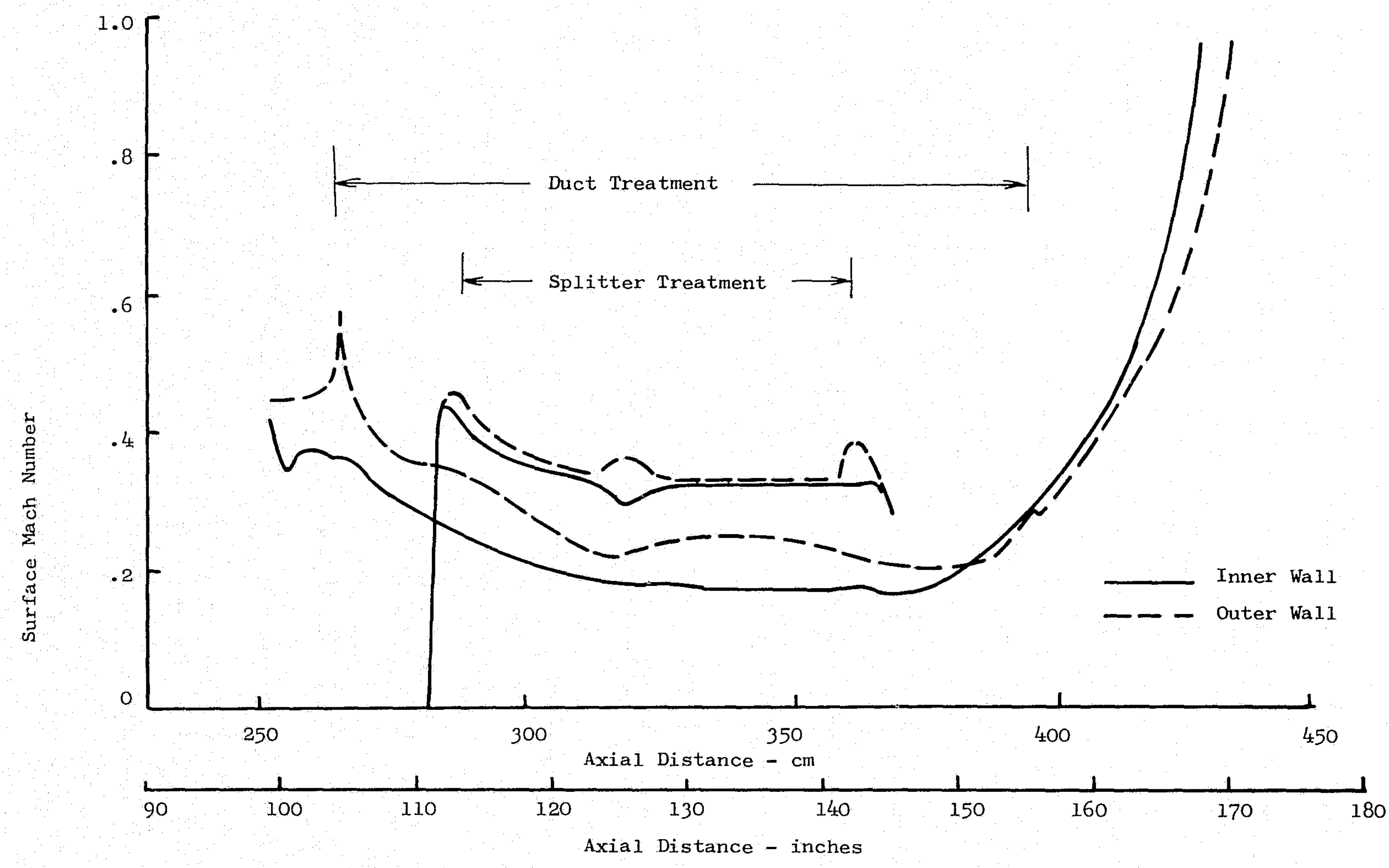
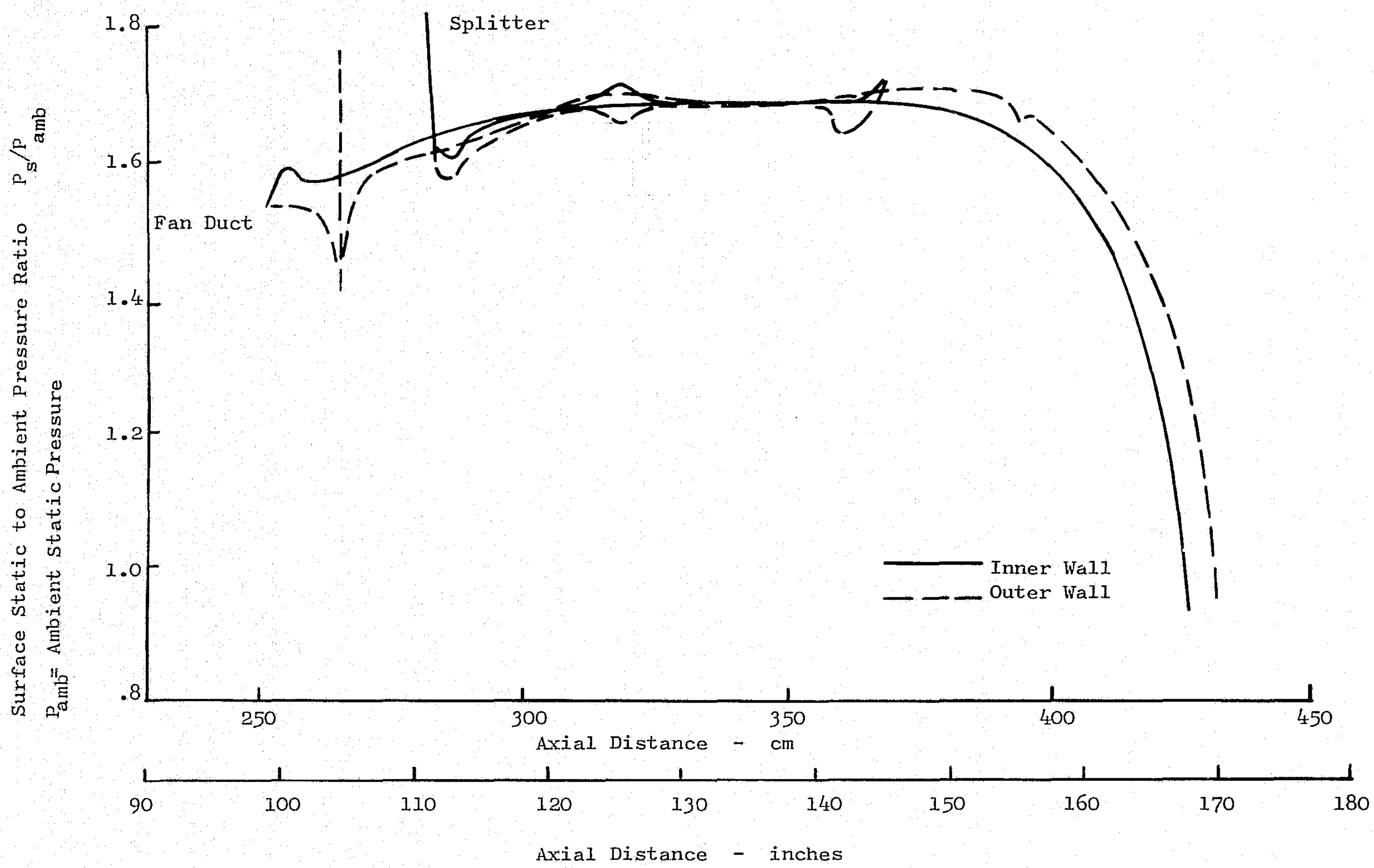


Figure 30. Advanced Technology Fan Exit Duct Flowpath.



(a) Surface Mach Number Distribution

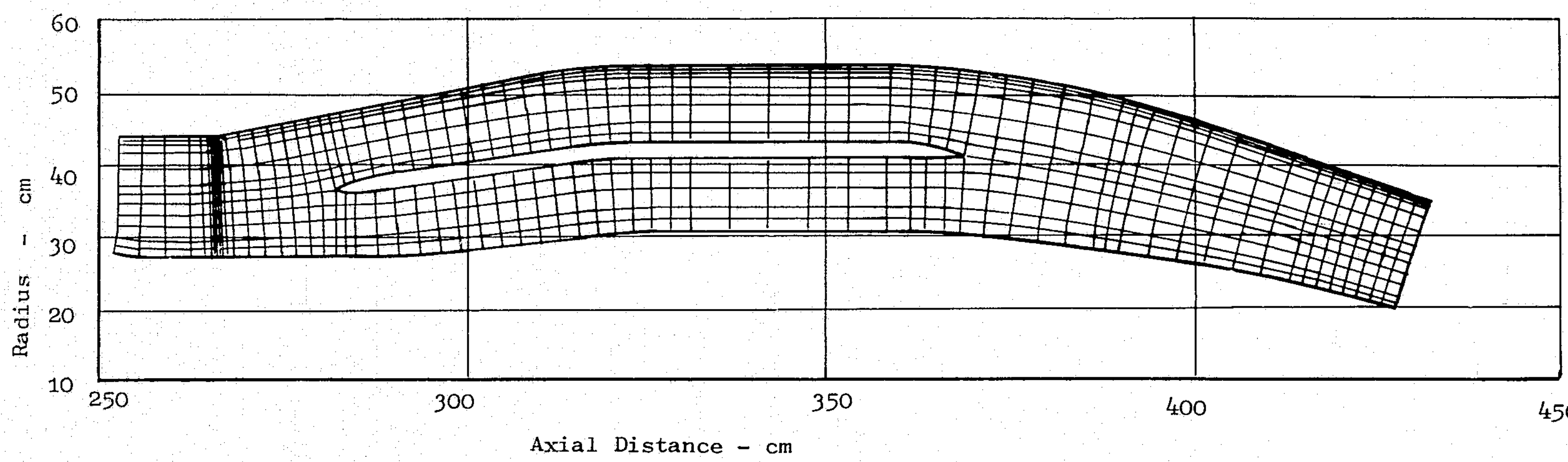
Figure 31. Fan Exit Duct Design Analysis at Cruise Point Operation.



(b) Surface Static Pressure Distribution

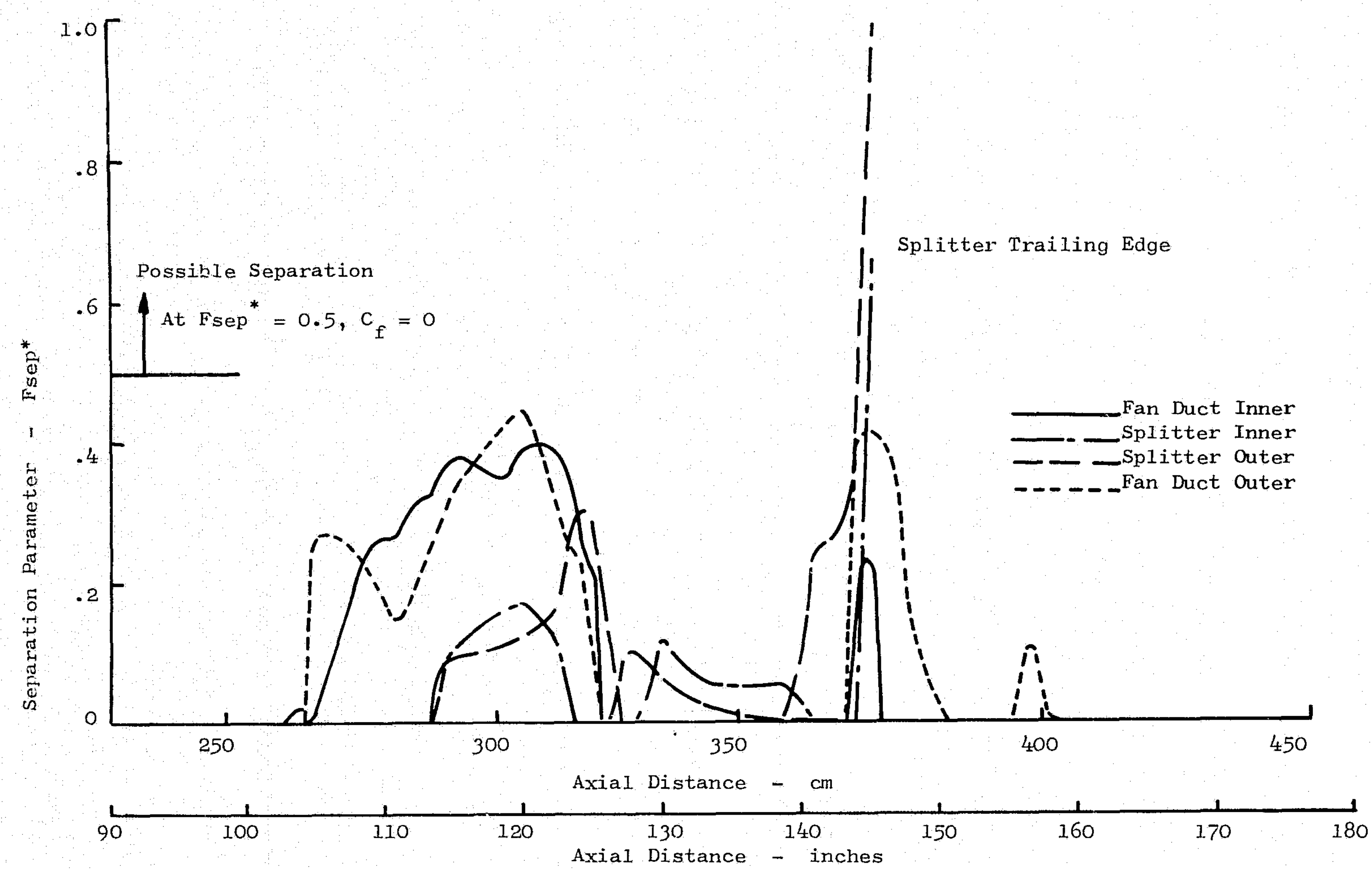
Figure 31. Fan Exit Duct Design Analysis at Cruise Point Operation (Cont nued).

NOTE: Streamline Spacing Directly Proportional to Local Velocity Gradient



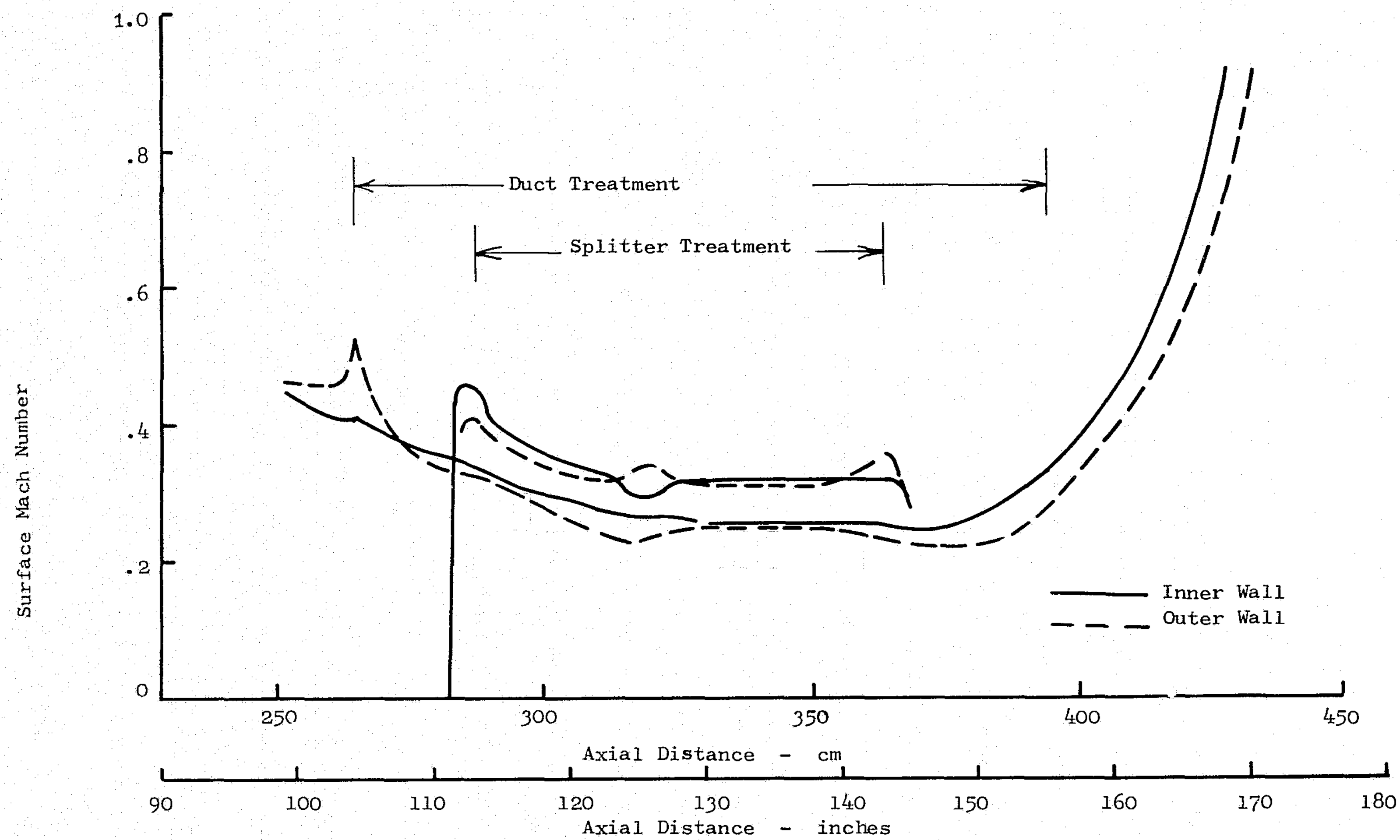
(c) Streamlines for Potential Flow-Field Solution

Figure 31. Fan Exit Duct Design Analysis at Cruise Point Operation (Continued).



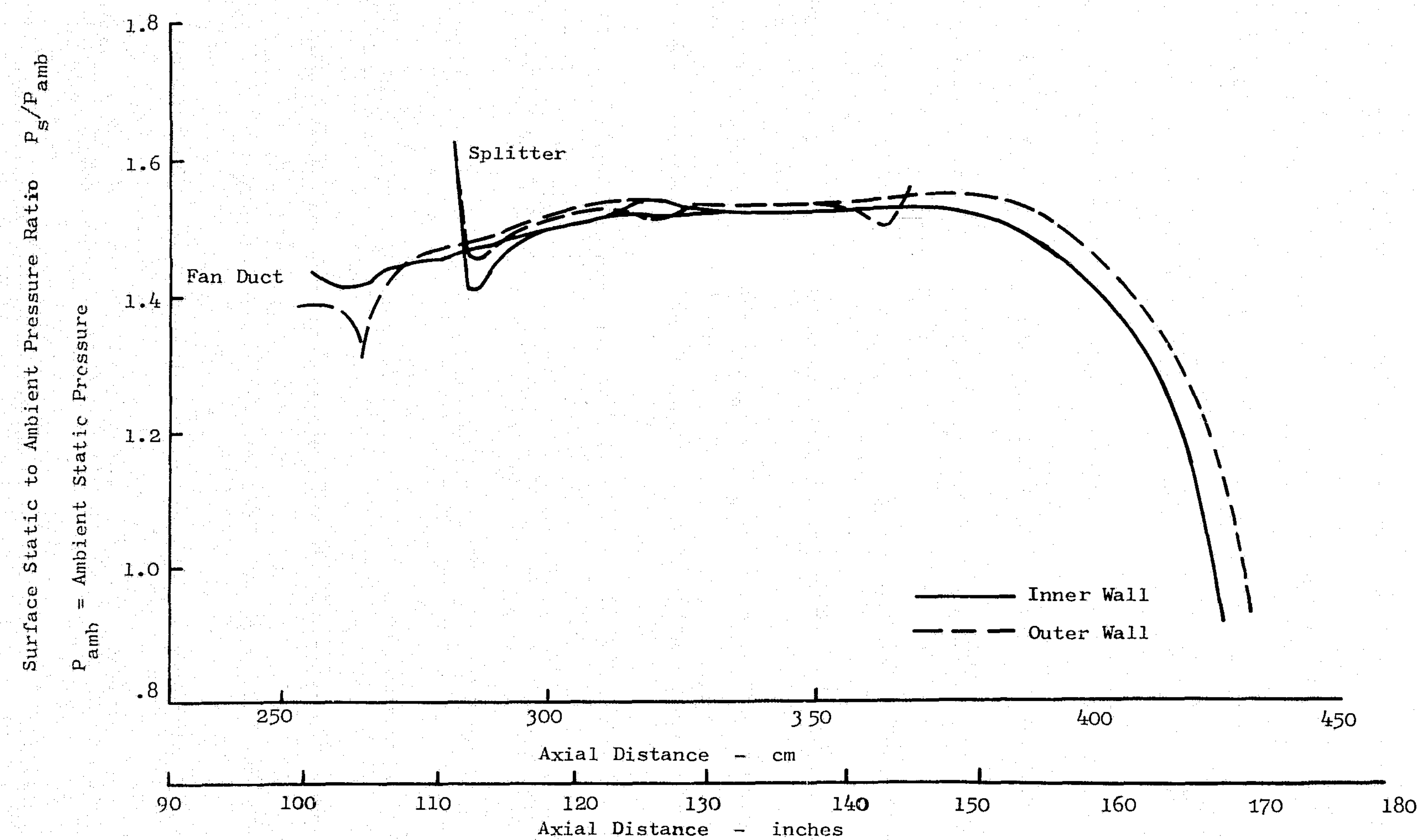
(d) Separation Parameter - Modified Stratford, See Reference 11

Figure 31. Fan Exit Duct Design Analysis at Cruise Point Operation (Concluded).



(a) Surface Mach Number Distribution

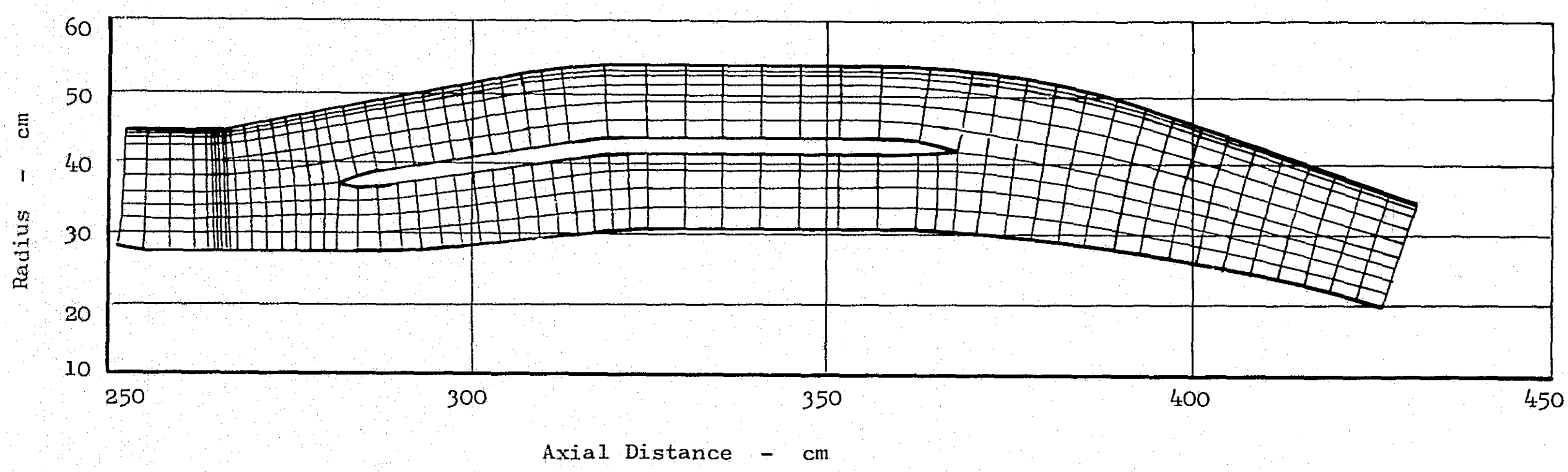
Figure 32. Fan Exit Duct Design Analysis at Takeoff Point Operation.



(b) Surface Static Pressure Distribution

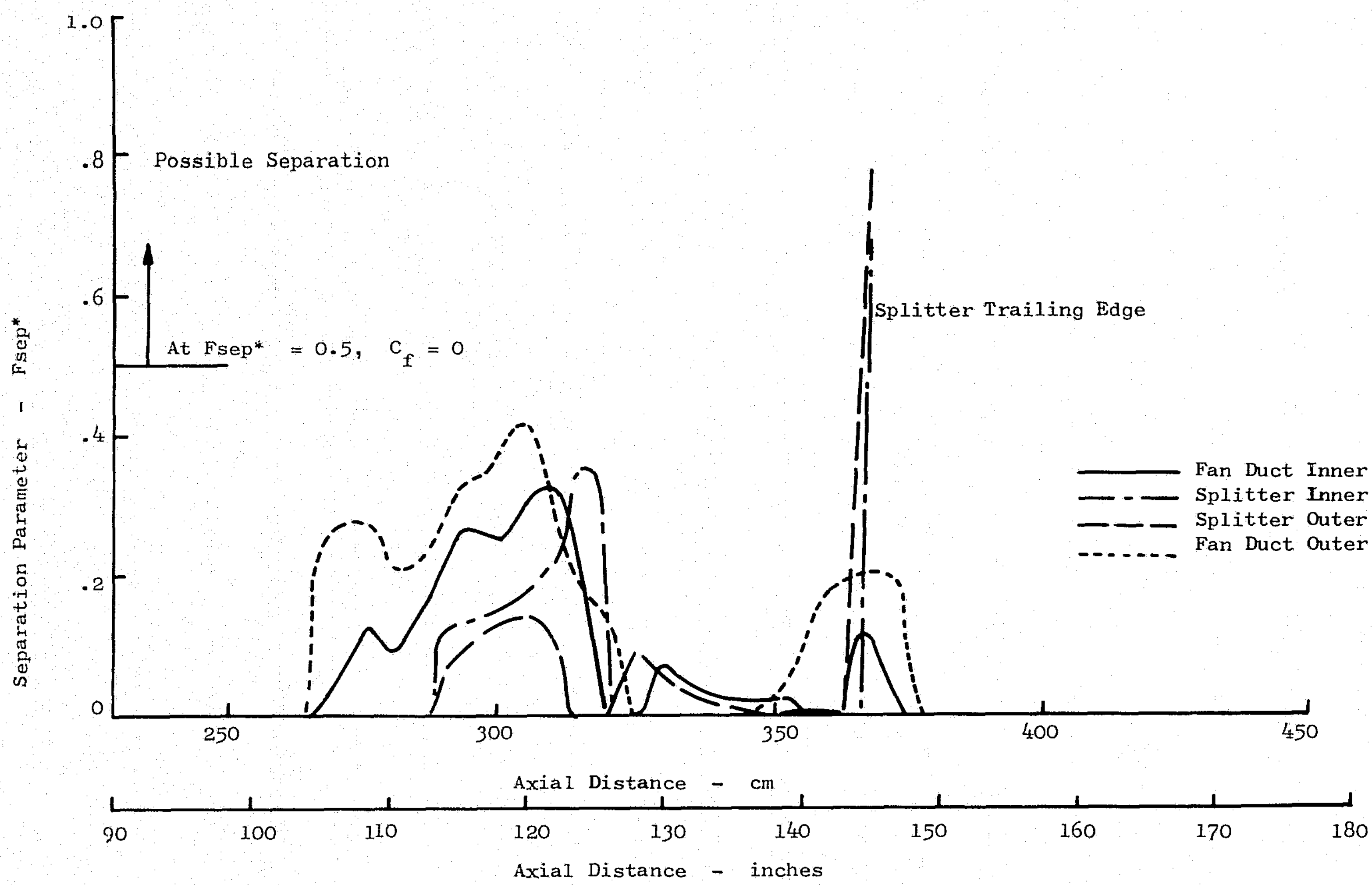
Figure 32. Fan Exit Duct Design Analysis at Takeoff Point Operation (Continued).

NOTE: Streamline Spacing Directly Proportional to
Local Velocity Gradient



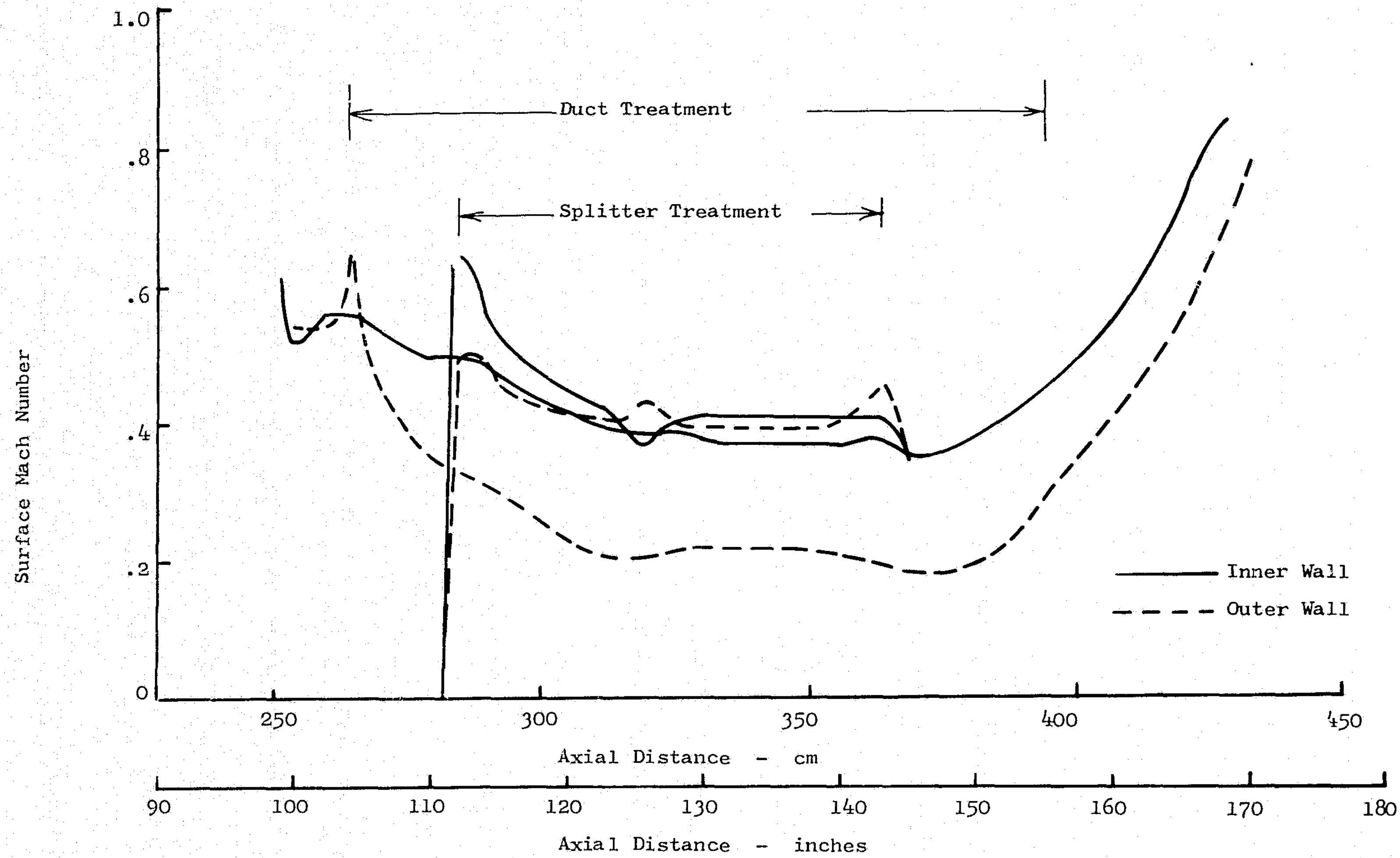
(c) Streamlines for Potential Flow-Field Solution

Figure 32. Fan Exit Duct Design Analysis at Takeoff Point Operation (Continued).



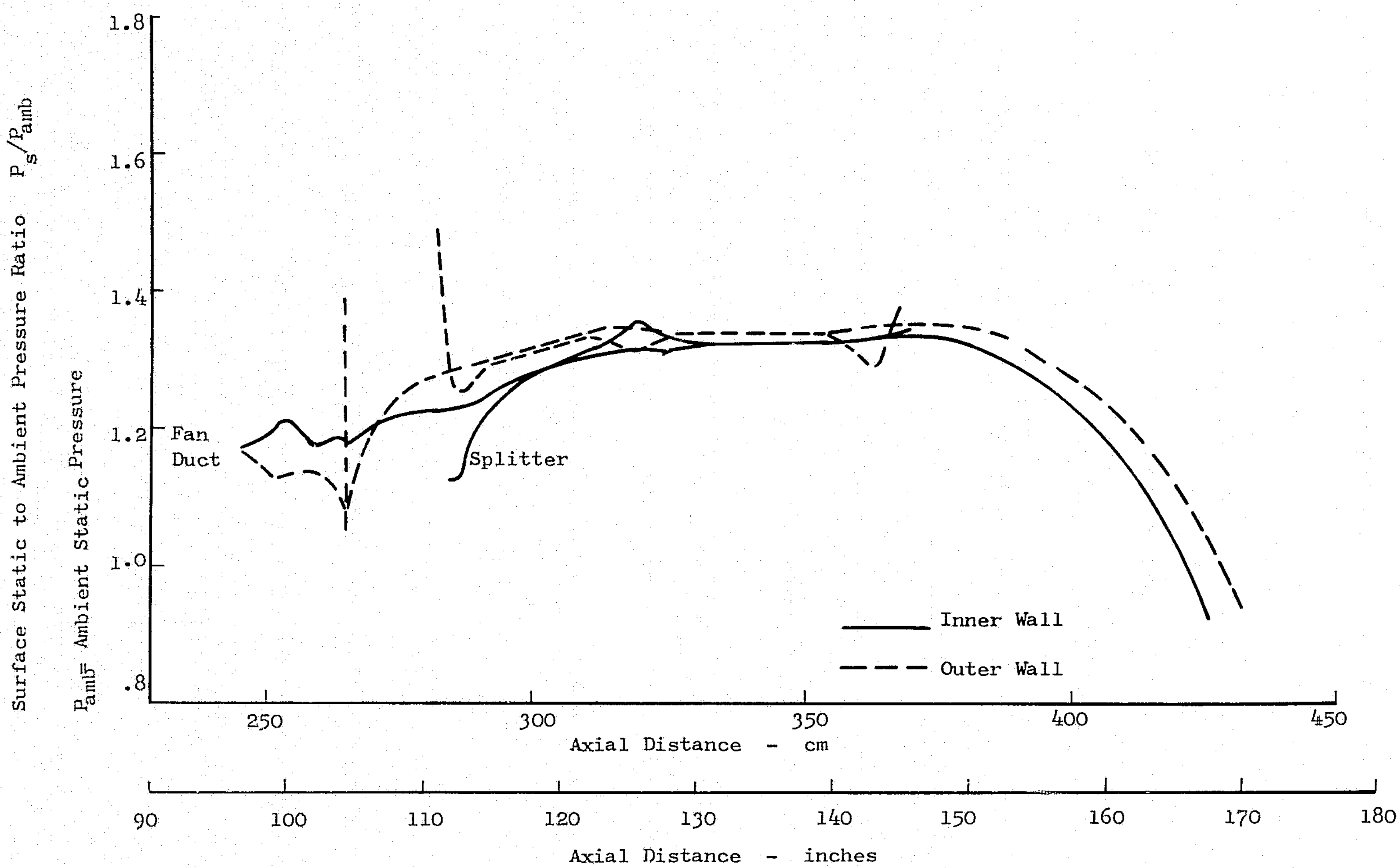
(d) Separation Parameter - Modified Stratford, See Reference 11

Figure 32. Fan Exit Duct Design Analysis at Takeoff Point Operation (Concluded).



(a) Surface Mach Number Distribution

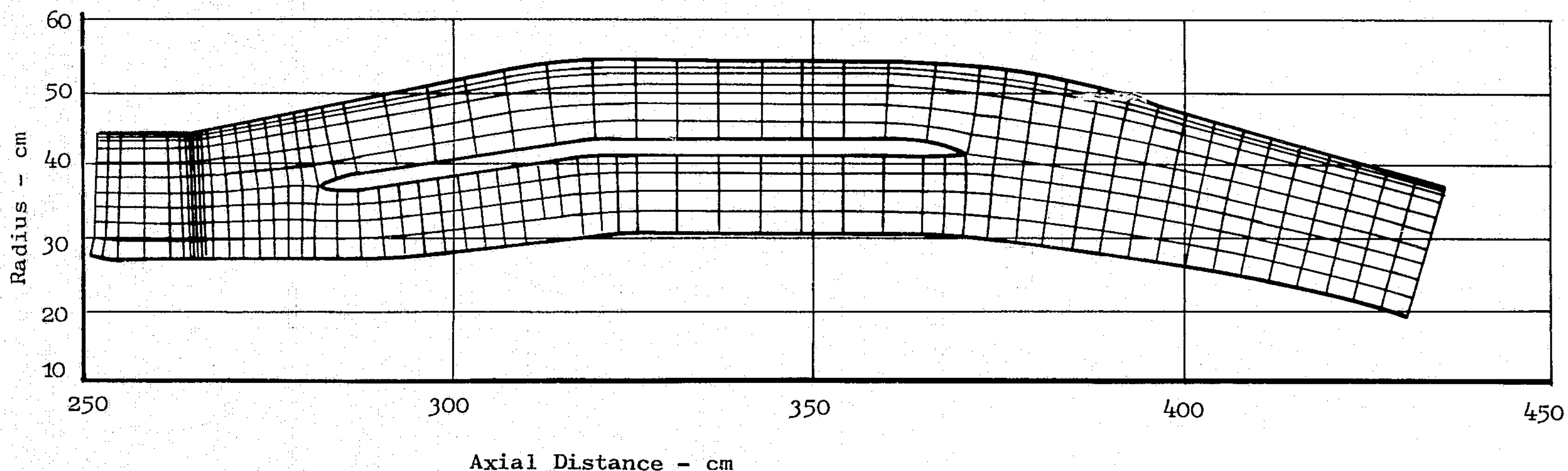
Figure 33. Fan Exit Duct Design Analysis at Cutback Point Operation.



(b) Surface Static Pressure Distribution

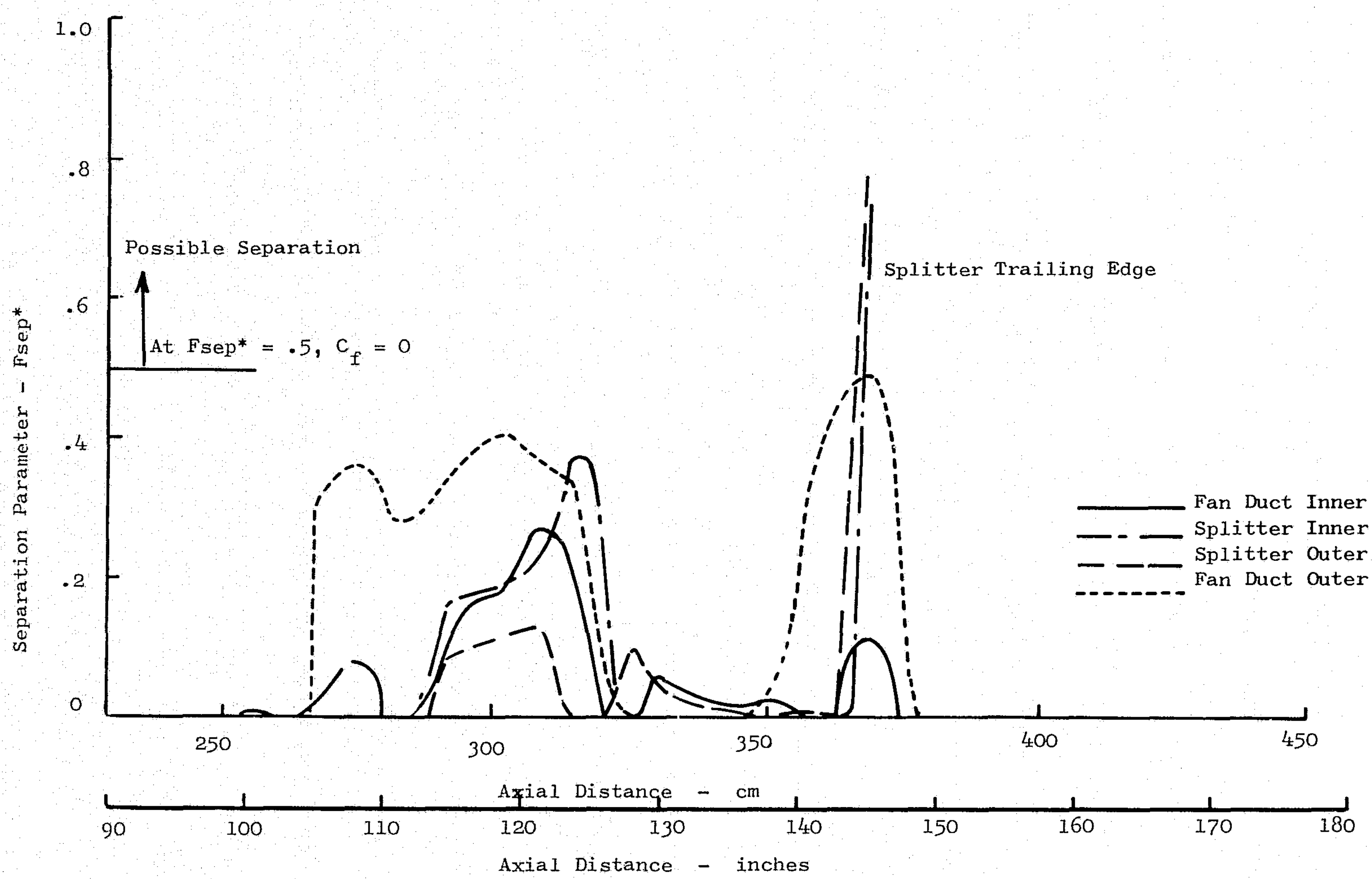
Figure 33. Fan Exit Duct Design Analysis at Cutback Point Operation (Continued).

NOTE: Streamline Spacing Directly Proportional
to Local Velocity Gradient



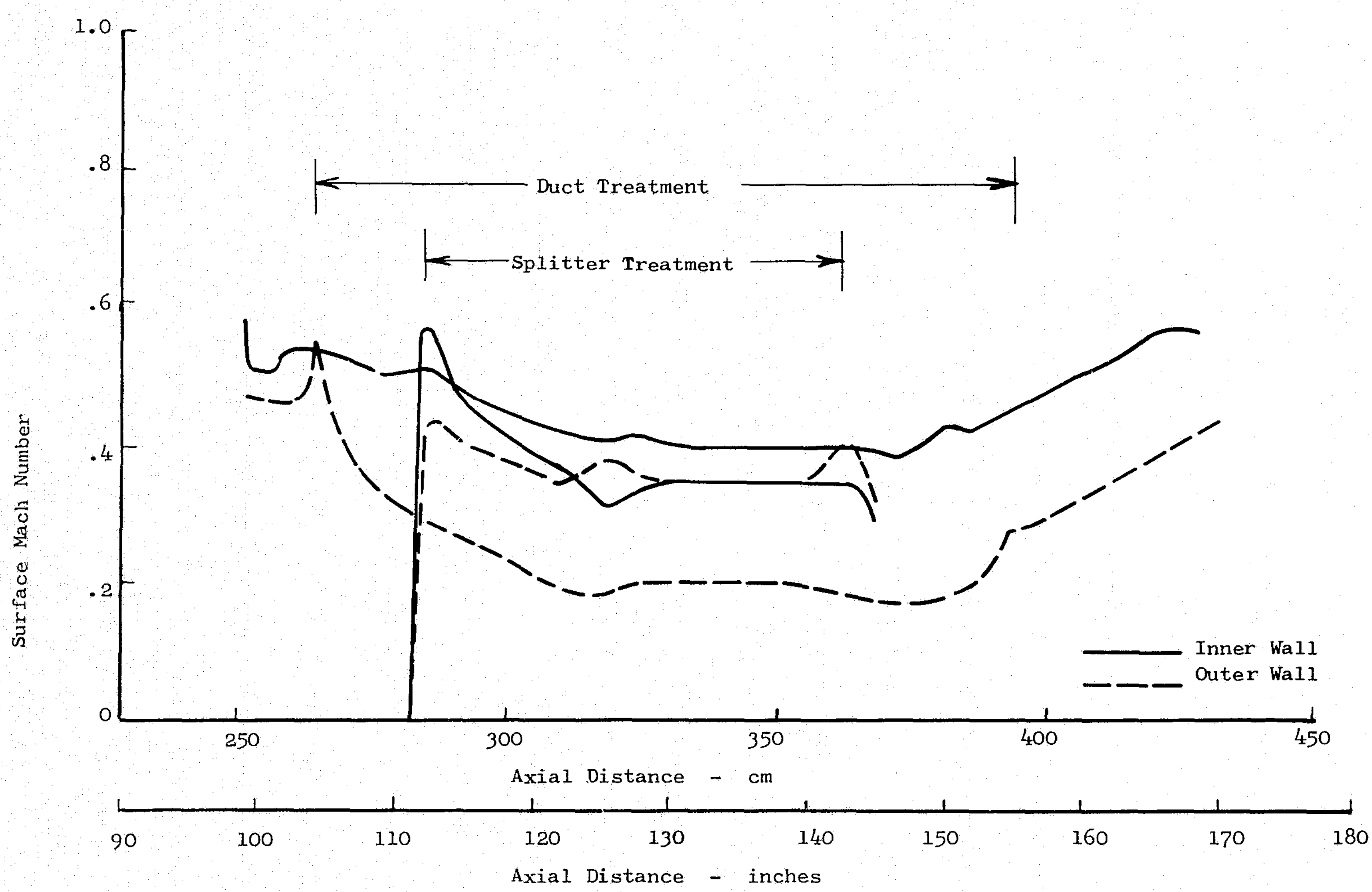
(c) Streamlines for Potential Flow-Field Solution

Figure 33. Fan Exit Duct Design Analysis at Cutback Point Operation (Continued).



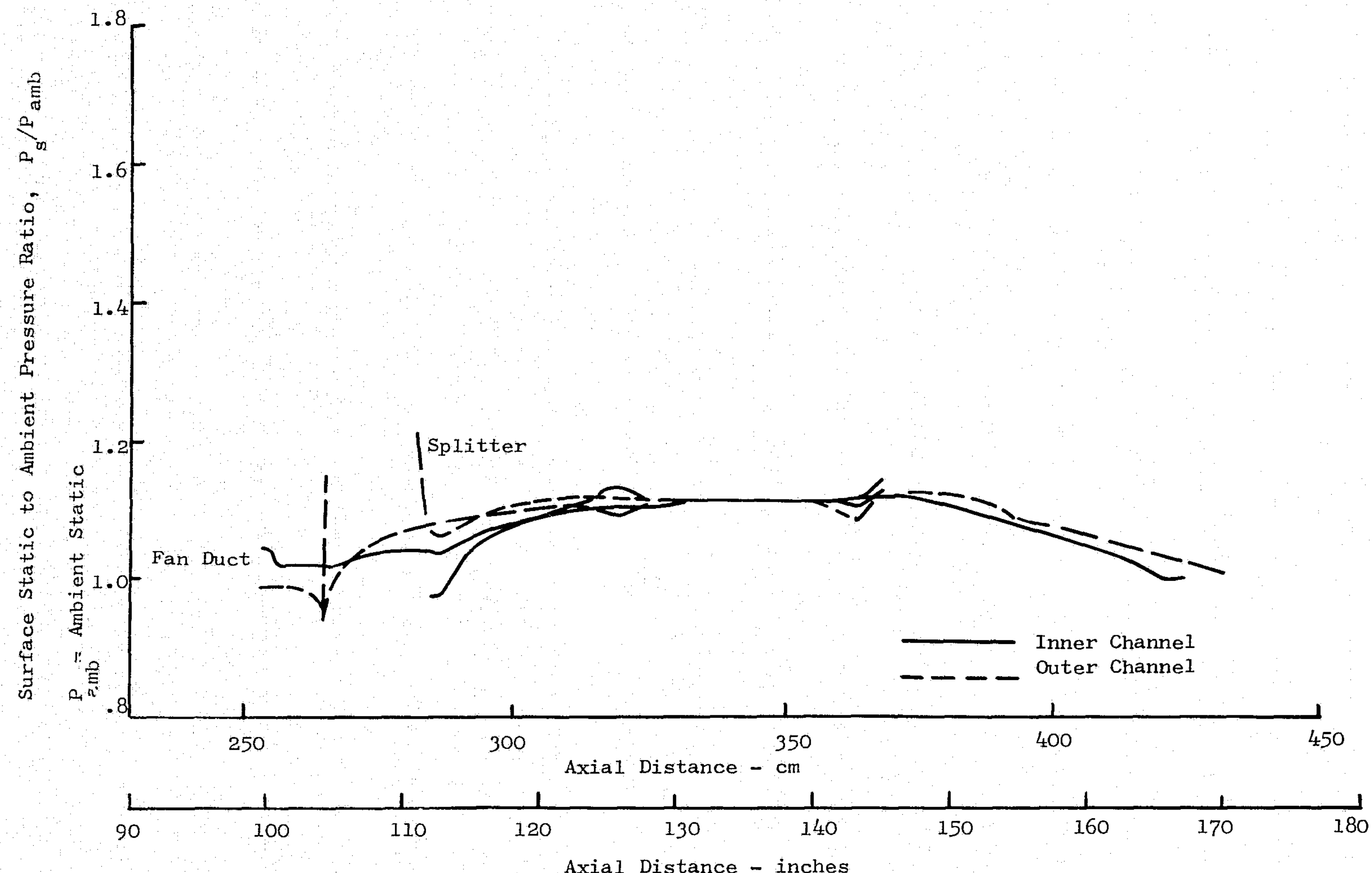
(d) Separation Parameter - Modified Stratford, See Reference 11

Figure 33. Fan Exit Duct Design Analysis at Cutback Point Operation (Concluded).



(a) Surface Mach Number Distribution

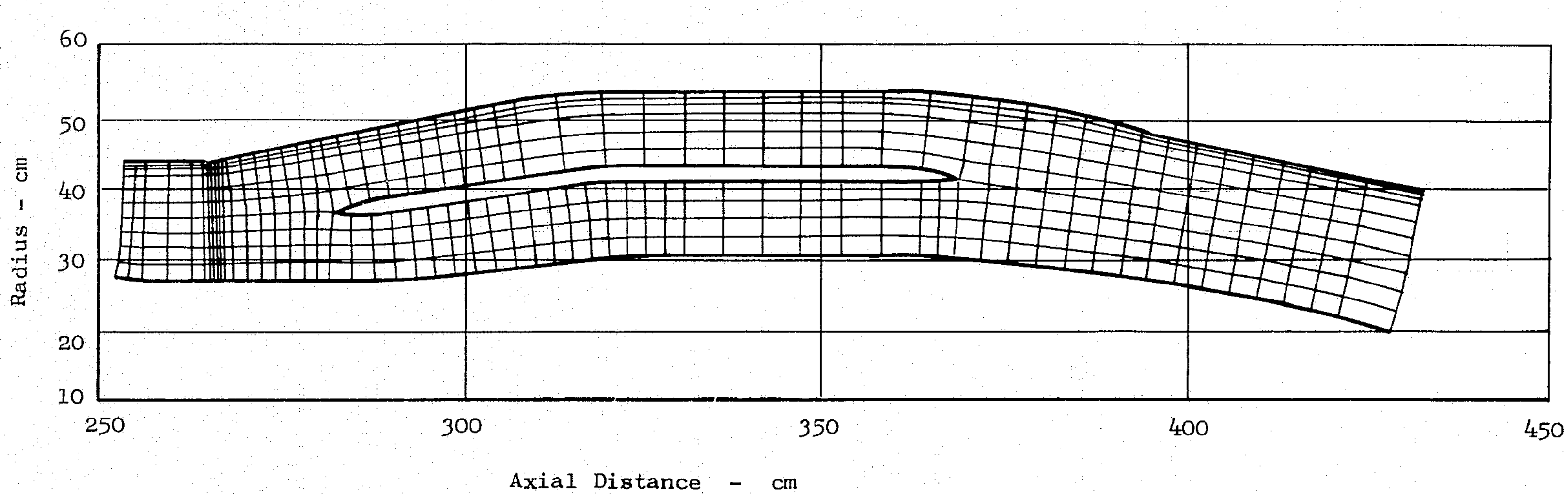
Figure 34. Fan Exit Duct Design Analysis at Approach Point Operation.



(b) Surface Static Pressure Distribution

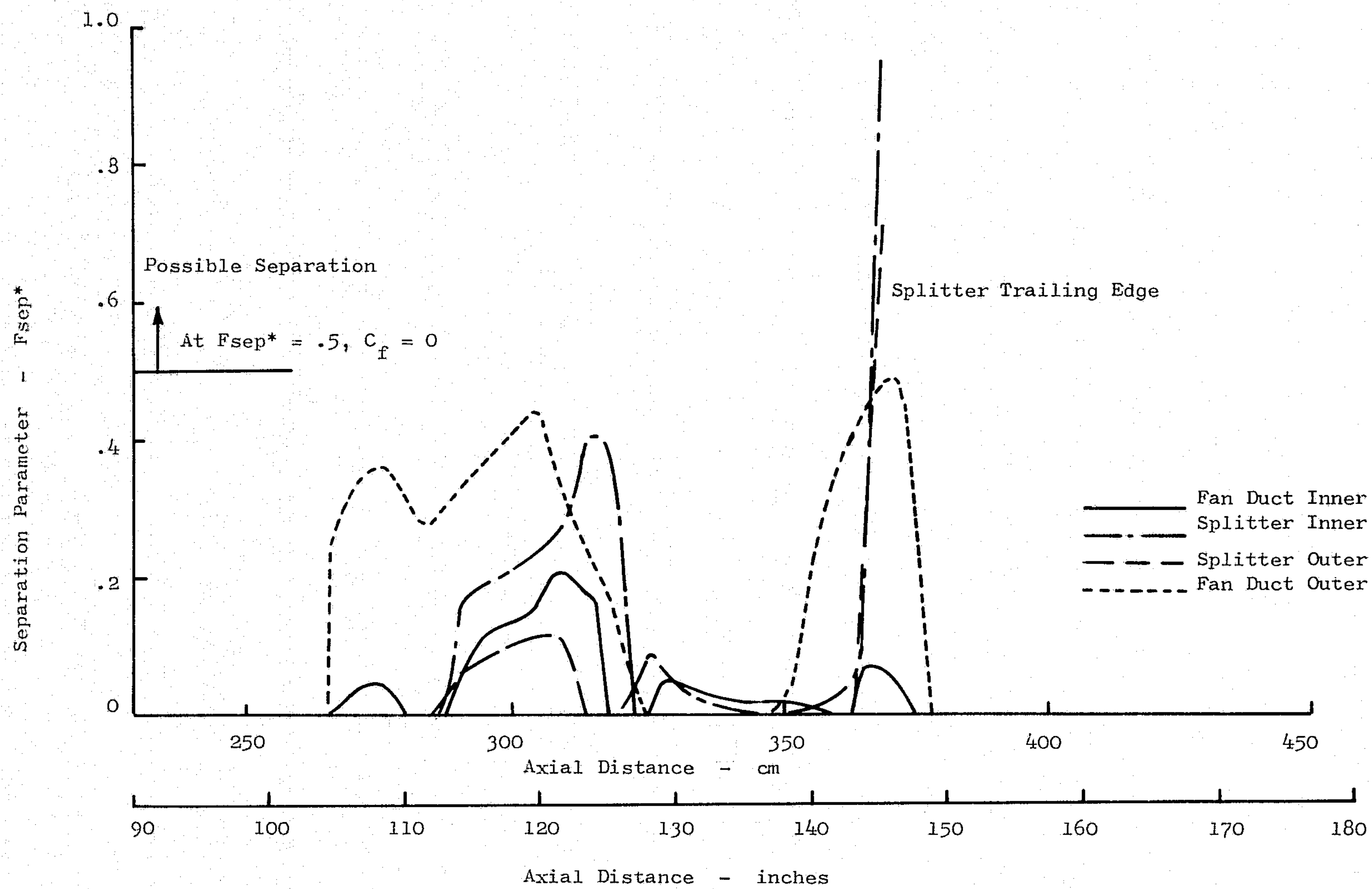
Figure 34. Fan Exit Duct Design Analysis at Approach Point Operation (Continued).

NOTE: Streamline Spacing Directly Proportional to Local Velocity Gradient



(c) Streamlines for Potential Flow-Field Solution

Figure 34. Fan Exit Duct Design Analysis at Approach Point Operation (Continued).



(d) Separation Parameter - Modified Stratford, See Reference 11

Figure 34. Fan Exit Duct Design Analysis at Approach Point Operation (Concluded).