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TRANSONIC FAN/COMPRESSOR ROTOR DESIGN STUDY

Volume I

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February 1982

Final Report for Period September 1980 - February 1982

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This technical report has been reviewed and is approved for publication.



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→ The report contains six volumes. Volume I contains primarily introduction and summary information plus details of a data match analysis of the base design. Volumes II through VI each contain design details for one of the series of five rotors. ←

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VOLUME I

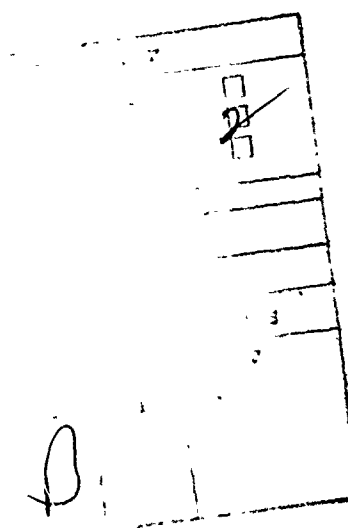
BASELINE DESIGN

Foreword

This Final Technical Report was prepared by the Advanced Technology Programs Department, Aircraft Engine Business Group, General Electric Company, Evendale, Ohio for the United States Air Force Systems Command, Air Force Wright Aeronautical Laboratories Wright-Patterson Air Force Base, Ohio under Contract F33615-80-C-2059. The work was performed over a period of one year starting in September 1980. Effren Strain (Captain USAF) was the Air Force Project Engineer for this program.

This report describes the results of an effort to aerodynamically define five rotor designs, all parametrically related to a base line design which could be evaluated by future testing in order to define the sensitivity of transonic blade rows to several design variables.

For the General Electric Company Mr. D.E. Parker was the Technical Program Manager for this program. Mr. M.R. Simonson was the principal investigator. Mr. A.J. Bilhardt was the overall Program Manager.



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LIST OF SYMBOLS AND ABBREVIATIONS

1. Used in Circumferential Average Flow Output Tables

STA	calculation station number	
WTF	total airflow	
PSIC	stream function (0 = tip (OD), 1 = hub (ID))	
Z	axial location	inches
R	radius	inches
PHI	streamline slope	degrees
CURV	streamline curvature  = neg.,  = pos.	1/inches
VM	meridional velocity	ft/sec
CU	absolute tangential velocity	ft/sec
ALPHAM	absolute flow angle on stream surface	degrees
MM	meridional Mach number	
SL	calculation streamline number	
BLDBLK	flow blockage factor	(free area - blocked area)/free area
PS	static pressure	psia
PT	total pressure	psia
TT	total temperature	degrees
BETAM	relative flow angle on stream surface	degrees
UREL	relative velocity	ft/sec
MREL	relative Mach number	
VABS	absolute velocity	ft/sec
MABS	absolute Mach number	
GAMMA	specific heat ratio	
PT-RAT	total pressure/inlet total pressure	
TT-RAT	total temperature/inlet total temperature	
RCU	radius x tangential velocity	in-ft/sec
CZ	axial velocity	ft/sec
PCT IMM	percent annulus immersion from tip (OD)	
RAD	average of leading and trailing edge streamline radii	inches
ACC PT RATIO	cumulative total pressure ratio	
ACC TT RATIO	cumulative total temperature ratio	

LIST OF SYMBOLS AND ABBREVIATIONS

1. Used in Circumferential Average Flow Output Tables (Cont'd)

AD.	adiabatic efficiency	
POLY	polytropic efficiency	
Axial VEL R	axial velocity ratio across blade row	

2. Used in Stream Surface Blade Coordinate Tables

PT	point number	
PCT X	fraction of meridional distance from leading edge	
X	meridional coordinate on meanline	inches
Y	tangential coordinate on meanline	inches
B*M	meanline angle on stream surface	degrees
T(M)	thickness of blade perpendicular to meanline	inches
XS	meridional coordinate on suction surface	inches
YS	tangential coordinate on suction surface	inches
XP	meridional coordinate on pressure surface	inches
YP	tangential coordinate on pressure surface	inches

3. Used in Plane Section Coordinate Tables

Z	axial coordinate of stacking axis	inches
R	radius of coordinate system origin	inches
MU	tilt angle in axial direction	degrees
ETA	tilt angle in tangential direction	degrees
RHO	section height	inches
PT	point number	
ALPHA	axial coordinate	inches
ZETA*	meanline angle from axial	degrees
UPSILON	coordinate perpendicular to ALPHA and radius	inches
PCT AL	fraction of axial distance from leading edge	
T/C	local thickness/chord ratio	

SECTION I

INTRODUCTION

Exploratory development programs funded by the Department of Defense, and similar programs supported by NASA, have traditionally attempted to advance the component state of the art by increasing component overall performance goals, each time relative to a previous program or a known level of achievement. Although major progress has been achieved in this manner, it is also apparent that in certain detailed areas of design, the same assumptions are made time after time for no better reason than past experience has proven them "safe"; i.e., they have a high probability of providing a satisfactory, if not optimum, design. At present, there exists no good basis from which to depart from many of these assumptions, because neither IR&D programs nor Government-funded programs, as presently structured, have provided a data matrix that is sufficiently systematic to allow one to assess the sensitivity of component behavior to variations in these favorite assumptions. Although analysis in the subsonic area has proven able to distinguish these sensitivities, this is not yet true in the transonic area and is not likely to be for several years to come. To achieve further performance improvements in transonic compressor stages, it would be desirable to conduct a comprehensive experimental program aimed at exploring the sensitivity of compressor performance to variations in several common design parameters.

One parameter, sometimes defined more on the basis of historical reasons than on a knowledge of its aerodynamic effect, is the chordwise location of maximum blade thickness. Research by NACA in the 1950's generally indicated that as relative inlet Mach number rose, it was desirable to move the location of maximum thickness aft on an airfoil. This may remain true. However, the early work was done with airfoils having significant positive camber. Today, many airfoils at rotor tips have little overall relative turning, sometimes negative turning, and frequently have camber lines of S-shape: negative camber followed by some positive camber. In some instances with S-shaped camber lines, a shift in maximum airfoil thickness forward of the more customary location would reduce the peak curvature of the airfoil, assuming all other design criteria were held constant. There are other incentives to move thickness forward related to meeting bird-strike structural criteria. Rather than penalizing aerodynamic performance, it might even be improved in some instances.

Another design variable commonly considered in transonic and supersonic blade rows is the throat margin, and the interrelation between the airfoil mean line shape and the cascade throat area. While there is some variation in the way throat margin is defined, it is common practice to specify some minimum acceptable throat margin over that "theoretically" required accounting for leading edge shock loss, stream tube contraction, etc.

Increasing the average suction surface angle in the supersonic region ahead of the leading edge passage shock reduces the average Mach number just ahead of the shock and presumably reduces the shock loss. However, this results in a reduced cascade throat area. If the throat is too small, the cascade will not pass the design flow and may not achieve the attached shock pattern which is desired for minimum loss.

Also, if the blade suction surface angle is made steep ahead of the cascade mouth, or covered portion, it may be necessary to have a rapid change in blade mean line angle at the cascade mouth to prevent the throat from becoming too small within the covered channel. A rapid change of the suction surface angle increases the surface Mach number ahead of the shock and tends to worsen the shock-boundary layer interaction. This consideration may influence the optimum throat margin for best efficiency.

If the throat area is sufficient to pass the design flow, then (for transonic cascades) the maximum flow is limited by the average suction surface angle in the flow induction region ahead of the first captured Mach wave. The average suction surface angle in this region cannot be increased and still pass the desired flow so that any increase in surface angle must take place aft of this region.

Another parameter which can influence the performance of transonic cascades is the "effective camber" of the blade. The term "effective camber" is loosely used to indicate the circulation capacity of the cascade, since the normal camber definition is not sufficient for cascades with nonstandard mean lines which may depart significantly from a circle arc.

The best efficiency at the design speed for transonic rotors normally occurs near the "knee" of the pressure ratio - flow characteristic where the flow begins to decrease. For the baseline rotor the peak efficiency at design speed was about 2 points higher than that at the test data point selected as the base for the designs carried out under this contract. This peak efficiency occurred at a pressure ratio about 8 percent higher than the selected data point. The baseline point was selected for this work because it provides reasonable stall margin. If it is thought of as an "operating line" point, then there is reason to think that an improvement in efficiency might be achieved at this "operating line" point by adjusting the effective camber so that the "knee" of the characteristic more nearly coincides with the operating line point. The reduced effective camber does not necessarily reduce the stall line, however, it may have an adverse effect on the efficiency at reduced RPM operation. However, currently there is inadequate definitive data to allow an assessment of the trade.

The objective of the work presented in this report was to perform the aerodynamic design of a series of five transonic compressor rotors, all parametrically related to a base line design documented in Reference 1. This base line design was a high-through-flow, high-aerodynamic-loading, low hub tip ratio compressor first stage and was the result of a redesign effort by the Air Force Aero Propulsion Laboratory to improve the aeromechanical performance of a similar earlier design. Each of the five designs deviate from the baseline, in so far as practical, by a variation of one parameter only. The parameter variations are specified at the rotor tip. The original hub characteristics were preserved to the maximum extent practical. The varied parameter was adjusted proportionately along the span.

A broader objective of this work is to define a matrix of aerodynamic designs for future testing that will help define the sensitivity of transonic blade rows to variation of several important design variables about which there is little available data.

The work was conducted in five phases; each consisting of the aerodynamic design of one of the five rotors. For Phase I and Phase II the location of the airfoil maximum thickness was changed from 70% of meanline length in the baseline design to 40% and 55% respectively.

The Phase III rotor was designed to have a steeper average suction surface angle in the supersonic region to reduce the Mach number ahead of the leading edge shock. This results in a smaller cascade throat area than the baseline rotor.

The Phase IV rotor was also designed to have a steeper average suction surface angle ahead of the shock but differed from the Phase III blade in that it had somewhat less external compression and somewhat more internal contraction. This reduces the rapid mean line (and suction surface) curvatures in the region of the cascade mouth. The cascade throat areas of the Phase III and Phase IV blades were essentially the same.

The Phase V blade was designed to have a somewhat smaller effective trailing edge camber than the base line rotor.

The Phase III, IV, and V all used the same airfoil thickness distribution as the base line rotor.

SECTION II

DESIGN APPROACH AND CRITERIA

It was the intent of this program to vary only one parameter at a time in the design of the new rotors, keeping other design variables as close as practical to the baseline rotor. In order to expeditiously accomplish this effort it was deemed highly desirable to reproduce the actual test results of the baseline rotor on the General Electric computer.

The test data point selected as the baseline point was the most unthrottled point available at the design speed. The measured stage pressure ratio of this point was 1.92, which is essentially the same as the design, while the measured corrected airflow of 61.36 lbm/sec was about 2 percent lower than the original design. This lower than design flow makes it possible to consider designs for Phase III and IV rotors which have smaller throat areas. The measured airflow represents a specific flow of $43.13 \text{ lbm/sec/ft}^2$. The measured stage efficiency was 85.4%.

The measured airflow, discharge pressures and temperatures as well as flow path and blading geometry were used in the General Electric Circumferential Average Flow Determination computer program (CAFD). Calculation stations were included within the rotor at every 10 percent of the rotor axial projection. The assumed chordwise work distribution was adjusted at each streamline until a reasonable match was obtained of the measured static pressure over the rotor tip, and the calculated throat margins, the internal blade meanline departure (deviation) angle, and the difference between the "free flow" streamline and the blade suction surface angle in the flow induction region were all reasonable when compared with past experience. This synthesis of the baseline rotor operation is referred to as the "data match" case and served as a basis to perturbate the baseline configuration to the other aerodynamic designs carried out under this contract. The data match calculations are described in greater detail in Section IV.

Since the rotor internal blade blockage of the five designs differed from the baseline rotor, the chordwise distribution of work input was adjusted for each case to make the calculated streamline static pressure distribution similar to that calculated for the baseline case. Also, the blade meanline

departure angles were adjusted so that the flow induction capacity of the blade, and the throat areas were the same as the baseline rotor (except for the Phase III and IV blades where the throat areas were intentionally changed).

The rotor leading and trailing edges were kept at the same axial projection as the baseline rotor. Since the blade stagger angle in the outer portion changed some for the 5 different rotors, the blade chords differed some from the reference blade.

The radial distribution of maximum thickness was kept the same as the baseline. Since the chords for the different designs were not identical to the baseline, there were some variations in the thickness/chord ratio.

The baseline design used a chordwise thickness distribution described in Reference 2. The thickness distribution as a function of distance along the meanline is described by two cubic equations. The first equation describes the thickness from the leading edge to the maximum thickness point, while the second defines the thickness between the point of maximum thickness and the trailing edge. The magnitude and chordwise location of the airfoil maximum thickness (as well as the leading and trailing edge thickness) are specified by the designer. The slope and curvatures are continuous at the maximum thickness location where the two equations meet. The same procedure was used for the rotors designed under this contract.

A modified version of Carter's Rule was used to calculate a reference deviation angle for the baseline rotor. This procedure converts the vector diagrams (from the data match calculations) to an equivalent two-dimensional set of vectors which would produce the same circulation as the actual blade taking into account the change in streamline radius and meridional velocity. The difference between the deviation angle implied by the data match calculations and the reference deviation angle was maintained in the design of the five rotors.

SECTION III

COMPUTATIONAL PROCEDURES

The General Electric Circumferential Average Flow Determination (CAFD) computer program was used both for the data match calculation and for the design of the rotors. This computer program is similar (but differing in detail) to that used in the design of the baseline rotor and as described in Reference 3. In both cases the "full" radial equilibrium version of the momentum equation is satisfied at each computational station, with the streamline slope and curvature being obtained by a curve fit of the calculated streamline locations. Blade circumferential blockage and blade force terms are included, determined from the stacked blade geometry and the specified chordwise work distribution, for calculation stations within a blade row. A fast convergence technique is incorporated which results in a converged solution in a relative few number of iterations.

The Streamsurface Blade Sections Program (SBS) uses CAFD intra blade station output plus a distribution of blade departure (deviation) angles and thickness between the leading and trailing edge along each streamline. Passage area distribution, throat area and choke margin are calculated for each stream-surface section.

A "free-flow" streamline is also calculated. This streamline represents the path an air particle would follow in the absence of any blade force or blade annulus blockage. An approximate suction surface Mach number is calculated for the front portion of the blade (if the flow is supersonic) by applying a Prandtl-Meyer expansion from the free-flow streamline to the blade suction surface. The average angle difference between the blade suction surface and the free flow stream-line between the leading edge and the first "captured wave" is also calculated. This is used as a guide in selecting the incidence angle and meanline shape in the flow induction region of transonic airfoils.

The blade sections generated by the SBS program are then stacked and new values of blade lean angles and annulus blockage are calculated for input to the CAFD program for the next iteration.

Two streamline sections for the base configuration and each new rotor were analyzed using the Method of Characteristics (MOC) computer program. This was

done to assure that the computed unique incidence angle was consistent with the design flow. These calculations were carried out for streamlines 10% and 40% flow from the tip.

SECTION IV

DATA MATCH OF BASELINE ROTOR

A "data match" analysis was made of a selected test data point of the baseline rotor as previously discussed in Section II. Test data for this point was received from AFAPL in reference 4 and included measured total temperature and total pressure profiles at rotor exit and stator discharge. It also includes measured casing static pressures over the rotor tip.

The flowpath geometry for the data match was extracted from reference 1 and is reproduced in Figure 1. The rotor blade geometry was basically obtained from plane section manufacturing coordinates supplied by AFWAL. These coordinates were first interpolated to stream surface coordinates and then adjusted for blade deformation due to centrifugal force and pressure loading. This adjustment for deformation was calculated by means of a finite element program used in the mechanical design and analysis of blades and vanes.

It was found that the interpolation from plane to stream surface sections introduced some irregularities near the hub. Because of this the hub section was derived directly from reference 1 and the adjacent stream surface section was somewhat smoothed to obtain a good blend.

In a "data match" analysis the CAFD circumferential average program is run with measured test data as input with, the objective of obtaining best estimates of the many aerodynamic parameters which are not measured directly. For this work, calculations were made for 13 streamlines. Calculation stations within the annulus are shown in Figure 2. Station designations were kept similar to the base line design except that additional internal rotor stations have fractional station numbers. Figures 3 and 4 show the total pressure and temperature distributions which were used at the rotor exit and stage exit stations. Also shown are the test data extracted from reference 4. As can be seen some smoothing and extrapolation of the data was required. Casing static pressures over the rotor tip cannot be input directly into the program, so matching these values is done iteratively by adjusting the chordwise distribution of rotor work input. The assumed boundary layer allowance is shown on Figure 5. The same boundary layer allowance was specified at each streamline at a given calculation station. Figure 6 shows both the measured and "data

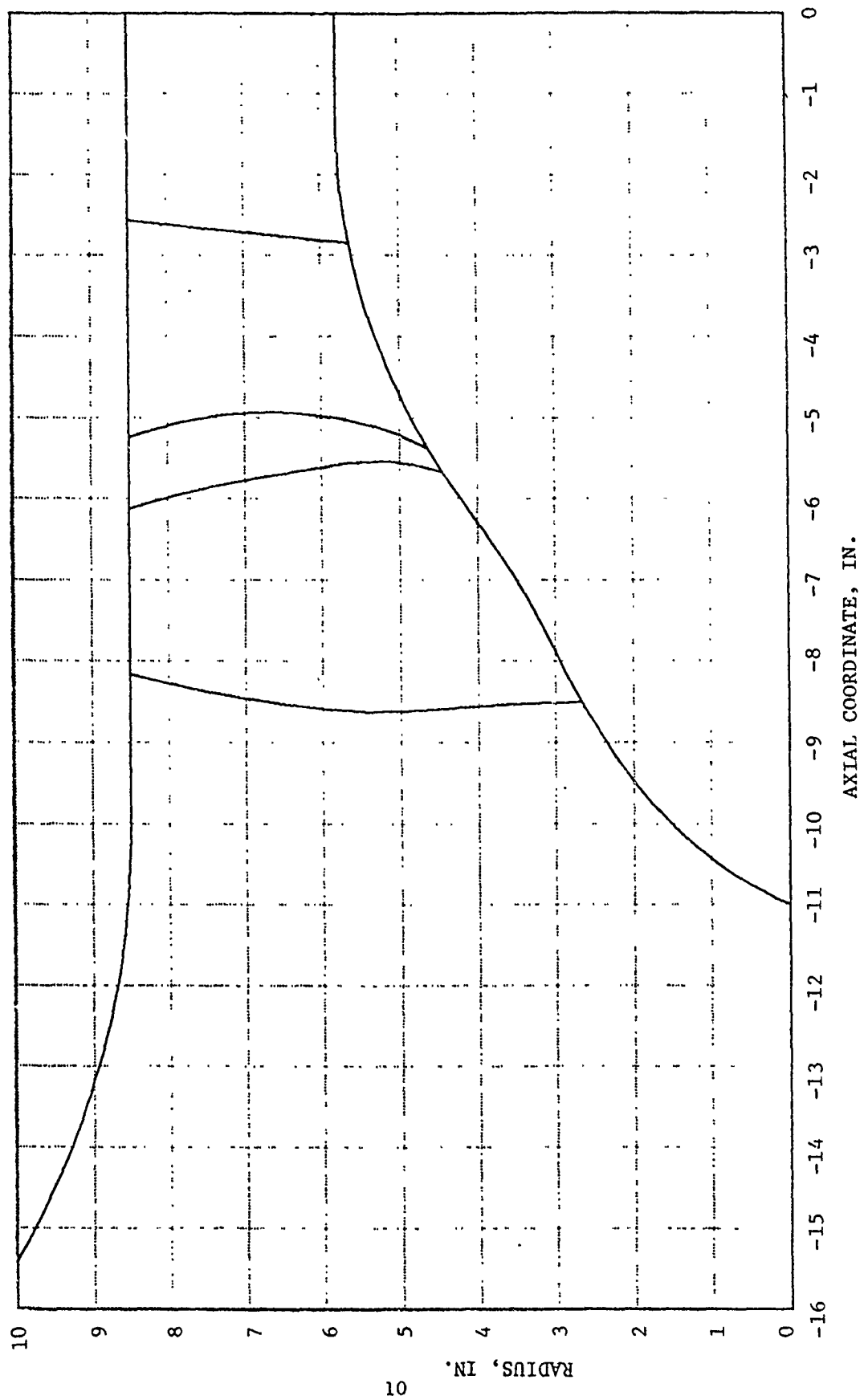


Figure 1. Compressor Flowpath With Blade Edge Stations

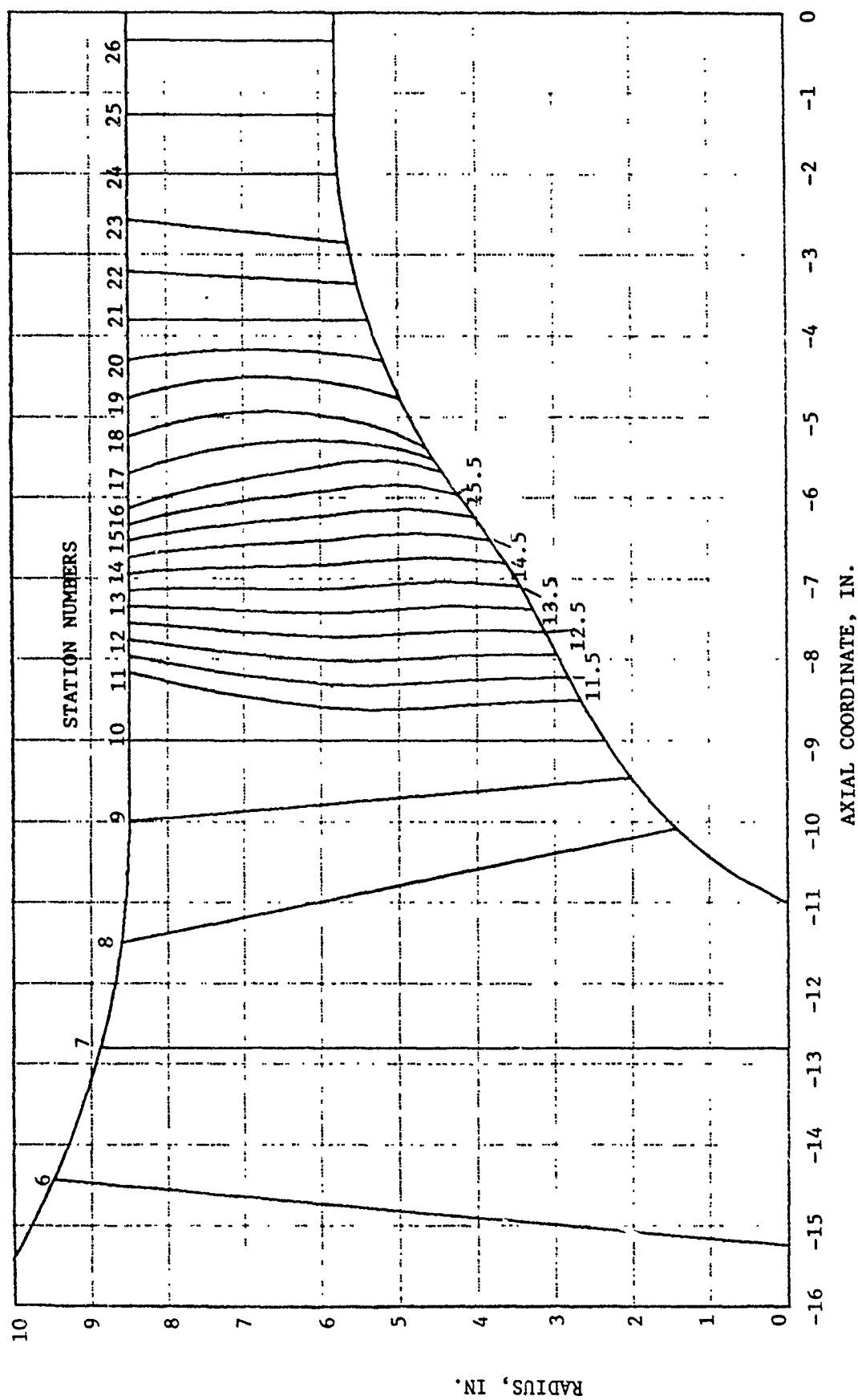


Figure 2. Compressor Flowpath With Calculation Stations

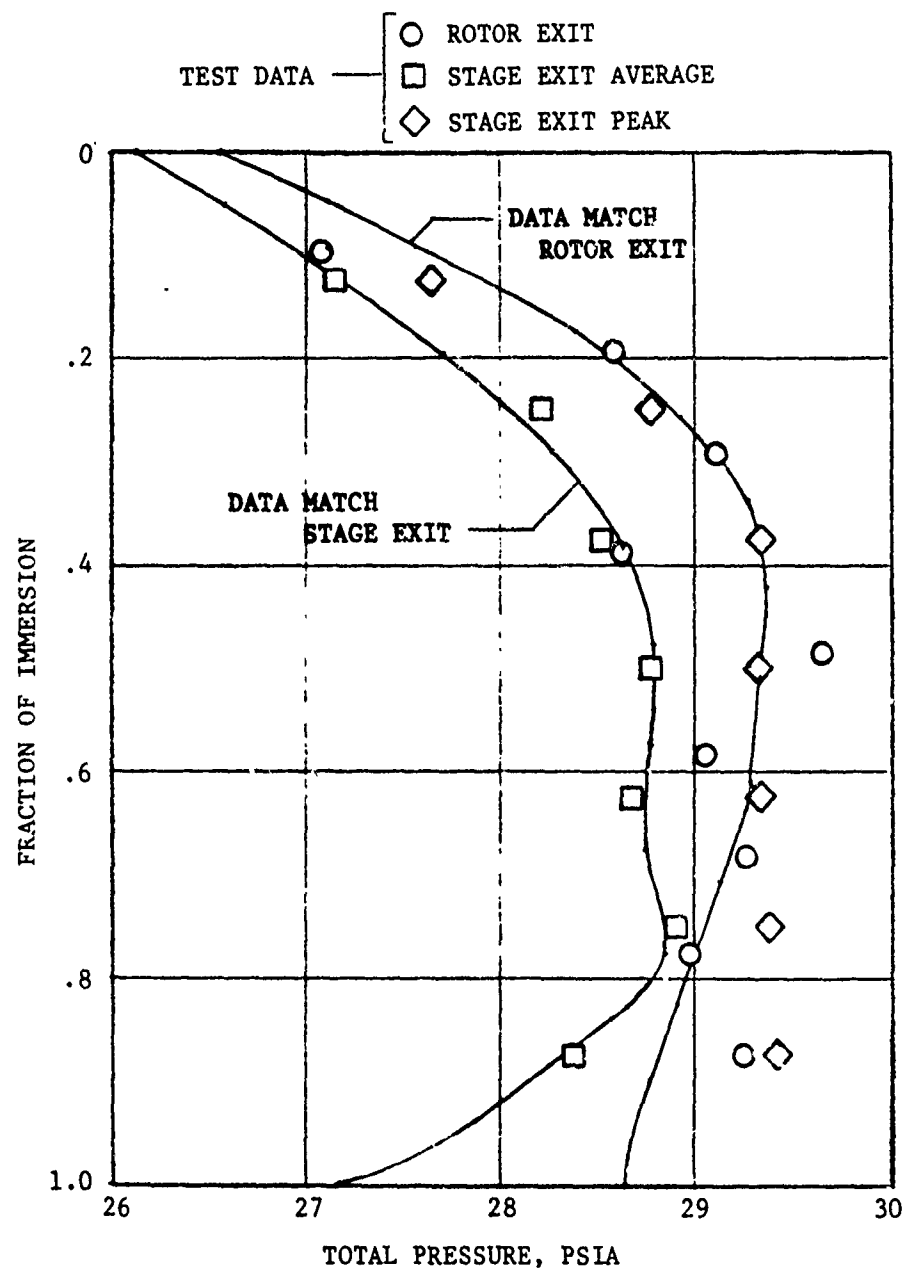


Figure 3. Data Match Total Pressures at Rotor Exit and at Stage Exit Compared with Measured Data

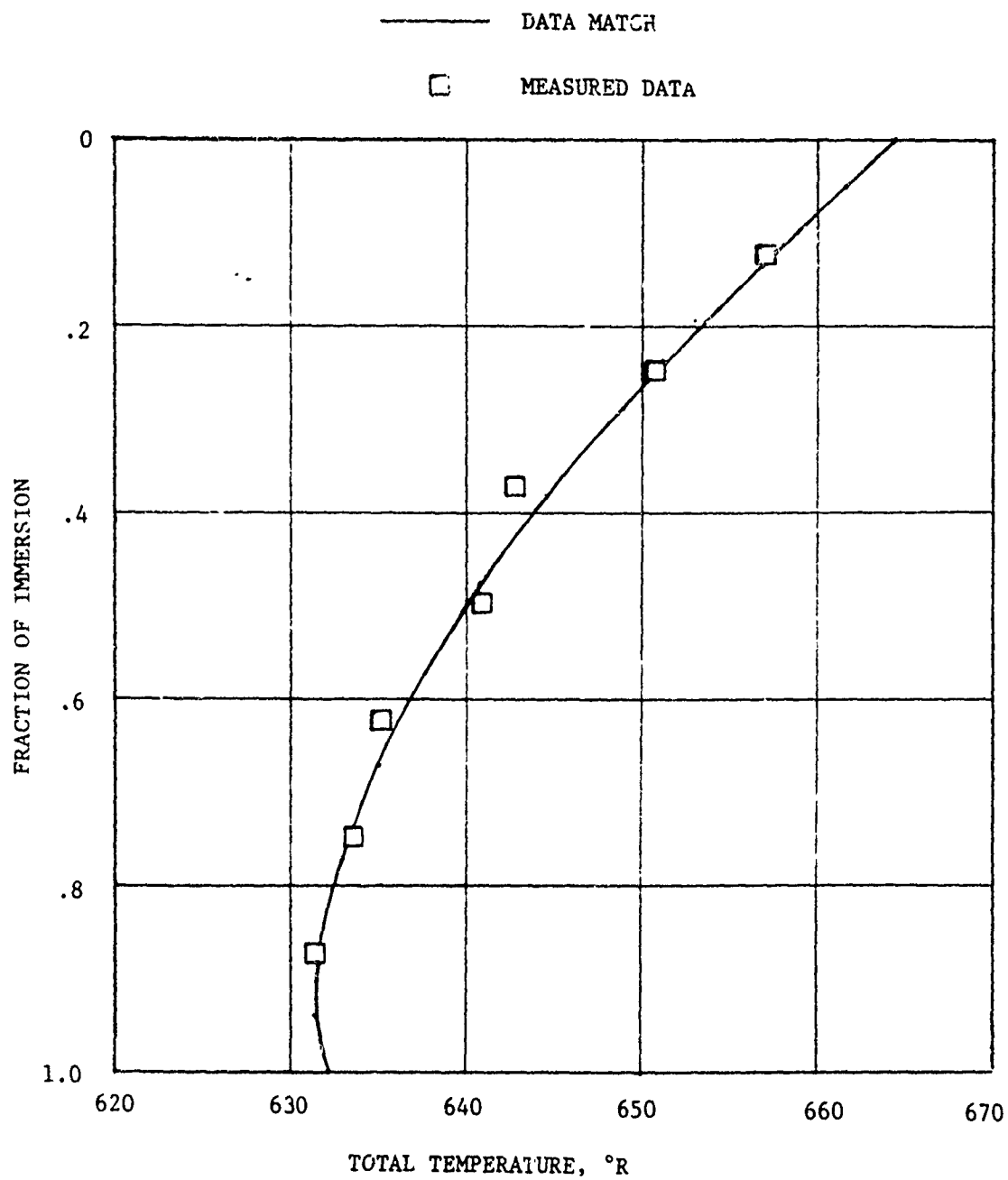


Figure 4. Data Match Total Temperatures at Stage Exit Compared With Measured Data

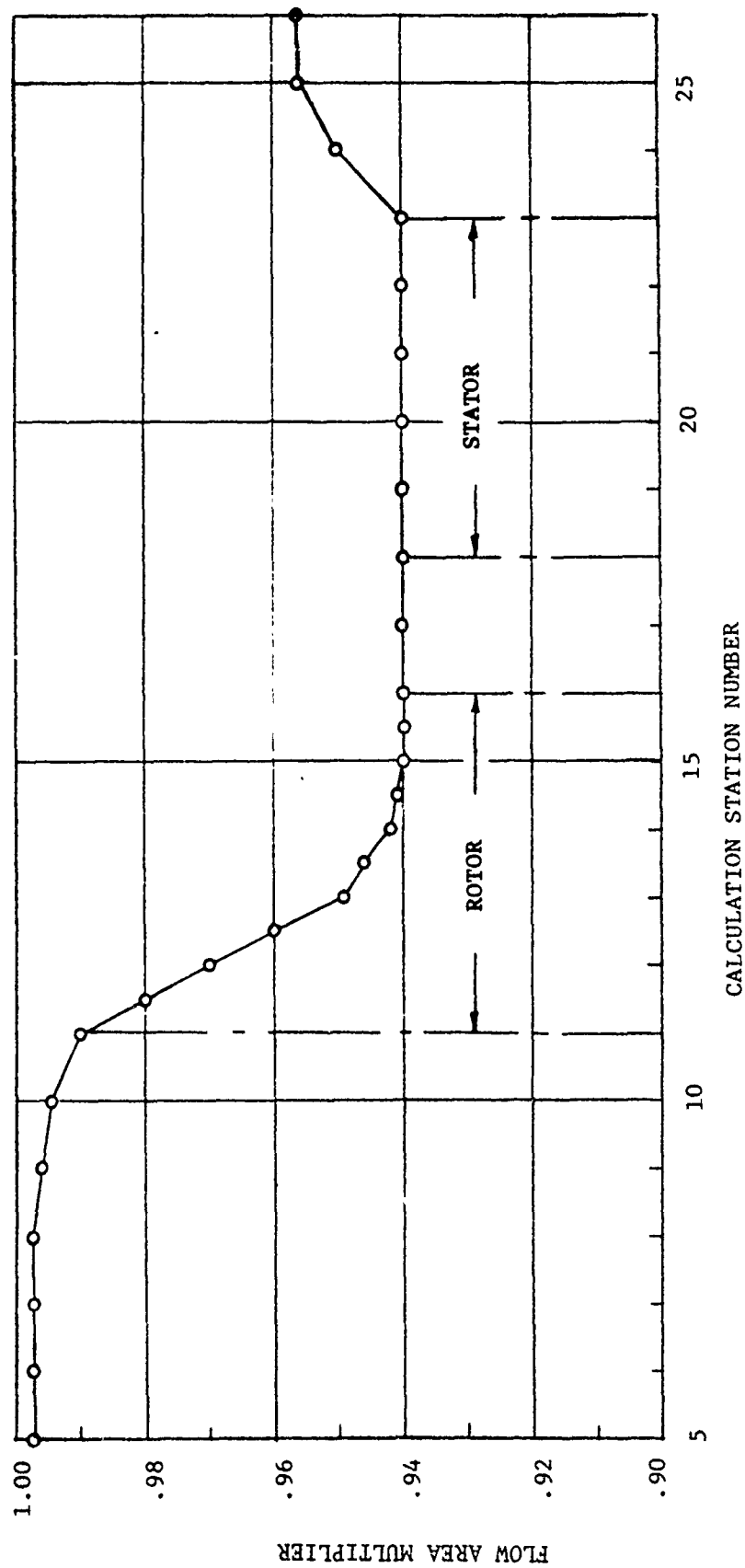


Figure 5. Multiplier On Flow Area Used To Account For Assumed Boundary Layer Displacement Thicknesses

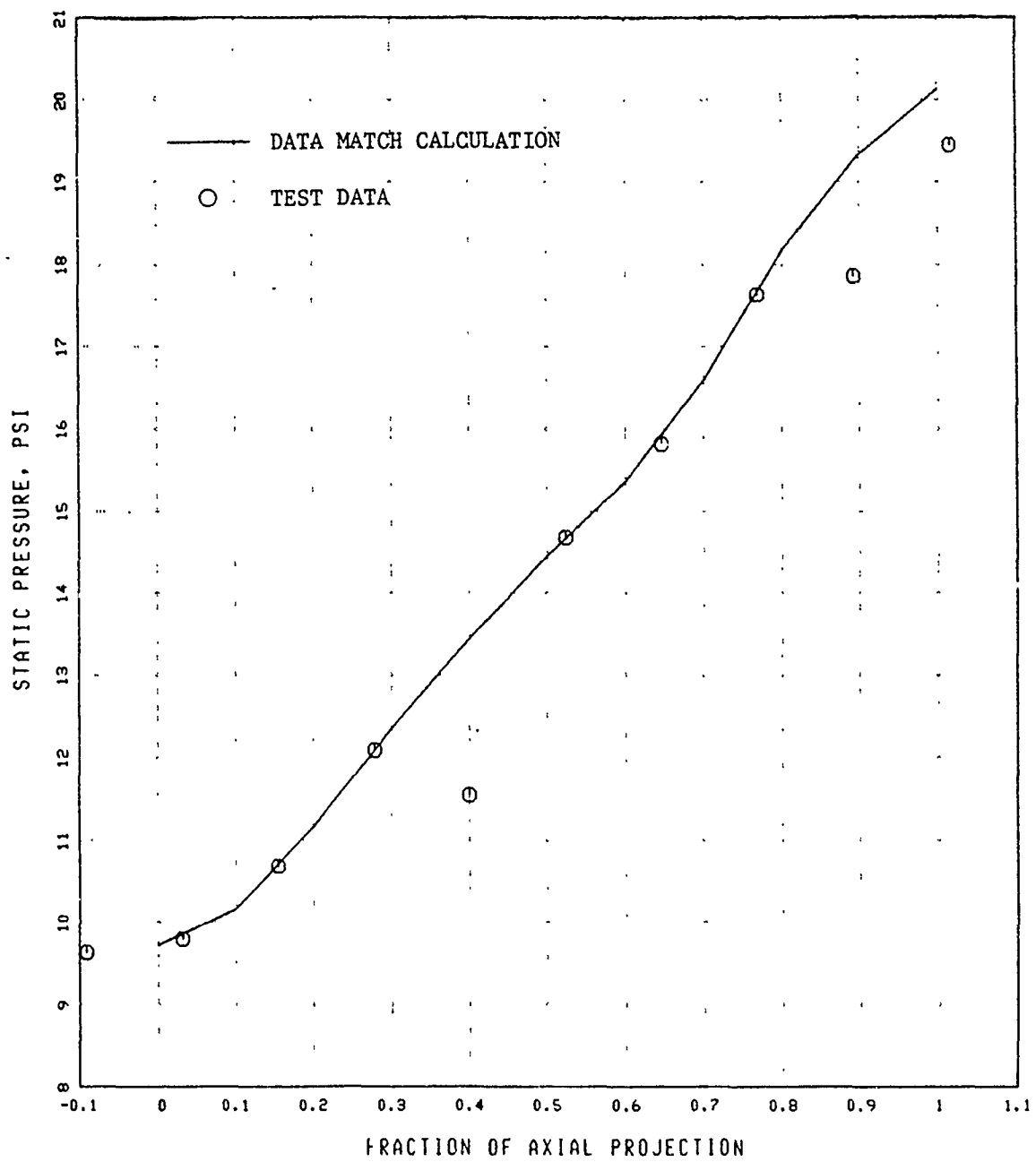


Figure 6. Data Match Rotor Static Pressure Distribution

match" casing static pressures. As can be seen, a perfect match could not be achieved. In particular, three measured casing stations appear to be lower than the corresponding data match values. No explanation for this has been determined.

The overall radial distribution of rotor work input was defined by the radial distribution of the total temperature at the rotor trailing edge station. Radial distribution of the rotor work input at the internal blade stations however is not so defined. At the internal rotor blade stations, the radial distribution of work input was iteratively adjusted so as to result in reasonable departure angle distributions along the blade span. Departure angle is here defined as the difference between the blade meanline angle and the air angle on a stream surface. The assumed streamline work input (as a fraction of the total streamline work) is plotted versus percent axial projection in Figure 7. The tip streamline is the one on the left. Each subsequent streamline is indexed to the right by the value of its stream function (fraction of the total flow from the tip). The dashed lines are lines of constant fraction of axial projection. A plot of departure angle on each data match streamline is shown in Figure 8.

The input stage work distribution and total pressure distributions at the rotor exit and stage exit imply blade row pressure loss coefficients. These pressure loss coefficients are shown in Figures 9 and 10 for the rotor and stator respectively. Rotor and overall stage efficiency distributions are also implied by the input work and total pressure distributions. These adiabatic efficiencies for the rotor and overall stage are shown in Figures 11 and 12 respectively.

After a satisfactory data match was obtained with the CAFD program, the SBS program was run to calculate various aerodynamic parameters including the several passage area ratios on each stream surface. Also a method of characteristics program called "MOC" was run on SBS streamlines 2 and 5 to serve as a later basis for assuring that the rotors to be designed under this contract would achieve the same flow as the base line rotor.

Figure 13 shows the rotor throat margin versus immersion. As here defined, the throat margin for a streamsurface blade section is the percent

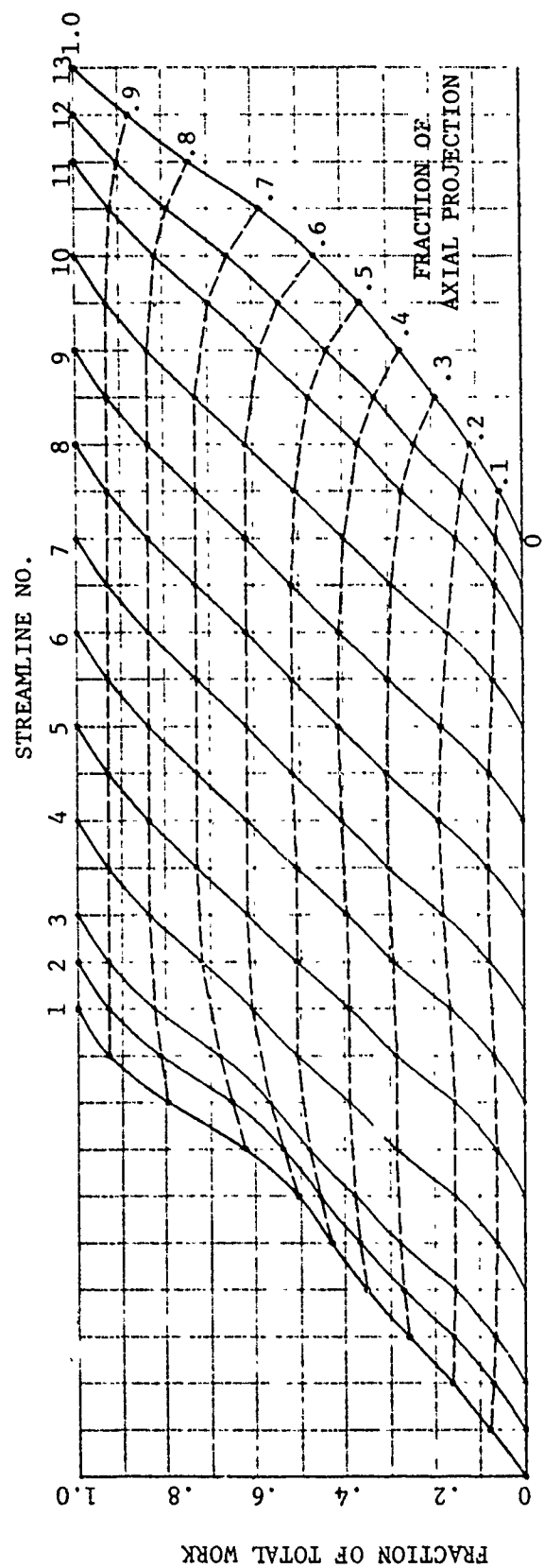


Figure 7. Data Match Rotor Intrablade Work Distribution

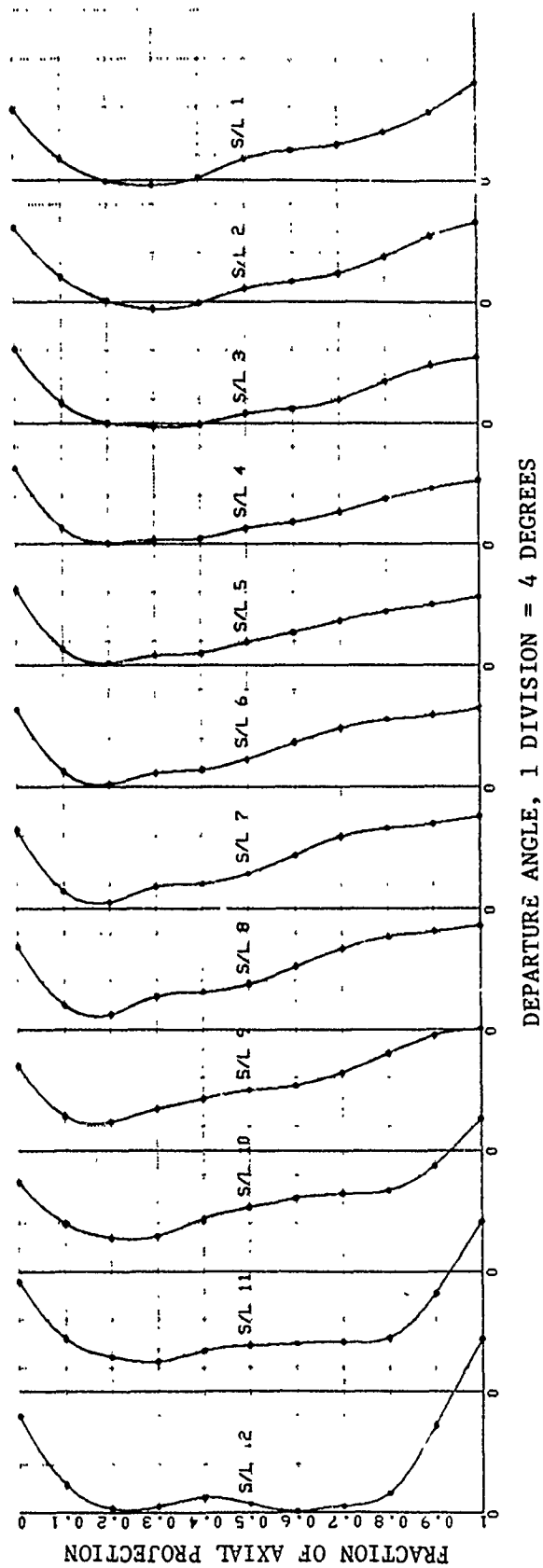


Figure 8. Data Match Rotor Intrablade Departure Angle Distribution

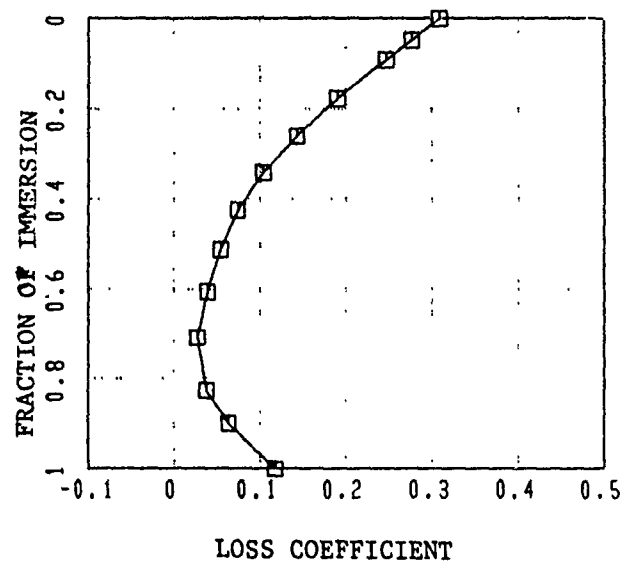


Figure 9. Data Match Rotor Total Pressure Loss Coefficient Versus Fractional Immersion

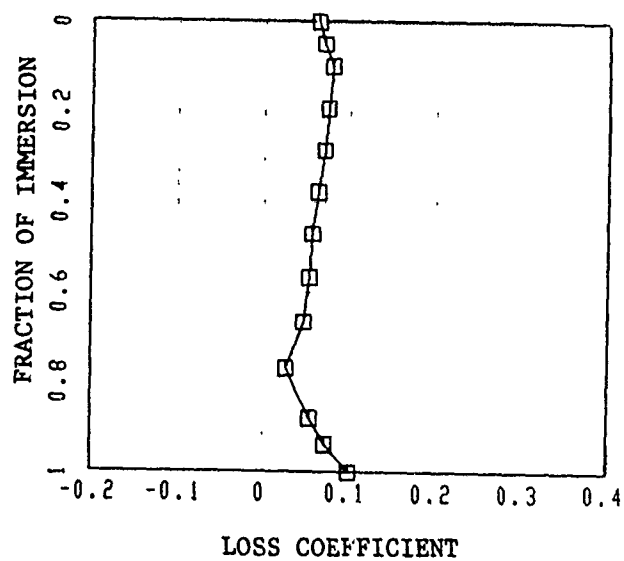


Figure 10. Data Match Stator Total Pressure Loss Coefficient Versus Fractional Immersion

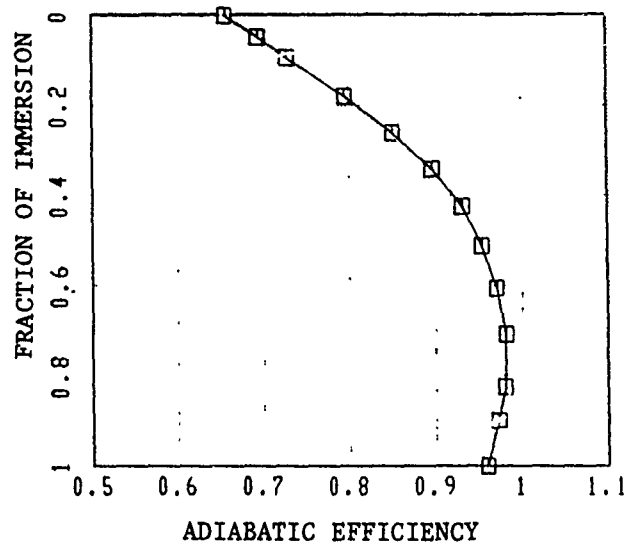


Figure 11. Data Match Rotor Efficiency Versus Fractional Immersion

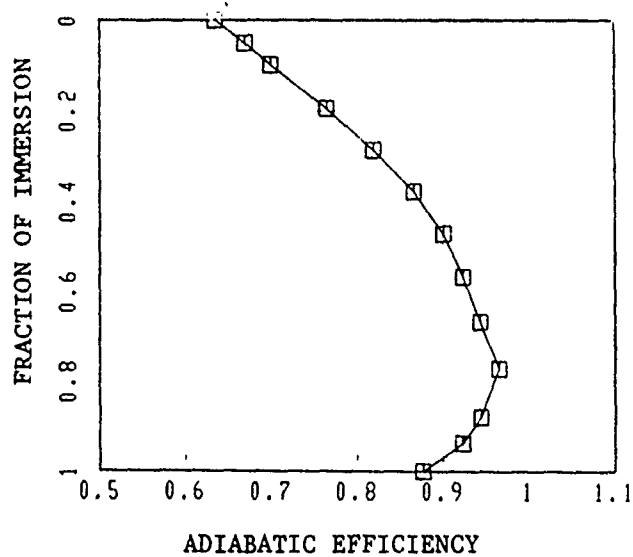


Figure 12. Data Match Stage Efficiency Versus Fractional Immersion

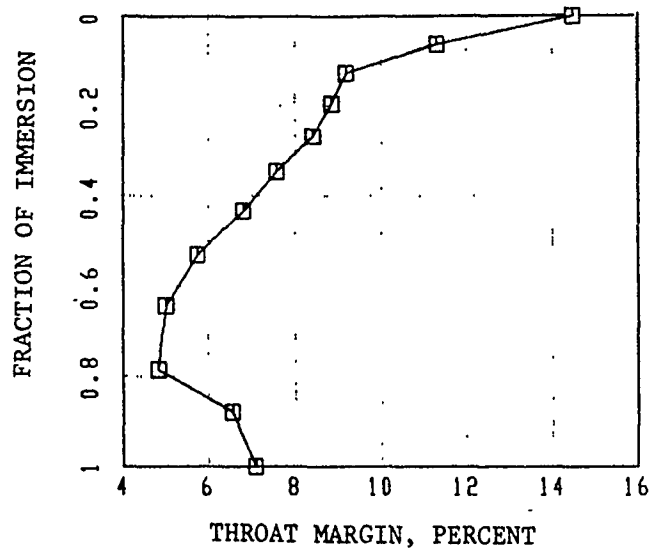


Figure 13. Data Match Rotor Throat Margin Versus Fractional Immersion

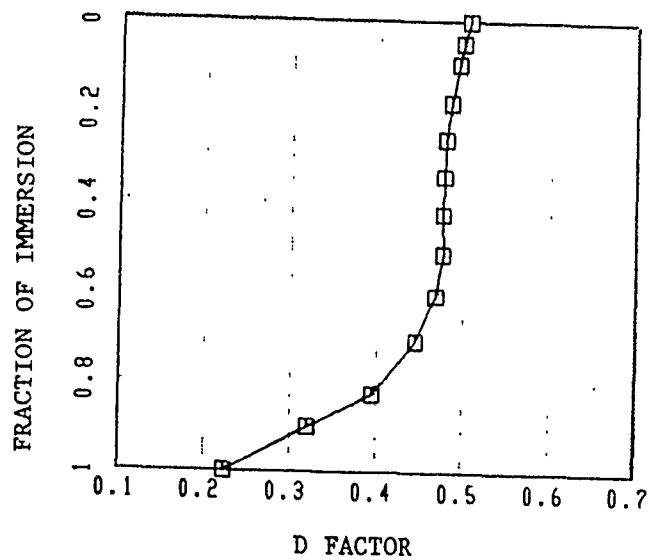


Figure 14. Data Match Rotor D Factor Versus Fractional Immersion

excess throat area over and above the minimum theoretical area required to pass the streamtube flow at a throat Mach number of 1.0 and assuming a total pressure loss equivalent to one normal shock at the upstream Mach number. In a rotor, the effect of radius change (between the leading edge and throat) on the relative total enthalpy and pressure is included. Throat margin distributions for Phase I, II, and V rotors were kept nearly identical to the data match case. For Phase III and IV rotors, it was intentionally different.

Figure 14 shows the rotor Lieblein Diffusion Factor (D factor) versus immersion.

Figures 15 and 16 show the data match rotor incidence and deviation angles respectively. Here the incidence and deviation angles are defined as seen in a streamsurface section. The irregularity in the incidence angle shown in Figure 15 near the hub may be the result of interpolating from the plane section coordinates of the baseline rotor.

A modified version of Carter's Rule was used to calculate a reference deviation angle for the baseline rotor. This procedure converts the vector diagrams (from the data match calculations) to an equivalent two-dimensional set of vectors which would produce the same circulation as the actual blade taking into account the change in streamline radius and meridional velocity. The difference between the deviation angle implied by the data match calculations and the reference deviation angle is shown in Figure 17. This "delta deviation angle" was used as a guide in setting deviation angles for the other five rotor designs.

Figure 18 shows the stator incidence angle implied by the data match calculations and the baseline stator geometry. Since the other five rotor designs will be tested with this same stator, it is important that their design stator incidence angles do not depart too greatly from the data match case.

The detail results of the data match analysis are given in Section V.

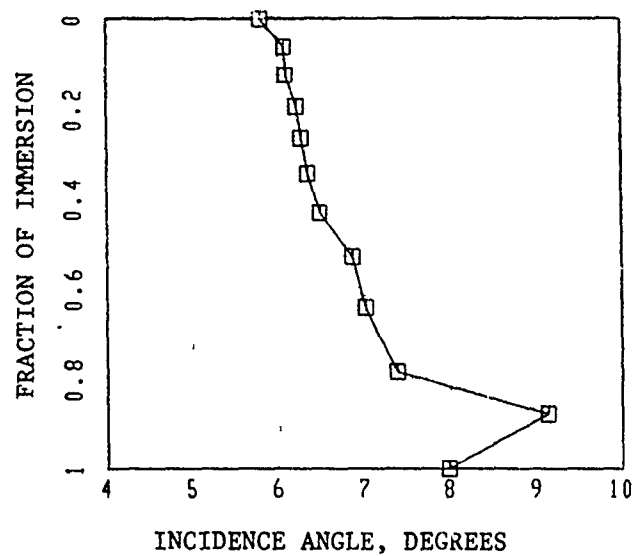


Figure 15. Data Match Rotor Incidence Angle Versus Fractional Immersion

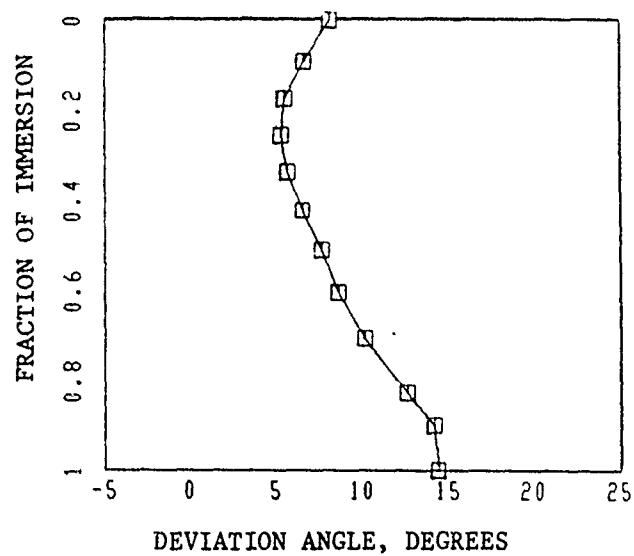


Figure 16. Data Match Rotor Deviation Angle Versus Fractional Immersion

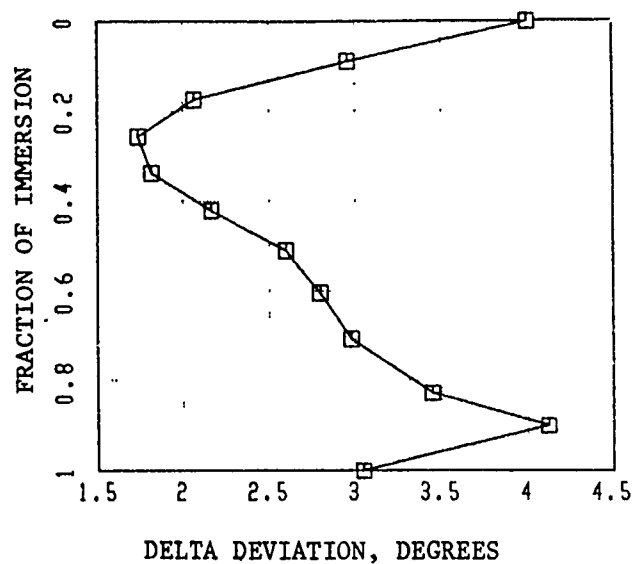


Figure 17. Data Match Rotor Deviation Angle Minus Reference Deviation Angle

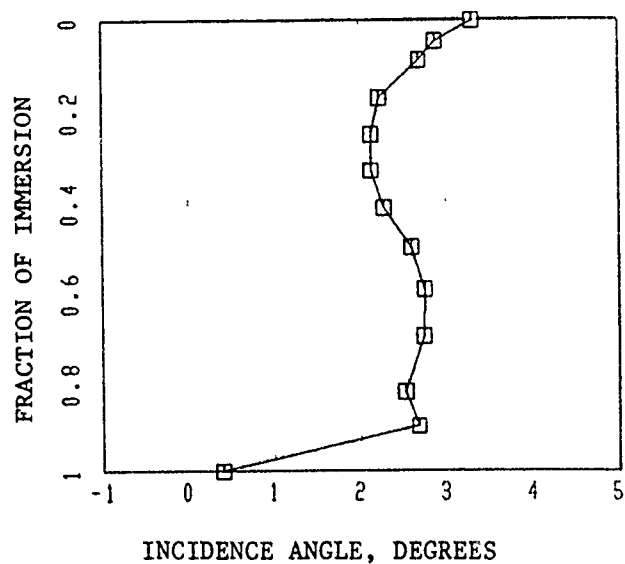


Figure 18. Data Match Stator Incidence Angle Versus Fractional Immersion

SECTION V
DETAIL RESULTS OF DATA MATCH

The following tabulation presents the detail results of the data match circumferential average flow computation. Each page of the tabulation gives results for one calculation station. Figure 2 shows the calculation station locations within the flowpath. At each calculation station various aerodynamic parameters are given on each of thirteen calculation streamlines. Also given are several mass averaged station flow properties.

INLET STA= 5.000 FREE
 WTF= 61.365 I= 1 AFLOW= 478.13 D=C=O. D=H=O.
 PSIC Z OPTX=OPP MTIP= 1 ITYPE=O INBR=O ABC=O. ABH=O.
 R PHI CURV VM CU ALPHAM MM
 0. -18.800 13.207 -50.10 0.0831 150.4 0. 0. 0.135
 0.050 -18.800 12.564 -43.54 0. 181.0 0. 0. 0.163
 0.100 -18.800 12.020 -40.31 0. 195.9 0. 0. 0.176
 0.200 -18.800 11.027 -34.70 0. 218.6 0. 0. 0.196
 0.300 -18.800 10.099 -29.90 0. 237.1 0. 0. 0.213
 0.400 -18.800 9.193 -25.65 0. 252.4 0. 0. 0.227
 0.500 -18.800 8.277 -21.78 0. 265.1 0. 0. 0.239
 0.600 -18.800 7.319 -19.16 0. 275.9 0. 0. 0.248
 0.700 -18.800 6.277 -14.68 0. 284.9 0. 0. 0.257
 0.800 -18.800 5.083 -11.18 0. 292.5 0. 0. 0.264
 0.900 -18.800 3.559 -7.34 0. 298.9 0. 0. 0.270
 0.950 -18.800 2.516 -4.91 0. 301.6 0. 0. 0.272
 1.000 -18.800 0.000 0. 303.9 0. 0. 0.274

SL BLDLCK PS PT TT BETAM VREL MREL VABS MABS
 1 0.997 14.510 14.696 518.7 86.31 2335.4 2.095 150.4 0.135
 2 0.997 14.427 14.696 518.7 85.33 2224.5 1.997 181.0 0.163
 3 0.997 14.382 14.696 518.7 84.72 2130.2 1.913 195.9 0.176
 4 0.997 14.305 14.696 518.7 83.59 1958.1 1.760 218.6 0.196
 5 0.997 14.237 14.696 518.7 82.42 1797.9 1.617 237.1 0.213
 6 0.997 14.177 14.696 518.7 81.16 1641.9 1.477 252.4 0.227
 7 0.997 14.124 14.696 518.7 79.71 1484.6 1.337 265.1 0.239
 8 0.997 14.077 14.696 518.7 77.94 1320.6 1.190 275.9 0.248
 9 0.997 14.037 14.696 518.7 75.58 1143.7 1.031 284.9 0.257
 10 0.997 14.002 14.696 518.7 71.94 943.5 0.850 292.5 0.264
 11 0.997 13.972 14.696 518.7 64.61 697.2 0.629 298.9 0.270
 12 0.997 13.959 14.696 518.7 55.81 536.8 0.484 301.6 0.272
 13 0.997 13.947 14.696 518.7 0.00 303.9 0.274 303.9 0.274

STA 5.000 MASS AVERAGED PROPERTIES
 PT= 14.696 TT= 518.69 GAMMA=1.4015 PT-RAT= 1.000 TT-RAT= 1.000
 RCU= 0. VM= 255.3 CZ= 233.4 MM=0.230 MABS=0.230 MREL=1.300

INLET		I = 2		STA = 6.000		AFLOW = 277.56		FREE	
WTF = 61 365		OPTX=DPP		MTIP = 14		ITYPE=O		D+C=O.	
PSIC		Z		PHI		CURV		ABC=O.	
								MM	
0	-14.431	9.481	-24.96	-0.0952	514.6	0.	0.	0.	0.471
0.050	-14.450	9.254	-24.10	-0.1028	507.6	0.	0.	0.	0.464
0.100	-14.470	9.020	-22.95	-0.0955	501.1	0.	0.	0.	0.458
0.200	-14.513	8.532	-20.65	-0.0825	489.4	0.	0.	0.	0.447
0.300	-14.558	8.010	-18.38	-0.0712	478.4	0.	0.	0.	0.436
0.400	-14.606	7.446	-16.13	-0.0614	467.8	0.	0.	0.	0.426
0.500	-14.660	6.829	-13.87	-0.0529	457.2	0.	0.	0.	0.416
0.600	-14.719	6.141	-11.59	-0.0455	446.4	0.	0.	0.	0.406
0.700	-14.787	5.352	-9.23	-0.0390	434.9	0.	0.	0.	0.395
0.800	-14.869	4.403	-6.73	-0.0330	422.1	0.	0.	0.	0.383
0.900	-14.978	3.142	-4.03	-0.0257	407.0	0.	0.	0.	0.369
0.950	-15.057	2.235	-2.57	-0.0189	398.2	0.	0.	0.	0.361
1.000	-15.250	-0.000	0.	0	387.2	0.	0.	0.	0.351

SL		PS		PT		TT		BETAM		VREL		MREL		VABS		MABS	
1	0.997	12.623	14.696	518.7	72.90	1750.4	1.601	514.6	0.471	507.6	0.464	501.1	0.458	489.4	0.447	478.4	0.436
2	0.997	12.677	14.696	518.7	72.73	1710.1	1.564	507.6	0.464	501.1	0.458	489.4	0.447	478.4	0.436	467.8	0.426
3	0.997	12.726	14.696	518.7	72.53	1668.8	1.525	501.1	0.458	489.4	0.447	478.4	0.436	467.8	0.426	457.2	0.416
4	0.997	12.812	14.696	518.7	71.99	1583.2	1.445	489.4	0.447	478.4	0.436	467.8	0.426	457.2	0.416	446.4	0.406
5	0.997	12.892	14.696	518.7	71.30	1492.2	1.361	478.4	0.436	467.8	0.426	457.2	0.416	446.4	0.406	434.9	0.395
6	0.997	12.968	14.696	518.7	70.41	1394.8	1.271	467.8	0.426	457.2	0.416	446.4	0.406	434.9	0.395	422.1	0.383
7	0.997	13.042	14.696	518.7	69.22	1288.9	1.174	457.2	0.416	446.4	0.406	434.9	0.395	422.1	0.383	407.0	0.369
8	0.997	13.116	14.696	518.7	67.61	1172.0	1.066	446.4	0.406	434.9	0.395	422.1	0.383	407.0	0.369	398.2	0.361
9	0.997	13.193	14.696	518.7	65.27	1039.7	0.945	434.9	0.395	422.1	0.383	407.0	0.369	398.2	0.361	387.2	0.351
10	0.997	13.277	14.696	518.7	61.48	884.2	0.803	422.1	0.383	407.0	0.369	398.2	0.361	387.2	0.351		
11	0.997	13.374	14.696	518.7	53.72	687.8	0.624	407.0	0.369	398.2	0.361	387.2	0.351				
12	0.997	13.428	14.696	518.7	44.72	560.4	0.508	398.2	0.361	387.2	0.351						
13	0.997	13.495	14.696	518.7	-0.00	387.2	0.351	387.2	0.351								

STA 6.000 MASS AVERAGED PROPERTIES
PT= 14.696 TT= 518.69 GAMMA=1.4016 PT-RAT= 1.000 TT-RAT= 1.000
RCU= 0. VM= 455.5 C7= 438.5 MM=0.415 MABS=0.415 MREL=1.120

INLET		I= 3		STA= 7.000		AFLOW= 244.35		D*C=O.		FREE	
WTF= 61.365		OPTX=DPP		OPTV=FREE		ITYPE=O		INBR=O		ABC=O.	
PSIC		R		PHI		CURV		VM		CU	
Z		PS		PT		TT		BETAM		VREL	
0.	-12.800	8.880	-15.47	-0.0952	625.2	0.	0.	0.578			
0.050	-12.800	8.675	-14.65	-0.0872	617.8	0.	0.	0.571			
0.100	-12.800	8.464	-13.90	-0.0849	610.4	0.	0.	0.564			
0.200	-12.800	8.021	-12.40	-0.0794	595.1	0.	0.	0.549			
0.300	-12.800	7.546	-10.87	-0.0736	579.6	0.	0.	0.533			
0.400	-12.800	7.032	-9.28	-0.0680	563.9	0.	0.	0.518			
0.500	-12.800	6.468	-7.60	-0.0629	547.6	0.	0.	0.502			
0.600	-12.800	5.837	-5.79	-0.0587	530.4	0.	0.	0.486			
0.700	-12.800	5.112	-3.79	-0.0560	511.3	0.	0.	0.468			
0.800	-12.800	4.237	-1.46	-0.0558	488.4	0.	0.	0.446			
0.900	-12.800	3.064	1.52	-0.0634	455.9	0.	0.	0.415			
0.950	-12.800	2.206	3.54	-0.0760	428.6	0.	0.	0.390			
1.000	-12.800	0.000	0	0.	383.5	0.	0.	0.347			
SL	BLOBLK	PS	PT	TT	BETAM	VREL	MREL	VABS	MABS		
1	0.998	11.715	14.696	518.7	68.25	1687.2	1.560	625.2	0.578		
2	0.998	11.779	14.696	518.7	68.02	1650.8	1.525	617.8	0.571		
3	0.998	11.843	14.696	518.7	67.77	1613.5	1.490	610.4	0.564		
4	0.998	11.974	14.696	518.7	67.20	1535.5	1.415	595.1	0.549		
5	0.998	12.105	14.696	518.7	66.48	1452.4	1.337	579.6	0.533		
6	0.998	12.235	14.696	518.7	65.56	1363.1	1.253	563.9	0.518		
7	0.998	12.366	14.696	518.7	64.37	1266.0	1.162	547.6	0.502		
8	0.998	12.502	14.696	518.7	62.76	1158.6	1.061	530.4	0.486		
9	0.998	12.649	14.696	518.7	60.46	1036.9	0.948	511.3	0.468		
10	0.998	12.819	14.696	518.7	56.85	893.1	0.815	488.4	0.446		
11	0.998	13.051	14.696	518.7	49.87	707.2	0.644	455.9	0.415		
12	0.998	13.234	14.696	518.7	42.25	579.1	0.526	428.6	0.390		
13	0.998	13.517	14.696	518.7	0.00	383.5	0.347	383.5	0.347		

INLET STA= 9 000 AFLOW= 211.87 D=C=O. FREE D=H=O
WTF= 61.365 MTIP= 53 OPTX=FREE ITYPE=O INBR=O ABC=O. ABH=O.
PSIC Z R PHI CURV VM CU ALPHAM MM

0.050	-9.999	8.500	0.	0	758.6	0.	0.	0.713
0.100	-9.984	8.315	-1.11	-0.0542	751.6	0.	0.	0.706
0.200	-9.968	8.125	-0.88	-0.0525	743.7	0.	0.	0.697
0.300	-9.935	7.728	-0.27	-0.0507	729.9	0.	0.	0.683
0.400	-9.900	7.305	0.60	-0.0510	715.8	0.	0.	0.669
0.500	-9.862	6.851	1.76	-0.0530	700.5	0.	0.	0.653
0.600	-9.821	6.399	3.28	-0.0573	682.8	0.	0.	0.635
0.700	-9.776	5.816	5.23	-0.0634	661.0	0.	0.	0.614
0.800	-9.725	5.201	7.76	-0.0714	633.1	0.	0.	0.586
0.900	-9.665	4.475	11.17	-0.0793	596.3	0.	0.	0.550
0.950	-9.587	3.542	16.58	-0.0807	546.2	0.	0.	0.501
1.000	-9.536	2.919	21.63	-0.0405	515.5	0.	0.	0.472
	-9.460	2.011	38.65	0.1881	511.6	0.	0.	0.468

SL BLDLTK PS PT TT BETAM VREL MREL VABS MABS

1	0.996	10.469	14.696	518.7	63.17	1680.9	1.580	758.6	0.713
2	0.996	10.537	14.696	518.7	62.88	1648.6	1.548	751.6	0.706
3	0.996	10.615	14.696	518.7	62.59	1615.2	1.515	743.7	0.697
4	0.996	10.748	14.696	518.7	61.84	1546.7	1.448	729.9	0.683
5	0.996	10.883	14.696	518.7	60.96	1474.5	1.378	715.8	0.669
6	0.996	11.028	14.696	518.7	59.91	1397.3	1.303	700.5	0.653
7	0.996	11.194	14.696	518.7	58.68	1313.6	1.223	682.8	0.635
8	0.996	11.394	14.696	518.7	57.22	1220.8	1.133	661.0	0.614
9	0.996	11.645	14.696	518.7	55.40	1115.0	1.032	633.1	0.586
10	0.996	11.964	14.696	518.7	52.94	989.6	0.912	596.3	0.550
11	0.996	12.377	14.696	518.7	48.85	830.0	0.62	546.2	0.501
12	0.996	12.617	14.696	518.7	44.98	728.8	0.667	515.5	0.472
13	0.996	12.647	14.696	518.7	34.75	622.6	0.569	511.6	0.468

STA 9.000 MASS AVERAGED PROPERTIES
PT= 14.696 TT= 518.69 GAMMA=1.4018 PT-RAT= 1.000 TT-RAT= 1.000
RCU= 0. VM= 663.8 CZ= 655.3 MM=0.617 MABS=0.617 MREL=1.178

INLET										FREE									
STA= 10.000										D=C=O									
I= 6										D=H=O									
MTIP= 66										ABH=O.									
AFLOW= 204.14										ALPHAM									
CURV										CU									
VM										MM									
INBR=O										ABC=O									
PHI										D=H=O									
OPTX=DPP										ABH=O.									
R										MM									
Z										ALPHAM									
PSIC										CU									
-9.000										0									
8.530										773.6									
0.050										0.0029									
0.100										0.0022									
0.200										0.0120									
0.300										0.0206									
0.400										0.0302									
0.500										0.0406									
0.600										0.0566									
0.700										0.0740									
0.800										0.0876									
0.900										0.0856									
0.950										0.0817									
1.000										0.1922									
2.340										0.1922									
32.46										0.1922									
544.2										544.2									

STA 10.000 MASS AVERAGED PROPERTIES
PT= 14.696 TT= 518.69 GAMMA=1.4018 PT-RAT= 1.000 TT-RAT= 1.000
RCU= 0. VM= 705.8 CZ= 694.5 MM=0.660 MABS=0.660 MREL=1.217

ROTOR1		STA= 11.000		AFLOW= 197.41		D+C=0.		LE ROTOR		D+H=0.	
WTF= 61.365		I= 7		MTIP= 79		INBR= 3		ABC=0.		ABH=0.	
PSIC		Z		OPTX=DPP		ITYPE= 4		CURV		VM	
O.		-8.166		8.503		PHI		O.		832.8	
0.050		-8.204		8.322		O.36		-0.0040		834.5	
0.100		-8.242		8.140		O.74		-0.0026		835.6	
0.200		-8.322		7.762		1.72		-0.0036		835.7	
0.300		-8.397		7.362		3.00		-0.0113		830.5	
0.400		-8.466		6.936		4.60		-0.0206		818.7	
0.500		-8.531		6.475		6.64		-0.0372		798.1	
0.600		-8.592		5.968		9.21		-0.0526		765.5	
0.700		-8.624		5.397		12.37		-0.0666		721.0	
0.800		-8.604		4.735		16.27		-0.0684		668.5	
0.900		-8.548		3.903		21.64		-0.0674		602.3	
0.950		-8.526		3.360		25.82		-0.0627		558.9	
1.000		-8.507		2.653		31.20		0.1471		554.4	

STA 11.000 MASS AVERAGED PROPERTIES
PT= 14.696 TT= 518.69 GAMMA=1.4018 PT-RAT= 1.000 TT-RAT= 1.000
RCU= 0. VM= 756 O CZ= 741.7 MM=0.712 MABS=0.712 MREL=1.260

ROTOR1		I= 8		STA= 11 500		AFLOW= 181.11		IN ROTOR	
WTF= 61.365		OPTX=TT		MTIP= 92		ITYPE=5		D+C=0	
PS1C	Z	R	PHI	CURV	VM	CU	ALPHAM	MM	ABH=0.
0.	-7.963	8.500	0	0	847.8	44.8	3.03	0.797	D+H=0.
0.050	-7.991	8.323	0.22	0.0264	851.4	40.5	2.72	0.802	
0.100	-8.020	8.142	0.56	0.0298	859.4	38.3	2.55	0.812	
0.200	-8.083	7.769	1.51	0.0191	876.2	36.5	2.38	0.830	
0.300	-8.143	7.376	3.07	0.0025	886.3	37.1	2.40	0.841	
0.400	-8.198	6.958	4.85	-0.0135	886.4	40.3	2.61	0.841	
0.500	-8.251	6.509	7.07	-0.0166	878.6	47.8	3.12	0.832	
0.600	-8.301	6.017	9.72	-0.0088	854.8	51.7	3.46	0.807	
0.700	-8.324	5.466	12.93	0.0027	819.7	53.6	3.74	0.770	
0.800	-8.299	4.827	16.85	0.0046	772.0	52.8	3.91	0.721	
0.900	-8.247	4.026	22.16	0.0115	709.7	57.0	4.59	0.658	
0.900	-8.231	3.505	25.84	0.0596	676.5	62.3	5.26	0.625	
1.000	-8.224	2.817	29.07	0.0300	652.5	69.0	6.04	0.602	

SL		PS		PT		BETAM		VREL		MREL		VABS		MABS	
1	0.955	10.156	15.467	529.9	59.77	1684.2	1.584	849.0	0.799						
2	0.955	10.074	15.414	528.6	59.20	1562.8	1.567	852.3	0.803						
3	0.955	9.968	15.391	527.9	58.43	1641.5	1.550	860.3	0.812						
4	0.952	9.774	15.379	527.0	56.71	1596.4	1.513	876.9	0.831						
5	0.948	9.673	15.397	526.7	54.97	1544.2	1.466	887.1	0.842						
6	0.943	9.706	15.451	527.0	53.26	1481.9	1.407	887.3	0.842						
7	0.935	9.867	15.565	527.9	51.40	1408.4	1.334	879.9	0.833						
8	0.925	10.135	15.584	527.9	49.76	1323.2	1.249	856.4	0.808						
9	0.913	10.480	15.545	527.3	48.01	1225.4	1.151	821.5	0.772						
10	0.897	10.899	15.440	526.2	45.98	1111.0	1.038	773.8	0.723						
11	0.878	11.462	15.365	525.4	42.64	964.7	0.895	712.0	0.660						
12	0.853	11.748	15.328	525.1	39.43	875.8	0.809	679.4	0.628						
13	0.816	11.904	15.250	524.4	33.27	780.4	0.720	656.1	0.605						

STA 11.500 MASS AVERAGED PROPERTIES
PT= 15.448 TT= 527.04 GAMMA=1.4018 PT-RAT= 1.051 TT-RAT= 1.016
RCU= 283.5 VM= 829.0 CZ= 811.8 MM=0.781 MABS=0.782 MREL=1.276

ROTOR1 STA= 12.000 AFLOW= 170.55 D+C=O. D*H=O. ABH=O.
 WTF= 61.365 I= 9 OPTX=TT OPTV=PT PHI CURV VM CU ALPHAM MM
 PSIC Z R
 0. -7.759 8.500 0. 0. 815 5 94.9 6.64 0.754
 0.050 -7.778 8.323 -0.16 0.0356 822.9 93.4 6.47 0.762
 0.100 -7.798 8.144 0.11 0.0412 832.6 91.7 6.29 0.773
 0.200 -7.844 7.775 1.30 0.0261 855.5 92.0 6.14 0.798
 0.300 -7.889 7.389 3.03 0.0030 870.9 93.4 6.12 0.815
 0.400 -7.931 6.981 5.05 -0.0115 883.0 101.8 6.57 0.827
 0.500 -7.972 6.544 7.31 -0.0130 888.5 114.1 7.32 0.832
 0.600 -8.010 6.067 9.83 -0.0042 880.6 124.6 8.05 0.824
 0.700 -8.024 5.534 12.79 0.0138 859.5 130.7 8.65 0.802
 0.800 -7.995 4.919 16.68 0.0146 825.5 132.6 9.13 0.769
 0.900 -7.946 4.148 21.90 0.0165 771.1 136.8 10.06 0.714
 0.950 -7.936 3.645 25.22 0.0071 734.5 141.9 10.93 0.678
 1.000 -7.941 2.971 28.21 0.0136 689.8 149.3 12.22 0.635

IN ROTOR
 VABS MABS
 821.0 0.759
 828.1 0.767
 837.6 0.778
 860.4 0.802
 875.9 0.819
 888.9 0.833
 895.8 0.839
 889.4 0.832
 869.4 0.812
 836.1 0.778
 783.1 0.726
 748.1 0.691
 705.7 0.650

SL BLDLCK PS PT YT BETAM VREL MREL VABS MABS
 1 0.933 11.161 16.356 542.4 59.87 1624.6 1.502 821.0 0.759
 2 0.932 11.093 16.382 541.6 59.11 1602.8 1.485 828.1 0.767
 3 0.931 10.987 16.392 540.7 58.25 1582.2 1.469 837.6 0.778
 4 0.927 10.767 16.459 539.8 56.24 1539.6 1.436 860.4 0.802
 5 0.921 10.616 16.507 539.0 54.27 1491.3 1.395 875.9 0.819
 6 0.912 10.569 16.658 539.6 52.00 1434.3 1.343 888.9 0.833
 7 0.898 10.612 16.837 540.7 49.51 1368.4 1.282 895.8 0.839
 8 0.882 10.740 16.916 540.9 47.05 1292.5 1.209 889.4 0.832
 9 0.863 10.924 16.854 540.0 44.54 1206.0 1.126 869.4 0.812
 10 0.840 11.155 16.654 537.9 41.69 1105.6 1.029 836.1 0.778
 11 0.813 11.540 16.388 535.4 37.66 974.1 0.902 783.1 0.726
 12 0.781 11.785 15.222 533.9 34.32 889.3 0.821 748.1 0.691
 13 0.735 12.029 15.981 531.8 28.53 785.1 0.723 705.7 0.650

STA 12.000 MASS AVERAGED PROPERTIES
 PT= 16.585 TT= 539.12 GAMMA=1.4018 PT-RAT= 1.129 TT-RAT= 1.039
 RCU= 694.0 VM= 842.1 CZ= 824.3 MM=0.785 MABS=0.792 MREL=1.231

ROTOR1 STA= 12 500 AFLOW= 162.22 D-C=O. D-H=O.
 WTF= 61.365 I=10 MTIP=118 OPTYPE=PT INBR=3 ARC=O. ABH=O.
 PSIC 7 556 8.500 0. 0. 7.2.8 150 5 11 02 0.701
 0 050 -7 565 8.322 -0.33 -0.0071 786.2 158 1 11.37 0.714
 0.100 -7 576 8.143 -0.20 0.0072 796.0 162.6 11.54 0.724
 0.200 -7 605 7.780 0.95 0.0255 816.8 168.2 11.64 0.745
 0.300 -7 635 7.402 2.80 0.0279 832.7 170 6 11.58 0.763
 0.400 -7 664 7.005 4.93 0.0278 849.9 178 2 11.84 0.781
 0.500 -7 692 6.580 7.18 0.0292 866.3 190.3 12.39 0.798
 0.600 -7 719 6.117 9.63 0.0284 873.0 201 6 13.00 0.806
 0.700 -7 724 5.602 12.52 0.0166 864.3 212.4 13.81 0.798
 0.800 -7 690 5.009 16.31 0.0252 844.4 226.0 14.99 0.779
 0.900 -7 645 4.268 21.60 0.0155 804.2 241 6 16.72 0.740
 0.950 -7 641 3.784 25.11 0.0046 767.0 242.9 17.57 0.705
 1.000 -7 658 3.123 28.51 -0.0461 708.3 236.3 18.45 0.650

IN ROTOR
 CU ALPHAM MM
 150 5 11 02 0.701
 158 1 11.37 0.714
 162.6 11.54 0.724
 168.2 11.64 0.745
 170 6 11.58 0.763
 178 2 11.84 0.781
 190.3 12.39 0.798
 201 6 13.00 0.806
 212.4 13.81 0.798
 226.0 14.99 0.779
 241 6 16.72 0.740
 242.9 17.57 0.705
 236.3 18.45 0.650

SL BLD8LK PS PT TT BETAM VREL MREL VABS MABS
 1 0.911 12.361 17.377 556.4 60.20 1555.1 1.411 787.3 0.715
 2 0.911 12.372 17.616 557.4 59.04 1528.2 1.388 801.9 0.728
 3 0.909 12.367 17.760 557.7 58.01 1502.7 1.367 812.5 0.739
 4 0.905 12.274 18.020 557.2 55.86 1455.5 1.328 834.0 0.761
 5 0.898 12.135 18.118 555.9 53.75 1408.2 1.290 850.0 0.778
 6 0.887 11.998 18.256 555.4 51.22 1357.1 1.247 868.4 0.798
 7 0.869 11.865 18.404 555.6 48.26 1301.2 1.198 886.9 0.817
 8 0.850 11.764 18.432 555.0 45.16 1238.2 1.143 896.0 0.827
 9 0.828 11.778 18.357 553.7 41.92 1161.6 1.072 890.0 0.822
 10 0.803 11.862 18.207 552.0 37.92 1070.4 0.988 874.1 0.806
 11 0.765 12.029 17.869 549.0 32.46 953.1 0.878 839.7 0.773
 12 0.736 12.150 17.482 545.7 28.98 876.8 0.806 804.5 0.740
 13 0.683 12.325 16.876 540.4 23.96 775.1 0.711 746.7 0.685

STA 12.500 MASS AVERAGED PROPERTIES
 PT= 18.062 TT= 554.06 GAMMA=1.4017 PT-RAT= 1.229 TT-RAT= 1.068
 RCU= 1201.5 VM= 829.4 CZ= 811.6 MM=0.761 MABS=0.783 MREL=1.158

ROTOR1 STA= 13.000
 MTIP=131 AFLOW= 155.41 IN ROTOR D*H=O.
 WTF= 61.365 OPTX=TT I TYPE=5 INBR=3 ABC=O. ABH=O.
 PSIC Z R CURV VM CU ALPHAM MM
 0.050 -7.352 8.500 0.0362 739.5 206.0 15.57 0.661
 0.100 -7.354 8.142 -0.51 758.4 214.9 15.82 0.678
 0.200 -7.366 7.783 0.51 807.8 229.6 15.87 0.728
 0.300 -7.381 7.414 2.34 827.9 232.6 15.70 0.749
 0.400 -7.396 7.027 4.45 847.2 239.8 15.81 0.770
 0.500 -7.412 6.614 6.73 866.3 254.0 16.34 0.790
 0.600 -7.428 6.166 9.19 876.2 269.5 17.10 0.801
 0.700 -7.424 5.667 12.13 876.7 285.4 18.03 0.803
 0.800 -7.386 5.097 15.93 864.2 302.3 19.28 0.793
 0.900 -7.344 4.386 21.44 837.5 320.1 20.92 0.769
 0.950 -7.346 3.922 25.25 -0.0194 806.1 321.7 21.76 0.740
 1.000 -7.375 3.281 29.92 -0.1052 732.5 318.7 23.51 0.670

SL ELDBLK PS PT TT BETAM VREL MREL VABS MABS
 1 0.893 13.454 18.431 570.2 60.25 1490.4 1.331 767.7 0.686
 2 0.893 13.446 18.742 571.3 58.82 1465.0 1.310 788.3 0.705
 3 0.892 13.392 18.981 571.7 57.44 1442.4 1.293 807.1 0.723
 4 0.887 13.236 19.345 571.3 54.77 1400.3 1.261 839.8 0.756
 5 0.879 13.059 19.489 569.4 52.42 1357.4 1.228 859.9 0.778
 6 0.866 12.874 19.630 568.3 49.73 1310.8 1.191 880.5 0.800
 7 0.847 12.690 19.804 568.1 46.51 1258.8 1.148 902.8 0.823
 8 0.826 12.541 19.873 567.6 43.05 1199.0 1.096 916.7 0.838
 9 0.803 12.421 19.817 566.3 39.19 1131.1 1.036 922.0 0.844
 10 0.778 12.351 19.608 564.0 34.64 1050.5 0.963 915.6 0.840
 11 0.740 12.251 19.126 560.0 28.46 952.7 0.875 896.6 0.823
 12 0.705 12.240 18.609 555.8 24.68 887.1 0.815 867.9 0.797
 13 0.656 12.504 17.848 549.5 19.56 777.4 0.711 798.8 0.731

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STA 13.000 MASS AVERAGED PROPERTIES
 PT= 19.385 TT= 566.74 GAMMA=1.4016 PT-RAT= 1.319 TT-RAT= 1.093
 RCU= 1632.4 VM= 832.7 CZ= 814.7 MM=0.757 MABS=0.794 MREL=1.112

ROTOR1 STA= 13.500
 WTF= 61.365 I=12 MTIP=144 AFLOW= 151.01 D+C=O. D+H=O.
 PSIC Z OPTX=TT OPTY=PT PHI CURV VM CU ALPHAM MM ABH=O.
 0. -7.148 8.500 0. 0. 699.2 250.1 19.68 0.616
 0.050 -7.138 8.318 -0.64 -0.0152 723.6 266.2 20.19 0.638
 0.100 -7.132 8.139 -0.74 -0.0099 745.3 281.3 20.67 0.658
 0.200 -7.128 7.784 0.10 0.0221 780.3 298.8 20.96 0.692
 0.300 -7.128 7.423 1.83 0.0369 801.4 302.4 20.68 0.714
 0.400 -7.129 7.047 3.94 0.0332 820.9 308.1 20.57 0.735
 0.500 -7.132 6.646 6.23 0.0358 842.0 321.6 20.90 0.757
 0.600 -7.137 6.212 8.73 0.0302 856.4 335.3 21.38 0.774
 0.700 -7.124 5.731 11.74 0.0175 865.1 355.5 22.34 0.784
 0.800 -7.081 5.183 15.81 -0.0043 858.8 379.9 23.86 0.781
 0.900 -7.043 4.505 21.58 -0.0167 833.7 406.0 25.97 0.760
 0.950 -7.051 4.062 25.78 -0.0379 813.3 409.8 26.74 0.743
 1.000 -7.092 3.450 31.86 -0.0937 763.0 402.5 27.81 0.697

SL BLDCLK PS PT TT BETAM VREL MREL VABS MABS
 1 0.885 14.467 19.294 581.2 60.78 1432.2 1.262 742.6 0.654
 2 0.885 14.518 19.792 583.8 58.95 1402.8 1.237 771.0 0.680
 3 0.884 14.557 20.260 586.0 57.17 1374.7 1.214 796.6 0.703
 4 0.880 14.522 20.913 587.1 54.02 1328.2 1.177 835.6 0.741
 5 0.871 14.354 21.116 584.7 51.50 1287.4 1.147 856.6 0.763
 6 0.857 14.133 21.236 582.6 48.73 1244.5 1.114 876.8 0.785
 7 0.837 13.873 21.382 581.6 45.31 1197.4 1.077 901.4 0.811
 8 0.815 13.580 21.361 580.0 41.62 1145.6 1.035 919.7 0.831
 9 0.793 13.320 21.326 578.6 37.16 1085.6 0.984 935.3 0.848
 10 0.768 13.137 21.157 576.6 31.91 1011.7 0.920 939.1 0.854
 11 0.737 12.929 20.634 572.5 25.01 920.0 0.838 927.3 0.845
 12 0.699 12.703 20.000 567.7 20.68 869.4 0.794 910.7 0.832
 13 0.650 12.586 18.978 559.6 15.13 790.5 0.723 862.7 0.789

STA 13.500 MASS AVERAGED PROPERTIES
 PT= 20.856 TT= 580.12 GAMMA=1.4015 PT-RAT= 1.419 TT-RAT= 1.118
 RCU= 2087.5 VM= 814.3 CZ= 796.2 MM=0.732 MABS=0.791 MREL=1.051

ROTOR 1		STA= 14.000										IN ROTOR									
WTF= 61.365		I=13		MTIP=157		AFLOW=		147 59		D+C=0		D+H=0.		ABH=0.		D+H=0.		ABH=0.		D+H=0.	
PSIC		Z		OPTX=TT		DPTV=PT		CURV		VM		CU		ALPHAM		MM		ALPHAM		MM	
0.		-6.945		8.500		0.		0.		668.1		294.3		23.77		0.582		23.77		0.582	
0.050		-6.925		8.316		-0.44		-0.0172		697.4		313.9		24.23		0.608		24.23		0.608	
0.100		-6.910		8.137		-0.54		-0.0213		721.9		331.3		24.65		0.630		24.65		0.630	
0.200		-6.889		7.784		0.06		-0.0160		762.8		358.5		25.17		0.668		25.17		0.668	
0.300		-6.874		7.430		1.49		0.0086		783.9		368.5		25.18		0.690		25.18		0.690	
0.400		-6.862		7.064		3.44		0.0312		802.2		374.8		25.04		0.710		25.04		0.710	
0.500		-6.853		6.675		5.69		0.0309		819.8		384.3		25.11		0.729		25.11		0.729	
0.600		-6.846		6.255		8.29		0.0218		834.5		399.7		25.59		0.745		25.59		0.745	
0.700		-6.824		5.792		11.52		0.0076		844.0		422.2		26.57		0.757		26.57		0.757	
0.800		-6.777		5.269		15.87		-0.0017		850.1		455.7		28.19		0.766		28.19		0.766	
0.900		-6.742		4.625		22.01		-0.0293		832.9		484.6		30.19		0.754		30.19		0.754	
0.950		-6.756		4.207		26.51		-0.0396		813.6		492.1		31.17		0.739		31.17		0.739	
1.000		-6.809		3.632		33.48		-0.0749		784.6		490.0		31.99		0.716		31.99		0.716	

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SL BLDLCK PS PT TT BETAM VREL MREL VABS MABS

1 0.878 15.368 20.180 592.3 61.01 1378.5 1.201 730.0 0.636

2 0.879 15.433 20.801 595.5 58.85 1348.1 1.176 764.8 0.667

3 0.878 15.488 21.364 598.0 56.83 1319.6 1.152 794.3 0.694

4 0.874 15.536 22.326 600.8 53.08 1269.8 1.113 842.9 0.739

5 0.867 15.470 22.736 599.2 50.26 1226.0 1.079 866.1 0.762

6 0.853 15.266 22.896 596.6 47.38 1184.7 1.048 885.4 0.783

7 0.834 14.966 22.935 594.2 44.07 1141.1 1.015 905.4 0.805

8 0.814 14.629 22.911 592.2 40.16 1091.9 0.975 925.2 0.827

9 0.793 14.303 22.869 590.6 35.41 1035.5 0.929 943.7 0.847

10 0.770 13.928 22.803 589.3 29.15 973.4 0.877 964.5 0.869

11 0.739 13.499 22.174 584.6 21.71 896.5 0.812 963.6 0.872

12 0.711 13.196 21.469 579.6 17.11 851.2 0.773 950.8 0.863

13 0.662 12.751 20.324 571.1 10.89 799.0 0.729 925.0 0.844

STA 14.000 MASS AVERAGED PROPERTIES

PT= 22.329 TT= 592.83 GAMMA=1.4014 PT-RAT= 1.519 TT-RAT= 1.143

RCU= 2520.0 VM= 798.2 CZ= 779.7 MM=0.710 MABS=0.794 MREL=0.997

ROTOR1 STA= 15.000 AFLOW= 144 66 D+C=O. IN ROTOR
 WTF= 61.365 I=15 MTIP=183 OPTV=PT PHI CURV VM CU ALPHAM MM
 PSIC Z OPTX-TT R
 0. -6.538 8.500 0. -0.0008 591.4 462.9 38.05 0.498
 0.050 -6.499 8.314 -0.24 -0.0008 623.6 474.5 37.27 0.526
 0.100 -6.466 8.135 -0.20 0.0105 651.1 483.4 36.59 0.552
 0.200 -6.411 7.786 0.36 0.0094 698.2 493.1 35.23 0.596
 0.300 -6.367 7.443 1.47 -0.0059 727.7 497.9 34.38 0.626
 0.400 -6.327 7.093 3.18 -0.0131 747.9 505.1 34.04 0.647
 0.500 -6.293 6.728 5.43 -0.0155 760.5 516.0 34.16 0.661
 0.600 -6.264 6.338 8.20 -0.0184 769.9 533.9 34.74 0.672
 0.700 -6.224 5.914 11.73 -0.0252 778.0 559.6 35.73 0.683
 0.800 -6.168 5.445 16.47 -0.0297 789.1 596.9 37.10 0.697
 0.900 -6.140 4.876 23.49 -0.0524 799.4 643.9 38.85 0.713
 0.950 -6.166 4.515 28.62 -0.0427 806.9 670.8 39.74 0.724
 1.000 -6.243 4.026 36.12 -0.0570 815.4 710.2 41.06 0.740

SL BLOBLK PS PT TT BETAM VREL MREL VABS MABS
 1 0.883 18.167 23.777 634.3 60.31 1193.9 1.005 751.0 0.632
 2 0.885 18.200 24.416 634.6 57.87 1172.3 0.990 783.5 0.662
 3 0.886 18.188 24.943 634.3 55.64 1153.5 0.977 810.9 0.687
 4 0.883 18.058 25.738 631.6 51.60 1124.1 0.960 854.8 0.730
 5 0.878 17.871 26.154 627.6 48.26 1093.0 0.940 881.7 0.758
 6 0.868 17.658 26.407 624.0 44.95 1056.8 0.914 902.5 0.780
 7 0.855 17.386 26.477 620.8 41.44 1014.4 0.882 919.0 0.799
 8 0.842 17.031 26.448 618.2 37.21 966.7 0.844 936.9 0.818
 9 0.829 16.599 26.390 616.0 31.89 916.3 0.804 958.3 0.841
 10 0.817 15.980 26.295 614.3 24.76 869.0 0.768 989.4 0.874
 11 0.795 15.007 25.810 611.0 15.16 828.3 0.738 1026.5 0.915
 12 0.778 14.247 25.244 607.8 8.87 816.7 0.733 1049.4 0.942
 13 0.746 13.168 24.388 602.8 0.01 815.4 0.740 1081.4 0.981

STA 15.000 MASS AVERAGED PROPERTIES
 PT= 25.878 TT= 621.69 GAMMA=1.4010 PT-RAT= 1.761 TT-RAT= 1.199
 RCU= 3503.1 VM= 742.6 CZ= 722.7 MM=0.646 MABS=0.801 MREL=0.870

ROTOR1 STA= 15.500 AFLOW= 145.33 D+C=0. D+H=0.
 WTF= 61.365 I=16 MTIP=196 OPTX=TT PTY=PT INBR=3 ABC=0. ABH=0.
 PSIC Z R PHI CURV VM CU ALPHAM MM
 0. -6.334 8.500 0. 0. 555.4 541.4 44.27 0.461
 0.050 -6.286 8.313 -0.42 0.0300 590.8 543.3 42.60 0.493
 0.100 -6.243 8.133 -0.37 0.0175 620.0 544.0 41.26 0.520
 0.200 -6.172 7.788 0.38 -0.0120 668.8 547.4 39.30 0.565
 0.300 -6.113 7.450 1.73 -0.0304 698.3 552.3 38.34 0.595
 0.400 -6.060 7.109 3.58 -0.0390 716.9 559.6 37.98 0.614
 0.500 -6.013 6.756 5.90 -0.0432 726.3 570.6 38.16 0.625
 0.600 -5.973 6.381 8.74 -0.0461 731.7 588.7 38.82 0.633
 0.700 -5.925 5.978 12.33 -0.0437 738.3 614.7 39.78 0.642
 0.800 -5.864 5.536 17.11 -0.0415 750.3 651.7 40.98 0.657
 0.900 -5.838 5.010 24.18 -0.0203 777.8 704.3 42.16 0.688
 0.950 -5.871 4.679 29.48 -0.0461 797.1 740.3 42.88 0.711
 1.000 -5.960 4.235 36.53 0.015R 837.9 799.8 43.67 0.759

IN ROTOR
 VABS MABS
 1 0.900 19.348 25.568 653.9 59.91 1107.8 0.920 775.6 0.644
 2 0.902 19.302 26.071 651.4 57.40 1096.5 0.915 802.6 0.670
 3 0.902 19.224 26.464 648.7 55.18 1085.7 0.910 824.8 0.691
 4 0.900 19.070 27.205 644.0 51.03 1063.4 0.899 864.3 0.731
 5 0.897 18.920 27.694 639.6 47.51 1033.8 0.880 890.3 0.758
 6 0.891 18.743 27.994 635.6 44.11 997.3 0.855 909.4 0.779
 7 0.883 18.504 28.080 632.0 40.56 957.9 0.823 923.6 0.795
 8 0.876 18.170 27.050 629.1 36.29 907.3 0.785 939.1 0.812
 9 0.870 17.709 27.985 626.7 30.81 859.6 0.747 960.7 0.835
 10 0.864 17.014 27.876 624.8 23.44 817.8 0.716 993.8 0.870
 11 0.849 15.752 27.505 622.4 13.02 798.3 0.707 1049.3 0.929
 12 0.833 14.800 27.101 620.5 6.12 801.7 0.715 1087.8 0.971
 13 0.807 13.228 26.566 618.3 -3.58 839.6 0.761 1158.4 1.049

STA 15.500 MASS AVERAGED PROPERTIES
 PT= 27.493 TT= 633.92 GAMMA=1.4008 PT-RAT= 1.871 TT-RAT= 1.222
 RCU= 3920.2 VM= 712.1 CZ= 691.3 MM=0.614 MABS=0.804 MREL=0.815

ROTOR1 STA= 16.000 AFLOW= 148.37 D+C=0. D+H=0. ABH=0.
 WTF= 61.365 OPTX=TT I=17 MTIP=209 OPTV=PT PHI CURV VM CU ALPHAM MM
 PSIC Z R
 0 -6.131 8.500 0. 0. 517.5 583.6 48.43 0.426
 0.050 -6.073 8.311 -0.32 -0.0452 561.1 585.7 46.23 0.465
 0.100 -6.021 8.132 -0.07 -0.0653 591.7 586.5 44.75 0.492
 0.200 -5.933 7.790 1.05 -0.0864 639.5 589.9 42.69 0.537
 0.300 -5.859 7.459 2.62 -0.0914 665.7 594.5 41.77 0.562
 0.400 -5.792 7.127 4.52 -0.0832 680.4 601.6 41.48 0.578
 0.500 -5.733 6.787 6.79 -0.0673 685.4 612.2 41.77 0.585
 0.600 -5.682 6.428 9.52 -0.0464 686.7 629.9 42.53 0.589
 0.700 -5.625 6.045 12.89 -0.0193 691.6 655.1 43.45 0.596
 0.800 -5.559 5.631 17.24 0.0282 704.9 690.5 44.41 0.612
 0.900 -5.537 5.146 23.63 0.0784 725.0 746.5 45.84 0.635
 0.950 -5.576 4.846 28.25 0.1725 754.4 791.9 46.39 0.667
 1.000 -5.677 4.442 35.49 0.0883 779.2 870.1 48.16 0.698

SL BLDLCK PS PT TT BETAM VREL MREL VABS MABS
 1 0.926 20.126 26.560 664.4 60.55 1052.4 0.867 780.0 0.642
 2 0.927 20.046 27.120 661.7 57.51 1044.4 0.865 811.1 0.672
 3 0.927 19.990 27.560 658.8 55.11 1034.5 0.861 833.1 0.693
 4 0.927 19.913 28.390 653.7 50.82 1012.4 0.850 870.0 0.730
 5 0.928 19.848 28.940 649.0 47.31 981.8 0.830 892.6 0.754
 6 0.928 19.745 29.280 644.7 43.96 945.2 0.803 908.2 0.772
 7 0.928 19.563 29.380 640.8 40.50 901.4 0.770 919.0 0.785
 8 0.928 19.266 29.350 637.7 36.30 852.0 0.731 931.9 0.799
 9 0.928 18.799 29.280 635.1 30.77 804.8 0.694 952.6 0.821
 10 0.928 18.054 29.160 633.0 23.28 767.4 0.666 986.7 0.856
 11 0.930 16.873 28.920 631.6 12.56 742.8 0.651 1040.6 0.912
 12 0.914 15.782 28.770 631.5 4.80 757.1 0.669 1093.7 0.967
 13 0.875 14.331 28.650 632.3 -6.32 783.9 0.702 1168.0 1.046

STA 16.000 MASS AVERAGED PROPERTIES
 PT= 28.783 TT= 643.26 GAMMA=1.4006 PT-RAT= 1.959 TT-RAT= 1.240
 RCU= 4238.7 VM= 672.4 CZ= 653.1 MM=0.575 MABS=0.796 MREL=0.764

AVERAGE BLADE SPEED ACC PT ACC TT EFFICIENCY AXIAL
 PCT IMM RAD IN OUT RATIO RATIO AD. POLY VEL R
 0. 8.500 1500.0 1500.0 1.8073 1.2809 0.656 0.683 0.621
 3.7 8.316 1468.6 1466.7 1.8454 1.2757 0.694 0.719 0.672
 7.4 8.136 1436.4 1435.1 1.8753 1.2701 0.729 0.752 0.708
 14.6 7.776 1369.7 1374.7 1.9318 1.2603 0.796 0.814 0.765
 22.0 7.410 1299.2 1316.2 1.9692 1.2512 0.851 0.864 0.802
 29.7 7.031 1223.9 1257.8 1.9924 1.2429 0.897 0.906 0.831
 37.7 6.631 1142.6 1197.6 1.9992 1.2354 0.930 0.937 0.859
 46.5 6.198 1053.1 1134.3 1.9971 1.2294 0.953 0.957 0.896
 56.1 5.721 952.4 1066.8 1.9924 1.2244 0.971 0.973 0.957
 67.0 5.183 835.6 993.8 1.9842 1.2204 0.982 0.984 1.049
 80.3 4.525 688.9 908.0 1.9679 1.2177 0.981 0.983 1.186
 88.8 4.103 593.0 855.2 1.9577 1.2175 0.974 0.976 1.321
 100.0 3.547 468.2 783.8 1.9495 1.2190 0.960 0.964 1.338

FREE STA= 17.000
 WTF= 61.365 I=18 MTIP=222 AFLOW= 146.27 D=C=O. FREE
 PSIC Z OPTX=DPP PHI CURV VM CU ALPHAM MM
 0. -5.700 8.500 0. 0. 509.5 583.6 48.88 0.419
 0.050 -5.639 8.313 0.81 -0.0461 560.1 585.6 46.27 0.464
 0.100 -5.586 8.138 1.56 -0.0653 594.9 586.1 44.57 0.495
 0.200 -5.498 7.806 3.02 -0.0720 650.1 588.7 42.16 0.546
 0.300 -5.429 7.486 4.50 -0.0611 681.6 592.4 40.99 0.577
 0.400 -5.374 7.167 6.07 -0.0455 701.4 598.3 40.46 0.597
 0.500 -5.332 6.839 7.86 -0.0248 710.5 607.5 40.53 0.608
 0.600 -5.305 6.494 10.03 0.0002 714.3 623.5 41.12 0.614
 0.700 -5.294 6.122 12.78 0.0300 718.4 646.9 42.00 0.621
 0.800 -5.304 5.709 16.53 0.0643 721.5 681.1 43.35 0.627
 0.900 -5.350 5.225 22.35 0.1421 728.6 735.1 45.25 0.638
 0.950 -5.405 4.934 26.15 0.2095 742.8 777.7 46.32 0.655
 1.000 -5.521 4.550 33.90 0.2101 729.7 849.4 49.34 0.648

SL BLDLCK PS PT TT BETAM VREL MREL VABS MABS
 1 0.940 20.185 26.533 664.4 60.93 1048.5 0.863 774.7 0.638
 2 0.940 20.037 27.093 661.7 57.5 1044.3 0.865 810.4 0.671
 3 0.940 19.937 27.532 658.8 55.01 1037.5 0.863 835.1 0.695
 4 0.940 19.794 28.390 653.7 50.51 1022.2 0.859 877.0 0.737
 5 0.940 19.661 28.940 649.0 46.91 997.8 0.844 903.1 0.764
 6 0.940 19.496 29.280 644.7 43.54 967.6 0.824 921.9 0.785
 7 0.940 19.273 29.380 640.8 40.15 929.6 0.795 934.8 0.800
 8 0.940 18.964 29.350 637.7 36.18 884.9 0.761 948.1 0.815
 9 0.940 18.534 29.280 635.1 31.10 839.0 0.725 966.8 0.835
 10 0.940 17.952 29.160 633.0 24.35 791.9 0.688 992.2 0.862
 11 0.940 16.979 28.920 631.6 14.40 752.2 0.659 1035.0 0.906
 12 0.940 16.127 28.770 631.5 7.14 748.6 0.660 1075.4 0.948
 13 0.940 15.192 28.564 632.3 -3.65 731.1 0.649 1119.8 0.994

STA 17.000 MASS AVERAGED PROPERTIES
 PT= 28.777 TT= 643.26 GAMMA=1.4006 PT-RAT= 1.958 TT-RAT= 1.240
 RCU= 4238.7 VM= 685.2 CZ= 666.9 MM=0.586 MABS=0.802 MREL=0.778

STATOR STA= 18.000 AFLOW= 141.60 D+C=O. LE STATOR
 WTF= 61.365 MTIP=235 OPTV=FREE ITYPE=1 INSR=4 ABC=O. D+H=O.
 PSIC Z R PHI CURV VM CU ALPHAM MM
 0 -5.250 8.500 0. 0. 552.0 583.6 46.60 0.456
 0 050 -5.192 8.323 1.46 -0.0051 591.7 584.9 44.67 0.491
 0 100 -5.143 8.155 2.54 -0.0117 621.7 584.8 43.25 0.518
 0 200 -5.063 7.835 4.18 -0.0203 674.0 586.5 41.03 0.567
 0 300 -5.003 7.525 5.53 -0.0230 706.9 589.3 39.82 0.599
 0 400 -4.962 7.215 6.88 -0.0233 729.3 594.3 39.18 0.622
 0 500 -4.938 6.896 8.38 -0.0212 741.8 602.5 39.08 0.637
 0 600 -4.933 6.560 10.22 -0.0175 749.4 617.2 39.48 0.646
 0 700 -4.953 6.198 12.60 -0.0118 757.0 639.0 40.17 0.656
 0 800 -5.004 5.796 15.90 0.0056 764.0 670.9 41.29 0.666
 0 900 -5.108 5.321 21.07 0.0285 767.9 721.9 43.23 0.674
 0 950 -5.201 5.029 24.63 0.0260 755.5 763.0 45.28 0.666
 1 000 -5.375 4.643 31.23 0.3271 798.9 832.3 46.17 0.713

SL BLDLCK PS PT TT BETAM VREL MREL VABS MABS
 1 0.940 19.756 26.533 664.4 58.94 1069.8 0.883 803.3 0.663
 2 0.940 19.698 27.093 661.7 56.20 1063.6 0.883 832.0 0.691
 3 0.940 19.639 27.532 658.8 53.96 1056.6 0.881 853.5 0.712
 4 0.940 19.511 28.390 653.7 49.75 1043.1 0.878 893.5 0.752
 5 0.940 19.353 28.940 649.0 46.26 1022.3 0.867 920.3 0.780
 6 0.940 19.150 29.280 644.7 42.95 996.3 0.850 940.8 0.803
 7 0.940 18.886 29.380 640.8 39.63 963.2 0.827 955.7 0.820
 8 0.940 18.539 29.350 637.7 35.79 923.9 0.797 970.9 0.837
 9 0.940 18.086 29.280 635.1 30.99 883.1 0.765 990.6 0.859
 10 0.940 17.487 29.160 633.0 24.73 841.2 0.733 1016.8 0.887
 11 0.940 16.620 28.920 631.6 15.78 798.0 0.701 1054.0 0.926
 12 0.940 16.160 28.770 631.5 9.36 765.7 0.675 1073.7 0.946
 13 0.940 14.557 28.564 632.3 -0.92 799.0 0.713 1153.6 1.030

STA 18.000 MASS AVERAGED PROPERTIES
 PT= 28.777 TT= 643.26 GAMMA=1.4007 PT-RAT= 1.958 TT-RAT= 1.240
 RCU= 4238.7 VM= 717.6 CZ= 699.6 MM=O 616 MABS=O 821 MREL=O 808

STATOR STA= 19.000
 WTF= 61.365 I=20 MTIP=248 AFLOW= 126.04 IN STATOR D=C=O. D=H=O.
 PSI= 61.365 OPTX=DPP PHI= 0.000 OPIY=BETM ITYPE=2 INBR=4 ABC=O. ABH=O.
 PSIC Z R CURV VM CU ALPHAM MM
 0. -4.770 8.500 0. 0. 615 2 375.8 31.42 0.504
 0.050 -4.723 8.335 1.11 0.0316 644.1 384 8 30.86 0.530
 0.100 -4.683 8.175 2.03 0.0506 667.5 391.3 30.38 0.552
 0.200 -4.616 7.868 3.58 0.0670 712.4 406.2 29.69 0.594
 0.300 -4.566 7.568 4.97 0.0675 744.1 417.3 29.29 0.626
 0.400 -4.532 7.267 6.40 0.0622 767.6 427.8 29.13 0.650
 0.500 -4.512 6.959 7.99 0.0529 783.0 437.9 29.22 0.667
 0.600 -4.508 6.637 9.88 0.0445 796.1 450.4 29.50 0.681
 0.700 -4.524 6.293 12.21 0.0431 812.2 469.8 30.05 0.699
 0.800 -4.565 5.919 15.21 0.0474 833.2 499.3 30.93 0.722
 0.900 -4.641 5.495 19.44 0.0857 863.5 540.7 32.05 0.754
 0.950 -4.696 5.253 22.40 0.1150 888.3 568.3 32.61 0.780
 1.000 -4.770 4.975 26.23 0.1265 919.4 606.2 33.40 0.813

SL BLDLCK PS PT TT BETAM VREL MREL VABS MABS
 1 0.875 20.965 26.533 664.4 61.31 1281.5 1.049 720.9 0.590
 2 0.877 20.953 27.093 661.7 59.33 1262.7 1.039 750.3 0.617
 3 0.878 20.908 27.532 658.8 57.59 1245.4 1.030 773.8 0.640
 4 0.879 20.754 28.390 653.7 54.04 1213.4 1.012 820.1 0.684
 5 0.880 20.539 28.940 649.0 50.98 1181.8 0.994 853.1 0.717
 6 0.881 20.274 29.280 644.7 48.07 1148.7 0.972 878.8 0.744
 7 0.880 19.963 29.380 640.8 45.26 1112.4 0.947 897.1 0.764
 8 0.880 19.582 29.350 637.7 42.16 1073.9 0.919 914.7 0.783
 9 0.878 19.066 29.280 635.1 38.27 1034.5 0.890 938.3 0.807
 10 0.875 18.343 29.160 633.0 33.20 995.8 0.862 971.3 0.841
 11 0.867 17.284 28.920 631.6 26.42 964.2 0.842 1018.8 0.890
 12 0.857 16.521 28.770 631.5 21.99 958.0 0.841 1054.5 0.926
 13 0.837 15.540 28.564 632.3 16.47 958.8 0.848 1101.3 0.974

STA 19.000 MASS AVERAGED PROPERTIES
 PT= 28.777 TT= 643.26 GAMMA=1.4005 PT-RAT= 1.958 TT-RAT= 1.240
 RCU= 3068.9 VM= 774.7 CZ= 757.3 MM=0.660 MABS=0.765 MREL=0.942

STATOR STA= 20.000
 WTF= 61.365 I=21 MTIP=261 AFLOW= 118.86 IN STATOR D*H=0.
 PSIC Z OPTX=DPP PHI CURV VM CU ALPHAM MM ABH=0.
 0.050 -4.300 8.500 0. 0. 655.1 262.3 21.82 0.536
 0.100 -4.277 8.341 0.65 0.0045 685.0 271.8 21.64 0.563
 0.200 -4.257 8.187 1.30 0.0093 707.3 278.4 21.49 0.584
 0.300 -4.225 7.888 2.63 0.0179 748.4 290.8 21.24 0.623
 0.400 -4.200 7.596 4.01 0.0240 775.0 298.0 21.03 0.650
 0.500 -4.184 7.303 5.49 0.0291 793.5 303.0 20.90 0.669
 0.600 -4.174 7.004 7.13 0.0358 804.2 306.5 20.86 0.682
 0.700 -4.173 6.693 9.01 0.0450 813.4 311.0 20.93 0.692
 0.800 -4.180 6.365 11.21 0.0560 825.9 319.5 21.15 0.706
 0.900 -4.199 6.015 13.89 0.0745 844.3 334.1 21.59 0.725
 0.950 -4.233 5.631 17.33 0.0855 869.3 354.8 22.20 0.750
 1.000 -4.261 5.420 19.55 0.0986 886.5 367.5 22.52 0.767
 1.000 -4.300 5.188 22.50 0.1259 908.2 383.9 22.91 0.789

SL BLOBLK PS PT TT BETAM VREL MREL VABS MABS
 1 0.849 21.180 26.533 664.4 62.11 1400.3 1.145 705.7 0.577
 2 0.851 21.151 27.093 661.7 60.28 1381.8 1.135 737.0 0.606
 3 0.852 21.118 27.532 658.8 58.77 1364.0 1.126 760.1 0.628
 4 0.855 21.037 28.390 653.7 55.80 1331.4 1.109 802.9 0.669
 5 0.857 20.932 28.940 649.0 53.37 1298.9 1.089 830.3 0.696
 6 0.859 20.796 29.280 644.7 51.17 1265.4 1.067 849.4 0.716
 7 0.860 20.621 29.380 640.8 49.13 1229.1 1.042 860.6 0.729
 8 0.860 20.380 29.350 637.7 46.93 1191.0 1.013 870.8 0.741
 9 0.858 20.034 29.280 635.1 44.22 1152.4 0.985 885.5 0.757
 10 0.855 19.515 29.160 633.0 40.74 1114.4 0.957 908.0 0.780
 11 0.847 18.772 28.920 631.6 36.31 1078.8 0.931 938.9 0.810
 12 0.840 18.292 28.770 631.5 33.59 1064.2 0.921 959.7 0.831
 13 0.828 17.689 28.564 632.3 30.34 1052.4 0.914 986.0 0.856

STA 20.000 MASS AVERAGED PROPERTIES
 PT= 28.777 TT= 643.26 GAMMA=1.4003 PT-RAT= 1.958 TT-RAT= 1.240
 RCU= 2143.5 VM= 756.4 CZ= 782.8 MM=0.674 MABS=0.724 MREL=1.035

STATOR
 WTF= 61.365 I=22 STA= 21.000
 PSIC Z R OPTX=OPP MTIP=274 AFLOW= 115.14
 PHI OPTY=BETM ITYPE=2 INBR=4 D+C=O. D+H=O.
 CURV VM CU ALPHAM MM ABH=O.

0.	-3.800	8.500	0.54	0.0029	703.2	170.1	14.20	0.549
0.050	-3.800	8.346	1.11	0.0051	726.1	175.6	14.02	0.577
0.100	-3.800	8.196	2.29	0.0101	767.8	185.7	13.86	0.599
0.200	-3.800	7.906	4.89	0.0168	793.8	191.7	13.59	0.639
0.300	-3.800	7.622	6.37	0.0247	811.5	192.7	13.41	0.665
0.400	-3.800	7.335	8.04	0.0341	828.7	193.7	13.29	0.683
0.500	-3.800	7.048	9.95	0.0449	838.4	196.7	13.21	0.694
0.600	-3.800	6.749	12.18	0.0572	850.9	203.4	13.16	0.703
0.700	-3.800	6.436	14.97	0.0715	867.3	212.9	13.20	0.714
0.800	-3.800	6.107	16.63	0.0980	879.9	217.7	13.44	0.727
0.900	-3.800	5.756	18.63	0.1116	894.5	222.6	13.79	0.744
0.950	-3.800	5.570		0.1266			13.90	0.756
1.000	-3.800	5.376					13.98	0.770

SL BLDRLK PS PT TT
 1 0.849 21.352 26.533 664.4
 2 0.850 21.330 27.093 661.7
 3 0.851 21.305 27.532 658.8
 4 0.853 21.249 28.390 653.7
 5 0.855 21.174 28.940 649.0
 6 0.856 21.069 29.280 644.7
 7 0.858 20.926 29.380 640.8
 8 0.858 20.734 29.350 637.7
 9 0.859 20.472 29.280 635.1
 10 0.858 20.118 29.160 633.0
 11 0.855 19.608 28.920 631.6
 12 0.854 19.263 28.770 631.5
 13 0.852 18.860 28.564 632.3

BETAM VREL MREL VABS MABS
 63.19 1490.1 1.217 693.3 0.566
 61.54 1475.5 1.211 724.8 0.595
 60.19 1460.5 1.204 747.9 0.617
 57.59 1432.6 1.191 790.0 0.657
 55.51 1402.1 1.174 816.1 0.683
 53.66 1369.5 1.153 833.8 0.702
 52.00 1333.7 1.128 843.5 0.712
 50.27 1296.6 1.101 851.0 0.722
 48.24 1258.9 1.072 861.2 0.734
 45.78 1220.0 1.043 874.8 0.748
 42.79 1181.9 1.014 893.0 0.766
 41.01 1166.1 1.002 906.5 0.779
 39.06 1152.0 0.991 921.8 0.793

STA 21.000 MASS AVERAGED PROPERTIES
 TT= 28.777 TT= 643.26 GAMMA=1.4003 PT-RAT= 1.958 TT-RAT= 1.240
 RCU= 1351.1 VM= 809.1 CZ= 798.8 MN=0.683 MABS=0.702 MREL=1.118

STA= 22.000
 MTIP=287 AFLOW= 114.72 D*C=0. IN STATOR D*H=0.
 WTF= 61.365 OPTX=PPP OPIY=BETM ITYPE=2 INBR=4 ABC=0. ABH=0.
 PSIC Z R CURV VM CU ALPHAM MM
 0. -3.204 8.500 0. 0. 553.5 83.7 7.19 0.541
 0.050 -3.211 8.351 0.55 -0.0032 695.3 86.3 7.08 0.569
 0.100 -3.218 8.207 1.05 -0.0017 718.2 87.8 6.97 0.591
 0.200 -3.232 7.927 2.01 0.0066 760.3 90.6 6.79 0.631
 0.300 -3.245 7.653 3.03 0.0155 786.5 91.8 6.66 0.657
 0.400 -3.259 7.380 4.13 0.0243 804.4 92.5 6.56 0.675
 0.500 -3.272 7.102 5.36 0.0329 813.9 92.5 6.48 0.686
 0.600 -3.287 6.815 6.74 0.0428 820.8 92.5 6.43 0.695
 0.700 -3.301 6.516 8.33 0.0546 829.6 93.4 6.43 0.704
 0.800 -3.316 6.203 10.35 0.0577 839.6 95.7 6.51 0.715
 0.900 -3.333 5.870 12.73 0.0642 847.5 98.8 6.65 0.723
 0.950 -3.341 5.695 13.99 0.0824 853.1 100.5 6.72 0.729
 1.000 -3.350 5.512 15.23 0.1249 862.9 102.5 6.77 0.737

STA 22.000 MASS AVERAGED PROPERTIES
 PT= 28.777 TT= 643.26 GAMMA=1.4002 PT-RAT= 1.958 TT-RAT= 1.240
 RCU= 653.5 VM= 798.5 CZ= 791.4 MM=0.672 MABS=0.676 MREL=1.183

STATOR		I=24		STA= 23 000		AFLOW= 118.17		TE STATOR	
WTF= 61.365		OPTX=DPP		MTIP=300		D*H=O.		D*H=O.	
PSIC		Z		PHI		CURV		INBR=4	
		R		O		VM		CU	
								ALPHAM	
								MM	
0.	-2.567	8.500	0	0	0	658.2	0.	0.	0.536
0.050	-2.581	8.357	0.49	0.0062	685.3	0.	0.	0.	0.560
0.100	-2.595	8.218	0.92	0.0090	702.9	0.	0.	0.	0.577
0.200	-2.622	7.947	1.68	0.0123	744.8	0.	0.	0.	0.616
0.300	-2.648	7.682	2.	0.0182	770.3	0.	0.	0.	0.642
0.400	-2.674	7.418	3.27	0.0266	788.1	0.	0.	0.	0.660
0.500	-2.700	7.150	4.20	0.0376	797.4	0.	0.	0.	0.671
0.600	-2.728	6.874	5.24	0.0503	803.0	0.	0.	0.	0.678
0.700	-2.756	6.588	6.44	0.0653	811.6	0.	0.	0.	0.687
0.800	-2.785	6.290	8.02	0.0936	831.2	0.	0.	0.	0.707
0.900	-2.816	5.976	9.88	0.1247	831.2	0.	0.	0.	0.708
0.950	-2.833	5.809	10.79	0.1318	831.2	0.	0.	0.	0.708
1.000	-2.850	5.631	11.52	0.1267	819.5	0.	0.	0.	0.696
SL		BLOBLK		PS		PT		TT	
								BETAM	
								VREL	
								MREL	
								VABS	
								MABS	
1	0.940	21.479	26.109	664.4	66.31	1638.1	1.333	658.2	0.536
2	0.940	21.481	26.581	661.7	65.08	1626.3	1.330	685.3	0.560
3	0.940	21.477	26.910	658.8	64.14	1611.6	1.323	702.9	0.577
4	0.940	21.460	27.731	653.7	62.03	1587.9	1.314	744.8	0.616
5	0.940	21.430	28.269	649.0	60.40	1559.2	1.299	770.3	0.642
6	0.940	21.375	28.639	644.7	58.95	1528.0	1.280	788.1	0.660
7	0.940	21.285	28.780	640.8	57.71	1492.6	1.256	797.4	0.671
8	0.940	21.149	28.769	637.7	56.50	1454.8	1.228	803.0	0.678
9	0.940	20.961	28.750	635.1	55.08	1417.8	1.200	811.6	0.687
10	0.940	20.672	28.851	633.0	53.17	1386.8	1.179	831.2	0.707
11	0.940	20.227	28.250	631.6	51.76	1342.8	1.143	831.2	0.707
12	0.940	19.945	27.860	631.5	50.96	1319.7	1.123	831.2	0.708
13	0.940	19.643	27.159	632.3	50.49	1288.1	1.094	819.5	0.696

STA 23.000 MASS AVERAGED PROPERTIES
 PT= 28.163 TT= 643.26 GAMMA=1.4001 PT-RAT= 1.916 TT-RAT= 1.24
 RCU= 0. VM= 782.5 CZ= 778.3 MM=0.657 MABS=0.657 MREL=1.244

AVERAGE		BLADE SPEED		ACC PT		ACC TT		EFFICIENCY		AXIAL	
PCT IMM RAD		IN OUT		RATIO		RATIO		AD.		POLY	
0.	8.500			1.7766	1.2809	0.635	0.663	1.192			
4.8	8.340			1.8087	1.2757	0.669	0.696	1.159			
9.3	8.187			1.8311	1.2701	0.699	0.723	1.132			
18.1	7.891			1.8870	1.2603	0.765	0.785	1.108			
26.7	7.604			1.9236	1.2512	0.818	0.834	1.094			
35.2	7.316			1.9488	1.2429	0.865	0.877	1.087			
43.9	7.023			1.9584	1.2354	0.900	0.909	1.084			
53.0	6.717			1.9576	1.2294	0.923	0.930	1.084			
62.7	6.393			1.9563	1.2244	0.942	0.948	1.092			
73.1	6.043			1.9632	1.2204	0.965	0.968	1.120			
84.8	5.648			1.9223	1.2177	0.944	0.949	1.143			
91.6	5.419			1.8957	1.2175	0.923	0.929	1.189			
100.0	5.137			1.8480	1.2190	0.876	0.887	1.175			

EXIT STA= 24.000
 WTF= 61.365 I=25 OPTX-DPP AFLOW= 116.57 D*H=O. D*H=O.
 PSIC Z R PHI OPTY=FREE ITYPE=O INBR=O ABC=O. ABH=O.
 0.050 -2.000 8.500 0.32 0.0039 675.8 0. 0. 0. 0.551
 0.100 -2.000 8.361 0.63 0.0080 702.5 0. 0. 0. 0.575
 0.200 -2.000 8.226 1.18 0.0158 719.8 0. 0. 0. 0.592
 0.300 -2.000 7.963 1.68 0.0233 761.6 0. 0. 0. 0.631
 0.400 -2.000 7.706 2.16 0.0312 788.0 0. 0. 0. 0.658
 0.500 -2.000 7.450 2.63 0.0401 807.2 0. 0. 0. 0.678
 0.600 -2.000 7.192 3.12 0.0509 817.9 0. 0. 0. 0.690
 0.700 -2.000 6.927 3.63 0.0643 824.8 0. 0. 0. 0.698
 0.800 -2.000 6.654 4.11 0.0792 834.7 0. 0. 0. 0.709
 0.900 -2.000 6.373 4.59 0.0997 853.9 0. 0. 0. 0.728
 0.950 -2.000 6.077 4.85 0.1151 850.6 0. 0. 0. 0.726
 1.000 -2.000 5.921 5.28 0.1260 848.4 0. 0. 0. 0.724
 1.000 -2.000 5.757 5.28 0.1260 835.4 0. 0. 0. 0.711

STA 24.000 MASS AVERAGED PROPERTIES
 PT= 28.163 TT= 643.26 GAMMA=1.4002 PT-RAT= 1.916 TT-RAT= 1.210
 RCU= 0. VM= 801.9 CZ= 800.8 MABS=0.674 MREL=1.261

EXIT STA= 25.000
 WTF= 61.365 I=26 MTIP=326 AFLOW= 116.27 D+C=O. FREE
 PSIC Z OPIX=OPP R PHI OPIY=FREE ITYPE=O INBR=O CU ALPHAM MM
 0. -1.270 8.500 0. 0. 0. 693.1 0. 0. 0.566
 0.050 -1.270 8.365 0.19 0.0025 718.9 0 0 0.590
 0.100 -1.270 8.232 0.36 0.0048 735.5 0 0 0.606
 0.200 -1.270 7.974 0.66 0.0092 775.4 0 0 0.644
 0.300 -1.270 7.722 0.91 0.0136 799.9 0 0 0.668
 0.400 -1.270 7.470 1.13 0.0180 816.7 0 0 0.686
 0.500 -1.270 7.216 1.32 0.0228 824.4 0 0 0.696
 0.600 -1.270 6.954 1.47 0.0280 827.3 0 0 0.700
 0.700 -1.270 6.684 1.58 0.0335 831.7 0 0 0.706
 0.800 -1.270 6.406 1.62 0.0398 843.0 0 0 0.718
 0.900 -1.270 6.112 1.54 0.0464 828.0 0 0 0.705
 0.950 -1.270 5.956 1.41 0.0493 817.6 0 0 0.695
 1.000 -1.270 5.790 0.00 0.1263 798.1 0 0 0.676

SL BLDLTK PS PT TT BETAM VREL MREL VABS MABS
 1 0.956 21.013 26.109 664.4 65.20 1652.4 1.349 693.1 0.566
 2 0.956 21.011 26.581 661.7 64.03 1641.8 1.347 718.9 0.590
 3 0.956 21.006 26.910 658.8 63.15 1628.3 1.341 735.5 0.606
 4 0.956 20.985 27.731 653.7 61.14 1606.7 1.334 775.4 0.644
 5 0.956 20.950 28.269 649.0 59.59 1580.0 1.320 799.9 0.668
 6 0.956 20.898 28.639 644.7 58.22 1550.7 1.303 816.7 0.686
 7 0.956 20.827 28.780 640.8 57.08 1516.9 1.280 824.4 0.696
 8 0.956 20.734 28.769 637.7 56.01 1480.1 1.253 827.3 0.700
 9 0.956 20.616 28.750 635.1 54.81 1443.3 1.225 831.7 0.706
 10 0.956 20.466 28.851 633.0 53.29 1410.1 1.201 843.0 0.718
 11 0.956 20.281 28.250 631.6 52.49 1359.7 1.157 828.0 0.705
 12 0.956 20.174 27.860 63.5 52.12 1331.6 1.132 817.6 0.695
 13 0.956 19.990 27.159 632.3 52.01 1296.5 1.099 798.1 0.676

STA 25.000 MASS AVERAGED PROPERTIES
 PT= 28.163 TT= 643.26 GAMMA=1.4002 PT-RAT= 1.916 TT-RAT= 1.240
 RCU= 0. VM= 803.2 CZ= 803.0 MM=0.675 MABS=0.675 MREL=1.264

EXIT STA= 26.000
 WTF= 61.365 I=27 MTIP=339 AFLOW= 116.28 D+C=O. D+H=O.
 PSIC Z OPTX=DPP PHI CURV VM CU ALPHAM MM ABH=O.
 0. -0.350 8.500 0. 0. 710.9 0. 0. 0. 0.581
 0.050 -0.350 8.367 0.11 0.0000 735.8 0. 0. 0. 0.605
 0.100 -0.350 8.236 0.21 -0.0000 751.6 0. 0. 0. 0.620
 0.200 -0.350 7.981 0.37 -0.0000 789.2 0. 0. 0. 0.656
 0.300 -0.350 7.731 0.49 -0.0000 811.0 0. 0. 0. 0.679
 0.400 -0.350 7.482 0.57 -0.0000 824.4 0. 0. 0. 0.693
 0.500 -0.350 7.229 0.61 -0.0000 827.9 0. 0. 0. 0.699
 0.600 -0.350 6.968 0.61 -0.0000 825.4 0. 0. 0. 0.698
 0.700 -0.350 6.698 0.54 -0.0000 822.9 0. 0. 0. 0.698
 0.800 -0.350 6.418 0.39 -0.0000 825.8 0. 0. 0. 0.702
 0.900 -0.350 6.120 0.11 -0.0000 799.3 0. 0. 0. 0.678
 0.950 -0.350 5.961 -0.10 -0.0000 781.7 0. 0. 0. 0.662
 1.000 -0.350 5.791 0. 0. 748.9 0. 0. 0. 0.631

SL BLOBLK PS PT TT BETAM VREL MREL VABS MABS
 1 0.956 20.769 26.109 664.4 64.64 1660.0 1.358 710.9 0.581
 2 0.956 20.768 26.581 661.7 63.51 1649.7 1.355 731.8 0.605
 3 0.956 20.768 26.910 658.8 62.66 1636.3 1.350 751.6 0.620
 4 0.956 20.767 27.731 653.7 60.73 1614.5 1.342 789.2 0.656
 5 0.956 20.768 28.269 649.0 59.27 1587.2 1.328 811.0 0.679
 6 0.956 20.768 28.639 644.7 58.02 1556.5 1.309 824.4 0.693
 7 0.956 20.768 28.780 640.8 57.02 1520.8 1.284 827.9 0.699
 8 0.956 20.767 28.769 637.7 56.13 1481.0 1.253 825.4 0.698
 9 0.956 20.767 28.750 635.1 55.15 1440.3 1.221 822.9 0.698
 10 0.956 20.766 28.851 633.0 53.90 1401.6 1.191 825.8 0.702
 11 0.956 20.765 28.250 631.6 53.50 1343.6 1.139 799.3 0.678
 12 0.956 20.765 27.860 631.5 53.38 1310.6 1.109 781.7 0.662
 13 0.956 20.765 27.159 632.3 53.76 1266.9 1.068 748.9 0.631

STA 26.000 MASS AVERAGED PROPERTIES
 PT= 28.163 TT= 643.26 GAMMA=1.4002 PT-RAT= 1.916 TT-RAT= 1.240
 RCU= 0. VM= 801.3 CZ= 801.3 MABS=0.673 MREL=1.263

SECTION VI

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2. George R. Frost, Richard M. Hearsey, Arthur J. Wennerstrom, A Computer Program for the Specification of Axial Compressor Airfoils, Aerospace Research Laboratories, Wright-Patterson Air Force Base, Ohio 45433, ARL 72-0171,
3. Richard M. Hearsey, A Revised Computer Program for Axial Compressor Design Volume I, Aerospace Research Laboratories, Wright-Patterson Air Force Base, Ohio 45433, ARL TF 75-0001, January 1975.
4. Arthur J. Wennerstrom, Personal Communication to L.H. Smith of General Electric Company, September 12, 1980.