NASA CR-54530, 1967
Allison EDR-4575

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Computer Program for Design of Multistage Axial-Flow Compressors

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Contract NAS3-7277

Allison Division • General Motors

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Technical Management
NASA-Lewis Research Center
Cleveland, Ohio

Lewis Project Manager: William L. Beede

Lewis Research Advisor: L. Joseph Herrig

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ABSTRACT

A compressor design program was developed based on simple-radial-equilibrium design philosophy with constant efficiency radially. The program was developed specifically for the determination of the flow path for a given overall pressure ratio or number of stages by specifying the tip axial velocity ratio across each blade row and initial blade row aspect ratio. Energy addition at the rotor tip is specified through rotor tip diffusion factor. The variation of energy addition radially is arbitrary. The rotor tip diffusion factor is reduced if limit values are exceeded on stator hub Mach number, stator hub diffusion factor, and rotor relative exit hub flow angle. Blade row aspect ratio is reduced if limit values are exceeded on hub and tip ramp angles.

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COMPUTER PROGRAM FOR DESIGN OF MULTISTAGE AXIAL-FLOW COMPRESSORS

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SUMMARY

This technical report contains the development of the compressor design program based on simple-radial-equilibrium design philosophy with constant efficiency radially. A detailed description is given of this compressor design program and its capabilities.

The program logic is developed in detail in the System of Equations (Appendix A) and in the Flow Charts (Appendix C). Sections indicated in Appendices A and C are cross referenced through Roman numerals. The FORTRAN listing of the computer program is given in Appendix B which is also cross referenced with the Flow Charts through statement numbers.

The input format is described in Appendix D. There are two types of input format available for the user. One option is a "Standard" format and the other option is a "Namelist" format which permits minimum amount of data for either one or more compressor problems. It should be noted that the reading of input data is generally the major portion of the machine time for a single compressor problem.

Two sample problems, which show the output format, are given in Appendix E. The first sample problem is a free vortex case and the second problem is a nonfree vortex case in the first stage. Two input data listings are also shown in Appendix E. The listing on page E-1 is for the two sample problems and is in the Namelist format. The listing on page E-2 is the Standard format for the free vortex sample problem.

INTRODUCTION

The work reported herein was performed under contract NAS3-7277 for the NASA-Lewis Research Center to devise a compressor design computer program for making a parametric compressor study on advanced multistage axial-flow compressors. The purpose of this study is to examine a wide range of design parameters to determine their effects and indicate significant areas for study and research to increase average stage pressure ratio and reduce compressor length.

To obtain the effects of the design parameters on average stage pressure ratio and compressor length, it was necessary to devise a compressor design program to compute the flow path for arbitrary specified conditions. Since the effects of streamline curvature or radial velocity are not well defined for state-of-the-art compressor design technology, the simple-radial-equilibrium design philosophy was selected. Constant efficiency radially was also selected as the type of blading required for the high loadings to be investigated and their element losses are not known.

Additional requirements of this design program to accomplish the objective are:

1. Energy addition is to be determined through rotor tip diffusion factor and is to be reduced from an initial value if stator hub diffusion factor, stator hub Mach number, or rotor relative hub exit flow angle exceed specified limits.

2. Blade row axial length is to be determined through blade aspect ratio which will be increased by reducing aspect ratio when hub and tip ramp angle have attained their specified limit values before continuity has been satisfied.

3. The flow path will be computed until either a specified overall pressure ratio or maximum number of stages has been exceeded.

This compressor design program can be used for obtaining compressor results over a range of design parameters within the scope of design philosophy selected.

SYMBOLS

Note: The primary symbols are illustrated schematically in Figure 1.

a	sonic velocity, ft/sec
A	annulus area, $in.^2$
AR	aspect ratio
b	blade row axial length, in.
B, C, D, E	constants in tangential velocity equation
c_p	constant pressure specific heat, BTU/lb_m-°R
D	diffusion factor
F	blade force, lb_f/lb_m
g_c	gravitational constant, ft-lb_m/lb_f-sec^2
H	enthalpy, BTU/lb_m
J	mechanical equivalent of heat, ft-lb_f/BTU
L	compressor length, in.
M	Mach number
$\mathcal{M}$	molecular weight, lb_m/mole
n	stage number
N	number of stages
P	pressure, $lb_f/in.^2$
Q	heat transfer rate, BTU/lb_m-sec
R	radius, in.
R_c	total pressure ratio

R, θ, z	cylindrical coordinates
$\mathcal{R}$	universal gas constant, 1545.4 ft-lb_f/mole-°R
$\mathcal{R}_m$	gas constant, ft-lb_f/lb_m-°R
S	entropy, BTU/lb_m-°R
T	temperature, °R
T_R	total temperature ratio
t	time, sec
U	wheel speed, ft/sec
V	gas velocity, ft/sec
$\dot{w}$	flow rate, lb_m/sec
Z	loss parameter

Greek

α	ramp angle, degrees
β	flow angle, degrees
γ	ratio of specific heats
ϵ	weight flow convergence tolerance
δ^*	blockage factor
η_{ad}	adiabatic efficiency
η_P	polytropic efficiency
ω	angular velocity, rad/sec
$\bar{\omega}$	loss coefficient
ρ	gas density, lb_m/ft^3
σ	solidity (chord/spacing)

Subscripts

e	effective
f	fractional
g	geometric
H	hub
i	initial
id	ideal
L	limit
m	streamline number
n	stage number
N	number of streamlines and number of stages
ov	overall and cumulative
R	rotor, radial direction, or ratio
S	stator and stage
t	total
T	tip
z	axial direction
1	rotor inlet
2	stator inlet
3	stator outlet
θ	tangential direction

Superscript

'	relative value

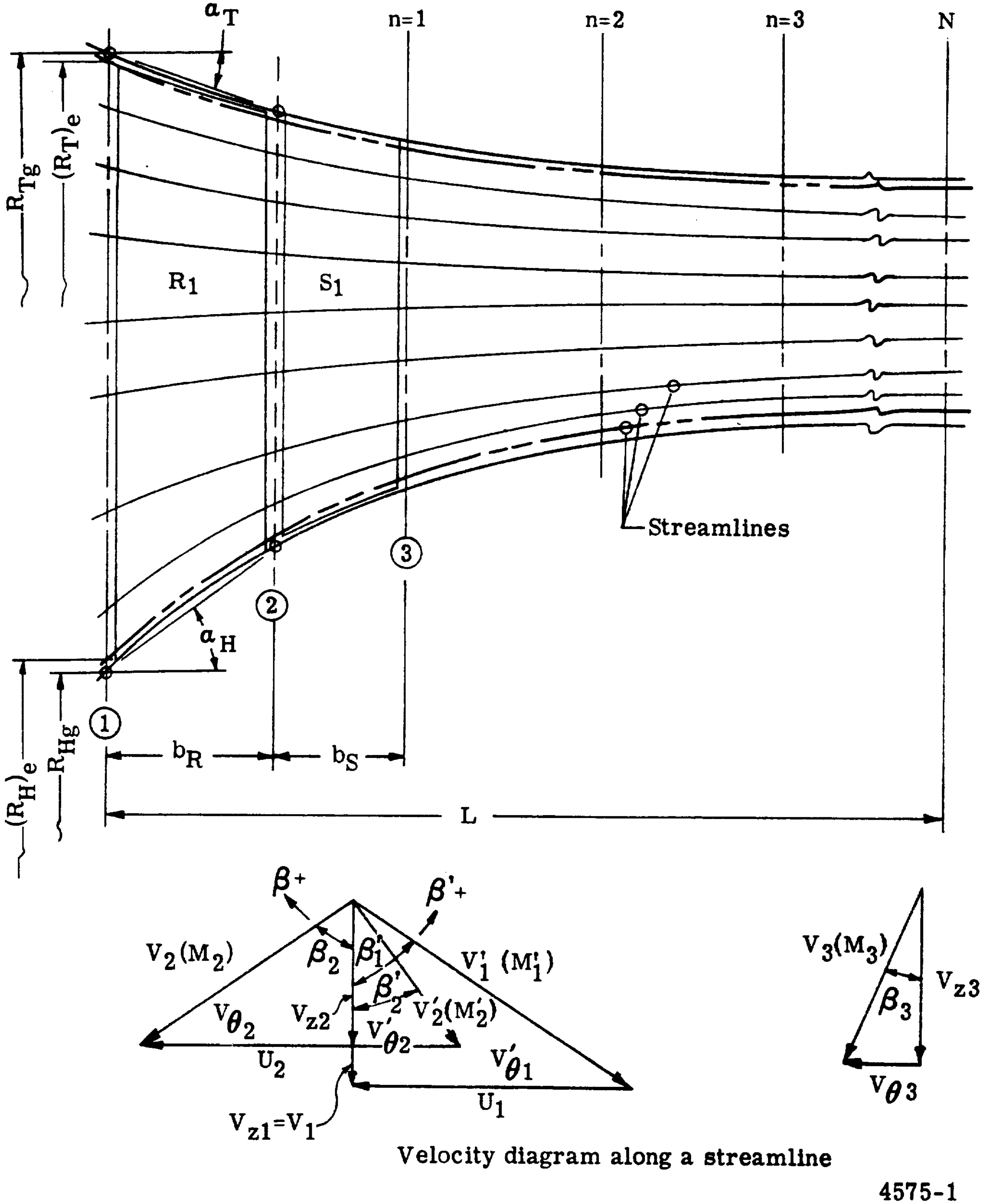

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Figure 1. Schematic presentation of symbols.

AXIAL-FLOW COMPRESSOR DESIGN PROGRAM

PROGRAM DESCRIPTION

The basic equations of motion which govern the three-dimensional flow of an inviscid compressible gas through a turbomachine have been derived in many reports such as Reference 1.

The pertinent equations for steady axisymmetric flow in cylindrical coordinates are:

Continuity Equation

$$\frac{1}{R}\frac{\partial(\rho R V_R)}{\partial R} + \frac{1}{R}\frac{\partial(\rho V_\theta)}{\partial \theta} + \frac{\partial(\rho V_z)}{\partial z} = 0 \qquad (1)$$

Radial Equation of Motion

$$g_c J \frac{\partial H_t}{\partial R} = g_c F_R + g_c J T \frac{\partial S}{\partial R} + \frac{V_\theta}{R}\frac{\partial(RV_\theta)}{\partial R} + V_z\left(\frac{\partial V_z}{\partial R} - \frac{\partial V_R}{\partial z}\right) \qquad (2)$$

Circumferential Equation of Motion

$$0 = g_c F_\theta - \frac{1}{R}\left[V_R \frac{\partial(RV_\theta)}{\partial R} + V_z \frac{\partial(RV_\theta)}{\partial z}\right] \qquad (3)$$

Axial Equation of Motion

$$g_c J \frac{\partial H_t}{\partial z} = g_c F_z + g_c J T \frac{\partial S}{\partial z} + \frac{V_\theta}{R}\frac{\partial(RV_\theta)}{\partial z} - V_R\left[\frac{\partial V_z}{\partial R} - \frac{\partial V_R}{\partial z}\right] \qquad (4)$$

Energy Equation

$$\frac{DH_t}{Dt} = Q + \frac{\omega}{g_c J}\frac{D(RV_\theta)}{Dt} \qquad (5)$$

Gradient of Entropy

$$\frac{DS}{Dt} = \frac{Q}{T} \tag{6}$$

Condition of Integrability

$$\frac{\partial}{\partial R}\left(\frac{F_z}{RF_\theta}\right) = \frac{\partial}{\partial z}\left(\frac{F_R}{RF_\theta}\right) \tag{7}$$

Equations (1) through (7) relate eight unknowns in F_R, F_θ, F_z, V_R, V_θ, V_z, S, and H_t.

The compressor design analysis considered for this study is referred to as the simple-radial-equilibrium solution without entropy gradient. The simplifying assumptions to be made are.

1. Only stations between blade rows are considered; therefore, F_R, F_θ and F_z are zero.
2. Heat transfer is zero; therefore, Q is zero.
3. Consideration need be given only to the radial equation of motion.
4. $\partial S/\partial R = 0$
5. $\partial V_R/\partial z = 0$; therefore, streamline curvature is ignored.

With these assumptions, Equations (3), (4), (6), and (7) are eliminated. Equation (1) is then rewritten for convenience as

$$\dot{w} = 2\pi \int_{R_H}^{R_T} \rho V_z RdR \tag{8}$$

and Equations (2) and (5) become

$$g_c J \frac{\partial H_t}{\partial R} = \frac{V_\theta}{R}\frac{\partial(RV_\theta)}{\partial R} + V_z \frac{\partial V_z}{\partial R} \tag{9}$$

$$g_c J \Delta H_t = \omega \Delta (RV_\theta) \tag{10}$$

The usual method in the solution of this set of equations is to specify an efficiency or total pressure loss, flow path geometry, and energy addition through total enthalpy change or exit tangential velocity. With the blade row inlet conditions known, the exit velocity conditions are then determined iteratively through Equations (8) and (9).

The primary objective of this compressor design program, however, is to determine the flow path of the compressor for a given overall pressure ratio. The secondary objective is that resultant aerodynamic parameters (defined as stator hub Mach number, rotor relative hub exit flow angle, and stator hub diffusion factor) must be less than or equal to a specified value and that blade aspect ratio is equal to or less than an initial value as required by specified limit values of hub and tip ramp angle.

To accomplish this objective, it is required that energy addition be determined through rotor tip diffusion factor, axial velocity ratio at the tip, and a specified form for tangential velocity distribution. Once the energy addition has been determined, the blade row exit annulus area is determined. With appropriate hierarchy established on the limit ramp angle, the exit annulus area can be located radially and the aerodynamic parameter values calculated. If the aerodynamic parameter limits are exceeded, the rotor tip diffusion factor must be reduced to lower the aerodynamic parameter values.

The detailed procedure to accomplish the aforementioned objectives and the development of the program logic to computerize this compressor design analysis are discussed in the following subsection. A detailed summary of the step-by-step calculation is given in Appendix A.

DEVELOPMENT OF PROGRAM LOGIC

Rotor tip diffusion factor and tip axial velocity ratio are two parameters exerting a controlling influence on stage configuration. For the case of a rotor of defined tip solidity having inlet and outlet radii, these two parameters define stage energy addition. Under these restricted conditions, the equation for diffusion factor at the rotor tip may be resolved to give outlet absolute tangential velocity and from this energy addition is obtained.

The method of rewriting the equation for diffusion factor in the form of a quadratic in V_θ is developed in Appendix A.

$$V_{\theta T2} = \frac{1}{2\left(1 - \frac{1}{4\sigma_{RT}^2}\right)} \left\{ 2\left(U_{T2} + \frac{q}{2\sigma_{RT}}\right) - \left[4\left(U_{T2} + \frac{q}{2\sigma_{RT}}\right)^2 \left(\frac{1}{1 - \frac{1}{4\sigma_{RT}^2}}\right) - 4\left(V_{z2}^2 + U_{T2}^2 - q^2\right)\right]^{1/2} \right\} \quad (11)$$

where

$$q = (1 - D_{RT})\, V'_{T1} + \frac{1}{2\sigma_{RT}} \left(U_{T1} - V_{\theta T1} - U_{T2}\right) \quad (12)$$

As always, in the case of a quadratic, certain restrictions in the selection of roots must be recognized. These restrictions are emphasized at appropriate places in this report.

The absolute tangential velocity at the rotor exit is defined by the non-linear functional relationship:

$$V_{\theta 2} = \frac{B}{R_2} + C + DR_2 + ER_2^2 \quad (13)$$

where B, C, D, and E are constant coefficients. To use this expression for the radial evaluation of tangential velocity, some arbitrary method of determining the coefficients must be adopted since only one boundary condition (i.e., at the tip) is known. It was decided to set values for the usually less prominent coefficients C, D, and E and compute a value for B. This decision was influenced by the fact that assigning a value of zero to C, D, and E results in a "free-vortex" type velocity distribution.

The radial profile of axial velocity may be obtained by substituting Equation (13) into Equation (9) and integrating the resulting function with respect to R.

Rewriting Equation (9) as

$$V_z \frac{\partial V_z}{\partial R} = g_c J \frac{\partial H_t}{\partial R} - \frac{V_\theta}{R} \frac{\partial (RV_\theta)}{\partial R}$$

or

$$\frac{\partial V_z^2}{\partial R} = 2\, g_c J\, c_p \frac{\partial T_t}{\partial R} - \frac{\partial V_\theta^2}{\partial R} - \frac{2\, V_\theta^2}{R} \tag{14}$$

Squaring Equation (13) and differentiating gives

$$\frac{\partial V_\theta^2}{\partial R} = -\frac{2B^2}{R^3} - \frac{2BC}{R^2} + 2\,(BE + CD) + 2\,(2CE + D^2)R + 6DER^2 + 4E^2R^3 \tag{15}$$

Squaring Equation (13) and multiplying by 2/R gives

$$\frac{2V_\theta^2}{R} = \frac{2B^2}{R^3} + \frac{4BC}{R^2} + \frac{2\,(2BD + C^2)}{R} + 4\,(BE + CD) + 2\,(2CE + D^2)R + 4DER^2 + 2E^2R^3 \tag{16}$$

Substituting Equations (15) and (16) into Equation (14) and integrating gives

$$V_z^2 = 2\, g_c J\, c_p\, T_t + \frac{2BC}{R} - (4\,BD + 2C^2)\log R - 6\,(BE + CD)\,R - (4CE + 2D^2)\,R^2 - \frac{10}{3}\,DER^3 - \frac{3}{2}\,E^2R^4 + K \tag{17}$$

where K is a constant of integration, the value of which may be established by the boundary conditions.

The program commences by defining conditions at the rotor inlet: hub/tip radius ratio, tip speed, tip axial velocity, blockage factors, and the absolute tangential velocity distribution. Assuming stagnation pressure and temperature uniform radially, the axial velocity distribution is determined by integrating the radial equilibrium equation. The mass flow is determined by integrating the flow derivative in the radial direction. Having determined the axial velocity distribution at the rotor inlet, all other aerodynamic quantities may be readily calculated.

To determine rotor outlet conditions, values must be assigned to the rotor tip diffusion factor and tip axial velocity ratio. Further, to define the axial location of the rotor exit station, an "aspect ratio" is required. This "aspect ratio" is interpreted as the result of dividing the difference of the geometric tip and hub radii at the rotor inlet station by the axial projected distance between inlet and exit stations. To account for nonisentropic compression, a rotor polytropic efficiency is required. This is assumed constant radially.

The rotor outlet conditions are arrived at by an iterative procedure which commences by setting the geometric exit hub and tip radii equal to the inlet. From the rotor tip diffusion factor, tip solidity, blockage factors and axial velocity ratio, the tip absolute tangential velocity is established and from this boundary condition, the tangential velocity distribution across the annulus may be established. The energy transfer and stagnation pressure rise may now be calculated.

Since all the radial variables in the equilibrium equation are now known, this equation may be numerically integrated and, from the boundary condition of a defined tip axial velocity, a constant of integration evaluated. This results in an axial velocity distribution across the annulus at the rotor exit station. From the radial distribution of axial velocity, the rate of change of flow with respect to radius may be established and integrated numerically to give the flow through the rotor exit station. If this flow does not equal the rotor inlet flow, the hub radius is increased (or reduced) and the calculation repeated until convergence occurs.

Once the calculation converges on mass flow, the rotor hub ramp angle is calculated and checked against an assigned limit. If the hub ramp angle violates the assigned limit, then the rotor geometric exit hub radius is set at a value for which the limit is attained, and the rotor geometric exit tip radius reduced to the point which satisfies the flow requirements. Should the reduction of the rotor exit tip radius cause a violation of the assigned tip ramp angle limit, then the "aspect ratio" is reduced and the calculation repeated until continuity of flow is obtained.

Having satisfied ramp angle tests and continuity of flow, the program now tests the absolute Mach number and relative flow angle at the exit of the rotor hub. If either of these parameters (in this stated order) violates its assigned limit, the program reduces the rotor tip diffusion factor and repeats the calculation until these limit tests are satisfied.

The calculation now proceeds to establish stator exit conditions. To determine the stator exit annulus, the coefficients in the polynomial, as defined by Equation (13), defining absolute tangential velocity at the stator exit are required. A polytropic stage efficiency, stator hub solidity, blockage factors, tip axial velocity ratio, and aspect ratio are also required.

The stator exit calculations for satisfying continuity commence similar to those for the rotor by setting the exit geometric hub and tip radius equal to the inlet values. The hub and tip ramp angles are then tested in the same order as for the rotor and the aspect ratio relaxed if necessary to satisfy the geometric limits. When the assigned geometric limits have been satisfied, the stator hub diffusion factor is checked against its assigned limit. If this limit is violated, the rotor tip diffusion factor is reduced and the calculation repeated for the current stage.

When a stage configuration, satisfying all limits, is achieved, the pressure ratio and energy addition are mass averaged to give stage performance. Successive stages are added until some predetermined limit in overall pressure ratio is achieved. If the limit in overall pressure cannot be exceeded in a predetermined maximum number of stages, the calculation is terminated and the values calculated up to this point printed out.

The logic of the program is restricted to consider only tip radii at any station which is equal to, or less than, the inlet blade tip radii. Positive tip ramp angles cannot occur.

This design program has been extensively used in a parametric compressor study of advanced multistage axial-flow compressors reported in Reference 2.

PROGRAM RESTRICTIONS

It has been pointed out already that the expression for the absolute tangential velocity is in the form of a quadratic and subject to restrictions on the choice of roots. It is incumbent on the user, when defining the absolute tangential velocity through the use of the polynomial coefficients, that rational input values for the coefficients be used since only restricted levels satisfy the equation of continuity.

A further restriction applies to defining the input level of rotor tip diffusion factor. If a maximum level is exceeded, both roots are complex and the physical meaning is lost. The program has error messages imbedded in the logic so that this condition may be readily identified.

The maximum level of rotor tip diffusion factor for the inlet flow conditions, tip speed, axial velocity ratio, and solidity can be easily established. The diffusion factor is

$$D_R = 1 - \frac{V_2'}{V_1'} + \frac{V_{\theta 1}' - V_{\theta 2}'}{2 \sigma V_1'} \qquad (18)$$

or

$$D_R = 1 - \frac{V_{z2}}{\left|\cos\beta_2'\right| V_1'} + \frac{(U_1 - V_{\theta 1}) - V_{z2}\tan\beta_2'}{2\sigma V_1'} \qquad (19)$$

Since with established inlet conditions and V_{z2} the rotor diffusion factor is dependent only on $V_{\theta 2}'$ or β_2', Equation (19) can be solved for its maximum value. Upon differentiating

$$\frac{d\,(D_R)}{d\,\beta_2'} = -\frac{V_{z2}}{\cos^2\beta_2' V_1'} \sin\beta_2' - \frac{V_{z2}}{2\sigma V_1'} \frac{1}{\cos^2\beta_2'}$$

Setting the right hand side to zero and solving for β_2', it is found that

$$\beta_{2\,max}' = \text{arc sin}\left(-\frac{1}{2\sigma}\right) \qquad (20)$$

and that D_R is at its maximum value. Substitution of Equation (20) into Equation (19) yields

$$D_{R_{max}} = 1 - \frac{V_{z2}}{\left(\frac{\sqrt{4\sigma^2 - 1}}{2\sigma}\right) V_1'} + \frac{(U_1 - V_{\theta 1}) + \frac{V_{z2}}{\sqrt{4\sigma^2 - 1}}}{2\sigma V_1'} \qquad (21)$$

REFERENCES

1. Aerodynamic Design of Axial-Flow Compressor, NASA-SP-36, 1965, (Revised).

2. Miller, M. L. and Bryans, A. C., Parametric Compressor Study of Advanced Multistage Axial-Flow Compressors, Allison Division, GMC, EDR 4576, NASA CR-797, 1967.

APPENDIX A

SYSTEM OF EQUATIONS

The system of equations given herein defines a method for the aerodynamic design of multistage, axial-flow compressors. The resulting designs satisfy prescribed limits on such parameters as:

- Rotor hub relative outlet flow angle.
- Stator hub inlet Mach number.
- Stator hub diffusion factor.
- Hub and tip ramp angles.

As a basis for calculation, the following simplifying assumptions are made:

- The working fluid is a perfect gas with constant specific heat.
- The flow is axisymmetric, steady, and radially isentropic.
- The effect of streamline curvature is neglected.

Roman numerals are used to define each section of the calculation. These in turn appear on the FORTRAN source deck listing (Appendix B) and on the logical flow chart (Appendix C).

SECTION I

At the inlet of the compressor the following quantities are known:

Specific heat at constant pressure	c_p
Equivalent molecular weight	$\mathcal{M}$
Ratio of specific heats	γ
Inlet total pressure	P_{ti}
Inlet total temperature	T_{ti}
Inlet tip radius	R_{T1i}
Inlet tip speed	U_{T1i}
Inlet hub/tip radius ratio	$(R_H/R_T)_{1i}$
Inlet axial velocity at tip	V_{zT1i}
Blockage factor at tip	δ^*_{T1}
Blockage factor at hub	δ^*_{H1}
Number of radial stations used	N
Coefficients in absolute tangential velocity equation	B_1, C_1, D_1, E_1

At each successive stage in the compressor the following quantities are known.

Axial velocity ratio at rotor tip	(V_{zT2}/V_{zT1})
Rotor polytropic efficiency	η_{PR}
Rotor tip solidity	σ_{RT}
Rotor aspect ratio	AR_R
Blockage factor at tip—rotor outlet	δ^*_{T2}
Blockage factor at hub—rotor outlet	δ^*_{H2}
Ramp angle limit, rotor hub	α_{RHL}
Ramp angle limit, rotor tip	α_{RTL}
Stage energy addition, either	
Rotor tip diffusion factor and	D_{RT}
coefficients in absolute tangential velocity at rotor outlet	C_2, D_2, E_2
or	
Coefficients in absolute tangential velocity at rotor outlet	B_2, C_2, D_2, E_2
Axial velocity ratio at stator tip	(V_{zT3}/V_{zT2})
Stage polytropic efficiency	η_{PS}
Stator hub solidity	σ_{SH}
Stator aspect ratio	AR_S
Blockage factor at tip—stator outlet	δ^*_{T3}
Blockage factor at hub—stator outlet	δ^*_{H3}
Ramp angle limit, stator hub	α_{SHL}
Ramp angle limit, stator tip	α_{STL}
Limiting stator hub diffusion factor	D_{SHL}
Limiting stator hub Mach number	M_{SHL}
Limiting relative air angle at rotor hub (outlet)	β'_{2HL}
Coefficients in absolute tangential velocity equation, stator outlet	B_3, C_3, D_3, E_3

SECTION II

Set the rotor inlet tip radius equal to the initial value.

$$R_{T1} = R_{T1i}$$

Calculate the gas constant.

$$\mathcal{R}_{\mathcal{M}} = 1545.4/\mathcal{M}$$

The stagnation density is

$$\rho_{t1} = \frac{144.0\ P_{t1}}{\mathcal{R}_{\mathcal{M}}\ T_{t1}}$$

The rotor hub geometric radius is

$$R_{H1} = R_{T1}\left(\frac{R_H}{R_T}\right)_1$$

The rotor tip effective radius is

$$R_{1,1} = \left\{\delta_{T1}^{*}\ R_{T1}^{2} + (1 - \delta_{T1}^{*})\ R_{H1}^{2}\right\}^{1/2}$$

The rotor hub effective radius is

$$R_{1,N} = \left\{\delta_{H1}^{*}\ R_{H1}^{2} + (1 - \delta_{H1}^{*})\ R_{T1}^{2}\right\}^{1/2}$$

where blockage is defined as

$$(1 - \delta_T^{*})\ (R_{Tg}^{2} - R_{Hg}^{2}) \equiv (R_{Tg}^{2} - R_{Te}^{2})$$

and

$$(1 - \delta_H^{*})\ (R_{Tg}^{2} - R_{Hg}^{2}) \equiv (R_{He}^{2} - R_{Hg}^{2})$$

such that

$$\dot{w} = 2\pi\ (\delta_T^{*} + \delta_H^{*} - 1) \int_{R_{Hg}}^{R_{Tg}} \rho V_z\ R\ dR$$

The axial velocity at the rotor tip may be used to evaluate the constant of integration in Equation (17).

$$K_1 = V_{zT1}^2 - 2\ B_1\ C_1/R_{1,1} + 2\ (2\ B_1\ D_1 + C_1^2)\ \log R_{1,1}$$
$$+ 6\ (B_1\ E_1 + C_1\ D_1)\ R_{1,1} + 2\ (2\ C_1\ E_1 + D_1^2)\ R_{1,1}^2$$
$$+ \left[(10/3)\ D_1\ E_1\right] R_{1,1}^3 + \left[(3/2)\ E_1^2\right] R_{1,1}^4 - 2\ g_c J\ c_p\ T_{t1,1}$$

Since the compressor inlet total temperature is assumed radially constant the 2 $g_c J\ c_p\ T_t$ term in the foregoing equation may be ignored.

The inlet axial velocity and blade speed at the rotor tip are set to their initial value

$$V_{z1,1} = V_{zT1i}$$

and

$$U_{T1} = U_{T1i}$$

SECTION III

The annulus at the rotor inlet is subdivided into N concentric rings of equal height, giving N+1 reference radii. At each of these radii compute the axial velocity using Equation (17) and the constant of integration from Section II. The following equations are evaluated from m = 2 to m = N.

Reference radii

$$R_{1,m} = R_{1,m-1} - \frac{R_{1,1} - R_{1,N}}{(N-1)}$$

Axial velocity

$$V_{z1,m} = \Big(2\ B_1\ C_1/R_{1,m} - 2\ (2\ B_1\ D_1 + C_1^2)\ \log R_{1,m}$$
$$- 6\ (B_1\ E_1 + C_1\ D_1)\ R_{1,m} - 2\ (2\ C_1\ E_1 + D_1^2)\ R_{1,m}^2$$
$$- \left[(10/3)\ D_1\ E_1\right] R_{1,m}^3 - \left[(3/2)\ E_1^2\right] R_{1,m}^4 + K_1\Big)^{1/2}$$

SECTION IV

Calculate the conditions at the rotor inlet by executing the following steps from m = 1 to m = N.

Rotor blade speed

$$U_{1,m} = R_{1,m}\left(\frac{U_{T1i}}{R_{T1i}}\right)$$

Absolute tangential velocity

$$V_{\theta 1,m} = \frac{B_1}{R_{1,m}} + C_1 + D_1 R_{1,m} + E_1 R_{1,m}^2$$

Absolute velocity

$$V_{1,m} = \left(V_{z1,m}^2 + V_{\theta 1,m}^2\right)^{1/2}$$

Static density

$$\rho_{1,m} = \rho_{t1,m}\left(1.0 - \frac{V_{1,m}^2}{2\, g_c J\, c_p\, T_{ti}}\right)^{1/(\gamma-1)}$$

Absolute air angle

$$\beta_{1,m} = \tan^{-1}\left(\frac{V_{\theta 1,m}}{V_{z1,m}}\right)$$

Relative air angle

$$\beta'_{1,m} = \tan^{-1}\left(\frac{U_{1,m} - V_{\theta 1,m}}{V_{z1,m}}\right)$$

Relative velocity

$$V'_{1,m} = \frac{V_{z1,m}}{\cos\beta'_{1,m}}$$

Relative Mach number

$$M'_{1,m} = \frac{V'_{1,m}}{\left[g_c \gamma \mathcal{R}_m \left(T_{ti} - \frac{V'^2_{1,m}}{2 g_c J c_p}\right)\right]^{1/2}}$$

Absolute Mach number

$$M_{1,m} = \frac{V_{1,m}}{\left[g_c \gamma \mathcal{R}_m \left(T_{ti} - \frac{V^2_{1,m}}{2 g_c J c_p}\right)\right]^{1/2}}$$

Axial Mach number

$$M_{z1,m} = \frac{V_{z1,m}}{\left[g_c \gamma \mathcal{R}_m \left(T_{ti} - \frac{V^2_{z1,m}}{2 g_c J c_p}\right)\right]^{1/2}}$$

Set the total temperature and pressure at each radial station equal to the value at the inlet.

$$T_{t1,m} = T_{ti}$$

$$P_{t1,m} = P_{ti}$$

SECTION V

Summate the weight flow across the annulus at the inlet of the first rotor.

$$\dot{w}_1 = \sum_{m=1}^{N-1} \frac{\pi (R^2_{1,m} - R^2_{1,m+1})}{144.0} \frac{(\rho_{1,m} V_{z1,m} + \rho_{1,m+1} V_{z1,m+1})}{2.0}$$

This completes the calculations for the inlet of the first rotor. Before proceeding to the rotor outlet calculation, set each of the ramp angles to zero,

$$\alpha_{RT} = 0.0$$

$$\alpha_{RH} = 0.0$$

$$\alpha_{ST} = 0.0$$

$$\alpha_{SH} = 0.0$$

and save initial values of aspect ratio and the B coefficient in the polynomial for tangential velocity.

$$AR_{Ri} = AR_R$$

$$AR_{Si} = AR_S$$

$$B_{2S} = B_2$$

SECTION VI

The absolute tangential velocity at the rotor outlet tip may be explicitly defined as a polynomial function of R_2, or implicitly defined through the rotor tip diffusion factor, D_{RT}. If D_{RT} is not given, go to Section VII.

If D_{RT} is given the B coefficient in the function for absolute tangential velocity is evaluated as follows. Determine the axial distance between rotor inlet and rotor outlet.

$$b_R = \frac{R_{T1} - R_{H1}}{AR_R}$$

Calculate rotor outlet tip radius,

$$R_{T2} = R_{T1} + b_R \tan \alpha_{RT}$$

axial velocity,

$$V_{zT2} = V_{zT1} \left(\frac{V_{zT2}}{V_{zT1}} \right)$$

and blade speed.

$$U_{T2} = R_{T2} \left(\frac{U_{T1i}}{R_{T1i}} \right)$$

The diffusion factor at the rotor tip is given by

$$D_{RT} = 1.0 - \frac{V'_{T2}}{V'_{T1}} + \frac{V'_{\theta T1} - V'_{\theta T2}}{2 \sigma_{RT} V'_{T1}}$$

or

$$D_{RT} = 1.0 - \frac{V'_{T2}}{V'_{T1}} + \frac{U_{T1} - V_{\theta T1} - U_{T2} + V_{\theta T2}}{2\sigma_{RT} V'_{T1}}$$

This may be rearranged as

$$V'_{T2} = \frac{V_{\theta T2}}{2\sigma_{RT}} + \left[(1.0 - D_{RT}) V'_{T1} + \frac{U_{T1} - V_{\theta T1} - U_{T2}}{2\sigma_{RT}}\right]$$

or as

$$V'_{T2} = R\, V_{\theta T2} + Q \qquad \text{(A-1)}$$

where

$$R = \frac{1}{2\sigma_{RT}}$$

and

$$Q = \left[(1.0 - D_{RT}) V'_{T1} + \frac{U_{T1} - V_{\theta T1} - U_{T2}}{2\sigma_{RT}}\right]$$

now

$$V'_{T2} = \left[\left(U_{T2} - V_{\theta T2}\right)^2 + V^2_{zT2}\right]^{1/2} \qquad \text{(A-2)}$$

Squaring and equating (A-1) and (A-2) results in

$$U^2_{T2} - 2\, U_{T2} V_{\theta T2} + V^2_{\theta T2} + V^2_{zT2} = R^2 V^2_{\theta T2} + 2\, QR\, V_{\theta T2} + Q^2$$

which reduces to

$$V^2_{\theta T2} + \left[\frac{-2\,(U_{T2} + RQ)}{1.0 - R^2}\right] V_{\theta T2} + \left[\frac{V^2_{zT2} + U^2_{T2} - Q^2}{1.0 - R^2}\right] = 0$$

or

$$V^2_{\theta 2,1} + S\, V_{\theta 2,1} + T = 0 \qquad \text{(A-3)}$$

where

$$S = \left[\frac{-2\,(U_{T2} + RQ)}{1.0 - R^2}\right]$$

and

$$T = \left[\frac{V_{zT2}^2 + U_{T2}^2 - Q^2}{1.0 - R^2}\right]$$

The absolute tangential velocity at the rotor tip may be obtained by solving Equation (A-3).

$$V_{\theta T2} = \frac{-S - \sqrt{S^2 - 4\,T}}{2}$$

The calculation is restricted to positive real roots. The coefficient B_2 is given by

$$B_2 = R_{T2}\, V_{\theta T2} - C_2\, R_{T2} - D_2\, R_{T2}^2 - E_2\, R_{T2}^3$$

Go to Section VIII.

SECTION VII

Determine the axial distance between rotor inlet and rotor outlet.

$$b_R = \frac{R_{T1} - R_{H1}}{AR_R}$$

Calculate rotor outlet tip radius,

$$R_{T2} = R_{T1} + b_R \tan \alpha_{RT}$$

axial velocity,

$$V_{zT2} = V_{zT1}\left(\frac{V_{zT2}}{V_{zT1}}\right)$$

and blade speed at geometric tip radii

$$U_{T2} = R_{T2}\left(\frac{U_{T1i}}{R_{T1i}}\right)$$

Set axial velocity at effective tip radii

$$V_{z2,1} = V_{zT2}$$

At the rotor exit station calculate the following.

Geometric hub radius

$$R_{H2} = R_{H1} + b_R \tan \alpha_{RH}$$

Effective tip radius

$$R_{2,1} = \left\{ \delta^*_{T2} R^2_{T2} + (1 - \delta^*_{T2}) R^2_{H2} \right\}^{1/2}$$

Effective hub radius

$$R_{2,N} = \left\{ \delta^*_{H2} R^2_{H2} + (1 - \delta^*_{H2}) R^2_{T2} \right\}^{1/2}$$

Geometric annulus area

$$A_{2g} = \pi (R^2_{T2} - R^2_{H2})$$

Effective annulus area

$$A_{2e} = \pi (R^2_{2,1} - R^2_{2,N})$$

Blade speed at effective tip radii

$$U_{2,1} = R_{2,1} \left(\frac{U_{T1i}}{R_{T1i}} \right)$$

Absolute tangential velocity at effective tip radii

$$V_{\theta 2,1} = \frac{B_2}{R_{2,1}} + C_2 + D_2 R_{2,1} + E_2 R^2_{2,1}$$

Total temperature at effective tip radii

$$T_{t2,1} = T_{t1,1} + \frac{(U_{2,1} V_{\theta 2,1} - U_{1,1} V_{\theta 1,1})}{g_c J c_p}$$

and the constant of integration, K_2, for the axial velocity equation is

$$K_2 = V_{zT2}^2 - 2\,B_2\,C_2/R_{2,1} + 2\,(2\,B_2\,D_2 + C_2^2)\log R_{2,1} + 6\,(B_2\,E_2 + C_2\,D_2)\,R_{2,1} + 2\,(2\,C_2\,E_2 + D_2^2)\,R_{2,1}^2 + \left[(10/3)\,D_2\,E_2\right] R_{2,1}^3 + \left[(3/2)\,E_2^2\right] R_{2,1}^4 - 2\,g_c J\,c_p\,T_{t2,1}$$

SECTION IX

The annulus at the rotor exit is subdivided into N concentric rings of equal height, giving N+1 reference radii. At each of these radii, compute the blade speed, absolute tangential velocity, total temperature, and axial velocity. The following steps are executed for m = 2, N.

$$R_{2,m} = R_{2,m-1} - \frac{R_{2,1} - R_{2,N}}{(N-1)}$$

$$U_{2,m} = R_{2,m}\left(\frac{U_{T1i}}{R_{T1i}}\right)$$

$$V_{\theta 2,m} = \frac{B_2}{R_{2,m}} + C_2 + D_2\,R_{2,m} + E_2\,R_{2,m}^2$$

$$T_{t2,m} = T_{t1,m} + \frac{U_{2,m}\,V_{\theta 2,m} - U_{1,m}\,V_{\theta 1,m}}{g_c J\,c_p}$$

$$V_{z2,m} = \left\{2\,B_2\,C_2/R_{2,m} - 2\,(2\,B_2\,D_2 + C_2^2)\log R_{2,m} - 6\,(B_2\,E_2 + C_2\,D_2)\,R_{2,m} - 2\,(2\,C_2\,E_2 + D_2^2)\,R_{2,m}^2 - \left[(10/3)\,D_2\,E_2\right] R_{2,m}^3 - \left[(3/2)\,E_2^2\right] R_{2,m}^4 + 2\,g_c J\,c_p\,T_{t2,m} + K_2\right\}^{1/2}$$

SECTION X

At the rotor exit station, the following functions are evaluated for m = 1, N.

Total pressure

$$P_{t2,m} = P_{t1,m}\left(\frac{T_{t2,m}}{T_{t1,m}}\right)^{\eta_{PR}\,(\gamma/(\gamma-1))}$$

Total density

$$\rho_{t2,m} = \frac{144.0\ P_{t2,m}}{\mathcal{R}_m\ T_{t2,m}}$$

Absolute velocity

$$V_{2,m} = (V^2_{z2,m} + V^2_{\theta 2,m})^{1/2}$$

Static density

$$\rho_{2,m} = \rho_{t2,m} \left(1.0 - \frac{V^2_{2,m}}{2\ g_c J\ c_p\ T_{t2,m}}\right)^{1/(\gamma-1)}$$

Absolute air angle

$$\beta_{2,m} = \tan^{-1}\left(\frac{V_{\theta 2,m}}{V_{z2,m}}\right)$$

Relative air angle

$$\beta'_{2,m} = \tan^{-1}\left(\frac{U_{2,m} - V_{\theta 2,m}}{V_{z2,m}}\right)$$

Relative velocity

$$V'_{2,m} = \frac{V_{z2,m}}{\cos\beta'_{2,m}}$$

Diffusion factor

$$D_{R,m} = 1.0 - \frac{V'_{2,m}}{V'_{1,m}} + \left[\frac{\left(U_{1,m} - V_{\theta 1,m}\right) - \left(U_{2,m} - V_{\theta 2,m}\right)}{2\,\sigma_{RT}\ V'_{1,m}}\right]\left[\frac{\left(R_{T1} + R_{T2}\right)}{\left(R_{1,m} + R_{2,m}\right)}\right]^{-1}$$

Static temperature

$$T_{2,m} = T_{t2,m} - \frac{V^2_{2,m}}{2\ g_c J\ c_p}$$

Sonic velocity

$$a_{2,m} = (g_c\ \gamma\ \mathcal{R}_m\ T_{2,m})^{1/2}$$

Absolute Mach number

$$M_{2,m} = \frac{V_{2,m}}{a_{2,m}}$$

Ideal relative total pressure ratio

$$(P'_{Rt,m})_{id} = \left\{ 1.0 + \frac{\frac{\gamma-1}{2}\left[1.0 - \left(\frac{R_{1,m}}{R_{2,m}}\right)^2\right] U_{2,m}^2}{g_c \; \gamma \mathcal{R}_m \left[T_{t1,m} + \frac{V'^2_{1,m} - V^2_{1,m}}{2\, g_c J\, c_p}\right]} \right\}^{\gamma/(\gamma-1)}$$

Loss coefficient

$$\bar{\omega}_{R,m} = (P'_{Rt,m})_{id} \left[\frac{1.0 - \frac{\left(\frac{P_{t2,m}}{P_{t1,m}}\right)}{\left(\frac{T_{t2,m}}{T_{t1,m}}\right)^{\gamma/(\gamma-1)}}}{1.0 - \left(\frac{1.0}{1.0 + \frac{\gamma-1}{2} M'^2_{1,m}}\right)^{\gamma/(\gamma-1)}} \right]$$

Relative Mach number

$$M'_{2,m} = \frac{V'_{2,m}}{a_{2,m}}$$

Axial Mach number

$$M_{z2,m} = \frac{V_{z2,m}}{a_{2,m}}$$

Loss parameter

$$Z_{R,m} = \frac{\bar{\omega}_{R,m} \cos \beta'_{2,m}}{2\sigma_{RT}} \left[\frac{(R_{T1} + R_{T2})}{(R_{1,m} + R_{2,m})}\right]^{-1}$$

SECTION XI

Summate the weight flow across the annulus at the exit of the rotor.

$$\dot{w}_2 = \sum_{m=1}^{N-1} \frac{\pi(R^2_{2,m} - R^2_{2,m+1})}{144.0} \frac{(\rho_{2,m} V_{z2,m} + \rho_{2,m+1} V_{z2,m+1})}{2.0}$$

SECTION XII

Calculate the absolute value of the error by which the weight flow at the rotor exit differs from the weight flow at the rotor inlet.

$$\epsilon_{\dot{w}} = \frac{|\dot{w}_2 - \dot{w}_1|}{\dot{w}_2}$$

If $\epsilon_{\dot{w}} \leq 0.001$ continuity of flow is assumed to be satisfied and the calculation proceeds to Section XXIV. If $\epsilon_{\dot{w}} > 0.001$ the rotor exit annulus area must be altered to satisfy continuity. Since this may be accomplished in one of three ways, a logical test must be made to determine the method to be followed.

If the rotor hub ramp angle is less than its specified limit, proceed to Section XXIII. If the rotor hub ramp angle is at its specified limit but the rotor tip ramp angle is equal to or less than zero and greater than its limit, proceed to Section XXV. If both the rotor hub and tip ramp angles are at their limit, calculate a new geometric area for the rotor exit.

$$A_{new} = A_{2g} + \frac{A_{2g}(\dot{w}_1 - \dot{w}_2)}{\dot{w}_2}$$

If the absolute value of the rotor tip ramp angle is equal to the absolute value of the rotor hub ramp angle proceed to Section XXVII; if the angles are unequal proceed to Section XXVI.

SECTION XIII

Having satisfied the limitations on rotor hub and tip ramp angles the absolute Mach number at the rotor hub is tested. If the Mach number does not exceed its desired limit go to Section XIV. If the desired limit is exceeded, modify the B coefficient in Equation (13) and calculate a new value for the absolute tangential velocity at the rotor tip.

The revised value of B_2 is calculated as follows. The total temperature at the rotor tip is

$$T_{t2,N} = T_{t1,N} + \frac{U_{2,N} V_{\theta 2,N} - U_{1,N} V_{\theta 1,N}}{g_c J\, c_p}$$

and the static temperature is

$$T_{2,N} = T_{t2,N} - \frac{V_{z2,N}^2 + V_{\theta 2,N}^2}{2\, g_c J\, c_p}$$

Combine these two equations and obtain the square of the Mach number.

$$M_{2,N}^2 = \frac{V_{z2,N}^2 + V_{\theta 2,N}^2}{g_c\, \gamma\, \mathcal{R}_m \left(T_{t1,N} + \frac{U_{2,N} V_{\theta 2,N} - U_{1,N} V_{\theta 1,N}}{g_c J\, c_p} - \frac{V_{z2,N}^2 + V_{\theta 2,N}^2}{2\, g_c J\, c_p}\right)}$$

This may be rearranged to give

$$V_{z2,N}^2 + V_{\theta 2,N}^2 = AA \left(T_{t1,N} + \frac{U_{2,N} V_{\theta 2,N} - U_{1,N} V_{\theta 1,N}}{g_c J\, c_p} - \frac{V_{z2,N}^2 - V_{\theta 2,N}^2}{2\, g_c J\, c_p}\right)$$

where

$$AA = M_{2,N}^2\, g_c\, \gamma \mathcal{R}_m$$

Separating the terms gives a quadratic in $V_{\theta 2,N}$:

$$V_{\theta 2,N}^2 \left(1 + \frac{AA}{2\, g_c J\, c_p}\right) - V_{\theta 2,N} \left(\frac{AA\, U_{2,N}}{g_c J\, c_p}\right) + \left(V_{z2,N}^2 - AA\, T_{t1,N} + \frac{AA\, U_{1,N} V_{\theta 1,N}}{g_c J\, c_p} - \frac{AA\, V_{z2,N}^2}{2\, g_c J\, c_p}\right) = 0$$

or

$$V_{\theta 2,N}^2 + V_{\theta 2,N} \left(- \frac{2BB\, U_{2,N}}{1 + BB}\right) + \left(\frac{V_{z2,N}^2 - AA\, T_{t1,N} + BB\, V_{z2,N}^2}{1 + BB} + \left(2BB\, U_{1,N} V_{\theta 1,N}\right)\right) = 0$$

where

$$BB = \frac{AA}{2 g_c J\, c_p}$$

This quadratic may be solved for $V_{\theta 2,N}$.

$$V_{\theta 2,N} = -CC + \sqrt{CC^2 - DD}$$

where

$$CC = -\frac{BB\ U_{2,N}}{1 + BB}$$

and

$$DD = \left(\frac{V_{z2,N}^2 - AA\ T_{t1,N} + BB\ V_{z2,N}^2}{1 + BB} + 2\ BB\ U_{1,N}\ V_{\theta 1,N}\right)$$

The B_2 coefficient is given by

$$B_2 = V_{\theta 2,N}\ R_{2,N} - C_2\ R_{2,N} - D_2\ R_{2,N}^2 - E_2\ R_{2,N}^3$$

Reinitialize the values of rotor hub ramp angle, rotor tip ramp angle, and aspect ratio,

$$\alpha_{RH} = 0.0$$

$$\alpha_{RT} = 0.0$$

$$AR_R = AR_{Ri}$$

and return to Section VII.

SECTION XIV

Test to see if the outlet relative flow angle at the rotor hub exceeds the desired limit. If the limit is not exceeded, go to Section XV. If the limit is exceeded modify the B_2 coefficient as follows.

$$B_2 = (U_{2,N} - V_{z2,N} \tan \beta'_{SH})\ R_{2,N} - C_2\ R_{2,N} - D_2\ R_{2,N}^2 - E_2\ R_{2,N}^3$$

Reinitialize rotor hub ramp angle, tip ramp angle, and aspect ratio

$$\alpha_{RH} = 0.0$$

$$\alpha_{RT} = 0.0$$

$$AR_R = AR_{Ri}$$

and return to Section VII.

SECTION XV

Having satisfied the specified limits on rotor hub and tip ramp angles, hub outlet absolute Mach number, and outlet relative air angle, the calculation proceeds to establish stator outlet conditions. Determine the axial distance between stator inlet and stator outlet.

$$b_S = \frac{R_{T2} - R_{H2}}{AR_S}$$

Calculate stator outlet tip radius

$$R_{T3} = R_{T2} + b_S \tan \alpha_{ST}$$

Set the outlet total temperature at the stator tip

$$T_{t3,1} = T_{t2,1}$$

Geometric hub radius

$$R_{H3} = R_{H2} + b_S \tan \alpha_{SH}$$

Effective tip radius

$$R_{3,1} = \left\{ \delta^*_{T3} R^2_{T3} + (1 - \delta^*_{T3}) R^2_{H3} \right\}^{1/2}$$

Effective hub radius

$$R_{3,N} = \left\{ \delta^*_{H3} R^2_{H3} + (1 - \delta^*_{H3}) R^2_{T3} \right\}^{1/2}$$

Geometric annulus area

$$A_{3g} = \pi(R^2_{T3} - R^2_{H3})$$

Effective annulus area

$$A_{3e} = \pi(R^2_{3,1} - R^2_{3,N})$$

Tip axial velocity

$$V_{zT3} = V_{zT2} \left(\frac{V_{zT3}}{V_{zT2}} \right)$$

Evaluate the constant of integration K_3, for the axial velocity equation.

$$K_3 = V_{zT3}^2 - 2\,B_3\,C_3/R_{3,1} + 2\,(2\,B_3\,D_3 + C_3^2)\log R_{3,1} + 6\,(B_3\,E_3 + C_3\,D_3)\,R_{3,1}$$
$$+ 2\,(2\,C_3\,E_3 + D_3^2)\,R_{3,1}^2 + \left[(10/3)\,D_3\,E_3\right]R_{3,1}^3 + \left[(3/2)\,E_3^2\right]R_{3,1}^4$$
$$- 2\,g_c J\,c_p\,T_{t3,1}$$

Set the axial velocity at the effective tip radii.

$$V_{z3,1} = V_{zT3}$$

SECTION XVI

The annulus at the stator exit is subdivided into N concentric rings of equal height, giving N+1 reference radii. At each of these radii calculate the total temperature and axial velocity.

$$R_{3,m} = R_{3,m-1} - \frac{R_{3,1} - R_{3,N}}{N - 1}$$

$$T_{t3,m} = T_{t2,m}$$

$$V_{z3,m} = \Big\{2\,B_3\,C_3/R_{3,m} - 2\,(2\,B_3\,D_3 + C_3^2)\log R_{3,m} - 6\,(B_3\,E_3 + C_3\,D_3)\,R_{3,m}$$
$$-2\,(2\,C_3\,E_3 + D_3^2)\,R_{3,m}^2 - \left[(10/3)\,D_3\,E_3\right]R_{3,m}^3 - \left[(3/2)\,E_3^2\right]R_{3,m}^4$$
$$+ 2\,g_c J\,c_p\,T_{t3,m} + K_3\Big\}^{1/2}$$

SECTION XVII

At the stator exit station the following functions are evaluated for m=1, N.

Absolute tangential velocity

$$V_{\theta 3,m} = \frac{B_3}{R_{3,m}} + C_3 + D_3\,R_{3,m} + E_3\,R_{3,m}^2$$

Total pressure

$$P_{t3,m} = P_{t1,m}\left(\frac{T_{t3,m}}{T_{t1,m}}\right)^{\eta_{PS}(\gamma/(\gamma-1))}$$

Total density

$$\rho_{t3,m} = \frac{144.0\ P_{t3,m}}{\mathcal{R}_m\ T_{t3,m}}$$

Absolute velocity

$$V_{3,m} = \left(V_{z3,m}^2 + V_{\theta 3,m}^2\right)^{1/2}$$

Static density

$$\rho_{3,m} = \rho_{t3,m}\left(1.0 - \frac{V_{3,m}^2}{2\ g_c J\ c_p\ T_{t3,m}}\right)^{1/(\gamma-1)}$$

Absolute air angle

$$\beta_{3,m} = \tan^{-1}\left(\frac{V_{\theta 3,m}}{V_{z3,m}}\right)$$

Diffusion factor

$$D_{S,m} = 1.0 - \frac{V_{3,m}}{V_{2,m}} + \frac{(V_{\theta 2,m} - V_{\theta 3,m})}{2\ \sigma_{SH}\ V_{2,m}}\left[\frac{(R_{H2} + R_{H3})}{(R_{2,m} + R_{3,m})}\right]^{-1}$$

Loss coefficient

$$\bar{\omega}_{S,m} = \frac{\left(1.0 - \frac{P_{t3,m}}{P_{t2,m}}\right)}{\left[1.0 - \frac{1.0}{\left(1.0 + \frac{\gamma-1}{2} M_{2,m}^2\right)^{\gamma/(\gamma-1)}}\right]}$$

Sonic velocity

$$a_{3,m} = \left[g_c\ \gamma\ \mathcal{R}_m\left(T_{t3,m} - \frac{V_{3,m}^2}{2\ g_c J\ c_p}\right)\right]^{1/2}$$

Absolute Mach number

$$M_{3,m} = \frac{V_{3,m}}{a_{3,m}}$$

Loss parameter

$$Z_{S,m} = \frac{\bar{\omega}_{S,m} \cos \beta_{3,m}}{2\,\sigma_{SH}} \left[\frac{R_{H2} + R_{H3}}{R_{2,m} + R_{3,m}} \right]^{-1}$$

SECTION XVIII

Summate the weight flow across the annulus at the exit of the stator.

$$\dot{w}_3 = \sum_{m=1}^{N-1} \frac{\pi (R_{3,m}^2 - R_{3,m+1}^2)}{144.0} \; \frac{(\rho_{3,m} V_{z3,m} + \rho_{3,m+1} V_{z3,m+1})}{2.0}$$

SECTION XIX

Calculate the following mass averaged parameters:

Stage pressure ratio

$$R_c = \left\{ \sum_{m=1}^{N-1} S \left[\left(\frac{P_{t3,m} + P_{t3,m+1}}{P_{t1,m} + P_{t1,m+1}} \right)^{(\gamma-1)/\gamma} -1.0 \right] \right\}^{\gamma/(\gamma-1)}$$

Cumulative pressure ratio

$$(R_c)_{ov} = \left\{ \frac{\sum_{m=1}^{N-1} S \left[\left(\frac{P_{t3,m} + P_{t3,m+1}}{2.0\, P_{ti}} \right)^{(\gamma-1)/\gamma} -1.0 \right]}{\dot{w}_3} \right\}^{\gamma/(\gamma-1)}$$

Stage temperature ratio

$$T_R = \left\{ \frac{\sum_{m=1}^{N-1} S \left[\left(\frac{T_{t3,m} + T_{t3,m+1}}{T_{t1,m} + T_{t1,m+1}} \right) - 1.0 \right]}{\dot{w}_3} \right\}$$

Cumulative temperature ratio

$$(T_R)_{ov} = \left\{ \frac{\sum_{m=1}^{N-1} S\left[\left(\frac{T_{t3,m} + T_{t3,m+1}}{2.0\ T_{ti}}\right) - 1.0\right]}{\dot{w}_3} \right\}$$

where:

$$S = \frac{\pi(R_{3,m}^2 - R_{3,m+1}^2)}{144.0} \quad \frac{(\rho_{3,m} V_{z3,m} + \rho_{3,m+1} V_{z3,m+1})}{2.0}$$

The stage adiabatic efficiency is given by

$$\eta_{ad} = \left[\frac{R_c^{(\gamma-1)/\gamma} - 1.0}{T_R - 1.0}\right]$$

and cumulative adiabatic efficiency by

$$(\eta_{ad})_{ov} = \left[\frac{(R_c)_{ov}^{(\gamma-1)/\gamma} - 1.0}{(T_R)_{ov} - 1.0}\right]$$

Calculate the absolute value of the error by which the weight flow at the stator exit differs from the weight flow at the rotor inlet.

$$\epsilon_{\dot{w}} = \frac{|\dot{w}_3 - \dot{w}_1|}{\dot{w}_3}$$

If $\epsilon_{\dot{w}} \leq 0.001$, continuity of flow is assumed to be satisfied and the calculation proceeds to Section XXIX. If $\epsilon_{\dot{w}} > 0.001$, the stator exit annulus area must be altered to satisfy continuity. This is accomplished in a manner similar to that outlined for the rotor in Section XII.

If the stator hub ramp angle is less than its specified limit proceed to Section XXVIII. If the stator hub ramp angle is at its specified limit, but the stator tip ramp angle is equal to or less than zero, and greater than its limit proceed to Section XXX. If both the stator hub and tip ramp angles are at their limit calculate a new effective area for the stator exit.

$$A_{new} = A_{3e} + \frac{A_{3e}(\dot{w}_1 - \dot{w}_3)}{\dot{w}_3}$$

If the absolute value of the stator tip ramp angle is equal to the absolute value of the stator hub ramp angle proceed to Section XXXII; if the angles are unequal proceed to Section XXXI.

SECTION XX

Having satisfied the limitations on stator hub and tip ramp angles, the diffusion factor at the stator hub is tested to determine if it exceeds a desired limit. If the limit has not been exceeded, go to Section XXI. If the limit has been exceeded, modify the B_2 coefficient in the polynomial function for absolute tangential velocity at the rotor exit and calculate new rotor exit conditions.

The revised value of B_2 is calculated as follows.

The stator hub D-factor is given by

$$D_{SH} = 1.0 - \frac{V_{3,N}}{(V_{\theta 2,N}^2 + V_{z2,N}^2)^{1/2}} + \frac{(V_{\theta 2,N} - V_{\theta 3,N})}{2\,\sigma_{SH}\,(V_{\theta 2,N}^2 + V_{z2,N}^2)^{1/2}}$$

This may be rearranged to give

$$\frac{V_{3,N} + (V_{\theta 3,N} - V_{\theta 2,N})/2\,\sigma_{SH}}{(1.0 - D_{SH})} = (V_{\theta 2,N}^2 + V_{z2,N}^2)^{1/2}$$

or

$$AF + BF\,V_{\theta 2,N} = (V_{\theta 2,N}^2 + V_{z2,N}^2)^{1/2} \qquad \text{(A-4)}$$

where

$$AF = \frac{-V_{3,N} - V_{\theta 3,N}/2\,\sigma_{SH}}{D_{SH} - 1.0}$$

$$BF = 1/2\,\sigma_{SH}\,(D_{SH} - 1.0)$$

Squaring Equation (A-4) and rearrangement into a quadratic in $V_{\theta 2}$ yields

$$V_{\theta 2,N}^2 + 2\,CF\,V_{\theta 2,N} + DF = 0$$

where

$$CF = \frac{-(AF)(BF)}{1-(BF)^2}$$

$$DF = \frac{V_{z2,N}^2 - (AF)^2}{1-(BF)^2}$$

Thus, the absolute tangential velocity at the rotor hub is given by

$$V_{\theta 2,N} = -CF \pm \sqrt{CF^2 - DF}$$

The required root must be positive. If two positive roots occur, the original expression for D_{SH} should be tested to determine which is the correct root. The new value for the B_2 coefficient is given by

$$B_2 = R_{2,N} V_{\theta 2,N} - C_2 R_{2,N} - D_2 R_{2,N}^2 - E_2 R_{2,N}^3$$

Reinitialize hub and tip ramp angles, and aspect ratios for both rotor and stator.

$$\alpha_{RH} = 0.0$$

$$\alpha_{RT} = 0.0$$

$$\alpha_{SH} = 0.0$$

$$\alpha_{ST} = 0.0$$

$$AR_R = AR_{Ri}$$

$$AR_S = AR_{Si}$$

and return to Section VII.

SECTION XXI

This completes the performance calculations for a stage. Print the stage output and test if the required overall pressure ratio has been achieved.

If the required pressure ratio has been reached, print a statement to this effect and proceed to Section I and commence another data set. If the required pressure ratio has not been reached, test to determine if the maximum number of stages has been exceeded. If the maximum number of stages has not been exceeded, go to Section XXII and calculate the inlet conditions to the next rotor. If the maximum number of stages has been exceeded, print a statement to this effect and proceed to Section I and commence another data set.

SECTION XXII

Calculate the conditions at the rotor inlet by executing the following steps from m=1 to m=N.

Rotor blade speed

$$U_{1,m} = R_{3,m}\left(\frac{U_{T1i}}{R_{T1i}}\right)$$

Absolute tangential velocity

$$V_{\theta 1,m} = V_{\theta 3,m}$$

Absolute velocity

$$V_{1,m} = V_{3,m}$$

Absolute air angle

$$\beta_{1,m} = \beta_{3,m}$$

Relative air angle

$$\beta'_{1,m} = \tan^{-1}\left(\frac{U_{1,m} - V_{\theta 1,m}}{V_{z3,m}}\right)$$

Relative velocity

$$V'_{1,m} = \frac{V_{z3,m}}{\cos \beta'_{1,m}}$$

Axial velocity

$$V_{z1,m} = V_{z3,m}$$

Reference radius

$$R_{1,m} = R_{3,m}$$

Sonic speed

$$a_{1,m} = \left[g_c\, \gamma\, \mathcal{R}_m \left(T_{t3,m} - \frac{V_{1,m}^2}{2\, g_c J\, c_p}\right)\right]^{1/2}$$

Absolute Mach number

$$M_{1,m} = \frac{V_{1,m}}{a_{1,m}}$$

Relative Mach number

$$M'_{1,m} = \frac{V'_{1,m}}{a_{1,m}}$$

Total temperature

$$T_{t1,m} = T_{t3,m}$$

Total pressure

$$P_{t1,m} = P_{t3,m}$$

Tip radius

$$R_{T1} = R_{T3}$$

Hub radius

$$R_{H1} = R_{H3}$$

Proceed to Section I and commence the calculation of another stage.

SECTION XXIII

Calculate new rotor exit annulus area, hub radius, and ramp angle.

$$A_{new} = A_{2e} + \frac{A_{2e}\,(\dot{w}_1 - \dot{w}_2)}{\dot{w}_2}$$

$$R_{H_{new}} = \left[R_{T,2}^2 - \frac{A_{new}}{\pi(\delta_{T2}^* + \delta_{H2}^* - 1)}\right]^{1/2}$$

$$\alpha_{RH} = \tan^{-1}\left[\frac{(R_{H_{new}} - R_{H1})}{b_R}\right]$$

Go to Section VIII.

SECTION XXIV

At this point in the calculation, continuity of flow has been satisfied; however, the hub or tip ramp angle limits may have been violated in the last iterative loop.

A three-branch logical test is made to determine the history of ramp angle changes. This test is as follows: If the hub ramp angle has not been previously set to its limit, check to see if it now exceeds its limit. If the limit is not exceeded go to Section XIII. If the limit is exceeded set $\alpha_{RH} = \alpha_{RHL}$ and go to Section VIII.

If the hub ramp angle has been previously set at its limit, but the tip ramp angle has not, check to see if the tip ramp angle is now below its limit. If the limit is not violated, test to see if α_{RT} is positive. If yes, this is considered unacceptable and the calculation is terminated. If no, go to Section XIII. If the limit is violated, set $\alpha_{RT} = \alpha_{RTL}$ and go to Section VI. If both the hub and tip ramp angles have been previously set at their limit go to Section XIII.

SECTION XXV

Calculate new rotor exit annulus area, tip radius, and tip ramp angle.

$$A_{new} = A_{2e} + \frac{A_{2e}(\dot{w}_1 - \dot{w}_2)}{\dot{w}_2}$$

$$R_{T_{new}} = \left[R_{H2}^2 + A_{new}/\pi\,(\delta_{T2}^* + \delta_{H2}^* - 1)\right]^{1/2}$$

$$\alpha_{RT} = \tan^{-1}\left[\frac{(R_{T_{new}} - R_{T1})}{b_R}\right]$$

Go to Section VI.

SECTION XXVI

Calculate a new value for the axial distance between rotor inlet and exit reference stations. The new annulus area calculated in Section XII may also be expressed as

$$A_{new} = \pi (R_{T2}^2 - R_{H2}^2)$$

where

$$R_{T2} = R_{T1} + b_R \tan \alpha_{RTL}$$

and

$$R_{H2} = R_{H1} + b_R \tan \alpha_{RHL}$$

or

$$A_{new}/\pi = (R_{T1}^2 + 2\, b_R\, R_{T1} \tan \alpha_{RTL} + b_R^2 \tan^2 \alpha_{RTL})$$
$$- (R_{H1}^2 + 2\, b_R\, R_{H1} \tan \alpha_{RHL} + b_R^2 \tan^2 \alpha_{RHL})$$

This may be rearranged as:

$$0 = b_R^2 (\tan^2 \alpha_{RTL} - \tan^2 \alpha_{RHL}) + 2\, b_R (R_{T1} \tan \alpha_{RTL} - R_{H1} \tan \alpha_{RHL})$$
$$+ (R_{T1}^2 - R_{H1}^2 - A_{new}/\pi)$$

or

$$0 = b_R^2 + 2\, BE\, b_R + CE$$

where

$$BE = \frac{R_{T1} \tan \alpha_{RTL} - R_{H1} \tan \alpha_{RHL}}{AE}$$

$$CE = \frac{R_{T1}^2 - R_{H1}^2 - A_{new}/\pi}{AE}$$

and

$$AE = (\tan^2 \alpha_{RTL} - \tan^2 \alpha_{RHL})$$

The axial distance between rotor inlet and exit reference stations is given by:

$$b_R = - BE + \sqrt{BE^2 - CE}$$

Calculate new aspect ratio.

$$AR_R = \frac{(R_{T1} - R_{H1})}{b_R}$$

Go to Section VI.

SECTION XXVII

This section is similar to Section XXVI with the restriction that $|\alpha_{RHL}| = |\alpha_{RTL}|$. This gives

$$A_{new}/\pi = (R_{T1}^2 - 2\, b_R\, R_{T1} \tan\alpha_{RHL} - R_{H1}^2 - 2\, b_R\, R_{H1} \tan\alpha_{RHL})$$

or

$$b_R = \frac{R_{T1}^2 - R_{H1}^2 - A_{new}/\pi}{2 \tan\alpha_{RHL}\,(R_{T1} + R_{H1})}$$

Calculate new aspect ratio.

$$AR_R = \frac{(R_{T1} - R_{H1})}{b_R}$$

Go to Section VI.

SECTION XXVIII

Calculate new effective annulus area at stator exit.

$$A_{new} = A_{3e} + \frac{A_{3e}\,(\dot{w}_1 - \dot{w}_3)}{\dot{w}_3}$$

Calculate new hub radius.

$$R_{H_{new}} = \left[R_{T3}^2 - \frac{A_{new}}{\pi\,(\delta_{T3}^* + \delta_{H3}^* - 1)}\right]^{1/2}$$

Calculate hub ramp angle.

$$\alpha_{SH} = \tan^{-1}\left(\frac{R_{H_{new}} - R_{H2}}{b_S}\right)$$

Go to Section XV.

SECTION XXIX

The situation in the stator at this point is similar to that which prevailed in the rotor at Section XXIV and an analogous test is made to determine ramp angle changes. If the hub ramp angle has not been previously set to its limit, check to see if it now exceeds its limit. If the limit is not exceeded go to Section XX. If the limit is exceeded, set $\alpha_{SH} = \alpha_{SHL}$ and go to Section XV.

If the hub ramp angle has been previously set at its limit, but the tip ramp angle has not, check to see if the tip ramp angle is now below its limit. If the limit is not violated, test if α_{ST} is positive. If yes, this is considered unacceptable and the calculation is terminated. If no, go to Section XX. If the limit is violated, set $\alpha_{ST} = \alpha_{STL}$ and go to Section XV. If both the hub and tip ramp angles have been previously set at their limit go to Section XX.

SECTION XXX

Calculate a new effective annulus area at stator exit.

$$A_{new} = A_{3e} + \frac{A_{3e}(\dot{w}_1 - \dot{w}_3)}{\dot{w}_3}$$

Calculate new tip radius.

$$R_{T_{new}} = \left[R_{H3}^2 + \frac{A_{new}}{\pi(\delta_{T3}^* + \delta_{H3}^* - 1)} \right]^{1/2}$$

Calculate new tip ramp angle.

$$\alpha_{ST} = \tan^{-1}\left[\frac{R_{T_{new}} - R_{T2}}{b_S}\right]$$

Go to Section XV.

SECTION XXXI

Using a method similar to that derived in Section XXVI for the rotor, a new value for the axial distance between stator inlet and exit reference stations may be calculated.

$$b_S = -BE + \sqrt{BE^2 - CE}$$

where

$$BE = \frac{R_{T2} \tan \alpha_{STL} - R_{H2} \tan \alpha_{SHL}}{AE}$$

$$CE = \frac{R_{T2}^2 - R_{H2}^2 - A_{new}/\pi}{AE}$$

and

$$AE = \tan^2 \alpha_{STL} - \tan^2 \alpha_{SHL}$$

Calculate new aspect ratio.

$$AR_S = \frac{R_{T2} - R_{H2}}{b_S}$$

Go to Section XV.

SECTION XXXII

This section is similar to Section XXVII for the rotor. The axial distance between the inlet and exit reference stations

$$b_S = \frac{R_{T2}^2 - R_{H2}^2 - A_{new}/\pi}{2 \tan \alpha_{RHL} (R_{T2} + R_{H2})}$$

Calculate new aspect ratio.

$$AR_S = \frac{R_{T2} - R_{H2}}{b_S}$$

Go to Section XV.

APPENDIX B

FORTRAN IV SOURCE DECK LISTING

SECTION INDEX

```
$EXECUTE       IBJOB
$IBJOB N34
$IBFTC MAIN     DD,NOLIST

C        *** ADVANCED MULTISTAGE AXIAL-FLOW COMPRESSOR DESIGN CALCULATION

C        *** CALCULATIONS ARE MADE AT UP TO 11 RADIAL POSITIONS USING THE
C        *** ENERGY, MOMENTUM AND CONTINUITY EQUATIONS.

C        *** AXISYMMETRIC FLOW IS ASSUMED AND NO RADIAL GRADIENTS OF
C        *** ENTROPY NOR EFFECT OF CURVATURES OF STREAMLINES ARE INCLUDED

C        *** BOUNDARY LAYER BLOCKAGE FACTORS ARE INCLUDED WITH MASS FLOW
C        *** BEING INTEGRATED RADIALLY.

C        *** THE WORKING FLUID IS A PERFECT GAS WITH CONSTANT SPECIFIC
C        *** HEAT.

C        *** STAGES WILL BE ADDED UNTIL A SPECIFIED PRESSURE RATIO IS
C        *** INCLUDED.

      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),ACNE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON /SINITL/CON5,CP,DH1,DTIP1,ER1,ER2,ER3,ER4,ER5,ER6,ER7,GAM,
     1MW,RCLIM,RHORT1,RTIP1I,TEMP,UTIP1I,VZTIP1
      COMMON /CHEC/IFLAG,NSLIM
      COMMON /COM2/PTI,TTI,CON1,CON2,CON3,CON4,OOGM1,B1,C1,D1,E1
      COMMON /COM3/IGO,ITS,ITR,IOPT,IIB,IID,IIM,FACTOR,ANM1,CON6,CON7,
     1CON8,ITAL7
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
```

```
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARC,ASO
      NAMELIST /NAME/CP,MW,GAM,TTI,PTI,RCLIM,RTIP1I,UTIP1I,RHORT1,VZTIPO
     1,DTIP1,DH1,B1,C1,D1,E1,N,NSLIM,IPR1,IPR2,VT2OT1,NPR,SRTIP,ARO,
     2DTIP2,DH2,ARHD,ARTD,DRT,BO,C2,D2,E2,VT3OT2,NPS,SSH,ASO,DTIP3,DH3,
     3ASHD,ASTD,DSH,MSH,BPSD,B3,C3,D3,E3

C        *** IPR1 IS A DUMP TRIGGER WHICH IS USED AS FOLLOWS ...
C        ***      WHEN =0, DUMPS WILL NOT OCCUR.
C        ***      WHEN =1, A MINIMUM OF DYNAMIC DUMPS WILL OCCUR.
C        ***      WHEN =2, ALL DYNAMIC DUMPS WILL OCCUR.

C        *** IPR2 IS A TRIGGER WHICH WHEN =1, WILL CAUSE ONLY INFORMATION
C        *** AT THE HUB AND TIP TO BE PRINTED.  IF IPR2 =0, INFORMATION
C        *** AT ALL STATIONS WILL BE PRINTED.

C        *** START SECTION I

   10 READ (5,11) IREAD,(TITL(I),I=1,12)
   11 FORMAT (I1,A5,11A6)
 1900 WRITE (6,26) (TITL(I),I=1,12)
   26 FORMAT (1H123X,A5,11A6///)
      IERROR=0

C        *** READ INITIAL DATA

C        *** READ DATA FOR EACH STAGE

      IF (IREAD.GT.0) GO TO 19
      READ (5,NAME)
      GO TO 21
   19 READ(5,15) CP,MW,GAM,TTI,PTI,RCLIM,RTIP1I,UTIP1I,RHORT1,VZTIPO,
     1 DTIP1,DH1,B1,C1,D1,E1,N,NSLIM,IPR1,IPR2
   15 FORMAT (9F8.0/7F8.0,2I3,2I1)
   20 DO 22 I=1,NSLIM
      READ (5,25) VT2OT1(I),NPR(I),SRTIP(I),ARO(I),DTIP2(I),DH2(I),
     1ARHD(I),ARTD(I),DRT(I),BO(I),C2(I),D2(I),E2(I)
      READ (5,25) VT3OT2(I),NPS(I),SSH(I),ASO(I),DTIP3(I),DH3(I),ASHD(I)
     1,ASTD(I),DSH(I),MSH(I),BPSD(I),B3(I),C3(I),D3(I),E3(I)
   22 CONTINUE
   25 FORMAT(8F9.0)

C        *** END SECTION I

   21 DO 24 I=1,NSLIM
      B2(I)=BO(I)
      ARR(I)=ARO(I)
   24 ARS(I)=ASO(I)
      ITR=0
      ITS=0
      IIM=0
      IIB=0
      IID=0
      VZTIP1=VZTIPO
      CALL CHECK
      IF (IFLAG.GT.0) GO TO 3500
      CALL INITL
      IF (IFLAG.GT.0) GO TO 10
```

```
C        *** CALCULATE AT FIRST ROTOR INLET...WHEEL SPEED, THETA VELOCITY
C        *** ABSOLUTE VELOCITY, STATIC DENSITY, ABSOLUTE FLOW ANGLE,
C        *** RELATIVE FLOW ANGLE, RELATIVE VELOCITY, RELATIVE MACH NUMBER
C        *** SET TOTAL TEMPERATURE, CALCULATE ABSOLUTE MACH NUMBER,
C        *** AXIAL MACH NUMBER, AND SET TOTAL PRESSURE

      CALL INLET
      IF (IFLAG.GT.0) GO TO 10

C        *** TEST THE DUMP TRIGGER

  101 IF (IPR1-1) 120,6000,6000
 6000 CALL OUT1

C        *** THIS ENDS INLET COMPUTATICNS
C        *** NOW LET US START THE ROTOR EXIT COMPUTATIONS
C        *** START MAJOR DO LOOP CN NUMBER OF STAGES

  120 DO 1000 I=1,NSLIM
      IOPT=1
      FACTOR=1.0

C        *** INITIALIZE LOOP COUNTERS

  122 ITAL1=0
      ITAL2=0
      ITAL3=C
      ITAL7=0
      ITAL8=0

C        *** SET RAMP ANGLES TO ZERO

      ALPRT= 0.
      ALPRH= 0.
      ALPST= 0.
      ALPSH= 0.

C        *** SAVE INPUT ASPECT RATIOS AND B2

      ARRI=ARR(I)
      ARSI=ARS(I)
      B2SAVE=B2(I)

C        *** START SECTION VI

C        *** IF DRT(I) (D-FACTOR) AT THE TIP IS NON-ZERO WE MUST
C        *** CALCULATE B2 IN THE POLYNOMIAL EXPRESSION OF WHIRL VELOCITY
C        *** B2/R+C2+D2*R+E2*R*R

  130 IF ((ITAL2+ITAL3+ITAL8).GT.0) GO TO 140
      IF (DRT(I).EQ.0.) GO TO 140

C        *** COMPUTE AXIAL BLADE LENGTH (RCTOR)

      BR= (RTIP1-RH1)/ARR(I)

C        *** CALCULATE TIP RADIUS AT ROTOR EXIT
```

```
      RTIP2= RTIP1+BR*SIN(ALPRT)/COS(ALPRT)

C       *** SET AXIAL VELOCITY AT TIP

      VZTIP2= VZTIP1*VT2OT1(I)

C       *** CALCULATE TIP WHEEL SPEED F.P.S.

      UTIP2= CON4*RTIP2

C       *** PREPARE TO CALCULATE COEFFICIENT OF 1/R IN WHIRL VELOCITY
C       *** POLYNOMIAL FROM D-FACTOR INITIAL

      Q= V1P(1)*(1.-DRT(I))+(UTIP1-VO1(1)-UTIP2)/(2.*SRTIP(I))
      R= 1./(2.*SRTIP(I))
      ER1= 1.-R*R
      S= -2.*(UTIP2+Q*R)/ER1
      T= (VZTIP2**2 + UTIP2**2 - Q*Q)/ER1
      TEMP=S*S-4.*T
      IF (TEMP.GE.0.) GO TO 8011
      WRITE (6,8010)
 8010 FORMAT(//104H WITH INPUT ROTOR INLET AND EXIT CONDITIONS, THE GIVE
     1N DRT WOULD REQUIRE NEGATIVE TANGENTIAL VEL. AT TIP )
      GO TO 3500
 8011 VOTIP2= (-S - SQRT(TEMP))/2.

C       *** B2 IS THE COEFFICIENT OF 1/R

      B2(I)=RTIP2*VOTIP2-C2(I)*RTIP2-D2(I)*RTIP2**2-E2(I)*RTIP2**3

C       *** END SECTION VI

C       *** TEST THE DUMP TRIGGER

  132 IF (IPR1-1) 160,6030,6030
 6030 CALL OUT3
      GO TO 160

C       *** START SECTION VII

C       *** COMPUTE AXIAL BLADE LENGTH (ROTOR)

  140 BR= (RTIP1-RH1)/ARR(I)

C       *** CALCULATE ROTOR EXIT TIP RADIUS

      RTIP2= RTIP1+BR*SIN(ALPRT)/COS(ALPRT)

C       *** CALCULATE ROTOR EXIT TIP AXIAL VELOCITY

      VZTIP2= VZTIP1*VT2OT1(I)

C       *** CALCULATE ROTOR EXIT TIP WHEEL SPEED

      UTIP2= CON4*RTIP2

C       *** END SECTION VII
```

```
C        *** START SECTICN VIII
  160 VZ2(1)= VZTIP2
C        *** CALCULATE HUB RADIUS AT RCTCR EXIT
      RH2= RH1 & BR*SIN(ALPRH)/CCS(ALPRH)
C        *** CALCULATE EFFECTIVE TIP AND HUB RADII
      R2(1)=SQRT(CTIP2(I)*RTIP2**2&(1.-CTIP2(1))*RH2**2)
      R2(N)=SQRT(DH2(I)*RH2**2&(1.-DH2(I))*RTIP2**2)
C        *** CALCULATE GEOMETRIC AREA AND EFFECTIVE AREA
      A2G=3.1415926*(RTIP2**2-RH2*RH2)
      A2E=3.1415926*(R2(1)**2-R2(N)**2)
C        *** CALCULATE TIP WHEEL SPEED
      U2(1)= CCN4*R2(1)
C        *** CALCULATE TIP TANGENTIAL VELOCITY
      VC2(1)= B2(I)/R2(1) & C2(I) &D2(I)*R2(1)&E2(1)*R2(1)**2
C        *** CALCULATE TIP RCTOR EXIT TCTAL TEMPERATURE
      TT2(1)= TT1(1)&(U2(1)*VO2(1)-U1(1)*VC1(1))/CCN5
C        *** PREPARE TC CALCULATE CONSTANT IN THE AXIAL VELCCITY EQ. (K1)
      ER1= 2.*B2(I)*C2(I)
      ER2= 4.*B2(I)*D2(I)&2.*C2(I)**2
      ER3= 6.*B2(I)*E2(I)&6.*C2(I)*D2(I)
      ER4= 4.*C2(I)*E2(I)&2.*D2(I)**2
      ER5= 10.*D2(I)*E2(I)/3.
      ER6= 1.5*E2(I)**2
  170 K2= VZTIP2**2-ER1/R2(1)&ER2*ALCG(R2(1)) & ER3*R2(1) & ER4*R2(1)**2
     1 & ER5*R2(1)**3 & ER6*R2(1)**4 - CON1*TT2(1)
C        *** END SECTICN VIII
C        *** START SECTICN IX
  180 ER7=(R2(1)-R2(N))/ANM1
C        *** DIVIDE FLOW PATH INTC EQUAL PARTS
C        *** CALCULATE INTERMEDIATE RADII, WHEEL SPEED, TANGENTIAL
C        *** VELCCITY, TCTAL TEMPERATURE, AND AXIAL VELCCITY AT EACH
C        *** STREAMLINE
      DC 190 M=2,N
      R2(M)= R2(M-1) - ER7
      U2(M)= CCN4*R2(M)
      VC2(M)= B2(1)/R2(M) & C2(I) &D2(I)*R2(M)&E2(1)*R2(M)**2
      TT2(M)= TT1(M)&(U2(M)*VO2(M)-U1(M)*VO1(M))/CCN5
      TEMP=ER1/R2(M)-ER2*ALCG(R2(M))-ER3*R2(M)-ER4*R2(M)**2-ER5*R2(M)**3
```

```
     1-ER6*R2(M)**4+CON1*TT2(M)+K2
      IF (TEMP.GE.0.) GO TO 190
      WRITE (6,8016)
 8016 FORMAT (//66H AXIAL VELOCITY IS NEGATIVE FOR SOME RADIAL LOCATION
     1AT ROTOR EXIT )
      GO TO 3500
  190 VZ2(M)=SQRT(TEMP)

C        *** END SECTION IX

C        *** START SECTION X

C        *** CALCULATE AT ROTOR EXIT FOR ALL STREAMLINES ...
C        *** TOTAL PRESSURE, TOTAL DENSITY, ABSOLUTE VELOCITY, STATIC
C        *** DENSITY, ABSOLUTE FLOW ANGLE, RELATIVE FLOW ANGLE, RELATIVE
C        *** VELOCITY, ROTOR D-FACTOR, STATIC TEMPERATURE, STATIC
C        *** PRESSURE, SONIC VELOCITY, ABSOLUTE MACH NUMBER, OMEGA BAR,
C        *** LOSS FUNCTION, RELATIVE MACH NUMBER, AND AXIAL MACH NUMBER

      DO 210 M=1,N
      TEMP=TT2(M)/TT1(M)
      IF (TEMP.GE.0.) GO TO 8019
      WRITE (6,8018)
 8018 FORMAT (//57H THE ABSOLUTE TOTAL TEMPERATURE AT ROTOR EXIT IS NEGA
     1TIVE )
      GO TO 3500
 8019 PT2(M)=PT1(M)*TEMP**(NPR(I)*CON6)
      RHOT2(M)= PT2(M)*144./(RM*TT2(M))
      V2(M)= SQRT(VZ2(M)**2 + VO2(M)**2)
      TEMP=1.-V2(M)**2/(CON1*TT2(M))
      IF (TEMP.GE.0.) GO TO 8021
      WRITE (6,2020)
 2020 FORMAT (//58H THE ABSOLUTE STATIC TEMPERATURE AT ROTOR EXIT IS NEG
     1ATIVE )
      GO TO 3500
 8021 RHOS2(M)=RHOT2(M)*TEMP**COGM1
      BETA2(M)= ATAN(VO2(M)/VZ2(M))
      BETA2P(M)=ATAN((U2(M)-VO2(M))/VZ2(M))
      V2P(M)= VZ2(M)/COS(BETA2P(M))
      DR(M)= 1.-V2P(M)/V1P(M) + (U1(M)-VO1(M)-U2(M)+VO2(M))/(2.*SRTIP(I)
     1 *V1P(M)*(RTIP1+RTIP2)/(R1(M)+R2(M)))
      TS2(M)= TT2(M) - V2(M)**2/CON1
      ATWO(M)= SQRT(CON3*TS2(M))
      M2(M)= V2(M)/ATWO(M)
      TEMP=1.+CON7*(1.-(R1(M)/R2(M))**2)*U2(M)**2/(CON3*(TT1(M)+(V1P(M)*
     1*2-V1(M)**2)/CON1))
      IF (TEMP.GE.0.) GO TO 8023
      WRITE (6,8022)
 8022 FORMAT (//86H THE IDEAL RELATIVE TOTAL PRESSURE IN ROTOR OMEGA BAR
     1 EQUATION IS NEGATIVE.  BAD DATA. )
      GO TO 3500
 8023 PRI(M)=TEMP**CON6
      WRB(M)= PRI(M)*(1.-PT2(M)/PT1(M)/(TT2(M)/TT1(M))**CON6)/(1. -
     1 (1./(1.+CON7*M1P(M)**2))**CON6)
      M2P(M)= V2P(M)/ATWO(M)
      MZ2(M)= VZ2(M)/ATWO(M)
  210 ZR(M)=WRB(M)*COS(BETA2P(M))/(2.*SRTIP(I)*(RTIP1+RTIP2)/(R1(M) +
     1 R2(M)))
```

```
C         *** END SECTION X

C         *** START SECTION XI

C         *** CALCULATE MASS FLOW

  220 W2= 0.
      DO 230 M=1,NM1
      RS2VZ2(M)= (RHOS2(M)*VZ2(M)&RHOS2(M&1)*VZ2(M&1))/2.
      ATO(M)= 3.1415926*(R2(M)**2-R2(M&1)**2)/144.
  230 W2= W2 & RS2VZ2(M)*ATO(M)

C         *** END SECTION XI

C         *** ROTOR EXIT COMPUTATIONS ARE COMPLETED
C         *** PREPARE TO MAKE LIMIT CHECKS - PRIOR TO STATOR CALCULATIONS

C         *** START SECTION XII

      EWA= ABS(W2-W1)/W2

C         *** TEST FOR MASS FLOW BALANCE
C         *** IF MASS FLOW MATCHES GO TO 250

  232 IF (EWA.LE..001) GO TO 235

C         *** CHECK LOOP COUNT AND IF GREATER THAN OR EQUAL TO 50 PROCEED
C         *** TO NEXT DATA SET

      IF (ITAL1.GE.50) GO TO 3000
      ITAL1= ITAL1 & 1

C         *** TEST THE DUMP TRIGGER

      IF (IPR1-1) 231,6050,6050
 6050 CALL OUT2
  231 IF (ITR-1) 233,254,234

C         *** END SECTION XII

C         *** START SECTION XXIII

C         *** CALCULATE NEW EFFECTIVE AREA TO MATCH MASS FLOW

  233 ANEW= A2E & (W1-W2)*A2E/W2

C         *** NEW HUB RADIUS

      TEMP=RTIP2**2-ANEW/(3.1415927*(OH2(I)&OTIP2(I)-1.))
      IF (TEMP.GE.0.) GO TO 8025
      WRITE (6,8024)
 8024 FORMAT (//98H AREA REQUIRED TO MATCH MASS FLOW WITH GIVEN TIP RADI
     1US REQUIRES NEGATIVE HUB RADIUS AT ROTOR EXIT )
      GO TO 3500
 8025 RHNEW=SQRT(TEMP)

C         *** CALCULATE ROTOR HUB RAMP ANGLE
```

```
      ALPRH= ATAN((RHNEW-RH1)/BR)
      GO TO 160
C         *** END SECTION XXIII
C         *** START SECTION XXV
C         *** CALCULATE NEW EFFECTIVE AREA
  254 ANEW=A2E&(W1-W2)*A2E/W2
C         *** CALCULATE NEW TIP RADIUS
      RTNEW=SQRT(RH2**2&ANEW/(3.1415927*(DH2(I)&DTIP2(I)-1.)))
C         *** CALCULATE NEW TIP RAMP ANGLE
      ALPRT=ATAN((RTNEW-RTIP1)/BR)
      GO TO 130
C         *** END SECTION XXV
C         *** CALCULATE NEW GEOMETRIC AREA
  234 ANEW=A2G&(W1-W2)*A2G/W2
C         *** CALCULATE NEW AXIAL LENGTH
      TAARHL= SIN(ARHL(I))/COS(ARHL(I))
      IF ( ABS(ARTL(I)) .NE. ABS(ARHL(I)) ) GO TO 253
C         *** START SECTION XXVII
      BR=(RTIP1**2-RH1**2-ANEW/3.1415926)/(2.*TAARHL*(RTIP1&RH1))
      GO TO 272
C         *** END SECTION XXVII
C         *** START SECTION XXVI
  253 TAARTL= SIN(ARTL(I))/COS(ARTL(I))
      AE= TAARTL**2 - TAARHL**2
      BE= (RTIP1*TAARTL - RH1*TAARHL)/AE
      CE=(RTIP1**2-RH1**2-ANEW/3.1415926)/AE
      BR= -BE & SQRT(BE**2 - CE)
C         *** CALCULATE NEW ASPECT RATIO
  272 ARR(I)=(RTIP1 - RH1)/BR
      GO TO 130
C         *** END SECTION XXVI
C         *** START SECTION XXIV
  235 IF (ITR-1) 236,237,250
```

```
C        *** IF NEW RAMP ANGLE EXCEEDS ITS LIMIT SET IT TO THE LIMIT

  236 IF (ALPRH.GT.ARHL(I)) GO TO 2332
      GO TO 250




 2332 ALPRH= ARHL(I)
      ITR=1
      WRITE (6,2333)
 2333 FORMAT (1H030X43H*** ROTOR HUB RAMP ANGLE LIMIT VIOLATED *** / )
      GO TO 160




C        *** IF NEW RAMP ANGLE EXCEEDS ITS LIMIT SET IT TO THE LIMIT

  237 IF (ALPRT.GE.ARTL(I)) GO TO 255
      ALPRT=ARTL(I)
      ITR=2
      WRITE (6,2335)
 2335 FORMAT (1H030X43H*** ROTOR TIP RAMP ANGLE LIMIT VIOLATED *** / )
      GO TO 130

C        *** ENSURE THAT THE TIP RAMP ANGLE IS NOT POSITIVE

  255 IF (ALPRT.LE.0.) GO TO 250
      WRITE (6,256)
  256 FORMAT (// 45H ROTOR TIP RAMP ANGLE IS POSITIVE.  BAD DATA )
      GO TO 3500

C        *** END SECTION XXIV

  250 CALL MIDDLE
      IGO=IGO
      GO TO (360,140,3000,3010,3020,3500),IGO
  360 ITAL7=0
      ITS=0

C        *** CHECK HUB D-FACTOR AGAINST ITS LIMIT
C        *** RECALCULATE 1/R COEFFICIENT TO MEET D-FACTOR TEST

      IF (IOPT.EQ.0) GO TO 420
      DF3=DS(N)-DSH(I)
      IF (DF3) 285,500,391

C        *** START SECTION XX (CONTINUED AT ST. 421)

  420 IF (DS(N).LE.DSH(I)) GO TO 500
      GO TO 421
  285 IF (ITAL8.EQ.0) GO TO 500
      IF (ABS(DF3/DSH(I)).LE..001) GO TO 392
      DFL3=DF3
      BL3=B2(I)
```

```
      IID=1
  387 B2(I)=BH3-DFH3*(BH3-BL3)/(DFH3-DFL3)
  389 ITAL8=ITAL8+1

C        *** CHECK LOOP COUNT

      IF (ITAL8.GE.50) GO TO 3030
      ALPRH=0.0
      ALPRT=0.0
      ARR(I)=ARRI
      ALPSH=0.
      ALPST=0.
      ARS(I)=ARSI
      GO TO 368
  391 IF (ITAL8.EQ.0) GO TO 390
      IF (ABS(DF3/DSH(I)).LE..001) GO TO 392
      DFH3=DF3
      BH3=B2(I)
      IF (IID.GT.0) GO TO 387
      B2(I)=CH3*B2(I)
      GO TO 389
  390 DFH3=DF3
      BH3=B2(I)

C        *** SECTION XX (CONTINUED)

  421 WRITE (6,2355)
 2355 FORMAT (1H030X42H*** STATOR HUB D FACTOR LIMIT VIOLATED *** / )

C        *** CHECK LOOP COUNT

      IF (ITAL8.GE.50) GO TO 3030
      ITAL8= ITAL8 + 1

C        *** IF THE STATOR HUB D FACTOR LIMIT IS 1., THE ABSOLUTE
C        *** VELOCITY AT THE STATOR EXIT MAY BE CALCULATED DIRECTLY.
C        *** THE EQUATIONS USED OTHERWISE MAY INTRODUCE EXTRANEOUS ROOTS
C        *** WHICH WILL BE DEALT WITH BY THE PROGRAM.

      IF (DSH(I).NE.1.) GO TO 425
      VO2(N)=2.*SSH(I)*V3(N)+VO3(N)
      GO TO 440
  425 AF= (-V3(N)-VO3(N)/(2.*SSH(I)))/(DSH(I)-1.)
      BF= 1./((DSH(I)-1.)*2.*SSH(I))
      CF= -AF*BF/(1.-BF*BF)
      DF= (VZ2(N)**2-AF*AF)/(1.-BF*BF)
      TEMP=CF*CF-DF
      IF (TEMP.GE.0.) GO TO 8039
      WRITE (6,8038)
 8038 FORMAT (// 96H IN CORRECTING FOR EXCESSIVE STATOR HUB D-FACTOR, SQ
     1UARE ROOT OF NEGATIVE NUMBER WAS ENCOUNTERED )
      GO TO 3500

C        *** CALCULATE BOTH ROOTS

 8039 VO2(N)=-CF+SQRT(TEMP)
      VO2SV=-CF-SQRT(TEMP)
      IF (VO2(N).GE.0.) GO TO 433
```

```
C        *** THE FIRST ROOT IS NEGATIVE.  USE THE SECOND ROOT IF POSITIVE

      IF (VO2SV.GE.0.) GO TO 437

C        *** BOTH ROOTS WERE NEGATIVE

      WRITE (6,8040)
 8040 FORMAT (// 62H NO POSITIVE ROOTS FOUND FOR STATOR ABSOLUTE VELOCIT
     1Y EQUATION )
      GO TO 3500

C        *** THE FIRST ROOT IS POSITIVE.  IF THE SECOND ROOT IS NEGATIVE
C        *** USE THE FIRST

  433 IF (VO2SV.LT.0.) GO TO 440

C        *** BOTH ROOTS WERE POSITIVE.  DETERMINE WHICH SATISFIES THE
C        *** D FACTOR EQUATION

      SROOT=SQRT(VO2(N)**2+VZ2(N)**2)
      TRY1=1.-V3(N)/SROOT-(VO3(N)-VO2(N))/(2.*SSH(I)*SROOT)
      SROOT=SQRT(VO2SV**2+VZ2(N)**2)
      TRY2=1.-V3(N)/SROOT-(VO3(N)-VO2SV )/(2.*SSH(I)*SROOT)
      IF (ABS(TRY1-DSH(I))/DSH(I).GT..01)   GO TO 434

C        *** THE FIRST ROOT SATISFIED THE D FACTOR EQUATION.  IF THE
C        *** SECOND DOES NOT, USE THE FIRST

      IF (ABS(TRY2-DSH(I))/DSH(I).GT..01)   GO TO 440

C        *** BOTH ROOTS SATISFIED THE D FACTOR EQUATION.  USE THE SMALLER

      IF (VO2(N)-VO2SV) 440,440,437

C        *** THE FIRST ROOT DID NOT SATISFY THE D FACTOR EQUATION.
C        *** IF THE SECOND DOES, USE IT

  434 IF (ABS(TRY2-DSH(I))/DSH(I).LE..01)   GO TO 437

C        *** NEITHER ROOT SATISFIED THE D FACTOR EQUATION

      WRITE (6,435)
  435 FORMAT (// 69H NEITHER POSITIVE ROOT WOULD SATISFY THE STATOR HUB
     1D FACTOR EQUATION )
      GO TO 3500

C        *** USE THE SECOND ROOT

  437 VO2(N)=VO2SV
  440 B2(I)=R2(N)*VO2(N)-C2(I)*R2(N)-D2(I)*R2(N)**2-E2(I)*R2(N)**3

C        *** END SECTION XX

      ALPRH=0.
      ALPRT=0.
      ALPSH=0.
      ALPST=0.
```

```
      ARS(I)=ARSI
      ARR(I)=ARRI
      IF (IOPT.EQ.0) GO TO 368
      CH3= .95
      IF (BF3.GT.B2(I)) GO TO 368
      CH3= 1.05

C        *** TEST THE DUMP TRIGGER

  368 IF (IPR1-1) 140,6150,6150
 6150 CALL OUT7
      GO TO 140
  392 DS(N)=DSH(I)

C        *** START SECTION XXI (CONTINUED IN OUTPUT S.R.)

  500 CALL OUTPUT
      IID=0
      IF((RCO-RCLIM).LT.0.) GO TO 501
      WRITE (6,502)
  502 FORMAT (1H024X71H*** OVERALL PRESSURE RATIO LIMIT HAS BEEN REACHED
     1 -- GO TO NEW DATA *** // )
      GO TO 10
  501 IF ((I-NSLIM).LT.0) GO TO 540
      WRITE (6,504)
  504 FORMAT (1H020X81H*** NUMBER OF STAGES FOR THIS DATA SET HAS BEEN R
     1EACHED -- GO TO NEW DATA SET *** //)
      GO TO 10

C        *** END SECTION XXI

C        *** START SECTION XXII

C        *** PUT STATOR EXIT PARAMETERS INTO ROTOR INLET FOR NEXT STAGE

  540 DO 550 M=1,N
      U1(M)=UTIP1I*R3(M)/RTIP1I
      VO1(M)= VO3(M)
      V1(M)= V3(M)
      BETA1(M)= BETA3(M)
      BETA1P(M)= ATAN((U1(M)-VO1(M))/VZ3(M))
      V1P(M)= VZ3(M)/COS(BETA1P(M))
      VZ1(M)= VZ3(M)
      R1(M)= R3(M)
      AONE(M)= SQRT(CON3*TT3(M)-V1(M)**2/CON1)
      M1P(M)=V1P(M)/AONE(M)
      TT1(M)= TT3(M)
      M1(M)= V1(M)/AONE(M)
      MZ1(M)= VZ1(M)/AONE(M)
  550 PT1(M)= PT3(M)
      RTIP1= RTIP3
      RH1= RH3
      VZTIP1= VZTIP3
      UTIP1= U1(1)
      WRITE (6,2360)
 2360 FORMAT (1H1)
 1000 CONTINUE
```

```
C        *** PROGRAM COMPLETED CURRENT STAGE - OFF TO ANOTHER STAGE
      GO TO 10
C        *** END SECTION XXII
 3000 WRITE (6,3001)
 3001 FORMAT (1H05X105H*** ERROR MESSAGE *** ITERATION COUNT EXCEEDED 50
     1 ON FLOW LOSS GREATER THAN .001 TEST,GO TO NEXT DATA SET /// )
      GO TO 3500
 3010 IF (IOPT.EQ.1) GO TO 3600
      WRITE (6,3011)
 3011 FORMAT (1H0 5X 92H*** ERROR MESSAGE *** ITERATION COUNT EXCEEDED 5
     10 ON MACH NO. LIMIT TEST, GO TO NEW DATA SET /// )
      GO TO 3500
 3020 IF (IOPT.EQ.1) GO TO 3600
      WRITE (6,3021)
 3021 FORMAT (1H0 5X 93H*** ERROR MESSAGE *** ITERATION COUNT EXCEEDED 5
     10 ON AIR ANGLE LIMIT TEST, GO TO NEW DATA SET /// )
      GO TO 3500
 3030 IF (IOPT.EQ.1) GO TO 3600
      WRITE (6,3031)
 3031 FORMAT (1H0 5X100H*** ERROR MESSAGE *** ITERATION COUNT EXCEEDED 5
     10 ON DIFFUSION FACTOR LIMIT TEST, GO TO NEW DATA SET /// )
 3500 IERROR=1
      CALL OUTPUT
      GO TO 10
 3600 FACTOR=.998
      ARR(I)=ARRI
      ARS(I)=ARSI
      B2(I)=B2SAVE
      WRITE (6,3601) I
 3601 FORMAT (///1X36(1H*),3X5HSTAGEI3,33H IS NOT THE OPTIMUM CONFIGURAT
     1ION 3X36(1H*) /// )
      IOPT=0
      GO TO 122
      END
```

```
$IBFTC INITL   DD,NOLIST
C        ***  INITL SUBROUTINE
      SUBROUTINE INITL
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON /SINITL/CON5,CP,DH1,DTIP1,ER1,ER2,ER3,ER4,ER5,ER6,ER7,GAM,
     1MW,RCLIM,RHORT1,RTIP1I,TEMP,UTIP1I,VZTIP1
      COMMON /CHEC/IFLAG,NSLIM
      COMMON /COM2/PTI,TTI,CON1,CON2,CON3,CON4,OOGM1,B1,C1,D1,E1
      COMMON /COM3/IGO,ITS,ITR,IOPT,IIB,IID,IIM,FACTOR,ANM1,CON6,CON7,
     1CON8,ITAL7
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCC,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO

C        *** WRITE OUT INPUT DATA

      WRITE (6,2000)
 2000 FORMAT(1H020X80H***--*** PARAMETRIC STUDY OF ADVANCED MULTISTAGE A
     1XIAL-FLOW COMPRESSORS ***--***  ////35X50H***   R O T O R   I N L E
     2T   I N P U T   D A T A   *** // )
      WRITE (6,2010) N,NSLIM,CP,MW,GAM,TTI,PTI,RCLIM,RTIP1I,UTIP1I,
     1 RHORT1,VZTIP1,DTIP1,DH1,B1,C1,D1,E1
 2010 FORMAT (/3X8HNO. RAD.8X6HNUMBER8X8HSP. HEAT8X8HMOL. WT.6X8HRATIO O
     1F4X45HIN. TOT. TEMP.    IN. TOT. PR.   MASS AVG. TOT./3X8HSTATIONS8X
     26HSTAGES6X12H(BTU/(LB-R))6X7H(MOLES)7X8HSP. HEAT7X8H(DEG. R)9X5H(P
     3SI)8X9HPR. RATIO //I8,I15,F17.4,F16.4,F14.4,F16.4,F15.4,F14.4/// 1
     47X40HTIP RADIUS   TIP WHEEL SPEED   HUB TO TIP5X10HAXIAL VEL.4X27HT
     5IP BLOCKAGE    HUB BLOCKAGE/18X8H(INCHES)7X8H(FT/SEC)5X12HRADIUS RA
     6TIO5X8H(FT/SEC)8X6HFACTOR9X6HFACTOR // F26.4,F16.4,F13.4,F16.4,F14
     7.4,F15.4 /// 38X44HCOEFFICIENTS IN TANGENTIAL VELOCITY EQUATION //
```

```
     837X1HB14X1HC14X1HC14X1HE // 27X4F15.4 /// 1X118(1H*) // )
      IF (N.LE.11) GO TO 28
      WRITE (6,27)
   27 FORMAT (//56H HAVE CONSIDERED MORE THAN 10 FLOW CHANNELS.  CHECK D
     1ATA )
      GO TO 10
   28 IF (NSLIM.LE.50) GO TO 30
      WRITE (6,29)
   29 FORMAT (// 49H HAVE CONSIDERED MORE THAN 50 STAGES.  CHECK DATA )
      GO TO 10

C        *** START SECTION II

C        *** SET TIP EQUAL TO INITIAL TIP RADIUS

   30 RTIP1= RTIP1I

C        *** CALCULATE GAS CONSTANT

      RM= 1545.4/MW
      AN= N
      NM1= N-1
      ANM1=NM1
      DO 33 I=1,NSLIM

C        *** CHANGE DEGREES TO RADIANS

      ARHL(I)=ARHD(I)*.0174533
      BPSH(I)=BPSD(I)*.0174533
      ARTL(I)=ARTD(I)*.0174533
      ASHL(I)=ASHD(I)*.0174533
   33 ASTL(I)=ASTD(I)*.0174533

C        *** CALCULATE TOTAL DENSITY

      RHOT1=PTI*144./(RM*TTI)

C        *** CALCULATE RADIUS OF HUB STREAMLINE

      RH1= RTIP1*RHORT1

C        *** CALCULATE RADIUS OF HUB AND TIP STREAMLINES

      WRITE (6,2330)
 2330 FORMAT (1H1)
      IF (DTIP1.GT.0.) GO TO 8001
      WRITE (6,8000)
 8000 FORMAT (//52H TIP BLOCKAGE FACTOR NOT POSITIVE AT INLET. BAD DATA)
      GO TO 10
 8001 R1(1)=SQRT(DTIP1*RTIP1**2&(1.-DTIP1)*RH1**2)
      IF (DH1.GT.0.) GO TO 8003
      WRITE (6,8002)
 8002 FORMAT (//52H HUB BLOCKAGE FACTOR NOT POSITIVE AT INLET  BAD DATA)
      GO TO 10
 8003 R1(N)=SQRT(DH1*RH1**2&(1.-DH1)*RTIP1**2)

C        *** CALCULATE COEFFICIENTS IN THE AXIAL VELOCITY EQUATION
```

```
      ER1= 2.*B1*C1
      ER2= 4.*B1*D1+2.*C1*C1
      ER3= 6.*B1*E1+6.*C1*D1
      ER4= 4.*C1*E1+2.*D1*D1
      ER5=10.*D1*E1/3.
      ER6=1.5*E1*E1
C        *** SET WHEEL TIP SPEED
      UTIP1=UTIP1I
C        *** CALCULATE CONSTANT OF INTEGRATION
      K1= VZTIP1**2-ER1/ R1(1)+ER2*ALOG(R1(1))+ER3*R1(1)+ER4*R1(1)**2 +
     1 ER5*R1(1)**3 + ER6*R1(1)**4
C        *** SET AXIAL VELOCITY AT THE TIP = TO INITIAL AXIAL VELOCITY
   40 VZ1(1)= VZTIP1
C        *** END SECTION II
C        *** START SECTION III
   50 ER7= (R1(1)-R1(N))/ANM1
      DO 60 M=2,N
C        *** CALCULATE STREAMLINE RADII
      R1(M)= R1(M-1) - ER7
C        *** CALCULATE AXIAL VELOCITY AT EACH RADIUS
      TEMP  =(ER1/R1(M)-ER2*ALOG(R1(M))-ER3*R1(M) - ER4*R1(M)**2 -
     1 ER5*R1(M)**3 - ER6*R1(M)**4 + K1)
      IF (TEMP.GE.0.) GO TO 8005
      WRITE (6,8004)
 8004 FORMAT (//61H AXIAL VELOCITY IS NEGATIVE FOR SOME RADIAL LOCATION
     1AT INLET )
      GO TO 10
 8005 VZ1(M)=TEMP**.5
   60 CONTINUE
C        *** END SECTION III
C        *** CALCULATE CONSTANTS
      OOGM1= 1./(GAM-1.)
      CON1= 50056.*CP
      CON2= CON1*TTI
      CON3= 32.174*GAM*RM
      CON4= UTIP1I/RTIP1I
      CON5= .5*CON1
      CON6= GAM/(GAM-1.)
      CON7= (GAM-1.)/2.
      CON8= (GAM-1.)/GAM
      RETURN
   10 IFLAG=1
```

```
RETURN
END
```

```
$IBFTC MIDDLE  DD,NOLIST
C        ***  MIDDLE SUBROUTINE
      SUBROUTINE MIDDLE
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON /CHEC/IFLAG,NSLIM
      COMMON /COM2/PTI,TTI,CON1,CON2,CON3,CON4,COGM1,B1,C1,D1,E1
      COMMON /COM3/IGO,ITS,ITR,IOPT,IIB,IID,IIM,FACTOR,ANM1,CON6,CON7,
     1CON8,ITAL7
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATC,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
  250 ITAL1 = 0
      I=I
      N=N
      NM1=NM1
      IGO=1
      ITR=0

C        *** ALTER THE COEFFICIENT OF 1/R IN THE TANGENTIAL VELOCITY
C        *** POLYNOMIAL TO SATISFY MACH NUMBER LIMIT

      IF (IOPT.EQ.0) GO TO 400
      DF1=M2(N)-MSH(I)
      IF (DF1) 283,260,251

C        *** START SECTION XIII (CONTINUED AT ST. 401)

  400 IF  (M2(N).LE.MSH(I)) GO TO 260
      GO TO 401
  283 IF (ITAL2.EQ.0) GO TO 260
```

```
      IF  (ABS(DF1/MSH(I)).LE..001) GO TC 252
      DFL1=DF1
      BL1=B2(I)
      IIM=1
  257 B2(I)=BH1-DFH1*(BH1-BL1)/(DFH1-DFL1)
  259 ITAL2=ITAL2+1
C        *** CHECK LOOP CCUNT
      IF (ITAL2.GE.50) GO TO 3010
      ALPRH=0.0
      ALPRT=0.0
      ARR(I)=ARRI
      GO TO 258
  251 IF (ITAL2.EQ.0) GO TO 280
      IF (ABS(DF1/MSH(I)).LE..001) GO TC 252
      DFH1=DF1
      BH1=B2(I)
      IF(IIM.GT.0) GO TO 257
      B2(I)=CH1*B2(I)
      GO TO 259
  280 DFH1=DF1
      BH1=B2(I)
C        *** SECTION XIII (CONTINUED)
  401 WRITE (6,2337)
 2337 FORMAT (1H030X42H*** STATOR HUB MACH NO. LIMIT VIOLATED *** / )
C        *** CHECK LOOP COUNT
      IF (ITAL2.GE.50) GO TO 3010
      ITAL2= ITAL2 + 1
      AA=MSH(I)**2*CON3*FACTOR
      BB= AA/CON1
      CC= -BB*U2(N)/(1.+BB)
      DD= (VZ2(N)**2*(1.+BB)-AA*TT1(N)+2.*BB*U1(N)*VO1(N))/(1.+BB)
      TEMP=CC**2-DD
      IF (TEMP.GE.0.) GO TO 8027
      WRITE (6,8026)
 8026 FORMAT(//106H IN CORRECTING FOR EXCESSIVE HUB MACH NUMBER AT ROTOR
     1 EXIT, SQUARE ROOT OF NEGATIVE NUMBER WAS ENCCUNTERED )
      GO TO 3500
 8027 VO2(N)=-CC+SQRT(TEMP)
      B2(I)=R2(N)*VO2(N)-C2(I)*R2(N)-D2(I)*R2(N)**2-E2(I)*R2(N)**3
      ALPRH=0.
      ALPRT=0.
      ARR(I)=ARRI
      IF (IOPT.EQ.0) GO TO 258
      CH1 = 0.95
      IF (BH1.GT.B2(I)) GO TO 258
      CH1 = 1.05
C        *** TEST THE DUMP TRIGGER
  258 IF (IPR1-1) 140,6070,6070
 6070 CALL OUT4
      GO TO 140
```

```
C        *** END SECTION XIII

  252 M2(N)=MSH(I)
  260 ITAL2= 0
      IIM=0

C        *** CHECK RELATIVE FLOW ANGLE.  IF LESS THAN THE LIMIT, ALTER
C        *** THE COEFFICIENT OF 1/R IN THE TANGENTIAL VELOCITY POLYNOMIAL

      IF (IOPT.EQ.0) GO TO 410
      DF2=BETA2P(N)-BPSH(I)
      IF (DF2) 281,299,284

C        *** START SECTION XIV (CONTINUED AT ST. 411)

  410 IF (BETA2P(N).GE.BPSH(I)) GO TO 299
      GO TO 411
  284 IF (ITAL3.EQ.0) GO TO 299
      IF (ABS(DF2/BPSH(I)).LE..001) GO TO 282
      DFL2=DF2
      BL2=B2(I)
      IIB=1
  287 B2(I)=BH2-DFH2*(BH2-BL2)/(DFH2-DFL2)
  289 ITAL3=ITAL3+1

C        *** CHECK LOOP COUNT

      IF (ITAL3.GE.50) GO TO 3020
      ALPRH=0.0
      ALPRT=0.0
      ARR(I)=ARRI
      GO TO 268
  281 IF (ITAL3.EQ.0) GO TO 290
      IF (ABS(DF2/BPSH(I)).LE..001) GO TO 282
      DFH2=DF2
      BH2=B2(I)
      IF (IIB.GT.0) GOTO 287
      B2(I)=CH2*B2(I)
      GO TO 289
  290 DFH2=DF2
      BH2=B2(I)

C        *** SECTION XIV (CONTINUED)

  411 WRITE (6,2340)
 2340 FORMAT (1H030X47H*** ROTOR HUB RELATIVE ANGLE LIMIT VIOLATED ***/)

C        *** CHECK LOOP COUNT

      IF (ITAL3.GE.50) GO TO 3020
      ITAL3= ITAL3 + 1
      B2(I)=(U2(N)-VZ2(N)*SIN(BPSH(I))/COS(BPSH(I)))*R2(N)-C2(I)*R2(N)-
     1D2(I)*R2(N)**2-E2(I)*R2(N)**3
      ALPRH=0.
      ALPRT=0.
      ARR(I)=ARRI
      IF (IOPT.EQ.0) GO TO 268
```

```
      CH2=0.95
      IF (BH2.GT.B2(I)) GO TO 268
      CH2=1.05

C         *** TEST THE DUMP TRIGGER

  268 IF (IPR1-1) 140,6080,6080
 6080 CALL CUT5
      GO TO 140

C         *** END SECTION XIV

  282 BETA2P(N)=BPSH(I)

C         *** START SECTION XV

C         *** WE HAVE SATISFIED ALL TESTS - OFF TO STATOR CALCULATIONS
C         *** BEGIN STATOR EXIT COMPUTATIONS
C         *** RESET LOOP COUNTERS

  299 ITAL3=0
      IIB=0

C         *** CALCULATE BLADE AXIAL LENGTH

  300 BS=(RTIP2 - RH2)/ARS(I)

C         *** CALCULATE STATOR EXIT TIP RADIUS

      RTIP3= RTIP2 & BS*SIN(ALPST)/COS(ALPST)

C         *** SET TOTAL TEMPERATURE AT THE TIP

      TT3(1)= TT2(1)

C         *** CALCULATE STATION EXIT HUB RADIUS

      RH3= RH2 & BS*SIN(ALPSH)/COS(ALPSH)

C         *** CALCULATE TIP AND HUB STREAMLINE RADII

      R3(1)=SQRT(DTIP3(I)*RTIP3**2&(1.-DTIP3(I))*RH3**2)
      R3(N)=SQRT(DH3(I)*RH3**2&(1.-DH3(I))*RTIP3**2)

C         *** CALCULATE GEOMETRIC AREA OF STATOR EXIT

      A3G= 3.1415926*(RTIP3**2 - RH3**2)

C         *** CALCULATE EFFECTIVE AREA OF STATOR EXIT

      A3E= 3.1415926*(R3(1)**2 - R3(N)**2)

C         *** CALCULATE DESIRED AXIAL VELOCITY AT THE TIP

      VZTIP3= VZTIP2*VT3OT2(I)
      ER1= 2.*B3(I)*C3(I)
      ER2= 4.*E3(I)*C3(I)&2.*C3(I)**2
      ER3= 6.*B3(I)*E3(I)&6.*C3(I)*D3(I)
```

```
      ER4= 4.*C3(I)*E3(I)+2.*D3(I)**2
      ER5= 10.*D3(I)*E3(I)/3.
      ER6= 1.5*E3(I)**2

C        *** CALCULATE CONSTANT OF INTEGRATION

      K3= VZTIP3**2 - ER1/R3(1) + ER2*ALOG(R3(1)) + ER3*R3(1) + ER4*
     1 R3(1)**2 + ER5*R3(1)**3 + ER6*R3(1)**4 - CON1*TT3(1)

C        *** SET AXIAL VELOCITY AT THE TIP

  302 VZ3(1)= VZTIP3

C        *** END SECTION XV

C        *** START SECTION XVI

      ER7= (R3(1)-R3(N))/ANM1
      DO 310 M=2,N

C        *** GET STREAMLINE RADII

      R3(M)= R3(M-1)-ER7

C        *** SET TOTAL TEMPERATURE AT EACH STREAMLINE

      TT3(M)= TT2(M)

C        *** CALCULATE AXIAL VELOCITY AT EACH STREAMLINE

      TEMP=ER1/R3(M)-ER2*ALOG(R3(M))-ER3*R3(M)-ER4*R3(M)**2-ER5*R3(M)**3
     1-ER6*R3(M)**4+CON1*TT3(M)+K3
      IF (TEMP.GE.0.) GO TO 310
      WRITE (6,8032)
 8032 FORMAT (//67H AXIAL VELOCITY IS NEGATIVE FOR SCME RADIAL LOCATION
     1AT STATOR EXIT )
      GO TO 3500
  310 VZ3(M)=SQRT(TEMP)

C        *** END SECTION XVI

C        *** START SECTION XVII

C        *** CALCULATE WHIRL VELOCITY, ABSOLUTE VELOCITY, STATIC
C        *** TEMPERATURE, STATIC PRESSURE, TOTAL PRESSURE, STATIC
C        *** DENSITY,ABSOLUTE FLOW ANGLE, D-FACTOR, OMEGA BAR, SONIC
C        *** VELOCITY, ABSOLUTE MACH NUMBER, AXIAL MACH NUMBER, AND
C        *** LOSS FACTOR

      DO 320 M=1,N
      VO3(M)= B3(I)/R3(M) + C3(I) + D3(I)*R3(M)+E3(I)*R3(M)**2
      TEMP=TT3(M)/TT1(M)
      IF (TEMP.GE.0.) GO TO 8051
      WRITE (6,8050)
 8050 FORMAT (//58H THE ABSOLUTE TOTAL TEMPERATURE AT STATOR EXIT IS NEG
     1ATIVE )
      GO TO 3500
 8051 PT3(M)=PT1(M)*TEMP**(NPS(I)*CON6)
```

```
      RHOT3(M)=PT3(M)*144./(RM*TT3(M))
      V3(M)= SQRT(VZ3(M)**2 + VO3(M)**2)
      TEMP=1.-V3(M)**2/(CON1*TT3(M))
      IF (TEMP.GE.0.) GO TO 8053
      WRITE (6,8052)
 8052 FORMAT (//59H THE ABSOLUTE STATIC TEMPERATURE AT STATOR EXIT IS NE
     1GATIVE )
      GO TO 3500
 8053 RHOS3(M)=RHOT3(M)*TEMP**OOGM1
      BETA3(M)= ATAN(VO3(M)/VZ3(M))
      DS(M)= 1.-V3(M)/V2(M) + (VO2(M)-VO3(M))/(2.*SSH(I)*V2(M)*(R2(N)+
     1R3(N))/(R2(M)+R3(M)))
      WSB(M)= (1.-PT3(M)/PT2(M))/(1.-(1./(1.+CON7*M2(M)**2))**CON6)
      A3(M)= SQRT(CON3*(TT3(M)-V3(M)**2/CON1))
      M3(M)= V3(M)/A3(M)
      MZ3(M)= VZ3(M)/A3(M)
  320 ZS(M)=WSB(M)*COS(BETA3(M))/(2.*SSH(I)*(RH2+RH3)/(R2(M)+R3(M)))

C        *** INITIALIZE CALCULATION OF MASS FLOW AND MASS AVERAGED
C        *** CONDITIONS

  322 W3=0.
      PRW3= 0.
      PROW3=0.
      TRW3= 0.
      TROW3=0.

C        *** END SECTION XVII

C        *** START SECTION XVIII

C        *** CALCULATE MASS AVERAGED QUANTITIES

      DO 330 M=1,NM1
      RS3VZ3(M)= (RHOS3(M)*VZ3(M)+RHOS3(M+1)*VZ3(M+1))/2.
      ATHRE(M)= 3.1415926*(R3(M)**2 - R3(M+1)**2)/144.
      WW3(M)= RS3VZ3(M)*ATHRE(M)
      TEMP=(PT3(M)+PT3(M+1))/(PT1(M)+PT1(M+1))
      IF (TEMP.GE.0.) GO TO 8035
      WRITE (6,8034)
 8034 FORMAT (//63H THE INITIAL TOTAL PRESSURE AT THE INLET IS NEGATIVE.
     1  BAD DATA )
      GO TO 3500
 8035 PRW3=PRW3+( TEMP **CON8-1.)*WW3(M)
      PROW3=PROW3+(((PT3(M)+PT3(M+1))/(2.*PTI))**CON8-1.)*WW3(M)
      TRW3=TRW3+((TT3(M)+TT3(M+1))/(TT1(M)+TT1(M+1))-1.)*WW3(M)
      TROW3=TROW3+((TT3(M)+TT3(M+1))/(2.*TTI)-1.)*WW3(M)

C        *** CALCULATE FLOW RATE (W3)

  330 W3= W3 + WW3(M)

C        *** END SECTION XVIII

C        *** START SECTION XIX

C        *** CALCULATE MASS AVERAGE QUANTITIES
C        *** COMPUTE MASS AVERAGED TOTAL PRESSURE RATIO
```

```
  340 RC= (PRW3/W3&1.)**CONE
C        *** OVERALL MASS AVERAGED TOTAL PRESSURE RATIO
      RCC=(PRCW3/W3&1.)**CONE
C        *** TOTAL TEMPERATURE RATIO
      TR= TRW3/W3 & 1.
C        *** OVERALL TOTAL TEMPERATURE RATIO
      TRC=TRCW3/W3 &1.
C        *** EFFICIENCY
      ETA= (RC**CONE-1.)/(TR-1.)
C        *** OVERALL EFFICIENCY
  350 ETAC=(RCC**CONE-1.)/(TRC-1.)
C        *** COMPUTE MASS FLOW RATE PERCENT ERROR
      EWA= ABS(W3-W1)/W3
C        *** PREPARE TO MAKE LIMIT CHECKS
C        *** FIRST TEST FOR MASS FLOW BALANCE
  351 IF (EWA.LE..001) GO TO 372
      IF (ITAL7.GE.50) GO TO 3000
      ITAL7= ITAL7 & 1
C        *** TEST THE DUMP TRIGGER
      IF (IPR1-1) 353,6130,6130
 6130 CALL OUT6
C        *** END SECTION XIX
  353 IF (ITS-1) 370,354,371
C        *** START SECTION XXVIII
C        *** CALCULATE NEW EQUIVALENT AREA
  370 ANEW= A3E & (W1-W3)*A3E/W3
C        *** CALCULATE NEW HUB RADIUS
      TEMP=RTIP3**2-ANEW/(3.1415927*(DH3(I)&DTIP3(I)-1.))
      IF (TEMP.GE.0.) GO TO 8037
      WRITE (6,8036)
 8036 FORMAT(//100H AREA REQUIRED TO MATCH MASS FLOW WITH GIVEN TIP RADI
     1US REQUIRES NEGATIVE HUB RADIUS AT STATOR EXIT. / 32H (CHECK STATO
     2R EFFICIENCY INPUT) )
      GO TO 3500
```

```
 8037 RHNEW=SCRT(TEMP)
C        *** CALCULATE NEW HUB RAMP ANGLE
      ALPSH= ATAN((RHNEW-RH2)/BS)
      GC TC 300
C        *** ENC SECTION XXVIII
C        *** START SECTICN XXX
C        *** CALCULATE NEW EFFECTIVE AREA
  354 ANEW=A3E&(W1-W3)*A3E/W3
C        *** CALCULATE NEW TIP RADIUS
      RTNEW=SCRT(RH3**2&ANEW/(3.1415927*(DH3(I)&DTIP3(I)-1.)))
C        *** CALCULATE NEW TIP RAMP ANGLE
      ALPST=ATAN((RTNEW-RTIP2)/BS)
      GC TC 300
C        *** ENC SECTICN XXX
C        *** CALCULATE NEW GECMETRIC AREA
  371 ANEW=A3G&(W1-W3)*A3G/W3
C        *** CALCULATE NEW AXIAL LENGTH
      TAASHL=SIN(ASHL(I))/CCS(ASHL(I))
      IF ( ABS(ASTL(I)) .NE. ABS(ASHL(I)) ) GC TC 356
C        *** START SECTICN XXXII
      BS=(RTIP2**2-RH2**2-ANEW/3.1415926)/(2.*TAASHL*(RTIP2&RH2))
      GC TC 357
C        *** ENC SECTICN XXXII
C        *** START SECTICN XXXI
  356 TAASTL=SIN(ASTL(I))/CCS(ASTL(I))
      AE=TAASTL**2-TAASHL**2
      BE=(RTIP2*TAASTL-RH2*TAASHL)/AE
      CE=(RTIP2**2-RH2**2-ANEW/3.1415926)/AE
      BS=-BE&SCRT(BE**2-CE)
C        *** CALCULATE NEW ASPECT RATIC
  357 ARS(I)=(RTIP2-RH2)/BS
      GC TC 300
C        *** ENC SECTICN XXXI
C        *** START SECTICN XXIX
```

```
  372 IF (ITS-1) 373,374,360
C        *** IF HUB RAMP ANGLE EXCEEDS THE LIMIT, SET THE RAMP ANGLE TO
C        *** THE LIMIT
  373 IF (ALPSH.GT.ASHL(I)) GO TO 2344
      GO TO 360
 2344 ALPSH=ASHL(I)
      ITS=1
      WRITE (6,2345)
 2345 FORMAT (1H030X44H*** STATOR HUB RAMP ANGLE LIMIT VIOLATED *** /)
      GO TO 300
C        *** CHECK TIP RAMP ANGLE AGAINST ITS LIMIT
  374 IF (ALPST.GE.ASTL(I)) GO TO 355
      ALPST=ASTL(I)
      ITS=2
      WRITE (6,2350)
 2350 FORMAT (1H030X44H*** STATOR TIP RAMP ANGLE LIMIT VIOLATED *** /)
      GO TO 300
C        *** END SECTION XXIX
C        *** ENSURE THAT THE TIP RAMP ANGLE IS NOT POSITIVE
  355 IF (ALPST.LE.0.) GO TO 360
      WRITE (6,358)
  358 FORMAT (// 46H STATOR TIP RAMP ANGLE IS POSITIVE.  BAD DATA. )
      GO TO 3500
  140 IGO=2
      RETURN
 3000 IGO=3
      RETURN
 3010 IGO=4
      RETURN
 3020 IGO=5
      RETURN
 3500 IGO=6
  360 RETURN
      END
```

```
$IBFTC CHECK
      SUBROUTINE CHECK
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON /CHEC/IFLAG,NSLIM
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,ACNE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
      IFLAG=0
      DO 23 I=1,NSLIM
      IF (DTIP2(I).GT.0.) GO TO 8013
      WRITE (6,8012)
 8012 FORMAT (//57H TIP BLOCKAGE FACTOR NOT POSITIVE AT ROTOR EXIT. BAD
     1DATA )
      IFLAG=1
      GO TO 3500
 8013 IF (DH2(I).GT.0.) GO TO 8015
      WRITE (6,8014)
 8014 FORMAT (//57H HUB BLOCKAGE FACTOR NOT POSITIVE AT ROTOR EXIT. BAD
     1DATA )
      IFLAG=1
      GO TO 3500
 8015 IF (DTIP3(I).GT.0.) GO TO 8029
      WRITE (6,8028)
 8028 FORMAT (//58H TIP BLOCKAGE FACTOR NOT POSITIVE AT STATOR EXIT. BAD
     1 DATA)
      IFLAG=1
      GO TO 3500
 8029 IF (DH3(I).GT.0.) GO TO 8031
      WRITE (6,8030)
 8030 FORMAT (//58H HUB BLOCKAGE FACTOR NOT POSITIVE AT STATOR EXIT. BAD
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     1 CATA )
      IFLAG=1
      GO TO 3500
8031  IF (ARTD(I).LE.0.) GO TO 2300
      ARTD(I)= -ARTD(I)
      WRITE (6,2301) I
2301  FORMAT (1H010X52H***ERROR ON ROTOR TIP RAMP ANGLE INPUT FOR STAGE
     XNO. I3,3X48HTHIS ANGLE CHANGED FROM POSITIVE TO NEGATIVE *** //)
2300  IF (ASTD(I).LE.0.) GO TO 2310
      ASTD(I)=-ASTD(I)
      WRITE (6,2308) I
2308  FORMAT (1H010X53H***ERROR ON STATOR TIP RAMP ANGLE INPUT FOR STAGE
     X NO. I3,3X48HTHIS ANGLE CHANGED FROM POSITIVE TO NEGATIVE *** //)
2310  IF (ARHD(I).GE.0.) GO TO 2320
      ARHD(I)=-ARHD(I)
      WRITE (6,2312) I
2312  FORMAT (1H010X52H***ERROR ON ROTOR HUB RAMP ANGLE INPUT FOR STAGE
     XNO. I3,3X48HTHIS ANGLE CHANGED FROM NEGATIVE TO POSITIVE *** //)
2320  IF (ASHD(I).GE.0.) GO TO 23
      ASHD(I)= -ASHD(I)
      WRITE (6,2322) I
2322  FORMAT (1H010X53H***ERROR ON STATOR HUB RAMP ANGLE INPUT FOR STAGE
     X NO. I3,3X48HTHIS ANGLE CHANGED FROM NEGATIVE TO POSITIVE *** //)
   23 CONTINUE
3500  RETURN
      END
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$IBFTC INLET
      SUBROUTINE INLET
      COMMON /CHEC/IFLAG,NSLIM
      COMMON /COM2/PTI,TTI,CON1,CON2,CON3,CON4,OOGM1,B1,C1,D1,E1
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAC,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
C          *** CHECK ON THE INPUT PARAMETERS OF THE ROTOR HUB AND TIP
C              BLOCKAGE FACTORS, THE STATOR HUB AND TIP BLOCKAGE FACTORS
C              AND THE RAMP ANGLES FOR ALL STAGES
      IFLAG=0

C         *** START SECTION IV

      DO 80 M=1,N
      U1(M)=CON4*R1(M)
      VO1(M)=B1/R1(M) + C1 + D1*R1(M) + E1*R1(M)**2
      V1(M)= SQRT(VZ1(M)**2+VO1(M)**2)
      TEMP=1.-V1(M)**2/CON2
      IF (TEMP.GE.0.) GO TO 8007
      WRITE (6,8006)
 8006 FORMAT (//55H ABSOLUTE STATIC TEMPERATURE AT ROTOR INLET IS NEGATI
     1VE )
      IFLAG=1
      GO TO 10
 8007 RHOS1(M)=RHOT1*TEMP**OOGM1
      BETA1(M)= ATAN(VO1(M)/VZ1(M))
      BETA1P(M)=ATAN((U1(M)-VO1(M))/VZ1(M))
      V1P(M)=VZ1(M)/COS(BETA1P(M))
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      TEMP=CON3*(TTI-V1(M)**2/CON1)
      IF (TEMP.GE.0.) GO TO 8C09
      WRITE (6,8006)
      IFLAG=1
      GO TO 10
 8009 M1P(M)= V1P(M)/SQRT(TEMP)
      TT1(M)= TTI
      M1(M)=V1(M)/SQRT(TEMP)
      MZ1(M)=VZ1(M)/SQRT(TEMP)
   80 PT1(M)= PTI
C         *** END SECTION IV
C         *** START SECTION V
C         *** CALCULATE MASS FLOW
   90 W1= 0.
      DO 100 M=1,NM1
      RS1VZ1(M)= (RHOS1(M)*VZ1(M)+RHOS1(M+1)*VZ1(M+1))/2.
      AONE(M)= 3.1415926*(R1(M)*R1(M)-R1(M+1)*R1(M+1))/144.
  100 W1= W1 + RS1VZ1(M)*AONE(M)
C         *** END SECTION V
   10 RETURN
      END
```

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$*
$IBFTC OUT1     LIST
      SUBROUTINE OUT1
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
      GO TO (6000,6020),IPR1
 6000 WRITE (6,6001) W1,K1,UTIP1,RTIP1,RM,RHOT1
 6001 FORMAT (1H013X2HW118X2HK117X5HUTIP115X5HRTIP116X2HRM17X5HRHOT1//
     1 6E20.8 /// )
      WRITE (6,6003)
 6003 FORMAT (13X2HR118X3HVZ117X3HVO1 //)
      DO 6002 M=1,N
 6002 WRITE (6,6005) R1(M),VZ1(M),VO1(M)
 6005 FORMAT (3E20.8)
      RETURN
 6020 WRITE (6,6001) W1,K1,UTIP1,RTIP1,RM,RHOT1
      WRITE (6,6024)
 6024 FORMAT (1H011X2HR114X3HVZ114X3HVO115X2HM1 14X3HMZ1    14X3HM1P 14X
     13HV1P //)
      DO 6026 M=1,N
 6026 WRITE (6,6025) R1(M),VZ1(M),VO1(M),  M1(M),    MZ1(M),M1P(M),V1P(M)
 6025 FORMAT (7E17.8)
      WRITE (6,6015) (AONE(M),RS1VZ1(M),M=1,NM1)
 6015 FORMAT (1H09X4HAONE12X6HRS1VZ1//(2E17.8))
      WRITE (6,6027)
 6027 FORMAT (1HO /11X2HU115X2HV113X5HRHOS112X5HBETA112X6HBETA1P12X3HTT1
     1 14X3HPT1 //)
      DO 6028 M=1,N
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6028 WRITE (6,6025) U1(M),V1(M),RHOS1(M),BETA1(M),BETA1P(M),TT1(M),
    1 PT1(M)
      RETURN
      END
```

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$*
$IBFTC OUT2    LIST
      SUBROUTINE OUT2
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
      GO TO (6050,6055),IPR1
 6050 WRITE (6,6051) BR,RTIP2,VZTIP2,W1,W2,EWA,BETA2P(N),M2(N),B2(I)
 6051 FORMAT (1H08X2HBR9X5HRTIP27X6HVZTIP210X2HW111X2HW211X3HEWA5X9HBETA
     12P(N)7X5HM2(N)8X5HB2(I) //9F13.5 //)
      RETURN
 6055 WRITE (6,6051) BR,RTIP2,VZTIP2,W1,W2,EWA,BETA2P(N),M2(N),B2(I)
      WRITE (6,6056) RH2,A2G,A2E,K2
 6056 FORMAT(1H013X3HRH217X3HA2G17X3HA2E17X2HK2 // 4E20.8 ///11X3HVZ2
     114X2HR215X2HU215X3HVO214X3HTT214X3HPT212X5HRHOT2 // )
 6025 FORMAT(7E17.8)
      DO 6057 M=1,N
 6057 WRITE (6,6025) VZ2(M),R2(M),U2(M),VO2(M),TT2(M),PT2(M),RHOT2(M)
      WRITE (6,6058)
 6058 FORMAT (1H0/9X2HV214X5HRHOS212X5HBETA212X3HV2P15X2HDR15X3HTS2 // )
      DO 6059 M=1,N
 6059 WRITE (6,6025) V2(M),RHOS2(M),BETA2(M),V2P(M),DR(M),TS2(M)
      WRITE (6,6060) (ATWO(M),M2(M),MZ2(M),M2P(M),PRI(M),WRB(M),ZR(M),
     1M=1,N)
 6060 FORMAT (1H07X4HATWO13X2HM212X3HMZ212X3HM2P12X3HPRI12X3HWRB13X2HZR
     1//(7E15.7))
      WRITE (6,6061) (ATO(M),RS2VZ2(M),M=1,NM1)
 6061 FORMAT (1H011X3HATO11X6HRS2VZ2//(2E17.8))
      WRITE (6,6062) ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,CE,ARR(I
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    1),ALPRT,RTNEW
6062 FORMAT (1HO/7X5HITAL112X5HALPRH12X5HRHNEW13X4HANEW12X6HTAARTL11X6H
    1TAARHL //I11,6X5E17.8 //9X2HAE15X2HBE15X2HCE13X6HARR(I)11X5HALPRT
    212X5HRTNEW //6E17.8 )
     RETURN
     END
```

```
$*
$IBFTC OUTPUT
C        *** OUTPUT SUBROUTINE
      SUBROUTINE OUTPUT
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASC(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARC,ASO

C         *** SECTION XXI (CONTINUED FROM MAIN)

C         *** WRITE TITLE

  500 WRITE (6,2020) I
 2020 FORMAT (1H141X37H******** S T A G E   D A T A ******** //54X9HSTAG
     1E NO. I3 //)
      INC=1
      IF (IPR2.GT.0) INC=N-1

C         *** WRITE ROTOR TITLE

      WRITE (6,2030)
 2030 FORMAT(    49X24H*** ROTOR INPUT DATA *** / )

C         *** WRITE ROTOR INPUT QUANTITIES AND TITLE FOR STATOR

      WRITE (6,2040) VT2OT1(I),NPR(I),SRTIP(I),ARRI   ,DTIP2(I),DH2(I),
     1ARHD(I),ARTD(I),DRT(I),BPSD(I),B2SAVE,C2(I),D2(I),E2(I)
 2040 FORMAT (/65X3HTIP12X3HHUB10X9HMAX ANGLE5X9HMAX ANGLE/12H  AXIAL VE
     1L.5X10HPOLYTROPIC6X8HSOLIDITY8X6HASPECT8X9HBLOCKAGE7X8HBLOCKAGE7X
```

```
     29HHUB TAPER5X9HTIP TAPER /4X5HRATIO8X10HEFFICIENCY7X6HAT TIP9X5HRA
     3TIO10X6HFACTOR9X6HFACTOR8X9H(DEGREES)5X9H(DEGREES) //F10.4,5F15.4,
     42F15.3 //16X13HMIN REL. FLOW39X44HCOEFFICIENTS IN TANGENTIAL VELOC
     5ITY EQUATION /30H   MAX ROTOR   ANGLE ROTOR HUB /27H  DIF. FACTOR
     6    (DEGREES)40X1HB14X1HC14X1HD14X1HE //F10.4,F16.4,31X,
     74F15.4 ///47X25H*** STATOR INPUT DATA *** )

C        *** WRITE STATOR INPUT QUANTITIES

      WRITE (6,2050) VT3OT2(I),NPS(I),SSH(I),ARSI   ,DTIP3(I),DH3(I),
     1 ASHD(I),ASTD(I),DSH(I),MSH(I),         B3(I),C3(I),D3(I),E3(I)
 2050 FORMAT ( / 4X5HAXIAL10X5HTOTAL41X3HTIP12X3HHUB10X9HMAX ANGLE6X9HMA
     1X ANGLE/11H    VELOCITY6X10HPOLYTROPIC 6X8HSOLIDITY8X6HASPECT8X8HBL
     2OCKAGE7X8HBLOCKAGE7X9HHUB TAPER6X9HTIP TAPER/4X5HRATIO8X10HEFFICIE
     3NCY7X6HAT HUB9X5HRATIO10X6HFACTOR9X6HFACTOR8X9H(DEGREES)6X9H(DEGRE
     4ES) // F10.4,5F15.4,F16.4,F15.4 //                     68X44HCOEFFIC
     5IENTS IN TANGENTIAL VELOCITY EQUATION /29H  MAX. STATOR   MAX HUB
     6INLET                     / 28H  DIF. FACTOR    MACH NUMBER
     7   39X1HB14X1HC14X1HD14X1HE //F10.4,F15.4,       32X4F15.4 )
      IF (IERROR.GT.0) RETURN

C        *** WRITE STAGE OUTPUT QUANTITIES

      ALPRTD=ALPRT/.0174533
      ALPRHD=ALPRH/.0174533
      ALPSTD=ALPST/.0174533
      ALPSHD=ALPSH/.0174533
      WRITE (6,2060) W1,RCO,TRO,ETAO,RC,TR,ETA,ARR(I),ARS(I),RTIP1,RH1,
     1RTIP2,RH2,RTIP3,RH3,BR,BS,ALPRTD,ALPRHD,ALPSTD,ALPSHD
 2060 FORMAT (//30X59H***--**--***  S T A G E  O U T P U T  D A T A  ***
     1--**--*** //46X20HMASS FLOW (LB/SEC) = F8.3 //4X7HOVERALL8X7HOVERA
     2LL8X7HOVERALL7X9HMASS AVE.6X9HMASS AVE.22X5HROTOR10X6HSTATOR/12H
     3 MASS AVE.6X9HMASS AVE.6X9HMASS AVE.6X8HPRESSURE6X11HTEMPERATURE5X
     49HMASS AVE.7X6HASPECT9X6HASPECT /12H    PR. RATIO5X11HTEMP. RATIO4X
     510HEFFICIENCY8X5HRATIO10X5HRATIO7X10HEFFICIENCY7X5HRATIO10X5HRATIO
     6//F10.4,7F15.4 //12H   ROTOR TIP 6X9HROTOR HUB  6X9HROTOR TIP6X9HR
     *OTOR HUB 5X 10HSTATOR TIP 5X 10HSTATOR HUB
     7         5X11HROTOR PROJ.3X12HSTATOR PROJ. /3X8HRAD. 1-G7X8HRAD. 1
     8-G7X8HRAD. 2-G7X8HRAD. 2-G7X8HRAD. 3-G7X8HRAD. 3-G8X6HLENGTH9X6HLE
     9NGTH /3X8H(INCHES)7(7X8H(INCHES)) //F11.4,F14.4,6F15.4 // 32X
     1 9HROTOR TIP6X9HROTOR HUB5X10HSTATOR TIP5X10HSTATOR HUB / 26X
     2 4(5X10HRAMP ANGLE) / 26X4(6X9H(DEGREES)) // 25X4F15.4    )

C        *** WRITE ROTOR TITLE  PART 1

      WRITE (6,2064)
 2064 FORMAT(1H124X70H***--**--***  R O T O R  I N L E T  O U T P U T  D
     1 A T A  ***--**--*** //)

C        *** WRITE ROTOR TITLE  PART 2

      WRITE (6,2065)
 2065 FORMAT (5X6HRADIUS4X5HWHEEL4X5HAXIAL2X8HTANGENT.3X4HABS.5X4HREL.
     15X4HABS.5X4HREL.4X5HTOTAL4X5HTOTAL11X4HREL.3X4HABS./4H STA3X2H-E6X
     25HSPEED4X4HVEL.5X4HVEL.5X4HVEL.5X4HVEL.3X24HAIR ANG. AIR ANG.  TEM
     3P.4X6HPRESS.10X17HMACH   MACH  LOSS /91H NO.  (IN)   (FT/SEC) (FT/
     4SEC) (FT/SEC) (FT/SEC) (FT/SEC)  (DEG)    (DEG)   (DEG R)   (PSI)
     511X18HNO.    NO.   COEFF // )
```

```
C        *** CONVERT ANGLES FROM RADIANS TO DEGREES

      DO 2070 M=1,N,INC
      BET1D(M)=BETA1(M)/ .0174533
      BET1PD(M)=BETA1P(M)/.0174533

C        *** WRITE ROTOR INLET COMPUTED QUANTITIES

 2070 WRITE (6,2075) M,R1(M),U1(M),VZ1(M),VO1(M),V1(M),V1P(M),BET1D(M),
     1BET1PD(M),TT1(M),PT1(M),M1P(M),M1(M),WRB(M)
 2075 FORMAT (I3,F8.3,F10.3,4F9.3,2F8.3,F10.3,F9.3,7X,3F7.3 )

C        *** WRITE ROTOR EXIT TITLE

      WRITE (6,2080)
 2080 FORMAT (//26X68H***--**--***  R O T O R   E X I T   O U T P U T   D A
     1 T A  ***--**--*** // 5X6HRADIUS4X5HWHEEL4X5HAXIAL2X8HTANGENT.3X
     24HABS.5X4HREL.5X4HABS.5X4HREL.4X5HTOTAL4X5HTOTAL3X5HROTOR3X4HREL.
     33X4HABS. / 4H STA3X2H-E6X5HSPEED4X4HVEL.5X4HVEL.5X4HVEL.5X4HVEL.
     43X24HAIR ANG. AIR ANG.  TEMP.4X6HPRESS.3X4HDIF.3X4HMACH3X4HMACH 2X
     5 4HLOSS /119H NO.  (IN)    (FT/SEC) (FT/SEC) (FT/SEC) (FT/SEC) (FT/
     6SEC)  (DEG)     (DEG)    (DEG R)    (PSI)    FACTOR  NO.     NO.    FUNC
     7 // )

C        *** CONVERT ANGLES FROM RADIANS TO DEGREES

      DO 2090 M=1,N,INC
      BET2D(M)=BETA2(M)/.0174533
      BET2PD(M)=BETA2P(M)/.0174533

C        *** WRITE ROTOR EXIT COMPUTED QUANTITIES

 2090 WRITE (6,2095) M,R2(M),U2(M),VZ2(M),VO2(M),V2(M),V2P(M),BET2D(M),
     1BET2PD(M),TT2(M),PT2(M),DR(M),M2P(M),M2(M),ZR(M)
 2095 FORMAT (I3,F8.3,F10.3,4F9.3,2F8.3,F10.3,F9.3,4F7.3 )

C        *** WRITE STATOR EXIT TITLE

      WRITE (6,2100)
 2100 FORMAT ( //25X70H***--**--***  S T A T O R   E X I T   O U T P U T
     1D A T A  ***--**--*** // 5X6HRADIUS13X22HAXIAL  TANGENT.   ABS.14X
     2 4HABS.30X19HSTATOR AXIAL   ABS. / 9H STA   -E15X4HVEL.5X4HVEL. 5X
     34HVEL. 12X8HAIR ANG.21X4HLOSS4X4HDIF.2X4HMACH4X4HMACH2X4HLOSS /
     44H NO.2X4H(IN)12X26H(FT/SEC) (FT/SEC) (FT/SEC)11X5H(DEG)23X 32HCOE
     5FF  FACTOR  NO.    NO.   FUNC //  )

C        *** CONVERT ANGLES FROM RADIANS TO DEGREES

      DO 2110 M=1,N,INC
      BET3D(M)=BETA3(M)/.0174533

C        *** WRITE STATOR EXIT COMPUTED QUANTITIES

 2110 WRITE (6,2120) M,R3(M),VZ3(M),VO3(M),V3(M),BET3D(M),WSB(M),DS(M),
     1MZ3(M),M3(M),ZS(M)
 2120 FORMAT (I3,F8.3,10X,3F9.3,F17.3,20X,5F7.3 )
      RETURN
```

```
C        *** SECTION XXI (CONTINUED IN MAIN AFTER ST. 500)
      END
```

```
$*
$IBFTC OUT3    LIST
      SUBROUTINE OUT3
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
      GO TO (6030,6035),IPR1
 6030 WRITE (6,6031) BR,RTIP2,VZTIP2,UTIP2,VOTIP2,B2(I)
 6031 FORMAT (1H013X2HBR17X5HRTIP214X6HVZTIP215X5HUTIP214X6HVOTIP2 15X
     1 5HB2(I) // 6E20.8 //)
      RETURN
 6035 WRITE (6,6031) BR,RTIP2,VZTIP2,UTIP2,VOTIP2,B2(I)
      WRITE (6,6036) Q,R,S,T
 6036 FORMAT (1H014X1HQ19X1HR19X1HS19X1HT //4E20.8 // 45X28H*** ROTOR MA
     1SS FLOW TEST *** // )
      RETURN
      END
```

```
$*
$IBFTC OUT4    LIST
      SUBROUTINE OUT4
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
 6070 WRITE (6,6071) ITAL2,B2(I),VO2(N),AA,BB,CC,DD,M2(N),MSH(I)
 6071 FORMAT (1HO6H ITAL25X5HB2(I)8X6HVO2(N)9X2HAA11X2HBB11X2HCC11X2HDD
     1 9X5HM2(N)8X6HMSH(I) // I4,2X8F13.5 // )
      RETURN
      END
```

```
$*
$IBFTC OUT5    LIST
      SUBROUTINE OUT5
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),ACNE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARC(50),ASC(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,ACNE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARC,ASO
 6080 WRITE (6,6081) ITAL3,B2(I),BETA2P(N),BPSH(I)
 6081 FORMAT (1H06H ITAL35X5HB2(I)6X9HBETA2P(N)5X7HBPSH(I) // I4,2X
     1 3F13.5 // )
      RETURN
      END
```

```
$*
$IBFTC OUT6    LIST
      SUBROUTINE OUT6
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),AONE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,AONE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
      GO TO (6130,6135),IPR1
 6130 WRITE (6,6131) W1,W3,EWA,RC,RCO,TR,TRO,ETA,ETAO
 6131 FORMAT (1H07X2HW111X2HW311X3HEWA10X2HRC11X3HRCO10X2HTR11X3HTRO10X
     13HETA9X4HETAO // 9F13.5 // )
      RETURN
 6135 WRITE (6,6131) W1,W3,EWA,RC,RCO,TR,TRO,ETA,ETAO
      WRITE (6,6136) BS,RTIP3,RH3,A3G,A3E,VZTIP3,K3,PRW3,PROW3,TRW3,
     1 TROW3
 6136 FORMAT (1H013X2HBS17X5HRTIP316X3HRH317X3HA3G17X3HA3E15X6HVZTIP3//
     1 6E20.8 //13X2HK317X4HPRW316X5HPROW315X4HTRW316X5HTROW3//5E20.8///
     211X3HTT314X2HR315X3HVZ314X3HVO314X3HPT313X5HRHOS313X2HV3 // )
      DO 6137 M=1,N
 6137 WRITE (6,6025) TT3(M),R3(M),VZ3(M),VO3(M),PT3(M),RHOS3(M),V3(M)
 6025 FORMAT (7E17.8)
      WRITE (6,6132) ALPSH,RHNEW,ANEW,TAASTL,TAASHL,ASHL(I),AE,BE,CE,ARS
     1(I),ALPST,RTNEW,ASTL(I)
 6132 FORMAT (1H0/24X5HALPSH12X5HRHNEW13X4HANEW12X6HTAASTL11X6HTAASHL10X
     17HASHL(I) //17X6E17.8 // 9X2HAE15X2HBE15X2HCE13X6HARS(I)11X5HALPST
     212X5HRTNEW11X7HASTL(I)//7E17.8  )
      WRITE (6,6138)
 6138 FORMAT (1H08X5HBETA315X2HDS14X3HWSB15X2HZS // )
      DO 6139 M=1,N
 6139 WRITE (6,6140) BETA3(M),DS(M),WSB(M),ZS(M)
```

```
6140 FORMAT (4E17.8)
     WRITE (6,6141) (A3(M),M3(M),MZ3(M),M=1,N)
6141 FORMAT (1H011X2HA315X2HM314X3HMZ3//(3E17.8))
     WRITE (6,6142) (ATHRE(M),RS3VZ3(M),WW3(M),M=1,NM1)
6142 FORMAT (1H08X5HATHRE12X6HRS3VZ313X3HWW3 //(3E17.8))
     RETURN
     END
```

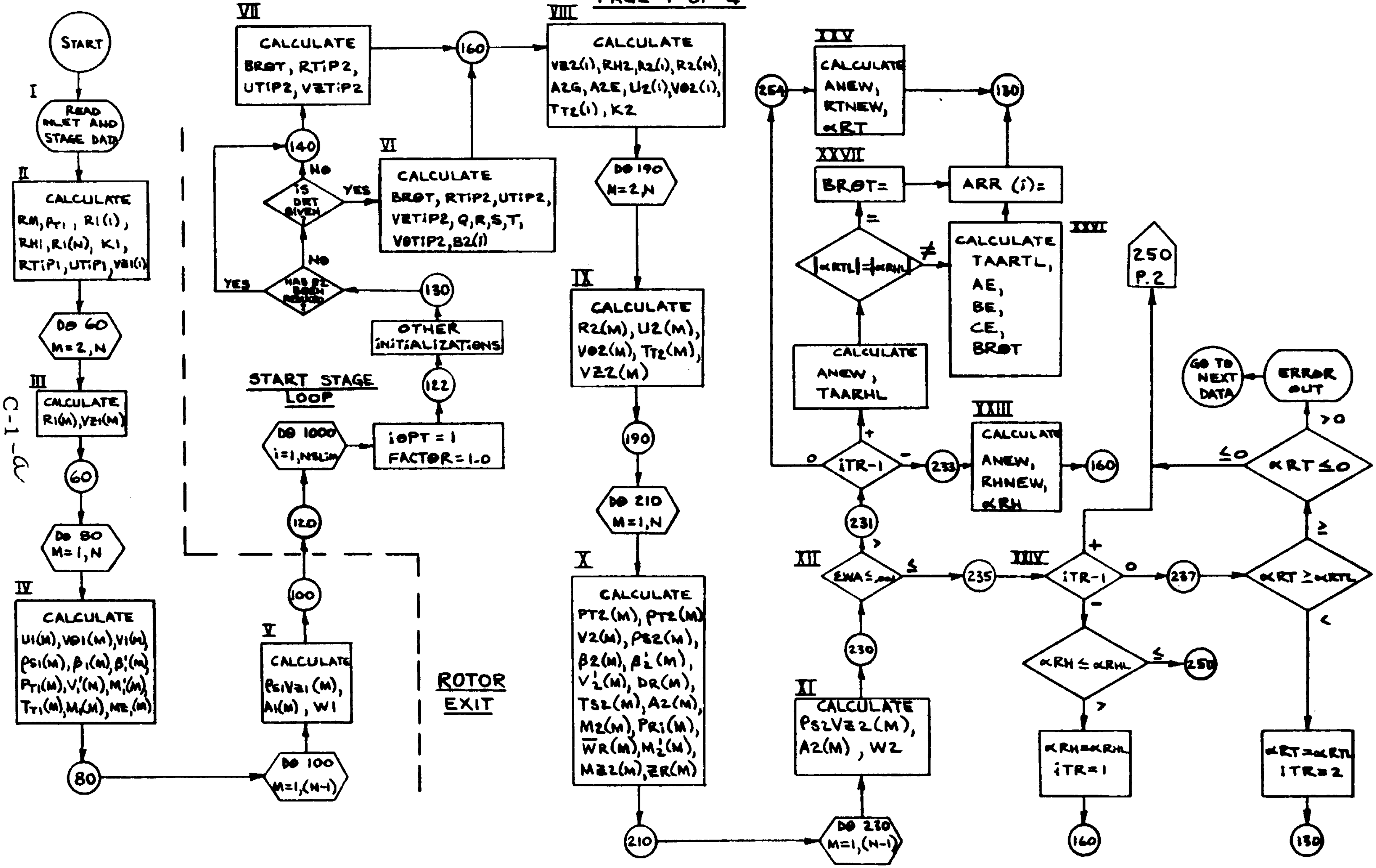
```
$*
$IBFTC OUT7    LIST
      SUBROUTINE OUT7
      REAL MW,NPR,NPS,MSH,K1,M1P,K2,M2,K3
      REAL M1,MZ1,M2P,MZ2,M3,MZ3
      DIMENSION M1(11),MZ1(11),M2P(11),MZ2(11),M3(11),MZ3(11),A3(11)
      DIMENSION VT2OT1(50),NPR(50),SRTIP(50),ARR(50),DTIP2(50),DH2(50),
     1ARHL(50),ARTL(50),DRT(50),B2(50),C2(50),D2(50),E2(50),VT3OT2(50),
     2NPS(50),SSH(50),ARS(50),DTIP3(50),DH3(50),ASHL(50),ASTL(50),
     3DSH(50),MSH(50),BPSH(50),B3(50),C3(50),D3(50),E3(50)
      DIMENSION VZ1(11),U1(11),VO1(11),RHOS1(11),BETA1(11),BETA1P(11),
     1V1P(11),M1P(11),TT1(11),PT1(11),RS1VZ1(11),ACNE(11),R2(11),U2(11),
     2VO2(11),TT2(11),VZ2(11),PT2(11),RHOT2(11),V2(11),RHOS2(11),
     3BETA2(11),BETA2P(11),V2P(11),DR(11),TS2(11),ATWO(11),M2(11),
     4PRI(11),WRB(11),ZR(11),RS2VZ2(11),ATO(11),TT3(11),R3(11),VO3(11),
     5PT3(11),RHOT3(11),V3(11),RHOS3(11),BETA3(11),DS(11),WSB(11),
     6ZS(11),RS3VZ3(11),ATHRE(11),WW3(11)
      DIMENSION R1(11),V1(11),VZ3(11)
      DIMENSION ARHD(50),ARTD(50),ASHD(50),ASTD(50),BET1D(11),BET1PD(11)
     1,BET2D(11),BET2PD(11),BET3D(11),BPSD(50),TITL(12)
      DIMENSION BO(50),ARO(50),ASO(50)
      COMMON I,INC,IPR2,N,VT2OT1,NPR,SRTIP,ARRI,DTIP2,DH2,ARHD,ARTD,DRT,
     1B2SAVE,C2,D2,E2,VT3OT2,NPS,SSH,ARSI,DTIP3,DH3,ASHD,ASTD,DSH,MSH,
     2BPSD,B3,C3,D3,E3,W1,RCO,TRO,ETAO,RC,TR,ETA,RTIP1,ARR,ARS,RH1,RTIP2
     3,RH2,RTIP3,RH3,BR,BS,M,BET1D,BETA1,BET1PD,BETA1P,R1,U1,VZ1,VO1,V1,
     4V1P,M1P,M1,MZ1,BET2D,BETA2,BET2PD,BETA2P,R2,U2,VZ2,VO2,V2,V2P,DR,
     5M2P,M2,MZ2,BET3D,BETA3,R3,VZ3,VO3,V3,DS,M3,WRB,ZR,WSB,ZS,MZ3,ALPST
     6,ALPSH,IERROR
      COMMON IPR1,K1,UTIP1,RM,RHOT1,ACNE,RS1VZ1,NM1,RHOS1,TT1,PT1,W2,
     1EWA,VZTIP2,A2G,A2E,K2,ITAL1,ALPRH,RHNEW,ANEW,TAARTL,TAARHL,AE,BE,
     2CE,ALPRT,RTNEW,B2,TT2,PT2,RHOT2,RHOS2,TS2,ATWO,PRI,ATO,RS2VZ2
     3,UTIP2,VOTIP2,Q,R,S,T,ITAL2,AA,BB,CC,DD,ITAL3,BPSH,W3,A3G,A3E,PT3,
     4VZTIP3,K3,PRW3,PROW3,TRW3,TROW3,TT3,RHOS3,TAASHL,TAASTL,ASHL,ASTL,
     5A3,ATHRE,RS3VZ3,WW3,ITAL8,AF,BF,CF,DF
     6,VZTIPO,ARHL,ARTL,RHOT3,TITL,BO,ARO,ASO
 6150 WRITE (6,6151) ITAL8,B2(I),VO2(N),AF,BF,CF,DF,DS(N),DSH(I)
 6151 FORMAT (1H06H ITAL810X5HB2(I)12X6HVO2(N)14X2HAF16X2HBF16X2HCF 16X
     1 2HDF // I4,2X6F18.8 // 16X5HDS(N) 12X 6HDSH(I) // 6X 2E18.8
     2                    ///25X69H*** THIS BRANCH RETURNS TO ROTOR CAL
     3CULATION AT STATEMENT NO. 160 *** // )
      RETURN
      END
$DATA
```

APPENDIX C

PROGRAM FLOW CHARTS

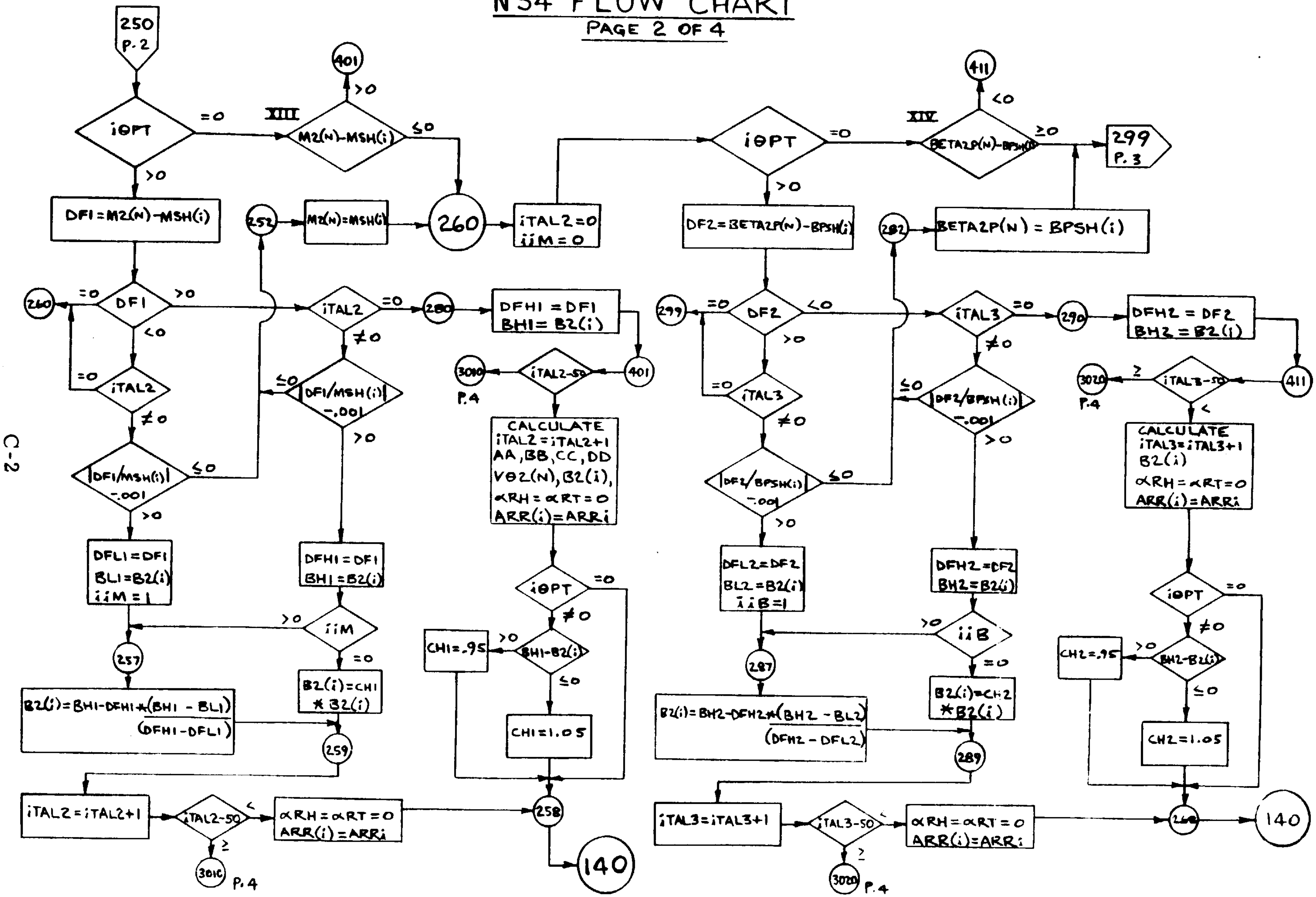
N34 FLOW CHART

PAGE 1 OF 4



N34 FLOW CHART

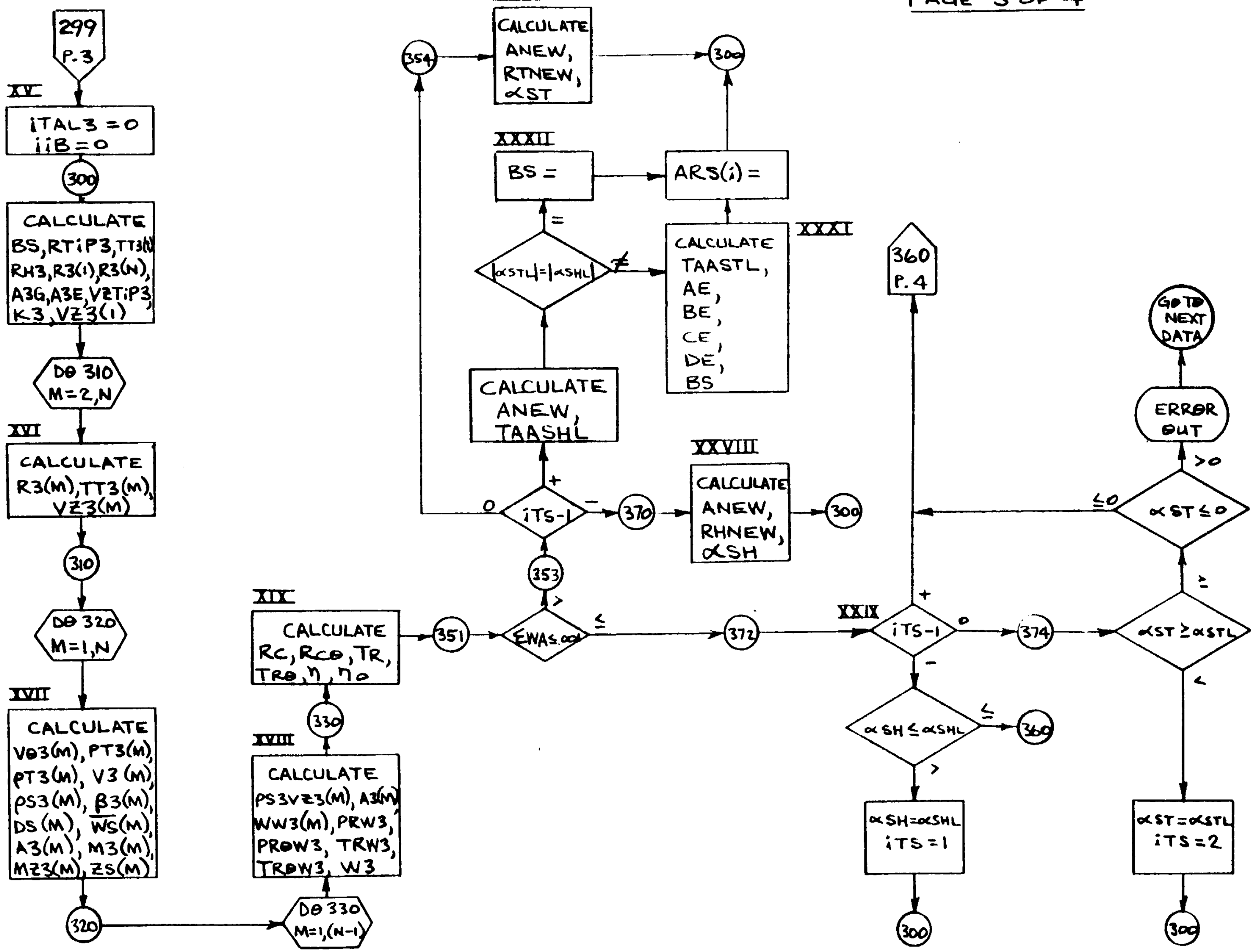
PAGE 2 OF 4



N34 FLOW CHART

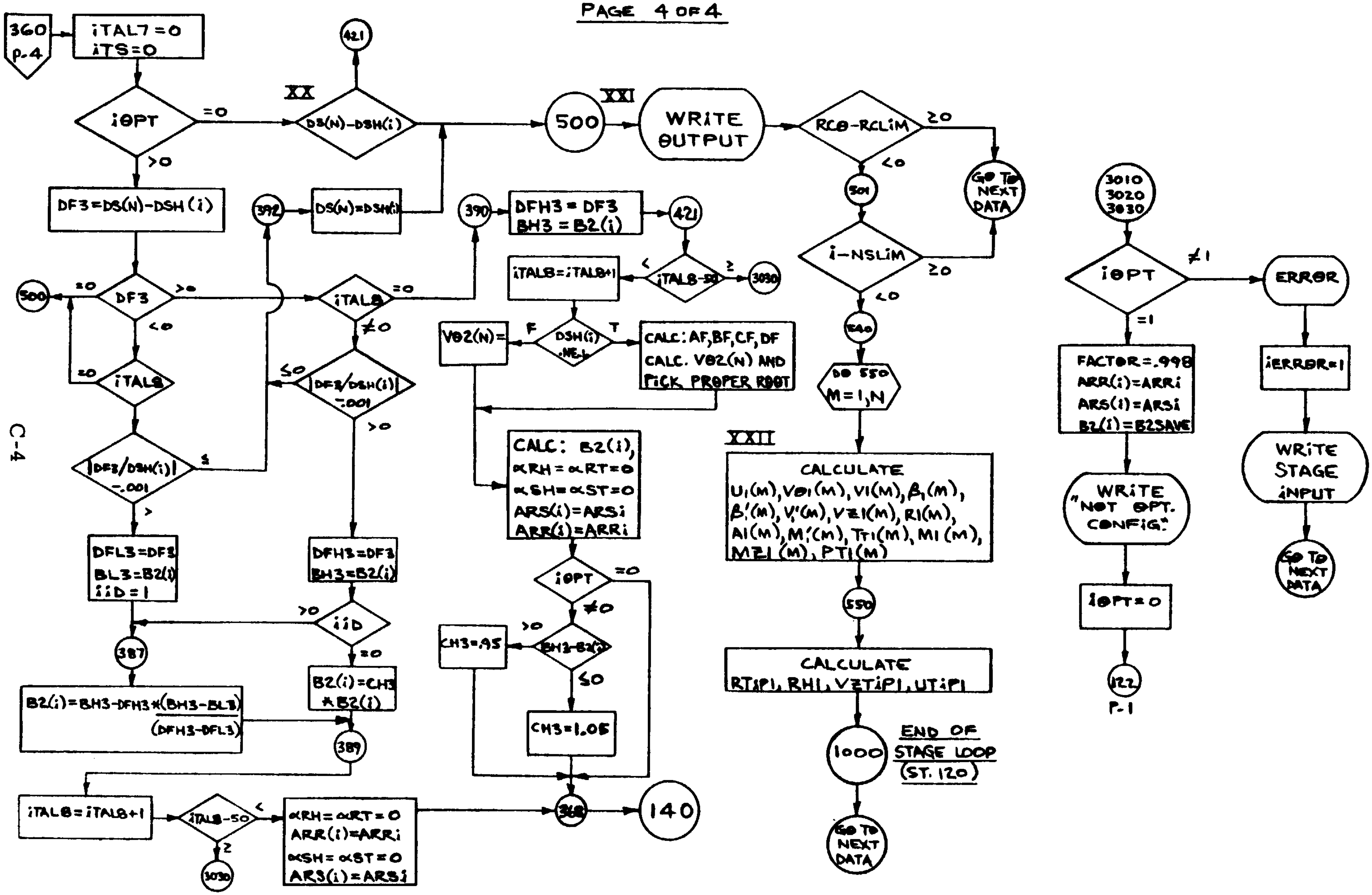
PAGE 3 OF 4

STATOR EXIT



N34 FLOW CHART

PAGE 4 OF 4



APPENDIX D

INPUT FORMAT - DATA PREPARATION

N34 DATA PREPARATION

The N34 program utilizes the option of using the FORTRAN IV NAME-LIST method of data input. The standard input method may still be used and the two may be intermixed from one data set to the next within a run. In either case, each input should be entered as a decimal number except IREAD, N, NSLIM, IPR1, and IPR2 which are integers. A sample data sheet for each method is included.

STANDARD OPTION

Card 1

Column 1 must contain a 1 which signifies that the standard input option is to be used. Columns 2 through 72 contain alphanumeric information to be printed at the beginning of the run.

Remaining Cards

These cards are used as shown on the data sheet.

NAMELIST OPTION

Card 1

Column 1 must contain a 0 (zero) which signifies that the NAMELIST option is to be used. Columns 2 through 72 contain alphanumeric information to be printed at the beginning of the run.

Card 2

Card 2 is the first card used by NAMELIST. Column 1 must be blank. Columns 2 through 6 must contain "$NAME". Column 7 must be blank. The remainder of Card 2 is similar to Card 3 through the last card.

Card 3 Through the Last Card

These cards are punched as in the NAMELIST sample. Any number of sets of "variable = constant, " may be put on a card, but the following conditions must be met.

1. Column 1 must always be blank.

2. No blanks are permitted except at end of card and in Column 1.

3. Each data card must end with a comma following a "variable = constant" set with the exception of the last card of a data set.

4. The last card of a data set must end with a $ symbol.

5. Arrays are read as on the 5th card of the NAMELIST sample data sheet.

   Example: SRTIP will contain 1.3 in 10 locations beginning with SRTIP (1). ARO will contain 4. in (1), 3.5 in (2), and 2.5 in 8 locations beginning with ARO(3).

Additional Comments on NAMELIST

The input parameters may be in any order on the cards. More or less items may be put on a card than are shown in the sample and may appear in any column (other than Column 1). Columns 73 through 80 are for data (NAMELIST ONLY) and may not be used for identification. More numbers may be read into an array than can be put on one card. The first card must end with a constant followed by a comma, and the next card must start with the next constant beginning in Column 2 and continuing on as before.

STACKING DATA

Data sets may be stacked. The option of using NAMELIST or the standard method of input may be changed from set to set within a run. Once the initial data have been read by either method, new sets may be read by using a complete standard data set or with NAMELIST as follows: A title card with a zero in Column 1 is followed by the card(s) needed to change any value(s) used in the initial data set. These cards must follow the same rules as a complete NAMELIST data set. The flexibility of the NAMELIST option will allow the input data to be simplified to whatever degree the user wishes.

IBM 7094 DATA SHEET

N 34 SAMPLE DATA SHEET (STANDARD OPTION)

IDENTIFICATION NUMBER

IREAD

										Identification
1	ONE TITLE CARD OF ALPHANUMERIC INFORMATION									
	CP (BTU/LB °R)	MW (MOLES)	GAM	TTI (°R)	PTI (PSI)	RCLIM	RTIPII (INCHES)	UTIPII (FT/SEC)	RH/RTIPI	
	VZTIPI (FT/SEC)	DTIPI	DHI	BI	CI	DI	EI	N, NS	IPRI, IPR2	
*	VT2ØTI(1)	NPR(1)	SRTIP(1)	ARR(1)	DTIP2(1)	DH2(1)	ARHL(1) (DEGREES)	ARTL(1) (DEGREES)		RØTØR 1
*	DRT(1)	B2(1)	C2(1)	D2(1)	E2(1)					RØTØR 1
*	VT3ØT2(1)	NPS(1)	SSH(1)	ARS(1)	DTIP3(1)	DH3(1)	ASHL(1) (DEGREES)	ASTL(1) (DEGREES)		STATØR 1
*	DSH(1)	MSH(1)	BPSH(1)	B3(1)	C3(1)	D3(1)	E3(1)			STATØR 1
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	VT2ØTI(NS)	NPR(NS)	SRTIP(NS)	ARR(NS)	DTIP2(NS)	DH2(NS)	ARHL(NS) (DEGREES)	ARTL(NS) (DEGREES)		RØTØR(NS)
	DRT(NS)	B2(NS)	C2(NS)	D2(NS)	E2(NS)					RØTØR(NS)
	VT3ØT2(NS)	NPS(NS)	SSH(NS)	ARS(NS)	DTIP3(NS)	DH3(NS)	ASHL(NS) (DEGREES)	ASTL(NS) (DEGREES)		STATØR(NS)
	DSH(NS)	MSH(NS)	BPSH(NS)	B3(NS)	C3(NS)	D3(NS)	E3(NS)			STATØR(NS)

* NØTE: CØNTINUE THESE 4 CARDS IN ØRDER UNTIL NØ. STAGES IS COMPLETED.

FORM 3237 (REV 10/63)

IBM 7094 DATA SHEET

N34 SAMPLE DATA SHEET (NAMELIST OPTION)

IDENTIFICATION NUMBER

iREAD

TITLE CARD

```
0       STD. DATA
 $NAME CP=.24,MW=29.,GAM=1.4,TTi=519.,PTi=14.7,RCLiM=9.,RTiPIi=12.,
 UTiPIi=1000.,RHORTI=.4,VZTiPO=600.,DTiPI=1.,DHI=1.,BI=0.,CI=0.,DI=0.,
 EI=0.,N=11,NSLiM=10,iPRI=0,iPR2=0,VT2OTI(1)=10*1.,NPR(1)=10*.85,
 SRTiP(1)=10*1.3,ARO(1)=4.,3.5,8*2.5,DTiP2(1)=10*1.,DH2(1)=10*1.,
 ARHD(1)=10*40.,ARTD(1)=10*-20.,DRT(1)=.35,.4,8*.45,BO(1)=10*0.,
 C2(1)=10*0.,D2(1)=10*0.,E2(1)=10*0.,VT3OT2(1)=10*1.,NPS(1)=10*.85,
 SSH(1)=10*2.,ASO(1)=4.,3.5,8*2.5,DTiP3(1)=10*1.,DH3(1)=10*1.,
 ASHD(1)=10*40.,ASTD(1)=10*-20.,DSH(1)=10*.5,MSH(1)=10*.8,
 BPSD(1)=10*-10.,B3(1)=10*0.,C3(1)=10*0.,D3(1)=10*0.,E3(1)=10*0.$
0       NASA DATA
 $NAME VT2OTI(1)=1.2,DRT(1)=.45,D2(1)=30.,VT3OT2(1)=1.12,DSH(1)=.6,MSH(1)=.6,
 BPSD(1)=0.0$
```

APPENDIX E

OUTPUT FORMAT—SAMPLE PROBLEMS

FREE VORTEX CASE

```
$NAME CP=.24,MW=29.,GAM=1.4,TTI=519.,PTI=14.7,RCLIM=9.,RTIP1I=12.,
UTIP1I=1[illegible].,FLDRTI=.4,VZTIPO=[illegible].,OTIPO=1.,DHL=1.,BL=0.,C1=0.,D1=0.,
E1=0.,N=[illegible],NSLIM=1[illegible],IPP1=[illegible],IPP2=0,VT2OT1(1)=10*1.,NPR(1)=10*.875,
SRTIP(1)=[illegible]*1.[illegible],ARO(1)=4.,3.5,8*2.5,OTIP2(1)=10*1.,DH2(1)=10*1.,
ARHD(1)=[illegible]*4[illegible].,ARTD(1)=1[illegible]*-2[illegible].,DRT(1)=.35,.4,8*.45,BC(1)=10*0.,
C2(1)=10*[illegible].,D2(1)=1[illegible]*0.,E2(1)=10*0.,VT3OT2(1)=10*1.,NPS(1)=10*.85,
SSH(1)=1[illegible]*2.,ASP(1)=4.,3.5, 8*2.5,OTIP3(1)=10*1.,DH3(1)=10*1.,
ASHD(1)=[illegible]*4[illegible].,ASTD(1)=1[illegible]*-2[illegible].,DSH(1)=[illegible]*.5,MSH(1)=10*.8,
BPSD(1)=[illegible]*-1[illegible].,B3(1)=[illegible]*[illegible].,C3(1)=[illegible]*[illegible].,D3(1)=1[illegible]*[illegible].,E3(1)=10*0.$
```

NON-FREE VORTEX CASE

```
$NAME VT2OT1(1)=..2,DRT(1)=.45,D2(1)=37.,VT3OT2(1)=1.12,DSH(1)=.6,MSH(1)=.6,
BPSD(1)=[illegible]$
```

```
1                          FREE VORTEX CASE
.24      20.      [illegible]    519.     14.7     0.       12.      1000.    .4
500.     1.       1.       0.       1.       0.       0.       011010
1.       .875     1.3      4.       1.       1.       40.      -20.     ROTOR  1
.35      0.       0.       0.       0.                                   ROTOR  1
1.       .85      2.       4.       1.       1.       40.      -20.     STATOR 1
.5       .8       -10.     0.       0.       0.       0.                STATOR 1
1.       .875     1.3      3.5      1.       1.       40.      -20.     ROTOR  2
.4       0.       0.       0.       0.                                   ROTOR  2
1.       .85      2.       3.5      1.       1.       40.      -20.     STATOR 2
.5       .8       -10.     0.       0.       0.       0.                STATOR 2
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  3
.45      0.       0.       0.       0.                                   ROTOR  3
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 3
.5       .8       -10.     0.       0.       0.       0.                STATOR 3
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  4
.45      0.       0.       0.       0.                                   ROTOR  4
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 4
.5       .8       -10.     0.       0.       0.       0.                STATOR 4
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  5
.45      0.       0.       0.       0.                                   ROTOR  5
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 5
.5       .8       -10.     0.       0.       0.       0.                STATOR 5
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  6
.45      0.       0.       0.       0.                                   ROTOR  6
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 6
.5       .8       -10.     0.       0.       0.       0.                STATOR 6
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  7
.45      0.       0.       0.       0.                                   ROTOR  7
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 7
.5       .8       -10.     0.       0.       0.       0.                STATOR 7
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  8
.45      0.       0.       0.       0.                                   ROTOR  8
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 8
.5       .9       -10.     0.       0.       0.       0.                STATOR 8
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR  9
.45      0.       0.       0.       0.                                   ROTOR  9
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR 9
.5       .8       -10.     0.       0.       0.       0.                STATOR 9
1.       .875     1.3      2.5      1.       1.       40.      -20.     ROTOR 10
.45      0.       0.       0.       0.                                   ROTOR 10
1.       .85      2.       2.5      1.       1.       40.      -20.     STATOR10
.5       .8       -10.     0.       0.       0.       0.                STATOR10
```

FREE VORTEX CASE

-- PARAMETRIC STUDY OF ADVANCED MULTISTAGE AXIAL-FLOW COMPRESSORS ***--***

*** R O T O R   I N L E T   I N P U T   D A T A ***

NO. RAD. STATIONS	NUMBER STAGES	SP. HEAT (BTU/(LB-R))	MOL. WT. (MOLES)	RATIO OF SP. HEAT	IN. TOT. TEMP. (DEG. R)	IN. TOT. PR. (PSI)	MASS AVG. TOT. PR. RATIO
11	10	0.2400	29.[illegible]	1.4000	519.0000	14.7000	9.0000

TIP RADIUS (INCHES)	TIP WHEEL SPEED (FT/SEC)	HUB TO TIP RADIUS RATIO	AXIAL VEL. (FT/SEC)	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR
12.00[illegible]	[illegible]	[illegible].45[illegible]	600.0000	1.0000	1.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
[illegible]	0.0000	0.0000	0.0000

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*** ROTOR HUB RAMP ANGLE LIMIT VIOLATED ***

*** STATOR HUB MACH NO. LIMIT VIOLATED ***

*** ROTOR HUB RELATIVE ANGLE LIMIT VIOLATED ***
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******** S T A G E   D A T A ********

STAGE NO. 1

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.3000	4.0000	1.0000	1.0000	40.0000	-20.0000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.3500	-10.0000	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	4.0000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	0.9000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
1.3491	1.1059	0.8435	1.3491	1.1059	0.8435	4.0000	4.0000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.0000	4.8000	12.0000	6.2889	12.0000	6.9033	1.8000	1.4278

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	39.5959	0.0000	19.8137

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	1000.000	600.000	0.000	600.000	1166.190	0.000	59.036	519.000	14.700	1.076	0.554	0.083
2	11.280	940.000	600.000	0.000	600.000	1115.158	0.000	57.450	519.000	14.700	1.029	0.554	0.089
3	10.560	880.000	600.000	0.000	600.000	1065.082	0.000	55.713	519.000	14.700	0.983	0.554	0.095
4	9.840	820.000	600.000	0.000	600.000	1016.071	0.000	53.807	519.000	14.700	0.938	0.554	0.103
5	9.120	760.000	600.000	0.000	600.000	968.297	0.000	51.710	519.000	14.700	0.894	0.554	0.111
6	8.400	700.000	600.000	0.000	600.000	921.954	0.000	49.399	519.000	14.700	0.851	0.554	0.120
7	7.680	640.000	600.000	0.000	600.000	877.268	0.000	46.848	519.000	14.700	0.810	0.554	0.130
8	6.960	580.000	600.000	0.000	600.000	834.505	0.000	44.029	519.000	14.700	0.770	0.554	0.141
9	6.240	520.000	600.000	0.000	600.000	793.977	0.000	40.914	519.000	14.700	0.733	0.554	0.152
10	5.520	460.000	600.000	0.000	600.000	756.042	0.000	37.476	519.000	14.700	0.699	0.554	0.165
11	4.800	400.000	600.000	0.000	600.000	721.110	0.000	33.690	519.000	14.700	0.666	0.554	0.178

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	1000.000	600.000	330.098	684.813	899.315	28.818	48.151	573.955	20.007	0.338	0.794	0.604	0.021
2	11.429	952.407	600.000	346.593	692.912	852.649	30.013	45.276	573.955	20.007	0.344	0.753	0.612	0.023
3	10.858	904.814	600.000	364.824	702.203	807.211	31.301	41.987	573.955	20.007	0.352	0.714	0.621	0.024
4	10.287	857.222	600.000	385.079	712.942	763.491	32.692	38.199	573.955	20.007	0.359	0.676	0.631	0.026
5	9.716	809.629	600.000	407.715	725.418	722.174	34.197	33.816	573.955	20.007	0.366	0.640	0.643	0.028
6	9.144	762.036	600.000	433.179	740.030	684.213	35.828	28.727	573.955	20.007	0.371	0.608	0.657	0.030
7	8.573	714.443	600.000	462.035	757.282	650.330	37.598	22.816	573.955	20.007	0.373	0.579	0.674	0.031
8	8.002	666.851	600.000	495.011	777.840	624.123	39.523	15.982	573.955	20.007	0.369	0.557	0.694	0.032
9	7.431	619.258	600.000	533.054	802.589	606.161	41.619	8.176	573.955	20.007	0.356	0.542	0.718	0.033
10	6.860	571.665	600.000	577.433	832.723	600.028	43.902	-0.551	573.955	20.007	0.329	0.539	0.748	0.033
11	6.289	524.073	600.000	629.871	869.907	609.256	46.391	-10.000	573.955	20.007	0.280	0.550	0.785	0.031

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	600.000	0.000	600.000	0.000	0.040	0.345	0.525	0.525	0.018
2	11.480	600.000	0.000	600.000	0.000	0.039	0.353	0.525	0.525	0.017
3	10.961	600.000	0.000	600.000	0.000	0.038	0.362	0.525	0.525	0.015
4	10.441	600.000	0.000	600.000	0.000	0.037	0.372	0.525	0.525	0.015
5	9.921	600.000	0.000	600.000	0.000	0.036	0.384	0.525	0.525	0.014
6	9.402	600.000	0.000	600.000	0.000	0.035	0.397	0.525	0.525	0.012
7	8.882	600.000	0.000	600.000	0.000	0.033	0.411	0.525	0.525	0.011
8	8.362	600.000	0.000	600.000	0.000	0.032	0.427	0.525	0.525	0.010
9	7.843	600.000	0.000	600.000	0.000	0.030	0.446	0.525	0.525	0.009
10	7.323	600.000	0.000	600.000	0.000	0.028	0.467	0.525	0.525	0.008
11	6.803	600.000	0.000	600.000	0.000	0.026	0.491	0.525	0.525	0.007

No data output appears on this
page since there were no aerodynamic
parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 2

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.[illegible]	0.875	[illegible]	3.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)						
0.400	-[illegible]						

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.850	[illegible]	3.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER
0.5000	0.8000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
1.8635	1.2227	0.8353	1.3813	1.1147	0.8430	3.5000	3.5000

ROTOR TIP RAD. 3-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.0000	4.[illegible]	12.0000	7.7744	12.0000	8.1394	1.4848	1.2073

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
[illegible]	33.1875	0.0000	16.8212

--**-- R O T O R I N L E T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	1000.000	600.000	0.000	600.000	1156.190	0.000	59.036	573.955	19.832	0.994	0.511	0.093
2	11.480	955.534	600.000	0.000	600.000	1129.276	0.000	57.906	573.955	19.832	0.962	0.511	0.104
3	10.963	913.338	600.000	0.000	600.000	1092.830	0.000	56.699	573.955	19.832	0.931	0.511	0.110
4	10.443	870.082	600.000	0.000	600.000	1056.703	0.000	55.410	573.955	19.832	0.900	0.511	0.116
5	9.923	826.776	600.000	0.000	600.000	1021.547	0.000	54.031	573.955	19.832	0.870	0.511	0.122
6	9.402	783.470	600.000	0.000	600.000	986.826	0.000	52.554	573.955	19.832	0.841	0.511	0.129
7	8.882	740.154	600.000	0.000	600.000	952.808	0.000	50.971	573.955	19.832	0.812	0.511	0.137
8	8.362	696.859	600.000	0.000	600.000	919.572	0.000	49.271	573.955	19.832	0.783	0.511	0.145
9	7.843	653.553	600.000	0.000	600.000	887.204	0.000	47.446	573.955	19.832	0.756	0.511	0.154
10	7.323	610.247	600.000	0.000	600.000	855.304	0.000	45.485	573.955	19.832	0.729	0.511	0.163
11	6.803	566.941	600.000	0.000	600.000	825.483	0.000	43.377	573.955	19.832	0.703	0.511	0.173

--**-- R O T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	1000.000	600.000	395.395	719.567	851.790	33.385	45.219	639.780	27.654	0.400	0.712	0.600	0.027
2	11.577	964.787	600.000	409.427	726.508	817.300	34.335	42.767	639.780	27.654	0.408	0.683	0.608	0.029
3	11.155	929.574	600.000	425.352	735.476	783.734	35.334	40.043	639.780	27.654	0.416	0.656	0.616	0.030
4	10.732	894.361	600.000	442.099	745.286	751.359	36.384	37.008	639.780	27.654	0.423	0.629	0.624	0.031
5	10.310	859.148	600.000	460.210	755.176	720.517	37.483	33.619	639.780	27.654	0.430	0.604	0.634	0.033
6	9.887	823.935	600.000	479.938	768.315	691.642	38.653	29.830	639.780	27.654	0.437	0.581	0.645	0.035
7	9.465	788.722	600.000	501.513	781.366	665.235	39.879	25.535	639.780	27.654	0.441	0.560	0.658	0.036
8	9.042	753.509	600.000	524.740	797.090	642.133	41.172	20.871	639.780	27.654	0.444	0.541	0.672	0.038
9	8.620	718.295	600.000	550.464	814.255	623.031	42.535	15.627	639.780	27.654	0.442	0.526	0.687	0.039
10	8.197	683.083	600.000	578.841	833.701	608.988	43.972	9.856	639.780	27.654	0.435	0.515	0.705	0.040
11	7.774	647.870	600.000	610.302	855.844	601.175	45.488	3.583	639.780	27.654	0.422	0.510	0.726	0.040

--**-- S T A T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	600.000	0.000	600.000	0.000	0.044	0.372	0.496	0.496	0.016
2	11.614	600.000	0.000	600.000	0.000	0.043	0.380	0.496	0.496	0.016
3	11.229	600.000	0.000	600.000	0.000	0.042	0.388	0.496	0.496	0.015
4	10.842	600.000	0.000	600.000	0.000	0.041	0.396	0.496	0.496	0.014
5	10.456	600.000	0.000	600.000	0.000	0.040	0.405	0.496	0.496	0.013
6	10.070	600.000	0.000	600.000	0.000	0.039	0.415	0.496	0.496	0.012
7	9.684	600.000	0.000	600.000	0.000	0.038	0.425	0.496	0.496	0.011
8	9.298	600.000	0.000	600.000	0.000	0.036	0.437	0.496	0.496	0.010
9	8.912	600.000	0.000	600.000	0.000	0.035	0.449	0.496	0.496	0.010
10	8.525	600.000	0.000	600.000	0.000	0.033	0.463	0.496	0.496	0.009
11	8.139	600.000	0.000	600.000	0.000	0.032	0.477	0.496	0.496	0.009

No data output appears on this
page since there were no aerodynamic
parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 3

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.9750	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.4500	-10.0000	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.9500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	0.8000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
2.5896	1.3759	0.8230	1.3897	1.1170	0.8429	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.0000	5.1394	12.0000	8.8063	12.0000	9.0722	1.5442	1.2775

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	23.3553	0.0000	11.7608

--**-- R O T O R   I N L E T   O U T P U T   D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	[illegible]	600.000	0.000	600.000	1165.190	0.000	59.036	639.780	27.393	0.941	0.484	0.109
2	11.614	967.828	600.000	0.000	600.000	1138.724	0.000	58.203	639.780	27.393	0.919	0.484	0.113
3	11.228	935.657	600.000	0.000	600.000	1111.510	0.000	57.330	639.780	27.393	0.897	0.484	0.117
4	10.842	903.486	600.000	0.000	600.000	1084.557	0.000	56.412	639.780	27.393	0.875	0.484	0.122
5	10.456	871.314	600.000	0.000	600.000	1057.917	0.000	55.448	639.780	27.393	0.854	0.484	0.127
6	10.070	839.143	600.000	0.000	600.000	1031.532	0.000	54.435	639.780	27.393	0.832	0.484	0.132
7	9.684	806.972	600.000	0.000	600.000	1005.586	0.000	53.369	639.780	27.393	0.811	0.484	0.138
8	9.298	774.800	600.000	0.000	600.000	979.957	0.000	52.246	639.780	27.393	0.791	0.484	0.143
9	8.912	742.629	600.000	0.000	600.000	954.724	0.000	51.064	639.780	27.393	0.770	0.484	0.150
10	8.525	[illegible]	600.000	0.000	600.000	929.919	0.000	49.818	639.780	27.393	0.750	0.484	0.155
11	8.139	[illegible]	600.000	0.000	600.000	905.578	0.000	48.505	639.780	27.393	0.731	0.484	0.163

--**-- R O T O R   E X I T   O U T P U T   D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	1000.000	600.000	449.490	749.694	814.236	36.839	42.537	714.612	38.438	0.450	0.643	0.592	0.031
2	11.681	973.385	600.000	461.780	757.127	788.505	37.583	40.453	714.612	38.438	0.457	0.623	0.598	0.032
3	11.361	946.771	600.000	474.761	765.113	763.409	38.353	38.121	714.612	38.438	0.464	0.604	0.605	0.033
4	11.042	920.156	600.000	488.443	773.709	739.143	39.151	35.733	714.612	38.438	0.471	0.585	0.612	0.035
5	10.723	893.542	600.000	502.043	782.977	715.883	39.977	33.057	714.612	38.438	0.478	0.567	0.620	0.036
6	10.403	866.927	600.000	516.487	792.937	693.339	40.832	30.145	714.612	38.438	0.483	0.550	0.629	0.037
7	10.084	840.313	600.000	534.303	803.420	673.255	41.717	26.976	714.612	38.438	0.488	0.535	0.638	0.039
8	9.764	813.698	600.000	552.404	815.569	654.427	42.635	23.533	714.612	38.438	0.492	0.520	0.648	0.040
9	9.445	787.083	600.000	571.193	828.532	637.625	43.586	19.799	714.612	38.439	0.494	0.508	0.659	0.041
10	9.126	760.469	600.000	591.070	842.237	623.455	44.570	15.766	714.612	38.438	0.494	0.497	0.671	0.043
11	8.806	733.954	600.000	612.506	857.417	612.148	45.591	11.434	714.612	38.439	0.491	0.489	0.685	0.044

--**-- S T A T O R   E X I T   O U T P U T   D A T A ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	600.000	0.000	600.000	0.000	0.046	0.401	0.468	0.468	0.015
2	11.707	600.000	0.000	600.000	0.000	0.045	0.407	0.468	0.468	0.015
3	11.414	600.000	0.000	600.000	0.000	0.044	0.413	0.468	0.468	0.014
4	11.122	600.000	0.000	600.000	0.000	0.043	0.420	0.468	0.468	0.013
5	10.829	600.000	0.000	600.000	0.000	0.042	0.427	0.468	0.468	0.013
6	10.536	600.000	0.000	600.000	0.000	0.041	0.435	0.468	0.468	0.012
7	10.243	600.000	0.000	600.000	0.000	0.040	0.443	0.468	0.468	0.011
8	9.951	600.000	0.000	600.000	0.000	0.039	0.451	0.468	0.468	0.011
9	9.658	600.000	0.000	600.000	0.000	0.038	0.459	0.468	0.468	0.010
10	9.365	600.000	0.000	600.000	0.000	0.037	0.469	0.468	0.468	0.010
11	9.072	600.000	0.000	600.000	0.000	0.036	0.479	0.468	0.468	0.009

No data output appears on this
page since there were no aerodynamic
parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 4

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0[illegible]	[illegible].47[illegible]	[illegible]	[illegible].5[illegible]	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN. REL. FLOW ANGLE ROTOR HUB (DEGREES)			COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
[illegible].45[illegible]	-[illegible]			0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.[illegible]	[illegible]	2.[illegible]	[illegible].5[illegible]	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER			COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	[illegible].3[illegible]			0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 164.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
3.4826	1.5211	0.9[illegible]	1.3448	1.1047	0.9436	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.0000	9.[illegible]72[illegible]	12.[illegible]	9.5217	12.0000	9.6873	1.1711	0.9913

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
[illegible]	20.9973	0.[illegible]	9.4806

###---##---### ROTOR INLET OUTPUT DATA ###---##---###

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	1000.000	600.000	0.000	600.000	1166.190	0.000	59.036	714.612	38.067	0.890	0.458	0.105
2	11.707	975.602	600.000	0.000	600.000	1145.338	0.000	58.408	714.612	38.067	0.875	0.458	0.109
3	11.414	951.234	600.000	0.000	600.000	1124.628	0.000	57.757	714.612	38.067	0.859	0.458	0.112
4	11.122	926.865	600.000	0.000	600.000	1104.059	0.000	57.082	714.612	38.067	0.843	0.458	0.115
5	10.829	902.407	600.000	0.000	600.000	1083.659	0.000	56.381	714.612	38.067	0.827	0.458	0.119
6	10.536	878.039	600.000	0.000	600.000	1063.438	0.000	55.653	714.612	38.067	0.812	0.458	0.123
7	10.243	853.611	600.000	0.000	600.000	1043.385	0.000	54.897	714.612	38.067	0.797	0.458	0.127
8	9.951	829.213	600.000	0.000	600.000	1023.525	0.000	54.111	714.612	38.067	0.781	0.458	0.131
9	9.659	804.815	600.000	0.000	600.000	1003.856	0.000	53.295	714.612	38.067	0.766	0.458	0.135
10	9.365	780.417	600.000	0.000	600.000	984.403	0.000	52.446	714.612	38.067	0.752	0.458	0.139
11	9.072	756.019	600.000	0.000	600.000	965.176	0.000	51.563	714.612	38.067	0.737	0.458	0.144

###---##---### ROTOR EXIT OUTPUT DATA ###---##---###

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	1000.000	600.000	449.490	749.694	814.256	36.839	42.537	789.443	51.643	0.450	0.610	0.562	0.030
2	11.752	979.348	600.000	458.909	755.415	794.225	37.414	40.935	789.443	51.643	0.456	0.595	0.566	0.031
3	11.504	958.695	600.000	468.835	761.403	774.559	38.005	39.228	789.443	51.643	0.462	0.581	0.571	0.032
4	11.257	938.043	600.000	479.173	767.862	755.352	38.612	37.408	789.443	51.643	0.468	0.567	0.576	0.033
5	11.009	917.390	600.000	489.966	774.540	736.676	39.235	35.465	789.443	51.643	0.474	0.553	0.581	0.034
6	10.761	896.738	600.000	501.251	781.826	718.617	39.876	33.391	789.443	51.643	0.479	0.540	0.587	0.035
7	10.513	876.085	600.000	513.057	789.454	701.272	40.534	31.175	789.443	51.643	0.484	0.527	0.593	0.035
8	10.265	855.433	600.000	525.454	797.550	684.753	41.210	28.809	789.443	51.643	0.489	0.515	0.600	0.037
9	10.017	834.780	600.000	538.453	806.184	669.186	41.905	26.284	789.443	51.643	0.493	0.504	0.607	0.038
10	9.770	814.123	600.000	552.103	815.370	654.715	42.620	23.591	789.443	51.643	0.496	0.493	0.614	0.039
11	9.522	793.475	600.000	566.483	825.159	641.503	43.354	20.723	789.443	51.643	0.499	0.484	0.622	0.040

###---##---### STATOR EXIT OUTPUT DATA ###---##---###

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	600.000	0.000	600.000	0.000	0.045	0.387	0.444	0.444	0.014
2	11.769	600.000	0.000	600.000	0.000	0.044	0.392	0.444	0.444	0.014
3	11.537	600.000	0.000	600.000	0.000	0.044	0.397	0.444	0.444	0.013
4	11.306	600.000	0.000	600.000	0.000	0.043	0.402	0.444	0.444	0.013
5	11.075	600.000	0.000	600.000	0.000	0.042	0.407	0.444	0.444	0.012
6	10.844	600.000	0.000	600.000	0.000	0.042	0.413	0.444	0.444	0.012
7	10.612	600.000	0.000	600.000	0.000	0.041	0.419	0.444	0.444	0.011
8	10.381	600.000	0.000	600.000	0.000	0.040	0.425	0.444	0.444	0.011
9	10.150	600.000	0.000	600.000	0.000	0.039	0.431	0.444	0.444	0.010
10	9.919	600.000	0.000	600.000	0.000	0.039	0.438	0.444	0.444	0.010
11	9.687	600.000	0.000	600.000	0.000	0.038	0.445	0.444	0.444	0.009

No data output appears on this page since there were no aerodynamic parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 5

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.4500	-1[illegible]	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	0.8000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
4.5595	1.5633	0.8157	1.3092	1.0948	0.8442	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.0000	9.6873	12.0000	10.0076	12.0000	10.1200	0.9251	0.7969

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	19.1029	0.0000	8.0217

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.[illegible]	[illegible]	500.000	0.000	500.000	1166.190	0.000	59.036	789.443	51.195	0.847	0.436	0.104
2	11.769	[illegible].727	500.000	0.000	500.000	1149.707	0.000	58.542	789.443	51.195	0.835	0.436	0.106
3	11.537	961.454	500.000	0.000	500.000	1133.311	0.000	58.034	789.443	51.195	0.823	0.436	0.109
4	11.306	942.181	500.000	0.000	500.000	1117.067	0.000	57.510	789.443	51.195	0.811	0.436	0.111
5	11.075	922.908	500.000	0.000	500.000	1100.800	0.000	56.971	789.443	51.195	0.800	0.436	0.114
6	10.844	903.635	500.000	0.000	500.000	1084.692	0.000	56.416	789.443	51.195	0.788	0.436	0.117
7	10.612	884.363	500.000	0.000	500.000	1068.639	0.000	55.845	789.443	51.195	0.776	0.436	0.119
8	10.381	865.090	500.000	0.000	500.000	1052.796	0.000	55.256	789.443	51.195	0.765	0.436	0.122
9	10.150	845.817	500.000	0.000	500.000	1037.019	0.000	54.649	789.443	51.195	0.753	0.436	0.125
10	9.919	826.544	500.000	0.000	500.000	1021.359	0.000	54.024	789.443	51.195	0.742	0.436	0.129
11	9.687	807.271	500.000	0.000	500.000	1005.926	0.000	53.379	789.443	51.195	0.731	0.436	0.132

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	1000.000	500.000	449.490	749.694	914.286	36.839	42.537	864.274	67.558	0.450	0.581	0.535	0.029
2	11.801	983.337	500.000	457.079	754.269	799.129	37.300	41.257	864.274	67.558	0.455	0.570	0.539	0.030
3	11.602	966.754	500.000	464.329	759.051	782.220	37.771	39.911	864.274	67.558	0.460	0.559	0.542	0.031
4	11.402	950.191	500.000	473.152	764.634	765.531	38.253	38.493	864.274	67.558	0.465	0.548	0.546	0.032
5	11.203	933.588	500.000	481.465	769.[illegible]	751.276	38.745	36.999	864.274	67.558	0.470	0.537	0.550	0.032
6	11.004	916.985	500.000	490.143	774.777	736.315	39.243	35.426	864.274	67.559	0.475	0.527	0.554	0.033
7	10.805	900.382	500.000	499.222	780.527	721.755	39.752	33.767	864.274	67.558	0.480	0.516	0.559	0.034
8	10.605	883.779	500.000	508.610	786.558	707.544	40.287	32.018	864.274	67.558	0.484	0.507	0.563	0.035
9	10.406	867.175	500.000	518.333	792.399	694.039	40.824	30.174	864.274	67.558	0.489	0.497	0.568	0.036
10	10.207	850.574	500.000	528.456	799.541	680.920	41.372	28.230	864.274	67.559	0.493	0.488	0.573	0.037
11	10.008	833.971	500.000	538.976	806.533	668.597	41.933	26.181	864.274	67.559	0.496	0.479	0.578	0.037

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	500.000	0.000	500.000	0.000	0.045	0.378	0.424	0.424	0.013
2	11.812	500.000	0.000	500.000	0.000	0.044	0.382	0.424	0.424	0.013
3	11.624	500.000	0.000	500.000	0.000	0.044	0.386	0.424	0.424	0.013
4	11.436	500.000	0.000	500.000	0.000	0.043	0.390	0.424	0.424	0.012
5	11.248	500.000	0.000	500.000	0.000	0.042	0.395	0.424	0.424	0.012
6	11.060	500.000	0.000	500.000	0.000	0.042	0.399	0.424	0.424	0.011
7	10.872	500.000	0.000	500.000	0.000	0.041	0.403	0.424	0.424	0.011
8	10.684	500.000	0.000	500.000	0.000	0.041	0.408	0.424	0.424	0.011
9	10.496	500.000	0.000	500.000	0.000	0.040	0.413	0.424	0.424	0.010
10	10.308	500.000	0.000	500.000	0.000	0.040	0.418	0.424	0.424	0.010
11	10.120	500.000	0.000	500.000	0.000	0.039	0.423	0.424	0.424	0.010

No data output appears on this
page since there were no aerodynamic
parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 6

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
[illegible]	[illegible]	[illegible]	2.5[illegible]	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	[illegible] ANGLE [illegible] HUB (DEGREES)			COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.45[illegible]	[illegible]			[illegible]	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
[illegible]	[illegible]	[illegible]	2.5[illegible]	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER			COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.50[illegible]	[illegible]			[illegible]	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 1[illegible].443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
5.8372	1.[illegible]55	[illegible]	[illegible]	1.[illegible]	0.8447	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.[illegible]	[illegible]	12.0000	10.[illegible]576	12.0000	10.4382	0.7520	0.6570

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	17.5347	0.0000	6.9932

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	[illegible]	[illegible]	0.000	[illegible]	1106.19[illegible]	0.000	59.036	864.274	67.024	0.810	0.417	0.102
2	11.812	[illegible]94.333	[illegible]	0.000	[illegible]	1152.784	0.000	58.636	864.274	67.024	0.800	0.417	0.104
3	11.624	968.55[illegible]	[illegible]	0.000	[illegible]	1139.435	0.000	58.226	864.274	67.024	0.791	0.417	0.106
4	11.436	952.4[illegible]	[illegible]	0.000	[illegible]	1125.147	0.000	57.806	864.274	67.024	0.782	0.417	0.108
5	11.248	937.[illegible]	[illegible]	0.000	[illegible]	1112.92[illegible]	0.000	57.376	864.274	67.024	0.773	0.417	0.110
6	11.060	[illegible].055	[illegible]	0.000	[illegible]	1099.757	0.000	56.936	864.274	67.024	0.764	0.417	0.112
7	10.872	905.998	[illegible]	0.000	[illegible]	1086.551	0.000	56.435	864.274	67.024	0.754	0.417	0.114
8	10.694	89[illegible].[illegible]31	[illegible]	0.000	[illegible]	1073.633	0.000	56.024	864.274	67.024	0.745	0.417	0.117
9	10.496	[illegible]7[illegible].55[illegible]	[illegible]	0.000	[illegible]	1060.677	0.000	55.551	864.274	67.024	0.736	0.417	0.119
10	10.308	858.997	[illegible]	0.000	[illegible]	1047.795	0.000	55.066	864.274	67.024	0.727	0.417	0.121
11	10.12[illegible]	843.33[illegible]	[illegible]	0.000	[illegible]	1034.97[illegible]	0.000	54.569	864.274	67.024	0.719	0.417	0.124

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	[illegible]	[illegible]	449.[illegible]	749.59[illegible]	814.286	36.839	42.537	939.105	86.432	0.450	0.555	0.512	0.029
2	11.836	985.513	[illegible]	455.728	753.45[illegible]	805.950	37.218	41.487	939.105	86.432	0.454	0.547	0.515	0.029
3	11.672	972.625	[illegible]	462.141	757.347	787.779	37.605	40.393	939.105	86.432	0.459	0.539	0.518	0.030
4	11.507	958.939	[illegible]	458.737	761.39[illegible]	774.789	37.938	39.249	939.105	85.432	0.463	0.530	0.521	0.031
5	11.343	945.252	[illegible]	475.524	765.597	762.00[illegible]	38.393	38.057	939.105	85.432	0.467	0.521	0.524	0.031
6	11.179	931.555	[illegible]	482.3[illegible]	769.5[illegible]	749.433	38.806	36.812	939.105	86.432	0.472	0.513	0.527	0.032
7	11.015	917.879	[illegible]	489.765	774.475	737.110	39.220	35.512	939.105	86.432	0.476	0.505	0.530	0.033
8	10.850	904.19[illegible]	[illegible]	497.198	779.[illegible]	725.058	39.643	34.155	939.105	86.432	0.480	0.496	0.534	0.033
9	10.686	890.505	[illegible]	504.759	784.08[illegible]	713.302	40.073	32.737	939.105	86.432	0.484	0.489	0.537	0.034
10	10.522	876.818	[illegible]	512.638	789.17[illegible]	701.874	40.510	31.256	939.105	86.432	0.488	0.481	0.541	0.035
11	10.358	863.13[illegible]	[illegible]	520.767	794.4[illegible]	690.806	40.955	29.709	939.105	86.432	0.491	0.474	0.545	0.035

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	[illegible]	[illegible]	[illegible]	0.000	0.044	0.373	0.406	0.406	0.013
2	11.844	[illegible]	[illegible]	[illegible]	0.000	0.044	0.376	0.406	0.406	0.012
3	11.688	[illegible]	[illegible]	[illegible]	0.000	0.043	0.379	0.406	0.406	0.012
4	11.532	[illegible]	[illegible]	[illegible]	0.000	0.043	0.382	0.406	0.406	0.012
5	11.375	[illegible]	[illegible]	[illegible]	0.000	0.042	0.386	0.406	0.405	0.012
6	11.219	[illegible]	[illegible]	[illegible]	0.000	0.042	0.389	0.406	0.406	0.011
7	11.063	[illegible]	[illegible]	[illegible]	0.000	0.042	0.393	0.406	0.405	0.011
8	10.907	[illegible]	[illegible]	[illegible]	0.000	0.041	0.397	0.406	0.405	0.011
9	10.751	[illegible]	[illegible]	[illegible]	0.000	0.041	0.401	0.406	0.406	0.010
10	10.594	[illegible]	[illegible]	[illegible]	0.000	0.040	0.405	0.406	0.406	0.010
11	10.438	[illegible]	[illegible]	[illegible]	0.000	0.040	0.409	0.406	0.405	0.010

No data output appears on this page since there were no aerodynamic parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 7

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)			B	C	D	E
				COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION			
0.4500	-10.000			0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER			B	C	D	E
				COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION			
0.5000	0.8000			0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
7.3326	1.9536	0.8042	1.2552	1.0797	0.8451	2.5000	2.5000
ROTOR TIP RAD. 1-G (INCHES)	**ROTOR HUB RAD. 1-G (INCHES)**	**ROTOR TIP RAD. 2-G (INCHES)**	**ROTOR HUB RAD. 2-G (INCHES)**	**STATOR TIP RAD. 3-G (INCHES)**	**STATOR HUB RAD. 3-G (INCHES)**	**ROTOR PROJ. LENGTH (INCHES)**	**STATOR PROJ. LENGTH (INCHES)**
12.0000	10.4582	12.0000	10.6186	12.0000	10.6800	0.6247	0.5526
		ROTOR TIP RAMP ANGLE (DEGREES)	**ROTOR HUB RAMP ANGLE (DEGREES)**	**STATOR TIP RAMP ANGLE (DEGREES)**	**STATOR HUB RAMP ANGLE (DEGREES)**		
		0.0000	15.1091	0.0000	6.3391		

--**-- R O T O R   I N L E T   O U T P U T   D A T A   ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1166.190	0.000	59.036	939.105	85.906	0.777	0.400	0.100
2	11.944	[illegible]	[illegible]	[illegible]	[illegible]	1155.049	0.000	58.704	939.105	85.906	0.769	0.400	0.102
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1143.948	0.000	58.355	939.105	85.906	0.762	0.400	0.104
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1132.887	0.000	58.020	939.105	85.906	0.755	0.400	0.105
5	11.275	647.038	[illegible]	[illegible]	[illegible]	1121.958	0.000	57.668	939.105	85.906	0.747	0.400	0.107
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1110.892	0.000	57.309	939.105	85.906	0.740	0.400	0.109
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1099.961	0.000	56.943	939.105	85.906	0.733	0.400	0.110
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1089.075	0.000	56.569	939.105	85.906	0.725	0.400	0.112
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1078.237	0.000	56.189	939.105	85.906	0.718	0.400	0.114
10	10.564	[illegible]	[illegible]	[illegible]	[illegible]	1067.448	0.000	55.800	939.105	85.906	0.711	0.400	0.116
11	10.439	[illegible]	[illegible]	[illegible]	[illegible]	1056.708	0.000	55.403	939.105	85.906	0.704	0.400	0.119

--**-- R O T O R   E X I T   O U T P U T   D A T A   ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	[illegible]	[illegible]	[illegible]	449.490	749.694	814.286	36.839	42.537	1013.937	108.515	0.450	0.534	0.492	0.028
2	11.862	699.463	[illegible]	454.725	752.344	803.059	37.158	41.656	1013.937	108.515	0.454	0.527	0.494	0.029
3	11.724	675.975	[illegible]	[illegible]	[illegible]	791.946	37.481	40.745	1013.937	108.515	0.458	0.520	0.496	0.029
4	11.586	[illegible]	[illegible]	[illegible]	759.443	780.958	37.810	39.800	1013.937	108.515	0.461	0.513	0.499	0.030
5	11.447	[illegible]	[illegible]	471.187	[illegible]	770.106	38.143	38.820	1013.937	108.515	0.465	0.506	0.501	0.030
6	11.309	647.441	[illegible]	[illegible]	766.449	759.400	38.481	37.605	1013.937	108.515	0.469	0.499	0.504	0.031
7	11.171	[illegible]	[illegible]	482.840	[illegible]	748.855	38.825	36.753	1013.937	108.515	0.473	0.492	0.506	0.032
8	[illegible]	619.417	[illegible]	[illegible]	[illegible]	735.493	39.173	35.861	1013.937	108.515	0.476	0.485	0.509	0.032
9	10.895	[illegible]	[illegible]	[illegible]	[illegible]	729.300	39.527	34.529	1013.937	108.515	0.480	0.479	0.511	0.033
10	10.757	[illegible]	[illegible]	[illegible]	[illegible]	719.322	39.887	33.355	1013.937	108.515	0.483	0.472	0.514	0.033
11	[illegible]	694.692	[illegible]	[illegible]	786.149	[illegible]	40.252	32.137	1013.937	108.515	0.487	0.466	0.517	0.034

--**-- S T A T O R   E X I T   O U T P U T   D A T A   ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.044	0.369	0.390	0.390	0.012
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.043	0.371	0.390	0.390	0.012
3	11.736	[illegible]	[illegible]	[illegible]	0.000	0.043	0.374	0.390	0.390	0.012
4	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.043	0.377	0.390	0.390	0.012
5	11.472	[illegible]	[illegible]	[illegible]	0.000	0.042	0.380	0.390	0.390	0.011
6	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.042	0.383	0.390	0.390	0.011
7	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.042	0.386	0.390	0.390	0.011
8	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.041	0.389	0.390	0.390	0.011
9	10.944	[illegible]	[illegible]	[illegible]	0.000	0.041	0.392	0.390	0.390	0.010
10	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.041	0.395	0.390	0.390	0.010
11	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.040	0.398	0.390	0.390	0.010

No data output appears on this
page since there were no aerodynamic
parameter or geometric violations.

******** S T A G E   D A T A ********

STAGE NO. 8

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.[illegible]	[illegible].875[illegible]	1.[illegible]	2.5[illegible]	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)			B	C	D	E
0.45[illegible]	-1[illegible]			0.0000	0.0000	0.0000	0.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION (B, C, D, E)

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.[illegible]	0.8500	2.[illegible]	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER			B	C	D	E
0.5000	0.8000			0.0000	0.0000	0.0000	0.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION (B, C, D, E)

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
9.0627	2.0978	0.799[illegible]	1.2359	1.0733	0.8454	2.5000	2.5000
ROTOR TIP RAD. 1-G (INCHES)	**ROTOR HUB RAD. 1-G (INCHES)**	**ROTOR TIP RAD. 2-G (INCHES)**	**ROTOR HUB RAD. 2-G (INCHES)**	**STATOR TIP RAD. 3-G (INCHES)**	**STATOR HUB RAD. 3-G (INCHES)**	**ROTOR PROJ. LENGTH (INCHES)**	**STATOR PROJ. LENGTH (INCHES)**
12.[illegible]	10.[illegible]	12.[illegible]	10.8215	12.0000	10.9685	0.5290	0.4714
		ROTOR TIP RAMP ANGLE (DEGREES)	**ROTOR HUB RAMP ANGLE (DEGREES)**	**STATOR TIP RAMP ANGLE (DEGREES)**	**STATOR HUB RAMP ANGLE (DEGREES)**		
		0.[illegible]	15.0024	0.0000	5.7006		

--**-- R O T O R I N L E T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	[illegible]	500.000	0.000	500.000	1166.190	0.000	59.036	1013.937	107.790	0.748	0.385	0.099
2	11.868	[illegible]	500.000	0.000	500.000	1156.772	0.000	58.756	1013.937	107.790	0.741	0.385	0.100
3	11.736	977.999	500.000	0.000	500.000	1147.381	0.000	58.471	1013.937	107.790	0.735	0.385	0.102
4	11.604	966.999	500.000	0.000	500.000	1138.019	0.000	58.181	1013.937	107.790	0.729	0.385	0.103
5	11.472	955.999	500.000	0.000	500.000	1128.687	0.000	57.887	1013.937	107.790	0.723	0.385	0.104
6	11.340	944.999	500.000	0.000	500.000	1119.385	0.000	57.588	1013.937	107.790	0.718	0.385	0.106
7	11.208	933.998	500.000	0.000	500.000	1110.114	0.000	57.283	1013.937	107.790	0.712	0.385	0.107
8	11.076	922.998	500.000	0.000	500.000	1100.875	0.000	56.974	1013.937	107.790	0.706	0.385	0.109
9	10.944	911.998	500.000	0.000	500.000	1091.669	0.000	56.659	1013.937	107.790	0.700	0.385	0.110
10	10.812	900.998	500.000	0.000	500.000	1082.495	0.000	56.339	1013.937	107.790	0.694	0.385	0.112
11	10.680	889.997	500.000	0.000	500.000	1073.357	0.000	56.014	1013.937	107.790	0.688	0.385	0.114

--**-- R O T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	1000.000	500.000	445.490	749.394	814.285	36.839	42.537	1088.768	134.055	0.450	0.515	0.474	0.028
2	11.882	990.173	500.000	453.443	752.475	804.701	37.110	41.788	1088.768	134.055	0.453	0.509	0.476	0.029
3	11.764	980.359	500.000	459.496	755.128	795.199	37.386	41.016	1088.768	134.055	0.457	0.503	0.478	0.029
4	11.646	970.537	500.000	463.155	757.954	785.784	37.664	40.220	1088.768	134.055	0.460	0.497	0.480	0.029
5	11.529	960.715	500.000	467.570	760.856	776.454	37.947	39.400	1088.768	134.055	0.463	0.491	0.491	0.030
6	11.411	950.895	500.000	472.702	763.837	767.247	38.232	38.554	1088.768	134.055	0.467	0.486	0.483	0.030
7	11.293	941.074	500.000	477.636	766.900	758.139	38.522	37.682	1088.768	134.055	0.470	0.480	0.485	0.031
8	11.175	931.253	500.000	482.673	770.047	749.149	38.815	36.793	1088.768	134.055	0.473	0.474	0.488	0.031
9	11.057	921.432	500.000	487.817	773.282	740.285	39.112	35.855	1088.768	134.055	0.476	0.469	0.490	0.032
10	10.939	911.611	500.000	493.073	776.608	731.556	39.413	34.898	1088.768	134.055	0.490	0.463	0.492	0.032
11	10.821	901.790	500.000	498.443	780.023	722.972	39.718	33.911	1088.768	134.055	0.483	0.458	0.494	0.033

--**-- S T A T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	12.000	500.000	0.000	500.000	0.000	0.044	0.366	0.376	0.376	0.012
2	11.887	500.000	0.000	500.000	0.000	0.043	0.368	0.376	0.376	0.012
3	11.774	500.000	0.000	500.000	0.000	0.043	0.370	0.376	0.376	0.012
4	11.661	500.000	0.000	500.000	0.000	0.043	0.373	0.376	0.376	0.011
5	11.547	500.000	0.000	500.000	0.000	0.042	0.375	0.376	0.376	0.011
6	11.434	500.000	0.000	500.000	0.000	0.042	0.377	0.376	0.376	0.011
7	11.321	500.000	0.000	500.000	0.000	0.042	0.380	0.376	0.376	0.011
8	11.208	500.000	0.000	500.000	0.000	0.041	0.393	0.376	0.376	0.011
9	11.095	500.000	0.000	500.000	0.000	0.041	0.395	0.376	0.376	0.010
10	10.982	500.000	0.000	500.000	0.000	0.041	0.338	0.376	0.376	0.010
11	10.869	500.000	0.000	500.000	0.000	0.040	0.391	0.376	0.376	0.010

*** OVERALL PRESSURE RATIO LIMIT HAS BEEN REACHED -- GO TO NEW DATA ***

NON-FREE VORTEX CASE

-- PARAMETRIC STUDY OF ADVANCED MULTISTAGE AXIAL-FLOW COMPRESSORS ***--***

*** R O T O R   I N L E T   I N P U T   D A T A ***

NO. RAD. STATIONS	NUMBER STAGES	SP. HEAT (BTU/(LB-R))	MOL. WT. (MOLES)	RATIO OF SP. HEAT	IN. TOT. TEMP. (DEG. R)	IN. TOT. PR. (PSI)	MASS AVG. TOT. PR. RATIO
11	[illegible]	0.2400	29.0000	1.4000	519.0000	14.7000	9.0000

TIP RADIUS (INCHES)	TIP WHEEL SPEED (FT/SEC)	HUB TO TIP RADIUS RATIO	AXIAL VEL. (FT/SEC)	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR
12.0000	1000.0000	0.4000	500.0000	1.0000	1.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

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*** ROTOR HUB RAMP ANGLE LIMIT VIOLATED ***
*** STATOR HUB MACH NO. LIMIT VIOLATED ***
*** ROTOR HUB RAMP ANGLE LIMIT VIOLATED ***
*** ROTOR HUB RAMP ANGLE LIMIT VIOLATED ***
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******** S T A G E   D A T A ********

STAGE NO. 1

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.2000	0.8750	[illegible]	4.0000	1.0000	1.0000	40.000	-20.000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	B	C	D	E
0.4500	0.0000	0.0000	0.0000	30.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.1200	0.8500	2.0000	4.0000	1.0000	1.0000	40.0000	-20.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	B	C	D	E
0.6000	0.5000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
1.3647	1.1102	0.8431	1.3647	1.1102	0.8431	4.0000	4.0000
ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
12.0000	4.9000	11.8469	6.2104	11.8469	6.6334	1.8000	1.3841
		ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)		
		-4.8615	40.0000	0.0000	13.1379		

###--##--### R O T O R   I N L E T   O U T P U T   D A T A   ###--##--###

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	12.000	[illegible]	500.000	0.000	500.000	1166.190	0.000	59.036	519.000	14.700	1.076	0.554	0.111
2	11.290	941.000	500.000	0.000	500.000	1115.153	0.000	57.450	519.000	14.700	1.029	0.554	0.111
3	10.560	88?.000	500.000	0.000	500.000	1065.082	0.000	55.713	519.000	14.700	0.983	0.554	0.112
4	9.840	82?.000	500.000	0.000	500.000	1016.071	0.000	53.807	519.000	14.700	0.938	0.554	0.112
5	9.120	76?.000	500.000	0.000	500.000	969.297	0.000	51.710	519.000	14.700	0.894	0.554	0.113
6	8.400	703.000	500.000	0.000	500.000	921.954	0.000	49.399	519.000	14.700	0.851	0.554	0.113
7	7.680	64?.000	500.000	0.000	500.000	877.268	0.000	46.848	519.000	14.700	0.810	0.554	0.114
8	6.960	58?.000	500.000	0.000	500.000	834.506	0.000	44.029	519.000	14.700	0.770	0.554	0.114
9	6.240	52?.000	500.000	0.000	500.000	793.977	0.000	40.914	519.000	14.700	0.733	0.554	0.115
10	5.520	46?.000	500.000	0.000	500.000	756.042	0.000	37.476	519.000	14.700	0.698	0.554	0.115
11	4.800	403.000	500.000	0.000	500.000	721.110	0.000	33.690	519.000	14.700	0.666	0.554	0.114

###--##--### R O T O R   E X I T   O U T P U T   D A T A   ###--##--###

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	987.242	720.000	462.378	855.986	890.671	32.740	36.082	595.087	22.350	0.393	0.787	0.756	0.034
2	11.293	941.104	696.218	451.601	829.957	851.076	32.969	35.111	589.755	21.742	0.384	0.753	0.734	0.033
3	10.740	894.957	673.326	440.405	804.795	812.175	33.212	34.000	584.678	21.174	0.375	0.720	0.713	0.032
4	10.186	848.929	651.449	430.644	780.923	774.122	33.467	32.698	579.856	20.644	0.366	0.687	0.693	0.030
5	9.632	802.691	630.729	421.223	758.450	737.113	33.736	31.166	575.289	20.150	0.357	0.655	0.674	0.029
6	9.079	756.554	611.224	412.679	737.578	702.404	34.022	29.358	570.977	19.591	0.348	0.624	0.657	0.028
7	8.525	711.416	593.421	405.182	718.555	667.320	34.325	27.220	566.921	19.265	0.339	0.595	0.641	0.026
8	7.971	664.278	577.223	398.952	701.075	635.283	34.651	24.686	563.120	18.873	0.330	0.567	0.627	0.025
9	7.418	618.140	562.942	394.270	687.296	605.842	35.005	21.686	559.574	18.511	0.319	0.542	0.615	0.023
10	6.864	572.003	550.892	391.513	675.844	579.706	35.401	18.140	556.283	18.180	0.307	0.520	0.606	0.022
11	6.310	525.865	541.292	391.137	667.351	557.795	35.855	13.372	553.247	17.877	0.292	0.501	0.600	0.020

###--##--### S T A T O R   E X I T   O U T P U T   D A T A   ###--##--###

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.038	0.305	0.708	0.708	0.017
2	11.326	765.552	0.000	765.552	0.000	0.037	0.315	0.672	0.672	0.016
3	10.804	724.728	0.000	724.728	0.000	0.036	0.327	0.636	0.636	0.015
4	10.283	683.595	0.000	683.596	0.000	0.035	0.343	0.600	0.600	0.014
5	9.762	642.216	0.000	642.215	0.000	0.034	0.361	0.564	0.564	0.013
6	9.240	600.536	0.000	600.536	0.000	0.033	0.384	0.527	0.527	0.012
7	8.719	559.491	0.000	559.491	0.000	0.032	0.411	0.490	0.490	0.011
8	8.197	515.991	0.000	515.991	0.000	0.031	0.442	0.453	0.453	0.010
9	7.676	472.912	0.000	472.912	0.000	0.029	0.479	0.415	0.415	0.008
10	7.155	429.080	0.000	429.080	0.000	0.028	0.522	0.377	0.377	0.007
11	6.633	384.239	0.000	384.239	0.000	0.026	0.571	0.337	0.337	0.006

*** ROTOR HUB RELATIVE ANGLE LIMIT VIOLATED ***

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

********** S T A G E   D A T A **********

STAGE NO. 2

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.3000	3.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.4000	-1[illegible]	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	3.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	0.8000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
1.6809	1.1967	[illegible]	1.2342	1.0733	0.8454	3.5000	3.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8469	6.[illegible]34	11.8469	7.3906	11.8469	7.5460	1.4396	1.2732

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
[illegible]	26.9446	0.0000	6.9607

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.847	987.242	806.400	0.000	806.400	1274.727	0.000	50.757	595.087	22.094	1.067	0.675	0.058
2	11.326	943.737	765.652	0.000	765.652	1215.309	0.000	50.949	589.755	21.500	1.021	0.644	0.062
3	10.804	900.251	724.728	0.000	724.728	1155.795	0.000	51.168	584.678	20.954	0.976	0.612	0.066
4	10.283	856.905	683.596	0.000	683.596	1096.171	0.000	51.419	579.856	20.444	0.929	0.579	0.072
5	9.762	813.455	642.216	0.000	642.216	1036.416	0.000	51.709	575.289	19.969	0.882	0.547	0.078
6	9.240	770.014	600.536	0.000	600.536	976.507	0.000	52.049	570.977	19.527	0.834	0.513	0.086
7	8.719	726.559	558.491	0.000	558.491	916.414	0.000	52.452	566.921	19.117	0.786	0.479	0.095
8	8.197	683.123	515.991	0.000	515.991	856.098	0.000	52.935	563.120	18.738	0.736	0.444	0.106
9	7.676	639.673	472.912	0.000	472.912	795.508	0.000	53.525	559.574	18.389	0.686	0.408	0.120
10	7.155	596.232	429.080	0.000	429.080	734.577	0.000	54.259	556.283	18.070	0.636	0.371	0.137
11	6.633	552.787	384.239	0.000	384.239	673.211	0.000	55.197	553.247	17.778	0.584	0.333	0.159

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	987.242	806.400	256.531	846.251	1088.151	17.653	42.177	637.266	27.236	0.224	0.924	0.719	0.016
2	11.401	950.106	765.652	264.562	810.750	1026.313	19.202	41.753	631.934	26.565	0.235	0.872	0.689	0.017
3	10.956	912.970	724.728	277.508	776.042	963.868	20.953	41.245	626.856	25.937	0.247	0.819	0.660	0.018
4	10.510	875.834	683.596	289.275	742.282	900.752	22.936	40.631	622.035	25.349	0.262	0.766	0.631	0.018
5	10.064	838.699	642.216	302.083	709.715	836.897	25.191	39.881	617.468	24.801	0.278	0.712	0.604	0.019
6	9.619	801.563	600.536	316.079	678.639	772.230	27.759	38.953	613.156	24.290	0.298	0.657	0.578	0.020
7	9.173	764.427	559.491	331.434	649.431	706.679	30.687	37.786	609.100	23.816	0.322	0.602	0.553	0.022
8	8.727	727.291	515.991	346.357	622.574	640.195	34.024	36.293	605.299	23.378	0.350	0.546	0.531	0.023
9	8.282	690.155	472.912	357.101	598.673	572.721	37.821	34.338	601.753	22.973	0.383	0.489	0.511	0.026
10	7.836	653.019	429.080	387.973	579.479	504.339	42.120	31.703	598.462	22.602	0.423	0.431	0.494	0.028
11	7.391	615.883	384.239	411.372	562.909	435.275	46.953	28.024	595.426	22.264	0.471	0.372	0.482	0.032

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.021	0.167	0.682	0.682	0.008
2	11.417	765.652	0.000	765.652	0.000	0.022	0.181	0.647	0.647	0.008
3	10.987	724.728	0.000	724.728	0.000	0.024	0.197	0.613	0.613	0.009
4	10.557	683.596	0.000	683.596	0.000	0.026	0.216	0.578	0.578	0.009
5	10.127	642.216	0.000	642.216	0.000	0.028	0.239	0.543	0.543	0.010
6	9.696	600.536	0.000	600.536	0.000	0.031	0.266	0.508	0.508	0.010
7	9.266	559.491	0.000	559.491	0.000	0.033	0.298	0.472	0.472	0.010
8	8.836	515.991	0.000	515.991	0.000	0.036	0.335	0.436	0.436	0.011
9	8.406	472.912	0.000	472.912	0.000	0.039	0.381	0.400	0.400	0.011
10	7.976	429.080	0.000	429.080	0.000	0.041	0.436	0.363	0.363	0.011
11	7.546	384.239	0.000	384.239	0.000	0.044	0.500	0.325	0.325	0.011

*** ROTOR HUB RELATIVE ANGLE LIMIT VIOLATED ***

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 3

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.00[illegible]	[illegible].8750	1.[illegible]	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)
0.45[illegible]	-10.[illegible]

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER
0.5000	0.8000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
2.0831	1.2799	0.8338	1.2410	1.0753	0.8453	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8469	7.5[illegible]	11.8469	9.1461	11.8469	8.2791	1.7203	1.4803

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	13.2285	0.0000	5.1331

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.847	997.242	806.400	0.000	806.400	1274.727	0.000	50.757	637.266	27.074	1.031	0.652	0.062
2	11.417	961.402	765.652	0.000	765.652	1221.224	0.000	51.174	631.934	26.405	0.992	0.622	0.066
3	10.987	925.561	724.728	0.000	724.728	1167.682	0.000	51.636	626.856	25.779	0.952	0.591	0.070
4	10.557	889.721	683.596	0.000	683.596	1114.097	0.000	52.151	622.035	25.194	0.912	0.559	0.075
5	10.127	843.880	642.216	0.000	642.216	1060.459	0.000	52.728	617.468	24.647	0.871	0.528	0.081
6	9.696	803.040	600.536	0.000	600.536	1006.763	0.000	53.380	613.156	24.139	0.830	0.495	0.088
7	9.266	772.199	558.491	0.000	558.491	952.997	0.000	54.124	609.100	23.667	0.788	0.462	0.096
8	8.836	736.359	515.991	0.000	515.991	899.150	0.000	54.980	605.299	23.230	0.746	0.428	0.105
9	8.406	700.518	472.912	0.000	472.912	845.205	0.000	55.977	601.753	22.828	0.703	0.393	0.117
10	7.976	664.678	429.080	0.000	429.080	791.142	0.000	57.156	598.462	22.458	0.660	0.358	0.131
11	7.546	628.837	384.239	0.000	384.239	736.937	0.000	58.574	595.426	22.121	0.616	0.321	0.147

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	997.242	806.400	282.871	854.574	1070.710	19.330	41.136	683.757	33.590	0.245	0.876	0.699	0.018
2	11.477	955.402	765.652	291.992	819.443	1013.737	20.875	40.950	678.425	32.818	0.257	0.829	0.670	0.018
3	11.107	925.562	724.728	301.721	785.025	955.246	22.603	40.722	673.348	32.094	0.271	0.783	0.642	0.019
4	10.737	894.722	683.596	312.121	751.430	898.179	24.541	40.440	668.526	31.417	0.286	0.735	0.615	0.020
5	10.367	863.892	642.216	323.264	719.985	839.469	26.719	40.091	663.959	30.784	0.304	0.688	0.589	0.021
6	9.997	833.042	600.536	335.251	687.747	780.038	29.171	39.557	659.648	30.194	0.324	0.639	0.564	0.022
7	9.626	802.212	558.491	349.119	658.133	719.794	31.936	39.113	655.591	29.647	0.347	0.590	0.540	0.023
8	9.256	771.322	515.991	362.037	630.331	659.629	35.055	38.424	651.790	29.139	0.374	0.540	0.517	0.024
9	8.886	740.521	472.912	377.115	604.865	596.414	38.570	37.540	648.244	28.671	0.406	0.490	0.497	0.026
10	8.516	709.681	429.080	393.513	582.198	532.990	42.523	36.386	644.953	28.241	0.444	0.438	0.479	0.028
11	8.146	673.841	384.239	411.380	562.915	468.162	46.954	34.841	641.917	27.848	0.490	0.385	0.463	0.031

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -F (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.022	0.176	0.656	0.656	0.008
2	11.490	765.652	0.000	765.652	0.000	0.024	0.190	0.623	0.623	0.008
3	11.133	724.728	0.000	724.728	0.000	0.026	0.207	0.590	0.590	0.009
4	10.777	683.596	0.000	683.596	0.000	0.028	0.226	0.556	0.556	0.009
5	10.420	642.215	0.000	642.215	0.000	0.030	0.249	0.522	0.522	0.010
6	10.063	600.536	0.000	600.536	0.000	0.033	0.276	0.488	0.488	0.010
7	9.706	558.491	0.000	558.491	0.000	0.036	0.307	0.454	0.454	0.011
8	9.349	515.991	0.000	515.991	0.000	0.039	0.344	0.420	0.420	0.011
9	8.993	472.912	0.000	472.912	0.000	0.042	0.388	0.385	0.385	0.011
10	8.636	429.080	0.000	429.080	0.000	0.045	0.439	0.349	0.349	0.012
11	8.279	384.239	0.000	384.239	0.000	0.048	0.500	0.313	0.313	0.012

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 4

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.9750	[illegible]	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.4500	-10.0000	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	0.8000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
2.5823	1.3756	0.8295	1.2409	1.0752	0.8453	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8469	8.2791	11.8469	8.7507	11.8469	8.8590	1.4271	1.2385

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
[illegible]	18.2956	0.0000	4.9979

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.947	987.242	806.400	0.000	806.400	1274.727	0.000	50.757	683.757	33.383	0.995	0.629	0.065
2	11.490	957.510	765.652	0.000	765.652	1225.989	0.000	51.353	678.425	32.515	0.961	0.600	0.069
3	11.133	927.778	724.728	0.000	724.728	1177.286	0.000	52.065	673.348	31.894	0.925	0.570	0.073
4	10.777	898.045	683.596	0.000	683.596	1128.623	0.000	52.721	668.526	31.219	0.891	0.540	0.078
5	10.420	868.314	642.215	0.000	642.215	1080.005	0.000	53.513	663.959	30.589	0.856	0.509	0.083
6	10.063	838.582	600.535	0.000	600.535	1031.438	0.000	54.392	659.648	30.002	0.820	0.477	0.089
7	9.706	808.851	558.491	0.000	558.491	982.938	0.000	55.376	655.591	29.456	0.784	0.445	0.096
8	9.349	779.119	515.991	0.000	515.991	934.490	0.000	56.494	651.790	28.951	0.747	0.413	0.105
9	8.993	749.387	472.912	0.000	472.912	886.131	0.000	57.745	648.244	28.485	0.710	0.379	0.114
10	8.636	719.655	429.089	0.000	429.089	837.862	0.000	59.195	644.953	28.057	0.673	0.345	0.125
11	8.279	689.923	384.239	0.000	384.239	789.705	0.000	60.385	641.917	27.666	0.636	0.310	0.139

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.947	987.242	806.400	302.355	861.743	1057.023	20.647	40.280	733.698	41.427	0.262	0.832	0.679	0.019
2	11.537	961.440	765.652	312.010	826.735	1003.393	22.171	40.305	728.356	40.540	0.275	0.791	0.651	0.020
3	11.228	935.639	724.728	320.514	792.479	951.519	23.864	40.319	723.289	39.707	0.289	0.749	0.624	0.020
4	10.918	909.836	683.596	329.707	758.953	895.578	25.749	40.319	718.467	38.926	0.305	0.707	0.598	0.021
5	10.608	884.034	642.215	339.330	726.351	842.106	27.651	40.303	713.900	38.196	0.323	0.664	0.573	0.022
6	10.299	858.232	600.535	349.531	694.850	787.032	30.201	40.267	709.588	37.516	0.343	0.621	0.548	0.023
7	9.989	832.430	558.491	360.365	664.652	731.271	32.832	40.206	705.532	36.883	0.366	0.577	0.525	0.024
8	9.680	806.628	515.991	371.393	636.043	674.715	35.782	40.115	701.731	36.296	0.392	0.533	0.502	0.025
9	9.370	780.825	472.912	384.132	609.295	617.229	39.090	39.997	698.185	35.754	0.422	0.488	0.481	0.026
10	9.060	755.023	429.089	397.311	584.778	558.531	42.798	39.817	694.894	35.256	0.457	0.442	0.462	0.028
11	8.751	729.221	384.239	411.369	562.907	498.668	46.953	39.598	691.858	34.801	0.499	0.395	0.445	0.029

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.947	806.400	0.000	806.400	0.000	0.023	0.193	0.631	0.631	0.009
2	11.548	765.652	0.000	765.652	0.000	0.025	0.198	0.599	0.599	0.008
3	11.249	724.728	0.000	724.728	0.000	0.027	0.215	0.567	0.567	0.009
4	10.951	683.596	0.000	683.596	0.000	0.029	0.234	0.535	0.535	0.009
5	10.652	642.215	0.000	642.215	0.000	0.032	0.257	0.503	0.503	0.010
6	10.353	600.535	0.000	600.535	0.000	0.034	0.293	0.470	0.470	0.010
7	10.054	558.491	0.000	558.491	0.000	0.037	0.314	0.437	0.437	0.011
8	9.755	515.991	0.000	515.991	0.000	0.041	0.350	0.404	0.404	0.011
9	9.457	472.912	0.000	472.912	0.000	0.044	0.392	0.370	0.370	0.012
10	9.158	429.089	0.000	429.089	0.000	0.049	0.442	0.336	0.336	0.012
11	8.859	384.239	0.000	384.239	0.000	0.051	0.500	0.301	0.301	0.013

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 5

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)						
				COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION			
				B	C	D	E
0.4500	-10.0000			0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER						
				COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION			
				B	C	D	E
0.5000	0.9000			0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
3.1900	1.4769	0.8240	1.2362	1.0739	0.8454	2.5000	2.5000
ROTOR TIP RAD. 1-G (INCHES)	**ROTOR HUB RAD. 1-G (INCHES)**	**ROTOR TIP RAD. 2-G (INCHES)**	**ROTOR HUB RAD. 2-G (INCHES)**	**STATOR TIP RAD. 3-G (INCHES)**	**STATOR HUB RAD. 3-G (INCHES)**	**ROTOR PROJ. LENGTH (INCHES)**	**STATOR PROJ. LENGTH (INCHES)**
11.9469	8.6306	11.8469	9.2345	11.8469	9.3226	1.1952	1.0449
		ROTOR TIP RAMP ANGLE (DEGREES)	**ROTOR HUB RAMP ANGLE (DEGREES)**	**STATOR TIP RAMP ANGLE (DEGREES)**	**STATOR HUB RAMP ANGLE (DEGREES)**		
		0.0000	17.4452	0.0000	4.8160		

--**-- R O T O R I N L E T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.947	987.242	806.400	0.000	806.400	1274.727	0.000	50.757	733.698	41.173	0.961	0.608	0.067
2	11.548	962.343	765.652	0.000	765.652	1223.767	0.000	51.494	728.366	40.289	0.930	0.579	0.071
3	11.249	937.443	724.728	0.000	724.728	1184.918	0.000	52.293	723.289	39.459	0.899	0.550	0.075
4	10.951	912.544	683.596	0.000	683.596	1140.192	0.000	53.163	718.467	38.682	0.868	0.521	0.079
5	10.652	887.644	642.215	0.000	642.215	1095.606	0.000	54.114	713.900	37.955	0.837	0.491	0.084
6	10.353	862.745	600.536	0.000	600.536	1051.176	0.000	55.159	709.588	37.277	0.805	0.460	0.090
7	10.054	837.845	558.491	0.000	558.491	1006.924	0.000	56.313	705.532	36.646	0.774	0.429	0.095
8	9.755	812.946	515.991	0.000	515.991	962.874	0.000	57.596	701.731	36.062	0.742	0.398	0.103
9	9.457	788.046	472.912	0.000	472.912	919.055	0.000	59.032	698.185	35.523	0.710	0.365	0.112
10	9.158	763.147	429.080	0.000	429.080	875.501	0.000	60.653	694.894	35.027	0.678	0.332	0.121
11	8.859	738.247	384.239	0.000	384.239	832.255	0.000	62.504	691.858	34.574	0.646	0.298	0.132

--**-- R O T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.947	987.242	806.400	320.722	867.638	1046.198	21.689	39.575	786.410	50.920	0.276	0.794	0.658	0.020
2	11.586	965.472	765.652	327.953	832.932	996.320	23.187	39.782	781.078	49.902	0.289	0.756	0.632	0.020
3	11.324	943.703	724.729	335.519	798.625	946.107	24.842	40.003	776.001	48.945	0.303	0.718	0.606	0.021
4	11.063	921.933	683.596	343.441	765.020	895.520	26.675	40.239	771.179	48.048	0.319	0.680	0.581	0.022
5	10.802	900.163	642.216	351.747	732.234	844.512	28.710	40.495	766.613	47.208	0.337	0.642	0.556	0.022
6	10.541	878.394	600.536	360.465	700.413	793.029	30.974	40.776	762.301	46.424	0.357	0.603	0.532	0.023
7	10.279	856.624	558.491	369.625	669.728	740.999	33.498	41.088	758.245	45.695	0.379	0.563	0.509	0.024
8	10.018	834.854	515.991	379.264	640.331	688.338	36.317	41.443	754.443	45.018	0.404	0.523	0.487	0.025
9	9.757	813.085	472.912	389.418	612.611	634.932	39.470	41.856	750.897	44.393	0.433	0.483	0.466	0.026
10	9.496	791.315	429.080	400.131	586.698	580.533	43.001	42.355	747.606	43.818	0.465	0.442	0.447	0.027
11	9.235	769.545	384.239	411.451	562.967	525.235	46.959	42.983	744.571	43.292	0.503	0.400	0.429	0.028

--**-- S T A T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.947	806.400	0.000	806.400	0.000	0.024	0.189	0.608	0.608	0.008
2	11.594	765.652	0.000	765.652	0.000	0.026	0.204	0.578	0.578	0.008
3	11.342	724.728	0.000	724.728	0.000	0.028	0.221	0.547	0.547	0.009
4	11.090	683.596	0.000	683.596	0.000	0.030	0.240	0.516	0.516	0.009
5	10.837	642.216	0.000	642.216	0.000	0.033	0.263	0.484	0.484	0.010
6	10.585	600.536	0.000	600.536	0.000	0.036	0.289	0.453	0.453	0.010
7	10.332	558.491	0.000	558.491	0.000	0.039	0.319	0.421	0.421	0.011
8	10.080	515.991	0.000	515.991	0.000	0.042	0.355	0.389	0.389	0.011
9	9.827	472.912	0.000	472.912	0.000	0.046	0.396	0.357	0.357	0.012
10	9.575	429.080	0.000	429.080	0.000	0.050	0.444	0.324	0.324	0.013
11	9.323	384.239	0.000	384.239	0.000	0.054	0.500	0.290	0.290	0.013

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO, 6

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8760	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	B	C	D	E
0.4500	-1[illegible]	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	[illegible]	2.5000	1.0000	1.0000	40.0000	-20.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	B	C	D	E
0.5000	0.8[illegible]00	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
3.9176	1.5825	0.8192	1.2287	1.0717	0.9455	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8469	9.[illegible]226	11.8469	9.6254	11.8469	9.6951	1.0097	0.8886

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	1[illegible].6951	0.0000	4.4837

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.847	997.242	806.400	0.000	806.400	1274.727	0.000	50.757	785.410	50.612	0.928	0.587	0.069
2	11.594	976.236	765.652	0.000	765.652	1232.792	0.000	51.606	781.078	49.598	0.900	0.559	0.072
3	11.342	945.170	724.728	0.000	724.728	1191.040	0.000	52.520	776.001	48.645	0.873	0.531	0.076
4	11.090	924.134	683.596	0.000	683.596	1149.490	0.000	53.509	771.179	47.751	0.845	0.502	0.080
5	10.837	903.098	642.215	0.000	642.215	1107.164	0.000	54.582	766.613	46.915	0.817	0.473	0.085
6	10.585	882.152	600.536	0.000	600.536	1067.089	0.000	55.752	762.301	46.134	0.789	0.444	0.090
7	10.332	861.025	558.491	0.000	558.491	1026.294	0.000	57.031	758.245	45.407	0.761	0.414	0.095
8	10.080	839.550	515.991	0.000	515.991	985.814	0.000	58.438	754.443	44.734	0.733	0.383	0.102
9	9.827	818.954	472.912	0.000	472.912	945.691	0.000	59.995	750.897	44.111	0.704	0.352	0.109
10	9.575	797.918	429.080	0.000	429.080	905.971	0.000	61.731	747.606	43.538	0.676	0.320	0.117
11	9.323	776.882	384.239	0.000	384.239	864.710	0.000	63.693	744.571	43.014	0.648	0.287	0.126

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	997.242	806.400	334.202	872.910	1037.662	22.511	39.011	841.339	62.237	0.237	0.759	0.639	0.020
2	11.625	969.730	765.652	340.588	837.988	990.346	23.981	39.365	835.006	61.073	0.300	0.725	0.613	0.021
3	11.403	950.218	724.728	347.224	803.613	942.779	25.600	39.761	830.929	59.979	0.315	0.690	0.588	0.021
4	11.180	931.706	683.596	354.223	769.874	894.933	27.385	40.195	826.107	58.951	0.330	0.655	0.564	0.022
5	10.958	913.193	642.215	361.361	736.871	845.773	29.361	40.674	821.541	57.989	0.348	0.620	0.540	0.023
6	10.736	894.681	600.536	368.777	704.727	798.260	31.553	41.209	817.229	57.090	0.357	0.585	0.516	0.023
7	10.514	875.169	558.491	376.559	673.585	749.341	33.993	41.814	813.173	56.253	0.393	0.549	0.494	0.024
8	10.292	857.657	515.991	384.607	643.513	699.955	36.705	42.509	809.372	55.476	0.413	0.513	0.472	0.025
9	10.070	839.145	472.912	393.184	615.011	650.020	39.740	43.320	805.825	54.758	0.440	0.477	0.451	0.026
10	9.848	820.632	429.080	402.063	588.011	599.432	43.137	44.290	802.534	54.096	0.470	0.440	0.431	0.026
11	9.625	802.120	384.239	411.352	562.880	549.046	46.950	45.484	799.499	53.491	0.505	0.402	0.413	0.027

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.025	0.194	0.587	0.587	0.009
2	11.632	765.652	0.000	765.652	0.000	0.026	0.209	0.557	0.557	0.009
3	11.417	724.728	0.000	724.728	0.000	0.029	0.226	0.527	0.527	0.008
4	11.201	683.596	0.000	683.596	0.000	0.031	0.245	0.497	0.497	0.009
5	10.986	642.215	0.000	642.215	0.000	0.034	0.268	0.467	0.467	0.010
6	10.771	600.536	0.000	600.536	0.000	0.037	0.293	0.437	0.437	0.010
7	10.556	558.491	0.000	558.491	0.000	0.040	0.323	0.406	0.406	0.011
8	10.341	515.991	0.000	515.991	0.000	0.043	0.358	0.375	0.375	0.012
9	10.125	472.912	0.000	472.912	0.000	0.047	0.398	0.344	0.344	0.012
10	9.910	429.080	0.000	429.080	0.000	0.051	0.445	0.312	0.312	0.013
11	9.695	384.239	0.000	384.239	0.000	0.056	0.500	0.280	0.280	0.014

*** STATOR HUB Q FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 7

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	[illegible]	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.4500	[illegible]	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION B	C	D	E
0.5000	0.8000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
4.7771	[illegible]	0.8145	1.2198	1.0691	0.9457	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8460	[illegible]	11.3460	9.9394	11.3462	9.9947	0.8507	0.7630

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
0.0000	15.8451	0.0000	4.2944

--**-- R O T O R   I N L E T   O U T P U T   D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.847	987.242	806.400	0.000	806.400	1274.727	0.000	50.757	841.339	61.870	0.897	0.567	0.069
2	11.632	969.311	765.652	0.000	765.652	1235.227	0.000	51.695	836.006	60.711	0.872	0.540	0.073
3	11.417	951.379	724.728	0.000	724.728	1195.973	0.000	52.701	830.929	59.621	0.847	0.513	0.076
4	11.201	933.447	683.596	0.000	683.596	1156.931	0.000	53.783	826.107	58.597	0.822	0.485	0.080
5	10.986	915.516	642.215	0.000	642.215	1118.307	0.000	54.951	821.541	57.639	0.796	0.457	0.085
6	10.771	897.584	600.536	0.000	600.536	1079.954	0.000	56.215	817.229	56.744	0.771	0.429	0.090
7	10.556	879.653	558.491	0.000	558.491	1041.970	0.000	57.589	813.173	55.910	0.746	0.400	0.095
8	10.341	861.721	515.991	0.000	515.991	1004.395	0.000	59.087	809.372	55.136	0.721	0.370	0.101
9	10.126	843.790	472.912	0.000	472.912	967.278	0.000	60.731	805.825	54.420	0.695	0.340	0.107
10	9.910	825.858	429.080	0.000	429.080	930.673	0.000	62.546	802.534	53.762	0.671	0.309	0.114
11	9.695	807.927	384.239	0.000	384.239	894.643	0.000	64.565	799.499	53.159	0.646	0.277	0.122

--**-- R O T O R   E X I T   O U T P U T   D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	987.242	806.400	345.094	877.135	1030.842	23.168	38.531	898.057	75.553	0.295	0.729	0.620	0.021
2	11.656	971.346	765.652	350.741	842.165	985.583	24.512	39.027	892.725	74.229	0.309	0.697	0.595	0.021
3	11.465	955.431	724.728	355.576	807.649	943.149	26.198	39.568	887.648	72.983	0.323	0.665	0.571	0.022
4	11.275	939.555	683.596	362.509	773.814	994.522	27.943	40.164	882.826	71.812	0.339	0.633	0.547	0.022
5	11.084	923.650	642.216	369.349	740.602	848.679	29.870	40.824	878.259	70.715	0.357	0.600	0.524	0.023
6	10.893	907.754	600.536	375.308	708.167	802.591	32.004	41.551	873.948	69.689	0.376	0.568	0.501	0.024
7	10.702	891.868	558.491	381.997	676.535	756.228	34.371	42.394	869.891	68.733	0.397	0.535	0.479	0.024
8	10.512	875.973	515.991	388.929	646.152	709.548	37.007	43.347	866.090	67.845	0.420	0.502	0.457	0.025
9	10.321	860.077	472.912	396.117	616.891	662.499	39.959	44.453	862.544	67.024	0.445	0.469	0.437	0.025
10	10.130	844.131	429.080	403.576	589.053	615.015	43.246	45.759	859.253	66.267	0.474	0.436	0.417	0.026
11	9.939	828.236	384.239	411.321	562.872	567.009	46.950	47.339	856.217	65.575	0.506	0.402	0.399	0.026

--**-- S T A T O R   E X I T   O U T P U T   D A T A ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.025	0.198	0.567	0.567	0.007
2	11.662	765.652	0.000	765.652	0.000	0.027	0.213	0.538	0.538	0.008
3	11.477	724.728	0.000	724.728	0.000	0.029	0.230	0.509	0.509	0.008
4	11.292	683.596	0.000	683.596	0.000	0.031	0.249	0.480	0.480	0.009
5	11.107	642.216	0.000	642.216	0.000	0.034	0.271	0.451	0.451	0.010
6	10.922	600.536	0.000	600.536	0.000	0.037	0.297	0.422	0.422	0.010
7	10.737	558.491	0.000	558.491	0.000	0.040	0.326	0.392	0.392	0.011
8	10.552	515.991	0.000	515.991	0.000	0.044	0.360	0.363	0.363	0.012
9	10.367	472.912	0.000	472.912	0.000	0.048	0.400	0.332	0.332	0.013
10	10.182	429.080	0.000	429.080	0.000	0.053	0.446	0.301	0.301	0.013
11	9.997	384.239	0.000	384.239	0.000	0.058	0.500	0.270	0.270	0.014

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 8

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.5000	2.5000	1.0000	1.0000	40.000	-20.000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	B	C	D	E
0.4500	-10.0000	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	B	C	D	E
0.5000	0.8000	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
5.7805	1.8035	[illegible]	1.2104	1.0663	0.8459	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8469	9.9567	11.8469	10.1955	11.8469	10.2429	0.7401	0.6605

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
[illegible]	15.0365	0.0000	4.1014

--**-- R O T O R I N L E T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.947	997.242	804.4[illegible]	0.000	804.4[illegible]	1274.727	0.000	50.757	898.057	75.123	0.858	0.549	0.070
2	11.662	976.829	765.652	0.000	765.652	1237.200	0.000	51.767	892.725	73.904	0.845	0.523	0.072
3	11.477	955.404	724.723	0.000	724.723	1199.974	0.000	52.447	887.648	72.562	0.822	0.497	0.077
4	11.292	934.933	683.596	0.000	683.595	1163.082	0.000	54.003	882.826	71.396	0.799	0.470	0.080
5	11.107	92[illegible].5[illegible]	642.216	0.000	642.215	1126.552	0.000	55.245	878.259	70.303	0.776	0.442	0.085
6	10.922	9[illegible].151	600.534	0.000	600.535	1090.422	0.000	56.582	873.948	69.291	0.753	0.415	0.09[illegible]
7	10.737	[illegible].743	558.491	0.000	558.491	1054.732	0.000	58.028	869.891	68.329	0.730	0.386	0.094
8	10.552	[illegible].315	515.991	0.000	515.991	1019.530	0.000	59.595	866.090	67.444	0.707	0.358	0.100
9	10.367	[illegible].837	472.912	0.000	472.912	984.867	0.000	61.303	862.544	66.626	0.684	0.329	0.105
10	10.182	843.478	429.080	0.000	429.080	951.403	0.000	63.174	859.253	65.873	0.662	0.299	0.112
11	9.997	8[illegible].05[illegible]	384.239	0.000	384.239	917.403	0.000	65.239	856.217	65.183	0.640	0.268	0.119

--**-- R O T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	997.242	804.4[illegible]	353.978	[illegible].671	1025.331	23.700	38.142	956.235	91.046	0.302	0.701	0.602	0.121
2	11.682	971.431	765.652	358.982	845.630	981.749	25.120	38.750	950.303	89.547	0.316	0.671	0.578	0.122
3	11.517	959.719	724.723	354.129	811.051	938.061	25.677	39.414	945.826	88.134	0.330	0.641	0.555	0.122
4	11.351	945.359	683.596	369.426	777.032	894.255	28.383	40.144	941.004	86.807	0.346	0.612	0.531	0.123
5	11.186	932.135	642.215	374.880	743.623	850.319	30.273	40.952	936.438	85.562	0.363	0.582	0.509	0.123
6	11.021	918.435	600.534	381.427	711.[illegible]	806.239	32.359	41.953	932.126	84.398	0.382	0.552	0.486	0.124
7	10.856	904.573	551.491	386.295	679.054	761.997	34.670	42.867	928.070	83.312	0.403	0.521	0.465	0.124
8	10.691	890.912	515.991	392.252	648.157	717.571	37.242	44.021	924.268	82.303	0.425	0.491	0.444	0.125
9	10.526	877.150	472.912	398.416	618.363	672.935	40.113	45.351	920.722	81.369	0.449	0.461	0.423	0.125
10	10.361	863.339	429.080	404.756	589.442	628.056	43.325	46.907	917.431	80.509	0.476	0.430	0.404	0.125
11	10.196	849.627	384.239	411.312	562.815	582.99[illegible]	46.949	48.761	914.395	79.720	0.506	0.399	0.386	0.125

--**-- S T A T O R E X I T O U T P U T D A T A ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	804.4[illegible]	0.000	804.4[illegible]	0.000	0.025	0.201	0.548	0.548	0.[illegible]
2	11.687	765.652	0.000	765.652	0.000	0.027	0.216	0.520	0.520	0.[illegible]
3	11.526	724.728	0.000	724.728	0.000	0.029	0.233	0.493	0.493	0.0[illegible]
4	11.366	683.596	0.000	683.596	0.000	0.032	0.252	0.465	0.465	0.009
5	11.205	642.215	0.000	642.215	0.000	0.035	0.274	0.436	0.436	0.009
6	11.045	600.535	0.000	600.535	0.000	0.038	0.300	0.408	0.408	0.010
7	10.884	558.491	0.000	558.491	0.000	0.041	0.329	0.380	0.380	0.011
8	10.724	515.991	0.000	515.991	0.000	0.045	0.362	0.351	0.351	0.012
9	10.564	472.912	0.000	472.912	0.000	0.049	0.401	0.321	0.321	0.013
10	10.403	429.080	0.000	429.080	0.000	0.054	0.447	0.292	0.292	0.014
11	10.243	384.239	0.000	384.239	0.000	0.059	0.500	0.261	0.261	0.015

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 9

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.87[illegible]	1.3[illegible]00	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)
0.4500	-10.[illegible]

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.85[illegible]	2.[illegible]	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER
0.5000	0.8000

COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION

B	C	D	E
0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
6.9399	1.9178	0.8655	1.2008	1.0635	0.9460	2.5000	2.5000

ROTOR TIP RAD. 1-G (INCHES)	ROTOR HUB RAD. 1-G (INCHES)	ROTOR TIP RAD. 2-G (INCHES)	ROTOR HUB RAD. 2-G (INCHES)	STATOR TIP RAD. 3-G (INCHES)	STATOR HUB RAD. 3-G (INCHES)	ROTOR PROJ. LENGTH (INCHES)	STATOR PROJ. LENGTH (INCHES)
11.8469	10.2479	11.8469	10.4051	11.8469	10.4456	0.6416	0.5763

ROTOR TIP RAMP ANGLE (DEGREES)	ROTOR HUB RAMP ANGLE (DEGREES)	STATOR TIP RAMP ANGLE (DEGREES)	STATOR HUB RAMP ANGLE (DEGREES)
[illegible].0000	14.2758	0.0000	3.9120

--**-- R O T O R   I N L E T   O U T P U T   D A T A   ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.847	987.242	806.400	0.000	806.400	1274.727	0.000	50.757	954.235	90.547	0.841	0.532	0.070
2	11.687	973.875	765.652	0.000	765.652	1238.812	0.000	51.826	950.903	89.055	0.820	0.507	0.073
3	11.526	960.509	724.728	0.000	724.728	1203.248	0.000	52.955	945.826	87.646	0.799	0.481	0.077
4	11.366	947.142	683.596	0.000	683.596	1169.067	0.000	54.180	941.004	86.324	0.777	0.455	0.080
5	11.205	933.775	642.215	0.000	642.215	1133.303	0.000	55.461	936.438	85.083	0.756	0.428	0.084
6	11.045	920.408	600.536	0.000	600.536	1098.997	0.000	56.877	932.126	83.923	0.735	0.401	0.089
7	10.884	907.042	558.491	0.000	558.491	1065.193	0.000	58.378	928.070	82.841	0.714	0.374	0.093
8	10.724	893.675	515.991	0.000	515.991	1031.940	0.000	59.959	924.268	81.836	0.693	0.346	0.098
9	10.564	880.308	472.912	0.000	472.912	999.294	0.000	61.755	920.722	80.905	0.672	0.318	0.104
10	10.403	866.941	429.080	0.000	429.080	967.314	0.000	63.668	917.431	80.048	0.652	0.289	0.110
11	10.243	853.574	384.239	0.000	384.239	935.071	0.000	65.765	914.395	79.263	0.632	0.259	0.116

--**-- R O T O R   E X I T   O U T P U T   D A T A   ***--**--***

STA NO.	RADIUS -F (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	987.242	806.400	361.284	883.633	1020.835	24.133	37.820	1015.615	108.894	0.308	0.676	0.585	0.021
2	11.703	975.236	765.652	365.732	848.518	978.631	25.533	38.522	1010.283	107.205	0.322	0.648	0.562	0.022
3	11.559	963.229	724.728	370.231	813.845	936.380	27.064	39.298	1005.205	105.613	0.336	0.620	0.539	0.022
4	11.415	951.223	683.596	374.674	779.580	894.079	28.746	40.130	1000.384	104.115	0.352	0.592	0.516	0.023
5	11.271	939.217	642.215	379.763	746.094	851.725	30.597	41.060	995.817	102.710	0.369	0.564	0.494	0.023
6	11.127	927.211	600.536	384.575	713.175	809.314	32.642	42.095	991.505	101.396	0.387	0.536	0.472	0.024
7	10.982	915.204	558.491	389.702	681.025	766.841	34.908	43.256	987.449	100.169	0.407	0.508	0.451	0.024
8	10.838	903.198	515.991	394.902	649.765	724.300	37.429	44.570	983.648	99.028	0.429	0.480	0.431	0.025
9	10.694	891.192	472.912	400.222	619.535	681.686	40.241	46.073	980.102	97.972	0.452	0.452	0.411	0.025
10	10.550	879.185	429.080	405.598	590.502	638.991	43.395	47.817	976.811	96.998	0.479	0.424	0.391	0.025
11	10.406	867.179	384.239	411.315	562.840	596.205	46.949	49.374	973.775	96.106	0.505	0.395	0.373	0.025

--**-- S T A T O R   E X I T   O U T P U T   D A T A   ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.025	0.204	0.531	0.531	0.007
2	11.707	765.652	0.000	765.652	0.000	0.027	0.219	0.504	0.504	0.008
3	11.567	724.728	0.000	724.728	0.000	0.030	0.236	0.477	0.477	0.008
4	11.427	683.596	0.000	683.596	0.000	0.032	0.255	0.450	0.450	0.009
5	11.286	642.215	0.000	642.215	0.000	0.035	0.277	0.423	0.423	0.009
6	11.146	600.536	0.000	600.536	0.000	0.038	0.302	0.395	0.395	0.010
7	11.006	558.491	0.000	558.491	0.000	0.042	0.331	0.368	0.368	0.011
8	10.866	515.991	0.000	515.991	0.000	0.045	0.364	0.340	0.340	0.012
9	10.726	472.912	0.000	472.912	0.000	0.050	0.403	0.311	0.311	0.013
10	10.586	429.080	0.000	429.080	0.000	0.055	0.447	0.282	0.282	0.014
11	10.446	384.239	0.000	384.239	0.000	0.060	0.500	0.253	0.253	0.015

*** STATOR HUB D FACTOR LIMIT VIOLATED ***

******** S T A G E   D A T A ********

STAGE NO. 10

*** ROTOR INPUT DATA ***

AXIAL VEL. RATIO	POLYTROPIC EFFICIENCY	SOLIDITY AT TIP	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8750	1.3000	2.5000	1.0000	1.0000	40.000	-20.000

MAX ROTOR DIF. FACTOR	MIN REL. FLOW ANGLE ROTOR HUB (DEGREES)	B	C	D	E
		COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION			
0.4500	-10.0000	0.0000	0.0000	0.0000	0.0000

*** STATOR INPUT DATA ***

AXIAL VELOCITY RATIO	TOTAL POLYTROPIC EFFICIENCY	SOLIDITY AT HUB	ASPECT RATIO	TIP BLOCKAGE FACTOR	HUB BLOCKAGE FACTOR	MAX ANGLE HUB TAPER (DEGREES)	MAX ANGLE TIP TAPER (DEGREES)
1.0000	0.8500	2.0000	2.5000	1.0000	1.0000	40.0000	-20.0000

MAX. STATOR DIF. FACTOR	MAX HUB INLET MACH NUMBER	B	C	D	E
		COEFFICIENTS IN TANGENTIAL VELOCITY EQUATION			
0.5000	0.3100	0.0000	0.0000	0.0000	0.0000

--**-- S T A G E   O U T P U T   D A T A ***--**--***

MASS FLOW (LB/SEC) = 104.443

OVERALL MASS AVE. PR. RATIO	OVERALL MASS AVE. TEMP. RATIO	OVERALL MASS AVE. EFFICIENCY	MASS AVE. PRESSURE RATIO	MASS AVE. TEMPERATURE RATIO	MASS AVE. EFFICIENCY	ROTOR ASPECT RATIO	STATOR ASPECT RATIO
8.2676	2.0341	0.8013	1.1915	1.0607	0.8462	2.5000	2.5000
ROTOR TIP RAD. 1-G (INCHES)	**ROTOR HUB RAD. 1-G (INCHES)**	**ROTOR TIP RAD. 2-G (INCHES)**	**ROTOR HUB RAD. 2-G (INCHES)**	**STATOR TIP RAD. 3-G (INCHES)**	**STATOR HUB RAD. 3-G (INCHES)**	**ROTOR PROJ. LENGTH (INCHES)**	**STATOR PROJ. LENGTH (INCHES)**
11.8469	10.4456	11.8469	10.5809	11.8469	10.6138	0.5505	0.5064
		ROTOR TIP RAMP ANGLE (DEGREES)	**ROTOR HUB RAMP ANGLE (DEGREES)**	**STATOR TIP RAMP ANGLE (DEGREES)**	**STATOR HUB RAMP ANGLE (DEGREES)**		
		0.0000	13.5651	0.0000	3.7305		

--**-- ROTOR INLET OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	REL. MACH NO.	ABS. MACH NO.	LOSS COEFF
1	11.947	997.242	806.400	0.000	806.400	1274.727	0.000	50.757	1015.615	108.321	0.816	0.516	0.070
2	11.707	975.[illegible]	765.652	0.000	765.652	1240.140	0.000	51.974	1010.283	106.638	0.796	0.492	0.073
3	11.567	964.985	724.729	0.000	724.729	1205.947	0.000	53.061	1005.265	105.052	0.776	0.467	0.077
4	11.427	952.2[illegible]	683.596	0.000	683.596	1172.179	0.000	54.325	1000.384	103.559	0.756	0.441	0.080
5	11.286	940.[illegible]	642.215	0.000	642.215	1138.876	0.000	55.674	995.617	102.159	0.737	0.415	0.084
6	11.146	929.953	600.536	0.000	600.536	1106.079	0.000	57.116	991.505	100.849	0.717	0.389	0.088
7	11.006	917.175	558.491	0.000	558.491	1073.835	0.000	58.662	987.449	99.627	0.698	0.363	0.093
8	10.866	905.437	515.901	0.000	515.901	1042.135	0.000	60.324	983.648	98.490	0.678	0.336	0.097
9	10.726	893.419	472.912	0.000	472.912	1011.216	0.000	62.117	980.102	97.437	0.659	0.308	0.102
10	10.586	882.141	429.090	0.000	429.090	980.960	0.000	64.061	975.811	96.467	0.641	0.280	0.109
11	10.446	871.443	384.239	0.000	384.239	951.497	0.000	66.132	973.775	95.578	0.622	0.251	0.114

--**-- ROTOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	WHEEL SPEED (FT/SEC)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	REL. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	REL. AIR ANG. (DEG)	TOTAL TEMP. (DEG R)	TOTAL PRESS. (PSI)	ROTOR DIF. FACTOR	REL. MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	997.242	806.400	357.343	880.129	1017.131	24.491	37.550	1075.990	129.276	0.313	0.653	0.569	0.021
2	11.720	976.691	765.652	371.312	850.938	976.067	25.872	38.332	1070.658	127.383	0.326	0.627	0.546	0.022
3	11.594	966.141	724.729	375.367	810.168	935.010	27.381	39.186	1065.581	125.597	0.341	0.600	0.524	0.022
4	11.467	955.590	683.596	379.511	781.877	893.953	29.038	40.121	1060.759	123.917	0.357	0.574	0.502	0.023
5	11.340	945.039	642.215	383.749	748.133	852.929	30.860	41.153	1056.192	122.339	0.373	0.548	0.481	0.023
6	11.214	934.488	600.536	389.091	715.019	811.915	32.871	42.298	1051.880	120.862	0.391	0.522	0.459	0.024
7	11.087	923.939	558.491	392.512	682.526	770.925	35.100	43.577	1047.824	119.483	0.411	0.495	0.439	0.024
8	10.961	913.387	515.901	397.046	651.070	729.958	37.578	45.019	1044.023	118.201	0.432	0.469	0.418	0.024
9	10.834	902.835	472.912	401.586	620.492	689.055	40.344	46.661	1040.477	117.012	0.454	0.443	0.399	0.025
10	10.707	892.285	429.090	406.436	591.015	648.137	43.448	48.550	1037.186	115.917	0.477	0.417	0.380	0.025
11	10.581	881.735	384.239	411.299	562.956	607.412	46.948	50.759	1034.150	114.912	0.505	0.391	0.362	0.025

--**-- STATOR EXIT OUTPUT DATA ***--**--***

STA NO.	RADIUS -E (IN)	AXIAL VEL. (FT/SEC)	TANGENT. VEL. (FT/SEC)	ABS. VEL. (FT/SEC)	ABS. AIR ANG. (DEG)	LOSS COEFF	STATOR DIF. FACTOR	AXIAL MACH NO.	ABS. MACH NO.	LOSS FUNC
1	11.847	806.400	0.000	806.400	0.000	0.026	0.205	0.515	0.515	0.007
2	11.724	765.652	0.000	765.652	0.000	0.028	0.221	0.489	0.489	0.008
3	11.600	724.729	0.000	724.729	0.000	0.030	0.239	0.463	0.463	0.008
4	11.477	683.596	0.000	683.596	0.000	0.032	0.257	0.436	0.436	0.009
5	11.354	642.215	0.000	642.215	0.000	0.035	0.279	0.410	0.410	0.009
6	11.230	600.536	0.000	600.536	0.000	0.038	0.304	0.383	0.383	0.010
7	11.107	558.491	0.000	558.491	0.000	0.042	0.332	0.357	0.357	0.011
8	10.984	515.901	0.000	515.901	0.000	0.046	0.365	0.329	0.329	0.012
9	10.860	472.912	0.000	472.912	0.000	0.050	0.403	0.302	0.302	0.013
10	10.737	429.090	0.000	429.090	0.000	0.055	0.448	0.274	0.274	0.014
11	10.614	384.239	0.000	384.239	0.000	0.061	0.500	0.245	0.245	0.015

*** NUMBER OF STAGES FOR THIS DATA SET HAS BEEN REACHED -- GO TO NEW DATA SET ***