

NASA
CR
3624
c.1

NASA Contractor Report 3624

TECH LIBRARY KAFB, NM



LOAN COPY: RETURN TO
TECHNICAL LIBRARY

WISGSK

A Computer Code for the Prediction of a Multistage Axial Compressor Performance With Water Ingestion

T. Tsuchiya and S. N. B. Murthy

GRANT NAG-3-62
NOVEMBER 1982





NASA Contractor Report 3624

WISGSK

A Computer Code for the Prediction of a Multistage Axial Compressor Performance With Water Ingestion

T. Tsuchiya and S. N. B. Murthy
Purdue University
West Lafayette, Indiana

Prepared for
Lewis Research Center
under Grant NAG-3-62



National Aeronautics
and Space Administration

Scientific and Technical
Information Branch

1982



TABLE OF CONTENTS

	Page
LIST OF SYMBOLS	v
SUMMARY	vii
CHAPTER I: INTRODUCTION	1
1.1 Background	4
1.2 Illustrative Example	7
1.3 Outline of Report	7
CHAPTER II: OVERALL PROGRAM DESCRIPTION	8
2.1 Description of the PURDU-WISCSTK Code and the NASA-STGSTK Code	8
2.1.1 The PURDU-WICSTK Code	8
2.1.2 The NASA-STGSTK Code	10
2.2 Correlations of Performance Parameters	10
2.2.1 Deviation Angle	10
2.2.2 Correlations for Stage Pressure-Rise Coefficient	12
2.2.3 Correlations for Efficiency	12
2.2.4 Procedure for Obtaining Correlations for Deviation Angle, Pressure-Rise Coefficient and Efficiency	12
2.3 Modification of NASA-STGSTK Code to NASA-WISGSK Code for Use with Two-Phase Flow	16
2.3.1 Efficiency Variation with Respect to Flow Coefficient	16
2.3.2 Pressure-Rise Coefficient vs. Flow Coefficient	17
2.3.3 Correction for Two-Phase Effects	18

	Page
2.4 The General Procedure for Utilization of the NASA-WISGSK Code	18
2.4.1 Calculation with Air Flow	20
2.4.2 Calculation with Air-Water Mixture Flow at Reference Speed	21
2.4.3 Calculation with Air-Water Mixture Flow under General Conditions of Operation	22
CHAPTER III: SUBROUTINES AND EXTERNAL FUNCTIONS	23
CHAPTER IV: INPUT DATA	27
CHAPTER V: OUTPUT	36
5.1 Output of Inputed Data	36
5.2 Output of Design Point Performance	36
5.2.1 Compressor Inlet (Design Point Performance)	36
5.2.2 Stage Performance (Design Point Performance)	37
5.2.3 Overall Performance (Design Point Performance)	38
5.3 Output of Stage Characteristics	38
5.4 Output of Stage Performance	38
5.5 Output of Overall Performance	41
CHAPTER VI: TEST CASE AND DISCUSSION	42
6.1 Discussion	44
FIGURES	47
REFERENCES	73
APPENDIX 1: DETAILS OF COMPRESSOR USED FOR DEMONSTRATION OF CODE	75
APPENDIX 2: DETAILED DESCRIPTION OF SUBROUTINES AND EXTERNAL FUNCTIONS	88
APPENDIX 3: ILLUSTRATIVE TEST CASE FOR THE NASA-WISGSK CODE	126
Test Case No. 1	127
Test Case No. 2	150
APPENDIX 4: PROGRAM SOURCE LIST	173

LIST OF SYMBOLS

C_p	Specific heat at constant pressure
D_o	Initial droplet diameter
D_{eq}	Equivalent pressure ratio
i	Incidence angle
K	Deviation constant
N	Rotor speed
$N/\sqrt{\theta}$	Rotor corrected speed
PR	Stagnation pressure ratio
P_{01}	Stagnation pressure at stage inlet
P_{02}	Stagnation pressure at stage outlet
P_{02}/P_{01}	Stagnation pressure ratio
P_{ref}	Reference pressure
TR	Stagnation temperature ratio
T_{01}	Stagnation temperature at stage inlet
T_{02}	Stagnation temperature at stage outlet
T_{02}/T_{01}	Stagnation temperature ratio
T_{ref}	Reference temperature
U	Blade speed
U_{tip}	Blade speed at tip
V_z	Axial velocity
V_{z1}	Axial velocity at stage inlet
V_{z2}	Axial velocity at stage outlet
w_1	Blade relative velocity at stage inlet
w_2	Blade relative velocity at stage outlet

LIST OF SYMBOLS (continued)

X_w	Water content (mass fraction)
$X_{w,0}$	Initial water content
β_1	Relative flow angle at rotor inlet
β_2	Relative flow angle at rotor outlet
γ	Ratio of specific heats
ζ	Adiabatic efficiency
ΔT_0	Rise in stagnation temperature across a stage
δ	Deviation angle
δ	Corrected pressure ($\delta = P/P_{ref}$)
ϵ	Deflection angle ($\epsilon = \beta_1 - \beta_2$)
θ	Corrected temperature ($\theta = T/T_{ref}$)
σ	Solidity
ϕ	Flow coefficient
ψ	Pressure-rise coefficient

Subscript

0	Stagnation value
1	Stage inlet
2	Stage outlet
tip	Blade tip
z	Axial direction

Superscript

*	Pertaining to design point
---	----------------------------

SUMMARY

A computer code for predicting the performance of an axial-flow compressor with water ingestion has been developed at Purdue University under the NASA Grant NAG 3-62 and presented along with a test case that illustrates the use of the Code. The Code employs the same procedure and architecture as the NASA-STGSTK Code. The Code uses a meanline stage stacking method; stage and cumulative compressor performance is calculated utilizing representative triangles located at rotor inlet and outlet mean radii.

The aero-thermo-mechanical interactions arising during air-water droplet mixture flow are taken into account in terms of four processes: (i) changes in blade performance parameters (deviation and efficiency), (ii) centrifugal action due to flow rotation, (iii) heat and mass transfer processes between the gaseous and liquid phases and (iv) droplet instability and break-up. The latter three are introduced at the exit of each blade row. The aerodynamic performance of a stage is based on estimated rules for deviation and efficiency with air-water mixture flow. The nature of such rules is discussed in detail.

The Code provides options for the calculation of performance with (a) mixtures of gases such as air and water vapor and (b) air-water droplet mixtures with different water content.

The Code is useful in obtaining preliminary estimates of overall performance of compressors with water ingestion given the design point details corresponding to air flow and the nature of corrections for air-water mixture flow.

CHAPTER I

INTRODUCTION

Water ingestion into jet engines may arise due to various circumstantial reasons: high humidity in air resulting in condensation of water at the inlet, tire-generated spray entering the air stream during take-off and landing on rough runways with puddles of water, and flight through rain storms. It has been found that such water ingestion can lead to a loss of performance, engine mismatch, and loss of surge margin, and in some cases causes undesirable mechanical and aerolastic effects. Both steady state and transient performance are affected and the operational margins in the control system also become affected. With ingestion of large amounts of water, water may flow through the engine at low power settings and a flameout may arise at higher power settings. From the point of view of criticality of changes in the performance of different engine components, the compressor presents unique problems and is in many ways central to the performance of the engine (References 1 and 2).

The air-water mixture ingested into a compressor is characterized by the water content, the droplet size distribution and the vapor content. The mixture may enter the compressor nonuniformly in the circumferential and radial directions. In the case of rain water ingestion, the water content may range from 2.0 percent to 15.0 percent or more. The water droplet size variations in rain and mist are presented in Figure 1. Water vapor content in the atmosphere varies with the degree of saturation and the altitude. Figure 2 presents the variation of water vapor content corresponding to the saturation state as a function of altitude. Some typical values of vapor content corresponding to the

saturation state under different temperature and pressure conditions that are of interest in aircraft operation are given in Table 1.

At the end of each stage, and therefore also at the exit of a multistage compressor, the characteristics of the air-water mixture undergo modification: water, vapor and air become redistributed; the work done on the gaseous phase and efficiency become affected; and the stalling characteristics of stages undergo changes.

The performance of a compressor stage at a given speed and flow coefficient undergoes a change during water ingestion, compared to the performance with air flow, on account of a combination of processes associated with droplet-laden air flow:

- (i) change in airfoil performance;
- (ii) centrifugal action causing motion and accumulation of water and vapor towards the tip and hub sections, respectively; and
- (iii) heat and mass transfer between the two phases.

These processes become further complicated due to:

- (a) droplet impact and rebound at the blades and casing,
- (b) droplet reingestion from blade surfaces into wakes,
- (c) droplet break-up to remain under the critical size and
- (d) droplet size distribution.

For a given compressor with specified

- (i) blade and blade-loading,
- (ii) aspect ratio and
- (iii) interstage spacing

one can examine the changes in performance in terms of two major parameters:

- (a) changes in aerodynamic performance and
- (b) characteristic times available for centrifugal action and heat and mass transfer processes.

The changes in a given compressor depend upon the following:

- (i) operating speed and throttle setting;
- (ii) water and water vapor mass fractions in the air-water mixture

TABLE 1

SATURATION VALUES OF WATER VAPOR
UNDER TYPICAL CONDITIONS

TEMPERATURE (°F)	PRESSURE (psi)	WATER VAPOR	
		w_s $\left(\frac{\text{lb}_m \text{ vapor}}{\text{lb}_m \text{ dry air}} \right)$	w_s^* $\left(\frac{\text{lb}_m \text{ vapor}}{\text{lb}_m \text{ mixture}} \right)$
59	14.696	0.011	0.011
86	14.696	0.027	0.026
104	14.696	0.049	0.047
125.4 ⁽¹⁾	22.402 ⁽⁴⁾	0.060	0.057
155.8 ⁽²⁾	22.402 ⁽⁴⁾	0.148	0.129
176.1 ⁽³⁾	22.402 ⁽⁴⁾	0.275	0.216
65.1 ⁽⁵⁾	12.648 ⁽⁶⁾	0.025	0.024
212	15.698	9.124	0.901
212	15.494	11.459	0.920
212	15.365	13.661	0.932

Note: Condition corresponding to

- (1) Mach number = 0.8 when $T = 59^\circ\text{F}$
 - (2) Mach number = 0.8 when $T = 86^\circ\text{F}$
 - (3) Mach number = 0.8 when $T = 104^\circ\text{F}$
 - (4) Mach number = 0.8 when $p = 14.696 \text{ psi}$
 - (5) Mach number = 0.8 when $T = 5.55^\circ\text{F}$
 - (6) Mach number = 0.8 when $p = 8.298 \text{ psi}$
- } 15,000 ft. altitude

- flow at entry; and
- (iii) water droplet size distribution.

In order to determine the performance of an axial flow compressor based on the aforementioned physical model, a three-dimensional flow calculation procedure is eventually desirable. However there are at present considerable uncertainties in regard to the various two phase flow processes associated with droplet-laden gas flow in general and in axial-flow compressors in particular. It is therefore considered that a parametric mean-line (one-dimensional) model should be developed in the first instance for determining the overall performance of a compressor stage with water ingestion. Such a calculation scheme requires incorporation of a stage-stacking procedure for use in multi-stage machines.

The current report describes such a calculation procedure written in the form of a computer code named the NASA-WISGSK Code. It is similar to the NASA-STGSTK Code (Reference 3) written for the purposes of calculating the off-design performance of axial-flow compressors given the details of the design point.

1.1 Background

A model for the calculation of overall performance of a multi-stage axial-flow compressor was developed based upon a mean-line, stage-stacking procedure (Reference 4). The model incorporates all of the essential features of droplet-laden air flow:

- (i) droplet motion during ingestion,
- (ii) droplet-blade interactions,
- (iii) blade performance changes,
- (iv) centrifugal action,
- (v) heat and mass transfer processes and
- (vi) droplet break-up.

Two limiting cases have been considered:

- (i) droplets generally following the air flow path and

(ii) droplets having equal probability of motion in all directions. Figure 3 illustrates the latter case which applies to large droplet sizes. The calculation procedure adopted with the model is

- (a) to calculate a blade row (rotor or stator) performance for two phase flow and
- (b) to "correct" the exit conditions for centrifugal action and heat and mass transfer based upon the (characteristic) times available for those processes, and for droplet size changes based on the concept of a critical diameter.

In order to calculate the transport and accumulation of water radially outwards, the flow is divided into ten streamtubes along the span and the calculations are carried out in the time domain over the available time (across the blade row). Water on the surface of blades is distinguished from that in the blade passages. The corrected conditions constitute the inlet conditions for the next blade row, and so on for various stages in a multistage machine. The calculation procedure, the associated computer code, namely the PURDU-WICSTK Code, and an illustrative case are presented in Reference 5.

The foregoing calculation procedure permits determination of the aerodynamic performance of a chosen section (such as the mean section), a compressor stage at given initial and operating conditions provided the details of the blade section are available. In other words, at design and at off-design conditions, the deviation of fluid flow over a blade section and the efficiency of the blade section are determined directly for given initial flow conditions.

The calculation procedure also permits such a direct determination of blade performance at other spanwise locations of a stage provided that, once again, details regarding the section under consideration are available. Such a calculation is again performed on a one-dimensional basis. It is, of course, necessary to account for the redistribution of water and water vapor due to centrifugal action across the span of the compressor. Thus, in most cases the hub sections may become depleted of water but repleted with water vapor, and there may arise

an appreciable accumulation of water in the tip sections. In the case of a compressor with many stages, there may also arise a change in the condition of the fluid mixture at the mean section of a stage.

The calculation procedure can be utilized for any specified inlet mixture of air, water and water vapor. When calculations have been performed for a compressor stage under a variety of conditions, one of the interesting results that can be obtained is a set of correlation rules for

- (a) diffusion factor and
- (b) efficiency for the particular type of blading in terms of flow coefficient and mass fraction of water content.

Such correlation rules may then be used to obtain off-design performance of the compressor utilizing a considerably simplified procedure such as for example the procedure of the NASA-STGSTK Code.

It will be recalled that the blade outlet conditions obtained on the basis of droplet-laden air flow over a blade section need to be "corrected" for (a) centrifugal action, (b) heat and mass transfer processes between the gaseous and the liquid phases and (c) droplet size adjustment according to the PURDU-WICSTK Code procedure. The corrected values then represent the final outlet conditions from a stage and thus the initial conditions into a following stage, if any.

The correlation rules for diffusion factor and efficiency are therefore of use only to obtain the initial aerodynamic performance of a blade section with two phase flow. The correlation rules will apply to the compressor for which they have been obtained utilizing the PURDU-WICSTK Code.

By performing such calculations on a number of compressors with different types of blading it is expected that distinct trends can be established in the correlation rules. It is then possible to utilize the generalized correlation rules for specific types of blading and thus to calculate the off-design performance of compressors.

The NASA-WISGSK Code, described in this Report, has been designed assuming that such correlation rules are available.

1.2 Illustrative Example

The utilization of the NASA-WISGSK Code is illustrated here utilizing the design details for a small 6-stage axial-flow Test Compressor consisting of the axial stages of a T-63 engine. Details regarding the Test Compressor are provided in Appendix 1.

It is of interest to point out that a series of tests has also been conducted on the Test Compressor with water ingestion, and the results of such tests have been reported in References 6 and 7.

1.3 Outline of the Report

Chapter II of the Report is devoted to a description of the overall program. The subroutines and external functions are listed in Chapter III. A listing of the input data and the output obtained in the code are given in Chapters IV and V respectively. In Chapter VI, an illustrative test case is presented along with a discussion on the utilization of the code.

CHAPTER II

OVERALL PROGRAM DESCRIPTION

The NASA-WISGSK Code is based on two earlier studies:

- i) the development of the PURDU-WICSTK Code for the calculation of the performance of multi-stage compressors with water ingestion (Reference 5); and
- ii) the NASA-STGSTK Code for the determination of the off-design performance of axial-flow compressors (Reference 3).

2.1 Description of the PURDU-WICSTK Code and the NASA-STGSTK Code

2.1.1 The PURDU-WICSTK Code

The one-dimensional flow equations for two phase flow in axial compressors have been derived in detail and presented in Reference 4. Those equations are suitable for the calculation of performance of any chosen section along the span of an axial compressor blade row. The PURDU-WICSTK Code is based on those equations. For given initial conditions at the entry to a stage, the outlet conditions can be calculated using those equations.

The PURDU-WICSTK program deals with a fluid that may consist of (a) a mixture of three different gases and (b) a mixture of two types of water droplets, distinguished by size. The mixture of gases may consist of air and water vapor along with another gas when necessary. The water droplets may be either "small" or "large" diameter droplets or a mixture of small and large droplets. Small droplets are defined as those that follow the gas flow path and hence, absorb work input into the compressor along with the gaseous phase. Large droplets are assumed to move largely independently of the gas phase, with equal probability of motion in all directions, and without absorbing work

input but introducing drag losses. Currently one can only choose the sizes for small and large droplets in an arbitrary fashion; for example if small droplets are assumed to be of mean diameter equal to $10\ \mu\text{m}$ large droplets may be assigned a mean size of about $1,000\ \mu\text{m}$ in diameter. In a general two-phase mixture that is utilized as the working fluid in a compressor, the proportion of various constituents (namely, different gases and two types of droplets) may be chosen as desired in the initial conditions assumed for a calculation. Thus, to consider humid air carrying large droplets, the content of small droplets is set equal to zero while water vapor content is related to humidity.

The performance of a stage of a compressor is based in the PURDU-WICSTK Code on five physical models as follows:

- (1) Model for the calculation of stage performance with respect to the gaseous phase and water droplets.
- (2) Model for droplet motion across a blade row from a chosen upstream location to a designated downstream location.
- (3) Model for centrifuging of water droplets.
- (4) Model for heat and mass transfer processes between the two phases; and
- (5) Model for droplet break-up and equilibration with respect to size.

The foregoing five models have been described in detail in Reference 5. The performance of a stage is calculated for given initial and operating conditions with respect to the gaseous phase and the water droplets. Regarding small droplets, any fraction of their total number may be taken into account depending upon assumptions relating to droplet impingement and rebound processes. Then, at the exit of a blade row, the three major processes, namely (1) centrifugal action on droplets, (2) heat and mass transfer processes between the two phases and (3) droplet size adjustment, are taken into account. When the stage performance parameters are "corrected" for the afore-mentioned three processes, one obtains the final outlet conditions from a stage. The

outlet conditions from a stage are modified, to account for geometry of compressor, in order to obtain the initial conditions for the next stage, where such exists. Calculations are repeated for subsequent stages based on the well-known concept of stage-stacking. The Code can be used to predict the design point performance as well as off-design performance of a multi-stage compressor.

2.1.2 The NASA-STGSTK Code

The details regarding the NASA-STGSTK Code are given in Reference 3.

2.2 Correlations of Performance Parameters with Water Ingestion

The two principal performance parameters for axial-flow compressor blading are (i) the stage pressure-rise coefficient and (ii) the aerodynamic efficiency of a blade row. These may be expressed as functions of flow coefficient for air flow and air-watermixture flow through the compressor. The stage pressure-rise coefficient can be obtained from a knowledge of deflection of the working fluid over a rotor blade row or from a knowledge of blade metal angles and incidence and corresponding deviation angles.

The methods of obtaining correlations for (i) deviation of the working fluid over a blade, (ii) the stage pressure-rise coefficient and (iii) the aerodynamic efficiency of blade rows are described in the following.

2.2.1 Deviation Angle

A general rule for deviation may be written as follows (Reference 9).

$$\delta - \delta^* = k (D_{eq} - D_{eq}^*) \quad (2.1)$$

where δ and D_{eq} are the deviation angle and the equivalent diffusion ratio, respectively; $()^*$ denotes values at the reference point; and k is a (proportionality) constant. According to Lieblein (Reference 8), the equivalent diffusion ratio can be written as follows:

$$D_{eq} = \frac{\cos\beta_2}{\cos\beta_1} \cdot \frac{V_{z1}}{V_{z2}} \left[1.12 + 0.0117(i-i^*)^{1.43} + 0.61 \frac{\cos^2\beta_1}{\sigma} \left(\tan\beta_1 - \frac{V_{z2}}{V_{z1}} \tan\beta_2 \right) \right] \quad (2.2)$$

the equivalent diffusion ratio at the reference point can be obtained by setting $i=i^*$. Thus, Equation (2.1) can be rewritten as follows:

$$\begin{aligned} \delta - \delta^* &= 1.12k \left[(W_1/W_2) - (W_1/W_2)^* \right] \\ &+ 0.0117 (i-i^*)^{1.43} k (W_1/W_2) \\ &+ 0.61 k (\sin \epsilon - \sin \epsilon^*)/\sigma \end{aligned} \quad (2.3)$$

Assuming that the second and third terms on the right-hand side can be incorporated into the first term, one can write the following equation.

$$\delta - \delta^* = K \left[(W_2/W_1) - (W_2/W_1)^* \right] \quad (2.4)$$

where K is referred to as the deviation constant. The deviation constant can be related to the amount of diffusion in a blade passage in the case of gas (single phase) flow through a compressor. In the case of droplet-laden gas flow, it is assumed that the deviation constant can still be related to the diffusion in a blade passage utilizing the water content in the mixture as a parameter. One can then obtain the deviation angle for given operating conditions and hence the corresponding blade outlet flow angle.

2.2.2 Correlations for Stage Pressure-Rise Coefficient

The stage pressure-rise coefficient for a compressor stage may be defined as follows.

$$\psi = \frac{\eta C_p \Delta T_o}{U^2}$$

where η : stage adiabatic efficiency
 C_p : specific heat at constant pressure
 ΔT_o : rise in stagnation temperature across a stage
 U : rotor whirl speed

The stage pressure-rise coefficient can be related to the stage flow coefficient utilizing water content.

2.2.3 Correlations for Efficiency

The adiabatic efficiency of the compression processes in a stage may be defined as follows:

$$\eta = \frac{PR^{(\gamma-1)/\gamma} - 1}{TR - 1}$$

where PR and TR are the stagnation pressure ratio and the stagnation temperature ratio across a stage, and γ is the ratio of specific heats. The stage adiabatic efficiency can be related to the stage flow coefficient utilizing water content as the parameter.

2.2.4 Procedure for Obtaining Correlations for Deviation Angle, Pressure-Rise Coefficient and Efficiency

It is common practice in compressor analysis to obtain correlations for the deviation angle, pressure-rise coefficient and efficiency for different classes of blading through cascade or compressor tests.

Such correlations with respect to flow coefficient are well-known in literature for air or other (single-phase) gaseous fluids. Similar correlations are not available for droplet-laden flows from experimental results.

One method of generating such correlations is by the use of the PURDU-WICSTK Code. The performance of a series of typical compressors can be calculated utilizing that code and from such performance calculations, the variation of the parameters of interest can be extracted for different classes of blading in those compressors while operating with two-phase fluids. The parametric variations may then be related to blading design and operational conditions. Thus, based on the performance results obtained on any compressor utilizing the PURDU-WICSTK program over appropriate ranges of initial and operating conditions, one can generate correlations for deviation angle, pressure-rise coefficient and efficiency in terms of the following.

- (i) Values of deviation constant, K , as a function of the diffusion of the working fluid;
- (ii) Values of pressure-rise coefficient as a function of the flow coefficient; and
- (iii) Values of efficiency as a function of the flow coefficient.

The correlations are obtained for each class of blading or stage with water content at entry to that blading or stage as one parameter and the operating speed as the other parameter. Those correlations can then be utilized in the NASA-WISGSK Code for obtaining the performance of a similar compressor under desired operating conditions. When a series of such correlations have been generated for various classes of blading and for various operating conditions, several classes of axial-flow compressors can be analyzed on this basis in order to determine changes in performance with water ingestion.

In order to illustrate the nature of correlations that can be obtained utilizing the PURDU-WICSTK program and that are suitable for incorporating into the NASA-WISGSK program, a series of correlations

have been obtained for the 6-stage axial-flow Test Compressor, referred to in Section 1.2 of the report, utilizing the PURDU-WICSTK program.

Some examples of such correlations have been obtained under the following conditions.

Operating speed	. . .	90 percent design speed.
Droplet size	. . .	600 μm (referred to as large).
Water content as mass fraction of water in the mixture	. . .	0.000, 0.025, 0.075, 0.125, and 0.150.

The correlations are presented in three parts, namely (i) for the deviation constant, (ii) for the pressure-rise coefficient and (iii) for the efficiency. In each case, the correlations have been given for different stages of the compressor. According to the basic design of the compressor, the type of blading employed in the different stages can be grouped as follows.

- a) blading in stage 1;
- b) blading in stage 2; and
- c) blading in stages 3, 4, 5 and 6.

From the point of view of blade loading, it appears that it is necessary to distinguish further between stage 3 and stages 4, 5 and 6.

The correlations for deviation constant have been presented in the following figures.

Figure 4(a): Deviation constant vs $[(W_2/W_1) - (W_2/W_2)^*]$
(Stage 1)

Figure 4(b): Deviation constant vs $[(W_2/W_1) - (W_2/W_1)^*]$
(Stage 2)

Figure 4(c): Deviation constant vs $[(W_2/W_1) - (W_2/W_1)^*]$
(Stages 3, 4, 5, 6)

The correlations for pressure-rise coefficient corresponding to the afore-mentioned examples of correlations for the deviation constant have been presented in the following figures.

- Figure 5(a): ψ/ψ^* vs ϕ/ϕ^* (Stage 1)
- Figure 5(b): ψ/ψ^* vs ϕ/ϕ^* (Stage 2)
- Figure 5(c): ψ/ψ^* vs ϕ/ϕ^* (Stage 3)
- Figure 5(d): ψ/ψ^* vs ϕ/ϕ^* (Stages 4, 5, 6)

In these correlations, the stage pressure-rise coefficient and stage flow coefficient are normalized with respect to the design point values.

A set of examples of correlations for the adiabatic efficiency of different stages have been presented in the following figures. In all of the cases again only large droplets have been considered. The adiabatic efficiency is again normalized with respect to the design point value.

- Figure 6(a): ψ/ψ^* vs ϕ/ϕ^* (Stage 1)
- Figure 6(b): ψ/ψ^* vs ϕ/ϕ^* (Stage 2)
- Figure 6(c): ψ/ψ^* vs ϕ/ϕ^* (Stage 3)
- Figure 6(d): ψ/ψ^* vs ϕ/ϕ^* (Stages 4, 5, 6)

It is of interest to observe the following from the correlations presented.

- (i) The correlations for both K and η show that there is some similarity in regard to their variation with water content in the entry mixture.
- (ii) The variation of K with respect to diffusion is rather severe for flow diffusion values in the vicinity of the design point, especially at the higher values of water content in the entry mixture. At large values of diffusion, the water content does not seem to have a significant effect.

It is of importance to note that the nature of variations of K and η may be different at other operating speeds. However, it is assumed

that such variations are small and that similar variations can be assumed over appropriate ranges of flow coefficients at other speeds. Nevertheless, the correlations presented should be considered as applicable only to the type of blading and blade-loading in the Test Compressor.

Other aspects of predictions of the Test Compressor performance utilizing the PURDU-WICSTK program can be found in References 6 and 7.

2.3 Modification of NASA-STGSTK Code to NASA-WISGSK Code for Use with Two-Phase Flow

The NASA-WISGSK Code for use with two-phase flow has been obtained by modifying the NASA-STGSTK Code in two respects.

- (i) Introducing the stage characteristics for two-phase fluid flow in place of the stage characteristics utilized originally for air flow through the compressor; and
- (ii) Incorporating various two-phase fluid associated processes at the stage exit in order to obtain the final state of the fluid at that location.

The principal stage characteristics are the efficiency and the pressure-rise coefficient. They are obtained at a reference operating speed, usually the design operating speed although another operating speed may be utilized.

The two-phase fluid flow effects of major interest are (i) the redistribution of water due to centrifugal action, (ii) the heat and mass transfer giving rise to a change in the temperature and mass fraction of the mixture constituents and (iii) the change in droplet size.

2.3.1. Efficiency Variation with Respect to Flow Coefficient

The reference curves for the variation of efficiency with respect to flow coefficient, obtained at the reference speed for various values

of water content in the entry mixture, for a particular compressor stage are adapted for use at other operating speeds in the NASA-WISGSK Code in two steps as follows.

- (i) First, the reference curve for the case of air flow (and no water in the mixture) is shifted as illustrated in Figure 7 for use at the desired off-reference operating speed over the appropriate range of flow coefficient.
- (ii) Next, the reference curve is modified for the presence of water following the correlations obtained for different water contents in the mixture at the reference speed. This part of the procedure is also illustrated in Figure 7.

2.3.2 Pressure-Rise Coefficient vs Flow Coefficiency

In the NASA-STGSTK Code, the pressure-rise coefficient is calculated in the subroutine CSPSI (Reference 3). In that subroutine, the pressure-rise coefficient is calculated based on the deflection of air flow over a rotor blade which in turn depends upon the blade outlet flow angle and hence the deviation angle. The blade deviation angle is estimated utilizing the following rule.

$$\delta - \delta^* = K [(W_2/W_1) - (W_2/W_1)^*]$$

with $K = -10$ for the case of air flow. In the case of operation with air-water mixture flow, the deviation constant, K , is a function of water content and amount of diffusion.

Utilizing the appropriate values of K , based, for example, upon the type of correlations presented in Figure 4, the pressure-rise coefficient can be obtained at the reference speed and at off-design speeds for various values of water content in the entry mixture as a function of flow coefficient.

2.3.3 Correction for Two-Phase Effects

The NASA-WISGSK Code incorporates the following new features in order to correct the blade outlet conditions that are obtained based upon stage characteristics for the following two-phase fluid flow effects:

- (i) droplet size adjustment;
- (ii) centrifugal force action; and
- (iii) heat and mass transfer.

The details regarding modelling of these processes can be found in Reference 5.

2.4 The General Procedure for Utilization of the NASA-WISGSK Code

It is expected that for the compressor under consideration, the following stage characteristics are available for each stage of the compressor at a convenient reference speed over a range of mass flows.

- (i) Adiabatic efficiency as a function of gas phase flow coefficient for various values of mass fraction of water in the mixture; and
- (ii) Deviation factor as a function of diffusion of the working fluid for various values of mass fraction of water in the mixture.

Utilizing the latter, the pressure-rise coefficient characteristics for different stages can be obtained as a function of flow coefficient utilizing the mass fraction of water in the entry mixture as a parameter.

As stated earlier (Section 2.3.1) the efficiency curves may need to be shifted for use at off-reference operating speeds. The pressure-rise coefficient characteristics are treated as applicable at all values of operating speed, at least over a substantial range of speeds.

It can be visualized that the efficiency and the pressure-rise coefficient characteristics may be available at discrete values of mass fraction of water. Since the mass fraction of water changes along a compressor flow path in different ways along different streamlines, it is useful to devise rules for interpolating the stage characteristics for various values of mass fraction of water.

The water vapor in the mixture at entry to a compressor stage is taken into account in the form of mass fraction of vapor for the purposes of determining the thermodynamic properties as a part of the gas phase in the mixture.

The initial and operating conditions to be specified in utilizing the NASA-WISGSK Code are the following:

- (i) the operating speed;
- (ii) the mixture mass flow;
- (iii) the mixture composition including the droplet size; and
- (iv) the ambient conditions in the mixture entering the compressor.

The calculation procedure may then be divided into three parts as follows:

- (i) calculation of performance of compressor at reference and off-reference speeds with air flow only;
- (ii) calculation of performance of compressor at reference speed and different values of mass flows with various values of water content; and
- (iii) calculation of performance of compressor at off-reference speeds with various values of mixture flows and mass fractions of water.

In each case, calculations may be performed along any streamtube selected in the compressor with specified (a) mass flow and mixture composition at entry, (b) area change and (c) work input at appropriate rotor locations. It may be recalled that the calculation procedure is based on a one-dimensional formulation.

2.4.1 Calculation with Air Flow

The performance calculation with air flow at the reference and the off-reference speeds is intended to establish (a) the extent to which the stage efficiency curve needs to be adjusted by shifting over the desired range of flow coefficient (utilizing the procedure described in Section 2.3.1) and (b) the ranges of flow coefficient that can be covered in the performance calculation at different operating speeds utilizing the available stage characteristics. When the compressor performance is available from another source at different operating speeds, one can compare such performance parameter values with those obtained utilizing the NASA-WISGSK Code. Utilizing a trial-and-error procedure, any small differences in performance at off-reference speeds can be adjusted through modifying the stage characteristics available at the reference speed for various off-reference speeds. However, such modifications need to be introduced with considerable judgement.

The calculation procedure for given (a) ambient conditions, (b) operating speed and (c) air mass flow may be summarized as follows.

- (i) The flow coefficient is determined at the compressor inlet.
- (ii) The stage efficiency can be obtained directly from the efficiency vs flow coefficient curve for the stage when the operating speed under consideration is the same as the reference speed. If the operating speed is different from the reference speed, the efficiency-flow coefficient curve has to be shifted appropriately (Section 2.3.1) and the efficiency then obtained for the value of flow coefficient specified.
- (iii) The stage pressure-rise coefficient characteristic is utilized for obtaining the value of pressure-rise coefficient at the specified value of flow coefficient.

- (iv) The stage pressure ratio and temperature ratio are calculated as follows:

$$PR = 1.0 + \frac{U^2}{C_{pT_{o1}}} \psi$$

$$TR = 1.0 + (PR)^{\gamma-1/\gamma} - 1.0) \eta$$

- (v) The resulting stage outlet conditions become the inlet conditions for the next stage, if any. The procedure given under items (i) to (iv) is then repeated for each of the stages until the compressor outlet station is reached.
- (vi) The performance of each stage of the compressor as well as the overall performance of the compressor can then be obtained from the predictions for the given operating conditions.
- (vii) The entire procedure may be repeated at the desired operating speeds and mass flows.

2.4.2 Calculation with Air-Water Mixture Flow at Reference Speed

At the reference speed, the available stage characteristics (pertaining to efficiency and pressure-rise coefficient) are usable directly.

The procedure for calculation of performance at various values of mixture mass flow (or gas phase flow coefficient and liquid phase mass fraction) is identical to that described in Section 2.4.1 except for the following: (i) the efficiency and pressure-rise coefficient values should be chosen for the local value of water content in the entry mixture for each stage and (ii) the stage outlet conditions have to be corrected for two-phase flow effects.

The primary purpose of the calculation of performance at the reference speed is to establish the applicability of the available

stage characteristics for the ranges of water content that are likely to arise in different stages under different conditions. Since centrifugal action is only a function of the rotation in the flow field, by performing calculations at the reference operating speed, the effect of water content and the applicability of the available stage characteristics can be examined in the different stages of a compressor. If the general trend of performance changes is acceptable, the pressure-rise coefficient information can be utilized with some confidence at off-reference speeds.

2.4.3 Calculation with Air-Water Mixture Flow under General Conditions of Operation

At off-reference operating speeds, the efficiency-flow coefficient curves need to be shifted to become applicable over the relevant range of flow coefficient in each stage of a compressor.

The calculation procedure for obtaining the performance is then identical to that described in Section 2.4.1 except for the following: (i) the efficiency and pressure-rise coefficient values should be chosen for the local values of water content in the entry mixture for each stage, (ii) the efficiency curves should be moved as required to become applicable over the relevant range of flow coefficient at the operating speed specified and (iii) the correction of stage outlet conditions for two-phase flow effects.

The stage outlet conditions are corrected for the following effects associated with two-phase flow:

- a) Droplet size adjustment;
- b) Centrifugal force action; and
- c) Heat and mass transfer.

The stage outlet conditions are then obtained in terms of mixture composition, gas phase properties and liquid phase properties, including the droplet size.

CHAPTER III

SUBROUTINES AND EXTERNAL FUNCTIONS

The following is the list of subroutines and external functions used in the NASA-WISGSK code. The subroutines and external functions consist of two parts as follows: Part I of the subroutines and external functions is the same as those in PURDU-WICSTK code (Reference 5) and Part II of the subroutines and external functions closely follows those in NASA-STGSK code (Reference 3). Only brief descriptions of these subprograms are given here. A more detailed description of each subprogram is presented in Appendix 3.

PART I

Subroutine WICSPC: calculation of stage performance based on the analytical/correlation method for large droplet.

Subroutine WICSPD: calculation of design point performance.

Subroutine WICSCC: calculation of the equivalent pressure ratio, equivalent temperature rise ratio, and stage adiabatic efficiency for a particular stage based on the inputted stage characteristic curves.

Subroutine WICGSL: calculation of single-phase (gas) flow loss.

Subroutine WICSDL: calculation of loss for small droplets on account of the change in momentum thickness of boundary layer due to the presence of such droplets.

Subroutine WICSTL: calculation of loss due to Stokesian drag of large droplets in the free stream of blade passage.

Subroutine WICFML: calculation of loss due to film formed on blade surface when large droplets are present either by themselves or along with small droplets.

Subroutine WICRSL: calculation of loss due to the rough surface when large droplets are present either by themselves or along with small droplets.

Subroutine WICVT: calculation of components of velocity triangle and angles.

Subroutine WICCEN: calculation of swanwise displacement of droplets due to centrifugal action.

Subroutine WICDMS: calculation of amount of small droplets which are centrifuged.

Subroutine WICDML: calculation of amount of large droplets which are centrifuged.

Subroutine WICDRG: calculation of drag force on large droplet.

Subroutine WICMAC: calculation of Mach number.

Function WICASD: calculation of acoustic speed in two phase flow.

Subroutine WICBOA: calculation of blade outlet angle.

Subroutine WICEDD: calculation of equivalent diffusion at design point.

Function WICED: calculation of equivalent diffusion.

Function WICMTK: calculation of dimensionless momentum thickness.

Function WICLOS: calculation of total pressure loss coefficient.

Subroutine WICIRS: calculation of droplet impingement and rebound in rotor for small droplet.

Subroutine WICIRL: calculation of droplet impingement and rebound in rotor for large droplet.

Subroutine WICISS: calculation of droplet impingement and rebound in stator for small droplet.

Subroutine WICISL: calculation of droplet impingement and rebound in stator for large droplet.

Subroutine WICWAK: calculation of water reingestion into wake.

Subroutine WICHET: calculation of heat transfer between gaseous phase and droplets.

Subroutine WICMAS: calculation of mass transfer between gaseous phase and droplets.

Function WICMTR: calculation of mass transfer rate.

Function WICPWB: calculation of vapor pressure.

Function WICNEW: calculation of new trial value in the iterative procedure.

Function WICTAN: calculation of the value of tangent function.

Function WICBPT: calculation of boiling point.

Function WICSH: calculation of specific humidity.

Subroutine WICSIZ: calculation of nominal droplet size.

Subroutine WICPRP: calculation of flow properties for gaseous phase.

Function WICCPA: calculation of specific heat at constant pressure for air.

Function WICCPH: calculation of specific heat at constant pressure for vapor.

Function WICPCP: calculation of specific heat at constant pressure for methane.

PART II

Subroutine NASA: subroutine which corresponds to MAIN program of NASA-STGSTK code.

Subroutine CSINPT: reads and writes the Part II of input data.

Subroutine CSPREF: calculates parameters at design speed and design flow conditions.

Function CPFM: calculates specific heat at constant pressure from static temperature using fifth degree polynomial.

Subroutine CSETA: calculates adiabatic efficiency versus flow coefficient.

Subroutine CSPSI: calculates pressure coefficients for inputted flow coefficients

Subroutine CSDEVS: calculates stator deviation angle for small droplet calculation.

Subroutine CDEVSL: calculates stator deviation angle for large droplet calculation.

Subroutine CSDEV: calculates rotor deviation angle for small droplet calculation.

Subroutine CSDEVL: calculates rotor deviation angle for large droplet calculation.

Subroutine CSETA1: calculates adiabatic efficiency for small droplet calculation.

Subroutine CSETAL: calculates adiabatic efficiency for large droplet calculation.

Subroutine CSPSD: alters pressure coefficient for off design speeds.

Subroutine CSPAN: alters flow coefficient and pressure coefficient for blade reset.

Subroutine CSOAPT: calculates and prints out stage performance for small droplet calculation.

Subroutine COAPTZ: calculates and prints out stage performance for large droplet calculation.

Function DELK70: alters diffusion constant for 70% rotor speed.

Function DELK80: alters diffusion constant for 80% rotor speed.

Function DELK10: alters diffusion constant for 100% rotor speed.

Function DPHI: alters flow coefficient for different rotational speed.

CHAPTER IV

INPUT DATA

The following is a list of the input data as they are read in the NASA-WISGSK code. All input data that are needed to use the code are described herein. The input data consist of two parts as follows: Part I of the input data is the same as those in the PURDU-WICSTK code (Reference 5), and Part II of the input data follow very closely those in the NASA-STGSTK code (Reference 3).

PART I

<u>Card</u> <u>No.</u>	<u>Input</u> <u>Data</u>	<u>Comment</u>	<u>Format</u>
1	NS	number of stage	I1
2	RRHUB(I)	hub radius at Ith stage rotor inlet. I = 1 ~ NS Unit: inch or cm	F 5.3
3	RC(I)	chord length of Ith stage rotor I = 1 ~ NS Unit: inch or cm	F 5.3
4	RBLADE(I)	number of blade for Ith stage rotor. I = 1 ~ NS	F 5.2
5	STAGER(I)	stagger angle for Ith stage rotor I = 1 ~ NS Unit: degree	F 5.2
6	SRHUB(I)	hub radius at Ith stage stator inlet. I = 1 ~ NS, I = NS + 1 for IGV Unit: inch or cm	F 5.3

<u>Card No.</u>	<u>Input Data</u>	<u>Comment</u>	<u>Format</u>
7	SC(I)	chord length of Ith stage stator I = 1 ~ NS, I = NS + 1 for IGV Unit: inch or cm	F 5.3
8	SBLADE(I)	number of blade for Ith stage stator. I = 1 ~ NS, I = NS + 1 for IGV	F 5.2
9	SIGUMR(I)	solidity of Ith stage rotor I = 1 ~ NS	F 5.3
10	SIGUMS(I)	solidity of Ith stage stator I = 1 ~ NS, I = NS + 1 for IGV	F 5.3
11	BET2SS(I)	absolute flow angle at Ith stage stator outlet I = 1 ~ NS, I = NS + 1 for IGV	F 5.2
12	FNF	fraction of design corrected rotor speed for a particular speed	F 8.2
13	XDIN	initial water content (mass fraction) of small droplet	F 5.3
13	ICENT	index for centrifugal calculation of small droplet ICENT = 1 when XDIN = 0.0 otherwise ICENT = 2	I1
13	XDDIN	initial water content (mass fraction) of large droplet	F 5.3
13	IICNET	index for centrifugal calculation of large droplet IICENT = 1 when IDDIN = 0.0 otherwise IICENT = 2	I1
14	TOG	total temperature of gas phase at compressor inlet Unit: Rankine or Kelvin	F 7.2
14	TOW	temperature of droplet at compressor inlet Unit: Rankine or Kelvin	F 7.2

(continued)

<u>Card No.</u>	<u>Input Data</u>	<u>Comment</u>	<u>Format</u>
14	PO	total pressure at compressor inlet Unit: lbf/ft ² or N/m ²	F 7.2
15	DIN	initial diameter of small droplet Unit: μm	F 6.1
15	DDIN	initial diameter of large droplet Unit: μm	F 6.1
16	FND	rotor corrected speed at design point Unit: RPM	F 7.1
16	T01D	compressor inlet temperature at design point Unit: Rankine or Kelvin	F 7.2
16	P01D	compressor inlet pressure at design point Unit: lbf/ft ² or N/m ²	F 7.2
17	XCH4	initial methane content (mass fraction)	F 5.3
17	RHUMID	initial relative humidity Unit: per cent	F 10.5
18	FMWA	molecular weight of air	F 7.3
18	FMWV	molecular weight of steam	F 7.3
18	FMWC	molecular weight of methane	F 7.3
19	PREB	percent of water droplet that rebound after impingement on blade surface	F 5.1
19	DLIMIT	maximum diameter for small droplet Unit: μm	F 7.1
20	STAGES(I)	stagger angle for Ith stage stator I = 1 ~ NS, I = NS + 1 for IGV Unit: degree	F 5.2

<u>Card No.</u>	<u>Input Data</u>	<u>Comment</u>	<u>Format</u>
21	GAPR(I)	gap between Ith stage rotor and (I - 1)th stage stator I = 1 ~ NS Unit: inch or cm	F 7.5
22	GAPS(I)	gap between rotor blade and stator blade for Ith stage I = 1 ~ NS Unit: inch or cm	F 7.5
23	RRTIP(I)	blade tip radius at Ith stage rotor inlet I = 1 ~ NS Unit: inch or cm	F 6.3
24	SRTIP(I)	blade tip radius at Ith stage stator inlet I = 1 ~ NS Unit: inch or cm	F 6.3
25	IRAD	index for radius at which calculation is carried out IRAD = 1: performance at tip IRAD = 2: performance at mean IRAD = 3. performance at hub	I1
26	RT(I)	rotor inlet radius at which tip performance calculation is carried out I = 1 ~ NS Unit: inch or cm	F 5.3
27	RM(I)	rotor inlet radius at which mean line performance calculation is carried out I = 1 ~ NS Unit: inch or cm	F 5.3
28	RH(I)	rotor inlet radius at which hub performance calculation is carried out I = 1 ~ NS Unit: inch or cm	F 5.3

<u>Card No.</u>	<u>Input Data</u>	<u>Comment</u>	<u>Format</u>
29	ST(I)	stator inlet radius at which tip performance calculation is carried out I = 1 ~ NS Unit: inch or cm	F 5.3
30	SM(I)	stator inlet radius at which mean line performance is carried out I = 1 ~ NS Unit: inch or cm	F 5.3
31	SH(I)	stator inlet radius at which hub performance calculation is carried out I = 1 ~ NS Unit: inch or cm	F 5.3
32	BLOCK(I)	blockage factor for Ith stage rotor 0 < BLOCK(I) < 1	F 5.3
33	BLOCKS(I)	blockage factor for Ith stage stator 0 < BLOCKS(I) < 1	F 5.3
34	BET1MR(I)	blade metal angle at Ith stage rotor inlet Unit: degree	F 5.2
35	BET2MR(I)	blade metal angle at Ith stage rotor outlet Unit: degree	F 5.2
36	BET1MS(I)	blade metal angle at Ith stage stator inlet Unit: degree	F 5.2
37	BET2MS(I)	blade metal angle at Ith stage stator outlet Unit: degree	F 5.2
38	DSMASS	mass flow rate at design point Unit: lb _m /s or kg/s	F 10.6
39	PR12D	total pressure ratio for the Ith stage rotor at design point	F 5.3

<u>Card No.</u>	<u>Input Data</u>	<u>Comment</u>	<u>Format</u>
40	PR13D	total pressure ratio for Ith stage	F 5.3
41	ETARD(I)	adiabatic efficiency for Ith stage rotor	F 5.3
42	SAREA(I)	stream tube area Ith stage rotor inlet Unit: ft ² or m ²	F 10.7
43	SAREAS(I)	stream tube area for Ith stage stator inlet Unit: ft ² or m ²	F 10.7
44	XBLEED(I)	amount of bleed at Ith stage outlet	F 5.2

PART II

<u>Card No.</u>	<u>Input Data</u>	<u>Comment</u>	<u>Format</u>
45	TITLE	title card on which any alphabetical data can be used	12A6
46	STAGEN	the number of stages	F 10.0
46	SPEEDN	always 1.0	F 10.0
46	CHAPTS	number of points used to describe the stage characteristic	F 10.0
46	P0	compressor inlet total pressure Unit: lb _f /ft ²	F 10.0
46	T0	compressor inlet total temperature Unit: Rankine	F 10.0
46	DESRPM	design rotative speed Unit: RPM	F 10.0
46	DESFLO	design flow rate Unit: lb _m /sec	F 10.0

<u>Card</u> <u>No.</u>	<u>Input</u> <u>Data</u>	<u>Comment</u>	<u>Format</u>
47	WTMOLA	molecular weight of air	F 10.0
47	WTMOLM	molecular weight of methane	F 10.0
47	WTMOLS	molecular weight of steam	F 10.0
47	XAR	mass fraction of dry air	F 10.0
47	XMET	mass fraction of methane	F 10.0
47	XSTM	mass fraction of steam	F 10.0
48	SPDPSI	index to alter pressure coefficient for off-design speed. Pressure coefficient is altered for off-design speed if SPDPSI = 1.0; otherwise not.	F 10.0
48	SPDPHI	index to alter flow coefficient for off-design speed. Flow coefficient is altered for off-design speed if SPDPHI = 1.0; otherwise not.	F 10.0
48	DRDEVG	index to alter rotor deviation angle for blade reset. Rotor deviation angle is altered for blade reset if DRDEVG = 1.0; otherwise not.	F 10.0
48	DRDEVN	index to alter rotor deviation angle for off-design speed. Rotor deviation angle is altered for off-design speed if DRDEVN = 1.0; otherwise not.	F 10.0
48	DRDEVP	index to alter rotor deviation angle for off-design flow coefficient. Rotor deviation is altered for off-design flow coefficient if DRDEVP = 1.0; otherwise not.	F 10.0
48	UNITS	always 0.0	F 10.0
49	CPCO(I)	coefficients for polynomial of specific heat at constant pressure for air	F 10.0

<u>Card</u> <u>No.</u>	<u>Input</u> <u>Data</u>	<u>Comment</u>	<u>Format</u>
50	CPCM(I)	coefficients for polynomial of specific heat at constant pressure for methane	F 10.0
51	CPCS(I)	coefficients for polynomial of specific heat at constant pressure for steam	F 10.0
52	RT2(I)	rotor inlet tip radius at Ith stage Unit: inch	F 10.0
53	RH2(I)	rotor inlet hub radius at Ith stage Unit: inch	F 10.0
54	RT3(I)	rotor outlet tip radius at Ith stage Unit: inch	F 10.0
55	RH3(I)	rotor outlet hub radius at Ith stage Unit: inch	F 10.0
56	BET2M(I)	rotor inlet absolute flow angle at mean line radius at Ith stage Unit: degree	F 10.0
57	CB2M(I)	change in rotor inlet absolute flow angle at mean line radius at Ith stage Unit: degree	F 10.0
58	CB2MR(I)	change in rotor inlet relative flow angle at mean line radius at Ith stage Unit: degree	F 10.0
59	CB3MR(I)	change in rotor outlet relative flow angle at mean line radius at Ith stage Unit: degree	F 10.0
60	RK2M(I)	rotor inlet blade metal angle at mean line radius at Ith stage Unit: degree	F 10.0

<u>Card</u> <u>No.</u>	<u>Input</u> <u>Data</u>	<u>Comment</u>	<u>Format</u>
61	RK3M(I)	rotor outlet blade metal angle at mean line radius at Ith stage Unit: degree	F 10.0
62	RSOLM(I)	rotor blade row solidity at Ith stage	F 10.0
63	SK2M(I)	stator inlet blade metal angle at mean line radius at Ith stage Unit: degree	F 10.0
64	PR(I)	stage pressure ratio at design point for Ith stage	F 10.0
65	ETAINP(I)	stage adiabatic efficiency at design point for Ith stage	F 10.0
66	PHIINP(I)	flow coefficient at design stage for Ith stage	F 10.0
67	PCTSPD	value of rotative speed expressed as a decimal fraction of design speed	F 10.0
68	ETARAT	ratio of adiabatic efficiency at design speed to adiabatic efficiency at speed corresponding to PCTSPD	F 10.0
69	BLEED	amount of bleed Unit: lb _m /sec	F 10.0
70	PHIDES	stage flow coefficient at design speed	F 10.0
71	PSIDES	stage pressure coefficient at design speed, when input PR is not zero, then PSIDES must be zero	F 10.0
72	ETADES	stage adiabatic efficiency at design speed, when input ETAINP is not zero, then ETADES must be zero	F 10.0
73	FAI(K)	initial flow coefficient K = 1 ~ CHAPTS one value per one card	F 7.5

CHAPTER V

OUTPUT

The output generated utilizing the NASA-WISGSK code is described here. The output consists of five parts as follows:

- (1) output of the input data;
- (2) output of design point performance;
- (3) output of stage characteristic;
- (4) output of stage performance; and
- (5) output of overall performance.

These five parts are described in the following.

5.1 Output of Inputed Data

All of the data inputed can be printed out at the beginning of output.

5.2 Output of Design Point Performance

5.2.1 Compressor Inlet (Design Point Performance)

At the compressor inlet, the following properties can be printed out for the design point performance:

- (1) total temperature at compressor inlet: (R) or (K)
- (2) total pressure at compressor inlet: (lbf/ft²) or (N/m²)
- (3) static temperature at compressor inlet: (R) or (K)
- (4) static pressure at compressor inlet: (lbf/ft²) or (N/m²)
- (5) static density at compressor inlet: (lbm/ft³) or (kg/m³)
- (6) acoustic speed at compressor inlet: (ft/s) or (m/s)
- (7) axial velocity at compressor inlet: (ft/s) or (m/s)

- (8) Mach number at compressor inlet
- (9) stream tube area at compressor inlet: (ft²) or (m²)
- (10) flow coefficient at compressor inlet

5.2.2 Stage Performance (Design Point Performance)

At the end of each stage, the following properties can be printed out for the design point performance:

- (1) total temperature: (R) or (K)
- (2) total pressure: (lbf/ft²) or (N/m²)
- (3) static temperature: (R) or (K)
- (4) static pressure: (lbf/ft²) or (N/m²)
- (5) static density: (lbm/ft³) or (kg/m³)
- (6) axial velocity: (ft/s) or (m/s)
- (7) absolute velocity: (ft/s) or (m/s)
- (8) relative velocity: (ft/s) or (m/s)
- (9) tangential component of absolute velocity: (ft/s) or (m/s)
- (10) tangential component of relative velocity: (ft/s) or (m/s)
- (11) rotor wheel speed: (ft/s) or (m/s)
- (12) absolute Mach number
- (13) relative Mach number
- (14) total temperature based on relative Mach number: (R) or (K)
- (15) total pressure based on relative Mach number: (lbf/ft²) or (N/m²)
- (16) absolute flow angle: (degree)
- (17) relative flow angle: (degree)
- (18) stream tube area: (ft²) or (m²)
- (19) radius at which calculation is carried out: (ft) or (m)
- (20) flow coefficient
- (21) stage total pressure ratio
- (22) stage adiabatic efficiency
- (23) rotor total pressure ratio
- (24) rotor adiabatic efficiency
- (25) stage total temperature ratio

5.2.3 Overall Performance (Design Point Performance)

After all of stage performance is printed out, the following properties can be printed out:

- (1) compressor inlet total temperature: (R) or (K)
- (2) compressor inlet total pressure: (lbf/ft²) or (N/m²)
- (3) corrected mass flow rate: (lbm/s) or (kg/s)
- (4) overall total pressure ratio
- (5) overall total temperature ratio
- (6) overall adiabatic efficiency
- (7) overall temperature rise: (F) or (C)
- (8) relative flow angle at rotor inlet: BET1SR(I) (degree)
- (9) relative flow angle at rotor outlet: BET2SR(I) (degree)
- (10) incidence for rotor: AINCSR(I) (degree)
- (11) deviation for rotor: ADEVSR (degree)
- (12) absolute flow angle for stator inlet: BET1SS(I) (degree)
- (13) absolute flow angle for stator outlet: BET2SS(I) (degree)
- (14) incidence for stator: AINCSS(I) (degree)
- (15) deviation for stator: ADEVSS(I) (degree)
- (16) stage inlet temperature: TD(I) (R) or (K)
- (17) total pressure loss coefficient for stator: OMEGS(I)
- (18) total pressure loss coefficient for rotor: OMEGR(I)

5.3 Output of Stage Characteristics

The inputted and/or computed stage characteristic can be printed out. The flow coefficient, pressure coefficient and adiabatic efficiency for each stage are printed out. This part of output is the same as one in NASA-SGSTK code (Reference 3).

5.4 Output of Stage Performance

The performance of a stage is calculated for given initial and operating conditions with respect to the gaseous phase and the water droplets. At the exit of a blade row, the four major processes

associated with two phase flow, namely (a) droplet impingement process; (b) centrifugal action on droplets; (c) heat and mass transfer processes between the two phases; and (d) droplet size adjustment are taken into account. When the stage performance parameters are corrected for the afore-mentioned four processes, then one obtains the outlet conditions from a stage. The output of stage performance consist of two parts. First the following properties can be printed out before the afore-mentioned four processes are taken into account:

- (1) stage total pressure ratio
- (2) stage total temperature ratio
- (3) stage adiabatic efficiency
- (4) stage flow coefficient
- (5) axial velocity: (ft/sec) or (m/sec)
- (6) rotor speed: (ft/sec) or (m/sec)
- (7) total pressure: (lbf/ft²) or (N/m²)
- (8) static pressure: (lbf/ft²) or (N/m²)
- (9) total temperature of gas phase: (R) or (K)
- (10) static temperature of gas phase: (R) or (K)
- (11) static density of gas phase: (lbm/ft³) or (kg/m³)
- (12) static density of mixture: (lbm/ft³) or (kg/m³)
- (13) axial velocity: (ft/s) or (m/s)
- (14) absolute velocity: (ft/s) or (m/s)
- (15) relative velocity: (ft/s) or (m/s)
- (16) blade wheel speed: (ft/s) or (m/s)
- (17) tangential component of absolute velocity: (ft/s) or (m/s)
- (18) tangential component of relative velocity: (ft/s) or (m/s)
- (19) acoustic speed: (ft/sec) or (m/s)
- (20) absolute Mach number
- (21) relative Mach number
- (22) flow coefficient
- (23) stream tube area (ft²) or (m²)
- (24) absolute flow angle: (degree)
- (25) relative flow angle: (degree)
- (26) incidence: (degree)
- (27) deviation: (degree)

After the stage parameters are corrected for the afore-mentioned four processes, the following second part of output of stage performance can be printed out:

- (1) stage total pressure ratio
- (2) stage total temperature ratio
- (3) stage adiabatic efficiency
- (4) water vapor content: XV
- (5) water content of small droplet: XW
- (6) water content of large droplet: XWW
- (7) total water content: XWT
- (8) mass fraction of dry air: XAIR
- (9) mass fraction of methane: XMETAN
- (10) mass fraction of gaseous phase: XGAS
- (11) mass flow rate of small droplet: WMASS (lbm/s) or (Kg/S)
- (12) mass flow rate of large droplet: WMASS (lbm/s) or (Kg/S)
- (13) total mass flow rate of droplet: WTMASS (lbm/s) or (Kg/S)
- (14) mass flow rate of dry air: AMASS (lbm/s) or (Kg/S)
- (15) mass flow rate of methane: CHMASS (lbm/s) or (Kg/S)
- (16) mass flow rate of water vapor: VMASS (lbm/s) or (Kg/S)
- (17) mass flow rate of gaseous phase: GMASS (lbm/s) or (Kg/S)
- (18) mass flow rate of mixture: TMASS (lbm/s) or (Kg/S)
- (19) specific humidity: WS
- (20) density of air: RHOA (lbm/ft³) or (Kg/m³)
- (21) density of mixture: RHOM (lbm/ft³) or (Kg/m³)
- (22) density of gaseous phase: RHOG (lbm/ft³) or (Kg/m³)
- (23) temperature of gaseous phase: TG (R) or (K)
- (24) temperature of small droplet: TW (R) or (K)
- (25) temperature of large droplet: TWW (R) or (K)
- (26) pressure: P (lbf/ft²) or (N/m²)
- (27) boiling point: TB (R) or (K)
- (28) dew point: TDEW (R) or (K)

5.5 Output of Overall Performance

At the end of compressor, the overall performance can be printed out. The properties to be printed out are as follows:

- (1) initial flow coefficient
- (2) corrected speed of compressor and fraction of design corrected speed
- (3) initial water content of small droplet
- (4) initial water content of large droplet
- (5) initial total water content
- (6) initial relative humidity
- (7) initial methane content
- (8) compressor inlet total temperature: (R) or (K)
- (9) compressor inlet total pressure: (lbf/ft²) or (N/m²)
- (10) corrected mass flow rate of mixture: (lbm/s) or (Kg/S)
- (11) corrected mass flow rate of gaseous phase: (lbm/s) or (Kg/S)
- (12) overall total pressure ratio
- (13) overall total temperature ratio
- (14) overall adiabatic efficiency
- (15) overall temperature rise of gaseous phase: (F) or (C)

CHAPTER VI

TEST CASE AND DISCUSSION

The performance calculation procedure is illustrated in the case of the Test-Compressor (referred to in Section 1.2) utilizing the correlations of performance parameters presented in Section 2.2 and the procedure for performance calculation presented in Sections 2.3 and 2.4.

The detailed printout of the input and output of the NASA-WISGSK Code is presented in Appendix 4 for the following two cases at a chosen value of inlet flow coefficient.

- 1) Test Case No. 1: Operation with air flow at 100 percent of the design speed at the meanline section of the compressor.
- 2) Test Case No. 2: Operation with air-water mixture containing large droplets (with a mass fraction of 0.040 of water) at 100 percent of design speed at the meanline section of the compressor.

Utilizing the same procedure, the performance of the Test Compressor has been determined at a number of operating conditions given in Table 2. The results of performance calculations have been presented in the following figures.

Figure 8(a): Overall stagnation pressure ratio as a function of gas phase corrected mass flow rate at tip section.

Figure 8(b): Overall stagnation temperature ratio as a function of gas phase corrected mass flow rate at tip section.

- Figure 8(c): Overall adiabatic efficiency as a function of gas phase corrected mass flow rate at tip section.
- Figure 9(a): Overall stagnation pressure ratio as a function of gas phase corrected mass flow rate at mean section.
- Figure 9(b): Overall stagnation temperature ratio as a function of gas phase corrected mass flow rate at mean section.
- Figure 9(c): Overall adiabatic efficiency as a function of gas phase corrected mass flow rate at mean section.
- Figure 10(a): Overall stagnation pressure ratio as a function of gas phase corrected mass flow rate at hub section.
- Figure 10(b): Overall stagnation temperature ratio as a function of gas phase corrected mass flow rate at hub section.
- Figure 10(c): Overall adiabatic efficiency as a function of gas phase corrected mass flow rate at hub section.

6.1 Discussion

The NASA-WISGSK Code provides a means of calculating the overall performance of an axial-flow compressor with water ingestion at selected spanwise sections utilizing a one-dimensional calculation procedure. The principal inputs to the Code are the following at a particular spanwise section.

- (i) The design point details of the compressor; and
- (ii) The stage characteristics at a selected speed of operation with air flow and air-water mixture flow, the latter over the desired range of water mass fraction in the mixture.

The stage characteristics are then approximated at other values of operating speed and at other spanwise sections.

During the calculations of performance for the cases given in Table 2, the stage characteristics have been assumed for operation at 90 percent design speed and at the meanline section of the compressor. It can be seen from Figures 11(a) and 11(b) that the meanline predicted performance for the case of operation with air flow at 90 and 80 percent design speed values corresponds very nearly to the experimental data (Reference 6) obtained at that spanwise section and speed. At 100 percent design speed, it can be observed from the same figure that some difference arises between predictions and experimental data, although the general trend of performance is obtained qualitatively correctly.

By means of a trial and error procedure for adaptation of stage characteristics for each of the stages in the compressor, it is possible to obtain a prediction that is close to experimental data to any desired degree of agreement at any speed and at any section of the compressor. However, this involves considerable empiricism in the adaptation of stage characteristics for different operating conditions at different spanwise sections.

TABLE 2

Operating Conditions of Test Compressor
(Utilized in the Illustration of
Performance Calculation Procedure)

<u>Parameter</u>	<u>Range of Values</u>
1) Compressor speed	80, 90 and 100% design speed
2) Mass fraction of water in the mixture	0.000, 0.030, 0.040, 0.080 and 0.150
3) Mixture mass flow rates	At least five values at each speed

During water ingestion, the basic performance of a stage is again obtained in the NASA-WISGSK Code utilizing the stage characteristics estimated for one selected speed and one spanwise section at all other speeds and spanwise sections. Thus only the general trends in performance changes can be established.

A further limitation of the NASA-WISGSK Code procedure is that the ranges of mixture mass flow and water mass fraction over which predictions can be obtained become restricted to different extents at different speeds and at different spanwise sections. Thus, in the present case, the stage characteristics with water ingestion are estimated first at 90 percent design speed and at the tip section. They are then adapted for use at other speeds and spanwise sections. It is then found that depending upon the mass fraction of water at the entry section of the compressor the prediction of performance at the tip section for high water mass fraction values at a higher operating speed (say, 100 percent design speed) may only be carried out for a small range of mixture mass flows, considerably less than, for example, at the mean and hub sections of the compressor.

It may be pointed out that no general conclusions may be drawn at this stage of utilization of the Code regarding its applicability to various compressors of different design and operating conditions. At the same time, it is clear that (a) the trend of performance changes can be established utilizing the Code and (b) the limitations in applicability arise in regard to the ranges of (i) speed, (ii) mixture mass flow and (iii) water mass fraction.

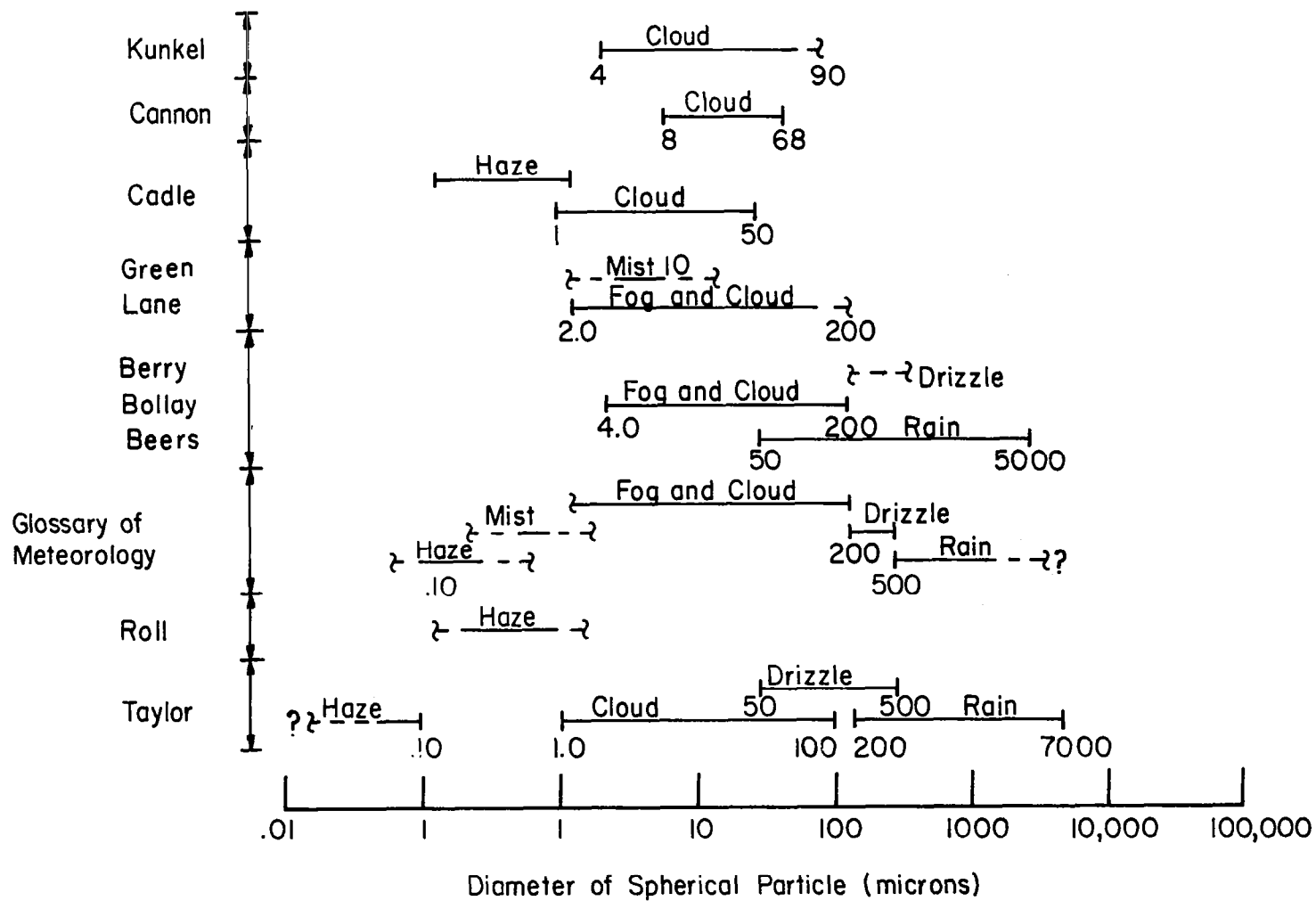


Figure 1: Droplet Size Variations in Rain and Mist

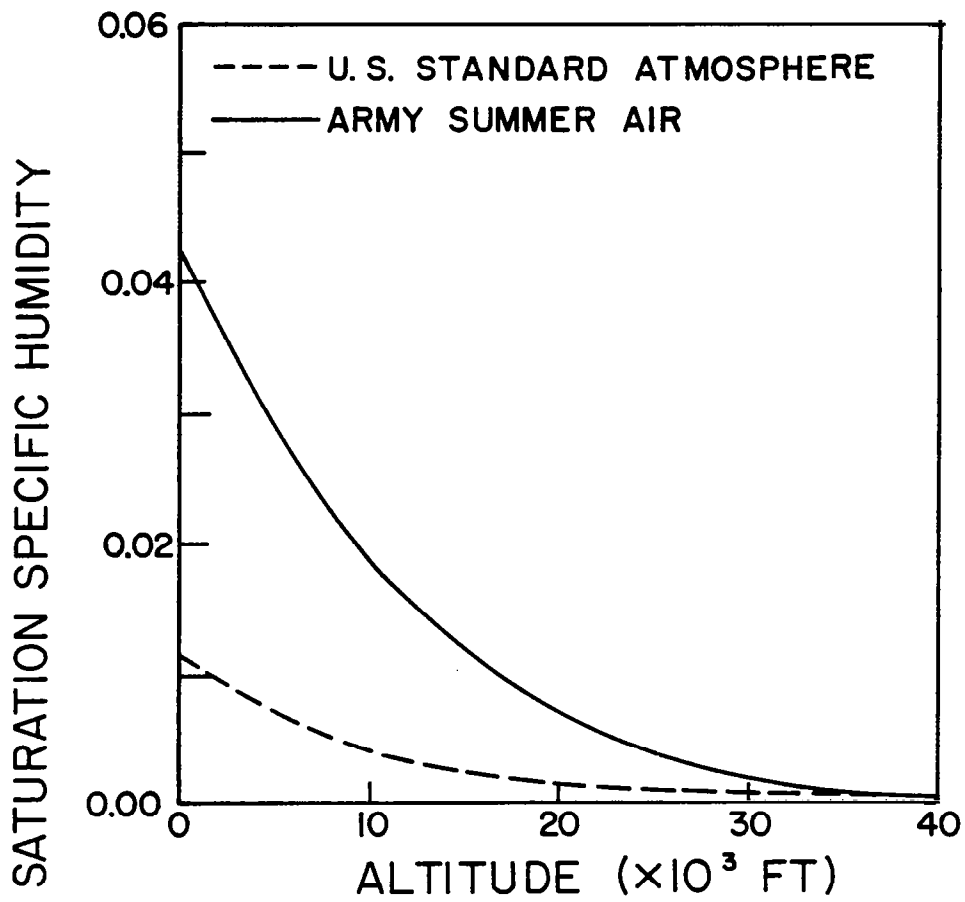


Figure 2: Variation of Saturation Water Vapor Content in Ambient Air as a Function of Altitude

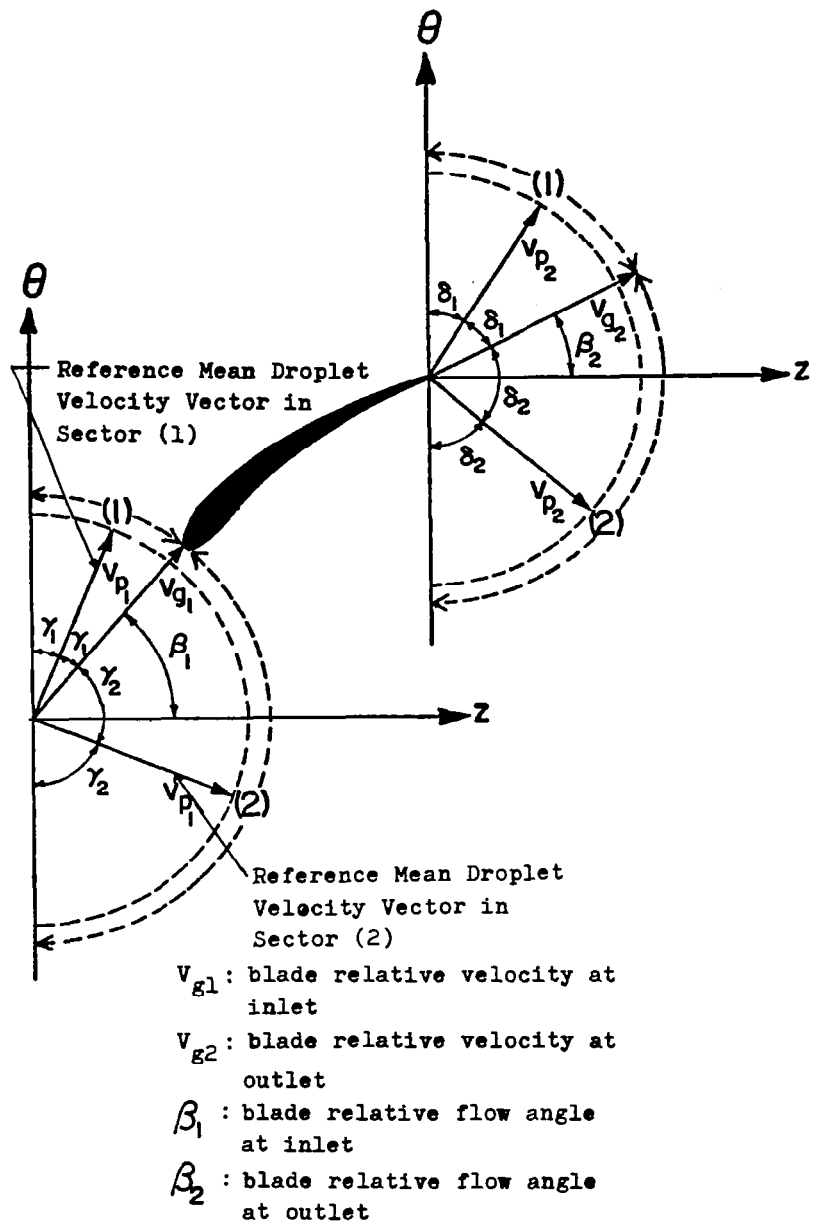


Figure 3: Model for Large Droplet Motion

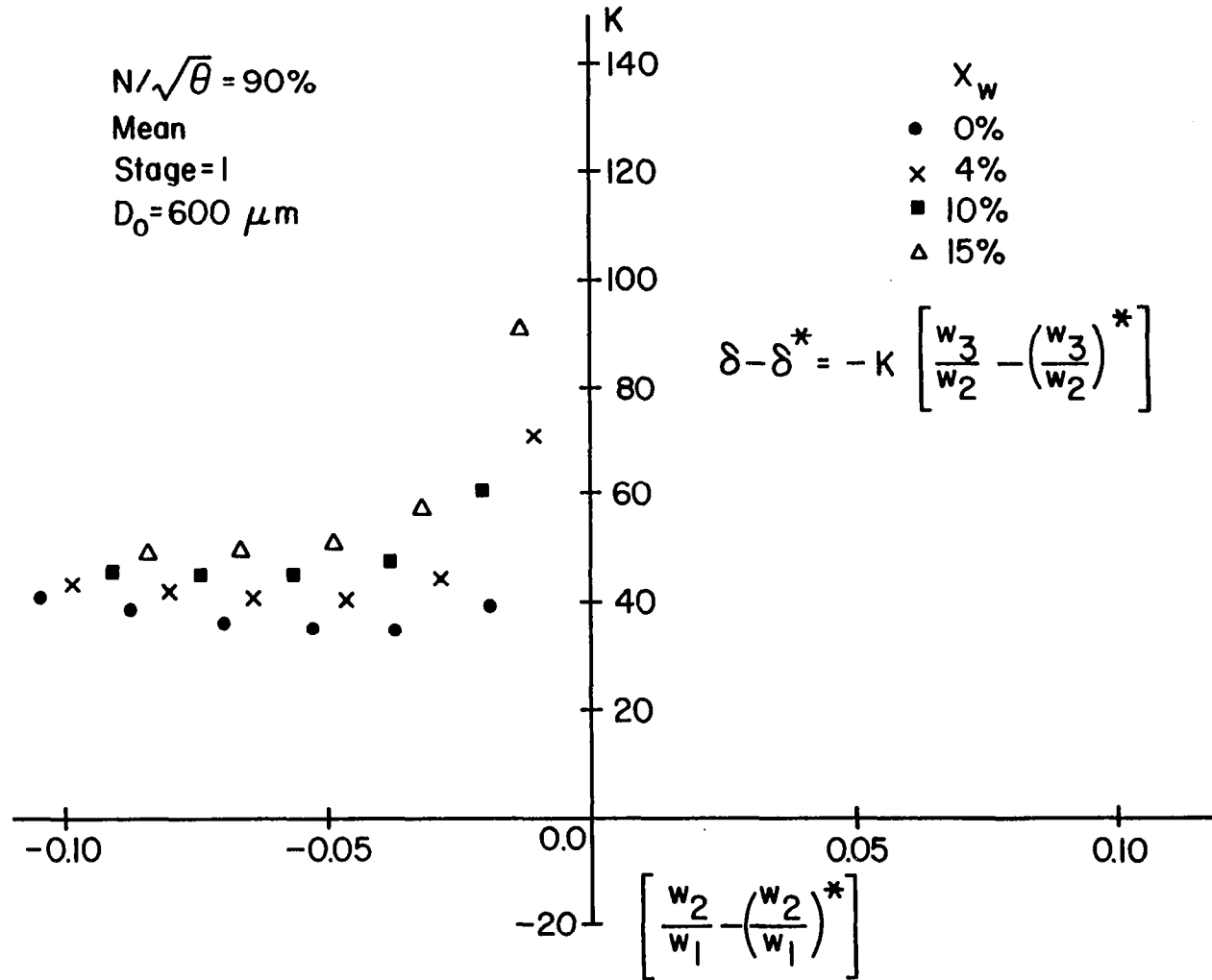


Figure 4(a): Deviation Constant vs Diffusion (Stage = 1)

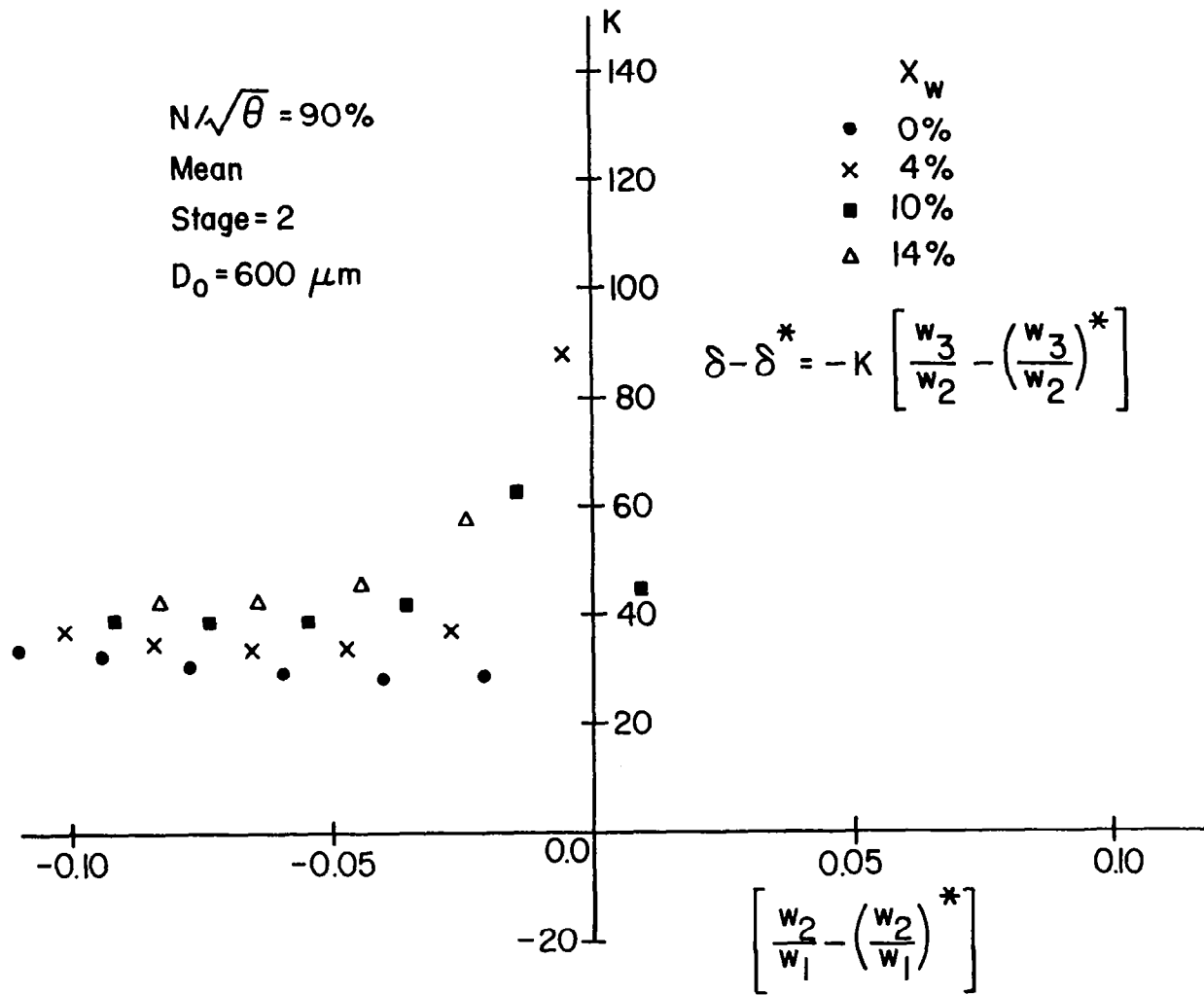


Figure 4(b): Deviation Constant vs Diffusion (Stage = 2)

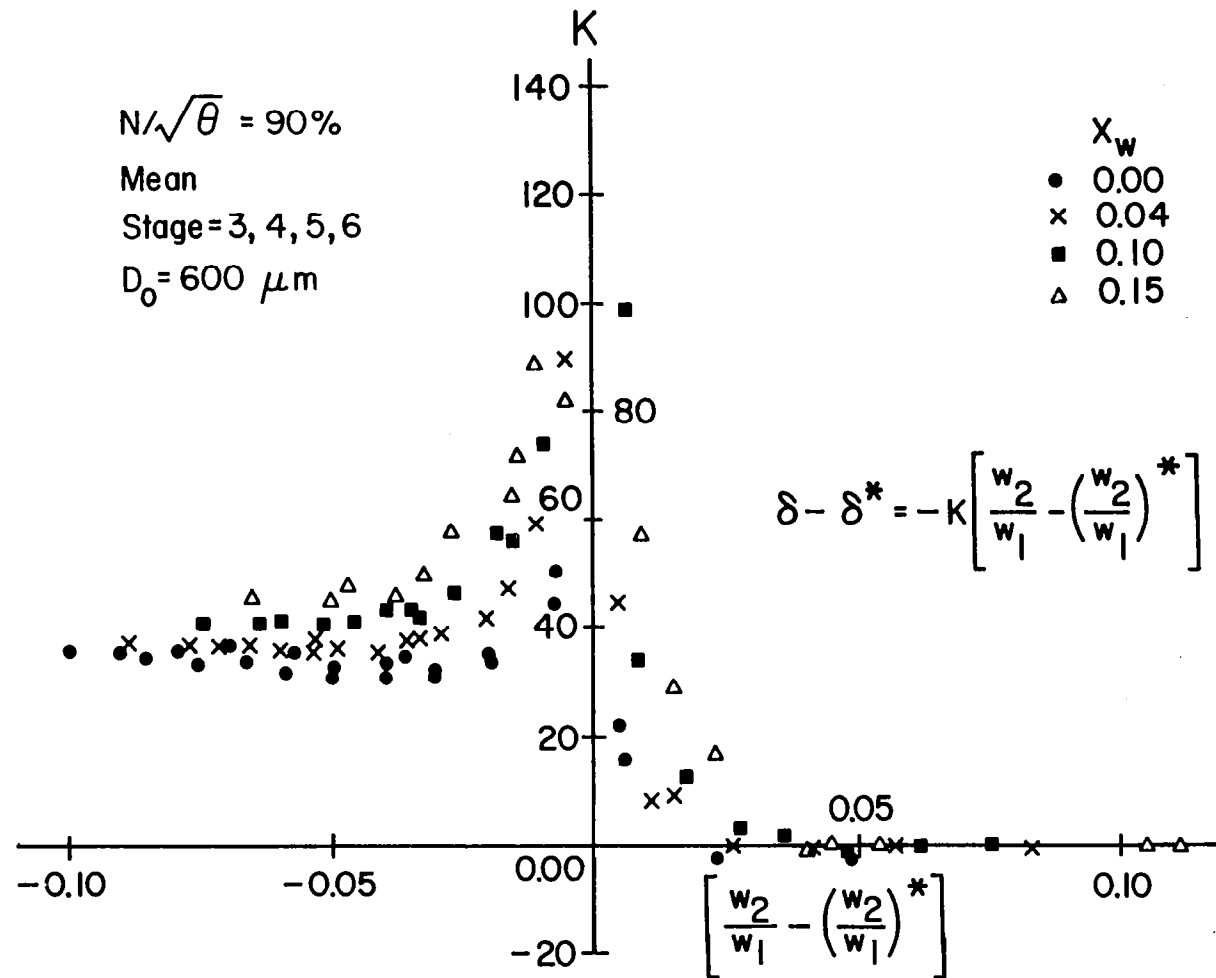


Figure 4(c): Deviation Constant vs Diffusion (Stage = 3-6)

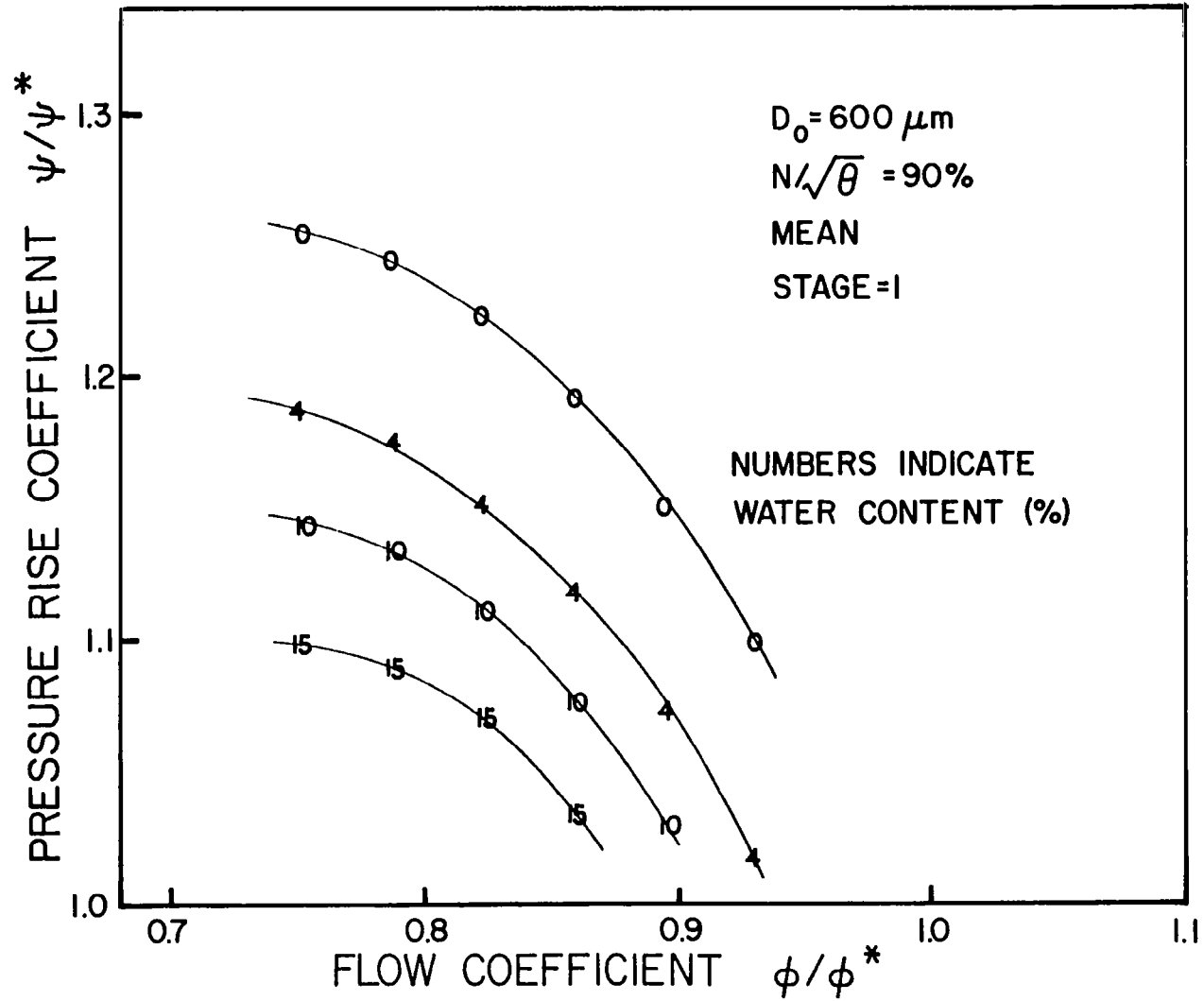


Figure 5(a): Pressure-Rise Coefficient vs Flow Coefficient (Stage = 1)

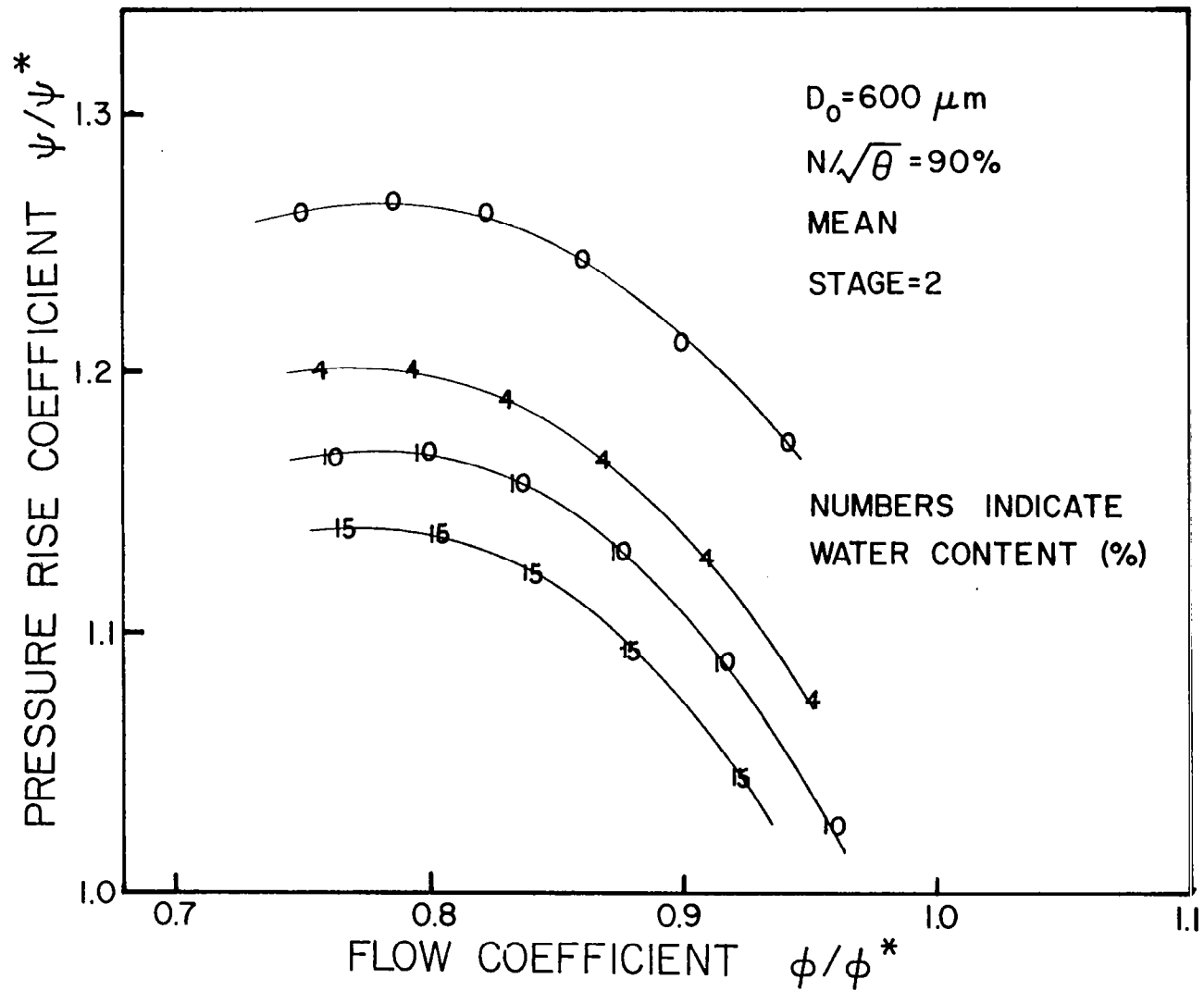


Figure 5(b): Pressure-Rise Coefficient vs Flow Coefficient (Stage = 2)

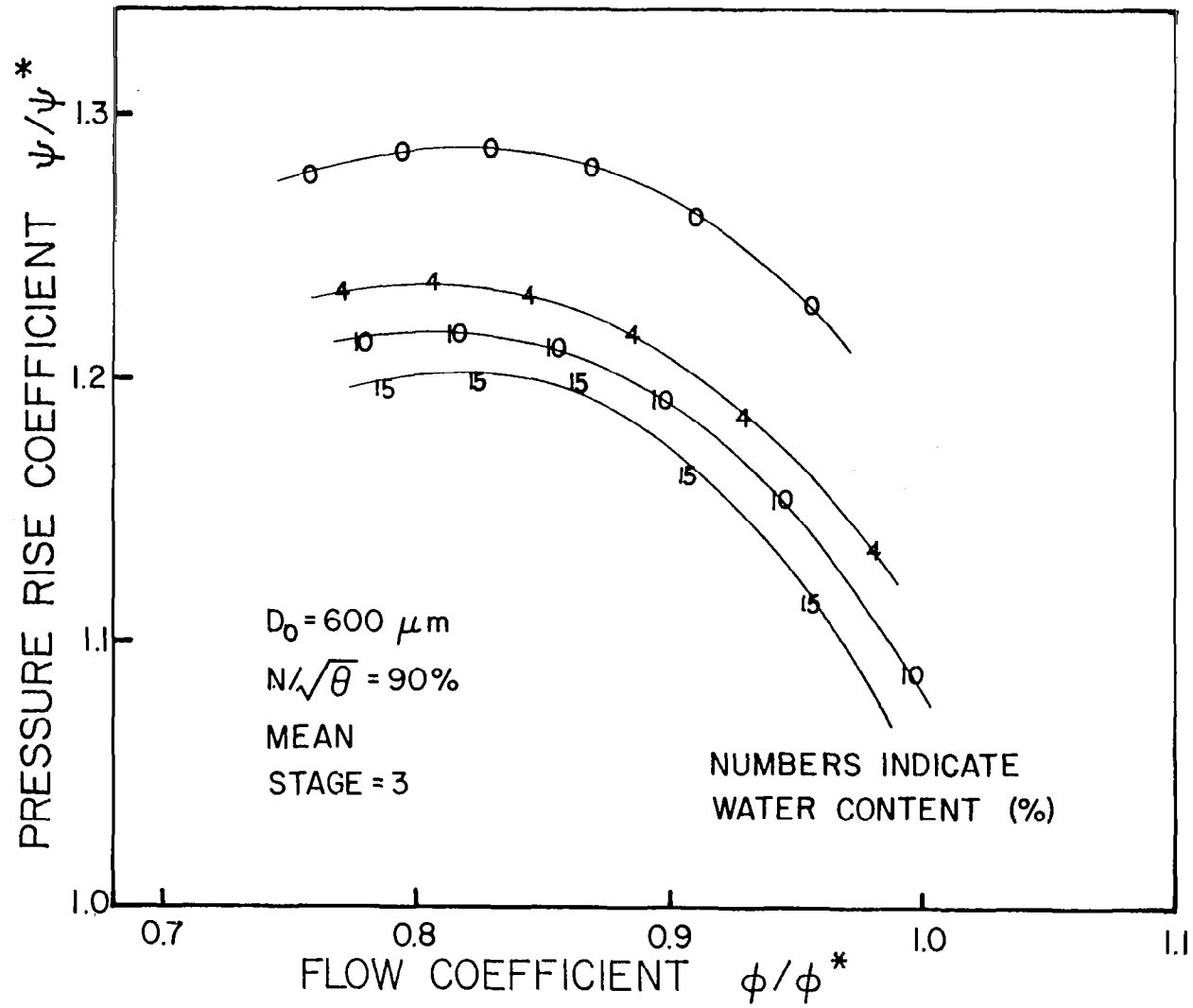


Figure 5(c): Pressure-Rise Coefficient vs Flow Coefficient (Stage = 3)

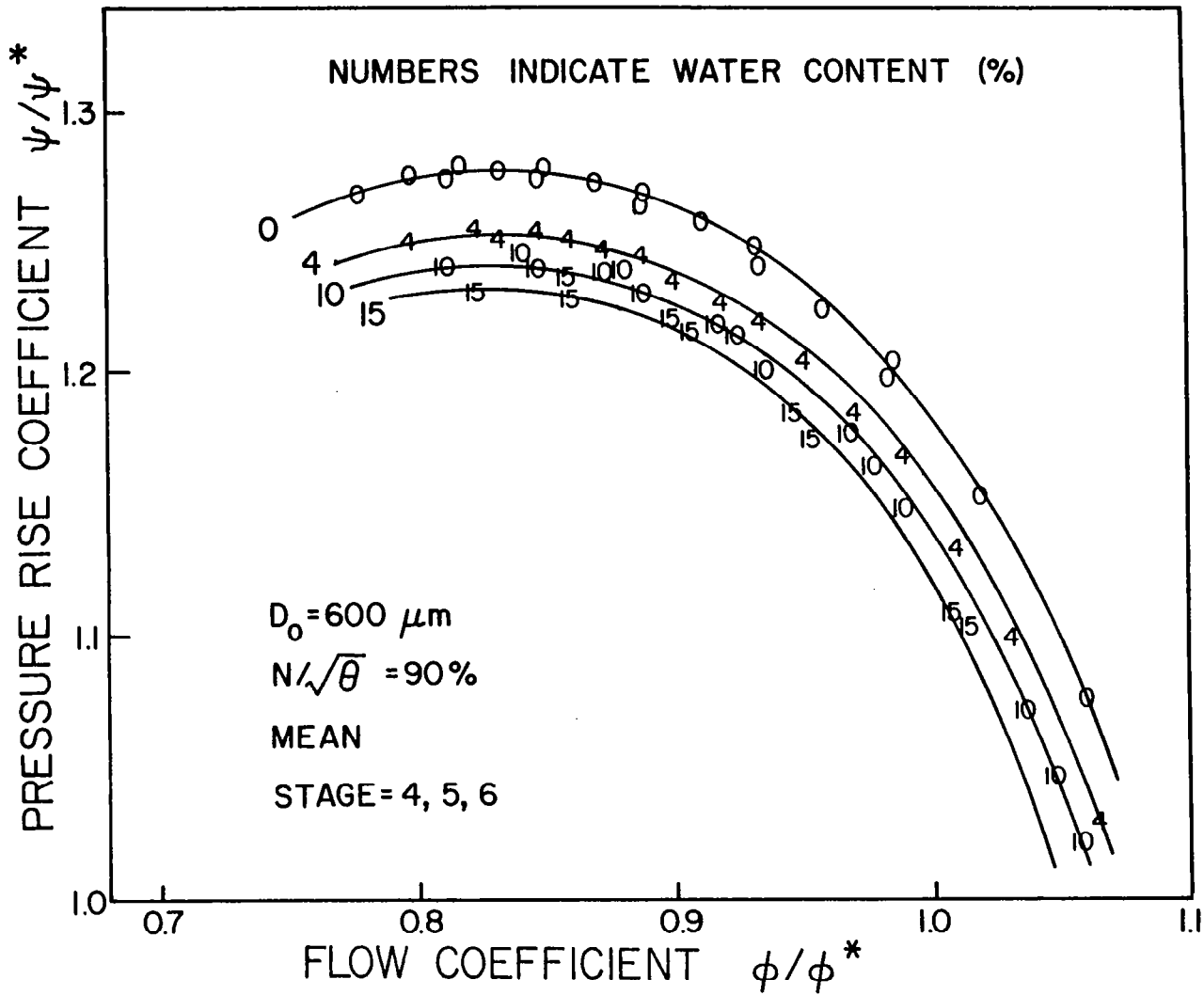


Figure 5(d): Pressure-Rise Coefficient vs Flow Coefficient (Stage = 4-6)

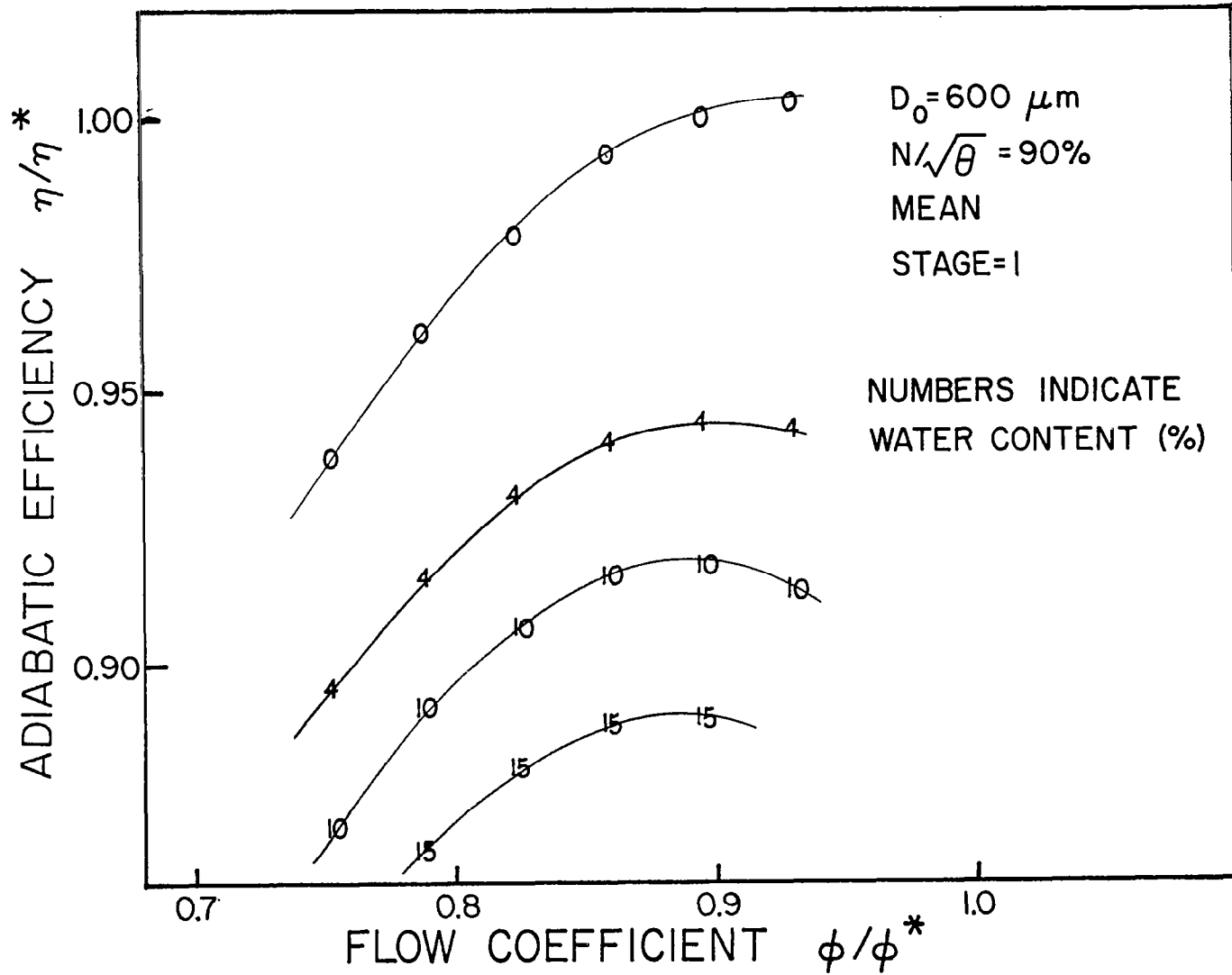


Figure 6(a): Efficiency vs Flow Coefficient (Stage = 1)

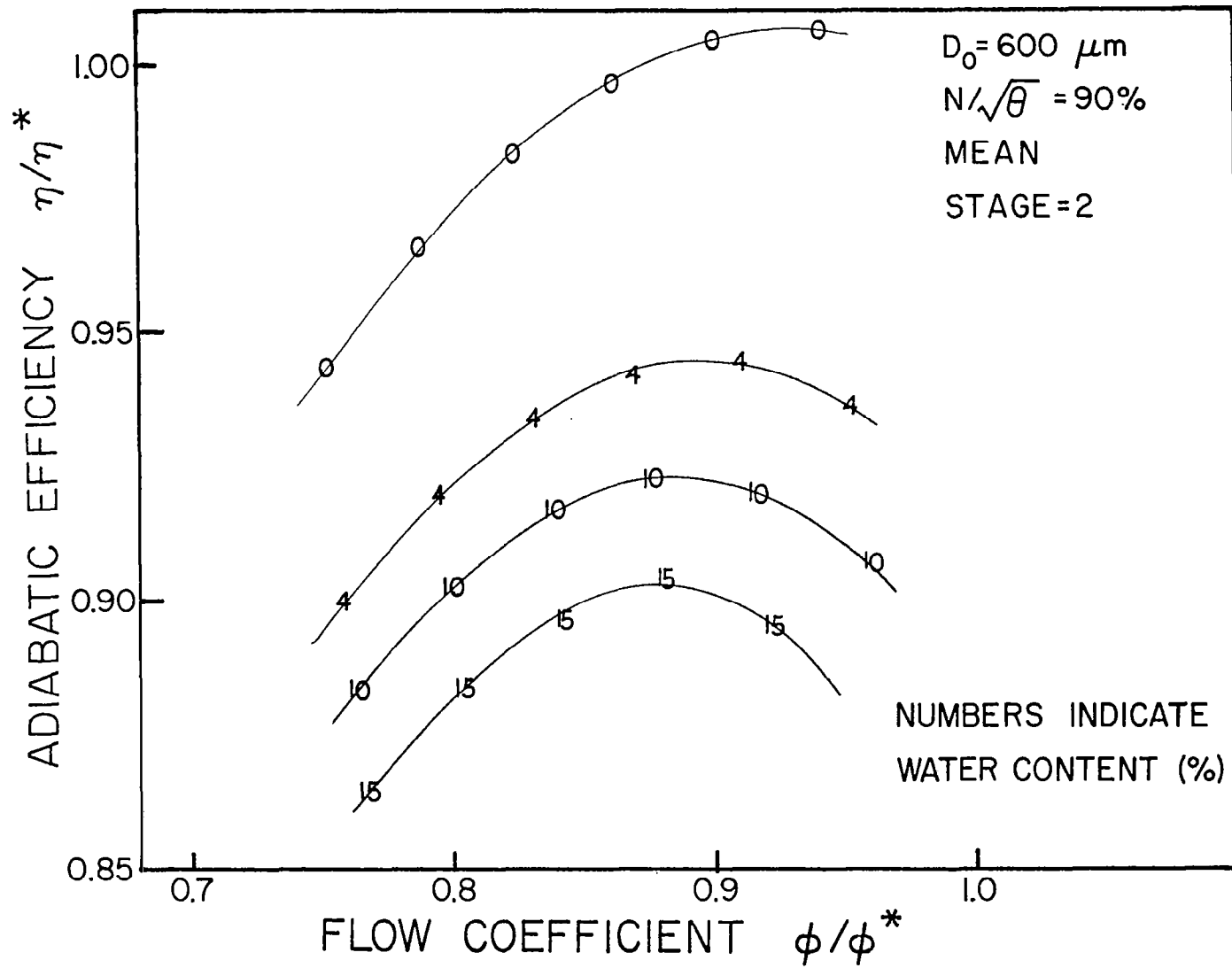


Figure 6(b): Efficiency vs Flow Coefficient (Stage = 2)

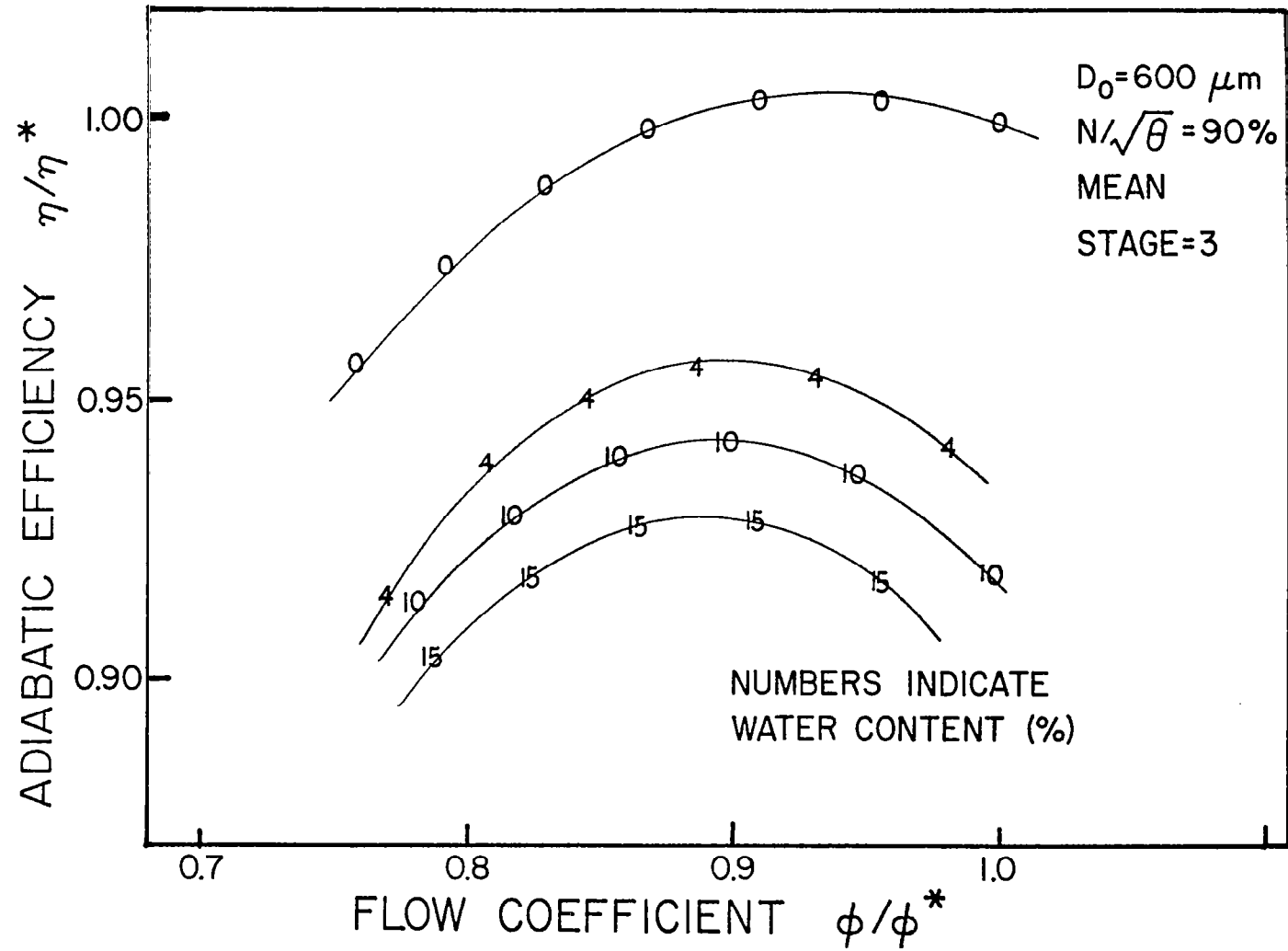


Figure 6(c): Efficiency vs Flow Coefficient (Stage = 3)

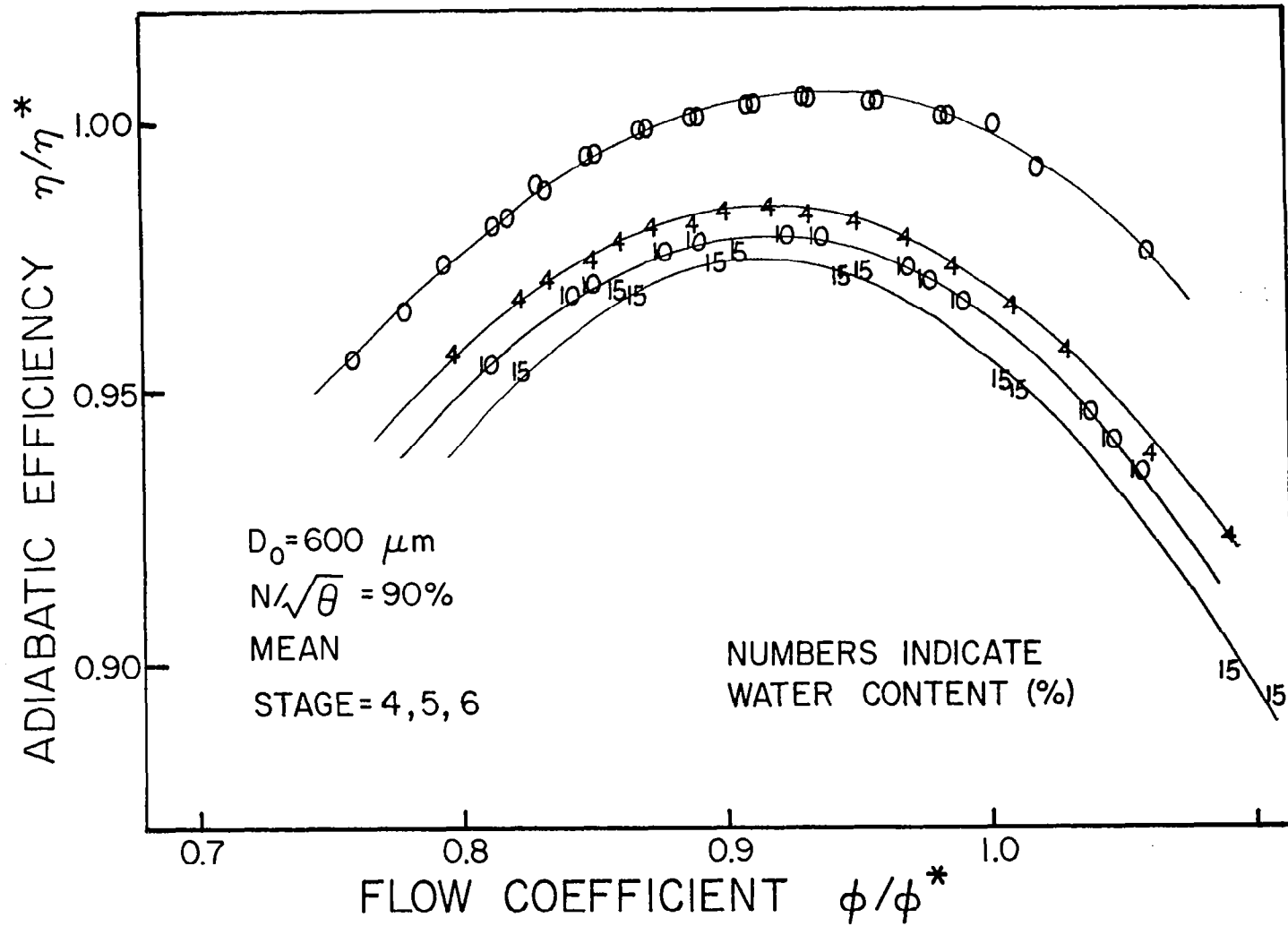


Figure 6(d): Efficiency vs Flow Coefficient (Stage = 4-6)

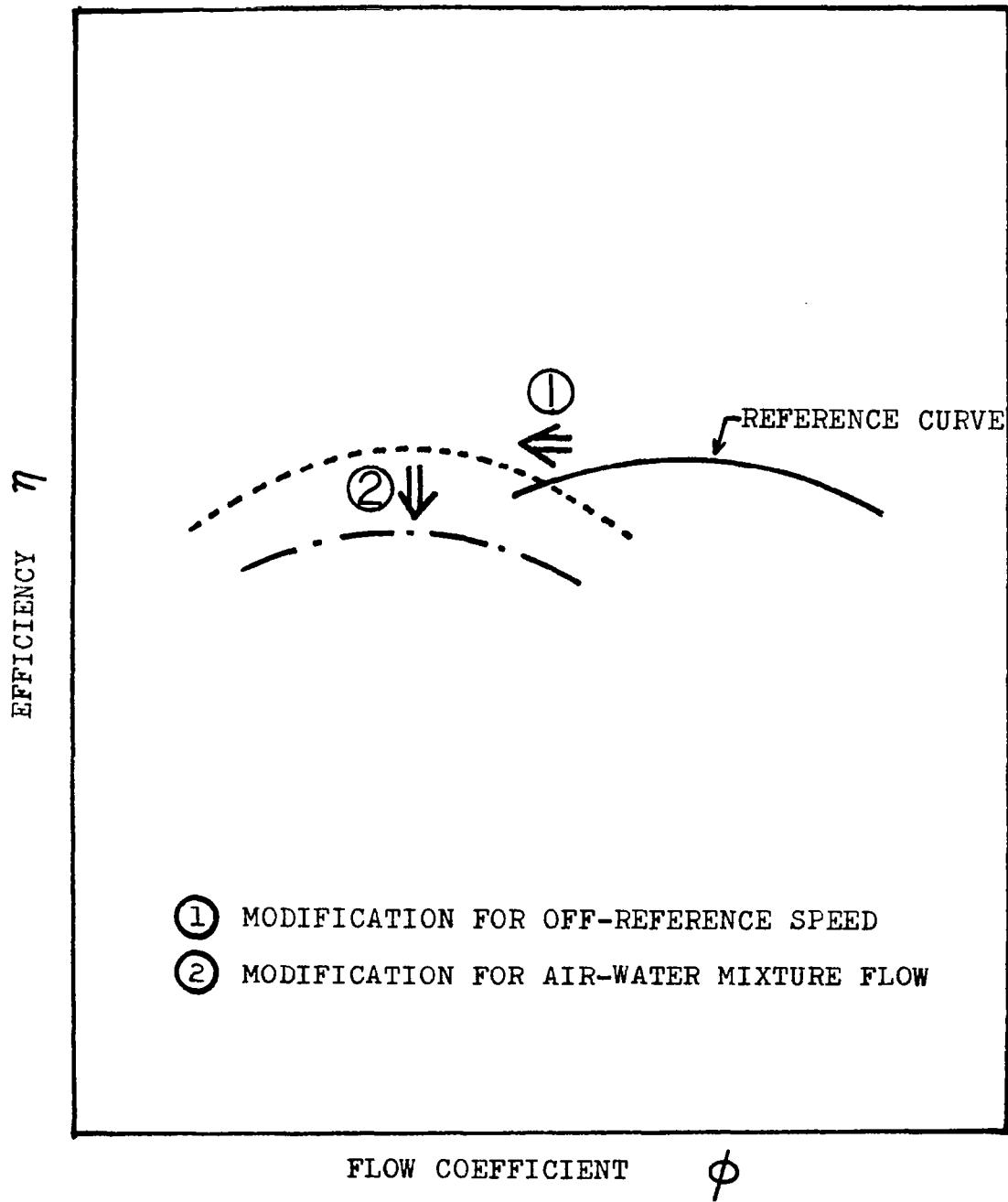


Figure 7: Modification of Reference Efficiency Curve

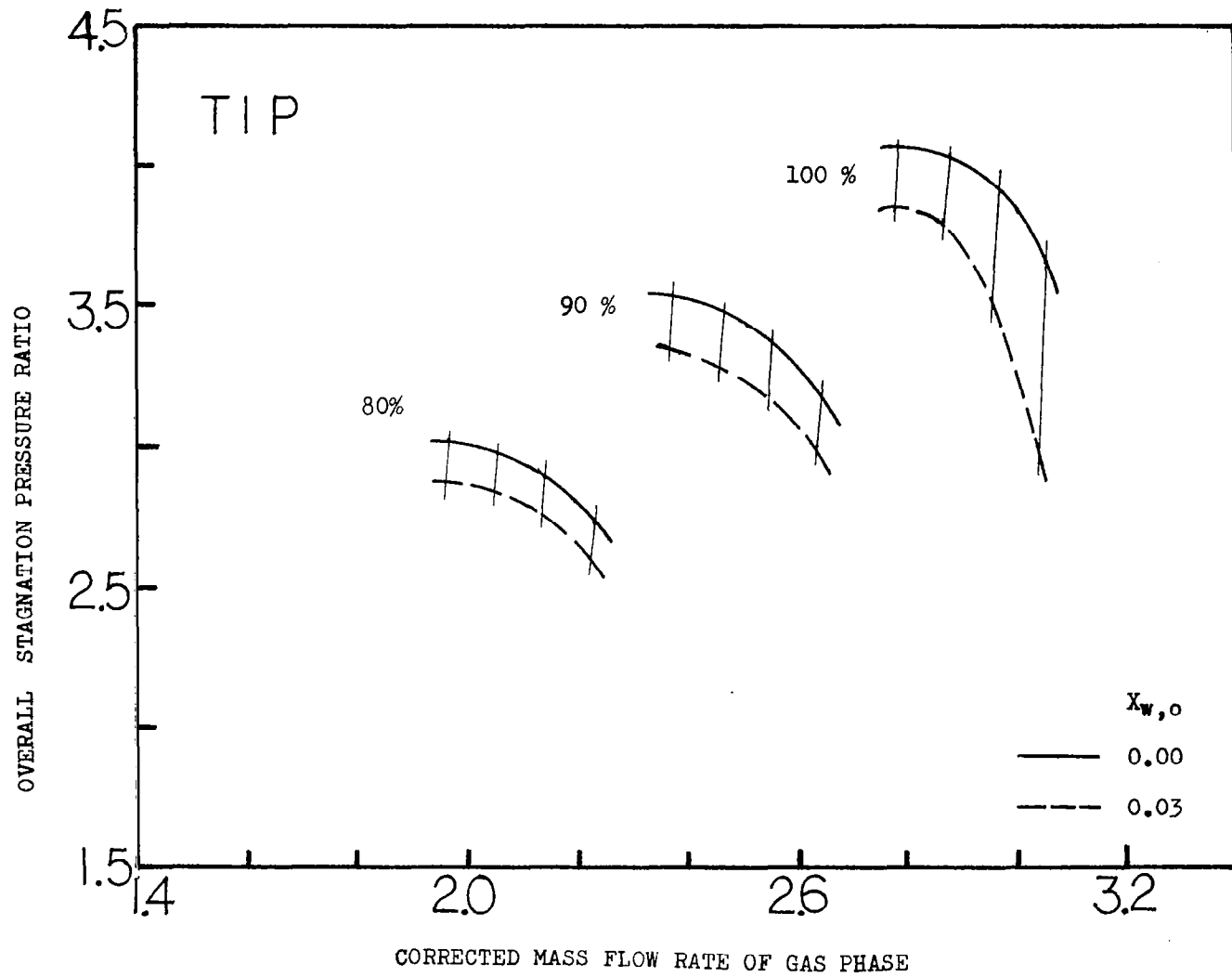


Figure 8(a): Predicted Overall Stagnation Pressure Ratio as a Function of Gas Phase Corrected Mass Flow Rate at Tip Section

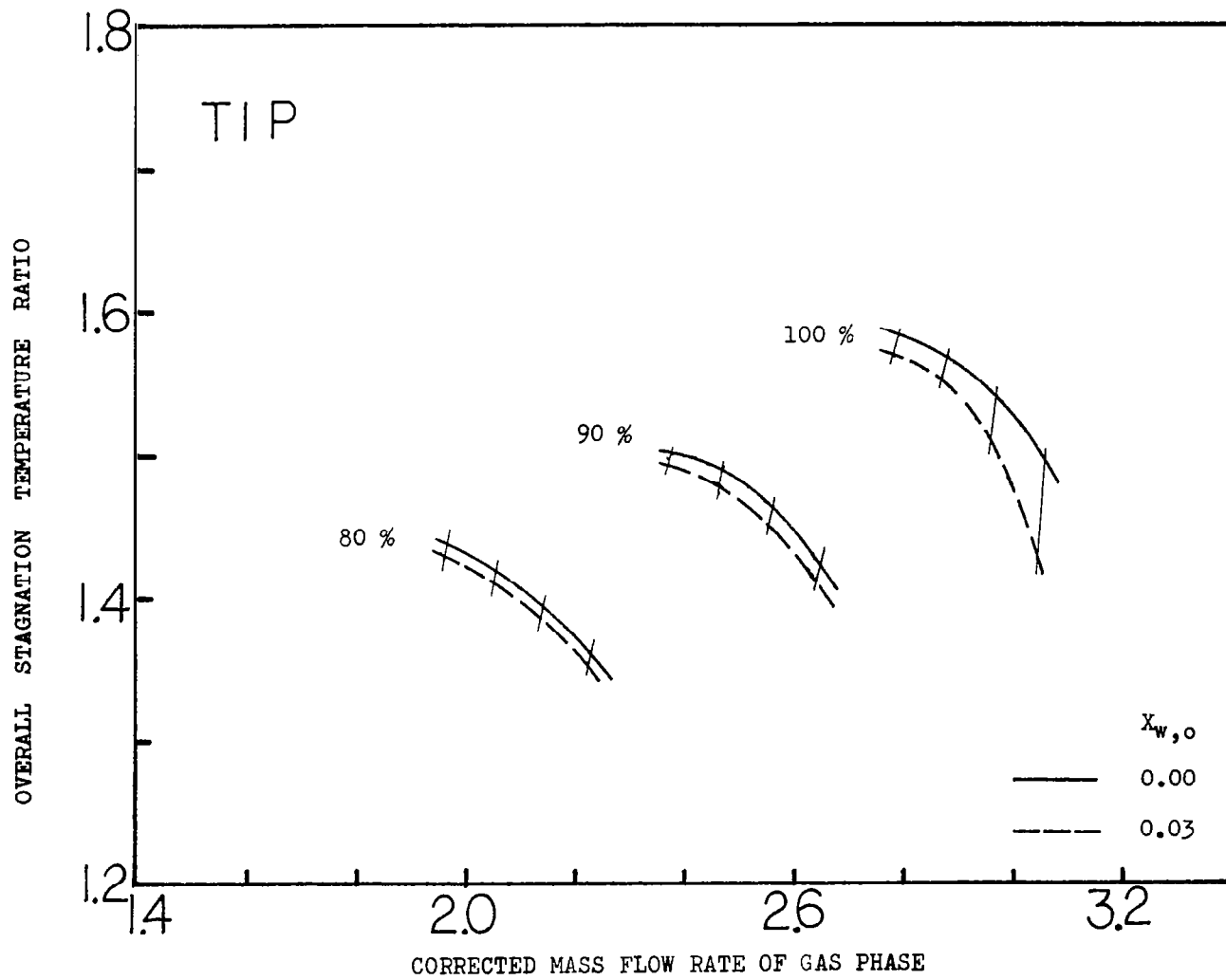


Figure 8(b): Predicted Overall Stagnation Temperature Ratio as a Function of Gas Phase Corrected Mass Flow Rate at Tip Section

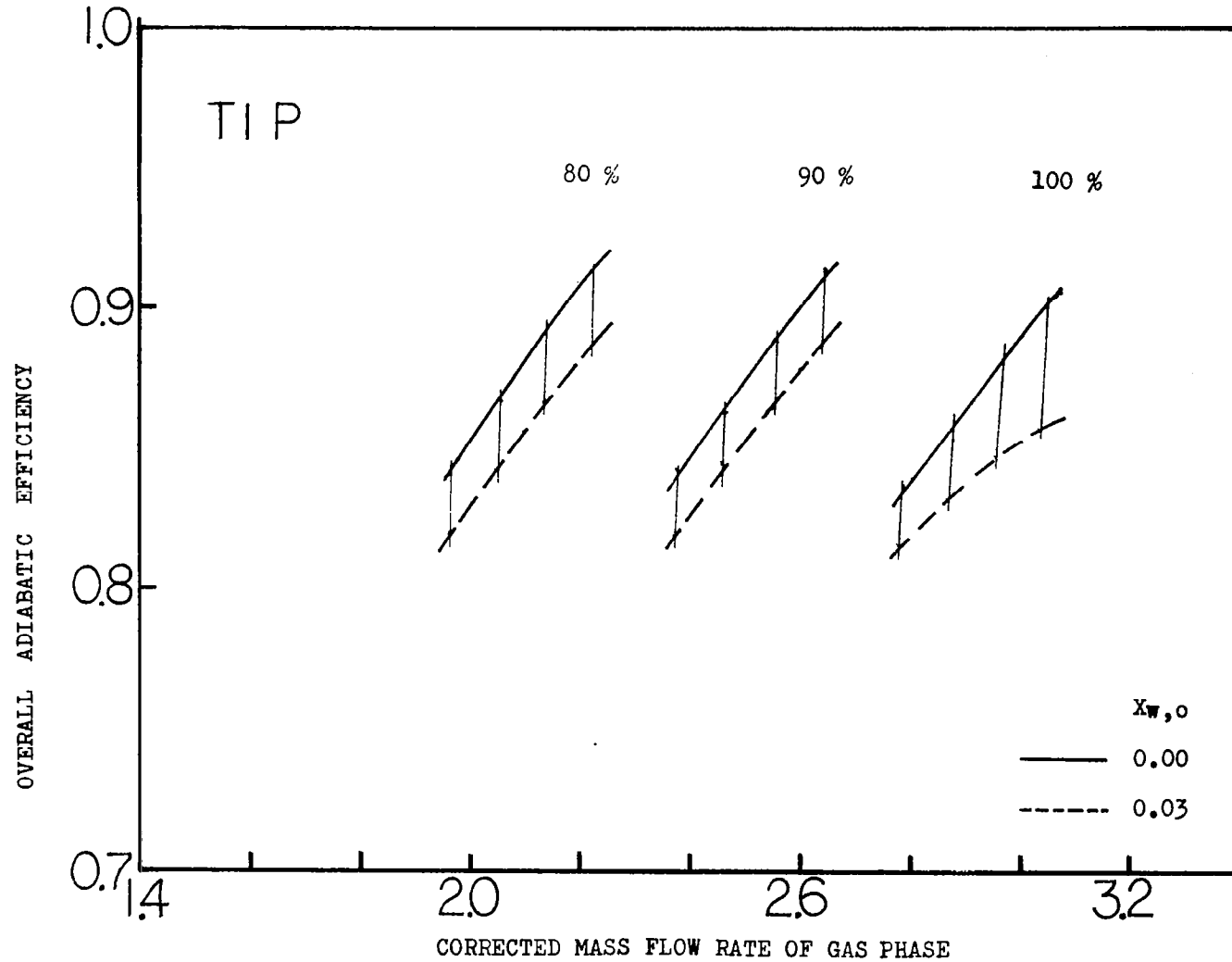


Figure 8(c): Predicted Overall Adiabatic Efficiency as a Function of Gas Phase Corrected Mass Flow at Tip Section

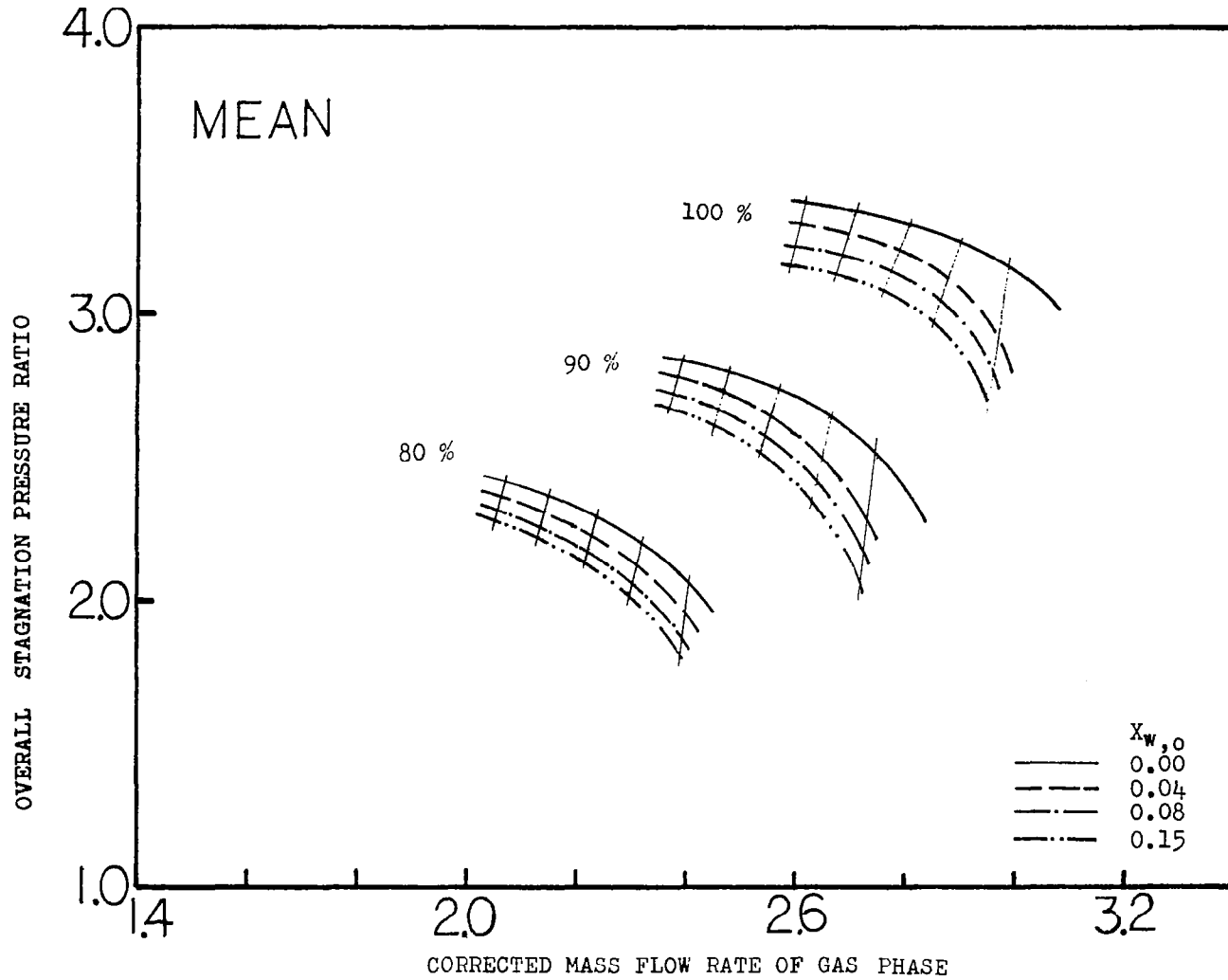


Figure 9(a): Predicted Overall Stagnation Pressure Ratio as a Function of Gas Phase Corrected Mass Flow Rate at Mean Section

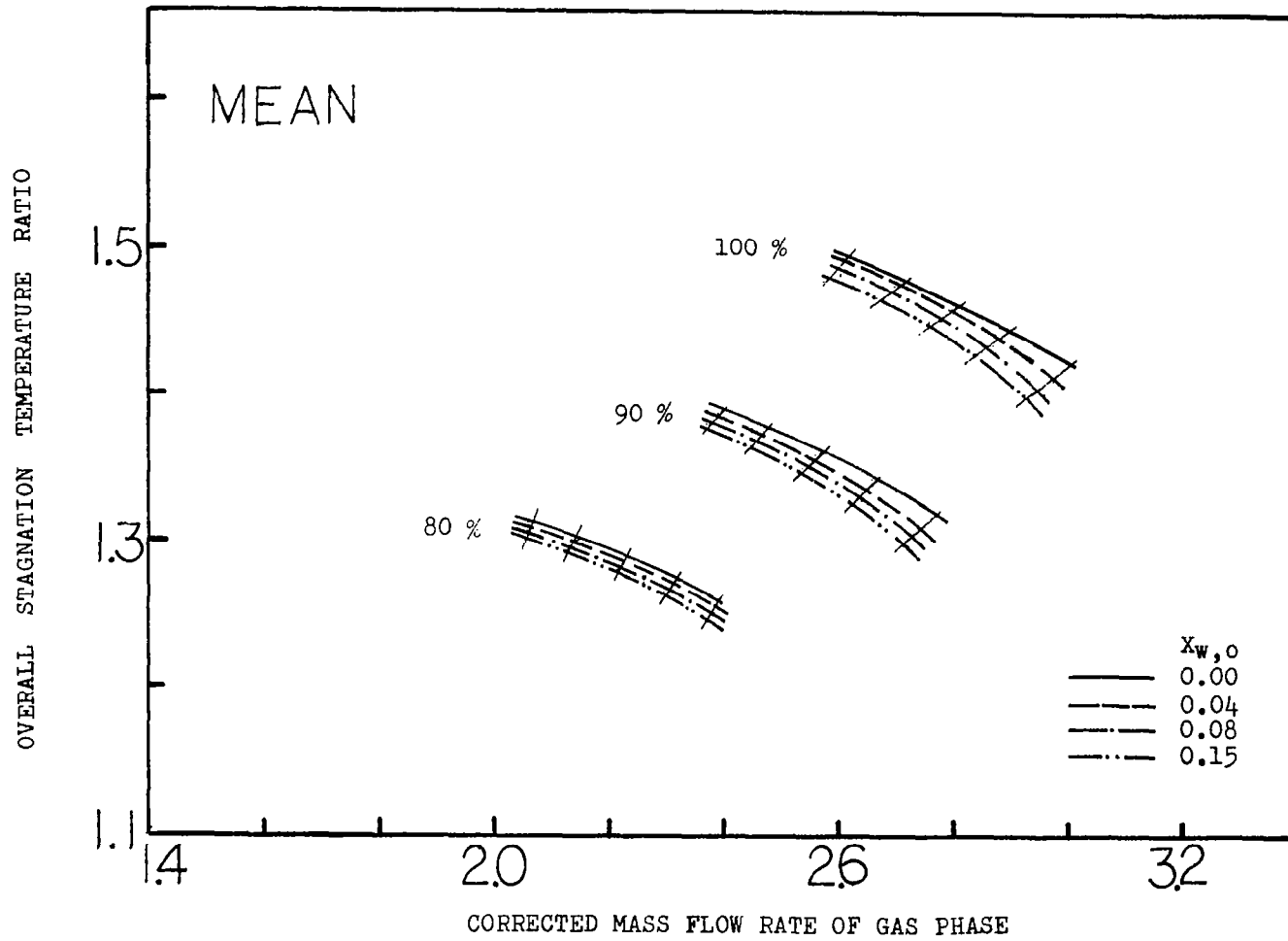


Figure 9(b): Predicted Overall Stagnation Temperature Ratio as a Function of Gas Phase Corrected Mass Flow Rate at Mean Section

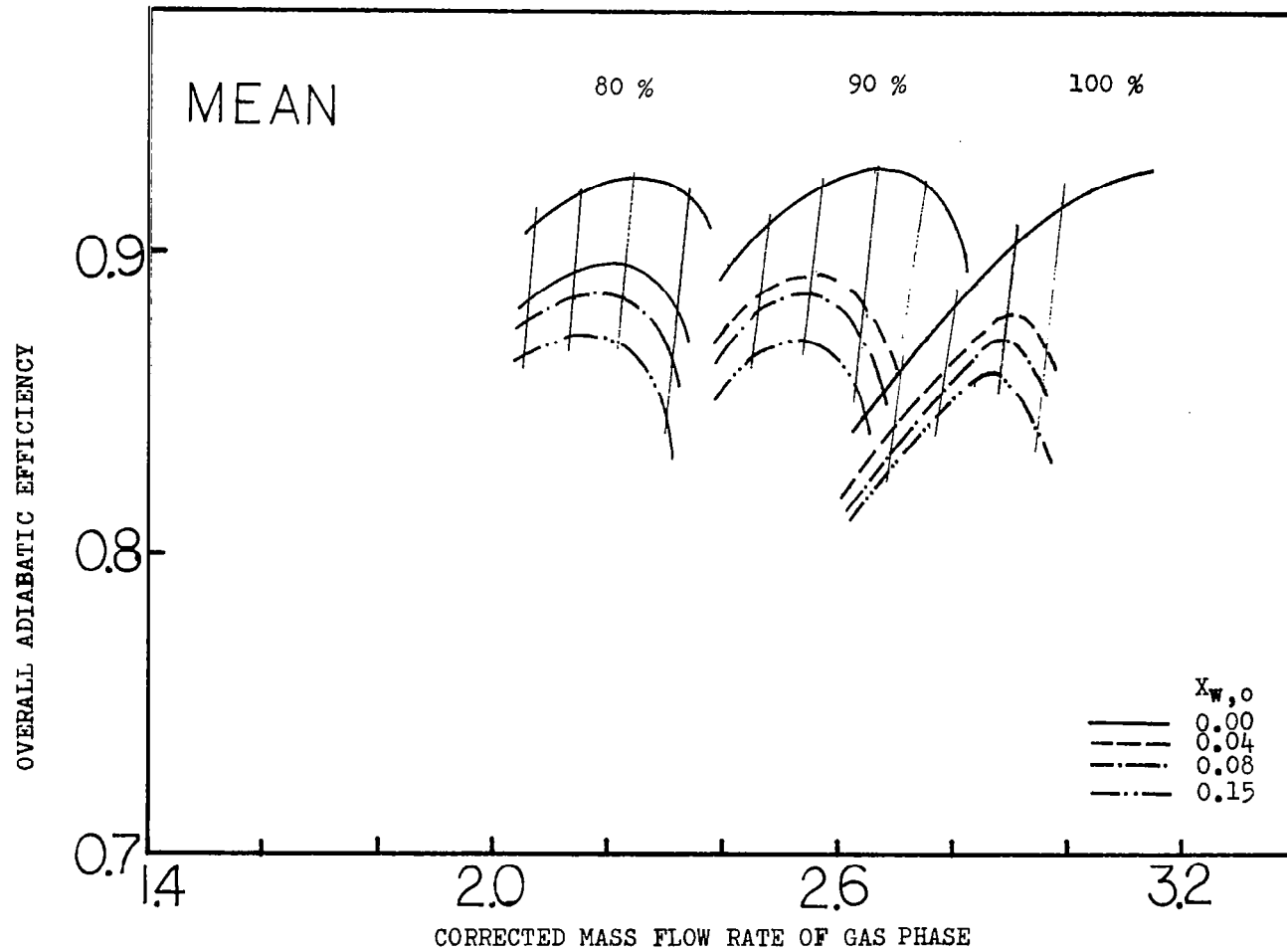


Figure 9(c): Predicted Overall Adiabatic Efficiency as a Function of Gas Phase Corrected Mass Flow Rate at Mean Section

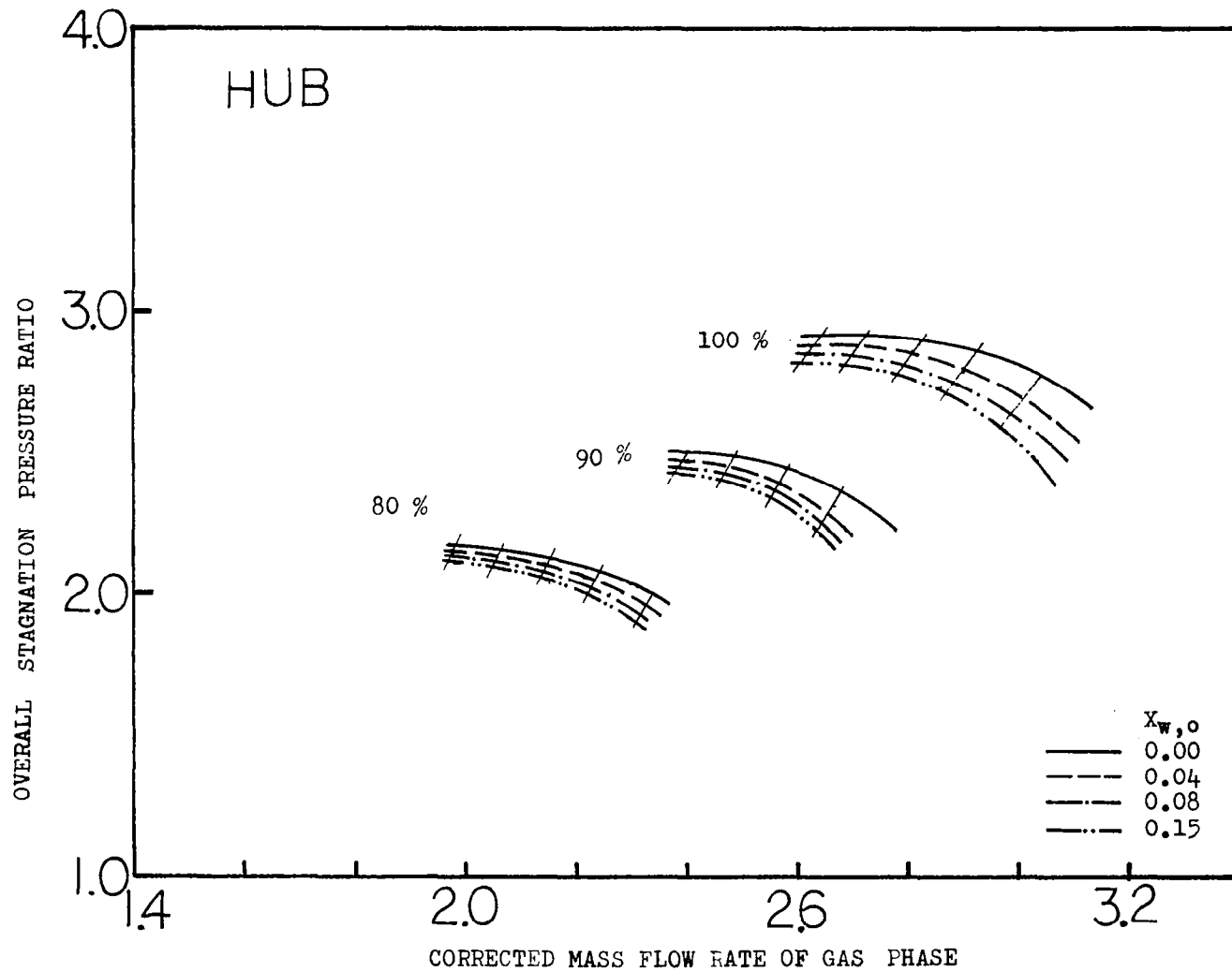


Figure 10(a): Predicted Overall Stagnation Pressure Ratio as a Function of Gas Phase Corrected Mass Flow Rate at Hub Section

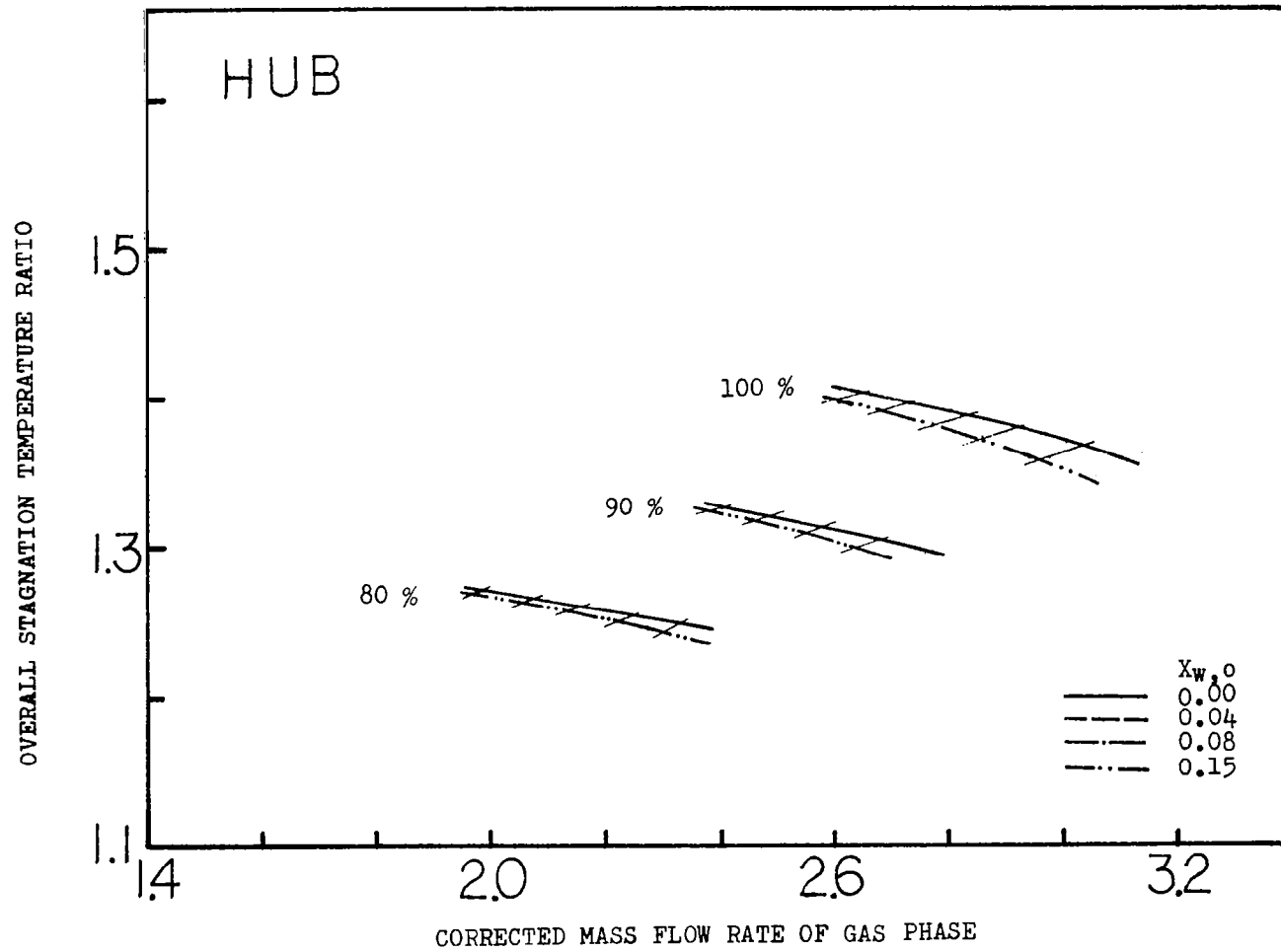


Figure 10(b): Predicted Overall Stagnation Temperature Ratio as a Function of Gas Phase Corrected Mass Flow Rate at Hub Section

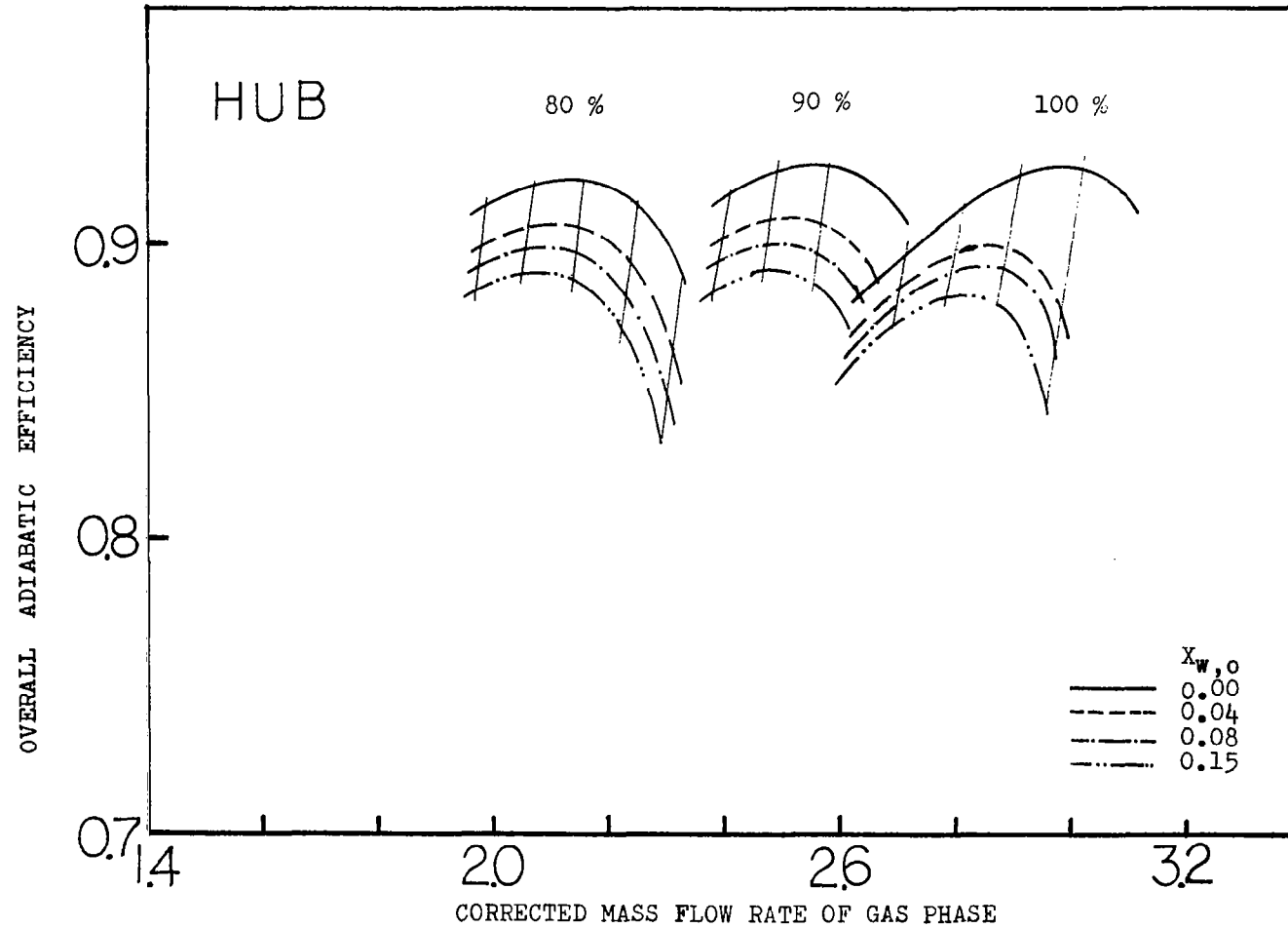


Figure 10(c): Predicted Overall Adiabatic Efficiency as a Function of Gas Phase Corrected Mass Flow Rate at Hub Section

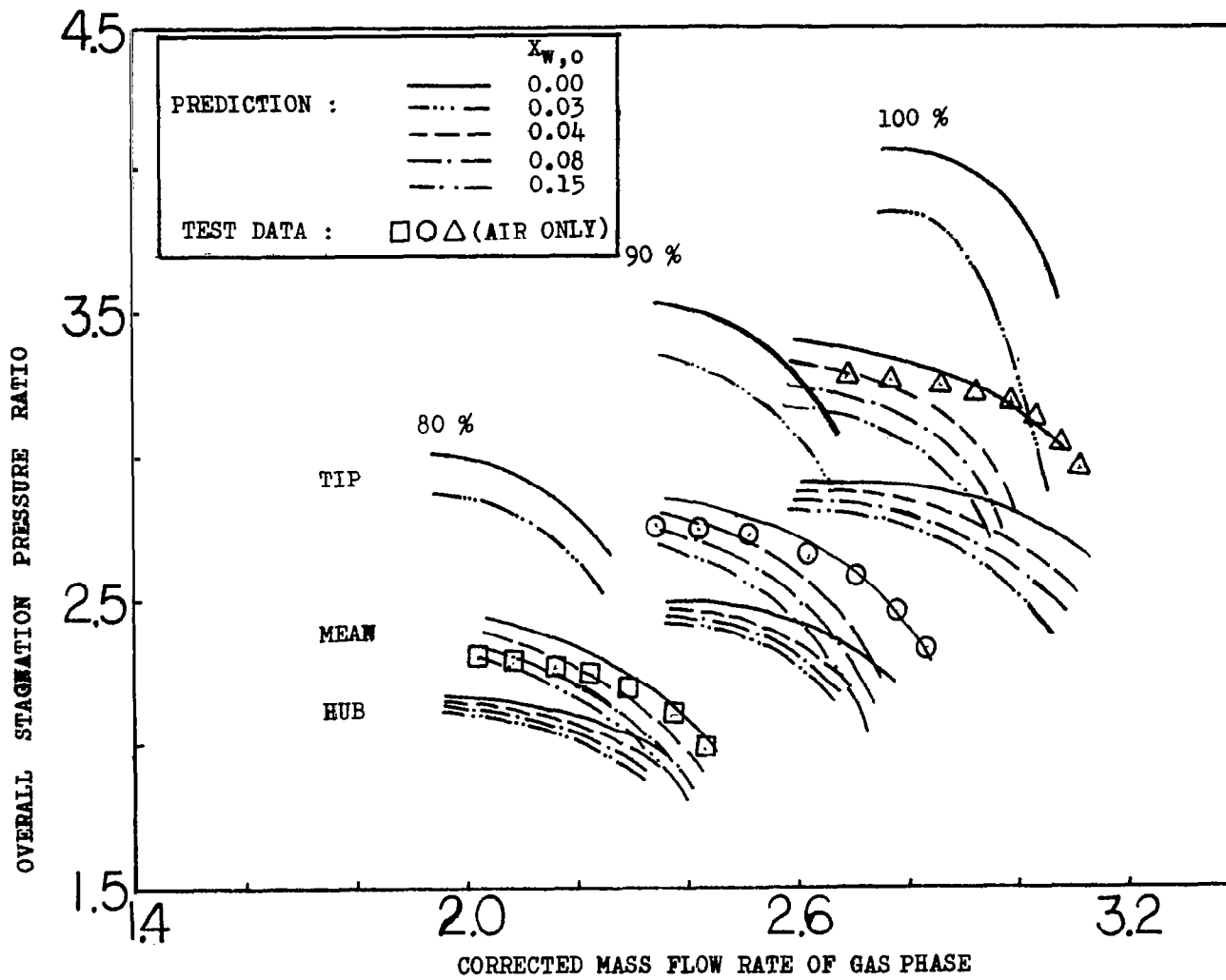


Figure 11(a): Overall Stagnation Pressure Ratio vs Gas Phase Corrected Mass Flow Rate ($N/\sqrt{\theta} = 80, 90, 100\%$, and Test Data)

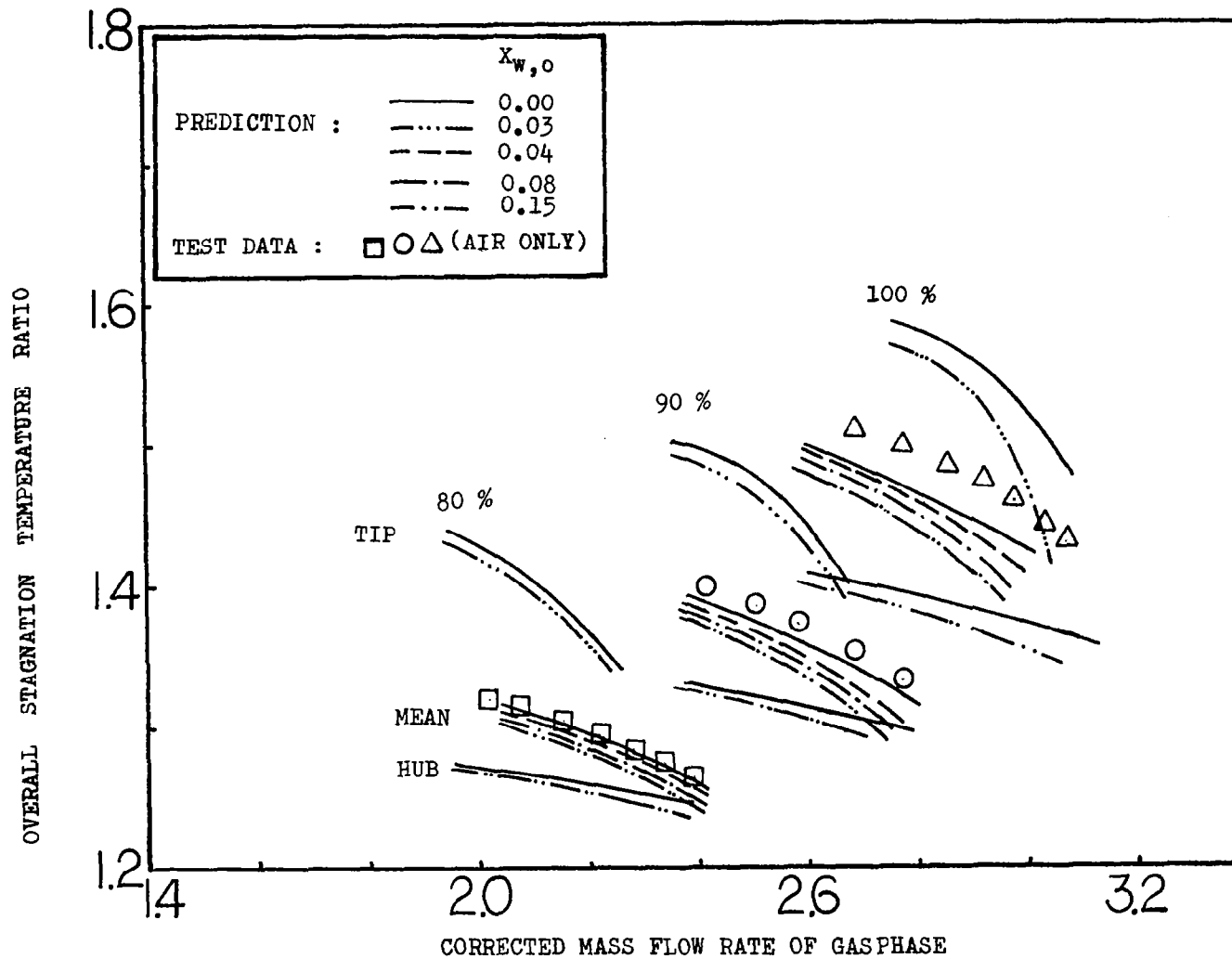


Figure 11(b): Overall Stagnation Temperature Ratio vs Gas Phase Corrected Mass Flow Rate ($N/\sqrt{\theta} = 80, 90, 100\%$ and Test Data)

REFERENCES

1. (a) "Concorde Complete Flooded Runway Tests," Aviation Week and Space Technology, p. 22, October 4, 1971.
- (b) "Board Assays Crash of DC-9 in Storm," Ibid, pp. 63-67, July 24, 1978.
- (c) "Storm Traced in Southern DC-9 Crash," Ibid, pp. 59-61, July 31, 1978.
- (d) "Damage Assessed in Southern Crash," Ibid, pp. 59-63, August 7, 1978.
- (e) "Thrust Loss Cited in Southern Accident," Ibid, pp. 55-58, August 21, 1978.
- (f) "Board Urges Improved Thunderstorm Reporting," Ibid, pp. 63-64, August 28, 1978.
- (g) "NTSB Cites Weather Data in Accident," Ibid, pp. 66-70, July 27, 1981.

2. Willenborg, J.A., et al., "F-111 Engine Water Ingestion Review," F-111 System Program Office, Wright-Patterson Air Force Base, Dayton, Ohio, October 31-November 10, 1972.

3. Steinke, R., "STGSTK - A Computer Code for Predicting Multistage Axial-Flow Compressor Performance Using a Meanline Stage-Stacking Method," NASA TP-2020, April 1982.

4. Tsuchiya, T. and Murthy, S.N.B., "Water Ingestion into Axial Flow Compressors Part I: Analysis and Predictions," Technical Report AFWAL-TR-80-2090, Air Force Systems Command, Wright-Patterson Air Force Base, October 1980.

5. Tsuchiya, T. and Murthy, S.N.B., "Water Ingestion into Axial Flow Compressors Part II: Computer Program" Technical Report AFWAL-TR-80-2090, Air Force Systems Command, Wright-Patterson Air Force Base, December 1980.

6. Murthy, S.N.B., Tsuchiya, T., Ehresman, C.M. and Richards, D., "Water Ingestion into Axial Flow Compressors Part III: Experimental Results and Discussion," Technical Report AFWAL-TR-80-2090, Air Force Systems Command, Wright-Patterson Air Force Base, July 1981.
7. Tsuchiya, T., "Effect of Water Ingestion into Axial Flow Compressors," Ph.D. Dissertation at Purdue University, December 1981.
8. Lieblein, S., "Loss and Stall Analysis of Compressor Cascades," Jr. of Basic Engineering, Transaction of the ASME, September 1959.
9. Swan, W.C., "A Practical Method of Predicting Transonic-Compressor Performance," Jr. of Engineering, Transaction of the ASME, July 1961
10. Collier, J.G. and Wallis, G.B., Two-Phase Flow and Heat Transfer, Vol. II, p. 405, Department of Mechanical Engineering, Stanford University, Stanford, California, 1967.
11. Holman, J.P., Heat Transfer, p. 427, McGraw-Hill, New York, 1976.
12. Zucrow, M.J. and Hoffman, J.D., Gas Dynamics, Vol. 1, pp. 55-57, John Wiley & Sons, New York, 1976.

APPENDIX 1

DETAILS OF COMPRESSOR USED FOR DEMONSTRATION OF CODE

The compressor utilized for demonstrating the application of the NASA-WISGSK Code is the so-called Test Compressor consisting of the six axial-flow stages of the ALLISON T63-A-5 engine compressor. The Test Compressor has been designed and built such that various stages of the compressor can be assembled and tested. Thus the first two, the intermediate two or the last two stages can be tested if desired, as well as the unit with all of the six stages. Only the 6-stage unit has been used in the current tests.

The first stage of the Test Compressor is preceded by an inlet guide vane row which imparts swirl to the inlet air. The relative Mach number of the incoming air at the rotor inlet is thereby reduced as far as permissible without causing inlet blockage. The axial component features unshrouded rotors, cantilever stators, and double circular arc blading in all stages. The values of T-63 compressor design velocity diagram are presented in Table A.1.1. Table A.1.3 and A.1.4 present the hardware geometry and aerodynamic design data for rotor and stator, respectively.

Figure A.1.1. to Figure A.1.6 show the stage performance characteristics of Test Compressor supplied by the manufacturer. In each of the figures, the equivalent pressure ratio, ψ , equivalent temperature ratio, τ , and stage adiabatic efficiency, η , are presented in terms of flow coefficient, ϕ . The definitions of these parameters are as follows:

(i) flow coefficient: ϕ

$$\phi = V_z / U_{tip}$$

(ii) equivalent pressure ratio: ψ

$$\psi = \left[\left(\frac{U_{tip}^2}{T_{01}} \right)_D \left(\frac{T_{01}}{U_{tip}^2} \right) \left[\left(\frac{P_{02}}{P_{01}} \right)^{\frac{\gamma-1}{\gamma}} - 1 \right] + 1 \right]^{\frac{\gamma}{\gamma-1}}$$

(iii) equivalent temperature ratio:

$$\tau = \left(\frac{U_{\text{tip}}}{T_{01}}\right)_D^2 \cdot \left(\frac{\Delta T_0}{U_{\text{tip}}^2}\right)$$

(iv) stage adiabatic efficiency:

$$\eta = T_{01} \left[\left(\frac{P_{02}}{P_{01}}\right)^{\frac{\gamma-1}{\gamma}} - 1 \right] \frac{1}{\Delta T_0} = \left(\psi \frac{\gamma-1}{\gamma} - 1\right) / \tau$$

where ΔT_0 is stage total temperature rise, P_0 total pressure, T_0 total temperatures, V_z axial velocity, U_{tip} blade tip wheel speed, γ specific heat ratio. The subscripts 1 and 2 mean inlet and outlet, respectively, and D design value.

Figure A.1.7 shows overall performance characteristics of Test Compressor supplied by the manufacturer. The performance parameters are the following:

(1) Corrected mass flow rate = $\frac{m\sqrt{\theta}}{\delta}$

where m = mass flow rate

P_{01} = compressor inlet pressure

T_{01} = compressor inlet temperature

θ = T_{01}/T_{ref}

δ = P_{01}/P_{ref}

$T_{\text{ref}} = 58.7^\circ\text{F} (15.2^\circ\text{C})$

$P_{\text{ref}} = 14.7 \text{ psi} (1.0132 \times 10^5 \text{ N/m}^2)$

(2) Corrected speed = $\frac{N}{\sqrt{\theta}}$

where N = rotor speed (RPM)

(3) Overall total pressure ratio = P_{02}/P_{01}

where P_{01} = compressor inlet total pressure

P_{02} = compressor outlet total pressure

(4) Overall adiabatic efficiency = $\eta = \frac{T_{01}}{\Delta T_0} \left[\left(\frac{P_{02}}{P_{01}}\right)^{\frac{\gamma-1}{\gamma}} - 1 \right]$

where T_{01} = compressor inlet total temperature

ΔT_0 = compressor total temperature rise
 P_{02}/P_{01} = overall total pressure ratio
 γ = ratio of specific heats

TABLE A.1.1.
TEST COMPRESSOR DESIGN VELOCITY DIAGRAM VALUES

Stage	1	2	3	4	5	6	
R	2.161	2.161	2.161	2.161	2.161	2.161	
U	963.5	963.5	963.5	963.5	963.5	963.5	
V_{z1}	508.4	544.1	547.0	554.9	554.1	543.7	
$V_{\theta 1}$	236.5	310.0	365.1	349.3	338.8	333.8	
$W_{\theta 1}$	727.0	653.5	598.4	614.2	624.7	629.9	Rotor Inlet
α_1	25.0	29.7	33.7	32.2	31.6	31.5	
β_1	54.9	50.3	47.6	47.9	48.5	49.3	
M_{1abs}	0.513	0.563	0.578	0.560	0.538	0.512	
M_{1rel}	0.812	0.765	0.713	0.707	0.692	0.658	
V_{z2}	507.0	554.9	551.0	554.5	548.9	544.6	
$V_{\theta 2}$	405.2	501.3	598.8	614.6	625.1	630.3	
$W_{\theta 2}$	558.3	462.2	364.7	348.9	338.4	333.2	Rotor Outlet
α_2	38.6	42.1	47.4	47.9	48.7	49.2	
β_2	47.8	39.8	33.6	32.2	31.7	31.5	
M_{2abs}	0.588	0.665	0.706	0.698	0.680	0.660	
M_{2rel}	0.683	0.643	0.574	0.552	0.528	0.506	

Note: Symbols for Table A.1.1 are provided in Table A.1.2.

TABLE A.1.2

SYMBOLS FOR TEST COMPRESSOR DESIGN VELOCITY DIAGRAM VALUES

R	Radius, inches
U	Rotor speed at R, ft/sec.
V_z	Air axial velocity, ft/sec.
V_θ	Air absolute tangential velocity, ft/sec.
W_θ	Air relative tangential velocity, ft/sec.
α	Air absolute flow angle, degrees
β	Air relative flow angle, degrees
M	Mach number
Subscript	
1	rotor inlet
2	rotor outlet
abs	absolute
rel	relative

TABLE A.1.3
TEST COMPRESSOR DESIGN DATA (ROTOR)

Stage		1	2	3	4	5	6
Radius	R	2.161	2.161	2.161	2.161	2.161	2.161
Chamber Angle	θ	22.6	15.9	18.0	19.7	20.9	22.0
Stagger	γ	46.1	42.3	36.5	36.1	36.0	36.3
Incidence	i	0.0	2.0	2.0	2.0	2.0	2.0
Deviation	δ	7.3	5.4	6.0	6.0	6.1	6.2
Chord	c	0.605	0.554	0.534	0.510	0.483	0.456
Solidity	σ	0.713	0.815	0.787	0.941	0.997	1.075
Max. Thickness	t	0.036	0.039	0.037	0.036	0.034	0.032
Thickness-Chord Ratio	t/c	0.060	0.070	0.070	0.070	0.070	0.070
No. of Blades	n	16	20	20	25	28	32

Note: R, c, t in (inches) and θ , γ , δ , i in (degrees)

TABLE A.1.4
TEST COMPRESSOR DESIGN DATA (STRATOR)

Stage	IGV	1	2	3	4	5	6
Radius	R	2.161	2.161	2.161	2.161	2.161	2.161
Camber Angle	θ	31.7	22.4	25.6	26.2	24.4	24.7
Stagger	γ	-15.9	31.3	36.3	36.6	36.8	37.4
Incidence	i	0.0	-2.0	-2.0	-2.0	-2.0	-2.0
Deviation	δ	6.7	9.6	5.2	8.0	7.9	7.5
Chord	c	1.395	0.442	0.412	0.412	0.412	0.412
Solidity	σ	0.719	0.456	0.789	0.850	0.972	1.093
Max. Thickness	t	0.170	0.040	0.025	0.025	0.025	0.025
Thickness-Chord Ratio	t/c	0.122	0.09	0.06	0.06	0.06	0.06
No. of Blades	n	7	14	26	28	32	36

Note: R, c, t in (inches) and θ , γ , δ , i in (degrees)

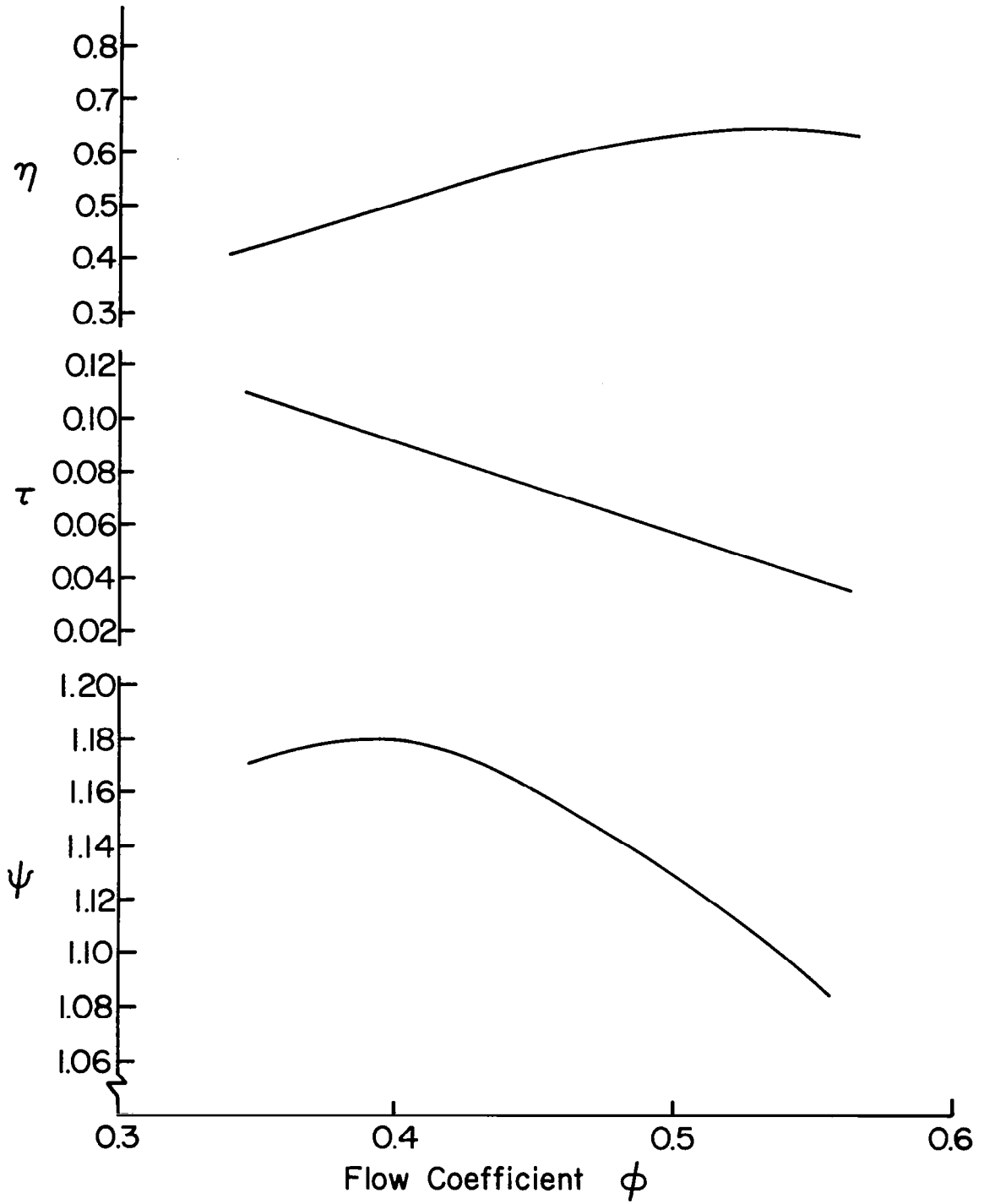


Figure A.1.1 Stage Characteristics of Test Compressor (1st Stage)

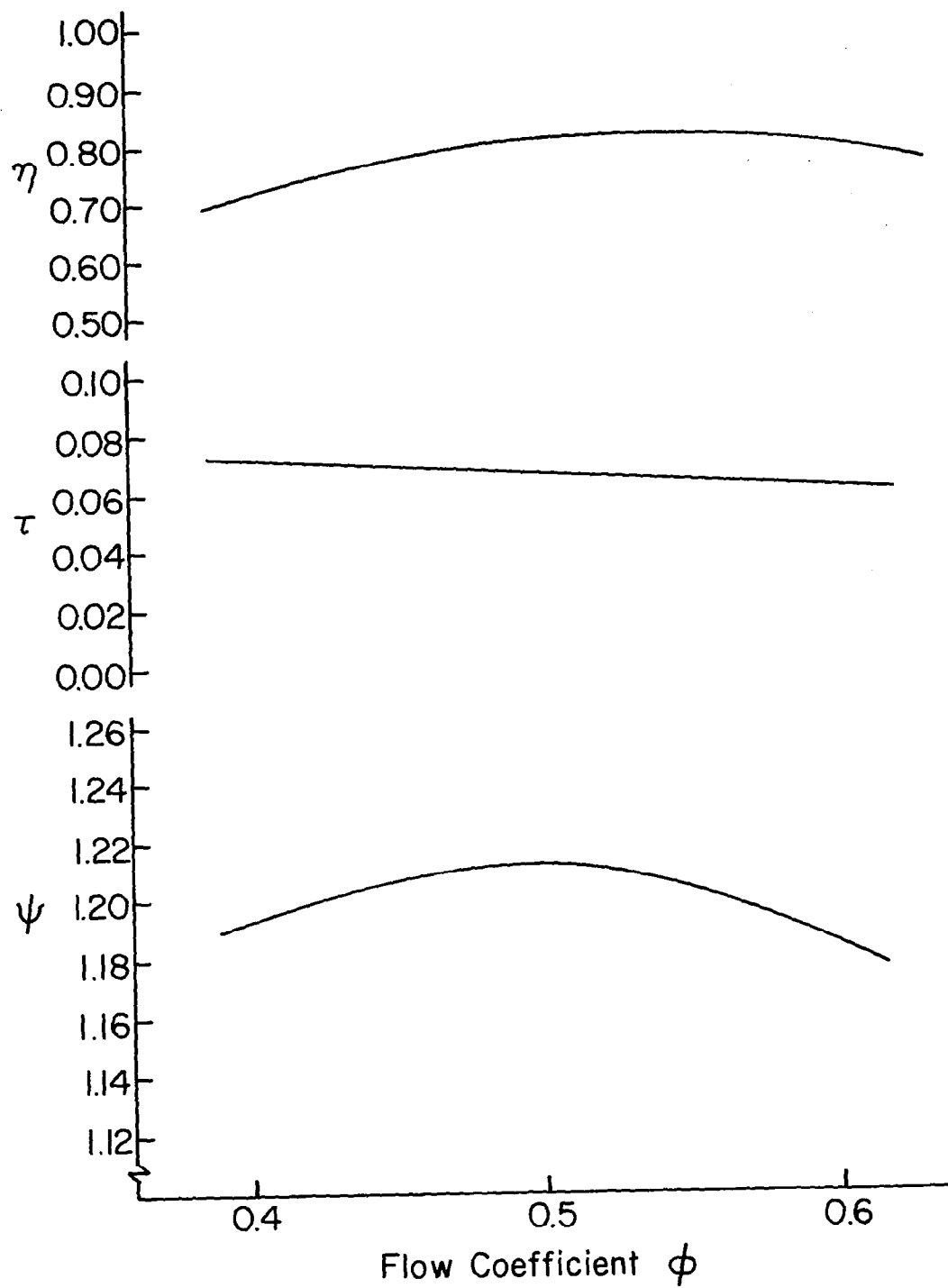


Figure A.1.2 Stage Characteristics of Test Compressor (2nd Stage)

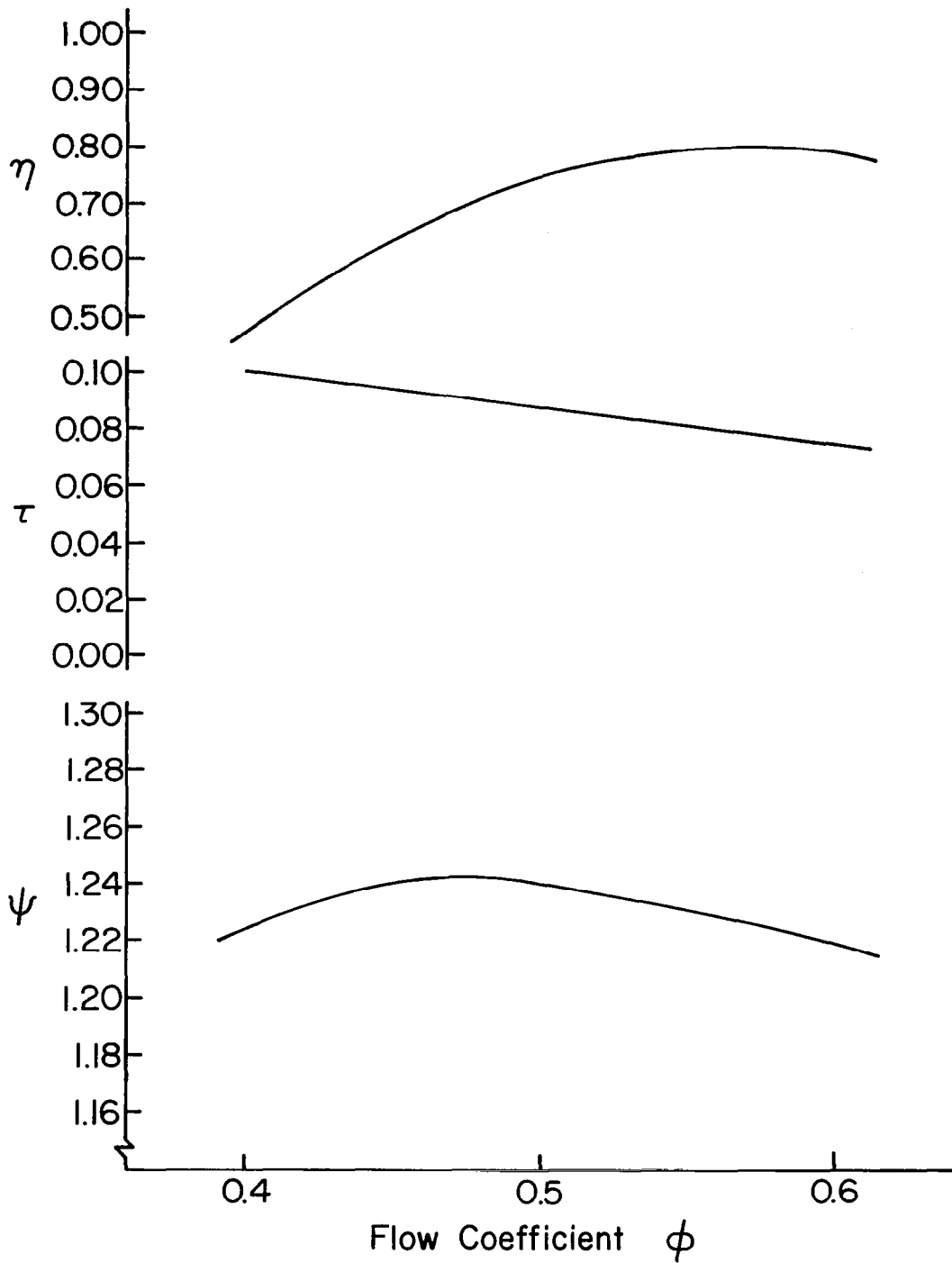


Figure A.1.3 Stage Characteristics of Test Compressor (3rd Stage)

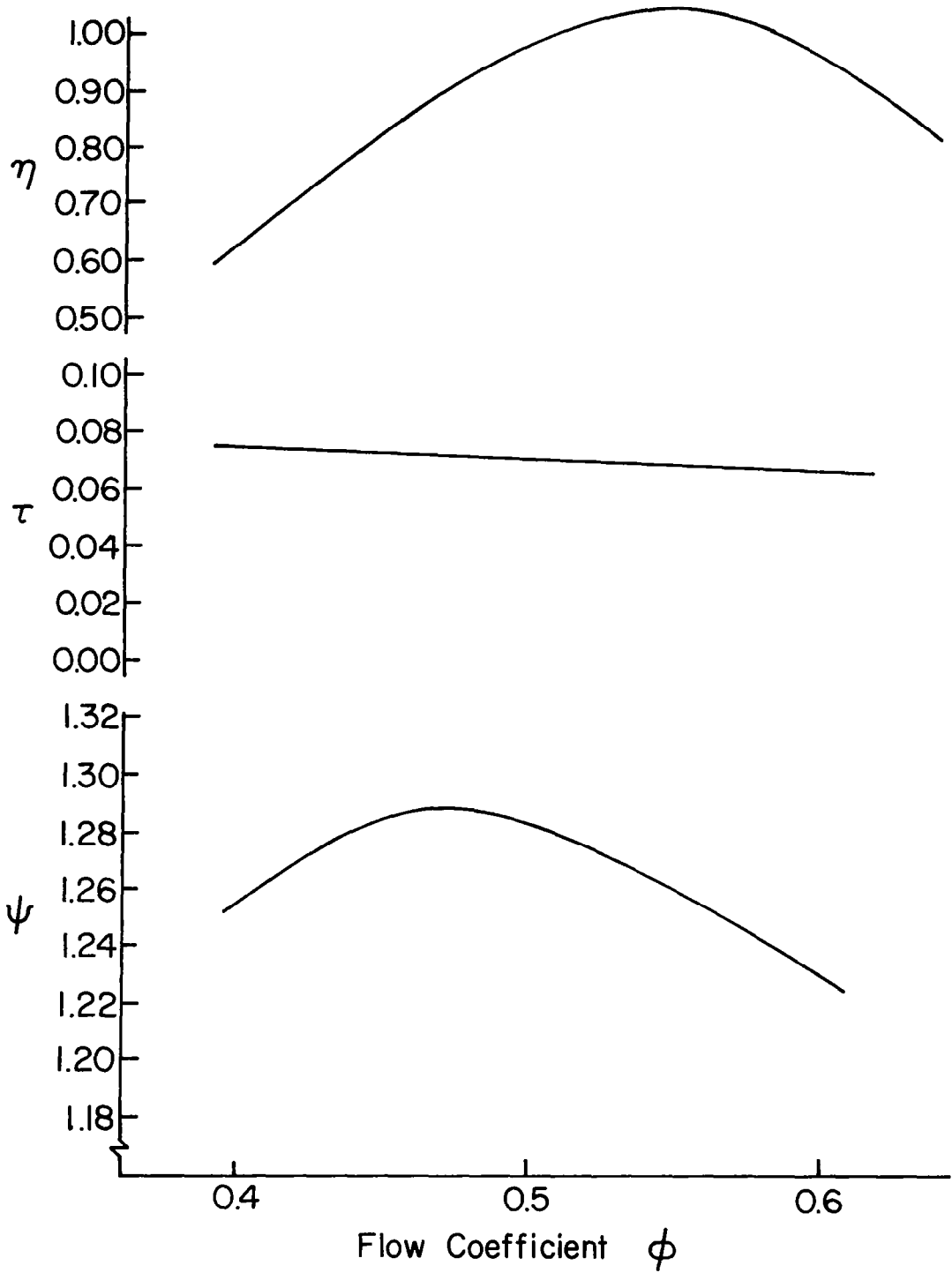


Figure A.1.4 Stage Characteristics of Test Compressor (4th Stage)

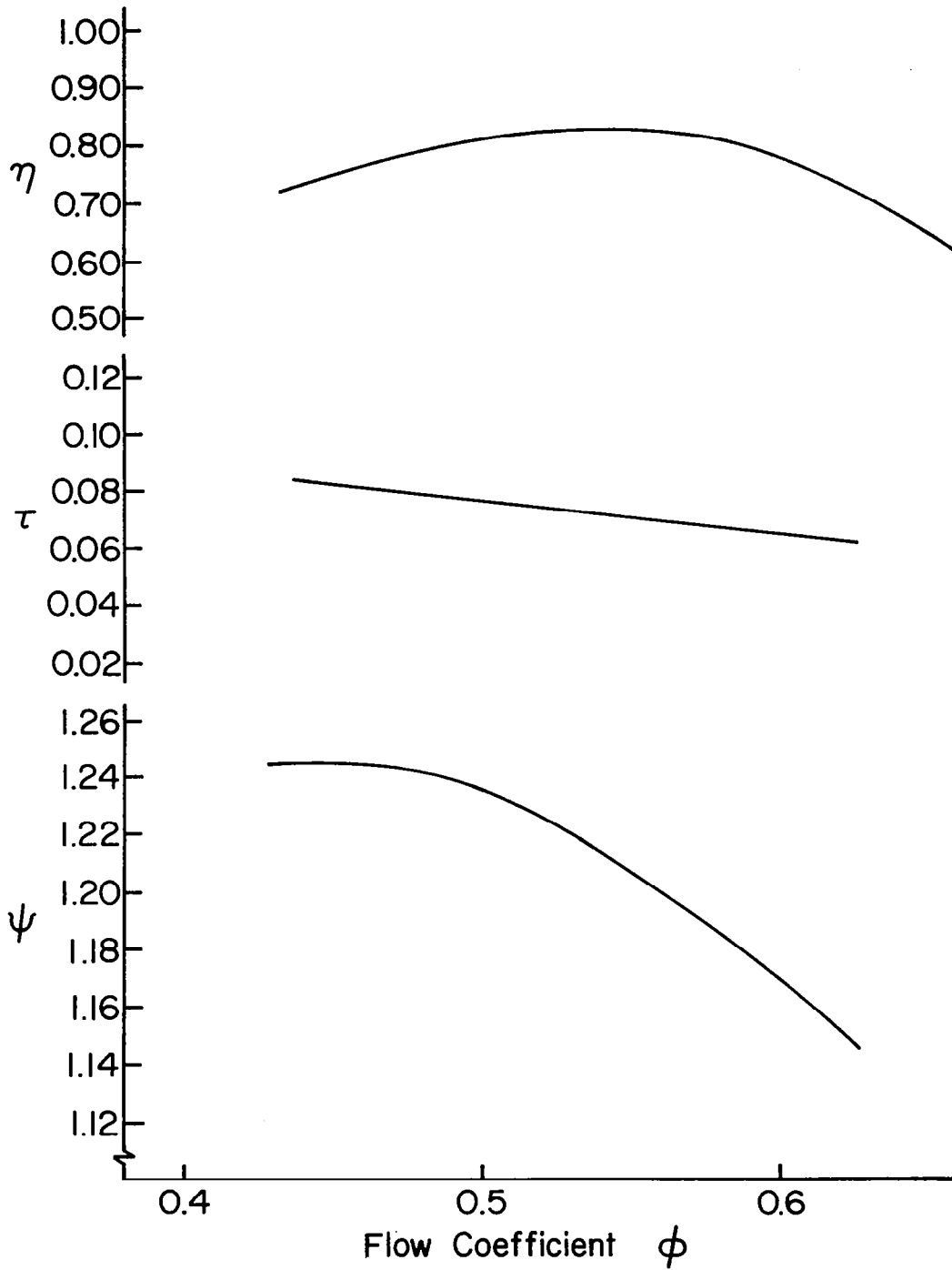


Figure A.1.5 Stage Characteristics of Test Compressor (5th Stage)

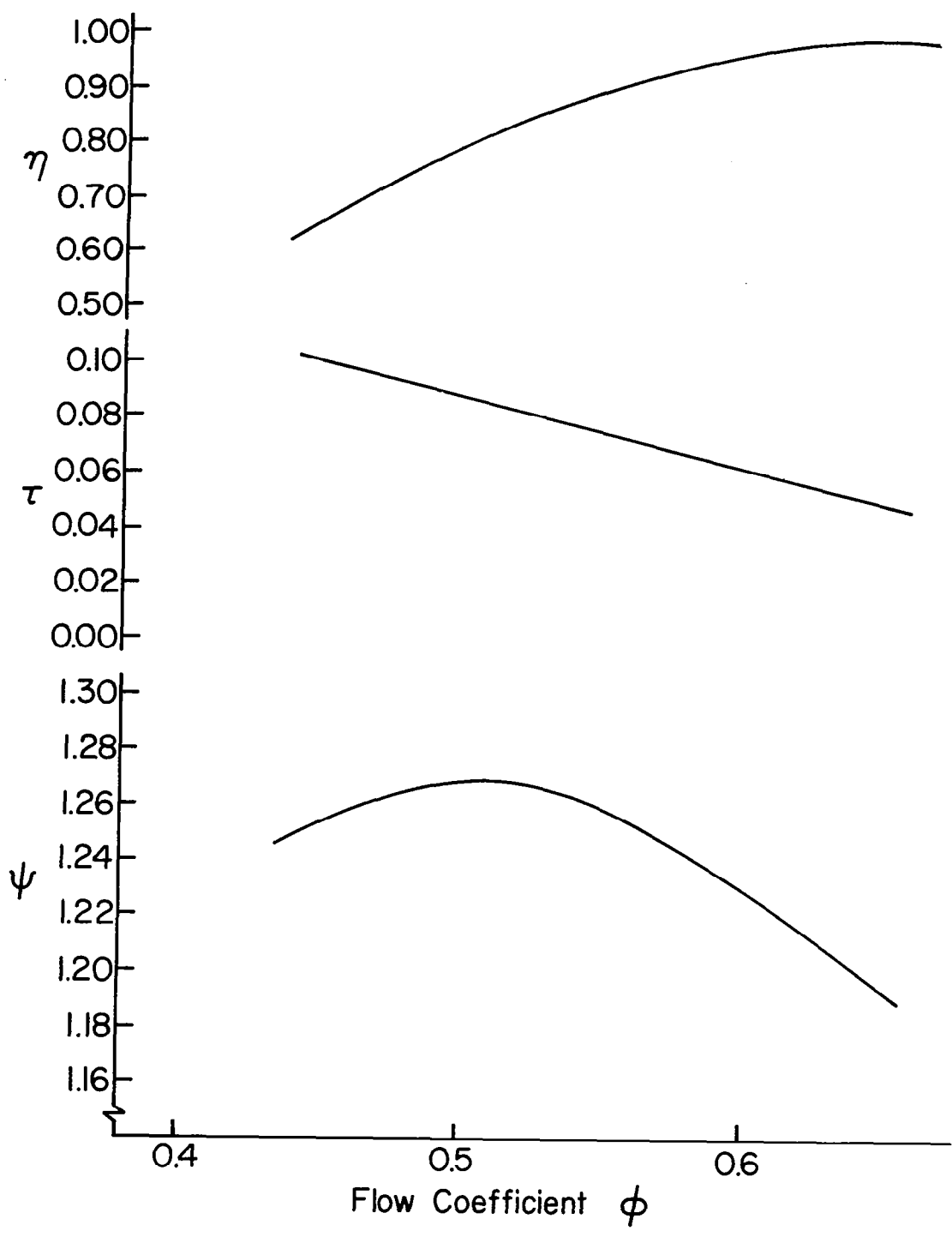


Figure A.1.6 Stage Characteristics of Test Compressor (6th Stage)

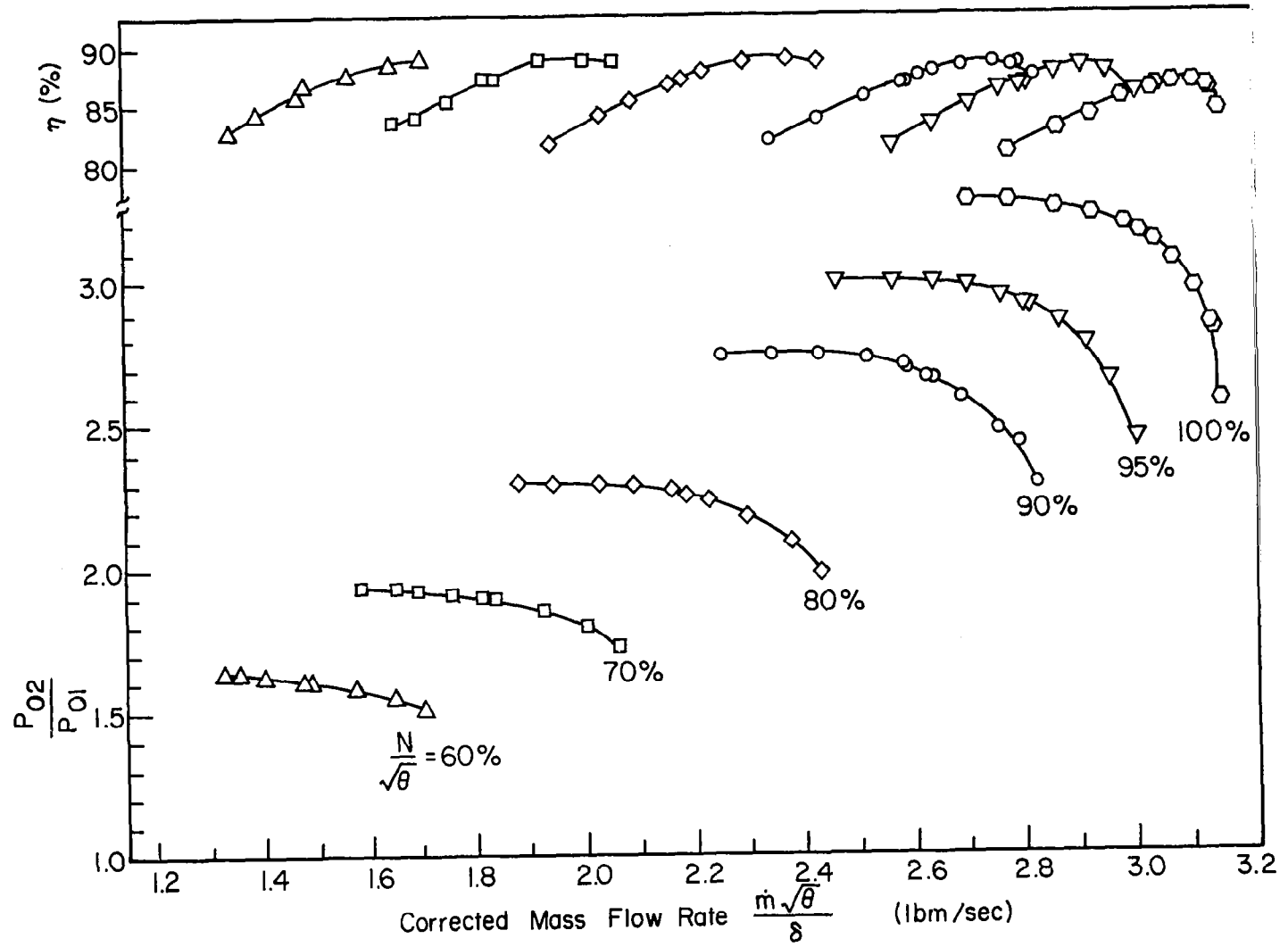


Figure A.1.7 Overall Performance of Test Compressor

APPENDIX 2

DETAILED DESCRIPTION OF SUBROUTINES AND EXTERNAL FUNCTIONS

Each of the subroutines and external functions is presented as follows: (1) Description, (2) Input variables, (3) Output variables, and (4) Usage.

SUBROUTINE WICSPD

(1) Description:

The subroutine WICSPD is used for the calculation of design point performance. The properties obtained in this subroutine become reference properties for calculation of off-design performance.

(2) Input Variables:

AMASS	mass flow rate
ISTAGE	stage at which performance calculation is carried out

(3) Output Variables:

none

(4) Usage:

CALL WICSPD (AMASS, ISTAGE)

SUBROUTINE WICCEN

(1) Description:

The subroutine WICCEN is used for the calculation of spanwise replacement of droplets due to centrifugal action.

Three forces act on a droplet moving through a fluid:
(1) the external force consisting of gravitational and

centrifugal forces; (2) the buoyancy force, which acts parallel to the external force, but in the opposite direction; and (3) the drag force, which appears whenever there is relative motion between the droplet and the fluid, and acts parallel to the direction of motion but in the opposite direction. In the present case, the direction of motion of a droplet relative to the fluid is not parallel to the direction of the external and buoyant forces, and therefore the drag force makes an angle with the other two forces. However, under the one-dimensional approximation, the lines of action of all forces acting on the droplet are co-linear and therefore the forces may be added in obtaining a balance of momentum, as follows:

$$\frac{m}{g_c} \frac{du}{dt} = F_e - F_b - F_D$$

where F_e , F_b and F_D are the external, buoyancy and drag forces respectively.

The external force can be expressed as the product of mass and acceleration, a_e , of the droplet due to this force, and therefore

$$F_e = \frac{m}{g_c} a_e.$$

In the present case, because of the large rotor speeds, the centrifugal acceleration is far larger than the gravitational acceleration. Thus

$$a_e = r\omega^2$$

where r is the radius and ω , the angular velocity. The acceleration can also be written as follows:

$$a_e = V_\theta^2/r$$

where V_θ is the circumferential velocity of the droplet. For droplets passing through a rotor blade passage, the

circumferential component of the relative velocity, W_θ , should be used in place of V_θ . When there is a large change in whirl velocity between the inlet and outlet of a blade row, a mean value of velocity may be more applicable.

The buoyancy force is, by Archimedes' Principle, the product of the mass of the fluid displaced by the droplet and the acceleration from the external force. The mass of fluid displaced is $(m/\rho_w)\rho_g$, where ρ_w is the density of water and ρ_g is the density of the surrounding fluid. The buoyancy force is then given

$$F_b = m\rho_g a_e / \rho_w g_c.$$

The drag force is expressed by the relation,

$$F_d = C_D \frac{\rho_g u^2}{2g_c} A_p$$

where C_D is the drag coefficient and A_p is the projected area of the droplet measured in a plane perpendicular to the direction of motion of the droplet. The drag coefficient C_D can be expressed in a general form as follows:

$$C_D = b_1 / \text{Re}^n$$

where Re is the Reynolds number based on relative velocity between gas and droplet. The constants b_1 and n are as follows:

$$b_1 = 24.0, \quad n = 1.0 \quad \text{when } \text{Re} < 1.9$$

$$b_1 = 18.5, \quad n = 0.6 \quad \text{when } 1.9 < \text{Re} < 500$$

$$b_1 = 0.44, \quad n = 0.0 \quad \text{when } 500 < \text{Re} < 200,000.$$

The equation of droplet motion then becomes the following:

$$\frac{du}{dt} = A/r - Bu^{2-n}$$

where

$$A = (W_\theta)_{\text{ave}}^2 \cdot (1 - \rho_g/\rho_w),$$

$$B = 3u^n b_1 \rho_g^{1-n} / 4\rho_w D^{1+n}, \text{ and}$$

D being the average droplet diameter. Over a small time interval, the equation of motion can be written as follows:

$$\Delta u = (A/r - Bu^{2-n})\Delta t.$$

This equation can be used to determine the radial location of a droplet in a stage as follows:

- (i) Select the initial values for u_1 and r_1 .
- (ii) Calculate the Reynolds number to determine the values of b_1 and n .
- (iii) Calculate A and B.
- (iv) Calculate the change of u during time interval Δt .
- (v) Calculate the new velocity u_2 .

$$u_2 = u_1 + \Delta u$$

- (vi) Calculate the change in location of droplet in terms of Δr .

$$\Delta r = (u_1 + u_2)/2.0 \cdot \Delta t$$

- (vii) Calculate the new radial location.

$$r_2 = r_1 + \Delta r$$

- (viii) Repeat the calculation for new value of u_2 and r_2 and progressively extend the calculation.

The time interval should be sufficiently small in order to obtain reasonable accuracy. As stated in Section 2.1.3 in Chapter II of Reference 4, the length between the leading and trailing edges of a blade is divided into ten steps. The time interval Δt is then given by the relation, namely

$$\Delta t = \frac{\text{chord}}{V} \times \frac{1}{10}$$

where V is the velocity of mixture in the blade passage.

(2) Input Variables:

RZERO droplet spanwise location at rotor inlet
 UZERO droplet spanwise velocity at rotor inlet

DD	droplet diameter
VZ	axial velocity
DELZZ	axial length of a stage
ALFAAV	average flow angle
FN	rotor blade rotational speed
IRS	index for rotor or stator
RHOGAS	density
RHUB	radius at hub
XG	mass fraction of gas phase
XA	mass fraction of dry air
XVV	mass fraction of vapor
XCH4	mass fraction of methane
RTIPIN	radius at blade tip

(3) Output Variables:

R2	droplet spanwise location blade outlet
U2	droplet spanwise velocity at blade outlet
ITIP	index for droplet spanwise location
VZTIME	time in which flow pass through a stage

(4) Usage:

CALL WICCEN (RZERO, VZERO, DD, VZ, DELZZ, ALFAAV, FN, IRS,
RHOGAS, RHUB, R2, U2, ITIP, VZTIME, XG, XA, XVV,
XCH4, RTIPIN)

SUBROUTINE WICDMS

(1) Description:

The subroutine WICDMS is used for the calculation of amount of small droplets which is centrifuged.

(2) Input Variables:

IPRINT	index for printout
IRAD	index for spanwise location
AMASW1	mass flow rate of water at rotor inlet
AMASWT	mass flow rate of droplet
AMASW	mass flow rate of droplet
R1	droplet spanwise location rotor inlet

R2 droplet spanwise location at rotor outlet
 STAREA streamtube area
 RSTAVE radius of streamtube at its center
 RTIP radius at blade tip

(3) Output Variables:

DMIN amount of water that is centrifuged and enters
 into a streamtube
 DMOUT amount of water that is centrifuged and leaves
 from a streamtube
 AMASW2 mass fraction of water at rotor outlet after
 correction for centrifugal action
 DELMAS net amount of water that is centrifuged

(4) Usage:

CALL WICDMS (IPRINT, IRAD, AMASW1, AMASWT, AMASW, R1, R2,
 STAREA, RSTAVE, RTIP, DMIN, DMOUT, AMASW2, DELMAS)

SUBROUTINE WICDML

(1) Description:

The subroutine WICDML is used for the calculation of amount of large droplets which is centrifuged.

(2) Input Variables:

IPRINT index for printout
 IRAD index for spanwise location
 AMASW1 mass flow rate of water at rotor inlet
 AMASWT mass flow rate of droplet
 AMASW mass flow rate of droplet
 R1 droplet spanwise location rotor inlet
 R2 droplet spanwise location at rotor outlet
 STAREA streamtube area
 RSTAVE radius of streamtube at its center
 RTIP radius at blade tip

(3) Output Variables:

DMIN amount of water that is centrifuged and enters into a streamtube
DMOUT amount of water that is centrifuged and leaves from a streamtube
AMASW2 mass fraction of water at rotor outlet after correction for centrifugal action
DELMAS net amount of water that is centrifuged

(4) Usage:

CALL WICDML (IPRINT, IRAD, AMASW1, AMASWT, AMASW, R1, R2, STAREA, RSTAVE, RTIP, DMIN, DMOUT, AMASW2, DELMAS)

SUBROUTINE WICMAC

(1) Description:

Subroutine WICMAC calculates the Mach number in the gas-water droplet mixture. First the acoustic speed in gaseous phase is determined by iteration as follows:

- (i) Assume Mach number and calculate static temperature and density.

$$t = (1 + \frac{\gamma-1}{2}M^2)^{-1}T_{01}$$

$$\rho = (1 + \frac{\gamma-1}{2}M^2)^{-1/(\gamma-1)}P_{01}/RT_{01}$$

- (ii) Calculate acoustic speed in gaseous phase

$$a_g = (\gamma R t g_c)^{0.5}$$

- (iii) Calculate the axial velocity

$$V_z = \dot{m}/\rho A$$

- (iv) Calculate absolute velocity

$$V_1 = V_z/\cos\alpha_1$$

- (v) Calculate Mach number

$$M_1 = V_1/a_g$$

Compare the calculated Mach number with the assumed value in (i). Iterate steps (i) to (v) until the desired accuracy is obtained. After determining the acoustic speed in gaseous phase, Function WICASD is called to determine the acoustic speed in droplet-laden gas flow.

(2) Input Variables:

ISTAGE	stage number
AMASSM	mixture mass flow rate
TOIG	total temperature of gaseous phase
PRES	total pressure
XW1	total water content
ALFA	stator outlet angle of the previous stage
RMIX	gas content of gaseous phase
CPMIX	specific heat at constant pressure for gaseous phase

(3) Output Variables:

M	Mach number
VZ	axial velocity
C	acoustic speed in mixture

(4) Usage:

CALL WICMAC (ISATE, AMASSM, TOIG, PRES, M, VZ, C, XW1, ALFA, RMIX, CPMIX)

FUNCTION WICASD

(1) Description:

Function WICASD calculates the acoustic speed in droplet-laden gas flow. The following equation is used (Ref. 10).

$$a = \left\{ \left\{ (1-\sigma_v)\rho_g + \sigma_v\rho_w \right\} \left\{ \frac{1-\sigma_v}{\rho_g a_g^2} + \frac{\sigma_v}{\rho_w a_w^2} \right\} \right\}^{-1/2}$$

where

a_g = acoustic speed in gaseous phase

a_w = acoustic speed in water
 ρ_g = density of gaseous phase
 ρ_w = density of water
 σ_v = particulate liquid volume fraction
 x_w = particulate liquid mass fraction
 $\sigma_v = x_w \rho_g / \{ \rho_w - x_w (\rho_w - \rho_g) \}$

(2) Input Variables:

XW total water content
RHOG density of gas phase
CG acoustic speed of gaseous phase

(3) Output Variable:

WICASD acoustic speed in gas-water droplet mixture

(4) Usage:

WICASD (XW, RHOG, CG)

SUBROUTINE WICIRS

(1) Description:

Subroutine WICIRS is called at outlet of rotor and performs the calculation of droplet impingement and rebound in rotor passage for small droplet.

(2) Input Variables:

ISTAGE stage number
RTIPIN blade tip radius
XW1 mass fraction of small droplet
XG mass fraction of gaseous phase
RHOG1 density of gaseous phase
BETA1 rotor inlet relative flow angle
W1 rotor inlet relative velocity

(3) Output Variables:

WW1 amount of water that impacts stagnation region
 of blade
WW2 amount of water that impacts aft of blade
WW total amount of water that impacts blade

- (4) Usage:
CALL WICIRS (ISTAGE, RTIPIN, XW1, XG, RHOG1, BETA1, W1, WW1,
WW2, WW)

SUBROUTINE WICIRL

- (1) Description:
Subroutine WICIRL is called at outlet of rotor and performs the calculation of droplet impingement and rebound in rotor passage for large droplet.

- (2) Input Variables:

ISTAGE	stage number
RTIPIN	blade tip radius
XW1	mass fraction of large droplet
XG	mass fraction of gaseous phase
RHOG1	density of gaseous phase
BETA1	rotor inlet relative flow angle
W1	rotor inlet relative velocity

- (3) Output Variables:

WW1	amount of water that impacts upper surface of blade
WW2	amount of water that impacts lower surface of blade
WW	amount of water that impacts blade surface

- (4) Usage:

CALL WICIRL (ISTAGE, RTIPIN, XW1, XG, RHOG1, BETA1, W1, WW1,
WW2, WW)

SUBROUTINE WICISS

- (1) Description:

Subroutine WICISS is called outlet of stator and performs the calculation of droplet impingement and rebound in stator passage for small droplet.

(2) Input Variables:

ISTAGE stage number
RTIPIN blade tip radius
XW mass fraction of small droplet
XG mass fraction of gaseous phase
RHOG1 density of gaseous phase
ALFA2 stator inlet absolute flow angle
W1 stator inlet absolute velocity

(3) Output Variables:

WW1 amount of water that impacts stagnation region
 of blade
WW2 amount of water that impacts off of blade
WW total amount of water that impacts the blade

(4) Usage:

CALL WICISS (ISTAGE, TRIPIN, XW, XG, RHOG1, ALFA2, W1, WW1,
 WW2, WW)

SUBROUTINE WICISL

(1) Description:

Subroutine WICISL is called at outlet of stator and performs the calculation of droplet impingement and rebound in stator passage for large droplet.

(2) Input Variables:

ISTAGE stage number
RTIPIN blade tip radius
XW mass fraction of
XG mass fraction of gaseous phase
RHOG1 density of gaseous phase
ALFA2 stator inlet absolute flow angle
W1 stator inlet absolute velocity

(3) Output Variables:

WW1 amount of water that impacts upper surface of
 blade

WW2 amount of water that impacts lower surface of
blade
WW total amount of water that impacts on blade
surface

(4) Usage:

CALL WICISL (ISTAGE, RTIPIN, XW, XG, RHOG1, ALFA2, W1, WW1,
WW2, WW)

SUBROUTINE WICWAK

(1) Description:

Subroutine WICWAK is called at rotor outlet and stator outlet,
and calculates the droplet size of water that is re-entrained
at trailing edge of rotor and stator blades.

(i) Assume a value for a droplet diameter, d , that is
re-entrained into wake.

(ii) Calculate the stability number, SN.

$$SN = \mu_f^2 / \rho_g \sigma d g_c$$

(iii) Calculate the critical Weber number

$$W_e = 12 \{1 + (SN)^{0.36}\}$$

(iv) Calculate the largest stable droplet diameter

$$d_{\max} = \frac{W_e}{\rho_g} \frac{\sigma g_c}{V_g^2}$$

(v) Compare the assumed droplet diameter with the calcu-
lated one. Iterate entire steps until the satisfac-
tory agreement is obtained.

(2) Input Variables:

RHOG density of gaseous phase

V velocity of gaseous phase for small droplet or
relative velocity between droplet and gaseous
phase for large droplet

(3) Output Variables:

DWAKE droplet size that re-entrained at trailing edge
 in(ft³)

DWAKEM droplet size that re-entrained at trailing edge
 in(μm)

(4) Usage:

CALL WICWAK (RHOG, V, DWAKE, DWAKEM)

SUBROUTINE WICHET

(1) Description:

Subroutine WICHET is called at end of stage to perform the heat transfer calculation between water droplet and gaseous phase. The heat transfer rate can be determined from the following equation:

$$\frac{dh}{dt} = h_h A (T_g - T_w)$$

where h_h is the heat transfer coefficient, A , the droplet surface area, T_w , the droplet surface temperature, and T_g , the temperature of the surrounding gas. The heat transfer coefficient can be expressed as follows:

$$h_h = \frac{k_a}{D_d} \cdot Nu$$

where k_a is the thermal conductivity of air, and Nu , the Nusselt Number. The Nusselt number can be expressed in terms of the dimensionless groups as follows:

$$Nu = 2.0 + 0.6 (Re)^{0.50} (Pr)^{0.33}$$

where Re is the Reynolds number based on the relative velocity between the droplet and the surrounding air, and Pr is Prandtl number.

After calculating the temperature rise of the water and gas phase due to the work done by the rotor, the heat transfer calculation is carried out as follows:

- (i) Calculate the average droplet diameter, D_d .
(ii) Calculate the number of droplets, N_d .

$$N_d = \frac{\dot{m}_w}{\rho_w \frac{4}{3} \pi (D_d/2)^3} \cdot \frac{\Delta z}{V_z}$$

where \dot{m}_w is the mass flow rate of water phase, ρ_w , the density of water, V_z , the axial direction velocity, and Δz , the axial length of one stage.

- (iii) Calculate the droplet surface area, A .
(iv) Calculate the Nusselt number, Nu .
(v) Calculate the heat transfer coefficient, h_h .
(vi) Calculate the stage outlet temperature for droplet and gas without heat transfer, that is

$$T_{g_2} = T_{g_1} + (\Delta T_g)_{wk}$$

$$T_{w_2} = T_{w_1} + (\Delta T_w)_{wk}$$

where $(\Delta T_g)_{wk}$ and $(\Delta T_w)_{wk}$ are the temperature rise of gas and water due to work done by rotor.

- (vii) Calculate the amount of heat transferred from the gas to the droplet.

$$\Delta H = h_h A (T_{g_2} - T_{w_2})$$

- (viii) Calculate the temperature rise of the droplet and the temperature drop of the surrounding gas.

$$(\Delta H_g)_{ht} = \Delta H / m_g C_s$$

$$(\Delta H_w)_{ht} = \Delta H / m_w C_w$$

where C_w is the specific heat for water and C_s is the humid heat for air-water mixture.

- (ix) Calculate the stage outlet temperature for droplet and gas.

$$T_{g_2} = T_{g_1} + (\Delta T_g)_{wk} - (\Delta T_g)_{ht}$$

$$T_{w_2} = T_{w_1} + (\Delta T_w)_{wk} + (\Delta T_w)_{ht}$$

(x) Using the temperature calculated in step (ix), repeat the steps (vii) to (ix) until a desired accuracy is obtained.

(2) Input Variables:

TG1	temperature of gaseous phase at stage inlet
TG3	temperature of gaseous phase at stage outlet
TW1	temperature of droplet at stage inlet
TW3	temperature of droplet at stage outlet
DAVEN2	droplet nominal diameter at stage inlet
DAVEN	droplet nominal diameter at stage outlet
DELZI	length of stage
VZ	axial velocity
WMASS1	mass flow rate of water
VMASS1	mass flow rate of water vapor
AMASS	mass flow rate of dry air
CHMASS	mass flow rate of methane
DPG	specific heat constant pressure to gaseous phase
CPW	specific heat of water
RE	Reynolds number based on relative velocity between droplet and gaseous phase

(3) Output Variables:

DELIGH	temperature drop in gaseous phase due to heat transfer between water droplet and gaseous phase
DELTWH	temperature rise in droplet due to heat transfer between water droplet and gaseous phase

(4) Usage:

CALL WICHET (TG1, TG3, TW3, DAVEN2, DAVEN, DELZI, VZ, WMASS1, VMASS1, AMASS, CHMASS, CPG, CPW, DELIGH, DELTWH, RE)

SUBROUTINE WICMAS

(1) Description:

Subroutine WICMAS is called at end of stage to perform the mass transfer calculation between water droplet and gas phases.

The mass transfer rate can be calculated by the following equation:

$$\frac{dm}{dt} = h_m A (C_{wb} - C_w)$$

where h_m is the mass transfer coefficient, A , the droplet surface area, C_{wb} , the water vapor concentration at droplet surface, and C_w , the water vapor concentration in fluid flow around droplet.

Since the density represents the mass concentration, and the vapor is almost a perfect gas, the mass transfer rate can be expressed in terms of vapor pressure as follows:

$$\frac{dm}{dt} = h_m A (\rho_{wb} - \rho_w)$$

or

$$\frac{dm}{dt} = h_m A \left(\frac{P_{wb}}{T_{wb}} - \frac{P_w}{T_w} \right) \cdot \frac{1}{R_v}$$

where R_v is the gas constant for water vapor, P_{wb} , the vapor pressure at droplet surface, P_w , the vapor pressure in fluid flowing around droplet, T_{wb} , the vapor temperature at droplet surface, and T_w , the vapor temperature in fluid flowing around droplet.

The surface area, A , for the droplet cloud is given by the relation,

$$A = \pi D_d^2 N_d$$

where D_d is the average droplet diameter, and N_d , the number of droplets.

The mass transfer coefficient, h_m , is expressed as follows:

$$h_m = \frac{D_v}{D_d} \cdot Sh$$

A semi-empirical equation for the diffusion coefficient in gases is given by the following: (Reference 11)

$$D_v = 435.7 \frac{T^{3/2}}{p(V_A^{1/3} + V_B^{1/3})^2} \left(\frac{1}{M_A} + \frac{1}{M_B} \right)^{1/2}$$

where D_v is in square centimeters per second, T is in degree Kelvin, p is the total system pressure in newtons per square meter, and V_A and V_B are the molecular volumes of constituents A and B as calculated from the atomic volumes. M_A and M_B are given as follows:

$$V_A = V_{\text{air}} = 29.9$$

$$M_A = M_{\text{air}} = 28.9$$

$$V_B = M_{\text{water}} = 18.8$$

$$M_B = M_{\text{water}} = 18.0$$

When the relative velocity between a single droplet and the surrounding fluid approaches zero, the following relationship is used to determine the mass transfer rate:

$$Sh = 2.0.$$

Mass transfer rates increase with increase in relative velocity between the droplet and the surrounding air due to the additional mass transfer caused by the convection in the boundary layer around the droplet. The mass transfer coefficient from a spherical droplet can be expressed in terms of dimensionless groups as follows:

$$Sh = 2.0 + k (Re)^x (Sc)^y$$

where Re is the Reynolds number based on relative velocity, which expresses the ratio of inertial force to viscous force, and Sc is the Schmidt number, which expressed the ratio of kinetic viscosity to molecular diffusivity.

There is much discussion over the values of x , y , and k . The form most widely applied is the Ranz and Marshall equation which is

$$Sh = 2.0 + 0.6 (Re)^{0.50} (Sc)^{0.33}$$

The procedure for determining the mass transfer rate is as follows:

- (i) Calculate the Sherwood number, Sh .
- (ii) Calculate the diffusion coefficient, D_v .
- (iii) Calculate the average droplet size, D_d .
- (iv) Calculate the mass transfer coefficient, h_m .
- (v) Calculate the total number of droplets, N_d .
- (vi) Calculate the total surface area for all droplets.
- (vii) Calculate the water vapor pressure at droplet surface, P_{wb} , based on the droplet surface temperature, T_s .
- (viii) Assume the vapor pressure, p_w , and set $p_w = (p_w)_a$.
- (ix) Calculate the mass transfer rate, $\frac{dm}{dt}$.
- (x) Calculate the new value of water mass flow rate.

$$\dot{m}_w = \dot{m}_w - \frac{dm}{dt}$$

- (xi) Calculate the new value of vapor mass flow rate.

$$\dot{m}_v = \dot{m}_v + \frac{dm}{dt}$$

- (xii) Calculate the specific humidity, W .

$$W = \dot{m}_v / \dot{m}_a$$

where \dot{m}_a is the air mass flow rate.

- (xiii) Calculate the vapor pressure.
- (xiv) Compare the calculated value, $(p_w)_c$, with the assumed value $(p_w)_a$.

If $(p_w)_c$ agrees reasonably well with the assumed value $(p_w)_a$ proceed to step (xv). Otherwise, steps (viii) to (xiv) should be repeated.

- (xv) Using the determined p_w , the mass transfer rate is calculated. Also, the specific humidity can be determined by the following equation:

$$W = 0.6219 \frac{P_w}{P - P_w}$$

(2) Input Variables:

HW1 specific humidity at stage inlet
TW1 temperature of droplet at stage inlet
TW2 temperature of droplet at stage outlet
PP1 pressure of gaseous phase at stage inlet
PP2 pressure of gaseous phase at stage outlet
TG1 temperature of gaseous phase at stage inlet
TG2 temperature of gaseous phase at stage outlet
DZ length of stage
VZ axial velocity
DDAVE1 droplet nominal diameter at stage inlet
DDAVE2 droplet nominal diameter at stage outlet
AMASS mass flow rate of air
RE Reynolds number based on relative velocity
 between droplet and gaseous phase
VMASS1 mass flow rate of water vapor at stage inlet
WMASS1 mass flow rate of water droplet at stage outlet

(3) Output Variables:

HW2 specific humidity at stage outlet
VMASS2 mass flow rate of water vapor at stage outlet
WMASS2 mass flow rate of water droplet at stage outlet
DMDTAV average mass transfer rate across stage

(4) Usage:

CALL WICMAS (HW1, TW1, TW2, PP1, PP2, TG1, TG2, DZ, PWB1,
 PWB2, PW1, PW2, VZ, DDAVE1, DDAVE2, HW2, VMASS1,
 VMASS2, WMASS1, WMASS2, DMDTAV, AMASS, RE)

FUNCTION WICMTR

(1) Description:

Function WICMTR is called in Subroutine WICMTR and calculates the mass transfer rate.

(2) Input Variables:

TTG temperature of gaseous phase

TTW	temperature of water droplet
PPP	pressure of gaseous phase
DAVW	droplet nominal diameter
VA	axial velocity
DZ	length of stage
MMASS	mass flow rate of mixture
PW	vapor pressure
RE	Reynolds number based on relative velocity between droplet and gaseous phase

(3) Output Variable:

DMDT mass transfer rate

(4) Usage:

WICMTR (TTG, TTW, PPP, DAVE, VZ, DZ, MMASS, PW, RE)

FUNCTION WICPWB

(1) Description:

Function WICPWB calculates the saturation pressure for water vapor as a function of temperature as follows:

$$\log_{10} p_s = A - B/T$$

where units are (Kg/cm²) for p_s and (K) for T. The values of constant A and B are given as follows:

$$A = 5.97780, B = 2224.4 \text{ when } 20^{\circ}\text{C} < T < 100^{\circ}\text{C}$$

$$A = 5.64850, B = 2101.1 \text{ when } 100^{\circ}\text{C} < T < 200^{\circ}\text{C}$$

$$A = 5.45142, B = 2010.8 \text{ when } 200^{\circ}\text{C} < T < 350^{\circ}\text{C}$$

(2) Input Variable:

TWB temperature of gaseous phase

(3) Output Variable:

WICPWB saturation pressure for water vapor

(4) Usage:

WICPWB (TWB)

FUNCTION WICNEW

(1) Description:

Function WICNEW is used to estimate the new trial value in the iteration procedure.

(2) Input Variables:

X1 first trial value
Y1 calculated value corresponds to X1
X2 second trial value
Y2 calculated value corresponds to X2

(3) Output Variable:

WICNEW new trial value

(4) Usage:

WICNEW (X1, Y1, X2, Y2)

FUNCTION WICTAN

(1) Description:

Function WICTAN(X) is used to obtain the ratio of SINE(X) to COSINE(X), that is, TAN(X).

(2) Input Variable:

X angle

(3) Output Variable:

WICTAN value of TAN(X)

(4) Usage:

WICTAN(X)

FUNCTION WICBPT

(1) Description:

Function WICBPT calculates the temperature at boiling point.

(2) Input Variables:

TSTAG temperature
PSTAGE pressure

- (3) Output Variable:
WICBPT temperature at boiling point
- (4) Usage:
WICBPT (TSTAG, PSTAG)

FUNCTION WICSH

- (1) Description:
Function WICSH calculates the specific humidity.
- (2) Input Variables:
TSTAGE temperature
PSTAG pressure
- (3) Output Variable:
WICSH specific humidity
- (4) Usage:
WICSH (TSTAG, PSTAG)

SUBROUTINE WICSIZ

- (1) Description
Subroutine WICSIZ is called at outlet of rotor and stator to determine the nominal droplet sizes. It is assumed that two kinds of droplets exist at inlet of compressor; namely, small droplet and large droplet. However, at trailing edge of each blade, the new droplets are re-entrained into blade wake. The droplets which are larger than DLIMIT are treated as large droplets and droplets which are smaller than DLIMIT are treated as small droplets. Each droplet size weighted based on its mass fraction in determining the nominal droplet size. Therefore, at outlet of each blade row, Subroutine WICSIZ gives two nominal diameters; one for small droplet and one for large droplet. It may be noted that only two classes of droplets are recognized in the model.
- (2) Input Variables:
WMASSL mass flow rate of large droplet

WMASSS	mass flow rate of small droplet
AMING1	amount of water which is to be re-entrained into wake, originally small droplet
AMING2	amount of water which is to be re-entrained into wake, originally large droplet and upper part
AMING3	amount of water which is to be re-entrained into wake, originally large droplet and lower part
DL	droplet nominal size for large droplet before impingement
DS	droplet nominal size for small droplet before impingement
D1	droplet size associated with AMING1
D2	droplet size associated with AMING2
D3	droplet size associated with AMING3
DLIMIT	largest droplet diameter which can be treated as small droplet

(3) Output Variables:

AMSL	mass flow rate of small droplet after re-entrainment
AMLGE	mass flow rate of large droplet after re-entrainment
DSLL	droplet nominal size for small droplet
DLGE	droplet nominal size for large droplet

(4) Usage:

CALL WICSIZ (WMASL, WMASSS, AMING1, AMING2, AMING3, DL, DS, D1, D2, D3, DLIMIT, AMSL, AMLGE, DSLL, DLGE)

SUBROUTINE WICPRP

(1) Description

Subroutine WICPRP determines the flow properties such as gas constant specific heat ratio, and specific heat at constant pressure for the gaseous mixture. The working equations are as follows:

$$R_{mix} = x_a \cdot R_a + x_v \cdot R_v + x_c \cdot R_c$$

$$c_{pmix} = x_a \cdot c_{pa} + x_v \cdot c_{pv} + x_c \cdot c_{pc}$$

$$\gamma_{mix} = (1.0 - \frac{R_{mix}}{c_{pmix} J})^{-1}$$

where

x_a = mass fraction of air in gaseous mixture

x_v = mass fraction of water vapor in gaseous mixture

x_c = mass fraction of methane in gaseous mixture

$$x_a + x_v + x_c = 1$$

R_a = gas constant of air

R_v = gas constant of water vapor

R_c = gas constant of methane

R_{mix} = gas constant of mixture

c_{pa} = specific heat constant pressure for air

c_{pv} = specific heat constant pressure for water vapor

c_{pc} = specific heat at constant pressure for methane

c_{pmix} = specific heat at constant pressure for mixture

r_{mix} = specific heat ratio for mixture

(2) Input Variables:

XAIR mass fraction of air in gaseous mixture
 XH2O mass fraction of water vapor in gaseous mixture
 XCH4 mass fraction of methane in gaseous mixture
 T temperature of gaseous mixture

(3) Output Variables:

RMIX gas constant of gaseous mixture
 CPMIX specific heat constant pressure for gaseous
 mixture
 GAMMA specific heat ratio of gaseous mixture
 G1 value for GAMMA/(GAMMA - 1.0)
 G2 value for (GAMMA - 1.0)/2.0
 G3 value for -1.0/(GAMMA - 1.0)

(4) Usage:

CALL WICPRP (XAIR, XH2O, XCH4, T, RMIX, CPMIX, GAMMA, G1, G2,
 G3)

FUNCTION WICCPA

(1) Description:

Function WICCPA calculates the specific heat at constant pressure for air as a function of temperature as follows: (Reference 11)

$$c_p = (a + bT + cT^2 + dT^3 + eT^4)R$$

where units are (J/kg-K) for c_p , (K) for T, and (J/kg-K) for R. The values of coefficients a, b, c, d, and e are as follows:

$$a = 3.65359$$

$$b = -1.33736 \times 10^{-10}$$

$$c = 3.29421 \times 10^{-6}$$

$$d = -1.91142 \times 10^{-9}$$

$$e = 0.275462 \times 10^{-12}$$

(2) Input Variable:

T temperature

(3) Output Variable:

WICCPH specific heat constant pressure

(4) Usage:

WICCPH(T)

FUNCTION WICCPH

(1) Description:

Function WICCPH calculates the specific heat at constant pressure for water vapor as a function of temperature as follows: (Reference 11)

$$c_p = (a + bT + cT^2 + dT^3 + eT^4)R$$

where units are (J/kg-K) for c_p , (K) for T, and (J/kg-K) for R. The values of coefficients a, b, c, d, and e are as follows:

$$a = 4.07013$$

$$b = -1.10845 \times 10^{-3}$$

$$c = 4.15212 \times 10^{-6}$$

$$d = -2.96374 \times 10^{-9}$$

$$e = 0.807021 \times 10^{-12}$$

(2) Input Variable:

T temperature

(3) Output Variable:

WICCPH specific heat at constant pressure

(4) Usage:

WICCPH(T)

FUNCTION WICCPH

(1) Description:

Function WICCPH calculates the specific heat at constant pressure for methane as a function of temperature as follows:
(Reference 12)

$$c_p = (a + bT + cT^2 + dT^3 + eT^4)R$$

where units are (J/kg-k) for c_p , (K) for T, and (J/kg-K) for R. The values of coefficients a, b, c, d, and e are as follows:

$$a = 3.82619$$

$$b = -3.97946 \times 10^{-3}$$

$$c = 24.5583 \times 10^{-6}$$

$$d = -22.7329 \times 10^{-9}$$

$$e = 6.92760 \times 10^{-12}$$

(2) Input Variable:

T temperature

(3) Output Variable:

WICCPH specific heat constant pressure

(4) Usage:

WICCPH(T)

SUBROUTINE NASA

(1) Description:

The subroutine NASA corresponds to MAIN program of NASA-STGSTK program. NASA calls all of the major subroutines in NASA-STGSTK program. NASA first calculates the flow area at inlet and outlet of each stage. It next calls the subroutine CSPREF to calculate reference velocity diagrams at the specified radius for each stage. Then NASA calls CSETA to calculate efficiency if it is not inputed. The pressure coefficient is also calculated by calling CSPI. These computed characteristics for stage can be printed out in this subroutine.

(2) Input Variables:

All input variables are specified in Common blocks.

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL NASA

SUBROUTINE CSINPT

(1) Description:

The primary purpose of subroutine CSINPT is to read and write the input data which the program requires. For input of design stage performance, there is an option of either of the following input: (i) stage pressure ratio and adiabatic efficiency, or (ii) stage characteristics which consists of pressure coefficient versus flow coefficient and adiabatic efficiency versus flow coefficient. When either of the two above input options are used as input, the input parameters for the option not used are input as zero values. An example of input data is given in Chapter IV.

(2) Input Variables:

All input variables are specified in Common blocks.

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL CSINPT

SUBROUTINE CSPREF

(1) Description:

At design speed and flow, the subroutine CSPREF is coded to calculate: (i) velocity diagram at the specified radius for each stage inlet and outlet, and (ii) selected performance parameter for each stage. Basically CSPREF perform a one-dimensional compressible invicid flow calculation at each rotor inlet and outlet to obtain the velocity diagram for design input conditions.

(2) Input Variables:

All input variables are specified in Common blocks.

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL CSPREF

FUNCTION CPFM

(1) Description:

The subroutine CPFM is used to obtain values of the specific heat at constant pressure, C_p , and ratio of specific heats, α , as a function of static temperature, t . CPFM calculates the value of the specific heat at constant pressure, C_p , from a fifth degree polynomial of static temperature, t , expressed by

$$C_p = \sum_{i=1}^5 C_i t^i$$

where the polynomial coefficients, C_i , are input data read by CSINPT. The value of the ratio of specific heats, γ , is then

calculated from the following relations:

$$\gamma = C_p / (C_p - R)$$

where R is gas constant.

(2) Input Variable:

TS static temperature for which the specific heat
 at constant pressure is determined

(3) Output Variable:

CPFM specific heat at constant pressure

(4) Usage:

CPRM(TS)

SUBROUTINE CSETA

(1) Description:

The subroutine CSETA is called by the subroutine NASA when values of stage adiabatic efficiency versus flow coefficient at design speed are not usable input (i.e. values of 0.0 for adiabatic efficiency are inputted). CSETA obtains values of adiabatic efficiency for each stage at the various input flow coefficient for the stage.

(2) Input Variables:

All input variables are specified in Common blocks.

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL CSETA

SUBROUTINE CSPSI

(1) Description:

The subroutine CSPSI is called by the subroutine NASA when values of stage pressure coefficient versus flow coefficient at design speed are not usable input (i.e. input values for stage pressure coefficient equal 0.0). The subroutine CSPSI

obtains values of stage pressure coefficient at the various input flow coefficient for the stage.

(2) Input Variables:

XWN water content
LORS index to specify calculation scheme
 LORS=1 for small droplet calculation
 LORS=2 for large droplet calculation

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL CSPSI(XWN, LORS)

SUBROUTINE CSDEVS

(1) Description:

The subroutine CSDEVS calculates the value of stator diffusion constant, K, for small droplet calculation. After determining the value of K, the deviation, δ , can be determined by the following:

$$\delta = \delta^* + K \{(V_2/V_3) - (V_2/V_3)^*\}$$

(2) Input Variables:

XW water content
V2M absolute velocity at stator inlet
V3M absolute velocity at stator outlet
V2V3S ratio of absolute velocity at stator inlet and
 absolute velocity at stator outlet at the design
 point
I stage

(3) Output Variable:

FK diffusion constant

(4) Usage:

CALL CSDEVS(XW, V2M, V3M, V2V3S, I, FK)

SUBROUTINE CDEVSL

(1) Description:

The subroutine CDEVSL calculates the value of stator diffusion constant, K, for large droplet calculation. After determining the value of K, the deviation, δ , can be determined by the following:

$$\delta = \delta^* + K \{(V_2/V_3) - (V_2/V_3)^*\}$$

(2) Input Variables:

XW	water content
V2M	absolute velocity at stator inlet
V3M	absolute velocity at stator outlet
V2V3S	ratio of absolute velocity at stator inlet and absolute velocity at stator outlet at the design point
I	stage

(3) Output Variable:

FK	diffusion constant
----	--------------------

(4) Usage:

CALL CDEVSL(XW, V2M, V3M, V2V3S, I, FK)

SUBROUTINE CSDEV

(1) Description:

The subroutine CSDEV calculates the value of rotor diffusion angle, K, for small droplet calculation. After determining the value of K, the deviation, δ , can be determined by the following:

$$\delta = \delta^* + K \{(W_2/W_3) - (W_2/W_3)^*\}$$

(2) Input Variables:

SPEEDF	rotor speed
XW	water content
V3MR	relative velocity at rotor outlet
V2MR	relative velocity at rotor inlet

V3DV2 ratio of relative velocity at rotor inlet and
 relative velocity at rotor outlet at the design
 point
 I stage

(3) Output Variable:

FK diffusion constant

(4) Usage:

CALL CSDEV(SPEEDF, XW, V3MR, V2MR, V3DV2, I, FK)

SUBROUTINE CSDEVL

(1) Description:

The subroutine CSDEVL calculates the value of rotor diffusion constant for large droplet calculation. After determining the value of K, the deviation, δ , can be determined by the following:

$$\delta = \delta^* + K \{(W_2/W_3) - (W_2/W_3)^*\}$$

(2) Input Variables:

SPEEDF rotor speed
 XW water content
 V3MR relative velocity at rotor outlet
 V2MR relative velocity at rotor inlet
 V3DV2 ratio of relative velocity at rotor inlet and
 relative velocity at rotor outlet and the design
 point
 I stage

(3) Output Variable:

FK diffusion constant

(4) Usage:

CALL CSDEVL(SPEED, XW, V3MR, V2MR, V3DV2, I, FK)

FUNCTION DELK70

(1) Description:

The function DELK70 calculates the difference between diffusion constant at 90 per cent rotor speed and diffusion constant at 70 per cent rotor speed.

(2) Input Variables:

I stage
T1 $(W_2/W_3) - (W_2/W_3)^*$

(3) Output Variable:

DELK70 difference between diffusion constant at 90 per cent rotor speed and diffusion constant at 70 per cent rotor speed

(4) Usage:

DELK70(I, T1)

FUNCTION DELK80

(1) Description:

The function DELK80 calculates the difference between diffusion constant at 90 per cent rotor speed and diffusion constant at 80 per cent rotor speed.

(2) Input Variables:

I stage
T1 $(W_2/W_3) - (W_2/W_3)^*$

(3) Output Variable:

DELK80 difference between diffusion constant at 90 per cent rotor speed and diffusion constant at 80 per cent rotor speed

(4) Usage:

DELK80(I, T1)

FUNCTION DELK10

(1) Description:

The function DELK10 calculates the difference between diffusion constant at 90 per cent rotor speed and diffusion constant at 100 per cent rotor speed.

(2) Input Variables:

I stage
T1 $(W_2/W_3) - (W_2/W_3)^*$

(3) Output Variable:

DELK10 difference between diffusion constant at 90 per cent rotor speed and diffusion constant at 100 per cent rotor speed

(4) Usage:

DELK10(I, T1)

FUNCTION DPHI

(1) Description:

When the efficiency-flow coefficient curve is input at reference speed, the function DPHI alters the curve for off-reference speed.

(2) Input Variables:

I stage
ISPD rotor speed in per cent

(3) Output Variable:

DPHI amount of flow coefficient which is shifted for all-reference speed

(4) Usage:

DPHI(I, ISPD)

SUBROUTINE CSETA1

(1) Description:

The subroutine CSETA1 corrects the stage efficiency for the presence of water in the small droplet calculation.

(2) Input Variables:

I stage
J index for speed
K index for point on a particular speed
XW water content
PHID flow coefficient at design point
PHIR flow coefficient
ETAD stage efficiency before correction for the
 presence of water

(3) Output Variable:

ETAD stage efficiency after correction for the pres-
 ence of water

(4) Usage:

CALL CSETA1(I, J, K, XW, PHID, PHIR, ETAD)

SUBROUTINE CSETAL

(1) Description:

The subroutine CSETAL corrects the stage efficiency for the presence of water in the large droplet calculation.

(2) Input Variables:

I stage
J index for speed
K index for point on a particular speed
XW water content
PHID flow coefficient at design point
PHIR flow coefficient
ETAD stage efficiency before correction for the pres-
 ence of water
ETADD stage efficiency at design point

(3) Output Variable:

ETAD stage efficiency after correction for the pres-
 ence of water

(4) Usage:

CALL CSETAL(I, J, K, XW, PHID, PHIR, ETAD, ETADD)

SUBROUTINE CSPSD

(1) Description:

The subroutine CSPSD alters the pressure coefficient for off design speeds. This subroutine is the same as one used in NASA-STGSTK program.

(2) Input Variables:

All input variables are specified in Common blocks.

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL CSPSD

SUBROUTINE CSPAN

(1) Description:

The subroutine CSPAN alters flow coefficient and pressure coefficient for blade reset. This subroutine is the same as one used in NASA-STGSTK program.

(2) Input Variables:

All input variables are specified in Common blocks.

(3) Output Variables:

All output variables are specified in Common blocks.

(4) Usage:

CALL CSPAN

SUBROUTINE CSOUP

(1) Description:

The subroutine CSOUP calculates the stage performance and prints them out in the small droplet calculation.

(2) Input Variables:

FAIO	initial flow coefficient
ISTAGE	stage
FLOW1	mass flow rate
ALFA1	absolute flow angle at rotor inlet
BETA1	relative flow angle at rotor outlet

(3) Output Variables:

BETA2	relative flow angle at rotor outlet
VZ	axial velocity
ALFA2	absolute flow angle at rotor outlet
ALFA3	absolute flow angle at stator outlet
DELTA	rise in stagnation temperature of gas phase
DELTA	temperature rise of water
W1	relative velocity at rotor inlet
W2	relative velocity at rotor outlet
V1	absolute velocity at stator inlet
V2	absolute velocity at stator outlet

(4) Usage:

```
CALL CSOUP2(FAIO, ISTAGE, FLOW1, ALFA1, BETA1, BETA2, VZ,  
            ALFA2, ALFA3, DELTA, DELTA, W1, W2, V1, V2)
```

SUBROUTINE CSOUP2

(1) Description:

The subroutine CSOUP2 calculates the stage performance and prints them out in the small droplet calculation.

(2) Input Variables:

FAIO	initial flow coefficient
ISTAGE	stage
FLOW1	mass flow rate
ALFA1	absolute flow angle at rotor inlet
BETA1	relative flow angle at rotor outlet

(3) Output Variables:

BETA2	relative flow angle at rotor outlet
VZ	axial velocity
ALFA2	absolute flow angle at rotor outlet
ALFA3	absolute flow angle at stator outlet
DELTG	rise in stagnation temperature of gas phase
DELTW	temperature rise of water
W1	relative velocity at rotor inlet
W2	relative velocity at rotor outlet
V1	absolute velocity at stator inlet
V2	absolute velocity at stator outlet

(4) Usage:

```
CALL CSOUP(T, FAIO, I, STAGE, FLOW1, ALFA1, BETA1, BETA2, VZ,  
           ALFA2, ALFA3, DELTG, DELTW, W1, W2, V1, V2)
```

APPENDIX 3

ILLUSTRATIVE TEST CASES FOR THE NASA-WISGSK CODE

Two illustrative test cases for the calculation of the Test Compressor performance utilizing the NASA-WISGSK Code are presented as follows.

- 1) Test Case No. 1: Operation with air flow at 100 percent of design speed at the meanline section of the compressor.
- 2) Test Case No. 2: Operation with air-water mixture containing large droplets (with a mass fraction of 0.04 of water) at 100 percent of design speed at the meanline section of the compressor.

Test Case No. 1

***** INPUT DATA *****

NS(NUMBER OF STAGE)= 6
 IPERFM=I
 PERFORMANCE AT MEAN

	1	2	3	4	5	6	
RRHUB(I)	.770	1.035	1.232	1.378	1.489	1.572	
RC(I)	.605	.554	.534	.510	.483	.456	
RBLADE(I)	16.00	20.00	20.00	25.00	28.00	32.00	
STAGER(I)	34.25	29.86	27.37	28.30	29.17	29.75	
STAGES(I)	23.67	25.62	26.94	28.41	29.82	38.99	
SRHUB(I)	.923	1.145	1.311	1.445	1.538	1.580	.774
SC(I)	.442	.412	.412	.412	.412	.412	
SELADE(I)	14.00	26.00	28.00	32.00	36.00	30.00	
SIGUMR(I)	1.052	1.120	1.037	1.182	1.211	1.283	
SIGUMS(I)	.640	1.061	1.093	1.199	1.311	1.087	
FAISTL(I)	I	I	I	I	I	I	
GAPR(I)	.125	.125	.125	.125	.125	.125	
CAPS(I)	.125	.125	.125	.125	.125	.125	
RRTIP(I)	2.16	2.16	2.16	2.16	2.16	2.16	
SRTIP(I)	2.16	2.16	2.16	2.16	2.16	2.16	2.16
RT(I)	2.149	2.151	2.148	2.149	2.149	2.147	
RM(I)	1.426	1.575	1.642	1.722	1.789	1.836	
RH(I)	.781	1.056	1.252	1.411	1.533	1.621	
SH(I)	2.147	2.138	2.127	2.123	2.118	2.100	
SM(I)	1.502	1.573	1.637	1.712	1.766	1.784	
SH(I)	.934	1.152	1.318	1.453	1.548	1.592	
BLOCK(I)	.983	.976	.967	.949	.923	.902	
BLOCKS(I)	.978	.966	.945	.929	.908	.863	
BET1MR(I)	42.72	42.74	41.62	42.85	44.00	45.07	
BET2MR(I)	25.79	17.17	13.12	13.76	14.33	14.43	
BET1MS(I)	35.15	40.11	43.36	45.00	48.31	48.71	0
BET2MS(I)	12.19	11.13	10.51	11.61	13.32	29.28	21.99
PR12D(I)	1.154	1.165	1.221	1.237	1.230	1.215	
PR13D(I)	1.152	1.159	1.213	1.223	1.221	1.208	
ETARD(I)	.986	.986	.988	.985	.962	.954	

***** INPUT DATA *****

FNF(FRACTION OF DESIGN CORRECTED SPEED)=1.000
XDIN(INITIAL WATER CONTENT OF SMALL DROPLET)= 0
XDDIN(INITIAL WATER CONTENT OF LARGE DROPLET)= 0
RHUMID(INITIAL RELATIVE HUMIDITY)= .00 PER CENT
XCH4(INITIAL METHANE CONTENT)= 0
TOG(COMPRESSOR INLET TOTAL TEMPERATURE OF GAS)= 518.70
TOW(COMPRESSOR INLET TEMPERATURE OF DROPLET)= 513.70
PO(COMPRESSOR INLET TOTAL PRESSURE)=2116.80
DIN(INITIAL DROPLET DIAMETER OF SMALL DROPLET)= 20.0
DDIN(INITIAL DROPLET DIAMETER OF LARGE DROPLET)= 600.0
FND(DESIGN ROTATIONAL SPEED)=51120.0
DSMASS(DESIGN MASS FLOW RATE)= .3755
COMPRESSOR INLET TATAL TEMPERATURE(GAS PHASE) 518.70 R
COMPRESSOR INLET TOTAL PRESSURE=2116.80 LB/FT**2
PREB(PERCENT OF WATER THAT REBOUND AFTER IMPINGEMENT)= 50.0 PERCENT
ROTOR SPEED=51120.0 RPM
CORRECTED ROTOR SPEED= 51120.0 RPM(100.0PER CENT OF DESIGN CORRECTED SPEED)

***** DESIGN POINT INFORMATION ***** **

***** COMPRESSOR INLET *****

TOTAL TEMPERATURE AT COMPRESSOR INLET= 518.70000
TOTAL PRESSURE AT COMPRESSOR INLET= 2116.80
STATIC TEMPERATURE AT COMPRESSOR INLET= 496.28109
STATIC PRESSURE AT COMPRESSOR INLET= 1813.73
STATIC DENSITY AT COMPRESSOR INLET= .06850

ACOUSTIC SPEED AT COMPRESSOR INLET=1092.25914
AXIAL VELOCITY AT COMPRESSOR INLET= 518.81873
MACH NUMBER AT COMPRESSOR INLET= .47500
STREAMTUBE AREA AT COMPRESSOR INLET= .01057
FLOW COEFFICIENT AT COMPRESSOR INLET= .53817

***** DESIGN POINT INFORMATION ***** **

***** STAGE= 1 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	518.700	2116.800	492.637	1767.579	.067
ROTOR OUTLET	541.148	2442.787	508.269	1931.576	.072
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	538.76531	559.39838	725.32398	150.52734	485.62003
ROTOR OUTLET	525.97105	628.55662	618.75550	344.14838	325.90306
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	639.147	.514	.667	536.454	2381.210
ROTOR OUTLET	670.051	.589	.560	540.141	5091.790
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	15.61000	42.03015	.01036	1.42600	.55886
ROTOR OUTLET	33.19714	31.78325	.00937	1.50200	.54559
STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.15200					
STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .95383					
ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.15400					
ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .98600					
ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.04328					

***** DESIGN POINT INFORMATION ***** **

***** STAGE= 2 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	541.148	2438.554	511.984	2008.852	.074
ROTOR OUTLET	566.141	2340.915	522.316	2142.394	.077
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	549.21299	591.88727	730.68951	220.67086	481.94632
ROTOR OUTLET	581.16447	725.94045	639.44211	435.01464	266.71034
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	702.617	.534	.659	556.431	2688.136
ROTOR OUTLET	701.725	.648	.571	556.331	5751.007
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	21.89000	41.26765	.00930	1.57500	.56970
ROTOR OUTLET	36.81569	24.65154	.00841	1.57300	.60285
STAGE TOTAL PRESSURE RATIO AT DESIGN POINT=	1.15900				
STAGE ADIABATIC EFFICIENCY AT DESIGN POINT=	.93231				
ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT=	1.16500				
ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT=	.96600				
ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT=	1.04618				

***** DESIGN POINT INFORMATION ***** **

***** STAGE= 3 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	556.141	2826.284	535.362	2323.868	.081
ROTOR OUTLET	600.462	3450.892	549.786	2533.049	.086
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	574.81563	608.26663	784.29006	198.93541	533.57089
ROTOR OUTLET	614.43880	781.11343	662.59507	482.28950	247.98627
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	732.506	.536	.692	586.533	3199.070
ROTOR OUTLET	730.276	.680	.577	586.263	6929.751
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	19.09000	42.86692	.00803	1.64200	.59626
ROTOR OUTLET	38.12932	21.97890	.00708	1.63700	.63736

STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.21300
 STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .93464
 ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.22100
 ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .96800
 ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.06062

***** DESIGN POINT INFORMATION *****

***** STAGE= 4 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	600.462	3428.282	569.069	2839.988	.094
ROTOR OUTLET	639.381	4240.785	585.841	3118.959	.100
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	580.04590	614.69778	809.54747	203.47020	564.72459
ROTOR OUTLET	619.63965	803.61317	668.93304	511.70446	252.02926
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	768.195	.526	.692	623.519	3912.431
ROTOR OUTLET	763.734	.678	.564	622.951	8231.914
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	19.33000	44.23321	.00692	1.72200	.60169
ROTOR OUTLET	39.55025	22.13332	.00607	1.71200	.64276

STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.22800
 STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .93002
 ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.23700
 ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .96500
 ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.06481

***** DESIGN POINT INFORMATION ***** **

***** STAGE= 5 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	639.381	4209.930	606.962	3506.755	.108
ROTOR OUTLET	679.732	5178.214	625.197	3857.244	.116
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	596.84149	625.22167	826.78513	215.68308	582.40082
ROTOR OUTLET	617.06868	811.98444	669.65381	527.75042	260.07304
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	798.084	.518	.685	663.653	4798.526
ROTOR OUTLET	787.823	.663	.547	662.302	9691.778
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	20.18000	44.78240	.00591	1.78900	.60873
ROTOR OUTLET	40.53794	22.85308	.00526	1.76600	.64011

STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.22100
 STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .92580
 ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.23000
 ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .96200
 ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.06311

***** DESIGN POINT INFORMATION ***** ***

***** STAGE= 6 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	679.732	5140.325	646.933	4318.954	.125
ROTOR OUTLET	720.259	6245.495	665.989	4736.291	.133
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	587.19574	629.60666	633.74045	227.16890	591.86199
ROTOR OUTLET	603.35773	811.06676	654.61329	542.02320	253.83017
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	819.051	.506	.669	704.449	5829.034
ROTOR OUTLET	795.653	.642	.518	701.350	10970.182
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	21.15000	45.22772	.00511	1.83600	.60910
ROTOR OUTLET	41.93288	22.81484	.00467	1.78400	.62591

STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.20800
 STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .92365
 ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.21500
 ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .95400
 ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.05962

***** DESIGN POINT INFORMATION ***** **

***** OVERALL PERFORMANCE AT DESIGN POINT **** *****

COMPRESSOR INLET TOTAL TEMPERATURE= 518.70

COMPRESSOR INLET TOTAL PRESSURE= 2116.80

CORRECTED MASS FLOW RATE= 3.168

OVERALL TOTAL PRESSURE RATIO=2.9334

OVERALL TOTAL TEMPERATURE RATIO=1.3886

OVERALL ADIABATIC EFFICIENCY= .9223

OVERALL TEMPERATURE RISE= 201.559

	1	2	3	4	5	6	IGU
BET1SR(I)	42.03	41.27	42.87	44.23	44.78	45.23	
BET2SR(I)	31.78	24.65	21.98	22.13	22.85	22.81	
AINCSR(I)	-.69	-1.47	1.25	1.38	.78	.16	
ADEUSR(I)	5.99	7.48	8.86	8.37	8.52	8.38	
BET1SS(I)	33.20	35.82	38.13	39.55	40.54	41.93	
BET2SS(I)	21.89	19.09	19.33	20.18	21.15	34.86	15.61
AINCSS(I)	-1.95	-3.29	-5.23	-5.45	-5.77	-6.78	
ADEUSS(I)	9.70	7.96	8.82	8.37	7.83	5.58	
TD(I)	518.7	541.1	566.1	600.5	639.4	679.7	
OMEGS(I)	.009	.021	.025	.028	.029	.024	
OMEGR(I)	.113	.018	.018	.016	.004	.036	

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 1) *****

STAGE TOTAL PRESSURE RATIO= 1.16675
 STAGE TOTAL TEMPERATURE RATIO= 1.04756
 STAGE ADIABATIC EFFICIENCY= .94581

STAGE FLOW COEFFICIENT= .501
 AXIAL VELOCITY= 480.05
 ROTOR SPEED= 958.68

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	2116.8000	2469.7801	2469.7801
STATIC PRESSURE	1835.8585	2047.8529	
TOTAL TEMPERATURE(GAS)	518.7000	543.3687	543.3687
STATIC TEMPERATURE(GAS)	498.0506	515.0967	
STATIC DENSITY(GAS)	.0691	.0745	
AXIAL VELOCITY	480.0486	467.4542	
ABSOLUTE VELOCITY	498.4330	583.2886	
RELATIVE VELOCITY	694.6048	567.1588	
BLADE SPEED	636.1474	670.0514	702.6172
TANG. COMP. OF ABS. VEL.	134.1223	348.8727	
TANG. COMP. OF REL. VEL.	502.0251	321.1787	
ACOUSTIC SPEED	1093.5459	1112.1022	
ABSOLUTE MACH NUMBER	.4558	.5245	
RELATIVE MACH NUMBER	.6352	.5100	
FLOW COEFFICIENT	.5007	.4881	
FLOW AREA	.0104	.0093	
ABSOLUTE FLOW ANGLE	15.6100	36.7349	21.8900
RELATIVE FLOW ANGLE	46.2819	34.4922	
INCIDENCE	3.5619	1.5849	
DEVIATION		8.7422	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 1) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.16675
 STAGE TOTAL TEMPERATURE RATIO= 1.04756
 STAGE ADIABATIC EFFICIENCY= .94773

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS=	1.00000	1.00000	1.00000
WMASS=	0	0	0
WMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34491	.34491	.34491
CMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34491	.34491	.34491
TMASS=	.34491	.34491	.34491
WS=	.00000	.00000	.00000
RHOA=	.07649	.07444	.07856
RHOM=	.06904	.07444	.07856
RHOC=	.06910	.07444	.07856
TG=	518.70000	543.36874	543.36874
TW=	513.70000	0	0
TWW=	513.70000	0	513.70000
P=	2116.80000	2469.78012	2469.78012
TB=	671.40656	0	679.03308
TDEW=	271.95506	273.23829	273.23829

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 2) *****

STAGE TOTAL PRESSURE RATIO= 1.19107
 STAGE TOTAL TEMPERATURE RATIO= 1.05518
 STAGE ADIABATIC EFFICIENCY= .92667

STAGE FLOW COEFFICIENT= .503
 AXIAL VELOCITY= 482.20
 ROTOR SPEED= 959.57

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	2469.7801	2941.6925	2941.6925
STATIC PRESSURE	2130.2903	2311.9417	
TOTAL TEMPERATURE(GAS)	543.3687	573.3511	573.3511
STATIC TEMPERATURE(GAS)	520.9302	535.2941	
STATIC DENSITY(GAS)	.0767	.0810	
AXIAL VELOCITY	482.2002	504.5504	
ABSOLUTE VELOCITY	519.6676	676.8799	
RELATIVE VELOCITY	701.0474	563.3171	
BLADE SPEED	702.6172	701.7250	732.5063
TANG. COMP. OF ABS. VEL.	193.7455	451.2154	
TANG. COMP. OF REL. VEL.	508.8717	250.5096	
ACOUSTIC SPEED	1118.2902	1133.6031	
ABSOLUTE MACH NUMBER	.4647	.5971	
RELATIVE MACH NUMBER	.6269	.4969	
FLOW COEFFICIENT	.5025	.5290	
FLOW AREA	.0093	.0084	
ABSOLUTE FLOW ANGLE	21.8900	41.8060	19.0900
RELATIVE FLOW ANGLE	46.5416	26.4044	
INCIDENCE	3.8016	1.6960	
DEVIATION		9.2344	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 2) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.19107
 STAGE TOTAL TEMPERATURE RATIO= 1.05518
 STAGE ADIABATIC EFFICIENCY= .92822

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XV=	.00000	.00000	.00000
XW=	0	0	0
XWW=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS=	1.00000	1.00000	1.00000
WMASS=	0	0	0
WWMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34491	.34491	.34491
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34491	.34491	.34491
TMASS=	.34491	.34491	.34491
WS=	.00000	.00000	.00000
RHQA=	.08519	.08076	.09103
RHQM=	.06904	.08076	.09103
RHQC=	.07666	.08076	.09103
TG=	543.36874	573.35113	573.35113
TW=	0	0	0
TWW=	513.70000	0	513.70000
P=	2469.78012	2941.69246	2941.69246
TB=	679.03308	0	687.89220
TDEW=	273.23829	274.66167	274.66167

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 3) *****

STAGE TOTAL PRESSURE RATIO= 1.23327
 STAGE TOTAL TEMPERATURE RATIO= 1.06669
 STAGE ADIABATIC EFFICIENCY= .92335

STAGE FLOW COEFFICIENT= .514
 AXIAL VELOCITY= 492.32
 ROTOR SPEED= 958.24

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	2941.6925	3627.8878	3627.8878
STATIC PRESSURE	2555.6014	2821.5666	
TOTAL TEMPERATURE(GAS)	573.3511	611.5863	611.5863
STATIC TEMPERATURE(GAS)	550.8154	569.3302	
STATIC DENSITY(GAS)	.0870	.0929	
AXIAL VELOCITY	492.3213	522.1031	
ABSOLUTE VELOCITY	520.9716	713.5891	
RELATIVE VELOCITY	747.2351	576.2383	
BLADE SPEED	732.5063	730.2758	768.1948
TANG. COMP. OF ABS. VEL.	170.3853	486.4338	
TANG. COMP. OF REL. VEL.	562.1210	243.8420	
ACOUSTIC SPEED	1149.6996	1168.8627	
ABSOLUTE MACH NUMBER	.4531	.6105	
RELATIVE MACH NUMBER	.6499	.4930	
FLOW COEFFICIENT	.5138	.5502	
FLOW AREA	.0080	.0071	
ABSOLUTE FLOW ANGLE	19.0900	42.9744	19.3300
RELATIVE FLOW ANGLE	48.7872	25.0344	
INCIDENCE	7.1672	-.3856	
DEVIATION		11.9144	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 3) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.23327
 STAGE TOTAL TEMPERATURE RATIO= 1.06669
 STAGE ADIABATIC EFFICIENCY= .92441

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWJ=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS	1.00000	1.00000	1.00000
WMASS=	0	0	0
WMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34491	.34491	.34491
CMMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34491	.34491	.34491
TMASS=	.34491	.34491	.34491
WS=	.00000	.00000	.00000
RHOA=	.09617	.09264	.10713
RHOM=	.06904	.09264	.10713
RHOG=	.08698	.09264	.10713
TC=	573.35113	611.58634	611.58634
TW=	0	0	0
TWW=	513.70000	0	513.70000
P=	2941.69246	3627.88778	3627.88778
TB=	687.89220	0	698.82458
TDEW=	274.66167	276.38807	276.38807

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 4) *****

STAGE TOTAL PRESSURE RATIO= 1.24777
 STAGE TOTAL TEMPERATURE RATIO= 1.07115
 STAGE ADIABATIC EFFICIENCY= .91401

STAGE FLOW COEFFICIENT= .512
 AXIAL VELOCITY= 491.04
 ROTOR SPEED= 958.68

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	3627.8878	4526.7581	4526.7581
STATIC PRESSURE	3181.1072	3530.5184	
TOTAL TEMPERATURE(GAS)	611.5863	655.1013	655.1013
STATIC TEMPERATURE(GAS)	589.1312	610.3937	
STATIC DENSITY(GAS)	.1012	.1084	
AXIAL VELOCITY	491.0360	521.6561	
ABSOLUTE VELOCITY	520.3705	734.5837	
RELATIVE VELOCITY	772.1853	576.9815	
BLADE SPEED	768.1948	763.7337	798.0839
TANG. COMP. OF ABS. VEL.	172.2471	517.1925	
TANG. COMP. OF REL. VEL.	595.9478	246.5412	
ACOUSTIC SPEED	1188.6369	1209.8965	
ABSOLUTE MACH NUMBER	.4378	.6071	
RELATIVE MACH NUMBER	.6486	.4769	
FLOW COEFFICIENT	.5122	.5508	
FLOW AREA	.0069	.0061	
ABSOLUTE FLOW ANGLE	19.3300	44.7538	20.1800
RELATIVE FLOW ANGLE	50.5129	25.2960	
INCIDENCE	7.6629	-.2462	
DEVIATION		11.5360	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 4) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.24777
 STAGE TOTAL TEMPERATURE RATIO= 1.07115
 STAGE ADIABATIC EFFICIENCY= .91452

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS=	1.00000	1.00000	1.00000
WMASS=	0	0	0
WMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34491	.34491	.34491
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34491	.34491	.34491
TMASS=	.34491	.34491	.34491
WS=	.00000	.00000	.00000
RHOA=	.11118	.10816	.12629
RHOM=	.06904	.10816	.12629
RHOG=	.10123	.10816	.12629
TC=	611.58634	655.10129	655.10129
TW=	0	0	0
TWW=	513.70000	0	513.70000
P=	3627.88778	4526.75812	4526.75812
TB=	698.82458	0	710.75001
TDEW=	276.38807	278.23445	278.23445

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 5) *****

STAGE TOTAL PRESSURE RATIO= 1.24015
 STAGE TOTAL TEMPERATURE RATIO= 1.06957
 STAGE ADIABATIC EFFICIENCY= .90502

STAGE FLOW COEFFICIENT= .513
 AXIAL VELOCITY= 491.33
 ROTOR SPEED= 958.68

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	4526.7581	5613.8784	5613.8784
STATIC PRESSURE	3998.7709	4431.6060	
TOTAL TEMPERATURE(GAS)	655.1013	700.7430	700.7430
STATIC TEMPERATURE(GAS)	632.4225	655.2672	
STATIC DENSITY(CAS)	.1185	.1268	
AXIAL VELOCITY	491.3271	515.3153	
ABSOLUTE VELOCITY	523.4605	741.7059	
RELATIVE VELOCITY	789.1231	574.6752	
BLADE SPEED	798.0839	787.8235	819.0509
TANG. COMP. OF ABS. VEL.	180.5785	533.4582	
TANG. COMP. OF REL. VEL.	617.5054	254.3652	
ACOUSTIC SPEED	1230.9834	1253.0193	
ABSOLUTE MACH NUMBER	.4252	.5919	
RELATIVE MACH NUMBER	.6411	.4566	
FLOW COEFFICIENT	.5125	.5454	
FLOW AREA	.0059	.0053	
ABSOLUTE FLOW ANGLE	20.1800	45.9911	21.1500
RELATIVE FLOW ANGLE	51.4920	26.2714	
INCIDENCE	7.4920	-.3189	
DEVIATION		11.9414	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 5) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.24015
 STAGE TOTAL TEMPERATURE RATIO= 1.06967
 STAGE ADIABATIC EFFICIENCY= .90499

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER- STAGE ADJUST- MENT)	**STAGE OUTLET** (AFTER INTER- STAGE ADJUST- MENT)
XU=	.00000	.00000	.00000
XN=	0	0	0
XW=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS=	1.00000	1.00000	1.00000
WMASS=	0	0	0
WWMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34491	.34491	.34491
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34491	.34491	.34491
TMASS=	.34491	.34491	.34491
WS=	.00000	.00000	.00000
RHOA=	.12952	.12654	.14756
RHOM=	.06904	.12654	.14756
RHOG=	.11854	.12654	.14756
TG=	655.10129	700.74303	700.74303
TW=	0	0	0
TWW=	513.70000	0	513.70000
P=	4526.75812	5613.87838	5613.87838
TB=	710.75001	0	725.82464
TDEW=	278.23445	270.76654	270.76654

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 6) *****

STAGE TOTAL PRESSURE RATIO= 1.22479
 STAGE TOTAL TEMPERATURE RATIO= 1.06583
 STAGE ADIABATIC EFFICIENCY= .89836

STAGE FLOW COEFFICIENT= .509
 AXIAL VELOCITY= 487.17
 ROTOR SPEED= 957.79

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	5613.8784	6875.8088	6875.8088
STATIC PRESSURE	5002.4952	5515.2479	
TOTAL TEMPERATURE(GAS)	700.7430	746.8730	746.8730
STATIC TEMPERATURE(GAS)	678.2178	701.7038	
STATIC DENSITY(GAS)	.1383	.1473	
AXIAL VELOCITY	487.1682	500.2128	
ABSOLUTE VELOCITY	522.3545	740.2563	
RELATIVE VELOCITY	796.8461	559.2849	
BLADE SPEED	819.0509	795.8534	.5000
TANG. COMP. OF ABS. VEL.	188.4712	545.6800	
TANG. COMP. OF REL. VEL.	630.5797	250.1734	
ACOUSTIC SPEED	1274.0547	1295.9266	
ABSOLUTE MACH NUMBER	.4100	.5712	
RELATIVE MACH NUMBER	.6254	.4316	
FLOW COEFFICIENT	.5086	.5339	
FLOW AREA	.0051	.0047	
ABSOLUTE FLOW ANGLE	21.1500	47.4892	0
RELATIVE FLOW ANGLE	52.3113	26.5712	
INCIDENCE	7.2413	-1.2208	
DEVIATION		12.1412	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 6) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.22479
 STAGE TOTAL TEMPERATURE RATIO= 1.06583
 STAGE ADIABATIC EFFICIENCY= .89787

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS=	1.00000	1.00000	1.00000
WMASS=	0	0	0
WWMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34491	.34491	.34491
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34491	.34491	.34491
TMASS=	.34491	.34491	.34491
WS=	.00000	.00000	.00000
RHOA=	.15016	.14714	.17073
RHOM=	.06904	.14714	.17073
RHOG=	.13828	.14714	.17073
TG=	700.74303	746.87297	746.87297
TW=	0	0	0
TWW=	513.70000	0	513.70000
P=	5613.87838	6875.80878	6875.80878
TB=	725.82464	0	738.30219
TDEW=	270.76654	272.48445	272.48445

***** OVERALL PERFORMANCE *****

INITIAL FLOW COEFFICIENT= .50

CORRECTED SPEED=51120.0 1.000 FRACTION OF DEIGN CORRECTED SPEED

INITIAL WATER CONTENT(SMALL DROPLET)= 0

INITIAL WATER CONTENT(LARGE DROPLET)= 0

INITIAL WATER CONTENT(TOTAL)= 0

INITIAL RELATIVE HUMIDITY= .0 PER CENT

INITIAL METHANE CONTENT= 0

COMPRESSOR INLET TOTAL TEMPERATURE= 518.70

COMPRESSOR INLET TOTAL PRESSURE= 2116.80

CORRECTED MASS FLOW RATE OF MIXTURE= .345(2.910)

CORRECTED MASS FLOW RATE OF GAS PHASE .345(2.910)

OVERALL TOTAL PRESSURE RATIO=3.2482

OVERALL TOTAL TEMPERATURE RATIO=1.4399

OVERALL ADIABATIC EFFICIENCY= .9046

OVERALL TEMPERATURE RISE OF GAS PHASE= 228.173

Test Case No. 2

***** INPUT DATA *****

NS(NUMBER OF STAGE)= 6
 IPERFM=I
 PERFORMANCE AT MEAN

	1	2	3	4	5	6	
RRHUB(I)	.770	1.035	1.232	1.378	1.489	1.572	
RC(I)	.605	.554	.534	.510	.483	.456	
RBLADE(I)	16.00	20.00	20.00	25.00	26.00	32.00	
STAGER(I)	34.25	29.56	27.37	26.30	29.17	29.75	
STAGES(I)	23.67	25.62	26.94	26.41	29.82	36.99	
SRHUB(I)	.923	1.145	1.311	1.445	1.538	1.580	.774
SC(I)	.442	.412	.412	.412	.412	.412	
SBLADE(I)	14.00	26.00	28.00	32.00	36.00	30.00	
SIGUMR(I)	1.052	1.120	1.037	1.182	1.211	1.283	
SIGUMS(I)	.640	1.061	1.093	1.159	1.311	1.087	
FA1STL(I)	I	I	I	I	I	I	
CAPR(I)	.125	.125	.125	.125	.125	.125	
GAPS(I)	.125	.125	.125	.125	.125	.125	
RRTIP(I)	2.16	2.16	2.16	2.16	2.16	2.16	
SRTIP(I)	2.16	2.16	2.16	2.16	2.16	2.16	2.16
RT(I)	2.149	2.151	2.148	2.149	2.149	2.147	
RM(I)	1.426	1.575	1.642	1.722	1.789	1.836	
RH(I)	.781	1.056	1.252	1.411	1.533	1.621	
SH(I)	2.147	2.138	2.127	2.123	2.118	2.100	
SM(I)	1.502	1.573	1.637	1.712	1.766	1.784	
SH(I)	.934	1.152	1.318	1.453	1.548	1.592	
BLOCK(I)	.983	.976	.967	.949	.923	.902	
BLOCKS(I)	.978	.966	.945	.928	.908	.863	
BET1MR(I)	42.72	42.74	41.62	42.85	44.00	45.07	
BET2MR(I)	25.79	17.17	13.12	13.76	14.33	14.43	
BET1MS(I)	35.15	40.11	43.36	45.00	46.31	48.71	0
BET2MS(I)	12.19	11.13	10.51	11.81	13.32	29.28	21.99
PR12D(I)	1.154	1.165	1.221	1.237	1.230	1.215	
PR13D(I)	1.152	1.159	1.213	1.226	1.221	1.208	
ETARD(I)	.966	.966	.968	.965	.962	.954	

***** INPUT DATA *****

FNF(FRACTION OF DESIGN CORRECTED SPEED)=1.000
XDIN(INITIAL WATER CONTENT OF SMALL DROPLET)= 0
XDDIN(INITIAL WATER CONTENT OF LARGE DROPLET)= .040
RHUMID(INITIAL RELATIVE HUMIDITY)= .00 PER CENT
XCH4(INITIAL METHANE CONTENT)= 0
TOG(COMPRESSOR INLET TOTAL TEMPRATURE OF GAS)= 518.70
TOW(COMPRESSOR INLET TEMPERATURE OF DROPLRET)= 513.70
PO(COMPRESSOR INLET TOTAL PRESSURE)=2116.80
DIN(INITIIL DROPLET DIAMETER OF SMALL DROPLET)= 20.0
DDIN(INITIAL DROPLET DIAMETER OF LARGE DROPLET)= 600.0
FND(DESIGN ROTATIONAL SPEED)=51120.0
DSMASS(DESIGN MASS FLOW RATE)= .3755
COMPRESSOR INLET TATAL TEMPERATURE(GAS PHASE) 518.70 R
COMPRESSOR INLET TOTAL PRESSURE=2116.80 LB/FT**2
PREB(PERCENT OF WATER THAT REBOUND AFTER IMPINGE MENT)= 50.0 PERCENT
ROTOR SPEED=51120.0 RPM
CORRECTED ROTOR SPEED= 51120.0 RPM(100.0PER CENT OF DESIGN CORRECTED SPEED)

***** DESIGN POINT INFORMATION ***** **

***** COMPRESSOR INLET *****

TOTAL TEMPERATURE AT COMPRESSOR INLET= 518.70000
TOTAL PRESSURE AT COMPRESSOR INLET= 2116.80
STATIC TEMPERATURE AT COMPRESSOR INLET= 496.28109
STATIC PRESSURE AT COMPRESSOR INLET= 1813.73
STATIC DENSITY AT COMPRESSOR INLET= .06850

ACOUSTIC SPEED AT COMPRESSOR INLET=1092.25914
AXIAL VELOCITY AT COMPRESSOR INLET= 518.81873
MACH NUMBER AT COMPRESSOR INLET= .47500
STREAMTUBE AREA AT COMPRESSOR INLET= .01057
FLOW COEFFICIENT AT COMPRESSOR INLET= .53817

***** DESIGN POINT INFORMATION ***** ***

***** STAGE= 1 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	518.700	2116.800	492.637	1767.579	.067
ROTOR OUTLET	541.148	2442.787	508.269	1961.576	.072
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	538.76531	559.39838	725.32398	150.52734	485.62003
ROTOR OUTLET	525.97105	628.55682	618.75550	344.14838	325.90306
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	636.147	.514	.667	536.454	2381.210
ROTOR OUTLET	670.051	.569	.560	540.141	5091.790
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	15.61000	42.03015	.01036	1.42600	.55886
ROTOR OUTLET	33.19714	31.78325	.00987	1.50200	.54559
STAGE	TOTAL PRESSURE RATIO AT DESIGN POINT= 1.15200				
STAGE	ADIABATIC EFFICIENCY AT DESIGN POINT= .95383				
ROTOR	TOTAL PRESSURE RATIO AT DESIGN POINT= 1.15400				
ROTOR	ADIABATIC EFFICIENCY AT DESIGN POINT= .96300				
ROTOR	TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.04328				

***** DESIGN POINT INFORMATION *****

***** STAGE= 2 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	541.148	2438.554	511.984	2008.852	.074
ROTOR OUTLET	566.141	2840.915	522.316	2142.394	.077
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	549.21299	591.68727	730.68951	220.67086	481.94632
ROTOR OUTLET	581.16447	725.94045	639.44211	435.01454	266.71034
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	702.617	.534	.659	556.431	2688.136
ROTOR OUTLET	701.725	.648	.571	556.331	5751.007
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	21.89000	41.26765	.00930	1.57500	.56970
ROTOR OUTLET	36.81569	24.65154	.00841	1.57300	.60285

STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.1590
 STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .93231
 ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.16500
 ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .96600
 ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.04618

***** DESIGN POINT INFORMATION ***** **

***** STAGE= 3 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	566.141	2626.284	535.362	2323.868	.081
ROTOR OUTLET	600.462	3450.692	549.786	2533.049	.086
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	574.81563	608.26663	784.29006	193.93541	533.57089
ROTOR OUTLET	614.43880	781.11343	662.59507	432.28950	247.56627
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	732.506	.536	.692	586.533	3199.070
ROTOR OUTLET	730.276	.630	.577	586.263	6929.751
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	19.09000	42.86892	.00803	1.64200	.58626
ROTOR OUTLET	38.12932	21.97650	.00708	1.63700	.63736
STAGE	TOTAL PRESSURE RATIO AT DESIGN POINT= 1.21300				
STAGE	ADIABATIC EFFICIENCY AT DESIGN POINT= .93464				
ROTOR	TOTAL PRESSURE RATIO AT DESIGN POINT= 1.22100				
ROTOR	ADIABATIC EFFICIENCY AT DESIGN POINT= .96800				
ROTOR	TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.06062				

***** DESIGN POINT INFORMATION ***** **

***** STAGE= 4 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	600.462	3428.282	569.069	2839.938	.094
ROTOR OUTLET	639.381	4240.785	585.841	3118.959	.100
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	580.04590	614.69778	809.54747	203.47020	564.72459
ROTOR OUTLET	619.63965	803.61317	668.93304	511.70446	252.02926
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	768.195	.526	.692	623.519	3912.431
ROTOR OUTLET	763.734	.678	.564	622.951	8231.914
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	19.33000	44.23321	.00692	1.72200	.60169
ROTOR OUTLET	39.55025	22.13332	.00607	1.71200	.64276

STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.23800
 STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .93002
 ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.23700
 ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .96500
 ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.06431

***** DESIGN POINT INFORMATION *****

***** STAGE= 5 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	639.381	4209.930	606.962	3506.755	.108
ROTOR OUTLET	679.732	5176.214	625.197	3857.244	.116
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	586.64149	625.22167	826.78513	215.68308	582.40082
ROTOR OUTLET	617.06868	811.98444	669.65381	527.75042	260.07304
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	796.084	.518	.665	663.653	4798.526
ROTOR OUTLET	787.623	.663	.547	662.302	9691.778
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	20.18000	44.78240	.00591	1.72900	.60873
ROTOR OUTLET	40.53794	22.65308	.00526	1.76600	.64011
STAGE TOTAL PRESSURE RATIO AT DESIGN POINT= 1.22100					
STAGE ADIABATIC EFFICIENCY AT DESIGN POINT= .92530					
ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT= 1.23000					
ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT= .96200					
ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT= 1.06311					

***** DESIGN POINT INFORMATION ***** ***

***** STAGE= 6 *****

	TOTAL TEMP	TOTAL PRESSURE	STATIC TEMP	STATIC PRESSURE	STATIC DENSITY
ROTOR INLET	679.732	5140.325	646.933	4318.954	.125
ROTOR OUTLET	720.259	6245.485	665.989	4736.291	.133
	AXIAL VELOCITY	ABSOLUTE VELOCITY	RELATIVE VELOCITY	TAN COMP OF ABS VEL	TAN COMP OF REL VEL
ROTOR INLET	587.19574	629.60666	833.74045	227.16890	591.68199
ROTOR OUTLET	603.39773	811.09676	654.61329	542.02320	253.83017
	ROTOR SPEED	ABS MACH NUMBER	REL MACH NUMBER	REL TOTAL TEMP	REL TOTAL PRESSURE
ROTOR INLET	819.051	.506	.669	704.449	5829.034
ROTOR OUTLET	795.853	.642	.518	701.350	10970.182
	ABS FLOW ANGLE	REL FLOW ANGLE	STREAMTUBE AREA	RADIUS	FLOW COEFFICIENT
ROTOR INLET	21.15000	45.22772	.00511	1.83600	.60910
ROTOR OUTLET	41.93288	22.81494	.00467	1.78400	.62591
STAGE TOTAL PRESSURE RATIO AT DESIGN POINT=				1.20800	
STAGE ADIABATIC EFFICIENCY AT DESIGN POINT=				.92365	
ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT=				1.21500	
ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT=				.95400	
ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT=				1.05962	

***** DESIGN POINT INFORMATION *****

***** OVERALL PERFORMANCE AT DESIGN POINT *****

COMPRESSOR INLET TOTAL TEMPERATURE= 518.70

COMPRESSOR INLET TOTAL PRESSURE= 2116.80

CORRECTED MASS FLOW RATE= 3.168

OVERALL TOTAL PRESSURE RATIO=2.9334

OVERALL TOTAL TEMPERATURE RATIO=1.3886

OVERALL ADIABATIC EFFICIENCY= .9223

OVERALL TEMPERATURE RISE= 201.559

	1	2	3	4	5	6	IGU
BET1SR(I)	42.03	41.27	42.87	44.23	44.78	45.23	
BET2SR(I)	31.78	24.65	21.98	22.13	22.85	22.81	
AINCSR(I)	-.69	-1.47	1.25	1.38	.78	.16	
ADEVSR(I)	5.99	7.48	8.86	8.37	8.52	8.38	
BET1SS(I)	33.20	36.62	38.13	39.55	40.54	41.93	
BET2SS(I)	21.89	19.09	19.33	20.18	21.15	34.86	15.61
AINCSS(I)	-1.95	-3.29	-5.23	-5.45	-5.77	-6.78	
ADEVSS(I)	9.70	7.96	8.82	8.37	7.83	5.58	
TD(I)	518.7	541.1	566.1	600.5	639.4	679.7	
OMEGS(I)	.009	.021	.025	.028	.029	.024	
OMEGR(I)	.113	.018	.018	.016	.004	.036	

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 1) *****

STAGE TOTAL PRESSURE RATIO= 1.15672
 STAGE TOTAL TEMPERATURE RATIO= 1.04306
 STAGE ADIABATIC EFFICIENCY= .88250

STAGE FLOW COEFFICIENT= .498
 AXIAL VELOCITY= 477.45
 ROTOR SPEED= 958.68

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	2116.8000	2448.5450	2443.5450
STATIC PRESSURE	1838.7412	2026.0491	
TOTAL TEMPERATURE(GAS)	518.7000	543.6271	543.6271
STATIC TEMPERATURE(GAS)	458.2736	515.0376	
STATIC DENSITY(GAS)	.0692	.0737	
AXIAL VELOCITY	477.4456	470.3117	
ABSOLUTE VELOCITY	495.7345	536.5545	
RELATIVE VELOCITY	693.3375	563.5979	
BLADE SPEED	636.1474	670.0514	702.6172
TANG. COMP. OF ABS. VEL.	133.3962	350.5041	
TANG. COMP. OF REL. VEL.	502.7512	319.5474	
ACGUSTIC SPEED	1093.7909	1112.0355	
ABSOLUTE MACH NUMBER	.4532	.5275	
RELATIVE MACH NUMBER	.6339	.5113	
FLOW COEFFICIENT	.4980	.4910	
FLOW AREA	.0104	.0099	
ABSOLUTE FLOW ANGLE	15.6100	36.6957	21.8900
RELATIVE FLOW ANGLE	46.4786	34.1937	
INCIDENCE	3.7586	1.5457	
DEVIATION		8.4437	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 1) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=3)

STAGE TOTAL PRESSURE RATIO= 1.15672
 STAGE TOTAL TEMPERATURE RATIO= 1.04806
 STAGE ADIABATIC EFFICIENCY= .88429

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	.04000	.04000	.04000
XWT=	.04000	.04000	.04000
XAIR=	.96000	.96000	.96000
XMETAN=	0	0	0
XGAS	.96000	.96000	.96000
WMASS=	0	0	0
WWMASS=	.01431	.01431	.01431
WTMASS=	.01431	.01431	.01431
AMASS=	.34340	.34340	.34340
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34340	.34340	.34340
TMASS=	.35771	.35771	.35771
WS=	.00000	.00000	.00000
RHOA=	.07649	.07304	.07106
RHOM=	.07160	.07608	.08067
RHOG=	.06918	.07304	.07745
TG=	518.70000	543.62714	543.62714
TW=	513.70000	0	513.70000
TWW=	513.70000	0	513.70001
P=	2116.80000	2448.54498	2448.54498
TB=	671.40656	0	678.60149
TDEW=	271.99506	273.16838	307.24761

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 2) *****

STAGE TOTAL PRESSURE RATIO= 1.17978
 STAGE TOTAL TEMPERATURE RATIO= 1.05521
 STAGE ADIABATIC EFFICIENCY= .87441

STAGE FLOW COEFFICIENT= .505
 AXIAL VELOCITY= 485.01
 ROTOR SPEED= 959.57

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	2448.5450	2828.7433	2888.7433
STATIC PRESSURE	2108.3989	2257.6036	
TOTAL TEMPERATURE(GAS)	543.6271	573.6432	573.6432
STATIC TEMPERATURE(GAS)	520.9261	534.7088	
STATIC DENSITY(GAS)	.0759	.0792	
AXIAL VELOCITY	485.0120	513.6592	
ABSOLUTE VELOCITY	522.6978	684.6335	
RELATIVE VELOCITY	702.1670	570.8697	
BLADE SPEED	702.6172	701.7250	732.5063
TANG. COMP. OF ABS. VEL.	194.8752	452.6337	
TANG. COMP. OF REL. VEL.	507.7420	249.0912	
ACOUSTIC SPEED	1118.2885	1132.9859	
ABSOLUTE MACH NUMBER	.4674	.6043	
RELATIVE MACH NUMBER	.6279	.5039	
FLOW COEFFICIENT	.5054	.5386	
FLOW AREA	.0093	.0084	
ABSOLUTE FLOW ANGLE	21.8900	41.3863	19.0900
RELATIVE FLOW ANGLE	46.3116	25.8704	
INCIDENCE	3.5716	1.2763	
DEVIATION		8.7004	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 2) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=3)

STAGE TOTAL PRESSURE RATIO= 1.17978
 STAGE TOTAL TEMPERATURE RATIO= 1.05521
 STAGE ADIABATIC EFFICIENCY= .87586

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	.04000	.04000	.04000
XWT=	.04000	.04000	.04000
XAIR=	.96000	.96000	.96000
XMETAN=	0	0	0
XGAS=	.96000	.96000	.96000
WMASS=	0	0	0
WWMASS=	.01431	.01431	.01431
WTMASS=	.01431	.01431	.01431
AMASS=	.34340	.34340	.34340
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34340	.34340	.34340
TMASS=	.35771	.35771	.35771
WS=	.00000	.00000	.00000
RHOA=	.08442	.07792	.08381
RHOM=	.07160	.08116	.09264
RHOG=	.07588	.07792	.08894
TC=	543.62714	573.64319	573.64319
TW=	513.70000	0	513.70000
TWW=	513.70001	0	513.70002
P=	2448.54498	2888.74326	2888.74326
TB=	678.60149	0	686.96120
TDEW=	307.24761	308.94985	321.39871

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 3) *****

STAGE TOTAL PRESSURE RATIO= 1.22015
 STAGE TOTAL TEMPERATURE RATIO= 1.06595
 STAGE ADIABATIC EFFICIENCY= .86472

STAGE FLOW COEFFICIENT= .523
 AXIAL VELOCITY= 501.06
 ROTOR SPEED= 958.24

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	2888.7433	3524.7140	3524.7140
STATIC PRESSURE	2496.9126	2718.3592	
TOTAL TEMPERATURE(GAS)	573.6432	611.4751	611.4751
STATIC TEMPERATURE(GAS)	550.3001	567.8526	
STATIC DENSITY(GAS)	.0851	.0897	
AXIAL VELOCITY	501.0593	537.7831	
ABSOLUTE VELOCITY	530.2182	724.9365	
RELATIVE VELOCITY	750.7661	590.6081	
BLADE SPEED	732.5063	730.2758	768.1948
TANG. COMP. OF ABS. VEL.	173.4094	486.1298	
TANG. COMP. OF REL. VEL.	559.0969	244.1460	
ACOUSTIC SPEED	1149.1717	1167.3652	
ABSOLUTE MACH NUMBER	.4614	.6210	
RELATIVE MACH NUMBER	.6533	.5059	
FLOW COEFFICIENT	.5229	.5668	
FLOW AREA	.0080	.0071	
ABSOLUTE FLOW ANGLE	19.0900	42.1120	19.3300
RELATIVE FLOW ANGLE	48.1335	24.4174	
INCIDENCE	6.5135	-1.2480	
DEVIATION		11.2974	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 3) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=3)

STAGE TOTAL PRESSURE RATIO= 1.22015
 STAGE TOTAL TEMPERATURE RATIO= 1.06595
 STAGE ADIABATIC EFFICIENCY= .88573

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	.04000	.04000	.04000
XWT=	.04000	.04000	.04000
XAIR=	.96000	.96000	.96000
XMETAN=	0	0	0
XGAS=	.96000	.96000	.96000
WMASS=	0	0	0
WWMASS=	.01431	.01431	.01431
WTMASS=	.01431	.01431	.01431
AMASS=	.34340	.34340	.34340
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34340	.34340	.34340
TMASS=	.35771	.35771	.35771
WS=	.00000	.00000	.00000
RHDA=	.05439	.08818	.09954
RHDM=	.07160	.09185	.10802
RHDC=	.08506	.08818	.10370
TG=	573.64319	611.47514	611.47514
TW=	513.70000	0	513.70000
TWW=	513.70002	0	513.70004
P=	2888.74326	3524.71402	3524.71402
TB=	686.96120	0	697.29964
TDEW=	321.39871	323.64370	332.71852

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 4) *****

STAGE TOTAL PRESSURE RATIO= 1.24003
 STAGE TOTAL TEMPERATURE RATIO= 1.06975
 STAGE ADIABATIC EFFICIENCY= .90548

STAGE FLOW COEFFICIENT= .528
 AXIAL VELOCITY= 505.84
 ROTOR SPEED= 958.68

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	3524.7140	4370.7663	4370.7663
STATIC PRESSURE	3065.3014	3378.4066	
TOTAL TEMPERATURE(GAS)	611.4751	654.1230	654.1230
STATIC TEMPERATURE(GAS)	587.6443	607.9245	
STATIC DENSITY(GAS)	.0978	.1042	
AXIAL VELOCITY	505.8407	540.1630	
ABSOLUTE VELOCITY	536.0586	746.6944	
RELATIVE VELOCITY	777.7311	594.4566	
BLADE SPEED	768.1948	763.7337	793.0839
TANG. COMP. OF ABS. VEL.	177.4403	515.5351	
TANG. COMP. OF REL. VEL.	590.7545	248.1986	
ACOUSTIC SPEED	1187.1599	1207.4712	
ABSOLUTE MACH NUMBER	.4515	.6184	
RELATIVE MACH NUMBER	.6551	.4923	
FLOW COEFFICIENT	.5276	.5703	
FLOW AREA	.0069	.0061	
ABSOLUTE FLOW ANGLE	19.3300	43.6636	20.1800
RELATIVE FLOW ANGLE	49.4278	24.6782	
INCIDENCE	6.5778	-1.3364	
DEVIATION		10.9182	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 4) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=3)

STAGE TOTAL PRESSURE RATIO= 1.24003
 STAGE TOTAL TEMPERATURE RATIO= 1.06975
 STAGE ADIABATIC EFFICIENCY= .90596

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	.04000	.04000	.04000
XWT=	.04000	.04000	.04000
XAIR=	.96000	.96000	.96000
XMETAN=	0	0	0
XGAS=	.96000	.96000	.96000
WMASS=	0	0	0
WWMASS=	.01431	.01431	.01431
WTMASS=	.01431	.01431	.01431
AMASS=	.34340	.34340	.34340
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34340	.34340	.34340
TMASS=	.35771	.35771	.35771
WS=	.00000	.00000	.00000
RHOA=	.10804	.10243	.11841
RHOM=	.07160	.10669	.12684
RHOG=	.09779	.10243	.12178
TG=	611.47514	654.12304	654.12303
TW=	513.70000	0	513.70000
TWW=	513.70004	0	513.70008
P=	3524.71402	4370.76630	4370.76630
TB=	697.29364	0	708.83369
TDEW=	332.71852	335.32202	342.89517

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 5) *****

STAGE TOTAL PRESSURE RATIO= 1.23254
 STAGE TOTAL TEMPERATURE RATIO= 1.06806
 STAGE ADIABATIC EFFICIENCY= .89928

STAGE FLOW COEFFICIENT= .531
 AXIAL VELOCITY= 509.08
 ROTOR SPEED= 958.68

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	4370.7663	5387.1456	5387.1456
STATIC PRESSURE	3624.4632	4211.8618	
TOTAL TEMPERATURE(GAS)	654.1230	698.6417	698.6417
STATIC TEMPERATURE(GAS)	629.7729	651.5103	
STATIC DENSITY(GAS)	.1138	.1212	
AXIAL VELOCITY	509.0775	536.3520	
ABSOLUTE VELOCITY	542.3718	755.0109	
RELATIVE VELOCITY	795.2725	594.5041	
BLADE SPEED	798.0839	787.8235	819.0509
TANG. COMP. OF ABS. VEL.	187.1023	531.3831	
TANG. COMP. OF REL. VEL.	610.9816	256.4404	
ACOUSTIC SPEED	1228.4506	1249.4716	
ABSOLUTE MACH NUMBER	.4415	.6043	
RELATIVE MACH NUMBER	.6474	.4758	
FLOW COEFFICIENT	.5310	.5677	
FLOW AREA	.0059	.0053	
ABSOLUTE FLOW ANGLE	20.1800	44.7334	21.1500
RELATIVE FLOW ANGLE	50.1985	25.5534	
INCIDENCE	6.1985	-1.5766	
DEVIATION		11.2234	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 5) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=3)

STAGE TOTAL PRESSURE RATIO= 1.23254
 STAGE TOTAL TEMPERATURE RATIO= 1.06806
 STAGE ADIABATIC EFFICIENCY= .89922

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XV=	0	0	0
XW=	.04000	.04000	0
XWT=	.04000	.04000	0
XAIR=	.96000	.96000	1.00000
XMETAN=	0	0	0
XGAS=	.96000	.96000	1.00000
WMASS=	0	0	0
WWMASS=	.01431	.01431	0
WTMASS=	.01431	.01431	0
AMASS=	.34342	.34342	.34342
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
CMASS=	.34340	.34340	.34342
TMASS=	.35771	.35771	.34342
WS=	.00000	.00000	.00000
RHOA=	.12524	.11937	.14183
RHOM=	.07160	.12434	.14183
RHOG=	.11385	.11937	.14183
TG=	654.12303	698.64174	698.64174
TW=	513.70000	0	0
TWW=	513.70008	0	513.70008
P=	4370.76630	5387.14558	5387.14558
TB=	708.83369	0	723.33915
TDEW=	342.89517	335.97580	335.97580

***** INITIAL FLOW COEFFICIENT= .500 (STAGE= 6) *****

STAGE TOTAL PRESSURE RATIO= 1.22195
 STAGE TOTAL TEMPERATURE RATIO= 1.06404
 STAGE ADIABATIC EFFICIENCY= .91275

STAGE FLOW COEFFICIENT= .530
 AXIAL VELOCITY= 507.49
 ROTOR SPEED= 957.79

	ROTOR INLET	*ROTOR OUTLET*	*STATOR OUTLET*
TOTAL PRESSURE	5387.1456	6582.8080	6582.8080
STATIC PRESSURE	4750.8982	5234.7740	
TOTAL TEMPERATURE(GAS)	698.6417	743.3658	743.3658
STATIC TEMPERATURE(GAS)	674.1926	696.7068	
STATIC DENSITY(GAS)	.1321	.1409	
AXIAL VELOCITY	507.4865	520.7245	
ABSOLUTE VELOCITY	544.1403	752.4057	
RELATIVE VELOCITY	803.3192	578.8237	
BLADE SPEED	819.0509	795.8534	.5000
TANG. COMP. OF ABS. VEL.	196.3317	543.1026	
TANG. COMP. OF REL. VEL.	622.7192	252.7508	
ACOUSTIC SPEED	1270.3492	1291.3863	
ABSOLUTE MACH NUMBER	.4283	.5826	
RELATIVE MACH NUMBER	.6324	.4482	
FLOW COEFFICIENT	.5299	.5558	
FLOW AREA	.0051	.0047	
ABSOLUTE FLOW ANGLE	21.1500	46.2051	0
RELATIVE FLOW ANGLE	50.8216	25.8911	
INCIDENCE	5.7516	-2.5049	
DEVIATION		11.4611	

***** INITIAL FLOW COEFFICIENT= .500 (ISTAGE= 6) *****

STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT(JPERFM=2)

STAGE TOTAL PRESSURE RATIO= 1.22195
 STAGE TOTAL TEMPERATURE RATIO= 1.06404
 STAGE ADIABATIC EFFICIENCY= .91223

	STAGE INLET	**STAGE OUTLET** (BEFORE INTER-STAGE ADJUSTMENT)	**STAGE OUTLET** (AFTER INTER-STAGE ADJUSTMENT)
XU=	.00000	.00000	.00000
XW=	0	0	0
XWW=	0	0	0
XWT=	0	0	0
XAIR=	1.00000	1.00000	1.00000
XMETAN=	0	0	0
XGAS=	1.00000	1.00000	1.00000
WMASS=	0	0	0
WMASS=	0	0	0
WTMASS=	0	0	0
AMASS=	.34342	.34342	.34342
CHMASS=	0	0	0
UMASS=	.00000	.00000	.00000
GMASS=	.34342	.34342	.34342
TMASS=	.34342	.34342	.34342
WS=	.00000	.00000	.00000
RHOA=	.14453	.14061	.16408
RHOM=	.07160	.14061	.16408
RHOG=	.13211	.14061	.16408
TG=	698.64174	743.38580	743.38580
TW=	0	0	0
TWW=	513.70008	0	513.70008
P=	5387.14558	6582.80801	6582.80801
TE=	723.33915	0	735.58638
TDEW=	335.97580	338.59428	338.59428

***** OVERALL PERFORMANCE *****

INITIAL FLOW COEFFICIENT= .50

CORRECTED SPEED=51120.0 1.000 FRACTION OF DEIGN CORRECTED SPEED

INITIAL WATER CONTENT(SMALL DROPLET)= 0

INITIAL WATER CONTENT(LARGE DROPLET)= .040

INITIAL WATER CONTENT(TOTAL)= .040

INITIAL RELATIVE HUMIDITY= .0 PER CENT

INITIAL METHANE CONTENT= 0

COMPRESSOR INLET TOTAL TEMPERATURE= 518.70

COMPRESSOR INLET TOTAL PRESSURE= 2116.80

CORRECTED MASS FLOW RATE OF MIXTURE= .358(3.018)

CORRECTED MASS FLOW RATE OF GAS PHASE .343(2.897)

OVERALL TOTAL PRESSURE RATIO=3.1058

OVERALL TOTAL TEMPERATURE RATIO=1.4332

OVERALL ADIABATIC EFFICIENCY= .8790

OVERALL TEMPERATURE RISE OF GAS PHASE= 224.686

APPENDIX 4

PROGRAM SOURCE LIST

C		MAIN	1
	PROGRAM MAIN (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)	MAIN	2
C	+++++	MAIN	3
C	PROGRAM NASA-WISGSK	MAIN	4
C	+++++	MAIN	5
C	ABSTRACT:	MAIN	6
C	THIS PROGRAM CODE HAS BEEN PRODUCED FOR THE STUDY OF THE AXIAL FLOW	MAIN	7
C	COMPRESSOR PERFORMANCE FOR THE GAS-WATER DROPLET MIXTURE FLOW.	MAIN	8
C	THE MIXTURE CONSISTS OF TWO TYPES OF DROPLET SIZES AND THREE	MAIN	9
C	KINDS OF GASEOUS PHASES.THIS PROGRAM CODE IS WRITTEN ESPECIALLY	MAIN	10
C	FOR AIR+WATER VAPOR+METHANE+SMALL DROPLET+LARGE DROPLET.	MAIN	11
C	THIS FORTRAN COMPUTER CODE CAN PREDICT THE DESIGN AND OFF-DESIGN	MAIN	12
C	PERFORMANCE OF AXIAL FLOW COMPRESSOR. STAGE AND OVERALL PERFORMANCE	MAIN	13
C	ARE OBTAINED BY A STAGE-BY-STAGE CALCULATION.	MAIN	14
C	+++++	MAIN	15
C	+++++	MAIN	16
	REAL ND,NU,KA,M,MMASS,MMASS1	MAIN	17
	REAL MMASSO	MAIN	18
	COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	MAIN	19
	X, PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	MAIN	20
	X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XHW(3),XWT(3),TW(3),TWW(3)	MAIN	21
	X, OMEGS(7),OMEGR(6),GAPR(6),GAPS(6)	MAIN	22
	X, RRHUB(6) , RC(6) , RBLADE(6) , STAGER(6)	MAIN	23
	X, SRHUB(7) , SC(7) , SBLADE(7) , STAGES(7)	MAIN	24
	X, SIGUMR(6) , BET1SR(6) , BET2SR(6) , AINC SR(6) , ADEUSR(6)	MAIN	25
	X, SIGUMS(7) , BET1SS(7) , BET2SS(7) , AINCSS(7) , ADEUSS(7)	MAIN	26
	X, UTIPG(6),UTIP(6),UTIPD(6),UGU(6),UMEAN(6),UHUB(6),U(6),FAI	MAIN	27
	X, AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT	MAIN	28
	X, ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID	MAIN	29
	X, NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)	MAIN	30
	X, DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)	MAIN	31
	X, DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)	MAIN	32
	X, BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)	MAIN	33
	COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	MAIN	34
	XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	MAIN	35
	XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	MAIN	36
	X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	MAIN	37
	XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	MAIN	38
	XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)	MAIN	39
	X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)	MAIN	40
	X,BAT2MR(12,9),DPSIS(12,9),RSOLM(12), RK2M(12),CB2M(12),CB2MR(	MAIN	41
	X12),CB3MR(12),RINCM(12),RDFM(12),SK2M(12),SINCM(12),BET3M(12	MAIN	42
	X,9),PHIFIX(12),DPHIF(12),CPREF(12),GF1REF(12),ETAINP(12)	MAIN	43
	X,FLOCAL(12,9),ETARAT(9),DB2M(12,9),DB2MR(12,9),DB3M(12,9),DB3MR	MAIN	44
	X(12,9),B2MB3R(12,9),SPEEDF,FLOWIN,U3DU2R(12),U2U3(12),DB3MRG(12)	MAIN	45
	X,DB3MRN(12,9),DB3MRP(12,8),CPCM(6),CPCS(6)	MAIN	46
	*,RK3M(12),RDEV(12),RDEF(12),GMREF(12)	MAIN	47
	*,PSID1(12,2,8),PSID2(12,2,8),PSID3(12,2,8),PSID4(12,2,8),	MAIN	48
	* PSID5(12,2,8),PSI1(12,2,8),PSI2(12,2,8),PSI3(12,2,8)	MAIN	49
	*,PSI4(12,2,8),PSI5(12,2,8)	MAIN	50
	*,PSID1L(12,2,8),PSID2L(12,2,8),PSID3L(12,2,8)	MAIN	51
	*,PSID4L(12,2,8),PSID5L(12,2,8),PSI1L(12,2,8)	MAIN	52
	*,PSI2L(12,2,8),PSI3L(12,2,8),PSI4L(12,2,8),PSI5L(12,2,8)	MAIN	53
	COMMON /SCALER/ RU, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	MAIN	54
	X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	MAIN	55
	X,CP,GAMMA,GM1,GF1,GF2,GF3,SPDPSI,SPDPHI,DRDEUG,DRDEUN,DRDEVP	MAIN	56
	X,XAR,XMET,XSTM	MAIN	57
	X,STAGEN,SPEEDN,CHAPTS,WTMOLE	MAIN	58
	DIMENSION D(20,3) , XD(20,3) , XXD(20,3),	MAIN	59
	,WS(3),WMASS(3),UMASS(3),RHOA(3),RHOM(3),TB(3)	MAIN	60
	DIMENSION TD(6),DELZ(6),ETAA(6)	MAIN	61
	DIMENSION XXA(3),XXU(3),DAVE(20)	MAIN	62
	DIMENSION TDEW(3)	MAIN	63
	DIMENSION DDAVE(20),WMASS(3),WTMASS(3)	MAIN	64
	DIMENSION TMASS(3),GMASS(3),XAIR(3),XMETAN(3),XGAS(3),FAISTL(6)	MAIN	65
	DIMENSION XBLEED(6)	MAIN	66
	DATA NSTAGE/1,2,3,4,5,6,7,8,9,10,11,12/, RU/1545.44/, PI/3.141592	MAIN	67
	17/, G/32.1740/, AJ/778.12/, RAD/57.29578/	MAIN	68
C	+++++	MAIN	69
	CC	MAIN	70

C		C	MAIN	71
C	INPUT DATA		MAIN	72
C		C	MAIN	73
CC			MAIN	74
C NS	NUMBER OF STAGE		MAIN	75
C RRHUB(I)	ROTOR INLET RUDIUS AT HUB FOR I-TH STAGE IN INCH		MAIN	76
C RC(I)	ROTOR CHORD FOR I-TH STAGE IN INCH		MAIN	77
C RBLADE(I)	NUMBER OF ROTOR BLADE FOR I-TH STAGE		MAIN	78
C STAGER(I)	ROTOR STAGER ANGLE FOR I-TH STAGE IN DEGREE.		MAIN	79
C SRHUB(I)	STATOR INLET RUDIUS AT HUB FOR I-TH STAGE IN INCH		MAIN	80
C SC(I)	STATOR CHORD FOR I-TH STAGE IN INCH(I=NS+1,IGU)		MAIN	81
C SBLADE(I)	NUMBER OF STATOR BLADE FOR I-TH STAGE (I=NS+1,IGU)		MAIN	82
C SIGUMR(I)	SOLIDITY OF ROTOR FOR I-TH STAGE		MAIN	83
C FNF	FRACTION OF DESIGN CORRECTED ROTOR SPEED FOR A PARTICULAR		MAIN	84
C	SPEED		MAIN	85
C XDIN	INITIAL WATER CONTENT (MASS FRACTION) OF SMALL DROPLET		MAIN	86
C XDDIN	INITIAL WATER CONTENT (MASS FRACTION) OF DARGE DROPLET		MAIN	87
C ICENT	INDEX FOR CENTRIFUGAL CALCULATION (ICENT=1 WHEN XDIN=0		MAIN	88
C	OTHERWISE ICENT=2)		MAIN	89
C IICENT	SAME AS ICENT		MAIN	90
C TOG	TOTAL TEMPERATURE AT COMPRESSR INLET IN RANKIN		MAIN	91
C TOW	WATER DROPLET TEMPERATURE AT COMPRESSOR INLET IN RANKIN		MAIN	92
C PO	TOTAL PRESSURE AT COMPRESSOR INLET IN LB/FT**2		MAIN	93
C DIN	INITIAL WATER DROPLET DIAMETER IN MICRON(SMALL DROLLET)		MAIN	94
C DDIN	INITIAL WATER DROPLET DIAMETER IN MICRON(LARGE DROPLET)		MAIN	95
C FND	ROTOR ROTATIONAL SPEED AT DESIGN SPEED IN RPM		MAIN	96
C T01D	DESIGN VALUE FOR COMPRESSOR INLET TOTAL TEMPERATURE		MAIN	97
C	IN RANKIN		MAIN	98
C P01D	DESIGN VALUE FOR COMPRESSOR INLET TOTAL PRESSURE		MAIN	99
C	IN LB/FT**2		MAIN	100
C XCH4	INITIAL METHANE CONTENT(MASS FRACTION)		MAIN	101
C RHUMID	INITIAL RELATIVE HUMIDITY(PER CENT)		MAIN	102
C FMWA	MOLECULAR WEIGHT OF AIR		MAIN	103
C FMWU	MOLECULAR WEIGHT OF WATER VAPOR		MAIN	104
C FMWC	MOLECULAR WEIGHT OF METHANE		MAIN	105
C PREB	PERCENT OF WATER THAT REBOUND AFTER IMPINGEMENT		MAIN	106
C DLIMIT	MAX. DIAMETER FOR SMALL DROPLET IN MICRON		MAIN	107
C STAGES(I)	STATOR STAGER ANGLE FOR I-TH STAGE IN DEGREE		MAIN	108
C GAPR(I)	GAP BETWEEN I TH STAGE ROTOR AND I-1 TH STAGE STATOR		MAIN	109
C	IN INCH		MAIN	110
C GAPS(I)	GAP BETWEEN I TH STAGE STATOR AND I-1 TH STAGE ROTOR		MAIN	111
C	IN INCH		MAIN	112
C XBLEED(I)	AMOUNT OF BLEED AT I-TH STAGE OUTLET		MAIN	113
C RRTIP(I)	ROTOR INLET TIP RADIUS FOR I-TH STAGE IN INCH		MAIN	114
C SRTIP(I)	STATOR INLET TIP RADIUS FOR I-TH STAGE IN INCH		MAIN	115
C IRAD	INDEX FOR RADIUS AT WHICH CALCULATION IS CARRIED OUT		MAIN	116
C	IRAD=1: TIP		MAIN	117
C	IRAD=2: MEAN		MAIN	118
C	IRAD=3: HUB		MAIN	119
C RT(I)	RADIUS AT ROTOR INLET WHERE PERFORMANCE CALCULATION		MAIN	120
C	IS CARRIED OUT WHEN IRAD=1, IN INCH		MAIN	121
C RM(I)	RADIUS AT ROTOR INLET WHERE PERFORMANCE CALCULATION		MAIN	122
C	IS CARRIED OUT WHEN IRAD=2, IN INCH		MAIN	123
C RH(I)	RADIUS AT ROTOR INLET WHERE PERFORMANCE CALCULATION		MAIN	124
C	IS CARRIED OUT WHEN IRAD=3, IN INCH		MAIN	125
C ST(I)	RADIUS AT ROTOR OUTLET WHERE PERFORMANCE CALCULATION		MAIN	126
C	IS CARRIED OUT WHEN IRAD=1, IN INCH		MAIN	127
C SM(I)	RADIUS AT ROTOR OUTLET WHERE PERFORMANCE CALCULATION		MAIN	128
C	IS CARRIED OUT WHEN IRAD=2, IN INCH		MAIN	129
C SH(I)	RADIUS AT ROTOR OUTLET WHERE PERFORMANCE CALCULATION		MAIN	130
C	IS CARRIED OUT WHEN IRAD=3, IN INCH		MAIN	131
C BLOCK(I)	BLOCKAGE FACTOR FOR ROTOR		MAIN	132
C BLOCKS(I)	BLOCKAGE FACTOR FOR STATOR		MAIN	133
C BET1MR(I)	BLADE METAL ANGLE AT ROTOR INLET FOR I-TH STAGE IN DEG		MAIN	134
C BET2MR(I)	BLADE METAL ANGLE AT ROTOR OUTLET FOR I-TH STAGE IN DEG		MAIN	135
C BET1MS(I)	BLADE METAL ANGLE AT STATOR INLET FOR I-TH STAGE IN DEG		MAIN	136
C BET2MS(I)	BLADE METAL ANGLE AT STATOR OUTLET FOR I-TH STAGE IN DEG		MAIN	137
C DSMASS	DESIGN MASS FLOW RATE(LB/SEC)		MAIN	138
C PR12D(I)	DESIGN TOTAL PRESSURE RATIO FOR I-TH STAGE ROTOR		MAIN	139
C PR13D(I)	DESIGN TOTAL PRESSURE RATIO FOR I-TH STAGE		MAIN	140

C	ETARD(I)	DESIGN ADIABATIC EFFICIENCY FOR I-TH STAGE ROTOR	MAIN	141	
C	SAREA(I)	STREAM TUBE AREA AT I-TH STAGE ROTOR INLET IN FT**2	MAIN	142	
C	SAREAS(I)	STREAM TUBE AREA AT I-TH STAGE STATOR INLET IN FT**2	MAIN	143	
C		CALCULATION	MAIN	144	
C	XBLEED(I)	BLEED(MASS FRACTION)	MAIN	145	
C	*****		MAIN	146	
C	CC		MAIN	147	
C			C	MAIN	148
C	READ INPUT DATA		C	MAIN	149
C			C	MAIN	150
C	CC		MAIN	151	
	READ(5,99) NS		MAIN	152	
	59 FORMAT(I1)		MAIN	153	
	NS1=NS+1		MAIN	154	
	READ(5,100) (RRHUB(I),I=1,NS)		MAIN	155	
100	FORMAT(6F5.3)		MAIN	156	
	READ(5,111)(RC(I),I=1,NS)		MAIN	157	
111	FORMAT(6F5.3)		MAIN	158	
	READ(5,112) (RBLADE(I),I=1,NS)		MAIN	159	
112	FORMAT(6F5.2)		MAIN	160	
	READ(5,113)(STAGER(I) ,I=1,NS)		MAIN	161	
113	FORMAT(6F5.2)		MAIN	162	
	READ(5,114)(SRHUB(I),I=1,7)		MAIN	163	
114	FORMAT(7F5.3)		MAIN	164	
	READ(5,115) (SC(I),I=1,7)		MAIN	165	
115	FORMAT(7F5.3)		MAIN	166	
	READ(5,116)(SBLADE(I),I=1,7)		MAIN	167	
116	FORMAT(7F5.2)		MAIN	168	
	READ(5,117)(SIGUMR(I),I=1,NS)		MAIN	169	
117	FORMAT(6F5.3)		MAIN	170	
	READ(5,122)(SIGUMS(I) ,I=1,NS1)		MAIN	171	
122	FORMAT(7F5.3)		MAIN	172	
	READ(5,124)(BET2SS(I),I=1,NS1)		MAIN	173	
124	FORMAT(7F5.2)		MAIN	174	
	READ(5,127) FNF		MAIN	175	
127	FORMAT(F8.2)		MAIN	176	
	READ(5,128) XDIN, ICENT, XDDIN, IICENT		MAIN	177	
128	FORMAT(F5.3, I1, F5.3, I1)		MAIN	178	
	READ(5,129) TOG, TOW, PO		MAIN	179	
129	FORMAT(3F7.2)		MAIN	180	
	READ(5,130) DIN, DDIN		MAIN	181	
130	FORMAT(2F6.1)		MAIN	182	
	READ(5,132) FND, T01D, P01D		MAIN	183	
132	FORMAT(F7.1, 2F7.2)		MAIN	184	
	READ(5,133) XCH4, RHUMID		MAIN	185	
133	FORMAT(F5.3, F10.5)		MAIN	186	
	READ(5,134) FMWA, FMWU, FMWC		MAIN	187	
134	FORMAT(3F7.3)		MAIN	188	
	READ(5,135) PREB, DLIMIT		MAIN	189	
135	FORMAT(F5.1, F7.1)		MAIN	190	
	READ(5,140) (STAGES(I),I=1,NS1)		MAIN	191	
140	FORMAT(7F5.2)		MAIN	192	
	READ(5,141) (GAPR(I),I=1,NS)		MAIN	193	
141	FORMAT(6F7.5)		MAIN	194	
	READ(5,142) (GAPS(I),I=1,NS)		MAIN	195	
142	FORMAT(6F7.5)		MAIN	196	
	READ(5,146) (RRTIP(I),I=1,NS)		MAIN	197	
146	FORMAT(6F6.3)		MAIN	198	
	READ(5,147) (SRTIP(I),I=1,NS1)		MAIN	199	
147	FORMAT(7F6.3)		MAIN	200	
	READ(5,1491) IRAD		MAIN	201	
1491	FORMAT(I1)		MAIN	202	
	READ(5,1492) (RT(I),I=1,NS)		MAIN	203	
1492	FORMAT(6F5.3)		MAIN	204	
	READ(5,1493) (RM(I),I=1,NS)		MAIN	205	
1493	FORMAT(6F5.3)		MAIN	206	
	READ(5,1494) (RH(I),I=1,NS)		MAIN	207	
1494	FORMAT(6F5.3)		MAIN	208	
	READ(5,1495) (ST(I),I=1,NS)		MAIN	209	
1495	FORMAT(6F5.3)		MAIN	210	

READ(5,1496) (SM(I),I=1,NS)	MAIN	211
1496 FORMAT(6F5.3)	MAIN	212
READ(5,1497) (SH(I),I=1,NS)	MAIN	213
1497 FORMAT(6F5.3)	MAIN	214
READ(5,1498) (BLOCK(I),I=1,NS)	MAIN	215
1498 FORMAT(6F5.3)	MAIN	216
READ(5,1499) (BLOCKS(I),I=1,NS1)	MAIN	217
1499 FORMAT(7F5.3)	MAIN	218
READ(5,1502) (BET1MR(I),I=1,NS)	MAIN	219
1502 FORMAT(6F5.2)	MAIN	220
READ(5,1503) (BET2MR(I),I=1,NS)	MAIN	221
1503 FORMAT(6F5.2)	MAIN	222
READ(5,1504) (BET1MS(I),I=1,NS1)	MAIN	223
1504 FORMAT(7F5.2)	MAIN	224
READ(5,1505) (BET2MS(I),I=1,NS1)	MAIN	225
1505 FORMAT(7F5.2)	MAIN	226
READ(5,1506) DSMASS	MAIN	227
1506 FORMAT(F10.6)	MAIN	228
READ(5,1507) (PR12D(I),I=1,NS)	MAIN	229
1507 FORMAT(6F5.3)	MAIN	230
READ(5,1508) (PR13D(I),I=1,NS)	MAIN	231
1508 FORMAT(6F5.3)	MAIN	232
READ(5,1509) (ETARD(I),I=1,NS)	MAIN	233
1509 FORMAT(6F5.3)	MAIN	234
READ(5,1511) (SAREA(I),I=1,NS)	MAIN	235
1511 FORMAT(6F10.7)	MAIN	236
READ(5,1512) (SAREAS(I),I=1,NS1)	MAIN	237
1512 FORMAT(7F10.7)	MAIN	238
READ(5,1513) (XBLEED(I),I=1,NS)	MAIN	239
1513 FORMAT(6F5.2)	MAIN	240
C ++++++	MAIN	241
C OTHER INPUT DATA	MAIN	242
FNFN=FN*100.0	MAIN	243
WKDONE=1.0	MAIN	244
IPRINT=1	MAIN	245
DO 1530 I=1,NS	MAIN	246
FMR1(I)=0.6	MAIN	247
FMA2(I)=0.6	MAIN	248
1530 CONTINUE	MAIN	249
AK1=1.0	MAIN	250
AK2=0.0	MAIN	251
AK3=0.0	MAIN	252
AAAIGU=SAREA(1)	MAIN	253
RU=1545.3	MAIN	254
RHOW=62.54	MAIN	255
CPW=1.0	MAIN	256
RA=RU/FMWA	MAIN	257
RU=RU/FMWU	MAIN	258
RCH=RU/FMWC	MAIN	259
DELU=0.0	MAIN	260
DELUU2=10.0	MAIN	261
DELU2=10.0	MAIN	262
REAVE=0.0	MAIN	263
GC=32.174	MAIN	264
AJ=778.16	MAIN	265
PAI=3.1415926	MAIN	266
DO 150 I=1,NS	MAIN	267
AAREA(I)=PAI*((RRTIP(I)/12.0)**2-(RRHUB(I)/12.0)**2)*BLOCK(I)	MAIN	268
AAREAS(I)=PAI*(SRTIP(I)**2-SRHUB(I)**2)/144.0*BLOCKS(I)	MAIN	269
DELZ(I)=(RC(I)+SC(I))/12.0	MAIN	270
150 CONTINUE	MAIN	271
NS1=NS+1	MAIN	272
AAREAS(NS1)=PAI*(SRTIP(NS1)**2-SRHUB(NS1)**2)/144.0*BLOCKS(NS1)	MAIN	273
AAAR1T=AAREA(1)	MAIN	274
DO 152 I=1,NS	MAIN	275
AREA(I)=SAREA(I)	MAIN	276
AREAS(I)=SAREAS(I)	MAIN	277
152 CONTINUE	MAIN	278
AREAS(NS1)=SAREAS(NS1)	MAIN	279
FN=FN*FNF*SQRT(TOG/518.7)	MAIN	280

OT01G=T0G	MAIN	281	
OT01D=T0W	MAIN	282	
OP01=P0	MAIN	283	
CRPM=FNF*FND	MAIN	284	
DO 151 I=1,NS	MAIN	285	
UTIP(I)=RT(I)/12.0*2.0*PAI*FND/60.0	MAIN	286	
UTIPG(I)=RRTIP(I)/12.0*2.0*PAI*FND/60.0	MAIN	287	
UTIP2(I)=ST(I)/12.0*2.0*PAI*FND/60.0	MAIN	288	
UTIPD(I)=RT(I)/12.0*2.0*PAI*FND/60.0	MAIN	289	
UOU(I)=(UTIP(I)/UTIPD(I))**2	MAIN	290	
UMEAN(I)=RM(I)/12.0*2.0*PAI*FND/60.0	MAIN	291	
UMEAN2(I)=SM(I)/12.0*2.0*PAI*FND/60.0	MAIN	292	
UHUB(I)=RH(I)/12.0*2.0*PAI*FND/60.0	MAIN	293	
UHUB2(I)=SH(I)/12.0*2.0*PAI*FND/60.0	MAIN	294	
IF(IRAD.EQ.1) U(I)=UTIP(I)	MAIN	295	
IF(IRAD.EQ.2) U(I)=UMEAN(I)	MAIN	296	
IF(IRAD.EQ.3) U(I)=UHUB(I)	MAIN	297	
IF(IRAD.EQ.1) UU2(I)=UTIP2(I)	MAIN	298	
IF(IRAD.EQ.2) UU2(I)=UMEAN2(I)	MAIN	299	
IF(IRAD.EQ.3) UU2(I)=UHUB2(I)	MAIN	300	
IF(IRAD.EQ.1) RADI1(I)=RT(I)	MAIN	301	
IF(IRAD.EQ.1) RADI2(I)=ST(I)	MAIN	302	
IF(IRAD.EQ.2) RADI1(I)=RM(I)	MAIN	303	
IF(IRAD.EQ.2) RADI2(I)=SM(I)	MAIN	304	
IF(IRAD.EQ.3) RADI1(I)=RH(I)	MAIN	305	
IF(IRAD.EQ.3) RADI2(I)=SH(I)	MAIN	306	
151 CONTINUE	MAIN	307	
C ++++++	MAIN	308	
CC	MAIN	309	
C	C	MAIN	310
C PRINT OUT OF INPUT DATA	MAIN	311	
C	C	MAIN	312
CC	MAIN	313	
WRITE(6,1600)	MAIN	314	
1600 FORMAT(1H1,5X,***** INPUT DATA *****	MAIN	315	
*****)	MAIN	316	
WRITE(6,1610) NS	MAIN	317	
1610 FORMAT(1H0,1X,NS(NUMBER OF STAGE)≠,I2)	MAIN	318	
IF(IUNIT.EQ.1) WRITE(6,1601)	MAIN	319	
1601 FORMAT(1H,1X,UNIT=ENGLISH UNIT≠)	MAIN	320	
IF(IUNIT.EQ.2) WRITE(6,1602)	MAIN	321	
1602 FORMAT(1H,1X,UNIT=METRIC UNIT≠)	MAIN	322	
WRITE(6,1603) IPERFM	MAIN	323	
1603 FORMAT(1H,1X,IPERFM≠,I1)	MAIN	324	
IF(IRAD.EQ.1) WRITE(6,1604)	MAIN	325	
1604 FORMAT(1H,1X,PERFORMANCE AT TIP≠)	MAIN	326	
IF(IRAD.EQ.2) WRITE(6,1605)	MAIN	327	
1605 FORMAT(1H,1X,PERFORMANCE AT MEAN≠)	MAIN	328	
IF(IRAD.EQ.3) WRITE(6,1606)	MAIN	329	
1606 FORMAT(1H,1X,PERFORMANCE AT HUB≠)	MAIN	330	
WRITE(6,1620)	MAIN	331	
1620 FORMAT(1H0,14X,≠1≠,5X,≠2≠,5X,≠3≠,5X,≠4≠,5X,≠5≠,5X,≠6≠)	MAIN	332	
WRITE(6,1630) (RRHUB(I),I=1,NS)	MAIN	333	
1630 FORMAT(1H,1X,RRHUB(I)≠,3X,6(F5.3,1X))	MAIN	334	
WRITE(6,1640) (RC(I),I=1,NS)	MAIN	335	
1640 FORMAT(1H,1X,RC(I)≠,6X,6(F5.3,1X))	MAIN	336	
WRITE(6,1650) (RBLADE(I),I=1,NS)	MAIN	337	
1650 FORMAT(1H,1X,RBLADE(I)≠,2X,6(F5.2,1X))	MAIN	338	
WRITE(6,1660) (STAGER(I),I=1,NS)	MAIN	339	
1660 FORMAT(1H,1X,STAGER(I)≠,2X,6(F5.2,1X))	MAIN	340	
WRITE(6,1661) (STAGES(I),I=1,NS)	MAIN	341	
1661 FORMAT(1H,1X,STAGES(I)≠,2X,6(F5.2,1X))	MAIN	342	
WRITE(6,1670) (SRHUB(I),I=1,NS1)	MAIN	343	
1670 FORMAT(1H,1X,SRHUB(I)≠,3X,7(F5.3,1X))	MAIN	344	
WRITE(6,1680) (SC(I),I=1,NS)	MAIN	345	
1680 FORMAT(1H,1X,SC(I)≠,6X,6(F5.3,1X))	MAIN	346	
WRITE(6,1690) (SBLADE(I),I=1,NS)	MAIN	347	
1690 FORMAT(1H,1X,SBLADE(I)≠,2X,6(F5.2,1X))	MAIN	348	
WRITE(6,1700) (SIGUMR(I),I=1,NS)	MAIN	349	
1700 FORMAT(1H,1X,SIGUMR(I)≠,2X,6(F5.3,1X))	MAIN	350	

WRITE(6,1750) (SIGUMS(I),I=1,NS)	MAIN	351
1750 FORMAT(1H ,1X, #SIGUMS(I)#,2X,6(F5.3,1X))	MAIN	352
WRITE(6,1792) (FAISTL(I),I=1,NS)	MAIN	353
1792 FORMAT(1H ,1X, #FAISTL(I)#,2X,6(F5.3,1X))	MAIN	354
WRITE(6,1795) (GAPR(I),I=1,NS)	MAIN	355
1795 FORMAT(1H ,1X, #GAPR(I)#,4X,6(F5.3,1X))	MAIN	356
WRITE(6,1796) (GAPS(I),I=1,NS)	MAIN	357
1796 FORMAT(1H ,1X, #GAPS(I)#,4X,6(F5.3,1X))	MAIN	358
WRITE(6,1798) (RRTIP(I),I=1,NS)	MAIN	359
1798 FORMAT(1H ,1X, #RRTIP(I)#,3X,6(F5.2,1X))	MAIN	360
WRITE(6,1799) (SRTIP(I),I=1,NS1)	MAIN	361
1799 FORMAT(1H ,1X, #SRTIP(I)#,3X,7(F5.2,1X))	MAIN	362
WRITE(6,1801) (RT(I),I=1,NS)	MAIN	363
1801 FORMAT(1H ,1X, #RT(I)#,6X,6(F5.3,1X))	MAIN	364
WRITE(6,1802) (RM(I),I=1,NS)	MAIN	365
1802 FORMAT(1H ,1X, #RM(I)#,6X,6(F5.3,1X))	MAIN	366
WRITE(6,1803) (RH(I),I=1,NS)	MAIN	367
1803 FORMAT(1H ,1X, #RH(I)#,6X,6(F5.3,1X))	MAIN	368
WRITE(6,1804) (ST(I),I=1,NS)	MAIN	369
1804 FORMAT(1H ,1X, #SH(I)#,6X,6(F5.3,1X))	MAIN	370
WRITE(6,1805) (SM(I),I=1,NS)	MAIN	371
1805 FORMAT(1H ,1X, #SM(I)#,6X,6(F5.3,1X))	MAIN	372
WRITE(6,1806) (SH(I),I=1,NS)	MAIN	373
1806 FORMAT(1H ,1X, #SH(I)#,6X,6(F5.3,1X))	MAIN	374
WRITE(6,1807) (BLOCK(I),I=1,NS)	MAIN	375
1807 FORMAT(1H ,1X, #BLOCK(I)#,3X,6(F5.3,1X))	MAIN	376
WRITE(6,1808) (BLOCKS(I),I=1,NS)	MAIN	377
1808 FORMAT(1H ,1X, #BLOCKS(I)#,2X,6(F5.3,1X))	MAIN	378
WRITE(6,1811) (BET1MR(I),I=1,NS)	MAIN	379
1811 FORMAT(1H ,1X, #BET1MR(I)#,2X,6(F5.2,1X))	MAIN	380
WRITE(6,1812) (BET2MR(I),I=1,NS)	MAIN	381
1812 FORMAT(1H ,1X, #BET2MR(I)#,2X,6(F5.2,1X))	MAIN	382
WRITE(6,1813) (BET1MS(I),I=1,NS1)	MAIN	383
1813 FORMAT(1H ,1X, #BET1MS(I)#,2X,7(F5.2,1X))	MAIN	384
WRITE(6,1814) (BET2MS(I),I=1,NS1)	MAIN	385
1814 FORMAT(1H ,1X, #BET2MS(I)#,2X,7(F5.2,1X))	MAIN	386
WRITE(6,1815) (PR12D(I),I=1,NS)	MAIN	387
1815 FORMAT(1H ,1X, #PR12D(I)#,3X,6(F5.3,1X))	MAIN	388
WRITE(6,1816) (PR13D(I),I=1,NS)	MAIN	389
1816 FORMAT(1H ,1X, #PR13D(I)#,3X,6(F5.3,1X))	MAIN	390
WRITE(6,1817) (ETARD(I),I=1,NS)	MAIN	391
1817 FORMAT(1H ,1X, #ETARD(I)#,3X,6(F5.3,1X))	MAIN	392
IF (IAREA.EQ.2) WRITE(6,1821) (SAREA(I),I=1,NS)	MAIN	393
1821 FORMAT(1H ,1X, #SAREA(I)#,3X,6(F10.7,1X))	MAIN	394
IF (IAREA.EQ.2) WRITE(6,1822) (SAREAS(I),I=1,NS1)	MAIN	395
1822 FORMAT(1H ,1X, #SAREAS(I)#,2X,7(F10.7,1X))	MAIN	396
WRITE(6,1818)	MAIN	397
1818 FORMAT(1H1,5X, #***** INPUT DATA *****	MAIN	398
\$*****#)	MAIN	399
WRITE(6,1800) FNF	MAIN	400
1800 FORMAT(1H0,1X, #FNF(FRACTION OF DESIGN CORRECTED SPEED)#,F5.3)	MAIN	401
WRITE(6,1810) XDIN,XDDIN,RHUMID,XCH4	MAIN	402
1810 FORMAT(1H0,1X, #XDIN(INITIAL WATER CONTENT OF SMALL DROPLET)#,F5.3	MAIN	403
\$,/,2X, #XDDIN(INITIAL WATER CONTENT OF LARGE DROPLET)#,F5.3,/,	MAIN	404
\$2X, #RHUMID(INITIAL RELATIVE HUMIDITY)#,F6.2,1X, #PER CENT#/,	MAIN	405
\$2X, #XCH4(INITIAL METHANE CONTENT)#,F5.3)	MAIN	406
WRITE(6,1820) TOG,TOW,P0	MAIN	407
1820 FORMAT(1H0,1X, #TOG(COMPRESSOR INLET TOTAL TEMPRATURE OF GAS)#,	MAIN	408
\$F7.2,/,2X, #TOW(COMPRESSOR INLET TEMPERATURE OF DROPLRET)#,F7.2,/,	MAIN	409
\$2X, #P0(COMPRESSOR INLET TOTAL PRESSURE)#,F7.2)	MAIN	410
WRITE(6,1830) DIN,DDIN	MAIN	411
1830 FORMAT(1H0,1X, #DIN(INITIIL DROPLET DIAMETER OF SMALL DROPLET)#,	MAIN	412
\$F6.1,/,2X, #DDIN(INITIAL DROPLET DIAMETER OF LARGE DROPLET)#,F6.1)	MAIN	413
WRITE(6,1850) FND	MAIN	414
1850 FORMAT(1H0,1X, #FND(DESIGN ROTATIONAL SPEED)#,F7.1)	MAIN	415
WRITE(6,1851) DSMASS	MAIN	416
1851 FORMAT(1H0,1X, #DSMASS(DESIGN MASS FLOW RATE)#,F10.4)	MAIN	417
WRITE(6,1860) TOG	MAIN	418
1860 FORMAT(1H0,1X, #COMPRESSOR INLET TATAL TEMPERATURE(GAS PHASE)# ,	MAIN	419
\$F7.2,1X, #R#)	MAIN	420

```

WRITE(6,1870) P0
1870 FORMAT(1H0,1X,#COMPRESSOR INLET TOTAL PRESSURE=#,F7.2,1X,#LB/FT**2
$#)
WRITE(6,1880) PREB
1880 FORMAT(1H0,1X,#PREB(PERCENT OF WATER THAT REBOUND AFTER IMPINGE
$MENT)=#,F5.1,1X,#PERCENT#)
WRITE(6,1900) FN
1900 FORMAT(1H0,1X,#ROTOR SPEED=#,F7.1,1X,#RPM#)
WRITE(6,1910) CRPM,FNFN
1910 FORMAT(1H0,1X,#CORRECTED ROTOR SPEED= #,F7.1,1X,#RPM#,#(=#,2X,F5.1,
$#PER CENT OF DESIGN CORRECTED SPEED)#)
TG(1)=T01D
P(1)=P01D
CALL WICSPD(DSMAS,ISTAGE)
SPEEDF=FNF
CALL CSINPT
XW(1)=0.0
CALL NASA
C ++++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C MAIN 421
C MAIN 422
C MAIN 423
C MAIN 424
C MAIN 425
C MAIN 426
C MAIN 427
C MAIN 428
C MAIN 429
C MAIN 430
C MAIN 431
C MAIN 432
C MAIN 433
C MAIN 434
C MAIN 435
C MAIN 436
C MAIN 437
C MAIN 438
C MAIN 439
C MAIN 440
C MAIN 441
C MAIN 442
C MAIN 443
C MAIN 444
C MAIN 445
C MAIN 446
C MAIN 447
C MAIN 448
C MAIN 449
C MAIN 450
C MAIN 451
C MAIN 452
C MAIN 453
C MAIN 454
C MAIN 455
C MAIN 456
C MAIN 457
C MAIN 458
C MAIN 459
C MAIN 460
C MAIN 461
C MAIN 462
C MAIN 463
C MAIN 464
C MAIN 465
C MAIN 466
C MAIN 467
C MAIN 468
C MAIN 469
C MAIN 470
C MAIN 471
C MAIN 472
C MAIN 473
C MAIN 474
C MAIN 475
C MAIN 476
C MAIN 477
C MAIN 478
C MAIN 479
C MAIN 480
C MAIN 481
C MAIN 482
C MAIN 483
C MAIN 484
C MAIN 485
C MAIN 486
C MAIN 487
C MAIN 488
C MAIN 489
C MAIN 490

```

DDAVE(N)=0.0	MAIN	491	
TW(1)=OT01D	MAIN	492	
TWW(1)=OT01D	MAIN	493	
IF(XDIN.GT.0.0) DAVE(N)=DIN	MAIN	494	
IF(XDDIN.GT.0.0) DDAVE(N)=DDIN	MAIN	495	
IF(XDIN.GT.0.0) TW(1)=OT01D	MAIN	496	
IF(XDDIN.GT.0.0) TWW(1)=OT01D	MAIN	497	
P(1)=OP01	MAIN	498	
TB(1) = WICBPT(TG(1), P(1))	MAIN	499	
WS(1) = WICSH(TG(1), P(1)) * RHUMID / 100.0	MAIN	500	
PW=WS(1)*P(1)/(WS(1)+0.6219)	MAIN	501	
TDEW(1)=WICBPT(TG(1),PW)	MAIN	502	
XW(1)=XDIN	MAIN	503	
XWW(1)=XDDIN	MAIN	504	
XWT(1)=XW(1)+XWW(1)	MAIN	505	
XWTO=XWT(1)	MAIN	506	
XU(1)=WS(1)/(1.0+WS(1))*(1.0-XWT(1)-XCH4)	MAIN	507	
XA=1.0-XWT(1)-XU(1)-XCH4	MAIN	508	
XG=XA+XU(1)+XCH4	MAIN	509	
XAIN=XA	MAIN	510	
XCH4IN=XCH4	MAIN	511	
ISTAGE=1	MAIN	512	
CALL WICPRP(XA, XU(1), XCH4, TG(1), RMIX, CPMIX, GAMMA, G1, G2, G3)	MAIN	513	
GAMMAI=GAMMA	MAIN	514	
RHOG(1)=P(1)/RMIX/TG(1)	MAIN	515	
RHOA(1)=P(1)/RA/TG(1)	MAIN	516	
AMASSM=-1.0	MAIN	517	
AAA2=AAAIGU	MAIN	518	
AAA3=AAAIGU	MAIN	519	
CALL WICMAC(ISTAGE, AMASSM, TG(1), P(1), M, UZ, C, XWT(1), BET2SS(NS1),	MAIN	520	
\$RMIX, CPMIX, AAA3)	MAIN	521	
RHOG(1)=(1.0+G2*M**2)**G3*RHOG(1)	MAIN	522	
RHOM(1)=1.0/((1.0-XWT(1))/RHOG(1)+XWT(1)/RHOW)	MAIN	523	
MMASS = RHOM(1)*FAI*UTIPG(1)*AAA3	MAIN	524	
MMASSO=MMASS	MAIN	525	
WMASSO=MMASSO*XDIN	MAIN	526	
WMMASSO=MMASSO*XDDIN	MAIN	527	
IF(IPRINT.EQ.2) WRITE(6,5558) MMASSO, XDIN, WMASSO, MMASS	MAIN	528	
5558 FORMAT(1H0,2X,4(F10.5,2X))	MAIN	529	
DAMY=OT01G/518.7	MAIN	530	
DAMY2=OP01/(14.7*144.0)	MAIN	531	
CMASS=MMASS*SQRT(DAMY)/DAMY2	MAIN	532	
AMASS = XA * MMASS	MAIN	533	
WMASS(1)=XW(1)*MMASS	MAIN	534	
WWMASS(1)=XWW(1)*MMASS	MAIN	535	
WTMASS(1)=XWT(1)*MMASS	MAIN	536	
UMASS(1)=XU(1)*MMASS	MAIN	537	
CHMASS=XCH4*MMASS	MAIN	538	
GMASS(1)=MMASS-WTMASS(1)	MAIN	539	
CMASS2=GMASS(1)*SQRT(DAMY)/DAMY2	MAIN	540	
AMD=AMASS	MAIN	541	
UMO=UMASS(1)	MAIN	542	
CMD=CHMASS	MAIN	543	
GMO=GMASS(1)	MAIN	544	
WMO=WMASS(1)	MAIN	545	
WWMO=WWMASS(1)	MAIN	546	
WTMO=WTMASS(1)	MAIN	547	
TLMO=GMO*WTMO	MAIN	548	
TWMAS=WMASSO*AAAR1T/AAAIGU	MAIN	549	
TWWMAS=WWMASSO*AAAR1T/AAAIGU	MAIN	550	
WMASTL=TWMAS+TWWMAS	MAIN	551	
C ++++++	MAIN	552	
CC	MAIN	553	
C	C	MAIN	554
C INITIAL VALUES	MAIN	555	
C	C	MAIN	556
CC	MAIN	557	
TG(3)=TG(1)	MAIN	558	
TW(3)=TW(1)	MAIN	559	
TWW(3)=TWW(1)	MAIN	560	

P(3)=P(1)	MAIN	561
TB(3)=TB(1)	MAIN	562
WS(3)=WS(1)	MAIN	563
TDEW(3)=TDEW(1)	MAIN	564
XU(3)=XU(1)	MAIN	565
XG=XA+XU(3)+XCH4	MAIN	566
XW(3)=XW(1)	MAIN	567
XWW(3)=XWW(1)	MAIN	568
UMASS(3)=UMASS(1)	MAIN	569
WMASS(3)=WMASS(1)	MAIN	570
WWMASS(3)=WWMASS(1)	MAIN	571
WCENT=WMASSO	MAIN	572
WCMASO=WWMASO	MAIN	573
C+++++	MAIN	574
CC	MAIN	575
C	C MAIN	576
C IGU	C MAIN	577
C	C MAIN	578
CC	MAIN	579
C IGU IMPINGEMENT	MAIN	580
CALL WICISS(7,RADI1(1), XW(1) , XG , RHOG(1),0.0,UZ,WW1,WW2,WW)	MAIN	581
AMIMPS=WW	MAIN	582
AMWAKS = AMIMPS * (1.0-PREB)	MAIN	583
AMREBS=AMIMPS*PREB	MAIN	584
C+++++	MAIN	585
C IGU WAKE	MAIN	586
N=2	MAIN	587
DAVE(2)=DAVE(1)	MAIN	588
DDAVE(2)=DDAVE(1)	MAIN	589
ALFA3=BET2SS(NS1)*(FAID/FAI)**(1.0/7.0)	MAIN	590
DWAKEM=0.0	MAIN	591
IF(XDIN.GT.0.0.OR.XDDIN.GT.0.0) GO TO 628	MAIN	592
GO TO 629	MAIN	593
628 CALL WICWAK(RHOG(1),UZ,DWAKE,DWAKEM)	MAIN	594
629 CONTINUE	MAIN	595
C +++++	MAIN	596
C IGU OUTLET	MAIN	597
WMASS(3) = WMASS(1)	MAIN	598
XW(3) = XW(1)	MAIN	599
PRATIO=1.0	MAIN	600
TRATIO=1.0	MAIN	601
EFF=1.0	MAIN	602
AMIMPR=0.0	MAIN	603
AMREBR=0.0	MAIN	604
AMWAKR=0.0	MAIN	605
DELTGW=0.0	MAIN	606
DELTDW=0.0	MAIN	607
DELTGH=0.0	MAIN	608
DELTDH=0.0	MAIN	609
DELT=0.0	MAIN	610
DELP=0.0	MAIN	611
DMDTAU=0.0	MAIN	612
XU(3)=XU(1)	MAIN	613
XW(3)=XW(1)	MAIN	614
XWW(3)=XWW(1)	MAIN	615
WMASS(3) = WMASS(1)	MAIN	616
WWMASS(3)=WWMASS(1)	MAIN	617
UMASS(3) = UMASS(1)	MAIN	618
WS(3) = WS(1)	MAIN	619
TDEW(3)=TDEW(1)	MAIN	620
RHOA(3) = RHOA(1)	MAIN	621
RHOM(3) = RHOM(1)	MAIN	622
RHOG(3) = RHOG(1)	MAIN	623
TG(3) = TG(1)	MAIN	624
TW(3) = TW(1)	MAIN	625
TWW(3)=TWW(1)	MAIN	626
P(3) = P(1)	MAIN	627
TB(3) = TB(1)	MAIN	628
XU(2)=0.0	MAIN	629
XW(2) = 0.0	MAIN	630

XW(2)=0.0	MAIN	631
WMASS(2) = 0.0	MAIN	632
WMASS(2)=0.0	MAIN	633
UMASS(2) = 0.0	MAIN	634
WS(2) = 0.0	MAIN	635
RHOA(2)=0.0	MAIN	636
RHOM(2) = 0.0	MAIN	637
RHOG(2)= 0.0	MAIN	638
TG(2)=0.0	MAIN	639
TW(2) =0.0	MAIN	640
TW(2)=0.0	MAIN	641
P(2) = 0.0	MAIN	642
TB(2) = 0.0	MAIN	643
TDEW(2)=0.0	MAIN	644
GAMMA=GAMMA	MAIN	645
C ++++++	MAIN	646
C IGV OUTLET	MAIN	647
IF(IPRINT.EQ.2) WRITE(6,300) ISTAGE	MAIN	648
300 FORMAT(1H0,5X,#ISTAGE=#,I1,2X,#(IGV)#)	MAIN	649
IF(IPRINT.EQ.2) WRITE(6,301) PRATIO,TRATIO,EFF	MAIN	650
301 FORMAT(1H0,5X,3(F12.5,5X))	MAIN	651
IF(IPRINT.EQ.2) WRITE(6,302) FAI, UZ, XA	MAIN	652
302 FORMAT(1H0,5X,3(F12.5,5X))	MAIN	653
IF(IPRINT.EQ.2) WRITE(6,303) MMASS, AMASS, AMIMPS, AMREBS, AMWAKS,	MAIN	654
1AMIMPR, AMREBR, AMWAKR	MAIN	655
303 FORMAT(1H0,5X,8(F12.5,2X))	MAIN	656
IF(IPRINT.EQ.2) WRITE(6,304) DELTCW, DELTDW, DELTGH, DELTDH, DMDTAU,	MAIN	657
\$DELT, DELP	MAIN	658
304 FORMAT(1H0,5X,7(F12.5,2X))	MAIN	659
IF(IPRINT.EQ.2) WRITE(6,305) XU(1), XU(2), XU(3)	MAIN	660
305 FORMAT(1H0,5X,#XU=#,3(F20.10,5X))	MAIN	661
IF(IPRINT.EQ.2) WRITE(6,306) XW(1), XW(2) , XW(3)	MAIN	662
306 FORMAT(1H0,5X,#XW=#,3(F20.10,5X))	MAIN	663
IF(IPRINT.EQ.2) WRITE(6,307) WMASS(1), WMASS(2) , WMASS(3)	MAIN	664
307 FORMAT(1H0,5X,#WMASS=#,3(F20.10,5X))	MAIN	665
IF(IPRINT.EQ.2) WRITE(6,308) UMASS(1) , UMASS(2) , UMASS(3)	MAIN	666
308 FORMAT(1H0,5X,#UMASS=#,3(F20.10,5X))	MAIN	667
IF(IPRINT.EQ.2) WRITE(6,309) WS(1) , WS(2) , WS(3)	MAIN	668
309 FORMAT(1H0,5X,#WS=#,3(F20.10,5X))	MAIN	669
IF(IPRINT.EQ.2) WRITE(6,310) RHOA(1) , RHOA(2) , RHOA(3)	MAIN	670
310 FORMAT(1H0,5X,#RHOA=#,3(F20.10,5X))	MAIN	671
IF(IPRINT.EQ.2) WRITE(6,311) RHOM(1), RHOM(2),RHOM(3)	MAIN	672
311 FORMAT(1H0,5X,#RHOM=#,3(F20.10,5X))	MAIN	673
IF(IPRINT.EQ.2) WRITE(6,312) RHOG(1),RHOG(2),RHOG(3)	MAIN	674
312 FORMAT(1H0,5X,#RHOG=#,3(F20.10,5X))	MAIN	675
IF(IPRINT.EQ.2) WRITE(6,313) TG(1),TG(2),TG(3)	MAIN	676
313 FORMAT(1H0,5X,#TG=#,3(F20.10,5X))	MAIN	677
IF(IPRINT.EQ.2) WRITE(6,314) TW(1),TW(2),TW(3)	MAIN	678
314 FORMAT(1H0,5X,#TW=#,3(F20.10,5X))	MAIN	679
IF(IPRINT.EQ.2) WRITE(6,315) P(1),P(2),P(3)	MAIN	680
315 FORMAT(1H0,5X,#P=#,3(F20.10,5X))	MAIN	681
IF(IPRINT.EQ.2) WRITE(6,316) TB(1),TB(2),TB(3)	MAIN	682
316 FORMAT(1H0,5X,#TB=#,3(F20.10,5X))	MAIN	683
IF(IPRINT.EQ.2) WRITE(6,321) TDEW(1),TDEW(2),TDEW(3)	MAIN	684
321 FORMAT(1H0,5X,#TDEW=#,3(F20.10,5X))	MAIN	685
RHOG(2)=RHOG(1)	MAIN	686
C ++++++	MAIN	687
CC	MAIN	688
C	MAIN	689
C ROTER INLET	MAIN	690
C	MAIN	691
CC	MAIN	692
900 ISTAGE=ISTAGE+1	MAIN	693
IF(IPRINT.EQ.2) WRITE(6,8001) FAIO, ISTAGE	MAIN	694
8001 FORMAT(1H1,1X,#####,1X,	MAIN	695
\$=INITIAL FLOW COEFFICIENT=#,1X,F5.3,1X,#(ISTAGE= #,I2,1X,	MAIN	696
\$#)#,2X,#####)	MAIN	697
TG(1)=TG(3)	MAIN	698
TW(1)=TW(3)	MAIN	699
TW(1)=TW(3)	MAIN	700

```

P(1)=P(3)
TB(1)=TB(3)
RHOA(1)=P(1)/RA/TG(1)
WS(1)=WS(3)
TDEW(1)=TDEW(3)
XU(1)=XU(3)
XCH4=CHMASS/MMASS
XA=AMASS/MMASS
XG=XA+XU(1)+XCH4
XAIR(1)=XA
XMETAN(1)=XCH4
XGAS(1)=XG
XW(1)=XW(3)
XWW(1)=XWW(3)
XWT(1)=XW(1)+XWW(1)
UMASS(1)=UMASS(3)
WMASS(1)=WMASS(3)
WWMASS(1)=WWMASS(3)
WTMASS(1)=WMASS(1)+WWMASS(1)
MMASS=AMASS+CHMASS+UMASS(1)+WTMASS(1)
TMASS(1)=MMASS
GMASS(1)=TMASS(1)-WTMASS(1)
ALFA1=ALFA3
CALL WICPRP(XA,XU(1),XCH4,TG(1),RMIX,CPMIX,GAMMA,G1,G2,G3)
GAMMAS=GAMMA
AAA1=AAA3
C *****
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C STAGE PERFORMANCE CALCULATION
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
JPERFM=2
DAMY=0.0
IF(WTMASS(1).GT.1.0E-4)
$DAMY=WWMASS(1)/WTMASS(1)
IF(DAMY.GT.0.20) JPERFM=3
IF(IPRINT.EQ.2) WRITE(6,8000) JPERFM
8000 FORMAT(1H0,≠ STAGE PERFORMANCE CALCULATION (JPERFM=≠,I2,≠ )≠)
IF(JPERFM.EQ.2) GO TO 1301
IF(JPERFM.EQ.3) GO TO 1302
1301 CALL CSOUP2(FAIO,ISTAGE,MMASS,ALFA1,BETA1,BETA2,UZ,ALFA2,ALFA3,
XDELTA,DELTW,W1,W2,U1,U2)
GO TO 1303
1302 CALL COUPT2(FAIO,ISTAGE,GMASS(1),ALFA1,BETA1,BETA2,UZ,ALFA2,
$ALFA3,DELTG,DELTW,W1,W2,U1,U2)
1303 CONTINUE
DELTG1=DELTG
DELTW1=DELTW
IF(UZ.LT.0.0.OR.UZ.GT.1000.0) WRITE(6,1304) UZ
1304 FORMAT(1H0,1X,≠ AXIAL VELOCITY IS TOO HIGH OR TOO LOW≠,≠UZ=≠,
$F10.5)
IF(UZ.LT.0.0.OR.UZ.GT.1000.0) GO TO 901
C *****
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C ROTOR IMPINGEMENT
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C ROTOR IMPINGEMENT (SMALL DROPLET)
IF(IPRINT.EQ.2) WRITE(6,8010)
8010 FORMAT(1H1,≠ ROTOR IMPINGEMENT (SMALL DROPLET)≠)
CALL WICIRS(ISTAGE,RADI1(ISTAGE),XW(1),XG,RHOG(1),BETA1,W1,WW1,
$WW2,WW)
AMIMPR=WW
IF(AMIMPR.LT.0.0) AMIMPR=0.0
IF(AMIMPR.GT.WMASS(1)) AMIMPR=WMASS(1)
AKREBR=AMIMPR*PREB/100.0
AKWAKR=AMIMPR*(1.0-PREB/100.0)
AKNOIR=WMASS(1)-AMIMPR

```

```

MAIN 701
MAIN 702
MAIN 703
MAIN 704
MAIN 705
MAIN 706
MAIN 707
MAIN 708
MAIN 709
MAIN 710
MAIN 711
MAIN 712
MAIN 713
MAIN 714
MAIN 715
MAIN 716
MAIN 717
MAIN 718
MAIN 719
MAIN 720
MAIN 721
MAIN 722
MAIN 723
MAIN 724
MAIN 725
MAIN 726
MAIN 727
MAIN 728
MAIN 729
MAIN 730
MAIN 731
MAIN 732
MAIN 733
MAIN 734
MAIN 735
MAIN 736
MAIN 737
MAIN 738
MAIN 739
MAIN 740
MAIN 741
MAIN 742
MAIN 743
MAIN 744
MAIN 745
MAIN 746
MAIN 747
MAIN 748
MAIN 749
MAIN 750
MAIN 751
MAIN 752
MAIN 753
MAIN 754
MAIN 755
MAIN 756
MAIN 757
MAIN 758
MAIN 759
MAIN 760
MAIN 761
MAIN 762
MAIN 763
MAIN 764
MAIN 765
MAIN 766
MAIN 767
MAIN 768
MAIN 769
MAIN 770

```

XWNOIR=AMNOIR/MMASS	MAIN	771
XWREBR=AMREBR/MMASS	MAIN	772
XWAKR=AMWAKR/MMASS	MAIN	773
IF(IPRINT.EQ.2) WRITE(6,609) AMIMPR,AMREBR,AMWAKR,AMNOIR,	MAIN	774
\$XWNOIR,XWREBR,XWAKR	MAIN	775
609 FORMAT(1H ,7(F12.5,1X))	MAIN	776
C ++++++	MAIN	777
C ROTOR IMPINGEMENT(LARGE DROPLET)	MAIN	778
IF(IPRINT.EQ.2) WRITE(6,8020)	MAIN	779
8020 FORMAT(1H0,≠ ROTOR IMPINGEMENT(LARGE DROPLET)≠)	MAIN	780
CALL WICIRL(ISTAGE,RADI1(ISTAGE),XWW(1),XG,RHOG(1),BETA1,W1,WW1,WW	MAIN	781
\$2,WW)	MAIN	782
BMIMPR=WW	MAIN	783
IF(BMIMPR.LT.0.0) BMIMPR=0.0	MAIN	784
IF(BMIMPR.GT.WWMASS(1)) BMIMPR=WWMASS(1)	MAIN	785
BMREBR=BMIMPR*PREB/100.0	MAIN	786
BMWAKR=BMIMPR*(1.0-PREB/100.0)	MAIN	787
BMNOIR=WWMASS(1)-BMIMPR	MAIN	788
XWWB=0.0	MAIN	789
IF(WWMASS(1).GT.1.0E-6) XWWB=BMWAKR/WWMASS(1)	MAIN	790
XWWNOR=BMNOIR/MMASS	MAIN	791
XWWRER=BMREBR/MMASS	MAIN	792
XWWAR=BMWAKR/MMASS	MAIN	793
IF(IPRINT.EQ.2) WRITE(6,6090) BMIMPR, BMREBR, BMWAKR, BMNOIR, XWWNOR,	MAIN	794
\$XWWRER, XWWAR	MAIN	795
6090 FORMAT(1H ,7(F12.5,1X))	MAIN	796
C ++++++	MAIN	797
CC	MAIN	798
C	MAIN	799
C ROTOR WAKE	MAIN	800
C	MAIN	801
CC	MAIN	802
IF(IPRINT.EQ.2) WRITE(6,8030)	MAIN	803
8030 FORMAT(1H0,≠ ROTOR WAKE≠)	MAIN	804
N=N+1	MAIN	805
ALFA=BETA2	MAIN	806
DWAKEM=0.0	MAIN	807
IF(AMWAKR.GT.0.0) GO TO 630	MAIN	808
GO TO 631	MAIN	809
630 CALL WICWAK(RHOG(1),W2,DWAKE,DWAKEM)	MAIN	810
631 D1=DWAKEM	MAIN	811
IF(D1.LT.0.0) D1=0.0	MAIN	812
IF(D1.GT.DIN) D1=DIN	MAIN	813
AMING1=AMWAKR	MAIN	814
ALFA=BETA2	MAIN	815
RDELV1=DELUV2	MAIN	816
DWAKEM=0.0	MAIN	817
IF(BMWAKR.GT.0.0) GO TO 6310	MAIN	818
GO TO 6311	MAIN	819
6310 CALL WICWAK(RHOG(1),RDELV1,DWAKE,DWAKEM)	MAIN	820
6311 D2=DWAKEM	MAIN	821
IF(D2.LT.0.0) D2=0.0	MAIN	822
IF(D2.GT.DDIN) D2=DDIN	MAIN	823
RUP2=(90.0-BETA2)/180.0	MAIN	824
AMING2=BMWAKR*RUP2	MAIN	825
RDELV2=DELVL2	MAIN	826
DWAKEM=0.0	MAIN	827
IF(BMWAKR.GT.0.0) GO TO 6312	MAIN	828
GO TO 6313	MAIN	829
6312 CALL WICWAK(RHOG(1),RDELV2,DWAKE,DWAKEM)	MAIN	830
6313 D3=DWAKEM	MAIN	831
IF(D3.LT.0.0) D3=0.0	MAIN	832
IF(D3.GT.DDIN) D3=DDIN	MAIN	833
RLOW2=(90.0+BETA2)/180.0	MAIN	834
AMING3=BMWAKR*RLOW2	MAIN	835
WMASSS=WMASS(1)-AMWAKR	MAIN	836
WMASSL=WMASS(1)-BMWAKR	MAIN	837
CALL WICSIZ(WMASSL,WMASSS,AMING1,AMING2,AMING3,DDAVE(1	MAIN	838
\$),DAVE(1),D1,D2,D3,DLIMIT,AMSL,AMLGE,DSL,DLGE)	MAIN	839
WMASS(2)=AMLGE	MAIN	840

WMASS(2)=AMSL	MAIN	841
IF(WMASS(2).LT.0.0) WMASS(2)=0.0	MAIN	842
IF(WWMASS(2).LT.0.0) WWMASS(2)=0.0	MAIN	843
WTMASS(2)=WWMASS(2)+WMASS(2)	MAIN	844
UMASS(2)=UMASS(1)	MAIN	845
MMASS=AMASS+CHMASS+UMASS(2)+WTMASS(2)	MAIN	846
TMASS(2)=MMASS	MAIN	847
GMASS(2)=TMASS(2)-WTMASS(2)	MAIN	848
DAVE(N)=DSL	MAIN	849
DDAVE(N)=DLGE	MAIN	850
XW(2)=WMASS(2)/MMASS	MAIN	851
XWW(2)=WWMASS(2)/MMASS	MAIN	852
XWT(2)=WTMASS(2)/MMASS	MAIN	853
XU(2)=XU(1)	MAIN	854
XCH4=CHMASS/MMASS	MAIN	855
XA=AMASS/MMASS	MAIN	856
XG=XA+XU(2)+XCH4	MAIN	857
XAIR(2)=XA	MAIN	858
XMETAN(2)=XCH4	MAIN	859
XGAS(2)=XG	MAIN	860
WS(2)=UMASS(2)/AMASS	MAIN	861
PW=WS(2)*P(2)/(WS(2)+0.6219)	MAIN	862
TDEW(2)=WICBPT(TG(2),PW)	MAIN	863
RHOA(2)=P(2)/RA/TG(2)	MAIN	864
CALL WICPRP(XA,XU(2),XCH4,TG(2),RMIX,CPMIX,GAMMA,G1,G2,G3)	MAIN	865
RHOG(2)=P(2)/RMIX/TG(2)	MAIN	866
IF(JPERFM.NE.3) BMASS=MMASS	MAIN	867
IF(JPERFM.EQ.3) BMASS=GMASS(2)	MAIN	868
CALL WICMAC(ISTAGE,BMASS,TG(2),P(2),M,UZ,C,XWT(2),ALFA2,	MAIN	869
\$RMIX,CPMIX,AAA2)	MAIN	870
RHOG(2)=(1.0+G2*M**2)**G3*RHOG(2)	MAIN	871
RHOM(2)=1.0/((1.0-XWT(2))/RHOG(2)+XWT(2)/RHOW)	MAIN	872
RHOA(2)=(1.0+G2*M**2)**G3*RHOA(2)	MAIN	873
IF(IPRINT.EQ.2) WRITE(6,614) UZ,ALFA,D1,D2,D3,WWMASS(2),	MAIN	874
\$WMASS(2),UMASS(2),XW(2),XU(2)	MAIN	875
614 FORMAT(1H,10(F12.5,1X))	MAIN	876
IF(IPRINT.EQ.2) WRITE(6,615)WS(2),DAVE(N),DDAVE(N),RHOM(2),RHOA	MAIN	877
\$(2),RHOM(2),RHOG(2)	MAIN	878
615 FORMAT(1H,7(F12.5,1X))	MAIN	879
IF(UZ.LT.0.0.OR.UZ.GT.1500.0) WRITE(6,6150)	MAIN	880
6150 FORMAT(1H0,=UZ IS TOO HIGH OR TOO LOW: UZ=,F10.4)	MAIN	881
C ++++++	MAIN	882
CC	MAIN	883
C	MAIN	884
C CENTRIFUGAL ACTION IN ROTOR	MAIN	885
C	MAIN	886
CC	MAIN	887
C CENTRIFUGAL EFFECT IN ROTOR(SMALL DROPLET)	MAIN	888
IF(IPRINT.EQ.2) WRITE(6,8040)	MAIN	889
8040 FORMAT(1H0,=CENTRIFUGAL ACTION IN ROTOR (SMALL DROPLET)=)	MAIN	890
DELMW=0.0	MAIN	891
DELMAS=0.0	MAIN	892
RW=0.0	MAIN	893
RWW=0.0	MAIN	894
IF(WTMASS(1).GT.1.0E-6) RW=WMASS(1)/WTMASS(1)	MAIN	895
IF(WTMASS(1).GT.1.0E-6) RWW=WWMASS(1)/WTMASS(1)	MAIN	896
AMASW=(WMASTL-WCENT-WWCENT)*RW	MAIN	897
BMASW=(WMASTL-WCENT-WWCENT)*RWW*XWUB	MAIN	898
IF(DAVE(N-1).LT.1.0E-6) GO TO 996	MAIN	899
DD=DAVE(N-1)	MAIN	900
DELZZ=RC(ISTAGE)/12.0	MAIN	901
ALFAAU=(BETA1+BETA2)/2.0	MAIN	902
IRS=2	MAIN	903
RHOGAS=RHOG(2)	MAIN	904
RHUB=RRHUB(ISTAGE)	MAIN	905
CALL WICENR(ZERO,UZERO,DD,UZ,DELZZ,ALFAAU, FN,IRS,RHOGAS,	MAIN	906
1RHUB,R2,U2,ITIP,UZTIME,XG,XA,XU(2),XCH4,RTIP(ISTAGE))	MAIN	907
CALL WICDMS(IPRINT,IRAD,WMASS(1),AMASW,AMASW,RZERO,R2,AAREA(ISTA	MAIN	908
\$GE),RADI1(ISTAGE),RTIP(ISTAGE),DMIN,DROUT,AMASW2,DELMAS)	MAIN	909
WCENT=DELMAS	MAIN	910

RZERO=R2	MAIN	911	
UZERO=U2	MAIN	912	
996 DELMW=DELMAS	MAIN	913	
C ++++++	MAIN	914	
C CENTRIFUGAL EFFECT IN ROTOR(LARGE DROPLET)	MAIN	915	
IF(IPRINT.EQ.2) WRITE(6,8050)	MAIN	916	
8050 FORMAT(1H0,≠ CENTRIFUGAL ACTION IN ROTOR (LARGE DROPLET)≠)	MAIN	917	
DELMAS=0.0	MAIN	918	
DELMW=0.0	MAIN	919	
IF(DDAVE(N-1).LT.1.0E-6) GO TO 9996	MAIN	920	
DD=DDAVE(N-1)	MAIN	921	
DELZZ=RC(ISTAGE)/12.0	MAIN	922	
ALFAAU=0.0	MAIN	923	
IIRS=2	MAIN	924	
RHOGAS=RHOG(2)	MAIN	925	
RHUB=RRHUB(ISTAGE)	MAIN	926	
CALL WICCEN(RRZERO,UZERO,DD,UZ,DELZZ,ALFAAU, FN,IIRS,RHOGAS,	MAIN	927	
1RHUB,R2,U2,IITIP,UZTIME,XG,XA,XU(2),XCH4,RRTIP(ISTAGE))	MAIN	928	
CALL WICDML(IPRINT,IRAD,WMASS(1),BMAW,BMASW,RRZERO,R2,AAREA(IS	MAIN	929	
STAGE),RADI1(ISTAGE),RRTIP(ISTAGE),DMIN,DMOUT,AMASW2,DELMAS)	MAIN	930	
RRZERO=R2	MAIN	931	
UZERO=U2	MAIN	932	
9996 DELMWW=DELMAS	MAIN	933	
WM=WMASS(2)	MAIN	934	
WWM=WMASS(2)	MAIN	935	
WMASS(2)=WMASS(2)+DELMW	MAIN	936	
WWMW=WMWMASS(2)+DELMW	MAIN	937	
WTMASS(2)=WMASS(2)+WWMW(2)	MAIN	938	
IF(WTMASS(2).GT.WMASTL) TT=WTMASS(2)/WMASTL	MAIN	939	
IF(WTMASS(2).GT.WMASTL) WMASS(2)=WMASS(2)/TT	MAIN	940	
IF(WTMASS(2).GT.WMASTL) WWMW(2)=WWMW(2)/TT	MAIN	941	
DELMW=WMASS(2)-WM	MAIN	942	
DELMW=WMWMASS(2)-WWM	MAIN	943	
WTMASS(2)=WMASS(2)+WWMW(2)	MAIN	944	
DELMAS=WTMASS(2)-WTMASS(1)	MAIN	945	
MMASS=MMASS+DELMAS	MAIN	946	
XW(2)=WMASS(2)/MMASS	MAIN	947	
XWW(2)=WWMW(2)/MMASS	MAIN	948	
XU(2)=UMASS(2)/MMASS	MAIN	949	
XA=AMASS/MMASS	MAIN	950	
XCH4=CHMASS/MMASS	MAIN	951	
XG=XA+XU(2)+XCH4	MAIN	952	
DELUM=RHOG(2)/RHOW*DELMAS	MAIN	953	
AMASS=AMASS-DELUM*(AMASS/GMASS(2))	MAIN	954	
UMASS(2)=UMASS(2)-DELUM*(UMASS(2)/GMASS(2))	MAIN	955	
CHMASS=CHMASS-DELUM*(CHMASS/GMASS(2))	MAIN	956	
MMASS=AMASS+UMASS(2)+CHMASS+WTMASS(2)	MAIN	957	
WS(2)=UMASS(2)/MMASS	MAIN	958	
WCENT=WCENT+DELMW	MAIN	959	
WCENT=WCENT+DELMW	MAIN	960	
IF(WMASS(2).LT.1.0E-6) DAVE(N)=0.0	MAIN	961	
IF(WWMW(2).LT.1.0E-6) DDAVE(N)=0.0	MAIN	962	
C ++++++	MAIN	963	
CC	MAIN	964	
C	C	MAIN	965
C STATOR IMPINGEMENT	C	MAIN	966
C	C	MAIN	967
CC	MAIN	968	
C STATOR IMPINGEMENT(SMALL DROPLET)	MAIN	969	
IF(IPRINT.EQ.2) WRITE(6,8060)	MAIN	970	
8060 FORMAT(1H0,≠ STATOR IMPINGEMENT (SMALL DROPLET)≠)	MAIN	971	
CALL WICISS(ISTAGE,RADI2(ISTAGE),XW(2),XG,RHOG(2),ALFA2,U2,	MAIN	972	
\$W1,W2,W)	MAIN	973	
AMIMPS=W	MAIN	974	
IF(AMIMPS.GT.WMASS(2)) AMIMPS=WMASS(2)	MAIN	975	
IF(AMIMPS.LT.0.0) AMIMPS=0.0	MAIN	976	
AMREBS=AMIMPS*PREB/100.0	MAIN	977	
AMWAKS=AMIMPS*(1.0-PREB/100.0)	MAIN	978	
IF(IPRINT.EQ.2) WRITE(6,617) XW(2),XG,RHOG(2),U2,W,AMIMPS,AMRE	MAIN	979	
\$BS,AMWAKS	MAIN	980	

617	FORMAT(1H ,8(F12.5,1X))	MAIN	981
C	+++++	MAIN	982
C	STATOR IMPINGEMENT(LARGE DROPLET)	MAIN	983
	IF(IPRINT.EQ.2) WRITE(6,8070)	MAIN	984
8070	FORMAT(1H0,≠ STATOR IMPINGEMENT (LARGE DROPLET)≠)	MAIN	985
	CALL WICISL(ISTAGE,RADI2(ISTAGE),XWW(2),XG,RHOG(2),ALFA2,U2,WW1	MAIN	986
	\$,WW2,WW)	MAIN	987
	BMIMPS=WW	MAIN	988
	IF(BMIMPS.LT.0.0) BMIMPS=0.0	MAIN	989
	IF(BMIMPS.GT.WWMASS(2)) BMIMPS=WWMASS(2)	MAIN	990
	BMREBS=BMIMPS*PREB/100.0	MAIN	991
	BMWAKS=BMIMPS*(1.0-PREB/100.0)	MAIN	992
	IF(IPRINT.EQ.2) WRITE(6,6617) XWW(2),XA,RHOA(2),UZ,WW,BMIMPS,BM	MAIN	993
	\$REBS,BMWAKS	MAIN	994
6617	FORMAT(1H ,8(F12.5,1X))	MAIN	995
C	+++++	MAIN	996
C	CC	MAIN	997
C	STATOR WAKE	MAIN	998
C		MAIN	999
C	CC	MAIN	1000
	IF(IPRINT.EQ.2) WRITE(6,8080)	MAIN	1001
8080	FORMAT(1H0,≠ STATOR WAKE≠)	MAIN	1002
	N=N+1	MAIN	1003
	ALFA=ALFA3	MAIN	1004
	DWAKEM=0.0	MAIN	1005
	IF(AMWAKS.GT.0.0) GO TO 632	MAIN	1006
	GO TO 633	MAIN	1007
632	CALL WICWAK(RHOG(2),U2,DWAKE,DWAKEM)	MAIN	1008
633	D1=DWAKEM	MAIN	1009
	IF(D1.LT.0.0) D1=0.0	MAIN	1010
	IF(D1.GT.DIN) D1=DIN	MAIN	1011
	AMING1=AMWAKS	MAIN	1012
	ALFA=ALFA3	MAIN	1013
	SDELV1=DELUU2	MAIN	1014
	DWAKEM=0.0	MAIN	1015
	IF(BMWAKS.GT.0.0) GO TO 6330	MAIN	1016
	GO TO 6331	MAIN	1017
6330	CALL WICWAK(RHOG(2),SDELV1,DWAKE,DWAKEM)	MAIN	1018
6331	D2=DWAKEM	MAIN	1019
	IF(D2.LT.0.0) D2=0.0	MAIN	1020
	IF(D2.GT.DDIN) D2=DDIN	MAIN	1021
	SUP2=(90.0-ALFA3)/180.0	MAIN	1022
	AMING2=BMWAKS*SUP2	MAIN	1023
	SDELV2=DELU2	MAIN	1024
	DWAKEM=0.0	MAIN	1025
	IF(BMWAKS.GT.0.0) GO TO 6332	MAIN	1026
	GO TO 6333	MAIN	1027
6332	CALL WICWAK(RHOG(2),SDELV2,DWAKE,DWAKEM)	MAIN	1028
6333	D3=DWAKEM	MAIN	1029
	IF(D3.LT.0.0) D3=0.0	MAIN	1030
	IF(D3.GT.DDIN) D3=DDIN	MAIN	1031
	SLOW2=(90.0+ALFA3)/180.0	MAIN	1032
	AMING3=BMWAKS*SLOW2	MAIN	1033
	WMASSS=WMASS(2)-AMWAKS	MAIN	1034
	WMASSL=WMASS(2)-BMWAKS	MAIN	1035
	IF(WMASSS.LT.0.0) WMASSS=0.0	MAIN	1036
	IF(WMASSL.LT.0.0) WMASSL=0.0	MAIN	1037
	CALL WICSIZ(WMASSL,WMASSS,AMING1,AMING2,AMING3,DDAVE(2),DAVE(	MAIN	1038
	\$2),D1,D2,D3,DLIMIT,AMSSL,AMLGE,DSL,DLGE)	MAIN	1039
	WMASS(3)=AMLGE	MAIN	1040
	WMASS(3)=AMSSL	MAIN	1041
	IF(WMASS(3).LT.0.0) WMASS(3)=0.0	MAIN	1042
	IF(WMASS(3).LT.0.0) WMASS(3)=0.0	MAIN	1043
	WTMASS(3)=WMASS(2)+WMASS(2)	MAIN	1044
	UMASS(3)=UMASS(2)	MAIN	1045
	MMASS=AMASS+CHMASS+UMASS(3)+WTMASS(3)	MAIN	1046
	TMASS(3)=MMASS	MAIN	1047
	CMASS(3)=TMASS(3)-WTMASS(3)	MAIN	1048
	DAVE(N)=DSL	MAIN	1049
		MAIN	1050

DDAVE(N)=DLGE	MAIN	1051
XW(3)=WMASS(3)/MMASS	MAIN	1052
XWW(3)=WWMASS(3)/MMASS	MAIN	1053
XWT(3)=WTMASS(3)/MMASS	MAIN	1054
XU(3)=XU(2)	MAIN	1055
XA=AMASS/MMASS	MAIN	1056
XCH4=CHMASS/MMASS	MAIN	1057
XG=XA+XU(3)+XCH4	MAIN	1058
XAIR(3)=XA	MAIN	1059
XMETAN(3)=XCH4	MAIN	1060
XGAS(3)=XG	MAIN	1061
IF(WMASSO.LT.1.0E-6) WMASSO=WMASS(3)	MAIN	1062
IF(WWMASO.LT.1.0E-6) WWMASO=WWMASS(3)	MAIN	1063
IF(WTMASS(3).GT.0.0) RW=WMASS(3)/WTMASS(3)	MAIN	1064
IF(WTMASS(3).GT.0.0) RWW=WWMASS(3)/WTMASS(3)	MAIN	1065
TG(3)=TG(2)	MAIN	1066
TW(3)=TW(2)	MAIN	1067
IF(IPRINT.EQ.2) WRITE(6,619) RHOA(2),UZ,ALFA,D1,D2,WWMASS(3)	MAIN	1068
\$,WMASS(3),UMASS(3),XW(3),XU(3)	MAIN	1069
619 FORMAT(1H ,10(F12.5,1X))	MAIN	1070
IF(IPRINT.EQ.2) WRITE(6,620) DAVE(N),TG(3),TW(3)	MAIN	1071
620 FORMAT(1H ,3(F12.5,1X))	MAIN	1072
IF(WMASS(2).GT.0.0.AND.WWMASS(2).GT.0.0) GO TO 951	MAIN	1073
IF(WMASS(2).GT.0.0) GO TO 951	MAIN	1074
IF(WWMASS(2).GT.0.0) GO TO 951	MAIN	1075
WS(3)=WS(2)	MAIN	1076
TB(3)=TB(2)	MAIN	1077
TDEW(3)=TDEW(2)	MAIN	1078
DELTC2=0.0	MAIN	1079
DELTC3=0.0	MAIN	1080
DELTW2=0.0	MAIN	1081
TRATIO=TG(3)/TG(1)	MAIN	1082
DAVE(N)=0.0	MAIN	1083
RHOA(3)=P(3)/RA/TG(3)	MAIN	1084
CALL WICPRP(XA,XU(3),XCH4,TG(3),RMIX,CPMIX,GAMMA,G1,G2,G3)	MAIN	1085
RHOG(3)=P(3)/RMIX/TG(3)	MAIN	1086
IF(JPERFM.NE.3) BMASS=MMASS	MAIN	1087
IF(JPERFM.EQ.3) BMASS=GMASS(3)	MAIN	1088
CALL WICMAC(ISTAGE,BMASS,TG(3),P(3),M,UZ,C,XWT(3),ALFA3,	MAIN	1089
\$RMIX,CPMIX,AAA3)	MAIN	1090
RHOG(3)=(1.0+G2*M**2)**G3*RHOG(3)	MAIN	1091
RHOM(3)=1.0/((1.0-XWT(3))/RHOG(3)+XWT(3)/RHOW)	MAIN	1092
RHOA(3)=(1.0+G2*M**2)**G3*RHOA(3)	MAIN	1093
GO TO 950	MAIN	1094
951 CONTINUE	MAIN	1095
C *****	MAIN	1096
CC	MAIN	1097
C	MAIN	1098
C CENTRIFUGAL EFFECT(IN STATOR)	MAIN	1099
C	MAIN	1100
CC	MAIN	1101
GO TO 708	MAIN	1102
IF(IPRINT.EQ.2) WRITE(6,8090)	MAIN	1103
8090 FORMAT(1H0,≠ CENTRIFUGAL ACTION IN STATOR≠)	MAIN	1104
IF(DAVE(N-1).LT.1.0E-6) GO TO 708	MAIN	1105
DD=DAVE(N-1)	MAIN	1106
DELZZ=SC(ISTAGE)/12.0	MAIN	1107
ALFAAV=(ALFA2+ALFA3)/2.0	MAIN	1108
IRS=1	MAIN	1109
RHOGAS=RHOG(2)	MAIN	1110
RHUB=SRHUB(ISTAGE)	MAIN	1111
CALL WICEN(RZERO,UZERO,DD,UZ,DELZZ,ALFAAV,FN,IRS,RHOGAS,	MAIN	1112
1RHUB,R2,U2,ITIP,UZTIME,XG,XA,XU(2),XCH4,SRTIP(ISTAGE))	MAIN	1113
TWMAS=WMASS(2)*AREAS(ISTAGE)/AAA2	MAIN	1114
TWWMAS=WWMASS(2)*AREAS(ISTAGE)/AAA2	MAIN	1115
TT=TWMAS+TWWMAS	MAIN	1116
IF(TT.GT.0.0) TWMAS=TWMAS*WMASTL/TT	MAIN	1117
IF(TT.GT.0.0) TWWMAS=TWWMAS*WMASTL/TT	MAIN	1118
AMASW=WMASSO	MAIN	1119
CALL WICDMS(IPRINT,IRAD,WMASS(2),TWMAS,AMASW,RZERO,R2,AAAIGU,	MAIN	1120

```

$RADI2(ISTAGE), SRTIP(ISTAGE), DMIN, DMOUT, AMASW2, DELMAS)          MAIN      1121
WMASS(3)=AMASW2                                                       MAIN      1122
IF(WMASS(3).LT.0.0) WMASS(3)=0.0                                     MAIN      1123
IF(WMASS(3).GT.TWMAS) WMASS(3)=TWMAS                                 MAIN      1124
MMASS=MMASS+DELMAS                                                    MAIN      1125
XW(3)=WMASS(3)/MMASS                                                  MAIN      1126
XWW(3)=WMASS(3)/MMASS                                                 MAIN      1127
XU(3)=UMASS(3)/MMASS                                                  MAIN      1128
XA=AMASS/MMASS                                                         MAIN      1129
XCH4=CHMASS/MMASS                                                      MAIN      1130
XG=XA+XU(3)+XCH4                                                      MAIN      1131
WS(3)=UMASS(3)/MMASS                                                  MAIN      1132
RZERO=R2                                                                MAIN      1133
UZERO=U2                                                                MAIN      1134
708 CONTINUE                                                            MAIN      1135
WTMASS(3)=WMASS(3)+WMASS(3)                                          MAIN      1136
C ++++++                                                                MAIN      1137
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MAIN      1138
C ++++++                                                                C MAIN      1139
C HEAT TRANSFER                                                         C MAIN      1140
C ++++++                                                                C MAIN      1141
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MAIN      1142
C HEAT-TRANSFER (SMALL DROPLET)                                       MAIN      1143
IF(IPRINT.EQ.2) WRITE(6,8120)                                         MAIN      1144
8120 FORMAT(1H0, ' HEAT TRANSFER#')                                    MAIN      1145
DELTGH=0.0                                                             MAIN      1146
DELTWH=0.0                                                             MAIN      1147
IF(DAVE(N-2).GT.0.0.AND.DAVE(N).GT.0.0) GO TO 8121                  MAIN      1148
GO TO 8122                                                             MAIN      1149
8121 RE=0.0                                                            MAIN      1150
XU1=(XU(1)+XU(3))/2.0                                                 MAIN      1151
XW1=(XW(1)+XW(3))/2.0                                                 MAIN      1152
WMASS1=(WMASS(1)+WMASS(3))/2.0                                       MAIN      1153
UMASS1=(UMASS(1)+UMASS(3))/2.0                                       MAIN      1154
CPG1=XA*WICCPA(TG(1))+XU(1)*WICCPH(TG(1))+XCH4*WICCCPC(TG(1))     MAIN      1155
CPG3=XA*WICCPA(TG(3))+XU(3)*WICCPH(TG(3))+XCH4*WICCCPC(TG(3))     MAIN      1156
CPG=(CPG1+CPG3)/2.0                                                  MAIN      1157
CALL WICHET(TG(1), TG(3), TW(1), TW(3), DAVE(N-2), DAVE(N))         MAIN      1158
$, DELZ(ISTAGE), UZ, WMASS1, UMASS1, AMASS, CHMASS, CPG, CPW, DELTGH MAIN      1159
$, DELTWH, RE)                                                         MAIN      1160
8122 DELTG2=DELTGH                                                    MAIN      1161
DELTW2=DELTWH                                                         MAIN      1162
C ++++++                                                                MAIN      1163
C HEAT TRANSFER(LARGE DROPLET)                                         MAIN      1164
DELTGH=0.0                                                             MAIN      1165
DELTWH=0.0                                                             MAIN      1166
IF(DDAVE(N-2).GT.0.0.AND.DDAVE(N).GT.0.0) GO TO 8123                MAIN      1167
GO TO 8124                                                             MAIN      1168
8123 RE=0.0                                                            MAIN      1169
IF(DDAVE(N-1).GT.0.0) RE=REAVE                                         MAIN      1170
XU1=(XU(1)+XU(3))/2.0                                                 MAIN      1171
XW1=(XWW(1)+XWW(3))/2.0                                               MAIN      1172
WMASS1=(WMASS(1)+WMASS(3))/2.0                                       MAIN      1173
UMASS1=(UMASS(1)+UMASS(3))/2.0                                       MAIN      1174
CPG1=XA*WICCPA(TG(1))+XU(1)*WICCPH(TG(1))+XCH4*WICCCPC(TG(1))     MAIN      1175
CPG3=XA*WICCPA(TG(1))+XU(3)*WICCPH(TG(3))+XCH4*WICCCPC(TG(3))     MAIN      1176
CPG=(CPG1+CPG3)/2.0                                                  MAIN      1177
CALL WICHET(TG(1), TG(3), TW(1), TW(3), DDAVE(N-2), DDAVE(N))     MAIN      1178
$, DELZ(ISTAGE), UZ, WMASS1, UMASS1, AMASS, CHMASS, CPG, CPW, DELTGH MAIN      1179
$, DELTWH, RE)                                                         MAIN      1180
8124 DELTG3=DELTGH                                                    MAIN      1181
DELTW3=DELTWH                                                         MAIN      1182
TG(3)=TG(1)+DELTG1-DELTG2-DELTG3                                       MAIN      1183
TW(3)=TW(1)+DELTW1+DELTW2                                             MAIN      1184
TWW(3)=TWW(1)+DELTW3                                                 MAIN      1185
TRATIO=TG(3)/TG(1)                                                    MAIN      1186
IF(IPRINT.EQ.2) WRITE(6,627) DELTG2, DELTW2, DELTG3, DELTW3, TG(3), MAIN      1187
$TW(3), TWW(3), TRATIO                                               MAIN      1188
627 FORMAT(1H ,8(F15.6,1X))                                          MAIN      1189
C ++++++                                                                MAIN      1190

```


IF(IPRINT.EQ.2) WRITE(6,625) RHOA(3),RHOM(3),RHOG(3),DMDTA1,DMD	MAIN	1261
\$TA2,PW2,TW(3),TG(3)	MAIN	1262
625 FORMAT(1H ,8(F12.5,1X))	MAIN	1263
950 DELTGW=DELTG1	MAIN	1264
DELTDW=DELTW1	MAIN	1265
DELTGH=-DELTG2-DELTG3	MAIN	1266
DELTDH=DELTW2	MAIN	1267
DELTP=P(3)-P(1)	MAIN	1268
GAMMAO=GAMMA	MAIN	1269
TB(3)=WICBPT(TG(3),P(3))	MAIN	1270
C ++++++	MAIN	1271
CC	MAIN	1272
C	C	MAIN 1273
C OUTPUT(STAGE PERFORMANCE)	MAIN	1274
C	C	MAIN 1275
CC	MAIN	1276
WRITE(6,400) FAIO,ISTAGE	MAIN	1277
400 FORMAT(1H1,1X,***** ≠,1X,	MAIN	1278
\$≠INITIAL FLOW COEFFICIENT=≠,1X,F5.3,1X,≠(ISTAGE= ≠,I2,1X,	MAIN	1279
\$≠)≠,2X,*****≠)	MAIN	1280
PRATIO=P(3)/P(1)	MAIN	1281
TRATIO=TG(3)/TG(1)	MAIN	1282
GAMMAU=(GAMMAS+GAMMAO)/2.0	MAIN	1283
G4=(GAMMAU-1.0)/GAMMAU	MAIN	1284
ETAA(ISTAGE)=(PRATIO**G4-1.0)/(TRATIO-1.0)	MAIN	1285
WRITE(6,402) JPERFM	MAIN	1286
402 FORMAT(1H0,5X,≠STAGE PERFORMANCE AFTER INTER-STAGE ADJUSTMENT≠,	MAIN	1287
\$≠(JPERFM=≠, I1,≠)≠)	MAIN	1288
WRITE(6,401) PRATIO,TRATIO,ETAA(ISTAGE)	MAIN	1289
401 FORMAT(1H0,5X,≠STAGE TOTAL PRESSURE RATIO=≠,F12.5,/,	MAIN	1290
\$6X,≠STAGE TOTAL TEMPERATURE RATIO=≠,F12.5,/,	MAIN	1291
\$6X,≠STAGE ADIABATIC EFFICIENCY=≠,F12.5)	MAIN	1292
WRITE(6,4025)	MAIN	1293
4025 FORMAT(1H0,12X,***STAGE INLET***,4X,***STAGE OUTLET***,	MAIN	1294
\$4X,***STAGE OUTLET***)	MAIN	1295
WRITE(6,4026)	MAIN	1296
4026 FORMAT(1H ,33X,≠(BEFORE INTER-≠,6X,≠(AFTER INTER-≠)	MAIN	1297
WRITE(6,4027)	MAIN	1298
4027 FORMAT(1H ,34X,≠STAGE ADJUST-≠,7X,≠STAGE ADJUST-≠)	MAIN	1299
WRITE(6,4028)	MAIN	1300
4028 FORMAT(1H ,34X,≠MENT)≠,15X,≠MENT)≠)	MAIN	1301
WRITE(6,405) XU(1), XU(1), XU(3)	MAIN	1302
405 FORMAT(1H ,5X,≠XU=≠,3(F15.5,5X))	MAIN	1303
WRITE(6,406) XW(1), XW(1), XW(3)	MAIN	1304
406 FORMAT(1H ,5X,≠XW=≠,3(F15.5,5X))	MAIN	1305
WRITE(6,4060) XWW(1),XWW(1),XWW(3)	MAIN	1306
4060 FORMAT(1H ,5X,≠XWW=≠,3(F15.5,5X))	MAIN	1307
WRITE(6,4061) XWT(1),XWT(1),XWT(3)	MAIN	1308
4061 FORMAT(1H ,5X,≠XWT=≠,3(F15.5,5X))	MAIN	1309
WRITE(6,4062) XAIR(1),XAIR(1),XAIR(3)	MAIN	1310
4062 FORMAT(1H ,5X,≠XAIR=≠,3(F15.5,5X))	MAIN	1311
WRITE(6,4063) XMETAN(1),XMETAN(1),XMETAN(3)	MAIN	1312
4063 FORMAT(1H ,5X,≠XMETAN=≠,3(F15.5,5X))	MAIN	1313
WRITE(6,4064) XGAS(1),XGAS(1),XGAS(3)	MAIN	1314
4064 FORMAT(1H ,5X,≠XGAS=≠,3(F15.5,5X))	MAIN	1315
WRITE(6,407) WMASS(1), WMASS(1), WMASS(3)	MAIN	1316
407 FORMAT(1H ,5X,≠WMASS=≠,3(F15.5,5X))	MAIN	1317
WRITE(6,4070) WWMASS(1),WWMASS(1),WWMASS(3)	MAIN	1318
4070 FORMAT(1H ,5X,≠WWMASS=≠,3(F15.5,5X))	MAIN	1319
WRITE(6,4071) WTMASS(1),WTMASS(1),WTMASS(3)	MAIN	1320
4071 FORMAT(1H ,5X,≠WTMASS=≠,3(F15.5,5X))	MAIN	1321
WRITE(6,4072) AMASS,AMASS,AMASS	MAIN	1322
4072 FORMAT(1H ,5X,≠AMASS=≠,3(F15.5,5X))	MAIN	1323
WRITE(6,4073) CHMASS,CHMASS,CHMASS	MAIN	1324
4073 FORMAT(1H ,5X,≠CHMASS=≠,3(F15.5,5X))	MAIN	1325
WRITE(6,408) UMASS(1), UMASS(1), UMASS(3)	MAIN	1326
408 FORMAT(1H ,5X,≠UMASS=≠,3(F15.5,5X))	MAIN	1327
WRITE(6,4080) GMASS(1),GMASS(1),GMASS(3)	MAIN	1328
4080 FORMAT(1H ,5X,≠GMASS=≠,3(F15.5,5X))	MAIN	1329
WRITE(6,4081) TMASS(1),TMASS(1),TMASS(3)	MAIN	1330

4081	FORMAT(1H ,5X, #TMASS=#, 3(F15.5,5X))	MAIN	1331	
	WRITE(6,409) WS(1) , WS(1) , WS(3)	MAIN	1332	
409	FORMAT(1H ,5X, #WS=#, 3(F15.5,5X))	MAIN	1333	
	WRITE(6,410) RHOA(1) , RHOA(2) , RHOA(3)	MAIN	1334	
410	FORMAT(1H ,5X, #RHOA=#, 3(F15.5,5X))	MAIN	1335	
	WRITE(6,411) RHOM(1), RHOM(2),RHOM(3)	MAIN	1336	
411	FORMAT(1H ,5X, #RHOM=#, 3(F15.5,5X))	MAIN	1337	
	WRITE(6,412) RHOG(1),RHOG(2),RHOG(3)	MAIN	1338	
412	FORMAT(1H ,5X, #RHOG=#, 3(F15.5,5X))	MAIN	1339	
	WRITE(6,413) TG(1),TG(2),TG(3)	MAIN	1340	
413	FORMAT(1H ,5X, #TG=#, 3(F15.5,5X))	MAIN	1341	
	WRITE(6,414) TW(1),TW(2),TW(3)	MAIN	1342	
414	FORMAT(1H ,5X, #TW=#, 3(F15.5,5X))	MAIN	1343	
	WRITE(6,4140) TWW(1),TWW(2),TWW(3)	MAIN	1344	
4140	FORMAT(1H ,5X, #TWW=#, 3(F15.5,5X))	MAIN	1345	
	WRITE(6,415) P(1),P(2),P(3)	MAIN	1346	
415	FORMAT(1H ,5X, #P=#, 3(F15.5,5X))	MAIN	1347	
	WRITE(6,416) TB(1),TB(2),TB(3)	MAIN	1348	
416	FORMAT(1H ,5X, #TB=#, 3(F15.5,5X))	MAIN	1349	
	WRITE(6,422) TDEW(1),TDEW(2),TDEW(3)	MAIN	1350	
422	FORMAT(1H ,5X, #TDEW=#, 3(F15.5,5X))	MAIN	1351	
C	+++++	MAIN	1352	
C	CC	MAIN	1353	
C		C	MAIN	1354
C	BOILING	MAIN	1355	
C		C	MAIN	1356
C	CC	MAIN	1357	
	GO TO 450	MAIN	1358	
	IF(XDIN.GT.0.0) GO TO 460	MAIN	1359	
	GO TO 450	MAIN	1360	
460	IF(TW(3).LT.TB(3)) GO TO 450	MAIN	1361	
	HU=1115.3272-0.6840909*(TB(3)-460.0)	MAIN	1362	
	DAMY=CPG/HU*(TG(3)-TB(3))	MAIN	1363	
	XE=DAMY/(DAMY+1.0)	MAIN	1364	
	IF(XE.GT.XW(3)) GO TO 451	MAIN	1365	
	XEVAPO=XE	MAIN	1366	
	TW(3)=TB(3)	MAIN	1367	
	TG(3)=TB(3)	MAIN	1368	
	XW(3)=XW(3)-XEVAPO	MAIN	1369	
	XU(3)=XU(3)+XEVAPO	MAIN	1370	
	GO TO 452	MAIN	1371	
451	XEVAPO=XW(3)	MAIN	1372	
	TW(3)=0.0	MAIN	1373	
	TG(3)=TG(3)-XW(3)/(1.0-XW(3))*HU/CPG	MAIN	1374	
	XW(3)=0.0	MAIN	1375	
	XU(3)=XU(3)+XEVAPO	MAIN	1376	
452	WMASS(3)=XW(3)*MMASS	MAIN	1377	
	UMASS(3)=XU(3)*MMASS	MAIN	1378	
	GMASS(3)=UMASS(3)+AMASS	MAIN	1379	
	IF(IPRINT.EQ.2) WRITE(6,453)	MAIN	1380	
453	FORMAT(1H0, #BOILING#)	MAIN	1381	
	IF(IPRINT.EQ.2) WRITE(6,454) HU, XEVAPO, TW(3), TG(3), XW(3), XU(3)	MAIN	1382	
	#, WMASS(3), GMASS, UMASS(3), MMASS	MAIN	1383	
454	FORMAT(1H0, 10(F10.5,2X))	MAIN	1384	
450	CONTINUE	MAIN	1385	
C	+++++	MAIN	1386	
C	CC	MAIN	1387	
C		C	MAIN	1388
C	BLEED	MAIN	1389	
C		C	MAIN	1390
C	CC	MAIN	1391	
	IF(XBLEED(ISTAGE).GT.0.0) GO TO 456	MAIN	1392	
	GO TO 455	MAIN	1393	
456	CONTINUE	MAIN	1394	
	XB=1.0-XBLEED(ISTAGE)	MAIN	1395	
	AMASS=AMASS*XB	MAIN	1396	
	CHMASS=CHMASS*XB	MAIN	1397	
	UMASS(3)=UMASS(3)*XB	MAIN	1398	
	MMASS=AMASS+CHMASS+UMASS(3)+WTMASS(3)	MAIN	1399	
	TMASS(3)=MMASS	MAIN	1400	

GMASS(3)=TMASS(3)-WTMASS(3)	MAIN	1401
XW(3)=WMASS(3)/MMASS	MAIN	1402
XWW(3)=WMASS(3)/MMASS	MAIN	1403
XWT(3)=WTMASS(3)/MMASS	MAIN	1404
XU(3)=UMASS(3)/MMASS	MAIN	1405
XA=AMASS/MMASS	MAIN	1406
XCH4=CHMASS/MMASS	MAIN	1407
XG=XA+XU(3)+XCH4	MAIN	1408
XAIR(3)=XA	MAIN	1409
XMETAN(3)=XCH4	MAIN	1410
XGAS(3)=XG	MAIN	1411
455 CONTINUE	MAIN	1412
C ++++++	MAIN	1413
CC	MAIN	1414
C	MAIN	1415
C REPEAT	MAIN	1416
C	MAIN	1417
CC	MAIN	1418
IF(ISTAGE.EQ.NS) GO TO 902	MAIN	1419
GO TO 900	MAIN	1420
902 OVALPR=P(3)/OP01	MAIN	1421
OVALTR=TG(3)/OT01G	MAIN	1422
GAMMAU=(GAMMAI+GAMMAO)/2.0	MAIN	1423
G4=(GAMMAU-1.0)/GAMMAU	MAIN	1424
OVALPR=(OVALPR**G4-1.0)/(OVALTR-1.0)	MAIN	1425
ODELTR=TG(3)-OT01G	MAIN	1426
ODELTR=0.0	MAIN	1427
DELTRW=0.0	MAIN	1428
DELMT=0.0	MAIN	1429
DELMWT=0.0	MAIN	1430
DELMG=0.0	MAIN	1431
IF(XDIN.GT.0.0) ODELTR=TR(3)-OT01D	MAIN	1432
IF(XDDIN.GT.0.0) DELTRW=TRW(3)-OT01D	MAIN	1433
DELMT=(MMASS-TLMO)/TLMO	MAIN	1434
IF(WTMO.GT.0.0) DELMWT=(WTMASS(3)-WTMO)/WTMO	MAIN	1435
DELMG=(CMASS(3)-GMO)/GMO	MAIN	1436
C ++++++	MAIN	1437
CC	MAIN	1438
C	MAIN	1439
C OUTPUT (OVERALL PERFORMANCE)	MAIN	1440
C	MAIN	1441
CC	MAIN	1442
WRITE(6,421)	MAIN	1443
421 FORMAT(1H1,***** OVERALL PERFORMANCE *****)	MAIN	1444
WRITE(6,422) FAIO	MAIN	1445
4220 FORMAT(1H0,1X,INITIAL FLOW COEFFICIENT=,F5.2)	MAIN	1446
WRITE(6,423) CRPM,FNF	MAIN	1447
423 FORMAT(1H0,1X,CORRECTED SPEED=,F7.1,5X,F5.3,1X,	MAIN	1448
\$FRACTION OF DEIGN CORRECTED SPEED=)	MAIN	1449
WRITE(6,424)XDIN,XDDIN,XWTO,RHUMID,XCH4IN	MAIN	1450
424 FORMAT(1H0,1X,INITIAL WATER CONTENT(SMALL DROPLET)=,F5.3,/,	MAIN	1451
\$2X,INITIAL WATER CONTENT(LARGE DROPLET)=,F5.3,/,	MAIN	1452
\$2X,INITIAL WATER CONTENT(TOTAL)=,F5.3,/,	MAIN	1453
\$2X,INITIAL RELATIVE HUMIDITY=,F5.1,1X,PER CENT=,/,	MAIN	1454
\$2X,INITIAL METHANE CONTENT=,F5.3)	MAIN	1455
WRITE(6,425) TOG	MAIN	1456
425 FORMAT(1H0,1X,COMPRESSOR INLET TOTAL TEMPERATURE=,F8.2)	MAIN	1457
WRITE(6,426) P0	MAIN	1458
426 FORMAT(1H0,1X,COMPRESSOR INLET TOTAL PRESSURE=,F8.2)	MAIN	1459
CCMASS=CMASS*AAARIT/AAAIU	MAIN	1460
C2MASS=CMASS2*AAARIT/AAAIU	MAIN	1461
WRITE(6,427) CMASS,CCMASS	MAIN	1462
427 FORMAT(1H0,1X,CORRECTED MASS FLOW RATE OF MIXTURE=,F6.3,	MAIN	1463
\$(,F6.3,)\$)	MAIN	1464
WRITE(6,428) CMASS2,C2MASS	MAIN	1465
428 FORMAT(1H0,1X,CORRECTED MASS FLOW RATE OF GAS PHASE =,F6.3,	MAIN	1466
\$(,F6.3,)\$)	MAIN	1467
WRITE(6,429) OVALPR	MAIN	1468
429 FORMAT(1H0,1X,OVERALL TOTAL PRESSURE RATIO=,F6.4)	MAIN	1469
WRITE(6,430) OVALTR	MAIN	1470

430	FORMAT(1H0,1X,#OVERALL TOTAL TEMPERATURE RATIO=#,F6.4)	MAIN	1471
	WRITE(6,431) OVALEF	MAIN	1472
431	FORMAT(1H0,1X,#OVERALL ADIABATIC EFFICIENCY=#,F6.4)	MAIN	1473
	WRITE(6,432) ODELTG	MAIN	1474
432	FORMAT(1H0,1X,#OVERALL TEMPERATURE RISE OF GAS PHASE=#,F8.3)	MAIN	1475
	GO TO 901	MAIN	1476
998	STOP	MAIN	1477
	END	MAIN	1478
C	+++++	WICSPC	1
C	CC	WICSPC	2
C		WICSPC	3
C	SUBROUTINE WICSPC	WICSPC	4
C		WICSPC	5
C	CC	WICSPC	6
	SUBROUTINE WICSPC(FAID, ISTAGE, MMAS, ALFA1, WKDONE, DAU, DELU, WMAS,	WICSPC	7
	\$WMAS, N,	WICSPC	8
	\$OMEGA1, OMEGA2, OMEGA3, OMEGA4, OMEGA5, OMEGA6, OMEGAT,	WICSPC	9
	\$BETA1, BETA2, UZ, ALFA2, ALFA3, DELTG, DELTW, W1, W2, U1, U2, U3, REAVE,	WICSPC	10
	\$DELVU2, DELVL2, AK1, AK2, AK3)	WICSPC	11
	REAL M, MMAS	WICSPC	12
	COMMON /PERDUE/ JPERFM, RHOG(3), RERUP, RERLOW, RESUP, RESLOW	WICSPC	13
	X, PREB, RRTIP(8), SRTIP(8), AAA1, AAA2, AAA3, SAREA(6), SAREAS(7)	WICSPC	14
	X, P(3), TG(3), XA, XU(3), XCH4, XW(3), XWM(3), XWT(3), TW(3), TWM(3)	WICSPC	15
	X, OMEGS(7), OMEGR(6), GAPR(6), GAPS(6)	WICSPC	16
	X, RRHUB(6), RC(6), RBLADE(6), STAGER(6)	WICSPC	17
	X, SRHUB(7), SC(7), SBLADE(7), STAGES(7)	WICSPC	18
	X, SIGUMR(6), BET1SR(6), BET2SR(6), AINCSR(6), ADEUSR(6)	WICSPC	19
	X, SIGUMS(7), BET1SS(7), BET2SS(7), AINCSS(7), ADEUSS(7)	WICSPC	20
	X, UTIPG(6), UTIP(6), UTIPD(6), UOU(6), UMEAN(6), UHUB(6), U(6), FAI	WICSPC	21
	X, AREA(6), AREAS(7), UO2(6), UTIP2(6), UMEAN2(6), UHUB2(6), IPRINT	WICSPC	22
	X, ICENT, IICENT, FMR1(6), FMA2(6), IRAD, FAID	WICSPC	23
	X, NS, NS1, RT(6), RM(6), RH(6), ST(6), SM(6), SH(6)	WICSPC	24
	X, DSMASS, AAREA(7), AAREAS(7), PR12D(6), PR13D(6), ETARD(6)	WICSPC	25
	X, DR(6), DS(6), DEQR(6), DEQS(6), BLOCK(6), BLOCKS(7)	WICSPC	26
	X, BET1MR(6), BET2MR(6), BET1MS(7), BET2MS(7), RAD11(6), RAD12(6)	WICSPC	27
	DIMENSION RHOM(3), ETAA(6)	WICSPC	28
	IPRINT=1	WICSPC	29
	CPW=1.0	WICSPC	30
	RHOW=62.3	WICSPC	31
	GC=32.174	WICSPC	32
	AJ=778.26	WICSPC	33
	PAI=3.1415926	WICSPC	34
	CALL WICPRP(XA, XU(1), XCH4, TG(1), RMIX, CPMIX, GAMMA, G1, G2, G3)	WICSPC	35
	RHOG(1)=P(1)/RMIX/TG(1)	WICSPC	36
	BMAS=MMAS-WMAS-WWMAS	WICSPC	37
	AAA2=AREAS(ISTAGE)	WICSPC	38
	AAA3=AREA(ISTAGE+1)	WICSPC	39
	CALL WICMAC(ISTAGE, BMAS, TG(1), P(1), M, UZ, C, XWT(1), ALFA1,	WICSPC	40
	\$RMIX, CPMIX, AAA1)	WICSPC	41
	ASPEED=C	WICSPC	42
	ASPEDI=ASPEED	WICSPC	43
	RHOG(1)=(1.0+G2*M **2)**G3*RHOG(1)	WICSPC	44
	RHOM(1)=1.0/((1.0-XWT(1))/RHOG(1)+XWT(1)/RHOW)	WICSPC	45
	UZ1=UZ	WICSPC	46
	UZZ=UZ	WICSPC	47
	FAI1=UZ1/UTIPG(ISTAGE)	WICSPC	48
	ALFA1R = ALFA1 * PAI / 180.0	WICSPC	49
	U1 = UZ / COS (ALFA1R)	WICSPC	50
	US1 = UZ * TAN (ALFA1R)	WICSPC	51
	WS1 = U(ISTAGE)- US1	WICSPC	52
	T = WS1 / UZ	WICSPC	53
	BETA1R = ATAN (T)	WICSPC	54
	BETA1 = BETA1R * 180.0 / PAI	WICSPC	55
	TT = UZ **2 + WS1 **2	WICSPC	56
	W1 = SQRT (TT)	WICSPC	57
	AMACH1 = W1 / ASPEED	WICSPC	58
	AMAC1=U1/ASPEED	WICSPC	59
	TS1=TG(1)/(1.0+G2*AMAC1**2)	WICSPC	60
	PS1=(TG(1)/TS1)**(-G1)*P(1)	WICSPC	61
	PREL1=(1.0+G2*AMACH1**2)**G1*PS1	WICSPC	62

	TREL1=(1.0+G2*AMACH1**2)*TS1	WICSPC	63
	TG(2)=TG(1)	WICSPC	64
	P(2)=P(1)	WICSPC	65
	ALFA2=BET1SS(ISTAGE)	WICSPC	66
	JJJ=1	WICSPC	67
2000	VZ2AS=VZ	WICSPC	68
	CALL WICGSL(OMEGR(ISTAGE),SIGUMR(ISTAGE),BET1SR(ISTAGE),BET2SR(	WICSPC	69
	\$ISTAGE),AINCSR(ISTAGE),ADEUSR(ISTAGE),AMACH1,BETA1,DEQS,DEQN,	WICSPC	70
	\$SITACS,SITACN,BET2N,OMEGAN,FMR1(ISTAGE),IDESIN,AK1,AK2,AK3,UZ1,	WICSPC	71
	\$UZ2AS,U(ISTAGE),RADI1(ISTAGE),RADI2(ISTAGE))	WICSPC	72
	OMEGA7=OMEGAN	WICSPC	73
	BETA2=BET2N	WICSPC	74
	BETA1R=BETA1*PAI/180.0	WICSPC	75
	BETA2R=BETA2*PAI/180.0	WICSPC	76
	BETAUE=(BETA1R+BETA2R)/2.0	WICSPC	77
	TANGT=WICTAN(BETA1R)-WICTAN(BETA2R)	WICSPC	78
	CSAU=COS(BETAUE)	WICSPC	79
	CS1=COS(BETA1R)	WICSPC	80
	CL=2.0/SIGUMR(ISTAGE)*TANGT*CSAU	WICSPC	81
	CDS=0.018*(CL**2)	WICSPC	82
	OMEGSE=CDS*SIGUMR(ISTAGE)*(CS1**2)/(CSAU**3)	WICSPC	83
	H=RR TIP(ISTAGE)-RRHUB(ISTAGE)	WICSPC	84
	SHR=RC(ISTAGE)/H/SIGUMR(ISTAGE)	WICSPC	85
	CDA=0.020*SHR	WICSPC	86
	OMEGAN=CDA*SIGUMR(ISTAGE)*(CS1**2)/(CSAU**3)	WICSPC	87
2001	IF(IPRINT.EQ.2) WRITE(6,2001) OMEGSE,OMEGAN,OMEGA7,CDS,CDA	WICSPC	88
	FORMAT(1H,5F10.6)	WICSPC	89
	OMES1=OMEGSE	WICSPC	90
	OMEA1=OMEGAN	WICSPC	91
	AINC1R=BETA1-BET1MR(ISTAGE)	WICSPC	92
	ADEV1R=BET2N-BET2MR(ISTAGE)	WICSPC	93
	BETA2R=BETA2*PAI/180.0	WICSPC	94
	W2=VZ/COS(BETA2R)	WICSPC	95
	UG=(W1+W2)/2.0	WICSPC	96
	CALL WICRSL(SIGUMR(ISTAGE),BETA1,BETA2,RC(ISTAGE),DAU,CDR,OMEGAR)	WICSPC	97
	OMEGA1=OMEGAR*2.0	WICSPC	98
	DEL P1=OMEGA1*0.5*RHO G(1)/GC*(W1**2)	WICSPC	99
2002	IF(IPRINT.EQ.2) WRITE(6,2002) OMEGA1,DEL P1	WICSPC	100
	FORMAT(1H,1X,#OMEGA1=#,2F10.5)	WICSPC	101
	XG=1.0-XWT(1)	WICSPC	102
	CALL WICIRL(ISTAGE,RR TIP(ISTAGE),XWW(1),XG,RHO G(1),BETA1,W1,WW1,WW	WICSPC	103
	\$2,WW)	WICSPC	104
	BMIMPR=WW	WICSPC	105
	IF(BMIMPR.GT.WWMAS) BMIMPR=WWMAS	WICSPC	106
	BMREBR=BMIMPR*PREB/100.0	WICSPC	107
	BMWAKR=BMIMPR*(1.0-PREB/100.0)	WICSPC	108
	BMNOIR=WWMAS-BMIMPR	WICSPC	109
	XWWNOR=BMNOIR/MMASS	WICSPC	110
	XWWRER=BMREBR/MMASS	WICSPC	111
	XWWWAR=BMWAKR/MMASS	WICSPC	112
	IF(IPRINT.EQ.2) WRITE(6,6090) BMIMPR,BMREBR,BMWAKR,BMNOIR,XWWNOR,	WICSPC	113
	\$XWWRER,XWWWAR	WICSPC	114
6090	FORMAT(1H,7(F12.5,1X))	WICSPC	115
	RST1=RADI1(ISTAGE)**2-AAA1*144.0/2.0/PAI	WICSPC	116
	RST1=SQRT(RST1)	WICSPC	117
	RST2=2.0*RADI1(ISTAGE)**2-RST1**2	WICSPC	118
	RST2=SQRT(RST2)	WICSPC	119
	DEL R=(RST2-RST1)/12.0	WICSPC	120
	FMASSR=BMWAKR/DEL R	WICSPC	121
	CALL WICFML(W1,W2,FMASSR,RHO G(1),RC(ISTAGE),SIGUMR(ISTAGE),BETA1,	WICSPC	122
	\$BETA2,CDF,OMEGAF)	WICSPC	123
	OMEGA2=OMEGAF	WICSPC	124
	DEL P2=OMEGA2*0.5*RHO G(1)/GC*(W1**2)	WICSPC	125
	IF(IPRINT.EQ.2) WRITE(6,6091) OMEGA2,DEL P2	WICSPC	126
6091	FORMAT(1H,1X,#OMEGA2=#,2F10.5)	WICSPC	127
	U2=0.0	WICSPC	128
	U3=0.0	WICSPC	129
	ALFA=0.0	WICSPC	130
	ALFA3=0.0	WICSPC	131
	CALL WICSTL(ISTAGE,1,DAU,W1,W2,DEL U,U2,U3,WWMAS,UZ,N,BETA1,BETA2,	WICSPC	132

\$ALFA2, ALFA3, BMASS, DELU2, DELUL2, OMEGRU, OMEGRL, OMEGSU, OMEGSL,	WICSPC	133
\$DRAGRU, DRAGRL, DRAGSU, DRAGSL, REAVE)	WICSPC	134
OMEGA3=OMEGRU+OMEGRL	WICSPC	135
DELP3=OMEGA3*0.5*RHOG(1)/GC*(W1**2)	WICSPC	136
IF(IPRINT.EQ.2) WRITE(6,6092) OMEGA3, DELP3	WICSPC	137
6092 FORMAT(1H , 1X, #OMEGA3=#, 2F10.5)	WICSPC	138
REAVE1=REAVE	WICSPC	139
BETA2R = BETA2 * PAI / 180.0	WICSPC	140
JJ=1	WICSPC	141
200 UZAS=UZ	WICSPC	142
WS2 = UZ * TAN (BETA2R)	WICSPC	143
US2 = UU2(ISTAGE) - WS2	WICSPC	144
TTT=US2/UZ	WICSPC	145
ALFA2R = ATAN (TTT)	WICSPC	146
ALFA2 = ALFA2R * 180.0 / PAI	WICSPC	147
TTTT = UZ ** 2 + WS2 ** 2	WICSPC	148
W2 = SQRT (TTTT)	WICSPC	149
TTTTT = UZ ** 2 + US2 ** 2	WICSPC	150
U2 = SQRT (TTTTT)	WICSPC	151
DELH=WKDONE*(UU2(ISTAGE)*US2-U(ISTAGE)*US1)/GC/AJ	WICSPC	152
CALL WICIRS(ISTAGE, RRTIP(ISTAGE), XW(1), XG, RHOG(1), BETA1, W1, WW1,	WICSPC	153
\$WW2, WW)	WICSPC	154
AMIMPR=WW	WICSPC	155
IF(AMIMPR.GT.WMAS) AMIMPR=WMAS	WICSPC	156
PREB=50.0	WICSPC	157
AMREBR=AMIMPR*PREB/100.0	WICSPC	158
AMWAKR=AMIMPR*(1.0-PREB/100.0)	WICSPC	159
AMNOIR=WMAS-AMIMPR	WICSPC	160
XW1=0.0	WICSPC	161
XW2=0.0	WICSPC	162
XW3=0.0	WICSPC	163
IF(WMAS.GT.0.0) XW1=AMNOIR/WMAS	WICSPC	164
IF(WMAS.GT.0.0) XW2=AMWAKR/WMAS	WICSPC	165
IF(WMAS.GT.0.0) XW3=AMREBR/WMAS	WICSPC	166
DELTG=DELH/CPMIX	WICSPC	167
DELTW1=DELH/CPW	WICSPC	168
DELTW2=DELH/CPW	WICSPC	169
DELTW3=0.0	WICSPC	170
DELTW=XW1*DELTW1+XW2*DELTW2+XW3*DELTW3	WICSPC	171
DETW1=0.0	WICSPC	172
DETW2=0.0	WICSPC	173
DETW3=0.0	WICSPC	174
DELTWW=0.0	WICSPC	175
TW(2)=TW(1)+DELTW	WICSPC	176
TWW(2)=TWW(1)+DELTWW	WICSPC	177
TG(2)=TG(1)+DELTG	WICSPC	178
TS2=TG(2)-U2**2/(2.0*CPMIX*GC*AJ)	WICSPC	179
AG2=(GAMMA*RMIX*TS2*GC)**0.5	WICSPC	180
ASPEED=WICASD(XWT(1), RHOG(1), AG2)	WICSPC	181
ASPED2=ASPEED	WICSPC	182
AMAC2=U2/ASPEED	WICSPC	183
AMACH2=W2/ASPEED	WICSPC	184
PP1=GAMMA*RMIX*TREL1*GC	WICSPC	185
PP2=(UU2(ISTAGE)/U(ISTAGE))**2-1.0	WICSPC	186
PP3=1.0+G2*U(ISTAGE)**2/PP1*PP2	WICSPC	187
PP=PP3**G1	WICSPC	188
PRREL=PP-(OMEGA7+OMEGA1+OMEGA2+OMEGA3)*(1.0-PS1/PREL1)	WICSPC	189
PR12=(TG(2)/TG(1))**G1*PRREL	WICSPC	190
P(2)=PR12*P(1)	WICSPC	191
PS2=(1.0+G2*AMAC2**2)**(-G1)*P(2)	WICSPC	192
RHOG2=PS2/RMIX/TS2	WICSPC	193
RHOG(2)=RHOG2	WICSPC	194
RHOM2=1.0/(XG/RHOG2+XWT(1)/RHOW)	WICSPC	195
UZ=BMASS/RHOG2/AAA2	WICSPC	196
UZ2=UZ	WICSPC	197
EPS=1.0E-4	WICSPC	198
IF(JJ.EQ.2) GO TO 201	WICSPC	199
IF(JJ.GT.2) GO TO 202	WICSPC	200
X1=UZAS	WICSPC	201
Y1=UZ2	WICSPC	202

	UZ=UZ2	WICSPC	203
	JJ=JJ+1	WICSPC	204
	IF(UZ.LT.0.0.OR.UZ.GT.ASPEED) GO TO 999	WICSPC	205
	GO TO 200	WICSPC	206
201	X2=UZAS	WICSPC	207
	Y2=UZ2	WICSPC	208
	UZ=WICNEW(X1,Y1,X2,Y2)	WICSPC	209
	IF(IPRINT.EQ.2) WRITE(6,203) JJ,UZ	WICSPC	210
203	FORMAT(1H ,1X,I1,2X,=UZ2=,F10.5)	WICSPC	211
	JJ=JJ+1	WICSPC	212
	IF(UZ.LT.0.0.OR.UZ.GT.ASPEED) GO TO 999	WICSPC	213
	GO TO 200	WICSPC	214
202	IF(ABS((UZAS-UZ2)/UZAS).LT.EPS) GO TO 300	WICSPC	215
	X1=X2	WICSPC	216
	Y1=Y2	WICSPC	217
	X2=UZAS	WICSPC	218
	Y2=UZ2	WICSPC	219
	UZ=WICNEW(X1,Y1,X2,Y2)	WICSPC	220
	IF(IPRINT.EQ.2) WRITE(6,204) JJ,UZ	WICSPC	221
204	FORMAT(1H0,1X,I1,2X,=UZ2=,F10.5)	WICSPC	222
	JJ=JJ+1	WICSPC	223
	IF(UZ.LT.0.0.OR.UZ.GT.ASPEED) GO TO 999	WICSPC	224
	IF(JJ.EQ.20) GO TO 999	WICSPC	225
	GO TO 200	WICSPC	226
300	UZ2CL=UZ	WICSPC	227
	IF(JJJ.EQ.2) GO TO 2010	WICSPC	228
	IF(JJJ.GT.2) GO TO 2020	WICSPC	229
	XX1=UZ2AS	WICSPC	230
	YY1=UZ2CL	WICSPC	231
	JJJ=JJJ+1	WICSPC	232
	GO TO 2000	WICSPC	233
2010	XX2=UZ2AS	WICSPC	234
	YY2=UZ2CL	WICSPC	235
	UZ=WICNEW(XX1,YY1,XX2,YY2)	WICSPC	236
	IF(IPRINT.EQ.2) WRITE(6,2030) JJJ,UZ	WICSPC	237
2030	FORMAT(1H ,1X,I2,=UZ22=,F10.5)	WICSPC	238
	JJJ=JJJ+1	WICSPC	239
	GO TO 2000	WICSPC	240
2020	IF(ABS((UZ2AS-UZ2CL)/UZ2AS).LT.EPS) GO TO 3000	WICSPC	241
	XX1=XX2	WICSPC	242
	YY1=YY2	WICSPC	243
	XX2=UZ2AS	WICSPC	244
	YY2=UZ2CL	WICSPC	245
	UZ=WICNEW(XX1,YY1,XX2,YY2)	WICSPC	246
	IF(IPRINT.EQ.2) WRITE(6,2040) JJJ,UZ	WICSPC	247
2040	FORMAT(1H ,1X,I2,=UZ22=,F10.5)	WICSPC	248
	JJJ=JJJ+1	WICSPC	249
	IF(JJJ.EQ.20) GO TO 3000	WICSPC	250
	GO TO 2000	WICSPC	251
3000	UZ2=UZ2CL	WICSPC	252
	FAI2=UZ2/UTIPG(ISTAGE)	WICSPC	253
	P(2)=(1.0+G2*AMAC2**2)**G1*PS2	WICSPC	254
	JJJJ=1	WICSPC	255
3001	UZ3AS=UZ	WICSPC	256
	CALL WICGSL(OMEGS(ISTAGE),SIGUMS(ISTAGE),BET1SS(ISTAGE),BET2SS	WICSPC	257
	\$(ISTAGE),AINCSS(ISTAGE),ADEUSS(ISTAGE),AMAC2,ALFA2,DEQS,DEQN,	WICSPC	258
	\$SITACS,SITACN,BET2N,OMEGAN,FMA2(ISTAGE),IDESIN,AK1,AK2,AK3,UZ2,	WICSPC	259
	\$UZ3AS,0.0,RADI2(ISTAGE),RADI1(ISTAGE+1))	WICSPC	260
	OMEGA8=OMEGAN	WICSPC	261
	ALFA3=BET2N	WICSPC	262
	ALFA1R=ALFA2*PAI/180.0	WICSPC	263
	ALFA2R=ALFA3*PAI/180.0	WICSPC	264
	ALFAAU=(ALFA1R+ALFA2R)/2.0	WICSPC	265
	TANGT=WICTAN(ALFA1R)-WICTAN(ALFA2R)	WICSPC	266
	CSAU=COS(ALFAAU)	WICSPC	267
	CS1=COS(ALFA1R)	WICSPC	268
	CL=2.0/SIGUMS(ISTAGE)*TANGT*CSAU	WICSPC	269
	CDS=0.018*(CL**2)	WICSPC	270
	OMEGSE=CDS*SIGUMS(ISTAGE)*(CS1**2)/(CSAU**3)	WICSPC	271
	H=SRTIP(ISTAGE)-SRHUB(ISTAGE)	WICSPC	272

SHR=SC(ISTAGE)/H/SIGUMR(ISTAGE)	WICSPC	273
CDA=0.020*SHR	WICSPC	274
OMEGAN=CDA*SIGUMS(ISTAGE)*(CS1**2)/(CSAU**3)	WICSPC	275
IF(IPRINT.EQ.2) WRITE(6,3002)	WICSPC	276
\$OMEGSE, OMEGAN, OMEGAS, CDS, CDA	WICSPC	277
3002 FORMAT(1H0,5F10.5)	WICSPC	278
OMES2=OMEGSE	WICSPC	279
OMEA2=OMEGAN	WICSPC	280
AINCIS=ALFA2-BET1MS(ISTAGE)	WICSPC	281
ADEVIS=BET2N-BET2MS(ISTAGE)	WICSPC	282
ALFA3R=ALFA3*PAI/180.0	WICSPC	283
U3=UZ/COS(ALFA3R)	WICSPC	284
CALL WICRSL(SIGUMS(ISTAGE),ALFA2,ALFA3,SC(ISTAGE),DAU,CDR,OMEGAR)	WICSPC	285
OMEGA4=OMEGAR*2.0	WICSPC	286
DELP4=OMEGA4*0.5*RHOG(2)/GC*(U2**2)	WICSPC	287
IF(IPRINT.EQ.2) WRITE(6,3003) OMEGA4,DELP4	WICSPC	288
3003 FORMAT(1H,1X,≠OMEGA4=≠,2F10.5)	WICSPC	289
CALL WICISL(ISTAGE,SRTIP(ISTAGE),XWW(2),XG,RHOG(2),ALFA2,U2,WW1	WICSPC	290
≠,WW2,WW)	WICSPC	291
BMIMPS=WW	WICSPC	292
IF(BMIMPS.GT.WWMAS) BMIMPS=WWMAS	WICSPC	293
BMREBS=BMIMPS*PREB/100.0	WICSPC	294
BMWAKS=BMIMPS*(1.0-PREB/100.0)	WICSPC	295
IF(IPRINT.EQ.2) WRITE(6,6616)	WICSPC	296
6616 FORMAT(1H,1X,≠IMPINS≠)	WICSPC	297
IF(IPRINT.EQ.2) WRITE(6,6617) XWW(2),XA,RHOG(2),UZ,WW, BMIMPS, BM	WICSPC	298
\$REBS, BMWAKS	WICSPC	299
6617 FORMAT(1H,8(F12.5,1X))	WICSPC	300
RST1=RADI2(ISTAGE)**2-AAA2*144.0/2.0/PAI	WICSPC	301
RST1=SQRT(RST1)	WICSPC	302
RST2=2.0*RADI2(ISTAGE)**2-RST1**2	WICSPC	303
RST2=SQRT(RST2)	WICSPC	304
DELR=(RST2-RST1)/12.0	WICSPC	305
FMASSS=BMWAKS/DELR	WICSPC	306
CALL WICFML(U2,U3,FMASSS,RHOG2,SC(ISTAGE),SIGUMS(ISTAGE),BETA1,	WICSPC	307
≠BETA2,CDF,OMEGAF)	WICSPC	308
OMEGA5=OMEGAF	WICSPC	309
DELP5=OMEGA5*0.5*RHOG(2)/GC*(U2**2)	WICSPC	310
IF(IPRINT.EQ.2) WRITE(6,6618) OMEGA5,DELP5	WICSPC	311
6618 FORMAT(1H,1X,≠OMEGA5=≠,2F10.5)	WICSPC	312
CALL WICSTL(ISTAGE,2,DAU,W1,W2,DELU,U2,U3,WWMAS,UZ,N,BETA1,BETA2,	WICSPC	313
≠ALFA2,ALFA3,BMASS,DELUU2,DELUU2,OMEGRU,OMEGRL,OMEGSU,OMEGSL,	WICSPC	314
≠DRAGRU,DRAGRL,DRAGSU,DRAGSL,REAVE)	WICSPC	315
OMEGA6=OMEGSU+OMEGSL	WICSPC	316
DELP6=OMEGA6*0.5*RHOG(2)/GC*(U2**2)	WICSPC	317
IF(IPRINT.EQ.2) WRITE(6,6619) OMEGA6,DELP6	WICSPC	318
6619 FORMAT(1H,1X,≠OMEGA6=≠,2F10.5)	WICSPC	319
REAVE2=REAVE	WICSPC	320
REAVE=(REAVE1+REAVE2)*0.5	WICSPC	321
PR23=1.0-(OMEGA8+OMEGA4+OMEGA5+OMEGA6)*(1.0-PS2/P(2))	WICSPC	322
PR13=(TG(2)/TG(1))**G1*PRREL*PR23	WICSPC	323
PR13I=(TG(2)/TG(1))**G1	WICSPC	324
P(3)=PR13*P(1)	WICSPC	325
TG(3)=TG(2)	WICSPC	326
TS3=TG(3)-U3**2/(2.0*CPMIX*GC*AJ)	WICSPC	327
AG3=(GAMMA*RMIX*TS3*GC)**0.5	WICSPC	328
ASPEED=WICASD(XWT(1),RHOG(2),AG3)	WICSPC	329
ASPED3=ASPEED	WICSPC	330
AMAC3=U3/ASPEED	WICSPC	331
PS3=(1.0+G2*AMAC3**2)**(-G1)*P(3)	WICSPC	332
RHOG3=PS3/RMIX/TS3	WICSPC	333
RHOG(3)=RHOG3	WICSPC	334
RHOM3=1.0/(XG/RHOG3+XWT(1)/RHOW)	WICSPC	335
UZ=BMASS/RHOG3/AAA3	WICSPC	336
UZ3CL=UZ	WICSPC	337
IF(JJJJ.EQ.2) GO TO 3010	WICSPC	338
IF(JJJJ.GT.2) GO TO 3020	WICSPC	339
XXX1=UZ3AS	WICSPC	340
YYY1=UZ3CL	WICSPC	341
JJJJ=JJJJ+1	WICSPC	342

GO TO 3001	WICSFC	343
3010 XXX2=UZ3AS	WICSFC	344
YYY2=UZ3CL	WICSFC	345
UZ=WICNEW(XXX1,YYY1,XXX2,YYY2)	WICSFC	346
IF(IPRINT.EQ.2) WRITE(6,3030) JJJJ,UZ	WICSFC	347
3030 FORMAT(1H ,1X,I2,2X,=UZ33=,F10.5)	WICSFC	348
JJJJ=JJJJ+1	WICSFC	349
GO TO 3001	WICSFC	350
3020 IF(ABS((UZ3AS-UZ3CL)/UZ3AS).LT.EPS) GO TO 4000	WICSFC	351
XXX1=XXX2	WICSFC	352
YYY1=YYY2	WICSFC	353
XXX2=UZ3AS	WICSFC	354
YYY2=UZ3CL	WICSFC	355
UZ=WICNEW(XXX1,YYY1,XXX2,YYY2)	WICSFC	356
IF(IPRINT.EQ.2) WRITE(6,3040) JJJJ,UZ	WICSFC	357
3040 FORMAT(1H ,1X,I2,=UZ33=,F10.5)	WICSFC	358
JJJJ=JJJJ+1	WICSFC	359
IF(JJJJ.EQ.20) GO TO 4000	WICSFC	360
GO TO 3001	WICSFC	361
4000 UZ3=UZ3CL	WICSFC	362
FAI3=UZ3/UTIPG(ISTAGE+1)	WICSFC	363
TW(3)=TW(2)	WICSFC	364
TWW(3)=TW(2)	WICSFC	365
OMEGTR=OMEGA1+OMEGA2+OMEGA3+OMEGA7	WICSFC	366
OMEGTS=OMEGA4+OMEGA5+OMEGA6+OMEGA8	WICSFC	367
POMEG1=OMEGA1/OMEGTR*100.0	WICSFC	368
POMEG2=OMEGA2/OMEGTR*100.0	WICSFC	369
POMEG3=OMEGA3/OMEGTR*100.0	WICSFC	370
POMEG4=OMEGA4/OMEGTS*100.0	WICSFC	371
POMEG5=OMEGA5/OMEGTS*100.0	WICSFC	372
POMEG6=OMEGA6/OMEGTS*100.0	WICSFC	373
POMEG7=OMEGA7/OMEGTR*100.0	WICSFC	374
POMEG8=OMEGA8/OMEGTS*100.0	WICSFC	375
PRATIO=P(3)/P(1)	WICSFC	376
TRATIO=TG(3)/TG(1)	WICSFC	377
CALL WICPRP(XA,XU(3),XCH4,TG(3),RMIX,CPMIX,GAMMA,G1,G2,G3)	WICSFC	378
G4=1.0/G1	WICSFC	379
ETAA(ISTAGE)=(PRATIO**G4-1.0)/(TRATIO-1.0)	WICSFC	380
WRITE(6,404) FAIO,ISTAGE	WICSFC	381
404 FORMAT(1H1,1X,=*****=,1X,	WICSFC	382
\$=INITIAL FLOW COEFFICIENT=,1X,F5.3,1X,=(STAGE=,I2,1X,	WICSFC	383
\$=),2X,=*****=)	WICSFC	384
WRITE(6,401) PRATIO,TRATIO,ETAA(ISTAGE)	WICSFC	385
401 FORMAT(1H0,5X,=STAGE TOTAL PRESSURE RATIO=,F12.5,/,	WICSFC	386
\$6X,=STAGE TOTAL TEMPERATURE RATIO=,F12.5,/,	WICSFC	387
\$6X,=STAGE ADIABATIC EFFICIENCY=,F12.5)	WICSFC	388
WRITE(6,402) FAI1,UZ1,UTIPG(ISTAGE)	WICSFC	389
402 FORMAT(1H0,5X,=STAGE FLOW COEFFICIENT=,F5.3,/,	WICSFC	390
\$6X,=AXIAL VELOCITY=,F7.2,/,	WICSFC	391
\$6X,=ROTOR SPEED=,F7.2,)	WICSFC	392
WRITE(6,403) PR13,PR13I,PRREL,PR23	WICSFC	393
403 FORMAT(1H ,5X,=STAGE TOTAL PRESSURE RATIO(ACTUAL)=,F12.5,/,	WICSFC	394
\$6X,=STAGE TOTAL PRESSURE RATIO(IDEAL)=,F12.5,/,	WICSFC	395
\$6X,=LOSS FACTOR IN ROTOR=,F12.5,/,	WICSFC	396
\$6X,=LOSS FACTOR IN STATOR=,F12.5,)	WICSFC	397
WRITE(6,405)	WICSFC	398
405 FORMAT(1H0,24X,=ROTOR INLET* *ROTOR OUTLET* *STATOR OUTLET=)	WICSFC	399
WRITE(6,406) P(1),P(2),P(3)	WICSFC	400
406 FORMAT(1H ,1X,=TOTAL PRESSURE=,10X,3(F10.4,5X))	WICSFC	401
WRITE(6,407) PS1,PS2,PS3	WICSFC	402
407 FORMAT(1H ,1X,=STATIC PRESSURE=,9X,3(F10.4,5X))	WICSFC	403
WRITE(6,408) TG(1),TG(2),TG(3)	WICSFC	404
408 FORMAT(1H ,1X,=TOTAL TEMPERATURE(GAS)=,3X,3(F10.4,5X))	WICSFC	405
WRITE(6,409) TS1,TS2,TS3	WICSFC	406
409 FORMAT(1H ,1X,=STATIC TEMPERATURE(GAS)=,1X,3(F10.4,5X))	WICSFC	407
WRITE(6,410) RHOG(1),RHOG2,RHOG3	WICSFC	408
410 FORMAT(1H ,1X,=STATIC DENSITY(GAS)=,5X,3(F10.4,5X))	WICSFC	409
WRITE(6,411) RHOM(1),RHOM2,RHOM3	WICSFC	410
411 FORMAT(1H ,1X,=STATIC DENSITY(MIXTURE)=,1X,3(F10.4,5X))	WICSFC	411
WRITE(6,412) UZ1,UZ2,UZ3	WICSFC	412

412	FORMAT(1H0,1X,AXIAL VELOCITY,10X,3(F10.4,5X))	WICSPC	413
	WRITE(6,413) U1,U2,U3	WICSPC	414
413	FORMAT(1H,1X,ABSOLUTE VELOCITY,7X,3(F10.4,5X))	WICSPC	415
	WRITE(6,414) W1,W2	WICSPC	416
414	FORMAT(1H,1X,RELATIVE VELOCITY,7X,2(F10.4,5X))	WICSPC	417
	WRITE(6,415) U(ISTAGE),UU2(ISTAGE),U(ISTAGE+1)	WICSPC	418
415	FORMAT(1H,1X,BLADE SPEED,13X,3(F10.4,5X))	WICSPC	419
	WRITE(6,416) US1,US2	WICSPC	420
416	FORMAT(1H,1X,TANG. COMP. OF ABS. VEL.,2(F10.4,5X))	WICSPC	421
	WRITE(6,417) WS1,WS2	WICSPC	422
417	FORMAT(1H,1X,TANG. COMP. OF REL. VEL.,2(F10.4,5X))	WICSPC	423
	WRITE(6,418) ASPED1,ASPED2,ASPED3	WICSPC	424
418	FORMAT(1H,1X,ACOUSTIC SPEED,10X,3(F10.4,5X))	WICSPC	425
	WRITE(6,419) AMAC1,AMAC2,AMAC3	WICSPC	426
419	FORMAT(1H,1X,ABSOLUTE MACH NUMBER,4X,3(F10.4,5X))	WICSPC	427
	WRITE(6,420) AMACH1,AMACH2	WICSPC	428
420	FORMAT(1H,1X,RELATIVE MACH NUMBER,4X,2(F10.4,5X))	WICSPC	429
	WRITE(6,421) FAI1,FAI2,FAI3	WICSPC	430
421	FORMAT(1H0,1X,FLOW COEFFICIENT,8X,3(F10.4,5X))	WICSPC	431
	WRITE(6,422) AAA1,AAA2,AAA3	WICSPC	432
422	FORMAT(1H,1X,FLOW AREA,15X,3(F10.4,5X))	WICSPC	433
	WRITE(6,423) ALFA1,ALFA2,ALFA3	WICSPC	434
423	FORMAT(1H0,1X,ABSOLUTE FLOW ANGLE,5X,3(F10.4,5X))	WICSPC	435
	WRITE(6,424) BETA1,BETA2	WICSPC	436
424	FORMAT(1H,1X,RELATIVE FLOW ANGLE,5X,3(F10.4,5X))	WICSPC	437
	WRITE(6,425) AINCIR,AINCIS	WICSPC	438
425	FORMAT(1H,1X,INCIDENCE,16X,2(F10.4,5X))	WICSPC	439
	WRITE(6,426) ADEVIR,ADEVIS	WICSPC	440
426	FORMAT(1H,1X,DEVIATION,30X,2(F10.4,5X))	WICSPC	441
999	RETURN	WICSPC	442
	END	WICSPC	443
C+++++		WICMAC	1
CC		WICMAC	2
C		WICMAC	3
C SUBROUTINE WICMAC		WICMAC	4
C		WICMAC	5
CC		WICMAC	6
	SUBROUTINE WICMAC(ISTAGE,AMASSM,T01G,PRES,M,UZ,C,XW1,ALFA,	WICMAC	7
	\$RMIX,CPMIX,AREA1)	WICMAC	8
	REAL M,MA1,MC1,MA2,MC2,MANEW,MCNEW	WICMAC	9
	COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	WICMAC	10
	X,PREB,RTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	WICMAC	11
	X,P(3),TG(3),XA,XU(3),XCH4,XW(3),XWW(3),XWT(3),TW(3),TWW(3)	WICMAC	12
	X,OMEGS(7),OMEGR(6),GAPR(6),GAPS(6)	WICMAC	13
	X,RRHUB(6),RC(6),RBLADE(6),STAGER(6)	WICMAC	14
	X,SRHUB(7),SC(7),SBLADE(7),STAGES(7)	WICMAC	15
	X,SIGUMR(6),BET1SR(6),BET2SR(6),AINC SR(6),ADEVSR(6)	WICMAC	16
	X,SIGUMS(7),BET1SS(7),BET2SS(7),AINCSS(7),ADEVSS(7)	WICMAC	17
	X,UTIPG(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI	WICMAC	18
	X,AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT	WICMAC	19
	X,ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID	WICMAC	20
	X,NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)	WICMAC	21
	X,DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)	WICMAC	22
	X,DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)	WICMAC	23
	X,BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)	WICMAC	24
	GAMMA=1.0/(1.0-RMIX/CPMIX/778.0)	WICMAC	25
	G2=(GAMMA-1.0)/2.0	WICMAC	26
	G3=-1.0/(GAMMA-1.0)	WICMAC	27
	MA1=0.5	WICMAC	28
	RHOG1=PRES/RMIX/T01G	WICMAC	29
	RHOGS=(1.0+G2*MA1**2)**G3*RHOG1	WICMAC	30
	RHOW=62.4	WICMAC	31
	RHOMS=1.0/((1.0-XW1)/RHOGS+XW1/RHOW)	WICMAC	32
	TS=T01G/(1.0+G2*MA1**2)	WICMAC	33
	A=SQRT(GAMMA*RMIX*TS*32.174)	WICMAC	34
	C=WICASD(XW1,RHOGS,A)	WICMAC	35
	IF(JPERFM.NE.3) UZ=AMASSM/RHOMS/AREA1	WICMAC	36
	IF(JPERFM.EQ.3) UZ=AMASSM/RHOGS/AREA1	WICMAC	37
	IF(AMASSM.LT.0.001) UZ=UTIPG(ISTAGE)*FAI	WICMAC	38
	ALFAR=ALFA*3.1415927/180.0	WICMAC	39


```

MC1=UZ/C/COS(ALFAR)
MA2=0.6
RHOGS=(1.0+G2*MA2**2)**G3*RHOG1
RHOMS=1.0/((1.0-XW1)/RHOGS+XW1/RHOW)
TS=TO1G/(1.0+G2*MA2**2)
A=SQRT(GAMMA*RMIX*TS*32.174)
C=WICASD(XW1,RHOGS,A)
IF(JPERFM.NE.3) VZ=AMASSM/RHOMS/AREA1
IF(JPERFM.EQ.3) VZ=AMASSM/RHOGS/AREA1
IF(AMASSM.LT.0.001) VZ=UTIPG(ISTAGE)*FAI
MC2=VZ/C/COS(ALFAR)
J=1
300 MANEW=WICNEW(MA1,MC1,MA2,MC2)
RHOGS=(1.0+G2*MANEW**2)**G3*RHOG1
RHOMS=1.0/((1.0-XW1)/RHOGS+XW1/RHOW)
TS=TO1G/(1.0+G2*MANEW**2)
A=SQRT(GAMMA*RMIX*TS*32.174)
C=WICASD(XW1,RHOGS,A)
IF(JPERFM.NE.3) VZ=AMASSM/RHOMS/AREA1
IF(JPERFM.EQ.3) VZ=AMASSM/RHOGS/AREA1
IF(AMASSM.LT.0.001) VZ=UTIPG(ISTAGE)*FAI
MCNEW=VZ/C/COS(ALFAR)
ERROR=ABS(MANEW-MCNEW)
ERROR=ERROR/MANEW
EPS=1.0E-6
IF(ERROR.LT.EPS) GO TO 200
MA1=MA2
MC1=MC2
MA2=MANEW
MC2=MCNEW
J=J+1
IF(J.LT.50) GO TO 300
WRITE(6,403) ISTAGE
403 FORMAT(1H0,≠MZ DOES NOT CONVERGE AT STAGE=≠,I1)
GO TO 998
200 M=MANEW
IF(AMASSM.LT.0.001) ISTAGE=0
998 RETURN
END
C+++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C FUNCTION WICASD
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
FUNCTION WICASD ( XW , RHOG , CG )
RHOW=62.2567
CW = 4956.04
SIGUMA = ( XW * RHOG ) / ( RHOW - XW * ( RHOW - RHOG ) )
A1 = ( 1.0-SIGUMA ) * RHOG + SIGUMA * RHOW
A2 = ( 1.0- SIGUMA ) / ( RHOG * CG* CG )
A3 = SIGUMA / ( RHOW * CW* CW)
A4 = A1 * ( A2 + A3)
WICASD = 1.0/ SQRT ( A4 )
RETURN
END
C +++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C SUBROUTINE WICBOA
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE WICBOA(OMEGAS,SIGUMA,BET1S,BET2S,AINCIS,ADEVIS,AMACH1,
1BET1,DEQS,DEQN,SITACS,SITACN,BET2N,X,AK1,AK3,UZ1,UZ2,UR1,R1,R2)
CALL WICEDD(AK3,UZ1,UZ2,UR1,R1,R2,BET1S,BET2S,SIGUMA,OMEGAS,
$DEQS,SITACS)
AINCI=BET1+AINCIS-BET1S
BET2A=BET2S
X1=BET2A
DELDEQ=WICED(AK3,UZ1,UZ2,UR1,R1,R2,BET1,X1,SIGUMA,AINCIS,AINCI)

```

```

WICMAC 40
WICMAC 41
WICMAC 42
WICMAC 43
WICMAC 44
WICMAC 45
WICMAC 46
WICMAC 47
WICMAC 48
WICMAC 49
WICMAC 50
WICMAC 51
WICMAC 52
WICMAC 53
WICMAC 54
WICMAC 55
WICMAC 56
WICMAC 57
WICMAC 58
WICMAC 59
WICMAC 60
WICMAC 61
WICMAC 62
WICMAC 63
WICMAC 64
WICMAC 65
WICMAC 66
WICMAC 67
WICMAC 68
WICMAC 69
WICMAC 70
WICMAC 71
WICMAC 72
WICMAC 73
WICMAC 74
WICMAC 75
WICMAC 76
WICMAC 77
WICMAC 78
WICASD 1
WICASD 2
WICASD 3
WICASD 4
WICASD 5
WICASD 6
WICASD 7
WICASD 8
WICASD 9
WICASD 10
WICASD 11
WICASD 12
WICASD 13
WICASD 14
WICASD 15
WICASD 16
WICASD 17
WICBOA 1
WICBOA 2
WICBOA 3
WICBOA 4
WICBOA 5
WICBOA 6
WICBOA 7
WICBOA 8
WICBOA 9
WICBOA 10
WICBOA 11
WICBOA 12
WICBOA 13
WICBOA 14

```

\$-DEQS	WICBOA	15
ADEVI=ADEVIS+(6.40-9.45*AMACH1+9.45*X)*DELDEQ*AK1	WICBOA	16
IF(AMACH1.LT.X) ADEVI=ADEVIS+6.40*DELDEQ*AK1	WICBOA	17
BET2C=BET2S-ADEVIS+ADEV1	WICBOA	18
Y1=BET2C	WICBOA	19
N=1	WICBOA	20
12 IF(N.GT.1) GO TO 10	WICBOA	21
BET2A=BET2S*1.1	WICBOA	22
10 X2=BET2A	WICBOA	23
DEQN=WICED(AK3,UZ1,UZ2,UR1,R1,R2,BET1,X2,SIGUMA,AINCIS,AINCI)	WICBOA	24
DELDEQ=DEQN-DEQS	WICBOA	25
ADEVI=ADEVIS+(6.40-9.45*AMACH1+9.45*X)*DELDEQ*AK1	WICBOA	26
IF(AMACH1.LT.X) ADEVI=ADEVIS+6.40*DELDEQ*AK1	WICBOA	27
BET2C=BET2S-ADEVIS+ADEV1	WICBOA	28
Y2=BET2C	WICBOA	29
DELBET=ABS((X2-Y2)/X2)	WICBOA	30
EPS=1.0E-6	WICBOA	31
IF(DELBET.LE.EPS) GO TO 11	WICBOA	32
BET2A=WICNEW(X1,Y1,X2,Y2)	WICBOA	33
X1=X2	WICBOA	34
Y1=Y2	WICBOA	35
N=N+1	WICBOA	36
IF(N.GT.50) GO TO 13	WICBOA	37
GO TO 12	WICBOA	38
11 BET2N=X2	WICBOA	39
GO TO 15	WICBOA	40
13 WRITE(6,201)	WICBOA	41
201 FORMAT(1H0,=DO NOT CONVERGE=)	WICBOA	42
15 RETURN	WICBOA	43
END	WICBOA	44
C ++++++	WICEDD	1
CC	WICEDD	2
C	C	3
C SUBROUTINE WICEDD	C	4
C	C	5
CC	WICEDD	6
SUBROUTINE WICEDD(AK3,UZ1,UZ2,UR1,R1,R2,BET1S,BET2S,SIGUMA,	WICEDD	7
\$OMEGAS,DEQS,SITACS)	WICEDD	8
C1=180.0/3.1415926	WICEDD	9
BET1SR=BET1S/C1	WICEDD	10
BET2SR=BET2S/C1	WICEDD	11
CSB1=COS(BET1SR)	WICEDD	12
CSB2=COS(BET2SR)	WICEDD	13
CSCS=CSB2/CSB1*(UZ1/UZ2)	WICEDD	14
CSCSS=CSB2/CSB1	WICEDD	15
TNB1=WICTAN(BET1SR)	WICEDD	16
TNB2=WICTAN(BET2SR)*(UZ2/UZ1)*(R2/R1)	WICEDD	17
TNTN=TNB1-TNB2-(UR1/UZ1)*(1.0-(R2/R1)**2)	WICEDD	18
DEQS=1.12*CSCS+0.61*(CSB1**2)/SIGUMA*TNTN*CSCS	WICEDD	19
DEQS=AK3*DEQS	WICEDD	20
SITACS=OMEGAS*CSB2/2.0/SIGUMA*(CSCSS**2)	WICEDD	21
RETURN	WICEDD	22
END	WICEDD	23
C ++++++	WICED	1
CC	WICED	2
C	C	3
C FUNCTION WICED	C	4
C	C	5
CC	WICED	6
FUNCTION WICED(AK3,UZ1,UZ2,UR1,R1,R2,BET1,BET2,SIGUMA,AINCIS,	WICED	7
\$AINCI)	WICED	8
C1=180.0/3.1415926	WICED	9
BET1R=BET1/C1	WICED	10
BET2R=BET2/C1	WICED	11
CSB1=COS(BET1R)	WICED	12
CSB2=COS(BET2R)	WICED	13
CSCS=CSB2/CSB1*(UZ1/UZ2)	WICED	14
TNB1=WICTAN(BET1R)	WICED	15
TNB2=WICTAN(BET2R)*(UZ2/UZ1)*(R2/R1)	WICED	16
TNTN=TNB1-TNB2-(UR1/UZ1)*(1.0-(R2/R1)**2)	WICED	17

PAI = 3.1415926	WICIRS	26
B1 = 1.0	WICIRS	27
B2R = (90.0 - BETA1 + STAGER (N)) * PAI / 180.0	WICIRS	28
B2 = COS (B2R)	WICIRS	29
LWC=XW1/XG*RHOG1	WICIRS	30
DS1=0.07*RC(N)	WICIRS	31
BETA1R = BETA1* PAI / 180.0	WICIRS	32
DS2 = 2.0 * PAI * R / RBLADE(N) * COS (BETA1R) /	WICIRS	33
\$COS(B2R)	WICIRS	34
IF(DS2.GE.RC(N)) DS2=RC(N)	WICIRS	35
H=(AAA1*144.0)/(2.0*PAI*R)	WICIRS	36
A1=DS1*H*RBLADE(N)/144.0	WICIRS	37
A2=DS2*H*RBLADE(N)/144.0	WICIRS	38
WW1 = LWC * W1 * B1 * A1	WICIRS	39
WW2 = LWC * W1 * B2 * A2	WICIRS	40
WW = WW1 + WW2	WICIRS	41
RETURN	WICIRS	42
END	WICIRS	43
C+++++	WICIRL	1
CC	WICIRL	2
C	C	3
C SUBROUTINE WICIRL	C	4
C	C	5
CC	WICIRL	6
SUBROUTINE WICIRL(ISTAGE,R,XW1,XG,RHOG1,BETA1,W1,	WICIRL	7
1WW1 , WW2 , WW)	WICIRL	8
REAL LWC	WICIRL	9
COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	WICIRL	10
X, PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	WICIRL	11
X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XWW(3),XWT(3),TW(3),TWW(3)	WICIRL	12
X, OMEGS(7),OMEGR(6),GAPR(6),GAPS(6)	WICIRL	13
X, RRHUB(6) , RC(6) , RBLADE(6) , STAGER(6)	WICIRL	14
X, SRHUB(7) , SC(7) , SBLADE(7) , STAGES(7)	WICIRL	15
X, SIGUMR(6) , BET1SR(6) , BET2SR(6) , AINCSR(6) , ADEUSR(6)	WICIRL	16
X, SIGUMS(7) , BET1SS(7) , BET2SS(7) , AINCSS(7) , ADEUSS(7)	WICIRL	17
X, UTIPC(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI	WICIRL	18
X, AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT	WICIRL	19
X, ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID	WICIRL	20
X, NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)	WICIRL	21
X, DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)	WICIRL	22
X, DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)	WICIRL	23
X, BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)	WICIRL	24
N = ISTAGE	WICIRL	25
PAI = 3.1415926	WICIRL	26
LWC=XW1/XG/RHOG1	WICIRL	27
ALFA=(90.0-BETA1)/2.0*PAI/180.0	WICIRL	28
BETA=(90.0+BETA1)/2.0*PAI/180.0	WICIRL	29
B1=SIN(ALFA)	WICIRL	30
B2=SIN(BETA)	WICIRL	31
V1=W1*COS(ALFA)	WICIRL	32
V2=W1*COS(BETA)	WICIRL	33
S=2.0*PAI*RRTIP(ISTAGE)/RBLADE(ISTAGE)/2.0	WICIRL	34
GSI=BETA1+(90.0-BETA1)/2.0	WICIRL	35
GSIR=GSI*PAI/180.0	WICIRL	36
STAGR=STAGER(ISTAGE)*PAI/180.0	WICIRL	37
Y2=GAPR(ISTAGE)/2.0*(WICTAN(STAGR)-WICTAN(GSIR))+S	WICIRL	38
DAMY1=(90.0-GSI)*PAI/180.0	WICIRL	39
Y1=Y2*SIN(DAMY1)	WICIRL	40
DAMY2=(GSI-STAGER(ISTAGE))*PAI/180.0	WICIRL	41
DS1=Y1/SIN(DAMY2)	WICIRL	42
IF(DS1.GT.RC(ISTAGE)) DS1=RC(ISTAGE)	WICIRL	43
DAMY3=(90.-(90.0+BETA1)/2.0)*PAI/180.0	WICIRL	44
DAMY4=STAGER(ISTAGE)*PAI/180.0	WICIRL	45
DAMY5=BETA1*PAI/180.0	WICIRL	46
DAMY6=S-GAPR(ISTAGE)/2.0*(WICTAN(DAMY5)-WICTAN(DAMY3))	WICIRL	47
DAMY7=COS(DAMY4)*WICTAN(DAMY3)+SIN(DAMY4)	WICIRL	48
DS2=DAMY6/DAMY7	WICIRL	49
IF(DS2.GT.RC(ISTAGE)) DS2=RC(ISTAGE)	WICIRL	50
H=(AAA1*144.0)/(2.0*PAI*R)	WICIRL	51
A1=DS1*H*RBLADE(N)/144.0	WICIRL	52

```

A2=DS2*H*SBLADE(N)/144.0
WW1 = LWC * U1 * B1 * A1
WW2 = LWC * U2 * B2 * A2
WW = WW1 + WW2
RETURN
END
C+++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C SUBROUTINE WICISS
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE WICISS( ISTAGE ,R ,XW1, XG , RHOGAS ,ALFA2,U1 ,
$WW1,WW2,WW)
REAL LWC
COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW
X, PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)
X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XWW(3),XWT(3),TW(3),TWW(3)
X, OMEGS(7),DMEGR(6),GAPR(6),GAPS(6)
X, RRHUB(6) , RC(6) , RBLADE(6) , STAGER(6)
X, SRHUB(7) , SC(7) , SBLADE(7) , STAGES(7)
X, SIGUMR(6) , BET1SR(6) , BET2SR(6) , AINCSR(6) , ADEUSR(6)
X, SIGUMS(7) , BET1SS(7) , BET2SS(7) , AINCSS(7) , ADEVSS(7)
X, UTIPG(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI
X, AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT
X, ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID
X, NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)
X, DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)
X, DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)
X, BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)
LWC = XW1/ XG * RHOGAS
DS1=( 0.06 * SC ( ISTAGE ) ) / 12.0
PAI=3.1415926
B1=1.0
B2R=(90.0-ALFA2+STAGES(ISTAGE))*PAI/180.0
B2=COS(B2R)
ALFA2R=ALFA2*PAI/180.0
DS2=2.0*PAI*R/SBLADE(ISTAGE)*COS(ALFA2R)/COS(B2R)
IF(DS2.GT.SC(ISTAGE)) DS2=SC(ISTAGE)
H=(AAA2*144.0)/(2.0*PAI*R)
A1=DS1*H*SBLADE(ISTAGE)/144.0
A2=DS2*H*SBLADE(ISTAGE)/144.0
WW1=LWC*U1*B1*A1
WW2=LWC*U1*B2*A2
WW=WW1+WW2
RETURN
END
C+++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C SUBROUTINE WICISL
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE WICISL(ISTAGE,R,XW1,XG,RHOG1,ALFA2,W1,WW1,WW2,WW)
REAL LWC
COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW
X, PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)
X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XWW(3),XWT(3),TW(3),TWW(3)
X, OMEGS(7),DMEGR(6),GAPR(6),GAPS(6)
X, RRHUB(6) , RC(6) , RBLADE(6) , STAGER(6)
X, SRHUB(7) , SC(7) , SBLADE(7) , STAGES(7)
X, SIGUMR(6) , BET1SR(6) , BET2SR(6) , AINCSR(6) , ADEUSR(6)
X, SIGUMS(7) , BET1SS(7) , BET2SS(7) , AINCSS(7) , ADEVSS(7)
X, UTIPG(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI
X, AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT
X, ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID
X, NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)
X, DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)
X, DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)

```

```

WICIRL 53
WICIRL 54
WICIRL 55
WICIRL 56
WICIRL 57
WICIRL 58
WICISS 1
WICISS 2
WICISS 3
WICISS 4
WICISS 5
WICISS 6
WICISS 7
WICISS 8
WICISS 9
WICISS 10
WICISS 11
WICISS 12
WICISS 13
WICISS 14
WICISS 15
WICISS 16
WICISS 17
WICISS 18
WICISS 19
WICISS 20
WICISS 21
WICISS 22
WICISS 23
WICISS 24
WICISS 25
WICISS 26
WICISS 27
WICISS 28
WICISS 29
WICISS 30
WICISS 31
WICISS 32
WICISS 33
WICISS 34
WICISS 35
WICISS 36
WICISS 37
WICISS 38
WICISS 39
WICISS 40
WICISS 41
WICISL 1
WICISL 2
WICISL 3
WICISL 4
WICISL 5
WICISL 6
WICISL 7
WICISL 8
WICISL 9
WICISL 10
WICISL 11
WICISL 12
WICISL 13
WICISL 14
WICISL 15
WICISL 16
WICISL 17
WICISL 18
WICISL 19
WICISL 20
WICISL 21
WICISL 22
WICISL 23

```

X, BET1MR(6), BET2MR(6), BET1MS(7), BET2MS(7), RAD1(6), RAD2(6)	WICISL	24
PAI=3.1415926	WICISL	25
LWC = XW1 / XG * RHOG1	WICISL	26
ALFA=(90.0-ALFA2)/2.0*PAI/180.0	WICISL	27
BETA=(90.0+ALFA2)/2.0*PAI/180.0	WICISL	28
B1=SIN(ALFA)	WICISL	29
B2=SIN(BETA)	WICISL	30
U1=W1*COS(ALFA)	WICISL	31
U2=W1*COS(BETA)	WICISL	32
S=2.0*PAI*SRTIP(ISTAGE)/SBLADE(ISTAGE)/2.0	WICISL	33
GSI=ALFA2+(90.0-ALFA2)/2.0	WICISL	34
GSIR=GSI*PAI/180.0	WICISL	35
STAGR=STAGES(ISTAGE)*PAI/180.0	WICISL	36
Y2=GAPS(ISTAGE)/2.0*(WICTAN(STAGR)-WICTAN(GSIR))+S	WICISL	37
DAMY1=(90.0-GSI)*PAI/180.0	WICISL	38
Y1=Y2*SIN(DAMY1)	WICISL	39
DAMY2=(GSI-STAGES(ISTAGE))*PAI/180.0	WICISL	40
DS1=Y1/SIN(DAMY2)	WICISL	41
IF(DS1.GT.SC(ISTAGE)) DS1=SC(ISTAGE)	WICISL	42
DAMY3=(90.-(90.0+ALFA2)/2.0)*PAI/180.0	WICISL	43
DAMY4=STAGES(ISTAGE)*PAI/180.0	WICISL	44
DAMY5=ALFA2*PAI/180.0	WICISL	45
DAMY6=S-GAPS(ISTAGE)/2.0*(WICTAN(DAMY5)-WICTAN(DAMY3))	WICISL	46
DAMY7=COS(DAMY4)*WICTAN(DAMY3)+SIN(DAMY4)	WICISL	47
DS2=DAMY6/DAMY7	WICISL	48
IF(DS2.GT.SC(ISTAGE)) DS2=SC(ISTAGE)	WICISL	49
H=(AAQ2*144.0)/(2.0*PAI*R)	WICISL	50
A1=DS1*H*SBLADE(ISTAGE)/144.0	WICISL	51
A2=DS2*H*SBLADE(ISTAGE)/144.0	WICISL	52
WW1=LWC*U1*B1*A1	WICISL	53
WW2=LWC*U2*B2*A2	WICISL	54
WW=WW1+WW2	WICISL	55
RETURN	WICISL	56
END	WICISL	57
C ++++++	WICWAK	1
CC	WICWAK	2
C	C	3
C SUBROUTINE WICWAK	C	4
C	C	5
CC	WICWAK	6
SUBROUTINE WICWAK (RHOG , U , DWAKE , DWAKEM)	WICWAK	7
VISCOF=1.20E-3	WICWAK	8
SIGUMA = 4.6534E-3	WICWAK	9
GC = 32.174	WICWAK	10
WE=21.0	WICWAK	11
DWAKE1 = (WE * SIGUMA * GC) / RHOG / U ** 2	WICWAK	12
SN=VISCOF**2/(RHOG*SIGUMA*DWAKE1*GC)	WICWAK	13
WELIMT=12.0*(1.0+SN**0.36)	WICWAK	14
D1=WELIMT*SIGUMA*GC/(RHOG*U**2)	WICWAK	15
WE=22.0	WICWAK	16
DWAKE2=(WE*SIGUMA*GC)/RHOG/U**2	WICWAK	17
SN=VISCOF**2/(RHOG*SIGUMA*DWAKE2*GC)	WICWAK	18
WELIMT=12.0*(1.0+SN**0.36)	WICWAK	19
D2=WELIMT*SIGUMA*GC/(RHOG*U**2)	WICWAK	20
XXXX=WICNEW(DWAKE1, D1, DWAKE2, D2)	WICWAK	21
SN=VISCOF**2/(RHOG*SIGUMA*XXXX*GC)	WICWAK	22
WELIMT=12.0*(1.0+SN**0.36)	WICWAK	23
DWAKE=WELIMT*SIGUMA*GC/(RHOG*U**2)	WICWAK	24
DWAKEM = DWAKE / 3.2802 * 1.0E6	WICWAK	25
RETURN	WICWAK	26
END	WICWAK	27
C ++++++	WICHET	1
CC	WICHET	2
C	C	3
C SUBROUTINE WICHET	C	4
C	C	5
CC	WICHET	6
SUBROUTINE WICHET(TG1, TG3, TW1, TW3, DAVEN2, DAVEN,	WICHET	7
\$DELZI, UZ, WMASS1, UMASS1, AMASS, CHMASS, CPG, CPW, DELTGH, DELTWH, RE)	WICHET	8
DIMENSION DELHET(51)	WICHET	9

REAL ND , KA , NU , Mmass,NU	WICHET	10
DELTGH=0.0	WICHET	11
DELTWH=0.0	WICHET	12
IF(WMASS1.LT.1.0E-6) GO TO 11	WICHET	13
PAI = 3.1415927	WICHET	14
DAVEAU=(DAVEN2+DAVEN)/2.0*1.0E-6*3.2802	WICHET	15
IF(DAVEAU.LT.1.0E-6) GO TO 11	WICHET	16
RHOW = 62.54	WICHET	17
ND = WMASS1 / (RHOW * 4.0 / 3.0 * PAI * (DAVEAU / 2.0) ** 3)	WICHET	18
KA = 0.015 / 3600.0	WICHET	19
PR=0.7	WICHET	20
NU=2.0+0.6*SQRT(RE)*PR**0.33	WICHET	21
HCONVE = KA / DAVEAU * NU	WICHET	22
J = 1	WICHET	23
10 DELT=((TG1-TW1)+(TG3-TW3))/2.0	WICHET	24
DELHH = HCONVE * 4.0 * PAI * (DAVEAU / 2.0) **2*DELT *	WICHET	25
\$ND*DELZI/UZ	WICHET	26
GMASS1=UMASS1+AMASS+CHMASS	WICHET	27
DELTGH=DELHH/(GMASS1*CPG)	WICHET	28
DELTWH=DELHH/(WMASS1*CPW)	WICHET	29
TG3=TG3-DELTGH	WICHET	30
TW3=TW3+DELTWH	WICHET	31
DELHET(J)=DELHH	WICHET	32
J=J+1	WICHET	33
IF(J.EQ.2) GO TO 10	WICHET	34
EROR=ABS(DELHET(J-1)-DELHET(J-2))	WICHET	35
EPS=0.0001	WICHET	36
IF(J.GT.50) GO TO 11	WICHET	37
IF(EROR.GT.EPS) GO TO 10	WICHET	38
11 RETURN	WICHET	39
END	WICHET	40
C ++++++	WICMAS	1
CC	WICMAS	2
C	C	3
C SUBROUTINE WICMAS	C	4
C	C	5
CC	WICMAS	6
SUBROUTINE WICMAS(HW1 , TW1 , TW2 , PP1 , PP2 , TG1 , TG2 , DZ ,	WICMAS	7
1 PWB1 , PWB2 , PW1 , PW2 , UZ , DDAVE1 , DDAVE2 , HW2 , UMASS1 ,	WICMAS	8
1 UMASS2 , WMASS1 , WMASS2 , DMDTAU , AMASS ,RE)	WICMAS	9
PWB1 = WICPWB(TW1)*144.0	WICMAS	10
PWB2 = WICPWB(TW2)*144.0	WICMAS	11
PW1 = (HW1 * PP1) / (HW1 + 0.6219)	WICMAS	12
DMDT1 = WICMTR(TG1 , TW1 , PP1 , DDAVE1 , UZ , DZ , WMASS1 ,	WICMAS	13
1PW1 ,RE)	WICMAS	14
PW2AS1 = PW1	WICMAS	15
DMDT2 = WICMTR(TG 2 , TW 2 , PP2 , DDAVE2 , UZ , DZ , WMASS1 ,	WICMAS	16
1PW2AS1 ,RE)	WICMAS	17
DMDTAU = (DMDT1 + DMDT2) / 2.0	WICMAS	18
UMASS2 = UMASS1 + DMDTAU	WICMAS	19
WMASS2 = WMASS1 - DMDTAU	WICMAS	20
HW2=UMASS2/AMASS	WICMAS	21
PW2CL1 = (HW2 * PP2) / (HW2 + 0.6219)	WICMAS	22
PW2AS2 = PW1 * 1.05	WICMAS	23
DMDT2 = WICMTR(TG2 , TW2 , PP2 , DDAVE2 , UZ , DZ , WMASS2 ,	WICMAS	24
1PW2AS2 ,RE)	WICMAS	25
DMDTAU = (DMDT1 + DMDT2) / 2.0	WICMAS	26
UMASS2 = UMASS1 + DMDTAU	WICMAS	27
WMASS2 = WMASS1 - DMDTAU	WICMAS	28
HW2 = UMASS2 / AMASS	WICMAS	29
PW2CL2 = (HW2 * PP2) / (HW2 + 0.6219)	WICMAS	30
2 PW2ASN = WICNEW (PW2AS1 , PW2CL1 , PW2AS2 , PW2CL2)	WICMAS	31
PW2AS1 = PW2AS2	WICMAS	32
PW2CL1 = PW2CL2	WICMAS	33
PW2AS2 = PW2ASN	WICMAS	34
DMDT2 = WICMTR(TG2 , TW2 , PP2 , DDAVE2 , UZ , DZ , WMASS2 , PW	WICMAS	35
12AS2 ,RE)	WICMAS	36
DMDTAU = (DMDT1 + DMDT2) / 2.0	WICMAS	37
UMASS2 = UMASS1 + DMDTAU	WICMAS	38
WMASS2 = WMASS1 - DMDTAU	WICMAS	39

```

      HW2 = UMASS2 / AMASS
      PW2CL2 = ( HW2 * PP2 ) / ( HW2 + 0.6219 )
      ERROR = ABS ( PW2AS2 - PW2CL2 )
      EPS = 0.01
      IF ( ERROR . GT . EPS ) GO TO 2
      PW2 = PW2AS2
      RETURN
      END
C ++++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C FUNCTION WICMTR
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION WICMTR(TTG, TTW, PPP, DAVE, UZ, DZ, MMASS, PW, RE)
      REAL KG , ND , MMASS
      IF(DAVE.LT.1.0E-6) WICMTR=0.0
      IF(DAVE.LT.1.0E-6) GO TO 10
      DD=DAVE*1.0E-6*3.2802
      T = ( TTG + TTW ) / 2.0
      PAI = 3.1415926
      RHOW = 62.2567
      RR = DD / 2.0
      TT = T * 5.0 / 9.0
      PP = PPP * 47.880258
      DU=4.24028E-3*(TT**1.5)/PP
      SCT=0.60
      SH=2.0+0.60*SQRT(RE)*SCT**0.33
      KG = DU / DD * SH
      HU=1115.3279-0.6840909*(TTW-460.0)
      PWBB=PW+29.0/18.0*0.45/HU*PPP*(TTG-TTW)
      R = 85.78
      ND = MMASS / ( RHOW * 4.0 / 3.0 * PAI * RR ** 3 )
      WICMTR = KG * 4.0 * PAI * RR ** 2 * ( PWBB / TTW - PW / TTG ) / R
1 * ND * DZ / UZ
10 RETURN
      END
C ++++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C FUNCTION WICPWB
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION WICPWB(TWB)
      TSTAG=TWB
      TSTAGC=(TSTAG-492.0)/1.8
      IF(TSTAGC.LT.100.0) GO TO 40
      IF(TSTAGC.GE.100.0.AND.TSTAGC.LT.200.0) GO TO 41
      A=5.45142
      B=2010.8
      GO TO 42
40 A=5.9778
      B=2224.4
      GO TO 42
41 A=5.6485
      B=2101.1
42 AA=A-B/(TSTAGC+273.0)
      PS=10.0**AA
      PS=PS/4.88247E-4
      WICPWB=PS/144.0
      RETURN
      END
C ++++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C FUNCTION WICNEW
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION WICNEW(X1,Y1,X2,Y2)
      T=ABS((X2-X1)/X1)

```


C	IRAD=1:TIP	WICDMS	13
C	IRAD=2:MEAN	WICDMS	14
C	IRAD=3:HUB	WICDMS	15
	PAI=3.1415926	WICDMS	16
	RST1=RSTAVE	WICDMS	17
	A1=STAREA	WICDMS	18
	A2=PAI*(R2**2-R1**2)/144.0	WICDMS	19
	A2=A2*0.5	WICDMS	20
	DMCENT=A2/A1*AMASW	WICDMS	21
120	IF(DMCENT.LT.0.0) DMCENT=0.0	WICDMS	22
	IF(DMCENT.GT.AMASWT) DMCENT=AMASWT	WICDMS	23
	IF(R1.GT.RST1) GO TO 110	WICDMS	24
C	R1.LT.RST1	WICDMS	25
	DMIN=DMCENT	WICDMS	26
	DMOUT=DMCENT	WICDMS	27
	GO TO 100	WICDMS	28
110	CONTINUE	WICDMS	29
C	R1.GT.RST1	WICDMS	30
	DMIN=0.0	WICDMS	31
	DMOUT=DMCENT	WICDMS	32
100	IF(IRAD.EQ.1) DMOUT=0.0	WICDMS	33
	IF(IRAD.EQ.3) DMIN=0.0	WICDMS	34
	AMASW2=AMASW1+DMIN-DMOUT	WICDMS	35
	IF(AMASW2.LT.0.0) AMASW2=0.0	WICDMS	36
	IF(AMASW2.GT.AMASWT) AMASW2=AMASWT	WICDMS	37
	DELMAS=AMASW2-AMASW1	WICDMS	38
	IF(IPRINT.EQ.2) WRITE(6,200) AMASW2,AMASW1,DMIN,DMOUT,DMCENT,	WICDMS	39
	\$AMASWT,AMASW,DELMAS	WICDMS	40
200	FORMAT(1H0,8(F10.5,3X))	WICDMS	41
	RETURN	WICDMS	42
	END	WICDMS	43
C	+++++	WICDML	1
CC		WICDML	2
C		WICDML	3
C	SUBROUTINE WICDML	WICDML	4
C		WICDML	5
CC		WICDML	6
	SUBROUTINE WICDML(IPRINT,IRAD,AMASW1,AMASWT,AMASW,R1,R2,STAREA,	WICDML	7
	\$RSTAVE,RTIP,DMIN,DMOUT,AMASW2,DELMAS)	WICDML	8
C	AMASW1:MASS FLOW RATE OF WATER IN A STREAM TUBE IN INTEREST	WICDML	9
C	AMASWT:TOTAL MASS FLOW RATE OF WATER WHICH ENTER THE COMPRESSOR	WICDML	10
C	AMASW:TOTAL MASS FLOW RATE OF WATER WHICH IS SUBJECT TO	WICDML	11
C	CENTRIFUGAL FORCE	WICDML	12
C	IRAD=1:TIP	WICDML	13
C	IRAD=2:MEAN	WICDML	14
C	IRAD=3:HUB	WICDML	15
	PAI=3.1415926	WICDML	16
	RST1=RSTAVE	WICDML	17
	A1=STAREA	WICDML	18
	A2=PAI*(R2**2-R1**2)/144.0	WICDML	19
	A2=A2*0.5	WICDML	20
	DMCENT=A2/A1*AMASW	WICDML	21
120	IF(DMCENT.LT.0.0) DMCENT=0.0	WICDML	22
	IF(DMCENT.GT.AMASWT) DMCENT=AMASWT	WICDML	23
	IF(R1.GT.RST1) GO TO 110	WICDML	24
	DMIN=DMCENT	WICDML	25
	DMOUT=DMCENT	WICDML	26
	GO TO 100	WICDML	27
110	CONTINUE	WICDML	28
	DMIN=0.0	WICDML	29
	DMOUT=DMCENT	WICDML	30
100	IF(IRAD.EQ.1) DMOUT=0.0	WICDML	31
	IF(IRAD.EQ.3) DMIN=0.0	WICDML	32
	AMASW2=AMASW1+DMIN-DMOUT	WICDML	33
	IF(AMASW2.LT.0.0) AMASW2=0.0	WICDML	34
	IF(AMASW2.GT.AMASWT) AMASW2=AMASWT	WICDML	35
	DELMAS=AMASW2-AMASW1	WICDML	36
	IF(IPRINT.EQ.2) WRITE(6,200) AMASW2,AMASW1,DMIN,DMOUT,DMCENT,	WICDML	37
	\$AMASWT,AMASW,DELMAS	WICDML	38
200	FORMAT(1H0,8(F10.5,3X))	WICDML	39

DELDEQ=DEQN-DEQS	WICGSL	26	
ADEVI=ADEVIS+(6.40-9.45*AMACH1+9.45*X)*DELDEQ*AK1	WICGSL	27	
IF(AMACH1.LT.X) ADEVI=ADEVIS+6.40*DELDEQ*AK1	WICGSL	28	
BET2C=BET2S-ADEVIS+ADEVI	WICGSL	29	
Y2=BET2C	WICGSL	30	
DEL BET=ABS((X2-Y2)/X2)	WICGSL	31	
EPS=1.0E-6	WICGSL	32	
IF(DEL BET.LE.EPS) GO TO 11	WICGSL	33	
BET2A=WICNEW(X1,Y1,X2,Y2)	WICGSL	34	
X1=X2	WICGSL	35	
Y1=Y2	WICGSL	36	
N=N+1	WICGSL	37	
IF(N.GT.50) GO TO 13	WICGSL	38	
GO TO 12	WICGSL	39	
11 BET2N=X2	WICGSL	40	
GO TO 14	WICGSL	41	
13 WRITE(6,201)	WICGSL	42	
201 FORMAT(1H0, #DO NOT CONVERGE#)	WICGSL	43	
GO TO 15	WICGSL	44	
14 SITACN=WICMTK(SITACS, AMACH1, DELDEQ, AK2)	WICGSL	45	
OMEGAN=WICLOS(BET1, BET2N, SIGUMA, SITACN)	WICGSL	46	
SSS=SITACN-SITACS	WICGSL	47	
15 RETURN	WICGSL	48	
END	WICGSL	49	
C+++++	WICSDL	1	
CC	WICSDL	2	
C	C	WICSDL	3
C SUBROUTINE WICSDL	C	WICSDL	4
C	C	WICSDL	5
CC	WICSDL	6	
SUBROUTINE WICSDL(CHORD, SIGUMA, BETA1, BETA2, UG, RHOG,	WICSDL	7	
\$AMASSW, AREA, UZ, IPRINT, OMEGAP)	WICSDL	8	
PAI=3.1415926	WICSDL	9	
RHOG0=RHOG	WICSDL	10	
RHOP0=AMASSW/AREA/UZ	WICSDL	11	
RR=RHOP0/RHOG0	WICSDL	12	
VISC0G=0.128E-4	WICSDL	13	
C=CHORD/12.0	WICSDL	14	
RE=UG*C*RHOG0/VISC0G	WICSDL	15	
DELC=0.37/(RE**0.2)/(1.0+1.442*RR)**0.8	WICSDL	16	
DELP=0.1402*DELC	WICSDL	17	
BETA1R=BETA1*PAI/180.0	WICSDL	18	
BETA2R=BETA2*PAI/180.0	WICSDL	19	
OMEGAP=DELP*2.0*SIGUMA/COS(BETA2R)*(COS(BETA1R)/COS(BETA2R))**2	WICSDL	20	
RETURN	WICSDL	21	
END	WICSDL	22	
C+++++	WICSTL	1	
CC	WICSTL	2	
C	C	WICSTL	3
C SUBROUTINE WICSTL	C	WICSTL	4
C	C	WICSTL	5
CC	WICSTL	6	
SUBROUTINE WICSTL(ISTAGE, IROTOR, DAU, W1, W2, DELU, U2, U3, WMASS, UZ, N	WICSTL	7	
\$, BETA1, BETA2, ALFA2, ALFA3, MMASS, DELU2, DELU2,	WICSTL	8	
\$OMEGRU, OMEGRL, OMEGSU, OMEGSL, DRAGRU, DRAGRL, DRAGSU, DRAGSL, REAVE)	WICSTL	9	
C IROTOR=1 ROTOR	WICSTL	10	
C IROTOR=2 STATOR	WICSTL	11	
REAL M, MMASS	WICSTL	12	
COMMON /PERDUE/ JPERFM, RHOG(3), RERUP, RERLOW, RESUP, RESLOW	WICSTL	13	
X, PREB, RRTIP(8), SRTIP(8), AAA1, AAA2, AAA3, SAREA(6), SAREAS(7)	WICSTL	14	
X, P(3), TG(3), XA, XU(3), XCH4, XW(3), XHW(3), XWT(3), TW(3), THW(3)	WICSTL	15	
X, OMEGS(7), OMEGR(6), GAPR(6), GAPS(6)	WICSTL	16	
X, RRHUB(6), RC(6), RBLADE(6), STAGER(6)	WICSTL	17	
X, SRHUB(7), SC(7), SBLADE(7), STAGES(7)	WICSTL	18	
X, SIGUMR(6), BET1SR(6), BET2SR(6), AINCSR(6), ADEVSR(6)	WICSTL	19	
X, SIGUMS(7), BET1SS(7), BET2SS(7), AINCSS(7), ADEVSS(7)	WICSTL	20	
X, UTIPG(6), UTIP(6), UTIPD(6), UOU(6), UMEAN(6), UHUB(6), U(6), FAI	WICSTL	21	
X, AREA(6), AREAS(7), UU2(6), UTIP2(6), UMEAN2(6), UHUB2(6), IPRINT	WICSTL	22	
X, ICENT, IICENT, FMR1(6), FMA2(6), IRAD, FAID	WICSTL	23	
X, NS, NS1, RT(6), RM(6), RH(6), ST(6), SM(6), SH(6)	WICSTL	24	

X, DSMASS, AAREA(7), AREAS(7), PR12D(6), PR13D(6), ETARD(6)	WICSTL	25
X, DR(6), DS(6), DEQR(6), DEQS(6), BLOCK(6), BLOCKS(7)	WICSTL	26
X, BET1MR(6), BET2MR(6), BET1MS(7), BET2MS(7), RAD11(6), RAD12(6)	WICSTL	27
PAI=3.1415927	WICSTL	28
GC=32.174	WICSTL	29
RHOW=62.3	WICSTL	30
IF(IROTOR.EQ.2) GO TO 100	WICSTL	31
C DROPLET DRAG IN ROTOR	WICSTL	32
DD=DAU*1.0E-6*3.28	WICSTL	33
UG1=W1	WICSTL	34
UP1=UG1-DELU	WICSTL	35
A1=WMASS*RC(ISTAGE)/12.0/UZ	WICSTL	36
A2=RHOW*4.0/3.0*PAI*(DD/2.0)**3	WICSTL	37
TN=0.0	WICSTL	38
IF(WMASS.GT.0.0) GO TO 2000	WICSTL	39
GO TO 2001	WICSTL	40
2000 TN=A1/A2	WICSTL	41
2001 UAVE=(W1+W2)/2.0	WICSTL	42
GMU1=(90.0-BETA1)/2.0*PAI/180.0	WICSTL	43
DELUU1=UG1-UP1*COS(GMU1)	WICSTL	44
IF(N.GT.2) DELUU1=DELUU2	WICSTL	45
TNU=TN*(180.0-BETA1-BETA2)/360.0	WICSTL	46
XWW(2)=XWW(1)	WICSTL	47
XWT(2)=XWT(1)	WICSTL	48
CALL WICPRP(XA, XU(2), XCH4, TG(2), RMIX, CPMIX, GAMMA, G1, G2, G3)	WICSTL	49
IF(IPRINT.EQ.2) WRITE(6,4000)	WICSTL	50
4000 FORMAT(1H0, #DROPLET DRAG IN ROTOR (UPPER PART)#)	WICSTL	51
CALL WICDRG(DD, DELUU1, RHOG(1), RHOG(2), CD2, DELU2, DRAG1, RE)	WICSTL	52
DELUU2=DELU2	WICSTL	53
CDRU=CD2	WICSTL	54
RERUP=RE	WICSTL	55
DRAGRU=DRAG1*TNU	WICSTL	56
AREA1=PAI*(RRIP(ISTAGE)**2-RRHUB(ISTAGE)**2)/144.0/10.0	WICSTL	57
DELPUR=DRAGRU/AREA1	WICSTL	58
OMEGRU=DELPUR/(0.5*RHOG(1)/GC*W1**2)	WICSTL	59
CDRUU=CDRU*DELUU2**2*PAI/4.0*DD**2*TNU/UAVE**2/RC(ISTAGE)*12.0	WICSTL	60
GML1=(90.0+BETA1)/2.0*PAI/180.0	WICSTL	61
DELU1=UG1-UP1*COS(GML1)	WICSTL	62
IF(N.GT.2) DELU1=DELU2	WICSTL	63
TNL=TN*(180.0+BETA1+BETA2)/360.0	WICSTL	64
IF(IPRINT.EQ.2) WRITE(6,4001)	WICSTL	65
4001 FORMAT(1H0, #DROPLET DRAG IN ROTOR (LOWER PART)#)	WICSTL	66
CALL WICDRG(DD, DELU1, RHOG(1), RHOG(2), CD2, DELU2, DRAG1, RE)	WICSTL	67
DELU2=DELU2	WICSTL	68
CDRL=CD2	WICSTL	69
RERLOW=RE	WICSTL	70
DRAGRL=DRAG1*TNU	WICSTL	71
DELPRL=DRAGRL/AREA1	WICSTL	72
OMEGRL=DELPRL/(0.5*RHOG(1)/GC*W1**2)	WICSTL	73
CDRLU=CDRL*DELU2**2*PAI/4.0*DD**2*TNL/UAVE**2/RC(ISTAGE)*12.0	WICSTL	74
IF(IPRINT.EQ.2) WRITE(6,2002)	WICSTL	75
2002 FORMAT(1H0, #DROPLET DRAG SUMMARY#)	WICSTL	76
IF(IPRINT.EQ.2) WRITE(6,720) DELUU1, DELUU2, DELU1, DELU2, CDRU, CD	WICSTL	77
\$RUU, CDRL, CDRLU	WICSTL	78
\$, DRAGRU, DRAGRL	WICSTL	79
720 FORMAT(1H0, 10(F10.5, 2X))	WICSTL	80
RUP1=(90.0-BETA1)/180.0	WICSTL	81
RLOW1=(90.0+BETA1)/180.0	WICSTL	82
RUP2=(90.0-BETA2)/180.0	WICSTL	83
RLOW2=(90.0+BETA2)/180.0	WICSTL	84
REAVE=RERUP*(RUP1+RUP2)*0.5+RERLOW*(RLOW1+RLOW2)*0.5	WICSTL	85
IF(IPRINT.EQ.2) WRITE(6,2010) RUP1, RUP2, RLOW1, RLOW2	WICSTL	86
2010 FORMAT(1H0, 4(F10.5, 2X))	WICSTL	87
GO TO 200	WICSTL	88
C DROPLET DRAG IN STATOR	WICSTL	89
100 DD=DAU*1.0E-6*3.28	WICSTL	90
UG1=W1	WICSTL	91
UP1=UG1-DELU	WICSTL	92
A1=WMASS*SC(ISTAGE)/12.0/UZ	WICSTL	93
A2=RHOW*4.0/3.0*PAI*(DD/2.0)**3	WICSTL	94

TN=0.0	WICSTL	95
IF(WMASS.GT.0.0) GO TO 5002	WICSTL	96
GO TO 5003	WICSTL	97
5002 TN=A1/A2	WICSTL	98
5003 UAVE=(U3+U2)/2.0	WICSTL	99
DELUV1=DELUV2	WICSTL	100
TNU=TN*(180.0-ALFA2-ALFA3)/360.0	WICSTL	101
IF(IPRINT.EQ.2) WRITE(6,2005)	WICSTL	102
2005 FORMAT(1H0,≠DROPLET DRAG IN STATOR (UPPER PART)≠)	WICSTL	103
CALL WICDRG(DD,DELUV1,RHOG(2),RHOG(2),CD2,DELUV2,DRAG1,RE)	WICSTL	104
DELUV2=DELUV2	WICSTL	105
CDSU=CD2	WICSTL	106
RESUP=RE	WICSTL	107
DRAGSU=DRAG1*TNU	WICSTL	108
AREA2=PAI*(SRTIP(ISTAGE)**2-SRHUB(ISTAGE)**2)/144.0/10.0	WICSTL	109
DELPSU=DRAGSU/AREA2	WICSTL	110
OMEGSU=DELPSU/(0.5*RHOG(2)/GC*U2**2)	WICSTL	111
CDSUU=CDSU*DELUV2**2*PAI/4.0*DD**2*TNU/UAVE**2/SC(ISTAGE)*12.0	WICSTL	112
DELVL1=DELVL2	WICSTL	113
TNL=TN*(180.0+ALFA2+ALFA3)/360.0	WICSTL	114
IF(IPRINT.EQ.2) WRITE(6,2006)	WICSTL	115
2006 FORMAT(1H0,≠DROPLET DRAG IN STATOR (LOWER PART)≠)	WICSTL	116
CALL WICDRG(DD,DELVL1,RHOG(2),RHOG(2),CD2,DELUV2,DRAG1,RE)	WICSTL	117
DELVL2=DELUV2	WICSTL	118
CDSL=CD2	WICSTL	119
RESLOW=RE	WICSTL	120
DRAGSL=DRAG1*TNL	WICSTL	121
DELPSL=DRAGSL/AREA2	WICSTL	122
OMEGSL=DELPSL/(0.5*RHOG(2)/GC*U2**2)	WICSTL	123
CDSL=CDSL*DELVL2**2*PAI/4.0*DD**2*TNL/UAVE**2/SC(ISTAGE)*12.0	WICSTL	124
IF(IPRINT.EQ.2) WRITE(6,2007)	WICSTL	125
2007 FORMAT(1H0,≠DROPLET DRAG IN STATOR (SUMMARY)≠)	WICSTL	126
IF(IPRINT.EQ.2)WRITE(6,721) DELUV1,DELUV2,DELVL1,DELVL2,CDSU,CD	WICSTL	127
\$SUU,CDSL,CDSL	WICSTL	128
~,DRAGSU,DRAGSL	WICSTL	129
721 FORMAT(1H0,10(F10.5,2X))	WICSTL	130
SUP1=(90.0-ALFA2)/180.0	WICSTL	131
SLOW1=(90.0+ALFA2)/180.0	WICSTL	132
SUP2=(90.0-ALFA3)/180.0	WICSTL	133
SLOW2=(90.0+ALFA3)/180.0	WICSTL	134
REAVE=RESUP*(SUP1+SUP2)*0.5+RESLOW*(SLOW1+SLOW2)*0.5	WICSTL	135
IF(IPRINT.EQ.2) WRITE(6,2011) SUP1,SUP2,SLOW1,SLOW2	WICSTL	136
2011 FORMAT(1H0,4(F10.5,2X))	WICSTL	137
200 RETURN	WICSTL	138
END	WICSTL	139
C+++++	WICFML	1
CC	WICFML	2
C	C	3
C SUBROUTINE WICFML	C	4
C	C	5
CC	WICFML	6
SUBROUTINE WICFML(WG1,WG2,FMASS,RHOG1,CHORD,SIGUMA,BETA1,BETA2,	WICFML	7
\$CDF,OMEGAF)	WICFML	8
PAI=3.1415926	WICFML	9
VISCOG=0.128E-4	WICFML	10
VISCOL=6.500E-4	WICFML	11
C=CHORD/12.0	WICFML	12
WGAVE=0.5*(WG1+WG2)	WICFML	13
UFILM=0.5*WGAVE*VISCOG/VISCOL	WICFML	14
CDF=FMASS*UFILM/(0.5*RHOG1*WG1*WG1*C)	WICFML	15
BETA1R=BETA1*PAI/180.0	WICFML	16
BETA2R=BETA2*PAI/180.0	WICFML	17
BETA3R=0.5*(BETA1R+BETA2R)	WICFML	18
CS1=COS(BETA1R)**2	WICFML	19
CS2=COS(BETA3R)**3	WICFML	20
OMEGAF=CDF*SIGUMA*CS1/CS2	WICFML	21
RETURN	WICFML	22
END	WICFML	23
C+++++	WICRSL	1
CC	WICRSL	2

C		C	WICRSL	3
C	SUBROUTINE WICRSL	C	WICRSL	4
C		C	WICRSL	5
CC		C	WICRSL	6
	SUBROUTINE WICRSL(SIGUMA,BETA1,BETA2,CHORD,DL,CDR,OMEGAR)	C	WICRSL	7
	PAI=3.1415926	C	WICRSL	8
	IF(DL.LT.1.0E-6) CDR=0.0	C	WICRSL	9
	IF(DL.LT.1.0E-6) OMEGAR=0.0	C	WICRSL	10
	IF(DL.LT.1.0E-6) GO TO 10	C	WICRSL	11
	BETA1R=BETA1*PAI/180.0	C	WICRSL	12
	BETA2R=BETA2*PAI/180.0	C	WICRSL	13
	BETA3R=0.5*(BETA1R+BETA2R)	C	WICRSL	14
	CS1=COS(BETA1R)**2	C	WICRSL	15
	CS2=COS(BETA3R)**3	C	WICRSL	16
	C=CHORD*2.54*0.01*1.0E6	C	WICRSL	17
	A=C/DL	C	WICRSL	18
	IF(A.LT.100.0) A=100.0	C	WICRSL	19
	CDR=1.89+1.62*ALOG10(A)	C	WICRSL	20
	CDR=1.0/CDR**2.5	C	WICRSL	21
	OMEGAR=CDR*SIGUMA*CS1/CS2	C	WICRSL	22
10	RETURN	C	WICRSL	23
	END	C	WICRSL	24
C+++++		C	WICUT	1
CC		C	WICUT	2
C		C	WICUT	3
C	SUBROUTINE WICUT	C	WICUT	4
C		C	WICUT	5
CC		C	WICUT	6
	SUBROUTINE WICUT(ISTAGE,ASPEED,ALFA1,UZ,U1,	C	WICUT	7
	1US1,WS1,BETA1,W1,BETA2,WS2,US2,ALFA2,W2,U2,	C	WICUT	8
	1ALFA3,U3,AK1,AK3)	C	WICUT	9
	COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	C	WICUT	10
	X,PREB,RTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	C	WICUT	11
	X,P(3),TG(3),XA,XU(3),XCH4,XW(3),XWH(3),XWT(3),TW(3),TWH(3)	C	WICUT	12
	X,OMEGS(7),OMEGR(6),GAPR(6),GAPS(6)	C	WICUT	13
	X,RRHUB(6),RC(6),RBLADE(6),STAGER(6)	C	WICUT	14
	X,SRHUB(6),SC(6),SBLADE(6),STAGES(6)	C	WICUT	15
	X,SIGUMR(6),BET1SR(6),BET2SR(6),AINCSR(6),ADEUSR(6)	C	WICUT	16
	X,SIGUMS(7),BET1SS(7),BET2SS(7),AINCSS(7),ADEUSS(7)	C	WICUT	17
	X,UTIPG(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI	C	WICUT	18
	X,AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT	C	WICUT	19
	X,ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID	C	WICUT	20
	X,NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)	C	WICUT	21
	X,DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)	C	WICUT	22
	X,DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)	C	WICUT	23
	X,BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)	C	WICUT	24
	PAI = 3.1415927	C	WICUT	25
	ALFA1R = ALFA1 * PAI / 180.0	C	WICUT	26
	U1 = UZ / COS (ALFA1R)	C	WICUT	27
	US1 = UZ * TAN (ALFA1R)	C	WICUT	28
	WS1 = U(ISTAGE)- US1	C	WICUT	29
	T = WS1 / UZ	C	WICUT	30
	BETA1R = ATAN (T)	C	WICUT	31
	BETA1 = BETA1R * 180.0 / PAI	C	WICUT	32
	TT = UZ **2 + WS1 **2	C	WICUT	33
	W1 = SQRT (TT)	C	WICUT	34
	AMACH1 = W1 / ASPEED	C	WICUT	35
	CALL WICBOA (OMEGR(ISTAGE), SIGUMR (ISTAGE) , BET1SR (ISTAGE	C	WICUT	36
	1),BET2SR(ISTAGE),	C	WICUT	37
	1 AINCSR (ISTAGE) , ADEUSR (ISTAGE) ,	C	WICUT	38
	1AMACH1 , BETA1 , DEQS,DEGN,SITACS,SITACN,BET2N ,FMR1(ISTAGE),	C	WICUT	39
	1AK1,AK3,UZ,UZ,U(ISTAGE),RADI1(ISTAGE),RADI2(ISTAGE))	C	WICUT	40
	BETA2 = BET2N	C	WICUT	41
	BETA2R = BETA2 * PAI / 180.0	C	WICUT	42
	WS2 = UZ * TAN (BETA2R)	C	WICUT	43
	US2 = U(ISTAGE) - WS2	C	WICUT	44
	TTT=US2/UZ	C	WICUT	45
	ALFA2R = ATAN (TTT)	C	WICUT	46
	ALFA2 = ALFA2R * 180.0 / PAI	C	WICUT	47
	TTTT = UZ ** 2 + WS2 ** 2	C	WICUT	48

W2 = SQRT (TTTT)	WICUT	49
TTTTT = UZ ** 2 + US2 ** 2	WICUT	50
U2 = SQRT (TTTTT)	WICUT	51
AMACH2 = U2 / ASPEED	WICUT	52
CALL WICBOA (OMEGS(ISTAGE), SIGUMS(ISTAGE) , BET1SS(ISTAGE) ,	WICUT	53
1BET2SS (ISTAGE) , AINCSS (ISTAGE) , ADEVSS (ISTAGE) ,	WICUT	54
1AMACH2 , ALFA2 , DEQS,DEQN,SITACS,SITACN,BET2N,FMA2(ISTAGE),	WICUT	55
1AK1,AK3,UZ,UZ,0.0,RADI2(ISTAGE),RADI1(ISTAGE+1))	WICUT	56
ALFA3 = BET2N	WICUT	57
ALFA3R=ALFA3*PAI/180.0	WICUT	58
U3=UZ/COS(ALFA3R)	WICUT	59
RETURN	WICUT	60
END	WICUT	61
C+++++	WICSPD	1
CC	WICSPD	2
C	C	3
C SUBROUTINE WICSPD	C	4
C	C	5
CC	WICSPD	6
SUBROUTINE WICSPD(AMASS,ISTAGE)	WICSPD	7
REAL M,MIN,M1,M2,M1REL,M2REL	WICSPD	8
COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	WICSPD	9
X, PREB,RTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	WICSPD	10
X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XWH(3),XWT(3),TW(3),TWW(3)	WICSPD	11
X, OMEGS(7),OMEGR(6),GAPR(6),GAPS(6)	WICSPD	12
X, RRHUB(6),RC(6),RBLADE(6),STAGER(6)	WICSPD	13
X, SRHUB(7),SC(7),SBLADE(7),STAGES(7)	WICSPD	14
X, SIGUMR(6),BET1SR(6),BET2SR(6),AINC SR(6),ADEUSR(6)	WICSPD	15
X, SIGUMS(7),BET1SS(7),BET2SS(7),AINCSS(7),ADEVSS(7)	WICSPD	16
X, UTIPG(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI	WICSPD	17
X, AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT	WICSPD	18
X, ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID	WICSPD	19
X, NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)	WICSPD	20
X, DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)	WICSPD	21
X, DR(6),DS(6),DEGR(6),DEQS(6),BLOCK(6),BLOCKS(7)	WICSPD	22
X, BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)	WICSPD	23
DIMENSION TD(8)	WICSPD	24
AJ=778.26	WICSPD	25
IUNIT=1	WICSPD	26
CFT=1.0/1.8	WICSPD	27
CFP=47.880258	WICSPD	28
CFD=16.018463	WICSPD	29
CFU=0.3048	WICSPD	30
CFA=0.09290304	WICSPD	31
CFL=2.54	WICSPD	32
CFM=0.45359237	WICSPD	33
PAI=3.1415926	WICSPD	34
GC=32.174	WICSPD	35
TREF=518.70	WICSPD	36
PREF=14.7*144.0	WICSPD	37
AAAR1=PAI*(RRTIP(1)**2-RRHUB(1)**2)/144.0*BLOCK(1)	WICSPD	38
CMASS=AMASS*SQRT(TG(1)/TREF)/(P(1)/PREF)*AAAR1/SAREA(1)	WICSPD	39
C IGU INLET	WICSPD	40
ISTAGE=NS1	WICSPD	41
CALL WICPRP(1.0,0.0,0.0,TG(1),RMIX,CPMIX,GAMMA,G1,G2,G3)	WICSPD	42
CALL WICMAC(ISTAGE,AMASS,TG(1),P(1),M,UZ,C,0.0,0.0,RMIX,CPMIX,ARE	WICSPD	43
\$AS(NS1))	WICSPD	44
UZIN=UZ	WICSPD	45
AIN=C	WICSPD	46
MIN=M	WICSPD	47
TOIN=TG(1)	WICSPD	48
POIN=P(1)	WICSPD	49
PSIN=P(1)/(1.0+G2*M**2)**G1	WICSPD	50
TSIN=TG(1)/(1.0+G2*M**2)	WICSPD	51
RHOGIN=PSIN/RMIX/TSIN	WICSPD	52
FAIIN=UZIN/UTIPG(1)	WICSPD	53
FAID=FAIIN	WICSPD	54
GAMAIN=GAMMA	WICSPD	55
TOIN=TG(1)	WICSPD	56
POIN=P(1)	WICSPD	57

C IGV INLET PRINTOUT	WICSPD	58
IF(IUNIT.EQ.2) THEN	WICSPD	59
TOIN=TOIN*CFT	WICSPD	60
POIN=POIN*CFP	WICSPD	61
TSIN=TSIN*CFT	WICSPD	62
PSIN=PSIN*CFP	WICSPD	63
RHOGIN=RHOGIN*CFD	WICSPD	64
AIN=AIN*CFU	WICSPD	65
UZIN=UZIN*CFU	WICSPD	66
AREAS(NS1)=AREAS(NS1)*CFA	WICSPD	67
ENDIF	WICSPD	68
WRITE(6,1000)	WICSPD	69
1000 FORMAT(1H1,***** DESIGN POINT INFORMATION *****	WICSPD	70
\$***\$)	WICSPD	71
WRITE(6,1010)	WICSPD	72
1010 FORMAT(1H0,1X,***** COMPRESSOR INLET *****\$)	WICSPD	73
WRITE(6,1020) TOIN,POIN,TSIN,PSIN,RHOGIN	WICSPD	74
1020 FORMAT(1H0,1X, TOTAL TEMPERATURE AT COMPRESSOR INLET=#,F10.5,/,	WICSPD	75
\$2X, TOTAL PRESSURE AT COMPRESSOR INLET=#,F10.2,/,	WICSPD	76
\$2X, STATIC TEMPERATURE AT COMPRESSOR INLET=#,F10.5,/,	WICSPD	77
\$2X, STATIC PRESSURE AT COMPRESSOR INLET=#,F10.2,/,	WICSPD	78
\$2X, STATIC DENSITY AT COMPRESSOR INLET=#,F10.5)	WICSPD	79
WRITE(6,1030) AIN,UZIN,MIN,AREAS(NS1),FAIN	WICSPD	80
1030 FORMAT(1H0,1X, ACOUSTIC SPEED AT COMPRESSOR INLET=#,F10.5,/,	WICSPD	81
\$2X, AXIAL VELOCITY AT COMPRESSOR INLET=#,F10.5,/,	WICSPD	82
\$2X, MACH NUMBER AT COMPRESSOR INLET=#,F10.5,/,	WICSPD	83
\$2X, STREAMTUBE AREA AT COMPRESSOR INLET=#,F10.5,/,	WICSPD	84
\$2X, FLOW COEFFICIENT AT COMPRESSOR INLET=#,F10.5)	WICSPD	85
IF(IUNIT.EQ.2) THEN	WICSPD	86
TOIN=TOIN/CFT	WICSPD	87
POIN=POIN/CFP	WICSPD	88
TSIN=TSIN/CFT	WICSPD	89
PSIN=PSIN/CFP	WICSPD	90
RHOGIN=RHOGIN/CFD	WICSPD	91
AIN=AIN/CFU	WICSPD	92
UZIN=UZIN/CFU	WICSPD	93
AREAS(NS1)=AREAS(NS1)/CFA	WICSPD	94
ENDIF	WICSPD	95
C ROTOR INLET	WICSPD	96
ISTAGE=1	WICSPD	97
100 I=ISTAGE-1	WICSPD	98
IF(I.EQ.0) I=NS1	WICSPD	99
ALFA1=BET2SS(I)	WICSPD	100
ADEUSS(I)=ALFA1-BET2MS(I)	WICSPD	101
CALL WICMAC(ISTAGE,AMASS,TG(1),P(1),M,UZ,C,0.0,ALFA1,RMIX,	WICSPD	102
\$CPMIX,AREA(ISTAGE))	WICSPD	103
CPMIX1=CPMIX	WICSPD	104
GAMMA1=GAMMA	WICSPD	105
UZ1=UZ	WICSPD	106
A1=C	WICSPD	107
M1=M	WICSPD	108
PS1=P(1)/(1.0+G2*M1**2)**G1	WICSPD	109
TS1=TG(1)/(1.0+G2*M1**2)	WICSPD	110
RHOGS1=PS1/RMIX/TS1	WICSPD	111
FAIRIN=UZ1/UTIPG(ISTAGE)	WICSPD	112
ALFA1R=ALFA1*PAI/180.0	WICSPD	113
U1=UZ1/COS(ALFA1R)	WICSPD	114
US1=UZ1*WICTAN(ALFA1R)	WICSPD	115
WS1=U(ISTAGE)-US1	WICSPD	116
WU=WS1/UZ1	WICSPD	117
BETA1R=ATAN(WU)	WICSPD	118
BETA1=BETA1R*180.0/PAI	WICSPD	119
BET1SR(ISTAGE)=BETA1	WICSPD	120
AINCSR(ISTAGE)=BETA1-BET1MR(ISTAGE)	WICSPD	121
W1=UZ1/COS(BETA1R)	WICSPD	122
M1REL=W1/A1	WICSPD	123
TREL1=(1.0+G2*M1REL**2)*TS1	WICSPD	124
PREL1=(1.0+G2*M1REL**2)**G1*PS1	WICSPD	125
IF(ISTAGE.GE.2) DS(ISTAGE-1)=1.0-U1/U2+ABS(US2-US1)/2.0/	WICSPD	126
\$SIGUMS(ISTAGE-1)/U2	WICSPD	127

IF(ISTAGE.GE.2) DEQS(ISTAGE-1)=COS(ALFA1R)/COS(ALFA2R)*	WICSPD	128
\$(1.12+0.61*COS(ALFA2R)**2/SIGUMS(ISTAGE-1)*(WICTAN(ALFA2R)-	WICSPD	129
\$WICTAN(ALFA1R)))	WICSPD	130
IF(ISTAGE.GT.NS) GO TO 101	WICSPD	131
C ROTOR OUTLET	WICSPD	132
P(2)=PR12D(ISTAGE)*P(1)	WICSPD	133
TR12=(PR12D(ISTAGE)**(1.0/G1)-1.0)/ETARD(ISTAGE)+1.0	WICSPD	134
TG(2)=JR12*TG(1)	WICSPD	135
CALL WICPRP(1.0,0.0,0.0,TG(2),RMIX,CPMIX,GAMMA,G1,G2,G3)	WICSPD	136
GAMMA2=GAMMA	WICSPD	137
CPMIX2=CPMIX	WICSPD	138
GAMMAU=(GAMMA1+GAMMA2)/2.0	WICSPD	139
CPMIXU=(CPMIX1+CPMIX2)/2.0	WICSPD	140
G1AU=GAMMAU/(GAMMAU-1.0)	WICSPD	141
G2AU=(GAMMAU-1.0)/2.0	WICSPD	142
PR13I=(TG(2)/TG(1))*G1AU	WICSPD	143
DELT=TG(2)-TG(1)	WICSPD	144
US2=(U(ISTAGE)*US1+DELT*CPMIXU*GC*AJ)/UU2(ISTAGE)	WICSPD	145
JJ=1	WICSPD	146
UZ2AS=UZ1	WICSPD	147
200 US2UZ2=US2/UZ2AS	WICSPD	148
ALFA2R=ATAN(US2UZ2)	WICSPD	149
ALFA2=ALFA2R*180.0/PAI	WICSPD	150
BET1SS(ISTAGE)=ALFA2	WICSPD	151
AINCSS(ISTAGE)=ALFA2-BET1MS(ISTAGE)	WICSPD	152
WS2=UU2(ISTAGE)-US2	WICSPD	153
WS2UZ2=WS2/UZ2AS	WICSPD	154
BETA2R=ATAN(WS2UZ2)	WICSPD	155
BETA2=BETA2R*180.0/PAI	WICSPD	156
BET2SR(ISTAGE)=BETA2	WICSPD	157
ADEVSR(ISTAGE)=BETA2-BET2MR(ISTAGE)	WICSPD	158
U2=UZ2AS/COS(ALFA2R)	WICSPD	159
W2=UZ2AS/COS(BETA2R)	WICSPD	160
TS2=TG(2)-U2**2/(2.0*CPMIX2*GC*AJ)	WICSPD	161
A2=SQRT(GAMMA2*RMIX*TS2*GC)	WICSPD	162
M2=U2/A2	WICSPD	163
PS2=P(2)/(1.0+G2*M2**2)**G1	WICSPD	164
RHOGS2=PS2/RMIX/TS2	WICSPD	165
M2REL=W2/A2	WICSPD	166
TREL2=(1.0+G2*M2REL**2)*TS2	WICSPD	167
PREL2=(1.0+M2REL**2)**G1*PS2	WICSPD	168
UZ2CL=AMASS/(RHOGS2*AREAS(ISTAGE))	WICSPD	169
EPS=1.0E-6	WICSPD	170
IF(JJ.EQ.2) GO TO 201	WICSPD	171
IF(JJ.GT.2) GO TO 202	WICSPD	172
X1=UZ2AS	WICSPD	173
Y1=UZ2CL	WICSPD	174
UZ2AS=UZ2CL	WICSPD	175
JJ=JJ+1	WICSPD	176
GO TO 200	WICSPD	177
201 X2=UZ2AS	WICSPD	178
Y2=UZ2CL	WICSPD	179
UZ2AS=WICNEW(X1,Y1,X2,Y2)	WICSPD	180
JJ=JJ+1	WICSPD	181
GO TO 200	WICSPD	182
202 IF((ABS(UZ2AS-UZ2CL)/UZ2AS).LT.EPS) GO TO 300	WICSPD	183
X1=X2	WICSPD	184
Y1=Y2	WICSPD	185
X2=UZ2AS	WICSPD	186
Y2=UZ2CL	WICSPD	187
UZ2AS=WICNEW(X1,Y1,X2,Y2)	WICSPD	188
JJ=JJ+1	WICSPD	189
GO TO 200	WICSPD	190
300 UZ2=UZ2CL	WICSPD	191
FAIOUT=UZ2/UTIPG(ISTAGE)	WICSPD	192
DR(ISTAGE)=1.0-W2/W1+ABS(WS1-WS2)/2.0/SIGUMR(ISTAGE)/W1	WICSPD	193
DEQR(ISTAGE)=COS(BETA2R)/COS(BETA1R)*	WICSPD	194
\$(1.12+0.61*COS(BETA1R)**2/SIGUMR(ISTAGE)*	WICSPD	195
\$(WICTAN(BETA1R)-WICTAN(BETA2R)))	WICSPD	196
PLOSSR=PR12D(ISTAGE)/(TG(2)/TG(1))*G1AU	WICSPD	197

PRRELI=(1.0+G2AU*U(ISTAGE)**2/(GAMMAU*RMIX*TREL1*GC)	WICSPD	198
\$*((UU2(ISTAGE)/U(ISTAGE))**2-1.0)**G1AU	WICSPD	199
IF(PRRELI.LT.PLOSSR) PRRELI=1.0	WICSPD	200
OMEGR(ISTAGE)=(PRRELI-PLOSSR)/(1.0-PS1/PREL1)	WICSPD	201
C STATOR OUTLET	WICSPD	202
PLOSSS=PR13D(ISTAGE)/PR12D(ISTAGE)	WICSPD	203
PR13=(TG(2)/TG(1))**G1AU*PLOSSR*PLOSSS	WICSPD	204
OMEGS(ISTAGE)=(1.0-PLOSSS)/(1.0-PS2/P(2))	WICSPD	205
ETASG=(PR13**(1.0/G1AU)-1.0)/(TR12-1.0)	WICSPD	206
P(3)=PR13*P(1)	WICSPD	207
TG(3)=TG(2)	WICSPD	208
TD(ISTAGE)=TG(1)	WICSPD	209
C PRINTOUT OF STAGE PERFORMANCE	WICSPD	210
IF(IUNIT.EQ.2) THEN	WICSPD	211
TG(1)=TG(1)*CFT	WICSPD	212
TG(2)=TG(2)*CFT	WICSPD	213
P(1)=P(1)*CFP	WICSPD	214
P(2)=P(2)*CFP	WICSPD	215
TS1=TS1*CFT	WICSPD	216
TS2=TS2*CFT	WICSPD	217
PS1=PS1*CFP	WICSPD	218
PS2=PS2*CFP	WICSPD	219
RHOGS1=RHOGS1*CFD	WICSPD	220
RHOGS2=RHOGS2*CFD	WICSPD	221
UZ1=UZ1*CFU	WICSPD	222
UZ2=UZ2*CFU	WICSPD	223
U1=U1*CFU	WICSPD	224
U2=U2*CFU	WICSPD	225
W1=W1*CFU	WICSPD	226
W2=W2*CFU	WICSPD	227
US1=US1*CFU	WICSPD	228
US2=US2*CFU	WICSPD	229
WS1=WS1*CFU	WICSPD	230
WS2=WS2*CFU	WICSPD	231
U(ISTAGE)=U(ISTAGE)*CFU	WICSPD	232
UU2(ISTAGE)=UU2(ISTAGE)*CFU	WICSPD	233
TREL1=TREL1*CFT	WICSPD	234
PREL1=PREL1*CFP	WICSPD	235
TREL2=TREL2*CFT	WICSPD	236
PREL2=PREL2*CFP	WICSPD	237
AREA(ISTAGE)=AREA(ISTAGE)*CFA	WICSPD	238
AREAS(ISTAGE)=AREAS(ISTAGE)*CFA	WICSPD	239
RADI1(ISTAGE)=RADI1(ISTAGE)*CFL	WICSPD	240
RADI2(ISTAGE)=RADI2(ISTAGE)*CFL	WICSPD	241
ENDIF	WICSPD	242
WRITE(6,1000)	WICSPD	243
WRITE(6,1100) ISTAGE	WICSPD	244
1100 FORMAT(1H0,1X,***** STAGE=#,I2,# *****)	WICSPD	245
WRITE(6,1101)	WICSPD	246
1101 FORMAT(1H0,16X,#TOTAL#,8X,#TOTAL#,7X,#STATIC#,7X,#STATIC#,7X,	WICSPD	247
\$#STATIC#,#/,17X,#TEMP#,7X,#PRESSURE#,7X,#TEMP#,7X,#PRESSURE#,6X,	WICSPD	248
\$#DENSITY#)	WICSPD	249
WRITE(6,1110) TG(1),P(1),TS1,PS1,RHOGS1	WICSPD	250
1110 FORMAT(1H0,1X,#ROTOR INLET#,1X,5(F10.3,3X))	WICSPD	251
WRITE(6,1120) TG(2),P(2),TS2,PS2,RHOGS2	WICSPD	252
1120 FORMAT(1H ,1X,#ROTOR OUTLET#,5(F10.3,3X))	WICSPD	253
WRITE(6,1111)	WICSPD	254
1111 FORMAT(1H0,16X,#AXIAL#,6X,#ABSOLUTE#,5X,#RELATIVE#,5X,#TAN COMP#,	WICSPD	255
\$5X,#TAN COMP#,#/,15X,#VELOCITY#,5X,#VELOCITY#,5X,#VELOCITY#,4X,	WICSPD	256
\$#OF ABS UEL#,3X,#OF REL UEL#)	WICSPD	257
WRITE(6,1130) UZ1,U1,W1,US1,WS1	WICSPD	258
1130 FORMAT(1H0,1X,#ROTOR INLET#,1X,5(F10.5,3X))	WICSPD	259
WRITE(6,1140) UZ2,U2,W2,US2,WS2	WICSPD	260
1140 FORMAT(1H ,1X,#ROTOR OUTLET#,5(F10.5,3X))	WICSPD	261
WRITE(6,1141)	WICSPD	262
1141 FORMAT(1H0,15X,#ROTOR#,7X,#ABS MACH#,5X,#REL MACH#,5X,#REL TOTAL#,	WICSPD	263
\$4X,#REL TOTAL#,#/,16X,#SPEED#,8X,#NUMBER#,7X,#NUMBER#,7X,#TEMP#,8X,	WICSPD	264
\$#PRESSURE#)	WICSPD	265
WRITE(6,1150) U(ISTAGE),M1,M1REL,TREL1,PREL1	WICSPD	266
1150 FORMAT(1H0,1X,#ROTOR INLET#,1X,5(F10.3,3X))	WICSPD	267

WRITE(6,1160) UU2(ISTAGE),M2,M2REL,TREL2,PREL2	WICSPD	268
1160 FORMAT(1H ,1X, #ROTOR OUTLET#,5(F10.3,3X))	WICSPD	269
I=ISTAGE	WICSPD	270
IF(ISTAGE.EQ.1) I=8	WICSPD	271
WRITE(6,1161)	WICSPD	272
1161 FORMAT(1H0,14X, #ABS FLOW#,5X, #REL FLOW#,4X, #STREAMTUBE#,18X,	WICSPD	273
\$#FLOW#,/,16X, #ANGLE#,8X, #ANGLE#,8X, #AREA#,9X, #RADIUS#,5X,	WICSPD	274
\$#COEFFICIENT#)	WICSPD	275
WRITE(6,1170) BET2SS(I-1),BET1SR(ISTAGE),AREA(ISTAGE),	WICSPD	276
\$RADI1(ISTAGE),FAIRIN	WICSPD	277
1170 FORMAT(1H0,1X, #ROTOR INLET#,1X,5(F10.5,3X))	WICSPD	278
WRITE(6,1180) BET1SS(ISTAGE),BET2SR(ISTAGE),AREAS(ISTAGE),	WICSPD	279
\$RADI2(ISTAGE),FAIOUT	WICSPD	280
1180 FORMAT(1H ,1X, #ROTOR OUTLET#,5(F10.5,3X))	WICSPD	281
WRITE(6,1190) PR13,ETASG,PR12D(ISTAGE),ETARD(ISTAGE),TR12	WICSPD	282
1190 FORMAT(1H0,1X, #STAGE TOTAL PRESSURE RATIO AT DESIGN POINT=#,F10.5,	WICSPD	283
\$/,2X, #STAGE ADIABATIC EFFICIENCY AT DESIGN POINT=#,F10.5,/,2X,	WICSPD	284
\$#ROTOR TOTAL PRESSURE RATIO AT DESIGN POINT=#,F10.5,/,2X,	WICSPD	285
\$#ROTOR ADIABATIC EFFICIENCY AT DESIGN POINT=#,F10.5,/,2X,	WICSPD	286
\$#ROTOR TOTAL TEMPERATURE RATIO AT DESIGN POINT=#,F10.5)	WICSPD	287
IF(IUNIT.EQ.2) THEN	WICSPD	288
TG(1)=TG(1)/CFT	WICSPD	289
TG(2)=TG(2)/CFT	WICSPD	290
P(1)=P(1)/CFP	WICSPD	291
P(2)=P(2)/CFP	WICSPD	292
TS1=TS1/CFT	WICSPD	293
TS2=TS2/CFT	WICSPD	294
PS1=PS1/CFP	WICSPD	295
PS2=PS2/CFP	WICSPD	296
RHOGS1=RHOGS1/CFD	WICSPD	297
RHOGS2=RHOGS2/CFD	WICSPD	298
UZ1=UZ1/CFU	WICSPD	299
UZ2=UZ2/CFU	WICSPD	300
U1=U1/CFU	WICSPD	301
U2=U2/CFU	WICSPD	302
W1=W1/CFU	WICSPD	303
W2=W2/CFU	WICSPD	304
US1=US1/CFU	WICSPD	305
US2=US2/CFU	WICSPD	306
WS1=WS1/CFU	WICSPD	307
WS2=WS2/CFU	WICSPD	308
U(ISTAGE)=U(ISTAGE)/CFU	WICSPD	309
UU2(ISTAGE)=UU2(ISTAGE)/CFU	WICSPD	310
TREL1=TREL1/CFT	WICSPD	311
PREL1=PREL1/CFP	WICSPD	312
TREL2=TREL2/CFT	WICSPD	313
PREL2=PREL2/CFP	WICSPD	314
AREA(ISTAGE)=AREA(ISTAGE)/CFA	WICSPD	315
AREAS(ISTAGE)=AREAS(ISTAGE)/CFA	WICSPD	316
RADI2(ISTAGE)=RADI2(ISTAGE)/CFL	WICSPD	317
ENDIF	WICSPD	318
C REPEAT	WICSPD	319
TG(1)=TG(3)	WICSPD	320
P(1)=P(3)	WICSPD	321
IF(ISTAGE.EQ.NS) ADEUSS(NS)=BET2SS(NS)-BET2MS(NS)	WICSPD	322
ISTAGE=ISTAGE+1	WICSPD	323
IF(ISTAGE.EQ.NS1) GO TO 101	WICSPD	324
GO TO 100	WICSPD	325
C OVERALL PERFORMANCE AT DESIGN POINT	WICSPD	326
101 OVALPR=P(3)/P0IN	WICSPD	327
QUALTR=TG(3)/TOIN	WICSPD	328
GAMMAU=(GAMAIN+GAMMA)/2.0	WICSPD	329
G1AU=GAMMAU/(GAMMAU-1.0)	WICSPD	330
OVALDF=(OVALPR**(1.0/G1AU)-1.0)/(QUALTR-1.0)	WICSPD	331
QUALDT=TG(3)-TOIN	WICSPD	332
C PRINTOUT OF OVERALL PERFORMANCE AT DESIGN POINT	WICSPD	333
IF(IUNIT.EQ.2) THEN	WICSPD	334
TOIN=TOIN*CFT	WICSPD	335
P0IN=P0IN*CFP	WICSPD	336
CMASS=CMASS*CFM	WICSPD	337

```

    QUALDT=QUALDT*CFT
    DO 422 I=1,NS
      TD(I)=TD(I)*CFT
422 CONTINUE
      ENDIF
      WRITE(6,1000)
      WRITE(6,421)
421 FORMAT(1H0,=#***** OVERALL PERFORMANCE AT DESIGN POINT ****
$*****#)
      WRITE(6,425) T0IN
425 FORMAT(1H0,1X,=#COMPRESSOR INLET TOTAL TEMPERATURE=#,F8.2)
      WRITE(6,426) P0IN
426 FORMAT(1H0,1X,=#COMPRESSOR INLET TOTAL PRESSURE=#,F10.2)
      WRITE(6,427) CMASS
427 FORMAT(1H0,1X,=#CORRECTED MASS FLOW RATE=#,F6.3)
      WRITE(6,429) QVALPR
429 FORMAT(1H0,1X,=#OVERALL TOTAL PRESSURE RATIO=#,F6.4)
      WRITE(6,430) QVALTR
430 FORMAT(1H0,1X,=#OVERALL TOTAL TEMPERATURE RATIO=#,F6.4)
      WRITE(6,431) QVALEF
431 FORMAT(1H0,1X,=#OVERALL ADIABATIC EFFICIENCY=#,F6.4)
      WRITE(6,432) QVALDT
432 FORMAT(1H0,1X,=#OVERALL TEMPERATURE RISE=#,F8.3)
      WRITE(6,1621)
1621 FORMAT(1H0,14X,#1#,5X,#2#,5X,#3#,5X,#4#,5X,#5#,5X,#6#,4X,#IGU#)
      WRITE(6,1710) (BET1SR(I),I=1,NS)
1710 FORMAT(1H ,1X,=#BET1SR(I)#,2X,6(F5.2,1X))
      WRITE(6,1720) (BET2SR(I),I=1,NS)
1720 FORMAT(1H ,1X,=#BET2SR(I)#,2X,6(F5.2,1X))
      WRITE(6,1730) (AINCSR(I),I=1,NS)
1730 FORMAT(1H ,1X,=#AINCSR(I)#,2X,6(F5.2,1X))
      WRITE(6,1740) (ADEUSR(I),I=1,NS)
1740 FORMAT(1H ,1X,=#ADEUSR(I)#,2X,6(F5.2,1X))
      WRITE(6,1760) (BET1SS(I),I=1,NS)
1760 FORMAT(1H ,1X,=#BET1SS(I)#,2X,6(F5.2,1X))
      WRITE(6,1770) (BET2SS(I),I=1,NS)
1770 FORMAT(1H ,1X,=#BET2SS(I)#,2X,7(F5.2,1X))
      WRITE(6,1780) (AINCSS(I),I=1,NS)
1780 FORMAT(1H ,1X,=#AINCSS(I)#,2X,6(F5.2,1X))
      WRITE(6,1790) (ADEUSS(I),I=1,NS)
1790 FORMAT(1H ,1X,=#ADEUSS(I)#,2X,6(F5.2,1X))
      WRITE(6,1791) (TD(I),I=1,NS)
1791 FORMAT(1H ,1X,=#TD(I)#,6X,6(F5.1,1X))
      WRITE(6,1793) (OMEGS(I),I=1,NS)
1793 FORMAT(1H ,1X,=#OMEGS(I)#,3X,6(F5.3,1X))
      WRITE(6,1794) (OMEGR(I),I=1,NS)
1794 FORMAT(1H ,1X,=#OMEGR(I)#,3X,6(F5.3,1X))
      IF(IUNIT.EQ.2) THEN
        T0IN=T0IN/CFT
        P0IN=P0IN/CFM
        CMASS=CMASS/CFM
        QUALDT=QUALDT/CFT
        DO 423 I=1,NS
          TD(I)=TD(I)*CFT
423 CONTINUE
          ENDIF
          RETURN
        END
C+++++
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C *** STGSK - A COMPUTER CODE FOR PREDICTING MULTISTAGE AXIAL FLOW
C COMPRESSOR PERFORMANCE USING A MEANLINE STAGE STACKING METHOD.
C DOCUMENTATION NASA TP-XXXX, XXX, 1980, BY R. J. STEINKE
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE NASA
COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW
X, PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)
X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XHW(3),XWT(3),TW(3),TWW(3)

```

```

WICSPD 338
WICSPD 339
WICSPD 340
WICSPD 341
WICSPD 342
WICSPD 343
WICSPD 344
WICSPD 345
WICSPD 346
WICSPD 347
WICSPD 348
WICSPD 349
WICSPD 350
WICSPD 351
WICSPD 352
WICSPD 353
WICSPD 354
WICSPD 355
WICSPD 356
WICSPD 357
WICSPD 358
WICSPD 359
WICSPD 360
WICSPD 361
WICSPD 362
WICSPD 363
WICSPD 364
WICSPD 365
WICSPD 366
WICSPD 367
WICSPD 368
WICSPD 369
WICSPD 370
WICSPD 371
WICSPD 372
WICSPD 373
WICSPD 374
WICSPD 375
WICSPD 376
WICSPD 377
WICSPD 378
WICSPD 379
WICSPD 380
WICSPD 381
WICSPD 382
WICSPD 383
WICSPD 384
WICSPD 385
WICSPD 386
WICSPD 387
WICSPD 388
WICSPD 389
WICSPD 390
WICSPD 391
WICSPD 392
WICSPD 393
WICSPD 394
WICSPD 395
NASA 1
NASA 2
NASA 3
NASA 4
NASA 5
NASA 6
NASA 7
NASA 8
NASA 9
NASA 10
NASA 11
NASA 12

```


X, OMEGS(7), OMEGR(6), GAPR(6), GAPS(6)	NASA	13
X, RRHUB(6), RC(6), RBLADE(6), STAGER(6)	NASA	14
X, SRHUB(7), SC(7), SBLADE(7), STAGES(7)	NASA	15
X, SIGUMR(6), BET1SR(6), BET2SR(6), AINCSR(6), ADEVSR(6)	NASA	16
X, SIGUMS(7), BET1SS(7), BET2SS(7), AINCSS(7), ADEVSS(7)	NASA	17
X, UTIPG(6), UTIP(6), UTIPD(6), UOU(6), UMEAN(6), UHUB(6), U(6), FAI	NASA	18
X, AREA(6), AREAS(7), UU2(6), UTIP2(6), UMEAN2(6), UHUB2(6), IPRINT	NASA	19
X, ICENT, IICENT, FMR1(6), FMA2(6), IRAD, FAID	NASA	20
X, NS, NS1, RT(6), RM(6), RH(6), ST(6), SM(6), SH(6)	NASA	21
X, DSMASS, AAREA(7), AAREAS(7), PR12D(6), PR13D(6), ETARD(6)	NASA	22
X, DR(6), DS(6), DEQR(6), DEQS(6), BLOCK(6), BLOCKS(7)	NASA	23
X, BET1MR(6), BET2MR(6), BET1MS(7), BET2MS(7), RAD1(6), RAD2(6)	NASA	24
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	NASA	25
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	NASA	26
XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	NASA	27
X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	NASA	28
XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	NASA	29
XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)	NASA	30
X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)	NASA	31
X, BAT2MR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(	NASA	32
X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12	NASA	33
X,9), PHIFIX(12), DPHIF(12), CPREF(12), GF1REF(12), ETAINP(12)	NASA	34
X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR	NASA	35
X(12,9), B2MB3R(12,9), SPEEDF, FLOWIN, U3DU2R(12), U2U3(12), DB3MRG(12)	NASA	36
X, DB3MRN(12,9), DB3MRP(12,8), CPCO(6), CPCS(6)	NASA	37
*, RK3M(12), RDEV(12), RDEF(12), GMREF(12)	NASA	38
*, PSID1(12,2,8), PSID2(12,2,8), PSID3(12,2,8), PSID4(12,2,8)	NASA	39
*, PSID5(12,2,8), PSI1(12,2,8), PSI2(12,2,8), PSI3(12,2,8)	NASA	40
*, PSI4(12,2,8), PSI5(12,2,8)	NASA	41
*, PSID1L(12,2,8), PSID2L(12,2,8), PSID3L(12,2,8)	NASA	42
*, PSID4L(12,2,8), PSID5L(12,2,8), PSI1L(12,2,8)	NASA	43
*, PSI2L(12,2,8), PSI3L(12,2,8), PSI4L(12,2,8), PSI5L(12,2,8)	NASA	44
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	NASA	45
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	NASA	46
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPHI, SPDPHI, DRDEUG, DRDEUN, DRDEUP	NASA	47
X, XAR, XMET, XSTM	NASA	48
X, STAGEN, SPEEDN, CHAPTS, WTMOLE	NASA	49
C *** CALCULATE FIXED PARAMETERS	NASA	50
PO = PO*144.0	NASA	51
DO 20 I=1, NSTA	NASA	52
AREA2(I) = (RT2(I)+RH2(I))*(RT2(I)-RH2(I))*PI/144.0	NASA	53
AREA3(I) = (RT3(I)+RH3(I))*(RT3(I)-RH3(I))*PI/144.0	NASA	54
IF(IRAD.EQ.1) RM2(I)=RT2(I)	NASA	55
IF(IRAD.EQ.1) RM3(I)=RT3(I)	NASA	56
IF(IRAD.EQ.2) RM2(I)=RM(I)	NASA	57
IF(IRAD.EQ.2) RM3(I)=SM(I)	NASA	58
IF(IRAD.EQ.3) RM2(I)=RH2(I)	NASA	59
IF(IRAD.EQ.3) RM3(I)=RH3(I)	NASA	60
AREA2(I)=SAREA(I)	NASA	61
AREA3(I)=SAREAS(I)	NASA	62
UM2(I) = RM2(I)*DESRPM*RPMRAD	NASA	63
UM3(I) = RM3(I)*DESRPM*RPMRAD	NASA	64
BET2M(I,1) = BET2M(I,1)/RAD	NASA	65
RK2M(I) = RK2M(I) + CB2MR(I)	NASA	66
SK2M(I) = SK2M(I) + CB2M(I)	NASA	67
CB2M(I) = CB2M(I)/RAD	NASA	68
CB2MR(I) = CB2MR(I)/RAD	NASA	69
CB3MR(I) = CB3MR(I)/RAD	NASA	70
20 CONTINUE	NASA	71
CALL CSPREF	NASA	72
IF(ETADES(1,1,1).EQ.0.0) CALL CSETA	NASA	73
CALL CSPSI(0.00,1)	NASA	74
DO 100 I=1, NSTA	NASA	75
DO 100 K=1, NPTS	NASA	76
PSID1(I,1,K)=PSIDES(I,1,K)	NASA	77
100 CONTINUE	NASA	78
CALL CSPSI(0.025,1)	NASA	79
DO 101 I=1, NSTA	NASA	80
DO 101 K=1, NPTS	NASA	81
PSID2(I,1,K)=PSIDES(I,1,K)	NASA	82

101	CONTINUE	NASA	83
	CALL CSPSI(0.075,1)	NASA	84
	DO 102 I=1,NSTA	NASA	85
	DO 102 K=1,NPTS	NASA	86
	PSID3(I,1,K)=PSIDES(I,1,K)	NASA	87
102	CONTINUE	NASA	88
	CALL CSPSI(0.125,1)	NASA	89
	DO 103 I=1,NSTA	NASA	90
	DO 103 K=1,NPTS	NASA	91
	PSID4(I,1,K)=PSIDES(I,1,K)	NASA	92
103	CONTINUE	NASA	93
	CALL CSPSI(0.150,1)	NASA	94
	DO 104 I=1,NSTA	NASA	95
	DO 104 K=1,NPTS	NASA	96
	PSID5(I,1,K)=PSIDES(I,1,K)	NASA	97
104	CONTINUE	NASA	98
	CALL CSPSI(0.00,2)	NASA	99
	DO 200 I=1,NSTA	NASA	100
	DO 200 K=1,NPTS	NASA	101
	PSID1L(I,1,K)=PSIDES(I,1,K)	NASA	102
200	CONTINUE	NASA	103
	CALL CSPSI(0.025,2)	NASA	104
	DO 201 I=1,NSTA	NASA	105
	DO 201 K=1,NPTS	NASA	106
	PSID2L(I,1,K)=PSIDES(I,1,K)	NASA	107
201	CONTINUE	NASA	108
	CALL CSPSI(0.075,2)	NASA	109
	DO 202 I=1,NSTA	NASA	110
	DO 202 K=1,NPTS	NASA	111
	PSID3L(I,1,K)=PSIDES(I,1,K)	NASA	112
202	CONTINUE	NASA	113
	CALL CSPSI(0.125,2)	NASA	114
	DO 203 I=1,NSTA	NASA	115
	DO 203 K=1,NPTS	NASA	116
	PSID4L(I,1,K)=PSIDES(I,1,K)	NASA	117
203	CONTINUE	NASA	118
	CALL CSPSI(0.150,2)	NASA	119
	DO 204 I=1,NSTA	NASA	120
	DO 204 K=1,NPTS	NASA	121
	PSID5L(I,1,K)=PSIDES(I,1,K)	NASA	122
204	CONTINUE	NASA	123
	DO 800 I=1,12	NASA	124
	DO 800 J=1,NSPE	NASA	125
	DPSIS(I,J)=0.0	NASA	126
800	CONTINUE	NASA	127
	IF (SPDPSI.EQ.1.0) CALL CSPSD	NASA	128
	CALL CSPAN	NASA	129
	DO 51 I=1,NSTA	NASA	130
	BET2M(I,1) = BET2M(I,1) * RAD	NASA	131
51	BET3MR(I,1) = BET3MR(I,1) * RAD	NASA	132
C ***	WRITE INTERMEDIATE OUTPUT	NASA	133
	WRITE (6,2120)	NASA	134
	IF(UNITS.EQ.1.0) THEN	NASA	135
	DO 300 I=1,NSTA	NASA	136
	FLOCAL(I,1)=FLOCAL(I,1)*0.453592	NASA	137
300	CONTINUE	NASA	138
	ENDIF	NASA	139
	WRITE (6,2051) (NSTAGE(I),PHIREF(I),PSIREF(I),ETAREF(I),CPREF(I),	NASA	140
	XGMREF(I),FLOCAL(I,1),	NASA	141
	X	NASA	142
	BET2M(I,1),BET3MR(I,1),RINCM(I),RDFM(I),SINCM(I),	NASA	143
	XI=1,NSTA)	NASA	144
	IF(UNITS.EQ.1.0) THEN	NASA	145
	DO 310 I=1,NSTA	NASA	146
	FLOCAL(I,1)=FLOCAL(I,1)/0.453592	NASA	147
310	CONTINUE	NASA	148
	ENDIF	NASA	149
2051	FORMAT (110H STAGE PHIREF PSIREF ETAREF CPREF	NASA	150
	X GMREF FLOCAL BET2M BET3MR RINCM RDFM,10H S	NASA	151
	XINCM// (5X, I5, 5F10.4, 4F10.2, F10.4, F10.2))	NASA	152
	WRITE(6,3474)	NASA	152

```

3474 FORMAT(1H-# STAGE      UZ2M      UZ3M#)          NASA      153
      DO 177 I=1,NSTA          NASA      154
      WRITE(6,3473) I,UZ2M(I,1),UZ3M(I,1)            NASA      155
3473 FORMAT(4X,I2,F14.2,F11.2)          NASA      156
      177 CONTINUE          NASA      157
      DO 52 I=1,NSTA          NASA      158
      BET2M(I,1) = BET2M(I,1) / RAD          NASA      159
      52 BET3MR(I,1) = BET3MR(I,1) / RAD          NASA      160
      WRITE (6,2120)          NASA      161
      WRITE (6,2052) (NSTAGE(I),I=1,12), (PCTSPD(J), (DPSIS(I,J), I=1,12
      1),J=1,NSPE)          NASA      162
2052 FORMAT (20X,27H DPSIS(STAGE,PCT SPD) TABLE//40X, 13H STAGE NUMBER/
      18H PCT SPD,12(I5,3X)//(13F8.4))          NASA      163
      DO 60 I=1,NSTA          NASA      164
      DO 60 J=1,NSPE          NASA      165
      DO 60 K=1,NPTS          NASA      166
      PHI(I,J,K)=PHIDES(I,J,K)          NASA      167
      IF (SPDPHI.EQ.1.0) PHI(I,J,K) = PHI(I,J,K)*(1.0 + ((PHI(I,J,K)/PHI
      XREF(I))**((1.0/SPEEDF) - 1.0)*1.0*ABS(1.0 - SPEEDF)))          NASA      168
C *** OPTION TO ALTER FLOW COEFICIENT FOR OFF DESIGN SPEEDS          NASA      169
      PSI1(I,J,K)=PSID1(I,1,K)          NASA      170
      PSI2(I,J,K)=PSID2(I,1,K)          NASA      171
      PSI3(I,J,K)=PSID3(I,1,K)          NASA      172
      PSI4(I,J,K)=PSID4(I,1,K)          NASA      173
      PSI5(I,J,K)=PSID5(I,1,K)          NASA      174
      PSI(I,J,K)=PSI1(I,1,K)          NASA      175
      PSI1L(I,J,K)=PSID1L(I,1,K)          NASA      176
      PSI2L(I,J,K)=PSID2L(I,1,K)          NASA      177
      PSI3L(I,J,K)=PSID3L(I,1,K)          NASA      178
      PSI4L(I,J,K)=PSID4L(I,1,K)          NASA      179
      PSI5L(I,J,K)=PSID5L(I,1,K)          NASA      180
      ETA(I,J,K) = ETADES(I,1,K)*ETARAT(J) + DETA(I)          NASA      181
      60 CONTINUE          NASA      182
      DO 70 I=1,NSTA          NASA      183
      WRITE (6,2120)          NASA      184
      WRITE(6,2060) NSTAGE(I),((PHI(I,J,K),PSI(I,J,K),
      1ETA(I,J,K),J=1,1),K=1,NPTS)          NASA      185
      IF(NSPE.LT.4) GO TO 70          NASA      186
      WRITE (6,2120)          NASA      187
      WRITE(6,2060) NSTAGE(I),((PHI(I,J,K),PSI(I,J,K),
      1ETA(I,J,K),J=4,6),K=1,NPTS)          NASA      188
      IF(NSPE.LT.7) GO TO 70          NASA      189
      WRITE (6,2120)          NASA      190
      WRITE(6,2060) NSTAGE(I),((PHI(I,J,K),PSI(I,J,K),
      1ETA(I,J,K),J=7,9),K=1,NPTS)          NASA      191
      70 CONTINUE          NASA      192
2060 FORMAT (20X,39H COMPUTED CHARACTERISTICS FOR STAGE NO.,I3//
      13(30H PHI      PSI      ETA      )/(9F1
      20.4))          NASA      193
2120 FORMAT (1H0////)          NASA      194
      RETURN          NASA      195
      END          NASA      196
C ++++++          NASA      197
      SUBROUTINE CSINPT          CSINPT      1
C *** SUBROUTINE CSINPT READS AND WRITES THE INPUT DATA          CSINPT      2
C *** ALL INPUT DATA MUST BE ENGLISH UNIT          CSINPT      3
C *** VALUE OF INPUT DATA #SPEEDN# MUST ALWAYS BE 1.0          CSINPT      4
C *** VALUE OF INPUT DATA #UNITS# MUST ALWAYS BE 0.0          CSINPT      5
      COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),
      XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),
      XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9
      X,8), DPHIA(12), DPSIA(12), RSOLM(12), NSTAGE(12), PCTSPD(9),
      XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),
      XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)
      X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)
      X,BAT2MR(12,9),DPSIS(12,9),RSOLM(12), RK2M(12), CB2M(12), CB2MR(
      X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12
      X,9), PHIFIX(12), DPHIF(12),CPREF(12), GF1REF(12),ETAINP(12)
      X,FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9),DB3M(12,9),DB3MR
      X(12,9),B2MB3R(12,9),SPEEDF,FLOWIN,U3DU2R(12),U2V3(12),DB3MRG(12)
      CSINPT      6
      CSINPT      7
      CSINPT      8
      CSINPT      9
      CSINPT     10
      CSINPT     11
      CSINPT     12
      CSINPT     13
      CSINPT     14
      CSINPT     15
      CSINPT     16
      CSINPT     17
      CSINPT     18

```

X, DB3MRN(12,9), DB3MRP(12,8), CPCM(6), CPCS(6)	CSINPT	19
* , RK3M(12), RDEV(12), RDEF(12), GMREF(12)	CSINPT	20
* , PSID1(12,2,8), PSID2(12,2,8), PSID3(12,2,8), PSID4(12,2,8)	CSINPT	21
* , PSID5(12,2,8), PSI1(12,2,8), PSI2(12,2,8), PSI3(12,2,8)	CSINPT	22
* , PSI4(12,2,8), PSI5(12,2,8)	CSINPT	23
* , PSID1L(12,2,8), PSID2L(12,2,8), PSID3L(12,2,8)	CSINPT	24
* , PSID4L(12,2,8), PSID5L(12,2,8), PSI1L(12,2,8)	CSINPT	25
* , PSI2L(12,2,8), PSI3L(12,2,8), PSI4L(12,2,8), PSI5L(12,2,8)	CSINPT	26
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	CSINPT	27
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	CSINPT	28
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEVG, DRDEVN, DRDEVP	CSINPT	29
X, XAR, XMET, XSTM	CSINPT	30
X, STAGEN, SPEEDN, CHAPTS, WTMOLE	CSINPT	31
DIMENSION PHIINP(10)	CSINPT	32
READ(5,1000) (TITLE(I), I=1,12)	CSINPT	33
WRITE(6,2000) (TITLE(I), I=1,12)	CSINPT	34
1000 FORMAT (12A6)	CSINPT	35
2000 FORMAT (1H1///20X,30H ** STAGE STACKING PROGRAM ** ///20X, 112A6////)	CSINPT	36
READ (5,4444) STAGEN, SPEEDN, CHAPTS ,PO,TO,DESRPM,DESFLO	CSINPT	38
4444 FORMAT(7F10.0)	CSINPT	39
WRITE(6,2010) STAGEN, SPEEDN, CHAPTS ,PO,TO,DESRPM,DESFLO	CSINPT	40
READ(5,1008) WTMOLA,WTMOLM,WTMOLS,XAR,XMET,XSTM	CSINPT	41
1008 FORMAT(6F10.0)	CSINPT	42
RGAIR=RU/WTMOLA	CSINPT	43
RCMET=RU/WTMOLM	CSINPT	44
RGSTM=RU/WTMOLS	CSINPT	45
RG=RGAIR*XAR+RCMET*XMET+RGSTM*XSTM	CSINPT	46
WTMOLE=RU/RC	CSINPT	47
WRITE(6,1006)WTMOLA,WTMOLM,WTMOLS,WTMOLE	CSINPT	48
1006 FORMAT(1H-,5X,≠MW AIR=≠,F7.4,3X,≠MW METHANE=≠,F7.4,3X,≠MW STEAM=≠, ≠F7.4,3X,≠MW MIXTURE=≠,F7.4)	CSINPT	49
WRITE(6,1004) XAR,XMET,XSTM	CSINPT	51
1004 FORMAT(1H-,5X,≠MASS FRACTION AIR=≠,F6.4,5X,≠MASS FRACTION METHANE= ≠,F6.4,5X,≠MASS FRACTION STEAM=≠,F6.4)	CSINPT	52
DCP = RG/AJ	CSINPT	54
GJ = G*AJ	CSINPT	55
G2J = GJ*2.0	CSINPT	56
RPMRAD = PI/360.0	CSINPT	57
1010 FORMAT (8F10.0)	CSINPT	58
2010 FORMAT (72H STAGES SPEEDS POINTS PO IN TO IN DES * RPM DES FLOW//(7F10.3)////)	CSINPT	59
READ (5,1010) SPDPSI, SPDPHI, DRDEVG, DRDEVN, DRDEVP, UNITS	CSINPT	61
WRITE (6,2011) SPDPSI, SPDPHI, DRDEVG, DRDEVN, DRDEVP, UNITS	CSINPT	62
2011 FORMAT (60H SPDPSI SPDPHI DRDEVG DRDEVN DRDEVP XUNITS//(6F10.1)////)	CSINPT	63
READ (5,1020) (CPCO(I), I=1,6)	CSINPT	65
WRITE(6,2020) (CPCO(I), I=1,6)	CSINPT	66
1020 FORMAT (3E20.8)	CSINPT	67
READ(5,1020) (CPCM(I), I=1,6)	CSINPT	68
WRITE(6,2021) (CPCM(I), I=1,6)	CSINPT	69
READ(5,1020) (CPCS(I), I=1,6)	CSINPT	70
WRITE(6,2022) (CPCS(I), I=1,6)	CSINPT	71
2020 FORMAT (072H CPCO(1) CPCO(2) CPCO(3) CPCO(4) C 1PCO(5) CPCO(6) //(6E12.5)////)	CSINPT	72
2021 FORMAT (072H CPCM(1) CPCM(2) CPCM(3) CPCM(4) C 1PCM(5) CPCM(6) //(6E12.5)////)	CSINPT	74
2022 FORMAT (072H CPCS(1) CPCS(2) CPCS(3) CPCS(4) C 1PCS(5) CPCS(6) //(6E12.5)////)	CSINPT	76
NSTA = STAGEN	CSINPT	78
NSPE= SPEEDN	CSINPT	79
NPTS = CHAPTS	CSINPT	80
READ (5,1010) (RT2(I), I=1,NSTA)	CSINPT	81
READ (5,1010) (RH2(I), I=1,NSTA)	CSINPT	82
READ (5,1010) (RT3(I), I=1,NSTA)	CSINPT	83
READ (5,1010) (RH3(I), I=1,NSTA)	CSINPT	84
READ (5,1010) (BET2M(I,1), I=1,NSTA)	CSINPT	85
READ (5,1010) (CB2M(I), I=1,NSTA)	CSINPT	86
READ (5,1010) (CB2MR(I), I=1,NSTA)	CSINPT	87
READ (5,1010) (CB3MR(I), I=1,NSTA)	CSINPT	88

READ (5,1010) (RK2M (I), I=1,NSTA)	CSINPT	89
READ(5,1010) (RK3M(I),I=1,NSTA)	CSINPT	90
READ (5,1010) (RSOLM(I), I=1,NSTA)	CSINPT	91
READ (5,1010) (SK2M(I),I=1,NSTA)	CSINPT	92
READ (5,1010) (PR(I),I=1,NSTA)	CSINPT	93
READ(5,1010) (ETAINP(I),I=1,NSTA)	CSINPT	94
READ(5,1010) (PHIINP(I),I=1,NSTA)	CSINPT	95
WRITE(6,2030) (NSTAGE(I),RT2(I),RH2(I),RT3(I),RH3(I),BET2M(I,1),	CSINPT	96
XCB2M(I),CB2MR(I),CB3MR(I),RK2M(I),RSOLM(I),SK2M(I), I=1,NSTA)	CSINPT	97
2030 FORMAT (110H STAGE RT2 RH2 RT3 RH3	CSINPT	98
X BET2M CB2M CB2MR CB3MR RK2M RSOLM,10H	CSINPT	99
XSK2M//(5X,I5,4F10.4,5F10.2,F10.4,F10.2))	CSINPT	100
WRITE (6,2120)	CSINPT	101
WRITE (6,2031) (NSTAGE(I), PR(I), ETAINP(I), I=1,NSTA)	CSINPT	102
2031 FORMAT (30H STAGE PR ETAINP//(5X,I5,2F10.4))	CSINPT	103
READ(5,1010) (PCTSPD(J),J=1,NSPE)	CSINPT	104
PCTSPD(1)=1.0	CSINPT	105
2120 FORMAT (1H0////)	CSINPT	106
READ (5,1010) (ETARAT(J),J=1,NSPE)	CSINPT	107
WRITE (6,2120)	CSINPT	108
WRITE (6,2121) (PCTSPD(J),ETARAT(J), J=1,NSPE)	CSINPT	109
2121 FORMAT (20H PCTSPD ETARAT//(2F10.4))	CSINPT	110
DO 21 I=1,NSTA	CSINPT	111
READ (5,1010) (BLEED(I,J),J=1,NSPE)	CSINPT	112
21 CONTINUE	CSINPT	113
WRITE (6,2120)	CSINPT	114
WRITE (6,2041) (NSTAGE(I),I=1,12), (PCTSPD(J), (BLEED(I,J), I=1,12	CSINPT	115
1),J=1,NSPE)	CSINPT	116
2041 FORMAT (20X,27H BLEED(STAGE,PCT SPD) TABLE//40X, 13H STAGE NUMBER/	CSINPT	117
18H PCT SPD,12(I5,3X)//(13F8.3))	CSINPT	118
DO 30 I=1,NSTA	CSINPT	119
READ (5,1011) (PHIDES(I,1,K),K=1,NPTS)	CSINPT	120
READ (5,1012) (PSIDES(I,1,K),K=1,NPTS)	CSINPT	121
READ (5,1013) (ETADES(I,1,K),K=1,NPTS)	CSINPT	122
30 CONTINUE	CSINPT	123
DO 300 I=1,NSTA	CSINPT	124
DO 301 K=1,NPTS	CSINPT	125
PHIPHI=PHIDES(I,1,K)/PHIINP(I)	CSINPT	126
ISPD=IFIX(SPEEDF*100.0)	CSINPT	127
DELPHI=DPHI(I,ISPD)	CSINPT	128
PHIPHI=PHIPHI+DELPHI	CSINPT	129
PHIDES(I,1,K)=PHIPHI*PHIINP(I)	CSINPT	130
301 CONTINUE	CSINPT	131
300 CONTINUE	CSINPT	132
1011 FORMAT(8F10.0)	CSINPT	133
1012 FORMAT(8F10.0)	CSINPT	134
1013 FORMAT(8F10.0)	CSINPT	135
DO 50 I=1,NSTA	CSINPT	136
WRITE (6,2120)	CSINPT	137
WRITE(6,2050) NSTAGE(I),((PHIDES(I,J,K),PSIDES(I	CSINPT	138
1,J,K),ETADES(I,J,K),J=1,1),K=1,NPTS)	CSINPT	139
IF(NSPE.LT.4) GO TO 50	CSINPT	140
WRITE (6,2120)	CSINPT	141
WRITE(6,2050) NSTAGE(I),((PHIDES(I,J,K),PSIDES(I	CSINPT	142
1,J,K),ETADES(I,J,K),J=4,6),K=1,NPTS)	CSINPT	143
IF(NSPE.LT.7) GO TO 50	CSINPT	144
WRITE (6,2120)	CSINPT	145
WRITE(6,2050) NSTAGE(I),((PHIDES(I,J,K),PSIDES(I	CSINPT	146
1,J,K),ETADES(I,J,K),J=7,9),K=1,NPTS)	CSINPT	147
50 CONTINUE	CSINPT	148
2050 FORMAT (20X,41H INPUT DESIGN CHARACTERISTICS FOR STAGE--,I3//	CSINPT	149
13(30H PHIDES PSIDES ETADES)/(9F1	CSINPT	150
20.4))	CSINPT	151
C *** CHANGE METRIC INPUT INTO ENGLISH UNITS	CSINPT	152
IF (UNITS.NE.1.0) GO TO 53	CSINPT	153
PO = PO/0.689476	CSINPT	154
TO = TO*9.0/5.0	CSINPT	155
DESFLD = DESFLD/0.453592	CSINPT	156
DO 51 I=1,NSTA	CSINPT	157
RT2(I) = RT2(I)/2.54	CSINPT	158

RH2(I) = RH2(I)/2.54	CSINPT	159
RT3(I) = RT3(I)/2.54	CSINPT	160
RH3(I) = RH3(I)/2.54	CSINPT	161
DO 52 J = 1, NSPE	CSINPT	162
52 BLEED(I, J) = BLEED(I, J)/0.453592	CSINPT	163
51 CONTINUE	CSINPT	164
53 RETURN	CSINPT	165
END	CSINPT	166
C ++++++	CSPREF	1
SUBROUTINE CSPREF	CSPREF	2
C *** SUBROUTINE CSPREF CALCULATES PARAMETERS AT DESIGN SPEED AND FLOW	CSPREF	3
C CONDITIONS	CSPREF	4
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	CSPREF	5
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	CSPREF	6
XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	CSPREF	7
X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	CSPREF	8
XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	CSPREF	9
XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12	CSPREF	10
X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)	CSPREF	11
X, BAT2MR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(	CSPREF	12
X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12	CSPREF	13
X,9), PHIFIX(12), DPHIF(12), CPREF(12), GF1REF(12), ETAINP(12)	CSPREF	14
X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR	CSPREF	15
X(12,9), B2MB3R(12,9), SPEEDF, FLOWIN, U3DU2R(12), U2U3(12), DB3MRG(12)	CSPREF	16
X, DB3MRN(12,9), DB3MRP(12,8), CPCO(6), CPCO(6)	CSPREF	17
*, RK3M(12), RDEV(12), RDEF(12), GMREF(12)	CSPREF	18
*, PSID1(12,2,8), PSID2(12,2,8), PSID3(12,2,8), PSID4(12,2,8)	CSPREF	19
*, PSID5(12,2,8), PSI1(12,2,8), PSI2(12,2,8), PSI3(12,2,8)	CSPREF	20
*, PSI4(12,2,8), PSI5(12,2,8)	CSPREF	21
*, PSID1L(12,2,8), PSID2L(12,2,8), PSID3L(12,2,8)	CSPREF	22
*, PSID4L(12,2,8), PSID5L(12,2,8), PSI1L(12,2,8)	CSPREF	23
*, PSI2L(12,2,8), PSI3L(12,2,8), PSI4L(12,2,8), PSI5L(12,2,8)	CSPREF	24
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	CSPREF	25
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	CSPREF	26
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPHI, SPDPHI, DRDEUG, DRDEUN, DRDEUP	CSPREF	27
X, XAR, XMET, XSTM	CSPREF	28
X, STAGEN, SPEEDN, CHAPTS, WTMOLE	CSPREF	29
J= 1	CSPREF	30
I= 1	CSPREF	31
TT(I)= TO	CSPREF	32
PT(I)= PO	CSPREF	33
20 RHOT=PT(I)/(TT(I)*RG)	CSPREF	34
TS= TT(I)	CSPREF	35
RHOS= RHOT	CSPREF	36
UT2(I)= RT2(I)*DESRPM*RPMRAD	CSPREF	37
UT3(I)= RT3(I)*DESRPM*RPMRAD	CSPREF	38
C *** CALCULATIONS AT ROTOR INLET	CSPREF	39
30 UZ2M(I, J) = DESFLO/(RHOS*AREA2(I))	CSPREF	40
V= UZ2M(I, J)/COS(BET2M(I, J))	CSPREF	41
CP=CPFM(TS)	CSPREF	42
RHOS= RHOT*(1.0-V*V/(G2J*CP*TT(I)))*GF1	CSPREF	43
TS= TT(I)*(RHOS/RHOT)*GM1	CSPREF	44
WCAL= RHOS*AREA2(I)*UZ2M(I, J)	CSPREF	45
IF((ABS(WCAL - DESFLO)/WCAL) .GT. 0.005) GO TO 30	CSPREF	46
CPREF(I) = CP	CSPREF	47
GMREF(I)=GAMMA	CSPREF	48
GF1REF(I) = GF1	CSPREF	49
PHIREF(I)= UZ2M(I, J)/UT2(I)	CSPREF	50
DO 40 K=2, NPTS	CSPREF	51
IF(PHIREF(I)-PHIDES(I, J, K)) 50, 60, 40	CSPREF	52
40 CONTINUE	CSPREF	53
K= NPTS	CSPREF	54
50 PSIREF(I)= (PSIDES(I, J, K)-PSIDES(I, J, K-1))*(PHIREF(I)-PHIDES(I, J,	CSPREF	55
1K-1))/ (PHIDES(I, J, K)-PHIDES(I, J, K-1)) + PSIDES(I, J, K-1)	CSPREF	56
ETAREF(I)= (ETADES(I, J, K)-ETADES(I, J, K-1))*(PHIREF(I)-PHIDES(I, J,	CSPREF	57
1K-1))/ (PHIDES(I, J, K)-PHIDES(I, J, K-1)) + ETADES(I, J, K-1)	CSPREF	58
GO TO 70	CSPREF	59
60 PSIREF(I)= PSIDES(I, J, K)	CSPREF	60
ETAREF(I)= ETADES(I, J, K)	CSPREF	61
70 CONTINUE	CSPREF	62

IF (PSIREF(I).EQ.0.0) GO TO 71	CSPREF	63
PR(I)= (1.0 + PSIREF(I)*UT3(I)*UT3(I)/(GJ*CP*TT(I)))*GF2	CSPREF	64
71 CONTINUE	CSPREF	65
IF(ETAREF(I).EQ.0.0) ETAREF(I)= ETAINP(I)	CSPREF	66
TR(I)= 1.0 + (PR(I)*GF3-1.0)/ETAREF(I)	CSPREF	67
TT(I+1)= TT(I)*TR(I)	CSPREF	68
IF (PSIREF(I).EQ.0.0) PSIREF(I) = GJ*CP*(TT(I+1)-TT(I))*ETAREF(I)	CSPREF	69
X/UT3(I)**2	CSPREF	70
PT(I+1)= PT(I)*PR(I)	CSPREF	71
TRO(I)= TT(I+1)/TO	CSPREF	72
PRO(I)= PT(I+1)/PO	CSPREF	73
I= I+1	CSPREF	74
IF(I .LE. NSTA) GO TO 20	CSPREF	75
DO 80 I=1,NSTA	CSPREF	76
UT2M= UZ2M(I,J)*TAN(BET2M(I,J))	CSPREF	77
UT2MR= UM2(I) - UT2M	CSPREF	78
BAT2MR(I,J)= ATAN2(UT2MR,UZ2M(I,J))	CSPREF	79
TS= TT(I+1)	CSPREF	80
RHOT= PT(I+1)/(TT(I+1)*RG)	CSPREF	81
RHOS= RHOT	CSPREF	82
C *** CALCULATIONS AT ROTOR OUTLET	CSPREF	83
81 UZ3M(I,J)= DESFLO/(RHOS*AREA3(I))	CSPREF	84
UT3M= (CP*(TT(I+1)-TT(I))*GJ + UM2(I)*UT2M)/UM3(I)	CSPREF	85
U= SQRT(UZ3M(I,J)**2 + UT3M**2)	CSPREF	86
CP=CPFM(TS)	CSPREF	87
RHOS = RHOT*(1.0-U*U/(GJ*CP*TT(I+1)))*GF1	CSPREF	88
TS = TT(I+1)*(RHOS/RHOT)**GM1	CSPREF	89
WCAL= RHOS*AREA3(I)*UZ3M(I,J)	CSPREF	90
IF((ABS(WCAL-DESFLO)/WCAL) .GT. 0.005) GO TO 81	CSPREF	91
BET3M(I,J) = ATAN2(UT3M,UZ3M(I,J))	CSPREF	92
SINCM(I) = BET3M(I,J)*RAD - SK2M(I)	CSPREF	93
UT3MR= UM3(I) - UT3M	CSPREF	94
BET3MR(I,J)= ATAN2(UT3MR,UZ3M(I,J))	CSPREF	95
RINCM(I)= BAT2MR(I,J)*RAD - RK2M(I)	CSPREF	96
U2MR= UZ2M(I,J)/COS(BAT2MR(I,J))	CSPREF	97
U3MR= UZ3M(I,J)/COS(BET3MR(I,J))	CSPREF	98
U3DU2R(I) = U3MR/U2MR	CSPREF	99
IF(I.EQ.NSTA) GO TO 82	CSPREF	100
U2M=UZ2M(I+1,J)/COS(BET2M(I+1,J))	CSPREF	101
U3M=U	CSPREF	102
U2U3(I)=U2M/U3M	CSPREF	103
82 CONTINUE	CSPREF	104
RDFM(I)= 1.0 - U3MR/U2MR + (RM3(I)*UT3M - RM2(I)*UT2M)/(RM3(I) +	CSPREF	105
XRM2(I))/RSOLM(I)/U2MR	CSPREF	106
DB2M(I,J) = BET2M(I,J)	CSPREF	107
DB2MR(I,J) = BAT2MR(I,J)	CSPREF	108
DB3M(I,J) = BET3M(I,J)	CSPREF	109
DB3MR(I,J) = BET3MR(I,J)	CSPREF	110
B2MB3R(I,J) = BAT2MR(I,J) - BET3MR(I,J)	CSPREF	111
80 CONTINUE	CSPREF	112
RETURN	CSPREF	113
END	CSPREF	114
C ++++++	CPFM	1
FUNCTION CPM(TS)	CPFM	2
C *** SUBROUTINE CPM(TS) CALCULATES SPECIFIC HEAT FROM STATIC	CPFM	3
C TEMPERATURE USING FIFTH DEGREE POLYNOMIAL	CPFM	4
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	CPFM	5
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	CPFM	6
XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	CPFM	7
X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	CPFM	8
XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	CPFM	9
XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)	CPFM	10
X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)	CPFM	11
X, BAT2MR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(	CPFM	12
X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12	CPFM	13
X,9), PHIFIX(12), DPHIF(12), CPREF(12), GF1REF(12), ETAINP(12)	CPFM	14
X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR	CPFM	15
X(12,9), B2MB3R(12,9), SPEEDF, FLOWIN, U3DU2R(12), U2U3(12), DB3MRG(12)	CPFM	16
X, DB3MRN(12,9), DB3MRP(12,8), CPCM(6), CPCS(6)	CPFM	17
*, RK3M(12), RDEU(12), RDEF(12), GMREF(12)	CPFM	18

```

*,PSID1(12,2,8),PSID2(12,2,8),PSID3(12,2,8),PSID4(12,2,8)
*,PSID5(12,2,8),PSI1(12,2,8),PSI2(12,2,8),PSI3(12,2,8)
*,PSI4(12,2,8),PSI5(12,2,8)
*,PSID1L(12,2,8),PSID2L(12,2,8),PSID3L(12,2,8)
*,PSID4L(12,2,8),PSID5L(12,2,8),PSI1L(12,2,8)
*,PSI2L(12,2,8),PSI3L(12,2,8),PSI4L(12,2,8),PSI5L(12,2,8)
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEUG, DRDEUN, DRDEUP
X, XAR, XMET, XSTM
X, STAGEN, SPEEDN, CHAPTS, WTMOLE
TS=TS/1.8
CPA=(CPCO(1)+(CPCO(2)*TS)+(CPCO(3)*TS*TS)+(CPCO(4)*TS*TS*TS)+(CPCO
*(5)*TS*TS*TS*TS))*267.056
CPS=(CPCS(1)+(CPCS(2)*TS)+(CPCS(3)*TS*TS)+(CPCS(4)*TS*TS*TS)+(CPCS
*(5)*TS*TS*TS*TS))*461.495
CPM=(CPCM(1)+(CPCM(2)*TS)+(CPCM(3)*TS*TS)+(CPCM(4)*TS*TS*TS)+(CPCM
*(5)*TS*TS*TS*TS))*518.251
CPFM=((CPA*XAR)+(CPS*XSTM)+(CPM*XMET))/4177.8
TS=TS*1.8
GAMMA=CPFM/(CPFM-DCP)
GM1 = GAMMA - 1.0
GF1 = 1.0/GM1
GF2 = GAMMA/GM1
GF3 = 1.0/GF2
RETURN
END
C *****
SUBROUTINE CSETA
C *** SUBROUTINE CSETA GENERATES ADIABATIC EFFICIENCY VERSUS FLOW
C COEFFICIENT
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),
XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9
X,8), DPHIA(12), DPSIA(12), DELTA(12), NSTAGE(12), PCTSPD(9),
XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),
XTRO(12), ETAD(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)
X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)
X, BAT2MR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(
X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12
X,9), PHIFIX(12), DPHIF(12), CFREF(12), GF1REF(12), ETAINP(12)
X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR
X(12,9), B2MB3R(12,9), SPEEDF, FLOWIN, U3DU2R(12), U2U3(12), DB3MRG(12)
X, DB3MRN(12,9), DB3MRP(12,8), CPCM(6), CPCS(6)
*,RK3M(12), RDEU(12), RDEF(12), GMREF(12)
*,PSID1(12,2,8),PSID2(12,2,8),PSID3(12,2,8),PSID4(12,2,8)
*,PSID5(12,2,8),PSI1(12,2,8),PSI2(12,2,8),PSI3(12,2,8)
*,PSI4(12,2,8),PSI5(12,2,8)
*,PSID1L(12,2,8),PSID2L(12,2,8),PSID3L(12,2,8)
*,PSID4L(12,2,8),PSID5L(12,2,8),PSI1L(12,2,8)
*,PSI2L(12,2,8),PSI3L(12,2,8),PSI4L(12,2,8),PSI5L(12,2,8)
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEUG, DRDEUN, DRDEUP
X, XAR, XMET, XSTM
X, STAGEN, SPEEDN, CHAPTS, WTMOLE
J = 1
C *** TWO PARABOLAS ARE USED FROM STALL AND CHOKE TO DESIGN CONDITIONS
DO 10 I=1,NSTA
RAM=0.76
PSMPRS=(PHIDES(I,J,1)-PHIREF(I))*2
PCMPRS=(PHIDES(I,J,NPTS)-PHIREF(I))*2
AS=-0.09*ETAREF(I)/PSMPRS
AC=-0.20*ETAREF(I)/PCMPRS
BS=-2.0*PHIREF(I)*AS
BC=-2.0*PHIREF(I)*AC
CS=ETAREF(I)+AS*PHIREF(I)**2
CC=ETAREF(I)+AC*PHIREF(I)**2
DO 20 K=1,NPTS
IF(PHIDES(I,J,K)-PHIREF(I)) 11,12,13

```


11	ETADES(I,J,K) = (AS*PHIDES(I,J,K) + BS)*PHIDES(I,J,K) + CS	CSETA	44
	GO TO 20	CSETA	45
12	ETADES(I,J,K)= ETAREF(I)	CSETA	46
	GO TO 20	CSETA	47
13	ETADES(I,J,K)=(AC*PHIDES(I,J,K)+BC)*PHIDES(I,J,K)+CC+((((PHIDES(I, XJ,K)-PHIREF(I))*3.0)/(PHIDES(I,J,NPTS)-PHIREF(I))*3.0))*20*RAM	CSETA	48
	X*ETAREF(I))	CSETA	49
20	CONTINUE	CSETA	50
10	CONTINUE	CSETA	51
	RETURN	CSETA	52
	END	CSETA	53
C	*****	CSETA	54
	SUBROUTINE CPSPI(XWN,LORS)	CSPSI	1
C	*** SUBROUTINE CPSPI CALCULATES PRESSURE COEFFICIENTS FOR INPUT FLOW	CSPSI	2
C	COEFFICIENTS	CSPSI	3
	COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	CSPSI	4
	XRM3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	CSPSI	5
	XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	CSPSI	6
	X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	CSPSI	7
	XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	CSPSI	8
	XTRD(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)	CSPSI	9
	X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)	CSPSI	10
	X, BATEMR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(	CSPSI	11
	X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12	CSPSI	12
	X,9), PHIFIX(12), DPHIF(12), CPREF(12), GF1REF(12), ETAINP(12)	CSPSI	13
	X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR	CSPSI	14
	X(12,9), DB3MR(12,9), SPEEDF, FLOWIN, U3DU2R(12), U2U3(12), DB3MRG(12)	CSPSI	15
	X, DB3MRN(12,9), DB3MRP(12,8), CPCM(6), CPCS(6)	CSPSI	16
	*, RK3M(12), RDEV(12), RDEF(12), GMREF(12)	CSPSI	17
	*, PSID1(12,2,8), PSID2(12,2,8), PSID3(12,2,8), PSID4(12,2,8)	CSPSI	18
	*, PSID5(12,2,8), PSI1(12,2,8), PSI2(12,2,8), PSI3(12,2,8)	CSPSI	19
	*, PSI4(12,2,8), PSI5(12,2,8)	CSPSI	20
	*, PSID1L(12,2,8), PSID2L(12,2,8), PSID3L(12,2,8)	CSPSI	21
	*, PSID4L(12,2,8), PSID5L(12,2,8), PSI1L(12,2,8)	CSPSI	22
	*, PSI2L(12,2,8), PSI3L(12,2,8), PSI4L(12,2,8), PSI5L(12,2,8)	CSPSI	23
	COMMON /SCALAR/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	CSPSI	24
	X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	CSPSI	25
	X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEVN, DRDEVP	CSPSI	26
	X, XAR, XMET, XSTM	CSPSI	27
	X, STAGEN, SPEEDN, CHAPTS, WTMOLE	CSPSI	28
	J=1	CSPSI	29
	DO 100 K=1, NPTS	CSPSI	30
	I=1	CSPSI	31
	TT(I) = TO	CSPSI	32
	PT(I) = PO	CSPSI	33
	UZ2=UZ2M(I,J)*PHIDES(I,J,K)/PHIREF(I)	CSPSI	34
	UT2=UZ2*TAN(DB2M(I,1))	CSPSI	35
	UT2R=UM2(I)-UT2	CSPSI	36
	B2MR=ATAN2(UT2R, UZ2)	CSPSI	37
	B2M=DB2M(I,1)	CSPSI	38
10	UZ3M(I,J) = UZ2M(I,J)*PHIDES(I,J,K)/PHIREF(I)	CSPSI	39
	U2MR = UZ3M(I,J)/COS(B2MR)	CSPSI	40
	BET3MR(I,J) = DB3MR(I,1)	CSPSI	41
	UT2M = UZ3M(I,J)*TAN(B2M)	CSPSI	42
	U2S = UT2M**2 + UZ3M(I,J)**2	CSPSI	43
	RHOT = PT(I)/(TT(I)*RG)	CSPSI	44
	RHOS = RHOT*(1.0 - U2S/(G2J*CPREF(I)*TT(I)))*GF1REF(I)	CSPSI	45
	DESFLC = RHOS*AREA2(I)*UZ3M(I,J)	CSPSI	46
	TS = TT(I)	CSPSI	47
	ID = 0	CSPSI	48
11	UT3M = UM3(I) - UZ3M(I,J)*TAN(BET3MR(I,J))	CSPSI	49
	CP=CPFM(TS)	CSPSI	50
	DT = (UM3(I)*UT3M - UM2(I)*UT2M)/(GJ*CP)	CSPSI	51
	TRA = (DT + TT(I))/TT(I)	CSPSI	52
	PTA3 = PT(I)*(1.0 + ETADES(I,J,K)*(TRA - 1.0))*GF2	CSPSI	53
	TTA3 = DT + TT(I)	CSPSI	54
	RHOT = PTA3/(TTA3*RG)	CSPSI	55
	U3S = UT3M**2 + UZ3M(I,J)**2	CSPSI	56
	USM=SQRT(U3S)	CSPSI	57
	RHOS = RHOT*(1.0 - U3S/(G2J*CP*TTA3))*GF1	CSPSI	58
		CSPSI	59

TS = TTA3*(RHOS/RHOT)**GM1	CSPSI	60
WCAL = RHOS*AREA3(I)*VZ3M(I,J)	CSPSI	61
IF (TRA.GE.1.0) GO TO 12	CSPSI	62
DT = 0.0	CSPSI	63
GO TO 13	CSPSI	64
12 ID = ID + 1	CSPSI	65
VZ3M(I,J) = DESFLC/(RHOS*AREA3(I))	CSPSI	66
V3MR = VZ3M(I,J)/COS(BET3MR(I,J))	CSPSI	67
C *** OPTION TO ALTER ROTOR DEVIATION ANGLE FOR OFF DESIGN FLOW	CSPSI	68
C COEFICIENT	CSPSI	69
IF(LORS.EQ.1) CALL CSDEV(SPEEDF,XWN,U3MR,U2MR,U3DU2R(I),I,FK)	CSPSI	70
IF(LORS.EQ.2) CALL CSDEVL(SPEEDF,XWN,U3MR,U2MR,U3DU2R(I),I,FK)	CSPSI	71
IF (DRDEUP.EQ.1.0)	CSPSI	72
XDB3MRP(I,K)=- (FK/RAD)*(U3MR/U2MR-U3DU2R(I))	CSPSI	73
BET3MR(I,J) = DB3MR(I,1) + DB3MRP(I,K)	CSPSI	74
IF ((ABS(WCAL-DESFLC)/WCAL).GT.0.005) GO TO 11	CSPSI	75
DUMMY=ETADES(I,J,K)	CSPSI	76
IF(LORS.EQ.1)	CSPSI	77
\$CALL CSETA1 (I,J,K,XWN,PHIDES(I,J,K),PHIREF(I),DUMMY)	CSPSI	78
IF(LORS.EQ.2) CALL CSETAL(I,J,K,XWN,PHIREF(I),PHIDES(I,J,K),	CSPSI	79
\$DUMMY,ETAREF(I))	CSPSI	80
13 PSIDES(I,J,K) = GJ*CP*DT*DUMMY/UT3(I)**2	CSPSI	81
DU3DU2 = U3DU2R(I)	CSPSI	82
FU3DU2 = U3MR/U2MR	CSPSI	83
IF(I.EQ.NSTA) GO TO 100	CSPSI	84
B2M=DB2M(I+1,1)	CSPSI	85
303 UZ2=UZ3M(I,J)	CSPSI	86
301 U2M=UZ2/COS(B2M)	CSPSI	87
U2MS=U2M**2	CSPSI	88
RHOT=PTA3/(TTA3*RG)	CSPSI	89
RHOS=RHOT*(1.0-U2MS/(C2J*CPREF(I+1)*TTA3))**GF1REF(I+1)	CSPSI	90
UZ2C=DESFLC/(RHOS*AREA2(I+1))	CSPSI	91
IF ((ABS(UZ2-UZ2C)/UZ2).LT.0.005) GO TO 300	CSPSI	92
UZ2=(UZ2+UZ2C)/2.0	CSPSI	93
GO TO 301	CSPSI	94
300 IF(LORS.EQ.1) CALL CSDEUS(XWN,U2M,U3M,U2U3(I),I,FK)	CSPSI	95
IF(LORS.EQ.2) CALL CDEVSL(XWN,U2M,U3M,U2U3(I),I,FK)	CSPSI	96
DEVIS=- (FK/RAD)*(U2M/U3M-U2U3(I))	CSPSI	97
B2MC=DB2M(I+1,1)+DEVIS	CSPSI	98
IF ((ABS(B2M-B2MC)/B2M).LT.0.005) GO TO 302	CSPSI	99
B2M=(B2M+B2MC)/2.0	CSPSI	100
GO TO 303	CSPSI	101
302 UT2R=UM2(I+1)-UZ2*TAN(B2M)	CSPSI	102
B2MR=ATAN2(UT2R,UZ2M)	CSPSI	103
I=I+1	CSPSI	104
IF(I.LE.NSTA) GO TO 10	CSPSI	105
100 CONTINUE	CSPSI	106
RETURN	CSPSI	107
END	CSPSI	108
SUBROUTINE CSDEUS(XW,U2M,U3M,U2U3S,I,FK)	CSDEUS	1
T1=U2M/U3M-U2U3S	CSDEUS	2
FK=26.0+0.12/T1	CSDEUS	3
RETURN	CSDEUS	4
END	CSDEUS	5
SUBROUTINE CDEVSL(XW,U2M,U3M,U2U3S,I,FK)	CDEVSL	1
T1=U2M/U3M-U2U3S	CDEVSL	2
FK=26.0+0.12/T1	CDEVSL	3
RETURN	CDEVSL	4
END	CDEVSL	5
SUBROUTINE CSDEV(SPEEDF,XW,U3MR,U2MR,U3DU2,I,FK)	CSDEV	1
T1=U3MR/U2MR-U3DU2	CSDEV	2
IF(I.EQ.1.AND.T1.LT.0.0) GO TO 200	CSDEV	3
IF(I.EQ.2.AND.T1.LT.0.0) GO TO 201	CSDEV	4
IF(I.GE.3.AND.T1.LT.0.0) GO TO 202	CSDEV	5
IF(T1.GT.0.0) GO TO 203	CSDEV	6
200 A1=-3.15	CSDEV	7
B1=-0.21	CSDEV	8
AFO=30.0	CSDEV	9
IF(T1.LT.-0.05) T1=-0.05	CSDEV	10
GO TO 204	CSDEV	11

201	A1=-3.70	CSDEV	12
	B1=-0.11	CSDEV	13
	AFO=25.0	CSDEV	14
	IF(T1.LT.-0.05) T1=-0.05	CSDEV	15
	GO TO 204	CSDEV	16
202	A1=-3.73	CSDEV	17
	B1=-0.13	CSDEV	18
	AFO=30.0	CSDEV	19
	IF(T1.LT.-0.05) T1=-0.05	CSDEV	20
	GO TO 204	CSDEV	21
203	A1=1.80	CSDEV	22
	B1=0.23	CSDEV	23
	AFO=-10.0	CSDEV	24
	IF(T1.GT.0.05) T1=0.05	CSDEV	25
204	T2=A1*XW+B1	CSDEV	26
	FK=T2/T1+AFO	CSDEV	27
	DK=0.0	CSDEV	28
	IF (T1.GT.0.0) GO TO 205	CSDEV	29
	ISPD=IFIX(SPEEDF*100.0)	CSDEV	30
	IF (ISPD.EQ.70.OR.ISPD.EQ.69) DK=DELK70(I,T1)	CSDEV	31
	IF (ISPD.EQ.80.OR.ISPD.EQ.79) DK=DELK80(I,T1)	CSDEV	32
	IF (ISPD.EQ.90.OR.ISPD.EQ.89) DK=0.0	CSDEV	33
	IF (ISPD.EQ.100.OR.ISPD.EQ.99) DK=DELK10(I,T1)	CSDEV	34
205	FK = FK-DK	CSDEV	35
	RETURN	CSDEV	36
	END	CSDEV	37
	SUBROUTINE CSDEVL(SPEEDF,XW,U3MR,U2MR,U3DU2,I,FK)	CSDEVL	1
	T1=U3MR/U2MR-U3DU2	CSDEVL	2
	IF(I.EQ.1.AND.T1.LT.0.0) GO TO 200	CSDEVL	3
	IF(I.EQ.2.AND.T1.LT.0.0) GO TO 201	CSDEVL	4
	IF(I.GE.3.AND.T1.LT.0.0) GO TO 202	CSDEVL	5
	IF(T1.GT.0.0) GO TO 203	CSDEVL	6
200	A1=-3.15	CSDEVL	7
	B1=-0.21	CSDEVL	8
	AFO=30.0	CSDEVL	9
	IF(T1.LT.-0.05) T1=-0.05	CSDEVL	10
	GO TO 204	CSDEVL	11
201	A1=-3.70	CSDEVL	12
	B1=-0.11	CSDEVL	13
	AFO=25.0	CSDEVL	14
	IF(T1.LT.-0.05) T1=-0.05	CSDEVL	15
	GO TO 204	CSDEVL	16
202	A1=-3.73	CSDEVL	17
	B1=-0.13	CSDEVL	18
	AFO=30.0	CSDEVL	19
	IF(T1.LT.-0.05) T1=-0.05	CSDEVL	20
	GO TO 204	CSDEVL	21
203	A1=1.80	CSDEVL	22
	B1=0.23	CSDEVL	23
	AFO=-10.0	CSDEVL	24
	IF(T1.GT.0.05) T1=0.05	CSDEVL	25
204	T2=A1*XW+B1	CSDEVL	26
	FK=T2/T1+AFO	CSDEVL	27
	DK = 0.0	CSDEVL	28
	IF (T1.GT.0.0) GO TO 205	CSDEVL	29
	ISPD = IFIX(SPEEDF*100.0)	CSDEVL	30
	IF (ISPD.EQ.70.OR.ISPD.EQ.69) DK = DELK70(I,T1)	CSDEVL	31
	IF (ISPD.EQ.80.OR.ISPD.EQ.79) DK = DELK80(I,T1)	CSDEVL	32
	IF (ISPD.EQ.90.OR.ISPD.EQ.89) DK = 0.0	CSDEVL	33
	IF (ISPD.EQ.100.OR.ISPD.EQ.99) DK = DELK10(I,T1)	CSDEVL	34
205	FK = FK - DK	CSDEVL	35
	RETURN	CSDEVL	36
	END	CSDEVL	37
	FUNCTION DELK70(I,T1)	DELK70	1
	IF (I.EQ.1) GO TO 1	DELK70	2
	IF (I.EQ.2) GO TO 2	DELK70	3
	IF (I.EQ.3) GO TO 3	DELK70	4
	IF (I.EQ.4) GO TO 4	DELK70	5
	IF (I.EQ.5) GO TO 5	DELK70	6
	IF (I.EQ.6) GO TO 6	DELK70	7

1	A = -140625.0	DELK70	8
	B = -262500.0	DELK70	9
	C = -12219.0	DELK70	10
	D = 311.0	DELK70	11
	E = 39.0	DELK70	12
	GO TO 100	DELK70	13
2	A = -312500.0	DELK70	14
	B = -35417.0	DELK70	15
	C = 1875.0	DELK70	16
	D = 399.0	DELK70	17
	E = 24.0	DELK70	18
	GO TO 100	DELK70	19
3	A = -2369792.0	DELK70	20
	B = -439583.0	DELK70	21
	C = -21568.0	DELK70	22
	D = 199.0	DELK70	23
	E = 36.0	DELK70	24
	GO TO 100	DELK70	25
4	A = -1953125.0	DELK70	26
	B = -377083.0	DELK70	27
	C = -20109.0	DELK70	28
	D = 93.0	DELK70	29
	E = 33.0	DELK70	30
	GO TO 100	DELK70	31
5	A = -1953125.0	DELK70	32
	B = -377083.0	DELK70	33
	C = -20109.0	DELK70	34
	D = 93.0	DELK70	35
	E = 33.0	DELK70	36
	GO TO 100	DELK70	37
6	A = -1953125.0	DELK70	38
	B = -377083.0	DELK70	39
	C = -20109.0	DELK70	40
	D = 93.0	DELK70	41
	E = 33.0	DELK70	42
100	DELK70=A*T1**4+B*T1**3+C*T1**2+D*T1+E	DELK70	43
	RETURN	DELK70	44
	END	DELK70	45
	FUNCTION DELK80(I,T1)	DELK80	1
	IF (I.EQ.1) GO TO 1	DELK80	2
	IF (I.EQ.2) GO TO 2	DELK80	3
	IF (I.EQ.3) GO TO 3	DELK80	4
	IF (I.EQ.4) GO TO 4	DELK80	5
	IF (I.EQ.5) GO TO 5	DELK80	6
	IF (I.EQ.6) GO TO 6	DELK80	7
1	A = -1093750.0	DELK80	8
	B = -227083.0	DELK80	9
	C = -14094.0	DELK80	10
	D = -87.0	DELK80	11
	E = 19.0	DELK80	12
	GO TO 100	DELK80	13
2	A = -546875.0	DELK80	14
	B = -95833.0	DELK80	15
	C = -3703.0	DELK80	16
	D = 150.0	DELK80	17
	E = 15.0	DELK80	18
	GO TO 100	DELK80	19
3	A = -859375.0	DELK80	20
	B = -152083.0	DELK80	21
	C = -6328.0	DELK80	22
	D = 200.0	DELK80	23
	E = 19.0	DELK80	24
	GO TO 100	DELK80	25
4	A = -520833.0	DELK80	26
	B = -83333.0	DELK80	27
	C = -1229.0	DELK80	28
	D = 393.0	DELK80	29
	E = 23.0	DELK80	30
	GO TO 100	DELK80	31
5	A = 572917.0	DELK80	32

```

B = 183333.0
C = 22052.0
D = 1217.0
E = 33.0
GO TO 100
6 A = 1953124.0
  B = 504167.0
  C = 47047.0
  D = 1920.0
  E = 38.0

100 DELK80=A*T1**4+B*T1**3+C*T1**2+D*T1+E
    RETURN
    END
    FUNCTION DELK10(I,T1)
    IF (I.EQ.1) GO TO 1
    IF (I.EQ.2) GO TO 2
    IF (I.EQ.3) GO TO 3
    IF (I.EQ.4) GO TO 4
    IF (I.EQ.5) GO TO 5
    IF (I.EQ.6) GO TO 6
  1 A = -755208.0
    B = -189583.0
    C = -19932.0
    D = -1161.0
    E = -38.0
    GO TO 100
  2 A = - 234375.0
    B = -66667.0
    C = -7891.0
    D = -528.0
    E = -20.0
    GO TO 100
  3 A = -1927083.0
    B = - 487500.0
    C = -44948.0
    D = -1921.0
    E = -42.0
    GO TO 100
  4 A = -1510417.0
    B = -350000.0
    C = -30865.0
    D = -1390.0
    E = -36.0
    GO TO 100
  5 A = -4479167.0
    B = -1050000.0
    C = -89396.0
    D = -3420.0
    E = -60.0
    GO TO 100
  6 A = -1562500.0
    B = -393750.0
    C = -38375.0
    D = -1826.0
    E = -42.0

100 DELK10=A*T1**4+B*T1**3+C*T1**2+D*T1+E
    RETURN
    END
    FUNCTION DPHI(I,ISPD)
    IF (I.EQ.1) GO TO 1
    IF (I.EQ.2) GO TO 2
    IF (I.GE.3) GO TO 3
  1 IF (ISPD.EQ.70.OR.ISPD.EQ.69) DPHI=-0.0357
    IF (ISPD.EQ.80.OR.ISPD.EQ.79) DPHI=-0.0357
    IF (ISPD.EQ.90.OR.ISPD.EQ.89) DPHI=0.0
    IF (ISPD.EQ.100.OR.ISPD.EQ.99) DPHI=0.0357
    GO TO 100
  2 IF (ISPD.EQ.70.OR.ISPD.EQ.69) DPHI = -0.0286

```

```

DELK80 33
DELK80 34
DELK80 35
DELK80 36
DELK80 37
DELK80 38
DELK80 39
DELK80 40
DELK80 41
DELK80 42
DELK80 43
DELK80 44
DELK80 45
DELK80 46
DELK10 1
DELK10 2
DELK10 3
DELK10 4
DELK10 5
DELK10 6
DELK10 7
DELK10 8
DELK10 9
DELK10 10
DELK10 11
DELK10 12
DELK10 13
DELK10 14
DELK10 15
DELK10 16
DELK10 17
DELK10 18
DELK10 19
DELK10 20
DELK10 21
DELK10 22
DELK10 23
DELK10 24
DELK10 25
DELK10 26
DELK10 27
DELK10 28
DELK10 29
DELK10 30
DELK10 31
DELK10 32
DELK10 33
DELK10 34
DELK10 35
DELK10 36
DELK10 37
DELK10 38
DELK10 39
DELK10 40
DELK10 41
DELK10 42
DELK10 43
DELK10 44
DELK10 45
DELK10 46
DPHI 1
DPHI 2
DPHI 3
DPHI 4
DPHI 5
DPHI 6
DPHI 7
DPHI 8
DPHI 9
DPHI 10

```

IF (ISPD.EQ.80.OR.ISPD.EQ.79) DPHI = -0.0286	DPHI	11
IF (ISPD.EQ.90.OR.ISPD.EQ.89) DPHI = 0.0	DPHI	12
IF (ISPD.EQ.100.OR.ISPD.EQ.99) DPHI = 0.0286	DPHI	13
GO TO 100	DPHI	14
3 IF (ISPD.EQ.70.OR.ISPD.EQ.69) DPHI = -0.0333	DPHI	15
IF (ISPD.EQ.80.OR.ISPD.EQ.79) DPHI = -0.0333	DPHI	16
IF (ISPD.EQ.90.OR.ISPD.EQ.89) DPHI = 0.0	DPHI	17
IF (ISPD.EQ.100.OR.ISPD.EQ.99) DPHI = 0.0333	DPHI	18
100 RETURN	DPHI	19
END	DPHI	20
SUBROUTINE CSETA1(I,J,K,XW,PHID,PHIR,ETAD)	CSETAD	1
IF(I.EQ.1.AND.XW.LT.0.04) Y=0.4575*XW	CSETAD	2
IF(I.EQ.1.AND.XW.GE.0.04) Y=0.12*XW+0.0135	CSETAD	3
T3=PHID-PHIR	CSETAD	4
IF(I.EQ.1) GO TO 304	CSETAD	5
IF(I.EQ.2.AND.T3.LT.-0.08) GO TO 300	CSETAD	6
IF(I.EQ.2.AND.T3.GE.-0.08) GO TO 301	CSETAD	7
IF(I.GE.3) GO TO 302	CSETAD	8
300 A=0.0	CSETAD	9
B=0.50*XW	CSETAD	10
IF(XW.GT.0.04) A=-0.982*XW+0.0393	CSETAD	11
IF(XW.GT.0.04) B=0.02	CSETAD	12
GO TO 303	CSETAD	13
301 A=3.125*XW	CSETAD	14
B=0.7375*XW	CSETAD	15
IF(XW.GT.0.04) A=0.125	CSETAD	16
IF(XW.GT.0.04) B=0.09*XW+0.026	CSETAD	17
GO TO 303	CSETAD	18
302 A=5.0*XW	CSETAD	19
B=0.625*XW	CSETAD	20
IF(XW.GT.0.04) A=0.80*XW+0.168	CSETAD	21
IF(XW.GT.0.04) B=0.1455*XW+0.0192	CSETAD	22
IF(T3.LT.-0.004) T3=-0.04	CSETAD	23
303 Y=A*T3+B	CSETAD	24
304 ETAD=ETAD-Y	CSETAD	25
RETURN	CSETAD	26
END	CSETAD	27
SUBROUTINE CSETAL(I,J,K,XW,PHID,PHIR,ETAD,ETADD)	CSETAL	1
T=PHIR/PHID	CSETAL	2
IF(I.EQ.1.OR.I.EQ.2) GO TO 10	CSETAL	3
IF(I.EQ.3) GO TO 20	CSETAL	4
GO TO 30	CSETAL	5
10 IF(T.LT.0.88.AND.XW.LT.0.44) Y=1.25*XW	CSETAL	6
IF(T.LT.0.88.AND.XW.GE.0.04) Y=0.4364*XW+0.032544	CSETAL	7
IF(T.GE.0.88.AND.XW.LT.0.04) Y=-27.0*(T-0.934)**2+1.1392*XW+0.0787	CSETAL	8
IF(T.GE.0.88.AND.XW.GE.0.04) Y=-27.0*(T-0.934)**2+0.5067*XW+0.1040	CSETAL	9
GO TO 40	CSETAL	10
20 IF(T.LT.0.87.AND.XW.LT.0.04) Y=1.050*XW	CSETAL	11
IF(T.LT.0.87.AND.XW.GE.0.04) Y=0.2333*XW+0.033	CSETAL	12
IF(T.GE.0.87.AND.XW.LT.0.04) Y=-11.90*(T-0.940)**2+1.0158*XW+0.058	CSETAL	13
\$3	CSETAL	14
IF(T.GE.0.87.AND.XW.GE.0.04) Y=-11.9*(T-0.94)**2+0.2733*XW+0.0880	CSETAL	15
GO TO 40	CSETAL	16
30 IF(T.LT.0.92.AND.XW.LT.0.04) Y=0.450*XW	CSETAL	17
IF(T.LT.0.92.AND.XW.GE.0.04) Y=0.09867*XW+0.0142	CSETAL	18
IF(T.GE.0.92.AND.XW.LT.0.04) Y=3.215*XW*T-2.5075*XW	CSETAL	19
IF(T.GE.0.92.AND.XW.GE.0.04) Y=(0.440*XW+0.1110)*T-0.3325*XW-	CSETAL	20
\$0.0870	CSETAL	21
40 IF(XW.LT.0.000000001) Y=0.0	CSETAL	22
ETAD=ETAD-Y*ETADD	CSETAL	23
RETURN	CSETAL	24
END	CSETAL	25
C+++++	CSPSD	1
SUBROUTINE CSPSD	CSPSD	2
C *** SUBROUTINE CSPSD ALTERS PRESSURE RISE COEFICIENTS FOR OFF DESIGN	CSPSD	3
C SPEEDS	CSPSD	4
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	CSPSD	5
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	CSPSD	6
XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	CSPSD	7

X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	CSPSD	8
XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	CSPSD	9
XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)	CSPSD	10
X, AREA3(12), RM2(12), RM3(12), UT2(12), UT3(12), UM2(12), UM3(12)	CSPSD	11
X, BAT2MR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(	CSPSD	12
X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12	CSPSD	13
X,9), PHIFIX(12), DPHIF(12), CPREF(12), GF1REF(12), ETAINP(12)	CSPSD	14
X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR	CSPSD	15
X(12,9), B2MB3R(12,9), SPEEDF, FLOWIN, U3DU2R(12), U2U3(12), DB3MRG(12)	CSPSD	16
X, DB3MRN(12,9), DB3MRP(12,8), CPCM(6), CPC6(6)	CSPSD	17
* , RK3M(12), RDEV(12), RDEF(12), GMREF(12)	CSPSD	18
* , PSID1(12,2,8), PSID2(12,2,8), PSID3(12,2,8), PSID4(12,2,8)	CSPSD	19
* , PSID5(12,2,8), PSI1(12,2,8), PSI2(12,2,8), PSI3(12,2,8)	CSPSD	20
* , PSI4(12,2,8), PSI5(12,2,8)	CSPSD	21
* , PSID1L(12,2,8), PSID2L(12,2,8), PSID3L(12,2,8)	CSPSD	22
* , PSID4L(12,2,8), PSID5L(12,2,8), PSI1L(12,2,8)	CSPSD	23
* , PSI2L(12,2,8), PSI3L(12,2,8), PSI4L(12,2,8), PSI5L(12,2,8)	CSPSD	24
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	CSPSD	25
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	CSPSD	26
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEUG, DRDEVN, DRDEVP	CSPSD	27
X, XAR, XMET, XSTM	CSPSD	28
X, STAGEN, SPEEDN, CHAPTS, WTMOLE	CSPSD	29
DO 100 J=1, NSPE	CSPSD	30
I = 1	CSPSD	31
TT(I) = TO	CSPSD	32
PT(I) = PO	CSPSD	33
10 UZ3M(I,J) = UZ2M(I,1)*SPEEDF	CSPSD	34
U2MR = UZ3M(I,J)/COS(DB2MR(I,1))	CSPSD	35
BET3MR(I,J) = DB3MR(I,1)	CSPSD	36
ID = 0	CSPSD	37
UT2M = UZ2M(I,1)*SPEEDF* TAN(DB2M(I,1))	CSPSD	38
U2S = UT2M**2 + UZ3M(I,J)**2	CSPSD	39
RHOT = PT(I)/(TT(I)*RG)	CSPSD	40
RHOS = RHOT*(1.0 - U2S/(G2J*CPREF(I)*TT(I)))**GF1REF(I)	CSPSD	41
DESFLO = RHOS*AREA2(I)*UZ3M(I,J)	CSPSD	42
TS = TT(I)	CSPSD	43
11 UT3M = UM3(I)*SPEEDF - UZ3M(I,J)*TAN(BET3MR(I,J))	CSPSD	44
CP=CPFM(TS)	CSPSD	45
DT = (UM3(I)*UT3M - UM2(I)*UT2M)/(GJ*CP)*SPEEDF	CSPSD	46
TRA = (DT + TT(I))/TT(I)	CSPSD	47
PTA3 = PT(I)*(1.0 + ETAREF(I)*(TRA - 1.0))**GF2	CSPSD	48
TTA3 = DT + TT(I)	CSPSD	49
RHOT = PTA3/(TTA3*RG)	CSPSD	50
U3S = UT3M**2 + UZ3M(I,J)**2	CSPSD	51
RHOS = RHOT*(1.0 - U3S/(G2J*CP*TTA3))**GF1	CSPSD	52
TS = TTA3*(RHOS/RHOT)**GM1	CSPSD	53
WCAL = RHOS*AREA3(I)*UZ3M(I,J)	CSPSD	54
IF (I.NE.1) GO TO 12	CSPSD	55
DUZ3M = UZ3M(I,J)	CSPSD	56
12 CONTINUE	CSPSD	57
ID = ID + 1	CSPSD	58
UZ3M(I,J)=DESFLO/(RHOS*AREA3(I))	CSPSD	59
U3MR=UZ3M(I,J)/COS(BET3MR(I,J))	CSPSD	60
IF(DRDEVN.EQ.1.0)	CSPSD	61
XDB3MRN(I,J) = -(10.00/RAD)*(U3MR/U2MR - U3DU2R(I))	CSPSD	62
BET3MR(I,J) = DB3MR(I,1) + DB3MRN(I,J)	CSPSD	63
IF ((ABS(WCAL-DESFLO)/WCAL).GT.0.005) GO TO 11	CSPSD	64
DPSIS(I,J) = GJ*CP*DT*ETAREF(I)/(UT3I)*SPEEDF**2 - PSIREF(I)	CSPSD	65
DPSIS(I,J) = DPSIS(I,J) - DPSIS(I,1)	CSPSD	66
I = I + 1	CSPSD	67
IF (I.LE.NSTA) GO TO 10	CSPSD	68
100 CONTINUE	CSPSD	69
RETURN	CSPSD	70
END	CSPSD	71
C+++++	CSPAN	1
SUBROUTINE CSPAN	CSPAN	2
C *** SUBROUTINE CSPAN ALTERS FLOW AND PRESSURE RISE COEFICIENTS FOR	CSPAN	3
C BLADE RESET	CSPAN	4
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	CSPAN	5
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	CSPAN	6

XPSIDES(12,9,8),	ETADES(12,9,8),	PHI(12,9,8),	PSI(12,9,8),	ETA(12,9	CSPAN	7		
X,8),	DPHIA(12),	DPSIA(12),	DETA(12),	NSTAGE(12),	PCTSPD(9),	CSPAN	8	
XBET2M(12,9),	BLEED(12,9),	TT(13),	PT(13),	PR(12),	TR(12),	PRO(12),	CSPAN	9
XTRO(12),	ETAO(12),	BET3MR(12,9),	UZ2M(12,9),	UZ3M(12,9),	AREA2(12)		CSPAN	10
X, AREA3(12),	RM2(12),	RM3(12),	UT2(12),	UT3(12),	UM2(12),	UM3(12)	CSPAN	11
X, BAT2MR(12,9),	DPSIS(12,9),	RSOLM(12),	RK2M(12),	CB2M(12),	CB2MR(		CSPAN	12
X12),	CB3MR(12),	RINCM(12),	RDFM(12),	SK2M(12),	SINCM(12),	BET3M(12	CSPAN	13
X,9),	PHIFIX(12),	DPHIF(12),	CPREF(12),	GF1REF(12),	ETAINP(12)		CSPAN	14
X, FLOCAL(12,9),	ETARAT(9),	DB2M(12,9),	DB2MR(12,9),	DB3M(12,9),	DB3MR		CSPAN	15
X(12,9),	B2MB3R(12,9),	SPEEDF, FLOWIN, U3DU2R(12),	U2U3(12),	DB3MRG(12)			CSPAN	16
X, DB3MRN(12,9),	DB3MRP(12,8),	CPCM(6),	CPCS(6)				CSPAN	17
*	RK3M(12),	RDEV(12),	RDEF(12),	GMREF(12)			CSPAN	18
*	PSID1(12,2,8),	PSID2(12,2,8),	PSID3(12,2,8),	PSID4(12,2,8)			CSPAN	19
*	PSID5(12,2,8),	PSI1(12,2,8),	PSI2(12,2,8),	PSI3(12,2,8)			CSPAN	20
*	PSI4(12,2,8),	PSI5(12,2,8)					CSPAN	21
*	PSID1L(12,2,8),	PSID2L(12,2,8),	PSID3L(12,2,8)				CSPAN	22
*	PSID4L(12,2,8),	PSID5L(12,2,8),	PSI1L(12,2,8)				CSPAN	23
*	PSI2L(12,2,8),	PSI3L(12,2,8),	PSI4L(12,2,8),	PSI5L(12,2,8)			CSPAN	24
COMMON /SCALER/	RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA						CSPAN	25
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS							CSPAN	26
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEUG, DRDEUN, DRDEUP							CSPAN	27
X, XAR, XMET, XSTM							CSPAN	28
X, STAGEN, SPEEDN, CHAPTS, WTMOLE							CSPAN	29
J=1							CSPAN	30
I=1							CSPAN	31
TT(I)= TO							CSPAN	32
PT(I)= PO							CSPAN	33
90 TS= TT(I)							CSPAN	34
DPHIA(I) = 0.0							CSPAN	35
DPSIA(I) = 0.0							CSPAN	36
DETA(I) = 0.0							CSPAN	37
IF((CB2M(I) + CB2MR(I) + CB3MR(I)).EQ.0.00) GO TO 93							CSPAN	38
BET2M(I,J)= DB2M(I,J) + CB2M(I)							CSPAN	39
BAT2MR(I,J)= DB2MR(I,J) + CB2MR(I)							CSPAN	40
BET3MR(I,J) = DB3MR(I,J) + CB3MR(I)							CSPAN	41
UZ2M(I,J)= UM2(I)/(TAN(BET2M(I,J))+ TAN(BAT2MR(I,J)))							CSPAN	42
U2MR = UZ2M(I,J)/COS(BAT2MR(I,J))							CSPAN	43
C *** CHANGE IN FLOW COEFICIENT FOR RESET							CSPAN	44
DPHIA(I)= UZ2M(I,J)/UT2(I) - PHIREF(I)							CSPAN	45
UZ3M(I,J)= UZ2M(I,J)							CSPAN	46
UT2M= UZ2M(I,J)*TAN(BET2M(I,J))							CSPAN	47
U2S = UT2M**2 + UZ3M(I,J)**2							CSPAN	48
RHOT = PT(I)/(TT(I)*RG)							CSPAN	49
RHOS = RHOT*(1.0 - U2S/(G2J*CPREF(I)*TT(I)))*GF1REF(I)							CSPAN	50
DESFLC = RHOS*AREA2(I)*UZ3M(I,J)							CSPAN	51
FLOCAL(I,J) = DESFLC							CSPAN	52
92 UT3M= UM3(I) - UZ3M(I,J) *TAN(BET3MR(I,J))							CSPAN	53
CP=CPFM(TS)							CSPAN	54
DT= (UM3(I) * UT3M - UM2(I)*UT2M)/(GJ*CP)							CSPAN	55
TRA = (DT + TT(I))/TT(I)							CSPAN	56
PTA3 = PT(I)*(1.0 + ETAREF(I)*(TRA -1.0))*GF2							CSPAN	57
TTA3 = DT + TT(I)							CSPAN	58
RHOT= PTA3 /((TTA3 *RG)							CSPAN	59
U3S = UT3M**2 + UZ3M(I,J)**2							CSPAN	60
RHOS = RHOT*(1.0 - U3S/(G2J*CP*TTA3))**GF1							CSPAN	61
TS = TTA3 *(RHOS/RHOT)**GM1							CSPAN	62
WCAL = RHOS*AREA3(I)*UZ3M(I,J)							CSPAN	63
UZ3M(I,J) = DESFLC/(RHOS*AREA3(I))							CSPAN	64
U3MR = UZ3M(I,J)/COS(BET3MR(I,J))							CSPAN	65
C *** OPTION TO ALTER ROTOR DEVIATION ANGLE FOR BLADE RESET							CSPAN	66
IF (DRDEUG.EQ.1.0)							CSPAN	67
XDB3MRG(I) = -(10.00/RAD)*(U3MR/U2MR - U3DU2R(I))							CSPAN	68
BET3MR(I,J) = DB3MR(I,J) + CB3MR(I) + DB3MRG(I)							CSPAN	69
IF ((ABS(WCAL-DESFLC)/WCAL).GT.0.005) GO TO 92							CSPAN	70
C *** CHANGE IN PRESSURE RISE COEFICIENT FOR RESET							CSPAN	71
DPSIA(I) = GJ*CP*DT/(UT3(I)*UT3(I))*ETAREF(I) - PSIREF(I)							CSPAN	72
93 I = I+1							CSPAN	73
IF (I.LE.NSTA) GO TO 90							CSPAN	74
RETURN							CSPAN	75
END							CSPAN	76

C+++++	SUBROUTINE CSOUP(T,FAID,ISTAGE,FLOW1,ALFA1,BETA1,BETA2,	CSOUP	1
	XUZ,ALFA2,ALFA3,DELTA,DELTA,W1,W2,U1,U2)	CSOUP	2
C	PERFORMANCE PARAMETERS	CSOUP	3
	COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	CSOUP	4
	X,PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	CSOUP	5
	X,P(3),TG(3),XA,XU(3),XCH4,XW(3),XWW(3),XWT(3),TW(3),TWW(3)	CSOUP	6
	X,OMEGS(7),OMEGR(6),GAPR(6),GAPS(6)	CSOUP	7
	X,RRHUB(6),RC(6),RBLADE(6),STAGER(6)	CSOUP	8
	X,SRHUB(7),SC(7),SBLADE(7),STAGES(7)	CSOUP	9
	X,SIGUMR(6),BET1SR(6),BET2SR(6),AINCSP(6),ADEVSR(6)	CSOUP	10
	X,SIGUMS(7),BET1SS(7),BET2SS(7),AINCSS(7),ADEUSS(7)	CSOUP	11
	X,UTIPG(6),UTIP(6),UTIPD(6),UOU(6),UMEAN(6),UHUB(6),U(6),FAI	CSOUP	12
	X,AREA(6),AREAS(7),UU2(6),UTIP2(6),UMEAN2(6),UHUB2(6),IPRINT	CSOUP	13
	X,ICENT,IICENT,FMR1(6),FMA2(6),IRAD,FAID	CSOUP	14
	X,NS,NS1,RT(6),RM(6),RH(6),ST(6),SM(6),SH(6)	CSOUP	15
	X,DSMASS,AAREA(7),AAREAS(7),PR12D(6),PR13D(6),ETARD(6)	CSOUP	16
	X,DR(6),DS(6),DEQR(6),DEQS(6),BLOCK(6),BLOCKS(7)	CSOUP	17
	X,BET1MR(6),BET2MR(6),BET1MS(7),BET2MS(7),RADI1(6),RADI2(6)	CSOUP	18
	COMMON /VECTOR/ CPCO(6),TITLE(12),RT2(12),RH2(12),RT3(12),	CSOUP	19
	XRH3(12),PHIREF(12),PSIREF(12),ETAREF(12),PHIDES(12,9,8),	CSOUP	20
	XPSIDES(12,9,8),ETADES(12,9,8),PHI(12,9,8),PSI(12,9,8),ETA(12,9	CSOUP	21
	X,8),DPHIA(12),DPSIA(12),DETA(12),NSTAGE(12),PCTSPD(9),	CSOUP	22
	XBET2M(12,9),BLEED(12,9),TT(13),PT(13),PR(12),TR(12),PRO(12),	CSOUP	23
	XTRO(12),ETAO(12),BET3MR(12,9),UZ2M(12,9),UZ3M(12,9),AREA2(12)	CSOUP	24
	X,AREA3(12),RM2(12),RM3(12),UT2(12),UT3(12),UM2(12),UM3(12)	CSOUP	25
	X,BAT2MR(12,9),DPSIS(12,9),RSOLM(12),RK2M(12),CB2MR(12),	CSOUP	26
	X12),CB3MR(12),RINCM(12),RDFM(12),SK2M(12),SINCM(12),BET3M(12	CSOUP	27
	X,9),PHIFIX(12),DPHIF(12),CPREF(12),GF1REF(12),ETAINP(12)	CSOUP	28
	X,FLOCAL(12,9),ETARAT(9),DB2M(12,9),DB2MR(12,9),DB3M(12,9),DB3MR	CSOUP	29
	X(12,9),B2MB3R(12,9),SPEEDF,FLOWIN,U3DU2R(12),U2U3(12),DB3MRG(12)	CSOUP	30
	X,DB3MRN(12,9),DB3MRP(12,8),CPCM(6),CPCS(6)	CSOUP	31
	*,RK3M(12),RDEV(12),RDEF(12),GMREF(12)	CSOUP	32
	*,PSID1(12,2,8),PSID2(12,2,8),PSID3(12,2,8),PSID4(12,2,8)	CSOUP	33
	*,PSID5(12,2,8),PSI1(12,2,8),PSI2(12,2,8),PSI3(12,2,8)	CSOUP	34
	*,PSI4(12,2,8),PSI5(12,2,8)	CSOUP	35
	*,PSID1L(12,2,8),PSID2L(12,2,8),PSID3L(12,2,8)	CSOUP	36
	*,PSID4L(12,2,8),PSID5L(12,2,8),PSI1L(12,2,8)	CSOUP	37
	*,PSI2L(12,2,8),PSI3L(12,2,8),PSI4L(12,2,8),PSI5L(12,2,8)	CSOUP	38
	COMMON /SCALER/ RU,PI,G,AJ,RAD,RG,DCP,GJ,G2J,RPMRAD,NSTA	CSOUP	39
	X,NSPE,NPTS,PO,TO,DESRPM,DESFLO,UNITS	CSOUP	40
	X,CP,GAMMA,GM1,GF1,GF2,GF3,SPDPSI,SPDPHI,DRDEVC,DRDEVN,DRDEUP	CSOUP	41
	X,XAR,XMET,XSTM	CSOUP	42
	X,STAGEN,SPEEDN,CHAPTS,WTMOLE	CSOUP	43
	FLOWIN=FLOW1	CSOUP	44
	DFLOW=FLOWIN	CSOUP	45
	FLOWFI=FLOWIN	CSOUP	46
	IF (UNITS.NE.1.0) GO TO 81	CSOUP	47
	FLOWIN = FLOWIN/0.453592	CSOUP	48
	DFLOW = DFLOW/0.453592	CSOUP	49
	FLOWFI = FLOWFI/0.453592	CSOUP	50
81	CONTINUE	CSOUP	51
	JS=1	CSOUP	52
	DO 82 J=1,NSPE	CSOUP	53
	IF (SPEEDF.EG.PCTSPD(J)) JS=J	CSOUP	54
82	CONTINUE	CSOUP	55
C ***	CALCULATE THE OUTPUT	CSOUP	56
	I=ISTAGE	CSOUP	57
	TT(I)=TG(1)	CSOUP	58
	PT(I)=P(1)	CSOUP	59
	WTFLOW = FLOWIN	CSOUP	60
	RHOT=PT(I)/(TT(I)*RG)	CSOUP	61
	TS=TT(I)	CSOUP	62
	RHOS=RHOT	CSOUP	63
	RHOW=62.3	CSOUP	64
	RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	CSOUP	65
	WTFLOW = WTFLOW - FLOWIN*BLEED(I,JS)	CSOUP	66
	U2 = UT2(I)*SPEEDF	CSOUP	67
	U3 = UT3(I)*SPEEDF	CSOUP	68
	UMM2 = UM2(I)*SPEEDF	CSOUP	69
		CSOUP	70

UMM3 = UMM3(I)*SPEEDF	CSOUP	71
100 UZ=WTFLOW/(RHOSM*AREA2(I))	CSOUP	72
V= UZ/COS(BET2M(I,1))	CSOUP	73
CP=CPFM(TS)	CSOUP	74
RHOS= RHOT*(1.0-U*U/(G2J*CP*TT(I)))*GF1	CSOUP	75
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	CSOUP	76
IF((U*U).GT.(G2J*CP*TT(I))) GO TO 113	CSOUP	77
TS= TT(I)*(RHOS/RHOT)**GM1	CSOUP	78
RHOS1=RHOS	CSOUP	79
TS1=TS	CSOUP	80
PS1=PT(I)*(TT(I)/TS1)**(-GF2)	CSOUP	81
WCAL=RHOSM*UZ*AREA2(I)	CSOUP	82
IF((ABS(WCAL-WTFLOW)/WCAL).GT.0.005) GO TO 100	CSOUP	83
PHIC = UZ/U2	CSOUP	84
IF(PHIC.GT.PHI(I,JS,NPTS)) GO TO 120	CSOUP	85
DO 200 I=1,NSTA	CSOUP	86
DO 200 J=1,NSPE	CSOUP	87
DO 200 K=1,NPTS	CSOUP	88
PSI(I,J,K)=PSI1(I,J,K)	CSOUP	89
IF(XW(1).GT.0.0.AND.XW(1).LE.0.05) PSI(I,J,K)=PSI2(I,J,K)	CSOUP	90
IF(XW(1).GT.0.05.AND.XW(1).LE.0.10)PSI(I,J,K)=PSI3(I,J,K)	CSOUP	91
IF(XW(1).GT.0.10.AND.XW(1).LE.0.15)PSI(I,J,K)=PSI4(I,J,K)	CSOUP	92
IF(XW(1).GT.0.15) PSI(I,J,K)=PSI5(I,J,K)	CSOUP	93
200 CONTINUE	CSOUP	94
I=ISTAGE	CSOUP	95
DO 130 K=2,NPTS	CSOUP	96
IF(PHIC-PHI(I,JS,K)) 140,150,130	CSOUP	97
130 CONTINUE	CSOUP	98
K= NPTS	CSOUP	99
140 PSIC=(PSI(I,JS,K)-PSI(I,JS,K-1))*(PHIC-PHI(I,JS,K-1))/	CSOUP	100
1 (PHI(I,JS,K)-PHI(I,JS,K-1)) + PSI(I,JS,K-1)	CSOUP	101
ETAC=(ETA(I,JS,K)-ETA(I,JS,K-1))*(PHIC-PHI(I,JS,K-1))/	CSOUP	102
1 (PHI(I,JS,K)-PHI(I,JS,K-1)) + ETA(I,JS,K-1)	CSOUP	103
GO TO 160	CSOUP	104
150 PSIC= PSI(I,JS,K)	CSOUP	105
ETAC= ETA(I,JS,K)	CSOUP	106
160 CONTINUE	CSOUP	107
CALL CSETA1(I,J,K,XW(1),PHIC,PHIREF(I),ETAC)	CSOUP	108
PR(I) = (1.0 + PSIC*U3*U3/ (GJ*CP*TT(I)))*GF2	CSOUP	109
TAU = PSIC/ETAC	CSOUP	110
TR(I)= 1.0 + (PR(I)**GF3-1.0)/ETAC	CSOUP	111
TT(I+1)= TT(I)*TR(I)	CSOUP	112
PT(I+1)= PT(I) *PR(I)	CSOUP	113
TRO(I)= TT(I+1)/TO	CSOUP	114
PRO(I)= PT(I+1)/PO	CSOUP	115
GF3S = GF3	CSOUP	116
GF30= (GF3 + GF3S)/2.0	CSOUP	117
ETA0(I)= (PRO(I)**GF30 - 1.0)/(TRO(I) - 1.0)	CSOUP	118
UT2M = UZ * TAN(BET2M(I,1))	CSOUP	119
UT2MR = UMM2 - UT2M	CSOUP	120
BAT2MR(I,JS)= ATAN2(UT2MR,UZ)	CSOUP	121
RINCM(I)= BAT2MR(I,JS) * RAD - RK2M(I)	CSOUP	122
U2MR= UZ/COS(BAT2MR(I,JS))	CSOUP	123
RHOT= PT(I+1)/(TT(I+1)*RG)	CSOUP	124
TS= TT(I+1)	CSOUP	125
RHOS= RHOT	CSOUP	126
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	CSOUP	127
161 UZ3M(I,JS)=WTFLOW/(RHOSM*AREA3(I))	CSOUP	128
UT3M= (CP*(TT(I+1)-TT(I))*GJ + UMM2 *UT2M)/UMM3	CSOUP	129
US= UZ3M(I,JS)**2 + UT3M**2	CSOUP	130
CP=CPFM(TS)	CSOUP	131
RHOS= RHOT*(1.0-US/(G2J*CP*TT(I+1)))*GF1	CSOUP	132
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	CSOUP	133
IF((US).GT.(G2J*CP*TT(I+1))) GO TO 113	CSOUP	134
TS= TT(I+1) * (RHOS/RHOT)**GM1	CSOUP	135
RHOS2=RHOS	CSOUP	136
TS2=TS	CSOUP	137
PS2=PT(I+1)*(TT(I+1)/TS2)**(-GF2)	CSOUP	138
WCAL=RHOSM*AREA3(I)*UZ3M(I,JS)	CSOUP	139
IF(ABS(WCAL-WTFLOW).GT.0.005) GO TO 161	CSOUP	140

BET3M(I,JS) = ATAN2(UT3M,UZ3M(I,JS))	CSOUP	141
SINCM(I) = BET3M(I,JS)*RAD - SK2M(I)	CSOUP	142
UT3MR = UMM3 - UT3M	CSOUP	143
BET3MR(I,JS) = ATAN2(UT3MR,UZ3M(I,JS))	CSOUP	144
U3MR = UZ3M(I,JS)/COS(BET3MR(I,JS))	CSOUP	145
RDFM(I) = 1.0 - U3MR/U2MR + (RM3(I)*UT3M - RM2(I)*UT2M)/(RM3(I) +	CSOUP	146
XRM2(I))/RSOLM(I)/U2MR	CSOUP	147
IF (UNITS.EQ.1.0) WFLOW = WFLOW*0.453592	CSOUP	148
RDEV(I) = BET3MR(I,JS)*RAD - RK3M(I)	CSOUP	149
BAT2MR(I,JS) = BAT2MR(I,JS)*RAD	CSOUP	150
BET3MR(I,JS) = BET3MR(I,JS)*RAD	CSOUP	151
RDEF(I) = BAT2MR(I,JS) - BET3MR(I,JS)	CSOUP	152
SOA1 = SQRT(GAMMA*RG*C*TS1)	CSOUP	153
SOA2 = SQRT(GAMMA*RG*C*TS2)	CSOUP	154
AM2 = U/SOA1	CSOUP	155
AM3 = SQRT(US)/SOA2	CSOUP	156
AM2R = U2MR/SOA1	CSOUP	157
AM3R = U3MR/SOA2	CSOUP	158
PRATIO = PR(I)	CSOUP	159
TRATIO = TR(I)	CSOUP	160
FAI1 = PHIC	CSOUP	161
FAI2 = UZ3M(I,JS)	CSOUP	162
UZ1 = UZ	CSOUP	163
UTIPG(I) = U2	CSOUP	164
P(1) = PT(I)	CSOUP	165
P(2) = PT(I+1)	CSOUP	166
P(3) = P(2)	CSOUP	167
TG(1) = TT(I)	CSOUP	168
TG(2) = TT(I+1)	CSOUP	169
TG(3) = TG(2)	CSOUP	170
DELTG = TG(2) - TG(1)	CSOUP	171
DELTW = (TG(2) - TG(1))*CP	CSOUP	172
RHOG(1) = RHOS1	CSOUP	173
RHOG(2) = RHOS2	CSOUP	174
UZ2 = UZ3M(I,JS)	CSOUP	175
U1 = U	CSOUP	176
U2 = SQRT(US)	CSOUP	177
W1 = U2MR	CSOUP	178
W2 = U3MR	CSOUP	179
US1 = UT2M	CSOUP	180
US2 = UT3M	CSOUP	181
WS1 = UT2MR	CSOUP	182
WS2 = UT3MR	CSOUP	183
ASPED1 = SOA1	CSOUP	184
ASPED2 = SOA2	CSOUP	185
AMAC1 = AM2	CSOUP	186
AMAC2 = AM3	CSOUP	187
AMACH1 = AM2R	CSOUP	188
AMACH2 = AM3R	CSOUP	189
FAI1 = PHIC	CSOUP	190
FAI2 = UZ3M(I,JS)/U3	CSOUP	191
AAA1 = SAREA(I)	CSOUP	192
AAA2 = SAREAS(I)	CSOUP	193
ALFA1 = BET2M(I,1)*RAD	CSOUP	194
ALFA2 = BET3M(I,JS)*RAD	CSOUP	195
ALFA3 = 0.0	CSOUP	196
IF (I.LT.NSTA) ALFA3 = BET2M(I+1,1)*RAD	CSOUP	197
BETA1 = BAT2MR(I,JS)	CSOUP	198
BETA2 = BET3MR(I,JS)	CSOUP	199
AINCIR = RINCM(I)	CSOUP	200
AINCIS = SINCM(I)	CSOUP	201
ADEVIR = RDEV(I)	CSOUP	202
C *** WRITE THE OUTPUT	CSOUP	203
WRITE(6,404) FAIO,ISTAGE	CSOUP	204
404 FORMAT(1H1,1X,***** #,1X,	CSOUP	205
\$=INITIAL FLOW COEFFICIENT=#,1X,F5.3,1X,=(STAGE=#,I2,1X,	CSOUP	206
\$#),2X,*****#)	CSOUP	207
WRITE(6,401) PRATIO,TRATIO,ETAC	CSOUP	208
401 FORMAT(1H0,5X,=STAGE TOTAL PRESSURE RATIO=#,F12.5,/,	CSOUP	209
\$6X,=STAGE TOTAL TEMPERATURE RATIO=#,F12.5,/,	CSOUP	210

\$6X, #STAGE ADIABATIC EFFICIENCY=#, F12.5)	CSOUP	211
WRITE(6,402) FAI1,UZ1,UTIPG(ISTAGE)	CSOUP	212
402 FORMAT(1H0,5X, #STAGE FLOW COEFFICIENT=#, F5.3, /,	CSOUP	213
\$6X, #AXIAL VELOCITY=#, F7.2, /,	CSOUP	214
\$6X, #ROTOR SPEED=#, F7.2, /)	CSOUP	215
WRITE(6,405)	CSOUP	216
405 FORMAT(1H0,24X, #*ROTOR INLET* *ROTOR OUTLET* *STATOR OUTLET*#)	CSOUP	217
WRITE(6,406) P(1),P(2),P(3)	CSOUP	218
406 FORMAT(1H ,1X, #TOTAL PRESSURE#, 10X, 3(F10.4,5X))	CSOUP	219
WRITE(6,407) PS1,PS2	CSOUP	220
407 FORMAT(1H ,1X, #STATIC PRESSURE#, 9X, 2(F10.4,5X))	CSOUP	221
WRITE(6,408) TG(1),TG(2),TG(3)	CSOUP	222
408 FORMAT(1H ,1X, #TOTAL TEMPERATURE(GAS)#, 3X, 3(F10.4,5X))	CSOUP	223
WRITE(6,409) TS1,TS2	CSOUP	224
409 FORMAT(1H ,1X, #STATIC TEMPERATURE(GAS)#, 1X, 2(F10.4,5X))	CSOUP	225
WRITE(6,410) RHOG(1),RHOG(2)	CSOUP	226
410 FORMAT(1H ,1X, #STATIC DENSITY(GAS)#, 5X, 2(F10.4,5X))	CSOUP	227
WRITE(6,412) UZ1,UZ2	CSOUP	228
412 FORMAT(1H0,1X, #AXIAL VELOCITY#, 10X, 2(F10.4,5X))	CSOUP	229
WRITE(6,413) U1,U2	CSOUP	230
413 FORMAT(1H ,1X, #ABSOLUTE VELOCITY#, 7X, 2(F10.4,5X))	CSOUP	231
WRITE(6,414) W1,W2	CSOUP	232
414 FORMAT(1H ,1X, #RELATIVE VELOCITY#, 7X, 2(F10.4,5X))	CSOUP	233
WRITE(6,415) U(ISTAGE),UU2(ISTAGE),U(ISTAGE+1)	CSOUP	234
415 FORMAT(1H ,1X, #BLADE SPEED#, 13X, 3(F10.4,5X))	CSOUP	235
WRITE(6,416) US1,US2	CSOUP	236
416 FORMAT(1H ,1X, #TANG. COMP. OF ABS. VEL.#, 2(F10.4,5X))	CSOUP	237
WRITE(6,417) WS1,WS2	CSOUP	238
417 FORMAT(1H ,1X, #TANG. COMP. OF REL. VEL.#, 2(F10.4,5X))	CSOUP	239
WRITE(6,418) ASPED1,ASPED2	CSOUP	240
418 FORMAT(1H ,1X, #ACOUSTIC SPEED#, 10X, 2(F10.4,5X))	CSOUP	241
WRITE(6,419) AMAC1,AMAC2	CSOUP	242
419 FORMAT(1H ,1X, #ABSOLUTE MACH NUMBER#, 4X, 2(F10.4,5X))	CSOUP	243
WRITE(6,420) AMACH1,AMACH2	CSOUP	244
420 FORMAT(1H ,1X, #RELATIVE MACH NUMBER#, 4X, 2(F10.4,5X))	CSOUP	245
WRITE(6,421) FAI1,FAI2	CSOUP	246
421 FORMAT(1H0,1X, #FLOW COEFFICIENT#, 8X, 2(F10.4,5X))	CSOUP	247
WRITE(6,422) AAA1,AAA2	CSOUP	248
422 FORMAT(1H ,1X, #FLOW AREA#, 15X, 2(F10.4,5X))	CSOUP	249
WRITE(6,423) ALFA1,ALFA2,ALFA3	CSOUP	250
423 FORMAT(1H0,1X, #ABSOLUTE FLOW ANGLE#, 5X, 3(F10.4,5X))	CSOUP	251
WRITE(6,424) BETA1,BETA2	CSOUP	252
424 FORMAT(1H ,1X, #RELATIVE FLOW ANGLE#, 5X, 3(F10.4,5X))	CSOUP	253
WRITE(6,425) AINCIR,AINCIS	CSOUP	254
425 FORMAT(1H ,1X, #INCIDENCE#, 16X, 2(F10.4,5X))	CSOUP	255
WRITE(6,426) ADEVIR	CSOUP	256
426 FORMAT(1H ,1X, #DEVIATION#, 30X, 1(F10.4,5X))	CSOUP	257
IF (UNITS.EQ.1.0) WTFLOW = WTFLOW/0.453592	CSOUP	258
GO TO 111	CSOUP	259
110 WRITE(6,2100) I,PHIC	CSOUP	260
2100 FORMAT (10H FOR STAGE, I3,18H , COMPUTED PHI IS,F8.4,06H STALL)	CSOUP	261
GO TO 111	CSOUP	262
120 WRITE(6,2110)I,PHIC	CSOUP	263
2110 FORMAT (10H FOR STAGE, I3,18H , COMPUTED PHI IS,F8.4,06H CHOKE)	CSOUP	264
GO TO 113	CSOUP	265
111 FLOWIN=FLOWIN+DFLOW	CSOUP	266
IF (FLOWIN.LE.FLOWFI) GO TO 81	CSOUP	267
113 CONTINUE	CSOUP	268
DO 112 I=1,NSTA	CSOUP	269
DO 112 J=1,NSPE	CSOUP	270
112 DPSIS(I,J) = 0.0	CSOUP	271
RETURN	CSOUP	272
END	CSOUP	273
C+*****	COUPT	1
SUBROUTINE COUPT2(FAIO,ISTAGE,FLOW1,ALFA1,BETA1,BETA2,	COUPT	2
XUZ,ALFA2,ALFA3,DELTA,DELTA,W1,W2,U1,U2)	COUPT	3
C PERFORMANCE PARAMETERS	COUPT	4
COMMON /PERDUE/ JPERFM,RHOG(3),RERUP,RERLOW,RESUP,RESLOW	COUPT	5
X, PREB,RRTIP(8),SRTIP(8),AAA1,AAA2,AAA3,SAREA(6),SAREAS(7)	COUPT	6
X, P(3),TG(3),XA,XU(3),XCH4,XW(3),XWW(3),XWT(3),TW(3),TWW(3)	COUPT	7

IF (UNITS.EQ.1.0) WTFLOW = WTFLOW*0.453592	COUPT	148
RDEU(I)=BET3MR(I,JS)*RAD-RK3M(I)	COUPT	149
BAT2MR(I,JS)=BAT2MR(I,JS)*RAD	COUPT	150
BET3MR(I,JS)=BET3MR(I,JS)*RAD	COUPT	151
RDEF(I)=BAT2MR(I,JS)-BET3MR(I,JS)	COUPT	152
SOA1=SQRT(GAMMA*RG*G*TS1)	COUPT	153
SOA2=SQRT(GAMMA*RG*G*TS2)	COUPT	154
AM2=U/SOA1	COUPT	155
AM3=SQRT(US)/SOA2	COUPT	156
AM2R=U2MR/SOA1	COUPT	157
AM3R=U3MR/SOA2	COUPT	158
PRATIO=PR(I)	COUPT	159
TRATIO=TR(I)	COUPT	160
FAI1=PHIC	COUPT	161
FAI2=UZ3M(I,JS)	COUPT	162
UZ1=UZ	COUPT	163
UTIPG(I)=U2	COUPT	164
P(1)=PT(I)	COUPT	165
P(2)=PT(I+1)	COUPT	166
P(3)=P(2)	COUPT	167
TG(1)=TT(I)	COUPT	168
TG(2)=TT(I+1)	COUPT	169
TG(3)=TG(2)	COUPT	170
DEL TG=TG(2)-TG(1)	COUPT	171
DEL TW=0.0	COUPT	172
RHOG(1)=RHOS1	COUPT	173
RHOG(2)=RHOS2	COUPT	174
VZ2=UZ3M(I,JS)	COUPT	175
U1=U	COUPT	176
U2=SQRT(US)	COUPT	177
W1=U2MR	COUPT	178
W2=U3MR	COUPT	179
US1=UT2M	COUPT	180
US2=UT3M	COUPT	181
WS1=UT2MR	COUPT	182
WS2=UT3MR	COUPT	183
ASPED1=SOA1	COUPT	184
ASPED2=SOA2	COUPT	185
AMAC1=AM2	COUPT	186
AMAC2=AM3	COUPT	187
AMACH1=AM2R	COUPT	188
AMACH2=AM3R	COUPT	189
FAI1=PHIC	COUPT	190
FAI2=UZ3M(I,JS)/U3	COUPT	191
AAA1=SAREA(I)	COUPT	192
AAA2=SAREAS(I)	COUPT	193
ALFA1=BET2M(I,1)*RAD	COUPT	194
ALFA2=BET3M(I,JS)*RAD	COUPT	195
ALFA3=0.0	COUPT	196
IF(I.LT.NSTA) ALFA3=BET2M(I+1,1)*RAD	COUPT	197
BETA1=BAT2MR(I,JS)	COUPT	198
BETA2=BET3MR(I,JS)	COUPT	199
AINCIR=RINCM(I)	COUPT	200
AINCIS=SINCM(I)	COUPT	201
ADEVIR=RDEV(I)	COUPT	202
C *** WRITE THE OUTPUT	COUPT	203
WRITE(6,404) FAIO,ISTAGE	COUPT	204
404 FORMAT(1H1,1X,***** ≠,1X,	COUPT	205
\$≠INITIAL FLOW COEFFICIENT=≠,1X,F5.3,1X,≠(STAGE=≠,I2,1X,	COUPT	206
\$≠)≠,2X,*****)	COUPT	207
WRITE(6,401) PRATIO,TRATIO,ETAC	COUPT	208
401 FORMAT(1H0,5X,≠STAGE TOTAL PRESSURE RATIO=≠,F12.5,/,	COUPT	209
\$6X,≠STAGE TOTAL TEMPERATURE RATIO=≠,F12.5,/,	COUPT	210
\$6X,≠STAGE ADIABATIC EFFICIENCY=≠,F12.5)	COUPT	211
WRITE(6,402) FAI1,UZ1,UTIPG(ISTAGE)	COUPT	212
402 FORMAT(1H0,5X,≠STAGE FLOW COEFFICIENT=≠,F5.3,/,	COUPT	213
\$6X,≠AXIAL VELOCITY=≠,F7.2,/,	COUPT	214
\$6X,≠ROTOR SPEED=≠,F7.2,/)	COUPT	215
WRITE(6,405)	COUPT	216
405 FORMAT(1H0,24X,≠*ROTOR INLET* *ROTOR OUTLET* *STATOR OUTLET*≠)	COUPT	217

TS= TT(I)*(RHOS/RHOT)**GM1	COUPT	78
RHOS1=RHOS	COUPT	79
TS1=TS	COUPT	80
PSI=PT(I)*(TT(I)/TS1)**(-GF2)	COUPT	81
WCAL=RHOS*UZ*AREA2(I)	COUPT	82
IF((ABS(WCAL-WTFLOW)/WCAL).GT.0.005) GO TO 100	COUPT	83
PHIC = UZ/U2	COUPT	84
IF(PHIC.GT.PHI(I,JS,NPTS)) GO TO 120	COUPT	85
DO 200 I=1,NSTA	COUPT	86
DO 200 J=1,NSPE	COUPT	87
DO 200 K=1,NPTS	COUPT	88
PSI(I,J,K)=PSI1L(I,J,K)	COUPT	89
IF(XWW(1).GT.0.0.AND.XWW(1).LE.0.05) PSI(I,J,K)=PSI2L(I,J,K)	COUPT	90
IF(XWW(1).GT.0.05.AND.XWW(1).LE.0.10)PSI(I,J,K)=PSI3L(I,J,K)	COUPT	91
IF(XWW(1).GT.0.10.AND.XWW(1).LE.0.15)PSI(I,J,K)=PSI4L(I,J,K)	COUPT	92
IF(XWW(1).GT.0.15) PSI(I,J,K)=PSI5L(I,J,K)	COUPT	93
200 CONTINUE	COUPT	94
I=ISTAGE	COUPT	95
DO 130 K=2,NPTS	COUPT	96
IF(PHIC-PHI(I,JS,K)) 140,150,130	COUPT	97
130 CONTINUE	COUPT	98
K= NPTS	COUPT	99
140 PSIC=(PSI(I,JS,K)-PSI(I,JS,K-1))*(PHIC-PHI(I,JS,K-1))/	COUPT	100
1 (PHI(I,JS,K)-PHI(I,JS,K-1)) + PSI(I,JS,K-1)	COUPT	101
ETAC=(ETA(I,JS,K)-ETA(I,JS,K-1))*(PHIC-PHI(I,JS,K-1))/	COUPT	102
1 (PHI(I,JS,K)-PHI(I,JS,K-1)) + ETA(I,JS,K-1)	COUPT	103
GO TO 160	COUPT	104
150 PSIC= PSI(I,JS,K)	COUPT	105
ETAC= ETA(I,JS,K)	COUPT	106
160 CONTINUE	COUPT	107
CALL CSETAL(I,J,K,XWW(1),PHIREF(I),PHIC,ETAC,ETAREF(I))	COUPT	108
PR(I) = (1.0 + PSIC*U3*U3/ (GJ*CP*TT(I)))*GF2	COUPT	109
TAU = PSIC/ETAC	COUPT	110
TR(I)= 1.0 + (PR(I)**GF3-1.0)/ETAC	COUPT	111
TT(I+1)= TT(I)*TR(I)	COUPT	112
PT(I+1)= PT(I) *PR(I)	COUPT	113
TRO(I)= TT(I+1)/TO	COUPT	114
PRO(I)= PT(I+1)/PO	COUPT	115
GF3S = GF3	COUPT	116
GF3O= (GF3 + GF3S)/2.0	COUPT	117
ETAO(I)= (PRO(I)**GF3O - 1.0)/(TRO(I) - 1.0)	COUPT	118
UT2M = UZ * TAN(BET2M(I,1))	COUPT	119
UT2MR = UMM2 - UT2M	COUPT	120
BAT2MR(I,JS)= ATAN2(UT2MR,UZ)	COUPT	121
RINCM(I)= BAT2MR(I,JS) * RAD - RK2M(I)	COUPT	122
U2MR= UZ/COS(BAT2MR(I,JS))	COUPT	123
RHOT= PT(I+1)/(TT(I+1)*RG)	COUPT	124
TS= TT(I+1)	COUPT	125
RHOS= RHOT	COUPT	126
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	COUPT	127
161 UZ3M(I,JS)=WTFLOW/(RHOS*AREA3(I))	COUPT	128
UT3M= (CP*(TT(I+1)-TT(I))*GJ + UMM2 *UT2M)/UMM3	COUPT	129
US= UZ3M(I,JS)**2 + UT3M**2	COUPT	130
CP=CPFM(TS)	COUPT	131
RHOS= RHOT*(1.0-US/(G2J*CP*TT(I+1)))*GF1	COUPT	132
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	COUPT	133
IF((US).GT.(G2J*CP*TT(I+1))) GO TO 113	COUPT	134
TS= TT(I+1) * (RHOS/RHOT)**GM1	COUPT	135
RHOS2=RHOS	COUPT	136
TS2=TS	COUPT	137
PS2=PT(I+1)*(TT(I+1)/TS2)**(-GF2)	COUPT	138
WCAL=RHOS*AREA3(I)*UZ3M(I,JS)	COUPT	139
IF(ABS(WCAL-WTFLOW).GT.0.005) GO TO 161	COUPT	140
BET3M(I,JS) = ATAN2(UT3M,UZ3M(I,JS))	COUPT	141
SINCM(I) = BET3M(I,JS)*RAD - SK2M(I)	COUPT	142
UT3MR = UMM3 - UT3M	COUPT	143
BET3MR(I,JS)= ATAN2(UT3MR,UZ3M(I,JS))	COUPT	144
U3MR = UZ3M(I,JS)/COS(BET3MR(I,JS))	COUPT	145
RDFM(I)= 1.0 - U3MR/U2MR + (RM3(I)*UT3M - RM2(I)*UT2M)/(RM3(I) +	COUPT	146
XRM2(I))/RSOLM(I)/U2MR	COUPT	147

X, OMEGS(7), OMEGR(6), GAPR(6), GAPS(6)	COUPT	8
X, RRHUB(6), RC(6), RBLADE(6), STAGER(6)	COUPT	9
X, SRHUB(7), SC(7), SBLADE(7), STAGES(7)	COUPT	10
X, SIGUMR(6), BET1SR(6), BET2SR(6), AINCSR(6), ADEUSR(6)	COUPT	11
X, SIGUMS(7), BET1SS(7), BET2SS(7), AINCSS(7), ADEVSS(7)	COUPT	12
X, UTIPG(6), UTIP(6), UTIPD(6), UOU(6), UMEAN(6), UHUB(6), U(6), FAI	COUPT	13
X, AREA(6), AREAS(7), UU2(6), UTIP2(6), UMEAN2(6), UHUB2(6), IPRINT	COUPT	14
X, ICENT, IICENT, FMR1(6), FMA2(6), IRAD, FAID	COUPT	15
X, NS, NS1, RT(6), RM(6), RH(6), ST(6), SM(6), SH(6)	COUPT	16
X, DSMASS, AAREA(7), AAREAS(7), PR12D(6), PR13D(6), ETARD(6)	COUPT	17
X, DR(6), DS(6), DEQR(6), DEQS(6), BLOCK(6), BLOCKS(7)	COUPT	18
X, BET1MR(6), BET2MR(6), BET1MS(7), BET2MS(7), RAD11(6), RAD12(6)	COUPT	19
COMMON /VECTOR/ CPCO(6), TITLE(12), RT2(12), RH2(12), RT3(12),	COUPT	20
XRH3(12), PHIREF(12), PSIREF(12), ETAREF(12), PHIDES(12,9,8),	COUPT	21
XPSIDES(12,9,8), ETADES(12,9,8), PHI(12,9,8), PSI(12,9,8), ETA(12,9	COUPT	22
X,8), DPHIA(12), DPSIA(12), DETA(12), NSTAGE(12), PCTSPD(9),	COUPT	23
XBET2M(12,9), BLEED(12,9), TT(13), PT(13), PR(12), TR(12), PRO(12),	COUPT	24
XTRO(12), ETAO(12), BET3MR(12,9), UZ2M(12,9), UZ3M(12,9), AREA2(12)	COUPT	25
X, AREA3(12), RM2(12), RM3(12), PHI(12), UT3(12), UM2(12), UM3(12)	COUPT	26
X, BAT2MR(12,9), DPSIS(12,9), RSOLM(12), RK2M(12), CB2M(12), CB2MR(	COUPT	27
X12), CB3MR(12), RINCM(12), RDFM(12), SK2M(12), SINCM(12), BET3M(12	COUPT	28
X,9), PHIFIX(12), DPHIF(12), CPREF(12), GF1REF(12), ETAINP(12)	COUPT	29
X, FLOCAL(12,9), ETARAT(9), DB2M(12,9), DB2MR(12,9), DB3M(12,9), DB3MR	COUPT	30
X(12,9), B2MB3R(12,9), SPEEDF, FLOWIN, U3DUV2R(12), U2UV3(12), DB3MRG(12)	COUPT	31
X, DB3MRN(12,9), DB3MRP(12,8), CPCM(6), CPCS(6)	COUPT	32
*, RK3M(12), RDEU(12), RDEF(12), GMREF(12)	COUPT	33
*, PSID1(12,2,8), PSID2(12,2,8), PSID3(12,2,8), PSID4(12,2,8)	COUPT	34
*, PSID5(12,2,8), PSI1(12,2,8), PSI2(12,2,8), PSI3(12,2,8)	COUPT	35
*, PSI4(12,2,8), PSI5(12,2,8)	COUPT	36
*, PSID1L(12,2,8), PSID2L(12,2,8), PSID3L(12,2,8)	COUPT	37
*, PSID4L(12,2,8), PSID5L(12,2,8), PSI1L(12,2,8)	COUPT	38
*, PSI2L(12,2,8), PSI3L(12,2,8), PSI4L(12,2,8), PSI5L(12,2,8)	COUPT	39
COMMON /SCALER/ RU, PI, G, AJ, RAD, RG, DCP, GJ, G2J, RPMRAD, NSTA	COUPT	40
X, NSPE, NPTS, PO, TO, DESRPM, DESFLO, UNITS	COUPT	41
X, CP, GAMMA, GM1, GF1, GF2, GF3, SPDPSI, SPDPHI, DRDEUG, DRDEUN, DRDEVP	COUPT	42
X, XAR, XMET, XSTM	COUPT	43
X, STAGEN, SPEEDN, CHAPTS, WTMOLE	COUPT	44
FLOWIN=FLOW1	COUPT	45
DFLOW=FLOWIN	COUPT	46
FLOWFI=FLOWIN	COUPT	47
IF (UNITS.NE.1.0) GO TO 81	COUPT	48
FLOWIN = FLOWIN/0.453592	COUPT	49
DFLOW = DFLOW/0.453592	COUPT	50
FLOWFI = FLOWFI/0.453592	COUPT	51
81 CONTINUE	COUPT	52
JS=1	COUPT	53
DO 82 J=1, NSPE	COUPT	54
IF (SPEEDF.EQ.PCTSPD(J)) JS=J	COUPT	55
82 CONTINUE	COUPT	56
C *** CALCULATE THE OUTPUT	COUPT	57
I=ISTAGE	COUPT	58
TT(I)=TG(1)	COUPT	59
PT(I)=P(1)	COUPT	60
WTFLOW = FLOWIN	COUPT	61
RHOT= PT(I)/(TT(I)*RG)	COUPT	62
TS= TT(I)	COUPT	63
RHOS= RHOT	COUPT	64
RHOW=62.3	COUPT	65
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	COUPT	66
WTFLOW = WTFLOW - FLOWIN*BLEED(I, JS)	COUPT	67
U2 = UT2(I)*SPEEDF	COUPT	68
U3 = UT3(I)*SPEEDF	COUPT	69
UMM2 = UM2(I)*SPEEDF	COUPT	70
UMM3 = UM3(I)*SPEEDF	COUPT	71
100 UZ=WTFLOW/(RHOS*AREA2(I))	COUPT	72
U= UZ/COS(BET2M(I,1))	COUPT	73
CP=CPFM(TS)	COUPT	74
RHOS= RHOT*(1.0-U*(G2J*CP*TT(I)))*GF1	COUPT	75
RHOSM=1.0/((1.0-XWT(1))/RHOS+XWT(1)/RHOW)	COUPT	76
IF ((U*U).GT.(G2J*CP*TT(I))) GO TO 113	COUPT	77

WRITE(6,406) P(1),P(2),P(3)	COUPT	218
406 FORMAT(1H ,1X,≠TOTAL PRESSURE≠,10X,3(F10.4,5X))	COUPT	219
WRITE(6,407) PS1,PS2	COUPT	220
407 FORMAT(1H ,1X,≠STATIC PRESSURE≠,9X,2(F10.4,5X))	COUPT	221
WRITE(6,408) TG(1),TG(2),TG(3)	COUPT	222
408 FORMAT(1H ,1X,≠TOTAL TEMPERATURE(GAS)≠,3X,3(F10.4,5X))	COUPT	223
WRITE(6,409) TS1,TS2	COUPT	224
409 FORMAT(1H ,1X,≠STATIC TEMPERATURE(GAS)≠,1X,2(F10.4,5X))	COUPT	225
WRITE(6,410) RHOG(1),RHOG(2)	COUPT	226
410 FORMAT(1H ,1X,≠STATIC DENSITY(GAS)≠,5X,2(F10.4,5X))	COUPT	227
WRITE(6,412) UZ1,UZ2	COUPT	228
412 FORMAT(1H0,1X,≠AXIAL VELOCITY≠,10X,2(F10.4,5X))	COUPT	229
WRITE(6,413) U1,U2	COUPT	230
413 FORMAT(1H ,1X,≠ABSOLUTE VELOCITY≠,7X,2(F10.4,5X))	COUPT	231
WRITE(6,414) W1,W2	COUPT	232
414 FORMAT(1H ,1X,≠RELATIVE VELOCITY≠,7X,2(F10.4,5X))	COUPT	233
WRITE(6,415) U(ISTAGE),UU2(ISTAGE),U(ISTAGE+1)	COUPT	234
415 FORMAT(1H ,1X,≠BLADE SPEED≠,13X,3(F10.4,5X))	COUPT	235
WRITE(6,416) US1,US2	COUPT	236
416 FORMAT(1H ,1X,≠TANG. COMP. OF ABS. VEL.≠,2(F10.4,5X))	COUPT	237
WRITE(6,417) WS1,WS2	COUPT	238
417 FORMAT(1H ,1X,≠TANG. COMP. OF REL. VEL.≠,2(F10.4,5X))	COUPT	239
WRITE(6,418) ASPED1,ASPED2	COUPT	240
418 FORMAT(1H ,1X,≠ACOUSTIC SPEED≠,10X,2(F10.4,5X))	COUPT	241
WRITE(6,419) AMAC1,AMAC2	COUPT	242
419 FORMAT(1H ,1X,≠ABSOLUTE MACH NUMBER≠,4X,2(F10.4,5X))	COUPT	243
WRITE(6,420) AMACH1,AMACH2	COUPT	244
420 FORMAT(1H ,1X,≠RELATIVE MACH NUMBER≠,4X,2(F10.4,5X))	COUPT	245
WRITE(6,421) FAI1,FAI2	COUPT	246
421 FORMAT(1H0,1X,≠FLOW COEFFICIENT≠,8X,2(F10.4,5X))	COUPT	247
WRITE(6,422) AAA1,AAA2	COUPT	248
422 FORMAT(1H ,1X,≠FLOW AREA≠,15X,2(F10.4,5X))	COUPT	249
WRITE(6,423) ALFA1,ALFA2,ALFA3	COUPT	250
423 FORMAT(1H0,1X,≠ABSOLUTE FLOW ANGLE≠,5X,3(F10.4,5X))	COUPT	251
WRITE(6,424) BETA1,BETA2	COUPT	252
424 FORMAT(1H ,1X,≠RELATIVE FLOW ANGLE≠,5X,3(F10.4,5X))	COUPT	253
WRITE(6,425) AINCIR,AINCIS	COUPT	254
425 FORMAT(1H ,1X,≠INCIDENCE≠,16X,2(F10.4,5X))	COUPT	255
WRITE(6,426) ADEVIR	COUPT	256
426 FORMAT(1H ,1X,≠DEVIATION≠,30X,1(F10.4,5X))	COUPT	257
IF (UNITS.EQ.1.0) WTFLOW = WTFLOW/0.453592	COUPT	258
GO TO 111	COUPT	259
110 WRITE(6,2100) I,PHIC	COUPT	260
2100 FORMAT (10H FOR STAGE,13,18H , COMPUTED PHI IS,F8.4,06H STALL)	COUPT	261
GO TO 111	COUPT	262
120 WRITE(6,2110)I,PHIC	COUPT	263
2110 FORMAT (10H FOR STAGE,I3,18H , COMPUTED PHI IS,F8.4,06H CHOKE)	COUPT	264
GO TO 113	COUPT	265
111 FLOWIN=FLOWIN+DFLOW	COUPT	266
IF (FLOWIN.LE.FLOWFI) GO TO 81	COUPT	267
113 CONTINUE	COUPT	268
DO 112 I=1,NSTA	COUPT	269
DO 112 J=1,NSPE	COUPT	270
112 DPSIS(I,J) = 0.0	COUPT	271
RETURN	COUPT	272
END	COUPT	273

1. Report No. NASA CR-3624	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle WISGSK - A COMPUTER CODE FOR THE PREDICTION OF A MULTISTAGE AXIAL COMPRESSOR PERFORMANCE WITH WATER INGESTION		5. Report Date NOVEMBER 1982	6. Performing Organization Code
		8. Performing Organization Report No. None	10. Work Unit No.
7. Author(s) T. Tsuchiya and S. N. B. Murthy		11. Contract or Grant No. NAG-3-62	13. Type of Report and Period Covered Contractor Report
9. Performing Organization Name and Address Purdue University School of Mechanical Engineering West Lafayette, Indiana 47907		14. Sponsoring Agency Code 505-32-2A (E-1242)	
		12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D. C. 20546	
15. Supplementary Notes Final report, Project Manager, Ronald J. Steinke, Fluid Mechanics and Acoustics Division, NASA Lewis Research Center, Cleveland, Ohio 44135.			
16. Abstract A computer code is presented for the prediction of off-design axial flow compressor performance with water ingestion. Four processes have been considered to account for the aero-thermo-mechanical interactions during operation with air-water droplet mixture flow: (i) blade performance change, (ii) centrifuging of water droplets, (iii) heat and mass transfer process between the gaseous and the liquid phases and (iv) droplet size redistribution due to break-up. Stage and compressor performance are obtained by a stage stacking procedure using representative velocity diagrams at a rotor inlet and outlet mean radii. The Code has options for performance estimation with (a) mixtures of gas and (b) gas-water droplet mixtures, and therefore can take into account the humidity present in ambient conditions. A test case illustrates the method of using the Code. The Code follows closely the methodology and architecture of the NASA-STGSTK Code for the estimation of axial-flow compressor performance with air flow.			
17. Key Words (Suggested by Author(s)) Compressor off-design Water ingestion Axial-flow compressor Water droplets Multistage compressor Stage stacking Two phase flow		18. Distribution Statement Unclassified - unlimited STAR Category 07	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 256	22. Price* A12

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