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LO-FREQUENCY AUGMENTOR INSTABILITY INVESTIGATION COMPUTER PROGRAM USER'S MANUAL

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December 1978

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This report describes the computer code and the models developed to form the computer code used to analyze low frequency augmentor instability (rumble). Rumble occurs mainly at high fuel-air ratios and at flight Mach numbers and altitudes where low duct inlet air temperatures and pressures exist. The model was developed in conjunction with and checked by two experimental programs. Complete descriptions of the models and the programs responsible for their development are contained in AFAPL-TR-78-82 and AFAPL-TR-78-24.

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FOREWORD

This report was prepared in accordance with Contract F33615-76-C-2024, Project Number 3066 Lo-Frequency Augmentor Instability Study. The work was conducted under the direction of Captain F. N. Underwood, Project Engineer, TBC of the Air Force Aero Propulsion Laboratory. The Naval Air Propulsion Center co-sponsored the contract and Mr. W. W. Wagner was the program monitor. This report presents the user's manual for the low-frequency instability digital computer program developed by Pratt & Whitney Aircraft Group, Government Products Division of United Technologies Corporation, P. O. Box 2691, West Palm Beach, Florida 33402. This was was performed during the period 1 March 1976 through 1 March 1978 and was submitted for approval 1 April 1978. The principal contributors were G. Petrino, R. Murphy, G. Brant, and R. Ernst, under the direction of P. L. Russell, the Program Manager for the Pratt & Whitney Aircraft Group.

TABLE OF CONTENTS

LIST OF SYMBOLS

English Symbol	Definition	Typical Units
A	Area	in^2
A	Stirred reactor mass loading	gm-mole/sec
A	Dummy variable in eqn. (128)	d'less
a	Reaction index in eqn. (111)	d'less
A_s	Surface area	sq. inches.
BPR	Bypass ratio	d'less
B/D	Wake width per unit flameholder	d'less
C	Activation energy constant in eqn. (111)	°K
c	Sonic velocity	in/second
C_d	Drag coefficient	d'less
C_p	Specific heat at constant pressure	Btu/lbm-°R
C_v	Specific heat at constant volume	Btu/lbm/°R
C_v	Wake shape factor	litre/in^2
C_1	Dummy variable in eqn. (85)	d'less
d	Diameter	in
D_v	Diffusion coefficient	in^2/sec
FA	Fuel-air ratio	d'less
H	Enthalpy	Btu/lbm
h_f	Film coefficient	Btu/in^2 sec°R
k	Reaction rate in eqn. (107)	d'less
k	Thermal conductivity in eqn. (91)	Btu/in sec°R
K	Dummy variable in eqn. (71)	d'less
K_1	Recirculative coefficient	d'less
L/D	Wake length per unit flameholder width	d'less
m	Mass	lbm
$\dot{m}$	Mass flowrate	lbm/sec
M	Mach number	d'less
MW	Molecular weight	lbm/lb-mole
n	Reaction order in eqn. (107)	d'less
N	Flameholder width	inches
Nu	Nusselt number	d'less

English Symbol	Definition	Typical Units
p	Pressure	lbf/in^2
Δp	Pressure drop	lbf/in^2
PFSR	Sprayring fuel pressure	lbf/in^2
Pr	Prandtl number	d'less
q	Volumetric heat release rate	Btu/second/in^3
$\dot{q}$	Heat flux	Btu/in^2 sec
R	Gas constant	ft-lbf/lbm-$^\circ$R
Re	Reynold's number	d'less
S	Entrophy	Btu/lbm/$^\circ$R
St	Turbulent flame speed	ft/sec
S1	Laminar flame speed	ft/sec
T	Temperature	$^\circ$F, $^\circ$R, $^\circ$K
Ti	Ideal temperature	$^\circ$R
t	Time	seconds
TFSR	Sprayring fuel temperature	$^\circ$F
U	Flameholder lip velocity	ft/sec
u	Internal energy	Btu/lbm/$^\circ$R
u	RMS turbulence velocity fluctuation	ft/sec
V	Velocity	ft/sec
Vo	Wake volume	litre
W	Duct width	inches
W	Mass flowrate	lbm/second
WCOOL	Liner cooling flow/total engine flow	d'less
X	Axial distance	inches
Δx	Distance	inches
y	Stoichiometry factor in eqn. (108)	d'less
Δy	Flame penetration distance	inches
z	Defined in eqn. (76)	d'less
Z	Defined in eqn. (125)	d'less

Greek Symbol	Definition	Typical Units
a	Flameholder apex angle	degrees
β	Defined in eqn. (75)	d'less
β_1	Droplet vaporization coefficient	d'less
β_2	Droplet collective coefficient	d'less
β_3	Surface vaporization coefficient	d'less
Γ	Blockage ratio	d'less
γ	Ratio of specific heats	d'less
ϵ	Wake reaction efficiency	d'less
ϵ_o	Turbulence intensity	d'less
η	Efficiency	d'less
λ	Latent heat of vaporization	Btu/lbm
μ	Viscosity	lbf/in
χ_o	Oxygen concentrative	gm-mole/litre
χ_{o2}	Oxygen volume fraction	d'less
χ_f	Fuel concentrative	gm-mole/litre
ρ	Density	lbm/in^3
τ	Wake residence time	seconds
τ'	Normalized residence time	d'less
ℓ	Axial length between stations	inches
δ	Ratio of specific heats	d'less
τ	Sonic travel time	seconds

Special Symbol:

Δ	Finite difference	

Subscripts	Definition
a	Air
c	Collected; Combustion, fan stream values
ex	Exit
ext	External
f	Fuel
F/H	Flameholder reference
fict	Fictitious
g	Gas
H	Core stream values
i	Initial — Ideal value
l	Liquid
MB	Main burner reference
o	Initial — Signifies ideal value
OA	Overall
r	Recirculated
stoich	Stoichiometric
T	Total (combined) value
v	Vapor; Vaporized
w	Wake reference

Superscripts

—	Average value (e.g., $\overline{x}$)
—	Superscript denotes steady-state value (e.g., $\overline{V}$)
′	Superscript denotes change in a variable divided by its steady-state value (e.g., $P' = \Delta P/P$)

SECTION I

INTRODUCTION

Pratt & Whitney Aircraft Group Customer Computer Deck (CCD 1144-0.0) is a two-part program consisting of: (1) Rumble Model — a dynamic analytical model that will predict the rumble stability limits and characteristics of turbofan engine augmentors, and (2) Flameholder Combustion Model — an analytical model that will predict the steady-state combustion field for a turbofan engine augmentor. The rumble model and flameholder combustion model may be exercised independent of each other or the flameholder combustion model may be exercised to supply combustion data to the rumble model (Figure 1).

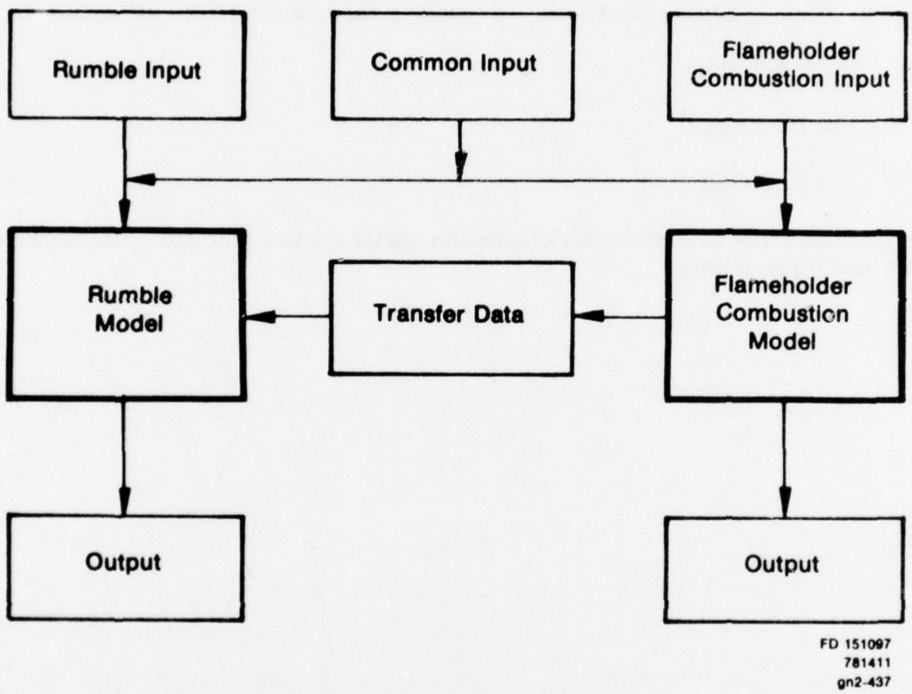

Figure 1. Combined Model Overview

The object of the rumble model is to predict the conditions under which low-frequency augmentor instability (rumble) will occur. The deck will not predict the magnitude of rumble (amplitude) but instead only identifies the conditions under which rumble will occur. The object of the flameholder combustion model is to model the augmentor heat release process in terms of physical geometry and operating conditions for liquid hydrocarbon fuels in a conventional spraybar injector — V-gutter flameholder configuration.

The deck provides the capability of changing augmentor geometry and operating conditions. In addition, the rumble model contains simulations of three augmentor designs: V-gutter, Vorbix and Full Swirl. Since the flameholder combustion model simulates only the V-gutter flameholder, empirical combustion data must be used for the Vorbix and Full Swirl cases.

The User's Manual describes the combined rumble/flameholder combustion model and how to use the program to predict: (1) turbofan engine augmentor low-frequency combustion instability (rumble) and (2) turbofan engine augmentor steady-state combustion field. To assist in checking out the CCD at the user facility, the following items are included:

(1) Program Listings

(2) Test Case Input

(3) Test Case Output

If questions arise concerning deck operation, please contact your local Pratt & Whitney Aircraft field representative.

SECTION II

TECHNICAL DISCUSSION

1. AUGMENTOR DESCRIPTION

Afterburning is a method by which the maximum thrust capability of a basic engine may be augmented by an additional 50 percent, or more. Fundamentally, an augmentor (afterburner) is a ramjet engine attached to the turbine exhaust case of a turbojet or turbofan engine. The gases discharged from the turbine of the basic engine have sufficient velocity at the higher thrust settings to satisfy ramjet requirements, regardless of whether the aircraft is in a steep dive or standing still at the end of a runway.

The basic augmentor (V-gutter), Figure 2, consists of only four fundamental parts: the afterburner duct, the fuel nozzles or spraybars, the flameholders, and a two-position or variable area nozzle. Because the exhaust nozzle area requirements vary significantly depending on whether or not the augmentor is operating, a variable area exhaust nozzle is incorporated.

Thrust modulation in the afterburning mode is accomplished by varying the flow of fuel to the augmentor. However, in order to maintain good combustion efficiency in the augmentor over a wide range of fuel-air ratios, the augmentor is separated into fuel supply "zones" or segments, for best fuel distribution.

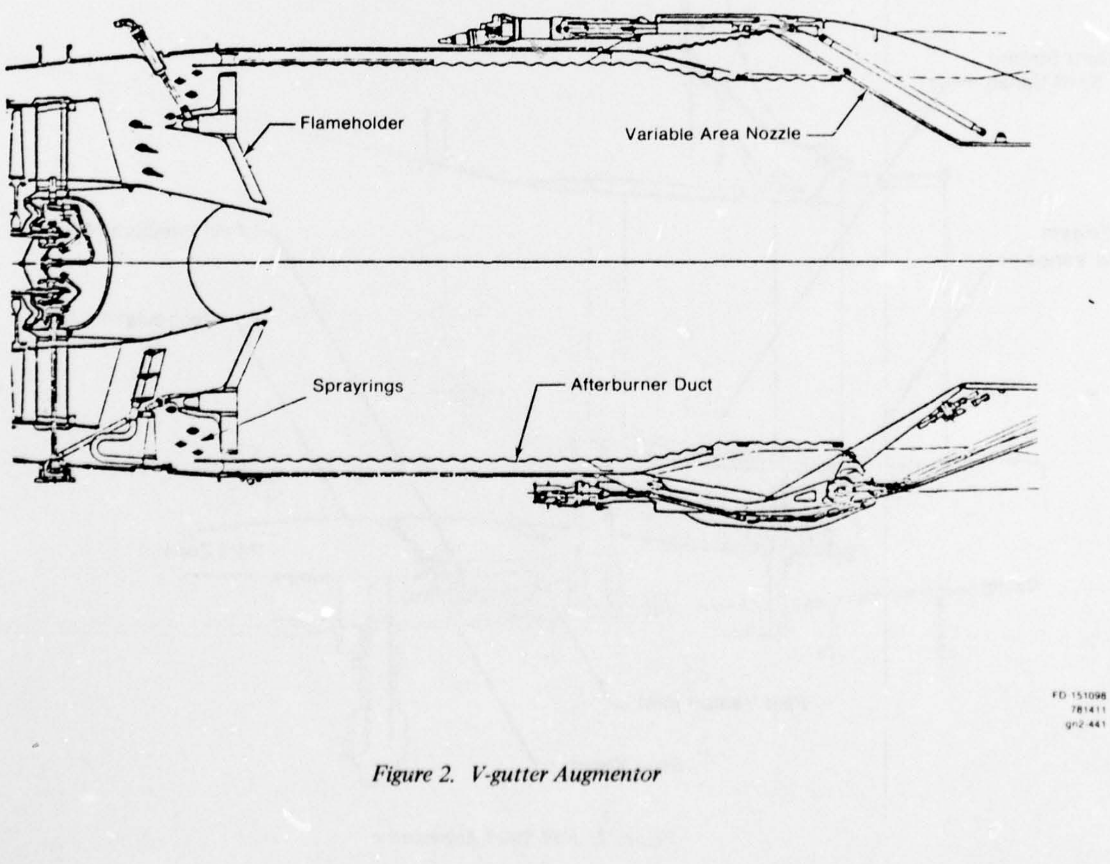

Figure 2. V-gutter Augmentor

The afterburner duct must be of such proportion that stable combustion can be maintained during augmentor operation. This requires a burning section of sufficient cross-sectional area to ensure that the gas velocity through the augmentor does not exceed the rate of flame propagation. Otherwise, the flame would not be able to establish a firm foothold because the onrushing turbine exhaust gases would push the burning mixture right out of the exhaust nozzle. Fuel is introduced through a series of perforated spraybars located inside the forward section of the afterburner duct. Not far aft of these, flameholders are provided to help create local turbulence and to reduce the gas velocity in the vicinity of the flame. The flameholders may take the form of concentric rings or radial arms of an angular "V" cross section, hence the name V-gutter augmentor.

Two advanced augmentor concepts are currently being investigated under Navy and NASA contracts. Both are swirling flow concepts which eliminate the necessity for flameholders. In one of the concepts, termed the Full Swirl augmentor, the entire augmentor flow is swirled around the engine centerline, Figure 3. Hot combustion products are provided on the OD of the swirling flow by an annular pilot burner on the OD of the augmentor. Main stream fuel injection is accomplished by several sprayrings. The swirling flow develops a strong centrifugal field in which hot combustion products issuing from the pilot burner on the OD of the swirling flow are rapidly displaced towards the center of the augmentor, while the cooler interior air and fuel mixture are centrifuged outward. Combustion occurs at the interface of the hot and cold gases.

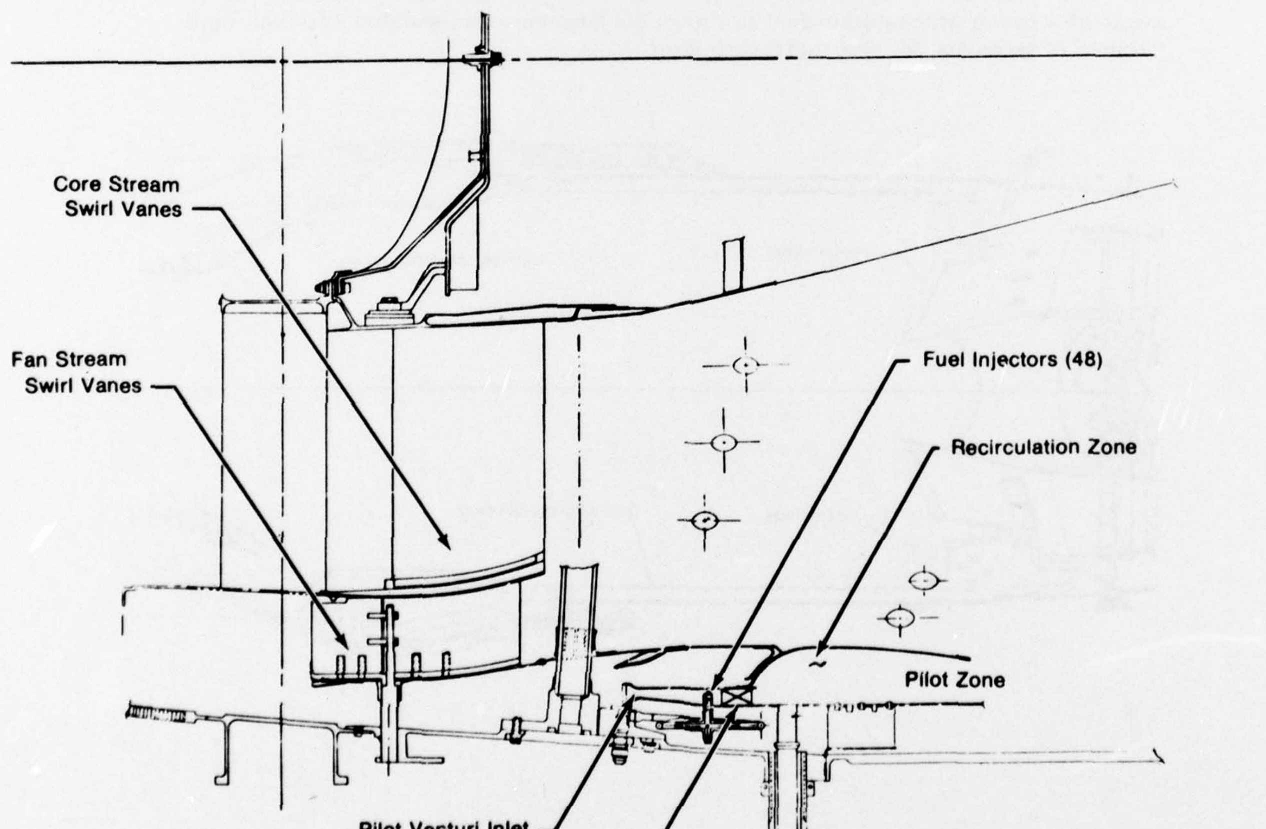

Figure 3. Full Swirl Augmentor

The second concept, termed Vorbix, (vortex burning and mixing) employs a large number of small-scale vortices developed by swirlers or triangular-wing vortex generators. Figure 4 schematically shows this concept. All augmentor fuel flow is admitted through an annular pilot burner located near midspan of the augmentor between the fan and core streams. Combustion occurs as the vortices mix the hot fuel-rich pilot exhaust with air in the fan and core streams.

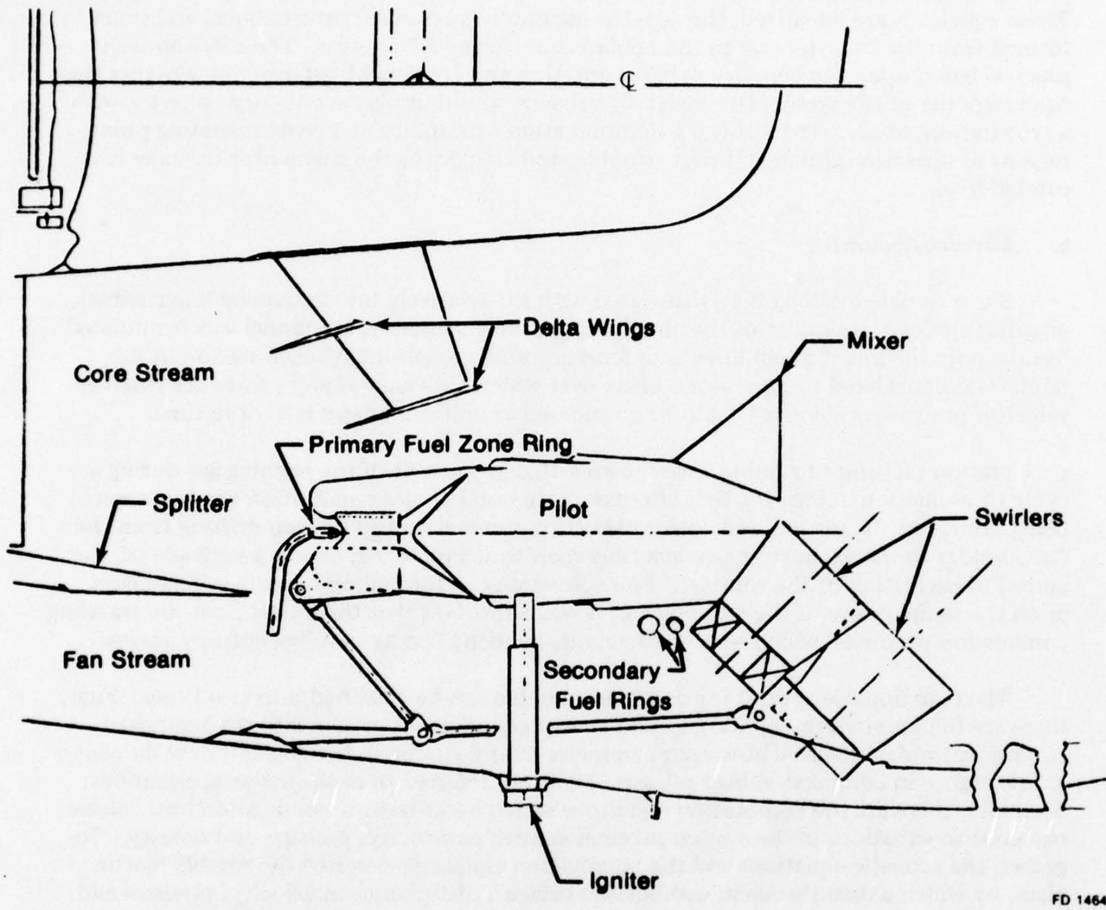

Figure 4. Vorbix Augmentor

2. RUMBLE MODEL PROGRAM DESCRIPTION

a. General

The augmentor math model consists of a set of time dependent equations describing the longitudinal dynamics of the flowing airstream and the axially distributed combustion process in the augmentor, coupled with a solution technique for determining stability. These equations are linearized, through the assumption of small perturbations, and transformed from the time domain to the Laplace transform "S" domain. The solution technique is based upon the Nyquist stability criterion and consists of determining whether the time response of the system to a small disturbance would display oscillatory behavior with a growing amplitude. The result is a determination of stability at a given operating point, regions of operation which will cause rumble, and changes to the augmentor to make it rumble-free.

b. Modeling Approach

Since rumble has long been associated with the relatively low-frequency longitudinal, or axial, modes of vibration of the air column in the augmentor, the model was formulated to take only the longitudinal dimension into account. Accordingly, each station in the model was considered to represent a plane over which the value of any parameter (such as velocity, pressure or density) could be considered as uniform at any instant in time.

Motion pictures of rumble have shown a change in color of the burning gas during a cycle of oscillation, indicating that alternate hotter and cooler combustion products were being produced. These hot and cold combustion products could be seen drifting from the flameholder to the exhaust nozzle in a time span which matched, or was a multiple of, the period of oscillation of the rumble. Since flowrate out through the nozzle is dependent upon the temperature of the entering gas, it was important that the model treat the traveling combustion products, which were mathematically identified as traveling entropy waves.

The equations developed for describing rumble can be classified into two types. First, there are the momentum, continuity and energy equations, together with the boundary conditions, which describe how each parameter at any station in the augmentor responds to a disturbance in combustion heat release. These are referred to as the acoustic equations. Secondly, there are the combustion equations which describe how combustion heat release responds to variations in the system parameters such as velocity, pressure and density. Together, the acoustic equations and the combustion equations describe the rumble mechanism, by which a disturbance in combustion causes a disturbance in velocity, pressure and density throughout the augmentor which in turn causes a disturbance in combustion. A description of the equations, boundary conditions and assumptions is presented in the Appendix A.

Since the purpose of the program was to develop an understanding of the rumble mechanism and demonstrate that the onset of rumble could be predicted, thereby defining the boundary between stable and unstable operating regions, it was necessary only to model the augmentor for the first few increments of time before the oscillation had built up into an appreciable amplitude. This allowed use of a small perturbation technique which led to linear equations and mathematical simplification. Linear equations can describe the system for small oscillation amplitudes and can predict whether the system initially at rest would begin to oscillate. Because the non-linearities associated with large amplitude oscillations (which eventually stop the amplitude from growing) were ignored, the linear equations do not allow a prediction of the final limit-cycle amplitude.

c. Model Description

The rumble model was designed for simple input-output and requires no intermediate engineering interpretation, Figure 5. The input requires engine geometry and pressures, temperatures and Mach numbers, obtained from engine steady-state cycle tables. The user may select to input augmentor fuel-air ratio and empirical combustion data or he may exercise the flameholder combustion model which calculates and supplies the required augmentor combustion data to the rumble model. An input option allows the user to specify the specific augmentor types (V-gutter, Vorbix or Swirl) to be used. No calculation nor dynamic information is required. The user may select either tabular and plotted output or only plotted output, as shown in Figure 6. From the plot the user identifies the frequencies at which the phase is zero. He then checks the gain at each of the identified frequencies. If the gain is one or greater, the program has predicted that rumble will occur. If the gain is less than one, the program has predicted that the operating point is stable. For example, Figure 6 indicates rumble at 60 Hz and at 140 Hz. The user can then change geometry or operating point inputs and repeat the process to determine the effects of the change. This form of output was chosen because it facilitated development of the model, yielded a compact, easy to interpret answer, and made better use of computer time than a time-domain solution.

To model, rumble required a transient description of the longitudinal dynamics of a turbofan engine. To computerize the formulation, the mathematical description was simplified by restricting the range of validity of the equations to small perturbations about a mean steady-state operating point. This allowed linearization of the equations to a form which correctly describes small scale transients, but in which the nonlinear terms which are important in large scale transients could be omitted. The resultant linearized equations describe the initial period of the time when rumble oscillations begin to grow and are valid to the point where the rumble amplitude reaches values at which the nonlinear terms become important. This is sufficient to determine whether an engine, if placed at a given operating point, will spontaneously bloom into rumble.

The model could have been made to yield solutions in the time-domain by programming the equations on an analog computer. The output would have been a time trace of any selected parameter (e.g., augmentor pressure). At a stable operating point the trace would be a straight line, whereas at an unstable operating point the trace would show a sinusoidal oscillation with an increasing amplitude. The amplitude would grow without bound for as long as the solution continued, because of the omission of the nonlinear terms.

The same information can be more easily obtained by a non-time-domain solution technique. Such a technique was chosen for the rumble model. Commonly called the Nyquist criterion, it is based upon the fact that the allowable forms of the time-domain solution are known. This technique allows use of a matrix program which can quickly solve large numbers of simultaneous equations.

The Nyquist criterion is a procedure which makes use of the Laplace transform and conformal mapping to determine whether the transient solution would show unstable behavior. To apply the criterion, the time-domain equations are transformed into the Laplace "S" domain. The result is a square homogenous matrix. The determinant of the matrix coefficients is a function of "S", called the characteristic function, and contains all of the information needed to determine whether the system being described is stable or unstable. If all zeros of the characteristic function have negative real parts, the system is stable; if any zeros have positive real parts, the system is unstable. Conformal mapping is used to examine the characteristic function for the presence of zeros with positive real parts.

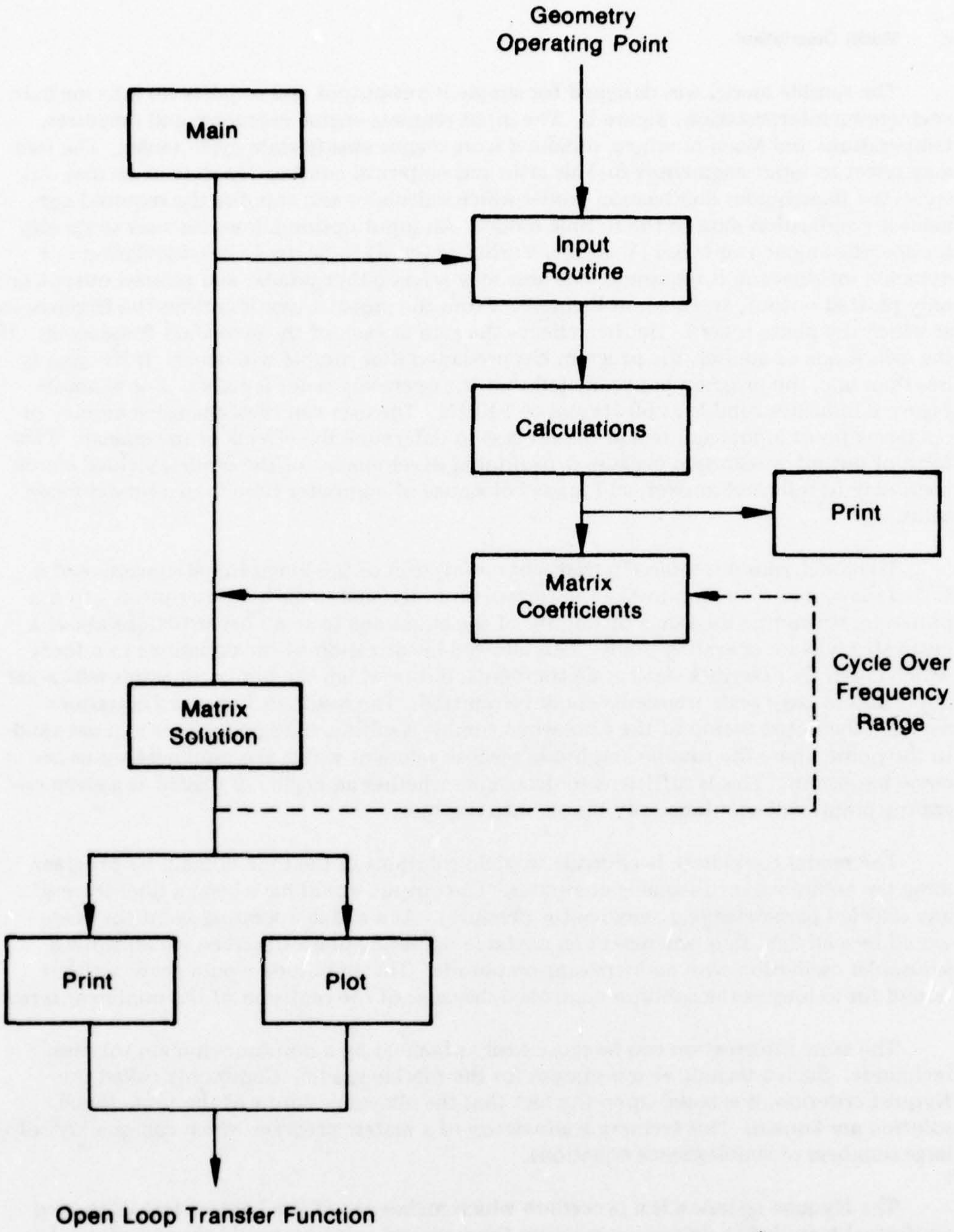

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Figure 5. Rumble Model Flow Diagram

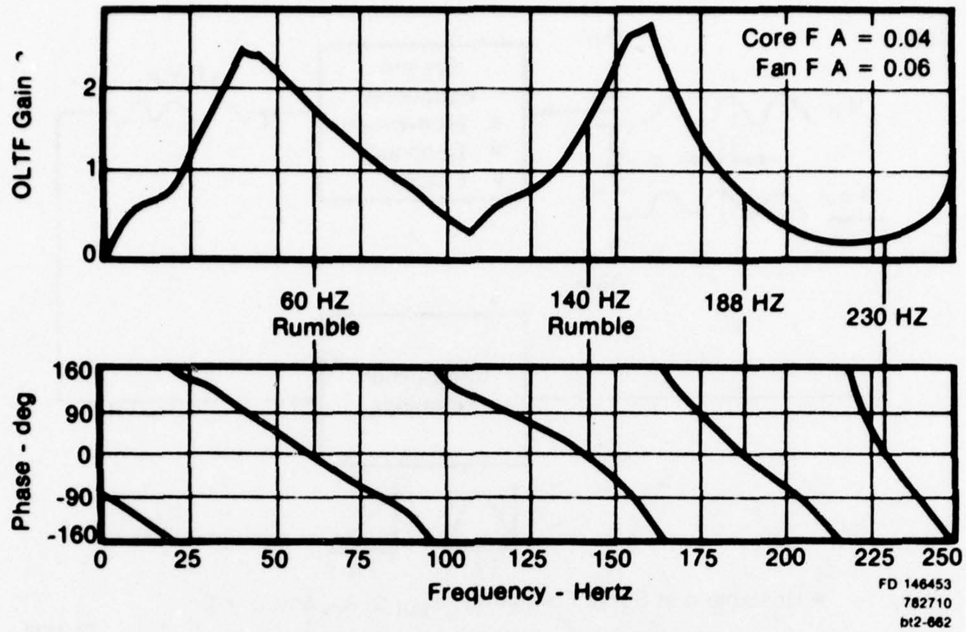


Figure 6. Rumble Model Plotted Computer Output

To accomplish the conformal mapping the equations which describe the augmentor were written to describe a "feedback loop". The feedback loop was formed for the rumble model by considering that the combustion rate, called q'_{in} was an "input" to the acoustic equations. This yielded as "output" the pressure, velocity and density at each station throughout the engine. The "output" was then considered to feedback through the combustion equations to form a "feedback" combustion heat release rate, called q'_{out}. The resultant "loop" is shown in Figure 7. Actually, only one heat release rate is present. The use of the two names q'_{in} and q'_{out} allows the formation of the ratio q'_{out}/q'_{in}, called the "Open Loop Transfer Function" (OLTF). Conformal mapping to examine the zeros of the characteristic function is carried out by using the OLTF.

Referring to Figure 7, the heuristic argument can be made that if a loop is subjected to an externally supplied sinosidal input (q'_{in}) and it returns a feedback (q'_{out}) which is in phase with the input ($\phi = 0$) and of equal amplitude (gain = 1), then the externally supplied input could be removed and the loop would continue to oscillate. A gain greater than one then implies that the loop would be driven to ever higher amplitude, while a gain less than one implied that the oscillations would die out once the input were removed. The model determines whether the time solution, if calculated would display oscillatory behavior with a growing amplitude. It does this through a solution technique which is simpler and faster to apply than a solution in the time-domain.

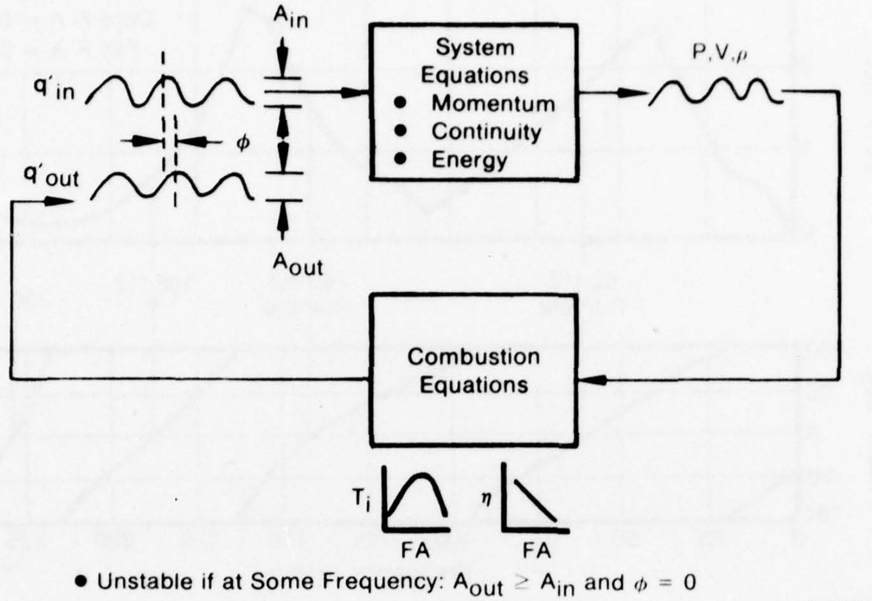


Figure 7. "Feedback Loop" Visualization of Rumble Model

3. FLAMEHOLDER COMBUSTION MODEL PROGRAM DESCRIPTION

a. General

The combustion model performs a multi-streamtube analysis of the flame stabilization and propagation phenomena in a turbofan augmentor. The augmentor is divided into a multitude of equivalent two-dimensional streamtubes with a single flameholder element in each. The program evaluates each streamtube and then mass averages the results.

For each streamtube the program proceeds from the augmentor inlet towards the exhaust nozzle and evaluates each step in the stabilization and propagation of the augmentor process. The ultimate result is the level of combustion efficiency in that streamtube. The program then performs a small perturbation in velocity, pressure, inlet temperature and fuel-air ratio to evaluate the efficiency slopes.

The final outputs are the fan duct efficiency, the core stream efficiency and the efficiency slopes with respect to the four perturbed variables.

b. Modeling Approach

The approach taken for each streamtube is a step-by-step solution to the physical phenomena which determine the flame stability limits of the spraybar-flameholder configuration and the subsequent turbulent flame propagation rate. These phenomena include liquid fuel injection, droplet formation, vaporization, fuel impingement onto the flameholder, wake reaction kinetics and turbulent flame penetration.

The approach used is different for the fan duct streamtubes and the core streamtubes. The necessity for different approaches lies in the degree of liquid fuel vaporization between the spraybar and the flameholder. In the core streamtubes,the fuel is virtually totally vaporized in the first few inches by the hot turbine exhaust flow. In the fan duct stream, the much cooler airflow results in only a slight degree of vaporization in the four to six inches typical spraybar to flameholder distance.

The core stream analysis is thus done assuming that the fuel at the flameholder is in the vapor phase and the flameholder wake fuel-air ratio is the same as the total fuel-air ratio. This value is used in the kinetics analysis of the wake reaction to evaluate the stability limits.

In the fan duct streamtubes, however, the low level of droplet vaporization yields a vapor phase fuel-air ratio at the flameholder which is well below the lean limit for hydrocarbon fuels. Since the liquid fuel droplets are not capable of entering the flameholder recirculation wake due to their excessive momentum, there must be some other mechanism to provide the necessary wake vapor fuel for stable combustion.

This mechanism in the fan duct streamtubes is the collection of the liquid fuel droplets onto the surface of the flameholders and the vaporization of the resultant liquid film. This evolved vapor recirculates into the flameholder wake with a portion of the droplet evolved vapor fuel to generate the wake vapor fuel concentration.

The streamtube analyses compute the degree of wake reaction at the level of vapor fuel-air ratio appropriate to the streamtube type and approach conditions. For the fan duct cases, this requires a convergent solution between the wake kinetics and the surface vaporization.

Once the flameholder wake reaction level is evaluated, the analysis computes the rate of flame penetration into the free-stream as a turbulent flame sheet. This rate is adjusted by the wake reaction level to account for the ignition response in the recirculation zone shear layers. The flame penetration rate is integrated over the available augmentor length to provide the level of streamtube efficiency.

The program thus performs a quantitative evaluation of the phenomological processes which occur in the turbofan augmentor. The individual calculations are a combination of analytical evaluations and empirical results as required to ensure quantitative accuracy.

c. Model Description

The combustion model was designed as a complete unit. The program does not require on-line engineering interaction. The combustion model may be run as a separate entity or as a generator for subsequent stability analysis with the rumble model. When exercised alone, the combustion model is an augmentor analysis program and the output is a comprehensive description of the injection, stabilization and flame propagation processes. In this mode, the program is useful as a design tool for conventional turbofan augmentors. The effects of fuel system distribution and V-gutter flameholder tailoring may be determined.

When exercised in conjunction with the stability analysis, a lesss extensive output is given and the prime purpose of the program is to generate the response of augmentor efficiency to variations in fuel-air ratio and inlet velocity, pressure and temperature.

The augmentor breakdown and specific description of one streamtube is shown in Figure 8. For a single fan duct streamtube, the computer logic is shown in Figure 9. The identified subroutines each evaluate a specific portion of the overall combustion process.

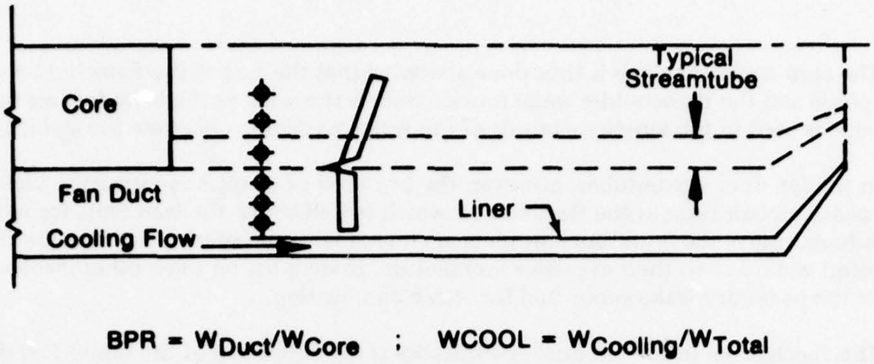


Figure 8. Location of a Core Streamtube in a Turbofan Engine Augmentor

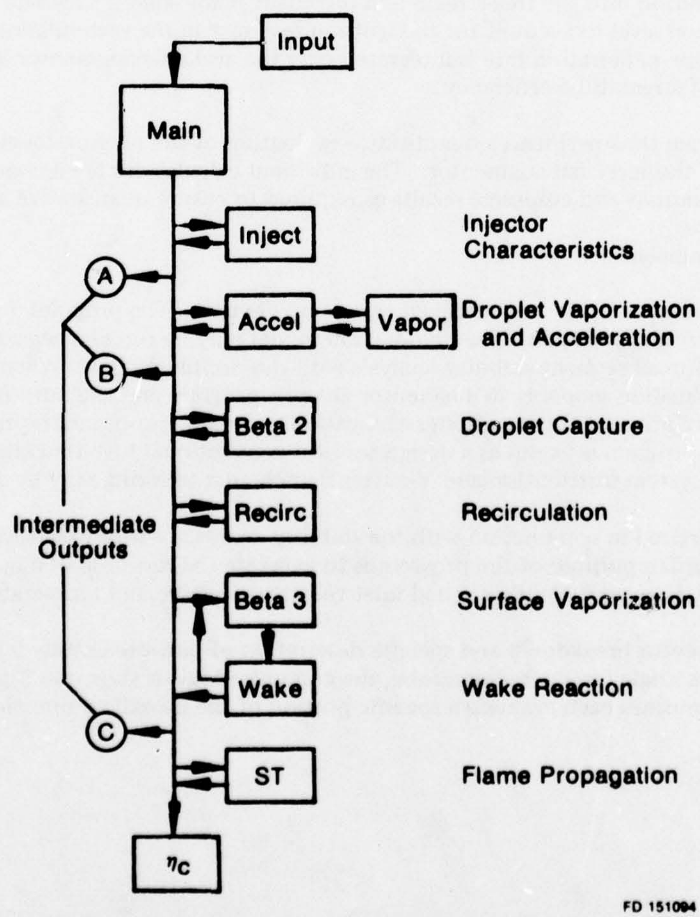


Figure 9. Single Streamtube Logic Map

The input requirements for a fan duct streamtube are those to fully describe the approach flow field, geometry of the streamtube and flameholder, and the total fuel-air ratio. The execution of one streamtube proceeds as follows:

(1) INJECT

This subroutine evaluates the droplet sizes formed by a variable area spraybar as a function of the injection pressure drop. Five droplet sizes are calculated which represent the cummulative volume versus pressure drop curve for this spraybar type.

This subroutine evaluates the amount of the liquid fuel which is flash-vaporized by the injection process. This evaluation is performed as an adiabatic expansion process from the high-pressure spraybar fuel condition to the low-pressure augmentor conditions. The appropriate fuel enthalpy chart is used, keyed by the fuel type input variable.

The liquid flowrate which remains is partitioned equally into the five size groups. The total flowrate is originally calculated from the total fuel-air ratio input and the air flow which is calculated from the streamtube geometry and flow conditions.

(2) ACCEL

This program subroutine evaluates the rate of droplet vaporization and acceleration which occurs between the spraybar and the downstream V-gutter flameholder.

The equations for acceleration assume a spherical liquid droplet which is accelerated by drag forces only. The drag coefficient is evaluated as a function of Reynold's number based on the relative air-liquid velocity.

Concurrently, the rate of liquid vaporization is evaluated as forced convection mass transfer utilizing a mass transfer Nusselt number correlation which is also based on the relative velocity Reynold's number. The requirement to simultaneously solve the vaporization and acceleration equations was met by a finite difference solution. A small time increment is selected and the acceleration solution performed to generate a velocity increase for the liquid droplet. Using the average velocity over this time increment, a vaporization rate is calculated and a vaporized fraction evaluated. This sets a new droplet size for the next time interval. The average velocity over this time is also used to calculate a distance travelled.

This procedure is repeated until either the liquid droplet reaches the flameholder or is fully vaporized. This analysis is repeated for each size group of the five initially set.

(3) COLLECT

At the flameholder plane, the program evaluates the rate of liquid deposition onto the surface of the V-gutter. This deposition occurs as the liquid droplets are unable to follow the divergent air flow streamlines around the leading edge of the flameholder.

The evaluation of the rate of deposition is performed as a correlative solution to the point where liquid droplets just hit the flameholder surface. The variables include flameholder geometry, droplet diameter and flow conditions. The correlation equations are based on calculations which were done externally to this program, where limit trajectories were established based on potential flow solutions to the flow field approaching the flameholder.

The program utilizes the droplet diameter which exists after the vaporization evaluation to calculate the percentage of the liquid flowrate in each size group which is deposited on the V-gutter surface. This is done for each of the five size groups. The collection mass flowrate is evaluated from each size group collection percentage and the liquid flowrate in each group at the flameholder.

(4) RECIRC

The gaseous recirculation rate into the flameholder wake is evaluated from a variety of literature sources which present recirculation zone volume and flowrate as a function of flameholder geometry and flow conditions. The program evaluates a "recirculation efficiency" which is the ratio of recirculated mass flow to the flowrate through the area blocked by the flameholder. This typically runs 15 to 25%.

The correlations cover a range of the variables which control the recirculation such as flameholder apex angle, blockage, approach Mach number, and temperature. The result of the subroutine is the recirculation zone. These are used in the analysis of the wake reaction efficiency.

(5) WAKE

The wake reaction is treated as if it occurred in a well-stirred reactor with volume and entry flowrate as evaluated in RECIRC. The kinetics are assumed to proceed as a single-step, second order conversion process. The kinetics utilize rate coefficients which simulate aircraft fuel behavior. The required inputs are wake volume, wake fuel-air ratio, recirculation rate and inlet conditions of pressure, temperature, etc. The output of the analysis is the wake reaction efficiency and mean wake temperature.

(6) BETA 3

This subroutine evaluates the degree of vaporization of the liquid film which exists on the flameholder surface. The vaporization process is one of forced convection from the surface into the trailing wake shear layer and heat transfer from the flameholder wake through the flameholder metal into the liquid film. The program utilizes a small element approach using 10 elements on each side of the flameholder. The mass flux and heat flux are evaluated for one-at-a-time starting at the flameholder leading edge. Any liquid left unvaporized is assumed to leave the trailing edge of the flameholder and traverse through the wake shear layers downstream.

The solution of WAKE and BETA 3 must be done simultaneously since BETA 3 requires wake temperature to find fuel vaporization and the vaporization influences WAKE through fuel-air ratio.

The solution approach is described in Appendix B with a typical result shown here in Figure 10.

(7) FLAME

The turbulent flame propagation downstream of the flameholder uses a small step difference solution with axial profiles of turbulence, flow, etc. The procedure is described in Appendix B.

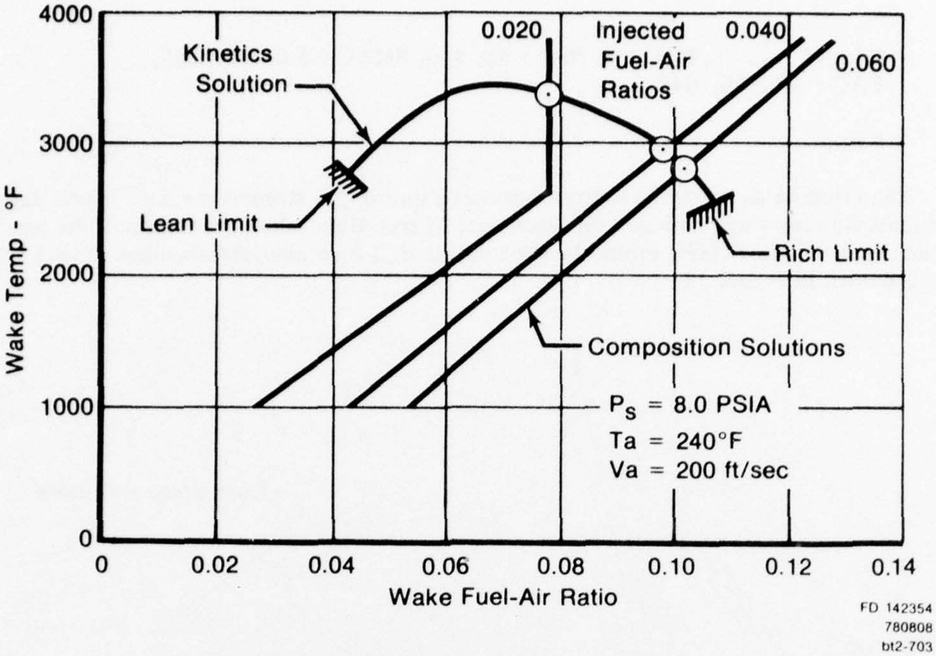


Figure 10. Duct Stream Flameholder Wake Solution

d. Input Requirements and Comments

The model requires as input the physical variables which describe the fan duct and core stream geometry and operating conditions. Since the model functions by repetitive analysis of single streamtubes, the input is required for each different type of streamtube. A different type is one with any input variable different.

The input requires the following values along with the input described in Section II. 6.

BPR	Actual value. Default to 1.0 if run as a duct burner with no core engine and WCOOL = 1/2 x ($\dot{m}$cool/$\dot{m}$duct)
M6C, M6H	Inlet Mach numbers
NTC	No. of types of fan duct streamtubes
NTH	No. of types of core streamtubes
PS6	Inlet static pressure, psia

Array input is required to describe each streamtube fully. These array values are aerodynamic and geometric. The array is the number of streamtube types in the fan (NTC) or core (NTH) and the number of stream flow tubes of each type identified in the fan (NSC) or core (NSH) sections. If three different types of fan streamtubes are used (NTC = 3), with a total number of 28 fan streamtubes (18 of flameholder width (FHWC) = 1.0 in., 4 of flameholder width = 0.75 in. and 6 of flameholder width = 1.25 in., NSC = 18, 4, 6) and if the first two types operate at the same fuel-air ratio (FAC), but different from the third, then the input to the model to describe this case would be (see Figure 18):

δ Input . . . . . . , NTC = 3, NSC = 18, 4, 6, FHWC = 1.0, .75, 1.25,
FAC = .05, .05, .045, ...

δ End

The program as currently written assumes a unit depth streamtube, i.e., 1 inch depth. The mass flowrates will be based on this value. If true flow values are required, the number of each type (NSC or NSH) should be the number of 1 inch deep streamtubes of that type. This is shown in Figure 11.

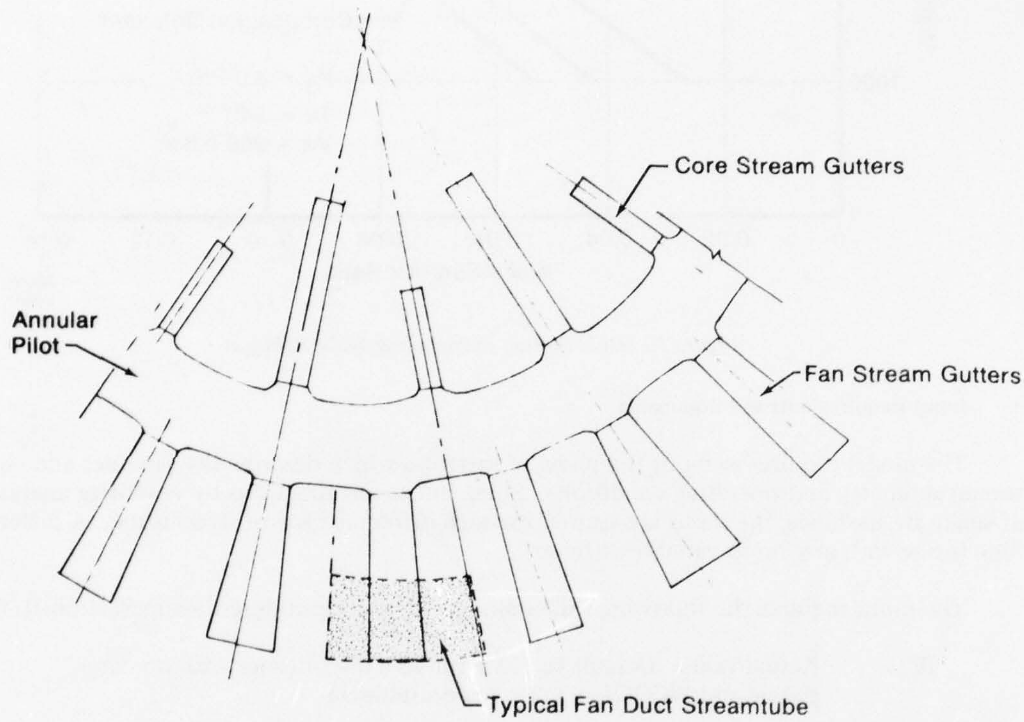


Figure 11. Location of Typical Fan Duct Streamtube

The geometric inputs required for a single streamtube are shown in Figure 12. The value of blockage is referenced to Figure 11. The input should reflect the ratio of flameholder width to the streamtube limits. This value of blockage sets the required flame penetration for 100% efficiency and must be input correctly.

The value of EPSC is the approach turbulence and will affect the flame speed. Unless specific data are available, use a value of 0.04 for a turbofan engine.

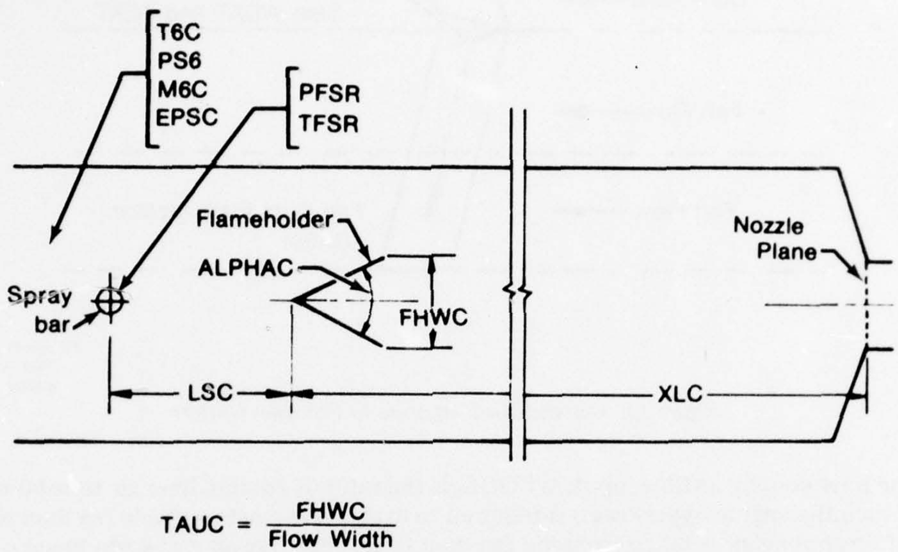


Figure 12. Single Streamtube Geometry and Flow Inputs - Fan

The input value for PFSR controls the mean droplet size from the sprayring, which has data from a variable area orifice built in. If other values are desired, use the equation:

$$d_{50} = 795 - (PFSR - PS6)^{-.4}$$

to determine the input value of PFSR required to yield a desired mean droplet diameter, in microns. This is the only place where PFSR is used, so no disruption occurs if non-true values are input.

For the aerodynamic inputs, also reference Figure 12, the required input is shown. As previously mentioned, PS6 is assumed to be uniform across the streamtubes.

One input set requires external evaluation. This is the values assigned to WEXT and TEXT in the fan duct streamtubes. The purpose of this input is to account for the influence of hot gas migration down the wake region of the fan duct flameholders from either the core or from a pilot. WEXT is defined as the ratio of this "external" flowrate to the recirculated flowrate. To allow for flexibility in design selection, this input format was selected. The user must evaluate whatever flowrate is expected and calculate WEXT. For use in estimating the recirculated flowrate, assume $K_1 = 0.25$ use:

$$\dot{m}_r = K_1 \cdot \rho a \, VaN$$

for recirculation rate per inch of flameholder length. Typical values of WEXT are .02 to .04. TEXT is the temperature of this "external" flowrate. These are shown in Figure 13.

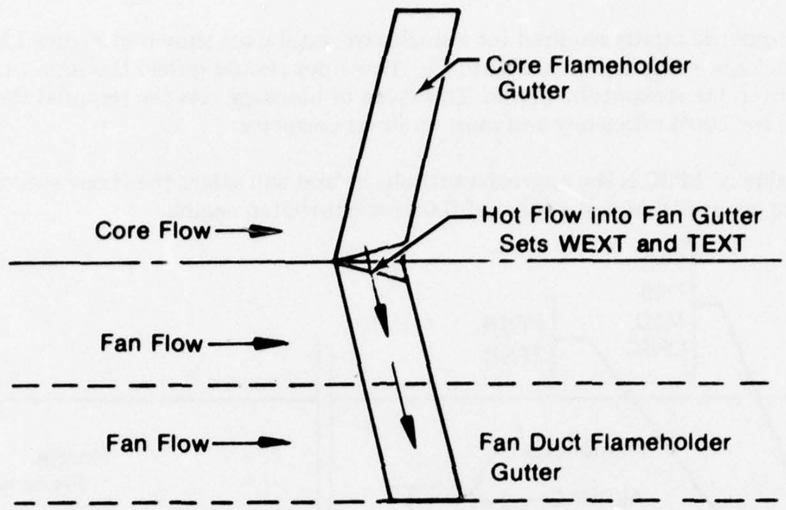


Figure 13. External Heat Addition to Fan Duct Gutters

The liner cooling airflow input, WCOOL, is the ratio of cooling liner air to total engine air. As such,the engine bypass ratio is required to evaluate the net available fan duct airflow. If no cooling air is taken from the fan duct or if input fuel-air ratios are based on the ture net air available for combustion, input WCOOL = 0.0. If a duct burner is being analyzed and it does have a cooling liner, set a dummy value of 1.0 for BPR and set WCOOL by:

$$WCOOL = \dot{m}_{cooling}/2 \cdot \dot{m}_{duct\ burner}$$

e. Output

The program has two output formats, long and short. The long format presents detailed values for the processes which control the wake vapor-phase fuel-air ratio and flame penetration. The short format essentially presents the overall results. For both, the results are presented as a streamline-by-streamline analysis with fan and core summaries.

(1) FAN STREAMTUBES

The long format presents the input data for each streamtube and two calculated values. These values are the effective streamtube fuel-air ratio and the effective recirculation temperature. The equations used for these are shown in Appendix B.

The output lists the calculated values for the injection process; mean droplet size and flash vaporization; and the influence coefficients, β_1, β_2, β_3 and K_1, which control the wake fuel-air ratio. The importance of these values is explained earlier in this section and Appendix B.

A word of caution is in order here. If the output is preceded by the warning that the wake temperature iteration has failed, the situation is such that the wake has exceeded the rich limit at the input conditions. Although output is presented, it is not valid and merely represents the limits of the internal convergence search routine. For example, wake temperature will always be 5000° F for a failed case. If a single streamtube is being run, several other error messages will result as the program attempts to interpret zero efficiency. If multiple streamtubes are being run, the program will ignore the failed streamtube in all calculations.

The initial flame speed is the laminar flame speed at the appropriate inlet conditions. The turbulence level is the value induced by the flameholder.

In the stream efficiency section for each streamtube, the following comments are applicable:

- The ideal temperature use is based on the effective fuel-air ratio.
- The efficiency is the ratio of flame penetration to streamtube width at the exhaust nozzle.
- The actual temperature rise is based on the above conditions. The exit temperature is based on streamtube inlet plus this actual temperature rise.
- The flowrates are for a 1 inch deep streamtube. The fuel flowrate uses the effective fuel-air ratio.

The fan streamtube summary presents the major items from each streamtube and then the exit average results. The cooling air flowrate ratio is repeated here. Two more values of combustion efficiency are presented and two values of average exit temperature.

The average streamline exit temperature is the mass weighted average of the individual exit temperatures. The chemical combustion efficiency is based on this value for exit and an ideal temperature use based on the average effective fuel-air ratio and average inlet temperature.

The average duct exit temperature includes the mass weighted effect of the liner cooling air being added to the streamtubes at the exhaust nozzle inlet. The average thermal combustion efficiency is based on this exit temperature, the average inlet temperature and an ideal temperature rise is based on the average input fuel-air ratio.

Since engine analysis procedures generally base the fan duct fuel-air on the total duct airflow and use the thermal nozzle inlet averages, the value of thermal combustion efficiency is the one which is used for rumble prediction.

The total flowrate presented here includes the number of each type of streamtube as do all of the above-mentioned mass averaged values.

Also note that at no time are efficiencies ever mass averaged directly. All average efficiencies are based on comparison of the average results of individual streamtubes to the result of the average inlet. That is, the burn-then-mix process is compared to the ideal mix-then-burn process. Since curves of ideal temperature rise exhibit peak vs. fuel-air ratio, the average efficiency of two streamtubes, one lean and one rich, may very well be less than either streamtube separately.

(2) CORE STREAMTUBES

Due to the absence of droplet effects, the output is greatly simplified. The wake reaction results are presented as well as initial flame properties. Without liner cooling air, there is no fuel-air ratio shift and thus, only one efficiency definition. The process of evaluation of the ideal temperature rise is given in Appendix B. All of the comments in the fan stream apply here, except that thermal efficiency is not defined here due to the lack of liner cooling air.

If the message "Aerodynamic Loading exceeds Kinetic Capacity" occurs, the blowout limits were exceeded.

4. PROGRAM SETUP

The combined rumble/flameholder combustion model program supplied by Pratt & Whitney Aircraft contains all the subroutines necessary to operate the program, with the exception of systems routines normally supplied by the computer manufacturer. The program is written in Fortran IV and runs on any large scale computer system with little or no modification required. Test case input and output are included to verify successful installation.

On the Pratt & Whitney Aircraft (GPD) IBM 370 Model 168 computer, the program requires approximately 364K bytes of core storage. Run time is approximately 1 second per point.

5. PROGRAM PERFORMANCE OPTIONS

The combined model has options to vary augmentor type, fan splitter type, combustion data source, fuel type and print-out. These options are described below:

AUGMENTOR OPTION

The rumble model is designed to simulate three augmentor designs: V-gutter, Vorbix or Swirl.

Input Symbol	Description
NAUGOP	If NAUGOP = 1, the rumble model simulates a V-gutter flameholder augmentor.
	If NAUGOP = 2, the rumble model simulates a Vorbix augmentor.
	If NAUGOP = 3, the rumble model simulates a Swirl augmentor.

SPLITTER OPTION

The rumble model is designed to simulate two fan splitter designs: proximate splitter or remote splitter.

Input Symbol	Description
NFSOP	If NFSOP = 1, the rumble model uses a proximate splitter assumption at fan discharge (Fan duct does not communicate with core at fan discharge).
	If NFSOP = 2, the rumble model uses a remote splitter assumption at fan discharge (Fan duct communicates with core at fan discharge).

COMBUSTION OPTION

The combined model is designed to exercise the rumble model with empirical combustion data or to exercise the rumble model and use combustion data generated by the flameholder combustion model or to exercise the flameholder combustion model only.

Input Symbol	Description
NCOMOP	If NCOMOP = 1, the program reads in empirical combustion data and executes the rumble model.
	If NCOMOP = 2, the program executes the flameholder combustion model to obtain combustion data and executes the rumble model.
	If NCOMOP = 3, the program executes only the flameholder combustion model.

FUEL OPTION

The combined model is designed to operate with fuels of different lower heating values.

Input Symbol	Description
JFUEL	If JFUEL = 1, the program uses values for JP4 fuel.
	If JFUEL = 2, the program uses values for JP5 fuel.

PRINT OPTIONS

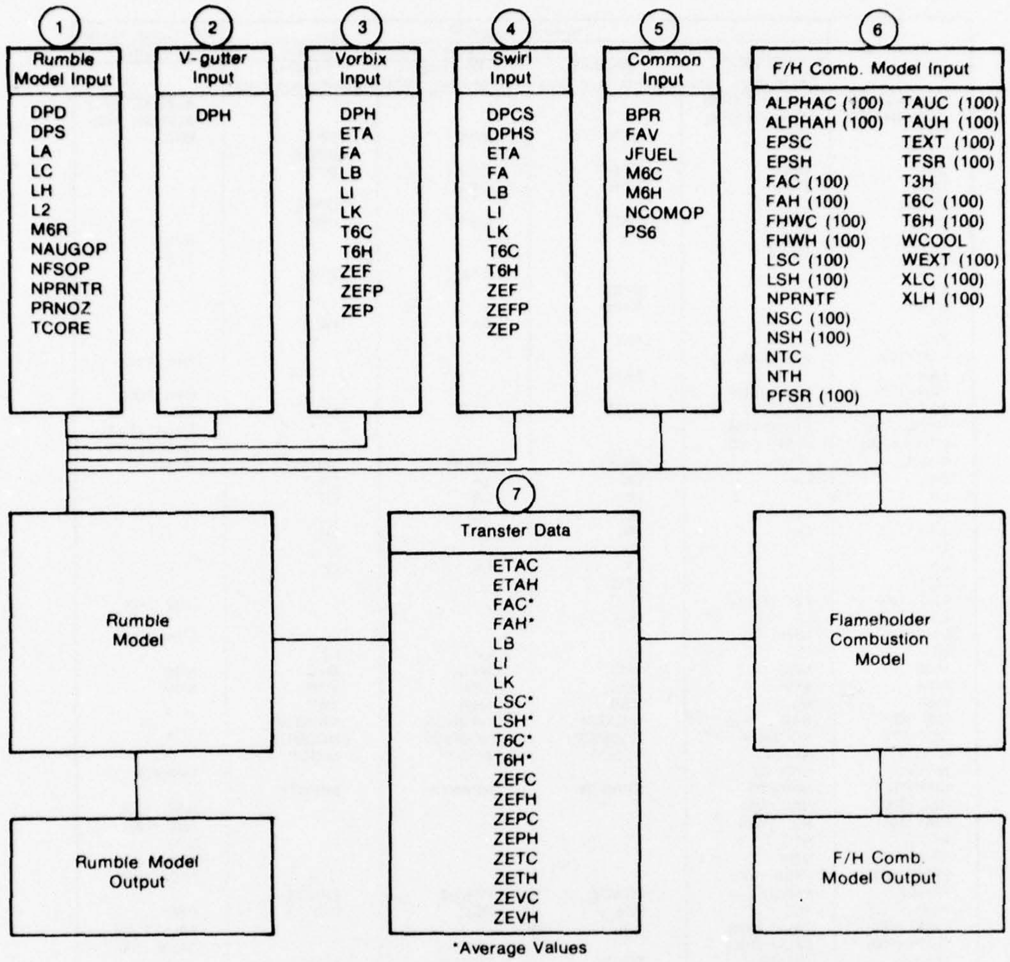
The rumble model provides either tabular and plotted output or just plotted output. The flameholder combustion model provides either limited or full tabular output.

Input Symbol	Description
NPRNTR	If NPRNTR = 0, the program provides both tabular rumble model output and Open Loop Transfer Function plots.
	If NPRNTR = 1, the program provides only Open Loop Transfer Function plots.
NPRNTF	If NPRNTF = 0, the program provides limited flameholder combustion model tabular output.
	If NPRNTF = 1, the program provides full flameholder combustion model tabular output.

6. INPUT

a. General

The combined model uses various input parameters depending on which combustion and augmentor options have been selected. An input data flow schematic for the combined model is presented in Figure 14. The chart at the bottom of Figure 14 indicates which data blocks are required for each option selected. Figure 15 lists the input required for each option. Figures 16 and 17 are schematics of the rumble model and flameholder model geometry identification. It should be noted that all input parameters are not required for any given option.



Model Combinations			Combustion Option: NCOMOP =	Augmentor Option: NAUGOP =	Input Blocks Req'd
	Augmentor Type	Combustion Data Source			
Rumble Model	V-gutter Flameholder	F/H Comb. Model	2	1	1, 2, 5, 6
Rumble Model	V-gutter Flameholder	Empirical	1	1	1, 2, 5, 7
Rumble Model	Vorbix	Empirical	1	2	1, 3, 5
Rumble Model	Swirl	Empirical	1	3	1, 4, 5
Flameholder Combustion Model			3	—	5, 6

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Figure 14. Combined Model Input Flow

Input List	Rumble Model				F/H Comb. Model
	V-Gutter		Vorbix	Swirl	V-Gutter
	F/H Model Combustion Data	Empirical Combustion Data	Empirical Combustion Data	Empirical Combustion Data	
ALPHAC (100)	ALPHAC (100)				ALPHAC (100)
ALPHAH (100)	ALPHAH (100)				ALPHAH (100)
BPR	BPR	BPR	BPR	BPR	BPR
DPCS				DPCS	
DPD	DPD	DPD	DPD	DPD	
DPH	DPH	DPH	DPH		
DPHS				DPHS	
DPS	DPS	DPS	DPS	DPS	
EPSC	EPSC				EPSC
EPSH	EPSH				EPSH
ETA			ETA	ETA	
ETAC		ETAC			
ETAH		ETAH			
FA			FA	FA	
FAC		FAC			
FAC (100)	FAC (100)				FAC (100)
FAH		FAH			
FAH (100)	FAH (100)				FAH (100)
FAV	FAV	FAV	FAV	FAV	FAV
FHWC (100)	FHWC (100)				FHWC (100)
FHWH (100)	FHWH (100)				FHWH (100)
JFUEL	JFUEL	JFUEL	JFUEL	JFUEL	JFUEL
LA	LA	LA	LA	LA	
LB		LB	LB	LB	
LC	LC	LC	LC	LC	
LH	LH	LH	LH	LH	
LI		LI	LI	LI	
LK		LK	LK	LK	
LSC		LSC			
LSC (100)	LSC (100)				LSC (100)
LSH		LSH			
LSH (100)	LSH (100)				LSH (100)
L2	L2	L2	L2	L2	
M6C	M6C	M6C	M6C	M6C	M6C
M6H	M6H	M6H	M6H	M6H	M6H
M6R	M6R	M6R	M6R	M6R	
NAUGOP	NAUGOP	NAUGOP	NAUGOP	NAUGOP	
NCOMOP	NCOMOP	NCOMOP	NCOMOP	NCOMOP	
NFSOP	NFSOP	NFSOP	NFSOP	NFSOP	
NPRNTF	NPRNTF				NPRNTF
NPRNTR	NPRNTR	NPRNTR	NPRNTR	NPRNTR	
NSC (100)	NSC (100)				NSC (100)
NSH (100)	NSH (100)				NSH (100)
NTC	NTC				NTC
NTH	NTH				NTH
PFSR (100)	PFSR (100)				PFSR (100)
PRNOZ	PRNOZ	PRNOZ	PRNOZ	PRNOZ	
PS6	PS6	PS6	PS6	PS6	PS6
TAUC (100)	TAUC (100)				TAUC (100)
TAUH (100)	TAUH (100)				TAUH (100)
TCORE	TCORE	TCORE	TCORE	TCORE	
TEXT (100)	TEXT (100)				TEXT (100)
TFSR (100)	TFSR (100)				TFSR (100)
T3H	T3H				T3H
T6C		T6C	T6C	T6C	
T6C (100)	T6C (100)				T6C (100)
T6H		T6H	T6H	T6H	
T6H (100)	T6H (100)				T6H (100)
WCOOL	WCOOL				WCOOL
WEXT (100)	WEXT (100)				WEXT (100)
ZEF			ZEF	ZEF	
ZEFC		ZEFC			
ZEFH		ZEFH			
ZEFP			ZEFP	ZEFP	
ZEP			ZEP	ZEP	
ZEPC		ZEPC			
ZEPH		ZEPH			
ZETC		ZETC			
ZETH		ZETH			
ZE VC		Z3VC			
ZEVH		ZEVH			
XLC (100)	XLC (100)				XLC (100)
XLH (100)	XLH (100)				XLH (100)

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Figure 15. Input List

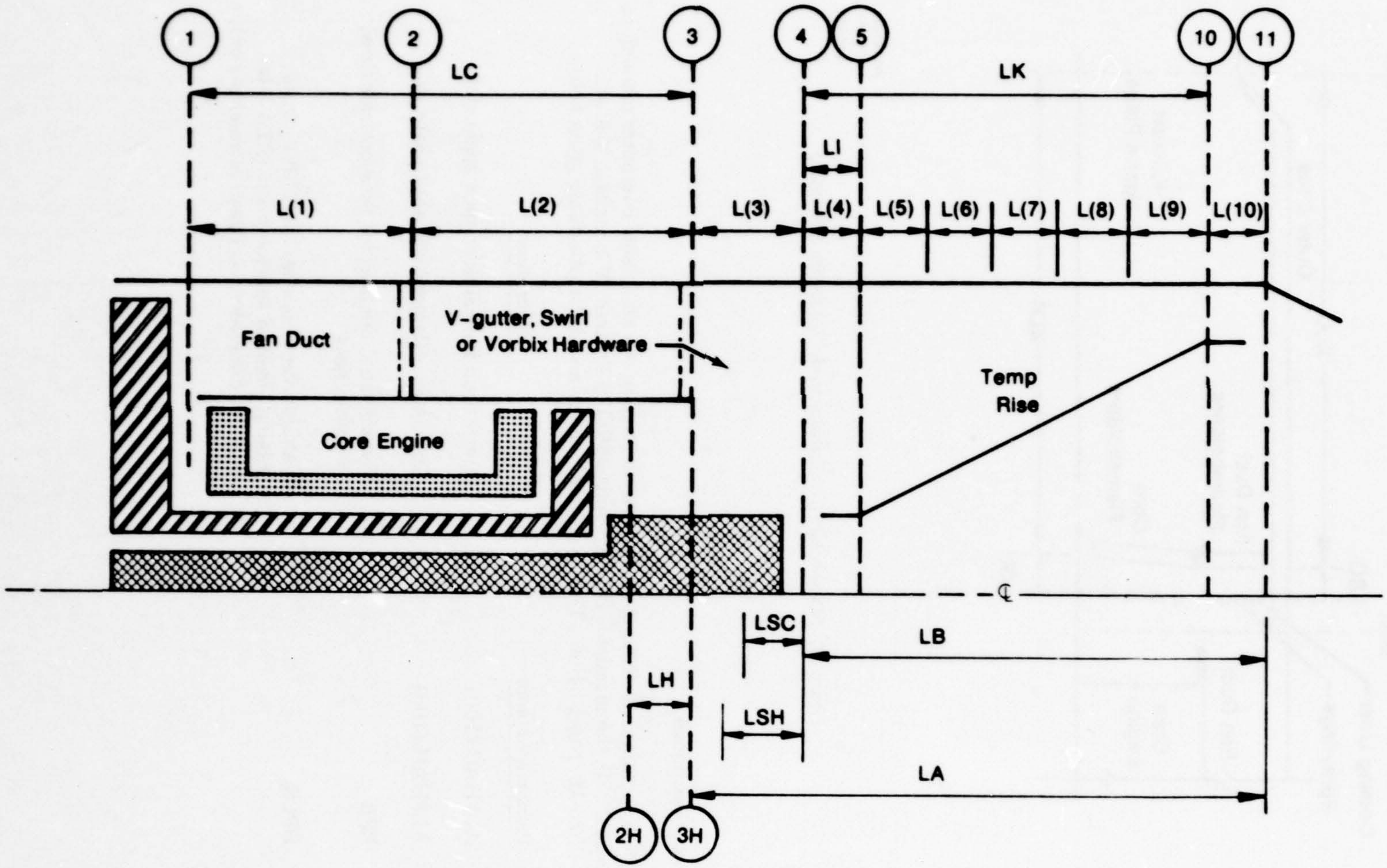

Figure 16. Rumble Model Geometry Identification

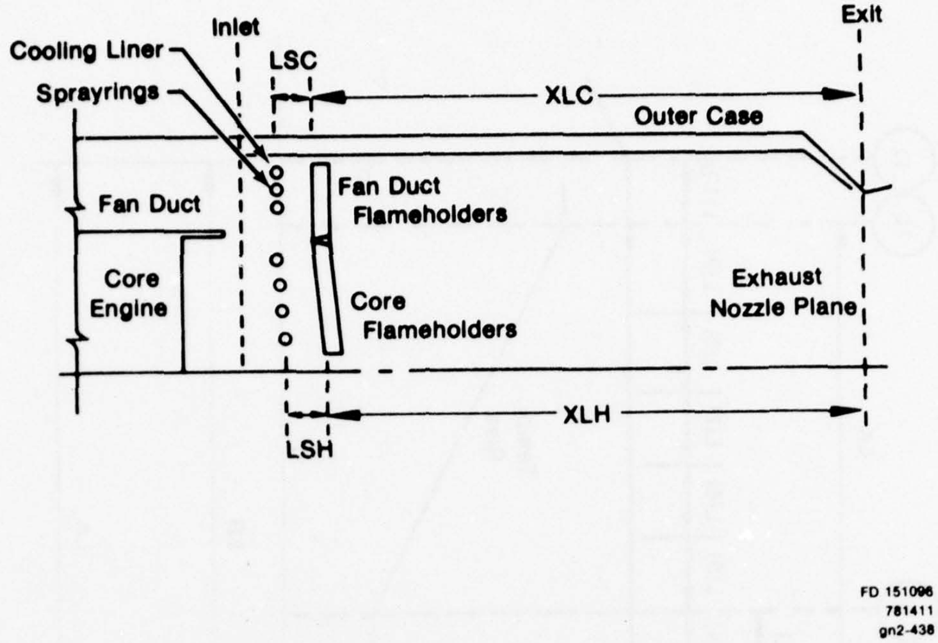

Figure 17. Flameholder Combustion Model Geometry Schematic

b. **Input Description**

The program uses "Namelist" input as defined in the applicable computer manual, i.e., for the IBM 370, the manual is IBM Systems 360/370 Fortran IV Language Manual, GC28-6515-10, pages 54-56. The "Namelist" names and descriptions are given below.

Parameter Name	Description
ALPHAC (100)	Fan stream flameholder apex angle, deg.
ALPHAH (100)	Core stream flameholder apex angle, deg.
BPR	Bypass ratio, fan duct air flow/core air flow, dimensionless.
DPCS	Fan side vane pressure loss ($\Delta P/P$) from mixing plane to ignition plane (STA 3 to STA 4), dimensionless (Swirl augmentor only).

Parameter Name	Description
DPD	Fan duct pressure loss ($\Delta P/P$) allocated to STA 2, dimensionless. Allocate remainder to STA 3; see DPS.
DPH	Pressure loss ($\Delta P/P$) from mixing plane to ignition plane (STA 3 to STA 4), dimensionless. For V-gutter augmentor this accounts for spraybar and flameholder pressure loss. For Vorbix augmentor this accounts for Vortex generator and pilot pressure loss (core and fan combined).
DPHS	Core side vane pressure loss ($\Delta P/P$) from mixing plane to ignition plane (STA 3H to STA 4), dimensionless (Swirl augmentor only).
DPS	Fan duct pressure loss ($\Delta P/P$) allocated to STA 3, dimensionless. Allocate remainder to STA 2; see DPD.
EPSC	Fan stream turbulence factor, dimensionless.
EPSH	Core stream turbulence factor, dimensionless.
ETA	Augmentor overall combustion efficiency, actual temperature rise/ideal temperature rise, dimensionless.
ETAC	Augmentor fan stream combustion efficiency, actual temperature rise/ideal temperature rise, dimensionless.
ETAH	Augmentor core stream combustion efficiency, actual temperature rise/ideal temperature rise, dimensionless.
FA	Augmentor overall fuel-air ratio, dimensionless. Defined as augmentor total fuel flow/fan stream air flow (STA 3) plus core stream air flow (STA 3H) plus primary engine fuel flow (STA 3H).
FAC	Augmentor fan stream fuel-air ratio, dimensionless. Defined as augmentor fan stream fuel flow/fan stream air flow (STA 3).
FAC (100)	Augmentor fuel-air ratio for each individual fan stream flow tube, dimensionless.

Parameter Name	Description
FAH	Augmentor core stream fuel-air ratio, dimensionless. Defined as augmentor core stream fuel flow/core stream air flow (STA 3H) plus primary engine fuel flow (STA 3H).
FAH (100)	Augmentor fuel-air ratio for each individual core stream flow tube, dimensionless.
FAV	Vitiated fuel-air ratio of core stream at entry to augmentor (STA 3H), dimensionless. Defined as primary engine fuel flow (STA 3H)/core stream air flow (STA 3H).
FHWC (100)	Individual flameholder widths in fan stream, inches.
FHWH (100)	Individual flameholder widths in core stream, inches.
LA	Length of augmentor, mixing plane to nozzle (STA 3 to STA 11), inches.
LB	Distance from ignition plane to nozzle (STA 4 to STA 11), inches.
LC	Length of fan duct, fan discharge to mixing plane (STA 1 to STA 3), inches.
LH	Distance from turbine discharge to mixing plane (STA 2H to STA 3H), inches.
LI	Distance from ignition plane to beginning of combustion zone (STA 4 to STA 5), inches.
LK	Distance from ignition plane to end of combustion zone (STA 4 to STA 10), inches.
LSC	Distance from spraybar to flameholder in fan stream, inches.
LSC (100)	Distance from spraybar to flameholder for each individual streamtube in the fan stream, inches.
LSH	Distance from spraybar to flameholder in core stream, inches.
LSH (100)	Distance from spraybar to flameholder for each individual streamtube in the core stream, inches.

Parameter Name	Description
L2	Distance from fan duct pressure loss (DPD) to mixing plane (STA 2 to STA 3), inches.
M6C	Fan stream Mach number at entry to augmentor (STA 3), dimensionless. (Must be > 0.)
M6H	Core stream Mach number at entry to augmentor (STA 3H), dimensionless. (Must be > 0.)
M6R	Mach number of mixed augmentor stream flow prior to combustion (STA 4), dimensionless. (Must be > 0.)
NSC (100)	Number of fan stream flow tubes of this type, integer.
NSH (100)	Number of core stream flow tubes of this type, integer.
NTC	Number of streamtube types in the fan flow, integer.
NTH	Number of streamtube types in the core flow, integer.
PFSR (100)	Individual spraybar fuel pressure for each fan flow tube, psia.
PRNOZ	Exhaust nozzle pressure ratio (always > 1.), dimensionless. If nozzle is choked, any value greater than critical value required to choke nozzle (approximately 2.0) may be input. Exact value of PRNOZ is required only if nozzle is unchoked.
PS6	Augmentor static pressure at entry to augmentor (STA 3), psia.
TAUC (100)	Individual streamtube blockage ratio for fan stream, dimensionless.
TAUH (100)	Individual streamtube blockage ratio for core stream, dimensionless.
TCORE	Core engine time constant, mass of air in core engine volume/mass flowrate of air through the core engine, sec.
TEXT (100)	External flow temperature for individual flow tubes in the fan flow, deg. R.

Parameter Name	Description
TFSR (100)	Spraybar fuel temperature for individual flow tubes in the fan flow, deg. R.
T3H	Main burner inlet temperature, deg. R.
T6C	Fan stream temperature at entry to augmentor (STA 3), deg. R.
T6C (100)	Fan stream temperature at entry to augmentor (STA 3), for individual flow tubes, deg. R.
T6H	Core stream temperature at entry to augmentor (STA 3H), deg. R.
T6H (100)	Core stream temperature at entry to augmentor (STA 3H), for individual flow tubes, deg. R.
WCOOL	Ratio of nozzle cooling air to total engine air flow, dimensionless.
WEXT (100)	External flow ratio for individual flow tubes in the fan stream, dimensionless.
XLC (100)	Distance from flameholder to nozzle for individual fan stream flow tubes, inches.
XLH (100)	Distance from flameholder to nozzle for individual core stream flow tubes, inches.
ZEF	Normalized slope, augmentor overall combustion efficiency vs. overall fuel-air ratio, $\frac{FA}{ETA} \frac{\partial ETA}{\partial FA}$, dimensionless.
ZEFC	Normalized slope, augmentor fan stream combustion efficiency vs. fan stream fuel-air ratio, $\frac{FAC}{ETAC} \frac{\partial ETAC}{\partial FAC}$, dimensionless.
ZEFH	Normalized slope, augmentor core stream combustion efficiency vs. core stream fuel-air ratio, $\frac{FAH}{ETAH} \frac{\partial ETAH}{\partial FAH}$, dimensionless.
ZEFP	Normalized slope, augmentor overall combustion efficiency vs. fuel-air ratio of the pilot burner, $\frac{FAP}{ETA} \frac{\partial ETA}{\partial FAP}$, dimensionless.

Parameter Name	Description
ZEP	Normalized slope, augmentor overall combustion efficiency vs. pressure at ignition plane, $\frac{P}{ETA} \frac{\partial ETA}{\partial P}$, dimensionless.
ZEPC	Normalized slope, augmentor fan stream combustion efficiency vs. pressure at ignition plane, $\frac{P}{ETAC} \frac{\partial ETAC}{\partial P}$, dimensionless.
ZEPH	Normalized slope, augmentor core stream combustion efficiency vs. pressure at ignition plane, $\frac{P}{ETAH} \frac{\partial ETAH}{\partial P}$, dimensionless.
ZETC	Normalized slope, augmentor fan stream combustion efficiency vs. fan stream entry temperature, $\frac{T6C}{ETAC} \frac{\partial ETAC}{\partial T6C}$, dimensionless.
ZETH	Normalized slope, augmentor core stream combustion efficiency vs. core stream entry temperature, $\frac{T6H}{ETAH} \frac{\partial ETAH}{\partial T6H}$, dimensionless.
ZEVC	Normalized slope, augmentor fan stream combustion efficiency vs. fan stream entry velocity, $\frac{V}{ETAC} \frac{\partial ETAC}{\partial V}$, dimensionless.
ZEVH	Normalized slope, augmentor core stream combustion efficiency vs. core stream entry velocity, $\frac{V}{ETAH} \frac{\partial ETAH}{\partial V}$, dimensionless.

c. **Input Setup**

In addition to the "Namelist" input, the program requires input for: (a) additional optional ratio calculations, (b) output plot selection and format, and (c) frequency range and increment selection. The input setup is shown in Figure 18 and is described below.

(1) Each input case requires a title card. Column 1 for the first case must contain a 1. The "Namelist" input must be preceded by an & INPUT starting in column 2 and followed by an & END starting in column 2. The "Namelist" input (Columns 2-80) required for each case is presented in Figure 15. Each input must be separated by a comma (see Figure 18). The ratio calculations, plot setup and frequency selection must follow the first input case. For additional input cases, follow the frequency selection cards with a blank card and then the additional title cards and input cases. Only those parameters that differ from the previous case must be input. For the additional input cases, if column 1 of the title card contains a 1, the ratio calculations, plot setup and frequency selection will be the same as the preceding case. If column 1 of the title card contains a 0, new ratio calculations, plot setup and frequency selection may be input.

(2) Additional ratio calculations may be performed by inputting the parameter identification numbers as indicated in Figure 18. Up to 40 ratios may be calculated and these ratios will automatically be included in the tabular output. The parameter identification numbers are presented in Figure 19. One blank field will terminate this type input. If columns 71-75 are used, a blank card must follow.

(3) Calcomp plots of any rumble model output parameter may be obtained by inputting one card for each parameter as described below. A maximum of 10 plots may be requested for any case. A blank card must be input to terminate plot requests or if no plots are desired.

Column 1 - 3 — Output Parameter No., right adjusted (integer; no decimal)

Column 11 - 20 — Amplitude Option (decimal required)

Column 21 - 30 — Phase Option (decimal required)

Column 31 - 40 — Frequency Option (decimal required)

Column 41 - 50 — Amplitude Factor (decimal required)

Column 51 - 60 — Frequency Factor (decimal required)

Column 61 - 70 — XMIN (decimal required)

Column 71 - 80 — XMAX (decimal required)

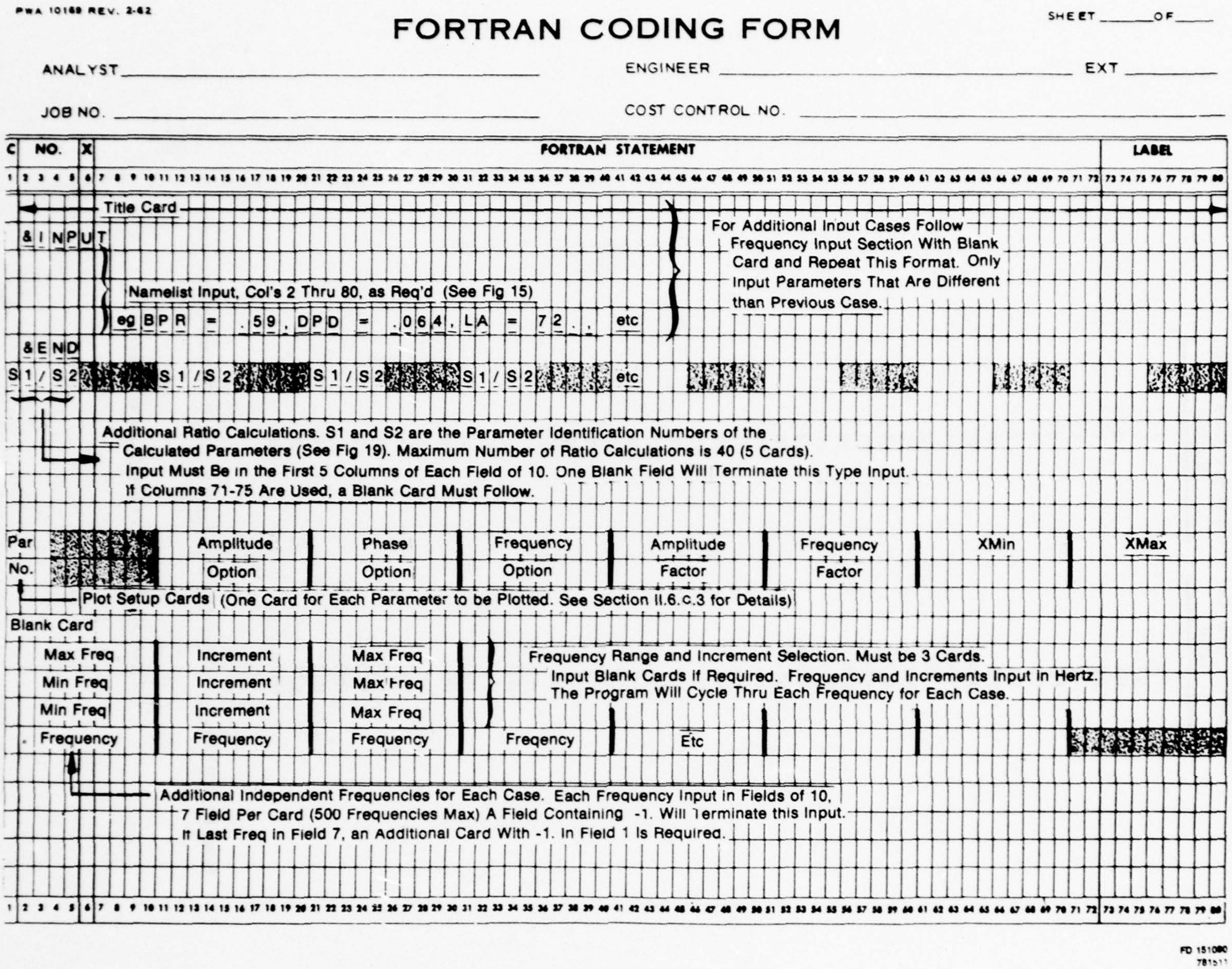

Figure 18. Combined Rumble Model Input Set-up

Output Parameter Name	Parameter Identification Number
P1	1
V1	2
R1	3
P2	4
V2	5
R2	6
P3	7
V3	8
R3	9
P3H	10
V3H	11
R3H	12
P2H	13
V2H	14
R2H	15
QIN	16
W3	17
W3H	18
QOUT	19
P4	20
V4	21
R4	22
P5	23
V5	24
R5	25
P6	26
V6	27
R6	28
P7	29
V7	30
R7	31
P8	32
V8	33
R8	34
P9	35
V9	36
R9	37
P10	38
V10	39
R10	40
P11	41
V11	42
R11	43

Note: $P1 = P1'/Q_{IN'} = (\Delta P_1/P_1)/(\Delta Q_{IN}/Q_{IN})$ Same for Other Output Parameters

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Figure 19. Parameter Identification Numbers

- *Output Parameter No.*

  A list of output parameter identification numbers is presented in Figure 19. If any of the additional ratio calculations (described above) are to be plotted, parameter identification numbers starting at 101 and incremented by 1 are used. The parameter identification numbers must be right adjusted in columns 1-3.

- *Amplitude Option*

  If Amplitude Option = 0., Log (amplitude) will be plotted.
  If Amplitude Option = 1., Amplitude will be plotted.

- *Phase Option*

  If Phase Option = 0., Phase angle of 0 to −360 will be plotted.
  If Phase Option = 1., Phase angle of 180 to −180 will be plotted.

- *Frequency Option*

  If Frequency Option = 0., Log (Frequency) will be plotted.
  If Frequency Option = 1., Frequency will be plotted.

- *Amplitude Factor*

  If Amplitude Option = 0., the Amplitude Factor must be input as a number which could be written as 10^N, where N = (±) integer. Log (Amplitude Factor) will be added to the base Log amplitude scale, where the base Log amplitude scale ranges from −1.0 to 2.0.

  If Amplitude Option = 1., the Amplitude Factor becomes a multiplier for the base amplitude scale, where the base amplitude scale ranges from 0. to 3.0.

- *Frequency Factor*

  If Frequency Option = 0., the Frequency Factor must be input as a number which could be written as 10^N, where N = (±) integer. Frequency factor will be a multiplier for the base frequency scale, where the base frequency scale ranges from .1 to 100.

  If Frequency Option = 1., the Frequency Factor will be a multiplier for the base frequency scale, where the base frequency scale ranges from 0. to 100., unless XMIN and XMAX are input. XMIN is the minimum value for the frequency scale when Frequency Option = 1. XMAX is the maximum value for the frequency scale when Frequency Option = 1. If either Amplitude Factor or Frequency Factor is input at 0. when XMIN and XMAX are input, the program automatically sets Amplitude Factor or Frequency Factor to 1.

(4) The frequencies used in the program calculations are input in two parts. First, there are three cards which contain the minimum frequency, increment and maximum frequency (see Figure 18). The increment is used to determine each frequency for the range defined. Additional independent frequencies (up to 500 values) may be input in fields of 10, 7 fields per card. A field containing −1. will terminate this input. If the 7th field of the last card is used, an additional card with −1. in the first field is required.

(5) The rumble model has been set up to model a turbofan engine with a mixed flow augmentor. To model a turbojet (no fan), set BPR = 0 and NFSOP = 1. To model a fan duct augmentor (separate fan and core flows), set BPR = 10^{10} and NFSOP = 1.

7. OUTPUT

a. General

The program output is presented in two parts: (1) rumble model output and (2) flameholder combustion model output. There are two rumble model output options: (1) NPRNTR = 0, the program provides both rumble model tabular output and Open Loop Transfer Function plots or (2) NPRNTR = 1, the program provides only Open Loop Transfer Function plots. There are also two flameholder combustion model output options: (1) NPRNTF = 0, the program provides limited flameholder combustion model tabular output and (2) NPRNTF = 1, the program provides full flameholder combustion model tabular output.

b. Output Description

(1) Rumble model tabular output (listed in the order they appear):

Parameter(s)	Description
NAMELIST INPUT	The "namelist" input parameters and the values input are listed for verification.
KNOZ	A parameter that relates the influence of pressure at STA 11 on velocity at STA 11, dimensionless.
FAAB	Augmentor overall fuel-air ratio, dimensionless.
ETAAB	Augmentor overall efficiency, dimensionless.
DTIAB	Augmentor overall ideal temperature rise, deg. R.
DTAB	Augmentor overall actual temperature rise, deg. R.
T6M	Augmentor mixed temperature before combustion (STA 3), deg. R.

Parameter(s)	Description
TKC	Augmentor mixed exhaust temperature (STA 10), deg. R.
XLHV	Lower heating value for the fuel selected, Btu/lbm.
DTC	Fan stream temperature rise, deg. R.
QCQT	Fraction of total heat release contributed to fan stream, dimensionless.
DTIC	Fan stream ideal temperature rise, deg. R.
TAUDC	Fan stream drift delay from spraybar to flameholder, sec.
DTH	Core stream temperature rise, deg. R.
QHQT	Fraction of total heat release contributed by core stream, dimensionless.
DTIH	Core stream ideal temperature rise, deg. R.
TAUDH	Core stream drift delay from spraybar to flameholder, sec.
ZTFC	Normalized slope, augmentor fan stream ideal temperature rise vs. fan stream fuel-air ratio, $\frac{FAC}{DTIC}\frac{\partial DTIC}{\partial FAC}$, dimensionless.
ZTFH	Normalized slope, augmentor core stream ideal temperature rise vs. core stream fuel-air ratio, $\frac{FAH}{DTIH}\frac{\partial DTIH}{\partial FAH}$, dimensionless.
L (1-11)	Distance between model stations, inches.
YL (1-11)	Station locations references to STA 1, inches.
C (1-11)	Velocity of sound at each station, in./sec.
CH	Velocity of sound in core stream at STA 3H, in./sec.
M (1-11)	Mach number at each station, dimensions.

Parameter(s)	Description
MH	Mach number in core stream at STA 3H, dimensionless.
T (1-11)	Temperature at each station, deg. R.
TH	Temperature in core stream at STA 3H, deg. R.
PRHOT	Pressure drop through combustion zone (STA 5 - STA 10), psia.
G (1-11)	Ratio of specific heats at each station, dimensionless.
GH	Ratio of specific heats in core stream at STA 3H, dimensionless.
TAUF (1-11)	Time delays for downstream running sonic waves between stations, sec.
TAUFH	Time delay for downstream running sonic wave between STA 2H and 3H, sec.
TAUG (1-11)	Time delays for upstream running sonic waves between stations, sec.
TAUGH	Time delay for upstream running sonic wave between STA 2H and 3H, sec.
TAUE (1-11)	Time delays for downstream running entropy waves between stations, sec.
TAUEH	Time delay for downstream running entropy wave between STA 2H and 3H, sec.
QOP (1-11)	Ratio of volumetric heat release rate at each station to pressure at each station, 1/sec.

(2) Rumble model Open Loop Transfer Function plots. Each plot consists of Open Loop Transfer Function Gain versus frequency and phase angle versus frequency for the parameters selected.

(3) Flameholder combustion model full tabular output.

Parameter(s)	Description
Fan Stream	Identifies following sections as fan duct output.
Streamtube type	Identifies for this set of input variables.
No. of this type	The number of streamtubes with this set of input variables.

Parameter(s)	Description
Static Pressure (PS6)	Inlet static pressure, psia.
Approach Temperature (T6C)	Inlet temperature, deg. R.
Approach Mach No. (M6C)	Inlet flow Mach No., d'less.
Input FA Ratio (FAC)	Inlet fuel-air ratio, d'less.
Effective FA Ratio	Effective fuel-air ratio accounting for liner cooling air flow.
F/H Width (FHWC)	Flameholder width, inches.
Blockage Ratio (TAUC)	Ratio of flameholder width to streamtube width, d'less.
F/H Apex Angle (ALPHAC)	V-gutter flameholder apex angle, degrees.
S/R Fuel Temperature (TFSR)	Temperature of the fuel within sprayring, deg. R.
S/R Fuel Pressure (PFSR)	Pressure of the fuel within the sprayring, psia.
S/R to F/H Distance (LSC)	Axial separation distance between the sprayring and the flameholder, inches.
F/H to Nozzle Distance (XLC)	Axial distance from the flameholder to the exhaust nozzle throat, inches.
Turbulence Level (EPSC)	Ratio of RMS turbulence velocity to the approach velocity at the inlet, d'less.
Wake Flow Addition (WEXT)	Ratio of external wake flow to recirculated flow, d'less.
Flow Source Temperature (TEXT)	Temperature of above flow, deg. R.
Effective Inlet Temperature	Mass average of WEXT flow at TEXT and recirculated flow at T6C, deg. R.
Fuel Type (JFUEL)	Identifies for fuel 1 = JP4 2 = JP5
Mean droplet size	The mass median droplet size produced by the injector, microns.
Flash vaporization	Fraction of the liquid fuel which is vaporized by injection from PFSR to PS6, d'less.

Parameter(s)	Description
Beta 1	Droplet vaporization fraction.
Beta 2	Droplet collection fraction.
Beta 3	Surface vaporization fraction.
K1	Recirculation fraction.
Wake FA	Flameholder wake vapor phase fuel-air ratio, d'less.
Wake temperature	Reaction temperature in the flameholder wake, deg. R.
Initial speed	Laminar flame speed at the flameholder, ft/sec.
Initial turbulence	Turbulence intensity at the flameholder, d'less.
Ideal temperature rise	Ideal temperature rise for effective fuel-air ratio, deg. R.
Efficiency	Streamtube combustion efficiency; ratio of flame penetration to streamtube width, d'less.
Actual temperature rise	Efficiency times ideal temperature rise, deg. R.
Exit temperature	Streamtube exit temperature without liner cooling air, deg. R.
Flowrate — air	Air flowrate for this streamtube, lbm/sec.
Flowrate — fuel	Fuel flowrate for this streamtube, lbm/sec.
Cooling flow/total engine flow (WCOOL)	Ratio of liner cooling air flowrate to total engine flowrate, d'less.
Chemical combustion efficiency	Average efficiency based on average streamtube exit temperature and average effective fuel-air ratio, d'less.
Thermal combustion efficiency	Average efficiency based on streamtube average exit temperature plus cooling air and average input fuel-air ratio, d'less.
Average cooling air temperature	Mass averaged inlet temperature used for cooling, deg. R.
Average streamline exit temperature	Mass average of the streamtubes without cooling air, deg. R.

Parameter(s)	Description
Average duct exit temperature	Mass average of streamtubes plus cooling air, deg. R.
Total flowrate	Total of each streamtube type times the number of each type, lbm/sec.
Average fuel-air ratio	Mass average of the input fuel-air ratios.
Core Stream	Identified following sections as core stream output.
Wake recirculation coefficient	Same as K1 in fan duct, d'less.
Ideal temperature rise	Ideal temperature rise based on input fuel-air ratio and main burner fuel-air ratio. See Appendix B.
M/B Fuel-air ratio	Fuel-air ratio of the vitiated air entering the core streamtubes.
M/B Inlet temperature	Inlet temperature to the main burner, d'less.
Average distance from spraybar to F/H	Average axial distance from the spraybars to the flameholders, inches.

Note: Any core stream parameters which are not listed above have the same definition as their fan stream counterpart.

(4) Flameholder combustion model limited tabular output.

Parameter(s)	Description
Fan stream	Identifies following as fan stream cases input and output.
Inlet temperature (T6C)	Streamtube inlet temperature, deg. R.
Fuel-air ratio (FAC)	Input fuel-air ratio, d'less.
Average inlet temperature	Mass averaged inlet temperature, deg. R.
Ideal temperature rise	Streamtube ideal temperature rise based on effective fuel-air ratio, deg. R.
Combustion efficiency	Streamtube combustion efficiency, d'less.
Exit temperature	Streamtube exit temperature based on effective fuel-air ratio, deg. R.
Average ideal temperature rise	Ideal temperature rise based on average input fuel-air ratio, deg. R.

Parameter(s)	Description
Average combustion efficiency	Efficiency based on average ideal temperature rise with cooling air effect included, d'less.
Average exit temperature	Exit temperature including cooling air, deg. R.
Core Stream	Identifies following as core stream section.
Mach No.	Streamtube inlet flow Mach number, d'less.
Average ideal temperature rise	Ideal temperature rise based on average input fuel-air ratio, deg. R.
Average combustion efficiency	Efficiency based on average temperature rise and average ideal temperature rise, d'less.
Average exit temperature	Exit temperature based on mass averaged actual temperature rise, deg. R.

8. PROGRAM MESSAGES AND LIMITS

a. Input Checks

The program checks all inputs to see if the inputs are missing or equal the default values built into the deck. Missing inputs are set equal to the default values. A warning message (presented below) is printed to alert the user if default input values are identified. The program also checks specific inputs to ensure reasonable input data. If these checks are not satisfied, the run will be canceled. These checks and corresponding print-out messages are presented below:

Condition	Message
Input value = default value or no input for certain parameter	WARNING — PARAMETER XXXXXX = YYY.Y is a default value
LA < LB, where LK and LB are Rumble Model Inputs	INPUT ERROR 1 — LA must be greater than or equal to LB
LK > LB, where LK and LB are Rumble Model Inputs	INPUT ERROR 2 — LB must be greater than or equal to LK
LA < LCALC, where LCALC = LB + MAX (LSC, LSH)	INPUT ERROR 3 — LA must be greater than or equal to the sum of LB plus the max of LSC or LSH. LA has been adjusted accordingly. Check input.
LI ⩾ LK	INPUT ERROR 4 — LI must be less than LK.
LC < L2	INPUT ERROR 5 — LC must be greater than or equal to L2

Condition	Message
ETA < 0 or > 1.	INPUT ERROR 6 — ETA must be between 0 and 1.
ETAC < 0 or > 1.	INPUT ERROR 7 — ETAC must be between 0 and 1.
ETAH < 0 or > 1.	INPUT ERROR 8 — ETAH must be between 0 and 1.
(FAC + FAH) = 0	INPUT ERROR 9 — FAC and FAH cannot both be zero with augmentor on.
$[FAV + (1 + FAV)\ FAH] \left[\frac{XLHV}{18500.}\right] \geqslant .09$ or if $(FAC) \left[\frac{XLHV}{18500.}\right] \geqslant .09$	INPUT ERROR 10 — Core of fan stream totoal fuel-air ratio exceeds limits of ideal temperature rise curve. Blowout likely.
NFSOP = 2 and BPR = 0.	INPUT ERROR 11 — BPR cannot be zero when the remote flow splitter option is selected.
DPCS < 0 or > 1.	INPUT ERROR 12 — DPCS must be between 0 and 1.
DPD < 0 or > 1.	INPUT ERROR 13 — DPD must be between 0 and 1.
DPH < 0 or > 1.	INPUT ERROR 14 — DPH must be between 0 and 1.
DPHS < 0 or > 1.	INPUT ERROR 15 — DPHS must be between 0 and 1.
DPS < 0 or > 1.	INPUT ERROR 16 — DPS must be between 0 and 1.
T3H ⩾ 2200.	INPUT ERROR 17 — T3H exceeds limits of ideal temperature rise curve. T3H must be less than 2200. deg.R.
BPR < 0.	INPUT ERROR 18 — BPR must be equal to or greater than 0.
FAV < 0.	INPUT ERROR 19 — FAV must be equal to or greater than 0.
NAUGOP ⩽ 0. or > 3.	INPUT ERROR 20 — NAUGOP must be 1, 2 or 3.

Condition	Messages
NFSOP $\leq$ 0 or > 2.	INPUT ERROR 21 — NFSOP must be 1 or 2.
NCOMOP $\leq$ 0 or > 3.	INPUT ERROR 22 — NCOMOP must be 1, 2 or 3.
JFUEL $\leq$ 0 or > 2.	INPUT ERROR 23 — JFUEL must be 1 or 2.
NPRNTR < 0 or > 1.	INPUT ERROR 24 — NPRNTR must be 0 or 1.
NPRNTF < 0 or > 1.	INPUT ERROR 25 — NPRNTF must be 0 or 1.
M6C $\leq$ 0	INPUT ERROR 26 — M6C must be greater than 0.
M6H $\leq$ 0	INPUT ERROR 27 — M6H must be greater than 0.
M6R $\leq$ 0	INPUT ERROR 28 — M6R must be greater than 0.
LI < 0	INPUT ERROR 29 — LI must be equal to or greater than 0.
LK $\leq$ 0	INPUT ERROR 30 — LK must be greater than 0.
LA $\leq$ 0	INPUT ERROR 31 — LA must be greater than 0.
LB $\leq$ 0	INPUT ERROR 32 — LB must be greater than 0.
LC $\leq$ 0	INPUT ERROR 33 — LC must be greater than 0.
LSC $\leq$ 0 or $\geq$ LA	INPUT ERROR 34 — LSC must be greater than 0 and less than LA.
LSH $\leq$ 0 or $\geq$ LA	INPUT ERROR 35 — LSH must be greater than 0 and less than LA.
LH $\leq$ 0	INPUT ERROR 36 — LH must be greater than 0.
L2 < 0	INPUT ERROR 37 — L2 must be greater than or equal to 0.
TCORE < 0	INPUT ERROR 38 — TCORE must be equal to or greater than 0.

Condition	Messages
PS6 ⩽ 0	INPUT ERROR 39 — PS6 must be greater than 0.
T6C ⩽ 0	INPUT ERROR 40 — T6C must be greater than 0.
T6H ⩽ 0	INPUT ERROR 41 — T6H must be greater than 0.
T3H ⩽ 460.	INPUT ERROR 42 — T3H must be greater than 460.
FA < 0	INPUT ERROR 43 — FA must be greater than or equal to 0.
FAC < 0	INPUT ERROR 44 — FAC must be greater than or equal to 0.
FAH < 0	INPUT ERROR 45 — FAH must be greater than or equal to 0.
PRNOZ ⩽ 1	INPUT ERROR 46 — PRNOZ must be greater than 1.
ALPHAC (100) ⩽ 0 or > 180	INPUT ERROR 47 — ALPHAC must be greater than 0 and less than or equal to 180 deg.
ALPHAH (100) ⩽ 0 or > 180	INPUT ERROR 48 — ALPHAH must be greater than 0 and less than or equal to 180 deg.
EPSC < 0 or > 1	INPUT ERROR 49 — EPSC must be greater than or equal to zero and less than or equal to 1.
EPSH < 0 or > 1	INPUT ERROR 50 — EPSH must be greater than or equal to zero and less than or equal to 1.
FAC (100) ⩽ 0	INPUT ERROR 51 — FAC must be greater than zero.
FAH (100) ⩽ 0	INPUT ERROR 52 — FAH must be greater than zero.
FAV > .068	INPUT ERROR 53 — FAV cannot exceed stoichiometric (.068).
FHWC (100) ⩽ 0.	INPUT ERROR 54 — FHWC must be greater than zero.

Condition	Messages
FHWH (100) $\leq$ 0.	INPUT ERROR 55 — FHWH must be greater than zero.
LSC (100) $\leq$ 0 or $\geq$ LA	INPUT ERROR 56 — LSC must be greater than zero and less than LA.
LSH (100) $\leq$ 0 or $\geq$ LA	INPUT ERROR 57 — LSH must be greater than zero and less than LA.
$\frac{M6C}{1 - TAUC (100)} > 1.$	INPUT ERROR 58 — Flow is supersonic in fan stream at the flameholder plane.
$\frac{M6H}{1 - TAUH (100)} > 1.$	INPUT ERROR 59 — Flow is supersonic in core stream at the flameholder plane.
NSC (100) < 0 or > 100.	INPUT ERROR 60 — NSC must be greater than or equal to zero and less than or equal to 100.
NSH (100) < 0 or > 100.	INPUT ERROR 61 — NSH must be greater than or equal to zero and less than or equal to 100.
NTC < 0 or > 100.	INPUT ERROR 62 — NTC must be greater than or equal to zero and less than or equal to 100.
NTH < 0 or > 100.	INPUT ERROR 63 — NTH must be greater than or equal to zero and less than or equal to 100.
PFSR (100) $\leq$ PS6	INPUT ERROR 64 — PFSR must be greater than PS6.
TAUC (100) $\leq$ 0 or $\geq$ 1.	INPUT ERROR 65 — TAUC must be greater than 0 and less than 1.
TAUH (100) $\leq$ 0 or $\geq$ 1.	INPUT ERROR 66 — TAUH must be greater than 0 and less than 1.
TEXT (100) < 460.	INPUT ERROR 67 — TEXT must be greater than or equal to 460.
TFSR (100) < 460.	INPUT ERROR 68 — TFSR must be greater than or equal to 460. deg. R.
T6C (100) $\leq$ 460.	INPUT ERROR 69 — T6C must be greater than 460.
T6H (100) $\leq$ 460.	INPUT ERROR 70 — T6H must be greater than 460.
WEXT (100) < 0	INPUT ERROR 71 — WEXT must be greater than or equal to zero.

Condition	Messages
XLC (100) $\leqslant$ 0	INPUT ERROR 72 — XLC must be greater than zero.
XLH (100) $\leqslant$ 0	INPUT ERROR 73 — XLH must be greater than zero.
WCOOL < 0. or $\geqslant$ 1.	INPUT ERROR 74 — WCOOL must be greater than or equal to 0. and less than 1.

b. Calculation Failure Messages for Flameholder Combustion Model

The Flameholder Combustion Model program checks for specific calculation failures. The causes and corresponding messages are presented below:

Message	Cause
Warning *** wake temperature iteration failed for streamtube No. XX	The calculated value of the fan duct flame-holder wake fuel-air ratio exceeds the rich limit at the inlet conditions for this stream-tube. This streamtube case has failed.
Aerodynamic loading exceeds kinetic capacity	The inlet values of velocity, pressure, and temperature produce a wake loading which exceeds the reaction limit at this fuel-air ratio. This streamtube case has failed.
All fuel vaporized--terminate case	The injection process has resulted in only vapor fuel. Run this input as a core case if desired.
Overall fuel-air ratio below lean limit	The input fuel-air ratio is less than the calculated minimum value for flame propagation in the fan stream.
FAR outside flammability limits	The input fuel-air ratio is outside the limits of the data for laminar flame speed built into the program. Currently set at .027 lean and .120 rich limit fuel-air ratios.

9. PROGRAM LISTINGS

Listings of the computer program formulation are provided in Appendix C.

10. TEST CASES

The test cases are provided in Appendix D as outlined below:

Test Case	*Model*	*Augmentor*	*Flow Splitter*	*Combustion Data Source*	*Fuel*	*Rumble Output*	*F/H Comb. Output*
1	Rumble	V-gutter F/H	Proximate	Flameholder Comb. Model	JP4	Tab & Plot	Full Tab
2	Rumble	V-gutter F/H	Remote	Flameholder Comb. Model	JP4	*	—
3	Rumble	V-gutter F/H	Proximate	Empirical	JP4	*	—
4	Rumble	V-gutter F/H	Remote	Empirical	JP4	Tab & Plot	—
5	Rumble	V-gutter F/H	Proximate	Empirical	JP5	*	—
6	Rumble	V-gutter F/H	Proximate	Empirical	JP4	*	—
7	Rumble	Vorbix	Proximate	Empirical	JP4	*	—
8	Rumble	Vorbix	Remote	Empirical	JP4	Tab & Plot	—
9	Rumble	Swirl	Proximate	Empirical	JP4	Tab & Plot	—
10	Rumble	Swirl	Remote	Empirical	JP4	*	—
11	Flameholder Combustion	V-gutter F/H	—	—	JP4	—	Full Tab
12	Flameholder Combustion	V-gutter F/H	—	—	JP5	—	*
13	Flameholder Combustion With Wake Heat Addition	V-gutter F/H	—	—	JP4	—	*

*Copy of output deleted due to similarity with other output.

11. PROGRAM IDENTIFICATION AND REVISION PROCEDURE

a. CCD Number

Customer Computer Decks (CCD's) are identified by a CCD number and date. An example is CCD 1001-0.0 November 15, 1969.

The CCD number consists of:

- Basic number (first four digits)
- Dash (or change) number
- Decimal (or addition/correction) number.

(1) Basic Number

This four-digit number generally corresponds to a given program. If another method is developed or studied which does not replace or supersede the original, a new four-digit number is issued.

(2) Dash Number

Major changes in the program are reflected in different dash numbers. A change in techniques or mathematical methods would produce a new dash number provided the new techniques replace or change the old techniques. For more than nine changes, the dash number shifts to letters. The dash number of the original program is zero.

(3) Decimal Number

The decimal is used for all other program changes such as:

- Adding new optional routines
- A change to the FORTRAN source language due to computer differences
- Correcting a mistake in the program
- Input and output changes
- Adding unique customer oriented curves or initialization data.

In most cases a decimal number change is made and documented by writing an addendum to the user's manual without reprinting the user's manual. An errata or addendum to the user's manual is used in conjunction with a Computer Simulation Change Notice, (Figure 20). This notice briefly describes the changes affecting the deck and manual.

Accompanying the notice is a new manual title page reflecting the new date and/or dash or decimal changes. The SCN also includes the change pages with black bars in the right-hand margin opposite data changed and a new date in the upper right-hand corner.

Programs revised by the user without written consent of the supplier are the responsibility of the user.

Engine or Component Designation ______________________ Date __________

User's Manual No. ______________ Customer Computer Deck No. __________

Deck and User's Designation is Changed to: ______________________

Dated: ______________

Change Nature: ☐ Errata ☐ Addendum Changes Effect: ☐ Deck ☐ Manual

---

Change: Reason:

Detailed Reasons for Changes are Shown in Enclosure

Approval:

Program Office ______________

Systems Stability and Control ______________

C. H. Borgmeyer

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Figure 20. Computer Simulation Change Notice

APPENDIX A

DEVELOPMENT OF RUMBLE MODEL EQUATIONS

1. DEVELOPMENT OF ACOUSTIC EQUATIONS

In this section equations are developed to describe how velocity, pressure and density at every point in the augmentor respond to a combustion disturbance, which is treated as a heat input to a flowing invicid ideal gas stream. Knowing how these three parameters (velocity, pressure, density) respond allows calculation of any other parameter needed, such as mass flowrate or temperature. The first equations to be developed are the three longitudinal wave equations, which are applicable between boundaries and discontinuities. Then equations for the boundaries and discontinuities are developed. The wave equations plus the boundary and discontinuity equations are referred to as the "acoustic" equations. The "combustion" equations needed to complete the rumble model are developed in paragraph 2 of this appendix.

Symbols used below are defined in the list of symbols. For any section of augmentor with rigid walls and constant cross-sectional area, such as shown in Figure 21, through which an invicid fluid (viscosity is zero) is flowing, the one-dimensional momentum, continuity and energy equations are:

$$\frac{\partial P}{\partial x} + \rho V \frac{\partial V}{\partial x} + \rho \frac{\partial V}{\partial t} = 0$$

$$\rho \frac{\partial V}{\partial x} + V \frac{\partial \rho}{\partial x} + \frac{\partial \rho}{\partial t} = 0 \qquad (1)$$

$$q + \frac{PV}{\rho}\frac{\partial \rho}{\partial x} + \frac{P}{\rho}\frac{\partial \rho}{\partial t} = \rho V \frac{\partial u}{\partial x} + \rho \frac{\partial u}{\partial t}$$

For an ideal gas, these equations reduce to the following non-linear wave equations:

$$(V+C)\left[\frac{1}{P}\frac{\partial P}{\partial x} + \frac{\gamma}{C}\frac{\partial V}{\partial x}\right] + \left[\frac{1}{P}\frac{\partial P}{\partial t} + \frac{\gamma}{C}\frac{\partial V}{\partial t}\right] = (\gamma-1)\frac{q}{P}$$

$$(V-C)\left[\frac{1}{P}\frac{\partial P}{\partial x} - \frac{\gamma}{C}\frac{\partial V}{\partial x}\right] + \left[\frac{1}{P}\frac{\partial P}{\partial t} - \frac{\gamma}{C}\frac{\partial V}{\partial t}\right] = (\gamma-1)\frac{q}{P} \qquad (2)$$

$$V\left[\frac{1}{P}\frac{\partial P}{\partial x} - \frac{\gamma}{\rho}\frac{\partial \rho}{\partial x}\right] + \left[\frac{1}{P}\frac{\partial P}{\partial t} - \frac{\gamma}{\rho}\frac{\partial \rho}{\partial t}\right] = (\gamma-1)\frac{q}{P}$$

The wave equations are linearized by the small perturbation substitutions:

$$\begin{aligned} P(x,t) &= \bar{P}(x) + \Delta P(x,t) \\ \rho(x,t) &= \bar{\rho}(x) + \Delta \rho(x,t) \\ C(x,t) &= \bar{C}(x) + \Delta C(x,t) \\ V(x,t) &= \bar{V}(x) + \Delta V(x,t) \\ q(x,t) &= \bar{q}(x) + \Delta q(x,t) \end{aligned} \qquad (3)$$

Second order terms are neglected in making the substitutions.

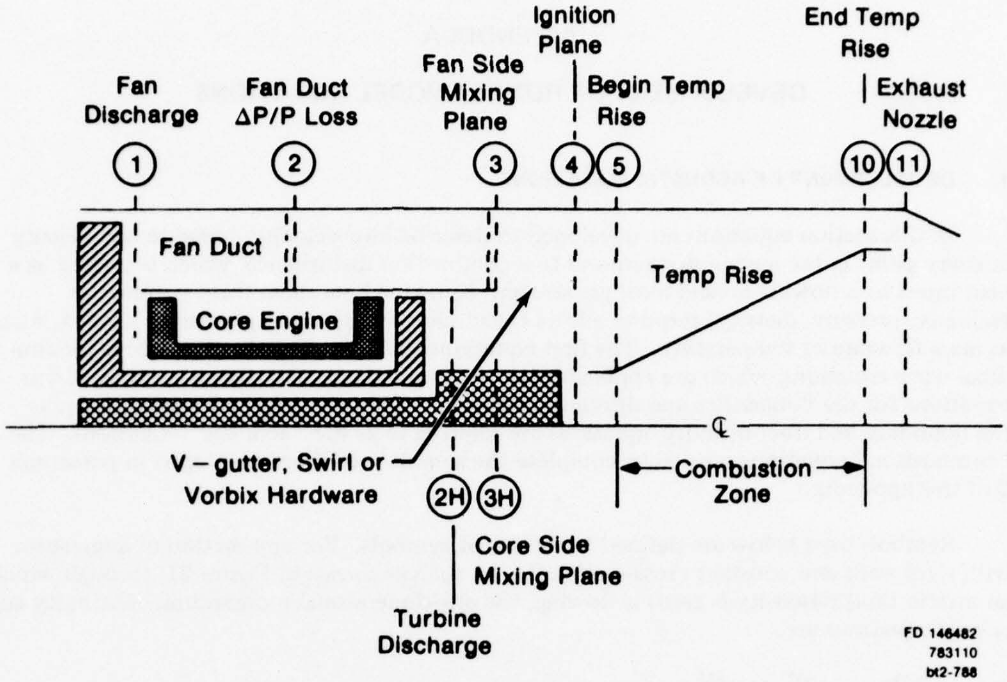

Figure 21. Rumble Model Station Identification

To simplify notation, the following substitutions are made which normalize the change in each variable by its steady-state value:

$$P' = \frac{\Delta P}{\bar{P}}, \; V' = \frac{\Delta V}{\bar{V}}, \; \rho' = \frac{\Delta \rho}{\bar{\rho}}, \; q' = \frac{\Delta q}{\bar{q}} \tag{4}$$

The linearized version of equations (2) becomes:

$$(\bar{V}+\bar{C}) \frac{\partial}{\partial x}\left[P'+\gamma\bar{M}V' \right] + \frac{\partial}{\partial t}\left[P'+\gamma\bar{M}V' \right] + (\gamma-1)\frac{\bar{q}}{\bar{P}}\beta_F' = (\gamma-1)\frac{\bar{q}}{\bar{P}}q'$$

$$(\bar{V}-\bar{C}) \frac{\partial}{\partial x}\left[P'-\gamma\bar{M}V' \right] + \frac{\partial}{\partial t}\left[P'-\gamma\bar{M}V' \right] + (\gamma-1)\frac{\bar{q}}{\bar{P}}\beta_G' = (\gamma-1)\frac{\bar{q}}{\bar{P}}q' \tag{5}$$

$$\bar{V} \frac{\partial}{\partial x}\left[P'-\gamma\rho' \right] + \frac{\partial}{\partial t}\left[P'-\gamma\rho' \right] + (\gamma-1)\frac{\bar{q}}{\bar{P}}\beta_E' = (\gamma-1)\frac{\bar{q}}{\bar{P}}q'$$

where:

$$\beta_F' = \frac{1}{(1-\bar{M}^2)}\left[P'(1-\bar{M}-\bar{M}^2) + \rho'\bar{M} + V'\left\{ \frac{1}{2} + \frac{3}{2}\bar{M} - \bar{M}^2\left[1 + (1+\bar{M})\frac{\gamma}{2}\right] \right\}\right]$$

$$\beta_G' = \frac{1}{(1-\bar{M}^2)}\left[P'(1+\bar{M}-\bar{M}^2) + \rho'\bar{M} + V'\left\{ \frac{1}{2} - \frac{3}{2}\bar{M} - \bar{M}^2\left[1 + (1-\bar{M})\frac{\gamma}{2}\right] \right\}\right] \tag{6}$$

$$\beta_E' = P' + V'$$

Taking the Laplace transform with respect to time, with zero initial conditions, and letting subscripts 1 and 2 stand for the upstream and downstream stations respectively (see Figure 21), the general solution to equations (5) becomes:

$$[P_2' + \gamma \bar{M}_2 V_2']\, e^{s\int_0^{\ell} \frac{dx}{\bar{V}+\bar{C}}} - [P_1' + \gamma \bar{M}_1 V_1'] + \frac{(\gamma-1)}{S}\int_0^{\ell} \frac{\bar{q}}{\bar{P}}\, \beta_F'(x,s)\, \frac{d}{dx}\, e^{s\int_0^{x} \frac{dx}{\bar{V}+\bar{C}}}\, dx$$

$$= \frac{(\gamma-1)}{S}\int_0^{\ell} \frac{\bar{q}}{\bar{P}}\, q'(x,s)\, \frac{d}{dx}\, e^{s\int_0^{x} \frac{dx}{\bar{V}+\bar{C}}}\, dx$$

$$[P_2' - \gamma \bar{M}_2 V_2']\, e^{s\int_0^{\ell} \frac{dx}{\bar{V}-\bar{C}}} - [P_1' - \gamma \bar{M}_1 V_1'] + \frac{(\gamma-1)}{S}\int_0^{\ell} \frac{\bar{q}}{\bar{P}}\, \beta_G'(x,s)\, \frac{d}{dx}\, e^{s\int_0^{x} \frac{dx}{\bar{V}-\bar{C}}}\, dx \tag{7}$$

$$= \frac{(\gamma-1)}{S}\int_0^{\ell} \frac{\bar{q}}{\bar{P}}\, q'(x,s)\, \frac{d}{dx}\, e^{s\int_0^{x} \frac{dx}{\bar{V}-\bar{C}}}\, dx$$

$$[P_2' - \gamma \rho_2']\, e^{s\int_0^{\ell} \frac{dx}{\bar{V}}} - [P_1' - \gamma \rho_2'] + \frac{(\gamma-1)}{S}\int_0^{\ell} \frac{\bar{q}}{\bar{P}}\, \beta_E'(x,s)\, \frac{d}{dx}\, e^{s\int_0^{x} \frac{dx}{\bar{V}}}\, dx$$

$$= \frac{(\gamma-1)}{S}\int_0^{\ell} \frac{\bar{q}}{\bar{P}}\, q'(x,s)\, \frac{d}{dx}\, e^{s\int_0^{x} \frac{dx}{\bar{V}}}\, dx$$

In equations (7) the first equation describes downstream running sonic waves of the form $P' + \gamma\bar{M}\,V'$, traveling at sonic speed plus through-flow velocity. The second equation describes upstream running sonic waves of the form $P' - \gamma\bar{M}\,V'$, traveling at sonic speed minus through-flow velocity. The third equation describes entropy waves, $P' - \gamma\rho'$, drifting downstream at through-flow velocity.

The entropy waves become more apparent from the expression for the entropy of an ideal gas:

$$\frac{\Delta S}{C_v} = S' = P' - \gamma\rho' \tag{8}$$

The entropy waves are related to temperature by:

$$\gamma T' = S' + (\gamma-1)\, P' \tag{9}$$

It is through equation (9) that the drifting hot and cold combustion products, or entropy waves, are accounted for in the rumble model. Temperature changes produced as the entropy waves strike the exhaust nozzle create waves which then travel back upstream at sonic speed.

Equations (7) are not useful until the integrals are evaluated, which will require definitions of $\bar{V}(x)$, $\bar{C}(X)$, $\bar{q}(x)$, $\bar{P}(x)$ and some assumptions that will allow integration of $q'(x, s)$, $\beta_F'(x, s)$, $\beta_G'(x, s)$ and $\beta_E'(x, s)$. To complete the solution, the augmentor is divided into several "short" sections, each of length ℓ, for each of which it can be assumed:

(a) $\dfrac{d\,\bar{P}(x)}{dx} = 0$

(b) $\dfrac{d\,\bar{T}(x)}{dx} = \text{constant}$

(c) $q'(x,t) = q'\left(0,\ t - \int_0^x \dfrac{dx}{\bar{V}}\right)$

(d) $\dfrac{\bar{q}(x)}{\bar{P}(x)} = \text{constant}$

The small static pressure drop in an augmentor justifies assumption (a). A linear temperature rise is also a good approximation, which justifies assumption (b). Assumption (c) is the equation for a "drifting burning particle" releasing heat at a constant volumetric rate as it drifts down the augmentor. A more detailed explanation of this assumption will be provided in part 2 (Development of Combustion Equations). To justify the constant steady-state heat release rate ($\bar{q}$), consider the steady-state version of the energy equation (third in equations (2)).

$$\bar{V}\left[\frac{1}{\bar{P}}\frac{d\bar{P}}{dx} - \frac{\gamma}{\bar{\rho}}\frac{d\bar{\rho}}{dx}\right] = (\gamma-1)\frac{\bar{q}}{\bar{P}}$$

With appropriate substitutions, the equation reduces to:

$$\frac{\bar{q}}{\bar{P}} = \left(\frac{\gamma}{\gamma-1}\right)\frac{R}{\bar{P}}\frac{\bar{W}}{A}\frac{d\bar{T}}{dx} - \frac{\bar{V}}{\bar{P}}\frac{d\bar{P}}{dx}$$

Since $\dfrac{d\bar{P}}{dx} = 0$ *and* $\dfrac{d\bar{T}}{dx} = $ *constant, then*

$$\frac{\bar{q}}{\bar{P}} = \text{constant} = \frac{\gamma}{\gamma-1}\frac{\bar{C}_1\bar{M}_1}{\ell}\left(\frac{\bar{T}_2}{\bar{T}_1} - 1\right) \tag{10}$$

For a "short" section of length ℓ, the integration of $\beta_F'(x, s)$ in equations (7) can be carried out as follows:

$$\int_0^\ell \frac{\bar{q}}{\bar{P}}\beta_F'(x,S)\frac{d}{dx}e^{s\int_0^x \frac{dx}{\bar{V}+\bar{C}}}dx \approx \frac{\bar{q}}{\bar{P}}\beta_F'(o,S)\int_0^{\ell/2}\frac{d}{dx}e^{s\int_0^x \frac{dx}{\bar{V}+\bar{C}}}dx$$

$$+\ \frac{\bar{q}}{\bar{P}}\beta_F'(\ell,S)\int_{\ell/2}^{\ell}\frac{d}{dx}e^{s\int_0^x \frac{dx}{\bar{V}+\bar{C}}}dx$$

Similar treatment allows integration of β'_G (x, s) and β'_E (x, s) in equation (7). To determine how "short" a section must be for the solution to be valid, the resulting rumble model was exercised repeatedly while decreasing the section length (by adding more stations in the combustion zone). As the section length decreases, the result will rapidly approach an exact solution. It was found that section lengths shorter than about 20 inches were unnecessary.

With the above assumptions, equation (7) becomes:

$$[P_2' + \gamma\bar{M}_2V_2' - [P_1' + \gamma\bar{M}_1V_1']e^{-\tau_F S} - (\gamma-1)\frac{\bar{q}}{\bar{P}}\,\beta'_{F_1}\left[\frac{e^{-\tau_F S} - e^{-\tau_{F_2} S}}{S}\right]$$

$$+ (\gamma-1)\frac{\bar{q}}{\bar{P}}\,\beta'_{F_2}\left[\frac{1-e^{-\tau_{F_2} S}}{S}\right] = (\gamma-1)\frac{\bar{q}}{\bar{P}}\,q_1'\left\{\bar{M}_1\left[\frac{e^{-\tau_F S} - e^{-(\tau_{E_1} + \tau_{F_2})S}}{S}\right]\right.$$

$$\left. + \bar{M}_2\left[\frac{e^{-(\tau_{F_2} + \tau_{E_1})S} - e^{-\tau_E S}}{S}\right]\right\} \qquad (11)$$

$$[P_1' - \gamma\bar{M}_1V_1'] - [P_2' + \gamma\bar{M}_2V_2']e^{-\tau_G S} + (\gamma-1)\frac{\bar{q}}{\bar{P}}\,\beta'_{G_1}\left[\frac{1-e^{-\tau_{G_1} S}}{S}\right]$$

$$- (\gamma-1)\frac{\bar{q}}{\bar{P}}\,\beta'_{G_2}\left[\frac{e^{-\tau_G S} - e^{-\tau_{G_1} S}}{S}\right]$$

$$= (\gamma-1)\frac{\bar{q}}{\bar{P}}\,q_1'\left\{\bar{M}_1\left[\frac{1-e^{-(\tau_{G_1}+\tau_{E_1})S}}{S}\right] + \bar{M}_2\left[\frac{e^{-(\tau_{G_1} + \tau_{E_1})S} - e^{-(\tau_G + \tau_E)S}}{S}\right]\right\}$$

$$[P_2' - \gamma\rho'_2] - [P_1' - \gamma\rho'_1]e^{-\tau_E S} - (\gamma-1)\frac{\bar{q}}{\bar{P}}\,\beta'_{E_1}\left[\frac{e^{-\tau_E S} - e^{-\tau_{E_2} S}}{S}\right]$$

$$+ (\gamma-1)\frac{\bar{q}}{\bar{P}}\,\beta'_{E_2}\left[\frac{1-e^{-\tau_{E_2} S}}{S}\right] = (\gamma-1)\frac{\bar{q}}{\bar{P}}\,q_1'\,\tau_E\,e^{-\tau_E S}$$

where:

$$\tau_F \equiv \int_0^{\ell} \frac{dx}{\bar{V}+\bar{C}} \qquad \tau_G \equiv -\int_0^{\ell} \frac{dx}{\bar{V}-\bar{C}} \qquad \tau_E \equiv \int_0^{\ell} \frac{dx}{\bar{V}}$$

$$\tau_{F_1} \equiv \int_0^{\ell/2} \frac{dx}{\bar{V}+\bar{C}} \qquad \tau_{G_1} \equiv -\int_0^{\ell/2} \frac{dx}{\bar{V}-\bar{C}} \qquad \tau_{E_1} \equiv \int_0^{\ell/2} \frac{dx}{\bar{V}} \tag{12}$$

$$\tau_{F_2} = \tau_F - \tau_{F_1} \qquad \tau_{E_2} = \tau_E - \tau_{E_1}$$

$$\beta'_{F_1} \equiv \frac{1}{(1-\bar{M}_1^2)}\left[P'_1 (1-\bar{M}_1-\bar{M}_1^2) + \rho'_1\bar{M}_1 + V'_1 \left\{ \frac{1}{2} + \frac{3}{2}\bar{M}_1 - \bar{M}_1^2 \left[1 + (1+\bar{M}_1)\frac{\gamma}{2} \right] \right\} \right]$$

$$\beta'_{F_2} \equiv \frac{1}{(1-\bar{M}_2^2)}\left[P'_2 (1-\bar{M}_2-\bar{M}_2^2) + \rho'_2\bar{M}_2 + V'_2 \left\{ \frac{1}{2} + \frac{3}{2}\bar{M}_2 - \bar{M}_2^2 \left[1 + (1+\bar{M}_2)\frac{\gamma}{2} \right] \right\} \right]$$

$$\beta'_{G_1} \equiv \frac{1}{(1-\bar{M}_1^2)}\left[P'_1 (1+\bar{M}_1-\bar{M}_1^2) - \rho'_1\bar{M}_1 + V'_1 \left\{ \frac{1}{2} - \frac{3}{2}\bar{M}_1 - \bar{M}_1^2 \left[1 + (1-\bar{M}_1)\frac{\gamma}{2} \right] \right\} \right]$$

$$\beta'_{G_2} \equiv \frac{1}{(1-\bar{M}_2^2)}\left[P'_2 (1+\bar{M}_2-\bar{M}_2^2) - \rho'_2\bar{M}_2 + V'_2 \left\{ \frac{1}{2} - \frac{3}{2}\bar{M}_2 - \bar{M}_2^2 \left[1 + (1-\bar{M}_2)\frac{\gamma}{2} \right] \right\} \right] \tag{13}$$

$$\beta'_{E_1} \equiv P'_1 + V'_1$$

$$\beta'_{E_2} \equiv P'_2 + V'_2$$

For convenience in programming equations (11) on the computer, the following identity substitutions were made:

$$\beta'_{F_1} = PF_1\, P'_1 + RF_1\rho'_1 + VF_1 V'_1$$

$$\beta'_{F_2} = PF_2\, P'_2 + RF_2\rho'_2 + VF_2 V'_2$$

$$\beta'_{G_1} = PG_1\, P'_1 + RG_1\rho'_1 + VG_1 V'_1 \tag{14}$$

$$\beta'_{G_2} = PG_2\, P'_2 + RG_2\rho'_2 + VG_2 V'_2$$

where by definition:

$$PF_1 = \frac{1}{(1-\bar{M}_1^2)} \quad [1-\bar{M}_1-\bar{M}_1^2]$$

$$RF_1 = \frac{\bar{M}_1}{(1-\bar{M}_1^2)}$$

$$VF_1 = \frac{1}{(1-\bar{M}_1^2)} \left\{ \frac{1}{2} + \frac{3}{2} \; \bar{M}_1 - \bar{M}_1^2 \left[1 + (1+\bar{M}_1) \frac{\gamma}{2} \right] \right\}$$

$$PF_2 = \frac{1}{(1-\bar{M}_2^2)} \quad [1 - \bar{M}_2-\bar{M}_2^2]$$

$$RF_2 = \frac{\bar{M}_2}{(1-\bar{M}_2^2)}$$

$$VF_2 = \frac{1}{(1-\bar{M}_2^2)} \left\{ \frac{1}{2} + \frac{3}{2} \; \bar{M}_2 - \bar{M}_2^2 \left[1 + (1+\bar{M}_2) \frac{\gamma}{2} \right] \right\}$$

(15)

$$PG_1 = \frac{1}{(1-\bar{M}_1^2)} \quad [1-\bar{M}_1-\bar{M}_1^2]$$

$$RG_1 = \frac{-\bar{M}_1}{(1-\bar{M}_1^2)}$$

$$VG_1 = \frac{1}{(1-\bar{M}_1^2)} \left\{ \frac{1}{2} - \frac{3}{2} \; \bar{M}_1 - \bar{M}_1^2 \left[1 + (1-\bar{M}_1) \frac{\gamma}{2} \right] \right\}$$

$$PG_2 = \frac{1}{(1-\bar{M}_2^2)} \quad [1 + \bar{M}_2-\bar{M}_2^2]$$

$$RG_2 = \frac{-\bar{M}_2}{(1-\bar{M}_2^2)}$$

$$VG_2 = \frac{1}{(1-\bar{M}_2^2)} \left\{ \frac{1}{2} - \frac{3}{2} \; \bar{M}_2 - \bar{M}_1^2 \left[1 + (1-\bar{M}_2) \frac{\gamma}{2} \right] \right\}$$

The time constants in equations (12) were evaluated based upon the steady-state through-flow and sonic speed profiles created by the linear temperature gradient.

$$\bar{V}(x) = \bar{V}_1 \left[1 + \left(\frac{\bar{T}_2}{\bar{T}_1} - 1 \right) \frac{x}{\ell} \right]$$

(16)

$$\bar{C}(x) = \bar{C}_1 \sqrt{1 + \left(\frac{\bar{T}_2 - \bar{T}_1}{\bar{T}_1} \right) \frac{x}{\ell}}$$

Then the time constants in equations (12) become:

$$\tau_F = \frac{\ell/\bar{C}_1}{\left(\frac{T_2}{T_1} - 1\right)} \frac{2}{M_1} \ell n \left[\frac{1 + M_1 \sqrt{T_2/T_1}}{1 + M_1} \right]$$

$$\tau_G = \frac{\ell/\bar{C}_1}{\left(\frac{T_2}{T_1} - 1\right)} \frac{2}{M_1} \ell n \left[\frac{1 - M_1}{1 - M_1 \sqrt{T_2/T_1}} \right]$$

$$\tau_E = \frac{\ell/\bar{C}_1}{\left(\frac{T_2}{T_1} - 1\right)} \frac{1}{M_1} \ell n \left[\frac{T_2}{T_1} \right]$$

$$\tau_{F_1} = \frac{\ell/\bar{C}_1}{\left(\frac{T_2}{T_1} - 1\right)} \frac{2}{M_1} \ell n \left[\frac{1 + M_1 \sqrt{\tfrac{1}{2}(1 + T_2/T_1)}}{1 + M_1} \right] \tag{17}$$

$$\tau_{G_1} = \frac{\ell/\bar{C}_1}{\left(\frac{T_2}{T_1} - 1\right)} \frac{2}{M_1} \ell n \left[\frac{1 - M_1}{1 - M_1 \sqrt{\tfrac{1}{2}(1 + T_2/T_1)}} \right]$$

$$\tau_{E_1} = \frac{\ell/\bar{C}_1}{\left(\frac{T_2}{T_1} - 1\right)} \frac{1}{M_1} \ell n \left[\tfrac{1}{2}(1 + T_2/T_1) \right]$$

This completes the development of the wave equations.

Equations (11) are applied throughout the augmentor between any two stations between which there is no discontinuity. In applying the equations, the general subscripts 1 and 2 are replaced by the actual upstream and downstream station numbers, respectively. Referring to Figure 21, they are applied between stations (1) - (2), (2) - (3), (4) - (5), (5) - (10) and (10) - (11). Between stations (1) through (5) and between stations (10) - (11) there is no heat addition, and so the heat addition terms $\bar{q}/\bar{P}$ are set to zero. The heat addition terms for the combustion zone, stations (5) - (10), are discussed in paragraph 2 of this appendix.

Discontinuities occur at the pressure drop locations, stations (2) and (3). These are modeled as small incompressible resistive pressure drops of zero length. The continuity and energy equations are also applied. Referring to Figure 21, across a pressure drop:

$$P_2 - P_3 \approx \frac{\rho_2 V_2^2}{2}$$

$$W_2 = W_3 \tag{18}$$

$$T_2 = T_3$$

The equations are linearized and normalized as before to yield:

$$P_2' - \left[1 - \left(\frac{\bar{P}_2 - \bar{P}_3}{\bar{P}_2}\right)\right] P_3' = \left(\frac{\bar{P}_2 - \bar{P}_3}{\bar{P}_2}\right)(\rho_2' + 2V_2')$$

$$\rho_2' + V_2' = \rho_3' + V_3' \tag{19}$$

$$P_2' - \rho_2' = P_3' - \rho_3'$$

In applying equations (19) to a given pressure drop, the general subscripts 2 and 3 are replaced by the actual upstream and downstream station numbers, respectively. For convenience in programming, equations (19) were combined with the wave equations (11) to eliminate the need for two stations at each pressure drop. It is the combined equations which appear in the rumble model listing.

A junction occurs where the core stream and fan stream enter the augmentor and form the overall augmentor stream (stations (3), (3H) and (4)). Again applying continuity, momentum and energy:

$$W_3 + W_{3H} = W_4$$

$$\left(\frac{P - P_4}{P}\right)_{\substack{\text{FAN SIDE}\\ \text{OR}\\ \text{CORE SIDE}}} \approx \left(\frac{W\sqrt{T}}{P}\right)^2_{\substack{\text{FAN SIDE}\\ \text{OR}\\ \text{CORE SIDE}}} \tag{20}$$

$$W_3T_3 + W_{3H}\,T_{3H} = W_4T_4$$

The linearized and normalized versions become:

$$\rho_4' + V_4' = \left(\frac{BPR}{1+BPR}\right)\rho_3' + \left(\frac{BPR}{1+BPR}\right)V_3' + \left(\frac{1}{1+BPR}\right)\rho_{3H}' + \left(\frac{1}{1+BPR}\right)V_{3H}'$$

$$P_3' - \left[1 - \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\right] P_4' = 2\left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{BPR}{1+BPR}\right)V_3'$$

$$+ \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{BPR}{1+BPR}\right)\rho_3' + 2\left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{1}{1+BPR}\right)V_{3H}'$$

$$+ \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{1}{1+BPR}\right)\rho_{3H}' \tag{21}$$

$$P_{3H}' - \left[1 - \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\right] P_4' = 2\left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{BPR}{1+BPR}\right)V_3'$$

$$+ \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{BPR}{1+BPR}\right)\rho_3' + 2\left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{1}{1+BPR}\right)V_{3H}'$$

$$+ \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3}\right)\left(\frac{1}{1+BPR}\right)\rho_{3H}'$$

$$V_4' + P_4' = \left[\frac{BPR\,(T_3/T_H)}{1 + BPR\,(T_3/T_H)}\right] P_3' + \left[\frac{BPR\,(T_3/T_H)}{1 + BPR\,(T_3/T_H)}\right]$$

$$= \left[\frac{1}{1 + BPR\,(T_3/T_H)}\right] P_{3H}' + \left[\frac{1}{1 + BPR\,(T_3/T_H)}\right]$$

For the Swirl augmentor, the momentum equations at stations (3) - (4) and (3H) - (4) are modified to account for the possibility of different pressure drops across the fan and core swirl vanes. The linearized version of the momentum equations for the Swirl augmentor becomes:

$$P_3' - \left[1 - \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3} \right) \right] P_4' = 2 \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3} \right) V_3' + \left(\frac{\bar{P}_3 - \bar{P}_4}{\bar{P}_3} \right) \rho_3'$$

$$P_{3H}' - \left[1 - \left(\frac{P'_{3H} - \bar{P}_4'}{\bar{P}_{3H}} \right) \right] P_4' = 2 \left(\frac{\bar{P}_{3H} - \bar{P}_4}{\bar{P}_{3H}} \right) V_{3H}' + \left(\frac{\bar{P}_{3H} - \bar{P}_4}{\bar{P}_{3H}} \right) \rho_{3H}' \qquad (22)$$

Definition of the upstream and downstream boundary conditions, at the fan and at the nozzle, respectively, will complete the acoustic equations. The fan was assumed to be delivering a constant mass flowrate through the fan OD (defined as that portion of the fan between the fan splitter and fan tip) and through the fan ID (defined as that portion of the fan between the centerline and the fan splitter). It was also assumed that the temperature of the fan discharge flow could be taken as time invarient (also, because of the low Mach number at fan discharge, total and static temperatures can be used interchangeably). To account for the presence of a core engine, and explore any possible attendant interaction with fan duct acoustics, a simple first order lag representation of the core engine was incorporated into the rumble model. The core engine was represented as a compressor delivering constant corrected air flow (corrected to compressor face conditions) into a lumped volume. Flow out of the volume exited through a choked turbine to emerge at station (3H). The resulting transfer function for the core engine is:

$$\frac{W'_{3H}}{P_C'} = \frac{1}{1 + \tau_{CORE}\, S} \qquad (23)$$

Where:

W'_{3H}	=	mass flowrate at station (3H)
P'_C	=	static pressure at the compressor face
τ_{CORE}	=	core engine time constant

A default value of τ_{CORE} = .005 seconds is built into the rumble model. A different value can be input by the user, and is calculated as the mass of air in the core engine volume divided by the mass flowrate of air through the core engine. Proximity of the fan splitter to fan discharge also affects the boundary condition at the fan. Two cases were considered and are built into the rumble model (see NFSOP). In the first case, called the "proximate" splitter configuration, the fan splitter is assumed to be so close to fan discharge that no communication can occur between the fan duct and the core engine across the fan splitter. For this case, the boundary condition at the fan becomes:

$$\begin{aligned} P'_C &= W'_{3H} = 0 \\ W_1' &= \rho'_1 + V_1' = 0 \\ T_1' &= P_1 - \rho_1' = 0 \end{aligned} \qquad (24)$$

In the second case, called the "remote" splitter configuration, the fan splitter is assumed to be sufficiently remote from fan discharge to allow perfect communication between the fan duct and the core engine across the fan splitter. For this case, the boundary condition at the fan becomes:

$$
\begin{aligned}
P'_C &= P_1' \\
W_1' &= \rho_1' + V_1' = -\frac{P_1'}{BPR} \\
T_1' &= P_1' - \rho_1' = 0 \\
W'_{3H} &= \frac{P_1'}{1 + \tau_{CORE} S}
\end{aligned}
\qquad (25)
$$

This completes the definition of the upstream boundary condition. It is of interest to note that entropy waves are created by sonic wave reflections at the upstream boundary. Since an entropy perturbation is $S_1' = P_1' - \gamma\rho_1'$, and at the boundary $\rho_1' = P_1'$, then $S_1' = (1-\gamma) P_1'$. A similar argument will show that entropy waves are also created at the pressure drops (stations (2) and (3)). These are automatically accounted for in the rumble model, but are of minor importance compared to the entropy waves created in the combustion zone by combustion disturbances.

The downstream boundary condition is based upon the presence of a "short" nozzle just downstream of station (11), for which:

$$
\frac{W\sqrt{T_o R}}{A\ P_o} = \phi\ (P_R) \qquad (26)
$$

where:

$$
\phi = \frac{\left[\left(P_R^{\frac{\gamma-1}{\gamma}} - 1\right)\left(\frac{2}{\gamma-1}\right)\right]^{1/2}}{P_R^{\frac{\gamma+1}{2\gamma}}}
$$

P_R = P_o /nozzle throat static pressure

$$
P_R \leq \left(\frac{\gamma+1}{2}\right)^{\frac{\gamma}{\gamma-1}}
$$

When linearized, the downstream boundary condition becomes:

$$V_{11}' = \frac{1}{2} \quad (P_{11}' - \rho_{11}') + (\mathrm{KNOZ})\, P_{11}' \tag{27}$$

where:

$$\mathrm{KNOZ} = \frac{\left[1 + \left(\frac{\gamma+1}{2}\right) \bar{M}_{11}\right]\left(\frac{P_R}{\phi}\frac{\partial\phi}{\partial P_R}\right)}{[1 - \bar{M}_{11}^2 (1+\gamma)] \left(\frac{P_R}{\phi}\frac{\partial\phi}{\partial P_R}\right)}$$

$$\frac{P_R}{\phi}\frac{\partial\phi}{\partial P_R} = \left[\frac{P_R^{\frac{\gamma-1}{\gamma}}}{2\left(P_R^{\frac{\gamma-1}{\gamma}} - 1\right)} - \frac{\gamma+1}{2\,(\gamma-1)}\right]\left(\frac{\gamma-1}{\gamma}\right)$$

It is also of interest to note that for choked flow,

$$P_R \geq \left(\frac{\gamma+1}{2}\right)^{\frac{\gamma}{\gamma-1}},$$

then KNOZ = 0 and:

$$V_{11}' = \frac{1}{2}(P_{11}' - \rho_{11}') = \frac{1}{2}\, T_{11}' \tag{28}$$

substituting from equation (16):

$$V_{11}' = \frac{1}{2\gamma} S_{11}' + \frac{(\gamma-1)}{2\gamma} P_{11}' \tag{29}$$

This equation directly relates how entropy waves, as well as pressure disturbances, striking a choked nozzle will produce a velocity disturbance.

This completes the acoustic equation development. These equations describe the response of pressure, velocity and density throughout the augmentor to a disturbance in combustion. Development of the corresponding combustion equations, which describe how combustion throughout the augmentor will respond to disturbances in pressure, velocity and density, is presented in the following section.

2. DEVELOPMENT OF COMBUSTION EQUATIONS

Development of the combustion equations for the V-gutter flameholder augmentor is presented first. Then the combustion equations for Vorbix and Swirl augmentors are presented.

For the V-gutter flameholder augmentor two combustion streams, the fan stream and the core stream, are treated. This is necessary to be able to account for the different combustion characteristics of the fan and core streams. The two streams can have different flameholder designs and fuel-air ratios as well as different flameholder approach temperatures and velocities, causing the two streams to have different efficiency vs. fuel-air ratio characteristics. In addition, the fan stream is preceded by a long fan duct which can exhibit longitudinal resonance at the low frequencies associated with rumble. The core stream is preceded by a short section terminating at turbine discharge, which is much less responsive at low frequencies.

The basic approach taken for the rumble model was to model combustion disturbances in the fan and core streams independently, accounting for the individual properties of each stream. The resulting two combustion disturbances (calculated as volumetric heat release rate disturbances) were then simply added to form a single overall disturbance. The overall disturbance was then distributed evenly over the total cross-sectional area of the augmentor, which was taken to consist of a single overall stream with mean mixed properties. This approach accounts for the different combustion characteristics of the fan and core streams, while avoiding the complexities associated with a rigorous treatment of the radial as well as the axial distribution of combustion throughout the augmentor.

Experience with modeling the combustion process as a plane heat addition with all combustion taking place in zero length, had shown that the resulting predictions of rumble were sensitive to the axial location chosen for the plane. Since combustion actually takes place over a distance of 30 to 60 inches, it was decided that the axially distributed nature of the burning should be accounted for. This was accomplished by dividing the combustion zone into a number of axial sections, each of length ℓ, as explained in part 1, "Development of Acoustic Equations".

Combustion equations used in the rumble model are based upon an extension of empirical steady-state processes to the case of time variant flow. A schematic of the steady-state processes is shown in Figure 22. Consider first that the augmentor contains only the fan stream. An identical set of equations will exist for the parallel core stream. Following a particle of air as it moves through the augmentor, the following steps will occur:

- Particle of air picks up fuel as it crosses the spraybar.
- Particle drifts at through-flow velocity to the flameholder, station (4).
- Particle is ignited by the flameholder wake as it drifts from the flameholder, to the beginning of the combustion zone, station (5) (defined as the location where the bulk fluid temperature begins to rise sharply).
- Particle drifts and burns from station (5) to the end of the combustion zone, station (10) (defined as the location where bulk fluid temperature ceases its sharp rise).

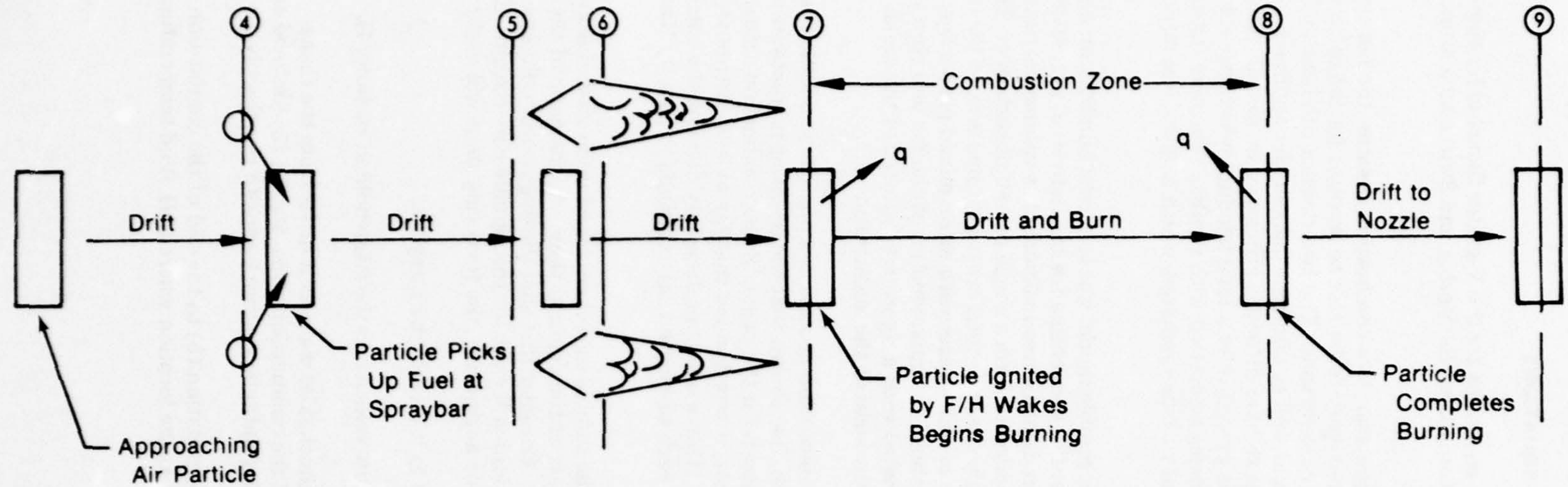

Figure 22. Steps in Augmentor Combustion Process

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It was determined (see equation (10)) that for a linear temperature gradient, the steady-state volumetric heat release rate in the augmentor could be taken as independent of axial position. This implies that at steady-state a particle of fuel-air mixture, drifting and burning through the combustion zone, has a volumetric heat release rate that is independent of axial position. The rate can be computed directly from the flowrate, ideal temperature rise, efficiency and combustion zone volume of the augmentor.

$$q = \frac{C_p}{V} W \, T_i \, \eta \qquad (30)$$

For small perturbations, it was assumed that transiently the volumetric heat release rate of a particle could still be taken as independent of axial position, and that equation (30) could be used to compute the rate when W, T_i and η are referenced to instantaneous approach conditions. The resulting equation will model combustion as though it behaves in a quasi-steady manner. The volumetric heat release rate at any location in the combustion zone will reach the steady-state value corresponding to instantaneous conditions at the flameholder and at the spraybar after a delay. The delay is the time required to purge the old combustion gases and refill with new combustion gases traveling at through-flow velocity.

For the fan stream, instantaneous approach conditions are taken to be the instantaneous conditions at station (3). Because of the large pressure drop in the fuel spraybar injector, changes in fuel flow in response to augmentor pressure at the spraybar are small compared to changes in air flow. Consequently, fuel flow can be considered constant, and the fuel-air ratio of the particle as it crosses the spraybar is determined by changes in air flow only.

$$FA_{S/B} = \frac{\text{constant}}{W_3} \qquad (31)$$

A period of time $\tau_{DC} = LSC/\overline{V}_3$ is required for the particle to drift from the spraybar to the flameholder. Therefore, the fuel-air ratio of the particle when it reaches the flameholder can be expressed as:

$$FA_c(t) = FA_{S/B} \, (t - \tau_{DC}) \qquad (32)$$

At the ignition plane (flameholder) the particle has a "potential" volumetric heat release rate of:

$$q_c = \frac{C_p}{V_c} \; W_3 \, T_{ic} \, \eta_c \qquad (33)$$

The ideal temperature rise is a function of the fuel-air ratio of the particle (effects of approach temperature and pressure are negligible). The efficiency is assumed to be a function of the fuel-air ratio and the approach pressure, temperature and velocity.

$$T_{ic} = \text{fcn}(FA_c) \qquad (34)$$

$$\eta_c = \text{Vfcn}(FA_c, P_3, T_3, V_3) \qquad (35)$$

The total volumetric heat release rate (subscript "T") is formed by adding the heat release rates of the fan and core streams:

$$q_t v_T = Q_t = Q_C + Q_H = q_C v_c + q_H v_H \tag{41}$$

or, in normalized form:

$$q_t' = \left[\frac{Q_C}{Q_t} \right] q_C' + \left[\frac{Q_H}{Q_t} \right] q_H' \tag{42}$$

Equation (42) computes the instantaneous volumetric heat release rate of a particle of combined fan stream and core stream fuel-air ratio mixture when the particle reaches the flameholder. The term "potential" is applied because the particle has not yet been ignited. The particle is ignited by the flameholder wake as it drifts a distance ℓ_4 at velocity $\bar{V}_4$. The particle begins releasing the "potential" heat at station (5), as defined by equation (36). To account for adding the core stream to the augmentor flow (originally only the fan stream was considered), equation (36) was rewritten to include the heat release of both the core and fan streams and emerges as:

$$q(o,t) = q_t\,(t - \ell_4 / \bar{V}_4) \tag{43}$$

Linearized:

$$q'(o,t) = q_t'\,(t - \ell_4 / \bar{V}_4) \tag{44}$$

Equation (44) simply adds a delay into the system which allows tailoring the axial location of the beginning of the combustion zone. For convenience in programming the equations, this delay is added to the drift delay in the combustion zone (τ_E) to form an overall particle drift delay from the flameholder.

$$\tau_Q = \ell_4 / \bar{V}_4 + \tau_E \tag{45}$$

The particle then releases heat throughout the combustion zone as defined by equation (37), the linearized version of which is:

$$q'(x,t) = q'(o, t - \tau_E) \tag{46}$$

Equation (45) was presented in part 1, "Development of Acoustic Equations", and used to evaluate integrals in equation (7). The combustion equations require that the following information about the steady-state operating point:

$$\left[\frac{Q_C}{Q_t} \right], \left[\frac{Q_H}{Q_t} \right], \left[\frac{FA}{T_t} \frac{\partial T_t}{\partial FA} \right]_{C,H}, \left[\frac{FA}{\eta} \frac{\partial \eta}{\partial FA} \right]_{C,H},$$

$$\left[\frac{P}{\eta} \frac{\partial \eta}{\partial P} \right]_{C,H}, \left[\frac{T}{\eta} \frac{\partial \eta}{\partial T} \right]_{C,H}, \text{ and } \left[\frac{V}{\eta} \frac{\partial \eta}{\partial V} \right]_{C,H}$$

The heat release rate ratios Q_C/Q_T and Q_H/Q_T are computed in the program from conditions known about each augmentor stream:

$$\frac{Q_C}{Q_t} = \frac{(BPR\ T_{ic}\ \eta_C)}{(BPR\ T_{ic}\ \eta_C) + (T_{iH}\ \eta_H)}$$

$$\frac{Q_H}{Q_t} = \frac{(Ti_H\ \eta_H)}{(BPR\ T_{ic}\ \eta_C) + (T_{iH}\ \eta_H)} \tag{47}$$

The partial derivative terms $\left[\frac{FA}{T_i}\ \frac{\partial T_i}{\partial FA}\right]_{C,\,H}$ are computed in the program from a subroutine curvefit of the ideal temperature rise curve. A graphical definition of the term is supplied in Figure 23. The partial derivative terms involving efficiency are computed in the flameholder combustion model and supplied directly to the rumble model. Alternately, they may be computed from empirical data and be input by the user. The graphical definition of terms is similar to that of Figure 23.

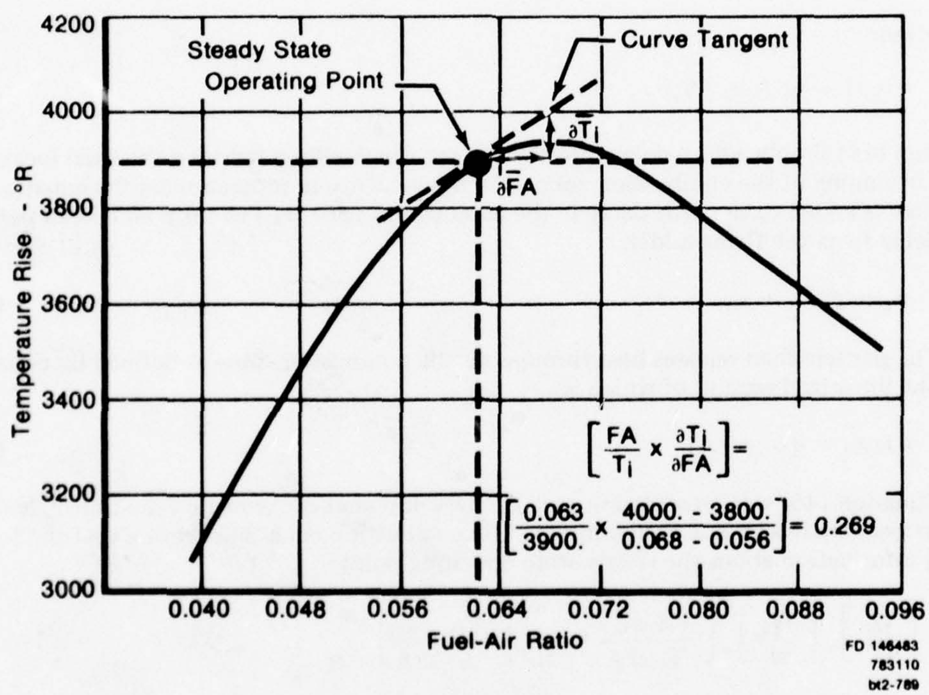

Figure 23. Ideal Temperature Rise for Constant Pressure Combustion of Hydrocarbon Fuels

This completes the combustion equation development for the V-gutter flameholder model. All of the above equations apply to the Vorbix and Swirl augmentors except as noted below.

For the Vorbix and Swirl augmentors, independent heat release rates for the fan and core streams cannot be identified because of the flow mixing. In addition, the effects of pilot fuel-air ratio on augmentor combustion efficiency must be accounted for. Equation (3) is again applied, but on an overall basis only.

$$q_t = \frac{Cp}{v} W_4 T_I \eta \qquad (48)$$

The overall fuel-air ratio is computed from total mixed air flow at station (4).

$$FA = \frac{\text{constant}}{W_4} \qquad (49)$$

The overall ideal temperature rise is a function of overall fuel-air ratio. The efficiency is assumed to be a function of overall fuel-air ratio, pilot fuel-air ratio and pressure at station (4).

$$T_I = fch(FA) \qquad (50)$$

$$\eta = fch(FA, FAP, P_4) \qquad (51)$$

Then for the Vorbix and Swirl augmentors, the instantaneous "potential" volumetric heat release rate of a particle of mixture when the particle reaches station (4) is:

$$q_t' = \left[1 - \left[\frac{FA}{T_I} \frac{\partial T_I}{\partial FA} \right] - \left[\frac{FA}{\eta} \frac{\partial \eta}{\partial FA} \right] \right] W_4' + \left[\frac{FAP}{\eta} \frac{\partial \eta}{\partial FAP} \right] FAP' + \left[\frac{P}{\eta} \frac{\partial \eta}{\partial P} \right] P_4' \qquad (52)$$

Equation (52) applies to both the Vorbix and Swirl augmentors, and is equivalent to equation (42) for the V-gutter augmentor. The Vorbix and Swirl augmentors differ in pilot location. The Swirl has the pilot at fan duct exit, so that air flow through the Swirl pilot is proportional to fan duct exit flow, W_3. The Vorbix has the pilot near midspan, radially, and slightly aft of stations (3) and (3H), so that air flow through the Vorbix pilot is proportional to total flow, W_4. Then, since fuel flow into both pilots is constant:

$$\text{Swirl: } FAP' = -W_3'$$
$$\text{Vorbix: } FAP' = -W_4' \qquad (53)$$

For convenience in programming, W_4 can be replaced by:

$$W_4 = W_3 + W_{3H}$$

$$W_4' = \left[\frac{BPR}{1 + BPR} \right] W_3' + \left[\frac{1}{1 + BPR} \right] W_{3H}' \qquad (54)$$

Substituting (53) and (54) into (52):

$$\text{Swirl: } q_t' = \left\{\left(1-\left[\frac{FA}{T_1}\frac{\partial T_1}{\partial FA}\right]-\left[\frac{FA}{\eta}\frac{\partial \eta}{\partial FA}\right]\right)\left(\frac{BPR}{1+BPR}\right)-\left(\frac{FAP}{\eta}\frac{\partial \eta}{\partial FAP}\right)\right\} W_3'$$

$$+\left\{\left(1-\left[\frac{FA}{T_1}\frac{\partial T_1}{\partial FA}\right]-\left[\frac{FA}{\eta}\frac{\partial \eta}{\partial FA}\right]\right)\left(\frac{1}{1+BPR}\right)\right\} W_{3H}'$$

$$+\left[\frac{P}{\eta}\frac{\partial \eta}{\partial P}\right] P_4' \qquad (55)$$

$$\text{Vorbix: } q_t' = \left\{\left(1-\left[\frac{FA}{T_1}\frac{\partial T_1}{\partial FA}\right]-\left[\frac{FA}{\eta}\frac{\partial \eta}{\partial FA}\right]-\left[\frac{FAP}{\eta}\frac{\partial \eta}{\partial FAP}\right]\right)\left(\frac{BPR}{1+BPR}\right)\right\} W_3'$$

$$+\left\{\left(1-\left[\frac{FA}{T_1}\frac{\partial T_1}{\partial FA}\right]-\left[\frac{FA}{\eta}\frac{\partial \eta}{\partial FA}\right]-\left[\frac{FAP}{\eta}\frac{\partial \eta}{\partial FAP}\right]\right)\left(\frac{1}{1+BPR}\right)\right\} W_{3H}'$$

$$+\left[\frac{P}{\eta}\frac{\partial \eta}{\partial P}\right] P_4' \qquad (56)$$

Equations (55) and (56) replace equation (42). All other combustion equations are identical to those developed for the V-gutter flameholder augmentor. The partial derivatives in equations (55) and (56) must be computed from empirical data and be input by the user.

This completes development of the combustion equations. For the solution technique, based upon applying the Nyquist criterion to the open loop transfer function (OLTF), the OLTF is formed by renaming q_T' to q_{IN}' in equation (44) and by renaming q_T' to q_{OUT}' in equations (42), (55) and (56).

APPENDIX B

DEVELOPMENT OF FLAMEHOLDER COMBUSTION MODEL EQUATIONS

1. DEVELOPMENT OF THE FAN DUCT COMBUSTION EQUATIONS

The equations which are used in the fan duct combustion analysis are highlighted in this section. The reader is referred to the AFAPL TR-78-24 (Contract F33615-76-C-2023) for full details of the analytical development.

The program utilizes the input to set-up and analyze each streamtube as a separate entity. The results are stored for final summation at the completion of the fan duct analysis.

The flow field is first developed from the input:

$$\rho_a = \frac{P_s}{RT_a} \tag{57}$$

$$V_a = M\sqrt{\gamma RT_a} \tag{58}$$

$$W = N/\Gamma \tag{59}$$

$$\dot{m}_a = \rho_a V_a W \tag{60}$$

The streamtube width has been set from the flameholder width and the blockage ratio. Note that the streamtube is assumed to be 1-in. deep. The total flowrates are thus per unit depth. If true total flowrates are desired, the number of streamtubes of each type must be set to reflect the total true depth of that type. For example, if 5 streamtubes, of 4 inches depth each, are input as one type, then set the input number of this type equal to 20.

To account for the removal of air from the streamtube for liner cooling, the input fuel-air ratio is adjusted by:

$$FA\Big)_{effective} = FA\Big)_{input} \frac{1}{1 - WCOOL\left(\frac{1 + BPR}{BPR}\right)} \tag{61}$$

This increases the fuel-air ratio to reflect the air removal when:

$$WCOOL = \dot{m}_{cooling}/\dot{m}_{engine} \tag{62}$$

$$BPR = \dot{m}_{duct}/\dot{m}_{core} \tag{63}$$

$$\dot{m}_{engine} = \dot{m}_{duct} + \dot{m}_{core} \tag{64}$$

Then

$$\dot{m}_f = \dot{m}_a\,(FA)_{effective} \tag{65}$$

This is required since fuel-air ratios are usually based on the total fan duct air flowrates. If true values are known or if no cooling air is used, set WCOOL = 0.0. Refer to Figure 24 for details.

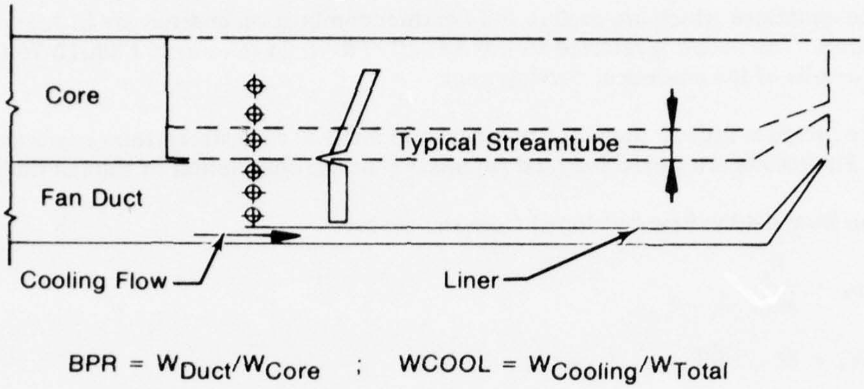

Figure 24. Location of a Core Streamtube in a Turbofan Engine Augmentor

The injection subroutine divides the fuel into 5 droplet size groups which represent the droplet size vs. volume distribution. The curve used is for a variable area pintle injection. The sizes used are:

Group	*% Covered*	*Mean Value*
1	0-20	d_{10}
2	20-40	d_{30}
3	40-60	d_{50}
4	60-80	d_{70}
5	80-100	d_{90}

The curve is a function of the injection pressure drop where:

$$\Delta P_{inj} = PFSR - Ps \quad (66)$$

Any flash vaporization is evaluated from the fuel enthalpy chart assuming adiabatic injection, i.e., $\Delta H = 0$

$$H_1 = fcn\ (PFSR, TFSR) \quad (67)$$

$$H_2 = fcn\ (\%\ vaporized, Ps) \quad (68)$$

The droplet vaporization and acceleration are evaluated by a small time step integration between the sprayring and flameholder. The equations are:

$$\frac{dV_\ell}{dt} = \frac{3}{4}\frac{C_d}{d_\ell}\frac{\rho_a}{\rho_\ell}(V_a - V_\ell)^2 \tag{69}$$

for acceleration, and:

$$\dot{m}_{vaporized} = KA_s P_s \ell n \left(\frac{P_s}{P_s - P_v} \right) \tag{70}$$

$$K = \frac{N_u D_v MW}{R d_\ell T_a} \tag{71}$$

$$N_u = 2 + 0.6 R_e^{1/2} P_r^{1/3} \tag{72}$$

for vaporization.

The evaluation of the liquid temperature follows:

$$h_f = kN_u/d_\ell \tag{73}$$

$$\dot{q} = h_f A_s (T_a - T_\ell) \beta \tag{74}$$

$$\beta = \frac{z}{e^z - 1} \tag{75}$$

$$z = Cp_v \dot{m}_v/\pi k d_\ell N_u \tag{76}$$

$$\Delta\dot{q} = \dot{q} - \dot{m}_v \lambda \tag{77}$$

$$\frac{dT_\ell}{dt} = \frac{\Delta\dot{q}}{m_\ell Cp_\ell} \tag{78}$$

$$m_\ell = \rho_\ell \frac{4}{3} \pi \left(\frac{d_\ell}{2} \right)^3 \tag{79}$$

$$R_e = \frac{\rho_a d_\ell (V_a - V_\ell)}{\mu_g} \tag{80}$$

This procedure is done for each size group until the flameholder is reached and the net fraction vaporized is evaluated.

$$\beta_1 = 1 - \left(\frac{\dot{m}_v}{\dot{m}_f} \right)_{at\ F/H} \tag{81}$$

The impingement of liquid fuel into the flameholder is evaluated by use of a term β_2 where:

$$\beta_2 = \frac{\dot{m}_{fc}}{\dot{m}_{f\ell} \cdot \Gamma} \tag{82}$$

This evaluates the percentage of the liquid fuel exposed to the flameholder which actually collects into its surface. The evaluation procedure is done for each size droplet group by a correlation of β_2 vs. flameholder size, apex angle, flow velocity and droplet diameter. The correlation is based on evaluations performed by droplet trajectory analysis using the potential flow field aerodynamics. The total impingement flowrate is thus:

$$\beta_2 = \frac{1}{\dot{m}} \sum_{i=1}^{5} \dot{m}(i)\ \beta_2(i) \tag{83}$$

or:

$$\dot{m}_{f_c} = \beta_2\ (1 - \beta_1)\ \Gamma\ \dot{m}_f \tag{84}$$

The liquid film vaporization rate is evaluated from the equations for the surface film vaporization caused by heat transfer from the flameholder wake. The surface is broken into ten elements and the vaporization and liquid temperature rise in each is calculated from:

$$\dot{m}_v = C_1\ A_s\ P_s\ \ell n \left(\frac{P_s}{P_s - P_v} \right) \tag{85}$$

$$C_1 = \frac{N_u\ D_v\ MW}{R\ \Delta x\ T_a} \tag{86}$$

$$N_u = 0.33\ R_e^{0.8}\ P_r^{0.33} \tag{87}$$

$$P_v = \text{fcn}\ (T_\ell) \tag{88}$$

$$\dot{q} = \dot{m}_{f_c}\ C_p\ \Delta T_\ell + \lambda \left(\frac{N_u\ D_v\ MW}{R\ \Delta x\ T_a} \right) P_s\ A_s\ l_n \left(\frac{P_s}{P_s - P_v} \right) \tag{89}$$

$$\dot{q} = h_f\ A_s\ (T_w - T_{F/H}) \tag{90}$$

$$h_f = N_{u_w}\ \frac{k}{N} \tag{91}$$

$$N_{u_w} = 0.99\ R_e^{0.5}\ P_r^{0.33} \tag{92}$$

The solution procedure for β_3 breaks the flameholder surface into 10 equally spaced increments. The length of each is:

$$\Delta x = \frac{1}{10}\ \frac{N/2}{\sin\ (\alpha/2)} \tag{93}$$

The fuel collected by the surface is equally divided into the 10 elements on each face of the flameholder:

$$\dot{m}_c(i) = \frac{1}{20}\ \beta_2\ (1 - \beta_1)\ \Gamma\ \dot{m}_f \tag{94}$$

Equations 29 to 36 are used for element i = 1 on the surface with $\dot{m}_{f_c} = \dot{m}_c$ (i) and the fuel temperature is assumed to be the same as the droplet liquid temperature at the flameholder. The fraction vaporized is calculated and the liquid temperature use evaluated. The procedure is repeated using fuel properties evaluated at:

$$\bar{T}_\ell (i) = T_\ell (i)_o + \frac{1}{2} \Delta T_\ell(i) \qquad (95)$$

This procedure continues until convergence, i.e., ΔT_ℓ varies less than 1% between passes. Into the next element, i = 2, the flowrate is set equal to the unvaporized portion of the i = 1 flow and the collection fraction per equation (94).

$$\dot{m}(2) = \dot{m}_c(2) + \dot{m}_c(1) - \dot{m}_v(1) \qquad (96)$$

This flowrate initial temperature is set equal to the mass average of the exit temperature from i = 1 and the droplet liquid collection temperature:

$$T_{fi}(2) = \frac{\dot{m}_c(2)\, T_{\ell c} + [\dot{m}_c(1) - \dot{m}_v(1)]\, T_{ff}(1)}{\dot{m}_c(2) + \dot{m}_c(1) - \dot{m}_v(1)} \qquad (97)$$

The solution procedure is separated until all 10 segments are finished. The vaporized flowrate is the sum of all 10 in both sides of the flameholder:

$$\dot{m}_v = 2 \times \sum_{i=1}^{10} \dot{m}_v(i) \qquad (98)$$

The fractive vaporized, β_3, is:

$$\beta_3 = \frac{\dot{m}_v}{\dot{m}_c} = \frac{\dot{m}_v}{(1 - \beta_1)\, \Gamma\, \beta_2\, \dot{m}_f} \qquad (99)$$

All of the vaporized fuel is assumed to enter the recirculation zone.

From these equations, β_3 is a function of the wake temperature. The temperature is a function of the wake fuel-air ratio and recirculation rate. Since β_3 strongly influences the wake fuel-air ratio, the solution for wake composition and efficiency becomes a curve intersection procedure.

First we define the recirculation and wake kinetics equations and then the solution procedure.

a. Recirculation

The wake recirculation flowrate coefficient is defined as:

$$K_1 = \dot{m}_r / \Gamma\, \dot{m}_a \qquad (100)$$

$$\dot{m}_r = \rho_a\, V_a\, N\, K_1 \qquad (101)$$

For mass transfer across the recirculation zone boundaries and a homogeneous wake:

$$\dot{m}_r = \frac{\rho_a\, V_o}{\tau} \qquad (102)$$

The wake volume is evaluated as a function of blockage, apex angle, and flow Mach number from literature references as shown in the flameholder Final Report, AFAPL TR-78-24. From this:

$$V_o = C_v\ (L/D)(B/D)N^2 \tag{103}$$

We set:

$$\tau' = \frac{\tau V_a}{N} \tag{104}$$

$$\dot{m}_r = \frac{V_a}{N}\frac{\rho_a V_o}{\tau'} \tag{105}$$

Thus:

$$\dot{m}_r = \frac{\rho_a V_a C_v (L/D)(B/D)N}{\tau'}$$

and

$$K_1 = C_v (L/D)(B/D)(\tau')^{-1} \tag{106}$$

By curve fits of L/D, B/D and τ' vs. α, N, Va, and Ta, we find the recirculation rate K_1.

b. Wake Reaction Kinetics

The wake reaction is assumed to be a single step, second order reactive controlled as follows:

$$-\frac{dm}{dt} = \frac{k}{R^n}\chi_o^{a}\chi_f^{n-a}\frac{e^{-C/T}}{T^{n-0.5}} \tag{107}$$

For a well stirred reactor (wake is assumed to behave as one):

$$\frac{A}{V_o P^n} = \frac{k(m+1)}{R^n y\epsilon}\chi_o^{a}\chi_f^{n-a}\frac{e^{-C/T}}{T^{n-0.5}} \tag{108}$$

For the assumed single-step reaction process postulated here, the reaction mass balance is (for propane fuel):

$$\begin{aligned} &\phi C_3H_8 + 5O_2 + 5mN_2 \rightarrow 3y\epsilon CO_2 + 4y\epsilon H_2O + \\ &(\phi - y\epsilon)C_3H_8 + 5(1 - y\epsilon)O_2 + 5mN_2 \end{aligned} \tag{109}$$

Also, a linear efficiency vs. temperature function is assumed:

$$T = T_a + \epsilon\Delta T_{ideal} \tag{110}$$

From these equations, the stirred reactor loading capability may be written as:

$$\frac{A}{V_o P^n} = \frac{k(m+1)[5(1-y\epsilon)]^a[\phi - y\epsilon]^{n-a}e^{-C/(T_1 + \epsilon\Delta T)}}{R^n y\epsilon[5(m+1) + \phi + y\epsilon]^n[T_1 + \epsilon\Delta T]^{n-0.5}} \tag{111}$$

Based on comparison of predicted results with available stirred reactor data, we use the following values for this reaction:

n: for $\phi<1$, $n = 2\phi$
for $\phi>1$, $n = 2/\phi$
a: $a = n/2$
C: $C = E/R$, see Figure 25

This yields:

$$\frac{A}{V_o P^{2\phi}} = \frac{1.29 \times 10^{10}\,(m+1)[5(1-y\epsilon)]^{\phi}\,(\phi-y\epsilon)^{\phi}\,e^{-C/(T_1 + \epsilon\Delta T)}}{(0.08206)^{2\phi}\,y\epsilon[5(m+1) + \phi + y\epsilon]^{2\phi}\,[T_1 + \epsilon\Delta T]} \qquad (112)$$

for lean mixtures.

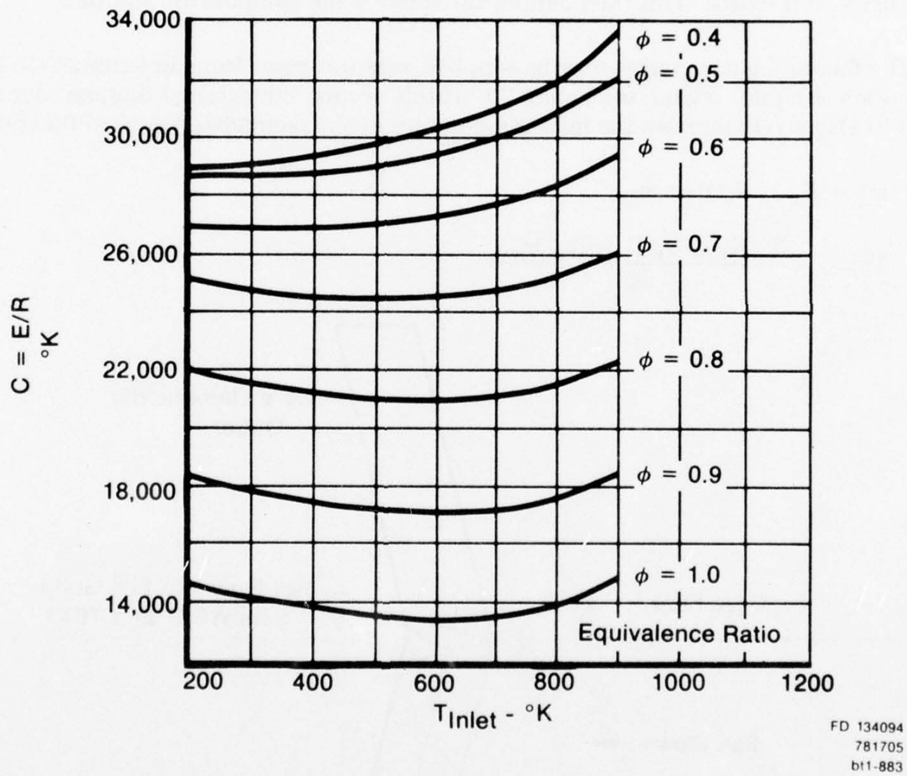

Figure 25. Variation in Activation Energy With Inlet Temperature and Equivalence Ratio

The kinetics solution proceeds by successive iteration between $\epsilon = .999$ and 0.70 to find the wake efficiency where:

$$\frac{A}{V_o P^2} = \frac{K_1\,\Gamma\,\dot{m}_a}{V_o P_a^2} \qquad (113)$$

at a given fuel-air ratio in the wake.

The solution procedure for the wake composition and reaction efficiency proceeds as follows:

(1) The wake temperature is varied in steps from 1000° F to 5000° F and calculated at each wake.

(2) The wake fuel-air ratio is varied from 0.02 to 0.20 and the wake temperature calculated at each fuel-air ratio.

The results of (1) are used in the wake fuel-air ratio equation:

$$FA)_{wake} = FA)_{total} \left\{ \beta_1 + (1 - \beta_1) \frac{\beta_2 \beta_3}{K_1} \right\} \tag{114}$$

This results in two curves, which define the wake fuel-air ratio vs. wake temperature and wake temperature vs. wake fuel-air ratio. A solution technique looks for the intersection of these curves, if it exists. This then defines the stable wake composition solution.

The fan duct gutter wakes may be supplied with hot gases from an external (to the wake) source such as a pilot region, see Figure 26. If this occurs, the external thermal source is assumed to effectively increase the inlet temperature of the recirculated air-fuel flowrate, i.e.,:

$$\dot{m}_r' = K_1 \rho_a V_a \Gamma + \dot{m}_{ext} \tag{115}$$

$$T_a' = \frac{T_a K_1 \rho_a V_a \Gamma + T_{ext} \dot{m}_{ext}}{\dot{m}_r'} \tag{116}$$

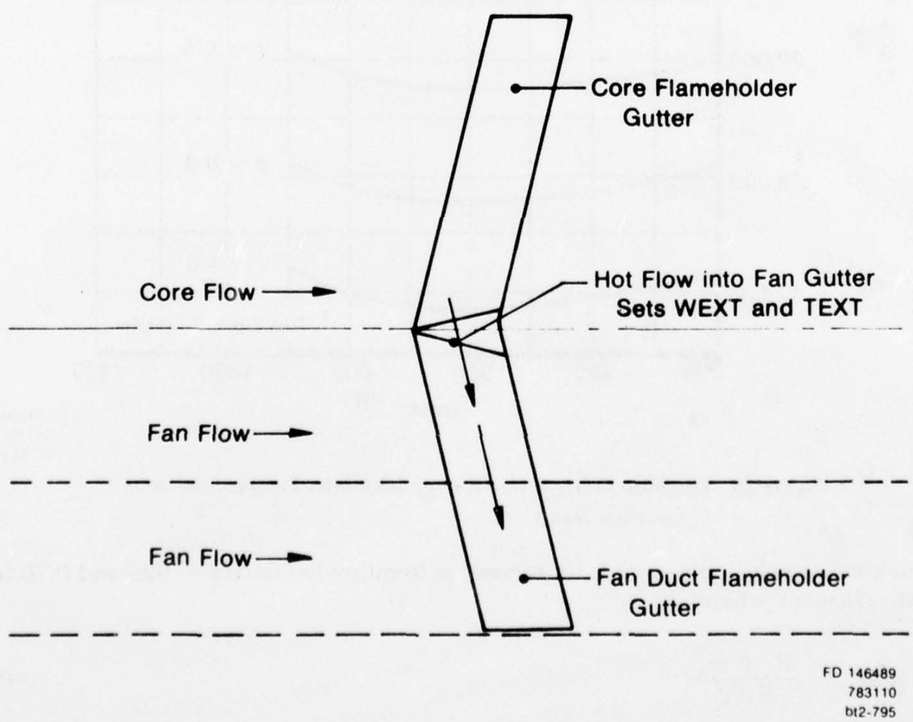

Figure 26. External Heat Addition to Fan Duct Gutters

The program then analyzes the behavior at these new conditions as if they were input.

After the wake has been analyzed, the turbulent flame penetration into the free-stream is analyzed.

The turbulent flame propagation into the unreacted free-stream is initiated in the shear layers of the wake. The model used relates the local turbulent flame speed to the local aerothermodynamic conditions and performs a finite difference integration of the flame front penetration starting in the wake and proceeding to the exhaust nozzle.

For the purposes of current analysis, the following assumptions were made:

- Uniform air flow profiles
- Uniform fuel-air ratio
- Incompressible acceleration of free air velocity by the flameholder blockage with no induced profile
- Known wake size and reaction efficiency
- Two-dimensional ducted flame.

The schematic of the situation which is analyzed is shown in Figure 27.

The approach flow, at known levels of pressure, temperature, velocity and fuel-air ratio, is accelerated by the blockage of the flameholder to velocity U, where:

$$U = \frac{V_a}{(1 - \Gamma)}$$

Where:

U = Velocity at flameholder tip
V_a = Approach velocity
Γ = Blockage ratio.

At this point, Station 1, an induced turbulence level is calculated from:

$$\epsilon_o = \left[\left\{ C_d \Gamma + \left(\frac{\Gamma}{1 - \Gamma} \right)^2 \right\} \frac{1}{6} \right]^{1/2}$$

This equation relates the turbulence intensity, ϵ_o, to the blockage ratio and the flameholder zero blockage drag coefficient, C_d.

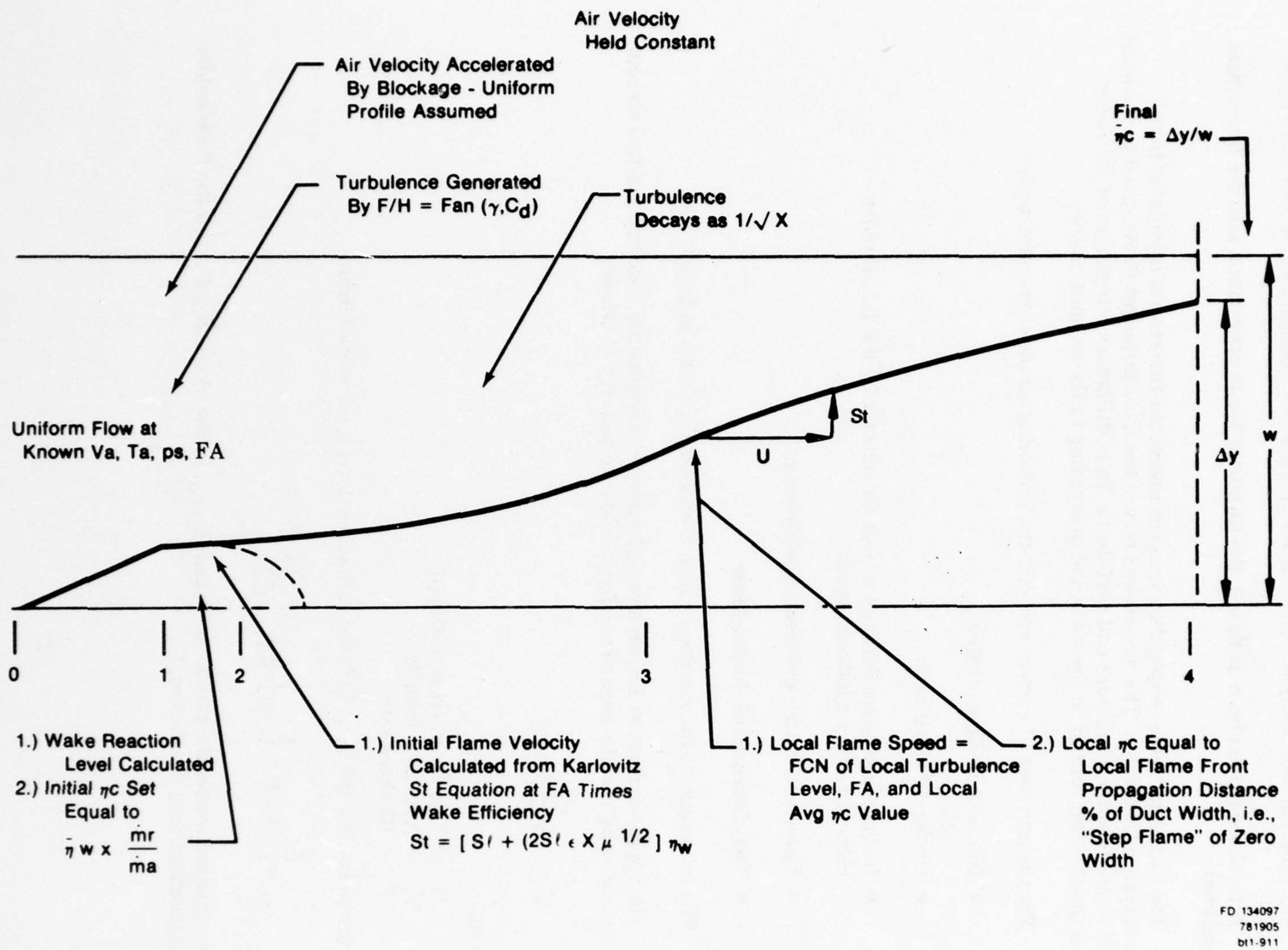

Figure 27. Schematic of Flame Spreading Analysis

At this location, the turbulent flame velocity calculations are initiated. The equation used for the local flame speed is the Karlovitz equation:

$$St = S\ell + (2u' S\ell)^{1/2}$$

Where:

St ~ Turbulent flame speed, ft/sec
$S\ell$ ~ Laminar flame speed, ft/sec
u' ~ RMS turbulence velocity, ft/sec.

The value of u' is:

$$u' = \epsilon_o U \tag{117}$$

Additionally, the turbulent flame speed initial value is related to the degree of initiation of the flame speed initial value is related to the degree of initiation of the flame front by the wake by the following:

$$St' = St \times \eta_w \tag{118}$$

This generates an effective turbulent flame speed which completely fills the depth of the duct and propagates at the same transverse rate as the full flame speed which does not fill the duct. This arises from the fact that the inefficiencies of the wake reaction generate localized regions where flame front ignition does not occur. This use of a reduced value effective flame speed accounts for this in a two-dimensional model.

The initial value for the augmentor efficiency is the wake reaction level on a mass weighted basis, expressed as an equation this is:

$$\eta_{c_o} = \eta_w \frac{\dot{m}_r}{\dot{m}_a} \tag{119}$$

Where:

η_{c_o} ~ Initial efficiency
η_w ~ Wake efficiency
$\dot{m}_r$ ~ Wake mass flowrate
$\dot{m}_a$ ~ Total duct flowrate.

The type of flame utilized in this model is a zero thickness flame which separates a region of unreacted propellants from a region of completely reacted products. From this setup, the average local augmentor efficiency is simply the ratio of the transverse flame penetration, Δy, to the duct width, w.

To be consistent, the transverse location of the flame front at the initial calculation station is taken to be:

$$\Delta y_o = \eta_{c_o} \cdot w \tag{120}$$

This value is assigned to the first axial station. This is assumed to occur halfway down the length of the recirculation zone. From visual observations of wake stabilized flames, this is the approximate location of transverse flame initiation.

From this location downstream to the exhaust nozzle, the flame front transverse location is calculated by a finite difference integration of the local flame speed. Several axial profiles are introduced as the integration proceeds. These are:

(1) The turbulence intensity is decayed from the value generated at the aft flameholder lip at a rate inversely proportional to the square root of axial distance over an effective jet length. The final value is set at the initial turbulence level. The effective jet length is set at 10 L/D where the D is the open area distance between adjacent flameholders.

(2) The velocity of the unreacted fuel-air mixture is retained at the level generated at the flameholder lip. Measured profiles from several ducted flame test rigs support this assumption.

(3) A term is introduced which relates the local flame speed to the local average duct combustion efficiency, peaking at 50%. This treats the counteracting influences of reduced heat loss as efficiency increases and reduces the free oxygen concentration. Local rates which roughly follow a sine wave function have been reported from duct data.

An additional term is added to account for the reduction in flame speed of a fuel spray compared to a premixed flame. This term relates the ratio of effective flame speed to premixed laminar flame speed. It accounts for the complicated interactions during flame spreading in an evaporating spray in a simplified manner. The effect of the liquid droplet diameter is shown in Figure 28. The droplet diameter utilized in the analysis will be the mean diameter as it exists at the flameholder trailing edge.

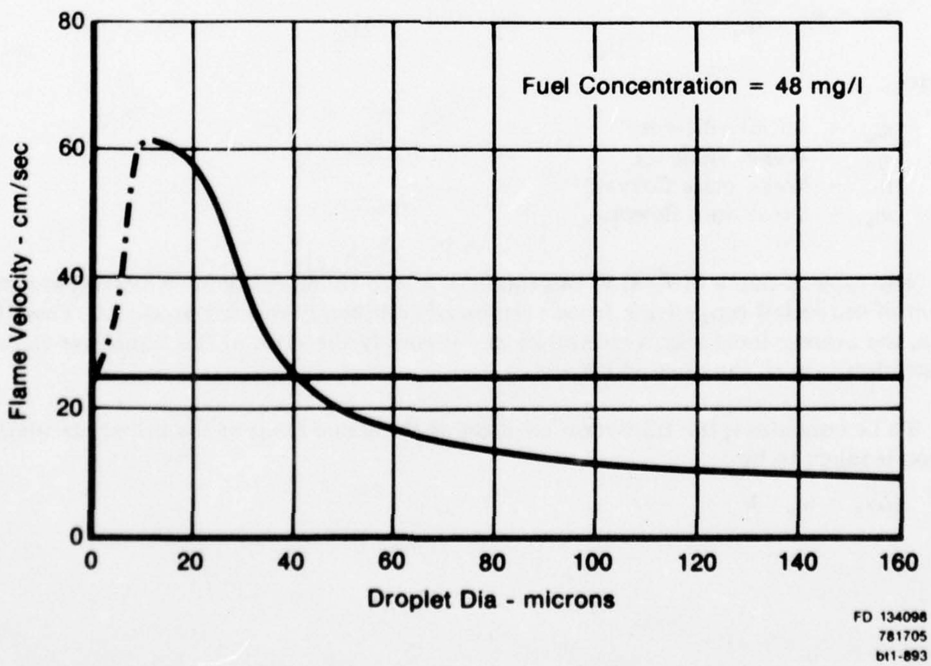

Figure 28. Flame Speed for Monodisperse Tetralin Spray

Analysis of the terms utilized for evaluation of the laminar flame speed term, S_ℓ, has resulted in the following:

$$S_\ell = S_\ell(\phi)\left(\frac{T_a}{540}\right)^{1.5}\left(\frac{\chi_{02}}{0.21}\right)^{3} \qquad (121)$$

Where:

S_ℓ = laminar flame speed at 1 atm and 540°
ϕ = equivalence ratio
T_a = air temperature, °F
χ_{02} = oxygen mole fraction.

The influence of pressure is indeterminate at this time and has been incorporated as $\sqrt{P_S}$ for subatmospheric data and no influence for pressures above 1 atmosphere.

The finite difference solution uses 1 in. increments in axial length as the stepping variable. This sets a time interval:

$$\Delta t = 0.0833/V. \qquad (122)$$

The transverse flame penetration distance is thus:

$$\Delta y = St\ \Delta t = y(i+1) - y(i) \qquad (123)$$

where St is evaluated at the conditions of x = x(i).

The stepping procedure terminates when either:

(1) x (i + 1) = augmentor length

(2) y (i + 1) = w.

The first defines η_c at the exhaust nozzle, the second defines 100% η_c before the nozzle. This defines one fan streamtube. The exit temperature is thus:

$$T_{ex}(i) = T_a(i) + \eta_c(i)\ \Delta T_l(i) \qquad (124)$$

$$\Delta T_l(i) = fcn\ (T_a(i),\ FA(i)_{effective}).$$

This represents the actual combustion efficiency based on the true fuel-air ratio in the streamtube.

For multi-streamtube cases, the exit and inlet conditions are mass averaged using the general equation:

$$\bar{Z} = \frac{\sum_{i=1}^{n} \dot{m}(i)\ Z(i)}{\sum_{i=1}^{n} \dot{m}(i)}. \qquad (125)$$

The average input fuel-air ratio and average inlet temperature combine to yield the average ideal temperature rise. The average inlet and exit temperatures yield the average actual temperature use. Thus:

$$\bar{\eta}_c = \frac{\Delta\bar{T}_{actual}}{\Delta\bar{T}_{ideal}}. \tag{126}$$

This is the chemical efficiency. The thermal exit efficiency assumes that the augmentor liner cooling air flow is included in the average exit temperature:

$$\bar{T}_{exit} = \frac{\sum_{i=1}^{n} \dot{m}(i)\, T_{ex}(i) + \dot{m}_{cool}\, \bar{T}_a}{\sum_{i=1}^{n} \dot{m}(i) + \dot{m}_{cool}}. \tag{127}$$

This reduces the average exit temperature and yields the lower value for thermal combustive efficiency. This value for η_c reflects the average exit temperature based on the average input fuel-air ratio and based on total fan duct air flow and fuel flow.

Before execution of the core streamtube analyses, the influence coefficients which are required are evaluated. These are of the form:

$$\frac{\partial\eta}{\partial A}\ \frac{\Delta}{\eta} = Z(\Delta) \tag{128}$$

Where:

$A = V_a,\ p_a,\ T_a,$ and FA.

They are calculated from a 1% change in the variables and the linear form:

$$\frac{\Delta\eta}{\Delta A}\ \frac{\bar{A}}{\bar{\eta}} = \frac{\eta_2 - \eta_1}{A_2 - A_1} \cdot \frac{(A_1 + A_2)}{(\eta_1 + \eta_2)} \tag{129}$$

Where:

$$A_2 = 1.01\ A_1. \tag{130}$$

The value of η_2 is obtained by execution of the analysis at all the same input as η_1, except A_1 is replaced with A_2. Thus, the analysis is done once for base and four more times for the Z factors.

2. DEVELOPMENT OF THE CORE STREAM COMBUSTION EQUATIONS

The same basic analysis procedure as accomplished in the duct is used in the core with several major operational differences:

a. There is no cooling air removal from the core streamtubes. Thus, the input fuel-air ratios are used in the analysis.

b. The droplet vaporization rate is so rapid that the fuel exists only as a vapor after a couple of inches from the spraybar. This removes the requirement to solve for the wake compositive since it is the same as the input fuel-air ratio.

c. The wake reaction efficiency is solved directly at the input fuel-air ratio and recirculation rates which are calculated the same as the fan duct.

d. There is no droplet size effect in the turbulent flame speed model. The rapid droplet vaporization results in gaseous phase turbulent flame penetration.

The solution for a core streamtube proceeds as follows:

(1) The set-up equations are the same as the fan streamtubes.

(2) The recirculation coefficient, K_1, is calculated the same way as done in the fan stream. This generates the value of A/V_oP^2 required for the kinetics solution.

(3) The wake reaction kinetics solution is performed at the same value of fuel-air ratio as input for the streamtube.

(4) The turbulent flame penetration solution is the same as for the fan stream except that the droplet correction term is absent. The equation introduces a value for the oxygen concentration, χ_{O_2}.

This value is less than the fan duct due to the removal of oxygen by the mainburner combustion process. This vitiation yields:

$$\chi_{O_2} = 0.21 \qquad \frac{FA)_{mB}}{FA)_{stoich}} \tag{131}$$

The analysis produces a value of η_c for each streamtube, i, by the same equation as used in the fan:

$$\eta_c(i) = \frac{Y(i)}{w(i)} \tag{132}$$

where Y(i) is the penetration distance transverse to the flow and w(i) is the streamtube width.

The exit temperature calculation is different from the fan duct due to the vitiation of the approach air flow and the temperature removal in the turbine between the main combustor and the augmentor inlet.

The ideal temperature rise for each streamtube is evaluated by generating a fictitious main combustor inlet temperature. The procedure is as follows:

(1) For known main burner FA and streamtube inlet temperature, Ta(i), a fictitious ΔT is read from a curve as in Figure 29.

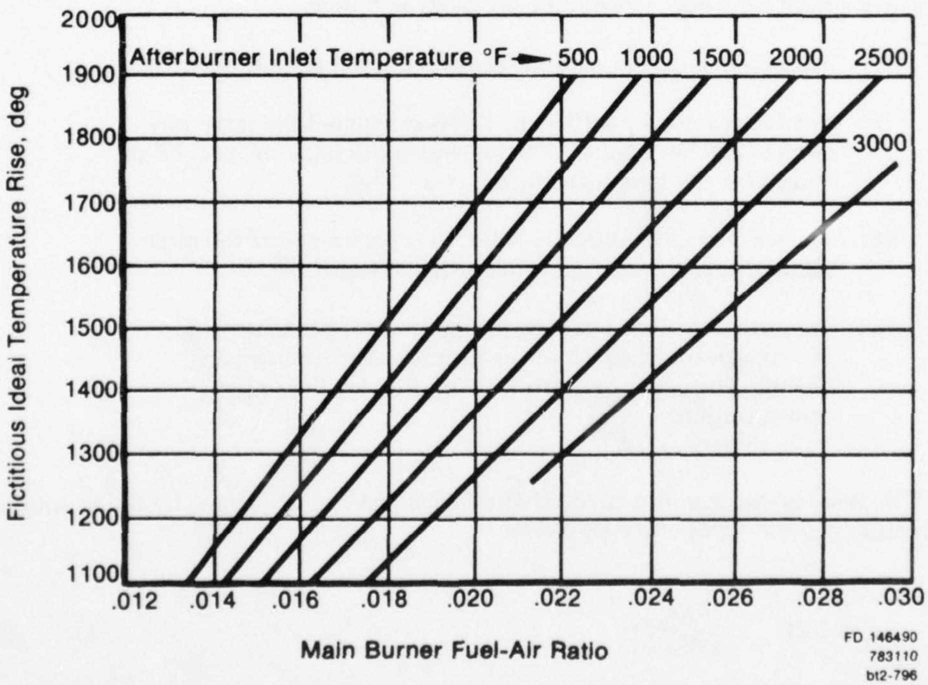

Figure 29. Fictitious Temperature Rise vs Main Burner Fuel-Air Ratio

(2) A fictitious main burner inlet temperature is calculated:

$$T'_{mB}(i) = T_a(i) - \Delta T_{fict}(i) \tag{133}$$

(3) An overall fuel-air ratio is calculated:

$$FA_{oa}(i) = FA)_{mB} + FA(i) \tag{134}$$

(4) With FA = $(FA)_{oa}(i)$ and T = $T'_{mB}(i)$, the overall effective temperature rise is read from the ideal temperature rise curve.

(5) The streamtube exit temperature is:

$$T_{ex}(i) = \Delta T_i(i) + T'_{mB}(i) \tag{135}$$

(6) The streamtube net ideal temperature rise is thus:

$$\Delta T'_i(i) = T_{ex}(i) - T_a(i) \tag{136}$$

This value is calculated for each streamtube and used exactly as the ideal ΔT curve is used in the fan streams. The streamtube exit temperature is:

$$T_{ex\ actual}(i) = T_a(i) + \eta_c\ \Delta T'_i(i) \tag{137}$$

The inlet temperatures and fuel-air ratios are mass averaged as is the exit temperature, using equation (125).

The overall core efficiency is calculated from steps (1) to (6) using average inlet conditions to yield the average ideal ΔT and equations (137) and (125) for the average exit temperature:

$$\bar{\Delta}\bar{T}_{actual} = \bar{T}_{exit} - \bar{T}_a \tag{138}$$

$$\bar{\eta}_c = \frac{\bar{\Delta}\bar{T}_{actual}}{\bar{\Delta}\bar{T}_i} \tag{139}$$

The influence coefficients are shown in equations (128) to (132) are evaluated as was done in the fan.

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LO-FREQUENCY AUGMENTOR INSTABILITY INVESTIGATION COMPUTER PROGR--ETC(U)
DEC 78 P L RUSSELL, G BRANT, R ERNST F33615-76-C-2024
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APPENDIX C

LISTING OF COMPUTER PROGRAM FORMULATION

```
PRATT & WHITNEY AIRCRAFT DIVISION                          VER     12/07/76       PAGE      SERIAL
CSG.PAN757                                                 10.0    11.35.02         1       021269

                                          PANVALET
                               THE PROGRAM MANAGEMENT AND SECURITY SYSTEM

                PROGRAMS AND ALL SUPPORTING MATERIALS COPYRIGHT 1975 BY PANSOPHIC SYSTEMS, INCORPORATED

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```
C          DATA SET B28DACCEL  AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE ACCEL(NDL)
C PURPOSE    FOR EACH DROPLET SIZE GROUP
C                1) EVALUATES ACCELERATION BETWEEN INJECTION AND FIH
C                2) EVALUATES PERCENT VAPORIZED FROM INJECTION TO FIH
C                3) SETS DROPLET SIZES AT FIH
      COMMON /CINPT/FHW,FFSR,PS,IFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARME,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MDDTA,MDDTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PS1,TLFEX,B3,TW,    ETAFH
     X,DLO(5),B1E,DMDDT,BDC,RTVD,DQDDT,Y,SL,EPSC,V,XO,EPSXO,ETAO
     X,ST(100),X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MOA,ADUCT,PI,LDC,   FHWIMP,B11,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDDTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30), TRJP4(283),CRVTSL(20)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      REAL KM,MUA,LAMBDA,MW,MDDTV,NU,ML,MDDT,KKM,MDDTFL     ,MDTFL1,MDDTF
      TAR = TA + 460.
      CALL UNBAR(CRVMUA,1,TAR,0.,MUA,KS)
      CALL UNBAR(CRVKM,1,TAR,0.,KM,KS)
      CALL UNBAR(CRVPR ,1,TA,0.,PR ,KS)
      MDTFL1 =  0.0
      DO  30  I=1,NDL
      VL  =  100
      MDDTV = 0.
      TL  =  TFO
      DT  = (5.E-3)*XF/VA
      X   =  0.
      DL(I) = 3.28E-06 * DL(I)
      DLI   = DL(I)
   10 RE  =  RHOA * (VA - VL) * DL(I) / MUA
      NU  = (2.0 + .6 * RE**.5 * PR**.33) * .5
      HF  =  KM * NU / DL(I)
      AS  =  PI * DL(I)**2
      IF(JFUEL.EQ.1) CALL UNBAR(CRVPV,1,TL,0.0,PV,KS)
      IF(JFUEL.EQ.2) CALL UNBAR(CRVPTR,1,TL,0.0,PV,IS)
      IF(JFUEL.EQ.1) CPL = .00053529 * TL + .455
      IF(JFUEL.EQ.2) CALL UNBAR(CRVCPT,1,TL,0.0,CPL,IS)
      IF(JFUEL.EQ.1) RHOL = -.02778 * TL + 56.
      IF(JFUEL.EQ.2) CALL UNBAR(CRVPT,1,TL,0.0,RHOL,IS)
      IF(JFUEL.EQ.1) CPV = .00053529 * TL + .455
      IF(JFUEL.EQ.2) CALL UNBAR(CRVCPT,1,TL,0.0,CPV,IS)
      CALL UNBAR(CRVLAM,1,TL,0.,LAMBDA,KS)
C   CURVE IS THE SAME FOR JP4 AND JP5
      MW = 128.
      TBAR = 460. + ((TA+TL)/2.)
      DV = KM / (RHOA * CPV)
      KKM = NU * DV * MW / (1545. * DL(I) * TBAR)
      MDDT = KKM * AS * PS * 144. * ALOG(PS/(PS-PV))
      Z = CPV * MDDT / (PI * KM * DL(I) * NU)
      B11  = Z /(EXP(Z)-1.)
      QDOT = HF * AS * (TA-TL) * B11
```

```
      QDOTL = QDOT - (MDOT * LAMBDA)
      ML     = 4.189 * RHOL * (DL(I)/2.)**3
      DTL   = QDOTL /(CPL * ML) * DT
      MDOTV = MDOTV + MDOT * DT
      TL     =  TL + DTL
      RHOM =  2.702 * PS / TBAR
      UM     =  (TBAR / 400.)**.71 * 1.E-05
      AL = 20.272*RHOM**.16*UM**.84*(VA-VL)**1.16/(RHOL*DL(I)**1.84)
      DVL    =  AL * DT
      DX     =  (DT * VL + (DT**2 * AL) / 2.) * 12.
      X      =  X + DX
      IF(DT*MDOT - ML)15,16,16
   15 DL(I) = DL(I) * ((ML - DT * MDOT) / ML)**.3333
      IF (X - XF)10,20,20
   16 DL(I) = 0.0
   20 BI(I) = 1. - (DL(I) / DLI)**3
      MDOTFL(I) = (1.-BI(I))*(MDOTF/NDL)
      MDTFLI = MDTFLI + MDOTFL(I)
      TLF(I) = TL
   30 CONTINUE
      RETURN
      END
```

```
C          DATA SET B28DBANDCX AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET 8456BANDCX AT LEVEL 001 AS OF 12/22/77
C     BANDCX
      SUBROUTINE BANDCX (N,MD,AC,BAND,NSUP,NSUB)
C     N    = NUMBER OF ROWS IN MATRIX TO BE PLACED IN BAND
C     MD   = MATRIX DIMENSION IN CALLING ROUTINE, MUST BE SQUARE
C     AC   = MATRIX TO BE PLACED IN BAND
C     BAND = SINGLE DIMENSION ARRAY OF THE ELEMENTS OF AC
C     NSUP = NUMBER OF SUPERDIAGONALS
C     NSUB = NUMBER OF SUBDIAGONALS
      COMPLEX  AC
      COMPLEX BAND
      DIMENSION  AC(MD,MD)
      DIMENSION  BAND(1)
C     TEST TO DETERMINE SUPERDIAGONAL COUNT
      ISZ = 0
      NS = N
   21 MSS = N-NS+1
      M   = NS
      DO 22 I=1,MSS
      CALL CIF (AC(I,M),&23)
   22 M = M+1
      ISZ = MSS
      NS = NS-1
      GO TO 21
   23 CONTINUE
      NSUP= N-ISZ-1
C     NSUP = NUMBER OF SUPERDIAGONALS
C     TEST TO DETERMINE SUBDIAGONAL COUNT
      ISZ = 0
      NS = N
   24 MSS = N-NS+1
      M   = NS
      DO 25 I=1,MSS
      CALL CIF (AC(M,I),&26)
   25 M   = M+1
      ISZ = MSS
      NS = NS-1
      GO TO 24
   26 CONTINUE
      NSUB= N-ISZ-1
C     NSUB = NUMBER OF SUBDIAGONALS
      RETURN
      END
```

```
C         DATA SET B28DBETA3  AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE BETA3
C PURPOSE    EVALUATES VAPORIZATION OF COLLECTED FUEL WITH ASSUMED WAKE
C            TEMPERATURE
C            (INITIAL WAKE TEMP = 3000)
      COMMON /CINPT/FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PS1,TLFEX,B3,TW,    ETAFH
     X,DLO(5),B1E,DMDOT,BDC,RTVD,DQDOTO,Y,SL,EPSO,V,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,   FHWTMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30), TRJP4(283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
         EXTERNAL  B3DQD2 ,B3DQD1
      COMMON /DQDT1/ DQDOT
      COMMON /DQDT/ DMDOT1,TL1,TAULC,B
      REAL MDOTC,MUA,MDTVT,KM,MDTFC
      RAD = .01745
      N = 20
      DX = FHWTMP / (2.*N*SIN(ALPHA*RAD))
      DAS =  .0833 * DX
      DV  =  KM /(.55 * RHOA)
      MDOTC = MDTFC / 2.
      DMDOTC = MDOTC / N
      WNU  =  0.558  * ( RHOA * VA * FHWTMP / MUA)**.5
      DQDOT  =  KM / FHWTMP * WNU * (TW - 800.) * DAS
      DQDOTO = 10. * DQDOT
C   CURVE IS THE SAME FOR JP4 AND JP5
      CALL UNBAR (CRVLAM,1,TLC,0.0,TAULC,KS)
      IF (DQDOT .GT. (DMDOTC * TAULC))GO TO 100
      DMDOT1  =  DMDOTC
      MDTVT   =  0.0
      TL1     =  TLC
      J       =  1
   10 XNU  =  .0238 * (RHOA * J * DX * VA / MUA)**.8
      B        = .0838 * DX * (TA+460.)/(XNU * DV * PS * DAS)
      TMX1 = DQDOT / (DMDOT1 * .55) + TL1
C   CURVE IS THE SAME FOR JP4 AND JP5
      CALL UNBAR(CRVLAM,1,TL1,0.0,TLAM,IS)
      TMX2 = 5666.85 /(11.157 - ALOG(PS*(1.-EXP(-DQDOT*B /TLAM))))-460.
      TXR  = TMX1
      IF (TMX2 .LT. TMX1)TXR = TMX2
      TXL  = TLC
      KJ = 0
      CALL REGULA(TXL,TXR,B3DQD1,B3DQD2,KJ,TLFEX,DQDT,IER)
      IF(IER .GT. 0)GO TO 1000
      DQDTS = DMDOT1*.55*(TLFEX-TL1)
      DQDOTL = DQDOT - DQDTS
      DMDTV = DQDOTL / TAULC
      TL1     =  (TLFEX*(DMDOT1 - DMDTV) + TLC * DMDOTC) /
```

```
      X (DMDOTI - DMDTV + DMDOTC)
       DMDOTI = DMDOTI - DMDTV + DMDOTC
       MDTVT  = MDTVT + DMDTV
       J      =  J + 1
       IF(J-N)10,10,50
   50  B3     = MDTVT / MDOTC
       GO TO 1000
  100  CONTINUE
C 100  WRITE(6,101)
C 101  FORMAT(' WAKE HEAT FLUX GREATER THAN LATENT HEAT')
       B3 = 1.
 1000  RETURN
       END
```

```
C          DATA SET B28DBMAT    AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET B28DRUMBLE  AT LEVEL 007 AS OF 01/27/78
C          DATA SET 84566MAT    AT LEVEL 001 AS OF 12/22/77
C     BMAT
      SUBROUTINE BMAT (NP,NB,NR,BAND,IERR)
      COMPLEX*16 BAND
      DIMENSION BAND(1)
C     BAND MATRIX DECOMPOSITION
C     ONLY THE BAND ELEMENTS OF THE MATRIX ARE STORED IN THE ARRAY BAND.
C     THE ELEMENTS ARE STORED ROW BY ROW SUCH THAT THE DIAGONAL ELEMENTS
C     FORM A COLUMN.
C     THE BAND MATRIX A IS DECOMPOSED INTO LU (LOWER AND UPPER TRIANGULA
C     THE ELEMENTS OF THE DECOMPOSED MATRIX LU ARE STORED IN THE SAME AR
C     BAND WHERE THE DIAGONAL ELEMENTS OF L ARE ASSUMED TO BE 1.
C     SUBROUTINE SOLBAN USES THE MATRIX FORM LU TO SOLVE FOR X, GIVEN AN
C     COLUMN VECTOR B.
C     VARIABLE DICTIONARY FOR ARGUMENT LIST
C     NP = NO. OF SUPERDIAGONALS IN BAND MATRIX
C     NB = NO. OF SUBDIAGONALS IN BAND MATRIX
C     NR = NO. OF ROWS IN BAND MATRIX
C     BAND(I)= ARRAY CONTAINING THE BAND ELEMENTS OF THE BAND MATRIX.
      NC = NP + NB + 1
      ID = NB + 1
      NEL= NC * NR
 35   CONTINUE
      CALL CTC( BAND(ID), &50 )
      GO TO 40
 50   CONTINUE
      DO 300 I=1,NB
      L = ID + I *(NC-1)
      IF(L .GT. NEL) GO TO 310
      BAND(L) = BAND(L) / BAND(ID)
      J = L
      K = ID
      DO 200 II=1,NP
      IF ( NP .EQ. 0 ) GO TO 200
      J = J + 1
      K = K + 1
      BAND(J) = BAND(J) - BAND(L) * BAND(K)
 200  CONTINUE
 300  CONTINUE
 310  CONTINUE
      ID = ID + NC
      IF (ID .LT. NEL) GO TO 35
 999  RETURN
 40   WRITE (6,41) ID
 41   FORMAT (21H DIAGONAL ELEMENT NO., I4, ' IS ZERO DURING BAND MATRIX
     1 DECOMPOSITION RUN ABORTED ' )
      IERR = 1
      GO TO 999
      END
```

```
C          DATA SET B28B3DQD1 AT LEVEL 001 AS OF 12/07/78  E33
      FUNCTION B3DQD1(X)
      COMMON /DQDT1/ DQDOT
      B3DQD1=DQDOT
      RETURN
      END
```

```
C          DATA SET B28DB3DQD2 AT LEVEL 001 AS OF 12/07/78   E33
      FUNCTION B3DQD2(X)
      COMMON /CINPT / FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR,XL,
     XEPS,CDFH,FARMB
      COMMON /QDOT/ DMDOTI,TLI,TAULC,B
      B3DQD2  = (DMDOTI * .55) * (X-TLI) + TAULC * 1. / B * ALOG(PS/(PS
     X - EXP(11.157 - 5666.85 / (X + 460.))))
      RETURN
      END
```

```
C         DATA SET B28DCHECK  AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE CHECK
      COMMON /PLUG/ TITLE, STITLE
     COMMON / FLAMIN/ ALPHAC(100), ALPHAH(100), FAC(100), FAH(100),
    * FHWC(100), FHWH(100), LSC(100), LSH(100), NSC(100), NSH(100),
    * PFSR(100), TAUC(100), TAUH(100), TEXT(100), TFSR(100),
    * T6C(100), T6H(100), WEXT(100), XLC(100), XLH(100), NTC, NTH
     COMMON /RMBLIN/ BPR, DPCS, DPD, DPH, DPHS, DPS, EPSC, EPSH, ETA,
    * ETAC,ETAH,FA,FAV,LA,LB,LC,LH,LI,LK,LZ,M6C,M6H,M6K,
    * PRNOZ,PS6,T3H,ZEF,ZEFC,ZEFH,ZEFP,ZEP,ZEPC,ZEPH,ZETC,
    * ZETH,ZEVC,ZEVH,TCORE,WCOOL
      COMMON /AUGIN/ JFUEL, NAUGOP, NCOMOP, NFSOP, NPRNTK, NPRNTF
      REAL LA, LB, LC, LH, LI, LK, LZ, M6C, M6H, M6K, LSC, LSH
      EQUIVALENCE (R(1),BPR)
      DIMENSION NAM1(39), NAM2(39), DFAULT(39), TITLE(20), STITLE(19),
    * NAM3(28), NAM4(28), DFT(22), R(39), IDFT(10)
      DATA NAM1 / 4HBPR , 4HDPCS, 4HDPD , 4HDPH , 4HDPHS, 4HDPS ,
    *      4HEPSC, 4HEPSH, 4HETA , 4HETAC, 4HETAH, 4HFA  , 4HFAV ,
    *      4HLA  , 4HLB  , 4HLC  , 4HLH  , 4HLI  , 4HLK  , 4HLZ  ,
    *      4HM6C , 4HM6H , 4HM6K , 4HPRNO, 4HPS6 , 4HT3H , 4HZEF ,
    *      4HZEFC, 4HZEFH, 4HZEFP, 4HZEP , 4HZEPC, 4HZEPH, 4HZETC,
    *      4HZETH, 4HZEVC, 4HZEVH, 4HTCOR, 4HWCOO/
      DATA NAM2 / 23*4H    , 4HZ     ,  13*4H    , 4HE    ,4HL   /
      DATA NAM3 / 4HNTC , 4HNTH , 4HALPH, 4HFAC , 4HFHWC, 4HLSC ,
    * 4HNSC , 4HPFSR, 4HTFSR, 4HTAUC, 4HTEXT, 4HWEXT, 4HT6C , 4HXLC ,
    * 4HALPH, 4HFAH , 4HFHWH, 4HLSH , 4HNSH , 4HTAUH, 4HT6H , 4HXLH ,
    * 4HJFUE, 4HNAUG, 4HNCOM, 4HNFSO, 4HNPRN, 4HNPRN /
      DATA NAM4 / 2*4H    , 4HAC  , 11*4H    , 4HAH  , 7*4H    ,
    *  4HL   , 4HOP  , 4HOP  , 4HP    , 4HTK  , 4HTF   /
      DATA DFAULT / .59, 0., .064, .032, 0., 0.,.04,.04, 0., .4, .91,
    * 0., .021, 82., 66., 72., 14., 5., 60., 36., .15, .28, .22, 4.4,
    * 7.92,1355.,0.,-5.5,.4,0.,0.,0.,0.,0.,0.,0.,0.,.005, 0./
      DATA IDFT / 1, 1, 1, 1, 1, 1, 2, 1, 0, 1/
      DATA DFT/ 1., 1., 60., .0595, 1.06, 4.0, 1., 134.7, 560., .256,
    * 0., 0., 700., 66., 60., .04, .75, 8.0, 1.0 .186, 1775., 66./
      DATA TL / .001 /
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.1) WRITE (6,1010)
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.2) WRITE (6,1011)
      IF (NAUGOP.EQ.2.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.1) WRITE (6,1012)
      IF (NAUGOP.EQ.2.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.2) WRITE (6,1013)
      IF (NAUGOP.EQ.3.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.1) WRITE (6,1014)
      IF (NAUGOP.EQ.3.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.2) WRITE (6,1015)
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.2.AND.NFSOP.EQ.1) WRITE (6,1016)
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.2.AND.NFSOP.EQ.2) WRITE (6,1017)
      IF (NCOMOP.EQ.3) WRITE (6,1018)
      WRITE (6,1019) STITLE
 1010 FORMAT (1H1,'RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AN
    *D PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1011 FORMAT (1H1,'RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AN
    *D REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1012 FORMAT (1H1,'RUMBLE MODEL WITH VORBIX AUGMENTOR AND PROXIMATE FLO
    *W SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1013 FORMAT (1H1,'RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW S
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     *PLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1014 FORMAT (1H1,'ROMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW
     * SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1015 FORMAT (1H1,'ROMBLE MODEL WITH SWIRL AUGMENTOR AND REMOTE FLOW SP
     *LITTER USING EMPIRICAL COMBUSTION DATA',//)
 1016 FORMAT (1H1,'ROMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AN
     *D PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBU
     *STION DATA',//)
 1017 FORMAT (1H1,'ROMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AN
     *D REMOTE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTI
     *ON DATA',//)
 1018 FORMAT (1H1,'FLAMEHOLDER MODEL ONLY',//)
 1019 FORMAT (1X,19A4,//)
    1 FORMAT (1X,'*** WARNING - PARAMETER ',2A4,' = ',G11.5,' IS A DEFA
     *ULT VALUE')
    2 FORMAT(1X,'*** WARNING - PARAMETER ',2A4,' = ',I1,10X,' IS A DEFA
     *ULT VALUE')
      IF(ABS(BPR-DFAULT(1)).LE.TL)WRITE(6,1)NAM1(1),NAM2(1),R(1)
      IF(ABS(FAV-DFAULT(13)).LE.TL)WRITE(6,1)NAM1(13),NAM2(13),R(13)
      IF(JFUEL.EQ.IDFT(5))WRITE(6,2)NAM3(23),NAM4(23),IDFT(5)
      IF(ABS(MOC-DFAULT(21)).LE.TL)WRITE(6,1)NAM1(21),NAM2(21),R(21)
      IF(ABS(MOH-DFAULT(22)).LE.TL)WRITE(6,1)NAM1(22),NAM2(22),R(22)
      IF(NCOMOP.EQ.IDFT(7))WRITE(6,2)NAM3(25),NAM4(25),IDFT(7)
      IF(ABS(PS6-DFAULT(25)).LE.TL)WRITE(6,1)NAM1(25),NAM2(25),R(25)
      IF (NCOMOP.EQ.3) GO TO 300
      IF(ABS(DPD-DFAULT(3)).LE.TL)WRITE(6,1)NAM1(3),NAM2(3),R(3)
      IF(ABS(DPS-DFAULT(6)).LE.TL)WRITE(6,1)NAM1(6),NAM2(6),R(6)
      IF(ABS(LA-DFAULT(14)).LE.TL)WRITE(6,1)NAM1(14),NAM2(14),R(14)
      IF(ABS(LC-DFAULT(16)).LE.TL)WRITE(6,1)NAM1(16),NAM2(16),R(16)
      IF(ABS(LH-DFAULT(17)).LE.TL)WRITE(6,1)NAM1(17),NAM2(17),R(17)
      IF(ABS(L2-DFAULT(20)).LE.TL)WRITE(6,1)NAM1(20),NAM2(20),R(20)
      IF(ABS(MOR-DFAULT(23)).LE.TL)WRITE(6,1)NAM1(23),NAM2(23),R(23)
      IF(NFSOP.EQ.IDFT(8))WRITE(6,2)NAM3(26),NAM4(26),IDFT(8)
      IF(NPRNTR.EQ.IDFT(9))WRITE(6,2)NAM3(27),NAM4(27),IDFT(9)
      IF(ABS(PRNOZ-DFAULT(24)).LE.TL)WRITE(6,1)NAM1(24),NAM2(24),R(24)
      IF(ABS(TCORE-DFAULT(38)).LE.TL)WRITE(6,1)NAM1(38),NAM2(38),R(38)
      IF(NAUGOP.EQ.IDFT(6))WRITE(6,2)NAM3(24),NAM4(24),IDFT(6)
      IF (NAUGOP.NE.1) GO TO 200
      IF(ABS(DPH-DFAULT(4)).LE.TL)WRITE(6,1)NAM1(4),NAM2(4),R(4)
      IF (NCOMOP.GE.2) GO TO 300
      IF(ABS(ETAC-DFAULT(10)).LE.TL)WRITE(6,1)NAM1(10),NAM2(10),R(10)
      IF(ABS(ETAH-DFAULT(11)).LE.TL)WRITE(6,1)NAM1(11),NAM2(11),R(11)
      IF(ABS(FAC(1)-DFT(4)).LE.TL)WRITE(6,1)NAM3(4),NAM4(4),DFT(4)
      IF(ABS(FAH(1)-DFT(16)).LE.TL)WRITE(6,1)NAM3(16),NAM4(16),DFT(16)
      IF(ABS(LB-DFAULT(15)).LE.TL)WRITE(6,1)NAM1(15),NAM2(15),R(15)
      IF(ABS(LI-DFAULT(18)).LE.TL)WRITE(6,1)NAM1(18),NAM2(18),R(18)
      IF(ABS(LK-DFAULT(19)).LE.TL)WRITE(6,1)NAM1(19),NAM2(19),R(19)
      IF(ABS(LSC(1)-DFT(6)).LE.TL)WRITE(6,1)NAM3(6),NAM4(6),DFT(6)
      IF(ABS(LSH(1)-DFT(18)).LE.TL)WRITE(6,1)NAM3(18),NAM4(18),DFT(18)
      IF(ABS(TOC(1)-DFT(13)).LE.TL)WRITE(6,1)NAM3(13),NAM4(13),DFT(13)
      IF(ABS(TOH(1)-DFT(21)).LE.TL)WRITE(6,1)NAM3(21),NAM4(21),DFT(21)
      IF(ABS(ZEFC-DFAULT(28)).LE.TL)WRITE(6,1)NAM1(28),NAM2(28),R(28)
      IF(ABS(ZEFH-DFAULT(29)).LE.TL)WRITE(6,1)NAM1(29),NAM2(29),R(29)
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      IF(ABS(ZEPC-DFAULT(32)).LE.TL)WRITE(6,1)NAM1(32),NAM2(32),R(32)
      IF(ABS(ZEPH-DFAULT(33)).LE.TL)WRITE(6,1)NAM1(33),NAM2(33),R(33)
      IF(ABS(ZETC-DFAULT(34)).LE.TL)WRITE(6,1)NAM1(34),NAM2(34),R(34)
      IF(ABS(ZETH-DFAULT(35)).LE.TL)WRITE(6,1)NAM1(35),NAM2(35),R(35)
      IF(ABS(ZEVC-DFAULT(36)).LE.TL)WRITE(6,1)NAM1(36),NAM2(36),R(36)
      IF(ABS(ZEVH-DFAULT(37)).LE.TL)WRITE(6,1)NAM1(37),NAM2(37),R(37)
      RETURN
  200 IF (NAUGUP.NE.2) GO TO 250
      IF(ABS(DPH-DFAULT(4)).LE.TL)WRITE(6,1)NAM1(4),NAM2(4),R(4)
      GO TO 275
  250 IF(ABS(DPCS-DFAULT(2)).LE.TL)WRITE(6,1)NAM1(2),NAM2(2),R(2)
      IF(ABS(DPHS-DFAULT(5)).LE.TL)WRITE(6,1)NAM1(5),NAM2(5),R(5)
  275 IF(ABS(ETA-DFAULT(9)).LE.TL)WRITE(6,1)NAM1(9),NAM2(9),R(9)
      IF(ABS(FA-DFAULT(12)).LE.TL)WRITE(6,1)NAM1(12),NAM2(12),R(12)
      IF(ABS(LB-DFAULT(15)).LE.TL)WRITE(6,1)NAM1(15),NAM2(15),R(15)
      IF(ABS(LI-DFAULT(18)).LE.TL)WRITE(6,1)NAM1(18),NAM2(18),R(18)
      IF(ABS(LK-DFAULT(19)).LE.TL)WRITE(6,1)NAM1(19),NAM2(19),R(19)
      IF(ABS(T6C(1)-DFT(13)).LE.TL)WRITE(6,1)NAM3(13),NAM4(13),DFT(13)
      IF(ABS(T6H(1)-DFT(21)).LE.TL)WRITE(6,1)NAM3(21),NAM4(21),DFT(21)
      IF(ABS(ZEF-DFAULT(27)).LE.TL)WRITE(6,1)NAM1(27),NAM2(27),R(27)
      IF(ABS(ZEFP-DFAULT(30)).LE.TL)WRITE(6,1)NAM1(30),NAM2(30),R(30)
      IF(ABS(ZEP-DFAULT(31)).LE.TL)WRITE(6,1)NAM1(31),NAM2(31),R(31)
      RETURN
  300 IF(ABS(ALPHAC(1)-DFT(3)).LE.TL)WRITE(6,1)NAM3(3),NAM4(3),DFT(3)
      IF(ABS(ALPHAH(1)-DFT(15)).LE.TL)WRITE(6,1)NAM3(15),NAM4(15),DFT(
     *15)
      IF(ABS(EPSC-DFAULT(7)).LE.TL)WRITE(6,1)NAM1(7),NAM2(7),DFAULT(7)
      IF(ABS(EPSH-DFAULT(8)).LE.TL)WRITE(6,1)NAM1(8),NAM2(8),DFAULT(8)
      IF(ABS(FAC(1)-DFT(4)).LE.TL)WRITE(6,1)NAM3(4),NAM4(4),DFT(4)
      IF(ABS(FAH(1)-DFT(16)).LE.TL)WRITE(6,1)NAM3(16),NAM4(16),DFT(16)
      IF(ABS(FHWC(1)-DFT(5)).LE.TL)WRITE(6,1)NAM3(5),NAM4(5),DFT(5)
      IF(ABS(FHWH(1)-DFT(17)).LE.TL)WRITE(6,1)NAM3(17),NAM4(17),DFT(17)
      IF(ABS(LSC(1)-DFT(6)).LE.TL)WRITE(6,1)NAM3(6),NAM4(6),DFT(6)
      IF(ABS(LSH(1)-DFT(18)).LE.TL)WRITE(6,1)NAM3(18),NAM4(18),DFT(18)
      IF(NPRNIF.EQ.IDFT(10))WRITE(6,2)NAM3(28),NAM4(28),IDFT(10)
      IF(ABS(NSC(1)-DFT(7)).LE.TL)WRITE(6,1)NAM3(7),NAM4(7),DFT(7)
      IF(ABS(NSH(1)-DFT(19)).LE.TL)WRITE(6,1)NAM3(19),NAM4(19),DFT(19)
      IF(ABS(NTC-DFT(1)).LE.TL)WRITE(6,1)NAM3(1),NAM4(1),DFT(1)
      IF(ABS(NTH-DFT(2)).LE.TL)WRITE(6,1)NAM3(2),NAM4(2),DFT(2)
      IF(ABS(PFSR(1)-DFT(8)).LE.TL)WRITE(6,1)NAM3(8),NAM4(8),DFT(8)
      IF(ABS(TAUC(1)-DFT(10)).LE.TL)WRITE(6,1)NAM3(10),NAM4(10),DFT(10)
      IF(ABS(TAUH(1)-DFT(20)).LE.TL)WRITE(6,1)NAM3(20),NAM4(20),DFT(20)
      IF(ABS(TEXT(1)-DFT(11)).LE.TL)WRITE(6,1)NAM3(11),NAM4(11),DFT(11)
      IF(ABS(TFSR(1)-DFT(9)).LE.TL)WRITE(6,1)NAM3(9),NAM4(9),DFT(9)
      IF(ABS(T3H-DFAULT(26)).LE.TL)WRITE(6,1)NAM1(26),NAM2(26),R(26)
      IF(ABS(T6C(1)-DFT(13)).LE.TL)WRITE(6,1)NAM3(13),NAM4(13),DFT(13)
      IF(ABS(T6H(1)-DFT(21)).LE.TL)WRITE(6,1)NAM3(21),NAM4(21),DFT(21)
      IF(ABS(WCDDL-DFAULT(39)).LE.TL)WRITE(6,1)NAM1(39),NAM2(39),
     *R(39)
      IF(ABS(WEXT(1)-DFT(12)).LE.TL)WRITE(6,1)NAM3(12),NAM4(12),DFT(12)
      IF(ABS(XLC(1)-DFT(14)).LE.TL)WRITE(6,1)NAM3(14),NAM4(14),DFT(14)
      IF(ABS(XLH(1)-DFT(22)).LE.TL)WRITE(6,1)NAM3(22),NAM4(22),DFT(22)
      RETURN
```

END 00159

```
C          DATA SET B2EDC1D     AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET 8458C1D     AT LEVEL 001 AS OF 12/22/77
      SUBROUTINE C1D( A, * )
      COMPLEX*16 A, AA
      REAL*8 B(2)
      EQUIVALENCE( AA, B(1))
      AA = A
      IF ( B(1) .NE. 0.0D0 ) RETURN 1
      IF ( B(2) .NE. 0.0D0 ) RETURN 1
      RETURN
      END
```

```
C          DATA SET B280CIF    AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET 8458CIF    AT LEVEL 001 AS OF 12/22/77
      SUBROUTINE CIF (A,*)
      COMPLEX A,AA
      DIMENSION B(2)
      EQUIVALENCE (AA,B(1))
      AA= A
      IF (B(1) .NE. 0.) RETURN 1
      IF (B(2) .NE. 0.) RETURN 1
      RETURN
      END
```

```
C          DATA SET B2BDCOLECT AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE COLECT (NDL)
C PURPOSE     FOR EACH DROPLET SIZE GROUP
C                1)EVALUATE MASS IMPINGEMENT RATE ON FIH SURFACE
C                2)SUMMATION SETS TOTAL MASS RATE ONTO FIH
      COMMON /CINPT/FHW,PFSR,PS,IFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,RI,PSI,TLFEX,B3,IW,    ETAFH
     X,DLC(5),BIE,DMDOT,BDC,RIVD,DQDOT,Y,SL,EPSO,V,X0,EPSX0,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,  FHWTMP,BIT,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30), TRJP4(283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      REAL MDTFC,MUA,MDOTFL     ,MDOTFC(10),LES
      MDTFC = 0.0
      DO 1000  I = 1,NDL
      IF(JFUEL.EQ.1) RHOL = -.027778 * TLF(I) + 50.
      IF(JFUEL.EQ.2) CALL UNBAR (CRVPT,1,TLF,0.0,RHOL,IS)
      REA    = RHOA * VA * DL(I) / MUA
      BPRIME = DL(I)**2 * VA * RHOL/(.75 * FHW * MUA)
      LES    =  1. / REA * (.8 * REA - .0256 * REA**2 / 2. + .458E-03 *
     XREA**3 / 3. - .3575E-05 * REA**4 / 4. + .9875E-08 * REA**5 / 5.)
      B      =  BPRIME * LES
      X      =  .4762 * ALOG(B) - .4266
      BETA2(I) =  .6373 + .4843 * X - .1676 * X**2 - .0637 * X**3
     X + .0469 * X**4
      BETA2(I) = BETA2(I)*(.62+579.1*DL(I))*(.271*ALOG(ALPHA))
     X * (1.208-.693*TAU)
      IF(BETA2(I) .GT. 1.0)BETA2(I) = 1.0
      MDOTFC(I) = MDOTFL(I) * BETA2(I)* TAU
      MDTFC  =  MDTFC + MDOTFC(I)
 1000 CONTINUE
      RETURN
      END
```

```
C          DATA SET B28DCRVS   AT LEVEL 001 AS OF 12/07/78  E33
       BLOCK DATA
       COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
      X,CRVSL(36),CRVPR(30),TRJP4 (283),CRVTSL(26)
      X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
       DIMENSION      TR1(  107),TR2(90),TR3(86)
       EQUIVALENCE (TRJP4(1),TR1(1)),(TRJP4(108),TR2(1)),(TRJP4(198),TR3(
      X1))
       DATA TR1    '/ 1.0, 1.0, 27.0, 9.0,.02,.300500E-01, .350300E-01
      X, .400000E-01, .450000E-01, .500500E-01, .550000E-01, .599900E-01
      X, .625200E-01, .650300E-01, .675000E-01, .700300E-01, .724800E-01
      X, .749600E-01, .775200E-01, .799600E-01, .824500E-01, .849700E-01
      X, .874600E-01, .899500E-01, .949700E-01, .999500E-01, .104970
      X, .109920    , .114950    , .119990,.2 , 100.000    , 200.000
      X, 400.000    , 600.000    , 800.000    , 1000.00    , 1200.00
      X, 1400.00, 1600.00, 1410., 1390., 1340., 1320.,1290.,1270.,1225.
      X, 1210., 1190., 1973.6,1949.2, 1899.5
      X, 1854.31    , 1806.09    , 1765.48    , 1723.35    , 1671.57
      X, 1626.90    , 2244.67    , 2216.24    , 2160.41    , 2108.63
      X, 2056.35    , 2003.05    , 1952.79    , 1891.88    , 1836.04
      X, 2498.48    , 2468.53    , 2409.14    , 2350.25    , 2291.37
      X, 2226.90    , 2162.44    , 2093.91    , 2018.78    , 2743.66
      X, 2707.11    , 2642.13    , 2571.07    , 2504.06    , 2428.43
      X, 2349.75    , 2262.44    , 2173.60    , 2974.62    , 2931.98
      X, 2857.36    , 2775.64    , 2694.92    , 2605.56    , 2504.06
      X, 2399.49    , 2301.52    , 3178.17    , 3135.02    , 3044.07
      X, 2952.28    , 2850.25    , 2742.13    , 2630.97    , 2515.74
      X, 2398.46    , 3348.22    , 3302.03    , 3195.94    , 3084.77 /
       DATA TR2 /
      X  2971.57    , 2848.22    , 2728.43    , 2602.54    , 2473.60
      X, 3419.29    , 3370.56    , 3255.33    , 3136.55    , 3016.75
      X, 2891.37    , 2765.99    , 2636.04    , 2504.06    , 3479.19
      X, 3423.86    , 3302.54    , 3178.17    , 3055.81    , 2924.87
      X, 2796.45    , 2663.96    , 2531.47    , 3520.81    , 3460.41
      X, 3335.53    , 3208.12    , 3082.23    , 2949.75    , 2817.77
      X, 2684.77    , 2549.75    , 3541.12    , 3460.20    , 3355.84
      X, 3228.93    , 3101.02    , 2967.01    , 2835.03    , 2699.49
      X, 2565.99    , 3537.56    , 3479.70    , 3363.45    , 3237.06
      X, 3111.68    , 2977.67    , 2840.19    , 2711.08    , 2575.64
      X, 3516.24    , 3461.42    , 3351.27    , 3235.03    , 3110.15
      X, 2980.20    , 2852.79    , 2717.77    , 2584.26    , 3480.71
      X, 3430.46    , 3326.40    , 3216.75    , 3096.96    , 2973.10
      X, 2849.75    , 2719.29    , 2564.26    , 3435.53    , 3390.36
      X, 3295.43    , 3189.85    , 3078.68    , 2959.39    , 2841.12
      X, 2712.69    , 2579.19    , 3388.85    , 3341.12    , 3253.30
      X, 3154.31    , 3046.19    , 2937.56    , 2821.83    , 2699.49
      X, 2576.56    , 3337.06    , 3290.66    , 3209.14    , 3113.20 /
       DATA TR3 /
      X  3014.72    , 2911.17    , 2800.00    , 2680.71    , 2556.85
      X, 3284.77    , 3240.1[illegible] , 3157.87    , 3069.54    , 2973.00
      X, 2875.13    , 2772.08    , 2655.64    , 2540.61    , 3228.43
      X, 3187.82    , 3106.60    , 3021.32    , 2931.47    , 2836.55
      X, 2737.56    , 2631.47    , 2518.78    , 3125.89    , 3083.25
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X, 3002.03    , 2927.41    , 2842.13    , 2749.24    , 2656.85
X, 2563.96    , 2455.33    , 3022.34    , 2982.23    , 2901.02
X, 2822.33    , 2739.59    , 2655.33    , 2571.07    , 2476.17
X, 2383.25    , 2921.83    , 2881.22    , 2801.52    , 2719.29
X, 2642.13    , 2557.30    , 2473.10    , 2384.77    , 2305.08
X, 2821.63    , 2762.25    , 2702.03    , 2622.84    , 2543.06
X, 2459.90    , 2378.68    , 2294.42    , 2219.29    , 2727.41
X, 2686.60    , 2605.58    , 2523.86    , 2446.70    , 2363.96
X, 2284.77    , 2203.55    , 2130.97    , 2651.96    , 2593.40
X, 2511.68    , 2426.93    , 2353.81    , 2273.60    , 2193.91
X, 2113.20    , 2039.09, 1149., 1126., 1011., 912., 869., 755.
X, 752., 745., 566./
 DATA CRVTSL / 1.,3.,11.,0.
X,0.,1.5,3.7,7.5,10.,15.,20.,30.,40.,50.,60.
Z,0.,58.,108.,156.,173.,193.,209.,234.,255.5,274.,290./
 DATA CRVPV /1.0,3.0,10.0,0.0,
X  0., 50.,100.,125.,150.,175.,200.,250.,300.,325.,
Z  .3, 1.6, 2.8, 4.6, 6.6, 9.9,13.5,24.5,42.0,54.0  /
 DATA CRVSL /1.0,3.0,16.,0.
X, .027, .034, .040, .050, .055, .060, .068, .071
X, .075, .078, .082, .090, .100, .110, .115, .120
Z,  .00,   .2,   .4,  .70, .965,1.115, 1.28,1.315
Z, 1.32,  1.3, 1.27, 1.11,  .78,  .33,  .14,   0.   /
 DATA CRVPR  /1.0,3.0,13.,0.
X,   0., 100., 200., 300., 400., 500., 600., 700.
X, 800., 900.,1000.,1100.,1200.
Z, .718, .702, .690, .679, .671, .665, .660, .657
Z, .654, .652, .651, .650, .650                       /
 DATA CRVMUA / 1.0,3.0,20.,0.
X,    450.,    500.,    550.,    600.,    650.
X,    700.,    750.,    800.,    900.,   1000.
X,   1100.,   1200.,   1300.,   1400.,   1500.
X,   1600.,   1700.,   1800.,   1900.,   2000.
Z,1.09E-05,1.18E-05,1.26E-05,1.35E-05,1.43E-05
Z,1.51E-05,1.58E-05,1.66E-05,1.79E-05,1.92E-05
Z,2.05E-05,2.18E-05,2.30E-05,2.42E-05,2.53E-05
Z,2.64E-05,2.74E-05,2.84E-05,2.93E-05,3.02E-05   /
 DATA CRVKM /1.0,3.0,20.,0.
X,     450.,      500.,      550.,      600.,      650.
X,     700.,      750.,      800.,      900.,     1000.
X,    1100.,     1200.,     1300.,     1400.,     1500.
X,    1600.,     1700.,     1800.,     1900.,     2000.
Z,3.611E-06,3.972E-06,4.333E-06,4.666E-06,5.000E-06
Z,5.306E-06,5.611E-06,5.917E-06,6.583E-06,7.222E-06
Z,7.777E-06,8.333E-06,8.889E-06,9.722E-06,10.277E-06
Z,10.833E-06,11.389E-06,11.944E-06,12.500E-06,12.777E-06 /
 DATA CRVLAM /1.,3.,9.,0.
X,    0.,  100.,  200.,  300.,  400.,  450.,  500.,  550.,  600.
Z,  161.,  152.,  140.,  126.,  110.,  100.,  87.5,   66.,   45. /
 DATA CRVCPT / 1.,1.,11.,0.,
X   0.,  50., 100., 150., 200., 250., 300., 350., 400., 450., 500.,
Z .435, .460, .485, .510, .535, .560, .585, .615, .640, .665, .690/
 DATA CRVPT / 1.,1.,11.,0.,
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X   0.,  50., 100., 150., 200., 250., 300., 350., 400., 450., 500.,00106
Z53.23,51.79,50.61,49.30,48.05,46.80,45.52,44.24,42.99,41.71,40.44/00107
 DATA CRVPTR / 1.,1.,10.,0.                                       00108
X, 510., 560., 610., 660., 710., 760., 810., 860., 910., 960.     00109
Z, .006, .034,  .14,  .49, 1.30, 2.50, 6.00, 14.5,  25., 47.2 /   00110
 DATA CRVSLE / 1.,1.,6.,0.                                        00111
X,   .1,  .25,   .5,   1.,   2.,   4.                             00112
Z, 118., 146., 169., 201., 236., 264.  /                          00113
 DATA CRVEVF / 1.,1.,6.,0.                                        00114
X,   .1,  .25,   .5,   1.,   2.,   4.                             00115
Z, 172., 166., 163., 157., 150., 132.   /                         00116
 DATA CRVTSP / 1.,1.,6.,0.                                        00117
X,  1.47,  3.68,  7.35,  14.7,  29.4,  58.8                       00118
Z,  250.,  300.,  340.,  390.,  442.,  515.  /                    00119
 END                                                              00120
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C         DATA SET B26DERROR  AT LEVEL 001 AS OF 12/07/78  E33
C         DATA SET B26DERROR  AT LEVEL 044 AS OF 03/15/78
      SUBROUTINE ERROR (I,SIG)
      COMMON /PLUG/ TITLE, STITLE, NAME1, NAME2, K1
      COMMON /AUGIN/ JFUEL, NAUGOP, NCUMOP, NFSOP, NPRNTR, NPRNTF
      COMMON / FLAMIN/ ALPHAC(100), ALPHAH(100), FAC(100), FAH(100),
     * FHWC(100), FHWH(100), LSC(100), LSH(100), NSC(100), NSH(100),
     * PFSR(100), TAUC(100), TAUH(100), TEXT(100), TFSR(100), T6C(100),
     * T6H(100), WEXT(100), XLC(100), XLH(100), NTC, NTH
      COMMON /RMBLIN/ BPR, DPCS, DPD, DPH, DPHS, DPS, EPSC, EPSH, ETA,
     * ETAC, ETAH, FA, FAV, LA, LB, LC, LH, L1, LR, L2, M6C, M6H, M6R,
     * PRNOZ, PS6, T3H, ZEF, ZEFC, ZEFH, ZEFP, ZEP, ZEPC, ZEPH, ZETC,
     * ZETH, ZEVC, ZEVH, TCORE,WCOOL
      COMMON /FHOUT/ FETAC, FETAH, FFAC, FFAH, FLI, FLR
      NAMELIST /EOUT/ JFUEL,NAUGOP,NCUMOP,NFSOP,NPRNTR,NPRNTF,ALPHAC,
     *ALPHAH,FAC,FAH,FHWC,FHWH,LSC,LSH,NSC,NSH,PFSR,TAUC,TAUH,TEXT,
     *TFSR,T6C,T6H,WEXT,XLC,XLH,NTC,NTH,BPR,DPCS,DPD,DPH,DPHS,DPS,
     *EPSC,EPSH,ETA,ETAC,ETAH,FA,FAV,LA,LB,LC,LH,L1,LR,L2,M6C,M6H,M6R,
     *PRNOZ,PS6,T3H,ZEF,ZEFC,ZEFH,ZEFP,ZEP,ZEPH,ZETC,ZETH,ZEVC,ZEVH,
     *TCORE
      REAL LA, LB, LC, LH, L1, LR, L2, M6C, M6H, M6R, LSC, LSH,
     * NAME1, NAME2, LCALC
      DATA IFIRST / 0 /
      XLHV = 18650.
      LCALC = LB + AMAX1(LSC(1), LSH(1))
      IF (SIG.LT.0.) WRITE (6,EOUT)
      IF (JFUEL.EQ.2) XLHV = 18500.
      IFIRST = 1
      GO TO (10,40,60), I
C   CHECK BLOCK NO. 5
   10 IF (NCUMOP.LE.0.OR.NCUMOP.GT.3) WRITE (6,1022)
      IF (NCUMOP.LE.0.OR.NCUMOP.GT.3) STOP
      IF (FAV.LT.0.) WRITE (6,1019)
      IF (FAV.GT..068) WRITE (6,1053)
      IF (JFUEL.LE.0.OR.JFUEL.GT.2) WRITE (6,1023)
      IF (M6C.LE.0.) WRITE (6,1026)
      IF (M6H.LE.0.) WRITE (6,1027)
      IF (PS6.LE.0.) WRITE (6,1039)
      IF (NCUMOP.EQ.3) GO TO 15
C   CHECK BLOCK NO. 1
      IF (LA.LT.LB) WRITE (6,1001)
      IF (LC.LT.L2) WRITE (6,1005)
      IF (NFSOP.EQ.2.AND.BPR.EQ.0.) WRITE (6,1011)
      IF (DPD.LT.0..OR.DPD.GT.1.) WRITE (6,1015)
      IF (DPS.LT.0..OR.DPS.GT.1.) WRITE (6,1016)
      IF (BPR.LT.0.) WRITE (6,1018)
      IF (NAUGOP.LE.0.OR.NAUGOP.GT.3) WRITE (6,1020)
      IF (NFSOP.LE.0.OR.NFSOP.GT.2) WRITE (6,1021)
      IF (NPRNTR.LT.0.OR.NPRNTR.GT.1) WRITE (6,1024)
      IF (M6R.LE.0.) WRITE (6,1028)
      IF (LA.LE.0.) WRITE (6,1031)
      IF (LB.LE.0.) WRITE (6,1032)
      IF (LC.LE.0.) WRITE (6,1033)
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      IF (LH.LE.0.) WRITE (6,1036)
      IF (L2.LT.0.) WRITE (6,1037)
      IF (TCORE.LT.0.) WRITE (6,1038)
      IF (PRNOZ.LE.1.) WRITE (6,1046)
      IF (NCOMOP.NE.2) GO TO 18
C  CHECK BLOCK NO. 6
   15 IF (T3H.GE.2200.) WRITE (6,1017)
      IF (T3H.LE.460..AND.NTH.LE.0) WRITE (6,1042)
      IF (NPRNTF.LT.0.OR.NPRNTF.GT.1) WRITE (6,1025)
      IF (WCOOL.LT.0.0.OR.WCOOL.GE.1.) WRITE (6,1074)
      IF (NTC.LE.0.OR.NTC.GT.100) GO TO 26
      DO 25 L = 1,NTC
      IF (ALPHAC(L).LE.0..OR.ALPHAC(L).GT.180.) WRITE (6,1047)
      IF (FAC(L).LE.0.) WRITE (6,1051)
      IF (FHWC(L).LE.0.) WRITE (6,1054)
      IF (LSC(L).LE.0..OR.LSC(L).GE.LA) WRITE (6,1056)
      XM6C = M6C/(1.-TAUC(L))
      IF (XM6C.GT.1.) WRITE (6,1058)
      IF (NSC(L).LT.0.OR.NSC(L).GT.100) WRITE (6,1060)
      IF (TAUC(L).LE.0..OR.TAUC(L).GE.1.) WRITE (6,1065)
      IF (T6C(L).LE.460.) WRITE (6,1069)
      IF (XLC(L).LE.0.) WRITE (6,1072)
      IF (PFSK(L).LE.PS6) WRITE (6,1064)
      IF (WEXT(L).GT.0..AND.TEXT(L).LT.460.) WRITE (6,1067)
      IF (TFSK(L).LT.460.) WRITE (6,1068)
      IF (WEXT(L).LT.0.) WRITE (6,1071)
   25 CONTINUE
   26 IF (NTH.LE.0.OR.NTH.GT.100) GO TO 28
      DO 27 K = 1,NTH
      IF (ALPHAH(K).LE.0..OR.ALPHAH(K).GT.180.) WRITE (6,1048)
      IF (FAH(K).LE.0.) WRITE (6,1052)
      IF (FHWH(K).LE.0.) WRITE (6,1055)
      IF (LSH(K).LE.0..OR.LSH(K).GE.LA) WRITE (6,1057)
      XM6H = M6H/(1.-TAUH(K))
      IF (XM6H.GT.1.) WRITE (6,1059)
      IF (NSH(K).LT.0.OR.NSH(K).GT.100) WRITE (6,1061)
      IF (TAUH(K).LE.0..OR.TAUH(K).GE.1.) WRITE (6,1066)
      IF (T6H(K).LE.460.) WRITE (6,1070)
      IF (XLH(K).LE.0.) WRITE (6,1073)
   27 CONTINUE
   28 IF (EPSC.LT.0..OR.EPSC.GT.1.) WRITE (6,1049)
      IF (EPSH.LT.0..OR.EPSH.GT.1.) WRITE (6,1050)
      IF (NTC.LT.0.OR.NTC.GT.100) WRITE (6,1062)
      IF (NTH.LT.0.OR.NTH.GT.100) WRITE (6,1063)
      IF (NCOMOP.EQ.3) RETURN
C  CHECK BLOCK NO. 2
   18 IF (NAUGOP.NE.1) GO TO 19
      IF (DPH.LT.0..OR.DPH.GT.1.) WRITE (6,1014)
      IF (NAUGOP.NE.1) RETURN
      GO TO 70
C  CHECK BLOCK NO. 3
   19 IF (NAUGOP.EQ.3) GO TO 44
      IF (ETA.LT.0..OR.ETA.GT.1.) WRITE (6,1006)
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      IF (FA.LT.0.) WRITE (6,1043)
 20   IF (EK.GT.EB.AND.NCOMOP.EQ.1) WRITE (6,1002)
      IF (EI.GE.EK) WRITE (6,1004)
      IF (EI.LT.0.) WRITE (6,1029)
      IF (EK.LE.0.) WRITE (6,1030)
      IF (EA.LT.ECALC.AND.NCOMOP.EQ.2) WRITE (6,1003)
      IF (DPH.LT.0..OR.DPH.GT.1.) WRITE (6,1014)
      IF (T6C(1).LE.0.) WRITE (6,1040)
      IF (T6H(1).LE.0.) WRITE (6,1041)
      IF (NAUGOP.EQ.2) RETURN
C  CHECK BLOCK NO. 4
 44   IF (DPCS.LT.0..OR.DPCS.GT.1.) WRITE (6,1012)
      IF (DPHS.LT.0..OR.DPHS.GT.1.) WRITE (6,1015)
      IF (ETA.LT.0..OR.ETA.GT.1.) WRITE (6,1006)
      IF (FA.LT.0.) WRITE (6,1043)
      IF (EK.GT.EB.AND.NCOMOP.EQ.1) WRITE (6,1002)
      IF (EI.LT.0.) WRITE (6,1029)
      IF (EK.LE.0.) WRITE (6,1030)
      IF (T6C(1).LE.0.) WRITE (6,1040)
      IF (T6H(1).LE.0.) WRITE (6,1041)
      RETURN
C  CHECK BLOCK NO. 7
 70   IF (NCOMOP.EQ.2) RETURN
      IF (ETAC.LT.0..OR.ETAC.GT.1.) WRITE (6,1007)
      IF (ETAH.LT.0..OR.ETAH.GT.1.) WRITE (6,1008)
      IF ((FAC(1)+FAH(1)).EQ.0.) WRITE (6,1009)
      X = (FAV+(1.+FAV)*FAH(1))*(XLHV/18500.)
      Y = FAC(1)*XLHV/18500.
      IF (X.GE..05.OR.Y.GE..09) WRITE (6,1010)
      IF (ESC(1).LE.0..OR.ESC(1).GE.EA) WRITE (6,1034)
      IF (ESH(1).LE.0..OR.ESH(1).GE.EA) WRITE (6,1035)
      IF (T6C(1).LE.0.) WRITE (6,1040)
      IF (T6H(1).LE.0.) WRITE (6,1041)
      IF (FAC(1).LT.0.) WRITE (6,1044)
      IF (FAH(1).LT.0.) WRITE (6,1045)
      IF (EI.LT.0.) WRITE (6,1029)
      IF (EK.LE.0.) WRITE (6,1030)
      RETURN
 40   IF (EA.LT.EB) STOP
      IF (EC.LT.E2) STOP
      IF (WCOOL.LT.0.0.OR.WCOOL.GE.1.0) STOP
      IF (ETA.LT.0..OR.ETA.GT.1.) STOP
      IF (NFSOP.EQ.2.AND.BPR.EQ.0.) STOP
      IF (DPCS.LT.0..OR.DPCS.GT.1.) STOP
      IF (DPD.LT.0..OR.DPD.GT.1.) STOP
      IF (DPH.LT.0..OR.DPH.GT.1.) STOP
      IF (DPHS.LT.0..OR.DPHS.GT.1.) STOP
      IF (DPS.LT.0..OR.DPS.GT.1.) STOP
      IF (BPR.LT.0.) STOP
      IF (FAV.LT.0..OR.FAV.GT.068) STOP
      IF (NCOMOP.NE.3.AND.NAUGOP.LE.0.OR.NAUGOP.GT.3) STOP
      IF (NCOMOP.NE.3.AND.NFSOP.LE.0.OR.NFSOP.GT.2) STOP
      IF (JFUEL.LE.0.OR.JFUEL.GT.2) STOP
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```
      IF (NPRNTK.LT.0.OR.NPRNTK.GT.1) STOP
      IF (M6C.LE.0.) STOP
      IF (M6H.LE.0.) STOP
      IF (M6R.LE.0.) STOP
      IF (LA.LE.0.) STOP
      IF (LB.LE.0.) STOP
      IF (LC.LE.0.) STOP
      IF (LH.LE.0.) STOP
      IF (L2.LT.0.) STOP
      IF (TCORE.LT.0.) STOP
      IF (PS6.LE.0.) STOP
      IF (FA.LT.0.) STOP
      IF (PRNOZ.LE.1.) STOP
   50 IF (LK.GT.LB) STOP
      IF (LI.GE.LK) STOP
      IF (LI.LT.0.) STOP
      IF (LK.LE.0.) STOP
      IF (NCOMOP.LT.2) RETURN
      IF (NTC.LE.0.OR.NTC.GT.100) GO TO 260
      DO 250 L = 1,NTC
      IF (ALPHAC(L).LE.0..OR.ALPHAC(L).GT.180.) STOP
      IF (FAC(L).LE.0.) STOP
      IF (FHWC(L).LE.0.) STOP
      IF (LSC(L).LE.0..OR.LSC(L).GE.LA) STOP
      XM6C = M6C/(1.-TAUC(L))
      IF (XM6C.GT.1.) STOP
      IF (NSC(L).LT.0.OR.NSC(L).GT.100) STOP
      IF (TAUC(L).LE.0..OR.TAUC(L).GE.1.) STOP
      IF (T6C(L).LE.460.) STOP
      IF (XLC(L).LE.0.) STOP
      IF (PFSK(L).LE.PS6) STOP
      IF (WEXT(L).GT.0..AND.TEXT(L).LT.460.) STOP
      IF (TFSK(L).LT.460.) STOP
      IF (WEXT(L).LT.0.) STOP
  250 CONTINUE
  260 IF (NTH.LE.0.OR.NTH.GT.100) GO TO 280
      DO 270 K = 1,NTH
      IF (ALPHAH(K).LE.0..OR.ALPHAH(K).GT.180.) STOP
      IF (FAH(K).LE.0.) STOP
      IF (FHWH(K).LE.0.) STOP
      IF (LSH(K).LE.0..OR.LSH(K).GE.LA) STOP
      XM6H = M6H/(1.-TAUH(K))
      IF (XM6H.GT.1.) STOP
      IF (NSH(K).LT.0.OR.NSH(K).GT.100) STOP
      IF (TAUH(K).LE.0..OR.TAUH(K).GE.1.) STOP
      IF (T6H(K).LE.460.) STOP
      IF (XLH(K).LE.0.) STOP
  270 CONTINUE
  280 IF (T3H.GE.2200.) STOP
      IF (NPRNTF.LT.0.OR.NPRNTF.GT.1) STOP
      IF (T3H.LE.0..AND.NTH.EQ.0) STOP
      IF (ETAC.LT.0..OR.ETAC.GT.1.) STOP
      IF (ETAH.LT.0..OR.ETAH.GT.1.) STOP
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```
      IF ((FAC(1)+FAH(1)).EQ.0.) STOP
      X = (FAV+(1.+FAV)*FAH(1))*(XLHV/18500.)
      Y = FAC(1)*XLHV/18500.
      IF (X.GE..09.OR.Y.GE..09) STOP
      IF (LSC(1).LE.0..OR.LSC(1).GE.LA) STOP
      IF (LSH(1).LE.0..OR.LSH(1).GE.LA) STOP
      IF (NTC.LT.0.OR.NTC.GT.100) STOP
      IF (NTH.LT.0.OR.NTH.GT.100) STOP
      IF (EPSC.LT.0..OR.EPSC.GT.1.) STOP
      IF (EPSH.LT.0..OR.EPSH.GT.1.) STOP
      IF (NADGOP.EQ.3) RETURN
      IF (T6C(1).LE.0.) STOP
      IF (T6H(1).LE.0.) STOP
      IF (FAC(1).LT.0.) STOP
      IF (FAH(1).LT.0.) STOP
      RETURN
   60 IF (LA.LT.LCALC) LA = LCALC
      IFIRST = 0
      RETURN
 1001 FORMAT (1X,'*****  INPUT ERROR NO. 1 - LA MUST BE GREATER THAN OR
     *EQUAL TO LB  *****',//)
 1002 FORMAT (1X,'***** INPUT ERROR NO. 2 - LB MUST BE GREATER THAN OR E
     *QUAL TO LK  *****',//)
 1003 FORMAT (1X,'***** INPUT ERROR NO. 3 - LA MUST BE GREATER THAN OR E
     *QUAL TO THE SUM OF LB PLUS THE MAX OF LSC OR LSH.',/,' LA HAS BEEN
     *ADJUSTED ACCORDINGLY.  CHECK INPUT.  *****',//)
 1004 FORMAT (1X,'***** INPUT ERROR NO. 4 - LI MUST BE LESS THAN LK  **
     ***',//)
 1005 FORMAT (1X,'***** INPUT ERROR NO. 5 - LC MUST BE GREATER THAN OR E
     *QUAL TO L2  *****',//)
 1006 FORMAT (1X,'***** INPUT ERROR NO. 6 - ETA MUST BE BETWEEN 0. AND 1
     *.  *****',//)
 1007 FORMAT (1X,'***** INPUT ERROR NO. 7 - ETAC MUST BE BETWEEN 0. AND
     *1.  *****',//)
 1008 FORMAT (1X,'***** INPUT ERROR NO. 8 - ETAH MUST BE BETWEEN 0. AND
     *1.  *****',//)
 1009 FORMAT (1X,'***** INPUT ERROR NO. 9 - FAC AND FAH CAN NOT BOTH BE
     *ZERO WITH AUGMENTOR ON  *****',//)
 1010 FORMAT (1X,'***** INPUT ERROR NO. 10 - CORE STREAM OR FAN TOTAL FU
     *EL AIR RATIO EXCEEDS LIMITS OF IDEAL TEMPERATURE RISE CURVE - ',//
     *1X,'       BLOWOUT LIKELY  *****',//)
 1011 FORMAT (1X,'***** INPUT ERROR NO. 11 - BPR CAN NOT BE ZERO WHEN TH
     *E REMOTE FLOW SPLITTER OPTION IS SELECTED  *****',//)
 1012 FORMAT (1X,'***** INPUT ERROR NO. 12 - DPCS MUST BE BETWEEN 0. AND
     * 1.  *****',//)
 1013 FORMAT (1X,'***** INPUT ERROR NO. 13 - DPD MUST BE BETWEEN 0. AND
     *1.  *****',//)
 1014 FORMAT (1X,'***** INPUT ERROR NO. 14 - DPH MUST BE BETWEEN 0. AND
     *1.  *****',//)
 1015 FORMAT (1X,'***** INPUT ERROR NO. 15 - DPHS MUST BE BETWEEN 0. AND
     * 1.  *****',//)
 1016 FORMAT (1X,'***** INPUT ERROR NO. 16 - DPS MUST BE BETWEEN 0. AND
     *1.  *****',//)
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1017 FORMAT (1X,'***** INPUT ERROR NO. 17 - T3H EXCEEDS LIMITS OF IDEAL
    * TEMPERATURE RISE CURVE.',/,1X,'T3H MUST BE LESS THAN 2200. DEG R'
    *,//)
1018 FORMAT (1X,'***** INPUT ERROR NO. 18 - BPR MUST BE EQUAL TO OR GRE
    *ATER THAN 0.  *****',//)
1019 FORMAT (1X,'***** INPUT ERROR NO. 19 - FAV MUST BE EQUAL TO OR GRE
    *ATER THAN 0.  *****',//)
1020 FORMAT (1X,'***** INPUT ERROR NO. 20 - NAUGOP MUST BE 1, 2, OR 3 *
    *****',//)
1021 FORMAT (1X,'***** INPUT ERROR NO. 21 - NFSOP MUST BE 1 OR 2  *****
    *',//)
1022 FORMAT (1X,'***** INPUT ERROR NO. 22 - NCUMOP MUST BE 1, 2, OR 3 *
    *****',//)
1023 FORMAT (1X,'***** INPUT ERROR NO. 23 - JFUEL MUST BE 1 OR 2  *****
    *',//)
1024 FORMAT (1X,'***** INPUT ERROR NO. 24 - NPRNTR MUST BE 0 OR 1  ****
    **',//)
1025 FORMAT (1X,'***** INPUT ERROR NO. 25 - NPRNTF MUST BE 0 OR 1  ****
    **',//)
1026 FORMAT (1X,'***** INPUT ERROR NO. 26 - M6C MUST BE GREATER THAN 0
    * *****',//)
1027 FORMAT (1X,'***** INPUT ERROR NO. 27 - M6H MUST BE GREATER THAN 0
    * *****',//)
1028 FORMAT (1X,'***** INPUT ERROR NO. 28 - M6R MUST BE GREATER THAN 0
    * *****',//)
1029 FORMAT (1X,'***** INPUT ERROR NO. 29 - LI MUST BE EQUAL TO OR GREA
    *TER THAN 0.  *****',//)
1030 FORMAT (1X,'***** INPUT ERROR NO. 30 - LR MUST BE GREATER THAN 0.
    *  *****',//)
1031 FORMAT (1X,'***** INPUT ERROR NO. 31 - LA MUST BE GREATER THAN 0.
    *  *****',//)
1032 FORMAT (1X,'***** INPUT ERROR NO. 32 - LB MUST BE GREATER THAN 0.
    *  *****',//)
1033 FORMAT (1X,'***** INPUT ERROR NO. 33 - LC MUST BE GREATER THAN 0.
    * *****',//)
1034 FORMAT (1X,'***** INPUT ERROR NO. 34 - LSC MUST BE GREATER THAN 0.
    * AND LESS THAN LA  *****',//)
1035 FORMAT (1X,'***** INPUT ERROR NO. 35 - LSH MUST BE GREATER THAN 0.
    * AND LESS THAN LA  *****',//)
1036 FORMAT (1X,'***** INPUT ERROR NO. 36 - LH MUST BE GREATER THAN 0.
    * *****',//)
1037 FORMAT (1X,'***** INPUT ERROR NO. 37 - LZ MUST BE GREATER THAN OR
    *EQUAL TO 0.   *****',//)
1038 FORMAT (1X,'***** INPUT ERROR NO. 38 - TCORE MUST BE EQUAL TO OR G
    *REATER THAN 0.  *****',//)
1039 FORMAT (1X,'***** INPUT ERROR NO. 39 - PS6 MUST BE GREATER THAN 0.
    *  *****',//)
1040 FORMAT (1X,'***** INPUT ERROR NO. 40 - T6C MUST BE GREATER THAN 0.
    *  *****',//)
1041 FORMAT (1X,'***** INPUT ERROR NO. 41 - T6H MUST BE GREATER THAN 0.
    *  *****',//)
1042 FORMAT (1X,'***** INPUT ERROR NO. 42 - T3H MUST BE GREATER THAN 46
    *0.  *****',//)
```

```
1043 FORMAT (1X,'***** INPUT ERROR NO. 43 - FA MUST BE GREATER THAN OR
    *EQUAL TO 0.  *****',//)
1044 FORMAT (1X,'***** INPUT ERROR NO. 44 - FAC MUST BE GREATER THAN OR
    * EQUAL TO 0.  *****',//)
1045 FORMAT (1X,'***** INPUT ERROR NO. 45 - FAH MUST BE GREATER THAN OR
    * EQUAL TO 0.  *****',//)
1046 FORMAT (1X,'***** INPUT ERROR NO. 46 - PRNOZ MUST BE GREATER THAN
    * 1.  *****',//)
1047 FORMAT (1X,'***** INPUT ERROR NO. 47 - ALPHAC MUST BE GREATER THAN
    * 0. AND LESS THAN OR EQUAL TO 180. DEGREES  *****',//)
1048 FORMAT (1X,'***** INPUT ERROR NO. 48 - ALPHAH MUST BE GREATER THAN
    * 0. AND LESS THAN OR EQUAL TO 180. DEGREES  *****',//)
1049 FORMAT (1X,'***** INPUT ERROR NO. 49 - EPSC MUST BE GREATER THAN O
    *R EQUAL TO 0. AND LESS THAN OR EQUAL TO 1.  *****',//)
1050 FORMAT (1X,'***** INPUT ERROR NO. 50 - EPSH MUST BE GREATER THAN O
    *R EQUAL TO 0. AND LESS THAN OE EQUAL TO 1.  *****',//)
1051 FORMAT (1X,'***** INPUT ERROR NO. 51 - FAC MUST BE GREATER THAN 0.
    *  *****',//)
1052 FORMAT (1X,'***** INPUT ERROR NO. 52 - FAH MUST BE GREATER THAN 0.
    *  *****',//)
1053 FORMAT (1X,'***** INPUT ERROR NO. 53 - FAV CAN NOT EXCEED STOICHIO
    *METRIC (.068)  *****',//)
1054 FORMAT (1X,'***** INPUT ERROR NO. 54 - FHWC MUST BE GREATER THAN 0
    *.  *****',//)
1055 FORMAT (1X,'***** INPUT ERROR NO. 55 - FHWH MUST BE GREATER THAN 0
    *.  *****',//)
1056 FORMAT (1X,'***** INPUT ERROR NO. 56 - LSC MUST BE GREATER THAN 0.
    * AND LES THAN LA  *****',//)
1057 FORMAT (1X,'***** INPUT ERROR NO. 57 - LSH MUST BE GREATER THAN 0.
    * AND LESS THAN LA  *****',//)
1058 FORMAT (1X,'***** INPUT ERROR NO. 58 - FLOW IS SUPERSONIC IN FAN S
    *TREAM AT THE FLAMEHOLDER PLANE  *****',//)
1059 FORMAT (1X,'***** INPUT ERROR NO. 59 - FLOW IS SUPERSONIC IN CORE
    *STREAM AT THE FLAMEHOLDER PLANE  *****',//)
1060 FORMAT (1X,'***** INPUT ERROR NO. 60 - NSC MUST BE GREATER THAN OR
    * EQUAL TO 0. AND LESS THAN OR EQUAL TO 100.  *****',//)
1061 FORMAT (1X,'***** INPUT ERROR NO. 61 - NSH MUST BE GREATER THAN OR
    * EQUAL TO 0. AND LESS THAN OR EQUAL TO 100.  *****',//)
1062 FORMAT (1X,'***** INPUT ERROR NO. 62 - NTC MUST BE GREATER THAN OR
    * EQUAL TO 0. AND LESS THAN OR EQUAL TO 100.  *****',//)
1063 FORMAT (1X,'***** INPUT ERROR NO. 63 - NTH MUST BE GREATER THAN OR
    * EQUAL TO 0. AND LESS THAN OR EQUAL TO 100.  *****',//)
1064 FORMAT (1X,'***** INPUT ERROR NO. 64 - PFSR MUST BE GREATER THAN P
    *S6  *****',//)
1065 FORMAT (1X,'***** INPUT ERROR NO. 65 - TAUC MUST BE GREATER THAN 0
    *. AND LESS THAN 1.  *****',//)
1066 FORMAT (1X,'***** INPUT ERROR NO. 66 - TAUH MUST BE GREATER THAN 0
    *. AND LESS THAN 1.  *****',//)
1067 FORMAT (1X,'***** INPUT ERROR NO. 67 - TEXT MUST BE GREATER THAN O
    *R EQUAL TO 460.  *****',//)
1068 FORMAT (1X,'***** INPUT ERROR NO. 68 - TFSR MUST BE GREATER THAN O
    *R EQUAL 460. DEGREES R  *****',//)
1069 FORMAT (1X,'***** INPUT ERROR NO. 69 - T6C MUST BE GREATER THAN 46
```

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      *0.  *****',//)
 1070 FORMAT (1X,'***** INPUT ERROR NO. 70 - T6H MUST BE GREATER THAN 46
      *0.  *****',//)
 1071 FORMAT (1X,'***** INPUT ERROR NO. 71 - WEXT MUST BE GREATER THAN O
      *R EQUAL TO 0.  *****',//)
 1072 FORMAT (1X,'***** INPUT ERROR NO. 72 - XLC MUST BE GREATER THAN 0.
      *  *****',//)
 1073 FORMAT (1X,'***** INPUT ERROR NO. 73 - XLH MUST BE GREATER THAN 0.
      *  *****',//)
 1074 FORMAT (1X,'***** INPUT ERROR NO. 74 - WCOOL MUST BE GREATER THAN
      * OR EQUAL TO 0.0 AND LESS THAN 1.0 ',
      * '*****',//)
       END
```

```
C          DATA SET B26DFATMP1 AT LEVEL 001 AS OF 12/07/78   E33
      FUNCTION FATMP1(X)
      COMMON /TAB/ TAB1(88),TAB2(44)
      CALL UNBAR (TAB1,1,X,0.,FATMP,IS)
      FATMP1 = FATMP
      RETURN
      END
```

```
C         DATA SET 628DFATMP2 AT LEVEL 001 AS OF 12/07/78  E33
      FUNCTION FATMP2(X)
      COMMON /TAB/ TAB1(86),TAB2(44)
      CALL UNBAR (TAB2,1,X,0.,FATMP,IS)
      FATMP2 = FATMP
      RETURN
      END
```

```
C          DATA SET B28DFHCOMB AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE FHCOMB
      COMMON /FHOUT/ FETAC, FETAH, FFAC, FFAH,FLB,FLI,FLK,FLSC,FLSH,
     * FTOC, FTOH, FZEFC, FZEFH, FZEPC, FZEPH, FZETC, FZETH, FZEVC,
     * FZEVH
      COMMON /AUGIN/ JFUELI,NAUGOP,NCOMOP,NFSOP,NPRNTR,NPRNCP
      COMMON /FLAMIN/ ALPHAC(100),ALPHAH(100),FAC(100),FAH(100),
     * FHWC(100),FHWH(100),LSC(100),LSH(100),NSC(100),NSH(100),
     * PFSRI(100),TAUC(100),TAUH(100),TEXTI(100),TFSRI(100),TOC(100),
     * TOH(100),WEXTI(100),XLC(100),XLH(100),NTC,NTH
      COMMON/RMBLIN/BPR,DPCS,DPD,DPH,DPHS,DPS,EPSC,EPSH,ETAI,ETAC,ETAH,
     * FA,FAV,LA,LB,LC,LH,LI,LK,LZ,MOC,MOH,MOR,PRNOZ,PSC,TSH,ZEF,ZEFC,
     * ZEFH,ZEFP,ZEP,ZEPC,ZEPH,ZETC,ZETH,ZEVC,ZEVH,ICORE,WCOOL
      REAL MDOTA,MDOTF,MDTFLO,MDTFVO,MDTFL1,MDTFC,MDOTFL
     X,K1,MOC,MOH,LSC,LSH,LI,LK,LC,LH
      COMMON /CINPT/FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PSI,TLFEX,B3,TW,    ETAFH
     X,DLO(5),B1E,DMDTO,BDC,RTVD,DQDOTO,Y,SLO,EPSO,VO,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,FHWIMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30),TRJP4 (283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      DIMENSION CINPT(18),OTPUT(419),XMISC(29)
      EQUIVALENCE (CINPT(1),FHW),(OTPUT(1),MDOTA)
     X,(XMISC(1),RHOA)
      COMMON/SV/SAVTE(2), SAVTA(2), SAVDT(2), SAVFAR(2), SAVDT1(2),
     X      SAVETA(2), SAVMDA(2), SAVMDF(2), ZCV(2), ZCP(2), ZCT(2),
     X      ZCFA(2), SAVVA(2),TEXAVG,ETAAVG,XMDTAD,FARAVG,TAAVG,XMDTFD,
     X      TEXIT(100), STMDTA(100), STMDTF(100), STTA(100),STVA(100),
     X      FARWK(100),ETAS(100),DTFIDL(100),AIR(100),ETAAVP,SAVLI(2),
     X      SAVLK(2),SAVXLS(2),SLI(100),SLK(100),SLS(100),SVFAC(100)
     X,     FACAVG,TEXAVS,IWTI(100),SLB(100),SAVXLB(2),IZ(2)
      DUMMY = 0.
      CALL GASTAB(-1,DUMMY,DUMMY,DUMMY,DUMMY)
      FARF = 1./(1. - WCOOL * ((1. + BPR)/BPR))
      DO 2 I=1,100
      SVFAC(I) = FAC(I)
      FAC(I) = FAC(I) * FARF
    2 CONTINUE
      ISTR  = 0
      IFIN = 0
      IPS = 0
      IPASS = 1
      NT = NTC
    1 DO 5 INDEX=1,NT
      IWTI(INDEX) = 0
      K = 0
      IF(INDEX.EQ. NT)IFIN = 1
      DO 10  I= 1,18
```

```
   10 CINPT(I) =  0.0
      DO 20  I= 1,419
   20 OTPUT(I) =  0.0
      DO 30  I= 1,29
   30 XMISC(I) =  0.0
      ISTRM = ISTR
      CALL SETUP(INDEX,IPASS)
      PI = 3.14159
      RHOA = 144. * PS / (53.3*(TA+460.))
      ADUCT = FMW / TAU
      MDOTA = RHOA * VA * ADUCT / 144.
      MDOTF = FAR * MDOTA
      IF(ISTRM)50,50,60
   50 CALL INJECT (NDL,IER)
      IF (IER .GT. 0)GO TO 1000
      MDTFLO  =  (1. - BIT    ) * MDOTF
      MDTFVC  =  BIT      *  MDOTF
      CALL ACCEL (NDL)
      TLC      =  0.0
      DO 40  I = 1,5
   40 TLC    = TLC    + TLF(I)
      TLC    = TLC    / 5.
      BETA1 = 1. - (MDTFL1 / MDOTF)
      BIE = 1. - (MDTFL1 / MDTFLO)
      DMDTO = MDOTF - MDTFL1
      CALL COLECT(NDL)
      B2 = MDTFC / (MDTFL1*TAU)
      CALL RECIRC
      ICNT = 1
      DO 70 I = 1,5
   70 DL(I) = DL(I) / 3.28E-06
      CALL SEVETA(K)
      IF(K .GT. 0) IWTI(INDEX) = 1
   60 CALL FLAME(IER)
      GO TO 4
   80 CALL RECIRC
      FARW = FAR
      B3 = 1.
      CALL WAKE(K,DTF1)
      FARE = FAR + FARMB
      CALL FLAME(IER)
    4 CALL RESULT(INDEX,IFIN,IPASS)
      IF(IPS .EQ. 0.AND. NPRNOP .EQ. 1) CALL FMPRT(INDEX)
      IF(INDEX .EQ. NT .AND. NPRNOP .EQ. 0 .AND. IPS .EQ. 0)
     *CALL FMPRT(INDEX)
    5 CONTINUE
      IPS = 1
      IF(IFIN .NE. 2)GO TO 1
      NT = NTH
      IF(ISTR .GT. 0)GO TO 1000
      ISTR  = 1
      IPS = 0
      IFIN = 0
```

```
      GO TO 1
 1000 IF (NCOMOP.NE.2) RETURN
      FZEFC = ZCFA(1)
      FZEFH = ZCFA(2)
      FZEPC = ZCP(1)
      FZEPH = ZCP(2)
      FZETC = ZCT(1)
      FZETH = ZCT(2)
      FZEVC = ZCV(1)
      FZEVH = ZCV(2)
      FLI=(SAVLI(1)*SAVMDA(1)+SAVLI(2)*SAVMDA(2))/(SAVMDA(1)+SAVMDA(2))
      FLK=(SAVLK(1)*SAVMDA(1)+SAVLK(2)*SAVMDA(2))/(SAVMDA(1)+SAVMDA(2))
      FLSC = SAVXLS(1)
      FLSH = SAVXLS(2)
      FLB    = (SAVXLB(1)*SAVMDA(1) + SAVXLB(2)*SAVMDA(2))/(SAVMDA(1)+
     *          SAVMDA(2))
      FETAC = SAVETA(1)
      FETAH = SAVETA(2)
      FFAC = SAVFAR(1)
      FFAH = SAVFAR(2)
      FTOC = SAVTA(1) + 460.
      FTOH = SAVTA(2) + 460.
C     WRITE(6,999)FZEFC,FZEFH,FZEPC,FZEPH,FZETC,FZETH,FZEVC,FZEVH,
C    XFLI,FLK,FLSC,FLSH,FLB
C 999 FORMAT('1  ZEFC      ZEFH      ZEPC      ZEPH      ZETC      ZETH
C    X     ZEVC      ZEVH      LI        LK        LC        LH'/
C    X,12F10.4,/,' FLB     '/F10.4)
      DO 100 I = 1,100
  100 FAC(I) = SVFAC(I)
      RETURN
      END
```

```
C          DATA SET B28DFHPRT  AT LEVEL 001 AS OF 12/07/76  E33
      SUBROUTINE FHPRT(INDEX)
      REAL LSH,LSC,M6H,M6C,LA,LB,LC,LH,LI,LK,L2,M6R
      DIMENSION FUELT(2)
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PSI,TLFEX,B3,IW,    ETAFH
     X,DLC(5),BIE,DMDTO,BDC,RTVD,DQDOTO,Y,SLO,EPSO,VO,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,FHWTMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30),TRJP4 (263),CRVTSL(26)
      COMMON/SV/SAVTE(2), SAVTA(2), SAVDT(2), SAVFAR(2), SAVDT1(2),
     X      SAVETA(2), SAVMDA(2), SAVMDF(2), ZCV(2), ZCP(2), ZCT(2),
     X      ZCFA(2) , SAVVA(2),TEXAVG,ETAAVG,XMDTAD,FARAVG,TAAVG,XMDTFD,
     X      TEXIT(100), STMDTA(100), STMDTF(100), STTA(100),STVA(100),
     X      FARWK(100),ETAS(100),DTFIDL(100),ATR(100),ETAAVP,SAVLI(2),
     X      SAVLK(2),SAVXLS(2),SLI(100),SLK(100),SLS(100),SVFAC(100)
     X,     FACAVG,TEXAVS,IWTI(100),SLB(100),SAVXLB(2),IZ(2)
      COMMON /CINPT/FHW,PFSK,PS,TFSK,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /AUGIN/ JFUEL1,NAUGOP,NCOMOP,NFSOP,NPRNTR,NPRNOP
      COMMON /FLAMIN/ ALPHAC(100),ALPHAH(100),FAC(100),FAH(100),
     * FHWC(100),FHWH(100),LSC(100),LSH(100),NSC(100),NSH(100),
     * PFSKI(100),TAUC(100),TAUH(100),TEXTI(100),TFSKI(100),T6C(100),
     * T6H(100),WEXTI(100),XLC(100),XLH(100),NTC,NTH
      COMMON/RMBLIN/BPR,DPCS,DPD,DPH,DPHS,DPS,EPSC,EPSH,ETAI,ETAC,ETAH,
     * FA,FAV,LA,LB,LC,LH,LI,LK,L2,M6C,M6H,M6R,PRNOZ,PS6,T3H,ZEF,ZEFC,
     * ZEFH,ZEFP,ZEP,ZEPC,ZEPH,ZETC,ZETH,ZEVC,ZEVH,TCORE,WCOOL
      DATA FUELT /4H JP4, 4H JP5/
      I = 0
  101 FORMAT(1H1,47X,'** COMBUSTION MODEL RESULTS **')
      IF (NPRNOP-1)10,100,100
   10 IF(ISTRM)11,11,34
   11 IF(INDEX .NE. NTC)GO TO 9000
      DO 210 J = 1, NTC
  210 IF (IWTI(J) .EQ.1) WRITE (6, 140) J
  140 FORMAT(' *** WARNING------WAKE TEMPERATURE ITERATION FAILED FOR
     XSTREAMTUBE NO. ',I3)
      WRITE(6,101)
      WRITE(6,103)
  103 FORMAT(//61X,'FAN STREAM')
      WRITE(6,102)
  102 FORMAT(//62X,'INPUT'/)
   15 WRITE(6,104)
  104 FORMAT(35X,'STREAMTUBE  NO. OF     INLET   INPUT     EFFECTIVE F/H
     X     BLOCKAGE MACH        '/
     X          35X,'TYPE         THIS TYPE TEMP     F/A RATIO F/A RATIO WIDT
     XH    RATIO     NO.        '/
     X          57X,                    'DEG R   D''LESS    D''LESS    IN.
     X     D''LESS   D''LESS     '/)
   20 I = I + 1
      T6C(I) = T6C(I) + 460.
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```
      WRITE(6,105)I,NSC(I),T6C(I),SVFAC(I),FAR,FHWC(I),TAUC(I),M6C
  105 FORMAT(35X,I4,7X,I5,2X,F9.1,F9.4,1X,F9.4,1X,F9.4,F8.4,F9.4)
C 105 FORMAT(35X,I6,5X,I6,2X,F9.1,F10.4,F9.4,1X,3F9.4)
      T6C(I) = T6C(I) - 460.
      IF(I .GE. NTC)GO TO 30
      IF(I .LT. 50)GO TO 20
      WRITE(6,106)
  106 FORMAT(1H1//61X,'FAN STREAM (CONT)')
      GO TO 15
   30 SAVTA(1) = SAVTA(1) + 460.
      WRITE(6,107)PS,SAVTA(1),SAVFAR(1)
      SAVTA(1) = SAVTA(1) - 460.
  107 FORMAT(/40X,'STATIC PRESSURE(PS6)         = ',F11.4,' PSIA  ' /
     X        40X,'AVG INLET TEMP(T6C)          = ',F11.4,' DEG R ' /
     X        40X,'AVG INPUT F/A RATIO(FAC) = ',F11.4,' D''LESS')
 1107 FORMAT(/40X,'STATIC PRESSURE(PS6)         = ',F11.4,' PSIA  ' /
     X        40X,'AVG INLET TEMP(T6H)          = ',F11.4,' DEG R ' /
     X        40X,'AVG INPUT F/A RATIO(FAH) = ',F11.4,' D''LESS')
      WRITE(6,110)
  110 FORMAT(1H1//61X,'OUTPUT')
      WRITE(6,103)
   55 WRITE(6,111)
  111 FORMAT(/ 40X,'STREAMTUBE WAKE F/A  IDEAL TEMP COMBUSTION EXIT ' /
     X        40X,'TYPE         RATIO     RISE        EFFICIENCY TEMP' /
     X        40X,'             D''LESS    DEG R       D''LESS      DEG R')
      I = 0
   60 I = I + 1
      TEXIT(I) = TEXIT(I) + 460.
      WRITE(6,112)I,FARWK(I),DTFIDL(I),ETAS(I),TEXIT(I)
      TEXIT(I) = TEXIT(I) - 460.
  112 FORMAT(/40X,I5,1X,F11.4,2X,F11.4,F8.4,3X,F11.4)
      IF (I .GE. NTC)GO TO 70
      IF (I .LT. 50)GO TO 60
      WRITE(6,106)
      GO TO 55
   70 SAVTE(1) = SAVTE(1) + 460.
      WRITE(6,113)SAVDTI(1),SAVETA(1),SAVTE(1)
      SAVTE(1) = SAVTE(1) - 460.
  113 FORMAT(//41X,'AVG IDEAL TEMP RISE        = ',F11.4,' DEG R ' /
     X        41X,'AVG THERMAL COMB. EFF.     = ',F11.4          /
     X        41X,'AVG DUCT EXIT TEMPERATURE = ',F11.4,' DEG R ' )
      GO TO 9000
   34 WRITE(6,108)
      WRITE(6,102)
  108 FORMAT(1H1, //60X,'CORE STREAM')
      I = 0
   35 WRITE(6,1104)
 1104 FORMAT(35X,'STREAMTUBE  NO. OF     INLET   INPUT     F/H      BLOCKA
     XGE  MACH    '/
     X        35X,'TYPE          THIS TYPE TEMP     F/A RATIO WIDTH    RATIO
     X    NO.    '/
     X        57X,                 'DEG R    D''LESS     IN.      D''LESS
     X    D''LESS
```

```
   40 I = I + 1
      T6H(I) = T6H(I) + 460.
      WRITE(6,1105)I,NSH(I),T6H(I),FAH(I),FHWH(I),TAUH(I),M6H
 1105 FORMAT(35X,I4,7X,I5,3X,F9.1,F8.4,1X,F9.4,F8.4,1X,F9.4)
      T6H(I) = T6H(I) - 460.
      IF(I .GE. NTH)GO TO 50
      IF(I .LT. 90) GO TO 40
      WRITE(6,109)
  109 FORMAT(1H1//60X,'CORE STREAM (CONT)')
      GO TO 35
   50 SAVTA(2) = SAVTA(2) + 460.
      WRITE(6,1107)PS,SAVTA(2),SAVFAR(2)
      SAVTA(2) = SAVTA(2) - 460.
      I = 0
      WRITE(6,110)
   75 WRITE(6,111)
   80 I = I + 1
      TEXIT(I) = TEXIT(I) + 460.
      WRITE(6,112)I,FARWK(I),DTFIDL(I),ETAS(I),TEXIT(I)
      TEXIT(I) = TEXIT(I) - 460.
      IF(I .GE.NTH)GO TO 90
      IF(I .LT. 50)GO TO 80
      WRITE(6,109)
      GO TO 75
   90 SAVTE(2) = SAVTE(2) + 460.
      WRITE(6,113)SAVDTI(2),SAVETA(2),SAVTE(2)
      SAVTE(2) = SAVTE(2) - 460.
      GO TO 9000
  100 IF(ISTRM .GT. 0)GO TO 200
  129 FORMAT(1H1)
      WRITE(6,129)
      IF(ISTRM .EQ. 0 .AND. INDEX .EQ. 1)WRITE(6,101)
      WRITE(6,103)
      WRITE(6,114)INDEX,NSC(INDEX)
  114 FORMAT(//40X,'STREAMTUBE TYPE            = ',I11/
     X         40X,'NO. OF THIS TYPE           = ',I11//
     X         64X,'INPUT ' )
      TA   = TA   + 460.
      TFSR = TFSR + 460.
      TEXT = TEXT + 460.
      TAEFF= TAEFF + 460.
      IF (IWTI(INDEX).EQ.1) WRITE (6, 140) INDEX
      WRITE(6,115)PS,TA,M6C,SVFAC(INDEX),FAR,FHW,TAU,ALPHA,TFSR,
     XPFSR,XF,XL,EPS,WEXT,TEXT,TAEFF,FUELT(JFUEL)
  115 FORMAT(/40X,'STATIC PRESSURE(PS6)      = ',F11.4,' PSIA '    /
     X         40X,'APPROACH TEMPERATURE(T6C)= ',F11.4,' DEG R '   /
     X         40X,'APPROACH MACH NO.(M6C)   = ',F11.4,' D''LESS'  /
     X         40X,'INPUT F/A RATIO(FAC)     = ',F11.4,' D''LESS'  /
     X         40X,'EFFECTIVE F/A RATIO      = ',F11.4,' D''LESS'  /
     X         40X,'F/H WIDTH(FHWC)          = ',F11.4,' INCHES'   /
     X         40X,'BLOCKAGE RATIO(TAUC)     = ',F11.4,' D''LESS'  /
     X         40X,'F/H APEX ANGLE(ALPHAC)   = ',F11.4,' DEG   '   /
     X         40X,'S/R FUEL TEMP(TFSR)      = ',F11.4,' DEG R '   /
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     X          40X,'S/R FUEL PRESSURE(PFSR)  = ',F11.4,' PSIA  '    /
     X          40X,'S/R TO F/H DISTANCE(LSC) = ',F11.4,' INCHES'    /
     X          40X,'F/H TO NOZZLE DIST.(XLC) = ',F11.4,' INCHES'    /
     X          40X,'TURBULENCE LEVEL(EPSC)   = ',F11.4,' D''LESS'   /
     X          40X,'WAKE FLOW ADDITION(WEXT) = ',F11.4,' D''LESS'   /
     X          40X,'FLOW SOURCE TEMP(TEXT)   = ',F11.4,' DEG R '    /
     X          40X,'EFFECTIVE INLET TEMP.    = ',F11.4,' DEG R '    /
     X          40X,'FUEL TYPE                = ',7X,A4              )
      TA   = TA    - 460.
      TFSR = TFSR  - 460.
      TEXT = TEXT  - 460.
      TAEFF= TAEFF - 460.
      WRITE(6,128)
  128 FORMAT(/63X,'OUTPUT')
      WRITE(6,116)DLO(3),BIT
  116 FORMAT(/,61X,'INJECTION'/
     X          40X,'MEAN DROPLET SIZE          = ',F11.4,' MICRONS'/
     X          40X,'FLASH VAPORIZATION         = ',F11.4,' D''LESS'/)
      TW = TW + 460.
      WRITE(6,117)BETA1,B2,B3,K1,FARW,TW
  117 FORMAT(54X,'WAKE COMPOSITION SOLUTION'/
     X          40X,'BETA 1                     = ',F11.4,' D''LESS'/
     X          40X,'BETA 2                     = ',F11.4,' D''LESS'/
     X          40X,'BETA 3                     = ',F11.4,' D''LESS'/
     X          40X,'K1                         = ',F11.4,' D''LESS'/
     X          40X,'WAKE F/A                   = ',F11.4,' D''LESS'/
     X          40X,'WAKE TEMP                  = ',F11.4,' DEG R ')
      TW = TW - 460.
      WRITE(6,118)SLO,EPSO
  118 FORMAT(/57X,'FLAME SPREADING' /
     X          40X,'INITIAL SPEED              = ',F11.4,' FPS    '/
     X          40X,'INITIAL TURBULANCE         = ',F11.4,' D''LESS')
      TEXIT(INDEX) = TEXIT(INDEX) + 460.
      WRITE(6,119)DTFIDL(INDEX),ETAS(INDEX),ATR(INDEX),TEXIT(INDEX),
     X STMDTA(INDEX),STMDTF(INDEX)
  119 FORMAT(/55X,'STREAMTUBE EFFICIENCY'/
     X          40X,'IDEAL TEMP RISE            = ',F11.4,' DEG R '/
     X          40X,'COMBUSTION EFFICIENCY      = ',F11.4          /
     X          40X,'ACTUAL TEMP RISE           = ',F11.4,' DEG R '/
     X          40X,'EXIT TEMP                  = ',F11.4,' DEG R '/
     X          40X,'FLOWRATE - AIR             = ',F11.4,' LBM/SEC'/
     X          40X,'FLOWRATE - FUEL            = ',F11.4,' LBM/SEC')
      TEXIT(INDEX) = TEXIT(INDEX) - 460.
      IF(INDEX .LT. NTC)GO TO 9000
      WRITE(6,120)
  120 FORMAT(1H1//57X,'FAN STREAM SUMMARY'//
     X          40X,'STREAMTUBE FUEL-AIR MASS      COMBUSTION  EXIT        '/
     X          40X,'TYPE       RATIO    FLOWRATE EFFICIENCY  TEMP        '/
     X          40X,'           D''LESS   LBM/SEC  D''LESS         DEG R   ')
      DO 121 I=1,NTC
      TEXIT(I) = TEXIT(I) + 460.
      WRITE(6,122)I,SVFAC(I),STMDTA(I),ETAS(I),TEXIT(I)
  121 TEXIT(I) = TEXIT(I) - 460.
```

```
  122 FORMAT(40X,I4,2X,F11.4,F9.4,F9.4,2X,F11.4)
      TAAVG = TAAVG + 460.
      TEXAVS = TEXAVS + 460.
      TEXAVG = TEXAVG + 460.
      WRITE(6,123)WCOOL,ETAAVP,ETAAVG,TAAVG,TEXAVS,TEXAVG,XMDTAD,FACAVG,
     XSAVDTI(1)
  123 FORMAT(//40X,'COOLING FLOW/TOTAL ENGINE FLOW =',F11.4,' D''LESS'/
     X          40X,'CHEMICAL COMBUSTION EFFICIENCY =',F11.4,' D''LESS'/
     X          40X,'THERMAL COMBUSTION EFFICIENCY  =',F11.4,' D''LESS'/
     X          40X,'AVG COOLING AIR TEMPERATURE    =',F11.4,' DEG R '/
     X          40X,'AVG STREAMLINE EXIT TEMP       =',F11.4,' DEG R '/
     X          40X,'AVG DUCT EXIT TEMPERATURE      =',F11.4,' DEG R '/
     X          40X,'TOTAL FLOWRATE                 =',F11.4,' LBM/SEC'/
     X          40X,'AVG FUEL-AIR RATIO             =',F11.4,' D''LESS'/
     X          40X,'AVG. IDEAL TEMPERATURE RISE    =',F11.4,' DEG R  ')
      TAAVG = TAAVG - 460.
      TEXAVS = TEXAVS - 460.
      TEXAVG = TEXAVG - 460.
      GO TO 9000
  200 WRITE(6,106)
      WRITE(6,114)INDEX,NSH(INDEX)
      TA    = TA  + 460.
      WRITE(6,124)PS,TA,M6H,FAR,FHW,ALPHA,TAU,XL,XF,EPS,FUELT(JFUEL)
  124 FORMAT(//40X,'STATIC PRESSURE(PS6)     = ',F11.4,' PSIA    '  /
     X          40X,'APPROACH TEMP(T6H)       = ',F11.4,' DEG R   '  /
     X          40X,'APPROACH MACH NO.(M6H)   = ',F11.4,' D''LESS'  /
     X          40X,'FUEL AIR RATIO(FAH)      = ',F11.4,' D''LESS'  /
     X          40X,'F/H WIDTH(FHWH)          = ',F11.4,' INCHES '  /
     X          40X,'F/H APEX ANGLE(ALPHAH)   = ',F11.4,' DEGREES'  /
     X          40X,'BLOCKAGE RATIO(TAUH)     = ',F11.4,' D''LESS'  /
     X          40X,'F/H TO NOZZLE DIST.(XLH)= ',F11.4,' INCHES '  /
     X          40X,'S/R TO F/H DISTANCE(LSH)= ',F11.4,' INCHES '  /
     X          40X,'TURBULENCE LEVEL(EPSH)   = ',F11.4,' D''LESS'  /
     X          40X,'FUEL TYPE                = ',7X,A4             )
      TA    = TA  - 460.
      TEXIT(INDEX) = TEXIT(INDEX) + 460.
      WRITE(6,128)
      WRITE(6,125)KI,ETAW,SLO,EPSO,DTFIDL(INDEX),ETAFH,ATR(INDEX),
     X TEXIT(INDEX),MDOTA,MDOTF
  125 FORMAT(//
     X          40X,'WAKE RECIRCULATION COEF = ',F11.4,' D''LESS'  /
     X          40X,'WAKE EFFICIENCY         = ',F11.4,' D''LESS'  /
     X          40X,'INITIAL FLAME SPEED     = ',F11.4,' FPS    '  /
     X          40X,'INITIAL TURBULENCE LEVEL= ',F11.4,' D''LESS'  /
     X          40X,'IDEAL TEMP RISE         = ',F11.4,' DEG R  '  /
     X          40X,'COMBUSTION EFFICIENCY   = ',F11.4,' D''LESS'  /
     X          40X,'ACTUAL TEMPERATURE RISE = ',F11.4,' DEG R  '  /
     X          40X,'EXIT TEMPERATURE        = ',F11.4,' DEG R  '  /
     X          40X,'FLOWRATE - AIR          = ',F11.4,' LBM/SEC'  /
     X          40X,'FLOWRATE - FUEL         = ',F11.4,' LBM/SEC'  )
      TEXIT(INDEX) = TEXIT(INDEX) - 460.
      IF(INDEX .NE. NTH)GO TO 9000
      WRITE(6,126)
```

```
  126 FORMAT(1H1//57X,'CORE STREAM SUMMARY' //
     X          40X,'STREAMTUBE FUEL-AIR MASS      COMBUSTION  EXIT    ' /
     X          40X,'TYPE       RATIO    FLOWRATE EFFICIENCY  TEMP    ' /
     X          40X,'           D''LESS   LBM/SEC  D''LESS       DEG R' )
      DO 127 I=1,NTH
      TEXIT(I) = TEXIT(I) + 460.
      WRITE(6,126)I,FAH(I),STMDTA(I),ETAS(I),TEXIT(I)
  127 TEXIT(I) = TEXIT(I) - 460.
      T3H = T3H + 460.
      TEXAVG = TEXAVG + 460.
      WRITE(6,130)FAV,T3H,TEXAVG,ETAAVG,XMDTAD,FARAVG,SAVXLS(2),
     XSAVDTI(2)
  130 FORMAT(//40X,'M/B FUEL-AIR RATIO(FAV) =',F11.4,' D''LESS'/
     X          40X,'M/B INLET TEMP(T3H)      =',F11.4,' DEG R  '/
     X          40X,'AVG EXIT TEMP            =',F11.4,' DEG R '/
     X          40X,'AVG COMB. EFFICIENCY     =',F11.4,' D''LESS'/
     X          40X,'TOTAL FLOWRATE           =',F11.4,' LBM/SEC'/
     X          40X,'AVG FUEL-AIR RATIO       =',F11.4,' D''LESS'/
     X          40X,'AVG DISTANCE FROM'/
     X          40X,'SPRAYBAR TO F/H          =',F11.4,' INCHES '/
     X          40X,'AVG. IDEAL TEMP. RISE    =',F11.4,' DEG R  ')
      T3H = T3H - 460.
      TEXAVG = TEXAVG - 460.
 9000 RETURN
      END
```

```
C          DATA SET 628DFLAME  AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE FLAME(IER)
C PURPOSE     EVALUATE TURBULENT FLAME RATE
      COMMON /CINPT/FHW,PFSR,PS,IFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,YEXT
      COMMON /OTPUT/ MDOTA,MDOTF,MDIFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PSI,TLFEX,B3,TW,    ETAFH
     X,DLO(5),B1E,DMDOT,BDC,RTVD,DQDOT,Y,SLO,EPSO,VO,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,   FHWTMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDIFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30), TRJP4(283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      REAL LDC,K1,MDOTFL
      IER = 0
      IO = 0
      IF(ISTRM .GT. 0)GO TO 40
      PHI = FAR / .0676
      SUMDL = 0.0
      SUMMD = 0.0
      DO 1 I = 1,5
      SUMDL = SUMDL + DL(I) * MDOTFL(I)
    1 SUMMD = SUMMD + MDOTFL(I)
      DLBAR = SUMDL / SUMMD
      PHIL = .769 - .025 * DLBAR +3.83E-04 * DLBAR**2 - 2.67E-06 * DLBAR
     X**3 + 6.79E-9 * DLBAR**4
      IF(PHI .LT. PHIL) GO TO 80
      SLPHI = SIN(PI/2.*(PHI-PHIL)/(1.-PHIL))
      IF(DLBAR-20.)2,2,3
    2 FDL = 1. + 1.23 * DLBAR / 20.
      GO TO 4
    3 FDL = 2.23 * 20. / DLBAR
    4 SLL = 1.17 * FDL * SLPHI
C     CURVE IS THE SAME FOR JP4 AND JP5
      CALL UNBAR(CRVSL,1,FAR,0.,SLG,IS)
      SL = BETA1 * SLG + (1. - BETA1) * SLL
      GO TO 50
C     CURVE IS THE SAME FOR JP4 AND JP5
   40 CALL UNBAR(CRVSL,1,FARE,0.,SL,IS)
   50 SL = SL * 12.
      IF(IS .NE. 0)GO TO 997
      PHIMB = FARMB / .0676
      XO2 = 3. * (1. - PHIMB) / (PHIMB + 14.3)
      IF(PS - 14.7)5,6,6
    5 SL = SL * SQRT(PS/14.7) * (XO2 / .21)**3 * ((TA+460.)/540.)**1.4
      GO TO 7
    6 SL = SL * (XO2/.21)**3 * ((TA+460.)/540.)**1.4
    7 SL = SL * B3 * ETAW
      V  = 12. * VA / (1.- TAU)
      SLO = SL / 12.
      VO = V / 12.
      XFT = 10.* FHW * (1. - TAU)/TAU
```

```
      EPSO = (.1667 * (CDFH * TAU + (TAU /(1.-TAU))**2))**.5
      GI = (XFT / ((1./EPS)**2 - (1./EPSO)**2))**.5
      DXPRIM = (GI / EPSO)**2
      DX = 1.
      ETAG   = KI * TAU * ETAW
      NSTEP= 0
      XO    = 0.0
      XI(1)= .5 * FHW * LDC
      YS    = ETAG * FHW / (2.*TAU)
 10   NSTEP = NSTEP + 1
      EPSXO = GI / SQRT(XO + DXPRIM)
      IF(XI(NSTEP) - XFT)11,12,12
   11 EPSXI(NSTEP) = GI / SQRT(XI(NSTEP) + DXPRIM)
      GO TO 13
   12 EPSXI(NSTEP) = EPS
   13 STO    =   (SL + SQRT(2. * SL * EPSXO * V))*(1.+SIN(PI*ETAG))
      STI(NSTEP) = (SL + SQRT(2.*SL*EPSXI(NSTEP)*V))*(1.+SIN(PI*ETAG))
      STBAR = .5*(STO+STI(NSTEP))
      DT     = (XI(NSTEP) - XO) / V
      DY     = STBAR * DT
      YS     = YS + DY
      ETA(NSTEP)    = 2. *  YS * TAU / FHW
      IF (ETA(NSTEP) - 1.)20,998,998
 20   IF (IG)30,30,60
 30   XO     =  XI(NSTEP)
      XI(NSTEP+1) = XI(NSTEP) + DX
      ETAG = ETA(NSTEP)
      IF(XI(NSTEP+1) - XL)10,25,25
   25 XI(NSTEP+1) = XL
      IG = 1
      GO TO 10
   80 WRITE(6,103)
  103 FORMAT (1H1,'-****** OVERALL FUEL AIR RATIO BELOW THE LEAN LIMIT
     X******')
      IER=1
      GO TO 999
  997 WRITE(6,101)
  101 FORMAT(' FAR OUTSIDE FLAMABILITY LIMITS')
      IER = 1
      GO TO 999
 998  ETAFH = 1.
      IER = 1
      GO TO 999
   60 ETAFH = ETA(NSTEP)
      XO = 0.0
      EPSXO = GI/SQRT(XO+DXPRIM)
      STO = SL + SQRT(2. * SL * EPSXO * V)
  999 RETURN
      END
```

```
C          DATA SET B28DGASTAB AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET GASTABWE   AT LEVEL 001 AS OF 09/12/75
C ****                 UTC PROPRIETARY INFORMATION               ****
      SUBROUTINE GASTAB (IDI, ARG, FAOLD, ANS, WAOLD)
C      APRIL 14, 1972 REVISED TO LUMP CONSTANTS AND REDUCE COMPUTER
C      CALCULATION TIME WHERE POSSIBLE
C                 THIS VERSION OF GASTAB USES CUBIC SPLINE FITS
C                 OF H AND PHI FOR AIR, STOICHIOMETRIC GAS, AND WATER
C                 BASED ON THE USE OF GASCAL/SPLNKK WITH HCR = .16
C                 AND LHV = 18500.
C        ZMWAIR = MOLECULAR WEIGHT OF AIR
C        HCR = HYDROGEN/CARBON MASS RATIO
C        HCRM = HYDROGEN/CARBON MOL RATIO
C        ZMWF = MOLECULAR WEIGHT OF FUEL
C        FA = FUEL/AIR MASS RATIO
C        FAM = FUEL/AIR MOL RATIO
C        FO2R = FUEL/OXYGEN MOL RATIO
C        WA = WATER/AIR MASS RATIO
C        WAM = WATER/AIR MOL RATIO
      DIMENSION IDI(13), GX(13), GTG(13), GPR(13), GKK(13)
      DIMENSION ITTAB(48)
      COMMON/GASP/ HCR,HCRM,STOIC,STDLHV,GHCR,GLHV
      DIMENSION         AHSTOC(47), BHSTOC(47), CHSTOC(47), DHSTOC(47),
     1                  APSTOC(47), BPSTOC(47), CPSTOC(47), DPSTOC(47),
     2                  AHAIR( 47), BHAIR( 47), CHAIR( 47), DHAIR( 47),
     3                  APAIR( 47), BPAIR( 47), CPAIR( 47), DPAIR( 47),
     4                  AHH2O( 47), BHH2O( 47), CHH2O( 47), DHH2O( 47),
     5                  APH2O( 47), BPH2O( 47), CPH2O( 47), DPH2O( 47)
C  *** COEFFICIENTS FOR AIR, WATER, AND STOIC. PRODUCTS- HCR = .16  CUB
C *** BASED ON 60,120 DEGREE CUBIC SPLINE FITS OF K AND K GAS CONSTITUEN
C       WITH LAMBDA CONDITIONS APPLIED AT FRONT END  ***
C*** COEFFICIENTS OF STOICHIOMETRIC PRODUCTS OF HCR =  .160 FUEL ***
      DATA AHSTOC /
     1 2.1162897E 3, 2.5444999E 3, 2.9760543E 3, 3.4107199E 3,
     2 3.8488099E 3, 4.2905022E 3, 4.7352036E 3, 5.1835904E 3,
     3 5.6355579E 3, 6.0912110E 3, 6.5507523E 3, 7.4825092E 3,
     4 8.4315898E 3, 9.3981799E 3, 1.0382321E 4, 1.1383751E 4,
     5 1.2401513E 4, 1.3434688E 4, 1.4483164E 4, 1.5545543E 4,
     6 1.6620912E 4, 1.7708046E 4, 1.8805813E 4, 1.9913830E 4,
     7 2.1031114E 4, 2.2157270E 4, 2.3291418E 4, 2.4433066E 4,
     8 2.5581827E 4, 2.6736844E 4, 2.7897812E 4, 2.9064316E 4,
     9 3.0236115E 4, 3.1412555E 4, 3.2593648E 4, 3.3778999E 4,
     A 3.4968299E 4, 3.6161451E 4, 3.7358148E 4, 3.8558252E 4,
     B 3.9761493E 4, 4.0967760E 4, 4.2176808E 4, 4.3388554E 4,
     C 4.4602703E 4, 4.5819432E 4, 4.7038445E 4/
      DATA BHSTOC /
     1 7.1165541E 0, 7.1647863E 0, 7.2185297E 0, 7.2720890E 0,
     2 7.3308972E 0, 7.3864475E 0, 7.4430153E 0, 7.5029035E 0,
     3 7.5630724E 0, 7.6258516E 0, 7.6933240E 0, 7.8364526E 0,
     4 7.9818107E 0, 8.1280812E 0, 8.2741517E 0, 8.4145851E 0,
     5 8.5472903E 0, 8.6740933E 0, 8.7957169E 0, 8.9088018E 0,
     6 9.0122898E 0, 9.1046351E 0, 9.1917216E 0, 9.2730824E 0,
     7 9.3484831E 0, 9.4190260E 0, 9.4830010E 0, 9.5443576E 0,
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     8  9.5997939E  0,  9.6504145E  0,  9.6981817E  0,  9.7436514E  0,  00053
     9  9.7847854E  0,  9.8231813E  0,  9.8608337E  0,  9.8945948E  0,  00054
     A  9.9270491E  0,  9.9560284E  0,  9.9870892E  0,  1.0014125E  1,  00055
     B  1.0040027E  1,  1.0064093E  1,  1.0086833E  1,  1.0107985E  1,  00056
     C  1.0128644E  1,  1.0149411E  1,  1.0167232E  1/                  00057
        DATA CHSTOC /                                                  00058
     1  4.1029745E -4,  4.9357129E -4,  4.0215520E -4,  4.9049840E -4,  00059
     2  4.8963760E -4,  4.3619979E -4,  5.0659803E -4,  4.9153797E -4,  00060
     3  5.1127672E -4,  5.3471227E -4,  5.9015815E -4,  6.0258059E -4,  00061
     4  6.0873695E -4,  6.1018397E -4,  6.0706954E -4,  5.6320912E -4,  00062
     5  5.4260755E -4,  5.1902269E -4,  4.8952553E -4,  4.5283337E -4,  00063
     6  4.0956391E -4,  3.5996452E -4,  3.6577123E -4,  3.1223749E -4,  00064
     7  3.1610171E -4,  2.7175533E -4,  2.6137090E -4,  2.4993279E -4,  00065
     8  2.1203687E -4,  2.0986100E -4,  1.8825889E -4,  1.9065517E -4,  00066
     9  1.5212982E -4,  1.6783451E -4,  1.4593576E -4,  1.3540700E -4,  00067
     A  1.3504493E -4,  1.2311691E -4,  1.1905526E -4,  1.0624773E -4,  00068
     B  1.0959919E -4,  9.0203495E -5,  1.0004545E -4,  7.6222540E -5,  00069
     C  9.5931233E -5,  7.7124604E -5,  7.1385769E -5/                  00070
        DATA DHSTOC /                                                  00071
     1  4.6263246E -7, -5.0785723E -7,  4.9079559E -7, -4.7822750E -9,  00072
     2 -2.9687666E -7,  3.9110132E -7, -8.3666988E -8,  1.0965979E -7,  00073
     3  1.3019743E -7,  3.0863274E -7,  3.4506690E -8,  1.7101044E -8,  00074
     4  4.0194581E -9, -8.6511271E -9, -1.2183454E -7, -5.7059921E -8,  00075
     5 -6.5680099E -8, -8.1936581E -8, -1.0192268E -7, -1.2019293E -7,  00076
     6 -1.3777610E -7,  1.6129763E -8, -1.4870484E -7,  1.0733966E -8,  00077
     7 -1.2318441E -7, -2.8845605E -8, -3.1772563E -8, -1.0526642E -7,  00078
     8 -6.2107655E -9, -5.9839202E -8,  6.6563526E -9, -1.0701486E -7,  00079
     9  4.3624122E -8, -6.0829870E -8, -2.9246541E -8, -1.0057489E -9,  00080
     A -3.3133402E -8, -1.1282336E -8, -3.5576490E -8,  9.3096000E -9,  00081
     B -5.3876911E -8,  2.7338771E -8, -6.6174755E -8,  5.4746372E -8,  00082
     C -5.2240472E -8, -1.5941373E -8, -3.0464246E-16/                  00083
        DATA APSTOC /                                                  00084
     1  4.2085682E  1,  4.3386975E  1,  4.4495534E  1,  4.5462856E  1,  00085
     2  4.6322612E  1,  4.7097716E  1,  4.7804433E  1,  4.8454591E  1,  00086
     3  4.9057502E  1,  4.9620247E  1,  5.0149295E  1,  5.1120766E  1,  00087
     4  5.1999543E  1,  5.2806502E  1,  5.3552409E  1,  5.4248714E  1,  00088
     5  5.4900463E  1,  5.5516487E  1,  5.6099059E  1,  5.6652565E  1,  00089
     6  5.7180599E  1,  5.7683305E  1,  5.8165660E  1,  5.8627804E  1,  00090
     7  5.9070600E  1,  5.9497975E  1,  5.9909137E  1,  6.0305880E  1,  00091
     8  6.0688473E  1,  6.1058904E  1,  6.1416051E  1,  6.1765432E  1,  00092
     9  6.2101202E  1,  6.2428534E  1,  6.2746705E  1,  6.3055383E  1,  00093
     A  6.3355689E  1,  6.3648438E  1,  6.3933666E  1,  6.4212032E  1,  00094
     B  6.4483012E  1,  6.4747958E  1,  6.5005805E  1,  6.5258604E  1,  00095
     C  6.5505771E  1,  6.5747429E  1,  6.5984321E  1/                  00096
        DATA BPSTOC /                                                  00097
     1  2.3611109E -2,  1.9925522E -2,  1.7179381E -2,  1.5151029E -2,  00098
     2  1.3570341E -2,  1.2310624E -2,  1.1278243E -2,  1.0420135E -2,  00099
     3  9.6946117E -3,  9.0842046E -3,  8.5582695E -3,  7.6735429E -3,  00100
     4  7.0037399E -3,  6.4549164E -3,  5.9982796E -3,  5.6072707E -3,  00101
     5  5.2739681E -3,  4.9911293E -3,  4.7264129E -3,  4.5052119E -3,  00102
     6  4.2912409E -3,  4.0998256E -3,  3.9359742E -3,  3.7672223E -3,  00103
     7  3.6236384E -3,  3.4925021E -3,  3.3648045E -3,  3.2458993E -3,  00104
     8  3.1349658E -3,  3.0396602E -3,  2.9450195E -3,  2.8432540E -3,  00105
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9  2.7606940E -3,  2.6914826E -3,  2.6110059E -3,  2.5557031E -3,   00106
A  2.4707640E -3,  2.4076404E -3,  2.3486016E -3,  2.2876525E -3,   00107
B  2.2331503E -3,  2.1776514E -3,  2.1260352E -3,  2.0843887E -3,   00108
C  2.0355798E -3,  1.9939083E -3,  1.9525252E -3/                   00109
  DATA CPSTUC /                                                     00110
1 -3.4719298E -5, -2.6707152E -5, -1.9661863E -5, -1.4744014E -5,   00111
2 -1.1600777E -5, -9.3945169E -6, -7.8118260E -6, -6.4899647E -6,   00112
3 -5.6026992E -6, -4.5713481E -6, -4.1942376E -6, -3.1784829E -6,   00113
4 -2.4632077E -6, -2.1703209E -6, -1.6349867E -6, -1.6234208E -6,   00114
5 -1.1541008E -6, -1.2028893E -6, -1.0630801E -6, -8.4626213E -7,   00115
6 -9.4285046E -7, -6.5229498E -7, -7.1313430E -7, -6.9313113E -7,   00116
7 -5.0340159E -7, -5.6940074E -7, -4.7474511E -7, -5.1613263E -7,   00117
8 -4.0631295E -7, -3.6416666E -7, -4.0623842E -7, -4.4180682E -7,   00118
9 -2.4619354E -7, -3.3056656E -7, -3.4007350E -7, -2.8744924E -7,   00119
A -2.5371056E -7, -2.7231897E -7, -2.1967199E -7, -2.8656992E -7,   00120
B -1.6926266E -7, -2.9320815E -7, -1.3092676E -7, -2.1012603E -7,   00121
C -1.9661570E -7, -1.5064707E -7, -1.9421172E -7/                   00122
  DATA DPSTUC /                                                     00123
1  4.4511916E -8,  4.2473827E -8,  2.3988049E -8,  1.7462424E -8,   00124
2  1.2257002E -8,  8.7927204E -9,  7.3436741E -9,  4.9325860E -9,   00125
3  5.7263946E -9,  2.0950580E -9,  2.8215410E -9,  2.1535420E -9,   00126
4  6.4690755E-10,  1.4870398E -9,  3.2127303E-11,  1.3036606E -9,   00127
5 -1.3552355E-10,  5.5502559E-10,  4.5227212E-10, -2.8491201E-10,   00128
6  8.0704292E-10, -1.6699812E-10,  5.5564348E-11,  5.2702648E-10,   00129
7 -2.3886648E-10,  3.1848778E-10, -1.1496534E-10,  2.9949911E-10,   00130
8  6.7672426E-11, -6.1311215E-11, -9.8799700E-11,  5.4337025E-10,   00131
9 -2.3436950E-10, -2.6408157E-11,  1.4617848E-10,  9.3718506E-11,   00132
A -5.1689979E-11,  1.4624162E-10, -1.8582761E-10,  3.2579797E-10,   00133
B -3.4423751E-10,  4.3411500E-10, -2.0333131E-10,  3.7528688E-11,   00134
C  1.2769066E-10, -1.2101295E-10,  1.6269102E-18/                   00135
  DATA AHAIR  /                                                     00136
1  2.0744608E  3,  2.4902241E  3,  2.9063175E  3,  3.3224017E  3,   00137
2  3.7389568E  3,  4.1563278E  3,  4.5745835E  3,  4.9943452E  3,   00138
3  5.4157476E  3,  5.8392709E  3,  6.2651075E  3,  7.1253489E  3,   00139
4  7.9979695E  3,  8.8830060E  3,  9.7826248E  3,  1.0694799E  4,   00140
5  1.1619349E  4,  1.2555608E  4,  1.3503012E  4,  1.4460783E  4,   00141
6  1.5427968E  4,  1.6403545E  4,  1.7386531E  4,  1.8376686E  4,   00142
7  1.9373223E  4,  2.0375962E  4,  2.1384059E  4,  2.2397435E  4,   00143
8  2.3415861E  4,  2.4438466E  4,  2.5465292E  4,  2.6496031E  4,   00144
9  2.7530602E  4,  2.8568456E  4,  2.9609812E  4,  3.0654310E  4,   00145
A  3.1701718E  4,  3.2752057E  4,  3.3805153E  4,  3.4860783E  4,   00146
B  3.5918833E  4,  3.6979284E  4,  3.8041880E  4,  3.9106678E  4,   00147
C  4.0173367E  4,  4.1242236E  4,  4.2313053E  4/                   00148
  DATA EHAIR  /                                                     00149
1  6.9275846E  0,  6.9332295E  0,  6.9346292E  0,  6.9370327E  0,   00150
2  6.9492085E  0,  6.9624402E  0,  6.9823715E  0,  7.0089451E  0,   00151
3  7.0400511E  0,  7.0771451E  0,  7.1193622E  0,  7.2192164E  0,   00152
4  7.3253262E  0,  7.4359031E  0,  7.5474443E  0,  7.6541249E  0,   00153
5  7.7541611E  0,  7.8494875E  0,  7.9394730E  0,  8.0220024E  0,   00154
6  8.0964162E  0,  8.1613886E  0,  8.2221254E  0,  8.2786318E  0,   00155
7  8.3306307E  0,  8.3792712E  0,  8.4231817E  0,  8.4663294E  0,   00156
8  8.5050333E  0,  8.5397746E  0,  8.5732108E  0,  8.6060449E  0,   00157
9  8.6353209E  0,  8.6635145E  0,  8.6916661E  0,  8.7163333E  0,   00158
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A  8.7406891E  0,  8.7640414E  0,  8.7860145E  0,  8.8070112E  0,  00159
B  8.8273568E  0,  8.8461161E  0,  8.8643894E  0,  8.8812011E  0,  00160
C  8.8979816E  0,  8.9158227E  0,  8.9308820E  0/                   00161
  DATA CHAIR  /                                                    00162
1  3.9425149E -5,  5.6321643E -5, -3.4058561E -5,  7.4717548E -5,  00163
2  1.2821305E -4,  9.2513038E -5,  2.3987384E -4,  2.0302041E -4,  00164
3  3.1541368E -4,  3.0281866E -4,  4.0079895E -4,  4.3132005E -4,  00165
4  4.5294361E -4,  4.6851413E -4,  4.6099555E -4,  4.2801005E -4,  00166
5  4.0562398E -4,  3.8676262E -4,  3.6111774E -4,  3.2662700E -4,  00167
6  2.9346671E -4,  2.4795030E -4,  2.5818933E -4,  2.1274809E -4,  00168
7  2.2052729E -4,  1.8480830E -4,  1.8111346E -4,  1.7844917E -4,  00169
8  1.4406340E -4,  1.4538840E -4,  1.3326544E -4,  1.4033343E -4,  00170
9  1.0363211E -4,  1.2964058E -4,  1.0661908E -4,  9.8938534E -5,  00171
A  1.0402768E -4,  9.5575248E -5,  8.7534249E -5,  8.2438336E -5,  00172
B  8.7107822E -5,  6.9170119E -5,  8.3158507E -5,  5.6939021E -5,  00173
C  8.2896159E -5,  6.5779416E -5,  5.9714264E -5/                   00174
  DATA DHAIR  /                                                    00175
1  9.3089422E -8, -5.0544558E -7,  6.0764502E -7,  2.9719721E -7,  00176
2 -1.9944115E -7,  8.1977690E -7, -2.0474125E -7,  6.2440819E -7,  00177
3 -6.9573484E -8,  5.4433501E -7,  8.4760749E -8,  6.0066037E -8,  00178
4  4.3250800E -8, -2.0884909E -8, -9.1826417E -8, -6.2183517E -8,  00179
5 -4.6837099E -8, -7.6791326E -8, -9.5807616E -8, -9.2056394E -8,  00180
6 -1.2646999E -7,  2.8441750E -8, -1.2622567E -7,  2.1608907E -8,  00181
7 -9.9219431E -8, -1.0263443E -8, -7.3991457E -9, -9.5462121E -8,  00182
8  3.6249783E -9, -3.3019308E -8,  1.9577748E -8, -1.0194813E -7,  00183
9  7.2262418E -8, -6.3965262E -8, -2.1334860E -8,  1.4134850E -8,  00184
A -2.3477309E -8, -2.2330109E -8, -1.4155313E -8,  1.2970784E -8,  00185
B -4.9626958E -8,  3.8856629E -8, -7.2831909E -8,  7.2104831E -8,  00186
C -4.7548173E -8, -1.6847645E -8,   .0000000E  0/                   00187
  DATA APAIR  /                                                    00188
1  4.2290584E  1,  4.3562261E  1,  4.4631264E  1,  4.5557303E  1,  00189
2  4.6374653E  1,  4.7107478E  1,  4.7771920E  1,  4.8380357E  1,  00190
3  4.8942754E  1,  4.9465672E  1,  4.9955876E  1,  5.0852961E  1,  00191
4  5.1606670E  1,  5.2400601E  1,  5.3081198E  1,  5.3715557E  1,  00192
5  5.4307594E  1,  5.4863428E  1,  5.5391704E  1,  5.5890621E  1,  00193
6  5.6365328E  1,  5.6816527E  1,  5.7248293E  1,  5.7661326E  1,  00194
7  5.8055999E  1,  5.8436266E  1,  5.8801411E  1,  5.9153578E  1,  00195
8  5.9492579E  1,  5.9820405E  1,  6.0137839E  1,  6.0444735E  1,  00196
9  6.0740892E  1,  6.1029436E  1,  6.1310203E  1,  6.1582016E  1,  00197
A  6.1845861E  1,  6.2103723E  1,  6.2354611E  1,  6.2599309E  1,  00198
B  6.2837251E  1,  6.3070208E  1,  6.3296197E  1,  6.3518195E  1,  00199
C  6.3735424E  1,  6.3947672E  1,  6.4155513E  1/                   00200
  DATA BPAIR  /                                                    00201
1  2.3602551E -2,  1.9281781E -2,  1.6504332E -2,  1.4452996E -2,  00202
2  1.2863066E -2,  1.1603469E -2,  1.0576395E -2,  9.7348318E -3,  00203
3  9.0259001E -3,  8.4273710E -3,  7.9207612E -3,  7.0681582E -3,  00204
4  6.4264274E -3,  5.9041520E -3,  5.4702632E -3,  5.1016964E -3,  00205
5  4.7828592E -3,  4.5136623E -3,  4.2652396E -3,  4.0552220E -3,  00206
6  3.8544343E -3,  3.6746714E -3,  3.5210202E -3,  3.3611988E -3,  00207
7  3.2268558E -3,  3.1053751E -3,  2.9869573E -3,  2.8791045E -3,  00208
8  2.7756197E -3,  2.6883021E -3,  2.6024571E -3,  2.5101488E -3,  00209
9  2.4332568E -3,  2.3741492E -3,  2.3029403E -3,  2.2287608E -3,  00210
A  2.1734560E -3,  2.1200632E -3,  2.0650160E -3,  2.0095468E -3,  00211
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     B  1.9627836E -3,  1.9117150E -3,  1.8640095E -3,  1.8319971E -3,  00212
     C  1.7886750E -3,  1.7502213E -3,  1.7127021E -3/                  00213
       DATA CPAIR  /                                                    00214
     1 -3.5050729E -5, -2.6962100E -5, -1.9328714E -5, -1.4860233E -5,  00215
     2 -1.1636560E -5, -9.3543859E -6, -7.7036432E -6, -6.2622078E -6,  00216
     3 -5.5533221E -6, -4.4221574E -6, -4.0213398E -6, -3.0836856E -6,  00217
     4 -2.2640717E -6, -2.0883892E -6, -1.5271829E -6, -1.5442075E -6,  00218
     5 -1.1127689E -6, -1.1305391E -6, -9.3964968E -7, -8.1049701E -7,  00219
     6 -8.6273479E -7, -6.3528805E -7, -6.4513792E -7, -6.6670732E -7,  00220
     7 -4.3281765E -7, -5.7952231E -7, -4.0729158E -7, -4.9148165E -7,  00221
     8 -3.6922536E -7, -3.6006798E -7, -3.5528595E -7, -4.1394992E -7,  00222
     9 -2.2681898E -7, -2.6574264E -7, -3.2766403E -7, -2.9044817E -7,  00223
     A -1.7047631E -7, -2.7446362E -7, -1.8426235E -7, -2.7798125E -7,  00224
     B -1.1171355E -7, -3.1385748E -7, -8.3688505E -8, -1.8506156E -7,  00225
     C -1.7793543E -7, -1.4251173E -7, -1.7014833E -7/                  00226
       DATA DPAIR  /                                                    00227
     1  4.4936829E -8,  4.2407696E -8,  2.4824895E -8,  1.7898067E -8,  00228
     2  1.2689968E -8,  8.8363484E -9,  8.3424182E -9,  3.9382536E -9,  00229
     3  6.2842483E -9,  2.2267638E -9,  2.6045951E -9,  2.2767053E -9,  00230
     4  4.8806677E-10,  1.5589065E -9, -4.7290359E-11,  1.1984403E -9,  00231
     5 -4.9361666E-11,  5.3024839E-10,  3.5675736E-10, -1.4510495E-10,  00232
     6  6.3179424E-10, -2.7356559E-11, -1.1547049E-10,  7.0524903E-10,  00233
     7 -4.0751294E-10,  4.7841868E-10, -2.3386133E-10,  3.3960076E-10,  00234
     8  2.5381736E-11,  1.3338907E-11, -1.6295550E-10,  5.1980818E-10,  00235
     9 -1.0812130E-10, -1.7200381E-10,  1.0337736E-10,  3.3325516E-10,  00236
     A -2.8665365E-10,  2.5655908E-10, -2.6033027E-10,  4.6185471E-10,  00237
     B -5.6151091E-10,  6.3933825E-10, -2.7609180E-10,  1.4294821E-11,  00238
     C  9.8399136E-11, -7.6768324E-11,   .0000000E  0/                  00239
       DATA  APH2O  /                                                   00240
     1  4.0438998E  1,  4.1888999E  1,  4.3116999E  1,  4.4181999E  1,  00241
     2  4.5123999E  1,  4.5970000E  1,  4.6740999E  1,  4.7449999E  1,  00242
     3  4.8105999E  1,  4.8725999E  1,  4.9297999E  1,  5.0359999E  1,  00243
     4  5.1324999E  1,  5.2211999E  1,  5.3036999E  1,  5.3807999E  1,  00244
     5  5.4534999E  1,  5.5226000E  1,  5.5883999E  1,  5.6513999E  1,  00245
     6  5.7118999E  1,  5.7700999E  1,  5.8261000E  1,  5.8803000E  1,  00246
     7  5.9328000E  1,  5.9836999E  1,  6.0329999E  1,  6.0808999E  1,  00247
     8  6.1274000E  1,  6.1726999E  1,  6.2166999E  1,  6.2596999E  1,  00248
     9  6.3015000E  1,  6.3423000E  1,  6.3820999E  1,  6.4209998E  1,  00249
     A  6.4590999E  1,  6.4961999E  1,  6.5324999E  1,  6.5679999E  1,  00250
     B  6.6026000E  1,  6.6367999E  1,  6.6700999E  1,  6.7027999E  1,  00251
     C  6.7347999E  1,  6.7661999E  1,  6.7968999E  1/                  00252
       DATA  BPH2O  /                                                   00253
     1  2.6380001E -2,  2.2137765E -2,  1.8968855E -2,  1.6636779E -2,  00254
     2  1.4834025E -2,  1.3427126E -2,  1.2307474E -2,  1.1342977E -2,  00255
     3  1.0570630E -2,  9.9244986E -3,  9.3313724E -3,  8.4127765E -3,  00256
     4  7.6925193E -3,  7.1171509E -3,  6.6388734E -3,  6.2273479E -3,  00257
     5  5.9017384E -3,  5.6157035E -3,  5.3604466E -3,  5.1425121E -3,  00258
     6  4.9445076E -3,  4.7544515E -3,  4.5876785E -3,  4.4448397E -3,  00259
     7  4.3079595E -3,  4.1733196E -3,  4.0487699E -3,  3.9315913E -3,  00260
     8  3.8248587E -3,  3.7189790E -3,  3.6242279E -3,  3.5341062E -3,  00261
     9  3.4393483E -3,  3.3565054E -3,  3.2766233E -3,  3.2099932E -3,  00262
     A  3.1334144E -3,  3.0563686E -3,  2.9911159E -3,  2.9291540E -3,  00263
     B  2.8672694E -3,  2.8017609E -3,  2.7506711E -3,  2.6955742E -3,  00264
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C  2.6420392E -3,  2.5862639E -3,  2.5379118E -3/                        00265
   DATA  CPH2O  /                                                          00266
1 -3.9962907E -5, -3.0740698E -5, -2.2074797E -5, -1.6793136E -5,        00267
2 -1.3252776E -5, -1.0195531E -5, -8.4653308E -6, -7.6096196E -6,        00268
3 -5.2628291E -6, -5.5060343E -6, -4.3793914E -6, -3.2755751E -6,        00269
4 -2.7265669E -6, -2.0681700E -6, -1.9174765E -6, -1.5119032E -6,        00270
5 -1.2015082E -6, -1.1821166E -6, -9.4502355E -7, -8.7109742E -7,        00271
6 -7.7893962E -7, -8.0486119E -7, -5.8491443E -7, -6.0540767E -7,        00272
7 -5.3526144E -7, -5.8673832E -7, -4.5117494E -7, -5.2531422E -7,        00273
8 -3.6412465E -7, -5.1820634E -7, -2.7138676E -7, -4.7962753E -7,        00274
9 -3.1602091E -7, -3.0306974E -7, -3.1668162E -7, -2.3656946E -7,        00275
A -4.0158752E -7, -2.4046134E -7, -3.0331139E -7, -2.1303737E -7,        00276
B -3.0266716E -7, -2.4323764E -7, -1.8251030E -7, -2.7663023E -7,        00277
C -1.6949482E -7, -2.9529957E -7, -1.0763431E -7/                        00278
   DATA  DPH2O  /                                                          00279
1  5.1234491E -8,  4.6143695E -8,  2.9342506E -8,  1.9666603E -8,        00280
2  1.6984695E -8,  9.6121861E -9,  4.7539842E -9,  1.3037725E -8,        00281
3 -1.3511462E -9,  6.2591270E -9,  3.0661561E -9,  1.5250231E -9,        00282
4  1.8260799E -9,  4.1659333E-10,  1.1265923E -9,  8.6220848E-10,        00283
5  5.3865334E-11,  6.5859193E-10,  2.0535031E-10,  2.5599393E-10,        00284
6 -7.2004346E-11,  6.1096318E-10, -5.6925681E-11,  1.9485067E-10,        00285
7 -1.4299133E-10,  3.7650489E-10, -2.0594241E-10,  4.4775045E-10,        00286
8 -4.2800633E-10,  6.8560992E-10, -5.7844601E-10,  4.7112953E-10,        00287
9 -1.4902453E-10,  1.2496867E-10,  2.2808765E-10, -4.5838351E-10,        00288
A  4.4757271E-10, -1.7458346E-10,  2.5076117E-10, -2.4897163E-10,        00289
B  1.6508196E-10,  1.6868709E-10, -2.6144426E-10,  2.9759838E-10,        00290
C -3.4945764E-10,  5.2129240E-10,  2.4671620E-10/                        00291
   DATA  AHH2O  /                                                          00292
1  2.3675999E  3,  2.8450999E  3,  3.3231999E  3,  3.8019999E  3,        00293
2  4.2823998E  3,  4.7646996E  3,  5.2499998E  3,  5.7387998E  3,        00294
3  6.2316998E  3,  6.7288998E  3,  7.2308998E  3,  8.2503998E  3,        00295
4  9.2913997E  3,  1.0354899E  4,  1.1441400E  4,  1.2551399E  4,        00296
5  1.3685699E  4,  1.4844299E  4,  1.6027599E  4,  1.7235299E  4,        00297
6  1.8466899E  4,  1.9721599E  4,  2.0998698E  4,  2.2297799E  4,        00298
7  2.3617499E  4,  2.4957199E  4,  2.6315599E  4,  2.7691898E  4,        00299
8  2.9084899E  4,  3.0493899E  4,  3.1918199E  4,  3.3356798E  4,        00300
9  3.4809098E  4,  3.6274298E  4,  3.7751498E  4,  3.9240199E  4,        00301
A  4.0739898E  4,  4.2249697E  4,  4.3769298E  4,  4.5298199E  4,        00302
B  4.6835898E  4,  4.8381898E  4,  4.9935698E  4,  5.1496998E  4,        00303
C  5.3065298E  4,  5.4640298E  4,  5.6221298E  4/                        00304
   DATA  BHH2O  /                                                          00305
1  7.9537975E  0,  7.9634362E  0,  7.9724582E  0,  7.9917322E  0,        00306
2  8.0260116E  0,  8.0608187E  0,  8.1161153E  0,  8.1797218E  0,        00307
3  8.2499956E  0,  8.3252972E  0,  8.4088167E  0,  8.5840049E  0,        00308
4  8.7676638E  0,  8.9578398E  0,  9.1509767E  0,  9.3507537E  0,        00309
5  9.5535102E  0,  9.7577063E  0,  9.9631651E  0,  1.0164633E  1,        00310
6  1.0366802E  1,  1.0549659E  1,  1.0735562E  1,  1.0913092E  1,        00311
7  1.1082071E  1,  1.1243627E  1,  1.1395917E  1,  1.1540203E  1,        00312
8  1.1675771E  1,  1.1806712E  1,  1.1929882E  1,  1.2046265E  1,        00313
9  1.2157557E  1,  1.2261006E  1,  1.2358428E  1,  1.2452780E  1,        00314
A  1.2540449E  1,  1.2622924E  1,  1.2702854E  1,  1.2778161E  1,        00315
B  1.2849503E  1,  1.2916330E  1,  1.2980171E  1,  1.3040489E  1,        00316
C  1.3097876E  1,  1.3150503E  1,  1.3200110E  1/                        00317
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      DATA  CHH2O  /
     1  6.6147610E -5,  9.4496874E -5,  5.5870172E -5,  2.6536416E -4,
     2  2.1555757E -4,  4.5416117E -4,  4.6744899E -4,  5.9265906E -4,
     3  5.7856025E -4,  6.7647748E -4,  7.1551406E -4,  7.4436713E -4,
     4  7.8010421E -4,  7.9869591E -4,  8.1077721E -4,  8.5403126E -4,
     5  8.3560620E -4,  8.6602864E -4,  8.4612693E -4,  8.3277711E -4,
     6  8.0196076E -4,  7.7184989E -4,  7.7733759E -4,  7.0208097E -4,
     7  7.0607854E -4,  6.4021976E -4,  6.2886450E -4,  5.7351956E -4,
     8  5.5621311E -4,  5.3496108E -4,  4.9145288E -4,  4.7840400E -4,
     9  4.4903450E -4,  4.1303970E -4,  3.9880724E -4,  3.8746253E -4,
     A  3.4511140E -4,  3.4417752E -4,  3.2190581E -4,  3.0565709E -4,
     B  2.8885998E -4,  2.6803073E -4,  2.6397382E -4,  2.3867827E -4,
     C  2.3954869E -4,  1.9902217E -4,  2.1436645E -4/
      DATA  DHH2O  /
     1  1.5749480E -7, -2.1459278E -7,  1.1636554E -6, -2.7448098E -7,
     2  1.3233533E -6,  7.3821177E -8,  6.9561152E -7, -7.8326730E -8,
     3  5.4398461E -7,  2.1686989E -7,  8.0202957E -8,  1.1588080E -7,
     4  3.4976900E -8,  3.3559222E -8,  1.2015015E -7, -5.1180781E -8,
     5  8.4506607E -8, -5.5282522E -8, -3.7082846E -8, -8.5600992E -8,
     6 -8.3641294E -8,  1.5243596E -8, -2.0904616E -7,  1.1104404E -8,
     7 -1.8294107E -7, -3.1542387E -8, -1.5373594E -7, -4.8073483E -8,
     8 -5.9033398E -8, -1.2085610E -7, -3.6245243E -8, -8.1583571E -8,
     9 -9.9985577E -8, -3.9534621E -8, -3.1513060E -8, -1.2319759E -7,
     A  2.9614359E -9, -6.1865827E -8, -4.5135370E -8, -4.6658622E -8,
     B -5.7859040E -8, -1.1269165E -8, -7.0265414E -8,  2.4039459E -9,
     C -1.1255979E -7,  4.2623033E -8, -5.0527478E-15/
C *** BASED ON 60,120 DEGREE CUBIC SPLINE FITS OF K AND K GAS CONSTITUEN
C        WITH LAMBDA CONDITIONS APPLIED AT FRONT END  ***
      DATA TITAB /
     1  300., 360., 420., 480., 540., 600., 660., 720., 780., 840.,
     2   900., 1020., 1140., 1260., 1380., 1500., 1620., 1740., 1860.,
     3  1980., 2100., 2220., 2340., 2460., 2580., 2700., 2820., 2940.,
     4  3060., 3180., 3300., 3420., 3540., 3660., 3780., 3900., 4020.,
     5  4140., 4260., 4380., 4500., 4620., 4740., 4860., 4980., 5100.,
     6  5220., 5340. /
      DATA IDT/ 65, 45, 54, 64, 56, 46, 16, 26, 36, 10, 11, 17, 37 /
      DATA GX  / 3.446, 17.413, 55.86, 141.51, 1.E10,
     1 3.467, 18.116, 59.8, 155.39, 346.2, 690.9, 1268.3, 1.E10 /
      DATA GTG / 500., 900., 1300., 1700., 2100.,
     1 500., 900., 1300., 1700., 2100., 2500., 2900., 3300. /
      DATA GPR / 1.059, 8.411, 32.39, 90.95, 212.1,
     1 1.0457, 8.611, 34.2, 98.64, 235.7, 494.9, 944.7, 1675.3 /
      DATA GKK / .2859, .2799, .2659, .2539, .236,
     1 .286, .274, .2593, .247, .24, .231, .227, .224 /
      DATA R,ZMWAIR /1.98587,28.96916 /
      DATA RR /.5035575/
     IF (IDI.LT.0) GO TO 160
     DO 100 ID=1,13
     IF (IDI.EQ.IDT(ID)) GO TO 120
  100 CONTINUE
      RETURN
  120 X = ARG
     IF (FA-FAOLD)180,140,180
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```
  140 IF (WA-WAOLD)180,280,180
  160  ID = 10
       STDLHV = GLHV
C  REPLACE CARDS BELOW FOR NEW HCR
       HCR =     .1600000
       HCRM =    1.906349
C      ZMWF =  13.9316
C      STDIC1 =    .6772373
C      STDIC2 =   1.023974
       STDIC =    .06836219
       IF(GLHV .LE. 0.) STDLHV = 18513.
C IF HCR IS OTHER THAN .16 GENERATE NEW SPLINE FITS USING GASTAB/BMFIT,
C INSERT NEW COEFFICIENTS AND CALCULATE COMBINED CONSTANTS
  180  FA = FAOLD
       FO2R = AMIN1 (9.906606*FA, 1.023974)
       ZMEA = 4.7642 - FO2R * 7.034757
       ZMSP = FO2R * 7.511344
       SPMW = 0.
      IF (ZMSP)200,220,200
  200   SPMW = 28.98589
  220  WA = WAOLD
      IF (WA.GE.0.) GO TO 240
       ZMSP  = 0.
       ZMEA  = 0.
       ZMH2O = 1.
      GO TO 260
C      THE FOLLOWING CHANGES WERE MADE TO INCREASE COMPUTER SPEED
  240  ZMH2O  = WA * 7.660665
C 240   ZMH2O = WA/18.016 * ZMWAIR*4.7642
C 260  TMLS  = ZMSP + ZMEA + ZMH2O
 260   RTMLS = 1.0/(ZMSP + ZMEA + ZMH2O)
       ZNUMR = 1.0/(ZMSP*SPMW + ZMEA*ZMWAIR + ZMH2O*18.016)
C      ZMWT  = (ZMSP*SPMW + ZMEA*ZMWAIR + ZMH2O *18.016)*RTMLS
       RZMWT = ZNUMR/RTMLS
  280 GO TO (340,340,660,660,300,620,880,880,880,1140,1080,880,880),ID
  300  TG = X
  320  J1 = 1
      GO TO 420
  340  I1 = 1
       J1 = 4
       IF (FA.LE.0. .AND. WA.LE.0.) GO TO 360
       I1 = 6
       J1 = 12
  360 DO 380 J=I1,J1
      IF (X.LE.GX(J)) GO TO 400
  380  CONTINUE
       J = J1 + 1
  400  TG = GTG(J)*(X/GPR(J))**GKK(J)
       ZK = GKK(J)
       J1 = 10
  420 DO 580 J=1,J1
      IF (TG.LT.TTTAB(I1)) GO TO 440
C THE CONSTANTS .01666666 AND .008333333 REPRESENT 60. AND 120. DEGREE
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C INCREMENTS USED FOR CUBIC SPLINE FITS
C THE MULTIPLICATION PROCESS IS SELECTED OVER DIVISION BECAUSE OF A
C 3.125 COMPUTER SPEED FACTOR (REF. UNIVAC 1108 COMPUTER)
      XFIX = ((AMIN1(TG,5339.)-TTTAB(11))*.008333333)
      IT = 11 + IFIX(XFIX)
     GO TO 460
 440  XFIX = ((AMAX1(TG,300.)-TTTAB(1))*.01666666)
      IT = 1 + IFIX(XFIX)
  460 CONTINUE
      DL = TG - TTTAB(IT)
      PHISP = 0.
      PHIEA = 0.
      PHIH2O = 0.
     IF (WA.LT.0.) GO TO 500
      PHIEA = ((DPAIR(IT)*DL + CPAIR(IT))* DL + BPAIR(IT))*DL+APAIR(IT)
     IF (FA.LE.0.) GO TO 480
      PHISP = ((DPSTOC(IT)*DL+CPSTOC(IT))*DL+BPSTOC(IT))*DL+APSTOC(IT)
  480 IF (WA.EQ.0.) GO TO 520
  500 PHIH2O = ((DPH2O(IT)*DL + CPH2O(IT))*DL + BPH2O(IT))*DL +
    1    APH2O(IT)
  520 CONTINUE
      PHIG = (PHISP*ZMSP + PHIEA*ZMEA + PHIH2O*ZMH2O)*RTMLS
      PRG = EXP(PHIG*RR - 23.02585)
     IF (J.EQ.J1) GO TO 600
     IF (ABS(X-PRG)/X-.00002)600,600,540
  540 IF (J.EQ.1) GO TO 560
     IF (ALOG(PRG/HGO).EQ.0.) GO TO 600
      ZK = ALOG(TG/TGO)/ALOG(PRG/HGO)
  560 TGO = TG
      HGO = PRG
  580 TG = TG*(X/PRG)**ZK
  600 GO TO (1200,640,1160,1220,1160,1220),ID
  620 TG = X
  640 I1 = 1
     GO TO 680
 660  TG = 3.55 * X
      TGO = 1.
      HGO = .282
      I1 = 10
  680 DO 840 J=1,I1
     IF (TG.LT.TTTAB(11)) GO TO 700
      XFIX = ((AMIN1(TG,5339.)-TTTAB(11))*.008333333)
      IT = 11 + IFIX(XFIX)
     GO TO 720
 700 XFIX = ((AMAX1(TG,300.)-TTTAB(1))*.01666666)
      IT = 1  + IFIX(XFIX)
  720 CONTINUE
      DL = TG - TTTAB(IT)
      HGEA = 0.
      HGSP = 0.
      HGH2O = 0.
      CPSP = 0.
     IF (WA.LT.0.) GO TO 760
```

```
      HGEA  = ((DHAIR(IT)*DL + CHAIR(IT))* DL + BHAIR(IT))*DL+AHAIR(IT)
     IF (FA.LE.0.) GO TO 740
      HGSP  = ((DHSTOC(IT)*DL+CHSTOC(IT))*DL+BHSTOC(IT))*DL+AHSTOC(IT)
 740 IF (WA.EQ.0.) GO TO 760
 760  HGH2O  = ((DHH2O(IT)*DL + CHH2O(IT))*DL + BHH2O(IT))*DL +
    1     AHH2O(IT)
 780  CONTINUE
      HG = (HGSP*ZMSP + HGEA*ZMEA +HGH2O*ZMH2O)*ZNUMR
     IF (J.EQ.11) GO TO 860
     IF (HG-HGO)800,860,800
 800  T = X - HG
     IF (ABS(T)/X-.00002)860,860,820
 820  D = (TG - TGO)/(HG - HGO)
      TGO = TG
      HGO = HG
 840  TG = TG + D*T
 860 GO TO (1220,1180,320,1200,1220,1180), ID
 880  TG = AMAX1(300.,AMIN1(X,5220.))
     IF (TG.LT.TTTAB(11)) GO TO 900
      XFIX = ((TG-TTTAB(11))*.008333333)
      IT = 11 + IFIX(XFIX)
     GO TO 920
900   XFIX = ((TG-TTTAB(1))*.01666666)
      IT = 1 + IFIX(XFIX)
 920  CONTINUE
      DL = TG - TTTAB(IT)
      CPEA = 0.
      CPSP = 0.
      CH2O = 0.
     IF (WA.LT.0.) GO TO 960
      CPEA = ((DHAIR(IT)+DHAIR(IT)+DHAIR(IT))*DL +CHAIR(IT)+CHAIR(IT))
    1       * DL + BHAIR(IT)
     IF (FA.LE.0.) GO TO 940
      CPSP = ((DHSTOC(IT)+DHSTOC(IT)+DHSTOC(IT))*DL+CHSTOC(IT) +
    1      CHSTOC(IT)) * DL + BHSTOC(IT)
 940 IF (WA.EQ.0.) GO TO 980
 960  CH2O  = ((DHH2O(IT)+DHH2O(IT)+DHH2O(IT))*DL + CHH2O(IT)+CHH2O(IT
    1 )*DL + BHH2O(IT)
 980  CP = (CPSP*ZMSP + CPEA*ZMEA + CH2O *ZMH2O)*RTMLS
      CV = CP - R
     IF (ID-12)1000,1100,1120
1000 IF (ID-8)1020,1040,1060
1020  Y = CP*RZMWT
     GO TO 1220
1040  Y = CV*RZMWT
     GO TO 1220
1060  Y  = CP/CV
     GO TO 1220
1080  Y = ZMWAIR*RZMWT
     GO TO 1220
1100  Y = CP*RZMWT*ZMWAIR/CPEA
     GO TO 1220
1120  Y = CP/CV*(CPEA - R)/CPEA
```

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PRATT & WHITNEY AIRCRAFT DIVISION                    VER    12/07/78    PAGE    SERIAL
CSG.PAN757                                           10.0   11.33.02     51     021264

      GO TO 1220
 1140  Y = 1545.523*RZMWT
      GO TO 1220
 1160  Y = PRG
      GO TO 1220
 1180  Y = HG
      GO TO 1220
 1200  Y = TG
 1220  ANS = Y
      RETURN
      END
```

```
C          DATA SET B28DINJECT AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET B28DFLAME  AT LEVEL 032 AS OF 03/20/78
C          DATA SET B28DFLAME  AT LEVEL 025 AS OF 03/14/78
C          DATA SET B28DFLAME  AT LEVEL 017 AS OF 02/20/78
      SUBROUTINE INJECT (NDL,IER)
C PURPOSE       1) EVALUATE INJECTION DROPLET FORMATION
C               2) SET FIVE DROPLET SIZE GROUPS
C               3) EVALUATE PERCENT VAPORIZED BY INJECTION PROCESS
      COMMON /CINPT/FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PSI,TLFEX,B3,TW,    ETAFH
     X,DLO(5),BIE,DMDOT,BDC,RTVD,DGDOT,Y,SL,EPSO,V,XO,EPSXO,ETAO
     X,STO,XI(100),EPSXI(100),STI(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,  FHWIMP,EIT,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFLI,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30),TRJP4 (283),CRVTSL(26)
     X,CRVCFT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      IER = 0
      NDL  =  5
      P    =  PS / 14.7
C   CURVE IS THE SAME FOR JP4 AND JP5
      HF   =  -2.788 + .47 * TFSR + 1.37E-04 * TFSR**2 +
     X 1.22E-07 * TFSR**3
      X    =  .54217 * ALOG(P) + .2484
      IF(JFUEL.EQ.1)HLF = 79.92 + 27.01 * X- 12.28* X**2+140.4 * X**3+
     X 19.38 * X**4 - 106.4 * X**5
      IF(JFUEL.EQ.2) CALL UNBAR(CRVSLE,1,X,0.0,HLF,IS)
      IF(JFUEL.EQ.1) HVAP =  219.39 - 5.7*X- 2.206* X**2 - 7.236 * X**3
      IF(JFUEL.EQ.2) CALL UNBAR(CRVEVP,1,X,0.0,HVAP,IS)
      BIT  = (HF - HLF) / HVAP
      IF (BIT)10,30,20
   10 BIT  =  0.0
      GO TO 30
   20 IF (BIT-1)30,30,999
   30 IF(JFUEL.EQ.1) CALL UNBAR (CRVTSL,1,P,0.0,TSL,IS)
      IF(JFUEL.EQ.2) CALL UNBAR (CRVTSP,1,P,0.0,TSL,IS)
      IF(JFUEL.EQ.1) TSV = TSL + 172.8
      IF(JFUEL.EQ.2)  CALL UNBAR (CRVTSP,1,TSL,0.0,TSV,IS)
      TFO  = TSL + BIT * (TSV - TSL)
      IF(BIT .EQ. 0.0)TFO = TFSR
      DPINJ = PFSR - PS
      DL(3) = 126. * (100. / DPINJ)**.4
      DL(1) = 0.52 * DL(3)
      DL(2) = 0.864 * DL(3)
      DL(4) = 1.181 * DL(3)
      DL(5) = 1.397 * DL(3)
      DO 400 I = 1,5
  400 DLO(I) = DL(I)
      GO TO 1000
C  DL(1) ---- DL10
C  DL(2) ---- DL30
```

```
C  DL(3) ---- DL50
C  DL(4) ---- DL70
C  DL(5) ---- DL90
 999  WRITE(6,100)
 100  FORMAT(' ALL FUEL VAPORIZED --TERMINATE CASE')
      IER = 1
 1000 RETURN
      END
```

```
C          DATA SET B28DINPUT  AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET B28DINPUT  AT LEVEL 016 AS OF 03/14/78
C          DATA SET B28DINPUT  AT LEVEL 013 AS OF 02/23/78
C *******************************************************************
C                          CUSTOMER DECK
C       RUMBLE-TURBOFAN VEEGUTTER ,VORBIX ,OR SWIRL AUGMENTOR
C *******************************************************************
      SUBROUTINE INPUT ( A, B, OMEGA, KASE, KV, IFIRST )
      COMMON /AUGIN/ JFUEL, NAUGOP, NCOMOP, NFSOP, NPRNTR, NPRNTF
      COMMON /FLAMIN/ ALPHAC(100), ALPHAH(100), FAC(100), FAH(100),
     * FHWC(100), FHWH(100), LSC(100), LSH(100), NSC(100), NSH(100),
     * PFSR(100), TAUC(100), TAUH(100), TEXT(100), TFSR(100), T6C(100),
     * T6H(100), WEXT(100), XLC(100), XLH(100), NTC, NTH
      COMMON /RMBLIN/ BPR, DPCS, DPD, DPH, DPHS, DPS, EPSC, EPSH, ETA,
     * ETAC, ETAH, FA, FAV, LA, LB, LC, LH, LI, LK, L2, M6C, M6H, M6R,
     * PRNOZ, PS6, T3H, ZEF, ZEFC, ZEFH, ZEFP, ZEP, ZEPC, ZEPH, ZETC,
     * ZETH, ZEVC, ZEVH, TCORE
     COMMON /FHOUT/ FETAC, FETAH, FFAC, FFAH,FLB,FLI,FLK,FLSC,FLSH,
     * FT6C, FT6H, FZEFC, FZEFH, FZEPC, FZEPH, FZETC, FZETH, FZEVC,
     * FZEVH
      DIMENSION A(75,75), B(75)
      COMPLEX A, S, B
     DIMENSION IP(11),IV(11),IR(11)
     DIMENSION YL(11),TAU(11),C(11),T(11),TR(11),G(11),PR(11)
     DIMENSION TAUF(11),PF(11),VF(11),RF(11)
     DIMENSION TAUG(11),PG(11),VG(11),RG(11)
     DIMENSION TAUQ(11),QOP(11),TAUE(11)
     DIMENSION TAUF1(11),TAUG1(11),TAUE1(11)
     DIMENSION TAUF2(11),TAUG2(11),TAUE2(11)
     COMPLEX FJ,FK,FQ,EF,EG,EE,EQ,EF2,EG1,EE1,EE2,EDC,EDH
     REAL LC,LA,L(11),M(11),LH,MH,M6C,M6H,M6R,KNOZ,LSC,LSH,LB
     REAL LIC,LKC,LIH,LKH,LI,LK,L2,LSCRUM,LSHRUM
C VARIABLE DEFINITIONS
C IP(J),IV(J),IR(J) = PRESSURE,VELOCITY,DENSITY AT STATION J (J=1-11)
C IP2H,IV2H,IR2H = PRESSURE,VELOCITY,DENSITY AT STATION 2H
C IP3H,IV3H,IR3H = PRESSURE,VELOCITY,DENSITY AT STATION 3H
C IW3,IW3H = MASS FLOWRATE AT STATION 3,3H
C IQIN,IQOUT = OPEN LOOP HEAT INPUT,OUTPUT
C VARIABLE NUMBERING CONVENTION
     DATA IP/ 1, 4, 7,20,23,26,29,32,35,38,41/
     DATA IV/ 2, 5, 8,21,24,27,30,33,36,39,42/
     DATA IR/ 3, 6, 9,22,25,28,31,34,37,40,43/
     DATA IP3H,IV3H,IR3H,IP2H,IV2H,IR2H/10,11,12,13,14,15/
     DATA IQIN,IW3,IW3H,IQOUT/16,17,18,19/
     DATA L / 11*0. /, YL / 11*0. /, C / 11*0. /, CH / 0. /,
    * M / 11*0. /, MH / 0. /, T / 11*0. /, TR / 11*0. /, TH / 0. /,
    * PR / 11*0. /, PRHOT / 0. /, G / 11*0. /, GH / 0. /,
    * TAU / 11*0. /, TAUF / 11*0. /, TAUFH / 0. /, TAUG / 11*0. /,
    * TAUGH / 0. /, TAUE / 11*0. /, TAUEH / 0. /, TAUQ / 11*0. /,
    * TAUF2 / 11*0. /, TAUG2 / 11*0. /, TAUE2 / 11*0. /, PF / 11*0. /,
    * VF / 11*0. /, RF / 11*0. /, PG / 11*0. /, VG / 11*0. /,
    * RG / 11*0. /, QOP / 11*0. /
C *************************************************************
```

```
C CHANGES REQUIRED TO MATE WITH F/H COMB. MODEL -
C ADD NPRNTF
C ****************************************************************
C OUTPUT
       NAMELIST /TRNSFR/ FETAC, FETAH, FFAC, FFAH, FLB, FLI, FLK, FLSC,
     * FLSH, FT6C, FT6H, FZEFC, FZEFH,FZEPC, FZEPH,FZETC, FZETH, FZEVC,
     * FZEVH
      NAMELIST/OUT    /RNOZ,FAAB,ETAAB,DTIAB,DTAB,T6M,TKC,XLHV
      NAMELIST/FANC   /DTC,QCOT,
     X                 DTIC,TAUDC
      NAMELIST/COREC  /DTH,QHOT,
     X                 DTIH,TAUDH
      NAMELIST/FANP   /ZTFC
      NAMELIST/COREP  /ZTFH
      NAMELIST/VSOUT  /DT,DTI
     X                 ZTF,FAVIT,T6M,TF,DTIP,DTIT,FAT
      NAMELIST/LJ     /L
      NAMELIST/YLJ    /YL
      NAMELIST/MJ     /M,MH
      NAMELIST/CJ     /C,CH
      NAMELIST/GJ     /G,GH
      NAMELIST/TJ     /T,TH
      NAMELIST/PRJ    /PRHOT
      NAMELIST/TAUFJ  /TAUF,TAUFH
      NAMELIST/TAUGJ  /TAUG,TAUGH
      NAMELIST/TAUEJ  /TAUE,TAUEH
      NAMELIST/QOPJ   /QOP
      IF (NCOMOP.NE.2) GO TO 1
      ETAC = FETAC
      ETAH = FETAH
      FAC(1) = FFAC
      FAH(1) = FFAH
      LI = FLI
      LK = FLK
      LB = FLB
      LSC(1) = FLSC
      LSH(1) = FLSH
      T6C(1) = FT6C
      T6H(1) = FT6H
      ZEFC = FZEFC
      ZEFH = FZEFH
      ZEPC = FZEPC
      ZEPH = FZEPH
      ZETC = FZETC
      ZETH = FZETH
      ZEVC = FZEVC
      ZEVH = FZEVH
    1 FACRUM = FAC(1)
      FAHRUM = FAH(1)
      LSCRUM = LSC(1)
      LSHRUM = LSH(1)
      T6CRUM = T6C(1)
      T6HRUM = T6H(1)
```

```
      S= CMPLX (0., OMEGA )
      IF (IFIRST .NE. 0 ) GO TO 30
C LOWER HEATING VALUE OF FUEL
      IF(JFUEL .EQ. 1) XLHV = 18650.
      IF(JFUEL .EQ. 2) XLHV = 18500.
C MIXED TEMPERATURE BEFORE ANY COMBUSTION
      T6M    = BPR/(1.+BPR)*T6CRUM+1./(1.+BPR)*T6HRUM
C VITIATED F/A BEFORE ANY COMBUSTION
      FAVIT  = FAV/(1.+BPR)
      GO TO (6,7,8),NAUGOP
 6    CONTINUE
C7*************************** VEEGUTTER COMBUSTION *******************
C FAN STREAM TEMPERATURE RISE
      CALL TIDEAL (FACRUM,0.,PS6,T6CRUM,XLHV,
     X             DTIC,DTIPC,DTITC,FATC,TFC,ZTFC)
      DTC    = DTIC*ETAC
      TCOLD  = T6CRUM+DTC
C CORE STREAM TEMPERATURE RISE
      CALL TIDEAL (FAHRUM,FAV,PS6,T6HRUM,XLHV,
     X             DTIH,DTIPH,DTITH,FATH,TFH,ZTFH)
      DTH    = DTIH*ETAH
      THOT   = T6HRUM+DTH
C AUGMENTOR MIXED EXHAUST TEMPERATURE
      TAC    = BPR/(1.+BPR)*TCOLD+1./(1.+BPR)*THOT
C FRACTION OF TOTAL HEAT RELEASE CONTRIBUTED BY FAN,CORE STREAMS
      QCOT   = 0.
      QHOT   = 0.
      X      = BPR*DTC+DTH
      IF(X .GT. 0.)QCOT = BPR*DTC/X
      IF(X .GT. 0.)QHOT =     DTH/X
C AUGMENTOR OVERALL FUEL/AIR
      FAAB   = BPR/(1.+BPR)*FACRUM+1./(1.+BPR)*FAHRUM
      GO TO 9
 7    CONTINUE
C8*************************** VORBIX COMBUSTION ***********************
C TEMPERATURE RISE
      CALL TIDEAL (FA,FAVIT,PS6,T6M,XLHV,
     X             DTI,DTIP,DTIT,FAT,TF,ZTF)
      DT = ETA*DTI
C AUGMENTOR MIXED EXHAUST TEMPERATURE
      TAC    = T6M+DT
      FAAB = FA
      GO TO 9
 8    CONTINUE
C9**************************** SWIRL COMBUSTION ***********************
C TEMPERATURE RISE
      CALL TIDEAL (FA,FAVIT,PS6,T6M,XLHV,
     X             DTI,DTIP,DTIT,FAT,TF,ZTF)
      DT = ETA*DTI
C AUGMENTOR MIXED EXHAUST TEMPERATURE
      TAC    = T6M+DT
      FAAB = FA
 9    CONTINUE
```

```
C AUGMENTOR OVERALL EFFICIENCY
      CALL TIDEAL (FAAB,FAVIT,PS6,T6M,XLHV,
     X             DTIAB,DUM,DUM,DUM,DUM,DUM)
      DTAB   = TKC - T6M
      ETAAB  = DTAB/DTIAB
C COMBUSTION ZONE STATIONS
      NC     = 5
      IC     = 5
      KC     = IC+NC
      KCM1   = KC-1
      ICP1   = IC+1
      ICM1   = IC-1
      KCP1   = KC+1
C LENGTH CALCULATIONS
      LI     = AMIN1(AMAX1(LI,0.),LB-1.)
      LK     = AMIN1(AMAX1(LK,LI+1.),LB)
      L(2)   = L2
      L(2)   = AMIN1(L(2),LC)
      LB     = AMIN1(LB,LA)
      L(3)   = LA-LB
      L(1)   = LC-L(2)
      L(4)   = LI
      DO 14 J=IC,KCM1
   14 L(J)   = (LK-LI)/NC
      L(KC) = LA - L(3) - LK
C STATION LOCATIONS REFERENCED TO STATION 1
      YL(1)  = 0.
      DO 20 J=2,KCP1
   20 YL(J)  = YL(J-1)+L(J-1)
C TEMPERATURES
      T(1)   = T6CRUM
      T(2)   = T(1)
      T(3)   = T(2)
      TH     = T6HRUM
      T(4)   = T6M
      T(IC)  = T(4)
      T(KC)  = TKC
      T(KC)  = AMAX1(T(KC),T(IC)*1.001)
      DO 15 J=ICP1,KCP1
      X      = (YL(J)-YL(IC))/(LK-LI)
      X      = AMIN1(AMAX1(X,0.),1.)
   15 T(J)   = T(IC)+(T(KC)-T(IC))*X
C GAMMAS & SONICS
      GH     = 1.45-9.64E-5*TH  +1.47E-8*TH  **2
      CH     = 497.1*SQRT(GH  *TH  )
      DO 13 J=1,KCP1
      G(J)   = 1.45-9.64E-5*T(J)+1.47E-8*T(J)**2
   13 C(J)   = 497.1*SQRT(G(J)*T(J))
C MACHS
      M(1)   = M6C
      M(2)   = M(1)
      M(3)   = M(2)
      M(4)   = M6R
```

```
      M(IC)  = M(4)
      MH     = M6H
      PRHOT  = 1.
      DO 19 J=IC,KC
      TR(J)  = T(J+1)/T(J)
      X      = 1.+G(J)*M(J)**2
      PR(J)  = .5*X+.5*SQRT(X**2-4.*(X-1.)*TR(J))
      PRHOT  = PRHOT*PR(J)
 19   M(J+1) = M(J)*SQRT(TR(J))/PR(J)
C DELAYS UPSTREAM OF COMBUSTION ZONE
      TAUH(1)  = LH/CH
      TAUFH  = TAUH(1)/(1.+MH)
      TAUGH  = TAUH(1)/(1.-MH)
      TAUEH  = TAUH(1)/MH
      DO 12 J=1,ICM1
      TAU(J) = L(J)/C(J)
      TAUF(J)= TAU(J)/(1.+M(J))
      TAUG(J)= TAU(J)/(1.-M(J))
 12   TAUE(J)= TAU(J)/M(J)
C DELAYS DOWNSTREAM OF COMBUSTION ZONE
      J      = KC
      TAU(J) = L(J)/C(J)
      TAUF(J)= TAU(J)/(1.+M(J))
      TAUG(J)= TAU(J)/(1.-M(J))
      TAUE(J)= TAU(J)/M(J)
C COMBUSTION ZONE DELAYS
      DO 16 J=IC,KCM1
      TAU(J) = L(J)/C(J)
      TAUF(J)= TAU(J)/(TR(J)-1.)*2./M(J)*ALOG((1.+M(J)*SQRT
     X             (TR(J)))/(1.+M(J)))
      TAUG(J)= TAU(J)/(TR(J)-1.)*2./M(J)*ALOG((1.-M(J))/
     X             (1.-M(J)*SQRT(TR(J))))
      TAUE(J)= TAU(J)/(TR(J)-1.)/M(J)*ALOG(TR(J))
      TAUF1(J)= TAU(J)/(TR(J)-1.)*2./M(J)*ALOG((1.+M(J)*SQRT
     X             (.5*(1.+TR(J))))/(1.+M(J)))
      TAUG1(J)= TAU(J)/(TR(J)-1.)*2./M(J)*ALOG((1.-M(J))/
     X             (1.-M(J)*SQRT(.5*(1.+TR(J)))))
      TAUE1(J)= TAU(J)/(TR(J)-1.)/M(J)*ALOG(.5*(1.+TR(J)))
      TAUF2(J)= TAUF(J)-TAUF1(J)
      TAUG2(J)= TAUG(J)-TAUG1(J)
      TAUE2(J)= TAUE(J)-TAUE1(J)
C VOLUMETRIC HEAT RELEASE RATE/PRESSURE
 16   QOP(J) = G(J)/(G(J)-1.)*M(J)/TAU(J)*(TR(J)-1.)
      QOP(KC)= QOP(KCM1)
C COMBUSTION ZONE MACH NO. FUNCTIONS
      DO 17 J=IC,KC
      Y      = M(J)
      PF(J)  = (1.-Y-Y**2)/(1.-Y**2)
      VF(J)  = (.5+1.5*Y-Y**2*(1.+(1.+Y)*G(J)/2.))/(1.-Y**2)
      RF(J)  = Y/(1.-Y**2)
      PG(J)  = (1.+Y-Y**2)/(1.-Y**2)
      VG(J)  = (.5-1.5*Y-Y**2*(1.+(1.-Y)*G(J)/2.))/(1.-Y**2)
      RG(J)  =-Y/(1.-Y**2)
```

```
 17   CONTINUE
C BURNING PARTICLE DRIFT DELAYS
      TAUQ(IC) = TAUE(ICM1)
      DO 18 J=ICP1,KCM1
 18   TAUQ(J)= TAUQ(J-1)+TAUE(J-1)
      IF(NAUGOP .NE. 1)GO TO 25
C DRIFT DELAY FROM SPRAYBAR TO FLAMEHOLDER
      TAUDC  = LSCRUM/C(3)/M(3)
      TAUDH  = LSHRUM/CH/MH
 25   CONTINUE
C FOR UNCHOKED NOZZLE
      J      = KC
      PRCRIT = ((G(J)+1.)/2.)**(G(J)/(G(J)-1.))
      PRN    = AMAX1(AMIN1(PRNOZ,PRCRIT),1.001)
      X      = PRN**((G(J)-1.)/G(J))
      ZPHIPR = (G(J)-1.)/G(J)/2.*(X/(X-1.)-(G(J)+1.)/(G(J)-1.))
      Y      = 1.+(G(J)-1.)/2.*M(J)**2
      KNOZ   = Y*ZPHIPR/(1.-M(J)**2*(1.+G(J)*ZPHIPR))
      IF (NPRNTR.GT.0) GO TO 31
      WRITE (6,1000)
 1000 FORMAT (1H1)
      IF(NCOMOP .EQ. 2)WRITE (6,TRNSFR)
      WRITE (6,OUT   )
      IF(NAUGOP .EQ. 1)WRITE (6,FANC  )
      IF(NAUGOP .EQ. 1)WRITE (6,COREC )
      IF(NAUGOP .EQ. 1)WRITE (6,FANP  )
      IF(NAUGOP .EQ. 1)WRITE (6,COREP )
      IF(NAUGOP .GT. 1)WRITE (6,VSOUT )
      WRITE (6,LJ    )
      WRITE (6,YLJ   )
      WRITE (6,CJ    )
      WRITE (6,MJ    )
      WRITE (6,TJ    )
      WRITE (6,PRJ   )
      WRITE (6,GJ    )
      WRITE (6,TAUFJ )
      WRITE (6,TAUGJ )
      WRITE (6,TAUEJ )
      WRITE (6,WOPJ  )
C10****************** FREQUENCY-INDEPENDENT EQNS *******************
C BOUNDARY CONDITIONS AT FAN DISCHARGE (STA 1)
C CONTINUITY (STA 1)
  31  N      = IR(1)
      A(N,IR(1)   ) =  1.
      A(N,IV(1)   ) =  1.
      A(N,IP(1)   ) =  0.
      IF(NFSOP .EQ. 2)
     XA(N,IP(1)   ) =  1./BPR
C CONSTANT TEMPERATURE (STA 1)
      N      = IP(1)
      A(N,IP(1)   ) =  1.
      A(N,IR(1)   ) = -1.
C DUCT/CORE JUNCTION (STA 363H-4)
```

```
      J      = 3
      K      = J+1
C MOMENTUM (STA 3-4)
      N      = IP(J)
      GO TO (32,32,33),NAUGUP
32    CONTINUE
      A(N,IP(J)   ) = -1.
      A(N,IP(K)   ) =  1.-DPH
      A(N,IV(J)   ) =  2.*DPH*BPR/(1. + BPR)
      A(N,IR(J)   ) =  DPH*BPR/(1. + BPR)
      A(N,IV3H    ) =  2.*DPH/(1. + BPR)
      A(N,IR3H    ) =  DPH/(1. + BPR)
      GO TO 34
33    CONTINUE
      A(N,IP(J)   ) = -1.
      A(N,IP(K)   ) =  1.-DPCS
      A(N,IV(J)   ) =  2.*DPCS
      A(N,IR(J)   ) =  DPCS
      A(N,IV3H    ) =  0.
      A(N,IR3H    ) =  0.
34    CONTINUE
C MOMENTUM (STA 3H-4)
      N      = IP3H
      GO TO (35,35,36),NAUGUP
35    CONTINUE
      A(N,IP3H    ) = -1.
      A(N,IP(K)   ) =  1.-DPH
      A(N,IV(J)   ) =  2.*DPH*BPR/(1. + BPR)
      A(N,IR(J)   ) =  DPH*BPR/(1. + BPR)
      A(N,IV3H    ) =  2.*DPH/(1. + BPR)
      A(N,IR3H    ) =  DPH/(1. + BPR)
      GO TO 37
36    CONTINUE
      A(N,IP3H    ) = -1.
      A(N,IP(K)   ) =  1.-DPHS
      A(N,IV(J)   ) =  0.
      A(N,IR(J)   ) =  0.
      A(N,IV3H    ) =  2.*DPHS
      A(N,IR3H    ) =  DPHS
37    CONTINUE
C CONTINUITY (STA 3 & 3H - 4)
      N      = IR(K)
      A(N,IR(K)   ) = -1.
      A(N,IV(K)   ) = -1.
      A(N,IR(J)   ) =  BPR/(1.+BPR)
      A(N,IV(J)   ) =  BPR/(1.+BPR)
      A(N,IR3H    ) =  1./(1.+BPR)
      A(N,IV3H    ) =  1./(1.+BPR)
C ENERGY (STA 3 & 3H - 4)
      N      = IV(K)
      A(N,IV(K) ) = -1.
      A(N,IP(K) ) = -1.
      A(N,IP(J) ) = BPR*(T(3)/TH)/(1.+BPR*(T(3)/TH))
```

```
      A(N,IV(J) ) = BPR*(T(3)/TH)/(1.+BPR*(T(3)/TH))
      A(N,IP3H  ) =              1./(1.+BPR*(T(3)/TH))
      A(N,IV3H  ) =              1./(1.+BPR*(T(3)/TH))
C CONSTANT TEMPERATURE AT TURBINE DISCHARGE (STA 2H)
      N       = IR2H
      A(N,IP2H  ) =  1.
      A(N,IR2H  ) = -1.
C BOUNDARY CONDITION AT NOZZLE (STA 11)
      J       = KCP1
      N       = IV(J)
      A(N,IV(J) ) = -1.
      A(N,IP(J) ) =  .5+KNOZ
      A(N,IR(J) ) = -.5
C OPEN LOOP INPUT (REFERENCED TO STA 4)
      N       = IQIN
      A(N,IQIN ) =  1.
      B(N)        =  1.
 30   CONTINUE
C11****************** FREQUENCY-DEPENDENT EQNS *******************
C FAN DUCT (STA 1-2)
      J       = 1
      K       = J+1
      EF      = CEXP(-TAUF(J)*S)
      EG      = CEXP(-TAUG(J)*S)
      EE      = CEXP(-TAUE(J)*S)
C DNSTREAM RUNNING SONIC WAVE (STA 1 - 2)
      N       = IP(K)
      A(N,IP(K)   ) = -1.
      A(N,IV(K)   ) = -(G(J)*M(J)+2.*DPD)/(1.+2.*DPD)
      A(N,IP(J)   ) =  EF
      A(N,IV(J)   ) =  EF*G(J)*M(J)
C UPSTREAM RUNNING SONIC WAVE (STA 1 - 2)
      N       = IV(J)
      A(N,IP(J)   ) = -1.
      A(N,IV(J)   ) =  G(J)*M(J)
      A(N,IP(K)   ) =  EG
      A(N,IV(K)   ) = -EG*(G(J)*M(J)-2.*DPD)/(1.+2.*DPD)
C DNSTREAM RUNNING ENTROPY WAVE (STA 1 - 2)
      N        = IR(K)
      A(N,IP(K)   ) = -1.
      A(N,IR(K)   ) =  G(J)
      A(N,IV(K)   ) =  (G(J)-1.)*2.*DPD/(1.+2.*DPD)
      A(N,IP(J)   ) =  EE
      A(N,IR(J)   ) = -EE* G(J)
C FAN DUCT (STA 2-3)
      J       = 2
      K       = J+1
      EF      = CEXP(-TAUF(J)*S)
      EG      = CEXP(-TAUG(J)*S)
      EE      = CEXP(-TAUE(J)*S)
C DNSTREAM RUNNING SONIC WAVE (STA 2 - 3)
      N       = IV(K)
      A(N,IP(K)   ) = -1.
```

```
      A(N,IV(K)   ) = -(G(J)*M(J)+2.*DPS)/(1.+2.*DPS)
      A(N,IP(J)   ) =  EF
      A(N,IV(J)   ) =  EF*G(J)*M(J)
C UPSTREAM RUNNING SONIC WAVE (STA 2 - 3)
      N        = IV(J)
      A(N,IP(J)   ) = -1.
      A(N,IV(J)   ) =  G(J)*M(J)
      A(N,IP(K)   ) =  EG
      A(N,IV(K)   ) = -EG*(G(J)*M(J)-2.*DPS)/(1.+2.*DPS)
C DNSTREAM RUNNING ENTROPY WAVE (STA 2 - 3)
      N          = IR(K)
      A(N,IP(K)   ) = -1.
      A(N,IR(K)   ) =  G(J)
      A(N,IV(K)   ) =  (G(J)-1.)*2.*DPS/(1.+2.*DPS)
      A(N,IP(J)   ) =  EE
      A(N,IR(J)   ) = -EE* G(J)
C CORE ENGINE TRANSFER FUNCTION (STA 1-2H)
      N        = IV2H
      A(N,IV2H   ) = -1.
      A(N,IR2H   ) = -1.
      A(N,IP( 1) ) =  0.
      IF(NFSUP .EQ. 2)
     XA(N,IP(1) ) =  1./(1.+TCORE*S)
C TURBINE DISCHARGE (STA 2H-3H)
      EF       = CEXP(-TAUFH*S)
      EG       = CEXP(-TAUGH*S)
      EE       = CEXP(-TAUEH*S)
C DNSTREAM RUNNING SONIC WAVE (STA 2H - 3H)
      N        = IV3H
      A(N,IP3H    ) = -1.
      A(N,IV3H    ) = -GH   *MH
      A(N,IP2H    ) =  EF
      A(N,IV2H    ) =  EF*GH   *MH
C UPSTREAM RUNNING SONIC WAVE (STA 2H - 3H)
      N        = IP2H
      A(N,IP2H    ) = -1.
      A(N,IV2H    ) =  GH   *MH
      A(N,IP3H    ) =  EG
      A(N,IV3H    ) = -EG*GH   *MH
C DNSTREAM RUNNING ENTROPY WAVE (STA 2H - 3H)
      N          = IR3H
      A(N,IP3H    ) = -1.
      A(N,IR3H    ) =  GH
      A(N,IP2H    ) =  EE
      A(N,IR2H    ) = -EE*GH
C IGNITION PLANE TO COMBUSTION ZONE (STA 4-5) - INCLUDE LENGTH
C FROM STA 3-4
      J        = 4
      K        = J+1
      EF       = CEXP(-(TAUF(J)+L(3)/C(J)/(1.+M(J)))*S)
      EG       = CEXP(-(TAUG(J)+L(3)/C(J)/(1.-M(J)))*S)
      EE       = CEXP(-(TAUE(J)+L(3)/C(J)/M(J))*S)
C DNSTREAM RUNNING SONIC WAVE (STA 4 - 5)
```

```
      N         = IP(K)
      A(N,IP(K)  ) = -1.
      A(N,IV(K)  ) = -G(J)*M(J)
      A(N,IP(J)  ) =  EF
      A(N,IV(J)  ) =  EF*G(J)*M(J)
C UPSTREAM RUNNING SONIC WAVE (STA 4 - 5)
      N         = IR(J)
      A(N,IP(J)  ) = -1.
      A(N,IV(J)  ) =  G(J)*M(J)
      A(N,IP(K)  ) =  EG
      A(N,IV(K)  ) = -EG*G(J)*M(J)
C DNSTREAM RUNNING ENTROPY WAVE (STA 4 - 5)
      N         = IR(K)
      A(N,IP(K)  ) = -1.
      A(N,IR(K)  ) =  G(J)
      A(N,IP(J)  ) =  EE
      A(N,IR(J)  ) = -EE* G(J)
C COMBUSTION ZONE (STA 5-10)
      DO 46 J=10,KCM1
      K         = J+1
      EF        = CEXP(-TAUF (J)*S)
      EF2       = CEXP(-TAUF2(J)*S)
      EG        = CEXP(-TAUG (J)*S)
      EG1       = CEXP(-TAUG1(J)*S)
      EE        = CEXP(-TAUE (J)*S)
      EE1       = CEXP(-TAUE1(J)*S)
      EE2       = CEXP(-TAUE2(J)*S)
      EQ        = CEXP(-TAUQ (J)*S)
C DOWNSTREAM RUNNING SONIC WAVE (STA 5-6,6-7,7-8,8-9,9-10)
      IF(AIMAG(S) .EQ. 0.) GO TO 50
      FJ        = (EF -EF2)/S
      FK        = (1. -EF2)/S
      FQ        = M(J)*(EF -EE1*EF2)/S + M(K)*(EF2*EE1-EE)/S
      GO TO 51
 50   FJ        = -TAUF1(J)
      FK        =  TAUF2(J)
      FQ        =  M(J)*(TAUE1(J)-TAUF1(J)) + M(K)*(TAUE2(J)-TAUF2(J))
 51   CONTINUE
      N         = IP(K)
      A(N,IP(J) ) = -(G(J)-1.)*QOP(J)*PF(J)*FJ-EF
      A(N,IV(J) ) = -(G(J)-1.)*QOP(J)*VF(J)*FJ-EF*G(J)*M(J)
      A(N,IR(J) ) = -(G(J)-1.)*QOP(J)*RF(J)*FJ
      A(N,IP(K) ) =  (G(J)-1.)*QOP(J)*PF(K)*FK+1.
      A(N,IV(K) ) =  (G(J)-1.)*QOP(J)*VF(K)*FK+G(J)*M(K)
      A(N,IR(K) ) =  (G(J)-1.)*QOP(J)*RF(K)*FK
      A(N,IQIN  ) = -(G(J)-1.)*QOP(J)     . *FQ*EQ
C UPSTREAM RUNNING SONIC WAVE (STA 5-6,6-7,7-8,8-9,9-10)
      IF(AIMAG(S) .EQ. 0.) GO TO 52
      FJ        = (1. -EG1)/S
      FK        = (EG -EG1)/S
      FQ        = M(J)*(1. -EG1*EE1)/S + M(K)*(EG1*EE1-EG*EE)/S
      GO TO 53
 52   FJ        =  TAUG1(J)
```

```
      FK       = -TAUG2(J)
      FQ       =  M(J)*(TAUG1(J)+TAUE1(J)) + M(K)*(TAUG2(J)+TAUE2(J))
 53   CONTINUE
      N        = IV(J)
      A(N,IP(J) ) =  (G(J)-1.)*QOP(J)*PG(J)*FJ+1.
      A(N,IV(J) ) =  (G(J)-1.)*QOP(J)*VG(J)*FJ-G(J)*M(J)
      A(N,IR(J) ) =  (G(J)-1.)*QOP(J)*RG(J)*FJ
      A(N,IP(K) ) = -(G(J)-1.)*QOP(J)*PG(K)*FK-EG
      A(N,IV(K) ) = -(G(J)-1.)*QOP(J)*VG(K)*FK+EG*G(J)*M(K)
      A(N,IR(K) ) = -(G(J)-1.)*QOP(J)*RG(K)*FK
      A(N,IQIN  ) = -(G(J)-1.)*QOP(J)       *FQ*EQ
C DOWNSTREAM RUNNING ENTROPY WAVE (STA 5-6,6-7,7-8,8-9,9-10)
      IF(AIMAG(S) .EQ. 0.) GO TO 54
      FJ       = (EE -EE2)/S
      FK       = (1. -EE2)/S
      FQ       = TAUE(J)*EE
      GO TO 55
 54   FJ       = -TAUE1(J)
      FK       =  TAUE2(J)
      FQ       =  TAUE (J)
 55   CONTINUE
      N        = IR(K)
      A(N,IP(J) ) = -(G(J)-1.)*QOP(J)*FJ-EE
      A(N,IV(J) ) = -(G(J)-1.)*QOP(J)*FJ
      A(N,IR(J) ) =                          EE*G(J)
      A(N,IP(K) ) =  (G(J)-1.)*QOP(J)*FK+1.
      A(N,IV(K) ) =  (G(J)-1.)*QOP(J)*FK
      A(N,IR(K) ) =                          -G(J)
      A(N,IQIN  ) = -(G(J)-1.)*QOP(J)*FQ*EQ
 46   CONTINUE
C COMBUSTION ZONE TO NOZZLE (STA 10-11)
      J        = KC
      K        = J+1
      EF       = CEXP(-TAUF(J)*S)
      EG       = CEXP(-TAUG(J)*S)
      EE       = CEXP(-TAUE(J)*S)
C DNSTREAM RUNNING SONIC WAVE (STA 10 - 11)
      N        = IP(K)
      A(N,IP(K)  ) = -1.
      A(N,IV(K)  ) = -G(J)*M(J)
      A(N,IP(J)  ) =  EF
      A(N,IV(J)  ) =  EF*G(J)*M(J)
C UPSTREAM RUNNING SONIC WAVE (STA 10 -11)
      N        = IV(J)
      A(N,IP(J)  ) = -1.
      A(N,IV(J)  ) =  G(J)*M(J)
      A(N,IP(K)  ) =  EG
      A(N,IV(K)  ) = -EG*G(J)*M(J)
C DNSTREAM RUNNING ENTROPY WAVE (STA 10 - 11)
      N        = IR(K)
      A(N,IP(K)  ) = -1.
      A(N,IR(K)  ) =  G(J)
      A(N,IP(J)  ) =  EE
```

```
      A(N,IR(J)   ) = -EE*G(J)
C FAN STREAM MASS FLOWRATE (STA 3)
      N        = IW3
      A(N,IW3    ) = -1.
      A(N,IV(3) ) =  1.
      A(N,IR(3) ) =  1.
C CORE STREAM MASS FLOWRATE (STA 3H)
      N        = IW3H
      A(N,IW3H  ) = -1.
      A(N,IV3H  ) =  1.
      A(N,IR3H  ) =  1.
C OPEN LOOP OUTPUT (REFERENCED TO STA 4)
      GO TO (63,64,65),NAUGOP
 63   CONTINUE
C12************************** VEEGUTTER ******************************
      N        = IQOUT
      EDC      = CEXP(-TAUDC*S)
      A(N,IQOUT ) = -1.
      A(N,IW3    ) =  QCOT*(1.-(ZTFC+ZEFC)*EDC)
      A(N,IV(3) ) =  QCOT*ZEVC
      A(N,IP(3) ) =  QCOT*(ZEPC+ZETC)
      A(N,IR(3) ) = -QCOT*ZETC
      EDH      = CEXP(-TAUDH*S)
      A(N,IW3H  ) =  QHOT*(1.-(ZTFH+ZEFH)*EDH)
      A(N,IV3H  ) =  QHOT*ZEVH
      A(N,IP3H  ) =  QHOT*(ZEPH+ZETH)
      A(N,IR3H  ) = -QHOT*ZETH
      A(N,IP(4) ) =  0.
      GO TO 66
 64   CONTINUE
C13****************************** VORBIX ********************************
      N        = IQOUT
      A(N,IQOUT ) = -1.
      A(N,IW3    ) =  (1.-ZTF-ZEF)*BPR/(1.+BPR)-ZEFP*BPR/(1.+BPR)
      A(N,IW3H  ) =  (1.-ZTF-ZEF)/(1.+BPR)-ZEFP/(1.+BPR)
      A(N,IP(4) ) =  ZEP
      A(N,IP(3) ) =  0.
      A(N,IV(3) ) =  0.
      A(N,IR(3) ) =  0.
      A(N,IP3H  ) =  0.
      A(N,IV3H  ) =  0.
      A(N,IR3H  ) =  0.
      GO TO 66
 65   CONTINUE
C14****************************** SWIRL *******************************
      N        = IQOUT
      A(N,IQOUT ) = -1.
      A(N,IW3    ) =  (1.-ZTF-ZEF)*BPR/(1.+BPR)-ZEFP
      A(N,IW3H  ) =  (1.-ZTF-ZEF)/(1.+BPR)
      A(N,IP(4) ) =  ZEP
      A(N,IP(3) ) =  0.
      A(N,IV(3) ) =  0.
      A(N,IR(3) ) =  0.
```

```
      A(N,IP3H  ) =  0.
      A(N,IV3H  ) =  0.
      A(N,IR3H  ) =  0.
 66   CONTINUE
      IFIRST = 1
      RETURN
      END
```

```
C         DATA SET B28DMAIN   AT LEVEL 001 AS OF 12/07/78  E33
C         DATA SET B28DSOURCE AT LEVEL 001 AS OF 04/05/78
C         DATA SET B28DCMBAUG AT LEVEL 007 AS OF 03/17/78
      COMMON /PLOG/ TITLE, STITLE, NAME1, NAME2, KI
      COMMON /FHOUT/ FETAC, FETAH, FFAC, FFAH, FLB, FLI, FLK, FLSC,
     * FLSH, FT6C, FT6H, FZEFC, FZEFH, FZEPC, FZEPH, FZETC, FZETH,
     * FZEVC, FZEVH
      COMMON /AUGIN/ JFUEL, NAUGOP, NCOMOP, NFSOP, NPRNTK, NPRNTF
      COMMON / HCAMIN/ ALPHAC(100), ALPHAH(100), FAC1(100), FAH1(100),
     * FHWC(100), FHWH(100), LSC1(100), LSH1(100), NSC(100), NSH(100),
     * PFSR(100), TAUC(100), TAUH1(100), TEXT1(100), TFSR1(100),
     * T6C1(100), T6H1(100), WEXT(100), XLC(100), XLH(100), NTC, NTH
      COMMON /RMBLIN/ BPR, DPCS, DPD, DPH, DPHS, DPS, EPSC, EPSH, ETA,
     * ETAC1,ETAH1,FA,FAV,LA,LB,LC1,LH1,LI1,LK1,LZ,M6C,M6H,M6R,
     * PRNOZ,PS6,T3H1,ZEF,ZEFC1,ZEFH1,ZEFP,ZEP,ZEPC1,ZEPH1,ZETC1,
     * ZETH1,ZEVC1,ZEVH1,TCORE,WCOOL
      COMMON/SV/SAVTE(2), SAVTA(2), SAVDT(2), SAVFAR(2), SAVDT1(2),
     X      SAVETA(2), SAVMDA(2), SAVMDF(2), ZCV(2), ZCP(2), ZCT(2),
     X      ZCFA(2), SAVVA(2),TEXAVG,ETAAVG,XMDTAD,FARAVG,TAAVG,XMDTFD,
     X      TEXT1(100), STMDTA(100), STMDTF(100), STTA(100), STVA(100),
     X      FARWK(100),ETAS(100),DTFIDL(100),ATR(100),ETAAVP,SAVLI(2),
     X      SAVLK(2),SAVXLS(2),SLI(100),SLK(100),SLS(100),SVFAC(100),
     X      FACAVG,TEXAVS,IWTI(100),SLB(100),SAVXLB(2),IZ(2)
      REAL LA, LB, LC, LH, LI, LK, LZ, M6C, M6H, M6R, LSC, LSH,
     * NAME1, NAME2,LI1,LK1,LSC1,LSH1,LC1,LH1
      NAMELIST /INPUT/ ALPHAC, ALPHAH, BPR, DPCS, DPD, DPH,
     * DPHS, DPS, EPSC, EPSH, ETA, ETAC, ETAH, FA, FAC, FAH,
     * FAV, FHWC, FHWH, JFUEL, LA, LB, LC, LH, LI, LK,
     * LSC, LSH, LZ, M6C, M6H, M6R, NAUGOP, NCOMOP, NFSOP,
     * NPRNTF, NPRNTK, NSC, NSH, NTC, NTH, PFSR, PRNOZ, PS6,
     * TAUC, TAUH,TCORE, TEXT, TFSR, T3H, T6C,
     * T6H, WCOOL, WEXT, ZEF, ZEFC, ZEFH, ZEFP, ZEP, ZEPC, ZEPH,
     * ZETC, ZETH, ZEVC, ZEVH, XLC, XLH, STOP
      DIMENSION TITLE(20), STITLE(19), GIV1(2002), GIV2(39),
     * NAME1(20,3), NAME2(20,3),TEXT(100), TFSR(100), T6C(100),T6H(100),
     * FAC(100),FAH(100),LSC(100),LSH(100), TAUH(100)
      NAMELIST /COMBIN/ ALPHAC, ALPHAH, BPR, DPD, DPH,
     * DPS, EPSC, EPSH,  FAC, FAH,
     * FAV, FHWC, FHWH, JFUEL, LA, LC, LH,
     * LSC, LSH, LZ, M6C, M6H, M6R, NAUGOP, NCOMOP, NFSOP,
     * NPRNTF, NPRNTK, NSC, NSH, NTC, NTH, PFSR, PRNOZ, PS6,
     * TAUC, TAUH, TCORE, TEXT, TFSR, T3H, T6C,
     * T6H, WCOOL, WEXT, XLC, XLH
      NAMELIST/VEEOUT/BPR,DPD,DPH,DPS,ETAC,ETAH,
     X FAC,FAH,FAV,JFUEL,LA,LB,LC,LH,LI,LK,LSC,LSH,
     X LZ,M6C,M6H,M6R,NAUGOP,NCOMOP,NFSOP,NPRNTK,
     X PRNOZ,PS6,TCORE, T6C,T6H,ZEFC,ZEFH,ZEPC,
     X                 ZEPH,ZETC,ZETH,ZEVC,ZEVH
      NAMELIST/VORBIX/BPR,DPD,DPH,DPS,ETA,FA,
     X                 FAV,JFUEL,LA,LB,LC,LH,LI,LK,
     X LZ,M6C,M6H,M6R,NAUGOP,NCOMOP,NFSOP,NPRNTK,
     X PRNOZ,TCORE, PS6,T6C,T6H,ZEF,ZEFP,ZEP
      NAMELIST/SWIRL /BPR,DPCS,DPD,DPHS,DPS,ETA,FA,
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     X                   FAV,JFUEL,LA,LB,LC,LH,LI,LK,
     X L2,M6C,M6H,M6R,NAUGOP,NCOMOP,NFSOP,NPRNTR,
     X PRNOZ,PS6,TCORE,T6C,T6H,ZEF,ZEFP,ZEP
       NAMELIST /FLAME/ ALPHAC, ALPHAH, BPR,
     *  EPSC, EPSH,  FAC, FAH,
     * FAV, FHWC, FHWH, JFUEL,
     * LSC, LSH, M6C, M6H, NCOMOP,
     * NPRNTF,  NSC, NSH, NTC, NTH, PFSR,  PS6,
     * TAUC, TAUH, TEXT, TFSR, T3H, T6C,
     * T6H, WCOOL, WEXT, XLC, XLH
       EQUIVALENCE (GIV1(1), ALPHAC(1)), (GIV2(1), BPR)
       DO 5 I = 1, 2002
       GIV1(I) = 0.
       IF (I.GT.39) GO TO 5
       GIV2(I) = 0.
     5 CONTINUE
       DO 6 I = 1, 100
       TEXT(I) = 0.
       TFSR(I) = 0.
       T6C(I) = 0.
       T6H(I) = 0.
     6 CONTINUE
       STOP = 0.
       JFUEL = 1
       NAUGOP = 1
       NCOMOP = 2
       NFSOP = 1
       NPRNTR = 0
       NPRNTF = 1
       TCORE = .005
       WCOOL = .0
       BPR = .59
       DPCS = 0.
       DPD =  .064
       DPH =  .032
       DPHS = 0.
       DPS =  0.
       EPSC = .04
       EPSH = .04
       ETA =  0.
       ETAC = .4
       ETAH = .91
       FA = 0.
       FAV = .021
       LA =  82.
       LB =  86.
       LC =  72.
       LH =  14.
       LI =  5.
       LK =  60.
       L2 =  36.
       M6C = .15
       M6H = .26
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      M6R = .22
      PRNOZ = 4.4
      ZEF = 0.
      ZEFC = -5.5
      ZEFH = .4
      ZEFP = 0.
      ZEP = 0.
      ZEPC = 0.
      ZEPH = 0.
      ZETC = 0.
      ZETH = 0.
      ZEVC = 0.
      ZEVH = 0.
      NTC = 1
      NTH = 1
      PS6 = 7.92
      T3H = 1355.
      ALPHAC(1) = 60.
      FAC(1) = .05950
      FHWC(1) = 1.06
      LSC(1) = 4.0
      NSC(1) = 1
      PFSR(1) = 134.7
      TFSR(1) = 560.
      TAUC(1) = .256
      TEXT(1) = 0.
      WEXT(1) = 0.
      T6C(1) = 700.
      XLC(1) = 66.
      ALPHAH(1) = 60.
      FAH(1) = .040
      FHWH(1) = .75
      LSH(1) = 6.0
      NSH(1) = 1
      TAUH(1) = .186
      T6H(1) = 1775.
      XLH(1) = 66.
   10 READ (5,20) K1, STITLE
      IZ(1) = 0
      IZ(2) = 0
   20 FORMAT (I1,19A4)
      READ (5,INPUT)
      DO 35 M = 1, 100
      TEXT1(M) =  TEXT(M)
      T6C1(M) = T6C(M)
      T6H1(M) = T6H(M)
      TAUH1(M) =  TAUH(M)
      TFSR1(M) =TFSR(M)
      LSC1(M) = LSC(M)
      LSH1(M) = LSH(M)
      FAC1(M) = FAC(M)
      FAC1(M) = FAC(M)
   35 FAH1(M) = FAH(M)
```

```
      T3HI = T3H
      ZEFCI = ZEFC
      ZEFHI = ZEFH
      ZEPCI = ZEPC
      ZEPHI = ZEPH
      ZETCI = ZETC
      ZETHI = ZETH
      ZEVCI = ZEVC
      ZEVHI = ZEVH
      LII = LI
      LKI = LK
      LCI = LC
      LHI = LH
      ETACI = ETAC
      ETAHI = ETAH
      IF (STOP.GT.0.) GO TO 100
      CALL CHECK
      WRITE (6, 1012)
1012  FORMAT (1H1,21HNAMELIST INPUT VALUES)
     IF(NCOMOP.EQ.2.AND.NAUGOP.EQ.1) WRITE (6,COMBIN)
     IF(NCOMOP.EQ.1.AND.NAUGOP.EQ.1) WRITE (6,VEEGUT)
     IF(NCOMOP.EQ.1.AND.NAUGOP.EQ.2) WRITE (6,VORBIX)
     IF(NCOMOP.EQ.1.AND.NAUGOP.EQ.3) WRITE (6,SWIRL )
     IF(NCOMOP.EQ.3) WRITE (6,FLAME )
      WRITE (6,1000)
1000  FORMAT(///25X,'THIS PROGRAM CHECKS SPECIFIC INPUTS TO ENSURE REASO
     *NABLE INPUT DATA.',//,25X,'IF THESE CHECKS ARE NOT SATISFIED THE
     *JOB WILL BE TERMINATED.',//,25X,'VIOLATIONS, IF ANY, WILL BE PRINT
     *ED BELOW-',///)
      CALL ERROR(1,STOP)
      CALL ERROR(2,STOP)
      DO 30 M = 1, 100
      TEXTI(M) = AMAX1 ( 0., TEXT(M) - 460.)
      IF (NCOMOP.EQ.2.OR.NCOMOP.EQ.3)
     * T6CI(M) = AMAX1 ( 0., T6C(M) - 460.)
      IF (NCOMOP.EQ.2.OR.NCOMOP.EQ.3)
     * T6HI(M) = AMAX1 (0., T6H(M) - 460.)
      TFSKI(M) = AMAX1 ( 0., TFSK(M) - 460.)
      LSCI(M) = LSC(M)
      LSHI(M) = LSH(M)
      FACI(M) = FAC(M)
   30 FAHI(M) = FAH(M)
      T3HI = T3H - 460.
      IF (NCOMOP.GE.2) CALL FHCOMB
      IF (NCOMOP.EQ.2) CALL ERROR(3,STOP)
      IF (NCOMOP.LT.3) CALL RUMBLE
      GO TO 10
  100 CALL PLOT (0.,0.,999)
      STOP
      END
```

```
C         DATA SET B28DPLOTG  AT LEVEL 001 AS OF 12/07/78  E33
C         DATA SET B28DPLOTG  AT LEVEL 021 AS OF 02/13/78
      SUBROUTINE PLOTG(X,Y1,Y2,NPTS,FREQUP,FRQFAC,PHASUP,AMPUP,AMPFAC,
     1     IG,YMEN,YMACKS, INORM )
      REAL NAME1, NAME2, N1, N2
      COMMON/PLOG/ TITLE,STITLE, NAME1, NAME2
      DIMENSION NAME1(20,3), NAME2(20,3)
      DIMENSION N1(3), N2(3)
      DIMENSION X(1),Y1(1),Y2(1)
      DIMENSION FTITL(4), PHT  (4), AMPT(4), XFVAL(4), YAMP(4),
     1          XINC(10)
      DIMENSION TITLE(20), STITLE(19)
      DIMENSION IBUF(1000)
      DIMENSION TEST(4)
      DIMENSION YAMP2(4), AMPT2(4)
      DIMENSION YAPT(4)
      DIMENSION  YAPL(4), OUT(3)
      DATA  FTITL/'FREQ','UENC','Y-HE','RTZ '/
      DATA  PHT  /'PHAS','E-DE','G   ','    '/
      DATA  AMPT /'LOG ','GAIN', '    ', '    '/
      DATA YAMP /-1.0,0.,1.0,2.0/
      DATA YAMP2/0.,1.,2.,3./
      DATA AMPT2/4H    ,4HGAIN, 4H    ,4H    /
      DATA  XFVAL/.1,1.,10.,100./, IFIRST / 0 /
      DATA FOMAT / '    ' /
C     .3937 CONVERSION CENTIMETER TO INCHES
      CONV = .3937
      TWOCO = 1.5* CONV
      IF (IFIRST.GT.0) GO TO 5
      CALL PLOTS(IBUF,1000)
      CALL PLOT ( .6, .75, -3 )
    5 IFIRST = 1
      XLTH  = 15. * CONV
      CYCLEX=(15.* CONV) / 3.
      CYCLY1=(8.* CONV) / 3.
      CYCLY2= ( 12. * CONV ) / 3.0
      YPMIN = -360.
      DELYP = 90.
      J = 0
      OLDVAL = 0.
      DO 10 I  = 2, 10
      ZI = I
      VAL = ALOG10(ZI) * CYCLEX
      J = J + 1
      XINC(J) = VAL - OLDVAL
      OLDVAL = VAL
   10 CONTINUE
      FXS = 0.
      FYS = 0.
      YD = 8. * CONV
      YE = YD + 2 * CONV
      YETH = YE + 12. * CONV
      IF (FREQUP .EQ. 0) GO TO 19
```

```
C  PLOT GRID LINES ON X AXIS (FREQOP=1)
      DO 18 I = 1,11
      CALL PLOT(FXS,FYS,3)
      CALL PLOT(FXS,YD,2)
      CALL PLOT(FXS,YE,3)
      CALL PLOT(FXS,YLTH,2)
      FXS = FXS + TWOCD
   18 CONTINUE
      GO TO 22
   19 CONTINUE
C  PLOT LOG GRID LINES ON X AXIS
      DO 20 N = 1, 3
      JN = 10
      DO 15 NN = 1, 9
      CALL PLOT(FXS,FYS,3)
      CALL PLOT(FXS,YD,2)
      CALL PLOT(FXS,YE,3)
      CALL PLOT(FXS,YLTH,2)
      IF (NN .EQ. 9) GO TO 15
      FXS = XINC(NN) + FXS
   15 CONTINUE
      FXS = N * CYCLEX
   20 CONTINUE
      CALL PLOT(FXS,FYS,3)
      CALL PLOT(FXS,YD,2)
      CALL PLOT(FXS,YE,3)
      CALL PLOT(FXS,YLTH,2)
   22 CONTINUE
C  PLOT Y1 AXIS, GRIDS, LABELS
      YNCX= 2. * CONV
      XX = XLTH
      CINC = 0.0
      IF (PHASOP .EQ. 1. ) YPMIN = -180.
      YVAL = YPMIN
      DO 35 N = 1,5
      CALL PLOT(0.0, CINC, 3 )
      CALL PLOT(XX, CINC, 2 )
      CALL NUMBER(-.5,CINC-.05,.07,YVAL,0.0,0)
      CINC = CINC + YNCX
      YVAL = YVAL + 90.
   35 CONTINUE
      CALL SYMBOL(-.70,1. ,.14,PHI,90.,16)
      Y1MIN = -360.
      Y1MAX = 0.
      IF (PHASOP .EQ. 0.) GO TO 50
      Y1MIN = -180.
      Y1MAX = 180.
   50 DELY1 = ABS(Y1MIN - Y1MAX)
      AYY = 10.0 * CONV
C  PLOT GRID LINES ON Y2 AXIS
      DO 28 I=1,4
      CALL PLOT(0., AYY,3)
      CALL PLOT(XLTH, AYY, 2 )
```

```
   28 AYY = AYY + CYCLY2
C     PLOT LABELS ON FREQUENCY AXIS , X AXIS
      IF (FRQFAC .EQ. 0.) FRQFAC = 1.
      IF (FREQOP .EQ. 0.) GO TO 29
      XMIN = 0.
      XMAX = 100. * FRQFAC
      IF (YMACKS .EQ. 0) GO TO 288
      XMAX = YMACKS
      XMIN = YMEN
  288 CONTINUE
      DELX = XMAX - XMIN
      XM = 0.0
      XXINC = ABS(DELX / 10. )
      FX = -.20
      DO 27 I = 1, 11
      CALL NUMBER (FX,-.2,.07,XM,0.0,1)
      XM = XM + XXINC
      FX = FX + TWOCO
   27 CONTINUE
      GO TO 31
   29 ADD = .5
      XA = ALOG10(FRQFAC)
      IF (XA .LT. 0) ADD = -.5
      NFAC = XA + ADD
      XF = -.20
      XFAC = 10. ** NFAC
      XMAX = 100. * XFAC
      XMIN = .1 * XFAC
      DELX = ALOG10(XMAX)  -ALOG10(XMIN)
      DO 30 I = 1, 4
      XVLU =   XFVAL(I) * XFAC
      CALL NUMBER(XF,-.2,.07,XVLU,0.0,2)
   30 XF  = XF + CYCLEX
   31 CONTINUE
      CALL SYMBOL( 2.0, -.42,.14,FTITL,0.0,16)
      IF (AMPFAC .EQ. 0.) AMPFAC = 1.
C     AMPOP = 1. SETUP UP AXIS LABELS
      IF (AMPOP .EQ. 0. ) GO TO 320
      DO 315 I = 1,4
      YAPL(I) = YAMP2(I) * AMPFAC
  315 YAPT(I) = AMPT2(I)
      Y2MIN = 0.
      Y2MAX = 3.0 * AMPFAC
      DELY2 = ABS(Y2MIN - Y2MAX)
      ATERM = 0.
      GO TO 322
C     AMPOP = 0. SET UP AXIS LABELS
  320 ADD = .5
      A = ALOG10(AMPFAC)
      IF (A .LT. 0 ) ADD = -.5
      ATERM = IFIX(A+ADD)
      Y2MIN = -1.0 + ATERM
      Y2MAX = 2.0 + ATERM
```

```
      DELY2 = ABS(Y2MIN - Y2MAX)
      DO 321 I  = 1,4
      YAPL(I) = YAMP(I) + ATERM
  321 YAPT(I) = AMPT(I)
  322 CONTINUE
      FY = 10. * CONV - .05
      DO 32 I = 1,4
      CALL NUMBER(-.50,FY,.07,YAPL(I),0.0,3)
   32 FY  = FY + CYCLY2
      FY = 10. * CONV
      CALL SYMBOL(-.70,FY+.5,.14, YAPT,90.,6 )
      YNORM = 1.0
      IF ( INORM .EQ. 0 ) GO TO 340
      FREMIN = X(1)
      YNORM = Y2(1)
      DO 330 I=2,NPTS
      IF ( X(I) .GT. FREMIN ) GO TO 330
      FREMIN = X(I)
      YNORM = Y2(I)
  330 CONTINUE
      IF ( YNORM .EQ. 0.0 ) YNORM = 1.0
      CALL SYMBOL( -.70, FY+1.82, .14, 10HNORM PT = ,90.0, 10 )
      OUT(1) = FOMAT
      OUT(2) = FOMAT
      OUT(3) = FOMAT
C     CALL FLPBCD ( YNORM, 11, 4, OUT, FOMAT )
      CALL SYMBOL ( -.7,FY+3.22,.14, OUT,90.0, 11 )
  340 CONTINUE
      CALL SYMBOL(-.7,9.1,.07,STITLE,0.,76)
      DO 34 I = 1,3
      N1(I) = NAME1(IG,I)
   34 N2(I) = NAME2(IG,I)
      CALL SYMBOL (-.7,9.0,.07,N1,0.0,10)
      CALL SYMBOL(-.7,8.9,.07,N2,0.0,10)
C     PLOT POINTS ON PHASE ANGLE VS FREQ PLOT
      SCALX = 15. * CONV
      SCALY1 = 8. * CONV
      SCALY2 = 12. * CONV
      DO 100 I = 1, NPTS
      Y1NEW = (Y1(I) - Y1MIN) * (SCALY1 / DELY1)
      IF (FREQOP .EQ. 0.) GO TO 90
      XNEW = (X(I) - XMIN) * (SCALX / DELX)
      GO TO 95
   90 CONTINUE
      XNEW = (ALOG10(X(I)+.001) - ALOG10(XMIN+.001)) * (SCALX/DELX)
   95 CONTINUE
      IF ( XNEW .LT. 0. .OR. XNEW .GT. SCALX) GO TO 100
      CALL SYMBOL(XNEW,Y1NEW,.025,0,0.0,-1)
  100 CONTINUE
      Y = 10.* CONV
      CALL PLOT (0.0, Y,+3)
C     PLOT POINTS ON AMPLITUDE VS FREQ PLOT
      IF ( AMPOP .EQ. 0. ) YNORM = ALOG10(YNORM)
```

```
      DO 110 I = 1, NPTS
      IF (AMPOP .EQ. 0.) GO TO 105
      Y2NEW = (Y2(I)/YNORM - Y2MIN) * (SCALY2 / DELY2 )
      GO TO 97
  105 CONTINUE
      Y2NEW = -1.0
      IF ( Y2(I) .EQ. 0.0 )  GO TO 97
      Y2(I) = ALOG10(Y2(I) ) - YNORM
      Y2NEW = (Y2(I) - Y2MIN) * (SCALY2 / DELY2)
   97 IF (FREQOP .EQ. 0.) GO TO 98
      XNEW = (X(I) - XMIN) * (SCALX/DELX)
      GO TO 99
   98 CONTINUE
      XNEW = (ALOG10(X(I)+.001) - ALOG10(XMIN+.001)) * (SCALX/DELX)
   99 CONTINUE
      IF (Y2NEW .LT. 0.) Y2NEW = -.1
      IF (Y2NEW .GT. SCALY2) Y2NEW=SCALY2 + .1
      IF (XNEW .LT. 0. .OR. XNEW .GT. SCALX) GO TO 110
      Y2NEW = Y2NEW + Y
      CALL SYMBOL(XNEW,Y2NEW,.025,0,0.0,-1)
  110 CONTINUE
      CALL PLOT(9.,0.,-3)
  200 RETURN
      END
```

```
C          DATA SET B28DPRNTR  AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET B28DPRNTR  AT LEVEL 019 AS OF 01/30/78
      SUBROUTINE PRNTR (SYM1,SYM2,SYM3,ICYM1,ICYM2,AMP,X1,CO,COMAX,MQ)
      COMMON /AUGIN/ JFUEL, NAUGOP, NCOMOP, NFSUP, NPRNTR, NPRNTF
      DIMENSION SYM1(1), SYM2(1), SYM3(1), VOUT1(4,8), VOUT2(4,8),
     * ICYM1(1), ICYM2(1)
      DATA I, J / 1, 1 /
      IF (NPRNTR.GT.0) RETURN
      MQP1 = MQ + 1
      VOUT1(I,J) = AMP
      VOUT2(I,J) = X1
      J = J + 1
      IF (J.GE.MQP1) I = I + 1
      IF (CO.GE.COMAX .AND. J.GE.MQP1) GO TO 10
      IF (J.GE.MQP1) J = 1
      IF (I.LE.4) RETURN
   10 DO 50 K = 1,3
      IRM = ICYM1(K)
      IRM2 = ICYM2(K)
   50 WRITE (6,1000) (SYM1(IRM), SYM2(IRM), SYM3(IRM),
     * SYM1(IRM2), SYM2(IRM2), SYM3(IRM2),
     * (VOUT1(N,K), VOUT2(N,K),N=1,4))
 1000 FORMAT (1X,A4,A1,2X,A2,'/',A4,A1,1X,A2,8G13.6)
      I = 1
      J = 1
      DO 100 II = 1,4
      DO 100 JJ = 1,MQ
      VOUT1(II,JJ) = 0.
  100 VOUT2(II,JJ) = 0.
      RETURN
      END
```

```
C          DATA SET B28DPRNTSV AT LEVEL 001 AS OF 12/07/78   E33
C          DATA SET B28DPRNTSV AT LEVEL 022 AS OF 03/20/78
C          DATA SET B28DPRNTSV AT LEVEL 018 AS OF 01/30/78
      SUBROUTINE PRNTSV (SYM1,SYM2,SYM3,AMP,X1,CO,COMAX)
      COMMON /AUGIN/ JFUEL, NAUGOP, NCOMOP, NFSOP, NPRNTR, NPRNTF
      COMMON /PLOG/ TITLE, STITLE, NAME1, NAME2, K1
      DIMENSION NAME1(20,3), NAME2(20,3), STITLE(19), TITLE(20),
     * SYM1(1), SYM2(1), SYM3(1), VOUT1(4,43), VOUT2(4,43), COP(4)
      DATA I, J / 1, 1 /, COP / 4*0. /
      IF (NPRNTR.GT.0) RETURN
      VOUT1(I,J) = AMP
      VOUT2(I,J) = X1
      IF (J.EQ.1) COP(I) = CO
      J = J + 1
      IF (J.GE.44) I = I + 1
      IF (CO.GE.COMAX .AND.J.GE.44) GO TO 10
      IF (J.GE.44) J = 1
      IF (I.LE.4) RETURN
   10 IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.1) WRITE (6,1010)
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.2) WRITE (6,1011)
      IF (NAUGOP.EQ.2.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.1) WRITE (6,1012)
      IF (NAUGOP.EQ.2.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.2) WRITE (6,1013)
      IF (NAUGOP.EQ.3.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.1) WRITE (6,1014)
      IF (NAUGOP.EQ.3.AND.NCOMOP.EQ.1.AND.NFSOP.EQ.2) WRITE (6,1015)
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.2.AND.NFSOP.EQ.1) WRITE (6,1016)
      IF (NAUGOP.EQ.1.AND.NCOMOP.EQ.2.AND.NFSOP.EQ.2) WRITE (6,1017)
      WRITE (6,1001) K1, STITLE, (COP(L),L=1,4)
      DO 50 K = 1,43
   50 WRITE (6,1000) (SYM1(K), SYM2(K), SYM3(K),
     * (VOUT1(N,K), VOUT2(N,K),N=1,4))
 1000 FORMAT (1X,2A4,2X,A2,6X,8G13.6)
 1001 FORMAT (1X,'RUMBLE',/,1X,11,19A4,/,20X,'FREQUENCY =',F6.2,
     * ' HERTZ',3X,'FREQUENCY =',F6.2,' HERTZ',3X,'FREQUENCY =',
     * F6.2,' HERTZ',3X,'FREQUENCY =',F6.2,' HERTZ',/,
     * 1X,'PARAMTER ID NO.',7X,'GAIN',5X,'PHASE ANGLE',6X,'GAIN',5X,
     * 'PHASE ANGLE',6X,'GAIN',5X,'PHASE ANGLE',6X,'GAIN',5X,
     * 'PHASE ANGLE')
      I = 1
      J = 1
      DO 100 II = 1,4
      DO 100 JJ = 1,43
      VOUT1(II,JJ) = 0.
  100 VOUT2(II,JJ) = 0.
      DO 110 KK = 1,4
  110 COP(KK) = 0.
 1010 FORMAT (1H1,'RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND
     * PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1011 FORMAT (1H1,'RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND
     * REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1012 FORMAT (1H1,'RUMBLE MODEL WITH VORBIX AUGMENTOR AND PROXIMATE FLOW
     * SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
 1013 FORMAT (1H1,'RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SP
     *LITTER USING EMPIRICAL COMBUSTION DATA',//)
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1014 FORMAT (1H1,'RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW
     * SPLITTER USING EMPIRICAL COMBUSTION DATA',//)
1015 FORMAT (1H1,'RUMBLE MODEL WITH SWIRL AUGMENTOR AND REMOTE FLOW SPL
     *ITTER USING EMPIRICAL COMBUSTION DATA',//)
1016 FORMAT (1H1,'RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND
     * PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUS
     *TION DATA',//)
1017 FORMAT (1H1,'RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND
     * REMOTE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTIO
     *N DATA',//)
      RETURN
      END
```

```
C           DATA SET B28UPSIC   AT LEVEL 001 AS OF 12/07/78  E33
      FUNCTION PSIC(ETAW,DTFI,TF,TA,PHI)
      DTF = DTFI * ETAW
      TF = TA + DTF
      IF (PHI - 1.)20,20,30
   20 PSIC = 430.*1.67E+10*EXP(-21150./TF)/TF**1.3*((2.*PHI*(1.-ETAW))
     X**.8)*(1.-PHI*ETAW)/(PHI*ETAW*(4.76+PHI*(1.36-ETAW))**1.8)
      RETURN
   30 PSIC = 430.*1.11E+11*EXP(-21150./TF)/TF**1.3*(.08*PHI)**.8/ETAW*
     X((1.-ETAW)/(4.76-ETAW + .08*PHI*(1.+1.6*ETAW)))**1.8
      RETURN
      END
```

```
C           DATA SET B28DPVAL    AT LEVEL 001 AS OF 12/07/78  E33
C           DATA SET C75CPVAL    AT LEVEL 001 AS OF 07/13/76
      FUNCTION PVAL (COF, X, Y, IT, IE)
C PVAL   POLYNOMIAL EVALUATION PROGRAM                          DECK 5914
C          SAME AS PEVAL EXCEPT THIS PROGRAM IS A FUNCTION SUBPROGRAM
C     COF IS THE COEFFICIENT ARRAY, WHERE COF(1+2) IS THE CURVE
C          IDENTIFICATION AND COF(3-N) ARE THE LIMITS,DEGREE, AND
C          COEFFICIENTS FOR EACH SECTION.
C      X   IS AN INDEPENDENT VARIABLE
C      Y   IS AN INDEPENDENT VARIABLE (BIVARIATE)
C      Z   IS THE DEPENDENT VARIABLE
C      IT  IS TYPE CURVE INDICATOR
C      IE  IS THE ERROR SIGNAL. =1.  X IS LESS THAN X MIN.
C                               =2.  X IS GREATER THAN X MAX.
C                               =3.  Y IS LESS THAN Y MIN.
C                               =4.  Y IS GREATER THAN Y MAX.
C                               =5.  Y IS LESS THAN Y MIN AND E =1.
C                               =6.  Y IS LESS THAN Y MIN AND E =2.
C                               =7.  Y IS GREATER THAN Y MAX AND E = 1.
C                               =8.  Y IS GREATER THAN Y MAX AND E = 2.
C          IF ANY LIMIT(S) IS EXCEEDED, Z WILL BE CALCULATED AT THE LIMIT
      DIMENSION COF(10)
      X1 = X
      IE = 0
C     TEST IF X IS LESS THAN X MIN.
      IF (X1.LT.COF(3)) GO TO 5
C     TEST IF X IS GREATER THAN X MAX.
      IF (X1.LE.COF(4)) GO TO 20
C     SET X EQUAL TO THE LIMIT EXCEEDED.
      X1 = COF(4)
      IE = 1
      GO TO 10
    5 X1 = COF(3)
C     SET ERROR SIGNAL,IE.
   10 IE = IE + 1
C     TEST IF UNIVARIATE OR BIVARIATE.
   20 IF (IT.EQ.2) GO TO 100
C     UNIVARIATE
      N =5
C     TEST IF X IS LESS THAN X MAX OF SECTION.
   30 XN =N
      IF (X1.LE.COF(N))  GO TO 40
C     RESET INDEX TO COMPARE X MAX OF NEXT SECTION.
      N = XN + COF(N+1)+ 5.1
      GO TO 30
C     CALCULATE XBAR = ALPHA*X + BETA
   40 XBAR =X1 * COF(N+2) + COF(N+3)
C     CALCULATE Z =  A0 + XBAR(A1 + XBAR(A2 + XBAR(A3 + ....)
      Z = COF(N+4)
      I1= N+5
      I2= XN + 4.1+ COF(N+1)
      DO  50  I = I1, I2
   50 Z = Z * XBAR + COF(I)
```

```
      PVAL = Z
      RETURN
C     BIVARIATE
  100 Y1 = Y
C     TEST IF Y IS LESS THAN Y MIN.
      IF (Y1.GE.COF(5)) GO TO 105
      IF (IE) 110, 110, 130
  105 CONTINUE
C     TEST IF Y IS GREATER THAN Y MAX.
      IF (Y1.LE.COF(6))  GO TO 150
C     SET ERROR SIGNAL,IE.
      IF (IE) 120, 120, 140
  110 IE = 3
      GO TO 135
  120 IE = 4
      GO TO 145
  130 IE = IE + 4
  135 Y1 = COF(5)
      GO TO 150
  140 IE = IE + 6
  145 Y1 = COF(6)
  150 N = 7
C     TEST IF X IS LESS THAN XMAX OF SECTION
  160 XN= N
      IF (X1.LE.COF(N))  GO TO 170
C     RESET INDEX TO COMPARE XMAX OF NEXT SECTION
      N = XN+(COF(N+1)+1.)*(COF(N+1)+2.)/2.+6.1
      GO TO 160
C     CALCULATE XBAR AND YBAR
  170 XBAR = COF(N+2) * X1 + COF(N+3)
      YBAR = COF(N+4) * Y1 + COF(N+5)
C     CALCULATE Z = (((A1*X+ A2*Y+A3)X+(A4*Y+A5)Y+A6)X+   ...... )
      I1 = COF(N+1) + .1
      NS = N +7
      Z = COF(NS-1)
      J1 = 1
      DO 190  I = 1,I1
      Z1 = COF(NS)
      DO  180  J = 1,J1
      NSJ = NS  + J
      Z1 = Z1 * YBAR + COF(NSJ)
  180 CONTINUE
      Z = Z1 + Z * XBAR
      J1 = J1 + 1
  190 NS = NS + J1
      PVAL = Z
      RETURN
      END
```

```
C          DATA SET B28DRECIRC AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE RECIRC
C PURPOSE     EVALUATE WAKE RECIRCULATION RATE
       COMMON /CINPT/FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
       COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTCF(5),MDTFC,K1,PSI,TCFEX,B3,TW,    ETAFH
     X,DLC(5),B1E,DMDOT,BDC,RTVD,DQDOT,Y,SL,EPSO,V,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
       COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,   FHWTMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
       COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30), TRJP4(283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
       REAL M1,M2,L,LOD,LDC,K1,LDB
       CBAR = 49.01 * SQRT(TA + 460.)
       M1   = VA / CBAR
       FHWTMP = FHW / 12.
       PS   =  144. * PS
       X2   = .6676 * ALOG(TAU) + 1.463
       L    = .0589 * X2**5 - .0093 * X2**4 - .0666 * X2**3 +
     X .0176 * X2**2 - .6662 * X2 + 2.426
       LOD  = EXP(L)
       LDB  = LOD * (-1.626E-10 * ALPHA**4 + 7.863E-08 * ALPHA**3
     X - 1.508E-05 * ALPHA**2 + 2.046E-03 * ALPHA + .8307)
       M2   =  M1 /(1.-TAU)
       LDC  = LDB  * (1.139 * M2 + .6046)
       BOD  = 30.4 * TAU**4 - 59.18 * TAU**3 + 47.38 * TAU**2 - 18.97 *
     X TAU + 4.50
       BDC  = BOD * (-6.378E-10 * ALPHA**4 + 3.317E-07 * ALPHA**3
     X - 6.769E-05 * ALPHA**2 + 8.09E-03 * ALPHA + .4698)
       RTD  = 21.21 / TAU**.25
       T2 = .998 * ALOG(TA+460.) - 6.725
       RTR  = .0266 * T2**4 + .0276 * T2**3 + .2547 * T2**2 + .954 * T2
     X + 1.364
       BDCC = BOD * 0.66
       RTVD = RTD * RTR * BDC / BDCC
       K1   = 0.8 * LDC * BDC / RTVD
       A    = K1 * RHOA * VA * FHWTMP
       VR = .8 * LDC * BDC * FHWTMP**2
       PSI = A / (VR * PS**2)
       PS = PS / 144.
       RETURN
       END
```

```
C          DATA SET 628DREGULA AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE REGULA(XL,XR,FCT1,FCT2,KJ,X2,Y2,IER)
      IER = 0
      YL1 = FCT1(XL)
      YR1 = FCT1(XR)
    3 YL2 = FCT2(XL)
      YR2 = FCT2(XR)
      DTL = (YL1 - YL2) / YL1
      DTR = (YR1 - YR2) / YR1
   10 X2  =   XL   -   DTL *(XR - XL) / (DTR - DTL)
      Y21=FCT1(X2)
      Y22 = FCT2(X2)
      DT2 = (Y21 - Y22) / Y21
      IF (ABS(DT2) - .005)40,20,20
   20 IF (KJ .GT. 20)GO TO 50
      KJ  =   KJ + 1
      IF (DT2 * DTL .LT. 0)GO TO 30
      XL  =   X2
      DTL =   DT2
      GO TO 10
   30 XR  =   X2
      DTR =   DT2
      GO TO 10
   40 Y2  =   Y21
      RETURN
   50 IER  =   1
      RETURN
      END
```

```
C          DATA SET B28DRESULT AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE RESULT(INDEX,IFIN,IPASS)
      COMMON /AUGIN/ JFUEL1,NAUGUP,NCUMUP,NFSUP,NPRNTR,NPRNUP
      COMMON /FLAMIN/ ALPHAC(100),ALPHAH(100),FAC(100),FAH(100),
     * FHWC(100),FHWH(100),LSC(100),LSH(100),NSC(100),NSH(100),
     * PFSK1(100),TAUC(100),TAUH(100),TEXT1(100),TFSK1(100),T6C(100),
     * T6H(100),WEXT1(100),XLC(100),XLH(100),NTC,NTH
      COMMON/RMBLIN/BPR,DPCS,DPD,DPH,DPHS,DPS,EPSC,EPSH,ETA1,ETAC,ETAH,
     * FA,FAV,LA,LB,LC,LH,L1,LK,L2,M6C,M6H,M6R,PRNOZ,PS6,T3H,ZEF,ZEFC,
     * ZEFH,ZEFP,ZEP,ZEPC,ZEPH,ZETC,ZETH,ZEVC,ZEVH,TCORE,WCOOL
      REAL LSC,LSH,M6C,M6H,LA,LB,LC,LH,L1,LK,L2,M6R
C     THIS SUBROUTINE STORES TYPE RESULTS, CALCULATES MASS AVERAGES, AND
C     SETS UP FOR INFLUENCE COEFFICIENT RUNS.
      REAL MDOTA,MDOTF,MDOTAS
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVC,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PS1,TLFEX,E3,TW,    ETAFH
     X,DLC(5),B1E,DMDTO,BDC,RIVD,DQDOTO,Y,SLO,EPSO,VO,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,FHWIMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30),TRJP4 (283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      COMMON/SV/SAVTE(2), SAVTA(2), SAVDT(2), SAVFAR(2), SAVDT1(2),
     X     SAVETA(2), SAVMDA(2), SAVMDF(2), ZCV(2), ZCP(2), ZCT(2),
     X     ZCFA(2), SAVVA(2),TEXAVG,ETAAVG,XMDTAD,FARAVG,TAAVG,XMDTFD,
     X     TEXIT(100), STMDTA(100), STMDTF(100), STTA(100),STVA(100),
     X     FARWK(100),ETAS(100),DTFIDL(100),ATR(100),ETAAVP,SAVLI(2),
     X     SAVLK(2),SAVXLS(2),SLI(100),SLK(100),SLS(100),SVFAC(100),
     X     FACAVG,TEXAVS,IWT1(100),SLB(100),SAVXLB(2),IZ(2)
      COMMON /CINPT/FHW,PFSK,PS,TFSK,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      IF(ISTRM .GT. 0)GO TO 5
C     CURVE IS THE SAME FOR JP4 AND JP5.
      CALL UNBAR(TRJP4,1,FAR,TA,DTI,IS)
      GO TO 6
    5 DTF = (72000. + 10. * (TA - 1200.))* FARMB
      T3HF = TA - DTF
      FAT = FARMB + FAR
C     CURVE IS THE SAME FOR JP4 AND JP5.
      CALL UNBAR(TRJP4,1,FAT,100.,DTOD,IS)
      DTOD = DTOD + .4 * (100. - T3HF)
      TEXI = DTOD + T3HF
      DTI = TEXI - TA
    6 DTFIDL(INDEX) = DTI
      ETAS(INDEX) = ETAFH
      ATR(INDEX) = ETAFH * DTI
      TEXIT(INDEX) = TA + ETAFH * DTI
      STMDTA(INDEX) = MDOTA
      STMDTF(INDEX) = MDOTF
      STVA(INDEX) = VA
      STTA(INDEX) = TA
      FARWK(INDEX) = FARW
```

```
      SLI(INDEX) = XI(1)
      SLK(INDEX) = XI(NSTEP) - XI(1)
      SLS(INDEX) = XF
      SLB(INDEX) = XL
      IF(IFIN .LE. 0) GO TO 1000
      SUMF = 0.0
      SUMA = 0.0
      SUMB = 0.0
      SUMC = 0.0
      SUMD = 0.0
      SUMG = 0.0
      SUMH = 0.0
      SUMI = 0.0
      SUMJ = 0.0
      SUMK = 0.0
      NT = NTC
      IF(ISTRM .EQ. 1)NT = NTH
      DO 10 I=1,NT
      IF (IWTI(I) .EQ. 1) GO TO 10
      IF(ISTRM .EQ. 0)NS=NSC(I)
      IF(ISTRM .EQ. 1)NS=NSH(I)
      SUMA = SUMA + NS * TEXIT(I) * STMDTA(I)
      SUMB = SUMB + NS * STMDTA(I)
      SUMC = SUMC + NS * STTA(I) * STMDTA(I)
      SUMD = SUMD + NS * STMDIF(I)
      SUMF = SUMF + NS * STVA(I) * STMDTA(I)
      SUMG = SUMG + NS *SLI(I) * STMDTA(I)
      SUMH = SUMH + NS * SLK(I) * STMDTA(I)
      SUMI = SUMI + NS * SLS(I) * STMDTA(I)
      SUMK = SUMK + NS * SLB(I) * STMDTA(I)
      IF(ISTRM .GT. 0) GO TO 10
      SUMJ = SUMJ + NS * SVFAC(I) * STMDTA(I)
   10 CONTINUE
      IF (SUMB .EQ. 0.) GO TO 17
      TEXAVG = SUMA/SUMB
      TEXAVS = TEXAVG
      TAAVG = SUMC/SUMB
      VAAVG = SUMF/SUMB
      FARAVG = SUMD/SUMB
      IF(ISTRM .LE. 0) FACAVG = SUMJ/SUMB
      XLIAVG = SUMG/SUMB
      XLKAVG = SUMH/SUMB
      XLSAVG = SUMI/SUMB
      XLBAVG = SUMK/SUMB
      IF(ISTRM .LE. 0)GO TO 15
      DTF = (72000. + 10. * (TAAVG - 1200.))* FARMB
      T3HF = TAAVG - DTF
      FATA = FARMB + FARAVG
C     CURVE IS THE SAME FOR JP4 AND JP5.
      CALL UNBAR(TRJP4,1,FATA,100.,DTUA,IS)
      DTUA = DTUA + .4 * (100. - T3HF)
      TEXI = DTUA + T3HF
      DTIAVG = TEXI - TAAVG
```

```
      DTAVG = TEXAVG - TAAVG
      ETAAVG = DTAVG/DTIAVG
      GO TO 16
   15 R = (1. + BPR) * WCOOL / (BPR - (1. + BPR) * WCOOL)
      TEXAVG = (TEXAVG + R*TAAVG) / (1. + R)
C     CURVE IS THE SAME FOR JP4 AND JP5.
      CALL UNBAR(TRJP4,1,FACAVG,TAAVG,DTIDTH,IS)
C     CURVE IS THE SAME FOR JP4 AND JP5.
      CALL UNBAR(TRJP4,1,FARAVG,TAAVG,DTIDCH,IS)
      ETAAVG = (TEXAVG - TAAVG) / DTIDTH
      ETAAVP = (TEXAVG - TAAVG) / DTIDCH
      DTIAVG = DTIDTH
   16 XMDTAD = SUMB
      XMDTFD = SUMD * 3600
   17 IF(IPASS-1)20,20,30
   20 ISTR = ISTRM + 1
      SAVTE(ISTR) = TEXAVG
      SAVTA(ISTR) = TAAVG
      SAVDT(ISTR) = DTAVG
      SAVFAR(ISTR) = FACAVG
      IF(ISTR.EQ.2) SAVFAR(ISTR) = FARAVG
      SAVDTI(ISTR) = DTIAVG
      SAVETA(ISTR) = ETAAVG
      SAVMDA(ISTR) = XMDTAD
      SAVMDF(ISTR) = XMDTFD
      SAVVA(ISTR) = VAAVG
      SAVLI(ISTR) = XLIAVG
      SAVLK(ISTR) = XLKAVG
      SAVXLS(ISTR) = XLSAVG
      SAVXLB(ISTR) = XLBAVG
      SAVPS = PS
   30 IF (SUMB.EQ.0.) GO TO 950
      IF (SAVETA(ISTR).EQ.0.) GO TO 950
      GO TO (900,40,50,60,70),IPASS
   40 VA1 = VAAVG
      ETAVA = ETAAVG
      GO TO 900
   50 PS1 = PS
      ETAPS = ETAAVG
      GO TO 900
   60 FAR1 = FACAVG*0.99
      IF (ISTR.EQ.2) FAR1 = FARAVG
      ETAFAR = ETAAVG
      GO TO 900
   70 TA1 = TA
      ETATA = ETAAVG
      ZCV(ISTR) = SAVVA(ISTR) / SAVETA(ISTR) * (( SAVETA(ISTR) - ETAVA)
     *   / (SAVVA(ISTR) - VA1))
      ZCP(ISTR) = SAVPS / SAVETA(ISTR) * (( SAVETA(ISTR) - ETAPS) /
     *   (SAVPS - PS1))
      ZCT(ISTR) = (SAVTA(ISTR) + 460.) / SAVETA(ISTR) * ((SAVETA(ISTR)
     *   - ETATA) / (SAVTA(ISTR) - TA1))
      ZCFA(ISTR) = SAVFAR(ISTR) / SAVETA(ISTR) * ((SAVETA(ISTR) -ETAFAR)
```

```
     *    / (SAVFAR(ISTR) - FAR1))
      IZ(ISTR) = 0
      IPASS = 1
      IFIN = 2
      GO TO 1000
  900 IFIN = 0
      IPASS = IPASS + 1
      GO TO 1000
  950 IPASS = 1
      IFIN = 2
      IZ(ISTR) = 1
 1000 RETURN
      END
```

```
C          DATA SET 828DRUMBLE AT LEVEL 001 AS OF 12/07/76  E33
C          DATA SET 8458MAIN   AT LEVEL 001 AS OF 12/22/77
C**********************************************************************
C     DECK 8458 SOLUTION OF COMPLEX SIMULTANEOUS EQUATIONS
C**********************************************************************
      SUBROUTINE RUMBLE
      COMMON /AUGIN/ JFUEL, NAUGOP, NCUMOP, NFSOP, NPRNTR, NPRNTF
      COMMON /DTRM/ RMAG, BIMIN, BIMAX, BIDEL, DETERM, IBETA
      COMMON ARX,AIX,BR,BI,CR,CI
      COMMON/PLOG/ TITLE,STITLE, NAME1, NAME2, K1
      COMMON/SV/SAVTE(2), SAVTA(2), SAVDT(2), SAVFAR(2), SAVDTI(2),
     X     SAVETA(2), SAVMDA(2), SAVMDF(2), ZCV(2), ZCP(2), ZCT(2),
     X     ZCFA(2), SAVVA(2),TEXAVG,ETAAVG,XMDTAD,FARAVG,TAAVG,XMDTFD,
     X     TEXIT(100), STMDTA(100), STMDTF(100), STTA(100),STVA(100),
     X     FARWK(100),ETAS(100),DTFIDL(100),ATR(100),ETAAVP,SAVLI(2),
     X     SAVLK(2),SAVXLS(2),SLI(100),SLK(100),SLS(100),SVFAC(100),
     X     FACAVG,TEXAVS,IWTI(100),SLB(100),SAVXLB(2),IZZ(2)
      DIMENSION KV(4)
      DIMENSION NOPARM(20)
      DIMENSION NAME1(20,3), NAME2(20,3)
      COMPLEX AC(75,75)
      DIMENSION CY(200), AX(200) , PX(200)
      DIMENSION                    AMPLOT(200,20),PHPLOT(200,20)
      DIMENSION CXPLOT(200), P2PLOT(200,20)
      DIMENSION SYM1(75), SYM2(75), SYM3(75), TITLE(20)
      DIMENSION OMEGA(500)
      DIMENSION CO(500), STITLE(19)
       DIMENSION BAND(5000)
      COMMON /RHODMV  CR1(150)
      DIMENSION BX(75),CX(75)
      DIMENSION ICMBL1(40), ICMBL2(40), SAVAM1(40), SAVAM2(40),
     1          SAVPH1(40),   SAVPH2(40),   SVPHA1(40), SVPHA2(40)
      DIMENSION ICYM1(40), ICYM2(40)
      DIMENSION WN(3), DW(3), WX(3), NPTS(3)
      DIMENSION SAVCO(500)
      DIMENSION TEMPCO(7), ITCY1(8), ITCY2(8)
      DIMENSION PHASOP(20),AMPOP(20),AMPFAC(20),FREQOP(20),FRQFAC(20)
      DIMENSION YMEN(20), YMACKS(20), INORM(20)
C     DIMENSION SCHR(2)
      COMPLEX XVAL, DETERM
      REAL NAME1, NAME2
      COMPLEX    BX
      COMPLEX    CX
      COMPLEX*16 BAND
      COMPLEX    DUM
      EQUIVALENCE (CR1(1),CX(1))
      EQUIVALENCE (CPLOT,CY(1)),(AX(1),OMEGA(1)), (PX(1),CO(1))
      DATA SYM1 / 4HP1  , 4HV1  , 4HR1  , 4HP2  , 4HV2  , 4HR2  ,
     *     4HP3  , 4HV3  , 4HR3  , 4HP3H , 4HV3H , 4HR3H , 4HP2H ,
     *     4HV2H , 4HR2H , 4HQIN , 4HW3  , 4HW3H , 4HQOUT, 4HP4  ,
     *     4HV4  , 4HR4  , 4HP5  , 4HV5  , 4HR5  , 4HP6  , 4HV6  ,
     *     4HR6  , 4HP7  , 4HV7  , 4HR7  , 4HP8  , 4HV8  , 4HR8  ,
     *     4HP9  , 4HV9  , 4HR9  , 4HP10 , 4HV10 , 4HR10 , 4HP11 ,
```

```
     *     4HV11 , 4HR11 , 32 * 4H     /
      DATA SYM2 / 75 * 4H     /
      DATA SYM3 / 4H 1  , 4H 2  , 4H 3  , 4H 4  , 4H 5  , 4H 6  ,
     *     4H 7  , 4H 8  , 4H 9  , 4H10  , 4H11  , 4H12  , 4H13  ,
     *     4H14  , 4H15  , 4H16  , 4H17  , 4H18  , 4H19  , 4H20  ,
     *     4H21  , 4H22  , 4H23  , 4H24  , 4H25  , 4H26  , 4H27  ,
     *     4H28  , 4H29  , 4H30  , 4H31  , 4H32  , 4H33  , 4H34  ,
     *     4H35  , 4H36  , 4H37  , 4H38  , 4H39  , 4H40  , 4H41  ,
     *     4H42  , 4H43  , 32 * 4H     /
      DATA XBL/'    '/
      DATA N / 43 /, IENTER / 0 /
      IF (K1.GT.0 .AND. IENTER.GT.0) GO TO 180
      IENTER = 1
      DUM  = (0.0,0.0)
C     INITIALIZE ARRAYS
   50 DO 60  I=1,75
      BX(I) = 0.
      CX(I)= 0.
      DO 60 J = 1, 75
      AC(I,J) = 0.
   60 CONTINUE
      IPT = 0
      INND = -1.
      IONE=0
      ICOUNT=0
      IPLOT = 0
      I1 = 1
      MQ = 0
   70 READ(5,3446) (ITCY1(INQ),ITCY2(INQ),INQ=1,8)
      DO 80 I = 1,8
      IF ( ITCY1(I) .EQ. 0 .OR. ITCY2(I) .EQ. 0 ) GO TO 90
      MQ = MQ + 1
      ICMBL1(MQ) = ITCY1(I)
      ICMBL2(MQ) = ITCY2(I)
   80 CONTINUE
      GO TO 70
 3446 FORMAT ( 8(I2, 1X, I2, 5X) )
   90 CONTINUE
C     PLOT INPUT
  100 IPT = IPT + 1
      IF ( IPT .GT. 20 ) GO TO 110
      READ (5,5900) NOPARM(IPT), INORM(IPT), AMPOP(IPT),PHASOP(IPT),
     1 FREQOP(IPT), AMPFAC(IPT), FRQFAC(IPT), YMEN(IPT), YMACKS(IPT)
      IF (NOPARM(IPT) .EQ. 0 ) GO TO 110
      GO TO 100
  110 IF (IPT .EQ. 1 ) GO TO 120
      NOGOOD = 0
      IPT = IPT - 1
      GO TO 130
  120 NOGOOD = 1
  130 CONTINUE
      READ(5,3333) (WN(IQ), DW(IQ), WX(IQ), IQ=1,3)
      DO 138 KQ = 1, 3
```

```
      IF (DW(KQ).EQ.0.) GO TO 138
      NPTS(KQ) = (WX(KQ) - WN(KQ))/DW(KQ) + 1
  138 CONTINUE
      LL = 0
  140 READ (5,201) (TEMPCO(I), I = 1, 7)
      DO 160  LLL = 1, 7
      IF (TEMPCO(LLL) .EQ. INND) GO TO 170
      LL = LL + 1
      IF ( LL .LT. 500 ) GO TO 150
      WRITE(6,2341)
      GO TO 810
  150 SAVCO(LL) = TEMPCO(LLL)
  160 CONTINUE
      GO TO 140
  170 CONTINUE
      READ (5,201) RMAG, BTMIN, BTMAX, BTDEL
      BTMIN = BTMIN / 57.29578
      BTMAX = BTMAX / 57.29578
      BTDEL = BTDEL / 57.29578
      RMAG = RMAG * 6.28318
      IBETA = 0
      ISVLL = LL
      KASE = 0
  180 CONTINUE
      IBETA = 0
      IFIRST = 0
      KV(1) = K1
      KASE = KASE + 1
      IF (KASE .LE.10) GO TO 200
      WRITE(6,2020)
      GO TO 810
  200 CONTINUE
  210 CONTINUE
      IFLEG = 0
      IQQ = 1
  220 IF (DW(IQQ) .EQ. 0. ) GO TO 700
      IZ = 0
      IO = -1
  230 IZ = IZ + 1
      IF ( IZ .GT. 500 ) GO TO 250
      IO = IO + 1
      VALUE = WN(IQQ) + IO * DW(IQQ)
      TOL = .1  * DW(IQQ)
      IF (VALUE - (WX(IQQ) + TOL) ) 240, 240, 250
  240 CO(IZ) = VALUE
      GO TO 230
  250 LL = IZ - 1
      COPMAX = CO(LL)
  260 DO 690 IM = I1, LL
      OMEGA(IM)=CO(IM)* 6.28318
C     CONSTANT 6.28318 IS  2.*3.14159
C ------------------------------------------------------------------
C     GET MATRIX ELEMENTS FROM SUBROUTINE INPUT
```

```
C -------------------------------------------------------------------
      IF (IZZ(1).EQ.1.OR.IZZ(2).EQ.1) WRITE (6,10101)
10101 FORMAT (' *** WARNING *** THE FLAMEHOLDER COMBUSTION MODEL CASE HA
     1S FAILED FOR AT LEAST ONE STREAMTUBE.'/'      THE RUMBLE MODEL CASE
     2 HAS NOT BEEN EXECUTED.')
      IF (IZZ(1).EQ.1.OR.IZZ(2).EQ.1) RETURN
      CALL INPUT (AC,BX,OMEGA(IM),KASE,KV,IFIRST)
      N2 = N+N
      II = 0
C     CALCULATE NUMBER OF SUB AND SUPER DIAGONALS
      CALL BANDCX(N,75,AC,BAND,NSUP,NSUB)
      NSS = NSUP + 1
      NS  = NSUB
      IBAN= 0
      ISZ = 1
      ISSZ= 1
C -------------------------------------------------------------------
C     SETUP SINGLE SUPSCRIPT BAND MATRIX ARRAY
C -------------------------------------------------------------------
  280 IF (NS .LE. 0) GO TO 300
      DO 290 I = 1,NS
      IBAN= IBAN+1
  290 BAND(IBAN) = 0.
  300 CONTINUE
      DO 310 J = ISSZ, NSS
      IF (J .GT. N) GO TO 320
      IBAN = IBAN+1
  310 BAND(IBAN) = AC(ISZ,J)
      GO TO 340
  320 DO 330 JJ = J, NSS
      IBAN=IBAN+1
  330 BAND(IBAN) = 0.
  340 ISZ = ISZ+1
      NS = NS-1
      NSS= NSS+1
      IF (ISZ .GT. NSUB+1) ISSZ = ISSZ+1
      IF (ISZ .LE. N) GO TO 280
      KMAGVL = KMAG / 6.28318
      BETVAL = OMEGA(IM) * 57.29578
      IF ( IBETA .EQ. 1 ) WRITE (6,2100) KMAGVL, BETVAL
C -------------------------------------------------------------------
C     SOLVE BAND MATRIX
C -------------------------------------------------------------------
      IERR = 0
      CALL BMAT (NSUP,NSUB,N,BAND,IERR)
      CALL SOLBAN (NSUP,NSUB,N,BAND,BX ,CX)
      IF ( NOGOOD .NE. 0) GO TO 400
      IF ( IPLOT .NE. 0 ) GO TO 400
  380 ICOUNT = ICOUNT + 1
      IF (ICOUNT .LT. 200) GO TO 390
      WRITE(6,6013)
 6013 FORMAT ( 10X, 'ICOUNT GREATER THAN 200' )
      IPLOT = 1
```

```
      GO TO 400
  390 CXPLOT (ICOUNT) = CO(IM)
  400 II = 0
C -----------------------------------------------------------------------
C     CALCUALTE AND PRINT AMP, REAL AND IMAG PART, ETC. FOR UNKNOWNS
C -----------------------------------------------------------------------
      DO 610 I=1,N2,2
      TEMP = 0.
      II = II+1
      CXR = CRI(I)* CRI(I)
      CXI = CRI(I+1)*CRI(I+1)
      AMP = SQRT(CXR+CXI)
      IF (AMP .NE. 0.) GO TO 420
      AL = -1.0E+70
      AL2 = -1.0E+70
      GO TO 430
C     CONSTANT  8.68589 =  20./2.302585
  420 AL = ALOG(AMP) * 8.68589
      AL2= AL/20.
  430 IF (CRI(I) .NE. 0.) GO TO 440
      IF (CRI(I+1) .GT. 0) TEMP = 90.
      IF ( CRI(I+1) .LT. 0) TEMP = 270.
      GO TO 470
  440 CICR = ABS(CRI(I+1)/CRI(I))
      TEMP = ATAN(CICR) * 57.3
      IF (CRI(I) .LT. 0.) GO TO 490
      IF (CRI(I+1).LT.0.) GO TO 480
  470 XI = TEMP-360.
      GO TO 520
  480 XI = -TEMP
      GO TO 520
  490 IF (CRI(I+1).LT.0.) GO TO 510
      XI = -TEMP - 180.
      GO TO 520
  510 XI =  TEMP - 180.
  520 XI2 = XI
      IF(ABS(XI2).GT.180) XI2=XI2 + 360.
      COP = CO(IM)
C     COPMAX = CO(LL)
      CALL PRNTSV (SYM1,SYM2,SYM3,AMP,XI,COP,COPMAX)
      IF ( MQ .EQ. 0 ) GO TO 550
      DO 540  JQ = 1, MQ
      IF ( ICMBL1(JQ) .NE. II ) GO TO 530
      SAVAM1(JQ) = AMP
      SAVPH1(JQ) = XI
      SVPHA1(JQ) = XI2
       ICYM1(JQ) = II
      GO TO 540
  530 IF ( ICMBL2(JQ) .NE. II ) GO TO 540
      SAVAM2(JQ) = AMP
      SAVPH2(JQ) = XI
      SVPHA2(JQ) = XI2
      ICYM2(JQ) = II
```

```
  540 CONTINUE
  550 CONTINUE
C       STORE PLOT INFORMATION FOR THE UNKNOWNS
        IF ( NOGOOD .NE. 0 ) GO TO 600
        IF ( IPLOT .NE. 0 ) GO TO 600
        DO 560  IPAR = 1, IPT
        IPA = NUPARM(IPAR)
        IF ( II .EQ. IPA ) GO TO 570
  560 CONTINUE
        GO TO 600
  570 AMPLOT(ICOUNT,IPAR) = AMP
        NAME1(IPAR,1) = SYM1(IPA )
        NAME1(IPAR,2) = SYM2(IPA )
        NAME1(IPAR,3) = SYM3(IPA )
        NAME2(IPAR,1) = XBL
        NAME2(IPAR,2) = XBL
        NAME2(IPAR,3) = XBL
  590 PHPLOT(ICOUNT,IPAR) = X1
        P2PLOT(ICOUNT,IPAR) = X12
  600 CONTINUE
  610 CONTINUE
  620 CONTINUE
C ----------------------------------------------------------------------
C       GENERATE S1 / S2 TYPE OUTPUT
C ----------------------------------------------------------------------
        IF ( MQ .EQ. 0 ) GO TO 680
        DO 670  JQ = 1, MQ
        JNJ = JQ + 100
        AMPAMP =  SAVAM1(JQ) / SAVAM2(JQ)
        XLG20 = -1.0E+70
        IF ( AMPAMP .NE. 0.0 )
       1XLG20  =   ALOG(AMPAMP) * 8.68589
        FAZE1  =   SAVPH1(JQ) - SAVPH2(JQ)
        XLOAM = -1.0E+70
        IF ( AMPAMP .NE. 0.0 )
       1XLOAM  =   XLG20 / 20.
        IF ( FAZE1 .GT. 0) FAZE1 = -360. + FAZE1
        FAZE2 = FAZE1
        IF ( ABS(FAZE1) .GT. 180.) FAZE2 = FAZE1 + 360.
        REEL = AMPAMP * COS(FAZE1 / 57.295)
        XIMG = AMPAMP * SIN(FAZE1/ 57.295)
        IRM = ICYM1(JQ)
        IRM2= ICYM2(JQ)
        CALL PRNTR (SYM1,SYM2,SYM3,ICYM1,ICYM2,AMPAMP,FAZE1,COP,COPMAX,MQ)
C       STORE PLOT INFORMATION FOR S1 / S2 TYPE TERMS
        IF ( NOGOOD .NE. 0 ) GO TO 670
        IF ( IPLOT .NE. 0 ) GO TO 670
        DO 630  IPAR = 1, IPT
        IPA = NUPARM(IPAR)
        IF (JNJ .EQ. IPA ) GO TO 640
  630 CONTINUE
        GO TO 670
  640 AMPLOT(ICOUNT,IPAR) = AMPAMP
```

```
      NAME1(IPAR,1) = SYM1(IRM)
      NAME1(IPAR,2) = SYM2(IRM)
      NAME1(IPAR,3)  = SYM3(IRM)
      NAME2(IPAR,1) = SYM1(IRM2)
      NAME2(IPAR,2) = SYM2(IRM2)
      NAME2(IPAR,3) = SYM3(IRM2)
      PHPLOT(ICOUNT,IPAR) = FAZE1
      P2PLOT(ICOUNT,IPAR) = FAZE2
  670 CONTINUE
  680 CONTINUE
C ------------------------------------------------------------------
C     DETERMINANT OUTPUT
C ------------------------------------------------------------------
      DO 5250 JQ=1,2
      XVAL = DETERM
      IF ( JQ .EQ. 2 ) XVAL = DETERM + ( 1., 0. )
      JNJ = 199 + JQ
      REALDT = REAL ( XVAL )
      CMPLDT = AIMAG ( XVAL )
      AMP = SQRT ( REALDT**2 + CMPLDT**2 )
      IF (AMP .NE. 0.) GO TO 4200
      AL = -1.0E+70
      AL2 = -1.0E+70
      GO TO 4300
C     CONSTANT  8.68589 = 20./2.302585
 4200 AL = ALOG(AMP) * 8.68589
      AL2= AL/20.
 4300 IF (REALDT .NE. 0.) GO TO 4400
      IF ( CMPLDT  .GT. 0) TEMP = 90.
      IF ( CMPLDT   .LT. 0) TEMP = 270.
      GO TO 4700
 4400 CICR = ABS(CMPLDT/REALDT)
      TEMP = ATAN(CICR) * 57.3
      IF (REALDT .LT. 0.) GO TO 4900
 4600 IF ( CMPLDT .LT.0.) GO TO 4800
 4700 X1 = TEMP-360.
      GO TO 5200
 4800 X1 = -TEMP
      GO TO 5200
 4900 IF ( CMPLDT .LT.0.) GO TO 5100
      X1 = -TEMP - 180.
      GO TO 5200
 5100 X1 =  TEMP - 180.
 5200 X12 = X1
      IF(ABS(X12).GT.180) X12=X12 + 360.
C     DETERMINANT PLOT INFORMATION
      IF ( NOGOOL .NE. 0 ) GO TO 5250
      IF ( IPLOT .NE. 0 ) GO TO 5250
      DO 6300 IPAR = 1,IPT
      IPA  = NOPARM(IPAR)
      IF ( IPA .NE. JNJ ) GO TO 6300
      AMPLOT(ICOUNT,IPAR) = AMP
      NAME1(IPAR,1) = XBL
```

```
      NAME1(IPAR,2) = XBL
      NAME1(IPAR,3) = XLAB
      NAME2(IPAR,1) = XBL
      NAME2(IPAR,2) = XBL
      NAME2(IPAR,3) = XBL
      PHPLOT(ICOUNT,IPAR) = X1
      P2PLOT(ICOUNT,IPAR) = X12
 6300 CONTINUE
 5250 CONTINUE
      IF ( IERR .EQ. 1 ) GO TO 790
  690 CONTINUE
      IF ( IBETA .EQ. 1 ) GO TO 7475
  700 IF ( IOO .GE. 3 ) GO TO 710
      IOO = IOO + 1
      GO TO 220
  710 IF ( IFLEG .EQ. 1 ) GO TO 730
      IFLEG = 1
      IF ( ISVLL .EQ. 0 ) GO TO 730
      DO 720  IZ = 1, ISVLL
  720 CO(IZ) = SAVCO(IZ)
      LL = ISVLL
      COPMAX = CO(ISVLL)
      GO TO 260
  730 CONTINUE
      IF ( BTDEL .EQ. 0. ) GO TO 7500
      IBETA = 1
      NGGOOL = NOGOOL
      NOGOOL = 1
      I1 = 1
      LL =  ABS(( BTMAX - BTMIN ) / BTDEL )  + 1.001
      DO 7300 I=1,LL
 7300 CO(I)  = ( BTMIN + (I-1) * BTDEL ) / 6.28318
      GO TO 260
 7475 NOGOOL = NGGOOL
 7500 CONTINUE
C ------------------------------------------------------------------------
C     GENERATE CALCOMP PLOTS
C ------------------------------------------------------------------------
      IF (NOGOOL .NE. 0) GO TO 790
      IF ( IPLOT .NE. 0 ) ICOUNT = 200
      DO 780 I = 1, IPT
      IG = 1
      DO 770  J = 1, ICOUNT
      CY(J) = CXPLOT(J)
      AX(J) = AMPLOT(J,1)
      IF (PHASOP(I) .EQ. 0) GO TO 750
      PX(J) = P2PLOT(J,1)
      GO TO 760
  750 PX(J) = PHPLOT(J,1)
  760 CONTINUE
  770 CONTINUE
      CALL PLOTG(CY,PX,AX,ICOUNT,FREQOP(I),FRQFAC(I),PHASOP(I),
     1      AMPOF(I), AMPFAC(I), IG, YMEN(I), YMACKS(I), INORM(I) )
```

```
  780 CONTINUE
  790 CONTINUE
      LZ = 0
      IPLOT = 0
      ICOUNT=0
  810 RETURN
 201  FORMAT ( 7F10.0)
 2100 FORMAT (T30,'MAGNITUDE =',F10.4,5X,'BETA',F10.4)
 5900 FORMAT (I3, I1, 6X, 7F10.0 )
 3333 FORMAT ( 3F10.0)
 2341 FORMAT (/ T10, 10('*'), 'YOU HAVE EXCEEDED THE MAXIMUM ALLOWABLE '
     1,     'NUMBER OF OMEGAS - PROGRAM WILL BE TERMINATED', / )
 2020 FORMAT (T5,'YOU HAVE EXCEEDED MAXIMUM NO. OF CASES ALLOWED', /
     1      T10,'PROGRAM WILL BE TERMINATED')
       END
```

AD-A065 774 PRATT AND WHITNEY AIRCRAFT GROUP WEST PALM BEACH FL G--ETC F/G 21/2
LO-FREQUENCY AUGMENTOR INSTABILITY INVESTIGATION COMPUTER PROGR--ETC(U)
DEC 78 P L RUSSELL, G BRANT, R ERNST F33615-76-C-2024
UNCLASSIFIED PWA-FR-9797 AFAPL-TR-78-83 NL

3 OF 4
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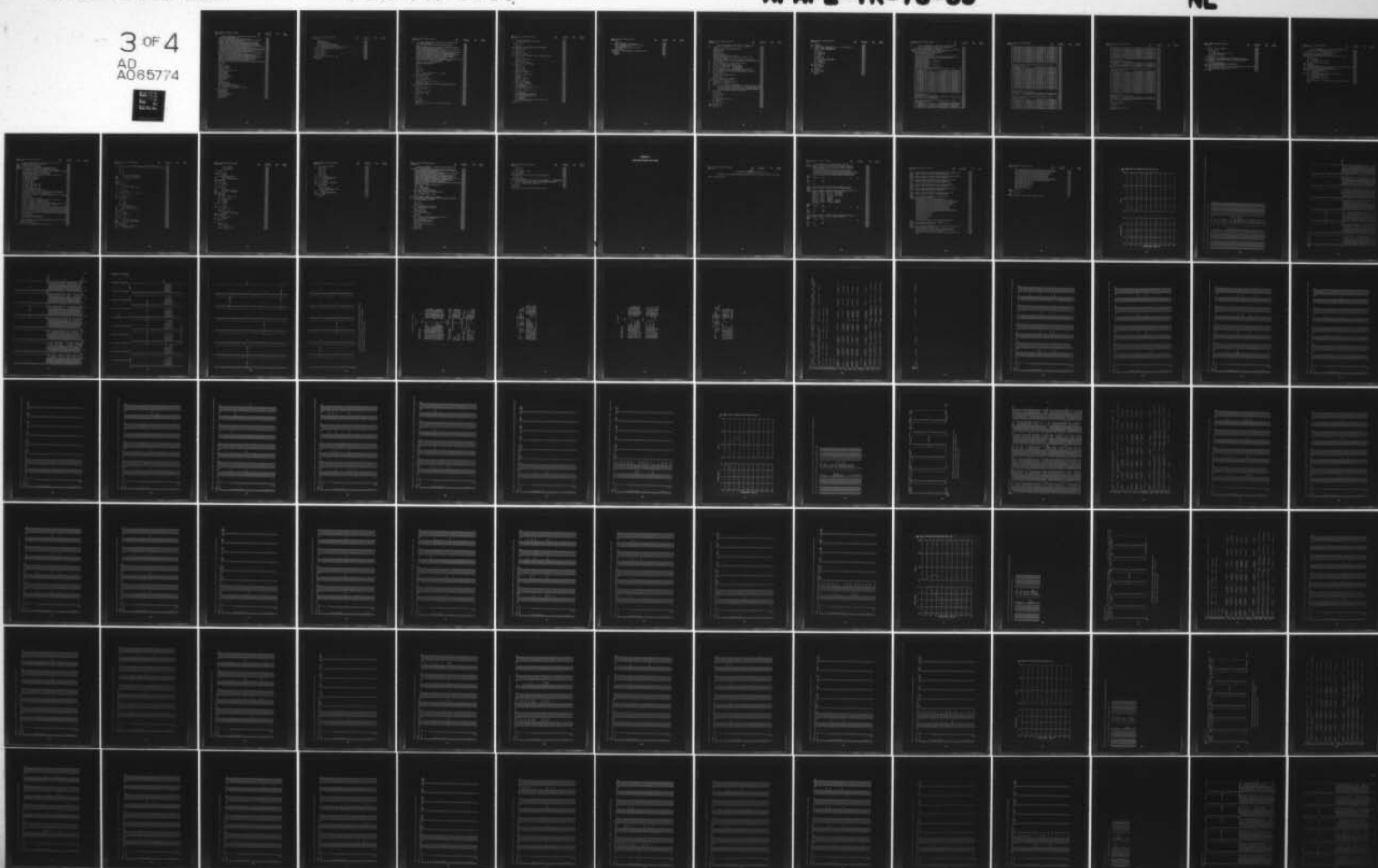
A065774



```
C          DATA SET B28DSETUP  AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE SETUP(INDEX,IPASS)
      REAL LSC,LSH,M6C,M6H,LA,LB,LC,LH,LI,LK,L2,M6R
      COMMON /CINPT/FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /AUGIN/ JFUEL1,NAUGUP,NCOMUP,NFSUP,NPRNTR,NPRNUP
      COMMON /FLAMIN/ ALPHAC(100),ALPHAH(100),FAC(100),FAH(100),
     * FHWC(100),FHWH(100),LSC(100),LSH(100 ),NSC(100),NSH(100),
     * PFSRI(100),TAUC(100),TAUH(100),TEXTI(100),TFSRI(100),T6C(100),
     * T6H(100),WEXTI(100),XLC(100),XLH(100 ),NTC,NTH
      COMMON/RMBLIN/BPR,DPCS,DPD,DPH,DPHS,DPS,EPSC,EPSH,ETAI,ETAC,ETAH,
     * FA,FAV,LA,LB,LC,LH,LI,LK,L2,M6C,M6H,M6R,PRNOZ,PS6,T3H,ZEF,ZEFC,
     * ZEFH,ZEFP,ZEP,ZEPC,ZEPH,ZETC,ZETH,ZEVC,ZEVH,TCORE
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PSI,TLFEX,B3,Tw,   ETAFH
     X,DLO(5),BIE,DMDTO,BDC,RTVD,DQDOTO,Y,SLO,EPSO,VO,XO,EPSXO,ETAO
     X,STO,XI(100),EPSXI(100),STI(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,FHWTMP,BIT,KM,TFC,DLF(5)
     X,BETA2(5),ETAW,MDTFLI,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30),TRJP4 (283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      G = 32.2
      WAR = 0.0
      PS=PS6
      JFUEL = JFUEL1
      PFSR=PFSRI(INDEX)
      TFSR=TFSRI(INDEX)
      CDFH=1.2
      IF(ISTRM .GT. 0) GO TO 100
      FHW=FHWC(INDEX)
      TA=T6C(INDEX)
      XF=LSC(INDEX)
      TAU=TAUC(INDEX)
      ALPHA=ALPHAC(INDEX)
      FAR=FAC(INDEX)
      XL=XLC(INDEX)
      EPS=EPSC
      FARMB=0.
      WEXT=WEXTI(INDEX)
      TEXT=TEXTI(INDEX)
      CALL GASTAB(10,TA,FAR,R,WAR)
      CALL GASTAB(36,TA,FAR,GAMA,WAR)
      VA = SQRT(GAMA * R *(TA+460.) * G) * M6C
      GO TO 200
  100 FHW=FHWH(INDEX)
      TA=T6H(INDEX)
      XF=LSH(INDEX)
      TAU=TAUH(INDEX)
      ALPHA=ALPHAH(INDEX)
      FAR=FAH(INDEX)
      XL=XLH(INDEX)
      EPS=EPSH
```

```
      FARMB=FAV
      WEXT=WEXT1(INDEX)
      TEXT=TEXT1(INDEX)
      CALL GASTAB(10,TA,FAR,R,WAR)
      CALL GASTAB(36,TA,FAR,GAMA,WAR)
      VA = SQRT(GAMA *R * (TA + 460.) * G) * M6H
  200 GO TO (1000,300,400,500,600),IPASS
  300 VA = VA * .99
      GO TO 1000
  400 PS = PS * 1.01
      GO TO 1000
  500 FAR = FAR * .99
      GO TO 1000
  600 TA = 1.01 * (TA + 460.) - 460.
 1000 RETURN
      END
```

```
C          DATA SET B28DSLVETA AT LEVEL 001 AS OF 12/07/78   E33
      SUBROUTINE SLVETA(KO)
      REAL MDOTA,MDOTF,MDTFLO,MDTFVO,MDTFL1,MDTFC,MDOTFL
     X,K1
      COMMON /CINPT/FHW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFH,FARMB,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MDOTA,MDOTF,MDTFLO,MDTFVO,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PS1,TLFEX,B3,TW,    ETAFH
     X,DLO(5),B1E,DMDTO,BDC,RTVD,DQDOTO,Y,SLO,EPSO,VO,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,FHWTMP,BIT,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(36),TRJP4 (283),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      DIMENSION TWW(41), FARWW(41), FARWB(20), TWB(20),
     X                 TAB3(44),B3WB(20)
      COMMON /TAB/ TAB1(66),TAB2(44)
      EXTERNAL FATMP1,FATMP2
      KO = 0
      IV = 0
      IVRT = 0
      ICNT = 0
      DX = .0045
      FARW = .02
      IEND = 0
      TAEFF = ((TEXT * WEXT) + TA) / (1. + WEXT)
      PSI = (1. + WEXT) * PSI
   10 CALL WAKE (K,DTFI)
      DTFI = DTFI * 1.8
      IF (K .GT. 0)GO TO 9
      IF(ICNT .GE. 40)GO TO 7
      ICNT = ICNT+1
      TWW(ICNT) = TAEFF + DTFI * ETAW
      FARWW(ICNT) = FARW
C     WRITE(6,998)I,ICNT,TAEFF,DTFI,ETAW,TWW(ICNT),FARWW(ICNT)
  998 FORMAT(2I5,5E15.7)
      GO TO 6
    9 IF(ICNT .GT. 0)GO TO 8
    6 FARW = FARW + DX
      K = 0
      IF(IEND .EQ. 1)GO TO 7
      GO TO 10
    8 FARW = FARW - .0005
      IEND = 1
      K = 0
      GO TO 10
    7 TW = 1000
      DX = 200
      DO 20 I=1,20
      CALL BETAS
      FARWB(I) = FAR * (BETA1 + (1.-BETA1) * B2 * B3/K1)
      TWB(I) = TW
```

```
      IF(I .EQ. 1)GO TO 12
      IF (FARWB(I) - FARWB(I-1))11,11,12
   11 IF(IV)13,13,12
   13 IV = 1
      IVRT = I - 1
   12 CONTINUE
C  12 WRITE(6,997)I,FAR,BETA1,B2,B3,K1,TW,FARWB(I)
  997 FORMAT(I5,7E12.4)
      B3WB(I) = B3
      TW = TW + DX
   20 CONTINUE
  999 FORMAT(I5, 4F12.4)
C     DO 25 I = 1,ICNT
C  25 WRITE (6,999)I, FARWW(I), TWW(I), FARWB(I), TWB(I)
      TAB1(1) = 1.
      TAB1(2) = 3.
      TAB1(3) = FLOAT(ICNT)
      TAB1(4) = 0.0
      DO 30 I=1,ICNT
      TAB1(I + 4) = FARWW(I)
   30 TAB1(I + 4 + ICNT) = TWW(I)
      TAB3(1) =  1.
      TAB3(2) =  3.
      TAB3(3) = 20.
      TAB3(4) =  0.
      DO 40 I = 1,20
      TAB3(I+4) = TWB(I)
   40 TAB3(I+24) = B3WB(I)
      NN = 20
      IF(IVRT .GT. 0)NN = IVRT
      TAB2(1) =  1.
      TAB2(2) =  3.
      TAB2(3) = FLOAT(NN)
      TAB2(4) =  0.
      DO 42 I = 1,NN
      TAB2(I + 4) = FARWB(I)
   42 TAB2(I+4+NN) = TWB(I)
      IF(IVRT .LE. 0)GO TO 41
      X = FARWB(IVRT)
      CALL UNBAR(TAB1, 1, X, 0, Y2, IS)
      IF(IS .GT. 0) GO TO 41
      Y1 = Y2
      IF(Y2 .GE. TWB(IVRT)) GO TO 70
   41 KJ = 0
      X = FARWW(ICNT)
      CALL UNBAR(TAB1,1,X,0.,YL1,IS)
      CALL UNBAR(TAB2,1,X,0.,YL2,IS)
      IF(YL2 .LT. YL1)GO TO 60
      XLL = FARWW(1)
      XR = FARWB(NN)
      CALL REGULA (XLL,XR,FATMP1,FATMP2,KJ,X,Y1,IER)
      IF(IER .GT. 0)GO TO 60
   70 TW = Y1
```

```
      FARW = X
C     CURVE IS THE SAME FOR JP4 AND JP5
      CALL UNBAR(TRJP4, 1,FARW, TA, DTF1, IS)
      ETAW = (TW-TA)/DTF1
      CALL UNBAR(TAB3, 1, TW, 0., B3, IS)
      GO TO 80
C  60 WRITE (6,101)
C 101 FORMAT (' WAKE TEMPERATURE ITERATION FAILED')
   60 KO = 1
   80 RETURN
      END
```

```
C          DATA SET B28DSOLBAN AT LEVEL 001 AS OF 12/07/76  E33
C          DATA SET 8458SOLBAN AT LEVEL 001 AS OF 12/22/77
C     SOLBAN
      SUBROUTINE SOLBAN (NP,NB,NR,BAND,B,XX)
      COMPLEX*16 BAND
      COMPLEX B, XX
      COMPLEX*16 X
      COMPLEX DETERM
      COMPLEX*16 S,BD,DP
      DIMENSION BAND(1),B(1),X(75), XX(1)
      COMMON /DTRM/ RMAG, BTMIN, BTMAX, BTDEL, DETERM, IBETA
C     BAND MATRIX SOLUTION
C     SOLVING THE DECOMPOSED BAND MATRIX, GIVEN A COLUMN VECTOR B.
C     THE DECOMPOSED BAND MATRIX IS OBTAINED FROM SUBROUTINE BMAT AND SI
C     IN ARRAY BAND.
C     THAT IS, SOLVE (LU)X = B FOR X, FOR A GIVEN B.
C     VARIABLE DICTIONARY FOR ARGUMENT LIST
C     NP = NO. OF SUPERDIAGONALS IN BAND MATRIX
C     NB = NO. OF SUBDIAGONALS    IN BAND MATRIX
C     NR = NO. OF ROWS            IN BAND MATRIX
C     BAND(I)= ARRAY CONTAINING THE DECOMPOSED BAND ELEMENTS.
C     B(I) = COLUMN VECTOR IN MATRIX EQUATION (BAND) X = B
C     X(I) = SOLUTION VECTOR FOR ABOVE MENTIONED MATRIX EQUATION.
      NC = NP + NB + 1
      NEL= NC * NR
C     CALCULATE DETERMINANT OF MATRIX
      DETERM = 1.
      DO 1000 I=1,NR
      IDIG = NB+1 + (I-1) * ( NP+NB+1)
 1000 DETERM = DETERM * BAND(IDIG)
C     SOLVING FOR X IN AX = B
C     BAND MATRIX A IS DECOMPOSED INTO LU
C     THEREFORE  (L * U) X = B
C     CALL               UX = Z,  THEN LZ = B
C     NOTE - DUE TO THE ANALYTICAL PROCEDURE, IT IS NOT NECESSARY TO MA
C            SEPARATE STORAGE LOCATIONS FOR ARRAYS X AND Z. FOR EACH EQ
C            IN WHICH X HAS BEEN SUBSTITUTED FOR Z, A COMMENT CARD PRECE
C            THE EQUATION AND CONTAINS THE ACTUAL ANALYTICAL EQUATION.
C     SOLVING LOWER TRIANGULAR FORM LZ=B FOR GIVEN B.
C     Z(1) = B(1)
      X(1) = B(1)
      ID = NB + 1 + NC
      DO 500 K=2,NR
      S = B(K)
      DO 400 I=1,NB
      IF ((K-I) .LE. 0) GO TO 450
      BD = BAND(ID-I)
C     DP = Z(K-I)
      DP = X(K-I)
      S  = S - BD * DP
  400 CONTINUE
  450 ID = ID + NC
C     Z(K) = S
```

```
      X(K) = S
  500 CONTINUE
C     SOLVING UPPER TRIANGULAR FORM UX = Z FOR THE ABOVE Z.
C     X(NR) = Z(NR) / BAND(NEL-NP)
      X(NR) = X(NR) / BAND(NEL-NP)
      KK = NR-1
      KR = KK
      DO 700 KKK=1,KK
      ID = KR*NC -NP
C     S = Z(KR)
      S = X(KR)
      DO 600 I=1,NP
      IF ( NP .EQ. 0 ) GO TO 600
      IF ((KR+I) .GT. NR) GO TO 650
      BD = BAND(ID+I)
      DP = X(KR+I)
      S = S - BD * DP
  600 CONTINUE
  650 BD = BAND(ID)
      X(KR) = S/BD
      KR= KR-1
  700 CONTINUE
      DO 800 I=1,NR
  800 XX(I) = X(I)
      RETURN
      END
```

```
C          DATA SET B28DTEMRIS AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET C75CTEMRIS AT LEVEL 001 AS OF 07/13/76
      SUBROUTINE TEMRIS (TEMP, FA, PPSI, DELT, XLHV)
C TRISE  GENERAL TEMPERATURE RISE PROGRAM                  DECK 6095
C MODIFIED 12SEP77 TO EXTRAPOLATE TO INLET TEMPERATURES LESS
C THAN 400 DEG RANKINE & TO PRINT ERROR MESSAGE
      DIMENSION CRV(416),KC( 5),PA( 5),Y(2)
      DATA PA/.333,1.,3.333,10.,20./
      DATA KC/1,82,158,241,332/
      EQUIVALENCE (CRV(1),CRVO11(1)),(CRV(82),CRVO12(1)),(CRV(158)
     1, CRVO13(1)),(CRV(241),CRVO14(1)),(CRV(332),CRVO15(1))
      DIMENSION CVO11(76)
      EQUIVALENCE (CRVO11( 1), CVO11( 1))
      DIMENSION CVO13(76)
      EQUIVALENCE (CRVO13( 1), CVO13( 1))
      DIMENSION CVO14(76)
      EQUIVALENCE (CRVO14( 1), CVO14( 1))
      DIMENSION CVO15(76)
      EQUIVALENCE (CRVO15( 1), CVO15( 1))
C       PZE CRV11  DF-33966 TEMP RISE=F(F/A,TT2) PO=.333   S.H.=0.      JP5
      DIMENSION CRVO11( 81)
      DATA CVO11  / 4H    , 4H         , 0.49999999E-02, 0.89999998E-01
     X, 0.40000000E 03, 0.21999999E 04, 0.29999999E-01, 0.40000000E 01
     X, 0.80000000E 02,-0.13999999E 01, 0.11111110E-02,-0.14444444E 01
     X,-0.13834636E 01,-0.50939079E 01, 0.47743057E-00,-0.76961371E 01
     X, 0.33766526E-00,-0.44123651E 02,-0.59063575E 01,-0.55629952E 01
     X,-0.69494746E 02, 0.72405308E 03,-0.90109405E 01,-0.22627641E 01
     X, 0.20524796E 02,-0.12265246E 03, 0.11007864E 04, 0.61999999E-01
     X, 0.50000000E 01, 0.62499999E 02,-0.28749999E 01, 0.11111110E-02
     X,-0.14444444E 01, 0.10568205E 02, 0.11445136E 02, 0.29369278E 01
     X, 0.10917355E 02, 0.23093481E 02,-0.33141516E 02, 0.13862297E 02
     X, 0.32243802E 02,-0.40962530E 02,-0.14434102E 03, 0.27958808E 01
     X, 0.11522203E 02,-0.28871720E 02,-0.21055271E 03, 0.59706444E 03
     X, 0.12880166E 01,-0.38360645E 01,-0.15901842E 02,-0.45276318E 02
     X,-0.35196384E 03, 0.24957401E 04, 0.89999996E-01, 0.50000000E 01
     X, 0.71428570E 02,-0.54285713E 01, 0.11111110E-02,-0.14444444E 01
     X,-0.37695136E 01,-0.15674456E 02, 0.93605640E 01, 0.37101162E 02
     X,-0.37291785E 02, 0.84586617E 01,-0.10901603E 02,-0.98135633E 01
     X, 0.95818713E 02,-0.12548207E 03, 0.42655104E 01,-0.25816980E 01
     X,-0.53401285E 02, 0.86214545E 02,-0.99939387E 01, 0.77261013E 00
     X/
      DIMENSION COO1(  5)
      EQUIVALENCE(CRVO11( 77),COO1(1))
      DATA COO1 /       -0.10952524E 01, 0.85139993E 01,-0.37314649E 02
     X,-0.59263129E 03, 0.30409201E 04
     X/
C       PZE CRV12  DF-33966 TEMP RISE=F(F/A,TT2) PO=1.0    S.H.=0.      JP5
      DIMENSION CRVO12( 76)
      DATA CRVO12 / 4H    , 4H         , 0.49999999E-02, 0.89999998E-01
     X, 0.40000000E 03, 0.21999999E 04, 0.29999999E-01, 0.30000000E 01
     X, 0.80000000E 02,-0.13999999E 01, 0.11111110E-02,-0.14444444E 01
     X, 0.18084491E 01, 0.25598620E 01,-0.47377232E 02,-0.30955763E 01
     X,-0.75557142E 02, 0.72315708E 03,-0.12538243E 01, 0.95497160E 01
```

```
     X,-0.12292387E 03, 0.11028187E 04, 0.61999999E-01, 0.50000000E 01
     X, 0.62499999E 02,-0.28749999E 01, 0.11111110E-02,-0.14444444E 01
     X,-0.55794874E 00, 0.13170248E 02, 0.21780886E 01, 0.18198347E 02
     X, 0.15488705E 02,-0.26048174E 02, 0.13233642E 02, 0.19387987E 02
     X,-0.51392150E 02,-0.12620277E 03, 0.28635873E 01, 0.64443620E 01
     X,-0.40359426E 02,-0.18289059E 03, 0.63744988E 03, 0.56515026E 01
     X,-0.68436682E 01,-0.17847223E 02,-0.29232556E 02,-0.32201842E 03
     X, 0.25155839E 04, 0.89999998E-01, 0.50000000E 01, 0.71428570E 02
     X,-0.54285713E 01, 0.11111110E-02,-0.14444444E 01,-0.13769680E 02
     X,-0.13177426E 02, 0.12192437E 02, 0.43960214E 02,-0.58781216E 02
     X, 0.33511422E 02,-0.14736564E 02, 0.22430874E 01, 0.95364440E 02
     X,-0.15451889E 03, 0.36681000E 01,-0.86575832E 01,-0.51047847E 02
     X, 0.11545467E 03,-0.43063209E 02, 0.15298486E 01,-0.21108501E-00
     X, 0.61557582E 01,-0.42230023E 02,-0.54747444E 03, 0.31217436E 04
     X/
C       PZE CRV13  DF-33966 TEMP RISE=F(F/A,TT2) PO=3.333 S.H.=0.
      DIMENSION CRV013( 83)
      DATA CV013  / 4H    , 4H          , 0.49999999E-02, 0.89999998E-01
     X, 0.40000000E 03, 0.21999999E 04, 0.29999999E-01, 0.30000000E 01
     X, 0.80000000E 02,-0.13999999E 01, 0.11111110E-02,-0.14444444E 01
     X, 0.22280093E 01, 0.40726461E 01,-0.46363929E 02,-0.14957386E 01
     X,-0.73708441E 02, 0.72323057E 03, 0.10325611E-00, 0.10598011E 02
     X,-0.12387981E 03, 0.11025447E 04, 0.61999999E-01, 0.50000000E 01
     X, 0.62499999E 02,-0.28749999E 01, 0.11111110E-02,-0.14444444E 01
     X, 0.42666668E-00, 0.16154609E 02,-0.87272730E 00, 0.18946281E 02
     X, 0.16793389E 01,-0.28603704E 02, 0.11860086E 02, 0.72374559E 01
     X,-0.57770953E 02,-0.10280920E 03, 0.26086922E 01, 0.21229458E 01
     X,-0.42463212E 02,-0.14598709E 03, 0.67302850E 03, 0.53360699E 01
     X,-0.37769614E 01,-0.16326205E 02,-0.18819857E 02,-0.29494584E 03
     X, 0.25307350E 04, 0.89999998E-01, 0.59999999E 01, 0.71428570E 02
     X,-0.54285713E 01, 0.11111110E-02,-0.14444444E 01, 0.13732976E 02
     X, 0.55035750E 02,-0.30548328E 02,-0.31598216E 02, 0.20814981E 01
     X, 0.35865293E 01, 0.44925446E 01, 0.40762997E 02,-0.15302914E 03
     X, 0.76453541E 02,-0.30391904E 01,-0.11904426E 02, 0.47753501E 02
     X, 0.70851698E 02,-0.18643314E 03, 0.22297149E 01, 0.84682928E 00
     X,-0.17377479E 02,-0.35076267E 02, 0.15775427E 03,-0.92999332E 02
     X/
      DIMENSION C002(   7)
      EQUIVALENCE(CRV013( 77),C002(1))
      DATA C002 /       -0.84575396E 00, 0.29177525E 01, 0.20401952E 01
     X,-0.63280181E 00,-0.46892191E 02,-0.49265007E 03, 0.31970481E 04
     X/
C       PZE CRV14  DF-33966 TEMP RISE=F(F/A,TT2) PO=10.0  S.H.=0.
      DIMENSION CRV014( 91)
      DATA CVC14  / 4H    , 4H          , 0.49999999E-02, 0.89999998E-01
     X, 0.40000000E 03, 0.21999999E 04, 0.29999999E-01, 0.30000000E 01
     X, 0.80000000E 02,-0.13999999E 01, 0.11111110E-02,-0.14444444E 01
     X, 0.27054399E 01, 0.53297484E 01,-0.45904019E 02,-0.28490260E-00
     X,-0.72658441E 02, 0.72301579E 03, 0.14160839E-00, 0.11352272E 02
     X,-0.12347148E 03, 0.11023968E 04, 0.61999999E-01, 0.50000000E 01
     X, 0.62499999E 02,-0.28749999E 01, 0.11111110E-02,-0.14444444E 01
     X,-0.18379488E 01, 0.69899556E 01,-0.59822845E 01, 0.14475207E 02
     X,-0.96822774E 01,-0.24567702E 02, 0.75165860E 01,-0.10081169E 01
```

```
     X,-0.41495395E 02,-0.79884857E 02, 0.37158929E 01,-0.63133743E 00
     X,-0.39370436E 02,-0.11454803E 03, 0.69732666E 03, 0.20765986E 01
     X,-0.54497106E 01,-0.11160222E 02,-0.62589833E 01,-0.27993259E 03
     X, 0.25388731E 04, 0.89999998E-01, 0.70000000E 01, 0.71428570E 02
     X,-0.54285713E 01, 0.11111110E-02,-0.14444444E 01, 0.10522443E 02
     X,-0.84630529E 02, 0.39647946E 02,-0.24772479E 02, 0.69868640E 02
     X,-0.55198689E 02, 0.17446780E 02,-0.45914562E 02, 0.13779138E 03
     X,-0.35097630E 02,-0.80224490E 01, 0.14819852E 02, 0.65746176E 02
     X,-0.19383461E 03, 0.12623758E 03, 0.13253794E 01,-0.80106048E 01
     X,-0.23822637E 02, 0.73180402E 02,-0.86547222E 00,-0.19394288E 03
     X/
      DIMENSION C003( 15)
      EQUIVALENCE(CRV014( 77),C003(1))
      DATA C003 /       -0.57665043E-01, 0.73929541E 00, 0.52074192E 01
     X,-0.22080105E 02,-0.27097432E 02, 0.17510998E 03,-0.14469204E 03
     X,-0.85625321E 01, 0.31139125E 01, 0.17088836E 02,-0.33933540E 01
     X,-0.10237508E 02,-0.42254121E 02,-0.44120632E 03, 0.32502860E 04
     X/
C       PZE CRV15  DF-33966 TEMP RISE=F(F/A,IT2) P0=20.0  S.H.=0.      JP5
      DIMENSION CRV015( 85)
      DATA CV015  / 4H    , 4H           , 0.49999999E-02, 0.89999998E-01
     X, 0.40000000E 03, 0.21999999E 04, 0.29999999E-01, 0.30000000E 01
     X, 0.80000000E 02,-0.13999999E 01, 0.11111110E-02,-0.14444444E 01
     X, 0.27633102E 01, 0.59324270E 01,-0.45546875E 02, 0.43831170E-00
     X,-0.72081818E 02, 0.72291723E 03, 0.46012763E-00, 0.11633523E 02
     X,-0.12371477E 03, 0.11022823E 04, 0.61999999E-01, 0.40000000E 01
     X, 0.62499999E 02,-0.28749999E 01, 0.11111110E-02,-0.14444444E 01
     X,-0.27897430E 01,-0.10825344E 02,-0.16086195E 02,-0.59132233E 01
     X,-0.26809445E 02,-0.73565315E 02,-0.15978147E 01,-0.21845455E 02
     X,-0.10155672E 03, 0.70109022E 03,-0.67839272E 01,-0.41892483E 01
     X, 0.19678856E 01,-0.27364410E 03, 0.25431748E 04, 0.89999998E-01
     X, 0.70000000E 01, 0.71428570E 02,-0.54285713E 01, 0.11111110E-02
     X,-0.14444444E 01,-0.38700332E 01,-0.11812907E 03, 0.58871721E 02
     X,-0.77828673E 01, 0.72402935E 02,-0.48967353E 02, 0.52289867E 01
     X,-0.49363377E 02, 0.21101776E 03,-0.67768156E 02,-0.32198828E 01
     X, 0.16815599E 02, 0.29021554E 02,-0.20544367E 03, 0.16032206E 03
     X, 0.99605371E 00,-0.56074470E 01,-0.79355039E 01, 0.74772408E 02
     X,-0.53517517E 02,-0.18976718E 03,-0.56600067E 01, 0.17920520E 01
     X, 0.81747187E 01,-0.24689963E 02,-0.61785530E 01, 0.17684626E 03
     X/
      DIMENSION C004(  9)
      EQUIVALENCE(CRV015( 77),C004(1))
      DATA C004 /       -0.18164793E 03, 0.22823727E 01,-0.88419732E 00
     X,-0.13271917E 01, 0.33648799E-04,-0.49178839E 01,-0.37280399E 02
     X,-0.41150196E 03, 0.32766557E 04
     X/
      PPSF = PPSI * 144.0
      P = PPSF /2116.216
      T = TEMP
      F = FA
      DO 5 K=2,5
      IF(P .LE. PA(K))GO TO 140
    5 CONTINUE
```

```
      K = 5
  140 F = F * XLHV   / 18500.0
      DO 220  I = 1,2
      KI = K + I - 2
      KK = KC(KI)
      Y(I) = PVAL (CRV(KK), F, T, 2, IE)
      IF (IE.NE.1) GO TO 220
      Y(I) = Y(I) * F / .005
  220 CONTINUE
      DELT=(Y(2)-Y(1))*((P-PA(K-1))/(PA(K)-PA(K-1))) + Y(1)
C EXTRAPOLATION TO INLET TEMPERATURES LESS THAN 400 DEG RANKINE
      IF(TEMP .LT. 400.)DELT = DELT*(1.-1.44E-4*(TEMP-400.))
C ERROR MESSAGE
      IF(IE .EQ. 0)GO TO 600
      GO TO(600,400,600,400,600,400,400,400),IE
 400  WRITE(6,500)IE,TEMP,FA
 500  FORMAT(T2,'UPPER LIMIT ON FUEL/AIR (.09) OR INLET TEMP (2200 R) WA
     XS EXCEEDED IN SUBR. TEMRIS - IE,TEMP,FA=',
     YT100,I1,T110,F10.1,T120,F10.4)
 600  RETURN
      END
```

```
C          DATA SET B28DTIDEAL AT LEVEL 001 AS OF 12/07/78  E33
C          DATA SET B28DINPUT  AT LEVEL 013 AS OF 02/23/78
      SUBROUTINE TIDEAL (FA,FAV,P,T,XLHV,
     X                  DTI,DTIP,DTIT,FAT,TF,ZTF)
C IDEAL TEMP RISE (DTI) VS. FUEL/AIR (FA) ,
C ACCOUNTING FOR VITIATED FUEL/AIR (FAV)
C FIND FICTICIOUS INLET TEMP (TF) WHICH YIELDS DTIP=T-TF AT FAV
      DTIP = 0.
      DO 1000 J=1,10
      TF     = T-DTIP
      CALL TEMRIS(TF,FAV,P,DTIP,XLHV)
      TX     = TF+DTIP
      IF(ABS(TX-T) .LE. 5.)GO TO 1005
 1000 CONTINUE
      WRITE(6,1001)
 1001 FORMAT(T2,'CONVERGENCE FAILURE AUGMENTOR IDEAL TEMPERATURE RISE')
      WRITE(6,1002)TF,FAV,P,DTIP,XLHV,TX
 1002 FORMAT(T2,'TF,FAV,P,DTIP,XLHV,TX=',T30,6E15.5)
 1005 FAT    = FAV+(1.+FAV)*FA
      CALL TEMRIS(TF,FAT,P,DTIT,XLHV)
      DTI    = DTIT-DTIP
C D'LESS PARTIAL OF IDEAL TEMP RISE WITH FUEL/AIR (ZTF)
      FA1    = AMAX1(FAT-.002,0.)
      CALL TEMRIS(TF,FA1,P,DTI1,XLHV)
      FA2    = FAT+.002
      CALL TEMRIS(TF,FA2,P,DTI2,XLHV)
      ZTF    = 1.
      IF(DTI1 .GT. 0.)ZTF  = FA/DTI*(DTI2-DTI1)/(FA2-FA1)*(1.+FAV)
      RETURN
      END
```

```
C          DATA SET B28DUNBAR  AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE UNBAR(T,IK,XIN,YIN,ZZ,KK)
CNAME     UNBAR(T,IK,XIN,YIN,ZZ,KK)
CDATE     MARCH 4,1961  REVISED 7/62
CPURPOSE  TO INTERPOLATE A UNIVARIATE OR BIVARIATE TABLE.
CUSAGE    THE ARGUMENTS IN THE LIST ARE DEFINED AS FOLLOWS-
C         T =NAME OF THE ARRAY WHICH CONTAINS THE TABLE VALUES.
C         IK =ELEMENT OF THE ARRAY AT WHICH THE TABLE STARTS. IF YOU HAVE
C         ONLY ONE TABLE IN THE ARRAY, IK=ONE.
C         XIN=INDEPENDENT VARIABLE IN THE X-SENSE.
C         YIN=INDEPENDENT VARIABLE IN THE Y-SENSE. IF THE TABLE IS A
C         UNIVARIATE, THEN YIN IS ZERO.
C         ZZ =DEPENDENT VARIABLE.
C         KK =OFF TABLE INDICATOR.
C         =0 NORMAL EVALUATION.
C         =1 OFF ON X MIN.
C         =2 OFF ON X MAX.
C         =3 OFF ON Y MIN.
C         =4 OFF ON X MIN. AND Y MIN.
C         =5 OFF ON X MAX. AND Y MIN.
C         =6 OFF ON Y MAX.
C         =7 OFF ON X MIN. AND Y MAX.
C         =8 OFF ON X MAX. AND Y MAX.
C         = LESS THAN 0, TABLE SET UP WRONG.
C         IF EITHER VARIABLE IS OFF THE TABLE, UNBAR WILL RETURN THE
C         CORNER VALUE. THIS IMPLIES THAT UNBAR WILL NOT EXTRAPOLATE
C         AND DOES NOT RECOGNIZE ANY DISCONTINUITIES.
C         THE TABLE MUST BE SET UP AS FOLLOWS-ALL NUMBERS ARE IN FLOATING
C         POINT MODE.
C         T(IK) =CURVE NO.
C         T(IK+1) =NX. NO. OF X VALUES.
C         T(IK+2) =NY. NO. OF Y VALUES. (IN UNIVARIATE MAKE ZERO.)
C         T(IK++) =X VALUES IN ASCENDING ORDER.
C         T(IK++) =Y VALUES IN ASCENDING ORDER.
C         T(IK++) =Z VALUES. PUT THEM IN FOLLOWING ORDER-Z(1,1),Z(1,2),
C         Z(1,3)---Z(1,NY),Z(2,1),Z(2,2)---Z(2,NY)---Z(NX,1),
C         Z(NX,2)---Z(NX,NY). FOR BIVARIATE ONLY.
C         IN THE REVISED UNBAR THERE IS THE OPTION OF USING A FIRST, SECO
C         THIRD ORDER INTERPOLATION EQUATION. TO USE THIS OPTION PUT THE
C         DEGREE IN FLOATING POINT BETWEEN T(IK) AND T(IK+1). IF THIS NUM
C         IS GREATER THAN 3.0, THEN THE ASSUMTION IS MADE THAT THIS IS TH
C         NUMBER OF X,S. THIS MEANS THAT TABLES THAT WERE SET UP FOR THE
C         UNBAR CAN BE USED IN THE REVISED EDITION. THUS THE REVISED TABL
C         BE AS FOLLOWS.
C         T(IK) =CURVE NO.
C         T(IK+1)=DEGREE OF INTERPOLATION.
C         T(IK+2)=NX. NO. OF X VALUES.
C         ETC.
C         NOTE. WHEN DOING AN N-TH DEGREE INTERPOLATION, YOU MUST HAVE AT
C         LEAST N+1 POINTS. N = 1, 2, OR 3.
      DIMENSION DUMXD(2)
      DIMENSION T(1),X(6),Y(6),A(6)
C  ------------------ MARCH 4, 1961 ------------
```

```
C  ------------------- MODIFIED 7/62 ------------------
C  -------------------   TO DO QUADRATIC AND LINEAR INTERPOLATION ALSO
      IU = 0
      KK = 0
      KY = 0
      II = IK+1
      N = 3
      N2= 2
         IF (T(II)-3.) 700,701,702
 700     IF (T(II)+0.) 60,701,704
 704     IF (T(II)-2.) 705,706,701
 705  N = 1
         GO TO 707
 706  N = 2
 707  N2= 1
 701  II = II +1
 702  N1 = N +1
         DO 50 L = II,II
         IF ( T(L) + 0. ) 60,60,51
 60    KK = -1
       ZZ = 0.
        GO TO 9999
 51   NX = T(L) + .5
         IF (T(L+1) + 0. ) 60,52,50
 52   NY = 0
         GO TO 53
 50   NY = T(L+1) + .5
 53     CONTINUE
      KK  = 0
      KY  = 0
      XX  = XIN
      YY  = YIN
      J1  = II+2
      J2  = NX+II+1
      IF(XX-T(J1))301,306,400
 400     DO 302 J=J1,J2
         IF (XX-T(J)) 304,304,302
 302  CONTINUE
 309  KK  = 2
      XX  = T(J2)
 308  JX1 = J2-N
         GO TO 305
 301  KK  = 1
      XX  = T(J1)
 306  JX1 = J1
         GO TO 305
 304     IF (J-J1-1) 301,306,307
 307     IF (J-J2)   303,308,309
 303  JX1 = J-N2
 305  CONTINUE
      XINT  = XX
        IF (NY) 1500, 1500, 3000
 1500    DO 1599 L=1,N1
```

```
          X(L) = T(JX1)
          LY = JX1 + NX
          Y(L) = T(LY)
 1599   JX1 = JX1+1
      I = 1
      GO TO 54
 3000 J1  = J1+NX
      J2  = J2+NY
      IF(YY-T(J1))311,316,401
 401        DO 312 J=J1,J2
            IF (YY-T(J)) 314,314,312
 312  CONTINUE
 319  KY  = 6
      YY  = T(J2)
 318  JY1 = J2-N
            GO TO 315
 311  KY  = 3
      YY  = T(J1)
 316  JY1 = J1
            GO TO 315
 314        IF (J-J1-1) 311,316,317
 317        IF (J-J2)   313,318,319
 313  JY1 = J-N2
 315  CONTINUE
      JX2  = JX1
      LY   = JY1 + NY*(JX2-I1-1)
      LY1 = LY
            DO 3099 L=1,N1
      X(L) = T(JX2)
      Y(L) = T(LY1)
      LY1  = LY1+NY
 3099 JX2  = JX2+1
      I    = 0
            GO TO 54
 3096  Y(1)  = Z2
            DO 4400 I=1,N
      LY1 = LY+1
      Y(I+1) = 0.
            DO 4050 MM=1,N1
      Y(I+1) = Y(I+1) + T(LY1)*X(MM)
 4050 LY1 = LY1+NY
 4400  CONTINUE
            DO 4199 L=1,N1
      X(L) = T(JY1)
 4199 JY1  = JY1+1
      XINT = YY
      I=  1
 54   D  = 1.
      X(N+2) = X(1)
      X(N+3) = X(2)
            DO 55 J=1,N1
      A(J+1) = X(J+1) - X(J)
      TPAL1  = XINT - X(J)
```

```
      IF ( TPAL1 ) 57,58,57
 58    ZZ = Y (J)
      X(1) = 0.
      X(2) = 0.
      X(3) = 0.
      X(4) = 0.
      X(J) = 1.0
      GO TO 59
 57  D = D * TPAL1
          GO TO (711,712,713) ,N
711  X(J)  = TPAL1/A(J+1)
          GO TO 55
712  X(J)  = -TPAL1
          GO TO 55
713  X(J)  = (X(J+2)-X(J))*TPAL1
55       CONTINUE
     A(1) = A(N+2)
     ZZ = 0.
         DO 56 J=1,N1
       X(J) = D/(A(J)*A(J+1)*  X(J))
     ZZ = ZZ + Y(J)*  X(J)
56       CONTINUE
 59        IF (I) 3098,3098,9999
9999 KK  = KK+KY
         RETURN
     END
```

```
C          DATA SET B28DWAKE    AT LEVEL 001 AS OF 12/07/78  E33
      SUBROUTINE WAKE(K, DTFI)
C PURPOSE     EVALUATES WAKE REACTION EFFICIENCY AND TEMPERATURE
      COMMON /CINPT/FMW,PFSR,PS,TFSR,JFUEL,VA,TA,XF,TAU,ALPHA,FAR
     X,XL,EPS,CDFM,FARMB,ISTRM,WEXT,TEXT
      COMMON /OTPUT/ MOOTA,MOUTF,MDTFLO,MDTFVG,BETA1,B2,DL(5),B1(5),
     XTLF(5),MDTFC,K1,PSI,TLFEX,B3,TW,    ETAFM
     X,DLO(5),B1E,DMOUT,BOC,RTVO,DQOUT,Y,SL,EPSO,V,XO,EPSXO,ETAO
     X,STO,X1(100),EPSX1(100),ST1(100),ETA(100),NSTEP,TAEFF
      COMMON /MISC/ RHOA,MUA,ADUCT,PI,LDC,  FMWTMP,B1T,KM,TFO,DLF(5)
     X,BETA2(5),ETAW,MDTFL1,TLC,MDOTFL(5),FARW,STBAR,FARE
      COMMON /CRVS/ CRVMUA(44),CRVKM(44),CRVLAM(22),CRVPV(24)
     X,CRVSL(36),CRVPR(30), TRJP4(285),CRVTSL(26)
     X,CRVCPT(26),CRVPT(26),CRVPTR(24),CRVSLE(16),CRVEVP(16),CRVTSP(16)
      DIMENSION  STOIFA(4)
      DATA  STOIFA  /.068,.069,.069,.064 /
      TOL   = .001
      STFAR = STOIFA(JFUEL)
      PHI  =  FARW/ STFAR
      IF (ISTRM .EQ.1) TAEFF = TA
C   CURVE IS THE SAME FOR JP4 AND JP5
      CALL UNBAR  (TRJP4,1,FARW,TAEFF,DTFI,KS)
      DTFI  =  DTFI / 1.8
      TAR =  ( TAEFF + 460. ) / 1.8
      KK = 0
C  2489444  CONVERTS FROM ENG TO SCI UNITS
C  17.3  INCREASES EFFECTIVE LOADING TO BRING THEORETICAL BLOWOUT
C    LIMITS IN LINE WITH EXPERIENCE
      Y = PSI * 2489444. * 2.96
      KK   =  0
      YO = 0.0
      ETAL = .999
      ETAR = .7
      YL = PSIC(ETAL,DTFI,TF,TAR,PHI)
   53 YR = PSIC(ETAR,DTFI,TF,TAR,PHI)
      DELL = (Y-YL)/Y
      DELR = (Y-YR)/Y
      IF(DELR)55,55,54
   54 ETAR = ETAR + .001
      IF(YR .LT. YO)GO TO 998
      YO = YR
      GO TO 53
   55 ETA2 = -DELL * (ETAR-ETAL)/(DELR-DELL) + ETAL
      Y2 = PSIC(ETA2,DTFI,TF,TAR,PHI)
      DEL2 = (Y-Y2)/Y
      IF(ABS(DEL2)-.001)70,60,60
   60 IF(KK .GT. 100)GO TO 999
      KK = KK + 1
      IF(DEL2*DELL .LT. 0.)GO TO 65
      ETAL = ETA2
      DELL = DEL2
      GO TO 55
   65 ETAR = ETA2
```

```
      DELR = DEL2
      GO TO 55
   70 ETAW = ETA2
   50 TW  = 1.8 * TF - 460.
      GO TO 1000
C 999 WRITE(6,997)
C 997 FORMAT(// ' WAKE EFFICIENCY ITERATION FAILED'//)
  999 K = 1
      GO TO 1000
C 998 WRITE(6,996)Y,YR
C 996 FORMAT('*****  WAKE ITERATION FAILED  *****'/'     AERODYNAMIC
C    XLOADING EXCEEDS KINETIC CAPACITY'//7X,'AERODYNAMIC LOADING = ',
C    XF12.4,'  GM-MOLE/LITRE ATM**2 SEC'/7X,'KINETIC CAPABILITY  = ',
C    XF12.4,'  GM-MOLE/LITRE ATM**2 SEC')
  998 K = 1
 1000 RETURN
      END
***** ABOVE ACTION SATISFACTORILY COMPLETED *****
```

APPENDIX D

COMPUTER PROGRAM TEST CASES

```
PRATT & WHITNEY AIRCRAFT DIVISION                         VER      12/07/78      PAGE      SERIAL
CSG.PAN757                                                10.0     10.35.37         1      021269

                                         PANVALET
                          THE PROGRAM MANAGEMENT AND SECURITY SYSTEM

         PROGRAMS AND ALL SUPPORTING MATERIALS COPYRIGHT 1975 BY PANSOPHIC SYSTEMS, INCORPORATED

++WRITE PRINT,PREFIX=B282
```

```
*             DATA SET B282F105   AT LEVEL 001 AS OF 03/29/78
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE
 $INPUT NCOMOP=2, NAUGOP=1, NFSUP=1, JFUEL=1, NPRNTR=0, NPRNTF=1,
        NTC=1,NTH=1,EPSC=.040,EPSH=.040,FAV=.021,M6C=.15,M6H=.28,
        PS6=7.92,T3H=1355.,
        ALPHAC=60.,FAC=.0595,FHWC=1.06,LSC=4.,NSC=1,PFSR=134.7,
        TFSR=560.,TAUC=.256,TEXT=0.,WEXT=0.,T6C=700.,XLC=66.,
        ALPHAH=60.,FAH=.040,FHWH=.755,LSH=8.,NSH=1,TAUH=.166,T6H=1775.,
        XLH=66.,WCOOL=0.08,BPR=.59,DPD=.064,DPH=.032,DPS=0.,LA=82.,
        LB=66.,LC=72.,LH=14.,L2=36.,M6R=.22,PRNOZ=4.4,TCORE=.005,
 $END
08/07     01/07     41/07
 19         1.        1.        1.        1.                  0.      250.

 0.        5.        80.
 90.0      10.       250.

 .01       -1.

1 CASE 2 RUMBLE VEEGUTTER F/H*REMOTE*F/H COMB. MODEL TEST CASE
 $INPUT NCOMOP=2, NAUGOP=1, NFSUP=2, JFUEL=1, NPRNTR=0,NPRNTF=0,
 $END
0 CASE 3 RUMBLE VEEGUTTER F/H*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE
 $INPUT NCOMOP=1, NAUGOP=1, NFSUP=1, JFUEL=1, NPRNTR=0,
        BPR=.59,   LA=82.,   M6H=.28,   T6H=1780.,
        DPD=.064,  LB=66.,   M6R =.22,  ZEFC=-5.5,
        DPH=.032,  LC=72.,   ZEFH=.4,   TCORE=.005,
        DPS=0.,    LH=14.,   ZEPC=0.,
        ETAC=.4,   LI=5.,    ZEPH=0.,
        ETAH=.91,  LR=60.,   ZETC=0.,
        FAC=.0595, LSC=4.,   PRNOZ=4.4, ZETH=0.,
        FAH=.04,   LSH=8.,   PS6=7.,    ZEVC=0.,
        FAV=.021,  L2=36.,   T6C=700.,  ZEVH=0.,
        M6C = .15,
 $END
08/07     01/07     41/07
 19         1.        1.        1.        1.                  0.      250.

 0.        5.        25.
 27.5      2.5       75.
 80.       5.        250.
 .01       -1.

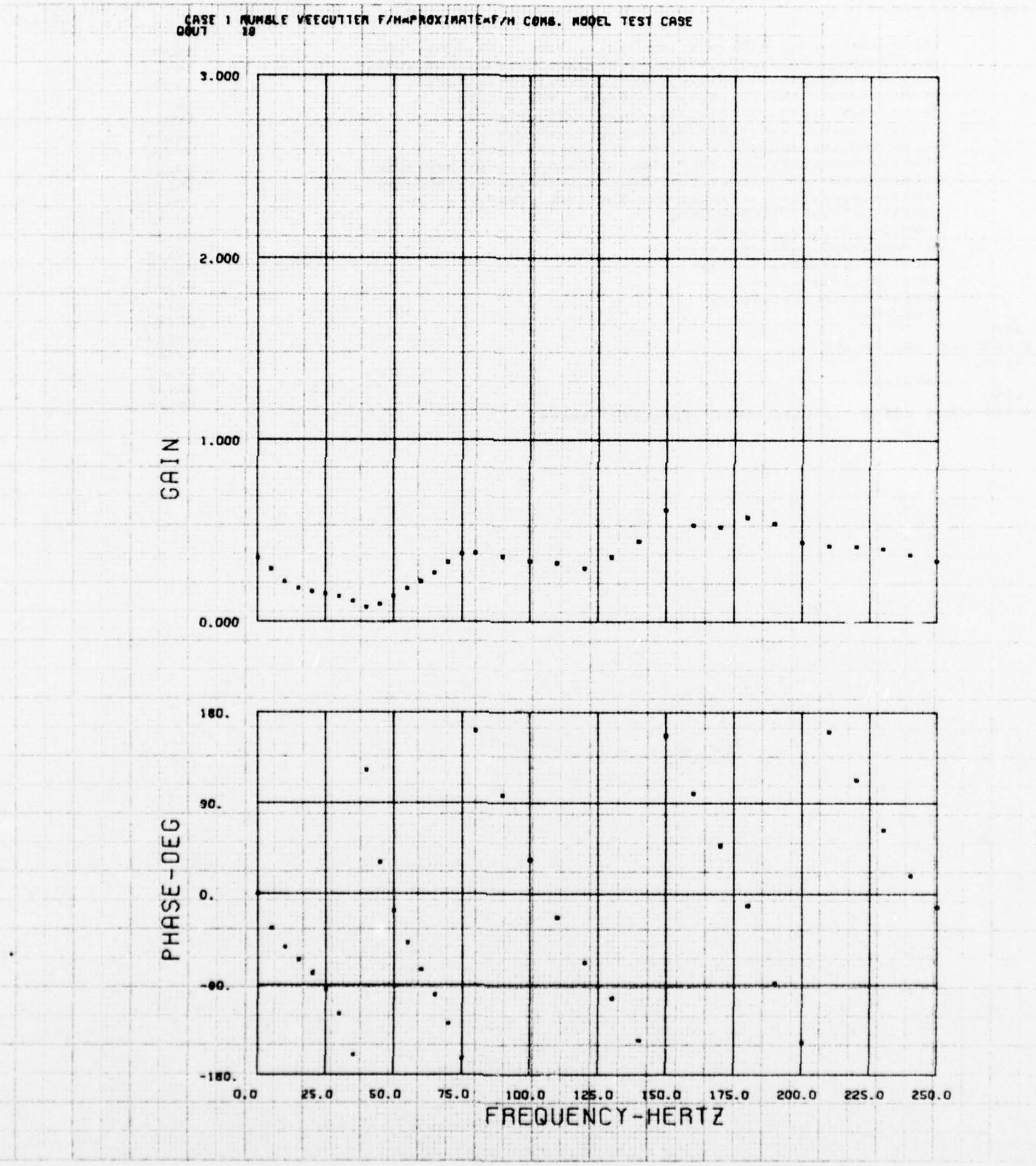
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE
 $INPUT NCOMOP=1, NAUGOP=1, NFSUP=2, JFUEL=1, NPRNTR=0,
 $END
08/07     01/07     41/07
 19         1.        1.        1.        1.                  0.      250.

 0.        5.        80.
 90.0      10.       250.

 .01       -1.
```

```
1 CASE 5 RUMBLE VEEGUTTER F/H*PROXIMATE*EMPERICAL*JP5*TAB&PLOT*TEST CASE
 $INPUT NCOMUP=1, NAUGUP=1, NFSUP=1, JFUEL=2, NPRNTR=0,
 $END
1 CASE 6 RUMBLE VEEGUTTER F/H*PROXIMATE*EMPERICAL*JP4*PLOT ONLY*TEST CAS
 $INPUT NCOMUP=1; NAUGUP=1, NFSUP=1, JFUEL=1, NPRNTR=1,
 $END
1 CASE 7 RUMBLE VORBIX*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE
 $INPUT NCOMUP=1, NAUGUP=2, NFSUP=1, JFUEL=1, NPRNTR=0,
        ETA=.85, FA=.05, LR=30., ZEF=-.04, ZEFP=0., ZEP=0.,
 $END
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE
 $INPUT NCOMUP=1, NAUGUP=2, NFSUP=2, JFUEL=1, NPRNTR=0,
 $END
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE
 $INPUT NCOMUP=1,NAUGUP=3,NFSUP=1,JFUEL=1,NPRNTR=0,
        ETA=.68, DPCS=.005, DPHS=.005, ZEF=-.6,
 $END
1 CASE 10 RUMBLE SWIRL*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE
 $INPUT NCOMUP=1, NAUGUP=3, NFSUP=2, JFUEL=1, NPRNTR=0,
 $END
1 CASE 11 F/H COMBUSTION MODEL*JP4*FULL TAB*TEST CASE
 $INPUT NCOMUP=3,JFUEL=1,NPRNTF=1,
  PS6=15.,EPSC=.04,EPSH=.04,M6C=.25,M6H=.25,NTC=10,
         NTH=4,NSC(1)=2,2,2,2,2,3,3,3,3,3,NSH(1)=10,10,10,10,
         T6C(1)=660.,670.,670.,670.,670.,710.,710.,710.,710.,710.,
         FAC(1)=.040,.045,.050,.050,.045,.045,.050,.050,.045,.040,
         FHWC(1)=1.05,1.05,1.05,1.05,1.05,2.1,2.1,2.1,2.1,2.1,
         ALPHAC(1)=60.,60.,60.,60.,60.,90.,90.,90.,90.,90.,
         TAUC(1)=.27,.27,.27,.27,.35,.27,.27,.35,.35,.27,
         LSC(1)=4.0,4.0,4.0,4.0,4.0,4.0,4.0,4.0,4.0,4.0,
         XLC(1)=66.,66.,66.,66.,66.,66.,66.,66.,66.,66.,
         TFSR(1)=560.,560.,560.,560.,560.,560.,560.,560.,560.,560.,
         PFSR(1)=250.,250.,250.,250.,250.,250.,250.,250.,250.,250.,
         T6H=1660.,1660.,1710.,1710.,
         FAH=.050,.055,.050,.055,
         FHWH=.75,.75,.75,.75,
         ALPHAH=60.,60.,60.,60.,
         TAUH=.25,.25,.25,.25,
         LSH=8.,8.,8.,8.,
         XLH=66.,66.,66.,66.,
         M6C=.25,M6H=.25,FAV=.02,T3H=1360.,WCOOL=.08,BPR=.59,
 $END
1 CASE 12 F/H COMBUSTION MODEL*JP5*FULL TAB*TEST CASE
 $INPUT NCOMUP=3, JFUEL=2, NPRNTF=1,
 $END
1 CASE 13 F/H COMBUSTION MODEL WITH WAKE HEAT ADD*JP4*FULL TAB*TEST CASE
 $INPUT NCOMUP=3, JFUEL=1, NPRNTF=1,
         PS6=15., EPSC=.04, EPSH=.04, M6C=.25, M6H=.25, NTC=10,
         NTH=4, NSC(1)=2,2,2,2,2,3,3,3,3,3, NSH(1)=10,10,10,10,
         WEXT(1)=.1,.1,.1,.1,.1,.1,.1,.1,.1,.1,
         TEXT(1)=3460.,3460.,3460.,3460.,3460.,3460.,3460.,3460.,3460.,
         3460.,
```

```
         TOC(1)=660.,670.,670.,670.,670.,710.,710.,710.,710.,710.,
         FAC(1)=.040,.045,.050,.050,.045,.045,.050,.050,.045,.040,
         FHWC(1)=1.05,1.05,1.05,1.05,1.05,2.1,2.1,2.1,2.1,2.1,
         ALPHAC(1)=60.,60.,60.,60.,60.,90.,90.,90.,90.,90.,
         TAUC(1)=.27,.27,.27,.27,.35,.27,.27,.35,.35,.27,
         LSC(1)=4.0,4.0,4.0,4.0,4.0,4.0,4.0,4.0,4.0,4.0,
         XLC(1)=66.,66.,66.,66.,66.,66.,66.,66.,66.,66.,
         TFSK(1)=560.,560.,560.,560.,560.,560.,560.,560.,560.,560.,
         PFSK(1)=250.,250.,250.,250.,250.,250.,250.,250.,250.,250.,
         TOH(1)=1660.,1660.,1710.,1710.,TSH=1360.,FAV=.02,
         FAH(1)=.050,.055,.050,.055,
         FHWH(1)=.75,.75,.75,.75
         ALPHAH(1)=60.,60.,60.,60.,
         TAUH(1)=.25,.25,.25,.25,
         LSH(1)=8.,8.,8.,8.,
         XLH(1)=66.,66.,66.,66.,
         WCOOL=0.,
 $END
1 CASE 14  END OF JOB
 $INPUT
        STOP=1.,
 $END
***** ABOVE ACTION SATISFACTORILY COMPLETED *****
```


CASE 1 RUMBLE VEEGUTTER F/H=PROXIMATE=F/H COMB. MODEL TEST CASE
QOUT 10
GAIN
PHASE-DEG
FREQUENCY-HERTZ

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

```
*** WARNING - PARAMETER BPR      =  .59000      IS A DEFAULT VALUE
*** WARNING - PARAMETER FAV      =  .21000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER JFUEL    = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER MOC      =  .15000      IS A DEFAULT VALUE
*** WARNING - PARAMETER MOH      =  .28000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NCOMOP   = 2            IS A DEFAULT VALUE
*** WARNING - PARAMETER PS6      =  7.9200      IS A DEFAULT VALUE
*** WARNING - PARAMETER DPJ      =  .64000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER DPS      =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER LA       =  82.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LC       =  72.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LH       =  14.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER L2       =  36.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER MOR      =  .22000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NFSOP    = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER NPRNTR   = 0            IS A DEFAULT VALUE
*** WARNING - PARAMETER PRNOZ    =  4.4000      IS A DEFAULT VALUE
*** WARNING - PARAMETER TCORE    =  .50000E-02  IS A DEFAULT VALUE
*** WARNING - PARAMETER NAUGOP   = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER DPH      =  .32000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER ALPHAC   =  60.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER ALPHAH   =  60.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER EPSC     =  .40000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER EPSH     =  .40000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER FAC      =  .59500E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER FAH      =  .40000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER FHWC     =  1.0600      IS A DEFAULT VALUE
*** WARNING - PARAMETER FHWH     =  .75000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LSC      =  4.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LSH      =  8.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NPRNTF   = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER NSC      =  1.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NSH      =  1.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NTC      =  1.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NTH      =  1.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER PFSR     =  134.70      IS A DEFAULT VALUE
*** WARNING - PARAMETER TAUC     =  .25600      IS A DEFAULT VALUE
*** WARNING - PARAMETER TAUH     =  .18600      IS A DEFAULT VALUE
*** WARNING - PARAMETER TEXT     =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER TFSR     =  560.00      IS A DEFAULT VALUE
*** WARNING - PARAMETER T3H      =  1355.0      IS A DEFAULT VALUE
*** WARNING - PARAMETER T6C      =  700.00      IS A DEFAULT VALUE
*** WARNING - PARAMETER T6H      =  1775.0      IS A DEFAULT VALUE
*** WARNING - PARAMETER WEXT     =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER XLC      =  66.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER XLH      =  66.000      IS A DEFAULT VALUE
```

```
NAMELIST INPUT VALUES
&COMBIN
ALPHAC=  60.0000000    ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,ALPHAH=  60.0000000    ,  .0          ,  .0          ,  .0          ,  .0
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,  .0          ,
  .0          ,  .0          ,  .0          ,  .0          ,BPR=  .589999974    ,DPD=  .640000105E-01,DPH=  .320000015E-0
DPS=  .0          ,EPSC=  .399999991E-01,EPSH=  .399999991E-01,FAC=  .595000014E-01,  .154019869E+67,  .015167184E-18,
 -.749337575E+12, -.263370506E+21, -.347317153E+22, -.105805303E+13, -.486208797    , -.515309994E-40, -.021583500E-40,
  .804804101E+57,  .745088561E+29,  1.05094910    ,  .846413608E-71,  .737057769E-77, -.249535448E+21, -.347439200E+22,
 -.486206889    , -.022420775E-40,  84717888.0    ,  .695573415E+29,  .154019869E+67,  .015101009E-18, -.444529115E+12,
 -.347685097E+22, -.267982192E+21, -.125956224E+22, -.443025877E+13, -.347166282E+22,  .020139446E+57,  252490752.    ,
  .695573415E+29,  .154019869E+67,  .015101009E-18, -.360565860E+13, -.347678792E+22, -.258484699E+21,  .804777163E+57,
 252490752.    ,  .086691094E+66,  .035363868E+70,  .020139446E+57,  .345649159E+67,  .804802605E+57,  .140763393E-19,
 -.258577550E+21, -.621753559E+13, -.267982755E+21, -.251516131E+22, -.516982079    , -.799568892E-01, -.680570154E+70,
 -.148214815E+22, -.407242775    , -.129720371E+20,  0003776.00    ,  .025413887E+28,  .004449456E-56, -.145751131E+14,
  .447985030E+29,  .345660087E+67,  .682648493E+67,  .101964911E+68,  .497497531E+29,  .249909145E+29,  .511657301E+30,
 118274944.    ,  .254087761E+58,  .175635962E+58,  .971841625E+57,  .748259884E+19,  252493056.    ,  .511669391E+30,
 118275328.    ,  .254093747E+58,  .175641948E+58,  .971901468E+57,  .748277476E+19, -.109388392E-68,  .398461950E+29,
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&END
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THIS PROGRAM CHECKS SPECIFIC INPUTS TO ENSURE REASONABLE INPUT DATA.

IF THESE CHECKS ARE NOT SATISFIED THE JOB WILL BE TERMINATED.

VIOLATIONS, IF ANY, WILL BE PRINTED BELOW-

```
** COMBUSTION MODEL RESULTS **

FAN STREAM

STREAMTUBE TYPE            =           1
NO. OF THIS TYPE           =           1

INPUT

STATIC PRESSURE(PS6)       =      7.9200 PSIA
APPROACH TEMPERATURE(T6C)=    700.0000 DEG R
APPROACH MACH NO.(M6C)     =      0.1500 D'LESS
INPUT F/A RATIO(FAC)       =      0.0595 D'LESS
EFFECTIVE F/A RATIO        =      0.0759 D'LESS
F/H WIDTH(FHWC)            =      1.0600 INCHES
BLOCKAGE RATIO(TAUC)       =      0.2560 D'LESS
F/H APEX ANGLE(ALPHAC)     =     60.0000 DEG
S/R FUEL TEMP(TFSR)        =    560.0000 DEG R
S/R FUEL PRESSURE(PFSR)    =    134.7000 PSIA
S/R TO F/H DISTANCE(LSC)   =      4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)   =     66.0000 INCHES
TURBULENCE LEVEL(EPSC)     =      0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)   =      0.0    D'LESS
FLOW SOURCE TEMP(TEXT)     =    460.0000 DEG R
EFFECTIVE INLET TEMP.      =    700.0000 DEG R
FUEL TYPE                  =         JP4

OUTPUT

INJECTION
MEAN DROPLET SIZE          =    114.5909 MICRONS
FLASH VAPORIZATION         =      0.0    D'LESS

WAKE COMPOSITION SOLUTION
BETA 1                     =      0.1558 D'LESS
BETA 2                     =      0.8900 D'LESS
BETA 3                     =      0.3268 D'LESS
K1                         =      0.2059 D'LESS
WAKE F/A                   =      0.1023 D'LESS
WAKE TEMP                  =   3203.4585 DEG R

FLAME SPREADING
INITIAL SPEED              =      0.1767 FPS
INITIAL TURBULANCE         =      0.2664 D'LESS

STREAMTUBE EFFICIENCY
IDEAL TEMP RISE            =   3429.1636 DEG R
COMBUSTION EFFICIENCY      =      0.5118
ACTUAL TEMP RISE           =   1754.9304 DEG R
EXIT TEMP                  =   2454.9304 DEG R
FLOWRATE - AIR             =      0.1702 LBM/SEC
FLOWRATE - FUEL            =      0.0129 LBM/SEC
```

FAN STREAM SUMMARY

STREAMTUBE TYPE	FUEL-AIR RATIO D'LESS	MASS FLOWRATE LBM/SEC	COMBUSTION EFFICIENCY D'LESS	EXIT TEMP DEG R
1	0.0595	0.1702	0.5118	2454.9304

COOLING FLOW/TOTAL ENGINE FLOW	=	0.0800 D'LESS
CHEMICAL COMBUSTION EFFICIENCY	=	0.4014 D'LESS
THERMAL COMBUSTION EFFICIENCY	=	0.4217 D'LESS
AVG COOLING AIR TEMPERATURE	=	699.9998 DEG R
AVG STREAMLINE EXIT TEMP	=	2454.9292 DEG R
AVG DUCT EXIT TEMPERATURE	=	2076.5789 DEG R
TOTAL FLOWRATE	=	0.1702 LBM/SEC
AVG FUEL-AIR RATIO	=	0.0595 D'LESS
AVG. IDEAL TEMPERATURE RISE	=	3264.7219 DEG R

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                         CORE STREAM

STREAMTUBE TYPE              =            1
NO. OF THIS TYPE             =            1

                            INPUT

STATIC PRESSURE(PS6)         =       7.9200 PSIA
APPROACH TEMP(T6H)           =    1775.0000 DEG R
APPROACH MACH NO.(M6H)       =       0.2800 D'LESS
FUEL AIR RATIO(FAH)          =       0.0400 D'LESS
F/H WIDTH(FHWH)              =       0.7500 INCHES
F/H APEX ANGLE(ALPHAH)       =      60.0000 DEGREES
BLOCKAGE RATIO(TAUH)         =       0.1860 D'LESS
F/H TO NOZZLE DIST.(XLH)=           66.0000 INCHES
S/R TO F/H DISTANCE(LSH)=            8.0000 INCHES
TURBULENCE LEVEL(EPSH)       =       0.0400 D'LESS
FUEL TYPE                    =          JP4

                           OUTPUT

WAKE RECIRCULATION COEF =            0.1625 D'LESS
WAKE EFFICIENCY              =       0.9973 D'LESS
INITIAL FLAME SPEED          =       1.3531 FPS
INITIAL TURBULENCE LEVEL=            0.2143 D'LESS
IDEAL TEMP RISE              =    1968.9004 DEG R
COMBUSTION EFFICIENCY        =       0.8950 D'LESS
ACTUAL TEMPERATURE RISE =         1762.1062 DEG R
EXIT TEMPERATURE             =    3537.1062 DEG R
FLOWRATE - AIR               =       0.1907 LBM/SEC
FLOWRATE - FUEL              =       0.0076 LBM/SEC
```

CORE STREAM SUMMARY

STREAMTUBE TYPE	FUEL-AIR RATIO D'LESS	MASS FLOWRATE LBM/SEC	COMBUSTION EFFICIENCY D'LESS	EXIT TEMP DEG R
1	0.0400	0.1907	0.8950	3537.1062

```
M/B FUEL-AIR RATIO(FAV) =      0.0210 D'LESS
M/B INLET TEMP(T3H)     =   1355.0000 DEG R
AVG EXIT TEMP           =   3537.1052 DEG R
AVG COMB. EFFICIENCY    =      0.8950 D'LESS
TOTAL FLOWRATE          =      0.1907 LBM/SEC
AVG FUEL-AIR RATIO      =      0.0400 D'LESS
AVG DISTANCE FROM
SPRAYBAR TO F/H         =      8.0000 INCHES
AVG. IDEAL TEMP. RISE   =   1968.9009 DEG R
```

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FLK=  62.2208374    ,FLSC=  4.00000000    ,FLSH=  7.99999714    ,FT6C=  699.999756    ,FT6H=  1774.99976    ,FZEFC= -1.42647362    ,
FZEFH=  .390983522    ,FZEPC=  1.30671215    ,FZEPH=  .216231106    ,FZETC=  1.23587799    ,FZETH=  .574392017    ,FZEVC=
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KNOZ=  .296627213E-05,FAAB=  .472358540E-01,ETAAB=  .668267667    ,DTIAB=  2480.60547    ,DTAB=  1657.70850    ,T6M=
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&END
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DTC=  1370.08521    ,QCQT=  .306686262    ,DTIC=  3249.32227    ,TAUDC=  .171993417E-02
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&END
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T=  699.999756    ,  699.999756    ,  699.999756    ,  1376.10083    ,  1376.10083    ,  1707.64233    ,  2039.18384    ,
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&PRJ
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&END
&GJ
G=  1.38972187    ,  1.38972187    ,  1.38972187    ,  1.34517956    ,  1.34517956    ,  1.32824802    ,  1.31454754    ,
  1.30408001    ,  1.29684353    ,  1.29283810    ,  1.29283810    ,GH=  1.32520294
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  .311026117E-03,  .287423143E-03,  .893075339E-04,  .0              ,TAUFH=  .453663291E-03
&END
&TAUGJ
TAUG=  .273166131E-02,  .273166131E-02,  .121407490E-02,  .226545162E-03,  .673753908E-03,  .638412777E-03,  .614093151E-03,
  .597285572E-03,  .586074777E-03,  .189465747E-03,  .0              ,TAUGH=  .806512544E-03
&END
&TAUEJ
TAUE=  .154794157E-01,  .154794157E-01,  .687975809E-02,  .803205417E-03,  .222562789E-02,  .180961634E-02,  .151685905E-02,
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&END
```

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

		FREQUENCY = 0.0 HERTZ		FREQUENCY = 5.00 HERTZ		FREQUENCY = 10.00 HERTZ		FREQUENCY = 15.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.255069	-360.000	.218746	-32.1054	.182294	-50.3916	.171146	-64.5300
V1	2	.255069	-180.000	.218746	-212.105	.182294	-230.392	.171146	-244.530
R1	3	.255069	-360.000	.218746	-32.1054	.182294	-50.3916	.171146	-64.5300
P2	4	.287718	-360.000	.246424	-28.3434	.204561	-42.8515	.190812	-53.1788
V2	5	.287718	-180.000	.261404	-191.732	.250722	-193.302	.278754	-195.078
R2	6	.287718	-360.000	.239384	-35.4920	.181981	-56.1062	.146408	-69.9910
P3	7	.287718	-360.000	.244608	-26.7900	.198569	-39.6173	.178380	-47.9918
V3	8	.287718	-180.000	.298084	-174.631	.344156	-170.374	.428169	-171.221
R3	9	.287718	-360.000	.220914	-41.3459	.131335	-60.6647	.861653E-01	-50.4881
P3H	10	.287718	-360.000	.244608	-26.7900	.198569	-39.6173	.178380	-47.9918
V3H	11	.287718	-180.000	.244949	-204.157	.199676	-214.366	.180611	-220.152
R3H	12	.287718	-360.000	.244480	-27.8871	.198154	-41.8098	.177541	-51.2763
P2H	13	.287718	-360.000	.244649	-27.5285	.198704	-41.0946	.178651	-50.2085
V2H	14	.287718	-180.000	.244649	-207.529	.198704	-221.095	.178651	-230.208
R2H	15	.287718	-360.000	.244649	-27.5285	.198704	-41.0946	.178651	-50.2085
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.130911E-06	-360.000	.217607	-126.983	.324342	-147.965	.391204	-160.307
W3H	18	.880748E-16	-360.000	.159359E-01	-117.702	.258683E-01	-131.446	.348461E-01	-140.738
QOUT	19	.350092	-360.000	.289759	-34.2679	.219890	-53.0141	.183601	-65.4878
P4	20	.306741	-360.000	.261405	-25.6636	.213440	-37.4983	.192995	-45.0012
V4	21	.306741	-180.000	.266577	-197.242	.229979	-201.392	.225984	-202.387
R4	22	.306741	-360.000	.252518	-37.1202	.189316	-57.6406	.158791	-69.6202
P5	23	.306741	-360.000	.260941	-24.7556	.211927	-35.6496	.189918	-42.1426
V5	24	.306741	-180.000	.271713	-191.223	.245430	-190.700	.254012	-188.712
R5	25	.306741	-360.000	.245972	-38.2610	.170825	-59.0773	.128363	-70.0398
P6	26	.300613	-360.000	.254734	-25.1844	.205310	-36.1521	.182844	-42.4255
V6	27	.106645	-180.000	.773169E-01	-211.286	.450147E-01	-205.197	.512670E-01	-177.413
R6	28	.106134	-360.000	.146816	-97.2516	.176493	-138.640	.189220	-159.943
P7	29	.293956	-360.000	.248103	-25.6287	.198366	-36.6888	.[illegible]75455	-42.7550
V7	30	.301921E-01	-360.000	.731759E-01	-343.175	.945817E-01	-11.6618	.777957E-01	-37.7825
R7	31	.308587E-01	-180.000	.203036	-143.229	.281673	-168.778	.[illegible]11774	-186.457
P8	32	.286657	-360.000	.240941	-26.1093	.190968	-37.3026	.167572	-43.1963
V8	33	.130642	-360.000	.168862	-359.941	.195999	-18.0765	.202867	-36.7641
R8	34	.131473	-180.000	.281733	-161.302	.372724	-182.776	.409827	-200.982
P9	35	.278579	-360.000	.233115	-26.6498	.162961	-38.0424	.158973	-43.8224
V9	36	.208392	-360.000	.245191	-4.93779	.274681	-21.8905	.285272	-39.5184
R9	37	.209529	-180.000	.350347	-170.714	.446699	-192.012	.488770	-211.645
P10	38	.269545	-360.000	.224462	-27.2799	.174162	-38.9718	.149401	-44.7284
V10	39	.271196	-360.000	.307106	-7.83660	.338207	-24.8991	.352072	-42.5472
R10	40	.272845	-180.000	.408397	-176.864	.508228	-199.049	.554712	-220.251
P11	41	.269545	-360.000	.224669	-27.3400	.174495	-39.2297	.149486	-45.2808
V11	42	.271196	-360.000	.306405	-8.12162	.337411	-25.2598	.351906	-42.9642
R11	43	.272845	-180.000	.407426	-177.664	.507239	-200.496	.554480	-222.340
V3	8/P3 7	1.00000	-180.000	1.21862	-147.841	1.73318	-130.757	2.40032	-123.229
P1	1/P3 7	.888525	.0	.894271	-5.31535	.918039	-10.7743	.959449	-16.5383
P11	41/P3 7	.936837	.0	.918486	-.549911	.878760	-359.612	.838020	-357.289

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

			FREQUENCY = 20.00 HERTZ		FREQUENCY = 25.00 HERTZ		FREQUENCY = 30.00 HERTZ		FREQUENCY = 35.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.171991	-79.3826	.180992	-94.3336	.207173	-110.517	.257228	-133.475
V1	2		.171991	-259.383	.180992	-274.333	.207173	-290.517	.257228	-313.475
R1	3		.171991	-79.3826	.180992	-94.3336	.207173	-110.517	.257228	-133.475
P2	4		.190036	-64.1710	.197705	-75.2081	.223199	-87.3808	.272715	-106.212
V2	5		.330592	-200.930	.404469	-209.171	.529082	-220.140	.738589	-238.898
R2	6		.119819	-79.4059	.104411	-80.3616	.117117	-76.1668	.171920	-83.7101
P3	7		.168398	-56.5751	.163380	-64.4964	.169275	-72.4900	.187256	-85.5887
V3	8		.536443	-177.012	.669938	-184.970	.875761	-195.228	1.20420	-212.850
R3	9		.109259	-36.5740	.148552	-53.9274	.168457	-80.8219	.147429	-116.291
P3H	10		.168398	-56.5751	.163380	-64.4954	.169275	-72.4900	.187256	-85.5887
V3H	11		.172130	-226.191	.169014	-231.624	.177639	-237.197	.199777	-247.952
R3H	12		.166992	-60.9466	.151251	-69.9482	.166102	-79.0133	.182484	-93.1598
P2H	13		.168854	-59.5519	.164072	-68.1946	.170309	-76.9310	.188815	-90.7611
V2H	14		.168854	-239.552	.164072	-248.195	.170309	-256.931	.188815	-270.761
R2H	15		.168854	-59.5519	.164072	-68.1946	.170309	-76.9310	.188815	-90.7611
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.460426	-167.954	.583251	-173.894	.820606	-184.453	1.19638	-205.817
W3H	18		.438424E-01	-150.257	.551400E-01	-159.073	.660235E-01	-167.979	.851406E-01	-181.989
QOUT	19		.164557	-78.6454	.150852	-95.2781	.136535	-118.982	.111539	-159.347
P4	20		.183362	-52.0698	.179529	-59.4743	.189278	-66.2074	.215690	-78.2757
V4	21		.238540	-204.983	.263784	-208.442	.316632	-215.836	.409745	-226.660
R4	22		.152183	-80.4753	.161228	-95.1415	.180580	-116.712	.200305	-149.119
P5	23		.178104	-48.6604	.171624	-54.1518	.177558	-59.2404	.198513	-69.2468
V5	24		.279929	-169.629	.318243	-192.134	.386449	-196.774	.499126	-208.672
R5	25		.107333	-81.0421	.908318E-01	-101.570	.648678E-01	-144.081	.641471E-01	-244.512
P6	26		.170627	-48.5636	.163667	-53.2954	.169769	-57.2504	.192335	-66.1458
V6	27		.776316E-01	-172.980	.114611	-176.588	.177564	-185.408	.280392	-204.583
R6	28		.204476	-173.711	.231699	-187.687	.263475	-207.467	.271979	-237.586
P7	29		.162771	-48.5082	.155384	-52.5351	.161496	-55.4530	.184965	-63.4209
V7	30		.972534E-01	-62.8799	.103759	-90.9635	.126816	-126.589	.173940	-170.819
R7	31		.335923	-200.043	.372637	-213.767	.418164	-231.678	.438619	-257.064
P8	32		.154328	-48.6053	.146337	-51.9633	.151982	-53.9326	.175274	-61.0358
V8	33		.204232	-54.7097	.209330	-74.0546	.216960	-98.7191	.221481	-133.260
R8	34		.439436	-216.329	.483232	-231.697	.539924	-250.347	.574301	-275.028
P9	35		.144961	-48.9511	.135985	-51.7395	.140382	-52.7113	.162142	-58.8523
V9	36		.291346	-56.4692	.302299	-74.0486	.318115	-94.8535	.321143	-121.698
R9	37		.523424	-228.923	.573907	-240.062	.640700	-265.837	.688460	-290.675
P10	38		.134292	-49.6681	.123758	-51.9176	.125867	-51.7675	.144571	-56.6111
V10	39		.362572	-59.4961	.379324	-76.6369	.403090	-95.9200	.416047	-119.466
R10	40		.594326	-239.330	.651074	-258.088	.726551	-278.965	.785504	-304.200
P11	41		.133600	-50.5522	.122166	-53.1108	.122447	-52.8781	.139259	-57.0916
V11	42		.363415	-59.9242	.381709	-76.9815	.407942	-96.0964	.424363	-119.422
R11	43		.595214	-242.022	.653571	-261.320	.731489	-282.680	.793719	-308.363
V3	8/P3	7	3.18556	-120.437	4.10049	-120.473	5.17359	-122.736	6.43079	-127.261
P1	1/P3	7	1.02133	-22.8076	1.10780	-29.8572	1.22388	-38.0274	1.37367	-47.8867
P11	41/P3	7	.794544	-353.977	.747740	-348.614	.723361	-340.388	.743681	-331.503

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

		FREQUENCY = 40.00 HERTZ		FREQUENCY = 45.00 HERTZ		FREQUENCY = 50.00 HERTZ		FREQUENCY = 55.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.298464	-166.756	.290998	-200.571	.274043	-230.101	.257344	-259.760
V1	2	.298464	-346.756	.290998	-20.5707	.274043	-50.1006	.257344	-79.7603
R1	3	.298464	-166.756	.290998	-200.571	.274043	-230.101	.257344	-259.760
P2	4	.310756	-135.259	.296997	-164.699	.273734	-189.697	.251266	-214.648
V2	5	.949638	-268.682	1.01295	-299.466	1.03198	-326.386	1.03799	-353.688
R2	6	.244429	-110.447	.276747	-143.440	.288267	-175.045	.279005	-206.022
P3	7	.192053	-106.656	.167210	-125.309	.146484	-136.770	.137295	-147.025
V3	8	1.50641	-241.103	1.55323	-270.002	1.51509	-294.620	1.44794	-319.242
R3	9	.537568E-01	-146.160	.883290E-01	-63.2050	.176070	-100.911	.200223	-144.810
P3H	10	.192053	-106.656	.167210	-125.309	.146484	-136.770	.137295	-147.025
V3H	11	.208718	-266.775	.165444	-283.244	.166056	-292.631	.159314	-300.909
R3H	12	.185670	-115.291	.160188	-134.975	.138904	-147.452	.128717	-158.703
P2H	13	.194146	-112.590	.169521	-131.990	.148990	-144.202	.140144	-155.212
V2H	14	.194146	-292.590	.169521	-311.990	.148990	-324.202	.140144	-335.212
R2H	15	.194146	-112.590	.169521	-131.990	.148990	-144.202	.140144	-155.212
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	1.50474	-239.063	1.47493	-271.550	1.34469	-296.398	1.24881	-318.350
W3H	18	.997038E-01	-203.980	.975551E-01	-223.537	.948493E-01	-235.901	.976653E-01	-247.056
QOUT	19	.761380E-01	-237.539	.935610E-01	-329.066	.137842	-17.2599	.180601	-48.9980
P4	20	.230159	-99.0735	.208638	-118.559	.188158	-131.859	.178091	-144.394
V4	21	.490510	-250.236	.487871	-274.417	.464565	-294.109	.439465	-313.594
R4	22	.183535	-193.483	.122958	-236.852	.722171E-01	-268.892	.500991E-01	-292.624
P5	23	.208668	-87.5334	.188215	-104.145	.171437	-114.733	.165553	-125.426
V5	24	.590155	-230.947	.574943	-255.290	.533450	-270.308	.492264	-286.046
R5	25	.141953	-325.172	.197491	-15.5328	.213685	-48.9592	.221851	-72.6799
P6	26	.205653	-83.7038	.188035	-99.6582	.173805	-109.317	.170947	-119.178
V6	27	.378523	-234.753	.398964	-262.915	.395222	-282.664	.395413	-299.317
R6	28	.197313	-279.959	.631577E-01	-332.116	.512319E-01	-123.340	.121750	-154.477
P7	29	.200097	-80.3813	.184415	-95.6574	.172381	-104.292	.172140	-113.293
V7	30	.220700	-219.929	.226799	-259.626	.225765	-284.685	.233891	-303.703
R7	31	.351238	-287.576	.196464	-300.763	.135865	-281.783	.148160	-264.703
P8	32	.190902	-77.3738	.176723	-91.8190	.166819	-99.4177	.168916	-107.600
V8	33	.185580	-177.843	.124772	-217.667	.928023E-01	-245.266	.840415E-01	-269.316
R8	34	.493821	-302.862	.348883	-315.775	.300436	-314.669	.301034	-316.242
P9	35	.176988	-74.4065	.164085	-87.8871	.156189	-94.3380	.160104	-101.743
V9	36	.268317	-151.984	.191424	-169.956	.161642	-178.033	.153546	-188.743
R9	37	.619140	-317.713	.487156	-331.961	.453351	-337.223	.463152	-345.139
P10	38	.157438	-71.0343	.145714	-83.2116	.139654	-88.2957	.144685	-94.6331
V10	39	.372189	-144.511	.306918	-159.254	.290485	-168.664	.293416	-180.476
R10	40	.726883	-331.025	.607358	-346.534	.586656	-355.281	.607265	-6.40342
P11	41	.151546	-70.9639	.140156	-82.9539	.133700	-87.8166	.137974	-94.0488
V11	42	.383357	-144.294	.318689	-158.978	.303191	-168.198	.308033	-179.696
R11	43	.737669	-335.645	.618683	-351.679	.598751	-.917298	.621010	-12.4966
V3	8/P3 7	7.85415	-134.445	9.28911	-144.693	10.3431	-157.850	10.5461	-172.217
P1	1/P3 7	1.55407	-60.0982	1.74032	-75.2616	1.87080	-93.3307	1.87438	-112.736
ŧP11	41/P3 7	.789082	-324.306	.638207	-317.645	.912728	-311.047	1.00494	-307.024

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

		FREQUENCY = 60.00 HERTZ		FREQUENCY = 65.00 HERTZ		FREQUENCY = 70.00 HERTZ		FREQUENCY = 75.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.232499	-288.348	.214945	-314.244	.213538	-341.669	.214384	-14.8540
V1	2	.232499	-108.348	.214945	-134.244	.213538	-161.669	.214384	-194.854
R1	3	.232499	-288.348	.214945	-314.244	.213538	-341.669	.214384	-14.8540
P2	4	.221712	-236.347	.200125	-259.133	.194160	-281.217	.190537	-308.849
V2	5	.995547	-20.1373	.969237	-44.0413	1.00655	-69.5985	1.04917	-100.998
R2	6	.243933	-240.063	.204455	-268.427	.171917	-295.731	.137399	-323.297
P3	7	.132952	-157.440	.137477	-168.017	.154518	-183.110	.174227	-206.336
V3	8	1.30479	-342.569	1.19421	-2.83664	1.15378	-24.1454	1.11250	-50.5688
R3	9	.156053	-185.508	.838384E-01	-209.705	.610661E-01	-177.811	.122439	-190.379
P3H	10	.132952	-157.440	.137477	-168.017	.154518	-183.110	.174227	-206.336
V3H	11	.158113	-309.447	.167746	-318.247	.193620	-331.659	.224378	-353.302
R3H	12	.123089	-170.092	.125539	-161.618	.139000	-197.631	.154204	-221.744
P2H	13	.136244	-166.385	.141485	-177.724	.159760	-193.582	.181037	-217.578
V2H	14	.136244	-346.385	.141485	-357.725	.159760	-13.5818	.181037	-37.5778
R2H	15	.136244	-166.385	.141485	-177.724	.159760	-193.582	.181037	-217.578
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	1.16766	-339.583	1.12006	-.898033	1.09939	-25.5574	1.02202	-55.0029
W3H	18	.103031	-258.367	.115245	-269.837	.139273	-285.804	.167972	-309.914
QOUT	19	.220367	-75.4267	.266733	-100.365	.325593	-126.687	.372966	-163.003
P4	20	.170980	-156.679	.173117	-168.922	.189445	-184.714	.208240	-207.899
V4	21	.399510	-331.726	.371731	-346.910	.372131	-3.34437	.378105	-25.2207
R4	22	.483367E-01	-328.333	.563085E-01	-18.8755	.729105E-01	-73.7521	.889715E-01	-129.624
P5	23	.161437	-137.112	.163777	-146.877	.177285	-164.407	.190975	-187.127
V5	24	.442525	-299.342	.417267	-309.111	.435204	-320.394	.470812	-338.139
R5	25	.241204	-93.5264	.271471	-117.154	.300586	-146.105	.302065	-180.074
P6	26	.168546	-130.186	.170859	-140.723	.183959	-154.058	.197095	-173.822
V6	27	.386126	-312.963	.390365	-321.522	.441198	-329.224	.530651	-342.714
R6	28	.196772	-171.543	.279164	-190.612	.354733	-213.237	.388273	-238.567
P7	29	.171286	-123.496	.174191	-132.667	.188491	-143.913	.203817	-161.104
V7	30	.234863	-318.331	.243143	-324.772	.298088	-328.539	.403469	-340.880
R7	31	.198832	-256.886	.286457	-263.651	.377985	-281.255	.426294	-304.721
P8	32	.169609	-117.052	.173549	-125.057	.189579	-134.694	.207794	-150.004
V8	33	.790508E-01	-284.298	.956404E-01	-283.763	.159995	-291.804	.255066	-315.037
R8	34	.325555	-317.337	.403440	-322.973	.511042	-338.178	.585125	-.717809
P9	35	.161923	-110.567	.166337	-117.657	.182729	-126.047	.202082	-139.850
V9	36	.157722	-199.049	.187923	-213.312	.237999	-236.743	.284302	-267.861
R9	37	.489998	-352.330	.572466	-1.09304	.699253	-16.5602	.800094	-38.5934
P10	38	.146808	-103.049	.150426	-109.222	.164931	-116.233	.182992	-128.278
V10	39	.305508	-192.310	.340707	-205.804	.393032	-224.458	.431134	-248.561
R10	40	.641323	-16.9125	.730031	-28.0848	.868567	-44.3228	.983858	-66.2578
P11	41	.139153	-102.007	.141241	-107.632	.154037	-113.670	.171373	-124.710
V11	42	.321686	-191.267	.358466	-204.295	.413013	-222.252	.452724	-245.559
R11	43	.656474	-23.5047	.746602	-35.1265	.887191	-51.7254	1.00414	-73.9855
V3	8/P3 7	9.85159	-185.129	8.68658	-194.819	7.46700	-201.035	6.38534	-204.232
P1	1/P3 7	1.74874	-130.908	1.56350	-146.227	1.38196	-158.559	1.23048	-168.518
P11	41/P3 7	1.04664	-304.567	1.02738	-299.615	.996886	-290.560	.983620	-278.373

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

		FREQUENCY = 80.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.200760	-50.8403	.0	.0	.0	.0	.0	.0
V1	2	.200760	-230.840	.0	.0	.0	.0	.0	.0
R1	3	.200760	-50.8403	.0	.0	.0	.0	.0	.0
P2	4	.174693	-339.082	.0	.0	.0	.0	.0	.0
V2	5	1.01356	-135.287	.0	.0	.0	.0	.0	.0
R2	6	.103523	-343.756	.0	.0	.0	.0	.0	.0
P3	7	.180409	-234.063	.0	.0	.0	.0	.0	.0
V3	8	.990247	-78.9696	.0	.0	.0	.0	.0	.0
R3	9	.153587	-232.535	.0	.0	.0	.0	.0	.0
P3H	10	.180409	-234.063	.0	.0	.0	.0	.0	.0
V3H	11	.238948	-19.5410	.0	.0	.0	.0	.0	.0
R3H	12	.156898	-250.320	.0	.0	.0	.0	.0	.0
P2H	13	.188463	-246.079	.0	.0	.0	.0	.0	.0
V2H	14	.188463	-66.0791	.0	.0	.0	.0	.0	.0
R2H	15	.188463	-246.079	.0	.0	.0	.0	.0	.0
QIN	16	1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17	.855452	-63.5540	.0	.0	.0	.0	.0	.0
W3H	18	.185196	-338.520	.0	.0	.0	.0	.0	.0
QOUT	19	.376049	-198.654	.0	.0	.0	.0	.0	.0
P4	20	.211612	-235.075	.0	.0	.0	.0	.0	.0
V4	21	.361460	-49.7153	.0	.0	.0	.0	.0	.0
R4	22	.897218E-01	-181.884	.0	.0	.0	.0	.0	.0
P5	23	.188965	-213.574	.0	.0	.0	.0	.0	.0
V5	24	.484251	-359.927	.0	.0	.0	.0	.0	.0
R5	25	.266334	-212.303	.0	.0	.0	.0	.0	.0
P6	26	.192907	-198.633	.0	.0	.0	.0	.0	.0
V6	27	.603510	-.818992	.0	.0	.0	.0	.0	.0
R6	28	.362586	-260.297	.0	.0	.0	.0	.0	.0
P7	29	.201291	-181.103	.0	.0	.0	.0	.0	.0
V7	30	.501413	-359.939	.0	.0	.0	.0	.0	.0
R7	31	.405438	-326.283	.0	.0	.0	.0	.0	.0
P8	32	.208616	-167.762	.0	.0	.0	.0	.0	.0
V8	33	.335526	-342.142	.0	.0	.0	.0	.0	.0
R8	34	.579451	-23.3053	.0	.0	.0	.0	.0	.0
P9	35	.205692	-155.805	.0	.0	.0	.0	.0	.0
V9	36	.303212	-299.579	.0	.0	.0	.0	.0	.0
R9	37	.812411	-61.1350	.0	.0	.0	.0	.0	.0
P10	38	.188477	-142.221	.0	.0	.0	.0	.0	.0
V10	39	.428324	-273.127	.0	.0	.0	.0	.0	.0
R10	40	1.00469	-88.7353	.0	.0	.0	.0	.0	.0
P11	41	.177723	-137.837	.0	.0	.0	.0	.0	.0
V11	42	.449127	-269.324	.0	.0	.0	.0	.0	.0
R11	43	1.02465	-96.7778	.0	.0	.0	.0	.0	.0
V3	8/P3 7	5.48890	-204.906	.0	.0	.0	.0	.0	.0
P1	1/P3 7	1.11281	-176.777	.0	.0	.0	.0	.0	.0
P11	41/P3 7	.985114	-263.773	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

			FREQUENCY = 90.00 HERTZ		FREQUENCY =100.00 HERTZ		FREQUENCY =110.00 HERTZ		FREQUENCY =120.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.171434	-121.087	.147546	-188.857	.158510	-251.460	.166922	-313.810
V1	2		.171434	-301.087	.147546	-8.85702	.158510	-71.4601	.166922	-133.810
R1	3		.171434	-121.087	.147546	-188.857	.158510	-251.460	.166922	-313.810
P2	4		.144129	-37.1691	.121682	-92.1659	.130661	-141.777	.140146	-191.359
V2	5		.904793	-202.312	.796053	-266.973	.855662	-326.494	.882394	-25.7519
R2	6		.106315	-14.1054	.135644	-74.9763	.165616	-143.265	.152064	-211.069
P3	7		.178205	-290.919	.164844	-347.436	.177400	-39.4080	.174432	-90.5651
V3	8		.752252	-130.824	.590849	-175.371	.633102	-212.195	.728301	-251.120
R3	9		.943225E-01	-303.914	.121058	-319.403	.199311	-38.9764	.131469	-120.439
P3H	10		.178205	-290.919	.164844	-347.436	.177400	-39.4080	.174432	-90.5651
V3H	11		.250033	-73.7056	.245364	-127.647	.280374	-177.772	.292865	-227.187
R3H	12		.149041	-308.747	.131844	-6.62186	.134898	-59.6640	.125343	-111.588
P2H	13		.188361	-304.500	.176553	-2.60400	.192810	-56.1909	.192676	-108.993
V2H	14		.188361	-124.500	.176553	-182.604	.192810	-236.191	.192676	-288.993
R2H	15		.188361	-304.500	.176553	-2.60400	.192810	-56.1909	.192676	-108.993
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.656712	-131.811	.497968	-183.580	.435821	-209.099	.650311	-242.299
W3H	18		.205023	-37.1299	.209663	-95.3502	.247359	-149.013	.264140	-201.845
QOUT	19		.355861	-262.946	.332507	-326.462	.322828	-24.0604	.292426	-68.5778
P4	20		.205655	-290.581	.188672	-346.007	.202592	-36.3947	.20270	-86.0349
V4	21		.331210	-97.7277	.310196	-145.444	.359873	-189.988	.39936[illegible]	-236.275
R4	22		.699534E-01	-257.130	.811939E-01	-316.333	.102157	-38.6934	.721512E-01	-128.218
P5	23		.171412	-288.736	.144739	-318.401	.142102	-3.23343	.130875	-45.1670
V5	24		.507076	-40.5530	.513295	-95.9231	.606285	-142.515	.658073	-189.848
R5	25		.229473	-267.738	.182242	-330.724	.153232	-7.89051	.203939	-53.5967
P6	26		.163982	-241.555	.124023	-283.274	.109386	-320.063	.990410E-01	-355.207
V6	27		.700349	-38.3595	.699448	-76.8454	.710072	-114.921	.626983	-156.558
R6	28		.290626	-292.430	.156733	-303.136	.174410	-290.938	.187293	-283.359
P7	29		.174142	-217.138	.138085	-247.606	.130366	-274.183	.127370	-305.837
V7	30		.649078	-38.3183	.698324	-76.2654	.743257	-110.454	.693764	-145.862
R7	31		.320898	-358.771	.171929	-7.05051	.202331	-347.812	.297865	-345.668
P8	32		.191461	-197.928	.168931	-223.137	.177320	-247.133	.179745	-278.442
V8	33		.460651	-28.8607	.508538	-71.4313	.551157	-106.154	.528673	-141.393
R8	34		.504244	-61.1685	.329983	-88.6182	.252214	-95.7035	.218486	-82.5866
P9	35		.200122	-182.057	.192459	-205.373	.214792	-229.548	.220744	-260.867
V9	36		.326447	-355.097	.301001	-43.5000	.302729	-80.2359	.265050	-115.082
R9	37		.761528	-99.9117	.602376	-130.565	.553015	-152.210	.473572	-169.024
P10	38		.194678	-165.012	.200873	-187.864	.231043	-213.021	.235974	-244.585
V10	39		.390426	-316.961	.311634	-352.225	.291824	-19.8994	.266133	-43.0755
R10	40		.964260	-127.793	.820118	-159.183	.810475	-184.599	.765748	-208.590
P11	41		.187782	-159.540	.197067	-182.513	.227367	-207.836	.230203	-239.394
V11	42		.405778	-311.222	.322698	-343.940	.304914	-9.12527	.290455	-31.0825
R11	43		.980922	-136.433	.834566	-168.253	.828398	-194.177	.791150	-219.015
V3	8/P3	7	4.22126	-199.905	3.58429	-187.935	3.56878	-172.787	4.17528	-160.554
P1	1/P3	7	.962003	-190.167	.895062	-201.421	.893521	-212.052	.956948	-223.245
P11	41/P3	7	1.05374	-228.621	1.19548	-195.078	1.28166	-168.428	1.31973	-148.829

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

		FREQUENCY =130.00 HERTZ		FREQUENCY =140.00 HERTZ		FREQUENCY =150.00 HERTZ		FREQUENCY =160.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.208828	-8.54986	.280817	-75.2723	.316505	-161.017	.225191	-232.718
V1	2	.208828	-188.550	.280817	-255.272	.316505	-341.017	.225191	-52.7176
R1	3	.208828	-8.54986	.280817	-75.2723	.316505	-161.017	.225191	-232.718
P2	4	.181354	-233.909	.254744	-289.249	.301109	-4.52542	.224442	-66.5768
V2	5	1.05719	-77.2652	1.32900	-140.521	1.36269	-222.443	.854159	-289.661
R2	6	.128031	-257.724	.149328	-284.337	.262016	-350.829	.239860	-65.3020
P3	7	.189350	-132.669	.205658	-180.907	.182765	-239.591	.119934	-273.932
V3	8	1.02442	-287.219	1.51205	-339.430	1.78176	-53.3446	1.24812	-114.673
R3	9	.944084E-01	-115.252	.184453	-182.663	.589417E-01	-236.818	.155037	-255.098
P3H	10	.189350	-132.669	.205658	-180.907	.182765	-239.591	.119934	-273.932
V3H	11	.337793	-267.201	.389836	-314.781	.368081	-12.4444	.256593	-45.9900
R3H	12	.127785	-153.401	.129568	-201.984	.106932	-259.687	.649390E-01	-292.128
P2H	13	.212893	-152.178	.235729	-202.736	.213909	-263.183	.143566	-299.338
V2H	14	.212893	-332.178	.235729	-22.7359	.213909	-83.1832	.143566	-119.339
R2H	15	.212893	-152.178	.235729	-202.736	.213909	-263.183	.143566	-299.338
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.931037	-286.407	1.34453	-336.328	1.72293	-53.2258	1.13295	-119.675
W3H	18	.309203	-244.980	.360014	-295.403	.341264	-355.649	.237865	-31.5299
QOUT	19	.353633	-103.758	.443231	-145.141	.612631	-203.523	.530200	-260.837
P4	20	.225774	-128.706	.254798	-174.982	.240442	-235.607	.156630	-275.071
V4	21	.501538	-275.937	.642138	-326.939	.653866	-34.9896	.402203	-84.2055
R4	22	.376077E-01	-193.487	.568133E-01	-286.249	.135434	-63.1925	.128803	-160.339
P5	23	.138270	-75.5860	.161182	-112.468	.170800	-166.807	.118951	-208.230
V5	24	.784390	-229.364	.925738	-277.891	.868649	-339.465	.529459	-17.4330
R5	25	.231533	-109.347	.264734	-166.208	.275198	-262.092	.124441	-.190861E-01
P6	26	.120505	-23.2109	.167839	-64.3639	.196910	-124.822	.136562	-167.211
V6	27	.618602	-196.809	.633717	-250.216	.601364	-319.280	.409159	-4.49621
R6	28	.358749	-296.633	.507488	-335.119	.540525	-40.3683	.198855	-100.541
P7	29	.154358	-338.628	.200273	-26.3969	.216386	-91.1335	.144500	-132.721
V7	30	.684362	-176.534	.669385	-215.009	.551093	-266.759	.330653	-297.873
R7	31	.545929	-7.32957	.794044	-46.6769	.829257	-106.243	.396824	-133.471
P8	32	.207861	-310.212	.245677	-356.095	.241018	-58.2004	.153915	-97.0341
V8	33	.534282	-167.570	.583465	-198.612	.604985	-243.305	.444788	-275.998
R8	34	.413790	-87.6028	.642193	-122.218	.686111	-178.245	.372721	-197.016
P9	35	.250636	-291.068	.264922	-333.741	.268712	-31.4306	.168648	-66.1097
V9	36	.277023	-132.800	.366515	-161.130	.452657	-213.671	.315877	-253.638
R9	37	.592293	-181.198	.785832	-213.279	.811706	-267.473	.455403	-293.101
P10	38	.260667	-273.661	.285520	-313.470	.261963	-6.85002	.164892	-37.4825
V10	39	.339695	-65.1190	.447216	-103.924	.464514	-161.986	.292884	-192.916
R10	40	.927580	-230.592	1.16396	-267.437	1.17812	-322.473	.742150	-351.651
P11	41	.250906	-267.732	.271749	-306.280	.249146	-358.237	.156335	-28.2508
V11	42	.372206	-54.1212	.485355	-93.6551	.496120	-151.516	.313882	-181.770
R11	43	.963440	-242.410	1.20850	-280.618	1.21994	-336.785	.770858	-6.95864
V3	8/P3 7	5.41020	-155.150	7.35228	-158.522	9.74892	-173.754	10.4067	-200.741
P1	1/P3 7	1.10287	-236.480	1.36546	-254.365	1.73176	-281.426	1.87762	-318.786
P11	41/P3 7	1.32509	-135.663	1.32137	-125.373	1.36320	-118.647	1.30351	-114.319

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

PARAMTER	ID NO.	FREQUENCY =170.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =180.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =190.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =200.00 HERTZ GAIN	PHASE ANGLE
P1	1	.189894	-299.508	.173041	-7.71480	.154704	-88.9783	.127073	-155.669
V1	2	.189894	-119.508	.173041	-187.715	.154704	-268.978	.127073	-335.668
R1	3	.189894	-299.508	.173041	-7.71480	.154704	-88.9783	.127073	-155.669
P2	4	.197340	-124.429	.186148	-184.265	.170760	-257.573	.142519	-316.582
V2	5	.609924	-350.909	.447382	-51.5580	.302057	-121.167	.177626	-167.163
R2	6	.200996	-138.833	.141766	-207.968	.882050E-01	-266.718	.900499E-01	-299.927
P3	7	.120726	-306.963	.139868	-352.643	.150385	-58.4394	.137926	-112.993
V3	8	.965808	-171.658	.739840	-229.562	.491750	-298.095	.247378	-343.296
R3	9	.114864	-346.163	.576149E-01	-324.064	.144285	-52.3499	.902178E-01	-130.713
P3H	10	.120726	-306.963	.139868	-352.643	.150385	-58.4394	.137926	-112.993
V3H	11	.274339	-78.4107	.337548	-123.656	.385396	-189.214	.375330	-243.720
R3H	12	.604942E-01	-322.118	.652570E-01	-3.41687	.663357E-01	-63.4227	.590662E-01	-110.993
P2H	13	.148051	-334.240	.176024	-21.8543	.194561	-89.6563	.183765	-146.296
V2H	14	.148051	-154.240	.176024	-201.854	.194561	-269.656	.183765	-326.296
R2H	15	.148051	-334.240	.176024	-21.8543	.194561	-89.6563	.183765	-146.296
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.851542	-172.398	.737552	-234.029	.452064	-315.015	.178111	-359.126
W3H	18	.253423	-66.0514	.309851	-113.173	.350749	-180.389	.338057	-236.344
QOUT	19	.521036	-312.422	.575474	-11.7515	.542326	-88.7588	.436312	-147.214
P4	20	.146967	-309.651	.161727	-354.309	.168791	-57.8775	.154441	-110.227
V4	21	.304625	-120.982	.290421	-155.643	.312532	-208.006	.317566	-253.431
R4	22	.117615	-218.802	.164354	-279.487	.176032	-6.71574	.132225	-72.9285
P5	23	.992721E-01	-245.920	.875258E-01	-284.479	.777172E-01	-332.122	.706971E-01	-4.83073
V5	24	.476333	-45.3025	.543618	-83.7566	.594994	-143.722	.562251	-193.748
R5	25	.891237E-01	-79.9104	.139583	-170.447	.153460	-272.791	.121931	-334.957
P6	26	.113643	-194.020	.118042	-216.324	.135008	-257.556	.136440	-296.756
V6	27	.432405	-35.1162	.527394	-69.7358	.572714	-117.720	.489118	-154.640
R6	28	.386697E-01	-217.993	.188141	-321.128	.215850	-13.9636	.191456	-18.8919
P7	29	.132687	-156.115	.161067	-181.654	.190359	-228.260	.182512	-268.728
V7	30	.275338	-331.079	.249626	-12.6637	.213376	-69.9742	.171089	-105.674
R7	31	.332303	-124.844	.484674	-151.022	.546949	-173.427	.410948	-199.223
P8	32	.145772	-121.402	.174118	-151.809	.192318	-200.611	.170575	-240.013
V8	33	.387769	-302.184	.368092	-325.737	.374643	-357.686	.378471	-25.8633
R8	34	.403760	-192.984	.613508	-209.217	.711012	-251.424	.628463	-278.649
P9	35	.157653	-90.0211	.174452	-120.544	.175249	-166.690	.143048	-199.765
V9	36	.261899	-276.101	.280527	-291.002	.356981	-327.581	.373617	-2.38348
R9	37	.414346	-296.167	.559931	-309.891	.644383	-350.729	.576993	-20.1283
P10	38	.151081	-60.4157	.154746	-88.2657	.145230	-127.537	.122502	-150.287
V10	39	.280582	-208.423	.357461	-231.632	.407048	-276.811	.376999	-312.664
R10	40	.701149	-6.99036	.853637	-28.9256	.944528	-71.1915	.862880	-103.494
P11	41	.140130	-50.6306	.138859	-76.3555	.130041	-112.163	.115124	-132.047
V11	42	.305789	-197.667	.386520	-222.152	.430194	-267.458	.387627	-302.569
R11	43	.733128	-23.6366	.891312	-47.1765	.980026	-90.6255	.889009	-123.791
V3	3/P3 7	8.00002	-224.696	5.28955	-236.919	3.26993	-239.656	1.79356	-230.303
P1	1/P3 7	1.57294	-352.545	1.23717	-15.0720	1.02872	-30.5390	.921314	-42.6756
P11	41/P3 7	1.16073	-103.668	.992784	-83.7129	.864720	-53.7233	.834682	-19.0541

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

PARAMTER	ID NO.	FREQUENCY =210.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =220.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =230.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =240.00 HERTZ GAIN	PHASE ANGLE
P1	1	.123764	-214.468	.147225	-268.724	.185253	-335.515	.207699	-44.1431
V1	2	.123764	-34.4676	.147225	-88.7243	.185253	-155.515	.207699	-224.143
R1	3	.123764	-214.468	.147225	-268.724	.185253	-335.515	.207699	-44.1431
P2	4	.139604	-7.83790	.165291	-54.5573	.204895	-113.686	.224095	-174.392
V2	5	.139690	-189.558	.199287	-206.084	.350499	-250.848	.523860	-307.215
R2	6	.124463	-353.497	.165825	-53.5457	.182964	-125.968	.141585	-188.367
P3	7	.139594	-160.988	.160913	-204.497	.182661	-259.367	.171520	-312.974
V3	8	.139922	-344.645	.269402	-336.404	.566697	-19.9363	.867800	-75.4040
R3	9	.881664E-01	-139.733	.162451	-202.321	.126068	-261.606	.111436	-293.369
P3H	10	.139594	-160.988	.160913	-204.497	.182661	-259.367	.171520	-312.974
V3H	11	.403373	-291.819	.493774	-335.626	.595288	-30.9776	.593749	-85.2710
R3H	12	.601616E-01	-151.418	.725247E-01	-187.646	.889298E-01	-236.317	.921604E-01	-285.254
P2H	13	.191864	-196.467	.228617	-242.255	.268725	-299.506	.261769	-355.651
V2H	14	.191884	-16.4670	.228617	-62.2552	.268725	-119.506	.261769	-175.651
R2H	15	.191864	-196.467	.228617	-242.255	.268725	-299.506	.261769	-355.651
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.705264E-01	-16.4196	.195117	-299.671	.562456	-7.12181	.782966	-70.3794
W3H	18	.359068	-285.689	.433988	-330.543	.516318	-26.7502	.508122	-81.7150
QOUT	19	.415452	-199.420	.413880	-247.480	.401912	-296.829	.369192	-342.173
P4	20	.156811	-156.646	.161608	-198.222	.211267	-251.110	.205220	-303.185
V4	21	.364066	-295.910	.479419	-335.929	.628484	-29.0733	.690131	-82.8774
R4	22	.138241	-121.830	.164232	-180.559	.143215	-248.618	.111237	-301.436
P5	23	.815188E-01	-34.2529	.114725	-64.3263	.162099	-110.587	.189865	-159.366
V5	24	.580893	-238.253	.676002	-278.074	.777563	-329.104	.738614	-19.0119
R5	25	.138826	-27.4389	.131504	-79.6953	.134270	-107.580	.178786	-153.048
P6	26	.148906	-337.075	.188003	-17.3249	.240375	-70.9806	.259668	-123.636
V6	27	.420283	-185.905	.396950	-213.949	.373703	-253.011	.331456	-291.680
R6	28	.221233	-23.0262	.350611	-35.2557	.421614	-75.1267	.363683	-105.528
P7	29	.181511	-307.613	.202961	-345.495	.227733	-36.6434	.217351	-86.1560
V7	30	.184635	-129.216	.275175	-150.028	.434952	-191.066	.556445	-235.565
R7	31	.298958	-215.806	.268075	-214.297	.258928	-230.338	.247857	-227.458
P8	32	.155526	-274.919	.157865	-305.911	.161495	-346.747	.149672	-22.9300
V8	33	.420531	-56.8712	.526911	-90.2671	.649682	-138.008	.675678	-186.321
R8	34	.576594	-300.323	.628076	-317.124	.667982	-347.805	.634528	-11.0681
P9	35	.126311	-224.178	.138207	-241.931	.174114	-273.115	.203160	-309.066
V9	36	.407477	-36.6378	.492793	-69.3796	.599654	-115.481	.603280	-160.663
R9	37	.529985	-45.7656	.554227	-67.6389	.546725	-101.252	.476343	-123.743
P10	38	.128890	-167.732	.173416	-187.650	.239989	-226.432	.275345	-268.399
V10	39	.360668	-345.832	.387533	-16.7709	.400044	-59.4141	.356347	-95.6726
R10	40	.828350	-132.642	.907018	-159.350	.978074	-197.815	.932223	-231.857
P11	41	.129377	-150.254	.178937	-172.718	.246166	-213.822	.275801	-256.936
V11	42	.359860	-333.943	.375720	-1.97525	.382245	-39.9871	.354709	-71.1222
R11	43	.848870	-153.381	.928494	-180.199	1.00958	-218.486	.984200	-252.749
V3	8/P3 7	1.00235	-183.657	1.67420	-131.906	3.10245	-120.570	5.05946	-122.430
P1	1/P3 7	.886600	-53.4802	.914936	-64.2270	1.01419	-76.1484	1.21093	-91.1694
P11	41/P3 7	.926806	-349.267	1.11201	-328.221	1.34768	-314.455	1.60798	-303.962

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

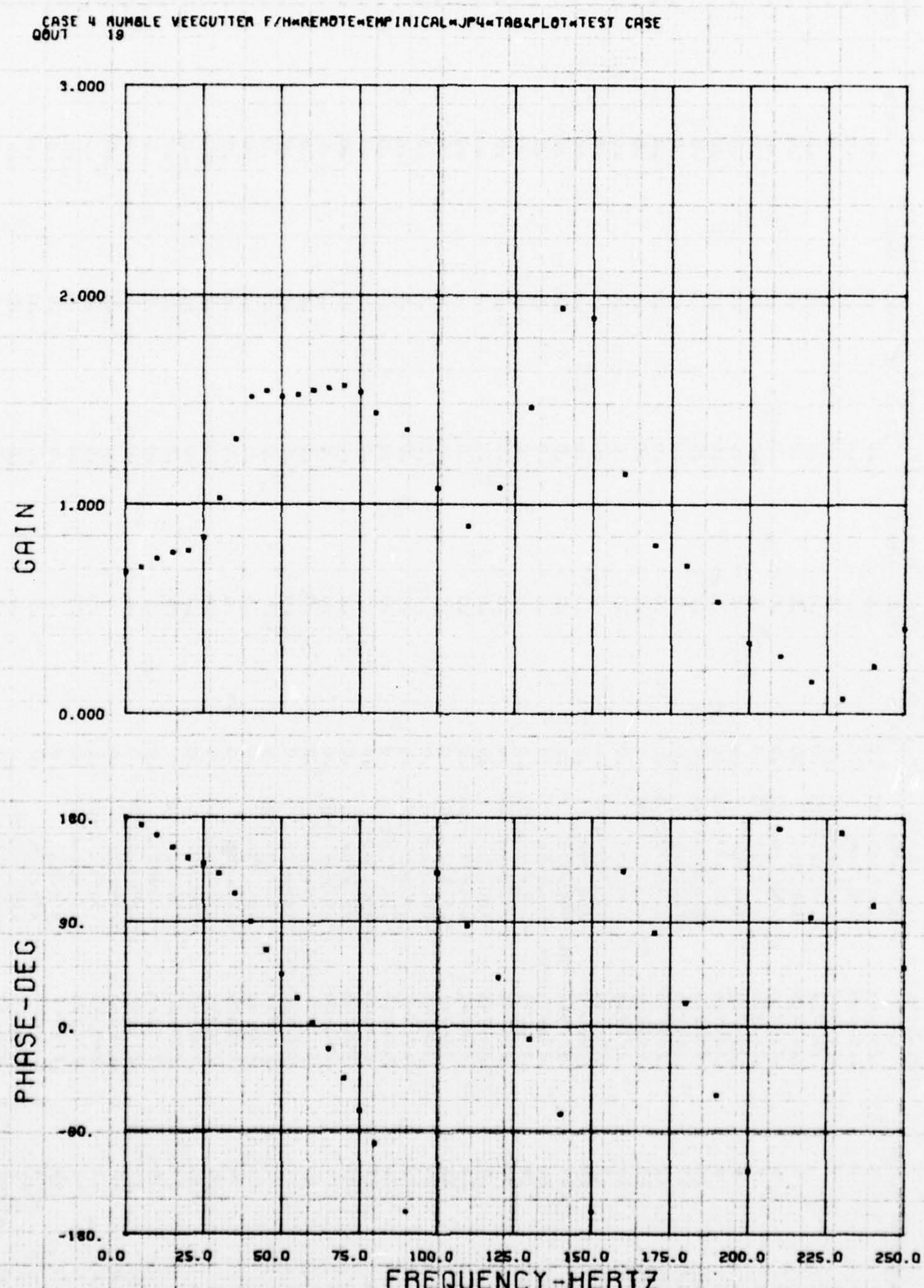
RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

			FREQUENCY =250.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.216493	-114.755	.0	.0	.0	.0	.0	.0
V1	2		.216493	-294.759	.0	.0	.0	.0	.0	.0
R1	3		.216493	-114.759	.0	.0	.0	.0	.0	.0
P2	4		.225833	-236.698	.0	.0	.0	.0	.0	.0
V2	5		.662272	-10.0048	.0	.0	.0	.0	.0	.0
R2	6		.121034	-223.512	.0	.0	.0	.0	.0	.0
P3	7		.141011	-2.00197	.0	.0	.0	.0	.0	.0
V3	8		1.08700	-135.592	.0	.0	.0	.0	.0	.0
R3	9		.145629	-15.2594	.0	.0	.0	.0	.0	.0
P3H	10		.141011	-2.00197	.0	.0	.0	.0	.0	.0
V3H	11		.518373	-135.161	.0	.0	.0	.0	.0	.0
R3H	12		.645172E-01	-331.222	.0	.0	.0	.0	.0	.0
P2H	13		.223658	-47.3521	.0	.0	.0	.0	.0	.0
V2H	14		.223658	-227.352	.0	.0	.0	.0	.0	.0
R2H	15		.223658	-47.3521	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		1.02113	-128.511	.0	.0	.0	.0	.0	.0
W3H	18		.437983	-132.101	.0	.0	.0	.0	.0	.0
QOUT	19		.334483	-13.4853	.0	.0	.0	.0	.0	.0
P4	20		.178429	-350.666	.0	.0	.0	.0	.0	.0
V4	21		.674711	-135.425	.0	.0	.0	.0	.0	.0
R4	22		.659319E-01	-24.4941	.0	.0	.0	.0	.0	.0
P5	23		.194998	-208.082	.0	.0	.0	.0	.0	.0
V5	24		.621794	-63.8693	.0	.0	.0	.0	.0	.0
R5	25		.215526	-191.965	.0	.0	.0	.0	.0	.0
P6	26		.247409	-171.955	.0	.0	.0	.0	.0	.0
V6	27		.318222	-332.018	.0	.0	.0	.0	.0	.0
R6	28		.246601	-121.565	.0	.0	.0	.0	.0	.0
P7	29		.188759	-128.792	.0	.0	.0	.0	.0	.0
V7	30		.613307	-279.554	.0	.0	.0	.0	.0	.0
R7	31		.321779	-228.715	.0	.0	.0	.0	.0	.0
P8	32		.145118	-53.9194	.0	.0	.0	.0	.0	.0
V8	33		.619221	-231.078	.0	.0	.0	.0	.0	.0
R8	34		.637163	-29.5705	.0	.0	.0	.0	.0	.0
P9	35		.217677	-347.333	.0	.0	.0	.0	.0	.0
V9	36		.539184	-199.645	.0	.0	.0	.0	.0	.0
R9	37		.482129	-137.790	.0	.0	.0	.0	.0	.0
P10	38		.273739	-308.594	.0	.0	.0	.0	.0	.0
V10	39		.323722	-122.899	.0	.0	.0	.0	.0	.0
R10	40		.886287	-260.321	.0	.0	.0	.0	.0	.0
P11	41		.265957	-297.067	.0	.0	.0	.0	.0	.0
V11	42		.352510	-97.2083	.0	.0	.0	.0	.0	.0
R11	43		.959428	-282.612	.0	.0	.0	.0	.0	.0
V3	8/P3	7	7.70860	-133.590	.0	.0	.0	.0	.0	.0
P1	1/P3	7	1.53529	-112.757	.0	.0	.0	.0	.0	.0
P11	41/P3	7	1.88607	-295.064	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND PROXIMATE FLOW SPLITTER USING FLAMEHOLDER COMBUSTION MODEL COMBUSTION DATA

RUMBLE
0 CASE 1 RUMBLE VEEGUTTER F/H*PROXIMATE*F/H COMB. MODEL TEST CASE

			FREQUENCY = 0.01 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMETER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.255069	-.658365E-01	.0	.0	.0	.0	.0	.0
V1	2		.255069	-180.066	.0	.0	.0	.0	.0	.0
R1	3		.255069	-.658365E-01	.0	.0	.0	.0	.0	.0
P2	4		.287718	-.583160E-01	.0	.0	.0	.0	.0	.0
V2	5		.287718	-180.024	.0	.0	.0	.0	.0	.0
R2	6		.287718	-.729350E-01	.0	.0	.0	.0	.0	.0
P3	7		.287718	-.552525E-01	.0	.0	.0	.0	.0	.0
V3	8		.287718	-179.961	.0	.0	.0	.0	.0	.0
R3	9		.287718	-.863577E-01	.0	.0	.0	.0	.0	.0
P3H	10		.287718	-.552525E-01	.0	.0	.0	.0	.0	.0
V3H	11		.287716	-180.050	.0	.0	.0	.0	.0	.0
R3H	12		.287718	-.574472E-01	.0	.0	.0	.0	.0	.0
P2H	13		.287718	-.567294E-01	.0	.0	.0	.0	.0	.0
V2H	14		.287718	-180.057	.0	.0	.0	.0	.0	.0
R2H	15		.287718	-.567294E-01	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.527914E-03	-90.0673	.0	.0	.0	.0	.0	.0
W3H	18		.374914E-04	-90.0486	.0	.0	.0	.0	.0	.0
QOUT	19		.350092	-.707998E-01	.0	.0	.0	.0	.0	.0
P4	20		.306741	-.529426E-01	.0	.0	.0	.0	.0	.0
V4	21		.306741	-180.036	.0	.0	.0	.0	.0	.0
R4	22		.306741	-.768219E-01	.0	.0	.0	.0	.0	.0
P5	23		.306741	-.511374E-01	.0	.0	.0	.0	.0	.0
V5	24		.306741	-180.023	.0	.0	.0	.0	.0	.0
R5	25		.306741	-.793634E-01	.0	.0	.0	.0	.0	.0
P6	26		.300613	-.519819E-01	.0	.0	.0	.0	.0	.0
V6	27		.106645	-180.063	.0	.0	.0	.0	.0	.0
R6	28		.106134	-.230502	.0	.0	.0	.0	.0	.0
P7	29		.293956	-.528343E-01	.0	.0	.0	.0	.0	.0
V7	30		.301924E-01	-359.833	.0	.0	.0	.0	.0	.0
R7	31		.308618E-01	-179.279	.0	.0	.0	.0	.0	.0
P8	32		.286657	-.537347E-01	.0	.0	.0	.0	.0	.0
V8	33		.130642	-359.978	.0	.0	.0	.0	.0	.0
R8	34		.131474	-179.855	.0	.0	.0	.0	.0	.0
P9	35		.278579	-.547231E-01	.0	.0	.0	.0	.0	.0
V9	36		.208392	-359.997	.0	.0	.0	.0	.0	.0
R9	37		.209530	-179.926	.0	.0	.0	.0	.0	.0
P10	38		.269545	-.558485E-01	.0	.0	.0	.0	.0	.0
V10	39		.271196	-.634653E-02	.0	.0	.0	.0	.0	.0
R10	40		.272846	-179.957	.0	.0	.0	.0	.0	.0
P11	41		.269545	-.559027E-01	.0	.0	.0	.0	.0	.0
V11	42		.271196	-.724004E-02	.0	.0	.0	.0	.0	.0
R11	43		.272846	-179.959	.0	.0	.0	.0	.0	.0
V3	8/P3	7	1.00000	-179.926	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.886524	-.105840E-01	.0	.0	.0	.0	.0	.0
P11	41/P3	7	.936837	-.650208E-03	.0	.0	.0	.0	.0	.0


CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPIRICAL*JP4*TAB&PLOT*TEST CASE
QOUT 19
3.000
2.000
1.000
0.000
GAIN
180.
90.
0.
-90.
-180.
PHASE-DEG
0.0
25.0
50.0
75.0
100.0
125.0
150.0
175.0
200.0
225.0
250.0
FREQUENCY-HERTZ

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

```
*** WARNING - PARAMETER BPR     =  .59000      IS A DEFAULT VALUE
*** WARNING - PARAMETER FAV     =  .21000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER JFUEL   = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER MBC     =  .15000      IS A DEFAULT VALUE
*** WARNING - PARAMETER MBH     =  .28000      IS A DEFAULT VALUE
*** WARNING - PARAMETER DPD     =  .64000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER DPS     =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER LA      =  82.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LC      =  72.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LH      =  14.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER L2      =  38.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER MBR     =  .22000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NPRNTR  = 0            IS A DEFAULT VALUE
*** WARNING - PARAMETER PRNOZ   =  4.4000      IS A DEFAULT VALUE
*** WARNING - PARAMETER TCORE   =  .50000E-02  IS A DEFAULT VALUE
*** WARNING - PARAMETER NAUGOP  = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER DPH     =  .32000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER ETAC    =  .40000      IS A DEFAULT VALUE
*** WARNING - PARAMETER ETAH    =  .91000      IS A DEFAULT VALUE
*** WARNING - PARAMETER FAC     =  .59500E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER FAH     =  .40000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER LB      =  66.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LI      =  5.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LK      =  60.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LSC     =  4.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LSH     =  8.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER T6C     =  700.00      IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEFC    = -5.5000      IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEFH    =  .40000      IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEPC    =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEPH    =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER ZETC    =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER ZETH    =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEVC    =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEVH    =  .0          IS A DEFAULT VALUE
```

```
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.399999976     ,ZEPC=  .0          ,ZEPH=  .0          ,ZETC=  .0          ,ZETH=  .0          ,ZEVC=  .0          ,
ZEVH=  .0
&END
```

THIS PROGRAM CHECKS SPECIFIC INPUTS TO ENSURE REASONABLE INPUT DATA.

IF THESE CHECKS ARE NOT SATISFIED THE JOB WILL BE TERMINATED.

VIOLATIONS, IF ANY, WILL BE PRINTED BELOW-

```
NAMELIST INPUT VALUES
&VEEGUT
BPK=  .569999974    ,DPD=  .640000105E-01,DPH=  .320000015E-01,DPS=  .0            ,ETAC=  .399999976    ,ETAH=  .910000026    ,
FAC=  .595000014E-01,  .154019869E+67,  .015167184E-18, -.749337575E+12, -.263370506E+21, -.347317153E+22, -.105605303E+13,
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  1379.24561    ,TKC=  3551.06667    ,XLHV=  18650.0000
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&END
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  .249733450E-03,  .246508513E-03,  .178852887E-02,  .0                ,TAUGH=  .805446412E-03
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&END
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RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TABLPLOT*TEST CASE

PARAMTER	ID NO.		FREQUENCY = 0.0 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 5.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 10.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 15.00 HERTZ GAIN	PHASE ANGLE
P1	1		.228205	-360.000	.193553	-35.2665	.158132	-56.2494	.143875	-72.9749
V1	2		.614994	-180.000	.521610	-215.267	.426153	-236.249	.387731	-252.975
R1	3		.228205	-360.000	.193553	-35.2665	.158132	-56.2494	.143875	-72.9749
P2	4		.306925	-360.000	.260149	-30.8853	.212125	-47.4771	.192376	-59.7921
V2	5		.693715	-180.000	.591911	-207.044	.492090	-219.981	.460141	-228.986
R2	6		.306925	-360.000	.253414	-37.1605	.191070	-56.9438	.152687	-73.9411
P3	7		.306925	-360.000	.258971	-28.2126	.208327	-42.0312	.184773	-51.3672
V3	8		.693715	-180.000	.603677	-197.556	.528113	-202.194	.527005	-204.611
R3	9		.306925	-360.000	.234955	-42.1855	.141920	-62.0768	.956823E-01	-56.3497
P3H	10		.306925	-360.000	.258971	-28.2126	.208327	-42.0312	.184773	-51.3672
V3H	11		.787193E-01	-180.000	.995993E-01	-167.461	.127412	-171.149	.154921	-179.979
R3H	12		.306925	-360.000	.258949	-29.2357	.206226	-44.1015	.184490	-54.5237
P2H	13		.306925	-360.000	.259397	-28.6518	.209617	-42.9878	.187122	-52.9698
V2H	14		.787193E-01	-180.000	.909756E-01	-174.377	.110980	-179.034	.132867	-188.901
R2H	15		.306925	-360.000	.259397	-28.6518	.209617	-42.9878	.187122	-52.9698
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.386788	-180.000	.402194	-183.465	.428968	-189.946	.448463	-198.167
W3H	18		.228205	-360.000	.196320	-48.9488	.166195	-81.8278	.157720	-107.651
QOUT	19		.675421	-180.000	.698213	-186.393	.739525	-195.394	.766255	-206.030
P4	20		.327217	-360.000	.277109	-26.9246	.224973	-39.6721	.201756	-48.1942
V4	21		.214831	-180.000	.206967	-185.498	.214257	-186.915	.239832	-191.384
R4	22		.214831	-360.000	.172861	-36.9550	.123962	-55.1837	.101472	-62.4697
P5	23		.327217	-360.000	.276246	-26.1336	.222308	-37.9663	.196759	-45.3645
V5	24		.214831	-180.000	.219754	-177.710	.243964	-176.333	.283313	-179.388
R5	25		.214831	-360.000	.167157	-34.4797	.110943	-46.7747	.889000E-01	-44.6768
P6	26		.321773	-360.000	.270532	-26.6410	.215886	-38.6264	.189617	-45.8676
V6	27		.364523E-01	-180.000	.332149E-01	-166.554	.536434E-01	-147.521	.864977E-01	-156.148
R6	28		.379734E-01	-360.000	.113475	-119.928	.147459	-154.477	.152712	-172.086
P7	29		.315863	-360.000	.264454	-27.1715	.209186	-39.3393	.182189	-46.4464
V7	30		.824882E-01	-360.000	.966226E-01	-9.88965	.103932	-33.1084	.998184E-01	-57.9824
R7	31		.831497E-01	-180.000	.208697	-156.359	.270523	-177.099	.287950	-192.853
P8	32		.309389	-360.000	.257913	-27.7460	.202085	-40.1466	.174316	-47.1625
V8	33		.171417	-360.000	.190248	-8.99710	.201661	-26.5370	.198459	-44.5447
R8	34		.172282	-180.000	.291666	-168.321	.365702	-187.598	.389867	-204.569
P9	35		.302233	-360.000	.250795	-28.3880	.194449	-41.0978	.165804	-46.0910
V9	36		.240316	-360.000	.262593	-9.79241	.278557	-26.5979	.279773	-43.7209
R9	37		.241523	-180.000	.360117	-174.952	.440406	-194.954	.469945	-213.593
P10	38		.294242	-360.000	.242957	-29.1274	.186121	-42.2575	.156439	-49.3336
V10	39		.295991	-360.000	.320830	-10.7956	.340632	-27.7815	.346112	-45.0216
R10	40		.297740	-180.000	.416382	-179.562	.501424	-200.800	.535787	-221.099
P11	41		.294242	-360.000	.243278	-29.2157	.186664	-42.6241	.156692	-50.1245
V11	42		.295991	-360.000	.319693	-11.2737	.339245	-28.4104	.345578	-45.7589
R11	43		.297740	-180.000	.414763	-180.864	.499647	-203.147	.535052	-224.482
V3	8/P3	7	2.26021	-180.000	2.33106	-169.343	2.53502	-160.163	2.85218	-153.244
P1	1/P3	7	.743522	.0	.747393	-7.05389	.759059	-14.2182	.778661	-21.6077
P11	41/P3	7	.958678	.0	.939401	-1.00302	.896013	-.592911	.848024	-358.757

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE + RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.		FREQUENCY = 20.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 25.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 30.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 35.00 HERTZ GAIN	PHASE ANGLE
P1	1		.138166	-89.8961	.137564	-106.379	.145636	-123.570	.161202	-144.750
V1	2		.372346	-269.896	.370723	-286.379	.392477	-303.570	.434424	-324.750
R1	3		.138166	-89.8961	.137564	-106.379	.145636	-123.570	.161202	-144.750
P2	4		.183923	-72.2735	.182096	-84.2916	.191496	-96.9433	.210351	-113.541
V2	5		.457702	-236.619	.474517	-248.313	.525035	-259.204	.608082	-274.554
R2	6		.124950	-84.5857	.109289	-88.5627	.115007	-89.5434	.143773	-97.8223
P3	7		.171350	-60.5512	.163362	-68.8301	.164486	-77.1833	.172427	-88.7692
V3	8		.558826	-209.251	.611717	-215.075	.704943	-222.852	.838941	-235.501
R3	9		.109106	-48.2678	.135068	-61.7026	.141240	-84.3426	.115587	-108.064
P3H	10		.171350	-60.5512	.163362	-68.8301	.164486	-77.1833	.172427	-88.7692
V3H	11		.178670	-191.465	.199429	-202.964	.225965	-214.872	.259123	-230.191
R3H	12		.170733	-64.8353	.142215	-74.2779	.162504	-83.8204	.169170	-96.5943
P2H	13		.174804	-62.9441	.167881	-72.1516	.170166	-81.5574	.179347	-94.2902
V2H	14		.152427	-201.754	.169986	-214.805	.193002	-228.373	.222391	-245.436
R2H	15		.174804	-62.9441	.167881	-72.1516	.170166	-81.5574	.179347	-94.2902
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.457089	-204.761	.494689	-208.046	.606402	-213.975	.774153	-228.691
W3H	18		.157062	-130.732	.160127	-150.708	.170978	-169.085	.187931	-189.493
QOUT	19		.778091	-214.913	.838960	-220.377	1.02763	-228.613	1.30989	-245.826
P4	20		.189173	-56.6951	.182583	-64.3049	.186826	-72.0594	.199839	-83.3255
V4	21		.268799	-199.361	.299105	-208.245	.342705	-218.322	.400519	-232.528
R4	22		.993358E-01	-69.3010	.105392	-82.5625	.109623	-102.276	.103593	-127.126
P5	23		.181542	-52.4831	.172184	-58.4228	.173205	-64.2159	.182531	-73.2673
V5	24		.323359	-186.012	.362763	-193.396	.416478	-201.785	.485799	-214.102
R5	25		.873249E-01	-46.9537	.795421E-01	-56.4604	.585957E-01	-58.5732	.558617E-01	-29.4741
P6	26		.173754	-52.6112	.163926	-57.8392	.165064	-62.6085	.175465	-70.6539
V6	27		.117011	-170.273	.149123	-182.643	.196536	-195.321	.261601	-212.852
R6	28		.157492	-181.540	.172687	-191.377	.184866	-206.746	.170952	-226.663
P7	29		.165645	-52.8303	.155293	-57.3574	.156389	-61.1318	.167446	-68.2401
V7	30		.932496E-01	-82.5339	.943698E-01	-108.934	.108762	-141.254	.135772	-178.919
R7	31		.299268	-204.534	.320966	-216.233	.342881	-231.268	.339043	-249.450
P8	32		.156993	-53.2234	.145952	-57.0751	.146663	-59.6601	.157772	-66.0480
V8	33		.191186	-61.3434	.187904	-79.4997	.186101	-101.845	.175589	-130.217
R8	34		.406803	-218.643	.434915	-232.639	.465862	-249.112	.473292	-268.086
P9	35		.147514	-53.8906	.135464	-57.0991	.135229	-58.8649	.145584	-64.0295
V9	36		.277583	-59.9165	.279918	-76.4945	.283436	-95.5318	.275341	-117.515
R9	37		.492283	-229.823	.526801	-245.857	.566564	-263.827	.585292	-283.827
P10	38		.136894	-54.9689	.123351	-57.5681	.121395	-58.1637	.130021	-62.0386
V10	39		.348972	-61.3888	.357253	-77.8264	.368161	-95.8543	.368951	-115.757
R10	40		.563333	-239.218	.604069	-257.006	.651893	-276.307	.680712	-297.292
P11	41		.136412	-58.2741	.121406	-59.4013	.117077	-60.0617	.123264	-63.3262
V11	42		.349851	-62.1545	.360348	-78.4946	.374628	-96.3218	.379616	-115.979
R11	43		.564182	-243.574	.607268	-262.244	.658517	-282.360	.691451	-304.128
V3	8/P3	7	3.26132	-148.680	3.74455	-146.245	4.28573	-145.669	4.86548	-146.732
P1	1/P3	7	.808342	-29.3449	.842082	-37.5491	.885402	-40.3863	.934897	-55.9803
P11	41/P3	7	.796103	-355.723	.743173	-350.571	.711773	-342.878	.714877	-334.557

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.		FREQUENCY = 40.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 45.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 50.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 55.00 HERTZ GAIN	PHASE ANGLE
P1	1		.173061	-170.412	.176131	-196.612	.178902	-222.524	.180425	-250.504
V1	2		.466440	-350.412	.474657	-16.6119	.482125	-42.5239	.486229	-70.5039
R1	3		.173061	-170.412	.176131	-196.612	.178902	-222.524	.180425	-250.504
P2	4		.223948	-134.558	.225819	-156.040	.227169	-177.158	.226833	-200.261
V2	5		.683042	-294.650	.726208	-316.085	.769001	-337.388	.806295	-1.06620
R2	6		.180697	-116.857	.209243	-141.114	.230196	-167.715	.238238	-197.537
P3	7		.175250	-103.958	.169581	-118.790	.165488	-132.506	.162872	-147.710
V3	8		.955990	-253.235	1.01936	-271.679	1.07178	-290.460	1.10622	-311.182
R3	9		.704892E-01	-108.072	.992354E-01	-85.5678	.162534	-107.653	.192155	-143.958
P3H	10		.175250	-103.958	.169581	-118.790	.165488	-132.508	.162872	-147.710
V3H	11		.281571	-249.286	.285111	-268.148	.284747	-285.899	.280235	-304.899
R3H	12		.170397	-112.991	.163049	-128.988	.157009	-143.808	.152213	-160.021
P2H	13		.182925	-110.737	.177181	-126.860	.172557	-141.851	.169001	-158.227
V2H	14		.243534	-266.373	.249279	-287.202	.252425	-307.150	.252494	-328.620
R2H	15		.182925	-110.737	.177181	-126.860	.172557	-141.851	.169001	-158.227
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.899043	-250.668	.920742	-272.560	.909474	-290.962	.919805	-308.534
W3H	18		.197385	-212.658	.193766	-234.752	.187568	-254.961	.178659	-275.549
QOUT	19		1.51540	-270.359	1.54338	-294.819	1.51560	-315.730	1.52572	-335.840
P4	20		.207366	-98.6263	.204065	-113.928	.201464	-128.245	.199979	-144.052
V4	21		.445021	-251.130	.461072	-269.996	.471065	-288.153	.473988	-307.955
R4	22		.811797E-01	-151.028	.585611E-01	-159.781	.596239E-01	-161.873	.682127E-01	-184.281
P5	23		.187274	-86.1805	.183092	-98.9692	.180628	-110.830	.180106	-124.437
V5	24		.537221	-230.623	.552565	-247.189	.559313	-262.752	.557616	-279.505
R5	25		.101596	-27.2967	.140325	-48.1870	.154761	-68.7938	.161005	-83.5254
P6	26		.182021	-82.7302	.179816	-94.5954	.179852	-105.300	.182716	-117.798
V6	27		.320276	-234.649	.355817	-254.964	.389218	-272.346	.424715	-290.063
R6	28		.119604	-241.816	.764458E-01	-228.402	.846492E-01	-207.716	.982309E-01	-199.251
P7	29		.175200	-79.5322	.174525	-90.4893	.176755	-100.113	.182532	-111.653
V7	30		.163921	-216.179	.185962	-245.753	.215495	-267.991	.253576	-289.111
R7	31		.293417	-265.289	.248269	-271.770	.235767	-275.872	.219553	-282.265
P8	32		.166060	-76.5466	.166483	-86.5966	.170496	-95.1854	.178588	-105.877
V8	33		.150145	-161.775	.126282	-190.851	.121808	-219.414	.129004	-251.112
R8	34		.438354	-285.463	.402158	-296.823	.396874	-307.119	.385709	-319.490
P9	35		.153633	-73.6328	.154612	-82.6765	.159762	-90.2161	.169324	-100.084
V9	36		.247411	-139.253	.219863	-157.155	.206888	-175.185	.192837	-195.910
R9	37		.562274	-302.529	.537654	-316.489	.544544	-329.686	.545994	-344.596
P10	38		.136980	-70.4709	.137907	-78.2430	.143454	-84.5167	.153560	-93.4052
V10	39		.350433	-134.969	.332351	-151.003	.328473	-166.812	.322449	-183.917
R10	40		.668566	-317.064	.654666	-332.754	.672725	-347.744	.685996	-4.13434
P11	41		.128684	-71.0586	.128477	-78.2304	.132644	-83.7012	.141703	-91.7950
V11	42		.364807	-134.940	.349535	-150.624	.349024	-165.859	.346849	-182.311
R11	43		.682828	-324.683	.671488	-341.133	.692547	-356.797	.709256	-13.8361
V3	8/P3	7	5.45502	-149.278	6.01105	-153.089	6.47645	-157.952	6.79197	-163.472
P1	1/P3	7	.987628	-66.4540	1.03862	-77.8219	1.08105	-90.0161	1.10777	-102.794
P11	41/P3	7	.734289	-327.101	.757619	-319.440	.801531	-311.193	.870029	-304.085

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

		FREQUENCY = 60.00 HERTZ		FREQUENCY = 65.00 HERTZ		FREQUENCY = 70.00 HERTZ		FREQUENCY = 75.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.173400	-279.071	.165442	-305.546	.166171	-332.202	.172004	-2.85192
V1	2	.467297	-99.0715	.445852	-125.546	.447817	-152.202	.463535	-182.852
R1	3	.173400	-279.071	.165442	-305.546	.166171	-332.202	.172004	-2.85192
P2	4	.215621	-223.879	.203886	-245.303	.202840	-266.822	.208094	-292.238
V2	5	.803068	-25.6082	.791337	-48.2677	.817925	-71.2965	.868007	-98.4614
R2	6	.222438	-227.998	.195174	-255.266	.171195	-280.123	.149778	-304.240
P3	7	.155638	-163.315	.150369	-177.044	.155164	-191.546	.166468	-210.832
V3	8	1.07674	-332.456	1.03077	-351.472	1.03043	-10.4219	1.05463	-33.0351
R3	9	.165548	-181.330	.106424	-207.656	.688270E-01	-199.449	.105152	-190.663
P3H	10	.155638	-163.315	.150369	-177.044	.155164	-191.546	.166468	-210.832
V3H	11	.261917	-323.675	.243170	-339.559	.238700	-354.948	.243247	-13.8191
R3H	12	.143111	-176.527	.135973	-191.061	.137968	-206.293	.145540	-226.264
P2H	13	.160402	-174.825	.153881	-189.339	.157883	-204.432	.168811	-224.181
V2H	14	.240127	-350.229	.226643	-9.37734	.225375	-28.4651	.231215	-51.4159
R2H	15	.160402	-174.825	.153881	-189.339	.157883	-204.432	.168811	-224.181
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.935195	-327.553	.946961	-347.068	.962512	-9.77903	.954200	-34.8152
W3H	18	.161566	-294.953	.145725	-310.379	.140564	-324.246	.143516	-340.659
QOUT	19	1.54450	-357.554	1.55417	-20.5106	1.56596	-45.5341	1.53544	-73.5049
P4	20	.192413	-160.351	.186412	-174.940	.191516	-190.296	.203345	-210.141
V4	21	.452000	-327.971	.425945	-345.534	.420793	-2.89033	.427375	-23.7641
R4	22	.611838E-01	-219.113	.396869E-01	-255.737	.126906E-01	-285.812	.151725E-01	-176.727
P5	23	.174379	-138.962	.169516	-152.191	.173772	-166.448	.182934	-185.310
V5	24	.529015	-296.014	.500113	-309.706	.501093	-323.050	.522202	-340.009
R5	25	.182591	-96.6598	.217080	-115.686	.248994	-140.607	.264153	-169.403
P6	26	.179845	-131.395	.176302	-143.466	.181282	-155.909	.191204	-172.320
V6	27	.440389	-307.301	.448821	-320.712	.483792	-331.906	.549589	-345.420
R6	28	.134098	-189.678	.204885	-195.520	.278875	-211.911	.329933	-232.248
P7	29	.182085	-124.390	.180059	-135.275	.186854	-145.990	.199546	-160.283
V7	30	.278468	-308.970	.294854	-322.969	.334942	-332.726	.411656	-344.954
R7	31	.201328	-280.401	.255946	-276.066	.305658	-284.146	.360891	-300.796
P8	32	.180233	-117.833	.179968	-127.666	.189098	-137.013	.205176	-149.779
V8	33	.132615	-279.117	.140924	-295.559	.178561	-306.490	.248703	-323.169
R8	34	.360836	-327.616	.378484	-331.452	.445568	-340.726	.512432	-357.398
P9	35	.172514	-111.315	.173696	-120.258	.184412	-128.550	.202588	-140.187
V9	36	.174954	-213.919	.177281	-228.202	.206717	-246.842	.246867	-272.544
R9	37	.530106	-356.641	.553637	-5.25081	.632841	-17.0135	.720307	-34.4627
P10	38	.157582	-103.850	.159460	-111.903	.170288	-119.159	.188458	-129.654
V10	39	.311938	-199.027	.320827	-212.310	.352633	-228.493	.386216	-249.336
R10	40	.680413	-18.2601	.712677	-29.5164	.803085	-42.9865	.905433	-61.0788
P11	41	.145050	-101.710	.145641	-109.096	.154596	-115.214	.171506	-124.433
V11	42	.339115	-196.883	.350141	-209.536	.384878	-224.734	.421459	-244.342
R11	43	.706220	-28.6871	.740637	-40.6879	.834217	-54.7946	.940242	-73.4411
V3	8/P3 7	6.91826	-169.143	6.85498	-174.428	6.64088	-178.876	6.33533	-182.203
P1	1/P3 7	1.11412	-115.758	1.10024	-128.502	1.07094	-140.657	1.03326	-152.020
P11	41/P3 7	.931970	-298.396	.968558	-292.052	.996341	-283.669	1.03026	-273.601

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TABEPLOT*TEST CASE

			FREQUENCY = 80.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.172984	-37.1178	.0	.0	.0	.0	.0	.0
V1	2		.466176	-217.118	.0	.0	.0	.0	.0	.0
R1	3		.172984	-37.1178	.0	.0	.0	.0	.0	.0
P2	4		.207600	-321.204	.0	.0	.0	.0	.0	.0
V2	5		.891623	-129.383	.0	.0	.0	.0	.0	.0
R2	6		.131430	-325.310	.0	.0	.0	.0	.0	.0
P3	7		.174056	-234.569	.0	.0	.0	.0	.0	.0
V3	8		1.04384	-58.8669	.0	.0	.0	.0	.0	.0
R3	9		.142622	-229.851	.0	.0	.0	.0	.0	.0
P3H	10		.174056	-234.569	.0	.0	.0	.0	.0	.0
V3H	11		.243018	-36.0078	.0	.0	.0	.0	.0	.0
R3H	12		.149586	-250.659	.0	.0	.0	.0	.0	.0
P2H	13		.176363	-248.315	.0	.0	.0	.0	.0	.0
V2H	14		.230615	-77.9467	.0	.0	.0	.0	.0	.0
R2H	15		.176363	-248.315	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.903256	-60.2847	.0	.0	.0	.0	.0	.0
W3H	18		.147048	-.670612	.0	.0	.0	.0	.0	.0
QOUT	19		1.43509	-101.873	.0	.0	.0	.0	.0	.0
P4	20		.210204	-234.020	.0	.0	.0	.0	.0	.0
V4	21		.422141	-47.7569	.0	.0	.0	.0	.0	.0
R4	22		.323577E-01	-218.923	.0	.0	.0	.0	.0	.0
P5	23		.186310	-208.216	.0	.0	.0	.0	.0	.0
V5	24		.535175	-.421755	.0	.0	.0	.0	.0	.0
R5	25		.259037	-197.799	.0	.0	.0	.0	.0	.0
P6	26		.194308	-192.355	.0	.0	.0	.0	.0	.0
V6	27		.615808	-2.11033	.0	.0	.0	.0	.0	.0
R6	28		.346981	-251.572	.0	.0	.0	.0	.0	.0
P7	29		.205314	-177.870	.0	.0	.0	.0	.0	.0
V7	30		.498078	-1.44693	.0	.0	.0	.0	.0	.0
R7	31		.377484	-318.668	.0	.0	.0	.0	.0	.0
P8	32		.214769	-165.635	.0	.0	.0	.0	.0	.0
V8	33		.325124	-344.690	.0	.0	.0	.0	.0	.0
R8	34		.539046	-16.5094	.0	.0	.0	.0	.0	.0
P9	35		.215023	-154.766	.0	.0	.0	.0	.0	.0
V9	36		.279605	-300.883	.0	.0	.0	.0	.0	.0
R9	37		.766498	-54.2258	.0	.0	.0	.0	.0	.0
P10	38		.201983	-142.946	.0	.0	.0	.0	.0	.0
V10	39		.401147	-272.164	.0	.0	.0	.0	.0	.0
R10	40		.965035	-81.2046	.0	.0	.0	.0	.0	.0
P11	41		.185218	-136.626	.0	.0	.0	.0	.0	.0
V11	42		.437263	-265.877	.0	.0	.0	.0	.0	.0
R11	43		1.00202	-94.0957	.0	.0	.0	.0	.0	.0
V3	8/P3	7	5.99716	-184.297	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.993845	-162.548	.0	.0	.0	.0	.0	.0
P11	41/P3	7	1.06413	-262.057	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

		FREQUENCY = 90.00 HERTZ		FREQUENCY =100.00 HERTZ		FREQUENCY =110.00 HERTZ		FREQUENCY =120.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.167903	-110.596	.143472	-185.699	.142274	-251.740	.148619	-314.453
V1	2	.452484	-290.596	.386645	-5.69867	.383416	-71.7399	.400516	-134.453
R1	3	.167903	-110.596	.143472	-185.699	.142274	-251.740	.148619	-314.453
P2	4	.198965	-23.8949	.168855	-88.0072	.167416	-142.976	.176028	-194.706
V2	5	.892584	-196.470	.774722	-265.402	.768541	-325.337	.790965	-21.8993
R2	6	.145252	-8.40342	.167383	-75.0256	.184796	-143.664	.172120	-208.802
P3	7	.181027	-289.154	.160944	-347.271	.159758	-36.9768	.160681	-82.7794
V3	8	.976508	-114.144	.812549	-169.447	.805182	-214.996	.862869	-257.861
R3	9	.102665	-302.788	.115708	-319.235	.179304	-37.3231	.113423	-112.153
P3H	10	.181027	-289.154	.160944	-347.271	.159758	-36.9768	.160681	-82.7794
V3H	11	.238787	-65.3115	.210532	-137.053	.214881	-180.566	.227804	-220.629
R3H	12	.150037	-306.500	.128136	-5.76687	.121608	-56.4495	.116370	-102.993
P2H	13	.184341	-303.671	.165718	-2.64031	.167023	-53.2692	.171252	-100.002
V2H	14	.219595	-136.081	.181636	-196.047	.170069	-246.705	.162489	-292.766
R2H	15	.184341	-303.671	.165718	-2.64031	.167023	-53.2692	.171252	-100.002
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.875144	-113.133	.714929	-174.118	.626068	-214.330	.771824	-253.110
W3H	18	.160051	-47.1773	.158557	-99.6617	.177894	-146.097	.202115	-189.955
QOUT	19	1.35570	-160.605	1.07273	-228.041	.894261	-274.059	1.08029	-318.325
P4	20	.215780	-288.315	.190008	-346.117	.187514	-34.8856	.190871	-79.8690
V4	21	.400596	-99.7361	.340146	-152.970	.339815	-197.087	.360575	-238.597
R4	22	.239735E-01	-291.033	.366831E-01	-307.551	.508301E-01	-37.9154	.236481E-01	-150.256
P5	23	.182225	-260.245	.149883	-314.716	.136956	-358.714	.129336	-37.4493
V5	24	.559473	-47.2130	.521023	-98.4140	.550300	-142.322	.595866	-183.772
R5	25	.271318	-256.256	.221630	-326.587	.183635	-13.1121	.214421	-64.3462
P6	26	.182482	-237.032	.138454	-282.408	.114570	-319.012	.102802	-351.962
V6	27	.727679	-39.6612	.703406	-79.9804	.674762	-114.969	.621321	-150.358
R6	28	.342509	-290.031	.182164	-319.351	.135519	-300.319	.180871	-276.128
P7	29	.197140	-215.661	.155390	-252.045	.133608	-279.491	.125221	-306.865
V7	30	.664871	-38.7257	.705373	-76.9512	.714438	-111.467	.689741	-142.458
R7	31	.359708	-354.626	.188239	-17.9697	.167724	-350.904	.281355	-340.658
P8	32	.216379	-196.874	.184136	-230.529	.172309	-254.163	.170044	-279.510
V8	33	.478558	-28.8985	.526604	-74.3315	.545428	-108.184	.535008	-139.128
R8	34	.531145	-56.1065	.338679	-91.6337	.219132	-96.3746	.203098	-73.4356
P9	35	.226154	-185.004	.205100	-214.312	.204135	-236.869	.208154	-261.671
V9	36	.344408	-356.889	.326836	-50.3000	.311679	-86.7214	.284652	-117.368
R9	37	.789742	-94.8817	.598959	-131.445	.492035	-150.902	.425293	-161.472
P10	38	.220378	-170.490	.210820	-198.342	.218429	-220.873	.225645	-245.766
V10	39	.400910	-319.304	.309620	-1.33695	.268477	-28.8746	.248483	-49.7595
R10	40	1.00757	-122.213	.821716	-158.513	.745054	-181.756	.711954	-200.834
P11	41	.207604	-162.442	.203861	-190.139	.212749	-212.737	.218010	-237.528
V11	42	.431545	-309.970	.330645	-347.964	.288970	-11.6509	.278470	-30.1089
R11	43	1.04421	-136.098	.853550	-173.136	.780209	-197.281	.757147	-217.728
V3	8/P3 7	5.39427	-184.990	5.04866	-182.175	5.04003	-176.019	5.37006	-175.081
P1	1/P3 7	.927502	-181.442	.891443	-198.427	.890561	-214.763	.924930	-231.673
P11	41/P3 7	1.14681	-233.286	1.26666	-202.868	1.33170	-175.761	1.35678	-154.748

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY =130.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =140.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =150.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =160.00 HERTZ GAIN	PHASE ANGLE
P1	1	.195661	-12.4752	.268734	-66.1497	.244923	-177.665	.165966	-242.643
V1	2	.527626	-192.475	.724215	-268.150	.660048	-357.664	.447269	-62.6427
R1	3	.195661	-12.4752	.268734	-66.1497	.244923	-177.665	.165966	-242.643
P2	4	.234879	-241.915	.327735	-307.041	.304541	-26.3645	.210540	-81.4858
V2	5	1.01144	-73.5326	1.32625	-142.404	1.13812	-224.526	.716250	-261.202
R2	6	.167931	-257.573	.206922	-302.565	.256665	-13.4606	.214769	-77.6546
P3	7	.197626	-122.018	.251750	-175.964	.219938	-240.711	.153036	-279.885
V3	8	1.17961	-297.580	1.66500	-356.705	1.52199	-71.0166	.997065	-121.409
R3	9	.113530	-105.660	.208097	-181.921	.995305E-01	-227.774	.165115	-265.709
P3H	10	.197626	-122.018	.251750	-175.964	.219938	-240.711	.153036	-279.885
V3H	11	.302364	-254.575	.426285	-304.004	.422428	-6.14890	.332536	-45.2778
R3H	12	.135591	-142.754	.162115	-196.946	.131526	-261.492	.838431E-01	-299.436
P2H	13	.216140	-140.201	.284287	-195.226	.258773	-261.546	.187664	-303.034
V2H	14	.190652	-331.223	.234521	-22.5026	.208261	-82.9733	.157256	-119.317
R2H	15	.216140	-140.201	.284287	-195.228	.258773	-261.546	.187664	-303.034
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	1.06690	-298.817	1.45788	-355.962	1.43108	-72.5915	.868359	-127.781
W3H	18	.281675	-228.026	.409199	-261.747	.409411	-348.040	.319800	-30.6674
QOUT	19	1.46526	-11.2763	1.93817	-75.6956	1.89008	-160.489	1.14324	-226.437
P4	20	.238062	-119.102	.306517	-173.177	.270513	-238.947	.185262	-279.149
V4	21	.476254	-275.857	.646558	-329.971	.581491	-36.7233	.394171	-76.9908
R4	22	.248345E-01	-347.364	.464984E-01	-46.0638	.119240	-117.613	.116319	-193.326
P5	23	.151742	-68.9737	.189636	-114.844	.164559	-173.632	.108777	-207.401
V5	24	.761738	-220.364	1.03940	-272.377	.929888	-335.756	.642046	-12.9336
R5	25	.234336	-124.600	.245580	-193.775	.191133	-300.574	.953085E-01	-46.7194
P6	26	.127965	-21.1516	.178143	-67.7529	.173524	-127.777	.127614	-160.448
V6	27	.685289	-187.763	.782802	-245.326	.658980	-318.359	.458740	-3.63682
R6	28	.400352	-296.412	.590479	-344.276	.500344	-52.4831	.181907	-96.3954
P7	29	.155461	-336.625	.209473	-26.5844	.199098	-90.2634	.149271	-125.753
V7	30	.753630	-172.084	.815572	-217.107	.590275	-274.187	.341918	-304.093
R7	31	.560195	-4.34061	.840318	-49.5770	.729965	-108.521	.410521	-125.315
P8	32	.209105	-307.401	.268244	-355.643	.239921	-58.3876	.170376	-94.6590
V8	33	.596012	-164.389	.708444	-202.617	.617256	-252.481	.435317	-279.535
R8	34	.421966	-81.0542	.663397	-120.856	.594998	-174.173	.399888	-184.219
P9	35	.257312	-288.277	.324498	-334.412	.280883	-34.7104	.189690	-68.6395
V9	36	.329897	-136.469	.450797	-173.318	.444977	-227.686	.312381	-258.051
R9	37	.578261	-172.643	.789149	-209.901	.676382	-262.550	.426888	-277.428
P10	38	.276682	-271.629	.341364	-316.374	.286670	-14.2820	.186646	-45.1077
V10	39	.330040	-72.0628	.442668	-115.761	.390487	-172.723	.273184	-196.122
R10	40	.921683	-221.469	1.20420	-262.627	1.04560	-317.034	.717438	-339.593
P11	41	.264144	-262.515	.323095	-305.782	.268962	-2.56207	.170472	-32.3066
V11	42	.374911	-52.7059	.502577	-96.3593	.445397	-152.911	.319252	-177.431
R11	43	.987787	-240.345	1.29633	-283.392	1.13238	-339.659	.784444	-4.56944
V3	8/P3 7	5.96380	-175.562	6.61370	-180.741	6.92008	-190.308	6.51525	-201.523
P1	1/P3 7	.990054	-250.457	1.06746	-272.185	1.11360	-296.954	1.08450	-322.757
P11	41/P3 7	1.33522	-140.496	1.28340	-129.818	1.22290	-121.852	1.11394	-112.421

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

		FREQUENCY =170.00 HERTZ		FREQUENCY =180.00 HERTZ		FREQUENCY =190.00 HERTZ		FREQUENCY =200.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.135213	-303.800	.119927	-5.71000	.112892	-78.5336	.100874	-148.229
V1	2	.364387	-123.801	.323192	-185.710	.304234	-258.533	.271848	-328.229
R1	3	.135213	-303.800	.119927	-5.71000	.112892	-78.5336	.100674	-148.229
P2	4	.174797	-133.116	.157579	-185.785	.150202	-249.595	.135281	-310.435
V2	5	.535958	-332.869	.434278	-23.6839	.375406	-83.5044	.314631	-138.277
R2	6	.174152	-142.743	.124606	-203.069	.892596E-01	-255.770	.923900E-01	-297.284
P3	7	.136186	-317.335	.134740	-359.019	.139455	-54.6641	.132617	-109.163
V3	8	.750712	-167.747	.585010	-213.315	.461052	-266.315	.339729	-309.791
R3	9	.123403	-342.590	.606763E-01	-352.110	.119092	-49.0461	.841236E-01	-121.463
P3H	10	.136186	-317.335	.134740	-359.019	.139455	-54.6641	.132617	-109.163
V3H	11	.325460	-84.1368	.345826	-127.352	.379740	-184.230	.381457	-239.727
R3H	12	.679982E-01	-333.973	.618526E-01	-10.8767	.601490E-01	-60.0534	.555626E-01	-106.847
P2H	13	.172744	-343.229	.175627	-27.6523	.186396	-85.9023	.181877	-142.929
V2H	14	.154501	-157.290	.165521	-201.507	.181858	-260.269	.181532	-317.928
R2H	15	.172744	-343.229	.175627	-27.6523	.186396	-85.9023	.181877	-142.929
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.627906	-168.759	.540836	-217.554	.373307	-277.441	.256782	-312.511
W3H	18	.308702	-72.2021	.323026	-117.483	.349509	-176.044	.346048	-232.900
QOUT	19	.803085	-279.289	.707414	-340.030	.534038	-60.0382	.336046	-124.902
P4	20	.161974	-316.427	.158010	-357.798	.161173	-52.4553	.153234	-105.688
V4	21	.337495	-112.348	.330494	-149.771	.352820	-200.475	.358516	-250.916
R4	22	.914719E-01	-243.507	.113281	-286.763	.129202	-.538967	.107468	-61.9465
P5	23	.893227E-01	-237.033	.818320E-01	-267.287	.834948E-01	-308.090	.854592E-01	-348.205
V5	24	.567820	-46.7793	.563824	-84.8767	.584419	-136.760	.559728	-187.597
R5	25	.832537E-01	-119.790	.129461	-186.341	.148758	-267.539	.138603	-326.879
P6	26	.121144	-186.026	.131302	-212.837	.150548	-252.855	.154424	-294.911
V6	27	.447107	-39.7290	.486147	-73.7518	.532569	-114.409	.496645	-151.260
R6	28	.258711E-01	-117.024	.115834	-331.275	.177689	-12.1522	.187392	-24.9062
P7	29	.149038	-154.669	.168343	-184.878	.194212	-226.956	.193711	-268.593
V7	30	.257242	-334.093	.217493	-8.21642	.200494	-55.5236	.187802	-95.8065
R7	31	.384763	-129.412	.455780	-139.186	.518291	-171.766	.433073	-199.850
P8	32	.161816	-125.536	.173498	-157.753	.189493	-200.336	.179151	-240.578
V8	33	.360235	-301.875	.371898	-323.791	.397858	-354.266	.410832	-26.4737
R8	34	.454500	-192.613	.587342	-210.167	.691809	-244.790	.655467	-274.248
P9	35	.169440	-97.4749	.168884	-127.412	.172077	-166.567	.153780	-201.428
V9	36	.283147	-278.078	.306998	-297.108	.380607	-330.039	.414960	-6.27755
R9	37	.434722	-286.150	.531692	-302.741	.618411	-337.066	.585299	-8.11134
P10	38	.159921	-70.5910	.151977	-96.0328	.150493	-129.089	.138799	-156.455
V10	39	.280735	-216.117	.332697	-241.502	.386543	-281.735	.380464	-320.134
R10	40	.704085	-358.084	.795639	-20.7029	.894784	-57.0905	.861887	-91.1905
P11	41	.140501	-55.4489	.129478	-76.8592	.130570	-105.127	.128547	-129.579
V11	42	.325619	-199.446	.374470	-226.062	.418971	-265.958	.396911	-302.946
R11	43	.769350	-25.6085	.862712	-50.4689	.962220	-88.5134	.921628	-123.869
V3	8/P3 7	5.51238	-210.411	4.34176	-214.296	3.30610	-211.651	2.56173	-200.628
P1	1/P3 7	.992852	-346.465	.890058	-6.69116	.809522	-23.8694	.760642	-39.0663
P11	41/P3 7	1.03168	-98.1138	.960948	-77.8403	.936289	-50.4628	.969308	-20.4156

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY =210.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =220.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =230.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =240.00 HERTZ GAIN	PHASE ANGLE
P1	1	.976657E-01	-213.049	.109939	-271.782	.131800	-336.856	.154612	-43.5556
V1	2	.263201	-33.0486	.296275	-91.7818	.355190	-156.856	.416666	-223.556
R1	3	.976657E-01	-213.049	.109939	-271.782	.131800	-336.856	.154612	-43.5556
P2	4	.131355	-6.48002	.147513	-56.4560	.175535	-112.672	.203444	-170.378
V2	5	.296908	-186.863	.341365	-229.308	.434972	-279.276	.554926	-332.776
R2	6	.118847	-354.641	.147748	-56.2041	.157861	-123.823	.137800	-181.925
P3	7	.131349	-159.741	.145123	-204.290	.164085	-254.305	.175534	-304.058
V3	8	.296867	-340.823	.364176	-5.26699	.527906	-43.3369	.742526	-89.7213
R3	9	.881191E-01	-139.497	.145997	-203.503	.113172	-274.987	.112455	-291.326
P3H	10	.131349	-159.741	.145123	-204.290	.164085	-254.305	.175534	-304.058
V3H	11	.398819	-291.193	.464483	-330.693	.553285	-27.8022	.621833	-78.8428
R3H	12	.557958E-01	-149.292	.651717E-01	-186.300	.805113E-01	-230.212	.959338E-01	-275.718
P2H	13	.185116	-196.042	.210489	-243.203	.245111	-295.941	.269887	-348.581
V2H	14	.187810	-11.6198	.216469	-59.2931	.255409	-112.541	.285166	-165.816
R2H	15	.185116	-196.042	.210489	-243.203	.245111	-295.941	.269887	-348.581
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.217258	-349.305	.230392	-353.814	.466230	-32.3605	.639323	-86.0057
W3H	18	.356376	-285.649	.409068	-332.178	.479835	-24.1347	.530768	-75.8330
QOUT	19	.272707	-169.666	.152770	-265.983	.690979E-01	-193.116	.225255	-255.862
P4	20	.152244	-155.333	.169142	-198.613	.195005	-247.484	.213254	-296.680
V4	21	.385363	-298.676	.466834	-341.441	.582892	-30.9603	.687586	-81.5627
R4	22	.116451	-112.859	.131550	-171.563	.114743	-226.966	.119853	-268.728
P5	23	.959535E-01	-26.9864	.123364	-62.6363	.162984	-106.655	.201423	-152.782
V5	24	.555042	-234.889	.608989	-275.746	.686066	-321.878	.727189	-7.82563
R5	25	.154490	-24.9691	.146893	-74.8354	.174525	-111.927	.216895	-164.817
P6	26	.159015	-337.600	.182722	-18.4597	.219499	-67.3102	.254747	-116.561
V6	27	.441256	-183.446	.417748	-210.959	.406482	-245.087	.400118	-282.576
R6	28	.201819	-32.8702	.299848	-41.7551	.370813	-71.8842	.414586	-98.5127
P7	29	.187763	-309.012	.196770	-346.715	.212163	-32.4201	.221756	-78.7131
V7	30	.207326	-128.840	.282238	-155.659	.410646	-193.266	.553006	-233.975
R7	31	.314258	-221.580	.246321	-221.917	.233098	-226.484	.283225	-225.464
P8	32	.163906	-277.388	.161368	-309.134	.164012	-346.433	.166698	-22.7471
V8	33	.433779	-60.4223	.502322	-94.6012	.590244	-137.877	.663713	-183.314
R8	34	.588942	-298.586	.600914	-315.036	.637718	-339.730	.687574	-2.73118
P9	35	.138014	-230.269	.142857	-252.121	.166152	-281.031	.199311	-314.070
V9	36	.441117	-42.5510	.499224	-75.8510	.580512	-116.740	.638059	-158.351
R9	37	.522785	-35.0306	.515535	-54.7589	.518110	-80.5341	.537767	-102.112
P10	38	.140066	-179.830	.169432	-201.134	.219011	-234.379	.269762	-271.949
V10	39	.360724	-356.197	.372299	-27.9589	.387571	-67.1130	.390455	-104.576
R10	40	.807262	-122.368	.830492	-148.803	.873990	-182.165	.907458	-214.383
P11	41	.139757	-153.549	.175476	-177.770	.227109	-213.790	.273985	-252.936
V11	42	.361283	-336.279	.359001	-3.93053	.365184	-37.1404	.376489	-66.0864
R11	43	.862191	-155.836	.892664	-182.722	.957181	-216.346	1.02624	-249.380
V3	8/P3 7	2.26091	-181.082	2.50943	-160.977	3.21726	-149.032	4.23008	-145.663
P1	1/P3 7	.743560	-53.3077	.757553	-67.4917	.803241	-82.5507	.880807	-99.4973
P11	41/P3 7	1.06401	-353.808	1.20915	-333.480	1.38409	-319.485	1.56086	-308.876

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

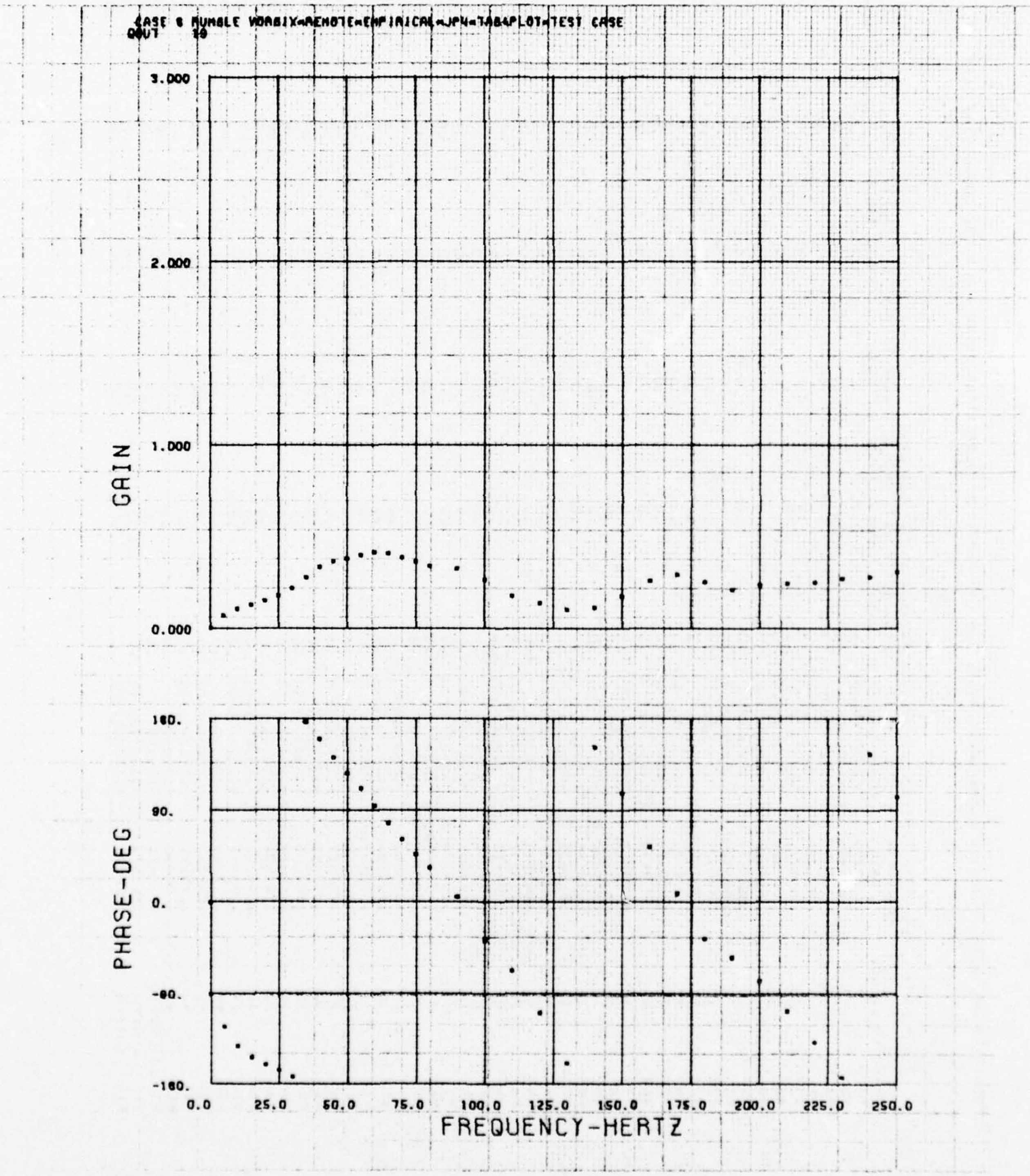
RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TABLPLOT*TEST CASE

			FREQUENCY =250.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.164128	-116.678	.0	.0	.0	.0	.0	.0
V1	2		.442511	-296.678	.0	.0	.0	.0	.0	.0
R1	3		.164128	-116.678	.0	.0	.0	.0	.0	.0
P2	4		.212549	-234.298	.0	.0	.0	.0	.0	.0
V2	5		.644849	-34.6393	.0	.0	.0	.0	.0	.0
R2	6		.129360	-225.746	.0	.0	.0	.0	.0	.0
P3	7		.167070	-357.309	.0	.0	.0	.0	.0	.0
V3	8		.901735	-146.262	.0	.0	.0	.0	.0	.0
R3	9		.143378	-6.67460	.0	.0	.0	.0	.0	.0
P3H	10		.167070	-357.309	.0	.0	.0	.0	.0	.0
V3H	11		.618433	-133.448	.0	.0	.0	.0	.0	.0
R3H	12		.102280	-326.595	.0	.0	.0	.0	.0	.0
P2H	13		.263741	-44.7619	.0	.0	.0	.0	.0	.0
V2H	14		.282617	-222.963	.0	.0	.0	.0	.0	.0
R2H	15		.263741	-44.7619	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.797995	-139.573	.0	.0	.0	.0	.0	.0
W3H	18		.519354	-130.880	.0	.0	.0	.0	.0	.0
QOUT	19		.407390	-309.448	.0	.0	.0	.0	.0	.0
P4	20		.208473	-349.471	.0	.0	.0	.0	.0	.0
V4	21		.717066	-137.006	.0	.0	.0	.0	.0	.0
R4	22		.988644E-01	-329.620	.0	.0	.0	.0	.0	.0
P5	23		.217501	-204.368	.0	.0	.0	.0	.0	.0
V5	24		.685778	-56.6295	.0	.0	.0	.0	.0	.0
R5	25		.223258	-214.749	.0	.0	.0	.0	.0	.0
P6	26		.264273	-166.736	.0	.0	.0	.0	.0	.0
V6	27		.381426	-328.996	.0	.0	.0	.0	.0	.0
R6	28		.376117	-131.436	.0	.0	.0	.0	.0	.0
P7	29		.212370	-127.280	.0	.0	.0	.0	.0	.0
V7	30		.647757	-280.610	.0	.0	.0	.0	.0	.0
R7	31		.347949	-241.654	.0	.0	.0	.0	.0	.0
P8	32		.164997	-61.9737	.0	.0	.0	.0	.0	.0
V8	33		.601510	-232.784	.0	.0	.0	.0	.0	.0
R8	34		.705330	-31.2165	.0	.0	.0	.0	.0	.0
P9	35		.221738	-355.129	.0	.0	.0	.0	.0	.0
V9	36		.630828	-202.369	.0	.0	.0	.0	.0	.0
R9	37		.565075	-127.429	.0	.0	.0	.0	.0	.0
P10	38		.292151	-315.460	.0	.0	.0	.0	.0	.0
V10	39		.367767	-143.319	.0	.0	.0	.0	.0	.0
R10	40		.891467	-249.377	.0	.0	.0	.0	.0	.0
P11	41		.268368	-296.830	.0	.0	.0	.0	.0	.0
V11	42		.381372	-102.235	.0	.0	.0	.0	.0	.0
R11	43		1.04436	-266.225	.0	.0	.0	.0	.0	.0
V3	8/P3	7	5.39734	-148.953	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.982389	-119.369	.0	.0	.0	.0	.0	.0
P11	41/P3	7	1.72615	-299.521	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH VEEGUTTER FLAMEHOLDER AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
0 CASE 4 RUMBLE VEEGUTTER F/H*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 0.01 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.228205	-.730791E-01	.0	.0	.0	.0	.0	.0
V1	2		.614994	-180.073	.0	.0	.0	.0	.0	.0
R1	3		.228205	-.730791E-01	.0	.0	.0	.0	.0	.0
P2	4		.306924	-.643199E-01	.0	.0	.0	.0	.0	.0
V2	5		.693712	-180.057	.0	.0	.0	.0	.0	.0
R2	6		.306924	-.772092E-01	.0	.0	.0	.0	.0	.0
P3	7		.306924	-.590078E-01	.0	.0	.0	.0	.0	.0
V3	8		.693713	-180.057	.0	.0	.0	.0	.0	.0
R3	9		.306924	-.890152E-01	.0	.0	.0	.0	.0	.0
P3H	10		.306924	-.590078E-01	.0	.0	.0	.0	.0	.0
V3H	11		.787193E-01	-179.945	.0	.0	.0	.0	.0	.0
R3H	12		.306924	-.610452E-01	.0	.0	.0	.0	.0	.0
P2H	13		.306924	-.598577E-01	.0	.0	.0	.0	.0	.0
V2H	14		.787193E-01	-179.969	.0	.0	.0	.0	.0	.0
R2H	15		.306924	-.598577E-01	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.386739	-179.996	.0	.0	.0	.0	.0	.0
W3H	18		.228205	-.101109	.0	.0	.0	.0	.0	.0
QOUT	19		.675421	-180.002	.0	.0	.0	.0	.0	.0
P4	20		.327217	-.563439E-01	.0	.0	.0	.0	.0	.0
V4	21		.214831	-180.008	.0	.0	.0	.0	.0	.0
R4	22		.214831	-.779526E-01	.0	.0	.0	.0	.0	.0
P5	23		.327217	-.548067E-01	.0	.0	.0	.0	.0	.0
V5	24		.214831	-179.988	.0	.0	.0	.0	.0	.0
R5	25		.214831	-.740839E-01	.0	.0	.0	.0	.0	.0
P6	26		.321773	-.558171E-01	.0	.0	.0	.0	.0	.0
V6	27		.384519E-01	-179.977	.0	.0	.0	.0	.0	.0
R6	28		.379740E-01	-.461321	.0	.0	.0	.0	.0	.0
P7	29		.315863	-.568546E-01	.0	.0	.0	.0	.0	.0
V7	30		.824866E-01	-.115301E-01	.0	.0	.0	.0	.0	.0
R7	31		.831307E-01	-179.801	.0	.0	.0	.0	.0	.0
P8	32		.309389	-.579590E-01	.0	.0	.0	.0	.0	.0
V8	33		.171417	-.108113E-01	.0	.0	.0	.0	.0	.0
R8	34		.172283	-179.917	.0	.0	.0	.0	.0	.0
P9	35		.302233	-.591715E-01	.0	.0	.0	.0	.0	.0
V9	36		.240316	-.131564E-01	.0	.0	.0	.0	.0	.0
R9	37		.241524	-179.952	.0	.0	.0	.0	.0	.0
P10	38		.294242	-.605428E-01	.0	.0	.0	.0	.0	.0
V10	39		.295991	-.157419E-01	.0	.0	.0	.0	.0	.0
R10	40		.297740	-179.971	.0	.0	.0	.0	.0	.0
P11	41		.294242	-.606286E-01	.0	.0	.0	.0	.0	.0
V11	42		.295991	-.171675E-01	.0	.0	.0	.0	.0	.0
R11	43		.297740	-179.974	.0	.0	.0	.0	.0	.0
V3	8/P3	7	2.26021	-179.976	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.743523	-.140713E-01	.0	.0	.0	.0	.0	.0
P11	41/P3	7	.958676	-.162077E-02	.0	.0	.0	.0	.0	.0


CASE 8 RUMBLE VORBIX=REMOTE=EMPIRICAL=JP4=TAB4PLOT=TEST CASE
QOUT 19
3.000
2.000
1.000
GAIN
0.000
180.
90.
0.
-90.
-180.
PHASE-DEG
0.0
25.0
50.0
75.0
100.0
125.0
150.0
175.0
200.0
225.0
250.0
FREQUENCY-HERTZ

```
RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TABLPLOT*TEST CASE

*** WARNING - PARAMETER BPR       =  .59000       IS A DEFAULT VALUE
*** WARNING - PARAMETER FAV       =  .21000E-01   IS A DEFAULT VALUE
*** WARNING - PARAMETER JFUEL     = 1             IS A DEFAULT VALUE
*** WARNING - PARAMETER MBC       =  .15000       IS A DEFAULT VALUE
*** WARNING - PARAMETER MBH       =  .28000       IS A DEFAULT VALUE
*** WARNING - PARAMETER DPD       =  .64000E-01   IS A DEFAULT VALUE
*** WARNING - PARAMETER DPS       =  .0           IS A DEFAULT VALUE
*** WARNING - PARAMETER LA        =  82.000       IS A DEFAULT VALUE
*** WARNING - PARAMETER LC        =  72.000       IS A DEFAULT VALUE
*** WARNING - PARAMETER LH        =  14.000       IS A DEFAULT VALUE
*** WARNING - PARAMETER L2        =  36.000       IS A DEFAULT VALUE
*** WARNING - PARAMETER MBR       =  .22000       IS A DEFAULT VALUE
*** WARNING - PARAMETER NPRNTR    = 0             IS A DEFAULT VALUE
*** WARNING - PARAMETER PRNOZ     =  4.4000       IS A DEFAULT VALUE
*** WARNING - PARAMETER TCORE     =  .50000E-02   IS A DEFAULT VALUE
*** WARNING - PARAMETER DPH       =  .32000E-01   IS A DEFAULT VALUE
*** WARNING - PARAMETER LB        =  66.000       IS A DEFAULT VALUE
*** WARNING - PARAMETER LI        =  5.0000       IS A DEFAULT VALUE
*** WARNING - PARAMETER TBC       =  700.00       IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEFP      =  .0           IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEP       =  .0           IS A DEFAULT VALUE
```

```
NAMELIST INPUT VALUES
&VORLIX
BPR= .589999974    ,DPD= .640000105E-01,DPH= .320000015E-01,DPS= .0          ,ETA= .850000024    ,FA= .500000007E-01,FAV=
  .210000016E-01,JFUEL=          1,LA= 62.0000000    ,LB= 66.0000000    ,LC= 72.0000000    ,LH= 14.0000000    ,LI=
  5.00000000    ,LK= 30.0000000    ,L2= 36.0000000    ,M6C= .149999976    ,M6H= .279999971    ,M6R= .220000029    ,NAUGOP=
          2,NCUMOP=          1,NFSOF=          2,NPRNTR=          0,PRNOZ= 4.39999962    ,TCORE= .499999696E-02,PS6=
  7.00000000    ,T6C= 700.000000    , .0           , .0           , .0           , .0           , .0           ,
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  .0            , .0            , .0            , .0            , .0            , .0            , .0            ,
  .0            , .0            , .0            , .0            , .0            , .0            , .0            ,
  .0            , .0            , .0            , .0            , .0            ,ZEF= -.399999991E-01,ZEFP= .0
ZEP=  .0
&END
```

THIS PROGRAM CHECKS SPECIFIC INPUTS TO ENSURE REASONABLE INPUT DATA.

IF THESE CHECKS ARE NOT SATISFIED THE JOB WILL BE TERMINATED.

VIOLATIONS, IF ANY, WILL BE PRINTED BELOW-

```
&OUT
KNOZ=  .0              ,FAAB=  .472356605IE-01,ETAAB=  .665296316    ,DTIAB=  2476.24951    ,DTAB=  1647.43970    ,T6M=
  1379.24561    ,TKC=  3026.68530    ,XLHV=  18650.0000
&END
&FANC
DTC=  1298.19360    ,QCQT=  .292405069    ,DTIC=  3245.48437    ,TAUDC=  .171993417E-02
&END
&COREC
DTH=  1853.49365    ,QHQT=  .707594872    ,DTIH=  2036.80640    ,TAUDH=  .118351309E-02
&END
&FANP
ZTFC=  .536133349
&END
&COREP
ZTFH=  .605663240
&END
&LJ
L=  36.0000000    ,  36.0000000    ,  16.0000000    ,  5.00000000    ,  11.0000000    ,  11.0000000    ,  11.0000000    ,
  11.0000000    ,  11.0000000    ,  6.00000000    ,  .0
&END
&YLJ
YL=  .0             ,  36.0000000    ,  72.0000000    ,  88.0000000    ,  93.0000000    ,  104.000000    ,  115.000000    ,
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&END
&CJ
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&END
&MJ
M=  .149999976    ,  .149999976    ,  .149999976    ,  .220000029    ,  .220000029    ,  .249091804    ,  .276939392    ,
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&END
&TJ
T=  700.000000    ,  700.000000    ,  700.000000    ,  1379.24561    ,  1379.24561    ,  1708.73340    ,  2038.22144    ,
  2367.70923    ,  2697.19727    ,  3026.68530    ,  3026.68530    ,TH=  1780.00000
&END
&PRJ
PRHOT=  .910050690
&END
&GJ
G=  1.38972187    ,  1.38972187    ,  1.38972187    ,  1.34500408    ,  1.34500408    ,  1.32819748    ,  1.31458378    ,
  1.30416012    ,  1.29692936    ,  1.29289055    ,  1.29289055    ,GH=  1.32498169
&END
&TAUFJ
TAUF=  .201905472E-02,  .201905472E-02,  .897357706E-03,  .191418527E-03,  .394577626E-03,  .352251576E-03,  .319539802E-03,
  .293103280E-03,  .270991353E-03,  .142071658E-03,  .0              ,TAUFH=  .453063753E-03
&END
&TAUGJ
TAUG=  .273166131E-02,  .273166131E-02,  .121407164E-02,  .299397856E-03,  .633584335E-03,  .600548461E-03,  .577728963E-03,
  .561898807E-03,  .551315956E-03,  .300596235E-03,  .0              ,TAUGH=  .805446412E-03
&END
&TAUEJ
TAUE=  .154794157E-01,  .154794157E-01,  .687973946E-02,  .106150191E-02,  .209409720E-02,  .170517899E-02,  .143086701E-02,
  .122598070E-02,  .106629496E-02,  .538795488E-03,  .0              ,TAUEH=  .207114846E-02
&END
&QOPJ
QOP=  .0             ,  .0             ,  .0             ,  .0             ,  398.798096    ,  418.475586    ,  437.618164    ,
  455.674072    ,  472.110352    ,  472.110352    ,  .0
&END
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RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY = 0.0 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 5.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 10.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 15.00 HERTZ GAIN	PHASE ANGLE
P1	1	.252917	-360.000	.220276	-28.7752	.184843	-45.1636	.171634	-57.3577
V1	2	.681589	-180.000	.593626	-208.775	.498137	-225.164	.462538	-237.358
R1	3	.252917	-360.000	.220276	-28.7752	.184843	-45.1636	.171634	-57.3577
P2	4	.340160	-360.000	.296066	-24.3940	.247956	-36.3914	.229494	-44.1749
V2	5	.768833	-180.000	.673633	-200.553	.575211	-208.695	.548919	-213.369
R2	6	.340160	-360.000	.288402	-30.6692	.223345	-47.8581	.182145	-58.3238
P3	7	.340160	-360.000	.294726	-21.7213	.243516	-30.9454	.220422	-35.7500
V3	8	.768833	-180.000	.687025	-191.065	.617320	-191.108	.626683	-188.994
R3	9	.340160	-360.000	.257394	-35.6942	.165692	-50.9911	.114143	-40.7325
P3H	10	.340160	-360.000	.294726	-21.7213	.243516	-30.9454	.220422	-35.7500
V3H	11	.872434E-01	-180.000	.113123	-160.970	.148934	-160.064	.184811	-164.362
R3H	12	.340160	-360.000	.294701	-22.7444	.243398	-33.0157	.220083	-38.9064
P2H	13	.340160	-360.000	.295211	-22.1605	.245024	-31.9020	.223224	-37.3526
V2H	14	.872434E-01	-180.000	.103536	-167.665	.129726	-167.948	.156502	-173.284
R2H	15	.340160	-360.000	.295211	-22.1605	.245024	-31.9020	.223224	-37.3526
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.428672	-180.000	.457723	-176.974	.501427	-178.660	.534987	-182.549
W3H	18	.252917	-360.000	.223425	-42.4575	.194268	-70.7420	.188150	-92.0342
QOUT	19	.129431E-06	-360.000	.691092E-01	-122.415	.105735	-140.751	.129362	-151.616
P4	20	.362650	-360.000	.315366	-20.4333	.262974	-28.5663	.240682	-32.5769
V4	21	.238095	-180.000	.235542	-179.007	.250448	-175.830	.286103	-175.767
R4	22	.238095	-360.000	.196727	-30.4637	.144901	-44.0980	.121049	-46.6525
P5	23	.362650	-360.000	.314365	-19.6423	.259860	-26.8805	.234726	-29.7473
V5	24	.238095	-180.000	.250094	-171.219	.285173	-165.247	.337974	-163.770
R5	25	.238095	-360.000	.190235	-27.9883	.129683	-35.6890	.106052	-29.0595
P6	26	.357033	-360.000	.308122	-20.0342	.252534	-27.2551	.226695	-29.6002
V6	27	.222632E-01	-180.000	.256558E-01	-125.205	.647759E-01	-111.645	.109285	-121.944
R6	28	.210487E-01	-360.000	.128206	-122.469	.176073	-150.520	.187221	-164.826
P7	29	.350776	-360.000	.301247	-20.4596	.244618	-27.6581	.218129	-29.8336
V7	30	.112021	-360.000	.130506	-6.79655	.146013	-25.5764	.150445	-45.5651
R7	31	.113503	-180.000	.242870	-152.694	.321716	-166.826	.347268	-177.322
P8	32	.343681	-360.000	.293550	-20.9420	.235859	-28.1199	.208726	-29.8651
V8	33	.204889	-360.000	.229754	-3.75366	.248934	-16.7973	.250704	-30.6995
R8	34	.206590	-180.000	.335591	-161.522	.425829	-173.120	.458336	-183.316
P9	35	.335495	-360.000	.284763	-21.5110	.225949	-28.6773	.198141	-29.9077
V9	36	.274102	-360.000	.303883	-3.22668	.327710	-14.7441	.331693	-26.9725
R9	37	.276246	-180.000	.406905	-165.912	.504043	-177.106	.541055	-187.632
P10	38	.325852	-360.000	.274511	-22.2163	.214460	-29.3854	.185891	-29.9768
V10	39	.328827	-360.000	.362494	-3.22813	.390358	-14.2242	.396954	-25.8817
R10	40	.331800	-180.000	.464381	-168.775	.566490	-180.096	.606827	-191.115
P11	41	.325852	-360.000	.276841	-22.7654	.218588	-31.6550	.187949	-34.7588
V11	42	.328827	-360.000	.355892	-5.52281	.361809	-17.1603	.393359	-29.3456
R11	43	.331800	-180.000	.454844	-175.129	.554690	-191.500	.599868	-207.652
V3	8/P3 7	2.26021	-180.000	2.33106	-169.343	2.53502	-160.163	2.85218	-153.244
P1	1/P3 7	.743523	.0	.747393	-7.05369	.759059	-14.2182	.778661	-21.6076
P11	41/P3 7	.957935	.0	.939314	-1.04401	.897632	-.709610	.852679	-359.009

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 20.00 HERTZ		FREQUENCY = 25.00 HERTZ		FREQUENCY = 30.00 HERTZ		FREQUENCY = 35.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.168882	-69.9473	.171066	-82.4801	.181958	-94.9277	.204928	-109.660
V1	2		.455124	-249.947	.461014	-262.480	.490362	-274.927	.552264	-289.660
R1	3		.168882	-69.9473	.171066	-82.4801	.181958	-94.9277	.204928	-109.660
P2	4		.224811	-52.3248	.226446	-60.3794	.239258	-68.3144	.267410	-78.4654
V2	5		.559455	-218.670	.590212	-224.401	.655981	-230.562	.773026	-239.479
R2	6		.152726	-64.6370	.155906	-64.6504	.143691	-60.9014	.182772	-62.7464
P3	7		.209443	-40.6025	.203149	-44.9179	.205509	-48.5413	.219199	-53.6801
V3	8		.683060	-189.282	.760702	-191.163	.880758	-194.210	1.06651	-200.412
R3	9		.133361	-28.3391	.167964	-37.7904	.176466	-55.7008	.146940	-72.9882
P3H	10		.209443	-40.6025	.203149	-44.9179	.205509	-48.5413	.219199	-53.6801
V3H	11		.218390	-171.516	.248001	-179.052	.282322	-186.230	.329411	-195.101
R3H	12		.208689	-44.8867	.201723	-50.3657	.203033	-55.1763	.215058	-61.5184
P2H	13		.213666	-42.9954	.208769	-48.2394	.212606	-52.9154	.227996	-59.2142
V2H	14		.186314	-181.805	.211387	-190.893	.241138	-199.731	.282716	-210.347
R2H	15		.213666	-42.9954	.208769	-48.2394	.212606	-52.9154	.227996	-59.2142
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.558706	-184.812	.615172	-184.134	.757640	-185.333	.984145	-193.602
W3H	18		.191978	-110.783	.199126	-126.796	.213621	-140.443	.238903	-154.404
QOUT	19		.150090	-159.051	.176499	-164.520	.218080	-171.191	.275856	-182.446
P4	20		.231229	-36.7463	.227051	-40.3927	.233421	-43.4174	.254046	-48.2364
V4	21		.328557	-179.412	.371953	-184.332	.428176	-189.680	.509162	-197.439
R4	22		.121419	-49.3523	.131060	-58.6502	.136964	-73.6487	.131694	-92.0366
P5	23		.221902	-32.5344	.214120	-34.5107	.216403	-35.5740	.232043	-38.1782
V5	24		.395246	-166.063	.451115	-169.484	.520348	-173.143	.617574	-179.013
R5	25		.106738	-27.0656	.969147E-01	-32.5482	.732096E-01	-29.9312	.710143E-01	-354.385
P6	26		.213459	-32.1244	.205733	-33.4270	.209158	-33.7148	.227084	-35.8310
V6	27		.149690	-133.747	.189981	-143.346	.243302	-152.339	.316299	-164.265
R6	28		.194339	-171.394	.215087	-177.011	.243454	-187.483	.255743	-203.328
P7	29		.204598	-31.6270	.197176	-32.1767	.202139	-31.6646	.222691	-33.3847
V7	30		.151929	-64.4413	.159810	-82.6905	.179506	-103.042	.209435	-127.318
R7	31		.363201	-183.993	.391928	-190.058	.428759	-198.834	.451364	-211.011
P8	32		.194595	-31.0356	.188118	-30.7213	.195011	-29.3672	.218516	-30.7841
V8	33		.246401	-43.8179	.244971	-57.3062	.246623	-73.6486	.243993	-94.5608
R8	34		.479460	-190.771	.512726	-197.775	.554686	-206.819	.583959	-218.564
P9	35		.184275	-30.3221	.178189	-28.9801	.187459	-26.7173	.214266	-27.9373
V9	36		.329012	-38.5047	.328231	-50.3498	.327535	-64.2865	.317074	-81.2949
R9	37		.565802	-195.914	.602235	-203.818	.647732	-213.421	.681825	-225.343
P10	38		.171945	-29.4287	.166962	-26.8044	.179183	-23.5354	.209712	-24.6999
V10	39		.396801	-36.9277	.398294	-48.2554	.398650	-61.2401	.388055	-76.4553
R10	40		.634345	-200.172	.673278	-208.893	.721493	-219.100	.759315	-231.371
P11	41		.168637	-36.9038	.153421	-36.6754	.149031	-33.2021	.161377	-30.6150
V11	42		.402010	-40.7043	.417921	-51.8107	.442297	-64.1299	.465643	-76.5171
R11	43		.635852	-221.712	.668907	-235.144	.760614	-249.910	.831754	-266.794
V3	8/P3	7	3.26132	-148.680	3.74435	-146.245	4.28573	-145.669	4.86548	-146.732
P1	1/P3	7	.806341	-29.3449	.842062	-37.5622	.885402	-46.3864	.934896	-55.9803
P11	41/P3	7	.805168	-356.301	.755215	-351.757	.725179	-344.661	.736211	-336.935

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TABLPLOT*TEST CASE

			FREQUENCY = 40.00 HERTZ		FREQUENCY = 45.00 HERTZ		FREQUENCY = 50.00 HERTZ		FREQUENCY = 55.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.234313	-128.770	.257836	-150.892	.275488	-173.585	.291112	-197.082
V1	2		.631453	-308.770	.694845	-330.891	.742418	-353.585	.784523	-17.6821
R1	3		.234313	-128.770	.257836	-150.892	.275488	-173.585	.291112	-197.082
P2	4		.303174	-92.9153	.330573	-110.320	.349814	-128.219	.365992	-147.439
V2	5		.924682	-253.221	1.08309	-270.365	1.18417	-288.449	1.30094	-308.244
R2	6		.244622	-75.2282	.306309	-95.3934	.354477	-118.774	.384392	-144.715
P3	7		.237246	-62.3288	.248247	-73.0828	.254833	-83.5820	.262791	-94.8882
V3	8		1.29419	-211.593	1.49223	-228.172	1.65042	-241.535	1.78487	-258.373
R3	9		.954264E-01	-88.4428	.145343	-39.8474	.250265	-58.7269	.310039	-91.1365
P3H	10		.237246	-62.3288	.248247	-73.0828	.254833	-83.5820	.262791	-94.8882
V3H	11		.381183	-207.844	.417372	-222.428	.438478	-236.973	.452154	-252.091
R3H	12		.230678	-71.3623	.238088	-83.2805	.241776	-94.8689	.245594	-107.199
P2H	13		.247838	-69.1077	.259373	-81.1528	.265719	-92.9124	.272680	-105.405
V2H	14		.329689	-224.731	.364918	-241.495	.388706	-258.224	.407395	-275.798
R2H	15		.247838	-69.1077	.259373	-81.1528	.265719	-92.9124	.272680	-105.405
WIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		1.21710	-209.025	1.34787	-226.852	1.40049	-242.036	1.48409	-255.725
W3H	18		.267214	-171.015	.283651	-189.032	.288834	-206.022	.288263	-222.741
WOUT	19		.333311	-198.977	.365453	-217.169	.379377	-232.933	.398794	-247.731
P4	20		.280727	-56.9973	.298729	-68.2208	.310232	-79.3192	.322663	-91.2301
V4	21		.602457	-209.488	.674939	-224.275	.725387	-239.227	.764772	-255.148
R4	22		.109899	-109.385	.857270E-01	-114.061	.918140E-01	-112.934	.110060	-131.459
P5	23		.253526	-44.5383	.268026	-53.2620	.278146	-61.9042	.290597	-71.6285
V5	24		.727275	-188.981	.803894	-201.469	.861280	-213.813	.899704	-226.697
R5	25		.137538	-345.655	.205420	-2.46861	.238315	-19.8549	.259779	-30.7035
P6	26		.251047	-42.1004	.267443	-50.7955	.279769	-59.2798	.295457	-68.9769
V6	27		.395491	-180.442	.435792	-197.987	.501864	-214.004	.547209	-230.097
R6	28		.229483	-221.599	.170078	-233.578	.126456	-232.943	.973725E-01	-235.911
P7	29		.249206	-39.6854	.267440	-48.4189	.282003	-56.8047	.300820	-66.5600
V7	30		.240359	-154.649	.263130	-180.991	.288192	-203.673	.323677	-225.670
R7	31		.433269	-224.424	.382507	-233.648	.349303	-238.270	.322814	-245.670
P8	32		.247048	-37.2293	.267680	-46.0711	.284529	-54.4170	.306408	-64.2995
V8	33		.228113	-119.869	.202629	-148.047	.188801	-173.943	.191749	-205.032
R8	34		.573557	-231.350	.530987	-241.091	.504701	-247.925	.481798	-257.025
P9	35		.246064	-34.8574	.267850	-43.6760	.287025	-52.0414	.311908	-62.1212
V9	36		.286282	-100.592	.241608	-119.579	.202822	-139.455	.186021	-166.189
R9	37		.677037	-238.214	.641974	-248.834	.621728	-256.868	.603061	-267.105
P10	38		.244232	-31.8517	.267704	-41.1302	.289241	-49.5795	.317073	-59.9321
V10	39		.355483	-92.8320	.309402	-107.923	.267984	-122.908	.219783	-141.312
R10	40		.760198	-244.521	.730433	-255.573	.715713	-264.844	.701459	-275.939
P11	41		.183021	-33.3453	.199535	-39.2548	.214798	-44.5045	.238650	-51.5237
V11	42		.472169	-94.1770	.461698	-108.513	.458668	-121.459	.457428	-136.031
R11	43		.869969	-284.764	.873326	-300.852	.893722	-313.001	.923133	-330.944
V3	8/P3	7	5.45502	-149.264	6.01105	-153.089	6.47046	-157.952	6.79197	-163.485
P1	1/P3	7	.987028	-68.4408	1.03862	-77.6087	1.08105	-90.0029	1.10777	-102.794
P11	41/P3	7	.771434	-331.016	.803775	-320.172	.842896	-320.922	.908138	-316.835

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 60.00 HERTZ		FREQUENCY = 65.00 HERTZ		FREQUENCY = 70.00 HERTZ		FREQUENCY = 75.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.293177	-223.410	.279971	-247.464	.269553	-269.012	.268321	-290.876
V1	2		.790087	-43.4101	.754496	-67.4636	.726424	-89.0126	.723103	-110.876
R1	3		.293177	-223.410	.279971	-247.464	.269553	-269.012	.268321	-290.876
P2	4		.364902	-168.204	.345028	-187.208	.329035	-203.620	.324622	-220.276
V2	5		1.35779	-329.934	1.33915	-350.172	1.32679	-8.09360	1.35407	-26.4990
R2	6		.376090	-172.323	.330286	-197.170	.277702	-216.933	.233649	-232.278
P3	7		.263146	-107.639	.254463	-118.948	.251698	-128.343	.259685	-138.857
V3	8		1.82051	-276.782	1.74434	-293.376	1.67150	-307.219	1.64519	-321.059
R3	9		.279902	-125.656	.180097	-149.560	.111647	-136.246	.164034	-124.687
P3H	10		.263146	-107.639	.254463	-118.948	.251698	-128.343	.259685	-138.857
V3H	11		.442839	-268.012	.411508	-281.464	.387205	-291.746	.379458	-301.843
R3H	12		.241967	-120.853	.230102	-132.966	.223804	-143.090	.227039	-154.288
P2H	13		.271201	-119.151	.260407	-131.243	.256109	-141.230	.263341	-152.205
V2H	14		.405998	-294.555	.383540	-311.281	.365591	-325.262	.360689	-339.440
R2H	15		.271201	-119.151	.260407	-131.243	.256109	-141.230	.263341	-152.205
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		1.58119	-271.878	1.60250	-289.572	1.56133	-306.576	1.48853	-322.839
W3H	18		.273169	-239.292	.248606	-252.297	.228015	-261.056	.223881	-268.896
QOUT	19		.414320	-264.679	.406934	-282.116	.386323	-298.015	.362633	-312.678
P4	20		.325325	-104.676	.315458	-116.844	.310666	-127.093	.317212	-138.165
V4	21		.764223	-272.296	.720810	-287.436	.682586	-299.687	.666694	-311.788
R4	22		.103447	-163.439	.671606E-01	-197.641	.205861E-01	-222.622	.236688E-01	-106.752
P5	23		.294831	-83.3007	.286866	-94.0949	.281883	-103.245	.285372	-113.334
V5	24		.894437	-240.352	.846322	-251.624	.812844	-259.860	.814622	-268.047
R5	25		.308717	-40.9984	.367356	-57.6031	.403904	-77.4169	.412072	-97.4269
P6	26		.302042	-80.8945	.293983	-91.8125	.288432	-100.604	.293027	-109.989
V6	27		.566770	-247.129	.551771	-261.304	.544343	-271.122	.569645	-279.965
R6	28		.328856E-01	-221.788	.954733E-01	-131.304	.208074	-146.880	.298872	-166.033
P7	29		.309304	-76.7316	.300860	-89.6879	.295128	-97.9865	.301616	-106.640
V7	30		.346286	-246.205	.343567	-266.387	.346099	-277.817	.379464	-286.834
R7	31		.251989	-251.288	.194305	-234.735	.254084	-216.207	.355267	-219.151
P8	32		.316487	-76.7366	.307554	-87.6540	.302142	-95.4107	.311911	-103.376
V8	33		.194280	-237.878	.187588	-263.484	.191063	-277.442	.225576	-286.640
R8	34		.410306	-265.166	.339530	-260.955	.365271	-251.033	.451041	-251.918
P9	35		.323322	-74.8487	.313836	-85.6838	.309221	-92.8722	.322954	-100.227
V9	36		.121052	-200.032	.845936E-01	-231.289	.790234E-01	-249.947	.110245	-265.918
R9	37		.533196	-276.871	.458893	-277.110	.471484	-272.491	.547358	-274.617
P10	38		.324560	-72.9817	.319416	-83.7132	.316020	-90.3162	.334513	-97.1449
V10	39		.153962	-158.871	.104355	-165.246	.938184E-01	-172.907	.985999E-01	-200.962
R10	40		.634301	-286.530	.559967	-289.586	.567603	-288.296	.638978	-291.956
P11	41		.255257	-62.4902	.250366	-72.6124	.241868	-78.1889	.247826	-81.6982
V11	42		.429149	-150.584	.395193	-159.765	.401953	-165.926	.442875	-175.805
R11	43		.867305	-347.295	.817177	-357.565	.830338	-2.84942	.936731	-11.1072
V3	8/P3	7	6.91827	-169.143	6.85499	-174.428	6.64088	-178.876	6.33533	-182.203
P1	1/P3	7	1.11412	-115.771	1.10024	-126.515	1.07094	-140.670	1.03326	-152.020
P11	41/P3	7	.970020	-314.852	.983899	-313.664	.960943	-309.846	.954334	-302.842

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 60.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.267590	-314.736	.0	.0	.0	.0	.0	.0
V1	2		.721154	-134.736	.0	.0	.0	.0	.0	.0
R1	3		.267590	-314.738	.0	.0	.0	.0	.0	.0
P2	4		.321137	-238.836	.0	.0	.0	.0	.0	.0
V2	5		1.37925	-47.0164	.0	.0	.0	.0	.0	.0
R2	6		.203510	-242.945	.0	.0	.0	.0	.0	.0
P3	7		.269248	-152.189	.0	.0	.0	.0	.0	.0
V3	8		1.61472	-336.467	.0	.0	.0	.0	.0	.0
R3	9		.220623	-147.471	.0	.0	.0	.0	.0	.0
P3H	10		.269248	-152.189	.0	.0	.0	.0	.0	.0
V3H	11		.375926	-313.628	.0	.0	.0	.0	.0	.0
R3H	12		.231395	-168.274	.0	.0	.0	.0	.0	.0
P2H	13		.272817	-165.935	.0	.0	.0	.0	.0	.0
V2H	14		.356740	-355.567	.0	.0	.0	.0	.0	.0
R2H	15		.272817	-165.935	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		1.39725	-337.905	.0	.0	.0	.0	.0	.0
W3H	18		.227470	-278.291	.0	.0	.0	.0	.0	.0
QOUT	19		.339186	-326.106	.0	.0	.0	.0	.0	.0
P4	20		.325166	-151.640	.0	.0	.0	.0	.0	.0
V4	21		.653012	-325.377	.0	.0	.0	.0	.0	.0
R4	22		.506543E-01	-136.545	.0	.0	.0	.0	.0	.0
P5	23		.288203	-125.836	.0	.0	.0	.0	.0	.0
V5	24		.827664	-278.042	.0	.0	.0	.0	.0	.0
R5	25		.400705	-115.419	.0	.0	.0	.0	.0	.0
P6	26		.298298	-121.759	.0	.0	.0	.0	.0	.0
V6	27		.613524	-290.622	.0	.0	.0	.0	.0	.0
R6	28		.358364	-162.699	.0	.0	.0	.0	.0	.0
P7	29		.310624	-117.750	.0	.0	.0	.0	.0	.0
V7	30		.435339	-297.856	.0	.0	.0	.0	.0	.0
R7	31		.431216	-228.939	.0	.0	.0	.0	.0	.0
P8	32		.325262	-113.956	.0	.0	.0	.0	.0	.0
V8	33		.284368	-298.715	.0	.0	.0	.0	.0	.0
R8	34		.524173	-259.808	.0	.0	.0	.0	.0	.0
P9	35		.341752	-110.430	.0	.0	.0	.0	.0	.0
V9	36		.164030	-286.117	.0	.0	.0	.0	.0	.0
R9	37		.616941	-282.610	.0	.0	.0	.0	.0	.0
P10	38		.359459	-107.123	.0	.0	.0	.0	.0	.0
V10	39		.113161	-241.297	.0	.0	.0	.0	.0	.0
R10	40		.707176	-300.593	.0	.0	.0	.0	.0	.0
P11	41		.263980	-67.6208	.0	.0	.0	.0	.0	.0
V11	42		.482306	-189.876	.0	.0	.0	.0	.0	.0
R11	43		1.05523	-23.9935	.0	.0	.0	.0	.0	.0
V3	8/P3	7	5.99715	-164.297	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.993845	-162.546	.0	.0	.0	.0	.0	.0
P11	41/P3	7	.980435	-294.831	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TABLPLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY = 90.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =100.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =110.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =120.00 HERTZ GAIN	PHASE ANGLE
P1	1	.258575	-5.82974	.218499	-66.9979	.152780	-125.020	.998781E-01	-187.916
V1	2	.696299	-185.830	.588836	-246.993	.411730	-305.020	.269165	-7.91572
R1	3	.258575	-5.82974	.218499	-66.9979	.152780	-125.020	.998781E-01	-187.916
P2	4	.306175	-279.115	.257155	-329.293	.174780	-16.2696	.118298	-68.1683
V2	5	1.37354	-91.6908	1.17985	-146.686	.825296	-198.630	.531561	-255.362
R2	6	.223519	-263.637	.254914	-316.312	.198443	-16.9576	.115672	-82.2653
P3	7	.278571	-184.387	.245107	-228.571	.171555	-270.257	.107984	-316.229
V3	8	1.50269	-9.37736	1.23746	-50.7459	.864643	-88.2897	.579883	-131.311
R3	9	.157986	-198.022	.176216	-200.535	.192545	-270.603	.762247E-01	-345.615
P3H	10	.278571	-184.387	.245107	-228.571	.171555	-270.257	.107984	-316.229
V3H	11	.367455	-340.552	.320627	-18.3526	.230749	-53.8595	.153094	-94.0788
R3H	12	.230883	-201.734	.195144	-247.066	.130589	-289.730	.782056E-01	-336.456
P2H	13	.283671	-198.905	.252376	-243.940	.179357	-286.550	.115086	-333.464
V2H	14	.337920	-31.5151	.276820	-77.3465	.182629	-119.986	.109199	-166.229
R2H	15	.283671	-198.905	.252378	-243.940	.179357	-286.550	.115088	-333.464
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	1.34670	-8.36708	1.08879	-55.4172	.672302	-87.6235	.518697	-126.560
W3H	18	.248292	-302.398	.241472	-340.961	.191031	-19.3905	.135829	-63.4182
QOUT	19	.326104	-354.256	.263087	-37.2052	.176725	-66.8420	.136721	-108.303
P4	20	.332051	-183.549	.289371	-227.416	.201361	-268.179	.128273	-313.319
V4	21	.616452	-354.970	.518022	-34.2692	.364910	-70.3803	.242321	-112.046
R4	22	.368913E-01	-186.267	.558661E-01	-188.850	.545838E-01	-271.196	.158925E-01	-23.7189
P5	23	.280414	-155.465	.228262	-196.016	.147070	-232.008	.869189E-01	-270.899
V5	24	.860938	-302.434	.793486	-339.713	.590938	-15.6157	.400446	-57.2350
R5	25	.417514	-151.477	.337528	-207.886	.197196	-246.406	.144100	-297.796
P6	26	.294864	-149.339	.249831	-186.106	.170870	-217.136	.108820	-246.383
V6	27	.725212	-315.524	.797465	-351.827	.712640	-24.7775	.594725	-55.8979
R6	28	.480207	-209.687	.495759	-250.732	.356935	-271.810	.262035	-286.964
P7	29	.314553	-143.514	.281338	-177.701	.206105	-206.145	.145431	-231.235
V7	30	.379877	-323.174	.727545	-359.707	.719410	-32.7007	.666637	-62.0193
R7	31	.568101	-248.617	.603318	-283.189	.457541	-301.597	.359986	-311.832
P8	32	.339392	-138.315	.321131	-171.143	.249544	-198.614	.190427	-222.423
V8	33	.438643	-325.714	.625366	-4.05312	.665809	-38.4426	.659676	-67.8817
R8	34	.655054	-277.794	.691646	-310.082	.534778	-328.871	.426832	-338.954
P9	35	.368303	-133.838	.365804	-166.233	.298262	-193.572	.240295	-217.156
V9	36	.312161	-321.216	.512837	-4.65904	.581058	-41.8031	.605921	-72.3156
R9	37	.741775	-301.135	.776062	-332.910	.607934	-353.089	.484966	-4.70918
P10	38	.400182	-129.990	.416457	-162.549	.350268	-190.144	.293100	-213.853
V10	39	.218367	-304.109	.405157	-.332640	.482675	-42.3082	.525619	-74.8531
R10	40	.830214	-320.349	.862960	-352.396	.685436	-14.2059	.547530	-28.0557
P11	41	.302227	-99.0617	.365647	-120.843	.364928	-143.098	.357506	-163.413
V11	42	.549329	-220.644	.557584	-262.858	.440747	-295.946	.348622	-322.307
R11	43	1.28300	-52.2220	1.42126	-91.9580	1.21766	-123.809	1.03878	-149.426
V3	8/P3 7	5.39427	-184.990	5.04866	-182.175	5.04003	-178.033	5.37006	-175.082
P1	1/P3 7	.927502	-181.442	.891443	-198.427	.890560	-214.763	.924931	-231.687
P11	41/P3 7	1.08492	-274.674	1.49179	-252.272	2.12718	-232.841	3.31071	-207.184

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 8 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

		FREQUENCY =130.00 HERTZ		FREQUENCY =140.00 HERTZ		FREQUENCY =150.00 HERTZ		FREQUENCY =160.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.724049E-01	-251.593	.804561E-01	-321.014	.123117	-22.0956	.214086	-93.7481
V1	2	.195125	-71.5930	.216823	-141.014	.331741	-202.096	.576945	-273.748
R1	3	.724049E-01	-251.593	.804561E-01	-321.014	.123117	-22.0956	.214086	-93.7481
P2	4	.868290E-01	-121.020	.981203E-01	-179.918	.153086	-230.795	.271582	-292.591
V2	5	.373905	-312.637	.397064	-15.2812	.572109	-66.9569	.923911	-132.321
R2	6	.620801E-01	-136.677	.619505E-01	-175.442	.129020	-217.892	.277037	-288.960
P3	7	.731323E-01	-1.13605	.753713E-01	-48.8418	.110558	-85.1416	.197405	-131.004
V3	8	.436147	-176.698	.498483	-229.583	.765069	-275.436	1.28614	-332.527
R3	9	.419693E-01	-344.978	.623021E-01	-54.7986	.500317E-01	-72.2051	.212987	-116.815
P3H	10	.731323E-01	-1.13605	.753713E-01	-48.8418	.110558	-85.1416	.197405	-131.004
V3H	11	.111776	-133.680	.127625	-176.881	.212345	-210.580	.428690	-256.396
R3H	12	.501246E-01	-21.8714	.485555E-01	-69.8238	.661151E-01	-105.910	.108152	-150.555
P2H	13	.799016E-01	-19.3187	.851125E-01	-68.1057	.130080	-105.964	.242073	-154.153
V2H	14	.704792E-01	-210.341	.702131E-01	-255.380	.104688	-287.391	.202651	-330.435
R2H	15	.799016E-01	-19.3187	.851125E-01	-68.1057	.130080	-105.964	.242073	-154.153
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.395145	-177.935	.438475	-228.840	.719369	-277.009	1.12012	-338.900
W3H	18	.104126	-107.132	.122510	-154.624	.205802	-192.471	.412519	-241.786
QOUT	19	.100687	-157.741	.110917	-206.775	.172815	-252.251	.259552	-305.022
P4	20	.880058E-01	-358.219	.917680E-01	-46.0547	.135981	-83.3776	.238974	-130.268
V4	21	.176060	-154.955	.193573	-202.849	.292302	-241.154	.508453	-288.096
R4	22	.918071E-02	-226.501	.139211E-01	-278.928	.599393E-01	-322.044	.150043	-44.4442
P5	23	.560954E-01	-308.078	.567751E-01	-347.721	.827102E-01	-18.0629	.140315	-58.5195
V5	24	.288989	-99.4889	.311186	-145.255	.467434	-180.187	.828194	-224.052
R5	25	.866282E-01	-3.71752	.735241E-01	-66.6524	.960781E-01	-145.005	.122941	-257.838
P6	26	.734650E-01	-271.065	.647486E-01	-304.380	.844001E-01	-341.555	.139522	-31.0751
V6	27	.487902	-80.4100	.439804	-106.603	.463993	-138.285	.573641	-193.935
R6	28	.177466	-274.516	.223091	-257.996	.371002	-260.176	.563684	-296.455
P7	29	.108155	-251.678	.944232E-01	-278.262	.105933	-313.091	.149443	-6.07902
V7	30	.599415	-64.1544	.577831	-105.100	.610619	-128.355	.660330	-169.837
R7	31	.298591	-303.327	.367365	-295.971	.549823	-299.602	.820620	-329.231
P8	32	.150433	-241.576	.133966	-264.046	.140293	-293.176	.171476	-342.118
V8	33	.623219	-89.9601	.625084	-109.346	.678946	-129.096	.765639	-162.378
R8	34	.364593	-333.447	.432769	-327.934	.623185	-330.881	.936045	-356.862
P9	35	.197016	-235.710	.179563	-255.394	.185581	-279.284	.214114	-321.112
V9	36	.589622	-95.0673	.604469	-113.806	.668058	-131.387	.795098	-159.965
R9	37	.409396	-2.31678	.459263	-357.752	.632651	-359.228	.950568	-21.7942
P10	38	.246322	-232.006	.229413	-249.665	.239970	-269.543	.279509	-305.222
V10	39	.520997	-96.8043	.539033	-117.178	.600389	-132.833	.753111	-157.809
R10	40	.454952	-29.2926	.477214	-26.6512	.615008	-27.0680	.904616	-46.0857
P11	41	.335661	-179.477	.333005	-192.966	.356364	-205.301	.423883	-227.354
V11	42	.281846	-337.671	.274605	-348.919	.322726	-1.04160	.438372	-30.0077
R11	43	.884176	-165.778	.864040	-177.955	.961337	-189.623	1.28757	-215.641
V3	8/P3 7	5.96380	-175.562	6.61370	-180.741	6.92009	-190.295	6.51525	-201.523
P1	1/P3 7	.990053	-250.457	1.06746	-272.172	1.11360	-296.954	1.08450	-322.744
P11	41/P3 7	4.58977	-178.341	4.41820	-144.125	3.22333	-120.160	2.14727	-96.3498

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 6 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY =170.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =180.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =190.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =200.00 HERTZ GAIN	PHASE ANGLE
P1	1	.246075	-168.651	.208050	-234.105	.178844	-281.377	.166066	-330.314
V1	2	.663150	-348.650	.560677	-54.1048	.481970	-101.377	.447535	-150.314
R1	3	.246075	-168.651	.208050	-234.105	.178844	-281.377	.166066	-330.314
P2	4	.318114	-357.966	.273370	-54.1801	.237952	-92.4386	.222710	-132.520
V2	5	.975392	-197.719	.753389	-252.079	.594720	-286.347	.517968	-320.361
R2	6	.316941	-7.59282	.216167	-71.4634	.141406	-98.6134	.152099	-119.369
P3	7	.247846	-182.165	.233748	-227.414	.220926	-257.520	.218324	-291.248
V3	8	1.36622	-32.5967	1.01488	-81.7101	.730402	-109.159	.559287	-131.876
R3	9	.224582	-207.440	.105262	-220.505	.188667	-251.902	.138490	-303.547
P3H	10	.247846	-182.185	.233748	-227.414	.220926	-257.520	.218324	-291.248
V3H	11	.592306	-308.974	.599942	-355.747	.601587	-27.0859	.627982	-61.8123
R3H	12	.123750	-198.823	.107302	-239.271	.952865E-01	-262.910	.915040E-01	-288.932
P2H	13	.314377	-206.079	.304679	-256.047	.295289	-288.745	.299418	-325.014
V2H	14	.281177	-22.1405	.287147	-69.9023	.288100	-103.112	.298851	-140.014
R2H	15	.314377	-206.079	.304679	-256.047	.295289	-288.745	.299418	-325.014
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	1.14273	-33.6089	.938248	-85.9485	.591396	-120.298	.422733	-134.597
W3H	18	.561807	-297.039	.560389	-345.877	.553695	-18.9002	.569688	-55.0515
QOUT	19	.292209	-351.148	.252901	-35.4942	.209662	-54.1116	.233975	-76.7991
P4	20	.294778	-181.276	.274117	-226.193	.255332	-255.312	.252264	-287.772
V4	21	.614206	-337.196	.573343	-18.1658	.558941	-43.3309	.590215	-73.0007
R4	22	.166470	-108.344	.196520	-155.158	.204683	-203.395	.176922	-244.032
P5	23	.162559	-101.870	.141963	-135.669	.132273	-150.947	.140689	-170.290
V5	24	1.03338	-271.616	.976126	-313.258	.925842	-339.636	.921465	-9.68162
R5	25	.151514	-344.640	.224590	-54.7350	.235664	-110.382	.228178	-148.904
P6	26	.168263	-77.9942	.158911	-114.166	.161974	-130.953	.187382	-153.120
V6	27	.610960	-256.378	.573654	-311.622	.573578	-343.429	.641100	-14.5641
R6	28	.520407	-336.524	.313194	-17.4806	.129190	-19.6239	.660139E-01	-358.492
P7	29	.174645	-57.1466	.168592	-97.0080	.180993	-116.546	.217446	-141.666
V7	30	.533666	-221.073	.328017	-275.527	.255686	-315.711	.282762	-1.22419
R7	31	.824399	-3.72777	.597797	-32.9684	.471610	-37.1068	.436291	-49.7385
P8	32	.182829	-34.7412	.170908	-78.3324	.186705	-101.650	.226932	-130.363
V8	33	.653842	-201.559	.414926	-233.979	.302236	-251.812	.222631	-279.915
R8	34	.996629	-28.8108	.607357	-55.2666	.737300	-63.0999	.747304	-79.3846
P9	35	.208589	-10.5589	.179105	-55.1818	.187371	-82.9046	.221045	-115.277
V9	36	.746949	-194.345	.560596	-221.508	.478369	-236.266	.430431	-255.677
R9	37	1.05369	-51.5770	.916114	-76.6357	.893091	-86.3532	.944598	-103.774
P10	38	.265035	-349.399	.212312	-30.7344	.201939	-59.1610	.217748	-93.5075
V10	39	.767278	-190.166	.640023	-216.958	.563109	-232.134	.571805	-250.697
R10	40	1.02621	-73.4307	.936622	-97.1557	.946724	-107.836	1.02474	-125.604
P11	41	.413231	-255.838	.334357	-278.330	.302047	-288.857	.300159	-302.517
V11	42	.466403	-66.5779	.404050	-99.1081	.392052	-118.138	.411520	-144.226
R11	43	1.34230	-249.417	1.14244	-278.880	1.08329	-295.561	1.10749	-318.472
V3	8/P3 7	5.51238	-210.411	4.34176	-214.296	3.30610	-211.638	2.56173	-200.628
P1	1/P3 7	.992852	-346.465	.890059	-6.69078	.809522	-23.8564	.760642	-39.0662
P11	41/P3 7	1.66729	-73.6524	1.43041	-50.9161	1.36719	-31.3367	1.37483	-11.2690

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 6 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY =210.00 HERTZ GAIN	FREQUENCY =210.00 HERTZ PHASE ANGLE	FREQUENCY =220.00 HERTZ GAIN	FREQUENCY =220.00 HERTZ PHASE ANGLE	FREQUENCY =230.00 HERTZ GAIN	FREQUENCY =230.00 HERTZ PHASE ANGLE	FREQUENCY =240.00 HERTZ GAIN	FREQUENCY =240.00 HERTZ PHASE ANGLE
P1	1	.156653	-18.2925	.144280	-71.4097	.133438	-121.249	.135596	-177.160
V1	2	.422705	-198.292	.388822	-251.410	.359605	-301.249	.365419	-357.160
R1	3	.156853	-18.2925	.144280	-71.4097	.133438	-121.249	.135596	-177.160
P2	4	.210956	-171.724	.193591	-216.071	.177717	-257.078	.178421	-303.962
V2	5	.476839	-352.107	.447996	-26.9231	.440379	-63.6625	.486674	-106.380
R2	6	.190870	-159.665	.193899	-215.819	.159823	-268.229	.120852	-315.530
P3	7	.210948	-324.985	.190455	-3.90474	.160125	-36.6980	.153945	-77.6761
V3	8	.476934	-146.067	.477933	-164.682	.534468	-187.736	.651200	-223.326
R3	9	.141521	-304.740	.191602	-3.11774	.114579	-59.3932	.986239E-01	-64.9437
P3H	10	.210948	-324.985	.190455	-3.90474	.160125	-36.6980	.153945	-77.6761
V3H	11	.640189	-96.4367	.609572	-136.306	.560162	-172.195	.545351	-212.447
R3H	12	.896090E-01	-314.535	.855292E-01	-345.915	.815120E-01	-14.6050	.841345E-01	-49.3356
P2H	13	.297299	-1.28595	.270239	-42.8176	.248156	-80.3475	.236693	-122.185
V2H	14	.301625	-176.664	.284087	-218.906	.256564	-256.947	.250110	-299.420
R2H	15	.297299	-1.28595	.270239	-42.8178	.248158	-80.3475	.236693	-122.185
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.346919	-154.549	.301964	-153.429	.472025	-176.753	.560690	-219.610
W3H	18	.572345	-90.8930	.536874	-131.793	.485800	-168.528	.465487	-209.436
QOUT	19	.243462	-106.427	.249355	-137.135	.269473	-171.523	.280350	-213.661
P4	20	.244507	-320.576	.221977	-356.226	.197429	-31.8767	.187025	-70.2981
V4	21	.618399	-103.920	.612658	-141.056	.590138	-175.353	.603017	-215.167
R4	22	.187022	-276.103	.172642	-331.177	.116169	-11.3589	.105111	-42.3324
P5	23	.154103	-192.230	.161899	-222.251	.165010	-251.061	.176650	-286.367
V5	24	.891406	-40.1326	.799217	-75.3742	.694594	-106.271	.637749	-141.430
R5	25	.248114	-190.213	.192778	-234.450	.176695	-256.333	.190216	-298.422
P6	26	.214925	-177.212	.232015	-206.182	.235575	-236.304	.246111	-269.010
V6	27	.690969	-42.5143	.702416	-71.9140	.672376	-94.9643	.661355	-118.084
R6	28	.100644	-303.966	.125160	-308.318	.200050	-299.576	.278798	-317.451
P7	29	.255165	-167.347	.279177	-198.947	.284276	-226.163	.297039	-256.715
V7	30	.333810	-36.1509	.392660	-66.6574	.421382	-91.2688	.483028	-111.131
R7	31	.393263	-59.6960	.313426	-76.6527	.196069	-74.0246	.177159	-55.7634
P8	32	.269466	-157.926	.297169	-190.343	.305169	-217.008	.322419	-246.100
V8	33	.171432	-312.073	.138525	-1.31836	.147958	-39.3743	.221153	-74.0745
R8	34	.743186	-95.2157	.669315	-117.662	.539136	-129.573	.457097	-140.508
P9	35	.259935	-145.443	.285680	-179.265	.295344	-206.075	.316170	-234.540
V9	36	.402956	-275.755	.359035	-301.428	.334977	-325.643	.330575	-.456070E-01
R9	37	.983002	-121.185	.937901	-143.942	.837953	-158.306	.787319	-173.696
P10	38	.241858	-126.083	.256704	-161.665	.262833	-189.374	.282457	-218.103
V10	39	.380257	-269.976	.572246	-294.019	.566443	-316.206	.574772	-343.909
R10	40	1.09154	-143.515	1.07435	-166.031	1.00810	-181.043	.995985	-197.307
P11	41	.316740	-317.216	.330172	-337.635	.343090	-356.621	.364262	-20.5611
V11	42	.426888	-170.242	.410178	-200.684	.375871	-222.823	.367420	-245.351
R11	43	1.13256	-341.475	1.08531	-8.69631	1.01974	-28.7686	1.02598	-50.8656
V3	8/P3 7	2.26091	-181.082	2.50943	-160.977	3.21727	-149.032	4.23006	-145.650
P1	1/P3 7	.743560	-53.3079	.757553	-67.5049	.803240	-82.5508	.880807	-99.4841
P11	41/P3 7	1.50151	-352.231	1.73359	-333.731	2.06526	-317.923	2.36618	-302.885

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

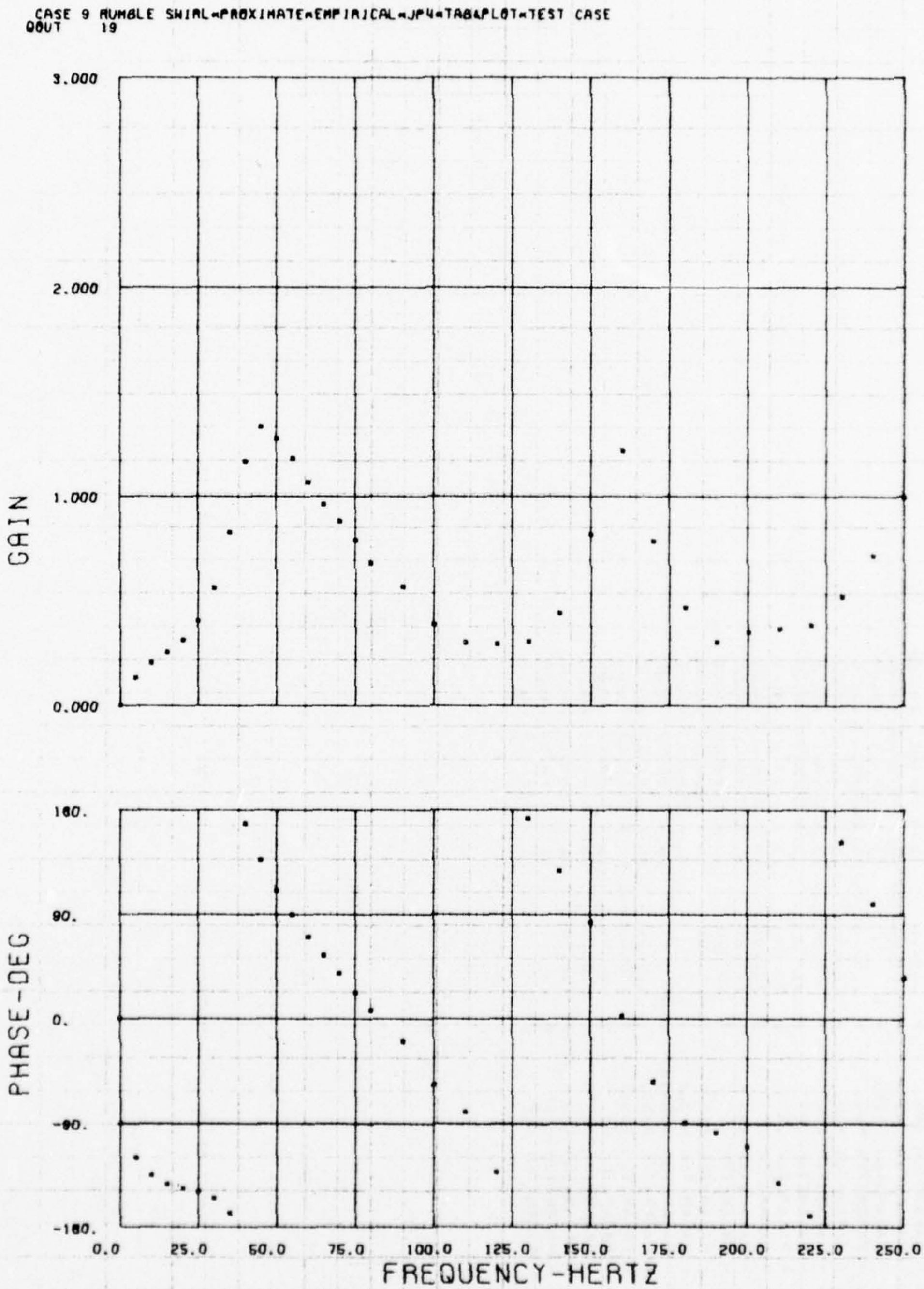
RUMBLE
1 CASE 6 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY =250.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.143895	-237.860	.0	.0	.0	.0	.0	.0
V1	2		.387765	-57.8596	.0	.0	.0	.0	.0	.0
R1	3		.143895	-237.860	.0	.0	.0	.0	.0	.0
P2	4		.186347	-355.406	.0	.0	.0	.0	.0	.0
V2	5		.565355	-155.606	.0	.0	.0	.0	.0	.0
R2	6		.113413	-346.917	.0	.0	.0	.0	.0	.0
P3	7		.146475	-118.477	.0	.0	.0	.0	.0	.0
V3	8		.790574	-267.443	.0	.0	.0	.0	.0	.0
R3	9		.125703	-127.643	.0	.0	.0	.0	.0	.0
P3H	10		.146475	-118.477	.0	.0	.0	.0	.0	.0
V3H	11		.542195	-254.630	.0	.0	.0	.0	.0	.0
R3H	12		.896715E-01	-87.7768	.0	.0	.0	.0	.0	.0
P2H	13		.231229	-165.930	.0	.0	.0	.0	.0	.0
V2H	14		.247778	-344.132	.0	.0	.0	.0	.0	.0
R2H	15		.231229	-165.930	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.699622	-260.754	.0	.0	.0	.0	.0	.0
W3H	18		.455331	-252.062	.0	.0	.0	.0	.0	.0
QOUT	19		.305927	-256.195	.0	.0	.0	.0	.0	.0
P4	20		.162774	-110.640	.0	.0	.0	.0	.0	.0
V4	21		.628687	-258.188	.0	.0	.0	.0	.0	.0
R4	22		.866944E-01	-90.7869	.0	.0	.0	.0	.0	.0
P5	23		.190689	-325.536	.0	.0	.0	.0	.0	.0
V5	24		.601238	-177.798	.0	.0	.0	.0	.0	.0
R5	25		.195736	-335.918	.0	.0	.0	.0	.0	.0
P6	26		.251398	-304.882	.0	.0	.0	.0	.0	.0
V6	27		.644952	-140.848	.0	.0	.0	.0	.0	.0
R6	28		.351144	-334.554	.0	.0	.0	.0	.0	.0
P7	29		.299211	-289.312	.0	.0	.0	.0	.0	.0
V7	30		.558616	-130.925	.0	.0	.0	.0	.0	.0
R7	31		.245571	-40.6305	.0	.0	.0	.0	.0	.0
P8	32		.327813	-276.109	.0	.0	.0	.0	.0	.0
V8	33		.327592	-104.262	.0	.0	.0	.0	.0	.0
R8	34		.378212	-143.716	.0	.0	.0	.0	.0	.0
P9	35		.327830	-262.973	.0	.0	.0	.0	.0	.0
V9	36		.341262	-40.6516	.0	.0	.0	.0	.0	.0
R9	37		.727164	-186.388	.0	.0	.0	.0	.0	.0
P10	38		.298375	-246.032	.0	.0	.0	.0	.0	.0
V10	39		.572284	-15.0648	.0	.0	.0	.0	.0	.0
R10	40		.982640	-211.980	.0	.0	.0	.0	.0	.0
P11	41		.375862	-46.7810	.0	.0	.0	.0	.0	.0
V11	42		.366854	-265.527	.0	.0	.0	.0	.0	.0
R11	43		1.05346	-72.6240	.0	.0	.0	.0	.0	.0
V3	8/P3	7	5.39734	-148.980	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.982389	-119.382	.0	.0	.0	.0	.0	.0
P11	41/P3	7	2.56606	-288.303	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH VORBIX AUGMENTOR AND REMOTE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 3 RUMBLE VORBIX*REMOTE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 0.01 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.252917	-.628355E-01	.0	.0	.0	.0	.0	.0
V1	2		.681589	-180.063	.0	.0	.0	.0	.0	.0
R1	3		.252917	-.628355E-01	.0	.0	.0	.0	.0	.0
P2	4		.340160	-.540764E-01	.0	.0	.0	.0	.0	.0
V2	5		.768032	-180.046	.0	.0	.0	.0	.0	.0
R2	6		.340160	-.669656E-01	.0	.0	.0	.0	.0	.0
P3	7		.340160	-.487643E-01	.0	.0	.0	.0	.0	.0
V3	8		.768832	-180.027	.0	.0	.0	.0	.0	.0
R3	9		.340160	-.767717E-01	.0	.0	.0	.0	.0	.0
P3H	10		.340160	-.487643E-01	.0	.0	.0	.0	.0	.0
V3H	11		.872436E-01	-179.955	.0	.0	.0	.0	.0	.0
R3H	12		.340160	-.508017E-01	.0	.0	.0	.0	.0	.0
P2H	13		.340160	-.498142E-01	.0	.0	.0	.0	.0	.0
V2H	14		.872435E-01	-179.959	.0	.0	.0	.0	.0	.0
R2H	15		.340160	-.498142E-01	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.428673	-179.966	.0	.0	.0	.0	.0	.0
W3H	18		.252917	-.908657E-01	.0	.0	.0	.0	.0	.0
QOUT	19		.164005E-03	-90.0242	.0	.0	.0	.0	.0	.0
P4	20		.362650	-.461004E-01	.0	.0	.0	.0	.0	.0
V4	21		.238095	-179.997	.0	.0	.0	.0	.0	.0
R4	22		.238095	-.677090E-01	.0	.0	.0	.0	.0	.0
P5	23		.362650	-.445651E-01	.0	.0	.0	.0	.0	.0
V5	24		.238095	-179.976	.0	.0	.0	.0	.0	.0
R5	25		.238095	-.636423E-01	.0	.0	.0	.0	.0	.0
P6	26		.357033	-.454610E-01	.0	.0	.0	.0	.0	.0
V6	27		.222633E-01	-179.921	.0	.0	.0	.0	.0	.0
R6	28		.210504E-01	-.885184	.0	.0	.0	.0	.0	.0
P7	29		.350776	-.464323E-01	.0	.0	.0	.0	.0	.0
V7	30		.112021	-.197140E-02	.0	.0	.0	.0	.0	.0
R7	31		.113505	-179.827	.0	.0	.0	.0	.0	.0
P8	32		.343681	-.475284E-01	.0	.0	.0	.0	.0	.0
V8	33		.204889	-359.998	.0	.0	.0	.0	.0	.0
R8	34		.206591	-179.905	.0	.0	.0	.0	.0	.0
P9	35		.335495	-.488110E-01	.0	.0	.0	.0	.0	.0
V9	36		.274102	-359.998	.0	.0	.0	.0	.0	.0
R9	37		.276247	-179.930	.0	.0	.0	.0	.0	.0
P10	38		.325851	-.503703E-01	.0	.0	.0	.0	.0	.0
V10	39		.328827	-359.998	.0	.0	.0	.0	.0	.0
R10	40		.331801	-179.944	.0	.0	.0	.0	.0	.0
P11	41		.325851	-.509336E-01	.0	.0	.0	.0	.0	.0
V11	42		.328827	-.519991E-02	.0	.0	.0	.0	.0	.0
R11	43		.331801	-179.960	.0	.0	.0	.0	.0	.0
V3	8/P3	7	2.26021	-179.976	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.743523	-.140712E-01	.0	.0	.0	.0	.0	.0
P11	41/P3	7	.957934	-.216931E-02	.0	.0	.0	.0	.0	.0


CASE 9 RUMBLE SWIRL*PROXIMATE*EMPIRICAL*JP4*TAB&PLOT*TEST CASE
QOUT 19
3.000
2.000
1.000
0.000
GAIN
180.
90.
0.
-90.
-180.
PHASE-DEG
0.0
25.0
50.0
75.0
100.0
125.0
150.0
175.0
200.0
225.0
250.0
FREQUENCY-HERTZ

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

```
*** WARNING - PARAMETER BPR      =  .59000      IS A DEFAULT VALUE
*** WARNING - PARAMETER FAV      =  .21000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER JFUEL    = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER M6C      =  .15000      IS A DEFAULT VALUE
*** WARNING - PARAMETER M6H      =  .28000      IS A DEFAULT VALUE
*** WARNING - PARAMETER DPD      =  .64000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER DPS      =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER LA       =  82.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LC       =  72.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LH       =  14.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER L2       =  36.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER M6R      =  .22000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NFSUP    = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER NPRNTR   = 0            IS A DEFAULT VALUE
*** WARNING - PARAMETER PRNOZ    =  4.4000      IS A DEFAULT VALUE
*** WARNING - PARAMETER TCORE    =  .50000E-02  IS A DEFAULT VALUE
*** WARNING - PARAMETER LB       =  66.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER L1       =  5.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER T6C      =  700.00      IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEFP     =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER ZEP      =  .0          IS A DEFAULT VALUE
```

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NAMELIST INPUT VALUES
&SWIRL
BPR=  .589999997,     ,DPCS=  .499999896E-02,DPL=  .840000105E-01,DPHS=  .499999896E-02,DPS=  .0              ,ETA=  .680000007    ,FA=
  .500000007E-01,FAV=  .210000016E-01,JFUEL=            1,LA=  82.0000000    ,LB=  66.0000000    ,LC=  72.0000000    ,LH=
  14.0000000    ,L1=  5.00000000    ,LK=  30.0000000    ,L2=  36.0000000    ,MOC=  .149999976    ,MOH=  .279999971    ,MOR=
  .220000029    ,NAUGOP=           3,NCOMOP=           1,NFSOP=           1,NPRNTR=           0,PRNOZ=  4.39999962    ,PS6=
  7.00000000    ,TCORE=  .499999896E-02,T6C=  700.000000    ,  .0            ,  .0            ,  .0            ,  .0            ,
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  .0            ,  .0            ,  .0            ,  .0            ,T6H=  1780.00000    ,  .0            ,  .0            ,
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  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,
  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,ZEF=  -.800000012    ,ZEFP=
  .0            ,ZEP=  .0
&END

          THIS PROGRAM CHECKS SPECIFIC INPUTS TO ENSURE REASONABLE INPUT DATA.

          IF THESE CHECKS ARE NOT SATISFIED THE JOB WILL BE TERMINATED.

          VIOLATIONS, IF ANY, WILL BE PRINTED BELOW-
```

```
&OUT
KNOZ=  .304634188E-05,FAAB=  .500000007E-01,ETAAB=  .679999948     ,DTIAB=  2555.10986     ,DTAB=  1737.47461     ,ToM=
  1379.24561     ,TRC=  3116.72021     ,XLHV=  18650.0000
&END
&VSOUT
DT=  1737.47461     ,DTIZIF= -.720359368E+47,FAVIT=  .132075548E-01,ToM=  1379.24561     ,TF=  417.910869     ,DTIP=  962.944824     ,
DTIT=  3516.05469     ,FAT=  .638679266E-01
&END
&LJ
L=  36.0000000     ,  36.0000000     ,  16.0000000     ,  5.00000000     ,  5.00000000     ,  5.00000000     ,  5.00000000     ,
  5.00000000     ,  5.00000000     ,  36.0000000     ,  .0
&END
&YLJ
YL=  .0           ,  36.0000000     ,  72.0000000     ,  88.0000000     ,  93.0000000     ,  98.0000000     ,  103.000000     ,
  108.000000     ,  113.000000     ,  118.000000     ,  154.000000
&END
&CJ
C=  15504.4609     ,  15504.4609     ,  15504.4609     ,  21410.4805     ,  21410.4805     ,  23798.7187     ,  25944.9570     ,
  27921.4727     ,  29777.4570     ,  31548.7031     ,  31548.7031     ,CH=  24141.1953
&END
&MJ
M=  .149999976     ,  .149999976     ,  .149999976     ,  .220000029     ,  .220000029     ,  .250641704     ,  .279937923     ,
  .308541954     ,  .336948097     ,  .365589032     ,  .365589082     ,MH=  .279999971
&END
&TJ
T=  700.000000     ,  700.000000     ,  700.000000     ,  1379.24561     ,  1379.24561     ,  1726.74048     ,  2074.23535     ,
  2421.73022     ,  2769.22510     ,  3116.72021     ,  3116.72021     ,TH=  1780.00000
&END
&PRJ
PRHOT=  .904600382
&END
&GJ
G=  1.38972187     ,  1.38972187     ,  1.38972187     ,  1.34500408     ,  1.34500408     ,  1.32737160     ,  1.31328869     ,
  1.30275631     ,  1.29577446     ,  1.29234219     ,  1.29234219     ,GH=  1.32498169
&END
&TAUFJ
TAUF=  .201905472E-02,  .201905472E-02,  .897357706E-03,  .191418527E-03,  .178765418E-03,  .158768205E-03,  .143473386E-03,
  .131193417E-03,  .120957076E-03,  .835605199E-03,  .0              ,TAUFH=  .453063753E-03
&END
&TAUGJ
TAUG=  .273166131E-02,  .273166131E-02,  .121407164E-02,  .299397856E-03,  .287441770E-03,  .271907309E-03,  .261390815E-03,
  .254254555E-03,  .249640318E-03,  .179866492E-02,  .0              ,TAUGH=  .805446412E-03
&END
&TAUEJ
TAUE=  .154794157E-01,  .154794157E-01,  .667973946E-02,  .106150191E-02,  .946704531E-03,  .763729447E-03,  .636483310E-03,
  .542344991E-03,  .[illegible]9457591E-03,  .312124402E-02,  .0              ,TAUEH=  .207114848E-02
&END
&QOPJ
QOP=  .0           ,  .0           ,  .0           ,  .0           ,  925.305176     ,  973.436279     ,  1020.11743     ,
  1063.83252     ,  1103.16138     ,  1103.16138     ,  .0
&END
```

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

		FREQUENCY = 0.0 HERTZ		FREQUENCY = 5.00 HERTZ		FREQUENCY = 10.00 HERTZ		FREQUENCY = 15.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.274675	-360.000	.240302	-25.9601	.206403	-39.4525	.199663	-49.3348
V1	2	.274675	-180.000	.240302	-205.960	.206403	-219.453	.199663	-229.335
R1	3	.274675	-360.000	.240302	-25.9601	.206403	-39.4525	.199663	-49.3348
P2	4	.309834	-360.000	.270708	-22.1981	.231614	-31.9123	.222606	-37.9836
V2	5	.309833	-180.000	.287165	-185.587	.285881	-182.363	.325201	-179.882
R2	6	.309834	-360.000	.262975	-29.3467	.206043	-45.1670	.170803	-54.7958
P3	7	.309834	-360.000	.268713	-20.6447	.224830	-28.6782	.208102	-32.7965
V3	8	.309833	-180.000	.327460	-168.486	.389671	-159.435	.499512	-156.025
R3	9	.309834	-360.000	.242685	-35.2005	.148704	-49.7256	.100523	-35.2929
P3H	10	.309834	-360.000	.268972	-20.2423	.225569	-27.9279	.209319	-31.7474
V3H	11	.309834	-180.000	.269346	-197.612	.226824	-202.682	.211932	-203.916
R3H	12	.309834	-360.000	.268832	-21.3373	.225099	-30.1164	.208339	-35.0259
P2H	13	.309834	-360.000	.269017	-20.9796	.225721	-29.4031	.209637	-33.9609
V2H	14	.309834	-180.000	.269017	-200.980	.225721	-209.403	.209637	-213.961
R2H	15	.309834	-360.000	.269017	-20.9796	.225721	-29.4031	.209637	-33.9609
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W5	17	.140974E-06	-360.000	.239052	-120.636	.367237	-137.025	.456389	-145.112
W3H	18	.171592E-16	-360.000	.175001E-01	-111.152	.293468E-01	-119.754	.408363E-01	-124.468
QOUT	19	.691520E-07	-360.000	.131627	-119.772	.203569	-134.986	.255928	-142.433
P4	20	.312947	-360.000	.271677	-20.2107	.227843	-27.8647	.211437	-31.6525
V4	21	.312947	-180.000	.276942	-191.311	.245372	-190.719	.247825	-187.382
R4	22	.312947	-360.000	.262948	-32.3618	.203386	-49.4543	.176014	-58.3739
P5	23	.312947	-360.000	.271137	-19.2485	.226025	-25.9100	.207618	-28.6382
V5	24	.312947	-180.000	.282923	-184.944	.263879	-179.506	.282302	-173.224
R5	25	.312947	-360.000	.255298	-33.5979	.180992	-51.1819	.137731	-59.4124
P6	26	.308781	-360.000	.264576	-19.5943	.218813	-26.1747	.200015	-28.5451
V6	27	.105592	-180.000	.748674E-01	-197.220	.501056E-01	-167.042	.787139E-01	-141.011
R6	28	.104984	-360.000	.142125	-91.2910	.172328	-129.996	.187588	-148.518
P7	29	.300014	-360.000	.257501	-19.9694	.211126	-26.4575	.192006	-28.4220
V7	30	.341551E-01	-360.000	.725868E-01	-347.455	.987336E-01	-15.6753	.112271	-41.5860
R7	31	.349551E-01	-180.000	.200302	-157.965	.282250	-157.594	.316233	-169.852
P8	32	.292580	-360.000	.249773	-20.3899	.202813	-26.7775	.183420	-28.2768
V8	33	.135764	-360.000	.173997	-357.368	.203568	-12.6047	.213235	-26.6898
R8	34	.136714	-180.000	.282532	-154.328	.376724	-168.180	.416780	-179.211
P9	35	.284305	-360.000	.241239	-20.8755	.193698	-27.1567	.174057	-28.1133
V9	36	.215916	-360.000	.252813	-.735962E-01	.284438	-12.7478	.294702	-26.3243
R9	37	.215189	-180.000	.353389	-162.013	.452441	-174.324	.495594	-185.350
P10	38	.274985	-360.000	.251696	-21.4537	.183559	-27.6257	.163674	-27.9322
V10	39	.276806	-360.000	.316341	-1.58126	.349525	-13.3939	.360935	-26.0469
R10	40	.276626	-180.000	.412928	-166.651	.514674	-178.650	.559820	-190.039
P11	41	.274985	-360.000	.233671	-22.0129	.186756	-29.9553	.164469	-32.7043
V11	42	.276868	-360.000	.309763	-4.24581	.341854	-16.8854	.359313	-30.2994
R11	43	.276626	-180.000	.403349	-174.063	.503562	-192.074	.554345	-209.586
V5	8/P3 7	1.00000	-180.000	1.21862	-147.841	1.73318	-130.757	2.40032	-123.229
P1	1/P3 7	.886525	.0	.894272	-5.31535	.918039	-10.7743	.939450	-16.5382
P11	41/P3 7	.887524	.0	.869595	-1.36813	.830651	-1.27705	.790328	-359.908

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 20.00 HERTZ		FREQUENCY = 25.00 HERTZ		FREQUENCY = 30.00 HERTZ		FREQUENCY = 35.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.206606	-60.3358	.221758	-71.6014	.255593	-82.9776	.325892	-98.2878
V1	2		.206608	-240.336	.221758	-251.601	.255593	-262.978	.325892	-278.288
R1	3		.206608	-60.3358	.221758	-71.6014	.255593	-82.9776	.325892	-98.2878
P2	4		.228285	-45.1242	.242235	-52.4627	.275364	-59.8277	.345514	-71.0376
V2	5		.397132	-181.884	.495569	-186.426	.652738	-192.587	.935746	-203.711
R2	6		.143936	-60.3591	.127928	-57.6162	.144489	-48.6137	.217812	-48.5224
P3	7		.202292	-37.5283	.200179	-41.7510	.208838	-44.9370	.237242	-50.4010
V3	8		.644414	-157.965	.620829	-162.224	1.08044	-167.675	1.52565	-177.662
R3	9		.131250	-19.5272	.162010	-31.1620	.207829	-53.2689	.186783	-81.1164
P3H	10		.203960	-36.1583	.202516	-39.9643	.212735	-42.6502	.244693	-47.6811
V3H	11		.208470	-205.785	.209464	-207.105	.223223	-207.372	.261018	-210.062
R3H	12		.202263	-40.5219	.199885	-45.4060	.208760	-49.1615	.238476	-55.2515
P2H	13		.204511	-39.1110	.203372	-43.6573	.214032	-47.0848	.246725	-52.8593
V2H	14		.204511	-219.111	.203372	-223.657	.214032	-227.085	.246725	-232.859
R2H	15		.204511	-39.1110	.203372	-43.6573	.214032	-47.0848	.246725	-52.8593
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.553100	-148.907	.714618	-151.149	1.01240	-156.900	1.51574	-170.630
W3H	18		.530310E-01	-129.814	.657825E-01	-134.533	.828657E-01	-138.130	.111110	-144.071
QOUT	19		.313309	-146.269	.403254	-148.926	.562280	-154.641	.827180	-167.768
P4	20		.208033	-36.0319	.204587	-39.8064	.214927	-42.4609	.247237	-47.4605
V4	21		.269104	-180.055	.303166	-185.767	.365622	-186.312	.484866	-191.335
R4	22		.174627	-66.2268	.192285	-77.8950	.223339	-95.3784	.265419	-120.849
P5	23		.199368	-31.8377	.194192	-34.2265	.199279	-35.1561	.223428	-37.9088
V5	24		.321368	-170.392	.373168	-169.412	.455752	-169.475	.602560	-173.897
R5	25		.117397	-68.2228	.101224	-88.6110	.813510E-01	-134.260	.110307	-214.719
P6	26		.191525	-31.2942	.186406	-33.0078	.192634	-33.0717	.219665	-35.2745
V6	27		.120950	-139.765	.170452	-142.923	.244617	-148.497	.364815	-160.253
R6	28		.207406	-158.811	.245976	-168.689	.302345	-183.751	.365134	-207.274
P7	29		.183412	-30.6641	.178609	-31.6424	.186398	-30.8506	.216660	-32.6813
V7	30		.125574	-64.3663	.149274	-85.3405	.193917	-107.445	.269061	-133.889
R7	31		.345230	-177.755	.392438	-185.333	.461053	-196.588	.536546	-214.498
P8	32		.174637	-29.9410	.170582	-30.1078	.160306	-28.4665	.214043	-30.0993
V8	33		.217713	-44.0464	.227502	-60.2954	.247685	-80.5263	.278664	-108.194
R8	34		.449562	-187.254	.500592	-195.022	.575194	-205.715	.658981	-222.033
P9	35		.165584	-29.1044	.162102	-28.3561	.174119	-25.8650	.211506	-27.4786
V9	36		.298900	-39.3665	.306909	-53.2014	.320493	-70.3562	.332540	-93.9736
R9	37		.530522	-193.995	.584034	-202.375	.662445	-213.231	.752227	-229.051
P10	38		.155401	-28.1152	.152936	-26.3038	.167622	-22.9554	.208802	-24.7473
V10	39		.366283	-38.2362	.375209	-51.0819	.388043	-66.6386	.394124	-87.4158
R10	40		.596330	-199.383	.651635	-208.458	.732825	-219.704	.827210	-235.445
P11	41		.150900	-35.3686	.138415	-35.7909	.135349	-31.6848	.154796	-27.7580
V11	42		.374620	-42.9588	.399658	-55.4367	.440886	-69.6603	.493255	-88.0972
R11	43		.599992	-224.862	.670574	-239.416	.779536	-255.793	.919784	-276.494
V3	8/P3	7	3.18556	-120.437	4.10048	-120.473	5.17358	-122.738	6.43079	-127.261
P1	1/P3	7	1.02133	-22.6075	1.10780	-29.8564	1.22388	-38.0406	1.37367	-47.8867
P11	41/P3	7	.745951	-357.840	.691457	-354.040	.648104	-346.748	.652484	-337.357

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

		FREQUENCY = 40.00 HERTZ		FREQUENCY = 45.00 HERTZ		FREQUENCY = 50.00 HERTZ		FREQUENCY = 55.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.430872	-123.511	.496432	-157.092	.497077	-169.211	.470733	-219.474
V1	2	.430872	-303.511	.496432	-337.092	.497077	-9.21134	.470733	-39.4735
R1	3	.430872	-123.511	.496432	-157.092	.497077	-189.211	.470733	-219.474
P2	4	.448616	-92.0137	.506666	-121.220	.496516	-148.808	.459615	-174.361
V2	5	1.37093	-225.438	1.72806	-256.021	1.87186	-285.497	1.89869	-313.401
R2	6	.352066	-67.2148	.475533	-99.9607	.522876	-134.155	.510355	-167.735
P3	7	.277254	-63.4263	.285254	-81.8431	.265702	-95.8806	.251141	-106.738
V3	8	2.17759	-197.858	2.64976	-226.536	2.74817	-253.744	2.64856	-278.955
R3	9	.776050E-01	-102.915	.150866	-19.7260	.319368	-60.0351	.360247	-104.524
P3H	10	.291041	-60.5835	.305177	-79.3699	.288372	-94.3319	.273974	-106.351
V3H	11	.316239	-220.707	.338363	-257.346	.326816	-250.228	.317815	-260.272
R3H	12	.281397	-69.2003	.292400	-89.0383	.273494	-164.995	.256907	-118.009
P2H	13	.294204	-66.5072	.309384	-86.0614	.293291	-101.754	.279643	-114.527
V2H	14	.294204	-246.507	.309384	-266.061	.293291	-281.754	.279643	-294.527
R2H	15	.294204	-66.5072	.309384	-86.0614	.293291	-101.754	.279643	-114.527
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	2.17229	-195.816	2.51618	-228.084	2.43908	-255.522	2.28432	-278.064
W3H	18	.150895	-157.880	.177818	-177.591	.186480	-193.448	.194639	-206.366
QOUT	19	1.16707	-192.029	1.33321	-223.176	1.27643	-249.361	1.18136	-270.590
P4	20	.294097	-60.3317	.308418	-79.1070	.291472	-94.0181	.276960	-106.007
V4	21	.601136	-200.618	.778535	-230.375	.790443	-252.553	.755278	-272.591
R4	22	.294572	-157.601	.255486	-200.727	.181770	-235.348	.141323	-259.849
P5	23	.259835	-47.8326	.269912	-63.0147	.258526	-74.4104	.253114	-84.1017
V5	24	.808056	-186.169	.927609	-210.254	.912006	-229.819	.845463	-246.057
R5	25	.235783	-278.294	.357774	-328.607	.398812	-5.22567	.413805	-30.3229
P6	26	.259967	-45.3377	.272369	-60.9438	.261916	-72.5034	.257775	-82.3616
V6	27	.522820	-182.159	.614790	-210.346	.614209	-233.974	.584048	-253.368
R6	28	.390273	-243.092	.307442	-286.371	.192473	-335.038	.151292	-28.9570
P7	29	.260600	-43.1023	.274548	-59.2116	.264406	-70.9003	.261104	-80.8465
V7	30	.364241	-167.704	.410609	-204.542	.403564	-233.857	.387763	-257.568
R7	31	.555193	-241.753	.421147	-272.316	.238485	-291.555	.985224E-01	-300.464
P8	32	.261424	-41.0576	.276159	-57.7197	.265898	-69.5021	.263181	-79.4735
V8	33	.304487	-140.460	.286397	-189.881	.252658	-226.168	.234407	-256.858
R8	34	.681967	-240.206	.540398	-271.377	.358550	-283.270	.230858	-283.594
P9	35	.261929	-39.1374	.276919	-56.3966	.266193	-68.2443	.263882	-78.1929
V9	36	.314855	-127.452	.237363	-166.604	.160694	-202.705	.117765	-242.253
R9	37	.781136	-251.837	.642081	-274.759	.468743	-285.425	.350658	-288.073
P10	38	.261689	-37.2726	.276560	-55.1819	.265038	-67.0733	.262972	-76.9600
V10	39	.357612	-115.611	.250559	-144.883	.148932	-164.921	.751194E-01	-181.544
R10	40	.861803	-257.540	.727930	-279.375	.563707	-290.083	.453305	-294.822
P11	41	.194175	-33.6150	.214529	-47.4392	.214677	-57.3732	.221134	-66.4066
V11	42	.516114	-112.720	.446370	-137.221	.361119	-151.356	.310448	-160.557
R11	43	1.01365	-303.564	.917385	-330.746	.767652	-347.557	.674030	-359.658
V3	8/P3 7	7.85415	-134.432	9.28911	-144.693	10.3431	-157.863	10.5461	-172.217
P1	1/P3 7	1.55407	-60.0850	1.74032	-75.2486	1.67080	-93.3307	1.87438	-112.736
P11	41/P3 7	.766356	-330.189	.752064	-325.596	.807960	-321.492	.680518	-319.668

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY = 60.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 65.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 70.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 75.00 HERTZ GAIN	PHASE ANGLE
P1	1	.417105	-247.071	.369060	-269.578	.349975	-290.457	.346088	-314.604
V1	2	.417105	-67.0706	.369060	-89.5780	.349975	-110.457	.346088	-134.604
R1	3	.417105	-247.071	.369060	-269.578	.349975	-290.457	.346088	-314.604
P2	4	.397754	-197.057	.343614	-214.454	.318215	-230.018	.307590	-248.613
V2	5	1.78602	-338.847	1.66418	-359.362	1.64967	-18.3860	1.69371	-40.7614
R2	6	.437618	-198.773	.351049	-223.747	.281760	-244.532	.221809	-263.061
P3	7	.238517	-116.149	.236048	-123.338	.253245	-131.898	.281261	-146.067
V3	8	2.34477	-301.278	2.05045	-318.157	1.89098	-332.933	1.79595	-350.319
R3	9	.279960	-144.218	.143950	-165.026	.100083	-126.598	.197657	-130.129
P3H	10	.259134	-116.641	.253810	-124.813	.268773	-133.781	.294853	-148.028
V3H	11	.308068	-288.886	.309570	-275.067	.336641	-282.355	.379544	-295.019
R3H	12	.239967	-129.472	.231835	-138.390	.241861	-148.277	.261066	-163.409
P2H	13	.265534	-125.773	.261190	-134.505	.277867	-144.238	.306346	-159.253
V2H	14	.265534	-305.773	.261190	-314.505	.277867	-324.238	.306346	-339.253
R2H	15	.265534	-125.773	.261190	-134.505	.277867	-144.238	.306346	-159.253
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	2.09479	-298.292	1.92314	-316.219	1.80183	-334.345	1.64989	-354.753
W3H	18	.200557	-217.751	.212492	-226.613	.241946	-236.468	.283905	-251.597
QOUT	19	1.06766	-289.430	.960933	-305.624	.879142	-321.244	.789759	-337.832
P4	20	.261999	-116.466	.256661	-124.407	.271842	-133.345	.298278	-147.562
V4	21	.674074	-289.665	.601191	-301.359	.576187	-311.181	.578701	-324.046
R4	22	.133626	-288.245	.135003	-324.964	.140294	-7.10007	.142343	-53.4423
P5	23	.245279	-93.7529	.241554	-101.611	.252826	-110.464	.270896	-124.308
V5	24	.742461	-258.121	.668871	-264.115	.667785	-268.457	.716158	-276.937
R5	25	.438562	-51.4416	.466344	-72.8659	.485220	-96.0902	.472988	-121.487
P6	26	.249581	-92.2567	.244077	-99.8490	.254794	-107.781	.274852	-120.498
V6	27	.523787	-268.420	.475933	-276.049	.487698	-279.975	.557467	-267.793
R6	28	.195432	-79.4392	.280204	-115.623	.373198	-144.769	.444472	-171.952
P7	29	.252312	-90.8288	.245341	-97.9491	.256522	-104.832	.280059	-116.464
V7	30	.350464	-276.335	.315614	-285.442	.329939	-287.588	.407071	-293.844
R7	31	.495612E-01	-164.179	.202539	-171.190	.351903	-190.359	.472556	-212.162
P8	32	.253737	-89.4412	.245747	-95.9343	.258459	-101.729	.286842	-112.477
V8	33	.207299	-281.826	.178265	-292.707	.190867	-289.899	.269989	-293.676
R8	34	.147057	-255.995	.230535	-223.214	.387001	-227.442	.527744	-243.735
P9	35	.253796	-88.0502	.245250	-93.8305	.260472	-98.5585	.294782	-106.617
V9	36	.861990E-01	-281.825	.583676E-01	-296.298	.742213E-01	-272.269	.156886	-279.546
R9	37	.263840	-276.792	.306382	-256.059	.449937	-255.532	.597645	-268.810
P10	38	.252266	-86.6436	.243585	-91.6302	.262156	-95.3409	.305161	-104.944
V10	39	.259647E-01	-153.652	.462469E-01	-131.396	.729222E-01	-175.517	.112723	-232.791
R10	40	.366639	-290.166	.391720	-277.419	.524664	-276.931	.676027	-289.020
P11	41	.216432	-76.6459	.201914	-82.9233	.200825	-84.1375	.222965	-87.0655
V11	42	.275524	-164.381	.292391	-164.114	.364036	-171.572	.449136	-169.143
R11	43	.583324	-6.14104	.588732	-3.92714	.746569	-7.16182	.969773	-22.1364
V3	8/P3 7	9.65159	-185.129	8.68658	-194.819	7.46701	-201.035	6.38534	-204.232
P1	1/P3 7	1.74674	-130.921	1.56350	-146.240	1.38196	-158.559	1.23048	-168.518
P11	41/P3 7	.907409	-320.697	.855393	-319.585	.793009	-312.240	.792732	-300.979

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.	FREQUENCY = 80.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 0.0 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 0.0 HERTZ GAIN	PHASE ANGLE	FREQUENCY = 0.0 HERTZ GAIN	PHASE ANGLE
P1	1	.329624	-342.098	.0	.0	.0	.0	.0	.0
V1	2	.329624	-162.098	.0	.0	.0	.0	.0	.0
R1	3	.329624	-342.098	.0	.0	.0	.0	.0	.0
P2	4	.286824	-270.320	.0	.0	.0	.0	.0	.0
V2	5	1.66414	-66.5580	.0	.0	.0	.0	.0	.0
R2	6	.169973	-275.014	.0	.0	.0	.0	.0	.0
P3	7	.296210	-165.321	.0	.0	.0	.0	.0	.0
V3	8	1.62587	-10.2271	.0	.0	.0	.0	.0	.0
R3	9	.252172	-165.793	.0	.0	.0	.0	.0	.0
P3H	10	.307689	-167.089	.0	.0	.0	.0	.0	.0
V3H	11	.407315	-312.592	.0	.0	.0	.0	.0	.0
R3H	12	.267710	-185.319	.0	.0	.0	.0	.0	.0
P2H	13	.321389	-179.088	.0	.0	.0	.0	.0	.0
V2H	14	.321389	-359.088	.0	.0	.0	.0	.0	.0
R2H	15	.321389	-179.088	.0	.0	.0	.0	.0	.0
QIN	16	1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17	1.40455	-14.8114	.0	.0	.0	.0	.0	.0
W3H	18	.315458	-271.522	.0	.0	.0	.0	.0	.0
QOUT	19	.678562	-352.713	.0	.0	.0	.0	.0	.0
P4	20	.311329	-166.594	.0	.0	.0	.0	.0	.0
V4	21	.563965	-340.174	.0	.0	.0	.0	.0	.0
R4	22	.127957	-99.6119	.0	.0	.0	.0	.0	.0
P5	23	.273837	-142.610	.0	.0	.0	.0	.0	.0
V5	24	.754073	-290.275	.0	.0	.0	.0	.0	.0
R5	25	.419431	-145.376	.0	.0	.0	.0	.0	.0
P6	26	.280919	-137.770	.0	.0	.0	.0	.0	.0
V6	27	.633692	-301.453	.0	.0	.0	.0	.0	.0
R6	28	.463329	-195.756	.0	.0	.0	.0	.0	.0
P7	29	.290592	-132.915	.0	.0	.0	.0	.0	.0
V7	30	.501675	-307.882	.0	.0	.0	.0	.0	.0
R7	31	.527366	-232.993	.0	.0	.0	.0	.0	.0
P8	32	.302920	-128.319	.0	.0	.0	.0	.0	.0
V8	33	.371877	-309.250	.0	.0	.0	.0	.0	.0
R8	34	.599447	-262.350	.0	.0	.0	.0	.0	.0
P9	35	.317126	-124.140	.0	.0	.0	.0	.0	.0
V9	36	.255598	-302.620	.0	.0	.0	.0	.0	.0
R9	37	.678612	-286.198	.0	.0	.0	.0	.0	.0
P10	38	.332126	-120.395	.0	.0	.0	.0	.0	.0
V10	39	.174491	-280.072	.0	.0	.0	.0	.0	.0
R10	40	.763866	-305.919	.0	.0	.0	.0	.0	.0
P11	41	.248935	-95.5183	.0	.0	.0	.0	.0	.0
V11	42	.496988	-211.584	.0	.0	.0	.0	.0	.0
R11	43	1.12576	-43.0433	.0	.0	.0	.0	.0	.0
V3	8/P3 7	5.48890	-204.906	.0	.0	.0	.0	.0	.0
P1	1/P3 7	1.11281	-176.777	.0	.0	.0	.0	.0	.0
P11	41/P3 7	.840402	-290.198	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 90.00 HERTZ		FREQUENCY =100.00 HERTZ		FREQUENCY =110.00 HERTZ		FREQUENCY =120.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.270948	-38.3449	.184509	-97.5352	.128666	-152.437	.952850E-01	-220.538
V1	2		.270948	-218.345	.184509	-277.535	.128666	-332.437	.952850E-01	-40.5376
R1	3		.270948	-38.3449	.184509	-97.5352	.128666	-152.437	.952850E-01	-220.538
P2	4		.227793	-314.414	.152165	-.857364	.106060	-42.7671	.800005E-01	-98.0730
V2	5		1.43001	-119.557	.995477	-175.651	.694554	-227.484	.503702	-292.466
R2	6		.168029	-291.350	.109626	-343.655	.134433	-44.2555	.868033E-01	-117.784
P3	7		.281650	-208.178	.206140	-256.127	.143998	-300.385	.995717E-01	-357.292
V3	8		1.18892	-48.0824	.738866	-84.0622	.513899	-113.172	.415740	-157.834
R3	9		.149075	-221.172	.151365	-228.095	.161784	-299.953	.750470E-01	-27.1666
P3H	10		.290031	-209.494	.211159	-257.111	.147068	-300.809	.102266	-357.147
V3H	11		.406683	-352.291	.314085	-37.5446	.232256	-79.2077	.171556	-133.775
R3H	12		.242705	-227.293	.169011	-276.255	.111934	-321.058	.735679E-01	-18.1472
P2H	13		.306514	-223.054	.226117	-272.243	.159807	-317.566	.112933	-15.5474
V2H	14		.306514	-43.0540	.226117	-92.2434	.159807	-137.566	.112933	-195.547
R2H	15		.306514	-223.054	.226117	-272.243	.159807	-317.566	.112933	-15.5474
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		1.04108	-49.0695	.622717	-92.2579	.353763	-110.076	.371220	-149.013
W3H	18		.333260	-315.665	.268494	-4.99641	.204815	-50.3954	.154674	-108.380
QOUT	19		.566386	-19.8360	.388830	-57.0697	.298223	-80.5527	.291958	-132.344
P4	20		.293597	-208.939	.213864	-256.498	.149034	-300.138	.103697	-350.420
V4	21		.497537	-14.3662	.368924	-53.6005	.277130	-90.5607	.215508	-142.382
R4	22		.819383E-01	-164.470	.788505E-01	-220.623	.675519E-01	-306.090	.385423E-01	-55.3161
P5	23		.238027	-182.352	.157125	-225.619	.981169E-01	-262.802	.613545E-01	-309.464
V5	24		.764820	-323.299	.613607	-4.54319	.469604	-44.0229	.355333	-97.6148
R5	25		.345240	-187.636	.210913	-243.301	.114566	-272.087	.108071	-327.008
P6	26		.248994	-174.655	.171316	-212.676	.111810	-241.914	.707567E-01	-274.417
V6	27		.741567	-334.431	.705833	-13.1579	.622101	-45.0741	.507209	-80.3477
R6	28		.465822	-231.303	.343883	-267.531	.236219	-273.039	.181058	-281.582
P7	29		.265461	-167.436	.194192	-201.961	.136858	-226.679	.973857E-01	-252.294
V7	30		.662166	-341.682	.704066	-20.4836	.673609	-50.7563	.606626	-81.5279
R7	31		.556010	-264.783	.435398	-296.076	.321223	-300.626	.276673	-303.673
P8	32		.286903	-161.154	.223448	-193.857	.168756	-216.583	.131850	-240.082
V8	33		.556493	-345.524	.647917	-23.9350	.655182	-56.3309	.630545	-85.9465
R8	34		.637632	-292.787	.512968	-323.062	.383853	-329.947	.331977	-332.452
P9	35		.311704	-155.963	.256255	-188.011	.203909	-209.999	.169453	-232.924
V9	36		.442605	-345.472	.561481	-29.3078	.592570	-60.8214	.598726	-90.4813
R9	37		.722458	-316.620	.592850	-347.307	.447330	-357.719	.374823	-2.12785
P10	38		.337934	-151.761	.290085	-183.832	.239672	-205.618	.207617	-228.405
V10	39		.334659	-359.734	.460357	-30.1474	.503621	-63.8109	.529689	-94.2751
R10	40		.814231	-330.850	.681202	-8.40705	.523328	-22.4143	.427403	-30.4583
P11	41		.283905	-114.203	.303389	-138.254	.301814	-157.249	.301555	-178.653
V11	42		.512353	-254.564	.420187	-298.139	.320767	-325.749	.257487	-349.049
R11	43		1.25643	-82.6546	1.13009	-123.437	.939220	-149.422	.813862	-172.593
V3	8/P3	7	4.22126	-199.905	3.58429	-187.935	3.56878	-172.787	4.17528	-160.541
P1	1/P3	7	.962002	-190.167	.895063	-201.408	.893521	-212.052	.956949	-223.245
P11	41/P3	7	1.00801	-266.025	1.47176	-242.127	2.09596	-216.864	3.02852	-181.360

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TABEPLOT*TEST CASE

		FREQUENCY =130.00 HERTZ		FREQUENCY =140.00 HERTZ		FREQUENCY =150.00 HERTZ		FREQUENCY =160.00 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.934508E-01	-284.722	.134514	-344.747	.248037	-38.9473	.448877	-131.346
V1	2	.934508E-01	-104.722	.134514	-164.747	.248037	-218.947	.448877	-311.345
R1	3	.934508E-01	-284.722	.134514	-344.747	.248037	-38.9473	.448877	-131.346
P2	4	.811561E-01	-150.081	.122025	-198.737	.235972	-242.456	.447384	-325.205
V2	5	.473095	-353.438	.636604	-50.0084	1.06790	-100.360	1.70261	-168.302
R2	6	.572942E-01	-173.897	.715296E-01	-193.825	.205335	-228.759	.478117	-323.930
P3	7	.847344E-01	-48.2551	.985121E-01	-90.3621	.143228	-117.508	.239066	-172.573
V3	8	.458431	-203.405	.724290	-248.918	1.39632	-291.261	2.48790	-13.3137
R3	9	.422470E-01	-31.4362	.863549E-01	-92.1376	.461911E-01	-114.735	.309038	-153.726
P3H	10	.878699E-01	-47.8335	.103776	-89.7769	.155170	-117.850	.257973	-175.563
V3H	11	.156612	-182.969	.196519	-223.665	.312173	-250.729	.551296	-307.617
R3H	12	.593794E-01	-69.1468	.654848E-01	-110.834	.909532E-01	-137.957	.139969	-193.795
P2H	13	.987643E-01	-67.9111	.118908	-111.558	.181535	-141.405	.308657	-200.929
V2H	14	.987643E-01	-247.911	.118908	-291.558	.181535	-321.405	.308657	-20.9289
R2H	15	.987645E-01	-67.9111	.118908	-111.558	.181535	-141.405	.308657	-200.929
QIN	16	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17	.416640	-202.593	.644042	-245.816	1.35022	-291.143	2.25833	-18.3166
W3H	18	.143319	-160.695	.181453	-204.234	.289401	-233.681	.511051	-293.107
QOUT	19	.303660	-187.403	.440307	-252.672	.817858	-276.813	1.21919	-357.994
P4	20	.891575E-01	-47.0502	.105371	-88.9385	.157674	-116.957	.262348	-174.617
V4	21	.212490	-191.226	.291911	-235.294	.489637	-271.387	.777860	-341.319
R4	22	.223776E-01	-148.731	.435684E-01	-214.624	.139161	-296.243	.284928	-49.5621
P5	23	.496387E-01	-346.455	.628481E-01	-13.2164	.114186	-33.7954	.211930	-96.1181
V5	24	.326291	-146.693	.408546	-169.013	.612187	-218.737	.937108	-275.854
R5	25	.926608E-01	-36.0591	.110231	-90.3272	.194766	-162.305	.272922	-289.234
P6	26	.556357E-01	-302.598	.679770E-01	-336.345	.125353	-9.15410	.224975	-79.9794
V6	27	.405136	-110.365	.355068	-144.977	.425559	-183.468	.601757	-260.309
R6	28	.154703	-259.079	.233480	-252.164	.457418	-263.604	.656873	-333.790
P7	29	.808332E-01	-276.263	.880917E-01	-310.247	.141097	-349.715	.227811	-65.8433
V7	30	.529084	-105.515	.485561	-129.800	.528376	-157.585	.525586	-225.529
R7	31	.288362	-292.199	.407360	-293.475	.696145	-305.806	.960841	-6.04776
P8	32	.113306	-262.286	.115564	-292.887	.158887	-332.042	.221857	-49.6314
V8	33	.582105	-108.525	.565453	-129.555	.633253	-151.326	.649106	-203.930
R8	34	.352230	-323.529	.490845	-325.515	.816105	-337.482	1.14003	-32.9857
P9	35	.148930	-253.647	.148247	-280.653	.183720	-315.354	.221758	-29.0802
V9	36	.571333	-112.898	.573926	-132.411	.660990	-150.487	.761332	-195.563
R9	37	.380239	-354.555	.514917	-355.182	.842167	-5.52998	1.20113	-57.3403
P10	38	.185679	-248.256	.184748	-271.803	.219235	-300.916	.246145	-6.69320
V10	39	.515272	-117.029	.526208	-135.427	.618001	-150.171	.802013	-191.090
R10	40	.404525	-25.6995	.513901	-24.9159	.813470	-32.8904	1.17635	-81.0292
P11	41	.286529	-196.201	.283953	-212.040	.317037	-225.430	.376857	-262.509
V11	42	.228400	-.632099	.261905	-13.1817	.383363	-31.9872	.527654	-90.6685
R11	43	.736842	-186.623	.797821	-199.788	1.07760	-215.909	1.42934	-268.533
V3	8/P3 7	5.41021	-155.150	7.35229	-158.536	9.74892	-173.754	10.4067	-200.741
P1	1/P3 7	1.10287	-236.467	1.36546	-254.365	1.73176	-281.439	1.87762	-318.773
P11	41/P3 7	3.38150	-147.946	2.88242	-121.658	2.21351	-107.922	1.57637	-89.9359

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 5 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TABGPLOT*TEST CASE

			FREQUENCY =170.00 HERTZ		FREQUENCY =180.00 HERTZ		FREQUENCY =190.00 HERTZ		FREQUENCY =200.00 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.348904	-211.632	.241244	-267.511	.215560	-314.853	.181295	-10.3391
V1	2		.348904	-31.6316	.241244	-87.5114	.215560	-134.853	.181295	-190.339
R1	3		.348904	-211.632	.241244	-267.511	.215560	-314.853	.181295	-10.3391
P2	4		.362586	-30.5534	.259519	-84.0616	.237933	-123.448	.203332	-171.253
V2	5		1.12065	-263.632	.623717	-311.341	.420879	-347.054	.253419	-21.8335
R2	6		.369304	-50.9566	.197643	-107.751	.122903	-132.592	.128474	-154.598
P3	7		.221617	-219.087	.194997	-252.459	.209543	-284.313	.196778	-327.663
V3	8		1.77454	-83.7823	1.03145	-129.346	.685191	-163.983	.352934	-197.967
R3	9		.211046	-258.267	.803238E-01	-223.861	.201043	-276.224	.126714	-345.384
P3H	10		.230967	-222.982	.197762	-256.016	.209016	-287.046	.195351	-329.549
V3H	11		.324223	-354.422	.476656	-27.0332	.534931	-57.8311	.530846	-100.256
R3H	12		.115966	-238.205	.924649E-01	-266.903	.923616E-01	-292.187	.837438E-01	-327.749
P2H	13		.283090	-250.214	.248729	-285.167	.270226	-318.208	.260074	-2.79260
V2H	14		.283090	-70.2139	.248729	-105.167	.270226	-138.209	.260074	-182.793
R2H	15		.283090	-250.214	.248729	-285.167	.270226	-318.208	.260074	-2.79260
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		1.56459	-84.5224	1.02826	-133.812	.629894	-180.903	.254111	-213.797
W3H	18		.464285	-342.014	.437605	-18.5030	.486941	-48.9624	.478259	-92.8397
QOUT	19		.785727	-54.5009	.467298	-90.0387	.303561	-98.1605	.350240	-110.613
P4	20		.235089	-221.932	.201477	-254.985	.213155	-285.940	.199433	-328.391
V4	21		.550042	-32.3067	.398642	-55.8401	.421734	-75.1516	.431784	-109.171
R4	22		.224489	-122.223	.225386	-173.978	.228751	-232.036	.167057	-286.885
P5	23		.164919	-147.936	.111434	-173.436	.101631	-186.602	.981014E-01	-208.228
V5	24		.789377	-316.217	.693334	-342.627	.760796	-9.58154	.728546	-49.2475
R5	25		.214794	-19.0564	.239833	-85.9606	.239556	-148.168	.183166	-195.647
P6	26		.171140	-131.943	.121505	-153.945	.129215	-163.487	.146045	-188.500
V6	27		.529613	-314.785	.497158	-349.776	.596277	-16.0651	.650472	-52.3391
R6	28		.334571	-25.5769	.101837	-83.9459	.885338E-01	-255.135	.133300	-288.727
P7	29		.169058	-117.803	.126997	-137.994	.152854	-148.525	.183502	-177.515
V7	30		.327703	-285.392	.245124	-335.946	.315028	-11.3487	.393191	-54.5125
R7	31		.540715	-44.0451	.256257	-48.8888	.282999	-28.2903	.286551	-46.6255
P8	32		.158614	-101.528	.126223	-121.794	.165514	-136.057	.203279	-168.656
V8	33		.382552	-244.813	.205600	-270.831	.163061	-309.021	.125856	-20.4658
R8	34		.712872	-65.8997	.465866	-66.7692	.561159	-68.1109	.582400	-91.6337
P9	35		.149556	-79.3121	.123230	-101.964	.167011	-122.076	.204001	-158.457
V9	36		.324162	-230.542	.355840	-247.752	.311983	-266.478	.227417	-291.296
R9	37		.812347	-87.6479	.614348	-91.7879	.761922	-97.1765	.818399	-122.002
P10	38		.159462	-52.7813	.128847	-77.6980	.165743	-103.740	.192524	-143.759
V10	39		.610694	-226.133	.465581	-244.293	.444776	-260.591	.403061	-282.223
R10	40		.840586	-109.416	.689495	-114.638	.865250	-122.581	.952026	-147.701
P11	41		.285621	-291.847	.217064	-305.764	.210246	-317.579	.200879	-334.091
V11	42		.358876	-129.476	.262956	-143.942	.350523	-160.700	.384362	-195.300
R11	43		.993739	-304.482	.775109	-318.930	.898211	-335.426	.929327	-7.11247
V3	8/P3	7	8.00001	-224.695	5.28954	-236.906	3.26993	-239.669	1.79356	-230.304
P1	1/P3	7	1.57294	-352.545	1.23717	-15.0718	1.02872	-30.5391	.921314	-42.6758
P11	41/P3	7	1.28764	-72.7604	1.11316	-53.3250	1.00336	-33.2654	1.02084	-6.42796

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

PARAMTER	ID NO.		FREQUENCY =210.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =220.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =230.00 HERTZ GAIN	PHASE ANGLE	FREQUENCY =240.00 HERTZ GAIN	PHASE ANGLE
P1	1		.152055	-62.4006	.128588	-114.058	.138922	-164.478	.184806	-229.057
V1	2		.152055	-242.401	.128588	-294.058	.138922	-344.478	.184806	-49.0574
R1	3		.152055	-62.4006	.128588	-114.058	.138922	-164.478	.184806	-229.057
P2	4		.171516	-215.771	.144366	-259.904	.153652	-302.649	.199394	-359.307
V2	5		.171621	-37.4912	.174056	-51.4310	.262841	-79.8106	.466118	-132.129
R2	6		.152913	-201.429	.144833	-258.893	.137205	-314.930	.125979	-13.2811
P3	7		.171504	-8.92037	.140543	-49.8441	.136978	-86.3294	.152614	-137.888
V3	8		.171906	-192.576	.235297	-161.751	.424969	-208.899	.772146	-260.318
R3	9		.108320	-347.665	.141886	-47.6081	.945391E-01	-110.569	.991526E-01	-118.283
P3H	10		.169834	-10.2325	.138663	-50.4063	.136084	-88.0589	.153176	-136.926
V3H	11		.490021	-141.052	.425305	-161.520	.442766	-219.646	.529333	-269.193
R3H	12		.731664E-01	-.886159	.625162E-01	-33.7765	.661006E-01	-65.2007	.820522E-01	-109.355
P2H	13		.233248	-45.6467	.197129	-88.0950	.199991	-128.120	.233502	-179.518
V2H	14		.233248	-225.647	.197129	-268.095	.199991	-308.120	.233502	-359.518
R2H	15		.233248	-45.6467	.197129	-88.0950	.199991	-128.120	.233502	-179.518
QIN	16		1.00000	-360.000	1.00000	-360.000	1.00000	-360.000	1.00000	-360.000
W3	17		.866478E-01	-224.352	.170416	-145.018	.421788	-196.084	.696664	-255.294
W3H	18		.436342	-134.884	.374126	-176.403	.384190	-215.390	.453199	-265.613
QOUT	19		.365656	-141.560	.364866	-169.909	.519211	-207.819	.715624	-260.706
P4	20		.173563	-4.02189	.142127	-49.1455	.139453	-86.7443	.157202	-135.561
V4	21		.425121	-144.576	.393752	-181.569	.442840	-217.736	.579629	-266.993
R4	22		.147616	-330.236	.123587	-30.0746	.877704E-01	-88.1436	.723866E-01	-141.964
P5	23		.100405	-232.407	.100979	-261.581	.122284	-292.435	.169551	-337.974
V5	24		.636766	-67.5639	.518930	-125.453	.497422	-160.679	.538410	-206.648
R5	25		.166734	-240.790	.997037E-01	-284.153	.105790	-288.860	.171443	-336.009
P6	26		.157787	-216.266	.158219	-246.667	.178797	-276.673	.221348	-320.526
V6	27		.628319	-63.5977	.551162	-110.689	.514874	-132.304	.488002	-159.601
R6	28		.178489	-303.334	.174983	-306.835	.282209	-309.413	.391327	-337.306
P7	29		.201382	-207.085	.200910	-237.515	.220319	-265.537	.258083	-306.130
V7	30		.422787	-86.6995	.412956	-112.743	.420306	-128.579	.481400	-145.550
R7	31		.243192	-55.8519	.156323	-53.6844	.208289	-21.2900	.349114	-30.2598
P8	32		.224722	-199.635	.223925	-229.927	.243659	-256.082	.279943	-293.380
V8	33		.137582	-73.8653	.153096	-107.126	.181372	-114.005	.307260	-125.261
R8	34		.527846	-1[illegible].690	.395191	-126.533	.321379	-123.252	.326618	-121.342
P9	35		.225002	-191.143	.223759	-221.650	.243968	-246.584	.280575	-281.277
V9	36		.176344	-311.182	.144770	-332.604	.174193	-6.72924	.263163	-62.1664
R9	37		.786634	-143.323	.659706	-161.857	.604931	-169.889	.599480	-183.088
P10	38		.206864	-176.576	.202897	-209.807	.221063	-234.257	.255930	-267.191
V10	39		.382203	-302.589	.363529	-324.378	.401965	-349.703	.465949	-30.5148
R10	40		.946466	-169.796	.839462	-189.077	.819884	-200.017	.861908	-216.735
P11	41		.207479	-350.865	.213073	-10.6243	.246643	-32.6102	.293261	-67.7565
V11	42		.380705	-226.817	.336438	-255.292	.328602	-274.492	.353926	-298.605
R11	43		.894266	-35.7335	.787954	-61.1446	.803427	-78.7937	.921466	-104.314
V3	8/P3	7	1.00235	-183.657	1.67420	-131.906	3.10245	-120.569	5.05946	-122.430
P1	1/P3	7	.886600	-53.4602	.914935	-64.2140	1.01419	-76.1484	1.21093	-91.1694
P11	41/P3	7	1.20977	-341.945	1.51607	-320.780	1.80060	-304.281	1.92159	-289.868

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL-JP4*TAL PLOT*TEST CASE

		FREQUENCY =250.00 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1	.246130	-310.991	.0	.0	.0	.0	.0	.0
V1	2	.246130	-130.992	.0	.0	.0	.0	.0	.0
R1	3	.246130	-310.991	.0	.0	.0	.0	.0	.0
P2	4	.256749	-72.9304	.0	.0	.0	.0	.0	.0
V2	5	.775675	-206.257	.0	.0	.0	.0	.0	.0
R2	6	.137603	-59.7443	.0	.0	.0	.0	.0	.0
P3	7	.160315	-198.234	.0	.0	.0	.0	.0	.0
V3	8	1.23580	-331.824	.0	.0	.0	.0	.0	.0
R3	9	.165795	-211.492	.0	.0	.0	.0	.0	.0
P3H	10	.164520	-196.530	.0	.0	.0	.0	.0	.0
V3H	11	.603946	-329.657	.0	.0	.0	.0	.0	.0
R3H	12	.982625E-01	-165.657	.0	.0	.0	.0	.0	.0
P2H	13	.260318	-241.791	.0	.0	.0	.0	.0	.0
V2H	14	.260618	-61.7912	.0	.0	.0	.0	.0	.0
R2H	15	.260618	-241.791	.0	.0	.0	.0	.0	.0
QIN	16	1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17	1.16092	-324.743	.0	.0	.0	.0	.0	.0
W3H	18	.510321	-326.577	.0	.0	.0	.0	.0	.0
QOUT	19	.993626	-325.526	.0	.0	.0	.0	.0	.0
P4	20	.169123	-195.120	.0	.0	.0	.0	.0	.0
V4	21	.730197	-330.382	.0	.0	.0	.0	.0	.0
R4	22	.663239E-01	-256.810	.0	.0	.0	.0	.0	.0
P5	23	.221631	-38.4810	.0	.0	.0	.0	.0	.0
V5	24	.546677	-262.094	.0	.0	.0	.0	.0	.0
R5	25	.273737	-32.9029	.0	.0	.0	.0	.0	.0
P6	26	.252565	-20.8629	.0	.0	.0	.0	.0	.0
V6	27	.410158	-194.074	.0	.0	.0	.0	.0	.0
R6	28	.423620	-21.6205	.0	.0	.0	.0	.0	.0
P7	29	.268269	-3.00719	.0	.0	.0	.0	.0	.0
V7	30	.571160	-172.400	.0	.0	.0	.0	.0	.0
R7	31	.462566	-60.7082	.0	.0	.0	.0	.0	.0
P8	32	.276635	-345.274	.0	.0	.0	.0	.0	.0
V8	33	.515177	-159.406	.0	.0	.0	.0	.0	.0
R8	34	.383397	-129.774	.0	.0	.0	.0	.0	.0
P9	35	.279545	-328.526	.0	.0	.0	.0	.0	.0
V9	36	.412115	-128.436	.0	.0	.0	.0	.0	.0
R9	37	.568555	-200.996	.0	.0	.0	.0	.0	.0
P10	38	.261526	-310.977	.0	.0	.0	.0	.0	.0
V10	39	.484726	-90.5404	.0	.0	.0	.0	.0	.0
R10	40	.860950	-240.123	.0	.0	.0	.0	.0	.0
P11	41	.297817	-118.565	.0	.0	.0	.0	.0	.0
V11	42	.379504	-329.959	.0	.0	.0	.0	.0	.0
R11	43	1.02508	-141.259	.0	.0	.0	.0	.0	.0
V3	8/P3 7	7.70860	-135.590	.0	.0	.0	.0	.0	.0
F1	1/P3 7	1.55525	-112.757	.0	.0	.0	.0	.0	.0
F11	41/P3 7	1.85770	-280.350	.0	.0	.0	.0	.0	.0

RUMBLE MODEL WITH SWIRL AUGMENTOR AND PROXIMATE FLOW SPLITTER USING EMPIRICAL COMBUSTION DATA

RUMBLE
1 CASE 9 RUMBLE SWIRL*PROXIMATE*EMPERICAL*JP4*TAB&PLOT*TEST CASE

			FREQUENCY = 0.01 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ		FREQUENCY = 0.0 HERTZ	
PARAMTER	ID NO.		GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE	GAIN	PHASE ANGLE
P1	1		.274675	-.575307E-01	.0	.0	.0	.0	.0	.0
V1	2		.274675	-180.056	.0	.0	.0	.0	.0	.0
R1	3		.274675	-.575307E-01	.0	.0	.0	.0	.0	.0
P2	4		.309833	-.500122E-01	.0	.0	.0	.0	.0	.0
V2	5		.309833	-180.015	.0	.0	.0	.0	.0	.0
R2	6		.309833	-.646293E-01	.0	.0	.0	.0	.0	.0
P3	7		.309833	-.489467E-01	.0	.0	.0	.0	.0	.0
V3	8		.309833	-179.973	.0	.0	.0	.0	.0	.0
R3	9		.309833	-.780519E-01	.0	.0	.0	.0	.0	.0
P3H	10		.309833	-.461187E-01	.0	.0	.0	.0	.0	.0
V3H	11		.309833	-180.041	.0	.0	.0	.0	.0	.0
R3H	12		.309833	-.483093E-01	.0	.0	.0	.0	.0	.0
P2H	13		.309833	-.475935E-01	.0	.0	.0	.0	.0	.0
V2H	14		.309833	-180.046	.0	.0	.0	.0	.0	.0
R2H	15		.309833	-.475935E-01	.0	.0	.0	.0	.0	.0
QIN	16		1.00000	-360.000	.0	.0	.0	.0	.0	.0
W3	17		.568491E-03	-90.0590	.0	.0	.0	.0	.0	.0
W3H	18		.403198E-04	-90.0395	.0	.0	.0	.0	.0	.0
QOUT	19		.312384E-03	-90.0569	.0	.0	.0	.0	.0	.0
P4	20		.312947	-.460553E-01	.0	.0	.0	.0	.0	.0
V4	21		.312947	-180.028	.0	.0	.0	.0	.0	.0
R4	22		.312947	-.712679E-01	.0	.0	.0	.0	.0	.0
P5	23		.312947	-.441409E-01	.0	.0	.0	.0	.0	.0
V5	24		.312947	-180.015	.0	.0	.0	.0	.0	.0
R5	25		.312947	-.739818E-01	.0	.0	.0	.0	.0	.0
P6	26		.306760	-.449697E-01	.0	.0	.0	.0	.0	.0
V6	27		.105592	-180.047	.0	.0	.0	.0	.0	.0
R6	28		.104983	-.220842	.0	.0	.0	.0	.0	.0
P7	29		.300013	-.458634E-01	.0	.0	.0	.0	.0	.0
V7	30		.341557E-01	-359.863	.0	.0	.0	.0	.0	.0
R7	31		.349384E-01	-179.335	.0	.0	.0	.0	.0	.0
P8	32		.292580	-.468583E-01	.0	.0	.0	.0	.0	.0
V8	33		.135765	-359.970	.0	.0	.0	.0	.0	.0
R8	34		.136716	-179.838	.0	.0	.0	.0	.0	.0
P9	35		.284305	-.479968E-01	.0	.0	.0	.0	.0	.0
V9	36		.213918	-359.965	.0	.0	.0	.0	.0	.0
R9	37		.215190	-179.903	.0	.0	.0	.0	.0	.0
P10	38		.274584	-.493363E-01	.0	.0	.0	.0	.0	.0
V10	39		.276806	-359.991	.0	.0	.0	.0	.0	.0
R10	40		.278627	-179.930	.0	.0	.0	.0	.0	.0
P11	41		.274984	-.498579E-01	.0	.0	.0	.0	.0	.0
V11	42		.276806	-359.999	.0	.0	.0	.0	.0	.0
R11	43		.278627	-179.950	.0	.0	.0	.0	.0	.0
V3	8/P3	7	1.00000	-179.928	.0	.0	.0	.0	.0	.0
P1	1/P3	7	.886525	-.105840E-01	.0	.0	.0	.0	.0	.0
P11	41/P3	7	.887523	-.291116E-02	.0	.0	.0	.0	.0	.0

```
FLAMEHOLDER MODEL ONLY

CASE 11 F/H COMBUSTION MODEL*JP4*FULL TAB*TEST CASE

*** WARNING - PARAMETER BPR      =  .59000      IS A DEFAULT VALUE
*** WARNING - PARAMETER JFUEL    = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER ALPHAC   =  60.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER ALPHAH   =  60.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER EPSC     =  .40000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER EPSH     =  .40000E-01  IS A DEFAULT VALUE
*** WARNING - PARAMETER FHWH     =  .75000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LSC      =  4.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER LSH      =  6.0000      IS A DEFAULT VALUE
*** WARNING - PARAMETER NPRNTF   = 1            IS A DEFAULT VALUE
*** WARNING - PARAMETER TEXT     =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER TFSR     =  560.00      IS A DEFAULT VALUE
*** WARNING - PARAMETER WEXT     =  .0          IS A DEFAULT VALUE
*** WARNING - PARAMETER XLC      =  66.000      IS A DEFAULT VALUE
*** WARNING - PARAMETER XLH      =  66.000      IS A DEFAULT VALUE
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AD-A065 774 PRATT AND WHITNEY AIRCRAFT GROUP WEST PALM BEACH FL G--ETC F/G 21/2
LO-FREQUENCY AUGMENTOR INSTABILITY INVESTIGATION COMPUTER PROGR--ETC(U)
DEC 78 P L RUSSELL, G BRANT, R ERNST F33615-76-C-2024

UNCLASSIFIED PWA-FR-9797 AFAPL-TR-78-83 NL

4 OF 4
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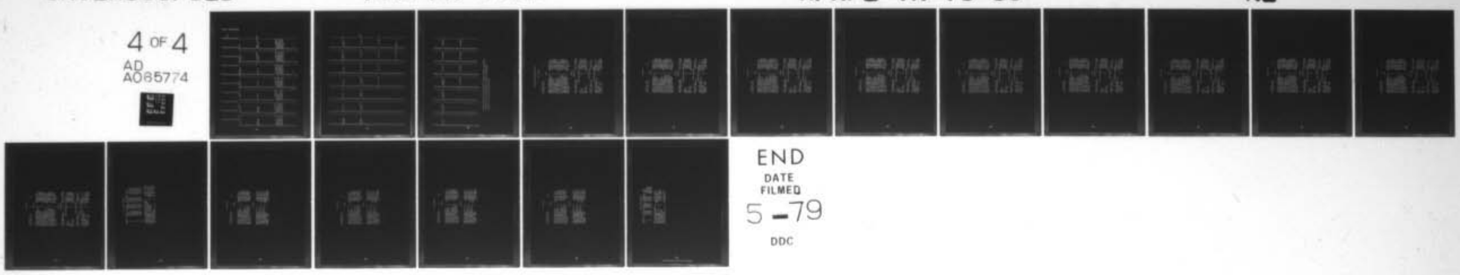
A065774



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THIS PROGRAM CHECKS SPECIFIC INPUTS TO ENSURE REASONABLE INPUT DATA.

IF THESE CHECKS ARE NOT SATISFIED THE JOB WILL BE TERMINATED.

VIOLATIONS, IF ANY, WILL BE PRINTED BELOW-

** COMBUSTION MODEL RESULTS **

FAN STREAM

STREAMTUBE TYPE	=	1	
NO. OF THIS TYPE	=	2	

INPUT

STATIC PRESSURE(PS6)	=	15.0000	PSIA
APPROACH TEMPERATURE(T6C)	=	660.0000	DEG R
APPROACH MACH NO.(M6C)	=	0.2500	D'LESS
INPUT F/A RATIO(FAC)	=	0.0400	D'LESS
EFFECTIVE F/A RATIO	=	0.0510	D'LESS
F/H WIDTH(FHWC)	=	1.0500	INCHES
BLOCKAGE RATIO(TAUC)	=	0.2700	D'LESS
F/H APEX ANGLE(ALPHAC)	=	60.0000	DEG
S/R FUEL TEMP(TFSR)	=	560.0000	DEG R
S/R FUEL PRESSURE(PFSR)	=	250.0000	PSIA
S/R TO F/H DISTANCE(LSC)	=	4.0000	INCHES
F/H TO NOZZLE DIST.(XLC)	=	66.0000	INCHES
TURBULENCE LEVEL(EPSC)	=	0.0400	D'LESS
WAKE FLOW ADDITION(WEXT)	=	0.0	D'LESS
FLOW SOURCE TEMP(TEXT)	=	460.0000	DEG R
EFFECTIVE INLET TEMP.	=	660.0000	DEG R
FUEL TYPE	=	JP4	

OUTPUT

INJECTION

MEAN DROPLET SIZE	=	89.5248	MICRONS
FLASH VAPORIZATION	=	0.0	D'LESS

WAKE COMPOSITION SOLUTION

BETA 1	=	0.1937	D'LESS
BETA 2	=	0.9222	D'LESS
BETA 3	=	0.3036	D'LESS
K1	=	0.2380	D'LESS
WAKE F/A	=	0.0561	D'LESS
WAKE TEMP	=	3857.2183	DEG R

FLAME SPREADING

INITIAL SPEED	=	0.2384	FPS
INITIAL TURBULANCE	=	0.2772	D'LESS

STREAMTUBE EFFICIENCY

IDEAL TEMP RISE	=	2970.6990	DEG R
COMBUSTION EFFICIENCY	=	0.5126	
ACTUAL TEMP RISE	=	1522.8154	DEG R
EXIT TEMP	=	2182.8154	DEG R
FLOWRATE - AIR	=	0.5205	LBM/SEC
FLOWRATE - FUEL	=	0.0265	LBM/SEC

```
                    FAN STREAM

STREAMTUBE TYPE              =         2
NO. OF THIS TYPE             =         2

                      INPUT

STATIC PRESSURE(PS6)         =    15.0000 PSIA
APPROACH TEMPERATURE(T6C)=       670.0000 DEG R
APPROACH MACH NO.(M6C)       =     0.2500 D'LESS
INPUT F/A RATIO(FAC)         =     0.0450 D'LESS
EFFECTIVE F/A RATIO          =     0.0574 D'LESS
F/H WIDTH(FHWC)              =     1.0500 INCHES
BLOCKAGE RATIO(TAUC)         =     0.2700 D'LESS
F/H APEX ANGLE(ALPHAC)       =    60.0000 DEG
S/R FUEL TEMP(TFSR)          =   560.0000 DEG R
S/R FUEL PRESSURE(PFSR)      =   250.0000 PSIA
S/R TO F/H DISTANCE(LSC)     =     4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)     =    66.0000 INCHES
TURBULENCE LEVEL(EPSC)       =     0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)     =     0.0    D'LESS
FLOW SOURCE TEMP(TEXT)       =   460.0000 DEG R
EFFECTIVE INLET TEMP.        =   670.0000 DEG R
FUEL TYPE                    =        JP4

                      OUTPUT

                    INJECTION
MEAN DROPLET SIZE            =    89.5248 MICRONS
FLASH VAPORIZATION           =     0.0    D'LESS

              WAKE COMPOSITION SOLUTION
BETA 1                       =     0.1960 D'LESS
BETA 2                       =     0.9193 D'LESS
BETA 3                       =     0.2842 D'LESS
K1                           =     0.2354 D'LESS
WAKE F/A                     =     0.0623 D'LESS
WAKE TEMP                    =  3966.6753 DEG R

                  FLAME SPREADING
INITIAL SPEED                =     0.2559 FPS
INITIAL TURBULANCE           =     0.2772 D'LESS

               STREAMTUBE EFFICIENCY
IDEAL TEMP RISE              =  3209.3884 DEG R
COMBUSTION EFFICIENCY        =     0.5293
ACTUAL TEMP RISE             =  1698.7263 DEG R
EXIT TEMP                    =  2368.7263 DEG R
FLOWRATE - AIR               =     0.5163 LBM/SEC
FLOWRATE - FUEL              =     0.0296 LBM/SEC
```

FAN STREAM

```
STREAMTUBE TYPE              =          3
NO. OF THIS TYPE             =          2

                         INPUT

STATIC PRESSURE(PS6)         =    15.0000 PSIA
APPROACH TEMPERATURE(T6C)=       670.0000 DEG R
APPROACH MACH NO.(M6C)       =     0.2500 D'LESS
INPUT F/A RATIO(FAC)         =     0.0500 D'LESS
EFFECTIVE F/A RATIO          =     0.0637 D'LESS
F/H WIDTH(FHWC)              =     1.0500 INCHES
BLOCKAGE RATIO(TAUC)         =     0.2700 D'LESS
F/H APEX ANGLE(ALPHAC)       =    60.0000 DEG
S/R FUEL TEMP(TFSR)          =   560.0000 DEG R
S/R FUEL PRESSURE(PFSR)      =   250.0000 PSIA
S/R TO F/H DISTANCE(LSC)     =     4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)     =    66.0000 INCHES
TURBULENCE LEVEL(EPSC)       =     0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)     =     0.0    D'LESS
FLOW SOURCE TEMP(TEXT)       =   460.0000 DEG R
EFFECTIVE INLET TEMP.        =   670.0000 DEG R
FUEL TYPE                    =        JP4

                         OUTPUT

                        INJECTION
MEAN DROPLET SIZE            =    89.5248 MICRONS
FLASH VAPORIZATION           =     0.0    D'LESS

                 WAKE COMPOSITION SOLUTION
BETA 1                       =     0.1981 D'LESS
BETA 2                       =     0.9193 D'LESS
BETA 3                       =     0.2575 D'LESS
K1                           =     0.2353 D'LESS
WAKE F/A                     =     0.0640 D'LESS
WAKE TEMP                    =  3988.2039 DEG R

                     FLAME SPREADING
INITIAL SPEED                =     0.2471 FPS
INITIAL TURBULANCE           =     0.2772 D'LESS

                  STREAMTUBE EFFICIENCY
IDEAL TEMP RISE              =  3390.6067 DEG R
COMBUSTION EFFICIENCY        =     0.5188
ACTUAL TEMP RISE             =  1758.9924 DEG R
EXIT TEMP                    =  2428.9924 DEG R
FLOWRATE - AIR               =     0.5161 LBM/SEC
FLOWRATE - FUEL              =     0.0329 LBM/SEC
```

FAN STREAM

```
STREAMTUBE TYPE            =          4
NO. OF THIS TYPE           =          2

                         INPUT

STATIC PRESSURE(PS6)       =     15.0000 PSIA
APPROACH TEMPERATURE(T6C)=      670.0000 DEG R
APPROACH MACH NO.(M6C)     =      0.2500 D'LESS
INPUT F/A RATIO(FAC)       =      0.0500 D'LESS
EFFECTIVE F/A RATIO        =      0.0637 D'LESS
F/H WIDTH(FHWC)            =      1.0500 INCHES
BLOCKAGE RATIO(TAUC)       =      0.2700 D'LESS
F/H APEX ANGLE(ALPHAC)     =     60.0000 DEG
S/R FUEL TEMP(TFSR)        =    560.0000 DEG R
S/R FUEL PRESSURE(PFSR)    =    250.0000 PSIA
S/R TO F/H DISTANCE(LSC)   =      4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)   =     66.0000 INCHES
TURBULENCE LEVEL(EPSC)     =      0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)   =      0.0    D'LESS
FLOW SOURCE TEMP(TEXT)     =    460.0000 DEG R
EFFECTIVE INLET TEMP.      =    670.0000 DEG R
FUEL TYPE                  =         JP4

                        OUTPUT

                       INJECTION
MEAN DROPLET SIZE          =     89.5248 MICRONS
FLASH VAPORIZATION         =      0.0    D'LESS

               WAKE COMPOSITION SOLUTION
BETA 1                     =      0.1981 D'LESS
BETA 2                     =      0.9193 D'LESS
BETA 3                     =      0.2575 D'LESS
K1                         =      0.2353 D'LESS
WAKE F/A                   =      0.0640 D'LESS
WAKE TEMP                  =   3988.2039 DEG R

                   FLAME SPREADING
INITIAL SPEED              =      0.2471 FPS
INITIAL TURBULANCE         =      0.2772 D'LESS

                 STREAMTUBE EFFICIENCY
IDEAL TEMP RISE            =   3390.6067 DEG R
COMBUSTION EFFICIENCY      =      0.5188
ACTUAL TEMP RISE           =   1758.9924 DEG R
EXIT TEMP                  =   2428.9924 DEG R
FLOWRATE - AIR             =      0.5161 LBM/SEC
FLOWRATE - FUEL            =      0.0329 LBM/SEC
```

```
                         FAN STREAM

STREAMTUBE TYPE            =          5
NO. OF THIS TYPE           =          2

                            INPUT

STATIC PRESSURE(PS6)       =    15.0000 PSIA
APPROACH TEMPERATURE(T6C)=     670.0000 DEG R
APPROACH MACH NO.(M6C)     =     0.2500 D'LESS
INPUT F/A RATIO(FAC)       =     0.0450 D'LESS
EFFECTIVE F/A RATIO        =     0.0574 D'LESS
F/H WIDTH(FHWC)            =     1.0500 INCHES
BLOCKAGE RATIO(TAUC)       =     0.3500 D'LESS
F/H APEX ANGLE(ALPHAC)     =    60.0000 DEG
S/R FUEL TEMP(TFSR)        =   560.0000 DEG R
S/R FUEL PRESSURE(PFSR)    =   250.0000 PSIA
S/R TO F/H DISTANCE(LSC) =       4.0000 INCHES
F/H TO NOZZLE DIST.(XLC) =      66.0000 INCHES
TURBULENCE LEVEL(EPSC)     =     0.0400 D'LESS
WAKE FLOW ADDITION(WEXT) =       0.0    D'LESS
FLOW SOURCE TEMP(TEXT)     =   460.0000 DEG R
EFFECTIVE INLET TEMP.      =   670.0000 DEG R
FUEL TYPE                  =        JP4

                           OUTPUT

                          INJECTION
MEAN DROPLET SIZE          =    89.5248 MICRONS
FLASH VAPORIZATION         =     0.0    D'LESS

                   WAKE COMPOSITION SOLUTION
BETA 1                     =     0.1980 D'LESS
BETA 2                     =     0.9043 D'LESS
BETA 3                     =     0.2673 D'LESS
K1                         =     0.2009 D'LESS
WAKE F/A                   =     0.0707 D'LESS
WAKE TEMP                  =  3943.2703 DEG R

                       FLAME SPREADING
INITIAL SPEED              =     0.2484 FPS
INITIAL TURBULANCE         =     0.3440 D'LESS

                     STREAMTUBE EFFICIENCY
IDEAL TEMP RISE            =  3209.3864 DEG R
COMBUSTION EFFICIENCY      =     0.6147
ACTUAL TEMP RISE           =  1972.8440 DEG R
EXIT TEMP                  =  2642.8440 DEG R
FLOWRATE - AIR             =     0.3983 LBM/SEC
FLOWRATE - FUEL            =     0.0229 LBM/SEC
```

```
                       FAN STREAM

STREAMTUBE TYPE            =          6
NO. OF THIS TYPE           =          3

                         INPUT

STATIC PRESSURE(PS6)       =     15.0000 PSIA
APPROACH TEMPERATURE(T6C)=      710.0000 DEG R
APPROACH MACH NO.(M6C)     =      0.2500 D'LESS
INPUT F/A RATIO(FAC)       =      0.0450 D'LESS
EFFECTIVE F/A RATIO        =      0.0574 D'LESS
F/H WIDTH(FHWC)            =      2.1000 INCHES
BLOCKAGE RATIO(TAUC)       =      0.2700 D'LESS
F/H APEX ANGLE(ALPHAC)     =     90.0000 DEG
S/R FUEL TEMP(TFSR)        =    560.0000 DEG R
S/R FUEL PRESSURE(PFSR)    =    250.0000 PSIA
S/R TO F/H DISTANCE(LSC)   =      4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)   =     66.0000 INCHES
TURBULENCE LEVEL(EPSC)     =      0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)   =      0.0    D'LESS
FLOW SOURCE TEMP(TEXT)     =    460.0000 DEG R
EFFECTIVE INLET TEMP.      =    710.0000 DEG R
FUEL TYPE                  =         JP4

                        OUTPUT

                       INJECTION
MEAN DROPLET SIZE          =     89.5248 MICRONS
FLASH VAPORIZATION         =      0.0    D'LESS

                WAKE COMPOSITION SOLUTION
BETA 1                     =      0.2141 D'LESS
BETA 2                     =      0.9166 D'LESS
BETA 3                     =      0.1943 D'LESS
K1                         =      0.2320 D'LESS
WAKE F/A                   =      0.0469 D'LESS
WAKE TEMP                  =   3468.3394 DEG R

                    FLAME SPREADING
INITIAL SPEED              =      0.1942 FPS
INITIAL TURBULANCE         =      0.2772 D'LESS

                  STREAMTUBE EFFICIENCY
IDEAL TEMP RISE            =   3189.6242 DEG R
COMBUSTION EFFICIENCY      =      0.2571
ACTUAL TEMP RISE           =    820.2532 DEG R
EXIT TEMP                  =   1530.2532 DEG R
FLOWRATE - AIR             =      1.0032 LBM/SEC
FLOWRATE - FUEL            =      0.0575 LBM/SEC
```

FAN STREAM

STREAMTUBE TYPE	=	7
NO. OF THIS TYPE	=	3

INPUT

STATIC PRESSURE(PS6)	=	15.0000	PSIA
APPROACH TEMPERATURE(T6C)	=	710.0000	DEG R
APPROACH MACH NO.(M6C)	=	0.2500	D'LESS
INPUT F/A RATIO(FAC)	=	0.0500	D'LESS
EFFECTIVE F/A RATIO	=	0.0637	D'LESS
F/H WIDTH(FHWC)	=	2.1000	INCHES
BLOCKAGE RATIO(TAUC)	=	0.2700	D'LESS
F/H APEX ANGLE(ALPHAC)	=	90.0000	DEG
S/R FUEL TEMP(TFSR)	=	560.0000	DEG R
S/R FUEL PRESSURE(PFSR)	=	250.0000	PSIA
S/R TO F/H DISTANCE(LSC)	=	4.0000	INCHES
F/H TO NOZZLE DIST.(XLC)	=	66.0000	INCHES
TURBULENCE LEVEL(EPSC)	=	0.0400	D'LESS
WAKE FLOW ADDITION(WEXT)	=	0.0	D'LESS
FLOW SOURCE TEMP(TEXT)	=	460.0000	DEG R
EFFECTIVE INLET TEMP.	=	710.0000	DEG R
FUEL TYPE	=	JP4	

OUTPUT

INJECTION

MEAN DROPLET SIZE	=	89.5248	MICRONS
FLASH VAPORIZATION	=	0.0	D'LESS

WAKE COMPOSITION SOLUTION

BETA 1	=	0.2142	D'LESS
BETA 2	=	0.9166	D'LESS
BETA 3	=	0.1803	D'LESS
K1	=	0.2320	D'LESS
WAKE F/A	=	0.0494	D'LESS
WAKE TEMP	=	3579.8777	DEG R

FLAME SPREADING

INITIAL SPEED	=	0.1936	FPS
INITIAL TURBULANCE	=	0.2772	D'LESS

STREAMTUBE EFFICIENCY

IDEAL TEMP RISE	=	3366.9673	DEG R
COMBUSTION EFFICIENCY	=	0.2569	
ACTUAL TEMP RISE	=	864.8762	DEG R
EXIT TEMP	=	1574.8762	DEG R
FLOWRATE - AIR	=	1.0027	LBM/SEC
FLOWRATE - FUEL	=	0.0639	LBM/SEC

FAN STREAM

```
STREAMTUBE TYPE              =         6
NO. OF THIS TYPE             =         3

                          INPUT

STATIC PRESSURE(PS6)         =   15.0000 PSIA
APPROACH TEMPERATURE(T6C)=      710.0000 DEG R
APPROACH MACH NO.(M6C)       =    0.2500 D'LESS
INPUT F/A RATIO(FAC)         =    0.0500 D'LESS
EFFECTIVE F/A RATIO          =    0.0637 D'LESS
F/H WIDTH(FHWC)              =    2.1000 INCHES
BLOCKAGE RATIO(TAUC)         =    0.3500 D'LESS
F/H APEX ANGLE(ALPHAC)       =   90.0000 DEG
S/R FUEL TEMP(TFSR)          =  560.0000 DEG R
S/R FUEL PRESSURE(PFSR)      =  250.0000 PSIA
S/R TO F/H DISTANCE(LSC)     =    4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)     =   66.0000 INCHES
TURBULENCE LEVEL(EPSC)       =    0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)     =    0.0    D'LESS
FLOW SOURCE TEMP(TEXT)       =  460.0000 DEG R
EFFECTIVE INLET TEMP.        =  710.0000 DEG R
FUEL TYPE                    =       JP4

                         OUTPUT

                        INJECTION
MEAN DROPLET SIZE            =   89.5248 MICRONS
FLASH VAPORIZATION           =    0.0    D'LESS

                 WAKE COMPOSITION SOLUTION
BETA 1                       =    0.2142 D'LESS
BETA 2                       =    0.9020 D'LESS
BETA 3                       =    0.1936 D'LESS
K1                           =    0.1980 D'LESS
WAKE F/A                     =    0.0578 D'LESS
WAKE TEMP                    = 3901.9136 DEG R

                     FLAME SPREADING
INITIAL SPEED                =    0.2084 FPS
INITIAL TURBULANCE           =    0.3440 D'LESS

                  STREAMTUBE EFFICIENCY
IDEAL TEMP RISE              = 3366.9673 DEG R
COMBUSTION EFFICIENCY        =    0.3152
ACTUAL TEMP RISE             = 1061.1807 DEG R
EXIT TEMP                    = 1771.1807 DEG R
FLOWRATE - AIR               =    0.7735 LBM/SEC
FLOWRATE - FUEL              =    0.0493 LBM/SEC
```

FAN STREAM

```
STREAMTUBE TYPE              =          9
NO. OF THIS TYPE             =          3

                          INPUT

STATIC PRESSURE(PS6)         =    15.0000 PSIA
APPROACH TEMPERATURE(T6C)=       710.0000 DEG R
APPROACH MACH NO.(M6C)       =     0.2500 D'LESS
INPUT F/A RATIO(FAC)         =     0.0450 D'LESS
EFFECTIVE F/A RATIO          =     0.0574 D'LESS
F/H WIDTH(FHWC)              =     2.1000 INCHES
BLOCKAGE RATIO(TAUC)         =     0.3500 D'LESS
F/H APEX ANGLE(ALPHAC)       =    90.0000 DEG
S/R FUEL TEMP(TFSR)          =   560.0000 DEG R
S/R FUEL PRESSURE(PFSR)      =   250.0000 PSIA
S/R TO F/H DISTANCE(LSC)     =     4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)     =    66.0000 INCHES
TURBULENCE LEVEL(EPSC)       =     0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)     =     0.0    D'LESS
FLOW SOURCE TEMP(TEXT)       =   460.0000 DEG R
EFFECTIVE INLET TEMP.        =   710.0000 DEG R
FUEL TYPE                    =        JP4

                         OUTPUT

                        INJECTION
MEAN DROPLET SIZE            =    89.5248 MICRONS
FLASH VAPORIZATION           =     0.0    D'LESS

                 WAKE COMPOSITION SOLUTION
BETA 1                       =     0.2141 D'LESS
BETA 2                       =     0.9021 D'LESS
BETA 3                       =     0.2109 D'LESS
K1                           =     0.1961 D'LESS
WAKE F/A                     =     0.0556 D'LESS
WAKE TEMP                    =  3828.2842 DEG R

                     FLAME SPREADING
INITIAL SPEED                =     0.2112 FPS
INITIAL TURBULANCE           =     0.3440 D'LESS

                  STREAMTUBE EFFICIENCY
IDEAL TEMP RISE              =  3189.8242 DEG R
COMBUSTION EFFICIENCY        =     0.3170
ACTUAL TEMP RISE             =  1011.2805 DEG R
EXIT TEMP                    =  1721.2805 DEG R
FLOWRATE - AIR               =     0.7739 LBM/SEC
FLOWRATE - FUEL              =     0.0444 LBM/SEC
```

```
                         FAN STREAM

STREAMTUBE TYPE              =           10
NO. OF THIS TYPE             =            3

                            INPUT

STATIC PRESSURE(PS6)         =      15.0000 PSIA
APPROACH TEMPERATURE(T6C)=         710.0000 DEG R
APPROACH MACH NO.(M6C)       =       0.2500 D'LESS
INPUT F/A RATIO(FAC)         =       0.0400 D'LESS
EFFECTIVE F/A RATIO          =       0.0510 D'LESS
F/H WIDTH(FHWC)              =       2.1000 INCHES
BLOCKAGE RATIO(TAUC)         =       0.2700 D'LESS
F/H APEX ANGLE(ALPHAC)       =      90.0000 DEG
S/R FUEL TEMP(TFSR)          =     560.0000 DEG R
S/R FUEL PRESSURE(PFSR)      =     250.0000 PSIA
S/R TO F/H DISTANCE(LSC)     =       4.0000 INCHES
F/H TO NOZZLE DIST.(XLC)     =      66.0000 INCHES
TURBULENCE LEVEL(EPSC)       =       0.0400 D'LESS
WAKE FLOW ADDITION(WEXT)     =       0.0    D'LESS
FLOW SOURCE TEMP(TEXT)       =     460.0000 DEG R
EFFECTIVE INLET TEMP.        =     710.0000 DEG R
FUEL TYPE                    =          JP4

                           OUTPUT

                          INJECTION
MEAN DROPLET SIZE            =      89.5248 MICRONS
FLASH VAPORIZATION           =       0.0    D'LESS

                   WAKE COMPOSITION SOLUTION
BETA 1                       =       0.2141 D'LESS
BETA 2                       =       0.9166 D'LESS
BETA 3                       =       0.2105 D'LESS
KI                           =       0.2320 D'LESS
WAKE F/A                     =       0.0443 D'LESS
WAKE TEMP                    =    3347.0767 DEG R

                        FLAME SPREADING
INITIAL SPEED                =       0.1856 FPS
INITIAL TURBULANCE           =       0.2772 D'LESS

                     STREAMTUBE EFFICIENCY
IDEAL TEMP RISE              =    2951.2939 DEG R
COMBUSTION EFFICIENCY        =       0.2515
ACTUAL TEMP RISE             =     742.3567 DEG R
EXIT TEMP                    =    1452.3567 DEG R
FLOWRATE - AIR               =       1.0036 LBM/SEC
FLOWRATE - FUEL              =       0.0512 LBM/SEC
```

FAN STREAM SUMMARY

STREAMTUBE TYPE	FUEL-AIR RATIO D'LESS	MASS FLOWRATE LBM/SEC	COMBUSTION EFFICIENCY D'LESS	EXIT TEMP DEG R
1	0.0400	0.5205	0.5126	2182.8154
2	0.0450	0.5163	0.5293	2366.7263
3	0.0500	0.5161	0.5188	2428.9924
4	0.0500	0.5161	0.5188	2428.9924
5	0.0450	0.3963	0.6147	2642.8440
6	0.0450	1.0032	0.2571	1530.2532
7	0.0500	1.0027	0.2569	1574.6762
8	0.0500	0.7735	0.3152	1771.1607
9	0.0450	0.7739	0.3170	1721.2805
10	0.0400	1.0036	0.2515	1452.3567

COOLING FLOW/TOTAL ENGINE FLOW	=	0.0600 D'LESS
CHEMICAL COMBUSTION EFFICIENCY	=	0.2694 D'LESS
THERMAL COMBUSTION EFFICIENCY	=	0.3185 D'LESS
AVG COOLING AIR TEMPERATURE	=	698.8313 DEG R
AVG STREAMLINE EXIT TEMP	=	1809.1572 DEG R
AVG DUCT EXIT TEMPERATURE	=	1569.7788 DEG R
TOTAL FLOWRATE	=	18.6052 LBM/SEC
AVG FUEL-AIR RATIO	=	0.0459 D'LESS
AVG. IDEAL TEMPERATURE RISE	=	2734.1433 DEG R

CORE STREAM

```
STREAMTUBE TYPE              =           1
NO. OF THIS TYPE             =          10

                          INPUT

STATIC PRESSURE(PS6)         =      15.0000 PSIA
APPROACH TEMP(T6H)           =    1660.0000 DEG R
APPROACH MACH NO.(M6H)       =       0.2500 D'LESS
FUEL AIR RATIO(FAH)          =       0.0500 D'LESS
F/H WIDTH(FHWH)              =       0.7500 INCHES
F/H APEX ANGLE(ALPHAH)       =      60.0000 DEGREES
BLOCKAGE RATIO(TAUH)         =       0.2500 D'LESS
F/H TO NOZZLE DIST.(XLH)=           66.0000 INCHES
S/R TO F/H DISTANCE(LSH)=            8.0000 INCHES
TURBULENCE LEVEL(EPSH)       =       0.0400 D'LESS
FUEL TYPE                    =          JP4

                          OUTPUT

WAKE RECIRCULATION COEF =            0.1334 D'LESS
WAKE EFFICIENCY              =       0.9988 D'LESS
INITIAL FLAME SPEED          =       2.0567 FPS
INITIAL TURBULENCE LEVEL=            0.2618 D'LESS
IDEAL TEMP RISE              =    2236.8818 DEG R
COMBUSTION EFFICIENCY        =       1.0000 D'LESS
ACTUAL TEMPERATURE RISE =         2236.8818 DEG R
EXIT TEMPERATURE             =    3896.8818 DEG R
FLOWRATE - AIR               =       0.2482 LBM/SEC
FLOWRATE - FUEL              =       0.0124 LBM/SEC
```

CORE STREAM

STREAMTUBE TYPE	=	2
NO. OF THIS TYPE	=	10

INPUT

STATIC PRESSURE(PS6)	=	15.0000	PSIA
APPROACH TEMP(T6H)	=	1660.0000	DEG R
APPROACH MACH NO.(M6H)	=	0.2500	D'LESS
FUEL AIR RATIO(FAH)	=	0.0550	D'LESS
F/H WIDTH(FHWH)	=	0.7500	INCHES
F/H APEX ANGLE(ALPHAH)	=	60.0000	DEGREES
BLOCKAGE RATIO(TAUH)	=	0.2500	D'LESS
F/H TO NOZZLE DIST.(XLH)	=	66.0000	INCHES
S/R TO F/H DISTANCE(LSH)	=	8.0000	INCHES
TURBULENCE LEVEL(EPSH)	=	0.0400	D'LESS
FUEL TYPE	=	JP4	

OUTPUT

WAKE RECIRCULATION COEF	=	0.1334	D'LESS
WAKE EFFICIENCY	=	0.9986	D'LESS
INITIAL FLAME SPEED	=	2.0786	FPS
INITIAL TURBULENCE LEVEL	=	0.2618	D'LESS
IDEAL TEMP RISE	=	2211.9614	DEG R
COMBUSTION EFFICIENCY	=	1.0000	D'LESS
ACTUAL TEMPERATURE RISE	=	2211.9614	DEG R
EXIT TEMPERATURE	=	3871.9614	DEG R
FLOWRATE - AIR	=	0.2479	LBM/SEC
FLOWRATE - FUEL	=	0.0136	LBM/SEC

CORE STREAM

```
STREAMTUBE TYPE            =          3
NO. OF THIS TYPE           =         10

                        INPUT

STATIC PRESSURE(PS6)       =     15.0000 PSIA
APPROACH TEMP(T6H)         =   1710.0000 DEG R
APPROACH MACH NO.(M6H)     =      0.2500 D'LESS
FUEL AIR RATIO(FAH)        =      0.0500 D'LESS
F/H WIDTH(FHWH)            =      0.7500 INCHES
F/H APEX ANGLE(ALPHAH)     =     60.0000 DEGREES
BLOCKAGE RATIO(TAUH)       =      0.2500 D'LESS
F/H TO NOZZLE DIST.(XLH)=        66.0000 INCHES
S/R TO F/H DISTANCE(LSH)=         8.0000 INCHES
TURBULENCE LEVEL(EPSH)     =      0.0400 D'LESS
FUEL TYPE                  =         JP4

                        OUTPUT

WAKE RECIRCULATION COEF =         0.1309 D'LESS
WAKE EFFICIENCY            =      0.9989 D'LESS
INITIAL FLAME SPEED        =      2.1442 FPS
INITIAL TURBULENCE LEVEL=         0.2618 D'LESS
IDEAL TEMP RISE            =   2210.8818 DEG R
COMBUSTION EFFICIENCY      =      1.0000 D'LESS
ACTUAL TEMPERATURE RISE =      2210.8818 DEG R
EXIT TEMPERATURE           =   3920.8818 DEG R
FLOWRATE - AIR             =      0.2443 LBM/SEC
FLOWRATE - FUEL            =      0.0122 LBM/SEC
```

CORE STREAM

STREAMTUBE TYPE	=	4	
NO. OF THIS TYPE	=	10	

INPUT

STATIC PRESSURE(PS6)	=	15.0000	PSIA
APPROACH TEMP(T6H)	=	1710.0000	DEG R
APPROACH MACH NO.(M6H)	=	0.2500	D'LESS
FUEL AIR RATIO(FAH)	=	0.0550	D'LESS
F/H WIDTH(FHWH)	=	0.7500	INCHES
F/H APEX ANGLE(ALPHAH)	=	60.0000	DEGREES
BLOCKAGE RATIO(TAUH)	=	0.2500	D'LESS
F/H TO NOZZLE DIST.(XLH)	=	66.0000	INCHES
S/R TO F/H DISTANCE(LSH)	=	8.0000	INCHES
TURBULENCE LEVEL(EPSH)	=	0.0400	D'LESS
FUEL TYPE	=	JP4	

OUTPUT

WAKE RECIRCULATION COEF	=	0.1308	D'LESS
WAKE EFFICIENCY	=	0.9987	D'LESS
INITIAL FLAME SPEED	=	2.1670	FPS
INITIAL TURBULENCE LEVEL	=	0.2618	D'LESS
IDEAL TEMP RISE	=	2185.9614	DEG R
COMBUSTION EFFICIENCY	=	1.0000	D'LESS
ACTUAL TEMPERATURE RISE	=	2185.9614	DEG R
EXIT TEMPERATURE	=	3895.9614	DEG R
FLOWRATE - AIR	=	0.2440	LBM/SEC
FLOWRATE - FUEL	=	0.0134	LBM/SEC

CORE STREAM SUMMARY

STREAMTUBE TYPE	FUEL-AIR RATIO D'LESS	MASS FLOWRATE LBM/SEC	COMBUSTION EFFICIENCY D'LESS	EXIT TEMP DEG R
1	0.0500	0.2482	1.0000	3896.8818
2	0.0550	0.2479	1.0000	3871.9614
3	0.0500	0.2443	1.0000	3920.8818
4	0.0550	0.2440	1.0000	3895.9614

M/B FUEL-AIR RATIO(FAV)	=	0.0200	D'LESS
M/B INLET TEMP(T3H)	=	1360.0000	DEG R
AVG EXIT TEMP	=	3896.3306	DEG R
AVG COMB. EFFICIENCY	=	0.9960	D'LESS
TOTAL FLOWRATE	=	9.8440	LBM/SEC
AVG FUEL-AIR RATIO	=	0.0525	D'LESS
AVG DISTANCE FROM SPRAYBAR TO F/H	=	8.0000	INCHES
AVG. IDEAL TEMP. RISE	=	2220.5083	DEG R

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