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Implementation of a Trailing-Edge Flap Analysis Model in the NASA Langley CAMRAD.MOD1/HIRES Program

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Introduction

Continual advances in rotorcraft performance, vibration and acoustic characteristics are being sought by rotary-wing vehicle manufacturers to improve efficiency, handling qualities and community noise acceptance of their products. The rotor system aerodynamic and dynamic behavior are among the key factors which must be addressed to meet the desired goals. Rotor aerodynamicists study how airload redistribution impacts performance and noise, and seek ways to achieve better airload distribution through changes in local aerodynamic response characteristics. One method currently receiving attention is the use of trailing-edge flaps mounted on the rotor blades to provide direct control of a portion of the spanwise lift characteristics. Flaps have been employed in the past by at least one manufacturer as a means to trim the rotor in place of the more conventional blade root pitch control. However, when used in conjunction with root pitch control, the flap provides an additional degree of freedom available to modify the lift distribution above that necessary for rotor trim. As an independent control, it is possible to vary the flap angle in an arbitrary fashion using higher harmonic or non-harmonic inputs as functions of rotor azimuth position, and further, the inputs may differ between blades giving the capability of individual blade control.

Thus a rotor with trailing-edge flaps exhibits several desirable features that may be used to explore designs for quieter and more efficient rotors. First, however, it is necessary to have the capability to perform detailed analysis of the new configurations which meet the stringent requirements needed for acoustics predictions. The following work describes the incorporation of a trailing-edge flap model in the CAMRAD.Mod1/HIRES comprehensive rotorcraft analysis code, Reference [1]. As described in Reference [l], CAMRAD.Mod1 is an extensively updated version of the early public domain CAMRAD [2] code. The Mod1 code enables analysis of rotor behavior with the high temporal and spatial airload resolution necessary for accurate acoustics calculations. Also, it contains a new wake model capable of simulating secondary trailing vortices which are expected to arise from the airload distributions produced by a flap located at the blade tip. The CAMRAD.Mod1/HIRES analysis consists of three separate executable codes. These include the comprehensive trim analysis, CAMRAD.Mod1, the Indicial Post-Processor, IPP, for high resolution airloads, and AIRFOIL, which produces the rotor airfoil tables from input airfoil section characteristics. The modifications made to these components permitting analysis of flapped rotor configurations are documented herein along with user instructions detailing the new input variables and operational notes. This information is intended to be used as a supplement to References [1] and [2]. The current work also includes sample cases of the code predictions compared with wind tunnel test results of the MDHS/NASA Active Flap Rotor tests conducted in the NASA Langley 14 x 22 foot Subsonic Wind Tunnel [3].

Active-Flap Rotor Prediction Methodology

The implementation of a trailing-edge flap in CAMRAD.MOD1 requires an aerodynamic model to define how the local section characteristics will vary with the trailing-edge flap deflection angles in addition to the usual two dimensional angle-of-attack and Mach number variables. In the new model, the user may choose a method which employs flap coefficient increments that are added to the standard airfoil section coefficients (without flaps) obtained from the usual data tables. Provisions have been made to compute the flap coefficient increments using thin airfoil theory or by a curve fit of increments obtained using Kaman airfoil data [4]. A second option utilizes experimental or predicted airfoil characteristics for a flapped airfoil section which are read from C-81 data tables. In this method, the airfoil table format was expanded to include flap lift and hinge moment coefficient tables for use in estimating airloads on the flap and the flap actuators. It should be noted that the CAMRAD.Mod1 flap model does not treat the flap motion as an additional degree of freedom in the blade dynamics solution. The code would have to be substantially rewritten to achieve this capability. Thus, a simplified flap dynamic analysis was developed to permit estimation of the flap inertial contributions to the flap actuator loads.

The CAMRAD.Mod1 code modifications give the user two options for introducing trailing-edge flap motion depending on the purpose of the flap. The First method employs the flap to trim the rotor and so its motion is controlled by the pilot's stick and possibly governor inputs. Here, the flap lift forces develop pitching moments on the rotor blade about the feathering axis to produce the blade collective and cyclic pitch changes needed for trim. In the second method the flap becomes an independent secondary control while root pitch actuation remains as the primary trim control. In this case, the flap can be employed to control rotor twist as a function of flight condition or impose twist variations as a function of azimuth. Thus, the coding was written to permit flap motion inputs given in terms of higher harmonics or specified as arbitrarily functions of rotor azimuth. CAMRAD.Mod1 assumes the motion of all blades on the rotor are identical, consequently individual blade control cannot be simulated.

Flap Aerodynamic Modeling

A general treatment of the flap aerodynamics for rotors would consider its highly unsteady, three dimensional and compressible flow environment. Most rotor codes utilize experimental airfoil data to include the effects of compressibility and correct the 2D data for unsteady effects and yawed flow. Unfortunately 2D airfoil tests for sections commonly employed on rotorcraft do not include configurations with flaps. Thus an approximate means of adding flap effects to the available rotorcraft airfoil data is desired. Although the flap motion introduces unsteady effects in addition to the normal airfoil motions, these have been neglected and the usual Theodorson or indicial methods are assumed valid for airfoils with a trailing edge flap. Further, all corrections applied for yawed flow remain unaltered.

Aerodynamic Loads using Thin Airfoil Theory

Plain trailing-edge flaps with no gap effectively change the airfoil section camber. The resulting changes in airfoil aerodynamic characteristics with deflected flaps can be analyzed using potential flow thin-airfoil theory. Thin-airfoil theory will give reasonably accurate prediction of the chordwise loading, section pitching moments and the angle of attack for zero lift. Prediction of the flap lift and flap hinge moments are less accurate in the absence of viscous effects which have significant influence near the section trailing edge. However, experimental data is scarce for the relatively high Mach number conditions in which the flaps will operate for most helicopter rotor applications. Thus, thin-airfoil theory can provide a needed degree of approximation in the absence of test data.

The following thin-airfoil equations (see References [5,6]) have been utilized in CAMRAD.Mod1 to estimate the flap effects on the both the total section loading and the flap loading.

Section lift	$C_l = a(\alpha - \alpha_0 + k\delta)$	(reference chord = c)
Section moment, c/4	$C_m = C_{m0} - m\delta$	(C_{ref} = c)
Flap lift	$C_{lf} = C_{lf0} + n_0 C_l - n\delta$	($C_{ref} = c_f$)
Flap hinge moment	$C_h = C_{h0} + h_0 C_l - h\delta$	($C_{ref} = c_f$)

where α_0, C_{lf0}, C_{h0} and C_{ho} are values at zero lift and zero flap deflection, **a** is the lift curve slope(per radian), α is the angle of attack (radian) and δ is the flap deflection angle (radian, positive TE down). Also,

$$k = (1/\pi)\{\cos^{-1}(1-2E) + 2(E(1-E))^{1/2}\}$$

$$m = (a/\pi)(1-E)(E(1-E))^{1/2}$$

$$n_o = (4/aE)\{(\pi/2) - \cos^{-1} E^{1/2} - (E(1-E))^{1/2}\} \qquad \text{Eqns (1-6)}$$

$$n = -2.5556(1-E)$$

$$h_0 = (-2/aE^2)\{(3/2 - E)(E(1-E))^{1/2} - (3/2 - 2E)[\pi/2 - \cos^{-1} E^{1/2}]\}$$

$$h = (4/\pi E^2)(1-E)\ (E(1-E))^{1/2}\{\pi/2 - \cos^{-1} E^{1/2} - (E(1-E)^{1/2}\}$$

where E is the flap chord ratio (c_f / c). The influence of the flap on the section drag is accounted for using a drag coefficient increment of the following form:

$$C_d = C_{d(\delta\text{-}o)} + \Delta C_d$$

$$\Delta Cd = a_1\delta + a_2\delta^2 + a_3\delta^3 + a_4\delta^4 \quad (\delta \text{ in degrees})$$

where the polynomial coefficients may be defined from Navier Stokes calculations or, perhaps, from some other means. Aerodynamic loads on the flap are obtained from the above coefficients as

$$L_f = 0.5rV^2c_fC_{lf}$$

$$M_h = 0.5rV^2\ c_f^2\ C_h$$

Similarly, the incremental section loads resulting from the flap deflection are defined to be

$$L_\delta = 0.5rV^2\ ck\delta$$

$$D_\delta = 0.5rV^2\ c(a_1\delta + a_2\delta^2 + a_3\delta^3 + a_4\delta^4)$$

$$M_\delta = -0.5rV^2\ c^2\ m\delta$$

Flap Inertial Model

The following simplified inertial analysis of the flap has been included in the CAMRAD.Mod1 flap modifications for the purpose of estimating control loading requirements. The blade section motions considered are the out-of-plane flap bending (w) and precone, rotation about the feathering and elastic axes (θ_b), and the trailing-edge flap deflection (3). In-plane motions and forces are neglected. The following quantities are used in the formulation:

I_h	flap inertia moment about hinge, slug-ft^2
m	flap mass, slug
r, R	radial station, rotor radius
x_h	flap hinge offset from blade feather axis, x_h/R

x_I	flap CG offset, positive aft of flap hinge, x_I/R
w	blade flapping motion
β_p	precone angle
θ_b	blade pitch angle
θ_{tw}	built-in twist
θ_0	blade root pitch (includes control inputs, control system flexibility, and kinematic coupling)
ϕ	elastic torsion
δ	flap deflection angle, positive TE down
Ω	rotor speed, rad/sec

The out-of-plane acceleration of the flap center of gravity is

$$a_{CG} = \ddot{w} + \Omega^2 r(w' + \beta_p) - (x_h + x_I)\ddot{\theta}_b - x_I\ddot{\delta}$$

where the dot quantities are time derivatives and the prime quantities are spatial derivatives.

The blade pitch angle is defined as

$$\theta_b = \theta_{tw} + \theta_0 + \phi$$

The inertia loads, including the propeller moment term are then

$$F_I = -ma_{CG} = m(x_h + x_I)\ddot{\theta}_b + mx_I\ddot{\delta} - m(\ddot{w} + \Omega^2 r(w' + \beta_p))$$

$$M_I = -\Omega^2 I_h(\theta_b + \delta) - I_h(\ddot{\theta}_b + \ddot{\delta} - mx_h x_I\ddot{\theta}_b + mx_I(\ddot{w} + \Omega^2 r(w' + \beta_p))$$

The flap can also be pre-loaded with a spring which exerts zero load at a particular flap angle, δ giving rise to the following zero deflection moment on the flap (positive leading-edge down)

$$M_{s0} = -k_f\delta_0$$

The structural moment on the flap is then

$$M_s = M_{s0} + k_f\delta_0$$

lb/rad. Damping forces on the flap include Couloumb friction and viscous damping given by

$$M_d = c_0 \mathrm{sign}(\dot{\delta}) + c_1(\dot{\delta})$$

where c_0 is the Coulomb friction coefficient, ft-lb, and c_1 is the viscous damping coefficient, ft-lb-sec. Equations have also been included expressing the power and energy requirements of the flap actuators. These are given by

$$W(\psi) = -\int_{\psi 1}^{\psi 2} M_f \delta d\psi$$

$$P(\psi) = -M_f\dot{\delta}$$

$$E(\psi) = -(1/2)M_f(\delta - \delta_e)$$

where W is the flap work, ft-lb, P is the actuator power required, ft-lb/sec, and E is the stored energy, ft-lb. In the last expression, ^{6}e represents the flap deflection for zero stored energy in the actuator.
Note in the above relationships, that the actuator output load is equal and opposite to the moment experienced by the flap.

CAMRAD.Mod1/HIRES Flap Model Implementation

The following sections describe the changes that were made to incorporate a trailing-edge flap model in the CAMRAD.Mod1, AIRFOIL and INDICIAL executable code elements. In addition to the flap model equations, the default parameters associated with several thin airfoil theory options are presented.

Trim Code Modifications

Overview

The rotor aerodynamic subroutines are the principal areas where code changes were necessary to model a rotor with flaps. It is here where the thin airfoil theory equations were implemented. The capability to use flap airfoil data tables also required the extension of table formats and common block sizes since additional flap parameters have been introduced and separate C8 I tables were needed to define the airfoil characteristics at each flap angle. A means to interpolate between the data tables for intermediate flap angles was added. All routines which need rotor airfoil table data, including the flutter model, were changed for compatibility with the new formats. In general, new namelists and associated commons were constructed to handle all flap related input information. The ability to trim the rotor using flap control required that the routines which initialize rotor parameters and define the relationship between pilot stick motion and blade pitch motion be updated. Finally, routines which print the input and output results were modified to reflect the various flap options and operating characteristics. The new code is capable of modeling two rotor systems having flaps. A partial program flow sequence diagram for the trim code showing only rotor- 1 subroutines is depicted in Figure 1. In the next section, the trim code modifications are described following the general sequence of Figure 1.

Modified Subroutines

Subroutine INPTN calls the rotor subroutines containing the rotor input information and the airfoil data tables for each Rotor. Rotor subroutine INPTR1 contains all flap input characteristics, aerodynamic modeling options and flap operating parameters which are read in namelist NLFLAP. INPTR1 also initializes flap variables and sets default values for the thin-airfoil theory coefficients. The variable, OPFT1 is introduced in INPTN and passed to the airfoil table read routine, INPTA1, to enable read format selection for either standard airfoil tables or modified flap tables in binary form. When reading tables for a flapped rotor, INPTA1 expects information defining the radial location of the flap, the number of C-8 t flap tables at each flap station and the flap angle associated with each table. The flap table contains the standard airfoil coefficients, C_1, Cd, and Cm, (representing a complete airfoil section with a deflected flap), plus additional values specifying the lift and hinge moment coefficients of the flap itself. Further details of the code modifications to enable use of flap tables are covered in the airfoil table generation section.
In cases where a trailing-edge flap is employed to trim the rotor, the control system matrix must relate the pilot's control inputs to the motions produced at the flap. The control system matrix is initialized in routine INITB and applies to both isolated rotor and full vehicle configurations. It must be modified to provide a simple sign change to the control inputs of each rotor that will be trimmed with flaps. Positive pilot control inputs are translated by the matrix into negative flap deflections (i.e. trailing edge up) which create nose-up aerodynamic pitching moments that, in turn, produce positive increments in

rotor blade pitch. In addition to the sign change, the pilot control inputs must also be "disconnected" from the root pitch and applied to flap motions. This is accomplished in subroutine TRIMI where the normal root pitch variable VCNTRL containing collective and cyclic pitch terms is assigned to the new flap variable, FCNTRL. The VCNTRL terms are then set to zero.

Reference [7] discusses the use of a trim flap on a rotor where the blade has a soft feathering restraint, or effectively, a root torsion spring. The spring can be biased to produce zero load at a large collective pitch value. This action serves to reduce the feathering moment required from the flap to trim at high pitch settings. A hover performance gain is thereby realized by reducing the flap download. When a root spring is employed, the above collective term in VCNTRL is set to the 3/4-radius pitch corresponding to the unloaded spring pitch value instead of zero.

Subroutine TRIMI calls RAMF to compute the rotor and airframe motion and forces. The interest here is restricted to motion and aerodynamic changes arising from the use of a trailing-edge flap. RAMF calls subroutine MOTNR1 to compute the spanwise and azimuthal airload distributions on rotor- I. In CAMRAD.Mod1, the blade low-resolution airloads can be computed with the original CAMRAD model, AEROF1, or the Beddoes indical model, AERBED1. Note that the low-resolution indical model will not function with flaps. [Although the routines AERBED1 and AEROS1B appear to have been modified, they contain only dummy flap variables, permitting the code to compile with the AEROT1 routine (called by AEROS1B) which must function with flaps in AEROF1.] The spanwise airloads are computed and integrated in subroutine AEROF1 which is called at each blade azimuth position. Before the radial forces are determined, the flap deflection angle is calculated depending on the flap option. The following statements are used:

```
C SERVO-FLAP OPTION
C FLAP USED FOR PRIMARY TRIM CONTROL (OPFLAP=1)
C INCLUDE PITCH-SERVOFLAP COUPLING PCHFL BASED ON ROOT DEFLECTION
       IF (OPFLAP .EQ. I) THEN
      PCHFL=KDT*PD
      FLAP = (F0+F1C*CS+F1S*SN+PCHFL)*CVERT
C HIGHER HARMONIC FLAP CONTROL (ROTATING SYSTEM)
      FLAPN=0
      DO 4 N=2,NFH
4 FLAPN = FLAPN+FHC(N)*CNN(N)+FHS(N)*SNN(N)
      FLAP=FLAP+FLAPN
C FLAP USED AS SECONDARY CAMBER/TWIST CONTROL (OPFLAP=2)
      ELSE IF (OPFLAP .EQ. 2) THEN
      FLAPN=0.
      DO 5 N=I,NFH
5 FLAPN=FLAPN+FHC(N)*CNN(N)+FHSN)*SNN(N)
      FLAP=FH0+FLAPN
C USE INPUT FLAP DEFLECTIONS FOR BVI-FLAP CONTROL
      ELSE IF (OPFLAP .EQ. 3) THEN
      FLAP=FDA(JPSI)
      ELSE
      FLAP=0.
      ENDIF
```

In option I (OPFLAP=1), the pilot's control inputs define the collective (F0) and cyclic (F1C, F1S) terms. An additional motion input has been introduced to account for possible mechanical coupling between the blade pitch angle and the trailing-edge flap angle input as discussed in Reference [7]. The resulting motion is defined by an input coupling coefficient, KDT, and the computed blade root torsional deflection contained in the variable PD. Further, higher harmonic flap motion can be prescribed in the rotating system using the FHC and FHS input cyclic values. In options 2 and 3, the flap motion is independent of the pilot's stick, pedal and throttle inputs. Option 2 permits use of both steady and cyclic motions including higher harmonics that could be employed to change blade twist. In option 3, the flap motion can be arbitrarily specified at the (low) azimuth resolution allowed by the code.

The radial integration loop in AEROF1 determines the blade flow velocities and angles, and calls AEROS1 to determine the aerodynamic properties associated with the airfoil type. If the airfoil has a trailing-edge flap, the aerodynamic coefficients returned by AEROS1 represent the lift, drag and section moment for the complete airfoil with deflected flap at the specified flap angle. In addition, coefficients for both the lift and the resulting hinge moment on the trailing-edge flap are obtained. Using the latter, AEROF1 calculates and stores the section and spanwise-integrated airloads separately from the total section loads. The flap lift and hinge moment loads are used only for printout purposes and do not influence the rotor motion or trim solution.

Subroutine AEROS1 corrects the 2-D angles-of-attack and Mach numbers computed in AEROF1 to account for dynamic stall effects and both yawed flow and sweep effects. These corrections remain unaltered for an airfoil section having a trailing-edge flap. AEROS1 gains access to the airfoil section characteristics using subroutine AEROT1 which performs a table lookup procedure. The CAMRAD code modifications allow the user to incorporate both flap lift and hinge moment data in the 2-D airfoil tables. However, if flap data tables are unavailable, a second option permits the use of flap coefficient increments which are added to standard airfoil table coefficients (using an airfoil without flap) to emulate a flapped section. The increments represent changes to the total section lift, drag and moment created by the flap (i.e. C_L (With flap) - C_L (without flap), etc.). A new subroutine, DFLAP1, was developed to compute the total coefficient increments from one of two sources. The first is based on thin-airfoil theory for flapped sections and is the simplest method. Here, of course, the drag increments must be determined from some other means such as CFD calculations. The second utilizes increments derived from Kaman airfoil data tables ~]. The derived increments were then curve fit as a functions of angle-of-attack, Mach number and flap angle yielding curve fit coefficients which are contained in DFLAP1 data statements. Flap lift and hinge moment coefficients are also computed in DFLAP1. Thin-airfoil theory is always used to compute the hinge moments, but the flap lift can be estimated either with thin-airfoil theory or by employing a user-specified flap center-of-lift location in conjunction with the hinge moment.

When the thin-airfoil theory is chosen to represent the flap aerodynamic characteristics, the user may compute the thin-airfoil coefficients using equations (1-6) which are based solely on the flap chord ratio = $E = C_f / C$ and the section lift curve slope. Alternatively, provision has been made to directly input the coefficients allowing information from other sources. The code has the flexibility to vary the flap airfoil characteristics along the flap span with a choice of up to six data sets at a given aerodynamic station. The First five use thin-airfoil coefficients and the sixth set employs the Kaman increments. The data set selection is controlled by the input variable RFLAP which performs two functions. RFLAP contains MRA values corresponding to the number of blade aerodynamic segments. Thus, a value of RFLAP > 0 is used for blade segments with a flap, and serves to define both the flap location and its spanwise extent on the rotor. (It is assumed that the flap extends over the entire length of each aerodynamic segment containing a flap.) In addition, RFLAP is used to select which data set will be used at a given flap station by choosing the value of RFLAP corresponding to a desired the thin airfoil coefficient data set or the Kaman data set (a number from 1 to 6).

The above description outlines the subroutines modified for the low-resolution airload analysis and trim solution. Once rotor trim is achieved, the information pertinent to the vehicle, including rotor data, modeling parameters and operating conditions is printed. The print subroutines have been updated to reflect the input model options, geometric data and operating parameters describing how the trailing-edge flap is used. In the case header subroutine, PRNTC, statements were added indicating to the user when flaps are being used on either rotor- 1 or rotor-2 and which OPFLAP option is in force. In subroutine PRNTR1, the location of the flap is denoted by printing the RFLAP variable in column format adjacent to the rotor aerodynamic property distributions. If the flap is used for trim, the flap-pitch coupling parameter, and the 3/4-radius collective pitch for zero root spring force are listed. The choice of using either flap data tables or thin airfoil theory for the flap aerodynamic characteristics is printed, and if thin airfoil theory is used, the coefficients are listed for each flap airfoil. Likewise, all properties pertinent to the flap inertial model are printed including the mass, inertia, cg offset, and hinge offset distributions and spring and damper values. When a high-resolution flap-rotor analysis is to be performed, subroutine PRNTHR1, prints the RFLAP parameter to define flap locations relative to the high-resolution radial stations. This information is also used in the Indicial Post-Processor airloads model.

The rotor trim performance parameters are computed in subroutine PERFR1. Here, the pilot collective and cyclic control positions defined in the trim process are printed. When the pilot's controls are connected to the trailing-edge flap, these values represent the mean and First harmonic flap deflection angles in place of the usual blade pitch terms. However, the resulting 3/4 radius blade pitch (collective) value is also given. The trailing-edge flap deflection angles are also printed as a function of azimuth position for all flap options, but the related sine and cosine harmonics are given only for OPFLAP = 1 or 2.

Selected rotor loading parameters are printed using subroutine LOADR1. LOADR1 was modified to include the flap airload information and contains new coding for the flap inertial analysis. The trim airload distributions, saved in coefficient form in AEROF1, are dimensionalized and printed both as section loads and as spanwise integrated loads at each blade azimuth. Likewise, the flap inertial loadings arising from the blade motion including flapping, pitching and the trailing-edge flap motion are determined for each segment and summed over the flap span. The inertial and airload forces and moments are then summed ignoring any directional differences between the lines of action of the forces. Hinge moments arising from spring and damping forces may be added to simulate control system effects. The above components and the resulting total flap (lift) force and hinge moment are printed at each azimuth along with the corresponding trailing edge flap angle. Calculations are also made to estimate the flap actuator power requirements. Work performed by the control system, and the instantaneous energy storage and power dissipation characteristics are computed and listed at each blade azimuth. The azimuthal minimum, maximum, mean and half peak-to-peak values are displayed for each constituent of the total flap forces and moments, and the actuator power estimates.

At this point, the description of subroutines modified for the low-resolution analysis of an active flap rotor is completed in accordance with Figure 1. However, if a high-resolution aerodynamic analysis is to be performed (OPINT>O), the additional routines listed in Figure 1 under the "HIRES" section will be executed. MNTRINT1 is essentially a high resolution version of MOTNR1 with the exception that the blade motion is interpolated from the low-resolution solution instead of being recalculated. The blade HIRES airloads and flow quantities computed here neglect the near wake inflow contribution and are printed to separate output files. The flap angle, flap lift and hinge moment have been added to these outputs The blade far wake aerodynamic solution is computed at high-resolution using interpolated wake geometry to determine the far wake inflow. MNTRINT1 calls the routines AEF1INT, AES1INT and AET1INT which are high-resolution versions of the aero routines, AEROF1, AEROS and AEROT1, and contain identical modifications for treatment of the flap aerodynamics. When input flap angles are specified (OPFLAP=3), the low-resolution values are interpolated to obtain angles at the required azimuth stations.

If the high resolution near wake model in CAMRAD.Mod1 is chosen rather than the Indicial Post-Processor near wake model, then subroutine NWAKE1 is invoked to compute the near wake geometry, and induced velocities and ultimately the blade high-resolution airloading. NWAKE1 calls subroutine AEF2INT which, in turn, calls AES1INT, and eventually AET1INT and DFLAP1 (if flap coefficient increments are used) to determine the blade loading. The changes made in AEF2INT to model a flapped rotor are identical to those described in subroutine AEF1INT.

Airfoil Table Generation Code Modifications

The CAMRAD AIRFOIL program reads two-dimensional airfoil characteristics in C-S I format for each airfoil section on the rotor. A C-81 table contains lift, drag and moment data at several Mach numbers for an angle-of-attack range from - 180 to + 180 degrees. However, the angle-of-attack and Mach number values need not be the same within the lift, drag, and moment tables of a given airfoil or for other airfoils on the rotor. To increase the CAMRAD program efficiency, the AIRFOIL program interpolates the C-81 tables to a common set of angle-of-attack and Mach number increments for all coefficients and all data sets. The user exercises control over the interpolation process by assigning angle-of-attack and Mach number ranges and the interpolation steps sizes within each range to faithfully reproduce the table values in areas where accuracy is most critical. The AIRFOIL program permits the user to specify a maximum of twenty angle-of-attack and twenty Mach number ranges and model a rotor having up to ten airfoils along the span. The interpolated coefficients are stored in one-dimensional lift, drag and moment arrays and placed in a binary formatted file, along with other pertinent table information, which are then read by the CAMRAD program as AFTABLE. The array coefficients are stored in order according to airfoil section, Mach number, and alpha, with alpha being the inner loop, Mach number the next loop and airfoil the outer loop.

The AIRFOIL program has been modified to construct CAMRAD binary input tables for a rotor having a trailing-edge flap. Thus, at blade radial stations where the flap is located, AFTABL includes additional data sets corresponding to the specified trailing-edge flap angle range for each flap airfoil section. The input parameter NRB specifies the number of airfoils used on the rotor. Sections without flaps use one C-81 table per airfoil, thus NRB also defines the number of C-81 tables needed for the rotor. When the airfoil has a flap, an additional C-81 table is required for each flap angle including the zero flap deflection angle. A minimum of three tables per airfoil are necessary to simulate positive and negative flap deflections. Consequently NRB (the number of airfoil sections) no longer corresponds to the number of C-81 tables. A new parameter, NFA, was introduced to define the number of flap angles (or tables) required for each airfoil section, where NFA = 1 for sections without flaps (zero deflection). The number of C-81 tables is given by

$$\mathrm{NRF} = \sum_{\mathrm{I}=1}^{\mathrm{NRB}} \mathrm{NFA}\ (\mathrm{I})$$

The original airfoil code uses a maximum of ten airfoil sections (NRB). The modified code maintains this limit, but has expanded the common block storage space permitting the use of up to thirteen C-81 tables.

Along with the increased number of tables, each C-81 input table format was modified to append flap lift and hinge moment coefficients as functions of angle-of-attack and Mach number. Since the capability to read either standard or flapped airfoil tables was to be maintained, a new variable OPF was incorporated into subroutine C81RD which reads the input data tables. The value OPF>O signals C81RD that all tables to be read will be in flap format. Thus, at blade stations that do not have a flap, the tables must include dummy input flap lift and hinge moment (zero) values in order to satisfy the read format statements. If OPF=0, these statements are ignored. With the additional flap data items, the header format in each C-81 table has also been changed to include the number of angle-of-attack and Mach number entries contained in the flap lift and hinge moment tables. After AIRFOIL reads each C-81 table, subroutine C81INT interpolates the table entries to the angle-of-attack and Mach number values needed for AFTABL. C81INT was modified to enable interpolation of the flap lift and hinge moment values when OPF > 0 is selected.

The AIRFOIL program contains an option permitting the AFTABLE entries to be interpolated and printed at user specified angles-of-attack and Mach numbers for as many as ten Mach numbers and sixty alpha values. The AEROT subroutine used to perform these interpolations is the same routine employed by CAMRAD to interpolate airfoil data in the rotor aerodynamics analysis. Thus, AEROT becomes an interface between AIRFOIL and CAMRAD. The AFTABLE data arrays created by AIRFOIL are also entered into the TABLES common block in the AIRFOIL program. Subroutine AEROT receives the airfoil data through the TABLES common block. Similarly in CAMRAD, the subroutine FILEA1 reads the binary AFTABLE file and enters the data in the TABLES common block so that AEROT functions the same way in both codes.

AEROT is asked to determine the coefficient values of a given airfoil section (corresponding to a selected radial location on the blade) for arbitrary angle-of-attack and Mach number inputs. The code determines the angle-of-attack and Mach number ranges (which are common to all data) that the selected point falls within (thereby reducing the serial search of angles and Mach numbers to those in one range) and computes interpolation factors. If the section has a trailing-edge flap, interpolation factors are also required to interpolate the input flap deflection angle between two airfoil tables representing the discrete bounding flap angles. It should be noted that input flap angles lying outside the table limits are not extrapolated but set equal to the closest table limit value. This practice is consistent with the manner in which the code handles all interpolated values. If standard airfoil tables (i.e. without flaps, OPF = 0) are being used, the flap interpolation logic is bypassed. The parameter OPF enters into AEROT through the TABLES common block and is defined by the AIRFOIL program. In CAMRAD, the subroutine AEROS1 obtains flap data from AEROT1 or uses thin-airfoil theory coefficients from DFLAP1 depending on the value of the variable OPFT (OPFT=0 for thin-airfoil theory' or OPFT1 for data table values). Since OPFT is a CAMRAD variable, the user must make certain that both OPF and OPFT inputs are consistent.

Options available in the original AIRFOIL program permit the user to interpolate the AFTABLE data for purposes of printing the data, as noted above, or plotting the tables using a printer plot scheme. In the modified AIRFOIL code the printer plot option has been bypassed for cases when tables are created for flapped airfoils (OPF > 0).

Indicial Post-Processor Code Modifications

The Indicial Post-Processor (IPP) is a separate executable code that provides an alternate method of computing blade unsteady airloads using indicial methods for the near wake solution. Indicial methods can produce good results at much smaller time steps than can be achieved with 'traditional' lattice models. The IPP requires input information defining both the far wake inflow, and the blade velocities and motions all of which are obtained from the high-resolution CAMRAD.Mod1 solution. The IPP combines the far wake results into its near wake solution to predict the total unsteady, high-resolution blade airloads.

Addition of a trailing-edge flap to the airfoil section introduces new motions and aerodynamic features which will affect the unsteady airloads. However, in the present model all unsteady effects introduced by the flap rotational motion are neglected. In effect, the changes in the section total lift and moments created by the flap are assumed to arise from an un-flapped section undergoing whatever angle-of-attack changes are necessary to achieve the same results. Likewise, the influence of the flap motion on the chordwise pressure distribution and resulting flow separation behavior is neglected. The leading and trailing edge separation predictions continue to use an un-flapped airfoil model.

In the IPP code, the aerodynamic forces and moments are computed in subroutine CLCALC. CLCALC employs airfoil data table coefficients determined at angles-of-attack defined by the unsteady flow environment as part of its prediction of the time-dependent airloads. When a flapped rotor is to be modeled, the airfoil tables must contain coefficients for the flap section, since the IPP model does not permit use of the thin-airfoil theory flap option. Consequently, the principal IPP modifications are those needed to bring the flap data tables and associated lookup routines into the code. Input information is also needed to define the flap option and supply the flap geometry. Subroutine INPTRD contains the input namelist variables OPFT to activate the flap option, and RFLAP to specify the flap radial location in high-resolution coordinates. The flap deflection angle is obtained from the CAMRAD.Mod1 high-resolution far wake data file read in subroutine RDFARW. The flap data tables are read into common using subroutine INPTA1 which as been modified to accept either flap or standard tables according to the value of OPFT. In CLCALC, the airfoil data is obtained using subroutine AEROTI in a manner identical to that previously described.

User Inputs and Operating Information

Introduction

CAMRAD_Mod1 has been modified to enable airloads and performance calculations to be made with rotors having a trailing-edge flap. The flap may be of any span (consistent with the aerodynamic segment distribution) and may be arbitrarily located along the rotor radius. The flap may be employed as the primary means of rotor control (i.e. where the flap is connected to the pilot's collective, longitudinal and lateral rotor pitch controls) or may be activated independent of the pilot's controls to superimpose aerodynamic loading variations on the rotor for the purpose of enhancing rotor performance or reducing rotor induced vibrations or blade-vortex interaction noise. The modifications permit flaps to be installed on one or both rotor systems.

CAMRAD.Mod1 Flap Model Namelist Variables

NAMELIST NLFLAP:

OPFLAP Flap trim option:
- 0 No flaps
- 1 Flap for rotor trim (connected to pilot's controls)
- 2 Flap with root pitch control (harmonic input)
- 3 Arbitrary input of flap deflection angle ~ f(y)

COLLO 3/4 Radius collective pitch for zero deflection of the root pitch spring (Pre-collective), deg (for OPFLAP=1 only)

KDT Pitch-(servo)flap feedback coupling, non-dimensional (for OPFLAP= 1 only)

RFLAP(MRA) Real, Defines radial location of flaps and also the flap airfoil section number (IAF). RFLAP=0. for any of the MRA blade stations where there is no flap. RFLAP>0. for those stations having an airfoil with flaps. When using thin airfoil theory for flap coefficient increments, the value of RFLAP (= IAF) defines the flap section number (which may have a value between 1 and 6) corresponding to input flap data (see thin airfoil theory inputs). Section number 6 internally defaults to the KAMAN 23012 airfoil flap coefficient increments derived from Kaman data tables and contained in internal curve fit equations.

NFPRNT Integer, Flag to print flap section force and moment data in CAMRAD.Mod1 output file. (1 for print, 0 for no print.)

Flap Motion Input (Harmonic)

NFH Integer, Number of flap harmonics used to specify flap motion (for OPFLAP=2 only). Max NFH = 10.

FHO Real, Mean flap deflection (+'ve flap TE down), deg

FHC(NFH) Real, Cosine harmonic of flap deflection in rotating system, deg

FHS(NFH) Real, Sine harmonic of flap deflection in rotating system, deg

Flap Motion Input (Arbitrary)

FDA(MPSI) Real, Input flap deflection angle schedule, deg.

Flap Aerodynamic Coefficient Options

OPFT Integer, Flap table option: OPFT=0 for flap coefficient increments defined either by thin airfoil theory or the KAMAN increments . OPFT=1 for use with flap tables in C-8 1 format; requires airfoil table generation using AIRFOIL program. **OPFT must have the same value as OPF in namelist NLTABL of the airfoil table generation program.**

Thin Airfoil Theory Inputs

OPFC Integer, Flap coefficient calculation option:
OPFC=0 to compute section coefficient increments using thin airfoil theory equations to define flap aerodynamic characteristics. OPFC=1 to use thin airfoil theory equations with user supplied values for the coefficients (KE, ME, H0, H, N0, N).

OPFL Integer, Option for computing flap lift:
OPFL=0 to use thin airfoil theory. OPFL=1 to compute flap lift using the hinge moment and a specified center-of-lift location on the flap.

CFOC(N) Real, ratio of flap chord to section chord (with zero flap deflection) at each flap section defined by RFLAP. (N is the number of flap sections used, max=6)

XFAC(N) Real, Center of lift location on the flap relative to the flap leading edge, ratio of flap chord length (xfac $= \mathbf{x_{liftcenter}} / \mathbf{cf}$). xfac has a default value of 0.40.

User Defined Thin-Airfoil Theory Equation Coefficients (OPFC=1)

KEI(N) Real, Input section lift derivative with flap deflection, cl per radian.

A0 (N) Real, Section lift curve slope, per radian.

Flap Hinge Moment Coefficient:

MEI(N) Real, Section moment derivative with flap deflection, per radian.

HOIN(N) Real, Hinge moment coefficient; variation with cl.

HIN(N) Real, Hinge moment coefficient; variation with flap deflection.

CH0(N) Real, Hinge moment coefficient at zero flap deflection, based on flap chord length.

Flap lift Coefficient:

NOIN(N) Real, Lift coefficient variation with section lift.

NIN(N) Real, Lift coefficient variation with flap deflection.

CLF0(N) Real, Flap lift Coefficient at zero flap deflection, based on flap chord length.

Flap Drag Coefficient: (The following are user defined for OPFC = 0 or 1)

CDFS0(N) Real, Drag coefficient for the airfoil section with zero flap deflection (first term in flap drag equation).

AD1(N)... AD4(N) Real, Coefficients of flap deflection terms in fourth order flap drag equation.

The input flap drag coefficient equation coefficients AD1...AD4 are internally non-dimensionalized by the zero deflection value, CDFSO, producing a drag coefficient factor which multiplies the C8 I drag table value to determine the flap drag increment.

Flap Inertia Inputs
The following flap inertial characteristics are used to define the flap inertial loads. The inertial loads are computed for print out purposes only and do not affect the blade elastic motion.

MASSF(N) Real, TE flap mass distribution, slug/ft

XHF(N) Real, TE flap hinge offset, x/R, positive aft of elastic axis.

XIF(N) Real, TE flap CG offset, x/R, positive aft of flap hinge

ITHETAH(N) Real, TE flap inertia moment about flap hinge, slug-ft

MSO Real, TE flap hinge zero-deflection spring moment, ft-lb

KFS Real, TE flap hinge spring constant, ft-lb/rad

COF Real, Coulomb friction damping coefficient, ft-lb

C1F Real, Viscous friction damping coefficient, ft-lb-sec

DELTAE Real, TE flap deflection angle for zero flap actuator stored energy, deg

Flap Airfoil Table Construction

When the option is chosen to employ flapped airfoil characteristics in C-81 table format, it is necessary that the CAMRAD_Mod1 airfoil binary tables be generated with the special version of the **AIRFOIL** code. The program reads input airfoil and flap characteristics in an expanded C-81 table format If flap tables are not required, AIRFOIL will generate (or read) the normal CAMRAD binary airfoil tables using the standard C-81 table input format The following namelist variables have been added to the AIRFOIL program inputs for use with the CAMRAD.Mod1 tailing-edge flap model.

NAMELIST NLTABL

OPF Integer, flap table option. OPF=1 to produce flap tables using input C-8I data at each flap setting; OPF=0 for rotors using flap data supplied by coefficient increments or for standard (no flap) CAMRAD.Mod1 data tables. **OPF must have the same value as OPFT in NLFLAP**. When OPF=0, AIRFOIL will also read a standard CAMRAD binary input file.

NFA(NRB) Integer, number of flap tables required at each blade segment. NFA=1 for sections NOT using flaps (zero deflection), and NFA>1 for sections with flaps. Each table contains data for one flap deflection angle.

FA(NFA) Real, flap deflection angle (deg) corresponding to the data in each NFA table. If at a given NRB section, NFA = N tables, the flap angles FA(1)...FA(N) must be in ascending order (i.e. negative to positive angles) and include the zero degree flap angle value. At all stations without flaps, FA(1)=0. Observe that the order of input tables in the AIRFOIL script file must correspond to the order of flap angles in FA.

NRF Integer, total number of flap tables on the rotor. NRF is sum of NFA (from 1 to NRB) and must be less than or equal to 13 for a rotor having flaps. NRF = NRB for a rotor without flaps.

NFPRNT Integer, Number of interpolated flap deflection values in the AIRFOIL output. For print out purposes only. Maximum = 5.

FPRNT(NFPRNT) Real, Print-out flap deflection values, deg.

C-81 AIRFOIL TABLE FORMAT FOR USE WITH FLAP SECTION DATA

The AIRFOIL program will accept data for the flap lift and hinge moment characteristics (flap drag coefficients are not included) in one C-81 file using the following expanded format. The additional tables are appended to the normal lift, drag and moment tables (following the moment table) using standard table formats and with the flap lift table appended first in order. The C-81 file title information format remains the same (A30), but the header line containing the number of Mach numbers and angles-of-attack in each table is expanded from 6I2 to 10I2 format to accommodate the additional flap lift and moment table values. Each C-81 file contains data for an airfoil with a specified flap angle. The main tables represent the section coefficients (lift, drag and quarter-chord moment) for the complete airfoil with deflected flap. The added flap lift and hinge moment table data are used only for control load estimates do not enter into the rotor trim calculations.

Indicial Post-Processor Inputs With Active Flap Rotors

High resolution airloads may be computed using the CAMRAD.Mod1/HIRES code in conjunction with the Indicial Post-Processor (IPP) aero model. The IPP is a standalone code requiring an input script file with the appropriate namelist inputs. Namelist INLST includes the two active-flap rotor variables OPFT and RFLAP. A value of OPFT = 1 signifies that the rotor calculations employ airfoil data tables for a flapped section. The variable RFLAP defines the high-resolution blade stations where the flap sections are located. Note that flap characteristics derived from thin-airfoil theory are presently not used in the IPP program.

Active—Flap Rotor Wind Tunnel Test Correlation

In 1994 McDonnell Douglas Helicopter Systems (MDHS) and the NASA Langley Research Center performed a test of an Active Flap rotor model in the Langley 14-by 22-Foot Subsonic Wind Tunnel [3]. The four-bladed rotor model was designed with an active trailing-edge flap placed near the blade tips. Testing was conducted to explore rotor blade-vortex interaction (BVI) noise reduction, rotor performance improvement and vibration reduction The CAMRDAD.Mod1 code has been used to predict the active flap rotor performance with and without flaps for one test condition, and the results are presented in this section. The test condition simulates a rotor in descending flight at low speeds where strong advancing blade BVI is encountered.

Rotor-Test Description

The Active flaps were mounted on a 6-foot diameter, 4-blade, fully articulated rotor system designed and constructed at MDHS with the geometric characteristics listed in Table 1. The flaps were actuated by a cable attached to the flap horn and passed inside the blade to a cam-follower arrangement mounted at the hub as illustrated in Figure 2. The flap motion on each blade was then determined as a function of blade azimuth by the cam profile The non-rotating cam could also be indexed in its mounting to shift the azimuth of the flap schedule motion by discrete phase angles. Several cams were available to vary the amplitude and azimuth extent of the flap deflection angles. The rotor was also instrumented with pressure transducers located on both upper and lower blade surfaces at 3% chord for the radial stations shown in Table 1. These measurements were recorded to judge the strength of the blade-vortex encounters and observe their behavior changes with various flap deflection schedules.

During the test, the rotor was trimed to selected tip path plane angles by specifying the shaft angle and minimizing the first harmonic flapping. The BVI conditions were 'mapped out' for several speeds and tip path plane angles in search of the strongest BVI encounters as determined from acoustic measurements. The mapping runs were carried out while operating with zero flap deflection. Later the maximum BVI conditions were repeated with the flaps activated.

CAMRAD.Mod1 Active Flap Model

CAMRAD.Mod1 input data for the Active-Flap Rotor model was developed using the configuration tested in the Langley 14 x 22-Foot Subsonic Wind Tunnel. The low resolution aerodynamic model utilizes 20 blade radial stations and 36 azimuthal stations. In the high resolution solution, these numbers were increased to 70 radial stations and 360 azimuthal stations. The low-resolution blade motions were computed using an elastic blade employing 10 bending modes and 5 torsion modes including one control system torsion mode. The rotor inflow calculations employed 3 revolutions of free tip-vortex and prescribed inboard-sheet wake, of which the first 40 degrees was modeled as near wake in the low-resolution model and the first 90 degrees was near wake in the high-resolution case. A tip vortex core radius of 0.03R was used in the inflow calculations, and a value of .09R was used in the wake distortion model. The free wake was permitted 8 iterations in defining the distortion and 4 wake-trim iterations were carried out to stabilize the trim solution. The roll-up wake model results employ the "variable multi-core, model" to define the vortex core sizes and circulation strength distributions. The "vortex spin model" was also used to determine the mutual effect of the primary and secondary vortices on wake geometry. Many of the roll-up model parameters employed for the Active Flap were defined by Langley engineers using information from wind tunnel validation studies of conventional and tilt-rotor systems.

Test - Theory Comparison

Run conditions representing a BVI case where the flap motions were found to significantly reduce BVI noise (compared to the baseline no-flap condition) were selected from the test report [3]. For the baseline blade, performance data and blade leading edge pressures were downloaded from the MDHS ASAP database for run T733/P891 corresponding to $\mu = 0.1487$, $\alpha_{tpp}= 5.0$ deg. aft, and $C_T/\sigma = 0.07643$. For the flapped rotor configuration, similar data were downloaded from ASAP for run T2916/P2082 corresponding to a -12.5 deg. peak flap deflection for $\mu = 0.1494$, $\alpha_{tpp}= 5.0$ deg. aft, and $C_T/\sigma = 0.07693$. CAMRAD.Mod1/Hires predictions were made for the baseline and flap cases at the tunnel test conditions. These runs utilized the standard Scully wake model, as well as the multiple roll-up wake model [2], for both low and high resolution airload computations. The purpose of the task was to assess the performance and aerodynamic prediction capability of the flap version of the code at one selected tunnel test condition.

A comparison between the measured and the predicted rotor performance parameters is presented in Tables 2 and 3 for the baseline and flapped rotor configurations respectively. The flap deflection schedule employed to achieve the Table 3 results was designed for the particular flight condition (based on airloads and acoustics predictions previously made with the CAMRAD/JA trim and Wopwop acoustics codes). This schedule is illustrated by the dashed line in Figure 3 for a phase delay angle of ϕ=-20 degrees. Figure 3 also contains the measured flap deflection as depicted by the solid line. The purpose of the negative flap angle input was twofold: to reduce the tip vortex strength on portions of the advancing blade azimuth and, to modify the wake trajectories for increased blade-vortex separation distances. The blade tip was expected to undergo greatly reduced, or possibly negative, loading during the period of peak deflection for this flap schedule. With the exception of the non-harmonic nature of its motion, the flap introduces blade motions similar to those created by cyclic pitch inputs. However, because of the loss of lift, an incremental collective pitch is needed in addition to cyclic pitch changes to maintain the baseline rotor trim (i.e. thrust and tip path plane angle).

The tabulated performance calculations are based on wind tunnel trim where rotor thrust and shaft angles are specified and rotor first harmonic flapping is minimized. A trim to the measured rotor forces was not attempted because of accuracy limitations inherent in the test stand balance. The balance was designed for rotors with higher drag and side forces than were attained in this test. Thus, the resolution of small forces was poor. Consequently, the drag and side force comparisons should be viewed with this limitation in mind.

The measured rotor control inputs show a collective pitch increase of 0.5 degrees between the baseline and the active flap case. Similar increments are predicted using the modified CAMRAD.Mod1 flap code. In general the collective pitch values predicted with the roll-up wake model give the best agreement with test results. The change in the measured longitudinal cyclic pitch appears, unexpectedly, to have the wrong sign and is also larger than the predicted value. If, indeed, the flap reduces the lift about the 90 degree azimuth position as indicated by the inputs in figure 3, then its effect should be equivalent to a forward cyclic stick input. Thus, to maintain flapping trim, a longitudinal cyclic pitch reduction would be necessary as has been predicted using the flap code. The lateral cyclic inputs reported in the data also appear to have the wrong sign or possibly a bias shift. Typically, increasing forward speed causes the rotor tip path plane to incline to the advancing side of the disk, requiring an opposing cyclic control input to maintain zero lateral flapping. The data do not show this behavior. However, the change in measured lateral flapping between the baseline and flap cases is small as would be expected due to the near-symmetry of the flap input about the 90 degree azimuth position. These arguments are based on simple rotor aerodynamic theory assuming true harmonic cyclic control inputs. With the deployment of the flap, the blade load distribution may significantly alter the rotor inflow and the wake behavior leading to considerable changes in the required root pitch control inputs (e.g. compare the predictions of the baseline and flap control inputs for cases with and without the use of the roll-up wake model). In any event, major discrepancies which need further investigation are apparent between the measured and predicted control positions.

As noted, the analysis was trimmed to thrust and tip path plane angle in a fashion identical to the procedure used in trimming the wind tunnel model. For these conditions, the rotor power predictions obtained using the roll-up model give good agreement with the measured data. (Note that the power predictions are compared with the "rotor-less-hub" values since the hub was not modeled in the calculations.) However, the question remains as to whether or not the measured and the predicted wind axis drag values are close enough to warrant this optimism. In general, the drag predictions depend on the accuracy with which the model can compute the inplane rotor force distribution; a task which is difficult even for a rotor without flaps. In this regard, it is interesting to note that the measured mean lag angle shows a small decrease with the application of the flap. On the other hand, the predicted mean lag angles with the flap deployed are larger (regardless of the wake model used) which is consistent with the higher drag values expected from the flapped rotor configuration. A comparison of the roll-up and no roll-up power values reveals that the roll-up model predictions are more than 20% lower than those given by the no roll-up model. An inspection of the corresponding power components (not shown) reveals that the induced power component is responsible for the differences. The lower collective pitch required in the roll-up model analysis also bears testimony to the reduced mean downwash relative to the no roll-up case and hence a lower induced power.

The Active-Flap rotor model was instrumented with pressure transducers on both upper and lower blade surfaces at the 3%-chord location at four spanwise positions: r/R=0.7522, 0.8214, 0.9105 and 0.9699. The differential pressures (P_{upper} - P_{lower}) give a reasonable indication of the lift variation (waveform shape) with azimuth and are utilized herein to show changes in the local aerodynamics arising from the flap deployment. The flap spans from 79% to 97% radius placing the first station inboard of the flap while the remaining stations are located at various radial positions on the flap.

Figure 4 illustrates the variation of the predicted local (dimensionless) lift, M^2C_L, at spanwise positions closest to the measured locations. Results are presented for cases with (solid line) and without flap deflection (dashed line). The results were obtained using the inherent CAMRAD.Mod1 low resolution freewake model without invoking the roll-up wake model. In general, the curves for negative flap angles (trailing-edge up) show locally reduced lift values (at three span stations on the flap) in azimuth regions corresponding to the flap schedule shown in Figure 3. The lift differences observed at azimuth positions where the flap is not deflected arise from the airload redistribution and slight trim differences.

Figure 5 illustrates the corresponding spanwise non-dimensional lift distributions at selected azimuths where the flap is deployed. As seen, the stations on the flap experience reduced lift while those inboard exhibit higher lift due, in part, to the induced upwash inboard of the flap. This upwash arises from changes in the near wake and from changes in the blade pitch. Note that for the flap case, the blade lift at the tip does not approach zero. This may be due to inconsistencies in the wake model where the tip vortex is assumed to carry the peak bound circulation even though the local lift values are negative or very small in the tip region. Also, one must consider the limitations of lifting-line theory which will not accurately capture large lift variations near the tip.

Figures 6a and 6b illustrate the measured differential pressure waveforms (upper plots) and the predicted lift characteristics without roll-up (lower plots) using the high resolution indicial airloads (HIRES/IPP) model. The sign of the measured data was changed for plotting purposes so that higher negative pressures reflect positive lift increases. Also, the data shown represents one revolution of recorded data rather than an averaged time history. The predicted characteristics show reasonably good correlation with the test data. The most striking feature evident is that the high resolution airloads do not show lift reductions, but rather increased lift, in azimuth regions where the flap is applied. Further, a higher degree of sensitivity to vortex interactions is exhibited in the calculations, particularly for the more inboard radial locations in the first azimuth quadrant. (Since lift variations involve the integrated section response, they should be less sensitive than the local pressure variations.) The tip stations, see Figure 6b, show remarkably good agreement with the data waveforms on both advancing and retreating sides of the disk. Figure 7 illustrates the spanwise airloads computed with the Hires model at selected azimuth positions for both the baseline and flapped rotor. Here, contrary to what one expects, a large increase in lift is evident on the flap during the negative flap deflection and, again, the distributions show no tendency for the lift to approach zero at the tip. Thus there are questionable areas in the flap model which need to be addressed.

The reasons for the change in sign of the lift variation between the high and low resolution calculations when flaps are deflected have not yet been investigated and remain unexplained. However, it should be noted that the HIRES calculations utilize the Beddoes unsteady airloads and near wake models which differ from the Johnson models inherent in the low resolution trim analysis. The indicial airloads model was modified for the flap analysis by introducing overall section coefficients obtained from C-81 tables corresponding to the specified flap angle. No attempt was made to incorporate unsteady aerodynamic effects arising from the trailing edge flap motions.

Figures 8a and 8b depict the Hires-computed airloads obtained using the most recent Langley-developed wake roll-up model. The upper data plots of Figures 6a, b are also included in these figures to facilitate comparisons. In the calculations, the roll-up parameters employed are those which were defined by Langley for the JVX model tilt rotor tests and may be inappropriate for a blade with a trailing edge flap. However, flapped-rotor data is unavailable to refine the model. The airloads produced with the roll-up model show increased vortex interactions on both advancing and retreating sides, particularly on the aft disk quadrants. The reasons for this behavior are twofold. First, the roll-up model produces additional vortex lines on the advancing side when secondary rollup occurs as a result of the lift changes introduced by the flap. Further, as noted earlier, the rollup model tends to produce a lower mean inflow than the no roll-up model which causes the roll-up vortex wake to lie closer to the rotor plane. This last feature becomes evident when the roll-up and no roll-up results for the baseline rotor are compared over the aft portions of the disk. The roll-up model was exercised for the baseline case to study the combined effects of changes in tip vortex roll-up location (arising from the Betz analysis, see Ref [2]) and from the use of the multicore vortex core model. No secondary vortices were developed (or expected) for the baseline rotor

Conclusions

In summary, comparison of the predicted and measured flapped-rotor behavior has shown good power correlation when using the roll-up model. However, the opposite trends in prediction of control positions is disturbing. The difference in flap lift characteristics between the low and high resolution models should be further investigated to understand the details of this behavior.

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CAMRAD
  INPTN
    INPTR1
    INPTA1
  INIT
    INITB
  PRNTC
  TRIM
    TRIMI
      RAMF
        MOTNR1
        (if OPBED=1)
          AERBED1
            AEROS1B
              AEROT1
        (ELSE)
          AEROF1
            AEROS1
        AEROT1
        DFLAP1

  (If OPROLLU1=1) LoRes Roll-up:
  MOTNR1 (large core iteration)
  TRIMI (roll-up wake-trim iteration)

  PRNT
    PRNTC
    PRNTR1
    PRNTHR1
  PERF
    PERFR1
  LOAD
    LOADR1
      PRFIL1

  HIRES Model:
  (OPINT > 0)
  MNTRINT1
    AEF1INT
      AES1INT
        AET1INT
        DFLAP1
  (If ITERNW > 0)
  NWAKE1
    AEF2INT
      AES1INT
        AET1INT
        DFLAP1

Flutter Analysis:
FLUT
  FLUTA1

Figure 1. Partial subroutine flow diagram with modified subroutines shown in boldface italics.

Rotor Data and Geometry		
Blade number	N	4
Rotor radius, inches	R	72.75
Rotor speed, rpm	Ω	1087
Blade chord, inches	c	5.25
Lock number	γ	2.2
Solidity	σ	0.092
Linear twist, deg	θ_{tw}	-9.0
Flap chord ratio	c_f/c	0.25
Flap-Lag hinge location	$r_\beta/R, r_\zeta/R$	0.0825
Pitch bearing location	r_θ/R	0.1409
Blade attachment location	r_a/R	0.2016
Root cutout location	r_c/R	0.2500
Inboard flap edge	r_I/R	0.7937
Outboard flap edge	r_O/R	0.9729
Pitch horn arm, inches	x_{ph}	4.6648
Lag damper arm, inches	x_d	4.4665
Pressure Transducer Radial Locations		
Transducers 1 & 2	r/R	0.7522
Transducers 3 &4	r/R	0.8214
Transducers 5 & 6	r/R	0.9105
Transducers 7 & 8	r/R	0.9699

Table 1. Active Flap Rotor geometric characteristics and pressure instrumentation locations

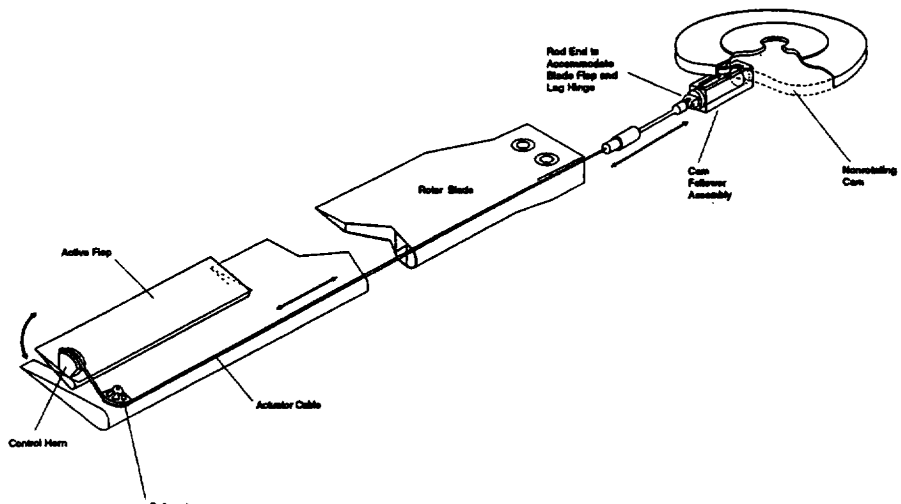

Figure 2. Flap actuation mechanism

Data Item	Test Measurement	CAMRAD.Mod1 Predicted Value	
		No Roll-up	With Roll-up
Collective pitch, deg	4.361	5.70	4.92
Lng. cyclic pitch, deg	1.375	2.40	1.76
Lat. cyclic pitch, deg	3.235	-2.24	-1.32
Coning angle, deg	0.786	1.10	1.05
Lng. flapping, deg	-.026	0.	0.
Lat. flapping, deg	0.015	0.	0.
Mean lag angle, deg	0.369	0.298	0.216
Wind axis Lift, lb	908.8	910.9	911.3
Wind axis Drag, lb	94.0	84.3	86.4
Side force, lb	-18.0	-16.5	-7.3
Roll Moment., in-lb	-1402.9	-333.9	-307.0
Pitch Moment., in-lb	1625.9	-65.9	-109.8
Total Power, hp	42.3	---	---
Power less Hub, hp	36.5	47.0	36.5

Table 2. Measured and predicted performance parameters for the baseline rotor:
Test # 733/Point 891: $\mu = 0.1487$, $C_T/\sigma = .0764$, α–shaft = 5.011 deg. aft, δ_f=0 deg

Data Item	Test Measurement	CAMRAD.Mod1 Predicted Value	
		No Roll-up	With Roll-up
Collective pitch, deg	4.852	6.14	5.25
Lng. cyclic pitch, deg	5.130	0.53	-1.04
Lat. cyclic pitch, deg	2.982	-2.07	0.37
Coning angle, deg	0.824	1.06	1.03
Lng. flapping, deg	-.027	-.01	-.01
Lat. flapping, deg	-.018	0.01	0.
Mean lag angle, deg	0.318	0.35	0.25
Wind axis Lift, lb	921.1	919.5	921.5
Wind axis Drag, lb	78.0	97.1	96.6
Side force, lb	-26.6	-18.3	-7.9
Roll Moment, in-lb	-1077.1	-609.7	-536.4
Pitch Moment, in-lb	3450.0	-5.5	-41.4
Total Power, hp	46.6	---	---
Power less Hub, hp	40.9	52.9	40.4

Table 3. Measured and predicted performance parameters for the rotor with flap input:
Test # 2916/Point 2082: $\mu = 0.1494$, $C_T/\sigma = .0768$, α–shaft = 5.007 deg. aft, δ_f=-12.5 deg, ϕ = -20 deg

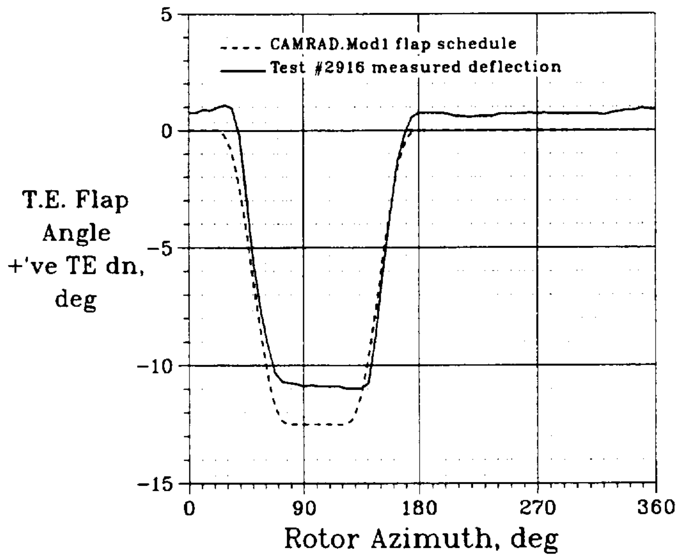

Figure 3. Trailing-edge flap deflection schedule used in the predictions compared with the measured flap angles.

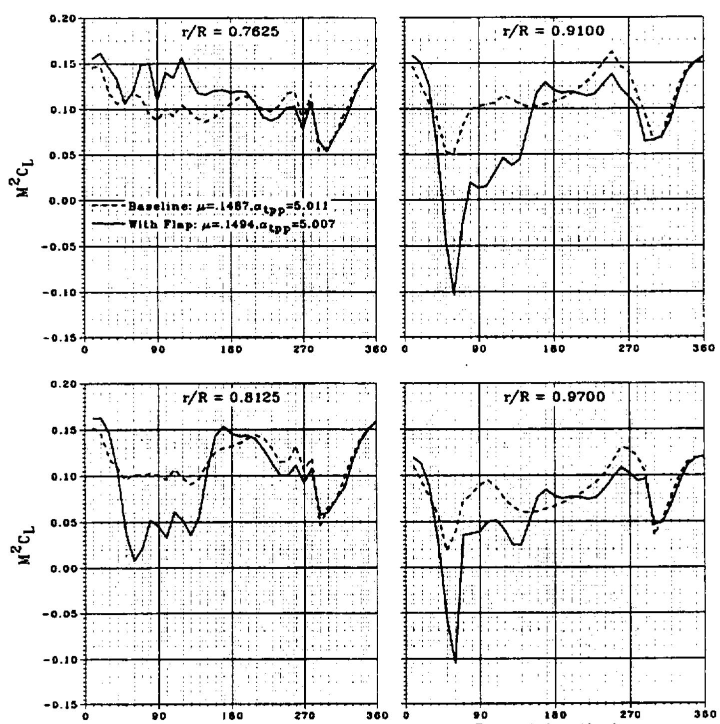

Figure 4. Low resolution airloads predicted for the baseline and flap configurations using the Scully freewake model

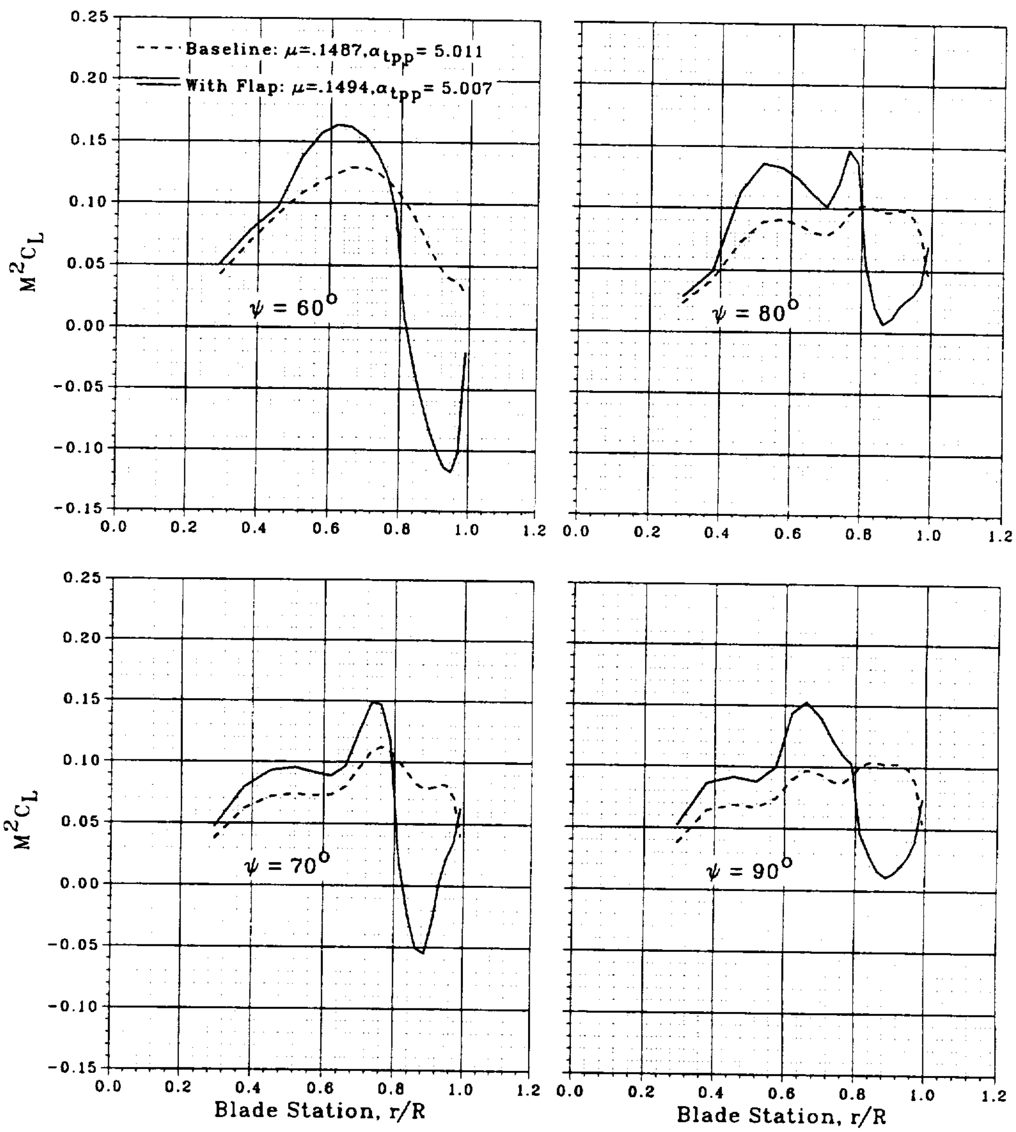

Figure 5. CAMRAD.Mod1 low resolution spanwise airload variation with and without flap deflection; no roll-up

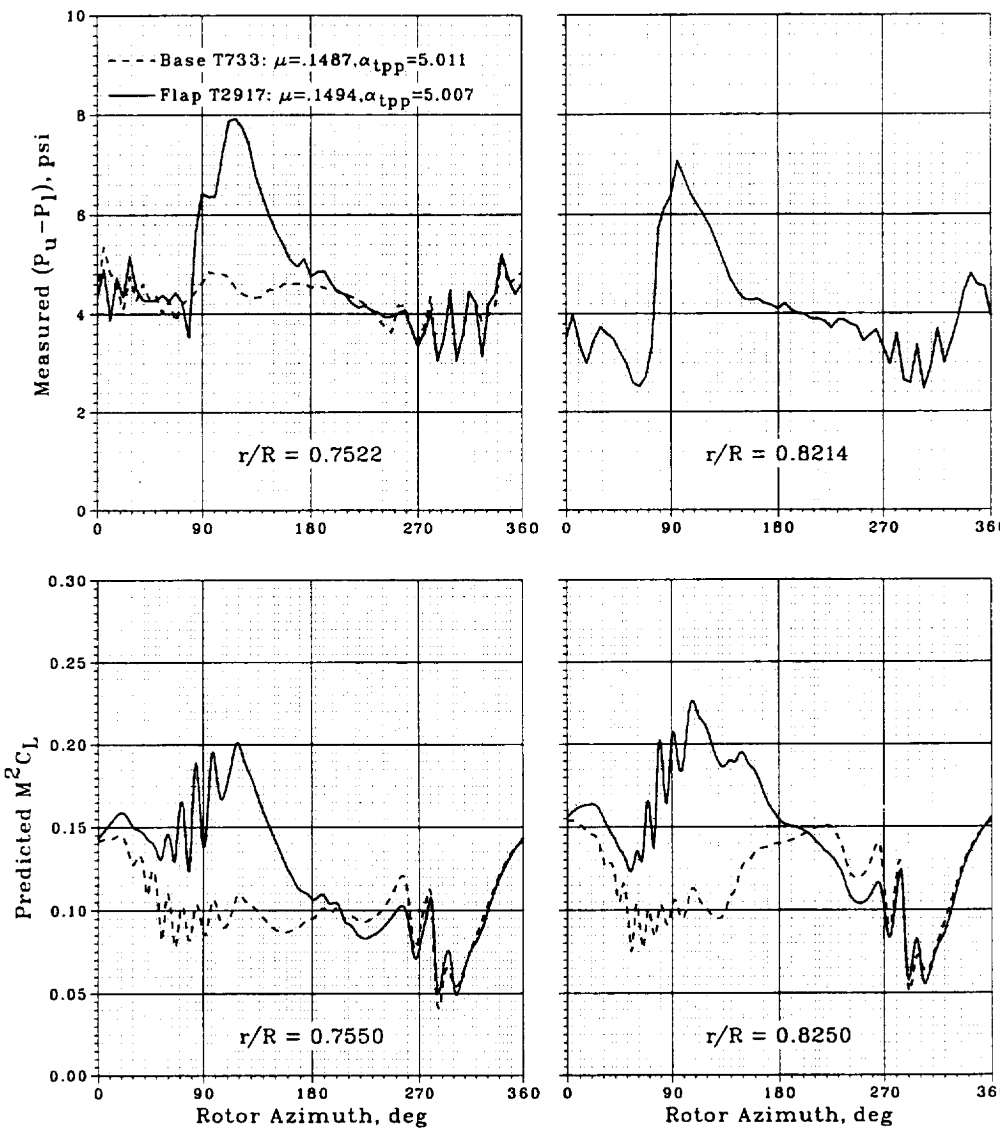

Figure 6a. Predicted airloads at inboard radial stations using Hires with no roll-up (lower plots) compared with measured 3%-chord differential pressure wave forms (upper plots).

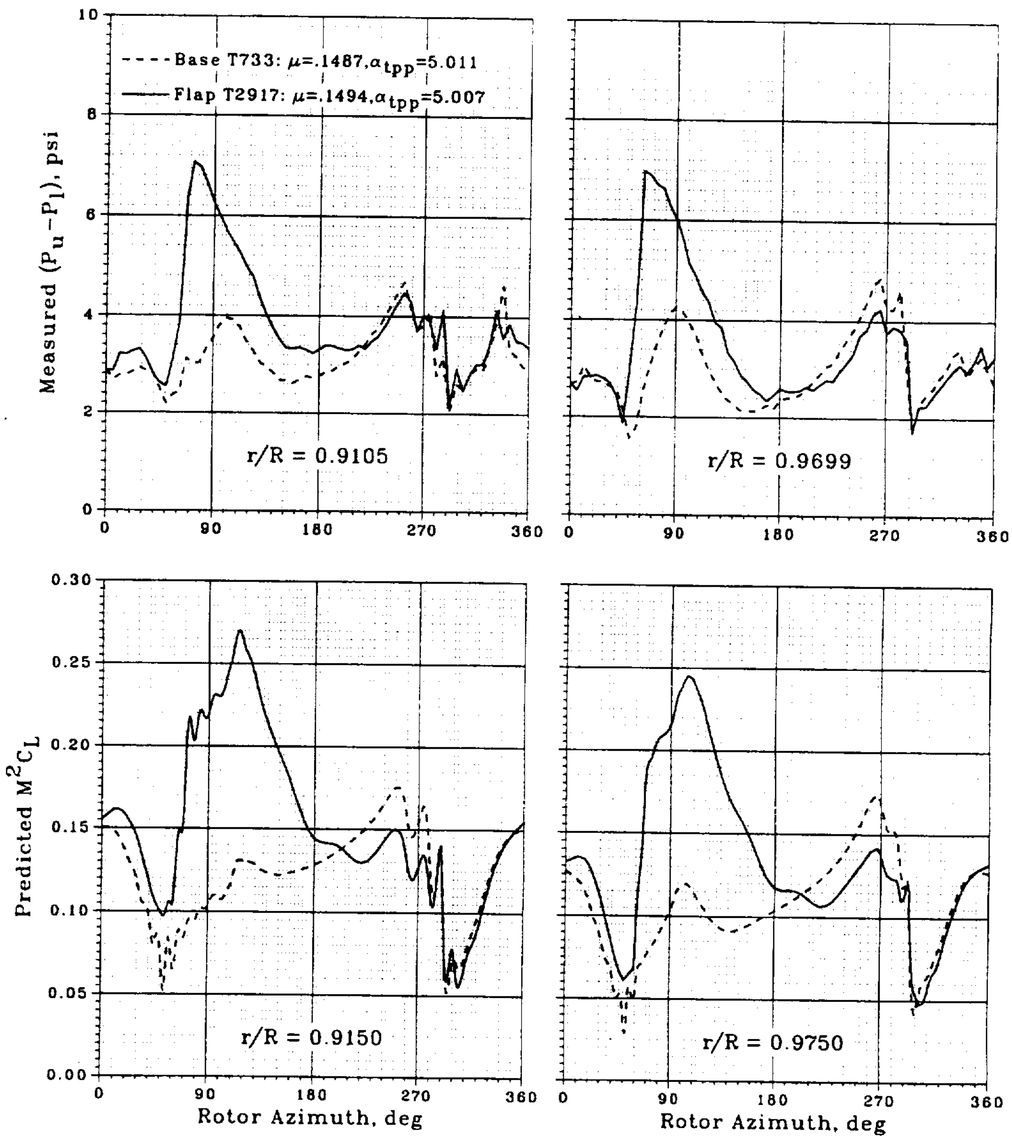

Figure 6b. Predicted airloads at outboard radial stations using Hires with no roll-up (lower plots) compared with measured 3%-chord differential pressure wave forms (upper plots).

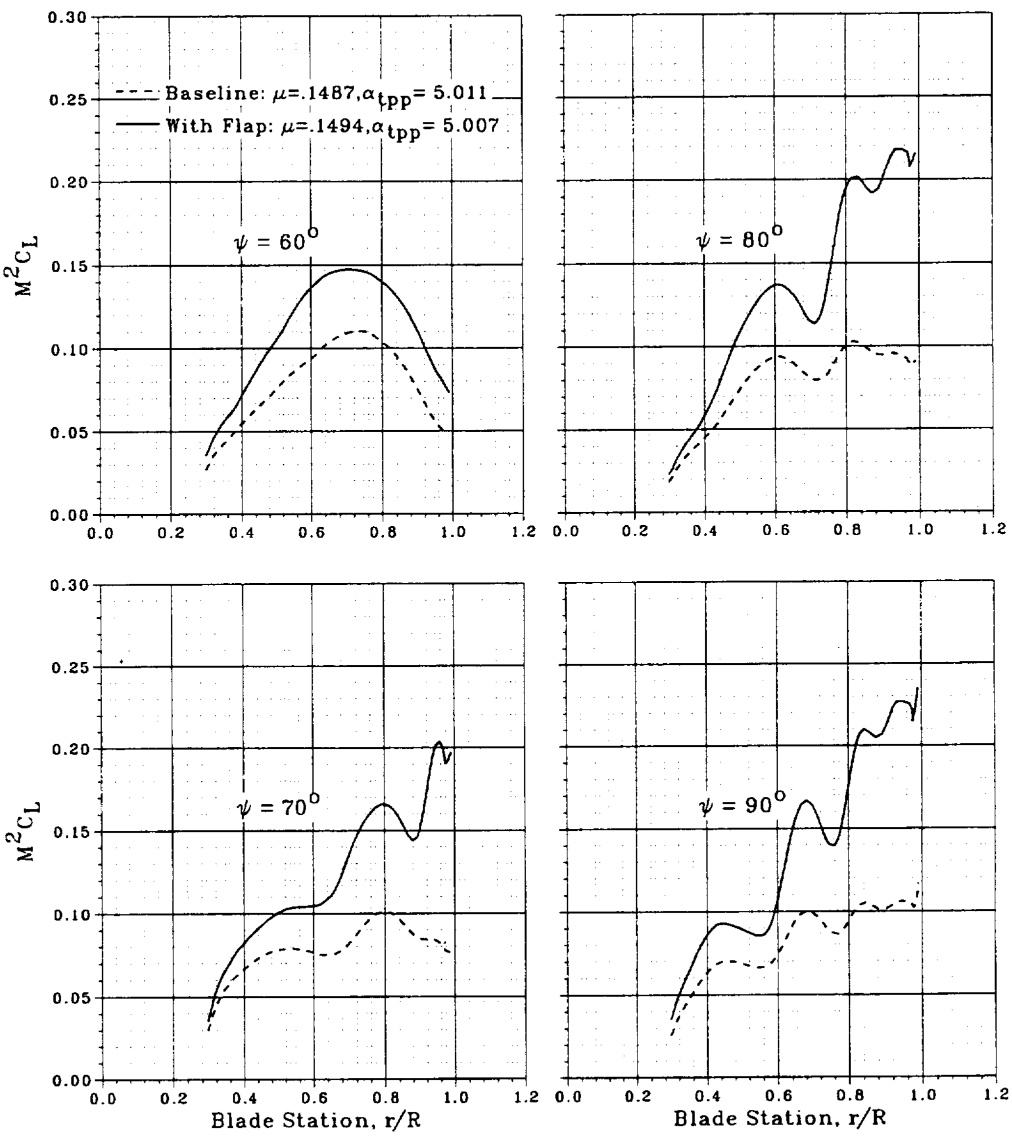

Figure 7. Predicted spanwise airloads for the baseline and flap cases using the Hires analyses with no roll-up

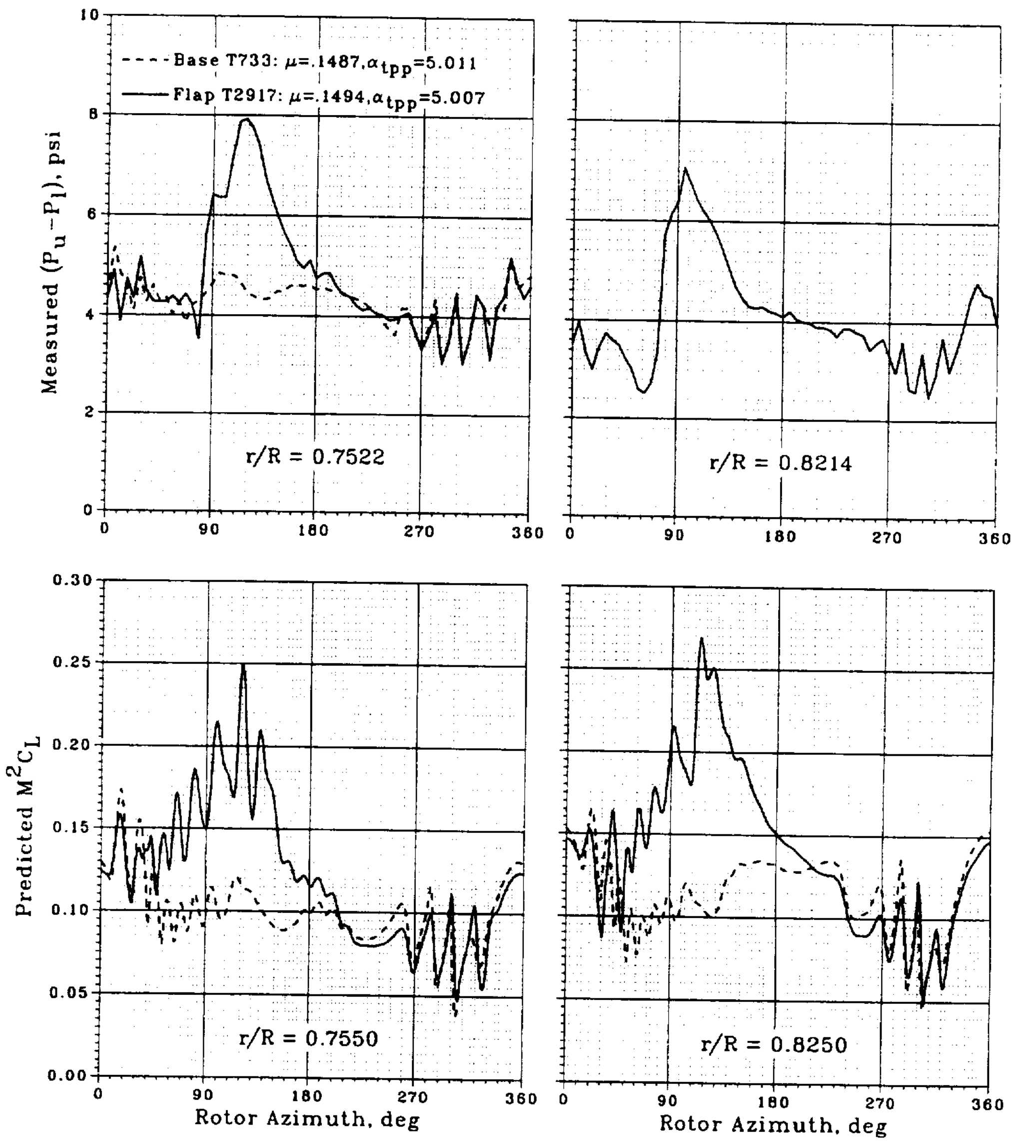

Figure 8a. Predicted airloads at inboard radial stations using Hires with roll-up (lower plots) compared with measured 3%-chord differential pressure wave forms (upper plots).

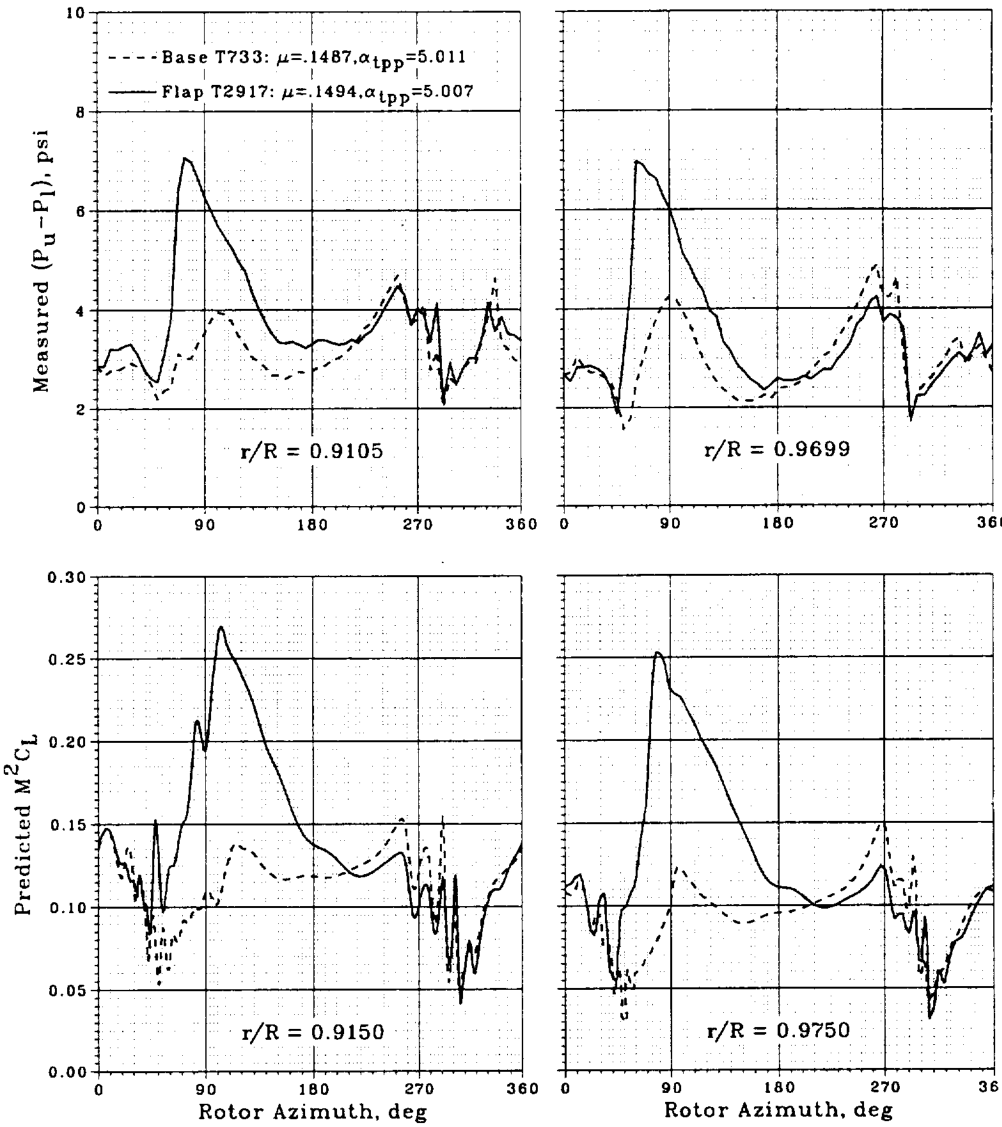

Figure 8b. Predicted airloads at outboard radial stations using Hires with roll-up (lower plots) compared with measured 3%-chord differential pressure wave forms (upper plots).

Appendix I: Active Flap Rotor Airfoil Table Construction

AIRFOIL input script file

```
#!/bin/csh
#
# MDHC BVI TEST blade with Ahmeds c81-flap tables
#
setenv AFDECK1   0015ft0.c81
setenv AFDECK2   0015ftm20.c81
setenv AFDECK3   0015ftm15.c81
setenv AFDECK4   0015ftm10.c81
setenv AFDECK5   0015ftm5.c81
setenv AFDECK6   0015ft0.c81
setenv AFDECK7   0015ftp5.c81
setenv AFDECK8   0015ftp10.c81
setenv AFDECK9   0015ftp15.c81
setenv AFDECK10  0015ftp20.c81
setenv AFDECK11  0015ft0.c81
setenv AFTABLE   0015ahft.tab
set campath=/mod1.v2/flapcode/AIRFOIL
$campath/airfoil > 0015ahft.out <<eoj
 NACA 0015, 25% Chord flap
&NLTABL OPREAD=2,
    OPPRNT=1,0,0,NMPRNT=5,MPRNT=.3,.6,.77,.82,.90,NAPRNT=18,
    APRNT=-10.,-9.,-8.,-7.,-6.,-5.,-4.,-3.,-2.,0.,2.,4.,5.,6.,
    7.,8.,9.,10.,
    NRB=3,R=0.,.78,.97,1.0,
    OPF=1,NFA=1,9,1,FA=0.,-20.,-15.,-10.,-5.,0.,5.,10.,15.,20.,0.,
    NRF=11,
    NMB=6, NA=1,16,28,88,100,115,
    A=-180.,-150.,-30.,30.,150.,180.,
    NMB=3, NM=1,7,20,
    M=0.,.6,.90,

&END
eoj
exit
```

Sample C-81 table input: 0015ft0.c81

```
NACA-0015 BASELINE (D=0.0)  156115611561156115611561
    .0000 .2000 .3000 .4000 .4500 .5000 .5500 .6000 .6500        LIFT
    .7000 .7500 .8000 .8500 .9000 1.0000
-180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
    .0000 .0000 .0000 .0000 .0000 .0000
    .
    .
    .
-1.00 -.1066 -.1066 -.1088 -.1114 -.1143 -.1172 -.1208 -.1260 -.1333
    -.1451 -.1365 -.1065 -.0148 -.0148 -.0148
  .00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
    .0000 .0000 .0000 .0000 .0000 .0000
 1.00 .1066 .1066 .1088 .1114 .1143 .1172 .1208 .1260 .1333
    .1451 .1365 .1065 .0148 .0148 .0148
    .
    .
    .
180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
    .0000 .0000 .0000 .0000 .0000 .0000
    .0000 .2000 .3000 .4000 .4500 .5000 .5500 .6000 .6500        DRAG
    .7000 .7500 .8000 .8500 .9000 1.0000
```

```
-180.00 .0220 .0220 .0220 .0220 .0220 .0220 .0220 .0220 .0220
     .0220 .0220 .0220 .0220 .0220 .0220
     .
     .
     .
-1.00 .0132 .0132 .0128 .0125 .0124 .0122 .0121 .0121 .0121
     .0123 .0176 .0420 .1372 .1372 .1372
  .00 .0130 .0130 .0127 .0123 .0122 .0120 .0119 .0118 .0118
     .0119 .0143 .0395 .1366 .1366 .1366
 1.00 .0132 .0132 .0128 .0125 .0124 .0122 .0121 .0121 .0121
     .0123 .0176 .0420 .1372 .1372 .1372
     .
     .
     .
180.00 .0220 .0220 .0220 .0220 .0220 .0220 .0220 .0220 .0220
     .0220 .0220 .0220 .0220 .0220 .0220
     .0000 .2000 .3000 .4000 .4500 .5000 .5500 .6000 .6500        MOMENT
     .7000 .7500 .8000 .8500 .9000 1.0000
-180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
     .
     .
     .
-1.00 -.0015 -.0015 -.0015 -.0019 -.0019 -.0021 -.0024 -.0029 -.0036
     -.0052 -.0075 .0051 -.0269 -.0269 -.0269
  .00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
 1.00 .0015 .0015 .0015 .0019 .0019 .0021 .0024 .0029 .0036
     .0052 .0075 -.0051 .0269 .0269 .0269
     .
     .
     .
180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .2000 .3000 .4000 .4500 .5000 .5500 .6000 .6500        FLAP LIFT
     .7000 .7500 .8000 .8500 .9000 1.0000
-180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
     .
     .
     .
-1.00 -.0046 -.0046 -.0047 -.0044 -.0045 -.0044 -.0042 -.0039 -.0034
     -.0024 .0059 .0105 .0635 .0635 .0635
  .00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
 1.00 .0046 .0046 .0047 .0044 .0045 .0044 .0042 .0039 .0034
     .0024 -.0059 -.0105 -.0635 -.0635 -.0635
     .
     .
     .
180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .2000 .3000 .4000 .4500 .5000 .5500 .6000 .6500        FLAP HINGE MOMENT
     .7000 .7500 .8000 .8500 .9000 1.0000
-180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
     .
     .
     .
-1.00 .0001 .0001 .0001 .0001 .0001 .0001 .0000 .0000 -.0001
     -.0002 -.0010 -.0014 -.0066 -.0066 -.0066
  .00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
 1.00 -.0001 -.0001 -.0001 -.0001 -.0001 -.0001 .0000 .0000 .0001
     .0002 .0010 .0014 .0066 .0066 .0066
     .
     .
```

```
180.00 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
     .0000 .0000 .0000 .0000 .0000 .0000
```

Sample AIRFOIL program output

```
AIRFOIL TABLE PREPARATION
*************************

  NACA 0015, 25% Chord flap

                FILE NAME =  0015ahft.tab

NUMBER OF ANGLE OF ATTACK BOUNDARIES =  6
BOUNDARY INDICES =   1  16  28  88 100 115
ANGLE OF ATTACK AT BOUNDARIES = -180.00 -150.00  -30.00   30.00  150.00  180.00

NUMBER OF MACH NUMBER BOUNDARIES =  3
BOUNDARY INDICES =   1   7  20
MACH NUMBER AT BOUNDARIES =  .0000  .6000  .9000

NUMBER OF RADIAL SEGMENTS =  3
RADIAL STATION BOUNDARIES =    .000   .780   .970  1.000

  NUMBER OF FLAP TABLES   =     1    9    1

RADIAL SEGMENT EXTENDING FROM R =    .000 TO    .780

     DATA FROM C81 AIRFOIL TABLES
     FILE NAME =  0015ft0.c81

RADIAL SEGMENT EXTENDING FROM R =    .780 TO    .970
  FLAPPED SECTION WITH  9 FLAP TABLES

     DATA FROM C81 AIRFOIL TABLES
     FLAP ANGLE =-20.00
     FILE NAME =  0015ftm20.c81

     DATA FROM C81 AIRFOIL TABLES
     FLAP ANGLE =-15.00
     FILE NAME =  0015ftm15.c81

     DATA FROM C81 AIRFOIL TABLES
     FLAP ANGLE =-10.00
     FILE NAME =  0015ftm10.c81

     DATA FROM C81 AIRFOIL TABLES
     FLAP ANGLE = -5.00
     FILE NAME =  0015ftm5.c81

     DATA FROM C81 AIRFOIL TABLES
     FLAP ANGLE =   .00
     FILE NAME =  0015ft0.c81

     DATA FROM C81 AIRFOIL TABLES
     FLAP ANGLE =  5.00
     FILE NAME =  0015ftp5.c81
```

DATA FROM C81 AIRFOIL TABLES
FLAP ANGLE = 10.00
FILE NAME = 0015ftp10.c81

DATA FROM C81 AIRFOIL TABLES
FLAP ANGLE = 15.00
FILE NAME = 0015ftp15.c81
DATA FROM C81 AIRFOIL TABLES
FLAP ANGLE = 20.00
FILE NAME = 0015ftp20.c81

RADIAL SEGMENT EXTENDING FROM R = .970 TO 1.000

DATA FROM C81 AIRFOIL TABLES
FILE NAME = 0015ft0.c81

AIRFOIL LIFT, DRAG, AND MOMENT CHARACTERISTICS (INTERPOLATED)

RADIAL SEGMENT EXTENDING FROM R = .000 TO .780

MACH NUMBER = .30000

ALPHA= -10.000 DEG	CL= -1.07130	CD = .02760	CM = -.01780	CLF = -.02550	CMH = .00140
ALPHA= -9.000 DEG	CL= -.96820	CD = .02470	CM = -.01540	CLF = -.02350	CMH = .00120
ALPHA = -8.000 DEG	CL= -.86340	CD = .02210	CM = -.01330	CLF = -.02130	CMH = .00110
ALPHA = -7.000 DEG	CL = -.75780	CD = .01980	CM = -.01130	CLF = -.01920	CMH = .00090
ALPHA = -6.000 DEG	CL = -.65090	CD =.01790	CM = -.00940	CLF = -.01690	CMH = .00080
ALPHA = -5.000 DEG	CL = -.54320	CD =.01630	CM = -.00770	CLF = -.01450	CMH = .00060
ALPHA = -4.000 DEG	CL = -.43470	CD =.01500	CM = -.00620	CLF = -.01200	CMH = .00050
ALPHA = -3.000 DEG	CL = -.32630	CD =.01400	CM = -.00460	CLF = -.00960	CMH = .00040
ALPHA = -2.000 DEG	CL = -.21720	CD = 01320	CM = -.00310	CLF = -.00700	CMH = .00020
ALPHA = .000 DEG	CL = .00000	CD =.01270	CM = .00000	CLF = .00000	CMH = .00000
ALPHA = 2.000 DEG	CL = .21720	CD =.01320	CM = .00310	CLF = .00700	CMH = -.00020
ALPHA = 4.000 DEG	CL = .43470	CD = 01500	CM = .00620	CLF = .01200	CMH = -.00050
ALPHA = 5.000 DEG	CL = .54320	CD = 01630	CM = .00770	CLF = .01450	CMH = -.00060
ALPHA = 6.000 DEG	CL = .65090	CD =.01790	CM = .00940	CLF = .01690	CMH = -.00080
ALPHA = 7.000 DEG	CL = .75780	CD =.01980	CM = .01130	CLF = .01920	CMH = -.00090
ALPHA = 8.000 DEG	CL = .86340	CD =.02210	CM = .01330	CLF = .02130	CMH = -.00110
ALPHA = 9.000 DEG	CL = .96820	CD =.02470	CM = .01540	CLF = .02350	CMH = -.00120
ALPHA = 10.000 DEG	CL = 1.07130	CD =.02760	CM = .01780	CLF = .02550	CMH = -.00140

.
.
.

MACH NUMBER = .90000

ALPHA = -10.000 DEG . . .

.
.
.

ALPHA = 10.000 DEG . . .

AIRFOIL LIFT, DRAG, AND MOMENT CHARACTERISTICS (INTERPOLATED)

RADIAL SEGMENT EXTENDING FROM R = .780 TO .970

FLAP ANGLE =-10.00

MACH NUMBER = .30000

ALPHA . . . CMH

.

.

.

MACH NUMBER = .90000

.

.

.

FLAP ANGLE = -5.00

.

.

.

FLAP ANGLE = 10.00

.

.

.

AIRFOIL LIFT, DRAG, AND MOMENT CHARACTERISTICS (INTERPOLATED)

RADIAL SEGMENT EXTENDING FROM R = .970 TO 1.000

MACH NUMBER = .30000

.

.

.

MACH NUMBER = .90000

Appendix II: CAMRAD.Mod1/HIRES Input/Output

CAMRAD.Mod1 input script file

```
##/bin/csh
#-----------------------------------------------------
# BVIRTR - Schedule 63,-12.5deg -20ph, rollup, hires
# Test 2916: mu=0.1494,CT/s=.0768,Ashaft=5.007
set case=T2916ru
set whereinfiles="/mod1v2/AF_rotor/Infiles"
set whereairfoil="/mod1v2/AF_rotor/C81FT"
set wheresources="/mod1v2/newflap"
#-----------------------------------------------------
echo set environment and links
setenv  INPUTFILE $whereinfiles/bvi14.bin
setenv  AFTABLE1  $whereairfoil/0015ahft.tab
#
ln -s  circhi_${case}.dat          ftn04
ln -s  circlo_${case}.dat          ftn09
#ln -s distort2.dat               ftn11
#ln -s tunnelv2.dat               ftn12
ln -s wake_${case}.dat             ftn13
ln -s blade_${case}.dat            ftn14
ln -s gamv_${case}.dat             ftn15
ln -s int_${case}.dat              ftn17
ln -s vind_${case}.dat             ftn18
ln -s hmw_${case}.dat              ftn19
ln -s  maplo_${case}.dat           ftn20
ln -s psum_${case}.dat             ftn53
echo starting camrad_mod1.v2
time nice +10 $wheresources/camrad_mod1fa.v2.1 >&  ${case}.out <<eoj;notify
 &NLCASE
  NFRS=-1,NFEIG=-1,NCASES=1,NFSCR=-1,NOISFL=0,
 &END
 &NLTRIM
  TITLE='BVI ','RTR,',' MU=','0.14','94, ','CT/S','=.07','68, ','ALS=',
  '5.00','7, A','FT  ','-12.','5 de','g fl','ap, ','-20 ','deg ','phas','e   ',
      DOF=10*1,5*1,0,38*0,DOFT=2*1,6*0,
      OPREAD=1,1,0,0,0,1,4*0,
      LEVEL=2,0,OPTRIM=15,
      VEL=.1494,VTIP=681.85,OPDENS=3,DENSE=.002441,TEMP=45.27,
      CTTRIM=.07693,BCTRIM=0.,BSTRIM=0.,APITCH=5.007,
      COLL=6.2916,LATCYC=-2.843,LNGCYC=3.2515,
      NPRNTI=1,NPRNTT=1,NPRNTP=0,NPRNTL=0,
      MREV=1,MPSI=36,
  ITERU = 1,   ITERR  = 1, ITERF = 3,
  OPUNIT=1, NROTOR=1,
  ITERC = 70,  EPCIRC=.0001,
  ITERM = 50,  EPMOTN=.008,  FACTM=.5,
  MTRIM = 80,  MTRIMD = 40,  FACTOR=.3, DELTA = 1.0,
  OPMXFWG = 1,
 &END
 &NLRTR
  INFLOW=1,5*0,rcpls=1.,xi(31)=-.00161,
 &END
 &NLHHC         &END
 &NLHHC2 OPHHC = 0, &END
 &NLHIRES
  OPINT  = 1,
  OPWFCOR = 0,
  ITERINT=1,
  MPSIINT=360,JFIRST=1,JLAST=360,MPSIWGP=36,
  COREINT=.03,
  OPNEGV = 1,
  WMDLINT=2,0,0,0,0,2,2,2,2,2,3,3,3,
```

```
WKMDL1 =2,0,0,0,0,2,2,2,2,2,3,3,3,
MRAINT=70,
RAEINT=
.2925, .30, .31, .32, .33, .34,
.35, .36, .37, .38, .39, .40, .41, .42, .43, .44,
.45, .46, .47, .48, .49, .50, .51, .52, .53, .54,
.55, .56, .57, .58, .59, .60, .61, .62, .63, .64,
.65, .66, .67, .68, .69, .70, .71, .72 ,.73, .74,
.75, .76, .77, .78, .79, .80, .81, .82, .83, .84,
.85, .86, .87, .88, .89, .90, .91, .92, .93, .94,
.95,.96,.97,.98,1.000,
KNWINT=90,
&END
&NLBED OPBED = 0, &END
&NLSWP        &END
&NLFLAP
OPFLAP=3,NFPRNT=1,
OPFT=1,OPFC=0,OPFL=0,
RFLAP=11*0.,8*1.,0.,
FDA=0.,0.,-.4436,-2.6236,-6.2500,-9.8764,-12.0564,5*-12.5000,
-12.0564,-9.8764,-6.2500,-2.6236,-.4436,19*0.
&END
&NLWAKE
FNW = 0.,
KNW=9,
WKMODL=2,2,2,2,2,2,2,2,2,2,3,3,3,
FACTWN = .0075,
COREWG(1) = .09,  COREWG(2) = -.03,
COREWG(3) = 1.0,  COREWG(4) = -1.,
CORE(1)  = .03,  CORE(2)  = -.03,
CORE(3)  = .03,  CORE(4)  = -1.,  CORE(5)  = -1.,
MRG = 20, MRL = 20,
NG = 1, 2, 3, 4, 5, 6, 7, 8, 9,10,
  11,12,13,14,15,16,17,18,19,20,
NL = 1, 2, 3, 4, 5, 6, 7, 8, 9,10,
  11,12,13,14,15,16,17,18,19,20,
&END
&NLBURST OPBURST = 0, &END
&NLROLL
OPROLLU=3,oplowr=1,ophiwr=1,
ICORYCB = 2,
CORELG=.3,ITERRUP=2,ITERFRU=2,
ITERLGC=20,FLGCORG=0.1,
NTIPFCT=1,TIPFC0=.0,TIPFC=0.15915,0.,0.,0.,0.,0.,0.,0.,0.,
NTCOR=9,TIPCORE=.01, .0167, .0233, .03, .045, .075, .1, .15, .2, 0.,
NSCOR=9,SECCORE=.01, .0167, .0233, .03, .045, .075, .1, .15, .2, 0.,
ISPIN=1,TAUC0=0.,TAUC1=1.,
IRUZCOR=0, NSEARCH=6, IRUDZ=0,
OPROLSS=0, CROLSSXY=.125, CROLSSZ=.125,
IFWLGC = 0,
IFWLGC = 1,
COREXP = 2,
&END
&NLCFD
OPCFD = 0,
OPBVI = 0,
OPBVI = 0,
PHICFD = 45.,
OPMOTN = 1,
OPMOTN = 0,
RDB = 0.449, 0.300, 0.449, 0.500, 0.446, 0.446,
BDB =  1.100, 1.100, 1.100, 1.100, 0.200, 0.200,
&END
&NLMEAS  IMODEIN = 0, IAEROIN = 0, &END
&NLLOAD
  MALOAD=1, MHLOAD=0, MRLOAD=0,
  NWKGMP = 1, MWKGMP = 1, JWKGMP = 1, NPOLAR=1,
```

```
   NPLOT(1)=2*1, NPLOT(5)=3, NPLOT(12)=3, NPLOT(17)=1, NPLOT(29)=3,
 &END
eoj
exit
```

CAMRAD.Mod1 output

```
*****************************************************************************
*                                                                           *
*  COMPREHENSIVE ANALYTICAL MODEL OF ROTORCRAFT AERODYNAMICS                *
*                           AND DYNAMICS                                    *
*  RELEASE ONE, JANUARY 1980                                                *
*  CAMRAD.Mod1, Release 1: Nov 1995 -- DEC ALPHA VERSION                    *
*  CAMRAD.Mod1, Release 2:        -- DEC ALPHA VERSION                      *
*                                                                           *
*****************************************************************************
```

```
 READING NAMELIST NLCASE

 NEW JOB, NUMBER OF CASES =  1
 RESTART FILE NOT WRITTEN  (RSWRT = 0)
 INPUT SOURCE IS FILE  (BLKDAT = 0)
 INPUT FILE READ EVERY CASE  (RDFILE = 1)

 UNIT NUMBERS
   INPUT FILE,   NFDAT = 40    RESTART FILE,   NFRS = -1    NAMELIST INPUT, NUIN =  5    DEBUG OUTPUT,
NUDB =  6
   AIRFOIL 1 FILE, NFAF1 = 41    EIGENVALUE FILE, NFEIG = -1    PRINTED OUTPUT, NUOUT =  6    PRINTER-
PLOTS,  NUPP =  6
   AIRFOIL 2 FILE, NFAF2 = 41    SCRATCH FILE,   NFSCR = -1                 LINEAR SYSTEMS, NULIN =  6

          INPUT FILE,     NAME  =  /hprs7/ts35537/ver2/Langley/AF_rotor/Infiles/bvi14.bin
          AIRFOIL 1 FILE,  NAME  =  /hprs7/ts35537/ver2/Langley/AF_rotor/C81FT/0015ahft.tab

 READING INPUT FILE
 READING NAMELIST NLTRIM
 READING NAMELIST NLRTR   (ROTOR 1)
 READING NAMELIST NLHHC   (ROTOR 1)
 READING NAMELIST NLHHC2  (ROTOR 1)
 READING NAMELIST NLHIRES (ROTOR 1)
 READING NAMELIST NLBED   (ROTOR 1)
 READING NAMELIST NLSWP   (ROTOR 1)
 READING NAMELIST NLFLAP (ROTOR 1)
 READING NAMELIST NLWAKE  (ROTOR 1)
 READING NAMELIST NLBURST (ROTOR 1)
 READING NAMELIST NLROLL  (ROTOR 1)
 READING NAMELIST NLMEAS  (ROTOR 1)
 READING NAMELIST NLLOAD  (ROTOR 1)
 READING AIRFOIL TABLES
1COMPREHENSIVE ANALYTICAL MODEL OF ROTORCRAFT AERODYNAMICS AND DYNAMICS

*****************************************************************************************************
*********************
 CASE NUMBER   1 (NEW JOB),  IDENTIFICATION =
2 GOV, 3 TO TRIM BOTH GOVERNORS),  OPGOVT = 0
```

```
MAIN ROTOR PARAMETERS
    RADIUS          =  6.063      V/(OMEGA*R)         =  .1494      OPSTLL =  1
    NUMBER OF BLADES =   4         TIP SPEED          =  681.85     OPYAW =   0
    LOCK NUMBER     =  2.2583      ROTATIONAL SPEED (RPM) =  1074.01     OPCOMP =  1
    SOLIDITY        =  .09188      OMEGA (RAD/SEC)     =  112.470    OPUSLD =  2
    IB              =  3.641       TIP MACH NUMBER     =  .6190      INFLOW =  1 0 0 0 0 0
    MEAN CHORD/RADIUS =  .07216                                       OPHVIB =  0 0 0

    COUNTER-CLOCKWISE ROTATION DIRECTION
    HINGED BLADE  (HINGE = 0, EFLAP = .0825, ELAG = .0825)
    NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY (LEVEL = 2)
    ROTOR WITH AUXILIARY TE-FLAP (OPFLAP = 3)


DEGREES OF FREEDOM
    DOF = Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10   P0,P1,P2,P3,P4   BG          (ROTOR-1)
        Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10   P0,P1,P2,P3,P4   BG          (ROTOR-2)
        PHIF,THETAF,PSIF,XF,YF,ZF   QF1,QF2,QF3,QF4,QF5,QF6,QF7,QF8,QF9,QF10   (AIRFRAME)
        PSIS,PSII,PSIE   TGOVT,TGOV1,TGOV2                        (DRIVE TRAIN)

    DOF = 1111111111  11111  0      (NBM =10, NTM = 5, NGM = 0)
        0000000000  00000  0      (NBM = 0, NTM = 0, NGM = 0)
        000000  0000000000        (NAM = 0)
        000  000                  (NDM = 0)

    DOFT =  TRIM Q1,Q2,Q3,Q4  (ROTOR-1)       TRIM Q1,Q2,Q3,Q4  (ROTOR-2)

    DOFT =  1100    (NBMT = 2)          0000     (NBMT = 0)


ANALYSIS PARAMETERS
    NUMBER OF AZIMUTH STATIONS = 36
    AZIMUTH INCREMENT (DEG) = 10.000
    NUMBER OF HARMONICS FOR ROTOR     = 13 (ROTOR-1)       0 (ROTOR-2)
    NUMBER OF HARMONICS FOR AIRFRAME =  0 (ROTOR-1)       0 (ROTOR-2)
1TRIM ITERATION

       DEL0   DELC   DELS   DELP     CT/S    BETAC   BETAS
      THETA-FT  PHI-FT  THETA-FP  PSI-FP
       TGOVR1   TGOVR2   THETA-T

TARGETS                              .076930  .000000  .000000

N = 0  7   .10981  -.04962  .05675  .00000     .064601  .036718  -.007451
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=1  4   .10108  -.04962  .05675  .00000     .058911  .040142  -.007428
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=2  5   .10981  -.06707  .05675  .00000     .064426  .045523  .004207
    2   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=3  7   .10981  -.04962  .03930  .00000     .066958  .024162  .000991
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

N = 1  5   .11325  -.04540  .04627  .00000     .068271  .025751  -.005235
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

N = 2  5   .11566  -.04244  .03893  .00000     .070857  .017992  -.003498
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739
```

```
              .
N =16  1   .12104  -.03516   .02175   .00000     .076928  .000130  -.000022
    1   .00000   .00000   .00000   .00000
        .00000   .00000   .08739
1*************
AIRCRAFT TRIM
*************


  UNIFORM INFLOW
  WAKE/TRIM ITERATION NUMBER  1    (MAXIMUM =  1)

  NUMBER OF TRIM ITERATION =  16    (MAXIMUM =  80,  TOLERANCE =   .00050)
  WIND TUNNEL, TRIM OPTION NUMBER  15

     FORCES                                CONTROL
            TRIMMED      TARGET     ERROR               TRIMMED         INPUT
     ** CT/S        .0769279   .0769300   .0000279 **     ** DEL0   =   6.93    COLL   =    6.29 **
       CP/S       .0044236   .0000000   .0000000         ** DELC   =  -2.01    LATCYC =   -2.84 **
       CL/S       .0765662   .0000000   .0000000         ** DELS   =   1.25    LNGCYC =    3.25 **
       CX/S       .0077109   .0000000   .0000000           THETA-T =   5.01    APITCH =    5.01
       CY/S      -.0017141   .0000000   .0000000           PSI-T   =    .00    AYAW   =     .00
     ** BETAC         .0075      .0000    .0001302 **
     ** BETAS        -.0012      .0000    .0000218 **


     COLLECTIVE CONTROLS -- DEL0 =   6.93    TGOVR1=    .00    TGOVR2=    .00
     THROTTLE CONTROLS   -- DELT =    .00    C-T  =    .00
     AIRCRAFT CONTROLS   -- DELF =    .00    DELE  =    .00    DELA  =    .00    DELR =    .00
     ROTOR CONTROLS      -- T75  =   6.93    T1C  =   2.01    T1S  =  -1.25
1TRIM ITERATION
                                  .
        DEL0     DELC     DELS     DELP      CT/S     BETAC     BETAS
       THETA-FT  PHI-FT  THETA-FP  PSI-FP
        TGOVR1   TGOVR2   THETA-T

TARGETS                                   .076930  .000000  .000000

N = 0  70    .12104  -.03516   .02175   .00000     .094398  .002656  .011099
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739
      ***  CIRCULATION NOT CONVERGED  ***

 I=1   4    .11231  -.03516   .02175   .00000     .084017  .006468  .010205
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=2   3    .12104  -.05261   .02175   .00000     .094291  .008834  .026215
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=3  25    .12104  -.03516   .00430   .00000     .096115  -.013389  .015340
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

N = 1   4    .11648  -.03141   .02016   .00000     .086401  .002119  .005998
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

N = 2   2    .11399  -.02932   .01909   .00000     .083671  .001501  .004222
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739
               .
               .
               .
N =23   1    .10755  -.02486   .01637   .00000     .076965  -.000024  -.000042
```

```
     1   .00000  .00000  .00000  .00000
         .00000  .00000  .08739
1*************
 AIRCRAFT TRIM
 *************


   NONUNIFORM INFLOW WITH PRESCRIBED WAKE GEOMETRY
   WAKE/TRIM ITERATION NUMBER  1    (MAXIMUM =  1)

   NUMBER OF TRIM ITERATION = 23    (MAXIMUM = 80,  TOLERANCE =   .00050)
   WIND TUNNEL, TRIM OPTION NUMBER  15

     FORCES                                  CONTROL
              TRIMMED     TARGET     ERROR              TRIMMED          INPUT
     ** CT/S    .0769653   .0769300   .0004583 **    ** DEL0   =   6.16   COLL   =   6.29 **
        CP/S    .0035783   .0000000   .0000000      ** DELC   =  -1.42   LATCYC =  -2.84 **
        CL/S    .0765413   .0000000   .0000000      ** DELS   =    .94   LNGCYC =   3.25 **
        CX/S    .0083068   .0000000   .0000000         THETA-T =  5.01   APITCH =   5.01
        CY/S   -.0011750   .0000000   .0000000         PSI-T   =   .00   AYAW   =    .00
     ** BETAC     -.0013     .0000   .0000236 **
     ** BETAS     -.0024     .0000   .0000421 **


     COLLECTIVE CONTROLS -- DEL0 =   6.16   TGOVR1=   .00   TGOVR2=   .00
     THROTTLE CONTROLS   -- DELT =    .00   C-T  =   .00
     AIRCRAFT CONTROLS   -- DELF =    .00   DELE  =   .00   DELA  =   .00   DELR  =   .00
     ROTOR CONTROLS      -- T75  =   6.16   T1C   =  1.42   T1S   =  -.94
1TRIM ITERATION

       DEL0    DELC    DELS    DELP      CT/S     BETAC    BETAS
      THETA-FT  PHI-FT  THETA-FP  PSI-FP
      TGOVR1   TGOVR2   THETA-T

 TARGETS                                    .076930  .000000  .000000

 N = 0  50    .10755  -.02486   .01637   .00000     .075840  .001434  -.010933
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739

  I=1   3    .09882  -.02486   .01637   .00000     .065890  .004945  -.011459
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739

  I=2   5    .10755  -.04231   .01637   .00000     .076267  .007623   .004512
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739

  I=3   4    .10755  -.02486  -.00108   .00000     .080635  -.014739  -.005311
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739

 N = 1   3    .10735  -.02795   .01464   .00000     .076289  .001139  -.007923
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739

 N = 2   3    .10716  -.03017   .01333   .00000     .076373  .000794  -.005578
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739
                         .
                         .
                         .
 N =21   1    .10708  -.03572   .00994   .00000     .076893  .000058  -.000080
      1   .00000   .00000   .00000   .00000
          .00000   .00000   .08739
1*************
 AIRCRAFT TRIM
```

```
*************

  NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
  WAKE/TRIM ITERATION NUMBER  1    (MAXIMUM =  3)

  NUMBER OF TRIM ITERATION = 21    (MAXIMUM = 80,  TOLERANCE =  .00050)
  WIND TUNNEL, TRIM OPTION NUMBER  15

    FORCES                                        CONTROL
           TRIMMED    TARGET     ERROR               TRIMMED         INPUT
    ** CT/S     .0768928   .0769300   .0004836 **    ** DEL0   =  6.14   COLL   =   6.29 **
       CP/S     .0035185   .0000000   .0000000     ** DELC   = -2.05   LATCYC =  -2.84 **
       CL/S     .0764978   .0000000   .0000000     ** DELS   =   .57   LNGCYC =   3.25 **
       CX/S     .0080405   .0000000   .0000000        THETA-T =  5.01   APITCH =  5.01
       CY/S    -.0015103   .0000000   .0000000        PSI-T  =   .00   AYAW   =   .00
    ** BETAC       .0033      .0000   .0000576 **
    ** BETAS      -.0046      .0000   .0000799 **


    COLLECTIVE CONTROLS -- DEL0 =  6.14   TGOVR1=   .00   TGOVR2=   .00
    THROTTLE CONTROLS  -- DELT =   .00   C-T  =   .00
    AIRCRAFT CONTROLS  -- DELF =   .00   DELE =   .00   DELA =   .00   DELR =   .00
    ROTOR CONTROLS     -- T75  =  6.14   T1C  =  2.05   T1S  =  -.57
1TRIM ITERATION

      DEL0   DELC   DELS   DELP     CT/S    BETAC    BETAS
     THETA-FT  PHI-FT  THETA-FP  PSI-FP
      TGOVR1  TGOVR2  THETA-T

TARGETS                              .076930  .000000  .000000

N = 0  3   .10708  -.03572   .00994   .00000    .076487  -.000135  -.000394
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=1  3   .09836  -.03572   .00994   .00000    .066198   .003553  -.000924
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=2  3   .10708  -.05318   .00994   .00000    .076627   .006197   .015196
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=3  3   .10708  -.03572  -.00751   .00000    .081030  -.016089   .005343
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

N = 1  3   .10720  -.03586   .00999   .00000    .076609   .000268  -.000453
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

N = 2  1   .10726  -.03597   .00988   .00000    .076713   .000194  -.000326
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739
                 .
                 .
                 .
N =11  1   .10741  -.03630   .00957   .00000    .076893   .000038  -.000064
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739
1*************
AIRCRAFT TRIM
*************


  NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
```

```
WAKE/TRIM ITERATION NUMBER  2   (MAXIMUM =  3)

NUMBER OF TRIM ITERATION = 11   (MAXIMUM = 80,  TOLERANCE =  .00050)
WIND TUNNEL, TRIM OPTION NUMBER  15

   FORCES                                    CONTROL
            TRIMMED     TARGET     ERROR              TRIMMED          INPUT
** CT/S      .0768932   .0769300   .0004779 **     ** DELO    =  6.15   COLL    =  6.29 **
   CP/S      .0035437   .0000000   .0000000        ** DELC    = -2.08   LATCYC  = -2.84 **
   CL/S      .0764944   .0000000   .0000000        ** DELS    =   .55   LNGCYC  =  3.25 **
   CX/S      .0080863   .0000000   .0000000           THETA-T =  5.01   APITCH  =  5.01
   CY/S     -.0015205   .0000000   .0000000           PSI-T   =   .00   AYAW    =   .00
** BETAC        .0022      .0000   .0000383 **
** BETAS       -.0037      .0000   .0000638 **


   COLLECTIVE CONTROLS -- DEL0 =  6.15   TGOVR1=   .00   TGOVR2=   .00
   THROTTLE CONTROLS   -- DELT =   .00   C-T  =   .00
   AIRCRAFT CONTROLS   -- DELF =   .00   DELE =   .00   DELA =   .00   DELR =   .00
   ROTOR CONTROLS      -- T75  =  6.15   T1C  =  2.08   T1S  =  -.55
1TRIM ITERATION

      DEL0    DELC    DELS    DELP      CT/S    BETAC    BETAS
     THETA-FT  PHI-FT  THETA-FP  PSI-FP
      TGOVR1   TGOVR2   THETA-T

TARGETS                                 .076930  .000000  .000000

N = 0  2   .10741  -.03630   .00957   .00000     .076895  .000016  .000030
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=1  3   .09869  -.03630   .00957   .00000     .066610  .003687  -.000507
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=2  3   .10741  -.05376   .00957   .00000     .077040  .006314  .015633
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=3  3   .10741  -.03630  -.00788   .00000     .081437  -.015979  .005784
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

N = 1  3   .10742  -.03629   .00957   .00000     .076897  .000315  -.000130
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

STARTING ROLLUP INITIALIZATION
ROLLUP CONVERGENCE LOOP  ITERATION NUMBER    1
STARTING LARGE CORE LOADS ITERATION NUMBER   1
STARTING LARGE CORE LOADS ITERATION NUMBER   2
STARTING LARGE CORE LOADS ITERATION NUMBER   3
STARTING LARGE CORE LOADS ITERATION NUMBER   4
STARTING LARGE CORE LOADS ITERATION NUMBER   5
STARTING LARGE CORE LOADS ITERATION NUMBER   6
STARTING LARGE CORE LOADS ITERATION NUMBER   7
STARTING LARGE CORE LOADS ITERATION NUMBER   8
STARTING LARGE CORE LOADS ITERATION NUMBER   9
STARTING LARGE CORE LOADS ITERATION NUMBER  10
STARTING LARGE CORE LOADS ITERATION NUMBER  11
STARTING LARGE CORE LOADS ITERATION NUMBER  12
STARTING LARGE CORE LOADS ITERATION NUMBER  13
STARTING LARGE CORE LOADS ITERATION NUMBER  14
STARTING LARGE CORE LOADS ITERATION NUMBER  15
STARTING LARGE CORE LOADS ITERATION NUMBER  16
STARTING LARGE CORE LOADS ITERATION NUMBER  17
```

```
STARTING LARGE CORE LOADS ITERATION NUMBER  18
STARTING LARGE CORE LOADS ITERATION NUMBER  19
STARTING LARGE CORE LOADS ITERATION NUMBER  20
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR = 2 YBAR = -.014438 RYBAR = .030000 GAMMA = .002157
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR = 3 YBAR = -.022850 RYBAR = .050000 GAMMA = .001868
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR = 4 YBAR = -.018743 RYBAR = .070000 GAMMA = .001966
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR = 5 YBAR = -.007013 RYBAR = .090000 GAMMA = .002231
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR = 2 YBAR = -.042418 RYBAR = .112500 GAMMA = .002687
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR = 3 YBAR = -.005432 RYBAR = .137500 GAMMA = .003449
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 2 YBAR = -.012141 RYBAR = .030000 GAMMA = .002735
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 3 YBAR = -.026749 RYBAR = .050000 GAMMA = .002137
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 4 YBAR = -.037195 RYBAR = .070000 GAMMA = .001907
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 5 YBAR = -.038642 RYBAR = .090000 GAMMA = .001884
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 6 YBAR = -.022276 RYBAR = .112500 GAMMA = .002133
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 2 YBAR = -.072375 RYBAR = .137500 GAMMA = .002758
 POINT OMITTED IN YBAR CALCULATION AT PSI = 70.0
IRYBAR = 3 YBAR = -.007371 RYBAR = .162500 GAMMA = .003897
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 2 YBAR = -.015517 RYBAR = .030000 GAMMA = .002405
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 3 YBAR = -.035851 RYBAR = .050000 GAMMA = .001760
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 4 YBAR = -.051804 RYBAR = .070000 GAMMA = .001509
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 5 YBAR = -.054704 RYBAR = .090000 GAMMA = .001476
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 6 YBAR = -.034570 RYBAR = .112500 GAMMA = .001695
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 2 YBAR = -.095919 RYBAR = .137500 GAMMA = .002307
 POINT OMITTED IN YBAR CALCULATION AT PSI = 80.0
IRYBAR = 3 YBAR = -.014812 RYBAR = .162500 GAMMA = .003443
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 2 YBAR = -.031635 RYBAR = .030000 GAMMA = .001438
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 3 YBAR = -.106202 RYBAR = .050000 GAMMA = .000704
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 4 YBAR = -.208351 RYBAR = .070000 GAMMA = .000436
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 5 YBAR = -.211345 RYBAR = .090000 GAMMA = .000432
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 6 YBAR = -.086442 RYBAR = .112500 GAMMA = .000719
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 2 YBAR = -.163844 RYBAR = .137500 GAMMA = .001432
 POINT OMITTED IN YBAR CALCULATION AT PSI = 89.99999
IRYBAR = 3 YBAR = -.020153 RYBAR = .162500 GAMMA = .002641
 POINT OMITTED IN YBAR CALCULATION AT PSI = 99.99999
IRYBAR = 2 YBAR = -.044538 RYBAR = .030000 GAMMA = .001072
 POINT OMITTED IN YBAR CALCULATION AT PSI = 99.99999
IRYBAR = 3 YBAR = -.249216 RYBAR = .050000 GAMMA = .000313
 POINT OMITTED IN YBAR CALCULATION AT PSI = 99.99999
IRYBAR = 4 YBAR = -.179203 RYBAR = .112500 GAMMA = .000397
 POINT OMITTED IN YBAR CALCULATION AT PSI = 99.99999
IRYBAR = 2 YBAR = -.196566 RYBAR = .137500 GAMMA = .001173
 POINT OMITTED IN YBAR CALCULATION AT PSI = 99.99999
IRYBAR = 3 YBAR = -.017262 RYBAR = .162500 GAMMA = .002430
```

```
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 2 YBAR = -.042342 RYBAR = .030000 GAMMA = .001101
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 3 YBAR = -.177778 RYBAR = .050000 GAMMA = .000416
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 4 YBAR = -.360546 RYBAR = .070000 GAMMA = .000235
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 5 YBAR = -.240340 RYBAR = .090000 GAMMA = .000324
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 6 YBAR = -.046814 RYBAR = .112500 GAMMA = .000747
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 2 YBAR = -.127736 RYBAR = .137500 GAMMA = .001561
POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR = 3 YBAR = -.003896 RYBAR = .162500 GAMMA = .002818
POINT OMITTED IN YBAR CALCULATION AT PSI = 120.0
IRYBAR = 2 YBAR = -.121720 RYBAR = .030000 GAMMA = .000440
POINT OMITTED IN YBAR CALCULATION AT PSI = 120.0
IRYBAR = 6 YBAR = -.088442 RYBAR = .112500 GAMMA = .000272
POINT OMITTED IN YBAR CALCULATION AT PSI = 140.0
IRYBAR = 3 YBAR = -.118036 RYBAR = .090000 GAMMA = .000362

STARTING ROLLUP WAKE-TRIM ITERATION NUMBER   1
before wakec1, wake-trim iteration # 1
after wakec1, wake-trim iteration # 1
1TRIM ITERATION

       DEL0  DELC  DELS  DELP    CT/S    BETAC   BETAS
      THETA-FT PHI-FT THETA-FP PSI-FP
      TGOVR1  TGOVR2  THETA-T

 TARGETS                                 .076930 .000000 .000000

N = 0 70  .10742 -.03629  .00957  .00000   .090126 .000416 .016829
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739
     *** CIRCULATION NOT CONVERGED ***

 I=1 30  .09870 -.03629  .00957  .00000   .081061 .004315 .016113
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739

 I=2 3   .10742 -.05375  .00957  .00000   .091156 .007426 .032023
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739

 I=3 4   .10742 -.03629 -.00788  .00000   .095609 -.014808 .022553
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739

N = 1 3   .10408 -.03102  .01015  .00000   .087123 .001365 .011616
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739

N = 2 3   .10131 -.02723  .01000  .00000   .083943 .000945 .008143
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739
                .
                .
                .
N =34 1   .09455 -.01843  .01019  .00000   .076968 -.000034 .000000
    1  .00000 .00000 .00000 .00000
       .00000 .00000 .08739
1*************
AIRCRAFT TRIM
*************
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```
NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
WAKE/TRIM ITERATION NUMBER  1   (MAXIMUM =  2)

NUMBER OF TRIM ITERATION = 34   (MAXIMUM = 80, TOLERANCE =  .00050)
WIND TUNNEL, TRIM OPTION NUMBER 15

  FORCES                               CONTROL
          TRIMMED    TARGET    ERROR            TRIMMED          INPUT
  ** CT/S    .0769680  .0769300  .0004935 **   ** DEL0   =  5.42   COLL   =  6.29 **
     CP/S    .0027949  .0000000  .0000000      ** DELC   = -1.06   LATCYC = -2.84 **
     CL/S    .0765692  .0000000  .0000000      ** DELS   =   .58   LNGCYC =  3.25 **
     CX/S    .0079516  .0000000  .0000000        THETA-T =  5.01   APITCH =  5.01
     CY/S   -.0006835  .0000000  .0000000        PSI-T   =   .00   AYAW   =   .00
  ** BETAC     -.0019     .0000  .0000338 **
  ** BETAS      .0000     .0000  .0000003 **


  COLLECTIVE CONTROLS -- DEL0 =  5.42   TGOVR1=  .00   TGOVR2=  .00
  THROTTLE CONTROLS   -- DELT =   .00   C-T  =  .00
  AIRCRAFT CONTROLS   -- DELF =   .00   DELE =  .00   DELA =  .00   DELR =  .00
  ROTOR CONTROLS      -- T75  =  5.42   T1C  = 1.06   T1S  = -.58

STARTING ROLLUP WAKE-TRIM ITERATION NUMBER   2
before wakec1, wake-trim iteration # 2
after  wakec1, wake-trim iteration # 2
1TRIM ITERATION

      DEL0   DELC   DELS   DELP     CT/S    BETAC   BETAS
     THETA-FT  PHI-FT  THETA-FP  PSI-FP
      TGOVR1  TGOVR2  THETA-T

TARGETS                                  .076930  .000000  .000000

N = 0  2   .09455  -.01843   .01019   .00000    .077094 -.000164  .000270
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=1 15   .08582  -.01843   .01019   .00000    .067630  .002989 -.000474
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=2  3   .09455  -.03589   .01019   .00000    .077952  .005730  .015537
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

 I=3  3   .09455  -.01843  -.00726   .00000    .082512 -.016688  .005873
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

N = 1  3   .09453  -.01837   .01026   .00000    .077895 -.000245 -.000049
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739

N = 2  6   .09425  -.01840   .01022   .00000    .077576 -.000200 -.000016
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739
                    .
                    .
                    .
N =10  1   .09373  -.01845   .01024   .00000    .076961 -.000033  .000002
     1   .00000   .00000   .00000   .00000
         .00000   .00000   .08739
1*************
AIRCRAFT TRIM
*************
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```
NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
WAKE/TRIM ITERATION NUMBER  2    (MAXIMUM =  2)

NUMBER OF TRIM ITERATION = 10    (MAXIMUM = 80,  TOLERANCE =   .00050)
WIND TUNNEL, TRIM OPTION NUMBER  15

  FORCES                                   CONTROL
           TRIMMED     TARGET      ERROR              TRIMMED          INPUT
  ** CT/S     .0769613   .0769300   .0004064 **      ** DEL0   =  5.37   COLL   =   6.29 **
     CP/S     .0027963   .0000000   .0000000        ** DELC   =  -1.06   LATCYC =  -2.84 **
     CL/S     .0765622   .0000000   .0000000        ** DELS   =   .59   LNGCYC =   3.25 **
     CX/S     .0079548   .0000000   .0000000         THETA-T =  5.01   APITCH =   5.01
     CY/S    -.0006901   .0000000   .0000000         PSI-T  =   .00   AYAW   =    .00
  ** BETAC      -.0019     .0000   .0000334 **
  ** BETAS       .0001     .0000   .0000024 **


  COLLECTIVE CONTROLS -- DEL0 =  5.37   TGOVR1=   .00   TGOVR2=   .00
  THROTTLE CONTROLS   -- DELT =   .00   C-T  =   .00
  AIRCRAFT CONTROLS   -- DELF =   .00   DELE  =   .00   DELA =   .00   DELR =   .00
  ROTOR CONTROLS      -- T75  =  5.37   T1C  =   1.06   T1S  =  -.59
ROLLUP CONVERGENCE LOOP  ITERATION NUMBER   2
STARTING LARGE CORE LOADS ITERATION NUMBER   1
STARTING LARGE CORE LOADS ITERATION NUMBER   2
STARTING LARGE CORE LOADS ITERATION NUMBER   3
STARTING LARGE CORE LOADS ITERATION NUMBER   4
STARTING LARGE CORE LOADS ITERATION NUMBER   5
STARTING LARGE CORE LOADS ITERATION NUMBER   6
STARTING LARGE CORE LOADS ITERATION NUMBER   7
STARTING LARGE CORE LOADS ITERATION NUMBER   8
STARTING LARGE CORE LOADS ITERATION NUMBER   9
STARTING LARGE CORE LOADS ITERATION NUMBER  10
STARTING LARGE CORE LOADS ITERATION NUMBER  11
STARTING LARGE CORE LOADS ITERATION NUMBER  12
STARTING LARGE CORE LOADS ITERATION NUMBER  13
STARTING LARGE CORE LOADS ITERATION NUMBER  14
STARTING LARGE CORE LOADS ITERATION NUMBER  15
STARTING LARGE CORE LOADS ITERATION NUMBER  16
STARTING LARGE CORE LOADS ITERATION NUMBER  17
STARTING LARGE CORE LOADS ITERATION NUMBER  18
STARTING LARGE CORE LOADS ITERATION NUMBER  19
STARTING LARGE CORE LOADS ITERATION NUMBER  20
 POINT OMITTED IN YBAR CALCULATION AT PSI = 49.99999
IRYBAR =  2  YBAR =  -.144202  RYBAR =   .030000  GAMMA =   .000208
 POINT OMITTED IN YBAR CALCULATION AT PSI = 49.99999
IRYBAR =  3  YBAR =  -.150532  RYBAR =   .050000  GAMMA =   .000201
 POINT OMITTED IN YBAR CALCULATION AT PSI = 49.99999
IRYBAR =  4  YBAR =  -.009869  RYBAR =   .070000  GAMMA =   .000607
 POINT OMITTED IN YBAR CALCULATION AT PSI = 49.99999
IRYBAR =  2  YBAR =  -.036681  RYBAR =   .090000  GAMMA =   .001184
 POINT OMITTED IN YBAR CALCULATION AT PSI = 60.0
IRYBAR =  7  YBAR =  -.395045  RYBAR =   .137500  GAMMA =  -.000262
 POINT OMITTED IN YBAR CALCULATION AT PSI = 99.99999
IRYBAR =  2  YBAR =  -.174101  RYBAR =   .030000  GAMMA =   .000323
 POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR =  2  YBAR =  -.144321  RYBAR =   .030000  GAMMA =   .000382
 POINT OMITTED IN YBAR CALCULATION AT PSI = 110.0
IRYBAR =  6  YBAR =  -.040106  RYBAR =   .137500  GAMMA =   .000272
 POINT OMITTED IN YBAR CALCULATION AT PSI = 120.0
IRYBAR =  7  YBAR =  -.103617  RYBAR =   .137500  GAMMA =  -.000239
 POINT OMITTED IN YBAR CALCULATION AT PSI = 130.0
IRYBAR =  7  YBAR =  -.115570  RYBAR =   .137500  GAMMA =  -.000518

STARTING ROLLUP WAKE-TRIM ITERATION NUMBER    1
before wakec1, wake-trim iteration #  1
after  wakec1, wake-trim iteration #  1
1TRIM ITERATION
```

```
     DEL0   DELC   DELS   DELP    CT/S   BETAC  BETAS
    THETA-FT  PHI-FT  THETA-FP  PSI-FP
     TGOVR1  TGOVR2  THETA-T

TARGETS                                  .076930 .000000 .000000

N = 0  41   .09373  -.01845  .01024  .00000    .078397  .002802  -.000786
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=1  5   .08501  -.01845  .01024  .00000    .068157  .006125  -.001349
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=2  3   .09373  -.03590  .01024  .00000    .078404  .009036  .014536
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=3  3   .09373  -.01845  -.00721  .00000    .082984  -.013392  .004873
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

N = 1  3   .09311  -.01835  .00912  .00000    .077966  .002133  -.000724
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739

N = 2  2   .09265  -.01831  .00826  .00000    .077652  .001456  -.000503
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739
                  .
                  .
                  .
N =10  1   .09170  -.01825  .00639  .00000    .076952  .000091  -.000039
     1  .00000  .00000  .00000  .00000
        .00000  .00000  .08739
1*************
AIRCRAFT TRIM
*************


  NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
  WAKE/TRIM ITERATION NUMBER  1   (MAXIMUM =  2)

  NUMBER OF TRIM ITERATION =  10   (MAXIMUM = 80,  TOLERANCE =  .00050)
  WIND TUNNEL, TRIM OPTION NUMBER  15

    FORCES                                 CONTROL
              TRIMMED    TARGET    ERROR            TRIMMED          INPUT
    ** CT/S      .0769518  .0769300  .0002840 **     ** DEL0   =   5.25    COLL   =   6.29 **
       CP/S      .0026965  .0000000  .0000000      ** DELC   =  -1.05    LATCYC =  -2.84 **
       CL/S      .0765458  .0000000  .0000000      ** DELS   =    .37    LNGCYC =   3.25 **
       CX/S      .0080303  .0000000  .0000000         THETA-T =  5.01    APITCH =  5.01
       CY/S     -.0006497  .0000000  .0000000         PSI-T  =   .00    AYAW   =   .00
    ** BETAC        .0052     .0000  .0000908 **
    ** BETAS       -.0022     .0000  .0000389 **


    COLLECTIVE CONTROLS -- DEL0 =  5.25   TGOVR1=   .00   TGOVR2=   .00
    THROTTLE CONTROLS   -- DELT =   .00   C-T  =   .00
    AIRCRAFT CONTROLS   -- DELF =   .00   DELE =   .00   DELA =   .00   DELR =   .00
    ROTOR CONTROLS      -- T75  =  5.25   T1C  =  1.05   T1S  =  -.37

STARTING ROLLUP WAKE-TRIM ITERATION NUMBER   2
 before wakec1, wake-trim iteration #  2
 after  wakec1, wake-trim iteration #  2
1TRIM ITERATION
```

```
      DEL0   DELC   DELS   DELP    CT/S   BETAC  BETAS
     THETA-FT  PHI-FT  THETA-FP  PSI-FP
      TGOVR1  TGOVR2  THETA-T

 TARGETS                            .076930  .000000  .000000

 N = 0  2   .09170  -.01825  .00639  .00000   .076991  .000059  .000018
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=1  3   .08297  -.01825  .00639  .00000   .066662  .003432  -.000484
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=2  3   .09170  -.03570  .00639  .00000   .076954  .006288  .015437
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 I=3  3   .09170  -.01825  -.01106  .00000   .081532  -.016134  .005768
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739

 N = 1  3   .09168  -.01823  .00637  .00000   .076941  .000233  -.000084
    1   .00000  .00000  .00000  .00000
        .00000  .00000  .08739
1*************
AIRCRAFT TRIM
*************


  NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
  WAKE/TRIM ITERATION NUMBER  2   (MAXIMUM =  2)

  NUMBER OF TRIM ITERATION =  1   (MAXIMUM = 80,  TOLERANCE =   .00050)
  WIND TUNNEL, TRIM OPTION NUMBER  15

    FORCES                                CONTROL
           TRIMMED    TARGET    ERROR              TRIMMED          INPUT
  ** CT/S     .0769408   .0769300  .0001403 **    ** DEL0  =  5.25   COLL  =  6.29 **
     CP/S     .0027057   .0000000  .0000000       ** DELC  =  -1.04  LATCYC =  -2.84 **
     CL/S     .0765351   .0000000  .0000000       ** DELS  =   .37   LNGCYC =  3.25 **
     CX/S     .0080267   .0000000  .0000000          THETA-T =  5.01   APITCH =  5.01
     CY/S    -.0006563   .0000000  .0000000          PSI-T  =   .00   AYAW  =   .00
  ** BETAC      .0133     .0000   .0002325 **
  ** BETAS     -.0048     .0000   .0000841 **


    COLLECTIVE CONTROLS -- DEL0 =  5.25   TGOVR1=   .00   TGOVR2=   .00
    THROTTLE CONTROLS   -- DELT =   .00   C-T  =   .00
    AIRCRAFT CONTROLS   -- DELF =   .00   DELE =   .00   DELA =   .00   DELR =   .00
    ROTOR CONTROLS      -- T75  =  5.25   T1C  =  1.04   T1S  =  -.37
1COMPREHENSIVE ANALYTICAL MODEL OF ROTORCRAFT AERODYNAMICS AND DYNAMICS

*****************************************************************************************************
*********************
CASE NUMBER  1 (NEW JOB),  IDENTIFICATION =


MAIN ROTOR PARAMETERS
   RADIUS         =  6.063      V/(OMEGA*R)          =  .1494      OPSTLL =  1
   NUMBER OF BLADES =  4        TIP SPEED            =  681.85     OPYAW =  0
   LOCK NUMBER    =  2.2583     ROTATIONAL SPEED (RPM) =  1074.01   OPCOMP =  1
   SOLIDITY       =  .09188     OMEGA (RAD/SEC)      =  112.470    OPUSLD =  2
   IB             =  3.641      TIP MACH NUMBER      =  .6190      INFLOW =  1 0 0 0 0 0
   MEAN CHORD/RADIUS =  .07216                                     OPHVIB =  0 0 0
```

```
    COUNTER-CLOCKWISE ROTATION DIRECTION
    HINGED BLADE  (HINGE = 0, EFLAP =  .0825, ELAG =  .0825)
    NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY (LEVEL = 2)
    ROTOR WITH AUXILIARY TE-FLAP (OPFLAP = 3)


 DEGREES OF FREEDOM
    DOF =  Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10   P0,P1,P2,P3,P4   BG          (ROTOR-1)
        Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10   P0,P1,P2,P3,P4   BG          (ROTOR-2)
        PHIF,THETAF,PSIF,XF,YF,ZF   QF1,QF2,QF3,QF4,QF5,QF6,QF7,QF8,QF9,QF10   (AIRFRAME)
        PSIS,PSII,PSIE   TGOVT,TGOV1,TGOV2                       (DRIVE TRAIN)

    DOF =  1111111111  11111  0      (NBM =10,  NTM = 5,  NGM = 0)
        0000000000  00000  0      (NBM = 0,  NTM = 0,  NGM = 0)
        000000   0000000000       (NAM =  0)
        000   000                 (NDM =  0)

    DOFT =   TRIM Q1,Q2,Q3,Q4  (ROTOR-1)       TRIM Q1,Q2,Q3,Q4  (ROTOR-2)

    DOFT =   1100      (NBMT = 2)          0000      (NBMT = 0)


 ANALYSIS PARAMETERS
    NUMBER OF AZIMUTH STATIONS =  36
    AZIMUTH INCREMENT (DEG)  =  10.000
    NUMBER OF HARMONICS FOR ROTOR     =  13 (ROTOR-1)       0 (ROTOR-2)
    NUMBER OF HARMONICS FOR AIRFRAME  =   0 (ROTOR-1)       0 (ROTOR-2)
1**********
 INPUT DATA
 **********


 TRIM DATA
 ---------

   TITLE = BVI RTR, MU=0.1494, CT/S=.0768, ALS=5.007, AFT  -12.5 deg flap, -20 deg phase

   JOB OR CASE IDENTIFICATION,  CODE =
   UNITS (1 FOR ENGLISH, 2 FOR METRIC),  OPUNIT = 1
   ANALYSIS TASKS (0 TO SUPPRESS)
        ANTYPE(1) = 0        FLUTTER
        ANTYPE(2) = 0        FLIGHT DYNAMICS
        ANTYPE(3) = 0        TRANSIENT
   NAMELIST READ CONTROL,  OPREAD =   1  1  0  0  0  1  0  0  0  0
   DEBUG PRINT CONTROL,  DEBUG =   0   0 0 1 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0
   INPUT PRINT CONTROL (0 FOR SHORT FORM, 1 FOR LONG FORM),  NPRNTI =  1

 OPERATING CONDITIONS
   AIRCRAFT SPEED (KNOTS),  VKTS =    60.36
   V/(OMEGA*R),  VEL =     .1494
   ROTOR-1 TIP SPEED,  VTIP =    681.85
   ROTOR-1 ROTATIONAL SPEED (RPM),  RPM =   1074.01
   AIRCRAFT ENVIRONMENT (1 FOR ALT AND STD DAY, 2 FOR ALT AND TEMP, 3 FOR DENSITY AND TEMP),
 OPDENS = 3
   ALTITUDE ABOVE MSL,  ALTMSL =     18.8
   AIR TEMPERATURE,  TEMP =    45.27
   AIR DENSITY,  DENSE =  .002441
   NUMBER OF ROTORS,  NROTOR =  1
   GROUND EFFECT (0 FOR OGE),  OPGRND =  0
   ALTITUDE CG ABOVE GROUND,  HAGL =       .00
   ENGINE STATE (1 FOR AUTOROTATION, 2 FOR ENGINE OUT),  OPENGN =  0
   WING FLAP ANGLE (DEG),  AFLAP =       .00

   DEGREE OF FREEDOM VECTOR,  DOF =   1111111111111110  0000000000000000  0000000000000000  000000
   TRIM BENDING DEGREE OF FREEDOM VECTOR,  DOFT =    1100   0000

 MOTION ANALYSIS
```

NUMBER OF AZIMUTH STEPS, MPSI = 36
NUMBER OF HARMONICS IN ROTOR MOTION, MHARM = 13 0
NUMBER OF HARMONICS IN AIRFRAME MOTION, MHARMF = 0 0
NUMBER OF ROTOR AZIMUTH STEPS BETWEEN UPDATE OF AIRFRAME VIBRATION, MPSIR = 36
NUMBER OF REVOLUTIONS BETWEEN TEST OF MOTION CONVERGENCE, MREV = 1
MAXIMUM NUMBER OF MOTION ITERATIONS, ITERM = 50
TOLERANCE FOR MOTION CONVERGENCE (DEG), EPMOTN = .00800
MAXIMUM NUMBER OF CIRCULATION ITERATIONS, ITERC = 70
TOLERANCE FOR CIRCULATION CONVERGENCE (CT/S), EPCIRC = .000100
LAG TO IMPROVE MOTION CONVERGENCE, FACTM = .500

WAKE ANALYSIS
INFLOW MODEL (0 FOR UNIFORM, 1 FOR PRESCRIBED WAKE, 2 FOR FREE WAKE), LEVEL = 2 0
WAKE/TRIM ITERATIONS (0 TO SKIP)
ITERU = 1 UNIFORM INFLOW LEVEL
ITERR = 1 NONUNIFORM INFLOW AND PRESCRIBED WAKE GEOMETRY LEVEL
ITERF = 3 NONUNIFORM INFLOW AND FREE WAKE GEOMETRY LEVEL

TRIM ANALYSIS
FREE FLIGHT TRIM (0-9) OR WIND TUNNEL TRIM (10-29), OPTRIM = 15
MAXIMUM NUMBER OF ITERATIONS ON CONTROL TO ACHIEVE TRIM, MTRIM = 80
NUMBER OF TRIM ITERATIONS BETWEEN UPDATE OF TRIM DERIVATIVE MATRIX, MTRIMD = 40
CONTROL STEP IN TRIM DERIVATIVE CALCULATION (DEG), DELTA = 1.0000
FACTOR REDUCING CONTROL INCREMENT, FACTOR = .3000
TOLERANCE ON TRIM CONVERGENCE, EPTRIM = .00050
GOVERNOR TRIM (0 TO TRIM COLL, 1 TO TRIM ROTOR-1 GOV, 2 TO TRIM ROTOR-2 GOV, 3 TO TRIM BOTH GOVERNORS), OPGOVT = 0

INITIAL CONTROL SETTINGS

COLL =	6.29	COLLECTIVE STICK DISPLACEMENT
LATCYC =	-2.84	LATERAL CYCLIC STICK DISPLACEMENT
LNGCYC =	3.25	LONGITUDINAL CYCLIC STICK DISPLACEMENT
PEDAL =	.00	PEDAL DISPLACEMENT
APITCH =	5.01	PITCH ANGLE THETA-FT OR THETA-T
AROLL =	.00	ROLL ANGLE PHI-FT
ACLIMB =	.00	CLIMB ANGLE THETA-FP
AYAW =	.00	YAW ANGLE PSI-FP OR PSI-T
RTURN =	.00	TRIM TURN RATE

TARGETS FOR WIND TUNNEL TRIM

CTTRIM =	.076930	(CT/S OR CL/S)
CPTRIM =	.000000	(CP/S)
CXTRIM =	.000000	(CX/S)
XTRIM =	.000	(X/Q)
CYTRIM =	.000000	(CY/S)
BCTRIM =	.000	(BETA-C)
BSTRIM =	.000	(BETA-S)

PRINT CONTROL FOR TRIM ITERATIONS (LE 0 TO SUPPRESS), NPRNTT = 1
PERFORMANCE PRINT CONTROL (LE 0 TO SUPPRESS), NPRNTP = 0
LOADS PRINT CONTROL (LE 0 TO SUPPRESS), NPRNTL = 0
1MAIN ROTOR DATA

TITLE = BVIRTR

RADIUS = 6.0625
NUMBER OF BLADES = 4
SOLIDITY = .09188
LOCK NUMBER (AT STANDARD DENSITY) = 2.2000
ROTATION DIRECTION (1 FOR COUNTER-CLOCKWISE AND -1 FOR CLOCKWISE), ROTATE = 1
NORMAL TIP SPEED, VTIPN = 690.0000

AERODYNAMIC MODEL
TIP LOSS PARAMETER, BTIP = 1.0000
TIP LOSS TYPE (1 FOR TIP LOSS FACTOR, 2 FOR PRANDTL FUNCTION), OPTIP = 1
TWIST TYPE (0 FOR NONLINEAR), LINTW = 0

LINEAR TWIST RATE (DEG), TWISTL = -9.000
ROOT RADIAL STATION, RROOT = .2500
MAXIMUM BOUND CIRCULATION FOUND OUTBOARD OF RGMAX = .2500
UNSTEADY AERODYNAMICS (0 TO SUPPRESS, 1 TO USE, 2 FOR ZERO IN STALL), OPUSLD = 2
INCOMPRESSIBLE AERODYNAMICS IF 0, OPCOMP = 1

STALL MODEL
STALL TYPE (0 FOR NONE, 1 FOR STATIC, 2-5 FOR DYNAMIC/WITH VORTEX LOADS IF ODD), OPSTLL = 1
YAWED FLOW (0 FOR BOTH, 1 FOR NO YAWED FLOW, 2 FOR NO RADIAL DRAG, 3 FOR NEITHER), OPYAW = 0
MAXIMUM DELAY ANGLE (DEG), ADELAY = 15.000
MAXIMUM ANGLE FOR NO STALL MODEL (DEG), AMAXNS = 4.000

DYNAMIC STALL PARAMETERS --	LIFT	DRAG	MOMENT
TAU (TIME CONST)	-1.000	-1.000	-1.000
PSIDS (DEG)	15.000	15.000	15.000
ALFDS (DEG)	15.000	15.000	15.000
ALFRE (DEG)	12.000	12.000	12.000
C-DSP (MAX PEAK)	2.0000	.0000	-.6500

INFLOW MODEL
INDUCED VELOCITY CALCULATION
INFLOW(1) = 1 THIS ROTOR (0 FOR UNIFORM, 1 FOR NONUNIFORM)
INFLOW(2) = 0 OTHER ROTOR (0 FOR ZERO, 1 FOR EMPIRICAL, 2 FOR HUB AVERAGE, 3 FOR NONUNIFORM)
INFLOW(3) = 0 WING-BODY (0 FOR ZERO, 1 FOR EMPIRICAL, 2 FOR NONUNIFORM)
INFLOW(4) = 0 HORIZONTAL TAIL (0 FOR ZERO, 1 FOR EMPIRICAL, 2 FOR NONUNIFORM)
INFLOW(5) = 0 VERTICAL TAIL (0 FOR ZERO, 1 FOR EMPIRICAL, 2 FOR NONUNIFORM)
INFLOW(6) = 0 OFF ROTOR DISK (0 FOR ZERO, 1 FOR NONUNIFORM)
EMPIRICAL INFLOW CORRECTION FACTORS, KHLMDA = 1.1000, KFLMDA = 1.8000
LINEAR INFLOW FACTOR FOR FORWARD FLIGHT, FXLMDA = 1.0000, FYLMDA = 1.0000
LINEAR INFLOW FACTOR FOR HUB MOMENTS, FMLMDA = 1.0000
INTERFERENCE VELOCITY AT OTHER ROTOR, KINTH = .0000, KINTF = .0000
INTERFERENCE VELOCITY AT AIRFRAME, KINTWB = .0000, KINTHT = .0000, KINTVT = .0000
FACTOR INTRODUCING LAG IN CT,CMX,CMY FOR INDUCED VELOCITY, FACTWU = .5000

DYNAMIC MODEL
BENDING MODE TYPE (0 FOR HINGED, 1 FOR CANTILEVER, 2 FOR ARTICULATED), HINGE = 0
NO PITCH BEARING IF 1, NOPB = 0
STRUCTURAL COUPLING, RCPL = 1.0000
HINGE OFFSET, EFLAP = .0825, ELAG = .0825
HINGE SPRING, KFLAP = .0000, KLAG = 2805.0000
HINGE SPRING PITCH (DEG), TSPRNG+RCPLS*T75 = .00 + 1.0000 * T75
COLLECTIVE CONTROL SYSTEM DAMPING, TDAMP0 = .0000
CYCLIC CONTROL SYSTEM DAMPING, TDAMPC = .0000
ROTATING CONTROL SYSTEM DAMPING, TDAMPR = .0000
LINEAR LAG DAMPER COEFFICIENT, LDAMPC = 31.7000
NONLINEAR LAG DAMPER MAXIMUM MOMENT (0. FOR LINEAR), LDAMPM = .0000
NONLINEAR LAG DAMPER, LAG RATE AT MAXIMUM MOMENT, LDAMPR = .0000
BENDING MODE STRUCTURAL DAMPING, GSB = .0100 .0100 .0100 .0100 .0100 .0100 .0100 .0100 .0100 .0100
TORSION MODE STRUCTURAL DAMPING, GST = .0100 .0100 .0100 .0100 .0100
PITCH BENDING COUPLING (1 FOR INPUT, 2 TO CALCULATE, NEGATIVE FOR NO COS FACTOR), KPIN = 1
PHIPH = -7.00, PHIPL = .00, RPB = .14090, RPH = .14090, XPH = -.06410
INPUT COUPLING FOR PITCH HORN LEVEL (DEG), ATANKP = .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
BLADE MASS (IF LE 0. INTEGRAL OF SECTION MASS USED), MBLADE = -1.0000
TIP MASS, MASST = .0000
TIP MASS CG OFFSET, XIT = .00000
FEATHERING AXIS RADIAL LOCATION, RFA = .14090
GIMBAL UNDERSLING, ZFA = .00000
TORQUE OFFSET, XFA = .00000
PRECONE (DEG), CONE = .00
DROOP AT T75=0. (DEG), DROOP = .00
SWEEP AT T75=0. (DEG), SWEEP = .00
FEATHERING AXIS DROOP (DEG), FDROOP = .00
FEATHERING AXIS SWEEP (DEG), FSWEEP = .00
CONTROL SYSTEM STIFFNESS INPUT (1 FOR SPRING, 2 FOR FREQUENCIES AT VTIPN), WTIN = 1

	FREQUENCY	SPRING
COLLECTIVE	5.511	18462.0000

CYCLIC 4.570 14106.0000
REACTIONLESS 9.857 50000.0000
NUMBER OF RADIAL STATIONS IN BLADE MODE CALCULATION, MRB = 50
NUMBER OF RADIAL STATIONS FOR NUMERICAL INTEGRATION OF INERTIAL COEFFICIENTS, MRM = 50
TOLERANCE ON COLLECTIVE (DEG) FOR UPDATE OF MODES, EPMODE = .50000
CALCULATE NONROTATING BENDING FREQUENCIES IF NE 0, NONROT = 0
NUMBER OF BENDING MODE COLLOCATION FUNCTIONS, NCOLB = 20
NUMBER OF TORSION MODE COLLOCATION FUNCTIONS, NCOLT = 10
HUB VIBRATION COMPONENTS (0 TO SUPPRESS)
OPHVIB(1) = 0 VIBRATION DUE TO THIS ROTOR
OPHVIB(2) = 0 VIBRATION DUE TO OTHER ROTOR
OPHVIB(3) = 0 STATIC ELASTIC DEFLECTION

SECTION AERODYNAMIC CHARACTERISTICS
NUMBER OF AERODYNAMIC SEGMENTS, MRA = 20
EDGES OF SEGMENTS, R = .2500 .3350 .4200 .4900 .5500 .6000 .6400 .6800 .7200 .7500
.7750 .8000 .8250 .8500 .8750 .9000 .9200 .9400 .9600 .9800
1.0000

RA	DRA	C/R	TWIST (DEG)	THETA-ZL (DEG)	XA/R LIFT	XAC/R DRAG	M-CORR MOMENT	M-CORR LOSS	M-CORR LOC	TIP	FLAP
.2925	.0850	.07290	4.118	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.3775	.0850	.07290	3.353	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.4550	.0700	.07290	2.655	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.5200	.0600	.07290	2.070	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.5750	.0500	.07290	1.575	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.6200	.0400	.07290	1.170	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.6600	.0400	.07290	.810	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.7000	.0400	.07290	.450	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.7350	.0300	.07290	.135	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.7625	.0250	.07290	-.113	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.7875	.0250	.07290	-.338	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0
.8125	.0250	.07290	-.563	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.8375	.0250	.07290	-.787	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.8625	.0250	.07290	-1.013	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.8875	.0250	.07290	-1.238	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.9100	.0200	.07290	-1.440	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.9300	.0200	.07290	-1.620	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.9500	.0200	.07290	-1.800	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.9700	.0200	.07290	-1.980	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	1.0
.9900	.0200	.07290	-2.160	.000	.00000	.00000	1.0000	1.0000	1.0000	1.0000	.0

SECTION INERTIAL AND STRUCTURAL CHRACTERISTICS
NUMBER OF INERTIAL STATIONS, MRI = 31

	TWIST	MASS	XI/R	XC/R	(KP/R)**2	EI-ZZ	EI-XX	I-THETA	GJ
RI = .0000	.00	.00000	.00000	.00000	.000000	.00000E+00	.00000E+00	.00000	.00000E+00
RI = .0600	.00	.00037	.00000	.00000	.000180	.34722E+06	.34722E+06	.00000	.00000E+00
RI = .0800	.00	1.78137	.00000	.00000	.000180	.34722E+06	.34722E+06	.00000	.00000E+00
RI = .0825	.00	1.74264	.00000	.00000	.000180	.34722E+06	.34722E+06	.00000	.00000E+00
RI = .1031	.00	1.41991	.00000	.00000	.000180	.34722E+06	.34722E+06	.00000	.00000E+00
RI = .1237	.00	1.09719	.00000	.00000	.000180	.67710E+05	.67710E+05	.00000	.43540E+05
RI = .1400	.00	.84224	.00000	.00000	.000180	.67710E+05	.67710E+05	.00970	.43540E+05
RI = .1409	-7.00	.83678	.00000	.00000	.000180	.67710E+05	.67710E+05	.00970	.43540E+05
RI = .1553	-7.00	.74857	.00000	.00000	.000180	.67710E+05	.67710E+05	.00970	.43540E+05
RI = .1800	-7.00	.59777	.00000	.00000	.000180	.67710E+05	.67710E+05	.00970	.43540E+05
RI = .1924	-7.00	.52174	.00000	.00000	.000180	.47917E+06	.25694E+06	.00970	.31944E+06
RI = .2016	-7.00	.49938	.00000	.00000	.000180	.47917E+06	.25694E+06	.00970	.31944E+06
RI = .2059	4.95	.49938	.00000	.00000	.000096	.20070E+05	.25694E+06	.00176	.20330E+05
RI = .2107	4.90	.17814	.00000	.00000	.000078	.20070E+05	.53190E+05	.00051	.20330E+05
RI = .2286	4.74	.05776	.00164	-.00030	.000194	.15470E+05	.53130E+05	.00041	.15070E+05
RI = .2463	4.58	.02683	.00341	-.00058	.000370	.89500E+04	.53060E+05	.00036	.98700E+04
RI = .3254	3.86	.02758	.00106	.00080	.000383	.35400E+04	.69510E+05	.00039	.33300E+04
RI = .3299	3.82	.02795	.00120	.00100	.000385	.35400E+04	.71600E+05	.00040	.33300E+04

RI = .4124	3.07	.02795	.00066	.00030	.000358	.35100E+04	.64980E+05	.00037	.33700E+04
RI = .4948	2.32	.02646	-.00124	-.00161	.000295	.33700E+04	.51750E+05	.00029	.34400E+04
RI = .7400	.09	.02646	-.00124	-.00063	.000290	.33300E+04	.47220E+05	.00028	.35100E+04
RI = .7600	-.09	.03727	-.00302	-.00161	.000300	.33700E+04	.44790E+05	.00058	.35100E+04
RI = .7800	-.27	.06298	.00859	-.00142	.000300	.30200E+04	.25690E+05	.00159	.35400E+04
RI = .7937	-.40	.06298	.00859	-.00142	.000300	.30200E+04	.25690E+05	.00159	.35400E+04
RI = .8000	-.46	.06298	.00859	-.00142	.000300	.30200E+04	.25760E+05	.00159	.35400E+04
RI = .8200	-.64	.04025	-.00247	-.00238	.000315	.29900E+04	.17360E+05	.00047	.36100E+04
RI = .9200	-1.55	.04025	-.00261	-.00238	.000315	.29200E+04	.17360E+05	.00047	.36100E+04
RI = .9400	-1.73	.05814	.00165	-.00238	.000300	.29200E+04	.16320E+05	.00041	.36100E+04
RI = .9729	-2.03	.07677	.00165	-.00161	.000300	.29200E+04	.15280E+05	.00041	.36100E+04
RI = .9800	-2.09	.08571	.00423	-.00161	.000300	.29200E+04	.15280E+05	.00041	.36100E+04
RI = 1.0000	-2.27	.08124	-.00161	-.00161	.000300	.29200E+04	.15280E+05	.00166	.36100E+04

TE-FLAP INERTIAL CHARACTERISTICS

RA (r/R)	MASSF	XHF (x/R)	XIF (x/R)	ITHETAH
.8125	.00000	.00000	.00000	.00000000
.8375	.00000	.00000	.00000	.00000000
.8625	.00000	.00000	.00000	.00000000
.8875	.00000	.00000	.00000	.00000000
.9100	.00000	.00000	.00000	.00000000
.9300	.00000	.00000	.00000	.00000000
.9500	.00000	.00000	.00000	.00000000
.9700	.00000	.00000	.00000	.00000000

TE-FLAP SPRING:
PRELOAD MOMENT, MS0 = .000 FT-LB
FLAP SPRING CONSTANT, KFS = .000 FT-LB/RAD

TE-FLAP DAMPING:
COULOMB FRICTION COEFF, C0F = .0000 FT-LB
VISCOUS DAMPING COEFF, C1F = .0000 FT-LB-SEC

TE-FLAP ANGLE FOR ZERO ACTUATOR STORED ENERGY, DELTAE = .00 DEG

FLAP SECTION CHARACTERISTICS
FLAP TRIM OPTION, OPFLAP = 3
FLAP AERODYNAMICS (0, FOR COEFFICIENT INCREMENTS; 1, FOR C81 FLAP TABLES), OPFT = 1

HIRES DATA (ROTOR 1)

HIRES ON/OFF SWITCH	OPINT = 1
NUMBER OF AZIMUTH STEPS	MPSIINT = 360
NUMBER OF RADIAL STATIONS	MRAINT = 70
FIRST AZIMUTH INDEX	JFIRST = 1
LAST AZIMUTH INDEX	JLAST = 360
TUNNEL/FUSELAGE CORRECTION OPTION	OPWFCOR = 0
NUMBER OF AZIMUTHS IN WAKE FILE PRINT	MPSIWGP = 36
NUMBER OF FAR WAKE ITERATIONS	ITERINT = 1
FAR WAKE RELAXATION FACTOR	FACTINT = 1.0000
NUMBER OF NEAR WAKE ITERATIONS	ITERNW = 0
NEAR WAKE RELAXATION FACTOR	FACTNW = .5000
NEAR WAKE EXTENT (NUMBER OF AGE STEPS)	KNWINT = 90
LIFTING SURFACE PARAMETER (USUALLY = -1.)	DLSINT = -1.0000
NEAR WAKE NEGATIVE TIP VORTEX IN FAR WAKE LOOPS	OPNEGV = 1
VORTEX SEGMENT DIVISION ON/OFF	OPSEGD = 1
NEAR WAKE PANEL MINIMIZE OPTION	OPNWMIN = 0
NEAR WAKE CIRCULATION UPDATE OPTION	OPNWCRC = 0

WAKE MODEL OPTIONS:

	WMDLINT(N)	WKMDL1(N)
N = 1	2	2
N = 2	0	0
N = 3	0	0
N = 4	0	0

N = 5	0	0
N = 6	2	2
N = 7	2	2
N = 8	2	2
N = 9	2	2
N = 10	2	2
N = 11	3	3
N = 12	3	3
N = 13	3	3

VORTEX CORE MODELS: OPDCORE = 0

FINAL CORE SIZES REVERT TO ROLLUP MODEL (SEE VORTEX ROLLUP DATA SECTION)

HIRES LATTICE NEAR WAKE CORE PARAMETERS:

SHED VORTICES VORTICITY OPTION OPCSNW = 0
SHED VORTICES MODEL OPTION MLDSNW = 2
SHED VORTICES CORE SIZE CORESNW = .0150R
TRAILED VORTICES VORTICITY OPTION OPCTNW = 0
TRAILED VORTICES MODEL OPTION MLDTNW = 2
TRAILED VORTICES CORE SIZE CORETNW = .0090R

HIRES RADIAL SEGMENT ENDPOINTS RAEINT =
.2925 .3000 .3100 .3200 .3300 .3400 .3500 .3600 .3700 .3800,
.3900 .4000 .4100 .4200 .4300 .4400 .4500 .4600 .4700 .4800,
.4900 .5000 .5100 .5200 .5300 .5400 .5500 .5600 .5700 .5800,
.5900 .6000 .6100 .6200 .6300 .6400 .6500 .6600 .6700 .6800,
.6900 .7000 .7100 .7200 .7300 .7400 .7500 .7600 .7700 .7800,
.7900 .8000 .8100 .8200 .8300 .8400 .8500 .8600 .8700 .8800,
.8900 .9000 .9100 .9200 .9300 .9400 .9500 .9600 .9700 .9800,
1.0000

RAINT	CORDINT	XAINT	XACINT	THZLINT	TWSTINT	RFLAP
.2962	.0729	.0000	.0000	.0000	4.0843	.0
.3050	.0729	.0000	.0000	.0000	4.0055	.0
.3150	.0729	.0000	.0000	.0000	3.9155	.0
.3250	.0729	.0000	.0000	.0000	3.8255	.0
.3350	.0729	.0000	.0000	.0000	3.7355	.0
.3450	.0729	.0000	.0000	.0000	3.6455	.0
.3550	.0729	.0000	.0000	.0000	3.5555	.0
.3650	.0729	.0000	.0000	.0000	3.4655	.0
.3750	.0729	.0000	.0000	.0000	3.3755	.0
.3850	.0729	.0000	.0000	.0000	3.2855	.0
.3950	.0729	.0000	.0000	.0000	3.1954	.0
.4050	.0729	.0000	.0000	.0000	3.1053	.0
.4150	.0729	.0000	.0000	.0000	3.0153	.0
.4250	.0729	.0000	.0000	.0000	2.9252	.0
.4350	.0729	.0000	.0000	.0000	2.8351	.0
.4450	.0729	.0000	.0000	.0000	2.7451	.0
.4550	.0729	.0000	.0000	.0000	2.6550	.0
.4650	.0729	.0000	.0000	.0000	2.5650	.0
.4750	.0729	.0000	.0000	.0000	2.4750	.0
.4850	.0729	.0000	.0000	.0000	2.3850	.0
.4950	.0729	.0000	.0000	.0000	2.2950	.0
.5050	.0729	.0000	.0000	.0000	2.2050	.0
.5150	.0729	.0000	.0000	.0000	2.1150	.0
.5250	.0729	.0000	.0000	.0000	2.0250	.0
.5350	.0729	.0000	.0000	.0000	1.9350	.0
.5450	.0729	.0000	.0000	.0000	1.8450	.0
.5550	.0729	.0000	.0000	.0000	1.7550	.0
.5650	.0729	.0000	.0000	.0000	1.6650	.0
.5750	.0729	.0000	.0000	.0000	1.5750	.0
.5850	.0729	.0000	.0000	.0000	1.4850	.0
.5950	.0729	.0000	.0000	.0000	1.3950	.0
.6050	.0729	.0000	.0000	.0000	1.3050	.0
.6150	.0729	.0000	.0000	.0000	1.2150	.0
.6250	.0729	.0000	.0000	.0000	1.1250	.0

.6350	.0729	.0000	.0000	.0000	1.0350	.0
.6450	.0729	.0000	.0000	.0000	.9450	.0
.6550	.0729	.0000	.0000	.0000	.8550	.0
.6650	.0729	.0000	.0000	.0000	.7650	.0
.6750	.0729	.0000	.0000	.0000	.6750	.0
.6850	.0729	.0000	.0000	.0000	.5850	.0
.6950	.0729	.0000	.0000	.0000	.4950	.0
.7050	.0729	.0000	.0000	.0000	.4050	.0
.7150	.0729	.0000	.0000	.0000	.3150	.0
.7250	.0729	.0000	.0000	.0000	.2250	.0
.7350	.0729	.0000	.0000	.0000	.1350	.0
.7450	.0729	.0000	.0000	.0000	.0448	.0
.7550	.0729	.0000	.0000	.0000	-.0454	.0
.7650	.0729	.0000	.0000	.0000	-.1355	.0
.7750	.0729	.0000	.0000	.0000	-.2255	.0
.7850	.0729	.0000	.0000	.0000	-.3155	.0
.7950	.0729	.0000	.0000	.0000	-.4055	.0
.8050	.0729	.0000	.0000	.0000	-.4955	1.0
.8150	.0729	.0000	.0000	.0000	-.5854	1.0
.8250	.0729	.0000	.0000	.0000	-.6750	1.0
.8350	.0729	.0000	.0000	.0000	-.7646	1.0
.8450	.0729	.0000	.0000	.0000	-.8548	1.0
.8550	.0729	.0000	.0000	.0000	-.9452	1.0
.8650	.0729	.0000	.0000	.0000	-1.0355	1.0
.8750	.0729	.0000	.0000	.0000	-1.1255	1.0
.8850	.0729	.0000	.0000	.0000	-1.2155	1.0
.8950	.0729	.0000	.0000	.0000	-1.3053	1.0
.9050	.0729	.0000	.0000	.0000	-1.3951	1.0
.9150	.0729	.0000	.0000	.0000	-1.4850	1.0
.9250	.0729	.0000	.0000	.0000	-1.5750	1.0
.9350	.0729	.0000	.0000	.0000	-1.6650	1.0
.9450	.0729	.0000	.0000	.0000	-1.7550	1.0
.9550	.0729	.0000	.0000	.0000	-1.8450	1.0
.9650	.0729	.0000	.0000	.0000	-1.9350	1.0
.9750	.0729	.0000	.0000	.0000	-2.0250	1.0
.9900	.0729	.0000	.0000	.0000	-2.1600	.0

RAINT	DRAINT	MCLINT	MCDINT	MCMINT	DRP
.2962	.0075	1.0000	1.0000	1.0000	.0000
.3050	.0100	1.0000	1.0000	1.0000	.0000
.3150	.0100	1.0000	1.0000	1.0000	.0000
.3250	.0100	1.0000	1.0000	1.0000	.0000
.3350	.0100	1.0000	1.0000	1.0000	.0000
.3450	.0100	1.0000	1.0000	1.0000	.0000
.3550	.0100	1.0000	1.0000	1.0000	.0000
.3650	.0100	1.0000	1.0000	1.0000	.0000
.3750	.0100	1.0000	1.0000	1.0000	.0000
.3850	.0100	1.0000	1.0000	1.0000	.0000
.3950	.0100	1.0000	1.0000	1.0000	.0000
.4050	.0100	1.0000	1.0000	1.0000	.0000
.4150	.0100	1.0000	1.0000	1.0000	.0000
.4250	.0100	1.0000	1.0000	1.0000	.0000
.4350	.0100	1.0000	1.0000	1.0000	.0000
.4450	.0100	1.0000	1.0000	1.0000	.0000
.4550	.0100	1.0000	1.0000	1.0000	.0000
.4650	.0100	1.0000	1.0000	1.0000	.0000
.4750	.0100	1.0000	1.0000	1.0000	.0000
.4850	.0100	1.0000	1.0000	1.0000	.0000
.4950	.0100	1.0000	1.0000	1.0000	.0000
.5050	.0100	1.0000	1.0000	1.0000	.0000
.5150	.0100	1.0000	1.0000	1.0000	.0000
.5250	.0100	1.0000	1.0000	1.0000	.0000
.5350	.0100	1.0000	1.0000	1.0000	.0000
.5450	.0100	1.0000	1.0000	1.0000	.0000
.5550	.0100	1.0000	1.0000	1.0000	.0000
.5650	.0100	1.0000	1.0000	1.0000	.0000
.5750	.0100	1.0000	1.0000	1.0000	.0000

.5850	.0100	1.0000	1.0000	1.0000	.0000
.5950	.0100	1.0000	1.0000	1.0000	.0000
.6050	.0100	1.0000	1.0000	1.0000	.0000
.6150	.0100	1.0000	1.0000	1.0000	.0000
.6250	.0100	1.0000	1.0000	1.0000	.0000
.6350	.0100	1.0000	1.0000	1.0000	.0000
.6450	.0100	1.0000	1.0000	1.0000	.0000
.6550	.0100	1.0000	1.0000	1.0000	.0000
.6650	.0100	1.0000	1.0000	1.0000	.0000
.6750	.0100	1.0000	1.0000	1.0000	.0000
.6850	.0100	1.0000	1.0000	1.0000	.0000
.6950	.0100	1.0000	1.0000	1.0000	.0000
.7050	.0100	1.0000	1.0000	1.0000	.0000
.7150	.0100	1.0000	1.0000	1.0000	.0000
.7250	.0100	1.0000	1.0000	1.0000	.0000
.7350	.0100	1.0000	1.0000	1.0000	.0000
.7450	.0100	1.0000	1.0000	1.0000	.0000
.7550	.0100	1.0000	1.0000	1.0000	.0000
.7650	.0100	1.0000	1.0000	1.0000	.0000
.7750	.0100	1.0000	1.0000	1.0000	.0000
.7850	.0100	1.0000	1.0000	1.0000	.0000
.7950	.0100	1.0000	1.0000	1.0000	.0000
.8050	.0100	1.0000	1.0000	1.0000	.0000
.8150	.0100	1.0000	1.0000	1.0000	.0000
.8250	.0100	1.0000	1.0000	1.0000	.0000
.8350	.0100	1.0000	1.0000	1.0000	.0000
.8450	.0100	1.0000	1.0000	1.0000	.0000
.8550	.0100	1.0000	1.0000	1.0000	.0000
.8650	.0100	1.0000	1.0000	1.0000	.0000
.8750	.0100	1.0000	1.0000	1.0000	.0000
.8850	.0100	1.0000	1.0000	1.0000	.0000
.8950	.0100	1.0000	1.0000	1.0000	.0000
.9050	.0100	1.0000	1.0000	1.0000	.0000
.9150	.0100	1.0000	1.0000	1.0000	.0000
.9250	.0100	1.0000	1.0000	1.0000	.0000
.9350	.0100	1.0000	1.0000	1.0000	.0000
.9450	.0100	1.0000	1.0000	1.0000	.0000
.9550	.0100	1.0000	1.0000	1.0000	.0000
.9650	.0100	1.0000	1.0000	1.0000	.0000
.9750	.0100	1.0000	1.0000	1.0000	.0000
.9900	.0200	1.0000	1.0000	1.0000	.0000

ROOT OFFSET DRPROOT = .0000
TIP OFFSET DRPTIP = .0000

MRGINT = 70
NGINT =
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20,
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40,
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60,
61 62 63 64 65 66 67 68 69 70
MRLINT = 70
NLINT =
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20,
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40,
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60,
61 62 63 64 65 66 67 68 69 70

INDICIAL AERO DATA (ROTOR 1)

INDICIAL AERO NOT USED IN THIS RUN

AERODYNAMICS MODEL CHOICE OPBED = 0
INBOARD TRAILED NW CORE SIZE (DEFAULT < 0.) HCOR = -.0500
CURVED(1) OR STRAIGHT(2) NW (DEFAULT = 1) ICURV = 1
LEAD TERMS ON/OFF (DEFAULT = 1 (ON)) ILEED = 1

AERODYNAMIC SWEEP DATA (ROTOR 1)

RAINT	SWEEP	RAE	SWEEP
.2962	.0000	.2925	.0000
.3050	.0000	.3775	.0000
.3150	.0000	.4550	.0000
.3250	.0000	.5200	.0000
.3350	.0000	.5750	.0000
.3450	.0000	.6200	.0000
.3550	.0000	.6600	.0000
.3650	.0000	.7000	.0000
.3750	.0000	.7350	.0000
.3850	.0000	.7625	.0000
.3950	.0000	.7875	.0000
.4050	.0000	.8125	.0000
.4150	.0000	.8375	.0000
.4250	.0000	.8625	.0000
.4350	.0000	.8875	.0000
.4450	.0000	.9100	.0000
.4550	.0000	.9300	.0000
.4650	.0000	.9500	.0000
.4750	.0000	.9700	.0000
.4850	.0000	.9900	.0000
.4950	.0000		
.5050	.0000		
.5150	.0000		
.5250	.0000		
.5350	.0000		
.5450	.0000		
.5550	.0000		
.5650	.0000		
.5750	.0000		
.5850	.0000		
.5950	.0000		
.6050	.0000		
.6150	.0000		
.6250	.0000		
.6350	.0000		
.6450	.0000		
.6550	.0000		
.6650	.0000		
.6750	.0000		
.6850	.0000		
.6950	.0000		
.7050	.0000		
.7150	.0000		
.7250	.0000		
.7350	.0000		
.7450	.0000		
.7550	.0000		
.7650	.0000		
.7750	.0000		
.7850	.0000		
.7950	.0000		
.8050	.0000		
.8150	.0000		
.8250	.0000		
.8350	.0000		

.8450	.0000
.8550	.0000
.8650	.0000
.8750	.0000
.8850	.0000
.8950	.0000
.9050	.0000
.9150	.0000
.9250	.0000
.9350	.0000
.9450	.0000
.9550	.0000
.9650	.0000
.9750	.0000
.9900	.0000

CFD DATA (ROTOR 1)

CFD INFO NOT USED IN THIS RUN

CFD INFO USAGE OPCFD = 0
BVI INFO USAGE OPBVI = 0
BLADE MOTION OUTPUT FILE OPMOTN = 0
WAKE AGE CUTOFF FOR VORTEX SEGMENT CFD TEST PHICFD = 45.0000

CFD BOX		BVI BOX	
FORWARD	.0000	UPSTREAM	.0000
OUTBOARD	.0000	STARBOARD	.0000
T.E.	.0000	DWNSTREAM	.0000
INBOARD	.0000	PORT	.0000
UPPER	.0000	UPPER	.0000
LOWER	.0000	LOWER	.0000

WOPWOP/ROTONET INTERFACE

WOPWOP/ROTONET INTERFACE NOT USED IN THIS RUN

WOPWOP/ROTONET INTERFACE OUTPUT NOISFL = 0

BURST DATA (ROTOR 1)

BURST MODEL NOT USED IN THIS RUN

VORTEX BURST OPTION OPBURST = 0
AZIMUTH TOLERANCE PSITOL = -1.0000
VERTICAL DISTANCE TOLERANCE (Z/R) ZTOL = .0000
CORE SIZE BURST FACTOR CORMULT = .0000
CIRCULATION BURST FACTOR CIRMULT = .0000

HHC DATA (ROTOR 1)

*** HHC NOT USED IN THIS CASE ***

VORTEX ROLLUP DATA (ROTOR 1)

*** ROLLUP MODEL USED IN TRIM AND HIRES ***

ROLLUP OPTION OPROLLU = 3
NUMBER OF TIP VORTEX CORES (MAX = 10) NTCORE = 9
NUMBER OF SECONDARY VORTEX CORES (MAX = 10) NSCOR = 9
TIP CORE SIZES (RE. R) = .0100 .0167 .0233 .0300 .0450 .0750 .1000 .1500 .2000
SECONDARY CORE SIZES (RE. R) = .0100 .0167 .0233 .0300 .0450 .0750 .1000 .1500 .2000
WRITE ROLLUP INFO IN TRIM OPLOWR = 1
WRITE ROLLUP INFO IN HIRES OPHIWR = 1
NUMBER OF ROLLUP CONVERGENCE ITERATIONS ITERRUP = 2
NUMBER OF WAKE-TRIM ITERATIONS WITH ROLLUP ITERFRU = 2
TIP CORE SIZE FOR "LARGE CORE" CALCULATION CORELG = .3000R
NUMBER OF LARGE CORE CIRCULATION ITERATIONS ITERLGC = 20
LAG FACTOR FOR LARGE CORE ITERATIONS FLGCORG = .1000

PHASE-IN MODEL (0 POLYNOMIAL, 1 SPREITER/SACKS) OPROLSS = 0
POLYNOMIAL:
NUMBER OF COEFFS FOR "PHASE-IN" FUNCTION NTIPFCT = 1
— PHASE-IN WILL BE LINEAR.
VALUES FOR PHASE-IN FUNCTION
TIPFC0 .0000
TIPFC(1) .1592
TIPFC(2) .0000
TIPFC(3) .0000
TIPFC(4) .0000
TIPFC(5) .0000
TIPFC(6) .0000
TIPFC(7) .0000
TIPFC(8) .0000
TIPFC(9) .0000
TIPFC(10) .0000
PHASE-IN OF SECONDARY VORTEX (ON/OFF) ISECPH = 0
SPREITER/SACKS:
CONSTANT IN SPREITER/SACKS ROLLUP MODEL (XY) CROLSSXY= .1250
CONSTANT IN SPREITER/SACKS ROLLUP MODEL (Z) CROLSSZ = .1250

SPIN OPTION ISPIN = 1
AGE TO START SPIN CALCULATIONS AFTER TAUC0 = .0000
TIME CONSTANT FACTOR (TAUC1*TAU) TAUC1 = 1.0000
ROLLUP Z CORRECTION OPTION (ON/OFF) IRUZCOR = 0
NUMBER OF WAKES TO SEARCH IN ROLLUP Z CORRECTION NSEARCH = 6
ROLLUP Z CORRECTION MODEL IRUDZ = 0
MULTI-CORE MODEL (0 (DEFAULT), 1, OR 2) ICORYCB = 2
EXPONENT IN CORE SIZE MODEL (DEFAULT = 1) COREXP = 2
LARGE CORE CIRCULATION USAGE IN FREE WAKE IFWLGC = 1

MEASURED MOTION DATA (ROTOR 1)

*** MEASURED MOTION IS NOT BEING USED ***

MEASURED AERO DATA (ROTOR 1)

*** MEASURED AERO IS NOT BEING USED ***

NONUNIFORM INFLOW MODEL
EXTENT OF NEAR WAKE, KNW = 9
EXTENT OF ROLLING UP WAKE, KRW = 9
EXTENT OF FAR WAKE, KFW = 108
EXTENT OF DISTANT WAKE, KDW = 108
ROLLUP INITIAL RADIAL STATION, RRU = 1.0000
ROLLUP INITIAL TIP VORTEX FRACTION, FRU = .0000
ROLLUP EXTENT (DEG), PRU = .00
NEAR WAKE TIP VORTEX FRACTION, FNW = .0000

NUMBER OF SPIRALS IN AXISYMMETRIC FAR WAKE, LHW = 30
AXISYMMETRIC WAKE GEOMETRY IF 0, OPHW = 1
NUMBER OF CIRCULATION POINTS, MRG = 20
CIRCULATION POINTS (AERODYNAMIC SEGMENT NUMBER), NG = 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20
NUMBER OF INFLOW POINTS, MRL = 20
INFLOW POINTS (AERODYNAMIC SEGMENT NUMBER), NL = 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20
VORTEX CORE RADII
CORE(1) = .03000 TIP VORTICES
CORE(2) = -.03000 BURST TIP VORTICES
CORE(3) = .03000 DISTANT WAKE TIP VORTICES
CORE(4) = -1.00000 INBOARD TRAILED LINES
CORE(5) = -1.00000 INBOARD SHED LINES
VORTEX CORE TYPE (0 FOR DISTRIBUTED VORTICITY, 1 FOR CONCENTRATED VORTICITY)
OPCORE(1) = 0 TIP VORTICES
OPCORE(2) = 0 INBOARD WAKE

WAKE MODEL (0 TO OMIT, 1 FOR STEPPED LINE, 2 FOR LINEAR LINE, 3 FOR SHEET)
WKMODL(1) = 2 TIP VORTICES
WKMODL(2) = 2 NEAR WAKE SHED
WKMODL(3) = 2 NEAR WAKE TRAILED
WKMODL(4) = 2 ROLLING UP WAKE SHED
WKMODL(5) = 2 ROLLING UP WAKE TRAILED
WKMODL(6) = 2 FAR WAKE SHED
WKMODL(7) = 2 FAR WAKE TRAILED
WKMODL(8) = 2 DISTANT WAKE SHED
WKMODL(9) = 2 DISTANT WAKE TRAILED
WKMODL(10) = 2 BOUND VORTICES
WKMODL(11) = 3 HOVER WAKE AXIAL
WKMODL(12) = 3 HOVER WAKE SHED
WKMODL(13) = 3 HOVER WAKE RING

CORE BURST PROPAGATION RATE, VELB = .3330
CORE BURST AGE INCREMENT, DPHIB = .000
CORE BURST CRITERION (LT 0. TO SUPPRESS), DBV = -1.000000
SHEET EDGE TEST CRITERION (LT 0. TO SUPPRESS), DVS = -1.000000
LIFTING SURFACE CORRECTION CRITERION (LT 0. TO SUPPRESS), DLS = -1.000000
FACTOR INTRODUCING LAG IN CIRCULATION FOR INDUCED VELOCITY, FACTWN = .0075
SUPPRESS X AND Y COMPONENTS OF INFLOW AT ROTORS IF 0, OPVXVY = 1
NEAR WAKE OPTION WHEN CIRC/INFLOW PT COINCIDE (0 FOR TWO SHEETS, 1 FOR LINES, 2 FOR SINGLE SHEET)
OPNWS(1) = 1 SHED WAKE
OPNWS(2) = 1 TRAILED WAKE
INCLUDE ROTATION MATRICES IN INFLUENCE COEFFICIENTS IF 1, OPRTS = 0
BLADE POSITION MODEL FOR WAKE GEOMETRY
OPWKBP(1) = 1 SUPPRESS INPLANE MOTION IF 0
OPWKBP(2) = 1 SUPPRESS ALL HARMONICS EXCEPT MEAN IF 0
OPWKBP(3) = 1 LINEAR FROM ROOT TO TIP IF 0
DEBUG PRINT CRITERION, QDEBUG = 1000.000000

PRESCRIBED WAKE GEOMETRY
EXTENT OF RIGID WAKE GEOMETRY, KRWG = 108
RIGID WAKE GEOMETRY MODEL, OPRWG = 1
PRESCRIBED WAKE GEOMETRY PARAMETERS

	TIP VORTEX	INSIDE SHEET EDGE	OUTSIDE SHEET EDGE
F1	1.000000	1.000000	1.000000
F2	1.000000	1.000000	1.000000
K1	1.000000	1.000000	1.000000
K2	1.000000	1.000000	1.000000
K3	1.000000	1.000000	1.000000
K4	1.000000	1.000000	1.000000

FREE WAKE GEOMETRY
EXTENT OF FREE WAKE GEOMETRY, KFWG = 108
FREE WAKE GEOMETRY MODEL, OPFWG = 1
WAKE MODEL (0 TO OMIT, 1 FOR LINE, 2 FOR SHEET)

```
     WGMODL(1) = 1        INBOARD TRAILED WAKE
     WGMODL(2) = 1        SHED WAKE
  VORTEX CORE RADII
     COREWG(1) =  .09000       TIP VORTICES
     COREWG(2) =  -.03000      BURST TIP VORTICES
     COREWG(3) =  1.00000      INBOARD TRAILED LINES
     COREWG(4) =  -1.00000     INBOARD SHED LINES
  RADIAL STATIONS FOR TRAILED VORTICITY
     RTWG(1) =   .1000     INSIDE SHEET EDGE
     RTWG(2) =   .4000     OUTSIDE SHEET EDGE OR TRAILED LINE
  NUMBER OF REVOLUTIONS OF WAKE BELOW POINT CALCULATING VELOCITY,  MRVBWG =  2
  GENERAL UPDATE,  LDMWG =  18
  BOUNDARY UPDATE,  NDMWG =  9  9  9  9  9  4  4  4  4  4  4  4  4  4  9  9  9  9
              9  9  9  9  9  4  4  4  4  4  4  4  4  4  9  9  9  9
  WAKE VELOCITY CRITERIA
     DQWG(1) =  .000500      NEAR WAKE ELEMENTS
     DQWG(2) =  .000500      BOUND VORTEX
  NUMBER OF WAKE GEOMETRY ITERATIONS,  ITERWG =  8
  FACTOR INTRODUCING LAG IN DISTORTION,  FACTWG =   .50000
  DEBUG PRINT CRITERIA
     IPWGDB(1) =   6        PRINT BEFORE GENERAL UPDATE
     IPWGDB(2) =   6        PRINT AFTER EACH ITERATION
     QWGDB    =  .100000     PRINT VELOCITY CONTRIBUTION
1AIRFRAME DATA
 -------------

  TITLE =

  CONFIGURATION (0 FOR ONE ROTOR, 1 FOR SINGLE MR/TR, 2 FOR TANDEM, 3 FOR TILTROTOR),  CONFIG =  0
  GROSS WEIGHT (LB OR KG) =        .0000
  AIRCRAFT MOMENTS OF INERTIA
     IXX =      .0000        IXY =       .0000
     IYY =      .0000        IXZ =       .0000
     IZZ =      .0000        IYZ =       .0000
  TRANSMISSION GEAR RATIO (OMEGA2/OMEGA1),  TRATIO =   1.0000
  SHAFT ANGLE OF ATTACK (DEG),  ASHAFT =     .00        .00
  SHAFT CANT ANGLE (DEG),  ACANT =          .00        .00
  ROTOR-2 AZIMUTH ANGLE (DEG) WHEN ROTOR-1 AZIMUTH ANGLE IS ZERO,  DPSI21 =      .00
  HORIZONTAL TAIL CANT ANGLE (DEG),  CANTHT =      .00
  VERTICAL TAIL CANT ANGLE (DEG),  CANTVT =      .00
  LOCATION OF AIRCRAFT COMPONENTS --       FUSELAGE STATION     BUTTLINE      WATERLINE
     CENTER OF GRAVITY                  .0000          .0000          .0000
     ROTOR-1 HUB                        .0000          .0000          .0000
     ROTOR-2 HUB                        .0000          .0000          .0000
     WING-BODY                          .0000          .0000          .0000
     HORIZONTAL TAIL                    .0000          .0000          .0000
     VERTICAL TAIL                      .0000          .0000          .0000
     POINT OFF ROTOR                    .0000          .0000          .0000

CONTROL SYSTEM --              GAIN              PHASE
  COLLECTIVE                1.000000
  LATERAL CYCLIC            1.000000             .000
  LONGITUDINAL CYCLIC       1.000000             .000
  PEDAL                     .000000
  FLAPERON                  .000000
  THROTTLE                  .000000
  AILERON                   .000000
  ELEVATOR                  .000000
  RUDDER                    .000000
  CONTROL INPUTS WITH STICKS CENTERED,  CNTRLZ =     .00      .00      .00      .00      .00      .00
                                 .00      .00      .00      .00      .00

AIRCRAFT AERODYNAMIC CHARACTERISTICS
  WING-BODY INCIDENCE ANGLE (DEG),  IWB =     .00
  WING-BODY MAXIMUM ANGLE OF ATTACK (DEG),  AMAXW =      .00
  WING-BODY INDUCED DRAG (L**2/DI),  DRGIW =       .0000
  WING-BODY VERTICAL DRAG,  DRGVW =       .0000
```

	BASE	ANGLE-OF-ATTACK	FLAP	FLAPERON
WING-BODY LIFT		.000	.000	.000
WING-BODY DRAG	.000		.000	.000
WING-BODY MOMENT	.000	.000	.000	.000

	SIDESLIP	ROLLING	YAWING	AILERON
WING-BODY SIDE	.000	.000	.000	
WING-BODY ROLL	.000	.000	.000	.000
WING-BODY YAW	.000	.000	.000	.000

	ANGLE-OF-ATTACK	CONTROL	INCIDENCE	ALPHA-MAX
HORIZONTAL TAIL LIFT	.000	.000	.00	.00
VERTICAL TAIL LIFT	.000	.000	.00	.00

SUPPRESS AIRFRAME/TAIL INTERFERENCE IF 0, OPTINT = 0
AREA FOR WING/TAIL INTERFERENCE, FETAIL = .000
HORIZONTAL TAIL LENGTH FOR INTERFERENCE, LHTAIL = .000
VERTICAL TAIL HEIGHT FOR INTERFERENCE, HVTAIL = .000

DRIVE TRAIN MODEL
CONFIGURATION (0 FOR ONE RTR, 1 FOR ENG BY RTR-1, 2 FOR ENG BY RTR-2, 3 FOR SYM), ENGPOS = 0
ENGINE POWER/THROTTLE DERIVATIVE, THRTLC = .000
ENGINE DAMPING FACTOR, KEDAMP = .0000
ENGINE ROTARY INERTIA, IENG = .000
ROTOR-1 SHAFT SPRING CONSTANT, KMAST1 = .00000E+00
ROTOR-2 SHAFT SPRING CONSTANT, KMAST2 = .00000E+00
INTERCONNECT SHAFT SPRING CONSTANT, KICS = .00000E+00
ENGINE SHAFT SPRING CONSTANT, KENG = .00000E+00
ENGINE SHAFT STRUCTURAL DAMPING, GSE = .00000
INTERCONNECT SHAFT STRUCTURAL DAMPING, GSI = .00000

GOVERNOR PARAMETERS --	ENGINE	ROTOR-1	ROTOR-2
PROPORTIONAL GAIN	.000000	.000000	.000000
INTEGRAL GAIN	.000000	.000000	.000000
TIME LAG 1	.000000	.000000	.000000
TIME LAG 2	.000000	.000000	.000000

1MAIN ROTOR BLADE MODES OMEGA = 112.470 RAD/SEC, = 17.900 HZ, = 1074.01 RPM

BENDING MODES, HINGED BLADE (T75 = 4.92)

FREQUENCY (PER REV) = .483 1.074 2.953 5.128 5.554 10.325 11.915 18.292 23.646 27.852
39.019 46.009 48.438 56.320 69.788 73.169 97.474 126.348 195.644 246.331

FREQUENCY (HZ) = 8.649 19.233 52.864 91.799 99.417 184.819 213.286 327.434 423.259 498.548
698.441 823.561 867.049 1008.146 1249.210 1309.745 1744.797 2261.653 3502.056 4409.366

MODE NUMBER 1	R =	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
DEFLECTION	FLAP	.000	.000	.000	.000	.001	.002	.004	.005	.007	.008	.009
	LEAD	.000	-.018	-.119	-.223	-.330	-.439	-.549	-.661	-.773	-.886	-1.000
SLOPE	FLAP	.000	.000	-.002	.004	.014	.015	.015	.013	.012	.011	.011
	LEAD	.000	-1.006	-1.029	-1.057	-1.079	-1.096	-1.111	-1.120	-1.128	-1.134	-1.136
CURVATURE	FLAP	.000	-.008	.002	.107	.057	-.005	-.010	-.018	-.010	-.008	.000
	LEAD	.000	-.080	-.303	-.253	-.182	-.167	-.117	-.084	-.063	-.059	.000

MODE NUMBER 2	R =	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
DEFLECTION	FLAP	.000	.017	.117	.219	.325	.434	.545	.658	.771	.885	1.000
	LEAD	.000	.000	.001	.003	.004	.004	.005	.005	.006	.006	.007
SLOPE	FLAP	.000	.997	1.003	1.035	1.080	1.103	1.120	1.129	1.138	1.144	1.148
	LEAD	.000	.012	.013	.011	.007	.006	.005	.006	.006	.006	.006
CURVATURE	FLAP	.000	.009	.147	.475	.337	.188	.120	.097	.063	.065	.000
	LEAD	.000	.008	.010	-.046	-.029	-.004	-.001	.000	.002	.002	.000

MODE NUMBER 3 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 -.057 -.379 -.658 -.806 -.803 -.664 -.399 -.018 .462 .992
LEAD .000 .008 .054 .092 .110 .106 .084 .047 -.002 -.060 -.123

SLOPE FLAP .000 -3.241 -3.143 -2.265 -.676 .715 2.042 3.239 4.363 5.157 5.357
LEAD .000 .457 .444 .300 .058 -.134 -.301 -.432 -.542 -.613 -.630

CURVATURE FLAP .000 -.014 3.417 14.205 15.350 13.326 12.731 11.603 10.274 5.059 .000
LEAD .000 .021 -.571 -2.252 -2.234 -1.750 -1.511 -1.182 -.963 -.427 .000

MODE NUMBER 4 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 -.008 -.054 -.069 .016 .162 .285 .316 .204 -.070 -.435
LEAD .000 .059 .380 .610 .717 .705 .570 .326 .000 -.422 -.901

SLOPE FLAP .000 -.456 -.426 .289 1.315 1.466 .874 -.342 -1.949 -3.392 -3.736
LEAD .000 3.378 2.890 1.666 .485 -.741 -1.937 -2.867 -3.714 -4.638 -4.842

CURVATURE FLAP .000 -.226 2.401 11.354 6.418 -2.502 -9.476 -14.256 -17.289 -9.197 .000
LEAD .000 -.925 -9.670 -12.627 -11.803 -12.297 -11.307 -7.435 -10.365 -5.815 .000

MODE NUMBER 5 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 .051 .334 .478 .268 -.180 -.614 -.819 -.628 .023 .929
LEAD .000 .011 .065 .112 .175 .234 .248 .195 .072 -.128 -.369

SLOPE FLAP .000 2.925 2.545 -.161 -3.758 -4.776 -3.543 -.283 4.270 8.356 9.320
LEAD .000 .599 .477 .517 .694 .413 -.170 -.874 -1.621 -2.303 -2.446

CURVATURE FLAP .000 -.076 -12.110 -39.606 -24.497 1.692 23.582 39.818 49.174 25.867 .000
LEAD .000 -.403 -1.360 2.336 -.323 -4.625 -6.911 -6.876 -8.209 -4.089 .000

MODE NUMBER 6 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 -.041 -.258 -.119 .635 1.194 .873 -.123 -.860 -.402 .994
LEAD .000 .017 .101 .086 -.063 -.201 -.224 -.141 -.037 .043 .107

SLOPE FLAP .000 -2.357 -1.402 4.950 8.420 1.530 -7.589 -10.659 -2.256 10.922 15.143
LEAD .000 .985 .538 -.944 -1.727 -.867 .401 1.085 .924 .698 .616

CURVATURE FLAP .000 -.888 33.883 75.490 -22.653 -96.191 -74.016 24.705 131.576 102.299 .000
LEAD .000 -.675 -10.091 -15.729 1.945 12.459 11.452 1.444 -2.738 -1.761 .000

MODE NUMBER 7 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 -.015 -.083 -.058 .089 .222 .214 .070 -.068 -.065 .051
LEAD .000 -.063 -.331 -.312 -.055 .294 .618 .759 .618 -.018 -.999

SLOPE FLAP .000 -.852 -.362 .944 1.714 .728 -.893 -1.716 -.784 .781 1.306
LEAD .000 -3.562 -1.383 1.643 3.212 3.628 2.512 .253 -3.600 -8.802 -10.170

CURVATURE FLAP .000 1.134 9.290 14.329 -1.711 -15.315 -14.983 .769 15.515 12.459 .000
LEAD .000 6.819 31.388 24.876 7.939 -.770 -20.681 -24.787 -54.446 -36.179 .000

MODE NUMBER 8 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 .034 .187 -.351 -1.276 -.633 .942 1.080 -.396 -.783 1.000
LEAD .000 -.009 -.044 .058 .234 .175 -.042 -.125 -.042 .029 .015

SLOPE FLAP .000 1.973 -.283 -10.375 -3.639 15.104 11.640 -9.363 -14.726 9.463 21.252
LEAD .000 -.502 .063 1.925 .897 -1.893 -1.853 .218 1.085 .195 -.283

CURVATURE FLAP .000 2.548 -75.753 -64.552 189.828 110.590 -166.336 -192.544 123.069 262.096 .000
LEAD .000 .083 15.460 11.049 -28.647 -17.541 16.128 18.860 -2.460 -10.525 .000

MODE NUMBER 9 R = .0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
DEFLECTION FLAP .000 .011 .033 -.055 -.189 -.170 .004 .104 .048 -.021 -.014
LEAD .000 .058 .181 -.235 -.783 -1.014 -.649 .127 .806 .424 -1.000

SLOPE FLAP .000 .599 -.303 -1.375 -.888 1.284 1.726 .124 -.953 -.243 .191
LEAD .000 3.215 -1.587 -5.793 -4.496 .497 6.355 8.490 3.093 -10.753 -15.587

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     CURVATURE  FLAP     .000 -2.983 -12.341 -6.332 17.486 18.050 -9.108 -18.141 -.439 9.557 .000
           LEAD     .000 -15.540 -63.812 -11.018 31.336 65.874 40.965 -1.464-116.728-116.958 .000

   MODE NUMBER 10       R = .0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
     DEFLECTION  FLAP     .000  -.028  -.084  .585  .890  -.581  -.733  .732  .346  -.933  .999
           LEAD     .000  .004  .015  -.096  -.149  .060  .115  -.037  -.041  .047  -.045

     SLOPE     FLAP     .000 -1.581  1.970  9.712  -7.877 -13.968 11.262 10.720 -17.497  2.954 26.641
           LEAD     .000  .235  -.303  -1.597  1.114  2.066  -1.020  -1.255  1.065  .005  -1.330

     CURVATURE  FLAP     .000  2.283  88.389 -17.612-247.881 175.593 200.410-225.084-154.585 450.269  .000
           LEAD     .000  .295 -15.511  4.029 35.489 -21.128 -25.038 19.554 12.776 -25.622  .000

 TORSION MODES

   FREQUENCY (PER REV) =  16.061   7.964  28.720  41.858  60.353
            74.197  84.180  95.445 115.080 136.633 156.186

   FREQUENCY (HZ)    = 287.501 142.548 514.091 749.258 1080.324
           1328.136 1506.843 1708.484 2059.944 2445.752 2795.762

   MODE NUMBER  1       R = .0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
     DEFLECTION          .000  .000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
     SLOPE          .000  .000  .000  .000  .000  .000  .000  .000  .000  .000  .000

   MODE NUMBER  2       R = .0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
     DEFLECTION          .000  .000  .009  .077  .263  .449  .623  .778  .908  .973 1.000
     SLOPE          .000  .000  .208 1.377 1.998 1.787 1.635 1.507  .959  .458  .000

   MODE NUMBER  3       R = .0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
     DEFLECTION          .000  .000  -.043  -.321  -.950 -1.239 -1.124  -.666  .011  .672 1.000
     SLOPE          .000  .000  -.870 -5.504 -5.222  -.847  3.168  5.807  7.232  5.633  .000

   MODE NUMBER  4       R = .0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
     DEFLECTION          .000  .000  .049  .318  .782  .639  .074  -.558  -.655  .361 1.000
     SLOPE          .000  .000  .972  4.959  2.197 -4.281 -6.501 -5.349  5.297 11.473  .000

   MODE NUMBER  5       R = .0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
     DEFLECTION          .000  .000  -.366 -1.283 -2.014  .525  2.302  1.290  -.983  -.254 1.000
     SLOPE          .000  .000 -4.688 -16.580 12.507 26.837  6.964 -25.908 -9.387 18.173  .000

   RIGID PITCH FREQUENCY (PER REV) -- COLLECTIVE =  16.061,   CYCLIC =  14.039,   REACTIONLESS =
26.432
   RIGID PITCH FREQUENCY (HZ)    -- COLLECTIVE = 287.501,   CYCLIC = 251.306,   REACTIONLESS =
473.135

  NUMBER OF BENDING MODES =  10       NUMBER OF COLLOCATION FUNCTIONS =  20
  NUMBER OF TORSION MODES =  5       NUMBER OF COLLOCATION FUNCTIONS =  10
  FLAP HINGE OFFSET =     .0825    LAG HINGE OFFSET =     .0825
  FLAP HINGE SPRING =      .00    LAG HINGE SPRING =    2805.00
  HINGE PITCH ANGLE =   .00 +  1.0000 * T75  =   4.92
  HINGE SLOPE, FLAP = -.0001  .9972 -3.2406  -.4535 2.9252 -2.3480  -.8620 1.9483  .6255 -1.5988
  HINGE SLOPE, LEAD = -1.0049  .0115  .4572 3.3858  .6025  .9908 -3.6216  -.5020 3.3516  .2320
  STRUCTURAL COUPLING = 1.0000
  PITCH/BENDING KINEMATIC COUPLING, KP = .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000
  COLLECTIVE, CYCLIC, REACTIONLESS PITCH STIFFNESS =  18462.00  14106.00  50000.00
  MB = 10.4704 *IB/R**2 =  1.037    SB = 2.2313 *IB/R =  1.340    I0 = 1.0126 *IB =   3.687
  IP =  .001554 *IB =   .0057
  REFERENCE -- IB =   3.641     RADIUS =   6.063
  PRECONE =   .00         DROOP =   .00            SWEEP =   .00
  PITCH AXIS DROOP =   .00       PITCH AXIS SWEEP =   .00
1*************
 AIRCRAFT TRIM
 *************
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NONUNIFORM INFLOW WITH FREE WAKE GEOMETRY
WAKE/TRIM ITERATION NUMBER  3   (MAXIMUM =  3)

NUMBER OF TRIM ITERATION =  1   (MAXIMUM = 80,  TOLERANCE =  .00050)
WIND TUNNEL, TRIM OPTION NUMBER  15

  FORCES                                CONTROL
         TRIMMED    TARGET     ERROR              TRIMMED          INPUT
  ** CT/S    .0769408  .0769300  .0001403 **    ** DEL0   =  5.25   COLL   =  6.29 **
    CP/S    .0027057  .0000000  .0000000       ** DELC   =  -1.04  LATCYC =  -2.84 **
    CL/S    .0765351  .0000000  .0000000       ** DELS   =   .37   LNGCYC =  3.25 **
    CX/S    .0080267  .0000000  .0000000          THETA-T =  5.01   APITCH =  5.01
    CY/S    -.0006563  .0000000  .0000000         PSI-T   =   .00   AYAW   =   .00
  ** BETAC      .0133     .0000  .0002325 **
  ** BETAS     -.0048     .0000  .0000841 **


  COLLECTIVE CONTROLS -- DEL0 =  5.25   TGOVR1=   .00   TGOVR2=   .00
  THROTTLE CONTROLS   -- DELT =   .00   C-T  =   .00
  AIRCRAFT CONTROLS   -- DELF =   .00   DELE =   .00   DELA =   .00   DELR =   .00
  ROTOR CONTROLS      -- T75  =  5.25   T1C  =  1.04   T1S  =  -.37
1***********
PERFORMANCE
***********


 VEL   =  .1494 =  101.87   DPHI-F  =  .0000 =    .00   THETA-FT =   .00   T75-R1 =  5.25
 Q     = .01116 =   12.67   DTHETA-F=  .0000 =    .00   PHI-FT   =   .00   T1C-R1 =  1.04
                            DPSI-F  =  .0000 =    .00                        T1S-R1 =  -.37
                                         THETA-FP =   .00   T75-R2 =   .00
 VELX  =  .1494 =  101.87   DX-F    =  .0000 =    .00   PSI-FP   =   .00   T1C-R2 =   .00
 VELY  =  .0000 =     .00   DY-F    =  .0000 =    .00                        T1S-R2 =   .00
 VELZ  =  .0000 =     .00   DZ-F    =  .0000 =    .00   THETA-T  =  5.01   DELF   =   .00
                                         PSI-T    =   .00   DELE   =   .00
 VCLIMB=  .0000 =     .00   DDZ-F   =  .0000 =    .00                      DELA   =   .00
 VSIDE =  .0000 =     .00                                          DELR   =   .00
 CW/S  =  .0000 =      .0   DOMEGA  =  .0000 =    .00                      DELT   =   .00


CONVERGENCE

  CIRCULATION ITERATIONS =  3        (MAXIMUM = 70,    TOLERANCE =  .00010)

    ROTOR-1   CG/S-RMS =  .0000379        G/E =  .3795

  BLADE MOTION ITERATIONS =  1        (MAXIMUM = 50,    TOLERANCE =  .00800)

    ROTOR-1
         BETA-RMS  =  .0002  .0016  .0001  .0000  .0000  .0000  .0000  .0000  .0000  .0000
         THETA-RMS =  .0000  .0002  .0000  .0000  .0000

         BETA/E    =  .0309  .1938  .0078  .0009  .0014  .0005  .0001  .0001  .0000  .0000
         THETA/E   =  .0009  .0225  .0006  .0002  .0000


AIRFRAME PERFORMANCE
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 AERODYNAMIC LOADS
   WB-LIFT  =      .00   WB-SIDE  =     .00   HT-LIFT  =     .00   VT-LIFT  =     .00
   WB-DRAG  =      .00   WB-ROLL  =     .00   HT-DRAG  =     .00   VT-DRAG  =     .00
   WB-PITCH =      .00   WB-YAW   =     .00

 WING-BODY
   ALPHA   =   .00   DELF  =   .00   LIFT/Q      =  .000   SIDE FORCE/Q =  .000
   BETA    =   .00   DELA  =   .00   DRAG/Q      =  .000   ROLL MOM/Q   =  .000
   DALPHA  =  .000   AFLAP =   .00   PITCH MOM/Q =  .000   YAW MOM/Q    =  .000
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   Q-WB    =  12.67   LX-R1 =  .0000   LX-R2    =  .0000   VELX-WB   =  .149
   Q-RATIO =  1.0000  LY-R1 =  .0000   LY-R2    =  .0000   VELY-WB   =  .000
                      LZ-R1 =  .0000   LZ-R2    =  .0000   VELZ-WB   =  .000

 HORIZONTAL TAIL
   ALPHA   =    .00   DELE  =  .0000   LIFT/Q   =  .000    DRAG/Q    =  .000
   Q-HT    =  12.67   LX-R1 =  .0000   LX-R2    =  .0000   VELX-HT   =  .149
   Q-RATIO =  1.0000  LY-R1 =  .0000   LY-R2    =  .0000   VELY-HT   =  .000
   EP-TAIL =   .000   LZ-R1 =  .0000   LZ-R2    =  .0000   VELZ-HT   =  .000

 VERTICAL TAIL
   ALPHA   =    .00   DELR  =  .0000   LIFT/Q   =  .000    DRAG/Q    =  .000
   Q-VT    =  12.67   LX-R1 =  .0000   LX-R2    =  .0000   VELX-VT   =  .149
   Q-RATIO =  1.0000  LY-R1 =  .0000   LY-R2    =  .0000   VELY-VT   =  .000
   SIG-TAIL=   .000   LZ-R1 =  .0000   LZ-R2    =  .0000   VELZ-VT   =  .000

 GUST VELOCITIES
   ROTOR-1 HUB        UG =  .0000   VG =  .0000   WG =  .0000
   ROTOR-2 HUB        UG =  .0000   VG =  .0000   WG =  .0000
   WING-BODY          UG =  .0000   VG =  .0000   WG =  .0000
   HORIZONTAL TAIL    UG =  .0000   VG =  .0000   WG =  .0000
   VERTICAL TAIL      UG =  .0000   VG =  .0000   WG =  .0000


MAIN ROTOR PERFORMANCE
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 MUX =  .1488  MUX-TPP =  .1488  ALF-HP  = -5.01  MTIP = .6190  T75 =  5.25  T1S    =  -.37  T1C    =  1.04
 MUY =  .0000  MUY-TPP =  .0000  ALF-TPP = -4.99  MAT  = .7111  B0  =  1.03  B1C-HP =   .01  B1S-HP =   .00
 MUZ = -.0130  MUZ-TPP = -.0130  ALF-CP  = -4.64  P-HP =  .00               B1C-CP =  -.35  B1S-CP = -1.05
 L   =  .0202  L-INT   =  .0000


   TE-FLAP INPUT DEFLECTION ANGLES (OPFLAP=3)
   PSI   FLAP ANGLE,DEG
   10.0        .00
   20.0        .00
   30.0       -.44
   40.0      -2.62
   50.0      -6.25
   60.0      -9.88
   70.0     -12.06
   80.0     -12.50
   90.0     -12.50
  100.0     -12.50
  110.0     -12.50
  120.0     -12.50
  130.0     -12.06
  140.0      -9.88
  150.0      -6.25
  160.0      -2.62
  170.0      -.44
  180.0       .00
  190.0       .00
  200.0       .00
  210.0       .00
  220.0       .00
  230.0       .00
  240.0       .00
  250.0       .00
  260.0       .00
  270.0       .00
  280.0       .00
  290.0       .00
  300.0       .00
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310.0	.00
320.0	.00
330.0	.00
340.0	.00
350.0	.00
360.0	.00

BENDING MODES, HINGED BLADE (T75 = 4.92)
FREQUENCIES (PER REV) = .4832 1.0744 2.9533 5.1284 5.5540 10.3250 11.9153 18.2923 23.6455 27.8516
FLAP TIP DEFLECTION = .0088 1.0000 .9925 -.4347 .9295 .9942 .0506 .9999 -.0144 .9990
LAG TIP DEFLECTION = 1.0000 -.0070 .1226 .9006 .3689 -.1074 .9987 -.0146 .9999 .0449
TORSION MODES
FREQUENCIES (PER REV) = 16.0614 7.9635 28.7199 41.8576 60.3528
COLLECTIVE, CYCLIC, REACTIONLESS PITCH FREQUENCIES (PER REV) = 16.0614 14.0393 26.4319

BLADE BENDING HARMONICS (DEG)

	BETA(1)		BETA(2)		BETA(3)		BETA(4)		BETA(5)	
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN
N= 0	.2921	.0000	1.1104	.0000	-.0603	.0000	-.0071	.0000	-.0288	.0000
N= 1	-.0322	-.0416	.0123	.0477	.0002	-.0491	-.0006	.0036	.0003	-.0059
N= 2	.0015	.0017	-.0852	.0062	.0122	.0106	.0006	-.0007	-.0023	.0008
N= 3	-.0004	-.0003	-.0115	-.0073	-.0460	-.0112	.0008	-.0008	-.0004	-.0018
N= 4	-.0003	-.0005	-.0052	-.0041	-.0068	-.0022	-.0011	-.0001	.0024	-.0019
N= 5	.0000	.0000	.0007	-.0020	.0007	-.0017	.0012	-.0002	-.0004	.0025
N= 6	.0001	-.0001	-.0007	.0008	.0005	.0005	-.0012	.0004	.0057	-.0037
N= 7	.0001	.0000	-.0003	.0004	.0002	.0001	-.0003	.0001	.0014	-.0004
N= 8	.0000	.0000	.0003	.0004	.0001	.0001	.0000	.0000	.0002	.0001
N= 9	.0000	.0000	.0001	.0000	-.0001	-.0001	.0000	.0000	-.0001	.0000
N=10	.0000	.0000	.0002	-.0004	.0000	.0000	.0000	-.0001	-.0001	.0003
N=11	.0000	.0000	.0001	-.0002	.0000	.0001	.0000	-.0001	-.0001	.0002
N=12	.0000	.0000	-.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
N=13	.0000	.0000	-.0001	.0001	-.0001	.0000	.0000	.0000	.0000	-.0001

	BETA(6)		BETA(7)		BETA(8)		BETA(9)		BETA(10)	
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN
N= 0	.0042	.0000	-.0083	.0000	.0002	.0000	-.0020	.0000	.0001	.0000
N= 1	.0003	.0029	.0000	.0005	.0001	.0005	.0000	.0000	.0001	.0003
N= 2	-.0012	-.0003	-.0001	-.0001	-.0004	.0000	.0000	.0000	-.0002	-.0001
N= 3	-.0001	-.0005	-.0001	.0001	-.0001	-.0001	.0000	.0000	.0000	.0000
N= 4	.0000	-.0005	-.0001	.0000	-.0001	-.0001	.0000	.0000	.0000	.0000
N= 5	.0003	.0000	.0001	-.0001	.0001	-.0001	.0000	.0000	.0000	.0000
N= 6	-.0002	.0004	.0000	.0001	.0000	.0000	.0000	.0000	.0000	.0000
N= 7	-.0002	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
N= 8	-.0001	.0003	.0000	.0000	.0001	.0001	.0000	.0000	.0000	.0000
N= 9	-.0003	-.0002	-.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
N=10	.0014	-.0003	.0000	-.0001	.0001	.0000	.0000	.0000	.0000	.0000
N=11	-.0005	-.0002	-.0002	.0002	.0000	.0000	.0000	.0000	.0000	.0000
N=12	.0002	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
N=13	.0001	.0002	.0001	.0001	.0000	-.0001	.0000	.0000	.0000	.0000

TIP DEFLECTION HARMONICS (DEG) GIMBAL/TEETER HARMONICS (DEG)

	FLAP		LAG		BETAG		BETAGC		BETAGS	
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN
N= 0	1.0334	.0000	.2491	.0000						
N= 1	.0133	-.0048	-.0327	-.0467						
N= 2	-.0773	.0173	.0034	.0026						
N= 3	-.0580	-.0203	-.0054	-.0029						
N= 4	-.0093	-.0085	-.0013	-.0015						
N= 5	.0008	-.0013	.0010	.0005						
N= 6	.0054	-.0018	.0012	-.0010						
N= 7	.0012	.0002	.0004	.0000						
N= 8	.0006	.0009	.0001	.0000						
N= 9	-.0003	-.0002	.0000	.0000						
N=10	.0016	-.0004	-.0002	.0000						
N=11	-.0005	-.0001	-.0001	.0002						

N=12	.0002	.0001	.0001	.0000
N=13	.0000	.0002	.0001	.0001

BLADE PITCH/TORSION HARMONICS (DEG)

	THETA(D)		THETA(1)		THETA(2)		THETA(3)		THETA(4)	
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN
N= 0	.0205	.0000	.4419	.0000	.0257	.0000	.0019	.0000	.0013	.0000
N= 1	-.0072	.0414	-.0981	.5819	-.0042	.0251	-.0016	.0087	.0002	-.0005
N= 2	-.0063	-.0027	-.3216	-.1351	-.0155	-.0057	-.0052	-.0018	.0003	.0001
N= 3	.0018	-.0021	.0936	-.1033	.0034	-.0050	.0013	-.0016	.0001	.0002
N= 4	-.0005	-.0002	-.0200	-.0083	-.0005	-.0005	-.0002	-.0003	.0001	.0000
N= 5	.0018	-.0012	.0843	-.0559	.0024	-.0021	.0009	-.0006	-.0001	.0001
N= 6	.0008	.0019	.0392	.0824	.0010	.0018	-.0003	.0009	-.0001	.0000
N= 7	-.0006	-.0004	-.0251	-.0173	-.0005	-.0001	-.0003	.0000	.0000	.0000
N= 8	-.0012	.0006	-.0503	.0267	.0001	.0002	-.0001	.0001	.0000	.0000
N= 9	.0005	-.0003	.0189	-.0121	-.0002	.0001	-.0001	.0000	.0000	.0000
N=10	.0001	-.0001	-.0001	-.0050	-.0005	.0001	-.0002	-.0001	.0000	.0000
N=11	.0001	-.0001	.0031	-.0021	.0002	.0001	.0002	.0000	.0000	.0000
N=12	.0000	.0000	-.0013	.0000	-.0001	.0000	-.0001	.0000	.0000	.0000
N=13	.0000	.0000	.0001	.0012	.0000	-.0001	.0000	-.0001	.0000	.0000

ROTOR FORCES

SHAFT AXES

THRUST	CT = .0070693	CT/S = .076941	T = 926.353
DRAG FORCE	CH = .0001210	CH/S = .001317	H = 15.851
SIDE FORCE	CY = -.0000603	CY/S = -.000656	Y = -7.902
ROLL MOMENT	CMX= .0000563	CMX/S= .000612	MX= 44.701
PITCH MOMENT	CMY= -.0000043	CMY/S= -.000047	MY= -3.446
TORQUE	CQ = .0002486	CQ/S = .002706	Q = 197.492

TIP-PATH PLANE AXES

THRUST	CT = .0070693	CT/S = .076940	T = 926.349
DRAG FORCE	CH = .0001226	CH/S = .001334	H = 16.067
SIDE FORCE	CY = -.0000609	CY/S = -.000663	Y = -7.980

WIND AXES

LIFT	CL = .0070320	CL/S = .076535	L = 921.469
DRAG	CX = .0007375	CX/S = .008027	X = 96.640

FORCE ANGLES

SHAFT AXES	PITCH = .98	ROLL = -.49
TIP-PATH PLANE AXES	PITCH = .99	ROLL = -.49
WIND AXES	PITCH = 5.99	

ROTOR POWER

TOTAL	CP= .0002486	CP/S= .0027057	P= 40.385
CLIMB + PARASITE	CPC+CPP= -.0001102	CPC/S+CPP/S= -.0011992	PC+PP= -17.899
PROFILE + INDUCED	CPO+CPI= .0003588	CPO/S+CPI/S= .0039049	PO+PI= 58.285
INDUCED	CPI= .0001501	CPI/S= .0016335	PI= 24.382
INTERFERENCE	CPINT= .0000000	CPINT/S= .0000000	PINT= .000
PROFILE	CPO= .0002087	CPO/S= .0022713	PO= 33.902
NON-IDEAL	CPN= .0001913	CPN/S= .0020822	PN= 31.080

PERFORMANCE INDICES

M = .2304	CPI/CT = .0212	L-INDUCED = .0202	D-ROTOR = 314.686	D-TOTAL = 218.046
CDO = .01817	CPINT/CT = .0000	L-INTER = .0000	D/Q-ROTOR = 24.846	D/Q-TOTAL = 17.216
CDN = .01666	K-INDUCED= .8962	L-IDEAL = .0237	L/D-ROTOR = 2.928	L/D-TOTAL = 4.226

ANGLE OF ATTACK (DEG) AND MAXIMUM BOUND CIRCULATION

		RA = .620	.660	.700	.735	.762	.788	.813	.837	.863	.887	.910	.930	.950	.970	.990
	GMAX															
PSI = 10.	.01987	6.6	6.8	6.5	5.4	4.6	4.3	4.1	3.9	3.8	3.6	3.3	3.0	2.6	2.1	1.2
PSI = 20.	.01983	4.4	4.5	4.7	4.8	4.7	4.5	4.3	4.0	3.7	3.2	2.8	2.4	2.0	1.5	.8
PSI = 30.	.01603	5.5	5.2	4.9	4.5	4.1	3.4	2.5	2.1	2.1	2.2	2.3	2.3	2.2	1.8	.8
PSI = 40.	.01780	5.0	4.0	4.7	5.0	4.8	4.4	5.1	4.1	3.0	2.3	1.9	1.6	1.4	1.4	.2
PSI = 50.	.02354	8.0	7.5	6.2	4.0	2.5	1.9	4.9	5.0	4.7	4.2	3.8	3.5	3.3	3.4	.5

PSI = 60.	.01714	5.1	4.2	3.0	2.7	3.2	3.2	6.9	6.0	5.2	4.6	4.2	4.1	4.2	4.7	.6
PSI = 70.	.02079	6.5	5.5	4.5	3.6	2.8	2.0	6.6	6.1	5.8	5.6	5.4	5.5	5.7	6.4	1.0
PSI = 80.	.01689	4.5	4.3	4.9	4.4	3.6	2.5	7.0	6.2	5.9	6.0	6.3	6.8	7.5	7.8	1.2
PSI = 90.	.01879	5.9	5.1	4.1	3.2	2.8	2.4	7.6	7.0	6.5	6.2	6.2	6.4	6.8	6.9	1.0
PSI = 100.	.01983	5.0	5.1	5.6	4.9	4.1	2.9	7.4	6.6	6.3	6.7	7.2	7.3	7.0	6.7	.8
PSI = 110.	.01946	5.5	5.8	5.0	4.0	3.2	2.3	7.4	7.4	7.5	7.4	7.1	6.8	6.6	6.4	.7
PSI = 120.	.02232	6.2	5.6	5.0	5.2	5.7	4.7	9.3	8.3	7.7	7.2	6.9	6.7	6.5	6.3	.6
PSI = 130.	.01783	5.4	4.8	4.1	3.6	3.5	3.4	8.3	7.6	7.2	6.8	6.5	6.4	6.2	6.2	.6
PSI = 140.	.02092	6.0	6.2	6.2	5.4	4.6	3.7	7.4	6.8	6.4	6.1	5.8	5.6	5.5	5.5	.6
PSI = 150.	.01852	6.4	5.7	4.9	4.4	4.1	3.8	6.4	6.0	5.5	5.1	4.8	4.6	4.3	4.1	.7
PSI = 160.	.01748	6.2	5.4	4.6	4.1	4.2	4.6	5.5	5.0	4.5	4.1	3.7	3.4	3.0	2.7	.7
PSI = 170.	.01751	5.9	5.1	4.4	4.1	4.6	4.9	4.8	4.4	3.9	3.4	3.0	2.7	2.2	1.7	.7
PSI = 180.	.01759	5.8	5.1	4.4	4.2	4.9	5.1	4.8	4.3	3.8	3.4	2.9	2.6	2.1	1.6	.7
PSI = 190.	.01771	5.9	5.1	4.5	4.5	5.2	5.3	4.9	4.5	4.0	3.5	3.1	2.7	2.3	1.7	.8
PSI = 200.	.01769	6.0	5.3	4.7	4.6	5.4	5.6	5.2	4.7	4.2	3.7	3.3	2.8	2.4	1.8	.9
PSI = 210.	.01694	6.2	5.4	4.7	4.5	5.0	5.5	5.3	4.8	4.3	3.8	3.3	2.9	2.4	1.9	.9
PSI = 220.	.01647	6.5	5.7	5.0	4.5	4.5	5.1	5.3	5.0	4.5	4.0	3.5	3.0	2.5	1.9	1.0
PSI = 230.	.01633	6.9	6.1	5.3	4.8	4.5	4.6	5.1	5.2	4.8	4.3	3.8	3.3	2.8	2.1	1.0
PSI = 240.	.01623	6.8	6.5	5.8	5.2	4.7	4.5	4.5	5.0	5.1	4.7	4.2	3.7	3.1	2.4	1.2
PSI = 250.	.01555	5.8	6.0	6.1	5.6	5.2	4.7	4.3	4.1	4.4	4.8	4.5	4.0	3.4	2.7	1.4
PSI = 260.	.01413	5.9	5.2	5.0	5.3	5.4	5.1	4.7	4.2	3.8	3.7	4.0	4.1	3.7	2.9	1.5
PSI = 270.	.01355	6.7	6.0	5.2	4.6	4.3	4.2	4.3	4.4	4.2	3.8	3.4	3.1	3.0	2.8	1.6
PSI = 280.	.01465	5.5	5.7	5.9	5.8	5.4	4.9	4.4	3.9	3.6	3.4	3.2	3.1	2.8	2.2	1.3
PSI = 290.	.01239	6.2	5.6	4.9	4.4	4.0	3.6	3.4	3.3	3.4	3.5	3.4	3.2	2.8	2.2	1.2
PSI = 300.	.01853	7.9	7.3	6.7	6.6	6.6	6.5	6.2	5.7	5.1	4.5	3.9	3.3	2.8	2.1	1.1
PSI = 310.	.01378	5.9	5.7	5.5	5.3	5.0	4.8	4.5	4.2	3.8	3.4	3.0	2.6	2.1	1.6	.8
PSI = 320.	.01834	7.3	7.3	7.4	7.3	6.2	4.3	2.9	2.3	2.1	2.1	2.0	2.0	1.8	1.5	.9
PSI = 330.	.01955	9.1	8.4	4.2	4.3	4.5	4.5	4.5	4.3	4.1	3.8	3.4	3.1	2.6	2.0	1.1
PSI = 340.	.01943	8.9	5.0	5.3	5.3	5.3	5.2	5.1	4.9	4.6	4.0	3.5	3.0	2.6	2.1	1.2
PSI = 350.	.01917	8.1	5.6	5.5	5.5	5.5	5.4	5.2	4.9	4.5	4.0	3.5	3.2	2.8	2.3	1.3
PSI = 360.	.01993	8.0	7.1	5.3	5.1	5.1	5.1	5.0	4.8	4.5	4.0	3.6	3.2	2.7	2.2	1.3

MAXIMUM BOUND CIRCULATION VALUES USED IN FREE WAKE CALCULATIONS:
OPMXFWG = 1: GMXPOS BEING USED.

	GMAX	GMXPOS	GMXNEG	GMXOUT	GMXIN
PSI = 10.	.01987	.01987	.00000	.01987	.01987
PSI = 20.	.01983	.01983	.00000	.01983	.01983
PSI = 30.	.01603	.01603	.00000	.01603	.01603
PSI = 40.	.01780	.01780	-.00020	-.00020	.01780
PSI = 50.	.02354	.02354	-.00023	-.00023	.02354
PSI = 60.	.01714	.01714	-.00604	-.00604	.01714
PSI = 70.	.02079	.02079	-.00464	-.00464	.02079
PSI = 80.	.01689	.01689	-.00372	-.00372	.01689
PSI = 90.	.01879	.01879	-.00215	-.00215	.01879
PSI = 100.	.01983	.01983	-.00162	-.00162	.01983
PSI = 110.	.01946	.01946	.00000	.01946	.01946
PSI = 120.	.02232	.02232	.00000	.02232	.02232
PSI = 130.	.01783	.01783	-.00012	-.00012	.01783
PSI = 140.	.02092	.02092	.00000	.02092	.02092
PSI = 150.	.01852	.01852	.00000	.01852	.01852
PSI = 160.	.01748	.01748	.00000	.01748	.01748
PSI = 170.	.01751	.01751	.00000	.01751	.01751
PSI = 180.	.01759	.01759	.00000	.01759	.01759
PSI = 190.	.01771	.01771	.00000	.01771	.01771
PSI = 200.	.01769	.01769	.00000	.01769	.01769
PSI = 210.	.01694	.01694	.00000	.01694	.01694
PSI = 220.	.01647	.01647	.00000	.01647	.01647
PSI = 230.	.01633	.01633	.00000	.01633	.01633
PSI = 240.	.01623	.01623	.00000	.01623	.01623
PSI = 250.	.01555	.01555	.00000	.01555	.01555
PSI = 260.	.01413	.01413	.00000	.01413	.01413
PSI = 270.	.01355	.01355	.00000	.01355	.01355
PSI = 280.	.01465	.01465	.00000	.01465	.01465
PSI = 290.	.01239	.01239	.00000	.01239	.01239
PSI = 300.	.01853	.01853	.00000	.01853	.01853

PSI = 310.	.01378	.01378	.00000	.01378	.01378
PSI = 320.	.01834	.01834	.00000	.01834	.01834
PSI = 330.	.01955	.01955	.00000	.01955	.01955
PSI = 340.	.01943	.01943	.00000	.01943	.01943
PSI = 350.	.01917	.01917	.00000	.01917	.01917
PSI = 360.	.01993	.01993	.00000	.01993	.01993

AIRCRAFT PERFORMANCE

	ROTOR-1	ROTOR-2	TOTAL
CLIMB + PARASITE POWER	-17.899 (-44.32)	.000 (.00)	-17.899 (-44.32)
INDUCED POWER	24.382 (60.37)	.000 (.00)	24.382 (60.37)
INTERFERENCE POWER	.000 (.00)	.000 (.00)	.000 (.00)
PROFILE POWER	33.902 (83.95)	.000 (.00)	33.902 (83.95)
CLIMB POWER			.000 (.00)
PARASITE POWER			-17.899 (-44.32)
NON-IDEAL POWER	31.080 (76.96)	.000 (.00)	31.080 (76.96)
TOTAL POWER	40.385	.000	40.385

GROSS WEIGHT = .00
DRAG-ROTOR = 314.69 D/Q-ROTOR = 24.846 L/D-ROTOR = .000
DRAG-TOTAL = 218.05 D/Q-TOTAL = 17.216 L/D-TOTAL = .000
FIGURE OF MERIT = .2304

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LOADS, VIBRATION, AND NOISE

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************ LOADS, VIBRATION, AND NOISE SECTION DELETED FOR BREVITY ****************

INTEGRATED TE-FLAP LOADS AND HINGE MOMENTS

PSI DEG	FLAP ANGLE DEG	AERO LIFT LB	AERO MOMENT FT-LB	INERTIA FORCE LB	INERTIA MOMENT FT-LB	SPRING MOMENT FT-LB	DAMPING MOMENT FT-LB	TOTAL FORCE LB	TOTAL MOMENT FT-LB
0.	.0000	1.8423	-.0064	.0000	.0000	.0000	.0000	1.8423	-.0064
10.	.0000	1.7250	-.0004	.0000	.0000	.0000	.0000	1.7250	-.0004
20.	.0000	1.6434	.0059	.0000	.0000	.0000	.0000	1.6434	.0059
30.	-.4436	.2092	.0458	.0000	.0000	.0000	.0000	.2092	.0458
40.	-2.6236	-4.8151	.1789	.0000	.0000	.0000	.0000	-4.8151	.1789
50.	-6.2500	-13.4563	.4158	.0000	.0000	.0000	.0000	-13.4563	.4158
60.	-9.8764	-24.4694	.6710	.0000	.0000	.0000	.0000	-24.4694	.6710
70.	-12.0564	-30.0731	.8419	.0000	.0000	.0000	.0000	-30.0731	.8419
80.	-12.5000	-32.1330	.9154	.0000	.0000	.0000	.0000	-32.1330	.9154
90.	-12.5000	-32.1731	.9121	.0000	.0000	.0000	.0000	-32.1731	.9121
100.	-12.5000	-32.4451	.9264	.0000	.0000	.0000	.0000	-32.4451	.9264
110.	-12.5000	-31.6613	.9072	.0000	.0000	.0000	.0000	-31.6613	.9072
120.	-12.5000	-31.7545	.9157	.0000	.0000	.0000	.0000	-31.7545	.9157
130.	-12.0564	-30.0006	.8544	.0000	.0000	.0000	.0000	-30.0006	.8544
140.	-9.8764	-23.9568	.6729	.0000	.0000	.0000	.0000	-23.9568	.6729
150.	-6.2500	-12.5344	.4023	.0000	.0000	.0000	.0000	-12.5344	.4023
160.	-2.6236	-3.6325	.1557	.0000	.0000	.0000	.0000	-3.6325	.1557
170.	-.4436	.8332	.0224	.0000	.0000	.0000	.0000	.8332	.0224
180.	.0000	1.6675	-.0051	.0000	.0000	.0000	.0000	1.6675	-.0051
190.	.0000	1.6756	-.0082	.0000	.0000	.0000	.0000	1.6756	-.0082
200.	.0000	1.6861	-.0111	.0000	.0000	.0000	.0000	1.6861	-.0111
210.	.0000	1.6691	-.0132	.0000	.0000	.0000	.0000	1.6691	-.0132
220.	.0000	1.6607	-.0150	.0000	.0000	.0000	.0000	1.6607	-.0150
230.	.0000	1.6899	-.0169	.0000	.0000	.0000	.0000	1.6899	-.0169
240.	.0000	1.7144	-.0183	.0000	.0000	.0000	.0000	1.7144	-.0183
250.	.0000	1.6787	-.0182	.0000	.0000	.0000	.0000	1.6787	-.0182
260.	.0000	1.6174	-.0170	.0000	.0000	.0000	.0000	1.6174	-.0170

270.	.0000	1.5560	-.0153	.0000	.0000	.0000	.0000	1.5560	-.0153
280.	.0000	1.4571	-.0132	.0000	.0000	.0000	.0000	1.4571	-.0132
290.	.0000	1.4582	-.0109	.0000	.0000	.0000	.0000	1.4582	-.0109
300.	.0000	1.7575	-.0189	.0000	.0000	.0000	.0000	1.7575	-.0189
310.	.0000	1.3936	-.0132	.0000	.0000	.0000	.0000	1.3936	-.0132
320.	.0000	1.0569	-.0086	.0000	.0000	.0000	.0000	1.0569	-.0086
330.	.0000	1.5823	-.0123	.0000	.0000	.0000	.0000	1.5823	-.0123
340.	.0000	1.7223	-.0127	.0000	.0000	.0000	.0000	1.7223	-.0127
350.	.0000	1.8111	-.0104	.0000	.0000	.0000	.0000	1.8111	-.0104
360.	.0000	1.8423	-.0064	.0000	.0000	.0000	.0000	1.8423	-.0064
MEAN	-3.4722	-7.4444	.2388	.0000	.0000	.0000	.0000	-7.4444	.2388
1/2PP	6.2500	17.1437	.4727	.0000	.0000	.0000	.0000	17.1437	.4727
MAX	.0000	1.8423	.9264	.0000	.0000	.0000	.0000	1.8423	.9264
MIN	-12.5000	-32.4451	-.0189	.0000	.0000	.0000	.0000	-32.4451	-.0189

FLAP ACTUATOR ENERGY AND POWER REQUIREMENTS

PSI DEG	FLAP ANGLE DEG	ACT. WORK FT-LB	ACT. POWER FT-LB/SEC	STORED ENERGY FT-LB
0.	.0000	.0000	.0007	.0000
10.	.0000	.0000	.0000	.0000
20.	.0000	.0000	.0021	.0000
30.	-.4436	.0002	.5907	.0002
40.	-2.6236	.0043	6.3124	.0041
50.	-6.2500	.0188	18.0385	.0227
60.	-9.8764	.0344	23.6885	.0578
70.	-12.0564	.0288	10.8322	.0886
80.	-12.5000	.0068	.3789	.0998
90.	-12.5000	.0000	.0335	.0995
100.	-12.5000	.0000	.0001	.1011
110.	-12.5000	.0000	-.0336	.0990
120.	-12.5000	.0000	-.3787	.0999
130.	-12.0564	-.0069	-10.9930	.0899
140.	-9.8764	-.0291	-23.7554	.0580
150.	-6.2500	-.0340	-17.4527	.0219
160.	-2.6236	-.0177	-5.4958	.0036
170.	-.4436	-.0034	-.2887	.0001
180.	.0000	-.0001	.0018	.0000
190.	.0000	.0000	.0009	.0000
200.	.0000	.0000	-.0012	.0000
210.	.0000	.0000	.0010	.0000
220.	.0000	.0000	-.0008	.0000
230.	.0000	.0000	.0007	.0000
240.	.0000	.0000	-.0005	.0000
250.	.0000	.0000	.0004	.0000
260.	.0000	.0000	-.0002	.0000
270.	.0000	.0000	.0001	.0000
280.	.0000	.0000	.0000	.0000
290.	.0000	.0000	-.0001	.0000
300.	.0000	.0000	.0002	.0000
310.	.0000	.0000	-.0003	.0000
320.	.0000	.0000	.0002	.0000
330.	.0000	.0000	-.0005	.0000
340.	.0000	.0000	.0007	.0000
350.	.0000	.0000	-.0008	.0000
360.	.0000	.0000	.0007	.0000
MEAN		.0001	.0412	.0235
1/2 P-P		.0342	23.7220	.0505
MAX		.0344	23.6885	.1011
MIN		-.0340	-23.7554	.0000
RMS			7.5726	

TE-FLAP SECTION LIFT, LB/FT

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	1.9224	1.8905	1.8320	1.7488	1.6520	1.5715	1.4527	1.2762
10.	1.7114	1.7010	1.6852	1.6574	1.6198	1.5673	1.3938	1.2022

20.	1.8142	1.7697	1.7019	1.6261	1.4437	1.2768	1.1567	1.0371
30.	.5031	.3407	.3160	.2771	.2094	.1247	-.1006	-.3043
40.	-2.6259	-3.1841	-3.8393	-4.5295	-4.9987	-5.3707	-5.6910	-5.9285
50.	-10.5924	-10.7700	-11.3087	-12.0777	-12.8093	-13.4384	-14.0625	-14.7337
60.	-17.3596	-19.2442	-20.9654	-22.5840	-23.9091	-24.9619	-25.8893	-26.8577
70.	-22.6512	-24.2297	-25.9813	-27.7879	-29.3157	-30.5061	-30.9951	-31.3963
80.	-24.9679	-26.7489	-28.1492	-29.5103	-31.0267	-31.9150	-32.4939	-32.8589
90.	-24.3503	-26.3973	-28.5143	-30.3390	-31.6673	-31.9487	-32.3013	-32.4264
100.	-25.5070	-27.2989	-28.7269	-29.8727	-31.4602	-32.1213	-32.3888	-32.3614
110.	-23.9114	-25.2252	-27.4173	-29.7916	-31.6352	-32.0422	-32.2736	-32.2411
120.	-24.3366	-25.9430	-27.7220	-29.5456	-31.1705	-31.8818	-32.1817	-32.2251
130.	-22.5668	-24.1874	-25.8388	-27.6120	-29.1513	-30.4811	-31.0371	-31.5020
140.	-17.6091	-18.9116	-20.2820	-21.7226	-23.0289	-24.2107	-25.4099	-26.7757
150.	-8.9455	-9.6871	-10.5042	-11.3215	-12.1265	-12.8567	-13.5658	-14.2544
160.	-2.2055	-2.5218	-2.8783	-3.2320	-3.5698	-3.9113	-4.2733	-4.6575
170.	1.2446	1.0986	.9554	.8089	.6827	.5393	.3612	.1542
180.	1.8767	1.7692	1.6649	1.5629	1.4697	1.3642	1.2349	1.0916
190.	1.8588	1.7843	1.6777	1.5705	1.4797	1.3781	1.2512	1.0967
200.	1.8482	1.7848	1.7054	1.5897	1.4884	1.3908	1.2643	1.1021
210.	1.8090	1.7566	1.6854	1.5917	1.4819	1.3822	1.2566	1.0916
220.	1.7588	1.7391	1.6747	1.5928	1.4948	1.3896	1.2633	1.0917
230.	1.6815	1.7559	1.7199	1.6422	1.5524	1.4463	1.3116	1.1278
240.	1.4789	1.6923	1.7780	1.7327	1.6472	1.5454	1.3965	1.1976
250.	1.3767	1.4235	1.6033	1.7558	1.7324	1.6441	1.4943	1.2754
260.	1.4564	1.4178	1.3877	1.4428	1.6043	1.6674	1.5785	1.3585
270.	1.4235	1.5089	1.5148	1.4564	1.3857	1.3599	1.3774	1.3303
280.	1.3985	1.3580	1.3352	1.3510	1.3838	1.3771	1.3009	1.1525
290.	1.2034	1.2776	1.3839	1.4659	1.4747	1.4194	1.3156	1.1535
300.	1.8998	1.8604	1.7905	1.6828	1.5695	1.4498	1.3063	1.1271
310.	1.4420	1.4313	1.3992	1.3418	1.2688	1.1908	1.0780	.9379
320.	.9454	.8976	.9330	.9849	1.0230	1.0305	1.0113	.9506
330.	1.5395	1.5690	1.5702	1.5422	1.4759	1.3959	1.2828	1.1193
340.	1.7828	1.8040	1.7718	1.6566	1.5247	1.4243	1.3151	1.1714
350.	1.9069	1.8962	1.7936	1.6832	1.5944	1.5278	1.4338	1.2813
360.	1.9224	1.8905	1.8320	1.7488	1.6520	1.5715	1.4527	1.2762

TE-FLAP AERO HINGE MOMENT, FT-LB/FT

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	-.0197	-.0150	-.0095	-.0042	-.0020	-.0018	.0020	.0094
10.	-.0103	-.0070	-.0039	-.0014	-.0004	.0002	.0088	.0161
20.	-.0072	-.0019	.0009	.0008	.0081	.0155	.0184	.0161
30.	.0232	.0286	.0334	.0387	.0451	.0513	.0614	.0650
40.	.1270	.1407	.1469	.1654	.1759	.1841	.1917	.1987
50.	.3388	.3450	.3582	.3773	.3919	.4044	.4193	.4395
60.	.5025	.5470	.5833	.6188	.6467	.6681	.6883	.7163
70.	.6515	.6894	.7335	.7757	.8108	.8389	.8534	.8780
80.	.7190	.7589	.7914	.8249	.8669	.9015	.9434	.9698
90.	.7093	.7573	.8079	.8485	.8802	.8943	.9161	.9278
100.	.7384	.7768	.8105	.8460	.9027	.9255	.9262	.9213
110.	.6952	.7311	.7947	.8603	.9031	.9084	.9107	.9079
120.	.7508	.7657	.8053	.8475	.8839	.8990	.9038	.9041
130.	.6718	.7044	.7425	.7857	.8218	.8523	.8647	.8775
140.	.5159	.5445	.5787	.6131	.6416	.6677	.6945	.7304
150.	.3058	.3232	.3435	.3624	.3847	.4048	.4223	.4374
160.	.1132	.1219	.1321	.1428	.1499	.1570	.1648	.1750
170.	.0044	.0111	.0169	.0201	.0217	.0268	.0338	.0367
180.	-.0184	-.0123	-.0074	-.0045	-.0026	.0013	.0068	.0059
190.	-.0210	-.0164	-.0107	-.0066	-.0046	-.0017	.0028	.0040
200.	-.0232	-.0194	-.0146	-.0094	-.0061	-.0039	-.0005	.0021
210.	-.0245	-.0211	-.0170	-.0120	-.0078	-.0054	-.0027	-.0001
220.	-.0249	-.0225	-.0189	-.0144	-.0099	-.0064	-.0046	-.0018
230.	-.0238	-.0241	-.0215	-.0174	-.0131	-.0087	-.0060	-.0034
240.	-.0206	-.0231	-.0236	-.0207	-.0166	-.0122	-.0073	-.0051
250.	-.0199	-.0186	-.0198	-.0214	-.0193	-.0154	-.0100	-.0061
260.	-.0219	-.0194	-.0165	-.0148	-.0156	-.0156	-.0119	-.0065
270.	-.0199	-.0202	-.0188	-.0156	-.0118	-.0086	-.0069	-.0060
280.	-.0204	-.0176	-.0147	-.0119	-.0097	-.0076	-.0063	-.0044

290.	-.0146	-.0129	-.0117	-.0110	-.0099	-.0078	-.0060	-.0036
300.	-.0295	-.0271	-.0236	-.0189	-.0140	-.0090	-.0060	-.0031
310.	-.0202	-.0182	-.0155	-.0120	-.0085	-.0073	-.0059	-.0050
320.	-.0125	-.0098	-.0088	-.0080	-.0074	-.0061	-.0047	-.0039
330.	-.0194	-.0178	-.0154	-.0122	-.0087	-.0062	-.0044	-.0012
340.	-.0226	-.0209	-.0178	-.0123	-.0077	-.0051	-.0022	.0024
350.	-.0227	-.0198	-.0139	-.0082	-.0051	-.0037	-.0009	.0047
360.	-.0197	-.0150	-.0095	-.0042	-.0020	-.0018	.0020	.0094

TE-FLAP AERO HINGE MOEMENT COEFFICIENT (based on Total Chord)

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	-.0003	-.0002	-.0001	.0000	.0000	.0000	.0000	.0001
10.	-.0001	-.0001	.0000	.0000	.0000	.0000	.0001	.0001
20.	-.0001	.0000	.0000	.0000	.0001	.0001	.0002	.0001
30.	.0002	.0003	.0003	.0004	.0004	.0004	.0005	.0005
40.	.0014	.0015	.0014	.0015	.0015	.0015	.0015	.0015
50.	.0035	.0035	.0035	.0036	.0036	.0036	.0036	.0036
60.	.0056	.0057	.0057	.0058	.0058	.0058	.0057	.0057
70.	.0070	.0071	.0071	.0071	.0070	.0070	.0069	.0068
80.	.0073	.0073	.0073	.0073	.0073	.0072	.0072	.0071
90.	.0073	.0073	.0073	.0073	.0073	.0071	.0070	.0068
100.	.0073	.0073	.0073	.0074	.0075	.0073	.0070	.0067
110.	.0073	.0073	.0074	.0075	.0075	.0072	.0070	.0067
120.	.0076	.0074	.0074	.0074	.0074	.0073	.0070	.0068
130.	.0071	.0070	.0070	.0071	.0071	.0071	.0069	.0067
140.	.0056	.0056	.0057	.0057	.0057	.0057	.0057	.0058
150.	.0035	.0035	.0035	.0035	.0036	.0036	.0036	.0036
160.	.0014	.0014	.0014	.0015	.0015	.0015	.0015	.0015
170.	.0001	.0001	.0002	.0002	.0002	.0003	.0003	.0003
180.	-.0003	-.0002	-.0001	-.0001	.0000	.0000	.0001	.0001
190.	-.0003	-.0002	-.0001	-.0001	-.0001	.0000	.0000	.0000
200.	-.0004	-.0003	-.0002	-.0001	-.0001	.0000	.0000	.0000
210.	-.0004	-.0003	-.0002	-.0002	-.0001	-.0001	.0000	.0000
220.	-.0004	-.0004	-.0003	-.0002	-.0001	-.0001	-.0001	.0000
230.	-.0004	-.0004	-.0003	-.0003	-.0002	-.0001	-.0001	.0000
240.	-.0004	-.0004	-.0004	-.0003	-.0002	-.0002	-.0001	-.0001
250.	-.0004	-.0003	-.0003	-.0003	-.0003	-.0002	-.0001	-.0001
260.	-.0004	-.0004	-.0003	-.0002	-.0002	-.0002	-.0002	-.0001
270.	-.0004	-.0004	-.0003	-.0002	-.0002	-.0001	-.0001	-.0001
280.	-.0004	-.0003	-.0002	-.0002	-.0001	-.0001	-.0001	-.0001
290.	-.0003	-.0002	-.0002	-.0002	-.0001	-.0001	-.0001	.0000
300.	-.0005	-.0005	-.0004	-.0003	-.0002	-.0001	-.0001	.0000
310.	-.0004	-.0003	-.0003	-.0002	-.0001	-.0001	-.0001	-.0001
320.	-.0003	-.0002	-.0001	-.0001	-.0001	-.0001	-.0001	.0000
330.	-.0003	-.0003	-.0002	-.0002	-.0001	-.0001	-.0001	.0000
340.	-.0004	-.0003	-.0003	-.0002	-.0001	-.0001	.0000	.0000
350.	-.0003	-.0003	-.0002	-.0001	-.0001	.0000	.0000	.0000
360.	-.0003	-.0002	-.0001	.0000	.0000	.0000	.0000	.0001

TE-FLAP SECTION LIFT COEFFICIENT (based on total Chord)

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	.0116	.0107	.0098	.0088	.0079	.0072	.0064	.0054
10.	.0096	.0090	.0084	.0078	.0073	.0067	.0057	.0047
20.	.0094	.0086	.0078	.0070	.0059	.0050	.0044	.0038
30.	.0024	.0015	.0014	.0011	.0008	.0005	-.0004	-.0010
40.	-.0129	-.0146	-.0164	-.0180	-.0188	-.0193	-.0197	-.0200
50.	-.0487	-.0487	-.0495	-.0506	-.0516	-.0524	-.0529	-.0533
60.	-.0850	-.0884	-.0908	-.0929	-.0943	-.0951	-.0954	-.0952
70.	-.1077	-.1096	-.1109	-.1118	-.1124	-.1126	-.1106	-.1080
80.	-.1118	-.1143	-.1153	-.1154	-.1156	-.1134	-.1101	-.1067
90.	-.1107	-.1124	-.1144	-.1154	-.1156	-.1128	-.1097	-.1052
100.	-.1115	-.1138	-.1148	-.1149	-.1156	-.1126	-.1087	-.1043
110.	-.1107	-.1114	-.1126	-.1145	-.1156	-.1124	-.1089	-.1048
120.	-.1094	-.1110	-.1128	-.1144	-.1155	-.1136	-.1105	-.1066
130.	-.1052	-.1068	-.1083	-.1100	-.1111	-.1117	-.1095	-.1071
140.	-.0845	-.0863	-.0881	-.0898	-.0910	-.0920	-.0929	-.0942
150.	-.0455	-.0467	-.0479	-.0490	-.0501	-.0510	-.0517	-.0523

160.	-.0118	-.0127	-.0138	-.0147	-.0155	-.0163	-.0171	-.0179
170.	.0070	.0059	.0048	.0039	.0031	.0024	.0015	.0006
180.	.0113	.0100	.0089	.0079	.0071	.0063	.0055	.0046
190.	.0119	.0108	.0095	.0084	.0075	.0067	.0058	.0049
200.	.0126	.0114	.0103	.0090	.0080	.0072	.0062	.0052
210.	.0131	.0119	.0108	.0096	.0085	.0075	.0065	.0054
220.	.0133	.0125	.0113	.0101	.0090	.0079	.0069	.0057
230.	.0131	.0130	.0121	.0109	.0097	.0086	.0075	.0061
240.	.0120	.0127	.0128	.0118	.0107	.0095	.0082	.0067
250.	.0118	.0112	.0116	.0120	.0114	.0104	.0090	.0073
260.	.0127	.0115	.0104	.0100	.0104	.0104	.0095	.0079
270.	.0117	.0118	.0112	.0102	.0092	.0085	.0081	.0075
280.	.0120	.0108	.0098	.0091	.0087	.0083	.0075	.0064
290.	.0096	.0092	.0091	.0092	.0090	.0084	.0075	.0063
300.	.0151	.0141	.0128	.0113	.0099	.0087	.0074	.0061
310.	.0118	.0110	.0101	.0091	.0082	.0073	.0063	.0052
320.	.0084	.0071	.0067	.0065	.0063	.0061	.0057	.0051
330.	.0114	.0109	.0103	.0095	.0087	.0079	.0069	.0058
340.	.0124	.0119	.0110	.0098	.0085	.0076	.0066	.0056
350.	.0124	.0116	.0103	.0091	.0082	.0075	.0067	.0058
360.	.0116	.0107	.0098	.0088	.0079	.0072	.0064	.0054

SECTION DRAG COEFFICIENT INCREMENT (based on flap Chord)

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
10.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
20.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
30.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
40.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
50.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.						
		.						
		.						
360.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

SECTION MOMENT COEFFICIENT INCREMENT (based on flap Chord)

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
10.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
20.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
30.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
40.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
50.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.						
		.						
		.						
360.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

TE-FLAP SECTION INERTIA LOAD, LB/FT

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
10.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
20.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
30.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
40.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
50.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.						
		.						
		.						
360.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

TE-FLAP SECTION INERTIAL HINGE MOMENT, FT-LB/FT

PSI	r/R=.8125	.8375	.8625	.8875	.9100	.9300	.9500	.9700
0.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
10.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
20.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
30.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

```
40.  .0000  .0000  .0000  .0000  .0000  .0000  .0000  .0000
50.  .0000  .0000  .0000  .0000  .0000  .0000  .0000  .0000
            .
            .
            .
360.  .0000  .0000  .0000  .0000  .0000  .0000  .0000  .0000
```

```
INITIALIZE RADIAL PARAMETERS FOR HIRES (ROTOR 1)
INITIALIZE CIRCULATION     FOR HIRES (ROTOR 1)
INITIALIZE BURST           FOR HIRES (ROTOR 1)
INITIALIZE ROLLUP          FOR HIRES (ROTOR 1)
START FAR  WAKE CALCS      FOR HIRES (ROTOR 1)
   FAR  WAKE ITERATION #  1 OF  1
     AZIMUTH INDEX #  1 OF 360
     AZIMUTH INDEX #  2 OF 360
     AZIMUTH INDEX #  3 OF 360
     AZIMUTH INDEX #  4 OF 360
     AZIMUTH INDEX #  5 OF 360
     AZIMUTH INDEX #  6 OF 360
     AZIMUTH INDEX #  7 OF 360
     AZIMUTH INDEX #  8 OF 360
     AZIMUTH INDEX #  9 OF 360
     AZIMUTH INDEX # 10 OF 360
              .
              .
              .
     AZIMUTH INDEX # 360 OF 360
```

```
1COMPUTATION TIMES

                         CPU TIME  PERCENT   NUMBER  TIME/CALL
                          (SEC)            OF CALLS   (SEC)

   CASE                         .000    .000      1     .000
   TRIM (TRIM)                  .000    .000      1     .000
   FLUTTER (FLUT)               .000    .000      0     .000
   FLIGHT DYNAMICS (STAB)       .000    .000      0     .000
   TRANSIENT (TRAN)             .000    .000      0     .000
   LINEAR ANALYSIS (STABL)      .000    .000      0     .000
   LINEAR ANALYSIS (FLUTL)      .000    .000      0     .000
   NONUNIFORM INFLOW (WAKEC)    .000    .000     10     .000
   WAKE GEOMETRY (GEOMR)        .000    .000      8     .000
   VIBRATORY SOLUTION (RAMF)    .000    .000    163     .000
   ROTOR MODES (MODE)           .000    .000    163     .000
   ROTOR EQUATIONS (MOTNR)      .000    .000   1005     .000
   PERFORMANCE (PERF)           .000    .000      1     .000
   LOADS (LOAD)                 .000    .000      1     .000
```

Indicial Post-Processor input

```
#!/bin/csh -v
#limit coredumpsize 1b
set case=T2916ru
set indi="/mod1v2/newflap"
```

```
set airf="/mod1v2/Langley/AF_rotor/C81FT"
echo link airfoil table
# link airfoil table
ln -s $airf/0015ahft.tab            ftn20
echo run indicial
#------------------------------------------------------
# input RADIUS, SOUND, DENSE in metric so that
# N/m results.
#------------------------------------------------------
time $indi/indic_doug-sf-1 >& indic_${case}.out <<eoj
 &INLST
  FWFILE  = '../int_${case}.dat',
  VINDFILE = '../vind_${case}.dat',
 NRAD    = 70
 NAZM    = 360
 RPM     = 1074.01
 RADIUS = 1.84785
 SOUND  = 335.7585
 DENSE  = 1.258
 CHORD  = .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
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 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082
 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .1347082 .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
 RAE     = .2924999 .3 .31 .3199999 .33 .34 .3499999 .36 .37 .3799999
 .3899999 .4 .4099999 .4199999 .43 .4399999 .4499999 .46 .4699999
 .4799999 .49 .5 .5099999 .5199999 .5299999 .54 .55 .56 .5699999
 .5799999 .5899999 .6 .61 .62 .6299999 .6399999 .6499999 .66 .67 .68
 .6899999 .6999999 .7099999 .72 .73 .74 .75 .7599999 .7699999 .7799999
 .79 .8 .81 .8199999 .8299999 .8399999 .85 .86 .87 .8799999 .8899999
 .8999999 .91 .92 .93 .9399999 .9499999 .9599999 .97 .98 1.0 .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
 SWP     = .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 .0 .0 .0 .0 .0 .0 .0 .0
  opft=1,
  rflap= 51*0.,18*1.,0.
  iload=2
 &END
eoj
echo done indicial
#unlimit coredumpsize
exit
```

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13. ABSTRACT *(Maximum 200 words)*
Continual advances in rotorcraft performance, vibration and acoustic characteristics are being sought by rotary-wing vehicle manufacturers to improve efficiency, handling qualities and community noise acceptance of their products. The rotor system aerodynamic and dynamic behavior are among the key factors which must be addressed to meet the desired goals. Rotor aerodynamicists study how airload redistribution impacts performance and noise, and seek ways to achieve better airload distribution through changes in local aerodynamic response characteristics. One method currently receiving attention is the use of trailing-edge flaps mounted on the rotor blades to provide direct control of a portion of the spanwise lift characteristics. The following work describes the incorporation of a trailing-edge flap model in the CAMRAD.Mod1/HIRES comprehensive rotorcraft analysis code. The CAMRAD.Mod1/HIRES analysis consists of three separate executable codes. These include the comprehensive trim analysis, CAMRAD.Mod1, the Indicial Post-Processor, IPP, for high resolution airloads, and AIRFOIL, which produces the rotor airfoil tables from input airfoil section characteristics. The modifications made to these components permitting analysis of flapped rotor configurations are documented herein along with user instructions detailing the new input variables and operational notes.

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