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HOVER PERFORMANCE TESTS OF FULL SCALE VARIABLE GEOMETRY ROTORS

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16. Abstract

Full scale whirl tests were conducted to determine the effects of interblade spatial relationships and pitch variations on the hover performance and acoustic signature of a 6-blade main rotor system. The Variable Geometry Rotor (VGR) variations from the conventional baseline were accomplished by: (1) shifting the axial position of alternate blades by one chord-length to form two tip path planes; and (2) varying the relative azimuthal spacing from the upper rotor to the lagging hover rotor in four increments from 25.2 degrees to 62.1 degrees. For each of these four configurations, the differential collective pitch between upper and lower rotors was set at $\pm1^{\circ}$, 0° and -1°. Hover performance data for all configurations were acquired at blade tip Mach numbers of 0.523 and 0.45. Acoustic data were recorded at all test conditions, but analyzed only at 0° differential pitch at the higher rotor speed.

The VGR configurations tested demonstrated improvements in thrust at constant power as high a 6 percent. Reductions of 3 PNdB in perceived noise level and of 4 dB in blade passage frequency noise level were achieved at the higher thrust levels. Consistent correlation exists between performance and acoustic improvements. For any given azimuth spacing, performance was consistently better for the differential pitch condition of ±1 degree, i.e. with the upper rotor pitch one degree higher than the lower rotor.

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SUMMARY

Full scale whirl tests were conducted to determine the effects of interblade spatial relationships and pitch variations on the hover performance and acoustic signature of a 6-blade main rotor system. The Variable Geometry Rotor (VGR) variations from the conventional baseline were accomplished by: (1) shifting the axial position of alternate blades by one chordlength to form two tip path planes; and (2) varying the relative azimuthal spacing from the upper rotor to the lagging lower rotor in four increments from 25.2 degrees to 62.1 degrees. For each of these four configurations, the differential collective pitch between upper and lower rotors was set at +1°, 0° and -1°. Hover performance data for all configurations were acquired at blade tip Mach numbers of 0.523 and 0.45. Acoustic data were recorded at all test conditions, but analyzed only at 0° differential pitch at the higher rotor speed.

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INTRODUCTION

The importance of the vortex system in the near wake of a rotor or propeller to the performance, dynamics and acoustic characteristics of that rotor or propeller is well established.

In hover, the close proximity of the tip vortex trailing from the preceding rotor blade causes extremely high local induced angles of attack near the tip of subsequent blades on the rotor, resulting in significant reductions in rotor efficiency [1], [2], [3].

In forward flight, both rotor performance and airloads are significantly affected by blade-vortex interactions. Trailing tip vortices often impinge directly on the rotor blades causing high vibratory loads [4]. The vortex system also has a large effect on the perceived noise level of the rotor system. Local flow separation, resulting from the large angle of attack changes which occur when a blade intercepts a trailing vortex filament, has been identified as a large contributor to the overall noise level of current generation helicopter rotors [5].

Analytic methods, which have been developed to account for the effect of the trailing vortex on hover performance [1], [2], [3], forward flight performance [6], [7], and perceived noise levels [5], all highlight the detrimental effect of the trailing tip vortex where tangential velocities approach the magnitude of the free stream velocity at the blade tip [8].

Previously, rotor design changes directed toward improving rotor performance and to controlling tip vortex-rotor blade interaction have mainly consisted of modifications to blade and tip design. Removing the conventional geometric design constraints of rotors, such as coplanar blades, equal blade azimuth spacing, and equal collective pitch values, opens an entirely new dimension of design variables. It was recognized that use of these design variables to reorientate the tip vortices relative to the blades could lead to improvements in rotor performance, dynamic and acoustic characteristics.

The Variable Geometry Rotor (VGR) concept originated at the NASA Langley Research Center. It is essentially composed of two corotating conventional rotor systems with equal numbers of blades that can be indexed axially and azimuthally relative to one another. The upper and lower rotors can also have unequal collective pitch settings.

The first experimental evaluation of such a rotor system was conducted by Landgrebe and Bellinger [9] under contract to NASA. This small scale model rotor experiment showed that properly selected variable-geometry rotor configurations can offer substantial improvements in hover performance without adversely affecting forward flight performance. Hover performance gains up to 7 percent were demonstrated.

The present experimental program was conducted to verify on a full scale rotor the performance gains demonstrated by the small scale test, and to measure the effect on acoustic signature of various staggered geometry configurations. Results of the model rotor tests were used as a guide in selecting the azimuthal spacings for full scale testing.

LIST OF ILLUSTRATIONS

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TEST FACILITY

The Sikorsky 10,000 HP Main Rotor Test Stand is used to perform development, performance, and endurance testing of main rotor systems. The rotor head is driven by a single direct current electric motor capable of producing up to 10,000 horsepower and is located 19.8 meters (65 feet) above ground level (Figure 1).

DESCRIPTION OF ROTORS

Test Baseline Rotor

A modified Sikorsky S-65 rotor head with six S-55 main rotor blades was used to obtain reference performance data. Figure 1 shows this rotor mounted on the test stand. Modifications to the rotor head included removing the damper positioner pistons and modifying the damper internal valving to obtain damping characteristics similar to the S-55 rotor system. Blade to rotor head adapters were fabricated to allow the S-55 blades to be mounted on the S-65 rotor head (Figures 2 and 3). Pertinent parameters for this rotor are given in the following table.

TEST BASELINE ROTOR

Radius, meters, (ft)	8.9 (29.2)
Chord, cm, (in)	41.7 (16.4)
Number of blades	6
Linear twist, deg.	-9.25
Airfoil section	NACA 0012
Tip Mach numbers tested	0.523, 0.580, 0.638

Variable Geometry Rotors

The variable geometry rotor head was fabricated primarily from Sikorsky S-55 rotor head hardware and is illustrated in Figures 4 through 6. Two S-55 rotor heads were mounted on a common shaft spaced one chordlenth, 41.7 cm (16.4 inches), apart. The collective pitch of the lower rotor was controlled in the usual fashion through a stationary swashplate, rotating swashplate and pushrods connected to the rotor head pitch horn. The collective pitch of the upper rotor was controlled by an electric actuator mounted on top of the rotating shaft. Collective pitch of the upper and lower rotors was controlled remotely from the control room of the whirl tower.

The relative azimuth spacing between the upper rotor blades and the following lower rotor blades was varied by removing the upper rotor head from the shaft spline and replacing it in the desired azimuth orientation.

The original intent was to test the VGR configurations at the same diameter and rotor speed as the test baseline rotor to provide a direct comparison. When the VGR was first operated at this diameter, however, an unusual Coriolis-induced mechanical instability was uncovered. This instability, which is described in detail in Appendix A, was caused by the particular combination of hardware used and is not necessarily peculiar to the variable geometry rotor concept. To allow operation at high blade loadings, the blade radius was shortened to 8.1 meters (26.5 ft) and the operating rotor speed reduced.

The following table defines the variable geometry rotor configurations tested.

VARIABLE GEOMETRY ROTOR

Radius, meters (ft)	8.1 (26.5)
Chord, cm (in)	41.7 (16.4)
Number of blades	6
Solidity	.098
Linear twist, deg.	-8
Airfoil Section	NACA 0012
Tip Mach Numbers Tested	0.450, 0.523
$\Delta\psi$ -upper blade to lagging lower blade, deg	62.1, 43.6, 34.4, 25.2
ΔZ, chordlengths	1.0
$\Delta\theta$ -upper rotor pitch minus lower rotor pitch, deg.	1.0, 0, -1.0

TEST PROCEDURE

Performance Testing

All instrumentation for measuring the performance parameters was calibrated as described in Table 1. Testing was generally performed in the early morning when favorable wind conditions existed. Wind velocity was monitored and recorded for each data point and all data were corrected to zero wind in accordance with NACA TN 1698. The average wind velocity for all test runs was less than 2.6 meters per second (5 knots).

Before the first test run (series of consecutive data points at a single rotor tip Mach number), and after each run, records of running zeros were taken. Running zeros consist of records of thrust, torque, and whirl stand bearing torque taken at approximately 1 to 2 rpm rotor speed in both the forward and reverse direction.

The following parameters were recorded for each data point. Blade parameters were measured on one blade of both the upper and lower rotors for the VGR.

1.	ambient temperature	degrees F
2.	wind velocity	knots
3.	rotor speed	RPM
4.	thrust	pounds
5.	torque	ft-lbs
6.	bearing torque	ft-lbs
7.	impressed pitch	degrees
8.	pitching moment	in. lbs
9.	coning angle (beta)	degrees
10.	lag angle	degrees

Data points were obtained by setting a particular rotor speed and blade angle. Data were recorded after allowing the system to settle for about 30 seconds. Strip chart records for a 20 to 40 second period were the source of the primary performance parameters. The order in which data points were taken was randomized to reduce the chance of systematic error.

Performance and acoustic data for the VGR were acquired at rotor speeds equivalent to tip Mach numbers of .450 and .523 at an axial spacing of one chordlength at azimuth spacings of 62.1°, 43.6°, 34.4°, and 25.2° measured from an upper blade to the following lower blade of the six bladed system. At each of these conditions, data were acquired at differential collective pitch (upper vs. lower rotor) of zero plus and minus one degree. Radius of the VGR system was 8.1 meters (26.5 feet).

Data were also acquired at the two rotor speeds with only the three lower blades installed to establish the whirl stand and ground interference effects on the VGR. The baseline six bladed rotor was tested at a radius of 8.9 meters (29.2 feet), but the mechanical stability problem discussed in Appendix A forced the reduction to 8.1 meters (26.5 feet) for the VGR configurations.

Blade Tracking Problem

Prior to acquiring test data, an attempt was made to track blades by first installing the three upper blades and adjusting the pushrod length until all three were in track. Then the three lower blades were added and the lower pushrods adjusted in an unsuccessful attempt to obtain a tracked lower rotor. After repeated attempts to track the lower blades in the presence of the upper rotor, the upper blades were removed and the lower blades were tracked. With both the upper and lower rotors tracked independently, all six blades were mounted on the stand and tested in the VGR configurations, but problems were encountered with the track of the lower blades. In all of the VGR configurations at the higher thrust levels, problems were consistently encountered in which any one blade on the lower rotor would randomly go out of track by as much as 0.3 to 0.6 meters (one to two feet). This random out-of-track condition occurred more frequently in unsteady wind conditions and with VGR configurations which gave poorer performance.

Although blade track problems due to blade-vortex interactions have been experienced on other rotor systems at high blade loading, it is believed that the difficulties with the VGR rotor at all thrust levels were a result of the basic concept of the VGR. In hover, it is desired to allow the tip vortices of an upper blade to pass over the following lower blade and then down through the lower rotor tip path plane between blades as described in Reference 9. In this manner, the adverse effects of blade-vortex interference on rotor performance are to be minimized or eliminated.

In the presence of the low wind conditions and small amounts of unsymmetrical whirlstand interference encountered during this test, it is concluded that small random perturbations occurred in the path of both the blade and the tip vortices causing the relative distance between a blade and a tip vortex to change. This change in separation distance would change the lift distribution of the blade and, therefore, cause a change in the coning angle or flatwise bending shape of the individual blade, resulting in an out-of-track condition. During the test, direct qualitative correlation was observed between wind gustiness and tip path plane stability. The characteristics of this out-of-track condition bore no resemblance to the mechanical stability problems encountered at higher rotor speeds and at larger diameters.

The random track problem was not encountered during the small scale model VGR hover tests because they were conducted in a controlled indoor environment (no wind) using rotor blades with a high flapping inertia. Stiffness and mass properties of the model rotor blades were much greater than full scale blades and, to obtain high Mach numbers with the low model rotor radius, rotational speed was very high. Thus, because the ratio of centrifugal to aerodynamic forces was much higher for the model rotor test and no wind was present, the track problem was not evident.

Acoustic Measurements

To insure data quality for the low frequency blade passage (6/rev) and sub-harmonic (3/rev) signals, a wide-band FM recording system was used. The Honeywell model 5600B, set up for half-inch, 7 channel tape, recorded the data at 15 ips yielding a frequency range of 0 - 10 KHz. General Radio type 1961-0601 1-inch electret-condenser microphones with windscreens and type 1560-P42 pre-amplifiers were used in the field. Dana DC amplifiers were used to maintain the signals at proper input levels for the recorder.

Acoustic measurement station 1 was mounted on the centerline of the rotor head, .91 meters (3 feet) above the plane of rotation. Station 2 was 38.1 meters (125 feet) from the rotor centerline, .91 meters (3 feet) off the ground. Stations 3, 4 and 5 were located on a pole 86.9 meters (285 feet) out at heights of 0.91, 8.2, and 21.3 meters (3, 27 and 70 feet) respectively. Station 6 was 125.3 meters (411 feet) out and 15.2 cm (6 inches) above the ground.

To insure close correlation of acoustic and performance data, noise data and performance data were recorded simultaneously. This gave thirty second records at each condition.

Complete details of the acoustic measurement technique and recorded data are presented in Reference 10.

COMPARATIVE BASELINE PERFORMANCE DERIVATION

Because of the difference in radius discussed previously and in Appendix A, it is necessary to analytically correct the baseline data to the VGR radius of 26.5 feet and solidity of .098. A refined version of the prescribed wake hover analysis reported in Reference 3, the Circulation Coupled Hover Analysis Program, (CCHAP) was used for this correction. The following procedure was followed:

1. To establish the validity of the analysis, performance of the 8.9 meter (29.2 feet) baseline rotor tested on the Sikorsky Stratford whirl tower was calculated using CCHAP. Figures 7, 8 and 9 show that agreement between test and calculated data is within 0.5% of thrust at constant power at all rotor speeds. The 8.9 meter (29.2 feet) radius rotor is free of ground and whirlstand interference on this test facility.

2. To estimate the effect of ground and whirlstand interference for the 8.1 meter (26.5 feet) radius rotor, a comparison was made between performance

data for an isolated, 3 bladed, 8.1 meter (26.5 feet) radius rotor tested on the Sikorsky Bridgeport whirl tower and the same rotor tested during the present program on the Stratford whirl tower. This comparison indicates that, for an 8.1 meter (26.5 feet) radius rotor, ground and whirlstand interference on the Stratford facility results in measured C_T/σ's 3.0% greater than those of an isolated rotor at the same power coefficient. (Several inboard pockets of the 8.1 meter (26.5 feet) radius rotor are over the top of the whirl tower.) It was noted that other 8.1 meter (26.5 feet) radius rotors have also experienced a 3.0% C_T/σ increase due to whirlstand and ground interference on the 10,000 HP Main Rotor Test Stand in Stratford.

3. To establish that the analysis and interference effects determined above are sufficient for an 8.1 meter (26.5 feet) rotor on the 10,000 HP Main Rotor Test Stand in Stratford, calculated (CCHAP) performance for the three bladed rotor was corrected by increasing C_T/σ by 3.0%. This calculated performance is in excellent agreement with test data acquired on the Stratford facility as shown in Figure 10.

4. Performance was calculated for the six bladed, 8.1 meter (26.5 feet) radius baseline rotor using CCHAP. The calculated C_T/σ's, increased by 3.0% to account for whirlstand and ground interference, are then compared directly to the VGR test data to determine the hover performance gains achieved by the VGR.

DISCUSSION OF RESULTS

Data Presentation

A brief summary of the gains achieved in both performance and acoustic signature is presented in Table 2.

Tabulated performance data for the test baseline rotor is presented in Tables 4 through 6. (Table 3 explains the abbreviations used on the computer printout.) Performance data for all tested VGR configurations is tabulated in Tables 7 through 32. Figures 11 through 30 present the VGR performance data in non dimensional graphic form. Unless otherwise noted, all data is corrected to zero wind conditions, but is not corrected for whirlstand interference or ground effect. Comparative baseline data is also presented with ground effect and whirlstand interference included.

Precision of Test Data

For all rotor configurations, precision of the least mean squares curve fit data is within 0.5 percent of thrust at constant power. Therefore, in comparing test results for different rotor configurations, differences of 0.5 percent or less should not be considered significant while differences greater than 0.5 percent must be considered both real and significant. Data for configurations with zero differential collective pitch are, in general, more precise and accurate than data for configurations with either $\pm 1.0^{\circ}$ collective pitch where fewer data points were taken.

Performance Results

The performance summary presented in Table 2 shows that, for all VGR configurations, hover performance was improved when compared to the baseline, in-plane, symmetrical, six bladed configuration. Improvements in thrust at constant power varied from 1.0 to 6.0 percent and agree reasonable well with the gains achieved for similar configurations during the model VGR test program reported in Reference 9.

For all azimuth spacings, configurations with a differential collective pitch of $+1^{\circ}$ (upper rotor pitch 1° higher than lower rotor) demonstrated improved performance compared to 0° and -1°. This improvement is most likely due to either a redistribution of the vortex path or increased separation of the two tip path planes for that configuration. Small scale tests[9] have shown that axial spacing has a strong effect on VGR performance. Axial hub spacings greater than one chordlength were not tested full scale due to considerations of hub parasite drag and shaft weight in practical applications. The small scale tests also indicated that the most significant ΔZ effect occurs in the first chordlength of separation.

Cross plots of the measured hover performance improvement trends presented in Table 2 did not yield clear trends and, for that reason, are not presented. This lack of clear trending is not surprising when one considers the concept of "threading the vortex through the blades" upon which the VGR hover improvements are based.

The subjective concensus of the persons involved in the test program, based upon the quantitative performance and acoustic data presented in Table 2, as well as qualitative observations of rotor tracking stability and acoustic signature, is that the azimuth spacing of 43.6 degrees (lower blade lagging) is definitely superior in all categories at differential collective pitch settings of +1 and 0 degrees.

It is suspected that the azimuthal, axial and collective pitch settings that demonstrated superior performance in the present test would change for a rotor with different solidity, radius, tip speed or twist. All of these parameters have been shown to have an effect on tip vortex trajectory.

Acoustic Results

Because the diameter of the baseline rotor (17.8m or 58.4 ft) was greater than that of the actual VGR configurations (16.2m or 53 ft), the acoustic signature of smaller baseline rotor had to be simulated analytically. It was found that at constant tip speed with the radius decreased to 8.1m (26.5 ft), the rotor system would be only 1 dB noisier. As 1 dB is within the range of data accuracy ($\pm$1 dB), no corrections were applied to the baseline data.

Acoustic data were analyzed only for the configurations with equal collective pitch on the upper and lower rotors although data were recorded for all configurations. A complete discussion of the acoustic measurements as well as a tabulation of all data is presented in Reference 10.

Table 2 shows that the acoustic gains of up to 4 dB consistently correlate with the aerodynamic performance gains.

CONCLUSIONS

1. Improvements in rotor thrust at constant power as high as 6 percent have been demonstrated in hover on a full scale variable geometry rotor (VGR).

2. Improvements in acoustic signature demonstrated by the VGR correlate with improvements in hover performance.

3. The VGR may be susceptible to a random blade-out-of-track problem when hovering in a light variable wind or when the rotor is in the presence of a solid body which could distort the vortex trajectory (such as a fuselage).

4. Changes in blade geometry (chord, radius, twist, airfoil section) will probably alter the optimum VGR configuration (axial and azimuthal separation).

RECOMMENDATIONS

1. The sensitivity of the VGR to random blade out-of-track conditions should be investigated further using dynamically scaled model rotor blades.

2. Since the variable geometry rotor was conceived, advances in material and blade technology have made practical the

use of high non-linear twist distributions on rotor blades. There is reason to question whether the hover performance gains of the VGR would be additive to the gains which have been demonstrated through the use of blade twist. A test program should be conducted to resolve this question.

APPENDIX A

CORIOLIS INDUCED MECHANICAL INSTABILITY

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SUMMARY

Full scale whirl tests were conducted to determine the effects of interblade spatial relationships and pitch variations on the hover performance and acoustic signature of a 6-blade main rotor system. The Variable Geometry Rotor (VGR) variations from the conventional baseline were accomplished by: (1) shifting the axial position of alternate blades by one chordlength to form two tip path planes; and (2) varying the relative azimuthal spacing from the upper rotor to the lagging lower rotor in four increments from 25.2 degrees to 62.1 degrees. For each of these four configurations, the differential collective pitch between upper and lower rotors was set at +1 degree, 0 degree and -1 degree. Hover performance and acoustic data were acquired for all configurations.

In the course of testing the full scale Variable Geometry Rotor system, an instability occurred which was shown to be purely mechanical and the result of Coriolis forces driving the system in a ground resonance mode. This unusual type of ground resonance is primarily the result of the rotor mass to effective hub mass ratio being very large (about 1.0) compared to that normally existing in conventional systems. The instability was initially uncovered when testing the VGR at a radius of 8.9 meters (29.2 ft). That radius was achieved with blade extenders weighing about 50 lbs each, mounted between the rotor head and blade cuff.

It must be stressed that this instability was not caused by aerodynamics or the VGR concept, but was only a function of the particular hardware selected for this test. The history and analysis of that instability are presented here for information and insight into a unique problem which could reoccur with other systems.

SYMBOLS

b	S_B/m_B
e	offset
I_B	blade mass moment inertia about hinge
K_γ	lag hinge spring stiffness
m_B	mass of one blade
M_q	effective fixed system mass at hub
N	number of blades
ϕ	$(1/\lambda) + \lambda X$
q	$\Lambda_3 X^2/(1-X)$
q_F	hub generalized coordinate
r	radius of gyration of blade about its c.g.
S_B	first mass moment of blade about hinge
X	$(\omega/\omega_r)^2$
y	$2\zeta_\gamma$
β	flapping generalized coordinate
β_s, β_c	cyclic flapping coordinates
β_o	coning angle
γ	lag generalized coordinate
γ_s, γ_c	cyclic lag coordinates
γ_o	steady lag angle
ζ_γ	percent critical lag damping
ζ_q	percent critical hub damping
λ	$2\ \zeta_q/(1-X)$
Λ_1	$e/b(1+r^2/b^2)$
Λ_2	$K\gamma/I_B\omega_r^2$
Λ_3	$\mu/2(1+r^2/b^2)$

μ $Nm_B/(M_q+Nm_B)$

ω_r reference fixed system frequency

ω_γ uncoupled lag frequency

ω_q uncoupled fixed system frequency

ψ azimuth angle

Ω rotor speed

PRETEST VGR STABILITY ANALYSIS

Prior to testing, a ground resonance analysis was performed. Unfortunately, the analysis being used could not accommodate coaxial rotors, and certain assumptions in the modeling of the system were necessary.

To obtain the required input to the analysis, a shake test was performed which defined the natural frequencies, damping generalized masses, and mode shapes of the non-rotating drive-shaft with the hubs in position and all of the flapping mass removed. This test showed the system to be essentially symmetrical, and produced the modal characteristics shown in Figure 31. Examination of the mode shape indicated that a reasonable representation of the system dynamics would be obtained if it were assumed that a single 6 bladed rotor were situated at a point on the shaft midway between the upper and lower rotors. Using this assumption, the modal data given in Figure 31, and the appropriate blade parameters in the analysis yielded the results shown in Figure 32. This indicates onset of an instability at a rotor speed of approximately 280 rpm.

Initially, that result was surprising since the appearance of the frequency loci did not resemble those characteristically obtained from conventional systems (see insert in Figure 32). The main difference between conventional systems and the VGR is that, for the VGR, the intercepts of the uncoupled shaft and blade lag frequencies occur at rotor speeds far in excess of that at which instability is predicted. Such a wide separation would normally preclude instability. Since prediction of the instability with such frequency separation was questionable, a check was in order.

Price[11] has developed closed form expressions for defining ground resonance stability boundaries. Although strictly only applicable to one degree of freedom hub motion, the expressions do provide valuable insight, and are repeated below in Price's nomenclature.

$$(\Omega/\omega_r) = [1 + (q/\phi y)]\sqrt{X} \quad (1)$$

$$y^2\{ \phi^2[\Lambda_1 + (\Lambda_2/X)] - (\phi q/\lambda X)\} + 2\phi q \Lambda_1 y - (1 - \Lambda_1)q^2 = 0 \quad (2)$$

Knowing all of the system parameters, these expressions are used by assuming a range of values of X and calculating corresponding values of y from (2). When substituted in (1), these give the appropriate rotor speeds. Since y is proportional to the blade lag damping required for stability, we can construct stability boundaries in the blade lag damping: rotor speed plane. This was done using VGR parameters. The results are shown in Figure 33. It can be seen that instability is predicted at a rotor speed of 350 rpm. The present analysis was then run using a single degree of freedom hub. This predicted instability at 330 rpm. The correlation between these results was considered sufficient to validate the initial VGR prediction.

If all of the parameters involved are examined, the reason for this apparently unusual predicted ground resonance becomes apparent. First, the ratio of the total blade mass to the effective mass at the hub: conventionally we might expect ratios in the order of 0.1. The VGR mass ratio was approximately 1.0 with the extenders mounted on the hub to achieve the 8.9 meter (29.2 ft). Second, the effective hub damping: with the landing gear oleos, etc., levels as high as 25% critical can be achieved. The VGR damping was 3% critical. Simply considering Deutsch's[12] product of damping criterion would suggest some kind of a problem. The mass ratio is probably of more importance for this VGR configuration. Although the hub frequency is relatively high, when the blades lag in their backward whirl mode, they are able, by virtue of their inordinate inertia forces, to produce sufficient hub motion to create the type of energy transference that leads to ground resonance.

The frequency of the lag motion in the rotating system predicted for the VGR at onset of instability is very low - on the order of 0.1 cycles per second. Attendant with this will be low lag velocities which will render the lag dampers relatively ineffective. This explains the nature of the stability boundary shown in Figure 33.

Based on the above, it was decided that the planned upper rotor speed limit of 233 rpm for the performance tests would be within the stable operating envelope.

OCCURRENCE OF INSTABILITY

On the first day of the proposed performance tests, the rotor was run up to a rotor speed of 220 rpm in flat pitch with no indication of instability. However, as the blade pitch angle was increased with the rotor running at a speed of 212 rpm, an instability was encountered at a blade angle of 6 degrees. The oscillograph record of this instability showed that the phenomenon is a rotating system backward whirl. During the instability, the shaft was also observed to precess. The frequency of the oscillations in the rotating axes is approximately 0.1 cycles per second. This is very similar to the type of instability predicted in the preliminary analysis but, since it had not occurred in flat pitch, it was naturally believed that it had somehow been induced by the aerodynamics.

Further tests were performed at progressively lower speeds. Instabilities similar to the above were again encountered at progressively higher blade angles. At the same time, aeroelastic analysis was being performed which predicted instabilities of the same type that had occurred. The experimental and analytical results are shown in Figure 34. The predicted instabilities were in every way similar to the test occurrences, but quantitative agreement in terms of the blade angle at onset is lacking. This lack of quantitative correlation will be discussed subsequently.

At this juncture it was decided to perform some analytical parametric studies to identify those elements of the system that were required for the instability to exist.

PARAMETRIC STUDIES

In Figure 31, it will be observed that the hub rotates out-of-plane as the driveshaft bends. Therefore, variations in the magnitude of these rotations were made to assess their importance. The effect of the rotations on the VGR stability is shown in Figure 35. From this it can be seen that, although increasing the rotations is destabilizing, they are not necessary for the instability to exist since with zero rotations, instability was still predicted.

The fact that the instability involved precession of the driveshaft suggested variations in hub impedance ratio; that is, the degree of hub asymmetry. Figure 36 shows that increasing asymmetry by softening in one direction is destabilizing and in fact leads to static divergence when the stiffness in one direction is zero. However, increasing asymmetry by stiffening in one direction has a stabilizing influence. In classical whirl flutter of propellers, increasing asymmetry by softening or stiffening in one direction can be stabilizing. Therefore, the instability we are dealing with cannot be placed in this class.

The limit case of infinite stiffness in one direction was also analyzed. Instability was predicted at virtually the same blade angle as in the 10:1 hub impedance ratio case. Therefore, we can conclude that shaft whirling precession, although destabilizing, is not a prerequisite for instability.

Since the blades were free to flap, the effect of increasing the flapping frequency by pitch-flap coupling was examined. This effect is shown in Figure 37. It can be seen that increasing pitch-flap coupling has a stabilizing influence. This would suggest that flapping does play a part in the instability. It would also seem reasonable to assume that increasing the flapping frequency via root springs would be stabilizing.

At this point it was decided to remove the flapping motion altogether. When this was done, the instability was not predicted. Therefore, flapping is an essential ingredient.

With the flapping reintroduced, the lag motion was locked out. Again, no instability was predicted. Thus, lagging is also a key ingredient.

We have thus far established that, for the instability to exist,

(a) hub rotations are not required,
(b) shaft whirling precession is not required,
(c) flapping is essential, and
(d) lagging is essential.

Therefore, all further analysis was performed with only the essential degrees of freedom. That is, flap, lag, and one purely translational hub mode.

To determine the effect of aerodynamics on the system, the unstable mode shape was examined. This is shown in Figure 38. It can be seen that, during the unstable oscillations, the rotor tip path plane is tilted. It follows that the thrust vector must also be tilted. To assess the importance of this effect, the thrust terms were removed from the stability matrices while all of the remaining steady and derivative aerodynamic terms were retained. Instability was still predicted. Therefore thrust, in itself, is not a key ingredient.

Since thrust also causes blade coning, coning was set equal to zero in the analysis with the consequence that no instability was predicted. Thus, coning is essential.

At this point, it was decided to remove the aerodynamics completely while retaining coning. Instability was still predicted. This made it clear that the phenomenon is not aeroelastic. It is in fact a purely mechanical instability, which, since the system being tested had no pre-cone, required the aerodynamics only to produce a coning angle.

Additional studies revealed that without aerodynamics and with an input coning angle, the flapping degree of freedom was still required for the instability to exist. The lag freedom is also required.

To assess the actual effect of the aerodynamic forces, stability boundaries were defined as functions of coning angle, with and without aerodynamics. It was found that both boundaries were essentially coincident. Therefore, other than producing coning, the aerodynamics participate little in the instability.

Using all of this information, we will, in what follows, establish the precise mechanism of the instability.

THE MECHANISM

We have now reduced the problem to that of a fairly simple dynamic system which has the following equations of motion.

$$I_B\ddot{\beta} + S_B\beta_0\cos\psi\,\ddot{q}_F + 2\Omega I_B\beta_0\dot{\gamma} + \Omega^2(I_B + eS_B)\beta = 0 \qquad (3)$$

$$I_B\ddot{\gamma} + (S_B\sin\psi + S_B\gamma_0\cos\psi)\ddot{q}_F - 2\Omega I_B\beta_0\dot{\beta} + 2\zeta_\gamma I_B\omega_\gamma\dot{\gamma} + \Omega^2 eS_B\gamma = 0 \qquad (4)$$

$$(Nm_B + M_q)\ddot{q}_F + S_B\beta_0\sum^N\ddot{\beta}\cos\psi + S_B\sum^N\ddot{\gamma}\sin\psi + S_B\gamma_0\sum^N\ddot{\gamma}\cos\psi$$
$$+ 2\zeta_q M_q\omega_q\dot{q}_F - 2\Omega S_B\beta_0\sum^N\dot{\beta}\sin\psi + 2\Omega S_B\sum^N\dot{\gamma}\cos\psi - 2\Omega S_B\gamma_0\sum^N\dot{\gamma}\sin\psi$$
$$+ \omega_q^2 M_q q_F - \Omega^2 S_B\beta_0\sum^N\beta\cos\psi - \Omega^2 S_B\sum^N\gamma\sin\psi + \Omega^2 S_B\gamma_0\sum^N\gamma\cos\psi = 0 \qquad (5)$$

If we assume that the flap and lag coordinates β and γ have the forms,

$$\beta = {}^2/N\ (\beta_s \sin\psi + \beta_c \cos\psi) \qquad (6)$$

$$\gamma = {}^2/N\ (\gamma_s \sin\psi + \gamma_c \cos\psi) \qquad (7)$$

where β_s, β_c, γ_s and γ_c are complex, time dependent quanties that combine to form cyclic rotor modes, then, using the additional relations,

$$\begin{aligned} \dot\beta &= {}^2/N\ [(\dot\beta_s - \Omega\beta_c)\sin\psi + (\dot\beta_c + \Omega\beta_s)\cos\psi\ ] \\ \ddot\beta &= {}^2/N\ [(\ddot\beta_s - 2\Omega\ \dot\beta_c - \Omega^2\beta_s)\sin\psi + \\ &\quad (\ddot\beta_c + 2\Omega\ \dot\beta_s - \Omega^2\beta_c)\cos\psi\ ] \end{aligned} \qquad (8)$$

with similar expressions for $\dot\gamma$ and $\ddot\gamma$, it can be shown that Equations (3), (4), and (5) become

$$I_B\ddot\beta_s - 2\Omega\ I_B\dot\beta_c + \Omega^2 eS_B\beta_s + 2\Omega I_B\beta_0\dot\gamma_s - 2\Omega^2 I_B\beta_0\gamma_c = 0 \qquad (9)$$

$$I_B\ddot\beta_c + 2\Omega I_B\dot\beta_s + \Omega^2 eS_B\beta_c + \underline{2\Omega I_B\beta_0\dot\gamma_c} + \underline{2\Omega^2 I_B\beta_0\gamma_s} + \underline{(N/2)S_B\beta_0\ddot q_F} = 0$$

(10)

$$I_B\ddot\gamma_s - 2\Omega I_B\dot\gamma_c - \Omega^2(I_B - eS_B)\gamma_s + 2\zeta_\gamma I_B\omega_\gamma\dot\gamma_s - 2\zeta_\gamma I_B\Omega\omega_\gamma\gamma_c - \underline{2\Omega I_B\beta_0\dot\beta_s} + 2\Omega^2 I_B\beta_0\beta_c + N/2S_B\ q_F = 0$$

(11)

$$I_B\ddot\gamma_c + 2\Omega I_B\dot\gamma_s - \Omega^2(I_B - eS_B)\gamma_c + 2\zeta_\gamma I_B\omega_\gamma\dot\gamma_c + 2\zeta_\gamma I_B\Omega\omega_\gamma\gamma_s - 2\Omega I_B\beta_0\dot\beta_c - 2\Omega^2 I_B\beta_0\beta_s + (N/2)S_B\ \gamma_0\ddot q_F = 0$$

(12)

$$S_B\beta_0\ddot\beta_c + S_B\ddot\gamma_s + S_B\gamma_0\ddot\gamma_c + (Nm_B + M_q)\ddot q_F + 2\zeta_q M_q\omega_q\dot q_F + \omega_q^2 M_q q_F = 0$$

(13)

Now, since coning has been shown to be essential to the instability, the destabilizing elements in these equations must contain the coning angle. To assist in identifying the critical elements, let us again examine the unstable mode shape in Figure 38. Choosing the instant in time when the hub is just approaching its maximum displacement, it can be seen that β_s, γ_c, $\dot{\beta}_c$, $\ddot{\beta}_s$, $\dot{\gamma}_s$ and $\ddot{\gamma}_c$ are all approaching zero. It is, therefore, apparent that the destabilizing elements are those terms in Equation (10), (11) and (13) that contain the coning angle. These are underlined and are seen to be inertial and Coriolis forces.

The mechanism of the instability is now clear. With the blades coned, the hub accelerations produce blade inertial forces that cause the blades to flap. The flapping motion produces Coriolis forces which, at the onset of instability, act as shown in Figure 39. A four bladed configuration is illustrated to simplify the presentation. It is important to note that the blade lagging motion is occurring in that mode which causes the rotor center of gravity to rotate in a retrograde sense about the center of rotation. This is the ground resonance mode. It can be seen that the Coriolis forces, by virtue of the phase relationship between flapping and lagging, are acting in phase with, and in the same direction as, the blade lag displacement in this retrograde mode. They are, therefore, acting in phase with and in the same direction as the offset rotor c.g. inertia forces. That is, the Coriolis forces are driving the rotor in the ground resonance mode, thereby precipatating instability.

The parametric trends observed can now be explained. The hub rotations are destabilizing because they increase the flapping and hence, the magnitude of the Coriolis forces. Increasing flapping frequency is stabilizing because this both decreases flapping and changes the phase angle between flap and lag. The effects of introducing asymmetry are entirely consistent with normal ground resonance behavior.

DISCUSSION

This work has uncovered what appears to be a phenomenon not heretofore encountered; a Coriolis induced mechanical instability. It is believed that such phenomena have been predicted previously, but have mistakingly been attributed to other causes.

In Reference 13, the author conducted analytical stability studies of large rotor propellers in high speed axial flight. In the studies of fully articulated systems, certain instabilities were predicted which, in the light of what has preceded, are now suggested to be of this Coriolis induced type. The rotor propellers being analyzed had similar dynamic characteristics to the VGR system as tested on the Sikorsky Stratford whirlstand (low effective hub damping and large rotor to effective hub mass ratios). The fact that the instability has now manifested itself is attributed to these rather unusual dynamic characteristics. In more conventional systems, it is unlikely that the Coriolis effect would be quite as important.

Since the instability was uncovered on an 8.9 meter (29.2 ft) VGR configuration incorporating heavy blade extenders to achieve that radius, this discussion has been directed exclusively toward that case. Removal of the blade extenders and reduction of the operating rotor speed permitted the completion of the VGR whirl test without incident. The instability probably only occurred because the existing rotor hardware, used to obtain the VGR test configurations economically, resulted in such low effective hub damping and a large rotor to effective hub mass ratio.

In a qualitative sense the correlation between the observed and the predicted phenomena is good, but quantitatively the predictions are overly conservative. It is believed that this is largely the result of inaccurate modeling. The fact that the VGR had two 3 bladed, coaxial rotors, while the analytical model had one 6 bladed rotor is important both from dynamic and aerodyamic considerations. The differing rotations at each of the VGR hubs, the rotor aerodynamic interference effects, and the differing rotor coning angles, not included in the analysis, must all contribute to the accurate definition of the stability boundaries.

It is important that we note that the instability encountered is in no way associated with the VGR concept. The analysis showed that it occurs even if there is only one rotor. The VGR configuration simply makes correlation that much more difficult.

A new vista of ground resonance has been opened. Clearly, this report has not covered the subject with the rigor of the classical papers on normal ground resonance and much remains to be done.

CONCLUSION

1. Rotor systems with a lag frequency less than the rotor speed and a large rotor to effective fixed system mass ratio can be susceptible to a Coriolis induced mechanical instability if they are coned and are able to flap.

2. Increasing the flapping frequency has a stabilizing influence.

3. Accurate modeling of the dynamics of such systems is important, particularly in relation to hub rotations since these are highly destabilizing.

4. It would appear that the Coriolis induced phenomenon has all the characteristics of normal ground resonance, but the complexity of the phenomenom is increased by adding flapping and coning parameters.

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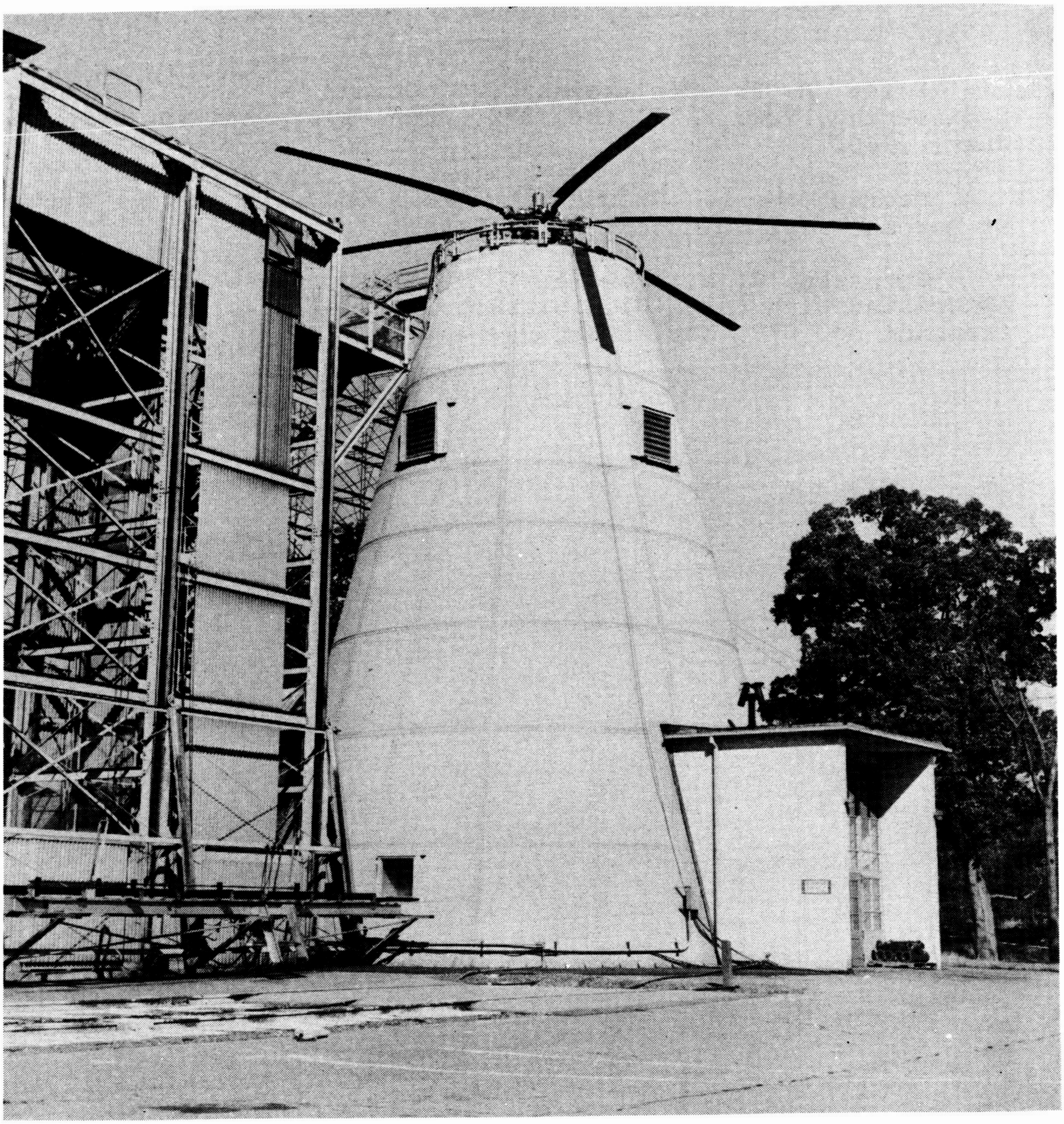

FIGURE 1. TEST BASELINE ROTOR INSTALLED ON SIKORSKY 10,000 HP MAIN ROTOR TEST STAND

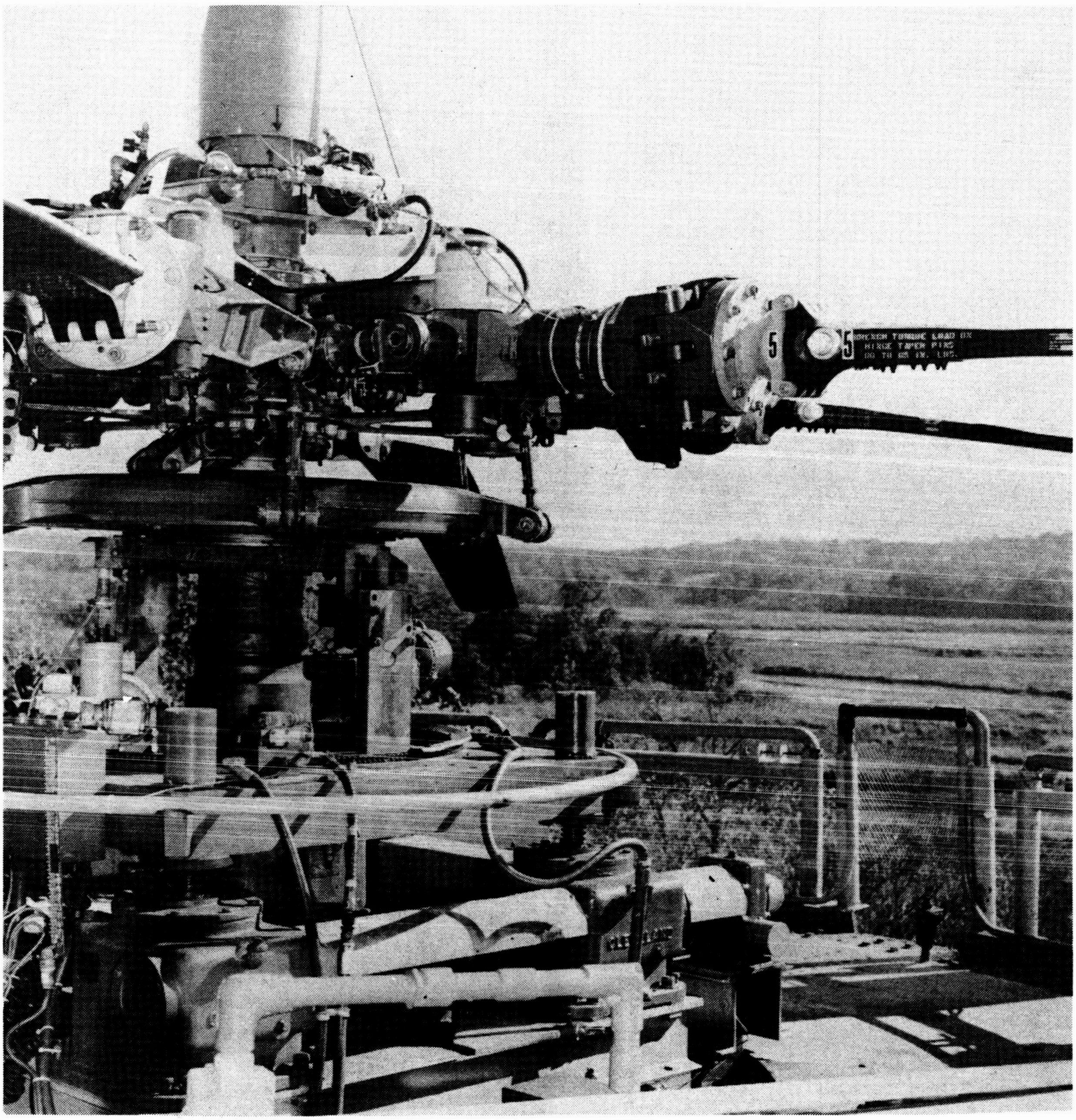

FIGURE 2. TEST BASELINE ROTOR INSTALLATION DETAILS

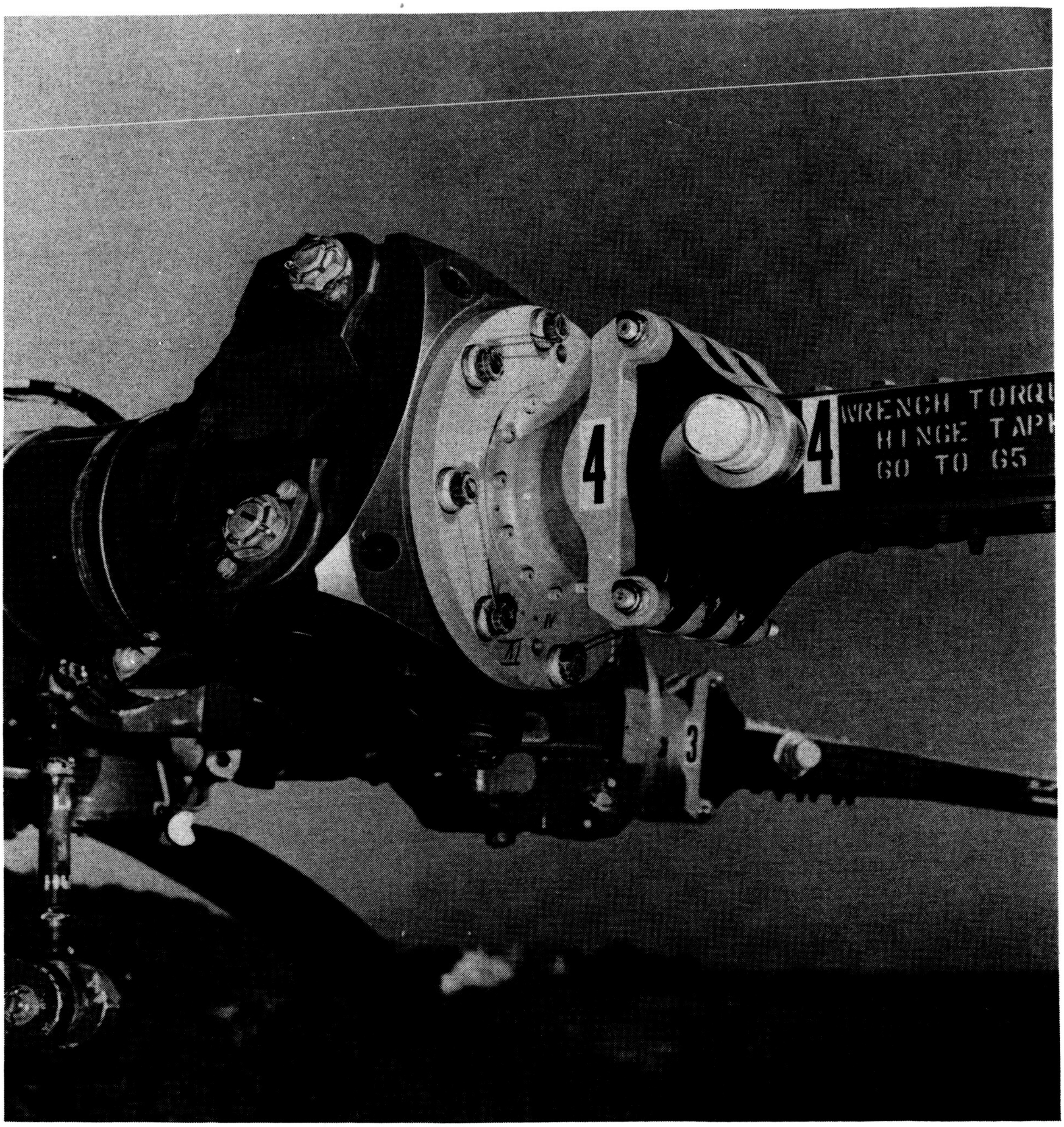

FIGURE 3. BLADE-ROTOR HEAD ADAPTERS FOR TEST BASELINE ROTOR

FIGURE 4. VARIABLE GEOMETRY ROTOR INSTALLED ON SIKORSKY 10,000 HP MAIN ROTOR TEST STAND

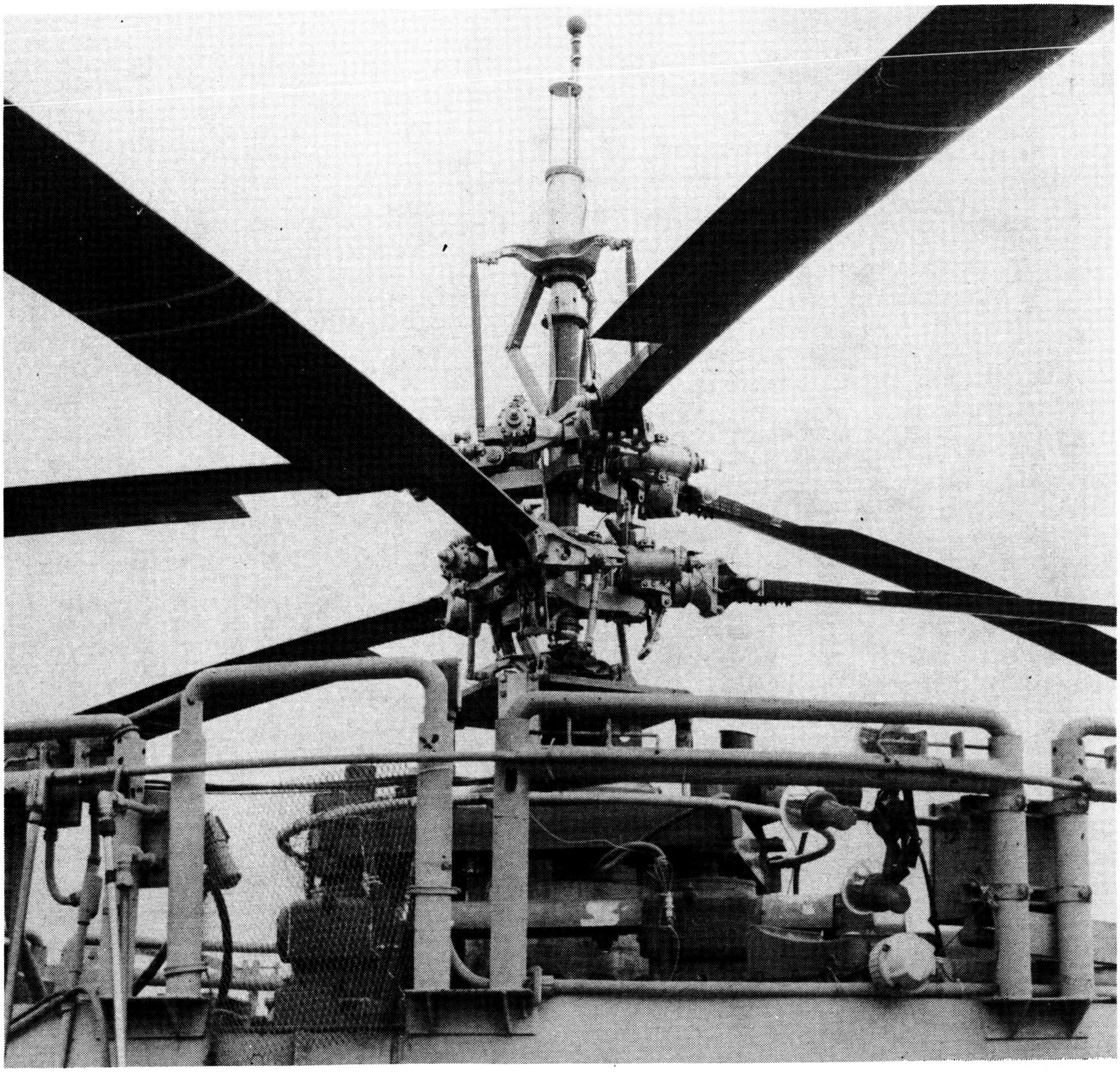

FIGURE 5. VARIABLE GEOMETRY ROTOR HEAD TEST INSTALLATION

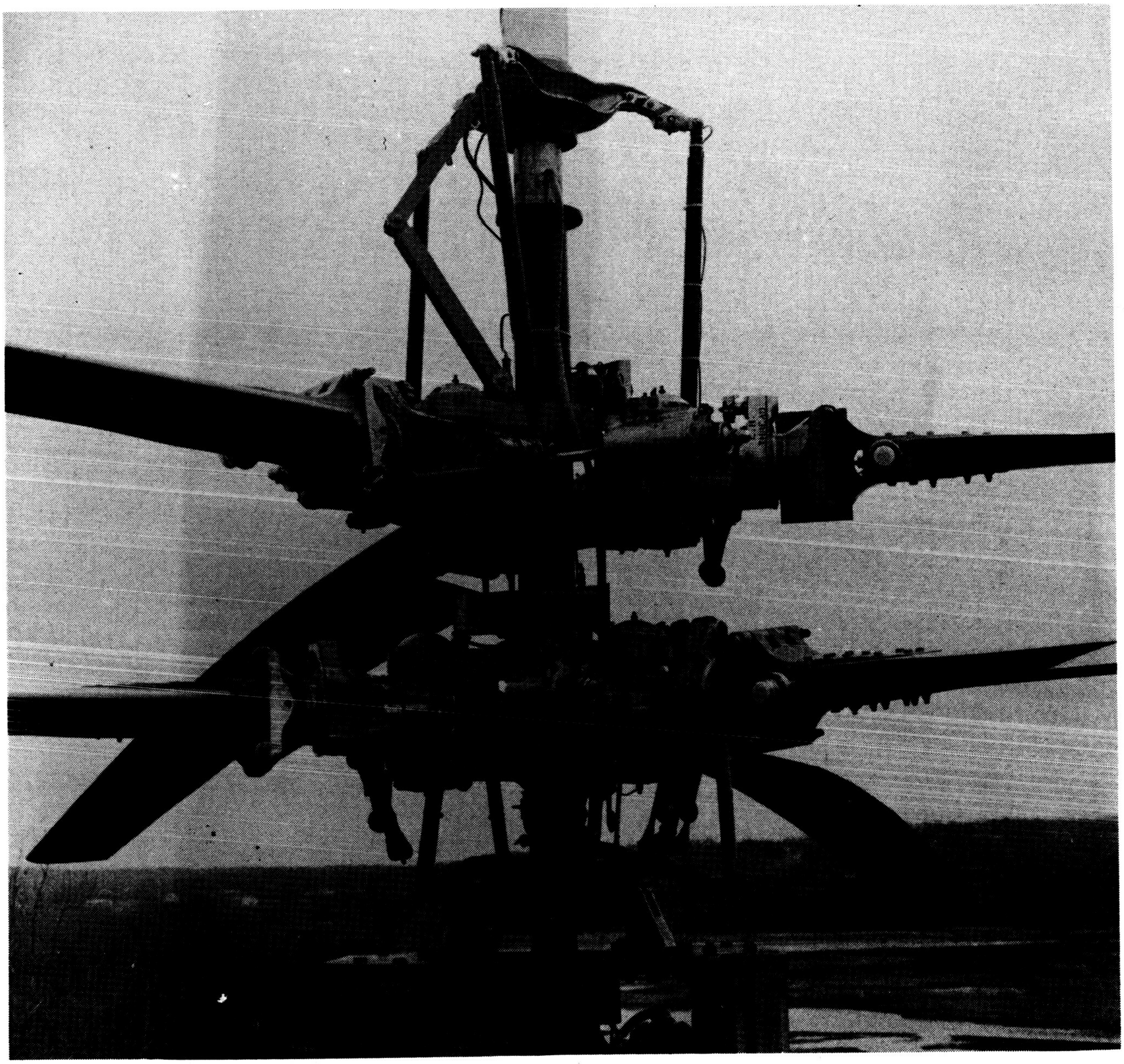

FIGURE 6. VARIABLE GEOMETRY ROTOR HEAD INSTALLATION DETAILS

Note
These data are unaffected by
ground and whirl tower
interference

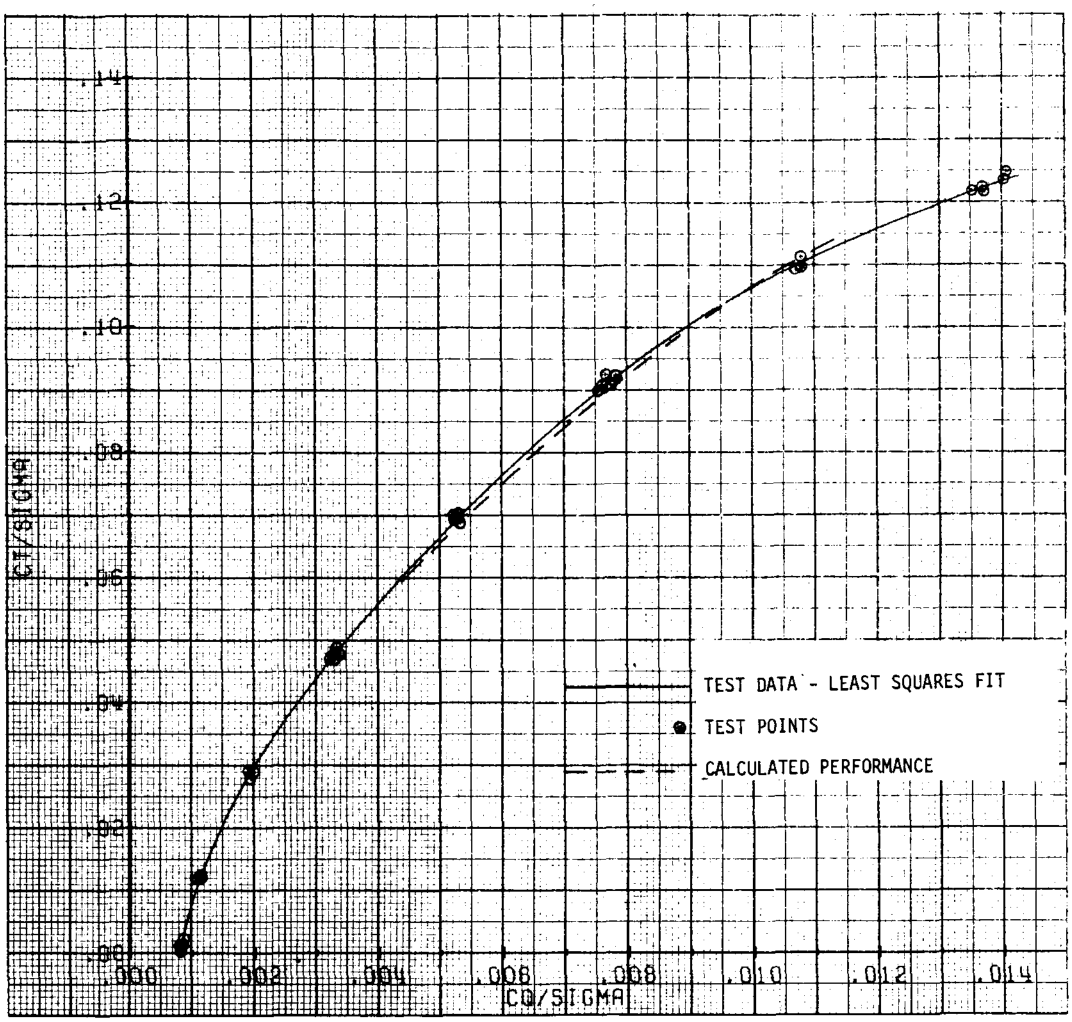

FIGURE 7. TEST BASELINE ROTOR MEASURED AND CALCULATED HOVER PERFORMANCE
C_T/σ vs C_Q/σ
MACH NUMBER = 0.523

Note
These data are unaffected by ground and whirl tower interference

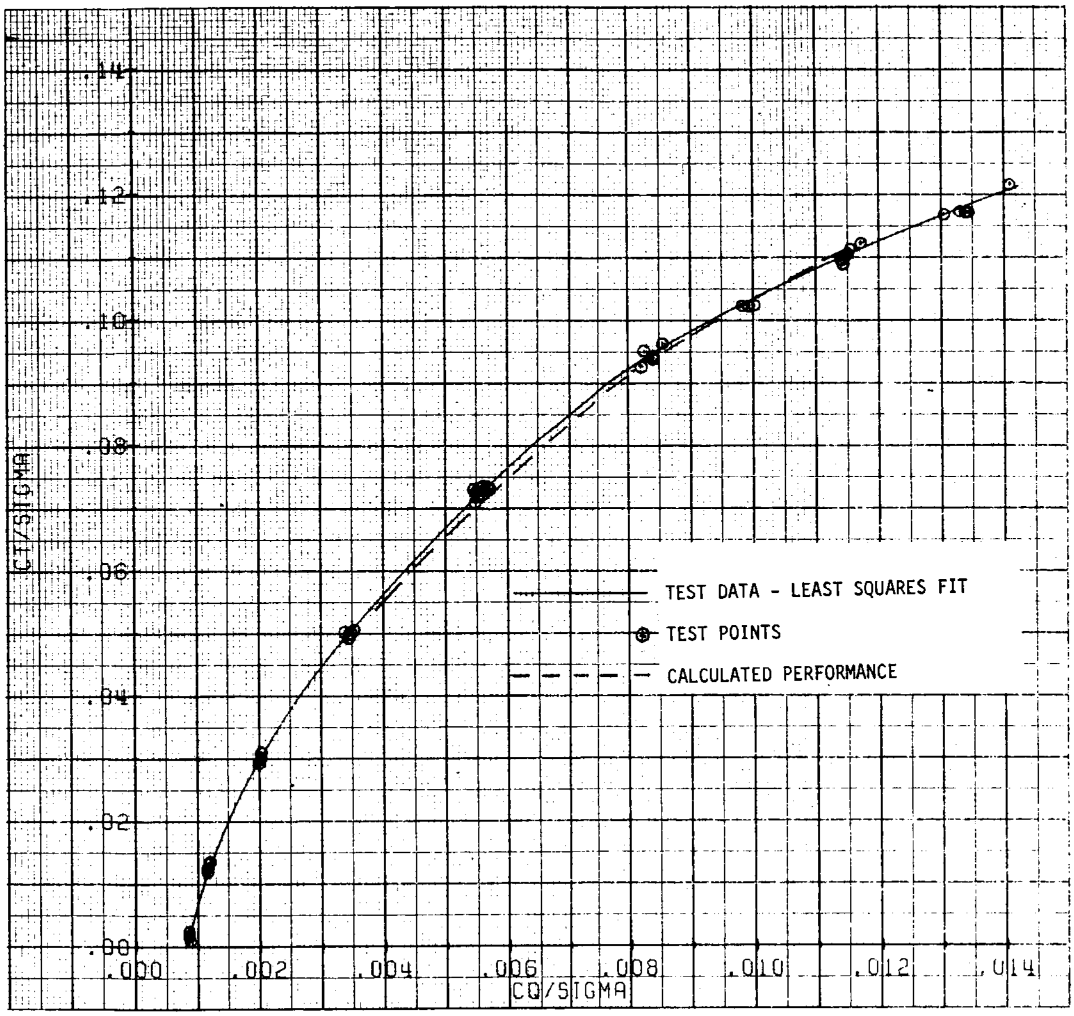

FIGURE 8. TEST BASELINE ROTOR MEASURED AND CALCULATED HOVER PERFORMANCE
C_T/σ vs C_Q/σ
MACH NUMBER = 0.580

Note
These data are unaffected by ground and whirl tower interference

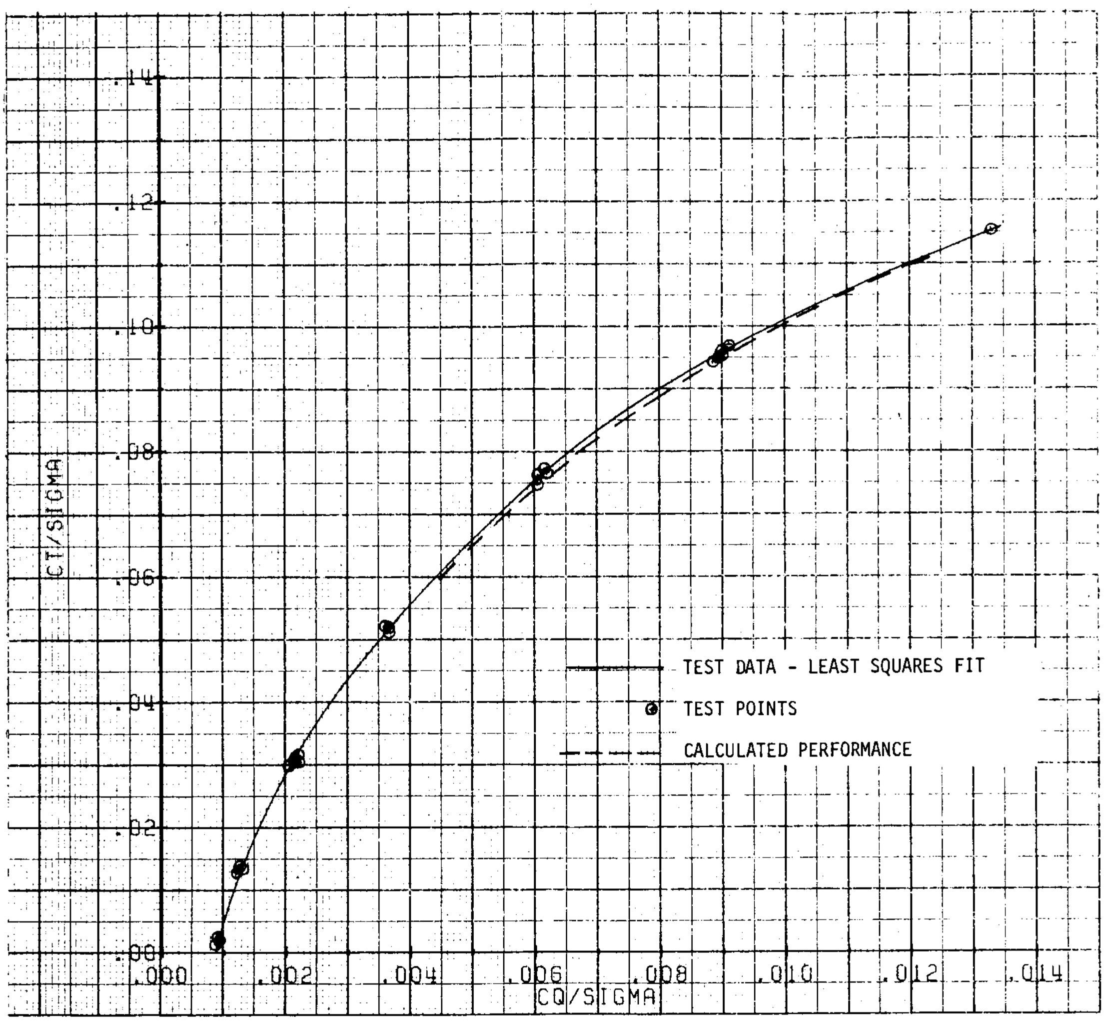

FIGURE 9. TEST BASELINE ROTOR MEASURED AND CALCULATED HOVER PERFORMANCE
C_T/σ vs C_Q/σ
MACH NUMBER = 0.638

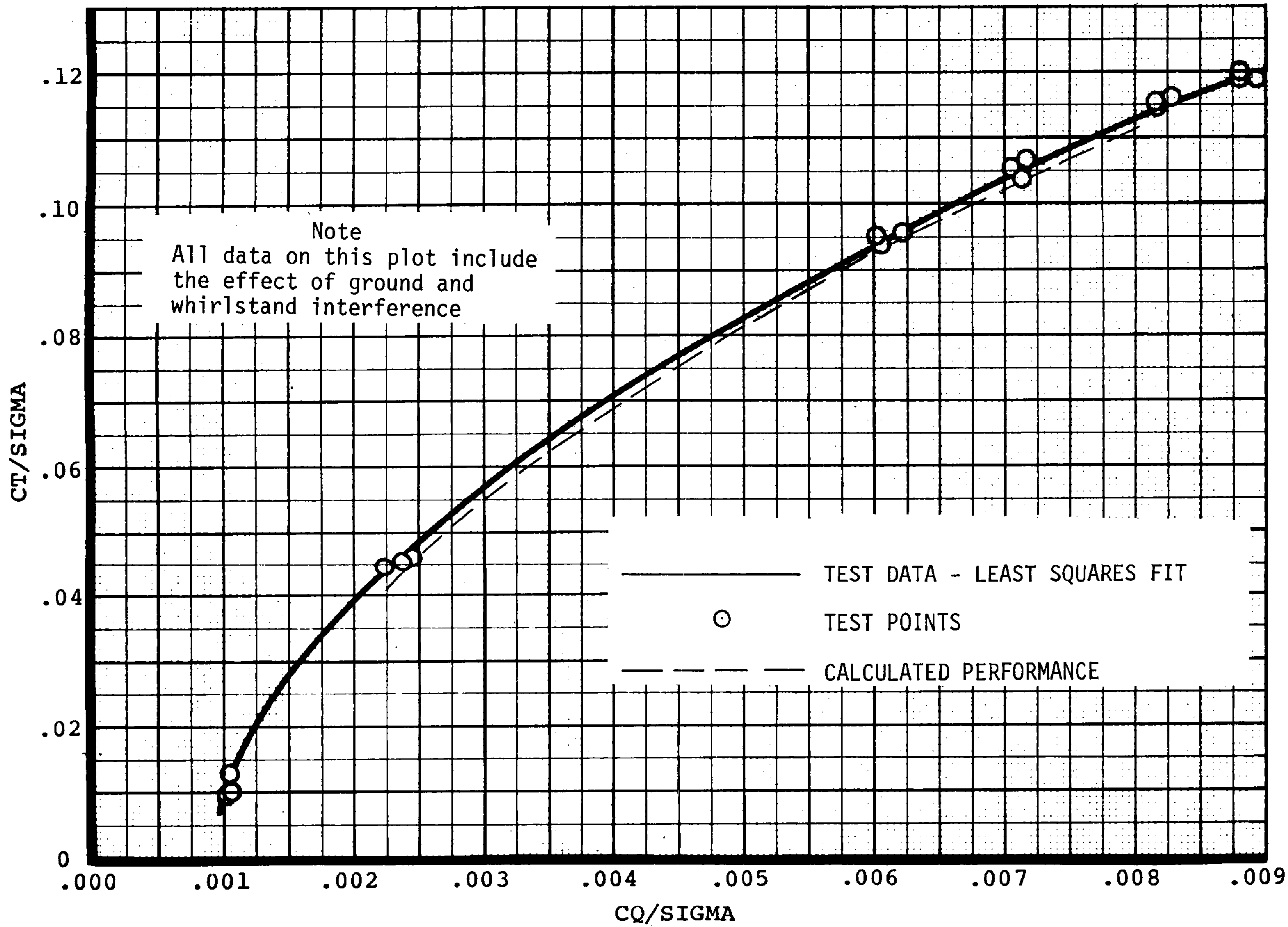

FIGURE 10. THREE LOWER BLADES ONLY ON VGR ROTOR HEAD COMPARISON OF MEASURED AND CALCULATED PERFORMANCE
MACH NUMBER = 0.523

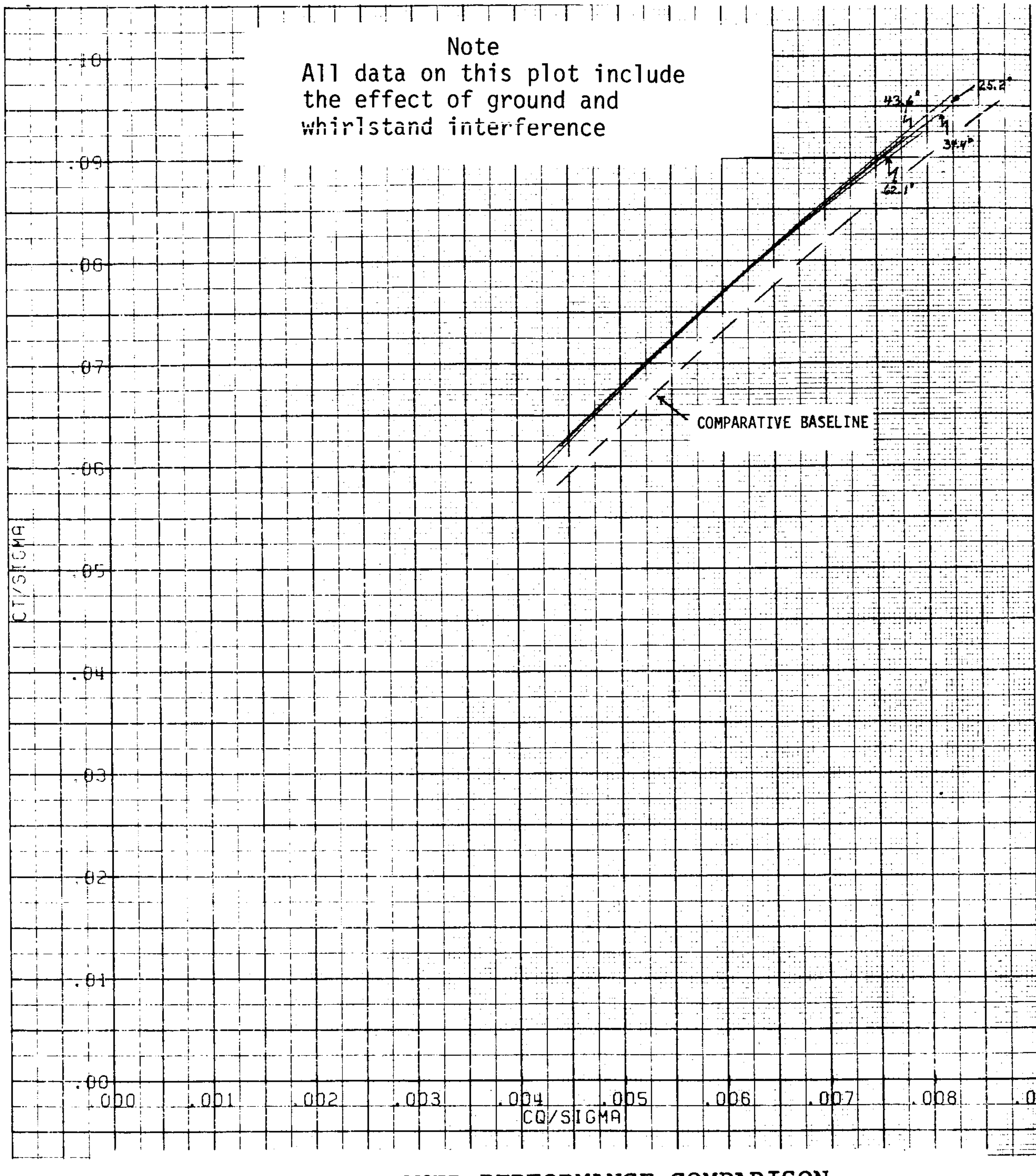

FIGURE 11. VGR HOVER PERFORMANCE COMPARISON
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 62.1°, 43.6°, 34.4°, 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.523

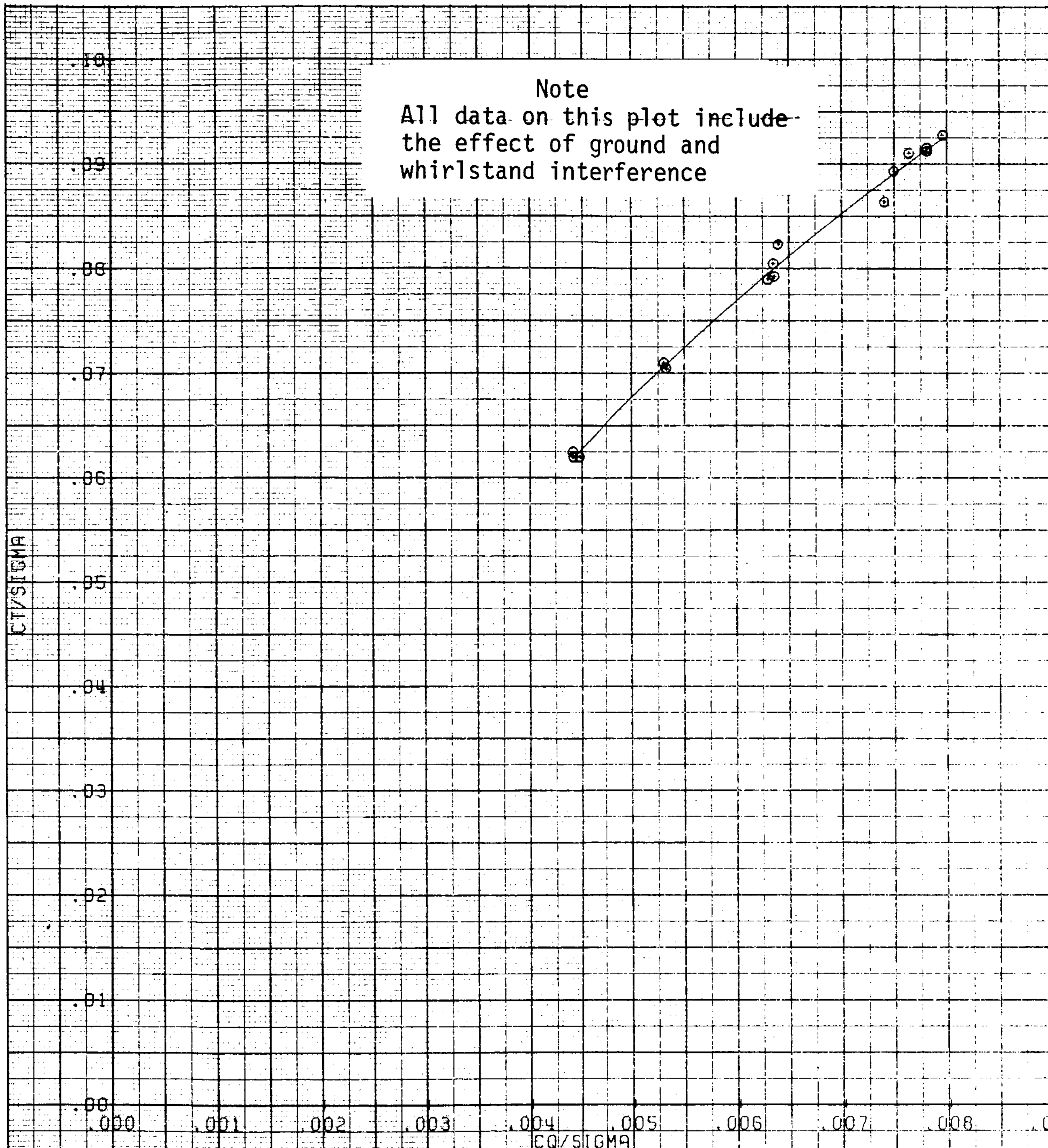

FIGURE 12. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
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DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.523

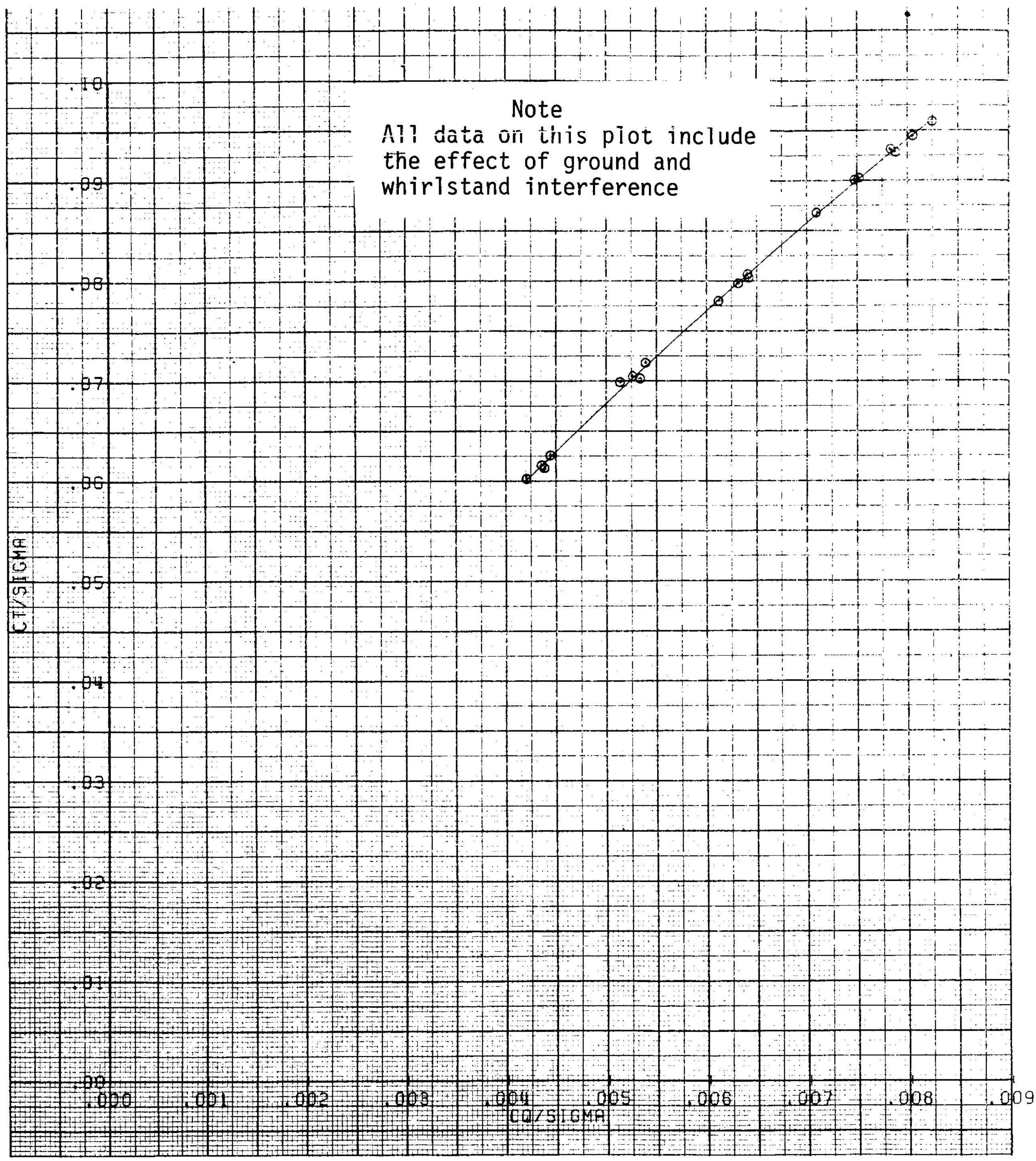

FIGURE 13. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.523

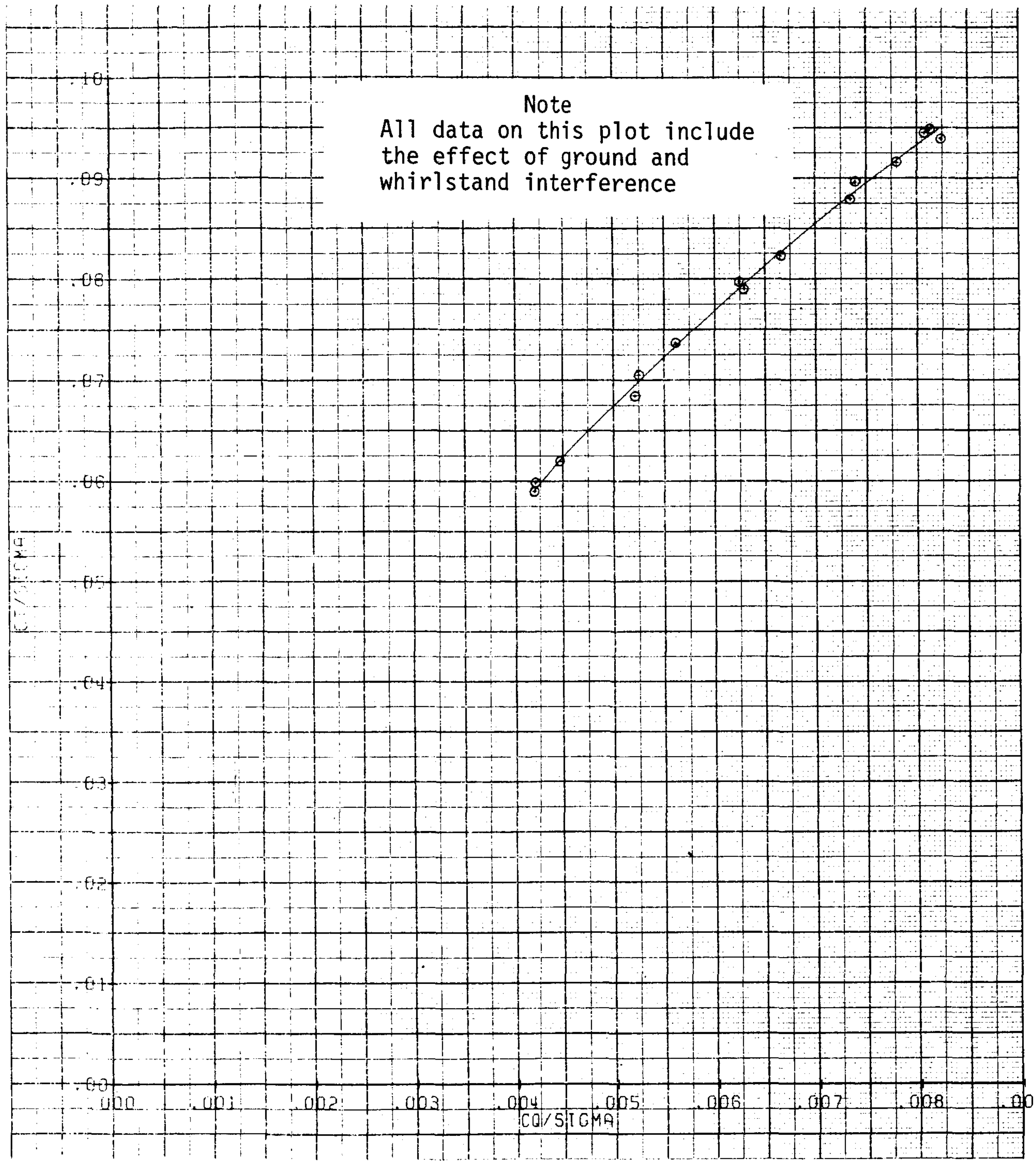

FIGURE 14. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.523

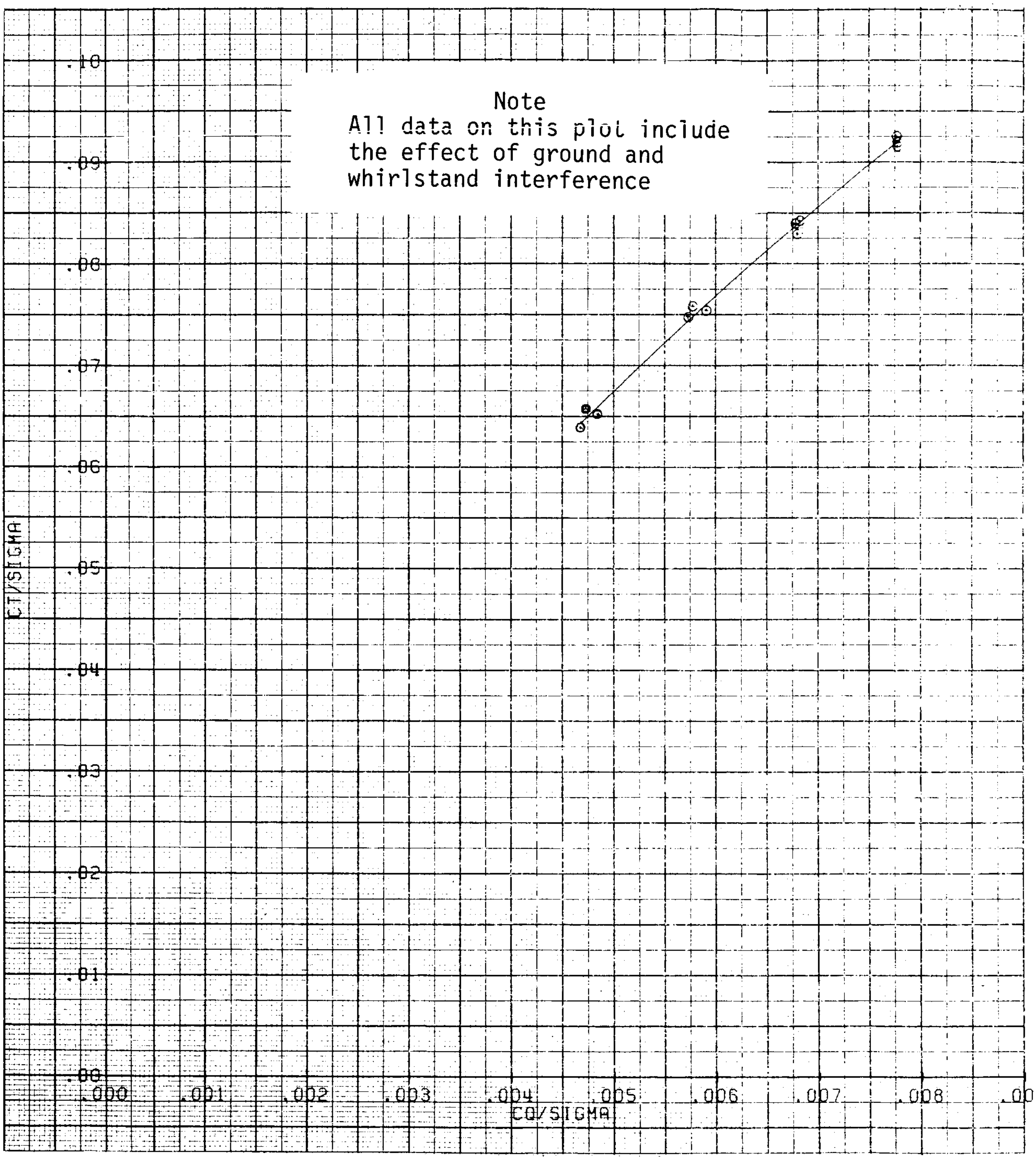

FIGURE 15. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.523

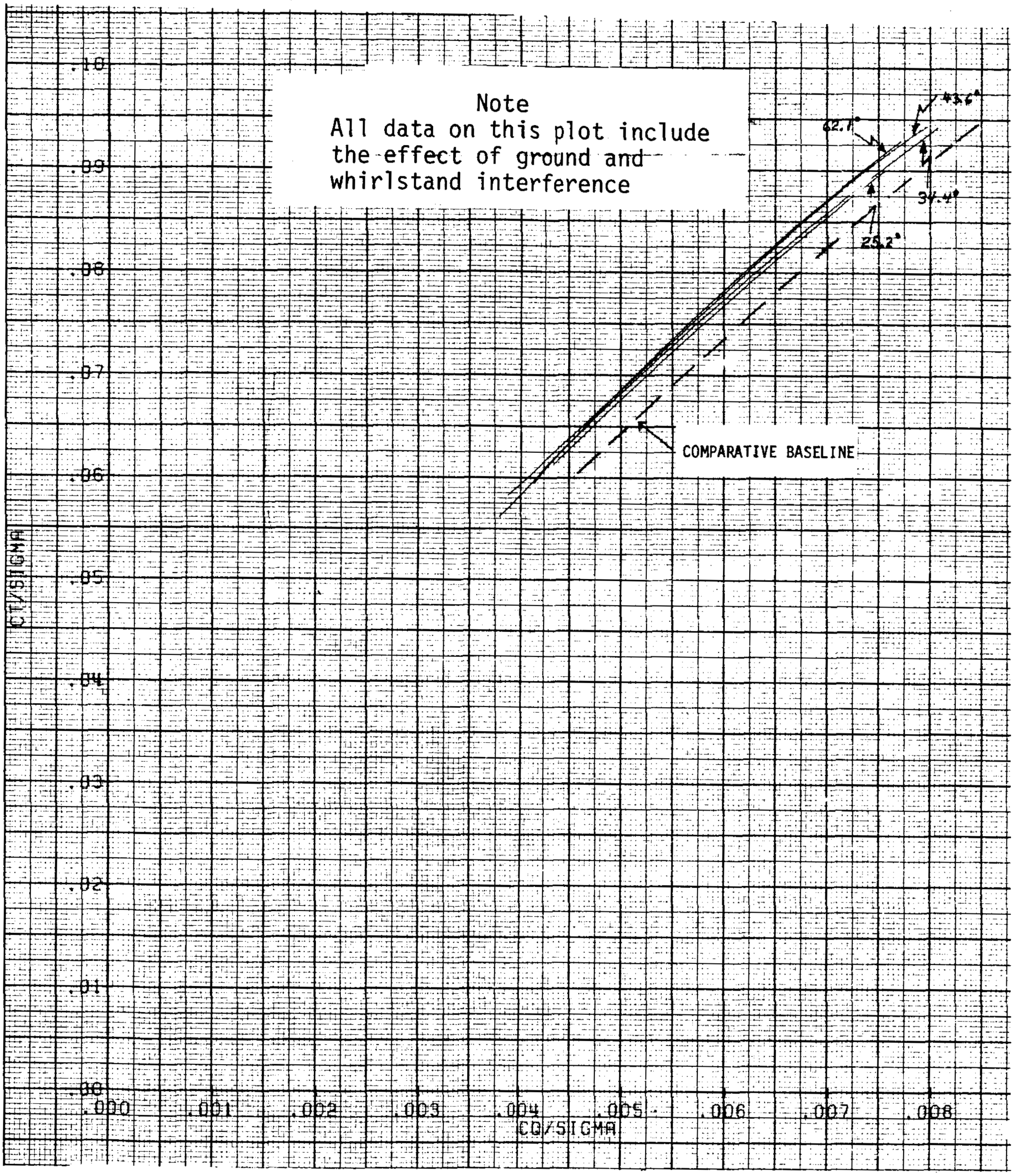

FIGURE 16. VGR HOVER PERFORMANCE COMPARISON
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 62.1°, 43.6°, 34.4°, 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.450

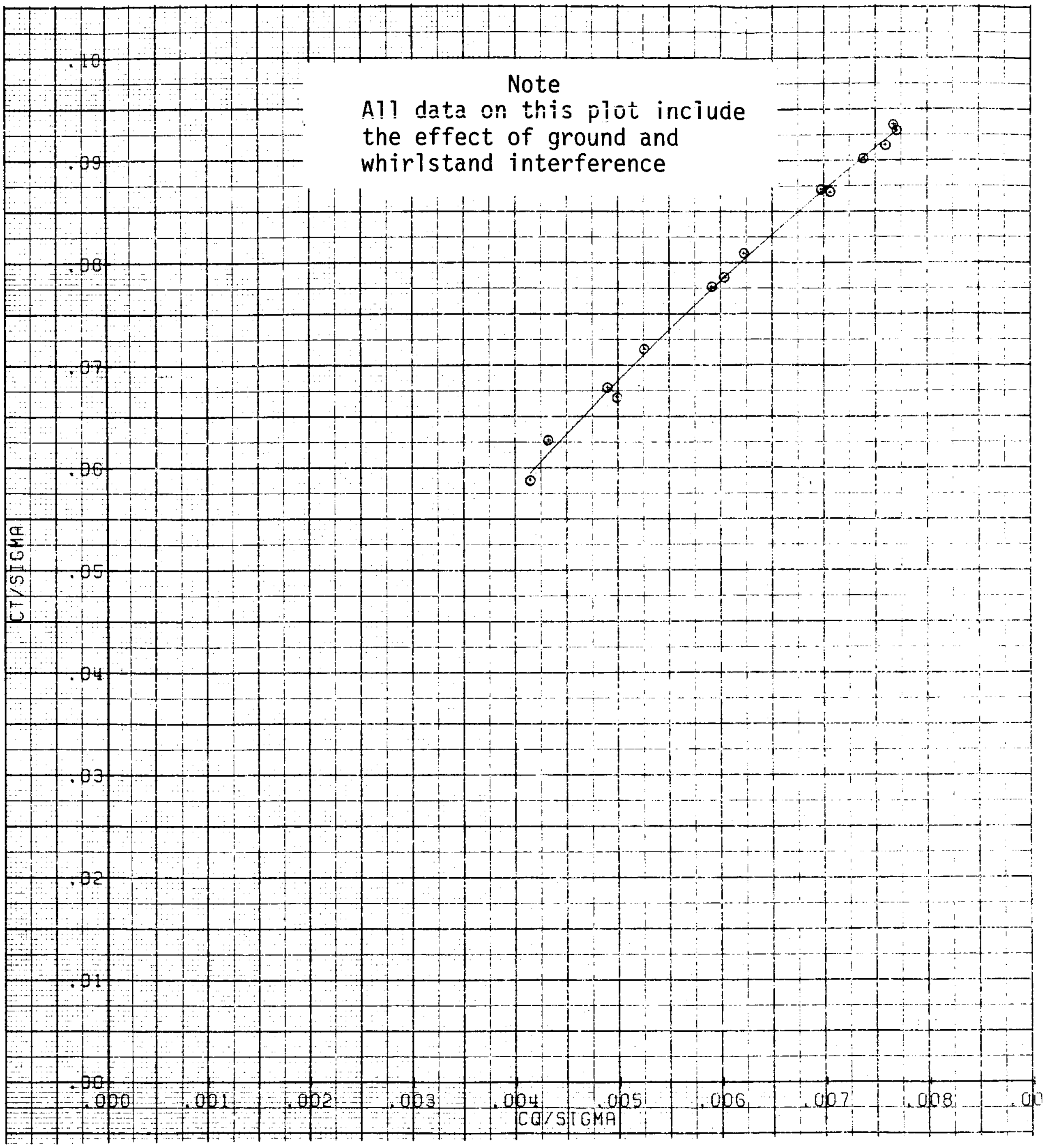

FIGURE 17. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.450

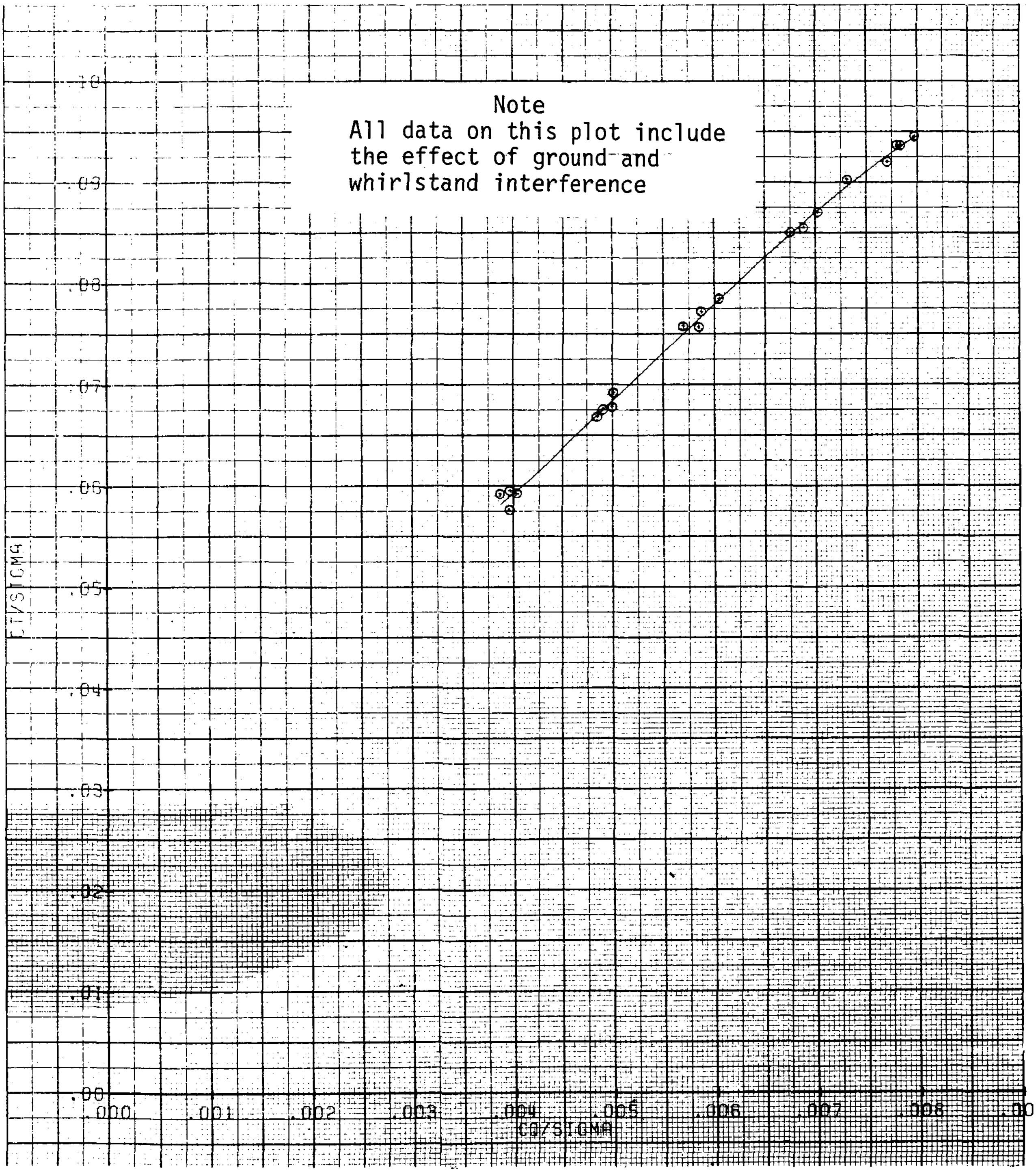

FIGURE 18. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.450

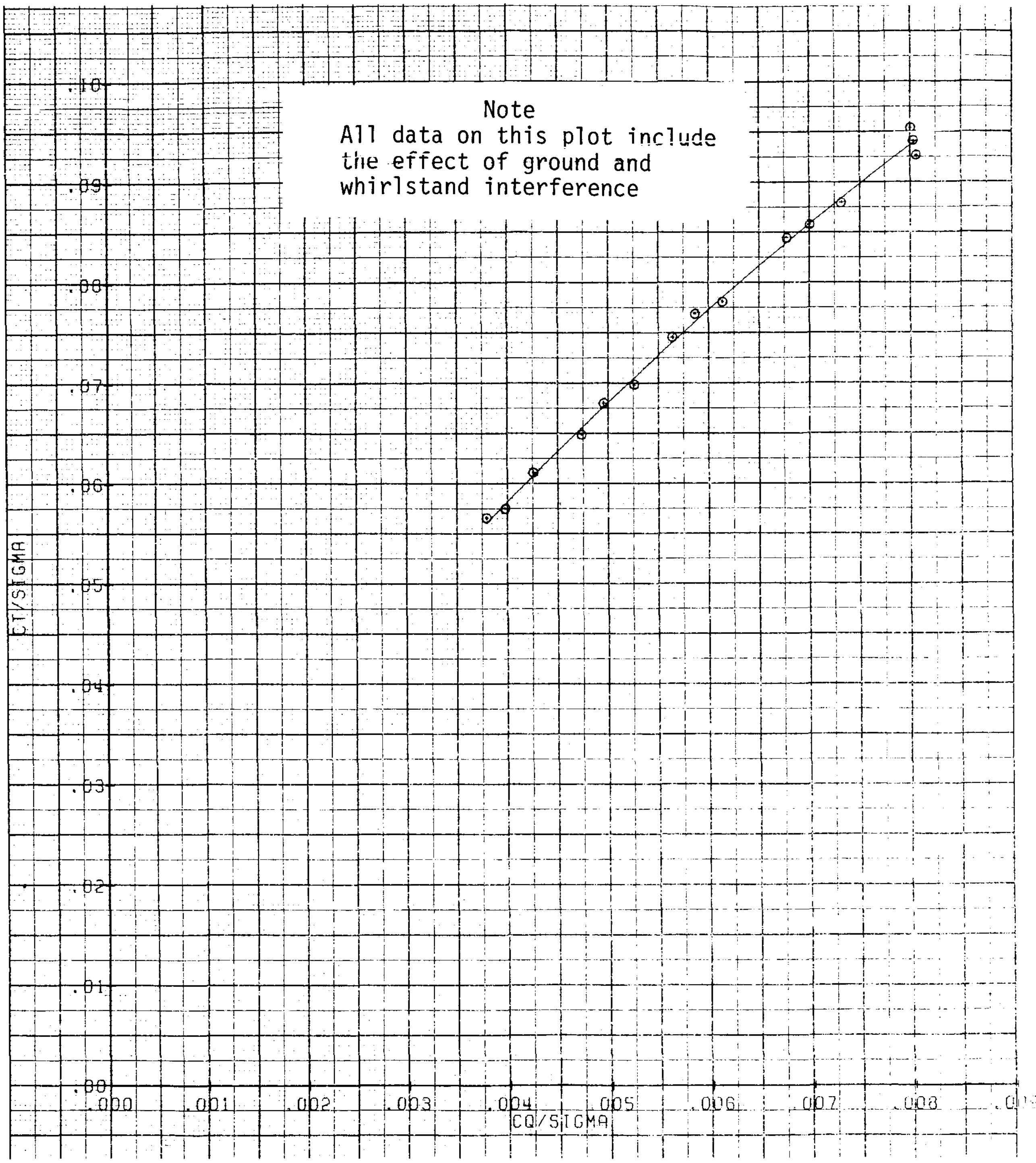

FIGURE 19. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.450

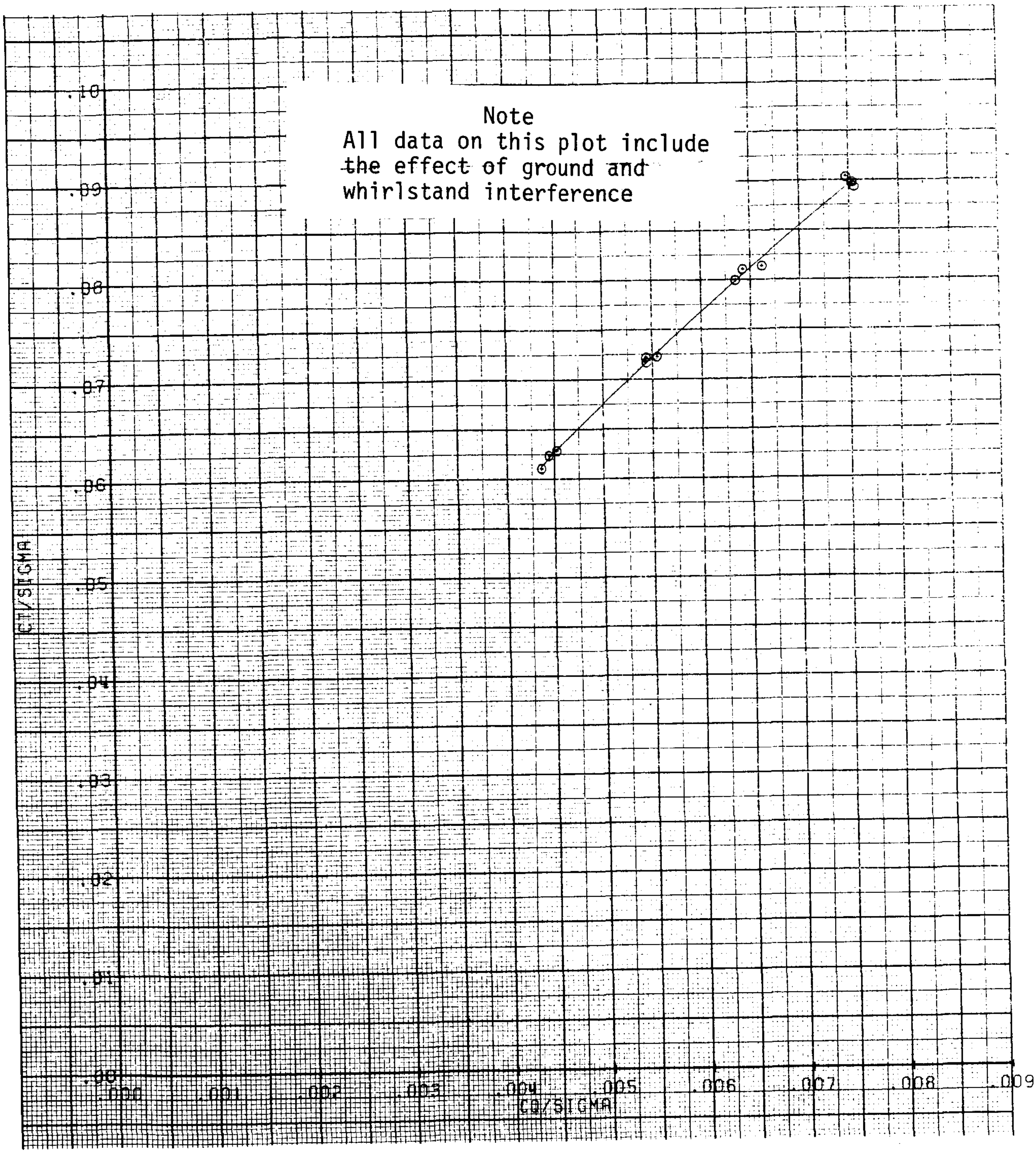

FIGURE 20. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS = 0°
MACH NUMBER = 0.450

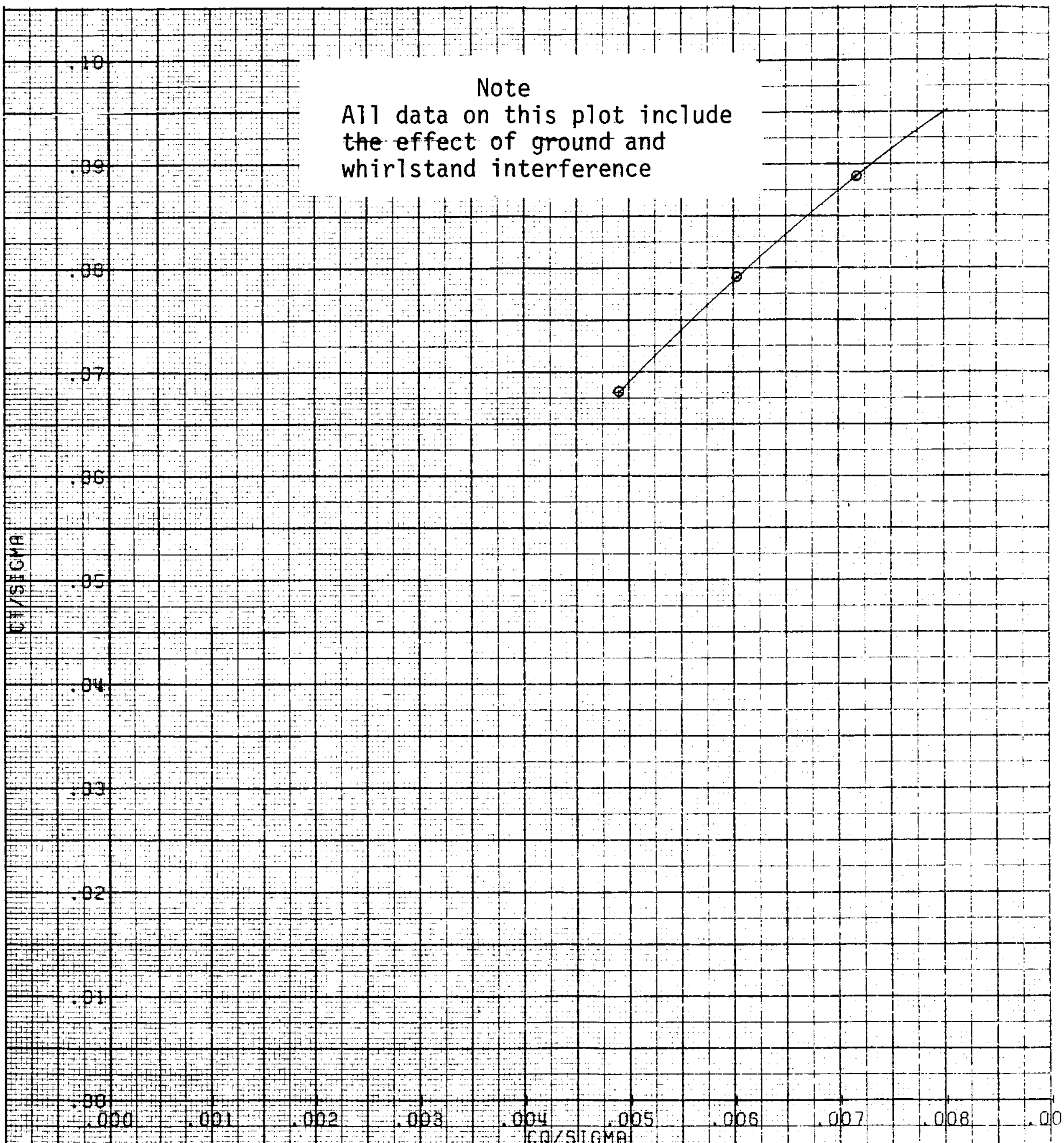

FIGURE 21. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTH SPACING = 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS = 1°
MACH NUMBER = 0.523

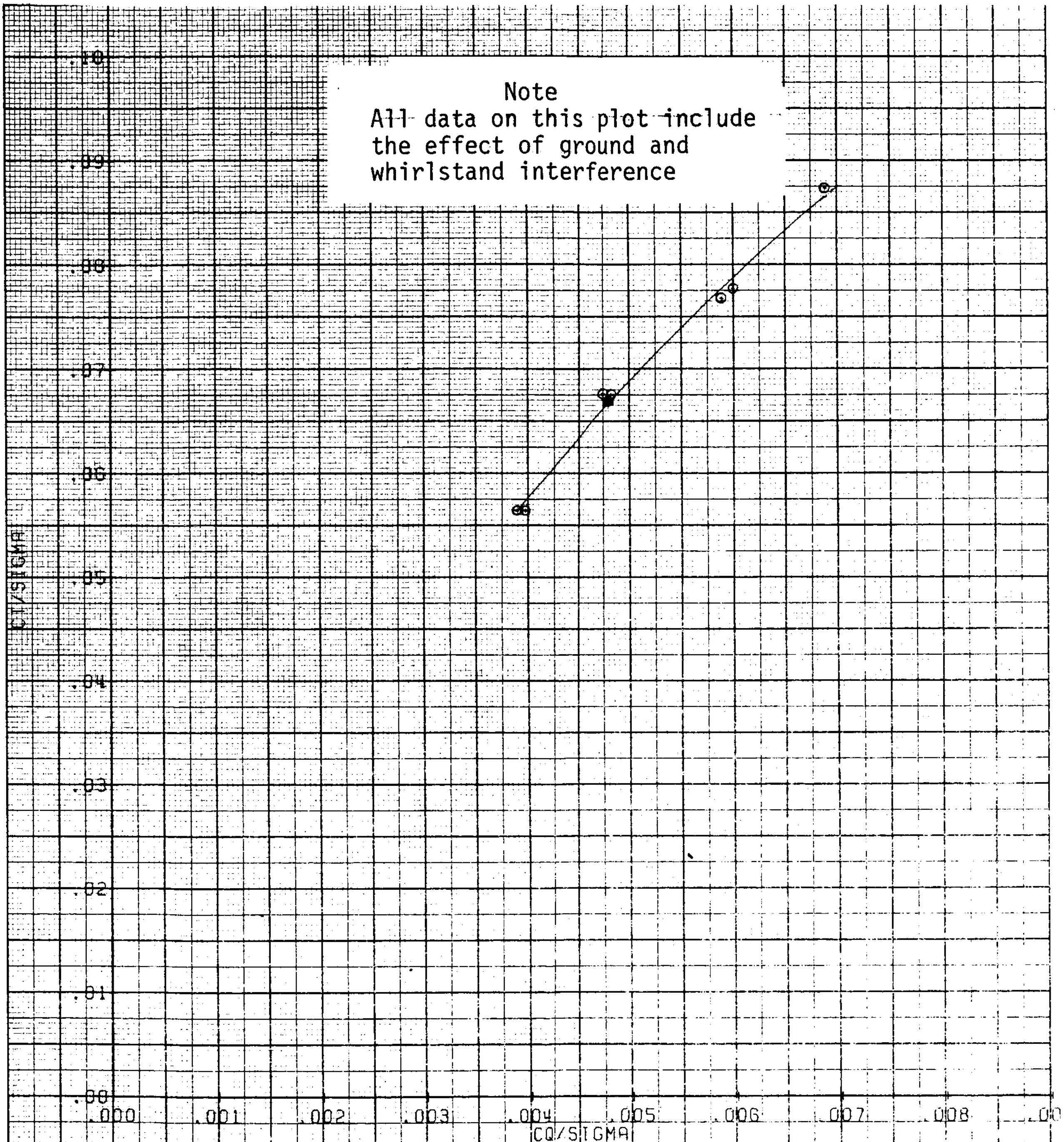

FIGURE 22. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTH SPACING = 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS = -1°
MACH NUMBER = 0.523

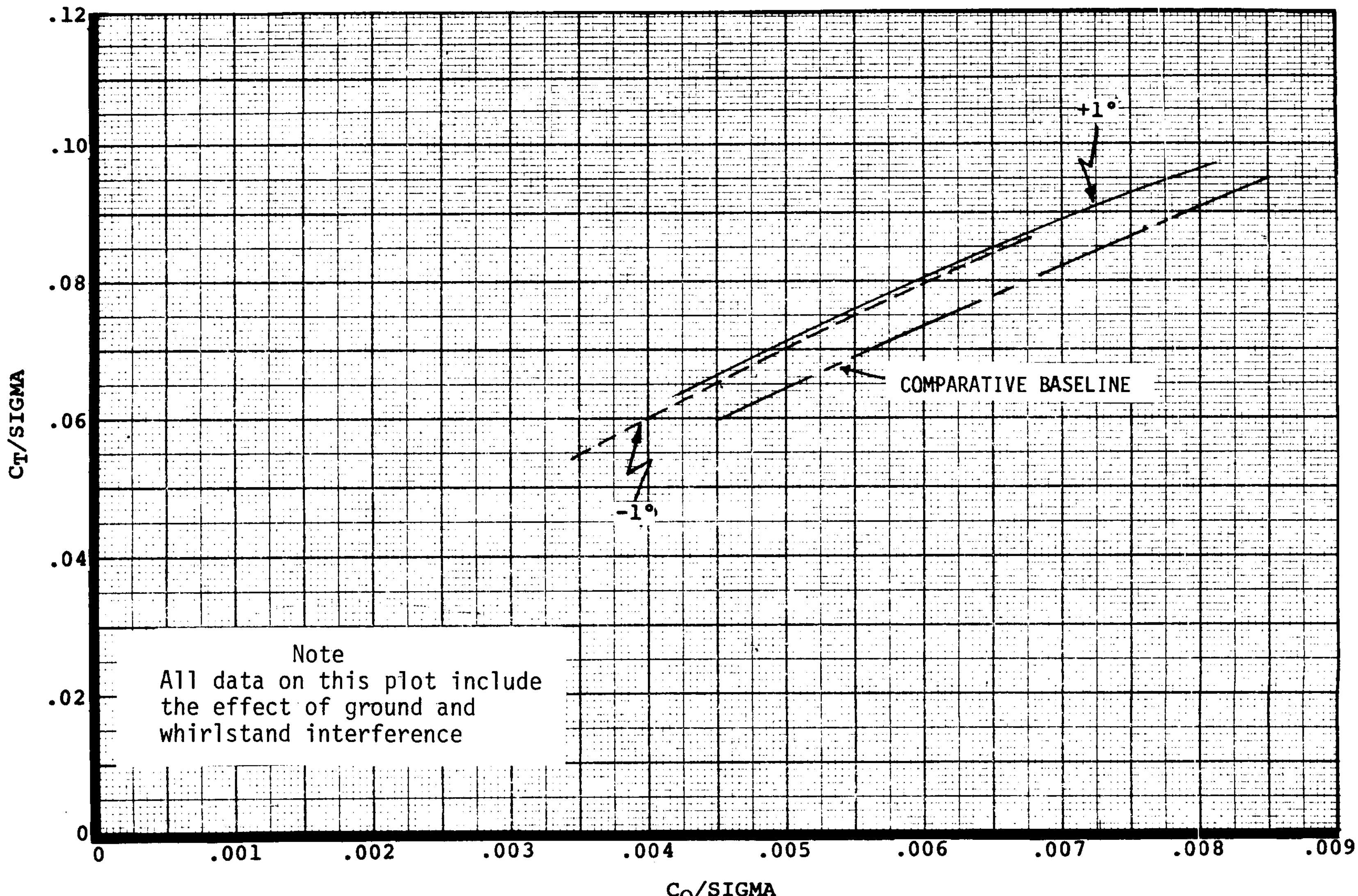

FIGURE 23, VGR HOVER PERFORMANCE COMPARISON PLOT, C_T/σ vs C_Q/σ, BLADE AZIMUTHAL SPACING = 62.1°, MACH NUMBER = 0.450, DELTA BLADE ANGLE BETWEEN ROTORS = -1°, +1°

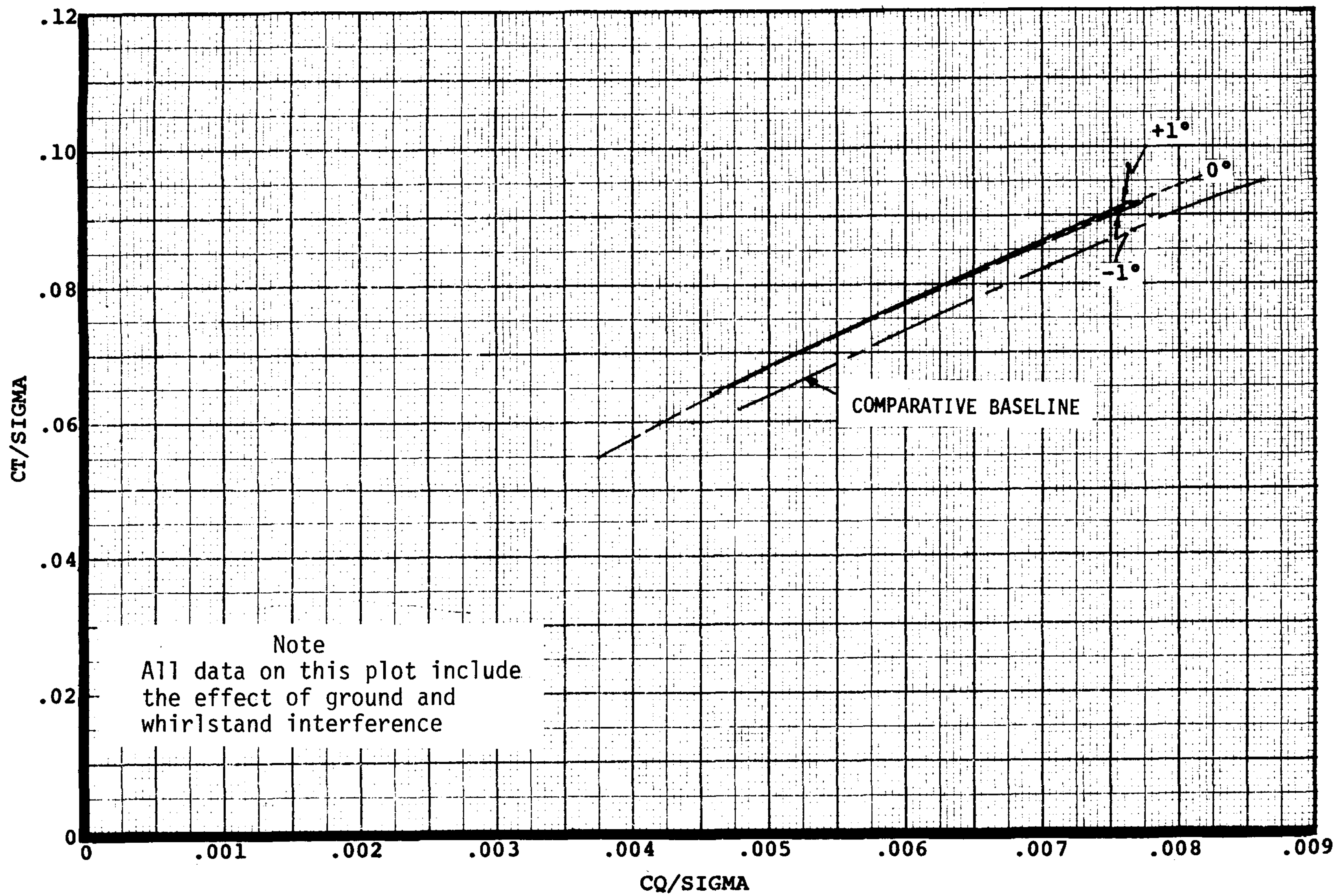

FIGURE 24, VGR HOVER PERFORMANCE COMPARISON PLOT, C_T/Q VS C_Q/Q
BLADE AZIMUTHAL SPACING = 43.6°, MACH NUMBER = 0.523
DELTA BLADE ANGLE BETWEEN ROTORS = -1°,0°,+1°

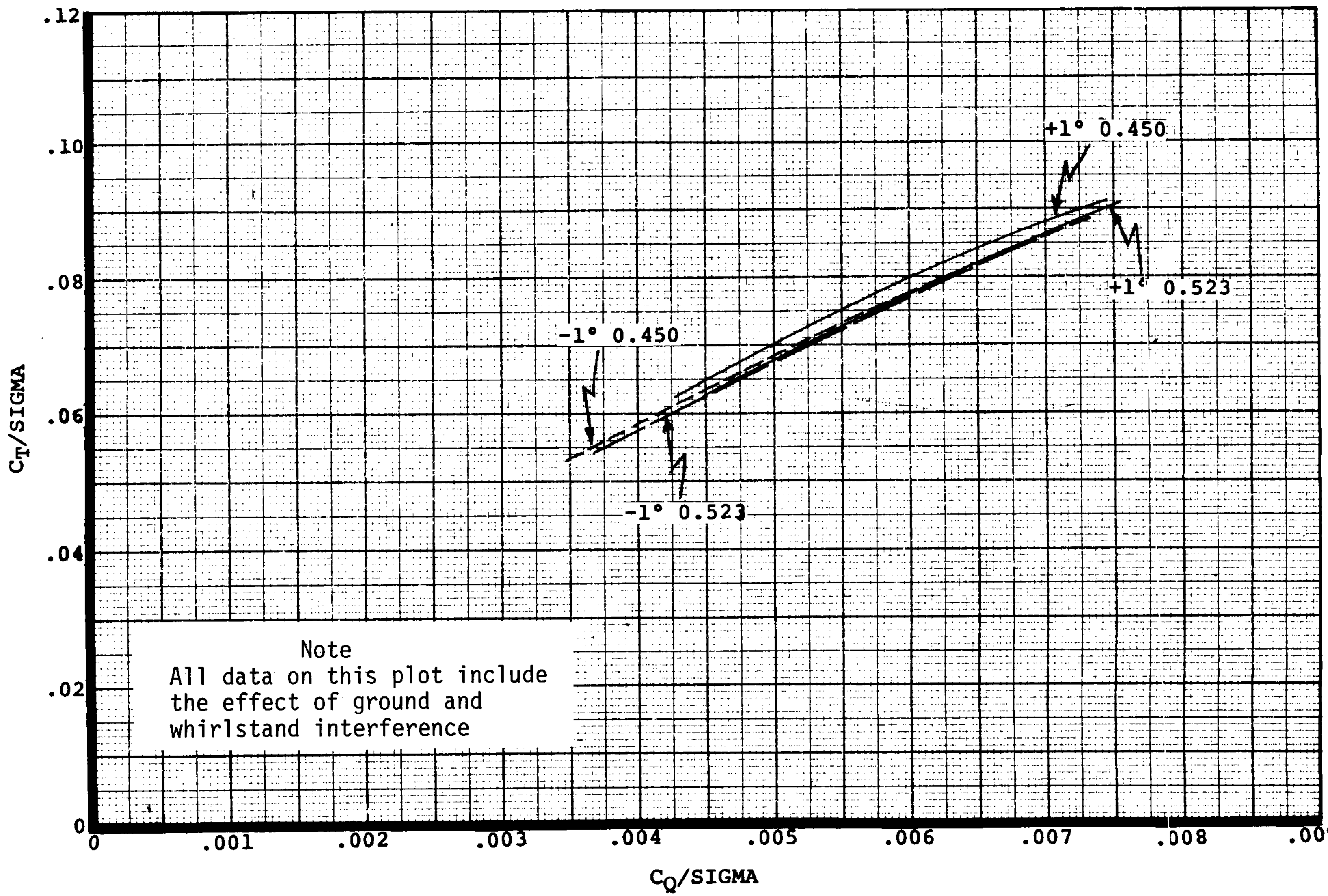

FIGURE 25 , VGR HOVER PERFORMANCE COMPARISON PLOT, C_T/σ vs C_Q/σ BLADE AZIMUTHAL SPACING = 43.6°, MACH NUMBER = 0.450 and 0.523, DELTA BLADE ANGLE BETWEEN ROTORS = -1°, +1°

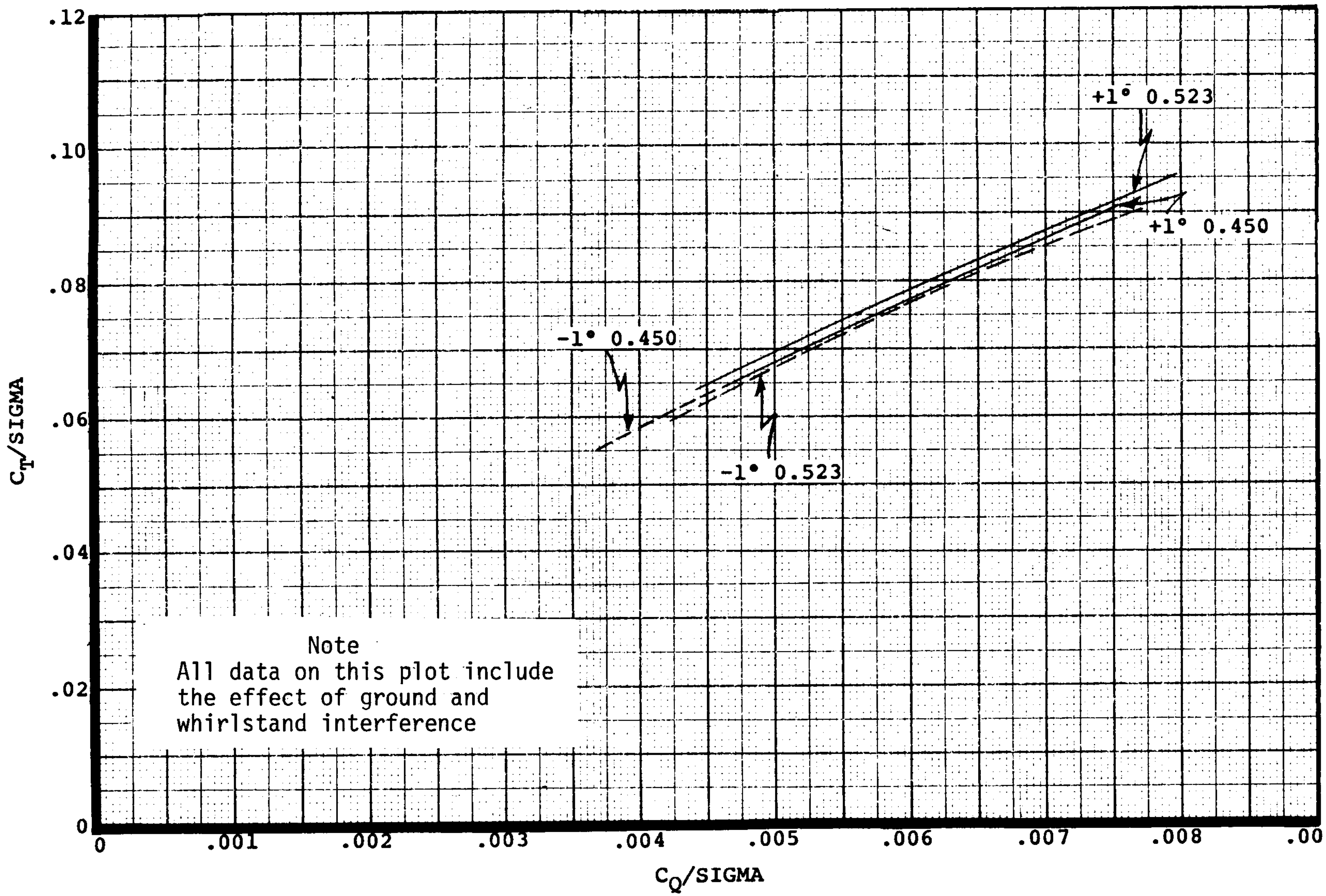

FIGURE 26, VGR HOVER PERFORMANCE COMPARISON PLOT, C_T/σ vs C_Q/σ, BLADE AZIMUTHAL SPACING = 34.4°, MACH NUMBER = 0.450 AND 0.523, DELTA BLADE ANGLE BETWEEN ROTORS = -1°, +1°

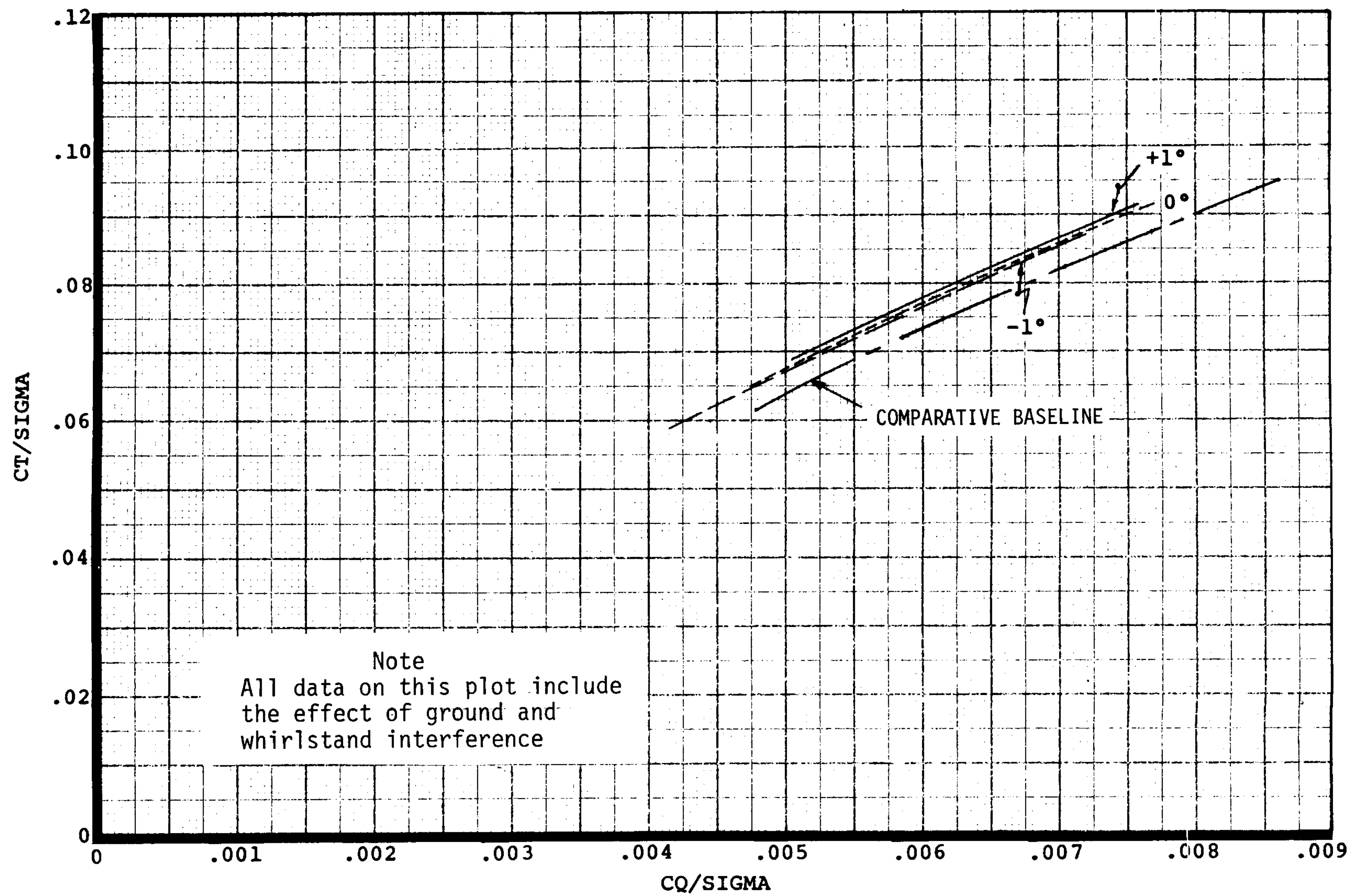

FIGURE 27, VGR HOVER PERFORMANCE COMPARISON PLOT, C_T/Q VS. C_Q/Q
BLADE AZIMUTHAL SPACING = 25.2°, MACH NUMBER = 0.523
DELTA BLADE ANGLE BETWEEN RPTORS = -1°, 0°, +1°

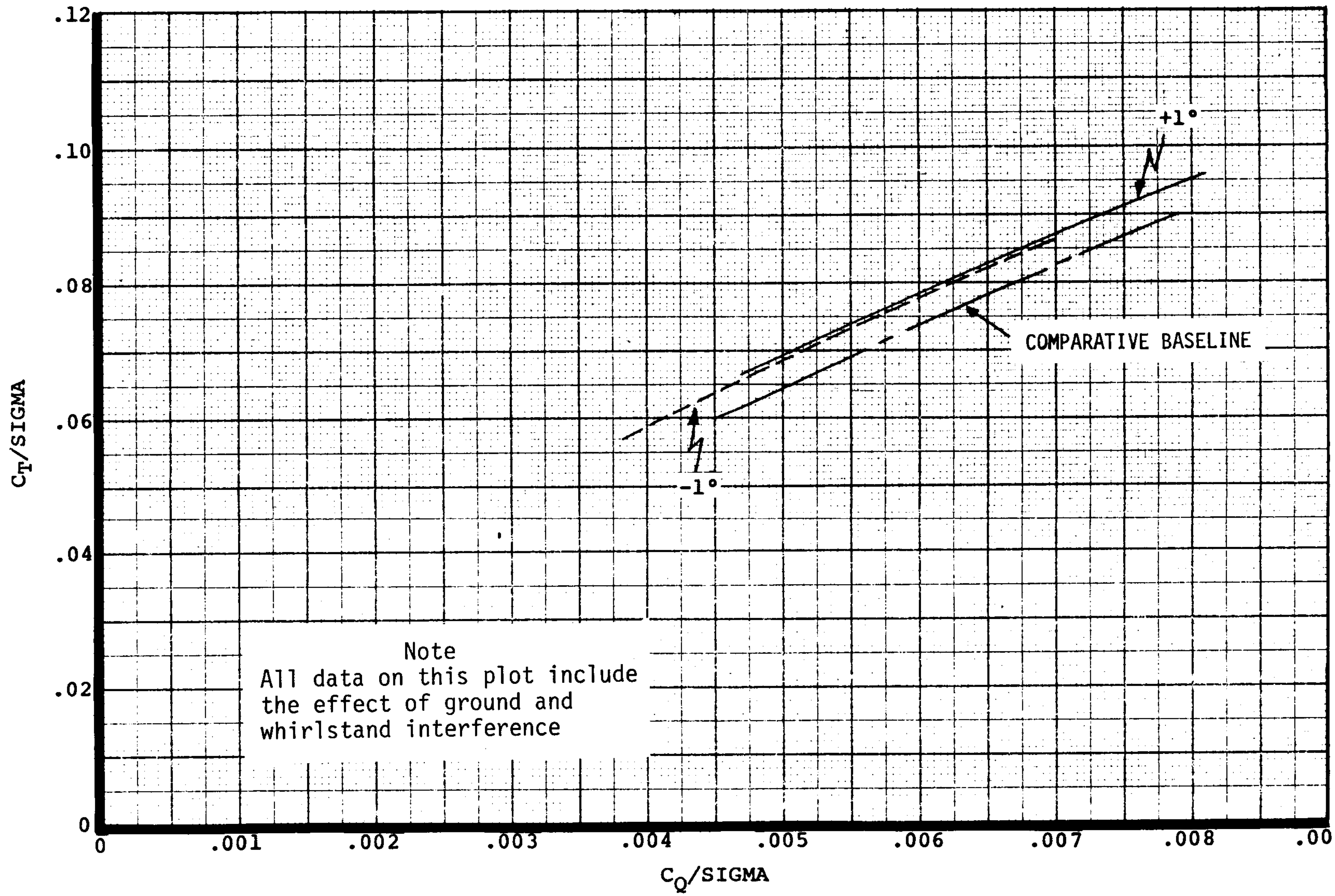

FIGURE 28, VGR HOVER PERFORMANCE COMPARISON PLOT, C_T/σ vs C_Q/σ, BLADE AZIMUTHAL SPACING = 25.2°, MACH NUMBER = 0.450, DELTA BLADE ANGLE BETWEEN ROTORS = -1°, +1°

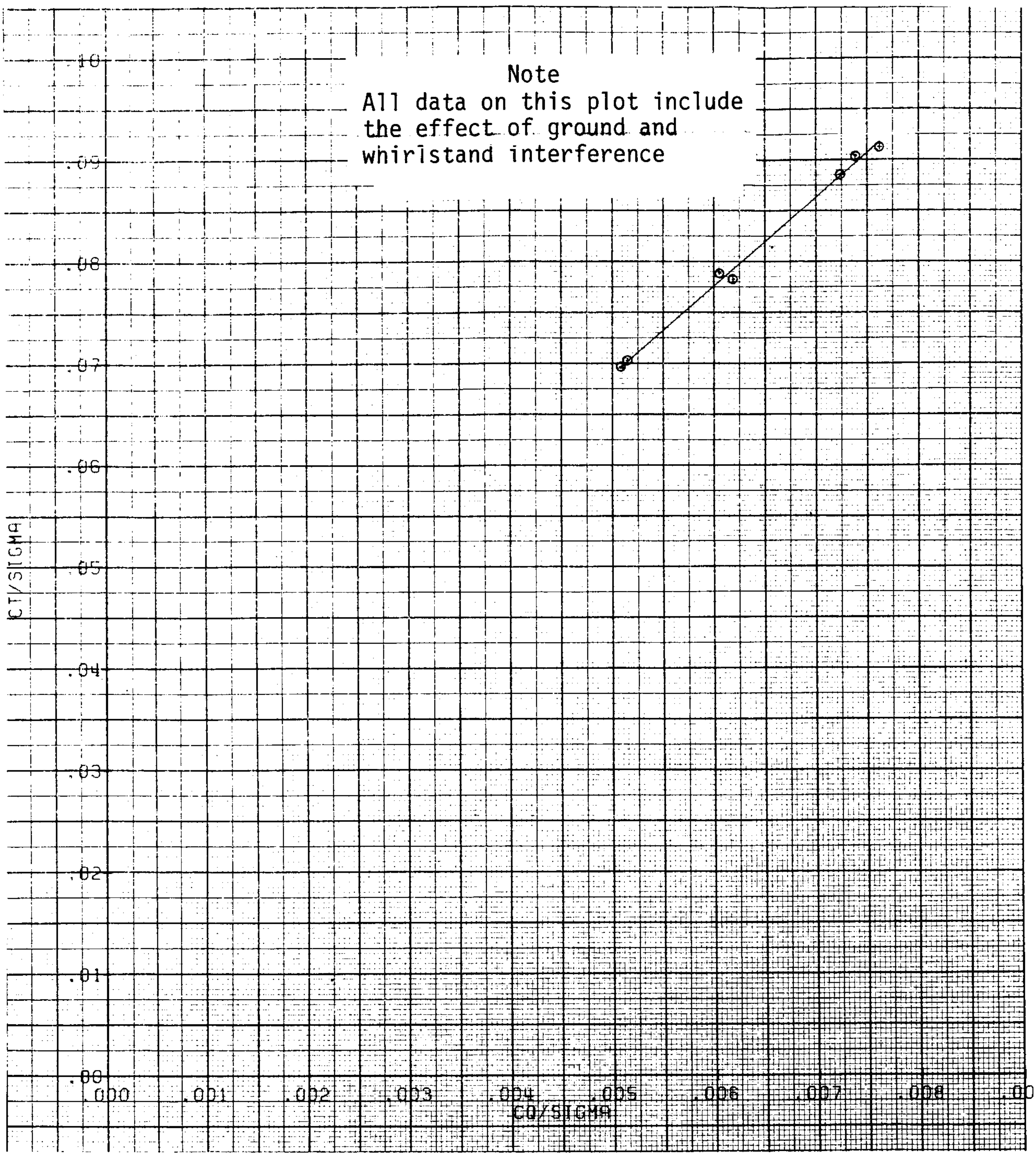

FIGURE 29. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS = 1°
MACH NUMBER = 0.523

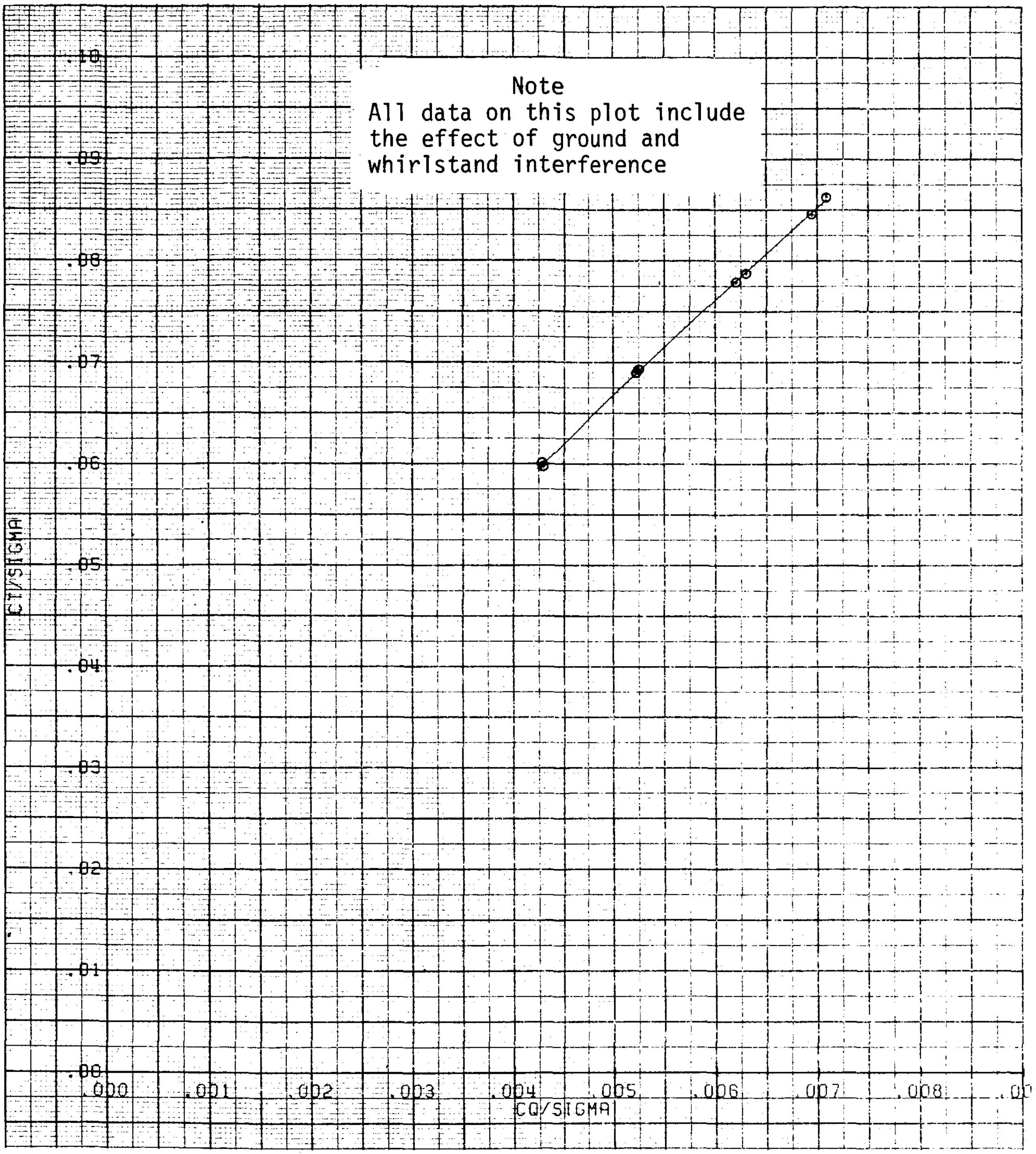

FIGURE 30. VGR HOVER PERFORMANCE
C_T/σ vs C_Q/σ
BLADE AZIMUTHAL SPACING = 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS =-1°
MACH NUMBER = 0.523

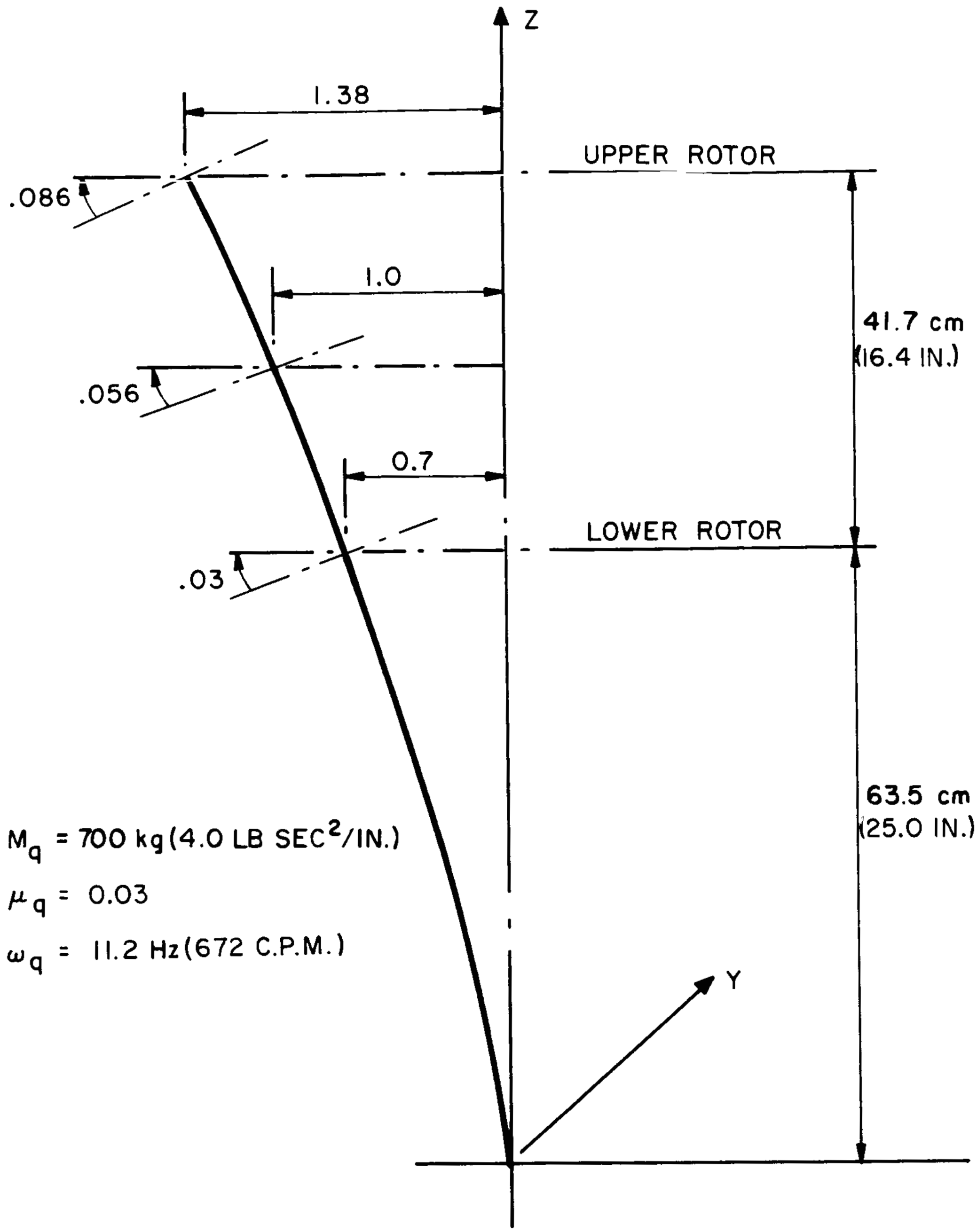

FIGURE 31. SHAFT MODAL PROPERTIES

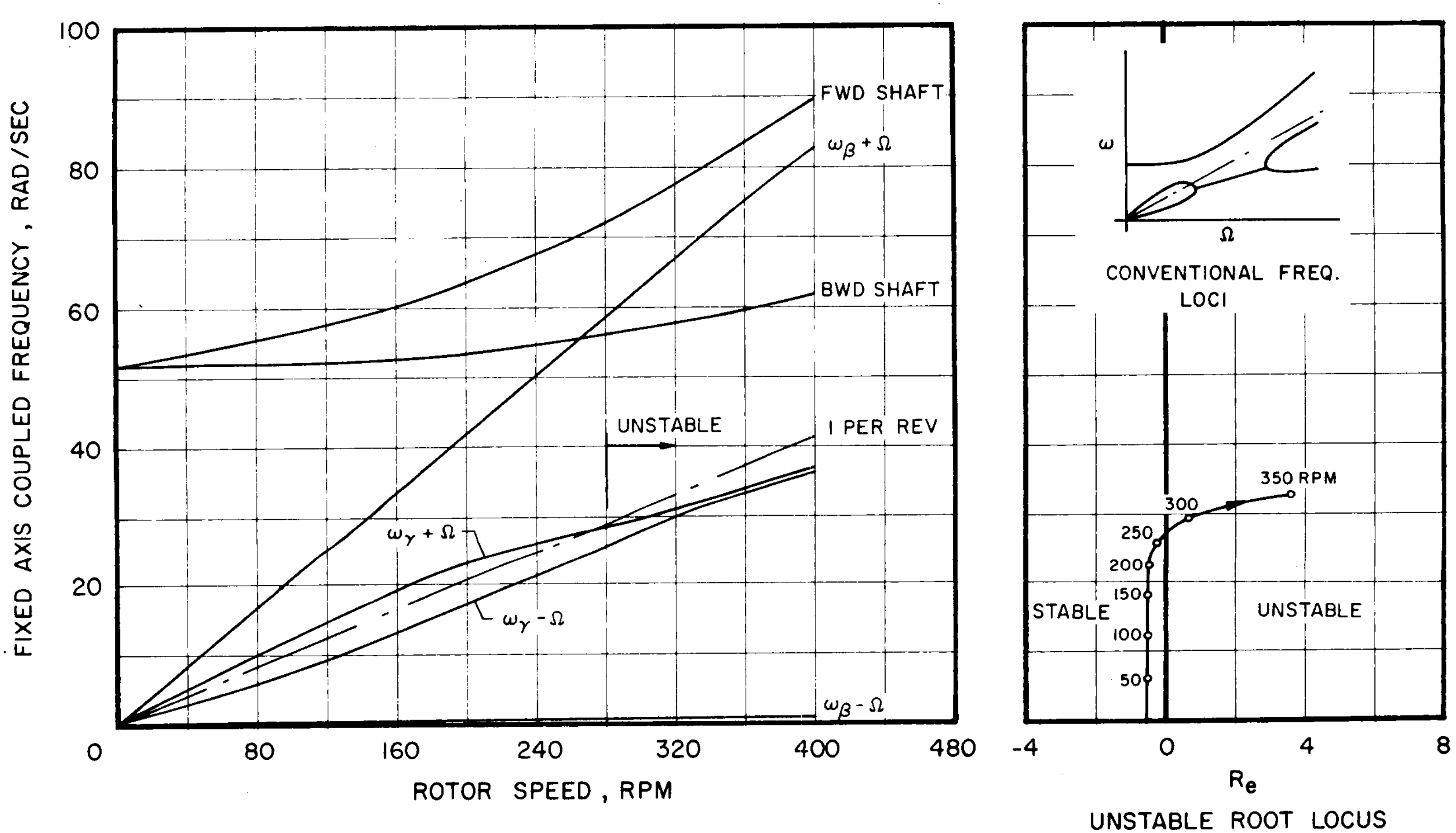

FIGURE 32. VGR GROUND RESONANCE

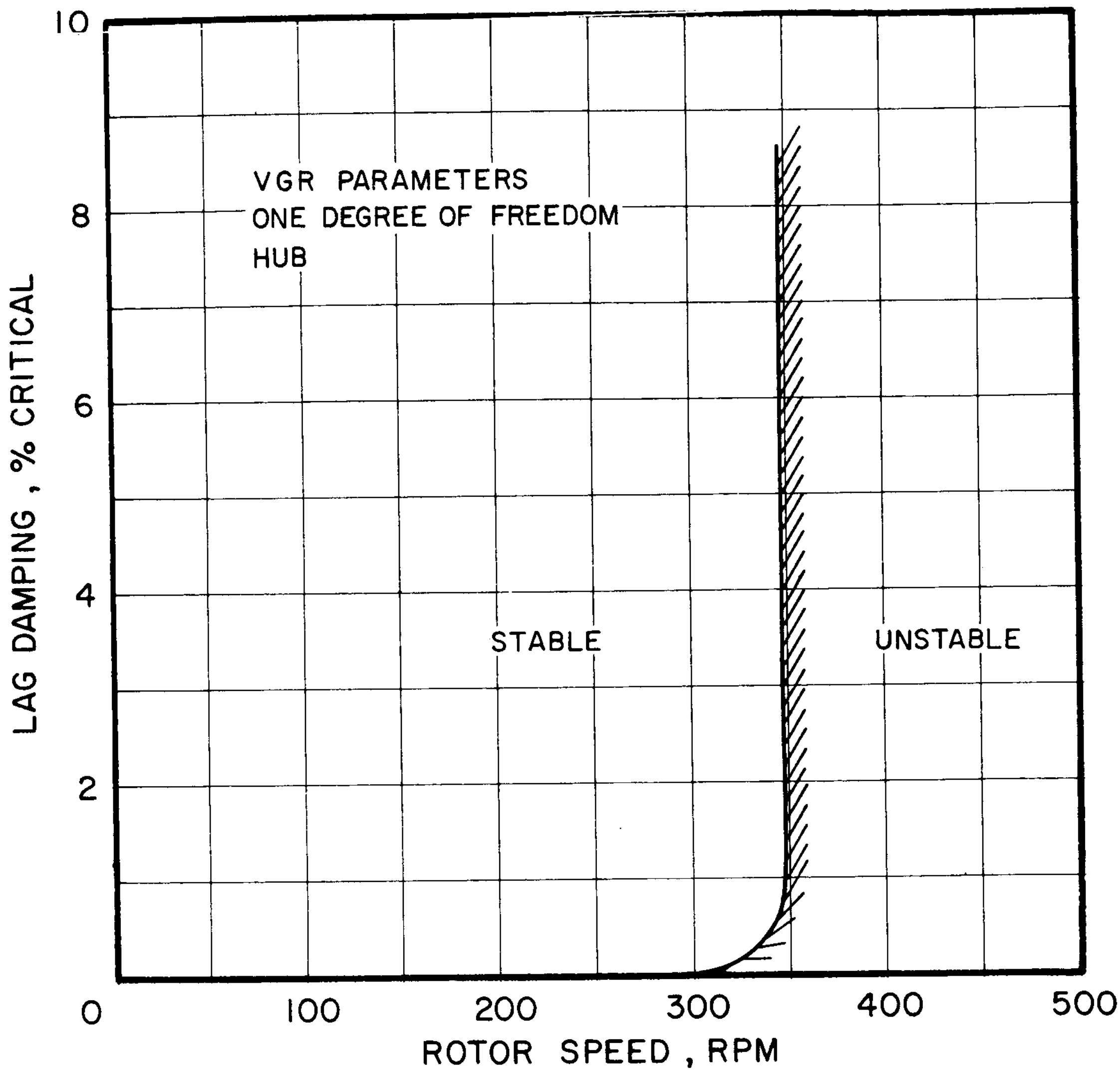

FIGURE 33. GROUND RESONANCE STABILITY FROM PRICE'S CRITERION

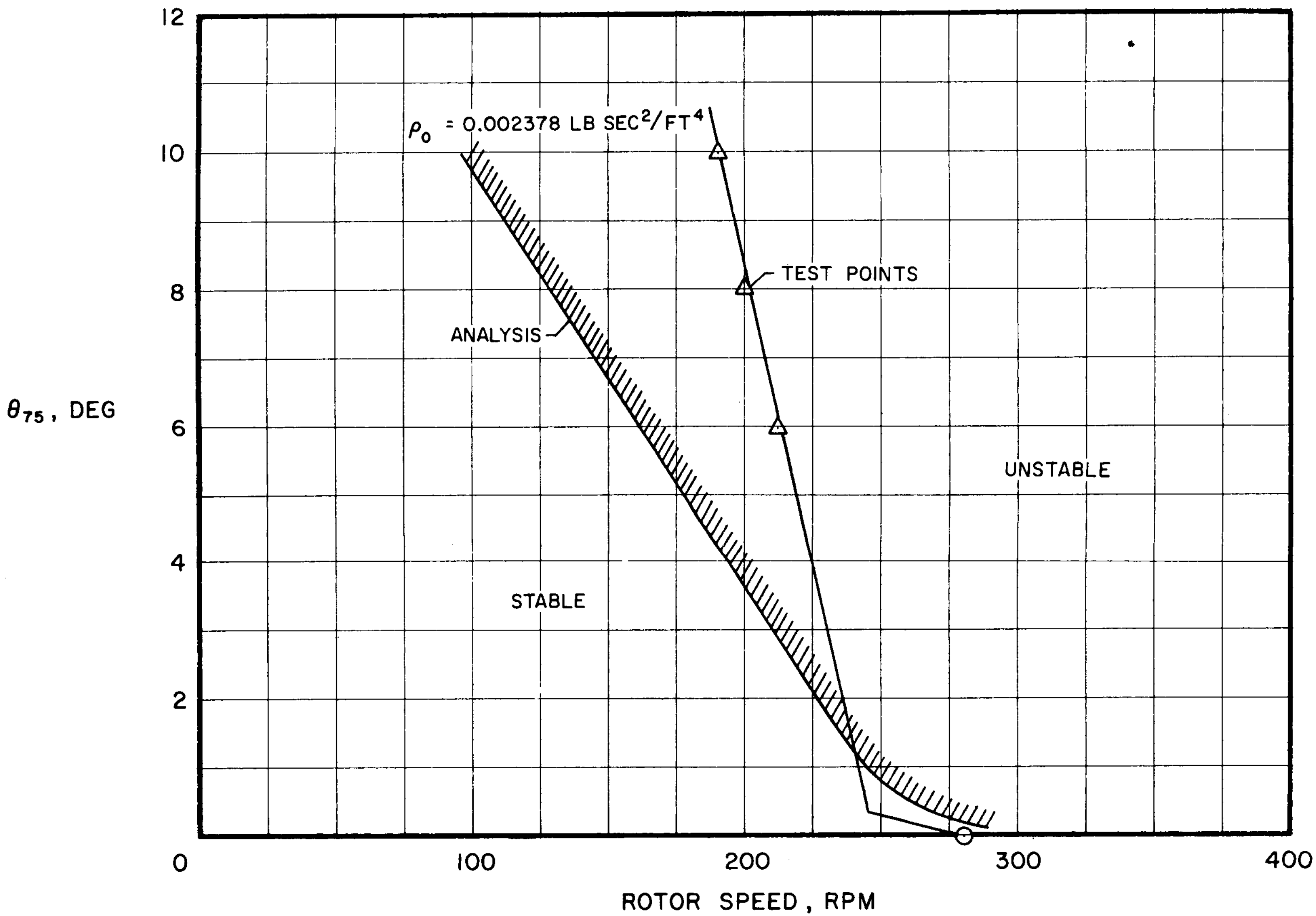

FIGURE 34. EFFECT OF ROTOR SPEED AND AIR DENSITY ON VGR STABILITY

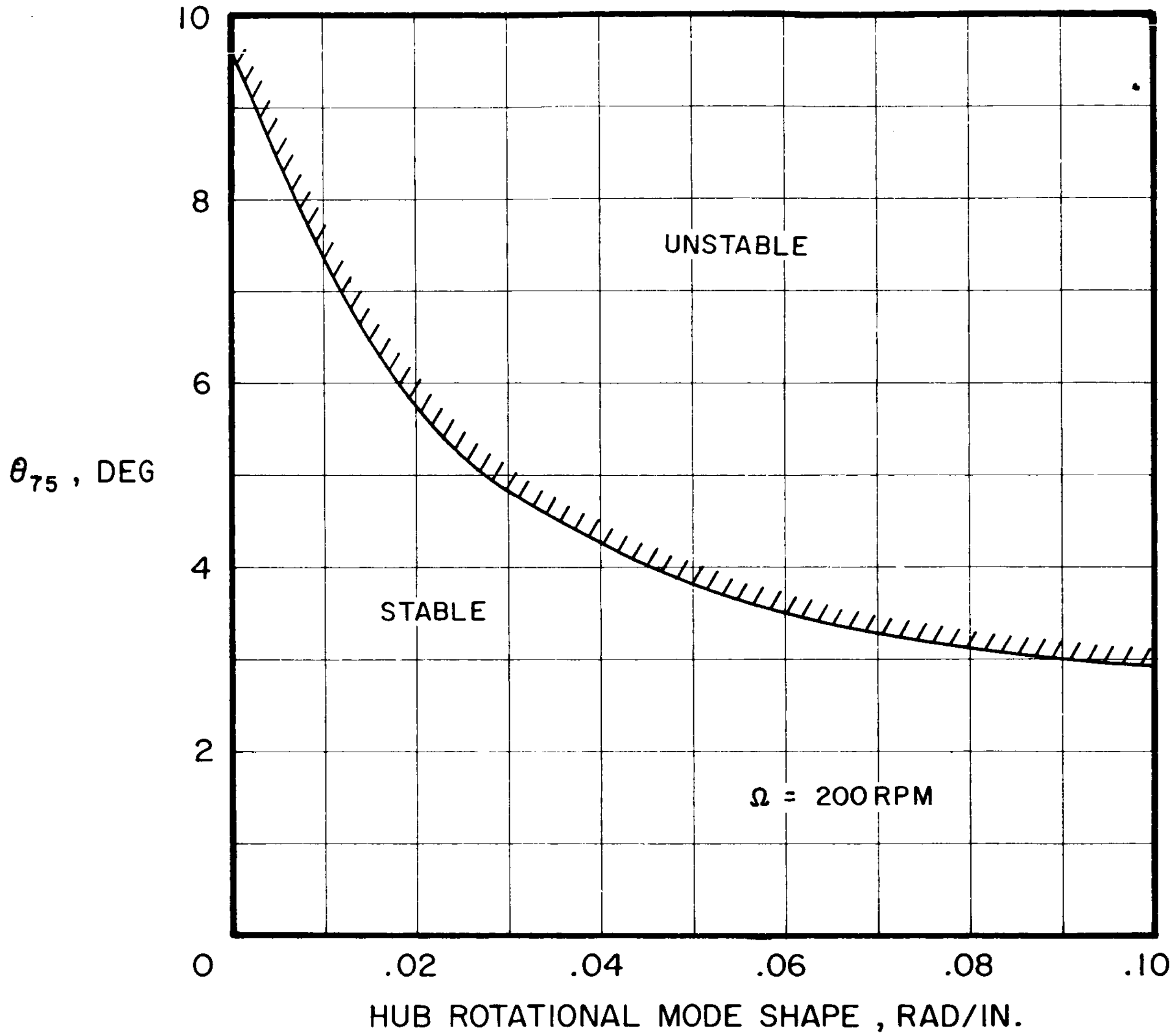

FIGURE 35. EFFECT OF HUB ROTATIONS ON VGR STABILITY

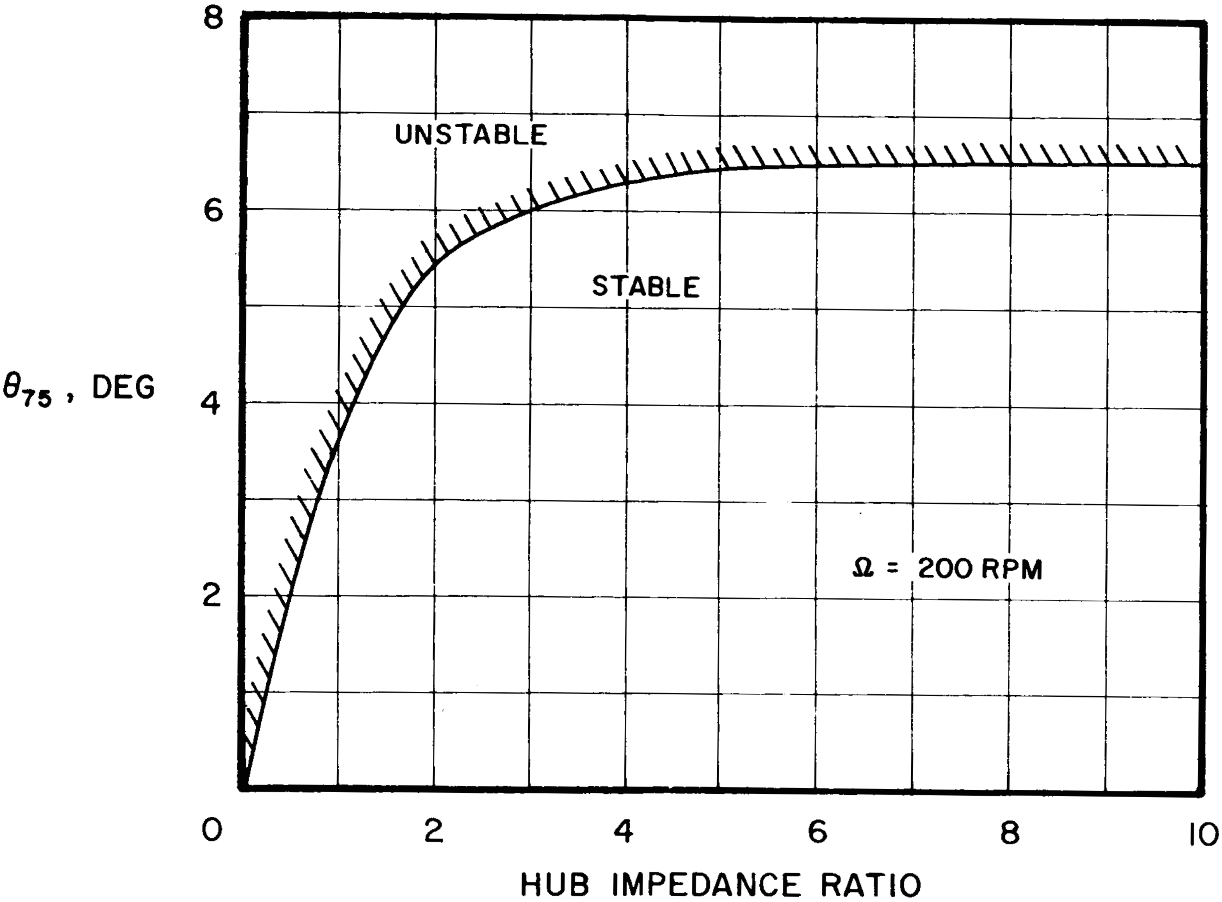

FIGURE 36. EFFECT OF HUB ASYMMETRY ON VGR STABILITY

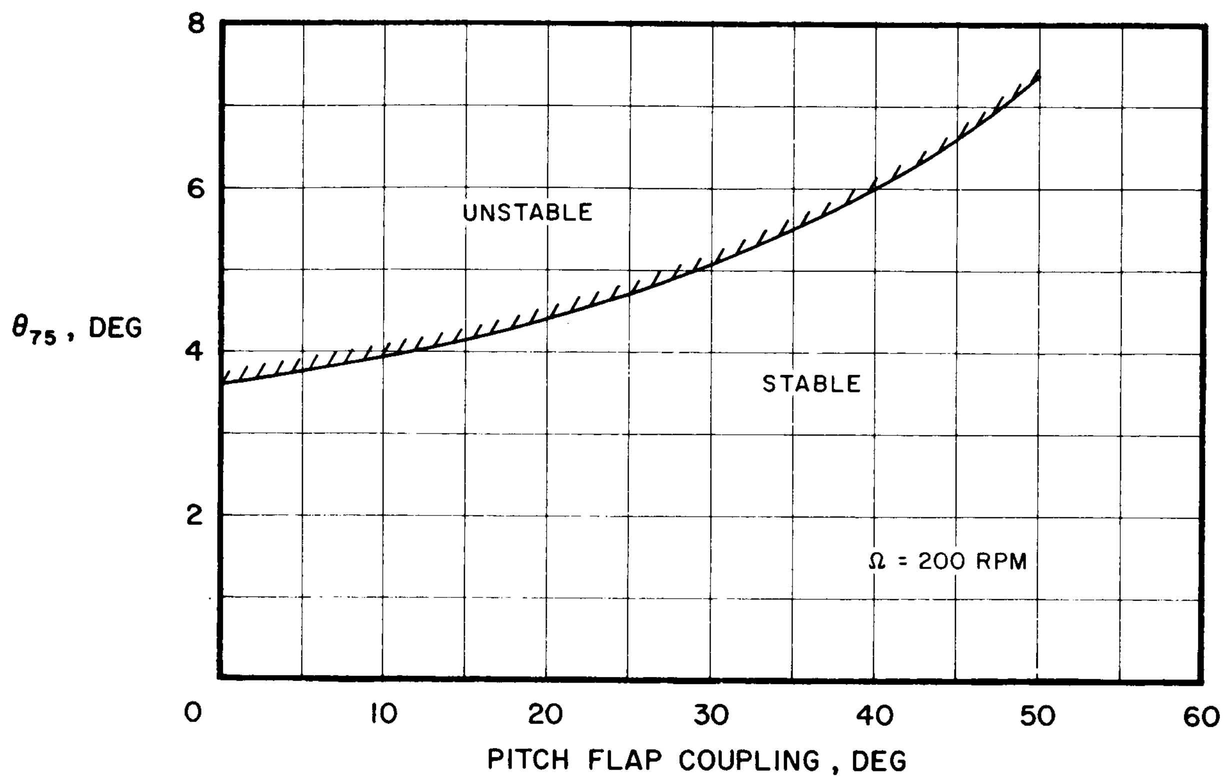

FIGURE 37. EFFECT OF PITCH-FLAP COUPLING ON VGR STABILITY

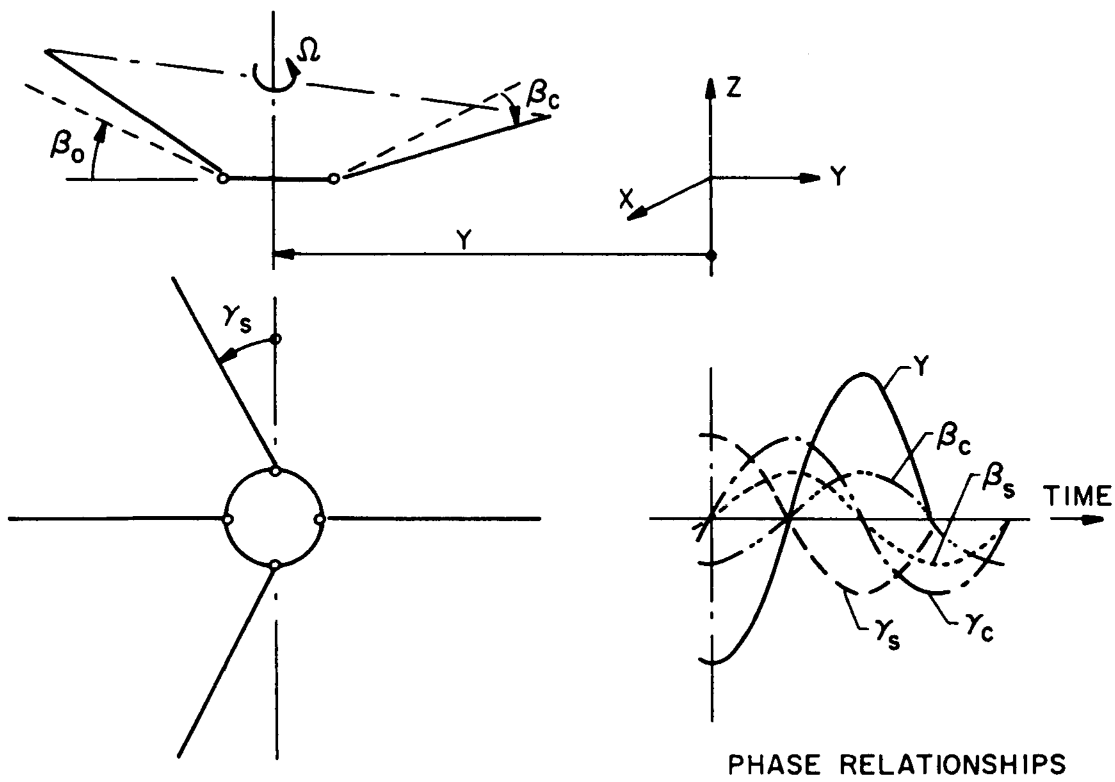

FIGURE 38. MODE SHAPE CONSTRUCTION

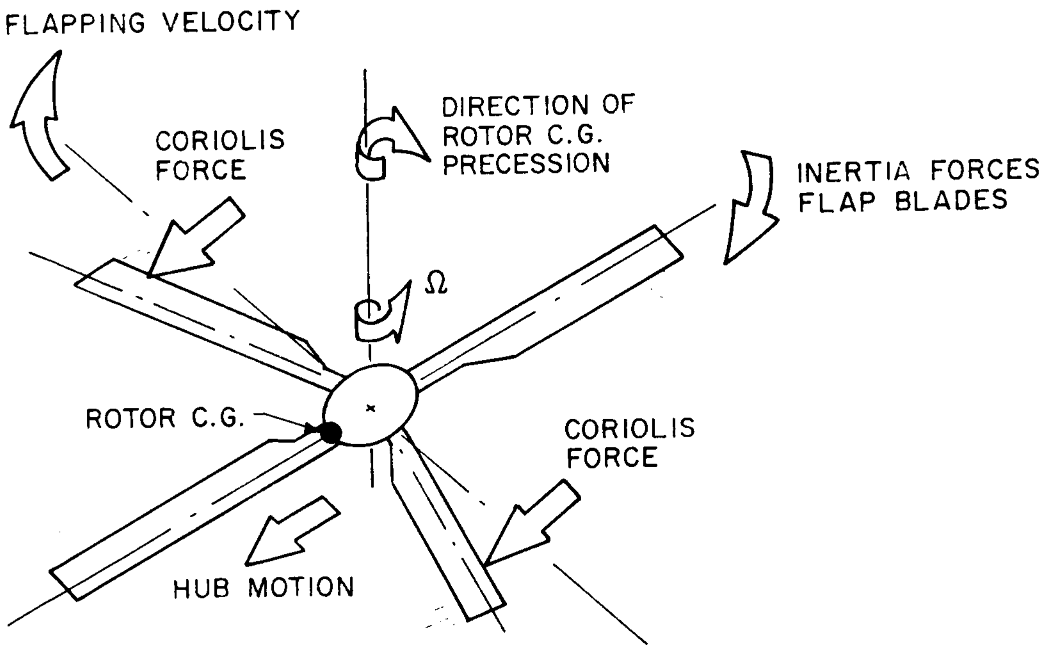

FIGURE 39. MECHANISM OF CORIOLIS INDUCED MECHANICAL INSTABILITY

TABLE 1

PERFORMANCE PARAMETER CALIBRATION TECHNIQUES

Parameter	Calibration
Impressed Blade Pitch	Daily Physical Calibration
Temperature	Metrology Lab Periodic Calibration
Rotor Speed	Metrology Lab Calibration of RPM Digital Counter
Thrust, Torque	Load Cells Physically Calibrated April 1974 Metrology Lab Periodic Calibration of Speedomax Recorders
Wind Velocity	Zero Offset Recorded Daily
Blade Angle	Daily Physical Calibrations
Pitching Moment	Strain Gaged Swashplate Physically Calibrated 8/20/74 Metrology Lab Periodic Calibration of Speedomax Recorder
Coning Angle	Physical Calibration at Each Azimuthal Spacing Change
Lag Angle	Daily Physical Calibration
Psychrometer	Metrology Lab Periodic Calibration
Barometer	Metrology Lab Periodic Calibration

TABLE 2

SUMMARY OF PERFORMANCE AND ACOUSTIC GAINS

FOR VGR CONFIGURATIONS

Tip Mach Number = 0.523

$\Delta\psi$ (deg.)	$\Delta\theta$ (deg.)	$\%C_T/\sigma$ gain at C_Q=.008 (%) (1)	Noise Reduction at Blade Passage Frequency(dB) (2)	Perceived Noise Level Reduction (PNdB) (2)
34.4	+1	6.1		
43.6	+1	5.6		
62.1	+1	5.5		
62.1	-1	5.5		
43.6	0	4.7	4	3
25.2	+1	4.4		
43.6	-1	4.4		
25.2	0	4.0	4	3
34.4	0	3.8	-1	0
62.1	0	2.9	-6	1
25.2	-1	2.8		
34.4	-1	1.1		

Tip Mach Number = 0.450

$\Delta\psi$ (deg.)	$\Delta\theta$ (deg.)	$\%C_T/\sigma$ gain at C_Q=.008 (%) (1)
62.1	+1	5.8
43.6	+1	5.5
62.1	-1	4.7
62.1	0	4.4
25.2	+1	4.4
25.2	-1	3.8
43.6	0	3.8
34.4	+1	3.8
34.4	-1	3.8
43.6	-1	3.3
34.4	0	2.9
25.2	0	2.2

(1) Precision of test data is $\pm 0.5\%$ $C_T/$
(2) At Station 5, in the rotor plane, 86.9m (285 ft) from the rotor centerline.

TABLE 3

DEFINITION OF ABBREVIATIONS FOR COMPUTER PRINTOUTS

ABBREVIATION	PARAMETER	UNITS
AIMP	Impressed Blade Angle at 75% RAD.	Degrees
BETA	Coning Angle	Degrees
CDO	Profile Drag Coefficient	Dimensionless
CL	Mean Lift Coefficient	Dimensionless
CQ	Torque Coefficient Corrected To Zero Wind	Dimensionless
CQO	Profile Torque Coefficient	Dimensionless
CQ/S	Corrected Torque Coefficient Divided by Rotor Solidity	Dimensionless
CT	Thrust Coefficient	Dimensionless
CT/S	Thrust Coefficient Divided by Rotor Solidity	Dimensionless
DCQI	Increment Added to Torque Coefficient To Correct to Zero Wind	Dimensionless
DENR	Density Ratio	Dimensionless
HP	Horsepower Corrected to Standard Day Conditions and Zero Wind	Horsepower
HPA	Horsepower Corrected to a Particular Rotor Speed at Standard Day Conditions and Zero Wind	Horsepower
LAG	LAG Angle	Degrees
MACH	Tip MACH Number	Dimensionless
MU	Advance Ratio	Dimensionless
PM	Pitching Moment	Inch-lbs
PRES	Barometric Pressure	Inches Hg
Reno	Renolds Number Based on TIP Speed and Nominal Blade Chord	Dimensionless
RPM	Rotor Operation Speed for a Particular Data Point	RPM
TEMP	Average Run Temperature	Degrees F
THTA	True Blade Angle	Degrees
TRA	Thrust Corrected to a Particular Rotor Speed at STD Day Cond.	Pounds
TRST	Thrust at Test RPM Corrected to Standard TEMP & Press.	Pounds
WIND	Wind Velocity	FT/SEC.

OUTPUT DATA IS:

TABLE 4 BASELINE ROTOR MACH NO. = .523

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
1	-0.14	0.523	188.50	81.	166.6	0.000037	0.0000722	0.51	-123.	0.0	0.60
2	9.86	0.523	188.50	17903.	1574.3	0.008240	0.0006823	7.32	46.	5.20	6.70
3	5.86	0.523	188.50	9267.	678.7	0.004265	0.0002941	6.60	31.	2.30	2.80
4	13.86	0.523	188.50	24168.	2899.9	0.011133	0.0012569	14.36	1181.	6.70	12.60
5	7.86	0.523	188.40	13639.	1087.4	0.006277	0.0004713	8.67	134.	3.70	4.50
6	3.86	0.523	188.50	5484.	395.6	0.002524	0.0001715	4.64	15.	1.00	1.40
7	11.86	0.523	188.50	21555.	2218.2	0.009920	0.0009614	12.54	349.	6.40	9.30
8	1.86	0.523	188.50	2378.	233.4	0.001095	0.0001012	2.66	0.	0.10	0.80

	CL	CDC	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
1	0.2752E-02	0.6448E-02	0.7614E-03	0.1287E-08	0.7204E-04	0.4186E-03	0.8078E-03	81.	163.3
2	0.6960E 00	0.1227E-01	0.9078E-03	0.2727E-07	0.1371E-03	0.9218E-01	0.7633E-02	17778.	1542.7
3	0.3137E 00	0.8152E-02	0.7907E-03	0.1490E-07	0.9109E-04	0.4771E-01	0.3291E-02	9202.	665.1
4	0.8187E 00	0.3585E-01	0.8200E-03	0.2608E-07	0.4006E-03	0.1245E 00	0.1406E-01	24019.	2841.9
5	0.4617E 00	0.9734E-02	0.8204E-03	0.1958E-07	0.1088E-03	0.7022E-01	0.5273E-02	13529.	1064.0
6	0.1856E 00	0.7072E-02	0.8200E-03	0.1234E-07	0.7902E-04	0.2823E-01	0.1918E-02	5445.	387.7
7	0.7296E 00	0.2158E-01	0.7907E-03	0.2271E-07	0.2411E-03	0.1110E 00	0.1076E-01	21404.	2173.8
8	0.8050E-01	0.6690E-02	0.8200E-03	0.8118E-08	0.7475E-04	0.1225E-01	0.1132E-02	2362.	228.7

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
45.5	0.5	188.5	0.523	5.213	29.71	0.981

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
17	1.86	0.523	189.00	2287.	225.8	0.001052	0.0000979		-77.	0.10	1.00
18	5.86	0.523	139.00	9155.	667.3	0.004214	0.0002892		0.	2.30	3.20
19	-0.14	0.523	189.10	42.	164.0	0.000019	0.0000711		-173.	0.0	0.90
20	9.86	0.523	189.00	17461.	1550.5	0.008036	0.0006720		107.	5.10	7.00
21	3.86	0.523	139.10	5475.	395.7	0.002520	0.0001715		1087.	1.10	1.90
22	13.86	0.523	189.10	23932.	2897.1	0.011014	0.0012535		1061.	6.70	12.80
23	7.86	0.523	139.20	13450.	1084.3	0.006190	0.0004699	5.78	61.	3.65	4.60
24	11.86	0.523	189.10	21244.	2223.3	0.009777	0.0009636	8.45	423.	6.00	9.40

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
17	0.7740E-01	0.6532E-02	0.1168E-02	0.1614E-07	0.7299E-04	0.1177E-01	0.1095E-02	2271.	221.9
18	0.3099E 00	0.8039E-02	0.1139E-02	0.3077E-07	0.8982E-04	0.4714E-01	0.3235E-02	9086.	655.2
19	0.1430E-02	0.6356E-02	0.1139E-02	0.2048E-08	0.7102E-04	0.2176E-03	0.7952E-03	42.	161.3
20	0.5910E 00	0.1314E-01	0.1139E-02	0.4251E-07	0.1468E-03	0.8990E-01	0.7518E-02	17324.	1522.2
21	0.1853E 00	0.7097E-02	0.1139E-02	0.2373E-07	0.7930E-04	0.2819E-01	0.1919E-02	5433.	388.7
22	0.8101E 00	0.3677E-01	0.1109E-02	0.4716E-07	0.4108E-03	0.1232E 00	0.1402E-01	23747.	2841.2
23	0.4553E 00	0.1028E-01	0.1109E-02	0.3536E-07	0.1149E-03	0.6925E-01	0.5257E-02	13361.	1066.8
24	0.7191E 00	0.2316E-01	0.1109E-02	0.4432E-07	0.2588E-03	0.1094E 00	0.1078E-01	21080.	2184.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
48.7	0.7	189.1	0.523	5.170	29.70	0.987

OUTPUT DATA IS:

TABLE 4 CONTINUED

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
31	13.86	0.523	189.10	23700.	2823.7	0.010908	0.0012238	4.29	893.	6.70	12.30
32	9.86	0.523	189.10	17594.	1564.0	0.008098	0.0006779	0.47	117.	4.90	6.70
33	5.86	0.523	189.10	9084.	660.0	0.004181	0.0002861	0.34	0.	2.20	2.70
34	-0.14	0.523	189.10	180.	161.8	0.000083	0.0000701	5.46	-173.	0.0	0.60
35	11.86	0.523	189.20	21173.	2203.8	0.009745	0.0009551	5.79	306.	6.20	9.40
36	7.86	0.523	189.10	13430.	1074.7	0.006181	0.0004658	2.85	61.	3.60	4.40
37	1.86	0.523	189.00	2321.	229.6	0.001068	0.0000995	3.48	-77.	0.10	0.90
38	3.86	0.523	189.00	5586.	390.9	0.002571	0.0001694	0.09	-31.	1.10	1.60

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
31	0.8022E 00	0.3520E-01	0.1518E-02	0.8781E-07	0.3933E-03	0.1220E 00	0.1369E-01	23521.	2774.2
32	0.5955E 00	0.1313E-01	0.1489E-02	0.7272E-07	0.1467E-03	0.9059E-01	0.7583E-02	17460.	1536.6
33	0.3075E 00	0.7966E-02	0.8057E-02	0.1524E-05	0.8900E-04	0.4677E-01	0.3200E-02	9015.	645.0
34	0.6076E-02	0.6227E-02	0.1343E-02	0.5941E-08	0.6958E-04	0.9243E-03	0.7846E-03	178.	159.0
35	0.7167E 00	0.2272E-01	0.9483E-02	0.3228E-05	0.2539E-03	0.1090E 00	0.1069E-01	21035.	2161.4
36	0.4546E 00	0.9981E-02	0.1428E-01	0.5791E-05	0.1115E-03	0.6915E-01	0.5211E-02	13341.	1043.8
37	0.7857E-01	0.6627E-02	0.5024E-02	0.2989E-06	0.7405E-04	0.1195E-01	0.1113E-02	2304.	224.8
38	0.1891E 00	0.6657E-02	0.2541E-02	0.1193E-06	0.7438E-04	0.2876E-01	0.1895E-02	5543.	383.5

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
48.8	3.2	189.1	0.523	5.169	29.71	0.987

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
68	5.86	0.523	186.30	9441.	683.2	0.004345	0.0002961	6.55	137.	2.60	2.60
69	-0.14	0.523	186.40	390.	175.6	0.000180	0.0000761	0.69	-37.	0.0	0.30
70	11.86	0.523	186.50	21207.	2226.0	0.009760	0.0009648	12.48	456.	6.70	9.70
71	3.86	0.523	186.50	5399.	397.8	0.002485	0.0001724	4.69	115.	1.25	1.30
72	7.86	0.523	186.50	13328.	1094.2	0.006134	0.0004742	8.67	215.	3.80	4.40
73	13.46	0.523	186.50	23569.	2789.2	0.010848	0.0012089	14.07	881.	7.50	12.50
74	1.86	0.523	186.50	2425.	232.5	0.001116	0.0001008	2.71	58.	0.30	0.60
75	9.86	0.523	186.50	17598.	1592.0	0.008099	0.0006900	10.62	257.	5.40	6.90

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
68	0.3196E 00	0.7811E-02	0.1224E-01	0.3567E-05	0.8728E-04	0.4861E-01	0.3312E-02	9577.	667.8
69	0.1322E-01	0.6653E-02	0.7404E-02	0.2450E-06	0.7434E-04	0.2011E-02	0.8513E-03	397.	173.4
70	0.7178E 00	0.2344E-01	0.4943E-02	0.8795E-06	0.2619E-03	0.1092E 00	0.1079E-01	21514.	2203.1
71	0.1827E 00	0.7348E-02	0.5002E-02	0.4535E-06	0.8210E-04	0.2780E-01	0.1929E-02	5477.	393.0
72	0.4511E 00	0.1110E-01	0.1379E-01	0.5389E-05	0.1240E-03	0.6862E-01	0.5305E-02	13522.	1071.6
73	0.7978E 00	0.3448E-01	0.1243E-02	0.5881E-07	0.3853E-03	0.1214E 00	0.1352E-01	23911.	2762.9
74	0.8208E-01	0.6587E-02	0.6689E-02	0.5393E-06	0.7360E-04	0.1249E-01	0.1127E-02	2460.	229.1
75	0.5957E 00	0.1419E-01	0.5476E-02	0.9828E-06	0.1586E-03	0.9061E-01	0.7719E-02	17853.	1574.7

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
34.8	4.0	186.5	0.523	5.477	30.36	0.939

OUTPUT DATA IS:

TABLE 4 CONTINUED

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
82	-0.14	0.523	184.80	397.	172.6	0.000183	0.0000748	0.71	0.	0.0	0.0
83	3.86	0.523	184.80	5549.	399.8	0.002554	0.0001733	4.63	123.	1.30	1.00
84	11.86	0.523	184.90	21362.	2217.3	0.009832	0.0009610	12.48	454.	7.00	9.70
85	1.86	0.523	184.80	2379.	232.9	0.001095	0.0001009	2.69	85.	0.30	0.40
86	9.86	0.523	185.00	17830.	1611.7	0.008206	0.0006985	10.60	336.	5.60	6.80
87	7.86	0.523	185.00	13567.	1096.9	0.006244	0.0004754	8.72	282.	4.10	4.50
88	13.36	0.523	185.00	23261.	2699.1	0.010706	0.0011698	13.90	1162.	7.40	12.20
89	5.86	0.523	185.10	9227.	689.8	0.004247	0.0002990	6.72	202.	2.60	2.60

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
82	0.1344E-01	0.6533E-02	0.1138E-01	0.5060E-06	0.7299E-04	0.2044E-02	0.8367E-03	404.	168.8
83	0.1878E 00	0.7086E-02	0.8185E-02	0.1226E-05	0.7918E-04	0.2857E-01	0.1938E-02	5648.	390.9
84	0.7231E 00	0.2240E-01	0.7225E-02	0.1884E-05	0.2503E-03	0.1100E 00	0.1075E-01	21765.	2182.7
85	0.8054E-01	0.6669E-02	0.8573E-02	0.8712E-06	0.7451E-04	0.1225E-01	0.1129E-02	2419.	227.1
86	0.6035E 00	0.1401E-01	0.5640E-02	0.1049E-05	0.1566E-03	0.9181E-01	0.7814E-02	18149.	1586.6
87	0.4592E 00	0.1036E-01	0.2477E-02	0.1768E-06	0.1157E-03	0.6985E-01	0.5319E-02	13810.	1081.1
88	0.7873E 00	0.3243E-01	0.2477E-02	0.2315E-06	0.3623E-03	0.1198E 00	0.1309E-01	23677.	2660.5
89	0.3123E 00	0.8699E-02	0.5726E-02	0.7774E-06	0.9720E-04	0.4751E-01	0.3344E-02	9393.	678.7

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.6	3.7	184.9	0.523	5.613	30.46	0.921

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
118	13.56	0.523	188.00	23520.	2822.8	0.010825	0.0012234	13.70	666.	7.30	12.80
119	11.86	0.523	188.00	21335.	2262.5	0.009819	0.0009806	12.67	666.	6.30	9.90
120	3.86	0.523	188.20	5585.	405.1	0.002571	0.0001756	4.76	118.	1.30	1.60
121	7.86	0.523	188.20	13510.	1067.9	0.006218	0.0004629	8.72	263.	3.90	4.50
122	1.86	0.523	188.20	2385.	226.4	0.001098	0.0000981	2.74	82.	0.30	0.80
123	5.86	0.523	138.30	9334.	677.2	0.004296	0.0002935	6.68	185.	2.50	2.80
124	9.86	0.523	188.20	17378.	1609.8	0.008228	0.0006977	10.67	309.	5.40	7.00
125	-0.14	0.523	188.20	251.	168.2	0.000116	0.0000729	0.74	0.	0.0	0.50

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
118	0.7961E 00	0.3602E-01	0.6871E-02	0.1788E-05	0.4024E-03	0.1211E 00	0.1369E-01	23915.	2821.1
119	0.7222E 00	0.2428E-01	0.8016E-02	0.2317E-05	0.2713E-03	0.1098E 00	0.1097E-01	21694.	2259.1
120	0.1891E 00	0.7208E-02	0.2640E-02	0.1287E-06	0.8054E-04	0.2876E-01	0.1964E-02	5680.	405.6
121	0.4573E 00	0.9438E-02	0.5016E-02	0.7224E-06	0.1055E-03	0.6956E-01	0.5178E-02	13739.	1068.5
122	0.8074E-01	0.6407E-02	0.3666E-02	0.1619E-06	0.7159E-04	0.1228E-01	0.1098E-02	2426.	226.5
123	0.3160E 00	0.7898E-02	0.2902E-02	0.2012E-06	0.8825E-04	0.4806E-01	0.3284E-02	9503.	679.2
124	0.6051E 00	0.1375E-01	0.5896E-02	0.1148E-05	0.1536E-03	0.9205E-01	0.7805E-02	18182.	1610.5
125	0.8507E-02	0.6442E-02	0.2523E-02	0.2459E-07	0.7198E-04	0.1294E-02	0.8154E-03	256.	168.5

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
43.8	2.7	188.2	0.523	5.364	30.43	0.954

TABLE 5 BASELINE ROTOR MACH NO. = .580

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
9	7.86	0.580	209.30	17436.	1523.6	0.006514	0.0004861	8.67	72.	3.75	4.70
10	1.86	0.580	209.30	2922.	323.4	0.001092	0.0001025	2.64	-15.	0.10	0.80
11	9.86	0.580	209.30	22683.	2324.9	0.008474	0.0007369	10.62	0.	5.20	7.00
12	13.46	0.580	209.30	29024.	3968.4	0.010843	0.0012578	14.10	1395.	6.50	12.40
13	5.86	0.580	209.30	11957.	947.7	0.004467	0.0003004	6.69	0.	2.40	2.80
14	-0.14	0.580	209.40	284.	240.0	0.000106	0.0000761	0.76	-205.	0.0	0.60
15	11.86	0.580	209.40	26546.	3247.5	0.009917	0.0010293	12.64	784.	5.70	9.90
16	3.86	0.580	209.40	7047.	573.5	0.002633	0.0001818	4.74	-56.	1.10	1.60

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
9	0.4791E 00	0.9205E-02	0.9495E-03	0.2663E-07	0.1029E-03	0.7287E-01	0.5438E-02	17308.	1502.9
10	0.8029E-01	0.6821E-02	0.9495E-03	0.1087E-07	0.7621E-04	0.1221E-01	0.1147E-02	2900.	316.9
11	0.6232E 00	0.1506E-01	0.9495E-03	0.3013E-07	0.1682E-03	0.9480E-01	0.8243E-02	22516.	2278.3
12	0.7974E 00	0.3891E-01	0.9759E-03	0.3606E-07	0.4347E-03	0.1213E 00	0.1407E-01	28810.	3888.9
13	0.3285E 00	0.7406E-02	0.9759E-03	0.2324E-07	0.8276E-04	0.4997E-01	0.3360E-02	11866.	928.5
14	0.7815E-02	0.6735E-02	0.1002E-02	0.3762E-08	0.7526E-04	0.1189E-02	0.8508E-03	282.	235.3
15	0.7293E 00	0.2769E-01	0.1028E-02	0.3858E-07	0.3094E-03	0.1109E 00	0.1151E-01	26349.	3183.9
16	0.1936E 00	0.7455E-02	0.1002E-02	0.1876E-07	0.8330E-04	0.2945E-01	0.2033E-02	6995.	562.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
46.2	0.6	209.3	0.580	5.775	29.71	0.982

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
46	5.86	0.580	205.10	11723.	960.3	0.004379	0.0003044	6.30	176.	2.60	2.40
47	7.86	0.580	205.10	17324.	1555.1	0.006472	0.0004929	8.35	230.	4.20	4.30
48	12.86	0.580	205.10	27864.	3672.5	0.010410	0.0011640	13.04	946.	7.00	10.80
49	9.86	0.581	205.20	22471.	2358.5	0.008395	0.0007475	10.40	272.	5.50	7.00
50	1.86	0.580	205.10	3219.	337.3	0.001203	0.0001069	2.51	64.	0.30	0.30
51	11.86	0.580	205.10	26184.	3205.3	0.009782	0.0010159	12.26	796.	6.50	10.00
52	3.86	0.580	205.10	7089.	570.5	0.002648	0.0001808	4.48	107.	1.30	1.20
53	-0.14	0.580	205.20	418.	246.9	0.000156	0.0000782	0.48	-53.	0.0	0.0

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
46	0.3221E 00	0.8331E-02	0.3768E-02	0.3423E-06	0.9309E-04	0.4899E-01	0.3405E-02	11873.	939.9
47	0.4760E 00	0.1014E-01	0.1884E-03	0.1086E-08	0.1133E-03	0.7240E-01	0.5514E-02	17546.	1523.8
48	0.7656E 00	0.3489E-01	0.3499E-02	0.4552E-06	0.3898E-03	0.1165E 00	0.1302E-01	28222.	3597.1
49	0.6174E 00	0.1672E-01	0.2690E-04	0.1337E-09	0.1869E-03	0.9391E-01	0.8363E-02	22781.	2314.4
50	0.8844E-01	0.6946E-02	0.9959E-03	0.1253E-07	0.7649E-04	0.1345E-01	0.1196E-02	3260.	330.4
51	0.7194E 00	0.2780E-01	0.3041E-02	0.3334E-06	0.3107E-03	0.1094E 00	0.1137E-01	26520.	3139.7
52	0.1948E 00	0.7292E-02	0.2611E-02	0.1278E-06	0.8148E-04	0.2963E-01	0.2023E-02	7180.	558.7
53	0.1148E-01	0.6875E-02	0.3363E-02	0.5052E-07	0.7682E-04	0.1746E-02	0.8753E-03	423.	241.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.1	1.4	205.1	0.580	6.210	30.32	0.924

TABLE 5 CONTINUED

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
60	10.86	0.580	206.40	24432.	2790.8	0.009127	0.0008845	11.62	549.	5.90	8.40
61	-0.14	0.580	206.50	436.	241.6	0.000163	0.0000766	0.78	11.	0.0	0.20
62	9.86	0.580	206.50	22349.	2335.1	0.008349	0.0007401	10.58	248.	5.50	7.00
63	1.86	0.580	206.50	3081.	333.4	0.001151	0.0001057	2.72	90.	0.30	0.60
64	3.86	0.580	206.50	6970.	566.3	0.002604	0.0001795	4.69	58.	1.30	1.30
65	10.86	0.580	206.50	24459.	2813.1	0.009137	0.0008916	11.61	285.	6.40	8.50
66	5.86	0.580	206.50	12080.	989.5	0.004513	0.0003136	6.74	116.	2.70	2.60
67	7.86	0.580	206.60	17470.	1595.2	0.006526	0.0005056	8.72	137.	4.10	4.60

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
60	0.6713E 00	0.2227E-01	0.3477E-03	0.4281E-08	0.2489E-03	0.1021E 00	0.9895E-02	24786.	2756.3
61	0.1198E-01	0.6719E-02	0.3475E-03	0.5618E-09	0.7507E-04	0.1823E-02	0.8568E-03	442.	238.8
62	0.6140E 00	0.1646E-01	0.3743E-03	0.4707E-08	0.1840E-03	0.9340E-01	0.8279E-02	22671.	2307.2
63	0.8464E-01	0.6909E-02	0.1631E-02	0.3286E-07	0.7720E-04	0.1287E-01	0.1182E-02	3125.	329.3
64	0.1915E 00	0.7396E-02	0.5641E-02	0.5900E-06	0.8263E-04	0.2913E-01	0.2008E-02	7071.	557.7
65	0.6720E 00	0.2281E-01	0.1470E-02	0.7545E-07	0.2549E-03	0.1022E 00	0.9975E-02	24811.	2779.4
66	0.3319E 00	0.8291E-02	0.1150E-02	0.3239E-07	0.9264E-04	0.5048E-01	0.3509E-02	12254.	977.6
67	0.4800E 00	0.1085E-01	0.8657E-02	0.2200E-05	0.1213E-03	0.7301E-01	0.5656E-02	17720.	1570.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.5	1.5	206.5	0.580	6.113	30.35	0.935

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
96	1.86	0.580	206.60	3045.	330.7	0.001137	0.0001048	2.73	68.	0.30	0.60
97	11.86	0.580	206.60	26325.	3232.5	0.009835	0.0010245	12.51	963.	6.20	10.10
98	5.86	0.580	206.80	11702.	961.5	0.004372	0.0003047	6.71	147.	2.50	2.70
99	-0.14	0.581	206.90	277.	241.3	0.000103	0.0000765	0.83	-10.	0.0	0.20
100	9.86	0.581	206.90	22116.	2310.4	0.008262	0.0007323	10.67	178.	5.50	7.10
101	3.86	0.580	206.90	7158.	575.0	0.002674	0.0001822	4.80	79.	1.30	1.40
102	13.06	0.580	206.90	28005.	3767.8	0.010462	0.0011942	13.65	1344.	6.70	12.00
103	7.86	0.580	207.00	16934.	1539.8	0.006326	0.0004880	8.80	210.	4.00	4.60

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
96	0.8366E-01	0.6879E-02	0.2298E-02	0.6483E-07	0.7686E-04	0.1272E-01	0.1173E-02	3098.	327.7
97	0.7233E 00	0.2806E-01	0.2298E-02	0.1909E-06	0.3136E-03	0.1100E 00	0.1146E-01	26787.	3204.7
98	0.3215E 00	0.8415E-02	0.2376E-02	0.1361E-06	0.9403E-04	0.4891E-01	0.3409E-02	11906.	953.8
99	0.7611E-02	0.6777E-02	0.2321E-02	0.1971E-07	0.7572E-04	0.1158E-02	0.8557E-03	282.	239.8
100	0.6076E 00	0.1654E-01	0.2295E-02	0.1745E-06	0.1848E-03	0.9243E-01	0.8192E-02	22524.	2295.8
101	0.1967E 00	0.7288E-02	0.2321E-02	0.1015E-06	0.8143E-04	0.2992E-01	0.2039E-02	7283.	570.6
102	0.7694E 00	0.3706E-01	0.2295E-02	0.1964E-06	0.4141E-03	0.1170E 00	0.1336E-01	28492.	3740.5
103	0.4653E 00	0.1085E-01	0.2293E-02	0.1525E-06	0.1212E-03	0.7077E-01	0.5460E-02	17228.	1529.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
34.0	1.5	206.8	0.580	6.109	30.45	0.935

TABLE 5 CONTINUED

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
110	3.86	0.580	207.90	7232.	570.3	0.002702	0.0001807	4.72	73.	1.40	1.60
111	13.06	0.580	208.10	27947.	3780.9	0.010440	0.0011983	13.68	1370.	6.50	12.00
112	5.86	0.580	208.10	11954.	979.9	0.004466	0.0003106	6.75	99.	2.60	2.90
113	9.86	0.580	208.10	22996.	2405.6	0.008591	0.0007624	10.66	150.	5.60	7.40
114	1.86	0.580	208.00	3098.	334.8	0.001157	0.0001061	2.82	42.	0.30	0.60
115	7.36	0.580	208.10	17563.	1578.5	0.006561	0.0005003	8.73	176.	4.10	4.80
116	11.86	0.580	208.10	26804.	3299.3	0.010013	0.0010457	12.54	918.	6.20	10.20
117	-0.14	0.580	208.10	607.	240.2	0.000227	0.0000761	0.83	-31.	0.0	0.50

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
110	0.1987E 00	0.7014E-02	0.1885E-02	0.6730E-07	0.7837E-04	0.3022E-01	0.2022E-02	7360.	568.9
111	0.7678E 00	0.3765E-01	0.3183E-02	0.3773E-06	0.4207E-03	0.1168E 00	0.1341E-01	28440.	3775.7
112	0.3284E 00	0.8328E-02	0.2334E-02	0.1328E-06	0.9306E-04	0.4996E-01	0.3475E-02	12165.	978.5
113	0.6318E 00	0.1629E-01	0.2361E-02	0.1883E-06	0.1820E-03	0.9611E-01	0.8530E-02	23402.	2402.4
114	0.8512E-01	0.6929E-02	0.2389E-02	0.7067E-07	0.7742E-04	0.1295E-01	0.1187E-02	3150.	333.8
115	0.4826E 00	0.1010E-01	0.2361E-02	0.1647E-06	0.1129E-03	0.7340E-01	0.5597E-02	17874.	1576.3
116	0.7364E 00	0.2821E-01	0.2361E-02	0.2033E-06	0.3152E-03	0.1120E 00	0.1170E-01	27278.	3295.1
117	0.1669E-01	0.6590E-02	0.2361E-02	0.3041E-07	0.7364E-04	0.2538E-02	0.8516E-03	618.	239.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
39.9	1.5	208.1	0.580	6.015	30.44	0.947

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
126	1.86	0.580	208.90	2945.	317.2	0.001100	0.0001005	2.69	41.	0.30	0.90
127	5.86	0.580	208.80	11950.	964.8	0.004464	0.0003058	6.68	139.	2.60	2.90
128	-0.14	0.581	209.20	430.	238.3	0.000160	0.0000755	0.78	36.	0.0	0.60
129	9.86	0.581	209.30	22364.	2353.5	0.008355	0.0007459	10.66	210.	5.30	7.20
130	3.86	0.580	209.20	7341.	570.9	0.002742	0.0001809	4.77	77.	1.30	1.60
131	12.86	0.580	209.20	27999.	3746.2	0.010460	0.0011874	13.53	1047.	7.00	12.00
132	7.86	0.580	209.30	17504.	1583.1	0.006539	0.0005018	8.80	180.	4.00	4.90
133	11.86	0.580	209.30	25992.	3219.1	0.009710	0.0010203	12.64	826.	6.00	10.00

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
126	0.8092E-01	0.6615E-02	0.2431E-02	0.7138E-07	0.7391E-04	0.1231E-01	0.1125E-02	2995.	317.5
127	0.3283E 00	0.7908E-02	0.6610E-02	0.1061E-05	0.8836E-04	0.4994E-01	0.3421E-02	12139.	961.9
128	0.1180E-01	0.6626E-02	0.1549E-01	0.6655E-06	0.7403E-04	0.1796E-02	0.8448E-03	437.	237.2
129	0.6145E 00	0.1694E-01	0.9785E-02	0.3181E-05	0.1892E-03	0.9347E-01	0.8345E-02	22782.	2356.8
130	0.2017E 00	0.6824E-02	0.5964E-02	0.6766E-06	0.7625E-04	0.3068E-01	0.2024E-02	7464.	570.6
131	0.7693E 00	0.3647E-01	0.9895E-02	0.3642E-05	0.4076E-03	0.1170E 00	0.1328E-01	28466.	3747.0
132	0.4809E 00	0.1041E-01	0.6778E-02	0.1352E-05	0.1163E-03	0.7316E-01	0.5613E-02	17796.	1584.7
133	0.7141E 00	0.2889E-01	0.3086E-02	0.3419E-06	0.3228E-03	0.1086E 00	0.1141E-01	26425.	3230.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
45.1	4.8	209.1	0.580	5.932	30.43	0.957

OUTPUT DATA IS:

TABLE 6 BASELINE ROTOR MACH NO. = .638

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
25	-0.14	0.638	231.10	359.	325.5	0.000111	0.0000777	12.95	-315.	0.0	0.80
26	1.86	0.638	231.10	3673.	447.3	0.001136	0.0001068	11.21	-178.	0.30	1.00
27	5.86	0.638	231.00	14970.	1357.2	0.004630	0.0003240	3.54	-173.	2.45	2.10
28	9.86	0.638	231.00	27728.	3392.0	0.008576	0.0008098	0.29	0.	5.00	7.70
29	3.86	0.638	231.00	8970.	794.6	0.002774	0.0001897	5.94	-198.	1.40	1.80
30	7.86	0.638	230.70	22055.	2283.4	0.006821	0.0005451	1.71	-219.	3.70	5.10

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
25	0.8156E-02	0.6879E-02	0.6967E-02	0.1281E-05	0.7686E-04	0.1241E-02	0.8694E-03	356.	320.1
26	0.8355E-01	0.7060E-02	0.1362E-02	0.2277E-07	0.7888E-04	0.1271E-01	0.1195E-02	3648.	440.5
27	0.3405E 00	0.8445E-02	0.1338E-02	0.4445E-07	0.9436E-04	0.5180E-01	0.3625E-02	14869.	1336.2
28	0.6307E 00	0.2067E-01	0.2533E-02	0.2166E-06	0.2309E-03	0.9594E-01	0.9060E-02	27540.	3339.2
29	0.2040E 00	0.7445E-02	0.1338E-02	0.3441E-07	0.8319E-04	0.3103E-01	0.2122E-02	8909.	782.3
30	0.5016E 00	0.1234E-01	0.1340E-02	0.5407E-07	0.1345E-03	0.7631E-01	0.6099E-02	21891.	2243.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
50.0	1.6	231.0	0.638	6.288	29.71	0.990

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
39	3.86	0.638	230.50	8625.	767.1	0.002667	0.0001831	6.12	-128.	1.00	1.70
40	5.86	0.638	230.50	15053.	1349.1	0.004656	0.0003221	4.43	-209.	2.30	3.00
41	9.86	0.638	230.50	27152.	3310.5	0.008397	0.0007903	1.75	20.	4.70	7.40
42	1.86	0.637	230.40	3976.	460.6	0.001230	0.0001100	5.45	-189.	0.10	0.90
43	7.86	0.638	230.50	21926.	2260.9	0.006781	0.0005398	1.19	-199.	3.80	5.00
44	-0.14	0.638	230.60	679.	330.2	0.000210	0.0000788	5.77	-316.	0.0	0.70
45	11.86	0.638	230.60	33239.	4975.2	0.010280	0.0011878	6.35	638.	6.50	11.60

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
39	0.1962E 00	0.7402E-02	0.1413E-02	0.3761E-07	0.8271E-04	0.2984E-01	0.2049E-02	8552.	752.3
40	0.3424E 00	0.8102E-02	0.3377E-02	0.2835E-06	0.9053E-04	0.5208E-01	0.3603E-02	14927.	1322.3
41	0.6176E 00	0.2053E-01	0.5365E-02	0.9605E-06	0.2294E-03	0.9394E-01	0.8842E-02	26925.	3243.6
42	0.9045E-01	0.7028E-02	0.9368E-02	0.1101E-05	0.7853E-04	0.1376E-01	0.1230E-02	3940.	446.8
43	0.4987E 00	0.1198E-01	0.1111E-01	0.3689E-05	0.1327E-03	0.7586E-01	0.6039E-02	21743.	2202.8
44	0.1544E-01	0.6856E-02	0.7565E-02	0.2794E-06	0.7661E-04	0.2349E-02	0.8818E-03	674.	323.2
45	0.7560E 00	0.3831E-01	0.4094E-02	0.6192E-06	0.4280E-03	0.1150E 00	0.1329E-01	32989.	4884.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
48.5	4.3	230.5	0.638	6.307	29.70	0.987

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TABLE 6 CONTINUED

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
54	9.86	0.638	226.20	27554.	3369.7	0.008522	0.0008045	10.37	377.	5.50	7.40
55	1.86	0.638	226.20	3859.	471.5	0.001193	0.0001126	2.57	111.	0.20	0.50
56	-0.14	0.638	226.20	527.	337.6	0.000163	0.0000806	0.79	-149.	0.0	0.0
57	7.86	0.638	226.20	21629.	2248.1	0.006689	0.0005367	8.68	-21.	4.20	4.90
58	5.86	0.638	226.20	14892.	1362.9	0.004606	0.0003254	6.72	-32.	2.60	2.70
59	3.86	0.638	226.20	9045.	820.7	0.002797	0.0001959	4.84	11.	1.40	1.40

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
54	0.6267E 00	0.2068E-01	0.1952E-02	0.1285E-06	0.2310E-03	0.9533E-01	0.9000E-02	27950.	3317.9
55	0.8776E-01	0.7385E-02	0.5686E-02	0.4043E-06	0.8251E-04	0.1335E-01	0.1259E-02	3914.	462.7
56	0.1200E-01	0.7077E-02	0.2270E-02	0.2379E-07	0.7907E-04	0.1825E-02	0.9016E-03	535.	332.3
57	0.4920E 00	0.1234E-01	0.2929E-03	0.2544E-08	0.1379E-03	0.7484E-01	0.6004E-02	21941.	2213.8
58	0.3387E 00	0.8729E-02	0.3173E-03	0.2485E-08	0.9753E-04	0.5153E-01	0.3640E-02	15106.	1342.2
59	0.2057E 00	0.7883E-02	0.1928E-02	0.7166E-07	0.8808E-04	0.3129E-01	0.2192E-02	9175.	807.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.0	1.4	226.2	0.638	6.779	30.34	0.929

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
76	7.86	0.638	225.20	21538.	2258.9	0.006661	0.0005393	8.70	-16.	4.30	6.40
77	-0.14	0.638	225.20	622.	332.8	0.000193	0.0000795	0.85	-155.	0.0	0.0
78	5.86	0.638	225.20	14735.	1356.9	0.004557	0.0003240	6.69	0.	2.70	2.60
79	1.86	0.638	225.20	3897.	468.3	0.001205	0.0001118	2.83	0.	0.30	0.40
80	9.86	0.638	225.20	27961.	3409.9	0.008648	0.0008141	10.62	-145.	5.80	7.80
81	3.86	0.638	225.30	9051.	809.8	0.002799	0.0001933	4.86	0.	1.30	1.20

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
76	0.4899E 00	0.1280E-01	0.2549E-02	0.1933E-06	0.1430E-03	0.7452E-01	0.6033E-02	21920.	2221.3
77	0.1416E-01	0.6937E-02	0.3579E-02	0.6366E-07	0.7751E-04	0.2154E-02	0.8889E-03	634.	327.1
78	0.3352E 00	0.8923E-02	0.6888E-02	0.1165E-05	0.9970E-04	0.5098E-01	0.3624E-02	14996.	1330.0
79	0.8864E-01	0.7276E-02	0.2108E-02	0.5619E-07	0.8130E-04	0.1348E-01	0.1251E-02	3966.	460.4
80	0.6360E 00	0.2039E-01	0.2084E-02	0.1471E-06	0.2279E-03	0.9674E-01	0.9107E-02	28458.	3353.7
81	0.2059E 00	0.7642E-02	0.4263E-02	0.3499E-06	0.8539E-04	0.3131E-01	0.2163E-02	9210.	795.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
25.1	2.5	225.2	0.638	6.875	30.46	0.918

TABLE 6 CONTINUED

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
90	-0.14	0.638	225.90	585.	325.9	0.000181	0.0000778	0.82	-117.	0.0	0.10
91	9.86	0.638	225.90	27698.	3364.0	0.008566	0.0008031	10.63	351.	5.30	7.60
92	1.86	0.638	226.20	3908.	471.5	0.001209	0.0001126	2.86	0.	0.30	0.60
93	3.86	0.638	226.30	8932.	803.0	0.002762	0.0001917	4.84	0.	1.40	1.40
94	5.86	0.638	226.40	15024.	1372.4	0.004646	0.0003277	6.76	0.	2.70	2.70
95	7.86	0.638	226.40	22079.	2314.8	0.006828	0.0005526	8.79	-48.	4.30	5.00

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
90	0.1330E-01	0.6805E-02	0.6060E-02	0.1700E-06	0.7604E-04	0.2022E-02	0.8705E-03	595.	320.9
91	0.6300E 00	0.2015E-01	0.2077E-02	0.1455E-06	0.2252E-03	0.9583E-01	0.8985E-02	28187.	3318.4
92	0.3888E-01	0.7334E-02	0.2074E-02	0.5448E-07	0.8194E-04	0.1352E-01	0.1259E-02	3979.	465.9
93	0.2032E 00	0.7684E-02	0.2098E-02	0.8427E-07	0.8586E-04	0.3090E-01	0.2145E-02	9094.	793.6
94	0.3417E 00	0.8661E-02	0.2097E-02	0.1093E-06	0.9577E-04	0.5198E-01	0.3665E-02	15294.	1357.0
95	0.5022E 00	0.1265E-01	0.2097E-02	0.1324E-06	0.1413E-03	0.7639E-01	0.6182E-02	22476.	2289.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.1	1.9	226.2	0.638	6.802	30.46	0.926

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ	THTA	PM	BETA	LAG
104	5.86	0.638	227.80	14981.	1344.7	0.004633	0.0003210	6.73	0.	2.70	2.90
105	-0.14	0.638	227.90	489.	322.0	0.000151	0.0000769	0.87	-136.	0.0	0.40
106	7.86	0.638	228.00	22195.	2299.6	0.006864	0.0005490	8.79	-63.	4.30	5.20
107	1.86	0.638	228.00	3866.	460.8	0.001196	0.0001100	2.86	0.	0.30	0.70
108	9.86	0.638	228.00	27426.	3352.4	0.008482	0.0008004	10.69	329.	5.20	7.50
109	3.86	0.638	228.10	8732.	827.1	0.002701	0.0001975	4.84	0.	1.30	1.50

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
104	0.3408E 00	0.8156E-02	0.2108E-02	0.1103E-06	0.9114E-04	0.5183E-01	0.3591E-02	15249.	1337.7
105	0.1113E-01	0.6758E-02	0.2107E-02	0.1976E-07	0.7551E-04	0.1693E-02	0.8599E-03	498.	320.4
106	0.5048E 00	0.1203E-01	0.2082E-02	0.1309E-06	0.1344E-03	0.7679E-01	0.6142E-02	22586.	2289.3
107	0.8793E-01	0.7143E-02	0.2082E-02	0.5460E-07	0.7987E-04	0.1338E-01	0.1231E-02	3934.	458.6
108	0.6238E 00	0.2066E-01	0.2106E-02	0.1491E-06	0.2309E-03	0.9489E-01	0.8954E-02	27909.	3337.6
109	0.1986E 00	0.8515E-02	0.2130E-02	0.8591E-07	0.9515E-04	0.3021E-01	0.2209E-02	8893.	824.3

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
36.8	1.5	228.0	0.638	6.666	30.45	0.941

TABLE 7, VGR

BLADE AZIMUTHAL SPACING: 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
134	11.11	0.450	175.20	11761.	876.8	0.008886	0.0007254
135	8.11	0.450	175.20	8172.	513.9	0.006174	0.0004252
136	10.11	0.450	175.30	10544.	739.2	0.007966	0.0006115
137	11.41	0.450	175.30	12193.	912.0	0.009212	0.0007545
138	9.11	0.450	175.20	9325.	624.9	0.007045	0.0005169

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
134	0.5931E 00	0.9324E-02	0.2778E-02	0.2649E-06	0.1148E-03	0.9021E-01	0.7365E-02	11596.	836.5
135	0.4121E 00	0.5808E-02	0.6944E-03	0.1400E-07	0.7150E-04	0.6268E-01	0.4316E-02	8057.	490.5
136	0.5317E 00	0.7571E-02	0.2082E-02	0.1410E-06	0.9321E-04	0.8088E-01	0.6209E-02	10408.	706.5
137	0.6148E 00	0.8933E-02	0.6246E-02	0.1363E-05	0.1100E-03	0.9352E-01	0.7660E-02	12035.	870.3
138	0.4702E 00	0.6976E-02	0.3819E-02	0.4462E-06	0.8588E-04	0.7153E-01	0.5248E-02	9194.	595.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.0	1.5	175.2	0.450	4.683	29.48	0.950

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
144	10.11	0.450	175.30	10244.	717.3	0.007740	0.0005934
145	9.11	0.450	175.40	8715.	592.9	0.006585	0.0004905
146	11.71	0.450	175.40	12116.	915.7	0.009154	0.0007575
147	8.11	0.450	175.40	7805.	638.8	0.005897	0.0005285
148	11.11	0.450	175.40	11367.	828.6	0.008588	0.0006855

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
144	0.5166E 00	0.7878E-02	0.3470E-02	0.3861E-06	0.9699E-04	0.7858E-01	0.6024E-02	10104.	684.7
145	0.4395E 00	0.8205E-02	0.8323E-02	0.2044E-05	0.1010E-03	0.6685E-01	0.4980E-02	8606.	565.0
146	0.6110E 00	0.9671E-02	0.3468E-02	0.4194E-06	0.1191E-03	0.9294E-01	0.7691E-02	11964.	875.7
147	0.3936E 00	0.1611E-01	0.4855E-02	0.6591E-06	0.1983E-03	0.5987E-01	0.5365E-02	7701.	610.8
148	0.5732E 00	0.8555E-02	0.9017E-02	0.2740E-05	0.1053E-03	0.8719E-01	0.6960E-02	11215.	789.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.8	2.8	175.4	0.450	4.676	29.50	0.951

TABLE 7 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
155	11.11	0.450	175.60	11325.	839.2	0.008556	0.0006942
156	10.11	0.450	175.70	10121.	702.2	0.007646	0.0005809
157	9.11	0.450	175.70	8839.	582.2	0.006678	0.0004816
158	8.11	0.450	175.70	7662.	492.0	0.005789	0.0004070
159	11.51	0.450	175.70	11926.	902.8	0.009010	0.0007469

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
155	0.5711E 00	0.9523E-02	0.1386E-02	0.6482E-07	0.1172E-03	0.8687E-01	0.7048E-02	11183.	803.8
156	0.5104E 00	0.7594E-02	0.9001E-02	0.2575E-05	0.9349E-04	0.7763E-01	0.5898E-02	9995.	670.2
157	0.4457E 00	0.6806E-02	0.5539E-02	0.9130E-06	0.8379E-04	0.6780E-01	0.4890E-02	8729.	557.0
158	0.3864E 00	0.6983E-02	0.1385E-02	0.5322E-07	0.8598E-04	0.5877E-01	0.4133E-02	7567.	471.6
159	0.6014E 00	0.1002E-01	0.1039E-01	0.3721E-05	0.1234E-03	0.9147E-01	0.7583E-02	11777.	861.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
28.4	2.7	175.7	0.450	4.658	29.51	0.954

TABLE 8, VGR

BLADE AZIMUTHAL SPACING: 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
139	8.11	0.523	203.70	10971.	843.1	0.006099	0.0004402
140	9.11	0.523	203.60	11508.	1013.2	0.006398	0.0005291
141	11.31	0.523	203.70	16212.	1470.3	0.009013	0.0007678
142	10.11	0.523	203.80	14027.	1197.7	0.007798	0.0006255
143	11.11	0.523	203.80	16134.	1437.5	0.008970	0.0007507

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
139	0.4071E 00	0.7553E-02	0.6868E-02	0.1340E-05	0.9299E-04	0.6193E-01	0.4470E-02	10762.	796.0
140	0.4270E 00	0.1267E-01	0.7768E-02	0.1755E-05	0.1560E-03	0.6496E-01	0.5372E-02	11278.	954.9
141	0.6016E 00	0.1170E-01	0.0	0.0	0.1440E-03	0.9151E-01	0.7795E-02	15903.	1392.3
142	0.5205E 00	0.1003E-01	0.7760E-02	0.1935E-05	0.1235E-03	0.7917E-01	0.6350E-02	13758.	1131.3
143	0.5987E 00	0.1067E-01	0.5969E-02	0.1229E-05	0.1314E-03	0.9106E-01	0.7621E-02	15825.	1359.7

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.2	3.2	203.7	0.523	5.441	29.49	0.951

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
149	9.11	0.523	203.90	12557.	998.2	0.006981	0.0005213
150	11.11	0.523	203.90	15821.	1411.0	0.008796	0.0007368
151	10.11	0.523	204.00	13991.	1187.1	0.007778	0.0006199
152	11.41	0.523	204.10	16148.	1469.1	0.008977	0.0007671
153	8.11	0.523	204.00	10979.	830.2	0.006104	0.0004335
154	10.11	0.523	204.00	14585.	1205.2	0.008108	0.0006294

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
149	0.4660E 00	0.7801E-02	0.4773E-02	0.6933E-06	0.9604E-04	0.7088E-01	0.5292E-02	12325.	945.5
150	0.5871E 00	0.1100E-01	0.1492E-02	0.7616E-07	0.1355E-03	0.8930E-01	0.7480E-02	15528.	1338.1
151	0.5192E 00	0.9730E-02	0.1759E-01	0.9848E-05	0.1198E-03	0.7897E-01	0.6293E-02	13746.	1109.6
152	0.5992E 00	0.1195E-01	0.2682E-02	0.2484E-06	0.1471E-03	0.9114E-01	0.7788E-02	15864.	1395.6
153	0.4074E 00	0.6978E-02	0.8647E-02	0.2123E-05	0.8591E-04	0.6197E-01	0.4401E-02	10775.	783.9
154	0.5412E 00	0.7889E-02	0.8647E-02	0.2448E-05	0.9712E-04	0.8232E-01	0.6390E-02	14314.	1139.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
27.3	4.1	204.0	0.523	5.431	29.51	0.952

TABLE 8 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
160	9.11	0.523	204.30	12458.	1003.1	0.006926	0.0005238
161	11.51	0.523	204.30	16432.	1496.8	0.009136	0.0007816
162	11.11	0.523	204.30	15300.	1394.3	0.008506	0.0007281
163	10.11	0.523	204.40	14246.	1195.5	0.007920	0.0006243
164	8.11	0.523	204.40	11037.	830.6	0.006136	0.0004337

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
160	0.4623E 00	0.8419E-02	0.6252E-02	0.1184E-05	0.1037E-03	0.7032E-01	0.5318E-02	12228.	951.2
161	0.6098E 00	0.1179E-01	0.8932E-02	0.2774E-05	0.1451E-03	0.9275E-01	0.7936E-02	16129.	1417.5
162	0.5677E 00	0.1269E-01	0.3573E-02	0.4291E-06	0.1562E-03	0.8636E-01	0.7392E-02	15018.	1324.3
163	0.5286E 00	0.8973E-02	0.4464E-02	0.6459E-06	0.1105E-03	0.8041E-01	0.6338E-02	13985.	1135.7
164	0.4096E 00	0.6766E-02	0.4464E-02	0.5686E-06	0.8331E-04	0.6230E-01	0.4403E-02	10833.	788.6

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.2	3.1	204.3	0.523	5.403	29.51	0.955

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TABLE 9, VGR

BLADE AZIMUTHAL SPACING: 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS: +1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
168	9.11	0.450	176.00	9534.	652.2	0.007203	0.0005395
169	8.11	0.450	176.00	8358.	524.1	0.006315	0.0004336
170	11.11	0.450	176.00	12097.	877.4	0.009139	0.0007259
171	10.11	0.450	176.10	10684.	766.0	0.008072	0.0006337
172	11.71	0.450	176.10	12592.	953.2	0.009513	0.0007885

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
168	0.4808E 00	0.7623E-02	0.6912E-03	0.1488E-07	0.9385E-04	0.7313E-01	0.5478E-02	9420.	626.5
169	0.4215E 00	0.5503E-02	0.1106E-01	0.3525E-05	0.6775E-04	0.6411E-01	0.4402E-02	8258.	499.4
170	0.6100E 00	0.7223E-02	0.6912E-02	0.1663E-05	0.8893E-04	0.9279E-01	0.7369E-02	11952.	841.0
171	0.5387E 00	0.8530E-02	0.1002E-01	0.3276E-05	0.1050E-03	0.8195E-01	0.6433E-02	10556.	732.6
172	0.6350E 00	0.9106E-02	0.8981E-02	0.2861E-05	0.1121E-03	0.9659E-01	0.8006E-02	12442.	913.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
30.2	3.7	176.0	0.450	4.638	29.52	0.957

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
178	9.11	0.450	176.40	9948.	651.7	0.007516	0.0005391
179	10.11	0.450	176.30	11084.	760.3	0.008374	0.0006290
180	11.61	0.450	176.30	12562.	955.0	0.009490	0.0007900
181	8.11	0.450	176.30	8634.	522.8	0.006523	0.0004325
182	11.11	0.450	176.30	12143.	897.0	0.009174	0.0007421

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
178	0.5016E 00	0.5208E-02	0.3448E-03	0.3879E-08	0.6412E-04	0.7631E-01	0.5473E-02	9834.	627.8
179	0.5589E 00	0.5715E-02	0.1380E-02	0.6363E-07	0.7036E-04	0.8502E-01	0.6386E-02	10944.	731.2
180	0.6334E 00	0.9426E-02	0.7590E-02	0.2043E-05	0.1160E-03	0.9635E-01	0.8021E-02	12390.	915.1
181	0.4354E 00	0.3933E-02	0.1139E-01	0.3797E-05	0.4843E-04	0.6623E-01	0.4391E-02	8516.	497.9
182	0.6123E 00	0.8248E-02	0.8281E-02	0.2389E-05	0.1015E-03	0.9314E-01	0.7534E-02	11977.	859.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.3	2.8	176.3	0.450	4.610	29.52	0.961

OUTPUT DATA IS:

TABLE 10, VGR

BLADE AZIMUTHAL SPACING: 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS: +1°
MACH NUMBER: .523

	AIMP	MACH	RPM	TRST	HP	CT	CQ
191	8.11	0.523	205.10	12048.	922.5	0.006698	0.0004817
192	10.11	0.523	205.10	15733.	1348.6	0.008746	0.0007042
193	9.11	0.523	205.00	14009.	1135.2	0.007788	0.0005928

	CL	CDD	MU	DCQI	CQD	CT/S	CQ/S	TRA	HPA
191	0.4471E 00	0.6667E-02	0.1186E-02	0.4202E-07	0.8208E-04	0.6801E-01	0.4891E-02	11828.	880.2
192	0.5838E 00	0.8767E-02	0.2669E-02	0.2427E-06	0.1079E-03	0.8880E-01	0.7150E-02	15445.	1286.5
193	0.5198E 00	0.7452E-02	0.2670E-02	0.2294E-06	0.9175E-04	0.7907E-01	0.6019E-02	13739.	1081.3

AVERAGES:

TEMP	WIND	RPM	MACH	REND	PRES	DENR
33.0	1.2	205.1	0.523	5.350	29.53	0.962

TABLE 11, VGR

BLADE AZIMUTHAL SPACING: 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
173	8.11	0.450	176.20	7219.	418.9	0.005454	0.0003465
174	10.11	0.450	176.20	9493.	624.7	0.007172	0.0005168
175	11.51	0.450	176.30	11123.	797.6	0.008404	0.0006598
176	11.11	0.450	176.40	10353.	727.5	0.007822	0.0006019
177	9.11	0.450	176.30	8298.	511.6	0.006269	0.0004232

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
173	0.3640E 00	0.4296E-02	0.3107E-02	0.2599E-06	0.5290E-04	0.5537E-01	0.3518E-02	7134.	402.7
174	0.4787E 00	0.6011E-02	0.7940E-02	0.1942E-05	0.7400E-04	0.7282E-01	0.5247E-02	9381.	598.7
175	0.5609E 00	0.7976E-02	0.5175E-02	0.8943E-06	0.9820E-04	0.8532E-01	0.6699E-02	10983.	766.0
176	0.5221E 00	0.7925E-02	0.3448E-02	0.3834E-06	0.9758E-04	0.7941E-01	0.6110E-02	10234.	700.4
177	0.4184E 00	0.4982E-02	0.4830E-02	0.6728E-06	0.6134E-04	0.6365E-01	0.4297E-02	8193.	491.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
31.6	2.4	176.3	0.450	4.620	29.52	0.960

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
183	8.11	0.450	176.40	7185.	428.3	0.005428	0.0003543
184	10.11	0.450	176.40	9565.	633.3	0.007227	0.0005239
185	9.11	0.450	176.40	8467.	536.2	0.006397	0.0004436
186	11.61	0.450	176.30	11409.	822.3	0.008620	0.0006803
187	11.11	0.450	176.40	10951.	761.6	0.008274	0.0006301

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
183	0.3623E 00	0.5097E-02	0.1517E-01	0.6115E-05	0.6275E-04	0.5511E-01	0.3597E-02	7095.	405.1
184	0.4823E 00	0.6182E-02	0.7586E-02	0.1780E-05	0.7611E-04	0.7337E-01	0.5319E-02	9446.	607.5
185	0.4269E 00	0.5738E-02	0.1172E-01	0.3985E-05	0.7064E-04	0.6494E-01	0.4504E-02	8361.	511.4
186	0.5753E 00	0.7872E-02	0.4830E-02	0.7891E-06	0.9692E-04	0.8751E-01	0.6907E-02	11254.	789.2
187	0.5522E 00	0.6615E-02	0.1862E-01	0.1137E-04	0.8145E-04	0.8400E-01	0.6397E-02	10815.	719.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.5	5.7	176.4	0.450	4.608	29.52	0.962

TABLE 12, VGR

BLADE AZIMUTHAL SPACING: 62.1°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
165	11.11	0.523	204.50	15473.	1295.4	0.008602	0.0006764
166	9.11	0.523	204.50	11972.	893.7	0.006656	0.0004667
167	10.11	0.523	204.50	13762.	1128.7	0.007651	0.0005894

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
165	0.5741E 00	0.7704E-02	0.8031E-02	0.2176E-05	0.9485E-04	0.8733E-01	0.6868E-02	15186.	1228.3
166	0.4442E 00	0.5753E-02	0.8923E-02	0.2361E-05	0.7082E-04	0.6757E-01	0.4738E-02	11750.	845.8
167	0.5107E 00	0.8247E-02	0.2147E-01	0.1440E-04	0.1015E-03	0.7768E-01	0.5984E-02	13507.	1047.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
30.0	7.3	204.5	0.523	5.391	29.51	0.957

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
188	8.11	0.523	205.00	9985.	731.8	0.005551	0.0003821
189	9.11	0.523	205.00	11959.	908.2	0.006648	0.0004742
190	10.11	0.523	205.00	13593.	1107.6	0.007557	0.0005784

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
188	0.3705E 00	0.6551E-02	0.7715E-02	0.1612E-05	0.8065E-04	0.5636E-01	0.3880E-02	9800.	694.9
189	0.4437E 00	0.6422E-02	0.1009E-01	0.3013E-05	0.7907E-04	0.6750E-01	0.4815E-02	11737.	860.5
190	0.5044E 00	0.8078E-02	0.1306E-01	0.5370E-05	0.9946E-04	0.7673E-01	0.5872E-02	13339.	1046.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.5	5.9	205.C	0.523	5.356	29.52	0.962

TABLE 12 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
194	8.11	0.523	205.20	9981.	748.2	0.005549	0.0003907
195	9.11	0.523	205.10	11860.	901.8	0.006594	0.0004709

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
194	0.3703E 00	0.7263E-02	0.1601E-01	0.6875E-05	0.8942E-04	0.5633E-01	0.3967E-02	9800.	701.9
195	0.4401E 00	0.6545E-02	0.1008E-01	0.2998E-05	0.8059E-04	0.6694E-01	0.4781E-02	11634.	854.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
33.5	7.4	205.1	0.523	5.343	29.54	0.963

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TABLE 13, VGR

BLADE AZIMUTHAL SPACING: 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
196	11.11	0.450	175.80	11013.	805.0	0.008321	0.0006660
197	8.11	0.450	175.80	7381.	450.5	0.005576	0.0003727
198	10.11	0.450	175.80	9725.	670.1	0.007347	0.0005543
199	12.51	0.450	175.90	12081.	958.5	0.009127	0.0007929
200	9.11	0.450	175.80	8463.	562.6	0.006394	0.0004654

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
196	0.5554E 00	0.9154E-02	0.9342E-02	0.2894E-05	0.1127E-03	0.8448E-01	0.6761E-02	11044.	780.7
197	0.3722E 00	0.5615E-02	0.7266E-02	0.1434E-05	0.6913E-04	0.5661E-01	0.3784E-02	7401.	437.1
198	0.4904E 00	0.7733E-02	0.6228E-02	0.1210E-05	0.9521E-04	0.7460E-01	0.5628E-02	9752.	651.2
199	0.6092E 00	0.1277E-01	0.3458E-03	0.4168E-08	0.1572E-03	0.9267E-01	0.8050E-02	12129.	935.1
200	0.4267E 00	0.7532E-02	0.6920E-03	0.1411E-07	0.9273E-04	0.6491E-01	0.4725E-02	8486.	547.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.0	2.3	175.8	0.450	4.723	29.97	0.941

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
206	10.11	0.450	176.30	10028.	697.2	0.007576	0.0005768
207	9.11	0.450	176.30	8867.	589.0	0.006699	0.0004872
208	12.11	0.450	176.30	12272.	954.8	0.009272	0.0007898
209	8.11	0.450	176.30	7501.	472.3	0.005667	0.0003907
210	11.11	0.450	176.30	11189.	832.1	0.008453	0.0006884

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
206	0.5057E 00	0.7803E-02	0.6900E-03	0.1501E-07	0.9607E-04	0.7692E-01	0.5856E-02	10045.	680.3
207	0.4472E 00	0.7106E-02	0.6900E-03	0.1425E-07	0.8748E-04	0.6802E-01	0.4947E-02	8882.	574.6
208	0.6188E 00	0.1129E-01	0.6900E-03	0.1676E-07	0.1391E-03	0.9413E-01	0.8019E-02	12293.	931.5
209	0.3782E 00	0.6475E-02	0.6900E-03	0.1309E-07	0.7972E-04	0.5753E-01	0.3967E-02	7513.	460.8
210	0.5642E 00	0.9892E-02	0.6900E-03	0.1597E-07	0.1218E-03	0.8582E-01	0.6989E-02	11208.	811.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.0	0.3	176.3	0.450	4.681	29.95	0.947

TABLE 13 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
216	11.11	0.450	176.80	11475.	869.9	0.008669	0.0007196
217	10.11	0.450	176.90	10185.	729.7	0.007695	0.0006036
218	9.11	0.450	176.90	9102.	624.7	0.006877	0.0005168
219	8.11	0.450	176.90	7968.	505.6	0.006020	0.0004183
220	11.71	0.450	176.90	12440.	951.1	0.009398	0.0007868

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
216	0.5786E 00	0.1066E-01	0.6881E-03	0.1617E-07	0.1312E-03	0.8802E-01	0.7306E-02	11501.	851.7
217	0.5136E 00	0.9063E-02	0.6877E-03	0.1502E-07	0.1116E-03	0.7812E-01	0.6128E-02	10210.	714.9
218	0.4590E 00	0.8207E-02	0.6877E-03	0.1442E-07	0.1010E-03	0.6982E-01	0.5247E-02	9125.	612.0
219	0.4018E 00	0.6316E-02	0.6877E-03	0.1338E-07	0.7777E-04	0.6112E-01	0.4247E-02	7988.	495.4
220	0.6273E 00	0.9962E-02	0.6877E-03	0.1686E-07	0.1226E-03	0.9542E-01	0.7989E-02	12457.	930.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
35.0	0.3	176.9	0.450	4.646	29.95	0.953

TABLE 14, VGR

BLADE AZIMUTHAL SPACING: 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
201	8.11	0.523	204.30	10434.	788.4	0.005801	0.0004117
202	9.11	0.523	204.30	12107.	980.5	0.006731	0.0005120
203	11.81	0.523	204.40	16634.	1550.1	0.009248	0.0008094
204	10.11	0.523	204.50	13989.	1183.9	0.007777	0.0006182
205	11.11	0.523	204.50	15572.	1382.4	0.008657	0.0007219

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
201	0.3872E 00	0.7277E-02	0.2977E-03	0.2476E-08	0.8960E-04	0.5890E-01	0.4180E-02	10394.	760.4
202	0.4492E 00	0.8891E-02	0.2977E-03	0.2567E-08	0.1095E-03	0.6833E-01	0.5198E-02	12047.	944.7
203	0.6173E 00	0.1309E-01	0.2976E-03	0.3130E-08	0.1611E-03	0.9389E-01	0.8218E-02	16569.	1495.7
204	0.5191E 00	0.9603E-02	0.0	0.0	0.1182E-03	0.7896E-01	0.6277E-02	13934.	1142.9
205	0.5778E 00	0.1094E-01	0.0	0.0	0.1347E-03	0.8789E-01	0.7329E-02	15510.	1334.5

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.6	0.1	204.4	0.523	5.476	29.95	0.942

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
211	9.11	0.523	204.90	12478.	987.9	0.006937	0.0005159
212	11.11	0.523	204.90	15878.	1390.9	0.008827	0.0007263
213	10.11	0.523	204.90	14113.	1174.2	0.007846	0.0006131
214	11.81	0.523	205.10	16813.	1529.5	0.009347	0.0007987
215	8.11	0.523	205.20	10585.	789.7	0.005885	0.0004124

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
211	0.4630E 00	0.7688E-02	0.2969E-03	0.2837E-08	0.9465E-04	0.7043E-01	0.5237E-02	12424.	955.1
212	0.5892E 00	0.9889E-02	0.5937E-03	0.1200E-07	0.1217E-03	0.8962E-01	0.7374E-02	15809.	1344.8
213	0.5237E 00	0.8650E-02	0.2672E-02	0.2305E-06	0.1065E-03	0.7966E-01	0.6225E-02	14052.	1134.9
214	0.6239E 00	0.1136E-01	0.5931E-03	0.1233E-07	0.1399E-03	0.9490E-01	0.8109E-02	16739.	1480.2
215	0.3928E 00	0.6765E-02	0.2964E-03	0.2491E-08	0.8329E-04	0.5975E-01	0.4187E-02	10538.	764.6

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.5	0.5	205.0	0.523	5.434	29.95	0.948

TABLE 14 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
221	9.11	0.523	205.60	13033.	1056.8	0.007246	0.0005518
222	11.31	0.523	205.70	16742.	1519.3	0.009308	0.0007934
223	11.11	0.523	205.80	16224.	1467.5	0.009020	0.0007663
224	10.11	0.523	205.80	14564.	1252.1	0.008097	0.0006538
225	8.11	0.523	205.80	10959.	841.8	0.006093	0.0004396

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
221	0.4836E 00	0.8304E-02	0.5917E-03	0.1088E-07	0.1022E-03	0.7356E-01	0.5603E-02	12986.	1026.0
222	0.6212E 00	0.1127E-01	0.2957E-03	0.3043E-08	0.1388E-03	0.9450E-01	0.8055E-02	16681.	1475.8
223	0.6020E 00	0.1152E-01	0.8867E-03	0.2721E-07	0.1419E-03	0.9157E-01	0.7780E-02	16164.	1426.1
224	0.5404E 00	0.9967E-02	0.2956E-03	0.3039E-08	0.1227E-03	0.8221E-01	0.6638E-02	14511.	1216.7
225	0.4067E 00	0.7547E-02	0.2956E-03	0.2542E-08	0.9291E-04	0.6186E-01	0.4463E-02	10919.	818.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
35.7	0.3	205.7	0.523	5.390	29.95	0.954

TABLE 15, VGR

BLADE AZIMUTHAL SPACING: 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS: +1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
230	10.91	0.450	177.50	12232.	949.1	0.009242	0.0007852
231	9.11	0.450	177.60	9757.	687.1	0.007372	0.0005684
232	8.11	0.450	177.60	8495.	562.1	0.006418	0.0004650
233	10.11	0.450	177.60	11071.	827.2	0.008364	0.0006843

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
230	0.6168E 00	0.1117E-01	0.6854E-03	0.1671E-07	0.1375E-03	0.9383E-01	0.7972E-02	12264.	933.1
231	0.4920E 00	0.8694E-02	0.6850E-03	0.1480E-07	0.1070E-03	0.7484E-01	0.5771E-02	9783.	676.0
232	0.4284E 00	0.7328E-02	0.6850E-03	0.1381E-07	0.9022E-04	0.6516E-01	0.4721E-02	8517.	553.0
233	0.5583E 00	0.1029E-01	0.3425E-03	0.3856E-08	0.1266E-03	0.8492E-01	0.6948E-02	11101.	813.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
38.9	0.3	177.6	0.450	4.602	29.96	0.960

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
247	9.11	0.450	178.10	9438.	630.1	0.007130	0.0005213
248	10.11	0.450	178.10	10701.	747.4	0.008084	0.0006183
249	11.61	0.450	178.20	12594.	944.7	0.009515	0.0007815
250	8.11	0.450	178.20	8552.	520.4	0.006461	0.0004305
251	11.11	0.450	178.20	11924.	868.3	0.009009	0.0007183

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
247	0.4759E 00	0.6688E-02	0.1400E-01	0.5993E-05	0.8234E-04	0.7239E-01	0.5292E-02	9461.	614.4
248	0.5396E 00	0.7177E-02	0.1059E-01	0.3661E-05	0.8836E-04	0.8208E-01	0.6277E-02	10727.	732.8
249	0.6351E 00	0.8523E-02	0.1297E-01	0.5955E-05	0.1049E-03	0.9660E-01	0.7934E-02	12639.	926.3
250	0.4313E 00	0.4213E-02	0.1843E-01	0.9820E-05	0.5188E-04	0.6560E-01	0.4371E-02	8583.	502.4
251	0.6013E 00	0.7712E-02	0.1502E-01	0.7754E-05	0.9495E-04	0.9147E-01	0.7293E-02	11967.	848.6

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
42.0	7.0	178.2	0.450	4.566	29.96	0.966

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TABLE 16, VGR

BLADE AZIMUTHAL SPACING: 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS: $+1^{\circ}$
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
226	10.11	0.523	206.00	15632.	1379.6	0.008691	0.0007204
227	8.11	0.523	206.10	11912.	940.9	0.006623	0.0004913
228	10.11	0.523	206.10	15477.	1380.9	0.008604	0.0007211
229	9.11	0.523	206.20	13766.	1151.9	0.007653	0.0006015

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
226	0.5801E 00	0.1054E-01	0.2953E-03	0.3063E-08	0.1298E-03	0.8823E-01	0.7314E-02	15577.	1342.1
227	0.4420E 00	0.7997E-02	0.2951E-03	0.2763E-08	0.9846E-04	0.6724E-01	0.4988E-02	11882.	916.7
228	0.5743E 00	0.1131E-01	0.2951E-03	0.2913E-08	0.1392E-03	0.8736E-01	0.7321E-02	15421.	1343.9
229	0.5108E 00	0.9216E-02	0.2950E-03	0.2851E-08	0.1135E-03	0.7770E-01	0.6107E-02	13716.	1121.6

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
37.4	0.2	206.1	0.523	5.368	29.95	0.957

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
243	10.61	0.523	207.00	15893.	1375.7	0.008836	0.0007184
244	8.11	0.523	207.00	11536.	864.0	0.006414	0.0004512
245	10.11	0.523	207.00	15193.	1287.8	0.008446	0.0006725
246	9.11	0.523	207.10	13313.	1076.3	0.007401	0.0005620

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
243	0.5897E 00	0.9174E-02	0.1264E-01	0.5445E-05	0.1129E-03	0.8971E-01	0.7294E-02	15835.	1334.5
244	0.4281E 00	0.5232E-02	0.2351E-02	0.1614E-06	0.7673E-04	0.6512E-01	0.4580E-02	11494.	844.2
245	0.5638E 00	0.8658E-02	0.4995E-02	0.8355E-06	0.1066E-03	0.8575E-01	0.6828E-02	15137.	1257.2
246	0.4940E 00	0.7949E-02	0.1410E-01	0.6190E-05	0.9787E-04	0.7514E-01	0.5706E-02	13277.	1042.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
42.0	4.9	207.0	0.523	5.305	29.96	0.966

TABLE 17, VGR

BLADE AZIMUTHAL SPACING: 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
238	10.11	0.450	177.90	9874.	687.7	0.007460	0.0005689
239	8.11	0.450	177.90	7398.	459.1	0.005590	0.0003798
240	11.51	0.450	177.90	11601.	876.8	0.008765	0.0007253
241	11.11	0.450	177.90	11008.	822.0	0.008317	0.0006800
242	9.11	0.450	178.00	8583.	567.9	0.006485	0.0004698

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
238	0.4979E 00	0.8064E-02	0.3419E-03	0.3779E-08	0.9928E-04	0.7573E-01	0.5776E-02	9893.	677.3
239	0.3721E 00	0.6102E-02	0.6838E-03	0.1291E-07	0.7513E-04	0.5675E-01	0.3856E-02	7413.	452.1
240	0.5850E 00	0.1033E-01	0.6838E-03	0.1604E-07	0.1272E-03	0.8899E-01	0.7364E-02	11624.	863.5
241	0.5551E 00	0.1032E-01	0.6838E-03	0.1572E-07	0.1271E-03	0.8444E-01	0.6904E-02	11030.	809.5
242	0.4328E 00	0.7239E-02	0.6835E-03	0.1377E-07	0.8312E-04	0.6584E-01	0.4770E-02	8601.	559.7

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
41.1	0.3	177.9	0.450	4.574	29.96	0.964

TABLE 18, VGR

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
234	8.11	0.523	206.60	10413.	787.4	0.005789	0.0004112
235	11.11	0.523	206.60	15625.	1399.7	0.008687	0.0007309
236	9.11	0.523	206.70	12358.	990.8	0.006871	0.0005174
237	10.11	0.523	206.70	13914.	1169.1	0.007736	0.0006105

BLADE AZIMUTHAL SPACING: 34.4°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .523

	CI	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
234	0.3864E 00	0.7316E-02	0.2944E-03	0.2584E-08	0.9008E-04	0.5879E-01	0.4175E-02	10376.	768.3
235	0.5798E 00	0.1143E-01	0.2944E-03	0.2920E-08	0.1407E-03	0.8819E-01	0.7421E-02	15570.	1365.7
236	0.4586E 00	0.8306E-02	0.2943E-03	0.2697E-08	0.1023E-03	0.6976E-01	0.5253E-02	12314.	967.2
237	0.5163E 00	0.9303E-02	0.2943E-03	0.2868E-08	0.1145E-03	0.7854E-01	0.6198E-02	13865.	1141.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
40.3	0.2	206.6	0.523	5.329	29.96	0.963

TABLE 19, VGR

BLADE AZIMUTHAL SPACING: 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
252	11.11	0.450	174.00	11147.	818.0	0.008422	0.0006767
253	8.11	0.450	174.10	7511.	470.5	0.005675	0.0003893
254	10.11	0.450	174.10	9866.	694.7	0.007454	0.0005747
255	11.81	0.450	174.20	11989.	916.0	0.009058	0.0007578
256	9.11	0.450	174.20	8841.	593.3	0.006680	0.0004908

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
252	0.5621E 00	0.9217E-02	0.3496E-03	0.4265E-08	0.1134E-03	0.8550E-01	0.6871E-02	11246.	793.4
253	0.3788E 00	0.6304E-02	0.3494E-03	0.3381E-08	0.7762E-04	0.5762E-01	0.3952E-02	7579.	456.6
254	0.4975E 00	0.8573E-02	0.3494E-03	0.3859E-08	0.1056E-03	0.7568E-01	0.5834E-02	9954.	674.2
255	0.6046E 00	0.1050E-01	0.3492E-03	0.4420E-08	0.1293E-03	0.9196E-01	0.7693E-02	12098.	889.6
256	0.4458E 00	0.7540E-02	0.3492E-03	0.3558E-08	0.9284E-04	0.6782E-01	0.4983E-02	8921.	576.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
19.6	0.2	174.1	0.450	4.872	30.14	0.917

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
262	10.11	0.450	174.20	10226.	719.0	0.007726	0.0005948
263	9.11	0.450	174.20	9023.	595.4	0.006817	0.0004926
264	11.81	0.450	174.20	12199.	927.3	0.009216	0.0007671
265	8.11	0.450	174.30	7759.	471.5	0.005862	0.0003900
266	11.11	0.450	174.20	11763.	868.8	0.008887	0.0007187

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
262	0.5157E 00	0.8100E-02	0.3330E-08	0.0	0.9973E-04	0.7844E-01	0.6039E-02	10310.	697.6
263	0.4550E 00	0.6684E-02	0.3492E-02	0.3668E-06	0.8230E-04	0.6921E-01	0.5001E-02	9196.	577.3
264	0.6151E 00	0.9922E-02	0.3330E-08	0.1538E-09	0.1222E-03	0.9357E-01	0.7789E-02	12298.	899.8
265	0.3912E 00	0.5108E-02	0.3328E-08	0.0	0.6289E-04	0.5951E-01	0.3960E-02	7831.	458.3
266	0.5932E 00	0.8767E-02	0.3330E-08	0.1456E-09	0.1079E-03	0.9023E-01	0.7297E-02	11859.	843.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
20.5	0.3	174.2	0.450	4.859	30.15	0.919

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
272	11.11	0.450	174.70	11339.	834.8	0.008567	0.0006906
273	10.11	0.450	174.70	10059.	697.9	0.007600	0.0005774
274	9.11	0.450	174.70	8805.	583.0	0.006652	0.0004823
275	8.11	0.450	174.80	7721.	478.0	0.005833	0.0003955
276	12.11	0.450	174.70	12312.	946.8	0.009302	0.0007832

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
272	0.5718E 00	0.9143E-02	0.3321E-08	0.0	0.1126E-03	0.8698E-01	0.7011E-02	11439.	812.9
273	0.5073E 00	0.7667E-02	0.3482E-03	0.4030E-08	0.9439E-04	0.7716E-01	0.5862E-02	10148.	679.6
274	0.4440E 00	0.7051E-02	0.3482E-03	0.3654E-08	0.8681E-04	0.6754E-01	0.4897E-02	8883.	567.7
275	0.3893E 00	0.5740E-02	0.3480E-03	0.3426E-08	0.7067E-04	0.5922E-01	0.4015E-02	7798.	466.3
276	0.6208E 00	0.1050E-01	0.3482E-03	0.4444E-08	0.1293E-03	0.9444E-01	0.7952E-02	12421.	921.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
23.0	0.1	174.7	0.450	4.828	30.15	0.923

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
320	11.11	0.450	175.80	11068.	802.7	0.008362	0.0006641
321	8.11	0.450	175.80	7716.	459.2	0.005830	0.0003798
322	10.11	0.450	175.90	9880.	676.6	0.007465	0.0005598
323	12.21	0.450	175.90	12206.	930.8	0.009222	0.0007700
324	9.11	0.450	175.80	8714.	576.5	0.006583	0.0004769

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
320	0.5581E 00	0.8659E-02	0.3300E-08	0.0	0.1066E-03	0.8490E-01	0.6742E-02	11168.	786.7
321	0.3891E 00	0.4498E-02	0.3300E-08	0.0	0.5538E-04	0.5919E-01	0.3856E-02	7786.	450.0
322	0.4982E 00	0.7279E-02	0.6916E-03	0.1516E-07	0.8962E-04	0.7578E-01	0.5683E-02	9981.	664.2
323	0.6155E 00	0.1010E-01	0.3458E-03	0.4310E-08	0.1244E-03	0.9363E-01	0.7817E-02	12330.	913.7
324	0.4394E 00	0.7106E-02	0.6920E-03	0.1432E-07	0.8749E-04	0.6684E-01	0.4842E-02	8793.	564.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.0	0.2	175.8	0.450	4.753	30.15	0.935

TABLE 20, VGR

BLADE AZIMUTHAL SPACING: 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
257	8.11	0.523	202.40	10839.	824.6	0.006026	0.0004306
258	9.11	0.523	202.40	12436.	1004.0	0.006914	0.0005243
259	11.71	0.523	202.50	16998.	1551.7	0.009450	0.0008103
260	10.11	0.523	202.50	14215.	1208.2	0.007903	0.0006309
261	11.11	0.523	202.50	15967.	1413.6	0.008877	0.0007382

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
257	0.4022E 00	0.7281E-02	0.2866E-08	0.0	0.8964E-04	0.6118E-01	0.4372E-02	10864.	792.9
258	0.4615E 00	0.8543E-02	0.2866E-08	0.1249E-09	0.1052E-03	0.7019E-01	0.5323E-02	12465.	965.3
259	0.6307E 00	0.1142E-01	0.2865E-08	0.0	0.1406E-03	0.9594E-01	0.8227E-02	17037.	1492.6
260	0.5275E 00	0.9648E-02	0.2865E-08	0.0	0.1188E-03	0.8023E-01	0.6405E-02	14247.	1162.2
261	0.5925E 00	0.1044E-01	0.2865E-08	0.1454E-09	0.1285E-03	0.9012E-01	0.7495E-02	16004.	1359.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
20.3	0.0	202.5	0.523	5.650	30.14	0.919

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
267	9.11	0.523	202.60	12474.	989.2	0.006935	0.0005166
268	11.11	0.523	202.70	15962.	1405.6	0.008874	0.0007340
269	10.11	0.523	202.70	14123.	1188.2	0.007852	0.0006205
270	11.61	0.523	202.70	16726.	1514.5	0.009299	0.0007908
271	8.11	0.523	202.80	11084.	835.7	0.006162	0.0004364

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
267	0.4629E 00	0.7764E-02	0.2863E-08	0.1255E-09	0.9559E-04	0.7041E-01	0.5245E-02	12504.	952.2
268	0.5923E 00	0.1012E-01	0.2862E-08	0.0	0.1246E-03	0.9009E-01	0.7452E-02	16017.	1355.0
269	0.5241E 00	0.9200E-02	0.2862E-08	0.0	0.1133E-03	0.7972E-01	0.6299E-02	14157.	1144.2
270	0.6206E 00	0.1114E-01	0.2862E-08	0.0	0.1372E-03	0.9441E-01	0.8029E-02	16766.	1458.4
271	0.4113E 00	0.6805E-02	0.2860E-08	0.0	0.8378E-04	0.6256E-01	0.4430E-02	11110.	805.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
21.4	0.0	202.7	0.523	5.634	30.15	0.920

TABLE 20 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
277	9.11	0.523	203.00	12708.	1014.1	0.007065	0.0005296
278	11.31	0.523	203.10	16452.	1481.8	0.009146	0.0007738
279	11.11	0.523	203.10	15989.	1414.5	0.008889	0.0007386
280	10.11	0.523	203.20	14291.	1204.9	0.007945	0.0006292
281	8.11	0.523	203.20	10895.	819.4	0.006057	0.0004279

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
277	0.4715E 00	0.7854E-02	0.2858E-08	0.1032E-09	0.9669E-04	0.7173E-01	0.5377E-02	12743.	978.4
278	0.6105E 00	0.1106E-01	0.2856E-08	0.1520E-09	0.1361E-03	0.9286E-01	0.7856E-02	16514.	1431.7
279	0.5933E 00	0.1037E-01	0.2856E-08	0.0	0.1277E-03	0.9025E-01	0.7499E-02	16049.	1366.7
280	0.5303E 00	0.9172E-02	0.2855E-08	0.0	0.1129E-03	0.8066E-01	0.6388E-02	14344.	1164.7
281	0.4043E 00	0.6844E-02	0.2855E-08	0.0	0.8426E-04	0.6149E-01	0.4344E-02	10935.	792.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
23.2	0.0	203.1	0.523	5.611	30.16	0.923

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
325	8.11	0.523	204.30	10673.	790.9	0.005934	0.0004130
326	9.11	0.523	204.30	12373.	966.2	0.006879	0.0005046
327	11.61	0.523	204.30	16494.	1472.5	0.009170	0.0007689
328	10.11	0.523	204.30	13815.	1152.0	0.007680	0.0006016
329	11.11	0.523	204.40	15371.	1336.8	0.008545	0.0006981

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
325	0.3960E 00	0.6483E-02	0.2084E-02	0.1220E-06	0.7982E-04	0.6024E-01	0.4193E-02	10703.	767.7
326	0.4591E 00	0.7202E-02	0.2839E-08	0.0	0.8868E-04	0.6984E-01	0.5123E-02	12407.	938.2
327	0.6120E 00	0.1047E-01	0.2839E-08	0.0	0.1288E-03	0.9310E-01	0.7807E-02	16540.	1429.7
328	0.5126E 00	0.9007E-02	0.2839E-08	0.1170E-09	0.1109E-03	0.7798E-01	0.6107E-02	13854.	1118.5
329	0.5704E 00	0.9927E-02	0.2838E-08	0.1373E-09	0.1222E-03	0.8676E-01	0.7087E-02	15429.	1299.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.0	0.2	204.3	0.523	5.523	30.15	0.935

TABLE 21, VGR

BLADE AZIMUTHAL SPACING: 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS: +1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
286	11.11	0.450	175.00	11908.	891.8	0.008997	0.0007378
287	9.11	0.450	175.10	9403.	630.4	0.007104	0.0005215
288	8.11	0.450	175.10	8364.	521.0	0.006319	0.0004310
289	10.11	0.450	175.10	10845.	753.5	0.008193	0.0006233

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
286	0.6005E 00	0.9397E-02	0.6952E-03	0.1676E-07	0.1157E-03	0.9134E-01	0.7490E-02	12033.	871.3
287	0.4741E 00	0.6906E-02	0.3474E-03	0.3668E-08	0.8503E-04	0.7212E-01	0.5295E-02	9503.	616.3
288	0.4218E 00	0.5267E-02	0.4169E-02	0.5032E-06	0.6484E-04	0.6415E-01	0.4376E-02	8444.	503.3
289	0.5469E 00	0.6714E-02	0.3474E-03	0.4060E-08	0.8267E-04	0.8319E-01	0.6328E-02	10949.	735.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
24.6	0.7	175.1	0.450	4.811	30.16	0.926

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
305	9.11	0.450	175.50	9520.	634.2	0.007193	0.0005247
306	10.11	0.450	175.60	10736.	765.6	0.008111	0.0006334
307	11.41	0.450	175.60	12168.	912.3	0.009193	0.0007547
308	8.11	0.450	175.70	8222.	517.8	0.006212	0.0004284
309	11.11	0.450	175.60	11899.	886.1	0.008990	0.0007331

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
305	0.4801E 00	0.6496E-02	0.3466E-03	0.3711E-08	0.7998E-04	0.7303E-01	0.5327E-02	9606.	620.5
306	0.5414E 00	0.8188E-02	0.3464E-03	0.4031E-08	0.1008E-03	0.8235E-01	0.6430E-02	10846.	750.3
307	0.6136E 00	0.9113E-02	0.3464E-03	0.4328E-08	0.1122E-03	0.9333E-01	0.7663E-02	12292.	894.1
308	0.4146E 00	0.5808E-02	0.3462E-03	0.3531E-08	0.7150E-04	0.6307E-01	0.4349E-02	8315.	508.4
309	0.6000E 00	0.9073E-02	0.3464E-03	0.4370E-08	0.1117E-03	0.9127E-01	0.7442E-02	12008.	867.5

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
27.6	0.2	175.6	0.450	4.772	30.16	0.932

TABLE 22, VGR

BLADE AZIMUTHAL SPACING: 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS: $+1^{\circ}$
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
282	10.11	0.523	203.30	14978.	1290.8	0.008327	0.0006741
283	8.11	0.523	203.30	11504.	1018.7	0.006395	0.0005320
284	10.61	0.523	203.30	15828.	1390.3	0.008799	0.0007260
285	9.11	0.523	203.40	13255.	1075.5	0.007369	0.0005616

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
282	0.5558E 00	0.9755E-02	0.2853E-08	0.0	0.1201E-03	0.8454E-01	0.6843E-02	15035.	1248.4
283	0.4269E 00	0.1292E-01	0.2853E-08	0.0	0.1591E-03	0.6493E-01	0.5401E-02	11547.	985.2
284	0.5873E 00	0.1009E-01	0.2853E-08	0.0	0.1243E-03	0.8934E-01	0.7371E-02	15888.	1344.6
285	0.4919E 00	0.8158E-02	0.2852E-08	0.1099E-09	0.1004E-03	0.7482E-01	0.5702E-02	13305.	1040.6

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
24.1	0.0	203.3	0.523	5.598	30.17	0.925

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
300	11.11	0.523	203.90	16027.	1433.0	0.008910	0.0007483
301	8.11	0.523	203.90	11497.	868.3	0.006392	0.0004534
302	10.11	0.523	203.90	14972.	1286.6	0.008324	0.0006718
303	9.11	0.523	204.00	12784.	1052.4	0.007107	0.0005496
304	10.61	0.523	204.00	16183.	1400.7	0.008997	0.0007315

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
300	0.5947E 00	0.1098E-01	0.2845E-08	0.0	0.1352E-03	0.9046E-01	0.7597E-02	16081.	1389.5
301	0.4266E 00	0.6571E-02	0.2845E-08	0.0	0.8091E-04	0.6489E-01	0.4603E-02	11536.	841.9
302	0.5556E 00	0.9606E-02	0.2845E-08	0.1320E-09	0.1183E-03	0.8451E-01	0.6821E-02	15022.	1247.5
303	0.4744E 00	0.9159E-02	0.2844E-08	0.0	0.1128E-03	0.7216E-01	0.5580E-02	12827.	1020.9
304	0.6005E 00	0.8883E-02	0.3280E-02	0.3719E-06	0.1094E-03	0.9134E-01	0.7426E-02	16237.	1358.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
27.2	0.4	203.9	0.523	5.551	30.16	0.931

TABLE 23, VGR

BLADE AZIMUTHAL SPACING: 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
295	10.11	0.450	175.20	9292.	634.4	0.007020	0.0005248
296	8.11	0.450	175.20	6936.	424.4	0.005241	0.0003511
297	12.01	0.450	175.30	11492.	866.1	0.008682	0.0007165
298	11.11	0.450	175.40	10354.	738.9	0.007822	0.0006113
299	9.11	0.450	175.40	8206.	529.6	0.006200	0.0004381

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
295	0.4685E 00	0.7801E-02	0.3472E-03	0.3757E-08	0.9604E-04	0.7127E-01	0.5328E-02	9374.	619.5
296	0.3498E 00	0.6056E-02	0.3472E-03	0.3346E-08	0.7456E-04	0.5321E-01	0.3565E-02	6998.	414.5
297	0.5795E 00	0.1030E-01	0.3470E-03	0.4183E-08	0.1268E-03	0.8815E-01	0.7275E-02	11594.	846.3
298	0.5221E 00	0.8638E-02	0.3468E-03	0.3968E-08	0.1070E-03	0.7942E-01	0.6206E-02	10458.	723.3
299	0.4138E 00	0.6681E-02	0.3468E-03	0.3627E-08	0.8226E-04	0.6295E-01	0.4448E-02	8289.	518.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.3	0.2	175.3	0.450	4.788	30.17	0.929

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
315	8.11	0.448	175.00	7263.	434.6	0.005487	0.0003595
316	10.11	0.450	175.80	9218.	629.7	0.006964	0.0005209
317	9.11	0.450	175.80	8041.	520.4	0.006075	0.0004305
318	12.11	0.450	175.80	11470.	871.2	0.008666	0.0007207
319	11.11	0.450	175.80	10267.	735.8	0.007757	0.0006087

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
315	0.3662E 00	0.5133E-02	0.3476E-03	0.3320E-08	0.6320E-04	0.5571E-01	0.3650E-02	7263.	420.1
316	0.4648E 00	0.7898E-02	0.3460E-03	0.3864E-08	0.9724E-04	0.7071E-01	0.5289E-02	9302.	617.2
317	0.4055E 00	0.6932E-02	0.3460E-03	0.3498E-08	0.8534E-04	0.6168E-01	0.4371E-02	8115.	510.1
318	0.5784E 00	0.1078E-01	0.3460E-03	0.4171E-08	0.1327E-03	0.8798E-01	0.7317E-02	11575.	853.9
319	0.5177E 00	0.8992E-02	0.3460E-03	0.4067E-08	0.1107E-03	0.7875E-01	0.6180E-02	10361.	721.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
29.0	0.2	175.6	0.450	4.748	30.16	0.935

TABLE 24. VGR

BLADE AZIMUTHAL SPACING: 43.6°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
290	8.11	0.523	203.60	9865.	718.8	0.005484	0.0003754
291	11.91	0.523	203.50	16026.	1431.5	0.008910	0.0007475
292	11.11	0.523	203.50	14585.	1256.0	0.008108	0.0006559
293	9.11	0.523	203.70	11523.	906.8	0.006406	0.0004735
294	10.11	0.523	203.70	12939.	1061.5	0.007193	0.0005543

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
290	0.3661E 00	0.6440E-02	0.2849E-08	0.1059E-09	0.7929E-04	0.5568E-01	0.3811E-02	9908.	696.7
291	0.5947E 00	0.1092E-01	0.2851E-08	0.0	0.1344E-03	0.9046E-01	0.7589E-02	16081.	1385.3
292	0.5412E 00	0.1004E-01	0.2851E-08	0.1269E-09	0.1236E-03	0.8232E-01	0.6659E-02	14635.	1215.5
293	0.4276E 00	0.8103E-02	0.2986E-03	0.2718E-08	0.9977E-04	0.6504E-01	0.4808E-02	11561.	878.4
294	0.4801E 00	0.8899E-02	0.2986E-03	0.2651E-08	0.1096E-03	0.7303E-01	0.5628E-02	12982.	1028.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
25.4	0.1	203.6	0.523	5.578	30.16	0.928

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
310	10.11	0.523	204.20	13289.	1087.7	0.007388	0.0005680
311	11.11	0.523	204.10	14821.	1266.7	0.008240	0.0006615
312	8.11	0.523	204.10	9697.	707.1	0.005391	0.0003693
313	9.11	0.523	204.20	11603.	889.6	0.006451	0.0004645
314	12.01	0.523	204.30	16170.	1431.9	0.008990	0.0007477

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
310	0.4931E 00	0.8536E-02	0.2841E-08	0.1104E-09	0.1051E-03	0.7501E-01	0.5767E-02	13344.	1057.0
311	0.5500E 00	0.9441E-02	0.2842E-08	0.0	0.1162E-03	0.8365E-01	0.6716E-02	14867.	1229.1
312	0.3598E 00	0.6555E-02	0.2842E-08	0.0	0.8070E-04	0.5473E-01	0.3749E-02	9728.	686.2
313	0.4306E 00	0.7055E-02	0.2841E-08	0.0	0.8686E-04	0.6549E-01	0.4716E-02	11639.	863.6
314	0.6000E 00	0.1026E-01	0.2977E-03	0.3222E-08	0.1263E-03	0.9127E-01	0.7591E-02	16236.	1392.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
28.2	0.0	204.2	0.523	5.537	30.16	0.933

TABLE 25. VGR

BLADE AZIMUTHAL SPACING: 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
330	11.11	0.450	177.40	11988.	881.9	0.009057	0.0007296
331	8.11	0.450	177.40	8404.	504.7	0.006349	0.0004175
332	10.11	0.450	177.40	11015.	739.5	0.008322	0.0006118
333	11.31	0.450	177.40	12321.	918.2	0.009309	0.0007596
334	9.11	0.450	177.50	9647.	635.5	0.007289	0.0005257

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
330	0.6045E 00	0.8221E-02	0.9944E-02	0.3420E-05	0.1012E-03	0.9195E-01	0.7407E-02	12096.	868.1
331	0.4238E 00	0.3955E-02	0.1166E-01	0.3926E-05	0.4870E-04	0.6446E-01	0.4239E-02	8480.	494.4
332	0.5555E 00	0.4736E-02	0.1509E-01	0.7516E-05	0.5831E-04	0.8449E-01	0.6211E-02	11115.	722.4
333	0.6213E 00	0.8522E-02	0.1852E-01	0.1194E-04	0.1049E-03	0.9451E-01	0.7712E-02	12432.	893.8
334	0.4865E 00	0.5857E-02	0.2022E-01	0.1254E-04	0.7211E-04	0.7400E-01	0.5338E-02	9746.	514.5

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
38.0	7.4	177.4	0.450	4.642	30.16	0.952

1

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
335	10.33	0.450	175.20	11649.	897.2	0.008801	0.0007422
336	7.68	0.450	175.30	8187.	537.3	0.006186	0.0004445
337	9.57	0.450	175.30	10605.	786.1	0.008012	0.0006503
338	8.62	0.450	175.30	9409.	658.8	0.007108	0.0005450

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
335	0.5874E 00	0.1140E-01	0.4861E-02	0.8074E-06	0.1403E-03	0.8936E-01	0.7535E-02	11824.	880.5
336	0.4129E 00	0.7299E-02	0.1249E-01	0.4445E-05	0.8987E-04	0.6280E-01	0.4513E-02	8311.	523.0
337	0.5348E 00	0.1036E-01	0.1145E-01	0.4260E-05	0.1276E-03	0.8134E-01	0.6603E-02	10765.	767.8
338	0.4745E 00	0.8783E-02	0.8328E-02	0.2126E-05	0.1081E-03	0.7217E-01	0.5534E-02	9551.	645.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
26.4	4.5	175.3	0.450	4.815	30.35	0.924

TABLE 25 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
343	9.57	0.450	175.50	10421.	754.2	0.007873	0.0006239
344	8.62	0.450	175.60	9351.	645.9	0.007065	0.0005344
345	10.52	0.450	175.70	11704.	895.4	0.008842	0.0007407
346	7.68	0.450	175.60	7952.	516.8	0.006008	0.0004276

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
343	0.5255E 00	0.9314E-02	0.6932E-03	0.1554E-07	0.1147E-03	0.7993E-01	0.6335E-02	10581.	742.5
344	0.4716E 00	0.8239E-02	0.5889E-02	0.1061E-05	0.1014E-03	0.7173E-01	0.5425E-02	9496.	635.1
345	0.5902E 00	0.1093E-01	0.1039E-02	0.3714E-07	0.1346E-03	0.8977E-01	0.7520E-02	11898.	883.6
346	0.4010E 00	0.7154E-02	0.1039E-02	0.3064E-07	0.8808E-04	0.6100E-01	0.4341E-02	8075.	509.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
27.9	1.1	175.6	0.450	4.797	30.35	0.927

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
351	10.33	0.450	176.00	11779.	888.0	0.008899	0.0007346
352	9.57	0.450	176.00	10559.	763.4	0.007977	0.0006315
353	8.62	0.450	176.10	9404.	645.7	0.007105	0.0005341
354	7.68	0.450	176.10	8116.	527.2	0.006132	0.0004362

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
351	0.5940E 00	0.9962E-02	0.6912E-03	0.1663E-07	0.1227E-03	0.9035E-01	0.7459E-02	11966.	877.2
352	0.5324E 00	0.9111E-02	0.6912E-03	0.1566E-07	0.1122E-03	0.8099E-01	0.6412E-02	10726.	754.1
353	0.4742E 00	0.7927E-02	0.6908E-03	0.1478E-07	0.9759E-04	0.7213E-01	0.5423E-02	9564.	638.9
354	0.4093E 00	0.6994E-02	0.6908E-03	0.1383E-07	0.8612E-04	0.6226E-01	0.4428E-02	8246.	521.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
30.1	0.3	176.0	0.450	4.770	30.35	0.931

TABLE 26, VGR

BLADE AZIMUTHAL SPACING: 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS: 0°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
339	7.68	0.523	203.90	11539.	914.1	0.006415	0.0004773
340	8.62	0.523	203.90	13356.	1114.0	0.007425	0.0005817
341	10.14	0.523	203.80	16212.	1465.1	0.009013	0.0007651
342	9.57	0.523	203.90	14686.	1280.3	0.008165	0.0006686

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
339	0.4282E 00	0.8350E-02	0.3580E-02	0.3740E-06	0.1028E-03	0.6513E-01	0.4846E-02	11649.	891.1
340	0.4956E 00	0.9367E-02	0.5966E-03	0.1123E-07	0.1153E-03	0.7538E-01	0.5906E-02	13484.	1086.8
341	0.6016E 00	0.1148E-01	0.3582E-02	0.4439E-06	0.1413E-03	0.9151E-01	0.7768E-02	16351.	1426.4
342	0.5450E 00	0.1062E-01	0.5370E-02	0.9490E-06	0.1307E-03	0.8289E-01	0.6788E-02	14827.	1247.3

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
27.0	1.9	203.9	0.523	5.588	30.35	0.925

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
347	8.62	0.523	204.10	13246.	1079.8	0.007364	0.0005639
348	10.33	0.523	204.20	16302.	1463.8	0.009063	0.0007644
349	9.57	0.523	204.20	14910.	1285.3	0.008289	0.0006712
350	7.68	0.523	204.20	11301.	882.0	0.006283	0.0004606

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
347	0.4915E 00	0.8380E-02	0.5961E-03	0.1131E-07	0.1032E-03	0.7477E-01	0.5725E-02	13371.	1054.3
348	0.6049E 00	0.1100E-01	0.5958E-03	0.1245E-07	0.1354E-03	0.9201E-01	0.7761E-02	16471.	1431.3
349	0.5533E 00	0.9830E-02	0.5958E-03	0.1187E-07	0.1210E-03	0.8416E-01	0.6814E-02	15050.	1255.5
350	0.4194E 00	0.7922E-02	0.5958E-03	0.1032E-07	0.9754E-04	0.6379E-01	0.4676E-02	11407.	861.5

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
28.3	0.3	204.2	0.523	5.570	30.35	0.927

TABLE 26 Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
355	8.62	0.523	204.70	13424.	1088.7	0.007463	0.0005685
356	10.33	0.523	204.70	16393.	1462.8	0.009114	0.0007639
357	9.57	0.523	204.70	14857.	1275.1	0.008260	0.0006659
358	7.68	0.523	204.80	11632.	891.3	0.006467	0.0004654

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
355	0.4981E 00	0.8004E-02	0.2972E-03	0.2689E-08	0.9854E-04	0.7577E-01	0.5772E-02	13548.	1066.0
356	0.6083E 00	0.1053E-01	0.2972E-03	0.3251E-08	0.1296E-03	0.9253E-01	0.7755E-02	16545.	1432.3
357	0.5513E 00	0.9637E-02	0.2972E-03	0.2838E-08	0.1187E-03	0.8386E-01	0.6760E-02	14995.	1248.6
358	0.4316E 00	0.7013E-02	0.2970E-03	0.2734E-08	0.8635E-04	0.6566E-01	0.4726E-02	11740.	873.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
31.1	0.2	204.7	0.523	5.528	30.35	0.933

TABLE 27, VGR

BLADE AZIMUTHAL SPACING: 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS: +1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
363	10.52	0.450	176.30	12520.	961.7	0.009459	0.0007956
364	8.62	0.450	176.30	9875.	688.5	0.007461	0.0005696
365	7.68	0.450	176.30	8654.	571.5	0.006538	0.0004728
366	9.57	0.450	176.30	11121.	814.2	0.008402	0.0006736

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
363	0.6314E 00	0.1015E-01	0.6900E-03	0.1691E-07	0.1249E-03	0.9604E-01	0.8077E-02	12716.	951.3
364	0.4980E 00	0.8106E-02	0.6900E-03	0.1504E-07	0.9981E-04	0.7575E-01	0.5783E-02	10029.	681.1
365	0.4364E 00	0.7096E-02	0.6900E-03	0.1406E-07	0.8737E-04	0.6638E-01	0.4800E-02	8789.	565.3
366	0.5608E 00	0.9106E-02	0.6900E-03	0.1580E-07	0.1121E-03	0.8531E-01	0.6838E-02	11295.	805.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
32.0	0.3	176.3	0.450	4.746	30.36	0.934

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
378	8.62	0.450	177.20	10131.	702.4	0.007654	0.0005811
379	9.57	0.450	177.20	11505.	843.3	0.008692	0.0006976
380	10.52	0.450	177.20	12356.	948.9	0.009335	0.0007850
381	7.68	0.450	177.30	8986.	577.2	0.006789	0.0004775

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
378	0.5109E 00	0.7544E-02	0.1030E-02	0.3387E-07	0.9289E-04	0.7771E-01	0.5899E-02	10291.	698.4
379	0.5801E 00	0.8683E-02	0.6865E-03	0.1599E-07	0.1069E-03	0.8825E-01	0.7083E-02	11686.	838.6
380	0.6231E 00	0.1035E-01	0.6865E-03	0.1666E-07	0.1274E-03	0.9478E-01	0.7969E-02	12538.	942.6
381	0.4531E 00	0.5661E-02	0.1098E-01	0.3604E-05	0.6970E-04	0.6893E-01	0.4848E-02	9129.	570.0

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
37.3	1.6	177.2	0.450	4.682	30.36	0.944

TABLE 28, VGR

BLADE AZIMUTHAL SPACING: 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS: +1°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
359	9.57	0.523	204.80	16008.	1390.9	0.008899	0.0007263
360	7.68	0.523	204.80	12424.	970.9	0.006907	0.0005070
361	9.76	0.523	204.80	16161.	1436.0	0.008985	0.0007498
362	8.62	0.523	204.90	13844.	1166.3	0.007696	0.0006090

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
359	0.5940E 00	0.9284E-02	0.2970E-03	0.3064E-08	0.1143E-03	0.9035E-01	0.7374E-02	16158.	1362.7
360	0.4610E 00	0.7191E-02	0.2970E-03	0.2719E-08	0.8853E-04	0.7013E-01	0.5147E-02	12541.	951.2
361	0.5997E 00	0.1048E-01	0.2970E-03	0.3071E-08	0.1290E-03	0.9122E-01	0.7613E-02	16313.	1406.9
362	0.5137E 00	0.9490E-02	0.2969E-03	0.2728E-08	0.1168E-03	0.7814E-01	0.6183E-02	13987.	1144.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
31.5	0.2	204.8	0.523	5.524	30.36	0.933

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
375	8.57	0.523	205.90	15682.	1363.3	0.008718	0.0007119
376	8.62	0.523	205.80	13958.	1141.4	0.007760	0.0005960
377	7.68	0.523	205.90	12321.	953.7	0.006850	0.0005006

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
375	0.5819E 00	0.9625E-02	0.8863E-03	0.2688E-07	0.1185E-03	0.8851E-01	0.7228E-02	15858.	1345.2
376	0.5179E 00	0.7937E-02	0.5911E-03	0.1126E-07	0.9773E-04	0.7878E-01	0.6051E-02	14101.	1124.6
377	0.4572E 00	0.7094E-02	0.2363E-02	0.1686E-06	0.8734E-04	0.6955E-01	0.5083E-02	12447.	944.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
36.2	0.7	205.9	0.523	5.460	30.36	0.942

TABLE 29. VGR

BLADE AZIMUTHAL SPACING: 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
371	9.57	0.450	176.90	10131.	700.6	0.007654	0.0005795
372	7.68	0.450	176.90	7615.	470.8	0.005753	0.0003895
373	10.52	0.450	176.90	11198.	814.7	0.008460	0.0006740
374	8.62	0.450	176.90	8920.	586.6	0.006739	0.0004853

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
371	0.5109E 00	0.7425E-02	0.6877E-03	0.1522E-07	0.9142E-04	0.7771E-01	0.5884E-02	10297.	695.9
372	0.3840E 00	0.5801E-02	0.1032E-02	0.2946E-07	0.7142E-04	0.5841E-01	0.3954E-02	7740.	467.7
373	0.5647E 00	0.8669E-02	0.6877E-03	0.1586E-07	0.1067E-03	0.8589E-01	0.6843E-02	11382.	809.4
374	0.4498E 00	0.6662E-02	0.6877E-03	0.1416E-07	0.8202E-04	0.6842E-01	0.4927E-02	9057.	582.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
35.1	0.4	176.9	0.450	4.709	30.36	0.940

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
386	7.68	0.450	177.60	7503.	465.5	0.005668	0.0003851
387	9.57	0.450	177.60	9892.	702.0	0.007474	0.0005807
388	8.62	0.450	177.70	8866.	586.4	0.006698	0.0004851
389	10.52	0.450	177.70	10973.	809.6	0.008290	0.0006697

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
386	0.3783E 00	0.6010E-02	0.2397E-02	0.1577E-06	0.7400E-04	0.5755E-01	0.3910E-02	7623.	463.9
387	0.4988E 00	0.8912E-02	0.1507E-01	0.7101E-05	0.1097E-03	0.7588E-01	0.5896E-02	10052.	691.3
388	0.4471E 00	0.6945E-02	0.5135E-02	0.7858E-06	0.8550E-04	0.6800E-01	0.4925E-02	9018.	584.7
389	0.5532E 00	0.9704E-02	0.3423E-02	0.3887E-06	0.1195E-03	0.8417E-01	0.6800E-02	11162.	808.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
39.0	3.2	177.6	0.450	4.663	30.36	0.948

TABLE 30, VGR

BLADE AZIMUTHAL SPACING: 25.2°
DELTA BLADE ANGLE BETWEEN ROTORS: -1°
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
367	7.68	0.523	205.20	10584.	809.0	0.005884	0.0004224
368	10.14	0.523	205.40	14972.	1309.3	0.008324	0.0006837
369	8.62	0.523	205.50	12211.	984.3	0.006788	0.0005140
370	9.57	0.523	205.50	13950.	1186.8	0.007755	0.0006197

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
367	0.3927E 00	0.7588E-02	0.2964E-03	0.2491E-08	0.9342E-04	0.5974E-01	0.4289E-02	10684.	794.1
368	0.5556E 00	0.1057E-01	0.5923E-03	0.1188E-07	0.1301E-03	0.8451E-01	0.6941E-02	15127.	1287.8
369	0.4531E 00	0.3632E-02	0.5920E-03	0.1062E-07	0.1063E-03	0.6892E-01	0.5219E-02	12337.	968.6
370	0.5176E 00	0.9910E-02	0.5920E-03	0.1125E-07	0.1219E-03	0.7874E-01	0.6292E-02	14094.	1167.8

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
34.1	0.3	205.4	0.523	5.488	30.36	0.938

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
382	9.57	0.523	206.20	13788.	1168.4	0.007666	0.0006101
383	10.33	0.523	206.30	15283.	1335.1	0.008496	0.0006972
384	7.68	0.523	206.30	10617.	807.1	0.005902	0.0004215
385	8.62	0.523	206.40	12254.	987.4	0.006813	0.0005156

	CL	CDO	MU	DCQI	CQO	CT/S	CQ/S	TRA	HPA
382	0.5116E 00	0.9817E-02	0.3835E-02	0.4692E-06	0.1209E-03	0.7783E-01	0.6194E-02	13926.	1152.3
383	0.5671E 00	0.1026E-01	0.1179E-02	0.4669E-07	0.1263E-03	0.8626E-01	0.7078E-02	15451.	1319.6
384	0.3940E 00	0.7383E-02	0.1002E-01	0.2802E-05	0.9090E-04	0.5993E-01	0.4279E-02	10723.	791.7
385	0.4547E 00	0.8583E-02	0.2947E-02	0.2613E-06	0.1057E-03	0.6917E-01	0.5235E-02	12376.	974.9

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
38.4	2.6	206.3	0.523	5.428	30.36	0.946

TABLE 31, VGR

THREE LOWER BLADES ONLY
MACH NUMBER .450

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
390	11.11	0.450	177.00	7957.	483.3	0.006011	0.0003998
391	8.11	0.450	177.10	6017.	303.5	0.004546	0.0002511
392	10.11	0.450	177.10	7363.	422.8	0.005563	0.0003497
393	9.11	0.450	177.10	6744.	367.1	0.005095	0.0003037
394	1.11	0.450	177.10	685.	20.2	0.000517	0.0000167
395	4.11	0.450	177.20	2696.	97.8	0.002037	0.0000726

	CL	CDO	MU	DCQI	CQO	TRA	HPA
390	0.4012E 00	0.4877E-02	0.8248E-02	0.1917E-05	0.6004E-04	7974.	471.4
391	0.3034E 00	0.2246E-02	0.1305E-01	0.4146E-05	0.2765E-04	6037.	293.0
392	0.3713E 00	0.3841E-02	0.3435E-02	0.3206E-06	0.4729E-04	7380.	414.3
393	0.3401E 00	0.3128E-02	0.3435E-02	0.3069E-06	0.3851E-04	6760.	359.6
394	0.3453E-01	0.6636E-03	0.5495E-02	0.2466E-06	0.8171E-05	686.	19.6
395	0.1360E 00	0.4525E-03	0.6865E-02	0.7709E-06	0.5572E-05	2703.	85.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
36.4	3.3	177.1	0.450	4.631	29.97	0.955

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
402	10.11	0.450	177.20	7410.	416.7	0.005598	0.0003447
403	9.11	0.450	177.20	6817.	353.6	0.005150	0.0002925
404	11.11	0.450	177.10	8038.	481.6	0.006073	0.0003984
405	8.11	0.450	177.30	5991.	296.8	0.004526	0.0002455
406	0.61	0.450	177.30	575.	17.3	0.000435	0.0000143
407	4.11	0.450	177.30	2742.	88.8	0.002072	0.0000735

	CL	CDO	MU	DCQI	CQO	TRA	HPA
402	0.3737E 00	0.3197E-02	0.1716E-02	0.8048E-07	0.3937E-04	7426.	408.7
403	0.3438E 00	0.1871E-02	0.4806E-02	0.6035E-06	0.2304E-04	6832.	346.2
404	0.4053E 00	0.4340E-02	0.6869E-03	0.1355E-07	0.5343E-04	8046.	471.7
405	0.3021E 00	0.1912E-02	0.6175E-02	0.9333E-06	0.2355E-04	6005.	290.3
406	0.2900E-01	0.6265E-03	0.6862E-02	0.3475E-06	0.7714E-05	576.	16.6
407	0.1383E 00	0.3848E-03	0.6518E-02	0.7012E-06	0.4737E-05	2748.	86.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
37.3	2.2	177.2	0.450	4.619	29.96	0.957

TABLE 31, Continued

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
414	11.11	0.450	177.40	8007.	485.0	0.006050	0.0004012
415	10.11	0.450	177.40	7440.	429.5	0.005621	0.0003553
416	9.11	0.450	177.50	6890.	370.9	0.005206	0.0003068
417	8.11	0.450	177.50	6072.	308.8	0.004587	0.0002554
418	11.11	0.450	177.50	8006.	491.5	0.006049	0.0004066
419	0.61	0.450	177.50	575.	22.8	0.000435	0.0000188
420	4.11	0.450	177.50	2873.	93.2	0.002170	0.0000771

	CL	CDO	MU	DCQI	CQO	TRA	HPA
414	0.4038E 00	0.4725E-02	0.1029E-02	0.3001E-07	0.5817E-04	8020.	476.0
415	0.3752E 00	0.3909E-02	0.3429E-03	0.3259E-08	0.4813E-04	7451.	421.6
416	0.3475E 00	0.2680E-02	0.6511E-02	0.1113E-05	0.3300E-04	6909.	363.4
417	0.3062E 00	0.2351E-02	0.4455E-02	0.4895E-06	0.2895E-04	6082.	302.7
418	0.4037E 00	0.5169E-02	0.0	0.0	0.6365E-04	8020.	482.8
419	0.2902E-01	0.9942E-03	0.4798E-02	0.1726E-06	0.1224E-04	576.	22.2
420	0.1449E 00	0.2785E-03	0.7882E-02	0.1047E-05	0.3429E-05	2878.	90.4

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
38.3	1.8	177.5	0.450	4.605	29.93	0.960

TABLE 32, VGR

THREE LOWER BLADES ONLY
MACH NUMBER: .523

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
396	8.11	0.523	206.10	8327.	532.0	0.004630	0.0002778
397	9.11	0.523	206.00	9243.	632.6	0.005138	0.0003303
398	10.71	0.523	206.10	10580.	790.8	0.005882	0.0004130
399	10.11	0.523	206.00	10176.	731.5	0.005657	0.0003820
400	1.11	0.523	206.00	1153.	59.2	0.000641	0.0000309
401	4.11	0.523	206.10	3976.	171.8	0.002211	0.0000897

	CL	CDO	MU	DCQI	CQO	TRA	HPA
396	0.3090E 00	0.3911E-02	0.4722E-02	0.5524E-06	0.4816E-04	8310.	517.5
397	0.3430E 00	0.5022E-02	0.2067E-02	0.1117E-06	0.6184E-04	9214.	615.5
398	0.3926E 00	0.6833E-02	0.2656E-02	0.1573E-06	0.8413E-04	10557.	770.5
399	0.3776E 00	0.5834E-02	0.5315E-02	0.7736E-06	0.7183E-04	10144.	710.6
400	0.4280E-01	0.1550E-02	0.3839E-02	0.1352E-06	0.1908E-04	1150.	57.4
401	0.1476E 00	0.1132E-02	0.7378E-02	0.9272E-05	0.1394E-04	3968.	165.7

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
37.0	2.5	206.0	0.523	5.377	29.97	0.956

OUTPUT DATA IS:

	AIMP	MACH	RPM	TRST	HP	CT	CQ
408	9.11	0.523	206.20	9336.	625.4	0.005190	0.0003266
409	10.71	0.523	206.20	10685.	789.5	0.005940	0.0004123
410	10.11	0.523	206.20	10244.	728.7	0.005695	0.0003805
411	8.11	0.523	206.30	8445.	527.1	0.004695	0.0002752
412	0.61	0.523	206.20	875.	58.6	0.000487	0.0000306
413	4.11	0.523	206.20	4042.	185.1	0.002247	0.0000967

	CL	CDO	MU	DCQI	CQO	TRA	HPA
408	0.3464E 00	0.4386E-02	0.4425E-02	0.5137E-06	0.5400E-04	9298.	607.7
409	0.3965E 00	0.6381E-02	0.2655E-02	0.1982E-06	0.7856E-04	10642.	768.1
410	0.3801E 00	0.5461E-02	0.2655E-02	0.1939E-06	0.6723E-04	10202.	708.9
411	0.3134E 00	0.3307E-02	0.3538E-02	0.3125E-06	0.4071E-04	8420.	513.2
412	0.3248E-01	0.1850E-02	0.0	0.0	0.2278E-04	872.	57.0
413	0.1500E 00	0.1544E-02	0.0	0.0	0.1902E-04	4026.	180.2

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
38.0	1.3	206.2	0.523	5.357	29.94	0.959

OUTPUT DATA IS:

TABLE 32. Continued

	AIMP	MACH	RPM	TRST	HP	CT	CQ
421	9.11	0.523	206.40	9494.	637.4	0.005273	0.0003329
422	10.71	0.523	206.50	10547.	803.2	0.005364	0.0004194
423	10.11	0.523	206.40	10298.	741.2	0.005725	0.0003871
424	8.11	0.523	206.40	8507.	547.2	0.004730	0.0002858
425	0.61	0.523	206.40	901.	61.2	0.000501	0.0000320
426	4.11	0.523	206.40	4095.	192.5	0.002277	0.0001005

	CL	CDO	MU	DCQI	CQO	TRA	HPA
421	0.3523E 00	0.4332E-02	0.0	0.0	0.5334E-04	9453.	620.9
422	0.3914E 00	0.7481E-02	0.7953E-02	0.1761E-05	0.9210E-04	10512.	780.2
423	0.3821E 00	0.5789E-02	0.7662E-02	0.1615E-05	0.7127E-04	10254.	718.9
424	0.3157E 00	0.3950E-02	0.2063E-02	0.1068E-06	0.4864E-04	8471.	532.8
425	0.2345E-01	0.1933E-02	0.1179E-02	0.1133E-07	0.2380E-04	898.	59.6
426	0.1520E 00	0.1734E-02	0.1532E-01	0.3974E-05	0.2134E-04	4078.	180.1

AVERAGES:

TEMP	WIND	RPM	MACH	RENO	PRES	DENR
39.0	3.3	206.4	0.523	5.342	29.93	0.961