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RSRA Vertical Drag Test Report

R. J. Flemming

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R. J. Flemming
Sikorsky Aircraft
Stratford, Connecticut

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Ames Research Center
Moffett Field, California 94035

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ABSTRACT

The Rotor Systems Research Aircraft (RSRA) offers unique test opportunities because of its ability to measure rotor loads. This capability was used to conduct an experiment to determine vertical drag, tail rotor blockage, and threat augmentation as affected by ground clearance and flight velocity. Tests were conducted by NASA at the Ames Research Center in July 1981, with data reduced by NASA and sent to Sikorsky Aircraft for analysis and documentation.

The RSRA was flown in the helicopter configuration at speeds from 0 to 15 knots for wheel heights from 5 to 150 feet, and to 60 knots out of ground effect. The vertical drag trends in hover, predicted by theory and shown in model tests, are generally confirmed.

The OGE hover vertical drag is 4.0 percent, 1.1 percent greater than predicted. The vertical drag decreases rapidly as wheel height is reduced, and is zero at a wheel height of 6 feet. The vertical drag also decreases with forward speed, approaching zero at sixty knots.

The test data show the effect of wheel height and forward speed on thrust, gross weight capability and power, and provide the relationships for power and collective pitch at constant gross weight required for the simulation of helicopter takeoffs and landings. Data showing tail rotor trends are presented.

This test for the RSRA in the clean helicopter configuration should be repeated for a higher vertical drag configuration to identify the analytical versus experimental trends.

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LIST OF SYMBOLS

BMRQ	Balance main rotor torque, ft-lb
C_D	Horizontal drag coefficient $(= D/\pi R^2(\Omega R)^2 \rho)$
C_Q	Rotor power coefficient $(= 550\ HP/\pi R^2(\Omega R)^3 \rho)$
C_P	Total power coefficient $(= 550\ SHP/\pi R^2(\Omega R)^3 \rho)$
C_{SF}	Side force coefficient $(= SF/\pi R^2(\Omega R)^2 \rho)$
C_T	Thrust coefficient $(= T/\pi R^2(\Omega R)^2 \rho)$
C_W	Gross weight coefficient $(= GW/\pi R^2(\Omega R)^2 \rho)$
D_V	Net vertical drag, %
DMR	Balance main rotor drag, lb
D	Download, lb
GW	Gross weight, lb
i	Incidence, degrees
R	Rotor radius, ft
SFMR	Balance main rotor side force in wind axis, lb
T	Thrust, lb

LIST OF SYMBOLS (Cont'd)

TMR	Balance main rotor thrust in wind axis, lb
TRBLK	Tail rotor blockage
TRT	Tail rotor thrust in tail rotor shaft axis, lb
X	Balance force perpendicular to shaft, positive forward, lb
Y	Balance force perpendicular to shaft, positive right, lb
Z	Balance force along shaft, positive up, lb
ΔT	Thrust recovery
θ	Pitch angle, positive nose up, degrees
μ	Advance ratio
ρ	Atmosphere density, slugs/cu. ft.
ϕ	Roll angle, positive to the right, degrees
ΩR	Rotor tip speed, fps

Subscripts

B	Body
H	Hover
MR	Main Rotor
S	Shaft
TR	Tail rotor
∞	Out of ground effect

INTRODUCTION

The verification of vertical drag prediction methodologies has been accomplished in the past using small scale models and by comparison of isolated and installed full-scale rotor performance. Both of these methods have produced realistic results for OGE hover conditions, but contain sources of uncertainty. Scale effects, if they do exist, are unknown. Use of flight test data, without the direct measurement of main rotor thrust, is accurate only to about 2% and there are no methods available to separate the effect of the interference of the tail rotor on the main rotor from the vertical drag. Similar problems exist in the determination of vertical drag in ground effect and at low forward speeds.

A flight test program utilizing the RSRA main rotor balance system was conducted to obtain data for the helicopter configuration. This report discusses the test program, data reduction methods, and results as required by Work Order 91 of Contract NAS2-11058.

The determination of rotor loads in this report uses the single loads correction matrix method reported in Reference 1. This is the initial method of loads correction. As improved methods are developed, the improved method will be used by NASA to update the results of this report if there are significant changes.

AIRCRAFT CONFIGURATION

The RSRA, NASA 740, used for the vertical drag test was in the standard helicopter configuration (see Figure 1). The configuration included the 35.4 square foot T-tail, a nose-mounted airspeed boom and fairings installed over the wing attachment region. The rudder was not installed, reducing the vertical tail area to 48.2 square feet (Figure 2). Dimensional data for the RSRA is provided on the General Arrangement drawing, Figure 3. Not shown in this drawing are the landing gear doors which were open during this test. These doors are shown in Figure 4.

The aircraft is powered by two T58-GE-5 engines with a take-off rating of 1500 HP each. Total power was limited to 2575 HP at a rotor speed of 209.1 RPM (103%). NASA 740 is equipped with a main rotor balance system to measure forces and moments at the base of the main gearbox. The tail rotor has a load cell to measure tail rotor thrust.

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TEST PERSONNEL

The following individuals were a witness to all or portions of the vertical drag flight test program:

R. Erickson - Test Director, NASA

R. Flemming - Program Manager, Sikorsky

J. Burks - Technical Monitor, NASA

G. Condon - Helicopter Flight Investigations Branch Chief, NASA

J. Brilla - Flight Investigations, NASA

C. W. Acree - Flight Investigations, NASA

R. Kufeld - Flight Investigations, NASA

R. Hodge - Technical Representative, Sikorsky

D. Leischer - Flight Test, Sikorsky

G. W. Hall - Project Pilot, NASA

G. Tucker - Pilot, NASA

R. Merrill - Pilot, Army

APPARATUS AND TEST PROCEDURE

Data Recording and Processing

On-board aircraft data measurements were recorded on the RSRA Piloted Aircraft Data System (PADS). The PADS is a hybrid FM and PCM system which records up to 110 FM and 104 PCM parameters. These parameters are recorded on two magnetic tapes. Re-calibration of the transducers and PADS was accomplished prior to conduct of the test.

Balance system load cell outputs were recorded on FM. The load cells were laboratory calibrated prior to the test. A system calibration was conducted before and after the test. The results of this system calibration were used to correct the laboratory calibration for errors that occur within the data recording and processing equipment. Identical components, by serial number, were used to record and process all load cell data. Final computation and correction of the load cell data to forces and moments in the shaft axis system was accomplished using the methods reported in Reference 1. This method used single loads correction matrices developed in the NASA Ames Static Calibration facility for RSRA 740.

Pace Vehicle

The pace vehicle was equipped with a calibrated fifth wheel speedometer system. Correction was made to pace speed for prevailing wind velocities.

Flight Test Plan

This test was conducted under Flight Test Plan (FTP) 2A for RSRA 740, Revision 1. Table I is a log of the flight tests conducted against this plan.

Test Procedure

The vertical drag test was conducted at Moffett Field, California, adjacent to the NASA Ames flight data acquisition facility. The taxiway, and later the nearby runway, were surveyed to establish elevation and centerline offset distance. A transit was then used to monitor wheel height, with information relayed to the RSRA when necessary. A pace vehicle was used to guide the RSRA at the required true airspeed, accounting for winds which were measured six feet above ground level. Aircraft position was recorded on film for later processing to determine actual speed and wheel height. Three consecutive records of each required data point were recorded, with each record treated as an independent data point. The run log is summarized in Table II. Flights 3-7 were flown at a referred rotor speed of 103%. Flight 8 was flown as a referred rotor speed of 104%.

Two events had an impact on the acquired data. First, Flight 4 does not include film data and the output for that flight is based on pace truck and transit-monitored wheel height. All points of Flight 4 were repeated in Flights 5 and 7 and, therefore, the Flight 4 data has not been used for the analysis of vertical drag and ground effect. Second, the taxiway was occupied during Flight 7 and the RSRA was flown over the runway centerline. The new offset distance, measured after the flight, resulted in wheel heights that differed from the target wheel heights. In addition, Flight 7 does not include film data. The height and forward velocity data are based on recorded transit wheel height measurements and pace truck speeds. Since most of the IGE data is plotted versus a non-dimensional rotor height parameter, this difference does not adversely affect the data analysis.

Standard pre- and post-flight calibration procedures were followed for each flight. NASA 740 was weighed before and after each flight and the gross weight during each flight is based on these weighings and the corrected cockpit fuel totalizer readings.

DATA ANALYSIS METHODS

The NASA/RSRA data reduction program (EASE) was used to process aircraft flight data taken on tape (see Reference 2). No modifications were made to this program to accommodate the special needs of the vertical drag test program. Tabulations of gross weight, wheel height and airspeed were prepared by NASA. The main rotor balance data were processed and oriented into the shaft axis system.

Main rotor balance forces were derived from individual load cell readings, which were processed by a set of calibration correction algorithms. These included corrections determined by load cell data system calibrations, individual load cell laboratory calibrations, a static calibration of the assembled rotor loads measurement system (Static Calibration Facility), and analysis of inertial effects due to the combined transmission, engine and rotor system masses. Procedures for determining the calibration algorithms are described in Reference 1.

A code to compute derived parameters was assembled at Sikorsky and used to analyze the NASA data. A listing of this code is included as Table III. This listing shows the constants used in the analysis. The assumptions that were made and the more important equations are discussed below.

The main rotor balance forces were transferred to the wind (horizon) axis system using the following relationships, with the sideslip terms omitted:

$$TMR = -Z \cos(\theta_B + i_s) \cos(\emptyset_B) - Y \sin(\emptyset_B) + X \sin(\theta_B + i_s) + 1377.7 - TRT \sin(\emptyset_B)/TRBLK$$

where 1377.7 pounds is the weight of the blade flapping mass.

$$DMR = -Z \sin(\theta_B + i_s) \cos(\emptyset_B) + X\cos(\theta_B + i_s)$$

$$SFMR = -Z \sin(\theta_B) \cos(\theta_B + i_s) + Y \cos(\emptyset_B) + TRT \cos(\emptyset_B)/TRBLK$$

Because the boom measurement of sideslip angle is influenced by the main rotor at low speeds, that quantity is not considered in this test. The resulting error, primarily in drag, will increase from a zero value in hover as speed increases. The tail rotor terms in these equations are:

TRT = Tail Rotor Thrust from Load Cell

TRBLK = Tail Rotor Blockage = TRT ÷ Required Antitorque Thrust

= TRT ÷ (BMRQ/36.915)

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This relationship ignores the favorable fuselage yawing moment caused by the swirl component of the main rotor wake. Model tests have shown this reduces the required antitorque moment by 2%.

The total power from either the balance or shaft torque readings is based on the following relationship, established in Reference (3):

$$SHP = 97.4\ HP + 1.0123 \times MRHP + 1.0197 \times TRHP$$

For several points tail rotor torque was not available. To allow the computation of total power from balance and shaft torques for all data records, tail rotor power for these points was computed using the predicted tail rotor performance of Reference (3). Thus, where tail rotor torque test data is not available, it is based on the antitorque thrust:

$$C_{Q_{TR}} = .0002899 + 1.2024\ (C_{T_{TR}})^{3/2}$$

The tail rotor torque signal for several flights contained an excessive amount of noise. The averaging of the data sample has been judged inaccurate for the points from Flight 3, Point 28 through Flight 7.

The download on the RSRA fuselage is the difference between the main rotor thrust and aircraft gross weight. The ratio of download/thrust is:

$$\frac{D}{T} = \frac{T-GW}{T}$$

The net vertical drag, includes the effect of the additional rotor thrust due to thrust recovery and is defined so that the gross weight is equal to the isolated rotor thrust minus net download. Therefore,

$$D_v = \frac{D - \Delta T}{GW} = \frac{T-GW-\Delta T}{GW}$$

The thrust recovery results from the partial ground effect caused by the presence of the fuselage near the rotor. Ideally the RSRA balance system could be used to determine thrust recovery. However, we must consider several factors that have a significant impact on the calculation of a number that is expected to be less than 1%. The performance of the rotor in isolation, either from theory or whirlstand tests, and the adverse impact of the tail rotor on main rotor performance must be known with greater accuracy than is now possible. Figure 5 shows the RSRA hover OGE thrust-power relationship. The isolated rotor whirlstand data fits the test data well and could be used to say that the thrust recovery was zero or was of the same magnitude as the tail rotor interference (which may be as high as 2% for some tail rotor configurations). Comparing the RSRA balance data with the theory of Reference 4, we could say that the thrust recovery exceeds the tail rotor interference by 0.8%. In either case uncertainties exist that are as great as the quantity being measured.

The thrust recovery that is predicted for the RSRA, using the Sikorsky Vertical Drag Standard Procedure (Reference 5) is 0.9% of the rotor thrust. The value is feasible based on the foregoing statements. Therefore, it has been used as the basis for the data analysis of this report. The thrust recovery can be expected to decrease as the helicopter enters ground effect and as forward speed increases. Limited data (References 6 and 7) show the trend of thrust recovery in ground effect. This is shown in Figure 6. The data has been extrapolated to give zero at an $(R/Z)^2 = 2.0$. Also, for the purposes of data reduction, the thrust recovery is assumed to become zero at 10 knots. Since the magnitude of the thrust recovery is generally within the data precision, this assumption is considered realistic. Thus, the thrust recovery is taken as:

$$\Delta T = T_H \text{ X } (1 - .5 \text{ X } (R/Z)^2) \text{ X } (1 - V/10)$$

with $\Delta T = 0$ for $(R/Z)^2 > 2$ or $V > 10$.

The parameter $(R/Z)^2$ has been chosen as the asbcissa for all ground effect plots. When plotted against the thrust ratio raised to the 1.5 power, the data falls into a pattern that is nearly linear. However, a suitable "out of ground" effect thrust or gross weight versus power curve must be selected to yield a data fairing that gives no augmentation ($T/T_\infty = 1.0$) at an infinite wheel height ($R/Z = 0$). This is satisfied by using a thrust that is about 1% less than the thrust at a 100-foot wheel height. The thrust and gross weight augmentation ratios, T/T_∞ and GW/GW_∞ have been raised to the 1.5 power in each of the ground effect plots, since the augmentation results from a decrease in induced power, a function of $(T/T_\infty)^{1.5}$.

Tabulations of the reduced data are presented in Tables IV to VIII.

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RESULTS

Balance Measurements

Of primary importance in a test where small quantities are being measured is the accuracy and precision of the data. The RSRA balance system offers the accuracy necessary for the determination of not only vertical drag and ground effect trends, but also absolute numbers. Most of the comparisons contained in this document were at a constant power setting. Any one of the three power measurements will give satisfactory results. The total power measurements contain more scatter than the main rotor shaft or balance torque measurements, due to either engine torque or tail rotor torque variability. Figure 7 shows the extremely low scatter that exists in the difference between main rotor strain gauge power and balance power. The tail rotor power measurement contributes to the scatter of the first two parts of Figure 7, most notably the circle symbols that are significantly above the remainder of the data. Figure 8 shows the same information in the form of total power based on strain gauge and balance data versus engine power. The balance system gave powers about 2% below that of the other two systems. The balance torque measurement is the only one that has been subjected to a complete system calibration and it has therefore been chosen as the torque reference in this report for all cases where main rotor power is plotted. The engine torque readings have been used where total power is shown to avoid any error that may exist in the tail rotor torque readings.

Figure 5 shows excellent agreement between the predicted and balance-measured main rotor performance. (The effects of thrust recovery and tail rotor-main rotor interference are discussed on page 7.) The middle set of points fall above the predicted line. This may be due to winds aloft that were not recorded with the ground level anemometer. At ground level the winds during the high weight testing of Flight 3 were below 1 knot, were 3 knots for the middle weight points of Flight 3, and were 2 knots for the low weight testing of Flight 7.

The transfer of measured balance forces into the wind axis system requires the use of the measured fuselage pitch and roll attitudes. These data have a scatter band of about ± 0.6 degrees as shown in Figure 9. This scatter has a negligible effect on thrust, but introduces drag and side force errors of up to 200 pounds (see Figure 10). The scatter plus the demonstrated calibration accuracy (Table IX) exceeds the scatter band of the horizontal drag measured in hover, with the mean of the measurement near zero as expected. The side force scatter is reasonable, but the data has a positive value, rather than averaging zero. Since the offset is still within the measurement accuracy, no explanation of the offset is warranted. The drag measurements made in the speed range of 5 to 20 knots show similar trends (Figure 11). An in-depth examination of these forces at higher speeds must include the effect of yaw angle, not recorded during this test.

Ground Effect

Figure 12 shows the thrust and weight coefficients for the full range of rotor heights, plotted against engine power coefficient. The increase in thrust due to ground effect is evident in this figure. The hover thrust augmentation is shown in Figure 13. A linear fairing fits this data well. The thrust augmentation (T/T_{∞}) at a 5-foot wheel height is 1.11 and is 1.07 at a 10-foot wheel height. No trend with C_W is evident over the range of gross weight tested.

Figure 14 shows the increase in thrust due to both ground effect and forward speed at a constant main rotor power. The data indicate that a linear fairing does not apply as speed is increased. The out of ground effect thrust at 10 knots (at constant power) is 4% above the hover thrust. An additional 4% increase in thrust will occur at a 10-foot wheel height. At 15 knots the forward speed increases thrust by 11% with a decrease in thrust due to a 10-foot wheel height of 1%. At a wheel height of 20 feet and a speed of 15 knots, the ground effect reduces thrust by 2%.

Similar trends have been produced for the ratio of gross weight IGE to hover gross weight OGE at a constant total power. Figure 15 shows the augmentation in hover. At a 5-foot wheel height the increase in gross weight is 15%, 1% less than provided in Reference 3. (The Reference 3 curve is based on SH-3A and SH-3D flight test data.) The increase in gross weight is 4% more than the increase in main rotor thrust because of the corresponding reduction in vertical drag. Figure 16 shows the gross weight augmentation for low forward speeds.

The airspeed-ground effect trends are summarized in Figure 17. This shows uniform trends for thrust augmentation, but the data for 5 and 10 knots gives less gross weight augmentation than expected. The augmentation due to ground effect has been separated from the speed effect in Figure 18.

The ground effect data can also be examined in terms of a power ratio at a constant thrust or gross weight. Figure 19 shows the main rotor balance torque ratio and the total engine power ratio versus the rotor height parameter. This and data at the forward speed conditions of this test are summarized in Figure 20. The upper portion shows the reduction in power referenced to the OGE hover power while the lower graph uses the OGE power at the noted speed as the denominator.

The RSRA ground effect data has been compared with the method of Cheeseman, Reference 8 in Figure 21. The agreement is good when compared with the RSRA gross weight augmentation up to speeds of 10 knots and at $(R/Z)^2$ below 1.6. The slope of the RSRA augmentation with rotor height decreases at low wheel heights while the Cheeseman slope increases slightly. The RSRA had very little augmentation at 15 knots, departing significantly from the Cheeseman prediction. The RSRA data has also been compared to the ground effect curves of References 9 and 10. The Reference 9 band of data from many U.S. Army helicopters encompasses the RSRA data down to a wheel height of 12 feet. At lower wheel heights the augmentation was lower than the Reference 9 data band, with Reference 9 following the same trend shown by Reference 8. The ground effect parameter given by Reference 10 gives lower augmentations than shown by the RSRA. This reference assumes that the ground effect is insignificant for a rotor 2 radii above the ground. The RSRA data gives an augmentation of 2.3% at that height and reduces to 0.5% 4 radii above the ground.

Figure 22 shows that the RSRA agrees well with the reduction in ground effect with forward speed given by Reference 10, although the level of augmentation at a given wheel height is greater (see Figure 21). The rapid drop-off in ground effect at 15 knots is not predicted.

The ability to simulate a landing or takeoff profile requires a knowledge of not only the change in power but also the change in collective stick position. Figure 9 shows the collective pitch as a function of power, where wheel height and gross weight are not significant variables. For simulator use, this relationship must be redefined to determine collective control motion for a helicopter, where gross weight is the independent variable. This is shown for the RSRA in Figure 23. Figure 24 shows the reduction in collective versus rotor height, at constant gross weight. Figure 24 shows that the collective pitch must be reduced by 1.0 degree during hovering flight from a wheel height of 100 feet to 10 feet. The power is reduced by 13% for this condition.

Vertical Drag

The measurement of main rotor thrust on the RSRA makes it possible to obtain download in a direct manner. The download is simply the difference between the main rotor thrust and the aircraft gross weight. No other calculations or assumptions are required. Figures 25-28 demonstrate low scatter - about ½% in hover increasing to only 1% in low speed flight. The hover data in Figure 25 shows the effect of the ground clearly. The download diminishes to half of its OGE value at a wheel height of 25 feet and is zero at a wheel height of 6 feet. The data do not show any trend with gross weight.

The download decreases with increasing speed at wheel heights above 15 feet. Below this height the download increases with increasing speed. These trends are shown in Figures 26-28. To increase the confidence in the download trends, data taken during Flight 8, a handling qualities flight, were analyzed. This flight extends the "OGE" download trending out to a speed of 60 knots, where the download-thrust ratio diminishes to a value of 0.5% as seen in Figure 29. Combining the data trends from Figures 25-28 into a single carpet plot yields consistent results. Figure 30 shows the effect of both speed and ground effect on D/T. This figure was used to obtain the fairings shown on the data plots.

While all of these figures provide useful information, the download used to give aircraft performance must include the improvement in rotor performance due to the presence of the fuselage beneath the rotor - a partial ground effect. (See discussion in Data Analysis Methods section.) This thrust recovery could, in theory, be obtained by comparing the RSRA balance thrust with "isolated rotor" whirlstand thrust at a constant power. However, the accuracy required for that comparison is better than that available. Any interference between the main and tail rotors would further complicate the comparison. Therefore, the OGE hover value of 0.9% of thrust has been used for the RSRA based on Reference 5. The thrust recovery is reduced to zero at a $(Z/R)^2$ of 2.0 or a speed of 10 knots.

Figure 31 shows the impact of the ground on net vertical drag in hover. The OGE vertical drag is 4.0%, 1.1% higher than the Reference 3 prediction (adjusted to include the landing gear in the extended position) and 1.5% above that shown by current methodology (see Table X). The information necessary to extend the RSRA OGE vertical drag prediction for ground effect is taken from Reference 11. The RSRA vertical drag is half of the OGE value at a wheel height of 28 feet, agreeing closely with the prediction. The net vertical drag becomes zero at a wheel height of six feet, four feet higher than predicted.

Tail Rotor Blockage

The RSRA has a tail rotor thrust load cell to provide a direct measurement of this parameter. Comparison of this value with the necessary antitorque thrust gives a measure of tail rotor blockage. A further insight into the total installation effect can be made using both theory and tail rotor test stand data, using tail rotor torque as the common variable. While a sizable portion of the tail rotor torque data contained a high vibratory content (in some cases the vibratory gave impossible results; in others it biased the torque reading to a lower value), there is sufficient information to provide meaningful results. Only the tail rotor torque data from Flight 8 and points 13 to 27 of Flight 3 have been used to prepare Figures 32-35, however, all data is included in Tables IV through VIII.

Figure 32 shows the relationship between tail rotor thrust and power in hover. The calculated antitorque thrust agrees very well with the RSRA prediction of Reference 3. At a tail rotor torque coefficient of .0019 the OGE load cell thrust is 23% greater than the antitorque thrust, comparing well with the trend information given by References 11 and 12 and summarized for the RSRA tail rotor-fin separation in Figure 33. The tail rotor thrust from the Sikorsky tail rotor test stand (which will cause some blockage) is 13% greater than the antitorque thrust while theory (Reference 4) is 16% greater. It is evident from Figure 32 that further work, including the measurement of the fin force, is required to identify the sources of the tail rotor loss and to better quantify the load cell thrust increase in the presence of the fin. The presence of a favorable wake interference effect on the rotor is possible and could explain differences in the measured and calculated performance.

Figure 34 shows the ratio of tail rotor power to main rotor power in hover. The predicted OGE value of .136 is substantiated by the data and this does not change with changes in wheel height. The tail rotor-main rotor power ratio trends with airspeed are given in Figure 35. The data indicates an increase in tail rotor power of up to 60% at low forward speeds (5 to 15 knots). The RSRA requires up to 9% more left pedal in this speed range. The tail rotor power requirements in right and left sidewinds follow expected trends.

Figures 36 and 37 present the ratio of load cell thrust and antitorque thrust versus rotor height for hover and low forward speeds. The OGE hover load cell thrust is 23% above the antitorque thrust value (see also Figure 32), increasing to 35% at a 5-foot wheel height for the RSRA. Figure 32 shows that this increase is primarily the result of higher load cell thrust in ground effect, although the antitorque thrust of a given tail rotor power may decrease slightly in ground effect. The thrust ratio increases significantly at low forward speeds, with the largest increases out of ground effect. The data contained in Table VIII indicate that this blockage is still greater than 30% at 60 knots, although aircraft yaw angle and fin lift must be known to provide more meaning to this value.

CONCLUSIONS

1. The rotor balance system is capable of providing high quality performance data. The ability to directly measure main and tail rotor thrust with a high degree of accuracy will make it possible to conduct tests where knowledge of thrust is mandatory, as in the vertical drag test.

2. The main rotor shaft and engine power measurement systems provided consistent data. The measurement of tail rotor power during this test was erratic.

3. The vertical drag of the RSRA is 4%, 1.1% greater than predicted. The vertical drag reduces with both forward speed and in ground effect. The vertical drag is zero for hover at a 6-foot wheel height. It is reduced to 0.5% at 60 knots out of ground effect.

4. At a 5-foot wheel height the gross weight augmentation was less than predicted by three prediction methods.

5. The load cell tail rotor thrust in hover is 23% above the calculated antitorque thrust at a constant tail rotor power level. This difference is a combination of the adverse fin force plus any wake interference effect (which may increase the isolated tail rotor thrust).

6. The ratio of load cell to antitorque tail rotor thrust increases in ground effect for hover and decreases at low forward speeds.

7. Tail rotor power percentage of main rotor power is not a function of wheel height at zero airspeed.

8. Tail rotor power percentage of main rotor power decreased with increased airspeed for speeds above 20 knots. An unexpected increase was found to occur between hover and 20 knots.

RECOMMENDATIONS

The following represent experimental studies that could provide additional information regarding the vertical drag and fin blockage effects on aircraft system performance.

1. Repeat this test for a higher vertical drag configuration using either a small wing or simulated stores. This could provide higher vertical drag levels that could be used to identify the analytical versus experimental trends.

2. Determine means to measure the vertical fin force so that components of tail rotor blockage can be isolated and understood. One possibility is the integration of fin surface pressures.

3. Conduct 1/6 scale model tests to correlate with full scale testing. This approach could identify the most promising configuration for full scale test while providing information on scale effects, thrust recovery, and tail rotor-main rotor interactions.

4. Investigate means to measure tail rotor main rotor interactions on the RSRA.

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*These reports are referenced only for completeness and are not generally available to the public.

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TABLE I.
RSRA FLIGHT LOG
NASA 740, FTP 2A

HELICOPTER CONFIGURATION

Flt. No.	Date	GW/CG @ T.O.	Tape No.	Flt. Time	Avg. Wind Vel - Kts	Data Units	Comments
1	06/30/81	19800/302	740-2A-1A & B	0.5	10	—	Maintenance check flight
2	07/01/81	18700/302	740-2A-2A & B	0.5	10	—	Maintenance check flight
3	07/10/81	19800/302	740-2A-3A & B	2.0	1½	60	Hover and slow forward flight performance
4	07/17/81	19800/302	740-2A-4A & B	2.3	3	59	Slow forward flight performance
5	07/21/81	19800/302	740-2A-5A & B	2.1	4	69	Slow forward flight performance
6	07/24/81	19800/302	740-2A-6A & B	0.2	3	—	Abort, fuel leak suspected
7	07/28/81	17800/302	740-2A-7A & B	0.5	1½	25	Lt wt hover, slow forward flight performance
8	07/28/81	19800/302	740-2A-8A & B	1.1	3	60	Forward flight, OGE to 60 kts, paced

TABLE II

RSRA VERTICAL DRAG TEST POINT SUMMARY

Target Airspeed (Knots)	Wheel Height (Feet)	Point Number		
		C_w = .0053	C_w = .0056	C_w = .0059
0	5	7.18-20	3.45-47	3.13-15
	10	7.21-23	3.48-50	3.16-18, 5.13
	20	7.24-26	3.51-53	3.19-21
	40	7.27-29	3.54-56	3.22-24
	100	7.30-32, 7.40-42	3.57-59	3.25-27
5	10	4.47-49, 5.56-58	3.61-62	3.28-30
	20	4.56-58, 5.65-67	4.28-30, 5.37-39	4.19-21, 5.17-19
	100	5.74-76	4.41-43, 5.46-48	5.26, 5.28-29 5.26, 28, 29
10	10	4.50-52, 5.59-61	3.63-65	3.31-3.33
	20	4.59-61, 5.68-70	4.31-33, 5.40-42	4.22-24, 5.20-22
	100	7.33-35	4.44-46, 5.49-51	5.30, 5.32-33
15	10	4.53-.55, 5.62-64	3.66-3.68	3.34, 4.16-18, 5.14-16
	20	4.62-64, 5.71-73	4.35-36, 4.40, 5.43-45	5.23-25
	100	7.36, 7.38-39	5.53-55	5.34-36

TABLE III

SIKORSKY DATA ANALYSIS CODE

```
C
C   RSRA VERTICAL DRAG DATA ANALYSIS PROGRAM
C   ROBERT FLEMMING    SIKORSKY AIRCRAFT    OCTOBER 1981
C
      DIMENSION PTN(100),VN(100),WHN(100),TCN(100),TMR(100),DMR(100),
     1 SFMR(100),CTTRP(100),CTTR(100),CW(100),CT(100),CQB(100),
     2 CQS(100),CPB(100),CPS(100),CPE(100),CQTR(100),HPTR(100),
     3 GWN(100),DV(100),TRBLK(100),CDWLD(100),DOW(100),ROZSQ(100),
     4 DOT(100),CWCWN(100),CTCTN(100),AMU(100)
C
C   PHYSICAL AND RSRA CONSTANTS
C
      R=31.
      PI=3.1415927
      RAD=57.29578
      HR=14.667
      RT=5.3021
      P0=.0023769
      SI=-2.
      WBLD=1377.7
C
C   INPUT CURVE COEFFICIENTS AND TEST DATA
C
    1 READ(5,5) DTIN,A0,A1,B0,B1,C0,C1
      WRITE(6,6) DTIN,A0,A1,B0,B1,C0,C1
    5 FORMAT(7F10.0)
    6 FORMAT(1H ,7F12.7///)
      WRITE(6,7)
    7 FORMAT(1H ,'  POINT      V      WH      TB      PB      TC     QR      TE
     1MP    ALT     GW     TRQ     TRT      X     -Z       Y     BMRQ')
      WRITE(6,8)
    8 FORMAT(1H ,'   NO.     (KT)   (FT)   (DEG)   (DEG)   (DEG) (FPS)   (DEG
     1 C)   (FT)   (LB)   (FT-LB) (LB)     (LB)   (LB)    (LB) (FT-LB)'/)
      DO 50 I=1,100
      READ(5,10)PT,V,WH,TB,PB,TC,OR,T,H,GW,TRQ,TRT,X,Z,Y,BMRQ
      IF(PT.LT.0) GO TO 60
      WRITE(6,11)PT,V,WH,TB,PB,TC,OR,T,H,GW,TRQ,TRT,X,Z,Y,BMRQ
   10 FORMAT(F5.2,F5.0,6F5.1,8F5.0)
   11 FORMAT(1H ,F7.2,F7.1,6F7.1,8F7.0)
```

TABLE III (CONT)

```
C  CALCULATE DENSITY AND THRUST AND POWER COEFFICIENTS
C
      DELT=(1.-6.875586*H/1000000.)**5.255853
      TT=(T+273.15)/288.15
      PP=DELT/TT
      Z=-Z
      TFTR=PI*RT*RT*OR*OR*1.0968*P0*PP
      HFTR=TFTR*OR*1.04728/550.
      TFMR=PI*R*R*OR*OR*P0*PP
      HFMR=TFMR*OR/550.
      TBRSI=(TB+SI)/RAD
      PBR=PB/RAD
      CTTR(I)=TRT/TFTR
      CTTRP(I)=BMRQ/(36.915*TFTR*COS(PBR))
C
C  CALCULATE TAIL ROTOR POWER, USING INPUT EQUATION, IF TRQ IS
C    NOT AVAILABLE FOR TEST POINT
C
      IF(TRQ.LT..1)GO TO 41
      HPTR(I)=TRQ*.5769
      CQTR(I)=HPTR(I)/HFTR
      GO TO 42
   41 CQTR(I)=B0+B1*CTTRP(I)**1.5
      HPTR(I)=CQTR(I)*HFTR
   42 CW(I)=GW/TFMR
C
C  CALCULATE COEFFICIENTS AND BALANCE FORCES
C
      CQB(I)=BMRQ/(TFMR*R)
      CPB(I)=CQB(I)*1.0123+HPTR(I)*1.0193/HFMR +97.4/HFMR
      TRBLK(I)=CTTR(I)/CTTRP(I)
      TMR(I)=-Z*COS(TBRSI)*COS(PBR)-Y*SIN(PBR)+X*SIN(TBRSI)+WBLD
     1   -TRT*SIN(PBR)/TRBLK(I)
      DMR(I)=-Z*SIN(TBRSI)*COS(PBR)+X*COS(TBRSI)
      SFMR(I)=-Z*SIN(PBR)*COS(TBRSI)+Y*COS(PBR)+TRT*COS(PBR)/TRBLK(I)
      DMR(I)=DMR(I)/TFMR
      SFMR(I)=SFMR(I)/TFMR
      CT(I)=TMR(I)/TFMR
      CDWLD(I)=CT(I)-CW(I)
```

TABLE III (CONT)

```
C
C  CALCULATE DOWNLOAD AND ROTOR HEIGHT VARIABLES
C
      DOW(I)=CDWLD(I)/CW(I)
      DOT(I)=CDWLD(I)/CT(I)
      ROZSQ(I)=(R/(WH+HR))**2
      PTN(I)=PT
      VN(I)=V
      AMU(I)=V*1.688/OR
      WHN(I)=WH
      TCN(I)=TC
      GWN(I)=GW
   50 CONTINUE
   60 K=I-1
C
C  READ ENGINE AND MAIN ROTOR SHAFT TORQUES
C
      DO 70 I=1,K
      READ(5,15)CQS(I),CPE(I)
   15 FORMAT(2F5.0)
      CQS(I)=CQS(I)/1000000.
      CPE(I)=CPE(I)/1000000.
C
C  CALCULATE THRUST RECOVERY AND NET VERTICAL DRAG
C
      DT=DTIN*(1.-.5*ROZSQ(I))*(1.-(VN(I)/10.))
      IF(DT.LT.0.OR.VN(I).GT.10.)DT=0.
      DV(I)=(CDWLD(I)-(DT*CT(I)))/CW(I)
C
C  CALCULATE OGE (R/Z**2=0.) CW**1.5 AND CT**1.5 AND THRUST AUGMENTATION
C
      CWINF=A0+A1*CPE(I)
      CTINF=C0+C1*CQB(I)
      CWCWN(I)=(CW(I)**1.5)/CWINF
      CTCTN(I)=(CT(I)**1.5)/CTINF
      DV(I)=DV(I)*100.
      DOT(I)=DOT(I)*100.
   70 CPS(I)=CQS(I)*1.0123+HPTR(I)*1.0193/HFMR+97.4/HFMR
```

TABLE III (CONCLUDED)

```
C
C   OUTPUT
C
      WRITE(6,21)
      WRITE(6,22)
      WRITE(6,23)
   21 FORMAT(1H1,'    POINT   SPEED     WHEEL      COLL    GROSS     BALAN
     1CE    BALANCE   BALANCE     D/T       DV   TAIL ROT   GW      T      R
     2 **2')
   22 FORMAT(1H ,'     NO.                 HGT                WEIGHT    THRU
     1ST      DRAG   SIDE FORCE                   BLOCKAGE   GW      T      Z
     2')
   23 FORMAT(1H ,'              (KT)       (FT)      (DEG)      (LB)      (LB
     1)       (--)       (--)       (%)      (%)     (--)      (--)    (--)    (-
     2-)'/)
      DO 80 I=1,K
      WRITE(6,20) PTN(I),VN(I),WHN(I),TCN(I),GWN(I),TMR(I),DMR(I),
     1 SFMR(I),DOT(I),DV(I),TRBLK(I),CWCWN(I),CTCTN(I),ROZSQ(I)
   20 FORMAT(1H ,F8.2,F8.1,2F10.1,2F10.0,2F10.6,2F8.2,4F8.3)
   80 CONTINUE
      WRITE(6,26)
   26 FORMAT(1H1,' POINT SPEED  W.HGT    MU        CW        CT         CQB
     1       CQS       CPB       CPS       CPE       CTTR       CQTR
     2CTTRP'/1H ,'  NO.   (KT)    (FT)'/)
      DO 90 I=1,K
      WRITE(6,25) PTN(I),VN(I),WHN(I),AMU(I),CW(I),CT(I),CQB(I),CQS(I)
     1   ,CPB(I),CPS(I),CPE(I),CTTR(I),CQTR(I),CTTRP(I)
   25 FORMAT(1H ,F6.2,F6.1,F7.1,F7.3,7F10.6,3F10.5)
   90 CONTINUE
      READ(5,99)X
   99 FORMAT(F5.0)
      IF(X.LT.0)STOP
      WRITE(6,100)
  100 FORMAT(1H1)
      GO TO 1
      END
```


SA 29 REV. G

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TABLE IV

TABULATED DATA — FLIGHT 3

POINT NO.	V (KT)	WH (FT)	TB (DEG)	PB (DEG)	TC (DEG)	OR (FPS)	TEMP (DEG C)	ALT (FT)	GW (LB)	TRQ (FT-LB)	TRT (LB)	X (LB)	-Z (LB)	Y (LB)	BMRQ (FT-LB)
3.13	0.0	6.0	1.9	-1.3	11.2	681.2	16.2	-40.	19703.	413.	1545.	189.	18240.	-398.	42140.
3.14	0.0	5.0	2.2	-1.4	9.6	681.7	16.2	-40.	19668.	392.	1505.	273.	18150.	-374.	41690.
3.15	0.0	5.6	1.9	-1.4	11.1	680.9	16.2	-40.	19639.	0.	1544.	209.	18220.	-386.	42110.
3.16	0.0	10.8	2.0	-1.6	12.3	678.8	16.2	-10.	19582.	451.	1610.	237.	18330.	-339.	45870.
3.17	0.0	10.9	1.8	-2.0	12.0	678.9	16.2	-10.	19557.	421.	1543.	152.	18270.	-352.	44840.
3.18	0.0	9.4	1.7	-1.7	11.4	679.7	16.2	-10.	19531.	409.	1522.	131.	18130.	-363.	43680.
3.19	0.0	19.6	2.0	-2.3	12.3	679.2	15.5	30.	19490.	447.	1579.	187.	18470.	-307.	46650.
3.20	0.0	21.0	1.5	-2.2	12.3	679.2	15.5	30.	19475.	463.	1605.	137.	18480.	-328.	46990.
3.21	0.0	21.0	1.9	-2.3	12.3	679.0	15.5	30.	19450.	430.	1568.	158.	18460.	-333.	47200.
3.22	0.0	40.2	1.4	-2.4	12.7	678.2	15.5	65.	19390.	450.	1580.	86.	18500.	-235.	49300.
3.23	0.0	40.7	1.7	-2.7	12.3	678.3	15.5	65.	19373.	431.	1562.	129.	18490.	-225.	48950.
3.24	0.0	40.9	1.5	-2.7	12.6	678.5	15.5	65.	19349.	436.	1547.	114.	18450.	-224.	48750.
3.25	0.0	101.7	1.4	-2.7	12.7	677.8	15.2	135.	19258.	462.	1587.	158.	18580.	12.	50070.
3.26	0.0	100.6	1.9	-2.7	12.8	677.9	15.2	135.	19241.	449.	1572.	203.	18630.	22.	49990.
3.27	0.0	103.0	1.9	-3.1	12.8	678.0	15.2	135.	19210.	487.	1573.	244.	18560.	25.	49930.
3.28	5.1	6.6	2.1	-1.0	10.8	683.3	16.1	-34.	19005.	0.	1641.	204.	17710.	-334.	40570.
3.29	5.7	5.2	1.5	-1.4	10.5	683.8	16.2	-41.	18995.	0.	1603.	178.	17690.	-313.	40120.
3.30	5.3	5.2	1.3	-2.0	11.0	684.2	16.7	-46.	18950.	0.	1627.	104.	17650.	-296.	39530.
3.31	9.3	6.1	1.9	-0.6	10.0	684.5	16.6	-25.	18907.	0.	1550.	166.	17600.	-328.	40010.
3.32	10.8	5.4	1.9	-2.2	10.5	684.7	16.9	-18.	18873.	0.	1473.	147.	17700.	-253.	40140.
3.33	10.7	4.5	1.3	-1.4	10.9	684.6	16.7	-33.	18823.	0.	1488.	60.	17530.	-282.	39780.
3.34	16.0	12.1	2.4	-2.2	11.3	684.7	16.9	-3.	18784.	426.	1538.	99.	17780.	-350.	39830.
3.45	0.0	5.2	1.8	-1.4	11.3	683.8	16.8	-500.	18324.	0.	1444.	189.	16960.	-241.	38180.
3.46	0.0	5.0	1.9	-1.4	11.0	682.9	17.1	-500.	18305.	0.	1434.	224.	16920.	-250.	38170.
3.47	0.0	4.9	2.0	-2.0	11.2	683.5	17.5	-500.	18274.	0.	1364.	214.	16990.	-206.	38200.
3.48	0.0	10.7	1.4	-2.0	10.8	680.5	17.0	-150.	18264.	0.	1482.	99.	17070.	-240.	40590.
3.49	0.0	10.4	1.7	-1.3	10.3	677.1	17.0	-150.	18249.	0.	1602.	108.	17120.	-288.	40110.
3.50	0.0	9.9	1.9	-2.0	9.0	682.1	17.0	-150.	18238.	0.	1424.	166.	17070.	-200.	39820.
3.51	0.0	20.1	1.1	-2.3	11.4	681.7	16.5	200.	18224.	0.	1504.	53.	17240.	-242.	42490.
3.52	0.0	19.5	1.5	-2.2	10.9	672.1	16.5	200.	18212.	0.	1564.	90.	17270.	-254.	42790.
3.53	0.0	20.4	1.5	-1.6	12.0	679.6	16.5	200.	18203.	0.	1451.	128.	17250.	-256.	43390.
3.54	0.0	39.6	0.9	-2.5	11.6	677.4	16.5	250.	18145.	0.	1578.	37.	17330.	-313.	44320.
3.55	0.0	40.2	1.6	-1.9	11.8	678.0	16.5	250.	18137.	0.	1559.	111.	17380.	-295.	44560.
3.56	0.0	39.5	1.5	-2.6	11.3	680.6	16.5	250.	18127.	451.	1481.	134.	17320.	-221.	44040.
3.57	0.0	98.7	1.4	-2.5	12.2	675.2	16.1	650.	18079.	432.	1568.	-5.	17600.	-298.	45450.
3.58	0.0	105.1	1.3	-3.0	12.3	679.0	16.1	650.	18052.	0.	1451.	13.	17470.	-212.	45230.
3.59	0.0	100.4	1.6	-2.5	12.3	678.9	16.1	650.	18041.	407.	1493.	80.	17530.	-253.	46090.
3.61	7.6	12.9	1.0	-1.3	11.4	682.6	16.8	0.	17959.	0.	1629.	31.	16880.	-297.	39730.
3.62	8.2	12.4	1.6	-0.6	11.5	681.5	16.5	0.	17933.	0.	1686.	137.	16890.	-337.	40360.
3.63	9.2	13.3	1.2	-1.1	10.7	682.6	16.6	0.	17926.	0.	1596.	59.	16880.	-317.	40060.
3.64	9.3	12.5	1.5	-0.6	10.4	681.4	17.4	0.	17871.	0.	1612.	121.	16690.	-308.	39920.
3.65	11.2	14.7	1.4	-1.5	11.0	682.5	17.5	-12.	17865.	0.	1583.	41.	16770.	-296.	39630.
3.66	10.5	8.4	2.1	-1.7	10.8	681.6	17.6	-12.	17748.	0.	1575.	158.	16680.	-265.	38620.
3.67	14.4	12.9	1.6	-1.3	11.2	682.7	17.7	0.	17692.	0.	1454.	-40.	16770.	-331.	37940.
3.68	16.2	13.8	2.3	-1.2	11.0	683.0	17.0	-12.	17666.	0.	1498.	89.	16730.	-360.	37520.
3.69	13.8	14.0	1.5	-0.5	11.3	682.4	17.5	-10.	17640.	0.	1515.	42.	16630.	-393.	38300.

TABLE IV (CONT)

POINT NO.	SPEED (KT)	WHEEL HGT (FT)	COLL (DEG)	GROSS WEIGHT (LB)	BALANCE THRUST (LB)	BALANCE DRAG (--)	BALANCE SIDE FORCE (--)	D/T (%)	DV (%)	TAIL ROT BLOCKAGE (--)	$\left(\frac{GW}{GW_\infty}\right)^{3/2}$ (--)	$\left(\frac{T}{T_\infty}\right)^{3/2}$ (--)	$\left(\frac{R}{Z}\right)$**2 (--)
3.13	0.0	6.0	11.2	19703.	19630.	0.000047	0.000099	-0.37	-0.37	1.353	1.224	1.168	2.250
3.14	0.0	5.0	9.6	19668.	19542.	0.000101	0.000094	-0.65	-0.64	1.332	1.237	1.173	2.485
3.15	0.0	5.6	11.1	19639.	19610.	0.000053	0.000093	-0.15	-0.15	1.353	1.212	1.168	2.340
3.16	0.0	10.8	12.3	19582.	19726.	0.000072	0.000119	0.73	0.50	1.295	1.117	1.082	1.482
3.17	0.0	10.9	12.0	19557.	19666.	0.000027	0.000068	0.55	0.32	1.270	1.153	1.102	1.470
3.18	0.0	9.4	11.4	19531.	19523.	0.000011	0.000086	-0.04	-0.19	1.286	1.184	1.119	1.659
3.19	0.0	19.6	12.3	19490.	19871.	0.000057	0.000065	1.92	1.41	1.248	1.100	1.074	0.818
3.20	0.0	21.0	12.3	19475.	19878.	-0.000007	0.000071	2.03	1.50	1.260	1.067	1.066	0.755
3.21	0.0	21.0	12.3	19450.	19861.	0.000038	0.000062	2.07	1.54	1.225	1.089	1.060	0.755
3.22	0.0	40.2	12.7	19390.	19906.	-0.000033	0.000099	2.59	1.88	1.182	1.036	1.018	0.319
3.23	0.0	40.7	12.3	19373.	19898.	0.000010	0.000070	2.64	1.93	1.177	1.045	1.025	0.313
3.24	0.0	40.9	12.6	19349.	19857.	-0.000014	0.000069	2.56	1.85	1.170	1.051	1.026	0.311
3.25	0.0	101.7	12.7	19258.	19999.	-0.000011	0.000150	3.70	2.95	1.169	1.007	1.010	0.071
3.26	0.0	100.6	12.8	19241.	20052.	0.000052	0.000152	4.04	3.31	1.160	1.012	1.016	0.072
3.27	0.0	103.0	12.8	19210.	19985.	0.000065	0.000114	3.88	3.13	1.161	1.011	1.012	0.069
3.28	5.1	6.6	10.8	19005.	19099.	0.000070	0.000136	0.49	0.49	1.493	1.172	1.163	2.125
3.29	5.7	5.2	10.5	18995.	19079.	0.000007	0.000102	0.44	0.44	1.475	1.188	1.174	2.435
3.30	5.3	5.2	11.0	18950.	19041.	-0.000033	0.000048	0.48	0.48	1.518	1.202	1.189	2.435
3.31	9.3	6.1	10.0	18907.	18984.	0.000040	0.000171	0.41	0.41	1.430	1.200	1.169	2.228
3.32	10.8	5.4	10.5	18873.	19096.	0.000035	0.000046	1.17	1.18	1.354	1.218	1.176	2.386
3.33	10.7	4.5	10.9	18823.	18920.	-0.000046	0.000110	0.51	0.51	1.380	1.217	1.170	2.616
3.34	16.0	12.1	11.3	18784.	19173.	0.000067	0.000014	2.03	2.07	1.424	1.211	1.193	1.341
3.45	0.0	5.2	11.3	18324.	18351.	0.000038	0.000112	0.15	0.15	1.396	1.188	1.159	2.435
3.46	0.0	5.0	11.0	18305.	18311.	0.000057	0.000110	0.03	0.03	1.386	1.190	1.158	2.485
3.47	0.0	4.9	11.2	18274.	18386.	0.000063	0.000070	0.61	0.61	1.317	1.202	1.164	2.510
3.48	0.0	10.7	10.8	18264.	18465.	-0.000024	0.000080	1.09	0.87	1.347	1.139	1.109	1.493
3.49	0.0	10.4	10.3	18249.	18511.	0.000006	0.000125	1.41	1.22	1.474	1.124	1.132	1.529
3.50	0.0	9.9	9.0	18238.	18468.	0.000041	0.000085	1.24	1.07	1.319	1.163	1.129	1.592
3.51	0.0	20.1	11.4	18224.	18637.	-0.000066	0.000066	2.22	1.71	1.306	1.100	1.076	0.795
3.52	0.0	19.5	10.9	18212.	18668.	-0.000019	0.000076	2.44	1.96	1.348	1.081	1.085	0.823
3.53	0.0	20.4	12.0	18203.	18645.	-0.000007	0.000134	2.37	1.87	1.234	1.091	1.056	0.781
3.54	0.0	39.6	11.6	18145.	18726.	-0.000091	0.000041	3.10	2.43	1.313	1.053	1.044	0.326
3.55	0.0	40.2	11.8	18137.	18777.	-0.000003	0.000103	3.41	2.75	1.291	1.046	1.041	0.319
3.56	0.0	39.5	11.3	18127.	18722.	-0.000005	0.000057	3.18	2.51	1.240	1.076	1.046	0.328
3.57	0.0	98.7	12.2	18079.	19001.	-0.000059	0.000052	4.85	4.19	1.272	1.045	1.049	0.075
3.58	0.0	105.1	12.3	18052.	18875.	-0.000062	0.000031	4.36	3.65	1.183	1.071	1.038	0.067
3.59	0.0	100.4	12.3	18041.	18933.	-0.000013	0.000072	4.71	4.04	1.195	1.040	1.023	0.073
3.61	7.6	12.9	11.4	17959.	18268.	-0.000079	0.000119	1.69	1.64	1.513	1.118	1.115	1.265
3.62	8.2	12.4	11.5	17933.	18273.	0.000006	0.000175	1.86	1.84	1.542	1.082	1.099	1.312
3.63	9.2	13.3	10.7	17926.	18267.	-0.000053	0.000134	1.87	1.87	1.470	1.109	1.105	1.229
3.64	9.3	12.5	10.4	17871.	18073.	-0.000007	0.000181	1.12	1.11	1.491	1.107	1.095	1.302
3.65	11.2	14.7	11.0	17865.	18161.	-0.000041	0.000102	1.63	1.66	1.474	1.117	1.109	1.114
3.66	10.5	8.4	10.8	17748.	18074.	0.000057	0.000087	1.80	1.84	1.505	1.131	1.133	1.806
3.67	14.4	12.9	11.2	17692.	18159.	-0.000047	0.000095	2.57	2.64	1.414	1.166	1.161	1.265
3.68	16.2	13.8	11.0	17666.	18118.	0.000053	0.000092	2.49	2.56	1.474	1.170	1.169	1.186
3.69	13.8	14.0	11.3	17640.	18012.	-0.000031	0.000151	2.06	2.11	1.460	1.143	1.136	1.169

TABLE IV (CONCLUDED)

POINT NO.	SPEED (KT)	W.HGT (FT)	MU	CW	CT	CQB	CQS	CPB	CPS	CPE	CTTR	CQTR	CTTRP
3.13	0.0	6.0	0.0	0.005933	0.005911	0.000409	0.000416	0.000497	0.000504	0.000506	0.01450	0.00172	0.01072
3.14	0.0	5.0	0.0	0.005914	0.005876	0.000404	0.000414	0.000489	0.000499	0.000498	0.01410	0.00163	0.01059
3.15	0.0	5.6	0.0	0.005919	0.005910	0.000409	0.000420	0.000494	0.000504	0.000509	0.01450	0.00162	0.01072
3.16	0.0	10.8	0.0	0.005945	0.005988	0.000449	0.000459	0.000544	0.000553	0.000555	0.01523	0.00190	0.01176
3.17	0.0	10.9	0.0	0.005935	0.005969	0.000439	0.000447	0.000529	0.000536	0.000537	0.01460	0.00178	0.01150
3.18	0.0	9.4	0.0	0.005914	0.005911	0.000427	0.000433	0.000515	0.000521	0.000520	0.01436	0.00172	0.01117
3.19	0.0	19.6	0.0	0.005904	0.006020	0.000456	0.000465	0.000550	0.000558	0.000558	0.01491	0.00188	0.01194
3.20	0.0	21.0	0.0	0.005900	0.006022	0.000459	0.000469	0.000556	0.000565	0.000574	0.01515	0.00195	0.01203
3.21	0.0	21.0	0.0	0.005895	0.006020	0.000462	0.000472	0.000553	0.000563	0.000562	0.01481	0.00181	0.01209
3.22	0.0	40.2	0.0	0.005899	0.006056	0.000484	0.000498	0.000579	0.000592	0.000591	0.01498	0.00191	0.01267
3.23	0.0	40.7	0.0	0.005892	0.006051	0.000480	0.000494	0.000573	0.000585	0.000585	0.01481	0.00182	0.01258
3.24	0.0	40.9	0.0	0.005881	0.006035	0.000478	0.000489	0.000571	0.000581	0.000580	0.01465	0.00184	0.01252
3.25	0.0	101.7	0.0	0.005874	0.006100	0.000493	0.000511	0.000590	0.000607	0.000604	0.01509	0.00196	0.01291
3.26	0.0	100.6	0.0	0.005867	0.006114	0.000492	0.000509	0.000587	0.000603	0.000600	0.01494	0.00191	0.01288
3.27	0.0	103.0	0.0	0.005856	0.006092	0.000491	0.000508	0.000592	0.000608	0.000599	0.01495	0.00207	0.01287
3.28	5.1	6.6	0.013	0.005687	0.005715	0.000392	0.000398	0.000473	0.000480	0.000496	0.01530	0.00154	0.01025
3.29	5.7	5.2	0.014	0.005676	0.005701	0.000387	0.000393	0.000467	0.000474	0.000488	0.01493	0.00151	0.01013
3.30	5.3	5.2	0.013	0.005665	0.005692	0.000381	0.000388	0.000460	0.000468	0.000481	0.01516	0.00149	0.00998
3.31	9.3	6.1	0.023	0.005649	0.005673	0.000386	0.000391	0.000465	0.000472	0.000480	0.01443	0.00151	0.01009
3.32	10.8	5.4	0.027	0.005643	0.005710	0.000387	0.000394	0.000467	0.000475	0.000472	0.01373	0.00152	0.01014
3.33	10.7	4.5	0.026	0.005623	0.005652	0.000383	0.000389	0.000463	0.000469	0.000470	0.01385	0.00150	0.01004
3.34	16.0	12.1	0.039	0.005620	0.005736	0.000384	0.000389	0.000473	0.000478	0.000472	0.01434	0.00176	0.01007
3.45	0.0	5.2	0.0	0.005397	0.005405	0.000363	0.000373	0.000438	0.000451	0.000453	0.01326	0.00140	0.00950
3.46	0.0	5.0	0.0	0.005411	0.005413	0.000364	0.000375	0.000440	0.000453	0.000454	0.01321	0.00141	0.00953
3.47	0.0	4.9	0.0	0.005400	0.005433	0.000364	0.000376	0.000440	0.000454	0.000448	0.01256	0.00141	0.00954
3.48	0.0	10.7	0.0	0.005504	0.005565	0.000395	0.000402	0.000476	0.000484	0.000486	0.01392	0.00155	0.01033
3.49	0.0	10.4	0.0	0.005555	0.005635	0.000394	0.000401	0.000476	0.000482	0.000499	0.01520	0.00155	0.01031
3.50	0.0	9.9	0.0	0.005471	0.005540	0.000385	0.000394	0.000465	0.000474	0.000472	0.01331	0.00151	0.01009
3.51	0.0	20.1	0.0	0.005533	0.005659	0.000416	0.000422	0.000502	0.000507	0.000507	0.01423	0.00166	0.01090
3.52	0.0	19.5	0.0	0.005689	0.005831	0.000431	0.000439	0.000521	0.000525	0.000537	0.01523	0.00173	0.01129
3.53	0.0	20.4	0.0	0.005561	0.005696	0.000428	0.000435	0.000516	0.000522	0.000515	0.01382	0.00171	0.01120
3.54	0.0	39.6	0.0	0.005589	0.005768	0.000440	0.000447	0.000531	0.000535	0.000537	0.01515	0.00178	0.01154
3.55	0.0	40.2	0.0	0.005577	0.005774	0.000442	0.000449	0.000533	0.000538	0.000539	0.01494	0.00179	0.01157
3.56	0.0	39.5	0.0	0.005531	0.005713	0.000434	0.000440	0.000528	0.000534	0.000518	0.01409	0.00191	0.01136
3.57	0.0	98.7	0.0	0.005679	0.005969	0.000461	0.000461	0.000556	0.000552	0.000554	0.01535	0.00190	0.01207
3.58	0.0	105.1	0.0	0.005608	0.005863	0.000453	0.000453	0.000547	0.000543	0.000531	0.01405	0.00185	0.01188
3.59	0.0	100.4	0.0	0.005606	0.005883	0.000462	0.000463	0.000552	0.000551	0.000546	0.01446	0.00176	0.01210
3.61	7.6	12.9	0.019	0.005405	0.005498	0.000386	0.000391	0.000466	0.000471	0.000482	0.01528	0.00151	0.01010
3.62	8.2	12.4	0.020	0.005409	0.005511	0.000393	0.000399	0.000474	0.000480	0.000498	0.01585	0.00154	0.01028
3.63	9.2	13.3	0.023	0.005391	0.005494	0.000389	0.000395	0.000469	0.000476	0.000484	0.01496	0.00152	0.01017
3.64	9.3	12.5	0.023	0.005408	0.005470	0.000390	0.000395	0.000471	0.000476	0.000487	0.01520	0.00153	0.01020
3.65	11.2	14.7	0.028	0.005389	0.005478	0.000386	0.000390	0.000466	0.000470	0.000480	0.01488	0.00151	0.01010
3.66	10.5	8.4	0.026	0.005369	0.005468	0.000377	0.000382	0.000456	0.000460	0.000472	0.01485	0.00147	0.00987
3.67	14.4	12.9	0.036	0.005339	0.005480	0.000369	0.000374	0.000447	0.000451	0.000454	0.01368	0.00143	0.00967
3.68	16.2	13.8	0.040	0.005312	0.005448	0.000364	0.000368	0.000440	0.000445	0.000449	0.01404	0.00141	0.00953
3.69	13.8	14.0	0.034	0.005323	0.005435	0.000373	0.000378	0.000451	0.000456	0.000461	0.01425	0.00145	0.00976

TABLE V

TABULATED DATA – FLIGHT 4

POINT NO.	V (KT)	WH (FT)	TB (DEG)	PB (DEG)	TC (DEG)	OR (FPS)	TEMP (DEG C)	ALT (FT)	GW (LB)	TRQ (FT-LB)	TRT (LB)	X (LB)	-Z (LB)	Y (LB)	BMRQ (FT-LB)
4.16	15.0	10.0	2.7	-0.9	12.1	685.7	14.9	66.	19070.	488.	1673.	124.	17890.	-367.	41180.
4.17	15.0	10.0	1.1	-2.0	11.4	685.4	15.0	39.	19038.	0.	1526.	95.	17590.	-198.	41340.
4.18	15.0	10.0	1.6	-1.9	11.3	684.2	15.2	53.	18985.	531.	1572.	167.	17700.	-221.	41480.
4.19	5.0	20.0	1.5	-1.4	11.7	683.7	15.0	42.	18923.	527.	1730.	157.	17500.	-211.	41560.
4.20	5.0	20.0	2.4	-1.0	11.1	684.0	15.2	27.	18844.	0.	1648.	272.	17450.	-186.	40750.
4.21	5.0	20.0	1.3	-1.8	11.7	684.0	15.2	43.	18822.	0.	1643.	111.	17430.	-194.	41480.
4.22	10.0	20.0	2.5	-1.5	11.4	683.9	15.1	43.	18766.	0.	1597.	255.	17450.	-216.	41230.
4.23	10.0	20.0	1.9	-1.7	11.5	684.1	15.2	43.	18757.	0.	1604.	178.	17380.	-208.	41160.
4.24	10.0	20.0	2.5	-1.5	12.0	684.8	15.2	43.	18715.	0.	1450.	242.	17350.	-176.	40840.
4.28	5.0	20.0	1.8	-0.9	11.4	682.2	15.0	33.	18580.	0.	1750.	168.	17160.	-311.	41060.
4.29	5.0	20.0	0.7	-1.8	11.1	681.9	15.1	42.	18558.	0.	1739.	112.	17300.	-261.	41700.
4.30	5.0	20.0	1.9	-1.2	11.3	682.5	15.0	47.	18553.	0.	1648.	148.	17250.	-259.	41650.
4.31	10.0	20.0	2.4	-0.6	12.1	682.3	15.0	36.	18505.	0.	1656.	256.	17110.	-286.	41140.
4.32	10.0	20.0	1.6	-0.7	11.6	682.9	15.2	33.	18496.	0.	1597.	186.	17200.	-268.	41150.
4.33	10.0	20.0	2.5	-1.6	11.4	685.9	15.2	51.	18397.	0.	1568.	292.	17100.	-205.	40730.
4.35	15.0	20.0	3.1	-1.4	11.0	689.8	15.4	18.	18287.	0.	1399.	299.	17100.	-321.	36280.
4.36	15.0	20.0	1.7	-0.6	11.5	686.5	15.5	54.	18238.	400.	1544.	63.	17160.	-371.	38720.
4.40	15.0	20.0	3.2	-1.5	11.7	688.5	15.5	46.	18083.	400.	1462.	189.	16860.	-248.	37610.
4.41	5.0	100.0	1.5	-2.8	11.7	686.4	15.0	120.	17968.	420.	1621.	74.	17140.	-217.	43130.
4.42	5.0	100.0	1.2	-1.8	11.6	687.0	15.0	120.	17933.	400.	1633.	31.	17090.	-330.	41430.
4.43	5.0	100.0	1.2	-2.2	10.9	686.6	15.0	120.	17923.	450.	1651.	37.	17160.	-328.	41910.
4.44	10.0	100.0	0.8	-2.7	12.0	686.2	14.9	110.	17879.	480.	1705.	138.	17120.	-356.	42200.
4.45	10.0	100.0	0.9	-2.2	11.4	687.1	14.9	110.	17858.	460.	1668.	164.	16960.	-345.	40710.
4.46	10.0	100.0	0.9	-1.7	11.7	688.4	14.8	147.	17813.	0.	1594.	280.	16870.	-349.	39390.
4.47	5.0	10.0	2.3	-1.2	11.4	689.9	15.4	6.	17716.	391.	1535.	196.	16290.	-201.	36660.
4.48	5.0	10.0	1.6	-1.0	11.4	689.9	15.5	6.	17700.	420.	1626.	116.	16280.	-267.	36820.
4.49	5.0	10.0	1.8	-1.1	11.4	689.8	15.5	6.	17693.	432.	1600.	133.	16270.	-276.	36840.
4.50	10.0	10.0	2.1	-2.2	11.5	686.8	15.7	19.	17616.	361.	1467.	172.	16180.	-145.	36940.
4.51	10.0	10.0	2.2	-1.8	11.6	686.0	15.7	28.	17605.	400.	1496.	234.	16320.	-186.	38030.
4.52	10.0	10.0	1.9	-1.2	11.5	686.4	15.5	25.	17565.	406.	1500.	189.	16190.	-208.	38030.
4.53	15.0	10.0	2.2	-1.5	11.5	687.8	15.6	48.	17521.	450.	1521.	140.	16220.	-252.	36720.
4.54	15.0	10.0	2.4	-1.4	11.4	688.6	15.8	38.	17471.	450.	1482.	80.	16270.	-288.	35860.
4.55	15.0	10.0	2.1	-1.0	11.2	689.6	15.8	52.	17466.	425.	1403.	-15.	16310.	-318.	34790.
4.56	5.0	20.0	1.7	-1.6	11.6	683.9	15.6	48.	17382.	0.	1588.	174.	16040.	-207.	37080.
4.57	5.0	20.0	1.6	-1.9	11.3	684.0	15.6	40.	17372.	0.	1599.	157.	16100.	-185.	37920.
4.58	5.0	20.0	1.8	-1.4	11.6	683.6	15.7	36.	17361.	0.	1612.	165.	16130.	-224.	37720.
4.59	10.0	20.0	1.8	-0.9	11.7	683.7	16.0	43.	17286.	0.	1521.	144.	15960.	-240.	38330.
4.60	10.0	20.0	1.7	-1.1	11.3	682.9	15.9	28.	17274.	0.	1603.	99.	16020.	-288.	38150.
4.61	10.0	20.0	2.3	-1.6	11.7	683.1	15.9	24.	17269.	0.	1617.	170.	16080.	-270.	38500.
4.62	15.0	20.0	2.2	-1.4	11.3	686.0	15.8	44.	17227.	0.	1389.	99.	16030.	-286.	35070.
4.63	15.0	20.0	1.5	-0.3	11.1	687.3	15.8	18.	17219.	0.	1357.	53.	15910.	-340.	33740.
4.64	15.0	20.0	2.3	-1.5	11.3	686.6	15.9	43.	17188.	0.	1372.	118.	15990.	-264.	34660.

TABLE V (CONT)

POINT NO.	SPEED (KT)	WHEEL HGT (FT)	COLL (DEG)	GROSS WEIGHT (LB)	BALANCE THRUST (LB)	BALANCE DRAG (--)	BALANCE SIDE FORCE (--)	D/T (%)	DV (%)	TAIL ROT BLOCKAGE (--)	$\left(\frac{GW}{GW_{\infty}}\right)^{3/2}$ (--)	$\left(\frac{T}{T_{\infty}}\right)^{3/2}$ (--)	$\left(\frac{R}{Z}\right)$ **2 (--)
4.16	15.0	10.0	12.1	19070.	19277.	0.000102	0.000139	1.08	1.09	1.500	1.179	1.157	1.579
4.17	15.0	10.0	11.4	19038.	18986.	-0.000054	0.000092	-0.28	-0.28	1.362	1.201	1.127	1.579
4.18	15.0	10.0	11.3	18985.	19096.	0.000013	0.000094	0.58	0.59	1.398	1.182	1.135	1.579
4.19	5.0	20.0	11.7	18923.	18893.	0.000001	0.000146	-0.16	-0.26	1.536	1.139	1.115	0.800
4.20	5.0	20.0	11.1	18844.	18843.	0.000117	0.000183	-0.01	-0.10	1.493	1.178	1.133	0.800
4.21	5.0	20.0	11.7	18822.	18826.	-0.000030	0.000114	0.02	-0.08	1.461	1.156	1.111	0.800
4.22	10.0	20.0	11.4	18766.	18847.	0.000122	0.000133	0.43	0.43	1.429	1.160	1.120	0.800
4.23	10.0	20.0	11.5	18757.	18777.	0.000044	0.000117	0.10	0.10	1.438	1.166	1.116	0.800
4.24	10.0	20.0	12.0	18715.	18748.	0.000117	0.000142	0.17	0.17	1.310	1.191	1.121	0.800
4.28	5.0	20.0	11.4	18580.	18547.	0.000032	0.000159	-0.18	-0.27	1.573	1.120	1.100	0.800
4.29	5.0	20.0	11.1	18558.	18689.	-0.000084	0.000098	0.70	0.61	1.539	1.103	1.096	0.800
4.30	5.0	20.0	11.3	18553.	18642.	0.000035	0.000152	0.48	0.38	1.460	1.130	1.092	0.800
4.31	10.0	20.0	12.1	18505.	18497.	0.000113	0.000195	-0.04	-0.04	1.486	1.133	1.093	0.800
4.32	10.0	20.0	11.6	18496.	18585.	0.000020	0.000191	0.48	0.48	1.433	1.142	1.100	0.800
4.33	10.0	20.0	11.4	18397.	18498.	0.000131	0.000125	0.55	0.55	1.421	1.141	1.100	0.800
4.35	15.0	20.0	11.0	18287.	18491.	0.000184	0.000072	1.11	1.12	1.423	1.291	1.235	0.800
4.36	15.0	20.0	11.5	18238.	18543.	-0.000008	0.000148	1.65	1.67	1.472	1.190	1.164	0.800
4.40	15.0	20.0	11.7	18083.	18252.	0.000160	0.000097	0.93	0.94	1.434	1.225	1.169	0.800
4.41	5.0	100.0	11.7	17968.	18542.	-0.000022	0.000034	3.10	3.04	1.386	1.050	1.041	0.073
4.42	5.0	100.0	11.6	17933.	18482.	-0.000062	0.000076	2.97	2.90	1.454	1.077	1.079	0.073
4.43	5.0	100.0	10.9	17923.	18554.	-0.000060	0.000044	3.40	3.36	1.453	1.056	1.073	0.073
4.44	10.0	100.0	12.0	17879.	18509.	-0.000065	-0.000006	3.40	3.52	1.490	1.030	1.062	0.073
4.45	10.0	100.0	11.4	17858.	18348.	-0.000048	0.000032	2.67	2.74	1.511	1.078	1.086	0.073
4.46	10.0	100.0	11.7	17813.	18253.	-0.000013	0.000064	2.41	2.47	1.493	1.109	1.114	0.073
4.47	5.0	10.0	11.4	17716.	17682.	0.000082	0.000132	-0.19	-0.23	1.545	1.183	1.142	1.579
4.48	5.0	10.0	11.4	17700.	17667.	0.000001	0.000131	-0.19	-0.22	1.630	1.155	1.135	1.579
4.49	5.0	10.0	11.4	17693.	17658.	0.000022	0.000120	-0.20	-0.23	1.603	1.155	1.134	1.579
4.50	10.0	10.0	11.5	17616.	17579.	0.000059	0.000070	-0.21	-0.21	1.465	1.178	1.128	1.579
4.51	10.0	10.0	11.6	17605.	17717.	0.000086	0.000099	0.63	0.64	1.451	1.136	1.109	1.579
4.52	10.0	10.0	11.5	17565.	17581.	0.000048	0.000143	0.09	0.09	1.456	1.129	1.095	1.579
4.53	15.0	10.0	11.5	17521.	17612.	0.000058	0.000094	0.52	0.52	1.529	1.170	1.137	1.579
4.54	15.0	10.0	11.4	17471.	17660.	0.000057	0.000084	1.07	1.08	1.525	1.189	1.170	1.579
4.55	15.0	10.0	11.2	17466.	17696.	0.000004	0.000100	1.30	1.32	1.488	1.238	1.210	1.579
4.56	5.0	20.0	11.6	17382.	17433.	0.000027	0.000105	0.29	0.19	1.580	1.103	1.114	0.800
4.57	5.0	20.0	11.3	17372.	17495.	0.000013	0.000092	0.70	0.61	1.556	1.104	1.094	0.800
4.58	5.0	20.0	11.6	17361.	17522.	0.000033	0.000121	0.92	0.83	1.577	1.107	1.103	0.800
4.59	10.0	20.0	11.7	17286.	17348.	0.000026	0.000164	0.36	0.36	1.465	1.107	1.069	0.800
4.60	10.0	20.0	11.3	17274.	17408.	0.000005	0.000131	0.77	0.78	1.551	1.093	1.081	0.800
4.61	10.0	20.0	11.7	17269.	17474.	0.000076	0.000097	1.17	1.19	1.550	1.080	1.076	0.800
4.62	15.0	20.0	11.3	17227.	17419.	0.000046	0.000081	1.10	1.12	1.462	1.216	1.177	0.800
4.63	15.0	20.0	11.1	17219.	17289.	-0.000025	0.000145	0.41	0.41	1.485	1.267	1.210	0.800
4.64	15.0	20.0	11.3	17188.	17380.	0.000060	0.000076	1.11	1.12	1.461	1.231	1.187	0.800

TABLE V (CONCLUDED)

POINT NO.	SPEED (KT)	W.HGT (FT)	MU	CW	CT	CQB	CQS	CPB	CPS	CPE	CTTR	CQTR	CTTRP
4.16	15.0	10.0	0.037	0.005663	0.005725	0.000395	0.000404	0.000491	0.000500	0.000490	0.01549	0.00200	0.01033
4.17	15.0	10.0	0.037	0.005655	0.005640	0.000396	0.000405	0.000478	0.000486	0.000480	0.01413	0.00156	0.01037
4.18	15.0	10.0	0.037	0.005666	0.005699	0.000399	0.000408	0.000503	0.000510	0.000489	0.01462	0.00219	0.01046
4.19	5.0	20.0	0.012	0.005650	0.005641	0.000400	0.000406	0.000503	0.000508	0.000505	0.01610	0.00217	0.01048
4.20	5.0	20.0	0.012	0.005622	0.005622	0.000392	0.000396	0.000473	0.000476	0.000485	0.01532	0.00154	0.01027
4.21	5.0	20.0	0.012	0.005619	0.005620	0.000399	0.000404	0.000482	0.000486	0.000494	0.01529	0.00158	0.01046
4.22	10.0	20.0	0.025	0.005602	0.005626	0.000397	0.000407	0.000479	0.000488	0.000490	0.01486	0.00156	0.01039
4.23	10.0	20.0	0.025	0.005598	0.005604	0.000396	0.000405	0.000478	0.000486	0.000487	0.01492	0.00156	0.01038
4.24	10.0	20.0	0.025	0.005574	0.005584	0.000392	0.000399	0.000473	0.000480	0.000474	0.01346	0.00154	0.01027
4.28	5.0	20.0	0.012	0.005570	0.005560	0.000397	0.000403	0.000479	0.000484	0.000503	0.01635	0.00156	0.01039
4.29	5.0	20.0	0.012	0.005572	0.005612	0.000404	0.000412	0.000487	0.000494	0.000511	0.01627	0.00160	0.01058
4.30	5.0	20.0	0.012	0.005560	0.005586	0.000403	0.000412	0.000486	0.000494	0.000497	0.01539	0.00159	0.01054
4.31	10.0	20.0	0.025	0.005547	0.005544	0.000398	0.000406	0.000480	0.000487	0.000494	0.01547	0.00157	0.01041
4.32	10.0	20.0	0.025	0.005537	0.005564	0.000397	0.000403	0.000479	0.000484	0.000489	0.01490	0.00157	0.01040
4.33	10.0	20.0	0.025	0.005463	0.005493	0.000390	0.000397	0.000471	0.000477	0.000480	0.01451	0.00153	0.01022
4.35	15.0	20.0	0.037	0.005367	0.005427	0.000343	0.000349	0.000416	0.000422	0.000414	0.01280	0.00132	0.00899
4.36	15.0	20.0	0.037	0.005413	0.005503	0.000371	0.000377	0.000454	0.000461	0.000454	0.01428	0.00163	0.00970
4.40	15.0	20.0	0.037	0.005334	0.005384	0.000358	0.000365	0.000441	0.000449	0.000432	0.01344	0.00162	0.00937
4.41	5.0	100.0	0.012	0.005338	0.005508	0.000413	0.000417	0.000500	0.000504	0.000503	0.01501	0.00172	0.01083
4.42	5.0	100.0	0.012	0.005318	0.005481	0.000396	0.000400	0.000480	0.000484	0.000488	0.01509	0.00163	0.01038
4.43	5.0	100.0	0.012	0.005321	0.005508	0.000401	0.000409	0.000492	0.000500	0.000498	0.01528	0.00184	0.01051
4.44	10.0	100.0	0.025	0.005310	0.005498	0.000404	0.000412	0.000500	0.000507	0.000509	0.01578	0.00196	0.01059
4.45	10.0	100.0	0.025	0.005290	0.005436	0.000389	0.000393	0.000481	0.000485	0.000484	0.01540	0.00187	0.01019
4.46	10.0	100.0	0.025	0.005262	0.005392	0.000375	0.000384	0.000453	0.000462	0.000467	0.01468	0.00146	0.00983
4.47	5.0	10.0	0.012	0.005195	0.005185	0.000347	0.000353	0.000428	0.000435	0.000430	0.01403	0.00157	0.00908
4.48	5.0	10.0	0.012	0.005192	0.005183	0.000348	0.000355	0.000433	0.000441	0.000440	0.01487	0.00169	0.00912
4.49	5.0	10.0	0.012	0.005192	0.005182	0.000349	0.000356	0.000435	0.000444	0.000440	0.01463	0.00174	0.00913
4.50	10.0	10.0	0.025	0.005221	0.005210	0.000353	0.000363	0.000431	0.000441	0.000435	0.01355	0.00147	0.00925
4.51	10.0	10.0	0.025	0.005231	0.005264	0.000365	0.000375	0.000448	0.000459	0.000452	0.01385	0.00164	0.00955
4.52	10.0	10.0	0.025	0.005209	0.005214	0.000364	0.000371	0.000448	0.000456	0.000452	0.01386	0.00166	0.00952
4.53	15.0	10.0	0.037	0.005181	0.005208	0.000350	0.000357	0.000440	0.000448	0.000433	0.01402	0.00183	0.00917
4.54	15.0	10.0	0.037	0.005156	0.005212	0.000341	0.000345	0.000431	0.000435	0.000423	0.01363	0.00182	0.00894
4.55	15.0	10.0	0.037	0.005142	0.005210	0.000330	0.000334	0.000416	0.000421	0.000405	0.01287	0.00171	0.00865
4.56	5.0	20.0	0.012	0.005199	0.005214	0.000358	0.000375	0.000433	0.000450	0.000461	0.01480	0.00138	0.00937
4.57	5.0	20.0	0.012	0.005193	0.005229	0.000366	0.000373	0.000442	0.000449	0.000460	0.01490	0.00142	0.00958
4.58	5.0	20.0	0.012	0.005196	0.005245	0.000364	0.000374	0.000440	0.000449	0.000459	0.01504	0.00141	0.00954
4.59	10.0	20.0	0.025	0.005179	0.005198	0.000370	0.000376	0.000448	0.000452	0.000457	0.01420	0.00144	0.00970
4.60	10.0	20.0	0.025	0.005183	0.005223	0.000369	0.000375	0.000446	0.000451	0.000463	0.01499	0.00143	0.00967
4.61	10.0	20.0	0.025	0.005178	0.005239	0.000372	0.000379	0.000450	0.000456	0.000468	0.01511	0.00145	0.00975
4.62	15.0	20.0	0.037	0.005124	0.005181	0.000336	0.000344	0.000408	0.000415	0.000410	0.01288	0.00128	0.00881
4.63	15.0	20.0	0.037	0.005097	0.005118	0.000322	0.000325	0.000391	0.000394	0.000391	0.01252	0.00122	0.00843
4.64	15.0	20.0	0.037	0.005105	0.005162	0.000332	0.000334	0.000403	0.000405	0.000403	0.01270	0.00126	0.00869

SIKORSKY AIRCRAFT UNITED TECHNOLOGIES ®

TABLE VI

TABULATED DATA – FLIGHT 5

POINT NO.	V (KT)	WH (FT)	TB (DEG)	PB (DEG)	TC (DEG)	OR (FPS)	TEMP (DEG C)	ALT (FT)	GW (LB)	TRQ (FT-LB)	TRT (LB)	X (LB)	-Z (LB)	Y (LB)	BMRQ (FT-LB)
5.14	14.6	8.2	1.2	-1.8	11.5	683.3	15.2	40.	19675.	423.	1647.	62.	18360.	-296.	43190.
5.15	15.5	6.2	1.8	-1.8	11.5	682.4	15.2	30.	19618.	453.	1706.	103.	18220.	-284.	43120.
5.16	17.8	6.4	3.0	-1.7	11.4	683.8	15.5	40.	19561.	386.	1599.	132.	18360.	-295.	41610.
5.17	6.2	21.7	1.4	-1.7	11.9	679.0	15.0	40.	19530.	447.	1681.	64.	18350.	-311.	45920.
5.18	6.5	21.3	1.5	-2.1	11.8	679.8	15.0	50.	19499.	542.	1811.	103.	18250.	-293.	46630.
5.19	6.5	17.3	0.7	-2.0	11.7	680.4	15.0	50.	19468.	393.	1599.	15.	18190.	-221.	44980.
5.20	8.5	14.5	1.2	-1.1	11.6	679.8	15.0	50.	19429.	509.	1793.	76.	18110.	-339.	45220.
5.21	9.6	16.3	1.0	-1.8	11.8	680.0	15.1	30.	19390.	442.	1701.	153.	18180.	-261.	45430.
5.22	9.4	17.4	1.7	-1.2	11.7	678.7	15.2	30.	19351.	520.	1806.	131.	18120.	-320.	45510.
5.23	15.9	22.3	2.7	-0.4	11.4	686.3	15.4	6.	19270.	520.	1823.	381.	18130.	-480.	41110.
5.24	16.2	23.7	2.3	-0.3	11.4	686.2	15.2	25.	19217.	501.	1766.	226.	18110.	-469.	42760.
5.25	15.5	21.1	2.0	-0.8	11.3	686.5	15.3	16.	19163.	406.	1622.	238.	17950.	-427.	40020.
5.26	8.3	98.7	1.0	-1.8	12.0	680.7	14.9	91.	19087.	576.	1850.	27.	18300.	-333.	47880.
5.28	9.5	125.9	2.0	-2.1	11.4	683.3	15.0	109.	18935.	679.	2072.	303.	17820.	-564.	41310.
5.29	8.6	93.0	0.8	-0.7	12.0	680.9	14.7	73.	18897.	751.	2100.	24.	18260.	-518.	46110.
5.31	11.4	104.0	4.1	-1.4	11.5	682.7	14.5	106.	18820.	622.	1964.	576.	17680.	-415.	40980.
5.32	9.4	98.2	1.1	-0.7	11.8	680.5	14.5	91.	18782.	861.	2217.	275.	18040.	-500.	43970.
5.33	11.7	121.8	1.5	-1.0	11.7	681.1	14.6	113.	18715.	740.	2084.	118.	17880.	-454.	45060.
5.34	15.5	101.1	4.0	-1.6	11.4	683.8	14.5	82.	18649.	556.	1885.	577.	17580.	-387.	40820.
5.35	12.7	110.9	3.1	-1.0	11.4	683.2	14.7	101.	18582.	650.	1996.	495.	17590.	-451.	40340.
5.36	17.6	155.1	4.4	-0.3	10.8	686.6	14.5	149.	18515.	488.	1818.	719.	17430.	-483.	36820.
5.37	7.9	20.2	1.3	-1.3	11.3	683.1	14.9	4.	18463.	488.	1748.	65.	17270.	-255.	42870.
5.38	8.5	21.4	1.3	-2.2	11.3	682.7	15.0	20.	18411.	507.	1773.	52.	17300.	-248.	43420.
5.39	8.5	23.5	1.4	-1.4	11.2	683.5	15.0	20.	18359.	502.	1758.	72.	17230.	-319.	42530.
5.40	11.0	17.7	1.3	-1.8	11.2	683.5	15.0	10.	18341.	520.	1785.	15.	17210.	-310.	42190.
5.41	10.8	19.2	1.7	-1.1	11.2	684.9	15.0	10.	18322.	450.	1689.	20.	17150.	-276.	41330.
5.42	10.7	19.3	0.8	-1.6	11.2	684.1	15.2	10.	18304.	456.	1696.	-30.	17180.	-287.	42170.
5.43	14.2	18.4	1.2	-1.1	10.9	686.7	15.0	30.	18271.	375.	1572.	8.	17120.	-297.	39390.
5.44	16.6	17.6	0.4	-1.0	11.3	685.9	14.3	-47.	18238.	389.	1626.	62.	17220.	-371.	39880.
5.45	16.2	15.8	1.8	-1.3	10.8	687.1	15.0	17.	18206.	374.	1564.	-13.	17000.	-307.	39030.
5.46	12.6	109.1	2.6	-2.2	11.5	682.6	14.7	98.	18176.	581.	1863.	161.	17470.	-337.	43650.
5.47	10.8	117.3	1.6	-1.9	11.5	682.2	14.7	106.	18147.	606.	1909.	56.	17560.	-362.	44050.
5.48	7.5	106.1	1.3	-1.4	11.6	681.2	14.6	93.	18117.	677.	1999.	24.	17480.	-422.	44240.
5.49	12.1	93.2	2.8	-1.7	11.6	682.0	14.5	80.	18086.	595.	1890.	227.	17390.	-419.	43340.
5.50	10.6	99.1	1.1	-1.1	11.3	683.2	14.6	80.	18055.	603.	1902.	41.	17390.	-455.	41840.
5.51	13.9	103.2	2.8	-0.5	10.7	677.6	14.6	80.	18024.	462.	1743.	435.	17010.	-370.	37380.
5.53	19.5	119.3	3.2	-0.9	10.1	692.0	14.5	100.	17903.	263.	1455.	604.	16740.	-304.	33660.
5.54	22.4	126.2	2.6	-0.2	10.2	690.7	14.5	100.	17867.	270.	1470.	495.	16830.	-310.	34840.
5.55	16.1	121.7	2.5	-0.8	10.6	687.8	14.5	100.	17831.	393.	1668.	492.	16750.	-341.	36520.
5.56	6.2	11.1	1.6	-2.2	10.8	682.1	14.0	15.	17793.	367.	1491.	80.	16460.	-184.	38370.
5.57	4.8	11.8	1.3	-2.6	10.7	682.5	15.0	15.	17754.	327.	1431.	98.	16520.	-134.	38880.
5.58	4.8	11.8	1.6	-2.3	10.8	681.8	15.0	15.	17716.	373.	1486.	103.	16470.	-181.	39170.
5.59	10.2	8.6	1.3	-1.4	10.6	682.6	15.9	15.	17700.	472.	1685.	6.	16410.	-274.	38190.
5.60	11.4	8.6	1.1	-2.2	10.7	682.3	14.0	15.	17677.	422.	1613.	1.	16400.	-189.	38650.
5.61	11.4	9.7	1.2	-2.0	10.8	682.2	15.0	15.	17658.	432.	1635.	19.	16430.	-210.	39090.
5.62	16.6	9.1	2.3	-1.3	10.6	684.6	15.2	20.	17631.	352.	1498.	83.	16470.	-201.	38350.
5.63	16.3	9.8	1.9	-2.4	10.5	686.3	15.5	20.	17604.	350.	1469.	-18.	16520.	-276.	36410.

TABLE VI (CONT)

POINT NO.	V (KT)	WH (FT)	TB (DEG)	PB (DEG)	TC (DEG)	OR (FPS)	TEMP (DEG C)	ALT (FT)	GW (LB)	TRQ (FT-LB)	TRT (LB)	X (LB)	-Z (LB)	Y (LB)	BMRQ (FT-LB)
5.64	15.8	7.5	2.2	-2.3	10.6	684.6	15.3	20.	17577.	379.	1559.	36.	16530.	-259.	36890.
5.65	6.7	21.1	1.0	-1.9	10.8	684.2	15.2	20.	17559.	361.	1462.	-11.	16420.	-199.	39830.
5.66	7.7	21.5	0.9	-2.1	11.0	683.1	15.4	20.	17540.	450.	1638.	-9.	16480.	-228.	40690.
5.67	8.3	20.2	1.2	-0.5	10.9	683.8	15.4	5.	17522.	454.	1658.	-12.	16510.	-322.	40130.
5.68	11.2	18.5	2.0	-2.2	10.8	684.7	15.1	5.	17505.	352.	1490.	75.	16460.	-177.	39600.
5.69	11.3	18.7	2.2	-1.3	10.9	683.8	15.1	5.	17487.	424.	1617.	68.	16500.	-284.	40030.
5.70	11.3	20.8	1.5	-0.8	10.9	683.5	15.2	5.	17470.	454.	1657.	28.	16440.	-311.	39670.
5.71	15.0	20.0	1.0	-1.5	10.7	685.0	15.2	21.	17447.	365.	1512.	-58.	16420.	-308.	38690.
5.72	15.0	20.0	2.4	-0.2	10.5	686.6	15.2	10.	17423.	346.	1479.	71.	16340.	-351.	37030.
5.73	15.7	16.4	1.4	-1.6	10.8	685.1	15.2	25.	17294.	407.	1607.	-64.	16290.	-287.	38230.
5.74	7.5	92.6	1.6	-1.7	11.0	683.6	14.9	25.	17186.	537.	1806.	60.	16690.	-361.	39690.
5.75	8.7	91.8	1.5	-2.5	11.3	683.2	14.6	77.	17181.	474.	1719.	18.	16640.	-290.	42090.
5.76	9.6	90.8	1.8	-1.7	11.1	683.7	14.7	70.	17175.	592.	1898.	126.	16590.	-410.	40020.

TABLE VI (CONT)

POINT NO.	SPEED (KT)	WHEEL HGT (FT)	COLL (DEG)	GROSS WEIGHT (LB)	BALANCE THRUST (LB)	BALANCE DRAG (--)	BALANCE SIDE FORCE (--)	D/T (%)	DV (%)	TAIL ROT BLOCKAGE (--)	$\left(\frac{GW}{GW_{\infty}}\right)^{3/2}$ (--)	$\left(\frac{T}{T_{\infty}}\right)^{3/2}$ (--)	$\left(\frac{R}{Z}\right)$**2 (--)
5.14	14.6	8.2	11.5	19675.	19753.	-0.000058	0.000089	0.40	0.40	1.407	1.199	1.146	1.838
5.15	15.5	6.2	11.5	19618.	19616.	0.000012	0.000094	-0.01	-0.01	1.460	1.191	1.137	2.207
5.16	17.8	6.4	11.4	19561.	19754.	0.000135	0.000086	0.98	0.99	1.418	1.242	1.191	2.165
5.17	6.2	21.7	11.9	19530.	19746.	-0.000039	0.000118	1.09	1.03	1.351	1.120	1.081	0.727
5.18	6.5	21.3	11.8	19499.	19649.	-0.000017	0.000091	0.77	0.70	1.433	1.071	1.055	0.743
5.19	6.5	17.3	11.7	19468.	19586.	-0.000120	0.000109	0.60	0.55	1.311	1.158	1.089	0.940
5.20	8.5	14.5	11.6	19429.	19499.	-0.000053	0.000163	0.36	0.34	1.463	1.116	1.076	1.130
5.21	9.6	16.3	11.8	19390.	19574.	-0.000050	0.000120	0.94	0.94	1.381	1.124	1.077	1.002
5.22	9.4	17.4	11.7	19351.	19512.	0.000011	0.000162	0.82	0.82	1.465	1.099	1.072	0.935
5.23	15.9	22.3	11.4	19270.	19515.	0.000179	0.000150	1.26	1.27	1.637	1.179	1.180	0.703
5.24	16.2	23.7	11.4	19217.	19492.	0.000095	0.000176	1.41	1.43	1.525	1.144	1.130	0.653
5.25	15.5	21.1	11.3	19163.	19335.	0.000070	0.000120	0.89	0.90	1.496	1.242	1.196	0.751
5.26	8.3	98.7	12.0	19087.	19696.	-0.000088	0.000117	3.09	3.14	1.426	1.020	1.029	0.075
5.28	9.5	125.9	11.4	18935.	19206.	0.000091	-0.000029	1.41	1.42	1.850	1.117	1.152	0.049
5.29	8.6	93.0	12.0	18897.	19641.	-0.000108	0.000153	3.79	3.89	1.681	0.986	1.065	0.083
5.31	11.4	104.0	11.5	18820.	19079.	0.000367	0.000079	1.36	1.37	1.769	1.114	1.150	0.068
5.32	9.4	98.2	11.8	18782.	19418.	-0.000003	0.000142	3.28	3.37	1.861	0.989	1.100	0.075
5.33	11.7	121.8	11.7	18715.	19267.	-0.000011	0.000137	2.86	2.95	1.707	0.997	1.060	0.052
5.34	15.5	101.1	11.4	18649.	18980.	0.000355	0.000068	1.75	1.78	1.704	1.120	1.144	0.072
5.35	12.7	110.9	11.4	18582.	18982.	0.000249	0.000100	2.11	2.16	1.826	1.097	1.160	0.061
5.36	17.6	155.1	10.8	18515.	18825.	0.000430	0.000126	1.65	1.67	1.823	1.234	1.255	0.033
5.37	7.9	20.2	11.3	18463.	18662.	-0.000044	0.000154	1.06	1.04	1.505	1.079	1.060	0.790
5.38	8.5	21.4	11.3	18411.	18699.	-0.000048	0.000079	1.54	1.53	1.506	1.054	1.050	0.739
5.39	8.5	23.5	11.2	18359.	18621.	-0.000032	0.000123	1.41	1.40	1.525	1.069	1.065	0.660
5.40	11.0	17.7	11.2	18341.	18604.	-0.000058	0.000087	1.41	1.43	1.561	1.065	1.072	0.917
5.41	10.8	19.2	11.2	18322.	18540.	-0.000021	0.000153	1.18	1.19	1.508	1.109	1.088	0.838
5.42	10.7	19.3	11.2	18304.	18572.	-0.000116	0.000112	1.44	1.46	1.484	1.083	1.069	0.833
5.43	14.2	18.4	10.9	18271.	18508.	-0.000068	0.000131	1.28	1.29	1.473	1.175	1.139	0.879
5.44	16.6	17.6	11.3	18238.	18599.	-0.000124	0.000121	1.94	1.98	1.505	1.156	1.131	0.923
5.45	16.2	15.8	10.8	18206.	18390.	-0.000021	0.000108	1.00	1.01	1.479	1.181	1.138	1.035
5.46	12.6	109.1	11.5	18176.	18868.	0.000103	0.000052	3.67	3.81	1.574	1.014	1.059	0.063
5.47	10.8	117.3	11.5	18147.	18955.	-0.000020	0.000075	4.26	4.45	1.599	0.995	1.057	0.055
5.48	7.5	106.1	11.6	18117.	18870.	-0.000057	0.000105	3.99	4.07	1.668	0.974	1.046	0.066
5.49	12.1	93.2	11.6	18086.	18784.	0.000141	0.000072	3.72	3.86	1.609	1.009	1.060	0.083
5.50	10.6	99.1	11.3	18055.	18775.	-0.000069	0.000103	3.83	3.99	1.678	1.031	1.097	0.074
5.51	13.9	103.2	10.7	18024.	18397.	0.000204	0.000150	2.03	2.07	1.721	1.226	1.207	0.069
5.53	19.5	119.3	10.1	17903.	18134.	0.000278	0.000101	1.27	1.29	1.596	1.355	1.294	0.054
5.54	22.4	126.2	10.2	17867.	18214.	0.000196	0.000168	1.91	1.94	1.558	1.313	1.258	0.048
5.55	16.1	121.7	10.6	17831.	18139.	0.000188	0.000122	1.70	1.73	1.686	1.206	1.195	0.052
5.56	6.2	11.1	10.8	17793.	17857.	-0.000010	0.000067	0.36	0.33	1.433	1.148	1.114	1.447
5.57	4.8	11.8	10.7	17754.	17920.	-0.000031	0.000051	0.93	0.88	1.357	1.148	1.105	1.372
5.58	4.8	11.8	10.8	17716.	17869.	-0.000004	0.000066	0.85	0.81	1.399	1.118	1.093	1.372
5.59	10.2	8.6	10.6	17700.	17800.	-0.000058	0.000108	0.56	0.57	1.628	1.130	1.117	1.775
5.60	11.4	8.6	10.7	17677.	17797.	-0.000077	0.000068	0.67	0.68	1.539	1.121	1.099	1.775
5.61	11.4	9.7	10.8	17658.	17825.	-0.000063	0.000083	0.94	0.95	1.543	1.106	1.091	1.619
5.62	16.6	9.1	10.6	17631.	17863.	0.000050	0.000138	1.30	1.31	1.442	1.153	1.113	1.701
5.63	16.3	9.8	10.5	17604.	17913.	-0.000014	0.000006	1.72	1.76	1.468	1.192	1.179	1.605

TABLE VI (CONT)

POINT NO.	SPEED (KT)	WHEEL HGT (FT)	COLL (DEG)	GROSS WEIGHT (LB)	BALANCE THRUST (LB)	BALANCE DRAG (--)	BALANCE SIDE FORCE (--)	D/T (%)	DV (%)	TAIL ROT BLOCKAGE (--)	$\left(\frac{GW}{GW_\infty}\right)^{3/2}$ (--)	$\left(\frac{T}{T_\infty}\right)^{3/2}$ (--)	$\left(\frac{R}{Z}\right)$ **2 (--)
5.64	15.8	7.5	10.6	17577.	17924.	0.000028	0.000023	1.94	1.97	1.559	1.166	1.166	1.956
5.65	6.7	21.1	10.8	17559.	17816.	-0.000089	0.000100	1.44	1.39	1.354	1.105	1.067	0.751
5.66	7.7	21.5	11.0	17540.	17876.	-0.000097	0.000081	1.88	1.87	1.485	1.050	1.050	0.735
5.67	8.3	20.2	10.9	17522.	17892.	-0.000072	0.000185	2.07	2.08	1.525	1.060	1.066	0.790
5.68	11.2	18.5	10.8	17505.	17860.	0.000022	0.000079	1.99	2.03	1.388	1.108	1.076	0.874
5.69	11.3	18.7	10.9	17487.	17892.	0.000037	0.000127	2.26	2.31	1.491	1.068	1.068	0.863
5.70	11.3	20.8	10.9	17470.	17826.	-0.000034	0.000159	2.00	2.04	1.542	1.066	1.073	0.764
5.71	15.0	20.0	10.7	17447.	17810.	-0.000102	0.000092	2.04	2.08	1.442	1.115	1.098	0.800
5.72	15.0	20.0	10.5	17423.	17720.	0.000055	0.000176	1.68	1.70	1.474	1.164	1.138	0.800
5.73	15.7	16.4	10.8	17294.	17682.	-0.000070	0.000087	2.19	2.24	1.551	1.103	1.100	0.996
5.74	7.5	92.6	11.0	17186.	18081.	-0.000017	0.000065	4.95	5.13	1.679	1.022	1.095	0.084
5.75	8.7	91.8	11.3	17181.	18038.	-0.000038	0.000037	4.75	4.95	1.506	0.994	1.027	0.085
5.76	9.6	90.8	11.1	17175.	17980.	0.000020	0.000054	4.48	4.67	1.750	0.997	1.077	0.086

TABLE VI (CONT)

POINT NO.	SPEED (KT)	W.HGT (FT)	MU	CW	CT	CQB	CQS	CPB	CPS	CPE	CTTR	CQTR	CTTRP
5.14	14.6	8.2	0.036	0.005885	0.005908	0.000417	0.000425	0.000505	0.000513	0.000510	0.01535	0.00175	0.01091
5.15	15.5	6.2	0.038	0.005881	0.005881	0.000417	0.000425	0.000510	0.000518	0.000513	0.01594	0.00188	0.01092
5.16	17.8	6.4	0.044	0.005848	0.005906	0.000401	0.000409	0.000484	0.000492	0.000488	0.01490	0.00159	0.01051
5.17	6.2	21.7	0.015	0.005912	0.005977	0.000448	0.000460	0.000542	0.000552	0.000549	0.01586	0.00188	0.01174
5.18	6.5	21.3	0.016	0.005890	0.005936	0.000454	0.000467	0.000562	0.000573	0.000571	0.01705	0.00227	0.01190
5.19	6.5	17.3	0.016	0.005871	0.005906	0.000438	0.000446	0.000523	0.000530	0.000526	0.01503	0.00164	0.01146
5.20	8.5	14.5	0.021	0.005869	0.005890	0.000441	0.000447	0.000543	0.000548	0.000545	0.01688	0.00214	0.01154
5.21	9.6	16.3	0.024	0.005852	0.005907	0.000442	0.000450	0.000535	0.000541	0.000539	0.01600	0.00185	0.01158
5.22	9.4	17.4	0.023	0.005865	0.005913	0.000445	0.000453	0.000549	0.000555	0.000553	0.01706	0.00219	0.01165
5.23	15.9	22.3	0.039	0.005710	0.005783	0.000393	0.000399	0.000494	0.000501	0.000496	0.01684	0.00212	0.01029
5.24	16.2	23.7	0.040	0.005696	0.005778	0.000409	0.000415	0.000507	0.000514	0.000509	0.01632	0.00204	0.01070
5.25	15.5	21.1	0.038	0.005675	0.005726	0.000382	0.000387	0.000467	0.000472	0.000467	0.01497	0.00165	0.01001
5.26	8.3	98.7	0.021	0.005757	0.005941	0.000466	0.000474	0.000578	0.000585	0.000579	0.01739	0.00241	0.01220
5.28	9.5	125.9	0.023	0.005674	0.005755	0.000399	0.000398	0.000524	0.000522	0.000518	0.01935	0.00281	0.01046
5.29	8.6	93.0	0.021	0.005689	0.005913	0.000448	0.000454	0.000584	0.000589	0.000588	0.01970	0.00314	0.01172
5.31	11.4	104.0	0.028	0.005639	0.005716	0.000396	0.000401	0.000513	0.000517	0.000515	0.01834	0.00258	0.01037
5.32	9.4	98.2	0.023	0.005661	0.005853	0.000427	0.000437	0.000580	0.000587	0.000582	0.02083	0.00360	0.01119
5.33	11.7	121.8	0.029	0.005637	0.005803	0.000438	0.000441	0.000573	0.000574	0.000574	0.01956	0.00309	0.01146
5.34	15.5	101.1	0.038	0.005565	0.005664	0.000393	0.000398	0.000500	0.000505	0.000502	0.01753	0.00229	0.01029
5.35	12.7	110.9	0.031	0.005562	0.005682	0.000390	0.000396	0.000510	0.000516	0.000512	0.01862	0.00269	0.01020
5.36	17.6	155.1	0.043	0.005493	0.005585	0.000352	0.000355	0.000448	0.000452	0.000448	0.01681	0.00199	0.00922
5.37	7.9	20.2	0.020	0.005513	0.005572	0.000413	0.000418	0.000510	0.000515	0.000514	0.01627	0.00201	0.01081
5.38	8.5	21.4	0.021	0.005509	0.005595	0.000419	0.000427	0.000520	0.000527	0.000525	0.01653	0.00210	0.01098
5.39	8.5	23.5	0.021	0.005480	0.005559	0.000410	0.000416	0.000509	0.000515	0.000514	0.01636	0.00207	0.01072
5.40	11.0	17.7	0.027	0.005473	0.005551	0.000406	0.000414	0.000508	0.000516	0.000515	0.01660	0.00214	0.01063
5.41	10.8	19.2	0.027	0.005445	0.005510	0.000396	0.000401	0.000487	0.000493	0.000491	0.01564	0.00184	0.01037
5.42	10.7	19.3	0.026	0.005456	0.005536	0.000405	0.000412	0.000498	0.000505	0.000504	0.01576	0.00188	0.01062
5.43	14.2	18.4	0.035	0.005405	0.005475	0.000376	0.000380	0.000456	0.000461	0.000459	0.01449	0.00153	0.00984
5.44	16.6	17.6	0.041	0.005380	0.005486	0.000379	0.000385	0.000461	0.000468	0.000463	0.01495	0.00158	0.00993
5.45	16.2	15.8	0.040	0.005377	0.005432	0.000372	0.000375	0.000451	0.000456	0.000453	0.01440	0.00152	0.00974
5.46	12.6	109.1	0.031	0.005450	0.005657	0.000422	0.000427	0.000533	0.000538	0.000537	0.01741	0.00241	0.01106
5.47	10.8	117.3	0.027	0.005449	0.005691	0.000427	0.000433	0.000542	0.000547	0.000547	0.01787	0.00252	0.01117
5.48	7.5	106.1	0.019	0.005451	0.005678	0.000429	0.000435	0.000555	0.000559	0.000559	0.01875	0.00282	0.01124
5.49	12.1	93.2	0.030	0.005425	0.005634	0.000419	0.000426	0.000533	0.000539	0.000536	0.01767	0.00247	0.01098
5.50	10.6	99.1	0.026	0.005398	0.005614	0.000404	0.000405	0.000517	0.000519	0.000521	0.01772	0.00249	0.01056
5.51	13.9	103.2	0.035	0.005479	0.005592	0.000367	0.000357	0.000462	0.000450	0.000449	0.01651	0.00196	0.00959
5.53	19.5	119.3	0.048	0.005220	0.005287	0.000317	0.000322	0.000379	0.000386	0.000379	0.01322	0.00105	0.00829
5.54	22.4	126.2	0.055	0.005229	0.005330	0.000329	0.000331	0.000393	0.000397	0.000392	0.01341	0.00108	0.00861
5.55	16.1	121.7	0.040	0.005262	0.005353	0.000348	0.000351	0.000429	0.000434	0.000430	0.01534	0.00159	0.00910
5.56	6.2	11.1	0.015	0.005314	0.005333	0.000370	0.000378	0.000450	0.000458	0.000458	0.01388	0.00152	0.00968
5.57	4.8	11.8	0.012	0.005314	0.005364	0.000375	0.000388	0.000450	0.000462	0.000458	0.01335	0.00135	0.00984
5.58	4.8	11.8	0.012	0.005314	0.005360	0.000379	0.000388	0.000460	0.000469	0.000470	0.01389	0.00155	0.00993
5.59	10.2	8.6	0.025	0.005313	0.005343	0.000370	0.000372	0.000465	0.000467	0.000465	0.01576	0.00196	0.00968
5.60	11.4	8.6	0.028	0.005276	0.005312	0.000372	0.000379	0.000460	0.000467	0.000464	0.01500	0.00174	0.00975
5.61	11.4	9.7	0.028	0.005290	0.005340	0.000378	0.000381	0.000467	0.000470	0.000472	0.01527	0.00179	0.00989
5.62	16.6	9.1	0.041	0.005250	0.005319	0.000368	0.000372	0.000446	0.000450	0.000448	0.01390	0.00145	0.00964
5.63	16.3	9.8	0.040	0.005221	0.005313	0.000348	0.000351	0.000425	0.000428	0.000430	0.01358	0.00143	0.00913

TABLE VI (CONCLUDED)

POINT NO.	SPEED (KT)	W.HGT (FT)	MU	CW	CT	CQB	CQS	CPB	CPS	CPE	CTTR	CQTR	CTTRP
5.64	15.8	7.5	0.039	0.005235	0.005339	0.000354	0.000362	0.000435	0.000443	0.000441	0.01447	0.00156	0.00928
5.65	6.7	21.1	0.017	0.005234	0.005311	0.000383	0.000388	0.000462	0.000467	0.000465	0.01358	0.00149	0.01003
5.66	7.7	21.5	0.019	0.005249	0.005350	0.000393	0.000401	0.000485	0.000493	0.000491	0.01528	0.00186	0.01029
5.67	8.3	20.2	0.020	0.005230	0.005341	0.000386	0.000392	0.000479	0.000484	0.000484	0.01542	0.00187	0.01011
5.68	11.2	18.5	0.028	0.005206	0.005312	0.000380	0.000386	0.000457	0.000464	0.000460	0.01381	0.00144	0.00995
5.69	11.3	18.7	0.028	0.005214	0.005335	0.000385	0.000391	0.000473	0.000479	0.000478	0.01503	0.00175	0.01008
5.70	11.3	20.8	0.028	0.005216	0.005322	0.000382	0.000365	0.000474	0.000477	0.000479	0.01542	0.00187	0.01000
5.71	15.0	20.0	0.037	0.005189	0.005297	0.000371	0.000379	0.000450	0.000459	0.000455	0.01402	0.00150	0.00972
5.72	15.0	20.0	0.037	0.005156	0.005244	0.000353	0.000357	0.000429	0.000434	0.000432	0.01364	0.00141	0.00925
5.73	15.7	16.4	0.039	0.005143	0.005258	0.000367	0.000373	0.000452	0.000458	0.000454	0.01489	0.00167	0.00960
5.74	7.5	92.6	0.019	0.005128	0.005395	0.000382	0.000388	0.000486	0.000492	0.000487	0.01679	0.00221	0.01000
5.75	8.7	91.8	0.021	0.005137	0.005393	0.000406	0.000410	0.000501	0.000505	0.000502	0.01602	0.00196	0.01063
5.76	9.6	90.8	0.024	0.005128	0.005368	0.000385	0.000388	0.000497	0.000500	0.000499	0.01766	0.00244	0.01009

TABLE VII

TABULATED DATA — FLIGHT 7

POINT NO.	V (KT)	WH (FT)	TB (DEG)	PB (DEG)	TC (DEG)	OR (FPS)	TEMP (DEG C)	ALT (FT)	GW (LB)	TRQ (FT-LB)	TRT (LB)	X (LB)	-Z (LB)	Y (LB)	BMRQ (FT-LB)
7.18	0.0	9.9	0.6	-2.0	10.1	688.5	16.6	5.	17795.	240.	1381.	-7.	16540.	-406.	38870.
7.19	0.0	9.9	0.9	-2.1	10.1	689.4	16.6	5.	17780.	240.	1347.	27.	16520.	-367.	38460.
7.20	0.0	9.9	1.5	-2.2	10.0	689.4	16.6	5.	17765.	257.	1360.	118.	16530.	-390.	38720.
7.21	0.0	14.0	1.7	-2.1	10.3	686.8	16.5	30.	17750.	260.	1386.	112.	16670.	-428.	39970.
7.22	0.0	14.0	1.5	-2.5	10.4	687.4	16.5	30.	17735.	260.	1392.	77.	16620.	-423.	40010.
7.23	0.0	14.0	0.7	-2.0	10.3	686.2	16.5	30.	17718.	280.	1417.	4.	16580.	-468.	40070.
7.24	0.0	21.5	1.3	-2.2	10.5	686.7	16.5	40.	17705.	260.	1439.	23.	16680.	-425.	41710.
7.25	0.0	21.5	0.8	-2.7	10.5	682.5	16.5	40.	17695.	259.	1443.	-17.	16620.	-413.	41660.
7.26	0.0	21.5	0.6	-2.8	10.6	686.2	16.5	40.	17683.	270.	1445.	-17.	16580.	-412.	41800.
7.27	0.0	39.8	1.5	-2.7	10.8	685.6	16.5	65.	17672.	318.	1489.	72.	16780.	-465.	43950.
7.28	0.0	39.8	1.1	-3.2	10.9	684.9	16.5	65.	17660.	314.	1499.	28.	16810.	-446.	44440.
7.29	0.0	39.8	1.5	-2.9	10.8	685.6	16.6	50.	17646.	300.	1469.	45.	16840.	-449.	43420.
7.30	0.0	142.6	0.5	-2.2	11.1	685.8	16.5	148.	17640.	300.	1472.	-39.	16940.	-456.	44580.
7.31	0.0	142.6	1.9	-2.1	11.0	685.8	16.5	139.	17625.	290.	1467.	171.	17020.	-400.	44100.
7.32	0.0	142.6	1.4	-2.4	11.0	685.1	16.5	150.	17612.	320.	1488.	119.	17120.	-447.	44540.
7.33	10.0	140.0	2.0	-2.7	10.6	685.9	16.2	136.	17554.	410.	1746.	24.	16810.	-509.	41060.
7.34	10.0	140.0	0.6	-3.8	10.7	686.8	16.3	124.	17495.	320.	1634.	-125.	16800.	-491.	41350.
7.35	10.0	140.0	1.2	-3.1	10.6	687.9	16.3	121.	17437.	290.	1469.	-47.	16740.	-480.	41380.
7.36	15.0	140.0	2.0	-0.5	10.4	689.6	16.3	99.	17387.	322.	1485.	298.	16480.	-592.	39150.
7.38	15.0	140.0	3.4	-1.6	10.3	689.3	16.3	73.	17338.	300.	1493.	457.	16550.	-479.	37630.
7.39	15.7	141.9	0.8	-3.1	10.6	687.3	16.3	110.	17288.	450.	1678.	27.	16670.	-449.	41190.
7.40	0.0	130.4	1.3	-2.3	10.8	685.4	16.3	112.	17280.	450.	1772.	56.	16800.	-512.	43100.
7.41	0.0	135.1	1.8	-2.4	10.8	686.5	16.3	119.	17273.	300.	1581.	25.	16750.	-466.	42980.
7.42	0.0	141.5	1.0	-1.5	10.6	686.3	16.3	125.	17265.	320.	1604.	-84.	16710.	-548.	42040.

TABLE VII (CONT)

POINT NO.	SPEED (KT)	WHEEL HGT (FT)	COLL (DEG)	GROSS WEIGHT (LB)	BALANCE THRUST (LB)	BALANCE DRAG (--)	BALANCE SIDE FORCE (--)	D/T (%)	DV (%)	TAIL ROT BLOCKAGE (--)	$\left(\frac{GW}{GW_\infty}\right)^{3/2}$ (--)	$\left(\frac{T}{T_\infty}\right)^{3/2}$ (--)	$\left(\frac{R}{Z}\right)$ **2 (--)
7.18	0.0	9.9	10.1	17795.	17925.	-0.000121	0.000021	0.73	0.55	1.311	1.164	1.100	1.592
7.19	0.0	9.9	10.1	17780.	17908.	-0.000085	0.000021	0.71	0.53	1.292	1.191	1.109	1.592
7.20	0.0	9.9	10.0	17765.	17919.	-0.000008	0.000007	0.86	0.68	1.296	1.160	1.103	1.592
7.21	0.0	14.0	10.3	17750.	18060.	0.000007	0.000013	1.71	1.36	1.279	1.118	1.083	1.169
7.22	0.0	14.0	10.4	17735.	18009.	-0.000020	-0.000019	1.52	1.17	1.283	1.114	1.077	1.169
7.23	0.0	14.0	10.3	17718.	17965.	-0.000111	0.000012	1.37	1.01	1.305	1.099	1.073	1.169
7.24	0.0	21.5	10.5	17705.	18071.	-0.000054	0.000019	2.03	1.49	1.273	1.075	1.037	0.735
7.25	0.0	21.5	10.5	17695.	18010.	-0.000110	-0.000020	1.75	1.20	1.277	1.069	1.039	0.735
7.26	0.0	21.5	10.6	17683.	17969.	-0.000126	-0.000026	1.59	1.04	1.275	1.062	1.027	0.735
7.27	0.0	39.8	10.8	17672.	18172.	-0.000022	-0.000019	2.75	2.05	1.249	1.015	0.992	0.324
7.28	0.0	39.8	10.9	17660.	18201.	-0.000071	-0.000054	2.97	2.29	1.243	1.007	0.984	0.324
7.29	0.0	39.8	10.8	17646.	18232.	-0.000030	-0.000037	3.21	2.54	1.247	1.030	1.010	0.324
7.30	0.0	142.6	11.1	17640.	18329.	-0.000144	0.000031	3.76	2.99	1.218	1.006	0.992	0.039
7.31	0.0	142.6	11.0	17625.	18415.	0.000042	0.000051	4.29	3.56	1.227	1.018	1.010	0.039
7.32	0.0	142.6	11.0	17612.	18512.	-0.000018	0.000013	4.86	4.18	1.232	1.006	1.008	0.039
7.33	10.0	140.0	10.6	17554.	18198.	0.000007	-0.000056	3.54	3.67	1.568	1.034	1.068	0.040
7.34	10.0	140.0	10.7	17495.	18181.	-0.000159	-0.000144	3.77	3.92	1.456	1.044	1.057	0.040
7.35	10.0	140.0	10.6	17437.	18127.	-0.000083	-0.000078	3.81	3.96	1.309	1.065	1.050	0.040
7.36	15.0	140.0	10.4	17387.	17861.	0.000088	0.000096	2.65	2.73	1.400	1.121	1.086	0.040
7.38	15.0	140.0	10.3	17338.	17943.	0.000254	0.000023	3.37	3.49	1.464	1.147	1.139	0.040
7.39	15.7	141.9	10.6	17288.	18055.	-0.000096	-0.000070	4.25	4.44	1.502	1.025	1.050	0.039
7.40	0.0	130.4	10.8	17280.	18189.	-0.000045	-0.000005	5.00	4.33	1.516	0.966	1.015	0.046
7.41	0.0	135.1	10.8	17273.	18142.	-0.000010	-0.000001	4.79	4.11	1.357	0.998	1.013	0.043
7.42	0.0	141.5	10.6	17265.	18096.	-0.000112	0.000046	4.59	3.89	1.408	1.015	1.033	0.039

TABLE VII (CONCLUDED)

POINT NO.	SPEED (KT)	W.HGT (FT)	MU	CW	CT	CQB	CQS	CPB	CPS	CPE	CTTR	CQTR	CTTRP
7.18	0.0	9.9	0.0	0.005261	0.005300	0.000371	0.000382	0.000432	0.000444	0.000445	0.01273	0.00097	0.00971
7.19	0.0	9.9	0.0	0.005243	0.005281	0.000366	0.000377	0.000426	0.000439	0.000433	0.01238	0.00097	0.00958
7.20	0.0	9.9	0.0	0.005239	0.005284	0.000368	0.000381	0.000431	0.000445	0.000444	0.01250	0.00104	0.00965
7.21	0.0	14.0	0.0	0.005277	0.005369	0.000383	0.000398	0.000448	0.000463	0.000465	0.01284	0.00106	0.01004
7.22	0.0	14.0	0.0	0.005263	0.005345	0.000383	0.000398	0.000447	0.000463	0.000465	0.01288	0.00106	0.01003
7.23	0.0	14.0	0.0	0.005277	0.005350	0.000385	0.000401	0.000452	0.000469	0.000473	0.01315	0.00115	0.01008
7.24	0.0	21.5	0.0	0.005267	0.005376	0.000400	0.000415	0.000465	0.000480	0.000482	0.01334	0.00106	0.01048
7.25	0.0	21.5	0.0	0.005329	0.005424	0.000405	0.000419	0.000470	0.000484	0.000493	0.01354	0.00108	0.01060
7.26	0.0	21.5	0.0	0.005268	0.005353	0.000402	0.000417	0.000468	0.000483	0.000488	0.01342	0.00111	0.01053
7.27	0.0	39.8	0.0	0.005279	0.005428	0.000423	0.000438	0.000497	0.000511	0.000512	0.01386	0.00131	0.01110
7.28	0.0	39.8	0.0	0.005286	0.005448	0.000429	0.000445	0.000502	0.000518	0.000517	0.01398	0.00130	0.01125
7.29	0.0	39.8	0.0	0.005270	0.005445	0.000418	0.000432	0.000489	0.000503	0.000503	0.01367	0.00123	0.01096
7.30	0.0	142.6	0.0	0.005282	0.005488	0.000431	0.000445	0.000502	0.000516	0.000517	0.01374	0.00124	0.01128
7.31	0.0	142.6	0.0	0.005276	0.005512	0.000426	0.000438	0.000495	0.000507	0.000510	0.01369	0.00120	0.01115
7.32	0.0	142.6	0.0	0.005285	0.005555	0.000431	0.000445	0.000505	0.000519	0.000517	0.01392	0.00132	0.01129
7.33	10.0	140.0	0.025	0.005247	0.005439	0.000396	0.000403	0.000482	0.000489	0.000498	0.01627	0.00169	0.01037
7.34	10.0	140.0	0.025	0.005215	0.005420	0.000398	0.000408	0.000471	0.000481	0.000489	0.01518	0.00131	0.01043
7.35	10.0	140.0	0.025	0.005181	0.005386	0.000397	0.000406	0.000465	0.000475	0.000475	0.01360	0.00118	0.01040
7.36	15.0	140.0	0.037	0.005136	0.005276	0.000373	0.000379	0.000445	0.000452	0.000446	0.01367	0.00130	0.00977
7.38	15.0	140.0	0.037	0.005122	0.005300	0.000359	0.000366	0.000428	0.000436	0.000434	0.01375	0.00121	0.00939
7.39	15.7	141.9	0.039	0.005143	0.005372	0.000395	0.000403	0.000486	0.000495	0.000488	0.01556	0.00184	0.01036
7.40	0.0	130.4	0.0	0.005170	0.005442	0.000416	0.000428	0.000508	0.000520	0.000521	0.01652	0.00185	0.01090
7.41	0.0	135.1	0.0	0.005153	0.005412	0.000414	0.000427	0.000484	0.000498	0.000502	0.01470	0.00123	0.01083
7.42	0.0	141.5	0.0	0.005154	0.005403	0.000405	0.000415	0.000478	0.000488	0.000494	0.01492	0.00131	0.01060

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TABLE VIII

TABULATED DATA — FLIGHT 8

POINT NO.	V (KT)	WH (FT)	TB (DEG)	PB (DEG)	TC (DEG)	OR (FPS)	TEMP (DEG C)	ALT (FT)	GW (LB)	TRQ (FT-LB)	TRT (LB)	X (LB)	-Z (LB)	Y (LB)	BMRQ (FT-LB)
8.05	0.0	110.0	2.0	-2.4	13.4	677.2	16.8	70.	19578.	411.	1676.	113.	18830.	66.	49630.
8.06	5.0	110.0	0.8	-2.5	13.2	681.1	16.8	70.	19565.	560.	1871.	40.	18870.	-40.	49010.
8.07	10.0	110.0	1.6	-2.7	13.0	682.3	16.8	70.	19552.	692.	2045.	150.	18830.	-216.	47350.
8.08	15.0	110.0	0.8	-1.4	12.9	684.6	16.8	70.	19538.	669.	2024.	156.	18760.	-291.	46520.
8.09	20.0	110.0	4.0	-1.7	11.9	690.4	16.5	70.	19525.	346.	1651.	669.	18270.	-156.	39890.
8.10	25.0	110.0	3.6	-1.8	11.9	690.0	16.5	70.	19512.	370.	1638.	740.	18380.	-161.	39030.
8.11	30.0	110.0	2.6	-1.4	11.3	693.0	16.1	95.	19499.	250.	1437.	672.	18270.	-126.	35970.
8.12	35.0	110.0	2.7	-0.5	11.1	693.9	15.8	95.	19486.	220.	1358.	701.	18340.	-102.	35060.
8.13	40.0	110.0	3.9	-0.1	10.5	695.8	16.0	100.	19448.	190.	1241.	1049.	18250.	17.	31960.
8.14	45.0	110.0	4.9	-0.3	10.2	696.3	15.8	100.	19411.	129.	1038.	1122.	18130.	1.	29930.
8.16	50.0	110.0	4.1	-0.8	10.0	697.6	15.8	100.	19374.	115.	1048.	1055.	18170.	-9.	29280.
8.17	60.0	110.0	6.3	0.0	9.1	700.7	15.9	100.	19344.	104.	885.	1141.	18150.	-110.	23690.
8.18	0.0	110.0	2.1	-2.0	13.2	682.3	16.5	100.	19313.	410.	1667.	278.	18510.	187.	49300.
8.19	5.0	110.0	2.9	-2.0	12.8	683.5	16.8	60.	19298.	590.	1941.	360.	18400.	-241.	45580.
8.20	10.0	110.0	2.4	-1.5	12.6	684.5	16.8	60.	19284.	544.	1902.	334.	18210.	-241.	43680.
8.22	15.0	110.0	3.6	-1.6	12.0	687.4	16.8	60.	19270.	300.	1613.	635.	18000.	-207.	39260.
8.23	20.0	110.0	4.5	-1.3	11.5	690.1	16.5	60.	19255.	280.	1428.	738.	17920.	-184.	36730.
8.24	25.0	110.0	1.7	-2.0	11.9	687.7	16.3	60.	19241.	340.	1544.	555.	18140.	-112.	39470.
8.25	30.0	110.0	3.7	-1.8	11.2	690.9	16.1	60.	19226.	214.	1287.	806.	18110.	-67.	34860.
8.26	35.0	110.0	2.9	-0.1	11.4	690.0	16.1	60.	19212.	220.	1358.	742.	18280.	-148.	36230.
8.27	40.0	110.0	7.1	-0.2	9.7	699.3	16.2	84.	19194.	116.	998.	1210.	17770.	-86.	27060.
8.28	45.0	110.0	3.2	-0.5	10.6	694.4	16.0	90.	19175.	132.	1145.	1021.	18080.	52.	32370.
8.29	50.0	110.0	4.8	0.3	10.0	698.0	15.9	115.	19157.	102.	1004.	1062.	18050.	-63.	27930.
8.30	55.0	110.0	5.2	-0.8	9.9	699.9	16.0	118.	19139.	108.	1045.	1099.	17870.	18.	29000.
8.31	55.0	110.0	5.1	0.2	9.4	701.6	15.9	137.	19121.	100.	996.	1038.	17800.	-127.	26340.
8.32	60.0	110.0	2.8	0.1	10.0	698.8	15.9	116.	19103.	93.	1046.	1027.	17910.	19.	29770.
8.33	5.0	110.0	0.2	-6.0	12.6	686.2	16.6	172.	19080.	340.	1509.	17.	18020.	100.	46790.
8.35	10.0	110.0	0.9	-6.2	12.3	688.7	16.6	225.	19056.	200.	1080.	-137.	18270.	162.	43060.
8.36	15.0	110.0	1.1	-9.0	12.3	687.9	16.6	198.	19033.	280.	1305.	-129.	18090.	173.	43830.
8.37	20.0	110.0	0.9	-9.4	11.9	689.9	16.5	283.	19009.	210.	1206.	-256.	17940.	175.	41880.
8.38	25.0	110.0	2.2	-13.1	12.3	689.1	16.9	165.	18982.	200.	992.	-108.	18150.	355.	42600.
8.39	30.0	110.0	2.6	-10.1	11.9	692.0	17.1	115.	18954.	180.	828.	-97.	17700.	143.	39710.
8.41	5.0	110.0	2.8	0.0	12.8	684.6	17.0	106.	18927.	490.	1852.	293.	18100.	-64.	47480.
8.42	10.0	110.0	1.1	1.1	12.9	683.7	17.0	64.	18900.	680.	2106.	20.	18010.	-199.	47780.
8.43	15.0	110.0	2.8	3.3	12.1	685.7	17.2	64.	18872.	798.	2163.	150.	17750.	-260.	40980.
8.44	20.0	110.0	3.2	3.6	12.1	685.4	17.0	89.	18845.	840.	2229.	210.	17920.	-214.	42050.

TABLE VIII (CONT)

POINT NO.	SPEED (KT)	WHEEL HGT (FT)	COLL (DEG)	GROSS WEIGHT (LB)	BALANCE THRUST (LB)	BALANCE DRAG (--)	BALANCE SIDE FORCE (--)	D/T (%)	DV (%)	TAIL ROT BLOCKAGE (--)	$\left(\frac{GH}{GH_\infty}\right)^{3/2}$ (--)	$\left(\frac{T}{T_\infty}\right)^{3/2}$ (--)	$\left(\frac{R}{Z}\right)$ **2 (--)
8.05	0.0	110.0	13.4	19578.	20250.	0.000035	0.000191	3.32	2.53	1.246	1.033	1.041	0.062
8.06	5.0	110.0	13.2	19565.	20281.	-0.000108	0.000141	3.53	3.21	1.408	1.020	1.052	0.062
8.07	10.0	110.0	13.0	19552.	20236.	0.000006	0.000054	3.38	3.50	1.593	1.012	1.085	0.062
8.08	15.0	110.0	12.9	19538.	20148.	-0.000071	0.000153	3.03	3.12	1.606	1.030	1.094	0.062
8.09	20.0	110.0	11.9	19525.	19679.	0.000385	0.000113	0.78	0.79	1.527	1.279	1.230	0.062
8.10	25.0	110.0	11.9	19512.	19790.	0.000369	0.000094	1.41	1.43	1.548	1.297	1.269	0.062
8.11	30.0	110.0	11.3	19499.	19669.	0.000252	0.000118	0.86	0.87	1.474	1.441	1.365	0.062
8.12	35.0	110.0	11.1	19486.	19732.	0.000269	0.000200	1.24	1.26	1.430	1.488	1.406	0.062
8.13	40.0	110.0	10.5	19448.	19654.	0.000479	0.000247	1.05	1.06	1.433	1.636	1.538	0.062
8.14	45.0	110.0	10.2	19411.	19545.	0.000589	0.000207	0.69	0.69	1.280	1.770	1.634	0.062
8.16	50.0	110.0	10.0	19374.	19583.	0.000496	0.000153	1.07	1.08	1.321	1.824	1.675	0.062
8.17	60.0	110.0	9.1	19344.	19562.	0.000714	0.000152	1.12	1.13	1.379	2.209	2.092	0.062
8.18	0.0	110.0	13.2	19313.	19930.	0.000094	0.000265	3.10	2.29	1.247	1.012	1.017	0.062
8.19	5.0	110.0	12.8	19298.	19805.	0.000195	0.000106	2.56	2.18	1.571	1.046	1.091	0.062
8.20	10.0	110.0	12.6	19284.	19608.	0.000138	0.000140	1.65	1.68	1.607	1.100	1.122	0.062
8.22	15.0	110.0	12.0	19270.	19405.	0.000338	0.000105	0.70	0.70	1.516	1.277	1.230	0.062
8.23	20.0	110.0	11.5	19255.	19327.	0.000448	0.000119	0.37	0.37	1.435	1.391	1.305	0.062
8.24	25.0	110.0	11.9	19241.	19537.	0.000136	0.000096	1.51	1.54	1.443	1.278	1.234	0.062
8.25	30.0	110.0	11.2	19226.	19522.	0.000394	0.000091	1.52	1.54	1.362	1.477	1.398	0.062
8.26	35.0	110.0	11.4	19212.	19669.	0.000303	0.000236	2.32	2.38	1.384	1.411	1.359	0.062
8.27	40.0	110.0	9.7	19194.	19187.	0.000799	0.000168	-0.04	-0.04	1.361	1.920	1.764	0.062
8.28	45.0	110.0	10.6	19175.	19483.	0.000407	0.000224	1.58	1.60	1.306	1.597	1.500	0.062
8.29	50.0	110.0	10.0	19157.	19454.	0.000560	0.000227	1.53	1.55	1.327	1.872	1.744	0.062
8.30	55.0	110.0	9.9	19139.	19291.	0.000601	0.000159	0.79	0.79	1.330	1.818	1.651	0.062
8.31	55.0	110.0	9.4	19121.	19206.	0.000571	0.000185	0.44	0.44	1.396	1.983	1.814	0.062
8.32	60.0	110.0	10.0	19103.	19299.	0.000367	0.000246	1.01	1.03	1.297	1.756	1.608	0.062
8.33	5.0	110.0	12.6	19080.	19433.	-0.000163	-0.000154	1.82	1.41	1.184	1.070	1.029	0.062
8.35	10.0	110.0	12.3	19056.	19684.	-0.000145	-0.000192	3.19	3.30	0.920	1.203	1.141	0.062
8.36	15.0	110.0	12.3	19033.	19460.	-0.000122	-0.000439	2.19	2.24	1.086	1.161	1.102	0.062
8.37	20.0	110.0	11.9	19009.	19295.	-0.000177	-0.000482	1.48	1.50	1.049	1.226	1.139	0.062
8.38	25.0	110.0	12.3	18982.	19404.	-0.000014	-0.000777	2.17	2.22	0.837	1.228	1.128	0.062
8.39	30.0	110.0	11.9	18954.	19018.	0.000025	-0.000556	0.34	0.34	0.758	1.342	1.173	0.062
8.41	5.0	110.0	12.8	18927.	19480.	0.000164	0.000367	2.84	2.47	1.440	1.004	1.019	0.062
8.42	10.0	110.0	12.9	18900.	19361.	-0.000079	0.000434	2.38	2.44	1.627	0.956	1.004	0.062
8.43	15.0	110.0	12.1	18872.	19050.	0.000119	0.000560	0.93	0.94	1.945	1.056	1.147	0.062
8.44	20.0	110.0	12.1	18845.	19205.	0.000175	0.000614	1.87	1.91	1.953	1.021	1.131	0.062

SA 29 REV. G

TABLE VIII (CONCLUDED)

POINT NO.	SPEED (KT)	W.HGT (FT)	MU	CW	CT	CQB	CQS	CPB	CPS	CPE	CTTR	CQTR	CTTRP
8.05	0.0	110.0	0.0	0.006001	0.006207	0.000491	0.000525	0.000581	0.000613	0.000608	0.01601	0.00176	0.01286
8.06	5.0	110.0	0.012	0.005929	0.006146	0.000479	0.000508	0.000589	0.000617	0.000605	0.01767	0.00235	0.01255
8.07	10.0	110.0	0.025	0.005904	0.006111	0.000461	0.000484	0.000590	0.000611	0.000606	0.01925	0.00289	0.01209
8.08	15.0	110.0	0.037	0.005860	0.006043	0.000450	0.000470	0.000574	0.000594	0.000589	0.01892	0.00277	0.01178
8.09	20.0	110.0	0.049	0.005753	0.005798	0.000379	0.000394	0.000454	0.000471	0.000463	0.01516	0.00139	0.00993
8.10	25.0	110.0	0.061	0.005755	0.005837	0.000371	0.000389	0.000450	0.000470	0.000457	0.01506	0.00149	0.00972
8.11	30.0	110.0	0.073	0.005699	0.005749	0.000339	0.000355	0.000400	0.000418	0.000406	0.01309	0.00100	0.00888
8.12	35.0	110.0	0.085	0.005675	0.005746	0.000329	0.000346	0.000386	0.000405	0.000391	0.01233	0.00087	0.00862
8.13	40.0	110.0	0.097	0.005638	0.005697	0.000299	0.000314	0.000350	0.000368	0.000353	0.01121	0.00075	0.00782
8.14	45.0	110.0	0.109	0.005615	0.005654	0.000279	0.000292	0.000322	0.000337	0.000325	0.00936	0.00051	0.00731
8.16	50.0	110.0	0.121	0.005583	0.005644	0.000272	0.000281	0.000313	0.000324	0.000313	0.00941	0.00045	0.00713
8.17	60.0	110.0	0.145	0.005527	0.005590	0.000218	0.000226	0.000257	0.000267	0.000256	0.00788	0.00040	0.00572
8.18	0.0	110.0	0.0	0.005832	0.006019	0.000480	0.000513	0.000569	0.000601	0.000595	0.01569	0.00171	0.01258
8.19	5.0	110.0	0.012	0.005805	0.005957	0.000442	0.000461	0.000555	0.000574	0.000572	0.01820	0.00245	0.01158
8.20	10.0	110.0	0.025	0.005784	0.005881	0.000423	0.000438	0.000528	0.000544	0.000541	0.01778	0.00225	0.01106
8.22	15.0	110.0	0.037	0.005731	0.005771	0.000377	0.000392	0.000446	0.000463	0.000461	0.01495	0.00123	0.00986
8.23	20.0	110.0	0.049	0.005676	0.005697	0.000349	0.000363	0.000415	0.000430	0.000418	0.01312	0.00113	0.00914
8.24	25.0	110.0	0.061	0.005707	0.005795	0.000378	0.000396	0.000453	0.000472	0.000458	0.01427	0.00138	0.00989
8.25	30.0	110.0	0.073	0.005646	0.005733	0.000330	0.000349	0.000387	0.000407	0.000391	0.01178	0.00086	0.00865
8.26	35.0	110.0	0.086	0.005657	0.005791	0.000344	0.000364	0.000402	0.000423	0.000410	0.01246	0.00089	0.00901
8.27	40.0	110.0	0.097	0.005509	0.005507	0.000251	0.000261	0.000291	0.000304	0.000292	0.00893	0.00045	0.00656
8.28	45.0	110.0	0.109	0.005579	0.005668	0.000304	0.000320	0.000348	0.000366	0.000356	0.01038	0.00052	0.00795
8.29	50.0	110.0	0.121	0.005519	0.005605	0.000260	0.000272	0.000299	0.000313	0.000300	0.00902	0.00040	0.00679
8.30	55.0	110.0	0.133	0.005487	0.005530	0.000268	0.000277	0.000308	0.000319	0.000306	0.00934	0.00042	0.00702
8.31	55.0	110.0	0.132	0.005457	0.005481	0.000242	0.000250	0.000280	0.000291	0.000279	0.00886	0.00038	0.00635
8.32	60.0	110.0	0.145	0.005491	0.005548	0.000276	0.000287	0.000314	0.000327	0.000317	0.00937	0.00036	0.00723
8.33	5.0	110.0	0.012	0.005713	0.005819	0.000452	0.000478	0.000529	0.000555	0.000546	0.01408	0.00140	0.01189
8.35	10.0	110.0	0.025	0.005676	0.005863	0.000414	0.000437	0.000470	0.000494	0.000482	0.01003	0.00082	0.01089
8.36	15.0	110.0	0.037	0.005677	0.005804	0.000422	0.000445	0.000489	0.000513	0.000499	0.01213	0.00115	0.01117
8.37	20.0	110.0	0.049	0.005652	0.005737	0.000402	0.000422	0.000459	0.000480	0.000470	0.01118	0.00085	0.01066
8.38	25.0	110.0	0.061	0.005641	0.005766	0.000408	0.000431	0.000464	0.000488	0.000468	0.00919	0.00081	0.01097
8.39	30.0	110.0	0.073	0.005579	0.005598	0.000377	0.000398	0.000429	0.000452	0.000422	0.00760	0.00072	0.01002
8.41	5.0	110.0	0.012	0.005688	0.005855	0.000460	0.000482	0.000559	0.000581	0.000578	0.01735	0.00203	0.01205
8.42	10.0	110.0	0.025	0.005687	0.005825	0.000464	0.000489	0.000590	0.000615	0.000606	0.01975	0.00283	0.01214
8.43	15.0	110.0	0.037	0.005649	0.005702	0.000396	0.000408	0.000537	0.000549	0.000544	0.02018	0.00329	0.01037
8.44	20.0	110.0	0.049	0.005647	0.005755	0.000406	0.000421	0.000554	0.000568	0.000562	0.02082	0.00347	0.01066

TABLE IX.
ESTIMATED MEASUREMENT SYSTEM ACCURACY

	Full Scale	Accuracy
Rotor		Hover-All Axes
X	8,620 Lb.	41 Lb. (± 0.5%)
Y	5,420 Lb.	62 Lb. (± 1.1%)
Z	48,800 Lb.	25 Lb. (± 0.05%)
L	16,650 Ft. Lb.	142 Ft. Lb. (± 0.9%)
M	25,000 Ft. Lb.	129 Ft. Lb. (± 0.5%)
N	58,200 Ft. Lb.	70 Ft. Lb. (± 0.1%)
Tail Rotor	3,250 Lb.	76 Lb. (± 2.3%)

TABLE X

RSRA PREDICTED VERTICAL DRAG

THRUST	17730.6	RHO	.002377
CT	.005363	TIP SPEED	678.8
RADIUS	31.00	THRUST RECRY	.9000

ELEMENT	X/R	H/R	CD	V FACTOR	AREA	VEL	W	DRAG	
1	.620	-.274	.640	1.000	13.92	66.92	5.32	47.4	NOSE AND
2	.532	-.218	.730	1.000	15.80	58.60	4.08	47.1	COCKPIT
3	.425	-.164	1.150	1.000	25.90	45.92	2.51	74.7	
4	.312	-.153	1.150	1.000	19.00	36.80	1.61	35.2	FORWARD
5	.236	-.067	.940	1.000	13.70	27.33	.89	11.4	CABIN
6	.154	-.048	.910	1.000	19.50	11.36	.15	2.7	
7	.042	-.030	.870	1.000	16.60	14.28	.24	3.5	
8	.040	-.027	.870	1.000	15.80	14.41	.25	3.4	AFT
9	.150	-.038	.870	1.000	20.10	11.03	.14	2.5	CABIN
10	.241	-.075	.920	1.000	16.20	27.51	.90	13.4	
11	.332	-.153	1.050	1.000	20.10	38.96	1.80	38.1	TAILCONE
12	.442	-.194	1.080	1.000	16.80	51.74	3.18	57.7	
13	.548	-.215	1.070	1.000	13.80	58.98	4.13	61.0	
14	.646	-.237	1.020	1.000	11.90	65.74	5.14	62.3	
15	.751	-.258	.960	1.000	9.76	72.15	6.19	58.0	
16	.848	-.280	.920	1.000	8.19	.00	.00	.0	
17	.954	-.296	1.500	1.000	18.48	.00	.00	.0	
18	.215	-.344	.950	1.229	16.39	39.66	1.87	29.1	LEFT MLG DOOR
19	.226	-.344	.880	1.229	6.11	39.83	1.89	10.1	RIGHT MLG DOOR
20	.414	-.413	1.250	1.265	2.00	71.69	6.11	15.3	VOR/LOC ANTENNAS
21	.780	-.324	1.170	1.000	.78	.00	.00	.0	AIRSPEED BOOM
MISC	--	--	--	--	--	--	--	17.2	MISCELLANEOUS

TOTAL DRAG (POUNDS)	ROTOR THRUST (POUNDS)	GROSS WEIGHT (POUNDS)	VERTICAL DRAG (PERCENT)	DRAG/THRUST (PERCENT)
590.2	17730.6	17300.0	2.51	3.33

THRUST	20194.3	RHO	.002377
CT	.006108	TIP SPEED	678.8
RADIUS	31.00	THRUST RECRY	.9000

ELEMENT	X/R	H/R	CD	V FACTOR	AREA	VEL	W	DRAG	
1	.620	-.274	.640	1.000	13.92	71.61	6.10	54.3	NOSE AND
2	.532	-.218	.730	1.000	15.80	62.87	4.70	54.2	COCKPIT
3	.425	-.164	1.150	1.000	25.90	48.73	2.82	84.1	
4	.312	-.153	1.150	1.000	19.00	39.46	1.85	40.4	FORWARD
5	.236	-.067	.940	1.000	13.70	29.13	1.01	13.0	CABIN
6	.154	-.048	.910	1.000	19.50	12.51	.19	3.3	
7	.042	-.030	.870	1.000	16.60	15.59	.29	4.2	
8	.040	-.027	.870	1.000	15.80	15.72	.29	4.0	AFT
9	.150	-.038	.870	1.000	20.10	12.11	.17	3.0	CABIN
10	.241	-.075	.920	1.000	16.20	29.42	1.03	15.3	
11	.332	-.153	1.050	1.000	20.10	40.82	1.98	41.8	TAILCONE
12	.442	-.194	1.080	1.000	16.80	55.32	3.64	66.0	
13	.548	-.215	1.070	1.000	13.80	63.39	4.78	70.5	
14	.646	-.237	1.020	1.000	11.90	70.82	5.96	72.4	
15	.751	-.258	.960	1.000	9.76	79.34	7.48	70.1	
16	.848	-.280	.920	1.000	8.19	.00	.00	.0	
17	.954	-.296	1.500	1.000	18.48	.00	.00	.0	
18	.215	-.344	.950	1.229	16.39	42.29	2.13	33.1	LEFT MLG DOOR
19	.226	-.344	.880	1.229	6.11	42.09	2.11	11.3	RIGHT MLG DOOR
20	.414	-.413	1.250	1.265	2.00	71.69	6.11	15.3	VOR/LOC ANTENNAS
21	.780	-.324	1.170	1.000	.78	.00	.00	.0	AIRSPEED BOOM
MISC	--	--	--	--	--	--	--	19.7	MISCELLANEOUS

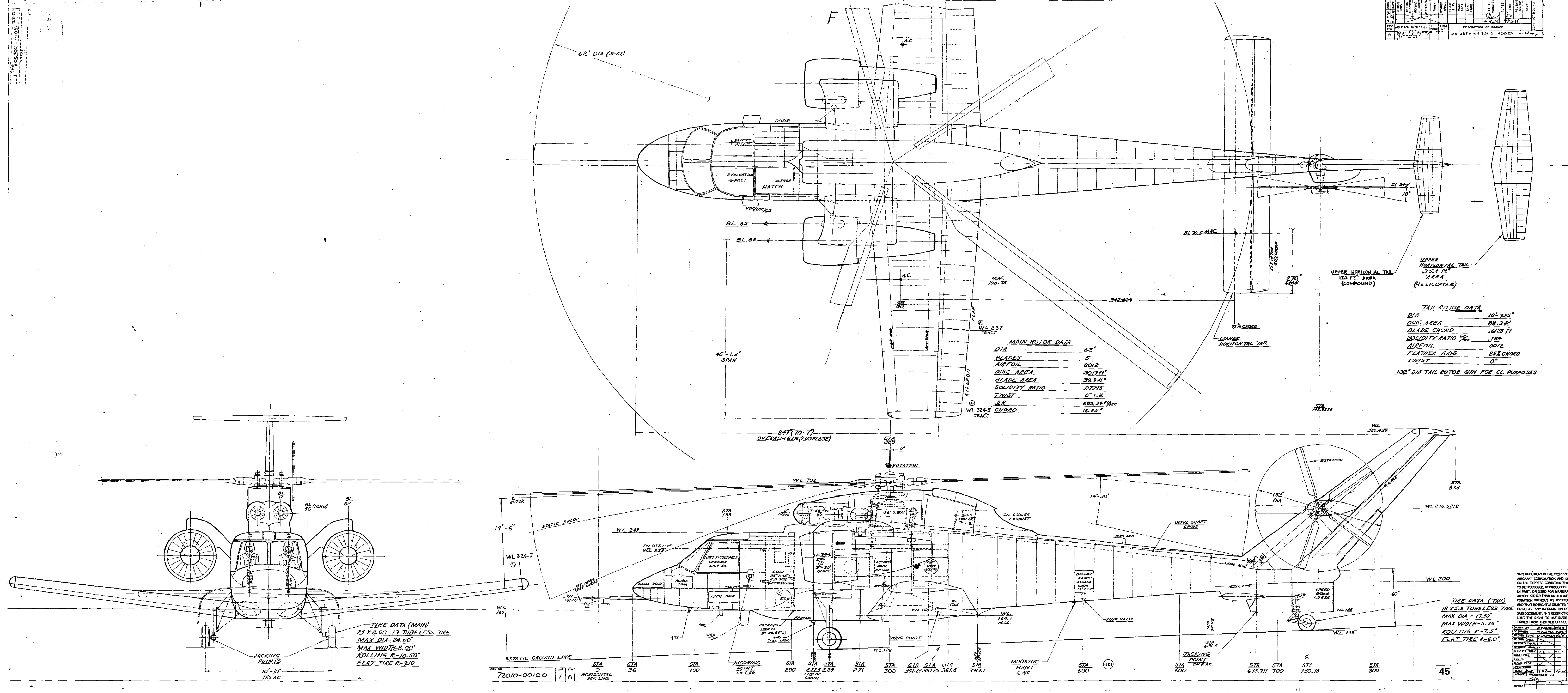
TOTAL DRAG (POUNDS)	ROTOR THRUST (POUNDS)	GROSS WEIGHT (POUNDS)	VERTICAL DRAG (PERCENT)	DRAG/THRUST (PERCENT)
676.0	20194.3	19700.0	2.53	3.35

RSRA NASA 740 IN HELICOPTER CONFIGURATION

FIGURE 2

RSRA TAIL ROTOR AND VERTICAL TAIL WITHOUT RUDDER

FIGURE 3



TIRE DATA (MAIN)
24 X 8.00 - 13 TUBELESS TIRE
MAX DIA - 24.00"
MAX WIDTH - 8.00"
ROLLING R - 10.50"
FLAT TIRE R - 9.10

TIRE DATA (TAIL)
18 X 5.5 TUBELESS TIRE
MAX DIA - 17.90"
MAX WIDTH - 5.75"
ROLLING R - 7.5"
FLAT TIRE R - 6.0"

WING DATA

AIRFOIL (ROOT)	63₂ 415
AIRFOIL (TIP)	63₂ 415
INCIDENCE (VARIABLE)	+15° -9°
ROOT CHORD	115.24"
TIP CHORD	76.85"
25% CHORD SWEEP	3°
FWD SPAR	10% CHORD
AFT SPAR	54% CHORD
PROJECTED AREA TOT.	370 ft²
TAPER RATIO	.66
ASPECT RATIO	5.52
DIHEDRAL	7°
FLAP ANGLE	+25°
AILERON ANGLE	+5 -15
FLAP AREA (TOT. PROJ.)	57.8 ft²
AILERON AREA (TOT. PROJ.)	35.7 ft²

VERTICAL FIN DATA

ROOT CHORD	WL 212.439	112.50"
TIP CHORD (LOWER)	WL 168.439	112.50"
TAPER RATIO (LOWER)		1.0
TAPER RATIO (UPPER)		.383
AREA TOTAL (EXPOSED)		68.86 ft²
ASPECT RATIO		3.62
AIRFOIL TIP (LOWER)		.0015 NACA
AIRFOIL TIP (UPPER)		.0015 NACA
TIP CHORD (UPPER)		43.14"
AIRFOIL ROOT		.0015 NACA
SPEED BRAKE AREA		8 ft² PER SIDE
RUDDER AREA		20.66 ft²
SPAN		100%
25° CHORD SWEEP (UPPER)		48°
RUDDER ANGLE (NORMAL TO HINGE)		±25°

MAIN ROTOR DATA

DIA	62'
BLADES	5
AIRFOIL	0012
DISC AREA	3019 ft²
BLADE AREA	39.9 ft²
SOLIDITY RATIO	.07745
TWIST	8° L.H.
ΩR	685.34 ft/sec
CHORD	18.25"

TAIL ROTOR DATA

DIA	10'-7.25"
DISC AREA	88.3 ft²
BLADE CHORD	.6125 ft
SOLIDITY RATIO bc/πr	.184
AIRFOIL	0012
FEATHER AXIS	25% CHORD
TWIST	0°

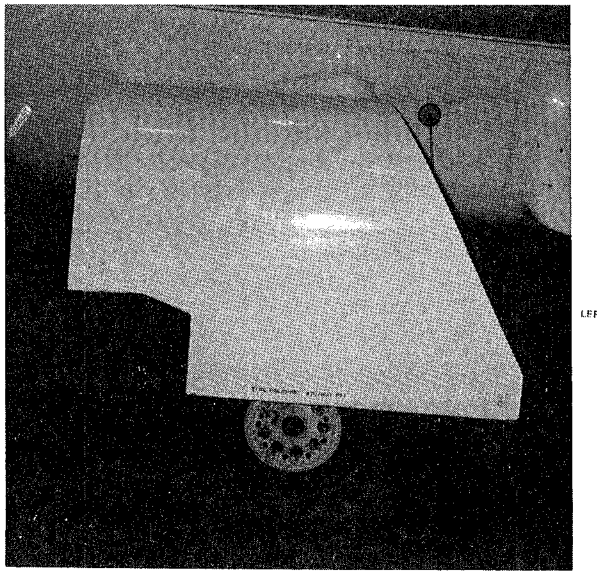
132" DIA TAIL ROTOR SHN FOR CL. PURPOSES

SEE SEPARATE PARTS LIST AND SEPARATE APPLICATION LIST

Sikorsky Aircraft
GENERAL ARRANGEMENT RSRA
79286 72010-00100

72010-00100 REV A

FIGURE 4



LEFT DOOR

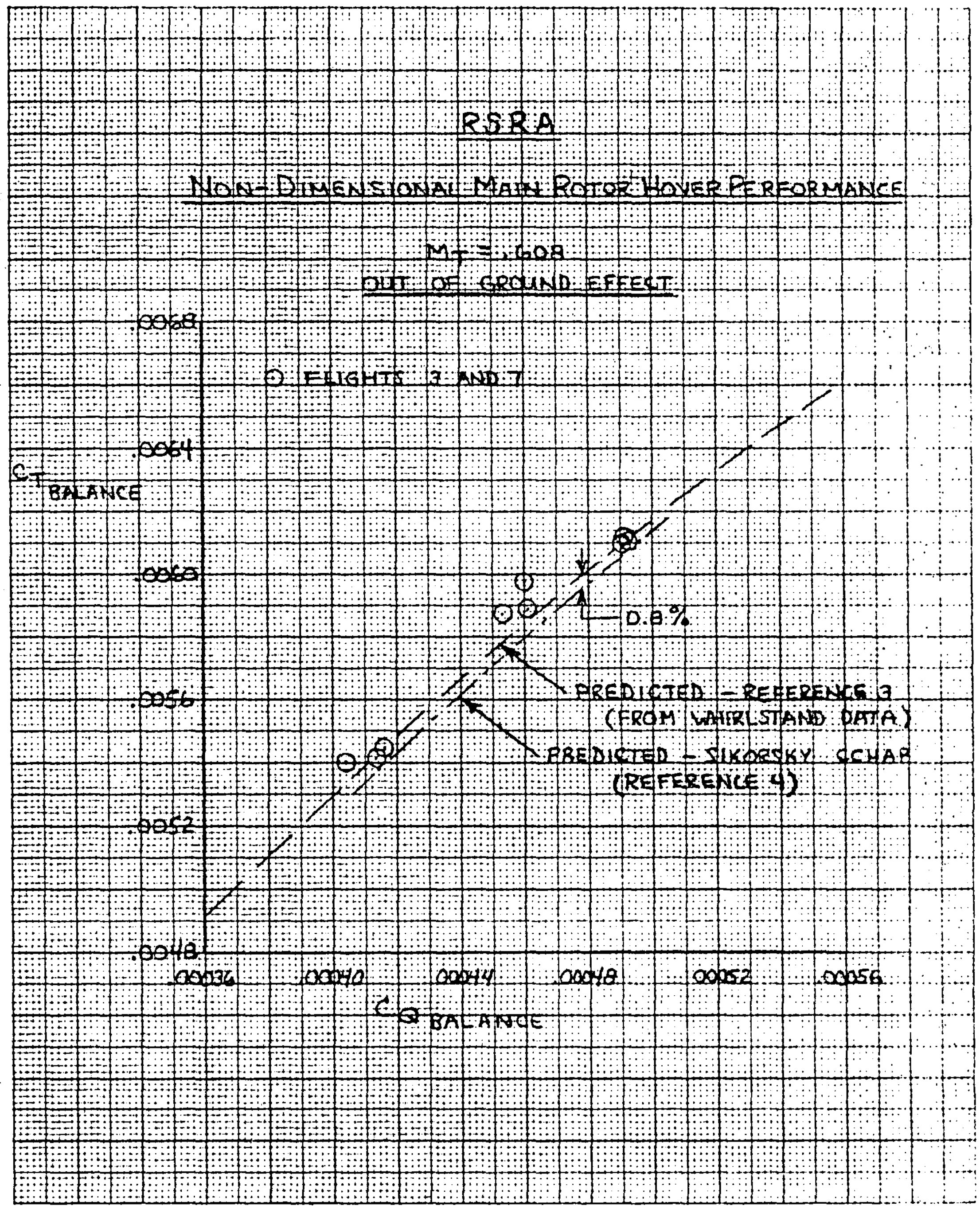
a. LEFT DOOR

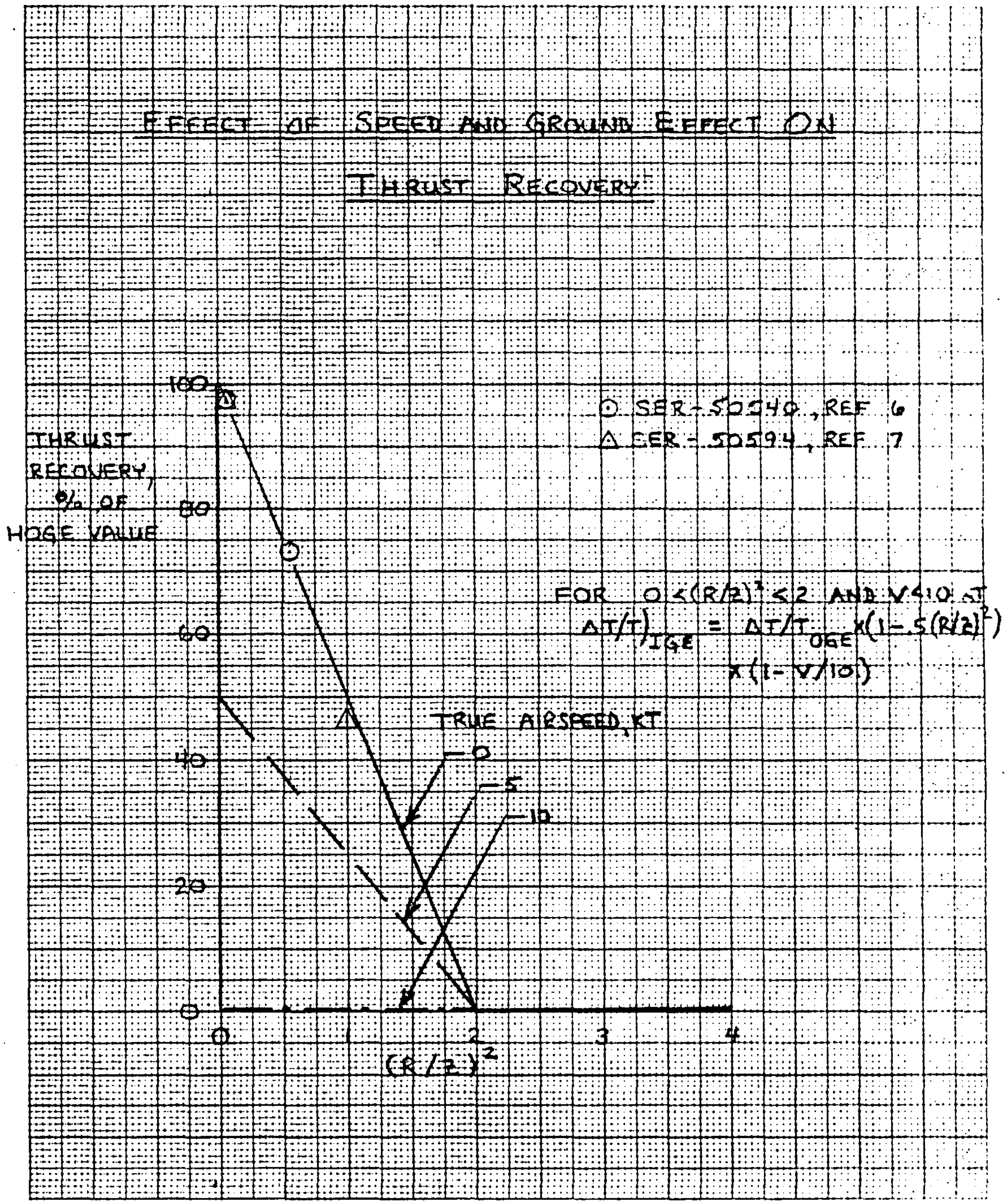
RIGHT DOOR

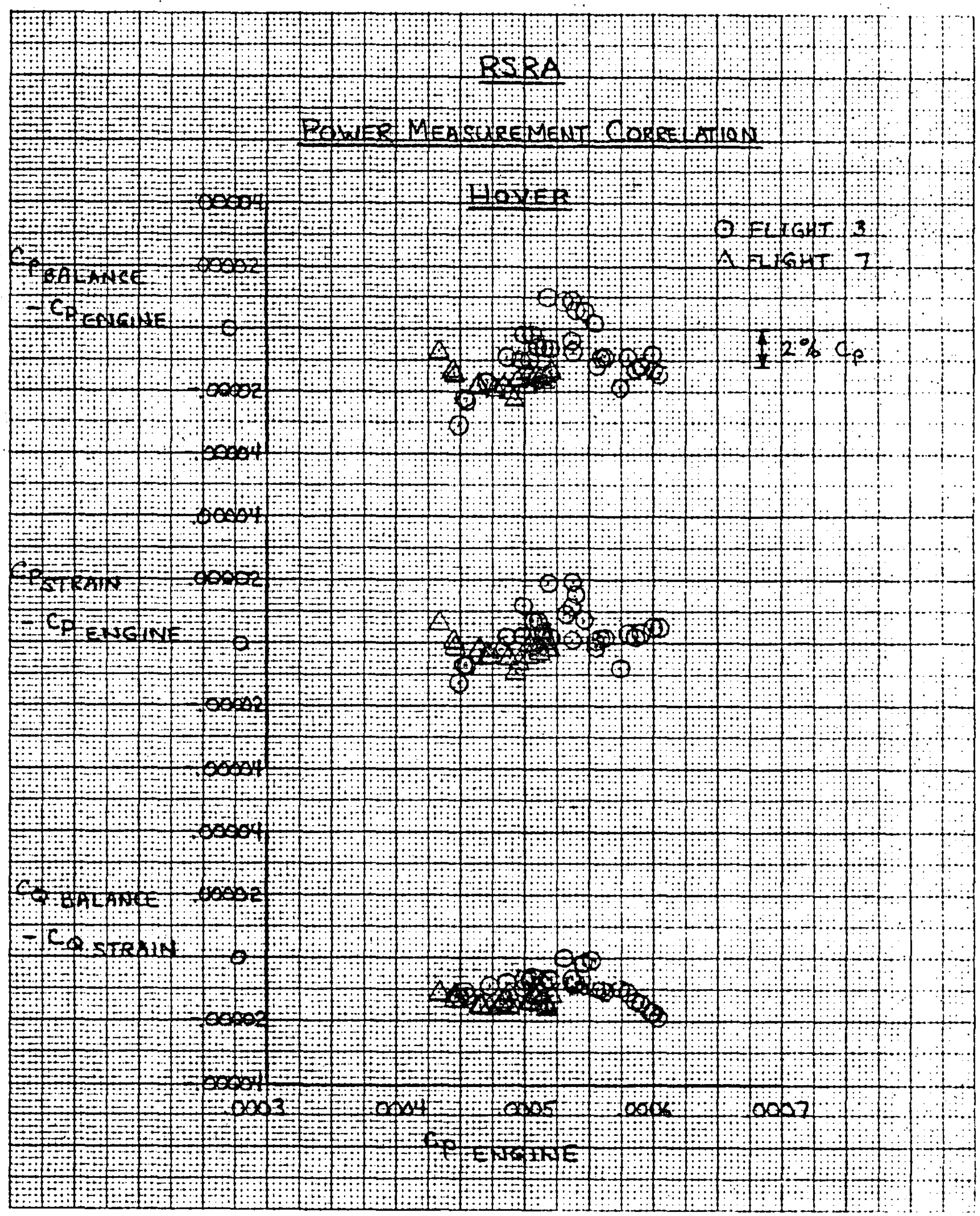
b. RIGHT DOOR

RSRA LANDING GEAR DOORS

FIGURE 5


RSRA
NON-DIMENSIONAL MAIN ROTOR HOVER PERFORMANCE
M_T = .608
OUT OF GROUND EFFECT
FLIGHTS 3 AND 7
C_T BALANCE
.0068
.0064
.0060
.0056
.0052
.0048
.00036
.00040
.00044
.00048
.00052
.00056
C_Q BALANCE
0.8%
PREDICTED – REFERENCE 3
(FROM WHIRLSTAND DATA)
PREDICTED – SIKORSKY CCHAR
(REFERENCE 4)


EFFECT OF SPEED AND GROUND EFFECT ON THRUST RECOVERY
⊙ SER-50540, REF 6
△ SER-50594, REF 7
THRUST RECOVERY, % OF HOGE VALUE
100
80
60
40
20
0
FOR 0≤(R/2)²≤2 AND V≤10 KT
ΔT/T)IGE = ΔT/T OGE x(1-.5(R/2)²) x(1-V/10)
TRUE AIRSPEED, KT
0
5
10
0
1
2
3
4
(R/2)²


RSRA
POWER MEASUREMENT CORRELATION
HOVER
⊙ FLIGHT 3
△ FLIGHT 7
2% Cp
CP BALANCE - CP ENGINE
CP STRAIN - CP ENGINE
CQ BALANCE - CQ STRAIN
CP ENGINE

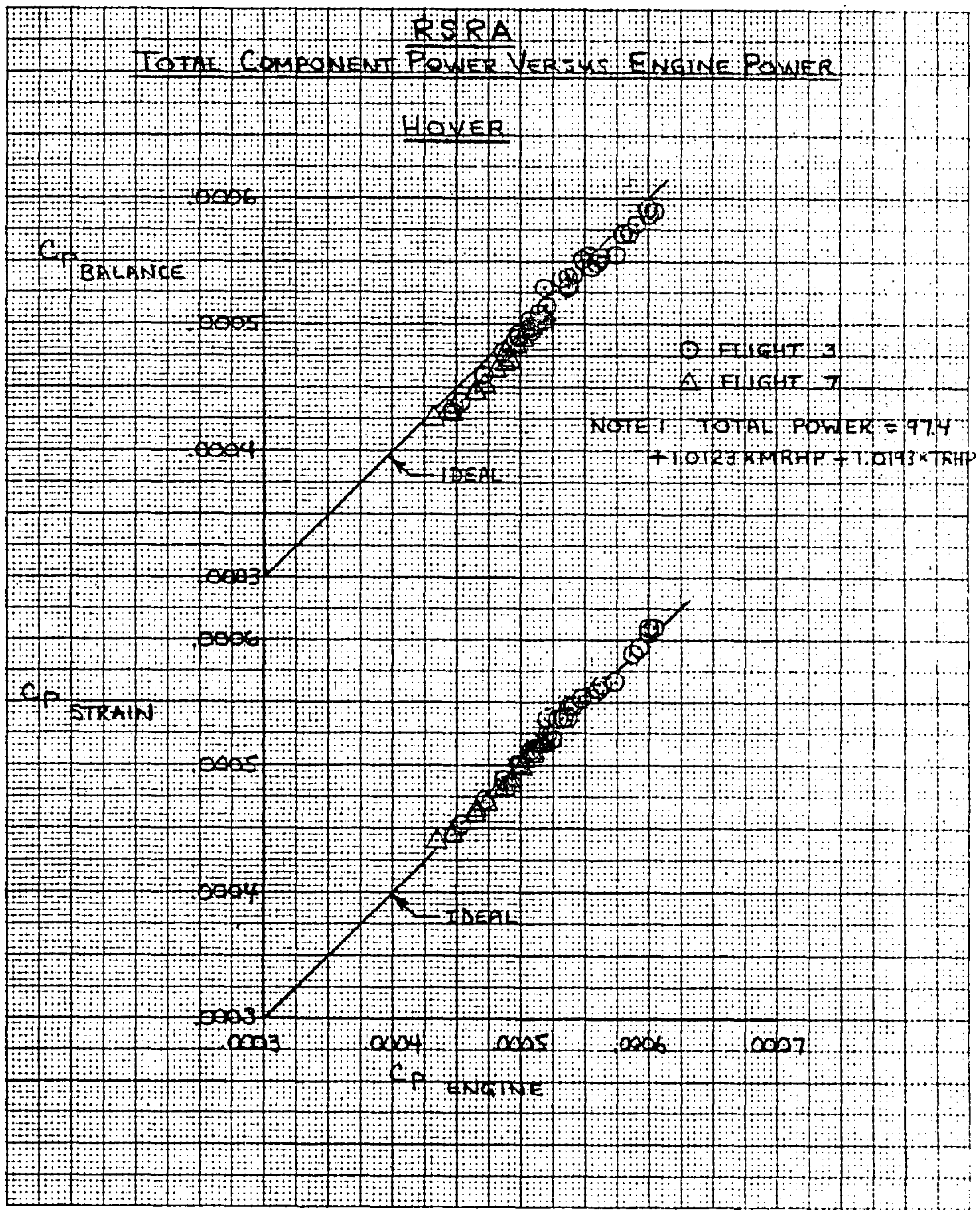
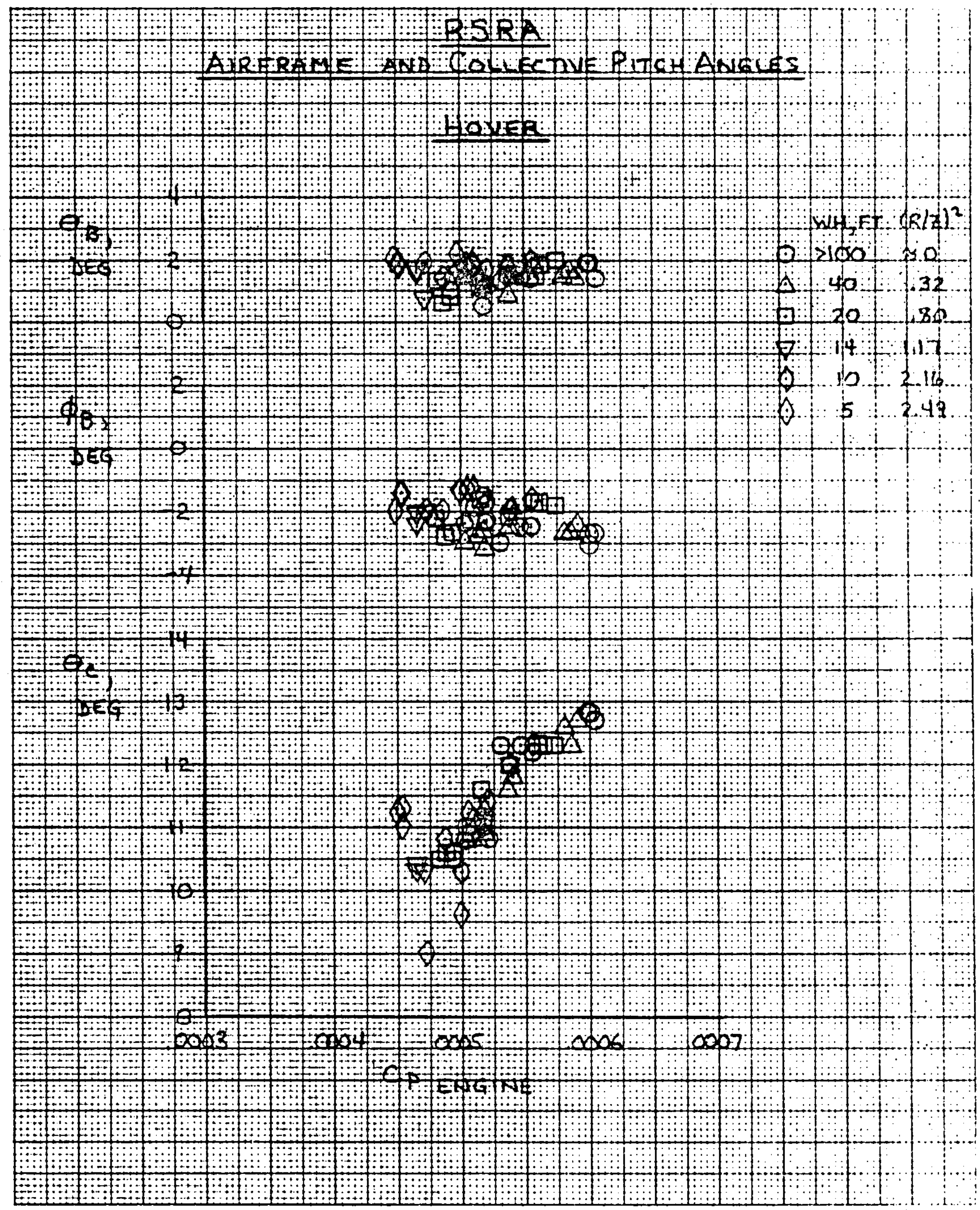

RSRA
TOTAL COMPONENT POWER VERSUS ENGINE POWER
HOVER
.0006
C_P BALANCE
.0005
.0004
.0003
IDEAL
○ FLIGHT 3
△ FLIGHT 7
NOTE: TOTAL POWER = 97.4 +1.0123×MRHP+1.0193×TRHP
.0006
C_P STRAIN
.0005
.0004
.0003
IDEAL
.0003
.0004
.0005
.0006
.0007
C_P ENGINE

FIGURE 9


RSRA
AIRFRAME AND COLLECTIVE PITCH ANGLES
HOVER
θB, DEG
4
2
0
φB, DEG
2
0
-2
-4
θC, DEG
14
13
12
11
10
9
8
.0003
.0004
.0005
.0006
.0007
CP ENGINE
WH, FT (R/Z)²
>100 ≈0
40 .32
20 .80
14 1.17
10 2.16
5 2.49

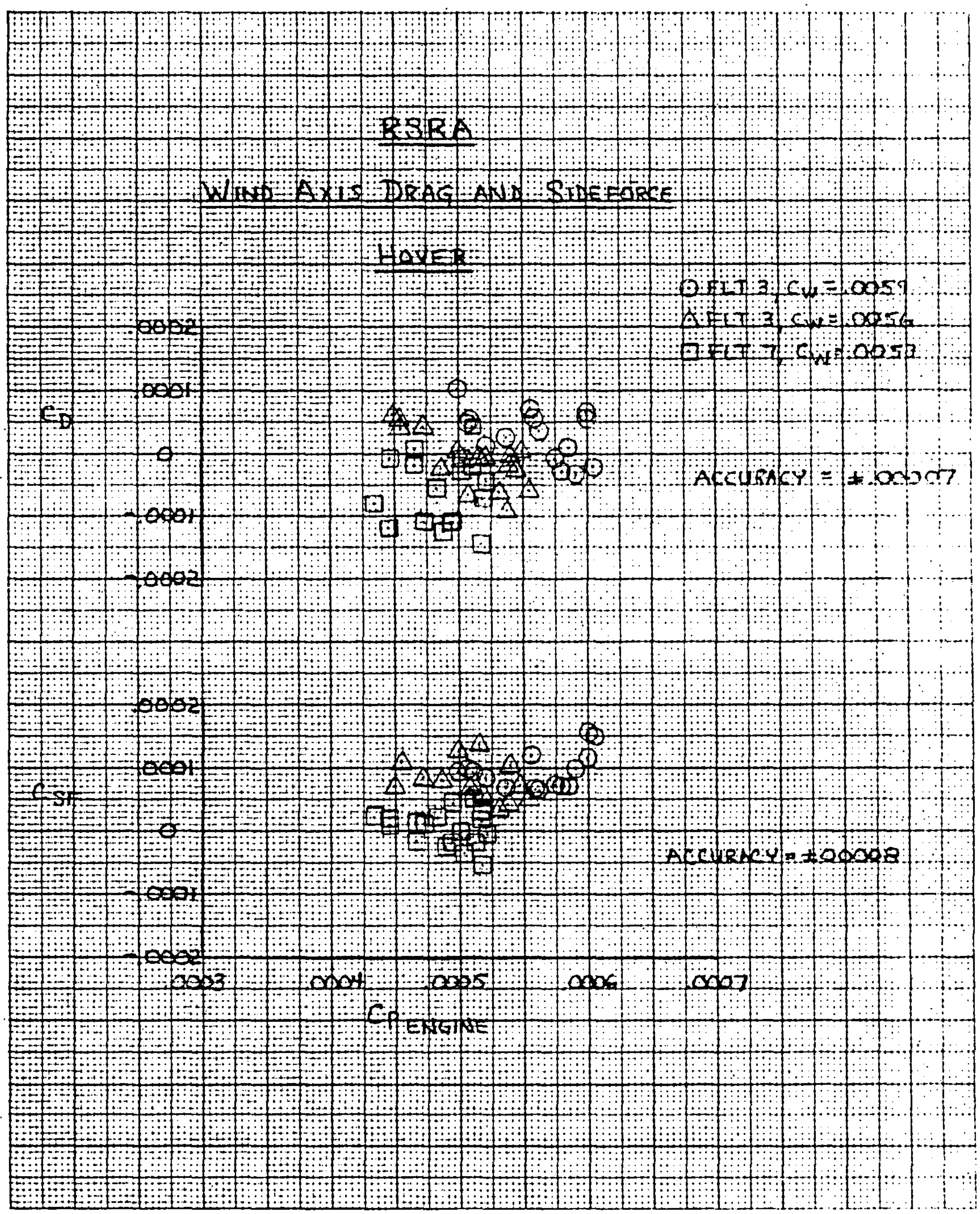
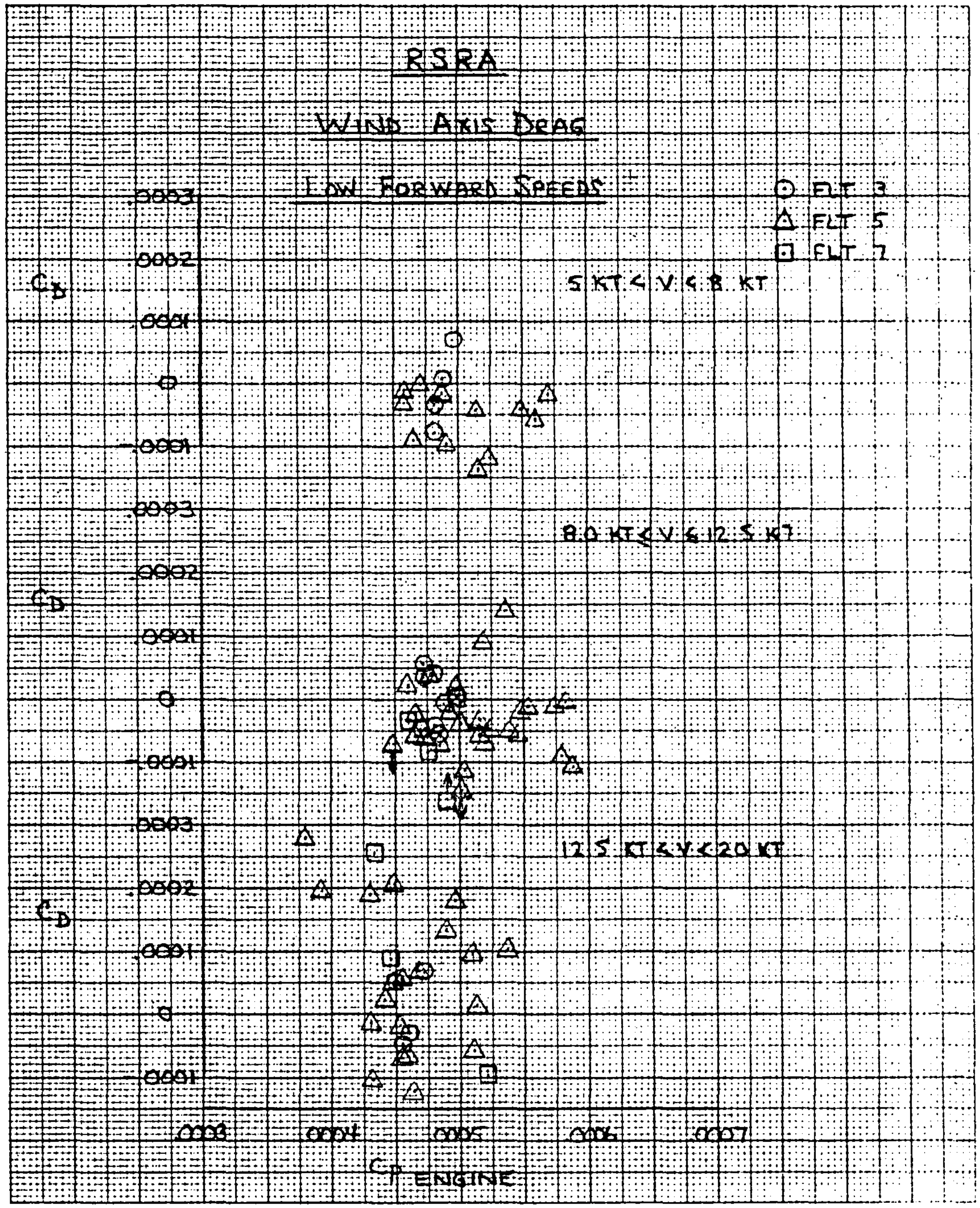
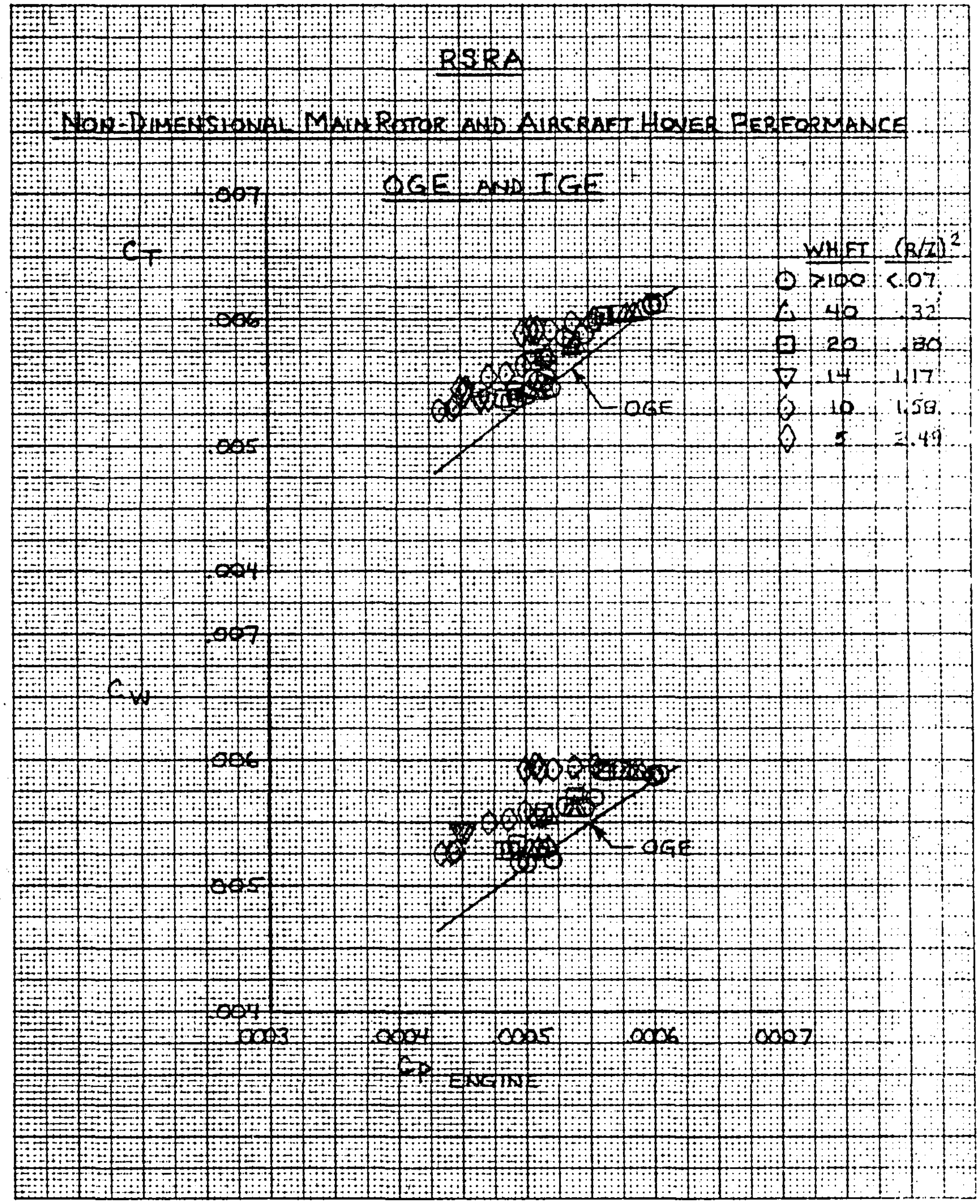
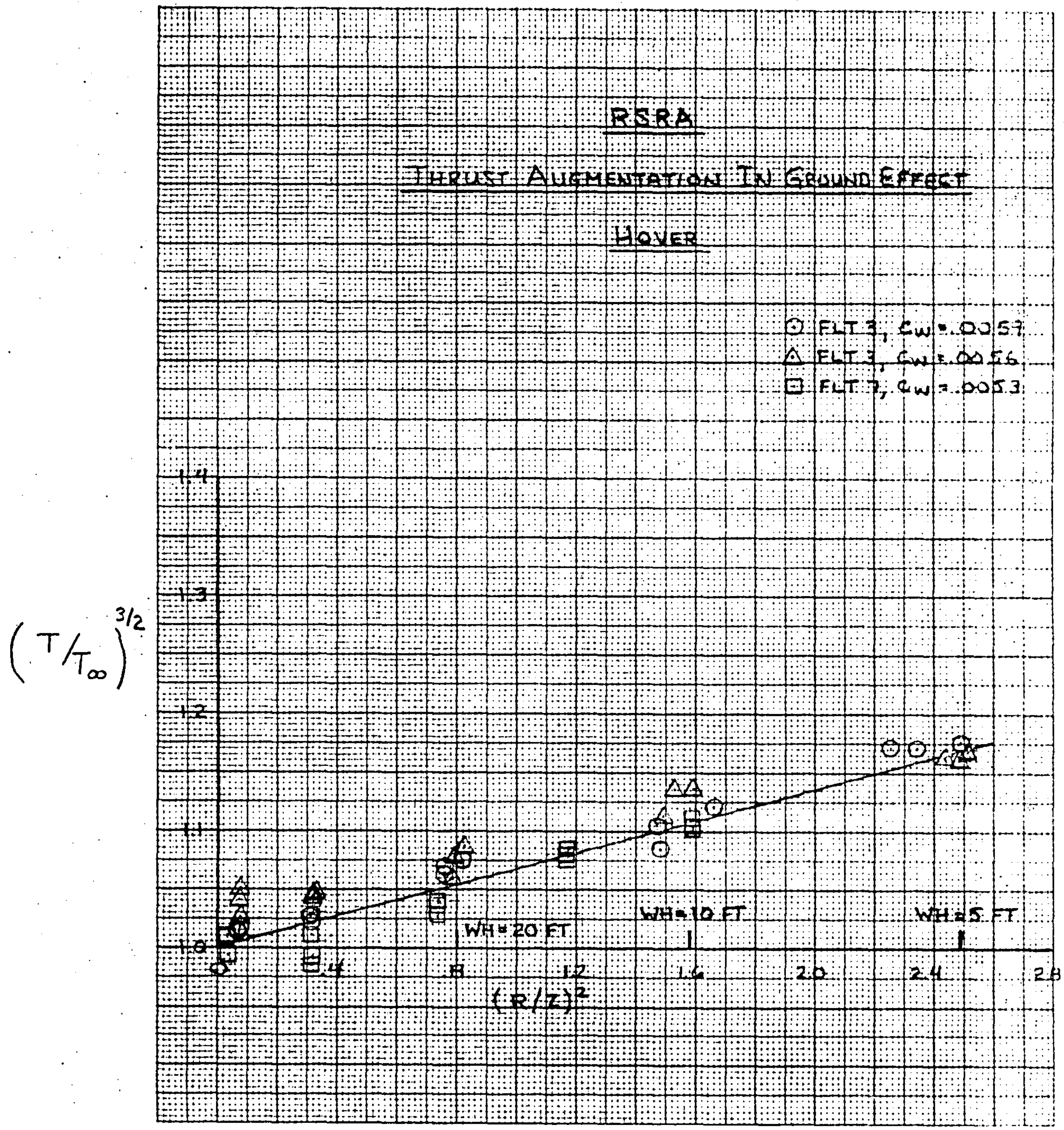

R3RA
WIND AXIS DRAG AND SIDEFORCE
HOVER
○ FLT 3, C_W = .0059
△ FLT 3, C_W = .0056
□ FLT 7, C_W = .0053
C_D
.0002
.0001
0
-.0001
-.0002
ACCURACY = ±.00007
C_{SF}
.0002
.0001
0
-.0001
-.0002
ACCURACY = ±.00008
.0003
.0004
.0005
.0006
.0007
C_P ENGINE

FIGURE 11


RSRA
WIND AXIS DRAG
LOW FORWARD SPEEDS
FLT 3
FLT 5
FLT 7
5 KT ≤ V ≤ 8 KT
8.0 KT ≤ V ≤ 12.5 KT
12.5 KT ≤ V ≤ 20 KT
C_D
C_P ENGINE


RSRA
NON-DIMENSIONAL MAIN ROTOR AND AIRCRAFT HOVER PERFORMANCE
OGE AND TGE
C_T
C_W
.007
.006
.005
.004
.007
.006
.005
.004
.0003
.0004
.0005
.0006
.0007
C_P ENGINE
OGE
OGE
WH FT
$(R/Z)^2$
>100
<.07
40
.32
20
.80
14
1.17
10
1.58
5
2.49


RSRA
THRUST AUGMENTATION IN GROUND EFFECT
HOVER
⊙ FLT 3, C_W = .0057
△ FLT 3, C_W = .0056
□ FLT 7, C_W = .0053
$(T/T_\infty)^{3/2}$
1.4
1.3
1.2
1.1
1.0
WH = 20 FT
WH = 10 FT
WH = 5 FT
.4
.8
1.2
1.6
2.0
2.4
2.8
$(R/Z)^2$

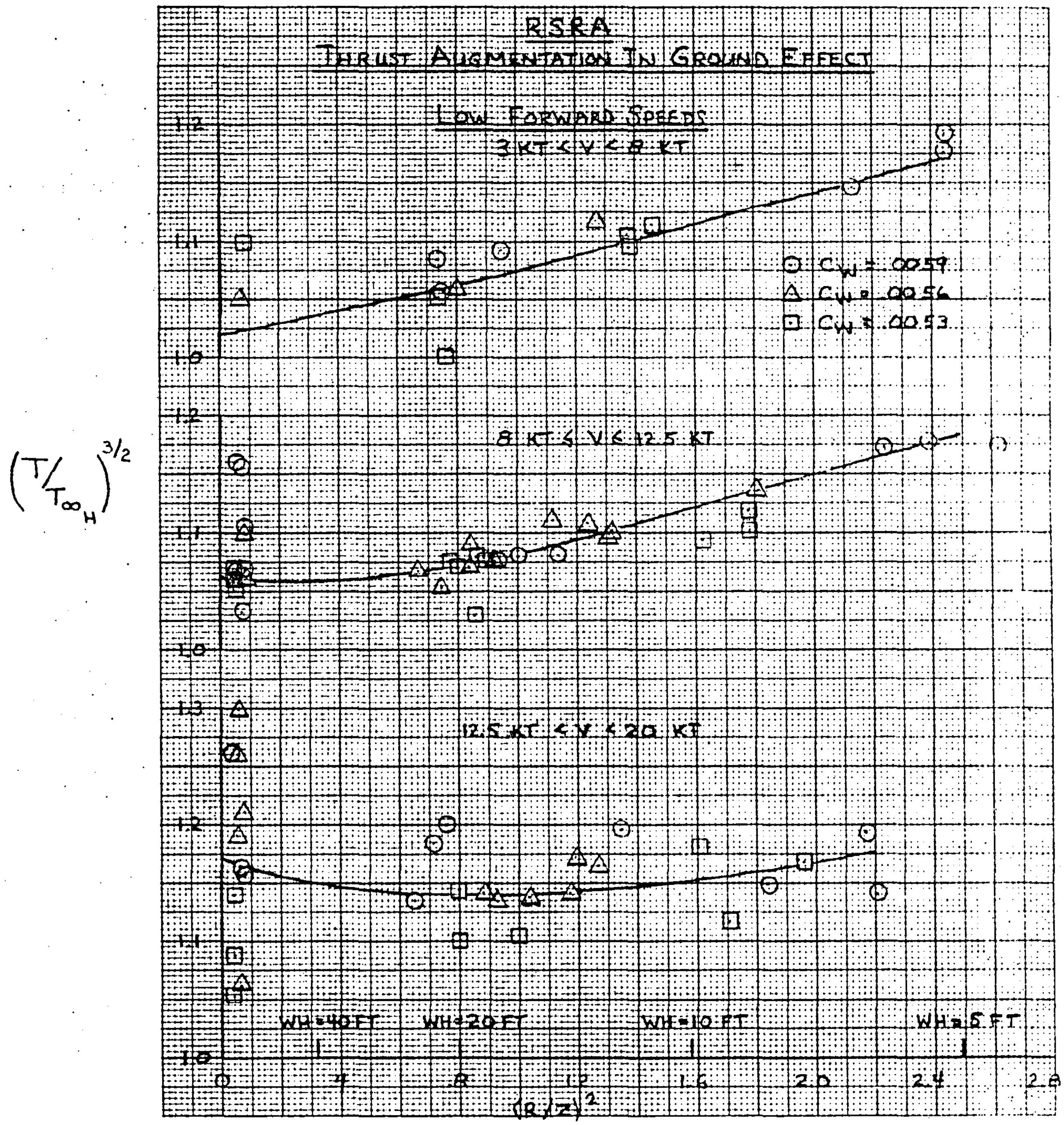
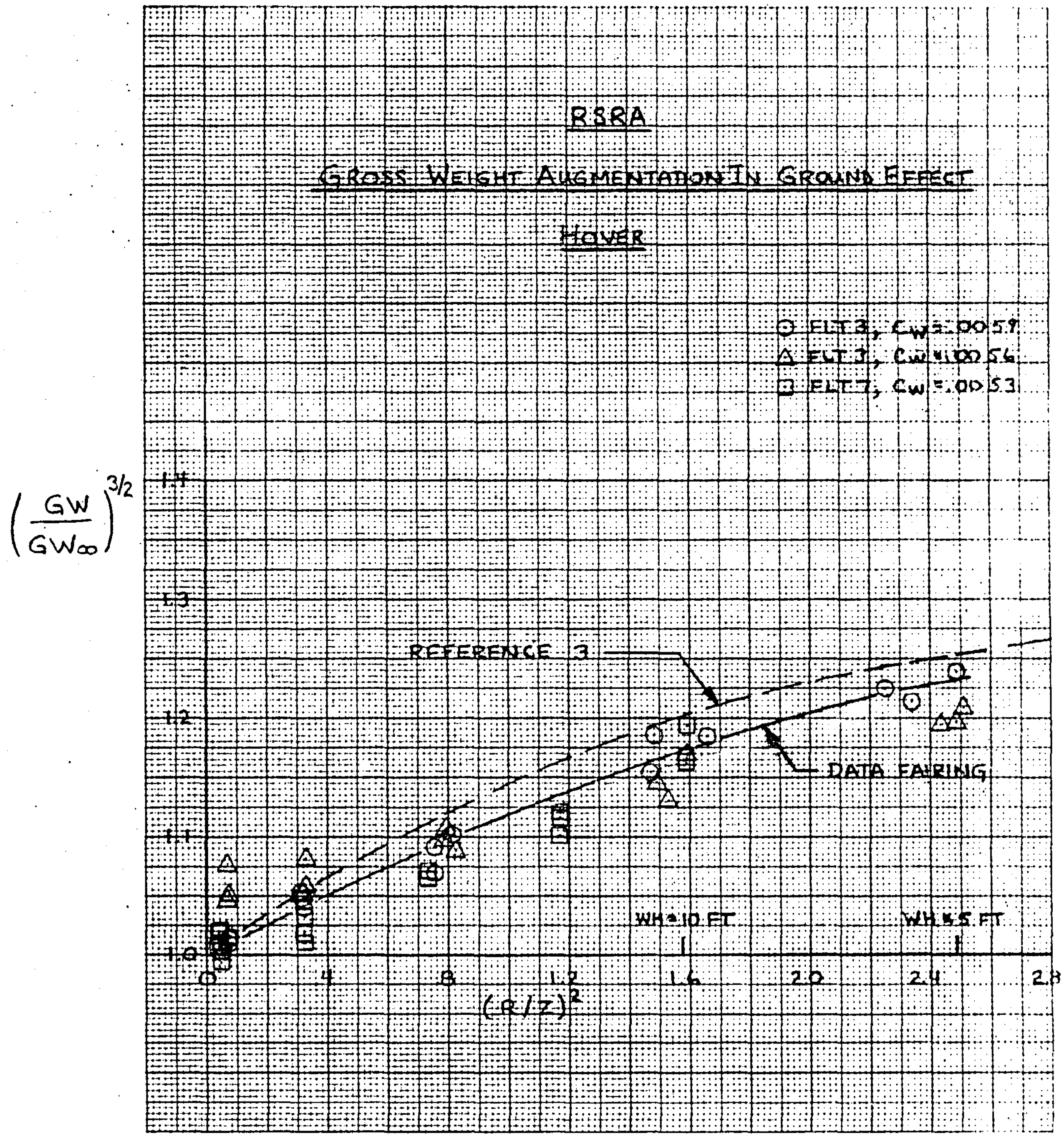
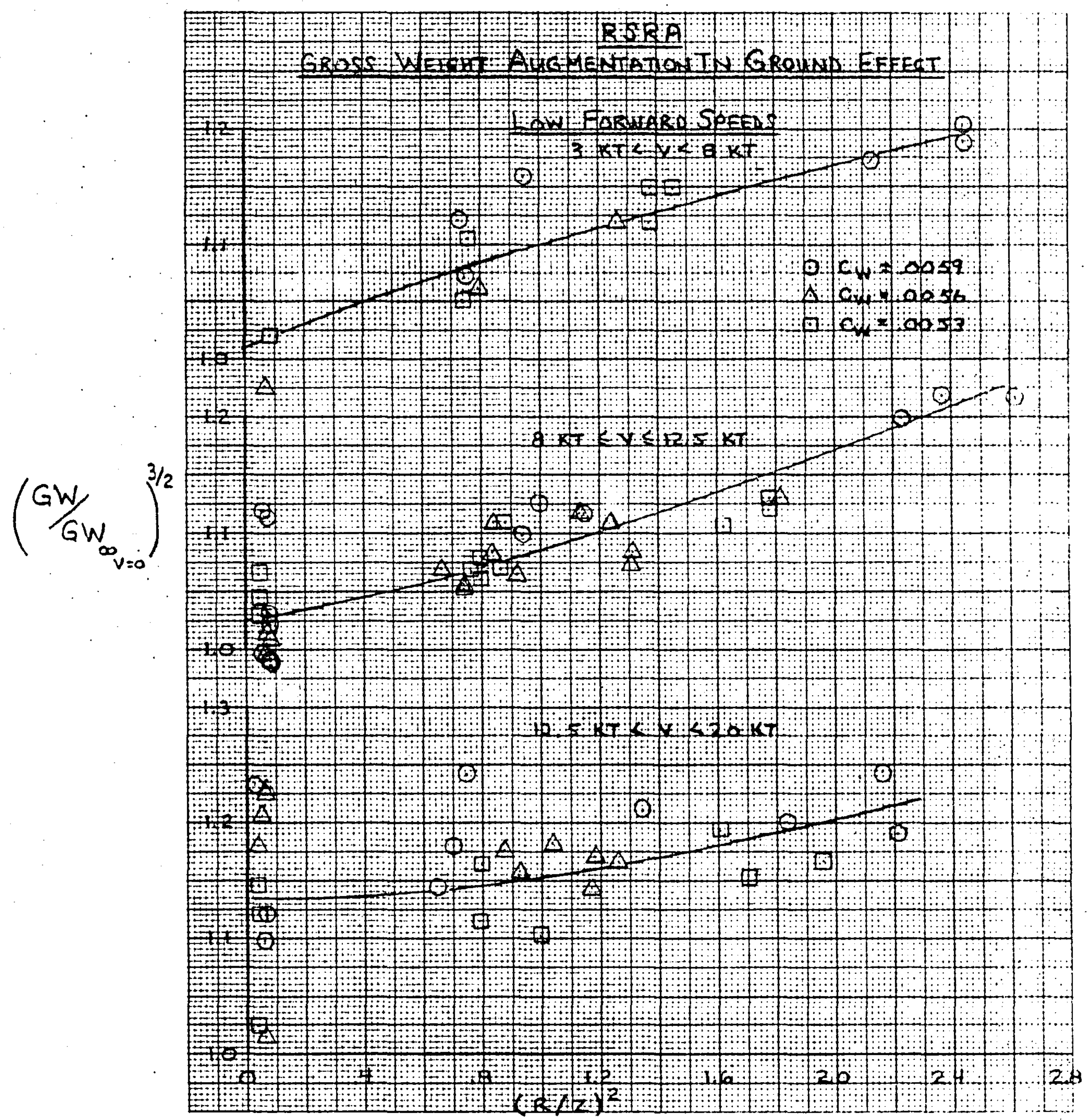
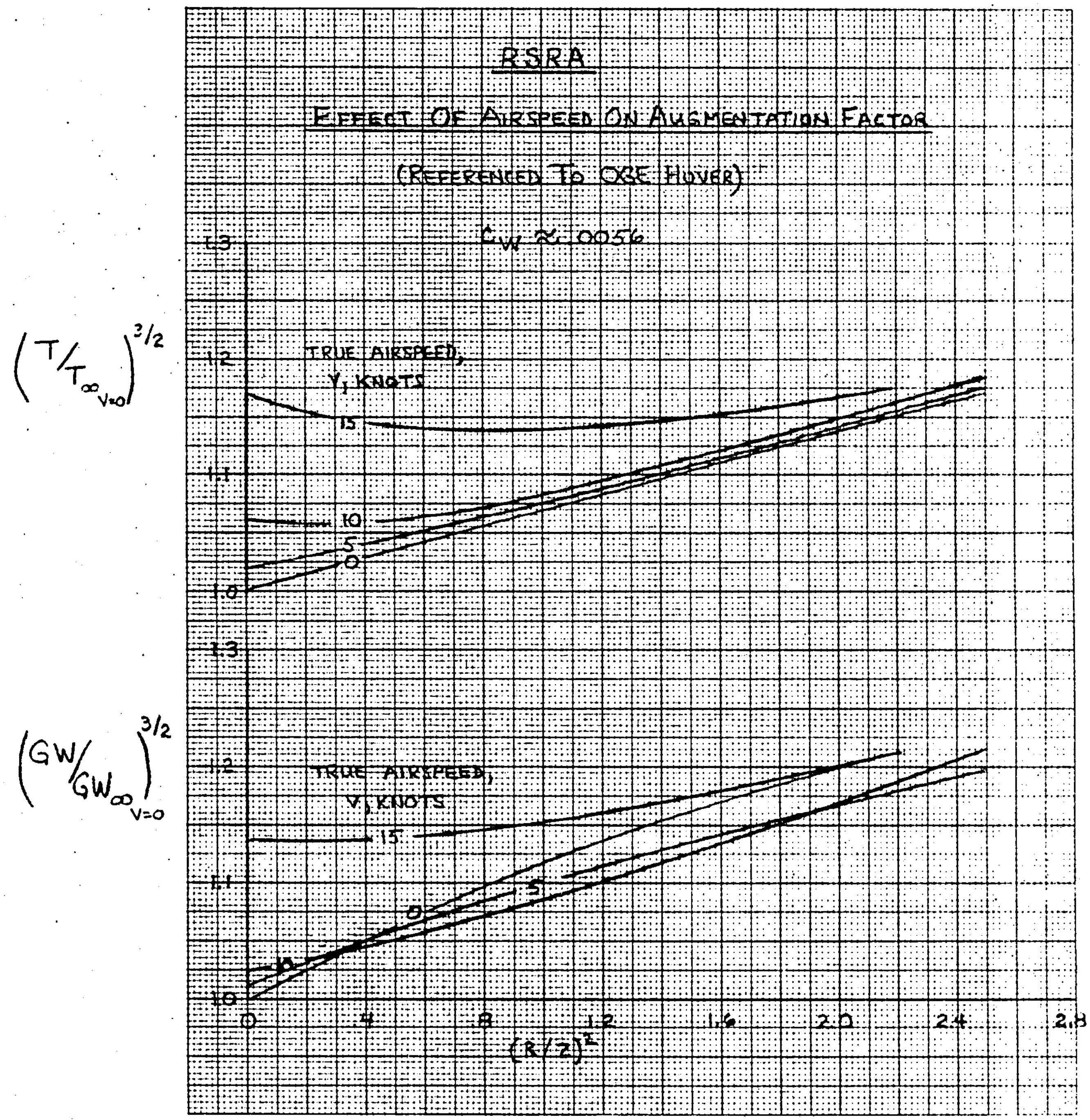
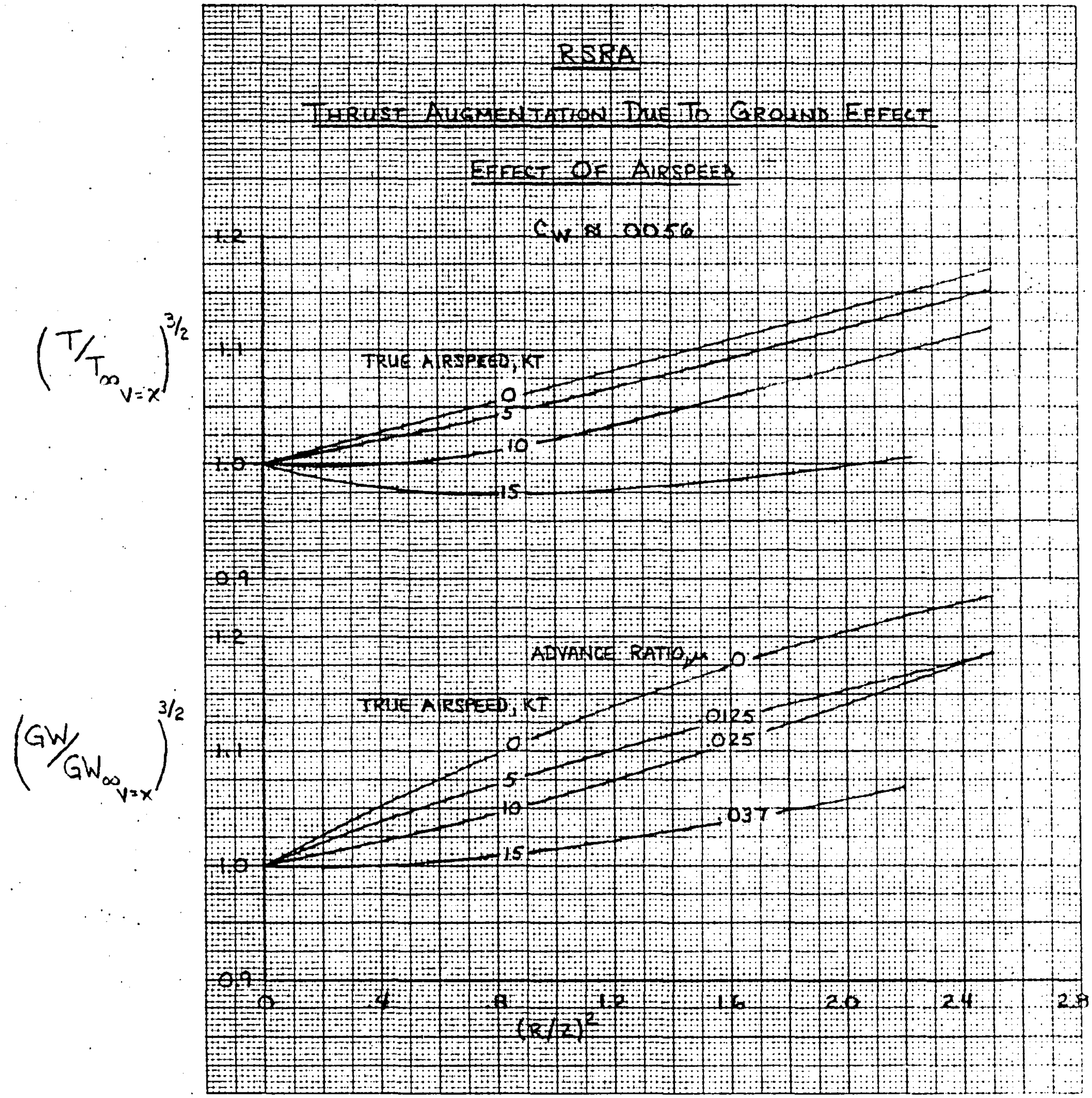

RSRA
THRUST AUGMENTATION IN GROUND EFFECT
LOW FORWARD SPEEDS
3 KT < V < 8 KT
8 KT ≤ V < 12.5 KT
12.5 KT < V < 20 KT
C_W = .0059
C_W = .0056
C_W = .0053
WH=40FT
WH=20FT
WH=10FT
WH=5FT
(T/T∞H)^3/2
(R/Z)^2

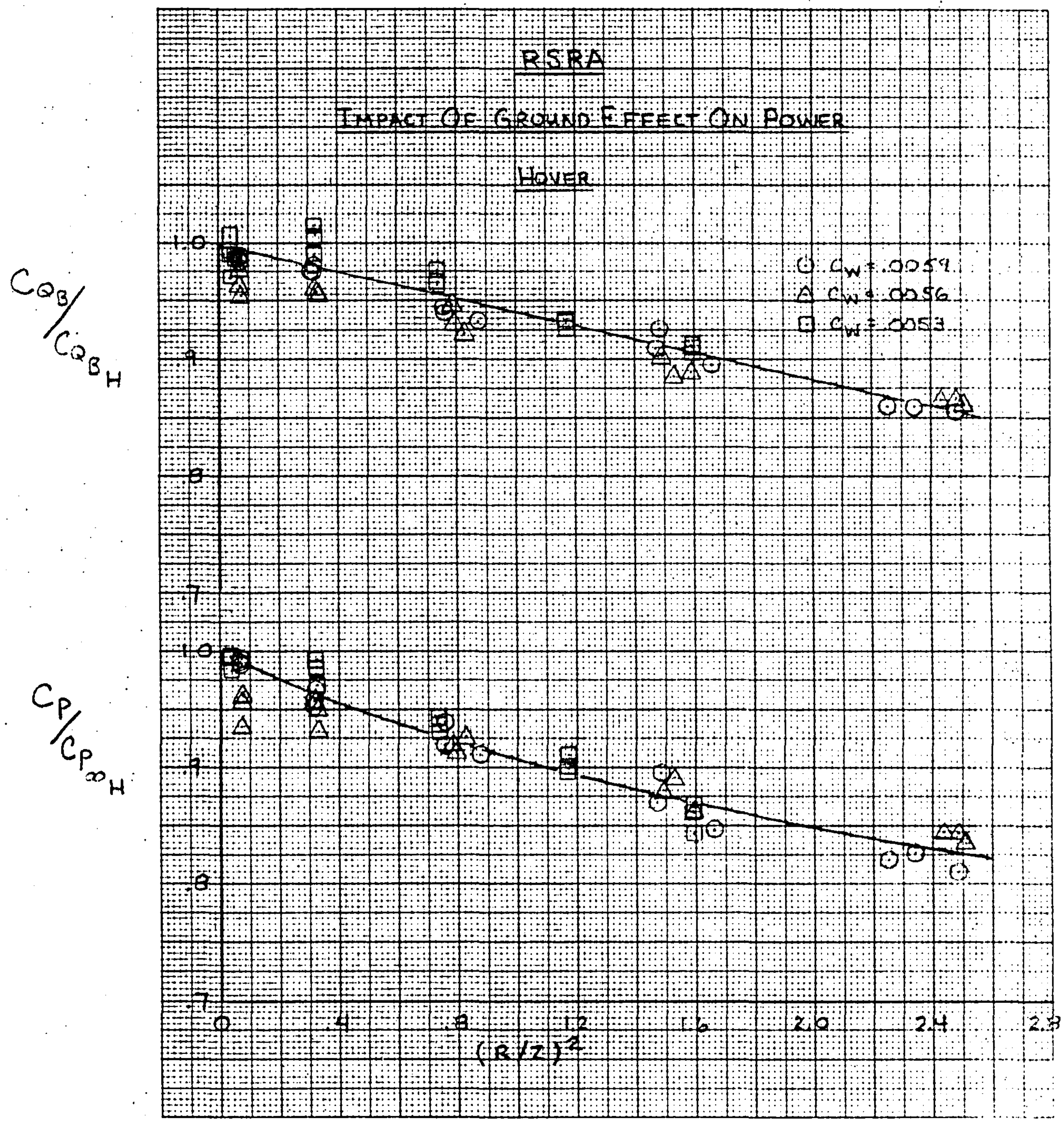
FIGURE 15

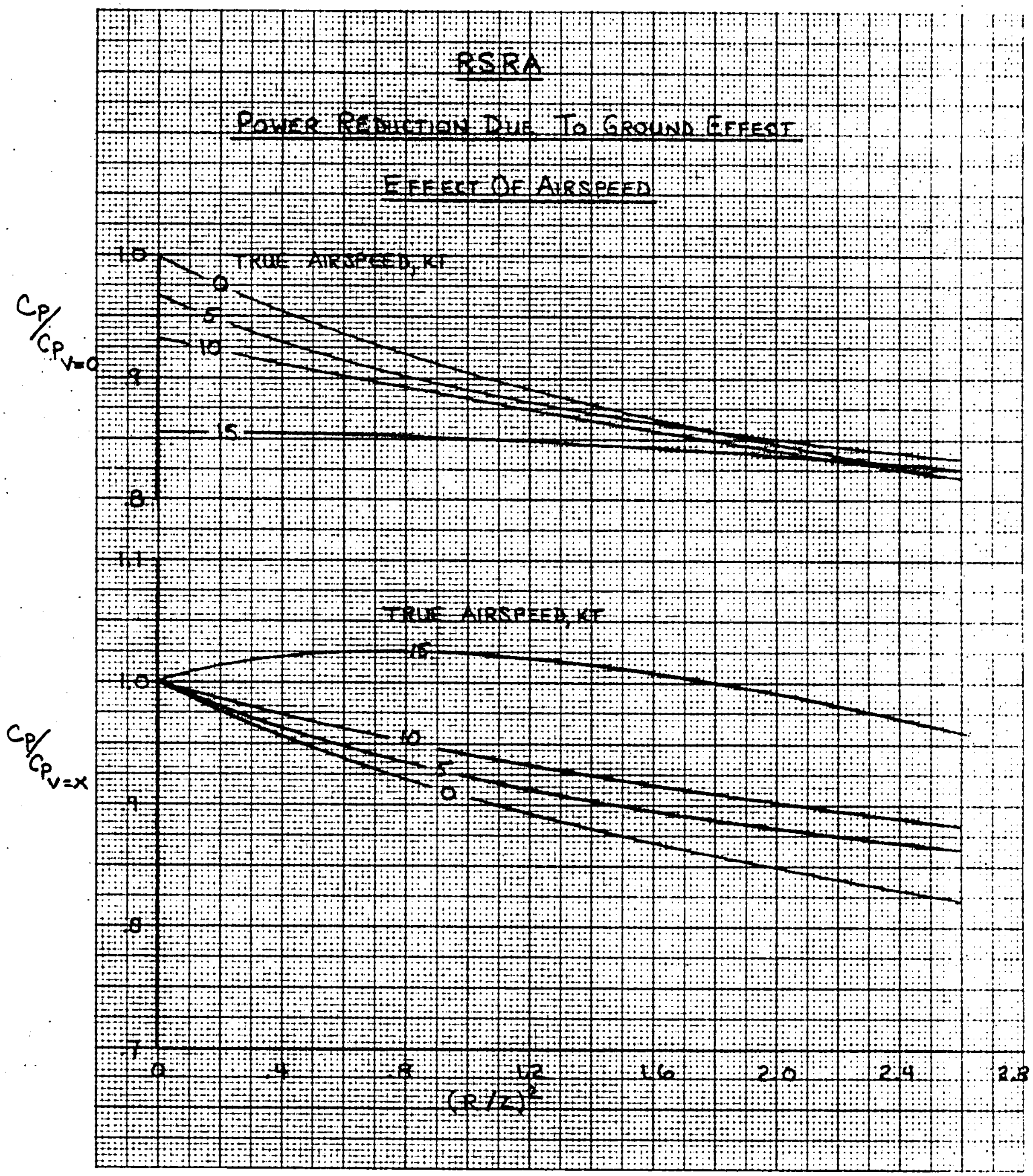

RSRA
GROSS WEIGHT AUGMENTATION IN GROUND EFFECT
HOVER
FLT 3, CW = .0057
FLT 3, CW = .0054
FLT 7, CW = .0053
$(GW/GW_\infty)^{3/2}$
1.4
1.3
1.2
1.1
1.0
REFERENCE 3
DATA FAIRING
WH = 10 FT
WH = 5 FT
0
.4
.8
1.2
1.6
2.0
2.4
2.8
$(R/Z)^2$

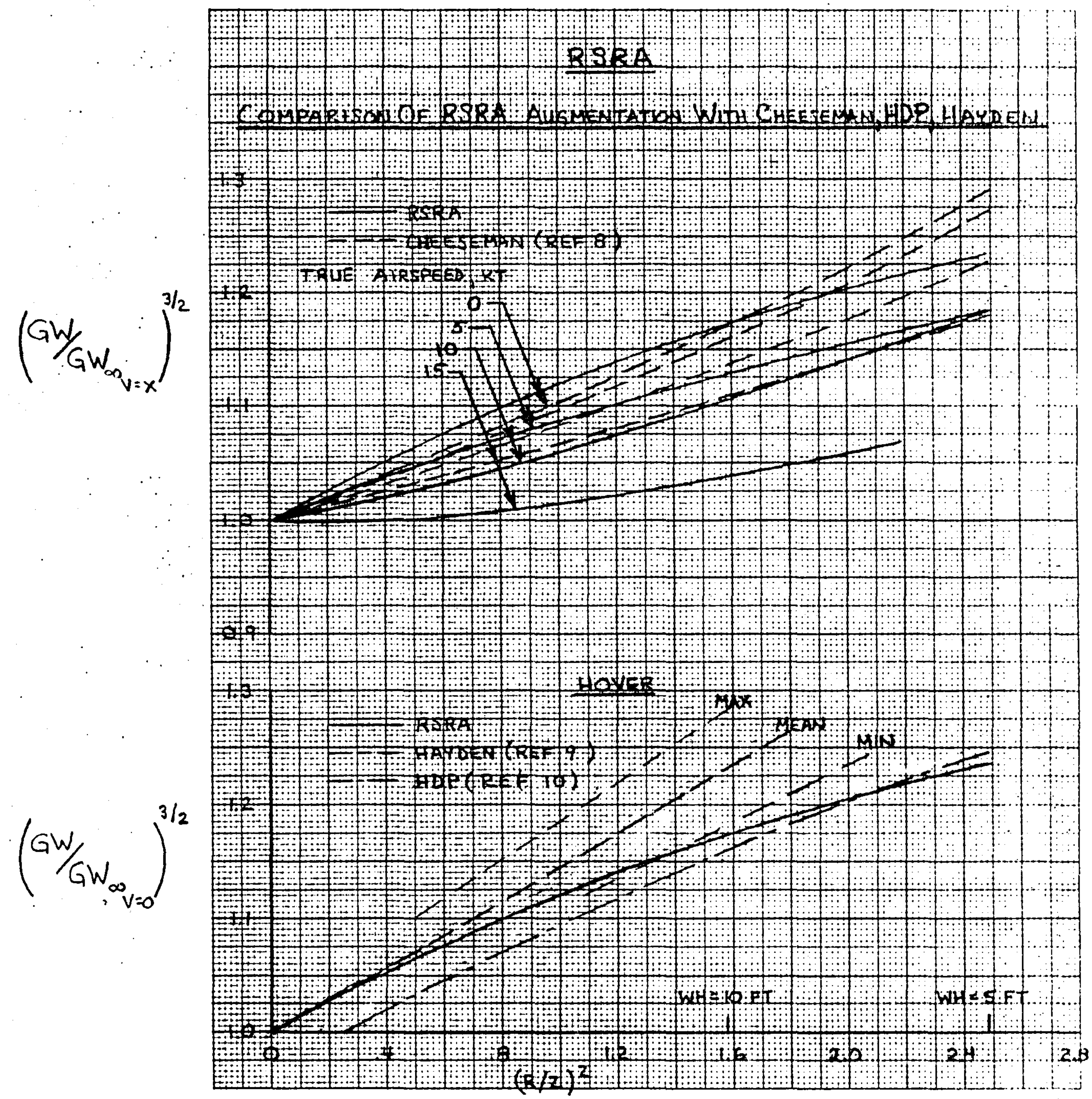

RSRA
GROSS WEIGHT AUGMENTATION IN GROUND EFFECT
LOW FORWARD SPEEDS
3 KT < V < 8 KT
8 KT < V ≤ 12.5 KT
12.5 KT < V < 20 KT
Cw = .0059
Cw = .0056
Cw = .0053
(GW/GW∞ V=0)^3/2
(R/Z)^2
1.0
1.1
1.2
1.3
0
.4
.8
1.2
1.6
2.0
2.4
2.8


RSRA
EFFECT OF AIRSPEED ON AUGMENTATION FACTOR
(REFERENCED TO OGE HOVER)
$C_W \approx .0056$
$(T/T_{\infty_{V=0}})^{3/2}$
TRUE AIRSPEED, V, KNOTS
15
10
5
0
$(GW/GW_{\infty_{V=0}})^{3/2}$
TRUE AIRSPEED, V, KNOTS
15
5
0
10
1.0
1.1
1.2
1.3
0
.4
.8
1.2
1.6
2.0
2.4
2.8
$(R/Z)^2$


RSRA
THRUST AUGMENTATION DUE TO GROUND EFFECT
EFFECT OF AIRSPEED
C_W = .0056
$\left(T/T_{\infty_{V=X}}\right)^{3/2}$
TRUE AIRSPEED, KT
0
5
10
15
1.2
1.1
1.0
0.9
$\left(GW/GW_{\infty_{V=X}}\right)^{3/2}$
ADVANCE RATIO, μ
0
.0125
.025
.037
TRUE AIRSPEED, KT
0
5
10
15
1.2
1.1
1.0
0.9
0
.4
.8
1.2
1.6
2.0
2.4
2.8
$(R/Z)^2$


RSRA
IMPACT OF GROUND EFFECT ON POWER
HOVER
$C_{Q_B}/C_{Q_{B_H}}$
$C_P/C_{P_{\infty H}}$
○ C_W = .0059
△ C_W = .0056
□ C_W = .0053
1.0
.9
.8
.7
1.0
.9
.8
.7
0
.4
.8
1.2
1.6
2.0
2.4
2.8
$(R/Z)^2$

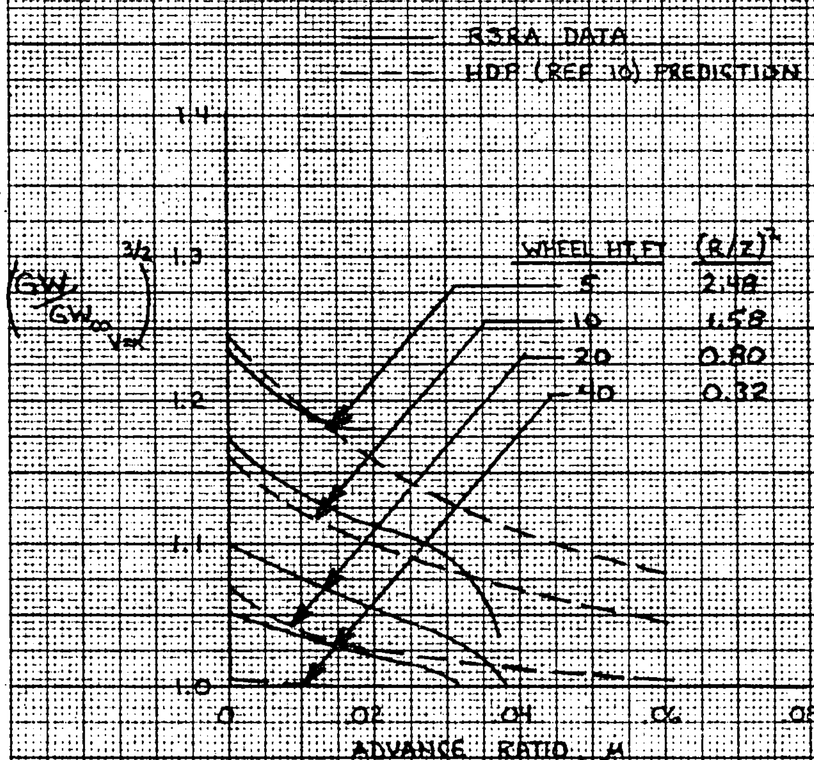

RSRA
POWER REDUCTION DUE TO GROUND EFFECT
EFFECT OF AIRSPEED
TRUE AIRSPEED, KT
0
5
10
15
1.0
.9
.8
Cp/Cp V=0
1.1
TRUE AIRSPEED, KT
15
10
5
0
1.0
.9
.8
.7
Cp/Cp V=X
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²

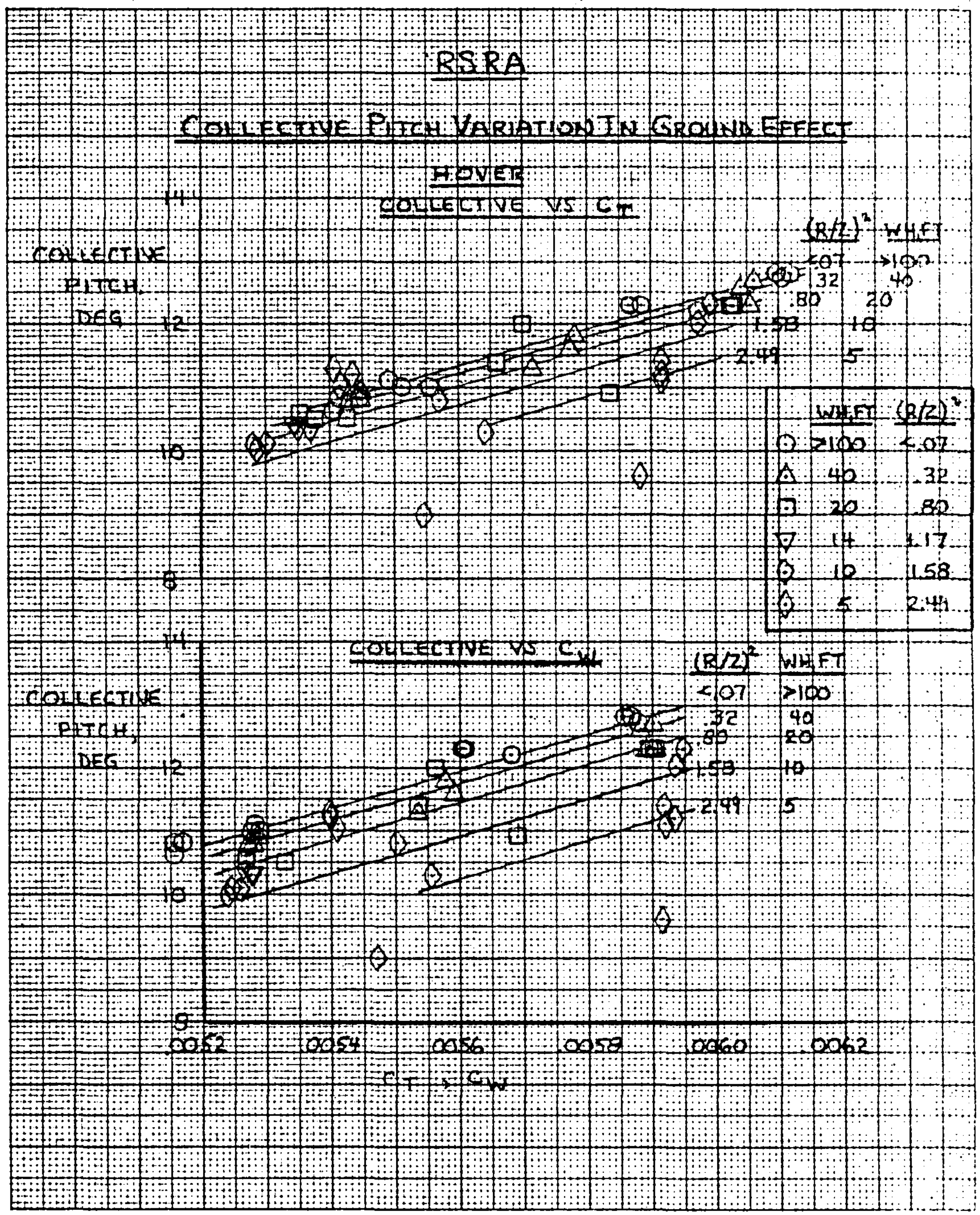

RSRA
COMPARISON OF RSRA AUGMENTATION WITH CHEESEMAN, HDP, HAYDEN
RSRA
CHEESEMAN (REF 8)
TRUE AIRSPEED, KT
0
5
10
15
HOVER
RSRA
HAYDEN (REF 9)
HDP (REF 10)
MAX
MEAN
MIN
WH=10 FT
WH=5 FT
1.3
1.2
1.1
1.0
0.9
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²

SA 31-1 REV. A

RSRA

Comparison Of RSRA Data With HDP Ground Effect Prediction




RSRA
COLLECTIVE PITCH VARIATION IN GROUND EFFECT
HOVER
COLLECTIVE VS CT
COLLECTIVE PITCH, DEG
14
12
10
8
(R/Z)² W.H.FT
<.07 >100
.32 40
.80 20
1.58 10
2.49 5
W.H.FT (R/Z)²
>100 <.07
40 .32
20 .80
14 1.17
10 1.58
5 2.49
COLLECTIVE VS CW
COLLECTIVE PITCH, DEG
.0052
.0054
.0056
.0058
.0060
.0062
CT, CW

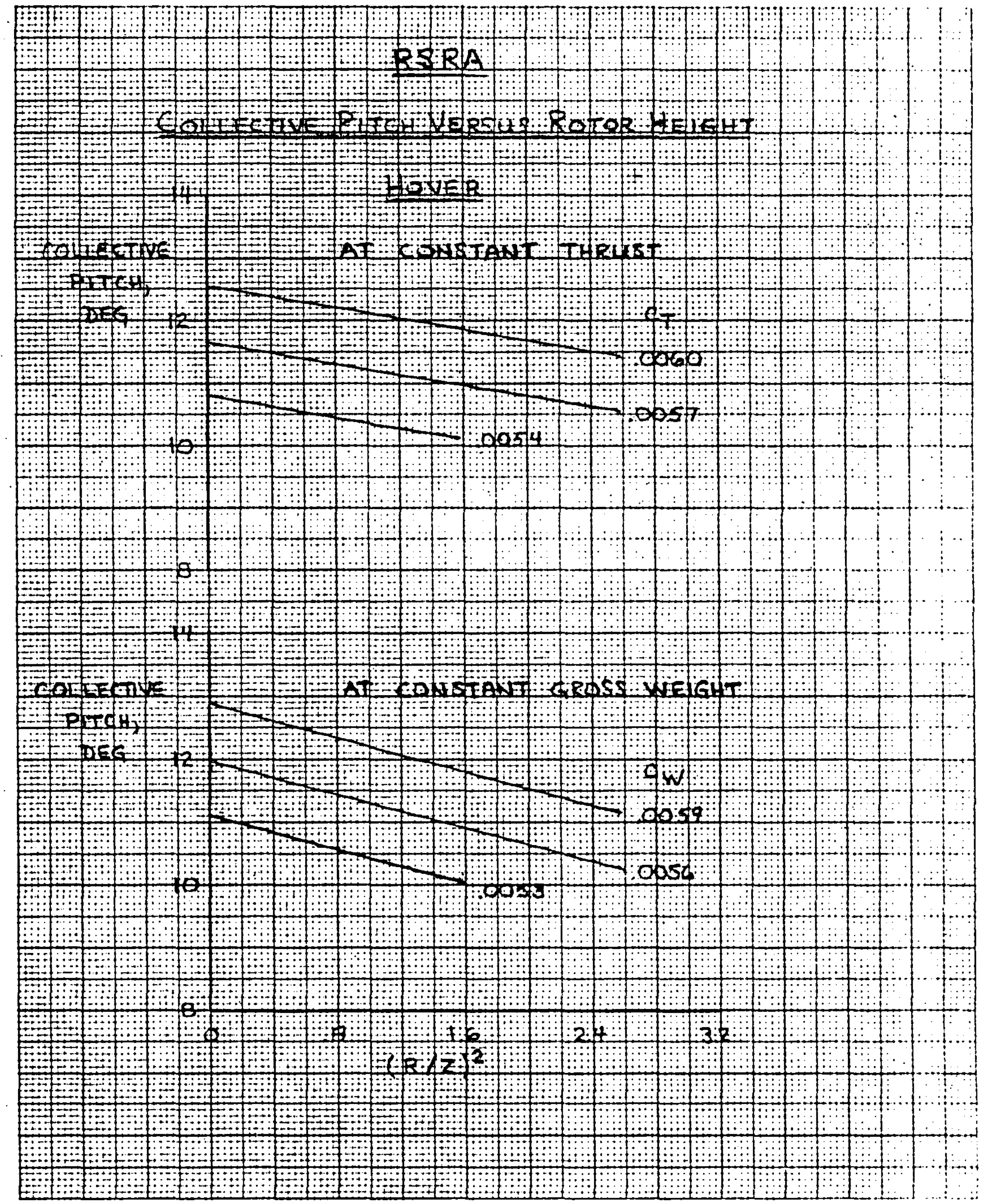
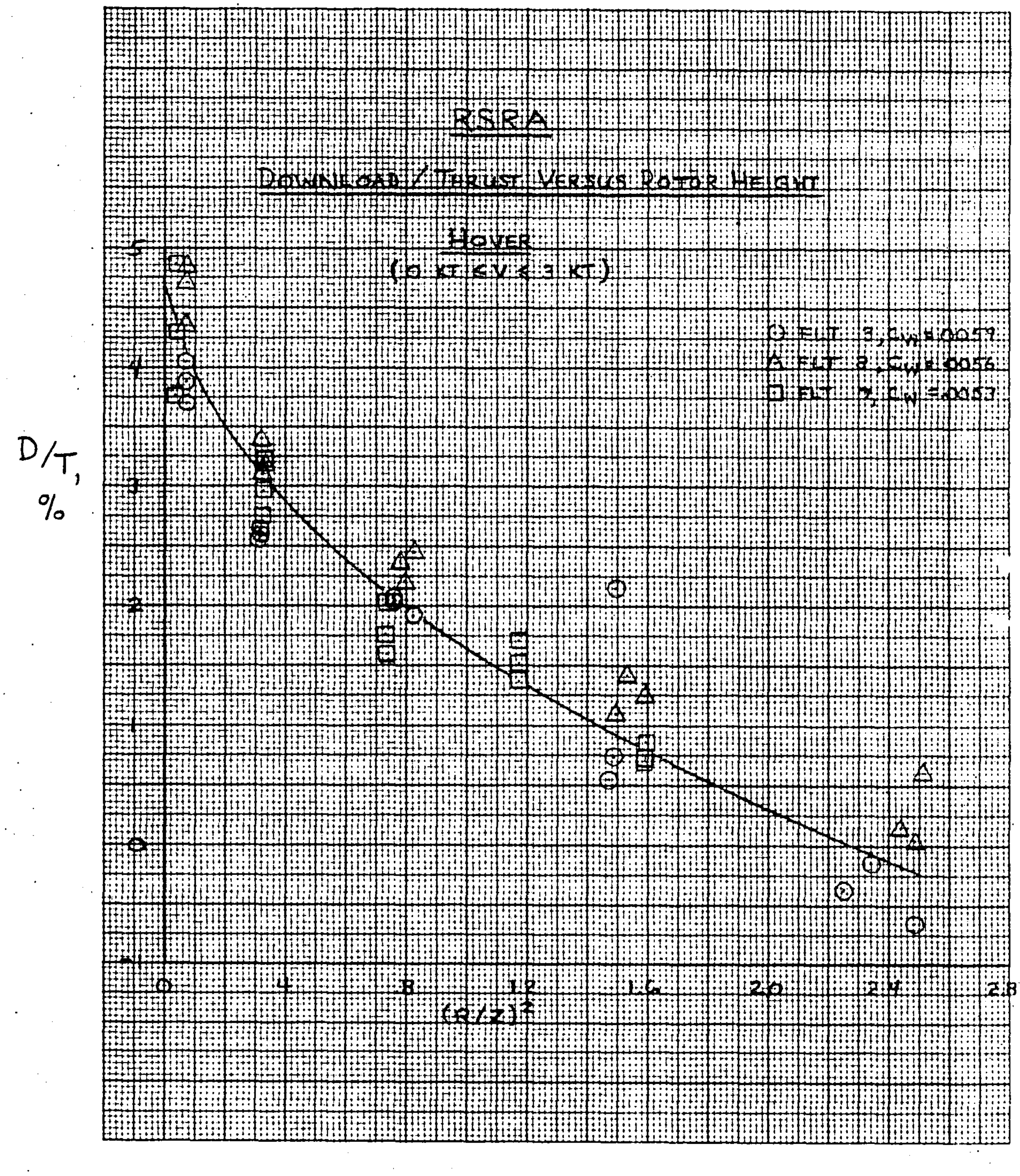
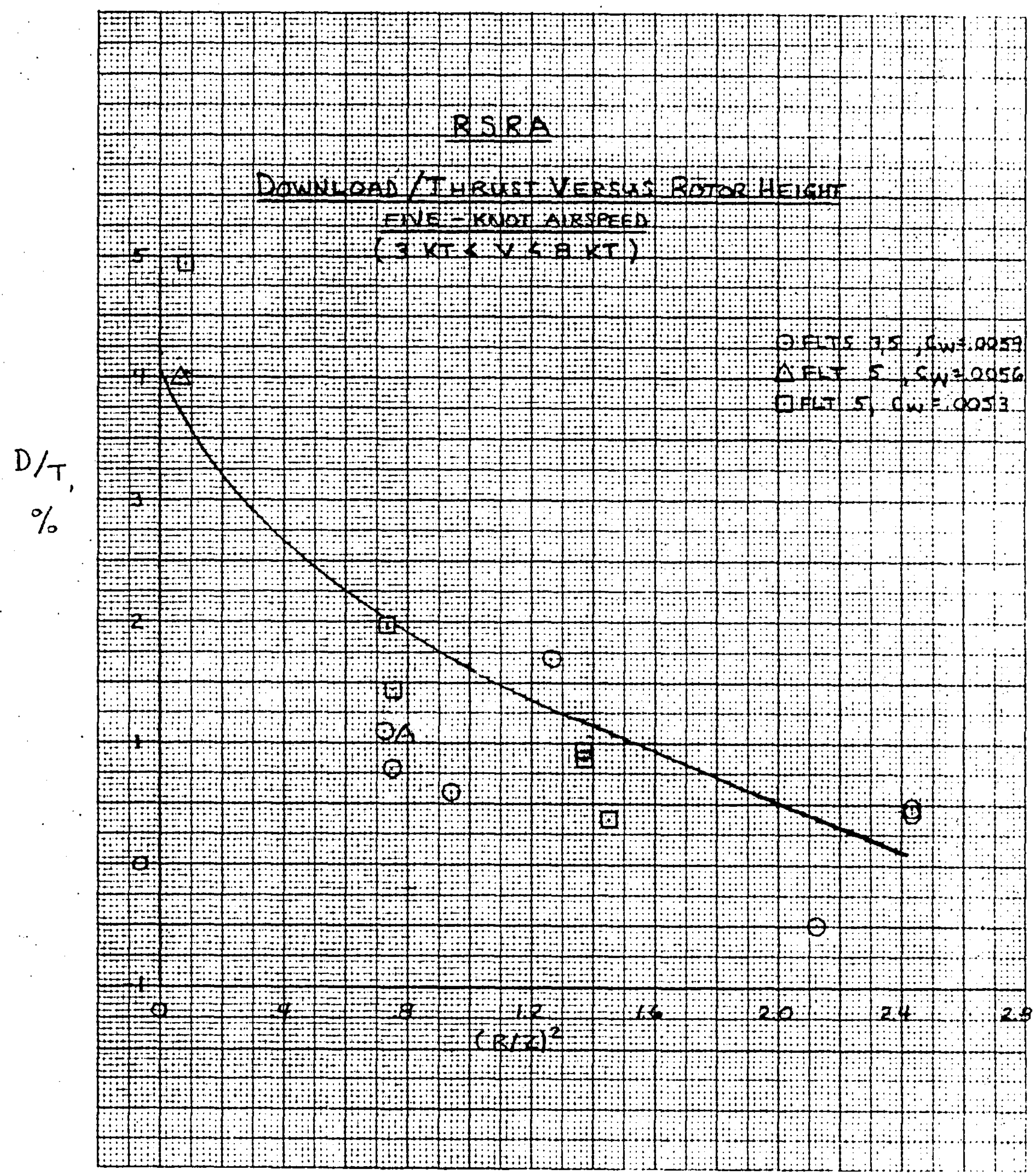
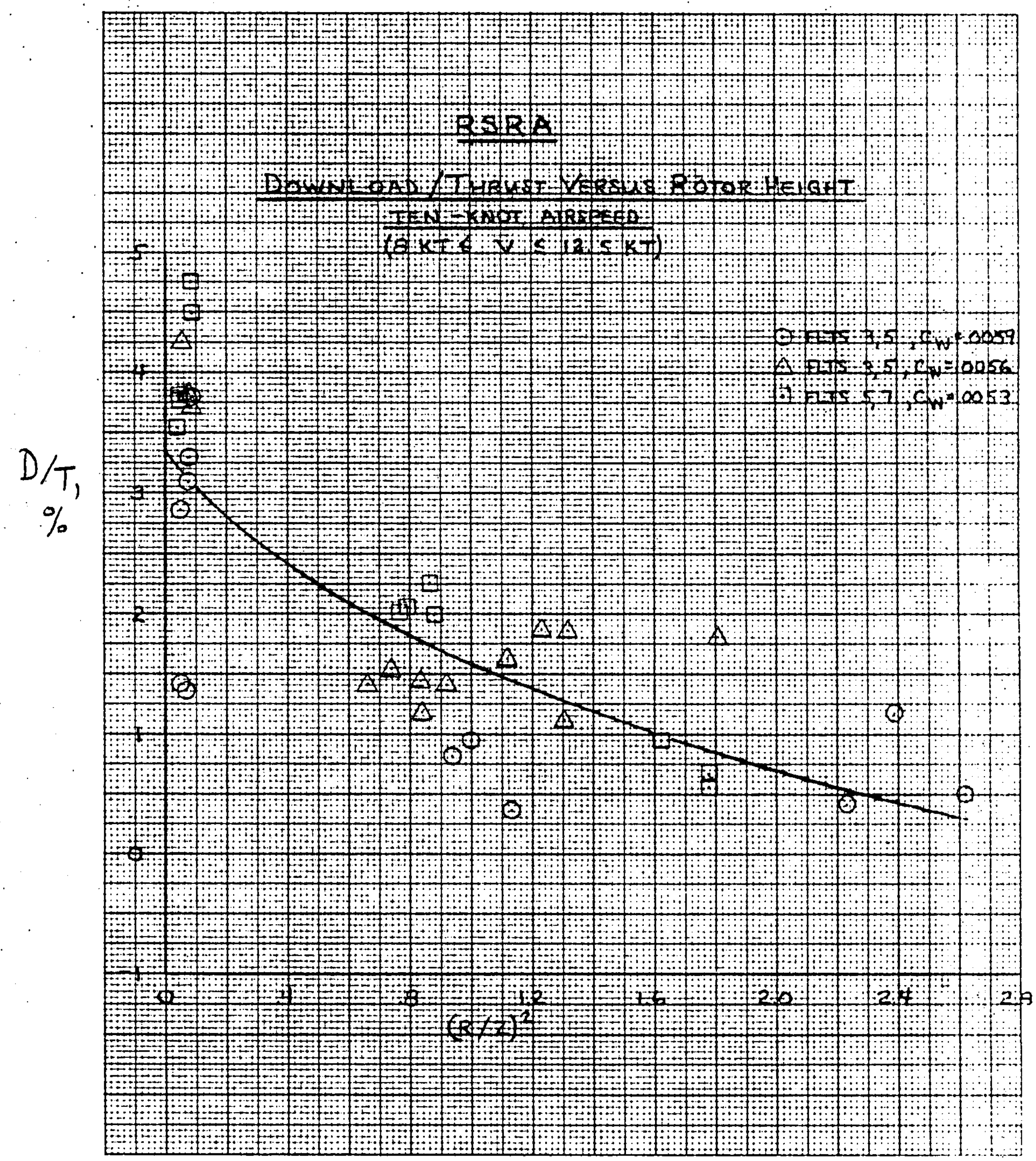
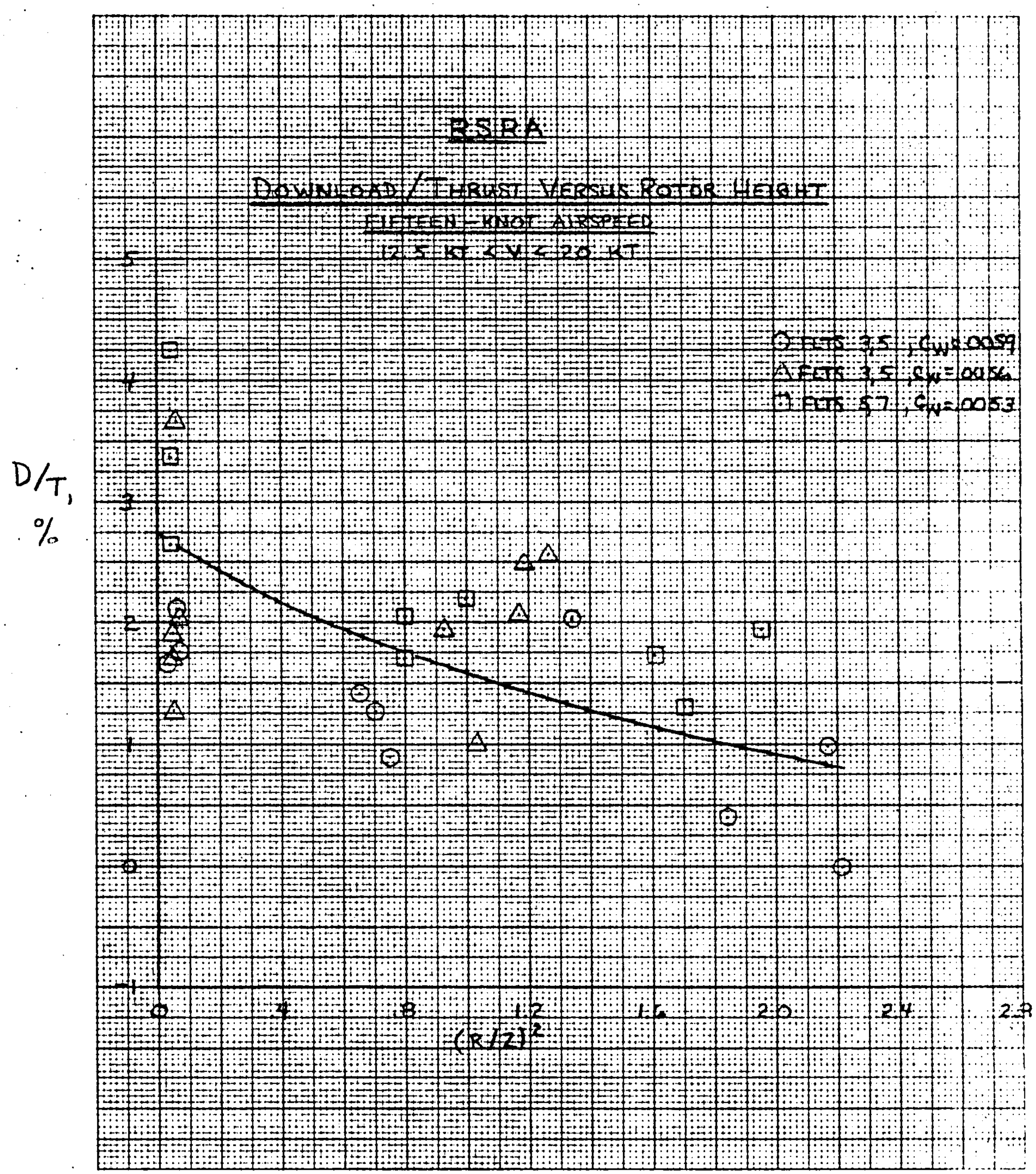

RSRA
COLLECTIVE PITCH VERSUS ROTOR HEIGHT
HOVER
AT CONSTANT THRUST
COLLECTIVE PITCH, DEG
14
12
10
8
CT
.0060
.0057
.0054
AT CONSTANT GROSS WEIGHT
COLLECTIVE PITCH, DEG
14
12
10
8
CW
.0059
.0056
.0053
0
.8
1.6
2.4
3.2
(R/Z)2

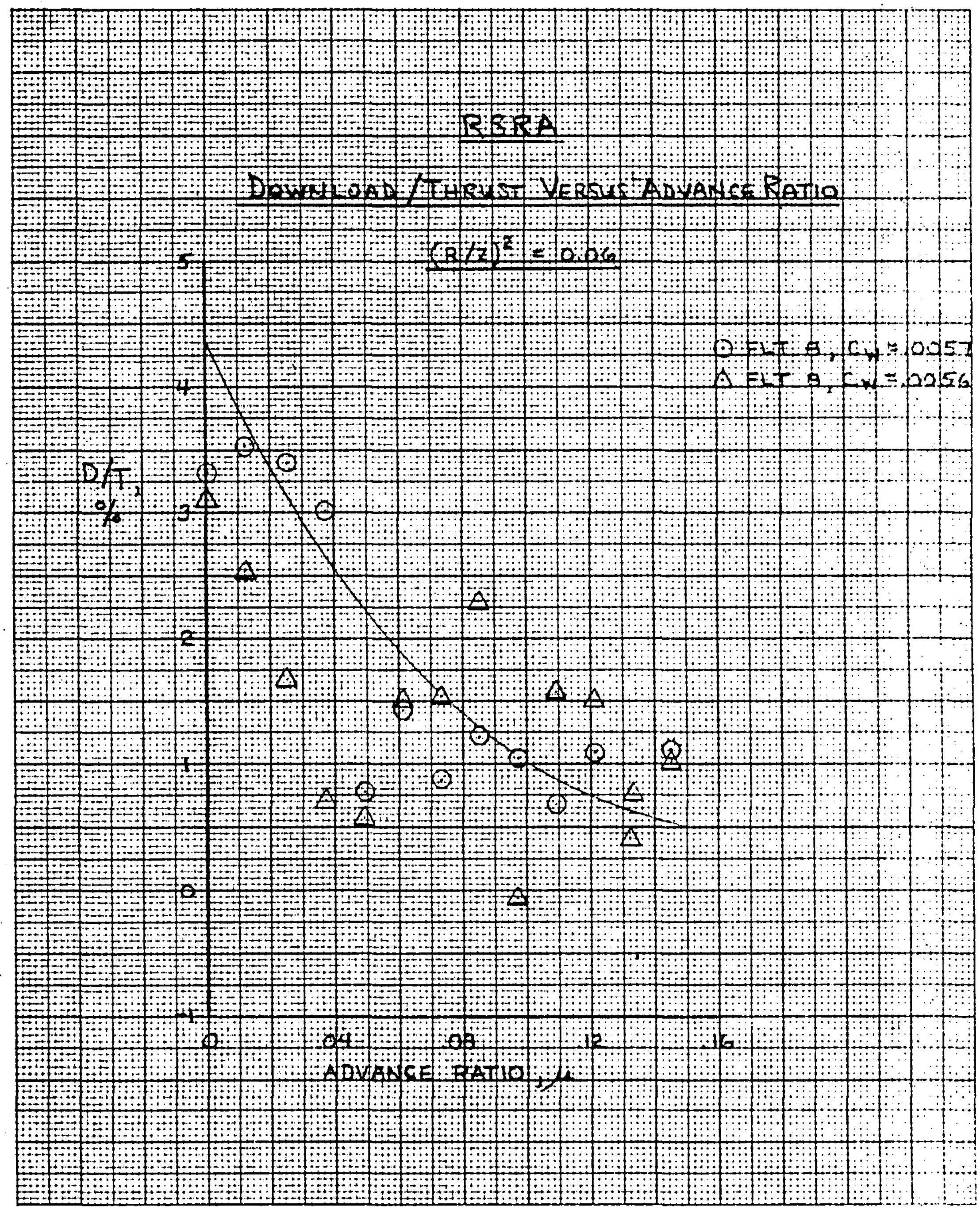
FIGURE 25

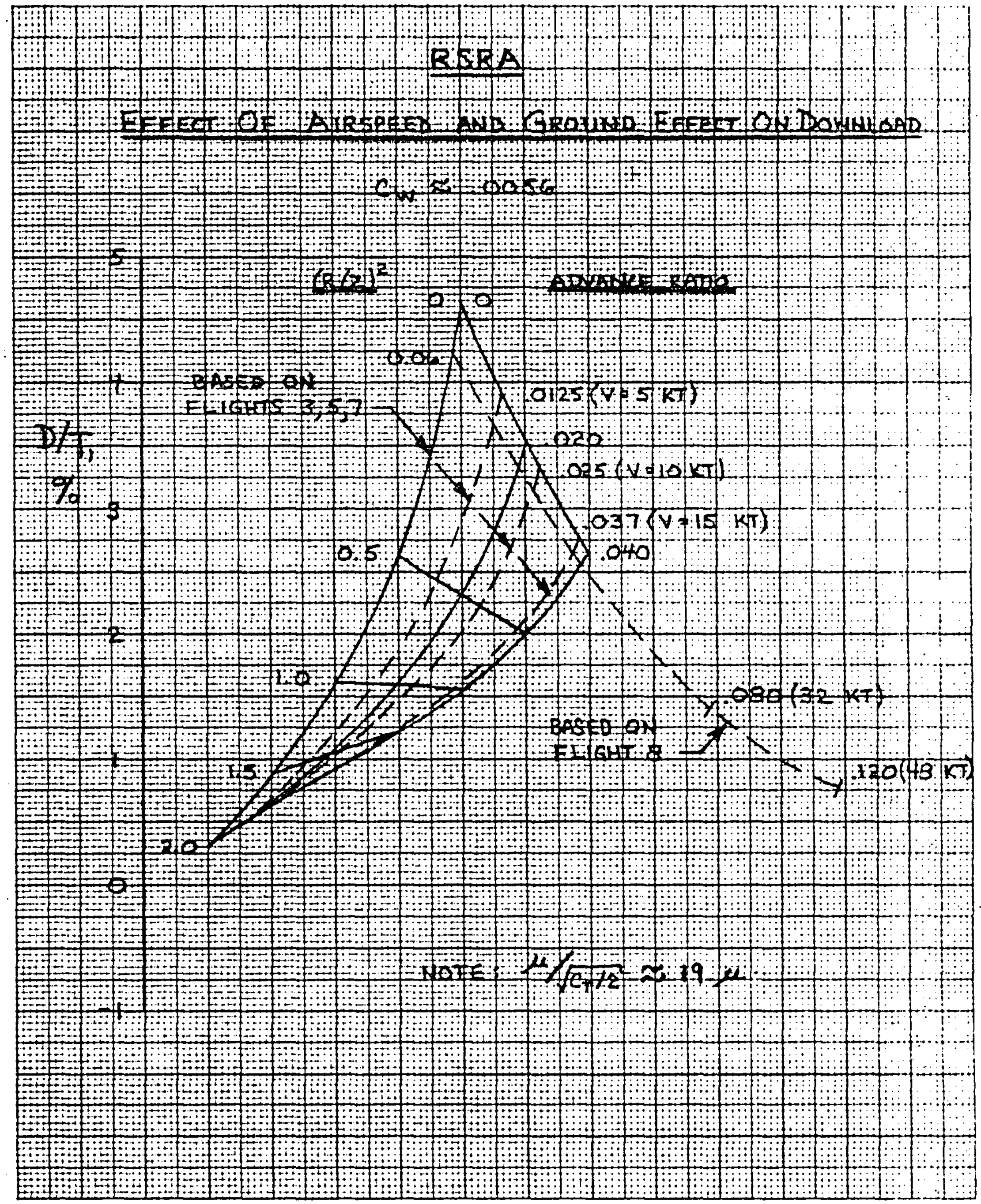

RSRA
DOWNLOAD / THRUST VERSUS ROTOR HEIGHT
HOVER
(0 KT ≤ V ≤ 3 KT)
○ FLT 3, CW = .0057
△ FLT 8, CW = .0056
□ FLT 7, CW = .0053
D/T, %
5
4
3
2
1
0
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²

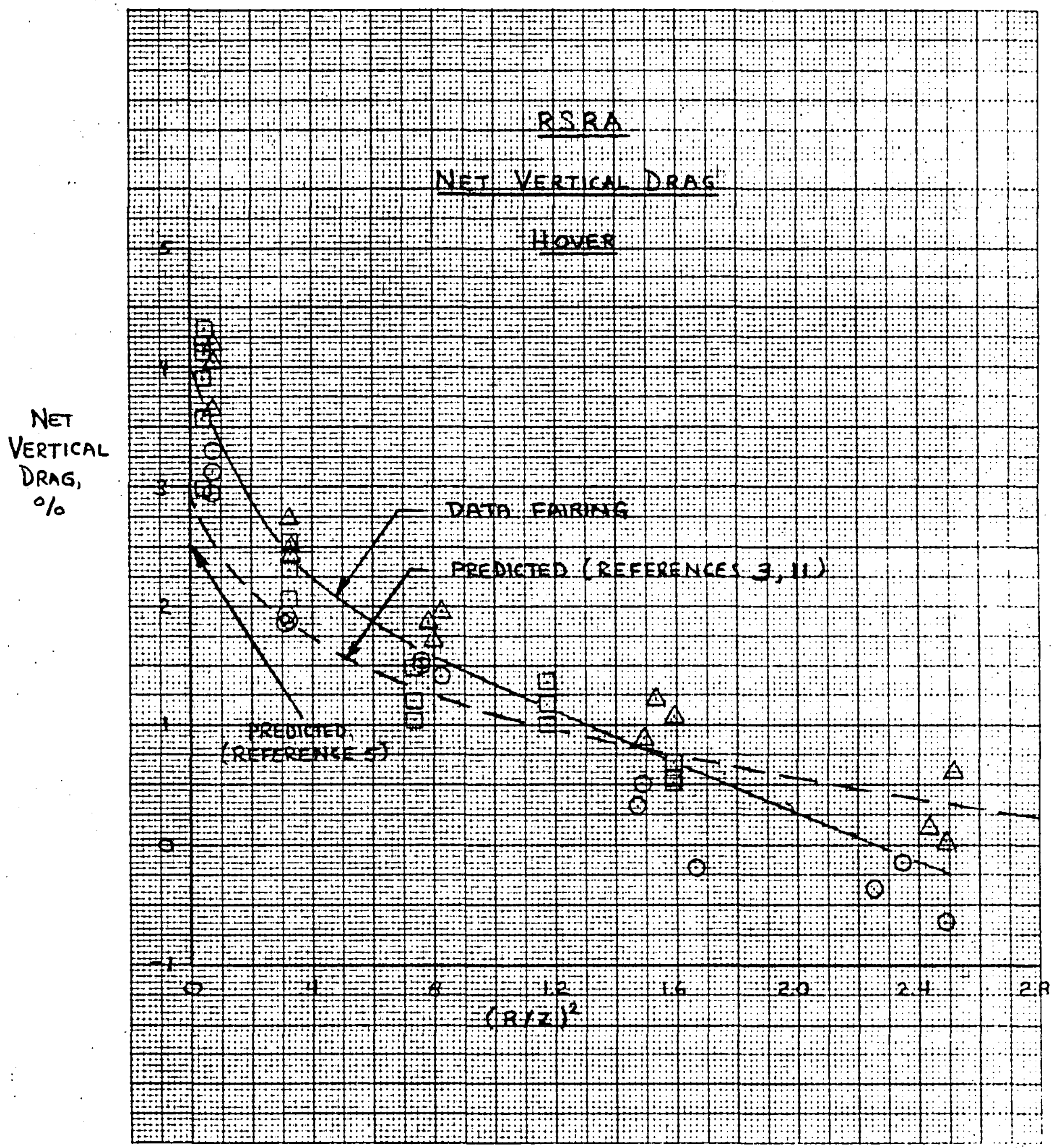

RSRA
DOWNLOAD / THRUST VERSUS ROTOR HEIGHT
FIVE - KNOT AIRSPEED
(3 KT < V < 8 KT)
⊙ FLTS 3,5 , Cw = .0059
△ FLT 5 , Cw = .0056
□ FLT 5 , Cw = .0053
D/T, %
5
4
3
2
1
0
-1
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²

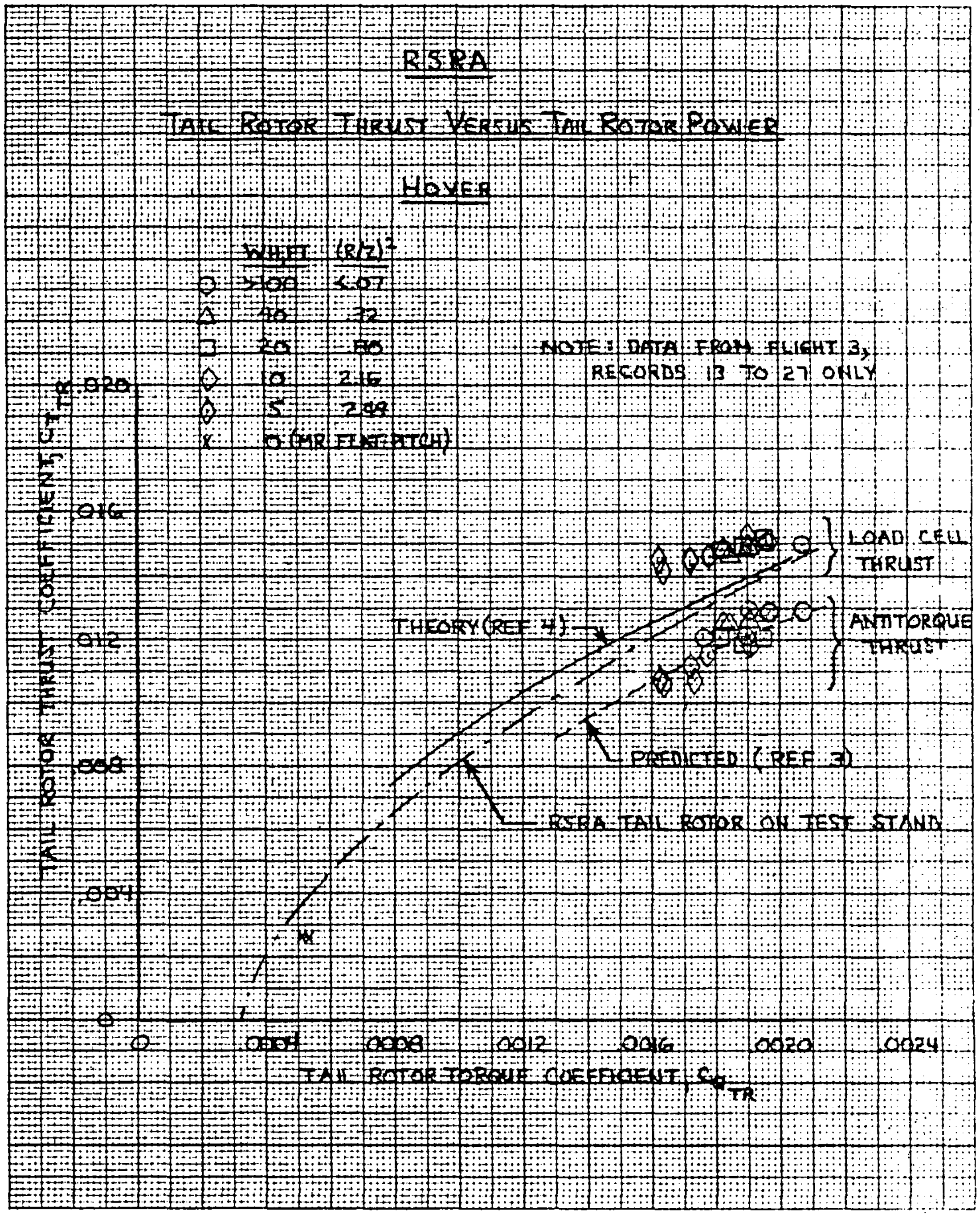

RSRA
DOWNLOAD / THRUST VERSUS ROTOR HEIGHT
TEN-KNOT AIRSPEED
(8 KT ≤ V ≤ 12.5 KT)
○ FLTS 3,5 , CW=.0059
△ FLTS 3,5 , CW=.0056
□ FLTS 5,7 , CW=.0053
D/T, %
5
4
3
2
1
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)2

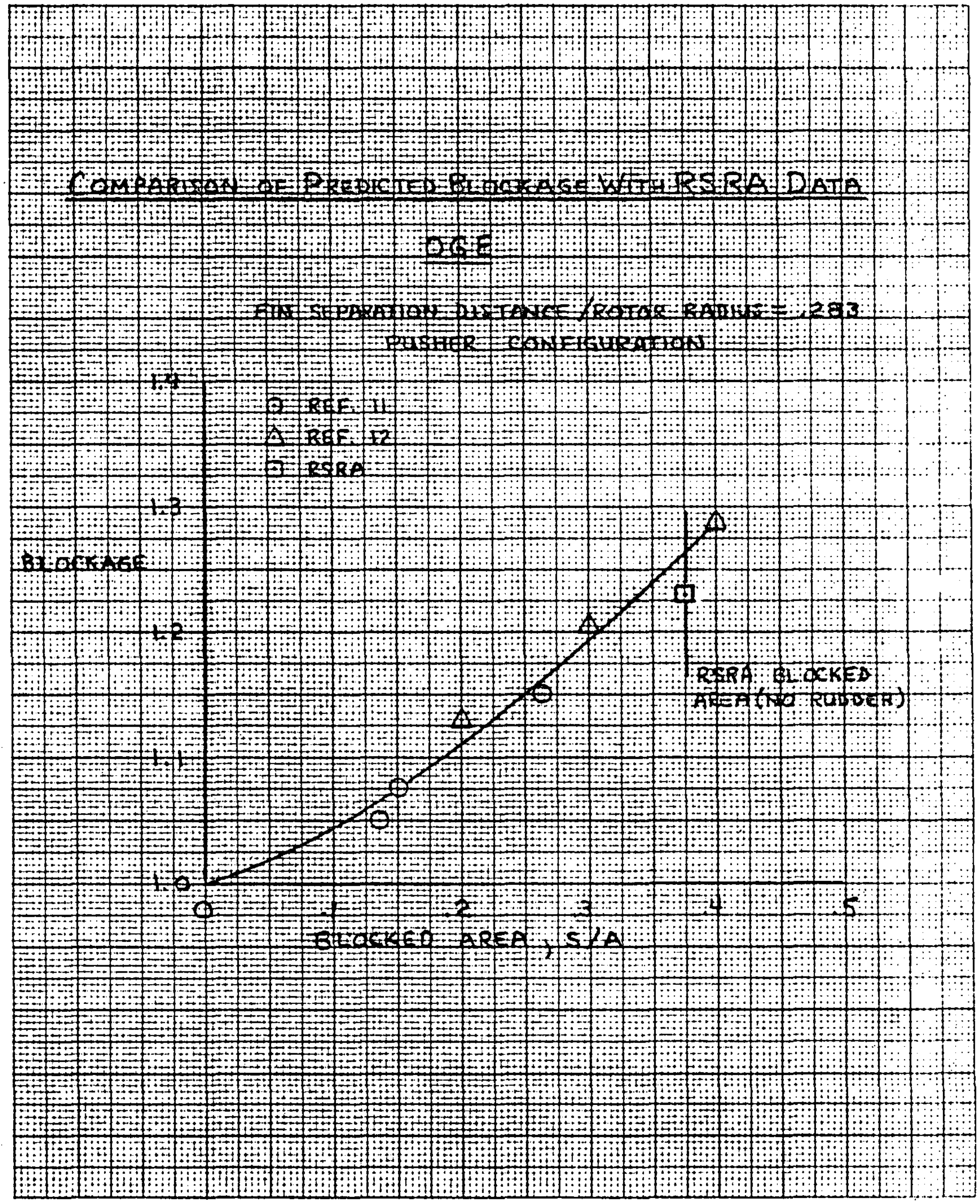

RSRA
DOWNLOAD/THRUST VERSUS ROTOR HEIGHT
FIFTEEN-KNOT AIRSPEED
12.5 KT < V < 20 KT
FLTS 3,5 ; CW = .0059
FLTS 3,5 ; CW = .0056
FLTS 5,7 ; CW = .0053
D/T, %
(R/Z)²

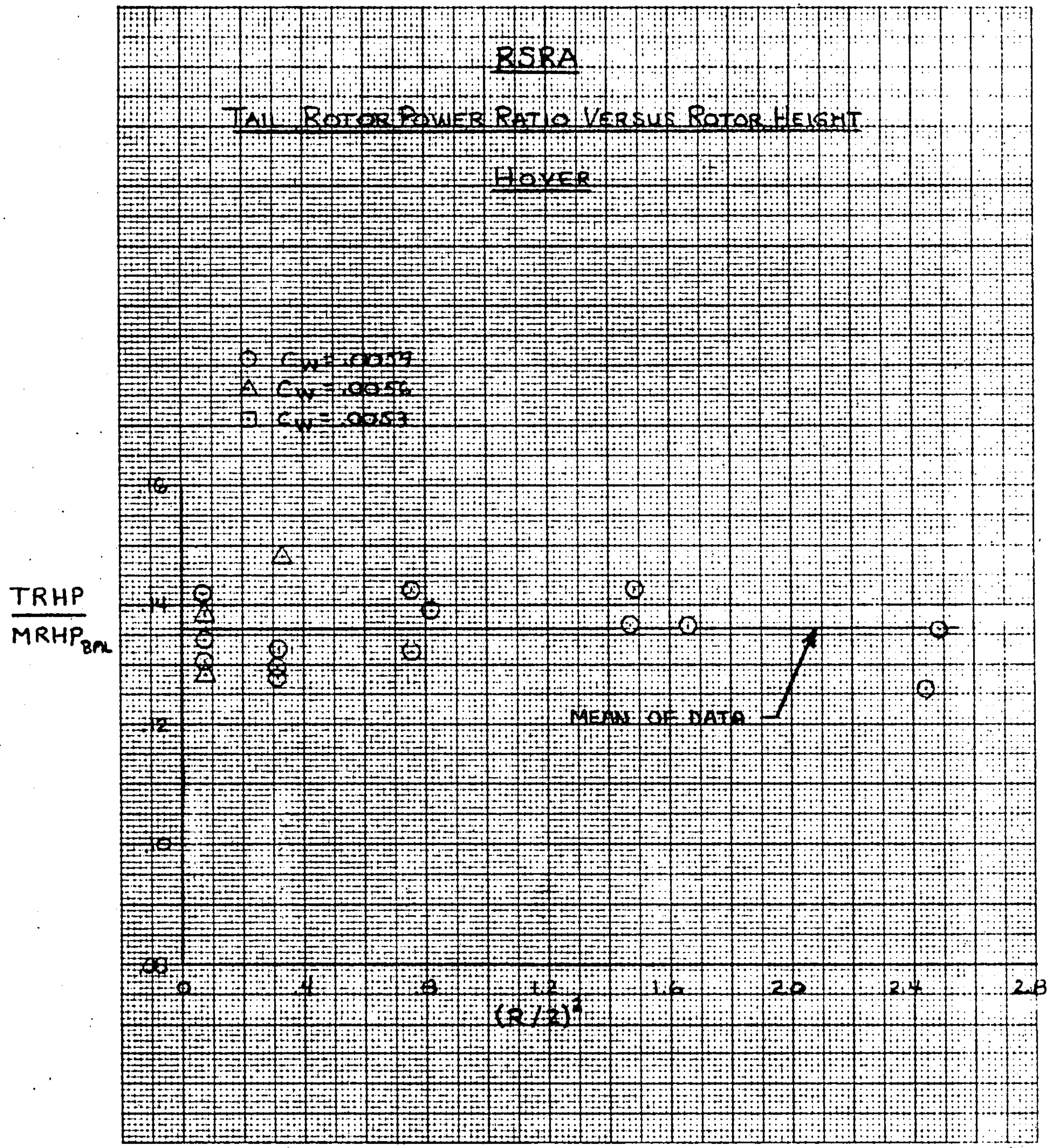

RSRA
DOWNLOAD/THRUST VERSUS ADVANCE RATIO
(R/Z)² = 0.06
○ FLT 8, C_W = .0057
△ FLT 9, C_W = .0056
D/T, %
5
4
3
2
1
0
-1
0
.04
.08
.12
.16
ADVANCE RATIO, μ


RSRA
EFFECT OF AIRSPEED AND GROUND EFFECT ON DOWNLOAD
$C_W \approx .0056$
$(R/Z)^2$
ADVANCE RATIO
D/T, %
BASED ON FLIGHTS 3,5,7
BASED ON FLIGHT 8
.0125 (V=5 KT)
.020
.025 (V=10 KT)
.037 (V=15 KT)
.040
.080 (32 KT)
.120 (48 KT)
0.06
0.5
1.0
1.5
2.0
NOTE: $\mu / \sqrt{C_T/2} \approx 19\mu$


RSRA
NET VERTICAL DRAG
HOVER
NET VERTICAL DRAG, %
DATA FAIRING
PREDICTED (REFERENCES 3, 11)
PREDICTED (REFERENCE 5)
5
4
3
2
1
0
-1
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²


RSRA
TAIL ROTOR THRUST VERSUS TAIL ROTOR POWER
HOVER
W.H. FT (R/Z)²
○ >100 <.07
△ 40 .32
□ 20 .56
◇ 10 2.16
5 2.89
X 0 (MR FLAT PITCH)
NOTE: DATA FROM FLIGHT 3, RECORDS 13 TO 27 ONLY
LOAD CELL THRUST
ANTITORQUE THRUST
THEORY (REF 4)
PREDICTED (REF 3)
RSRA TAIL ROTOR ON TEST STAND
TAIL ROTOR THRUST COEFFICIENT, $C_{T_{TR}}$
.020
.016
.012
.008
.004
0
.0004
.0008
.0012
.0016
.0020
.0024
TAIL ROTOR TORQUE COEFFICIENT, $C_{Q_{TR}}$


COMPARISON OF PREDICTED BLOCKAGE WITH RSRA DATA
OGE
FIN SEPARATION DISTANCE/ROTOR RADIUS = .283
PUSHER CONFIGURATION
○ REF. 11
△ REF. 12
□ RSRA
BLOCKAGE
1.4
1.3
1.2
1.1
1.0
0
.1
.2
.3
.4
.5
BLOCKED AREA, S/A
RSRA BLOCKED AREA (NO RUDDER)


RSRA
TAIL ROTOR POWER RATIO VERSUS ROTOR HEIGHT
HOVER
○ Cw = .0059
△ Cw = .0056
□ Cw = .0053
TRHP / MRHP BAL
.16
.14
.12
.10
.08
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²
MEAN OF DATA

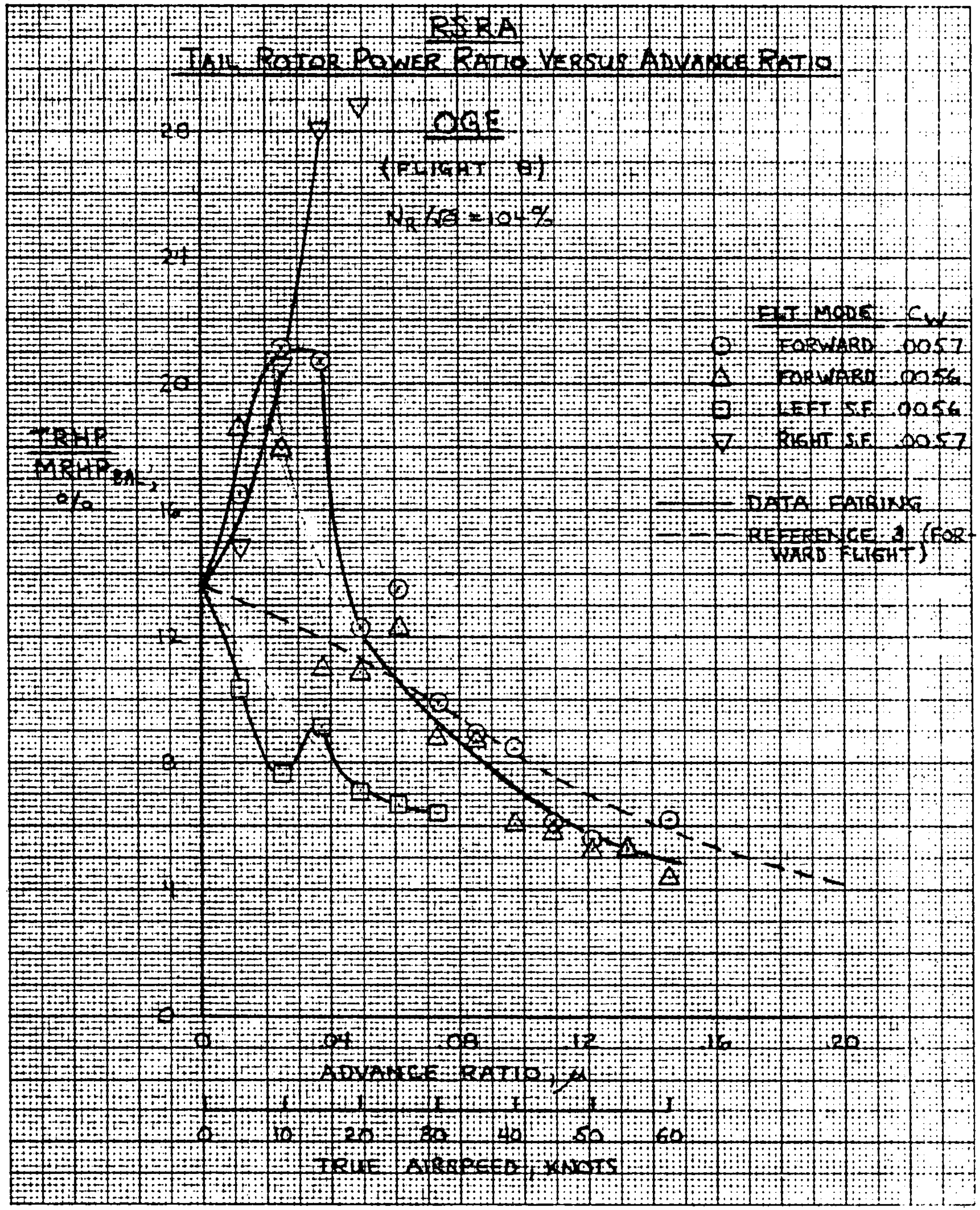
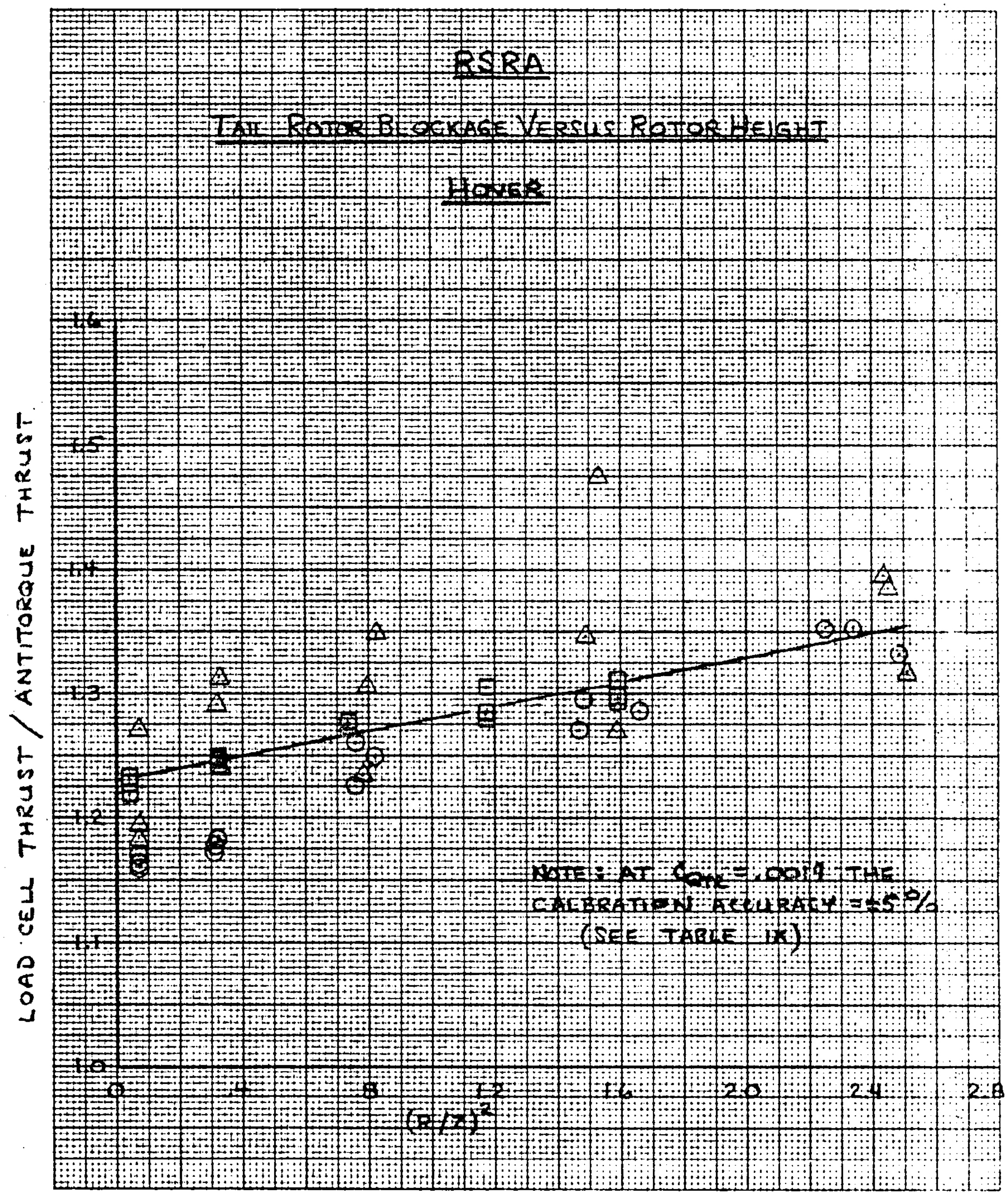
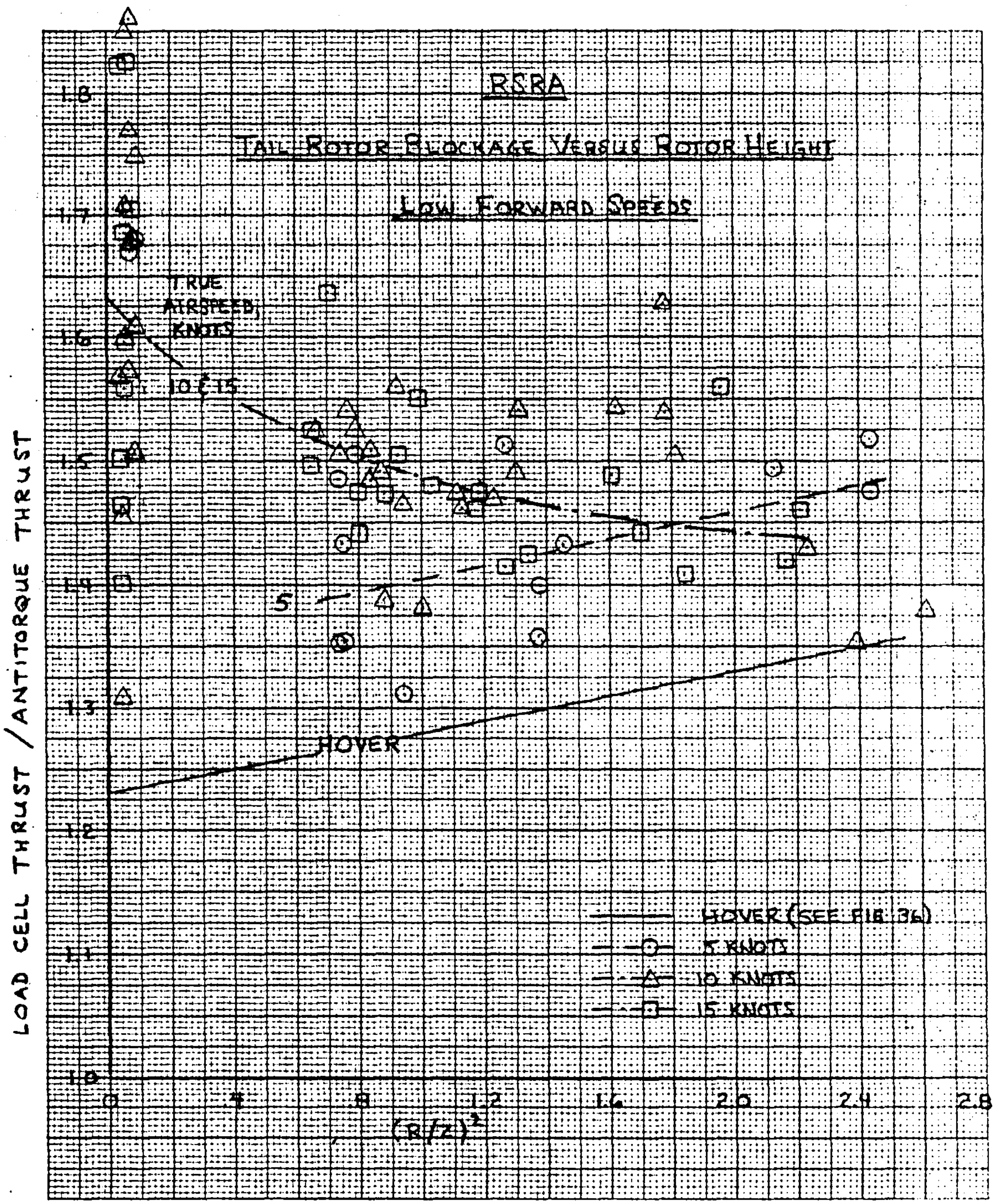

RSRA
TAIL ROTOR POWER RATIO VERSUS ADVANCE RATIO
OGE
(FLIGHT 8)
N_R/√θ = 104%
FLT MODE C_W
FORWARD .0057
FORWARD .0056
LEFT S.F. .0056
RIGHT S.F. .0057
DATA FAIRING
REFERENCE 3 (FORWARD FLIGHT)
TRHP / MRHP_BAL, %
28
24
20
16
12
8
4
0
0
.04
.08
.12
.16
.20
ADVANCE RATIO, μ
0
10
20
30
40
50
60
TRUE AIRSPEED, KNOTS

FIGURE 36


RSRA
TAIL ROTOR BLOCKAGE VERSUS ROTOR HEIGHT
HOVER
LOAD CELL THRUST / ANTITORQUE THRUST
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0
.4
.8
1.2
1.6
2.0
2.4
2.8
$(R/Z)^2$
NOTE: AT C_{QTR} = .0019 THE CALIBRATION ACCURACY = ±5%
(SEE TABLE IX)


RSRA
TAIL ROTOR BLOCKAGE VERSUS ROTOR HEIGHT
LOW FORWARD SPEEDS
TRUE AIRSPEED, KNOTS
10 & 15
5
HOVER
HOVER (SEE FIG 36)
5 KNOTS
10 KNOTS
15 KNOTS
LOAD CELL THRUST / ANTITORQUE THRUST
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
0
.4
.8
1.2
1.6
2.0
2.4
2.8
(R/Z)²

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Ames Contact: R. E. Erickson, M/S 237-3, NASA-Ames Research Center, Moffett Field, CA. 94035; FTS #448-6575; (415) 965-6575

16. Abstract

The Rotor Systems Research Aircraft (RSRA) offers unique test opportunities because of its ability to measure rotor loads. This capability was used to conduct an experiment to determine vertical drag, tail rotor blockage, and thrust augmentation as affected by ground clearance and flight velocity. Tests were conducted by NASA at the Ames Research Center in July 1981, with data reduced by NASA and sent to Sikorsky Aircraft for analysis and documentation.

The RSRA was flown in the helicopter configuration at speeds from 0 to 15 knots for wheel heights from 5 to 150 feet, and to 60 knots out of ground effect. The vertical drag trends in hover, predicted by theory and shown in model tests, are generally confirmed.

The OGE hover vertical drag is 4.0 percent, 1.1 percent greater than predicted. The vertical drag decreases rapidly as wheel height is reduced, and is zero at a wheel height of 6 feet. The vertical drag also decreases with forward speed, approaching zero at sixty knots.

The test data show the effect of wheel height and forward speed on thrust, gross weight capability and power, and provide the relationships for power and collective pitch at constant gross weight required for the simulation of helicopter takeoffs and landings.

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