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WIND TUNNEL TEST RESULTS

OF 25-FOOT TILT ROTOR

DURING AUTOROTATION

REPORT 301-099-005

NASA CONTRACT NAS2-8580

BELL HELICOPTER COMPANY

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WIND TUNNEL TEST RESULTS OF 25-FT. TILT ROTOR DURING AUTOROTATION

By

R. L. Marr

Bell Helicopter Textron Report No. 301-099-005

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By Bell Helicopter Textron

Fort Worth, Texas

For

National Aeronautics and Space Administration

Ames Research Center

Moffett Field, California

FOREWARD

This report is prepared by Bell Helicopter Textron, Fort Worth, Texas, for the National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California, under Contract NAS2-8580.

The Administrative Contracting Officer was Mr. Dennis Brown. The Technical Monitor was Mr. Kip Edenborough, Tilt Rotor Research Aircraft Project Office. The Tunnel Test Engineer was Mr. Robert H. Stroub, Rotor Group-Large Scale Aerodynamics Branch.

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LIST OF SYMBOLS

Symbol	Computer Notation Scale Data	Computer Notation HSDS	Description
a_{1_s}	SA1S	LONSP	Fore and aft flapping angle with respect to the shaft (positive aft), deg
A_{1_s}	A1	A1S	Lateral cyclic angle with respect to the shaft (positive down @ $\psi = 90^o$), deg
b_{1_s}	-	LATSP	Lateral flapping angle with respect to the shaft (positive down @ $\psi = 90^o$), deg
B_{1_s}	B1	B1S	Fore and aft cyclic angle with respect to the shaft (positive fwd), deg
c	VSND	-	Speed of sound, knots
$C_{H/\sigma}$	CHS	-	H-force coefficient/rotor solidity ratio $C_{H/\sigma} = H/\rho\pi\Omega^2R^4\sigma$
$C_{L/\sigma}$	CLR	-	Lift coefficient/rotor solidity ratio $C_{L/\sigma} = L/\rho\pi\Omega^2R^4\sigma$
C_{M_X}/σ	CMXS	-	Rolling moment coefficient/ rotor solidity ratio $C_{M_X}/\sigma = M_X/\rho\pi\Omega^2R^5\sigma$
C_{M_Y}/σ	CMYS	-	Yawing moment coefficient/ rotor solidity ratio $C_{M_Y}/\sigma = M_Y/\rho\pi\Omega^2R^5\sigma$
C_{M_Z}/σ	CMZS	-	Pitching moment coefficient/ rotor solidity ratio $C_{M_Z}/\sigma = M_Z/\rho\pi\Omega^2R^5\sigma$
C_p	CP	-	Power coefficient based on the mast torque $C_p = Q/\rho\pi\Omega^2R^5$

LIST OF SYMBOLS (Continued)

	Computer Notation		
Symbol	Scale Data	HSDS	Description
C_p/σ	CPS	-	Power coefficient/rotor solidity $C_p/\sigma = Q/\rho\pi\Omega^2R^5\sigma$
C_{P_o}/σ	CPOS	-	Minimum power coefficient/ rotor solidity ratio $C_{P_o}/\sigma = C_p/\sigma - (C_L/\sigma)^2\sigma/2\mu - (C_D/\sigma)\mu$
C_T	CT	-	Thrust coefficient $C_T = T/\rho\pi\Omega^2R^4$
C_T/σ	CTS	-	Thrust coefficient/rotor solidity ratio $C_T/\sigma = T/\rho\pi\Omega^2R^4\sigma$
C_X/σ	CXR	-	Drag coefficient/rotor solidity ratio $C_X/\sigma = D/\rho\pi\Omega^2R^4\sigma$
C_Y/σ	CYR	-	Y-force coefficient/rotor solidity ratio $C_Y/\sigma = Y/\rho\pi\Omega^2R^4\sigma$
D	D	-	Drag, lb
D/σ'	DRG6	-	Drag referred to sea level standard conditions, lb
f	FE	-	Flat plate drag area $F = D/q$, ft^2
FM	FM	-	Figure of merit $FM = .707\ C_T^{3/2}/C_p$
H	FORH	-	H-force, perpendicular to the shaft, lb
H/σ'	FRH6	-	H-force referred to sea level standard conditions

LIST OF SYMBOLS (Continued)

	Computer Notation		
Symbol	Scale Data	HSDS	Description
HP_{MAST}	MHP	-	Horsepower based on mast torque $HP = Q\Omega/550$
$HP_{MAST/\sigma'}$	PWR6	-	Horsepower based on mast torque referred to sea level standard conditions.
HP_B	HPB	-	Horsepower based on wind tunnel balance
HP_{LC}	PLC	-	Horsepower based on test stand load cell
L	L	-	Lift, lb
L/σ'	LFT6	-	Lift referred to sea level standard conditions, lb
M_{TIP}	MTIP	-	Advancing tip Mach number $M_{TIP} = (V_{FPS}2+(\Omega R)^2 + 2V_{FPS}\Omega R\cos\alpha_s)^{1/2}/c$
	PT	-	Data point number
q	Q	-	Dynamic pressure, lb/ft^2
Q_{MAST}	SFTQ	MASTQ	Mast torque, ft-lb
Q_{LC}	QLC	QLC	Load cell torque, ft-lb
R	R	-	Rotor radius, ft
T	THST	-	Thrust along the shaft axis, lb
T/σ'	TST6	-	Thrust referred to sea level standard conditions, lb
V_{KTS}	VKTS	-	Tunnel speed, knots
V_{TIP}	OR	-	Rotor tip speed, $V_{TIP}=\Omega R$, ft/sec
Y	SIDE	-	Y-force, lb
Y/σ'	SID6	-	Y-force referred to sea level standard conditions, lb

LIST OF SYMBOLS (Continued)

Symbol	Computer Notation		Description
	Scale Data	HSDS	
α_C	ALFC	-	Control axis angle of attack, deg $\alpha_C = \alpha_S - B_{1_S}$
α_S	ALFS	-	Shaft angle of attack referred to wind axis, deg
α_{TTP}	ALTP	-	Tip path plane angle of attack, deg $\alpha_{TTP} = \alpha_S - 90 + a_{1_S}$
η	EFF	-	Propulsive efficiency based on the mast torque power $\eta = (T\ V_{FPS}) \cos \alpha_S / 550\ HP_{MAST}$
θ_{TIP}	THTA	THETA	Tip collective angle, deg
μ	ADVR	-	Advance ratio $\mu = V/\Omega R$
Ω	RPM	NPR	Rotor rpm, rpm
σ	S1G	-	Rotor solidity (.0891)
σ'	RHOR	-	Air density ratio $\sigma' = \rho/\rho_o$

I. SUMMARY

A 25-foot diameter tilt rotor was tested in the NASA-Ames 40- by 80-foot Large-Scale Wind Tunnel under NASA Contract NAS2-8580. The test confirmed the predicted autorotation capability of the XV-15 tilt rotor aircraft.

Autorotations were made at 60, 80, and 100 knots. A limited evaluation of lateral cyclic was made. Due to instrumentation, electrical, and mechanical problems, there was not time to expand the 1970 test envelope. Check runs that were made compared with the 1970 wind tunnel test at hover and 80 knots.

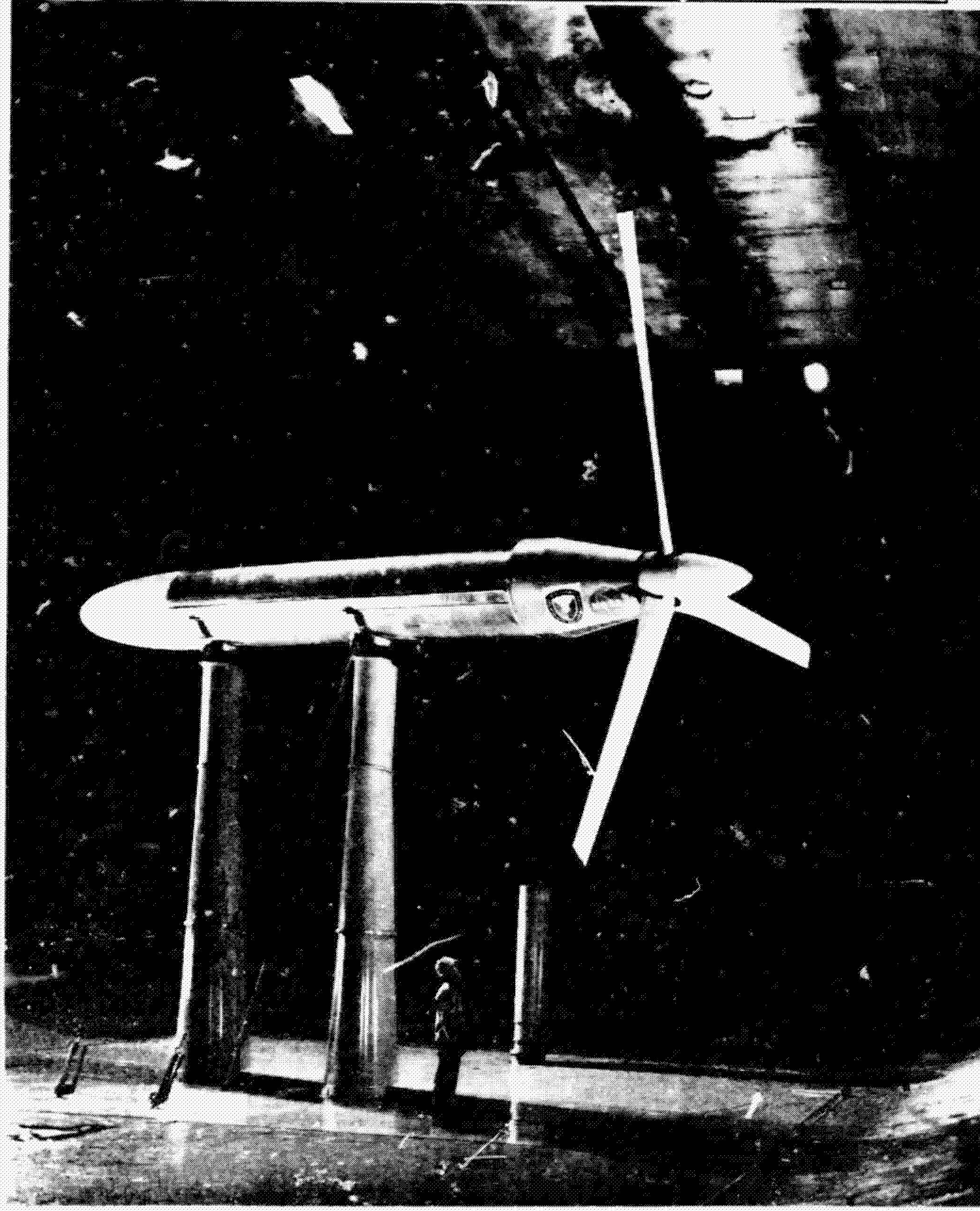
Test data indicate a minimum rate of descent of 2200 feet per minute at 60 knots at the XV-15 design gross weight of 13,000 pounds.

II. INTRODUCTION

This report presents the results and a brief analysis of a wind tunnel test of a 25-foot-diameter rotor designed for tilt-rotor aircraft operation as shown in Figure II-1. Testing was accomplished to determine rotor performance and blade loads during forward flight and autorotation. The rotor tested was identical to that used on the XV-15 tilt rotor research aircraft. Testing was accomplished in the NASA-Ames 40- by 80-foot wind tunnel. Work to prepare the model, testing, and documentation were accomplished under NASA Contract NAS2-8580.

This particular rotor configuration was tested in the ARC 40- by 80-foot wind tunnel in 1970 to obtain performance, blade loads, and dynamic stability characteristics in forward flight. Since that time, the control system design of the rotor has been changed to incorporate provisions for lateral cyclic control. In addition, the autorotation capabilities of the tilt rotor have been given considerable attention since that testing through analytical work and small scale model tests. The indications were that autorotation would be a critical area of operation and require full scale testing. Since the 1970 test, the tunnel test stand configuration was changed to accommodate autorotation shaft angles allowing the expansion of the test envelope of the tilt rotor.

Several instrumentation problems encountered during this test, although unrelated to rotor performance, limited the forward flight testing. Limited testing was accomplished to verify the effects of lateral cyclic on the reduction of lateral flapping and blade loads. Most of the test period was spent obtaining autorotation characteristics at several shaft angles and airspeeds. Comparisons made between analytical methods and test show the rotor to require higher shaft angles to autorotate than predicted.



II-1. 25-Foot Tilt Rotor/PTR in NASA-Ames 40- by 80-Foot Wind Tunnel

III. DESCRIPTION OF TEST HARDWARE

A. Tilt Rotor and Controls

1. Description

The 25-foot three-bladed tilt rotor is a gimbaled, stiff-inplane rotor with an elastomeric hub spring to provide increased control power and damping during helicopter mode. The rotor has a swashplate which provides two axes of cyclic pitch and has positive pitch flap coupling. Blade collective pitch is provided by a rise-and-fall collective head assembly above the rotor through three walking beams. Rotation of the rotors is such that inboard blade tip rotation is aft for helicopter mast angles and up for airplane mast angles. During this test the right hand rotor was tested giving rotation clockwise (view looking forward).

The blades have a bonded aluminum honeycomb afterbody and 17-7PH stainless steel spars and skins. The airfoil sections vary from an NACA 64-208 section at the tip to a NACA 64-429 at the root (r/R = .15). The combination of twist and camber was selected to meet the aerodynamic requirements for both helicopter and airplane flight, and to permit the blade spar structure to have a uniform twist rate. Total aerodynamic twist from rotor centerline to blade tip is 45 degrees.

Table III-1 provides a summary of the pertinent data concerning the rotor. References 1 and 2 provide a complete description of the rotor

2. Natural Frequencies

Prior to the wind tunnel tests, the rotor natural frequencies were calculated using the Myklestad - BHT normal modes program. These results were then compared with the frequencies reported in reference 2.

Figure III-1 shows the results obtained for the asymmetric (cyclic) modes, while Figure III-2 gives the comparison for the symmetric (collective) modes. These figures show good agreement between the recently calculated frequencies and those previously reported, especially for the lower frequencies.

The fan plots indicate that there would not be any serious resonance problems at operating RPM. During the test, the small resonance at 350 RPM, during run up to rpm, was quite evident confirming the crossing of the 2/rev line by the first cyclic inplane mode. Other than that, no problems were encountered.

B. Test Stand

1. Description

Test stand used for this test was the NASA Propeller Test Rig (PTR). The power module of this test rig consists of two 1500-HP electric motors mounted in tandem on a frame, driving an R-2800 engine reduction gearbox. The power module was mounted on the two 15-ft. main struts to the balance frame in the 40- by 80-foot wind tunnel. With the PTR in this configuration, rotor shaft angle-of-attack was changed by yawing the complete test rig. At $\psi = 0^{\circ}$, the rotor was in airplane flight. At $\psi = 90^{\circ}$, the rotor was in helicopter flight. Shaft angle-of-attack range tested was from 0 degrees (airplane) to 110 degrees (helicopter-autorotation). Tunnel test stand has the capability of varying shaft angle from +109 to -191 degrees.

The rotor gearbox adapter and mast case to the PTR was the same as used during the 1970 wind tunnel test as described in Reference 1.

2. Natural Frequencies

A vibration analysis of the Propeller Test Rig, with the 25-foot tilt rotor installed, was made prior to testing. The test stand structure was modeled on the NASTRAN structural analysis and the natural frequencies determined as reported in the pre-test report, Reference 3.

A vibration survey of the actual Propeller Test Rig installed in the tunnel was made without a rotor to determine the principal frequencies and damping of the structure and with dummy weights representative of the rotor. The rotor-off transfer function was measured in the longitudinal, lateral, and vertical directions for yaw angles of $\psi = 0^{\circ}$ and 90°. Rotor weights-on results were obtained for lateral and vertical modes at $\psi = 0^{\circ}$ only. The direction of shaking (lateral or longitudinal) is defined with respect to the PTR module, not the balance and wind tunnel. The test procedure and complete results are described in detail in References 4 through 6.

The measured test stand natural frequencies are compared to the calculated frequencies in Table III-2.

C. Instrumentation

Conventional instrumentation was used to measure loads, control positions, deflections, and accelerations. Rotating system instrumentation channels utilized a 52-ring slipring to provide 2 excitation power channels and 24 data channels.[1] Table III-3 summarizes the data channels recorded. All channels were recorded on the 40- by 80-foot wind tunnel High Speed Data Acquisition System (HSDAS). The HSDAS was used to provide digital printouts of analog traces, harmonic analysis, and calibration information. One oscillograph was used to monitor critical items during the test. The 50-channel Peak to Peak indicator unit was also used to monitor loads and vibration levels of all channels during the test. Yoke and blade beam /chord (Sta. 8.4 and 52.5) loads along with pitch link oscillatory loads were monitored on an oscilloscope and on the model control console panel.

[1] Originally only one excitation power channel and 25 data channels were available. High line voltage drop between the model and recording systems and the loss of one data channel allowed changing to two power channels. This change reduced the line voltage drop to a more acceptable level.

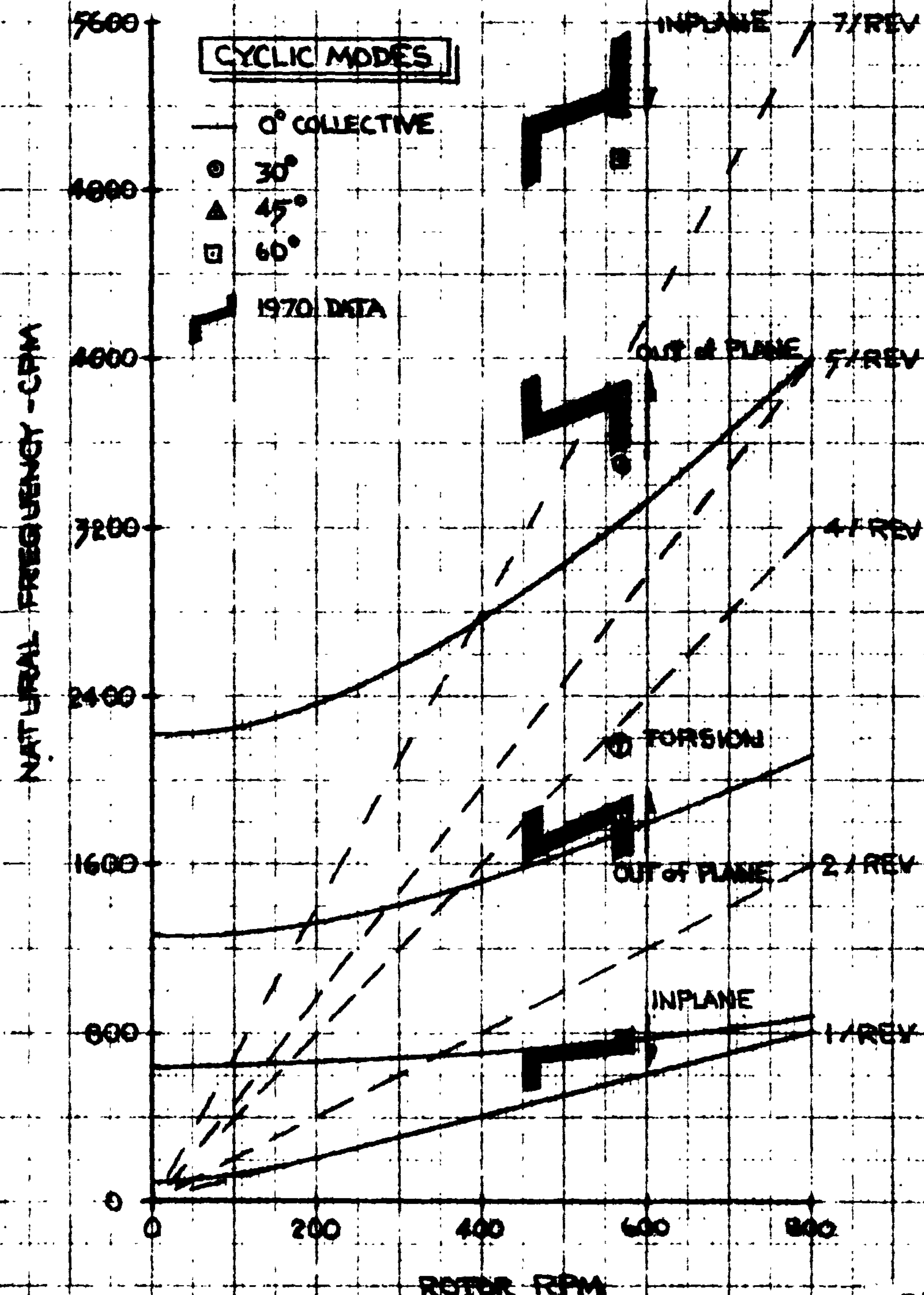

CYCLIC MODES
0° COLLECTIVE
30°
45°
60°
1970 DATA
NATURAL FREQUENCY - CPM
5600
4800
4000
3200
2400
1600
800
0
INPLANE
7/REV
OUT of PLANE
5/REV
4/REV
TORSION
OUT of PLANE
2/REV
INPLANE
1/REV
0
200
400
600
800
ROTOR RPM

Figure III-1

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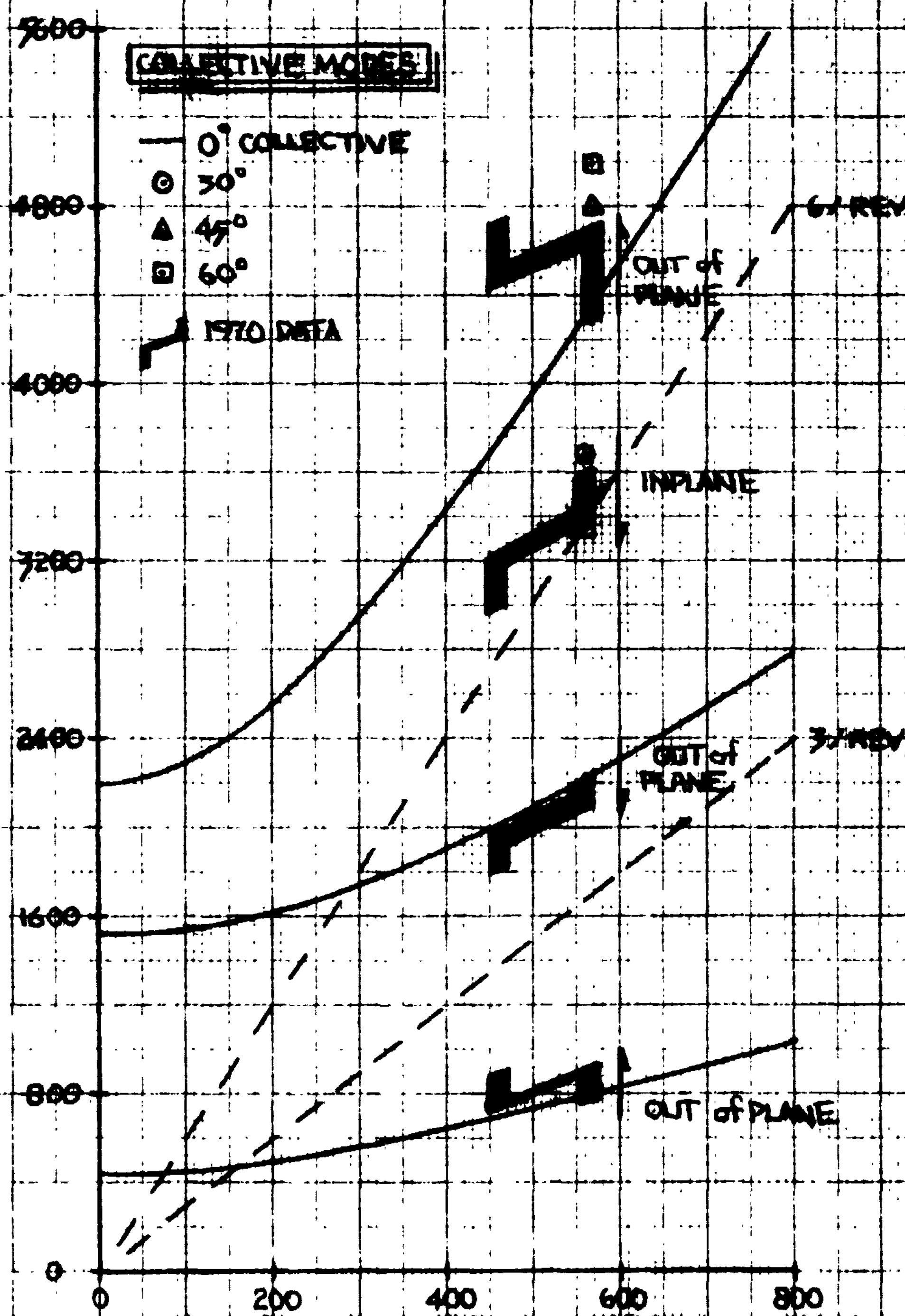

Figure III-2

TABLE III-1. ROTOR DESCRIPTIVE DATA

Number of blades	3
Diameter	7.62m (25 ft.)
Disc Area	$45.6m^2$ ($491\ ft.^2$)
Blade Chord	.356m (14 in.) (17 in. @ .0875R tapering to 14 in. at .25R
Blade Area (Total 3 blades)	$4.06m^2$ ($43.75\ ft.^2$)
Solidity	.089
Blade Airfoil Section	
Root (C_L mast)	NACA 64-935
.15R	NACA 64-429
.25R	NACA 64-425
.50R	NACA 64-218
.75R	NACA 64-112
1.00R	NACA 64-208
Blade Twist	
Aerodynamic	45 deg
Geometric	40.9 deg
Hub Precone	2.5 deg
δ_3	-15.0 deg
Hub Spring	2700 in-lb/deg
Flapping Design Clearance	$\pm$12/0 deg
Blade Inertia (per blade)	102.5 $slug\text{-}ft^2$
Rotor rpm/tip speed	
Helicopter	565 rpm/740 ft/sec
Airplane	458 rpm/600 ft/sec

TABLE III-2. PROPELLER TEST STAND NATURAL FREQUENCIES

Mode	Measured - HZ			NASTRAN Model (equiv. wt.)
	Rotor-Off		Rotor-On (equiv wt.)	
	$\psi=0°$	$\psi=90°$	$\psi=0°$	
Lateral Modes				
Balance Lateral	1.73	1.29	1.65	1.43
Yaw	3.14	2.41	3.26	2.09
Strut Side	5.56	5.55	4.90	6.68/2.52
Module	12.3	11.7		
Module	17.2	15.9		16.9
Mast			20.4	21.6
Module	33.3	33.1		
Longitudinal Modes				
Balance Longitudinal	1.44	2.3		1.80
Strut Longitudinal	3.54	3.9		3.99
Module	16.2	16.8		
Module	28.6	28.8		20.24
Vertical Modes				
Balance		1.56		
Balance		2.31		
Balance		5.54		
Balance		7.64	7.34	7.90
Module		13.5	11.0	12.8
Module		16.4	14.7	14.45
Mast			24.0	29.03

TABLE III-3. INSTRUMENTATION

Item	Channel No.		Computer Notation
	HSDAS	O-Graph	
Blade beamwise bending moment -Sta. 22.825 (red blade)	1		BB23
Blade beamwise bending moment -Sta. 52.5 (red blade)	2	3	BB53
Blade beamwise bending moment -Sta. 75.0 (red blade)	3		BB75
Blade beamwise bending moment -Sta. 112.5 (red blade)	4		BB113
Blade chordwise bending moment -Sta. 52.5 (red blade)	5	8	CH53
Blade chordwise bending moment -Sta. 75.0 (red blade)	6		CH75
Blade chordwise bending moment -Sta. 112.5 (red blade)	7		CH113
Blade torsion - Sta. 52.5 (red blade)	8		TR53
Blade torsion - Sta. 112.5 (red blade)	9		TR113
Blade stress trailing edge -Sta. 75.0	10		TE75
Blade stress leading edge -Sta. 9.5	11	20	LE9
Blade stress trailing edge -Sta. 9.5	12	21	TE9
Yoke chordwise bending moment -Sta. 8.375 (red blade)	13	23	YOKEC
Yoke beamwise bending moment -Sta. 8.375 (red blade)	14	24	YOKEB

TABLE III-3.
(Continued)

Item	Channel No.		Computer Notation
	HSDAS	O-Graph	
Fork stress (red blade)	15		FORK2
Fork stress (white blade)	16		FORK1
Mast perpendicular bending	17	26	MPERP
Mast parallel bending	18	5	MPARA
Mast torque	19	9	MASTQ
Pitch link axial load (red blade)	20	27	PLINK
Blade feathering (red blade)	21		PITCH
Blade flapping (red blade)	22	32	FLAP
Swashplate driver load	23	33	SDRIV
Collective slider - parallel bending	24		CSPAB
Collective slider - perpendicular bending	25		CSPEB
Lateral flapping	26		LATSP
Fore and aft flapping	27		LONSP
Collective tube axial load	28	13	COLAX
Lateral cyclic tube axial load	29	17	LATAX
Longitudinal cyclic tube axial load	30	29	LONAX
Collective position	31		THETA
Lateral cyclic position	32		A1S
Longitudinal cyclic position	33		B1S
Mast case vertical acceleration (reference to helicopter $\psi=0$)	34		ACCV

TABLE III-3.
(Continued)

Item	Channel No.		Computer Notation
	HSDAS	O-Graph	
Mast case lateral acceleration (reference to helicopter $\psi = 0$)	35		ACCLA
Mast case fore/aft acceleration (reference to helicopter $\psi = 0$)	36		ACCLO
Forward strut lateral acceleration	37		SAFLA
Aft strut lateral acceleration	38		SAALA
Strut longitudinal acceleration	39		SALO
Torque-transmission load cell	40		QLC
Static pressure	41		PSTAT
Lateral displacement guage-fwd	42		FLADG
Lateral displacement guage-aft	43		ALADG
Twice longitudinal flapping	44		LODG

IV. DESCRIPTION OF TEST

Testing was accomplished in the NASA-Ames 40- by 80-foot wind tunnel during 8 November 1975 through 23 November 1975 and designated Test No. 472. The test was to evaluate tilt rotor autorotation characteristics, the effect of lateral cyclic on rotor flapping and blade loads, and to expand the 1970 wind tunnel test envelope. Total occupancy time was 165 hours (blades on ready for track and balance). Instrumentation and mechanical problems accounted for most of the occupancy time leaving 11.5 hours of rotor on testing. A total of 128 points was obtained during this period for a 6.9 percent utilization of available test time.

Force and moment data was measured by the wind tunnel balance and converted to rotor thrust, H-force, Y-force, and torque. A second method used to measure torque was from a load cell on the test stand. The primary torque measurement was from a strain-gage on the rotor mast. The power coefficients and data presented in this report use the mast torque strain-gage because it was found to be more accurate than the other two methods. (The other two measurements were dropped from the scale data output. Power measurement by these methods appeared unreasonable and would not correlate with most torque measurements.) In addition, rotor rpm, collective pitch, cyclic pitch, and flapping angles were measured. For a more detailed description of data measured, rotor instrument and force/angle relationships, see List of Symbols, Section III.C, and in Section V respectively.

The major test variables were tunnel speed and shaft angle, see Run Schedule in Appendix. Generally, during the runs collective pitch was varied while other variables were held approximately constant. Fore and aft cyclic pitch was adjusted to hold fore and aft flapping constant at zero. Lateral cyclic pitch was set to zero during most of the test, but was changed to -4.0 degrees to obtain the effect of lateral cyclic on blade loads.

Basic procedure for the start of each run was to set the controls to zero ($\theta_{TIP} = B_1 = A_1 = 0^o$), bring the rotor to the desired rpm, then bring the tunnel up to speed. As tunnel speed increased, fore and aft cyclic pitch was changed to hold flapping to zero. Once the tunnel was on the desired test speed, collective sweeps were made so as not to exceed blade endurance limits. During the autorotation runs, the same initial start-up procedure was followed with the shaft angle set at 90 degrees while tunnel speed was increasing to the test speed. As shaft angle was increased for autorotation, collective pitch was reduced to keep from stalling the rotor. At the specified shaft angle, collective sweeps were made from the lower limit ($\theta_{TIP} = -8^{o}$) to a setting above the bucket in the thrust/power curve (generally $\theta_{TIP} = 0^{o}$).

V. DATA REDUCTION

Force and moment data, measured on the wind tunnel balance were reduced using a NASA-Ames data reduction program for scale data. Control positions and test conditions were thumb wheeled in for reference. Test data computer notation for the scale data is given in the List of Symbols for comparison with the symbol as used in this report. The force and moment sign convention used during this test is shown in Figure A-1. Scale data is given in the Appendix.

Rotor loads, stress, accelerations, and control positions were recorded on the High-Speed-Data-Acquisition System. Computer notation, channel number reference, and channel description is given in Table III-3, Section III. Due to the bulk of this information, the HSDAS information is not presented. The major test parameters recorded from this system that are presented in this report are tabulated (collective pitch, cyclic pitch, flapping, blade loads) in the Appendix.

Tare runs were made after the test. The only item modified on the model was the nonrotating fairing of PTR. It was interferring with the swashplate driver and had to be cut back past the rotating parts (approximately a 6.0 inch gap between the fairing and spinner). This did not seem to change the tare data significantly when compared with the previous tare from the 1970 test. Figures V-1 and V-2 compare the spinner tare used during the 1970 test with that of this test.

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NASA-AMES

25-FT TILT ROTOR
SPINNER LIFT TARE VS SHAFT ANGLE

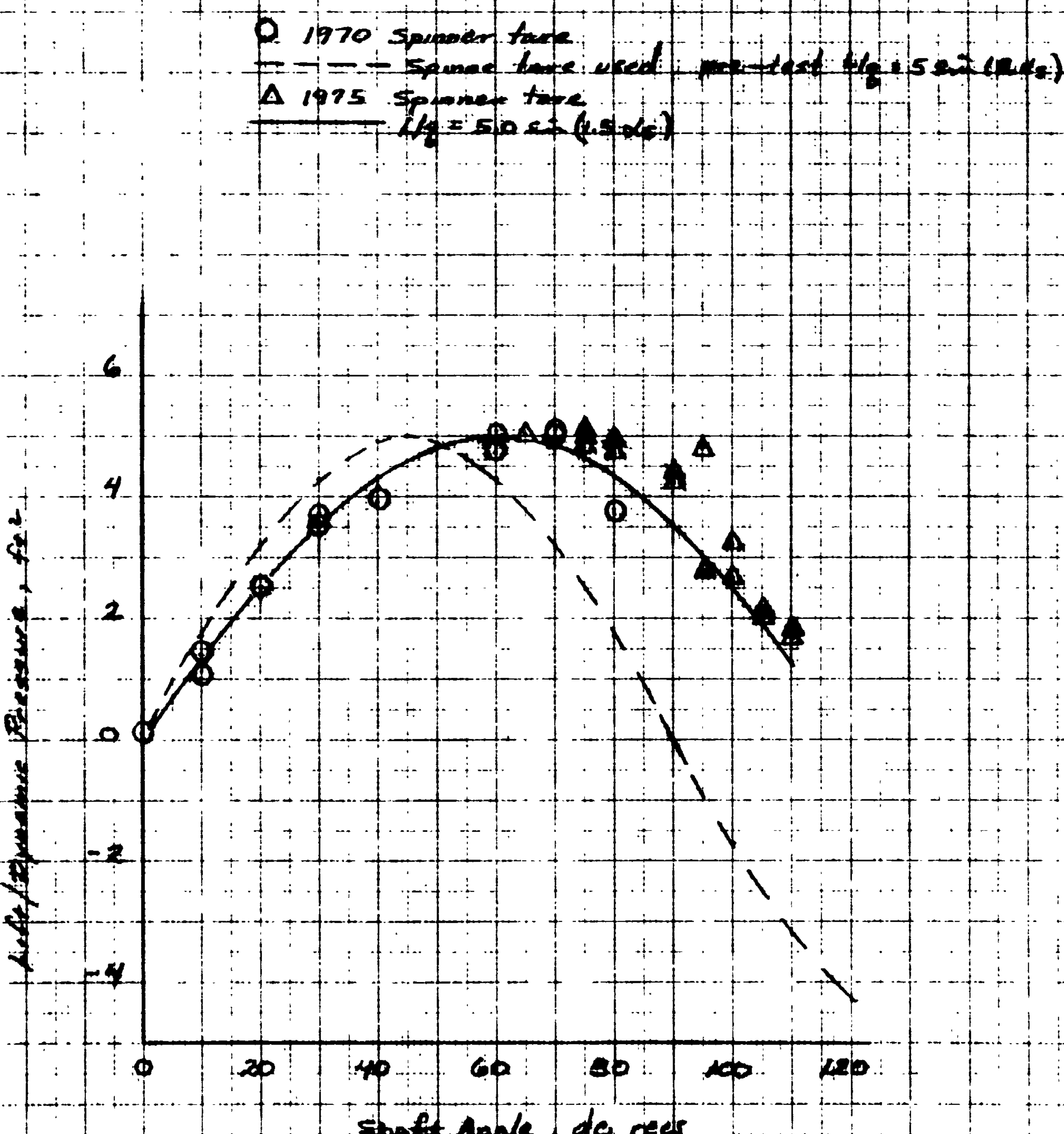
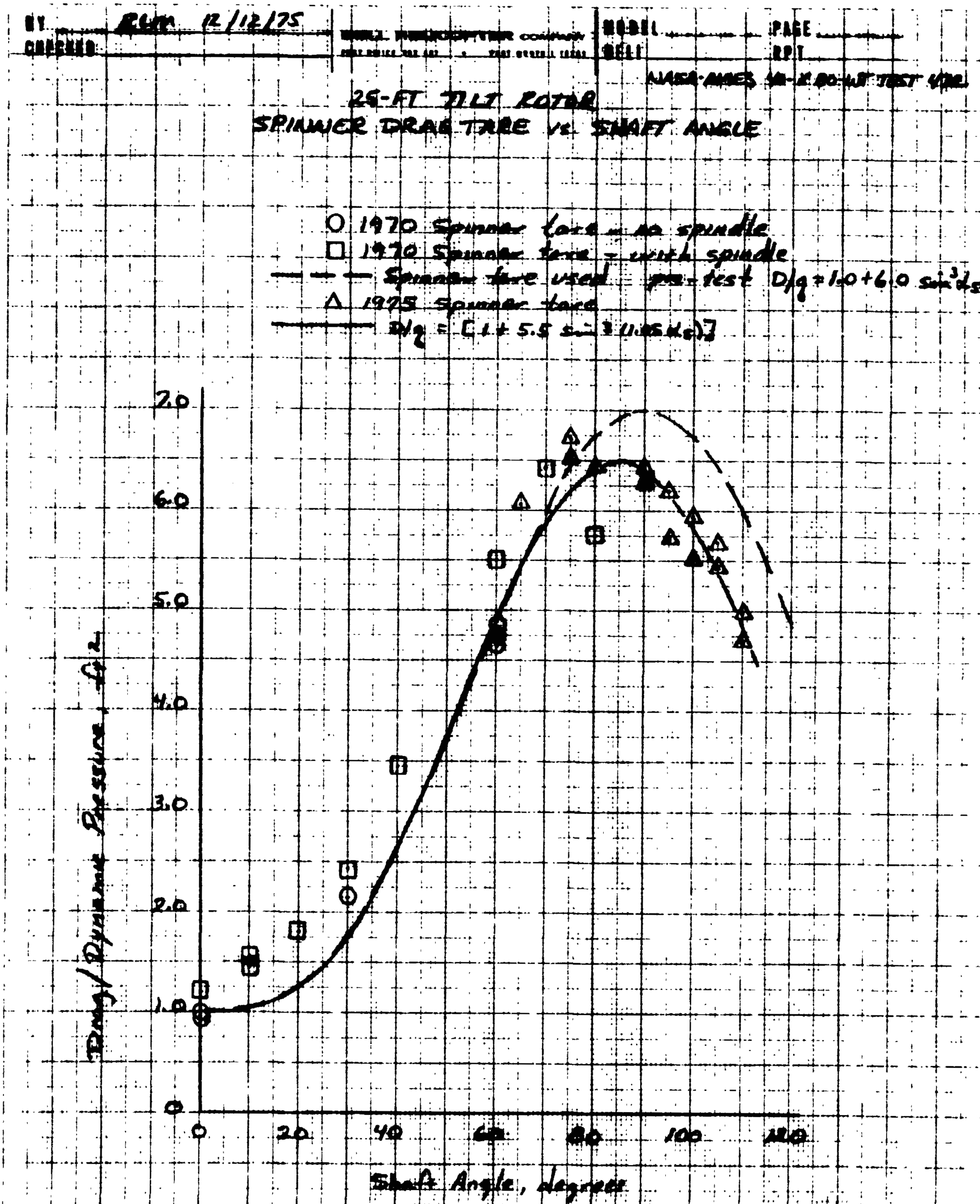


Figure V-1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RPT
NASA-AMES 40- x 80-WT TEST
25-FT TILT ROTOR
SPINNER DRAG TARE vs SHAFT ANGLE
○ 1970 Spinner tare – no spindle
□ 1970 Spinner tare – with spindle
– – – Spinner tare used pre-test D/q = 1.0 + 6.0 sin³αs
△ 1975 Spinner tare
—— D/q = [1 + 5.5 sin³(1.05αs)]
Drag/Dynamic Pressure, ft²
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
0
20
40
60
80
100
120
Shaft Angle, degrees

Figure V-2

VI. RESULTS OF TEST

Test results are divided into three sections, hover performance, forward flight, and autorotation. The first two configurations were tested to establish a correlation with the 1970 test. Autorotation data was made available as the result of this test. Therefore, comparisons are made between this test and the 1970 test for hover and forward flight and between this test and estimates for autorotation.

A. Hover Performance

Figures VI-1 and VI-2 present a summary of hover testing performed on the 25-foot rotor. Most of the hover testing in the wind tunnel was with the shaft angle at zero degrees (pointing upstream in the tunnel). In this configuration, the rotor produces enough circulation in the tunnel to develop airspeeds up to 20 knots for a low speed axial flight configuration. As the shaft is tilted towards helicopter, hover performance was shown to improve.

Figure VI-3 compares the test hover performance (whirl test) with the calculated from tilt rotor simulation (IFHB75), F-35, and C-81 computer programs. The math model representation for the IFHB75 rotor is a closed solution of the rotor disk whereas, C-81 determines rotor characteristics for twenty blade elements for several azimuth positions and uses two dimensional airfoil sectional data for five radial stations. Induced velocity distribution tables were used to give an elliptical distribution as opposed to conventional triangular distribution. With this type of distribution, good correlation is obtained between computed and test.

B. Forward Flight

Only one forward flight condition was obtained for comparison with the 1970 test. This case was for a shaft angle of 75 degrees at 80 knots. Comparison of rotor characteristics is shown in Figures VI-4 through VI-9.

Correlation between the two test results was good. High collective pitch testing was limited because of instrumentation problems in measuring blade loads and incidences of loosing rotor control at electrical connections to the control actuators. Data obtained was sufficient to establish that the rotor characteristics were similar to the last test and pre-test predictions.

C. Autorotation

Autorotation capability of the tilt rotor was investigated at 60, 80, and 100 knots for several shaft angles. Most of the autorotation data was taken at 458 rpm (600 fps). This is airplane mode cruise rpm. Analysis and simulation tests have shown this to be a more realistic autorotation rpm as opposed to the pre-test selected 565 rpm. A limited amount of testing was at 535 rpm which shows that autorotation capability tends to decrease with increasing rpm. Since pre-test estimates were for 565 rpm, post test comparisons are shown using IFHB75 and C81 calculations at 458 rpm which were made after the test.

Figures VI-10 through VI-12 compare the test data with IFHB75 calculations for 60, 80, and 100 knots. The computed autorotation is shown to be optimistic, i.e. less shaft angle required to autorotate. The differences become larger with increasing airspeed. Maximum thrust correlation between calculated and test is good. These two effects limit the airspeed range for autorotation. Wing loading during autorotation needs to be considered to unload the rotor to keep from stalling the rotor. Maximum thrust of the rotor at 458 rpm is between 4900 and 4400 pounds for 60 and 100 knots respectively.

Figure VI-13 compares the test data with C-81 calculations at 80 knots. The computed autorotation in this case is shown to be slightly conservative. Shaping of the thrust-power variation is closer than computed by the more linear IFHB75 rotor equations. Again the maximum thrust limit comparison is good.

Figure VI-14 is a comparison of fore/aft cyclic control position and lateral flapping. Fore/aft cyclic calculated by IFHB75 is less than that computed by C-81 and the test values. Both methods compute lower lateral flapping than test. This indicates the fore and aft induced velocity distribution to be highly nonlinear. Indications show it to be more so during autorotation than forward flight. This is based on that comparisons made in forward flight have shown better agreement for lateral flapping toward substantiating the distribution used.

Blade loads were low and comparable to calculated as shown in Figure VI-15. The variation of loads with collective pitch and shaft angle show the test values to be relatively constant. The effect of lateral cyclic on blade beam bending moment is shown in Figure VI-16.

Rotor performance parameters of power and lift coefficients during autorotation are presented in Figures VI-17 through VI-19 for 60, 80, and 100 knots respectively. The C_{P_ω} parameter is used as an indicator of rotor stall. The calculated values from IFHB75 and C-81 are compared with test in Figure VI-18. The C-81 rotor shows better agreement than the IFHB75 rotor. Figure VI-20 summarizes the projected maximum C_L/σ for forward flight and autorotation configurations tested at $\pm$15 degrees shaft angles from vertical.

Figure VI-21 summarizes the autorotation rate of descent capabilities computed for the XV-15 which includes the contribution of the airframe for a gross weight of 13,000 pounds. The optimum rate of descent was found to be obtained by tilting the nacelles to 95 degrees and positioning the flaps at 40 degees. Rate of descent can be held to around 2400 fpm if proper aircraft attitude and collective pitch are maintained. These results are different than observed during previous tilt rotor simulation tests for the XV-15. During the simulation tests, autorotation was made with the collective pitch set on the lower limits at -7.5 degrees. This requires the rotor to autorotate on the back side of the thrust/power bucket. Thrust provided by the rotor is lower and in order to trim the aircraft, the wing is operating very near maximum lift. This combination results in higher sink rates. Autorotation test results show that the optimum collective pitch setting for the tilt rotor to be about -5.0 degrees, which allows the rotor to operate on the front side of the thrust/power bucket. This increases the thrust provided by the rotor and reduces the lift required by the airframe.

As shown in the previous figures, the shaft angle required from test was greater than calculated. Autorotation at shaft angles around 105 degrees and with the nacelles at 90 degrees would generally require flying beyond wing stall. Tilting the nacelles to 95 degrees reduces the wing angle of attack and rate of descent. Raising the flaps would tend to stall out the rotor at low rpm or require higher rpm for autorotation resulting in higher sink rates and reduced flare capability. Equations used to estimate the autorotation rate of descent shown in Figure VI-21 and a sample calculation is given below.

Autorotation rates of descent were calculated using the following simplified method to account for the airframe.

$$R/D = V_{FPS} \sin \gamma$$

where

$$\gamma = \tan^{-1} (^{Drag}/Lift)$$

$$Lift = T_{ROTOR} \sin \alpha_S + L_{AIRFRAME}$$

$$Drag = -T_{ROTOR} \cos \alpha_S + D_{AIRFRAME}$$

$$\alpha_S = \alpha_F + i_N$$

Thrust of the rotor is obtained from Figures VI-10 through VI-12 at shaft angles for HP = 0 and HP = -20 (accounting for accessory and transmission drive). Lift and drag of the airframe are obtained from Reference 7.

For V = 80 kts, $i_N = 95^o$, $\delta_F = 40^o$, HP = -20, $\alpha_S = 107^o$ and $\theta_{TIP} = -5^o$

$$T_{ROTOR} = (3450)(2) = 6900 \text{ pounds}$$

$$\alpha_F = 105 - 95 = 10 \text{ deg}$$

$$Lift = 6900 \sin 107 + 1.32\ (21.69)(181)^{(1)} + 1000^{(1)} = 12780$$

$$Drag = -6900 \cos 107 + .45\ (21.69)(181)^{(1)} + 150^{(1)} = 3934$$

$$\therefore \gamma = \tan^{-1} (^{3934}/12780) = 17.1 \text{ degrees}$$

$$R/D = 101.26(80) \sin 17.1 = 2383 \text{ fpm}$$

(1) $C_{L_{WING}}$ @ α_F = 10 deg = 1.32

$C_{D_{WING}}$ @ α_F = 10 deg = .45

1000 pounds approximate lift of fuselage and empennage.
150 pounds approximate drag of fuselage and empennage.

Rate of descent for autorotation was determined for the optimum collective pitch and shaft angle to trim the aircraft at 458 rpm (600 fps) and 13000 pounds. At a specific collective pitch angle, rpm and shaft angle would change for a trim condition. The rates of descent for the collective pitch set on the lower limit (θ_{TIP} = -8.0 degrees) is also presented. These values may not be the same as the actual aircraft operating at different gross weight, rpm, or collective pitch settings. This is likewise the case for the simulation test results which was at a lower rpm.

BY RLM 12/12/75	BELL HELICOPTER COMPANY	MODEL	PAGE
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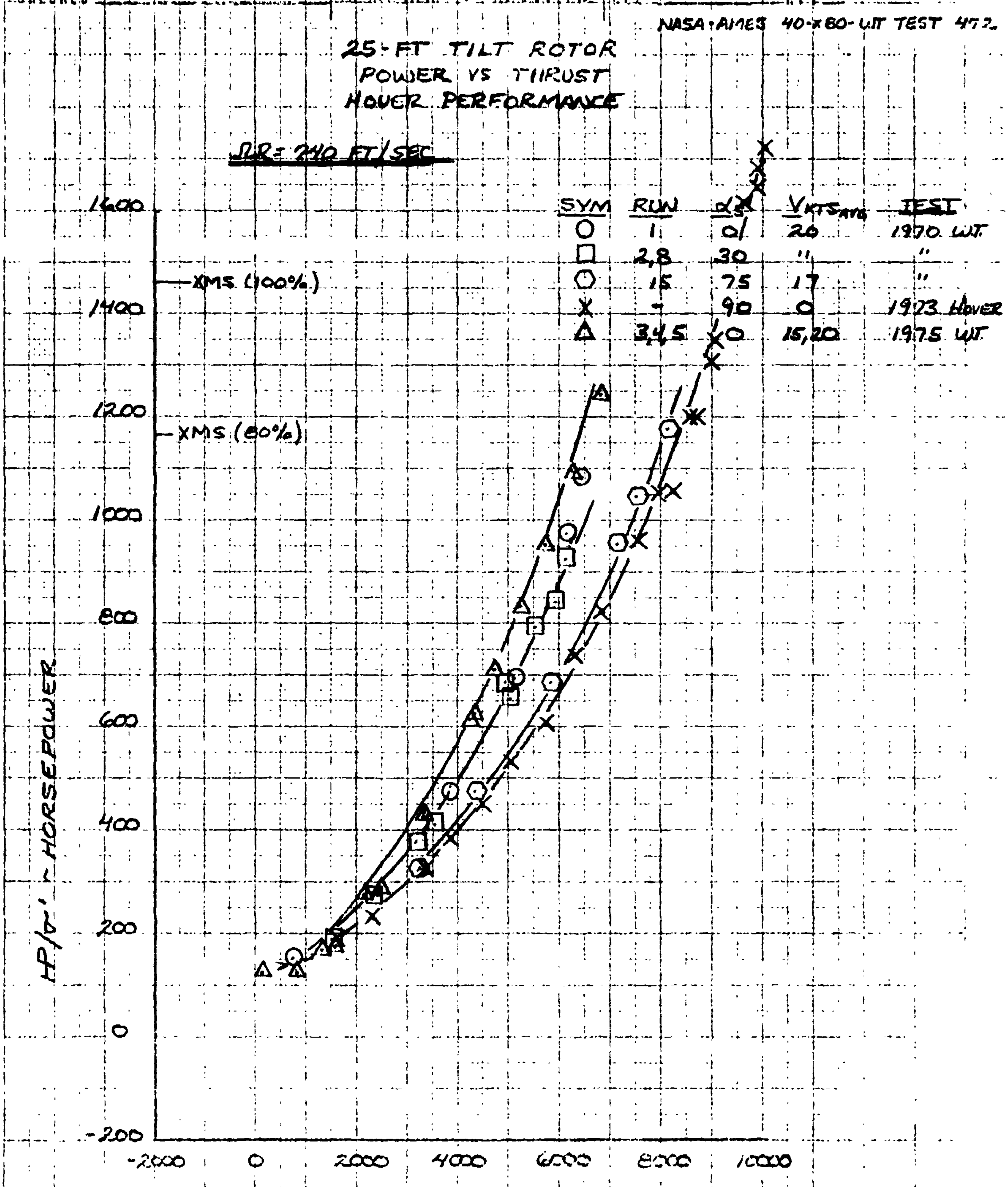
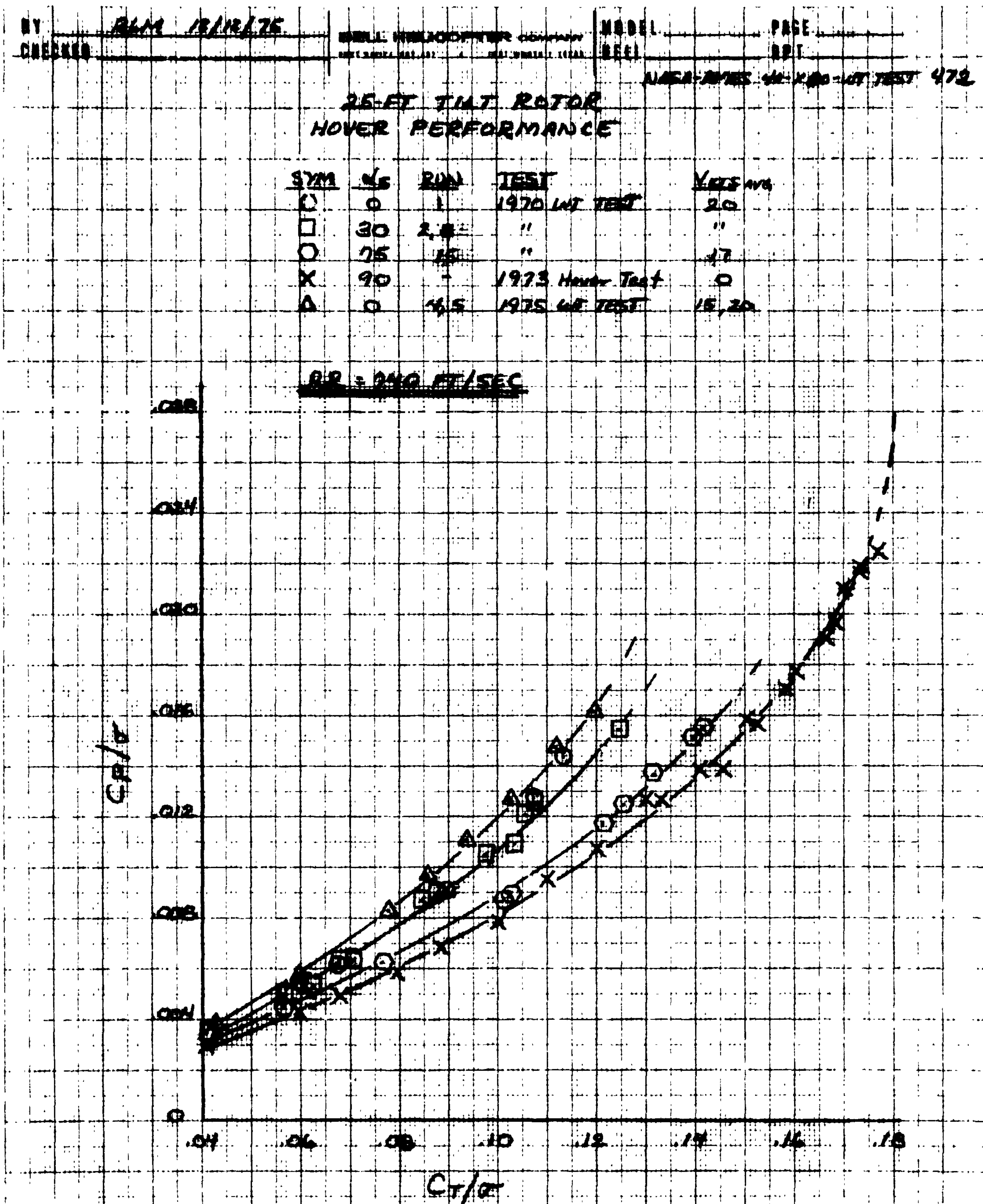


Figure VI-1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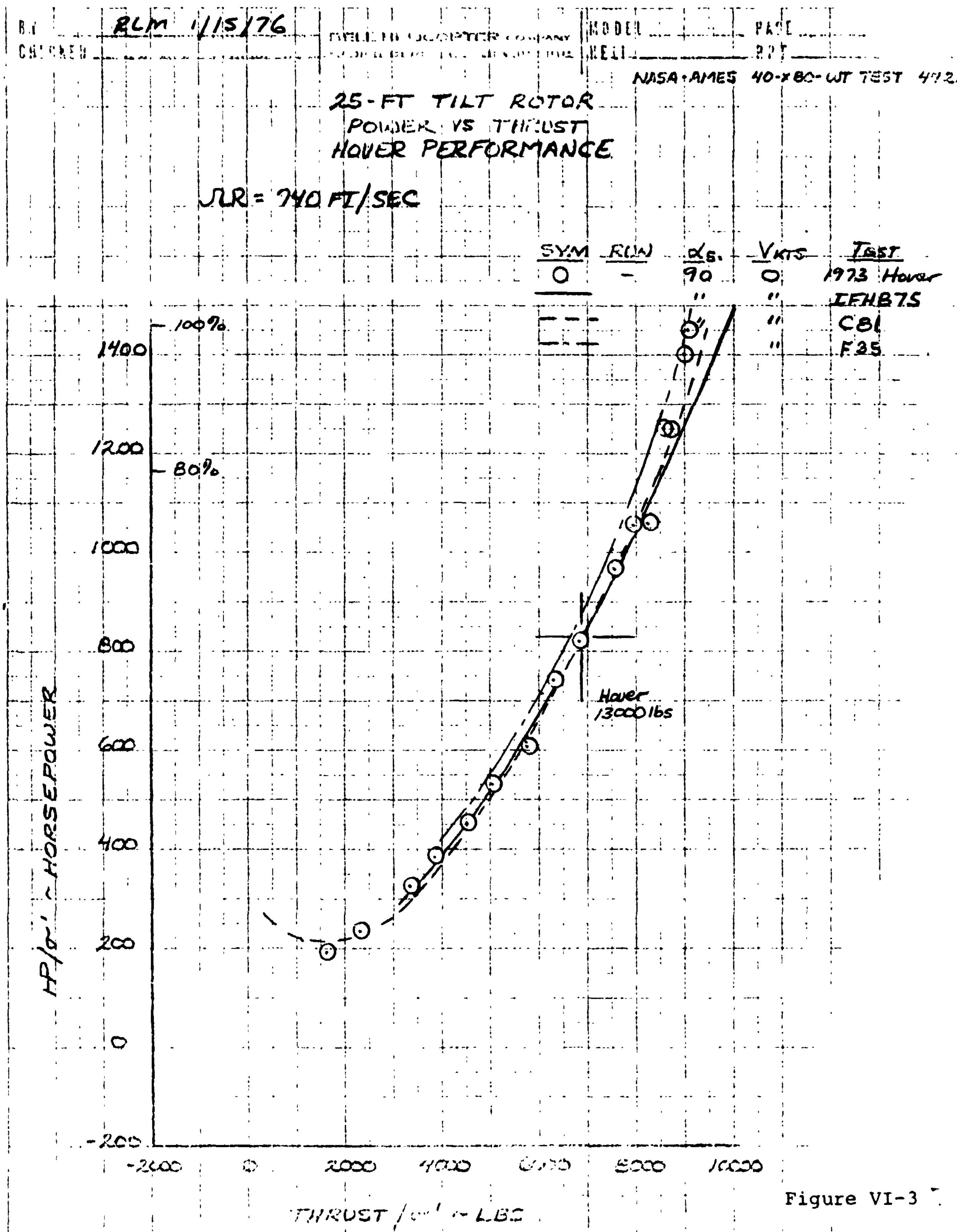
BELL HELICOPTER COMPANY
MODEL
PAGE
REPT
NASA-AMES 40×80 WT TEST 472
25-FT TILT ROTOR
HOVER PERFORMANCE
SYM
RUN
TEST
V avg
1970 WT TEST
1973 Hover Test
1975 WT TEST
ΩR = 740 FT/SEC
.028
.024
.020
.016
.012
.008
.004
0
.04
.06
.08
.10
.12
.14
.16
.18
Cq/σ
CT/σ

Figure VI-2



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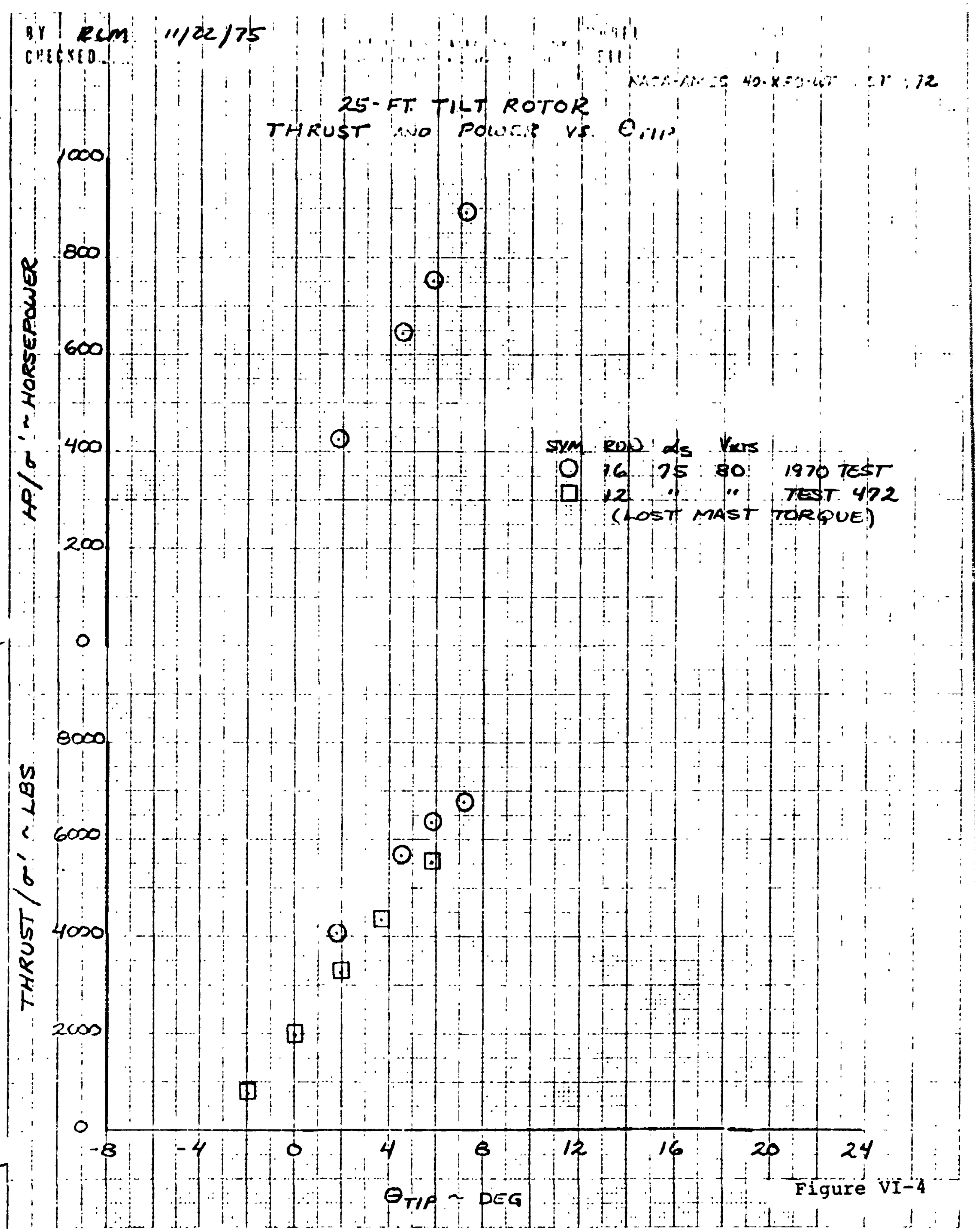
MODEL
PAGE
NASA-AMES 40-x80-WT TEST 472.
25-FT TILT ROTOR
POWER VS THRUST
HOVER PERFORMANCE
ΩR = 740 FT/SEC
SYM RUN αs VKTS TEST
O - 90 0 1973 Hover
" " IFHB75
" " CBI
" " F35
100%
80%
1400
1200
1000
800
600
400
200
0
-200
Hover 13000 lbs
HP/σ' ~ HORSEPOWER
-2000
0
2000
4000
6000
8000
10000
THRUST/σ' ~ LBS

Figure VI-3


BY RLM 11/22/75
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25-FT. TILT ROTOR
THRUST AND POWER VS. θTIP
HP/σ' ~ HORSEPOWER
THRUST/σ' ~ LBS
θTIP ~ DEG
SYM ROW αs VKTS
16 75 80 1970 TEST
12 " " TEST 472
(LOST MAST TORQUE)

Figure VI-4

BY RLM 11/22/75
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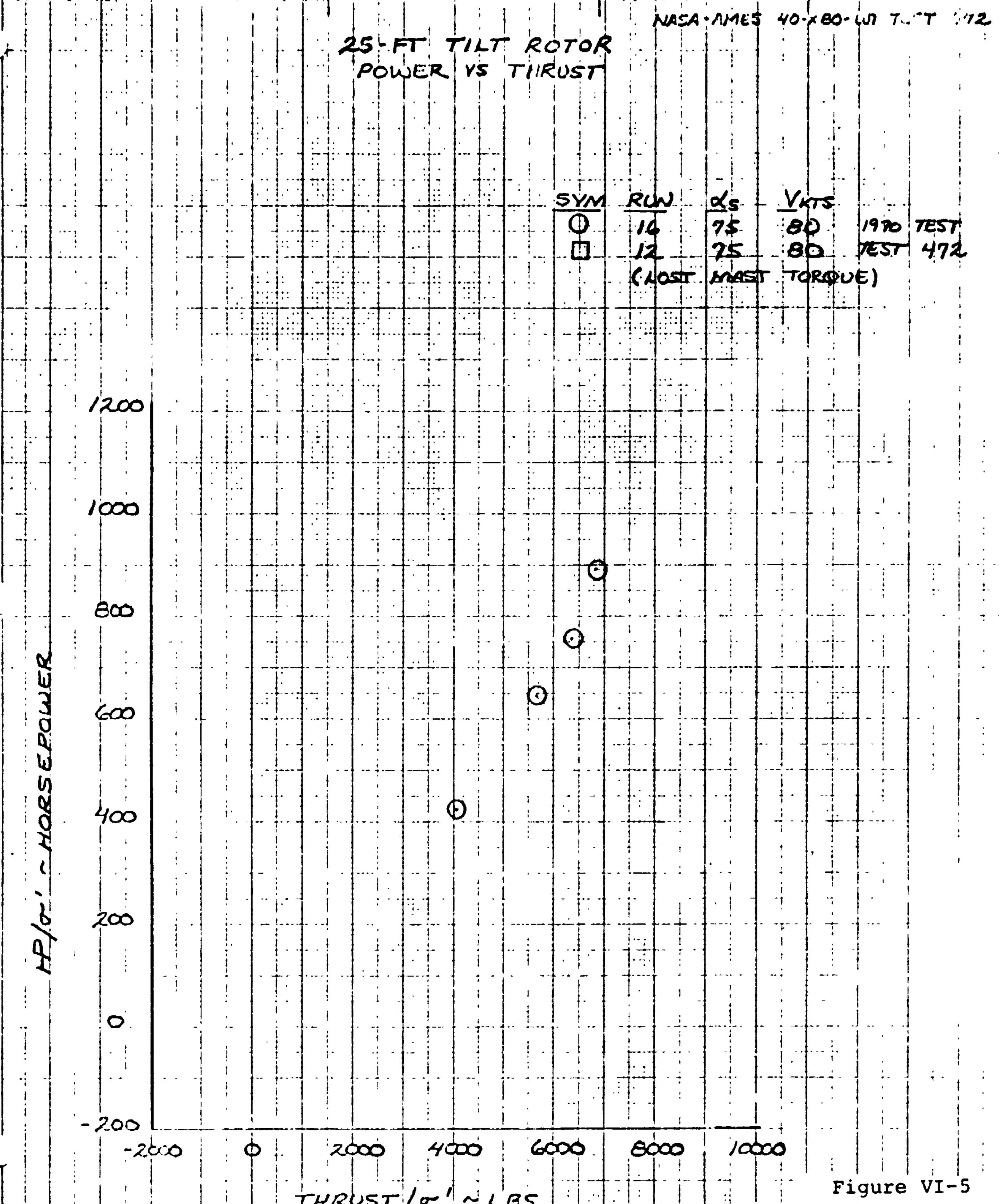

Figure VI-5

301-099-005

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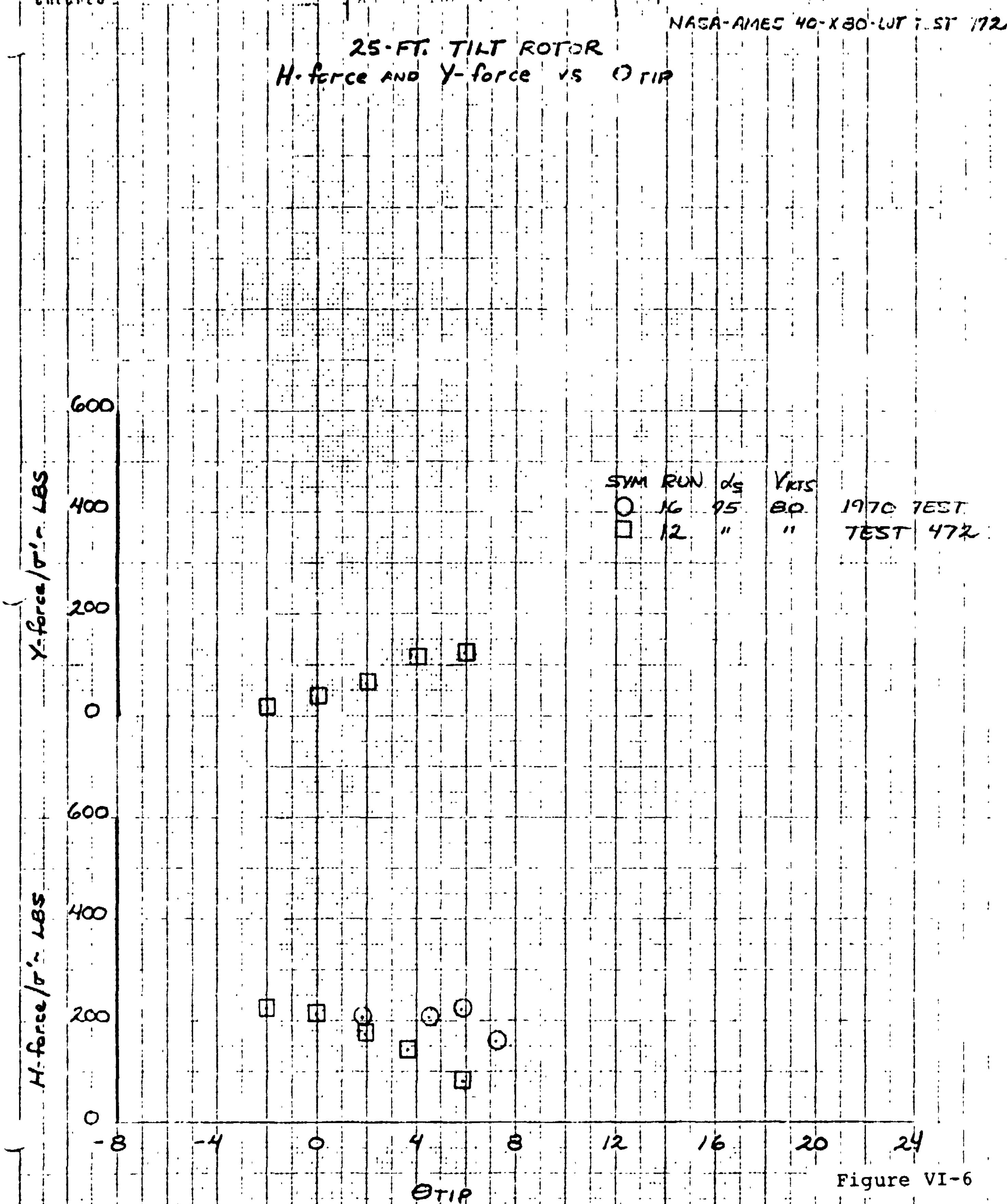

Figure VI-6

301-099-005

7872 56227

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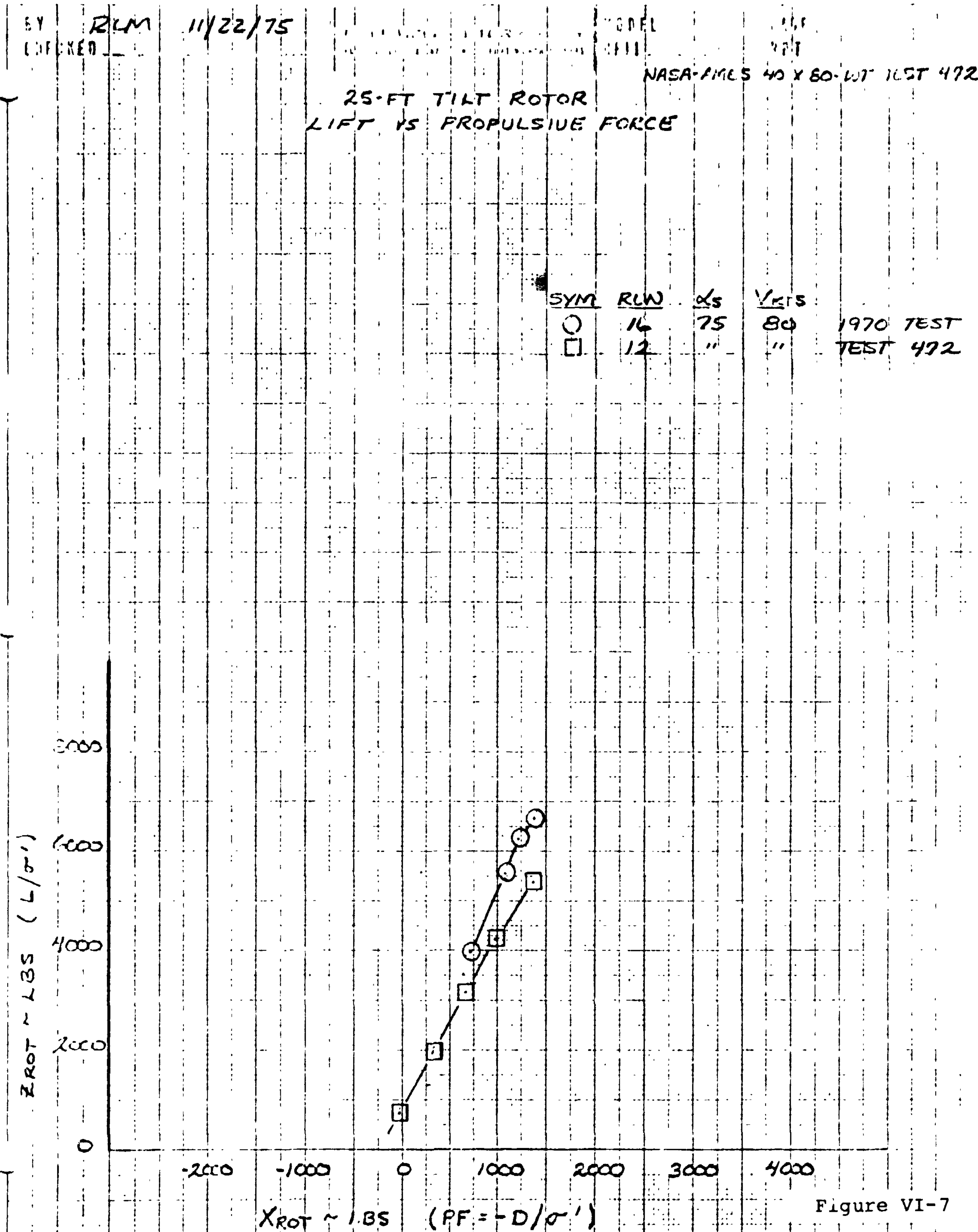
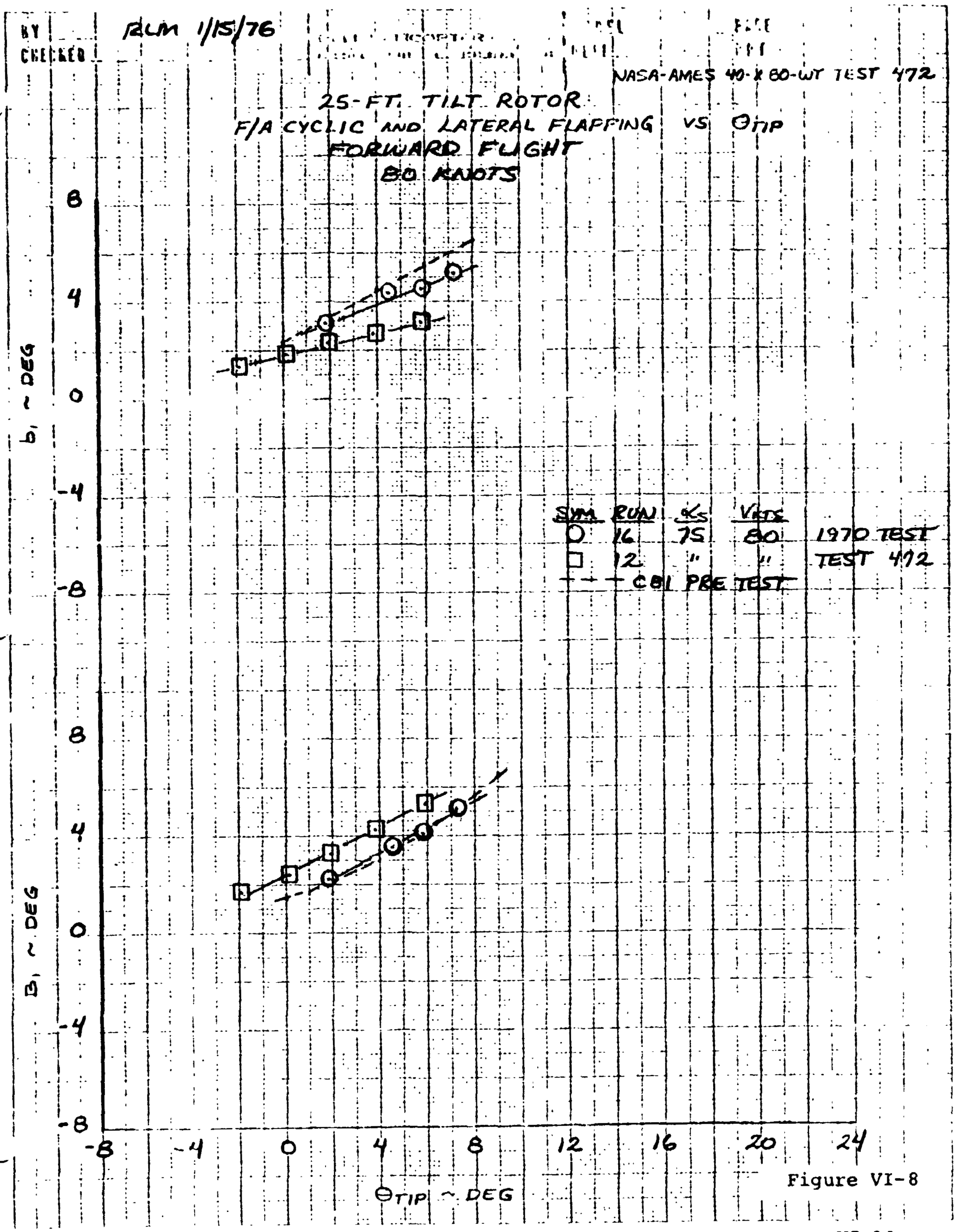


Figure VI-7



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NASA-AMES 40-X 80-WT TEST 472
25-FT. TILT ROTOR
F/A CYCLIC AND LATERAL FLAPPING VS θ_{TIP}
FORWARD FLIGHT
80 KNOTS
b_1 ~ DEG
8
4
0
-4
-8
SYM RUN α_S V_{KTS}
○ 16 75 80 1970 TEST
□ 12 " " TEST 472
CBI PRE TEST
B_1 ~ DEG
-8
-4
0
4
8
12
16
20
24
θ_{TIP} ~ DEG

Figure VI-8

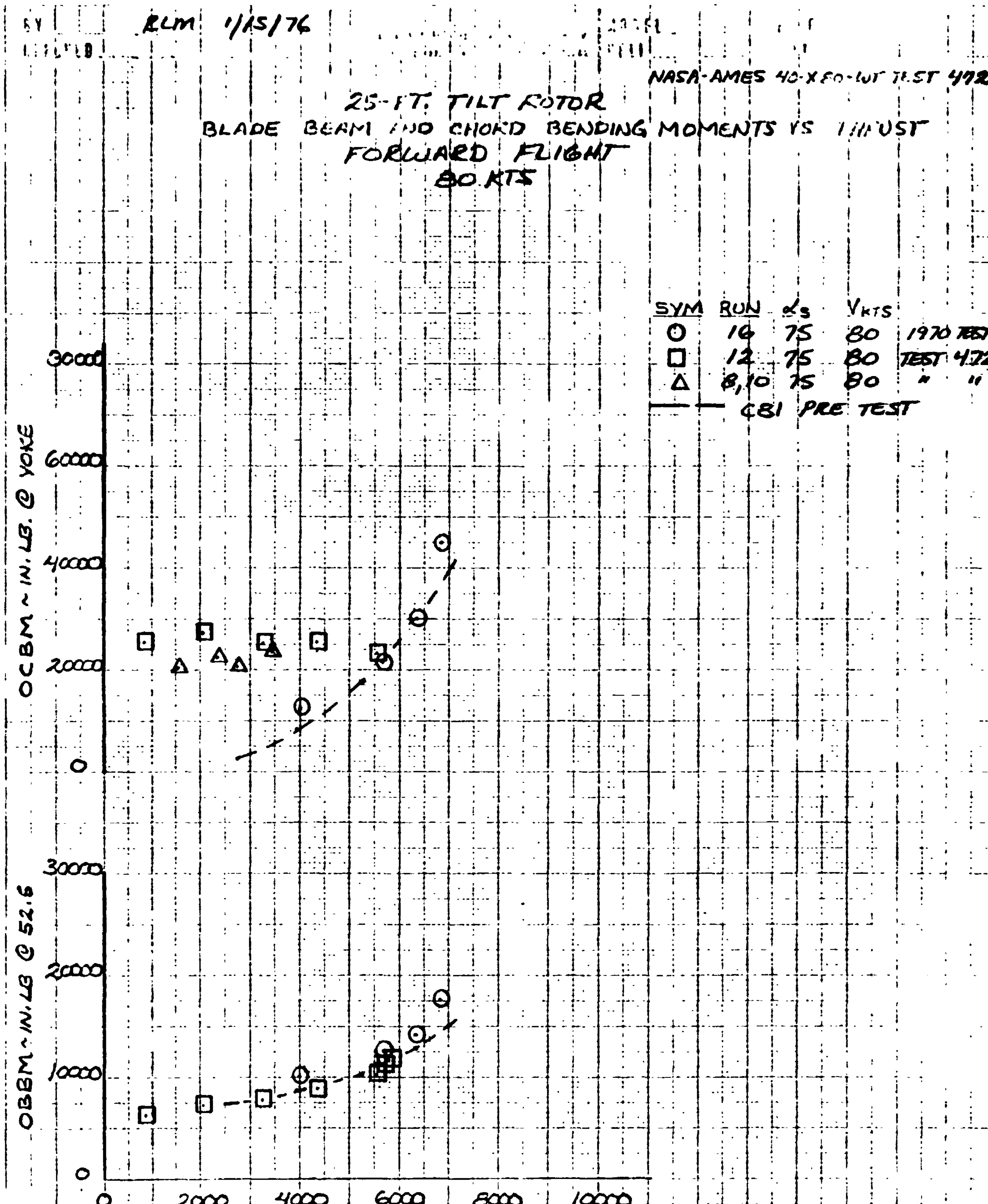

RLM 1/15/76
NASA-AMES 40-X 80-FT TEST 472
25-FT. TILT ROTOR
BLADE BEAM AND CHORD BENDING MOMENTS VS THRUST
FORWARD FLIGHT
80 KTS
SYM RUN αs VKTS
16 75 80 1970 TEST
12 75 80 TEST 472
8,10 75 80 " "
CBI PRE TEST
OCBM ~ IN. LB. @ YOKE
OBBM ~ IN. LB @ 52.6
0
10000
20000
30000
40000
60000
2000
4000
6000
8000
THRUST/σ' ~ LBS

Figure VI-9

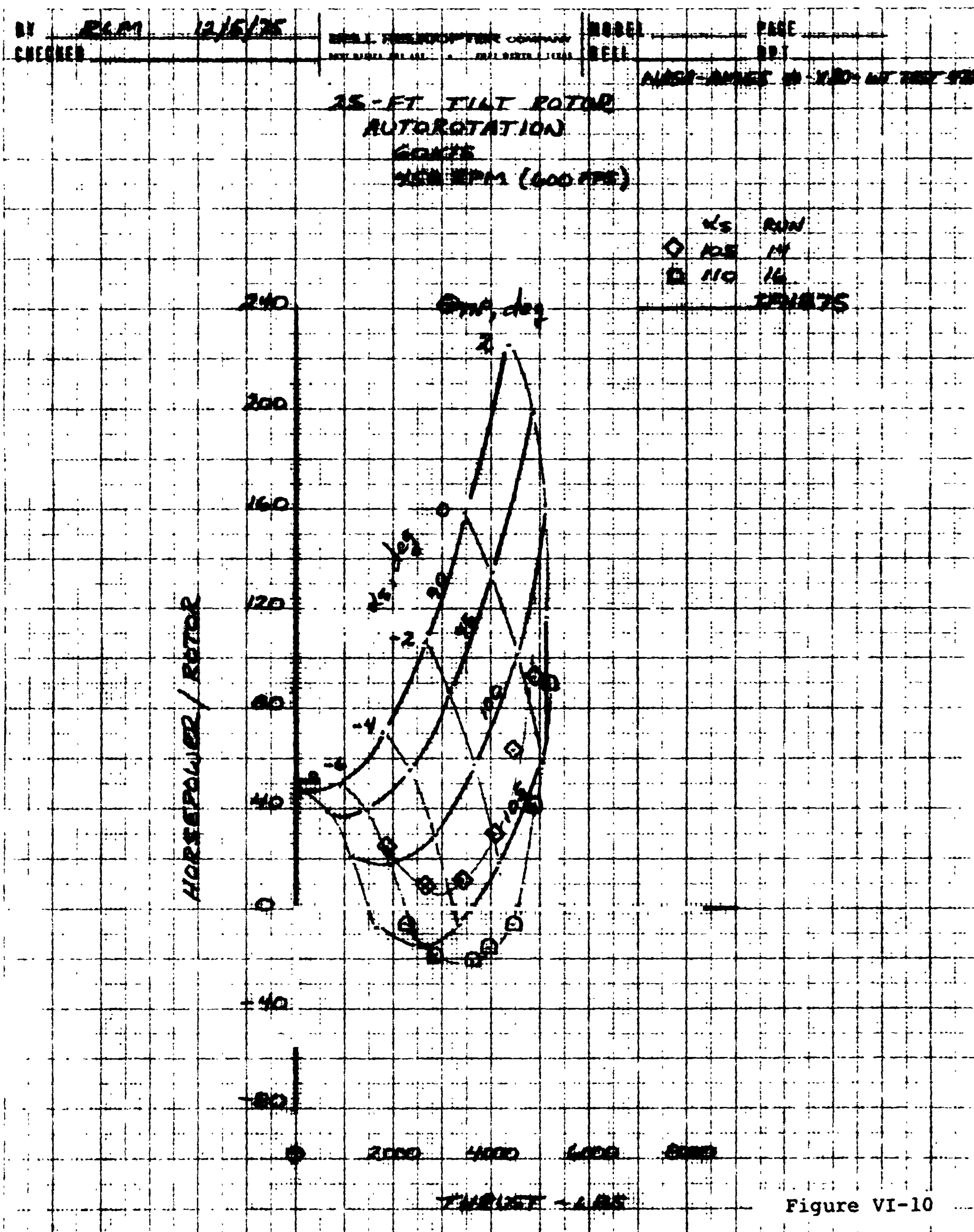
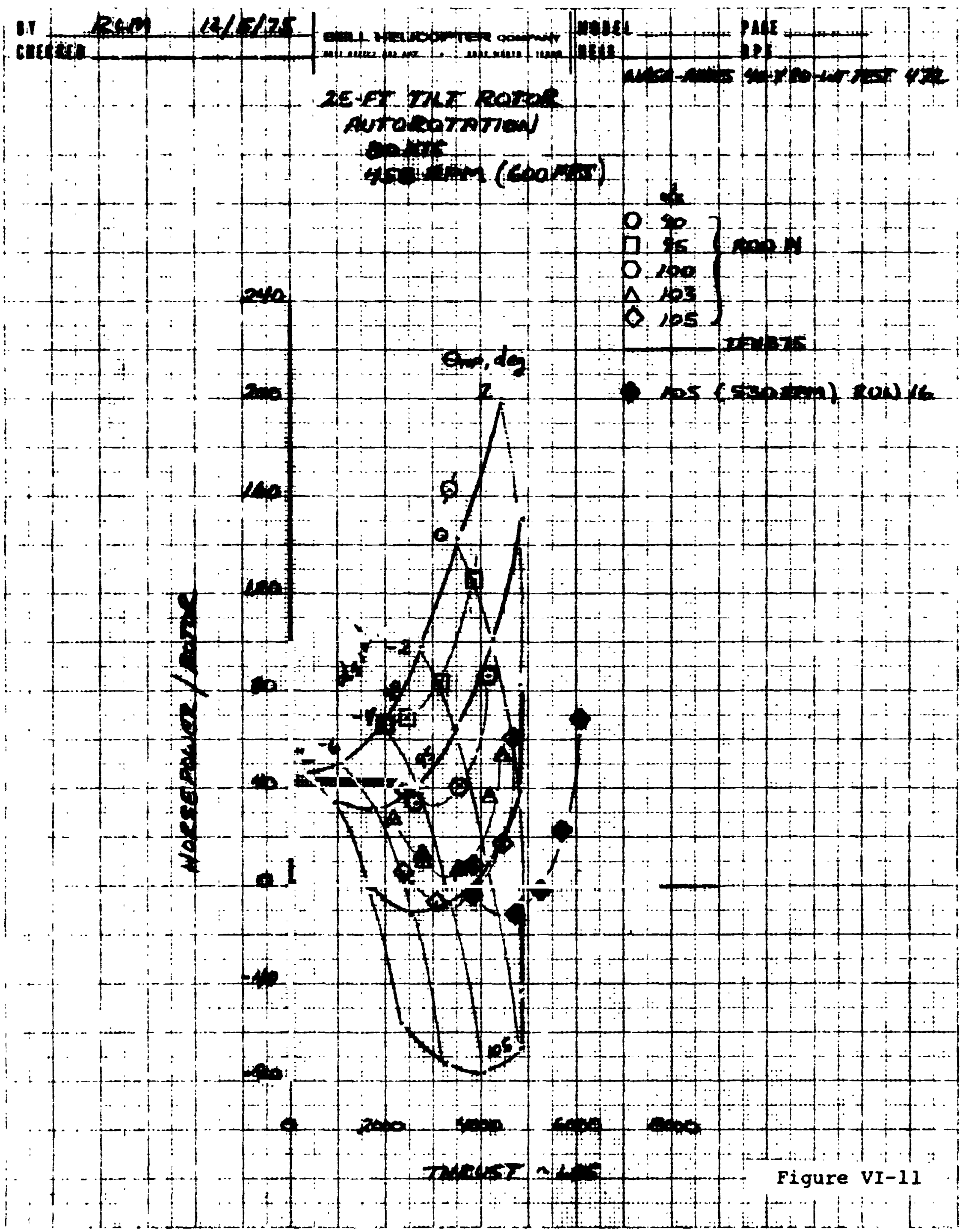


Figure VI-10


BY RGM 12/15/75
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BELL HELICOPTER COMPANY
MODEL
PAGE
AMES 40×80 WT TEST 432
25-FT TILT ROTOR
AUTOROTATION
450 RPM (600 FPS)
90
95
100
103
105
105 (530 RPM)
HORSEPOWER / ROTOR
THRUST ~ LBS
240
200
160
120
80
40
0
-40
-80
0
2000
4000
6000
8000

Figure VI-11

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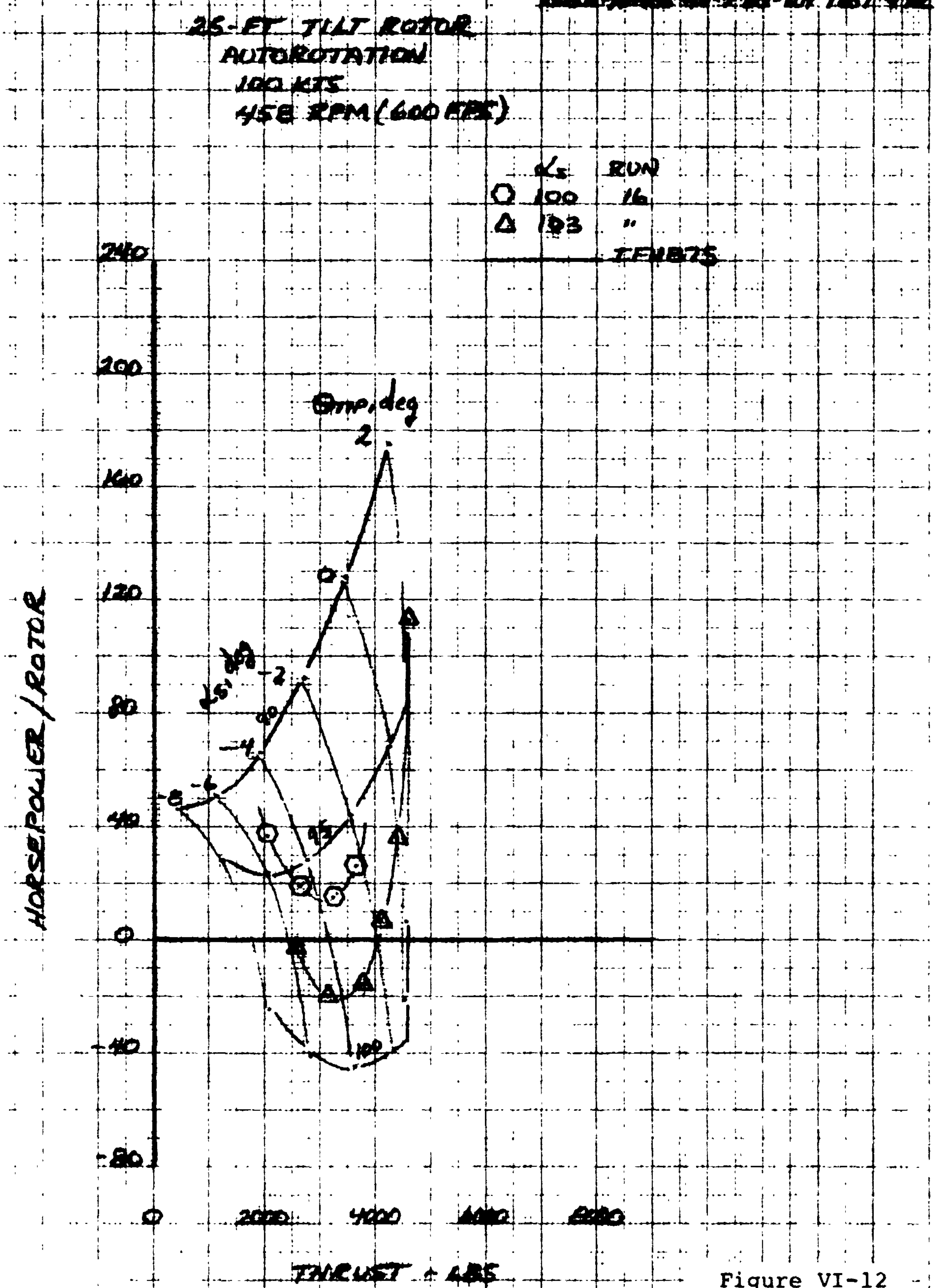


Figure VI-12

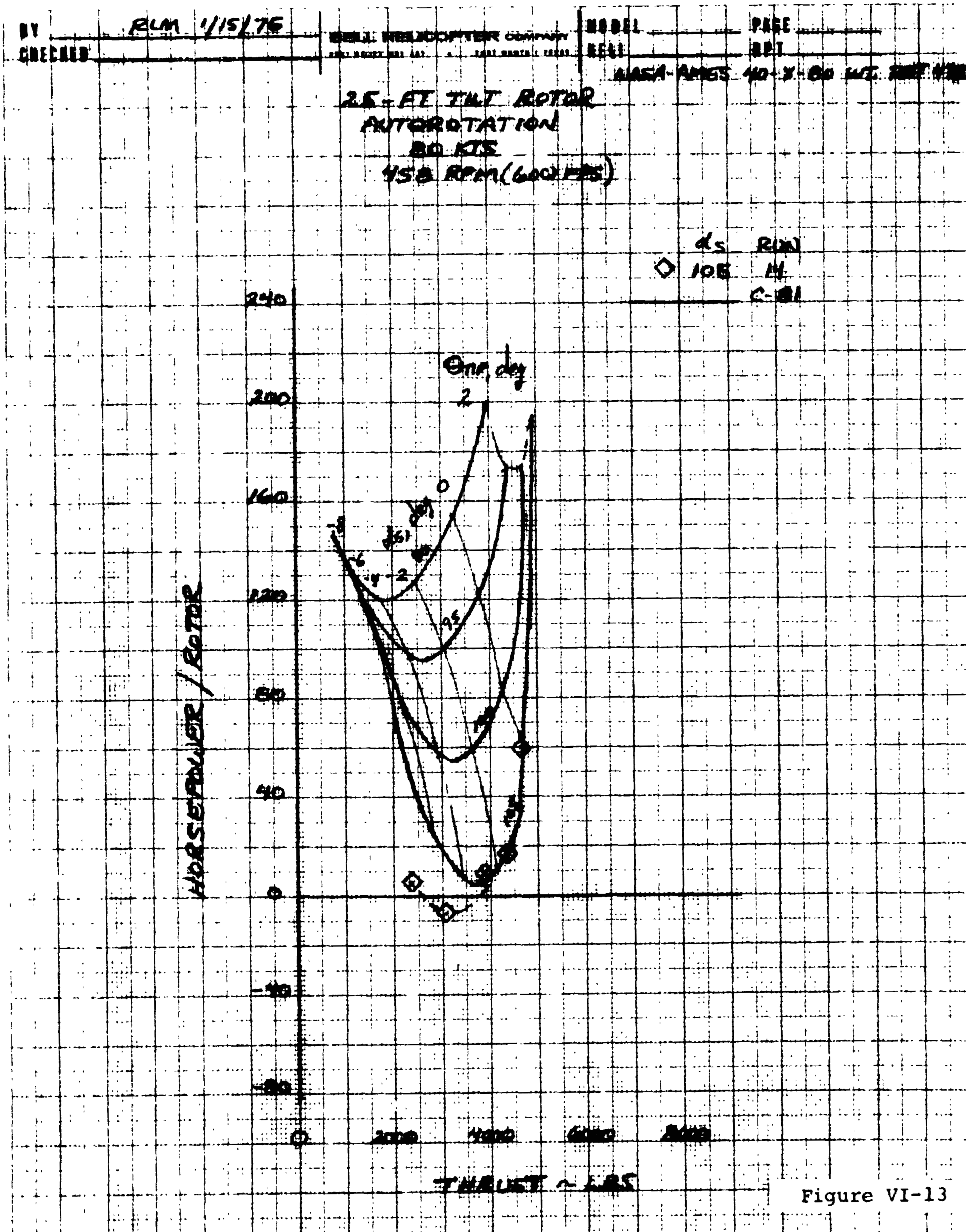
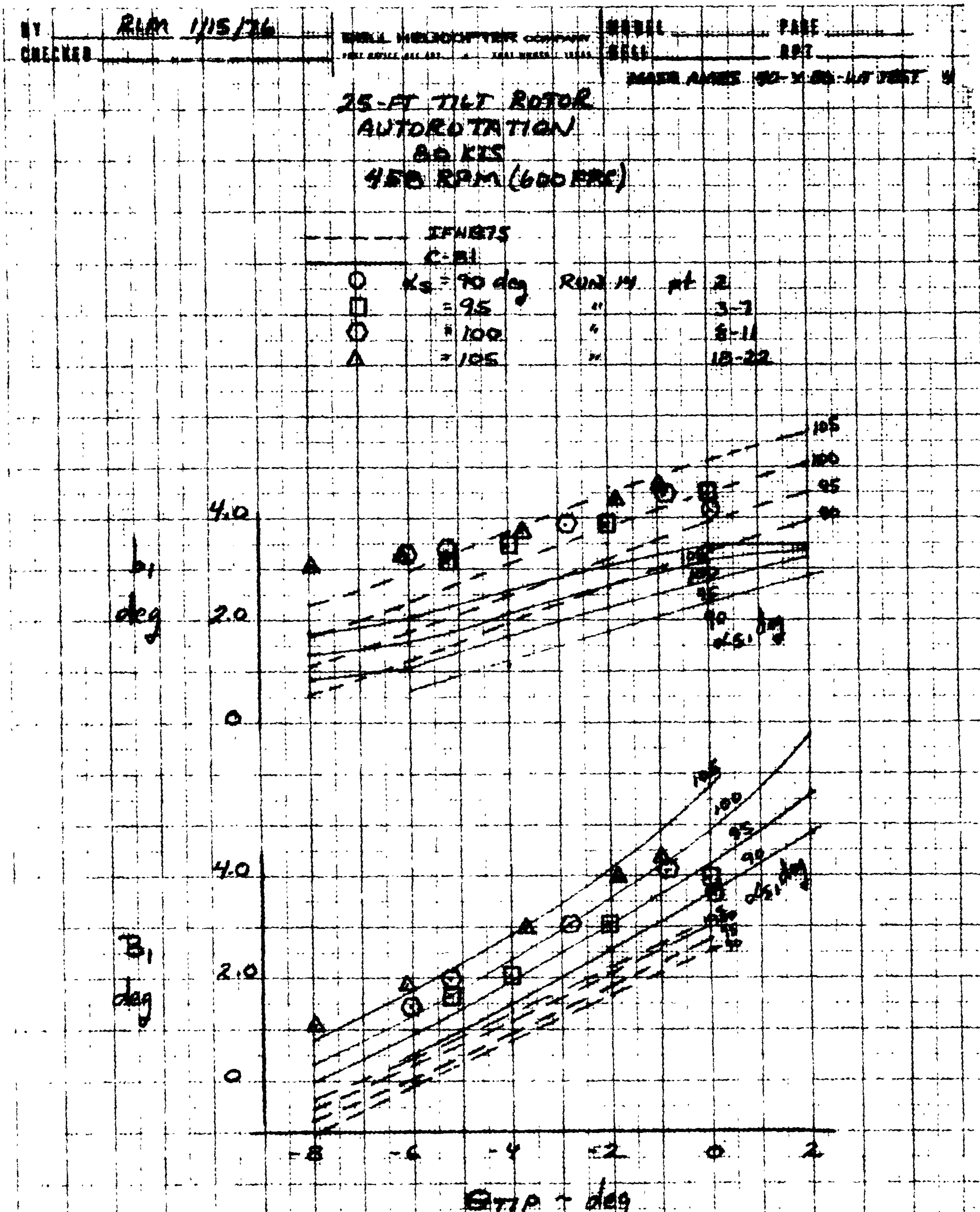

25-FT TILT ROTOR
AUTOROTATION
80 KTS
458 RPM (600 FPS)
α_s RUN
◇ 105 11
C-81
HORSEPOWER / ROTOR
THRUST ~ LBS
240
200
160
120
80
40
0
-40
-80
2000
4000
6000
8000
$\theta_{.75R}$, deg
2
0
-2
-4
-6
-8

Figure VI-13



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BELL HELICOPTER COMPANY
MODEL
PAGE
RPT
25-FT TILT ROTOR
AUTOROTATION
80 KTS
458 RPM (600 FPS)
IFWB75
C-81
Ks = 90 deg RUN 14 pt 2
= 95 " 3-7
= 100 " 8-11
= 105 " 18-22
b1 deg
B1 deg
θTIP ~ deg

Figure VI-14

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NASA AMES 40- x 80-WT TEST 482

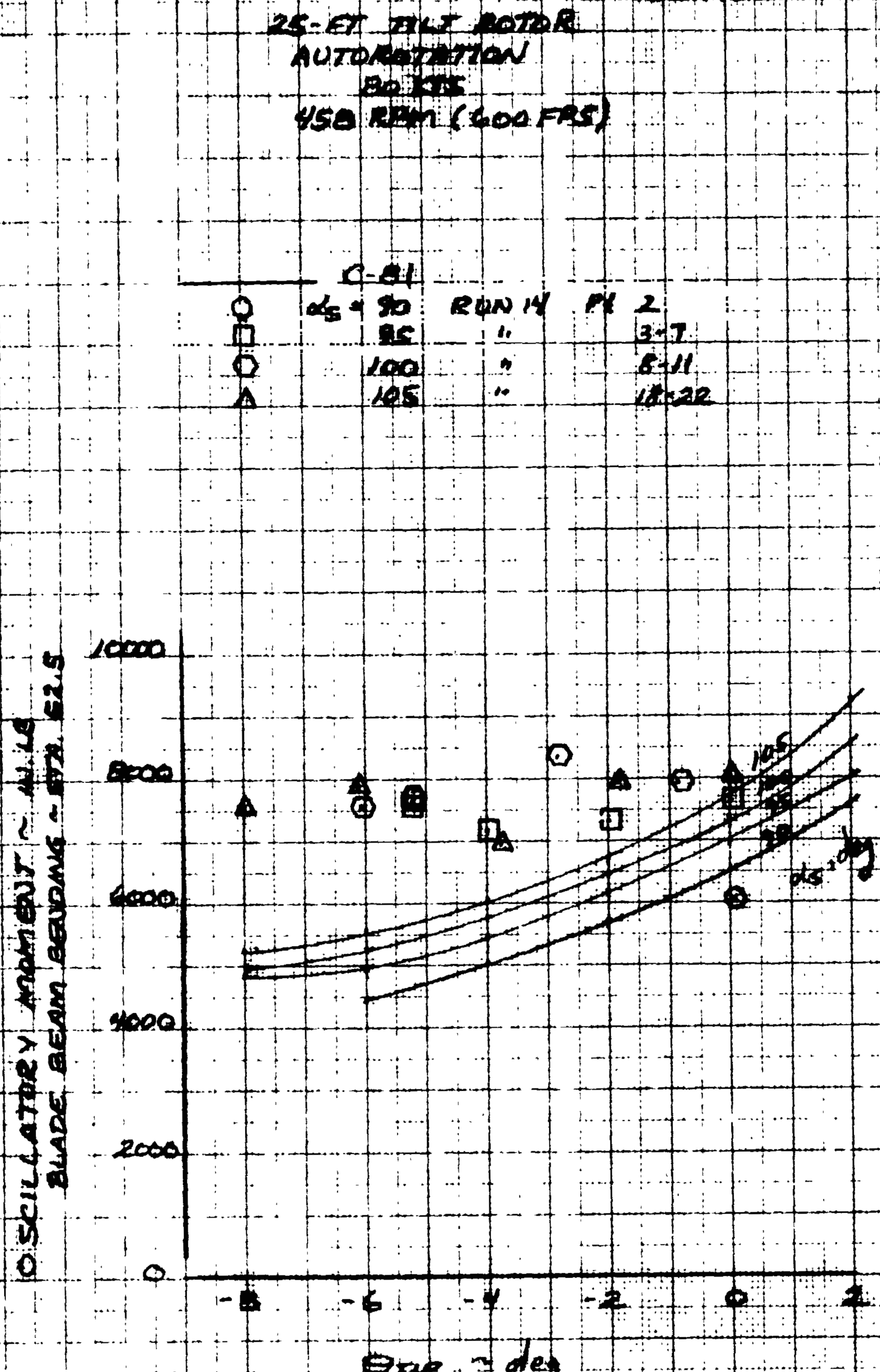

Figure VI-15

BY R.C.M. 2/20/76 BELL HELICOPTER COMPANY MODEL PAGE
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NASA AMES 40-X-80 WT TEST 472

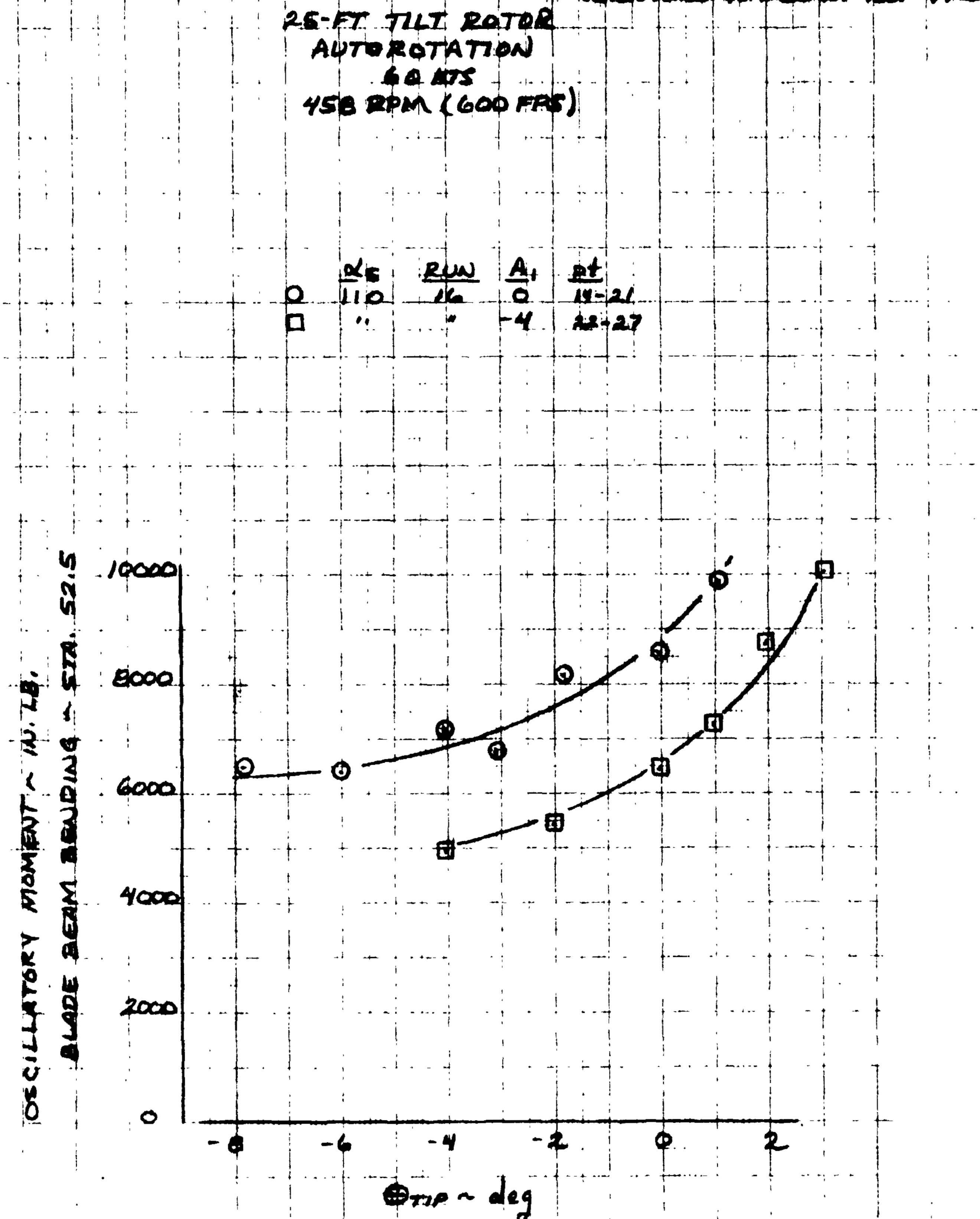

Figure VI-16

BY RLM 1/22/76 BELL HELICOPTER COMPANY MODEL PAGE
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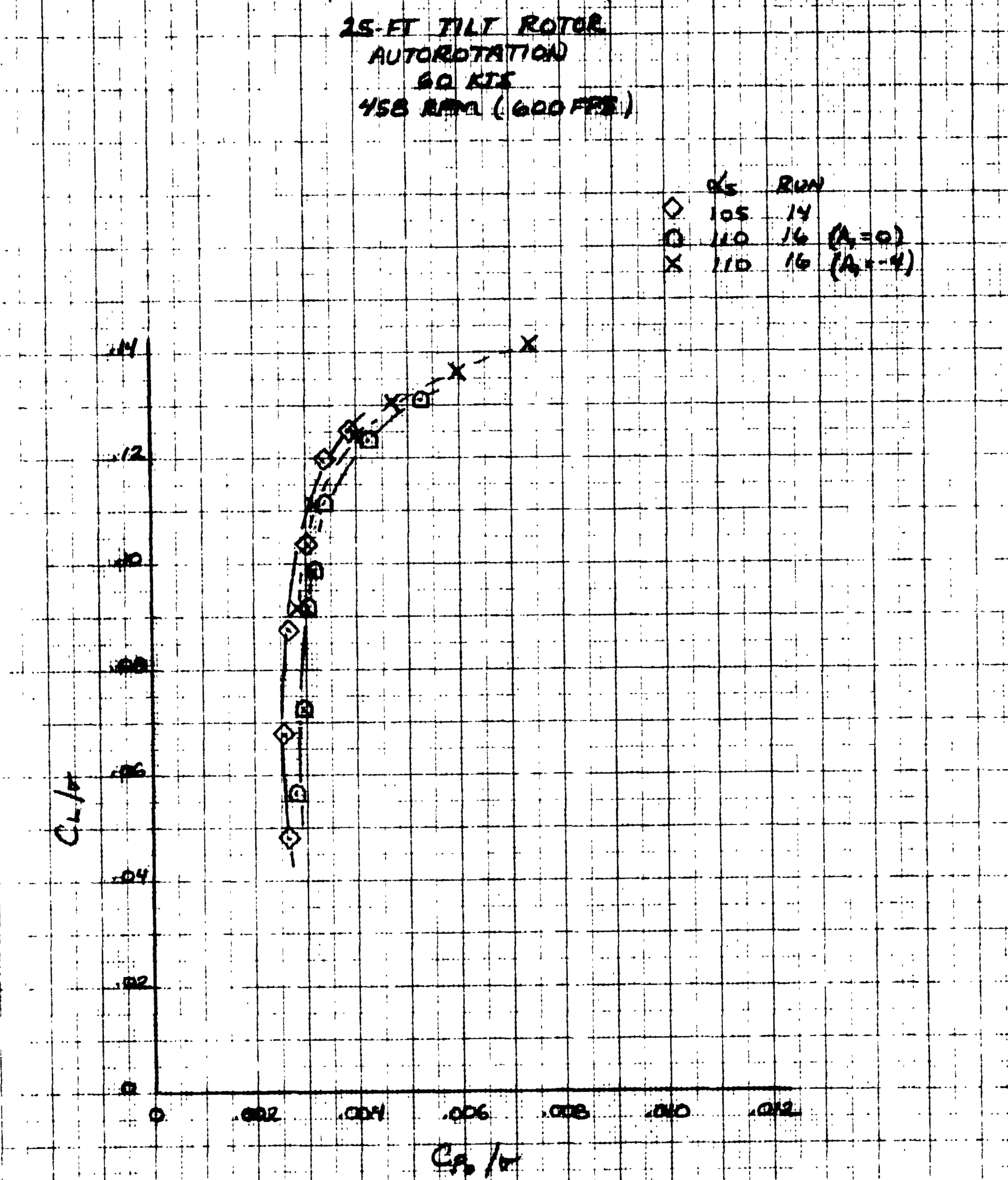

Figure VI-17

7072 00227

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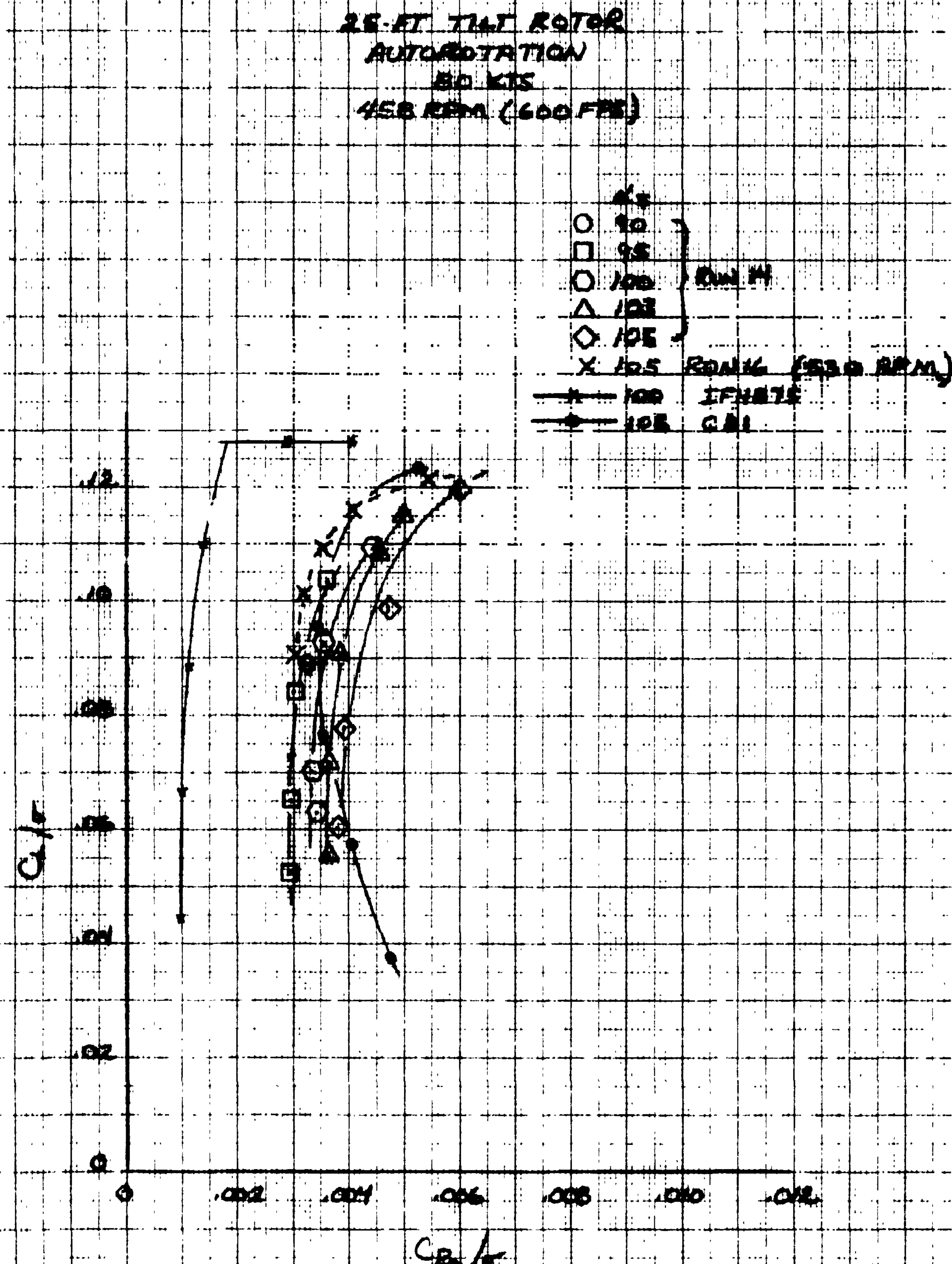
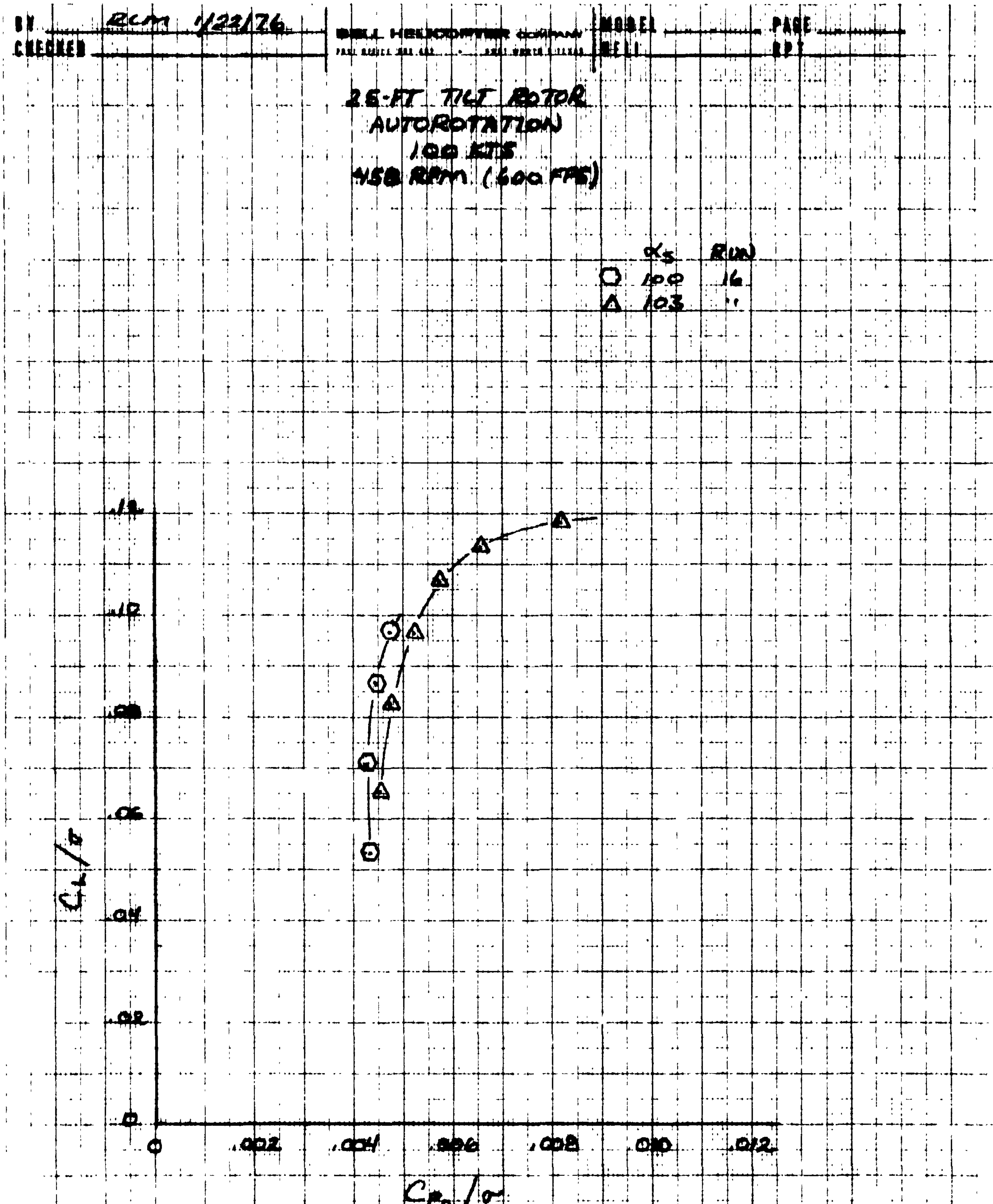


Figure VI-18

7072 00227


BY RCM 1/22/76
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BELL HELICOPTER COMPANY
MODEL
PAGE
25-FT TILT ROTOR
AUTOROTATION
100 KTS
458 RPM (600 FPS)
α_S RUN
100 16
103 "
C_L/σ
C_{P_0}/σ
0
.002
.004
.006
.008
.010
.012
.02
.04
.06
.08
.10
.12

Figure VI-19

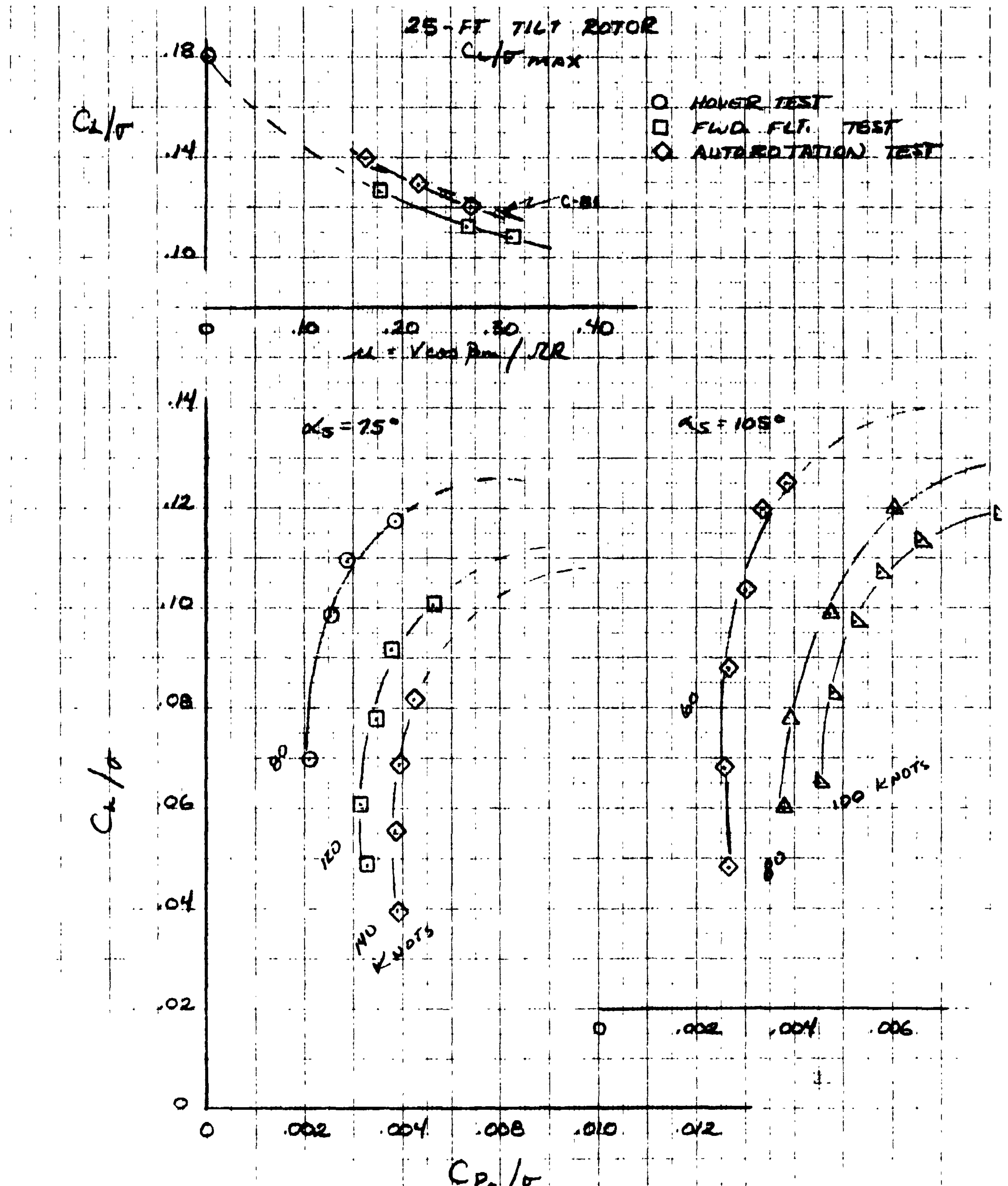
25-FT TILT ROTOR
C_L/σ MAX
HOVER TEST
FWD. FLT. TEST
AUTOROTATION TEST
C-81
C_L/σ
.18
.14
.10
0
.10
.20
.30
.40
$\mu = V\cos\beta_m/\Omega R$
$\alpha_s = 75°$
$\alpha_s = 105°$
.12
.08
.06
.04
.02
80
120
140 KNOTS
100 KNOTS
.002
.004
.008
.010
.012
.006
C_{P_0}/σ

Figure VI-20

25-FT TILT ROTOR AUTOROTATION

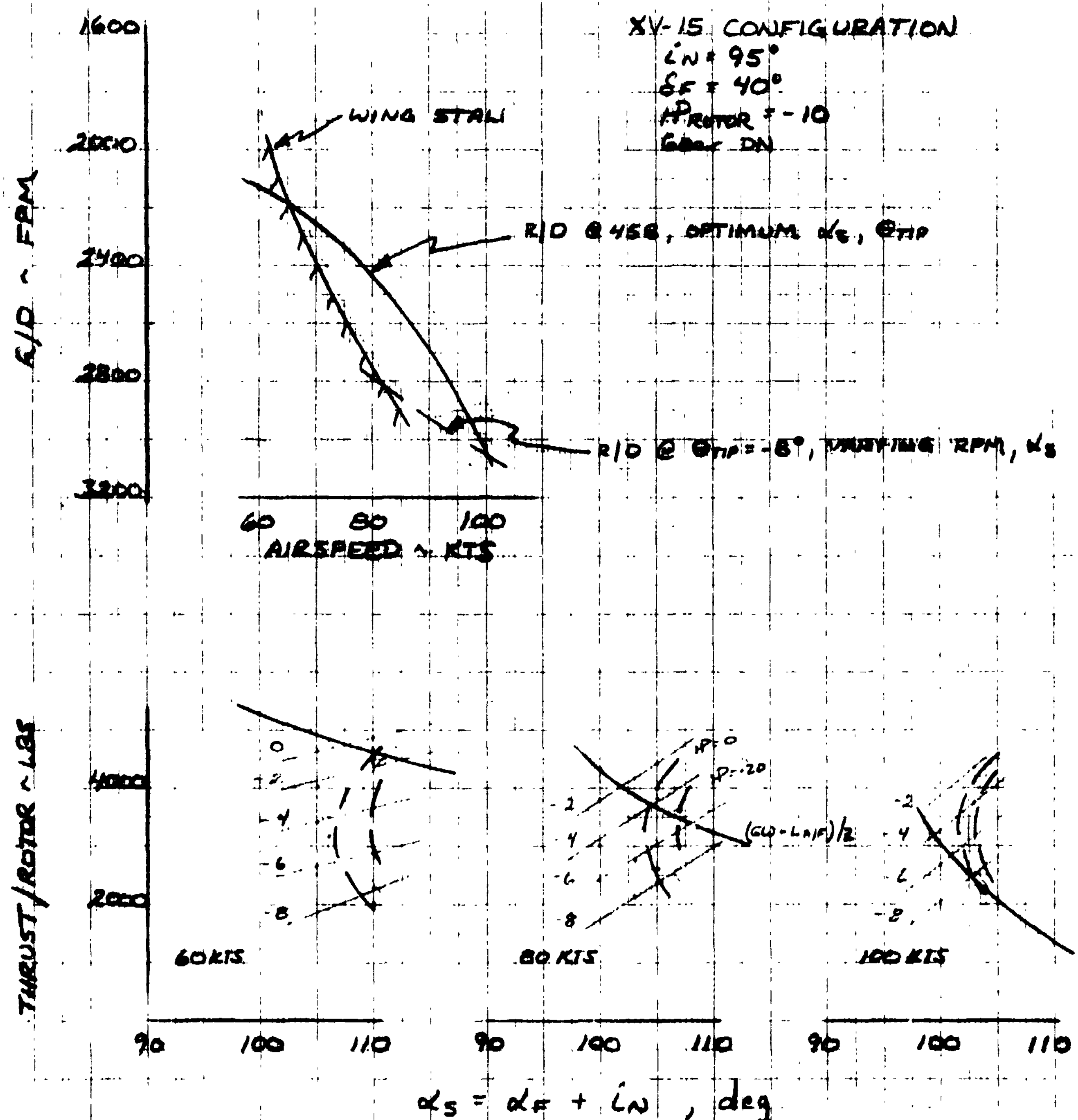

Figure VI-21

VII. CONCLUSIONS AND RECOMMENDATIONS

Although all test objectives were not accomplished, autorotation capability of the tilt rotor was confirmed. Autorotation capability was shown for variations in airspeed and rpm. Limited analysis indicates that the autorotation rates of descent of the XV-15 will be similar to predicted and that demonstrated during the tilt rotor simulation tests, but the shaft angles required would be approximately 5 degrees greater than pretest predictions. Use of lateral cyclic to reduce lateral flapping and blade loads was demonstrated. Rotor characteristics were similar to predicted, but indications are refinements need to be made to the drag representation in the rotor math models at low collective pitch settings before additional analysis is made. It is recommended that the rotor math model for the tilt rotor simulation be improved to better represent the tilt rotor autorotation characteristics for analysis of the optimum autorotation configuration, i.e. nacelle incidence, flap setting, rpm, collective setting, and airspeed.

VIII. REFERENCES

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2. V/STOL Tilt Rotor Research Aircraft, BHC Report 301-199-003, Volume 3.

3. Marr, Roger, "Test Plan for a 25-Foot Tilt Rotor Test in the ARC 40- by 80-Foot Wind Tunnel," 6 May 1975.

4. Johnson, Wayne, "Shake Test of a Propeller Test Rig in the 40- by 80-Foot Wind Tunnel," November 1975.

5. Johnson, Wayne and Biggers, James C., "Shake Test of Rotor Test Apparatus in the 40- by 80-Foot Wind Tunnel," NASA TMX-62,418, February 1975.

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7. Marr, Roger, V/STOL Tilt Rotor Study - Volume V - A Mathematical Model for Real Time Flight Simulation of the Bell Model 301 Tilt Rotor Research Aircraft, BHC Report 301-099-001, NASA Contractor Report CR 114614, April 13, 1973, Revision F.

Run Schedule

25-ft Tilt Rotor – Wind Tunnel Test No. 472

NASA-Ames 40- by 80-ft Tunnel

Run No.	Point No	V_{KTS}	α_s deg	$\theta_{.75}$ deg	B_1 deg	A_1 deg	Ω_{ext} rpm		Thrust lbs	Q_{mast} in-lb	BB53	BC53	PLINK	Comments	Date	Time (Rotor On)
1	1	0	0	-3	0	0	130							Track & Balance (Start 11:11 Stop 11:36) Checkout control console	11/12	:25
	2	"	"	-2	"	"	250									
2	1	0	0	0	0	0	350							Track & Balance (Start 18:33 Stop 20:30)	11/13	:14
3	1	0 (15)	0	0	0	0	565		2023					Track & Balance – Collective Sweep (Start 13:06 Stop 13:37) lost mstr: (BB53, BC53, F/A accel, M_β, 2.) Track & Balance – ok	11/14	:31
	2	" (16)	"	-2	"	"	"		1353							
	3	" (14)	"	-4	"	"	"		730							
4	1	0	0	0	0	0	565							Hover – Collective sweep (Start 19:14 Stop 19:29) lost mstr: (M_β, PLINK)	11/14	:15
	2	"	"	"	"	"	"									
	3	"	"	-2	"	"	"									
	4	"	"	-4	"	"	"									
	5	"	"	+2	"	"	"									
	6	"	"	+4	"	"	"									
5	1	0 (0)	0	0	0	0	565		2746					Hover – Axial Flow (Start 22:17 Stop 22:45) BB53 indicating 2x predicted, lost mstr: (BC53). M_β on console not indicating correctly	11/14	:28
	2	(10)	"	2	"	"	"		3327							
	3	(15)	"	4	"	"	"		4424							
	4	(20)	"	5	"	"	"		4807							
	5	(22)	"	6	"	"	"		5341							
	6	(25)	"	7	"	"	"		5615							
	7	(26)	"	8	"	"	"		6377							
	8	(27)	"	9	"	"	"		6818							
	9	(28)	"	1.0	"	"	"		7702							
6	–	0	0	0	0	0	565							Instr. Checkout Start 11:07 Stop 14:20	11/15	1:03
7	1	0	90	0	0	0	565							Lat. Flapping Check (Start 22:17 Stop 22:27 α_s=90°) (Start 22:30 Stop 23:13 α_s=75°) Blade loads high, changed shaft angle loads still high at 75°, cont. [illegible]	11/15	:43
	2	0	75	"	–	"	"									
	3	23	"	"	3	"	"									
	4	53	"	"	3	"	"									
8	1	80	75	0	–	0	565		2362		14000	26000		Check run with 1970 Test (Start 16:40 Stop 17:10) Blade loads, [illegible] too high	11/17	:30
	2	"	"	2	3.0	"	"		3478		15000	24000	220			
9	1	0	75	0	–	0	565							Checkout (Start 16:55 Stop 17:00)	11/18	:05
10	1	80	75	0	3.0	0	565		1550	25000	6000	15000	160	Check run with 1970 Test (Start 10:32 Stop 11:05) Collective/F/A actuator control out F/A flapping, lat accel; [illegible]	11/19	:33
	2	"	"	2	4.5	"	"		2762	36000	8000	15000	160			
	–	"	"	3	6.5	"	"		2882	45000	9500	16500				

Run Schedule

25 ft Tilt Rotor - Wind Tunnel Test No. 472
NASA-Ames 40- by 80- ft Tunnel

Run No.	Point No.	V_{KTS}	α_s deg	θ_{TIP} deg	B_1 deg	A_1 deg	Ω_{EST} rpm	HP HSDS	Thrust lbs	$Q_{A,EST}$ in-lb	BB53 in-lb	BC53 in-lb	PLINK lbs	Comments	Date	Time (21-Oct)
11	1	0(.5)	0	0	0	0	565			37500	2000	4000	20	F/A Cyclic & Flapping Check (Start 21:20 Stop 21:35)	11/21	15
	2	"	"	"	1	"	"									
	3	"	"	"	2	"	"									
	4	"	"	"	-1	"	"									
	5	"	"	"	-2	"	"									
12	1	80	75	0	2.5	0	565		2048	391 HP	7500	16000	160	Check with 1970 test lateral cyclic (start 21:45 Stop 22:45) Lost inst: LMG, MRIP, MPGRA, YCREC, cell a.t. indications.	11/21	1.00
	2	"	"	-2		"	"		815	291	7000	14000				
	3	"	"	2		"	"		3278	331	9000	14500	140			
	4	"	"	4		"	"		4363	374	10000	12000	160			
	5	"	"	6		"	"		5513	463	11000	16000				
	6	"	"	"		-4	"		5674		12000	22000				
	7	"	"	"		+2	"		5026	697	13000	12000				
	8	"	"	7		0	"		6100		14000	20000				
13	1	0	0	0	0	0	565		2230	30000	1000	4000	35	Lateral cyclic check (Start 16:25 Stop 17:15)	11/22	25
	2	"	"	2	"	"	"		3072	40000	1500	4000	35			
	3	"	"	4	"	"	"		3777	6000	2000	3500	40			
	4	"	"	6	"	"	"		4510	75000	2000	4000	35			
	5	"	"	"	2	"	"		—			—	—	F/A & Lat cyclic input caused breakup in all channels		
	6	"	"	"	-2	"	"		4355	75000	2000	6000	60			
	7	"	"	"	0	-3	"		4345	—	—	—	—			
	8	"	"	"	"	-2	"		—	—	—	—	—			
14	1	0	90	0	0	0	458	149.5	2028	20000	3000	4000	40	Autorotation (start 11:18 Stop 13:16)	11/23	1.5
	2	80	"	"	3.5	"	"	160.9	3348	20000	8000	10000	140			
	3	"	95	-2	3.0	"	"	81.4	3148	12500	5000	8000	120	HP - Hand recorded		
	4	"	"	-2	3.0	"	"	81.8					—			
	5	"	"	0	4.0	"	"	123.4	2933	15000	10000	10000	160			
	6	"	"	-4	2.5	"	"	68.3	2470	10000	9000	6000	80			
	7	"	"	-5	1.5	"	"	69.3	2022	10000	10000	8000	90			
	8	"	100	-5	2.0	"	"	33.2	2682	2000	9000	8000	80			
	9	"	"	-3	3.0	"	"	39.1	3526	3000	10000	9000	—			
	10	"	"	-1	4.0	"	"	84.8	4110	10000	10000	10000	140			
	11	"	"	-6	1.5	"	"	39.1	2482	5000	11000	8000	—			
	12	"	103	-6	2.0	"	"	13.3	2300	2100	1000	8000	90	14.5		
	13	"	"	-6	2.0	"	"	8.7	—	0	—	—	—	0		
	14	"	"	-8	1.0	"	"	26.5	2236	2000	9000	6000	90	14.5		
	15	"	"	-4	3.0	"	"	6.3	3550	0	10000	9000	100	← 0		
	16	"	"	-2	4.0	"	"	36.5	4220	3000	10000	11000	115	21.8		
	17	"	"	-1	4.0	"	"	52.6	4400	7510	10000	12000	160	51.5		
	18	"	105	-8	1.0	"	"	5.14	2400	0	9000	6000	90	0		
	19	"	"	-6	2.0	"	"	-6.2	3060	-2000	9000	2000	100	-14.5		
	20	"	"	-4	3.0	"	"	9.2	3820	-1500	9000	10000	120	-10.9		
	21	"	"	-2	4.0	"	"	16.7	4413	25.0	9500	12000	130	18.1		
	22	"	"	-1	4.5	"	"	59.1	4627	12000	13000	14000	180	42.6		
	23	60	105	-8	1.0	"	"	23.3	1864	2500	7000	6000	60	15.2		
	24	"	"	-6	2.0	"	"	8.9	2640	0	7600	7600	75	0		
	25	"	"	-4	3.0	"	"	10.7	3304	1250	7500	8000	80	9.08		

301-099-005

301-099-005

Run Schedule

25-ft Tilt Rotor - Wind Tunnel Test No. 472

NASA-Ames 40- by 80-ft Tunnel

Run No	Point No	V_{KTS}	α_s deg	θ_{OP} deg	B_1 deg	A_1 deg	Ω_{ROT} rpm	HP HSOS	Thrust lbs	Q_{MAST} in-lb	BB53 in-lb	BC53 in-lb	PLINK lb	Comments	Date	Time (Tach)
14 (cont)	26	60	105	-2	2.5	0	458	29.5	3990	2500	8000	10000	80	18.2		
	27	"	"	-1	3.0	"	"	72.2	4601	10000	9000	11500	120	72.7		
	28	"	"	1	3.5	"	"	90.1	4821	12500	-	-	-	Rotor new shell EG=1.5 blade load 90.8		
	29	"	100	-2	2.5	"	"	59.8	3550	7500	6000	9600	80	increased sharply		
15	1	0	90	0	0	0	458	143 HP	1912	37500	-	-	-	Hover Check	11/22	:15
	2	"	"	-2	"	"	"	134 HP	1430	30000	-	-	-	(Start 17:50 Stop 18:05)		
	3	"	"	-4	"	"	"	73 HP	1000	25000	-	-	-			
	4	"	"	-6	"	"	"	55 HP	565	20000	-	-	-			
16	1	0	90	0	0	0	458		2025	22000	-	-	-	Autorotation	11/23	2:00
	2	85	"	"	4.5	"	"		3153	20000	8500	6500	-	(Start 19:00 Stop 21:00)		
	3	95	95	-2	4.0	"	"		3157	10000	8400	6400	-	Model fairing fouling balance above		
	4	100	100	-3	4.5	"	"	21.8	3670	3000	9400	7200	-	95 kts until α_s > 100°		
	5	"	"	-4	3.5	"	"	18.16	3300	2500	9000	6200	-			
	6	"	"	-6	3.0	"	"	18.16	2650	2500	6600	6000	-			
	7	"	"	-8	2.0	"	"	36.33	2021	5000	8200	6000	-			
	8	"	103	-8	2.0	"	"	0	2400	0	8800	6000	-			
	9	"	"	-6	3.0	"	"	-18.16	3120	-2500	8800	6000	-	b_1 = 2.5		
	10	"	"	-4	4.0	"	"	-9.08	3650	-1250	1200	6500	-			
	11	"	"	-3	4.5	"	"	9.08	3937	1250	9500	8000	-			
	12	"	"	-2	5.0	"	"	36.3	4240	5000	10500	9000	-	b_1 = 4.0		
	13	"	"	-1	6.0	"	"	90.8	4365	12500	11000	10000	-	b_1 = 4.0		
	14	60	110	-4	2.0	"	"	-18.16	3380	-2500	6000	6500	-			
	15	"	"	-6	1.5	"	"	-18.16	2660	-2500	5800	5000	-			
	16	"	"	-5	1.0	"	"	0	2120	0	5500	4000	-	b_1 = 3.0		
	17	"	"	-3	2.0	"	"	-14.53	3007	-2000	6000	7000	-			
	18	"	"	-2	2.5	"	"	0	4130	0	7000	8200	-			
	19	"	"	0	3.0	"	"	36.3	4560	5000	8000	10000	-	b_1 = 4.5		
	20	"	"	1	4.0	"	"	90.8	4170	12500	8500	12000	-	b_1 = 5.0		
	21	"	"	-4	2.0	"	"	-29.1	3350	-4500	6400	7000	-	b_1 = 3.5		
	22	"	"	-4	2.0	-4	"		3420	-3500	4000	6000	-	b_1 = .5		
	23	"	"	-2	3.0	"	"		4160	-1250	5000	7000	-	b_1 = 0		
	24	"	"	0	3.5	"	"		4580	3500	5400	8200	-	b_1 = .5		
	25	"	"	1	4.0	"	"		4820	6000	6600	10000	-	b_1 = 1.0		
	26	"	"	2	4.5	"	"		5040	17000	7500	12000	-	b_1 = 1.5		
	27	"	"	3	5.0	"	"		5230	25000	9000	14500	-	b_1 = 2.0		
	28	80	105	-4	3.0	0	"		3540	-3000	7900	7000	-	b_1 = 3.0		
	29	"	"	-4	2.5	"	530		4525	0	7200	9000	-	Autorotation increased @ 565 rpm		
	30	"	"	-6	2.0	"	"		3730	0	8000	5000	-	backed off to 530 rpm		
	31	"	"	-3	3.0	"	"		5160	0	8400	10500	-	b_1 = 3.0		
	32	"	"	-2	3.5	"	"		5420	2500	8600	12000	-	b_1 = 3.5		
	33	"	"	-1	4.0	"	"		5760	[illegible]	9000	15000	-	b_1 = 4.0		
	34	"	"	0	4.5	"	"		6030	15000	10000	17000	-	b_1 = 4.0		

Run Schedule

25-ft Tilt Rotor - Wind Tunnel Test 472

NASA Ames 40- by 80 ft Tunnel

301-099-005

Run No	Point No	V_{KTS}	α_s deg	Θ_{TIP} deg	B_1 deg	A_1 deg	Ω_{ROT} rpm		Thrust lbs	Q_{MAST} in-lb	BBS3 in-lb	BCS3 in-lb	PLINK lb	Comments	Date	Time (Rotor On)
17	1	0	90	0	0	0	530		-	30000	1500	3000	-	Lateral Flapping / Level Flight Trim / Helicopter (Start 23:02 Stop 23:48)	11/23	.46
	2	0	"	3	0	"	"		4000	50000	3000	3500	-			
	3	40	"	"	3.0	"	"		5200	52000	1200	12700	-			
	4	40	85	"	3.0	"	"		4952	49000	9300	17000	-			
	5	60	"	"	3.5	"	"		5020	55000	9100	12500	-			
	6	22	"	"	4.0	"	"		4776	49500	10000	14000	-			
	7	"	80	"	4.0	"	"		4270	47500	9500	11000	-			
	8	"	75	"	4.0	"	"		3480	45000	6100	3500	-			
	9	"	"	0	2.5	"	"		-	25000	6000	6500	-			
	10	"	"	2	3.0	"	"		2250	31000	6500	6000	-	F/A Tilt Actuator out		

E.O.T.

Total pts: 128

Total Time (Rotor On): 11.26 hrs
Total Time (Occupancy): 165 hrs
% Utilization: 6.9%

TEST INSTRUMENTATION PROBLEMS

Several instrumentation problems were encountered during the 25-foot powered test at NASA-Ames 40- by 80-Foot Wind Tunnel during November 1975. It was felt that a discussion of these problems and possible ways that they can be avoided on future tests be included in this report. Table A-2 summarizes the problems encountered during the test. These problems generally fall into six (6) categories as follows:

I. Centrifugal Force on Connectors

Connectors were placed in the rotating system to expedite any test part replacement. As the test was run, the centrifugal force on their mass caused strain on the wire, and eventually caused wire failure. When the cause of these failures became evident, the connectors were removed and the wires were spliced together. In the future, connectors will be used only at location where they can be bonded (rotor blades, hub, etc.) or tied securely and taped (pitch links, cyclic tubes, etc.).

II. Centrifugal Force on Wire Loops

Since the slip ring wires must be routed out of the hub assembly to the top of the collective head, a loop of wires was formed. This loop was necessary due to the motion of the collective head with respect to the hub assembly as blade pitch was increased and decreased. Centrifugal force on this loop caused broken wires on several occasions due to fatigue. One solution for this problem would be to route a strain relief wire along with the bundle to take this strain away from the signal wires. A program to test the effects of centrifugal force might need to be initiated to determine proper strain relief techniques on wires. Another possible solution to this problem could be a redesign of the collective head (like the XV-15 flight hardware). This would allow the use of the flight test slip ring assembly and would eliminate the loop completely as the wires would be routed inside the collective tube to the slip ring.

The slip ring would be mounted on the top of the collective head, not below the swashplate as it was during this model test.

III. Motion Between Model and Cowling

A new drive motor stand was used for this test. Between the motor stand and the outer cowling existed a possible ± 2.5 inches of motion. To provide mechanical clearances, the front 6 inches were trimmed from the outer cowling. For ease of access, the instrumentation J-boxes were mounted on the cowling, not on the model. The vibration levels on this outer cowling were very high and the wind turbulence inside the cowling (with the forward portion cut off) was also high. The model-to-cowling motion, the cowling vibration and the wind turbulence each contributed to cause many broken wires due to fatigue. Possible solutions to these problems are: mounting of the J-boxes on the model where a more stable mount can be made; making a better nose cowling to reduce wind turbulence inside the nose cowling; improved cable routing and better securing techniques to control cable motion (eliminating fatigue points); larger gage wire for better fatique characteristics.

IV. Slip Ring Wire Routing

The slip ring system for this model has been a source of trouble during all tests on which it has been used. The slip ring itself is not the problem. The problem is the means by which the wires must be routed from the slip ring to the rotating system. All 52 wires must pass through two ¼-inch holes after being fanned through the teeth of the mast splines. This is necessary since the wires must pass under the nonrotating section (hub spring) of the rotor assembly. Due to this design, there is no solution to this problem except those solutions discussed earlier (use of flight slip ring with redesign of collective head; strain relief wires).

V. Short Calibration Steps

During the checkout of the instrumentation following installation in the tunnel, two channels were found to have short calibration steps. The short calibration steps caused the loads data to be incorrect at these two locations. After much checking, by both NASA and BHT personnel, the problem was found to be two pins shorted in one of the NASA connectors under the tunnel floor. This short had not shown up in previous tests because of the six wire system that the NASA tunnel uses. For this test a common power supply was used due to the limited amount of rings in the slip ring. Once the short was cleared, a check calibration of the system, using known weights at a given station, proved the data to be correct.

VI. Random 60 Hz Noise

During the entire test, the rotating channels were plagued by random 60 Hz noise. Many checks and many attempts were made to find the source and a cure for the problem, but none was found. It is now thought that the interface of the common bridge voltage for the rotating channels with the tunnel signal conditioning was the sole or major cause of the problem. For any future tests using this common bridge voltage, a test setup should be made to allow inserting dummy bridges into the system at various points to determine where the noise is being inserted into the system. When the location of entry of the noise is found, the cause should be easily found.

FAILURE SUMMARY

25 FT TILT ROTOR - WIND TUNNEL TEST NO. 472
NASA/AMES 40- BY -80 FT. TUNNEL

RUN NO.	DATE	REASON FOR SHUTDOWN	CAUSE/CORRECTIVE ACTION	ADDITIONAL REMARKS
1	11-12-75	COMPLETED TRACK & BALANCE CHECK.		POST RUN: SPINNER LOWER BEARING SHIM FAILURE
2	11-13-75	CONSOLE ACCELEROMETER GAGES INDICATED 2.0 G'S, OSCILLOGRAPH INDICATED ± 0.25 G'S	INSTALLED FILTERS ON CONSOLE GAGES SIMILAR TO OSCILLOGRAPH & NASA PEAK-TO-PEAK DISPLAY.	
3	11-14-75	LOST INSTR. (BLR. CHORD 52.5, F/A ROLL, MAST Q, F/A FLAPPING)		DURING INSPECTION, S/P DRIVE LINK WIRE WAS BROKEN & REPAIRED. PITCH LINK DATA COULD NOT BE BROUGHT ON-LINE PRIOR TO NEXT RUN.
4	11-14-75	MAST Q CONSOLE GAGE WAS READING IN REVERSE. G/B LOW OIL PRESS. & FLOW		NASA LOAD PANEL NOT WORKING
5	11-14-75	BB 52.5 ON CONSOLE READ REDLINE; OSCILLOGRAPH SHOWED ½ THIS VALUE. MAST Q STILL IN REVERSE. BC 52.5 WAS NOT INDICATING ON CONSOLE		CONSOLE BB 52.5 WAS READING PEAK-TO-PEAK INSTEAD OF OSCILLATORY. YOKE AND BLADE LOAD DISPLAYS ON NASA SCOPE WERE INTERCHANGED.
6	11-15-75	PITCH LINK HAD HASH ON OSCILL. TRACE. BB 52.5 & YOKE BM WERE NOT INDICATING ON NASA SCOPE. F/A FLAPPING GAGE WAS DRIFTING & WAS REVERSED.		
7	11-15-75	ROTATING INSTRUMENTATION CHANNELS FAILED.	NEGATIVE VOLTAGE WIRE WAS LOST.	
8	11-17-75	BB & BC LOADS AT 52.5 WERE ON 25 HR LIMIT.	REPAIRED A "SHORT" IN BB 52.5.	S/P DRIVE LINK WAS SPACED AT 2 PLACES. - Model fairing cut back away from rotating parts
9	11-18-75	F/A FLAPPING GAGE ERRATIC & F/A CYCLIC TUBE LOAD GAGE WAS BREAKING UP		
10	11-19-75	F/A FLAPPING FAILED, FOLLOWED BY COLL. & F/A ACTUATOR FAILURES.	3 BROKEN WIRES FOUND TO F/A & COLL. ACTUATOR	LOWER MAST SEAL FAILED - Fairing replaced, instrumentation rewired (7 pair sources), new power supply. Short found in plug between model wiring and tunnel wiring that causes loads to appear high.

FAILURE SUMMARY
25-FT. TILT ROTOR - WIND TUNNEL TEST NO. 472
NASA/AMES 40- BY -80 FT. TUNNEL

RUN NO	DATE	REASON FOR SHUTDOWN	CAUSE/CORRECTIVE ACTION	ADDITIONAL REMARKS
11	11-21-75	TO SHIFT TUNNEL BALANCE WGTS		
12	11-21-75	MAST Q, YOKE CHD, MAST ‖ & ⊥ BENDING GAGES FAILED. COLLECTIVE ACTUATOR FAILED TO FUNCTION	BROKEN WIRES IN COLLECTIVE HEAD. RELAY COIL TO COLL. ACTUATOR WAS OPEN	
13	11-22-75	ALL ROTATING CHANNELS WENT BERSERK WHEN EITHER F/A OR LAT. CYCLIC CONTROL WAS INTRODUCED 60~ INTERFERENCE.	AFTER RUN, LAT. FLAPPING POT WAS FOUND ON TUNNEL FLOOR. RETAINING SCREW HAD WORKED OUT.	
14	11-23-75	LOST YOKE BM & CHORD TRACES 60~ INTERFERENCE CAME BACK.	INSTALLED FILTERS TO DAMP 60~ INTERFERENCE.	
15	11-23-75	TUNNEL COMPUTER DATA NOT SATISFACTORY		
16	11-23-75	SHUT DOWN FOR DINNER AFTER 2.0 HRS OF RUNNING		
17	11-23-75	F/A & LAT. ACTUATORS FAILED TO OPERATE.		

HSDS - Mean/Peak to Peak Data

40- by 80-ft ARDC Wind Tunnel Test 472

Run No.	Point No.	BB53 (2)	YOKEC (13)	MASTQ (19)	PLINK (20)	LATSP (26)	LONSP (27)	THETA (31)	A1S (32)	B1S (33)
4	1	371	2834	35485	–	.14	1.4	-.13	.0	0
	2	383	2542	35278	–	0	1.33	-.13	0	0
	3	–								
	4	421	1267	20882	–	-.05	1.40	-4.04	0	0
	5	707	5045	50239	–	0	1.09	2.06	0	0
	6	749	5917	69282	–	.21	.97	4.24	0	0
5	1	390	2664	–	–	.09	2.57	-.06	0	.01
	2	421	3885	–	–	.13	2.09	2.07	0	.01
	3	459	5189	–	–	.13	1.91	4.33	0	.01
	4	552	6361	–	–	.03	1.92	5.24	0	.01
	5	563	8001	–	–	.09	2.09	6.35	0	.01
	6	1032	6417	–	–	-.30	1.94	7.24	0	.01
	7	635	6430	–	–	-.22	2.15	8.50	0	.01
	8	1084	4968	–	–	-.26	1.69	9.30	0	.01
	9									
7	1	–								
	2	–								
	3	–								
	4	–								
8	1	4560	22710	33563	144.7	2.18	.20	-.72	0	3.27
	2	4811	23456	47624	138.3	2.72	.11	1.25	0	3.86
10	1	4811	20489	28637	123.3	1.54	-.11	-.11	0	2.55
	2	5341	20630	40361	106.1	1.76	.37	2.06	0	4.00
11	1	–								
	2	–								
	3	–								
	4	–								
	5	–								

HSDS - MEAN/PEAK TO PEAK DATA
40 by 80-ft ARDC Wind Tunnel Test 472

RUN No.	POINT No.	BB53 (2)	YOKEC (13)	MASTQ. (19)	PLINK (20)	LATSP (26)	LONSP (27)	THETA (31)	A1S (32)	B1S (33)
12	1	7185	27175	110,777	144	1.87	.40	.04	0	2.41
	2	6157	25305	-	131	1.37	.64	-1.97	0	1.69
	3	7665	25104	—	136	2.24	.45	1.97	0	3.27
	4	8942	25235	—	131	2.65	.74	3.81	0	4.22
	5	10289	23935	—	141	3.15	.59	5.91	0	5.29
	6	11269	-	—	98	.22	.69	5.90	2.63	5.29
	7	11740	-	—	183	5.50	.82	5.91	2.28	5.31
	8									
13	1	1001	8789	27870	—	.20	.13	-.07	0	0
	2	1381	8442	40057	—	.37	.20	1.96	0	0
	3	1381	6384	54845	—	.25	.35	3.98	0	0
	4	1309	5738	71230	—	.25	.31	5.95	0	0
	5	915	11284	71817	—	.53	-1.89	6.02	0	-1.99
	6	3082	24777	69892	—	—	-3.24	6.02	0	-3.01
	7	—	—	64628	—	-1.6	-.11	6.02	-1.10	0
	8									

HSDS - MEAN/PEAK TO PEAK DATA

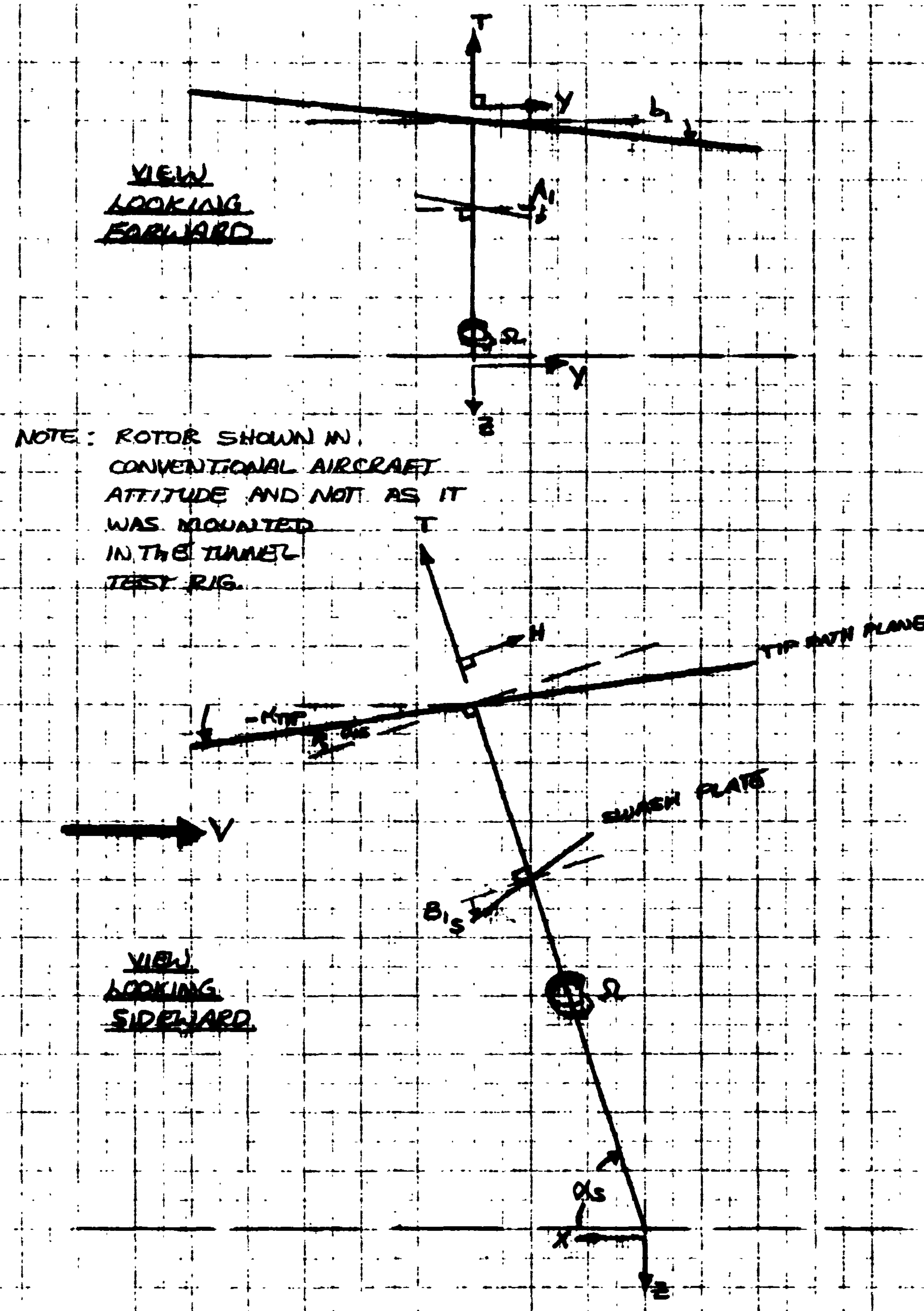
40- by 80 ft ARDC Wind Tunnel Test 472

RUN No.	POINT No	BB53 (2)	YOKEC (13)	MASTQ (19)	PLINK (20)	LATSP (26)	LOWSP (27)	THETA (31)	AIS (32)	BIS (33)
14	1	1398	-	20579	20.3	.44	.70	.15	0	4.86
	2	6072	-	22147	106.0	4.14	-.07	.13	0	3.63
	3	6654	-	11209	66.	3.89	.02	-2.01	0	3.01
	4	7345	-	11259	76.5	3.88	.10	-2.07	0	3.01
	5	7365	-	16984	140.4	4.45	.04	-.02	0	3.94
	6	7182	-	9404	80.5	3.43	.12	-4.0	0	2.08
	7	7553	-	8853	61.6	3.11	.35	-5.25	0	1.66
	8	7644	-	4564	67.3	3.34	.32	-5.26	0.	1.99
	9	8383	-	5375	64.3	3.88	.26	-2.85	0.	3.05
	10	7927	-	11668	112.5	4.45	.36	-.88	0	4.09
	11	7526	-	5384	64.9	3.21	.06	-6.06	0.	1.45
	12	7984	-	1835	65.4	3.30	.41	-6.06	0.	1.80
	13	7850	-	1202	74.0	3.35	.30	-6.06	0.	1.75
	14	7431	-	3640	67.1	2.97	.36	-7.85	0.	.95
	15	8215	-	872	78.4	3.77	.46	-3.82	0.	2.77
	16	7961	-	5017	124.2	4.29	.34	-1.87	0.	3.79
	17	8690	-	7242	109.9	4.56	.34	-1.08	0	4.12
	18	7571	-	707	70.3	3.05	.30	-7.96	0	1.02
	19	7832	-	-933	72.3	3.29	.37	-6.12	0	1.85
	20	6972	-	1255	123.8	3.71	.25	-3.72	0	2.94
	21	7974	-	2302	108.5	4.32	.37	-1.88	0	3.94
	22	8014	-	8128	151.3	4.61	.16	-1.00	0	4.23
	23	5562	-	3207	43.3	3.20	.29	-7.84	0	.72
	24	5873	-	1157	57.4	3.61	.40	-5.86	0	1.28
	25	6199	-	1469	61.1	4.00	.41	-3.81	0	1.95
	26	6881	-	4057	78.4	4.41	.42	-1.98	0	2.48
	27	7313	-	6770	88.8	4.98	.51	.12	0	3.37
	28	7966	-	12400	132.3	5.37	.37	1.05	0	3.80
	29	6214	-	8090	76.9	4.24	.40	-1.97	0	2.57

HSDS - MEAN/PEAK TO PEAK DATA

40- by 80-ft ARDC Wind Tunnel / Test 472

RUN No	POINT No.	BB53 (2)	YOKEC (13)	MASTQ (19)	PLINK (20)	LATSP (26)	LONSP (27)	THETA (31)	A1S (32)	B1S (33)
16	1	1893	-	24149	-	.78	.37	-.02	0.	0.
	2	9464	-	19906	-	3.75	.56	.0	0.	4.38
	3	10465	-	3552	-	3.59	.34	-2.92	0	4.00
	4	10401	-	2018	-	3.32	.40	-4.06	0	3.35
	5	9988	-	2597	-	2.86	.56	-5.98	0	2.29
	6	9512	-	4978	-	2.48	.72	-7.93	0	1.27
	7	9755	-	-706	-	2.78	.48	-7.93	0	1.57
	8	10071	-	-2648	-	3.04	.40	-5.94	0	2.58
	9	10457	-	-2108	-	3.43	.60	-4.05	0	3.75
	10	11125	-	738	-	3.81	.77	-3.02	0	4.57
	11	11645	-	4855	-	4.30	.18	-2.03	0	4.97
	12	11678	-	14962	-	4.71	.25	-.93	0	5.82
	13	6640	-	-2848	-	3.96	.43	-3.98	0	1.61
	14	6474	-	-2631	-	3.49	.73	-6.04	0	1.19
	15	6517	-	1074	-	3.35	.57	-7.87	0	.51
	16	6778	-	1156	-	4.14	.57	-3.10	0	1.91
	17	8137	-	1398	-	4.55	.43	-1.85	0	2.23
	18	8538	-	5509	-	5.12	.54	-.04	0	3.05
	19	9860	-	12060	-	5.61	.43	1.09	0	3.62
	20	7145	-	-4741	-	3.88	.49	-4.03	0	1.61
	21	4986	-	-4462	-	-.60	.48	-4.04	4.03	1.61
	22	5458	-	-1950	-	-.10	.58	-2.05	4.03	2.15
	23	6446	-	2939	-	.65	.38	.04	4.03	2.71
	24	7257	-	8158	-	1.11	.43	.99	4.03	3.31
	25	8774	-	16590	-	1.69	.50	1.97	4.03	4.16
	26	10041	-	26435	-	2.19	.20	3.04	4.03	4.66
	27	8974	-	-4528	-	3.43	.52	-4.12	0	2.57
	28	8399	-	-1355	-	3.36	.57	-4.14	0	2.05
	29	9072	-	-474	-	3.11	.61	-5.96	0	1.41
	30	1036	-	-290	-	3.81	.45	-2.96	0	2.41
	31	9547	-	2529	-	4.04	.54	-1.95	0	2.93
	32	9879	-	7986	-	4.41	.67	-.98	0	3.44
	33	11999	-	19624	-	4.76	.43	-.01	0	4.10
	34									
17	1	1651	-	29986	-	.45	.05	-.03	0	2.57
	2	1595	-	49127	-	.30	.06	0	0	0
	3	10080	-	47823	-	5.72	.55	2.94	0	2.96
	4	9947	-	48845	-	5.10	.49	2.95	0	2.70
	5	11309	-	54498	-	4.65	.31	2.95	0	3.76
	6	11870	-	45903	-	4.06	.41	2.97	0	4.67
	7	9985	-	44741	-	3.45	.52	2.97	0	4.32
	8	9712	-	44910	-	2.97	.21	2.96	0	3.67
	9	8767	-	36210	-	2.59	.67	1.94	0	3.18
	10									



ANGLE AND FORCE CONVENTION

TEST 473 RUN 3 STATIC 0 01/15/76 08,30,07

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READIN S IN COUNTS

FL+	RL+	D	Q	FL-	RL-	CF	CR	QM	A1	THETA	ALFS	BAR
8549.	8704.	15208.	8.	6593.	7970.	9243.	9197.	0.	57.	0.	0.00	30.02

AA1 = 0. BB1 = 0. RPM = 233. ULC = 2.

PT AV	V/OR ATPP OR J	ALF,S ALF,C AXOL	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U B1FLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO,100 RHOR	HF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1	.040	0.0	.655	0.0	.00009	.03862	.00344	.00049	5.	2174.	-10.	515.	66.	2174.	-2069.	2555 5.	-2151.
1	-90.0	-.4	18.	.0	.03862	.00009	.00038	.02665	-2174.	5.	-2151.	-343.	.2353	.377	316.	~~2054~~.	-10.
	736.	89.867	562.	.4	-.00018	.00268	.00428	.00920	-10.	~~220~~.276	-5.	-2797.	.9895	.368	1.04	2151.	5.
	.13		1124.								0.00						
2	.036	0.0	.655	-2.0	.00016	.02427	.00216	.00018	9.	1300.	20.	731.	66.	1366.	0.	1561 9.	-1352.
1	-90.0	-.5	16.	.0	.02427	.00016	.00028	.01675	-1300.	9.	-1352.	-126.	.2353	.253	235.	~~2195~~.	20.
	736.	89.619	562.	.5	.00036	.00227	.00315	.00683	20.	~~237~~.169	-9.	-1810.	.9896	.281	.85	1352.	9.
	.11		1124.								0.00						
3	.031	0.0	.657	-4.0	.00309	.01473	.00131	.00038	5.	835.	-10.	573.	66.	835.	0.	1120 5.	-826.
1	-90.0	-.5	14.	.0	.01473	.00009	.00022	.01016	-835.	5.	-826.	-264.	.2353	.152	187.	~~1703~~.	-10.
	739.	89.653	564.	.5	-.00018	.00202	.00248	.00539	-10.	~~180~~.123	-5.	-1740.	.9897	.185	.63	826.	5.
	.10		1124.								0.00						

TEST 472 RUN 4 STATIC 0 01/15/76 08.33.04

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	Q	FL-	RL-	CF	CH	QM	B1	THETA	ALFS	BAR
8549.	8701.	15211.	8.	6625.	7935.	9243.	9196.	67.	58.	0.	0.00	30.00

AAI = 1. SBI = 132. RPM = 232. OLC = 2.

PT AV	V/OR ATPP OR J	ALF,S ALF,C AXOL	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CM/S CPD/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U B1FLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	RF/6 FM EFF	FE HP H Q PSF	LIFT DM THRUST	DRAG SIDE HFOR
1	.031	0.0	.653	0.0	.00018	.04364	.00388	.00068	10.	2439.	45.	219.	65.	2439.	0.	10.	-2417.
1	-90.0	-.4	13.	.0	.04364	.00018	.00034	.03011	-2439.	10.	-2417.	-468.	.2356	.508	280.	2622.	45.
	733.	89.763	560.	.4	.00081	.00244	.00379	.00821	45.	282.	-10.	-2358.	.9909	.356	.60	2417.	10.
	.10		1123.								.20						
2	.031	0.0	.653	0.0	.00013	.04287	.00382	.00067	7.	2396.	40.	35.	65.	2396.	0.	7.	-2374.
1	-90.0	-.4	14.	.0	.04287	.00013	.00034	.02957	-23	7.	-2374.	-464.	.2356	.494	280.	2622.	40.
	733.	89.831	560.	.4	.00072	.00244	.00379	.00821	40.	282.	-7.	-2445.	.9909	.357	.63	2374.	7.
	.10		1123.								.20						
3	.029	0.0	.652	-2.0	.00013	.02982	.00265	.00046	7.	1661.	25.	-69.	65.	1661.	0.	7.	-1646.
1	-90.0	-.5	13.	.0	.02982	.00013	.00020	.02057	-1661.	7.	-1646.	-319.	.2357	.476	168.	1573.	25.
	732.	89.756	559.	.5	.00045	.00141	.00228	.00494	25.	169.	-7.	-1797.	.9910	.380	.53	1646.	7.
	.09		1123.								0.00						
4	.025	0.0	.658	-4.0	.00014	.01978	.00176	.00037	8.	1121.	15.	107.	65.	1121.	0.	8.	-1111.
1	-90.0	-.5	11.	.0	.01978	.00014	.00014	.01365	-1121.	8.	-1111.	-256.	.2357	.372	119.	1107.	15.
	739.	89.587	564.	.5	.00027	.00109	.00158	.00342	15.	120.	-8.	-1419.	.9910	.408	.39	1111.	8.
	.08		1123.								0.00						
5	.036	0.0	.655	2.0	.00013	.05942	.00529	.00072	7.	3333.	45.	176.	65.	3333.	0.	7.	-3302.
1	-90.0	-.5	16.	.0	.05942	.00013	.00050	.04099	-3333.	7.	-3302.	-499.	.2356	.544	417.	3983.	45.
	735.	89.879	561.	.5	.00081	.00345	.00562	.01218	45.	421.	-7.	-3718.	.9908	.386	.85	3302.	7.
	.11		1123.								0.00						
6	.043	0.0	.651	4.0	.00005	.07726	.00688	.00054	3.	4288.	65.	362.	65.	4288.	-3585.	3.	-4248.
1	-90.0	-.5	19.	0.0	.07726	.00005	.00074	.05330	-4288.	3.	-4248.	-368.	.2356	.545	607.	5709.	65.
	731.	89.960	558.	.5	.00118	.00495	.00831	.01801	66.	613.	-3.	-4831.	.9907	.404	1.18	4248.	3.
	.14		1123.								.10						

TEST 478 RUN 5 STATIC 0 01/15/76 08.31.29

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	Q	FL-	RL-	CF	CR	QM	B1	THETA	ALFS	BAR
8548.	8702.	15207.	8.	6627.	7935.	9242.	9195.	.0.	53.	0.	0.00	30.05

AA1 = 1. BB1 = 133. RPM = 233. QLC = 2.

PT AV	V/OR ATPP OR J	ALF,S ALF,C AXOL	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPD/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	RF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1	.034	0.0	.657	0.0	.00005	.04263	.00379	.00071	3.	2399.	10.	-70.	62.	2399.	0.	3.	-2395.
1	-90.0	-.4	15.	.1	.04263	.00005	~~.00039~~	.02941	-2399.	3.	-2395.	-496.	.2374	.426	326.	~~3049.~~	10.
	736.	89.928	562.	.4	.00018	~~.04291~~	~~.00434~~	.00941	10.	~~327.~~ 325	-3.	-2792.	.9982	.330	.73	2395.	3.
	.11		1120.								.10						
2	.037	0.0	.658	2.0	-.00004	.06002	.00534	.00072	-2.	3378.	45.	391.	62.	3378.	0.	-2.	-3372.
1	-90.0	-.4	16.	0.0	.06002	-.00004	~~.00054~~	.04141	-3378.	-2.	-3372.	-504.	.2374	.509	458.	~~4280.~~	45.
	736.	90.034	562.	.4	.00080	~~.00306~~	~~.00610~~	.01321	45.	~~459.~~ 435	2.	-3908.	.9981	.367	.89	3372.	-2.
	.12		1120.								.10						
3	.044	0.0	.654	4.0	.00011	.07840	.00698	.00066	6.	4367.	55.	373.	62.	4367.	-3605.	6.	-4358.
1	-90.0	-.4	19.	0.0	.07840	.00011	.00076	.05409	-4367.	6.	-4358.	-455.	.2373	.542	632.	~~5030.~~	55.
	732.	89.921	559.	.4	.00099	~~.00513~~	~~.00455~~	.01852	55.	~~634.~~ 623	-6.	-5111.	.9980	.400	1.21	4358.	6.
	.14		1120.								.10						
4	.045	0.0	.651	5.0	.00065	.08586	.00764	.00093	3.	4732.	50.	-515.	62.	4732.	-3685.	3.	-4722.
1	-90.0	-.4	19.	0.0	.08586	.00005	~~.00087~~	.05923	-4732.	3.	-4722.	-640.	.2373	.545	708.	~~6607.~~	50.
	728.	89.964	556.	.4	.00091	~~.00505~~	~~.00973~~	.02108	50.	~~710.~~ 710	-3.	-5831.	.9980	.398	1.28	4722.	3.
	.14		1120.								-.10						
5	.051	0.0	.657	6.0	.00014	.09378	.00835	.00053	8.	5260.	45.	964.	61.	5260.	-3198.	8.	-5258.
1	-90.0	-.4	24.	0.0	.09378	.00014	.00099	.06469	-5260.	8.	-5258.	-373.	.2377	.543	835.	~~7816.~~	45.
	735.	89.913	561.	.4	.00080	~~.00640~~	~~.01115~~	.02417	45.	~~836.~~ 832	-8.	-7069.	.9997	.426	1.64	5258.	8.
	.16		1119.								-.10						
6	.053	0.0	.658	7.0	-.00004	.10249	.00912	.00049	-2.	5748.	40.	1139.	61.	5748.	-3212.	-2.	-5746.
1	-90.0	-.4	23.	.0	.10249	-.00004	~~.00112~~	.07070	-5748.	-2.	-5746.	-344.	.2377	.551	941.	~~9002.~~	40.
	735.	90.020	561.	.4	.00071	~~.00715~~	~~.01250~~	.02722	40.	~~944.~~ 951	2.	-8003.	.9996	.431	1.79	5746.	-2.
	.17		1119.								-.10						
7	.057	0.0	.656	8.0	.00022	.11214	.00998	.00060	12.	6224.	15.	1589.	61.	6224.	-3028.	12.	-6221.
1	-90.0	-.8	25.	0.0	.11214	.00022	~~.00120~~	.07737	-6224.	12.	-6221.	-418.	.2377	.545	1072.	~~10006.~~	15.
	731.	89.890	558.	.4	.00027	~~.00817~~	.01455	.03153	15.	~~1073.~~ 1092	-12.	-9497.	.9995	.439	2.0	6221.	12.
	.18		1119.								-.10						
8	.058	0.0	.663	9.0	-.00011	.11904	.01059	.00132	-6.	6794.	25.	-1390.	61.	6794.	-3121.	-6.	-6790.
1	-90.0	-.4	25.	0.0	.11904	-.00011	~~.00000~~	.08213	-6794.	-6.	-6790.	-941.	.2377277	.708	2.	~~-22.~~	25.
	781.	90.051	566.	.4	.00044	~~-.00000~~ .00584	~~.00003~~	.00007	25.	~~2.~~ 1243	6.	-10816.	.9995220	.305	2.18	6790.	-6.
	.18		1119.								-.20						

TEST 472 RUN 6 STATIC 0 01/15/76 08.33.30

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	Q	FL-	RL-	CF	CR	QM	BI	THETA.	ALFS	BAR
8550.	8705.	15199.	6.	6541.	6021.	9241.	9198.	60.	57.	0.	0.00	30.07

AAI = 2. SBI = 131. RPM = 232. QLC = 2.

PT AV	V/OR ATPP OR J	ALF.S ALF.C AXOI	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	RF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1	.042	0.0	.652	0.0	.00002	.04136	.00368	.00064	1.	2303.	-5.	371.	66.	2303.	-2053.	1.	-2283.
1	-90.0	-.4	18.	0.0	.04136	.00002	.00050	.02853	-2303.	1.	-2283.	-440.	.2357	.318	410.	3045.	-5.
	732.	89.975	559.	.4	-.00009	.00384	.00557	.01208	-5.	413.	-1.	-2881.	.9911	.311	1.11	2283.	1.
	.13		1124.								0.00						
2	.083	0.0	.653	0.0	-.00007	.04100	.00365	.00063	-4.	2291.	10.	461.	66.	2291.	-1957.	-4.	-2271.
1	-90.0	-.4	19.	0.0	.04100	-.00007	.00049	.02828	-2291.	-4.	-2271.	-436.	.2357	.315	410.	3045.	10.
	733.	90.101	560.	.4	.00018	.00380	.00555	.01204	10.	414.	4.	-2837.	.9911	.316	1.16	2271.	-4.
	.13		1124.								0.00						

TEST 872   RUN 7   STATIC 0   01/15/76   09.08.08

STATIC COEFFICIENTS USED--	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

ZERO POINT READINGS IN COUNTS

FL.	RL.	D	Q	FL-	RL-	CF	CR	GM	B1	THETA.	ALFS	BAR
6833.	9661.	15222.	10.	7080.	4656.	9252.	9196.	-8.	72.	0.	90.00	29.97

AAI = 2.   SAI = 131.   RPM = 0.   OLC = 5.

PT AV	V/OR ATPP OR J	ALF.S ALF.C AXOL	MT VMTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	UNCORRECTED DATA LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	BALANCE AXIS LIFT,U DRAG,U SIDE,U B1FLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1	.023	90.0	.668	0.0	.05579	.05579	.00497	-.00039	3129.	3129.	5.	3312.	67.	3129.	0.	3086	-18.
1	0.0	88.6	10.	.0	.00033	-.00033	.00057	.03849	-18.	-18.	-18.	272.	.2345	.434	473.	4428.	5.
	735.	.334	561.	1.4	.00009	.00041	.00640	.01388	5.	480.	-3086.	-628.	.9863	.000	.38	3086.	-18.
	.07		1125.								.30						
2	.022	75.0	.670	0.0	.05498	.05892	.00524	-.00004	3229.	3339.	20.	3438.	67.	3339.	0.	3185.	-839.
1	-15.0	73.0	10.	0.0	.01501	.00025	.00050	.04065	-851.	14.	-839.	28.	.2345	.540	419.	3903.	20.
	739.	14.758	564.	1.6	.00036	-.00126	.00559	.01211	20.	425.	-3185.	-442.	.9863	.061	.31	3294.	14.
	.07		1125.								.20						
3	.053	75.0	.689	0.0	.06007	.06189	.00551	-.00021	3393.	3496.	30.	3266.	67.	3496.	-459.	3344.	-832.
1	-15.0	73.0	23.	0.0	.01495	.00111	.00063	.04270	-844.	63.	-832.	147.	.2344	.462	525.	4894.	30.
	737.	13.972	563.	2.0	.00054	.00323	.00703	.01524	30.	533.	-3344.	1426.	.9856	.122	1.81	3445.	62.
	.17		1125.								3.10						
4	.122	75.0	.799	0.0	.04765	.04851	.00432	-.00016	3200.	3258.	5.	3171.	67.	3264.	-57.	3140.	-633.
1	-15.0	73.0	58.	0.0	.00961	.00305	.00241	.03347	-645.	205.	-633.	129.	.2333	.083	2609.	22314.	5.
	804.	11.398	614.	2.0	.00008	.02509	.02709	.05871	5.	2659.	-3140.	1285.	.9813	.056	11.17	3197.	20.
	.38		1125.								3.10						

BELL HELICOPTER COMPANY

TEST 472 RUN 8 STATIC 0 01/15/76 08.31.46

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	U	FL-	RL-	CP	CH	QM	B1	THETA	ALFS	BAR
6299.	9803.	15211.	7.	7087.	6875.	9252.	9188.	0.	63.	0.	75.00	29.97

AA1 = 3. SA1 = 132. RPM = 233. QLC = 3.

PT AV	V/OP ATPP OR J	ALF.S ALF.C AXOL	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U B1FLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	RF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
2	.181	75.0	.770	0.0	.04023	.04069	.00362	-.00016	2264.	2290.	45.	2642.	65.	2299.	-19.	2220.	-390.
1	-15.0	76.6	79.	-.0	.00706	.00359	.00036	.02807	-397.	202.	-264.	109.	.2332	.427	299.	2796.	45.
	736.	9.953	562.	-1.6	.00082	.00238	.00405	.00878	46.	305.	-2323.	-21.	.9805	.471	20.72	2245.	198.
	.57		1123.								2.20						
3	.180	75.0	.770	2.0	.00036	.00166	.00549	-.00039	3397.	3471.	90.	4387.	65.	3075.	-35.	3331.	-717.
1	-15.0	79.5	79.	-.0	.01300	.00307	.00051	.04254	-731.	173.	-593.	270.	.2332	.562	425.	3967.	90.
	736.	12.152	562.	-4.5	.00163	.00251	.00575	.01246	92.	433.	-3433.	-356.	.9806	.500	20.51	3403.	109.
	.57		1123.								2.50						

TEST 472 RUN 10 STATIC 0 01/15/76 08.24.44

STATIC COEFFICIENTS USED--	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	Q	FL-	RL-	CF	CR	QM	B1	THETA	ALFS	BAR
6282.	9803.	15204.	4.	7098.	-884.	9247.	9189.	0.	62.	0.	75.00	30.22

AA1 = 4. SA1 = 0. RPM = 231. QLC = 3.

				WIND AXIS	-----SHAFT AXIS-----			UNCORRECTED DATA BALANCE AXIS								
PT AV OR J	V/OR ATPP AXOL	ALF.S ALF.C RPM VSND	MT VKTS B1	THETA A1 B1	CLR CXR CYR	CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1 1 728. .58	.184 -15.0 7.401	75.0 72.1 556. 1111.	.772 79. 2.9	0.0 .2 2.9	.02665 .00346 .00054	.02664 .00355 .00262	.00237 .00030 .00343	-.00067 .01838 .00743	1469. -191. 30.	1468. 196. 250.	30. -62. -1590. 14.80	2017. 465. 205.	54. .2401 1.0096	1481. .268 .370	-9. 252. 21.55	1483. 2383. 1482.	-193. 30. 198.
2 1 740. .57	.183 -15.0 11.938	75.0 70.4 565. 1114.	.782 80. 4.6	2.0 .1 4.6	.04634 .00980 .00026	.04729 .00253 .00240	.00421 .00042 .00471	-.00090 .03263 .01021	2635. -557. 15.	2690. 144. 360.	15. -428. -2758. 15.00	3519. 845. 91.	56. .2391 1.0055	2693. .461 .475	-26. 362. 21.82	2650. 3366. 2704.	-560. 15. 145.

TEST 472 -0 11 STATIC 0 01/02/76 08.17.24

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	U	FL-	RL-	CF	CR	QM	B1	THETA	ALFS	BAR
7752.	8334.	15211.	7.	10383.	8215.	9176.	9197.	0.	63.	0.	0.00	30.13

AA1 = -2. SB1 = .32' RPM = 0. QLC = 7.

WIND AXIS -----SHAFT AXIS----- UNCORRECTED DATA BALANCE AXIS

PT AV	V/OR ATPP OR J	ALF,B ALF,C AXOL	MT VKTS RPM VSND	THETA A1 B1	CLR CXR CYR	CT/S CM/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/Q DRAG/Q SIDE/Q	THRUST/Q HFORCE/Q POWER/Q	LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HF/Q FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1	.041	0.0	.663	0.0	-.00056	.04895	.00436	-.00673	-32.	2781.	-5.	19335.	58.	2782.	-2578.	-32.	-2805.
1	-90.0	-.3	18.	-.0	.04895	-.00056	.00032	.03377	-2781.	-32.	-2805.	4024.	.2398	.629	280.	2600.	-5.
	740.	90'654	565.	.3	-.00009	.00164	.00363	.00787	-5.	277.	32.	-14920.	1.0084	.549	1.09	2805.	-32.
	.13		1116.								0.00						
2	.044	0.0	.663	0.0	-.00042	.03471	.00309	-.00044	-47.	1972.	-15.	59.	58.	1973.	-1582.	-47.	-1989.
1	-90.0	-.9	19.	-.0	.03471	-.00082	.00031	.02395	-1972.	-47.	-1989.	313.	.2398	.393	268.	2487.	-15.
	740.	91'354	565.	.9	-.00026	.00195	.00347	.00753	-15.	265.	47.	-14184.	1.0084	.438	1.26	1989.	-47.
	.14		1116.								-.10						
3	.044	0.0	.663	0.0	-.00159	.03473	.00309	-.00093	-90.	1973.	-25.	265.	58.	1976.	-1583.	-91.	-1990.
1	-90.0	1.8	19.	-.0	.03473	-.00159	.00031	.02396	-1973.	-90.	-1990.	669.	.2398	.391	269.	2502.	-25.
	740.	92'61[illegible]	565.	1.8	-.00044	.00197	.00349	.00757	-25.	267.	91.	-15348.	1.0084	.435	1.26	1990.	-91.
	.14		1116.								-.40						
4	.043	0.0	.663	0.0	.00017	.03544	.00315	.00034	10.	2014.	-5.	684.	58.	2014.	-1647.	10.	-2031.
1	-90.0	.5	19.	-.0	.03544	.00017	.00031	.02445	-2014.	10.	-2031.	-244.	.2398	.406	267.	2481.	-5.
	740.	89'718	565.	-.5	-.00009	.00193	.00346	.00751	-5.	265.	-10.	-12024.	1.0084	.444	1.23	2031.	10.
	.14		1116.								0.00						
5	.042	0.0	.663	0.0	.00091	.03534	.00315	.00084	52.	2008.	5.	645.	58.	2009.	-1782.	52.	-2025.
1	-90.0	1.4	18.	-.0	.03534	.00091	.00031	.02438	-2008.	52.	-2025.	-599.	.2398	.397	272.	2529.	5.
	740.	88'529	565.	-1.4	.00009	.00236	.00353	.00765	5.	270.	-52.	-11437.	1.0084	.417	1.14	2025.	52.
	.13		1116.								0.00						

BELL HELICOPTER COMPANY

TEST 072 RUN 12 STATIC 0 01/02/76 08.11.51

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	U	FL-	RL-	CF	CR	OM	BI	THETA,	ALFS	BAR
6284.	9806.	15254.	8.	6893.	5861.	9157.	9201.	0.	59.	0.	75.00	30.13

AA1 = -3. SB1 = 132. RPM = 0. OLC = 7.

UNCORRECTED DATA

PT AV	V/OR ATPP UR J	ALF,S ALF,C AXOL	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	BALANCE AXIS LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HF/6 FM EFF	FE HP M Q PSF	LIFT GM THRUST	DRAG SIDE HFOR
1 1	.193 -15.0 740. .61	75.0 74.3 8.838	.786 85. 565. 1118.	~~4.0~~ 0.0 ~~2.2~~	.03489 .00543 .00062	.03511 .00379 .01175	.00312 .00116 .01308	-.00053 .02422 .02834	1983. -308. 35.	1995. 215. ~~949.~~	35. -160. -2090. 0.00	2148. 371. -3.	60. .2363 .9937	2007. .106 .134	-13. 993. 24.14	1970. ~~4231.~~ 1982.	-306. 35. 214.
2 1	.191 -15.0 740. .60	75.0 73.1 -1.829	.785 84. 565. 1118.	~~2.0~~ -.1 ~~1.4~~	.01361 -.00043 .00018	.01303 .00394 .00001	.00116 -.00000 -.00003	-.00055 .00699 -.00008	773. 25. 10.	741. 224. ~~1.~~	10. 168. -866. 1.40	1317. 386. 575.	60. .2364 .9939	774. -9.011 -18.535	1. -3. 23.07	769. ~~25.~~ 736.	25. 10. 223.
3 1	.187 -15.0 740. .59	75.0 74.6 11.934	.782 82. 565. 1118.	~~2.0~~ -.0 ~~3.27~~	.05630 .01195 .00106	.05746 .00308 -.00194	.00511 .00009 .00104	-.00050 .03964 .00225	3199. -676. 60.	3265. 175. ~~74.~~	60. -535. -3294. 2.20	3772. 555. -636.	60. .2365 .9944	3270. 2.600 2.664	-30. 79. 22.67	3182. ~~735.~~ 3247.	-672. 66. 174.
4 1	.187 -15.0 740. .59	75.0 75.8 13.083	.782 82. 565. 1118.	~~4.0~~ -.0 ~~3.~~	.07400 .01720 .00195	.07593 .00254 -.00324	.00676 .00011 .00128	.00015 .05239 .00277	4205. -977. 111.	4315. 144. ~~96.~~	110. -835. -4294. 2.20	4814. -108. -1274.	60. .2365 .9944	4317. 3.450 2.871	-43. 97. 22.58	4182. ~~944.~~ 4291.	-972. 110. 144.
5 1	.186 -15.0 740. .58	75.0 76.2 14.176	.780 81. 565. 1118.	~~6.0~~ -.1 ~~1.5~~	.09472 .02393 .00221	.09768 .00140 -.00338	.00869 .00028 .00320	.00042 .06739 .00693	5382. -1360. 126.	5551. 80. ~~344.~~	125. -1219. -5463. 3.10	5871. -297. -2063.	60. .2365 .9947	5551. 2.014 1.459	-61. 243. 22.01	5354. ~~2258.~~ 5521.	-1352. 125. 79.
6 1	.185 -15.0 740. .58	75.0 77.0 14.372	.779 81. 565. 1120.	0.0 -.0 -2.0	.10330 .02647 .00320	.10663 .00117 -.00746	.00949 .00000 .00001	.00051 .07356 .00001	5870. -1504. 182.	6059. 66. 0.	169. -1356. -5926. 3.40	7081. -358. -1152.	62. .2356 .9908982	6060. ******* .095	-67. 0. 22.15	5816. 4. 6004.	-1490. 180. 66.

301-099-005

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

TEST 472 RUN 13 STATIC 0 12/31/75 09.59.01

STATIC COEFFICIENTS USED-- -0. -0. -0. -0. -0. -0. -0. -0. -0. -0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	C	Q	FL-	RL-	CF	CR	WM	A1	THETA	ALFS	BAR
7745.	8338.	15200.	6.	6385.	8335.	9179.	9175.	-0.	56.	0.	0.00	30.21

AA1 = .4 SB1 = 132. RPM = 0. WLC = 7.

PT AV	V/QR ATPP QR J	ALF.S ALF.C AXOL	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	----SHAFT AXIS---- CT/S CM/S CPQ/S	CT CP CP/S	CPY/S CTPROP CPPROP	LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U HIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
1	.036	0.0	.657	0.0	-.00027	.03986	.00355	.00040	-15.	2265.	10.	369.	68.	2265.	0.	-15.	-2247.
1	-90.0	-.7	16.	0.0	.03986	-.00027	.00029	.02750	-2265.	-15.	-2247.	-279.	.2359	.509	250.	2322.	10.
	740.	90.383	565.	.7	.00018	.00185	.00330	.00714	10.	252.	15.	154697.	.9921	.438	.85	2247.	-15.
	.11		1127.								0.00						
2	.042	0.0	.657	2.0	-.00046	.05368	.00478	.00020	-26.	3051.	30.	581.	68.	3051.	-2663.	-26.	-3026.
1	-90.0	-.4	18.	0.0	.05368	-.00046	.00042	.03704	-3051.	-26.	-3026.	-144.	.2359	.554	359.	3338.	30.
	740.	90.492	565.	.4	.00053	.00248	.00474	.01027	30.	362.	26.	149777.	.9919	.476	1.14	3026.	-26.
	.13		1127.								.30						
3	.052	0.0	.657	4.0	-.00057	.06756	.00601	-.00067	-32.	3839.	15.	749.	68.	3839.	-2157.	-32.	-3807.
1	-90.0	-.5	23.	0.0	.06756	-.00057	.00058	.04661	-3839.	-32.	-3807.	469.	.2358	.571	492.	4570.	15.
	740.	90.482	565.	.5	.00027	.00295	.00649	.01406	15.	496.	32.	144579.	.9917	.545	1.76	3807.	-32.
	.16		1127.								.40						
4	.066	0.0	.658	6.0	.00201	.07840	.00698	-.00624	114.	4455.	20.	439.	68.	4456.	-1676.	113.	-4416.
1	-90.0	-.4	28.	0.0	.07840	.00201	.00075	.05409	-4455.	114.	-4416.	4395.	.2357	.549	639.	5936.	20.
	740.	88.534	565.	.4	.00036	.00342	.00843	.01827	20.	644.	-113.	144940.	.9912	.595	2.63	4416.	113.
	.20		1127.								.40						
5	.067	0.0	.659	6.0	-.00044	.07607	.00677	-.00782	-25.	4323.	-40.	707.	66.	4323.	-1495.	-25.	-4301.
1	-90.0	-1.7	29.	0.0	.07607	-.00044	.00075	.05248	-4323.	-25.	-4301.	5525.	.2366	.526	639.	5941.	-40.
	740.	90.333	565.	1.7	.00071	.00334	.00841	.01822	-40.	642.	25.	142140.	.9949	.603	2.88	4301.	-25.
	.21		1124.								-.30						
6	.066	0.0	.659	6.0	.00278	.07748	.00690	.00082	158.	4403.	40.	1259.	66.	4406.	-1633.	157.	-4381.
1	-90.0	.9	28.	0.0	.07748	.00278	.00075	.05345	-4403.	158.	-4381.	-560.	.2366	.537	644.	5985.	40.
	740.	87.948	565.	-.9	.00071	.00347	.00847	.01835	40.	647.	-157.	145713.	.9950	.589	2.68	4381.	157.
	.20		1124.								.60						

TEST 472 RUN 14 STATIC 4 12/31/75 09,48,46

STATIC COEFFICIENTS USED-- 320401, -563295, 271699, -21000, 0, 350750, -188900, -166019, 49434, 0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	C	U	FL-	RL-	CF	CR	UM	B1	THETA	ALFS	BAR
6275.	9813.	15248.	2.	7115.	7167.	9101.	9193.	0.	57.	0.	65.00	30.33

AA1 = 4. SA1 = 131. RPM = 0. ULC = 6.

PT AV	V/OR ATPP OR J	ALF.S ALF.C A1OL	HT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CH/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	UNCORRECTED DATA LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	BALANCE AXIS LIFT,U DRAG,U SIDE,U B1FLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	RF/6 FM EFF	FE HP M Q PSF	LIFT DM THRUST	DRAG SIDE HFOR
1	.024	90.0	.547	0.0	.05481	.05481	.00488	-.00023	2047.	2047.	20.	1662.	64.	2047.	0.	2055.	-21.
1	0.0	89.6	9.	-.1	.00057	-.00057	.00033	.03781	-21.	-21.	-4.	106.	.2388	.740	150.	1715.	20.
	600.	.593	458.	.4	.00053	-.00189	.00366	.00793	20.	149.	-2056.	-210.	1.0040	.000	.25	2055.	-21.
	.08		1132.								.40						
2	.226	90.0	.652	0.0	.08901	.08901	.00792	-.00046	3324.	3324.	155.	447.	69.	3326.	6.	3272.	123.
1	5.0	86.0	80.	-.1	-.00334	.00334	.00036	.00141	125.	125.	257.	209.	.2341	1.395	161.	1845.	155.
	600.	-2.150	458.	4.0	.00422	.00321	.00402	.00870	157.	163.	-3301.	-274.	.9846	.000	21.51	3272.	123.
	.71		1128.								4.00						
3	.225	95.0	.652	-2.0	.08435	.08495	.00756	-.00052	3150.	3172.	110.	428.	68.	3174.	18.	3107.	389.
1	5.0	92.0	80.	-.1	-.01056	.00318	.00018	.05861	350.	118.	516.	239.	.2346	2.575	81.	934.	110.
	600.	-7.133	458.	3.0	.00299	.00300	.00203	.00440	112.	83.	-3185.	-498.	.9865	-.822	21.36	3129.	117.
	.71		1127.								3.80						
4	.225	95.0	.652	-2.0	.08402	.08461	.00753	-.00063	3137.	3160.	105.	470.	68.	3162.	15.	3095.	386.
1	5.0	91.9	80.	-.1	-.01047	.00310	.00018	.05037	391.	116.	513.	291.	.2346	2.548	82.	938.	105.
	600.	-7.101	458.	3.1	.00285	.00300	.00204	.00442	106.	83.	-3173.	-435.	.9865	-.816	21.41	3117.	114.
	.71		1127.								3.80						
5	.226	95.0	.651	0.0	.10316	.10378	.00924	-.00074	3852.	3875.	155.	651.	69.	3876.	20.	3793.	427.
1	5.0	91.1	80.	-.1	-.01162	.00258	.00027	.07160	434.	97.	555.	341.	.2341	2.290	123.	1415.	155.
	600.	-6.497	458.	3.9	.00422	.00361	.00308	.00667	157.	125.	-3871.	-213.	.9846	-.004	21.48	3815.	95.
	.71		1128.								4.30						
6	.226	95.0	.651	-4.0	.06522	.06577	.00585	-.00041	2435.	2456.	60.	490.	69.	2459.	16.	2398.	338.
1	5.0	92.8	80.	-.1	-.00920	.00348	.00015	.04538	344.	130.	406.	191.	.2341	2.086	68.	784.	60.
	600.	-8.029	458.	2.2	.00163	.00295	.00171	.00370	61.	69.	-2476.	-463.	.9846	-.760	21.48	2418.	128.
	.71		1128.								3.30						
7	.226	95.0	.651	-5.	.05217	.05268	.00469	-.00046	1948.	1967.	45.	409.	69.	1971.	14.	1918.	299.
1	5.0	93.2	80.	-.1	-.00814	.00357	.00014	.03634	304.	133.	427.	212.	.2341	1.589	64.	738.	45.
	600.	-8.674	458.	1.8	.00122	.00291	.00161	.00348	46.	65.	-1946.	-376.	.9846	-.646	21.48	1937.	131
	.71		1128.								3.10						
8	.225	100.0	.649	-5.0	.07029	.07189	.00640	-.00048	2625.	2684.	55.	95.	70.	2687.	27.	2580.	564.
1	10.0	98.0	80.	-.1	-.01537	.00293	.00007	.04960	574.	109.	633.	222.	.2337	4.905	33.	380.	55.
	600.	-12.335	458.	2.0	.0015	.00331	.00083	.00180	56.	34.	-2645.	-72.	.9828	-3.389	21.27	2638.	108.
	.71		1129.								3.20						

TEST 472 RUN 14

PT / AV	V/OR / ATPP / CR / J	ALF.S / ALF.C / A1OI	MT / VKTS / RPM / VSND	THETA / A1 / B1	WIND AXIS CLP / CXW / CYR	-----SHAFT AXIS----- CT/S / CH/S / CPO/S	CT / CP / CP/S	CMY/S / CTPROP / CPPROP	LIFT/6 / DRAG/6 / SIDE/6	THRUST/6 / HFORCE/6 / POWER/6	UNCORRECTED DATA BALANCE AXIS LIFT,U / DRAG,U / SIDE,U / BIFLAP	PITCH,U / YAW,U / ROLL,U	TEMP F / RHO*100 / RHOR	RF/6 / FM / EFF	FE / HP M / Q PSF	LIFT / UM / THRUST	DRAG / SIDE / MEAN
9	.225	10.0	.649	-3.0	.09255	.09440	.00840	-.00060	3456.	3525.	105.	-64.	70.	3526.	32.	3396.	688.
1	10.0	96.9	80.	-.1	-.01874	.06239	.00009	.06512	700.	89.	807.	270.	.2337	6.265	39.	448.	105.
	600.	-11.448	458.	3.1	.00286	.00351	.00098	.00212	107.	40.	-3462.	-216.	.9828	-3.784	21.38	3464.	88.
	.71		1129.								3.70						
10	.226	10.0	.649	-1.0	.10923	.11114	.00989	-.00048	4079.	4150.	150.	177.	70.	4150.	35.	4008.	755.
1	10.0	45.9	90.	-.1	-.02056	.00129	.00019	.07667	768.	48.	874.	222.	.2337	3.687	85.	972.	150.
	600.	-10.663	458.	4.1	.00409	.03440	.00212	.00459	153.	86.	-4074.	243.	.9828	-2.053	21.36	4078.	47.
	.71		1129.								4.30						
11	.227	10.0	.650	-6.0	.06313	.06469	.00576	-.00022	2357.	2416.	45.	93.	70.	2419.	25.	2317.	533.
1	10.0	98.4	81.	-.1	-.01451	.00333	.00009	.04463	542.	124.	653.	100.	.2337	3.549	39.	469.	45.
	600.	-12.906	458.	1.6	.00123	.00349	.00098	.00212	46.	40.	-2383.	-143.	.9827	-2.605	21.60	2374.	122.
	.71		1129.								3.10						
12	.226	13.0	.649	-6.0	.07195	.07445	.00663	-.00056	2667.	2780.	45.	-30.	70.	2762.	33.	2640.	708.
1	13.0	10.8	80.	-.1	-.01929	.00261	.00003	.05136	721.	98.	822.	255.	.2337	12.852	13.	153.	45.
	600.	-15.009	458.	2.2	.00123	.00367	.00033	.00072	46.	14.	-2098.	-303.	.9827	-11.343	21.41	2732.	96.
	.71		1129.								3.20						
13	.226	13.0	.649	-6.0	.07182	.07435	.00662	-.00044	2682.	2770.	45.	-22.	70.	2778.	33.	2635.	713.
1	13.0	10.8	80.	-.1	-.01943	.00278	.00002	.05129	726.	104.	627.	201.	.2337	19.581	9.	100.	45.
	600.	-15.140	458.	2.2	.00123	.00359	.00022	.00047	46.	9.	-2693.	-329.	.9828	-17.284	21.39	2728.	102.
	.71		1129.								3.20						
14	.2[illegible]	13.0	.648	-8.0	.05519	.05753	.00510	-.00025	2061.	2141.	25.	323.	71.	2144.	27.	[illegible]	578.
1	13.	11.9	80.	-.1	-.01579	.00297	.00006	.03955	596.	111.	692.	116.	.2333	4.370	26.	[illegible]	25.
	600.	-15.965	458.	1.1	.00068	.00362	.00066	.00144	25.	27.	-2079.	-423.	.9609	-4.390	21.32	21[illegible].	109.
	.71		1130.								3.00						
15	.226	13.0	.647	-4.0	.09099	.09392	.00836	-.00126	3398.	3507.	60.	-521.	72.	35[illegible]	40.	3327.	854.
1	13.0	10.2	80.	-.1	-.02337	.00250	.00001	.06479	573.	86.	968.	574.	.2328	30.[illegible]	6.	73.	60.
	600.	-14.444	458.	2.6	.00219	.00360	.00016	.00034	82.	6.	-3384.	-916.	.9791	-29.99[illegible]	21.32	3434.	64.
	.71		1131.								3.60						
16	.226	13.0	.647	-2.0	.10896	.11216	.00998	-.00095	4069.	4185.	125.	-572.	72.	4189.	46.	3983.	974.
1	13.0	19.2	80.	-.1	-.02605	.00145	.00008	.07736	995.	54.	1068.	435.	.2328	6.662	36.	418.	125.
	600.	-13.742	458.	3.6	.00342	.00460	.00091	.00198	128.	37.	-4041.	-193.	.9791	-6.233	21.36	4101.	53.
	.71		1131.								4.20						
17	.227	13.0	.648	-1.0	.11500	.11821	.01052	-.00003	4294.	4414.	130.	-213.	72.	4414.	47.	4204.	1001.
1	13.0	58.9	80.	-.1	-.02737	.00080	.00012	.08155	1022.	30.	1115.	366.	.2328	6.491	53.	603.	130.
	600.	-13.388	458.	4.1	.00356	.00493	.00132	.00246	133.	54.	-4202.	72.	.9790	-4.563	21.48	4322.	29.
	.71		1131.								4.40						

TEST 472 [illegible] 14

PT / AV	V/VTIP / ATIP / UH / J	A1F,S / A1F,C / A/OL	VT / VTIS / RPM / VSND	THETA / A1 / B1	WIND AXIS CLR / CXR / CYR	SHAFT AXIS CT/S / CH/S / CPD/S	CT / CH / CP/S	CPT/S / CTPROP / CPPROP	LIFT/Q / DRAG/Q / SIDE/Q	THRUST/Q / HFORCE/Q / POWER/Q	UNCORRECTED DATA BALANCE AXIS LIFT,U / DRAG,U / SIDE,U / RIFLAP	PITCH,U / YAW,U / ROLL,U	TEMP F / ROTATION / RHOR	HP/Q / ETA / EFF	FE / HP / Q PSF	LIFT / DP / THRUST	DRAG / SIDE / HFOR
18	.226	15.0	.647	-6.0	.06029	.00317	.00562	-.00034	2251.	2359.	20.	10.	72.	2301.	32.	2204.	696.
1	15.0	13.6	83.	-.1	-.01903	.00276	.00001	.04350	711.	104.	806.	154.	.2328	25.971	5.	59.	20.
	600.	-17.518	458.	1.2	.00055	.00372	.00013	.00028	20.	5.	-2256.	-206.	.9790	-20.717	21.46	2309.	102.
	.71		1131.								3.10						
19	.226	15.[illegible]	.646	-6.0	.07792	.08132	.00724	-.00063	2910.	3030.	50.	-669.	73.	3038.	40.	2844.	853.
1	15.0	[illegible]	80.	-.1	-.02336	.00240	-.00002	.05610	872.	90.	902.	270.	.2320	-26.095	-7.	-78.	50.
	600.	-16.0[illegible]9	459.	2.0	.00137	.00390	-.00017	-.00037	51.	-7.	-2895.	-514.	.9773	27.865	21.27	2967.	88.
	.71		1132.								3.20						
20	.226	15.0	.646	-4.0	.09994	.10292	.00916	-.00090	3695.	3843.	65.	-1177.	73.	3644.	49.	3611.	1037.
1	15.0	12.0	80.	-.1	-.02841	.00143	.00002	.07101	1061.	60.	1146.	410.	.2324	30.378	9.	105.	65.
	600.	-16.019	458.	3.0	.00233	.00473	.00025	.00050	87.	9.	-3602.	-139.	.9773	-26.206	21.25	3756.	67.
	.[illegible]		1132.								3.60						
21	.225	15.0	.646	-2.0	.11456	.11881	.01057	-.00100	4278.	4036.	130.	-794.	73.	4436.	54.	4161.	1149.
1	15.0	10.8	80.	-.1	-.03148	.00076	.00004	.06190	1176.	28.	1258.	454.	.2324	20.540	17.	192.	130.
	600.	-15.365	458.	4.2	.00356	.00092	.00042	.00091	133.	17.	-4232.	-341.	.9773	-10.474	21.20	4336.	28.
	.71		1132.								4.20						
22	.226	15.0	.640	-1.0	.11925	.12354	.01099	-.00076	4453.	4613.	145.	-519.	73.	4613.	55.	4352.	1178.
1	15.0	10.8	80.	-.1	-.03227	.00031	.00013	.08523	1205.	11.	1207.	344.	.2324	6.160	59.	677.	145.
	600.	-15.143	458.	4.2	.00397	.00596	.00145	.00322	148.	60.	-4403.	-10.	.9773	-4.057	21.25	4506.	11.
	.71		1132.								4.70						
23	.175	15.0	.619	-8.0	.047[illegible]9	.05028	.00447	-.00004	1792.	1877.	30.	293.	74.	1879.	43.	1755.	554.
1	15.0	14.1	62.	-.1	-.01515	.00222	.00005	.03469	566.	83.	628.	18.	.2329	4.064	23.	267.	30.
	600.	-17.525	458.	.9	.00082	.00260	.00058	.00127	31.	24.	-1786.	60.	.9743	-3.402	12.65	1839.	81.
	.55		1133.								3.20						
24	.174	15.0	.619	-6.0	.06796	.07067	.00631	-.00026	2534.	2046.	50.	-254.	74.	2647.	58.	2485.	739.
1	15.0	13.6	62.	-.1	-.02020	.00192	.00002	.04689	754.	72.	812.	127.	.2329	16.666	8.	96.	50.
	600.	-16.555	458.	1.4	.00137	.00255	.00021	.00040	51.	9.	-2516.	261.	.9744	-15.155	12.71	2592.	70.
	.55		1133.								3.30						
25	.174	15.0	.618	-4.0	.08751	.09165	.00810	-.00092	3208.	3400.	100.	-759.	75.	3400.	73.	3195.	919.
1	15.0	12.9	62.	-.1	-.02518	.00167	.00002	.06281	940.	63.	992.	421.	.2325	21.615	11.	122.	100.
	600.	-16.054	458.	2.1	.00274	.00268	.00027	.00058	102.	11.	-3225.	26.	.9770	-15.256	12.59	3324.	61.
	.55		1134.								4.00						
26	.173	15.0	.619	-2.0	.10326	.10727	.00955	-.00152	3856.	4005.	145.	-014.	73.	4006.	85.	3784.	1065.
1	15.0	12.4	62.	-.1	-.02907	.00136	.00007	.07400	1086.	51.	1138.	096.	.2333	10.039	29.	338.	145.
	600.	-15.725	458.	2.6	.00396	.00304	.00074	.00160	148.	30.	-3814.	-900.	.9613	-0.517	12.59	3930.	50.
	.54		1132.								4.20						

TEST 472 RUN 15 STATIC 4 12/31/75 12,49,36

STATIC COEFFICIENTS USED-- 320401, -563295, 271699, -21006, 0, 356750, -188900, -166019, 49454, 0,

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	Q	FL-	RL-	CF	CM	QM	BI	THETA	ALFS	BAR
6276.	9809.	15227.	8.	7047.	7237.	9154.	9184.	79.	53.	0.	65.00	30.28

AA1 = .4, SB1 = 132. RPM = 0. QLC = 6.

PT AV	V/OR ATPP QR J	IF.S F.C AXDI	MT VKTS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CM/S CPQ/S	CT CQ CP/S	CMY/S CTPROP CPPROP	UNCORRECTED DATA BALANCE AXIS LIFT/6 DRAG/6 SIDE/6	THRUST/6 HFORCE/6 POWER/6	LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HP/6 FM EFF	FE HP M Q PSF	LIFT DM THRUST	DRAG SIDE HFOR
1	.024	90.0	.544	0.0	.05339	.05339	.00475	-.00088	1994.	1994.	20.	450.	71.	1994.	0.	1972.	-17.
1	0.0	90.0	9.	0.0	.00046	-.00046	.00091	.03683	-17.	-17.	-1.	408.	.2352	.255	412.	4719.	20.
	600.	.49	458.	.0	.00054	.00499	.01022	.02215	20.	416.	-1972.	-918.	.9891	.000	.25	1972.	-17.
	.08		1130.								6.83						
2	.024	90.0	.544	-2.0	.03910	.03910	.00348	-.00041	1460.	1460.	15.	34.	70.	1460.	0.	1447.	-10.
1	0.0	89.7	9.	0.0	.00027	-.00027	.00067	.02698	-10.	-10.	6.	189.	.2357	.216	305.	3496.	15.
	600.	.362	458.	.3	.00041	.00475	.00756	.01638	15.	308.	-1447.	-1122.	.9910	.000	.25	1447.	-10.
	.08		1129.								.30						
3	.024	90.0	.544	-4.0	.02754	.02754	.00245	.00003	1028.	1028.	15.	-264.	70.	1028.	0.	1019.	5.
1	0.0	89.8	9.	0.0	-.00014	.00014	.00049	.01900	5.	5.	21.	-12.	.2357	.174	224.	2563.	15.
	600.	-.286	458.	.2	.00041	.00416	.00554	.01201	15.	226.	-1019.	-664.	.9910	.000	.25	1019.	5.
	.08		1129.								.40						
4	.024	90.0	.544	-6.0	.01684	.01684	.00150	.00005	629.	629.	10.	-459.	70.	629.	0.	623.	10.
1	0.0	89.7	9.	0.0	-.00027	.00027	.00045	.01161	10.	10.	26.	-23.	.2357	.091	203.	2.30.	10.
	600.	-.928	458.	.3	.00027	.00453	.00504	.01092	10.	205.	-623.	-550.	.9910	.000	.25	623.	10.
	.08		1129.								.80						
5	.024	90.0	.544	0.0	.00005	.00005	.00000	.00015	2.	2.	5.	-1431.	70.	9.	0.	2.	9.
1	0.0	90.1	9.	0.0	-.00025	.00025	-.00008	.00004	9.	9.	25.	-70.	.2357	-.000	-36.	-408.	5.
	600.	-77.591	458.	-.1	.00014	-.00088	-.00088	-.00191	5.	-36.	-2.	-899.	.9910	-.000	.25	2.	9.
	.08		1129.								.80						
6	.024	90.0	.544	0.0	.00008	.00008	.00001	.00007	3.	3.	5.	-1401.	70.	11.	0.	3.	10.
1	0.0	90.1	9.	0.0	-.00027	.00027	-.00009	.00006	10.	10.	26.	-33.	.2357	-.000	-41.	-466.	9.
	600.	-73.402	458.	-.1	.00014	-.00100	-.00101	-.00218	5.	-41.	-3.	-784.	.9910	-.000	.25	3.	10.
	.08		1129.								.80						

301-099-005

TEST 672 RUN 16 STATIC 4 12/31/75 09.51.55

STATIC COEFFICIENTS USED-- 320401. -563295. 271699. -21006. 0. 356750. -188900. -106019. 49438. 0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	U	FL-	RL-	CF	CM	QM	B1	THETA	ALFS	BAR
6276.	9811.	15248.	7.	7067.	7226.	9153.	9195.	0.	54.	0.	65.00	30.29

AA1 = .4 SB1 = 133. RPM = 0. ULC = 6.

PT / AV	V/OR / ATPP / OR / J	ALF.S / ALF.C / AKOL	HT / VKTS / RPM / VSKD	THETA / A1 / B1	WIND AXIS CLR / CXH / CYR	-----SHAFT AXIS----- CT/S / CM/S / CPO/S	CT / CP / CP/8	CMY/S / CTPROP / CPPROP	UNCORRECTED DATA LIFT/D / DRAG/D / SIDE/D	THRUST/D / HFORCE/D / POWER/D	BALANCE AXIS LIFT,U / DRAG,U / SIDE,U / BIFLAP	PITCH,U / YAW,U / ROLL,U	TEMP F / RHO.100 / RHOR	RF/D / FF / CFF	FE / HP F / Q PSF	LIFT / OM / THRUST	DRAG / SIDE / HFOR
1	.024	90.0	.546	0.0	.05635	.05835	.00502	.00026	2104.	2104.	15.	1269.	67.	2104.	0.	2098.	-20.
1	0.0	89.8	9.	0.0	.00054	-.00054	.00038	.03888	-20.	-20.	-3.	-128.	.2371	.653	175.	2012.	15.
	600.	.554	458.	.2	.00040	-.00152	.00432	.00937	15.	176.	-2099.	-549.	.9970	.000	.25	2098.	-20.
	.08		1125.								.40						
2	.248	90.0	.665	0.0	.08253	.08253	.00735	-.00041	3082.	3082.	120.	103.	67.	3084.	4.	3035.	110.
1	0.0	85.5	86.	0.0	-.00300	.00300	.00032	.05694	112.	112.	269.	190.	.2342	1.386	145.	1659.	120.
	600.	-2.084	458.	4.5	.00326	.00313	.00361	.00782	122.	147.	-3142.	-500.	.9849	.000	25.95	3035.	110.
	.78		1125.								3.70						
3	.248	95.0	.664	-2.0	.08264	.08323	.00741	-.00045	3086.	3108.	100.	-351.	68.	3110.	15.	3034.	382.
1	5.0	91.4	88.	0.0	-.01042	.00318	.00017	.05742	389.	119.	533.	207.	.2338	2.656	76.	875.	100.
	600.	-7.185	455.	3.6	.00272	.00327	.00191	.00413	102.	78.	-3128.	-998.	.9831	-.945	25.90	3055.	117.
	.78		1127.								3.50						
4	.281	100.0	.680	-3.0	.09653	.09853	.00877	-.00078	3604.	3679.	115.	-886.	68.	3681.	22.	3531.	732.
1	10.0	95.7	100.	0.0	-.02000	.00293	.00006	.06798	747.	110.	906.	357.	.2330	10.079	26.	296.	115.
	600.	-11.705	458.	4.3	.00314	.00478	.00065	.00140	117.	26.	-3633.	-1019.	.9798	-7.420	32.98	3605.	107.
	.88		1127.								3.40						
5	.281	100.0	.679	-4.0	.08636	.08832	.00786	-.00055	3225.	3298.	90.	-957.	69.	3301.	21.	3154.	688.
1	10.0	96.4	100.	0.0	-.01884	.00356	.00003	.06093	704.	133.	862.	249.	.2326	15.029	15.	168.	90.
	600.	-12.309	458.	3.6	.00246	.00847	.00037	.00080	92.	15.	-3255.	-1517.	.9780	-11.079	32.86	3225.	130.
	.88		1128.								3.20						
6	.281	100.0	.679	-6.0	.07096	.07182	.00639	-.00062	2616.	2682.	45.	-695.	70.	2686.	18.	2553.	594.
1	10.0	95.5	100.	0.0	-.01629	.00387	.00004	.04955	608.	145.	768.	283.	.2321	8.550	19.	216.	45.
	600.	-13.087	458.	4.5	.00123	.00428	.00047	.00103	46.	19.	-2655.	-933.	.9761	-7.389	33.01	2618.	141.
	.88		1129.								2.70						
7	.282	100.0	.679	-8.0	.05310	.05467	.00487	-.00046	1983.	2041.	10.	-445.	70.	2047.	15.	1935.	498.
1	10.0	98.4	100.	0.0	-.01367	.00424	.00008	.03771	510.	158.	673.	206.	.2321	2.961	36.	415.	10.
	600.	-14.438	458.	1.8	.00027	.00431	.00091	.00197	10.	37.	-2037.	-704.	.9760	-2.936	33.08	1992.	155.
	.88		1129.								2.50						
8	.280	113.0	.677	-8.0	.06520	.06779	.00603	-.00045	2435.	2531.	30.	-716.	70.	2535.	21.	2377.	689.
1	13.0	111.2	100.	0.0	-.01891	.00376	-.00001	.04676	704.	140.	854.	206.	.2321	-28.829	-5.	-59.	30.
	600.	-16.174	454.	1.8	.00042	.00450	-.00013	-.00028	31.	-5.	-2465.	-1380.	.9762	33.123	32.42	2471.	137.
	.88		1129.								2.70						

BELL HELICOPTER COMPANY

BELL HELICOPTER COMPANY

TEST 472 RUN 10

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PT AV	V/OR ATPP UR J	ALF,S ALF,C ALDI	MT VKTS RPM VSND	THETA A1 B1	AXIS CLR CXR CYR	-----SHAFT AXIS----- CT/S CM/S CPU/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/O DRAG/O SIDE/O	THRUST/O HFORCE/O POWER/O	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U HIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO/RHO0 RHOR	HP/O FA EFF	PE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
9	.280	113.0	.676	-6.0	.04215	.08509	.00757	-.00068	3068.	3177.	50.	-1266.	71.	3180.	25.	2989.	816.
1	13.0	110.2	99.	0.0	-.02223	.00338	-.00004	.05871	858.	125.	980.	311.	.2317	-10.791	-19.	-221.	50.
	600.	-15.271	458.	2.8	.00137	.00472	-.00049	-.00105	51.	-20.	-3077.	-1176.	.9744	11.044	32.63	3096.	123.
	.88		1130.								2.90						
10	.280	113.0	.676	-4.0	.09867	.09993	.00869	-.00180	3610.	3750.	80.	-1401.	71.	3732.	28.	3517.	924.
1	13.0	99.1	99.	0.0	-.02540	.00300	-.00003	.06892	948.	112.	1088.	821.	.2317	-17.243	-15.	-176.	80.
	600.	-14.720	458.	3.9	.00220	.00520	-.00039	-.00084	82.	-10.	-3605.	-1740.	.9744	16.293	32.65	3635.	109.
	.88		1130.								3.20						
11	.281	113.0	.677	-3.0	.10656	.10970	.00977	-.00127	3979.	4098.	100.	-1255.	71.	4098.	29.	3877.	956.
1	13.0	48.3	100.	0.0	-.02629	.00104	.00001	.07571	982.	61.	1121.	578.	.2317	56.700	5.	61.	106.
	600.	-13.857	453.	4.7	.00275	.00571	.00014	.00029	103.	0.	-3965.	-603.	.9743	-51.249	32.82	3992.	-0.
	.88		1130.								3.						
12	.280	113.0	.676	-2.0	.11332	.11661	.01038	-.00107	4231.	4354.	135.	-1046.	71.	4355.	31.	4123.	1003.
1	13.0	48.0	100.	0.0	-.02756	.00136	.00006	.08045	1029.	51.	1107.	487.	.2317	9.448	35.	808.	135
	600.	-13.669	458.	5.0	.00371	.00658	.00089	.00193	139.	30.	-4211.	-775.	.9744	-8.268	32.72	4243.	50
	.88		1130.								3.70						
13	.280	113.0	.676	-1.0	.11832	.12143	.01081	-.00110	4418.	4534.	145.	-695.	71.	4534.	30.	4305.	994
1	13.0	47.1	100.	0.0	-.02731	-.00000	.00024	.08378	1020.	-0.	1158.	500.	.2317	3.256	109.	1247.	145
	600.	-12.906	458.	5.9	.00399	.00818	.01274	.00594	149.	112.	-4393.	-272.	.9744	-2.793	32.72	4410.	-0
	.88		1130.								4.50						
14	.168	110.0	.615	-4.0	.09116	.09749	.00868	-.00104	3405.	3640.	90.	-1771.	71.	3641.	107.	3350.	1268.
1	20.0	118.2	60.	0.0	-.03451	.00124	-.00005	.00726	1289.	46.	1332.	476.	.2340	-12.429	-21.	-237.	90.
	600.	-20.730	458.	1.8	.00245	.00308	-.00052	-.00112	91.	-21.	-3370.	-484.	.9840	10.848	11.67	3582.	46.
	.53		1130.								3.70						
15	.170	110.0	.616	-6.0	.07237	.07757	.00690	-.00100	2702.	2896.	45.	-1363.	71.	2897.	84.	2659.	1027.
1	20.0	118.6	60.	0.0	-.02795	.00151	-.00006	.05351	1044.	57.	1092.	460.	.2340	-9.545	-19.	-219.	45.
	600.	-21.119	458.	1.4	.00122	.00291	-.00048	-.00103	46.	-19.	-2679.	-879.	.9839	9.449	12.10	2850.	56.
	.53		1130.								3.40						
16	.168	110.0	.615	-8.0	.05678	.06112	.00544	-.00044	2120.	2282.	25.	-1025.	71.	2283.	70.	2086.	838.
1	20.0	119.2	60.	0.0	-.02270	.00191	-.00011	.04217	848.	71.	698.	204.	.2340	-19.963	-6.	-73.	25.
	600.	-21.791	458.	.8	.00068	.00279	-.00016	-.00035	25.	-6.	-2106.	-774.	.9840	21.973	11.88	2246.	70.
	.53		1130.								3.20						
17	.167	110.0	.615	-3.0	.09892	.10563	.00940	-.00193	3694.	3944.	100.	-1990.	70.	3944.	116.	3641.	1568.
1	20.0	118.2	59.	0.0	-.03706	.00049	-.00004	.07237	1364.	37.	1428.	680.	.2344	-17.930	-16.	-186.	100.
	600.	-20.540	458.	1.8	.00272	.00312	-.00040	-.00088	101.	-16.	-3661.	-378.	.9859	14.953	11.77	388[illegible]	37.
	.53		1129.								3.90						

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

TEST 472 RUN 10

PT AV	V/OR ATPP UR J	ALF.S ALF.C A-OI	HT VRIS RPM VSND	THETA A1 B1	WIND AXIS CLR CXR CYR	-----SHAFT CT/S CH/S CPU/S	CT CP CP/S	IS----- CMY/S CIPROP CPPROP	LIFT/D DRAG/D SIDE/D	THRUST/D HFORCE/D POWER/D	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U MIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	HP/D FM EFF	FE HP P Q PSF	LIFT UM THRUST	DRAG SIDE MHOR
19	.157	110.0	.615	-2.0	.13138	.11874	.01057	-.00119	4159.	4434.	145.	-1692.	70.	4434.	129.	4101.	1515.
1	20.0	1.7.6	59.	0.0	-.04114	.00056	-.00001	.08192	1536.	21.	1578.	540.	.2345	-54.710	-6.	-73.	145.
	600.	-20.273	458.	2.4	.00398	.00338	-.00016	-.00034	147.	-6.	-4120.	3488.	.9859	42.904	11.70	4371.	21.
	.52		1129.								4.40						
19	.156	110.0	.615	0.0	.12325	.13064	.01164	-.00114	4662.	4686.	160.	-1594.	70.	4806.	139.	4538.	1617.
1	20.0	1.6.7	5.	0.0	-.04392	-.00069	.00009	.09027	1640.	-35.	1660.	523.	.2345	10.009	40.	459.	180.
	600.	-19.611	458.	3.3	.00489	.00423	.00100	.00216	183.	41.	-4557.	7976.	.9660	-7.461	11.65	4817.	-33.
	.52		1129.								5.10						
20	.168	110.0	.616	1.0	.13127	.13892	.01236	-.00108	4962.	5187.	215.	-1115.	70.	5188.	141.	4832.	1675.
1	20.0	1.6.3	60.	0.0	-.04550	-.00214	.00019	.09584	1699.	-86.	1739.	496.	.2344	5.000	88.	1005.	215.
	600.	-19.116	458.	3.7	.00588	.00528	.00218	.00473	218.	64.	-4852.	10763.	.9858	-3.050	11.91	5114.	-79.
	.53		1129.								5.40						
21	.169	110.0	.616	-4.0	.09098	.09728	.00856	-.00117	3397.	3632.	85.	-1520.	70.	3633.	106.	3349.	1266.
1	20.0	1.8.2	60.	0.3	-.03444	.00124	-.00008	.06711	1200.	40.	1332.	537.	.2344	-7.455	-34.	-395.	85.
	600.	-20.732	458.	1.8	.00231	.00276	-.00086	-.00186	66.	-35.	-3369.	-461.	.9858	6.531	11.96	3581.	46.
	.53		1129.								3.80						
22	.167	110.0	.616	-4.0	.09188	.09849	.00876	-.00105	3429.	3674.	-170.	-1522.	69.	3675.	111.	3387.	1364.
1	20.0	1.8.6	59.	-4.0	-.03536	.00142	-.00007	.06786	1320.	60.	1368.	485.	.2349	-8.071	-32.	-372.	-170.
	600.	-21.058	458.	1.4	-.00461	.00280	-.00081	-.00175	-172.	-35.	-3407.	-1107.	.9678	6.974	11.79	3629.	67.
	.53		1128.								-.90						
23	.165	110.0	.615	-2.0	.11102	.11852	.01055	-.00118	4145.	4426.	-175.	-1342.	66.	4426.	134.	4103.	1534.
1	20.0	1.7.7	59.	-4.0	-.04152	.0.104	-.00003	.08177	1550.	39.	1597.	544.	.2354	-24.468	-14.	-162.	-175.
	600.	-20.505	458.	2.3	-.00474	.00316	-.00035	-.00076	-177.	-14.	-4122.	5666.	.9898	16.988	11.48	4380.	39.
	.52		1127.								-.20						
24	.166	110.0	.616	0.0	.12467	.13300	.01184	-.00101	4603.	4966.	-185.	-1192.	68.	4966.	145.	4615.	1692.
1	20.0	1.7.1	59.	-4.0	-.04578	.00031	.00005	.09175	1709.	12.	1755.	465.	.2353	19.296	21.	245.	-185.
	600.	-20.133	458.	2.9	-.00501	.00396	.00053	.00115	-187.	22.	-4634.	11079.	.9697	-14.255	11.67	4915.	11.
	.52		1127.								.60						
25	.166	110.0	.616	1.0	.13034	.13848	.01232	-.00119	4867.	5171.	-175.	-891.	68.	5171.	148.	4817.	1729.
1	20.0	1.6.6	59.	-4.0	-.04678	-.00062	.00013	.09553	1747.	-23.	1742.	551.	.2353	7.386	59.	640.	-175.
	600.	-19.743	458.	3.4	-.00474	.00469	.00147	.00319	-177.	60.	-4836.	12993.	.9897	-5.347	11.67	5117.	-23.
	.52		1127.								1.00						
26	.168	110.0	.617	2.0	.13643	.14431	.01284	-.00108	5194.	5388.	-165.	-307.	68.	5389.	145.	5041.	1740.
1	20.0	1.5.7	60.	-4.0	-.04708	-.00242	.00027	.09456	1758.	-40.	1604.	498.	.2353	3.865	121.	1382.	-165.
	600.	-19.039	458.	4.3	-.00447	.00544	.00299	.00649	-167.	122.	-5061.	15434.	.9695	-2.773	11.96	5332.	-89.
	.53		1127.								1.60						

TEST 472 RUN 16

PT AV	V/OR ATPP OR J	A.F.S A.F.C AXUL	MT VTIS RPM VSND	THETA A1 B1	WIND AXIS CLP CXP CYR	-----SHAFT AXIS----- CT/S CM/S CPC/S	CT CP CP/S	CMY/S CIPHCP CHPROP	LIFT/B DRAG/B SIDE/B	THRUST/B HFORCE/B POWER/B	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U BIFLAP	PITCH,U YAW,U ROLL,U	TEMP F RHO*100 RHOR	RF/6 FM EFF	FE HP M Q PSF	LIFT QM THRUST	DRAG SIDE HFOR
27	.167	110.0	.616	3.0	.14125	.14698	.01326	-.00100	5274.	5563.	-135.	294.	68.	5565.	149.	5219.	1756.
1	20.0	115.3	59.	-4.0	-.04753	-.00365	.00042	.10278	1775.	-136.	1820.	489.	.2353	2.543	192.	2203.	-135.
	600.	-18.598	458.	4.7	-.10305	.00738	.00477	.01034	-136.	194.	-5239.	17125.	.9896	-1.785	11.77	5505.	-135.
	.52		1127.								2.00						
28	.225	115.0	.649	-4.0	.09466	.09836	.00876	-.00129	3535.	3677.	70.	-1657.	68.	3677.	47.	3482.	998.
1	15.0	112.2	80.	0.0	-.02713	.00171	-.00007	.06793	1013.	64.	1108.	594.	.2343	-7.940	-33.	-377.	70.
	600.	-13.903	458.	2.8	.00190	.00352	-.00082	-.00176	71.	-33.	-3534.	-376.	.9652	6.998	21.39	3822.	63.
	.71		1127.								3.30						
29	.195	115.0	.732	-4.0	.09052	.09419	.00838	-.00124	4526.	4710.	75.	-1896.	68.	4711.	60.	4459.	1266.
1	15.0	112.7	80.	0.0	-.02610	.00175	-.00002	.06498	1305.	89.	1396.	762.	.2343	-33.252	-11.	-113.	75.
	694.	-16.085	530.	2.3	.00152	.00304	-.00018	-.00040	76.	-12.	-4511.	462.	.9851	25.924	21.44	4640.	88.
	.61		1127.								3.30						
30	.195	115.0	.732	-6.0	.07394	.07715	.00687	-.00116	3697.	3858.	70.	-1454.	68.	3860.	51.	3642.	1091.
1	15.0	113.3	80.	0.0	-.02215	.00226	-.00001	.05325	1108.	.113.	1201.	715.	.2343	-70.467	-4.	-39.	70.
	694.	-16.677	530.	1.7	.00142	.00300	-.00006	-.00014	71.	-4.	-3694.	-442.	.9652	60.599	21.36	3801.	111.
	.61		1127.								2.90						
31	.190	115.0	.732	-3.0	.10169	.10569	.00941	-.00108	5085.	5285.	125.	-1949.	68.	5285.	67.	5010.	1422.
1	15.0	112.3	80.	0.0	-.02886	.00156	-.00000	.07292	1443.	78.	1551.	664.	.2343	*******	-2.	-24.	125.
	694.	-15.846	530.	2.7	.00254	.00318	-.00004	-.00009	127.	-2.	-5061.	1246.	.9853	134.027	21.17	5207.	77.
	.61		1127.								3.70						
32	.194	115.0	.732	-2.0	.10922	.11354	.01009	-.00133	5461.	5667.	155.	-1835.	68.	5668.	70.	5381.	1492.
1	15.0	111.9	80.	0.0	-.03032	.00097	.00003	.07819	1515.	40.	1662.	820.	.2343	23.510	21.	211.	155.
	694.	-15.563	530.	3.1	.00315	.00350	.00034	.00074	157.	22.	-5432.	709.	.9652	-10.057	21.29	5584.	49.
	.61		1127.								3.70						
33	.195	115.0	.732	-1.0	.11689	.12105	.01077	-.00167	5845.	6053.	175.	-1708.	68.	6053.	73.	5758.	1549.
1	15.0	111.3	80.	0.0	-.03145	.00012	.00010	.08351	1572.	6.	1659.	1031.	.2343	8.220	67.	665.	175.
	694.	-15.058	530.	3.7	.00355	.00404	.00118	.00234	174.	68.	-5810.	3956.	.9652	-5.045	21.36	5963.	6.
	.61		1127.								4.10						
34	.195	115.0	.732	0.0	.12134	.12540	.01116	-.00151	6067.	6270.	195.	-977.	68.	6271.	73.	5977.	1560.
1	15.0	110.7	80.	0.0	-.03167	-.00082	.00024	.09651	1584.	-41.	1670.	960.	.2343	5.527	165.	1635.	195.
	694.	-14.628	530.	4.3	.00396	.00546	.00266	.00576	198.	168.	-6029.	5694.	.9852	-2.380	21.39	6177.	-40.
	.61		1127.								4.50						

TEST 472 RUN 17 STATIC 4 12/31/75 09,50,40

STATIC COEFFICIENTS USED-- 320401, -563295, 271699, -21006, 0, 356750, -188900, -166019, 49434, 0.

ZERO POINT READINGS IN COUNTS

FL+	RL+	D	U	FL-	RL-	CF	CR	QM	H1	THETA	ALFS	BAR
6277.	6813.	15248.	7.	7035.	7242.	9151.	9191.	0.	57.	0.	65.00	30.31

AA1 = .4, SA1 = 131. RPM = 0. QLC = 8.

PT / AV	V/OR / ATPP / QR / J	ALF,S / ALF,C / AXQI	MT / VKTS / RPM / VSND	THETA / A1 / B1	WIND AXIS: CR / CXR / CYR	SHAFT AXIS: CT/S / CM/S / CPO/S	CT / CP / CP/S	CMY/S / CTPROP / CPPROP	UNCORRECTED DATA: LIFT/6 / DRAG/6 / SIDE/6	THRUST/6 / HFORCE/6 / POWER/6	BALANCE AXIS: LIFT,U / DRAG,U / SIDE,U / BIFLAP	PITCH,U / YAW,U / ROLL,U	TEMP F / RHO+100 / RHOR	RF/6 / FM / EFF	FE / HP M / Q PSF	LIFT / QM / THRUST	DRAG / SIDE / HFOR
1	.022	90.0	.633	0.0	.05409	.05409	.00481	.00022	2705.	2705.	5.	2014.	63.	2705.	0.	2719.	-22.
1	0.0	89.7	9.	0.0	.00043	-.00043	.00035	.03732	-21.	-21.	-4.	-141.	.2390	.667	252.	2499.	5.
	694.	.453	530.	.3	.00010	-.00183	.00398	.00862	5.	251.	-2720.	311.	1.0051	.000	.29	2719.	-22.
	.07		1121.								-.10						
2	.029	90.0	.637	3.0	.08353	.08353	.00743	.00022	4177.	4177.	5.	3393.	63.	4177.	0.	4198.	-21.
1	0.0	89.6	12.	0.0	.00041	-.00041	.00058	.05763	-20.	-20.	-2.	-130.	.2390	.781	413.	4094.	5.
	694.	.281	530.	.4	.00010	-.00420	.00652	.01412	5.	411.	-4200.	-097.	1.0051	.000	.48	4198.	-21.
	.09		1121.								.10						
3	.097	90.0	.679	3.0	.10452	.10452	.00930	-.00046	5226.	5226.	270.	3191.	63.	5226.	-4.	5241.	-20.
1	0.0	86.9	40.	0.0	.00039	-.00039	.00057	.07211	-19.	-19.	26.	290.	.2385	1.121	402.	3985.	270.
	694.	.213	530.	3.1	.00538	.00130	.00636	.01378	269.	401.	-5263.	775.	1.0028	.000	5.39	5241.	-20.
	.30		1121.								5.50						
4	.099	85.0	.680	3.0	.09784	.09818	.00874	-.00088	4892.	4909.	210.	4567.	62.	4909.	-73.	4915.	-408.
1	-5.0	82.1	40.	0.0	.00812	.00044	.00058	.06775	-406.	22.	-361.	552.	.2389	1.001	411.	4070.	210.
	690.	4.740	530.	2.9	.00419	.00136	.00646	.01405	209.	409.	-4940.	514.	1.0046	.130	5.58	4932.	22.
	.31		1120.								4.90						
5	.140	85.0	.709	3.0	.09988	.10015	.00891	-.00086	4994.	5008.	200.	4030.	62.	5008.	-31.	5002.	-372.
1	-5.0	81.1	59.	0.0	.00742	.00151	.00065	.06909	-371.	66.	-288.	541.	.2362	.921	458.	4541.	200.
	694.	4.249	530.	3.9	.00399	.00311	.00725	.01572	200.	458.	-5056.	417.	1.0016	.174	11.96	5016.	46.
	.45		1120.								4.40						

TEST 472 RUN 17

PT AV	V/QR ATPP QR J	AIF,S AIF,C AXOL	MT VMIS RPM VSND	THETA A1 B1	WIND AXIS CLW CAW CYW	-----SHAFT AXIS----- CT/S CM/S CPO/S	CT CP CP/S	CMY/S CTPROP CPPROP	LIFT/Q DRAG/Q SIDE/Q	THRUST/Q MFORCE/Q POWER/Q	UNCORRECTED DATA BALANCE AXIS LIFT,U DRAG,U SIDE,U HIFLAP	PITCH,U YAW,U ROLL,U	TIP F MACH ION RHOR	MF/Q FM EFF	FE HP Q PSF	LIFT CP THRUST	CHAL SIDE HFOR
6	.196	-5.0	.730	3.0	.09823	.09862	.00876	-.00090	4912.	4921.	165.	3579.	63.	4922.	-15.	4887.	-318.
1	-5.0	-0.2	81.	0.6	.00659	.00219	.00055	.06790	-320.	110.	-177.	559.	.2366	1.059	386.	3825.	185.
	694.	3.734	530.	4.8	.00372	.00271	.00015	.01335	186.	385.	-4986.	14.	.9950	.274	21.93	4897.	109.
	.62		1121.								4.10						
7	.195	80.0	.738	3.0	.08251	.08330	.00741	-.00083	4126.	4165.	125.	4377.	63.	4167.	-27.	4105.	-586.
1	-10.0	75.6	80.	0.0	.01177	.00274	.00053	.05747	-589.	137.	-443.	516.	.2366	.846	376.	3728.	125.
	694.	8.119	530.	4.4	.00251	.00214	.00599	.01299	126.	378.	-4209.	-382.	.9951	.471	21.70	4145.	136.
	.61		1121.								3.30						
8	.196	75.0	.736	3.0	.06708	.06861	.00611	-.00082	3354.	3431.	110.	4052.	63.	3434.	-34.	3348.	-733.
1	-15.0	71.1	80.	0.0	.01472	.00314	.00054	.04733	-736.	157.	-588.	512.	.2366	.630	378.	3742.	110.
	694.	12.379	530.	3.9	.00221	.00211	.00602	.01304	111.	380.	-3446.	-1320.	.9951	.578	21.82	3414.	156.
	.61		1121.								2.90						
9	.194	75.0	.735	0.0	.03458	.03492	.00311	-.00061	1729.	1740.	40.	2077.	63.	1754.	-14.	1721.	-292.
1	-15.0	72.3	80.	0.0	.00586	.00323	.00030	.02409	-293.	164.	-150.	376.	.2367	.411	210.	2083.	40.
	694.	9.625	530.	2.7	.00080	.00194	.00335	.00726	40.	211.	-1827.	-1094.	.9953	.523	21.56	1738.	164.
	.61		1121.								2.20						
10	.195	75.0	.736	2.0	.05555	.05607	.00504	-.00074	2778.	2834.	80.	3059.	63.	2838.	-27.	2764.	-519.
1	-15.0	71.7	80.	0.0	.01164	.00313	.00045	.03910	-582.	157.	-435.	460.	.2366	.559	320.	3167.	80.
	694.	11.834	530.	3.3	.00161	.00211	.00509	.01103	80.	321.	-2872.	-1350.	.9951	.563	21.78	2820.	150.
	.61		1121.								2.60						