USAAEFA PROJECT NO. 76-11-2

AIRWORTHINESS AND FLIGHT CHARACTERISTICS EVALUATION

OH-58C INTERIM SCOUT HELICOPTER

FINAL REPORT

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UNITED STATES ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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OH-58C Helicopter Performance and Handling Qualities
Allison T63-A-720 Engine Performance Installed in the OH-58C
Flat Plate Canopy Effects - OH-58C
Nap-of-the-Earth Evaluation/Low Speed Flight Characteristics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The United States Army Aviation Engineering Flight Activity conducted an airworthiness and flight characteristics evaluation of the OH-58C Interim Scout helicopter. ~~from 25 June through 6 December 1978.~~ Performance, handling qualities, and vibration characteristics were evaluated to provide engineering test data for use in the OH-58C Operator's Manual and to detect any aircraft deficiencies or shortcomings. The OH-58C was tested at Edwards Air Force Base, California (elevation 2302 feet), and alternate test site elevations of 4120, and 9980 feet. A total of 97 flights were conducted for a total of 123.5 flight hours. Due to the more powerful T63-A-720 engine installed in the helicopter, the hover and takeoff capability at heavy gross weights and high altitudes and the forward flight climb performance of the OH-58C is → next page

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cont. significantly improved over the OH-58A. Performance in terms of power required and fuel flow is slightly degraded when compared to the OH-58A at similar gross weights and altitudes and in general did not meet the estimates of the detail specification for the OH-58C. The handling qualities and vibrations of the OH-58C are similar to the OH-58A when operating at similar gross weights and altitudes. Three handling qualities deficiencies relative to the low speed flight characteristics were identified: the inadequate directional control; the tendency for the aircraft to pitch and yaw excessively in rearward flight. These lead to the overall conclusion of unsatisfactory low speed flight characteristics. Another handling qualities deficiency was an aperiodic pitch divergence in forward flight climbs at rates of climb above 1000 ft/min. This deficiency was corrected when the engine infrared exhaust stacks were replaced with standard exhaust stacks. A human factors evaluation of the cockpit revealed one deficiency (the night vision goggle switch is easily activited and renders the caution/advisory panel unreadable), and fourteen shortcomings. Two maintenance deficiencies were also noted: an easily clogged transmission oil cooler system and an uncommanded disconnect of the primary directional control system during right sideward flight. A total of seven deficiencies and 23 shortcomings were identified. The low speed flying qualities deficiencies were observed in the OH-58A, but increased in severity due to the higher gross weight, higher altitude capability and primary mission change to Nap-of-the-Earth flight for the OH-58C. The easily clogged transmission oil cooler deficiency is common to both the OH-58A and C. The other three deficiencies are caused by OH-58C aircraft changes. Of the 23 shortcomings, 10 were attributed to the OH-58C modification and 12 shortcomings are common to both the OH-58A and C.

DEPARTMENT OF THE ARMY
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DRDAV-DI

31 DEC 1979

SUBJECT: Director for Development and Qualification Position on the Final Report of USAAEFA Project No. 76-11-2, Airworthiness and Flight Characteristics Evaluation, OH-58C Interim Scout Helicopter

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1. The Directorate for Development and Qualification position on the subject report is provided herein. Paragraph numbers from the subject report are provided for reference.

2. While the OH-58C fell short of the estimated performance as defined in paragraph 103, it exceeded the minimum vertical rate of climb requirement of the ROC dated 4 Dec 75 based on the following analysis:

Requirement at 3000 lbs	Equivalent ROC Hover Requirement	Test Result
VROC = 200 ft/min at 2000 ft/95° F	2820 ft/95° F	4350 ft/95° F

As stated in the conclusions (para 99), while the fuel consumption is increased due to the higher drag resulting from the flat plate canopy to reduce glint detectability, the OH-58C represents a substantial overall performance improvement over the OH-58A.

3. The increase in gross weight of the OH-58C to 3200 lbs from the 3000 pounds of the OH-58A appears to be a setback in terms of vibration characteristics. The vibration data contained in this report and flight loads data obtained during the contractor test program will be used to re-evaluate the never exceed speed (VNE) limits of the OH-58C at 3200 lbs.

a. Deficiencies

(1) Para 100a - A product improvement program is underway which will eliminate the inadequate directional control problem with the increased OH-58C performance capability. It involves a larger tail rotor and potentially the incorporation of a 3 axis SCAS. An engineering evaluation of the larger tail rotor has been conducted and a user evaluation of both the larger tail rotor and SCAS is scheduled for March, 1980.

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(2) Para 100b - The incorporation of a SCAS will eliminate the excessive pitch and yaw in rearward flight.

(3) Para 100c - Pending any incorporation of a SCAS, the rate of climb has been limited to 1000 ft/min in the Operator's manual when the IR exhaust stacks are installed. This eliminates the aperiodic pitch divergence discussed in this report in that neutral stability will exist.

(4) Para 100d - Since the inspection time was reduced from 150 hours to 50 hours on the OH-58A, no field problems have been reported. The transmission oil cooler system is the same on both the OH-58A and OH-58C. Even if the cooler did clog, an oil temperature caution light is included in the instrument panel which would allow pilot action before any detrimental condition resulted; therefore, this is not considered a deficiency.

(5) Para 100e - The manufacturer inspected the disconnect and discovered the internal shimming to be out of tolerance. The disconnects have been reworked and the acceptance test procedure revised.

(6) Para 100f - A night vision goggle ENABLE/DISABLE switch has been added to all aircraft solving this problem.

(7) Para 100g - The incorporation of a SCAS will eliminate the excessive pitch, roll and yaw in left sideward flight.

b. Shortcomings

(1) Para 101a and c - The incorporation of a SCAS will improve dynamic stability, thus reducing the significance of the poor static stability characteristics.

(2) Para 101b - No corrective action is planned at this time, however the 3200 lb flight envelope will be re-evaluated as mentioned above.

(3) Para 101d - An improved, convex windshield has been installed in all OH-58C's to solve the bowing and vibrating problem.

(4) Para 101e and g - The only way to solve these problems is to install individual rheostats to all gauges, adjusting to a common light level before delivery. This will be considered in any future instrument panel modification.

(5) Para 101f - Do not agree that this is a problem. The subject comments would require dual instruments for each pilot and necessitate a larger instrument panel, which the user community says is too large now. For "out-of-the cockpit" operation, only a torque limiter would improve the situation.

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(6) Para 101h - Relocation of the AN/ARN-89 will be considered in any future instrument panel modification.

(7) Para 101i and j - The radar altimeter has been removed from the aircraft.

(8) Para 102a, b, c, e, g, i and l - Military characteristics for the procurement of the OH-58A emphasized an extremely small, simple and low cost aircraft recognizing that to achieve this, many desirable military features would have to be traded off. The OH-58C was intended to improve the performance, detectability and vulnerability of the OH-58A with minimal possible changes. In light of the above, improvements were never intended.

(9) Para 102d - The incorporation of a SCAS will eliminate the easily excited gust response.

(10) Para 102f - This problem is present on early serial numbered OH-58A's. The fix, a suppression diode across the magnetic brake, will be incorporated on all affected unmodified aircraft during conversion.

(11) Para 102h - An ECP has been requested from BHT to provide a better location of the stand-by compass, however this instrument is very susceptible to EMI, therefore few alternate locations are available.

(12) Para 102j and k - The incorporation of a larger boosted tail rotor should improve the directional control sensitivity. No improvement in the cyclic trim displacement bands are invisioned.

(13) Para 102m - For the present the AN/APX-100 and KY-28 controls were interchanged. This somewhat improved the readability of the APX-100 but only a redesign of the instrument panel will totally solve this problem.

c. Recommendations

(1) Para 105, 106, 110 and 116 - Concur, except as noted above.

(2) Para 107 and 109 - The incorporation of a SCAS and larger tail rotor will satisfy these recommendations.

(3) Para 108 - Nonconcur in that such a limit is not practical.

(4) Para 111, 114 and 117 - Maintenance manual changes have been submitted for these items.

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(5) Para 112 - Incorporation of a warning system would be too complex and expensive. A caution in the Operator's manual may be appropriate when more data is available.

(6) Para 113 - This recommendation will be considered for future evaluations.

(7) Para 115 - The inspection interval has already been reduced and no field problems have been reported.

CHARLES C. CRAWFORD, JR.
Director of Development
and Qualification

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INTRODUCTION

BACKGROUND

1. The United States Army Aviation Systems Command* awarded a contract to Bell Helicopter Textron (BHT) in June 1976 to design, fabricate, and test two prototype Model OH-58C helicopters. The primary design objectives were to provide improved hover performance, improved climb performance, and reduced ballistic vulnerability. The OH-58C is a derivative of the OH-58A and is intended to be the Army's interim scout helicopter into the 1980's. The interim scout mission includes a number of demanding tasks which were not a part of light observation Helicopter (OH-58A) mission to include extensive operation in a Nap-of-the-Earth (NOE) environment. Modifications include incorporation of an Allison T63-A-720 engine rated at 420 shaft horsepower (SHP) at sea level standard day conditions, flat plate canopy, low reflective (LR) paint, infrared counter measure (IRCM) exhaust system, ballistic-tolerant flight control rods and vulnerability-reduction directional flight control system. In November 1977, the United States Army Aviation Engineering Flight Activity (USAAEFA) was directed to prepare a test plan and conduct an airworthiness and flight characteristics evaluation (A&FC) of a production OH-58C helicopter. A test plan was prepared in April 1978 (ref 1, app A).

TEST OBJECTIVES

2. The objectives of the OH-58C A&FC were as follows:

a. Determine compliance with the requirements of the OH-58C Detail Specification (ref 2, app A).

b. Obtain engineering flight test data for use in the OH-58C operator's manual (ref 3).

c. Determine the effects of the flat plate canopy on the aircraft pitot-static system error.

d. Determine any shortcomings or deficiencies.

DESCRIPTION

3. The OH-58C is a derivative of the OH-58A helicopter that is manufactured by Bell Helicopter Textron (BHT) Fort Worth, Texas. OH-58A helicopters are modified to the OH-58C configuration by 19 primary kits. The OH-58C modification incorporates a flat plate canopy, low reflective (LR) fuselage paint, infrared counter measure (IRCM) exhaust system, a tail rotor drive shaft cover, and a redesigned cockpit instrument panel with new types of indicator gauges and avionics. Also, a vulnerability-reduction directional control system is installed. This system is redundant with push-pull tubes in the primary system and a push-pull cable in the

*Since redesignated the Army Aviation Research and Development Command (AVRADCOM).

secondary (backup) system, neither of which is hydraulically boosted. The OH-58A and OH-58C have identical two-bladed semi-rigid, teetering-type main rotors and single two-bladed, delta-hinged, semi-rigid, teetering-type tail rotors. The maximum takeoff gross weight of the OH-58C is 3200 pounds compared to 3000 pounds for the OH-58A. The OH-58C is powered by an Allison T63-A-720 turboshaft engine that has an uninstalled standard day, sea level, static intermediate rated power (30 minutes) of 420 SHP. The main transmission has the same power limits as the OH-58A, takeoff power (5 minutes) of 317 SHP and maximum continuous of 270 SHP. The OH-58C aircraft configuration, cockpit and flight controls are similar to the OH-58A. A more detailed description is presented in appendix B.

4. The test helicopter, US Army S/N 68-16724 (photos 1 and 2, appendix B) was a production model OH-58A with 1800 airframe hours prior to reconfiguration to OH-58C specifications. The test aircraft is representative of a production OH-58C with the exception of a flight test boom which extended forward of the aircraft from the landing light mounting point, a modified instrument panel, and special test instrumentation equipment. The special instrumentation equipment was installed in the passenger/cargo compartment of the aircraft and is described in appendix C.

TEST SCOPE

5. The A&FC evaluation was conducted at Edwards Air Force Base (2302-foot elevation), Bishop (4120-foot elevation), and Coyote Flats (9980-foot elevation), California. During the program 97 flights were flown for a total of 123.5 flight hours of which 79.6 were productive test hours. General test conditions are shown in tables 1 and 2. Flight restrictions and limitations observed during the A&FC are contained in the operator's manual and the airworthiness release (ref 4, app A). Test results were analyzed with respect to the OH-58C Detail Specification (ref 2), Military Specification MIL-H-8501A (ref 5), and previous USAAEFA test results (refs 6 through 11).

6. The test scope was expanded after the original flight tests were completed. USAAEFA was directed (ref 12, app A) to evaluate the OH-58C on a NOE training course and obtain quantitative vibration data at high airspeeds. An abbreviated test plan was prepared in November 1978 and is included as appendix G in this report. A total of 16 additional flights were conducted for a total of 19.7 flight hours, of which 8.3 was productive test time. The vibration assessment was conducted at Edwards Air Force Base, California. The NOE course used for the evaluation is located at Fort Hunter-Liggett, California.

TEST METHODOLOGY

7. Established flight test techniques were used (refs 13 and 14, app A). The test methods and data analysis methods are briefly described in appendix D. A Handling Qualities Rating Scale (HQRS) (Fig. 1, app D) was used to augment pilot comments relative to handling qualities. A Vibration Rating Scale (VRS) (fig. 2, app D) was used to augment pilot comments relative to vibration.

RESULTS AND DISCUSSION

GENERAL

8. The performance and handling qualities of the OH-58C helicopter were evaluated at Edwards Air Force Base (elevation 2302 feet), Bishop (elevation 4120 feet), and Coyote Flats (elevation 9980 feet), California at the general test conditions listed in tables 1 and 2. The performance evaluation included free flight and tethered hover, forward climbs, level flight and autorotational descents. Due to the more powerful T63-A-720 engine installed in the helicopter, the hover and takeoff capability at heavy gross weights and high altitudes and the forward flight climb performance of the OH-58C is significantly improved over the OH-58A. Performance in terms of power required and fuel flow is slightly degraded when compared to the OH-58A at similar gross weights and altitudes and in general did not meet the estimates of the detail specification for the OH-58C. The handling qualities and vibrations of the OH-58C are similar to the OH-58A when operating at similar gross weights and altitudes. Three handling qualities deficiencies relative to the low speed flight characteristics were identified: the inadequate directional control; the tendency for the aircraft to pitch, roll, and yaw excessively in left sideward flight; and the tendency for the aircraft to pitch and yaw excessively in rearward flight. These lead to the overall conclusion of unsatisfactory low speed flight characteristics. One deficiency attributed to the increased rate of climb capability of the OH-58C was an aperiodic pitch divergence in forward flight climbs at rates of climb above 1000 ft/min. A human factors evaluation of the cockpit revealed one deficiency (the night vision goggle switch is easily activated and renders the caution/advisory panel unreadable), and fourteen shortcomings. Two maintenance deficiencies were also noted: an easily clogged transmission oil cooler system and an uncommanded disconnect of the primary directional control system during right sideward flight. A total of seven deficiencies and 24 shortcomings were identified. The low speed flying qualities deficiencies were observed in the OH-58A, but increased in severity due to the higher gross weight, higher altitude capability and primary mission change to Nap-of-the-Earth flight for the OH-58C. The easily clogged transmission oil cooler deficiency is common to both the OH-58A and C. The other three deficiencies are caused by OH-58C aircraft changes. Of the 24 shortcomings, 11 were attributed to the OH-58C modification and 13 shortcomings are common to both the OH-58A and C.

PERFORMANCE

Hover Performance

9. The hover performance capability of the OH-58C was evaluated by determining the engine power required to hover in-ground-effect (IGE) at skid heights of 2 and 10 feet and out-of-ground-effect (OGE) at a 50 foot skid height. Tests were conducted using free flight and tethered hover techniques. A description and photographs of the tethered hover rig are included in appendix C. A summary of the hover performance is presented in figure 1 and non-dimensional test results are presented in figures 2 through 4, appendix E.

Table 1. General Performance Test Conditions[1]

Test	Gross Weight (LB)	Density Altitude (FT)	Calibrated Airspeed (KTS)	Remarks
Hover	2700 to 3250	2860 to 10200	zero	Skid heights: 2 & 10 feet IGE and 50 OGE, free flight and tethered hover
Takeoff	3050, 3100	10600, 10180	zero to 53	Level acceleration from a 2 foot hover
Forward Flight Climb	2700	6600	30 to 80	Sawtooth climbs Kp[2]
Level Flight	2720 to 3160	2720 to 9920	30 to 111	Baseline data, $N/\sqrt{\theta}$ 345 rpm
	2740, 3100	4520, 4920		CG effects 111.1 & 111.5 (AFT)
	2700, 3040	4960, 5960		Crew doors off
	2780, 3040	9640, 6560		$N/\sqrt{\theta}$ variation 350 and 355
	2940	7000	55, 78, 93	Sideslip effects
Autorotation	2700. 3150	6920	20 to 101	Rotor speeds varied from 330 to 389 rpm

[1]Tests conducted at zero sideslip in the clean configuration with all doors on maintaining $N/\sqrt{\theta}$ = 345 rpm constant and longitudinal cg near 107.5 in. (FWD), lateral cg within ±1 inch unless otherwise noted.

[2]Kp - Power correction factor.

Table 2. General Handling Qualities Test Conditions[1]

Test	Gross Weight (LB)	Density Altitude (FT)	Trim Calibrated Airspeed (KTS)	Remarks	
Control Position in Trimmed Forward Flight	3000	5100, 6000, 10100	29 to 111	Level flight	FWD CG
		4400, 4900, 11600			AFT CG
		5000, 7000			FWD CG, doors off
		7200	38 to 71	Climb, FWD CG	
	2700	6700	33 to 102	Autorotation, FWD CG	
Static Longitudinal Stability	2900	6700	56 and 94	Level flight	
			55 and 72		
		11900	52	Climb	
		6800	49	Autorotation	
		5700			
Static Lateral-Directional Stability	2800	4900	52	Level flight	
			79		
		11500	48	Climb	
		8500	54	Autorotation	
		7300			
Maneuvering Stability	2900	7100	51, 89, 95	Steady turns (both directions)	
Dynamic Stability	2900	6200	51, 93	Level flight	
		11600	50, 71	Climb and autorotation	
		6400	50		
Controllability	3200	4400, 9600	zero	Hover	
	2900	6200	91	Level flight	112.3 (AFT)
	3200	5200	51, 72, 82, 93		108.0 (FWD)
	2700	6200			109.4 (AFT)
	3200	6100	93		110.4 (AFT)
					111.3 (MID)
Low Speed Flight Characteristics	3200, 3100	5000, 11100	zero to limit airspeeds[2]	Slow speed forward, rearward, and sideward flight	
	3200, 3000	5400, 10300		Critical azimuth tests	
Simulated Engine Failures	2800	6200	51, 105	Level flight	
		6400	52	Climb	
Vibration	3200	5300, 10600 and 13400	61 to 118	Level flight and dives	
	3000				
	2800				

[1]Tests were conducted in ball-centered flight in the clean configuration with all doors on, with the longitudinal CG maintained near the AFT limit, and the lateral CG maintained within ±1 inch unless otherwise noted.

[2]Limit airspeeds; sideward airspeed limit 35 knots true airspeed (KTAS), rearward airspeed limit 30 KTAS.

10. Figure A presents the OH-58C hover performance capability compared to the OH-58A for both standard and hot days. Under standard day conditions and 3000 pounds gross weight, the OH-58C is capable of hovering OGE at 9640 feet; whereas, the OH-58A hover ceiling is 4580 feet. This is an increase of 5060 feet in the OH-58C hover ceiling. At the same gross weight but using the Army hot day criteria (35°C), the OH-58A is not capable of hovering OGE at sea level where the OH-58C has an OGE hover ceiling of 4380 feet. The OH-58C can operate at higher gross weights and altitudes than the OH-58A. These increases in hover performance capability are a result of the additional power available from the Allison T63-A-720 engine installed in the OH-58C helicopter. The hover performance capability of the OH-58C is significantly improved over the OH-58A, but failed to meet the estimates of the detail specification for the Interim Scout helicopter, 206-947-203 (ref 2, app E). The OH-58C can not hover OGE at 3200 lb gross weight at the specified 4250 feet on a hot day (35°C). The OGE hover ceiling at these conditions was 2890 feet, 1360 feet less than the estimate.

11. Test results for the OH-58A helicopter obtained from the US Army Aviation Sytems Test Activity Final Report Number 68-30 (ref 6, app A), are presented on the OH-58C non-dimensional plots in appendix E. Comparing these results shows that slightly more power is required to hover the OH-58C than the OH-58A at the same gross weight and density altitude. This was observed at all skid heights, gross weights, and altitudes tested. No compressibility effects were observed in the non-dimensional hover performance data at the conditions tested.

12. The standard day OGE hover ceiling at the OH-58C maximum takeoff gross weight of 3200 pounds was 7680 feet using the intermediate rated power (IRP) (30 minutes) of the engine. At a 2 foot skid height under the same conditions and gross weight, the IGE hover ceiling was 11680 feet. The OGE hover ceiling using the Army hot day criteria (35°C) was 2880 feet at 3200 pounds using the intermediate rated power (30 minutes) of the engine.

Takeoff Performance

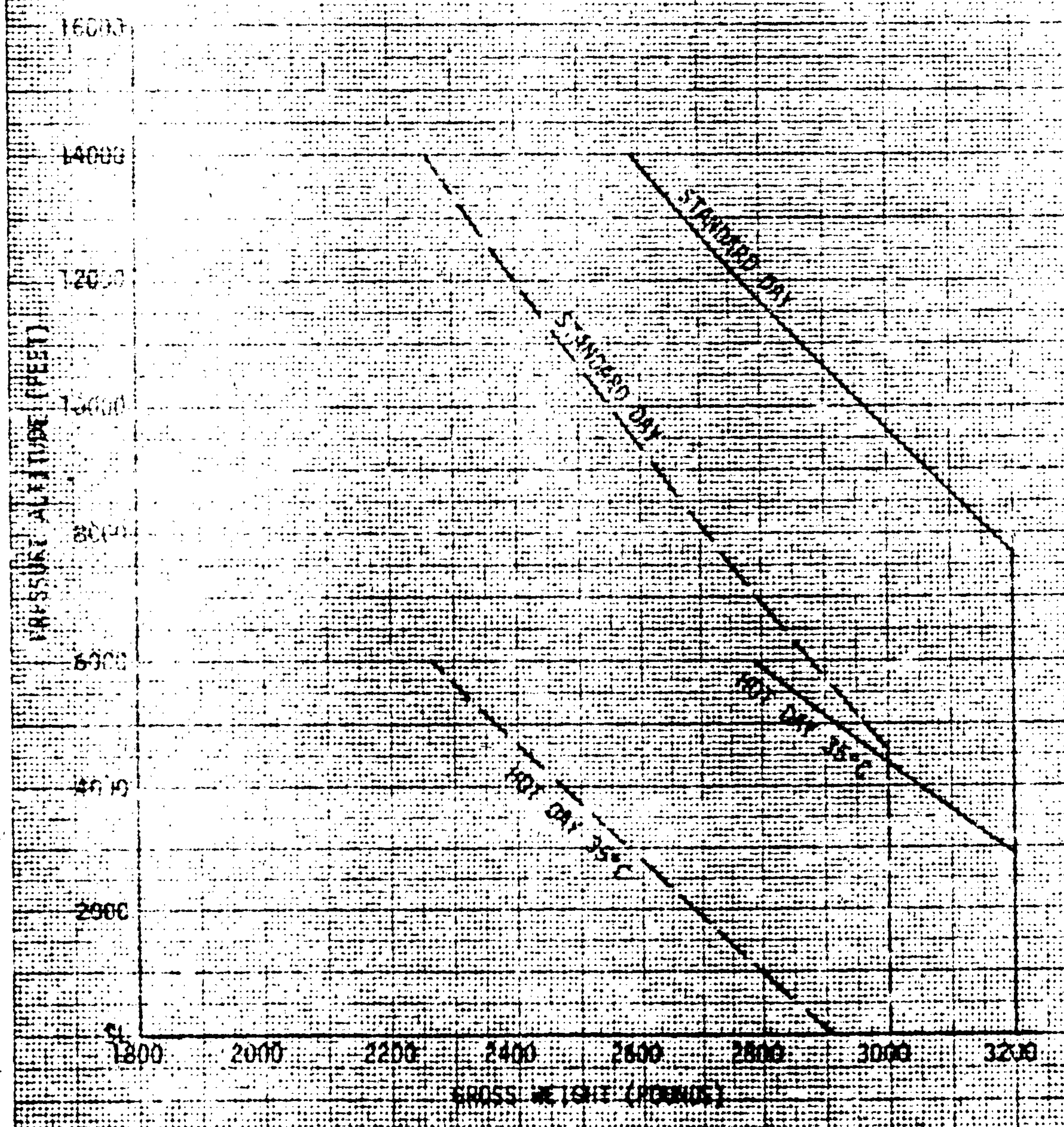
13. Takeoff performance tests to determine the takeoff distance required to clear a 50-foot obstacle were conducted for comparison with the OH-58A helicopter (ref 6, app A). Takeoffs utilized the level acceleration takeoff method and were initiated from a stabilized hover at a two foot skid height. These tests were conducted at density altitudes and gross weights where limited excess power was available in order to compare OH-58C data to the OH-58A test results. Test results are presented in figures 5 and 6, appendix E. The curves presented in these figures were derived from reference 6 and show that the OH-58C has similar takeoff performance characteristics in terms of takeoff distance when compared to the OH-58A helicopter. Vertical Climb performance tests were not conducted. However, based on the engine specifications, the excess power available (engine power available minus the power required to hover OGE) of the OH-58C is significantly increased over that of the OH-58A. This allows the OH-58C to takeoff and climb vertically or initiate normal forward flight takeoffs at higher gross weights and altitudes than the OH-58A.

FIGURE A

HOVER CEILING (OGE) COMPARISON

(INTERMEDIATE RATED POWER)

OH-58A	OH-58C
1. DASHED LINES.	1. SOLID LINES.
2. ROTOR SPEED: 354 RPM.	2. ROTOR SPEED: 354 RPM.
3. DATA DERIVED FROM FINAL REPORT USAASTA 68-30.	3. DATA DERIVED FROM FIGURES 4 AND 10



Generalized Forward Flight Climb and Descent Performance

14. The forward flight climb and descent performance of the OH-58C was evaluated using the sawtooth climb and descent technique at a constant referred rotor speed. Summaries of the forward flight climb performance and the climb airspeed schedules are presented in figures 7 and 8, appendix E. Generalized climb and descent test data are presented in figure 9.

15. The maximum rate of climb at sea level, standard day and hot day (35°C) conditions at 3200 pounds gross weight was determined to be 1375 ft/min and is limited by the main rotor transmission 317 shp limit. At the same gross weight and standard day conditions, the OH-58C has over 1000 ft/min rate of climb capability at 10,000 feet. The standard day service ceiling (altitude at which a 100 ft/min rate of climb is the maximum achievable) was determined to be 15,520 feet. This fails to meet the estimated service ceiling (16,400 feet) of the detail specification.

16. The power correction factor, Kp, was determined from figure 9 to be 0.75 for climb performance calculations. This compares to 0.80 for the OH-58A (ref 6, app A). While the Kp comparison shows degraded climb efficiency, the rate of climb capability is increased due to the additional power available from the engine installed in the OH-58C. Figure B presents a comparison of the OH-58C climb performance to the OH-58A and shows, at the same gross weight, the service ceiling of the OH-58C is slightly reduced, but that the rate of climb is improved at altitudes below 16,500 feet.

Level Flight Performance

17. Level flight performance tests were conducted to determine power required and fuel flow as a function of airspeed, gross weight and density altitude. The constant referred gross weight and rotor speed (W/δ, $N/\sqrt{\theta}$) method was used to obtain data in stabilized level flight at incremental airspeeds ranging from approximately 30 knots true airspeed (KTAS) to the maximum airspeed for level flight. Baseline data were obtained at zero sideslip and a forward longitudinal cg location (found to be most adverse for performance). Additional data was obtained to determine the effects of sideslip, longitudinal cg location, removing crew doors and various referred rotor speeds. Results of these tests are presented non-dimensionally in figures 10 through 12, as range and endurance summaries in figures 13 through 15, and dimensionally in figures 16 through 29.

18. Figure C presents a comparison of the OH-58A and OH-58C level flight performance at sea level, standard day conditions. These data were derived for the clean, doors on configuration, with a forward cg location and zero sideslip. Test results show that the OH-58C has increased power required when compared to the OH-58A due to increased accessory losses and fuselage drag (refs 2 and 9, app A). For example, at the OH-58A cruise airspeed, 109 KTAS, the OH-58C requires an additional 30 shp. This increased power requirement reduces the range and endurance of the OH-58C in comparison to the OH-58A, at sea level, standard day conditions for the mission profile presented in figure D. Paragraphs 95 through 97 present a discussion of the installed engine power available of the OH-58C. The more powerful engine improves the level flight capability of the OH-58C over the OH-58A

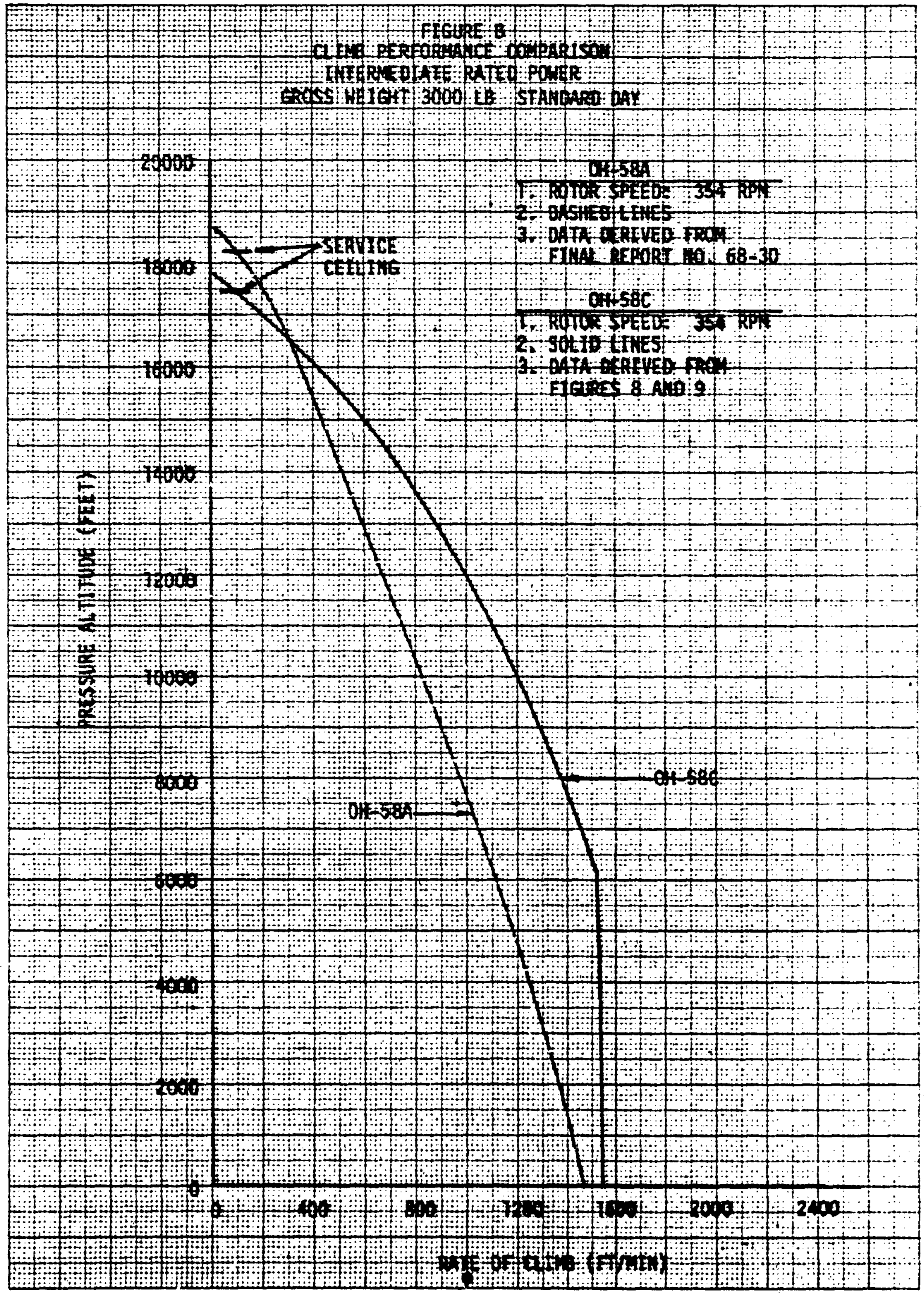


FIGURE 8
CLIMB PERFORMANCE COMPARISON
INTERMEDIATE RATED POWER
GROSS WEIGHT 3000 LB STANDARD DAY
OH-58A
1. ROTOR SPEED: 354 RPM
2. DASHED LINES
3. DATA DERIVED FROM
FINAL REPORT NO. 68-30
OH-58C
1. ROTOR SPEED: 354 RPM
2. SOLID LINES
3. DATA DERIVED FROM
FIGURES 8 AND 9
SERVICE
CEILING
OH-58C
OH-58A
PRESSURE ALTITUDE (FEET)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
400
800
1200
1600
2000
2400
RATE OF CLIMB (FT/MIN)

FIGURE C
LEVEL FLIGHT PERFORMANCE COMPARISON
OH-58A AND OH-58C

AIRCRAFT MODEL	GROSS WEIGHT (LB)	LONGITUDINAL CG LOCATION (FS)	DENSITY ALTITUDE	OAT (°C)	ROTOR SPEED (RPM)	C_T
OH-58A	3000	107.3	SEA LEVEL	15.0	354	0.002999
OH-58C	3000	107.3	SEA LEVEL	15.0	354	0.002999

NOTES: 1. ZERO SIDESLIP.
2. CONFIGURATION: CLEAN, DOORS ON.

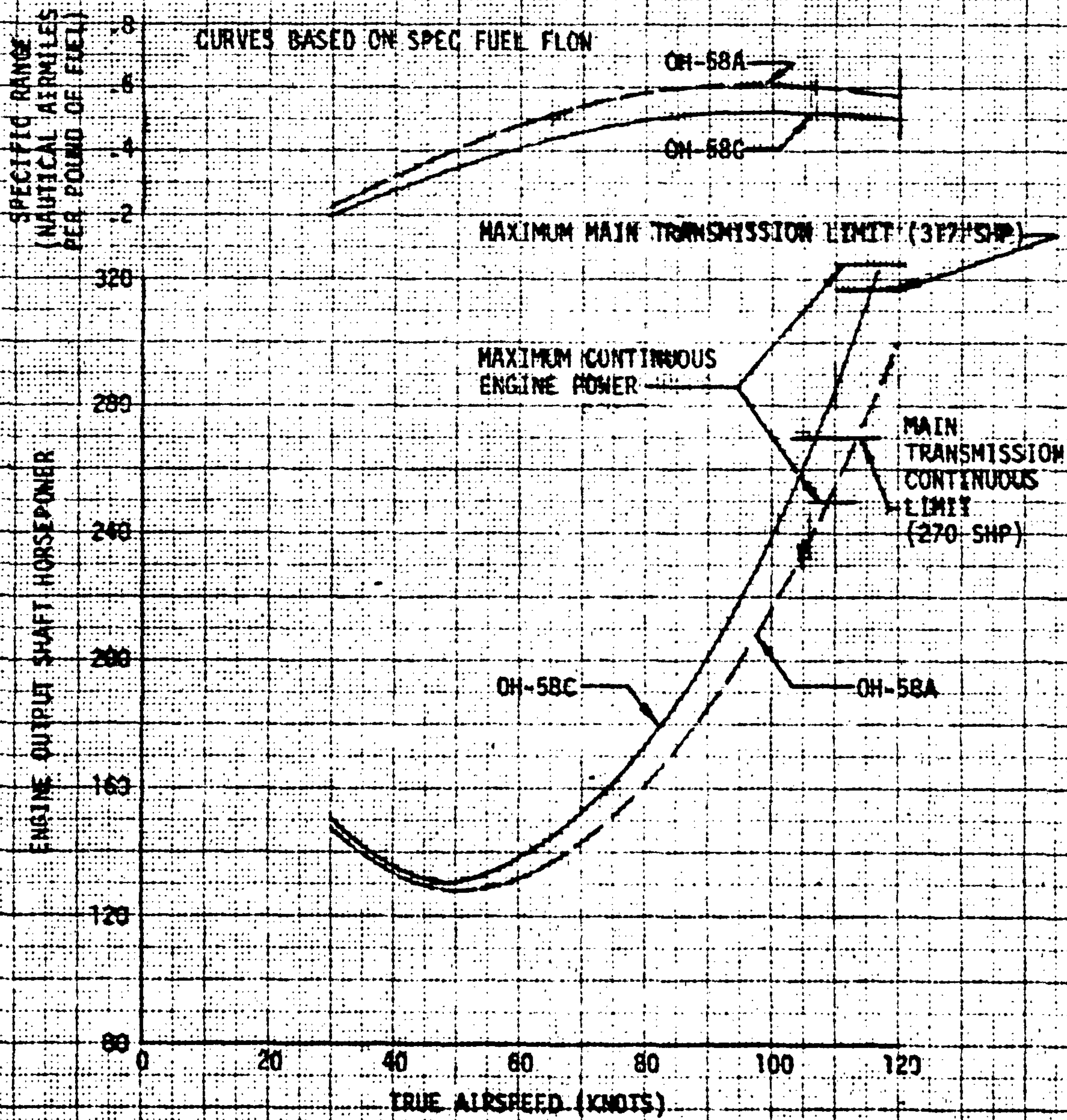
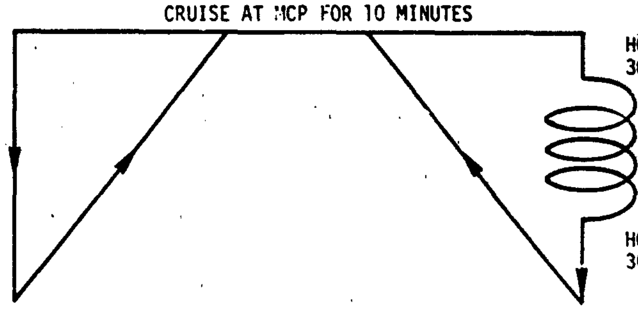


FIGURE D
MISSION PROFILE

SEA LEVEL STANDARD DAY CONDITIONS



MISSION SEGMENT	FUEL USED (LB) OH-58A	OH-58C
8 MINUTES AT GROUND IDLE (FLAT PITCH)	13.0	13.0
CRUISE OUT AT MCP FOR 10 MINUTES	30.5	34.6
HOVER OGE FOR 30 MINUTES	91.0	100.4
LOITER FOR 30 MINUTES AT V_{END}	62.0	70.0
HOVER OGE FOR 30 MINUTES	91.0	100.4
CRUISE IN AT MCP FOR 10 MINUTES	30.5	34.6
LAND WITH 30 MINUTES RESERVE FUEL AT MCP	91.5	103.8
TOTAL FUEL FOR MISSION	409.5	456.8

NOTE: 1. ALL MISSION SEGMENTS CALCULATED AT 3000 LB GROSS WEIGHT.
2. USEABLE FUEL FOR BOTH OH-58C AND OH-58A = 457 LB.

in that operation at heavier gross weights and slightly higher airspeeds is possible. However, the estimates for range and endurance of the detail specification (ref 2, app A) were not met. At 2000 feet pressure altitude, 35°C, maximum continuous power, the range was 175 nautical miles, 10 nautical miles less than the estimate, and the endurance was 2.4 hours, 0.4 hours less than the estimate.

19. The effects of removing the crew doors or changing to an aft cg on the level flight performance was a constant change in the equivalent flatplate area (Δfe) of the clean, doors on configured helicopter. Removing the crew doors caused an increase in equivalent flatplate area of 0.65 square feet while changing to an aft cg caused a decrease of 0.25 square feet. Figure 15, appendix E, presents a comparison of the effect of removing the crew doors on the range performance of the OH-58C. Removing the crew doors caused a reduction of approximately 1.5% in the range performance.

20. Data for three referred rotor speeds (345, 350, 355 rpm) was obtained at the same non-dimensional thrust coefficient (C_T = 0.003723). Data at these referred rotor speeds is presented in figures 20, 28, and 29. There were no significant differences in level flight performance attributed to the different referred rotor speeds which indicates negligible compressibility effects within the range tested.

21. The effects of various angles of sideslip on the power required for level flight are presented in figure 16. The change in power required is greater for right than for left sideslip and increases with both airspeed and sideslip angle. However, with the aircraft trimmed in ball-centered flight there was less than 5 degrees of sideslip for airspeeds up to 93 knots with no change in the power required from the zero sideslip condition.

Autorotational Descent Performance

22. The autorotational descent performance of the OH-58C was evaluated to determine any change to the optimum airspeed for minimum rate of descent ($V_{min\ R/D}$) or maximum glide distance ($V_{max\ glide}$) in autorotational flight. Figure 30, appendix E presents the test results.

23. Figure 30 presents the autorotational descent performance for two gross weights near the same density altitude. The fairing through the data was derived from reference 6, appendix A and shows the optimum airspeed for minimum rate of descent and for the maximum glide distance in power-off flight to be the same as for an OH-58A. The estimate of the detail specification (ref 2, app A) was met. The autorotational descent performance of the OH-58C is similar to an OH-58A and is satisfactory.

HANDLING QUALITIES

Control System Characteristics

24. The mechanical characteristics of the OH-58C flight control system were measured on the ground with the rotor and engine stopped. Hydraulic and electrical power were provided by external sources. All adjustable control friction devices were OFF and force trim was ON. The only control cross coupling is a mechanical cross coupling of longitudinal cyclic to collective.

25. The variation of control position with applied control force for the longitudinal and lateral controls is presented in figures 31 and 32, appendix E. The longitudinal and lateral cyclic control force gradients were positive and essentially linear with no discontinuities. A summary of the cyclic control system mechanical characteristics is presented in table 3. Longitudinal and lateral characteristics were positive

Table 3. Longitudinal and Lateral Control System Mechanical Characteristics Summary[1]

PARAMETER	CONTROL	
	LONGITUDINAL	LATERAL
Control travel (in.)	12.0	9.7
Breakout force including friction (lb)	0.8 FWD 1.5 AFT	1.3 LT 2.0 RT
Average force gradient near trim (lb/in.)	1.0 FWD 1.5 AFT	0.5 LT 0.5 RT
Average friction band near trim (lb)	2.0 FWD 2.5 AFT	2.5 LT 2.5 RT
Trim control displacement band (in.)	1.3	3.4
Control centering	Positive FWD and AFT	Positive LT and RT
Control position free play (in.)	<0.1	<0.1
Stick jump	Negligible	Negligible

[1]Hydraulic boost and force trim ON, adjustable control friction OFF. Rotor stopped, external hydraulic and electrical power applied.

but did not return the control to the original position. This resulted in 1.3-inch longitudinal and 3.4-inch lateral trim control displacement bands. In flight, the large trim control displacement bands resulted in increased pilot compensation to maintain desired attitude and airspeed (HQRS 4) in that the controls would not return to trim and there were no force cues to the pilot indicating an out of trim condition. The large longitudinal and lateral cyclic trim control displacement bands are similar to those of an OH-58A and remain a shortcoming.

26. The directional control breakout force (including friction) for the primary system was 6.8 pounds right and 5.5 pounds left. The backup directional control system breakout force (including friction) was 5.5 pounds in both directions when measured with the primary system disengaged. The directional control system did not incorporate a force trim mechanism; therefore, no force gradient or control centering were measured. In flight, with the primary directional control system disengaged, a slight reduction in tail rotor control authority was evident. Negligible control position free play (less than 0.1 inch) was measured in the directional control system on the ground.

27. The collective control breakout force (including friction) was approximately 3 pounds when pulling up from a full down position and approximately 2.5 pounds when pushing down from a full up position. Total collective control travel was 10 inches at the center of the grip. Negligible control position free play (less than 0.1 inch) was noted in the collective control system. Other than attributing to the ease of overtorque discussed in paragraph 78, the collective control system is satisfactory.

Control Positions in Trimmed Forward Flight

28. Control positions of the OH-58C in trimmed forward flight were evaluated in conjunction with level flight, climb and autorotation performance testing. Test results are presented as figures 33 through 38, appendix E.

29. The variation of longitudinal control position with airspeed during trimmed forward flight was conventional in that increasing forward cyclic displacement was required with increasing trimmed airspeed. At a forward cg, the longitudinal control gradient was conventional throughout the airspeed range tested. At an aft cg, the longitudinal control position gradient was conventional at high airspeeds, but was essentially neutral between 30 and 50 KCAS (figs. 33 through 35, app E). The variation of lateral and directional control postions with airspeed during level flight was minimal. Control position characteristics in the clean, doors off configuration (figs. 36 and 37) were essentially the same. Control margins in all cases were adequate and trim changes from level flight to autorotation or climbs were not objectional (fig. 38). The control position characteristics in level and autorotational flight were similar to the OH-58A and are satisfactory.

30. During high power climbing flight at airspeeds between 35 and 70 KCAS, the aircraft was difficult to control in pitch and required continuous large amplitude control motions to maintain pitch attitude and airspeed (HQRS 6). Pitch attitude excursions of ±6 degrees with pilot control motions of up to one inch while trying to maintain stabilized flight are shown in figure 38. The inability to trim the aircraft in climbing flight is a shortcoming and is further discussed in paragraphs 32 and 45.

Static Longitudinal Stability

31. Static longitudinal stability characteristics of the OH-58C were determined using the techniques described in appendix D. Test results are presented in figures 39 through 41, appendix E. The static longitudinal stability was weak but positive at level flight trim airspeeds near 55 KCAS at both altitudes tested. At trim airspeeds near recommended cruise airspeeds the static longitudinal stability was neutral for airspeeds below trim and weakly positive for airspeeds above trim. The weakly positive to neutral longitudinal stability required increased pilot attention to establish and maintain a desired airspeed (HQRS 4). The difficulty in maintaining airspeed may result in large airspeed excursions when the pilot is performing mission tasks and may degrade mission accomplishment. The longitudinal control gradients near cruise airspeeds at an aft cg failed to meet the requirements of MIL-H-8501A, paragraph 3.2.10. The static longitudinal stability of the OH-58C near cruise airspeeds is unchanged from the OH-58A, is unsatisfactory, and remains a shortcoming.

32. In climbing flight, at rates of climb in excess of 1000 ft/min, at a trim airspeed near 50 KCAS, stabilizing the aircraft in pitch was difficult (HQRS 6) and required extensive pilot compensation to keep the aircraft from developing large pitch attitude deviations. This tendency is unsatisfactory, a shortcoming, and further discussed in paragraph 45.

33. In autorotational flight at trim airspeeds near 50 KCAS the longitudinal stability was positive for airspeeds below trim but neutral at airspeeds above trim. Although these characteristics do not meet the requirements of MIL-H-8501A paragraph 3.2.10 precise airspeeds were easily established and maintained and were satisfactory.

Static Lateral-Directional Stability

34. Static lateral-directional stability characteristics of the OH-58C were determined by trimming the aircraft at zero sideslip and the desired conditions. With the collective control fixed, the aircraft was then stabilized at incremental sideslip angles up to the limit sideslip, both right and left, while maintaining a steady heading at the trim airspeed. Test results are presented in figures 42 through 44, appendix E.

35. Static directional stability, as indicated by the variation of directional control position with sideslip, was positive at all test conditions. The static directional stability was essentially neutral in autorotation at a trim airspeed of 54 KIAS, which required increased pilot attention to preclude an out of trim condition with resulting increased rates of descent. The static directional stability of the OH-58C was essentially unchanged from OH-58A test results and is satisfactory.

36. Dihedral effect, as indicated by the variation of lateral control position with sideslip, was positive at all conditions tested, but very weak in autorotation. The effective dihedral of the OH-58C was essentially unchanged from OH-58A and is satisfactory.

37. Side force characteristics, as indicated by the variation of roll attitude with sideslip, were positive at all conditions tested. The side force characteristics in level flight were weaker at trim airspeeds near 50 KCAS than at trim airspeeds near

80 KCAS. In a stabilized autorotation at 54 KCAS, the roll attitude gradient was very shallow at sideslip angles less than 20°. The side force characteristics are essentially unchanged from OH-58A test results and are marginally satisfactory.

Maneuvering Stability

38. Maneuvering stability was evaluated in left and right steady turns. Steady turns were conducted by establishing the desired level flight airspeed and then stabilizing at increasing bank angles while maintaining collective control and airspeed constant. Results of the maneuvering stability tests are presented in figure 45, appendix E.

39. The stick-fixed maneuvering stability in steady state turns, as indicated by the variation of longitudinal control position with normal acceleration (g), was positive at all test conditions except at 99 KCAS and above 1.35g. Above 1.35g's at 99 KCAS the maneuvering stability changes from positive to negative giving a divergent pitch-up which appears to the pilot as a "dig in" tendency. In addition to this reversal, continuous cyclic control inputs were required to control the aircraft. The pilot was unable to maintain a constant bank angle without extensive compensation (HQRS 6). Forward longitudinal control inputs were required to avoid exceeding the load factor limit of the aircraft (at 7000 feet density altitude, the load factor limit equals 1.67g's). The pilot can easily exceed the load factor limit when performing mission maneuvers at high airspeeds and bank angles greater than approximately 45 degrees. The divergent pitch-up (dig in) tendency at and above cruise airspeeds was also observed during dynamic stability and controllability testing, paragraphs 44 and 50. This characteristic fails to meet the requirements of MIL-H-8501A paragraph 3.2.11.1 and is unsatisfactory. The divergent pitch up (dig in) tendency at and above cruise airspeeds is a shortcoming.

Dynamic Stability

40. The short-term and long-term dynamic stability characteristics of the OH-58C helicopter were evaluated at the conditions listed in table 2. Gust response characteristics were simulated in all control axes by single axis 1-inch control inputs which were held for approximately 0.5 seconds, and by releases from steady heading sideslips.

41. The short-term longitudinal and lateral response characteristics of the helicopter were essentially deadbeat. The deadbeat short-term characteristics were also evident in moderate turbulence. However, the directional control inputs resulted in light to moderately damped lateral-directional oscillations. These oscillations were convergent and damped in 10 to 15 seconds (approximately 2 cycles). The short-term dynamic stability characteristics of the OH-58C are similar to OH-58A characteristics and are satisfactory.

42. Additional lateral-directional gust response characteristics were evaluated by releases from steady heading sideslips. Figures 46 through 49 present time histories of releases from steady heading sideslips at trim airspeeds of 51, 81, and 93 KCAS. The lateral-directional oscillatory responses were light to moderately damped, and easily excited. Although unchanged from OH-58A characteristics, the easily excited lateral-directional gust response of the OH-58C is particularly annoying when precise bank angle and heading control is necessary and is a shortcoming.

43. The longitudinal long-term response characteristics were evaluated by trimming the aircraft at the desired airspeed and then increasing or decreasing the airspeed incrementally using only the cyclic control. The cyclic control was then returned to the trim position and the response noted. Figures 50 and 51, appendix E, present time histories of longitudinal long-term responses at 11700 feet density altitude with the aircraft trimmed near 50 KCAS in level flight. The longitudinal long-term response was convergent and moderately damped with a period of oscillation of approximately 28 seconds. This characteristic is similar to the OH-58A and is satisfactory.

44. Time histories of the longitudinal long-term response in level flight near cruise airspeeds are presented in figures 52 through 55 (app E). All tests resulted in an aperiodic divergent pitch response which required recovery by the pilot to keep from exceeding load factor limits of the aircraft. The response of the helicopter was unpredictable as to the direction the response would follow, nose up or down. Figures 52 and 53 present time histories at near the same trim conditions. Figure 52 shows the aircraft pitched up then down through the trim attitutde and diverged nose down. Figure 53 shows the aircraft pitched nose up until pilot recovery was accomplished. This "dig in" tendency was also observed during the maneuvering stability tests (para 39), and is further discussed in paragraph 50.

45. In climbing flight with rates of climb less than 1000 ft/min the longitudinal long-term response of the OH-58C was convergent but lightly damped. This is similar to OH-58A characteristics using takeoff rated power and at similar gross weights and cg's. However, with the increased power available provided for the OH-58C, rates of climb greater than 1000 ft/min are possible. It was noted previously (para 30 and 32) that the pilot had difficulty trimming the aircraft "hands off" when the rate of climb was greater than approximately 1000 ft/min. This "hands off" condition could be maintained for only a few seconds. Once the aircraft was stabilized at a trim airspeed and the controls held fixed, the aircraft's immediate reaction was to pitch either nose up or down. If the aircraft initially pitched nose up, attitudes from 20 to 30 degrees were encountered, followed by an abrupt nose down pitch that continued with increasing pitch rate until recovery was initiated. Figure 57 (app E) presents a time history of a nose down divergence encountered from a trim airspeed of 63 KCAS in a climb using 80% torque (approximately 1275 FPM). With the controls held fixed, the limit load factor (0.5g's) was exceeded within 4 seconds after the nose down pitch began. The lack of longitudinal long-term stability at rates of climb above 1000 ft/min can lead to unusual aircraft attitudes and exceeding safe aircraft operating limits. The longitudinal long-term response was qualitatively evaluated at a forward cg in climbs. The nose down pitch attitudes and rates encountered were greater than those observed at the aft cg. MIL-H-8501A paragraph 3.2.11 was not met in that pitch oscillations were divergent. The aperiodic pitch divergence in forward flight climbs at rates of climb above 1000 ft/min is unsatisfactory and a deficiency.

46. Four flights were conducted with the infrared counter measure (IRCM) exhaust stacks replaced with standard OH-58A exhaust stacks. The aperiodic pitch divergence tendency at high rates of climb was eliminated with standard OH-58A exhaust stacks. The aircraft was flown at forward and aft cg locations and over a range of gross weights from 2750 to 3250 pounds. The longitudinal long-term response of the OH-58C with standard OH-58A exhaust stacks in forward flight climbs was similar to the OH-58A and is satisfactory. Consideration should be given to modifying the IRCM exhaust stacks to alleviate the aperiodic pitch divergence in forward flight climb.

47. The longitudinal long-term response of the OH-58C in autorotation, figure 58, near 50 KCAS is oscillatory and divergent with a period of approximately 22 seconds. This characteristic is similar to that for an OH-58A and is not objectionable.

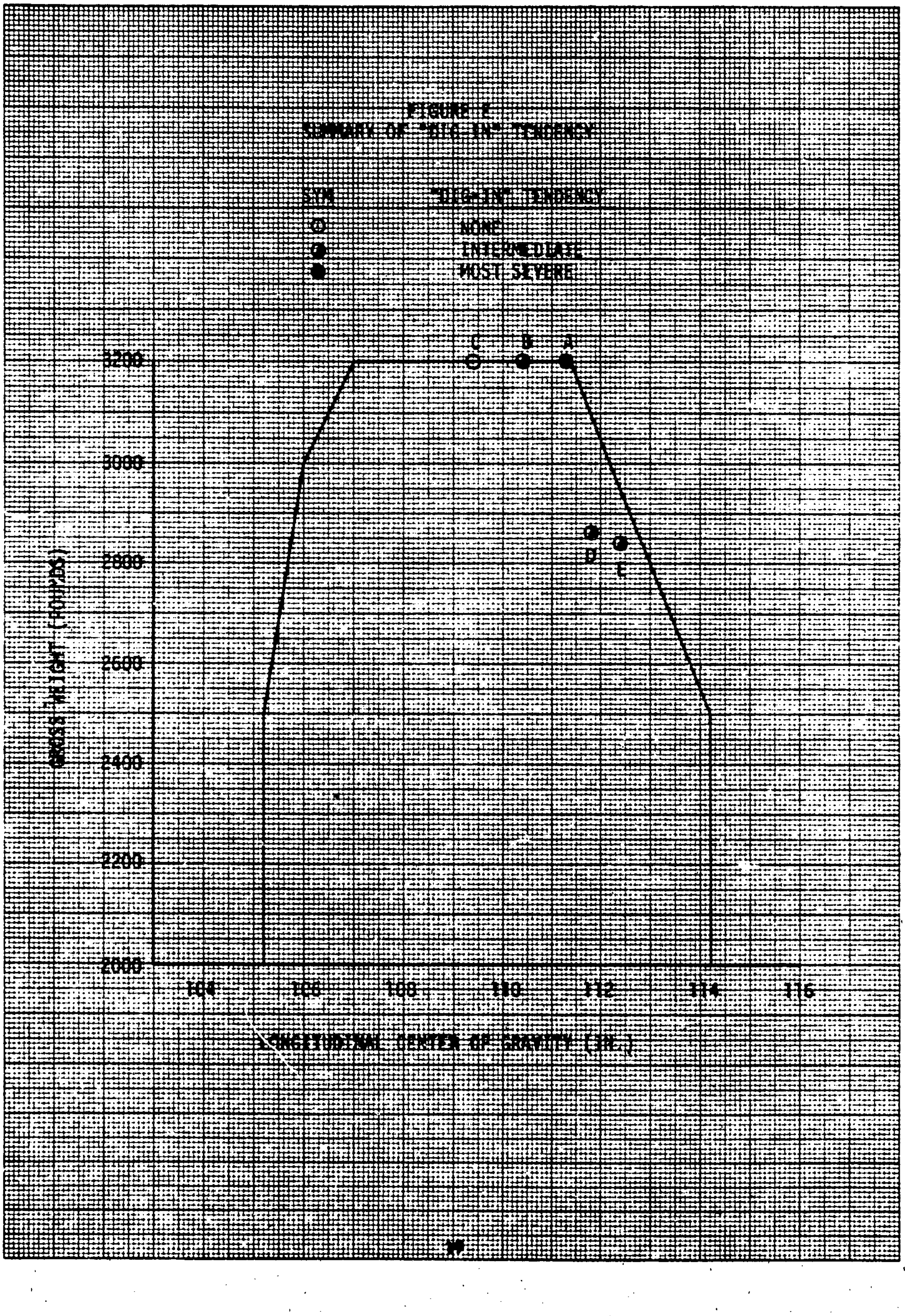
Controllability

48. Controllability tests were conducted using step inputs of varying magnitudes on the pedals during hover and on the longitudinal cyclic during level flight. Control fixtures were used to obtain the desired input size. Test results are presented in figures 59 through 71, appendix E.

49. The maximum directional control response (yaw rate) in hover could not be measured since the rate increased steadily with time. Figure 59 (app E) presents a summary of the directional controllability test results and figure 60 presents a time history of a right directional step input that is typical of the OH-58C response in a hover. The aircraft responds in the proper direction within the specified time (0.2 seconds) and no objectionable coupling was observed. However, at density altitudes of 4360 and 9460 feet, a one inch right directional step (fig. 59) produced yaw displacements of over 70 and 90 degrees respectively within one second after the initial input. This high directional response causes yaw displacements that are excessive and can lead to overcontrol of the aircraft. Figure 59 also shows that the control sensitivity is higher for right pedal inputs than for left pedal inputs. The uneven and high control sensitivity leads to directional overcontrol and is a shortcoming.

50. During level flight at cruise airspeeds, all forward longitudinal control step inputs and aft step inputs smaller than 0.75 inches acheived maximum pitch rate responses that are similar to the OH-58A. Figure 61 (app E) presents the test results for the OH-58C level flight longitudinal controllability and figure 62 presents a typical time history of a forward step input. Maximum pitch rates could not be measured with aft control step inputs greater than 0.75 inches since the pitch rate steadily increased with time. A typical time history of an aft control step input, approximately 1.2 inches, is presented in figure 63. The pitch rate trace initially is concave downward (a damping effect) but then increases linearly with time until recovery. The aircraft at the aft cg location and near cruise airspeeds (91 KCAS) tends to "dig in" and required extensive pilot compensation (HQRS 6) to check the rapidly increasing load factor and will significantly increase the pilot work load in turbulence. The aircraft tendency near cruise airspeeds for divergent pitch up (dig in) was previously discussed in paragraphs 39 and 44.

51. Aft step inputs of approximately 1.0 inch were conducted to determine the effects of gross weight, airspeed, and cg location on the "dig in" tendency. Figure E presents a summary of these test conditions on the OH-58C gross weight versus cg diagram. The "dig in" tendency was observed at the conditions of points A, B, D, and E near cruise airspeeds. Time histories of these data are presented in figures 64, 65, 67, and 68 (app E). The "dig in" tendency was most severe at the conditions of point A, 3200 pounds gross weight and an aft cg location 111.3 inches. Within the range available for the test aircraft, gross weight had little effect (points A and D, fig. D) on the "dig in" tendency at aft cg locations. However, at the conditions of point C, 3200 pounds and mid cg location 109.4 inches, the aircraft exhibited a damped longitudinal response to aft control inputs and was satisfactory (fig. 66). The aircraft controllability at the conditions of point F, 2700 pounds gross weight and a forward cg location was also satisfactory.


SUMMARY OF "DIG-IN" TENDENCY
SYM
"DIG-IN" TENDENCY
NONE
INTERMEDIATE
MOST SEVERE
C
B
A
D
E
3200
3000
2800
2600
2400
2200
2000
104
106
108
110
112
114
116
GROSS WEIGHT (POUNDS)
LONGITUDINAL CENTER OF GRAVITY (IN.)

52. The effects of various airspeeds from 61 to 93 KCAS on the longitudinal controllability of the OH-58C were evaluated at the conditions of point A, figure D and a summary of these effects is presented in figure 69 (app E). Typical time histories of 1.0 inch aft step inputs are presented as figures 64, 70, and 71. The "dig in" tendency was exhibited at airspeeds of 32 and 93 KCAS. At 71 KCAS the aircraft longitudinal controllability was determined to be satisfactory. A maneuvering airspeed of 65 knots indicated airspeed (70 KCAS) should be established for the OH-58C or the divergent pitch-up (dig in) should be corrected.

<u>Low Speed Flight Characteristics</u>

53. The low speed flight tests of the OH-58C were conducted to determine control margins and handling characteristics in low speed flight, with simulated wind conditions from various relative azimuths. Surface wind conditions were 3 knots or less. Test results are presented in figures 72 through 89, appendix E.

54. Figure 72 (app E) presents a summary of low speed flight characteristics. Control position and attitude variations of the OH-58C were similar at all three test altitudes; however, control margins decreased with increasing altitude. The minimum longitudinal, lateral and directional control margins were observed at the high density altitude (11120 feet). At a zero wind hover at this altitude, the directional control margin was slightly more than 10% (0.7 inches) at 3050 pound gross weight. The longitudinal, lateral and directional control gradients with respect to airspeed at and near hover are neutral (fig. 73 through 76). These neutral control gradients combined with the ability to generate excessive yaw displacements (para 49) make precise hovering difficult (HQRS 4).

55. Low speed forward flight was easily accomplished (HQRS 2) even though the longitudinal control gradient was shallow and a slight longitudinal control reversal was evident. These were not objectionable to the pilot. Low speed forward flight was satisfactory at all speeds with headwinds from 30° right to 60° left.

56. At rearward speeds between 5 and 10 KTAS, (figs. 73 and 75, App E) abrupt aft longitudinal control displacement is required. This characteristic is similar to an OH-58A. Satisfactory stabilized rearward flight could not be performed because of the tendency of the aircraft to pitch and yaw excessively. Pitch excursions of ±3 degrees and yaw excursions of ±5 degrees required considerable pilot compensation to control (HQRS 5). This also applies when hovering with a tailwind from approximately 150° relative to the nose of the aircraft (wind from the right rear of the aircraft) to 240° (wind from the left rear of the aircraft). The pitch and yaw excursions increase in severity with increasing gross weight and altitude. The tendency for the aircraft to pitch and yaw excessively in rearward flight is a deficiency. The rearward flight characteristics of the OH-58C failed to meet the requirements of MIL-H-8501A paragraph 3.2.1 in that steady, smooth flight was not obtainable in rearward flight to 30 KTAS. Additionally, at 3050 pounds gross weight and 11120 feet density altitude less than 10% (1.2 inches) aft longitudinal control remained at rearward airspeeds above 15 KTAS.

57. Right sideward flight was accomplished with minimal pilot compensation (HQRS 3). At a density altitude of 5000 feet and gross weight of 3200 pounds, less than 10% directional margin remained above 31 KTAS. At 3050 pounds gross weight and 11120 feet density altitude, less than 10% directional margin remained above 6 KTAS in right sideward flight and the directional control limit was reached

at 32 KTAS, which is below the 35 KTAS sideward limit airspeed. The directional control gradient between 5 and 25 knots was very shallow. The right sideward flight characteristics of the OH-58C at high gross weights and altitudes failed to meet the requirements of MIL-H-8501A paragraph 3.3.2 in that the directional control limit was reached within the sideward airspeed limit. The inadequate directional control is a deficiency. The critical azimuth, the wind azimuth at which the minimum control margin remaining occurred, was determined to be 100° based on the directional control requirements.

58. Smooth, stabilized left sideward flight between approximately 15 and 35 KTAS could not be satisfactorily performed (HQRS 7) because of the tendency of the aircraft to pitch, roll, and yaw excessively. Yaw excursions up to ±8 degrees and roll excursions up to ±4 degrees were observed. Control excursions up to ±1.5 inches longitudinally, ±0.75 inches laterally, and ±2.0 inches directionally were required simultaneously to control the aircraft at the 11120 feet density altitude. Occasionally the right directional control stop was encountered in left sideward flight. While hovering in left crosswind conditions or in left sideward flight the pilot will be required to devote most of his attention to aircraft control resulting in degradation of mission accomplishment. The pitch, yaw and roll tendencies in left sideward flight increase in severity with increasing altitude and gross weight. The tendency of the OH-58C to pitch, roll, and yaw excessively in left sideward flight is unsatisfactory and a deficiency.

59. At density altitudes lower than 5000 feet, gross weights near 3200 pounds and skid height of 10 feet (IGE) the low speed handling qualities are unsatisfactory in that considerable pilot effort was required to maintain rearward flight, and that less than 10% directional control margin remained above 31 KTAS in right sideward flight. Whereas, at high density altitudes and gross weight combinations the only satisfactory low speed flight regime was low speed forward flight. The aircraft was difficult to hover precisely (para 54). In rearward flight (para 56) it had the tendency to pitch and yaw excessively and had less than 10% longitudinal control margin remaining at airspeeds above 15 KTAS rearward. In right sideward flight (para 57) less than 10% directional control margin remained at airspeeds above 6 KTAS and the directional control limit was reached at 32 KTAS. In left sideward flight it had the tendency to pitch, roll, and yaw excessively (para 58). Nap-of-the-earth flight is a primary mission of the OH-58C helicopter and involves extensive aircraft operation in close proximity to the ground or foliage cover with much of the flight spent below 35 knots. In the OH-58C, it is anticipated that the pilot will devote most of his attention to aircraft control rather than mission accomplishment, particularly at high gross weights and density altitudes. This situation will further be degraded in other than day visual flight rules (VFR) conditions. Night Nap-of-the-earth flight or using night vision goggles deny the pilot much of the daytime attitude references. Subsequently, the pilot will be slower to implement corrective actions in situations that require immediate actions to control the aircraft. Because of the mission environment for Nap-of-the-earth flight (various and unpredictable wind conditions), and the three deficiencies, it is anticipated that the low speed handling qualities of the OH-58C are unsatisfactory for the Nap-of-the-earth missions particularly at high density altitude and high gross weight. Consideration should be given to increase the directional control margins and to installation of a stability augmentation system (SAS) to improve the overall handling qualities of the OH-58C helicopter.

AIRCRAFT SYSTEM FAILURE

Simulated Engine Failure

60. Sudden engine failures were simulated by trimming the aircraft at the test condition and abruptly closing the throttle to the flight-idle position. The flight controls were held fixed until the minimum transient rotor speed of 304 rpm was approached or until 2 seconds had elapsed. The delay in moving the controls was to simulate the normal delay in pilot reaction time following an actual engine failure. Time histories of the test results are presented in figures 90 through 92.

61. The response of the OH-58C following simulated sudden engine failure in level flight was characterized by rapid rotor speed decay, moderate left yaw, slight left roll followed by a slight nose down pitch. The rapid rotor speed decay does not meet the requirements of MIL-H-8501A in that the safe minimum transient rotor speed was reached following the simulated engine failure. The rolling tendency and rotor speed decay increased while the yaw rate decreased at higher airspeeds. Simulated engine failures during maximum power climbs were characterized by a more rapid rotor speed decay, a pronounced nose up pitch, and higher yaw rates than during level flight. Warning of engine failures was adequate in that a distinct decrease in noise level was apparent and accompanied by simultaneous yaw to the left. In addition to these tests, several simulated engine failure tests were conducted with the crew doors removed. No change in the aircraft response was observed with the crew doors removed. The average delay time for all conditions tested was acceptable but rapid pilot compensation was required to arrest the quick rotor speed decay. The overall aircraft response to a simulated engine failure was similar to an OH-58A and is satisfactory.

STRUCTURAL DYNAMICS

Vibration

62. Vibration characteristics were qualitatively assessed throughout the flight tests. During high speed flight, excessive vibrations were observed at the pilot station and instrument panel. These vibrations were at the main rotor 1/rev (5.9 Hz) and 2/rev (11.8 Hz) frequencies and significantly higher than a typical OH-58A helicopter. The aircraft rotating components were checked by Army maintenance personnel for any abnormalities and the main rotor blades were tracked. No unusual condition of the aircraft was found using the prescribed maintenance procedures listed in the Army maintenance manual TM 55-1520-228-23 for the OH-58C helicopter. Discussions between USAAEFA, USAAVRADCOM, and BHT led to additional flight investigation of the vibration characteristics.

63. The test aircraft's instrument panel was returned to as near standard configuration as possible and the instrumentation airspeed boom was removed. Vibration accelerometers were installed on the floor at the pilot and copilot station, on the front side in the center of the instrument panel, and on the back side in the upper right corner of the instrument panel. After a flight in the test aircraft BHT personnel agreed that the 1/rev and 2/rev vibration levels were high but not representative of a production OH-58C. They recommended and performed the following maintenance

actions: adjustment; swash plate and support assembly; change, main transmission mount; and track main rotor blades. After these maintenance actions and a test flight were performed, BHT personnel considered the vibration characteristics typical for the OH-58C.

64. Figures 93 through 98 present the vibration data obtained at the pilot station and instrument panel of the test aircraft after the recommended maintenance actions were performed. The 2/rev (11.8 Hz) vertical vibrations at the pilot station with a gross weight of 3230 pounds and at 13380 feet density altitude were excessive and uncomfortable to the pilot and exceeded the vibration limit (0.15 g's) of MIL-H8501A, paragraph 3.7.1.b (ref 5, app A) throughout the airspeed range tested. The excessive 2/rev vertical vibrations at these conditions are unsatisfactory and a shortcoming. At lower density altitudes, 5260 and 10640 feet and at or above gross weights of 3000 pounds and airspeeds near V_{NE}, the 2/rev vertical vibration at the pilot station was excessive. These test results at lower gross weights are similar to those obtained for the OH-58A (ref 7, app A). The excessive 2/rev vertical vibrations at or near V_{NE} airspeeds for the OH-58C are unsatisfactory and are a shortcoming.

65. The maintenance actions performed by BHT personnel are listed in the Army maintenance manual as phase items for the OH-58C, and are requried at the 300 and 900 hour inspections only. Since these items affected both the 1/rev and 2/rev vibrations, consideration should be given to decreasing the time between inspections and/or listing them as trouble shooting guides when either a high 1/rev or 2/rev vibration is encountered.

HUMAN FACTORS

Cockpit Evaluation

66. The OH-58C cockpit was evaluated during all phases of flight testing and during ground operations. Cockpit changes from the OH-58A include the addition of:

a. "Engage/Disengage" switch on the pilot's collective control for vulnerability reduction (VR) back-up tail rotor control system.

b. Transmission hot oil warning light.

c. Night Vision Goggle (NVG) switch on the pilot's cyclic grip.

d. Primary directional control disconnect jam light.

e. A modified glare shield and glare shield extensions.

f. A larger torque gage.

g. Engine and flight instruments marked for use with night vision goggles.

h. A flat plate canopy.

67. The test aircraft did not have the following standard equipment installed.

a. Communications security set TSEC (KY-28).

b. Radio set, AN/ARN-123(V) 1 (CONUS NAV).

c. Radar warning set, AN/APR-39.

d. Transponder set, AN/APX-100.

e. Proximity warning system, YG-1054.

f. Armored seat protection.

68. The pilot and copilot/observer seats are unmodified from those in the OH-58A, and are constructed of tubing and stretched nylon webbing. The back of the seat is a cushion which is attached to a bulkhead with snaps. The seat is not adjustable in any direction. The pedals are adjustable through a range of 4.5 inches to partially accommodate pilots of different heights. The nonadjustable seat requires the pilot to sit in a slouched position to properly position himself at the controls. The uncomfortable position promoted back strain, and after approximately 2.0 hours of flying, led to rapid fatigue and eventual lower back, neck, and shoulder strain, and prolonged backaches. The nonadjustable seat of the OH-58C is the same as the seat on the OH-58A and is a shortcoming. Consultation was requested from the US Army Aeromedical Research Laboratory, Fort Rucker, Alabama. The report from the lab stated that the current seat would cause back injury in the 5th through 95th percentile Army aviator. The report is included as appendix H.

69. The cyclic grip of the OH-58C is unmodified from the OH-58A except for the addition of the NVG switch. The grip is designed with the force trim release button located at the top right side of the grip, and the thumb is used to activate it. The thumb is also required to activate the ICS/RADIO switch. To release the force trim, the pilot must reposition his hand on the cyclic grip causing numerous changes in hand position during flight. The pilot also is unable to use the ICS/RADIO switch whenever he is depressing the force trim release button. The poor cyclic grip and poor location of the force trim release button are shortcomings which are unchanged from the OH-58A.

70. The standby compass is located below the pilot's right triangular window just above the pilot's right foot. In this location, the pilot is normally unable to read or use the compass. In the event of a loss of directional gyro, the pilot would need to lean forward and lower his head to view the standby compass. This motion would tend to induce vertigo. The poor location of the standby compass is a shortcoming which is unchanged from the OH-58A.

71. The AN/APX-100, transponder set is located in the lower center console of both the OH-58A and OH-58C. The AN/ARN-89, ADF set is also located on the lower center console, but is installed in the OH-58C only. When seated in the cockpit, the pilot is unable to see large portions of the tuning heads because of the collective control and the switches on the end of the collective. To observe the radio or transponder or to set frequencies and codes, the pilot must reposition his head.

The movement and distraction of the frequency or code changes may tend to disorient the pilot and induce vertigo as well as require a diversion of attention from tactical mission requirements. The poor location of the AN/APX-100, transponder set and the AN/ARN-89 ADF set are shortcomings. The location of the AN/ARN-89 ADF set pertains to the OH-58C only.

72. The UHF/AM radio set AN/ARC-116 is located on the lower center of the instrument panel. This radio does not have a preset frequency capability and frequencies must be manually tuned. A scout pilot needs to operate on several frequencies during a typical tactical mission. The requirement to manually tune each frequency will cause a frequent and lengthy diversion of his attention from mission tasks, and requires the pilot to lean over to view and dial frequencies. The lack of a preselect frequency-select function on the AN/ARC-116 UHF/AM radio set remains a shortcoming.

73. The engine starter button and the engine idle release control are both located near the end of the pilot's collective on both the OH-58A and OH-58C. During the start sequence, the pilot must use both hands to operate the controls, one for the throttle and the other for the starter button and the engine idle release button. In the event of an engine fire on start or an imminent hot start, the pilot must continue to engage the starter until the turbine outlet temperature (TOT) is below 200°C after closing the throttle immediately, which requires the engine idle release button to be depressed. Then the pilot must close the fuel ON/OFF control handle. To accomplish all this, the pilot is not able to hold the cyclic stick even though the blades are turning. In the event the aircraft is started in high winds and the force trim is unable to hold the controls, cyclic control could be input, which could contribute to blades striking the tail boom. The awkward operation of the engine start controls remains a shortcoming.

74. The OH-58C or OH-58A are not equipped with an engine compartment fire detection system. The single pilot scout mission will require the aircraft to be flown for long periods where other aircraft will not be able to provide a visual detection function for the OH-58C. In the event of an engine compartment fire, the pilot will be unaware of a fire until it has progressed to where the entire engine compartment may be involved and other instruments provide indication malfunction. A fire warning system would provide an early indication of an engine compartment fire. The lack of a fire warning system is a shortcoming.

75. Three items in the cockpit have electro-mechanical interference (EMI) problems. Each time the force trim release button is depressed, the needle in the fuel gauge deflects a distance equivalent to 50 pounds of fuel, the rate of turn pointer in the attitude indicator deflects up to full scale to the right, and the radar altimeter display shows an erroneous altitude for 2 to 3 seconds. Under tactical conditions, the force trim release button will be used repeatedly causing the indicators and needles to fluctuate and jump. The jumping needles and fluctuating indicators are distracting and an annoyance and may divert pilot attention from the mission. The electromagnetic interference between the force trim release button and the fuel gauge and rate of turn indicator remains a shortcoming. The EMI between the force trim release button and the radar altimeter is a shortcoming attributed to the OH-58C.

76. The NVG/NORM LGT switch is located on the OH-58C cyclic stick. The instrument panel, overhead console, and lower console lights are controlled by this switch. With the switch in the NVG position, the instruments, console light, caution and warning lights are dimmed to a level readable only with NVG. The switch is an unguarded, two-position switch which can easily be inadvertently placed in the NVG position. With the switch in the NVG position during the day, the pilot would be unaware of the switch position and would not be able to see the illumination of a warning or caution light. A NVG switch which is easily activated and renders the caution/advisory panel unreadable is a deficiency attributed to the OH-58C.

77. The flat plate canopy on the OH-58C consists of thin sheets of unreinforced plexiglass riveted into a metal windshield frame. At airspeeds greater than approximately 30 KCAS, the air pressure on the flat plate bows the canopy inward creating a pocket. The thin plexiglass also vibrates or oscillates at the rotor passage frequency at all airspeeds with an amplitude of approximately one-half inch at 60 KCAS. During daylight conditions with a clean windshield, the canopy vibration does not present a problem; however, bug spots, scratches, and other surface irregularities are highlighted by the vibration and tend to distract the pilot and impair vision. The addition of metal bracing to hold the flat plate canopy reduces the field of view for pilots taller than approximately the 70th percentile. The flat plate canopy which bows in at high airspeed, vibrates at the rotor passage frequency, and reduces the field of view is a shortcoming.

78. The torque gauge on the OH-58C has a large easy-to-read dial with well defined range marks and color codes for operating limits. However, the gauge is located at the center of the instrument panel, which is outside the pilot's normal scan. The mission of the OH-58C requires the pilot's primary attention to be directed outside the cockpit for visual attitude reference and observation hence, unless the pilot knows he will be performing maneuvers using engine power close to the operating limits, he will not include the torque gauge (or other engine instruments) in a rapid or frequent cross check. The collective lever has a very shallow gradient of collective position with torque. The maximum torque (100%) collective position is approximately 8 inches from full down and is slightly above the bottom edge of the pilot's seat. The relatively low collective position for one hundred percent power combined with an engine that will readily produce enough power to overtorque the main transmission at most altitudes and the poor location of the torque gauge cause a situation that can easily lead to an overtorque condition. The ease of inadvertent main transmission overtorque in the OH-58C is a shortcoming. At density altitudes above approximately 7000 feet, engine temperature limits (TOT) may be reached prior to torque limits. For the same reasons described above, at density altitudes above 7000 feet, an engine overtemperature condition can easily result. The ease of engine overtemperature at density altitudes greater than 7000 feet in the OH-58C and at lower density altitudes in the OH-58A is a shortcoming. A warning light with aural tone should be incorporated to warn of an impending overtorque/overtemperature condition.

Night Evaluation

79. A night evaluation of the OH-58C cockpit and external lighting was conducted in a darkened hangar for a period of 1.5 hours and on a night flight of 1.0 hours. The purpose of the test was to evaluate:

a. Canopy glare from cockpit lighting or from external sources.

b. Readability of instruments and labels.

c. Consistency of illumination of instruments.

d. Dimming characteristics of cockpit lighting.

e. Readability of instruments and gauges while wearing NVG.

A set of night vision goggles (AN/PVS-5) was worn by the pilot during portions of the evaluation in the darkened hangar. The NVG were also worn on the night flight to evaluate the cockpit lighting and windshield glare, but the pilot did not fly the aircraft while wearing the NVG.

80. With the pilot seated normally, wearing full mission equipment, two sources of cockpit glare were noted. One originated from the lower center console. The other was manifest when the copilot/observer shined an unshielded light on his lap, as in reading a map. The intensity of the glare from the radios in the lower console could be minimized by reducing the intensity of the lighting; however when the copilot/observer used the utility light or a flashlight, the glare was evident. A reflection was also noted in the triangular window just forward of the pilot's door. The source of this reflection was the bottom half of the instantaneous vertical velocity indicator (IVSI). This glare could also be minimized by dimming the instrument lights. The same cockpit reflections were noted when the NVG were worn. In flight, bank angles of up to 45 degrees were made over brightly lit areas on the ground. No significant reflections from the ground sources were noted. The windshield glare from cockpit and external sources was satisfactory.

81. Dimming of instrument and console lighting is provided by two variable rheostats located on the overhead console. In the full bright position, all instruments except the magnetic compass are readable (para 75). In flight with the light intensity at a level for readability and glare reduction, the brightest instrument was the attitude indicator. The remainder of the instruments were at a readable level except the gas generator tachometer, fuel quantity gauge, ammeter, and the digits in the frequency window of the UHF radio (AN/ARC-116). With the NVG on, all instruments were readable except the torque gauge. Even with the "INST KT" rheostat in the full bright position, the torque gauge was unreadable because of the low light level. The inability to read the gas generator tachometer, fuel quantity gauge, ammeter, and the digits in the frequency window of the UHF radio with the lighting dimmed to a level compatible with night flying is a shortcoming. The inability to read the torquemeter when using NVG is a shortcoming.

82. The OH-58C radar altimeter, AN/APN 209, has a separate rheostat for adjusting the light intensity for NVG operation, night operation or full daylight use. The rheostat is located on the pilot's instrument panel within easy reach. The sense of the rheostat or direction of rotation is nonstandard in that clockwise rotation dims the intensity rather than increases it. The nonstandard operation of the radar altimeter rheostat is a shortcoming.

Nap-of-the-Earth Evaluation

83. The OH-58C helicopter was evaluated on a Nap-of-the-earth (NOE) training course located on the Fort Hunter-Liggett Military Reservation, California. The evaluation consisted of a qualitative pilot workload survey, vibration assessment and quantitative flight control margins encountered in flight. Generally, the course consisted of very hilly terrain covered with trees and large rocks. There were also large, flat, clear areas as well as stream beds, ravines, ridges, and saddles. The course elevation ranged from approximately 1000 to 2000 feet. The OH-58C instrument panel, cockpit, and external configuration was in as near standard configuration as possible for these tests. The instrument panel glare shield was reinstalled and the instrumentation airspeed boom was removed. Takeoff gross weight was 3250 pounds, and a forward cg location was used. The crew doors were removed for all flights along the NOE course, and a local NOE instructor pilot was always on board the aircraft with access to the flight controls. Weather conditions were generally the same each day tests were conducted on the NOE course: outside air temperature was approximately 6°C, winds were less than 5 knots and days were clear and sunny.

84. Tests were conducted using two methods. The first method consisted of continuous flight, taking advantage of as much terrain or foliage cover as possible from the start point to a predesignated area located approximately one flight hour further along the course. This was to simulate a mission from one point to another that was almost entirely NOE. The second method was an evaluation of distinct NOE maneuvers, such as masking and unmasking using a hilltop, saddle, or clump of trees for cover, dashes across open terrain, quick stops, climbing hillsides close to the foliage cover, and sideward and rearward flight.

85. While flying continuously or executing a specific maneuver along the NOE course, directional control margins were less than 10 percent when right crosswinds were encountered, when quick stops were accomplished, or during unmasking maneuvers from a hover. However, these tasks were performed without difficulty (HQRS 3). Aircraft vibrations were not objectionable to the pilot and were satisfactory. Constant monitoring of the engine torque gauge was required to keep from exceeding the main transmission horsepower limit of 317 shp. Small collective control displacements, like those required to climb over an obstacle, produce large changes in power (para 83) and contribute to ease of overtorquing the main transmission. The overall handling qualities, vibrations and pilot workload of the OH-58C in a NOE environment were satisfactory at the wind conditions and density altitudes encountered (less than 2000 feet).

86. Results from the NOE evaluation at Fort Hunter-Liggett do not reflect the deficiencies observed during low speed flight at high density altitudes and heavy gross weights since the density altitudes and wind conditions were low. The OH-58C should be evaluated at a high altitude NOE site.

RELIABILITY AND MAINTAINABILITY

87. During the conduct of this evaluation, numerous reliability and maintainability items were observed. A total of eight equipment performance reports (EPR's) were submitted and are included in this report as appendix F.

Directional Control System

88. During stabilized right sideward flight at 30 KTAS, the primary directional control system disconnected without pilot actuation. Disconnect was evidenced by the PRI. DIR. CONTR disconnect and jam light illuminating and by slippage of the left directional pedal to the mechanical stop (approximately 1 inch). Controlled flight was maintained through the secondary system, and primary directional control was regained after neutralizing pedals. The failure was repeated four times and was traced to the forward electromechanical "disconnect." A thorough rigging and electrical check was performed as outlined in the maintenance manual and revealed no discrepancies in the system other than caution light sequencing which had been previously documented. The failure could not be duplicated on the ground.

89. The forward electromechanical disconnect was replaced and sent to the manufacturer for tear-down analysis. Analysis revealed two items slightly out of tolerance, but the manufacturer claims that the disconnect should have worked properly. With the new disconnect installed, the system worked satisfactorily for approximately 60 hours of performance and handling qualities testing. However, during follow-on testing, the directional system again disconnected during right sideward flight at 25 KTAS without pilot actuation. The uncommanded disconnect of the primary directional control system during right sideward (right crosswind) flight is a deficiency. Equipment performance reports were submitted following both failures and are included in appendix F.

90. The maintenance procedures outlined in the maintenance manual, TM 55-1520-228-23 (ref 15, app A), for removal and reinstallation of the disconnect were sketchy and vague. Direction of removal, thread direction, and proper location of tools on the parts to prevent damage should be specifically stated in the maintenance procedures.

Fuel Control Adjustment

91. During attempted battery starts of the OH-58C at various pressure altitudes from 2300 to 7010 feet the engine would hang start at 30 percent gas generator (N_1) speed. The start sequence to 30 percent N_1 was normal and boost pump operation or advanced throttle had no effect. Starts with an auxiliary power unit (APU) were intermittently successful, but not reliable. A sample of two engines were evaluated. One engine was involved at 7010 feet and a second at 2300 and 4100 feet.

92. The trouble-shooting guides listed in table 4-1 of the maintenance manual (ref 16, app A) were used to investigate the cause of the intermittant starts. A simple fuel control adjustment was required as item K of the trouble-shooting guide. The gas generator fuel control start derichment valve was adjusted according to the instructions in the maintenance manual, and subsequent normal starts occurred. The following note should be added to the operator's manual and to the appropriate sections of the maintenance manual to draw attention to the requirement for fuel control adjustment.

NOTE

When changing aircraft operating environment, fuel control adjustment may be required to preclude stagnated or hot starts.

Transmission Oil Cooler

93. During transmission replacement on the test aircraft, the transmission oil cooler (which is attached to the transmission) and transmission oil cooler hose were also removed. Approximately one pound of grass, leaves, and compacted debris was found lodged inside the oil cooler assembly. Although no transmission OIL HOT warning light had illuminated in previous flight, only a little additional debris may have caused an air blockage. The only inspection required, item 3.23 TM 55-1520-288-PMS, calls for a visual inspection, "Transmission oil cooler and duct for condition, security, and obstruction." There is no screen on the intake end of the transmission cooler hose. An inspection interval and procedure should be implemented and a small mesh screen should be placed over the intake to the blower leading into the transmission oil cooler hose. The easily clogged transmission oil cooler system is a deficiency. This deficiency is common to the OH-58A, but not previously documented.

Engine Air Line

94. During flight, engine roughness, torque fluctuations and lateral airframe oscillations were observed. Post-flight analysis of inflight data indicated a fuel control malfunction. A leak check was performed and revealed a hairline crack on the inside of the flared end of the power turbine (PT) air line from the double check valve to the fuel control. An identical air line was removed from a spare engine and had a similar crack on the opposite end of the line of the inside of the flared portion. An investigation should be conducted on the manufacturing and installation techniques as well as the final item quality control.

SUBSYSTEM TESTS

Engine Performance

95. The uninstalled T63-A-720 engine is rated at 420 shp at the intermediate limit and 370 shp for maximum continuous operation under sea level, standard day conditions. These ratings are based on measured gas temperature and an output shaft speed of 6180 rpm. Installed in the OH-58C at an operational main rotor speed of 354 rpm (6180 engine output shaft rpm), this engine will produce power in excess of the helicopter main transmission takeoff limit of 317 shp. Power in excess of the main transmission limit is maintained up to 6420 feet at intermediate rated power and up to 800 feet at maximum continuous power. These installed powers are based on the Allison Engine Specification 876 Model T63-A-720, 12 September 1975, at zero airspeed with zero customer bleed air and engine anti-ice OFF. Also, the OH-58A installation losses described in references 6, 7, 8, appendix A, were applied to obtain the installed powers presented above. No attempt was made to measure any of these losses during this test program.

96. Figures 99 and 100, appendix E, present the installed intermediate rated power and maximum continuous power available at various pressure altitudes and temperatures. Figures 101 and 102, appendix E, present the engine specification fuel flow under standard day and hot day conditions, respectively. Figure F compares the power available to the OH-58C and OH-58A at intermediate rated power.

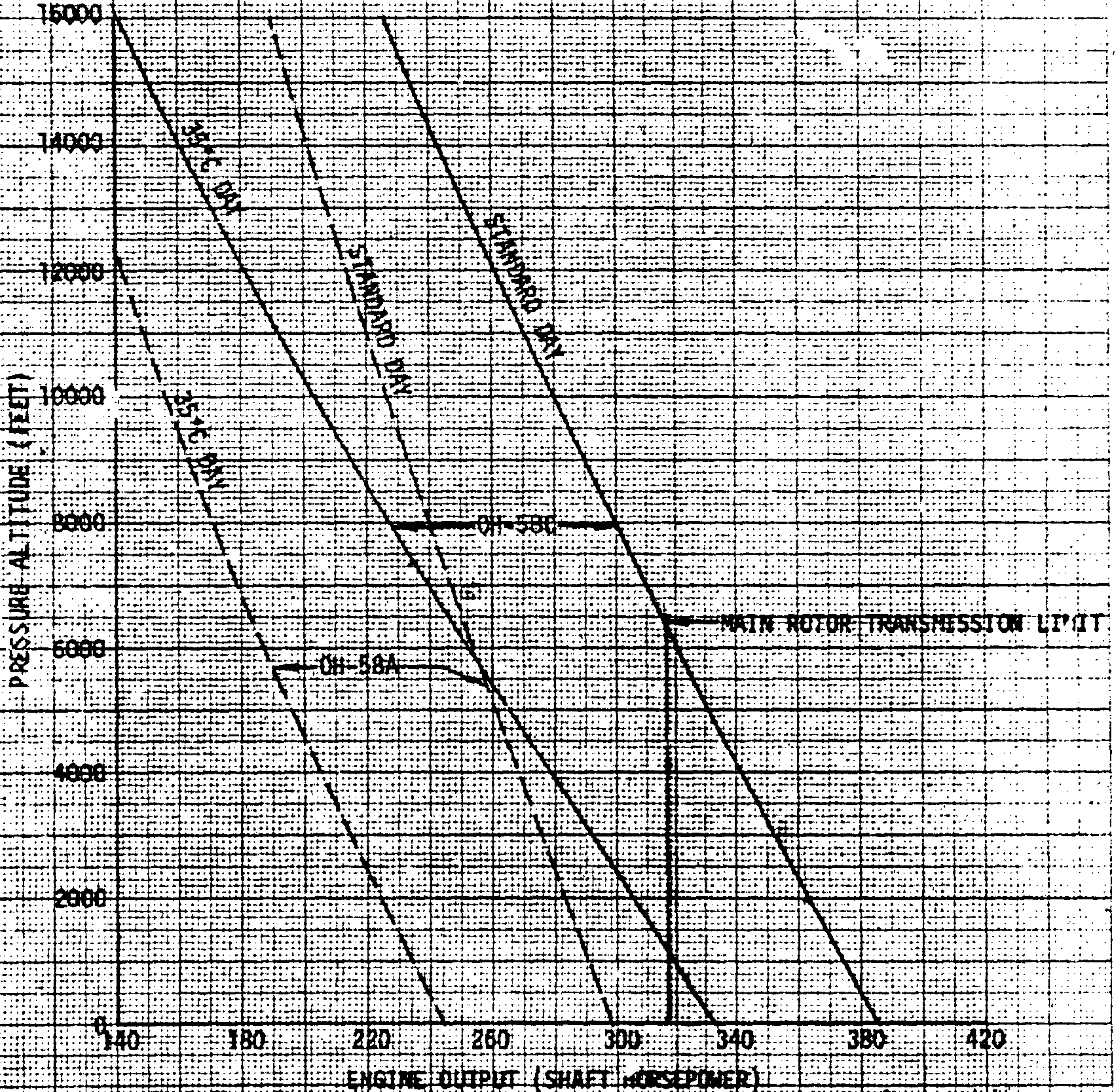
FIGURE F

SHAFT HORSEPOWER AVAILABLE COMPARISON

NOTES: 1. SOLID LINES DENOTE MODEL OH-58C WITH MODEL T63-A-720 ENGINE INSTALLED; INTERMEDIATE RATED POWER, T_{T_5} = 810°C.

2. DASHED LINES DENOTE MODEL OH-58A WITH MODEL T63-A-700 ENGINE INSTALLED; INTERMEDIATE RATED POWER, T_{T_5} = 749°C.

3. CURVES DERIVED FROM ALLISON ENGINE SPECIFICATIONS MODEL T63-A-720, 12 SEP 75, AND MODEL T63-A-700, 19 JUL 67.
   A. STATIC CONDITIONS, ENGINE SPEED = 6180 RPM.
   B. ZERO CUSTOMER BLEED AIR AND ANTIICE OFF.
   C. OH-58A INLET AND EXHAUST LOSSES AND 2.0 SHP ACCESSORY LOSS FROM USAASTA REPORT NO. 68-30.
   D. OH-58C INLET LOSSES FROM USAASTA REPORT NO. 68-30. EXHAUST LOSSES FROM USAASTA REPORT NO. 75-11, 11.09 SHP ACCESSORY LOSS FROM DETAIL SPECIFICATION 206-947-203.



Under hot day conditions (35°C), the OH-58A does not have 317 shp available at sea level. However, the OH-58C has 317 shp (main transmission power limit) available to 800 feet. The installation of the T63-A-720 engine significantly improves the overall performance capability of the OH-58C.

97. Figures 103 through 108 present data of referred power, gas generator speed, fuel flow, and turbine outlet temperature. The Allison Engine Specification 876 curves are also presented in the figures.

Airspeed Calibration

98. The airspeed system for the OH-58C was calibrated using the trailing bomb and pace aircraft methods. The ship's system airspeed calibrations in level flight, climbs, and autorotation are presented in figures 109 through 111, appendix E. The calibrations were first conducted with the instrumentation boom installed and repeated with it removed. The boom influenced the calibration in autorotation at airspeeds above 55 KIAS. The OH-58C ship's system airspeed calibration is slightly changed from the OH-58A in all flight regimes tested. The position error (correction to be added) during level flight is increased by approximately 3.5 knots and during autorotational flight the increase in position error varies from 1 to 5 knots. The OH-58C ship's system airspeed calibration was satisfactory.

CONCLUSIONS

GENERAL

99. The following general conclusions were reached:

a. The hover and takeoff capability at heavy gross weights and high altitudes and the forward flight climb performance of the OH-58C are improved over the OH-58A due to the more powerful T63-A-720 engine installed.

b. Performance of the OH-58C in terms of power required and fuel consumption is slightly degraded when compared to the OH-58A at similar gross weights and altitudes and did not meet the estimates of the detail specification for the OH-58C interim Scout helicopter.

c. The handling qualities and vibration characteristics of the OH-58C are similar to the OH-58A when operating at similar gross weights and altitudes.

d. The OH-58C ship system airspeed position error is slightly changed from the OH-58A.

e. It is anticipated that the low speed flying qualities of the OH-58C are unsatisfactory for the Nap-of-the-earth mission particularly at high density altitude and high gross weight.

DEFICIENCIES

100. The following deficiencies were identified and are listed in order of their relative importance. Of the deficiencies listed below, c, e, and f are new to the OH-58C. Deficiencies a, b, and g were noted for the OH-58A as shortcomings, but increased in severity due to the higher gross weight, higher altitude capability and mission change for the OH-58C. Deficiency d, was not previously documented, but is common to the OH-58A and C helicopters.

a. Inadequate directional control (para 57).

b. The tendency to pitch and yaw excessively in rearward flight (para 56).

c. The aperiodic pitch divergence in forward flight climbs above rates of climb of 1000 ft/min. (para 45).

d. The easily clogged transmission oil cooler system (para 93).

e. Uncommanded disconnect of the primary directional control system during right sideward flight (para 76).

f. A night vision goggle switch capable of rendering the caution/advisory panel unreadable (para 76).

g. The tendency to pitch, roll, and yaw excessively in left sideward flight (para 58).

SHORTCOMINGS

101. The following shortcomings were identified and are attributed to the OH-58C modification. They are listed in order of their importance.

a. Divergent pitch-up (dig-in) tendency near cruise airspeeds (para 50).

b. Excessive 2/rev vibration at all airspeeds above density altitudes of 13,000 feet and with a gross weight near 3,200 pounds (para 64).

c. Unsatisfactory static longitudinal stability near cruise airspeed (para 31).

d. The flat plate canopy which bows in at high airspeed, vibrates at the rotor passage frequency and reduces the field of view (para 77).

e. Inability to read the gas generator tachometer, fuel quantity and ammeter gauges and the digits in the frequency window of the UHF radio with the lights dimmed to a level compatible with night flying (para 81).

f. Ease of inadvertent main transmission overtorque (para 78).

g. Inability to read the torquemeter gauge when using night vision goggles (para 81).

h. Poor location of the AN/ARN-89 ADF set (para 71).

i. Nonstandard operation of the radar altimeter rheostat (para 82).

j. Electromechanical interferance between the force trim release button and the radar altimeter (para 75).

102. The following shortcomings were identified in previous evaluations of the OH-58A and remain in the OH-58C. They are listed in order of their importance.

a. Ease of inadvertent engine overtemperature above 7000 feet density altitude (para 78).

b. Lack of pre-select frequency-select function of the AN/ARC-116 UHF AM radio set (para 72).

c. Awkward operation of the engine start controls (para 73).

d. Easily excited lateral-directional gust response (para 42).

e. Poorly designed cyclic grip and poor location of the force trim release button (para 69).

f. Electromechanical interference between the force trim release button and the fuel quantity gauge and rate of turn indicator (para 75).

g. Lack of a fire warning system (para 74).

h. Poor location of the standby compass (para 70).

i. Nonadjustable crew seat (para 68).

j. The uneven and high directional control sensitivity (para 49).

k. Large longitudinal and lateral cyclic trim control displacement bands (para 25).

l. Excessive 2/rev vibrations at or near V_{NE} airspeeds (para 64).

m. Poor location of AN/APX-100 transponder (para 71).

SPECIFICATION COMPLIANCE

103. Within the scope of this test, the OH-58C helicopter failed to meet the performance estimates of the detail specification for the OH-58C interim Scout helicopter.

a. Paragraph 3.1.2.2b. The out-of-ground effect hover ceiling on a 35°C hot day at 3200 pounds using intermediate rated power was 2890 feet (1360 feet less than the 4250 foot estimate) (para 12).

b. Paragraph 3.1.2.2f. The service ceiling (100 ft/min rate of climb) on a standard day was 15,520 (1080 feet less than estimated) (para 15).

c. Paragraph 3.1.2.2g. The aircraft range at 2000 feet pressure altitude, 35°C at MCP (with a takeoff fuel allowance of 2 minutes at MCP at sea level and reserve fuel of 0.5 hour at 2000 feet and 35°C) was 175 NM (10 NM less than estimated) (para 8).

d. Paragraph 3.1.2.2h. The cruise airspeed at a pressure altitude of 2000 feet and 35°C at 3200 pounds was 98 KTAS (2 knots less than estimated) (para 18).

e. Paragraph 3.1.2.2i. The aircraft endurance at 2000 feet pressure altitude, 35°C (with a takeoff allowance of 2 minutes at MCP at sea level and reserve fuel of 0.5-hour at 2000 feet and 35°C) was 2.4 hours (.4 hours less than estimated) (para 18).

104. Within the scope of this test, the OH-58C helicopter failed to meet the requirements of the Military Specification, MIL-H-8501A, Helicopter Flying and Ground Handling Qualities; General Requirements for, as modified by the deviations contained in the detail specification.

a. Paragraph 3.2.10. The longitudinal control gradients near cruise airspeeds in level flight at an aft cg location were not positive (para 31).

b. Paragraph 3.2.10. The longitudinal control gradient near 50 KCAS in autorotations are not positive at airspeeds higher than trim (para 33).

c. Paragraph 3.2.11.1b. The time history of angular velocity is not concave downward within 2.0 seconds following an aft longitudinal control displacement (para 39).

d. Paragraph 3.2.1. Steady, smooth flight was not obtainable in rearward flight to 30 KTAS (para 56).

e. Paragraph 3.2.2. The directional control limit was reached within 35 KTAS in right sideward flight (para 57).

RECOMMENDATIONS

105. Correct the deficiencies.

106. Correct the shortcomings as soon as possible.

107. Consideration should be given to modifying the infrared countermeasure exhaust stacks to alleviate the aperiodic pitch divergence deficiency (para 46).

108. Observe a maneuvering airspeed of 65 KTAS (70 KCAS) to preclude divergent pitch-up (dig-in) (para 52).

109. Increase directional control margins at high density altitudes (para 59).

110. Consideration should be given to installing stability augmentation system to improve the overall handling qualities of the helicopter (para 59).

111. Decrease the time between inspections for the following maintenance actions: adjustment, swashplate and support assembly; main transmission mount; change and track main rotor blades and/or list them as trouble shooting guides when either a 1/rev or 2/rev vibration is encountered (para 64).

112. Incorporate a warning to the pilot for impending overtorque or overtemperature (para 78).

113. The OH-58C should be evaluated at a high altitude Nap-of-the-earth test site (para 86).

114. Add note to the operator's manual and appropriate maintenance manual regarding the requirement for fuel control (start derichment valve) adjustment when changing operations environment (para 92).

NOTE

When changing aircraft operating environment, fuel control adjustment may be required to preclude stagnated or hot starts.

115. An inspection interval and procedure should be implemented for the transmission oil cooler. Consideration should be given to placing a small wire mesh screen placed over the intake to the blower leading into the main transmission oil cooler hose (para 93).

116. Investigate the manufacturing and installation techniques as well as the final item quality control of the power turbine air line from the double check valve to the fuel control (para 94).

117. Direction of removal, thread direction, and proper location of tools on the electromechanical disconnect should be specifically stated in the maintenance procedures outlined in TM 55-1520-228-23 to preclude a needless waste of manpower and parts (para 90).

APPENDIX A. REFERENCES

1. Test Plan, USAAEFA, Project No. 76-11-2, *Airworthiness and Flight Characteristics Evaluation, OH-58C Helicopter*, April 1978.

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3. Technical Manual, TM 55-1520-235-10, *Operator's Manual, Army Model OH-58C Helicopter*, Final Draft, 29 April 1977.

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5. Military Specification, MIL-H-8501A, *Helicopter Flying and Ground Handling Qualities, General Requirements For*, 7 September 1961, with Amendment 1, 3 April 1962.

6. Final Report, USAASTA, Project No. 68-30, *Airworthiness and Flight Characteristics Test, Production OH-58A Helicopter, Unarmed and Armed with the MX27E1 Weapons System, Performance*, September 1970.

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15. Technical Manual, TM 55-1520-228-23, Headquarters, Department of the Army, *Aviation Unit and Intermediate Maintenance Manual, Army Model OH-58A and OH-58C Helicopters*, 4 August 1978.

16. Technical Manual, TM 55-2840-241-23, *Aviation Unit and Aviation Intermediate Maintenance Manual, Engine Aircraft, Gas Turbine Model T63A-720, P/N 6887191, NSN 2840-01-013-1339*, 2 November 1977.

17. Model Specification, Detroit Diesel Allison Division of General Motors Corporation, No. 876, "Military Turboshaft Engine, Model T63-A-720, 12 September 1975.

APPENDIX B. DESCRIPTION

GENERAL

1. The OH-58C helicopter is a modification of the OH-58A scout helicopter. The modification consists of 19 primary changes to the aircraft in addition to numerous hardware changes. Table 1 presents a list of the 19 primary changes.

2. Overall aircraft dimensions and general configuration of OH-58C are unchanged from the OH-58A. Maximum takeoff gross weight of the OH-58C is 3200 pounds compared to 3000 pounds for the OH-58A. The OH-58C main and tail rotor are identical to those on the OH-58A. A general description of the OH-58C aircraft including operating procedures and limitations is presented in reference 3, appendix A. Specific changes is discussed in the following paragraphs.

ENGINE

3. The T63-A-720 turboshaft engine built by Allison division of Detroit Diesel Corporation is installed in the OH-58C to increase its performance capability. The physical characteristics of this engine are similar to the T63-A-700 turboshaft engine which powers the OH-58A. The T63-A-720 has an uninstalled sea level, standard-day intermediate rating of 420 shp and maximum continuous rating of 370 shp.

4. The engine is equipped with an automatic relight system, which provides automatic engine reignition in the event of engine flame out. The system consists of a control box, bleed pressure sensing line, and electrical connectors. In the event of bleed air pressure loss resulting from engine flame out, the system causes electrical power to be applied to the ignitor plug to resume fuel combustion. Activation of the system is indicated by the illumination of an indicator light on the cockpit instrument panel. Additional system description is presented in reference 16, appendix A.

MAIN TRANSMISSION

5. Numerous bearing design and metalurgical improvements are incorporated in the main transmission. Although the power output limit of the transmission is unchanged from the OH-58A, the transmission dry run capability and survivability in the event of loss of lubrication fluid is improved.

6. Improved main transmission pylon support fittings are installed to enhance the crashworthiness of the main transmission support structure. These fittings, which are used to fasten the main transmission pylon support link to the roof beam of the helicopter, are fabricated from a stronger steel alloy.

7. A main transmission oil pressure guage is provided on the cockpit instrument panel to provide direct reading of transmission oil pressure. This instrument is in addition to the transmission low oil pressure warning light on the instrument panel.

Table 1. OH-58C Primary Changes.

T63-A-720 engine	Improved main transmission bearings
Flat glass cockpit canopy	Improved main transmission pylon support fittings
Tail rotor drive shaft cover	Transmission oil pressure gauge
Improved tail rotor drive shaft bearings	Reconfigured instrument panel
Infrared suppression engine exhaust	Improved cabin air distribution system
Infrared suppression engine cowling	AN/APR 89 radar warning
Low reflective fuselage paint	AN/ARM-123 CONUS navigation
Automatic engine relight system	AN/APN-209 radar altimeter
Vulnerability reduced flight controls	YG-1054 proximity warning
Controllable landing light	

TAIL ROTOR DRIVE SHAFT

8. A cover is installed over the tail rotor drive shaft to aid in keeping dust and dirt from the tail rotor drive shaft bearings. The cover extends from the engine oil reservoir cowling to just forward of the tail rotor gearbox.

9. New tail rotor drive shaft bearing, and improved rubber seal for placement between each bearing and the drive shaft are installed on the OH-58C. The new bearing which can now be periodically lubricated, and the improved rubber seal are designed to increase the reliability and maintainability of the tail rotor drive shaft.

FUSELAGE

10. A four-panel flat plate canopy is installed on the OH-58C in place of the typical bubble canopy on the OH-58A. Two rectangular forward panels and two triangular side panels are fabricated from stretched acrylic and riveted in place. Photos 1 and 2 illustrate the flat plate canopy installation. Additional descriptions are presented in reference 2, appendix A.

11. Infrared suppressive engine exhaust ducts are installed on the OH-58C. These exhaust ducts, illustrated in photo 2, incorporate cooling fins and serve to re-direct and to cool the engine exhaust gases before venting to the atmosphere.

12. The engine cowl of the OH-58C is re-designed to suppress infrared radiation from the engine area and provide improved engine cooling. Two screened ports are located on the top panel of the engine cowl forward of the engine exhaust ducts. The side panels of the engine cowl are also modified to incorporate a heat elimination tunnel.

13. The external fuselage of the OH-58C is painted with low reflective paint. This paint is designed to reduce glare from the aircraft structure.

14. A controllable landing light is installed on the OH-58C. The light is controllable in elevation and azimuth and is similar to a UH-1 search light. A four-way momentary thumb switch is installed on the collective control head to provide control of the landing light position (fig. 1).

FUSELAGE CONTROLS

15. The cyclic and collective controls of the OH-58C are essentially unchanged from the OH-58A. Four structural changes have been incorporated to reduce the vulnerability of the cyclic and collective control systems to ballistic damage. The longitudinal cyclic, lateral cyclic, and collective vertical push-pull tubes located in the enclosed column behind the front cockpit seats have been enlarged in diameter. The cyclic yoke beneath the front cockpit seats has also been enlarged.

Photo 1. Flat Plate Canopy Installed In OH-58C.

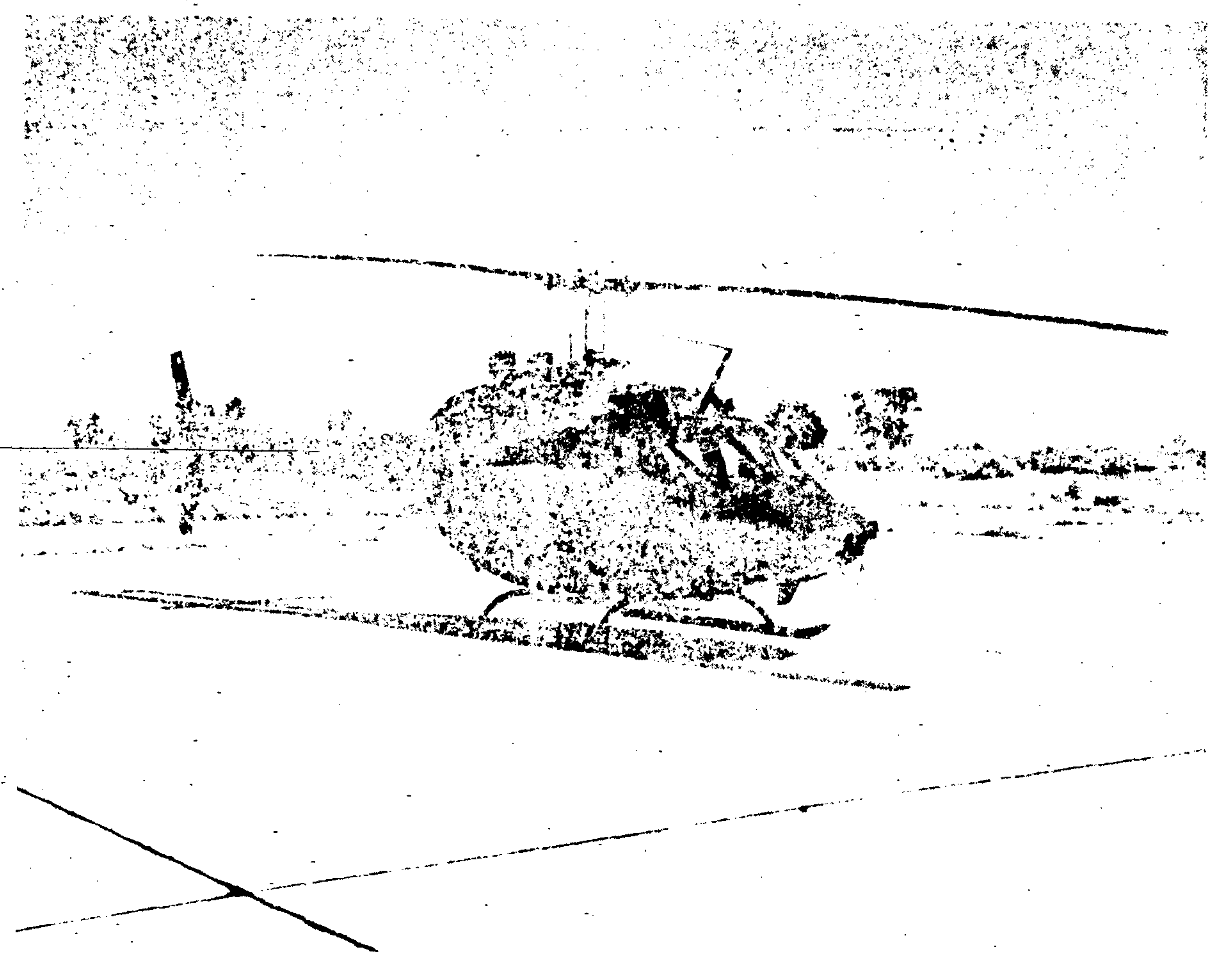


Photo 2. Right Front View of OH-58C.

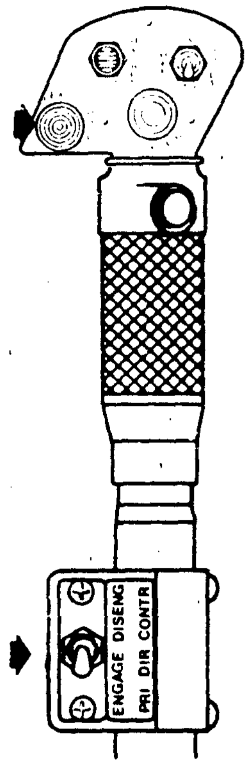
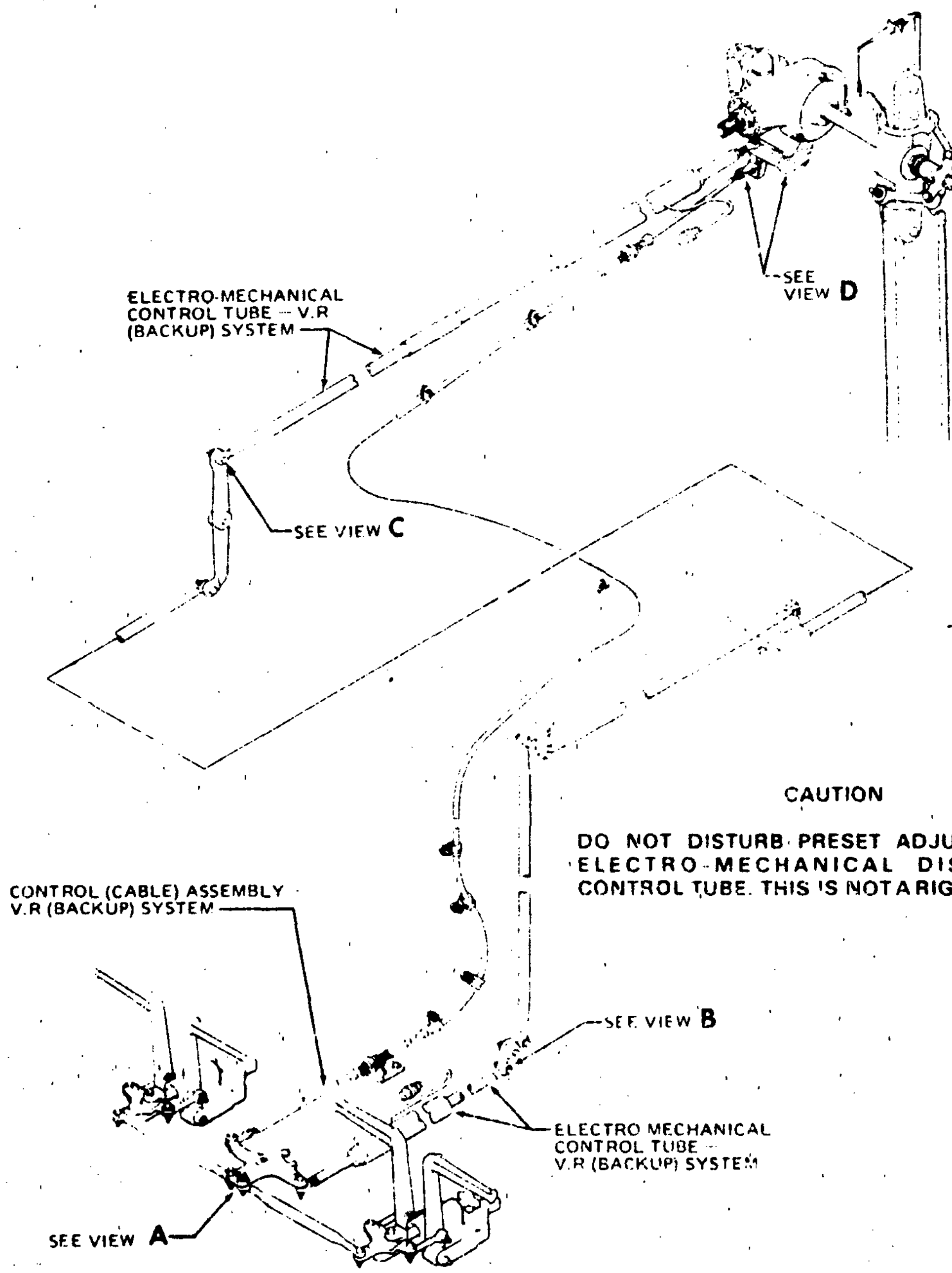


Figure 1. Pilot Collective Control Stick.

16. A redundant tail rotor control system is installed to provide backup tail rotor control. A diagram of the primary and backup tail rotor control systems is presented in figure 2. The backup system consists of a push-pull cable located in a rigid housing. The push-pull cable is connected into the primary tail rotor control system at a forward bellcrank between the pilot and the copilot pedals and at an aft bellcrank below the tail rotor gearbox. The backup tail rotor control system functions with the primary system during normal operation. In the event of a primary control jam, the primary system is disconnected at each end by a electro-mechanical disconnect link enabling the tail rotor to be controlled solely by the backup control system. The two disconnect links in the primary system are activated by a toggle switch located on the pilot collective control stick (fig. 1). Lights on the instrument panel indicate whether the primary tail rotor system is jammed and if the disconnect switch has been activated. There are shear pins in the backup system to guard against possible malfunctions of that system.



CAUTION

DO NOT DISTURB PRESET ADJUSTMENT OF ELECTRO-MECHANICAL DISCONNECT CONTROL TUBE. THIS IS NOT A RIGGING POINT.

Figure 2. Tail Rotor Control Systems

INSTRUMENT PANEL

17. The OH-58C instrument panel is enlarged to incorporate additional instruments, indicators and avionics controls. A diagram of the instrument panel is presented in figure 3. Four principal new items of avionics equipment have been added:

a. AN/APR-39 radar warning set

b. AN/ARN-123 CONUS navigation receiver

c. AN/APN-209 radar altimeter

d. YG-1045 proximity warning device

A more detailed description including operational procedures for these items is presented in reference 3, appendix A.

18. All instruments, indicators, and control panels on the instrument panel are internally lighted with red light. In addition, the engine and flight instruments employ low-light level symbology.

HEATING/DEFROSTING SYSTEM

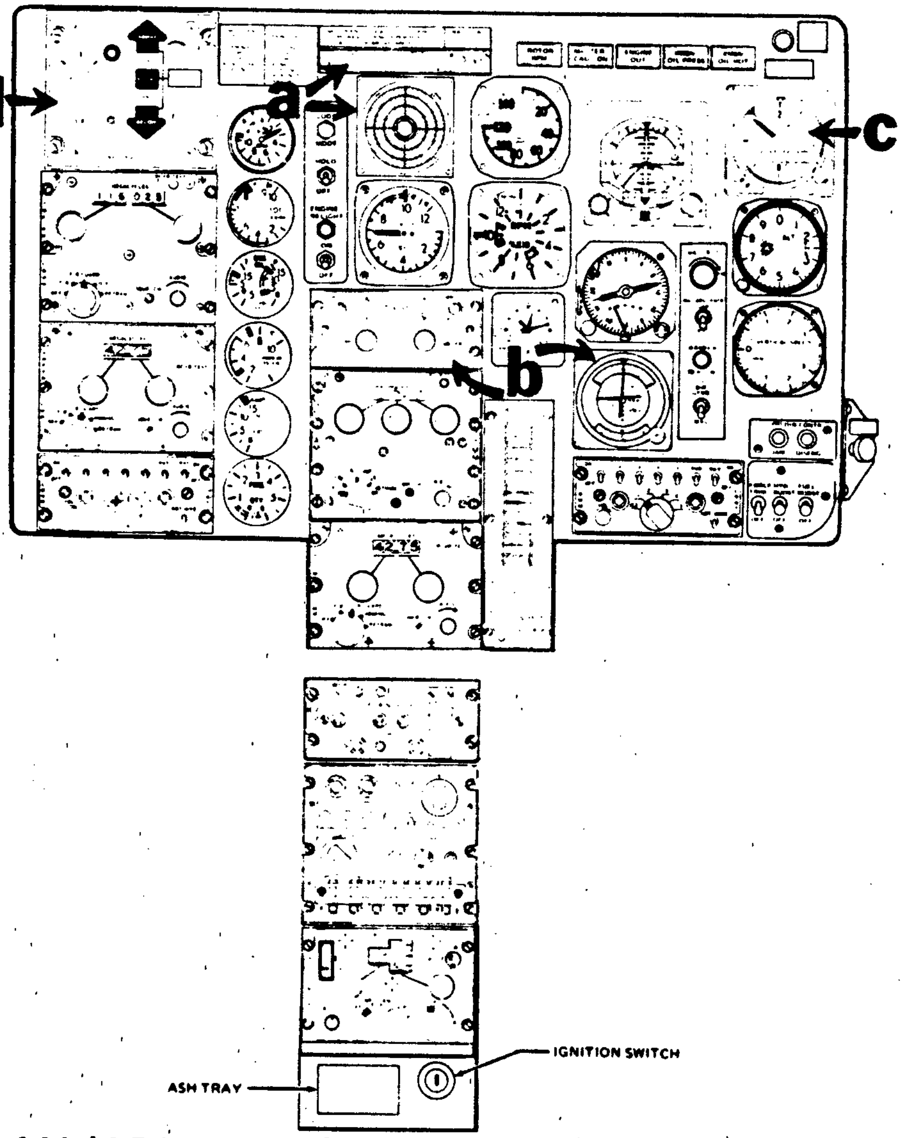
19. Two ventilating and defogging blowers are installed in the nose of the OH-58C. These blowers improve the flow of bleed air heat to the windshields for defrosting and improve the flow of ventilating air in the cockpit.

FLIGHT CONTROL

20. A flight control rigging check was performed in the aircraft prior to testing. Measurements were taken in accordance with applicable maintenance procedures and were within acceptable limits.

WEIGHT AND BALANCE

21. The weight and balance of the test aircraft were determined by weighing the aircraft after all airframe modifications and instrumentation changes were completed. The empty gross weight including full oil and trapped fuel was determined to be 2137 pounds with a longitudinal center of gravity at 115.1 inches and lateral center of gravity at 0.4 inches.



a. AN/APR-39 radar warning set
b. AN/ARN-123 CONUS navigation receiver
c. AN/APN-209 radar altimeter
d. YG-1045 proximity warning device

Figure 3. OH-58C Instrument Panel

APPENDIX C. INSTRUMENTATION AND SPECIAL EQUIPMENT

INSTRUMENTATION

1. In addition to, or instead of, standard aircraft instruments, calibrated instrumentation was installed aboard the test aircraft and maintained by USAAEFA personnel. Data were recorded from cockpit instruments on flight data cards and from the test instrumentation system on magnetic tape (PCM and FM).

2. The test instrumentation, calibrated ship's system instrumentation and related special equipment installed are listed below. The test instrumentation package was installed in the passenger/cargo area of the test aircraft (photos 1 and 2).

PILOT STATION

Airspeed (boom and ship's systems)
Pressure altitude (boom and ship's system)
Radar altitude
Main rotor speed
Engine torque
Turbine outlet temperature
Gas generator speed
Power turbine speed
Angle of sideslip
Normal acceleration
Load cell (tethered hover performance)

COPILOT/ENGINEER STATION

Roll attitude indicator
Free air temperature
Fuel flow rate
Fuel used
Run number
Time of day
Event
Control fixture mounts
Decommutation unit

DIGITAL (PCM) DATA RECORDED ON MAGNETIC TAPE

Airspeed (boom and ship's system)
Pressure altitude (boom and ship's system)
Angle of attack
Angle of sideslip
Main rotor speed
Free air temperature

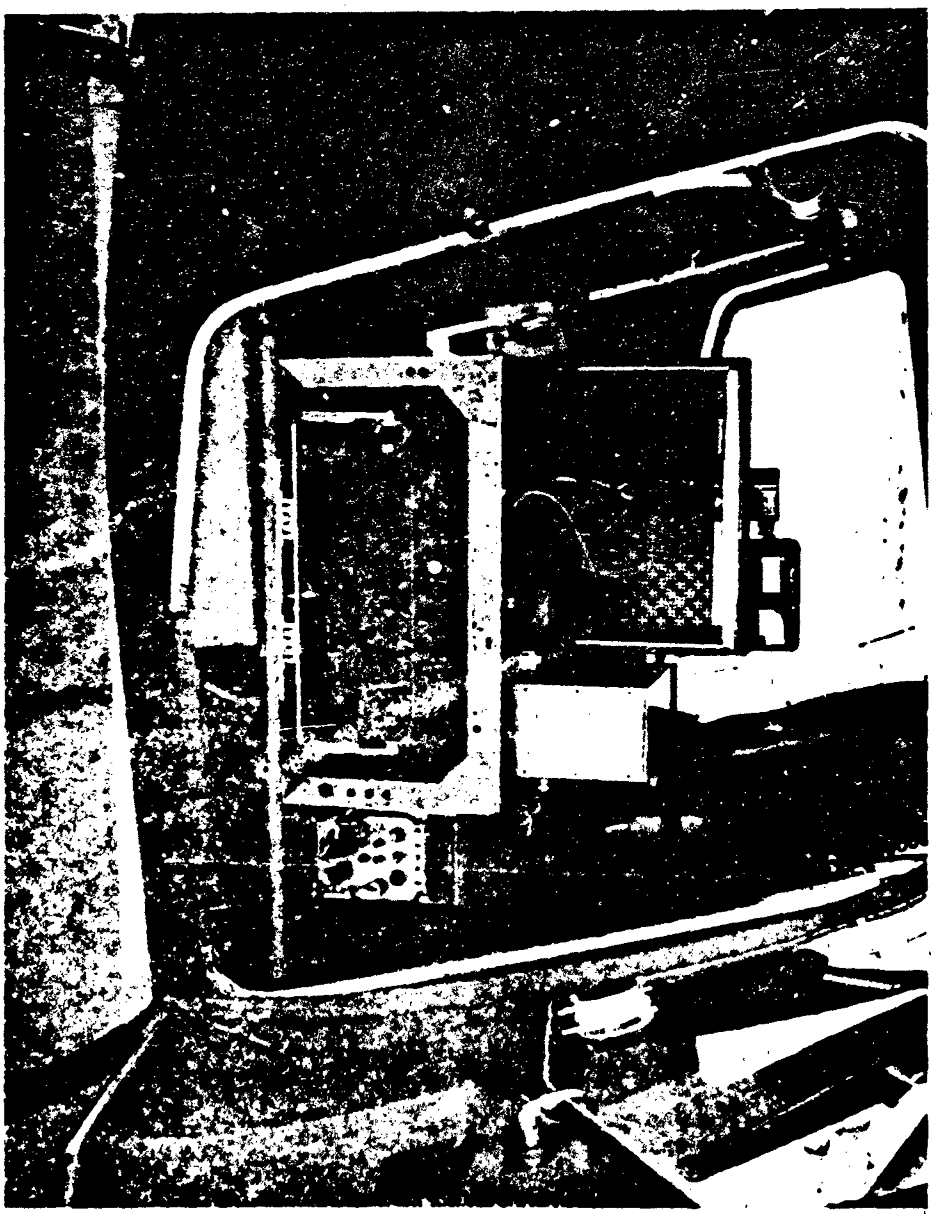


Photo 1. Instrument Package Right Side

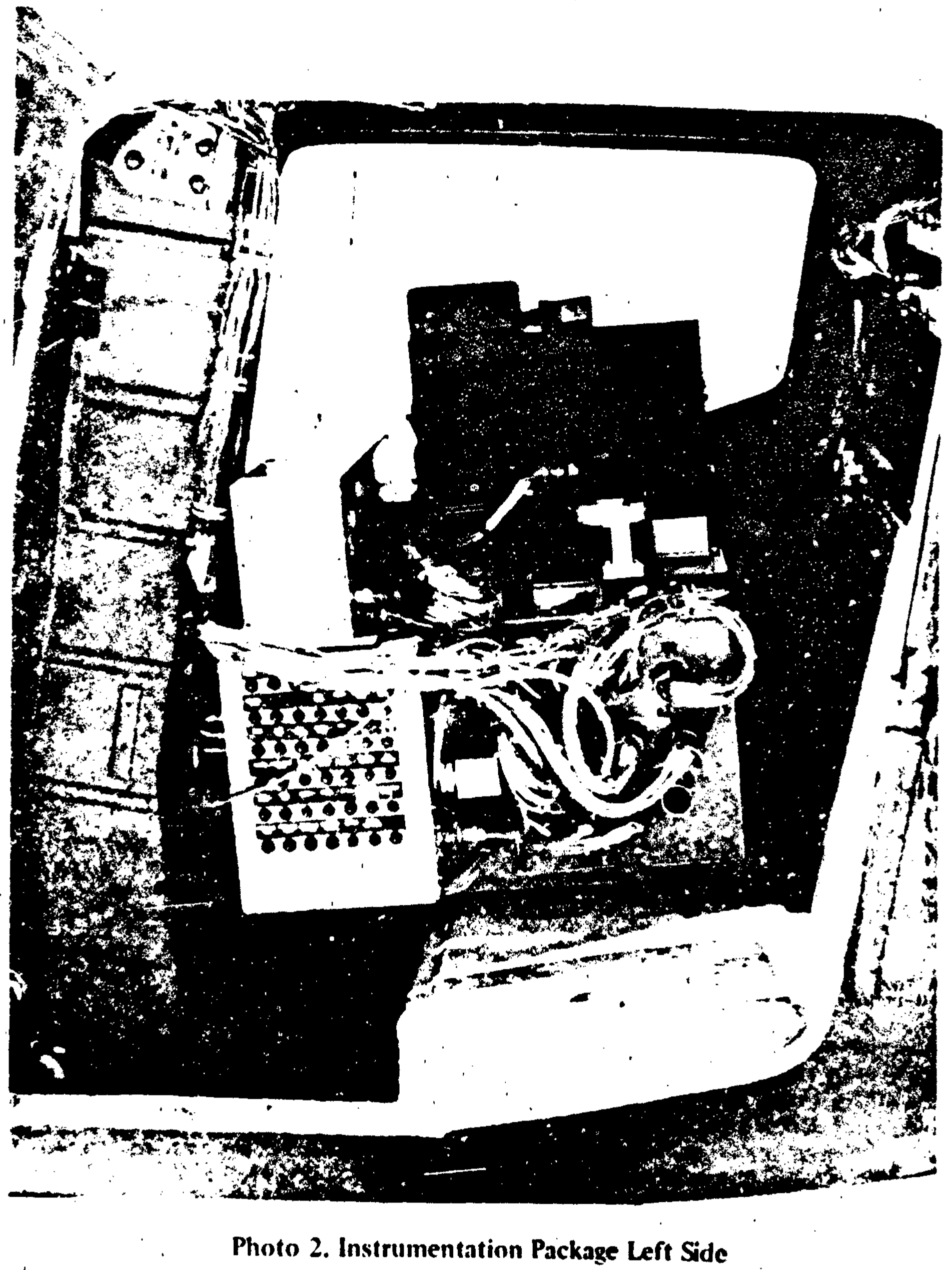


Photo 2. Instrumentation Package Left Side

Fuel used
Fuel flow rate
Turbine outlet temperature
Engine torque
Gas generator speed
Power turbine speed
Center of gravity normal acceleration
Control positions
- Longitudinal
- Lateral
- Directional
- Collective
- Throttle

Aircraft attitudes and angular velocities
- Pitch
- Roll
- Yaw

Event
Run number
Time of day
Radar altitude (NOE evaluation only)

ANALOG (FM) DATA RECORDED ON MAGNETIC TAPE (VIBRATION ASSESSMENT AND NOE EVALUATION ONLY)

Vibration (accelerometer location)
- Pilot station (floor)
  - Vertical
  - Lateral
  - Longitudinal
- Copilot station
  - Vertical
  - Lateral
  - Longitudinal
- Instrument panel front center
  - Vertical
  - Lateral
  - Longitudinal
- Instrument panel backside upper right corner
  - Vertical
  - Lateral
  - Longitudinal

3. A tethered hover rig and load cell arrangement manufactured by USAAEFA personnel were used for the hover performance tests (photo 3). In addition to instrumentation installed on the aircraft other specialized equipment was required. Portable wind towers (50 feet) were used to measure wind speed and direction during all the low speed and hover tests. A pace vehicle with a calibrated fifth wheel and/or radar speed gun was also used during the low speed flight tests. Takeoff distances and speeds were determined for the takeoff performance tests from azimuth and elevation angles recorded on paper tape from recording optical instruments, and a mobile computer van was used to process data recorded on magnetic tape at the remote test sites.

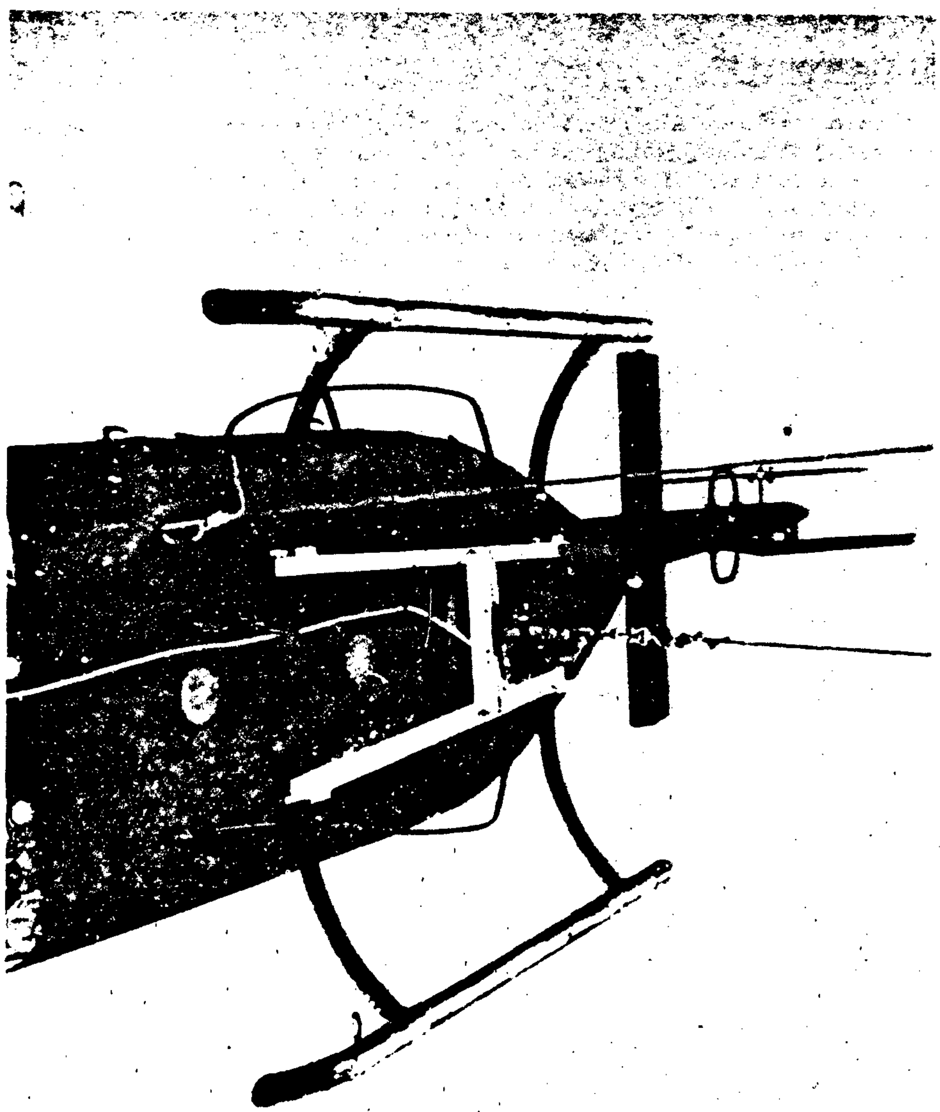


Photo 3. Tethered Hover Rig

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

TEST TECHNIQUES

1. Conventional test techniques were used in both the performance and handling qualities tests. Detailed descriptions of all test techniques are contained in references 13 and 14, appendix A. The Handling Qualities Rating Scale presented in figure 1 was used to augment pilot comments relative to handling qualities and the Vibration Rating Scale in figure 2 was used to augment the pilot comments relative to vibrations. Definitions of deficiencies and shortcomings are as stipulated in Army Regulation AR 310-25 (ref 19).

DATA ANALYSIS METHODS

Nondimensional Coefficients

2. The helicopter performance test data were generalized by use of nondimensional coefficients. The following nondimensional coefficients were used to generalize the hover, climb, level flight, and autorotational results obtained during this evaluation:

a. Coefficient of the power (Cp):

$$C_p = \frac{SHP \times 550}{\rho A(\Omega R)^3} \qquad (1)$$

b. Coefficient of thrust (C_T):

$$C_T = \frac{GW}{\rho A(\Omega R)^2} \qquad (2)$$

c. Advance ratio (μ):

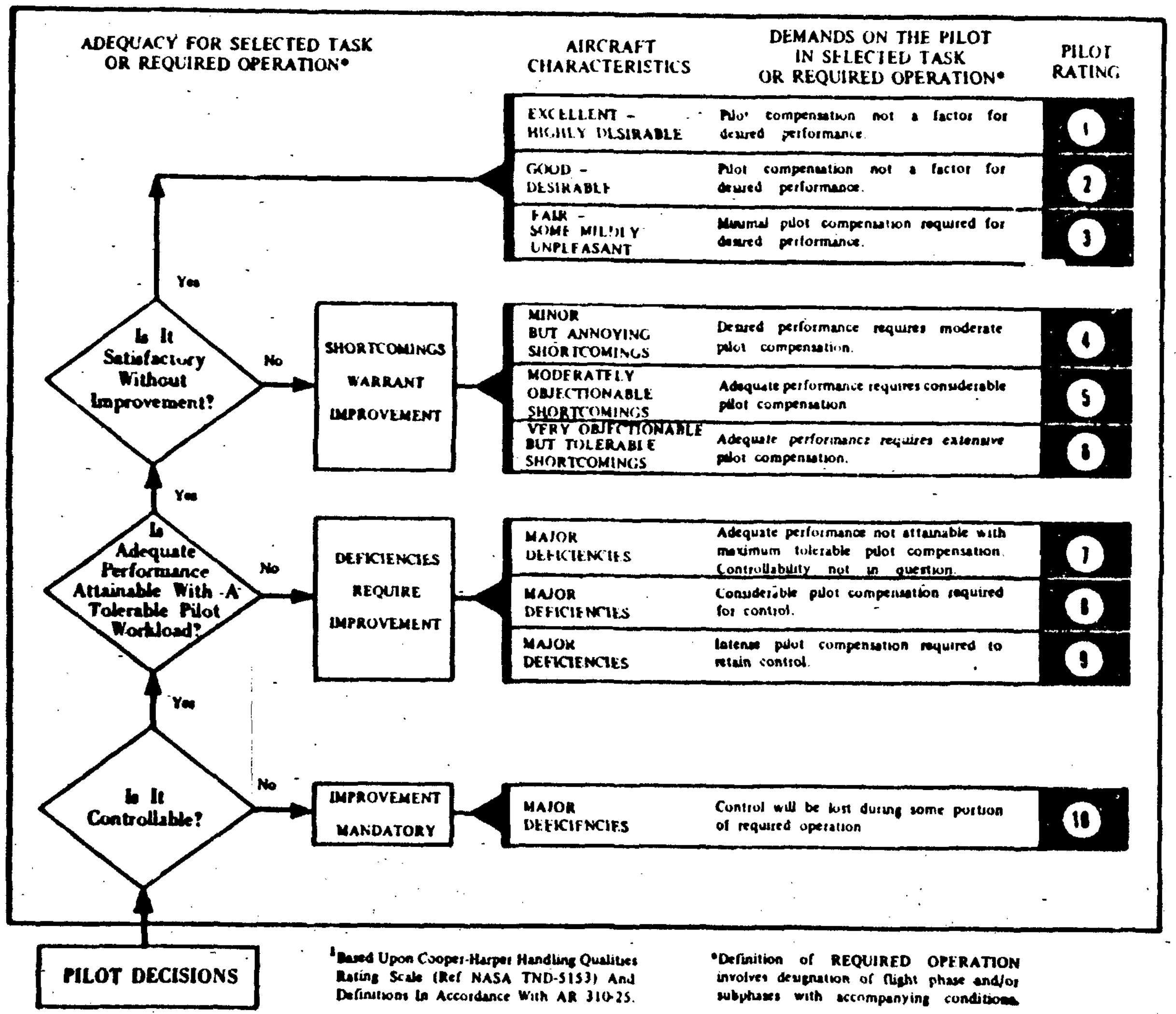
$$\mu = \frac{1.6878\ V_T}{\Omega R} \qquad (3)$$

d. Advancing blade tip mach number (M_{TIP}):

$$M_{tip} = \frac{1.6878\ V_T + (\Omega R)}{a} \qquad (4)$$

Where:

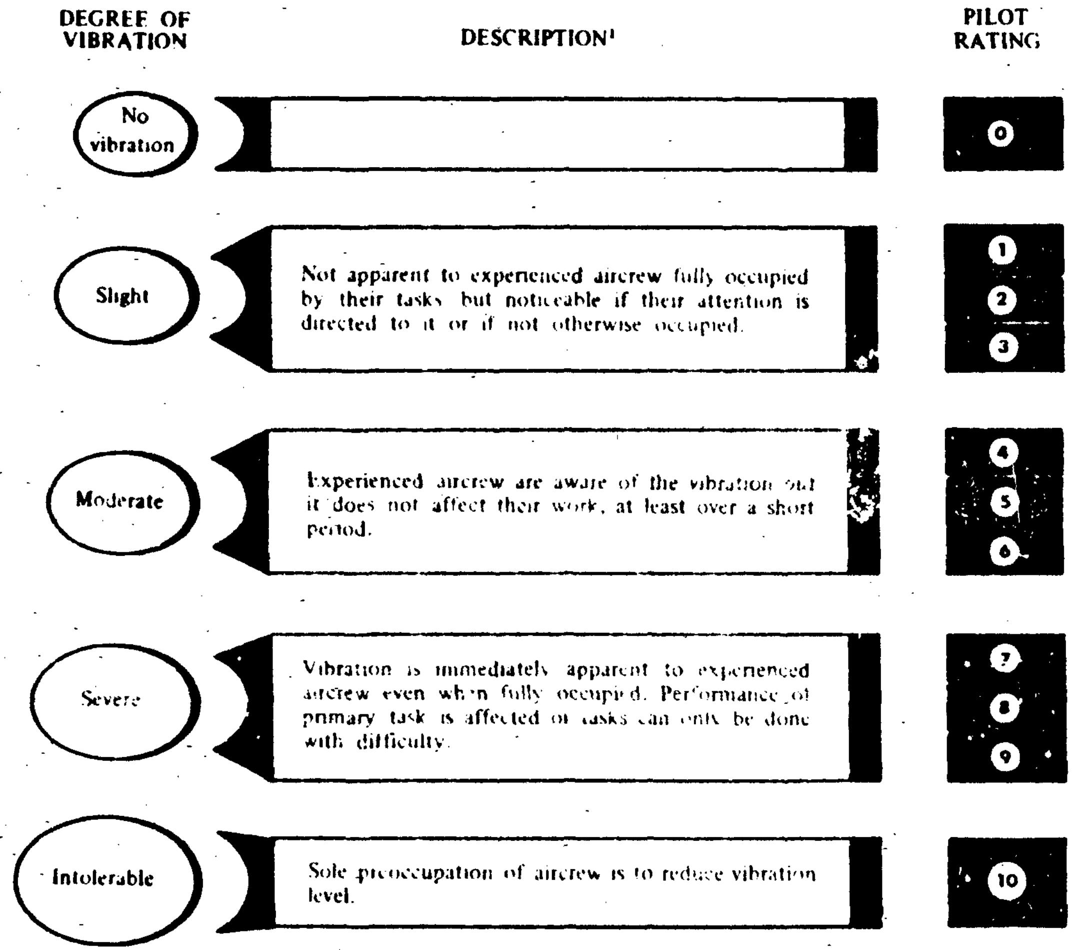
SHP = Engine output shaft horsepower
550 = Conversion factor (ft-lb/sec/shp)
ρ = Air density (slug/ft^3)
A = Main rotor disc area (ft^2)
Ω = Main rotor angular velocity (radian/sec)



[1]Based Upon Cooper-Harper Handling Qualities Rating Scale (Ref NASA TND-5153) And Definitions In Accordance With AR 310-25.

*Definition of REQUIRED OPERATION involves designation of flight phase and/or subphases with accompanying conditions.

Figure 1. Handling Qualities Rating Scale.



[1] Based upon the Subjective Vibration Assessment Scale developed by the Aeroplane and Armament Experimental Establishment, Boscombe Down, England.

Figure 2. Vibration Rating Scale.

R = Main rotor radius (ft)

GW = Aircraft gross weight (lb)

V_T = True airspeed (kt)

a = Speed of sound (ft/sec)

1.6878 = Conversion factor (ft/sec/kt)

35', 4" = Main rotor diameter

True airspeed (V_T) was calculated using calibrated airspeed (V_{CAL}) and density ratio (σ) as follows:

$$V_T = \frac{V_{CAL}}{\sqrt{\sigma}} \quad (5)$$

Where:

$\sigma = \rho / .0023769$

Shaft Horsepower Required

3. The engine output shaft torque was determined from the engine manufacturer's torque system. The relationship of measured torque pressure (psi) to engine output shaft torque (in-lb) as determined in the engine test cell calibration is shown in figure 3. The output shp was determined from the engine output shaft torque and rotational speed by the following equation:

$$SHP = \frac{2\pi \times Np \times Q}{33000} \quad (6)$$

Where:

Np = Engine output shaft rotational speed (rpm)

Q = Engine output shaft torque (in-lb)

33000 = Conversion factor (ft-lb/min/shp)

Hover

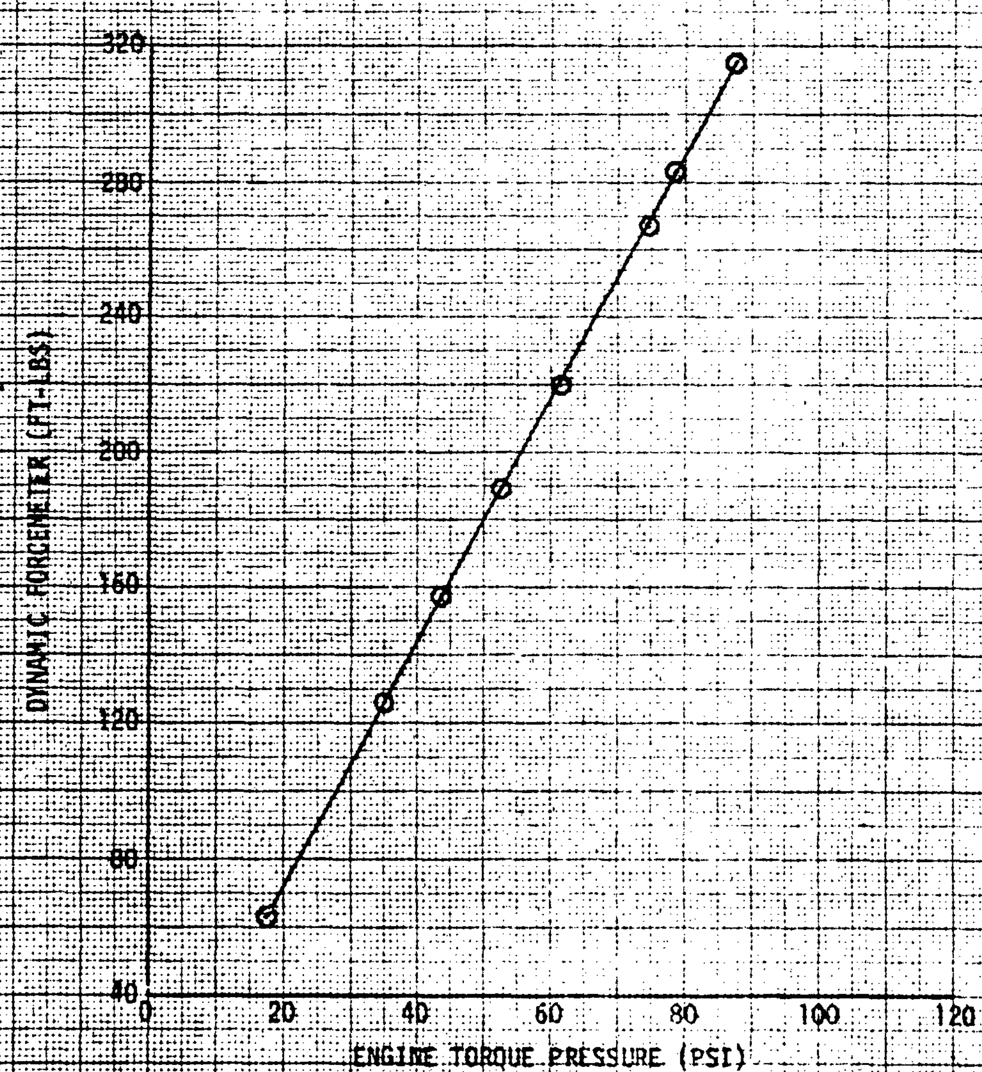
4. Hover performance was obtained both IGE and OGE by the free flight and tethered hover techniques. All hover tests were conducted in winds of less than three knots. Atmospheric pressure, temperature, and wind velocity were recorded from a ground weather station. Free flight hover tests consisted of stabilizing the helicopter at a desired height with reference to a pre-measured weighted cord hung from the landing fear skid. The aircraft initial gross weight for free flight hover was determined by either the maximum gross weight or maximum power (drive train limit). Weight was incrementally removed from the aircraft until the minimum gross weight was obtained. Tethered hover test used a tethered hover load cell arrangement described in appendix C. All hover data were reduced to nondimensional parameters of C_P and C_T (equations 1 and 2, respectively).

Level Flight Performance and Specific Range

5. Level flight speed power performance data was reduced using equations 1, 2, and 3. Each speed power was flown at a predetermined constant C_T by maintaining a constant referred gross weight (W/δ) and referred rotor speed ($N/\sqrt{\theta}$). A constant

FIGURE 3
ENGINE TORQUE VS. ENGINE TORQUE PRESSURE
ALLISON ENGINE MODEL T63-A-720 S/N 404534
TYPE FUEL: JP-4 FUEL LOWER HEATING VALUE: 18745 BTU/LB
POWER TURBINE SPEED: 34200 RPM
AVERAGE COMPRESSOR INLET TEMPERATURE: 50°F

NOTE: DATA OBTAINED FROM ENGINE INSPECTION TEST LOG DATED 15 MAR 78.



W/δ was maintained by increasing ambient pressure ratio (δ) as the aircraft gross weight decreased due to fuel burnoff. Rotor speed was also varied to maintain a constant $N/\sqrt{\theta}$ as the ambient air temperature varied.

6. Test-day level flight power was corrected to standard day conditions by assuming that the test-day dimensionless parameters, C_{P_t}, C_{T_t}, and μ_t are independent of atmospheric conditions. Consequently, the standard day dimensionless parameters C_{P_s}, C_{T_s}, and μ_s are identical to C_{P_t}, C_{T_t}, and μ_t respectively. From equations 1 and 3 the following relationship can be derived:

$$SHP_s = SHP_t \frac{\rho_s}{\rho_t} \quad (7)$$

Where:

t = Test day
s = Standard day

7. Specific range was calculated using level flight performance curves and the specification installed engine fuel flow characteristics.

$$NAMPP = \frac{V_T}{W_f} \quad (8)$$

Where:

NAMPP = Nautical air miles per pound of fuel
V_T = True airspeed (kt)
W_f = Fuel flow (lb/hr)

8. Changes in the equivalent flat plate area (Δfe) for various aircraft configurations were calculated by the following equation:

$$\Delta fe = \frac{2\,(\Delta C_P)A}{\mu^3} \quad (9)$$

Where:

Δfe = Change in flat plate area (ft^2)
ΔC_P = Change in coefficient of power at constant C_T and μ
A = Main rotor disc area (ft^2)

Sawtooth Climbs and Autorotational Descents

9. A series of sawtooth climbs and autorotorational descents were flown to determine generalized climb and descent performance. The rates of climb and descent (dHp/dt) were determined from the rate of change of boom pressure altitude (Hp) with time, corrected for instrument error, static position error, and altimeter error caused by nonstandard temperature using the following equation:

$$R/C = \frac{dHp}{dt} \frac{T_t}{T_s} \qquad (10)$$

Where:

$\frac{dHp}{dt} = \frac{R/C}{60}$ = Slope of pressure altitude versus time curve at a given pressure altitude (ft/min)

T_t = Test ambient air temperature at the pressure atlitude at which the slope is taken (°K)

T_s = Standard ambient air temperature at the pressure altitude at which the slope is taken (°K)

10. Climb and descent performance data were reduced to generalized parameters to provide a format for computing performance at any specified climb or descent conditions. The following parameters were used to generalize the climb and descent data:

Generalized power, variation from level flight:

$$C_{P_{GEN}} = \frac{C_{P_C} - C_{P_L}}{0.707\ C_T^{1.5}} \qquad (11)$$

Vertical velocity ratio:

$$VVR = \frac{V_V}{\Omega R\sqrt{C_T/2}} \qquad (12)$$

Forward velocity ratio:

$$FVR = \frac{V_F}{\Omega R\sqrt{C_T/2}} \qquad (13)$$

Where:

C_{P_C} = Climb power coefficient
C_{P_L} = Level flight power coefficient
V_V = Vertical velocity (ft/sec) = Rate of Climb/60
V_F = Forward velocity (ft/sec) = $\sqrt{(V_T \times 1.6878)^2 - V_V^2}$

11. Climb power required for any condition can then be computed from these equations by determining $\Delta C_{P_{GEN}}$ as a function of the VVR and FVR required for the specific condition. The level flight power coefficient (C_{P_L}) was obtained from the nondimensional level flight performance curves.

$$C_{P_C} = 0.707\ C_{P_{GEN}} + C_{P_L} \tag{14}$$

12. The climb power correction coefficient (Kp) can be derived as a function of dimensional and nondimensional terms as shown below:

Dimensional:

$$K_P = \frac{\Delta R/C}{\Delta SHP} \ \frac{GW}{33000} \tag{15}$$

Nondimensional:

$$K_P = \frac{\Delta \mu_V}{\Delta C_P}\ C_T \tag{16}$$

Engine Inlet Characteristics

13. The engine inlet temperature and pressure characteristics were obtained from references 6, 7, and 8, appendix A.

Shaft Horsepower Available and Specification Fuel Flow

14. Shaft horsepower available and specificaiton fuel flow were obtained from Allison Engine Model Specification computer program, US Army Model T63-A-720, Model Spec 876, dated 12 September 1975 (250-C20C) and the inlet characteristics described in reference 2, app A.

15. The referred terms of the engine parameters were used to compare the test engine with the model specification engine. Data on SHP, turbine outlet temperature (TOT), fuel flow (W_f), and gas producer speed (N_1) were referred as follows:

a. Referred SHP (RSHP)

$$RSHP = \frac{SHP}{\delta_1 \sqrt{\theta}} \tag{17}$$

b. Referred turbine outlet temperature (RTOT)

$$RTOT = \frac{TOT}{\theta_1} \tag{18}$$

c. Referred fuel flow (RW_f)

$$RW_f = \frac{W_f}{\theta_1} \quad (19)$$

d. Referred gas producer speed (RN_1)

$$RN_1 = \frac{N_1}{\sqrt{\theta_1}} \quad (20)$$

Where;

$$\delta_1 = \frac{PT_1}{14.697}$$

$$\theta_1 = \frac{T_1}{288.15}$$

W_f = Engine fuel flow (lb/hr)
PT_1 = Engine inlet total pressure (psi)
T_1 = Engine inlet total temperature (°K)
N_1 = Gas generator speed referenced to 51120 rpm (percent)
K_1, K_2, K_3 = Correction factors for shaft horsepower, gas generator speed and fuel flow.

Pitot-Static Calibration

16. The boom and ship's standard pitot-static system were calibrated by using the pace aircraft and trailing bomb methods to determine the airspeed and altimeter position error. Calibrated airspeed (V_{CAL}) was obtained by corrected indicated airspeed (V_i) for instrument error (ΔV_{ic}) and position error (ΔV_{pc}) (figs 4, 5, and 6). Likewise pressure altitude (Hp) was obtained by correcting indicated pressure altitude (Hp_i) for instrument error (ΔHp_{ic}) and position error (ΔHp_{pc}). The altimeter position error (ΔH_{pc}) was calculated using ΔV_{pc} and assuming all error were introduced at the static port.

$$V_{CAL} = V_i + \Delta V_{ic} + \Delta V_{pc} \quad (21)$$

$$\Delta Hp_{pc} = \Delta V_{pc} \times \frac{58.566}{\sigma_s} \quad \frac{V_{ic}}{a_{SL}} \left[1 + 0.2 \left(\frac{V_{ic}}{a_{SL}}\right)^2\right]^{2.5} \quad (22)$$

$$Hp = Hp_i + \Delta Hp_{ic} + \Delta Hp_{pc} \quad (23)$$

FIGURE 4
BOOM SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	METHOD
⊙	2820	109.1 (MID)	0.5	5020	9.0	355	TRAILING BOMB
⊡	2820	109.1 (MID)	0.5	5020	9.0	355	PACE
⚠	2840	109.2 (MID)	0.5	5100	15.0	355	PACE

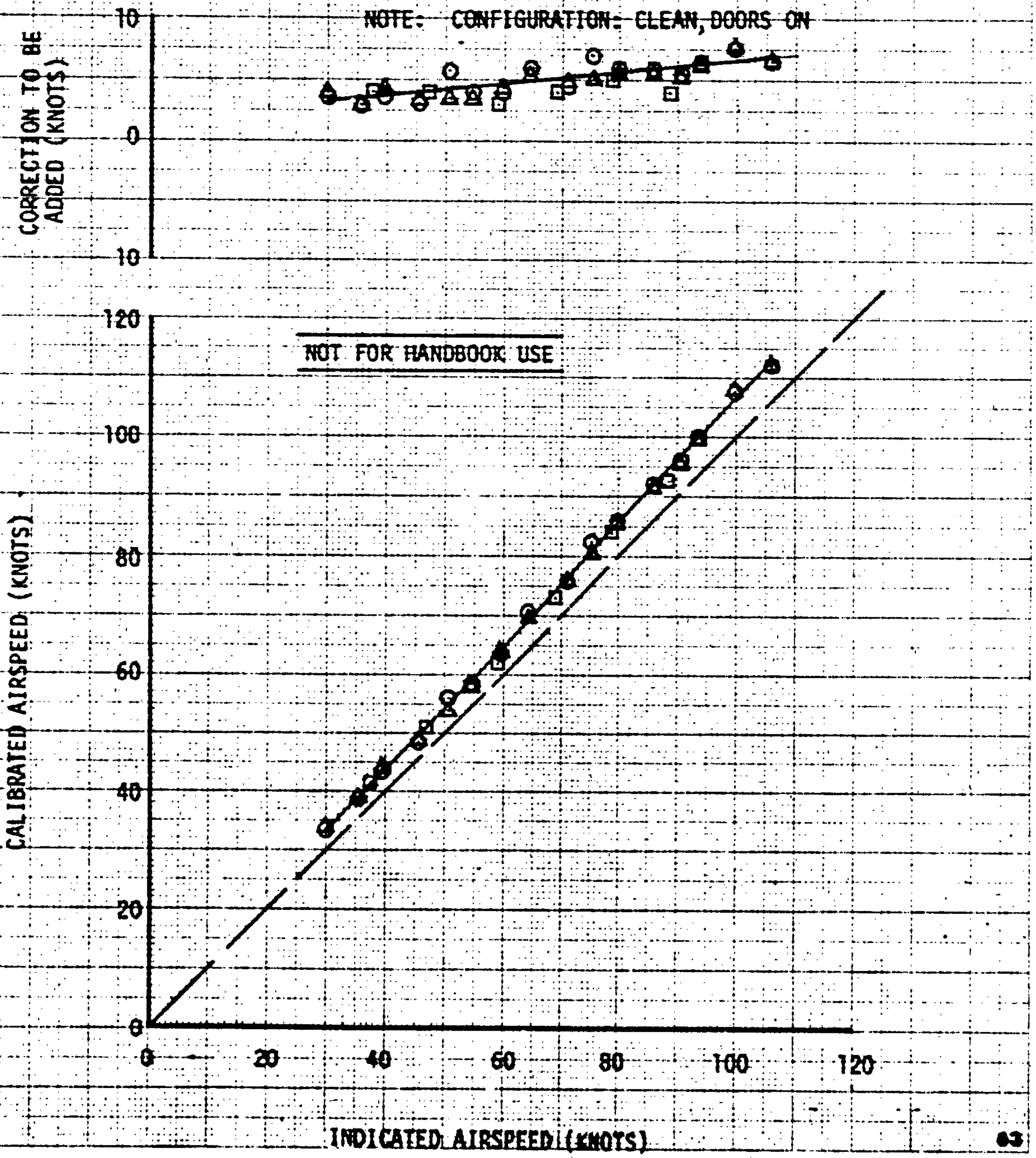


FIGURE 5
BOOM SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	METHOD
2800	109.1 (MID)	0.5	5200	9.0	355	TRAILING BOMB

NOTE: CONFIGURATION: CLEAN, DOORS ON

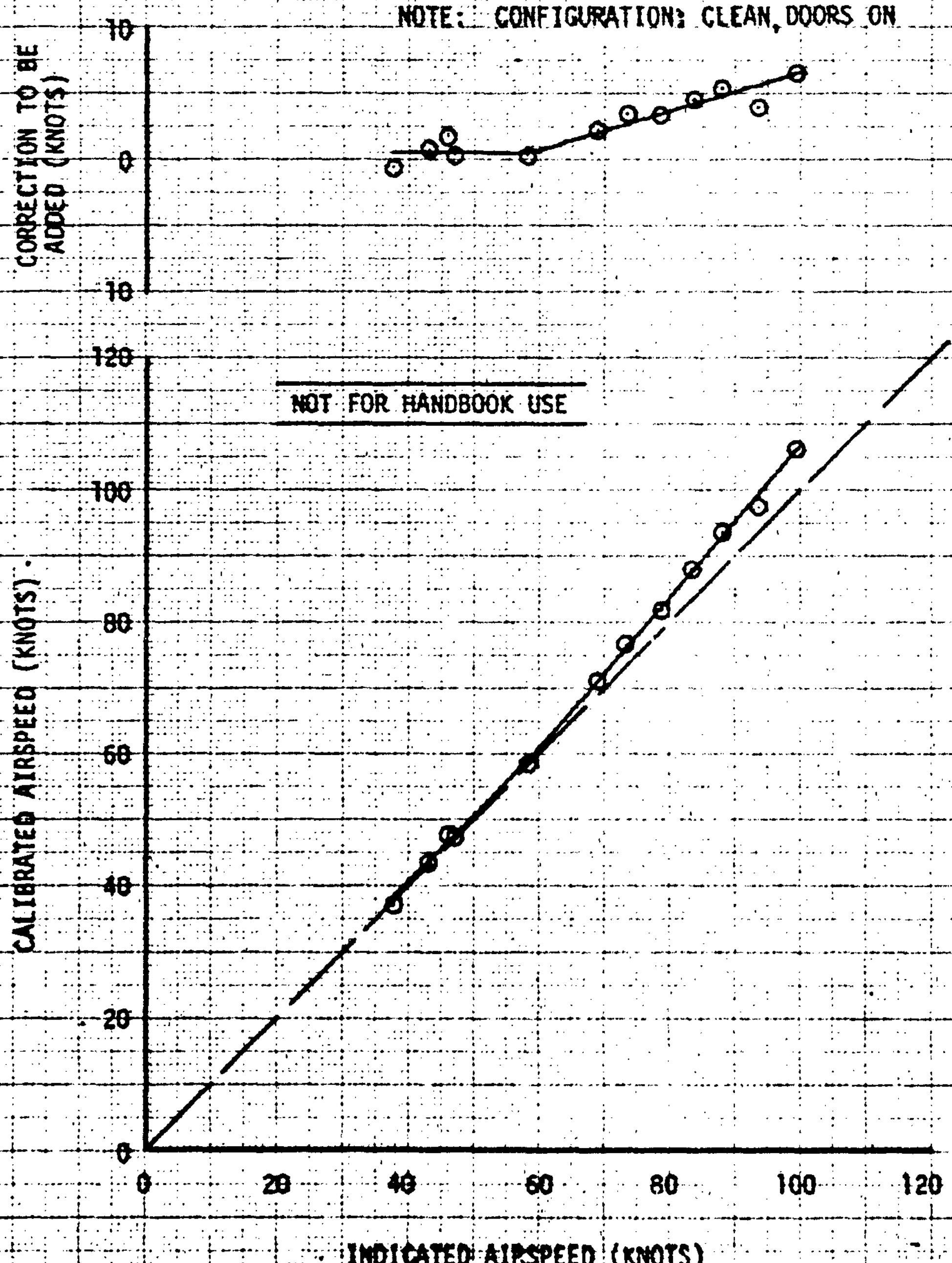
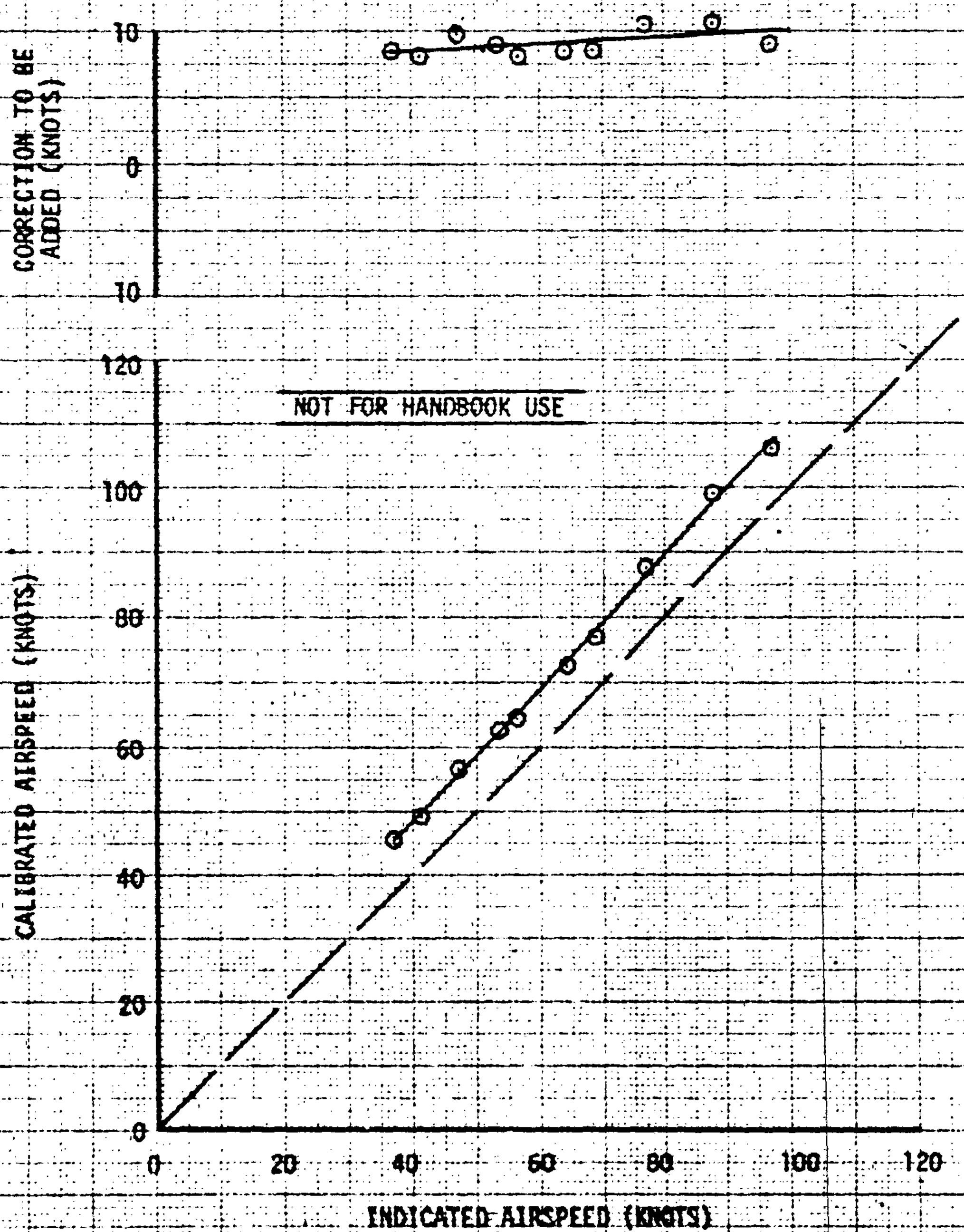


FIGURE 6
BOOM SYSTEM AIRSPEED CALIBRATION IN AUTOROTATION
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	METHOD
2800	109.1 (MID)	0.5	5120	9.0	355	TRAILING BOMB

NOTE: CONFIGURATION: CLEAN, DOORS ON



Where:

σ_S = Density ratio at the indicated pressure altitude corrected for instrument error
V_{ic} = Indicated airspeed corrected for instrument error
a_{SL} = Speed of sound at sea level (kt)

APPENDIX E. TEST DATA

INDEX

FIGURE 1
HOVER PERFORMANCE SUMMARY
OH-58C USA S/N 68-16724

NOTES: 1. SKID HEIGHT MEASURED FROM BOTTOM OF LEFT SKID.
2. SOLID LINES DENOTE STANDARD DAY CONDITIONS.
3. DASHED LINES DENOTE ARMY HOT CRITERIA 35°C.
4. MAIN ROTOR SPEED: 354 RPM.
5. DATA DERIVED FROM FIGURES 2 THROUGH 4.

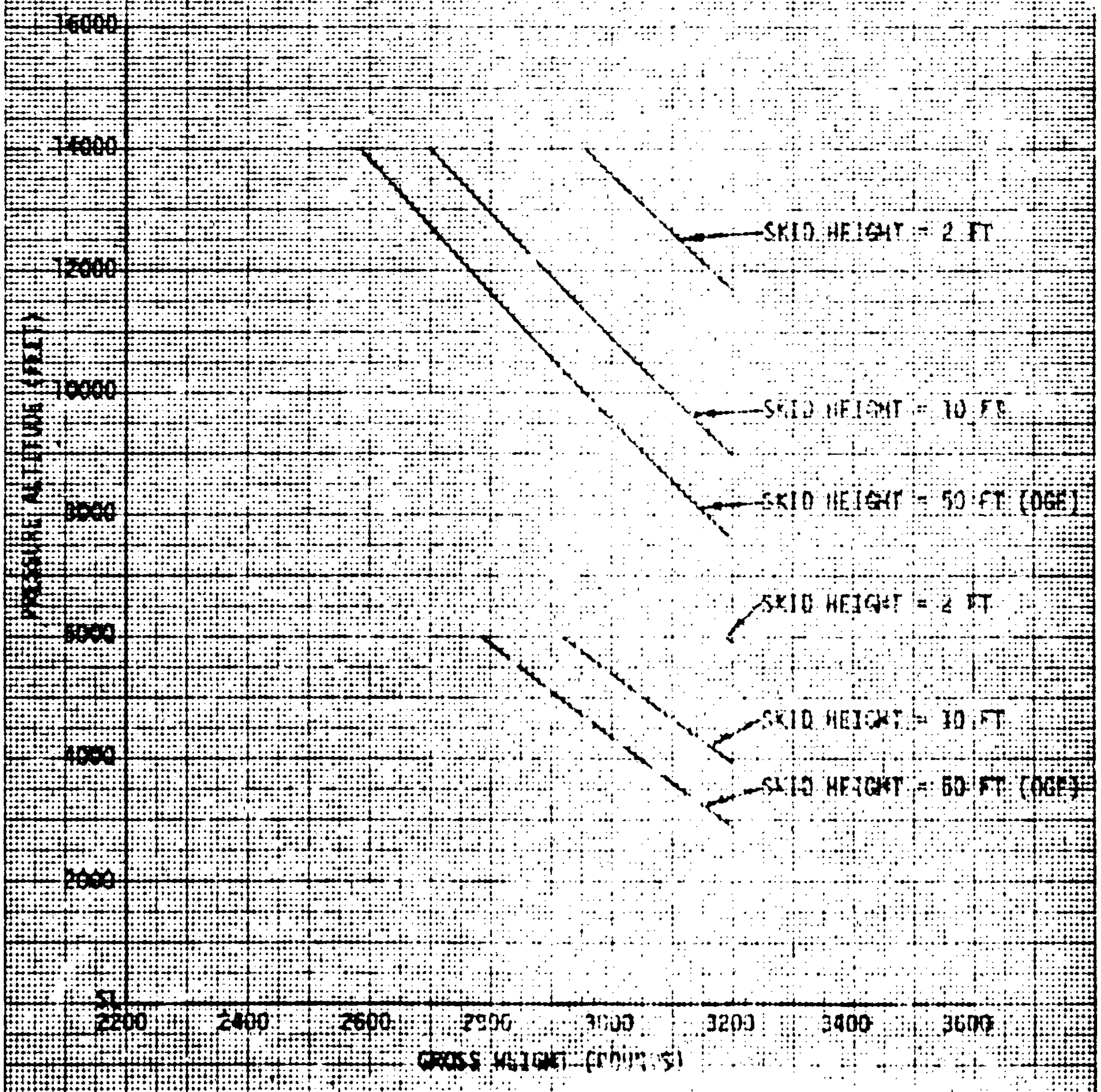


FIGURE 2
NON-DIMENSIONAL HOVERING PERFORMANCE
OH-58C USA S/N 68-16724
SKID HEIGHT = 2 FT

SYMBOL	ROTOR SPEED (RPM)	DENSITY ALTITUDE (FT)	OAT (DEG C)
⊕	352.	5040.	34.5
⊡	345.	2940.	18.5
▲	347.	10060.	1.5
+	358.	10200.	1.5

NOTES: 1. SKID HEIGHT MEASURED FROM BOTTOM OF LEFT SKID.
2. WIND LESS THAN 3 KNOTS.
3. FLAGGED SYMBOLS DENOTE FREE FLIGHT HOVER METHOD. UNFLAGGED SYMBOLS DENOTE TETHERED HOVER METHOD.

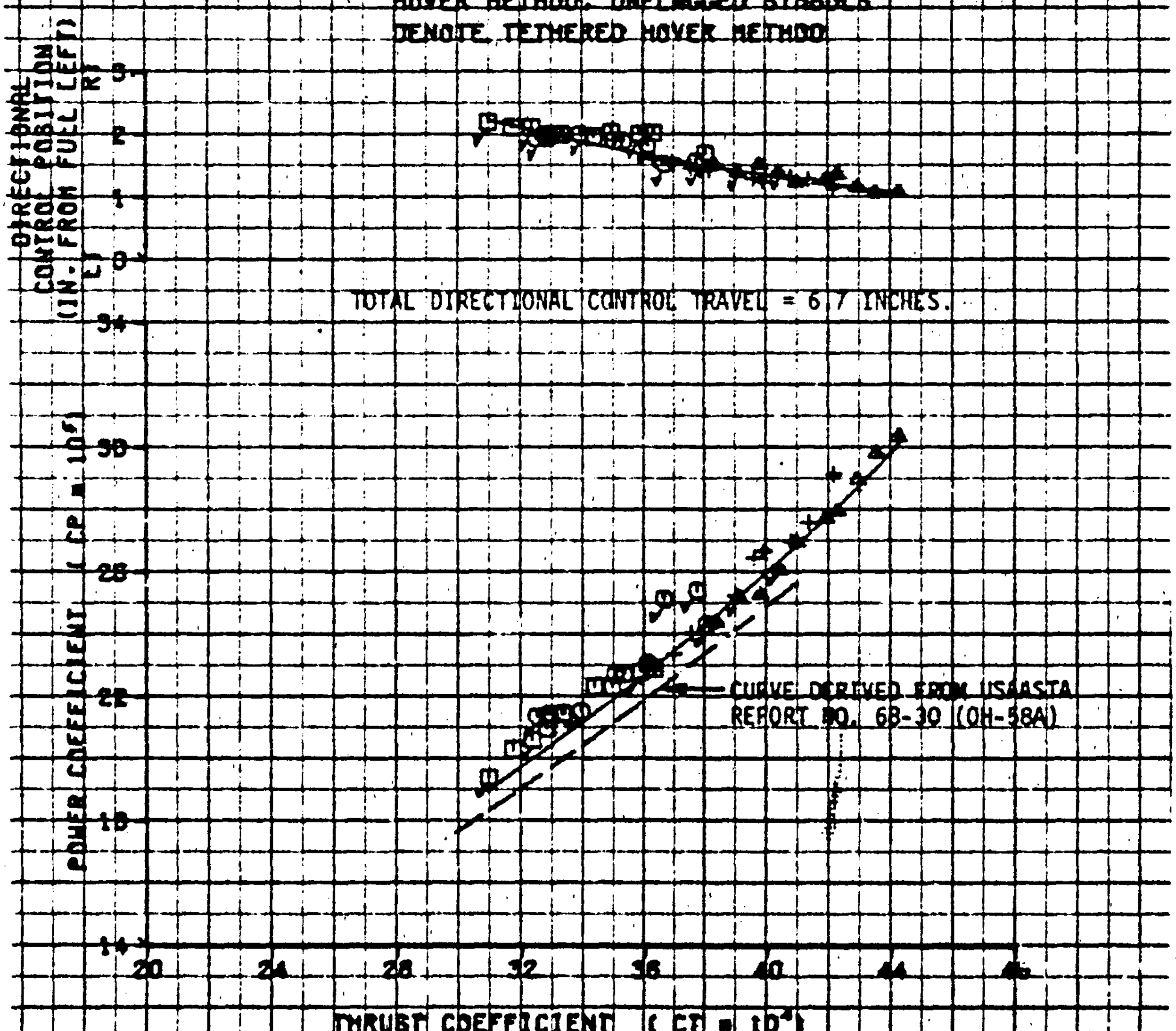


FIGURE 3

NON-DIMENSIONAL HOVERING PERFORMANCE

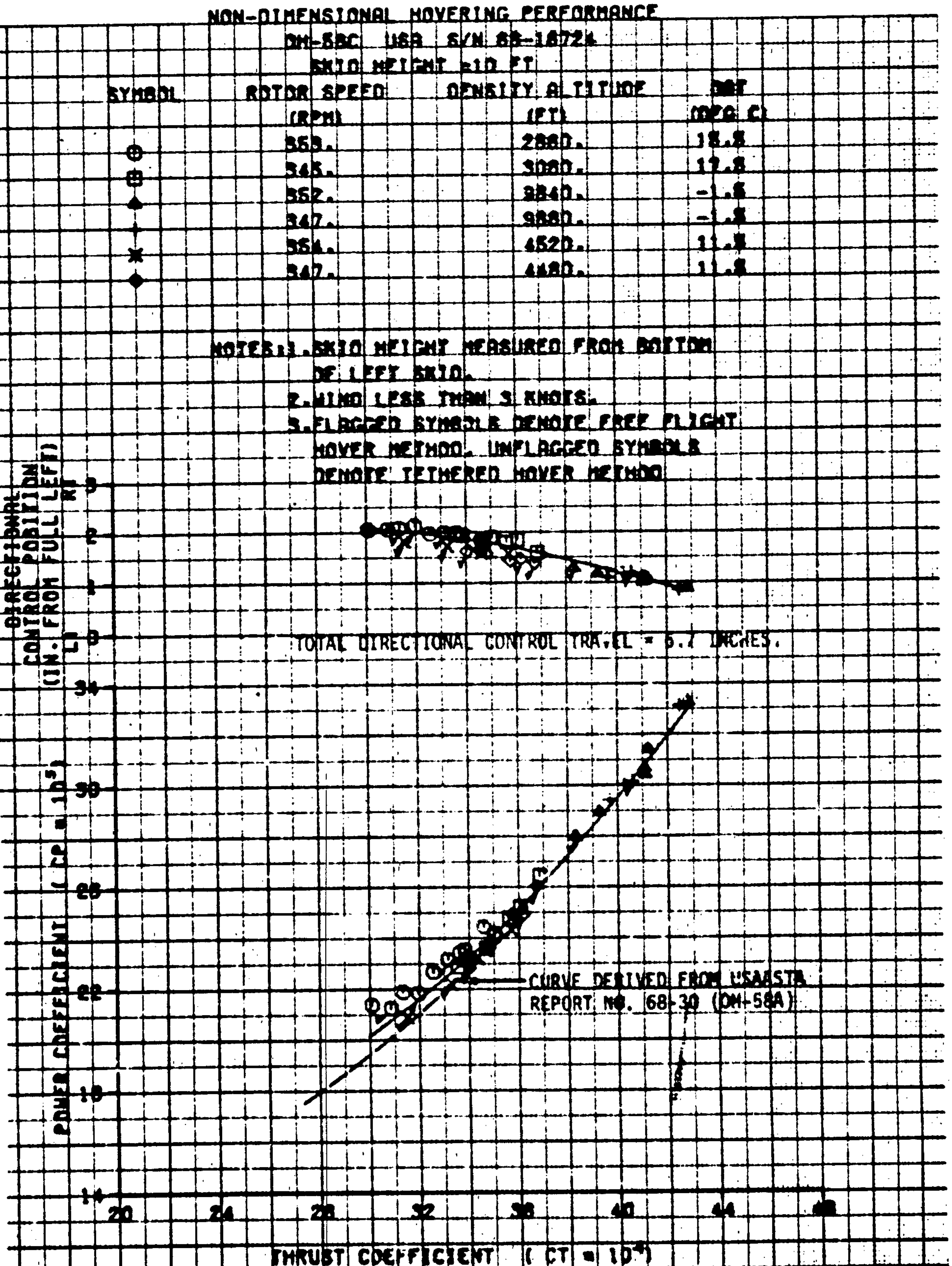


FIGURE 4

NON-DIMENSIONAL HOVERING PERFORMANCE

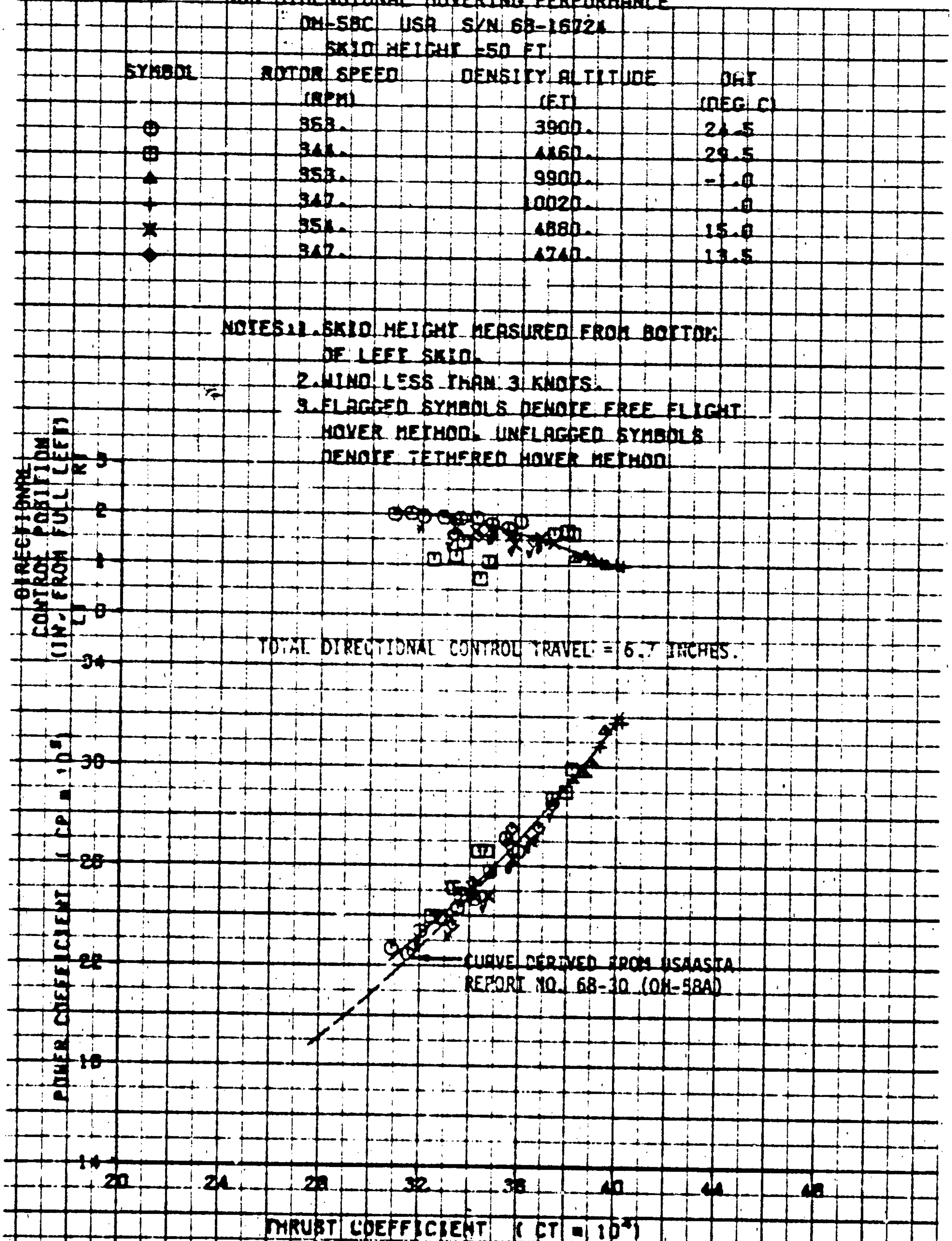


FIGURE 5
TAKEOFF DISTANCE REQUIRED
TO CLEAR A 50 FOOT OBSTACLE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG ΔC_p
3050	107.3(FWD)	0.3	10600	6.0	354	1.66×10^{-5}

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. DATA OBTAINED DURING LEVEL ACCELERATION FROM A 2 FOOT HOVER.
3. WINDS LESS THAN 3 KNOTS.

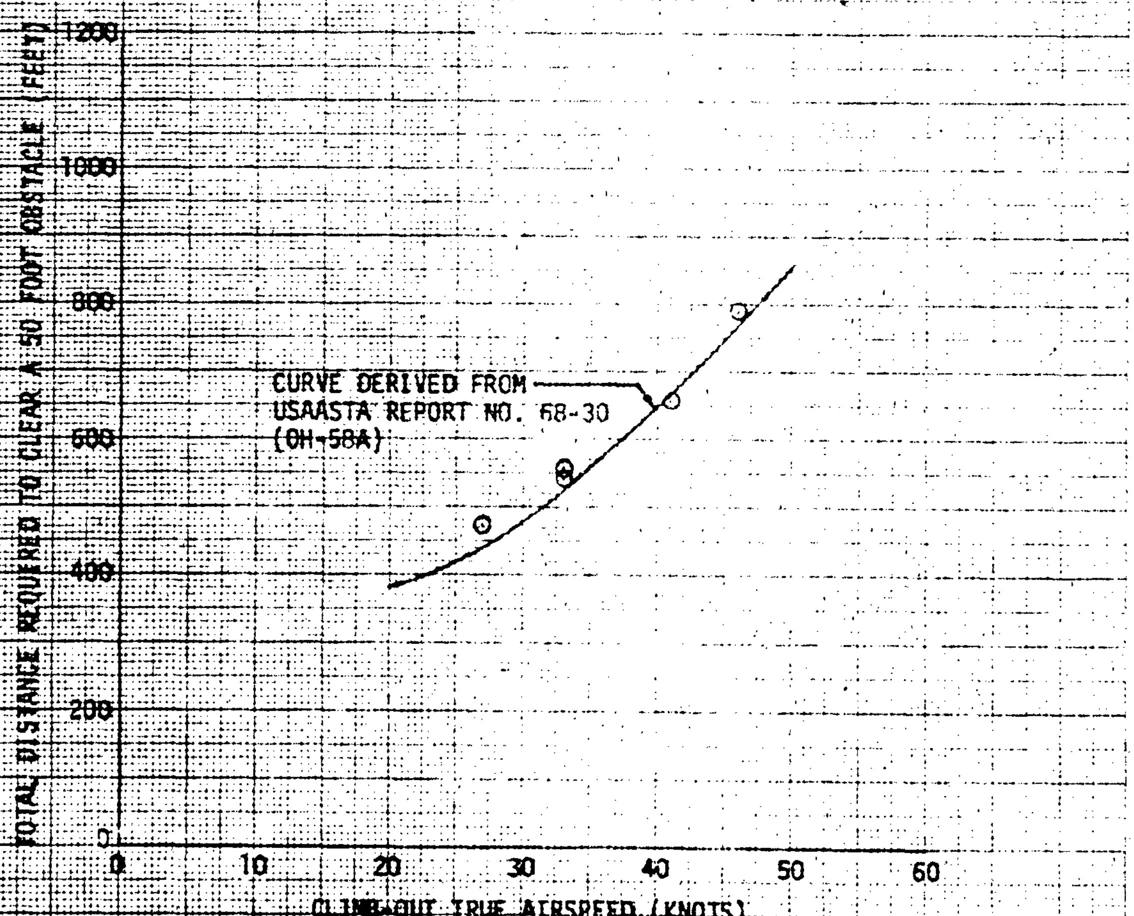


FIGURE 6
TAKEOFF DISTANCE REQUIRED
TO CLEAR A 50 FOOT OBSTACLE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG ΔC_p
3100	107.1(FWD)	0.2	10180	2.5	353	2.90×10^{-5}

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. DATA OBTAINED DURING LEVEL ACCELERATION FROM A 2 FOOT HOVER.
3. WINDS LESS THAN 3 KNOTS.

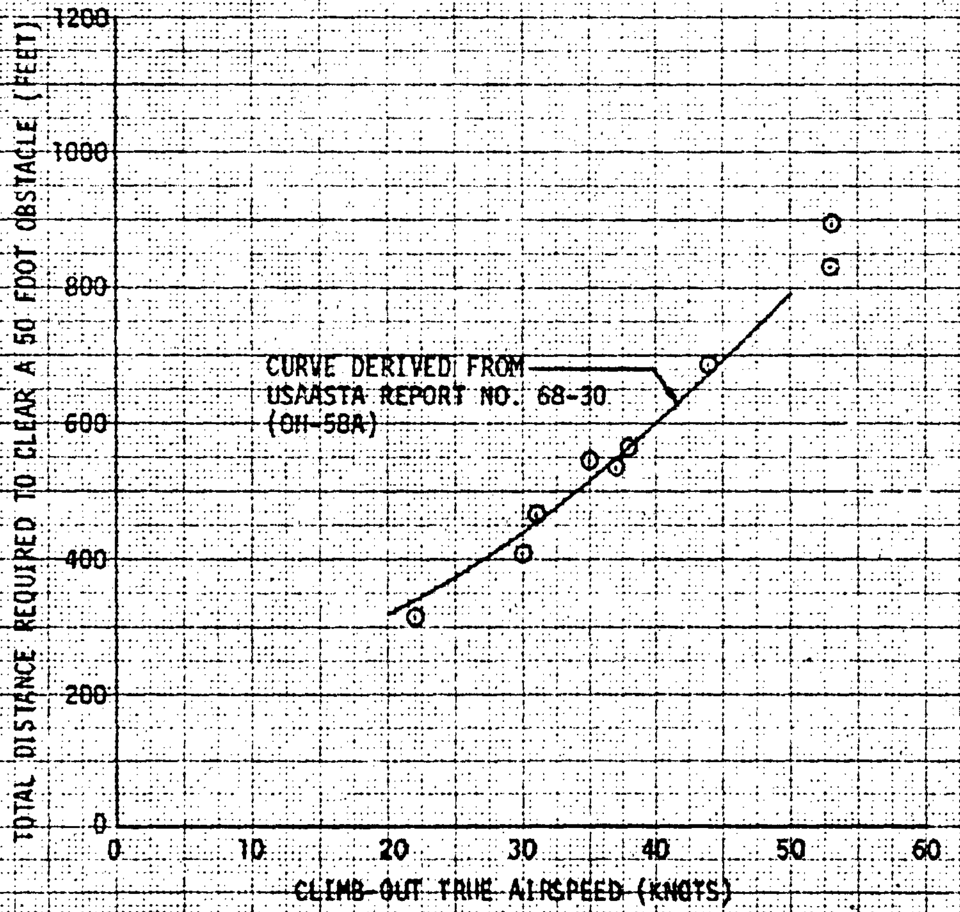


FIGURE 7
FORWARD FLIGHT CLIMB PERFORMANCE SUMMARY
OH-58C USA S/N 68-16724

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. ROTOR SPEED 354 RPM, LONGITUDINAL CG = 107.4(FWD).
3. CLIMB SPEED BASED ON FIGURE 8.
4. DATA DERIVED FROM FIGURE 9.
5. TAKEOFF RATED POWER.

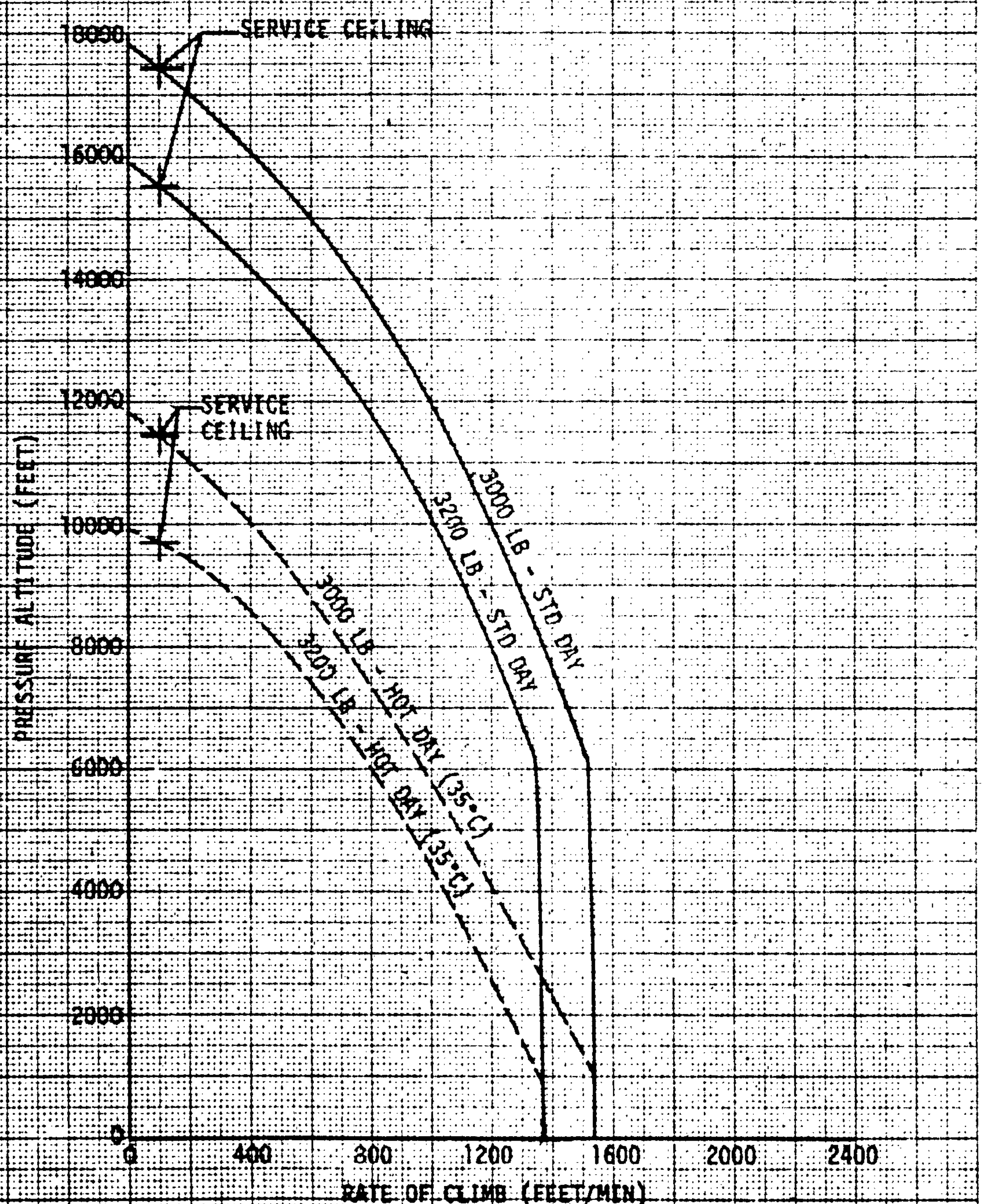


FIGURE 8
FORWARD FLIGHT CLIMB AIRSPEED SCHEDULE
OH-58C USA S/N 68-16724
ROTOR SPEED 354 RPM

NOTE: DATA OBTAINED FROM FIGURES 10 THROUGH 12.

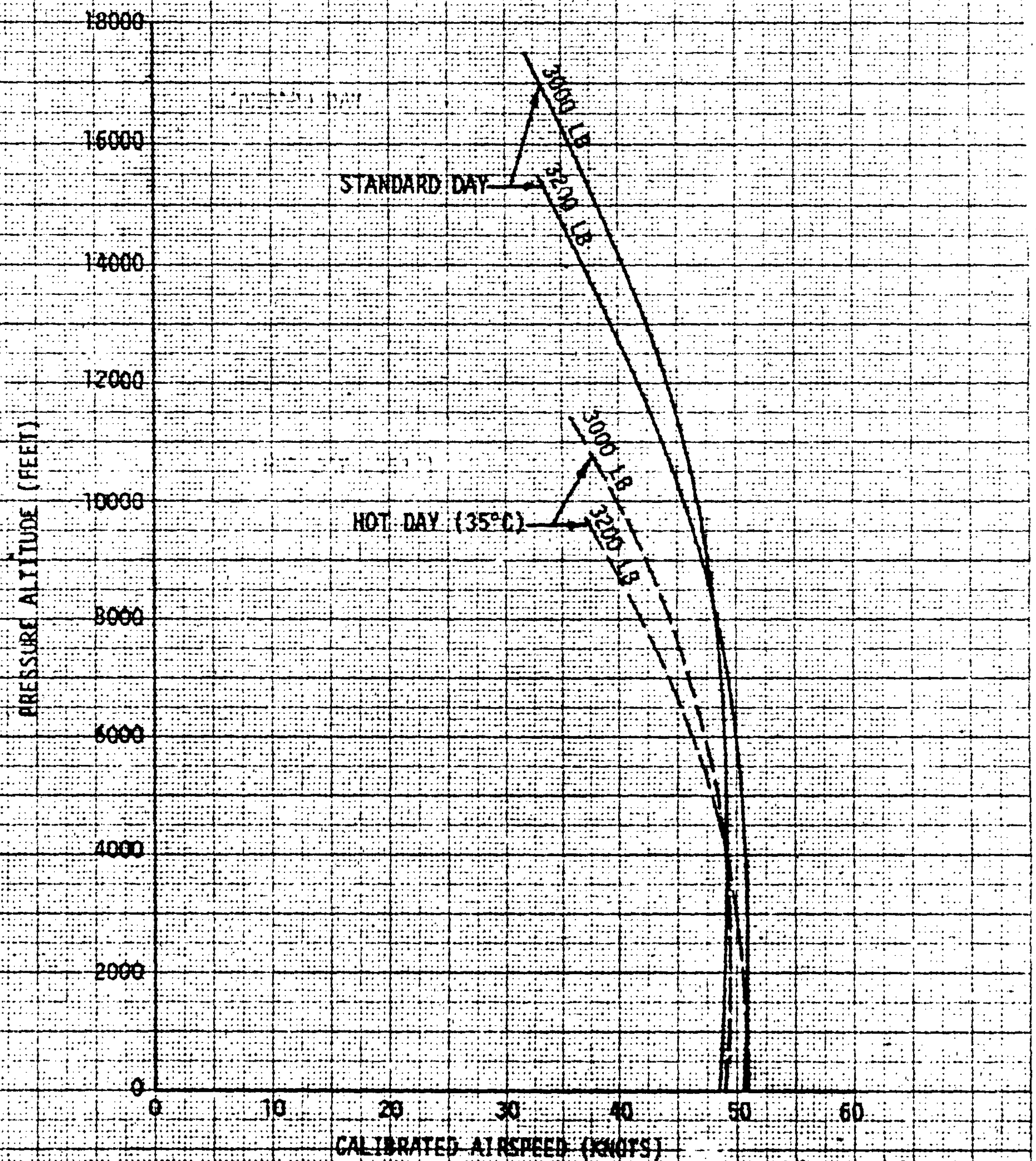


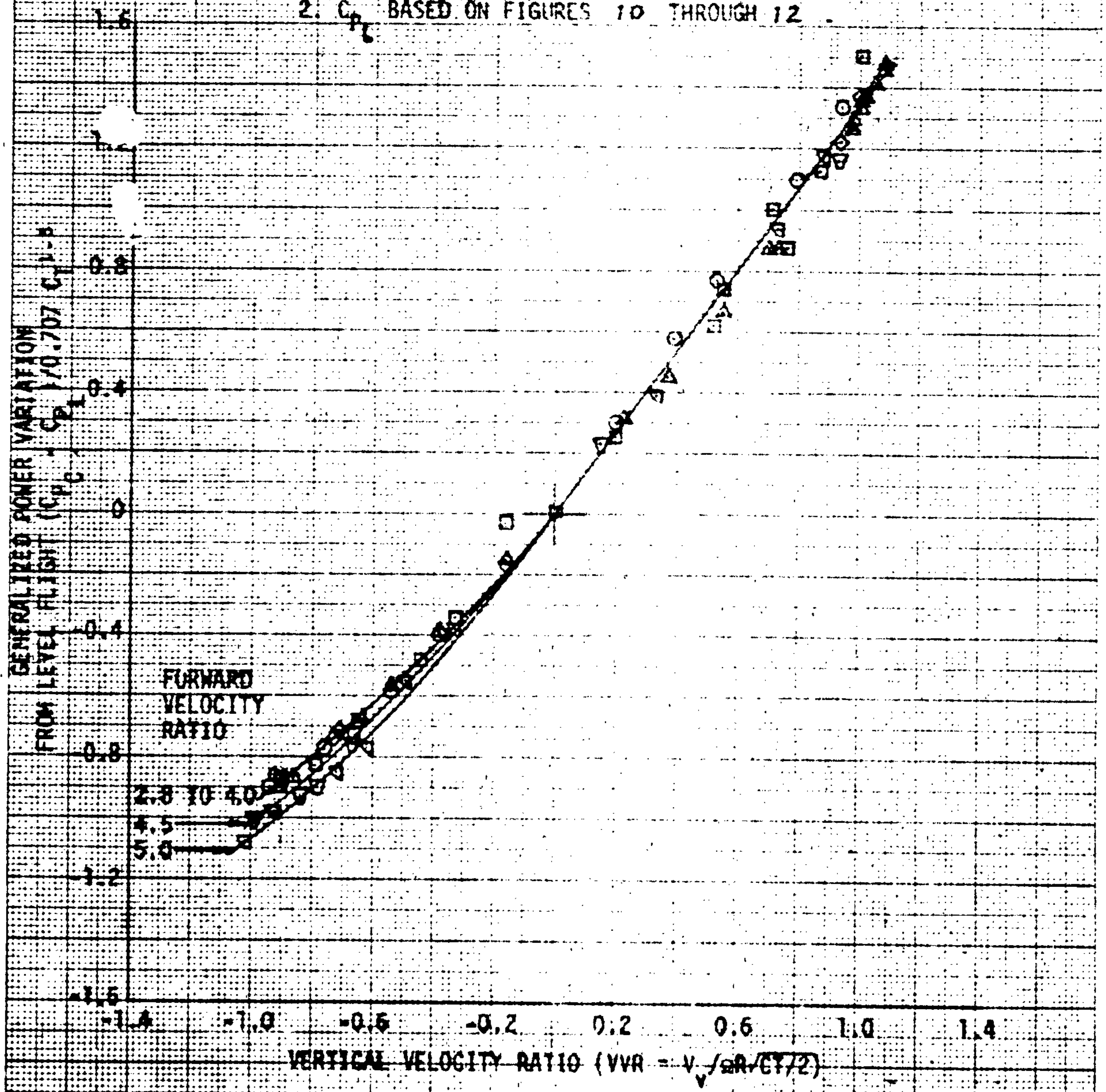
FIGURE 9

GENERALIZED CLIMB AND DESCENT PERFORMANCE

OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG OAT (°C)	AVG REFERRED ROTOR SPEED (RPM)	AVG C_T	FORWARD VELOCITY RATIO
○	2580	107.2(FWD)	0.8	26.0	345	0.00325	2.8
□	2700	107.5(FWD)	0.7	23.5	346	0.00340	3.3
◇	2720	107.5(FWD)	0.7	22.5	346	0.00342	3.7
△	2680	107.4(FWD)	0.7	23.5	346	0.00338	4.0
▽	2720	107.5(FWD)	0.6	23.5	346	0.00340	4.5
◪	2660	107.3(FWD)	0.7	25.0	345	0.00335	5.0

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. C_{P_L} BASED ON FIGURES 10 THROUGH 12.



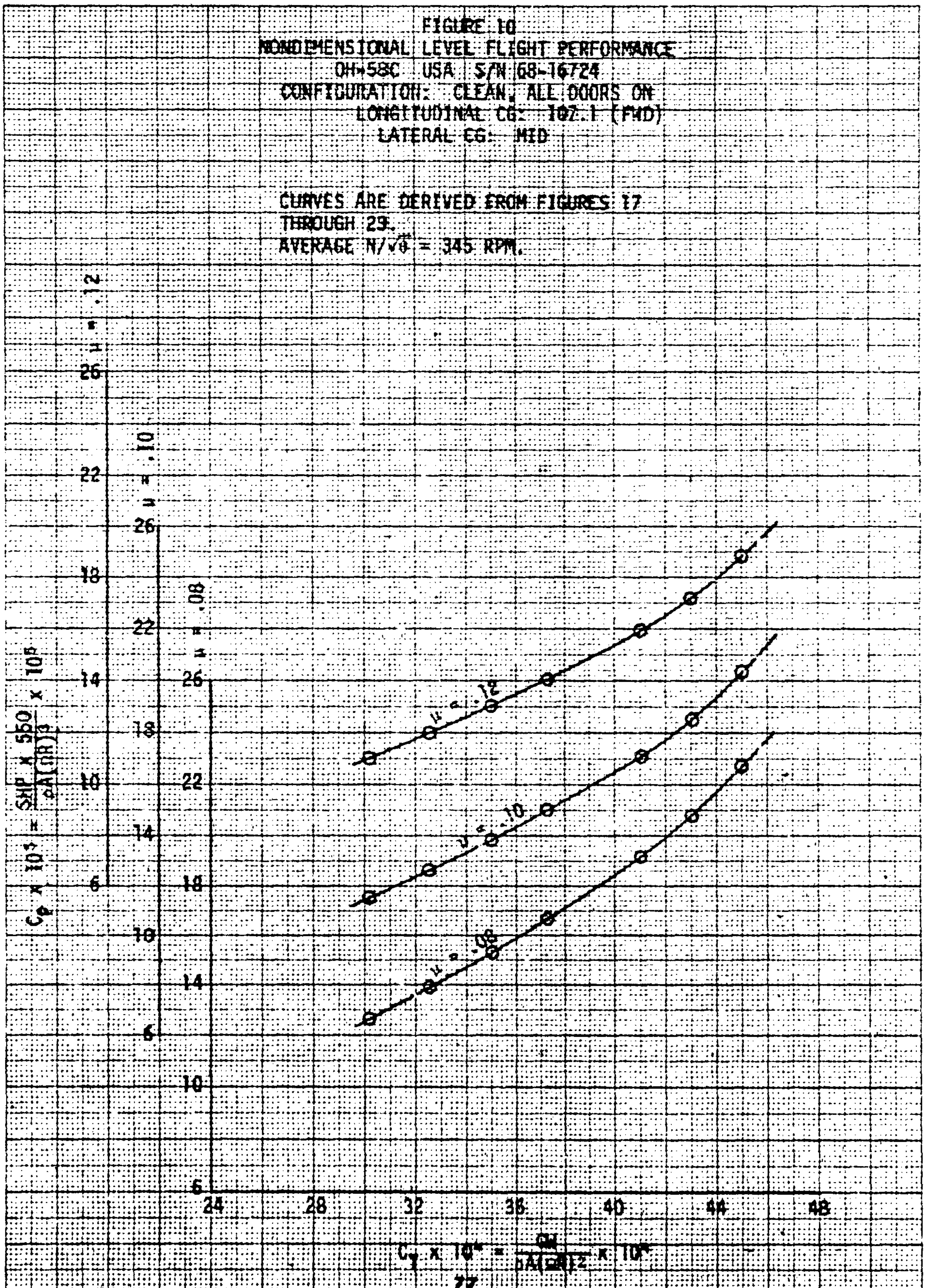


FIGURE 10
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724
CONFIGURATION: CLEAN, ALL DOORS ON
LONGITUDINAL CG: 107.1 (FWD)
LATERAL CG: MID

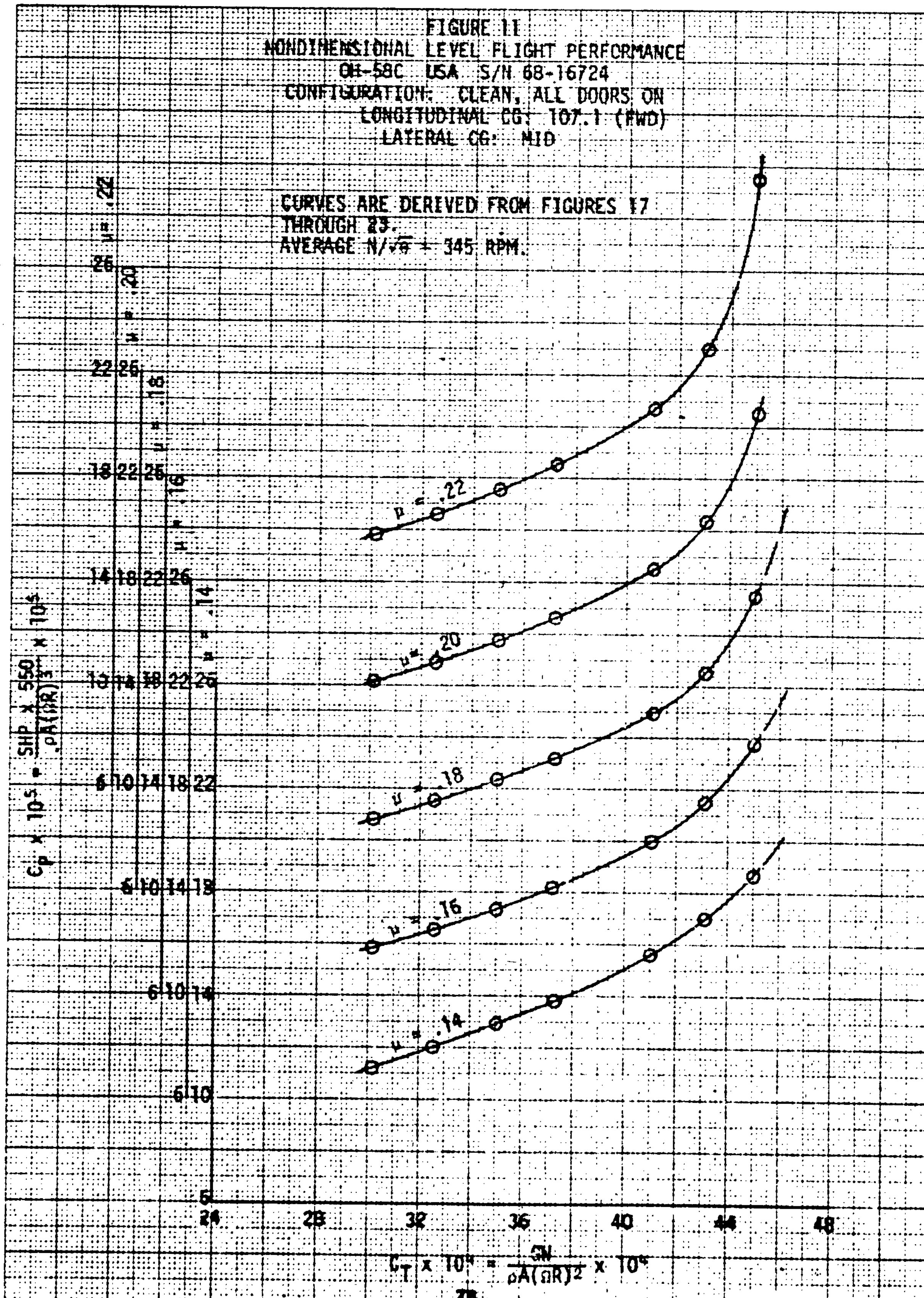


FIGURE 11
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724
CONFIGURATION: CLEAN, ALL DOORS ON
LONGITUDINAL CG: 107.1 (FWD)
LATERAL CG: MID
CURVES ARE DERIVED FROM FIGURES 17
THROUGH 23.
AVERAGE N/√θ = 345 RPM.
μ = .22
μ = .20
μ = .18
μ = .16
μ = .14
$C_P \times 10^5 = \frac{SHP \times 550}{\rho A(\Omega R)^3} \times 10^5$
$C_T \times 10^4 = \frac{GW}{\rho A(\Omega R)^2} \times 10^4$

FIGURE 12
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724
CONFIGURATION: CLEAN, ALL DOORS ON
LONGITUDINAL CG: 107.1 (FWD)
LATERAL CG: MID

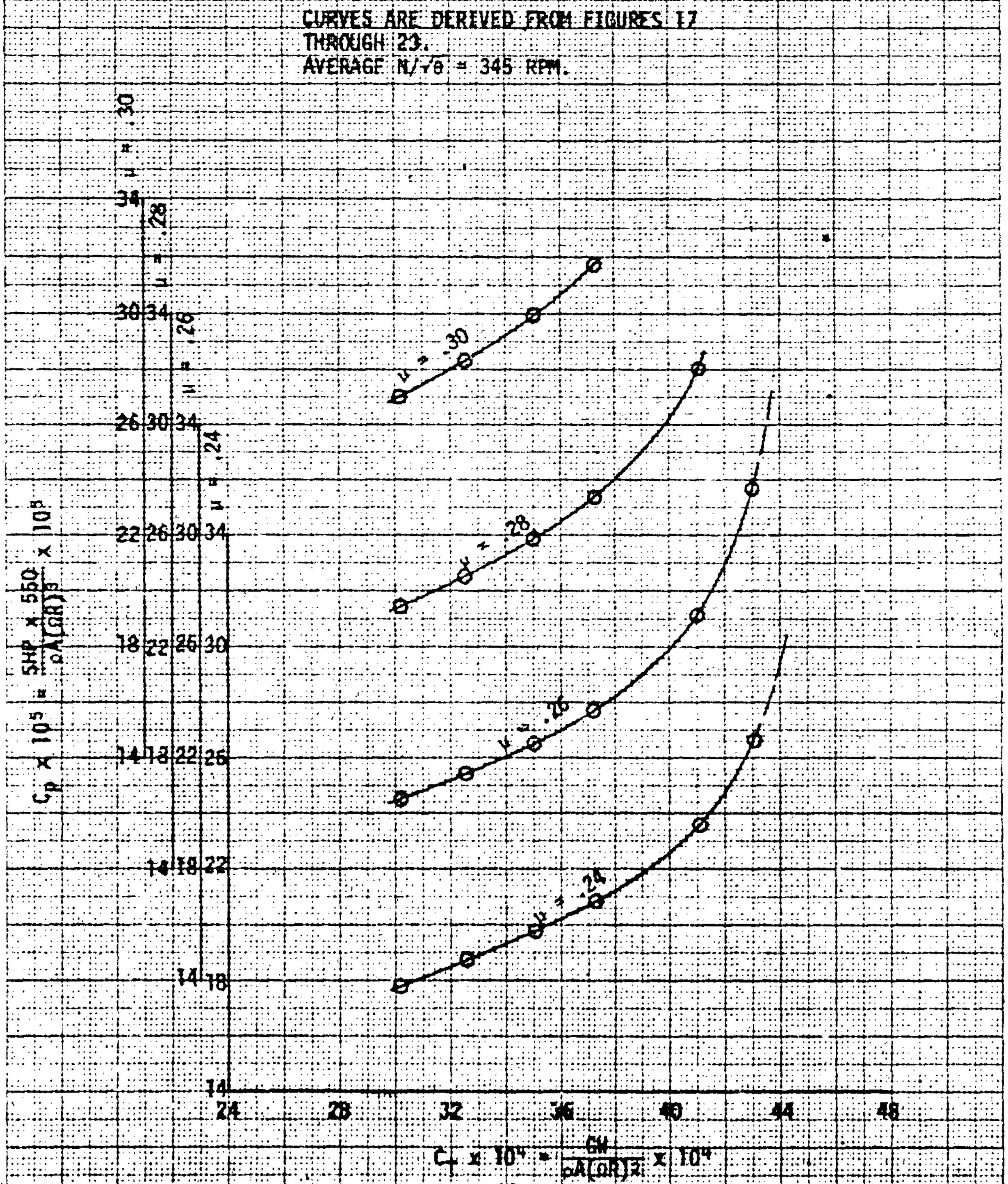


FIGURE 13
LEVEL FLIGHT RANGE SUMMARY
OH-58C USA S/N 68-16724
CONFIGURATION: CLEAN, DOORS ON

NOTES: 1. DATA DERIVED FROM FIGURES 10 THROUGH 12, 101 AND 102.
2. SHORT DASHED LINES DENOTE MAXIMUM CONTINUOUS POWER LIMIT.
3. BROKEN LINE DENOTES ARMY HOT DAY CRITERIA 4000 FT, 35°C.

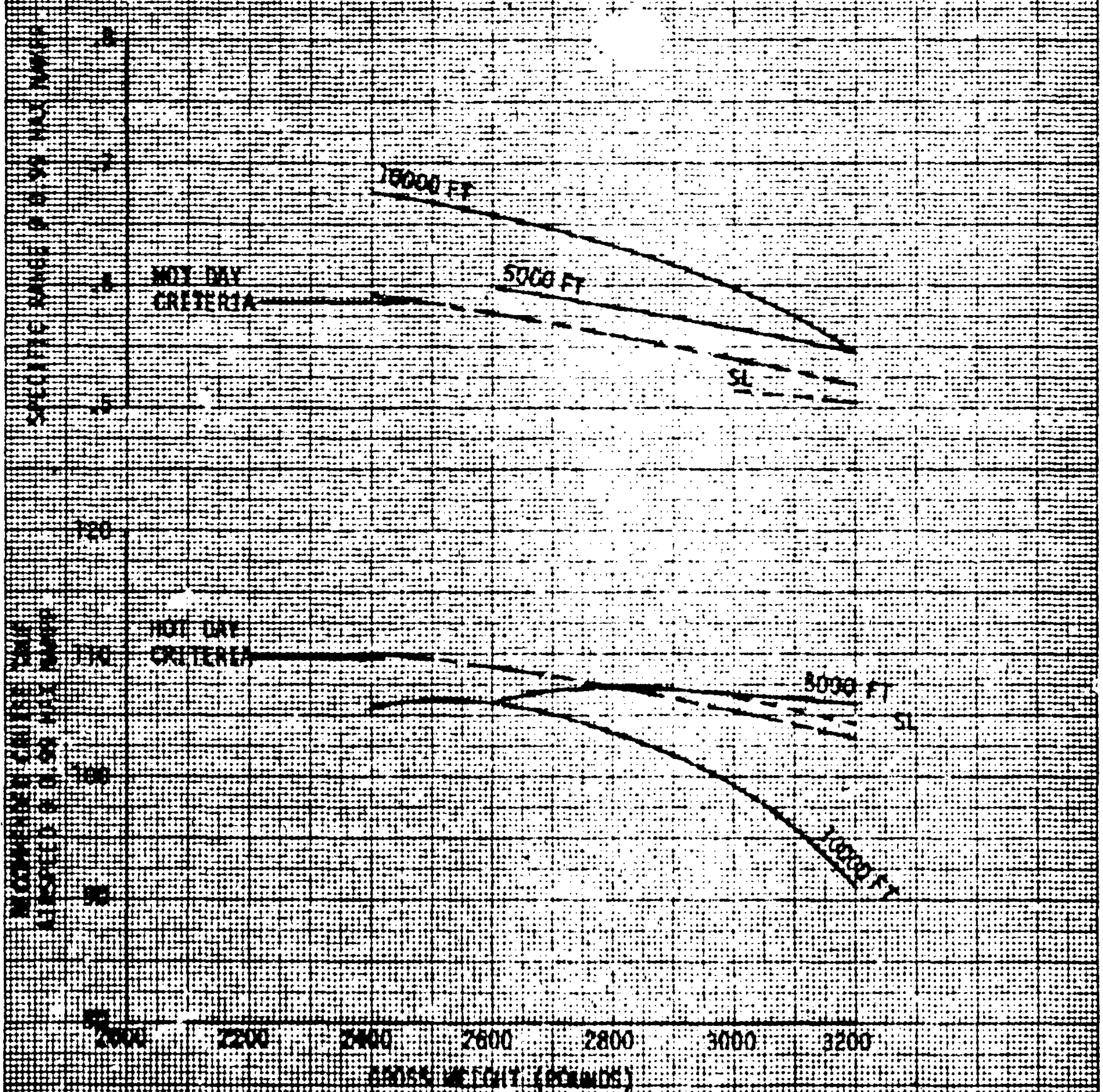


FIGURE 14
LEVEL FLIGHT ENDURANCE SUMMARY
OH-58C USA S/N 68-16724
CONFIGURATION: CLEAN, DOORS ON

NOTES: 1. DATA DERIVED FROM FIGURES 10 THROUGH 12, 101 AND 102.
2. BROKEN LINE DENOTES ARMY HOT DAY CRITERIA 4000 FT., 35°C.

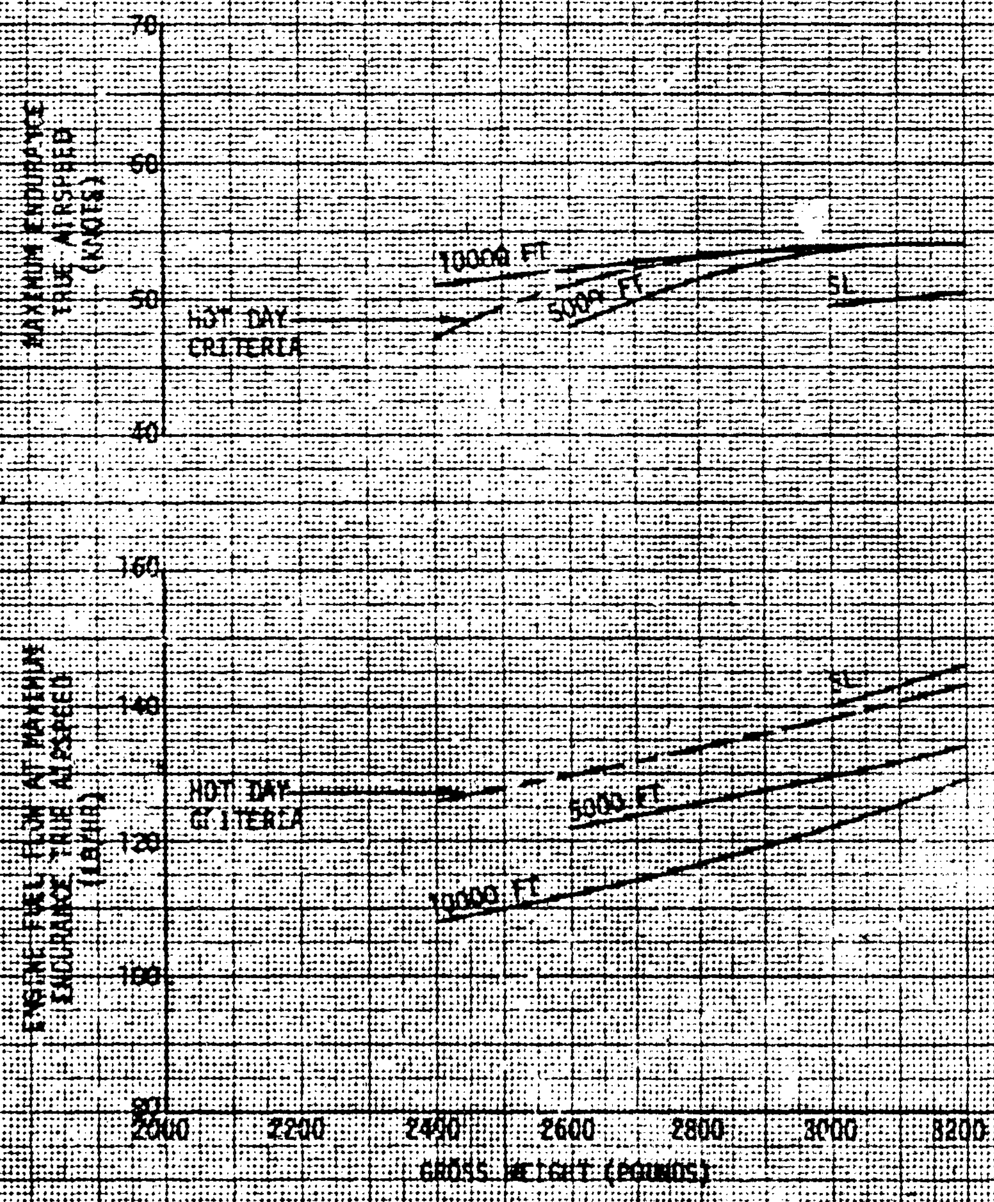


FIGURE 15
LEVEL FLIGHT RANGE SUMMARY
(EFFECTS OF CREW DOORS REMOVAL)
OH-58C USA S/N 68-16724

PRESSURE ALTITUDE: 5000 FT
STANDARD DAY CONDITIONS

CONFIGURATION: CLEAN

NOTE: DATA DERIVED FROM FIGURES 10 THROUGH 12, AND 102 FOR DOORS ON.
DATA DERIVED FROM FIGURES 24 AND 25 AND 103 FOR DOORS OFF.

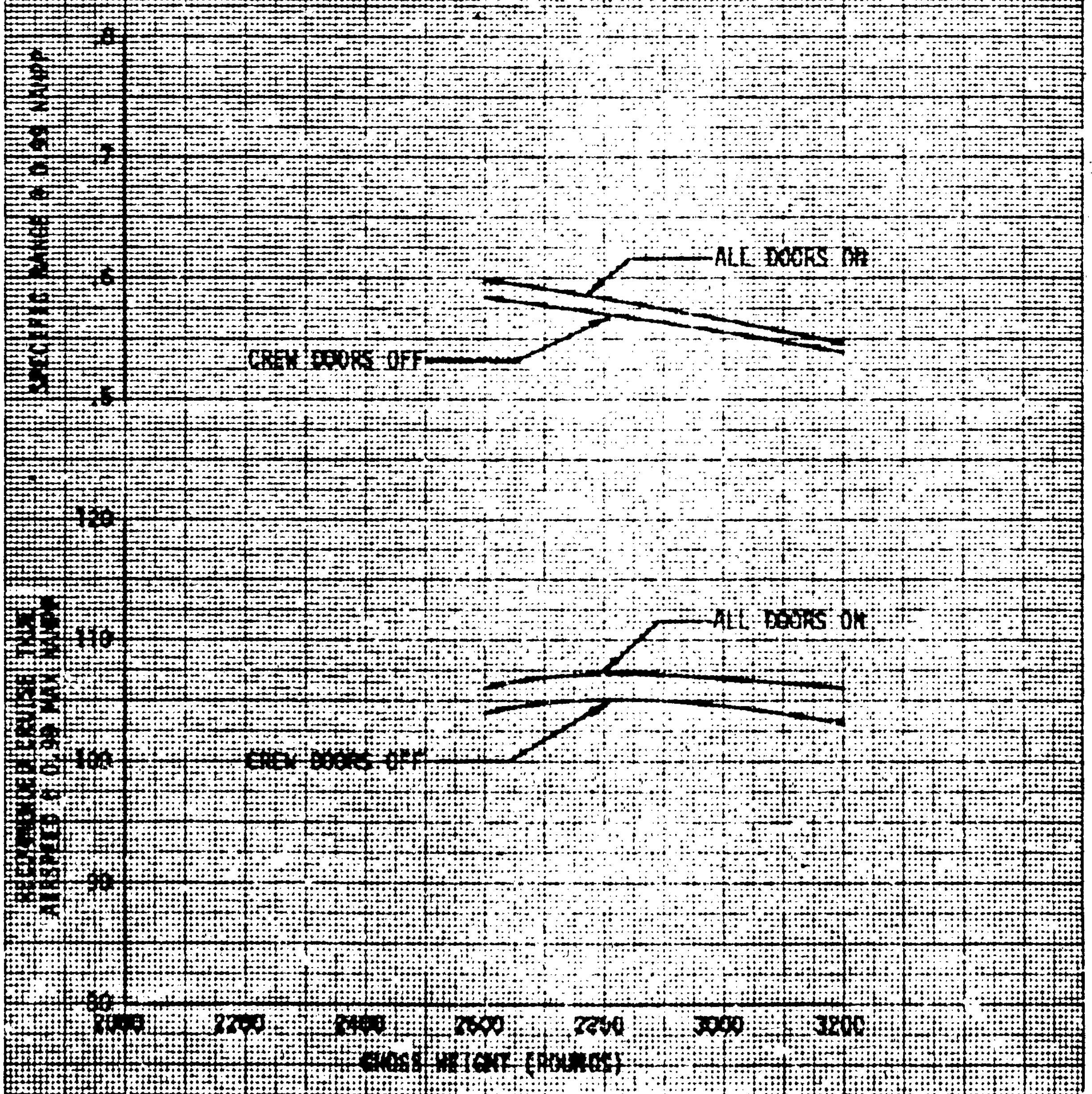
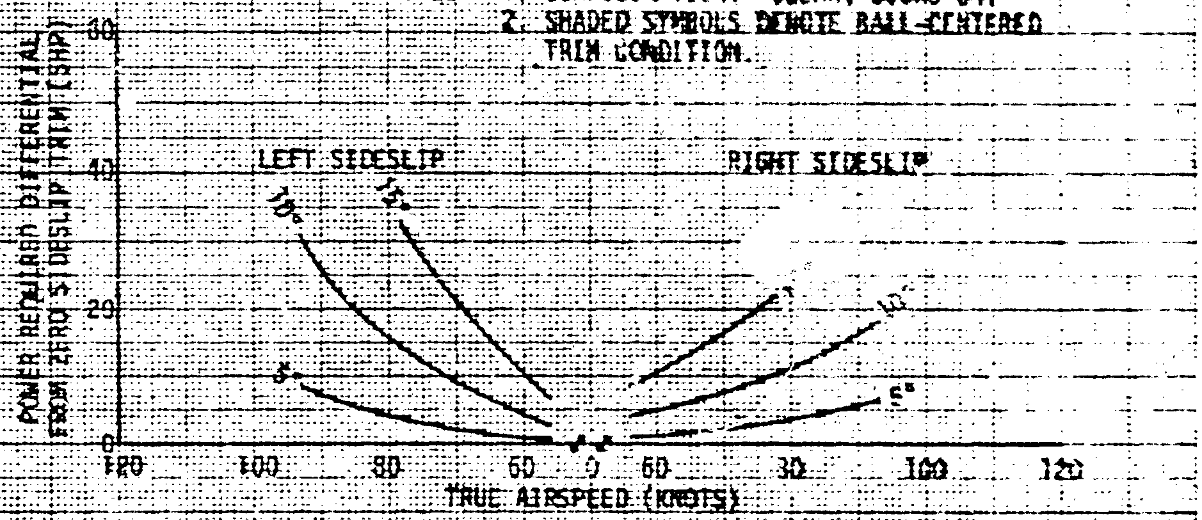


FIGURE 16
SIDESLIP EFFECTS ON LEVEL FLIGHT POWER REQUIRED
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG TRUE AIRSPEED (KTS)
○	3080	107.2(FWD)	0.4	5600	25.0	347	56
□	2920	106.2(FWD)	0.4	7280	20.5	347	78
△	2820	106.3(FWD)	0.4	8100	19.0	347	93

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. SHADED SYMBOLS DENOTE BALL-CENTERED TRIM CONDITION.



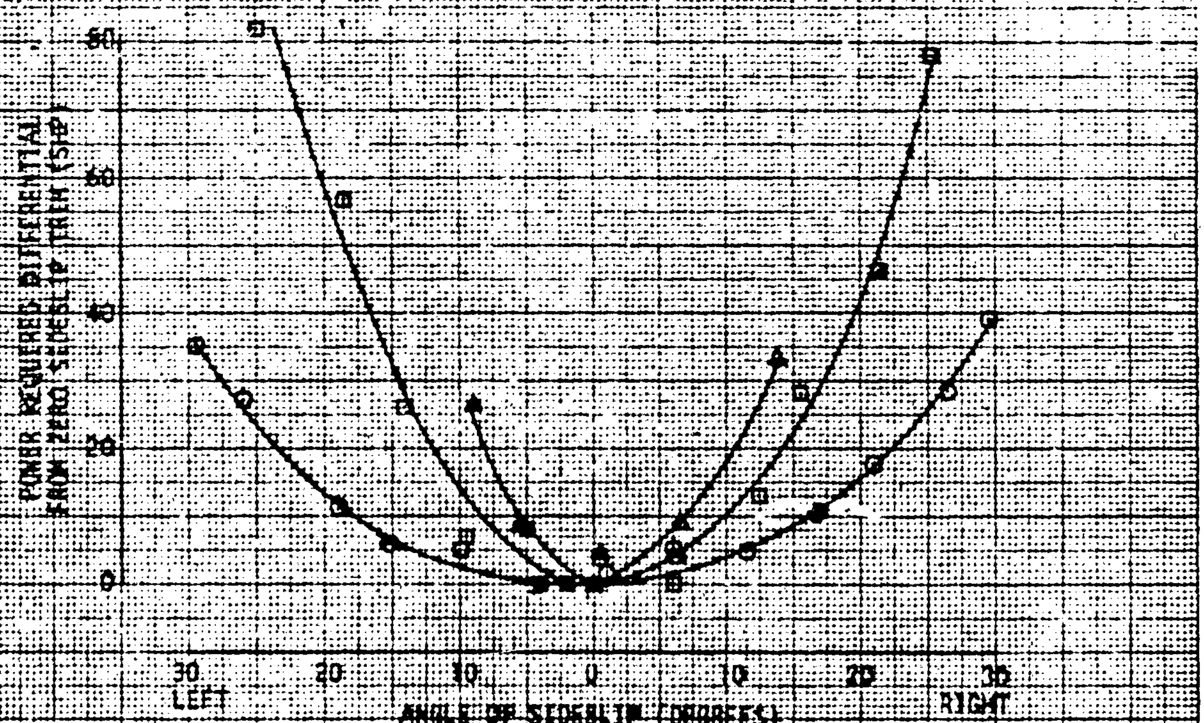


FIGURE 17
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2720	106.8(FWD)	0.5(RT)	2720	23.5	350	0.003016	DOORS ON

NOTE: $N/\sqrt{\theta}$ = 345 RPM

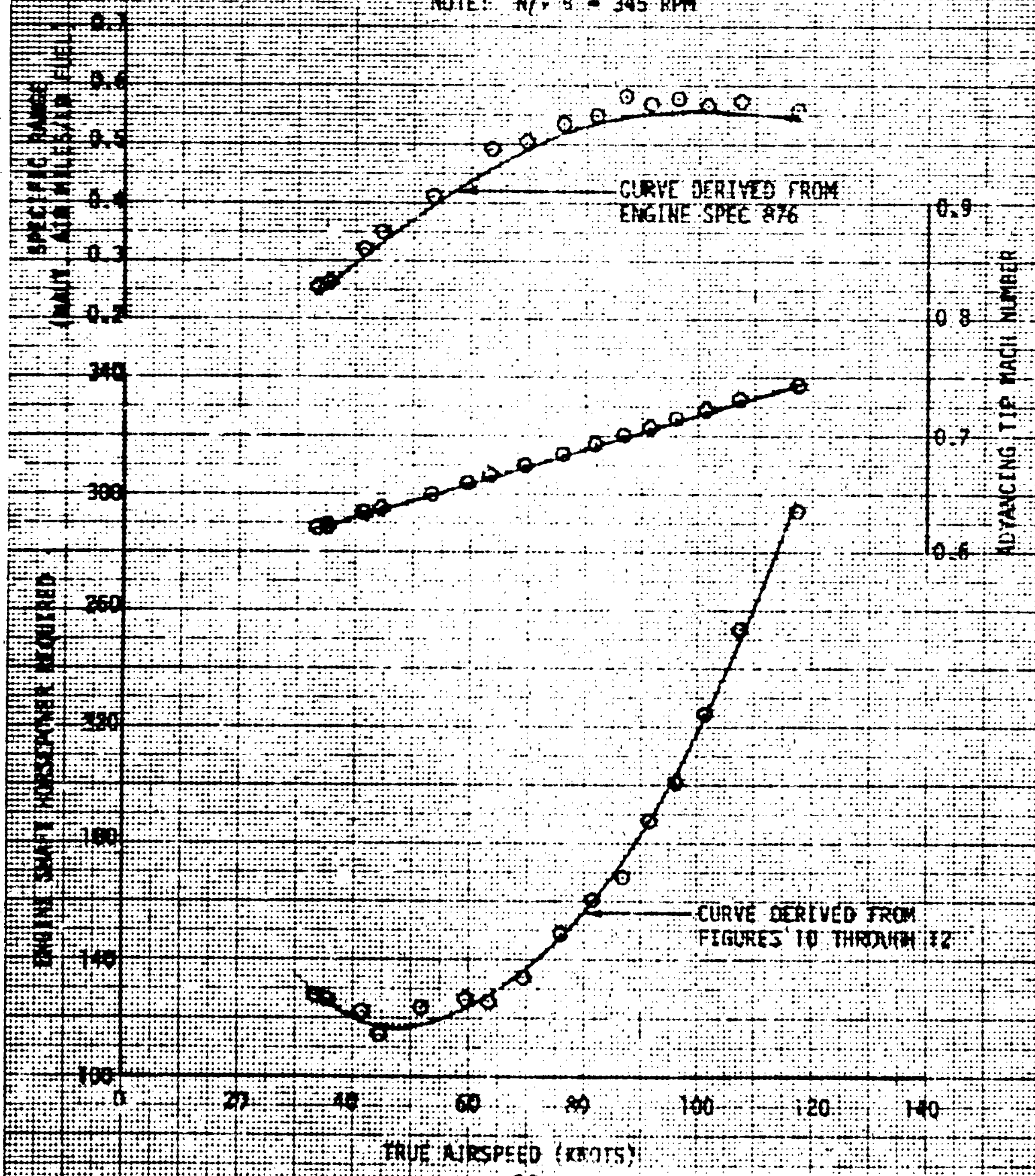


FIGURE 18
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2740	107.7(FWD)	0.0(MID)	5400	28.5	352	0.003256	DOORS ON

NOTE: $N/\sqrt{\theta}$ = 345 RPM

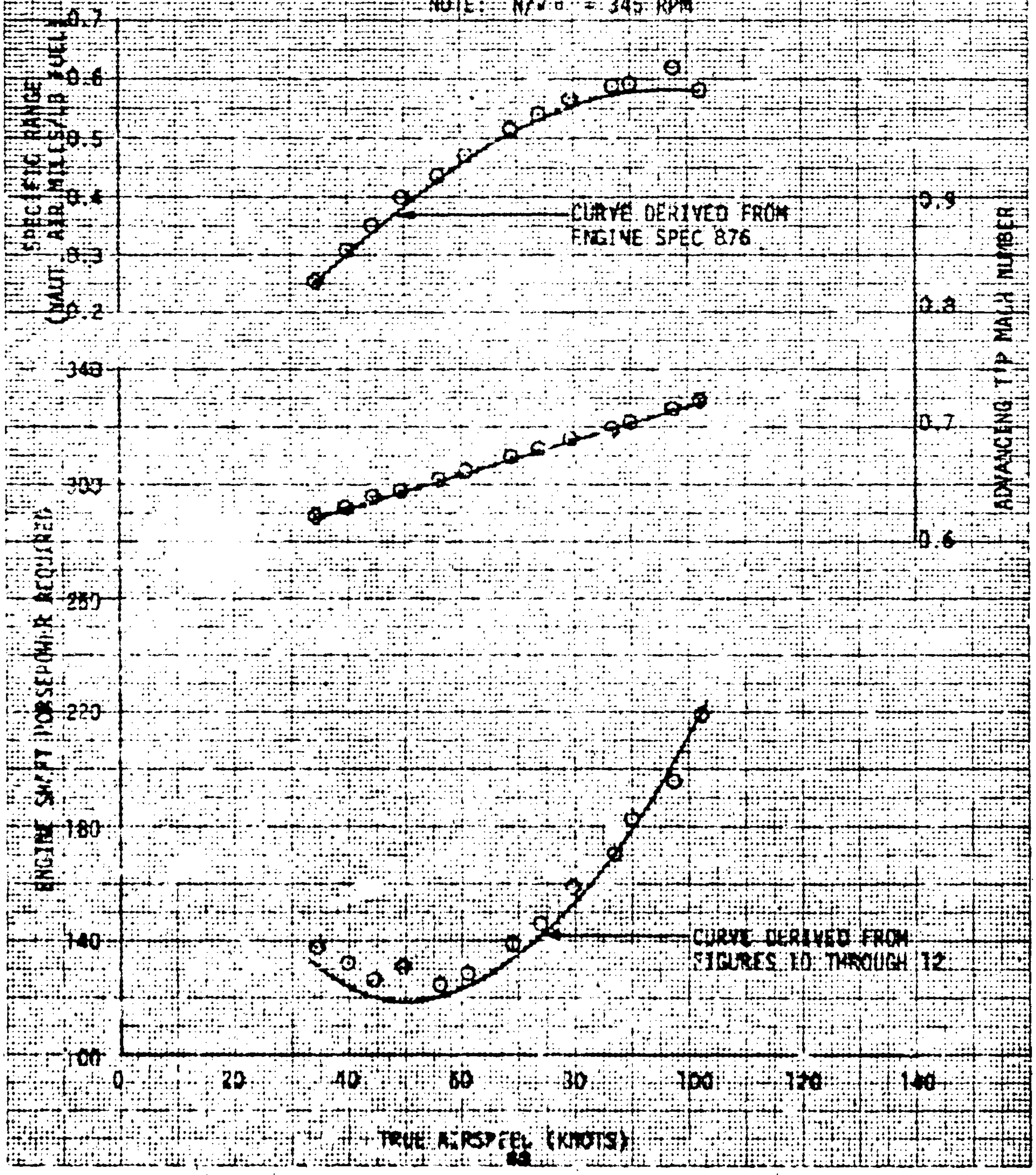


FIGURE 19
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2840	162.5(FWD)	0.0(MID)	6600	27.0	352	0.00356I	DOORS ON

NOTE: $N/\sqrt{\theta}$ = 345 RPM.

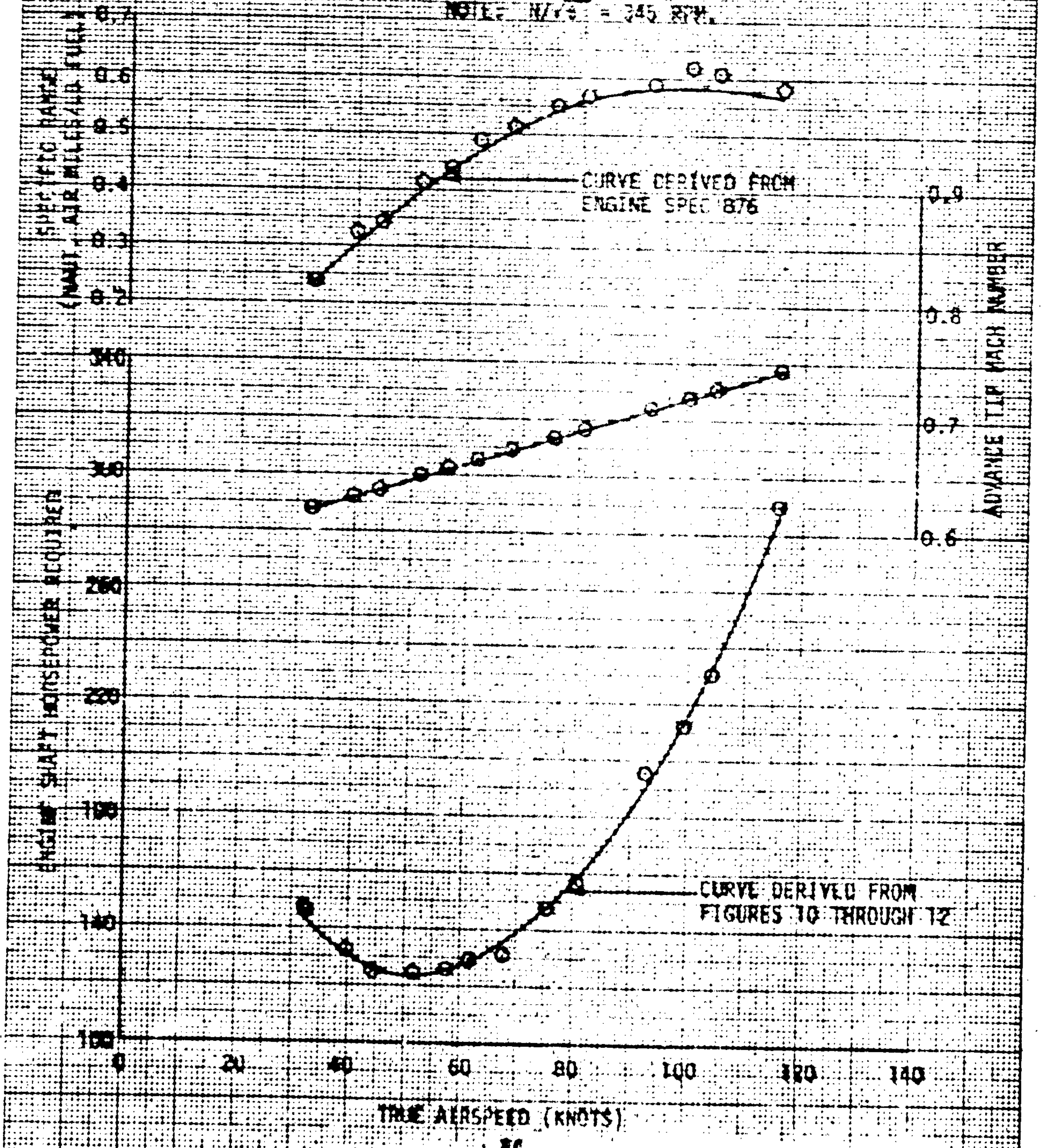


FIGURE 20
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16729

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2940	102.3(FWD)	0.0(MID)	2100	23.0	350	0.003723	DOORS ON

NOTE: $N/\sqrt{\theta}$ = 345 RPM.

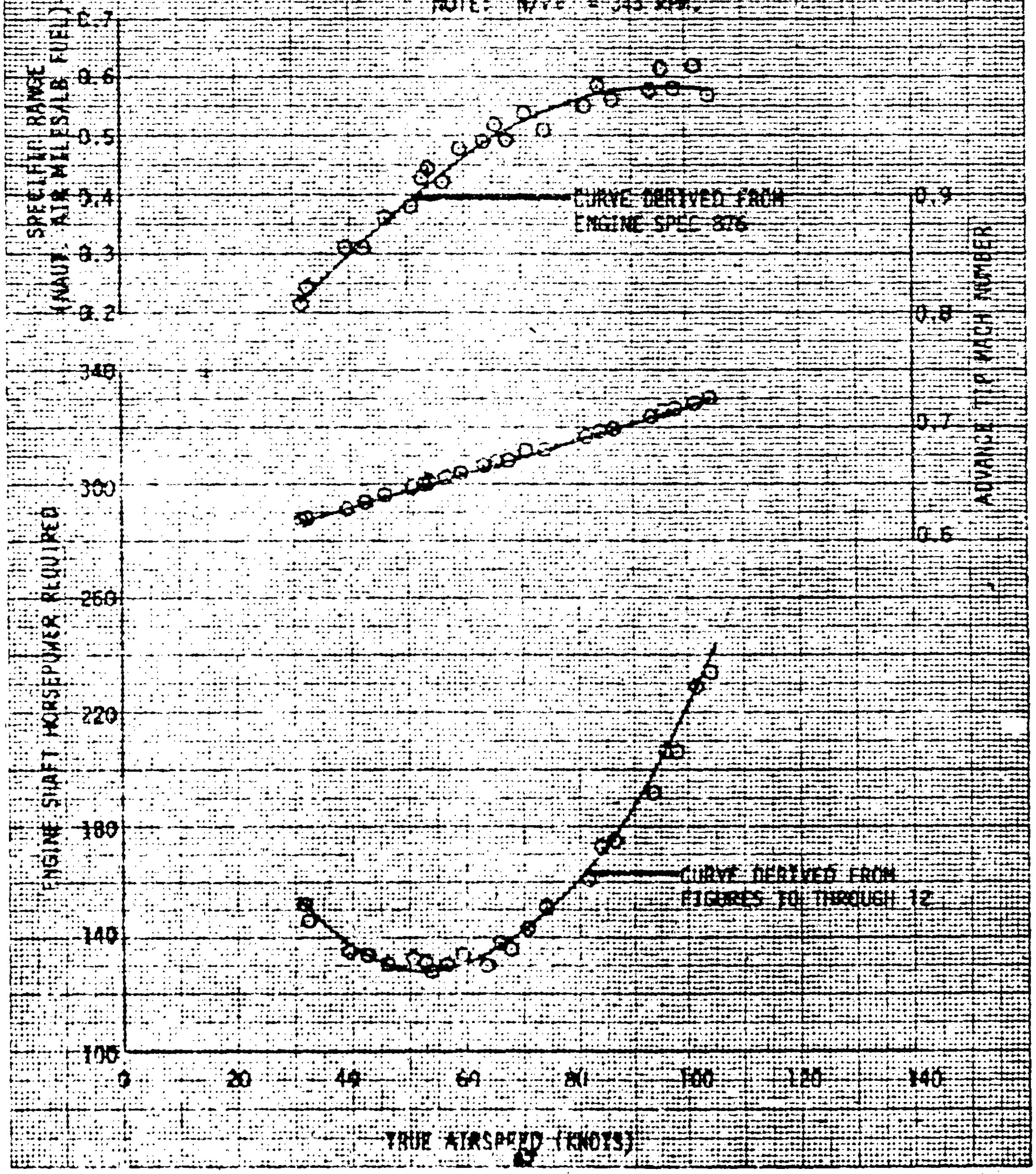


FIGURE 21
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N [illegible]16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
3100	107.5(FWD)	0.0(MID)	3360	22.0	349	0.004104	DOORS ON

NOTE: $N/\sqrt{\theta}$ = 348 RPM

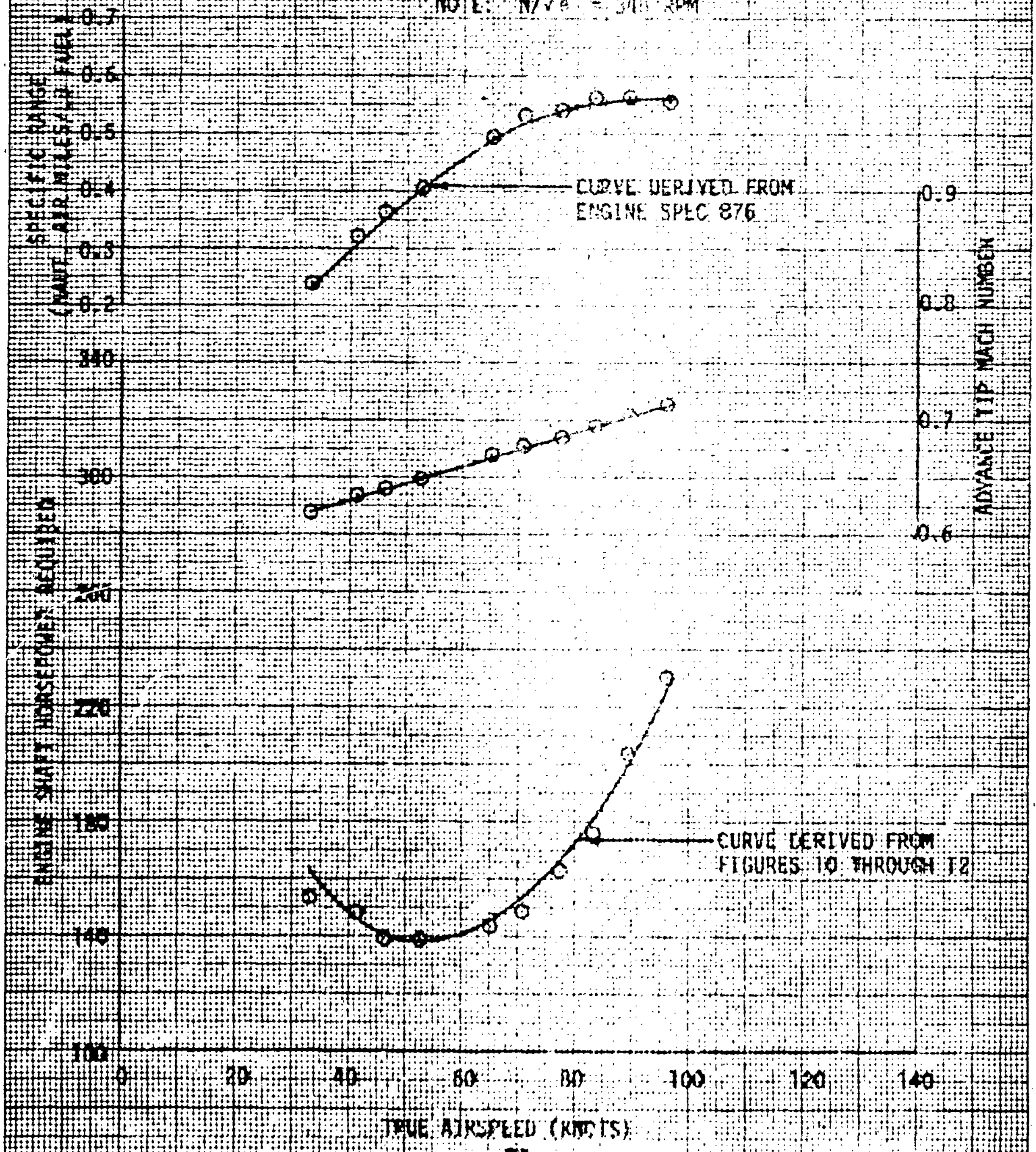


FIGURE 22
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
3120	106.3(FWD)	0.2(RT)	9140	17.0	346	0.004306	DOORS ON

NOTE: $N/\sqrt{\theta}$ = 345 RPM.

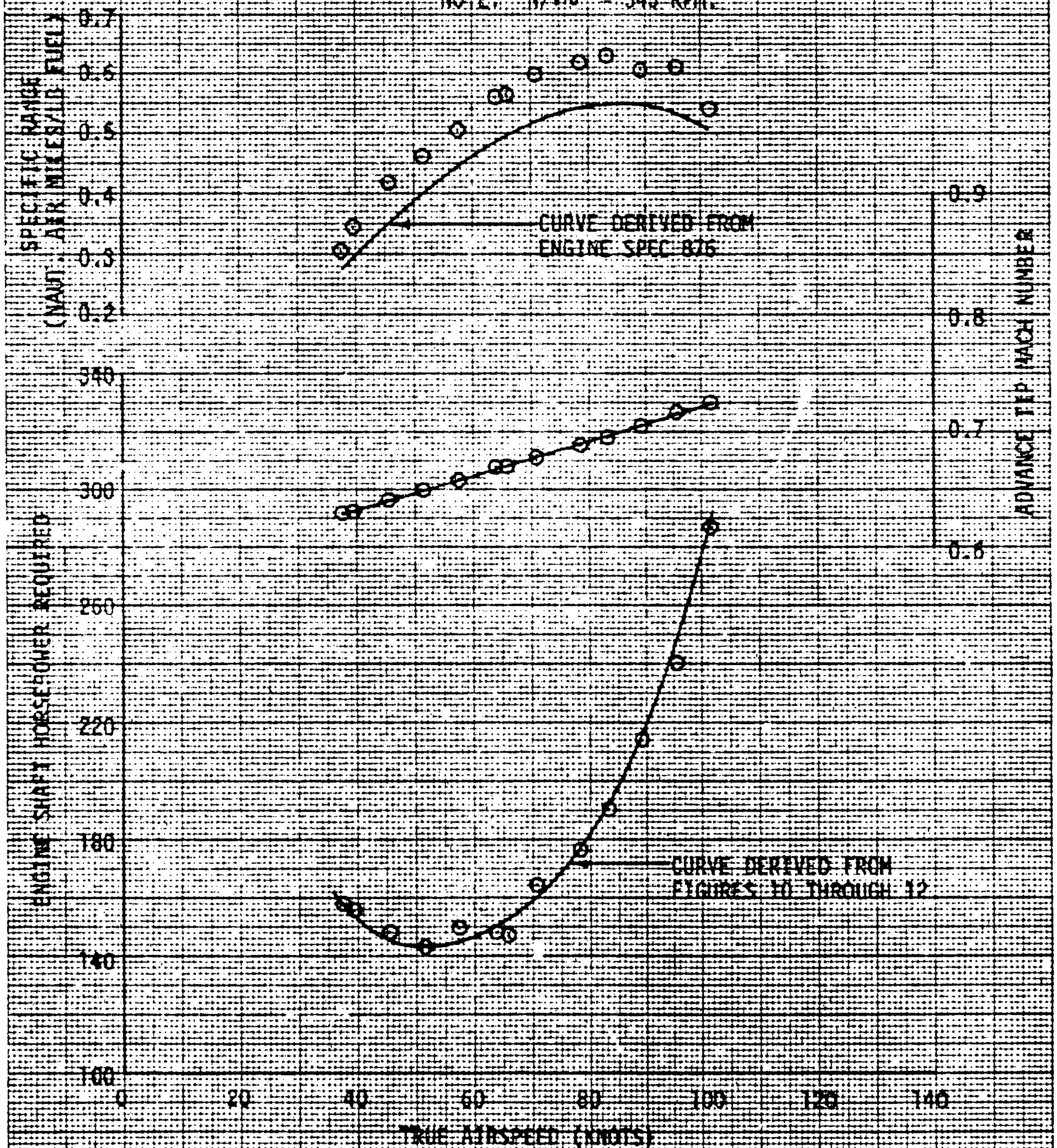


FIGURE 23
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

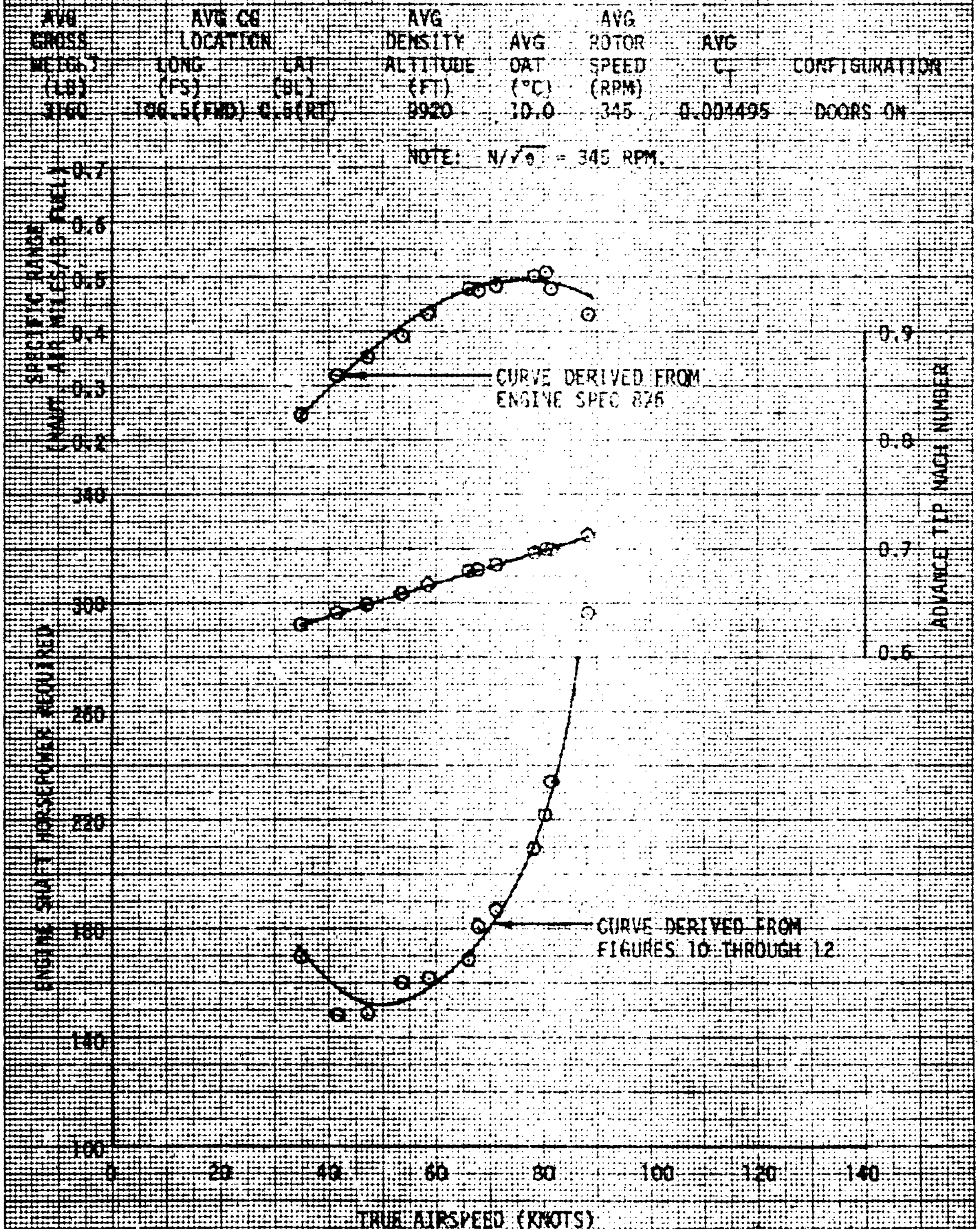


FIGURE 24
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2700	106.9 (FWD)	0.5 (RT)	4940	19.0	347	0.003254	DOORS OFF

NOTE: $N/\sqrt{\theta}$ = 345 RPM.

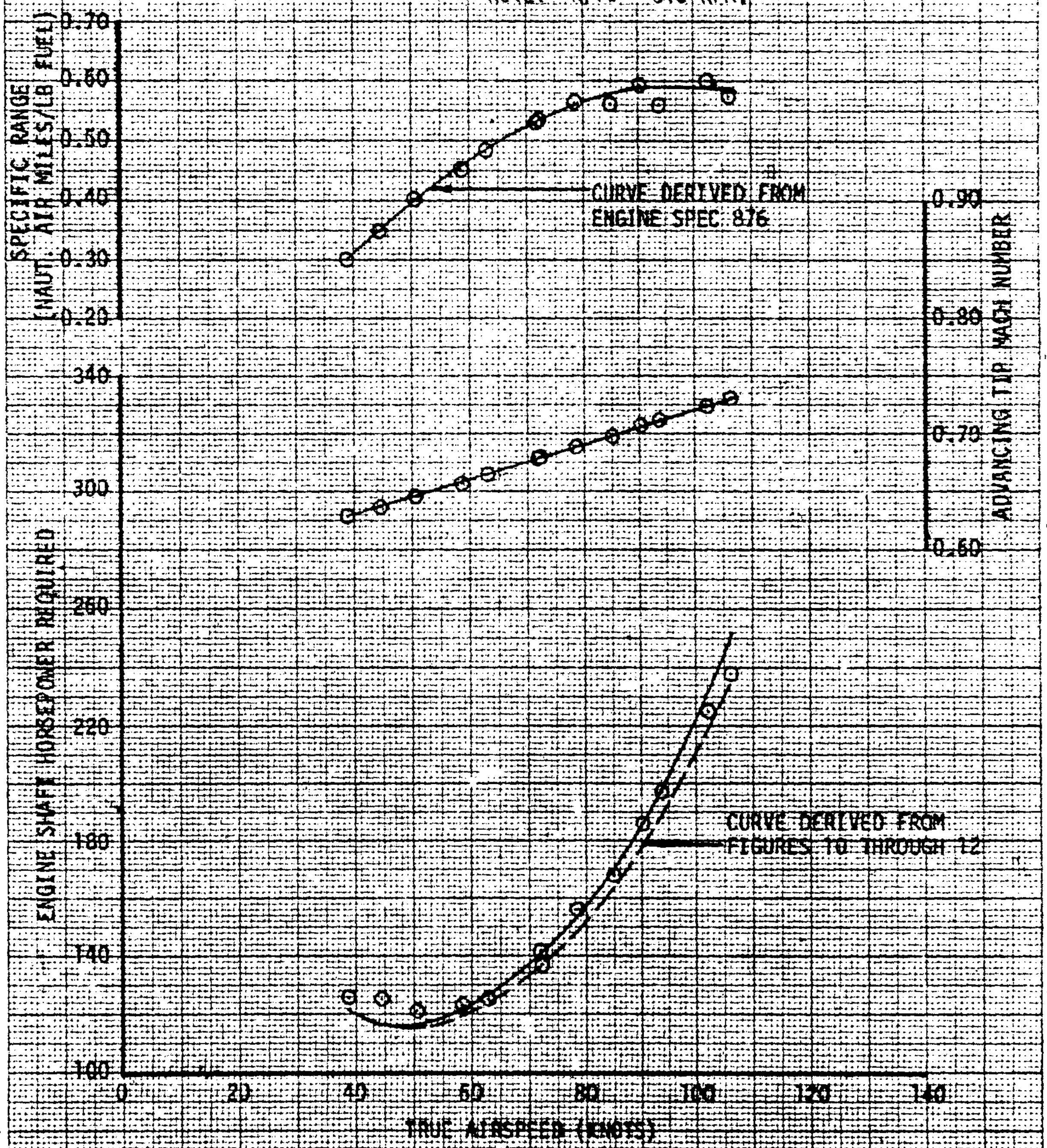


FIGURE 25
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
3040	107.7(FWD)	0.6(RT)	5960	24.0	350	0.003717	DOORS OFF

NOTE: $N/\sqrt{\theta}$ = 345 RPM.

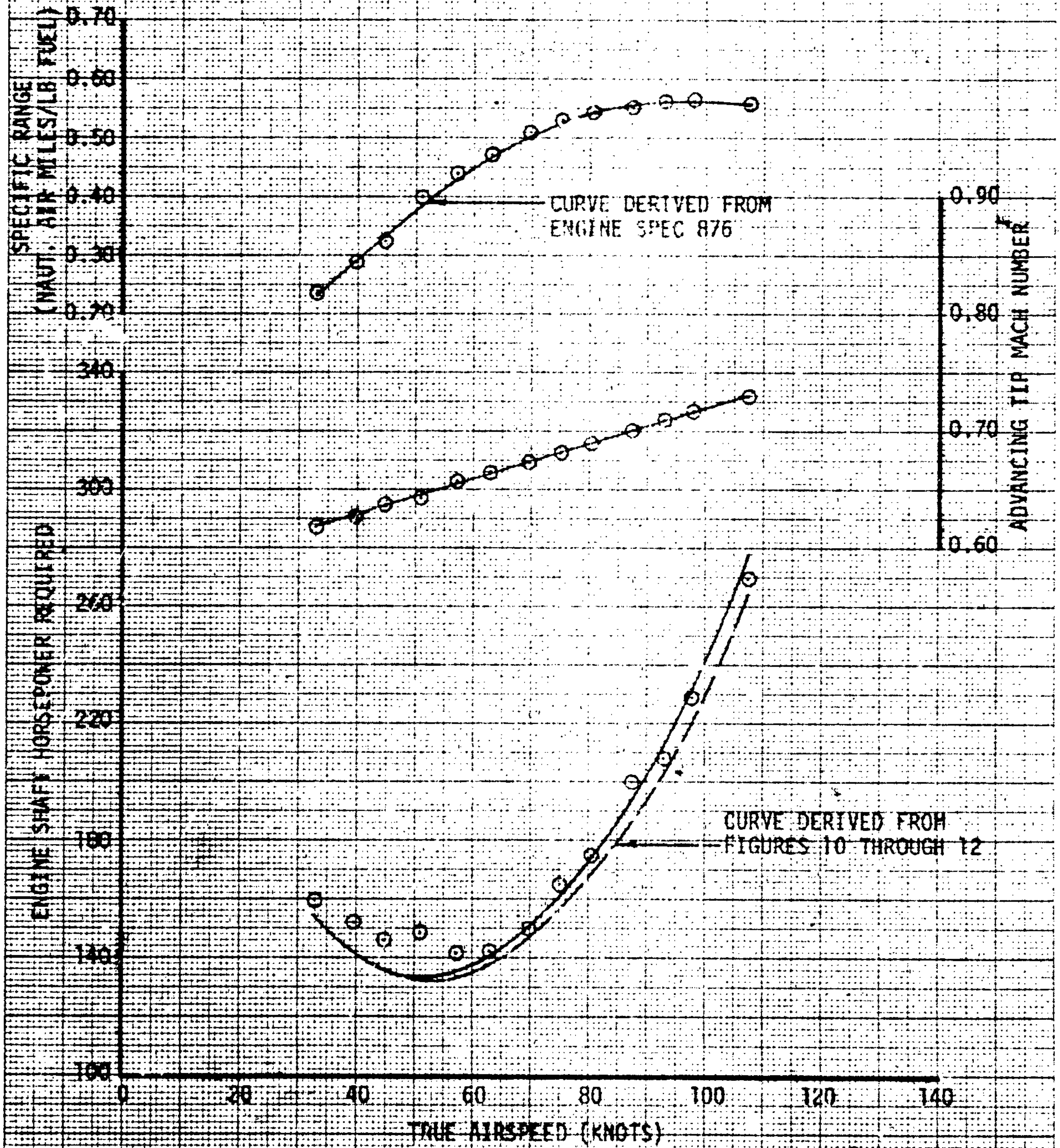


FIGURE 26
LEVEL FLIGHT PERFORMANCE
OH-58C S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG LONG CG (FS)	AVG LAT CG (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2740	111.7(AFT)	.6(RT)	4520	19.0	347	0.003260	CREW DOORS ON

NOTE: $N/\sqrt{\theta} = 345$ RPM

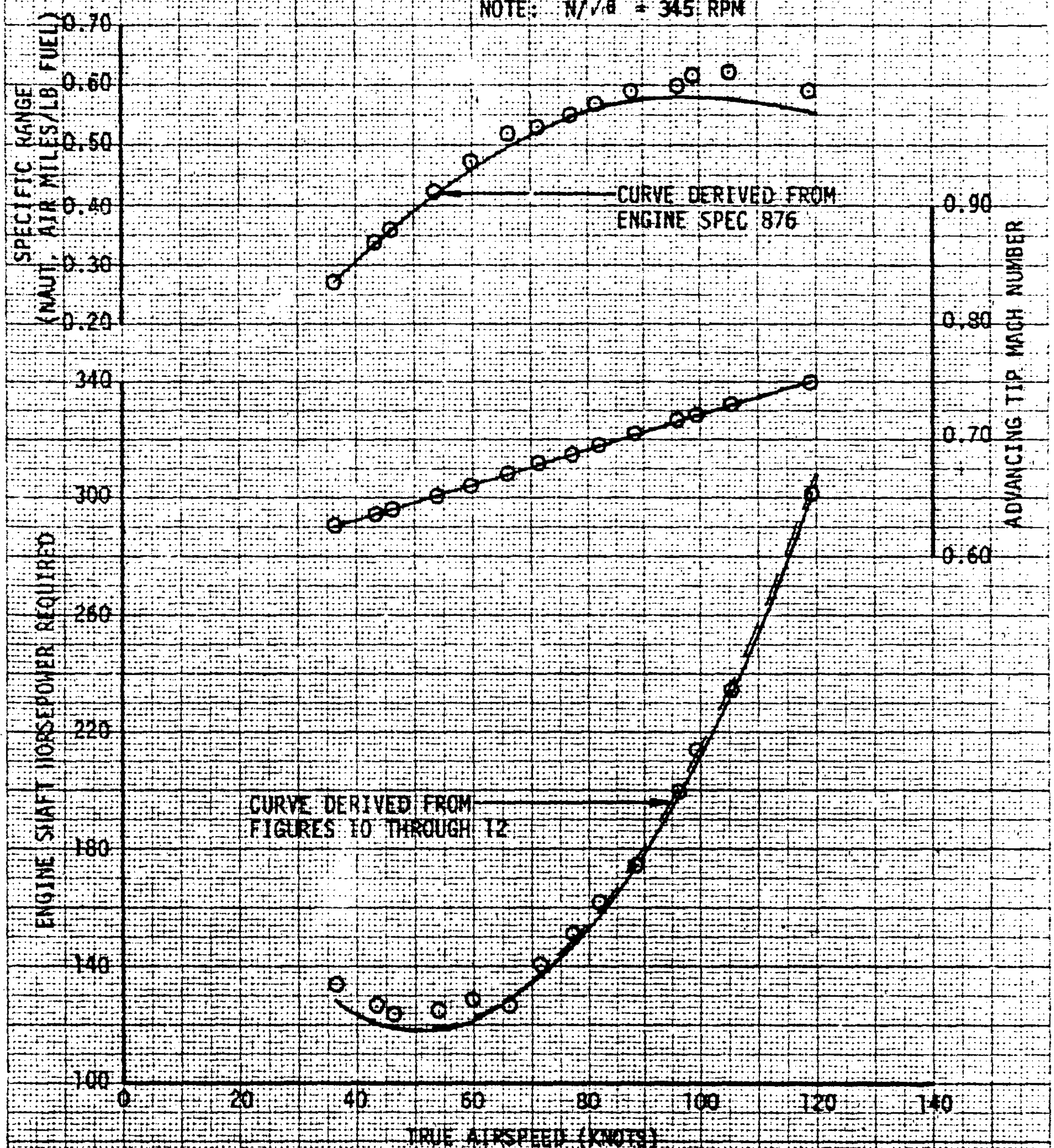


FIGURE 27
LEVEL FLIGHT PERFORMANCE
OH-58C S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG LONG CG (FS)	AVG LAT CG (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
3100	111.5(AFT)	.5(RT)	4960	19.5	343	.003719	CREW DOORS ON

NOTE: $N/\sqrt{\theta}$ = 345 RPM

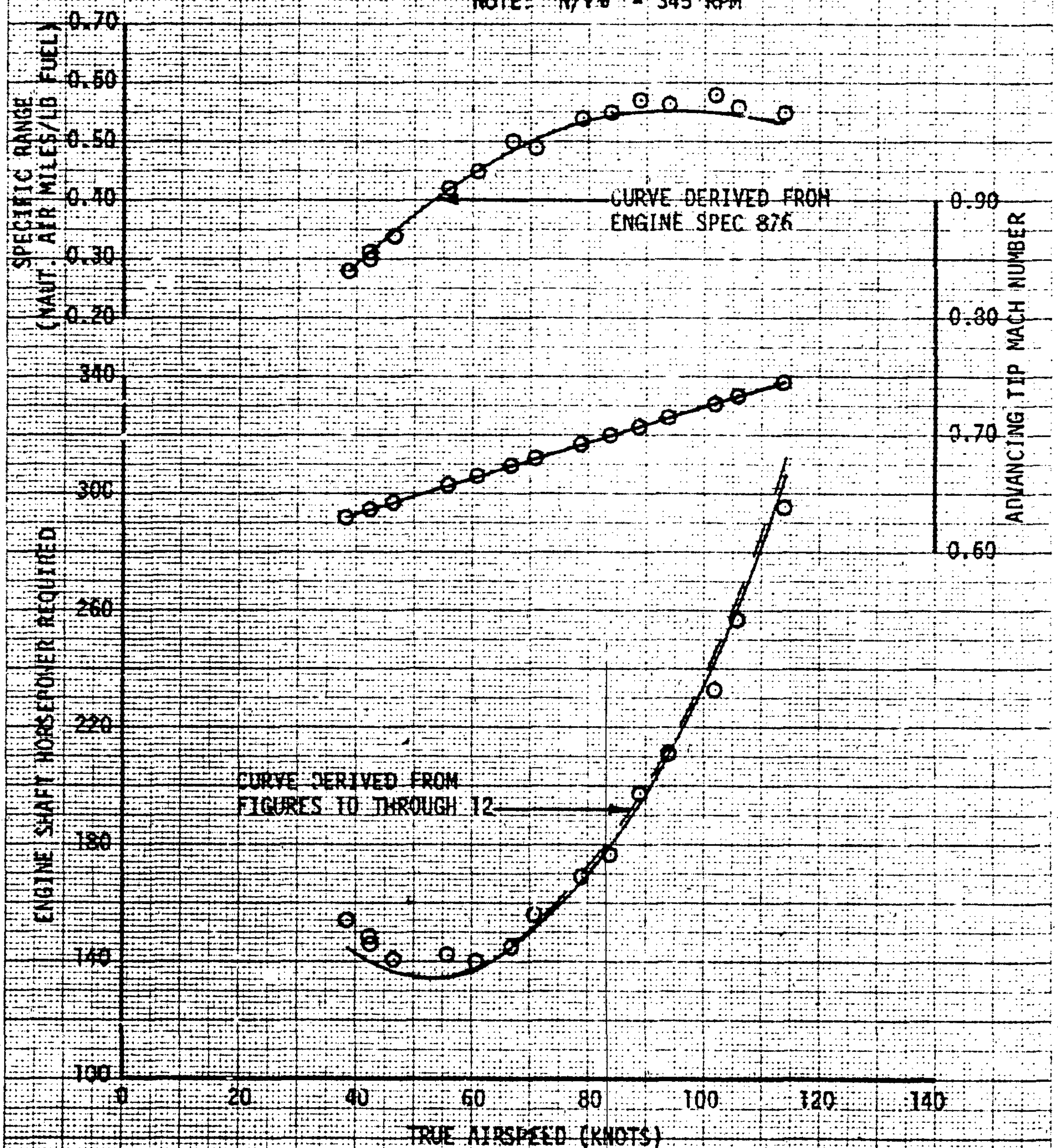


FIGURE 28
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
3040	106.7(FWD)	0.5(LT)	[illegible]60	20.5	353	0.003722	CREW DOORS ON

NOTE: $N/\sqrt{\theta} = 350$ RPM

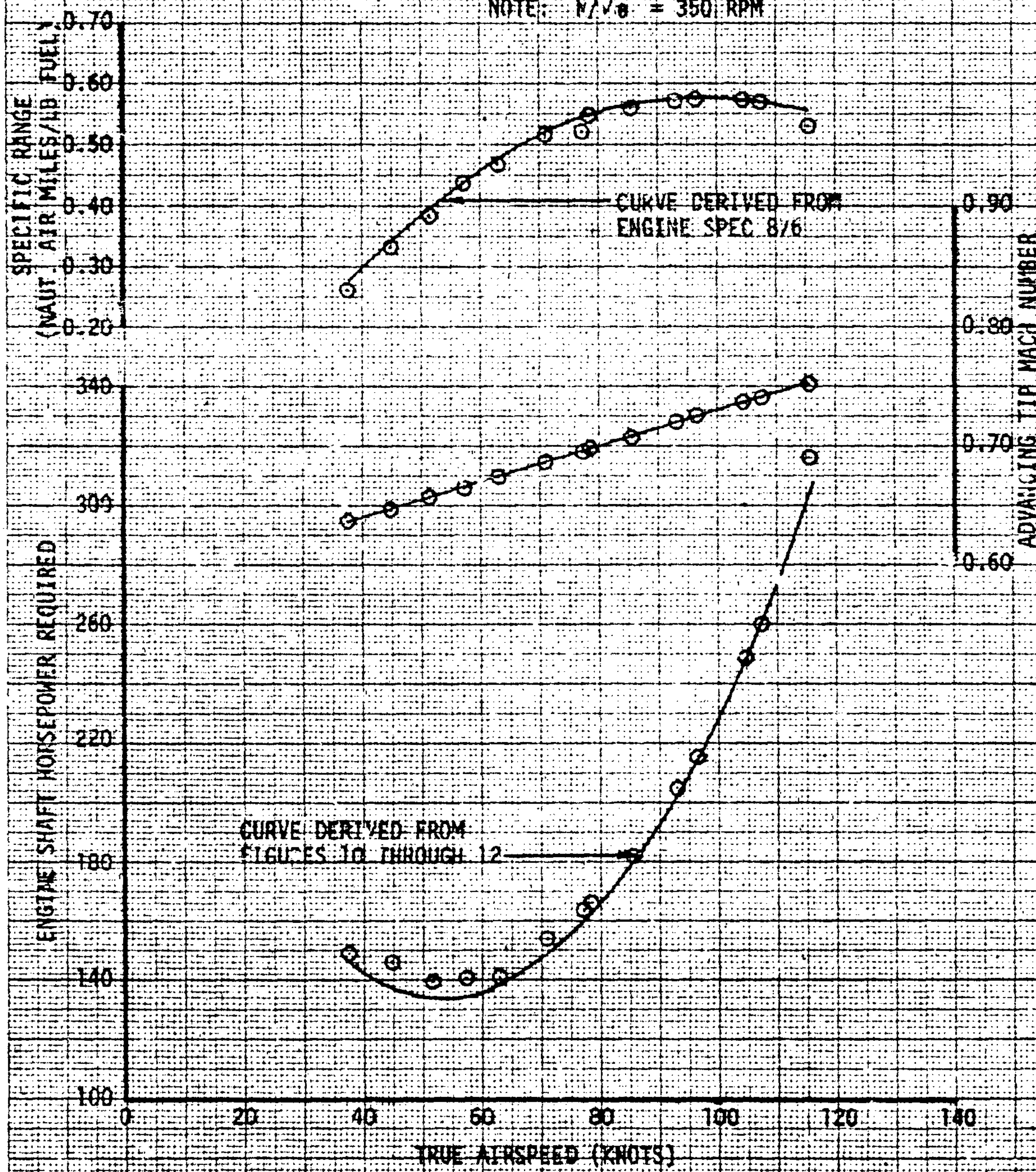


FIGURE 29

LEVEL FLIGHT PERFORMANCE

OV-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	CONFIGURATION
2780	107.6(FWD)	0.5(RT)	9640	13.0	354	0.003723	CREW DOORS ON

NOTE: $N/\sqrt{\theta}$ = 355 RPM

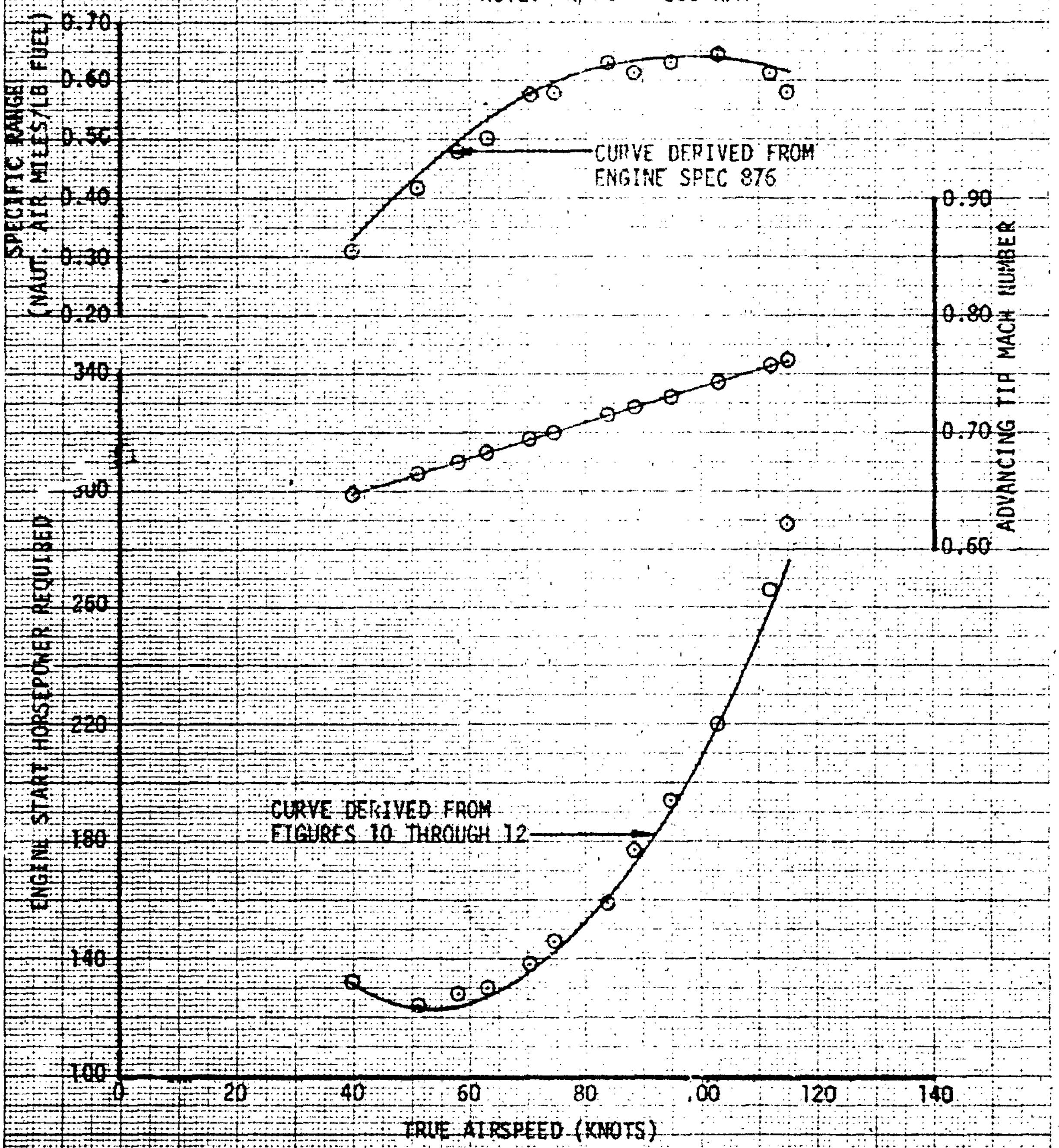


FIGURE 30
AUTOROTATIONAL DESCENT PERFORMANCE
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)
⊙	2700	107.5(FWD)	0.2	7320	25.0	355
⊡	3150	107.5(FWD)	0.2	6520	24.0	355

NOTE: CONFIGURATION: CLEAN, DOORS ON.

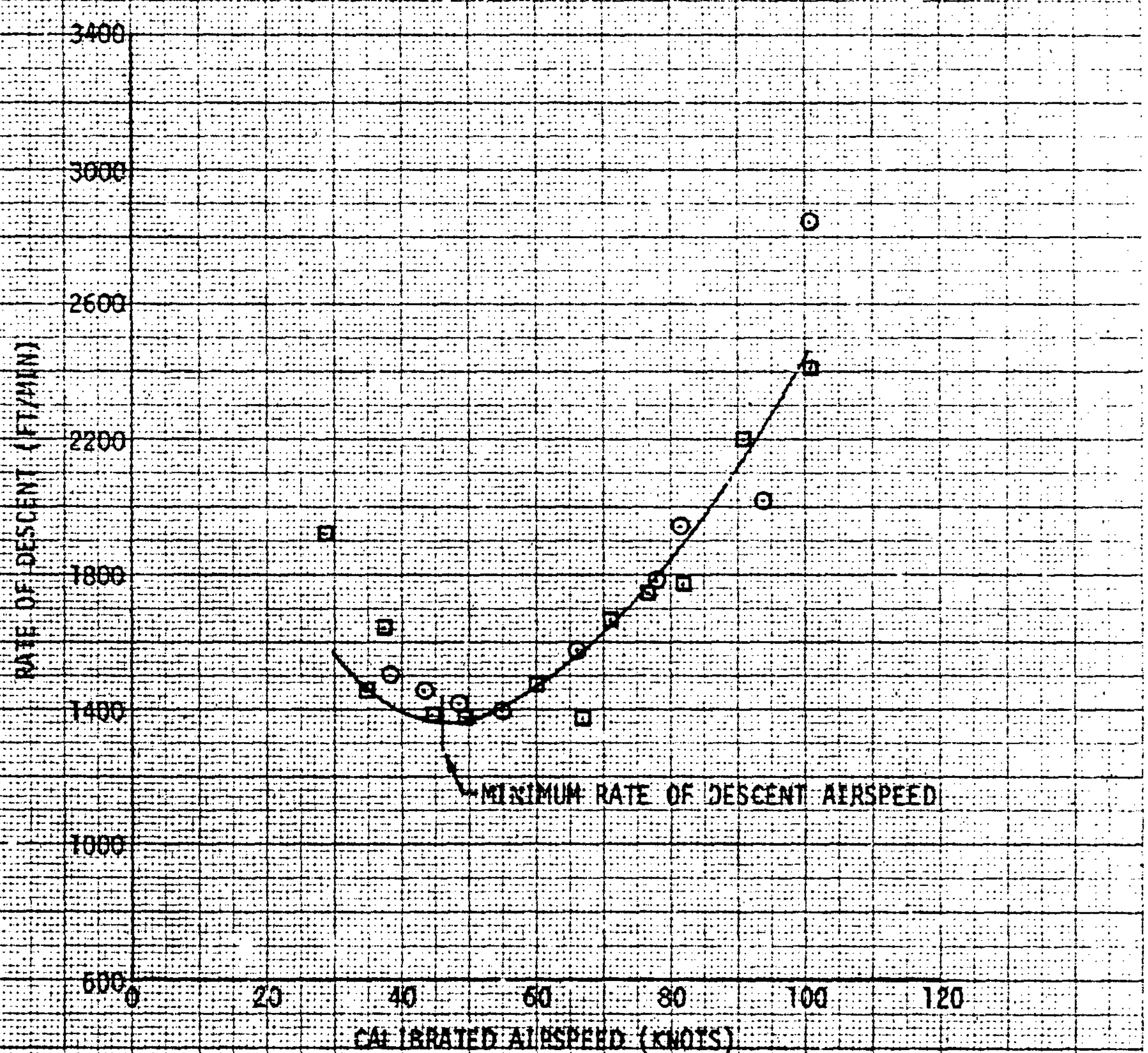


FIGURE 37

LONGITUDINAL CONTROL SYSTEM CHARACTERISTICS

OH-58C USA S/N 68-16724

NOTES:
1. ROTORS STATIC.
2. FORCES AND POSITIONS MEASURED AT CENTER OF CONTROL GRIP.
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY EXTERNAL POWER UNITS.
4. BOOST AND FORCE TRIM SYSTEMS ON.
5. TOTAL LONGITUDINAL CONTROL TRAVEL = 12.0 INCHES.

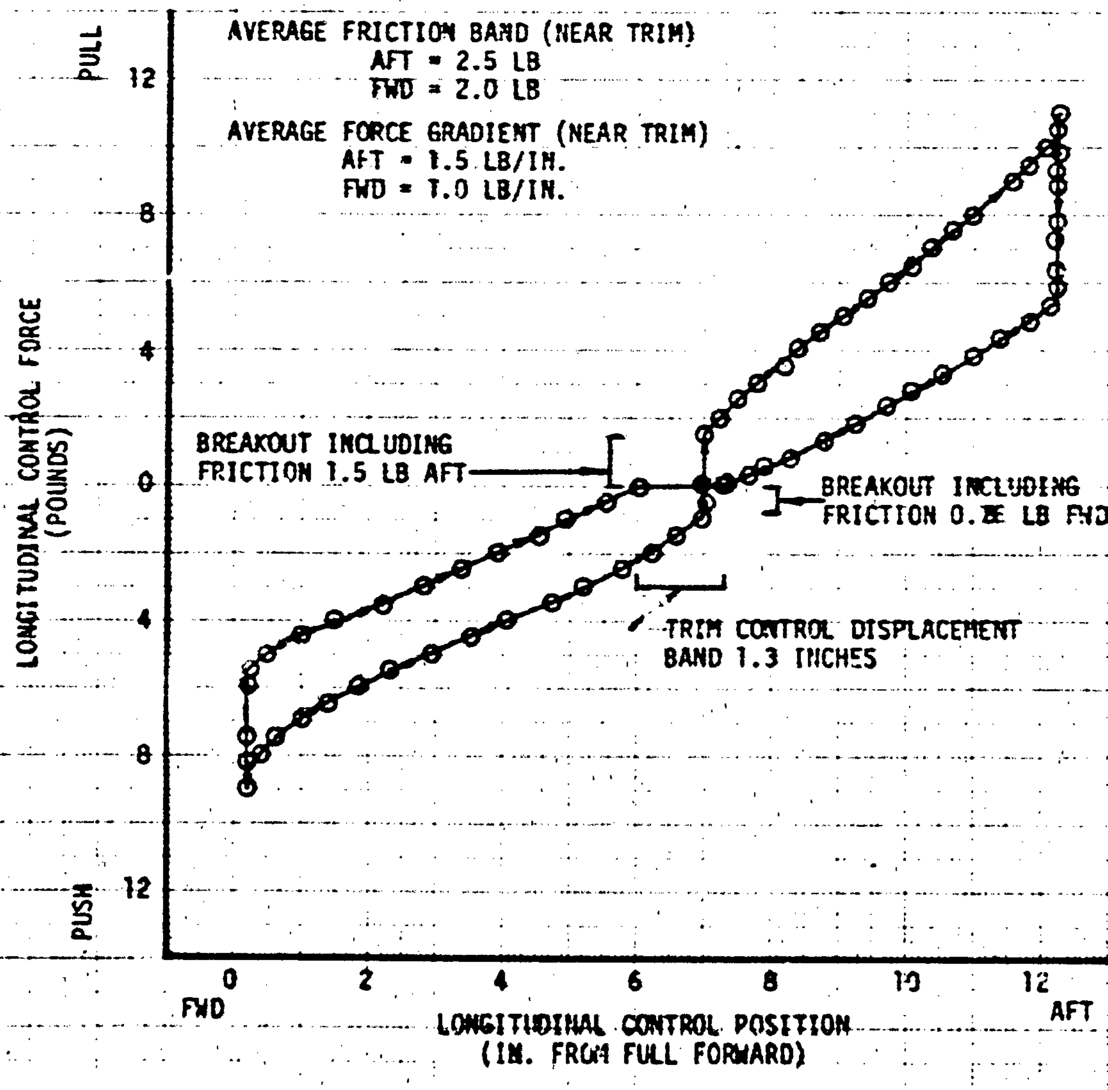


FIGURE 32
LATERAL CONTROL SYSTEM CHARACTERISTICS
OH-58C USA S/N 68-16724

NOTES: 1. ROTORS STATIC.
2. FORCES AND POSITIONS MEASURED AT CENTER OF CONTROL GRIP.
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY EXTERNAL POWER UNITS.
4. BOOST AND FORCE TRIM SYSTEMS ON.
5. TOTAL LATERAL CONTROL TRAVEL = 9.7 INCHES.

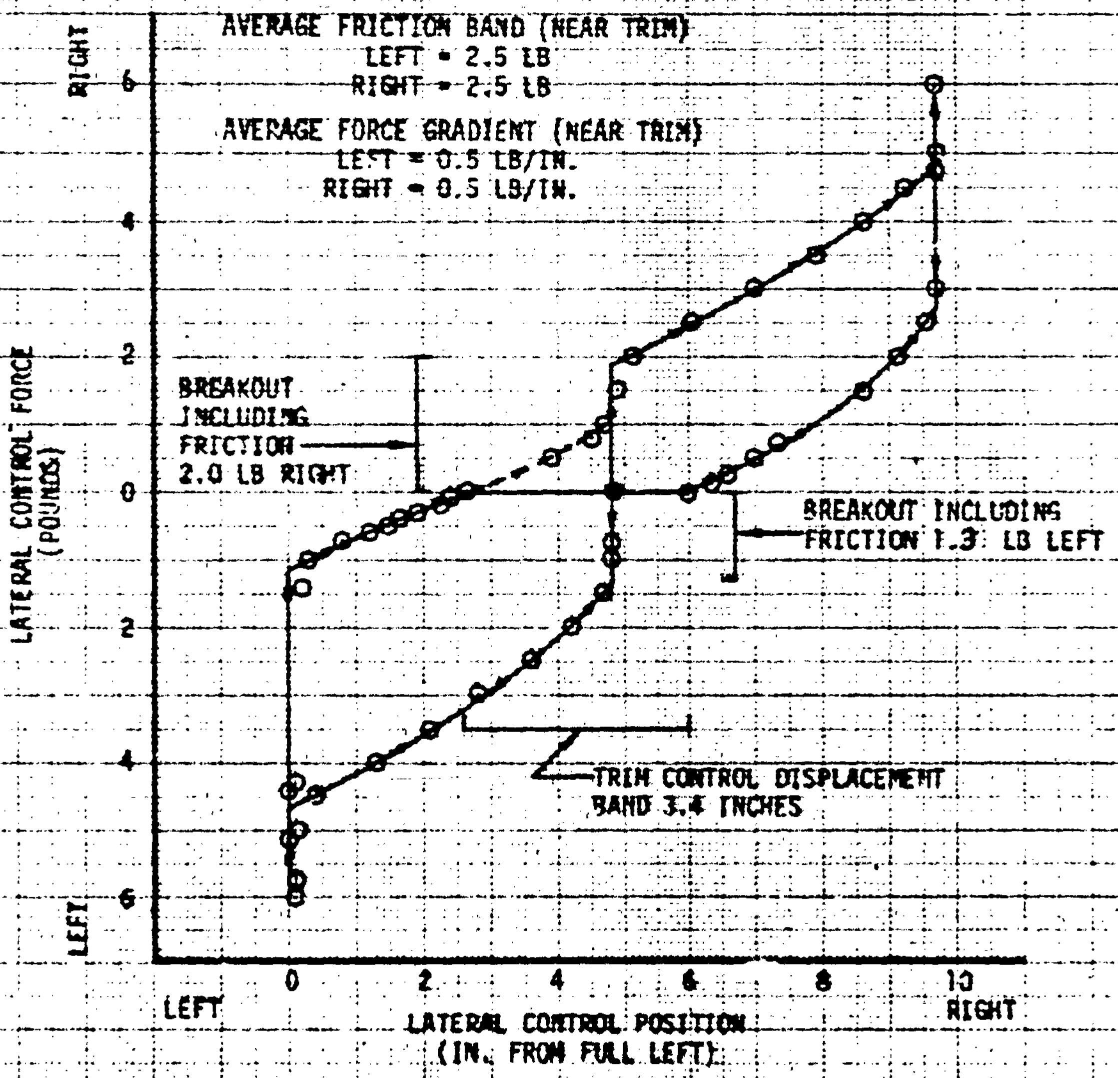


FIGURE 33

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C S/N 68-18724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	CREW DOORS	FLIGHT COND
□	2760.	111.1(AFT)	.8(RT)	4440.	19.0	347.	ON	LEVEL
○	2740.	107.7(FWD)	.0(RT)	5400.	28.5	352.	ON	LEVEL

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. ZERO SIDESLIP CONSTANT N/√θ: 345 RPM.

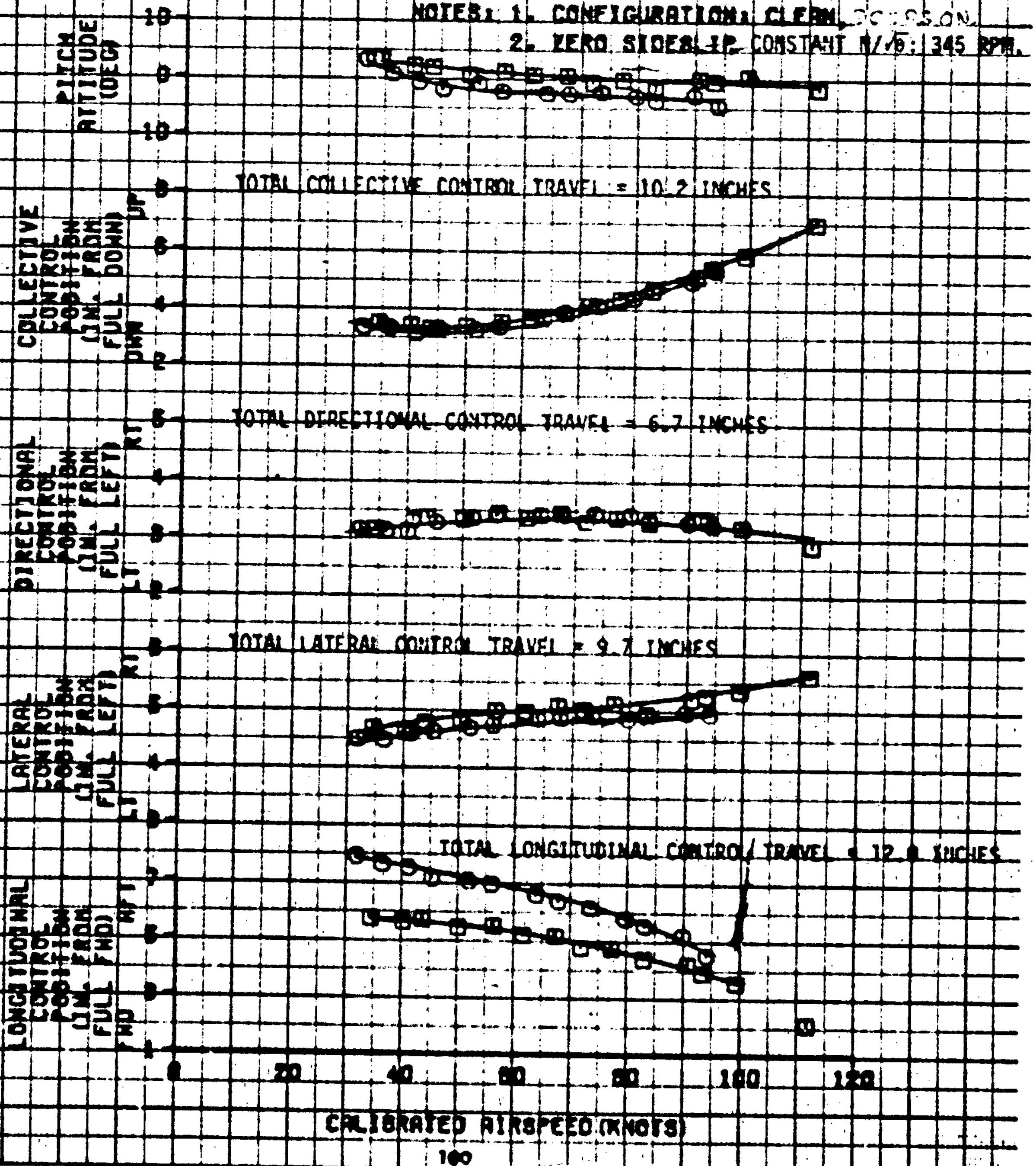


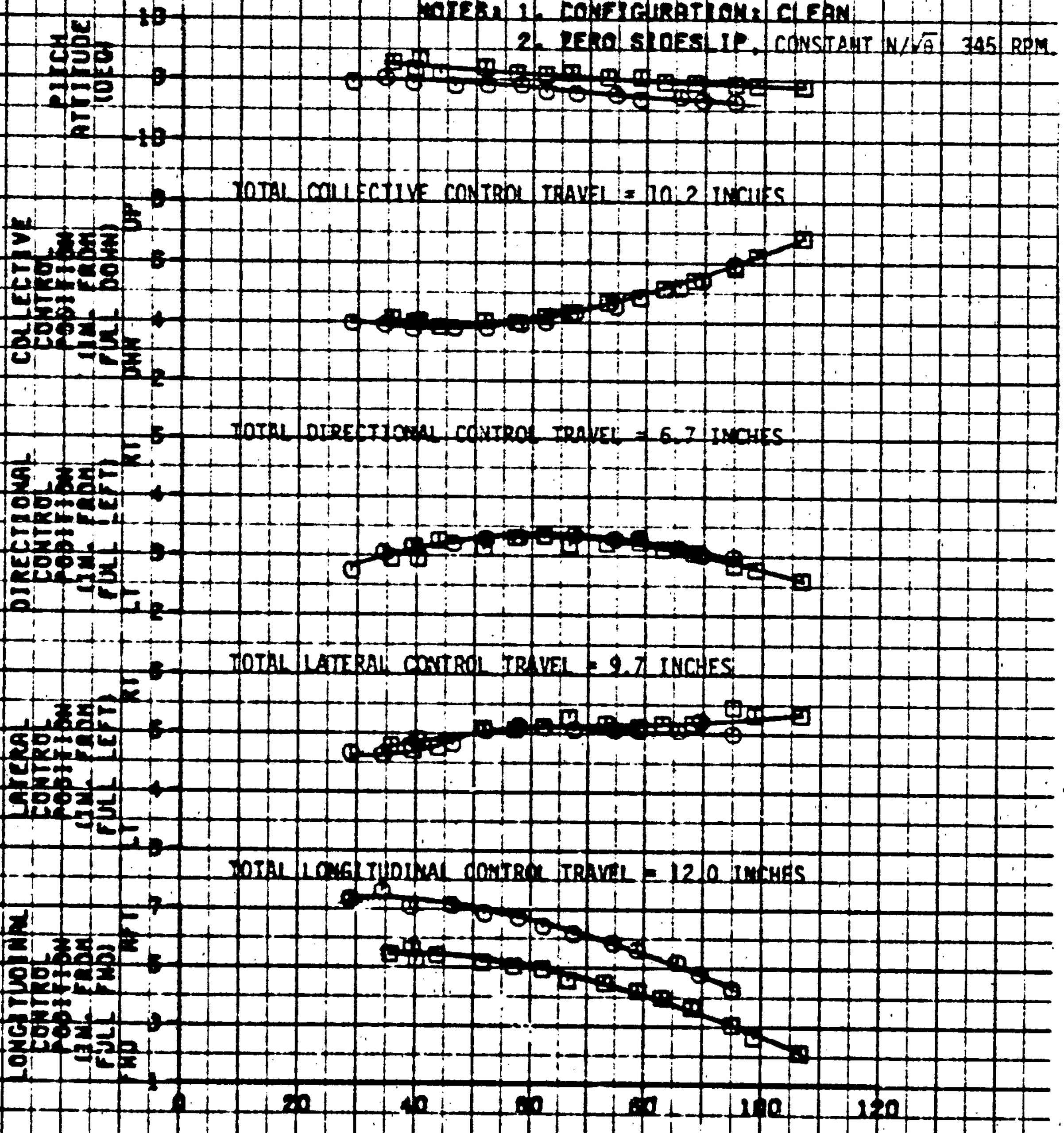
FIGURE 34

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	CREW DOORS	FLIGHT COND
⊡	3100.	111.5(AFT)	.5(RT)	4900.	19.5	348.	ON	LEVEL
⊙	3040.	107.7(FWD)	.0(RT)	8000.	25.0	350.	ON	LEVEL

NOTES: 1. CONFIGURATION: CLEAN
2. ZERO SIDESLIP. CONSTANT $N/\sqrt{\theta}$ 345 RPM.



CALIBRATED AIRSPEED (KNOTS)

FIGURE 36

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	CREW DOORS	FLIGHT COND
□	2920.	112.3(AFT)	.8(RT)	11680.	8.0	354.	ON	LEVEL
○	3140.	105.5(FWD)	.5(RT)	10120.	10.0	347.	ON	LEVEL

NOTES: 1. CONFIGURATION: CLEAN
2. ZERO SIDESLIP, CONSTANT $N/\sqrt{\theta}$: 345 RPM.

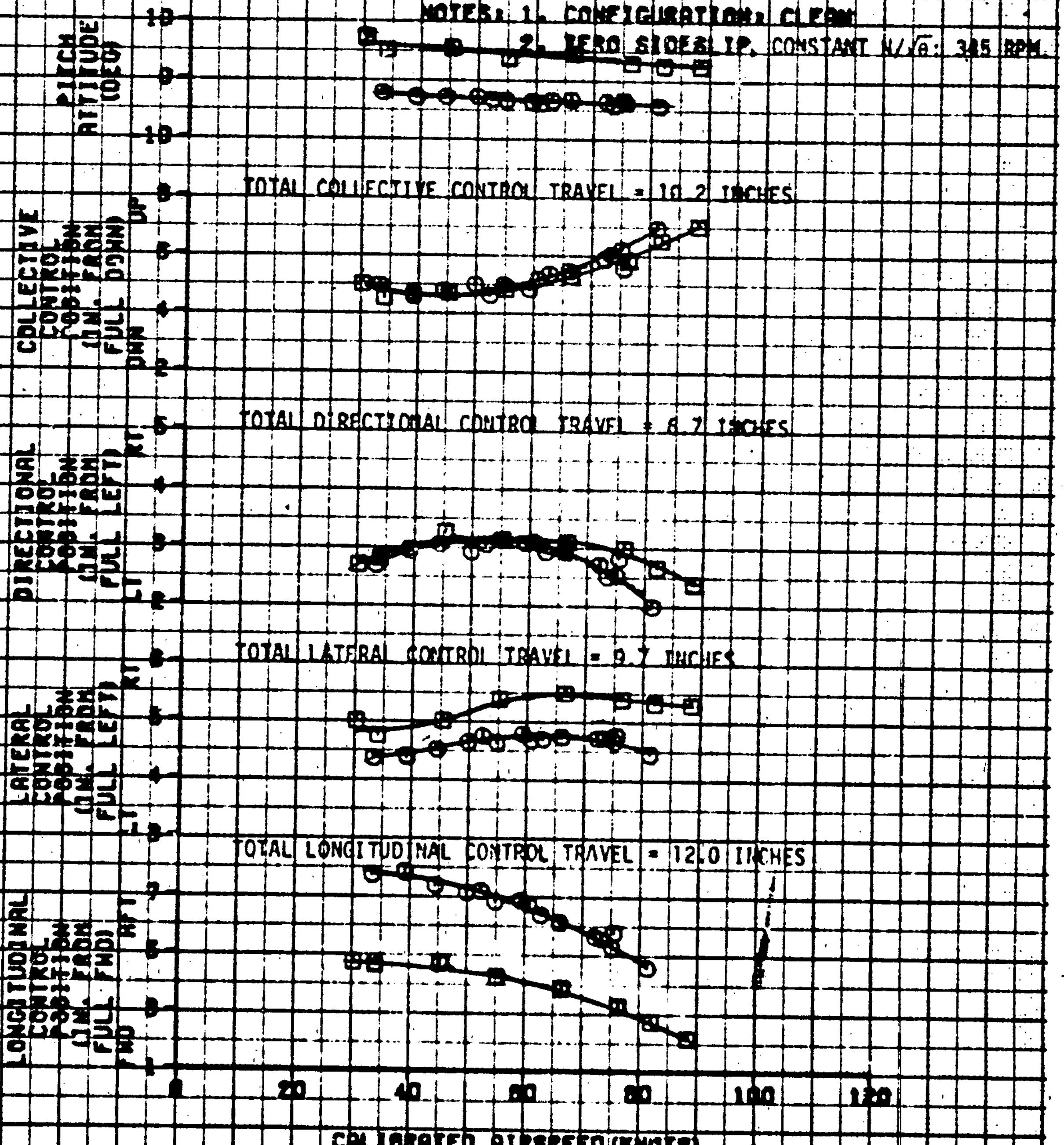


FIGURE 36

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	CREW DOORS	FLIGHT COND
□	2740.	107.7(FWD)	.0(RT)	5400.	28.5	352.	ON	LEVEL
○	2700.	108.8(FWD)	.5(RT)	4980.	19.0	347.	OFF	LEVEL

NOTES: 1. CONFIGURATION: CLEAN
2. ZERO SIDESLIP, CONSTANT $N/\sqrt{\theta}$: 385 RPM

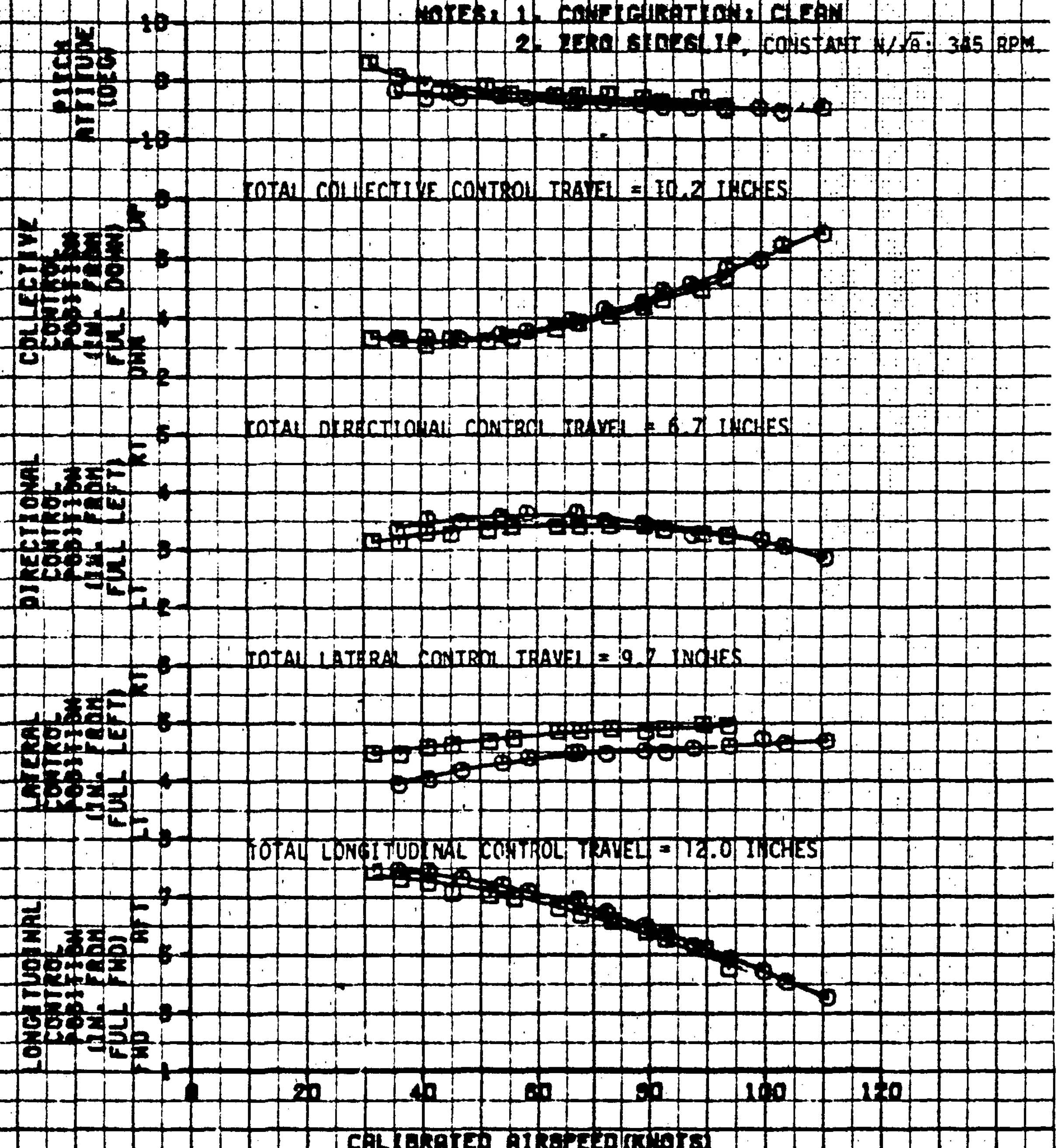


FIGURE 37

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	CREW DOORS	FLIGHT COND
⊡	3040.	107.7(FWD)	.0(RT)	6000.	25.0	350.	ON	LEVEL
⊙	2920.	107.8(FWD)	.8(RT)	7040.	21.5	348.	OFF	LEVEL

NOTES: 1. CONFIGURATION: CLEAN

2. ZERO SIDESLIP. CONSTANT $N/\sqrt{\theta}$ = 345 RPM.

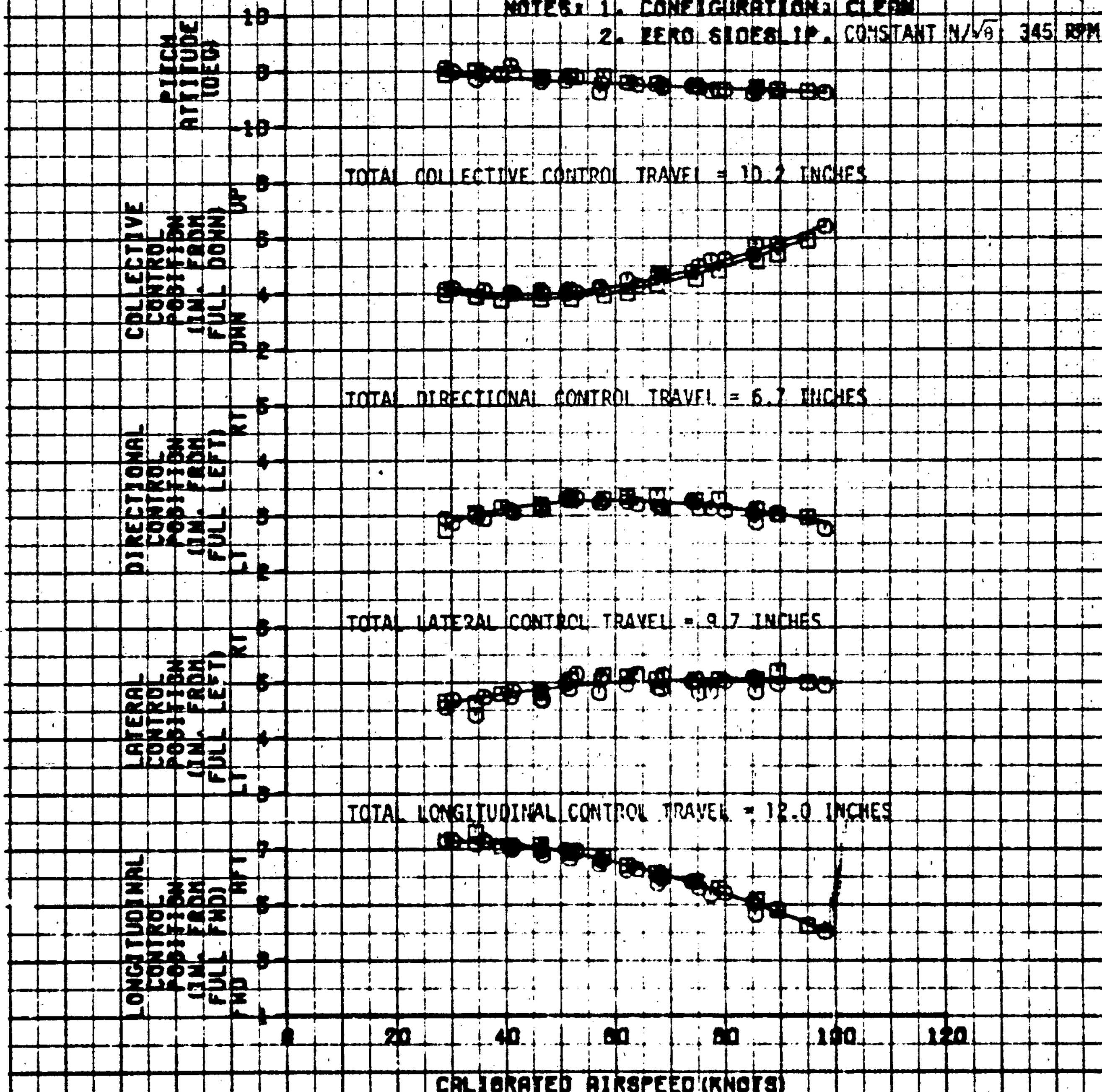


FIGURE 38

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	CREW DOORS	FLIGHT COND
□	2880.	107.3(FWD)	.7(RT)	6720.	23.5	351.	ON	AUTO
○	2860.	107.4(FWD)	.7(RT)	7200.	24.0	351.	ON	CLIMB

NOTES: 1. CONFIGURATION: CLEAN
2. ZERO SIDESLIP

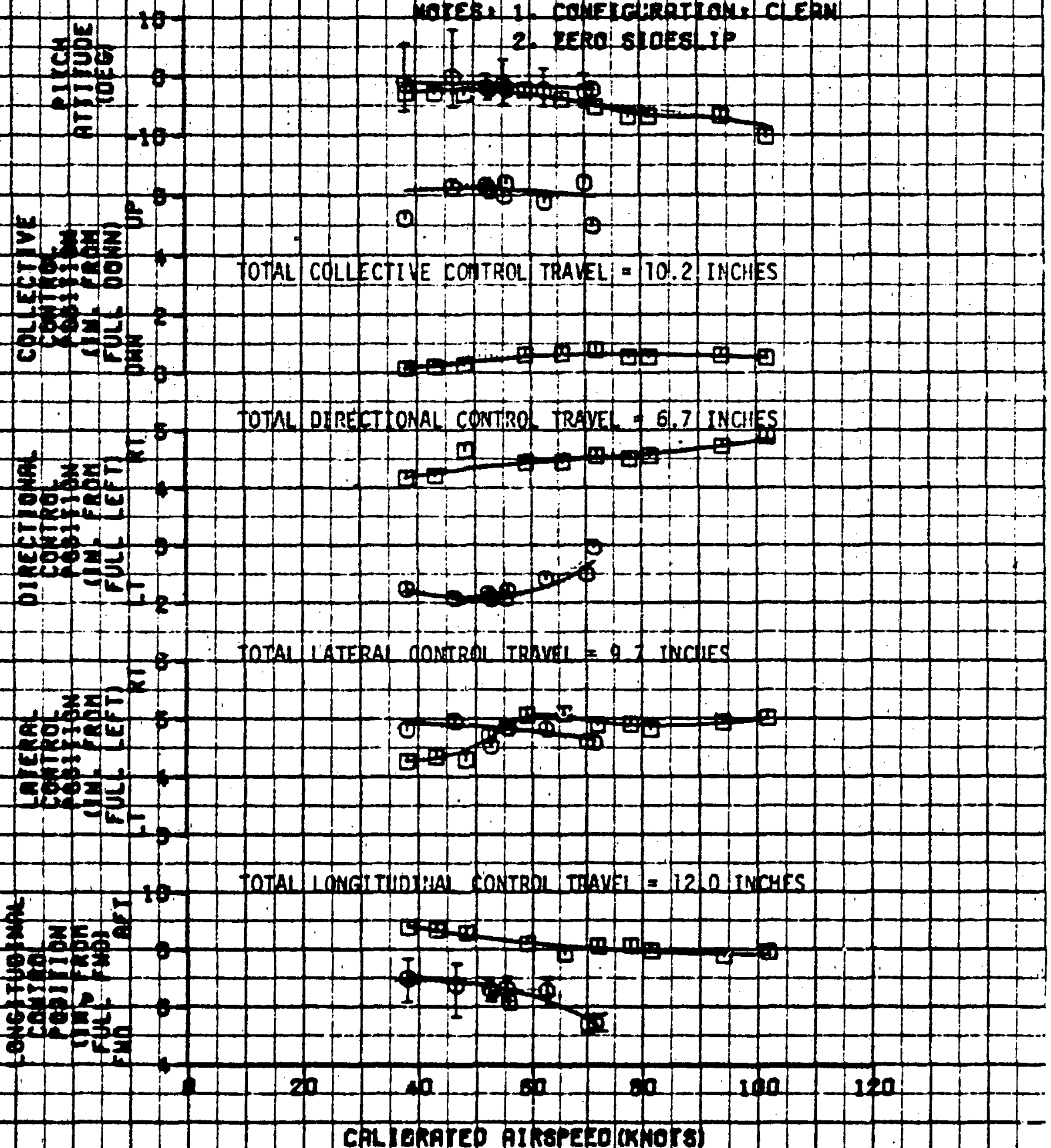


FIGURE 34

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	FLIGHT CONDITION
□	2940.	112.7(AFT)	.9(RT)	8680.	23.5	355.	LEVEL
○	2900.	112.5(AFT)	.9(RT)	8800.	23.5	354.	LEVEL

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON
2. SHADED SYMBOLS DENOTE TRIM
3. BALL-CENTERED FLIGHT

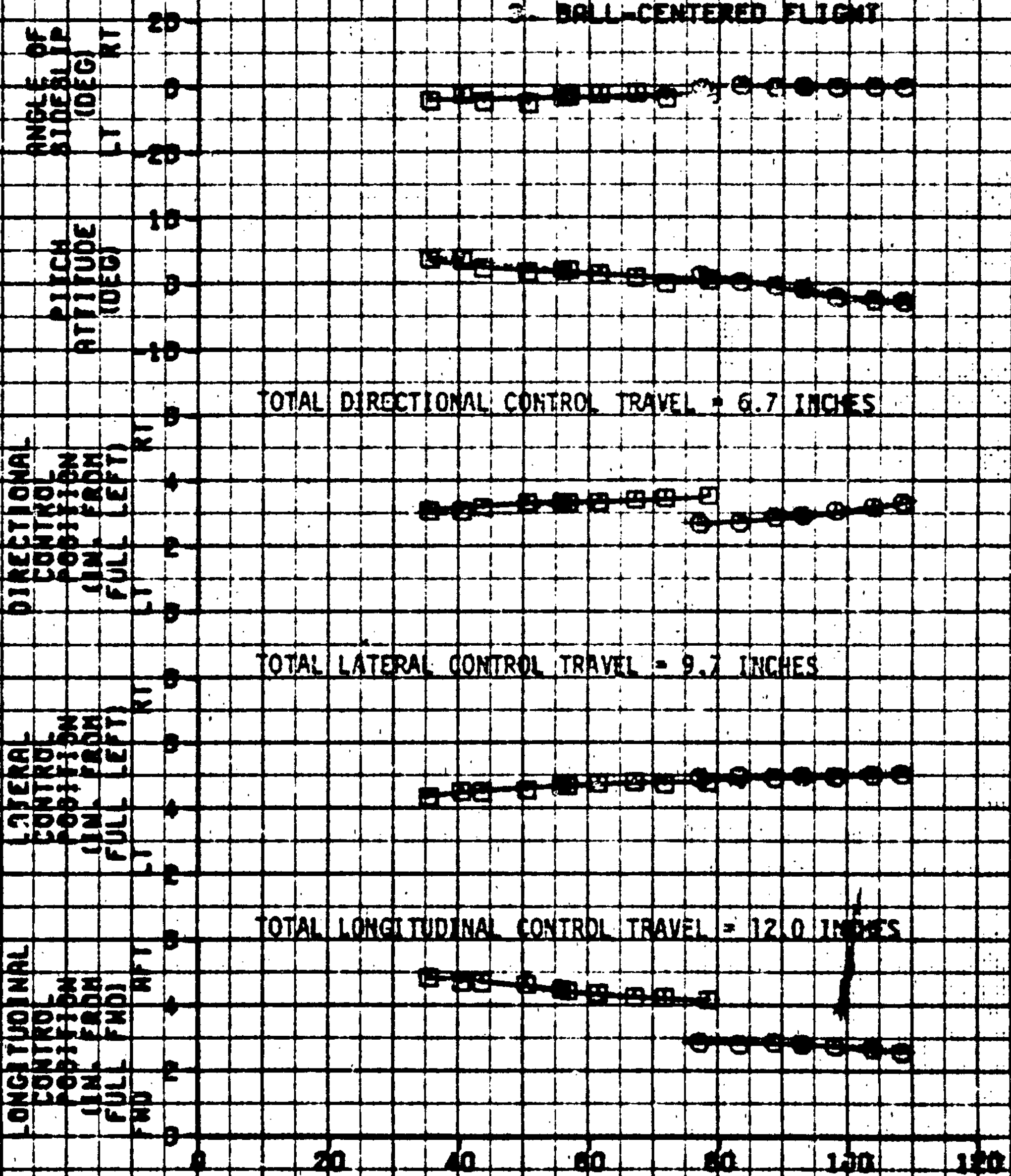


FIGURE 40

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	FLIGHT CONDITION
□	[illegible]	112.7(AFT)	.6(RT)	11940.	8.0	355.	LEVEL
○	[illegible]	112.7(AFT)	.6(RT)	11600.	8.0	354.	LEVEL

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON
2. SHADED SYMBOLS DENOTE TRIM
3. BALL-CENTERED FLIGHT

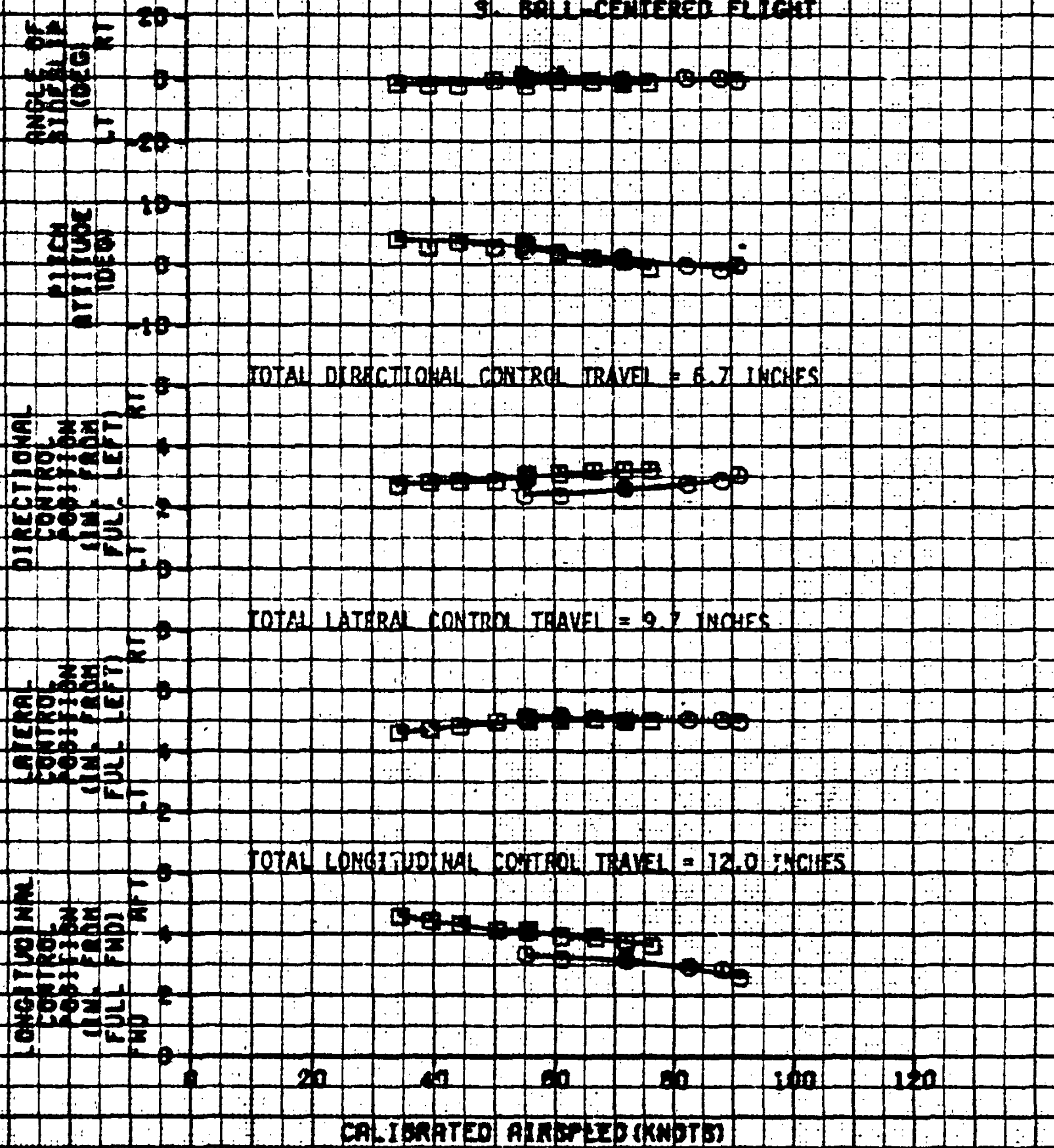


FIGURE 4:

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	FLIGHT CONDITION
□	2860	112.5(AFT)	.9(RT)	6840	24.0	351	CLIMB
○	2820	112.5(AFT)	1.0(RT)	5720	17.0	352	AUTOROTATION

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON
2. SHADED SYMBOLS DENOTE TRIM
3. BALL-CENTERED FLIGHT

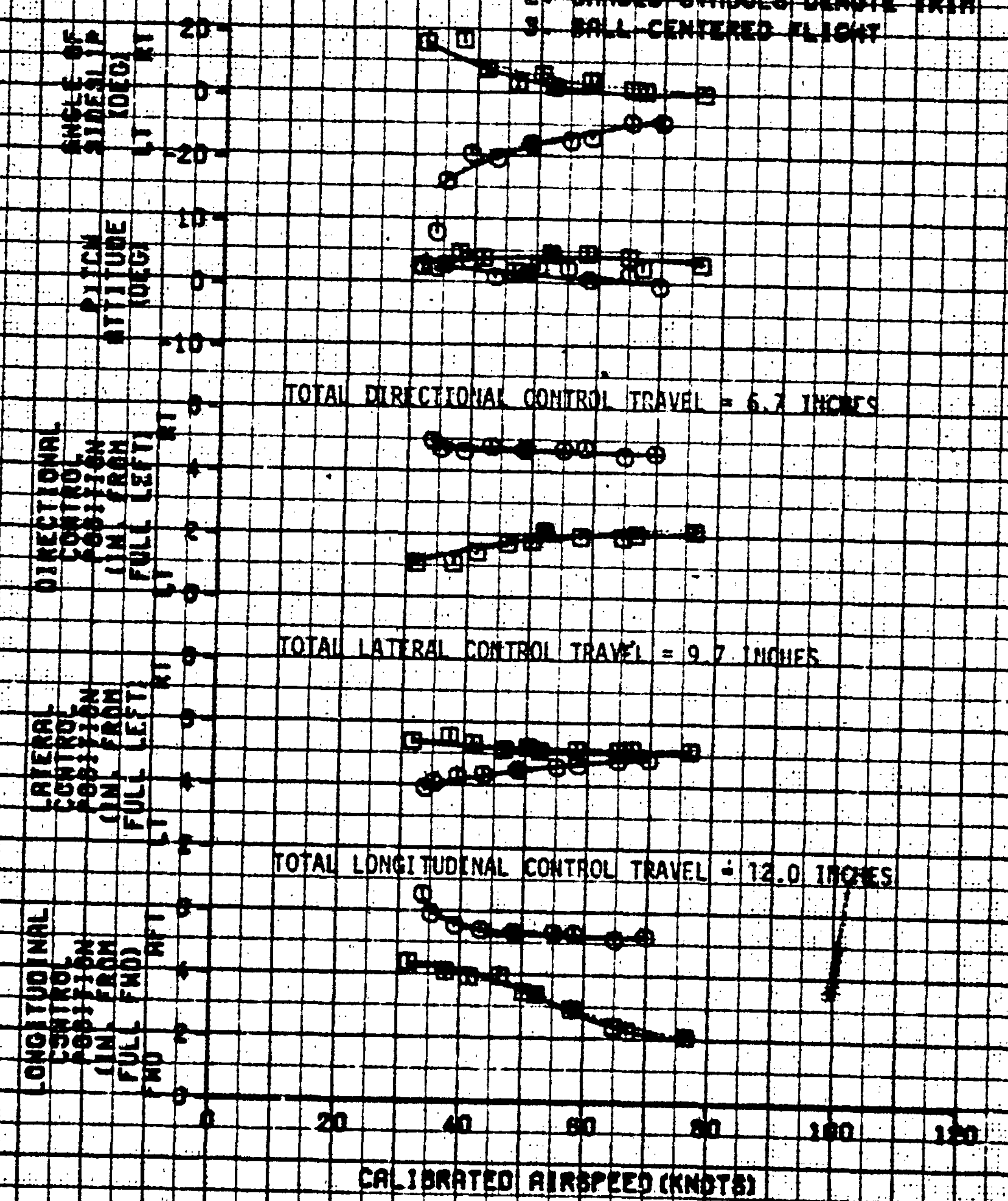


FIGURE 42

STATIC LATERAL-DIRECTIONAL STABILITY

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIB AIRSPEED (KNOTS)	FLIGHT COND
□	2860.	111.9(AFT)	.4(RT)	5300.	26.5	354.	52	LEVEL
○	2860.	112.0(AFT)	.5(RT)	4440.	24.5	352.	78	LEVEL

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON
2. SHADED SYMBOLS DENOTE TRIM

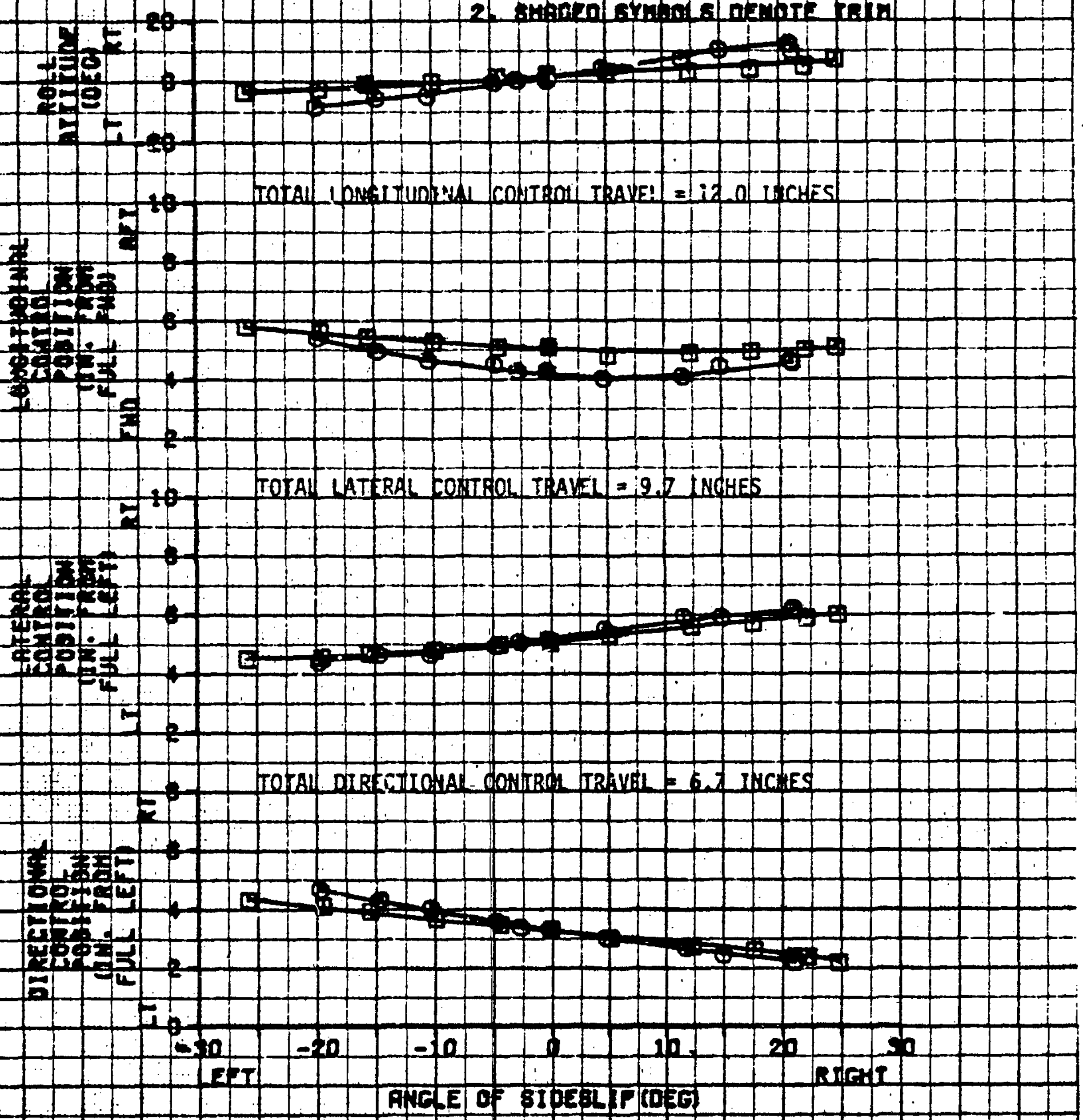


FIGURE 43

STATIC LATERAL-DIRECTIONAL STABILITY

OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIB AIRSPEED (KNOTS)	FLIGHT COND
☐	2840.	112.7(AFT)	.6(RT)	11640.	8.0	354.	55	LEVEL
○	2820.	112.7(AFT)	.6(RT)	11320.	9.0	352.	77	LEVEL

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON
2. SHADED SYMBOLS DENOTE TRIM

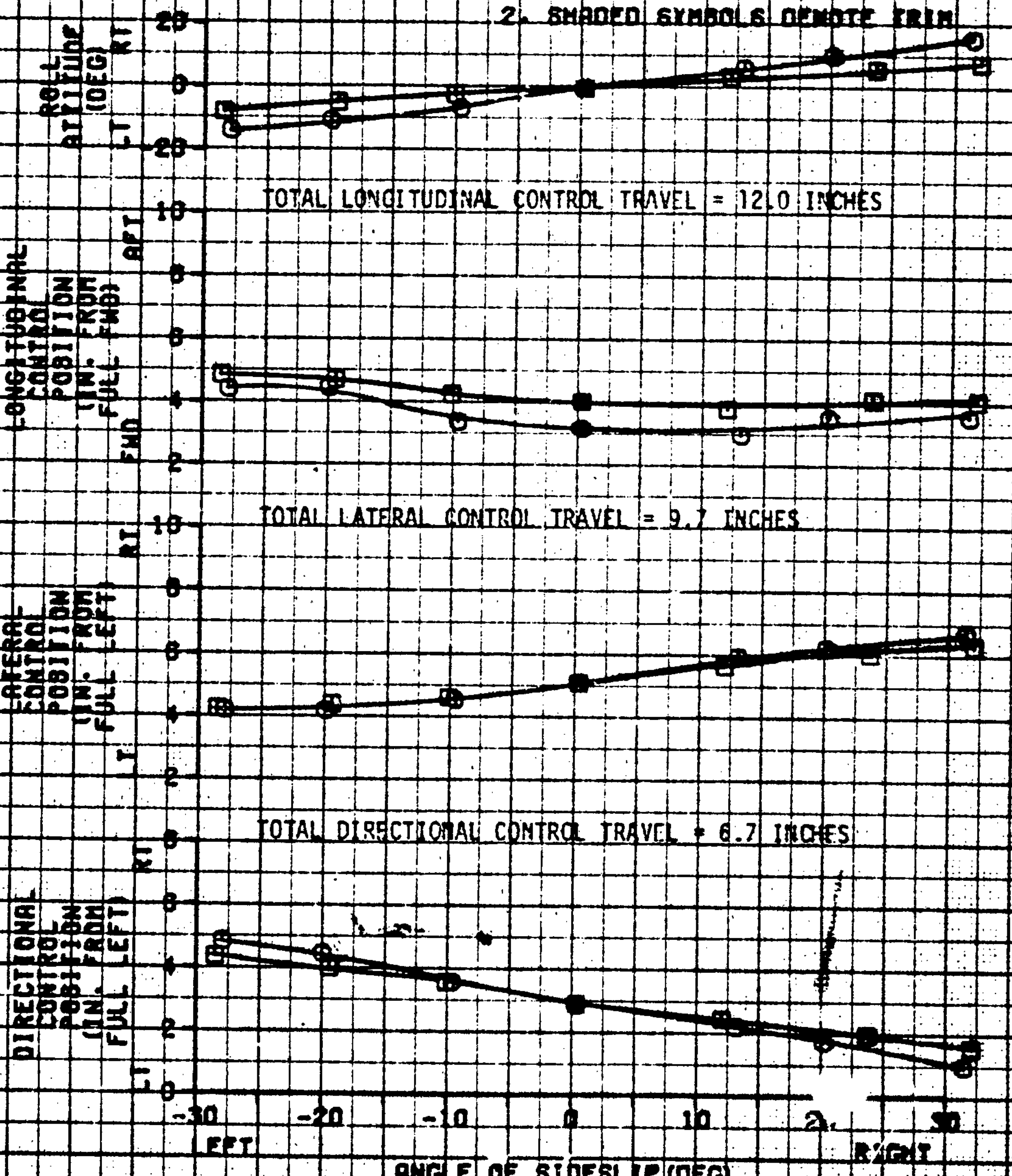


FIGURE 44
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C S/N 68-16724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIB AIRSPEED (KNOTS)	FLIGHT COND
□	2800.	113.8(AFT)	.5(RT)	8480.	22.0	353.	48	CLIMB
○	2780.	113.8(AFT)	.5(RT)	7340.	23.5	345.	54	AUTO

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON
2. SHADED SYMBOLS DENOTE TRIM

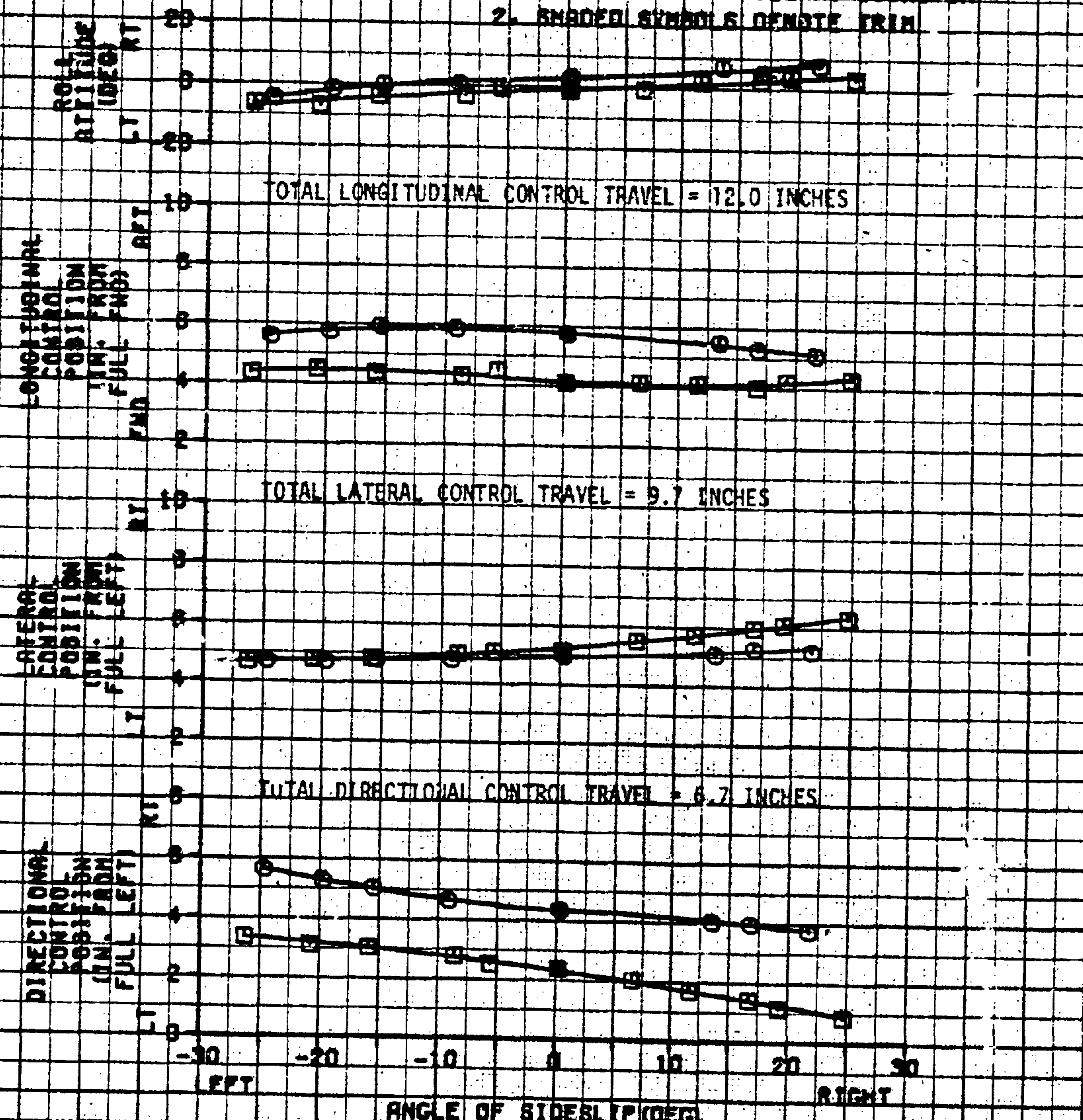
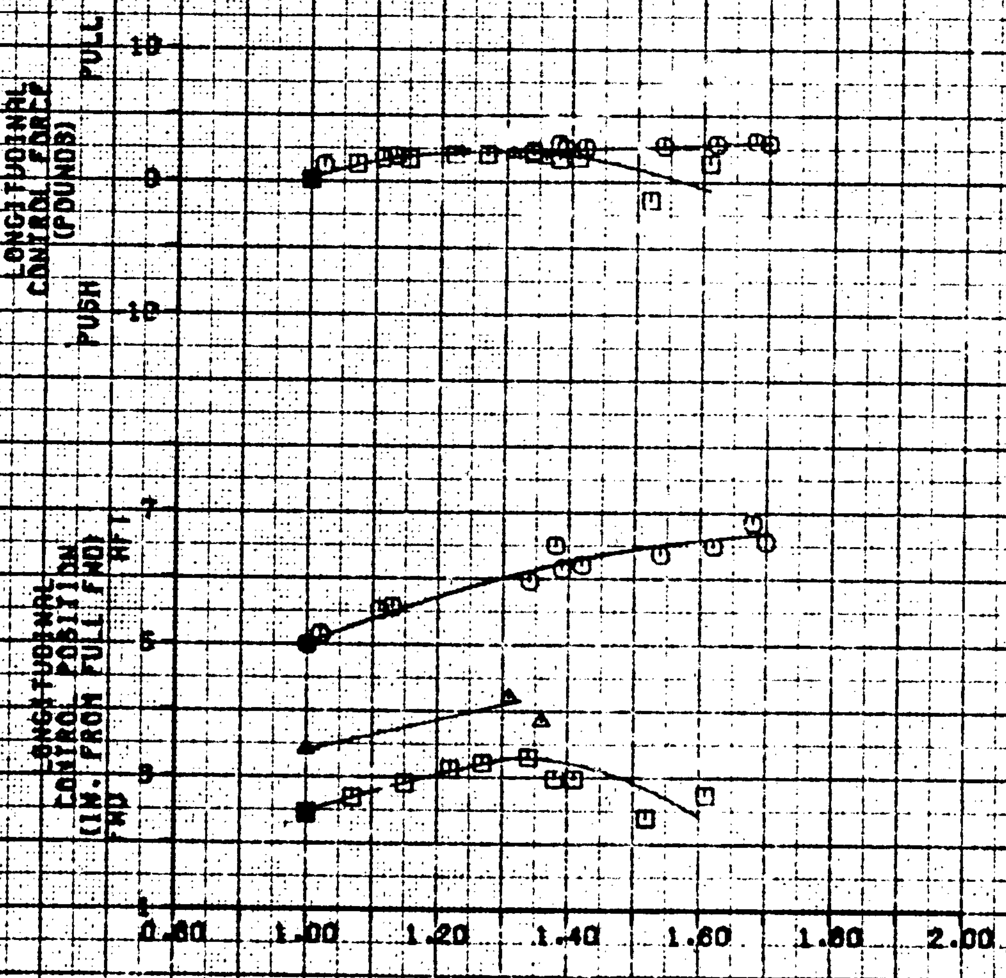


FIGURE 46
MANEUVERING STABILITY
OH-58C USA S/N 68-18724

SYM	AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIB AIRSPEED (KNOTS)	FLIGHT COND
⊖	2920	112.1 (AFT)	0.9	7160	24.0	355	51	LEVEL
⊡	2940	112.2 (AFT)	1.0	7020	24.0	355	98	LEVEL
▲	2880	112.0 (AFT)	1.0	7120	26.0	355	88	LEVEL

NOTE: SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM



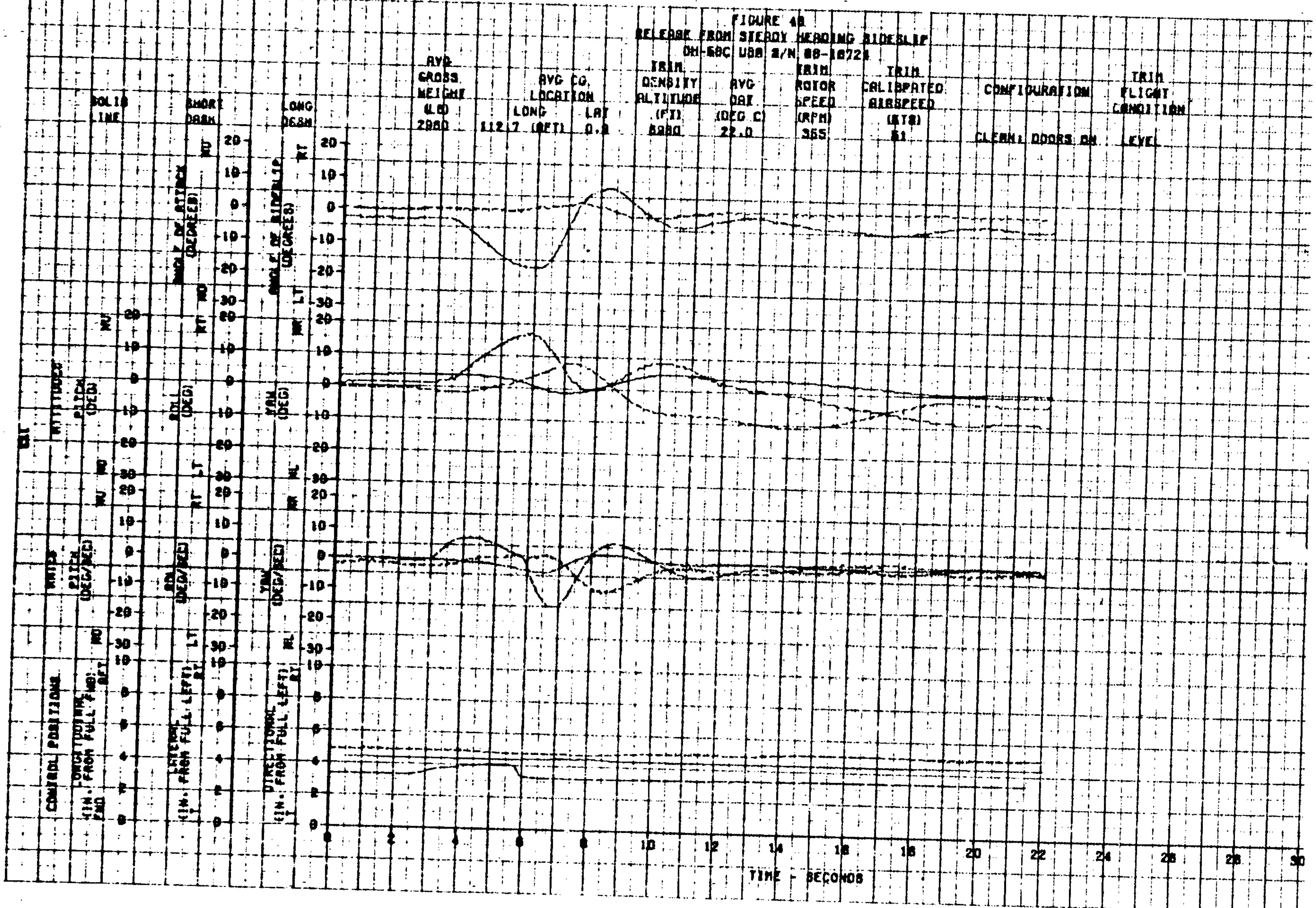


FIGURE 48
RELEASE FROM STEADY HEADING SIDESLIP
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 2980
AVG CG LOCATION LONG 112.7 (AFT) LAT 0.0
TRIM DENSITY ALTITUDE (FT) 6980
AVG OAT (DEG C) 22.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 61
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
ANGLE OF ATTACK (DEGREES)
ANGLE OF SIDESLIP (DEGREES)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
NU
ND
RT
LT
NR
NL
AFT
FWD
TIME - SECONDS

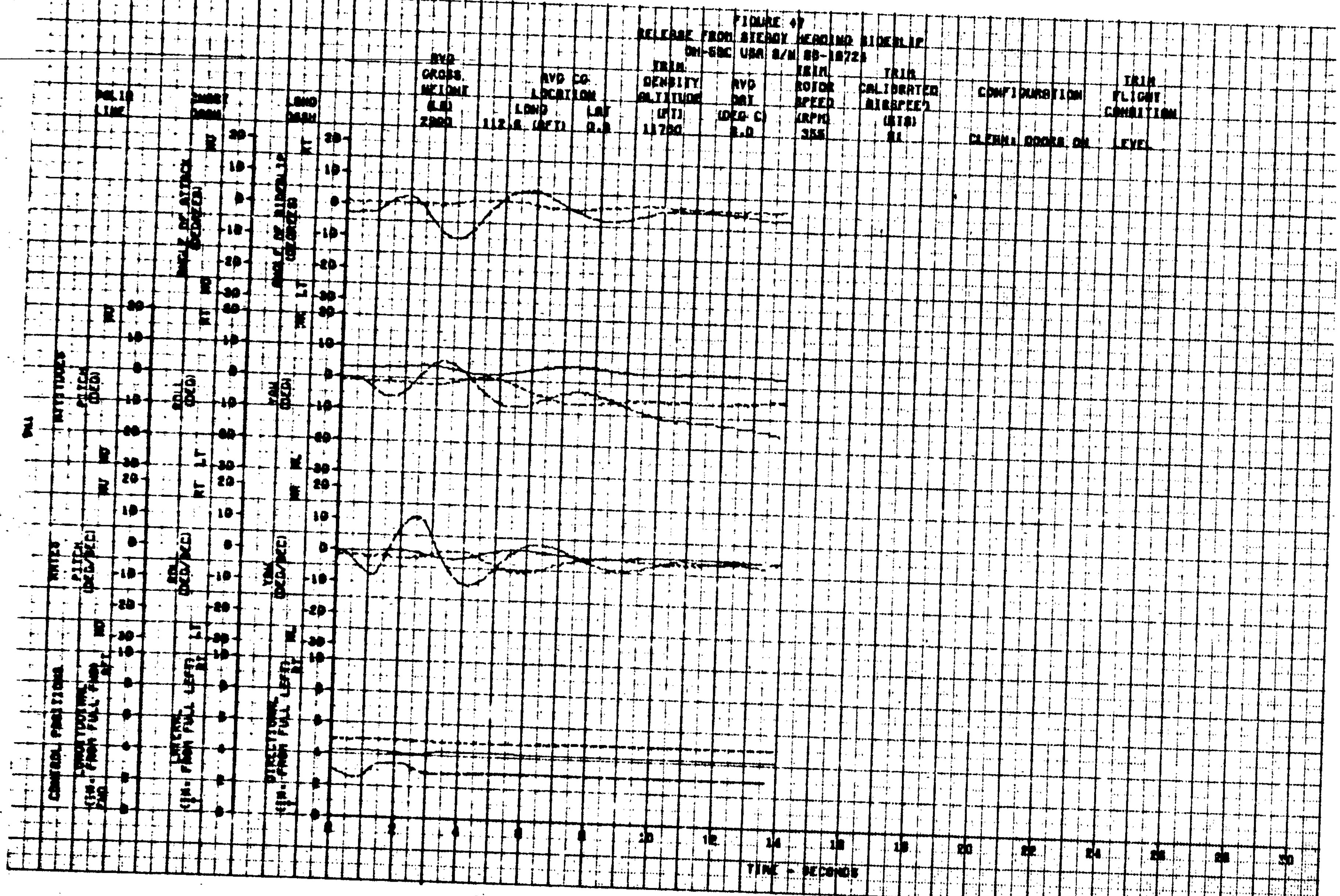


FIGURE 47
RELEASE FROM STEADY HEADING SIDESLIP
OH-58C USA S/N 68-16728
AVG GROSS WEIGHT (LB) 2900
AVG CG LOCATION LONG 112.6 (AFT) LAT 0.3
TRIM DENSITY ALTITUDE (FT) 11700
AVG OAT (DEG C) 3.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 81
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
POLID LINE
SHORT DASH
LONG DASH
ANGLE OF ATTACK (DEGREES)
ANGLE OF SIDESLIP (DEGREES)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

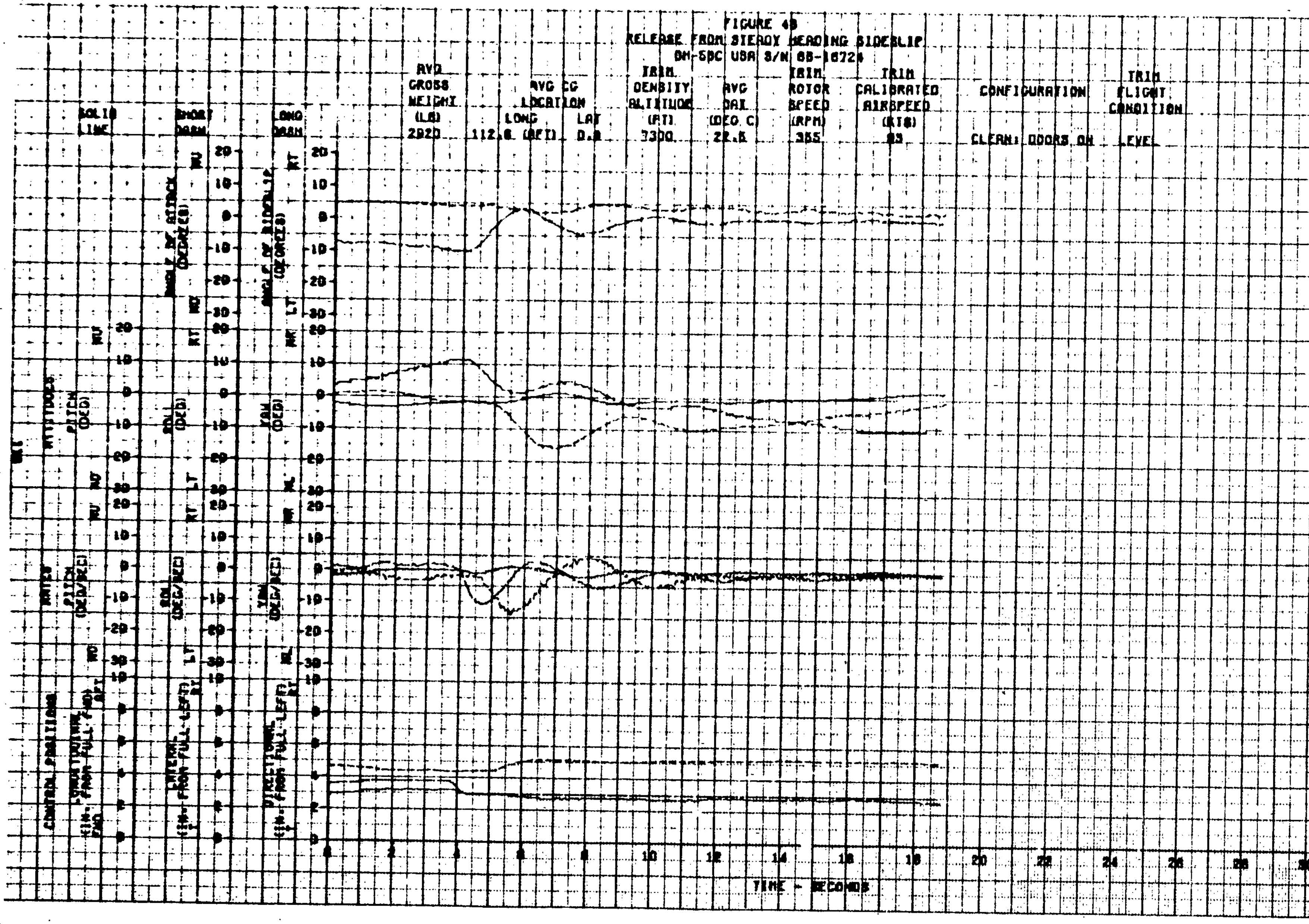
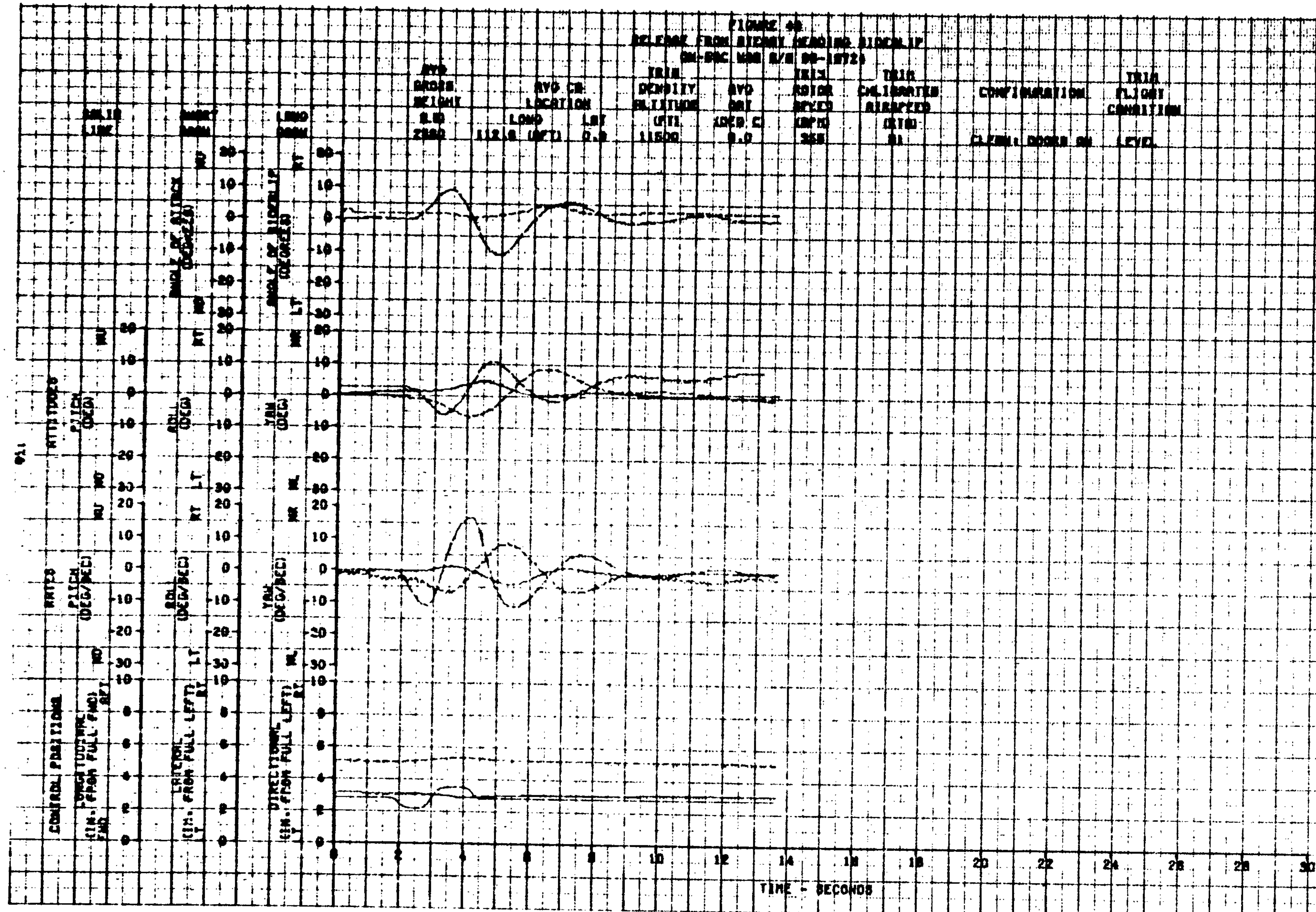


FIGURE 48
RELEASE FROM STEADY HEADING SIDESLIP
OH-58C USA S/N 68-16724



RELEASE FROM STEADY HEADING SIDESLIP
AVG GROSS WEIGHT (LB) 2880
AVG CG LOCATION LONG 112.8 (AFT) LAT 0.3
TRIM DENSITY ALTITUDE (FT) 11500
AVG OAT (DEG C) 8.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 81
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
ANGLE OF ATTACK (DEGREES)
ANGLE OF SIDESLIP (DEGREES)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

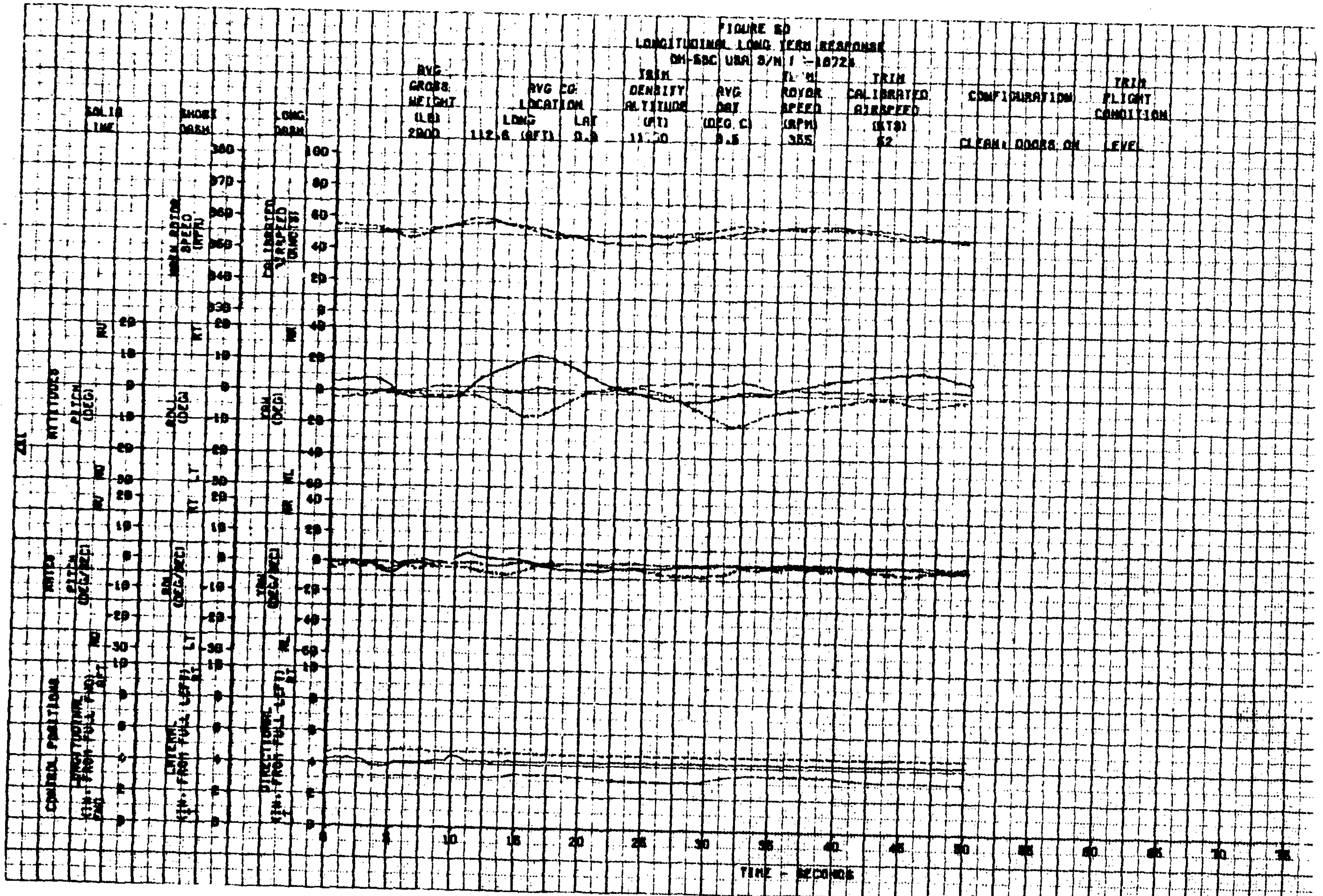


FIGURE 80
LONGITUDINAL LONG TERM RESPONSE
AVG GROSS WEIGHT (LB) 2900
AVG CG LOCATION LONG 112.6 (AFT) LAT 0.0
TRIM DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 52
CONFIGURATION CLEAN, DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

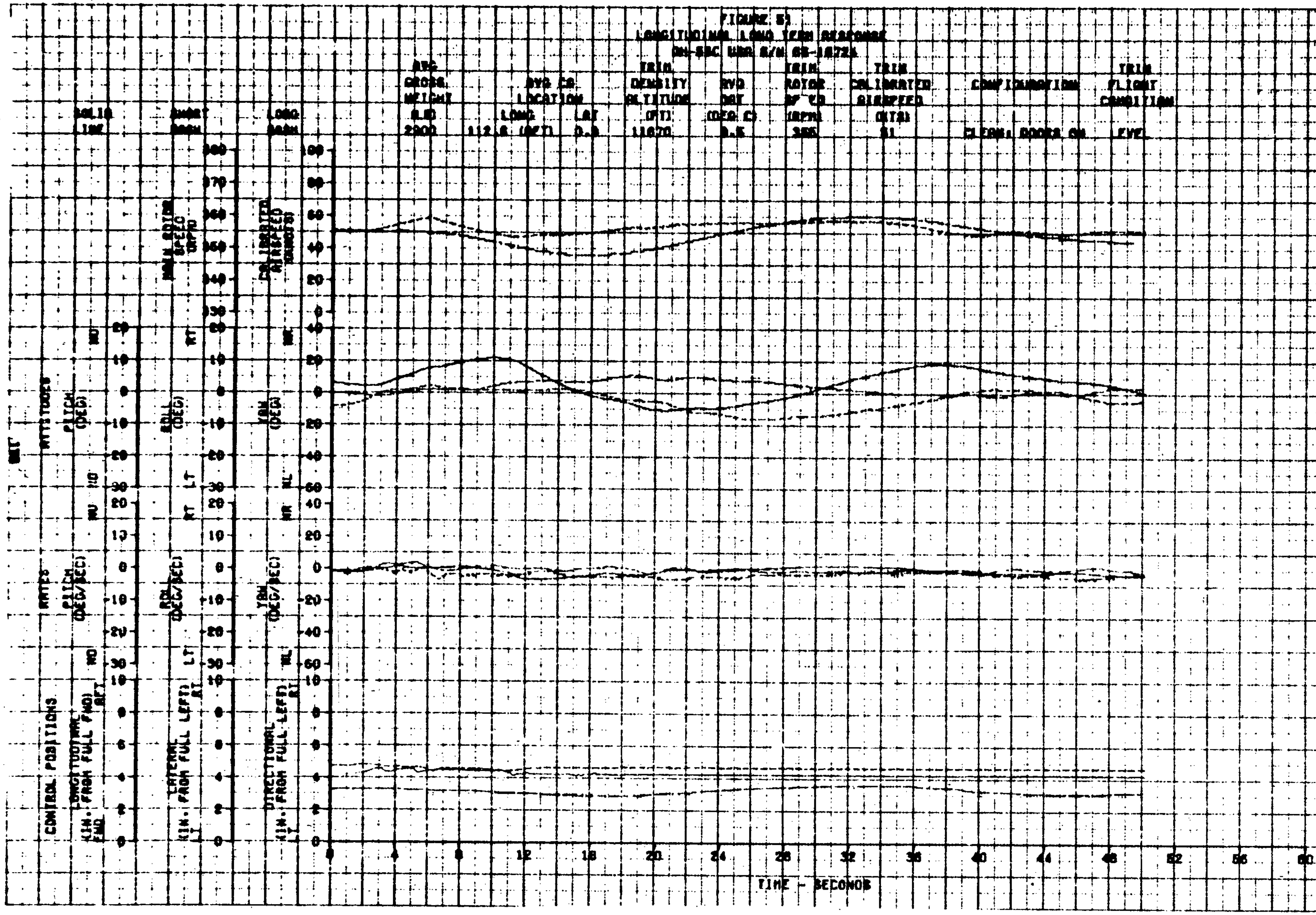
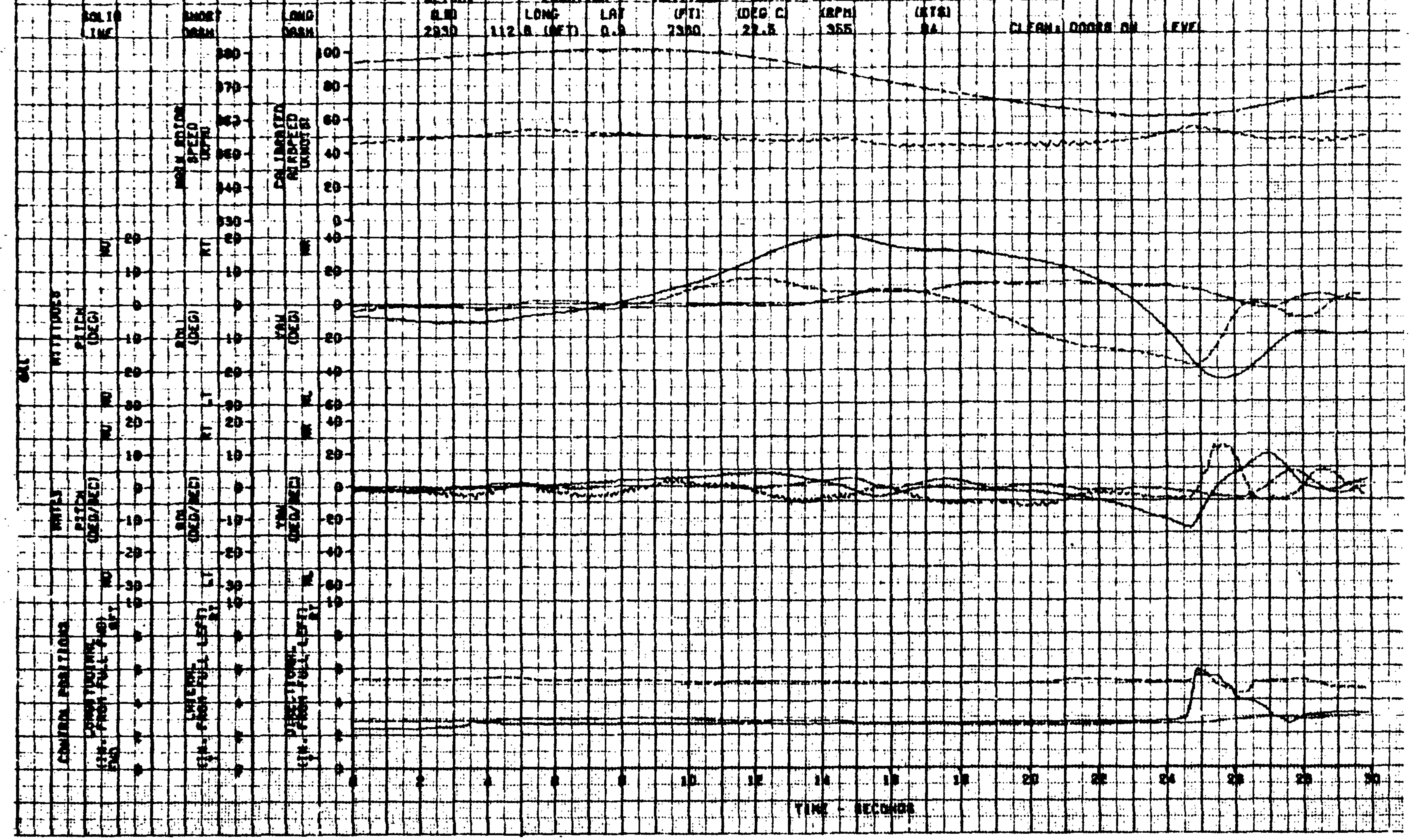

AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG
LAT
TRIM DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
TRIM ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KTS)
CONFIGURATION
CLEAN, DOORS ON
TRIM FLIGHT CONDITION
LEVEL
SOLID LINE
SHORT DASH
LONG DASH
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 82
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG	AVG CG LOCATION LAT	TRIM DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	CONFIGURATION	TRIM FLIGHT CONDITION
2930	112.8 (AFT)	0.3	2300	22.5	355	84	CLEAN; DOORS ON	LEVEL



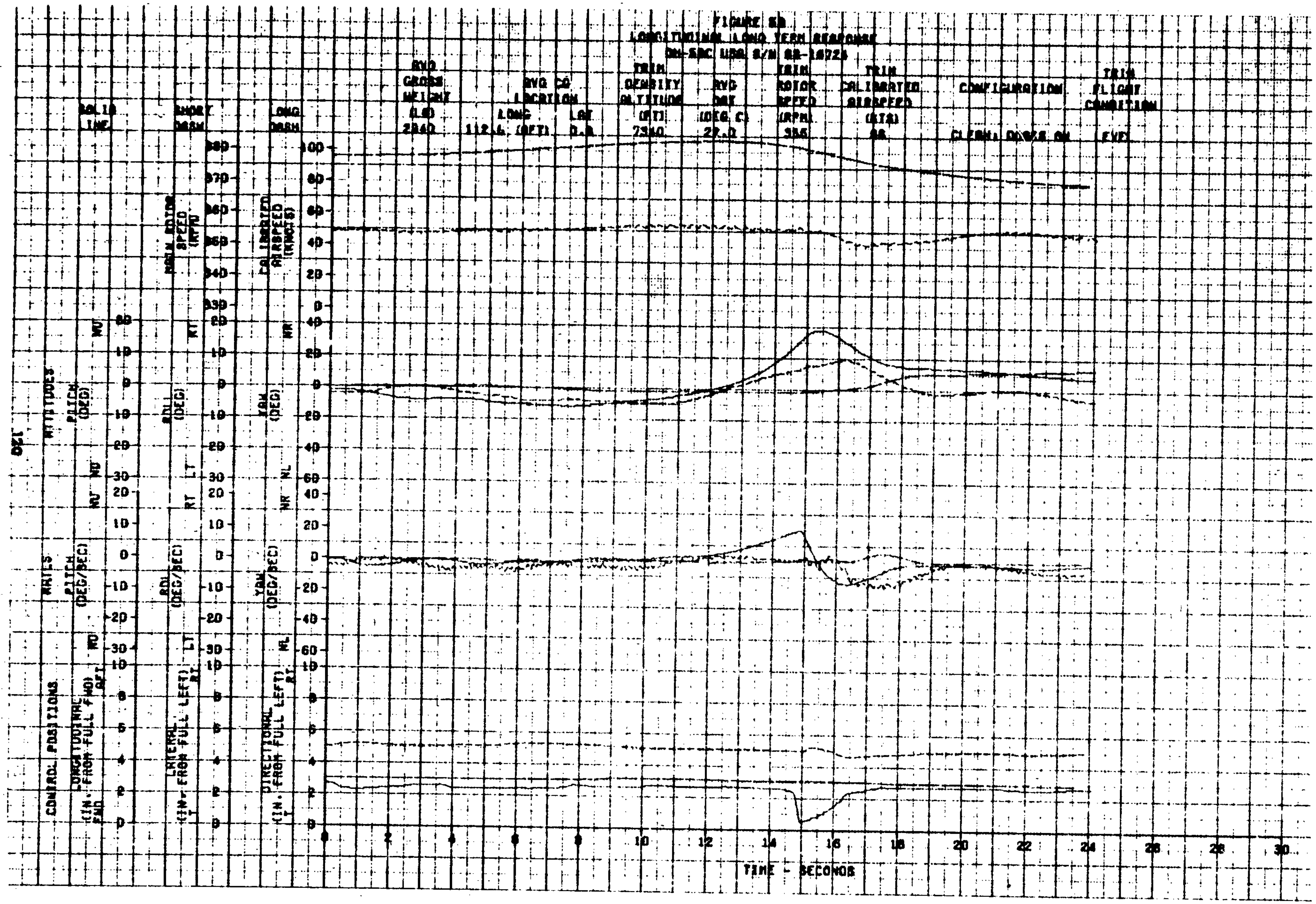


FIGURE 58
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16726
AVG GROSS WEIGHT (LB) 2840
AVG CG LOCATION LONG 112.6 (AFT) LAT 0.0
TRIM DENSITY ALTITUDE (FT) 7340
AVG OAT (DEG C) 27.0
TRIM ROTOR SPEED (RPM) 356
TRIM CALIBRATED AIRSPEED (KTS)
CONFIGURATION
TRIM FLIGHT CONDITION
SOLID LINE
SHORT DASH
LONG DASH
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

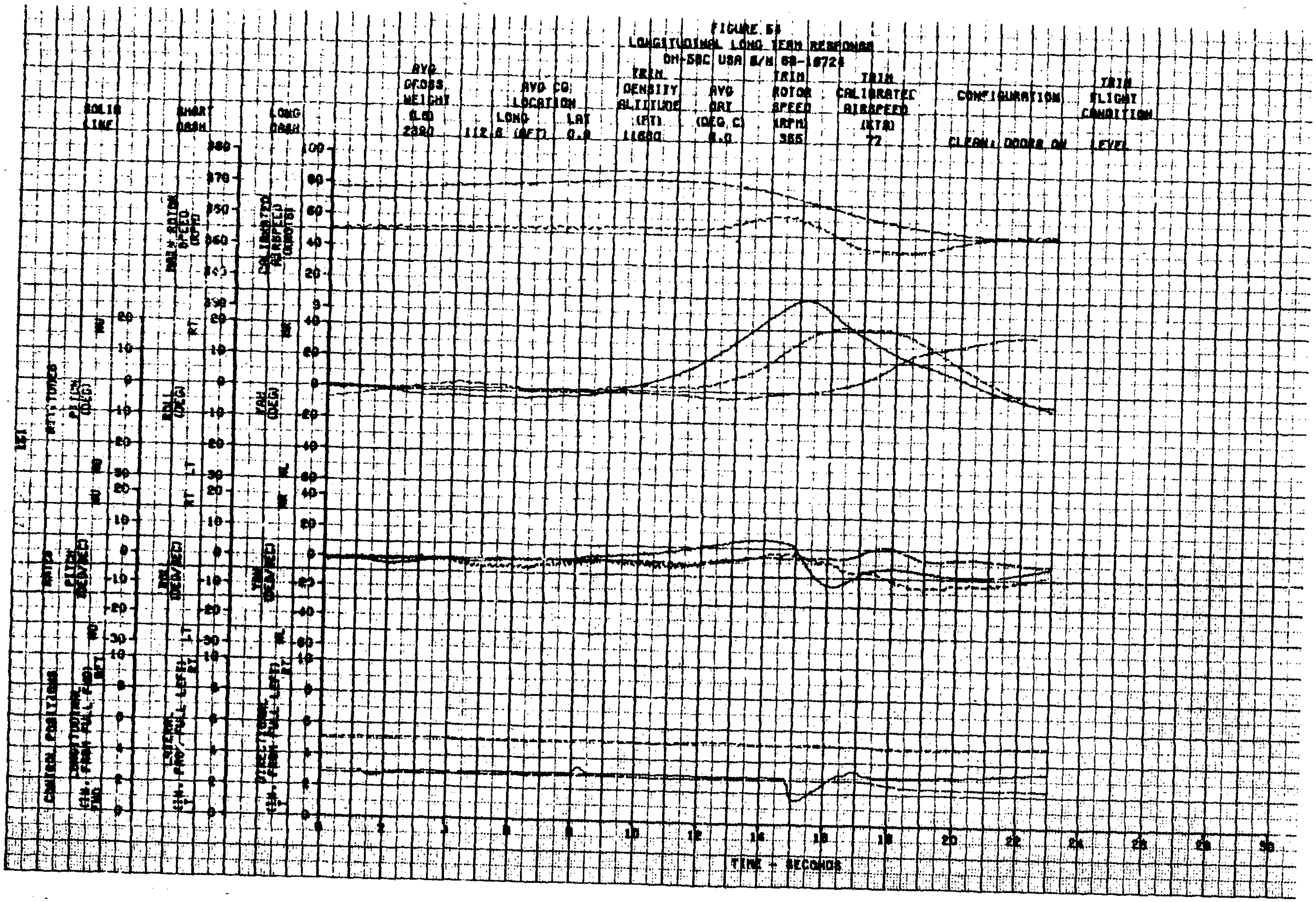


FIGURE 58
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 2380
AVG CG LOCATION LONG 112.6 (AFT) LAT 0.0
TRIM DENSITY ALTITUDE (FT) 11680
AVG OAT (DEG C) 8.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 72
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

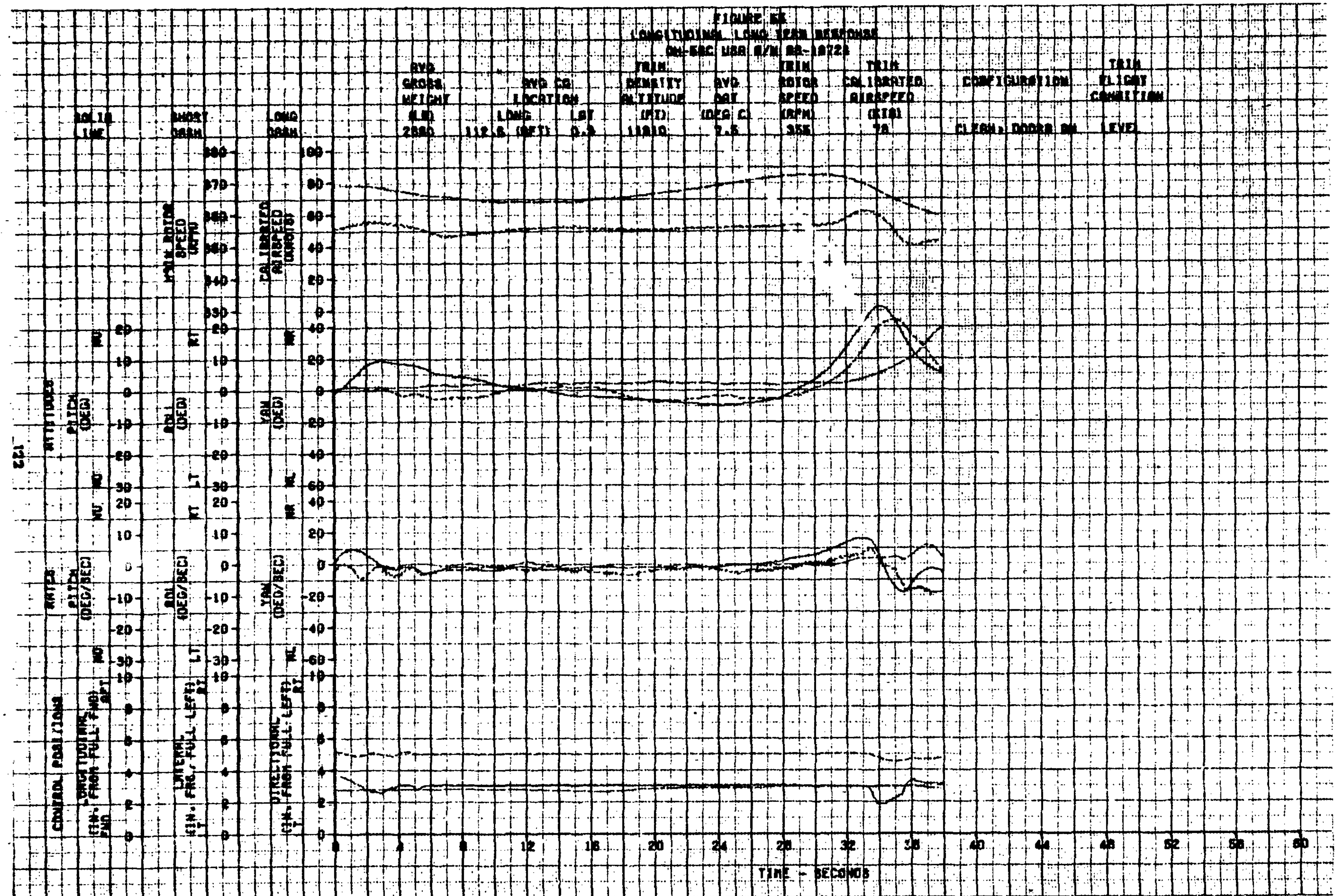
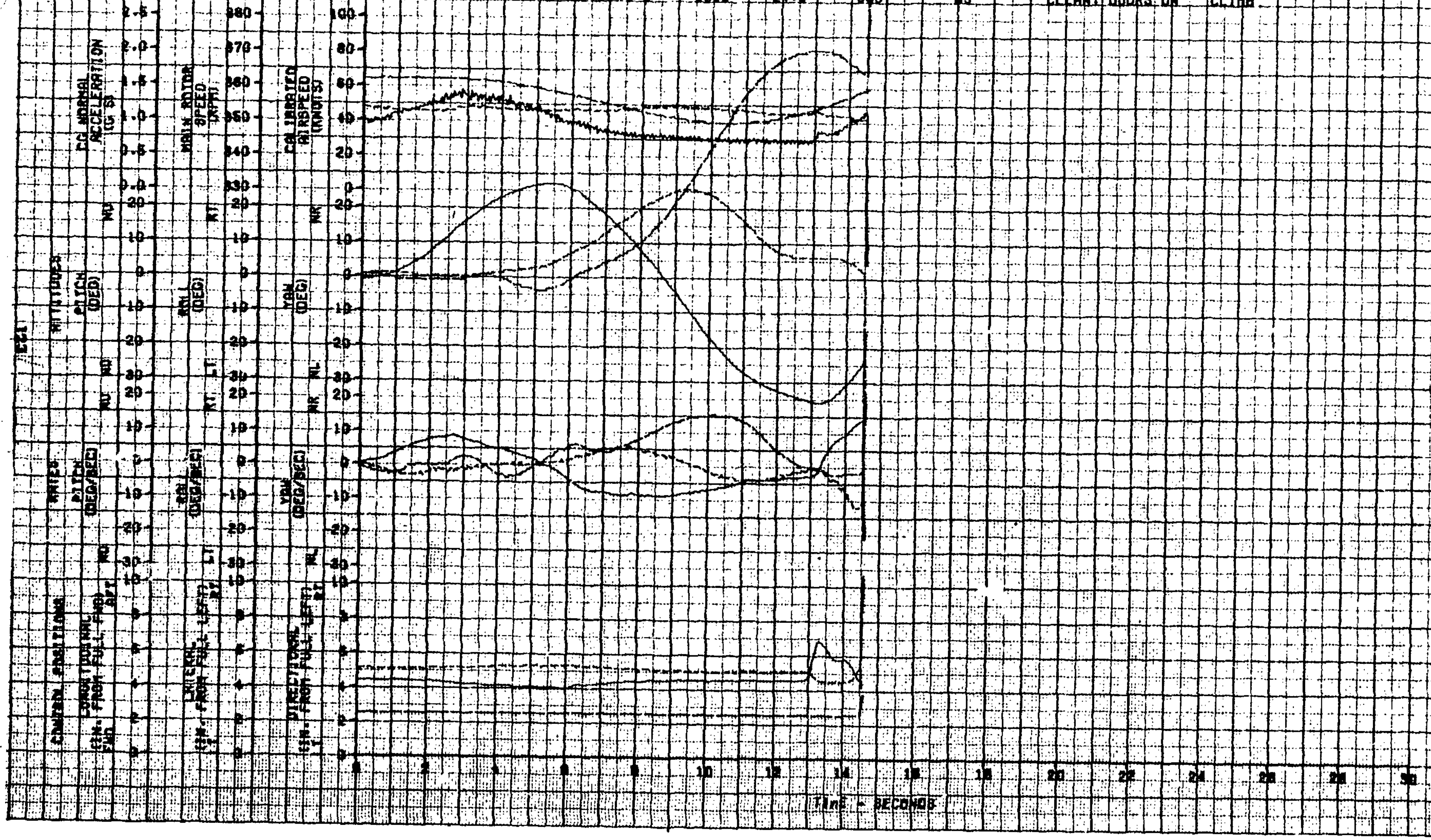


FIGURE 55
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16723
AVG GROSS WEIGHT (LB) 2880
AVG CG LOCATION LONG 112.6 (AFT) LAT 0.3
TRIM DENSITY ALTITUDE (FT) 11810
AVG OAT (DEG C) 7.5
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KIAS) 78
CONFIGURATION CLEAN, DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FRO. FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 58
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG	AVG CG LOCATION LAT	TRIM DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	CONFIGURATION	TRIM FLIGHT CONDITION
2820	111.9 (AFT)	0.5	6000	21.5	353	63	CLEAN; DOORS ON	CLIMB



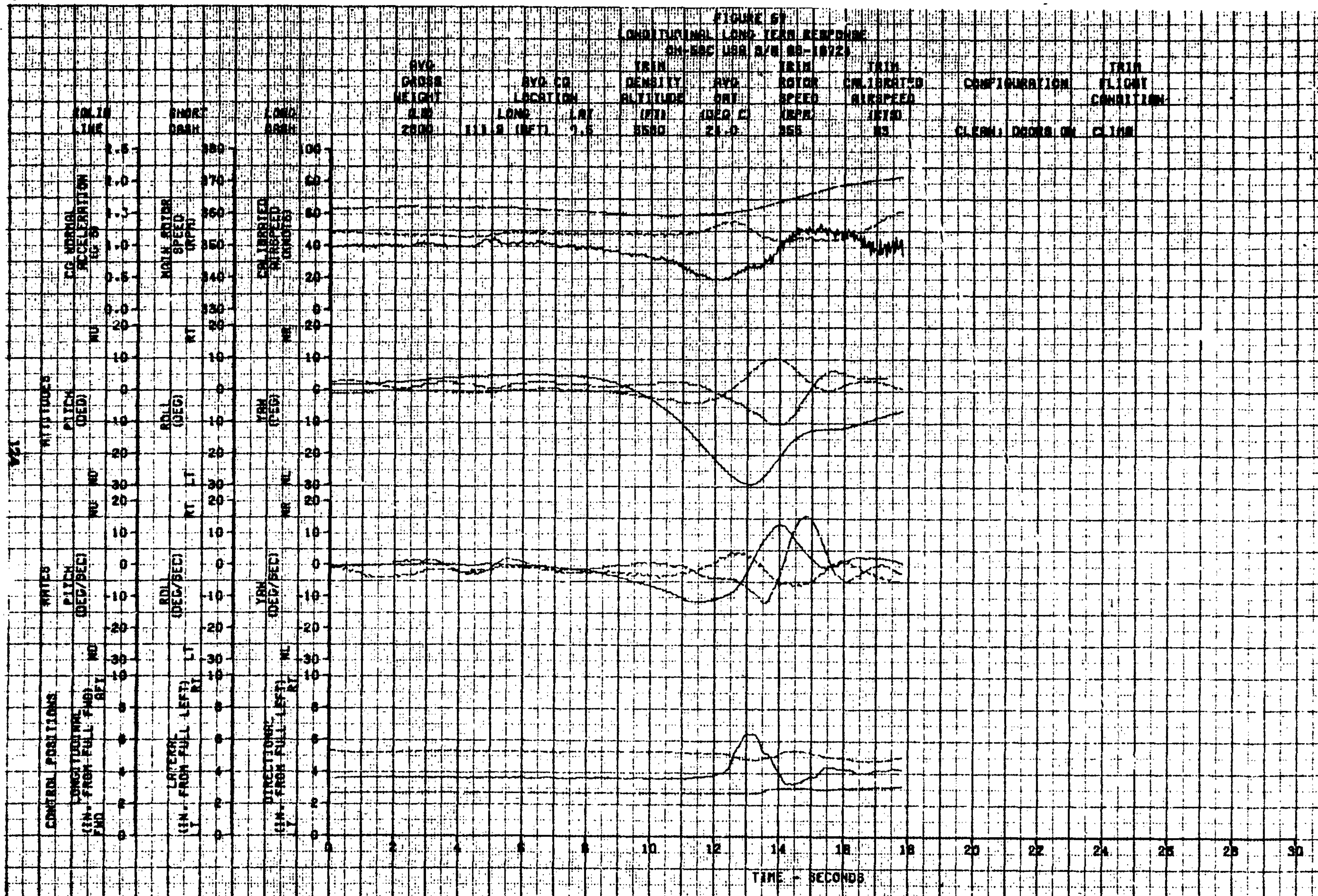


FIGURE 57
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16723
AVG GROSS WEIGHT (LB) 2800
AVG CG LOCATION LONG 111.9 (AFT) LAT 0.5
TRIM DENSITY ALTITUDE (FT) 5580
AVG OAT (DEG C) 21.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 83
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION CLIMB
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
NU
ND
RT
LT
NR
NL
AFT
FWD
TIME - SECONDS

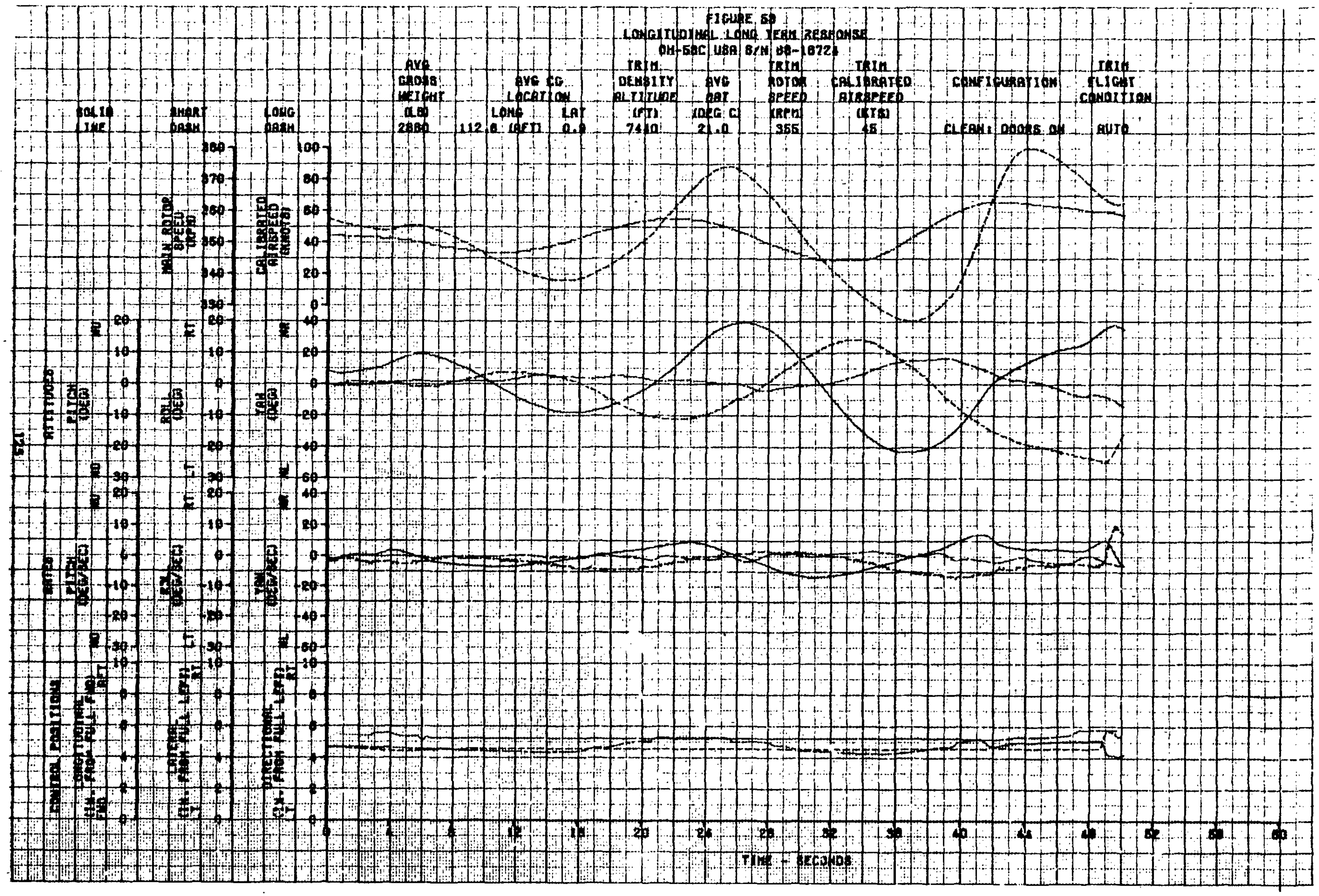
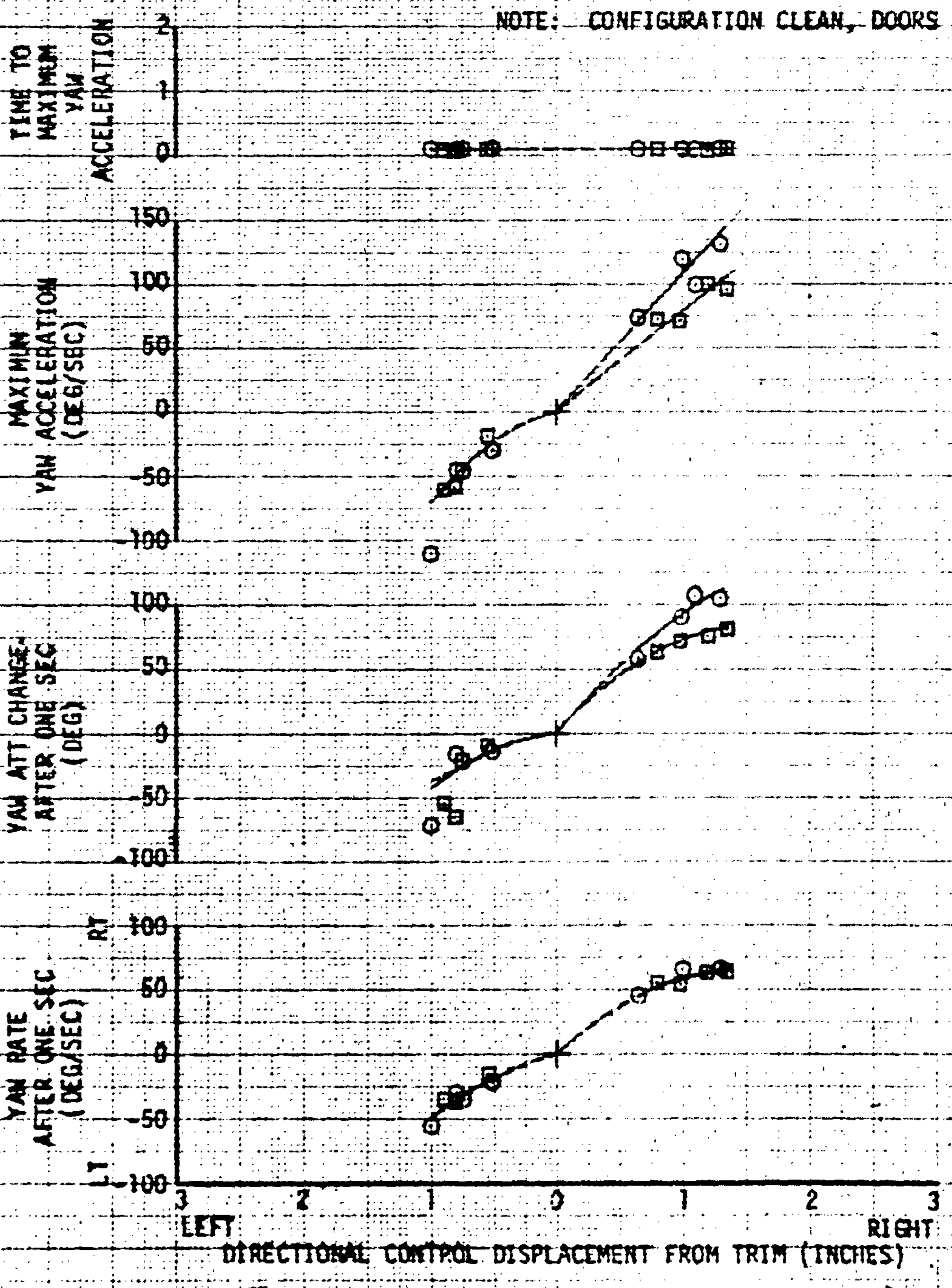


FIGURE 58
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 2880
AVG CG LOCATION LONG 112.8 (AFT) LAT 0.0
TRIM DENSITY ALTITUDE (FT) 7440
AVG OAT (DEG C) 21.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 45
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION AUTO
SOLID LINE
SHORT DASH
LONG DASH
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 59
HOVER CONTROLLABILITY
OH-58C USA S/N 16-724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
○	3200	111.2(AFT)	0.6	9640	-3.5	355	10
□	3200	111.3(AFT)	0.6	4360	11.0	355	10

NOTE: CONFIGURATION CLEAN, DOORS ON



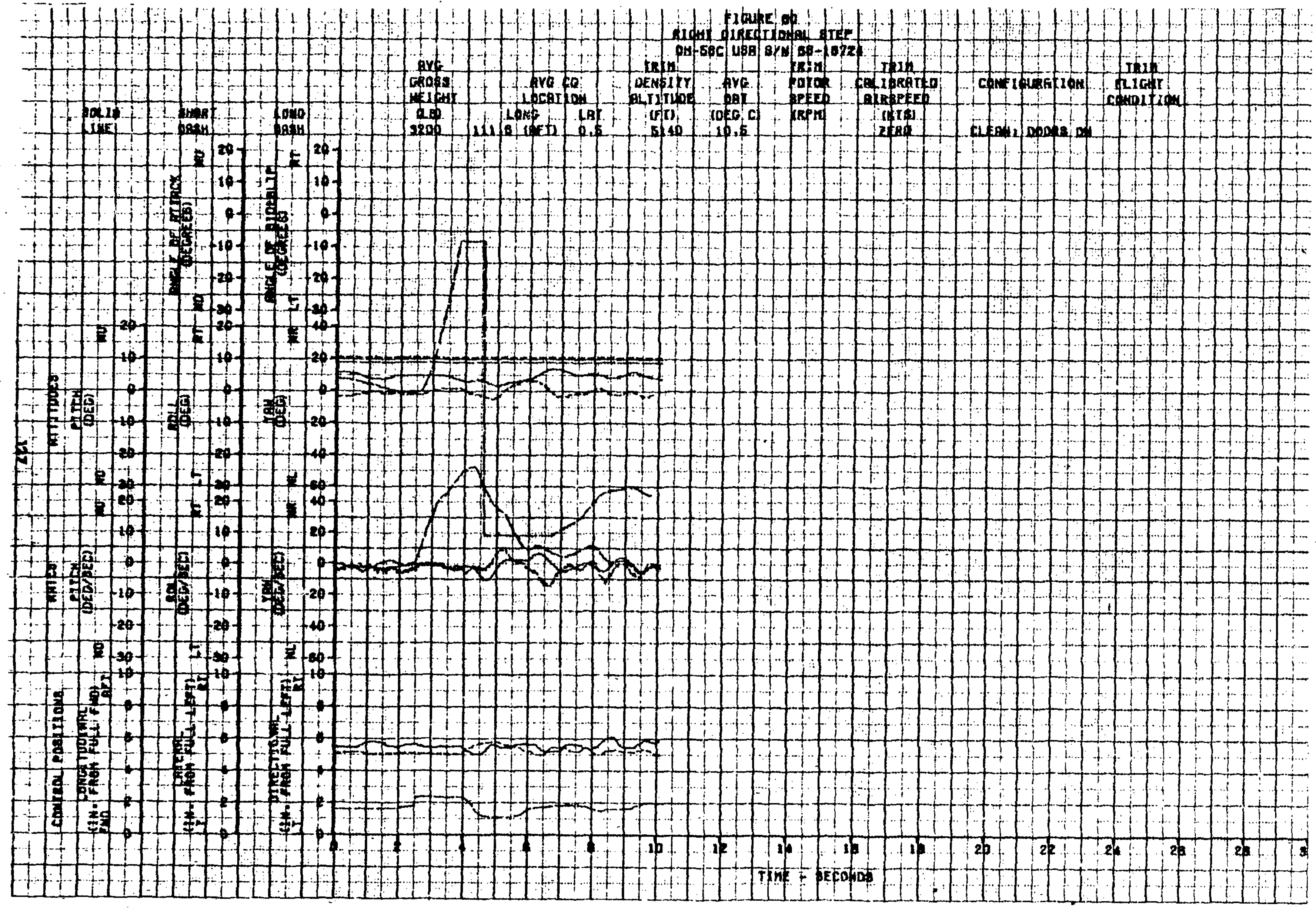


FIGURE 80
RIGHT DIRECTIONAL STEP
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 3200
AVG CG LOCATION LONG 111.8 (AFT) LAT 0.5
TRIM DENSITY ALTITUDE (FT) 5140
AVG OAT (DEG C) 10.5
TRIM ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KTS) ZERO
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION
SOLID LINE
SHORT DASH
LONG DASH
ANGLE OF ATTACK (DEGREES)
ANGLE OF SIDESLIP (DEGREES)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 61
LONGITUDINAL CONTROLLABILITY IN LEVEL FLIGHT
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG CALIB AIRSPEED (KTS)	AIRCRAFT CONFIGURATION
[illegible]	112.7(AFT)	0.7	6180	19.5	355	91	CLEAN, DOORS ON

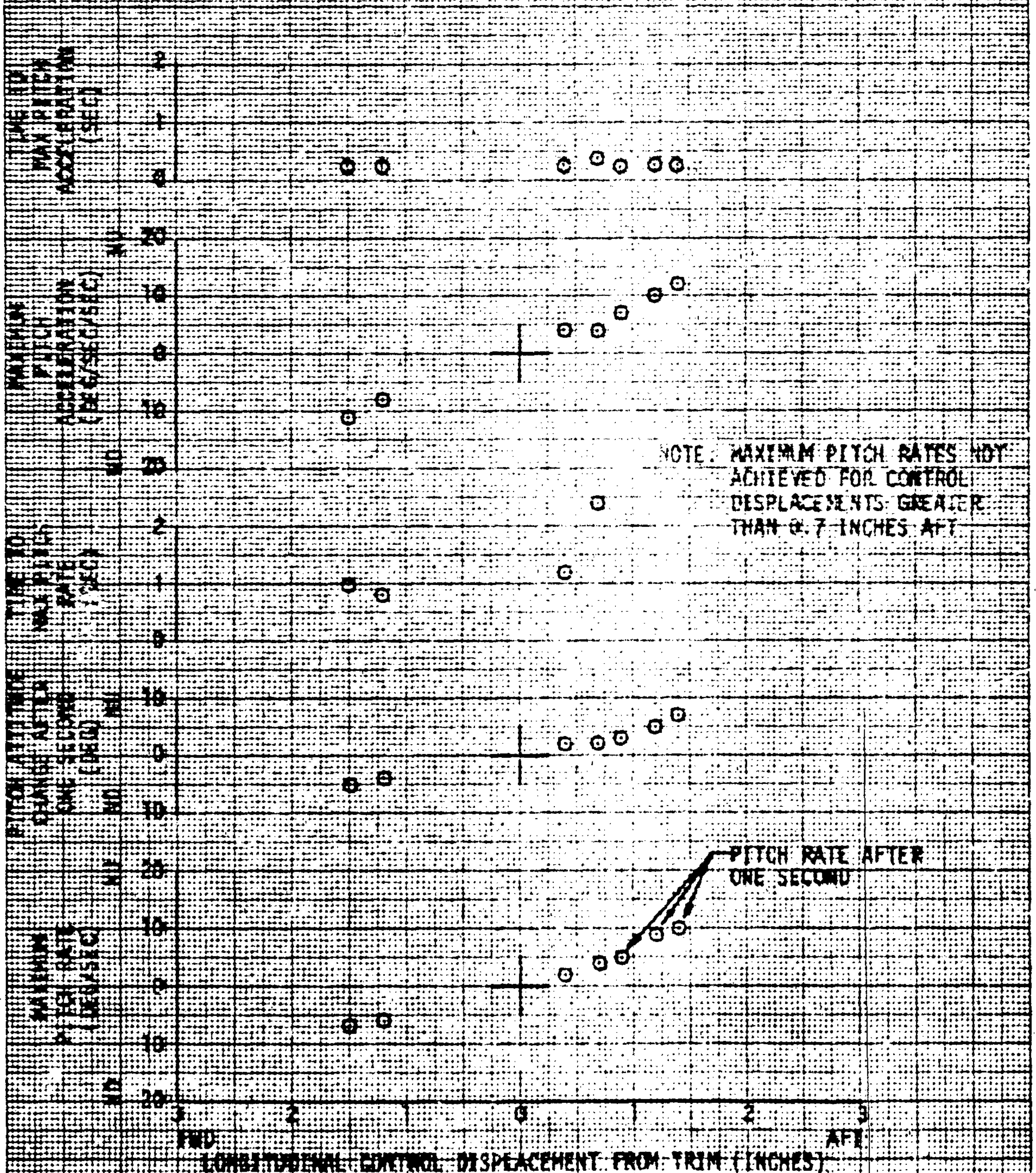
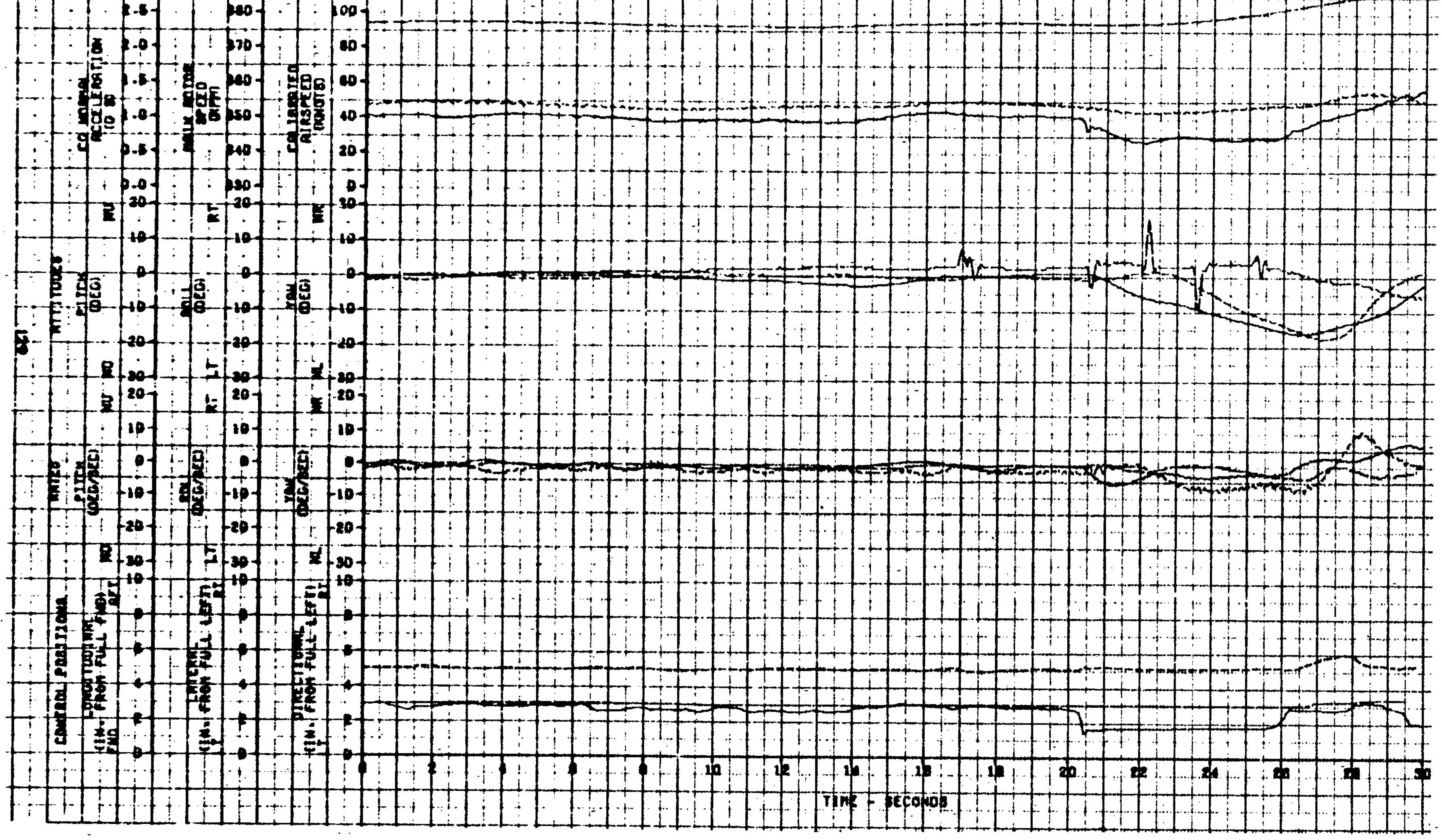


FIGURE 62
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG	AVG CG LOCATION LAT	TRIM DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	CONFIGURATION	TRIM FLIGHT CONDITION
2940	112.8 (AFT)		5880	19.0	355	81	CLEAN; DOORS ON	LEVEL



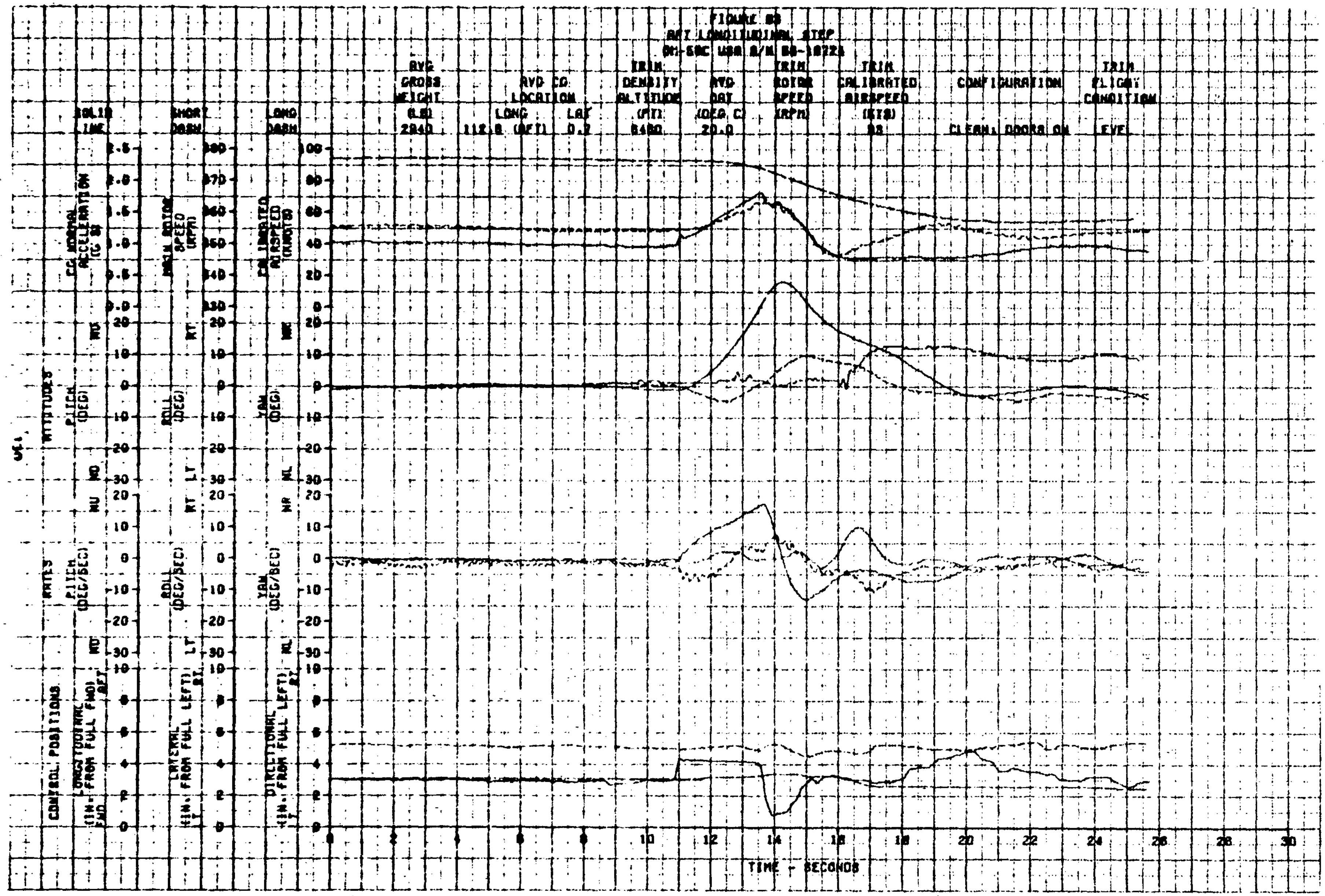
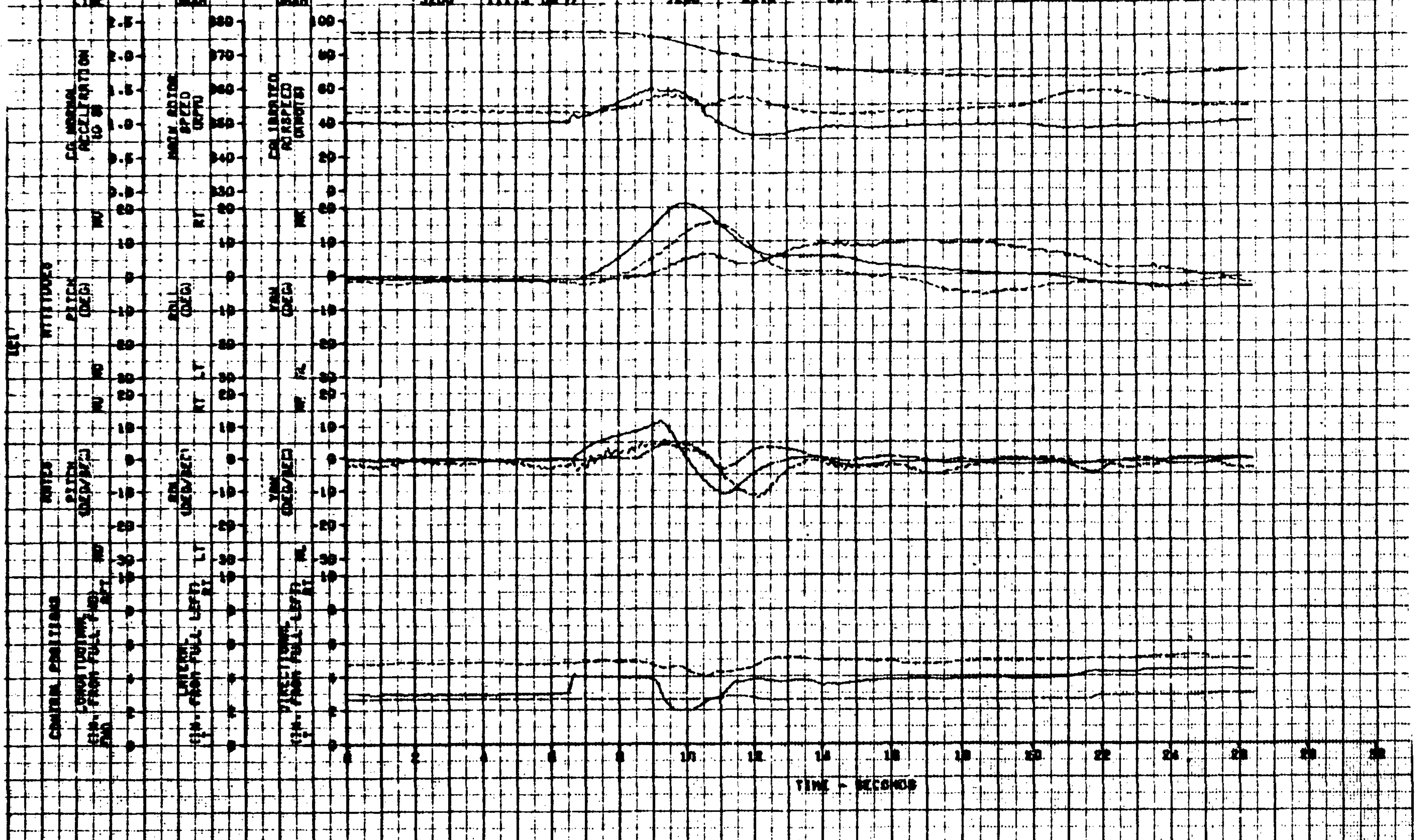
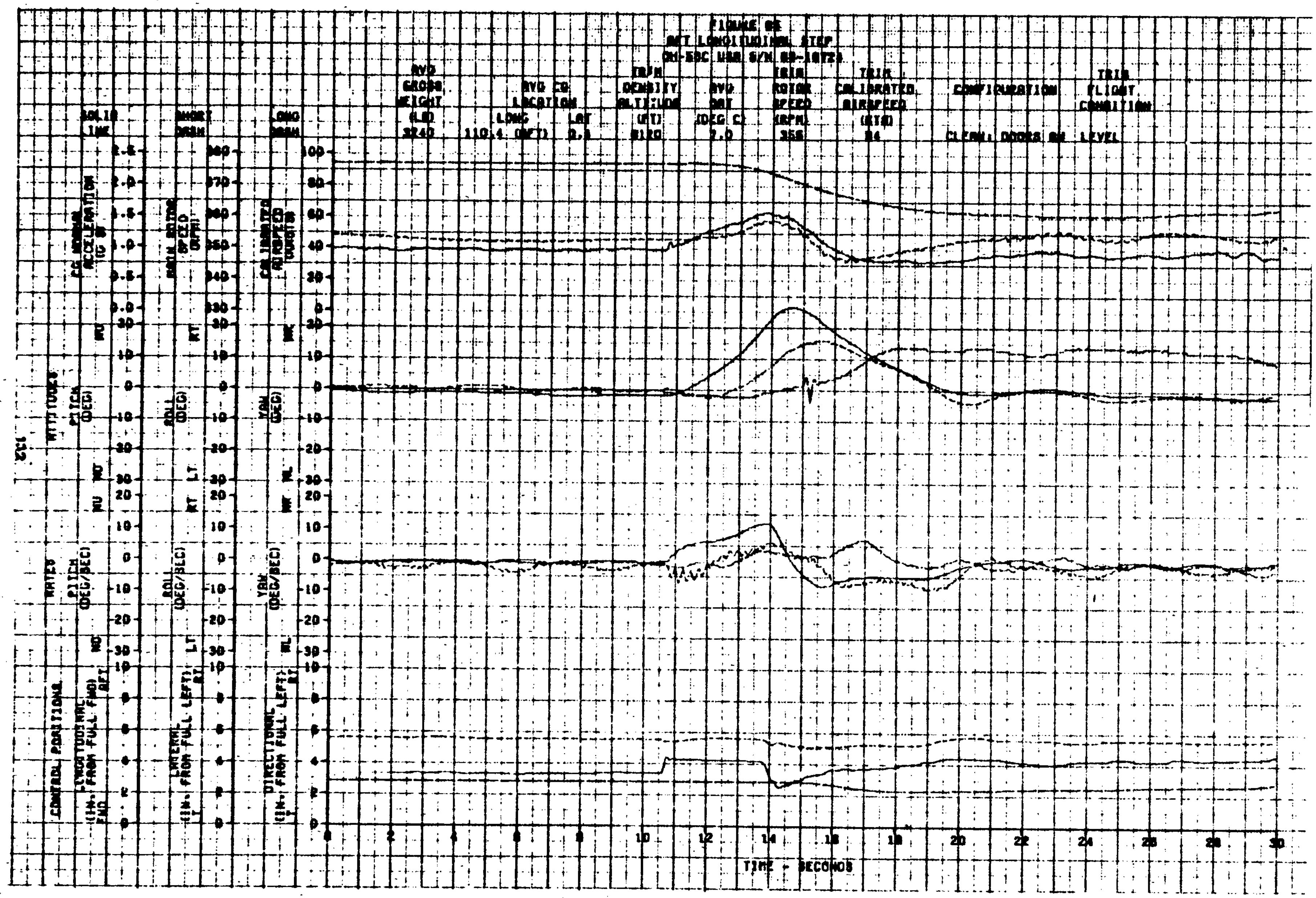

AFT LONGITUDINAL STEP
AVG GROSS WEIGHT (LB) 2840
AVG CG LOCATION LONG 112.8 (AFT) LAT 0.2
TRIM DENSITY ALTITUDE (FT)
AVG OAT (DEG C) 20.0
TRIM ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KTS)
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 66
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16724





AFT LONGITUDINAL STEP
AVG GROSS WEIGHT (LB) 3240
AVG CG LOCATION LONG 110.4 (AFT) LAT
TRIM DENSITY ALTITUDE (FT)
AVG OAT (DEG C) 7.0
TRIM ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KTS)
CONFIGURATION
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

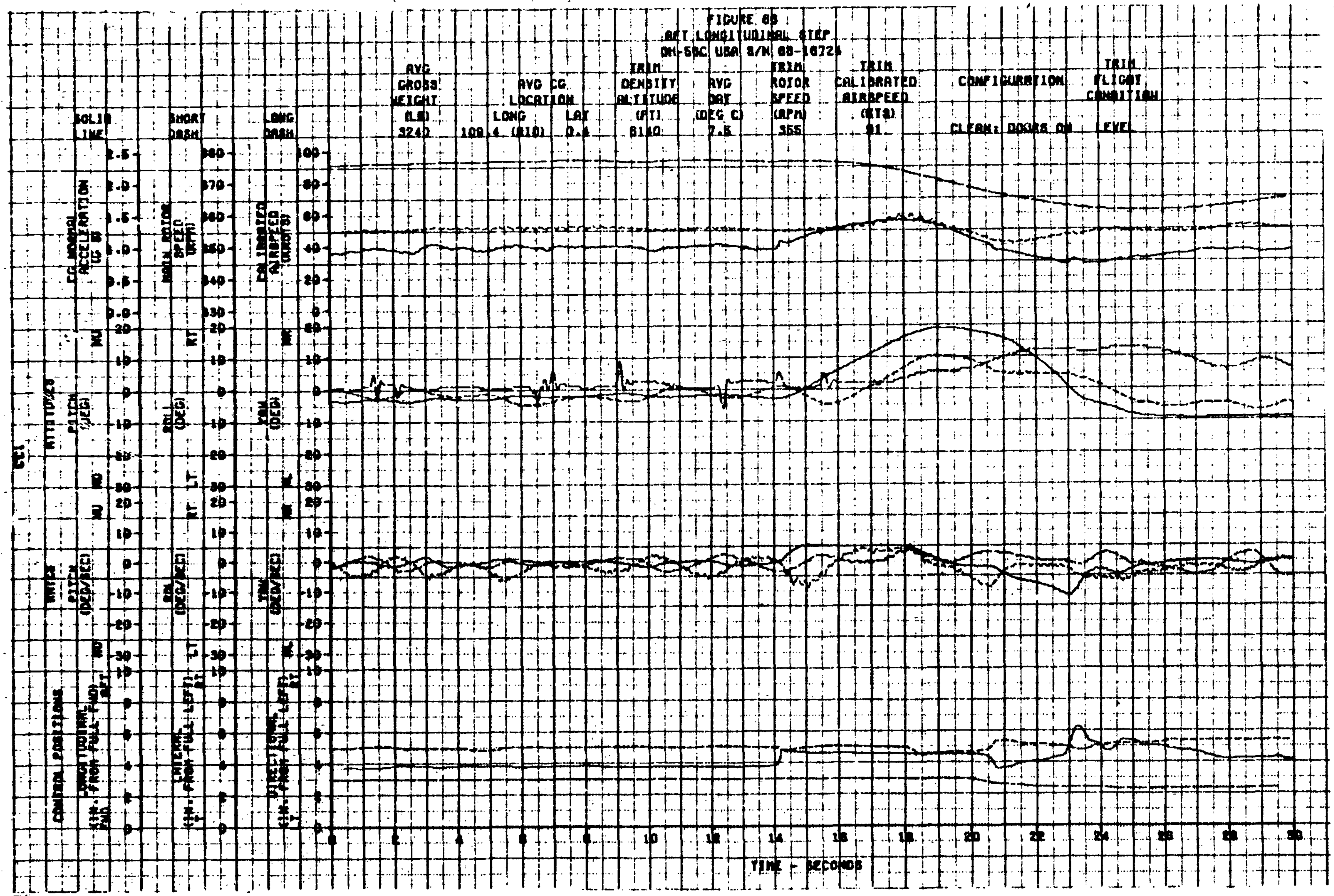
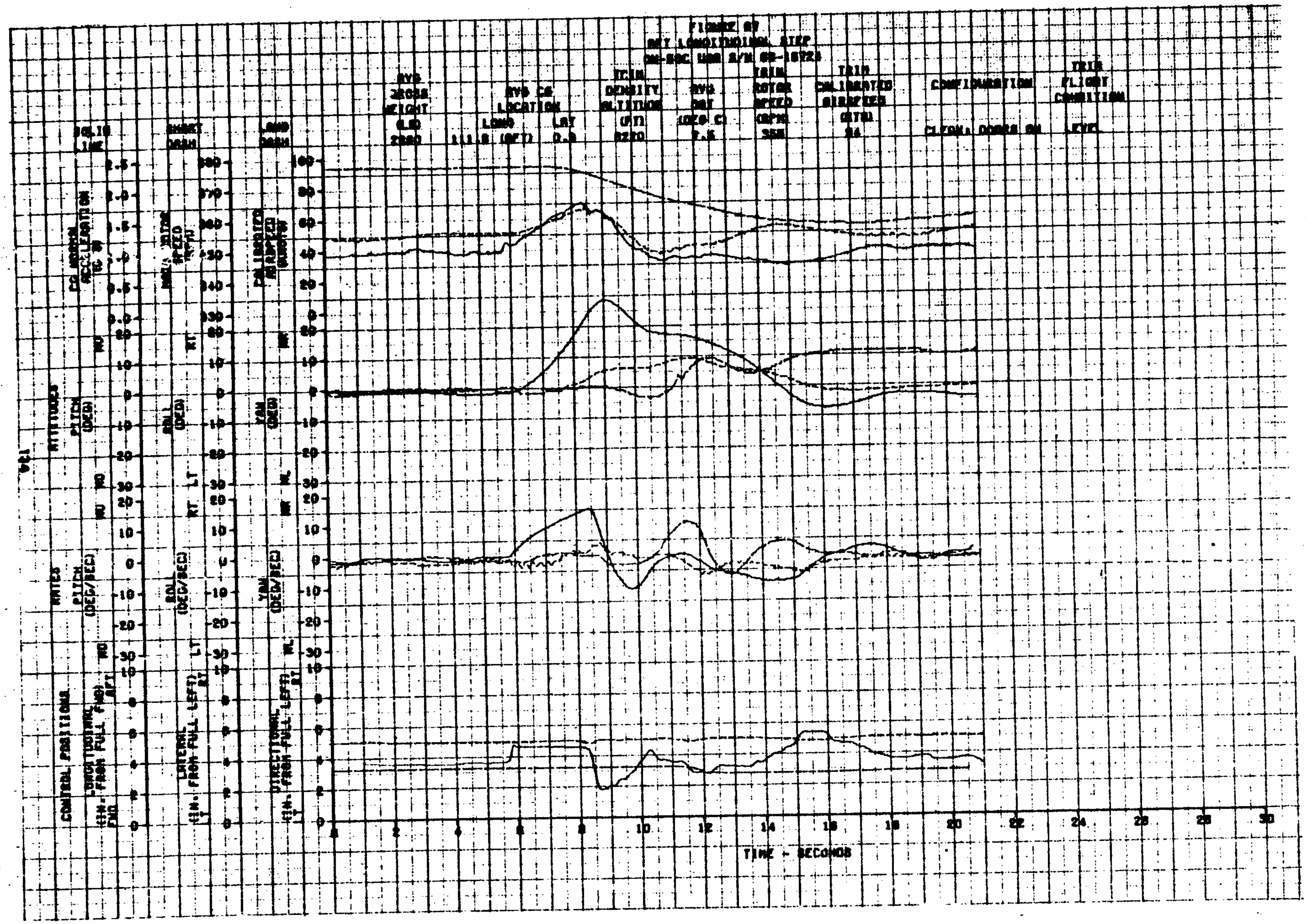


FIGURE 68
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 3240
AVG CG LOCATION LONG (FS) 109.4 (MID) LAT 0.4
TRIM DENSITY ALTITUDE (FT) 8140
AVG OAT (DEG C) 7.5
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 81
CONFIGURATION CLEAN: DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
NU ND RT LT NR NL AFT FWD
TIME - SECONDS

FIGURE 87
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16723



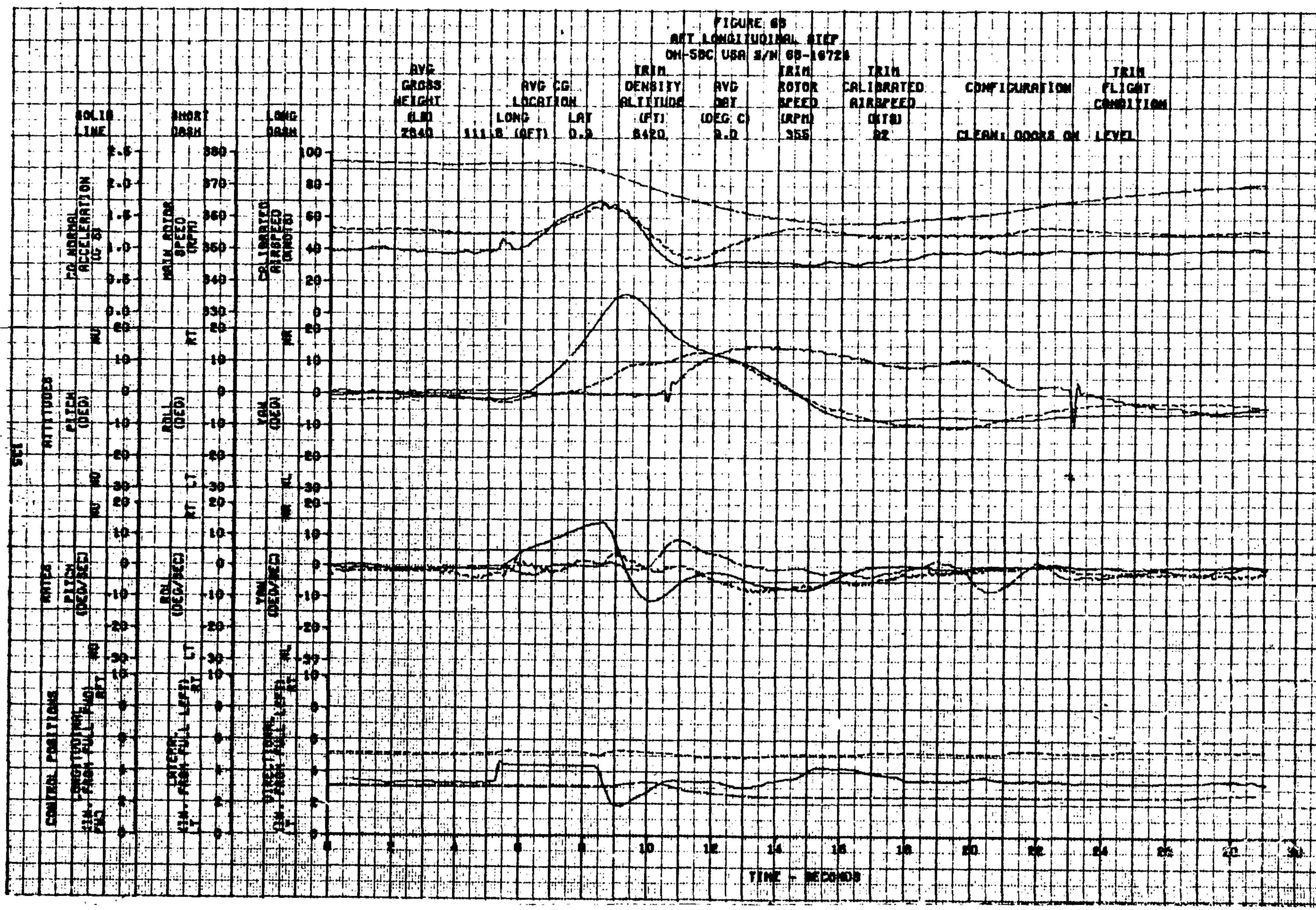
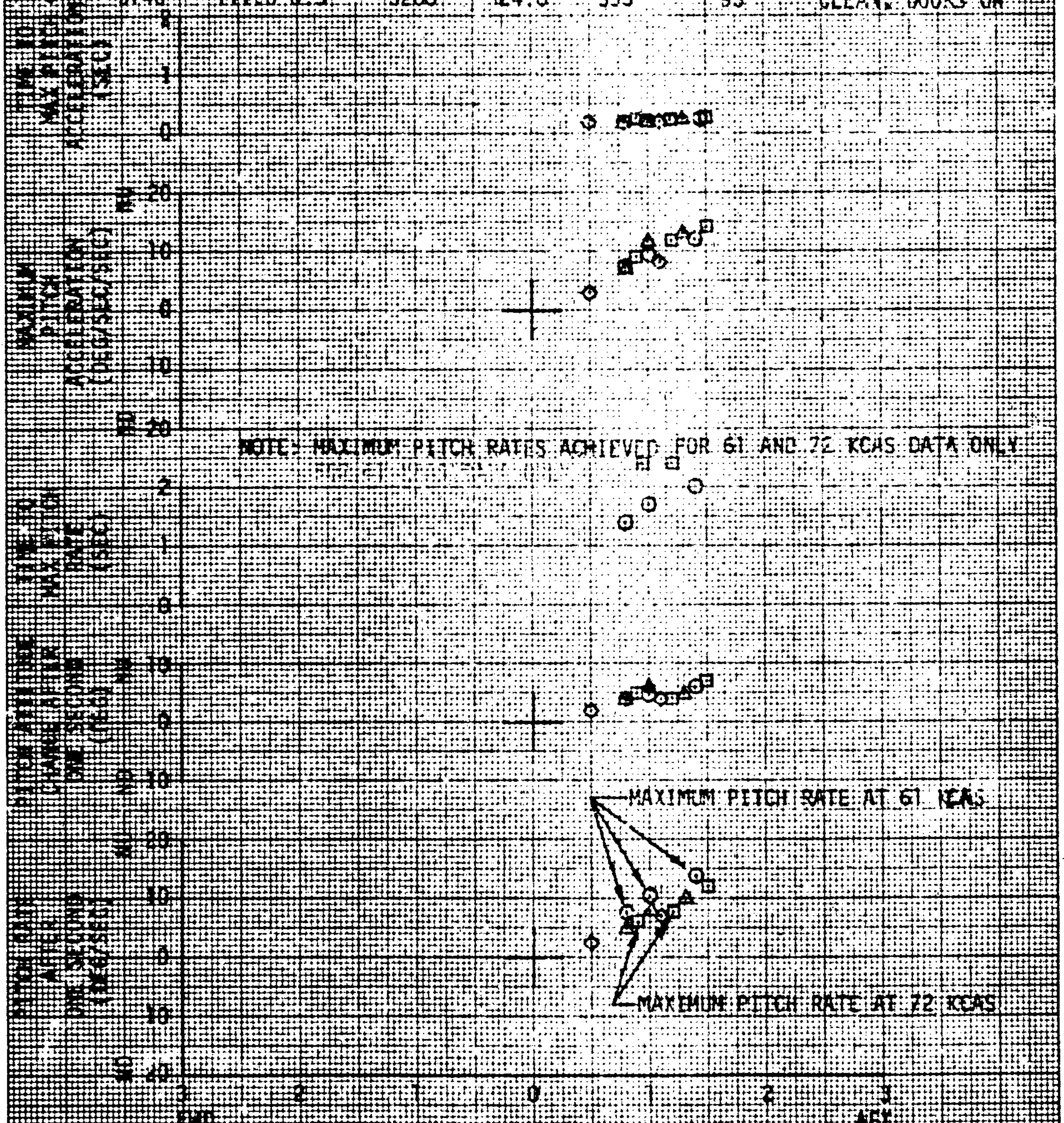


FIGURE 65
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16728
AVG GROSS WEIGHT (LB) 2840
AVG CG LOCATION LONG 111.8 (AFT) LAT 0.3
TRIM DENSITY ALTITUDE (FT) 6420
AVG OAT (DEG C) 9.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 82
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 89
LONGITUDINAL CONTROLLABILITY AT VARIOUS AIRSPEEDS
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG CALIB AIRSPEED (KTS)	AIRCRAFT CONFIGURATION
○	3220	111.4	0.5	5080	24.0	355	61	CLEAN, DOORS ON
□	3200	111.3	0.5	5120	21.0	355	72	CLEAN, DOORS ON
△	3180	111.2	0.5	5340	23.5	355	82	CLEAN, DOORS ON
◇	3140	111.0	0.5	5200	24.0	355	93	CLEAN, DOORS ON



LONGITUDINAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

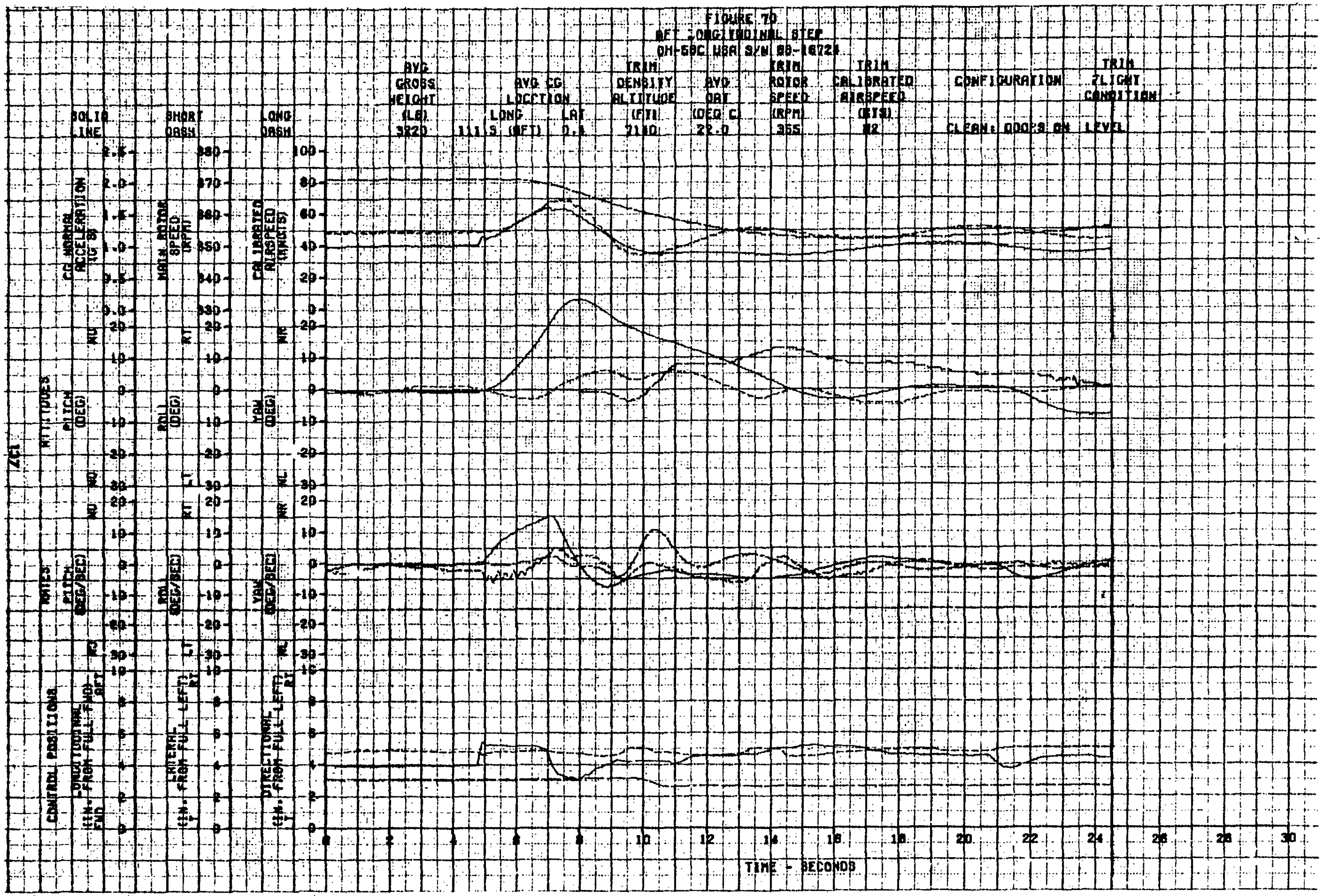


FIGURE 70
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 3320
AVG CG LOCATION LONG 111.5 (AFT) LAT 0.4
TRIM DENSITY ALTITUDE (FT) 2140
AVG OAT (DEG C) 22.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 42
CONFIGURATION CLEAN: DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

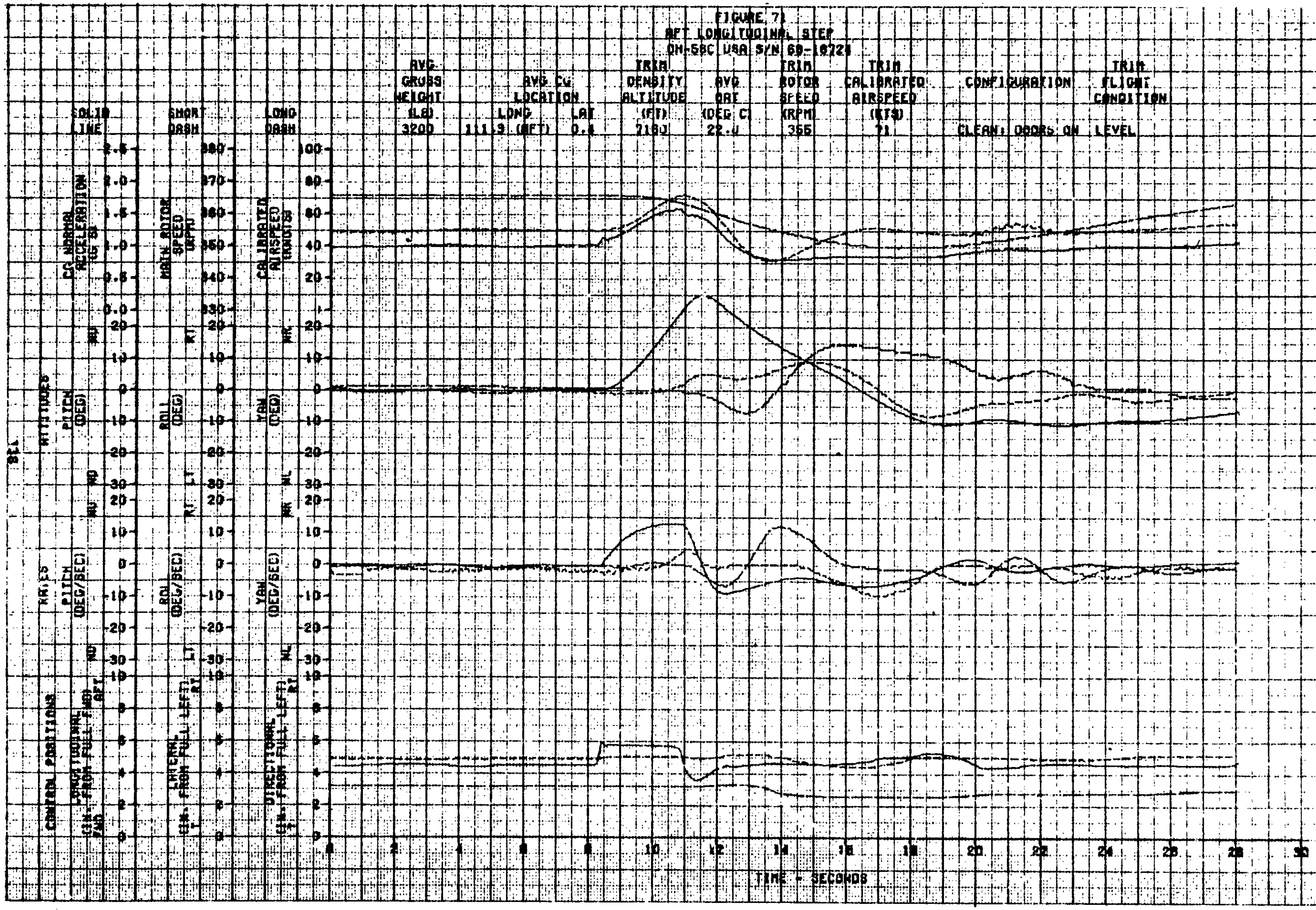


FIGURE 71
AFT LONGITUDINAL STEP
OH-58C USA S/N 68-16724
AVG. GROSS WEIGHT (LB) 3200
AVG CG LOCATION LONG 111.9 (AFT) LAT 0.4
TRIM DENSITY ALTITUDE (FT) 2180
AVG OAT (DEG C) 22.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 71
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
CG NORMAL ACCELERATION (G'S)
MAIN ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
YAW (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

FIGURE 72-A
LOW SPEED FLIGHT CHARACTERISTICS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16724
SKID HEIGHT = 10 FEET

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T
3180	107.0(FWD)	0.6	5400	18.0	355	0.003713

NOTE: CONFIGURATION: CLEAN, DOORS ON

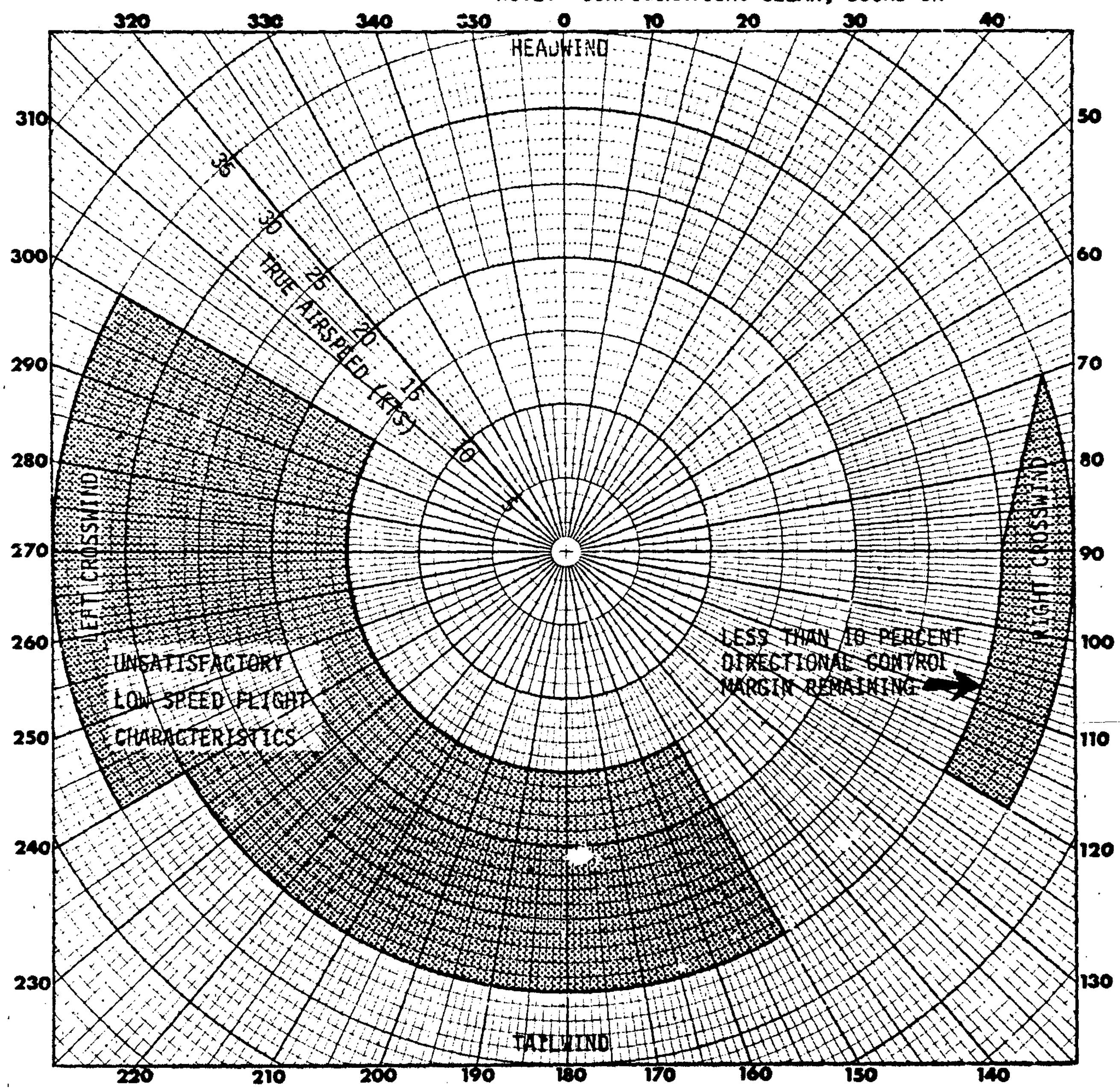


FIGURE 72-B
LOW SPEED FLIGHT CHARACTERISTICS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16724
SKID HEIGHT = 10 FEET

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T
3050	107.0(FWD)	0.2	11120	9.0	355	0.004254

NOTE: CONFIGURATION: CLEAN. DOORS ON

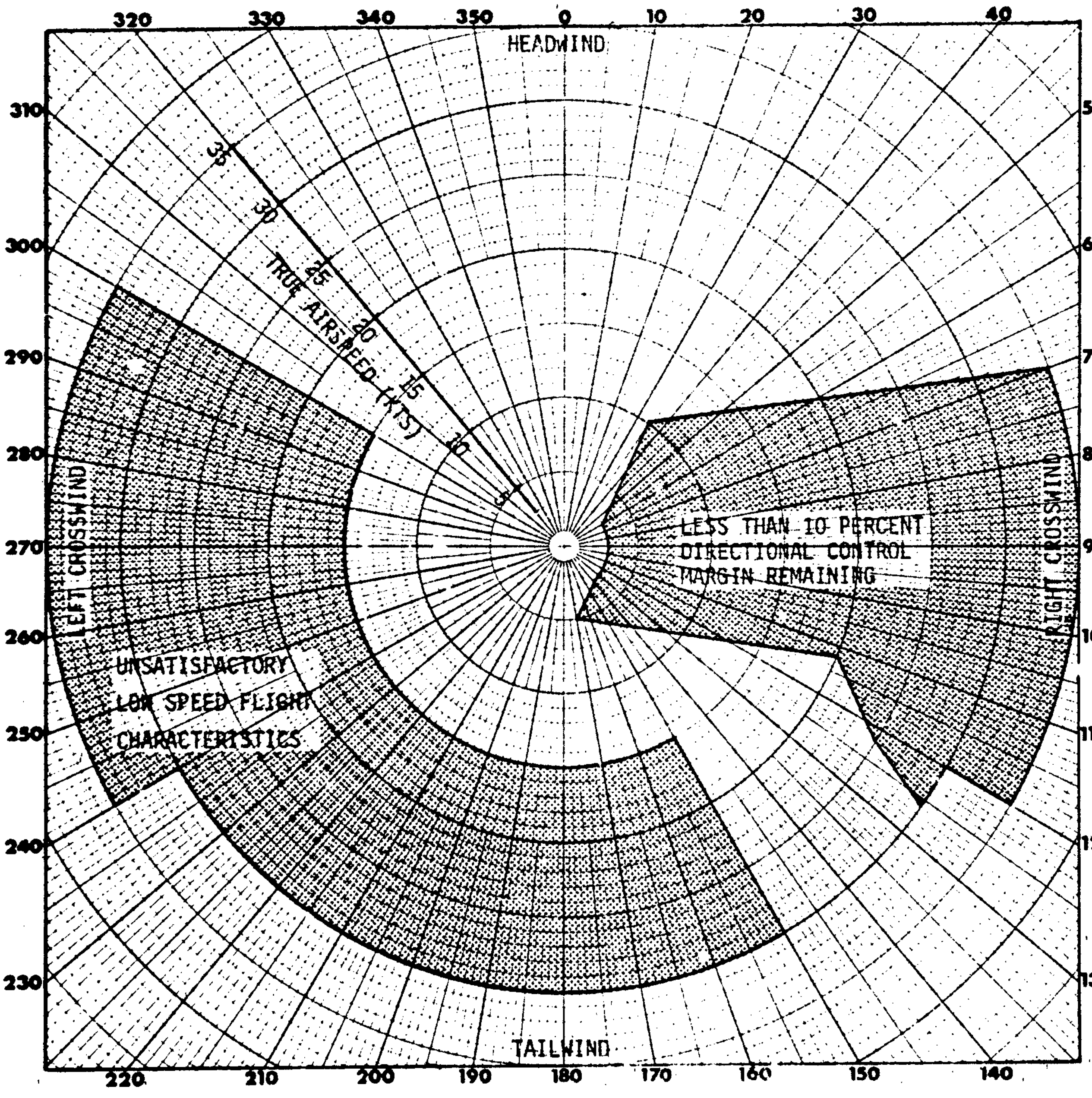


FIGURE 73
LOW SPEED FORWARD AND REARWARD FLIGHT
OH-58C USA S/N 16-724

AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3200	107.4 (FWD)	0.5	5000	14.0	355	10

NOTE: CONFIGURATION: CLEAN, DOORS ON

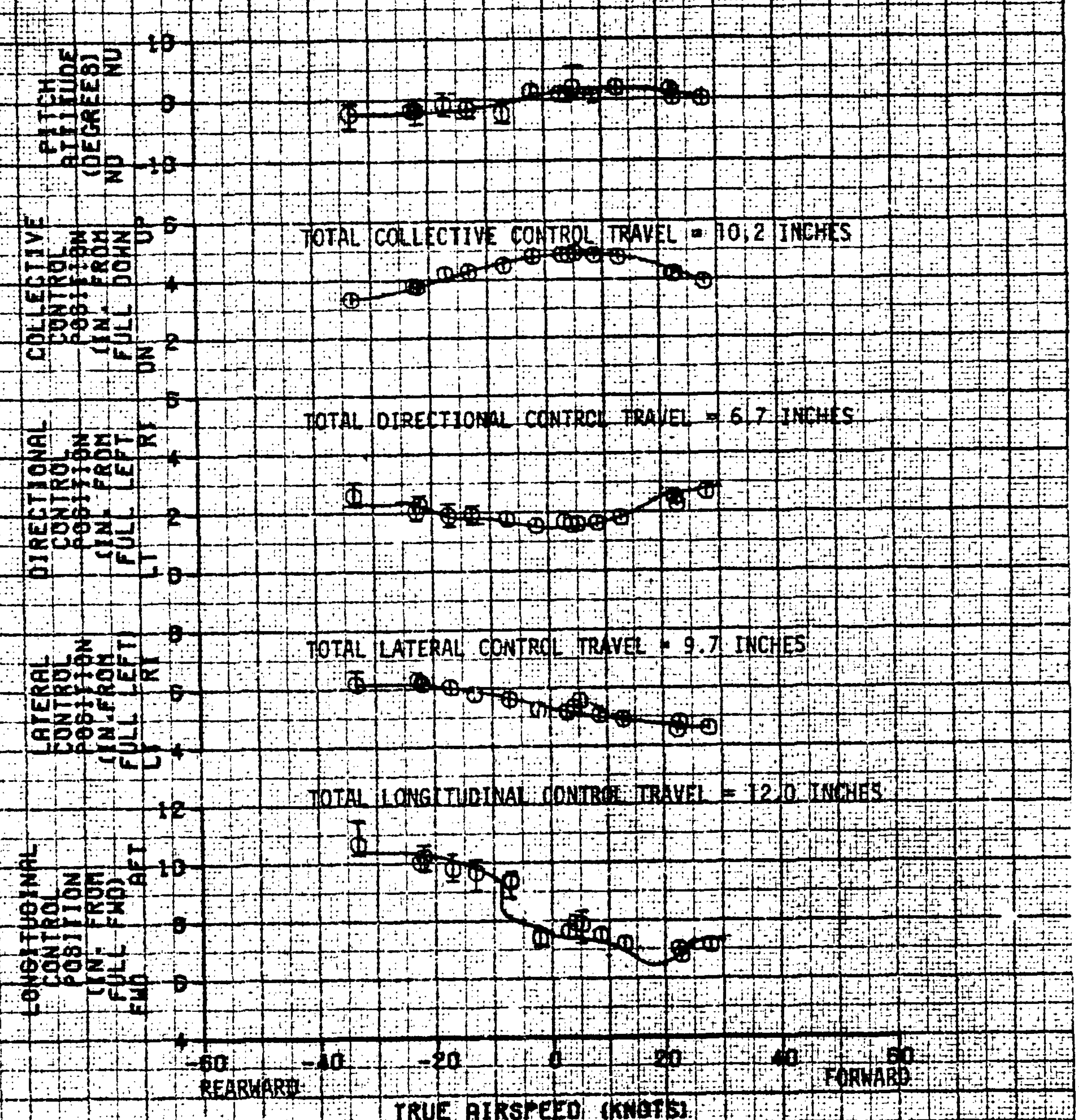


FIGURE 74
SIDEWARD FLIGHT
OH-58C USA S/N 16-724

AVG GROSS WEIGHT (LBS)	AVG CG LOCATION LONG (IN.)		AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3200	107.4	(FWD)	0.5	5000	14.0	355	10

NOTE: CONFIGURATION: CLEAN, DOORS ON

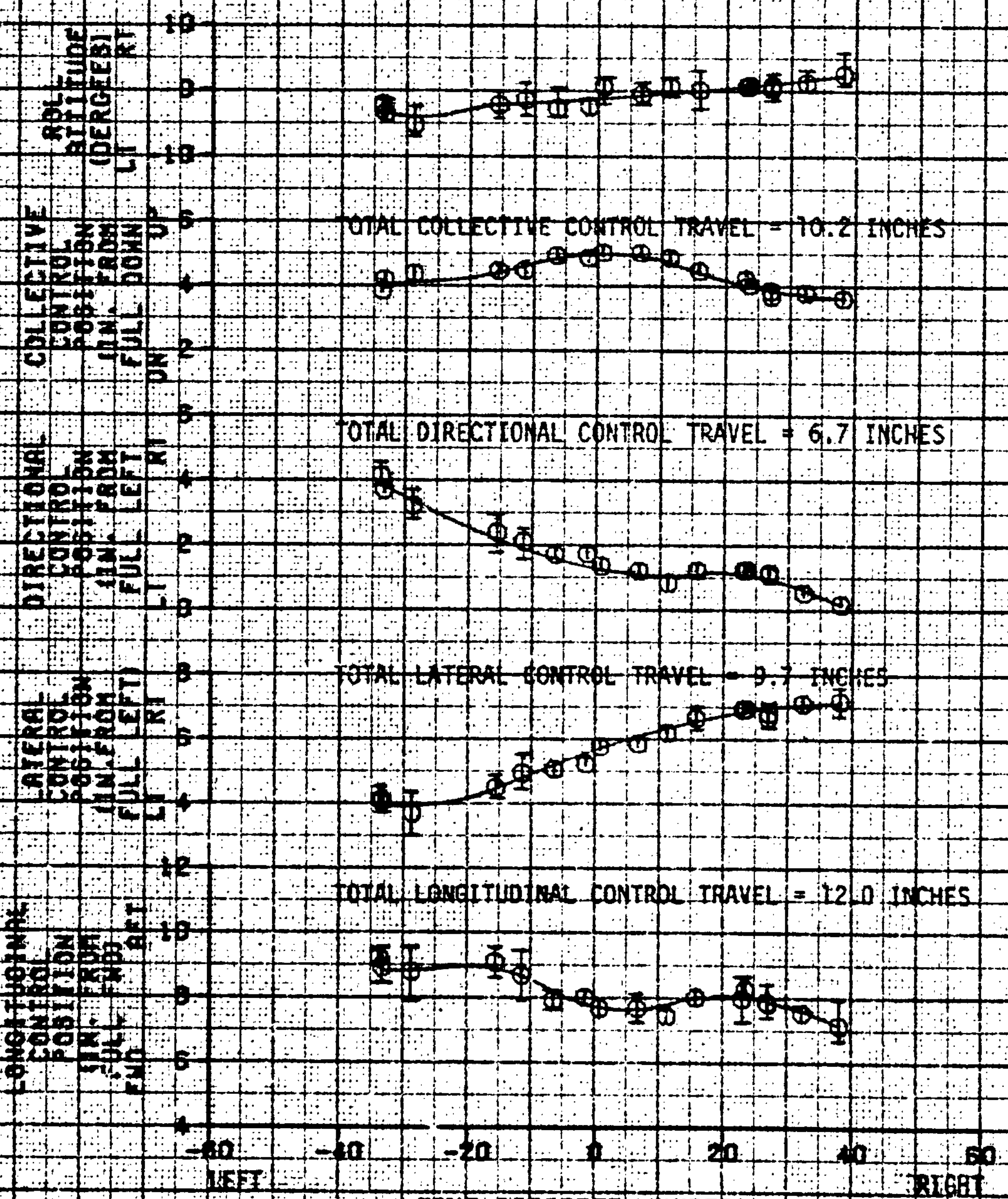


FIGURE 35
SLOW SPEED FORWARD AND REARWARD FLIGHT
OH-58C USA S/N 16-724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3050	107.0 (FWD)	0.2	11120	9.0	355	10

NOTE: CONFIGURATION: CLEAN, DOORS ON

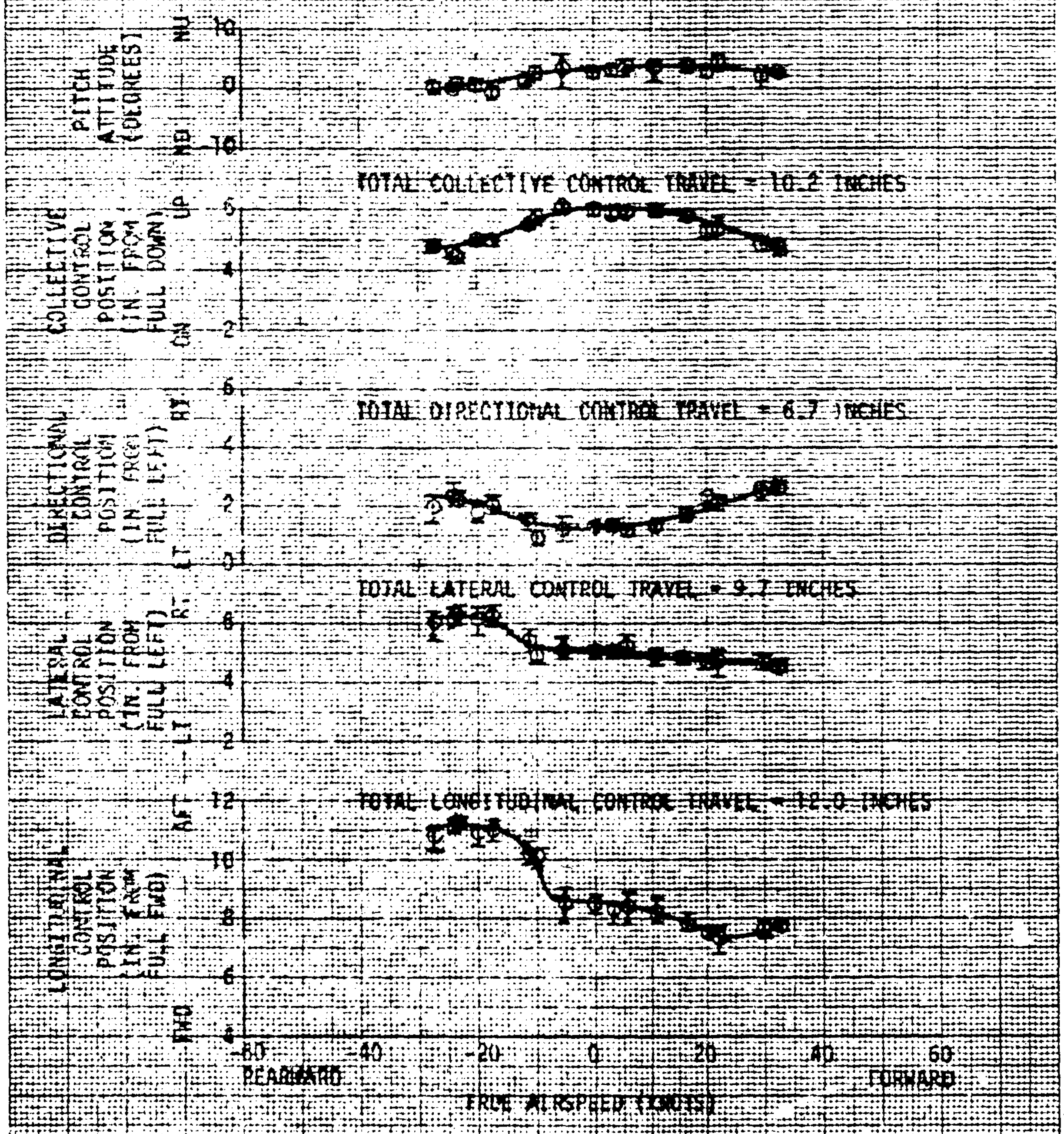


FIGURE 76
SIDEWARD FLIGHT
OH-58C USA S/N 16-724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN)	AVG CG LOCATION LAT (IN)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3050	107.0(FWD)	9.2	11120	9.0	355	10

NOTE: CONFIGURATION: CLEAN, DOORS ON

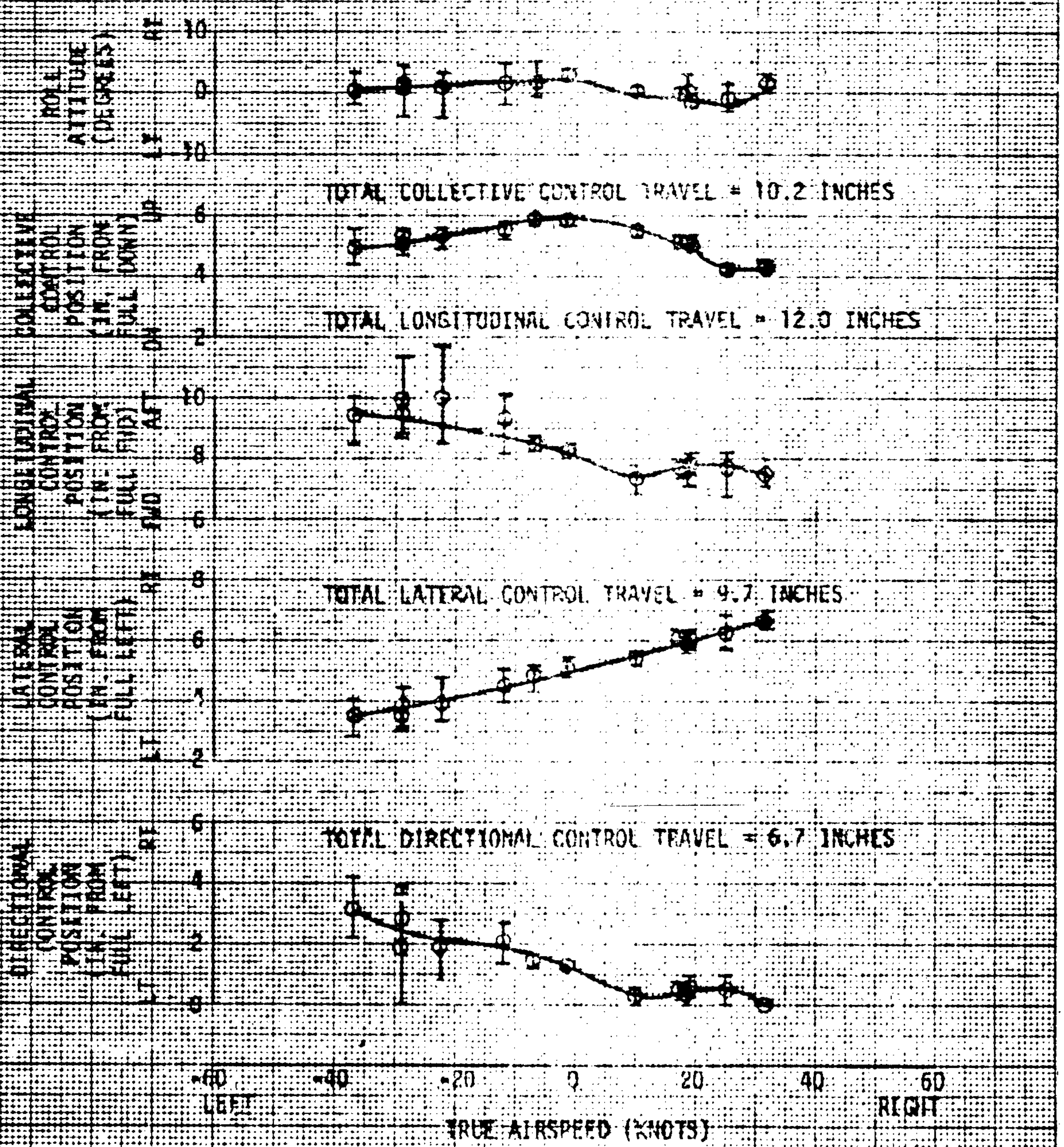


FIGURE 77

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3180	107.0(FWD)	0.6	5400	18.0	355	0.003713	5

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

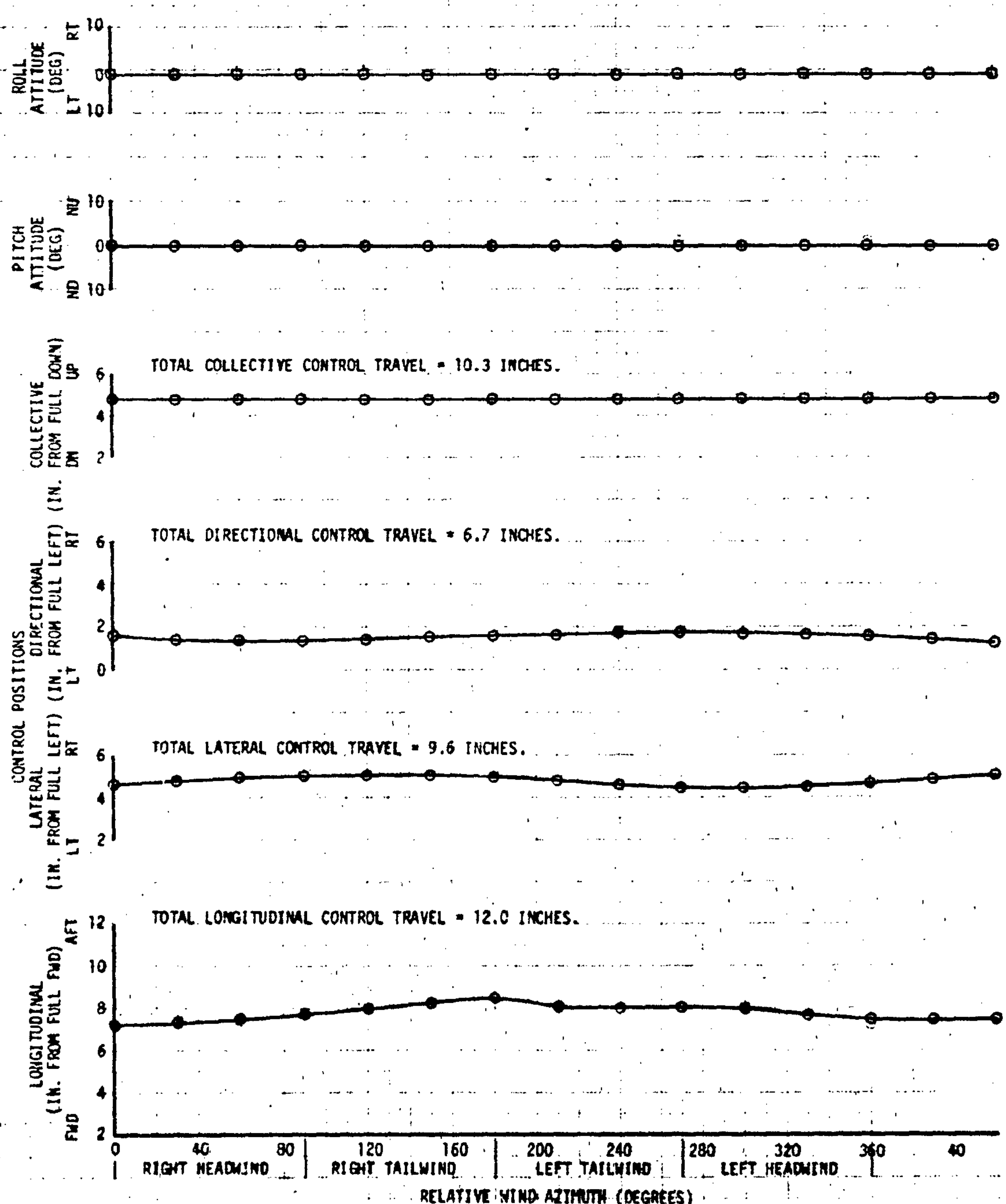


FIGURE [redacted]
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3180	107.0(FWD)	0.6	5400	18.0	355	0.003713	10

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

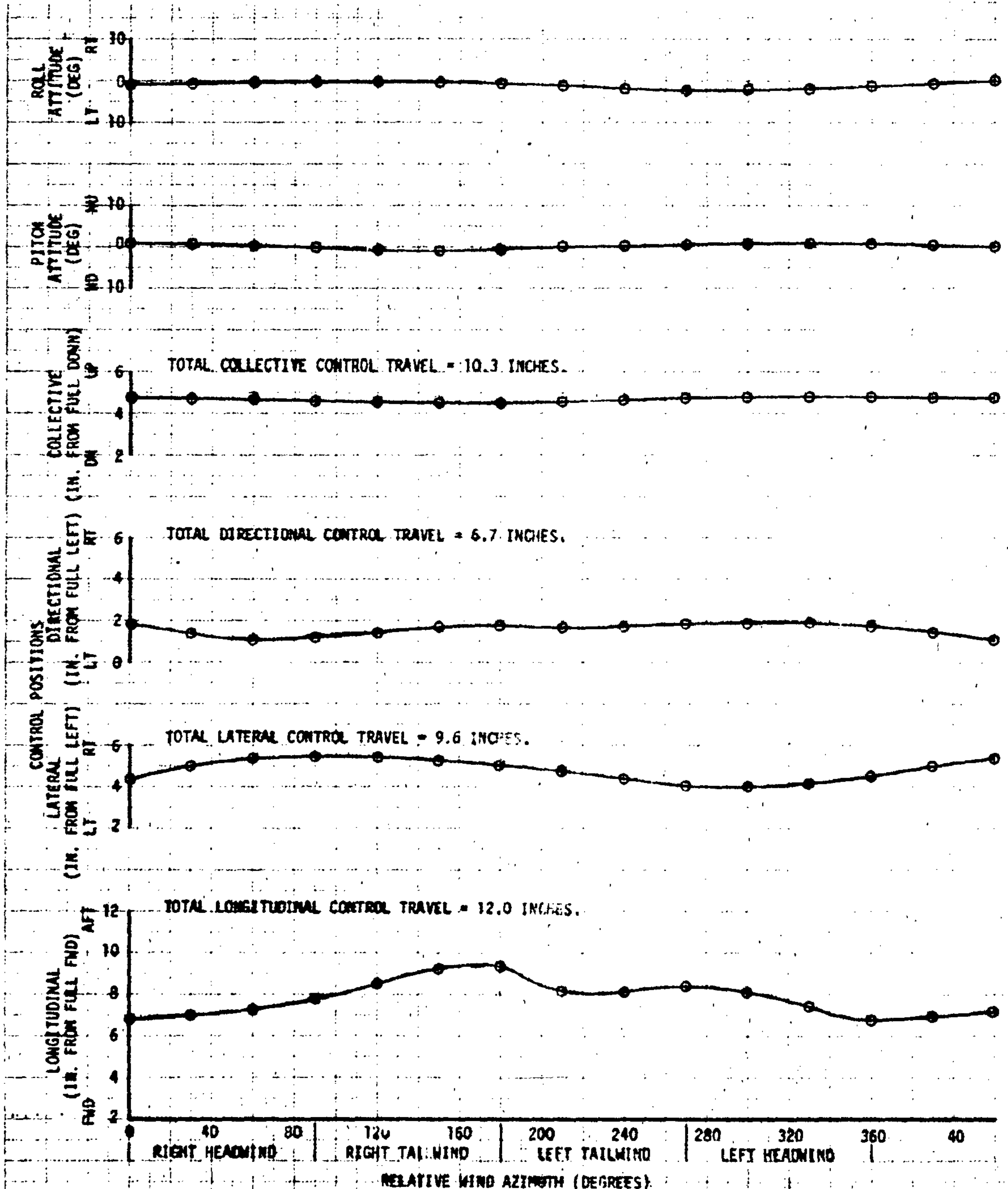


FIGURE [illegible]

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3180	107.0(FED)	0.0	5400	18.0	355	0.003713	TS

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

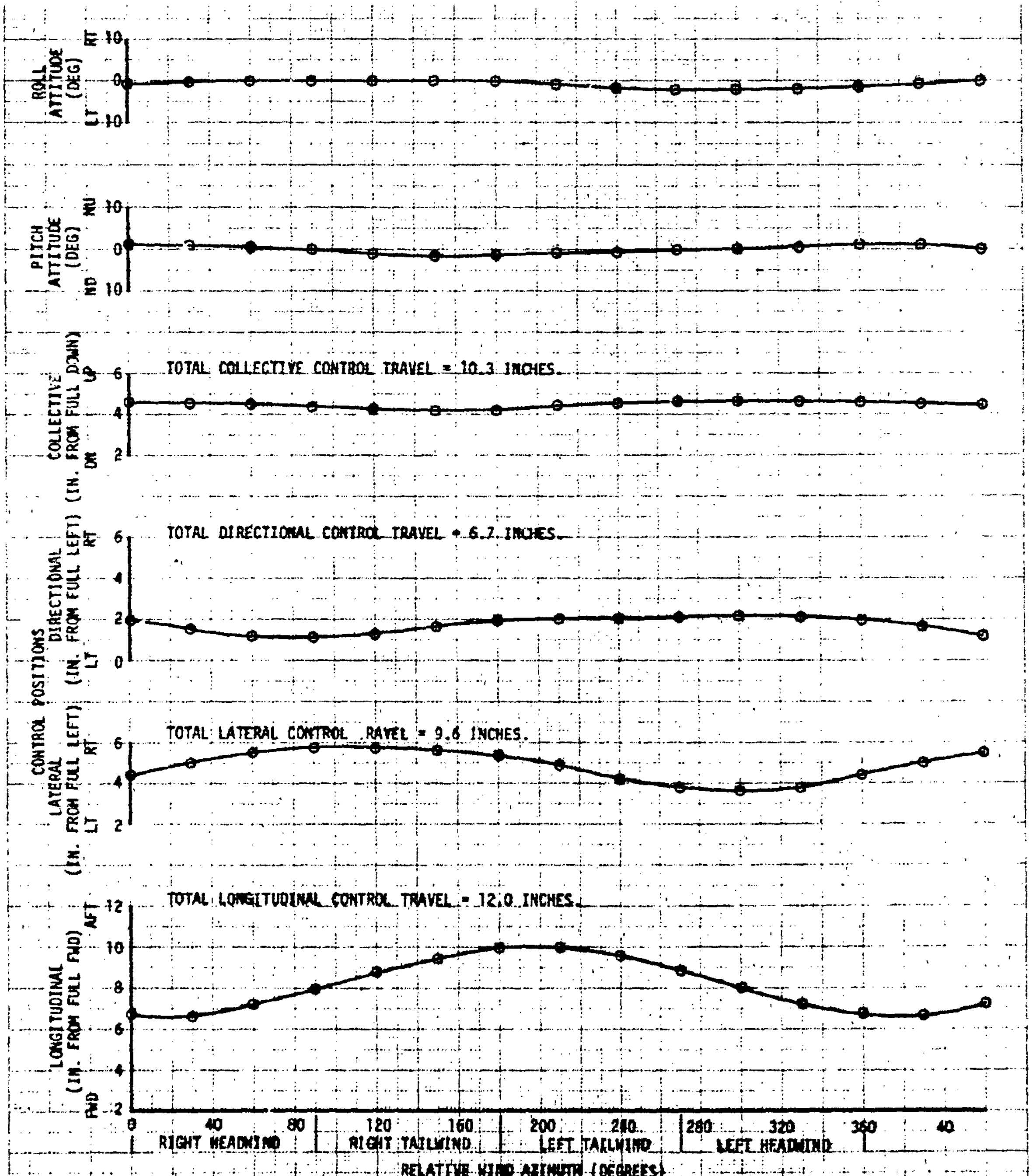


FIGURE [illegible]

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3160	107.0(FWD)	0.6	5400	18.0	355	0.003713	20

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

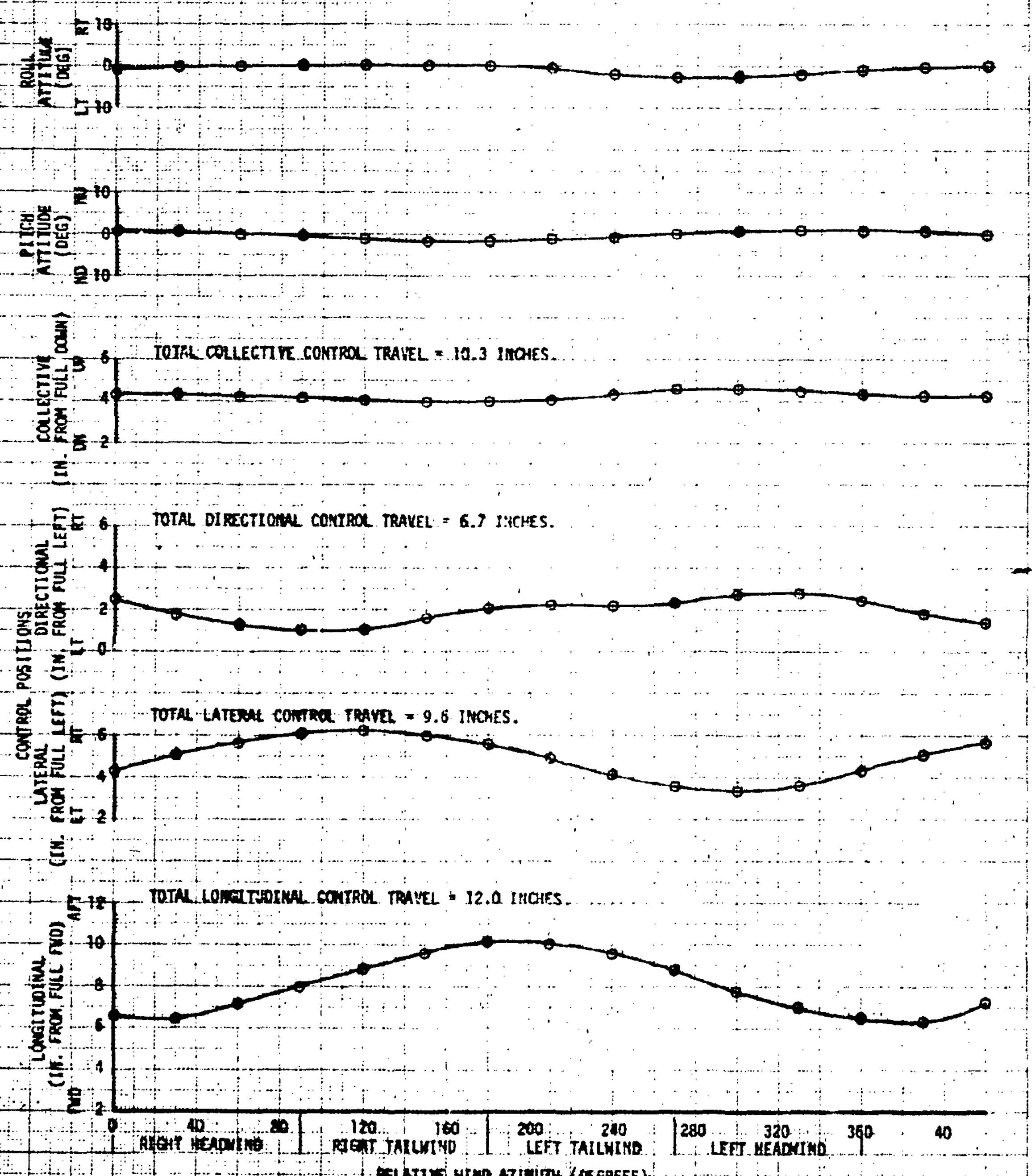


FIGURE [illegible]

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3180	107.0(FWD)	0.6	5400	18.0	355	0.003213	25

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

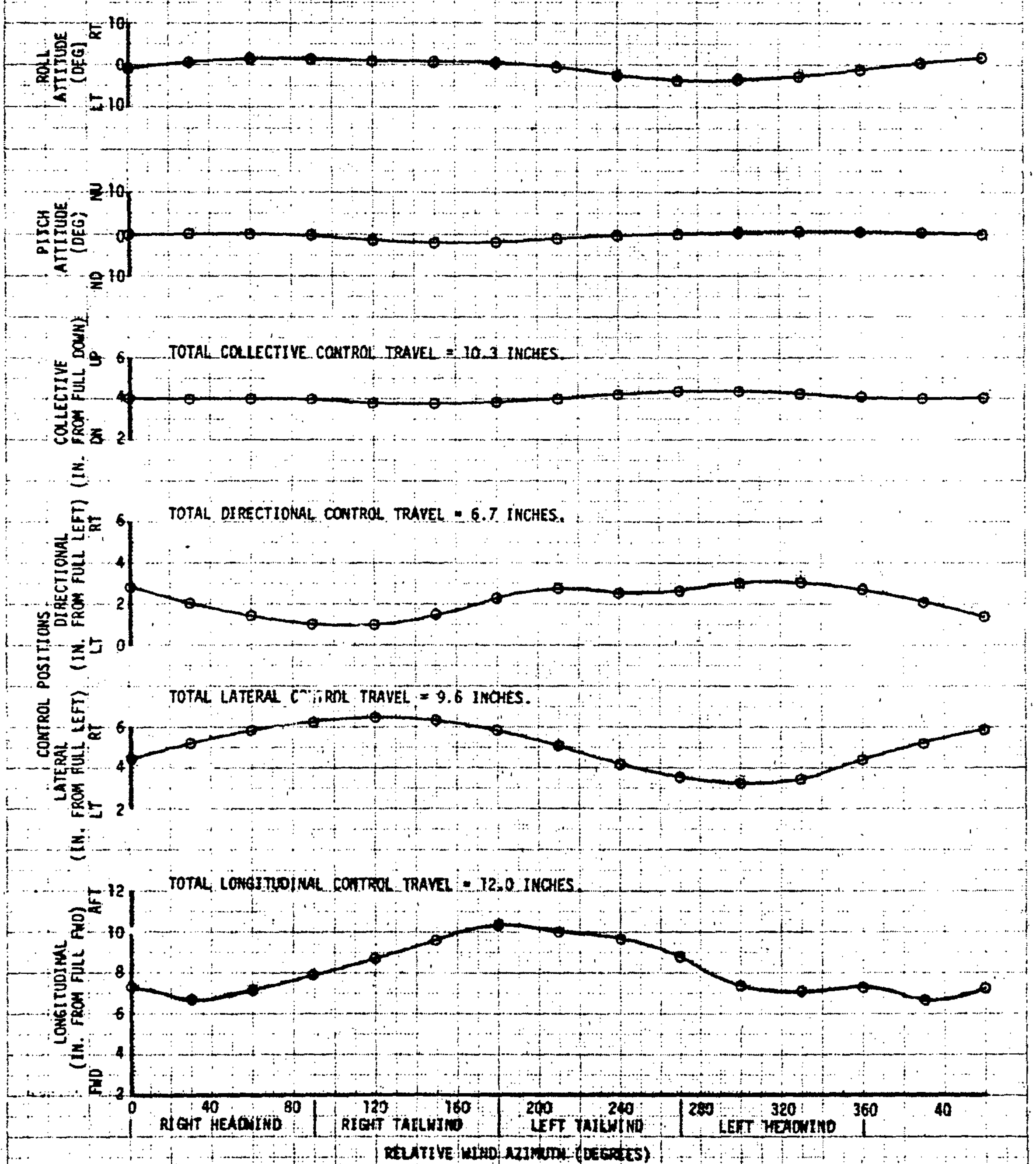


FIGURE 82

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3180	107.0(FWD)	0.6	5400	18.0	355	0.003773	30

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

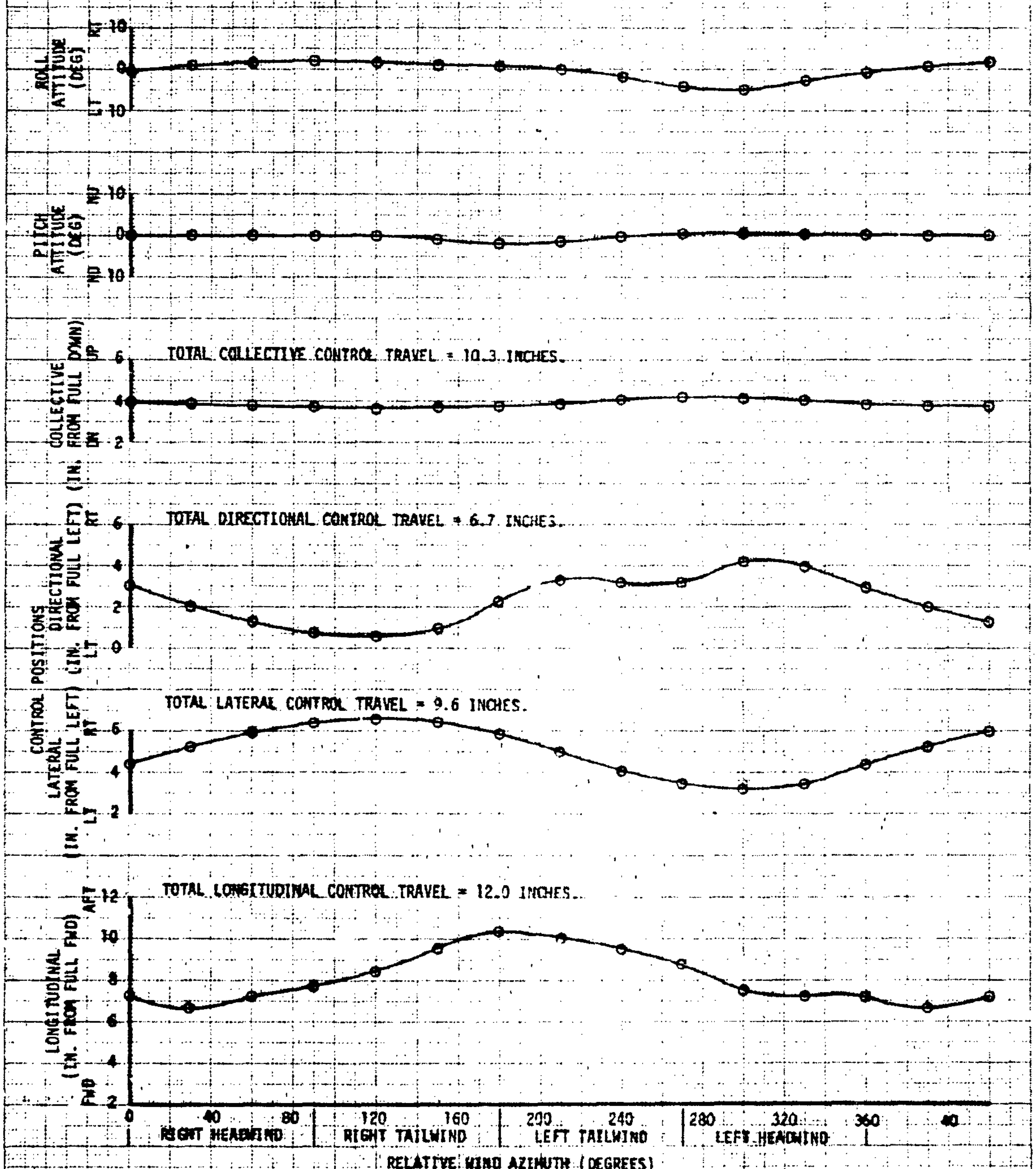


FIGURE 83

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
3180	107.0(FWD)	0.6	5400	18.0	355	0.003713	35

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

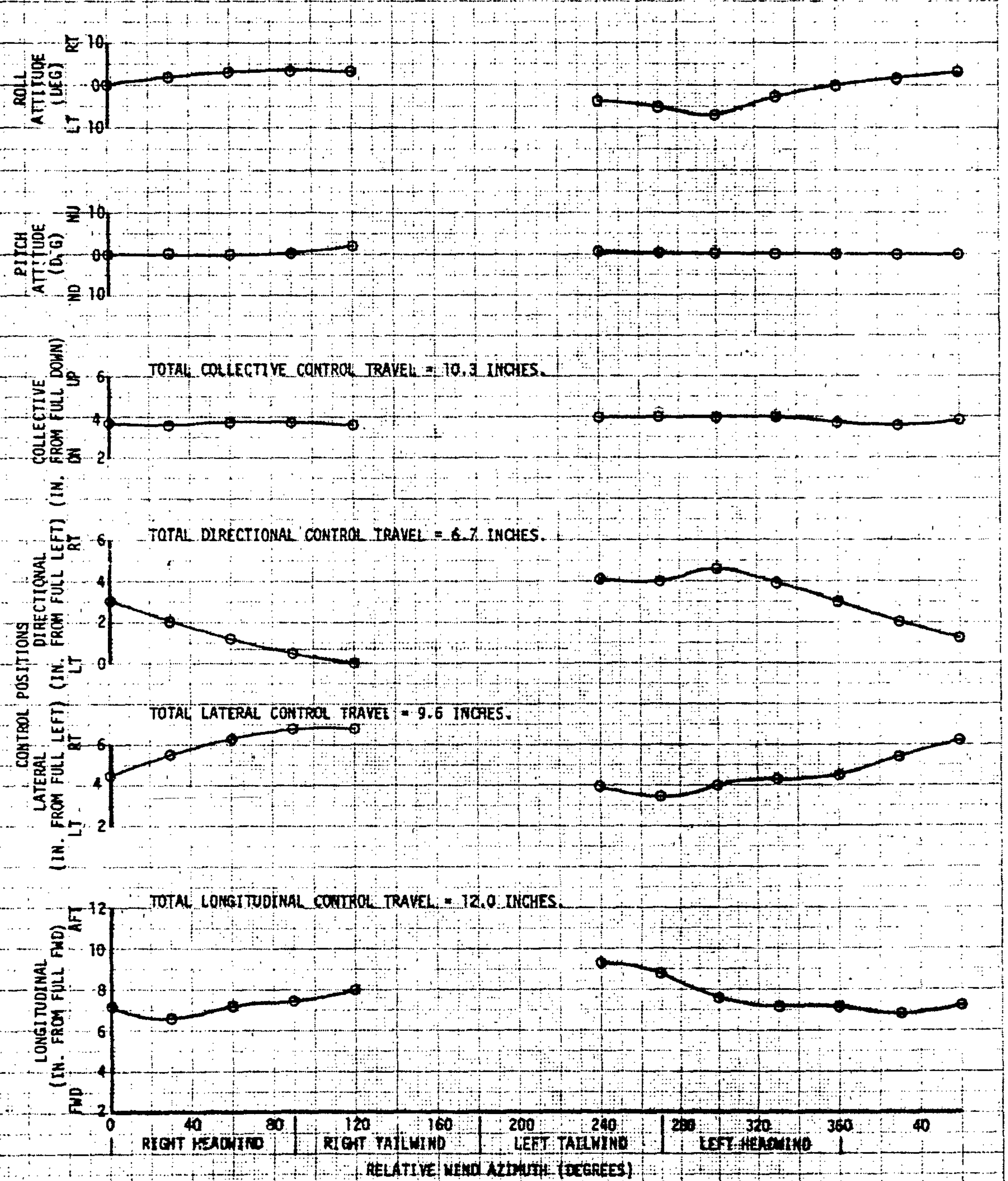


FIGURE [illegible]

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
2980	107.8(FWD)	0.2	10300	2.5	355	0.004048	5

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

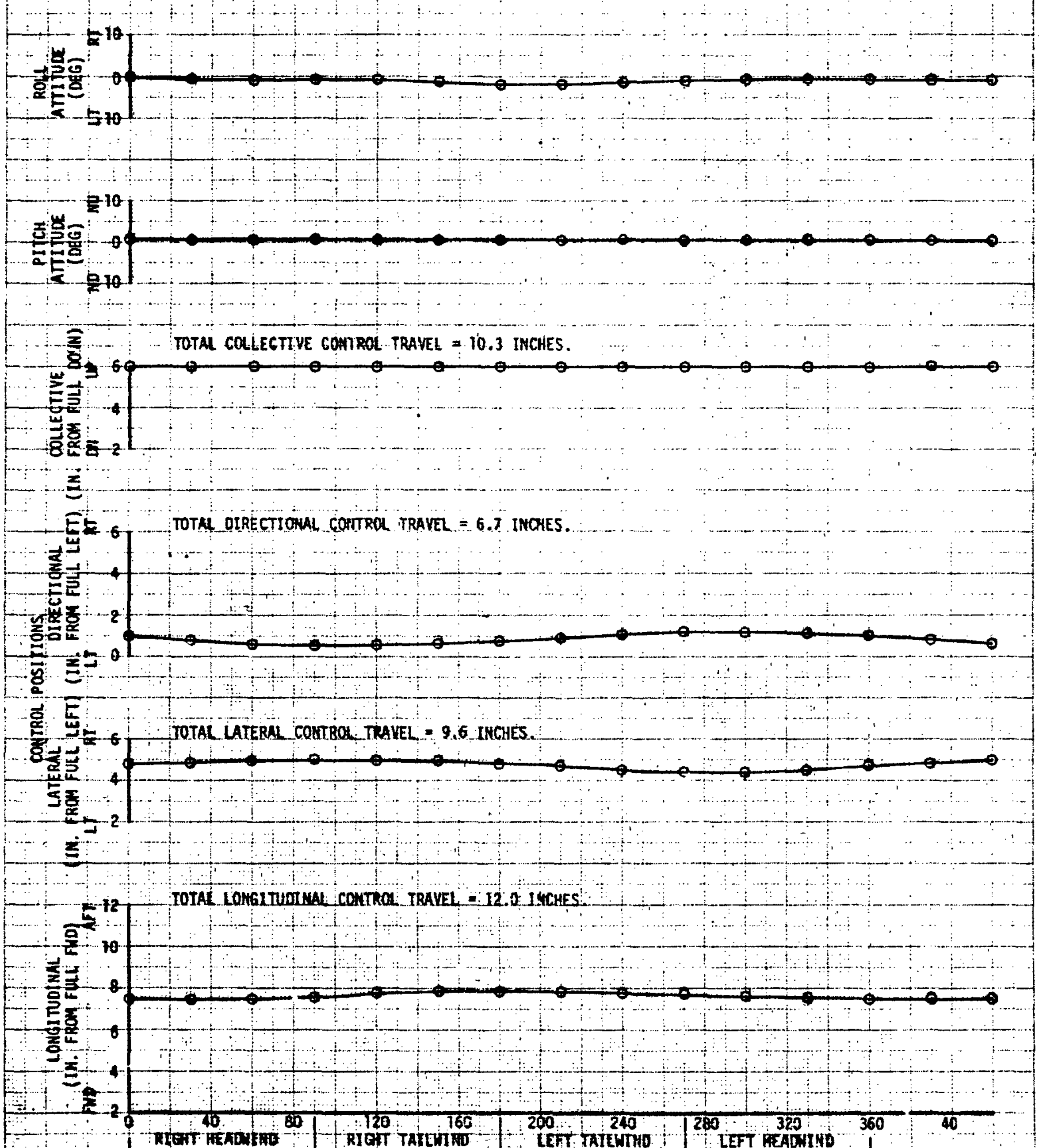


FIGURE [redacted]
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
2980	107.8(FWD)	0.2	10300	2.5	355	0.004048	10

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

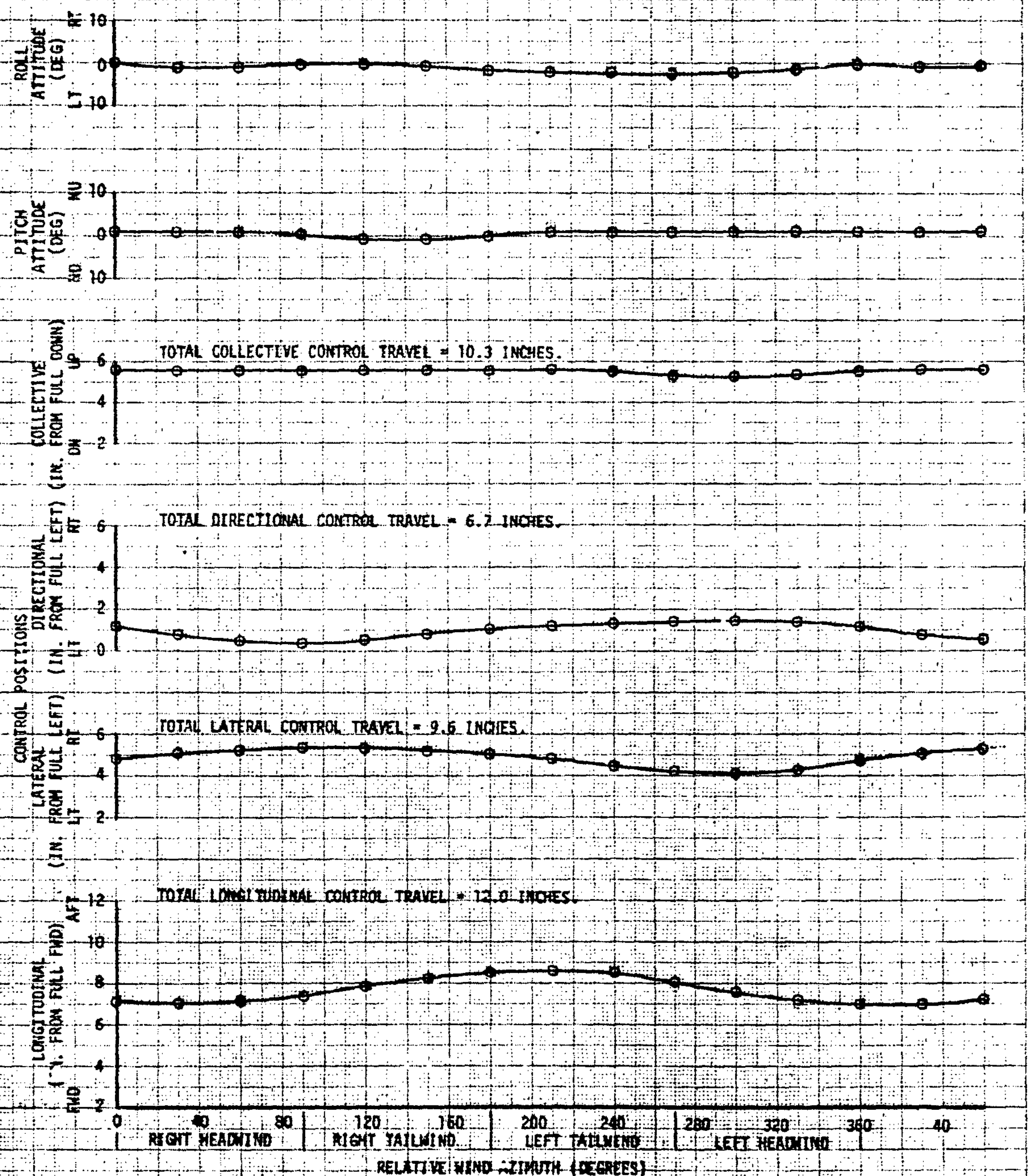


FIGURE 86
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
2980	107.8(FWD)	0.2	10300	2.5	355	0.004048	15

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

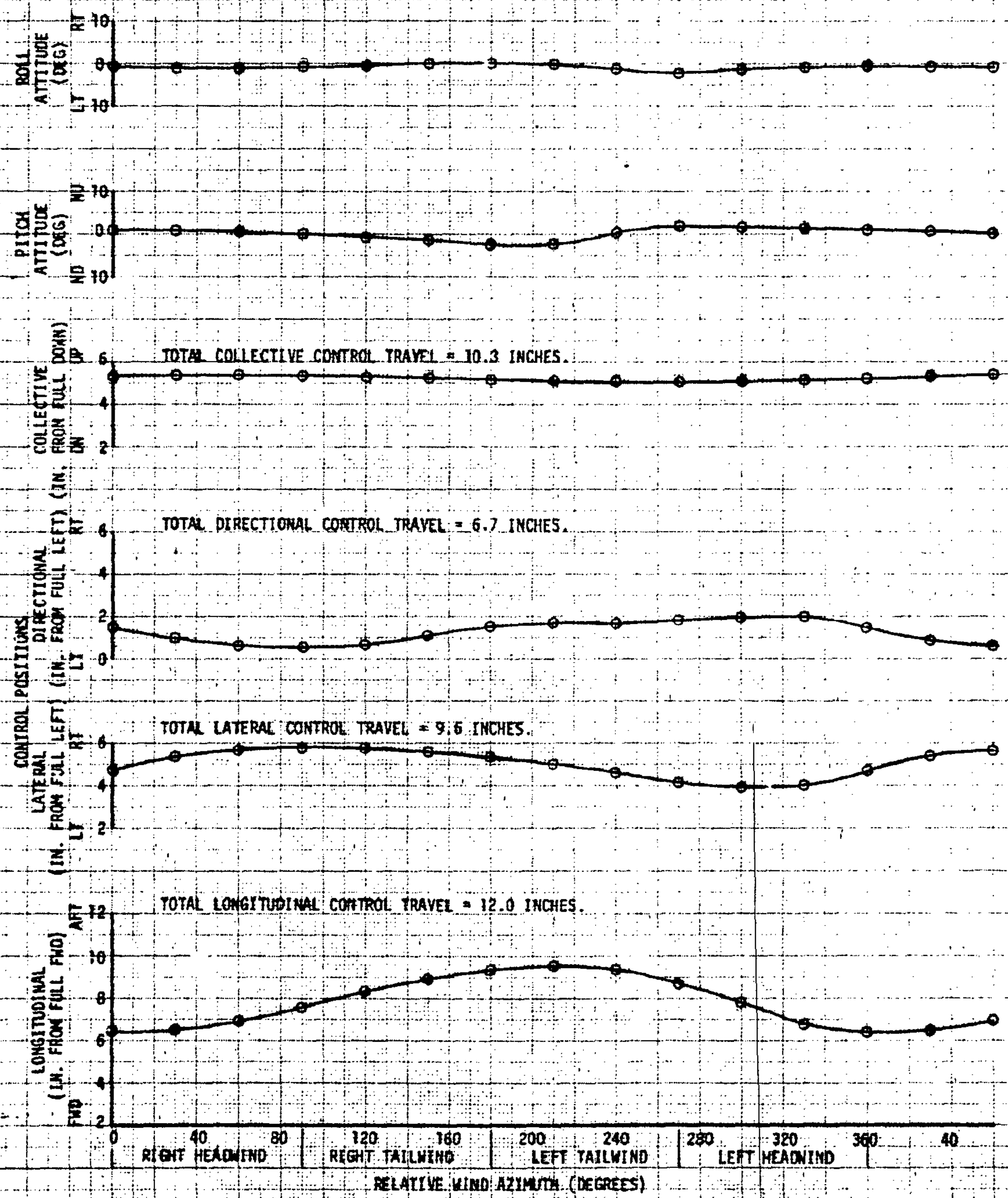


FIGURE 87

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
2980	107.8(FWD)	0.2	10300	2.5	355	0.004044	20

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

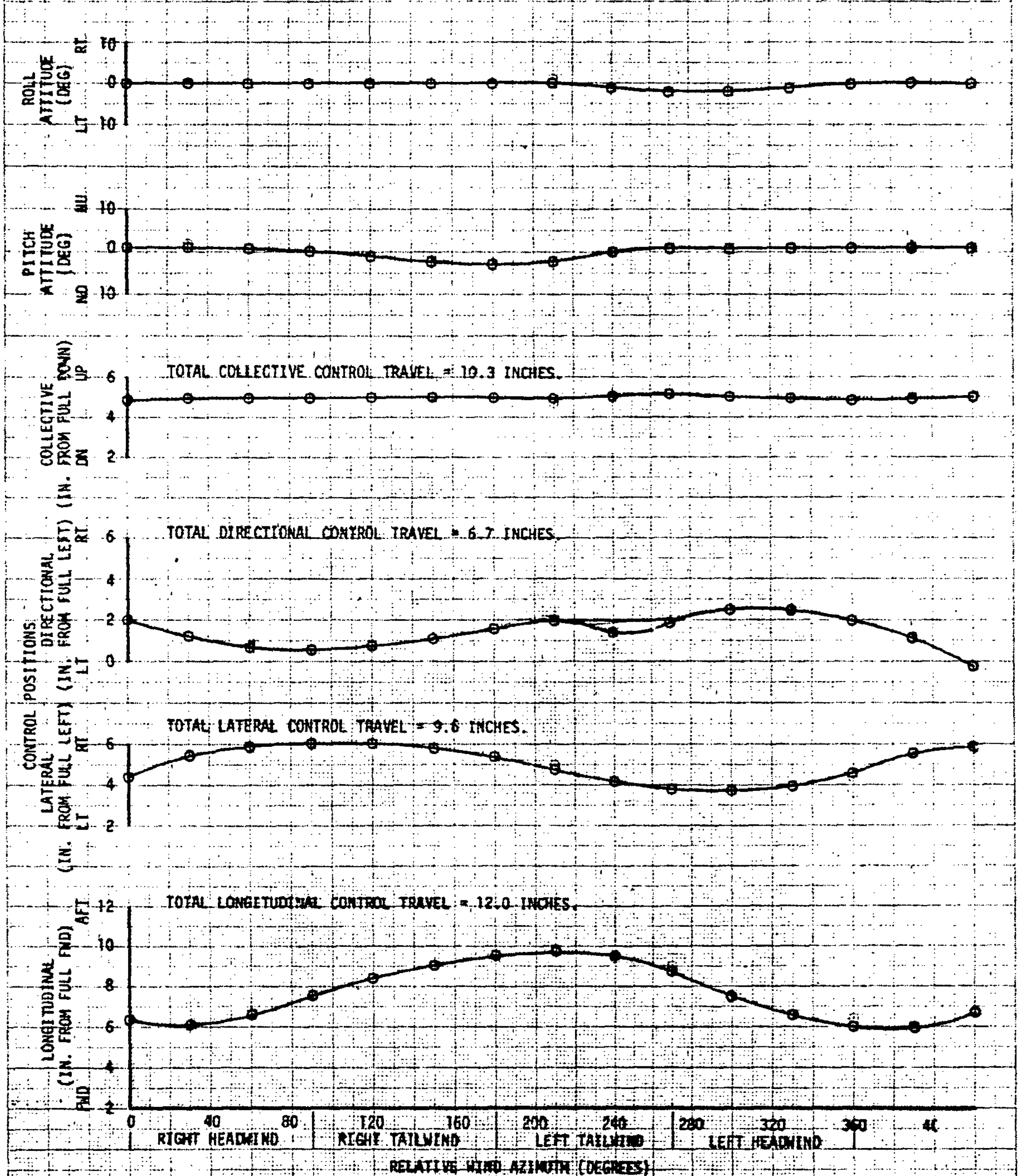


FIGURE 88

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
2980	107.8(FWD)	0.2	10300	2.5	355	0.004048	25

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.

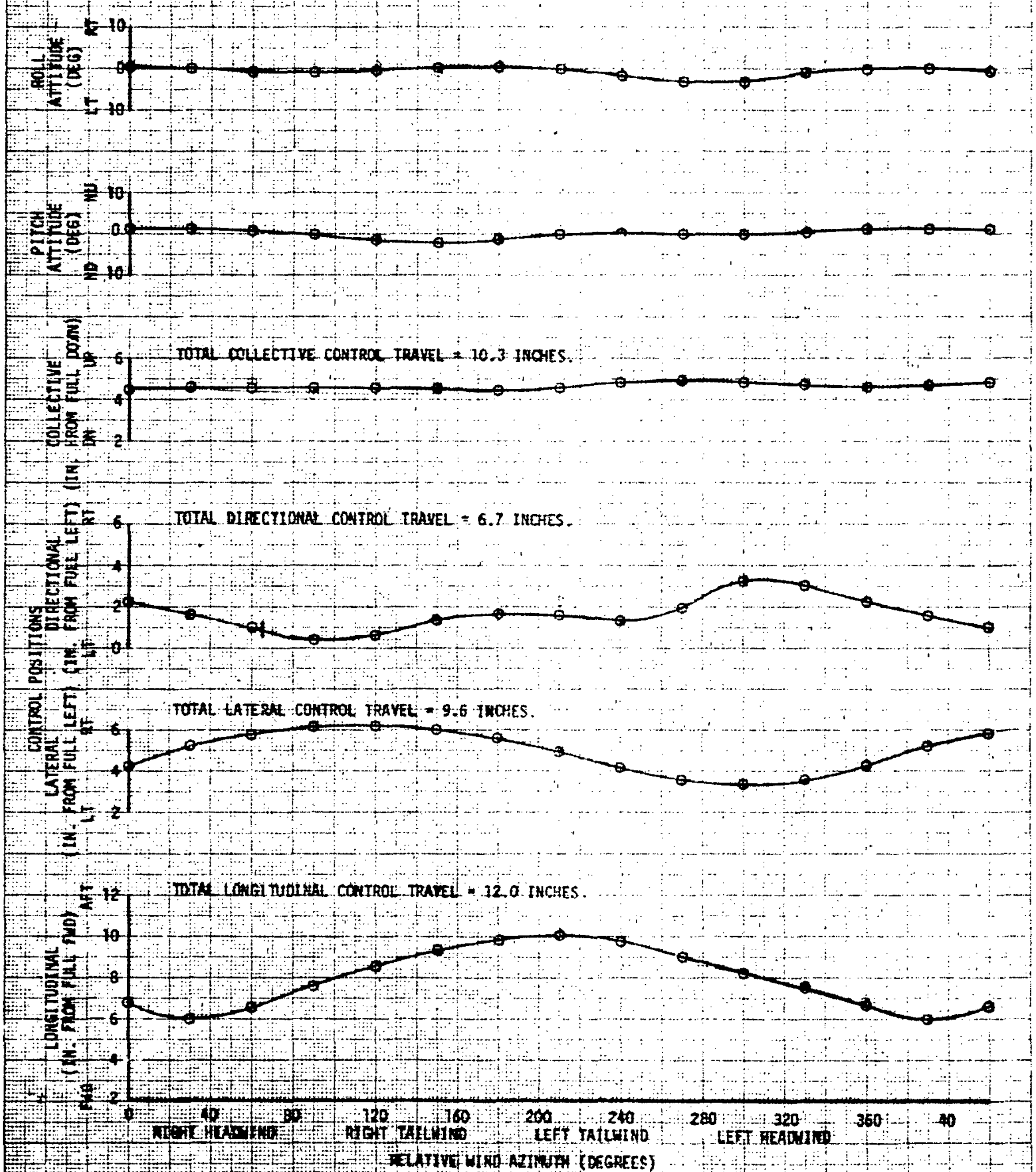


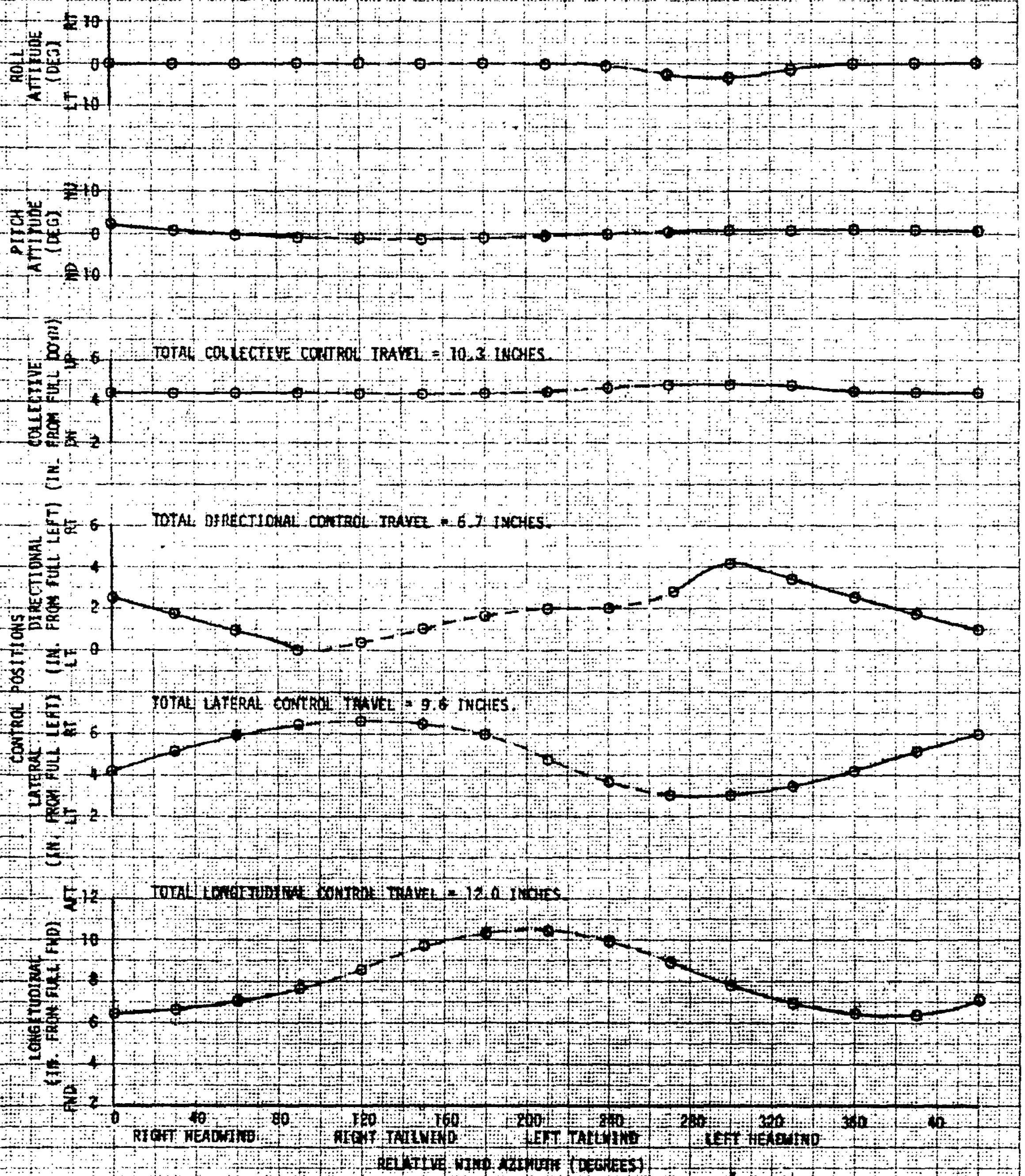
FIGURE [illegible]

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16724

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	AVG C_T	AVG TRUE AIRSPEED (KNOTS)
2980	107.8(FWD)	0.2	10300	2.5	3̄5	0.004048	30

NOTES: 1. CONFIGURATION: CLEAN, DOORS ON.
2. TRUE AIRSPEED IS THE VECTORIAL SUM OF GROUND SPEED AND WIND VELOCITY.
3. WINDS LESS THAN 3 KNOTS.
4. DASHED LINE DENOTES EXTRAPOLATED DATA.



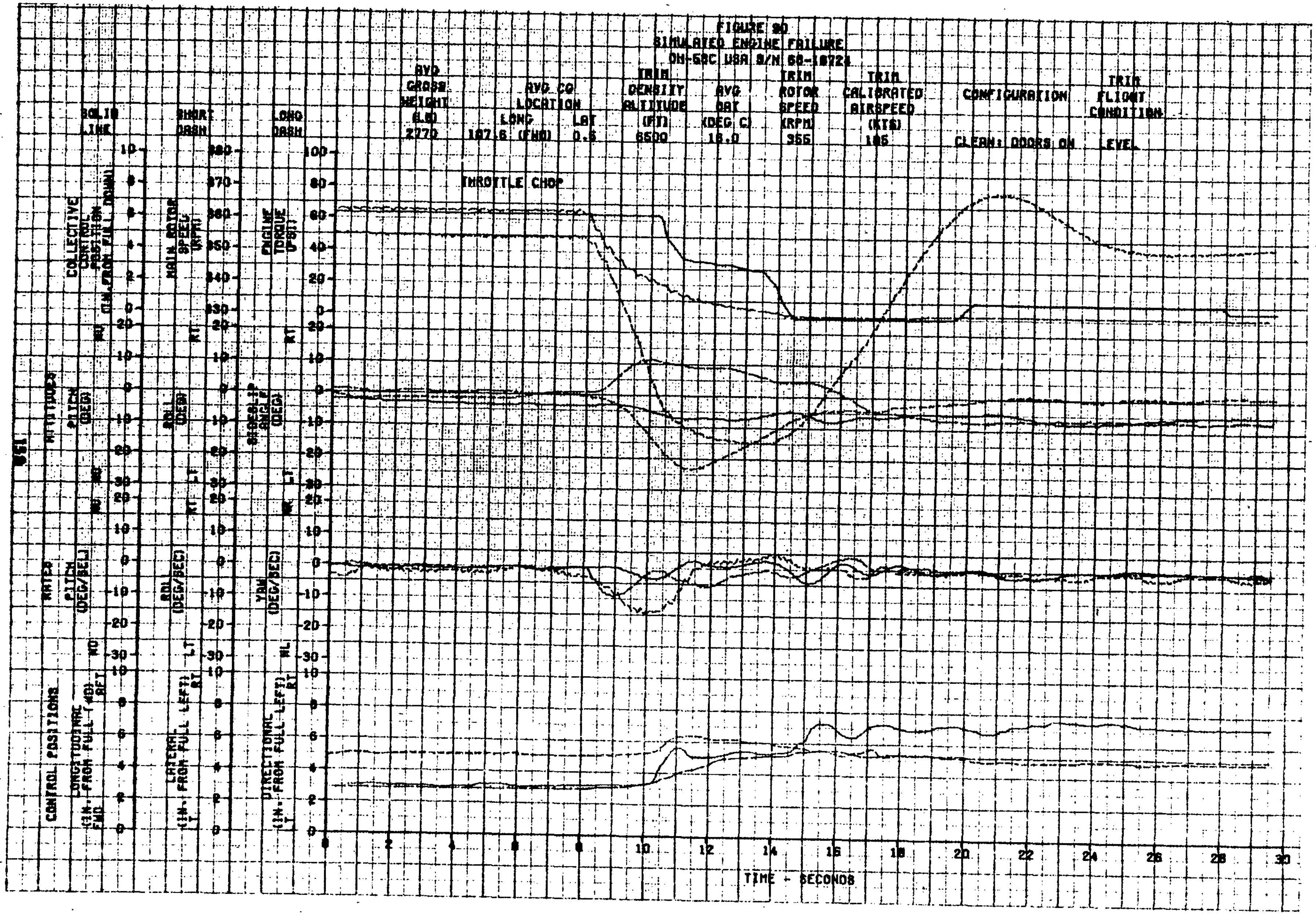


FIGURE 90
SIMULATED ENGINE FAILURE
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 2770
AVG CG LOCATION LONG 107.6 (FWD) LAT 0.5
TRIM DENSITY ALTITUDE (FT) 6500
AVG OAT (DEG C) 18.0
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 105
CONFIGURATION CLEAN: DOORS ON
TRIM FLIGHT CONDITION LEVEL
SOLID LINE
SHORT DASH
LONG DASH
THROTTLE CHOP
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
MAIN ROTOR SPEED (RPM)
ENGINE TORQUE (PSI)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
SIDESLIP ANGLE (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

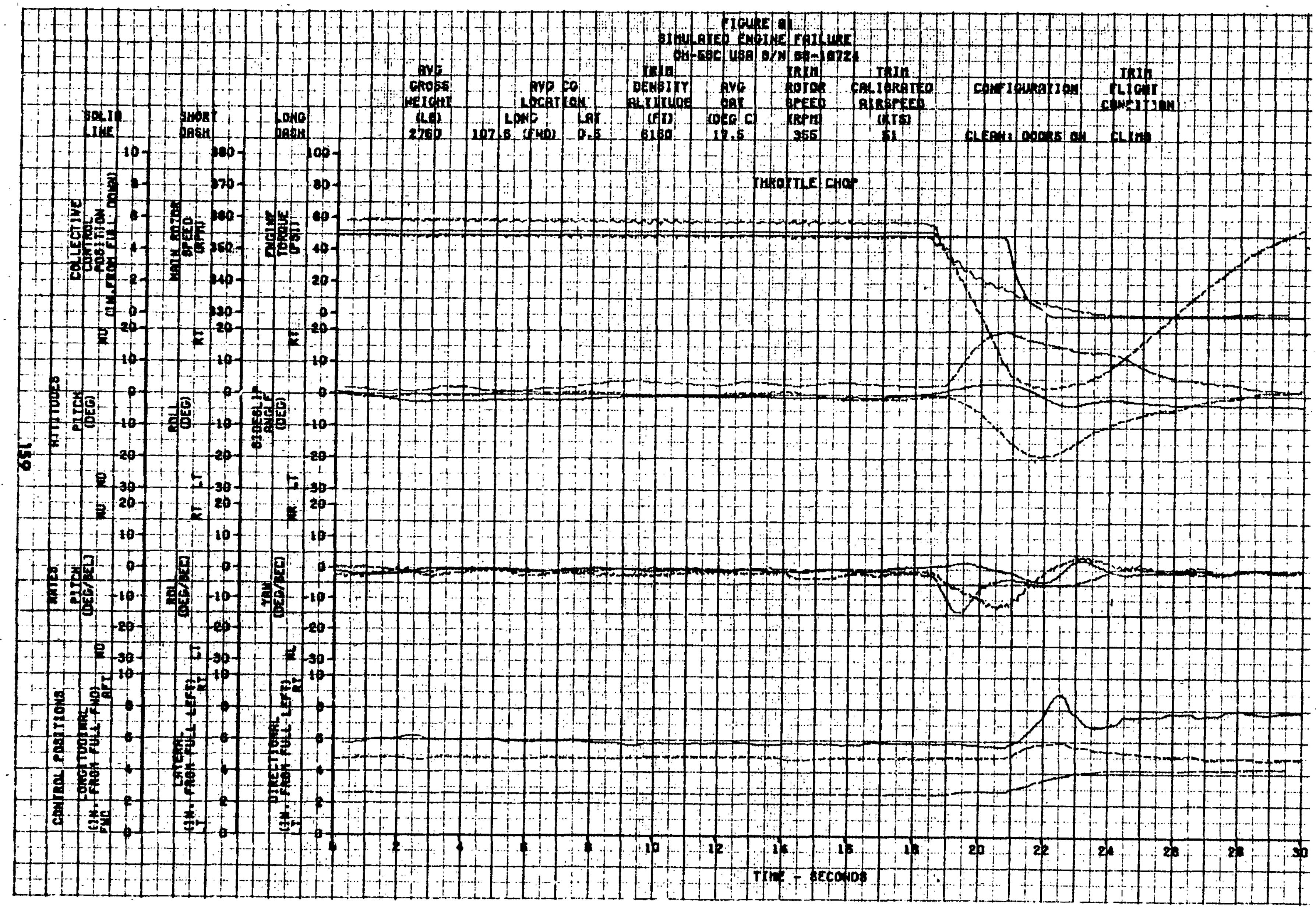


FIGURE 81
SIMULATED ENGINE FAILURE
OH-58C USA S/N 68-16724
AVG GROSS WEIGHT (LB) 2760
AVG CG LOCATION LONG 107.6 (FWD) LAT 0.5
TRIM DENSITY ALTITUDE (FT) 6180
AVG OAT (DEG C) 17.5
TRIM ROTOR SPEED (RPM) 355
TRIM CALIBRATED AIRSPEED (KTS) 51
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION CLIMB
SOLID LINE
SHORT DASH
LONG DASH
THROTTLE CHOP
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
MAIN ROTOR SPEED (RPM)
ENGINE TORQUE (PSI)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
SIDESLIP ANGLE (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
TIME - SECONDS

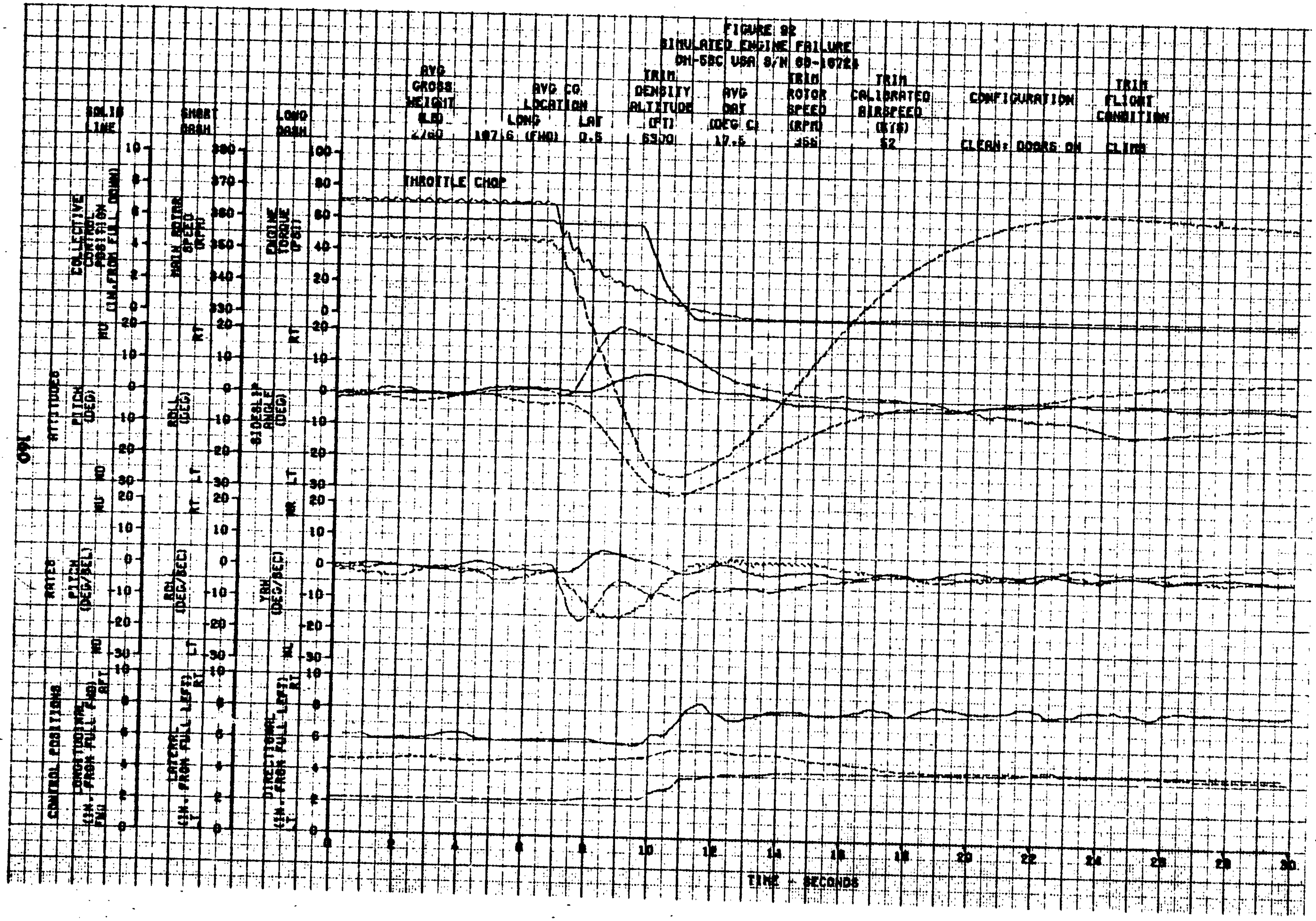
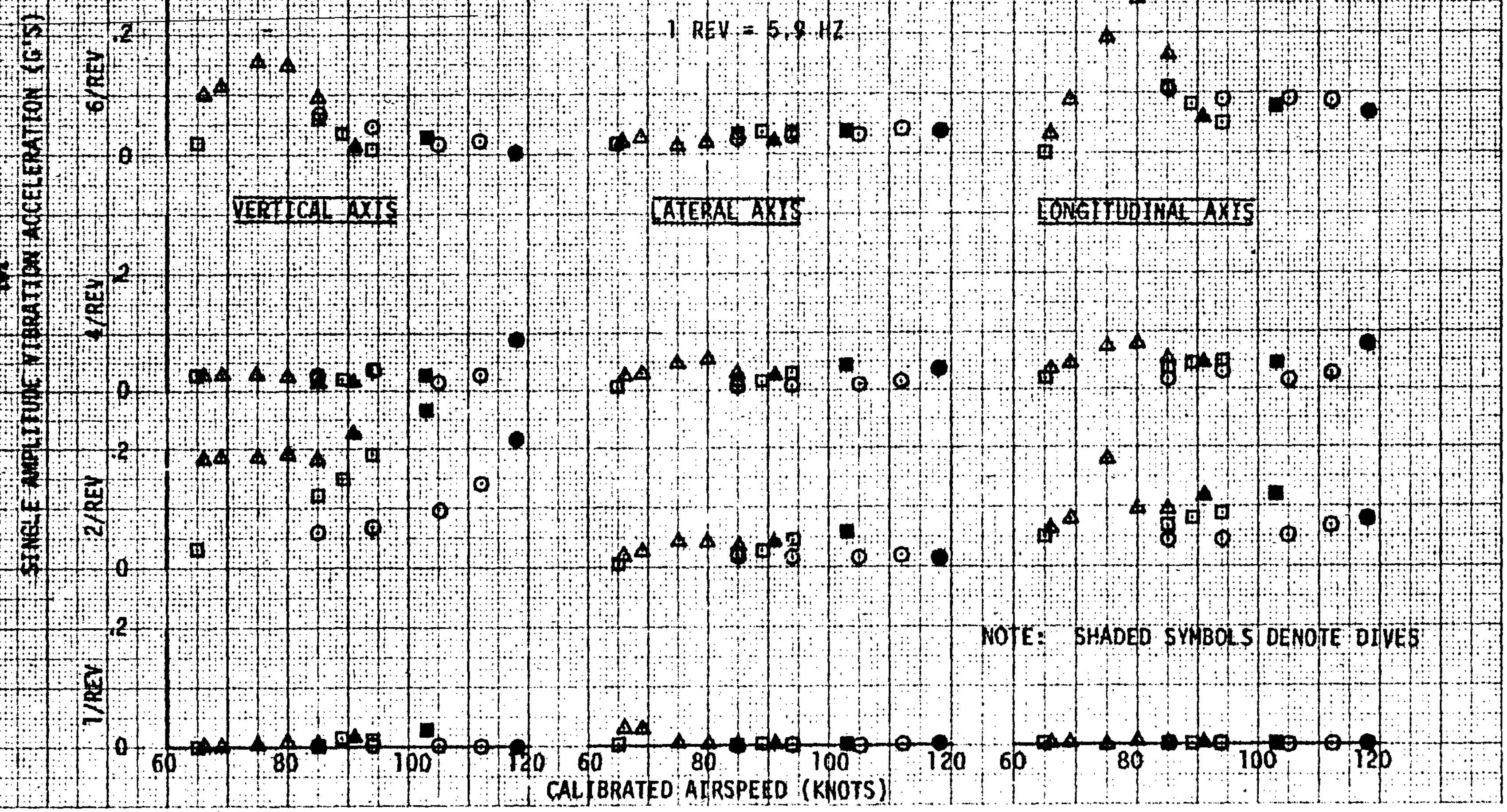


FIGURE 92
SIMULATED ENGINE FAILURE
OH-58C USA S/N 68-16728
AVG GROSS WEIGHT (LB) 2760
AVG CG LOCATION LONG 107.6 (FWD) LAT 0.5
TRIM DENSITY ALTITUDE (FT) 5530
AVG OAT (DEG C) 17.5
TRIM ROTOR SPEED (RPM) 356
TRIM CALIBRATED AIRSPEED (KTS) 52
CONFIGURATION CLEAN; DOORS ON
TRIM FLIGHT CONDITION CLIMB
SOLID LINE
SHORT DASH
LONG DASH
THROTTLE CHOP
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
MAIN ROTOR SPEED (RPM)
ENGINE TORQUE (PSI)
ATTITUDES
PITCH (DEG)
ROLL (DEG)
SIDESLIP ANGLE (DEG)
RATES
PITCH (DEG/SEC)
ROLL (DEG/SEC)
YAW (DEG/SEC)
CONTROL POSITIONS
LONGITUDINAL (IN. FROM FULL FWD)
LATERAL (IN. FROM FULL LEFT)
DIRECTIONAL (IN. FROM FULL LEFT)
NU ND RT LT NR NL AFT FWD
TIME - SECONDS

FIGURE 93
VIBRATION CHARACTERISTICS AT THE PILOT STATION
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
⊙	3190	107.0(FWD)	0.1	5260	-12.0	355	CLEAN, DOORS ON	LEVEL
⊡	3210	107.2(FWD)	0.1	10640	-20.0	355	CLEAN, DOORS ON	LEVEL
⚠	3230	107.4(FWD)	0.1	13380	-25.0	355	CLEAN, DOORS ON	LEVEL

1 REV = 5.9 HZ



NOTE: SHADED SYMBOLS DENOTE DIVES

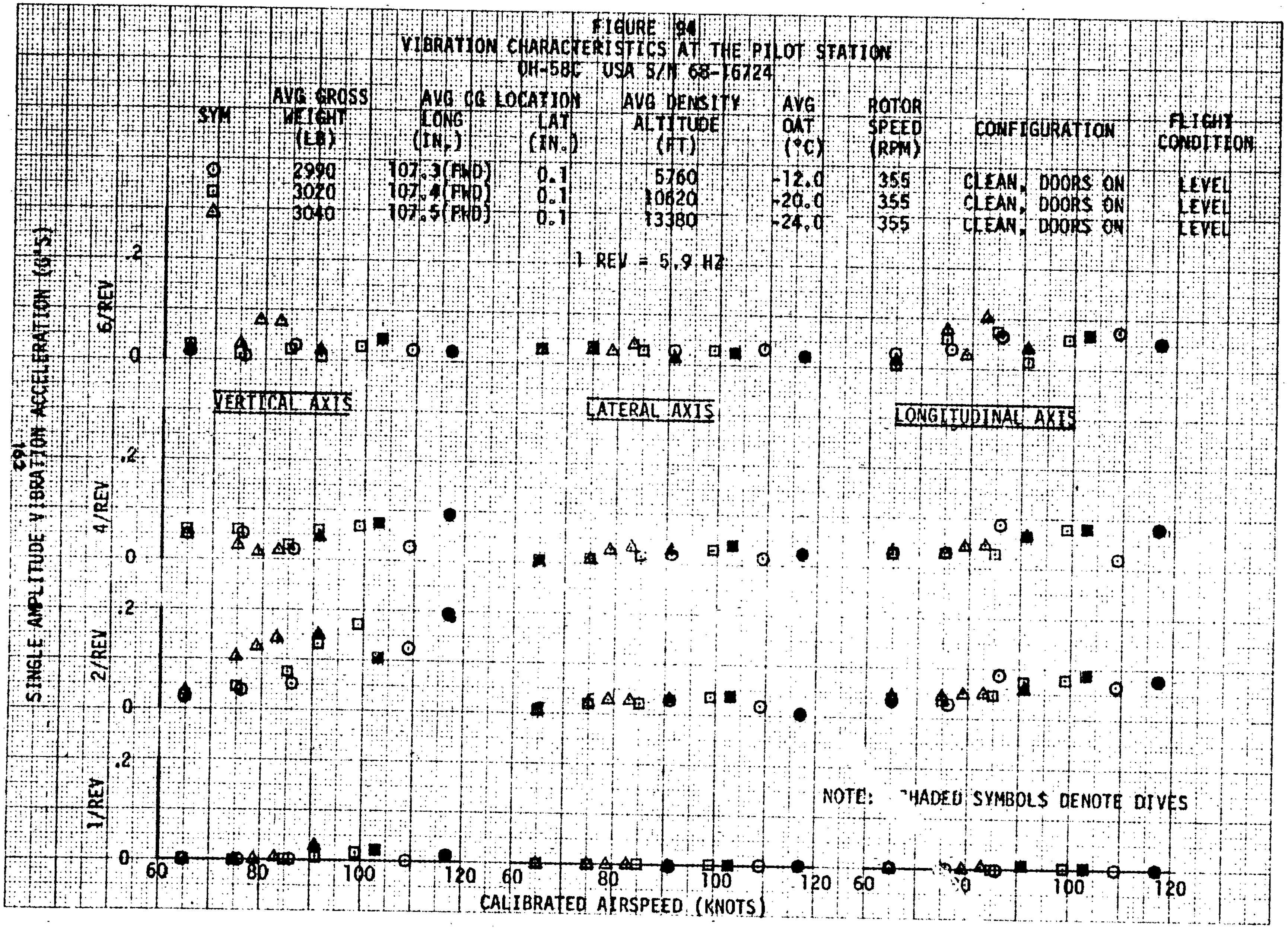


FIGURE 94
VIBRATION CHARACTERISTICS AT THE PILOT STATION
OH-58C USA S/N 68-16724
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (IN.)
LAT (IN.)
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
ROTOR SPEED (RPM)
CONFIGURATION
FLIGHT CONDITION
2990 107.3(FWD) 0.1 5760 -12.0 355 CLEAN, DOORS ON LEVEL
3020 107.4(FWD) 0.1 10620 -20.0 355 CLEAN, DOORS ON LEVEL
3040 107.5(FWD) 0.1 13380 -24.0 355 CLEAN, DOORS ON LEVEL
1 REV = 5.9 HZ
VERTICAL AXIS
LATERAL AXIS
LONGITUDINAL AXIS
6/REV
4/REV
2/REV
1/REV
.2
0
SINGLE AMPLITUDE VIBRATION ACCELERATION (G'S)
NOTE: SHADED SYMBOLS DENOTE DIVES
60
80
100
120
CALIBRATED AIRSPEED (KNOTS)

FIGURE 96
VIBRATION CHARACTERISTICS AT THE PILOT STATION
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
○	2770	107.3(FWD)	0.1	5460	-10.5	355	CLEAN, DOORS ON	LEVEL
□	2800	107.4(FWD)	0.1	10620	-20.0	355	CLEAN, DOORS ON	LEVEL
△	2820	107.5(FWD)	0.1	13880	-22.0	355	CLEAN, DOORS ON	LEVEL

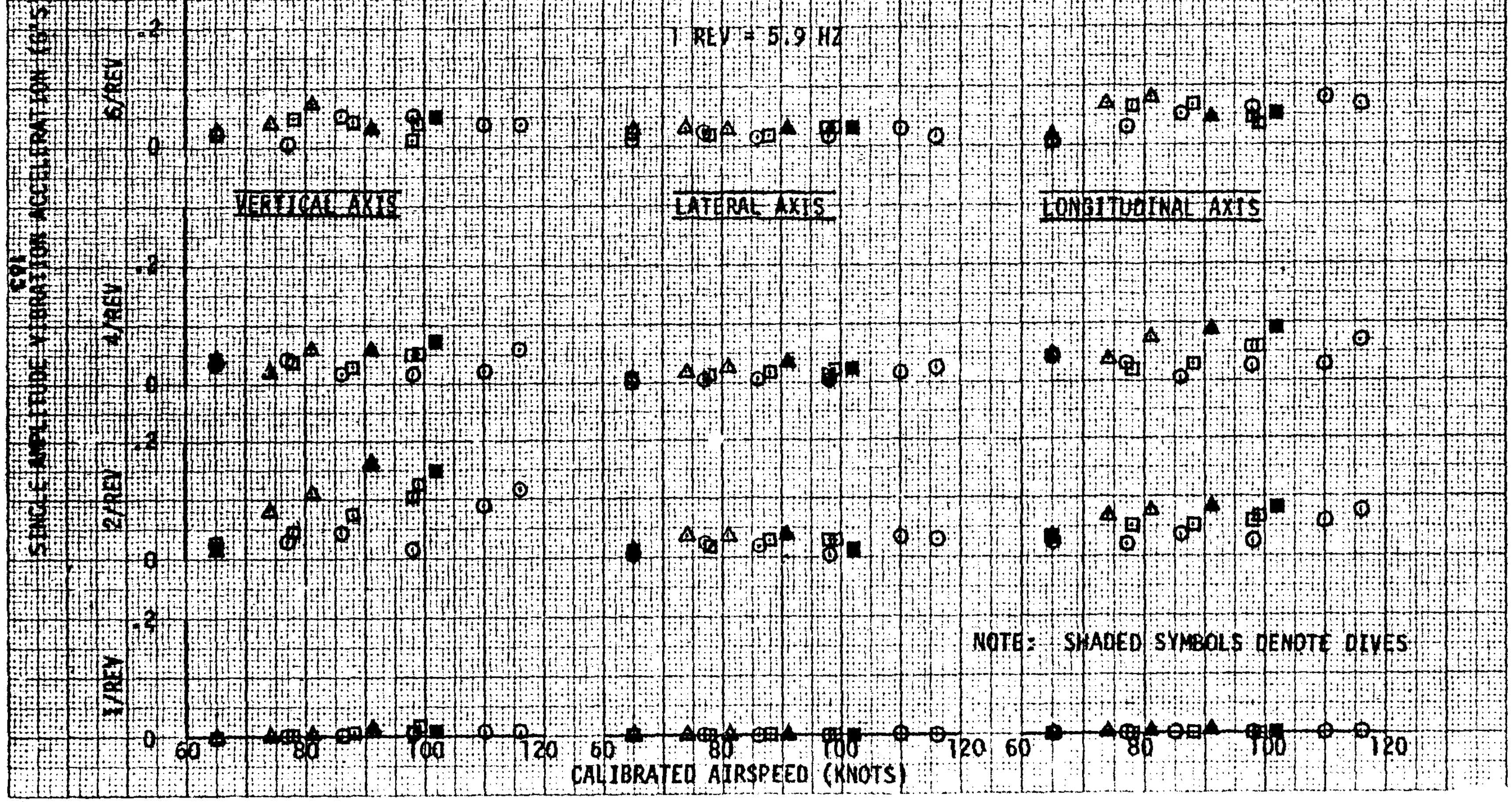


FIGURE 96
VIBRATION CHARACTERISTICS OF THE INSTRUMENT PANEL (CENTER)
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
○	3190	107.0(FWD)	0.1	5260	-12.0	355	CLEAN, DOORS ON	LEVEL
□	3210	107.2(FWD)	0.1	10640	-20.0	355	CLEAN, DOORS ON	LEVEL
△	3230	107.4(FWD)	0.1	13380	-25.0	355	CLEAN, DOORS ON	LEVEL

1 REV = 5.9 HZ

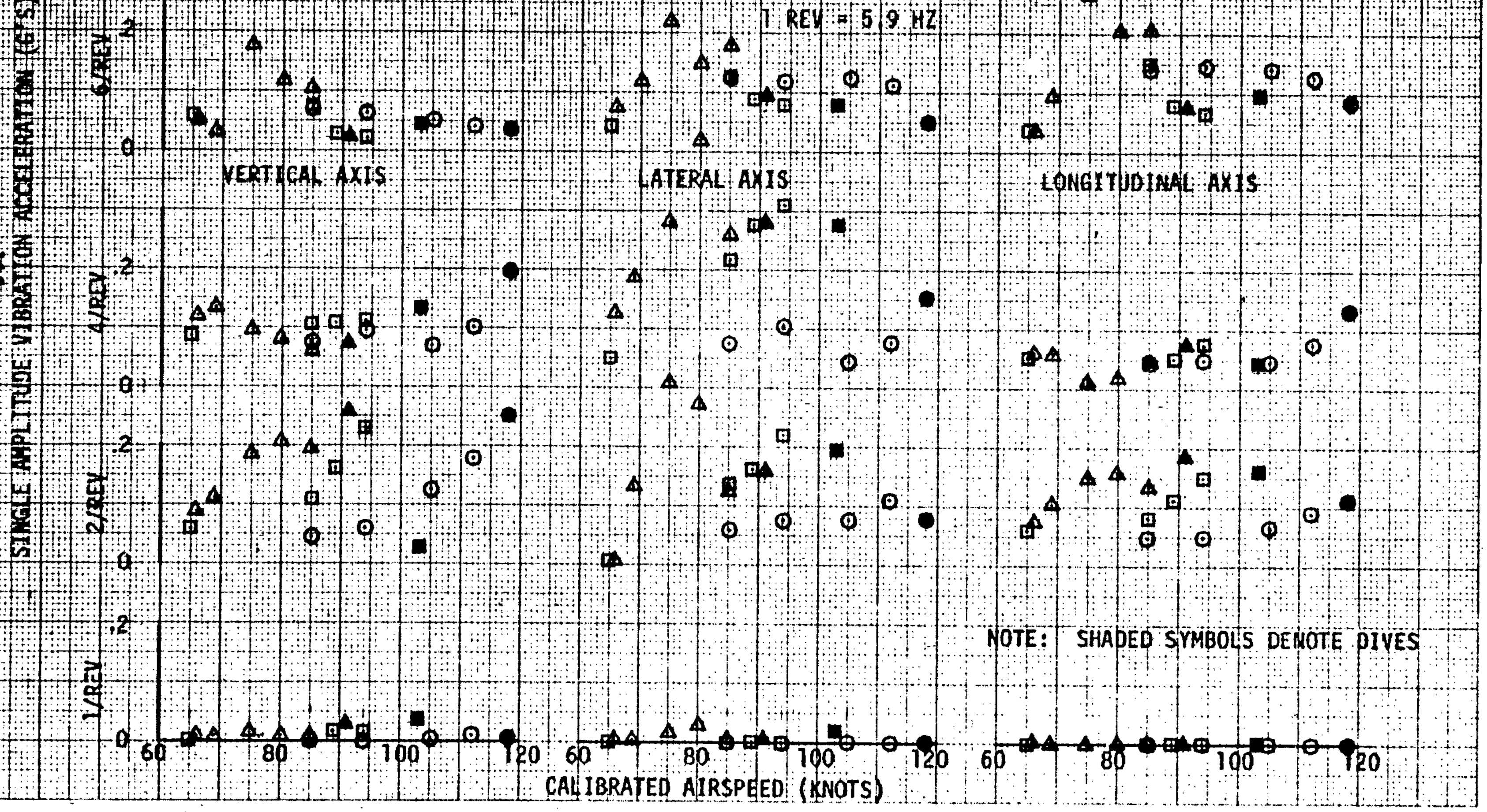


FIGURE 97

VIBRATION CHARACTERISTICS OF THE INSTRUMENT PANEL (CENTER)

OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
⊙	2980	107.3(FWD)	0.1	5760	-12.0	355	CLEAN, DOORS ON	LEVEL
⊡	3020	107.4(FWD)	0.1	10620	-20.0	355	CLEAN, DOORS ON	LEVEL
△	3040	107.5(FWD)	0.1	13380	-24.0	355	CLEAN, DOORS ON	LEVEL

1 REV = 5.9 HZ

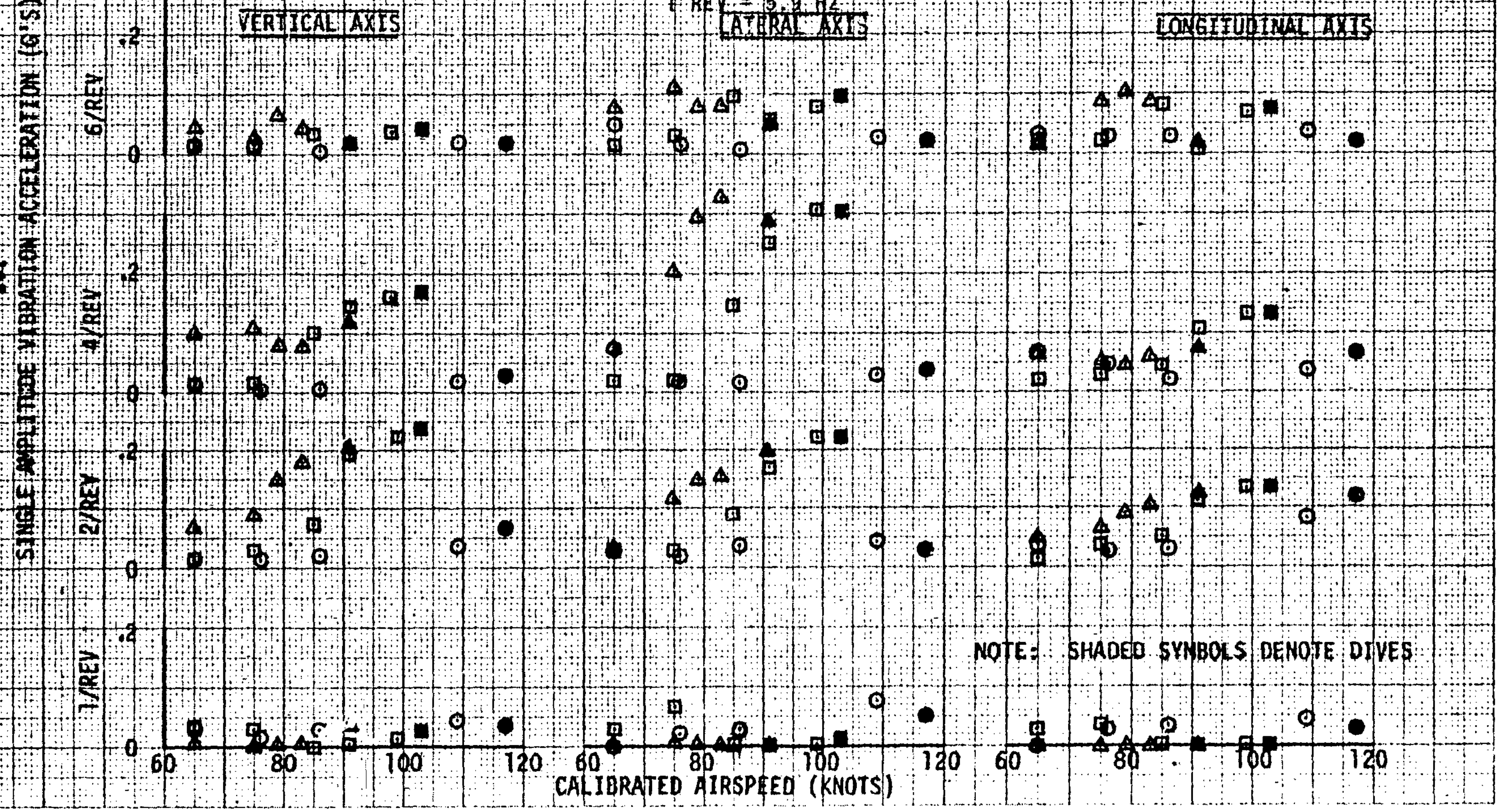


FIGURE 98

VIBRATION CHARACTERISTICS OF THE INSTRUMENT PANEL (CENTER)
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
⊙	2770	107.3(FWD)	0.1	5460	-10.5	355	CLEAN, DOORS ON	LEVEL
⊡	2800	107.4(FWD)	0.1	10620	-20.0	355	CLEAN, DOORS ON	LEVEL
△	2820	107.5(FWD)	0.1	13880	-22.0	355	CLEAN, DOORS ON	LEVEL

1 REV = 5.9 HZ

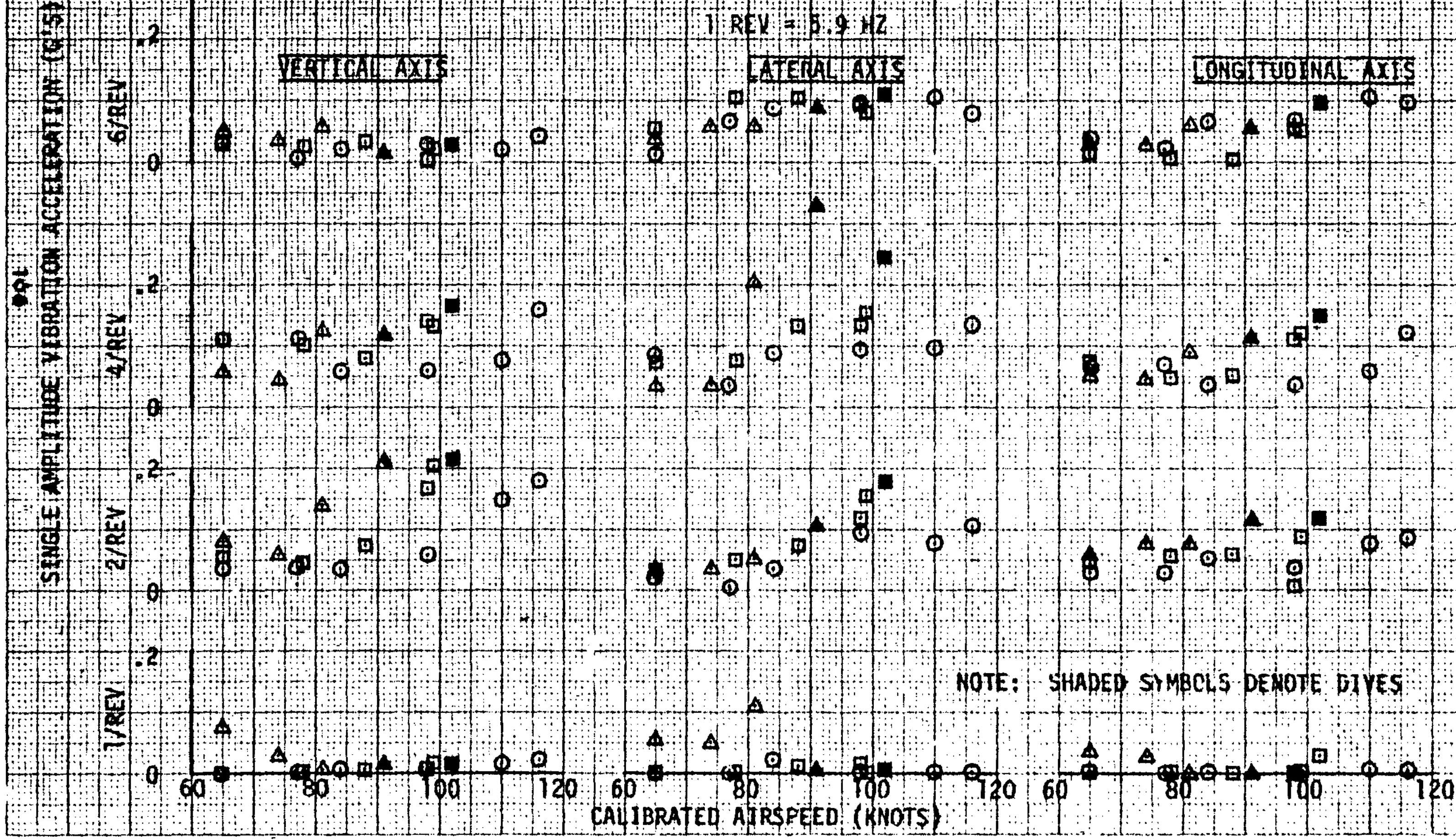


FIGURE 99
SHAFT HORSEPOWER AVAILABLE
OH-58C USA S/N 68-16724
MODEL T63-A-720 ENGINE
MAXIMUM CONTINUOUS POWER T_{16} = 738°C

NOTE: CURVES DERIVED FROM ALLISON ENGINE SPECIFICATIONS MODEL T63-A-720, 12 SEP 75, AND MODEL T63-A-700, 19 JUL 67.
A. STATIC CONDITIONS, ENGINE SPEED = 6180 RPM.
B. ZERO CUSTOMER BLEED AIR AND ANTIICE OFF.
C. OH-58A INLET AND EXHAUST LOSSES AND 2.0 SHP ACCESSORY LOSS FROM USAASTA REPORT NO. 68-30.
D. OH-58A INLET LOSSES FROM USAASTA REPORT NO. 68-30, EXHAUST LOSSES FROM USAASTA REPORT NO. 75-11, 11.09 SHP ACCESSORY LOSS FROM DETAIL SPECIFICATION 206-947-203.

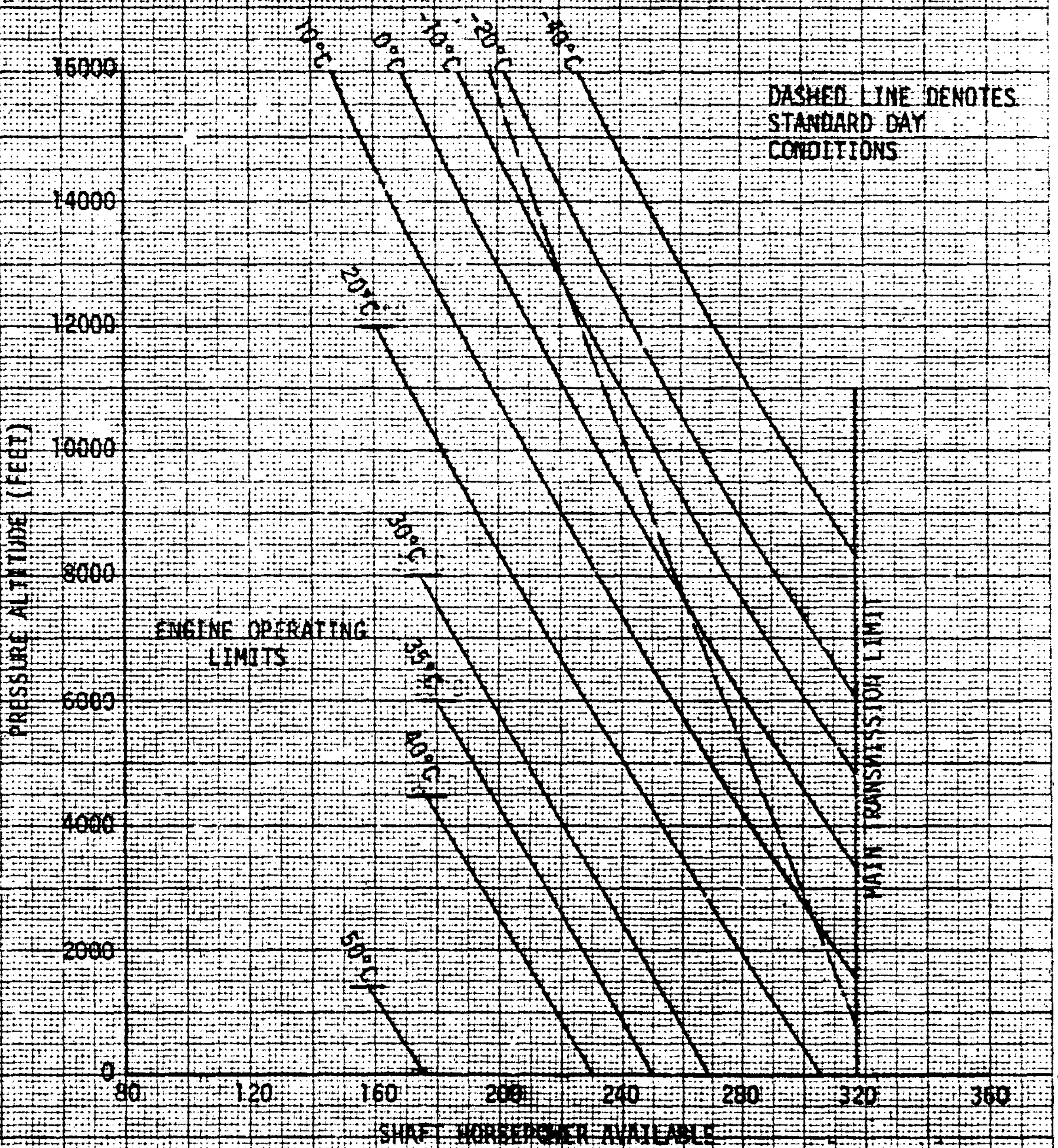


FIGURE 100
SHAFT HORSEPOWER AVAILABLE
OH-58C USA S/N 68-16724
MODEL T63-A-720 ENGINE
INTERMEDIATE RATED POWER T_{T5} = 810°C

NOTE: CURVES DERIVED FROM ALLISON ENGINE SPECIFICATIONS MODEL T63-A-720, 12 SEP 75, AND MODEL T63-A-700, 19 JUL 67.
A. STATIC CONDITIONS, ENGINE SPEED = 6180 RPM
B. ZERO CUSTOMER BLEED AIR AND ANTIICE OFF.
C. OH-58A INLET AND EXHAUST LOSSES AND 2.0 SHP ACCESSORY LOSS FROM USAASTA REPORT NO. 68-30.
D. OH-58A INLET LOSSES FROM USAASTA REPORT NO. 68-30, EXHAUST LOSSES FROM USAASTA REPORT NO. 75-11, 11.09 SHP ACCESSORY LOSS FROM DETAIL SPECIFICATION 206-947-203.

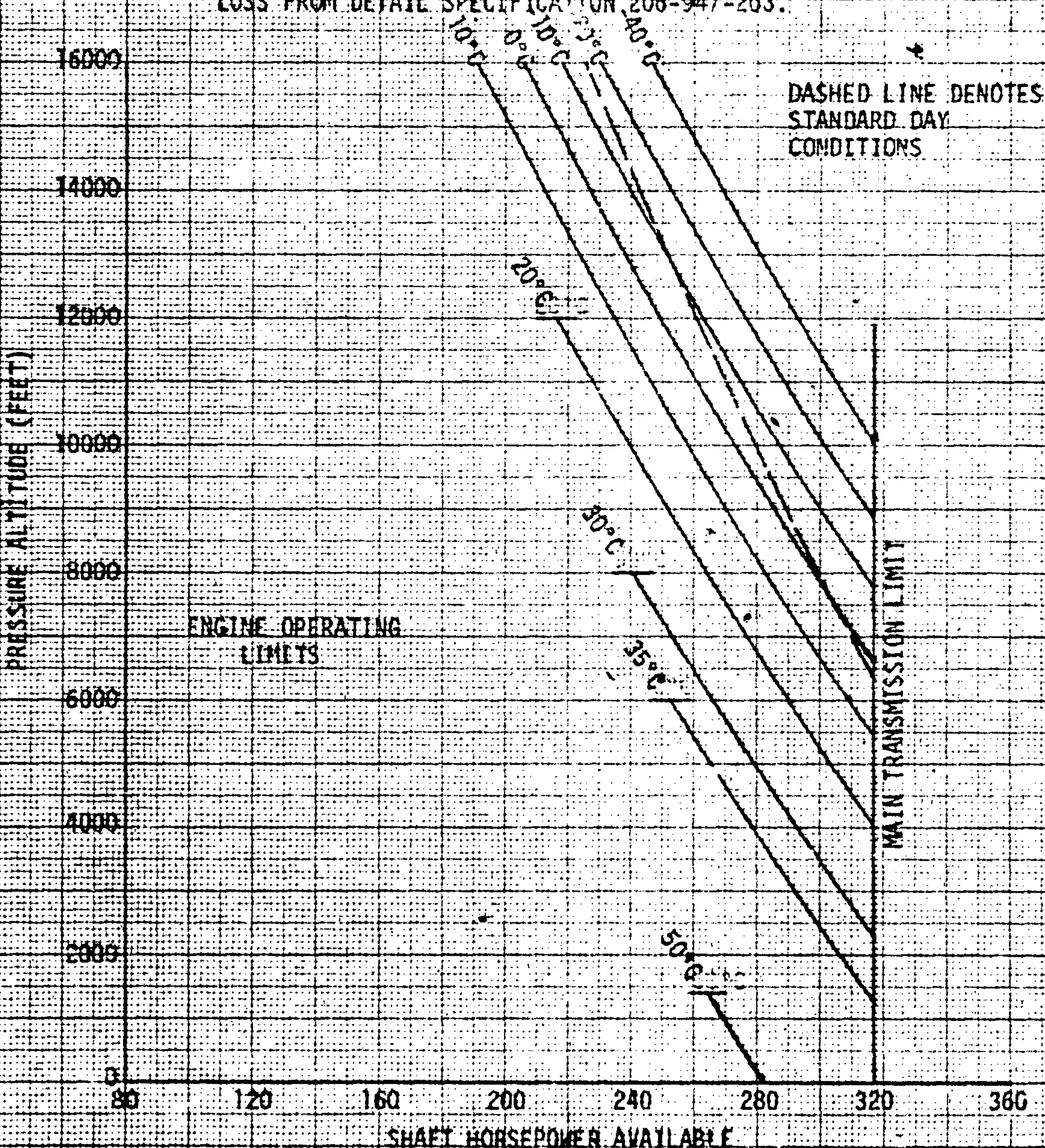


FIGURE 101
ENGINE SPECIFICATION FUEL FLOW
MODEL T63-A-720 ENGINE
STANDARD DAY CONDITIONS

NOTE: CURVES DERIVED FROM ALLISON ENGINE SPECIFICATION MODEL T63-A-720, 12 SEP 75; AND MODEL T63-A-700, 19 JUL 67.

A. STATIC CONDITIONS.
B. ZERO CUSTOMER BLEED AIR AND ANTIICE OFF.
C. OH-58A INLET AND EXHAUST LOSSES AND 2.0 SHP ACCESSORY LOSS FROM USAASTA REPORT NO. 68-30.
D. OH-58C INLET LOSSES FROM USAASTA REPORT NO. 68-30, EXHAUST LOSSES FROM USAASTA REPORT NO. 75-11, 11.09 SHP ACCESSORY LOSS FROM DETAIL SPECIFICATION 206-947-203.

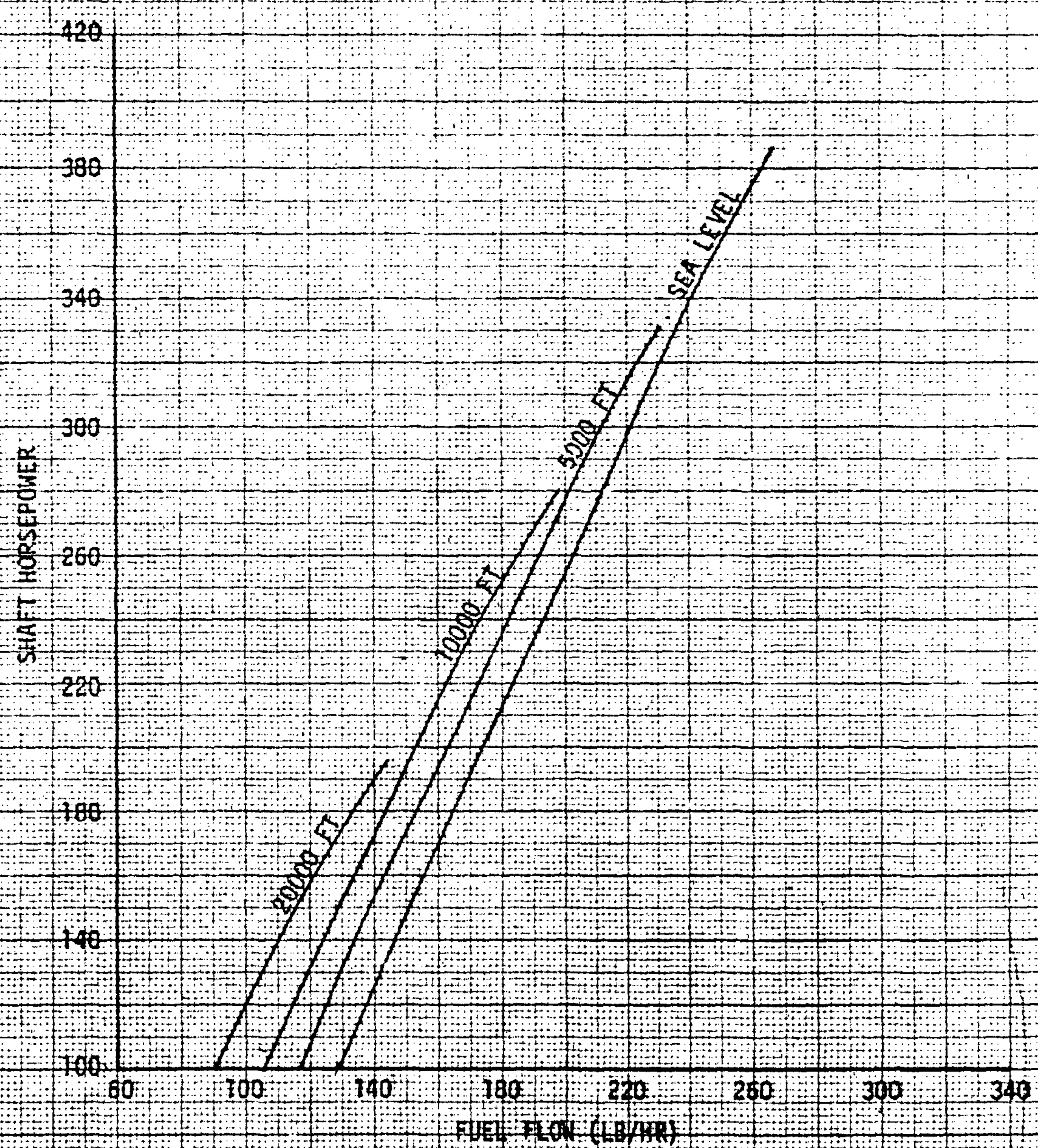
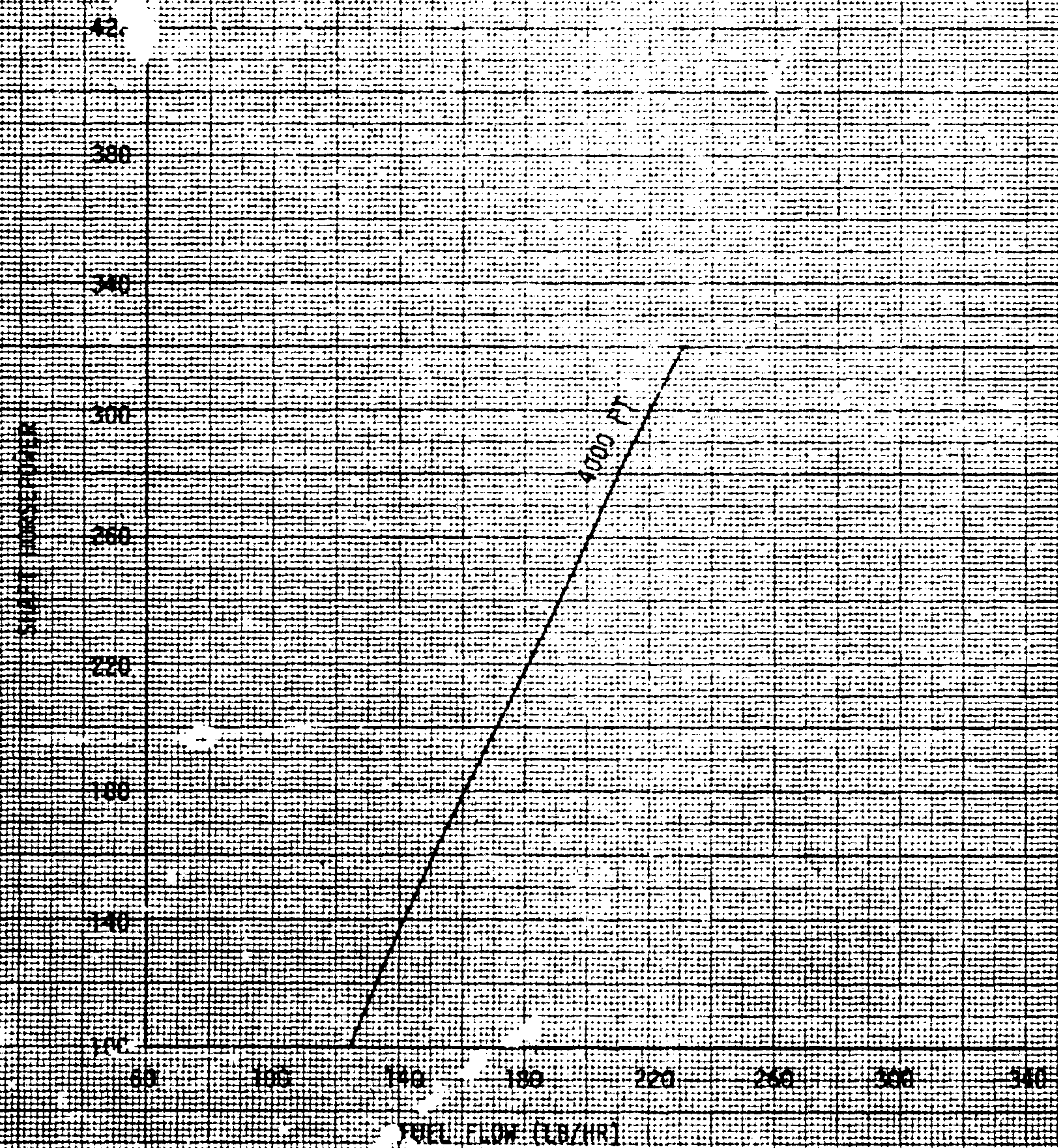


FIGURE 102
ENGINE SPECIFICATION FUEL FLOW
MODEL T63-A-720 ENGINE
HOT DAY (35°C) CONDITIONS

NOTE: CURVES DERIVED FROM ALLISON ENGINE SPECIFICATION MODEL T63-A-720, 12 SEP 75, AND MODEL T63-A-700, 19 JUL 67.

A. STATIC CONDITIONS.
B. ZERO CUSTOMER BLEED AIR AND ANTI-ICE OFF.
C. OH-58A INLET AND EXHAUST LOSSES AND 2.0 SHP ACCESSORY LOSS FROM USAASTA REPORT NO. 68-30.
D. OH-58C INLET LOSSES FROM USAASTA REPORT NO. 68-30, EXHAUST LOSSES FROM USAASTA REPORT NO. 75-11, 11.09 SHP ACCESSORY LOSS FROM DETAIL SPECIFICATION 206-947-203.



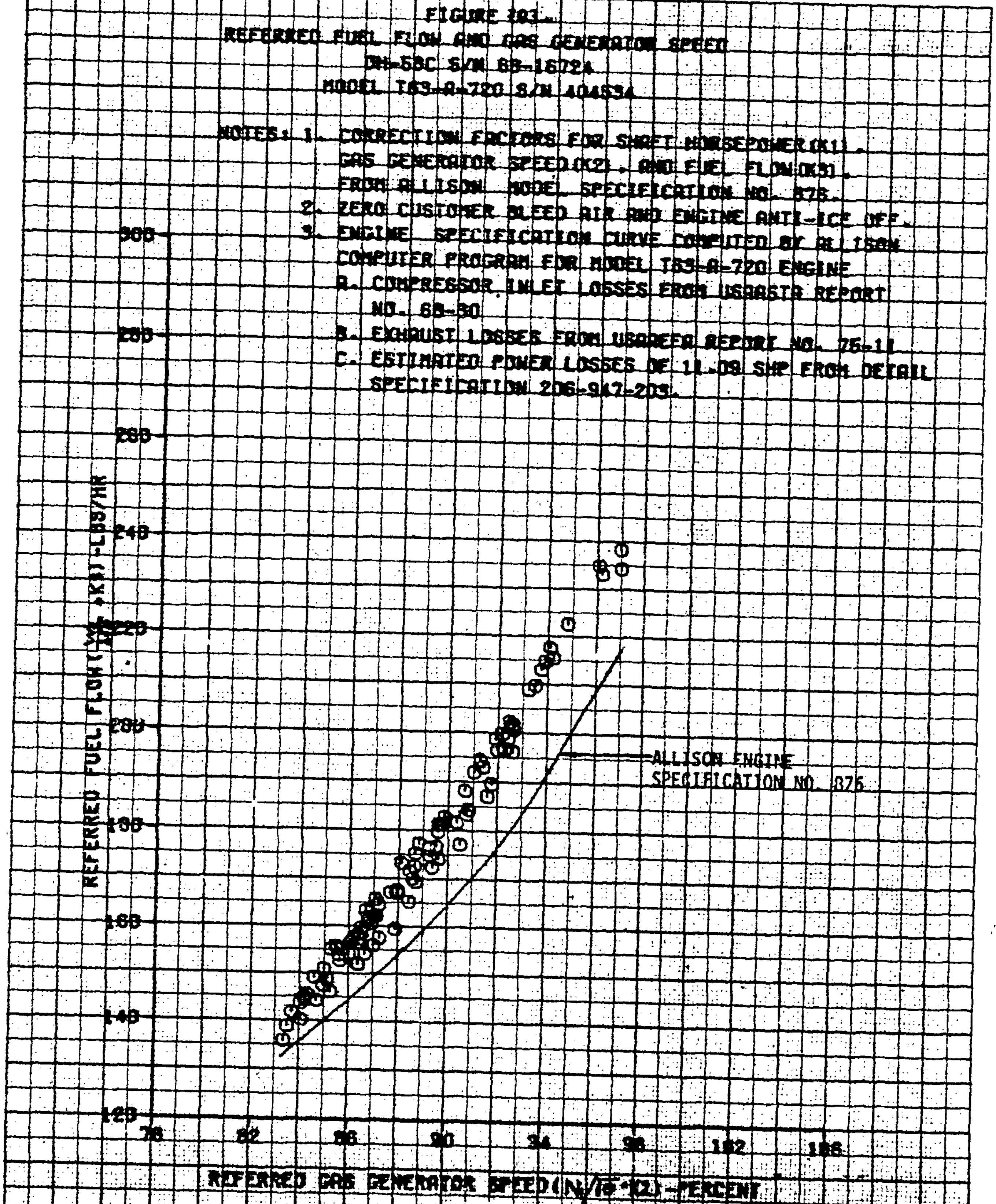


FIGURE 103.
REFERRED FUEL FLOW AND GAS GENERATOR SPEED
OH-58C S/N 68-16724
MODEL T63-A-720 S/N 404534
NOTES: 1. CORRECTION FACTORS FOR SHAFT HORSEPOWER(K1), GAS GENERATOR SPEED(K2), AND FUEL FLOW(K3), FROM ALLISON MODEL SPECIFICATION NO. 876.
2. ZERO CUSTOMER BLEED AIR AND ENGINE ANTI-ICE OFF.
3. ENGINE SPECIFICATION CURVE COMPUTED BY ALLISON COMPUTER PROGRAM FOR MODEL T63-A-720 ENGINE
A. COMPRESSOR INLET LOSSES FROM USAASTA REPORT NO. 68-30
B. EXHAUST LOSSES FROM USAAEFA REPORT NO. 75-11
C. ESTIMATED POWER LOSSES OF 11.09 SHP FROM DETAIL SPECIFICATION 206-947-203.
ALLISON ENGINE SPECIFICATION NO. 876
REFERRED FUEL FLOW -LBS/HR
300
280
260
240
220
200
180
160
140
120
78
82
86
90
94
98
102
106
REFERRED GAS GENERATOR SPEED -PERCENT

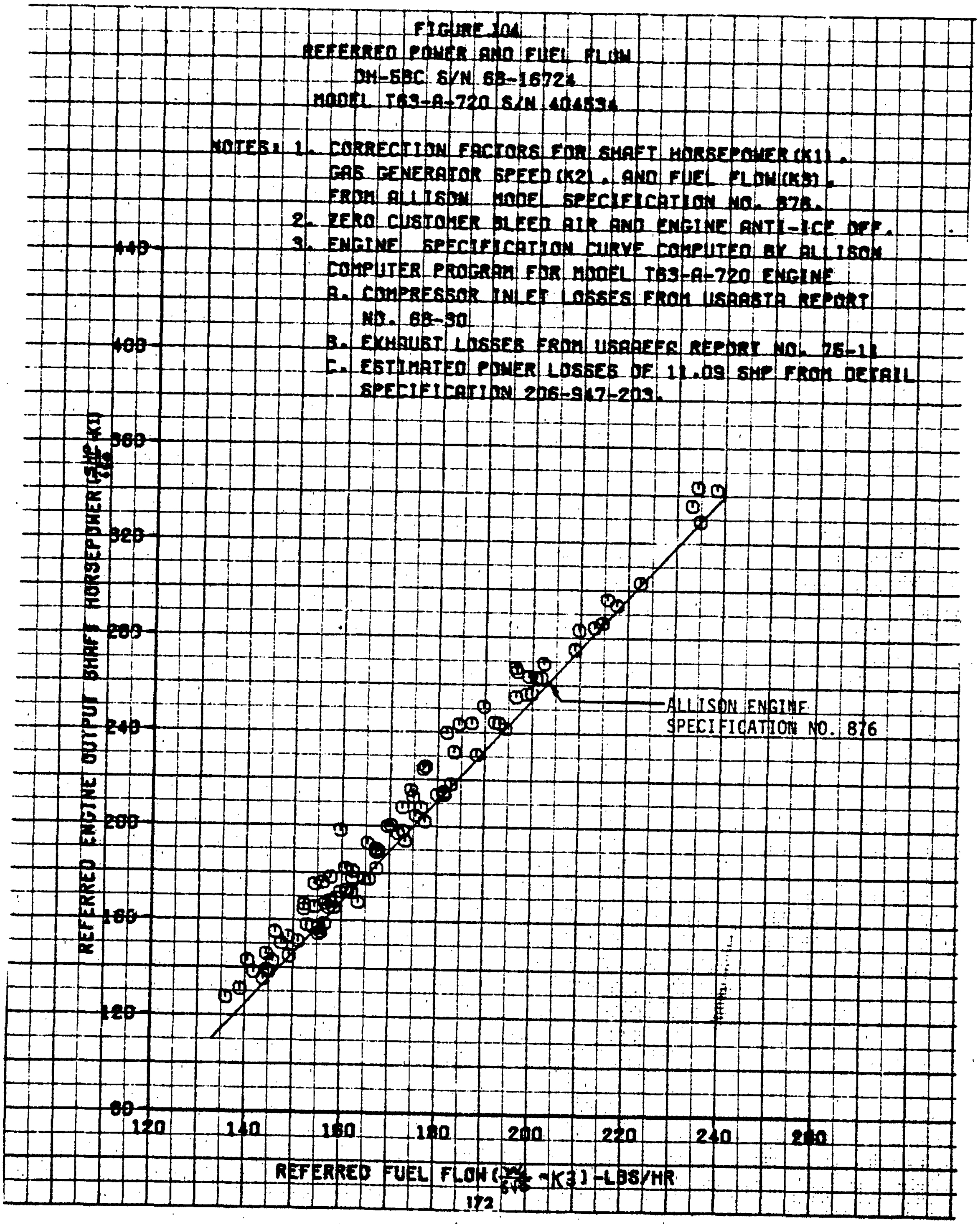


FIGURE 104
REFERRED POWER AND FUEL FLOW
OH-58C S/N 68-16724
MODEL T63-A-720 S/N 404534

FIGURE 105
REFERRED POWER AND GAS GENERATOR SPEED
OH-58C S/N 68-16724
MODEL T63-A-720 S/N 404534

NOTES: 1. CORRECTION FACTORS FOR SHAFT HORSEPOWER (K1), GAS GENERATOR SPEED (K2), AND FUEL FLOW (K3) FROM ALLISON MODEL SPECIFICATION NO. 876.
2. ZERO CUSTOMER BLEED AIR AND ENGINE ANTI-ICE OFF.
3. ENGINE SPECIFICATION CURVE COMPUTED BY ALLISON COMPUTER PROGRAM FOR MODEL T63-A-720 ENGINE
A. COMPRESSOR INLET LOSSES FROM USAASTA REPORT NO. 68-30
B. EXHAUST LOSSES FROM USAAEFA REPORT NO. 75-11
C. ESTIMATED POWER LOSSES OF 11.09 SHP FROM DETAIL SPECIFICATION 206-947-203.

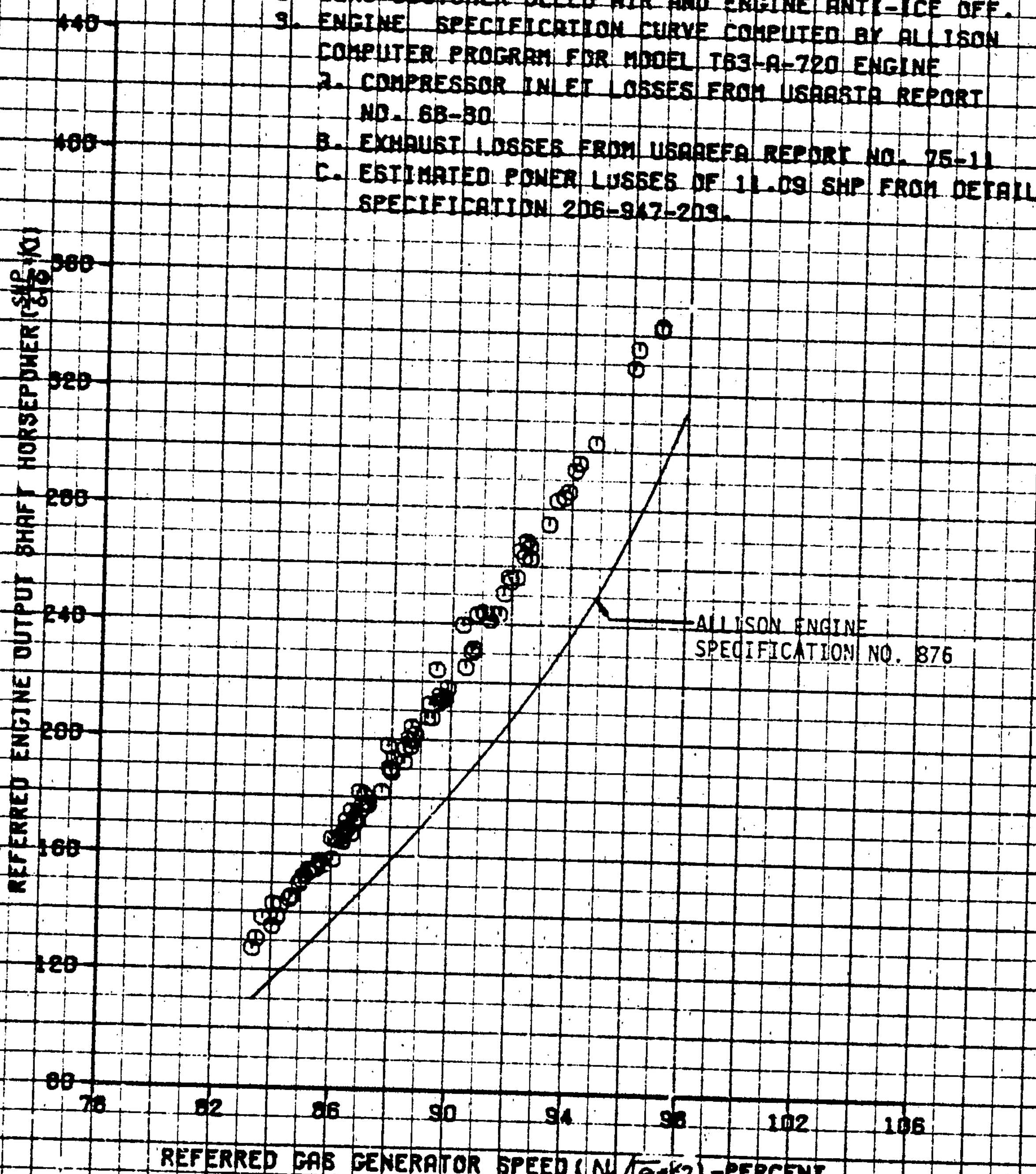


FIGURE 106

REFERRED POWER AND TURBINE OUTLET TEMPERATURE

OH-58C S/N 68-16724

MODEL T63-A-720 S/N 404534

NOTES: 1. CORRECTION FACTORS FOR SHAFT HORSEPOWER (K1), GAS GENERATOR SPEED (K2), AND FUEL FLOW (K3), FROM ALLISON MODEL SPECIFICATION NO. 876.

2. ZERO CUSTOMER BLEED AIR AND ENGINE ANTI-ICE OFF.

3. ENGINE SPECIFICATION CURVE COMPUTED BY ALLISON COMPUTER PROGRAM FOR MODEL T63-A-720 ENGINE

   A. COMPRESSOR INLET LOSSES FROM USAASTA REPORT NO. 68-30

   B. EXHAUST LOSSES FROM USAAEFA REPORT NO. 76-11

   C. ESTIMATED POWER LOSSES OF 11.09 SHP FROM DETAIL SPECIFICATION 206-947-203.

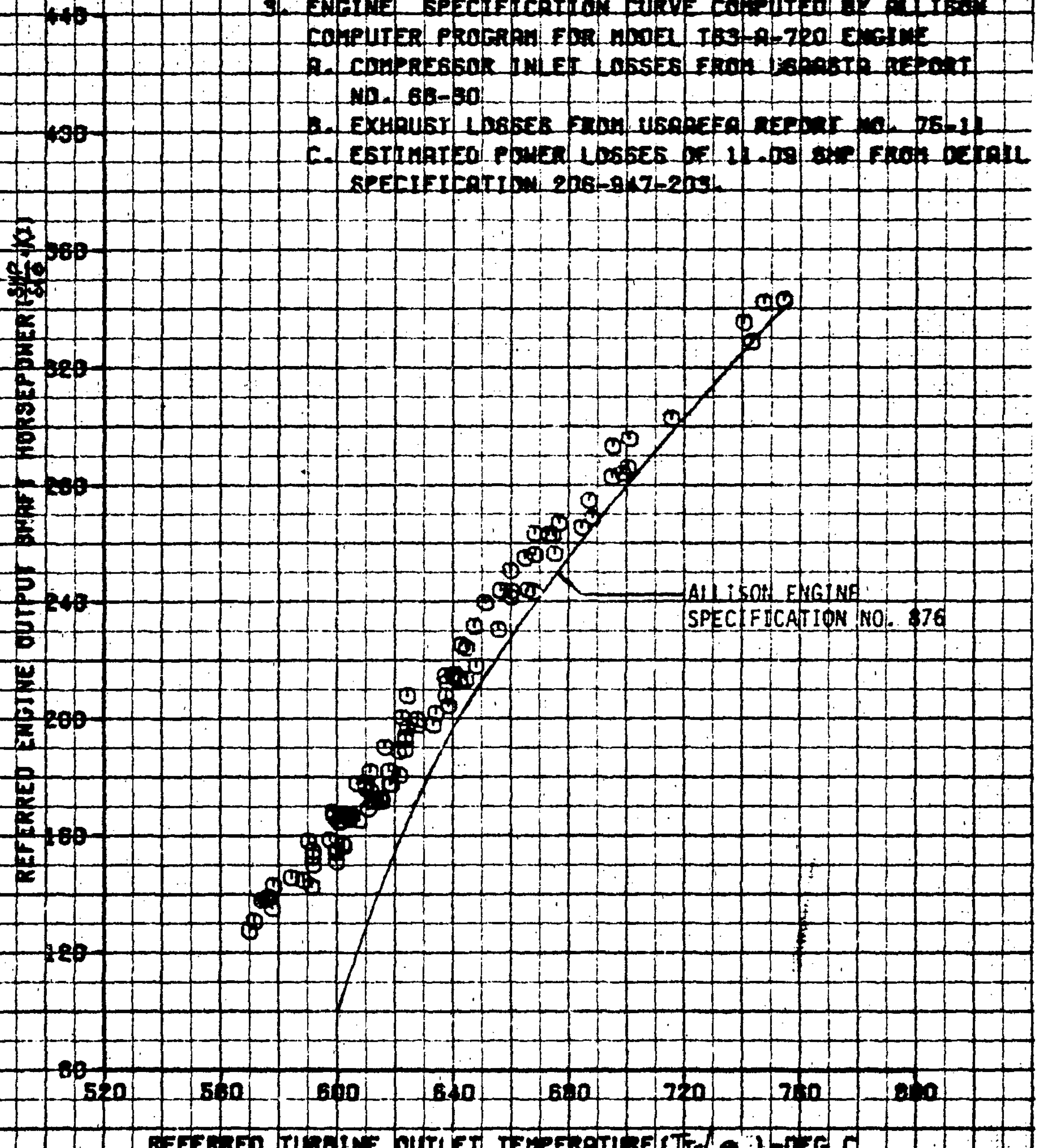


FIGURE 107
REFERRED TURBINE OUTLET TEMPERATURE AND GAS GENERATOR SPEED
OH-58C S/N 68-16724
MODEL T63-A-720 S/N 404534

NOTES: 1. CORRECTION FACTORS FOR SHAFT HORSEPOWER (K1), GAS GENERATOR SPEED (K2), AND FUEL FLOW (K3) FROM ALLISON MODEL SPECIFICATION NO. 876.
2. ZERO CUSTOMER BLEED AIR AND ENGINE ANTI-ICE OFF.
3. ENGINE SPECIFICATION CURVE COMPUTED BY ALLISON COMPUTER PROGRAM FOR MODEL T63-A-720 ENGINE
A. COMPRESSOR INLET LOSSES FROM USAASTA REPORT NO. 68-30
B. EXHAUST LOSSES FROM USAAEFA REPORT NO. 75-11
C. ESTIMATED POWER LOSSES OF 11.09 SHP FROM DETAIL SPECIFICATION 206-947-203.

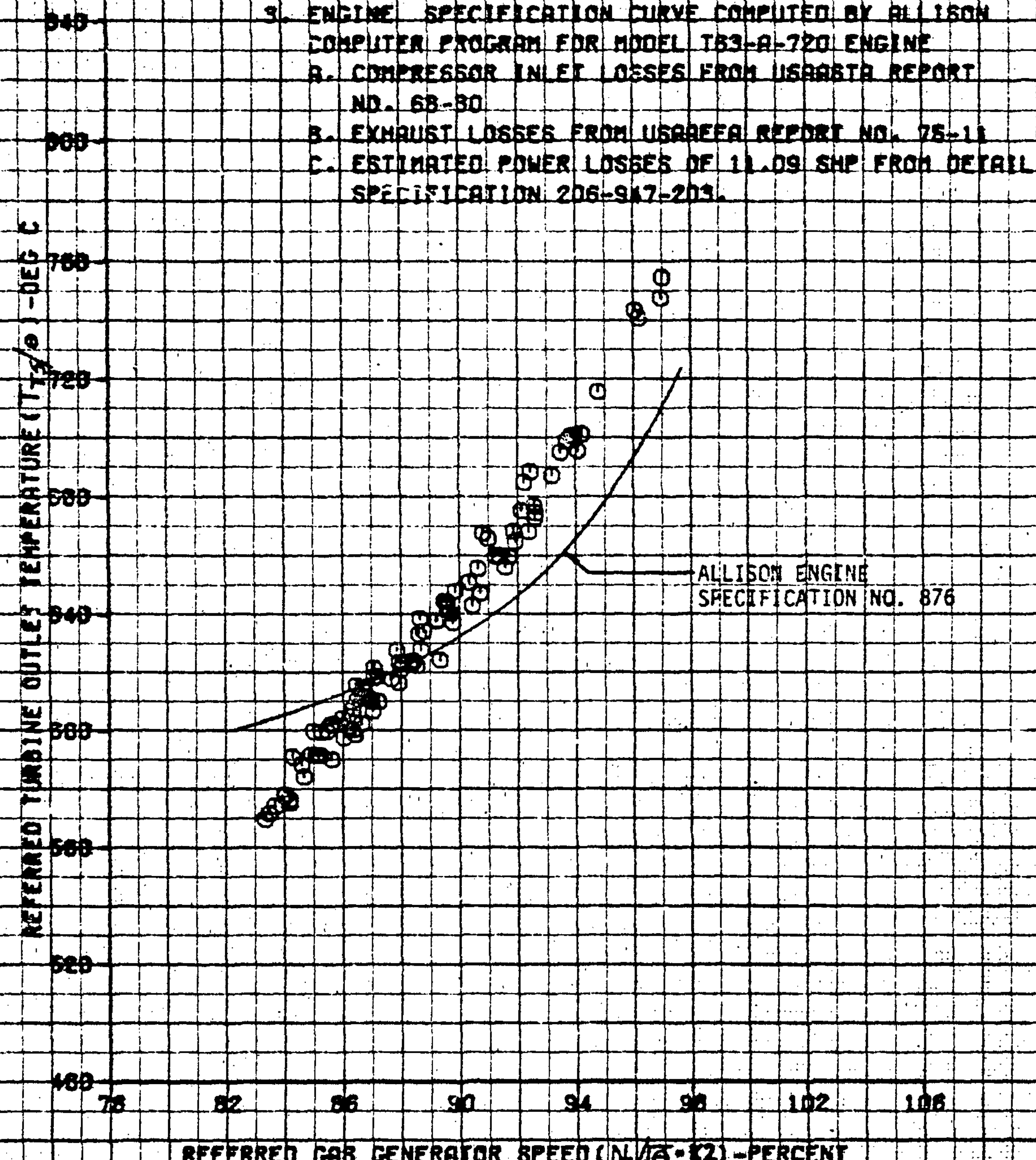


FIGURE 108

REFERRED TURBINE OUTLET TEMPERATURE AND FUEL FLOW

OH-58C S/N 68-16724

MODEL T63-A-720 S/N 404534

NOTES: 1. CORRECTION FACTORS FOR SHAFT HORSEPOWER (K1), GAS GENERATOR SPEED (K2), AND FUEL FLOW (K3), FROM ALLISON MODEL SPECIFICATION NO. 876.

2. ZERO CUSTOMER BLEED AIR AND ENGINE ANTI-ICE OFF.

3. ENGINE SPECIFICATION CURVE COMPUTED BY ALLISON COMPUTER PROGRAM FOR MODEL T63-A-720 ENGINE

A. COMPRESSOR INLET LOSSES FROM USAASTA REPORT NO. 68-30

B. EXHAUST LOSSES FROM USAAEFA REPORT NO. 75-14

C. ESTIMATED POWER LOSSES OF 11.09 SHP FROM DETAIL SPECIFICATION 206-947-203.

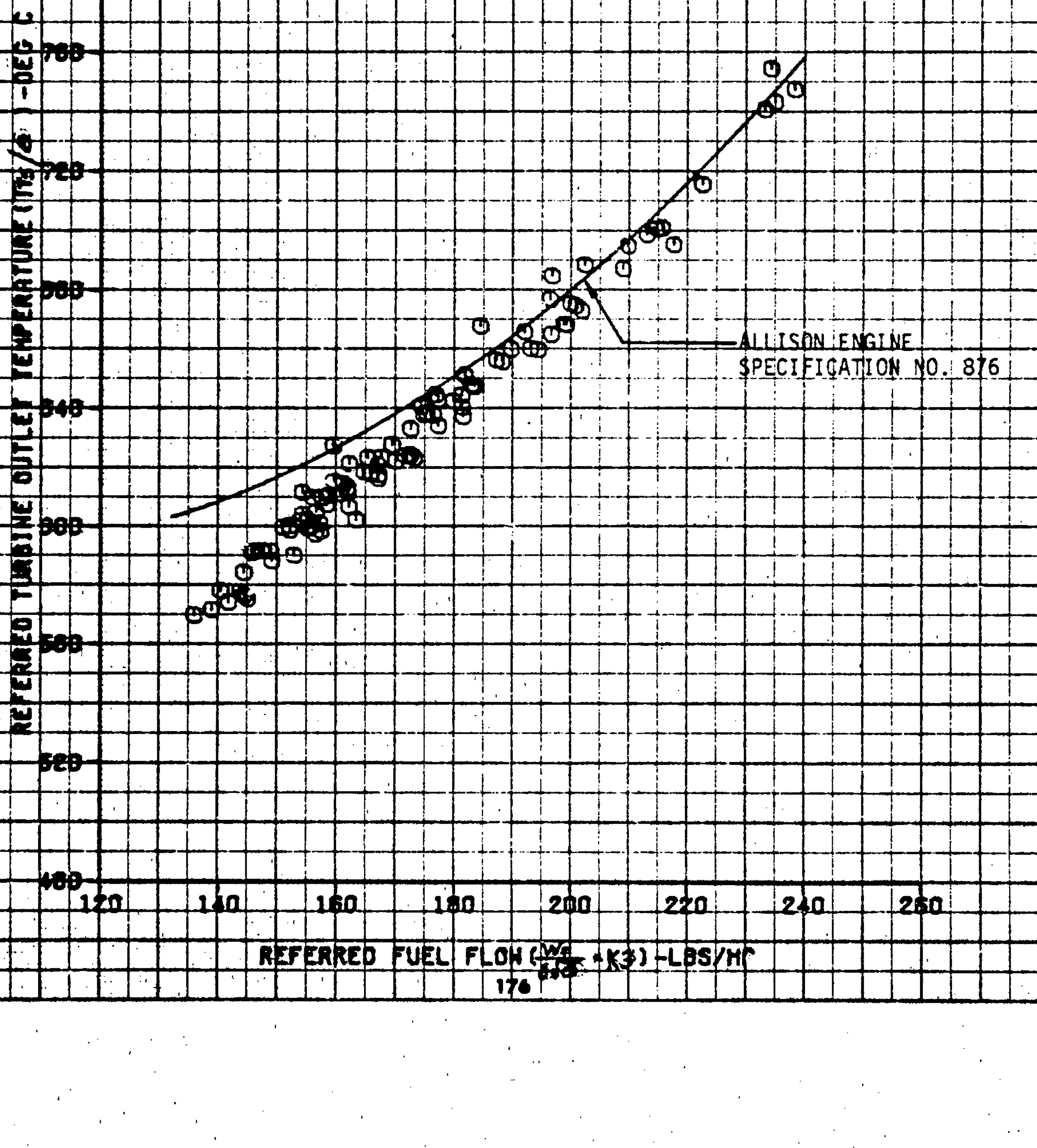


FIGURE 109

SHIPS SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT

OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	METHOD
○	2820	109.1 (MID)	0.5	5020	9.0	355	TRAILING BOMB
□	2820	109.1 (MID)	0.5	5020	9.0	355	PACE
△	2840	109.2 (MID)	0.5	5100	15.0	355	PACE
◇	2820	109.3 (MID)	0.5	5200	24.0	355	TRAILING BOMB

NOTE: 1. DIAMONDS DENOTE BOOM SYSTEM REMOVED
2. CONFIGURATION CLEAN, DOORS ON

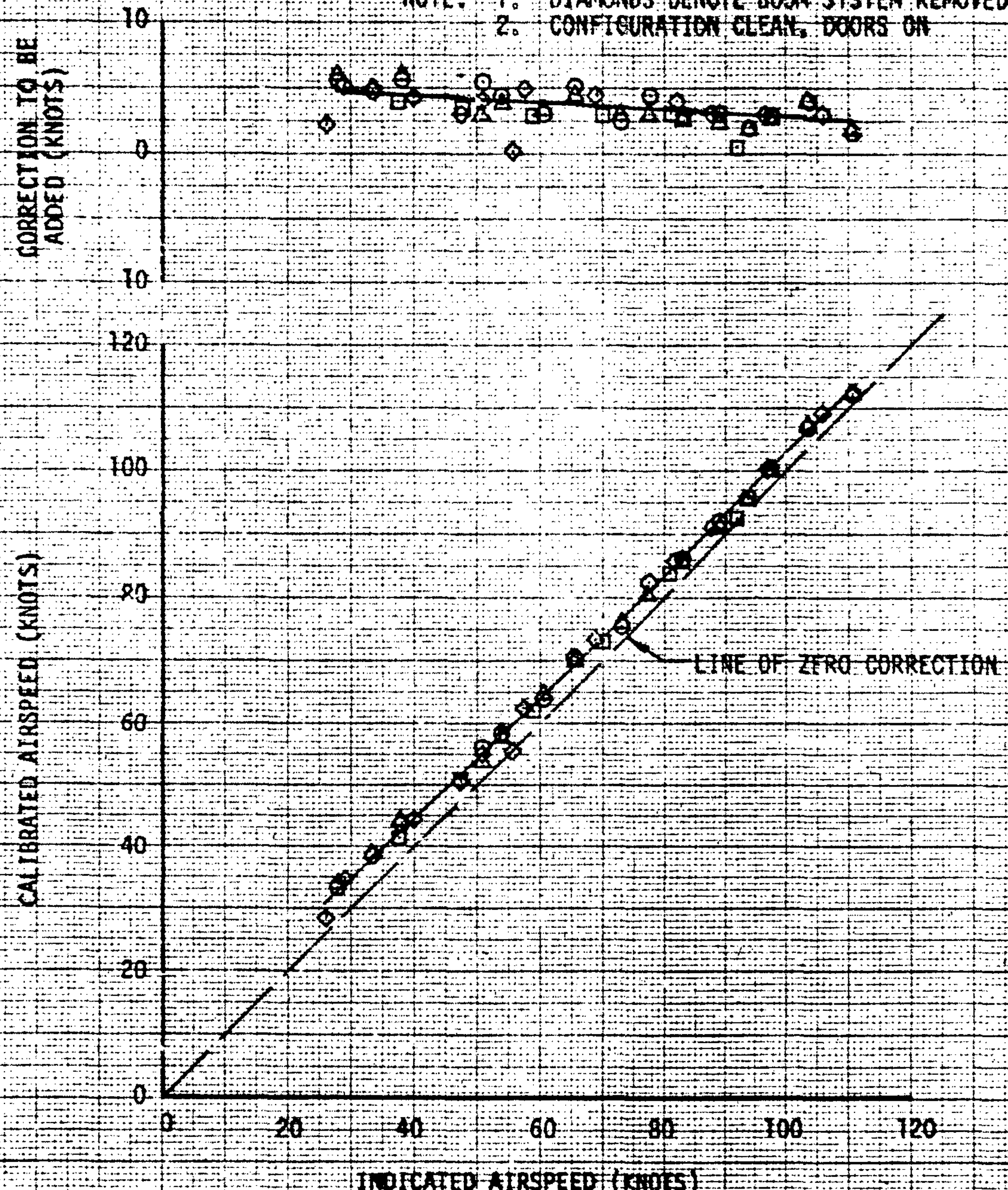


FIGURE 410
SHIPS SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	METHOD
○	2800	109.1 (MID)	0.5	5200	9.0	355	TRAILING BOMB
◇	2820	109.3 (MID)	0.5	5120	24.0	355	TRAILING BOMB

NOTE: 1. DIAMONDS DENOTE BOOM SYSTEM REMOVED
2. CONFIGURATION CLEAN, DOORS ON

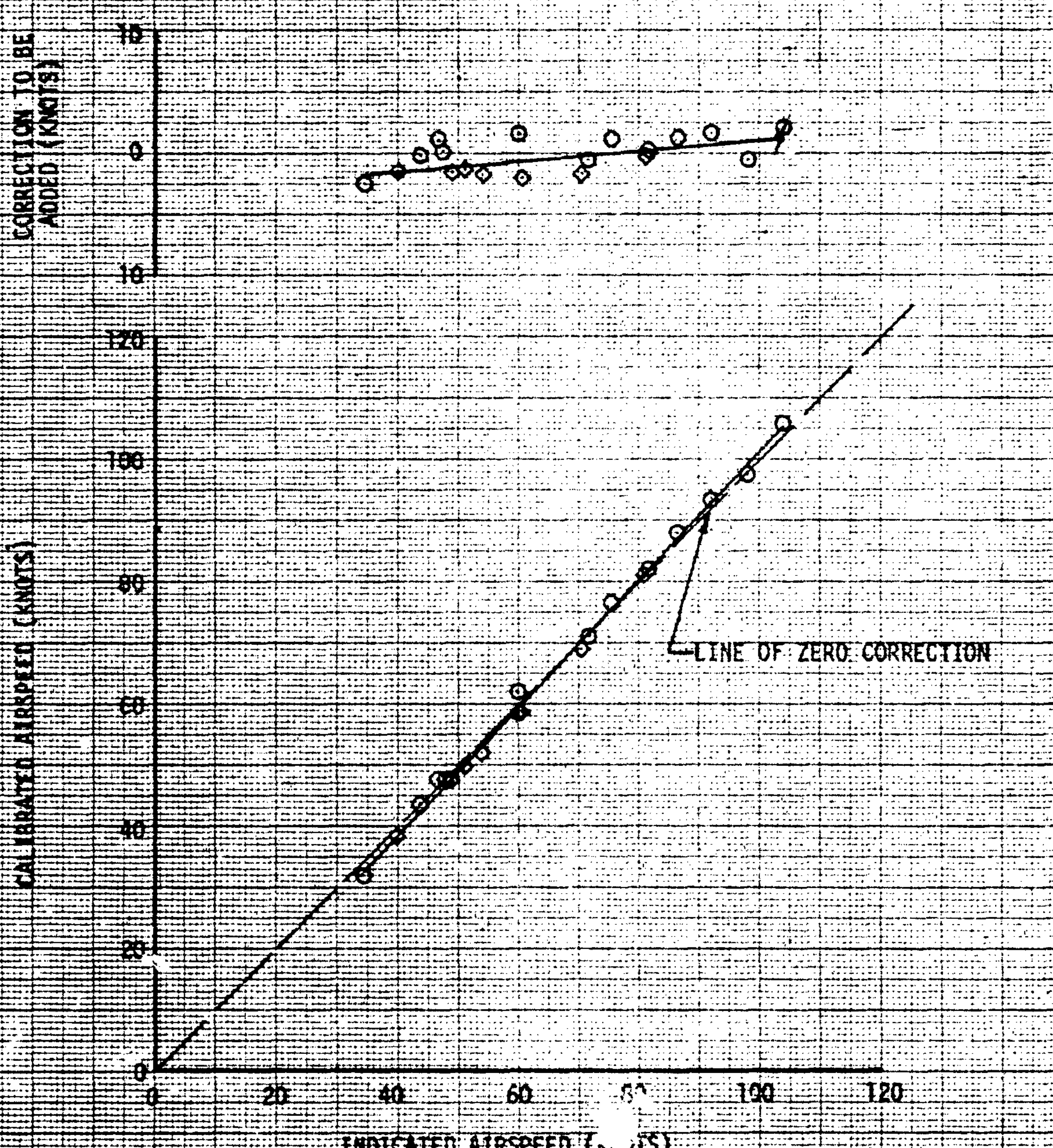


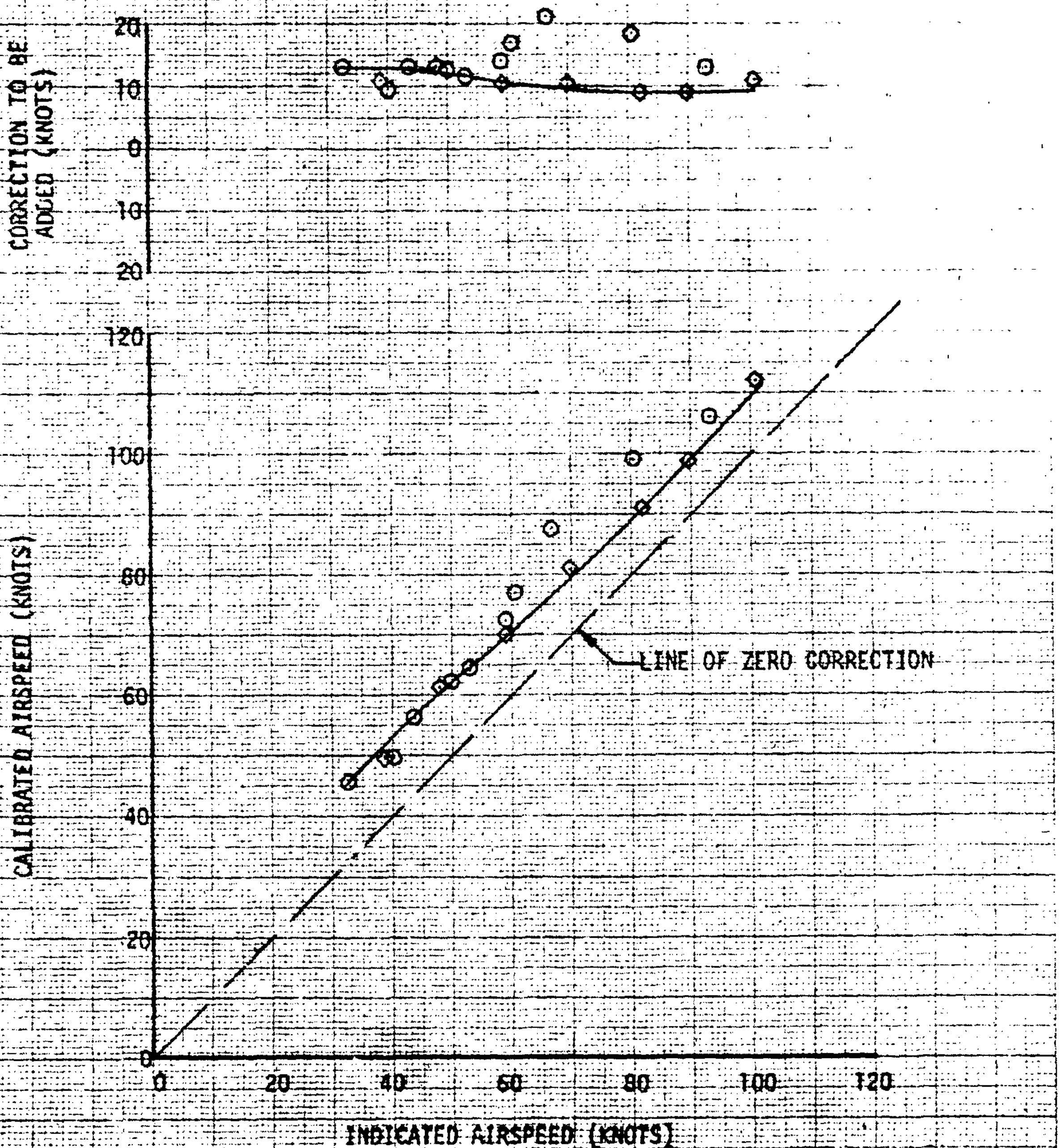
FIGURE [illegible]

SHIPS SYSTEM AIRSPEED CALIBRATION IN AUTOROTATION

OH-58C USA S/N 68-16724

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	METHOD
⊙	2800	109.1 (MID)	0.5	5120	9.0	355	TRAILING BOMB
◇	2840	109.3 (MID)	0.5	5200	24.0	355	TRAILING BOMB

NOTE: 1. DIAMONDS DENOTE BOOM SYSTEM REMOVED
2. CONFIGURATION CLEAN, DOORS ON



APPENDIX F. EQUIPMENT PERFORMANCE REPORTS

The following EPR's were submitted during the Model OH-58C A&FC and are included as part of this appendix.

EPR NO.	Date Submitted	Descriptive Title
76-11-1	21 Jun 78	Primary Directional Control System Uncommanded Disconnect
76-11-2	1 Jul 78	Adjustment: Gas Generato Fuel Control Start Derichment
76-11-3	12 Jul 78	Stiff Directional Control System at Cold Ambient Temperature
76-11-4	29 Aug 78	Failure P.T. Line (Engine Air Line
76-11-5	5 Sep 78	Clogged Oil Cooler Transmission Hose
76-11-6	20 Sep 78	Failure Caution Light Annunciator and Control Panel
76-11-7	26 Sep 78	Failure Caution Light Annunciator and Controi Panel

APPENDIX G. ABBREVIATED TEST PLAN, OH-58C VIBRATION AND NOE TESTS

DEPARTMENT OF THE ARMY
U. S. ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

14 NOV 1978

DAVTE-TA

SUBJECT: Abbreviated Test Plan, OH-58C Vibration and NOE Tests, USAAEFA Project No. 76-11-3

Commander
US Army Aviation Research and Development Command
ATTN: DRDAV-EQI
PO Box 209
St. Louis, Missouri 63166

1. References. a. Fonecon between Mr. Charles Crawford, DRDAV-EQI, and Mr. John Blaha, USAAEFA, 27 Oct 78.

b. Message, DRDAV-EQI, subject: USAAEFA Project No. 76-11-2 OH-58C A&FC, dated 28 Oct 78.

2. Introduction. As a result of the US Army Aviation Engineering Flight Activity (USAAEFA) testing of the OH-58C helicopter during Project No. 76-11-2 A&FC, an investigation of the never-exceed airspeed limit envelope based on gross weight as well as density altitude was recommended. The USAAEFA was tasked (ref b) to conduct flight tests to obtain vibration data in level and diving flight and fly a nap-of-the-earth (NOE) course with the specially instrumented OH-58C helicopter S/N 68-167[illegible]. It is anticipated that a total of 12 flying hours will be required (6 hours at Edwards AFB and 6 hours at a NOE course). Test flying is scheduled to begin on or about 20 Nov 78, with a target completion date of 1 Dec 78.

3. Detail of Test. The tests for vibration data in level and diving flight will be conducted at Edwards AFB, CA, under the conditions listed in table 1. The instrument panel will be returned to near standard configuration for these tests. The vibration at the floor under the pilot and copilot seats and at the center and upper left corner of the instrument panel will be recorded on magnetic tape. This instrumentation will be installed by the USAAEFA personnel. This is in addition to the parameters already installed on the test aircraft. The NOE courses at Fort Hunter-Liggett, CA, will be utilized for the NOE portion of this test. A NOE flight instructor will be on board for all NOE tests. Several NOE courses will be used to obtain data for vibrations and handling qualities

and two USAAEFA test pilots will fly the courses. A motion picture camera will be used from the chase aircraft to photograph the test helicopter during the performance of several of its mission maneuvers.

Table 1. Test Conditions[1]

Test	Gross Weight (lb)	Density Altitude (ft)	Indicated Airspeed (kts)	Remarks
Level and[2] diving flight	2700, 3000 & 3200	5000, 10000 & 14000	50 to V_{NE}[3] (10 knot increments)	Power for[4] level flight
NOE course	3200	surface	zero to 50	

[1]Configuration: clean, all doors on. Fuselage cg 107.3(FWD), butt line cg 0.5(RT).
[2]Main rotor speed 347 and 355 rpm.
[3]V_{NE} never exceed airspeed.
[4]Power for maximum level flight airspeed will be used during dives.

4. The following pretest checks and calibrations have been performed during Project 76-11-2 OH-58C A&FC and will be used or upgraded as necessary for these tests:

Weight and balance
Fuel cell calibration
Control system rigging

5. Safety. The highest degree of safety precautions will be observed throughout the entire test program. During the flight test on the NOE course, a crash rescue UH-1 (Firebird) aircraft with trained firemen and a medic will be utilized. The project officer will have an up-to-date preaccident plan for the test site.

6. Test Report. An abbreviated test report will be submitted to the US Army Aviation Research and Development Command as soon as practical after completion of test flying.

DENNIS M. BOYLE
Colonel, Armor
Commanding

EQUIPMENT PERFORMANCE REPORT
(AVSCOM Reg 70-12)

DATE: 12 JUL 78

OFFICE SYMBOL: DAVTE-TA

TO	FROM
COMMANDER US ARMY AVIATION SYSTEMS COMMAND ATTN: DRSAV-EQ PO BOX 209 ST. LOUIS, MISSOURI 63166	Commander US Army Aviation Engr Flt Activity ATTN: DAVTE-TA Edwards AFB, CA 93523

1. EPR NUMBER	2. PROJECT NUMBER	3. TEST TITLE
76-11-3	76-11	OH-58C A & FC

SECTION A - MAJOR ITEM DATA

4. MODEL: OH-58C	5. SERIAL NO: 68-16724
6. QUANTITY: One (1)	7. MANUFACTURER: Bell Helicopter Textron

SECTION B - PART DATA

8. NOMENCLATURE/DESCRIPTION	9. NSN
10. MFR PART NO	11. MANUFACTURER
12. QUANTITY	13. NEXT ASSEMBLY

SECTION C - INCIDENT DATA

14. OBSERVED DURING	15. TEST ENVIRONMENT	16. INCIDENT CLASS	17. ACTION TAKEN
X a. OPERATION	Experimental Flight Testing	X a. DEFICIENCY	REPLACED
b. MAINTENANCE		b. SHORTCOMING	REPAIRED
c.		c. SUGGESTED IMPROVEMENT	ADJUSTED
		d. OTHER	DISCONNECTED
			REMOVED
			X NONE

18. DATE AND HOUR OF INCIDENT

SECTION D - INCIDENT DESCRIPTION

19. DESCRIBE INCIDENT FULLY (Deficiencies and Shortcomings are subject to reclassification)

During early morning high altitude testing, with ambient temperature of 0° C, the directional control system became extremely stiff. Pedal breakout force was estimated at 35 lb. Rapid pedal inputs resulted in jam light illumination (50 lb). After 1.5 hrs. of flight, the pedals returned to normal (ambient temp at 10°C). A similar problem was encountered on another flight with an ambient temperature of 3°C; however, pedal stiffness was not as severe.

Suspect cold induced binding in secondary directional control system due to lubricant used or dissimilar metals. Potential problem during cold weather operations.

20. DEFECTIVE MATERIAL SENT TO

NAME, TITLE, TELEPHONE OF PREPARER	SIGNATURE
SHERWOOD C. SPRING, MAJ, SC Project Officer 76-11-2, 350-6234	Sherwood C. Spring

AV Form 1002, 1 May 76 — Edition of 1 Aug 74, may be used.

EQUIPMENT PERFORMANCE REPORT
(AVSCOM Reg 70-12)

DATE: 1 July 1978

OFFICE SYMBOL: DAVTE-TA

TO:
COMMANDER
US ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-EQ
PO BOX [illegible]
ST. LOUIS, MISSOURI [illegible]

FROM:
Commander
US Army Aviation Engr Flight Activity
ATTN: DAVTE-TA
Edwards AFB, CA 93523

1. EPR NUMBER: 76-11-2

2. PROJECT NUMBER: 76-11

3. TEST TITLE: OH-58C A & FC

SECTION A - MAJOR ITEM DATA

4. MODEL: OH-58C

5. SERIAL NO: 68-16724

6. QUANTITY: One (1)

7. MANUFACTURER: Bell Helicopter Textron

SECTION B - PART DATA

8. NOMENCLATURE/DESCRIPTION: Engine/T63-A720

9. NSN: T63-A720

10. MFR PART NO:

11. MANUFACTURER: Allison

12. QUANTITY: Two (2)

13. NEXT ASSEMBLY:

SECTION C - INCIDENT DATA

14. OBSERVED DURING	15. TEST ENVIRONMENT	16. INCIDENT CLASS	17. ACTION TAKEN
X a. OPERATION	1) Experimental Flight Testing - Engine Start 2) Ferry Flight - Engine Start	a. DEFICIENCY	REPLACED
b. MAINTENANCE		b. SHORTCOMING	REPAIRED
c.		c. SUGGESTED IMPROVEMENT	X ADJUSTED (Fuel Control)
		X d. OTHER	DISCONNECTED
			REMOVED
			NONE

18. DATE AND HOUR OF INCIDENT:

SECTION D - INCIDENT DESCRIPTION

19. DESCRIBE INCIDENT FULLY (Deficiencies and Shortcomings are subject to reclassification)

During battery start at 2300 ft, 4100 ft, and 7012 ft, engine would hang start at 30% N., start sequence to 30% N. was normal, boost pump and advanced throttle had no effect. Starts with auxiliary power (APU) were intermittently successful, but not reliable. Production engine involved at 7012 ft, 2nd production engine with calibrated torque system involved at 2300 and 4100 ft.

Adjusted gas producer fuel control start derichment per instructions in TM 55-2840-241-23 pg. 5-11 (g) on the 2nd production engine.

Recommend NOTE be added to maintenance manual and operator's manual highlight requirement for fuel control adjustment when changing aircraft operating environment. The required fuel control adjustment is listed as item K or the 11th item of trouble shooting table 4-1 (TM 55-2840-241-23) with no note or highlight to emphasize need during altitude changes.

20. DEFECTIVE MATERIAL SENT TO

NAME, TEL AND OF PREPARER: SHERWOOD C. SPRING, MAJ, SC, Project Officer 76-11, 350-6234

SIGNATURE: [signature]

AV Form 1002, 1 May 76 — Edition of 1 Aug 74, may be used.

EQUIPMENT PERFORMANCE REPORT
(AVSCOM Reg 70-12)

DATE: 21 June 1978

OFFICE SYMBOL: DAVTE-TA

TO: COMMANDER
US ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-EQ
PO BOX 209
ST. LOUIS, MISSOURI 63166

FROM: Commander
US Army Avn Engr Flight Activity
ATTN: DAVTE-TA
Edwards AFB, CA 93523

1. EPR NUMBER	2. PROJECT NUMBER	3. TEST TITLE
76-11-1	76-11	OH-58C A & FC

SECTION A - MAJOR ITEM DATA

4. MODEL: OH-58C	5. SERIAL NO: 68-16724
6. QUANTITY: One (1)	7. MANUFACTURER: Bell Helicopter Textron

SECTION B - PART DATA

8. NOMENCLATURE/DESCRIPTION: "Disconnect" Electro-Mechanical Control Tube	9. NSN: 1680 01-734-0521
10. MFR PART NO: 206 001 798-1	11. MANUFACTURER:
12. QUANTITY:	13. NEXT ASSEMBLY:

SECTION C - INCIDENT DATA

14. OBSERVED DURING	15. TEST ENVIRONMENT	16. INCIDENT CLASS	17. ACTION TAKEN
X a. OPERATION	Experimental Flight Test	X a. DEFICIENCY	X REPLACED
b. MAINTENANCE	30 Knot Right Sideward Flight	b. SHORTCOMING	REPAIRED
c.	- Repeatable	c. SUGGESTED IMPROVEMENT	ADJUSTED
		d. OTHER	DISCONNECTED
			REMOVED
			NONE

18. DATE AND HOUR OF INCIDENT

SECTION D - INCIDENT DESCRIPTION

19. DESCRIBE INCIDENT FULLY (Deficiencies and Shortcomings are subject to reclassification)

During stabilized right sideward flight at 30 kts, the primary directional control system disconnected without pilot actuation. Disconnect was evidenced by the PRI. DIR. CONTR. Disconnect and JAM Light illuminating and by slippage of the left directional pedal to the mechanical stop (approximately one inch). Controlled flight was maintained through the secondary system, and primary directional control was regained after neutralizing pedals. Failure was repeated four times and recorded on an onboard flight recorder. Through recorded data, failure was traced to the forward Electro-mechanical "disconnect". A thorough rigging and electrical check was performed as outlined in the maintenance manual and revealed no discrepancies in the system other than caution light sequencing which had been previously documented. The failure could not be duplicated on the ground.

20. DEFECTIVE MATERIAL SENT TO

NAME, TITLE, TEL EXT OF PREPARER	SIGNATURE
SHERWOOD C. SPRING, MAJ, SC Project Officer 76-11-2 76234	

AV Form 1002, 1 May 76 — Edition of 1 Aug 74, may be used.

EQUIPMENT PERFORMANCE REPORT
(AVSCOM Reg [illegible])

DATE: 29 August 1978

OFFICE SYMBOL: DAVTE-TA

TO:
COMMANDER
US ARMY AVIATION SYSTEMS COMMAND
ATTN: [illegible]
PO BOX [illegible]
ST. LOUIS, [illegible]

FROM:
Commander
US Army Avia ion Engr Flight Activity
ATTN: DAVTE-TA
Edwards AFB, CA 93523

1. EPR NUMBER	2. PROJECT NUMBER	3. TEST TITLE
76-11-4	76-11	OH-58C A&FC

SECTION A - MAJOR ITEM DATA

4. MODEL: OH-58C (engine)	6. SERIAL NO: 68-16724
5. QUANTITY: one (1)	7. MANUFACTURER: Bell Helicopter Textron

SECTION B - PART DATA

8. NOMENCLATURE/DESCRIPTION: P.T. line (engine air line)	9. NSN: FSN:4710-01-042-5501
10. MFR PART NO: PN: 6877277-A	11. MANUFACTURER: Allison
12. QUANTITY: two (2)	13. NEXT ASSEMBLY:

SECTION C - INCIDENT DATA

14. OBSERVED DURING	15. TEST ENVIRONMENT	16. INCIDENT CLASS	17. ACTION TAKEN
X a. OPERATION	Engine surge in flight.	X a. DEFICIENCY	X REPLACED
X b. MAINTENANCE	Leak check on ground.	b. SHORTCOMING	REPAIRED
c.		c. SUGGESTED IMPROVEMENT	ADJUSTED
		d. OTHER	DISCONNECTED
			X REMOVED
			NONE

18. DATE AND HOUR OF INCIDENT: 25 Aug 78, 0730 hrs

SECTION D - INCIDENT DESCRIPTION

19. DESCRIBE INCIDENT FULLY (Deficiencies and Shortcomings are subject to reclassification)

During an experimental test flight, engine roughness, torque fluctuations and lateral airframe oscillations were observed. Post flight analysis of inflight data indicated a fuel control malfunction. A leak check was performed and revealed a hairline crack on the inside of the flared end of the PT air line from the double check valve to the fuel control. An identical air line was removed from a spare engine (we are testing with a calibrated engine) and had a similar crack on the opposite end of the line on the inside of the flared portion.

NOTE: Flight Fax Vol. 6 No. 37, dated 5 Jul 78 strictly prohibits local manufacture of replacement lines.

20. DEFECTIVE MATERIAL SENT TO:

NAME, TITLE, TEL EXT OF PREPARER	SIGNATURE
SHERWOOD C. SPRING, MAJ, SC Project Officer, Project 76-11	Sherwood C Spring

AV Form 1002, 1 May 76 — Edition of 1 Aug 74, may be used.

EQUIPMENT PERFORMANCE REPORT

(USAAVSCOM Reg [illegible])

DATE: 5 September 1978

OFFICE SYMBOL: DAVTE-TA

TO:
COMMANDING GENERAL
US ARMY AVIATION SYSTEMS COMMAND
ATTN: [illegible]
PO BOX [illegible]
ST. LOUIS, MISSOURI [illegible]

FROM:
Commander
US Army Aviation Engr Flight Activity
ATTN: DAVTE-TA
Edwards AFB, CA 93523

1. EPR NUMBER	2. PROJECT NUMBER	3. TEST TITLE
76-11-5	76-11	OH-58C A&FC

SECTION A - MAJOR ITEM DATA

4. MODEL: OH-58C	5. SERIAL NO: 68-16724
6. QUANTITY: one (1)	7. MANUFACTURER: Bell Helicopter Textron

SECTION B - PART DATA

8. NOMENCLATURE/DESCRIPTION: transmission oil cooler	9. FSN:
10. MFR PART NO: 8537936	11. MANUFACTURER: Bell Helicopter Textron
12. QUANTITY: one	13. NEXT ASSEMBLY: transmission

SECTION C - INCIDENT DATA

14. OBSERVED DURING	15. TEST ENVIRONMENT	16. INCIDENT CLASS	17. ACTION TAKEN
a. OPERATION	observed during transmission replacement	X a. DEFICIENCY	REPLACED
X b. MAINTENANCE		b. SHORTCOMING	REPAIRED
c.		X c. SUGGESTED IMPROVEMENT	ADJUSTED
		d. OTHER	DISCONNECTED
			REMOVED
			X NONE cleaned

18. DATE AND HOUR OF INCIDENT: 26 Aug 78

SECTION D - INCIDENT DESCRIPTION

19. DESCRIBE INCIDENT FULLY (Deficiencies and Shortcomings are subject to reclassification)

During transmission replacement on an OH-58C, the transmission cooler (which is attached) and transmission cooler hose were also removed. Approximately one pound of grass, leaves, and compacted debris was found lodged inside the oil cooler assembly. Although no transmission OIL HOT warning light had illuminated in previous flights, it is felt that only a little additional debris would have been required to cause an air blockage and probable forced landing. The only inspection required, item 3.23 TM 55-1520-228-PMS, calls for a visual inspection. "Transmission oil cooler and duct for condition, security, and obstruction." There is no screen on the intake end of the transmission cooler hose.

Recommend an inspection interval and procedure be implemented and that a small mesh screen be placed over the intake to the blower leading into the transmission oil cooler hose.

20. DEFECTIVE MATERIAL SENT TO

NAME, TITLE, TEL EXT OF PREPARER	SIGNATURE
AV 350-6234 SHERWOOD C. SPRING, MAJ, SC Project Officer, Project 76-11	Sherwood C. Spring

SAV Form 1002
7 Apr 76

EQUIPMENT PERFORMANCE REPORT
(AVSCOM [illegible])

DATE: 26 Sep 78

OFFICE SYMBOL: DAVTE-TA

TO:
COMMANDER
US ARMY AVIATION SYSTEMS COMMAND
ATTN: [illegible]
PO BOX [illegible]
ST. LOUIS, MISSOURI [illegible]

FROM:
Commander
US Army Aviation Engr Flt Activity
ATTN: DAVTE-TA
Edwards AFB, CA 93523

1. EPR NUMBER	2. PROJECT NUMBER	3. TEST TITLE
76-11-7	76-11	OH-58C A&FC

SECTION A - MAJOR ITEM DATA

4. MODEL: OH-58C	6. SERIAL NO: 68-16724
5. QUANTITY: one (1)	7. MANUFACTURER: Bell Helicopter Textron

SECTION B - PART DATA

8. NOMENCLATURE/DESCRIPTION: Caution Light Annunciator & Control Pane	9. NSN: 1680-01-033-8134
10. MFR PART NO: 206-075-456-17 Change 1	11. MANUFACTURER: Grimes Mfg Co
12. QUANTITY: three (3)	13. NEXT ASSEMBLY:

SECTION C - INCIDENT DATA

14. OBSERVED DURING	15. TEST ENVIRONMENT	16. INCIDENT CLASS	17. ACTION TAKEN
X a. OPERATION	aircraft start	X a. DEFICIENCY	X REPLACED
b. MAINTENANCE		b. SHORTCOMING	REPAIRED
c.		c. SUGGESTED IMPROVEMENT	ADJUSTED
		d. OTHER	DISCONNECTED
			X REMOVED
			NONE

18. DATE AND HOUR OF INCIDENT: 26 Sep 78 0730 hrs

SECTION D - INCIDENT DESCRIPTION

19. DESCRIBE INCIDENT FULLY (Deficiencies and Shortcomings are subject to reclassification)

During a power ON aircraft inspection, the caution panel circuit breaker popped and would not reset. Failure was traced to an internal electrical short inside the caution light annunciator and control panel. This is the third caution panel to fail in the same manner in a two month period (first fail 3 Aug 78, second fail 20 Sep 78). Total flight time on the third caution panel is 0.7 hours. The caution panels are being held for analysis. A visual and electrical inspection of the helicopter is being conducted to try to determine if the failures could have been caused by abnormalities within the aircraft.

20. DEFECTIVE MATERIAL SENT TO

NAME, TITLE, TEL EXT OF PREPARER	SIGNATURE
AV 350-6234 SHERWOOD C. SPRING, MAJ, SC Project Officer, Project No. 76-11	Sherwood C. Spring

AV Form 1 May 76 1002 — Edition of 1 Aug 74, may be used.

APPENDIX H. LETTER, SUBJECT: AVIATOR BACKACHE IN THE OH-58C HELICOPTER

DEPARTMENT OF THE ARMY
U. S. ARMY AEROMEDICAL RESEARCH LABORATORY
FORT RUCKER ALABAMA 36362

SGRD-UAF-LS 13 October 1978

SUBJECT: Aviator Backache in the OH-58C Helicopter

Commander
US Army Aviation Engineering
Flight Activity
ATTN: DAVTE-TA (COL D. M. Boyle)
Edwards Air Force Base, CA 93523

1. Reference is made to your letter, dtd 18 Sep 78, subject: OH-58 Helicopter Seat. In response to your request, the Field Research and Biomedical Applications Division, US Army Aeromedical Research Laboratory (USAARL), conducted an evaluation of the reported aviator backache and pain experienced in the OH-58 Scout Helicopter.

2. The evaluation consisted of an anthropometric review of the seat design and crew station configuration of the OH-58C and OH-58A model aircraft located at Fort Rucker, AL. In addition, a questionnaire relating to seat comfort and back pain in the OH-58 was administered to 25 OH-58 instructor pilots and 25 initial entry rotary wing aviator students of the Aeroscout Branch, Department of Flight Training, Fort Rucker, AL. Structured interviews regarding the topic were also conducted with aviators who have flown both the OH-58A and OH-58C model aircraft. The above approach was followed to provide the most effective evaluation within the allotted time schedule.

3. The conclusions reached from the data obtained during that evaluation and past laboratory experience related to aviator seats are:

a. The reported backache and pain are not limited to the OH-58C. A similar problem exists in the OH-58A. Of the aviators questioned, 86% indicated they do experience some back pain while flying the OH-58. Aviators who have flown both aircraft indicated no noticeable difference between the two aircraft with respect to backache or pain.

b. The problem does not appear to be limited to a given age group or aviator experience levels. Both the experienced instructor pilots and the initial entry rotary wing aviator students reported some degree of backache and discomfort during flight. There was one noticeable difference in that the newer aviators reported experiencing back pain earlier in the flight period than did the instructor pilots.

c. The seat configurations of both the OH-58A and OH-58C model helicopters do not conform to the anthropometric measurements of US Army aviators. In particular, the support provided by the increased width of the lower portion of the back cushion is located too low to provide proper support to the critical lumbar spine region of aviators in the 5th to 95th percentile range. In addition, the trunk to thigh angle of the seat (back support slope) is less than optimal. The present seat configuration actually makes it difficult, if not impossible, for aviators to position their back with proper spinal alignment and balance

d. The location of the aircraft controls in relation to the non-adjustable seat position requires the majority of the aviators surveyed to adopt a seating position that forces flexation of the spine, i.e., typical OH-58 aviator slouch. This places the spine in a position that increases the probability of back pain.

4. If the backache experienced by US Army aviators associated with the OH-58 helicopter is to be alleviated, strong consideration should be given to the design of aircrew seats as well as the aircraft control locations that are more compatible with the anthropometry of US Army aviators.

5. The above information was discussed with MAJ W. Spring by telephone on 5 October 1978. USAARL POC is Mr. Richard Armstrong, Autovon 558-3211/6504.

STANLEY C. KNAPP, MC
Colonel
Commanding

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