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IRWORTHINESS AND FLIGHT CHARACTERISTICS TEST OF AN OH-58C CONFIGURED TO A LIGHT COMBAT HELICOPTER (LCH)

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FINAL REPORT

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

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OH-58C Light Combat Helicopter (LCH)
OH-58 Performance and Handling Qualities

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

The United States Army Aviation Engineering Flight Activity conducted a limited airworthiness and flight characteristics test of the OH-58C Light Combat Helicopter (LCH) from 22 July through 9 September 1981. The OH-58C LCH configuration increases the gross weight of the helicopter to 3425 pounds and includes one 7-tube 2.75-inch rocket pod and one 7.62mm minigun mounted externally. Performance and handling qualities were evaluated. The OH-58C LCH was tested at Edwards Air Force Base, California (elevation 2302 feet). A total of 20 flights were conducted for a total of 26.0 flight hours. As a result of the increased maximum gross weight of the OH-58C LCH, the hover ceiling was reduced. Level flight performance was degraded by the LCH configuration. No

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) significant handling qualities differences were noted when comparing test results for the OH-58C LCH to the test results of the standard OH-58C. A total of one deficiency and two shortcomings were identified. The deficiency and one shortcoming were relative to low-speed flight characteristics and were previously identified in the standard OH-58C. The remaining shortcoming was a high pilot work load which occurs due to the inadequate margin between torque required and the main transmission torque limit of the OH-58C LCH at mission gross weight conditions.

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DRDAV-D

SUBJECT: Directorate for Development and Qualification Position on the Airworthiness and Flight Characteristics Test of an OH-58C Configured to a Light Combat Helicopter (LCH), USAAEFA Project Number 81-07

SEE DISTRIBUTION

1. The purpose of this letter is to establish the Directorate for Development and Qualification position on the subject report.

2. This Directorate agrees with the subject report; however, the configuration is no longer to be utilized by operational units.

3. The deficiency cited in the report (paragraph 18) will be corrected by application of the OH-58C upgrade program. This program, currently under contract with Bell Helicopter Textron, will result in airworthiness qualification of an increased transmission rating, an improved tail rotor, and a three-axis stability and control augmentation system.

4. We agree that a reduction of the never exceed airspeed (V_{NE}) would be appropriate for operation above 3200 pounds gross weight and at a high density altitude. However, there is insufficient data available to determine a new V_{NE}. Should the OH-58C be used at higher weights and/or density altitudes, a test effort would be required to accurately determine a new V_{NE}.

5. A change will not be made to the operator's manual regarding inadvertent overtorques for two reasons. Use of the aircraft at weights above 3200 pounds has been abandoned. In addition, the aforementioned transmission uprating will significantly reduce the potential for overtorque.

FOR THE COMMANDER:

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

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INTRODUCTION

BACKGROUND

1. The US Army was evaluating the potential of the OH-58C as a light combat helicopter (LCH). The OH-58C LCH configuration increases the gross weight of the helicopter to 3425 pounds and includes one 7-tube 2.75-inch rocket pod and one 7.62mm minigun mounted externally. The United States Army Aviation Research and Development Command (AVRADCOM) directed the United States Army Aviation Engineering Flight Activity (USAAEFA) to conduct an airworthiness and flight characteristics (A&FC) test on the OH-58C LCH (app A, ref 1).

TEST OBJECTIVE

2. The objective of this test was to obtain limited performance and handling quality data at gross weights of 3300 to 3400 pounds.

DESCRIPTION

3. The test helicopter (USA S/N 68-16870) was a standard OH-58C manufactured by Bell Helicopter Textron (BHT). Operation of the OH-58C in the LCH configuration required increasing the maximum gross weight from 3200 to 3425 pounds. Major external modifications included installation of BHT two-position landing gear, an M27E1 (7.62 minigun) armament subsystem mounted on the left side of the aircraft, and an M158A1 2.75-inch folding fin aerial rocket (FFAR) seven-tube pod mounted on the right side of the aircraft. Internal modifications included installation of additional secure voice radios, an OMEGA LTN-211 navigation system, and lighting system modifications to better accommodate night vision goggle operations. Photographs of the test aircraft are presented in appendix B. A detailed description of the standard OH-58C is contained in the operator's manual (app A, ref 2), with modifications incorporated in the LCH configuration contained in the test request (app A, ref 1), and described in Appendix B.

TEST SCOPE

4. The A&FC was conducted at Edwards AFB, California from 22 July through 9 September 1981, and consisted of 26.0 flight hours of which 15.2 hours were productive. The use of an OH-58C as an LCH was discontinued by the user and the A&FC was terminated before all the planned tests were completed. Flight limitations contained in the operator's manual and the airworthiness release (app A, refs 2 and 3) were observed. Test conditions are presented in table 1. Center of gravity, sideslip, and airspeed limitations from the airworthiness release are presented in figures 1 through 4, appendix B.

TEST METHODOLOGY

5. Flight test techniques used are described in references 4 and 5, appendix A. Handling qualities ratings were assigned in accordance with a Handling Qualities Rating Scale (HQRS). Data were recorded utilizing an onboard magnetic tape

recording system installed and maintained by USAAEFA. Control system rigging check and aircraft weight and balance were performed by USAAEFA personnel.

Table 1. Test Conditions[1]

Condition	Average Gross Weight (lb)	Average Density Altitude (ft)	Trim Calibrated Airspeed (KCAS)	Remarks
Hover Performance	2920-3500	3800	zero	Tethered method skid heights: 2 ft IGE; 50 ft OGE Rotor speed: 97 to 100 percent (344-354 rpm)
Level Flight Performance[2]	2840-3420	6780-11,600	33-105	Constant referred weight (W/δ) Constant referred rotor speed ($N/\sqrt{\theta}$) method
Control Positions in Trimmed Forward Flight[2]	2840-3420	6780-11,600	33-105	Level flight
Static Longitudinal Stability	3360-3420	6420-7140	62-66	Level flight, climb, and autorotation
Static Lateral-directional Stability	3260-3380	6880-7320	62-66	Level flight, climb, and autorotation
Maneuvering Stability	3400-3420	6740-6960	66	Left and right steady turns
Dynamic Stability and Controllability	3380-3480	3880	zero	Hover
	3260-3380	7100-7240	68	Level flight
Low-speed Flight	3300-3440	3700-3800	Sideward: 0-35 KTAS Rearward: 0-30 KTAS Forward: 0-40 KTAS	3kid height: 10 ft Mid and extreme right lateral cg

NOTES:

[1] Test conducted in ball-centered flight, LCH configuration with all doors removed and armament installed, 100 percent rotor speed (354 rpm), and mission longitudinal cg (aft), unless otherwise designated.

[2] Zero sideslip.

RESULTS AND DISCUSSION

GENERAL

6. Hover and level flight performance testing was conducted to determine the effects of the LCH configuration on the OH-58C. Hover performance capability was essentially unchanged from the standard OH-58C. As a result of the increased maximum gross weight of the OH-58C LCH the hover ceiling was reduced. Level flight performance was degraded by the LCH configuration. The handling qualities of the OH-58C LCH were evaluated at 3380 pounds gross weight and FS 110.8 longitudinal cg (aft) which were assumed to be mission conditions. Test results were compared with previous OH-58C test results (refs 6 and 7, app A). No significant handling qualities differences were noted when comparing test results for the OH-58C LCH to the test results of the standard OH-58C. A total of one deficiency and two shortcomings were identified. The deficiency and one shortcoming were relative to low-speed flight characteristics and were previously identified in the standard OH-58C. The remaining shortcoming was a high pilot work load which occurs due to the inadequate margin between torque required and the main transmission torque limit of the OH-58C LCH at mission gross weight conditions.

PERFORMANCE

Hover Performance

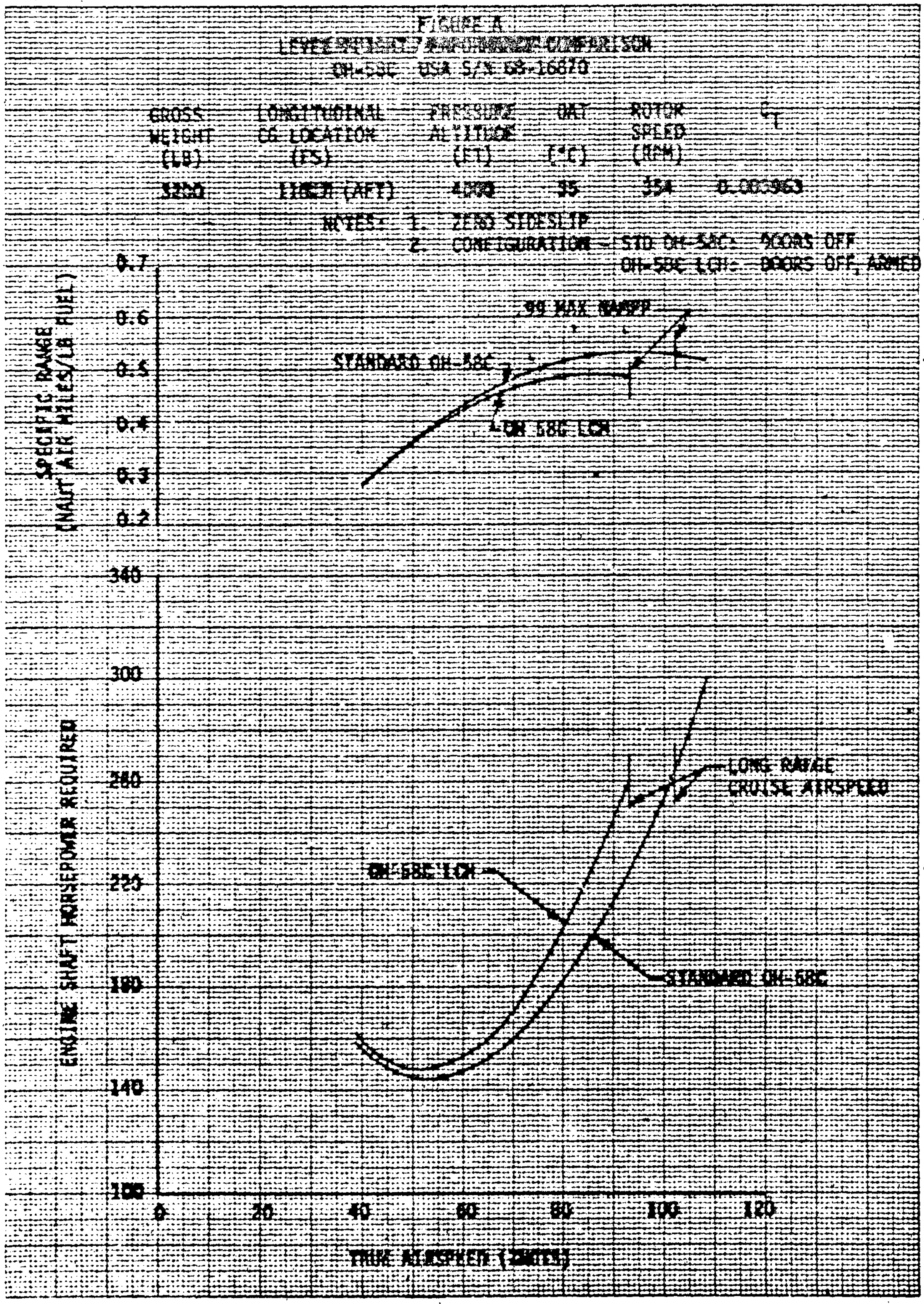
7. a. The hover performance capability of the OH-58C LCH was evaluated by determining the engine power required to hover in-ground-effect (IGE) at a 2-foot skid height and out-of-ground-effect (OGE) at a 50-foot skid height. Testing was accomplished at Edwards Air Force Base (2302-foot elevation) using the tethered hover method. Photographs of the tethered hover rig are presented in appendix C. A summary of the OGE hover performance is presented in figure 1, appendix E, and nondimensional test results are presented in figures 2 and 3.

b. The hover performance capability of the OH-58C LCH is essentially unchanged from the standard OH-58C. At the higher maximum gross weight of the OH-58C LCH (3425 lb), the OGE hover capability is limited by the main transmission limit (317 shp at 100 percent rotor speed). This means that the maximum OGE hover ceiling for the OH-58C LCH at 3425 pounds on a standard day is 3300 ft and is 950 ft on a 35°C day.

Level Flight Performance

8. 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 and $N/\sqrt{\theta}$) method was used. Data were obtained in zero sideslip stabilized level flight at incremental airspeeds ranging from 33 to 105 knots true airspeed (KTAS). Results of these tests are presented nondimensionally in figures 4 and 5 and dimensionally in figures 6 through 11, appendix E.

a. Figure A shows a comparison between the standard OH-58C with doors removed and the OH-58C in the LCH configuration. The specific conditions for this comparison are 3200 pounds gross weight, 4000 feet pressure altitude, and 35°C (C_T = 0.003963). This is the maximum takeoff gross weight for the standard OH-58C



OH-58C USA S/N 68-16870
GROSS WEIGHT (LB)
LONGITUDINAL CG LOCATION (FS)
PRESSURE ALTITUDE (FT)
OAT (°C)
ROTOR SPEED (RPM)
C_T
3200
(AFT)
4000
35
354
0.003963
NOTES: 1. ZERO SIDESLIP
2. CONFIGURATION - STD OH-58C - DOORS OFF
OH-58C LCH - DOORS OFF, ARMED
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
0.7
0.6
0.5
0.4
0.3
0.2
99 MAX NAMPP
STANDARD OH-58C
OH 58C LCH
ENGINE SHAFT HORSEPOWER REQUIRED
340
300
260
220
180
140
100
LONG RANGE CRUISE AIRSPEED
OH-58C LCH
STANDARD OH-58C
0
20
40
60
80
100
120
TRUE AIRSPEED (KNOTS)

but is 225 pounds less than the maximum allowable takeoff gross weight of 3425 pounds for the OH-58C LCH. Test results show that the OH-58C LCH has increased power required when compared to the standard OH-58C. For example, from figure A, at 90 KTAS, the OH-58C LCH requires an additional 32 shp. As a result of the increased shp required, the range and endurance capabilities of the OH-58C LCH will be decreased.

b. In all tests above 3200 pounds gross weight, airspeed was not power limited but rather was limited by the airworthiness release. (fig. 4, app B). One exception occurred at the highest C_T tested (C_T = 0.005001). In this case, V_{NE} (never exceed airspeed) could not be reached because of excessively high two/rev vibration, probably caused by blade stall. This vibration was severe enough that the pilot would not operate the aircraft at these conditions due to discomfort and fear of aircraft damage. The vibration encountered prior to V_{NE} at high density altitude conditions restrict the usable airspeed envelope.

HANDLING QUALITIES

Control Positions in Trimmed Forward Flight

9. Control positions in trimmed forward flight were evaluated during level flight performance testing at the conditions listed in table 1. Data are presented in figures 12 through 17, appendix E. Control positions in trimmed forward flight are basically unchanged from those of the standard OH-58C.

Static Longitudinal Stability

10. Collective fixed static longitudinal stability was evaluated in ball-centered flight for level flight, climbs, and autorotations at the conditions listed in table 1. Data are presented in figures 18 through 20, appendix E. Static longitudinal stability, indicated by longitudinal control position variation with airspeed, was positive for all conditions evaluated. The pitch divergence observed during climbs (ref 6, app A) were not observed during this evaluation probably because the high gross weight of the LCH precluded rates of climb over 1000 foot per minute. As evaluated, the longitudinal static stability of the OH-58C in the LCH configuration is similar to the standard OH-58C.

Static Lateral-Directional Stability

11. Static lateral-directional stability was evaluated during level flight, climbs, and autorotations using steady heading sideslips at the conditions listed in table 1. Data are presented in figures 21 through 23, appendix E. Static directional stability, indicated by variation of directional control with sideslip, was positive at all test conditions. Dihedral effect, indicated by variation of lateral control position with sideslip, was positive at all test conditions. Sideforce cues, indicated by roll attitude with sideslip, were weak but positive. The static lateral-directional characteristics of the OH-58C in the LCH configuration are similar to the standard OH-58C.

Maneuvering Stability

12. Maneuvering stability was conducted at the conditions listed in table 1, using coordinated, fixed collective, steady turns at various bank angles. Data are presented in figure 24, appendix E. Longitudinal stick force cues were light but in the correct direction for all conditions evaluated. At load factors equivalent to bank angles of 45 to 50 degrees an oscillatory feedback force was felt in the longitudinal cyclic control. However, this should not adversely impact the aircraft's mission capability. For the airspeeds evaluated, the maneuvering stability characteristics of the OH-58C in the LCH configuration is similar to the standard OH-58C.

Dynamic Stability

13. Hovering and forward flight, longitudinal, lateral and directional dynamic stability were evaluated at the conditions listed in table 1, using control pulse inputs.

a. Hover. Lateral and directional control pulses generated an essentially deadbeat aircraft response. Forward and aft longitudinal control inputs were accompanied by a divergent pitch oscillation which became uncomfortable after the first cycle. However, the motion was slow to develop, easily controlled (HQRS 3), and should not adversely impact the LCH mission capability.

b. Forward Flight. Aircraft response was well damped (1 to 2 oscillations) in all axes. The long-term response was excited by a 10-knot decrease in airspeed and was followed by two overshoots. Minimal lateral or directional control inputs were required to maintain aircraft heading and roll attitude. Forward flight dynamic stability characteristices of the OH-58C in the LCH configuration are similar to that of the standard OH-58C.

Controllability

14. Hovering and forward flight longitudinal, lateral and directional controllability tests were conducted at the conditions listed in table 1. Control fixtures were used to obtain various size inputs. Test results are presented in figures 25 through 30, appendix E.

a. Hover. (1) There was no unusual response to control inputs while hovering. Forward longitudinal inputs were accompanied by a slight right yaw; however, there was no perceptible delay in aircraft response and pitch rate was steady state within a second. As with all tail rotor configured helicopters, directional control inputs generated vertical climbs and descents. However, because of the high power required at the high gross weight of the LCH, descents could be difficult to control if inputs were made near the ground. OGE hover controllability of the OH-58C in the LCH configuration is similar to the standard OH-58C.

b. Forward Flight. Aircraft response to longitudinal, lateral, and directional step inputs was similar to that of the standard OH-58C (ref 6, App A) except there was no dig-in tendency observed during aft longitudinal inputs at the airspeed evaluated. There was no observed delay time between control input and aircraft response and the rate was steady state within a second. There was no objectionable coupling resulting from control inputs. Forward flight controllability of the OH-58C in the LCH configuration is similar to the standard OH-58C.

(2) Torque required to hover OGE will be within 5 percent of the transmission limit at mission gross weight (3400 lb) and density altitudes above 900 feet. At these conditions, pilot inputs to maintain a hover and counter the effects of wind gusts may exceed the torque limit. Pilot work load to prevent overtorques will increase and mission capability will be degraded when the combination of gross weight and ambient condtions dictate operations near the torque limits. The inadequate margin between torque required and the main transmission limit of the OH-58C LCH at mission gross weight conditions causes high pilot work load which is a shortcoming. Recommend that the following caution be placed in the operator's manual:

CAUTION

Inadvertent overtorque may occur when operating the aircraft at high gross weights.

Low-Speed Flight Characteristics

15. Low-speed flight was conducted at the conditions listed in table 1, utilizing a ground pace vehicle as a speed reference. The radar altimeter was used to maintain a constant skid height of 10 feet. The wind varied from zero to 5 knots during this evaluation. Data are presented in figures 31 through 48, appendix E.

a. Forward and rearward flight were conducted at both mid and extreme right lateral cg. Low-speed forward flight was easily accomplished (HQRS 2). Rearward flight was accomplished from zero to 30 KTAS with considerable pilot compensation required to limit pitch and yaw oscillations to 15 degrees (HQRS 5). These uncommanded pitch and yaw excursions were similar at both the mid and extreme right lateral cg. All control margins were adequate. The tendency for the OH-58C LCH to pitch and yaw excessively in rearward flight (which is essentially the same as the standard OH-58C) is a shortcoming.

b. Right sideward flight was accomplished from zero to 35 KTAS with minimal pilot compensation to control pitch, roll, and yaw excursions (HQRS 3). At the mid lateral cg all control margins were adequate. At the extreme right lateral cg condition the 10 percent directional control limit was reached at 35 KTAS. The right sideward flight characteristics of the OH-58C LCH are essentially unchanged from the standard OH-58C and are satisfactory.

c. Left sideward flight at 20 and 25 KTAS could not be satisfactorily performed due to excessive pitch, roll, and yaw excursions (HQRS 7). Continuous and simultaneous control movements of up to ±1.0 inch longitudinally, ±0.8 inches laterally, and ±1.5 inches directionally were required to control the aircraft in left sideward flight at 20 and 25 KTAS. Left sideward flight at 30 and 35 KTAS required only minimal pilot compensation (HQRS 3). Within the range tested, the left sideward flight characteristics were similar at both mid and extreme right lateral cg and all control margins were adequate. The excessive pitch, roll, and yaw excursions of the OH-58C LCH in left sideward flight (which are essentially the same as the standard OH-58C) are a deficiency. Consideration should be given to installation of a stability augmentation system (SAS) to improve the overall handling qualities of the OH-58C LCH.

CONCLUSIONS

GENERAL

16. a. The handling qualities of the OH-58C LCH were not significantly changed from the standard OH-58C (para 6).

b. Hover performance capability at the same gross weight was essentially unchanged from the standard OH-58C. Maximum OGE hover ceiling for the OH-58C LCH at 3425 pounds on a standard day was 3300 feet and was 950 feet on a 35°C day (para 7b).

SPECIFIC

17. The vibrations encountered prior to V_{NE} at high density altitude conditions restrict the usable airspeed envelope (para 8b).

Deficiency

18. The excessive pitch, roll, and yaw excursions of the OH-58C LCH in left sideward flight (which are essentially the same as the standard OH-58C) are a deficiency (para 15c).

Shortcomings

19. a. The inadequate margin between torque required and the main transmission torque limit of the OH-58C LCH at mission gross weight conditions causes high pilot work load which is a shortcoming (para 14b(2)).

b. The tendency for the OH-58C LCH to pitch and yaw excessively in rearward flight (which is essentially the same as the standard OH-58C) is a shortcoming (para 15a).

RECOMMENDATIONS

18. Correct the deficiency listed in paragraph 18.

19. Correct the shortcomings listed in paragraphs 19a and 19b.

20. The following caution should be placed in the operator's manual (para 19b(2)):

CAUTION

> Inadvertent overtorque may occur when operating the aircraft at high gross weights.

21. Consideration should be given to installation of a stability augmentation system (SAS) to improve the overall handling qualities of the OH-58C LCH (para 15c).

APPENDIX A. REFERENCES

1. Letter, AVRADCOM, DRDAV-DI, 30 April 1981, subject: Airworthiness and Flight Characteristics Test of OH-58C Configured to a Light Combat Helicopter (LCH).

2. Technical Manual, TM 55-1520-235-10, *Operator's Manual, Army Model OH-58C Helicopter,* 7 April 1978, with changes 1 through 6, and 8 through 21.

3. Letter, AVRADCOM, DRDAV-DI, 14 July 1981, subject: Airworthiness Release for Flight Operation of the JOH-58C Aircraft in the Light Combat Helicopter (LCH) Configuration, with Revision 1, 23 July 1981.

4. Pamphlet, Army Materiel Command, AMCP 706-204, "Engineering Design Handbook, Helicopter Performance Testing", 1 August 1974.

5. Flight Test Manual, Naval Air Test Center, FTM No. 101, *Stability and Control,* 10 June 1968.

6. Final Report, USAAEFA, Project No. 76-11-2, *Airworthiness and Flight Characteristics Evaluation, OH-58C Interim Scout Helicopter,* April 1979.

7. Letter, USAAEFA, DAVTE-TI, 22 May 1981, subject: Letter Report, Preliminary Airworthiness Evaluation of OH-58C Expanded Gross Weight and Lateral CG Envelope, USAAEFA Project No. 80-21.

APPENDIX B. DESCRIPTION

GENERAL

1. The OH-58C Light Combat Helicopter (LCH) is a modification of the standard OH-58C Scout helicopter. Primary modifications include provisions for rapid air transportability, addition of 7.62mm minigun and 2.75-inch folding fin aerial rocket (FFAR) armament subsystems, installation of an OMEGA navigation system, and lighting system modifications to better accommodate night vision goggles. Photographs 1 through 3 show the OH-58C LCH.

2. Overall aircraft dimensions and general configuration of the OH-58C LCH are unchanged from the standard OH-58C. Maximum takeoff gross weight of the LCH is 3425 pounds compared to 3200 pounds for the standard OH-58C. A general description of the standard OH-58C including operating procedures and limitations is presented in the operator's manual (ref 2, app A). Specific changes incorporated in the LCH configuration will be discussed in the following paragraphs.

CREW STATION

3. Numerous equipment changes were made to the instrument panel, console, and controls. The following equipment was added:

   a. OMEGA LTN-211 navigation control panel.

   b. Crosstrack indicator for OMEGA.

   c. Second KY-28 secure control panel for FM radio no. 2.

   d. Third KY-28 secure control panel for UHF radio.

   e. M27E1 armament control panel.

   f. Rocket armament control panel.

   g. Rocket fire function on pilot and copilot cyclic grips.

4. The following equipment was deleted:

   a. AN/ARN-89 (ADF) control panel.

   b. Course deviation indicator (CDI).

   c. AN/ARN-123 CONUS navigation receiver control panel.

   d. CONUS RMI BRG pointer switch and marker beacon light.

   e. Sweep second hand clock.

The instrument panel is shown in photograph 4.

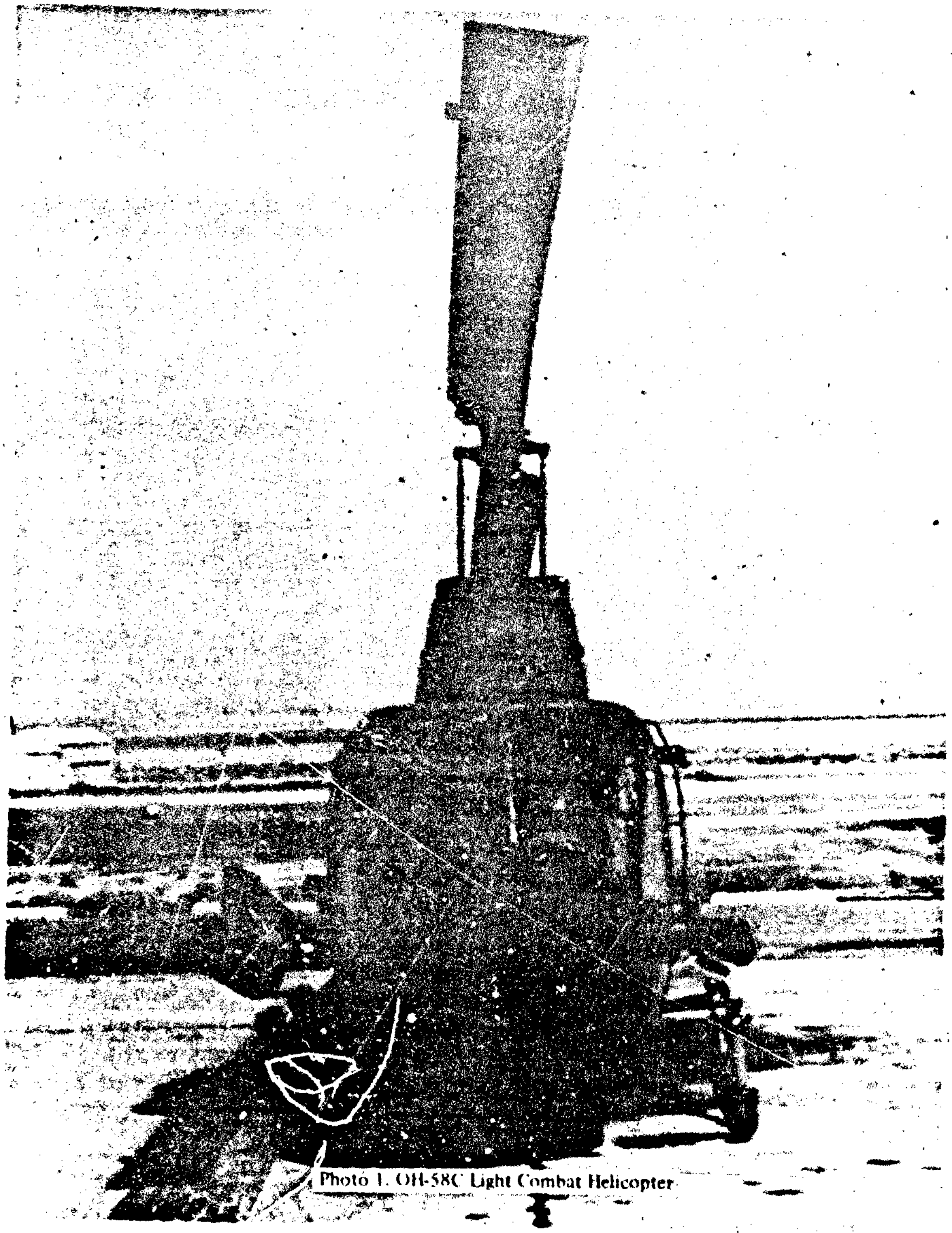


Photo 1. OH-58C Light Combat Helicopter

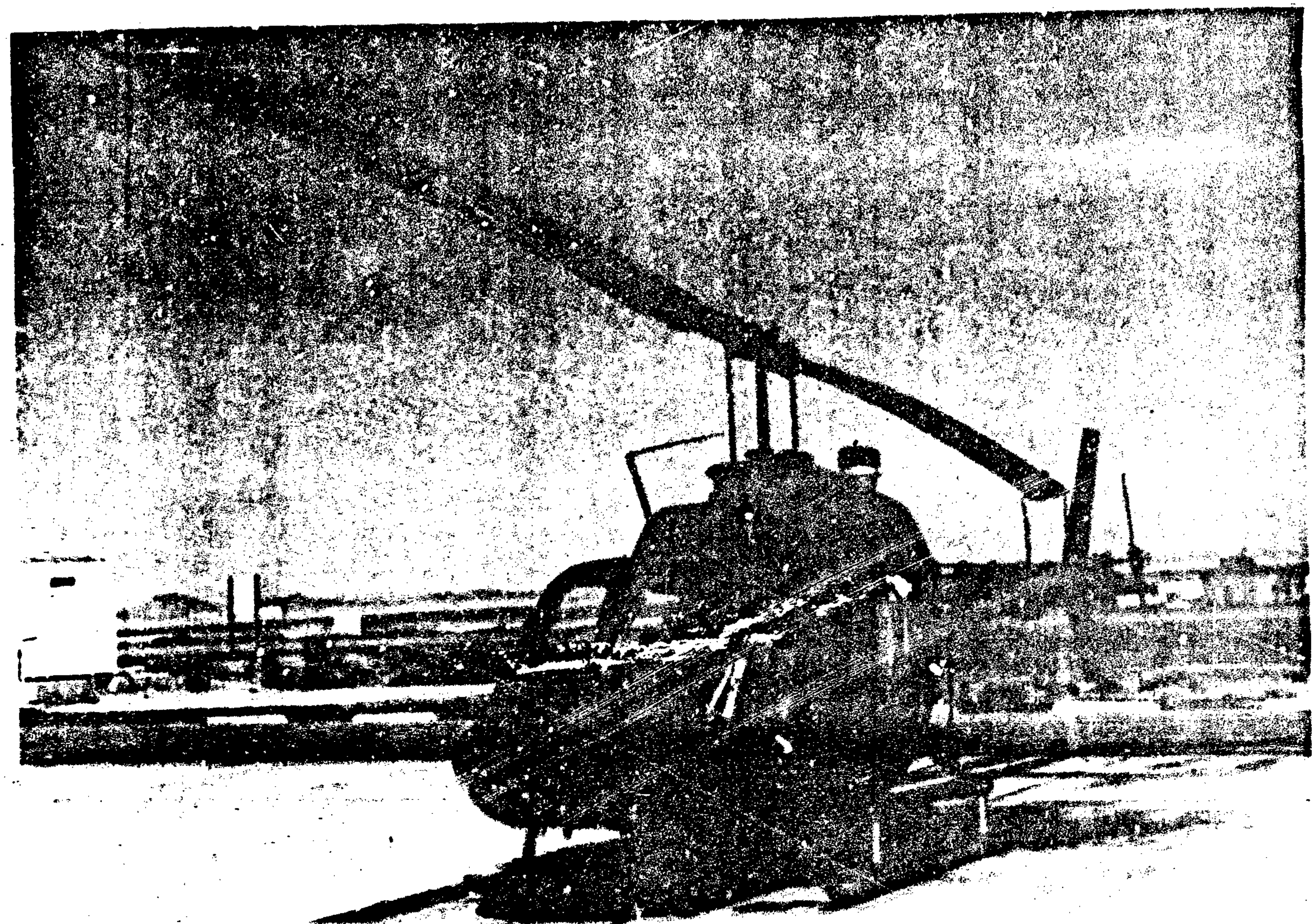


Photo 2. OH-58C Light Combat Helicopter

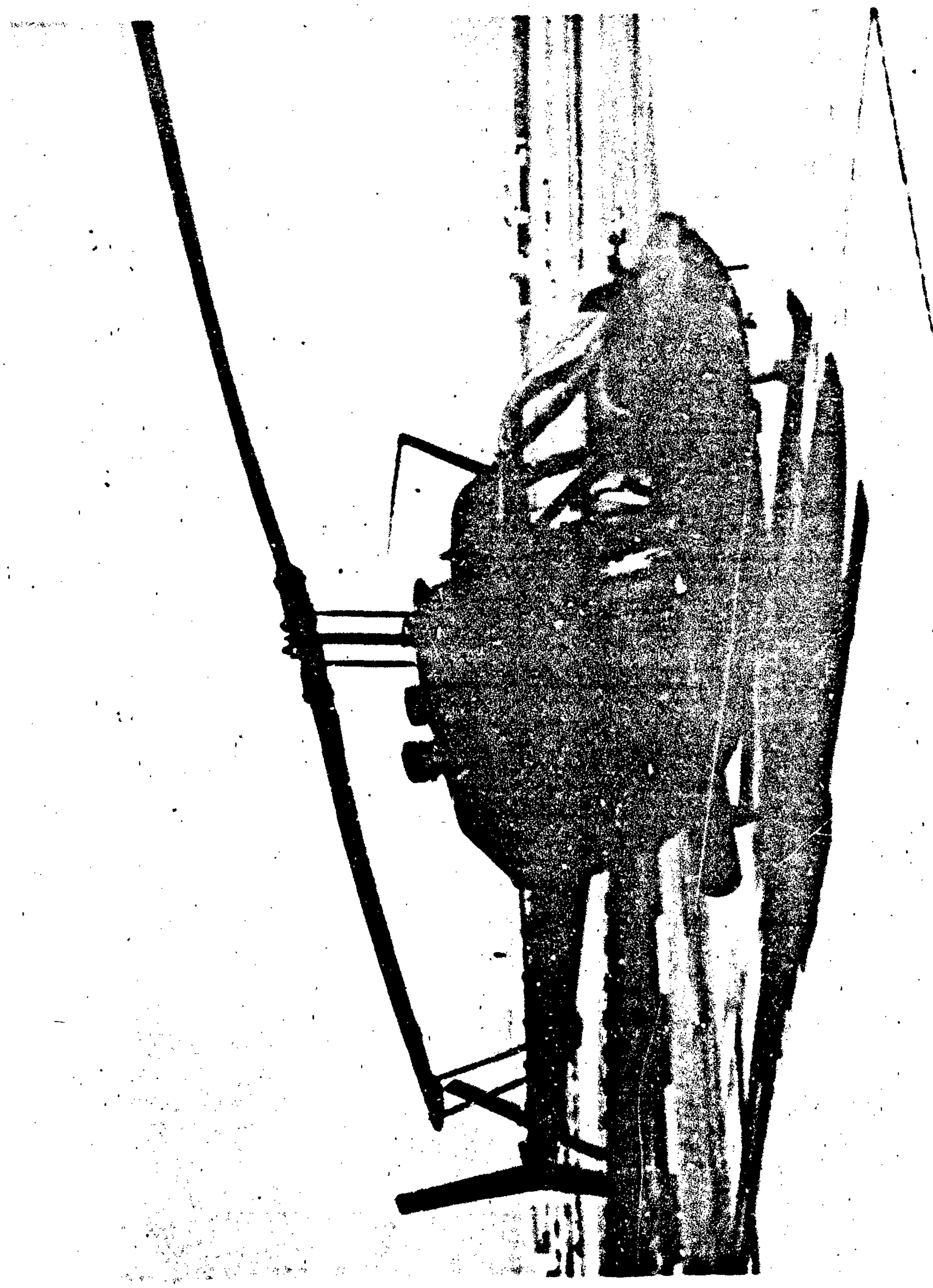


Photo 3. OH-58C Light Combat Helicopter

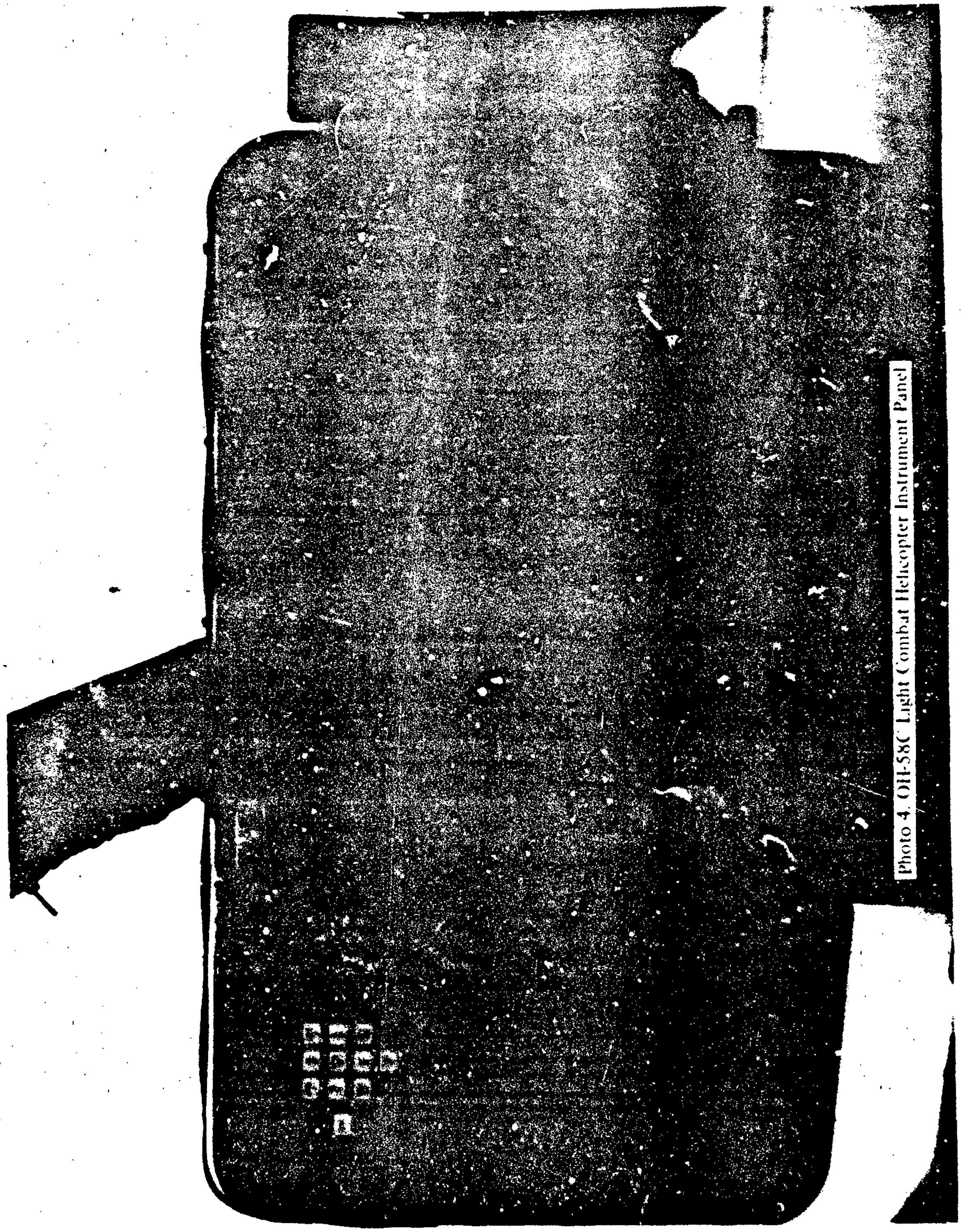


Photo 4. OH-58C Light Combat Helicopter Instrument Panel

LIGHTING

5. In order to better accommodate night vision goggles (NVG) and formation flight operations, the lower anticollision light was removed and the following equipment was added:

a. External cateye position lights and shields with switch function tied to existing position lights switch DIM position.

b. External formation lights with switch and dimmer on instrument panel.

c. Masking added to white position light on tail of aircraft.

d. Filters and masking added on the three M27El armament control panel lighted legends.

e. Filter added on APR-39 indicator light.

f. Filter added on cockpit utility light.

ARMAMENT SYSTEM

6. The M158Al subsystem, a 2.75-inch FFAR pod with seven launch tubes, was mounted on the right side of the aircraft. The M27El subsystem with M134 machine gun assembly consisting of a six barrel 7.62 millimeter gun, delinking feeder, flash suppressors, electric gun drive and ram air breech cooling was mounted on the left side of the aircraft. The M70El helicopter reflex sight is not a part of this configuration. Photographs of the armament system are presented in photographs 5 and 6.

RAPID AIR TRANSPORTABILITY

7. In order to allow rapid air transportability the following modifications were incorporated:

a. Installation of the two-position landing gear, Bell Helicopter Drawing Number SKT JB-111580 with EO-206 HAB-209, utilizing either the 206-HAB-024-101 (straight) or 206-HAB-089-101 (curved) forward cross tube assembly.

b. Modification of the vertical fin for air transporability, Bell Helicopter Drawing Number SKRB112180.

c. Brackets added for attachment of hardware for securing folded main rotor blades.

d. The UHF antenna was relocated on the nose of the aircraft. Photographs of the two-position landing gear and UHF antenna are presented in photographs 7 and 8.

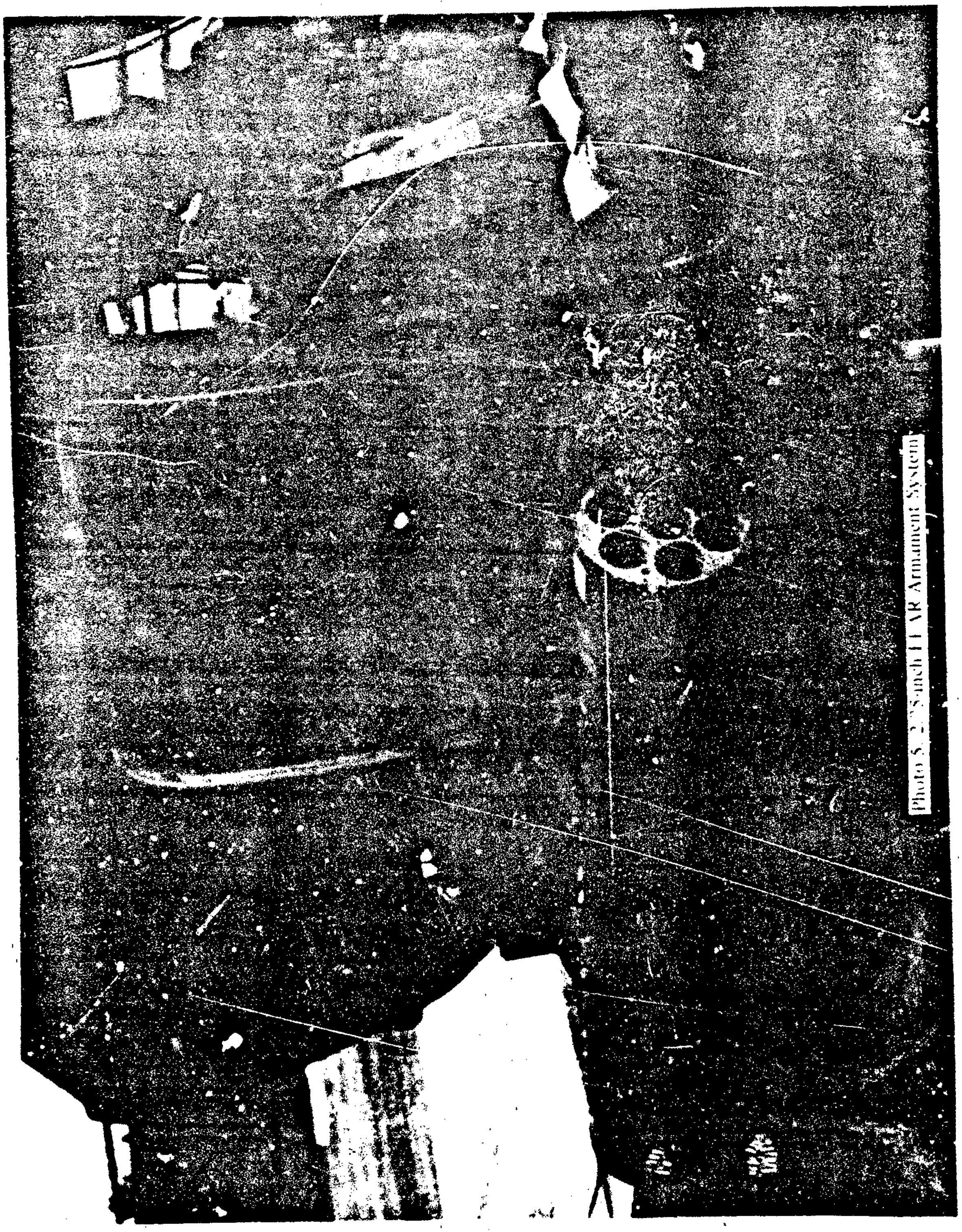


Photo 5. 2.75-inch FFAR Armament System

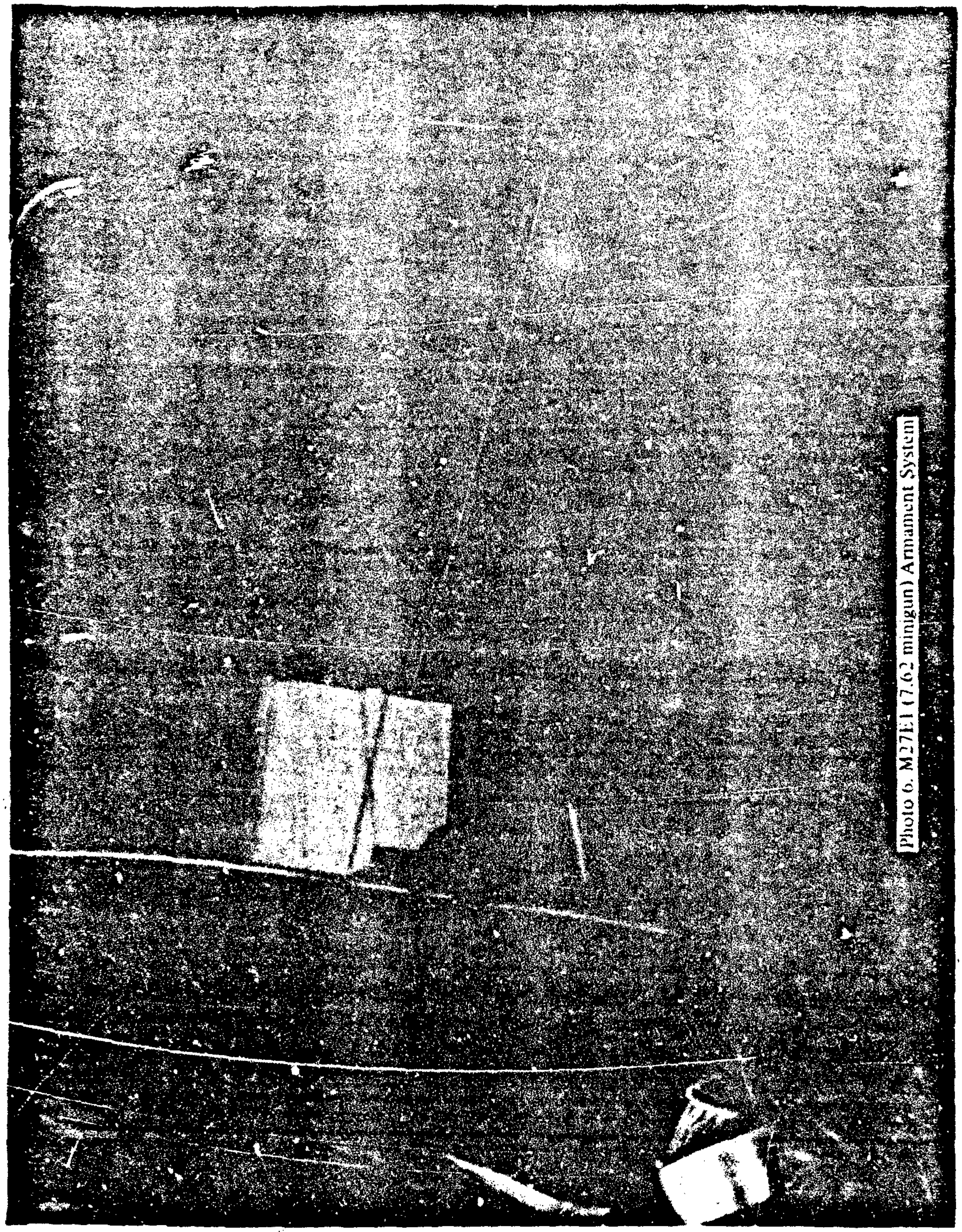


Photo 6. M27E1 (7.62 minigun) Armament System

Photo 7. Relocated UHF Antenna and External Night Vision Goggle Light

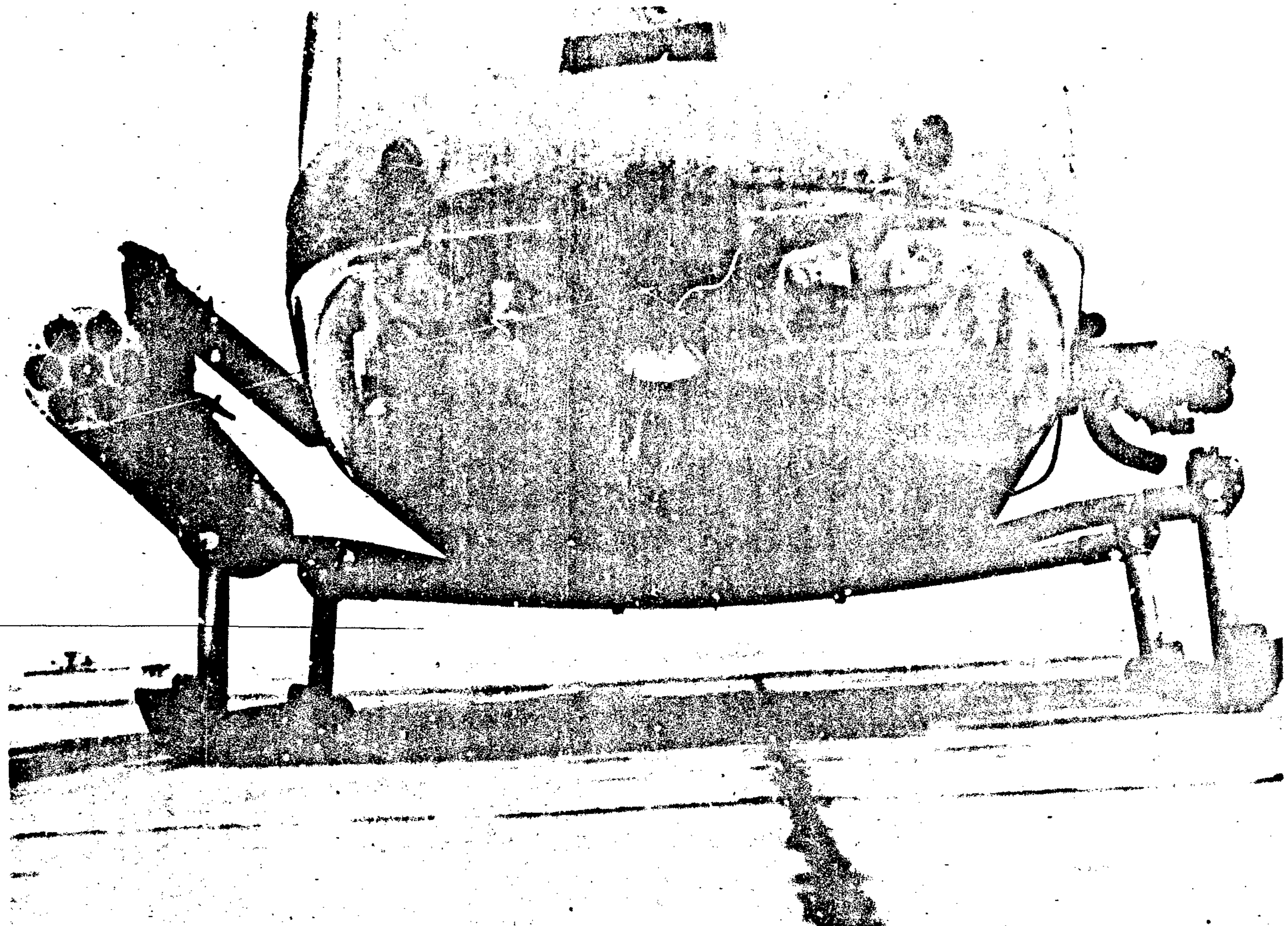


Photo 8. Two position Landing Gear (Extended Position)

ELECTRICAL AND AVIONICS

8. The helicopter is equipped with a solid state 250VA inverter powered from the nonessential 28 VDC, protected by the INV PWR circuit breaker and manually controlled by the INV switch. The inverter delivers 115 VAC, 400 Hz to the AC bus to power the AN/ASN-43, the AC fail relay, and the OMEGA system. This new inverter is mounted in the left hand equipment bay. A new equipment shelf has been added in the left hand equipment bay. It is raised 10 inches off the floor and the receiver unit for the OMEGA, the KY-28 for the AN/ARC-114 number 2 and the 250 VA inverter are mounted on it. The battery has been moved 17 inches nearer the door where the AN/ARN-89 receiver unit was. A photograph of the left hand equipment bay is presented in photograph 9.

9. The OH-58C Light Combat Helicopter is equipped with two AN/ARC-114 VHF-FM radios, an AN/ARC-115 VHF-AM radios, an AN/ARC-164 UHF-AM radio, three TSEC/KY-28 voice security devices for the two AN/ARC-114's and the AN/ARC-164, an AN/ASN-43 gyromagnetic compass set, an AN/APN-209 radar altimeter, an AN/APR-39 radar warning set, the AN/APX-100 transponder set with Kit-1A, an OMEGA navigation set, and two C-6533/ARC communication system control devices. Also in this configuration, the following have been removed: The AN/ARN-89 ADF control head, along with the AN/ARN-123 CONUS navigation receiver and one C-6533/ARC interphone receiver. It should be noted that the FM homing function does not exist in the LCH configuration.

10. An OMEGA cross-track indicator has been added to the instrument panel. This indicator displays continuous cross track (left or right of the course) information. This indicator has five index markings. The center position indicates a null condition. The next is for 2.25 nautical miles and the last is for 4.5 nautical miles. The indicator needle will move left when the aircraft position is right of course. If the needle moves right, actual aircraft position is left of course.

11. The electrical disconnects for the vulnerability reduction directional anti-torque system have been disabled by physically disconnecting their electrical connectors and stowing them, in place, so they will not bind with the existing control wire/rod.

ADDITIONAL MODIFICATIONS

12. To accommodate the armament system the rear seats were removed. All doors and the tail rotor drive shaft cover were also removed.

AIRWORTHINESS RELEASE OPERATING LIMITATIONS

13. The airspeed limits, sideslip limits, and longitudinal and lateral cg limits from the AVRADCOM Airworthiness Release are presented in figures 1 through 4.

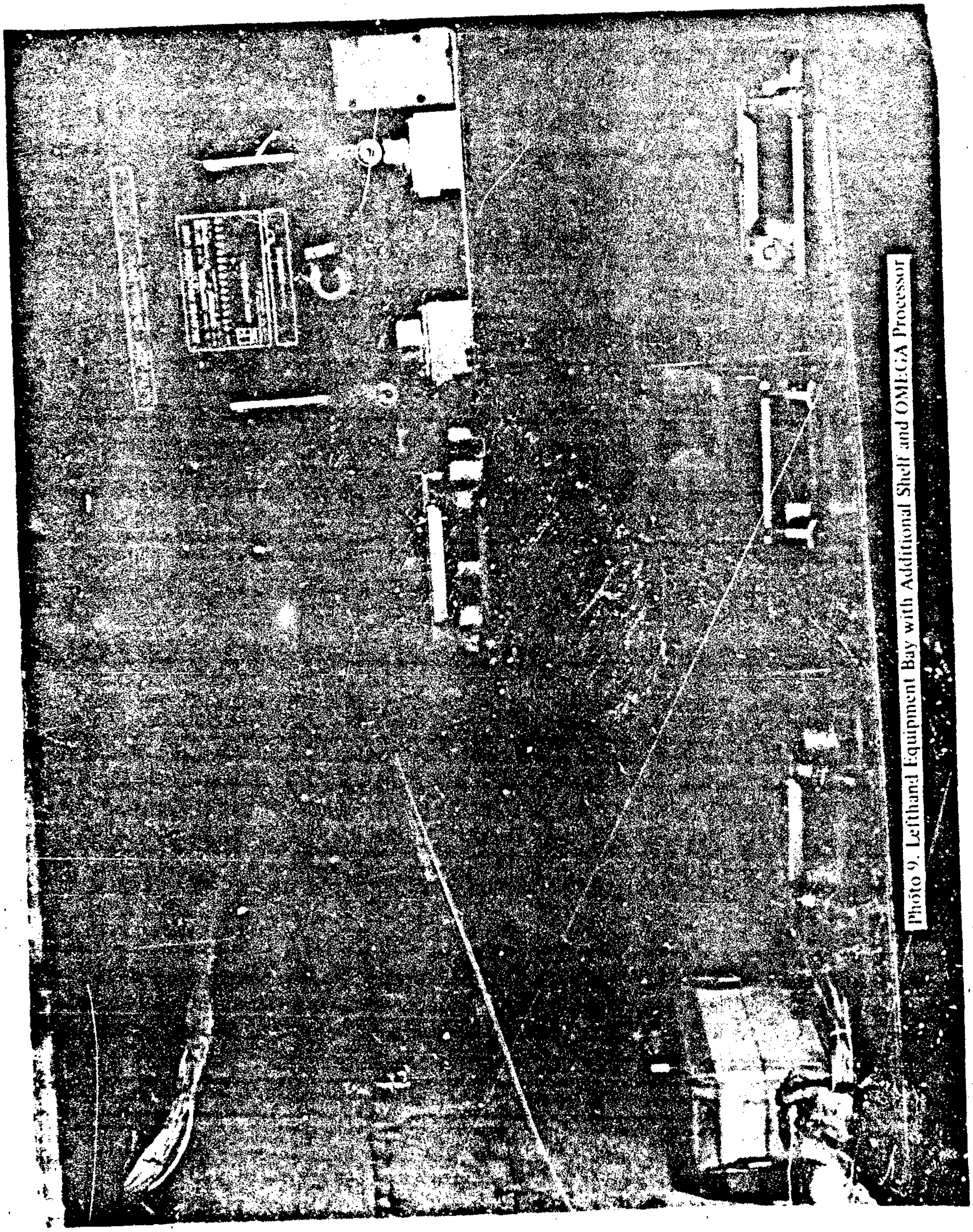


Photo 9. Lefthand Equipment Bay with Additional Shelf and OMEGA Processor

FIGURE 1
AIRWORTHINESS RELEASE GROSS WEIGHT -- LONGITUDINAL
CENTER-OF-GRAVITY ENVELOPE
OH-58C LCH

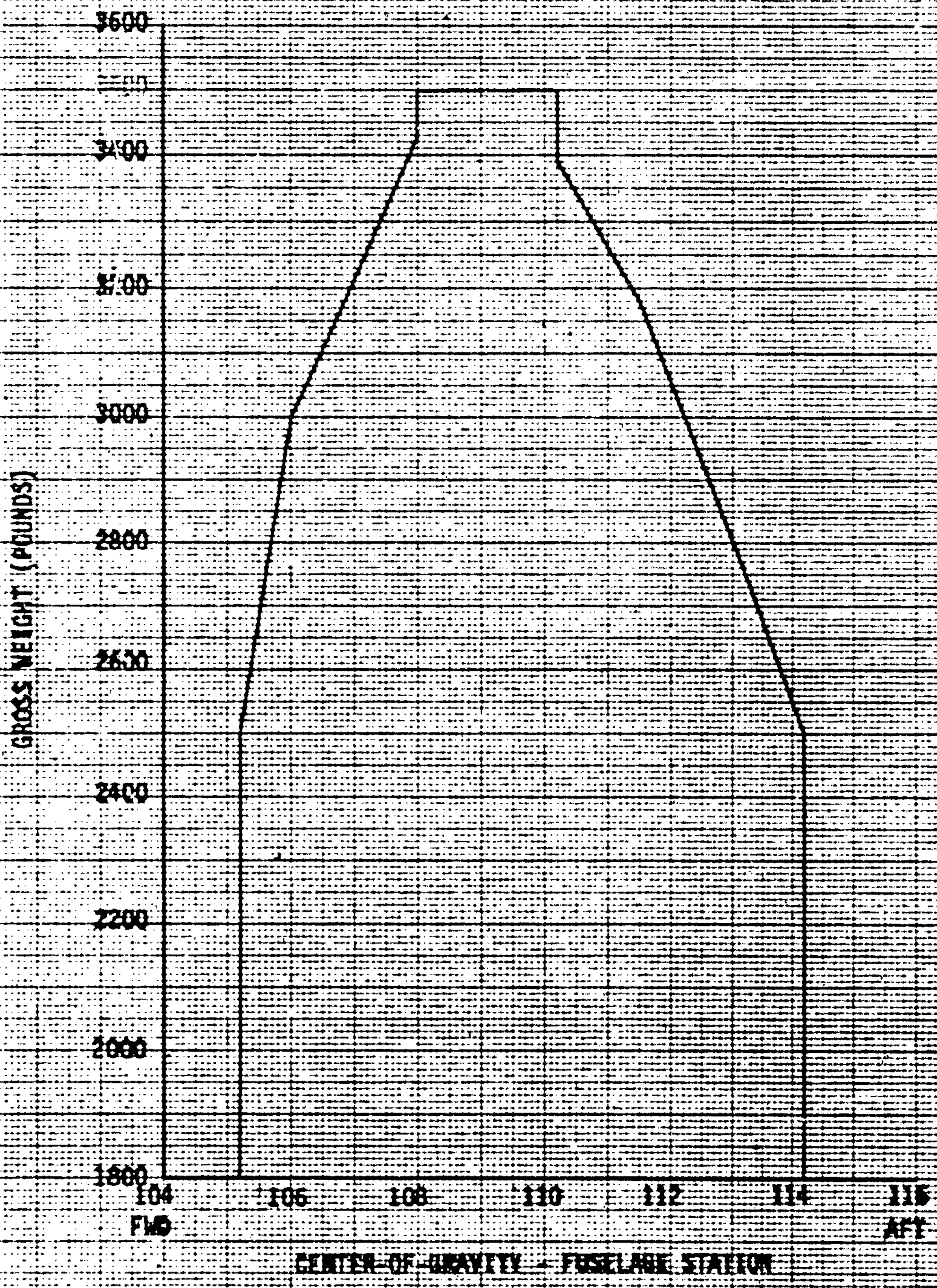


FIGURE 2
AIRWORTHINESS RELEASE GROSS WEIGHT-
LATERAL CENTER-OF-GRAVITY ENVELOPE
OH-58C LCH

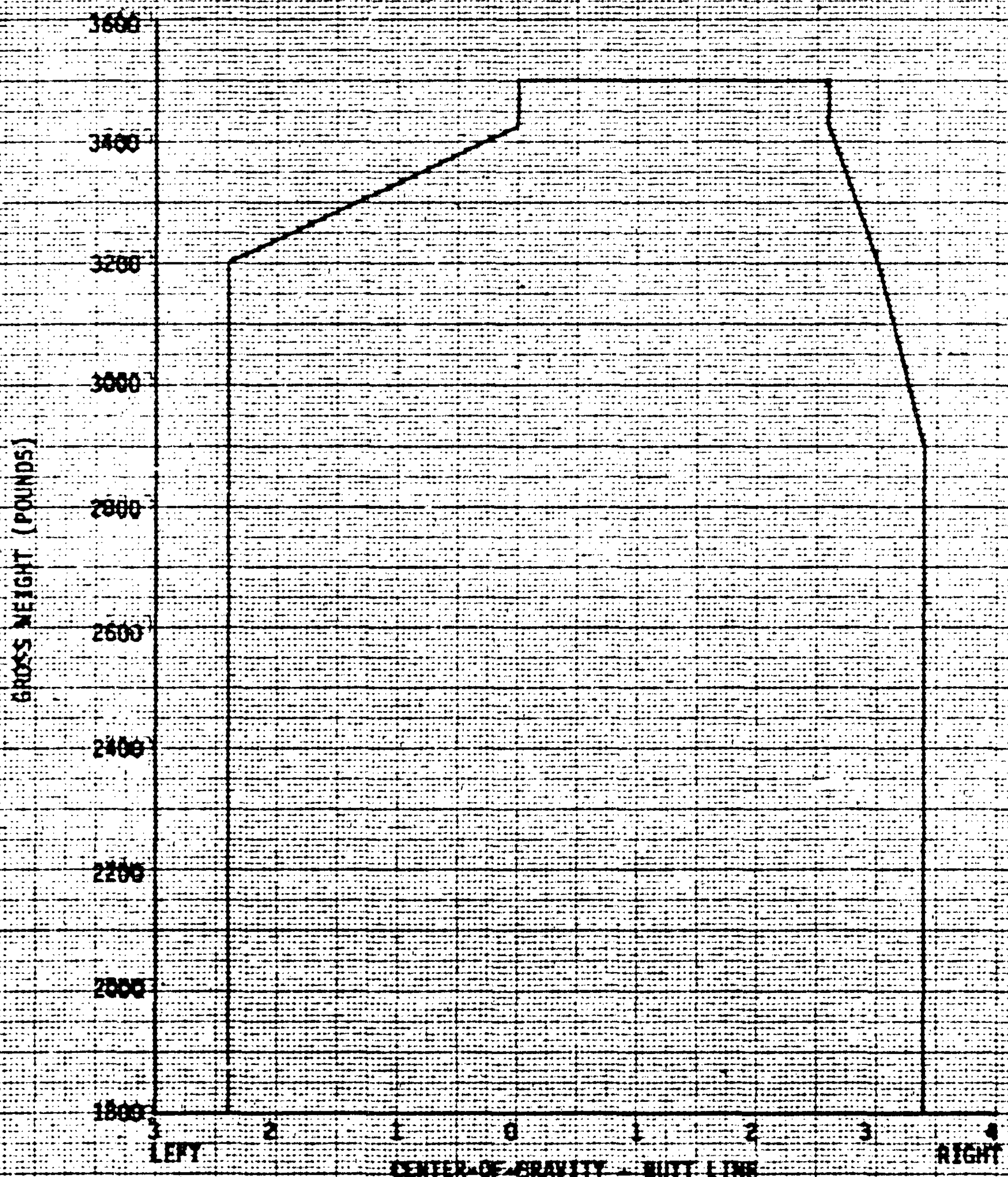


FIGURE 3
AIRWORTHINESS RELEASE SIDESLIP ANGLE LIMITATIONS
OH-58C LCH

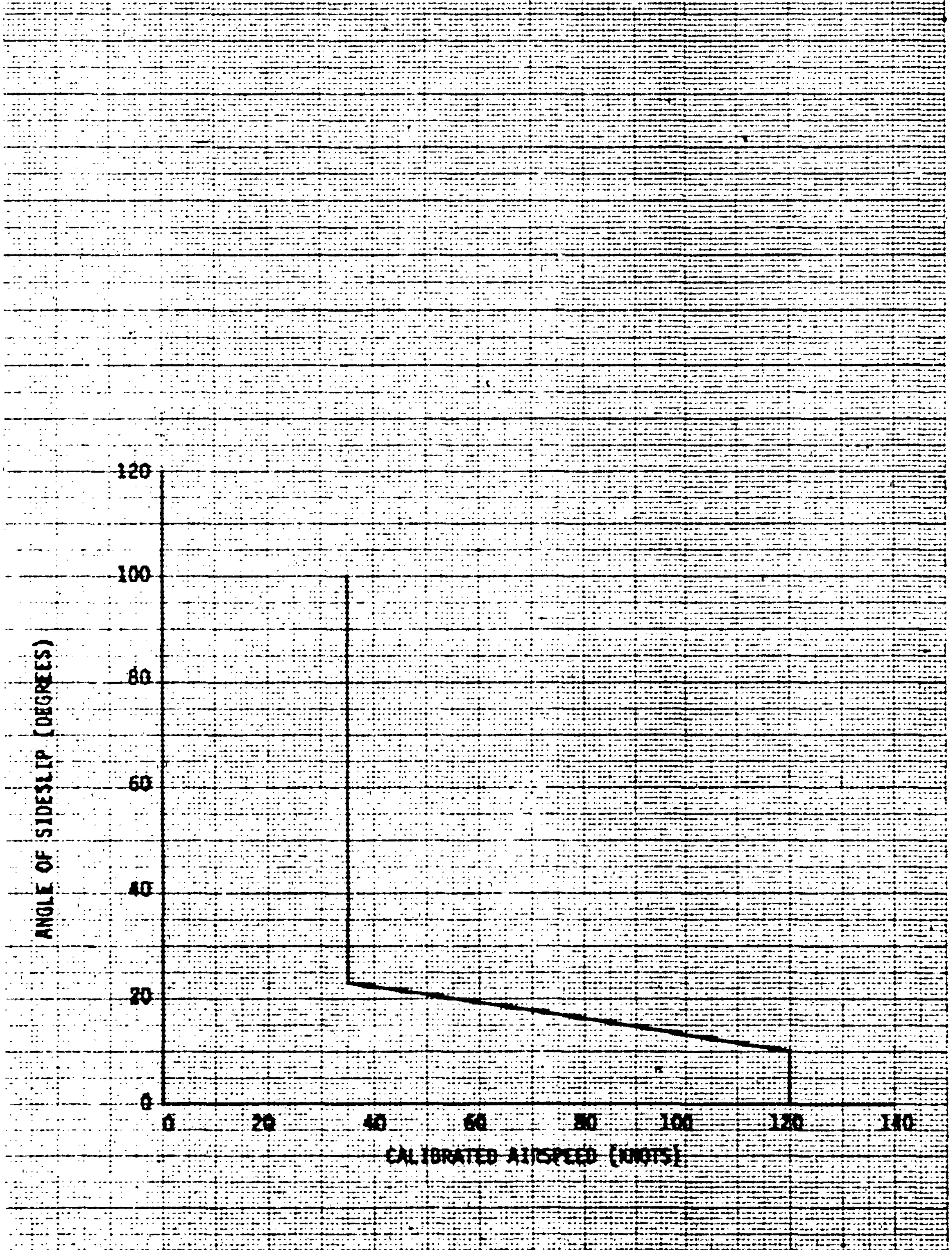
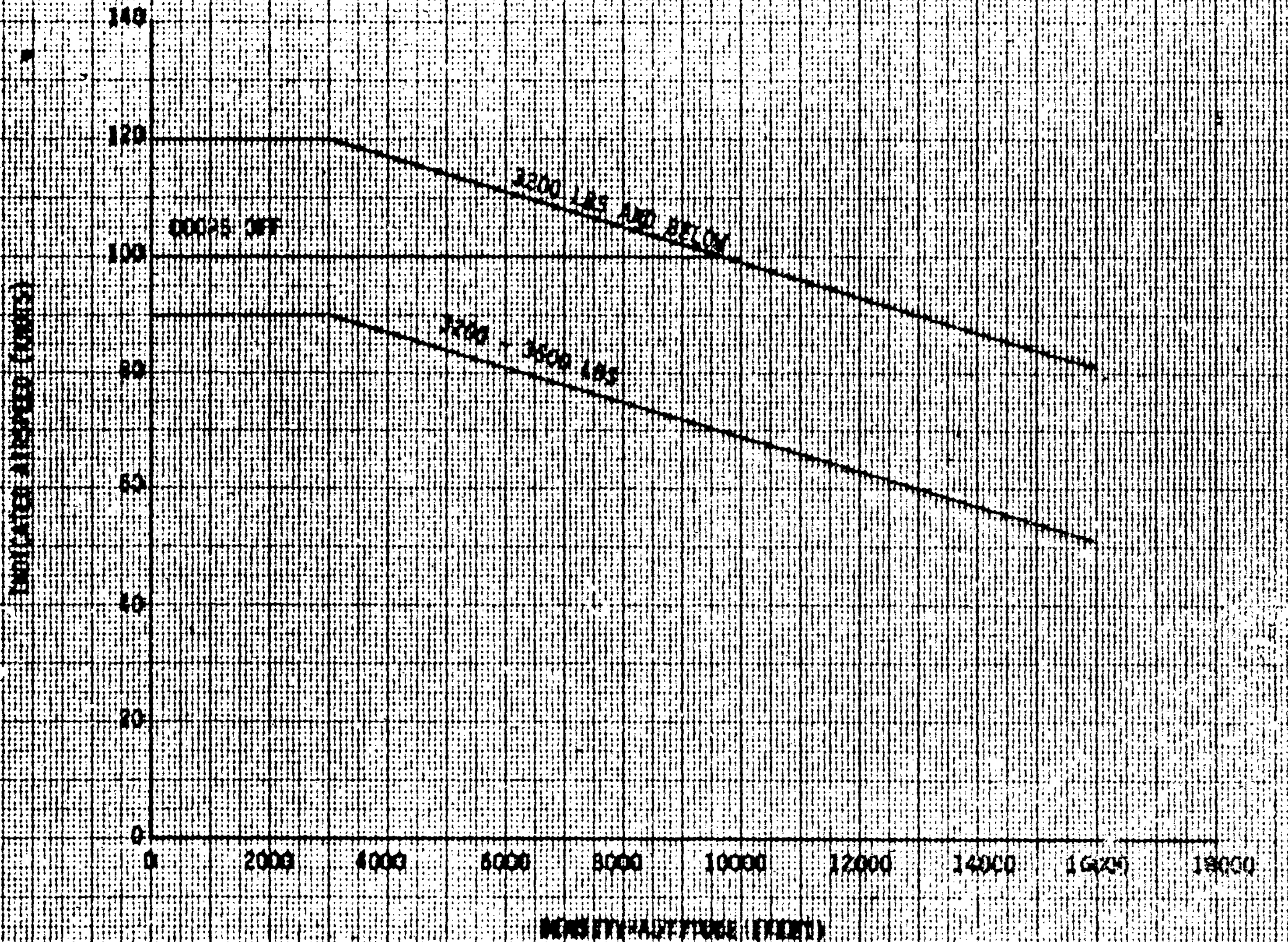


FIGURE 4
AIRWORTHINESS RELEASE AIRSPEED LIMITS
OH-58C LCH



APPENDIX C. INSTRUMENTATION

1. The test instrumentation system was designed, calibrated, installed, and maintained by USAAEFA. Digital and analog data were obtained from calibrated instrumentation and were recorded on magnetic tape and/or displayed in the cockpit. The instrumentation system consisted of various transducers, signal conditioning units, a ten-bit PCM encoder, and the Ampex AR 700 tape recorder. Time correlation was accomplished with a pilot/engineer event switch and onboard recorded and displayed Inter-Range Instrumentation Group (IRIG) B time. Various specialized test indicators displayed data to the pilot and engineer continuously during the flight. A boom with the following sensors was mounted on the nose of the aircraft: swiveling pitot-static head, sideslip vane, and angle-of-attack vane. Photographs 1 through 4 show the instrumentation installation. Boom airspeed system calibration is shown in figures 1 through 3. The engine torquemeter calibration is shown in figure 4.

2. The following parameters were displayed on calibrated instruments in the cockpit:

Airspeed (boom)
Airspeed (ship's system)
Altitude (boom)
Rotor speed
Engine torque
Fuel flow rate
Fuel used (totalizer)
Outside air temperature
Normal acceleration
Angle of sideslip
Tether cable tension
Tether cable angle
Time of day
Record counter

3. The following parameters were recorded on magnetic tape:

Time code
Run number
Pilot/engineer event
Fuel used
Airspeed (boom)
Altitude (boom)
Main rotor speed
Outside air temperature
Angle of sideslip
Angle of attack
Engine torque
Turbine outlet temperature
Gas producer speed
Fuel flow rate
Control positions
- Longitudinal
- Lateral
- Directional
- Collective

- Aircraft attitudes and rates
  - Pitch
  - Roll
  - Yaw
- Tether cable tension
- Tether cable angles
  - Longitudinal
  - Lateral
- Aircraft center-of-gravity accelerations
  - Longitudinal
  - Lateral
  - Normal
- Pilot seat accelerations
  - Longitudinal
  - Lateral
  - Vertical

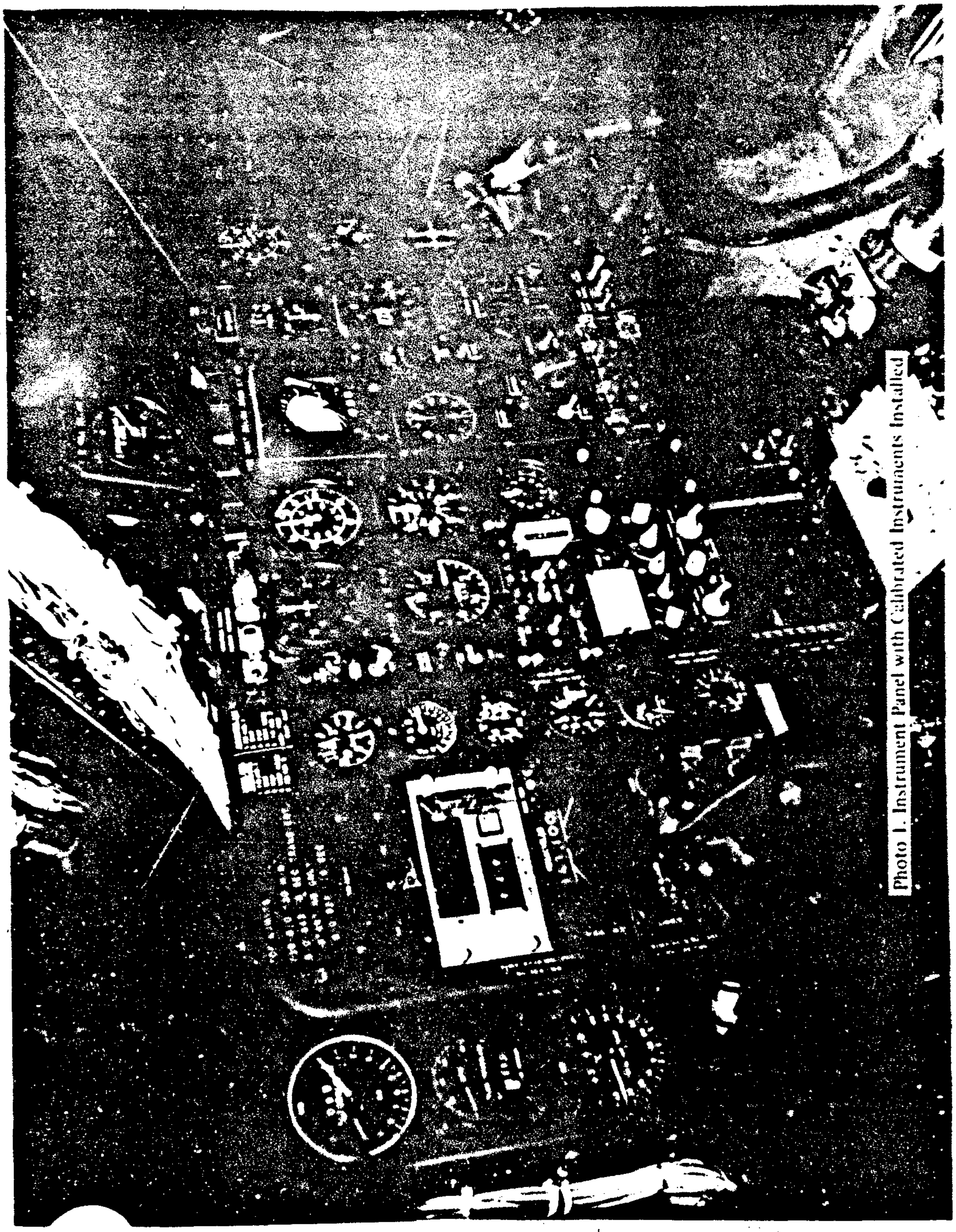


Photo 1. Instrument Panel with Calibrated Instruments Installed

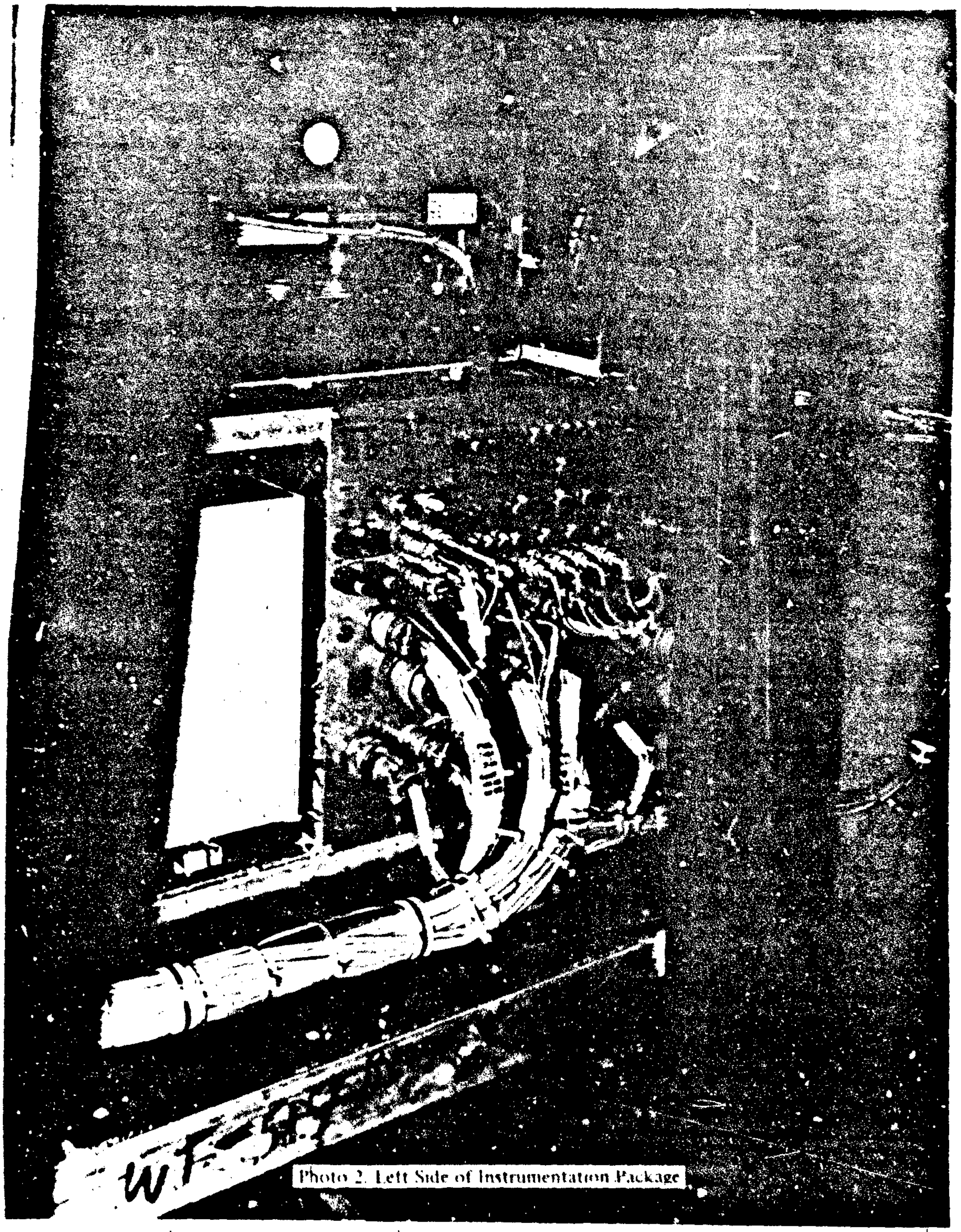


Photo 2. Left Side of Instrumentation Package

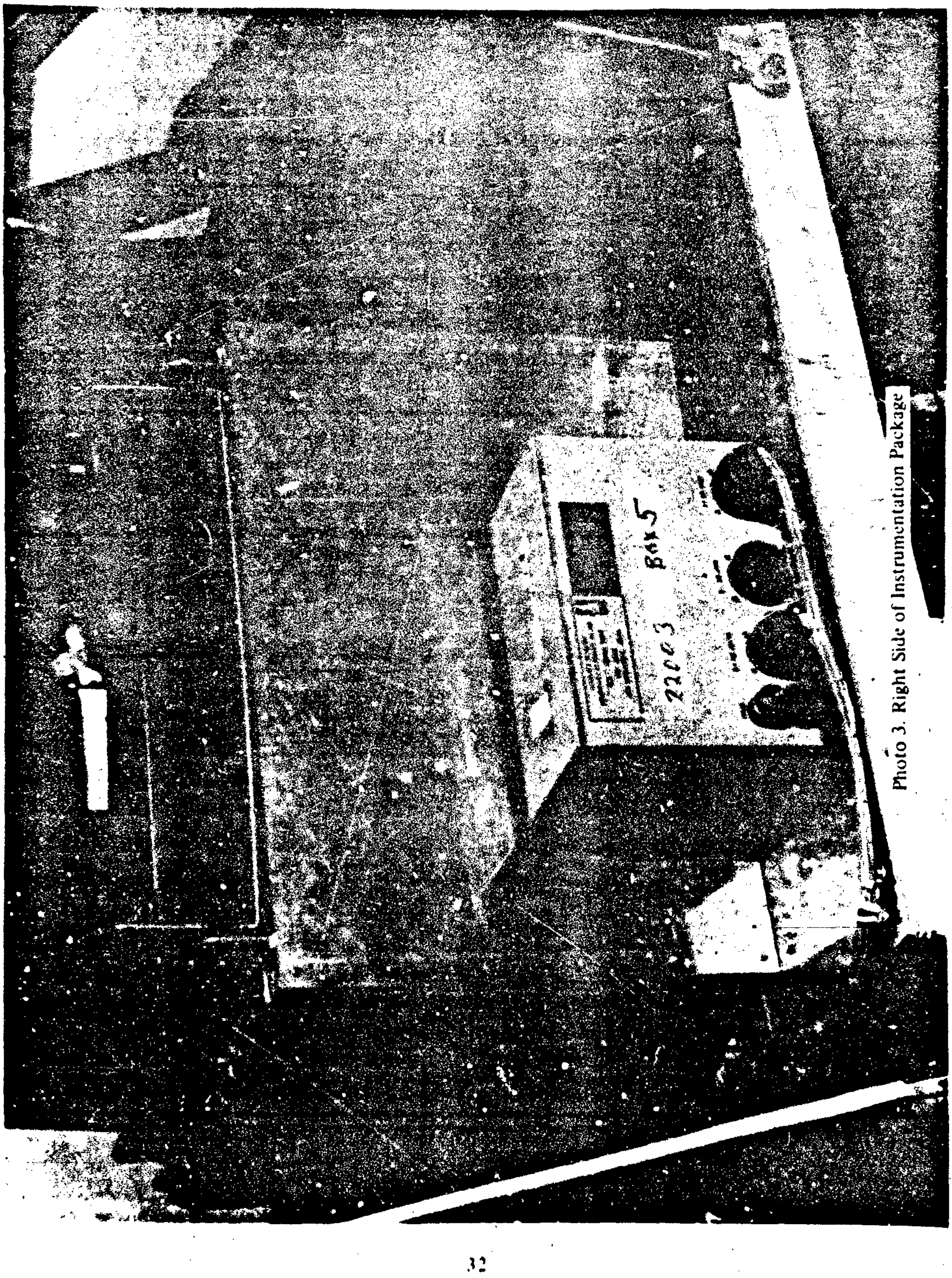


Photo 3. Right Side of Instrumentation Package

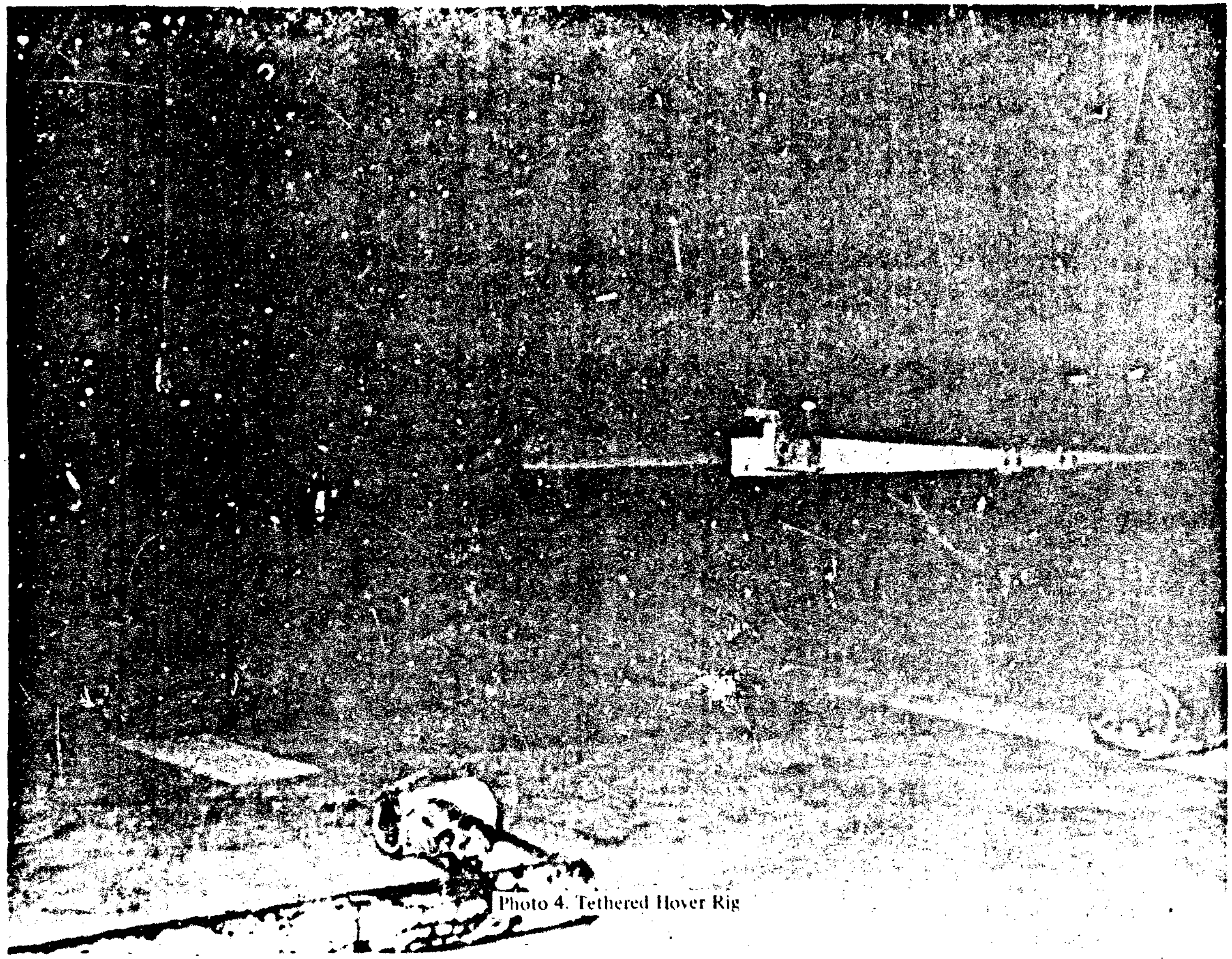


Photo 4. Tethered Hover Rig

FIGURE 1
BOOM SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
OH-58C USA S/N 68-16870

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)
3349	108.7(MID)	0.9(RT)	7200	25.5	354

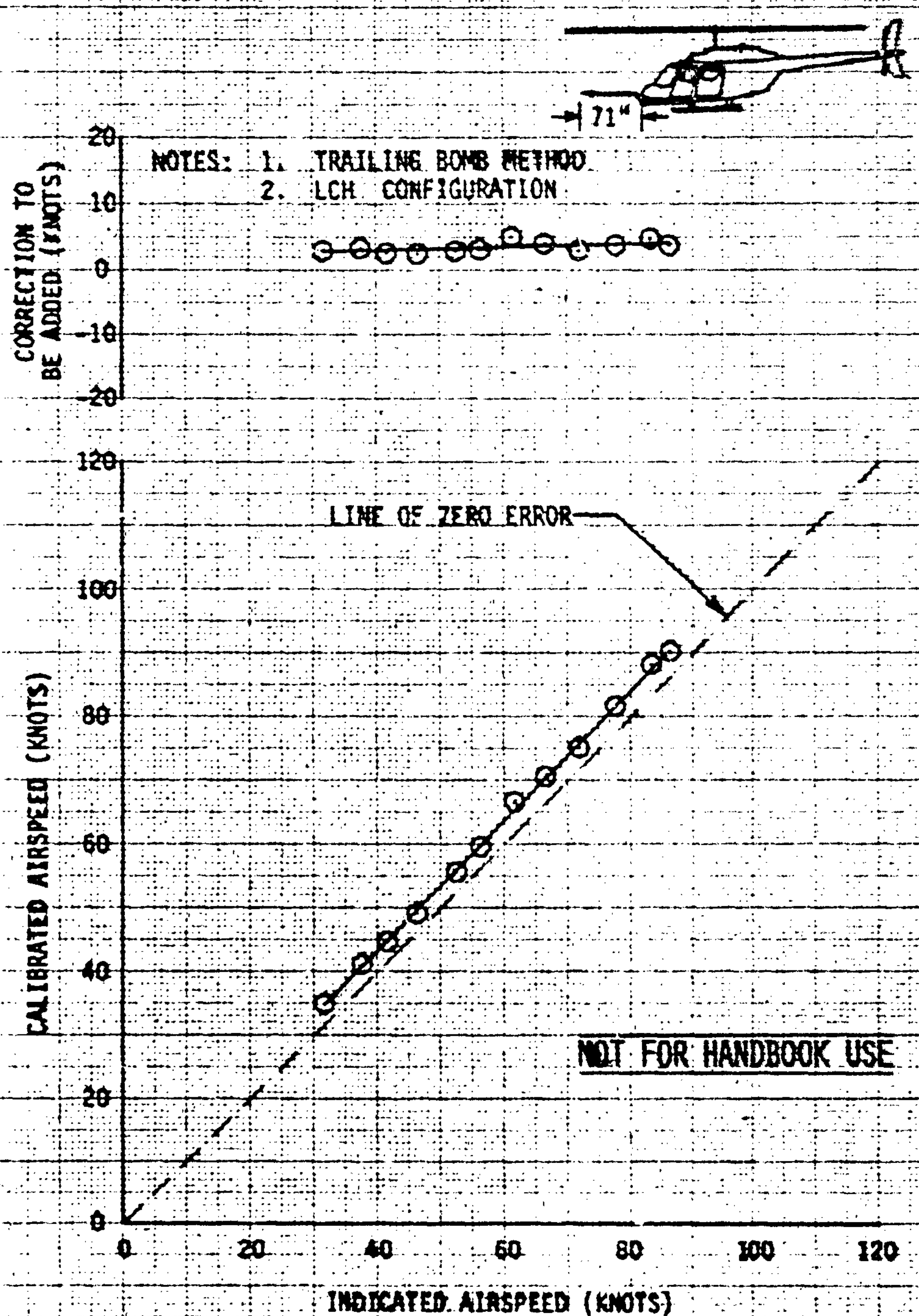


FIGURE 2
BOOM SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
OH-58C USA S/N 68-16870

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)
3280	108.5(MID)	0.9(RT)	7560	25.0	354

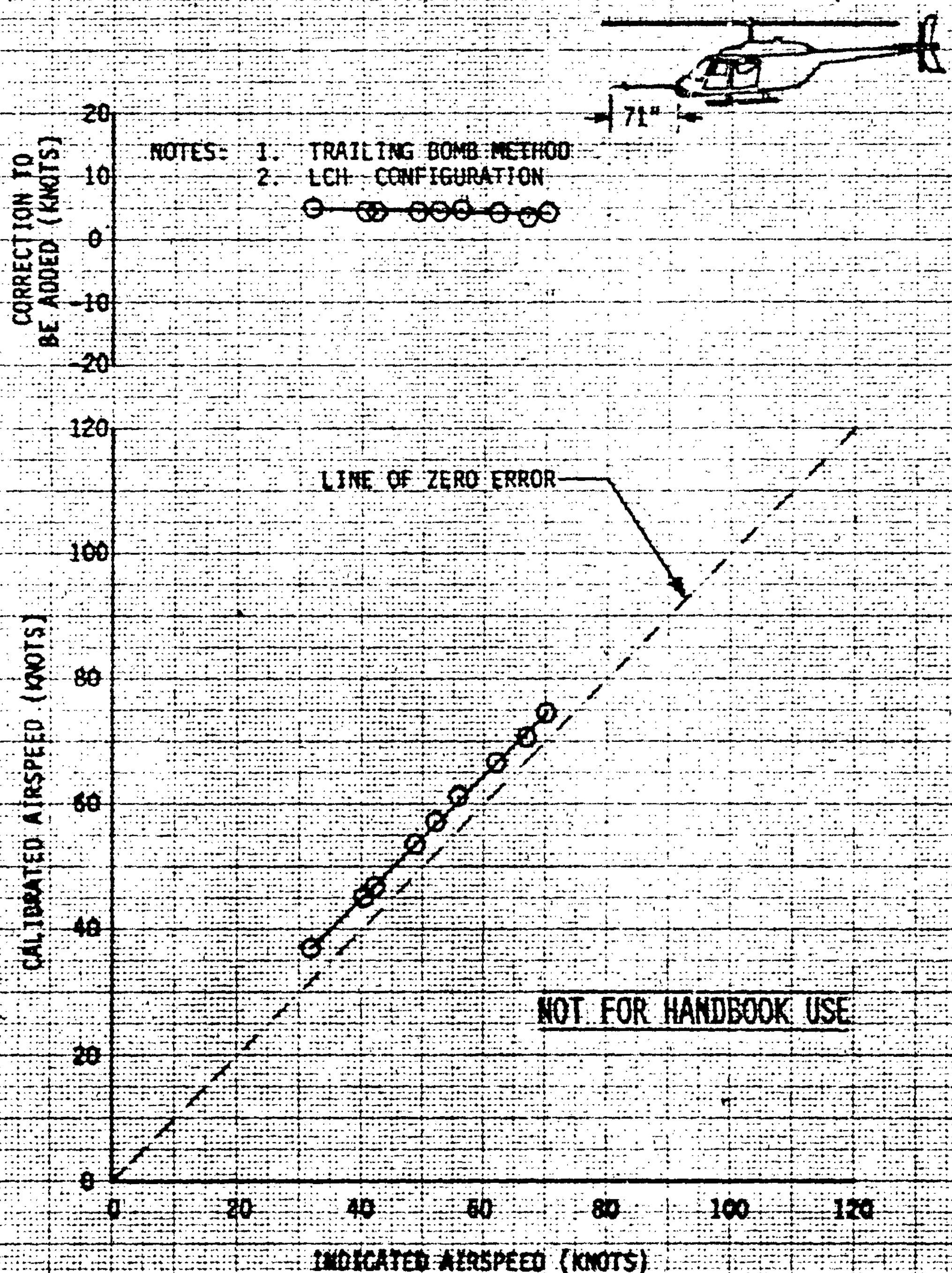


FIGURE 3
BOOM SYSTEM AIRSPEED CALIBRATION IN AUTOROTATION
OH-58C USA S/N 68-16870

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)
3280	108.5(MID)	0.9(RT)	7300	25.0	354

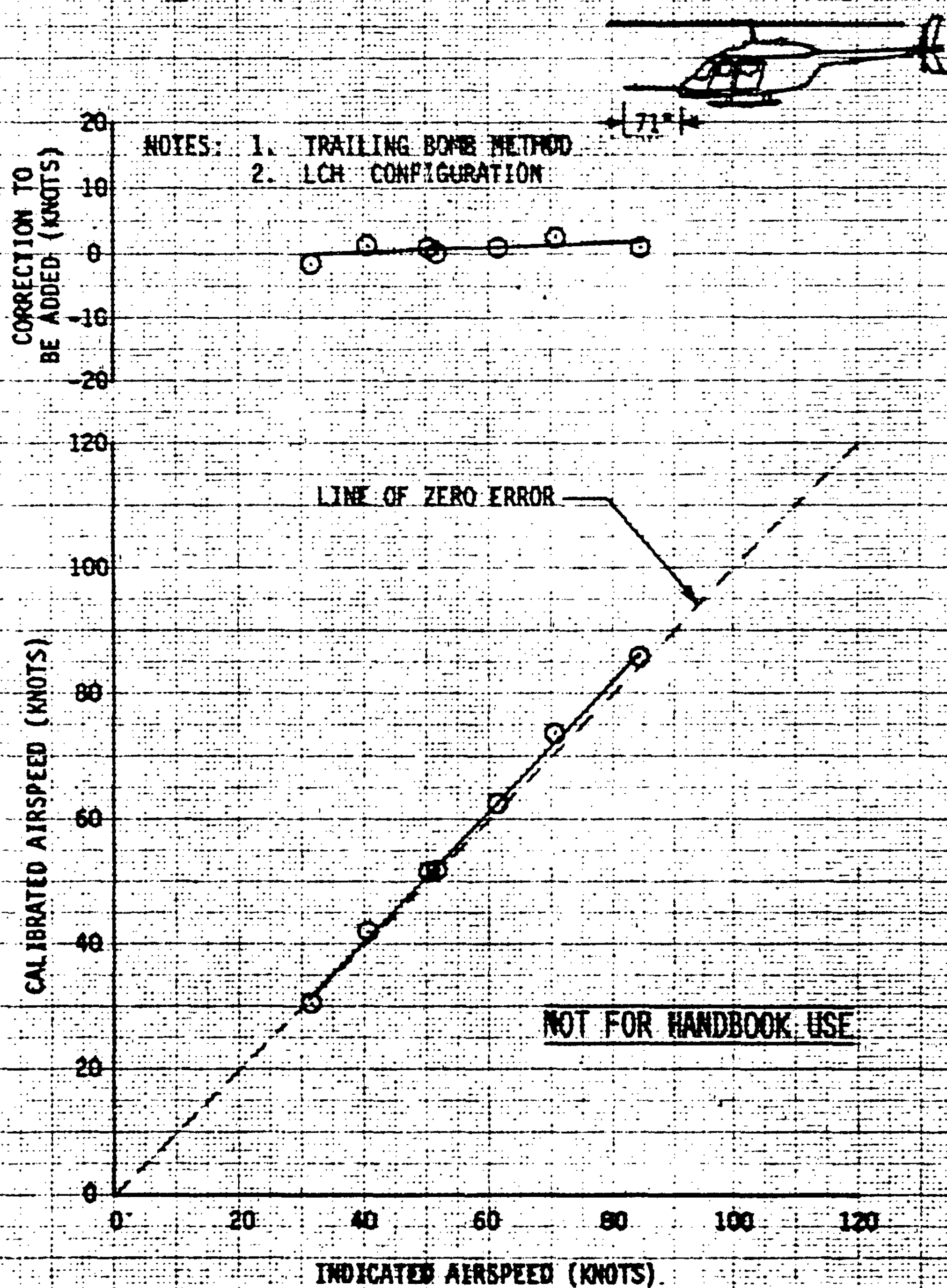
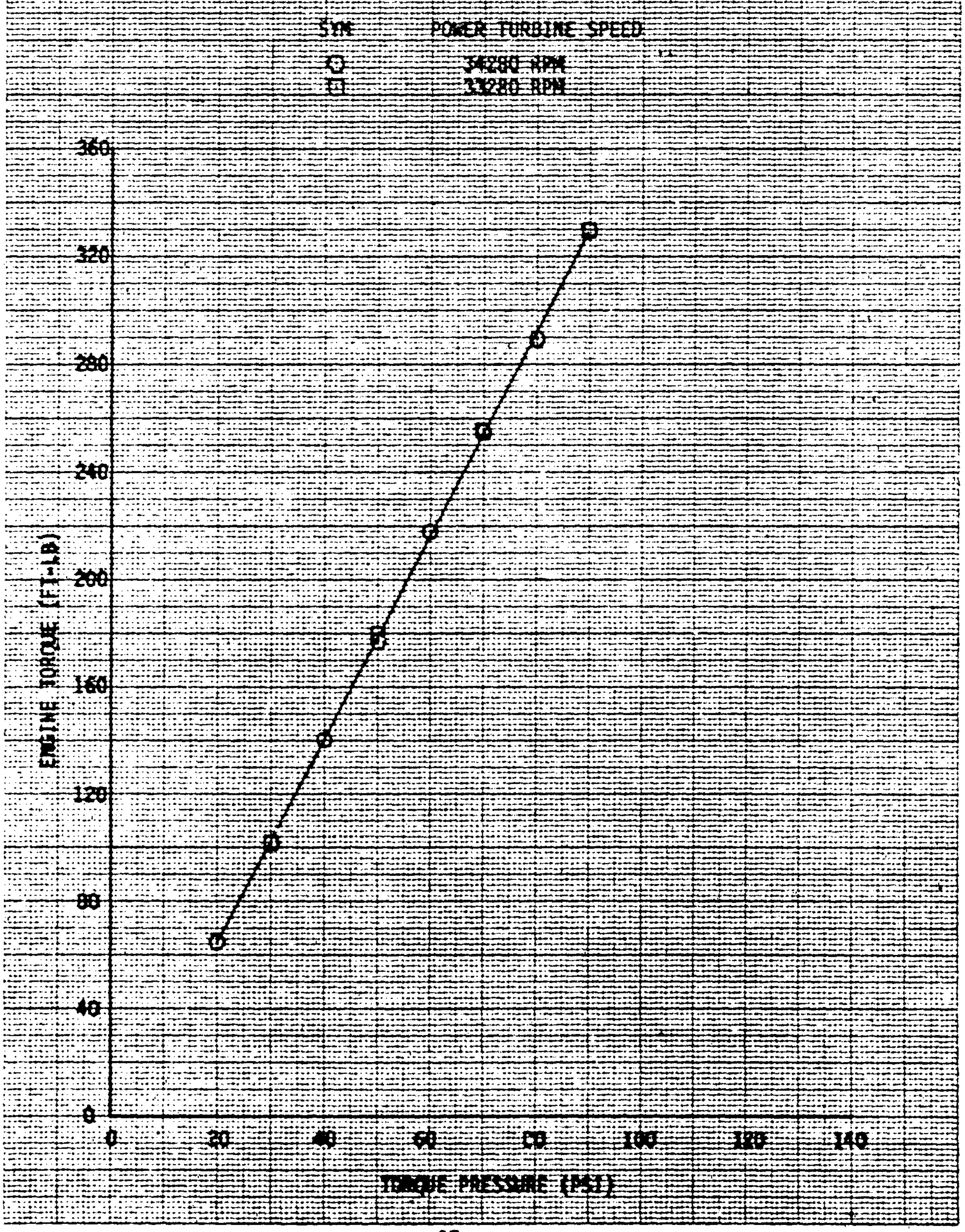


FIGURE 4
ENGINE TORQUEMETER CALIBRATION
ALLISON ENGINE MODEL T63-A-720 S/N 404951
TYPE FUEL: COMMA 50,FUEL LOWER HEATING VALUE: 18400 BTU/LB
AVG COMPRESSOR INLET TEMPERATURE: 29° F



APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

PERFORMANCE

1. The helicopter performance test data were generalized by use of nondimensional coefficients and were such that the effects of compressibility and blade stall were not separated and defined. The following nondimensional coefficients were used to generalize the hover and level flight test results obtained during this flight test program.

a. Coefficient of power (C_P):

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

b. Coefficient of thrust (C_T):

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

c. Advance ratio (μ):

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

d. Advancing 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) = 980.56
Ω = Main rotor angular velocity (radian/sec) = 37.07 (at 354 rpm)
R = Main rotor radius (ft) = 17.667
Thrust = Gross weight (lb) during free flight in which there is no acceleration or velocity component in the vertical direction. Tether load must be added in the case of tethered hover.
1.6878 = Conversion factor (ft/sec/knot)
V_T = True airspeed (knot)
a = Speed of sound (ft/sec) = $1116.45\sqrt{\theta}$
θ = (T + 273.15)/288.15
T = Ambient air temperature (°C)

For a rotor speed of 354 rpm, the following constants were used:

A = 980.56 ft^2
ΩR = 654.93 ft/sec

$A(\Omega R)^2 = 420594463.5\ ft^4/sec^2$
$A(\Omega R)^3 = 2.7544598083 \times 10^{11}\ ft^5/sec^3$

Shaft Horsepower Required

2. 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 4, appendix C. The output shp was determined from the engine output shaft torque and rotational speed by the following equation:

$$SHP = \frac{2\pi \times N_p \times Q}{33{,}000} \qquad (5)$$

Where:

N_p = Engine output shaft rotational speed (rpm)
Q = Engine output shaft torque (ft-lb)
33,000 = Conversion factor (ft-lb/min/shp)

HOVER PERFORMANCE

3. Hover performance data were gathered during 2-foot and 50-foot tethered hovering flight. Power was varied between data points from the minimum required to maintain tension in the tehter cable, to the maximjm power available. Cable tension was measured and added to the aircraft gross weight to determine thrust (required in equation 2). To further increase the range of C_T and C_P, main rotor speed was varied from approximately 97 to 100 percent.

Level Flight Performance and Specific Range

4. Level flight performance data were 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 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.

5. Test-day (measured) level flight power was corrected to standard-day conditions (average for the flight) by assuming that the test-day dimensionless parameters C_{P_t}, C_{T_t}, and μ_t are identical to C_{P_s}, C_{T_s}, and μ_s, respectively.

From equation 1, the following relationship can be derived:

$$SHP_s = SHP_t \left(\frac{\rho_s}{\rho_t}\right) \qquad (6)$$

Where:

Subscript t = test day
Subscript s = standard day

6. Test specific range was calculated using level flight performance data and the measured fuel flow.

$$SR = \frac{V_T}{W_f} \tag{7}$$

Where:

SR = Specific range (nautical air miles per pound of fuel)
V_T = True airspeed (knot)
W_f = Fuel flow (lb/hr)

HANDLING QUALITIES

7. Stability and control data were collected and evaluated using standard test methods as described in reference 5, appendix A. Definitions of deficiencies and shortcomings used during this test are shown below.

a. Deficiency. A defect or malfunction discovered during the life cycle of an item of equipment that constitutes a safety hazard to personnel; will result in serious damage to the equipment if operation is continued; or indicates improper design or other cause of failure of an item or part, which seriously impairs the equipment's operational capability.

b. Shortcoming. An imperfection or malfunction occurring during the life cycle of equipment which must be reported and which should be corrected to increase efficiency and to render the equipment completely serviceable. It will not cause an immediate breakdown, jeopardize safe operation, or materially reduce the useability of the material or end product.

AIRSPEED CALIBRATION

8. The boom pitot-static system was calibrated by using the trailing bomb method to determine the airspeed position error. Calibrated airspeed (V_{cal}) was obtained by correcting indicated airspeed (V_i) using instrument (ΔV_{ic}) and position (ΔV_{pc}) error corrections.

$$V_{cal} = V_i + \Delta V_{ic} + \Delta V_{pc} \tag{8}$$

9. True airspeed (V_t) was calculated from the calibrated airspeed and density ratio.

$$V_t = \frac{V_c}{\sqrt{\sigma}} \quad (9)$$

Where:

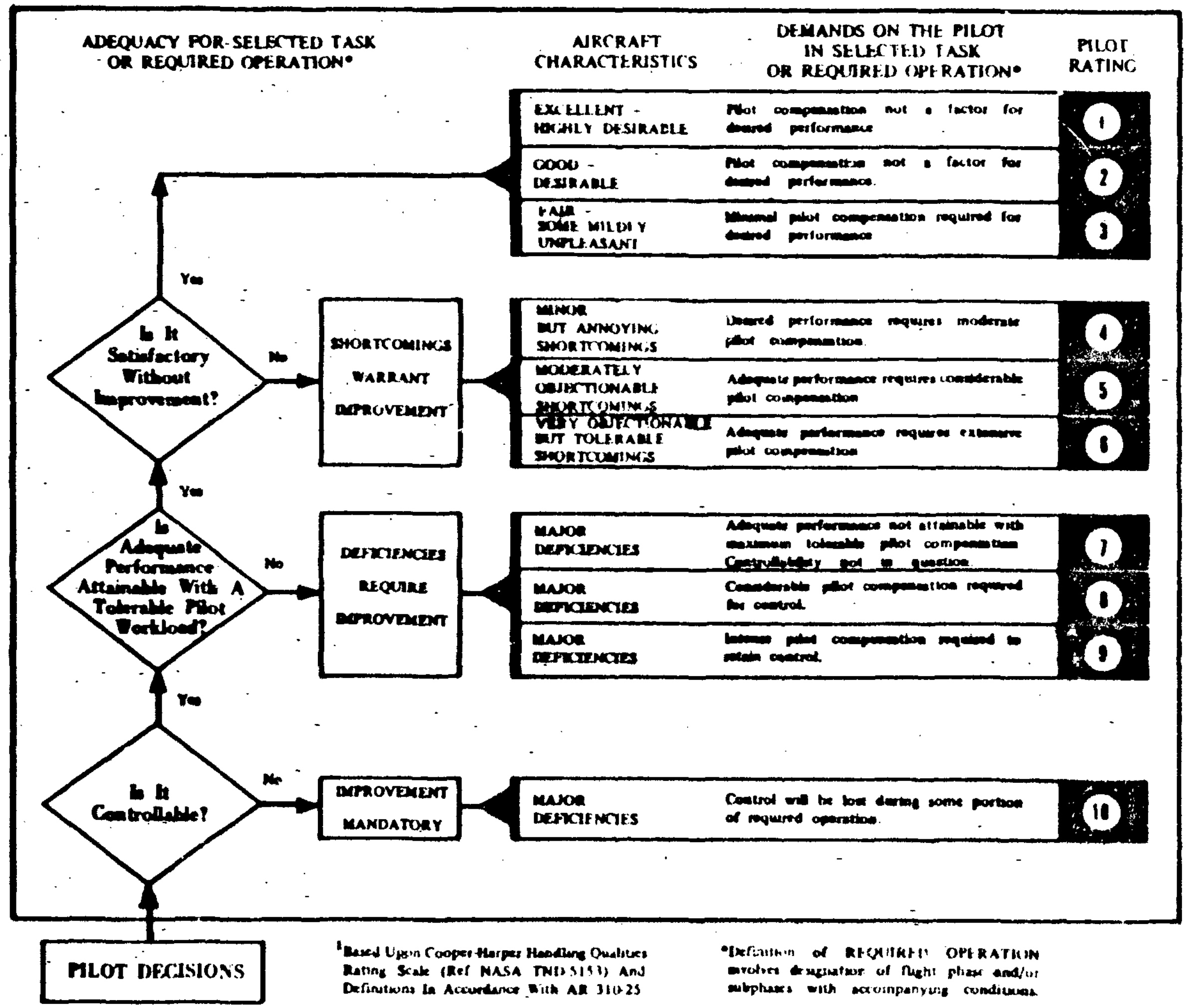
σ = Density ratio ($\frac{\rho}{\rho_o}$) where ρ_o is the density at sea level on a standard day.

WEIGHT AND BALANCE

10. Prior to testing, the aircraft gross weight and center-of-gravity (cg) location were determined by using calibrated scales. The aircraft was weighed with full fuel in the light combat helicopter configuration with instrumentation on board. The aircraft weight was 2921 pounds with a longitudinal cg location at FS 113.59 and a lateral cg location at BL 0.72.

HANDLING QUALITIES RATING SCALE

11. The Handling Qualities Rating Scale (HQRS) presented in figure 1 was used to augment pilot comments relative to handling qualities and work load.



[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

APPENDIX E. TEST DATA

INDEX

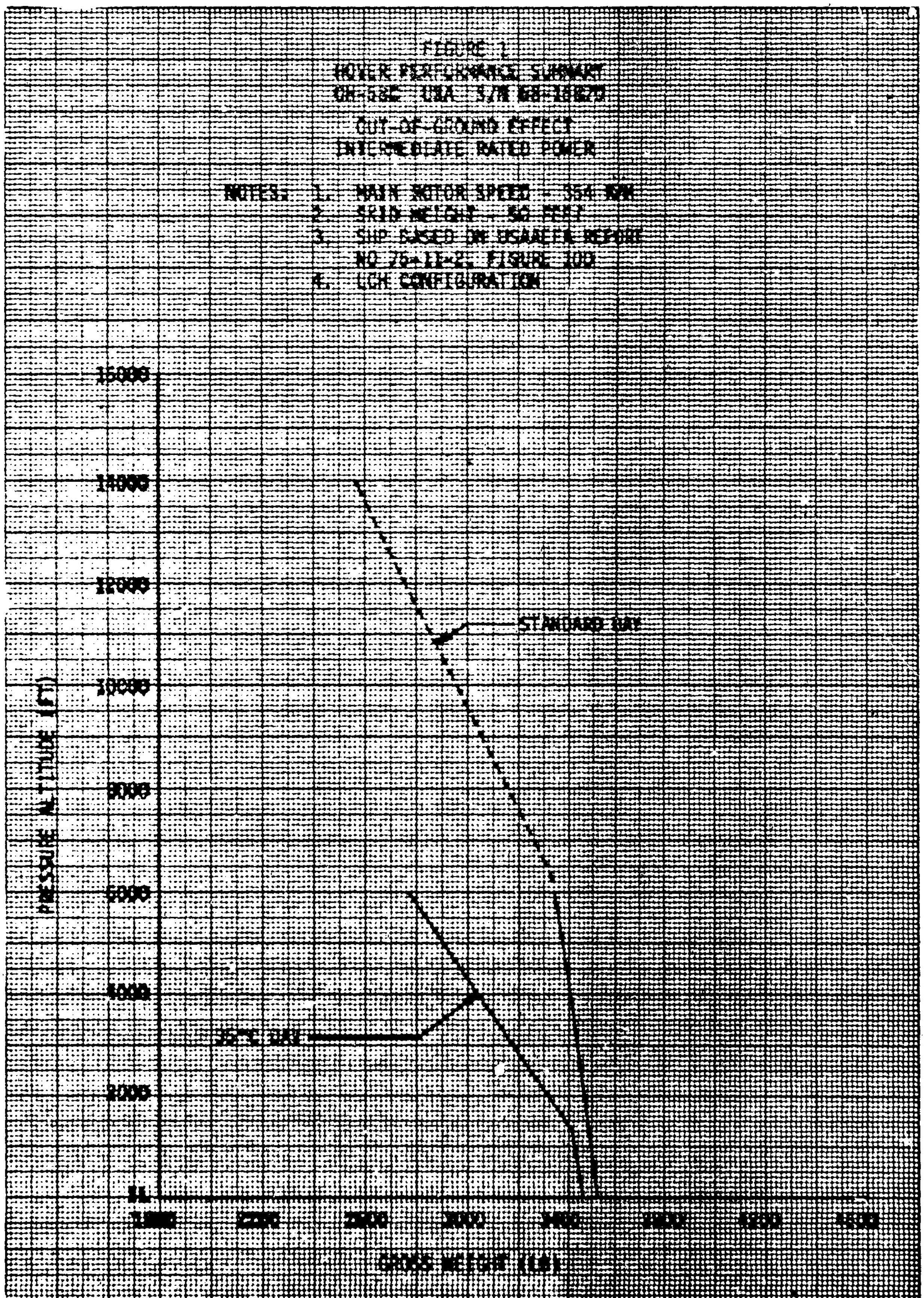
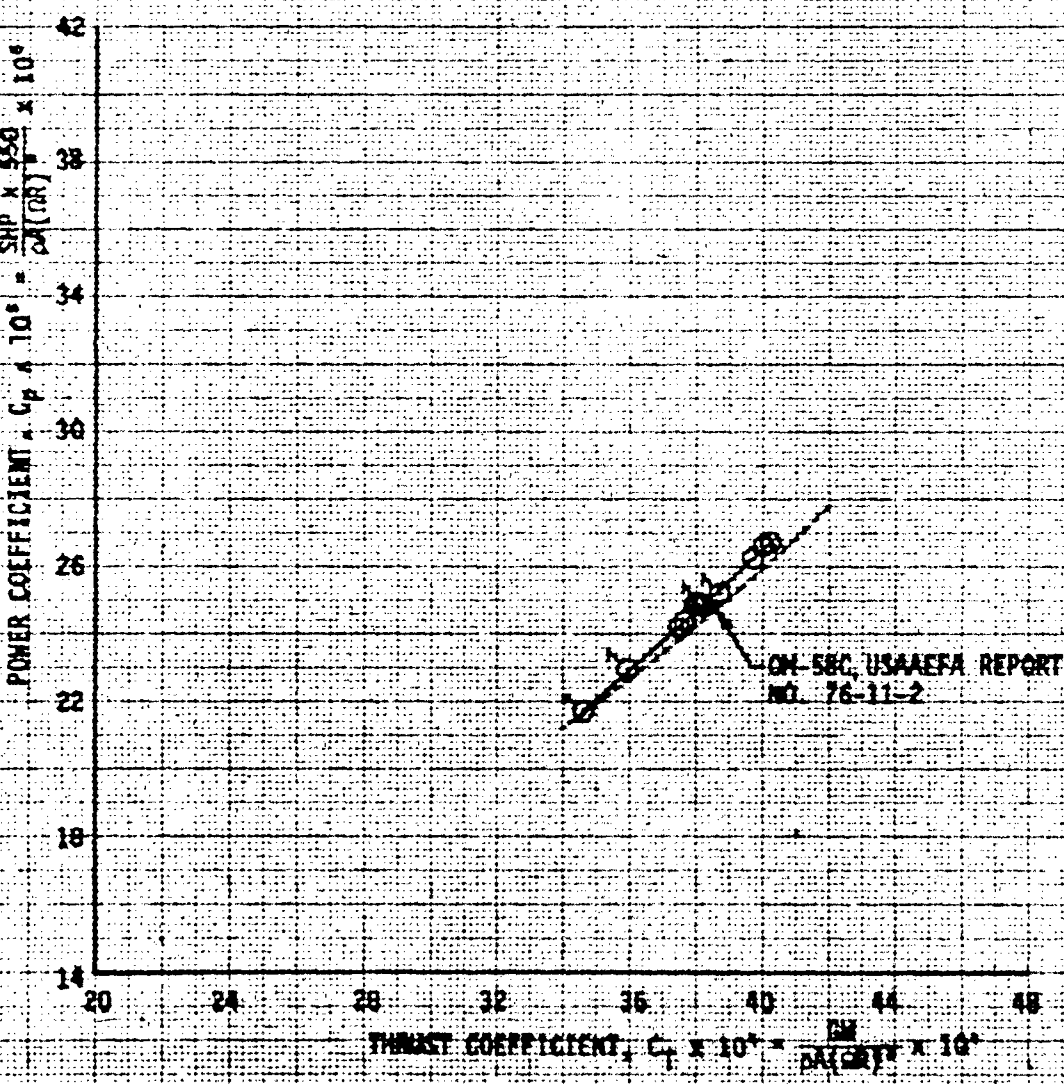


FIGURE 1
HOVER PERFORMANCE SUMMARY
OUT-OF-GROUND EFFECT
INTERMEDIATE RATED POWER
NOTES: 1. MAIN ROTOR SPEED - 354 RPM
2. SKID HEIGHT - 50 FEET
3. SHP BASED ON USAAEFA REPORT NO 75-11-2, FIGURE 109
4. LOH CONFIGURATION
STANDARD DAY
35°C DAY
PRESSURE ALTITUDE (FT)
SL
2000
4000
6000
8000
10000
12000
14000
16000
1800
2200
2600
3000
3400
3800
4200
4600
GROSS WEIGHT (LB)

FIGURE 2
NONDIMENSIONAL HOVER PERFORMANCE
OH-58C USA S/N 68-16870
SKID HEIGHT = 2 FEET

SYM	ROTOR SPEED (RPM)	DENSITY ALTITUDE (FT)	OAT (°C)
○	344	3420	20.0
○ (flagged)	351	3420	20.0

NOTES:
1. TETHERED HOVER TECHNIQUE
2. WINDS LESS THAN 3 KNOTS
3. VERTICAL HEIGHT FROM BOTTOM OF SKID TO CENTER OF ROTOR HUB = 9.33 FEET
4. LCH CONGIURATION



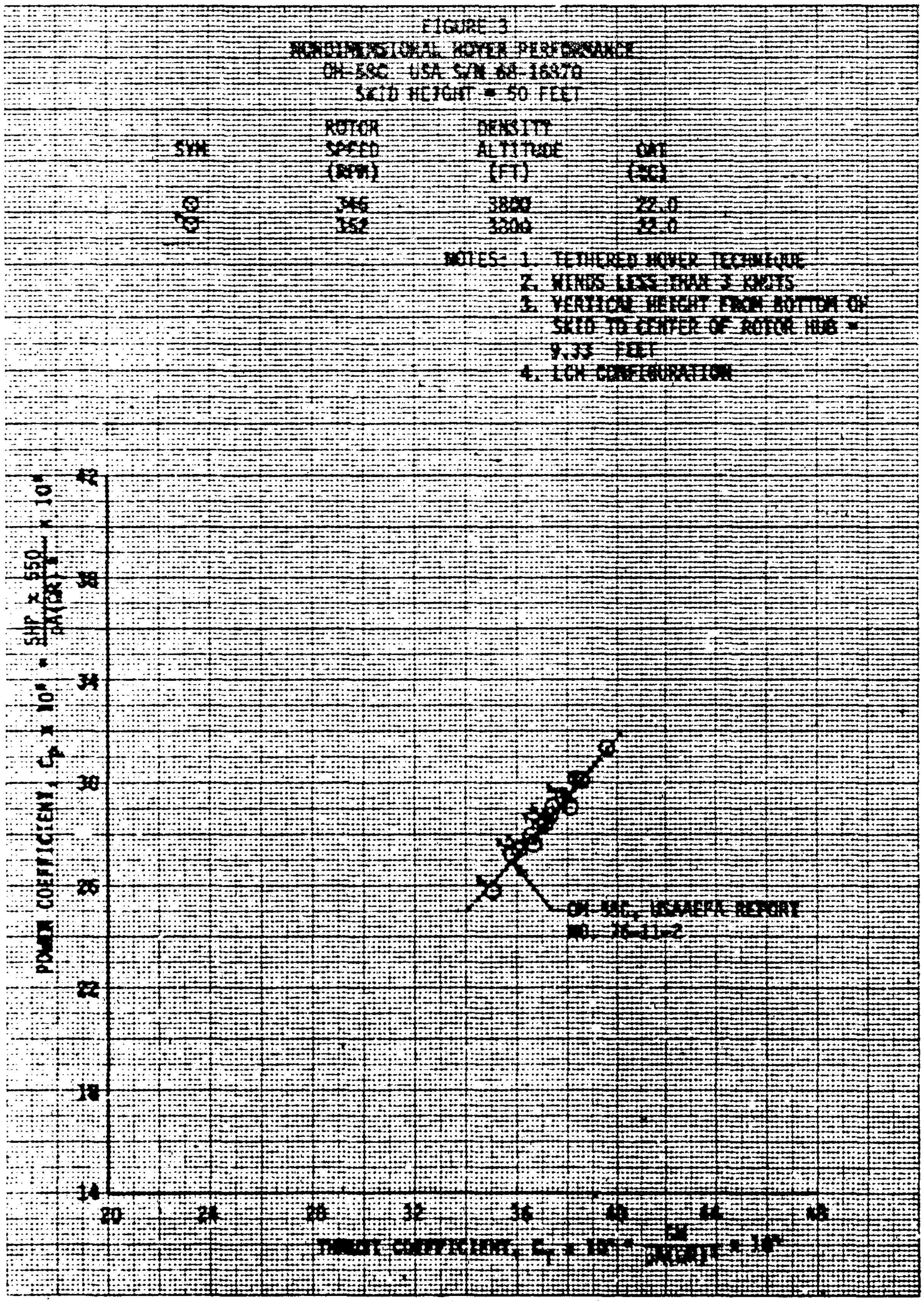


FIGURE 3
NONDIMENSIONAL HOVER PERFORMANCE
OH-58C USA S/N 68-16870
SKID HEIGHT = 50 FEET
SYM
ROTOR SPEED (RPM)
DENSITY ALTITUDE (FT)
OAT (°C)
346
3800
22.0
352
3200
22.0
NOTES: 1. TETHERED HOVER TECHNIQUE
2. WINDS LESS THAN 3 KNOTS
3. VERTICAL HEIGHT FROM BOTTOM OF SKID TO CENTER OF ROTOR HUB = 9.33 FEET
4. LCH CONFIGURATION
OH-58C, USAAEFA REPORT NO. 76-11-2
POWER COEFFICIENT, $C_P \times 10^6 = \frac{SHP \times 550}{\rho A (\Omega R)^3} \times 10^6$
THRUST COEFFICIENT, $C_T \times 10^4 = \frac{GW}{\rho A (\Omega R)^2} \times 10^4$
14
18
22
26
30
34
38
42
20
24
28
32
36
40
44
48

FIGURE 4
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 69-16870

NOTES: 1. ICH CONFIGURATION
2. ZERO SIDESLIP
3. AVG LONGITUDINAL CG = (FS) 110.4 (AFT)
4. AVG $N_R/\sqrt{\theta}$ = 346.0
5. CURVES DERIVED FROM FIGS. 6 THROUGH 11

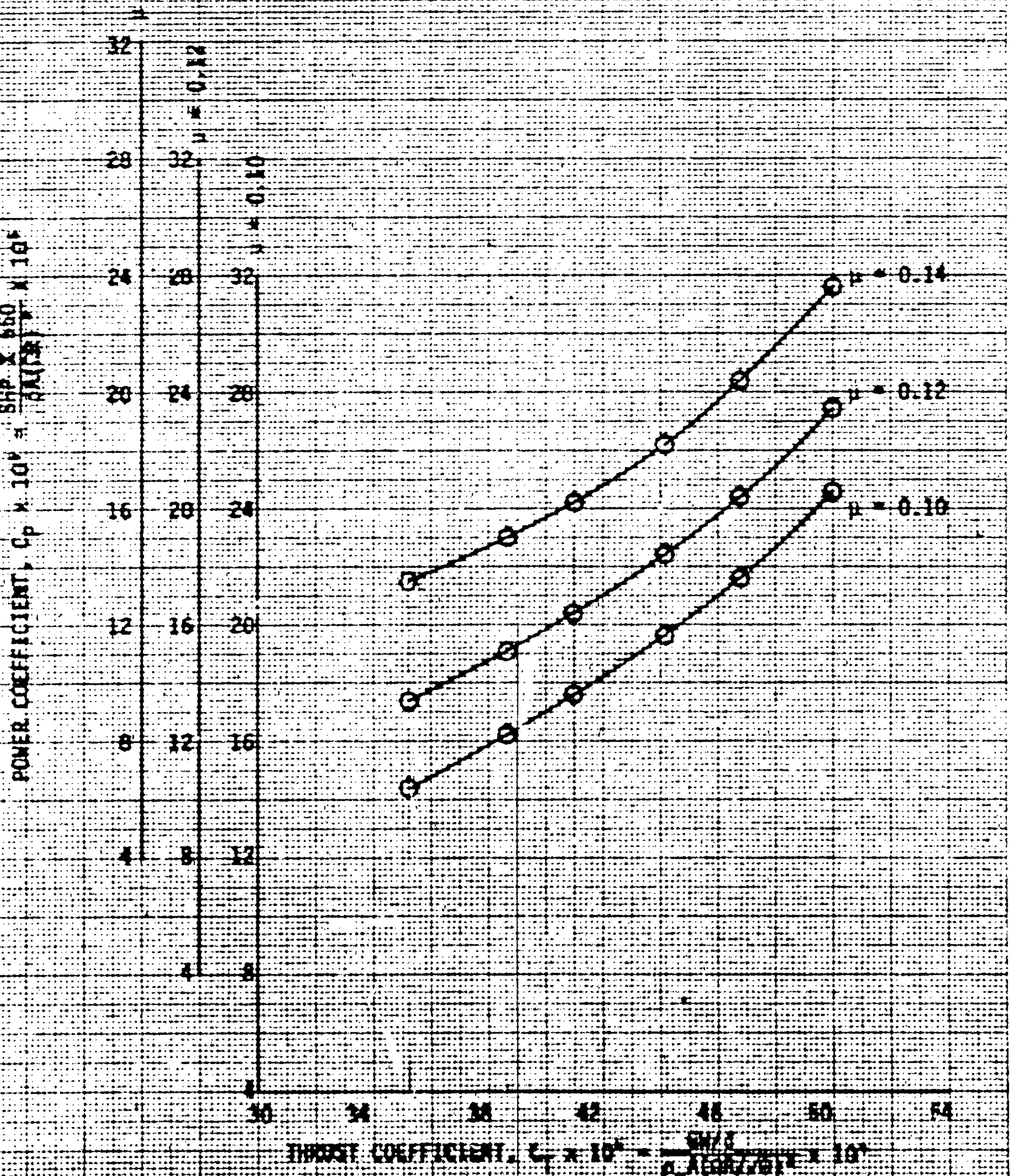
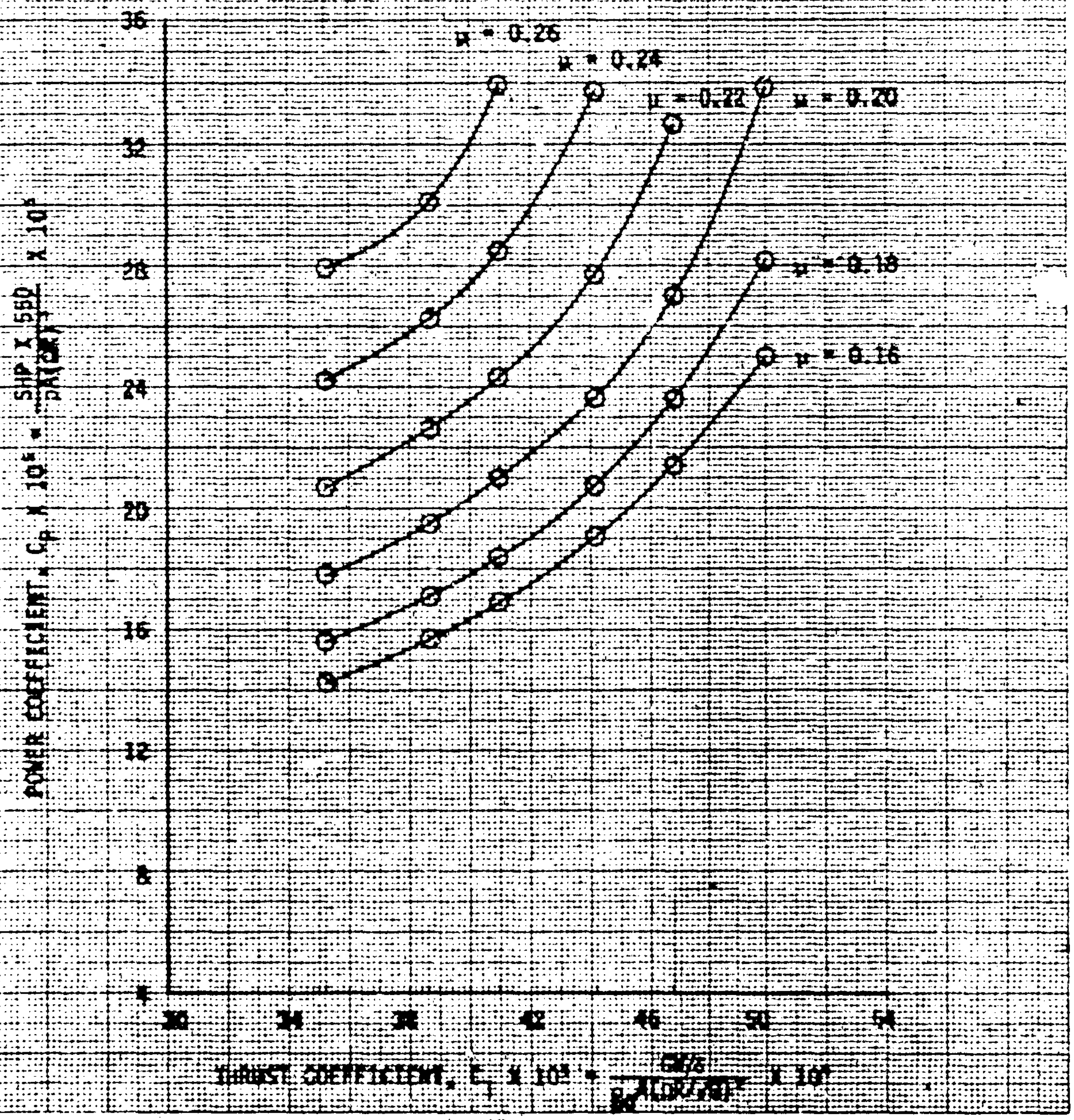


FIGURE 6

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

UH-58C USA S/N 68-16870

NOTES: 1. CLEAN CONFIGURATION
2. ZERO SIDESLIP
3. AVG LONGITUDINAL CG = (FS) 110.4 (AFT)
4. AVG $N_R/\sqrt{\theta}$ = 346.0
5. CURVES DERIVED FROM FIGS. 6 THROUGH 11



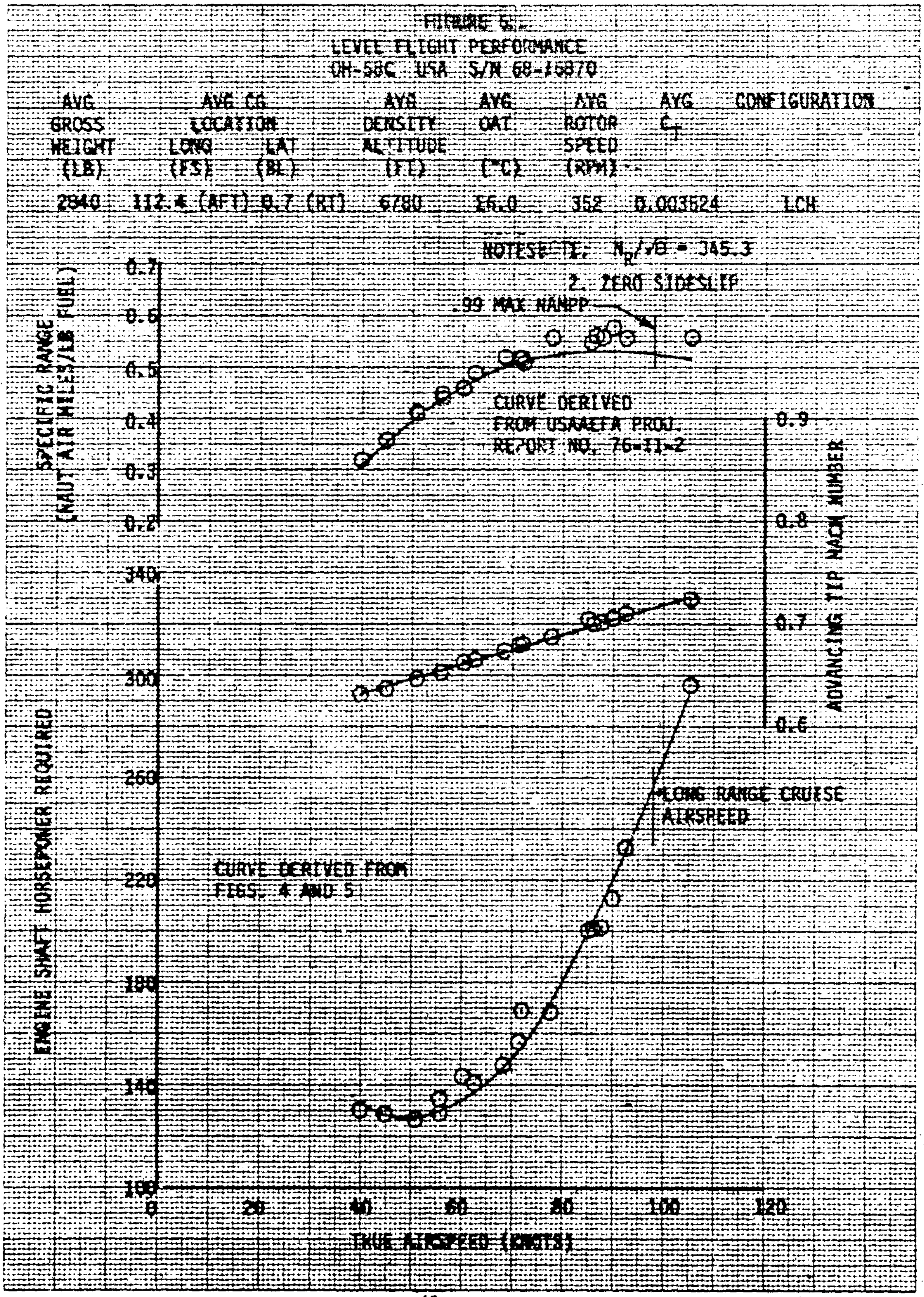


FIGURE 6.
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16870
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED (RPM)
AVG C_T
CONFIGURATION
2840
112.4 (AFT)
0.7 (RT)
6780
16.0
352
0.003624
LCH
NOTES: 1. $N_R/\sqrt{\theta}$ = 345.3
2. ZERO SIDESLIP
.99 MAX NAMPP
CURVE DERIVED FROM USAAEFA PROJ. REPORT NO. 76-11-2
LONG RANGE CRUISE AIRSPEED
CURVE DERIVED FROM FIGS. 4 AND 5
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
ENGINE SHAFT HORSEPOWER REQUIRED
ADVANCING TIP MACH NUMBER
TRUE AIRSPEED (KNOTS)
0.2
0.3
0.4
0.5
0.6
0.7
100
140
180
220
260
300
340
0.6
0.7
0.8
0.9
0
20
40
60
80
100
120

FIGURE [illegible]
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16876

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
3080	110.8 (AFT)	0.7 (RT)	6780	22.0	350	0.003856	LCH

NOTES: 1. $N_R/\sqrt{\theta}$ = 345.5
2. ZERO SIDESLIP

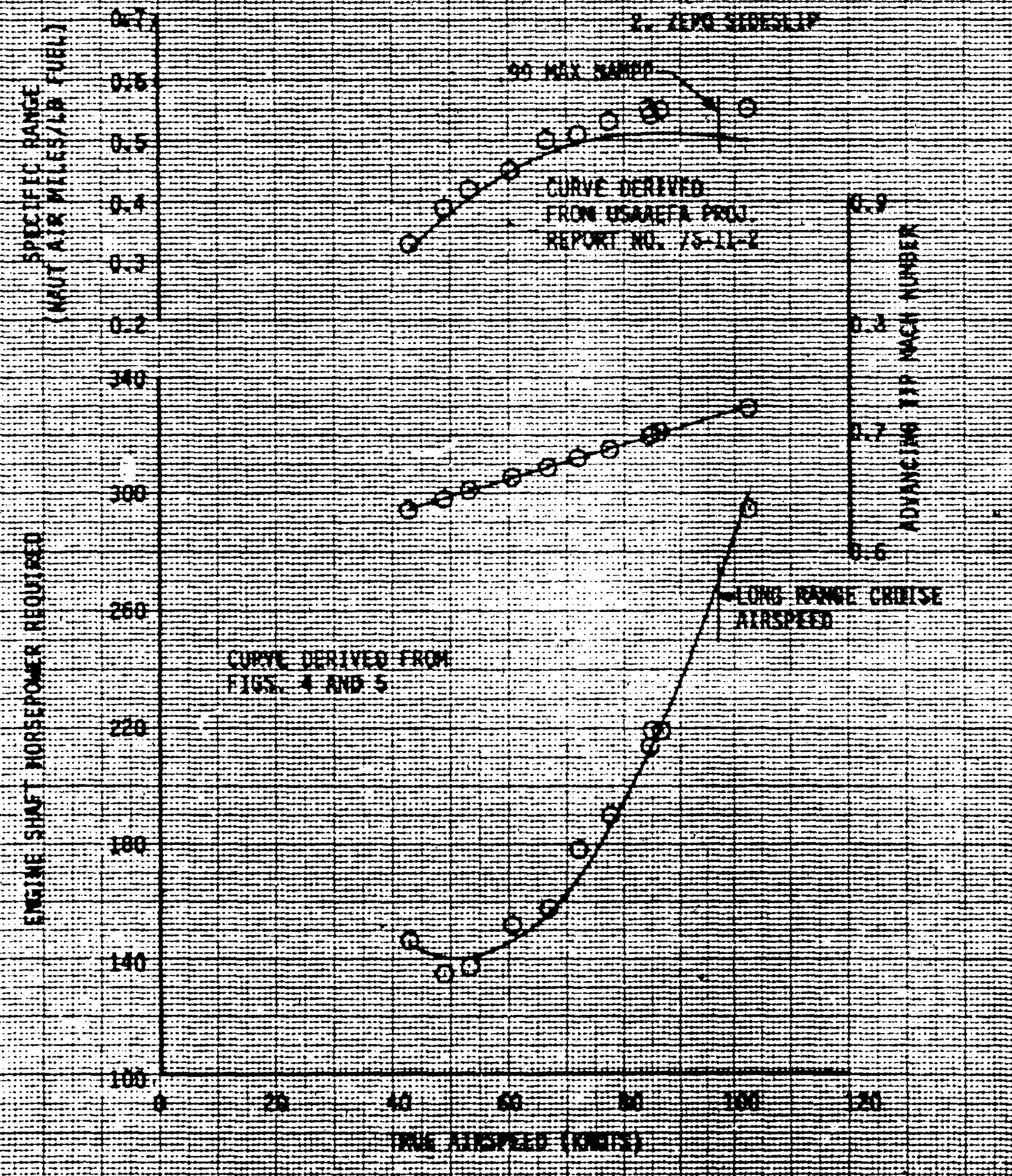
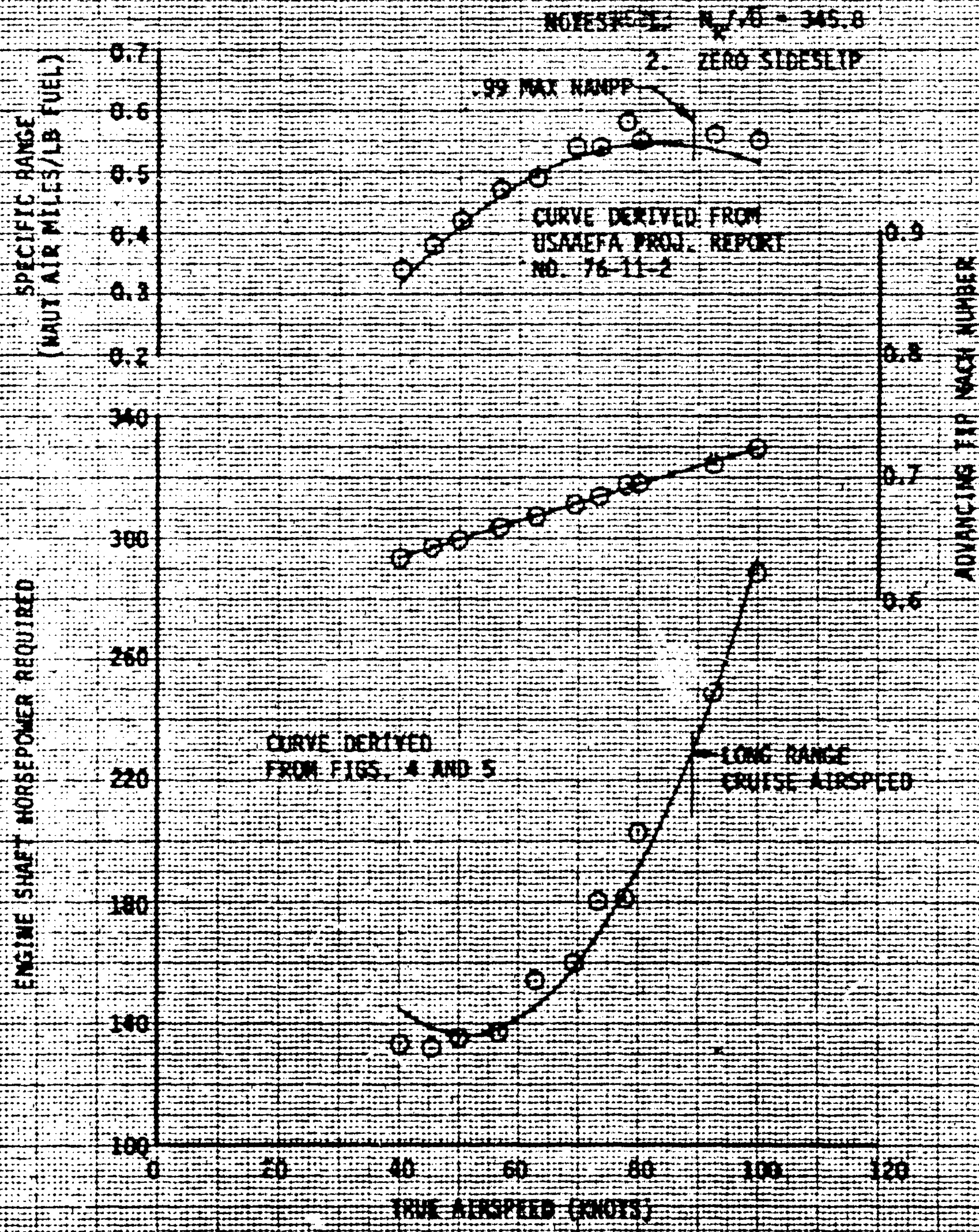
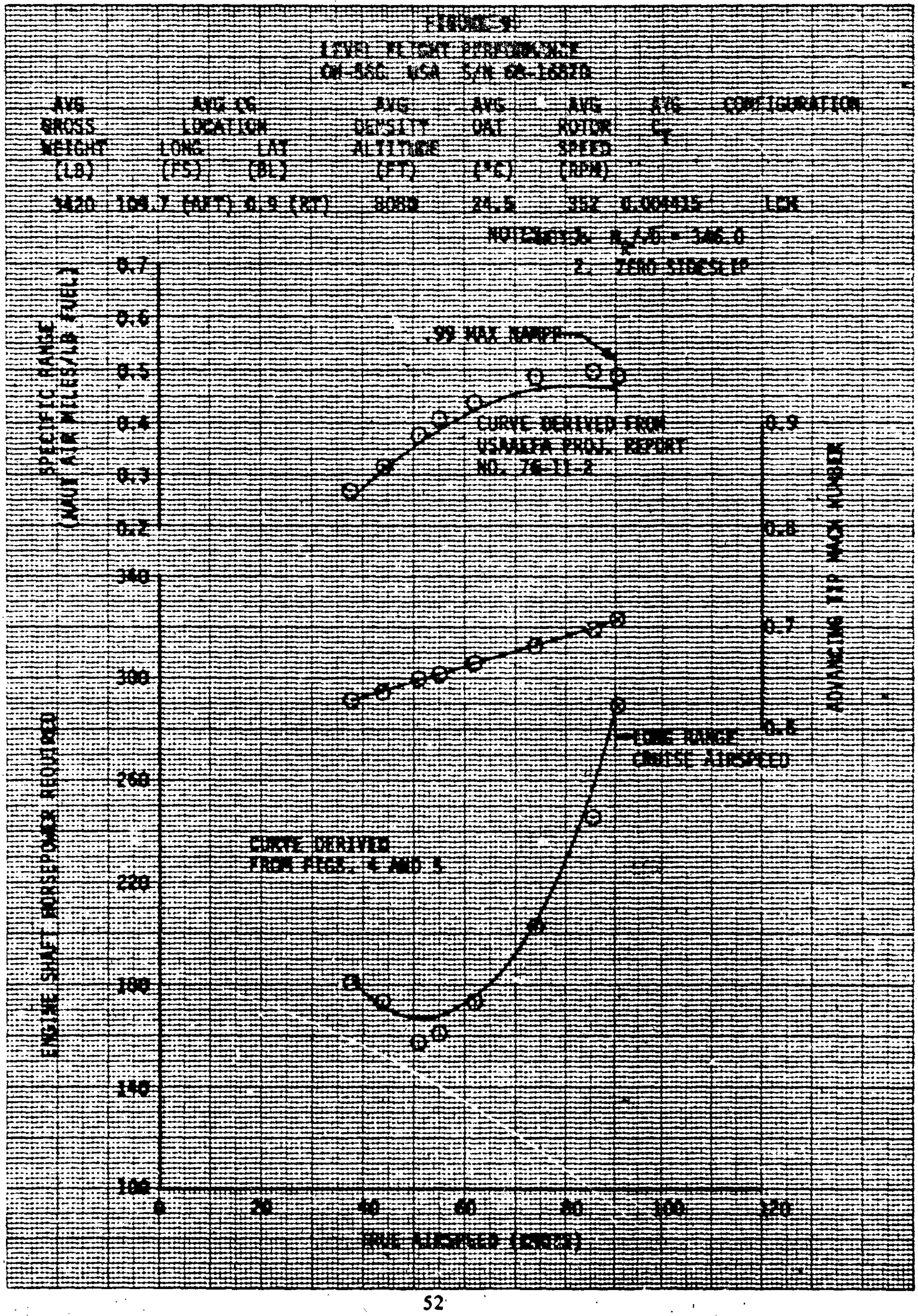


FIGURE 8
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16870

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
2980	110.8 (AFT)	0.7 (RT)	9320	16.0	346	0.004096	LCH




LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16870
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED (RPM)
AVG C_T
CONFIGURATION
3420
8080
24.5
352
2. ZERO SIDESLIP
.99 MAX NAMPP
CURVE DERIVED FROM USAAEFA PROJ. REPORT NO. 76-11-2
LONG RANGE CRUISE AIRSPEED
CURVE DERIVED FROM FIGS. 4 AND 5
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
ENGINE SHAFT HORSEPOWER REQUIRED
ADVANCING TIP MACH NUMBER
TRUE AIRSPEED (KNOTS)

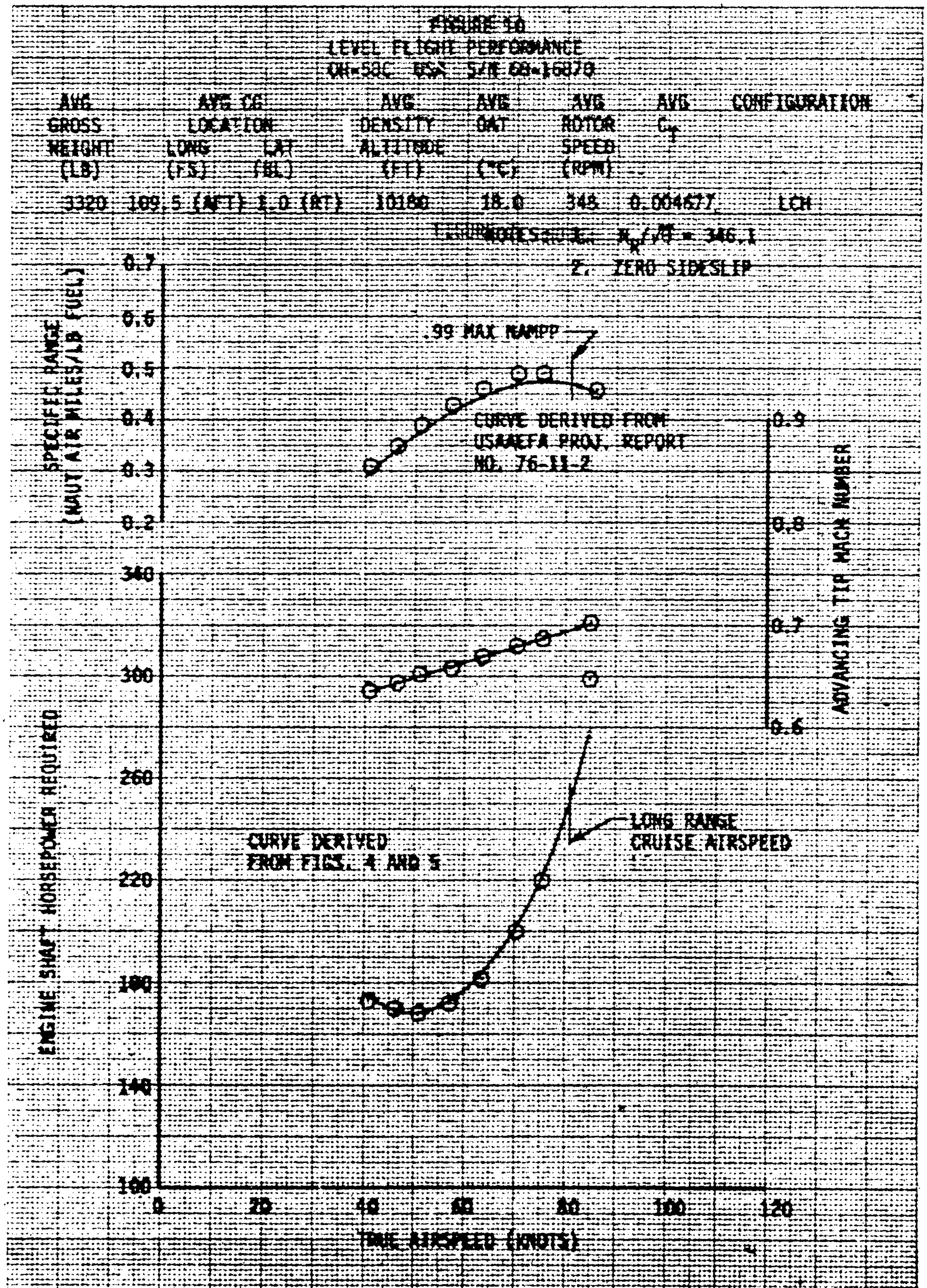


FIGURE 50
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16870
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED (RPM)
AVG C_T
CONFIGURATION
3320 109.5 (AFT) 1.0 (RT) 10180 18.0 348 0.004677 LCH
NOTES: 1. $N_R/\sqrt{\theta}$ = 346.1
2. ZERO SIDESLIP
.99 MAX NAMPP
CURVE DERIVED FROM USAAEFA PROJ. REPORT NO. 76-11-2
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
ADVANCING TIP MACH NUMBER
ENGINE SHAFT HORSEPOWER REQUIRED
CURVE DERIVED FROM FIGS. 4 AND 5
LONG RANGE CRUISE AIRSPEED
TRUE AIRSPEED (KNOTS)

FIGURE 11
LEVEL FLIGHT PERFORMANCE
OH-58C USA S/N 68-16870

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
3380	109.6 (AFT)	1.0 (RT)	11600	12.0	346	0.005001	ECH

NOTES: 1. $N_R/\sqrt{\theta}$ = 347.3
2. ZERO SIDESLIP

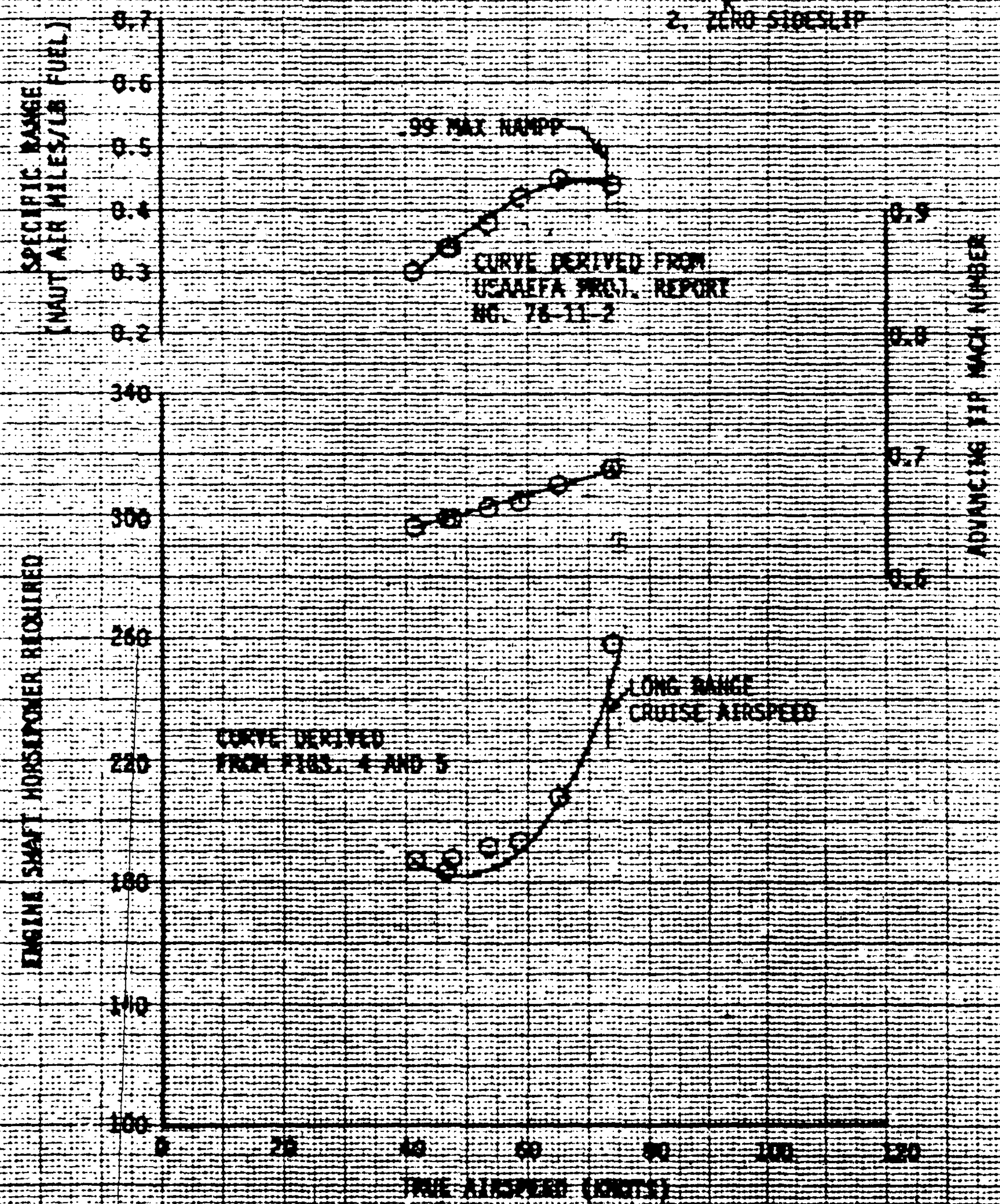


FIGURE 12
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 68-16870

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	FLIGHT CONDITION
2840	112.4 (AFT)	0.7 (RT)	6780	26.0	352	0.003524	LEVEL

NOTES: 1. ZERO SIDESLIP
2. LCH CONFIGURATION

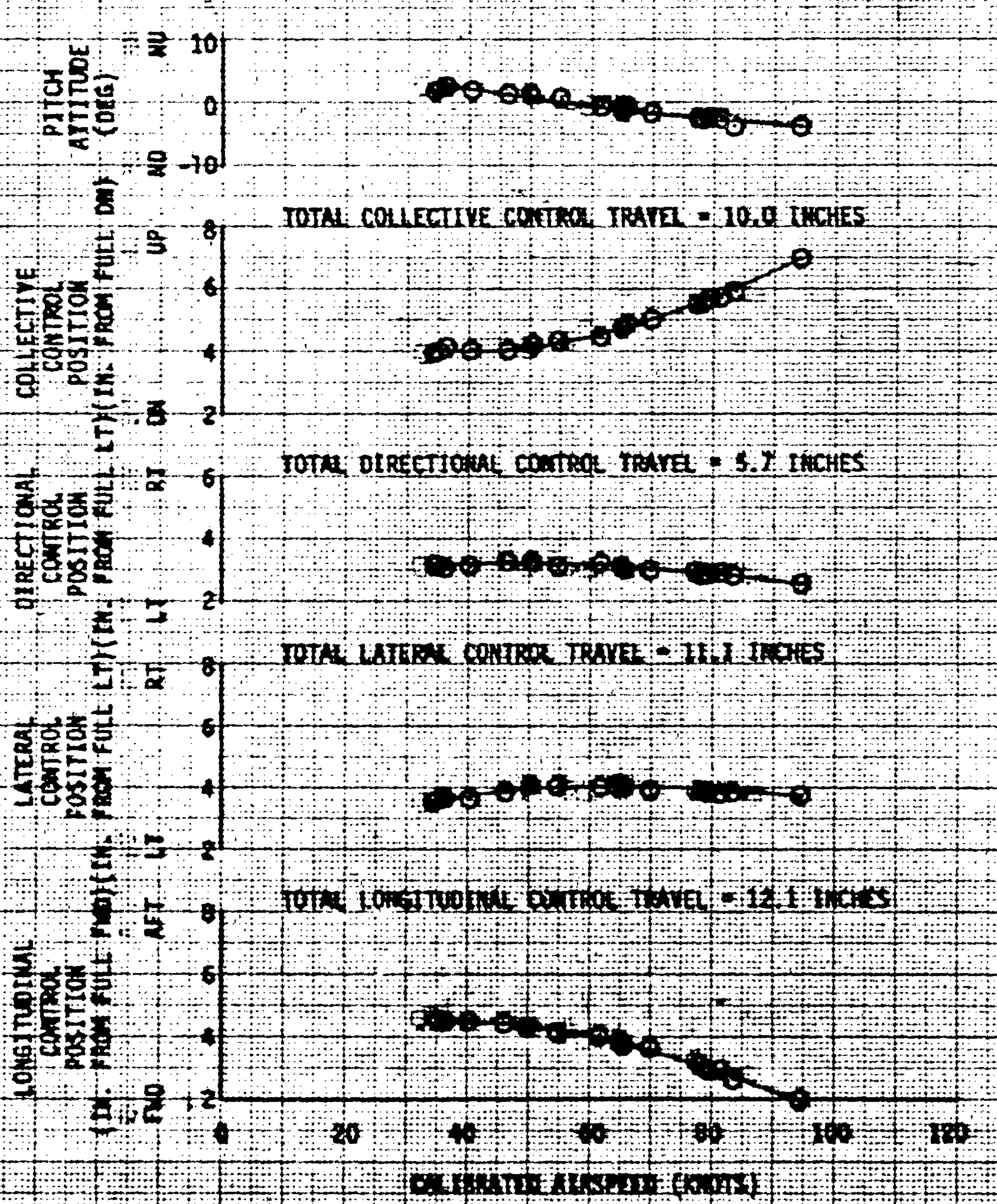


FIGURE 13

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C USA S/N 68-16870

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	FLIGHT CONDITION
3080	110.8 (AFT)	0.7 (RT)	6780	22.0	350	0.003866	LEVEL

NOTES: 1. ZERO SIDESLIP
2. LCH CONFIGURATION

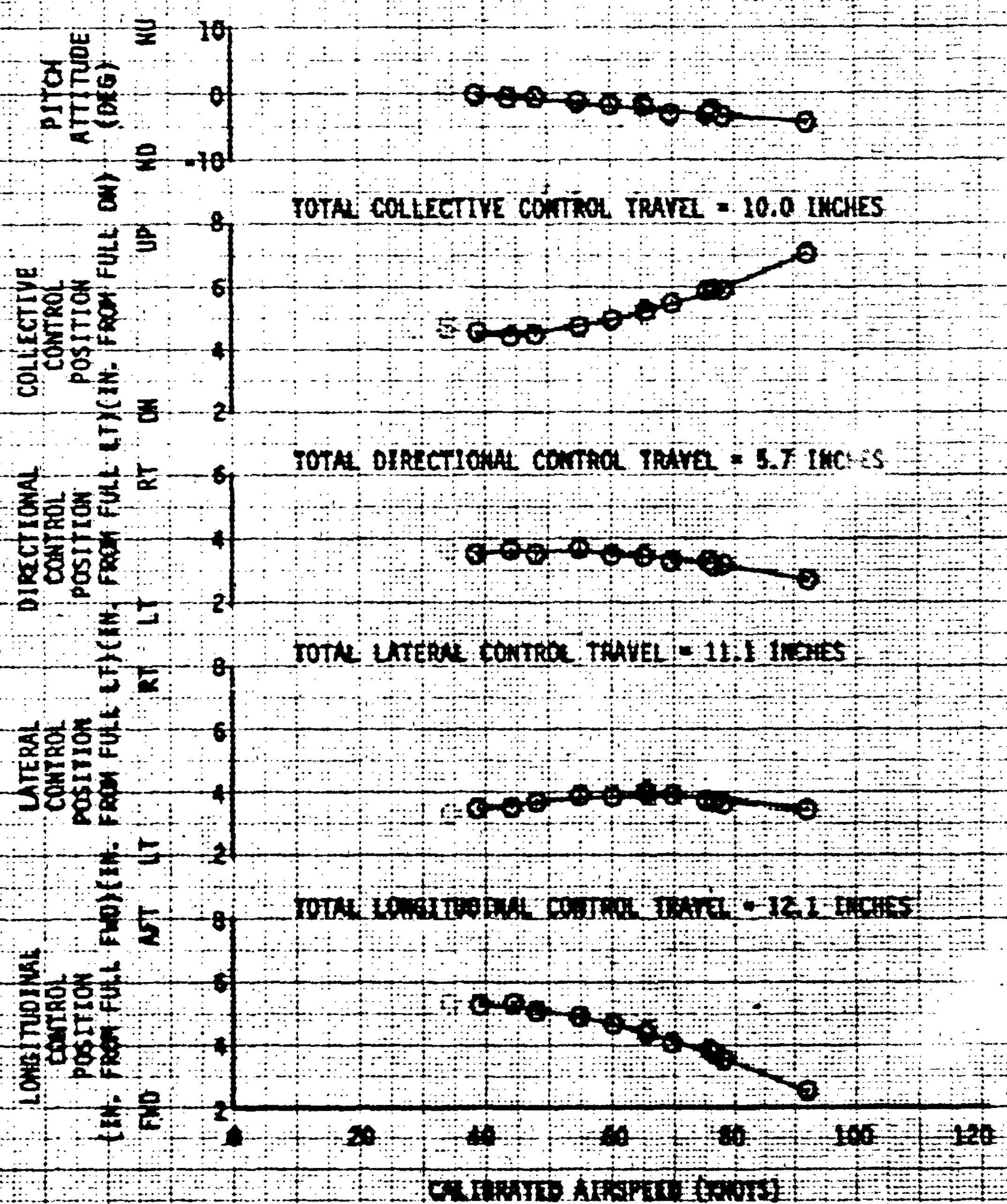


FIGURE 14

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C USA S/N 68-16870

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	FLIGHT CONDITION
2960	110.6 (AFT)	0.7 (RT)	9320	16.0	346	0.004096	LEVEL

NOTES: 1. ZERO SIDESLIP
2. LCH CONFIGURATION

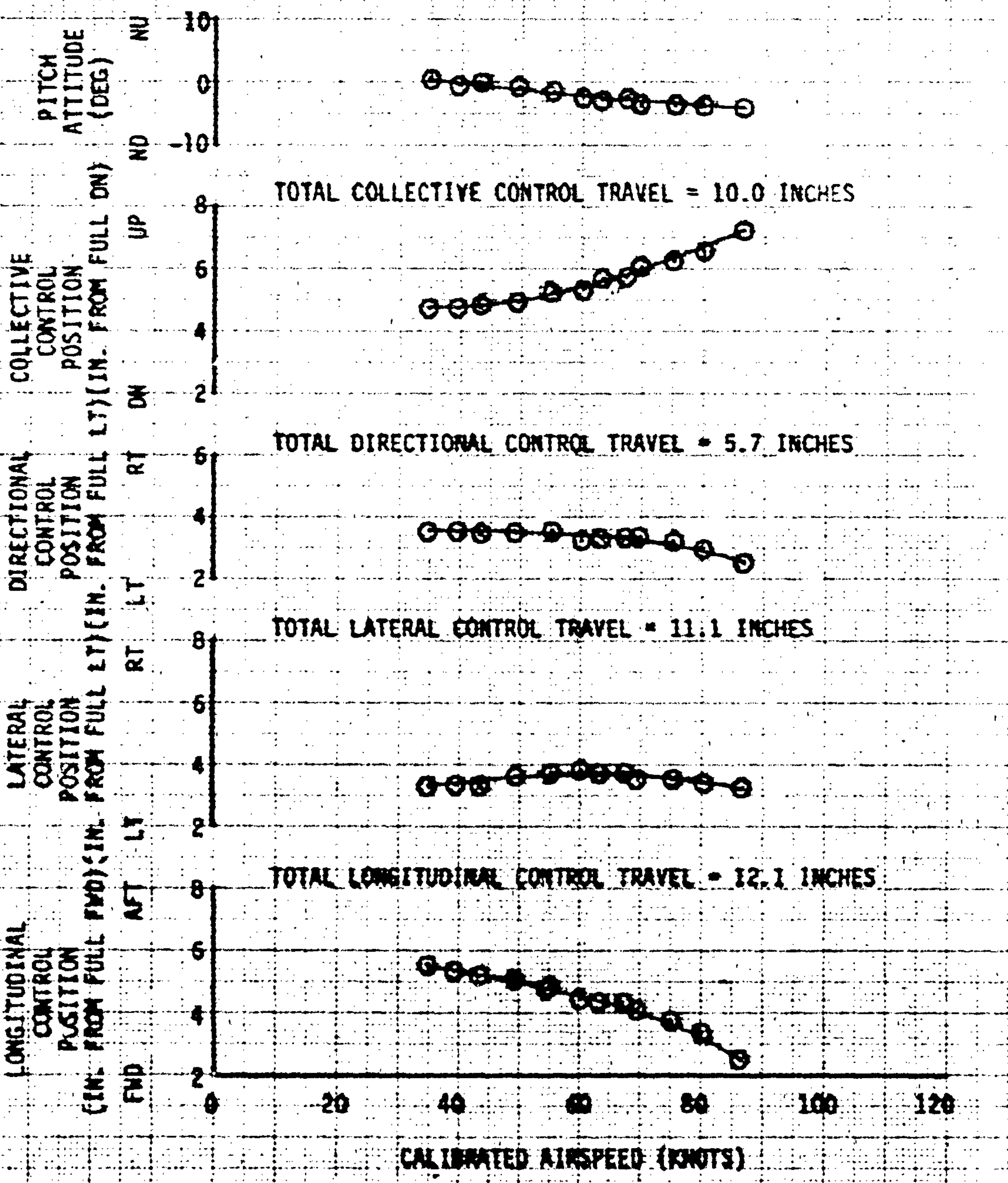


FIGURE 15
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 68-16870

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	FLIGHT CONDITION
3420	109.7 (AFT)	0.9 (RT)	8080	24.5	352	0.004415	LEVEL

NOTES: 1. ZERO SIDESLIP
2. LCH CONFIGURATION

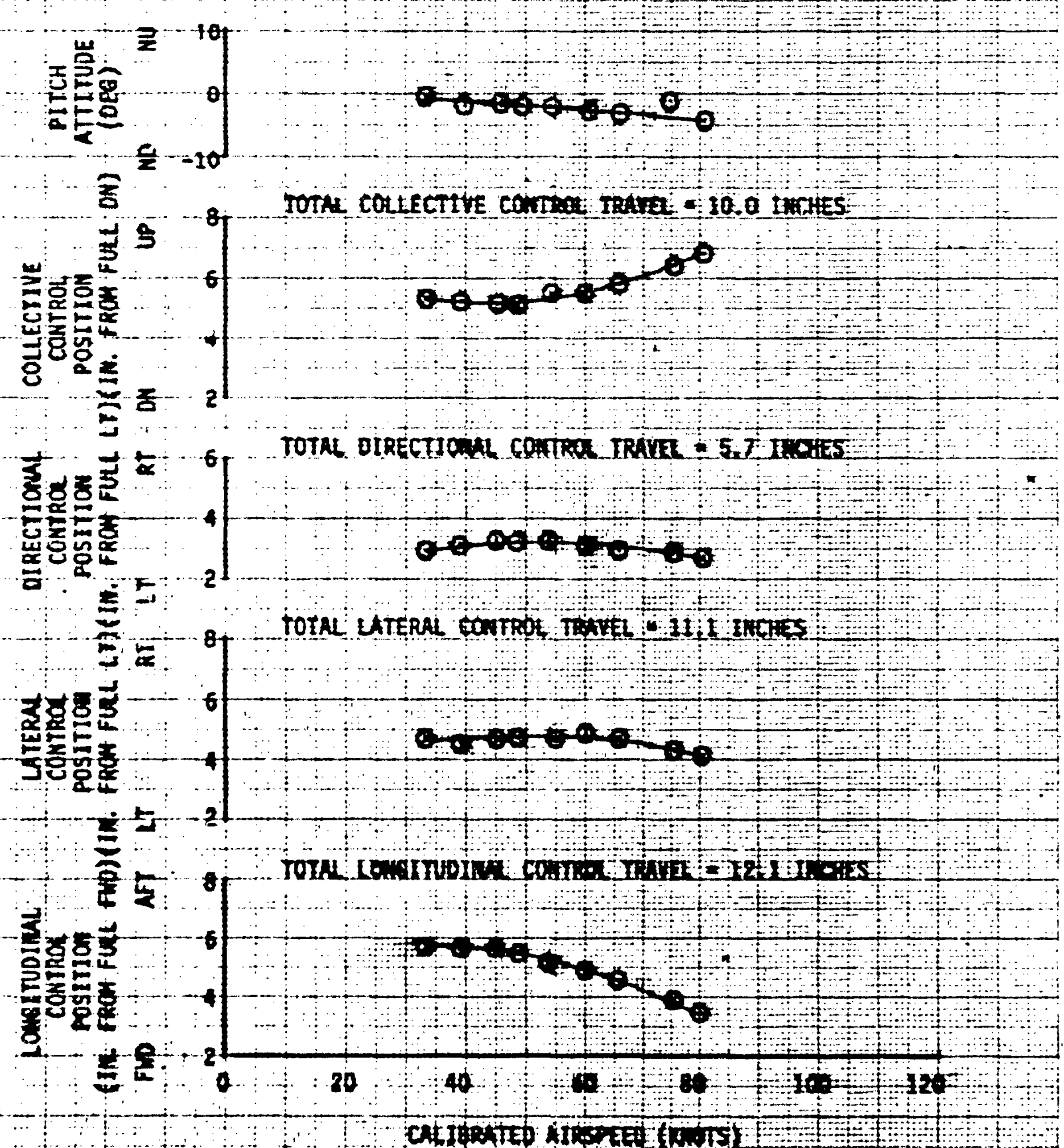


FIGURE 16

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

OH-58C USA S/N 68-16870

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	FLIGHT CONDITION
3320	109.5 (AFT)	1.0 (RT)	10180	18.0	348	0.004677	LEVEL

NOTES: 1. ZERO SIDESLIP
2. LCH CONFIGURATION

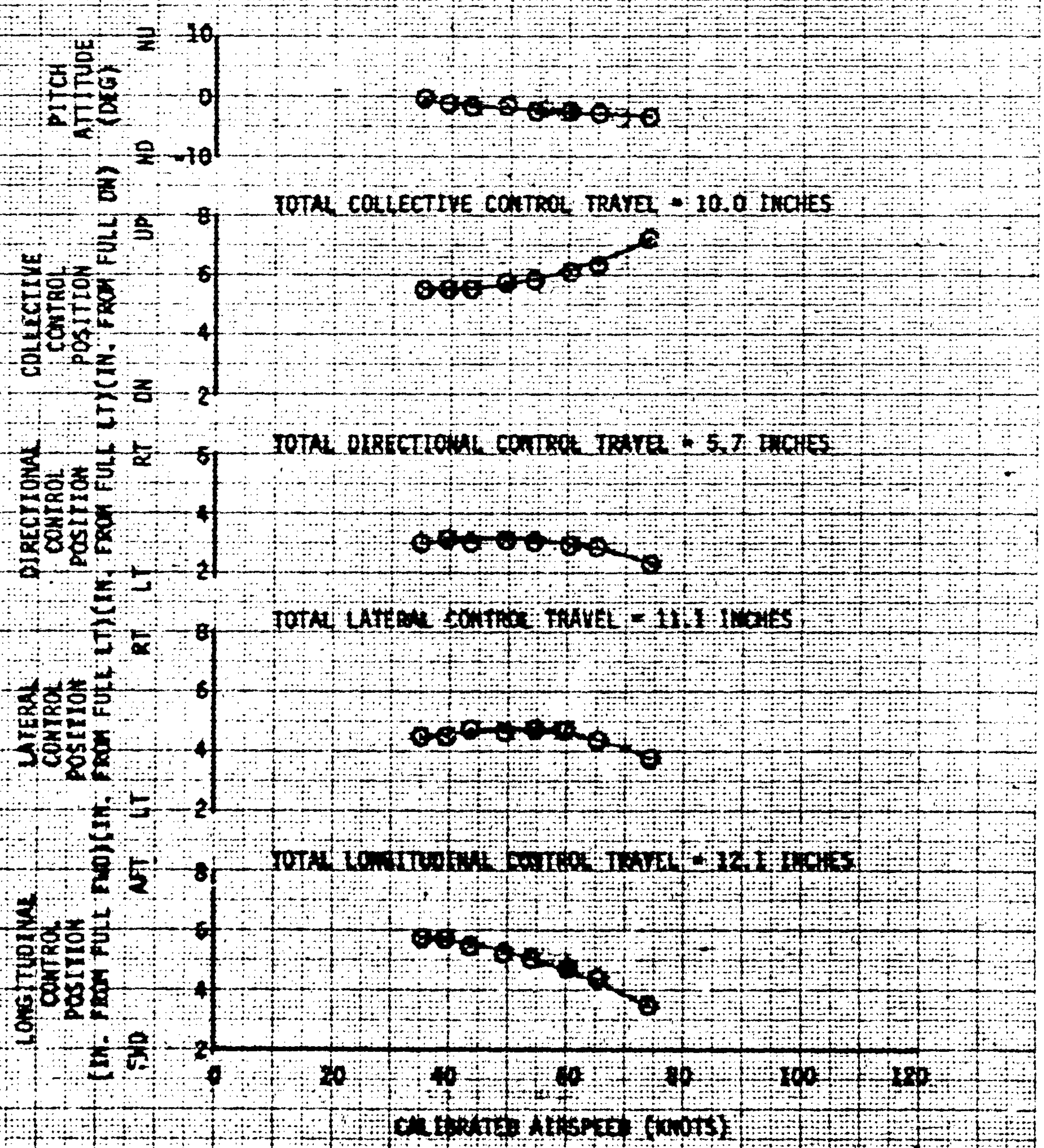


FIGURE 17
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 68-16870

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	FLIGHT CONDITION
3380	109.6 (AFT)	1.0 (RT)	11600	12.0	346	0.005001	LEVEL

NOTES: 1. ZERO SIDESLIP
2. LCH CONFIGURATION

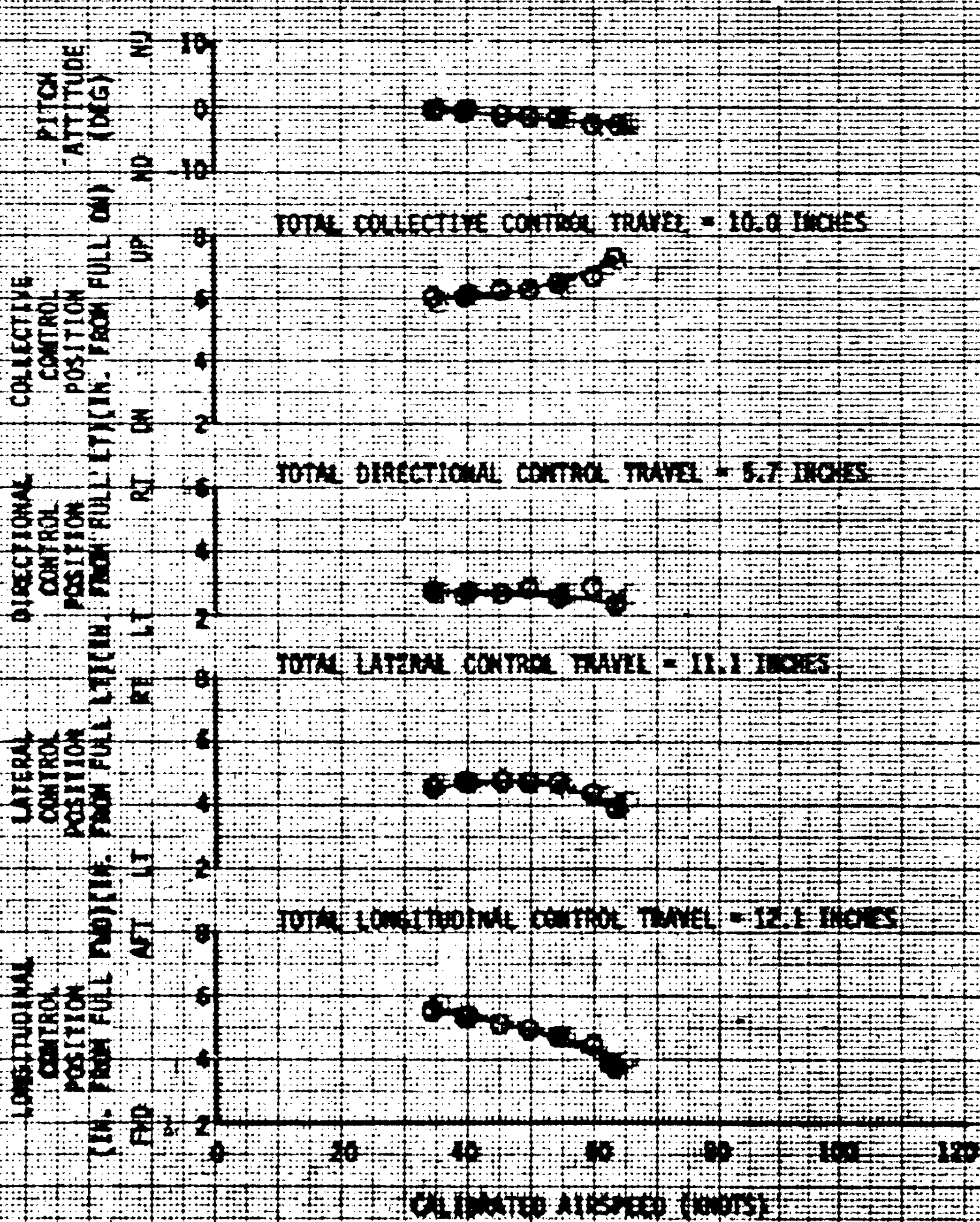


FIGURE 18
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
OH-58C USA S/N 68-16870

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)	FLIGHT CONDITION
3420	109.7 (AFT)	0.9 (RT)	7140	20.5	354	LEVEL

NOTES: 1. SHADED SYMBOLS DENOTE TRIM
2. LCH CONFIGURATION

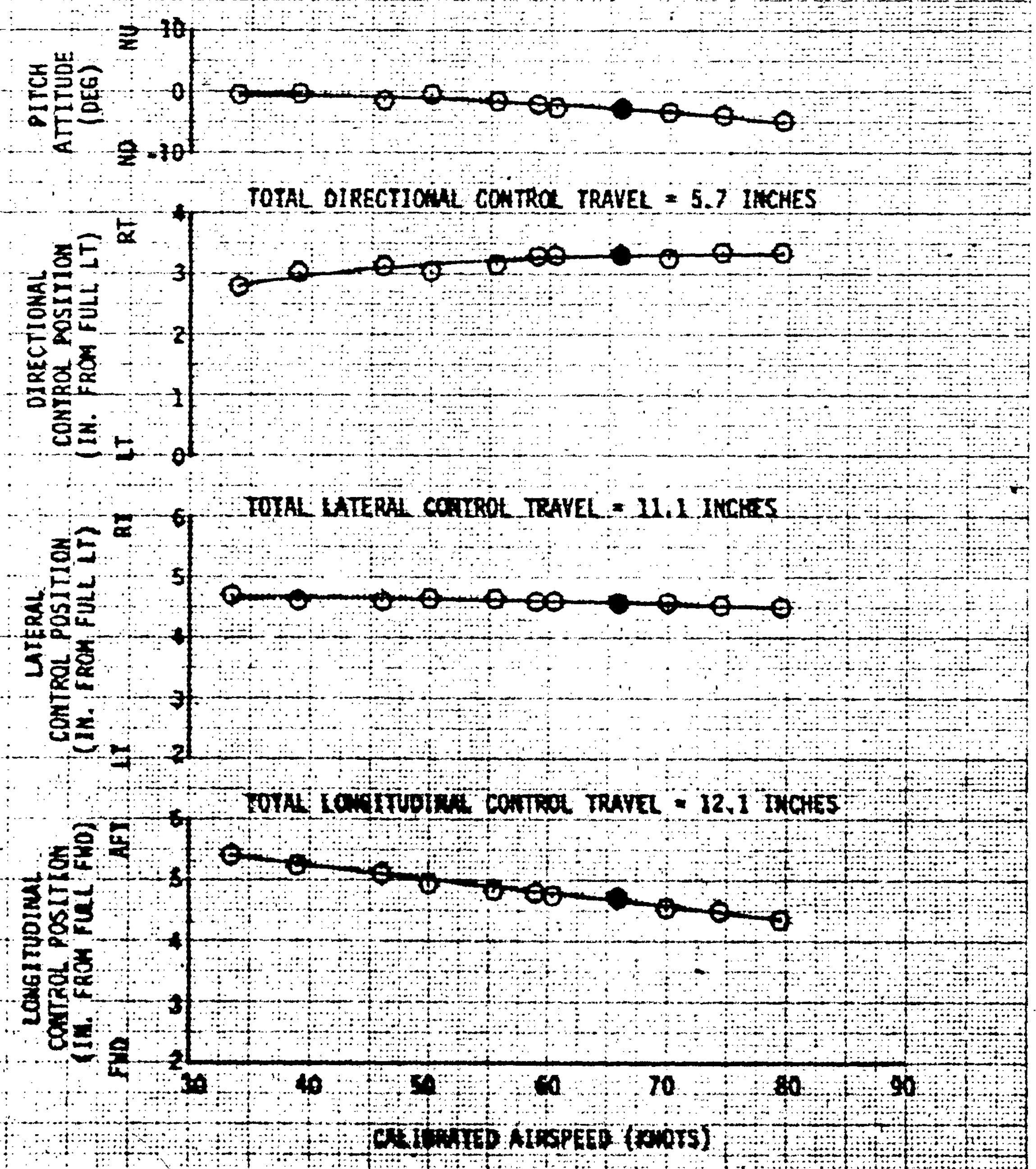


FIGURE 19

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

OH-58C USA S/N 68-16870

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)	FLIGHT CONDITION
3420	110.0 (AFT)	0.9 (RT)	7260	20.5	354	CLIMB

NOTES: 1. SHADED SYMBOLS DENOTE TRIM
2. LCH CONFIGURATION

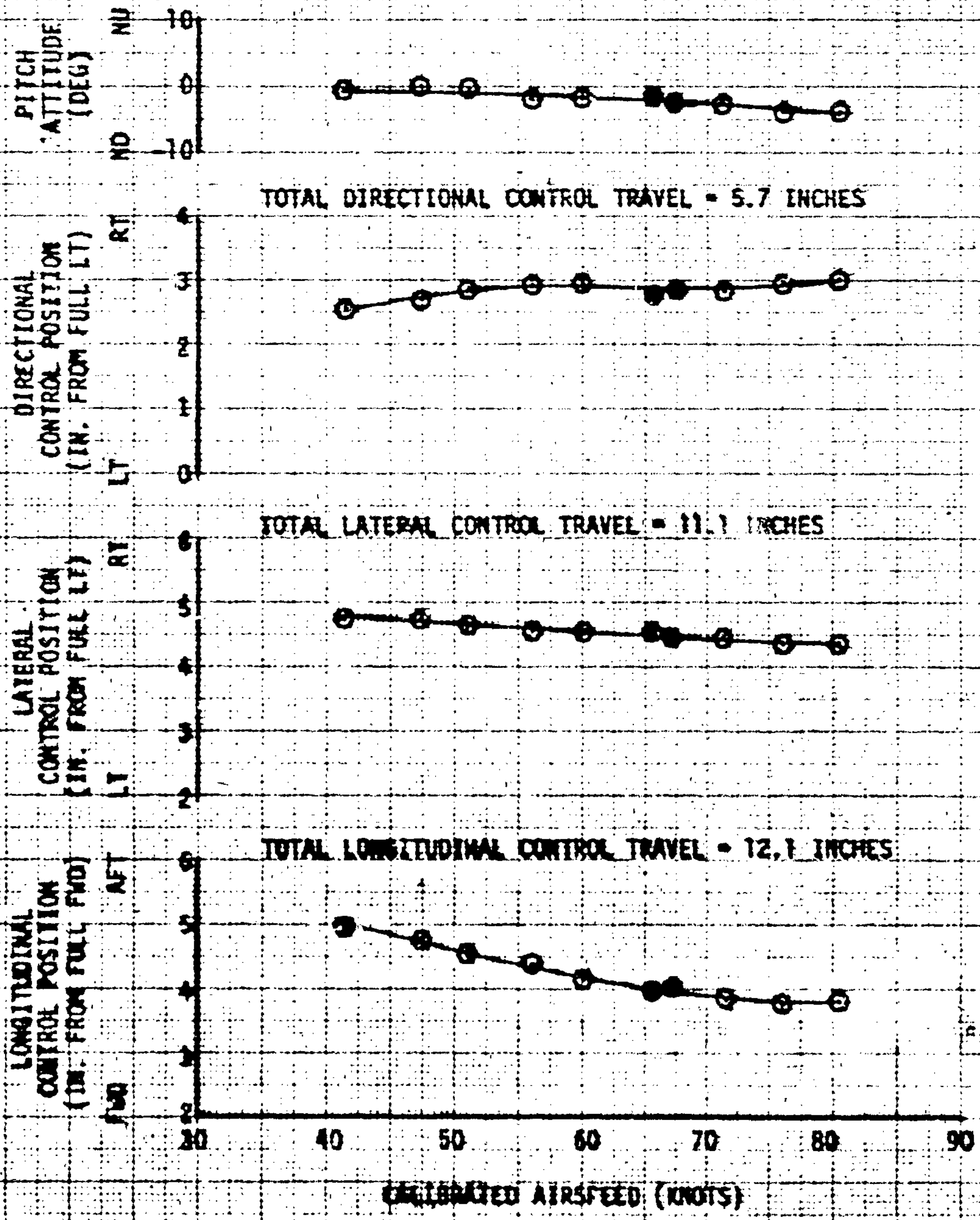


FIGURE 20
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
OH-58C USA S/N 68-16870

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)	FLIGHT CONDITION
3360	109.8 (AFT)	0.9 (RT)	6420	21.5	350	AUTOROTATION

NOTES: 1. SHADED SYMBOLS DENOTE TRIM
2. LCH CONFIGURATION

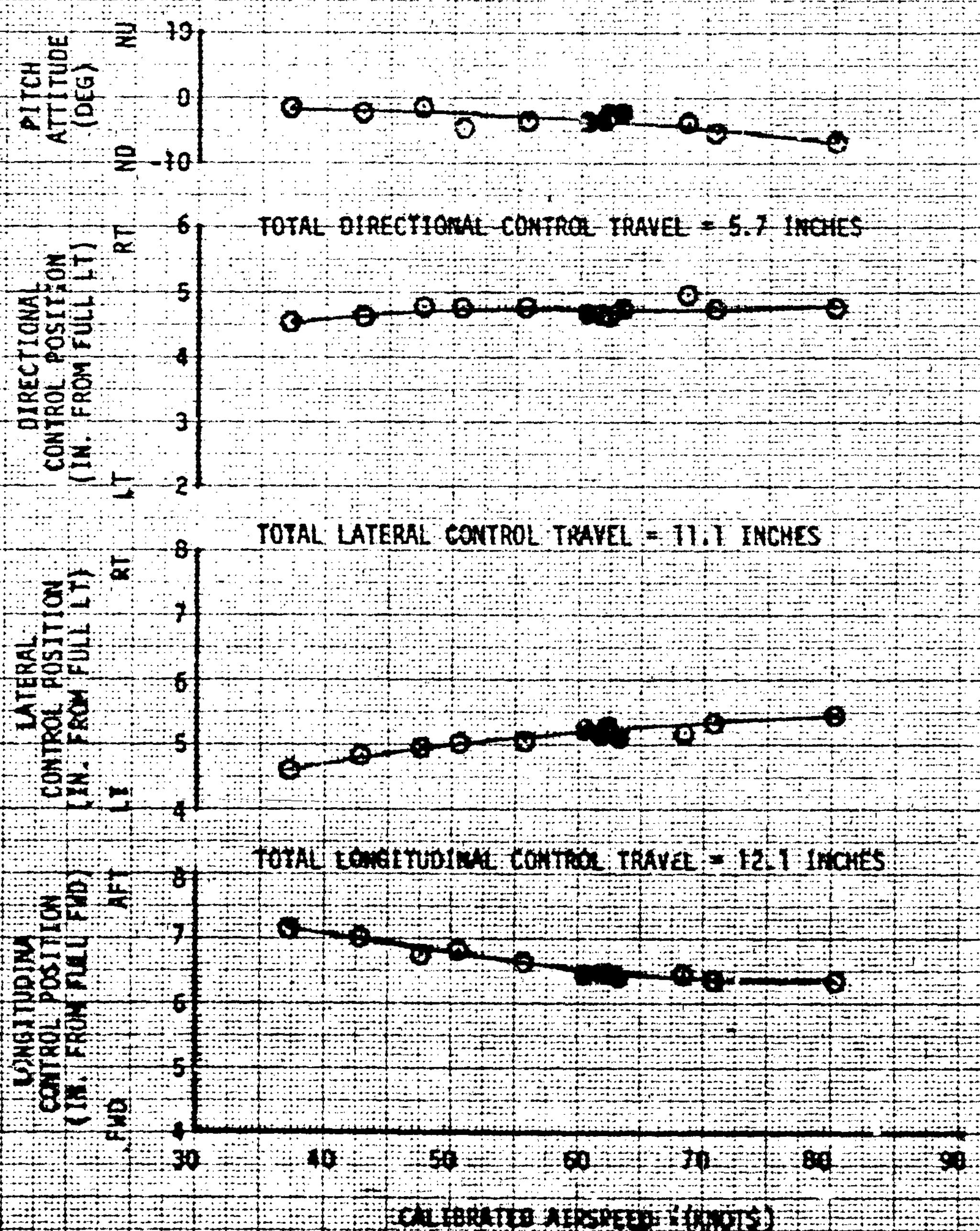


FIGURE 21
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16870

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 CALIBRATED AIRSPEED (KTS)
3380	109.5 (AFT)	0.9 (RT)	6960	20.5	354	65

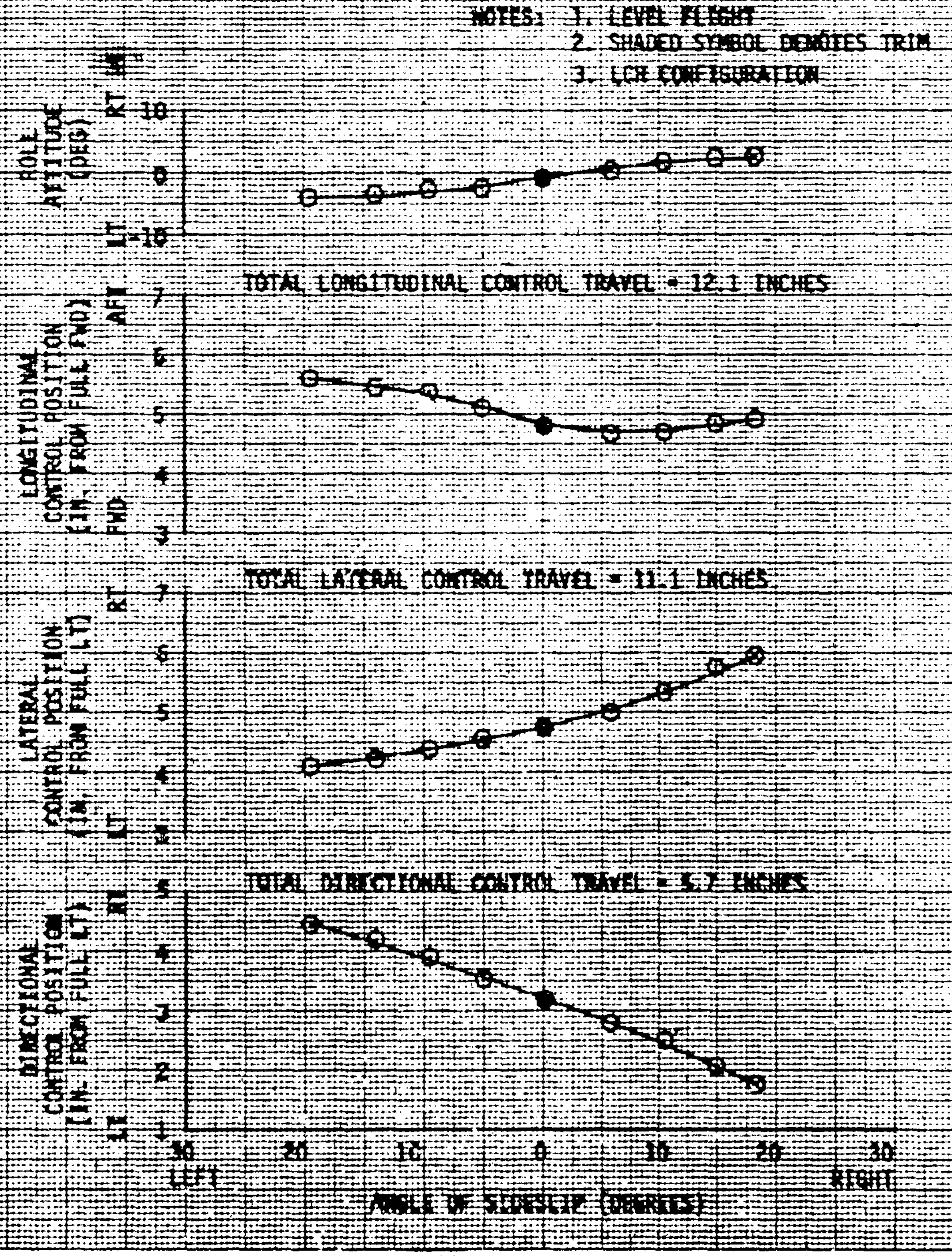
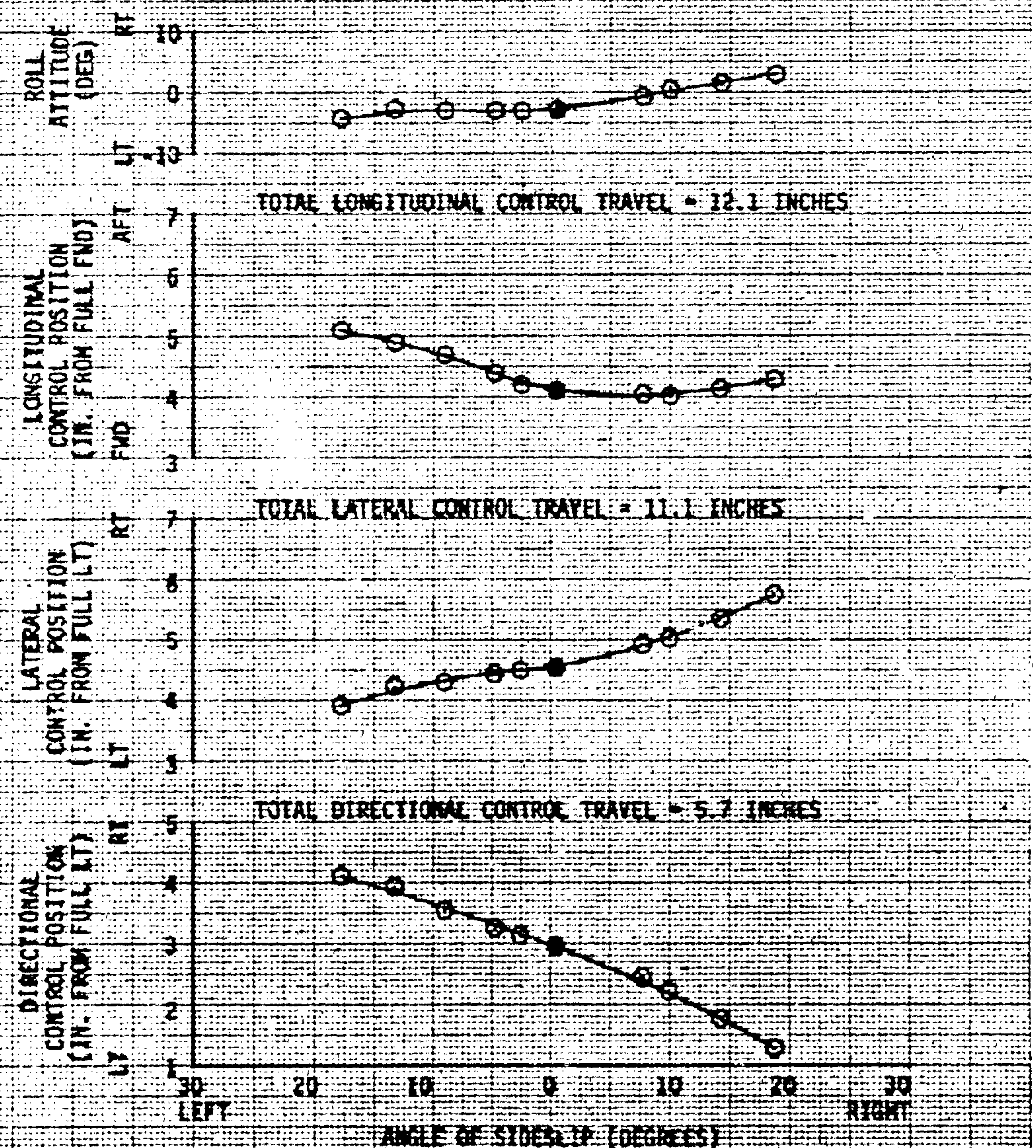


FIGURE 22
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16870

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 CALIBRATED AIRSPEED (KTS)
3300	109.7 (AFT)	0.9 (RT)	7320	20.0	354	66

NOTES: 1. CLIMBING FLIGHT
2. SHADED SYMBOLS DENOTE TRIM
3. CCH CONFIGURATION



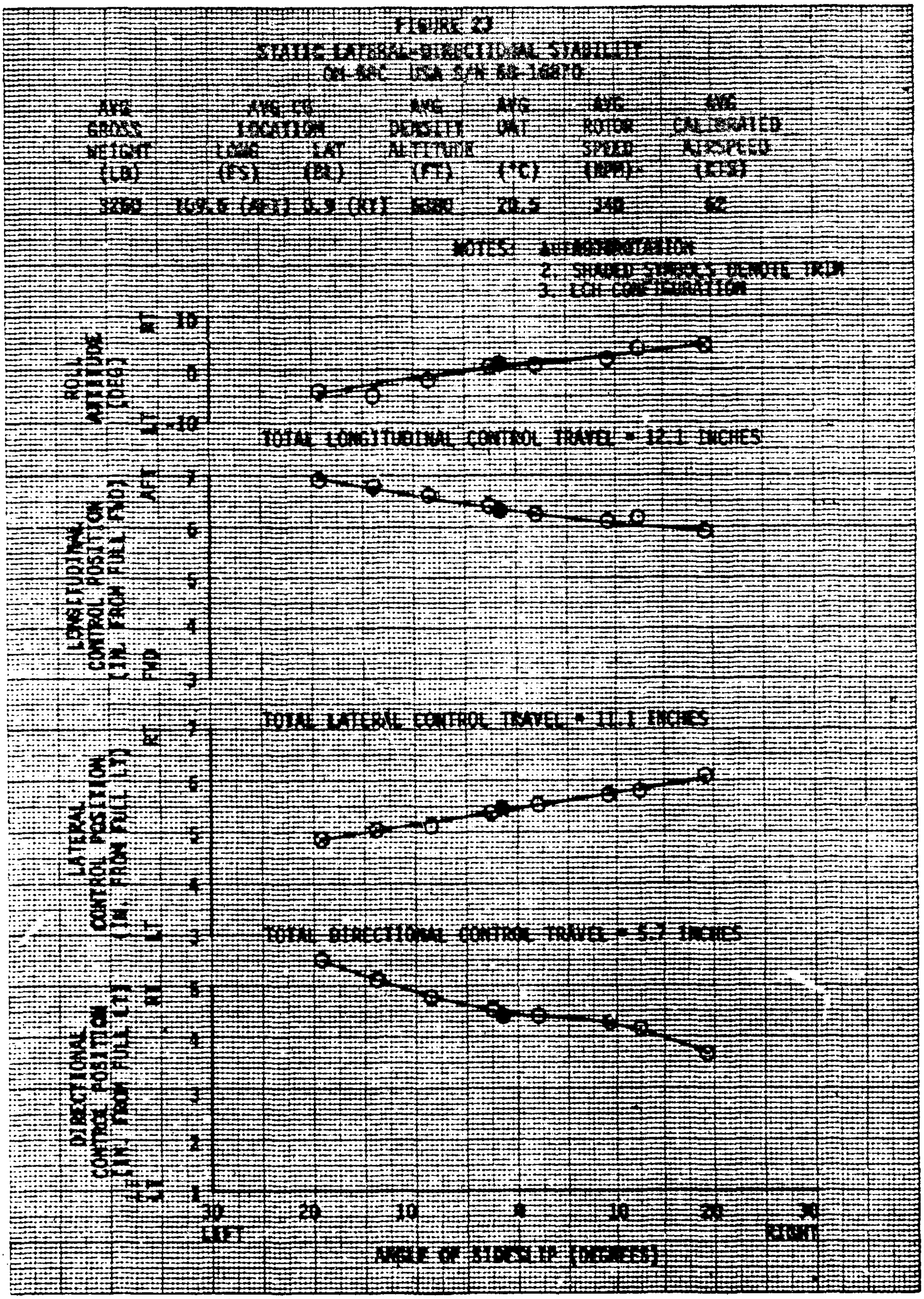
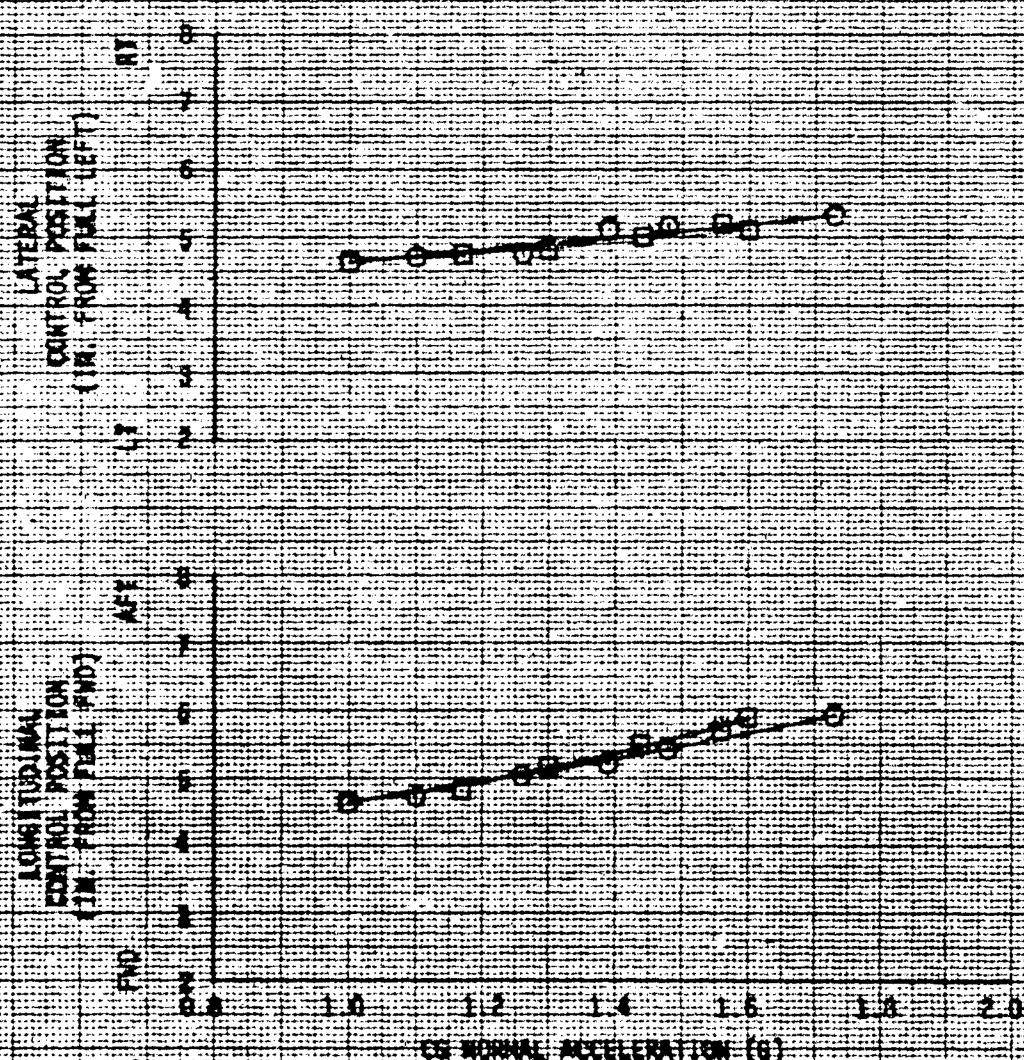


FIGURE 23
STATIC LATERAL-DIRECTIONAL STABILITY
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LAT
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED
AVG CALIBRATED AIRSPEED
20.5
62
NOTES:
2. SHADED SYMBOLS DENOTE TRIM
ROLL ATTITUDE (DEG)
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.1 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
TOTAL LATERAL CONTROL TRAVEL = 11.1 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL DIRECTIONAL CONTROL TRAVEL
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
LEFT
RIGHT
ANGLE OF SIDESLIP (DEGREES)

FIGURE 26
MANEUVERING STABILITY
OH-58C USA S/N 68-16870

SYM	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 CALIBRATED AIRSPEED (KTS)	FLIGHT CONDITION
○	3420	110.0 (AFT)	0.9 (RT)	6740	23.5	354	66	RIGHT TURN
□	3408	109.9 (AFT)	0.9 (RT)	6960	23.0	354	66	LEFT TURN

NOTE: LCH CONFIGURATION



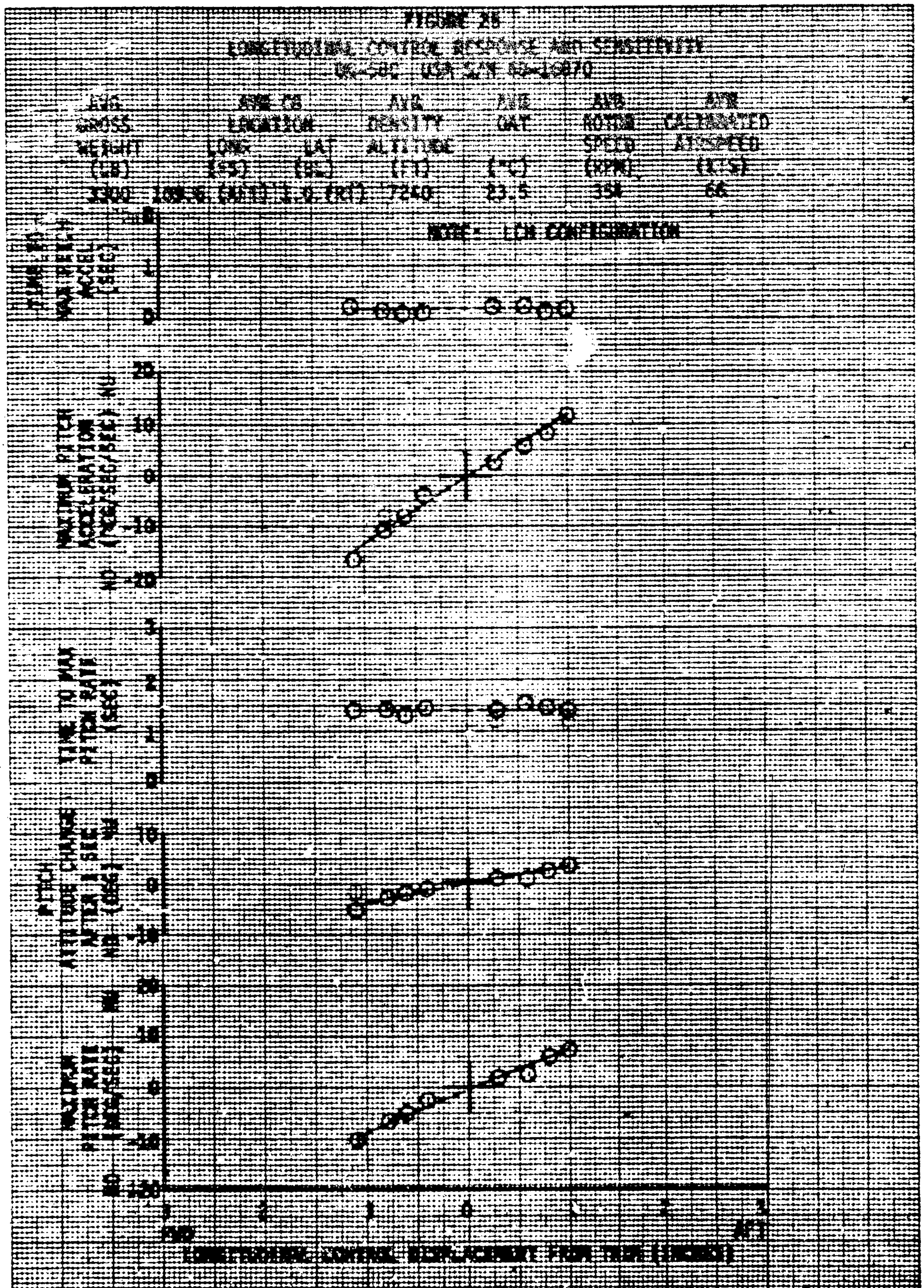

LONGITUDINAL CONTROL RESPONSE AND SENSITIVITY
GROSS
WEIGHT
(LB)
3300
LOCATION
LAT
DENSITY
ALTITUDE
(FT)
7240
OAT
23.5
ROTOR
SPEED
(RPM)
CALIBRATED
AIRSPEED
66
FWD
AFT
LONGITUDINAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

FIGURE 25
LATERAL CONTROL RESPONSE AND SENSITIVITY
OH-58C USA S/N 68-16870

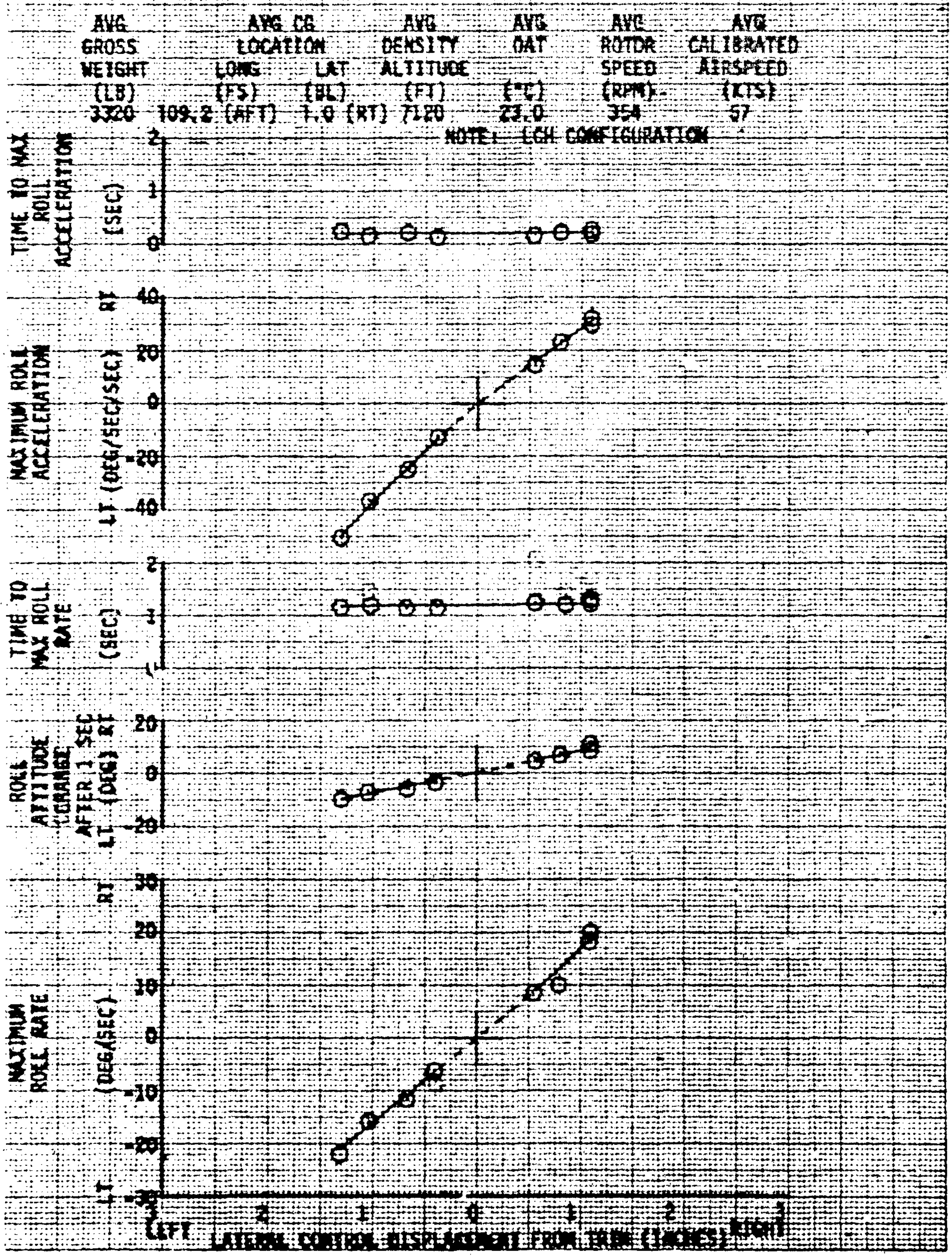


FIGURE [illegible]
DIRECTIONAL CONTROL RESPONSE AND SENSITIVITY
OH-58C USA S/N 68-16070

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 CALIBRATED AIRSPEED (KTS)
3260	109.6 (AFT)	1.0 (RT)	7200	24.0	354	67

NOTE: LCH CONFIGURATION

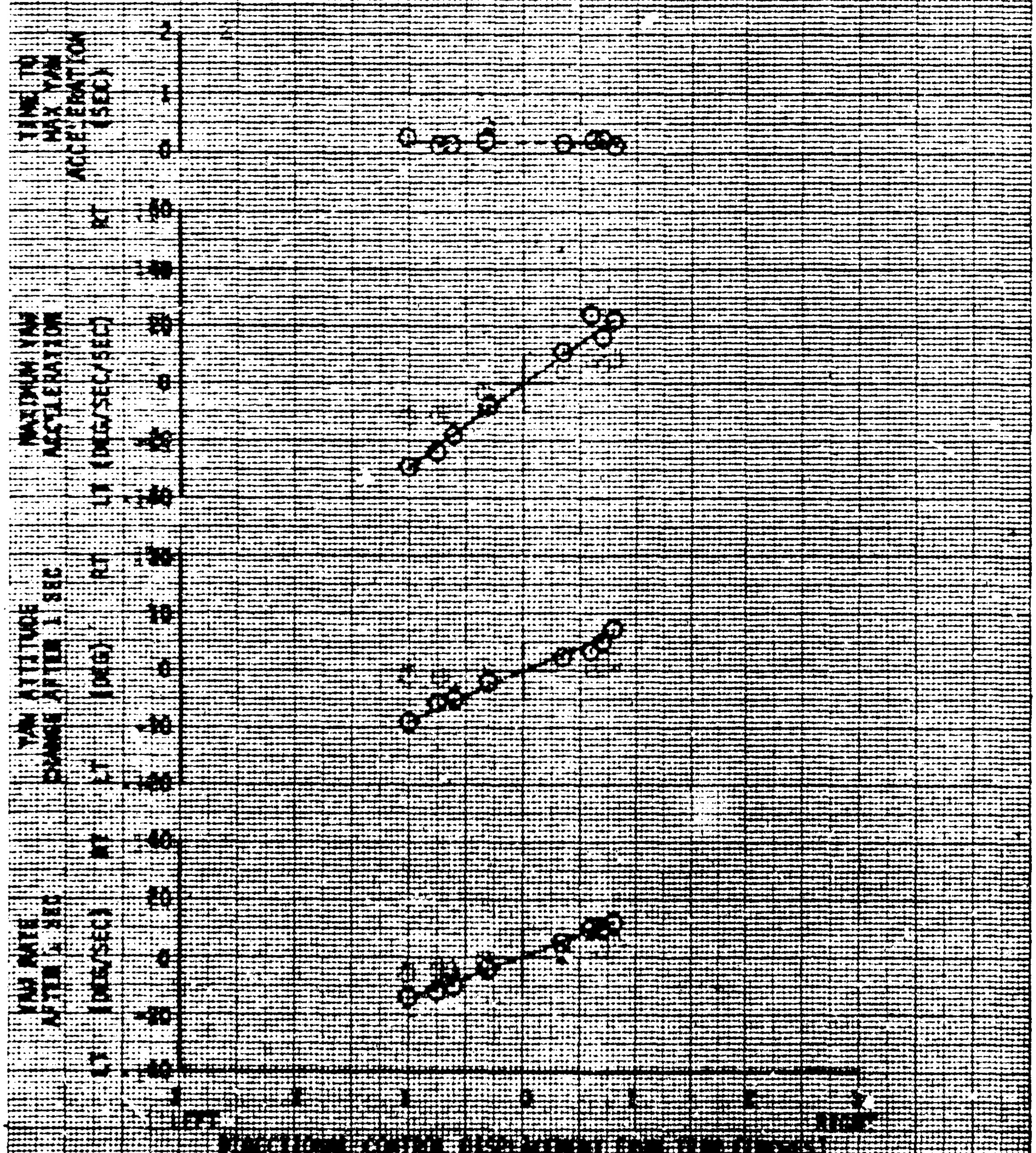
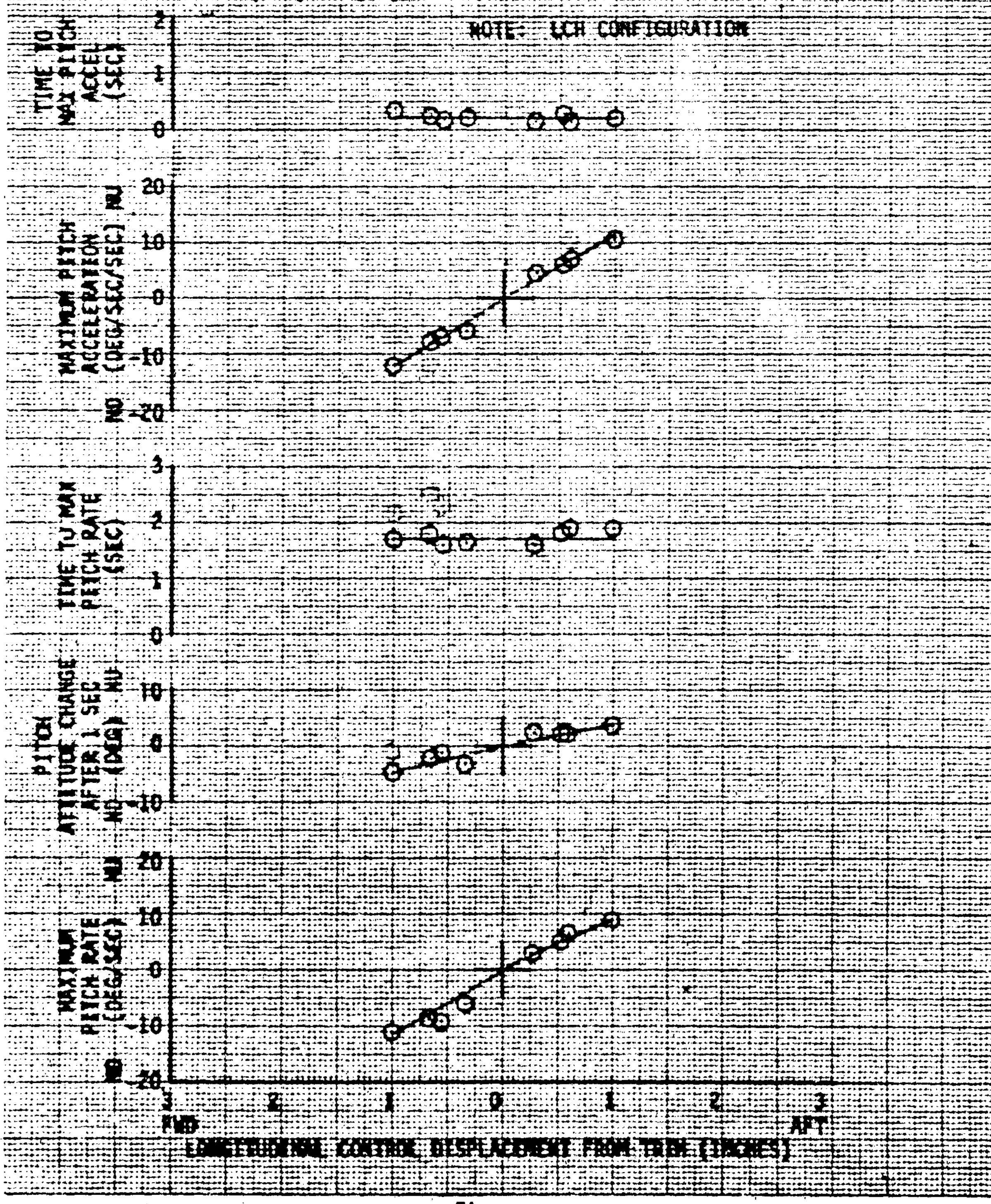


FIGURE 28
LONGITUDINAL CONTROL RESPONSE AND SENSITIVITY
OH-58C USA S/N 68-16870

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 CALIBRATED AIRSPEED (KTS)
3400	109.7 (AFT)	1.0(RT)	3880	23.0	354	HOVER



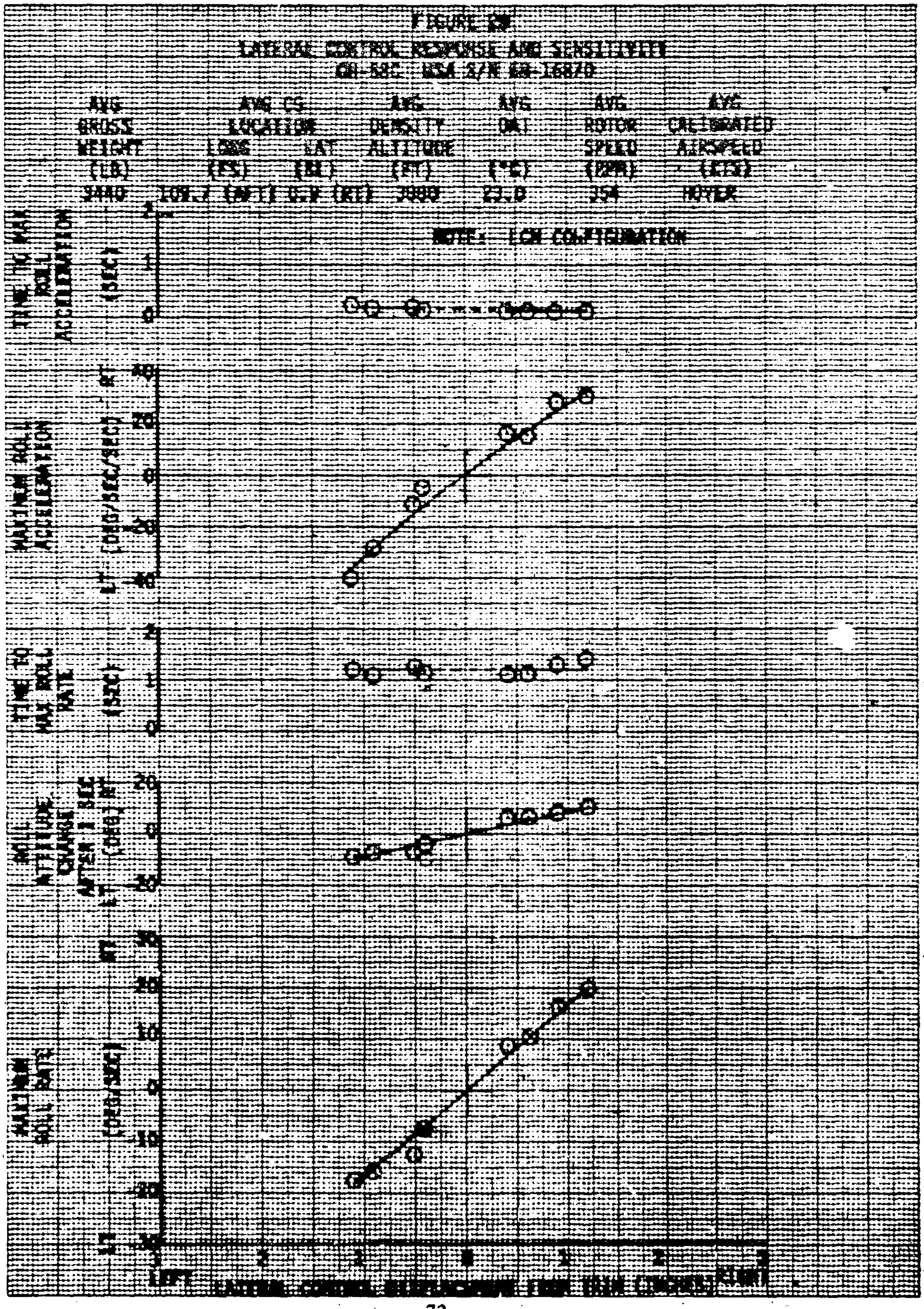

LATERAL CONTROL RESPONSE AND SENSITIVITY
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED (RPM)
AVG CALIBRATED AIRSPEED (KTS)
3440
23.0
354
HOVER
NOTE: LCH CONFIGURATION
TIME TO MAX ROLL ACCELERATION (SEC)
MAXIMUM ROLL ACCELERATION LT (DEG/SEC/SEC) RT
TIME TO MAX ROLL RATE (SEC)
ROLL ATTITUDE CHANGE AFTER 1 SEC LT (DEG) RT
MAXIMUM ROLL RATE LT (DEG/SEC) RT
LEFT LATERAL CONTROL DISPLACEMENT FROM TRIM (INCHES) RIGHT

FIGURE 30
DIRECTIONAL CONTROL RESPONSE AND SENSITIVITY
OH-58C USA S/N 68-16870

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 CALIBRATED AIRSPEED (KTS)
3880	109.6 (AFT)	1.0 (RT)	3880	23.0	354	HOVER

NOTE: ECH CONFIGURATION

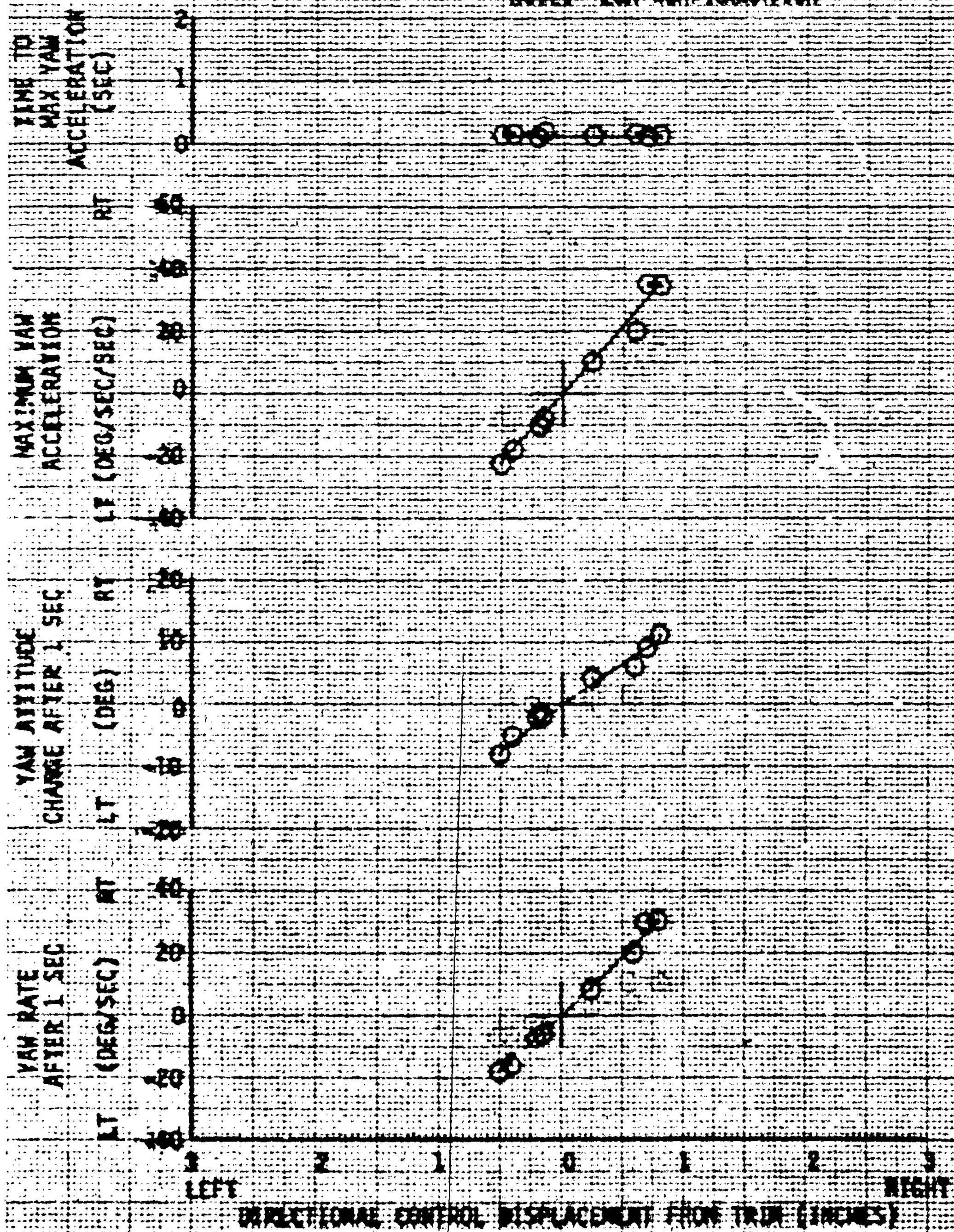


FIGURE 31
LOW-SPEED FORWARD AND REARWARD FLIGHT
OH-58C USA S/N 68-16870

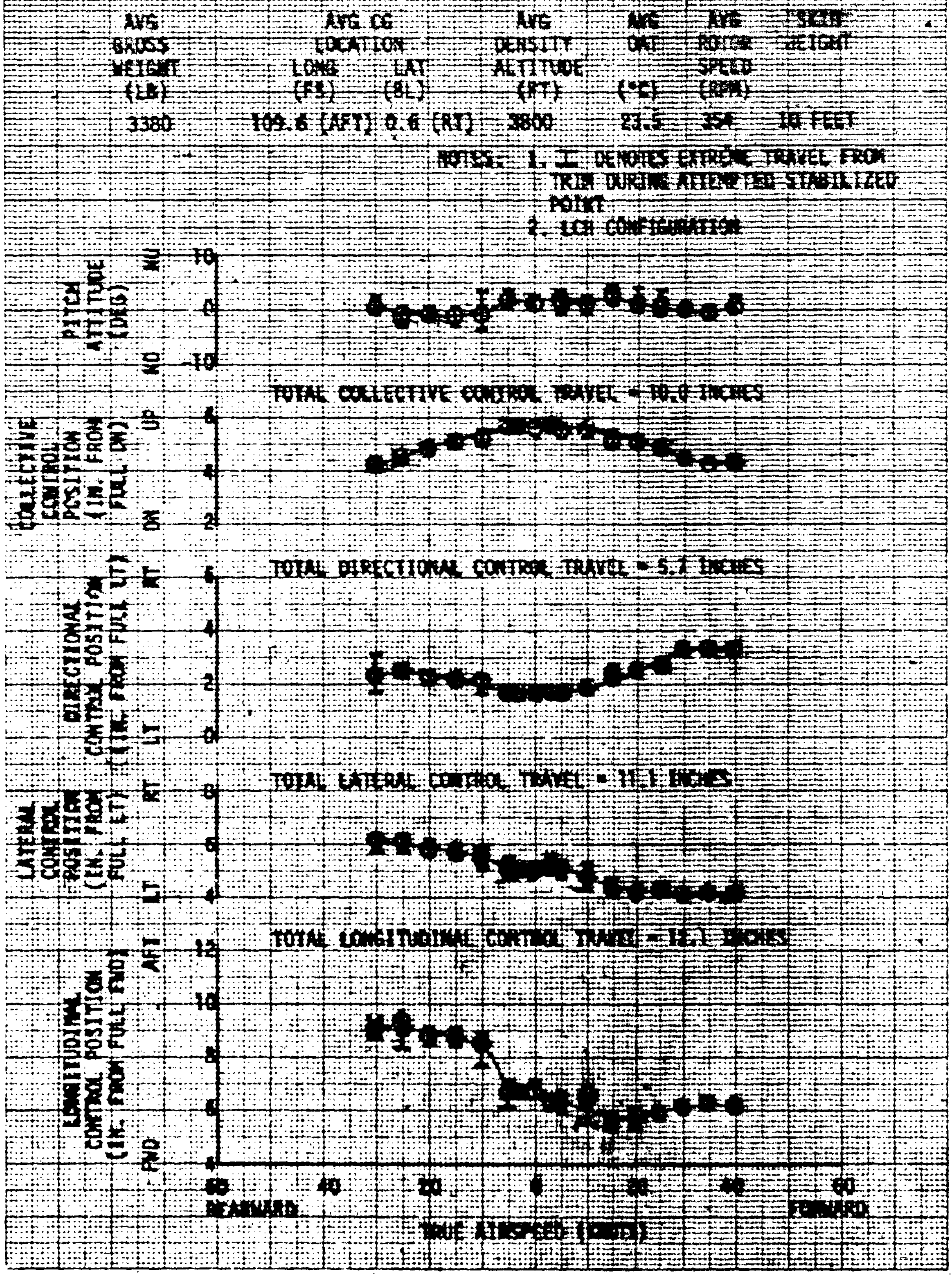
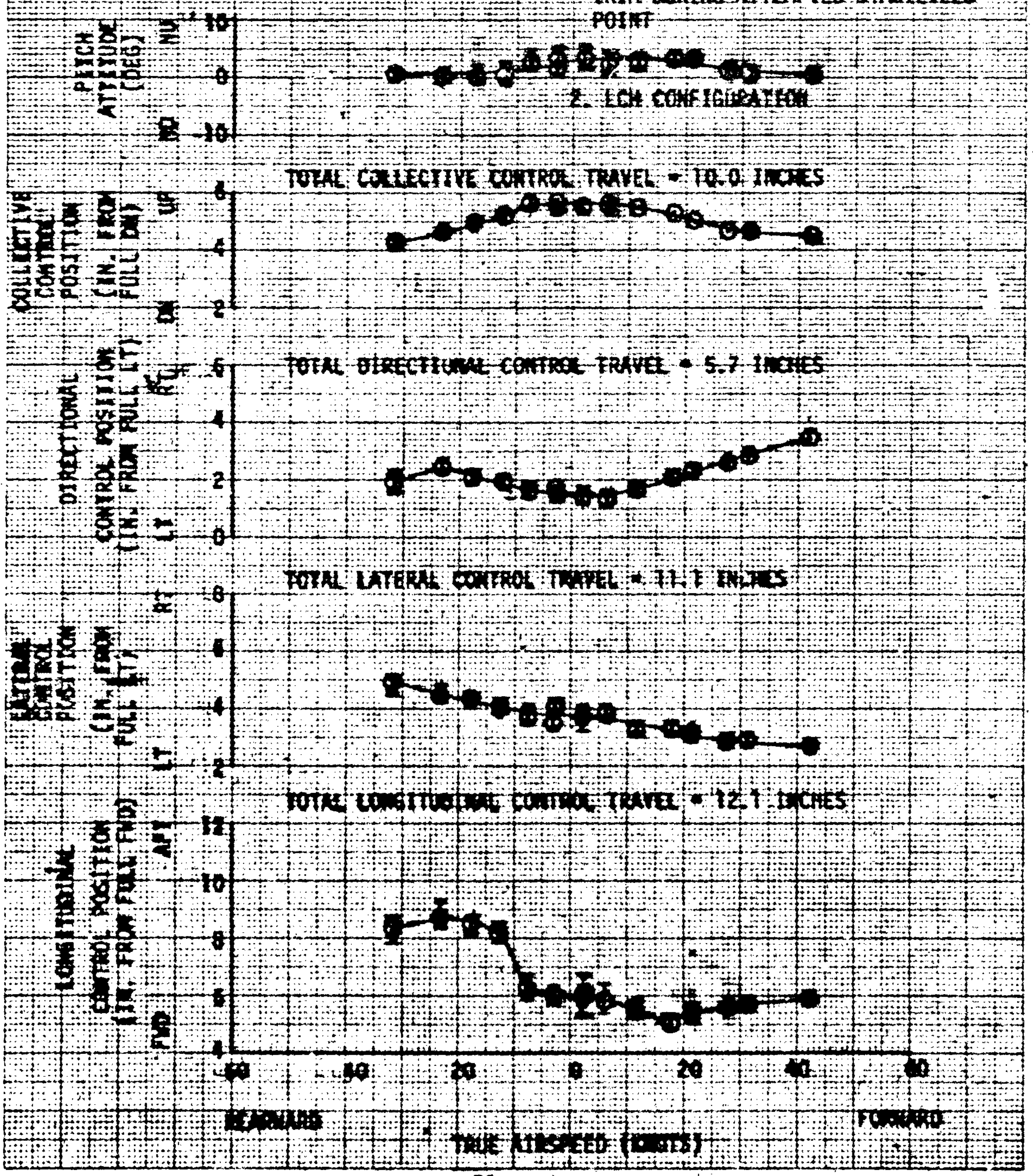


FIGURE 37
LOW-SPEED FORWARD AND REARWARD FLIGHT
OH-58C USA S/N 68-16870

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)	SKID HEIGHT
3380	109.9 (AFT)	2.6 (RT)	3700	23.0	354	10 FEET

NOTES: 1. I DENOTES EXTREME TRAVEL FROM TRIM DURING ATTEMPTED STABILIZED POINT
2. LCH CONFIGURATION



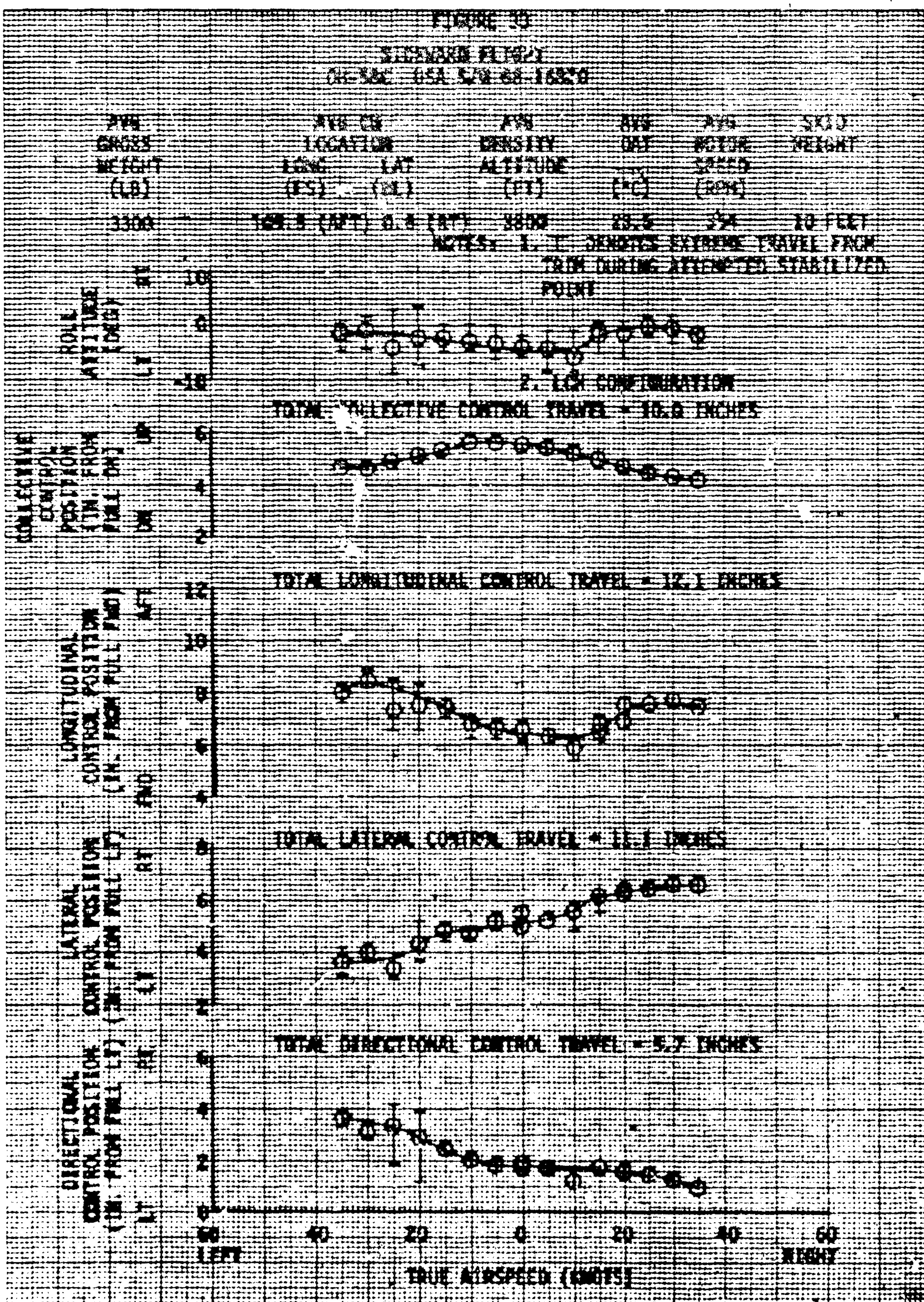


FIGURE 33
SIDEWARD FLIGHT
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED (RPM)
SKID HEIGHT
3300
354
10 FEET
NOTES: 1. I DENOTES EXTREME TRAVEL FROM TRIM DURING ATTEMPTED STABILIZED POINT
ROLL ATTITUDE (DEG)
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN)
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.1 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TOTAL LATERAL CONTROL TRAVEL
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL DIRECTIONAL CONTROL TRAVEL
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
LEFT
RIGHT
TRUE AIRSPEED (KNOTS)

FIGURE 38
SIDEWARD FLIGHT
OH-58C USA S/N 68-16870

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)	SKID HEIGHT
3440	110.0 (AFT)	2.6 (RT)	3700	23.0	354	10 FEET

NOTES: 1. Ɪ DENOTES EXTREME TRAVEL FROM TRIM DURING ATTEMPTED STABILIZED POINT
2. LCH CONFIGURATION

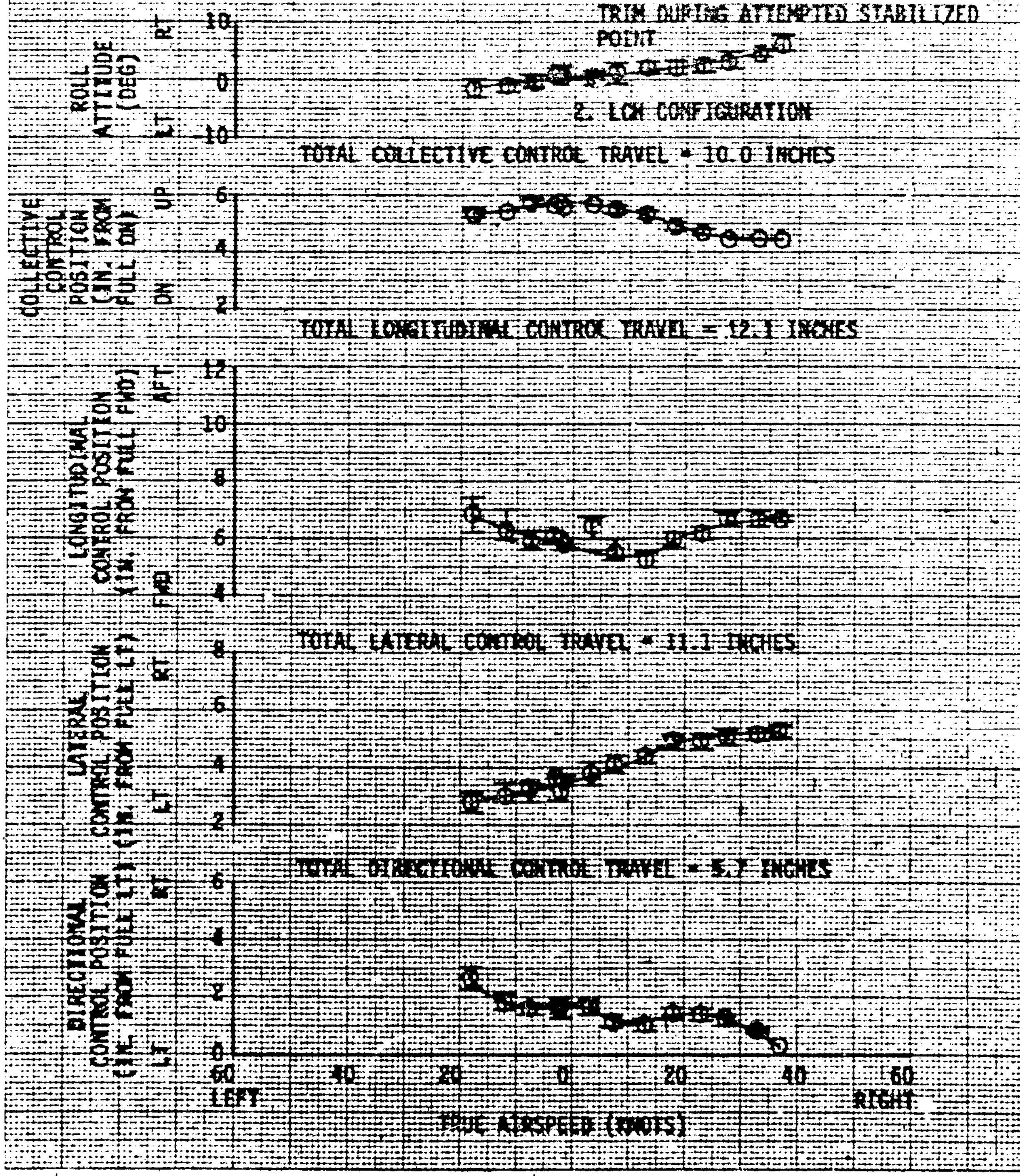


FIGURE 35
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3360	109.6 (AFT)	0.9 (RT)	3640	22.5	354	5

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

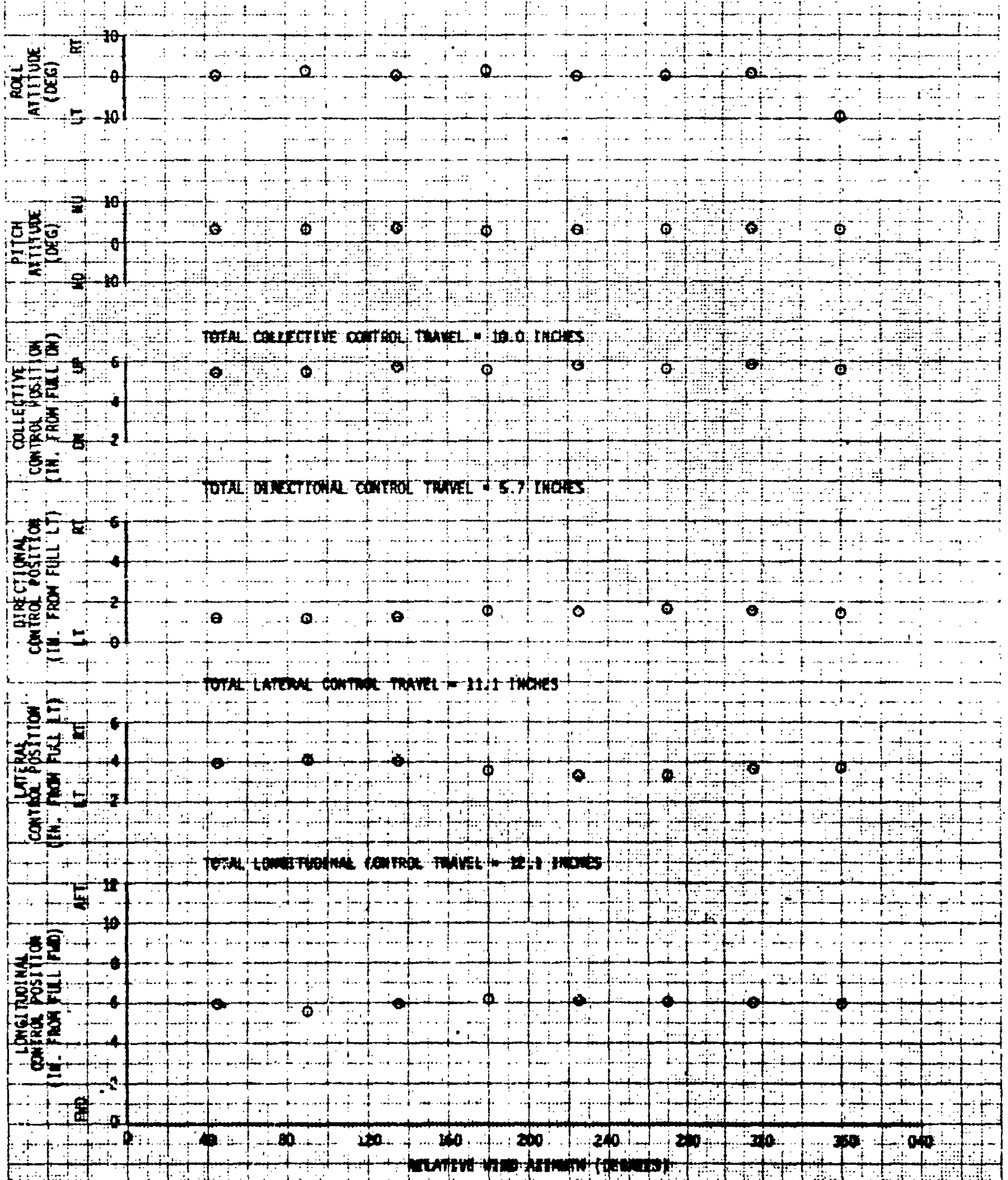


FIGURE 36
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 83-15678

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)	TRUE AIRSPEED (KTS)
3240	110.0 (AFT)	2.6(RT)	4100	27.0	354	35

NOTES: 1. LOW CONFIGURATION
2. SKID HEIGHT - 10 FEET

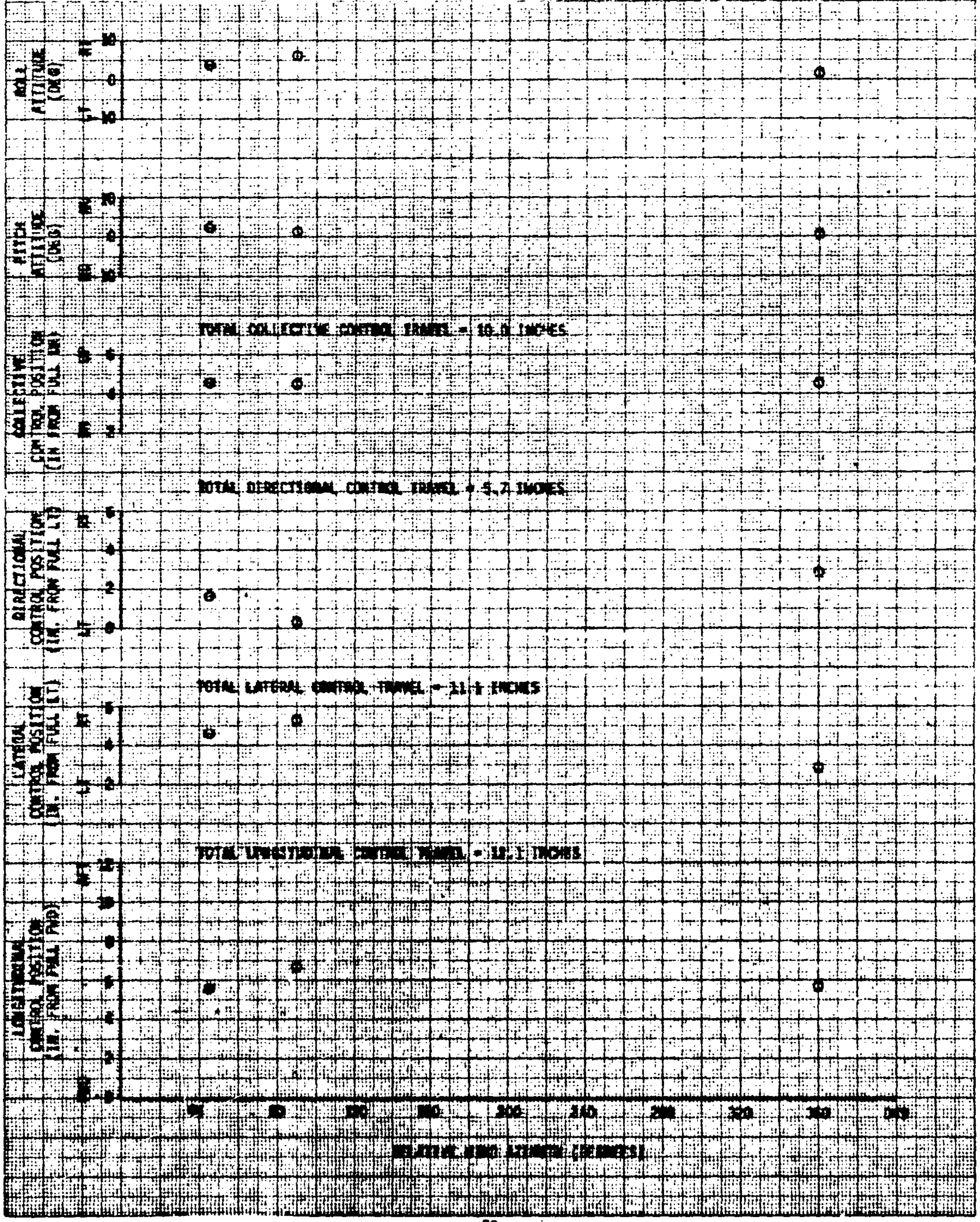


FIGURE 37
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRUE AIRSPEED (KTS)
1980	109.6 (AFT)	0.5 (RT)	3640	22.5	354	10

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

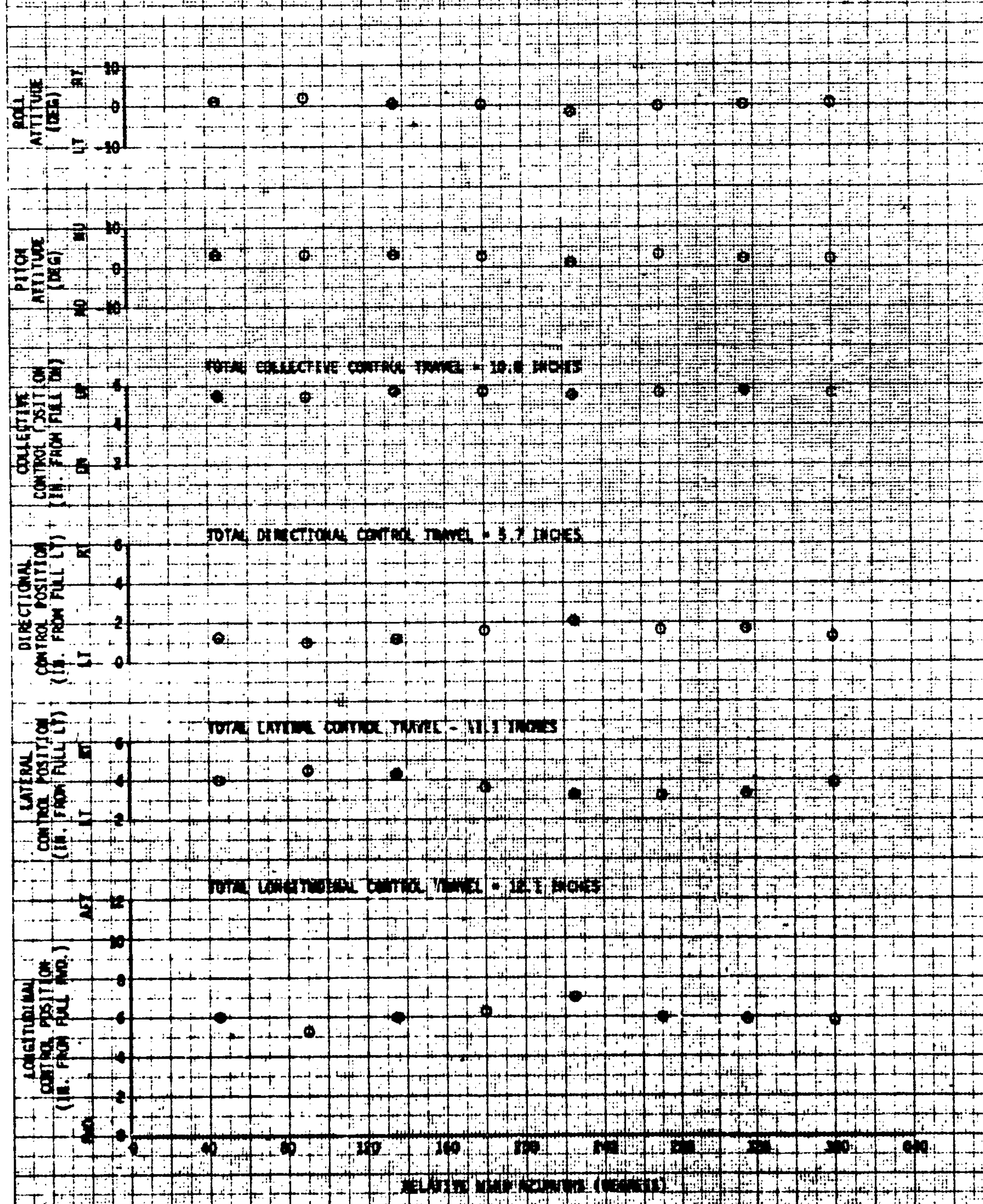


FIGURE 38
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3360	109.6 (AFT)	0.9 (RT)	3640	22.5	354	15

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT ≈ 10 FEET

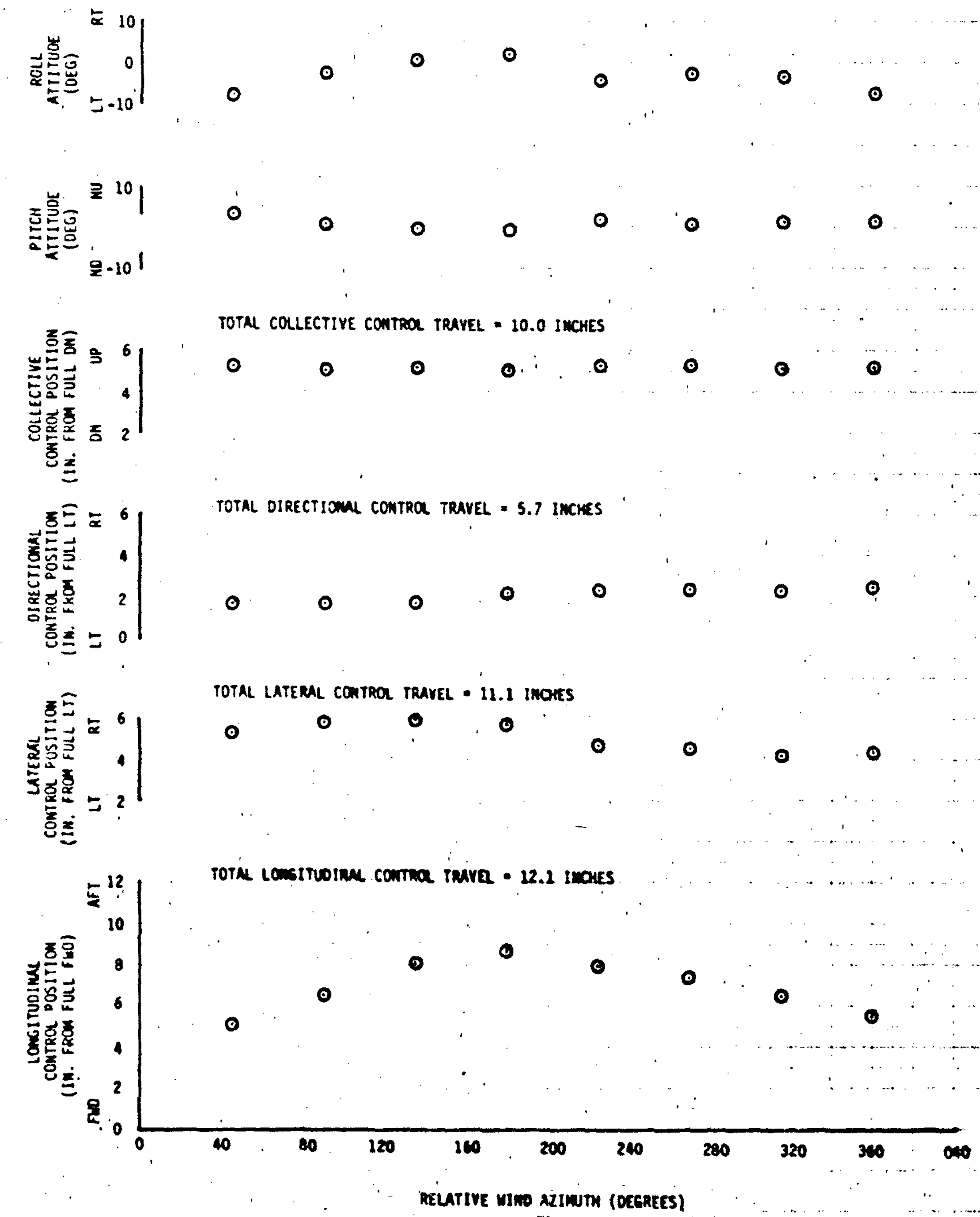


FIGURE 39
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3360	109.6 (AFT)	0.9 (RT)	3640	22.5	354	20

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

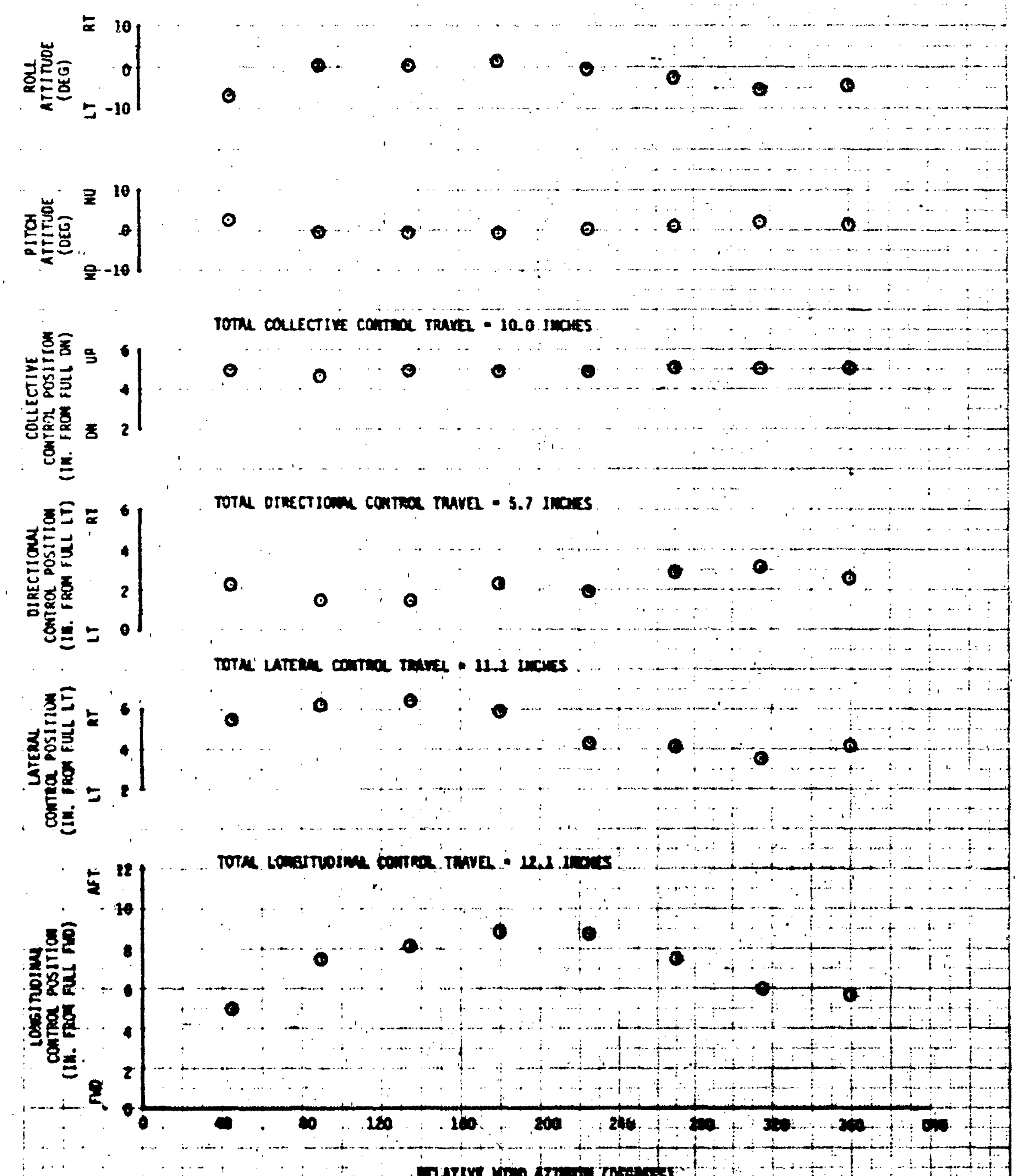


FIGURE 40
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3360	109.6 (AFT)	0.9 (RT)	3640	22.5	354	25

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

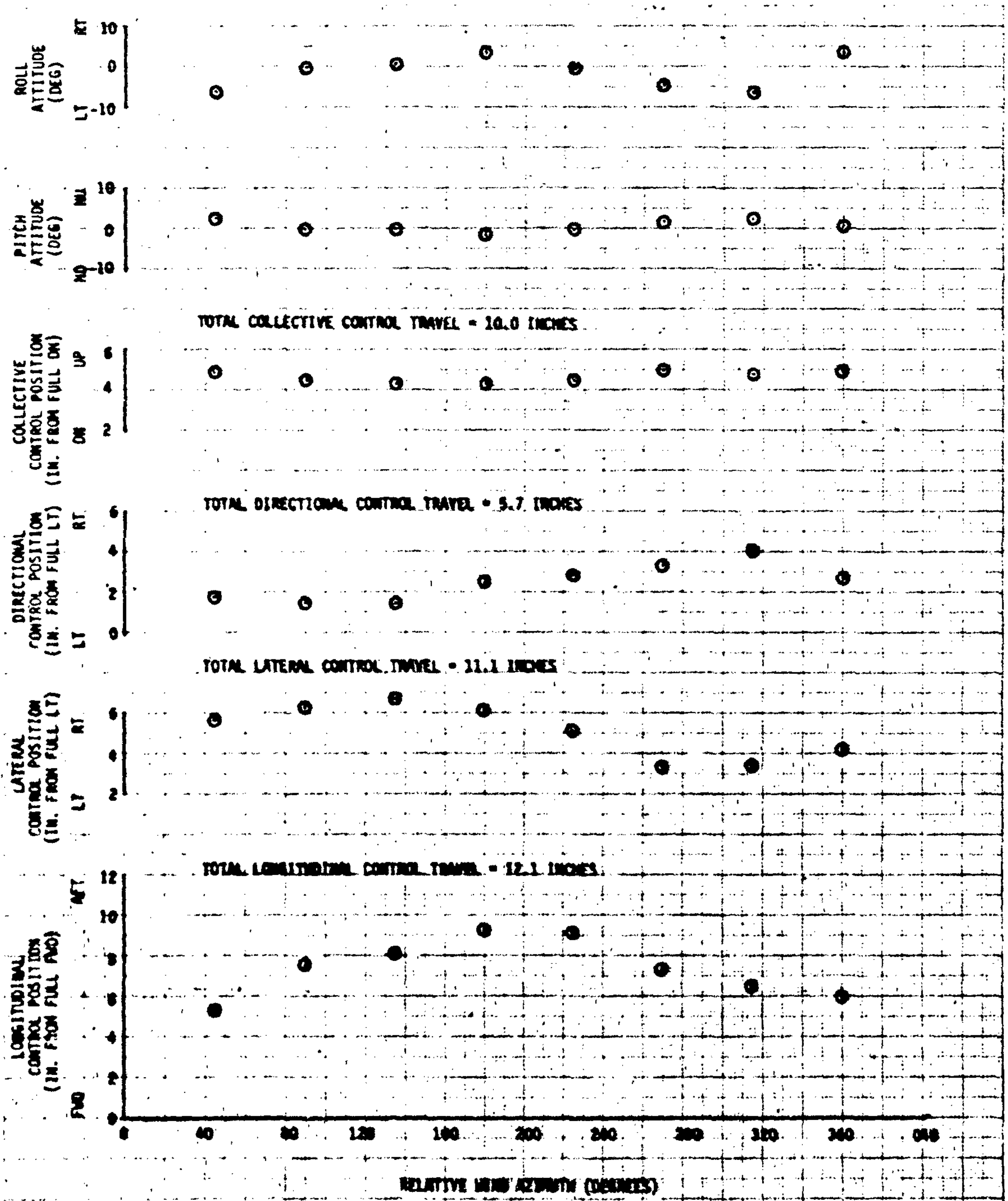


FIGURE [illegible]
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16830

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)	TRUE AIRSPEED (KTS)
3360	109.6 (AFT)	0.9 (RT)	1640	22.5	354	30

NOTES: 1. LOW CONFIGURATION
2. SKID HEIGHT = 10 FEET

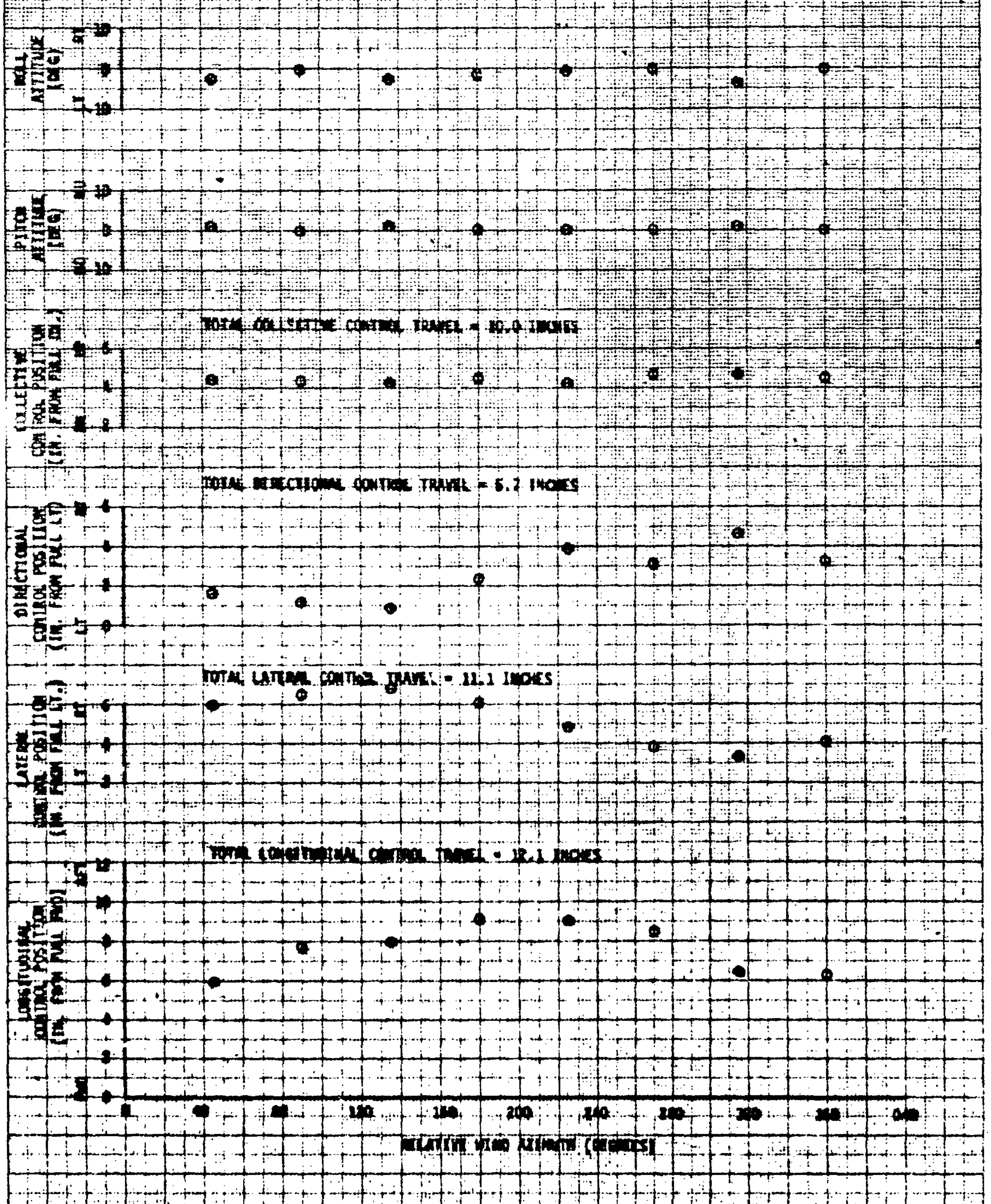


FIGURE 42
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16890

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)	TRUE AIRSPEED (KT)
3000	106.6 (AFT)	0.9 (RT)	3840	22.5	354	35

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT - 10 FEET

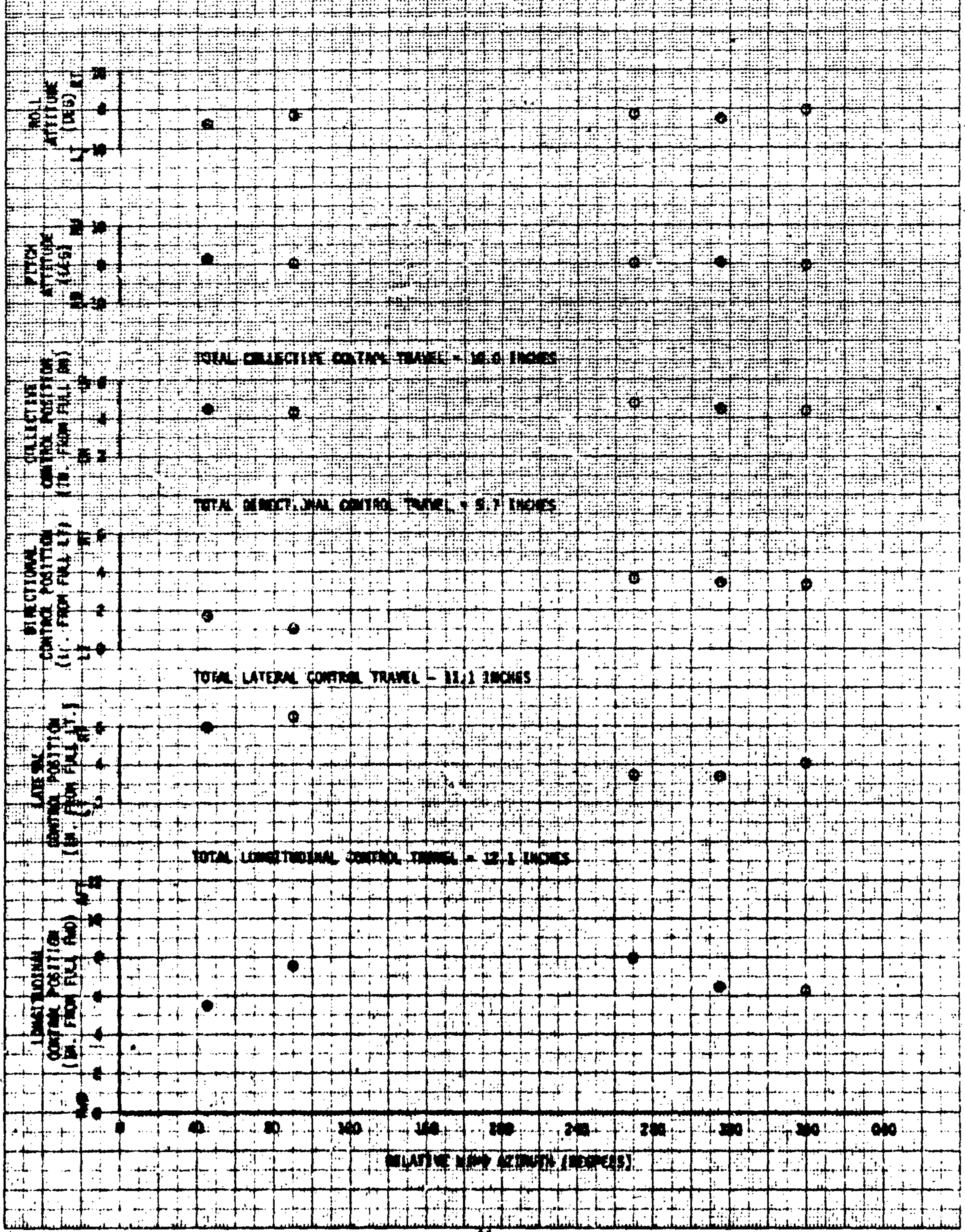


FIGURE 43
CONTROL POSITIONS AT VARIOUS [redacted]
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3420	110.0 (AFT)	2.6 (RT)	4140	27.0	354	5

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

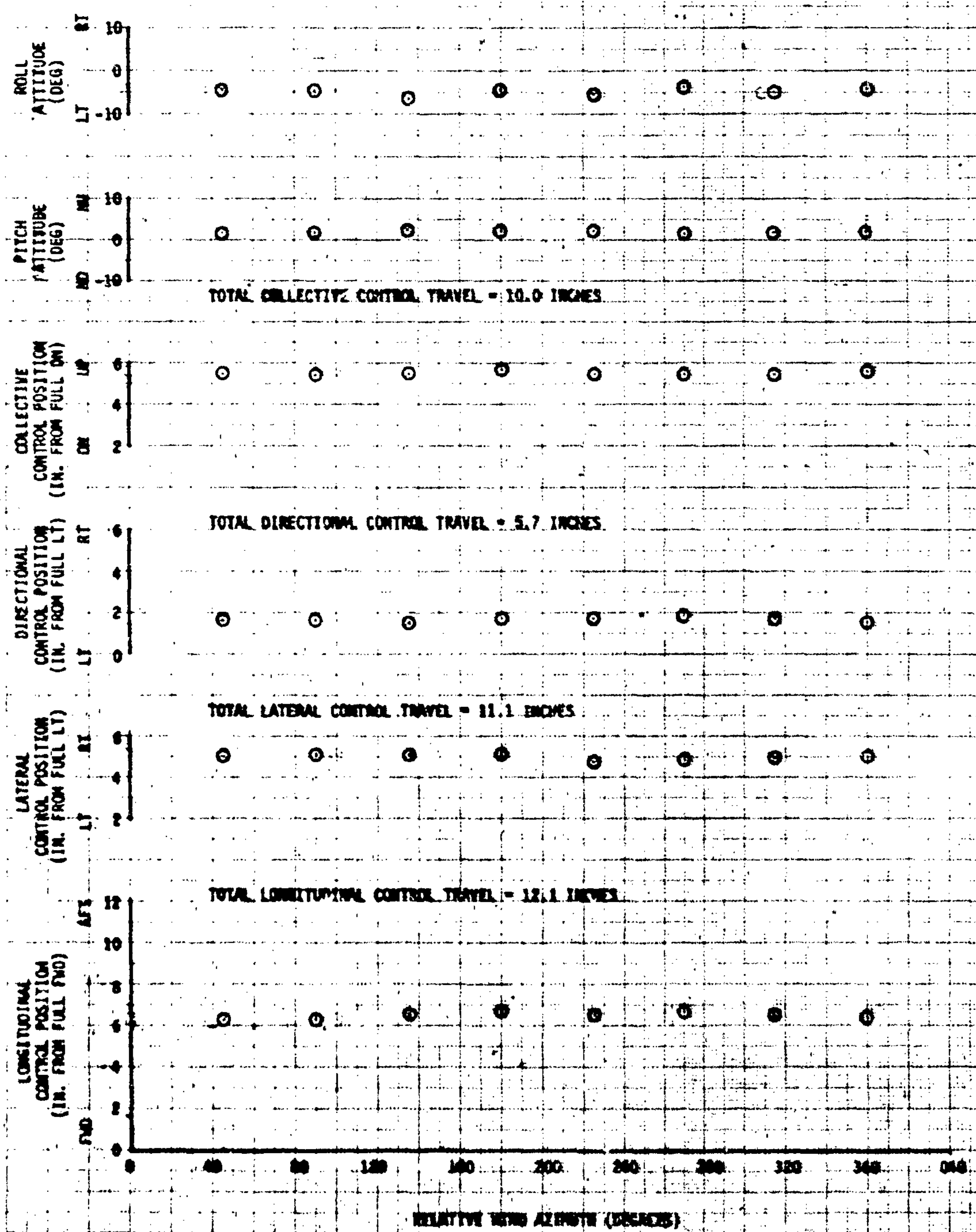


FIGURE 44
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3420	110.0 (AFT)	2.6 (RT)	4140	27.0	354	16

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

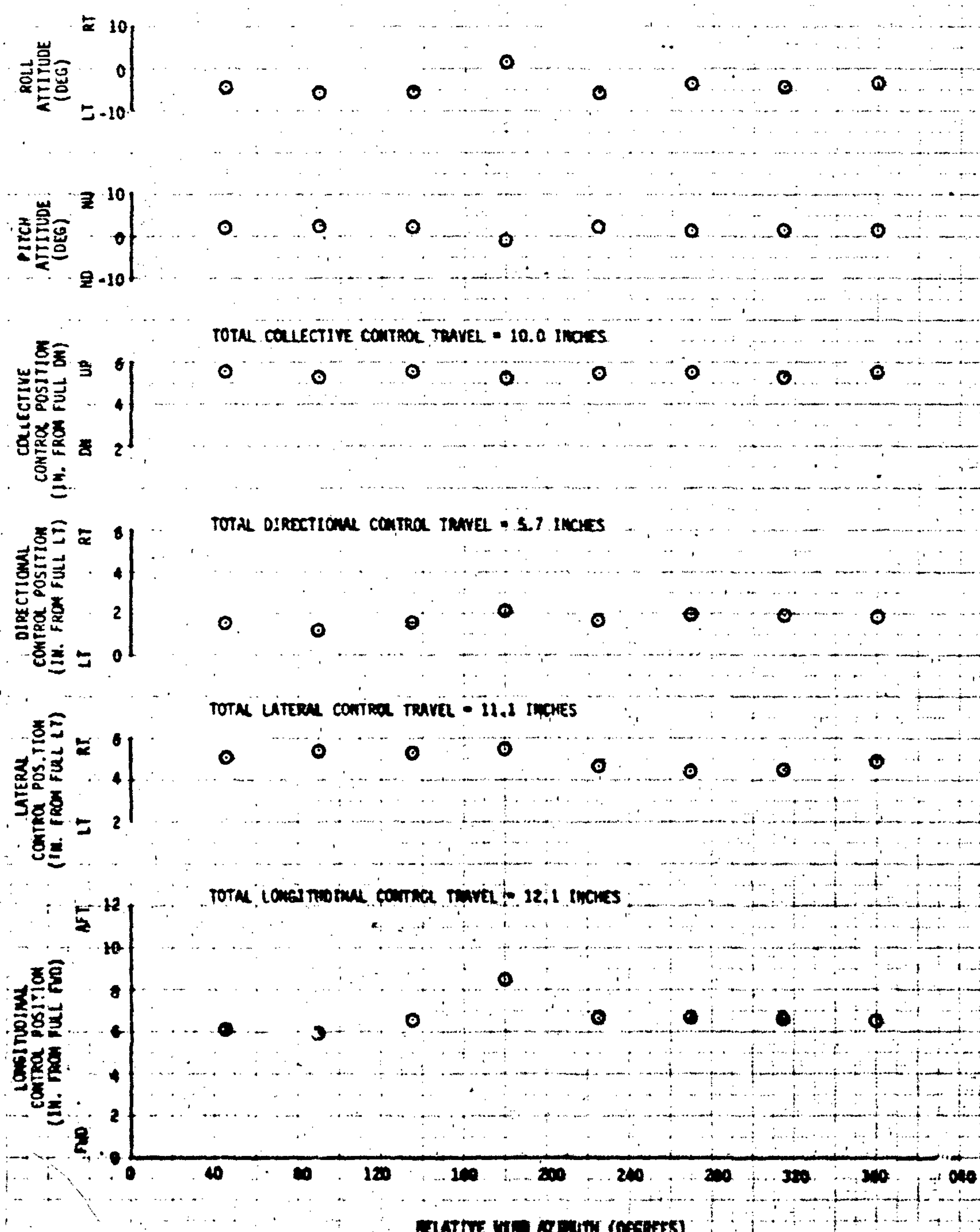


FIGURE 45
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3420	110.0 (AFT)	2.6 (RT)	4140	27.0	354	15

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET

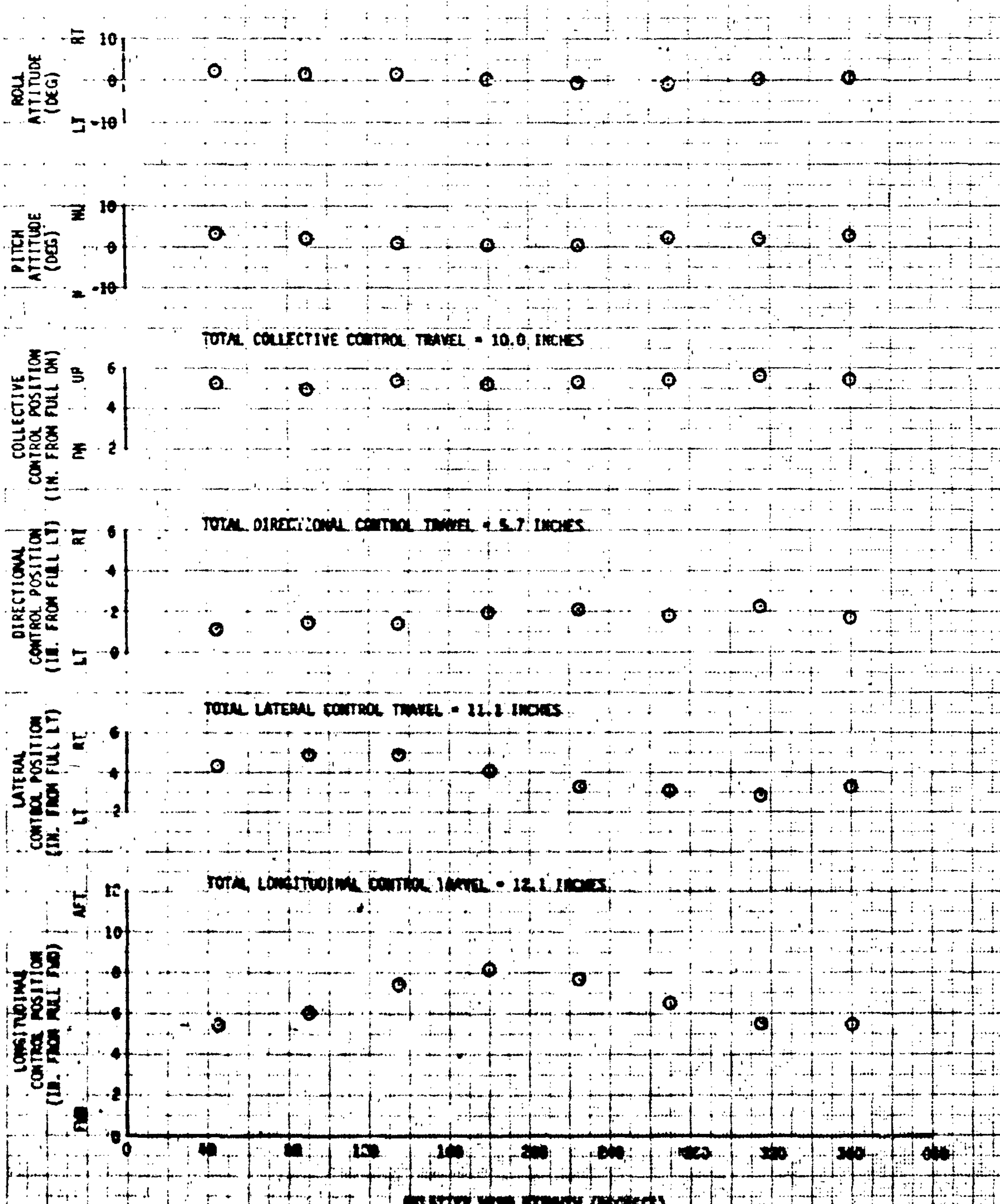


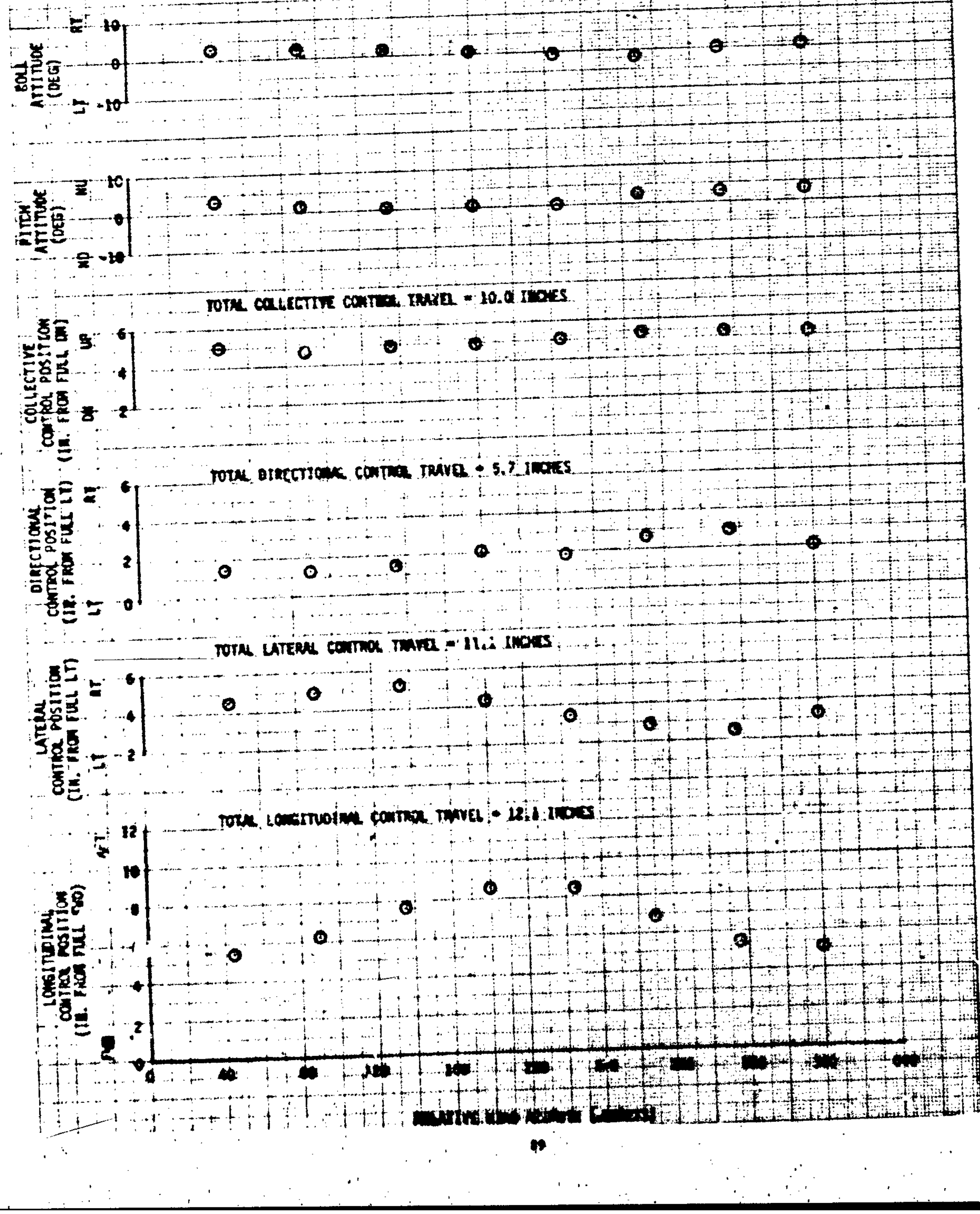
FIGURE 46

CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS

OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3420	110.0 (AFT)	2.4 (RT)	4140	27.0	354	20

NOTES: 1. LCH CONFIGURATION
2. SKID HEIGHT = 10 FEET



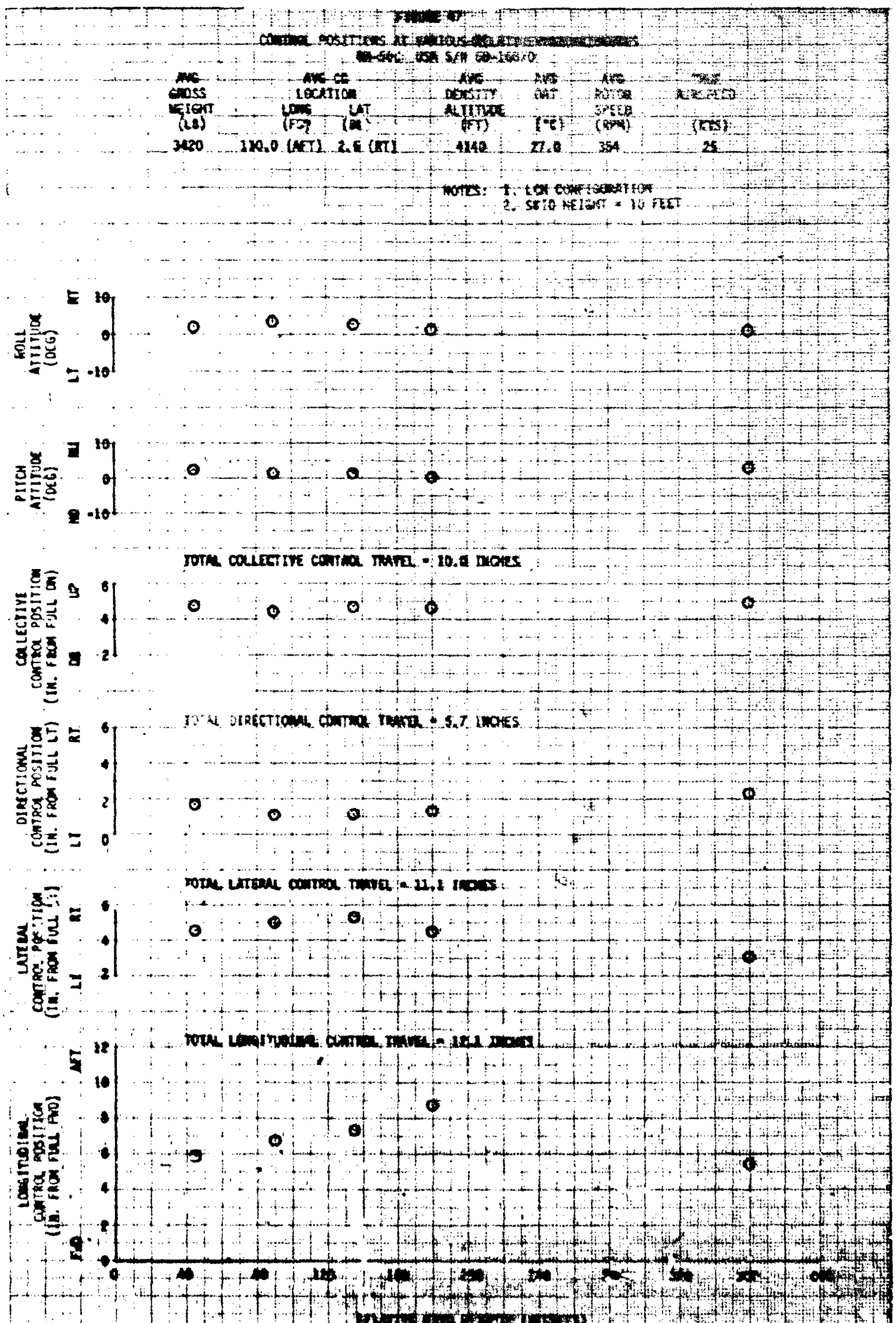
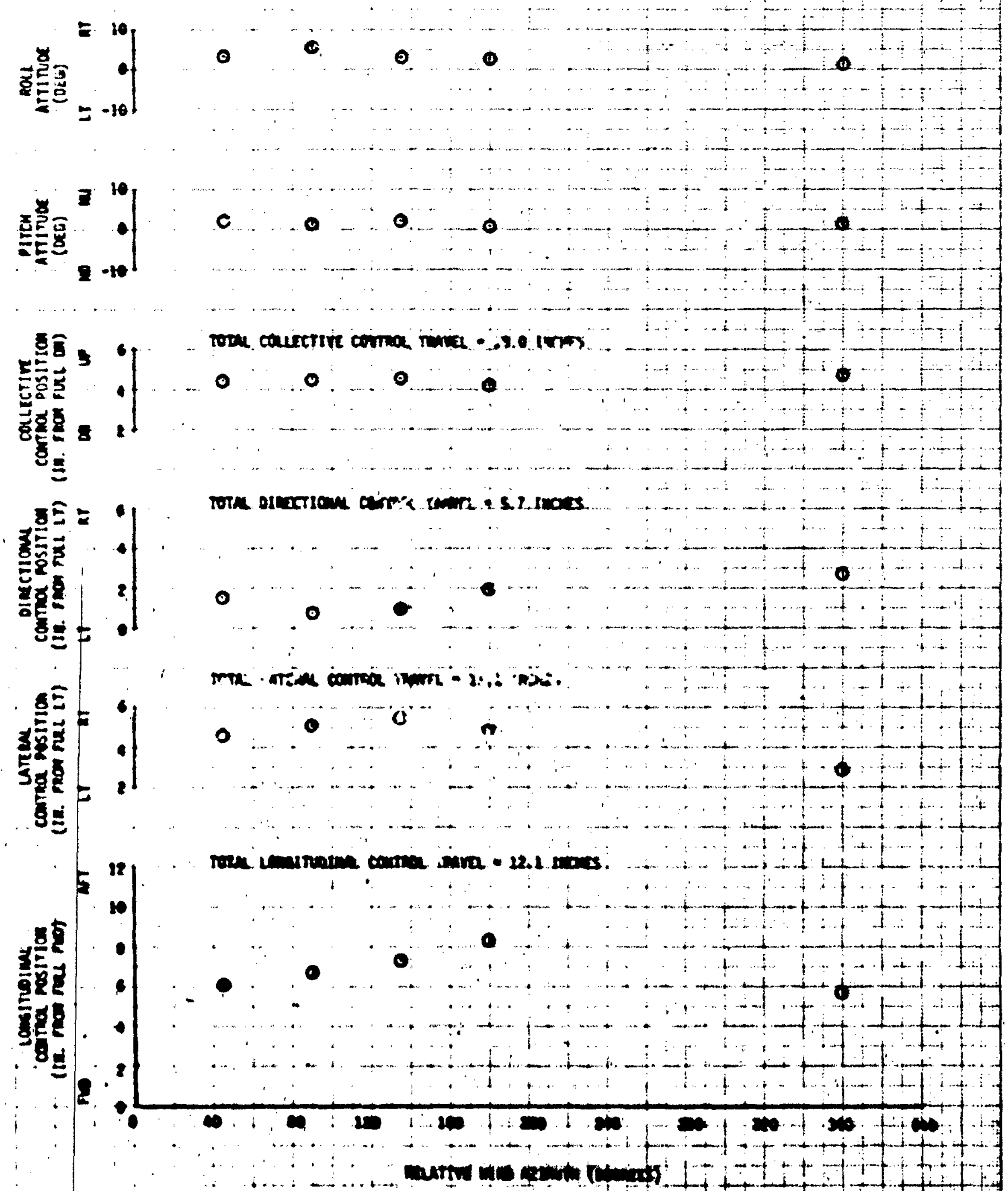

CONTROL POSITIONS AT VARIOUS
USA S/N
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG
LAT
AVG DENSITY ALTITUDE (FT)
AVG OAT (°C)
AVG ROTOR SPEED (RPM)
(KTS)
3420
110.0 (AFT)
2.6 (RT)
4140
27.0
354
25
NOTES:
2. SKID HEIGHT = 10 FEET
ROLL ATTITUDE (DEG)
RT
LT
10
0
-10
PITCH ATTITUDE (DEG)
10
0
-10
TOTAL COLLECTIVE CONTROL TRAVEL = 10.8 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN)
UP
DN
6
4
2
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.7 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
6
4
2
0
TOTAL LATERAL CONTROL TRAVEL = 11.1 INCHES
LATERAL CONTROL POSITION
RT
LT
6
4
2
TOTAL LONGITUDINAL CONTROL TRAVEL
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
12
10
8
6
4
2
0
0
40

FIGURE [illegible]
CONTROL POSITIONS AT VARIOUS RELATIVE WIND AZIMUTHS
OH-58C USA S/N 68-16870

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)	TRUE AIRSPEED (KTS)
3420	110.0 (AFT)	2.6 (RT)	4140	27.0	354	30

NOTES: 1. LOH CONFIGURATION
2. SKID HEIGHT = 10 FEET



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