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AEFA PROJECT NO. 86-14

US ARMY
AVIATION
SYSTEMS COMMAND

AD-A191 414

AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST OF A SKI ASSEMBLY FOR THE UH-60A BLACK HAWK HELICOPTER

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AUGUST 1987

FINAL REPORT

Approved for public release; distribution unlimited.

AVIATION ENGINEERING FLIGHT ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523 - 5000

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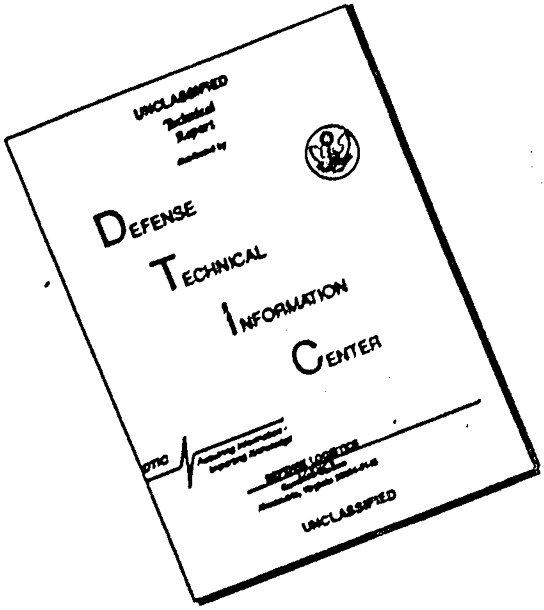

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY: U.S. ARMY AVIATION SYSTEMS COMMAND	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release, distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): AEFA PROJECT NO. 86-14	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: U.S. ARMY AVIATION ENGINEERING FLIGHT ACTIVITY; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code): EDWARDS AIR FORCE BASE, CALIFORNIA 93523-5000	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: U.S. ARMY AVIATION SYSTEMS COMMAND; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code): 4300 GOODFELLOW BLVD. ST. LOUIS, MO 63120-1998	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 68-7BE344-01; PROJECT NO. -68-EC; TASK NO.; WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Airworthiness and Flight Characteristics Test of a Ski Assembly For the UH-60A Black Hawk Helicopter. Unclassified

12. PERSONAL AUTHOR(S)
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13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
FINAL	FROM 87/04 TO 87-04/30	87/08	124

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Airworthiness and Flight Characteristics, Performance Decrement, Ski Assembly, UH-60A Helicopter

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

An Airworthiness and Flight Characteristics test of the UH-60A helicopter (S/N 84-23953) configured with a ski assembly was conducted by the U.S. Army Aviation Engineering Flight Activity. The test was conducted at the Sikorsky Flight Test Facility at West Palm Beach, Florida (elevation 28 feet). A total of 25.5 productive flight hours were flown during the period 6 to 30 April 1987. Tests were conducted to determine the handling qualities and performance decrement of the ski assembly on the UH-60A helicopter at average mission gross weights of approximately 16,000 and 22,000 pounds. The handling qualities of the UH-60A with the ski assembly installed were essentially unchanged from those previously reported for the normal utility UH-60A. Two previously reported shortcomings are still evident: neutral static longitudinal stability during intermediate rated power climbs, and self-excited aircraft pitch oscillation with the collective control raised sufficiently for the aircraft

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL: SHEILA R. LEWIS	22b. TELEPHONE (Include Area Code): (805)277-4024; 22c. OFFICE SYMBOL: SAVTE-PR

DD Form 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Cont.

Block No. 19
to be "light" on its wheels. The equivalent flat plate area of the ski assembly was determined to be 3 square feet. Several miscellaneous observations were made regarding the effects of the ski installation.

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INTRODUCTION

BACKGROUND

1. The U.S. Army has contracted with Airglas Engineering Co., Inc., of Anchorage, Alaska, to develop a ski assembly for use on the UH-60A helicopter. This assembly is to be used with UH-60A aircraft stationed with the Alaska Army National Guard and will be procured in limited quantities for other Army units. The skis are to keep the aircraft from becoming immobile when operating on snow (winter) and tundra (summer). Sikorsky Aircraft, under contract with the U.S. Army Aviation Systems Command (AVSCOM), was tasked to demonstrate the structural integrity of the skis and landing gear by conducting a limit load test of the Black Hawk main and tail landing gear equipped with the skis, to conduct a flight loads survey, and to demonstrate freedom from ground resonance and tail wheel shimmy with the skis installed prior to U.S. Army testing. AVSCOM tasked the U.S. Army Aviation Engineering Flight Activity (AEFA) (ref 1, app A) to plan, conduct and report on an Airworthiness and Flight Characteristics (A&FC) test of the ski assembly designed for the UH-60A Black Hawk helicopter.

TEST OBJECTIVE

2. The objective of this test was to determine the handling qualities and performance decrement of the ski assembly on the UH-60A helicopter.

DESCRIPTION

3. The UH-60A Black Hawk helicopter is a twin-turbine, single main rotor helicopter capable of transporting cargo, 11 combat troops and weapons during day, night, visual meteorological conditions, and instrument meteorological conditions. Conventional wheel-type landing gear are provided. The main and tail rotors are both four-bladed. Manual main rotor blade and tail pylon folding capabilities are provided for air transportability. A movable horizontal stabilator is located on the lower portion of the tail rotor pylon. The helicopter is powered by two T700-GE-700 turboshaft engines each having an uninstalled thermodynamic rating (30 minute) of 1553 shaft horsepower (shp) (power turbine speed of 20,900 rpm) at sea level, standard day static conditions. Installed dual engine power is transmission limited to 2828 shp.

4. The UH-60A helicopter (USA S/N 84-23953) used for this test was a production Black Hawk which incorporates the External Stores Support System fixed provisions and fairings, the reoriented

production airspeed probes and the modified production stabilator schedule. A more detailed description of the UH-60A is contained in the Prime Item Development Specification (PIDS) (ref 2), the operator's manual (ref 3), and appendix B. The test helicopter, configured with the ski assembly, is depicted in photo 1.

5. The ski assembly designed for each UH-60A main landing gear are a modification of the Airglas Model L44000-13, CH-47 aft ski. The UH-60A main landing gear skis are 114.8 inches long by 37.5 inches wide. The ski designed for the UH-60A tail wheel is 55.5 inches long by 32 inches wide. All three skis are constructed of fiberglass-reinforced plastic. The skis are mounted to the axle of their respective landing gear. The mounting hardware includes a front mounted spring cylinder and a rear attached check cable to retain the ski in a predetermined (5-degree nose-up) attitude. Additional information is contained in Airglas drawing L20500 (ref 4, app A). A more detailed description of the ski assembly is contained in appendix B.

TEST SCOPE

6. The A&FC was conducted by AEFA personnel at the Sikorsky Flight Test Facility at West Palm Beach, Florida (elevation 28 feet). A total of 25.5 productive flight hours were flown during the period 6 to 30 April 1987. The contractor provided all maintenance and logistical support of the test aircraft and test instrumentation and provided data reduction support. Tests were conducted to determine handling qualities and performance of the UH-60A with the ski assembly installed at average mission gross weights of approximately 16,000 and 22,000 pounds. Results were compared to the requirements of the PIDS and previous test results (refs 5 and 6). Flight restrictions and operating limitations observed throughout the test are contained in the operator's manual (ref 3) and the airworthiness release issued by AVSCOM (ref 7). Testing was conducted in accordance with the approved test plan (ref 8) at the conditions presented in tables 1 and 2.

TEST METHODOLOGY

7. The flight test data were recorded by hand from test instrumentation displayed in the cockpit, by on-board magnetic tape recording equipment and via telemetry to the Sikorsky Real-Time Acquisition and Processing of In-flight Data system. A detailed listing of test instrumentation is contained in appendix C. Flight test techniques and data reduction procedures are described in appendix D.

Photo 1. UH-60A Helicopter with the Ski Assembly Installed

Table 1. Level Flight Performance Test Conditions [1]

Average Gross Weight (lb)	Average Thrust Coefficient ($\times 10^4$)	Average Longitudinal Center of Gravity (FS)[2]	Average Density Altitude (ft)	Airspeed Range (KTAS)[3]	Configuration
18,540	69.99	346.5	1,610	46 to 158	Normal Utility
18,490	79.96	345.9	6,140	48 to 158	Normal Utility
18,460	89.98	345.8	9,270	49 to 146	Normal Utility
18,490	100.08	345.8	12,010	55 to 127	Normal Utility
18,580	69.76	346.6	1,830	47 to 155	Skis
18,550	80.12	346.3	5,480	47 to 155	Skis
18,490	90.12	345.9	9,580	52 to 146	Skis
18,540	100.36	346.3	12,250	55 to 127	Skis

NOTES:

[1]Tests conducted with doors and windows closed, engine bleed air systems-OFF, SAS ON, PBA centered and locked. Main rotor speed of 258 referred rpm, approximate mid-lateral center of gravity.
[2]FS: Fuselage station.
[3]KTAS: Knots true airspeed.

Table 2. Handling Qualities Test Conditions[1]

Type of Test	Average Gross Weight (lb)	Average Longitudinal Center of Gravity (FS)[2]	Average Density Altitude (ft)	Trim Calibrated Airspeed (kt)	Configuration	Remarks
Control Positions in Trimmed Forward Flight[3]	18,540	346.3	1,830 to 12,250	43 to 151	Skis ON	Level Flight in conjunction with level flight performance
	18,490	346.0	1,610 to 12,010	43 to 154	Skis OFF	
	16,240	364.0	6800	30 to 141	Skis ON	IRP[4] climbs and autorotational descents
	22,120	361.0	5860	31 to 136		
Static Longitudinal Stability[3]	16,360	364.4	6300	72 and 147	Skis ON	Level flight
	22,120	361.1	6320	71 and 122		
	16,440	364.6	6400	72		IRP climbs and autorotational descents
	22,080	360.9	6320	72		
Static Lateral-Directional Stability	16,040	363.3	6220	73 and 147	Skis ON	Level flight
	22,020	360.7	6180	71 and 126		
	16,420	346.6	5920	74		IRP climbs and autorotational descents
	22,140	361.1	6480	71		
Dynamic Stability[3]	16,360	364.5	6100	72 and 148	Skis ON	Level flight
	22,100	360.9	6240	71 and 124		
	16,460	364.7	6140	72		IRP climbs and autorotational descents
	22,280	361.4	6200	71		
Ground Handling	15,600 to 22,500	342.6 to 365.7	Ground	N/A	SKis ON and OFF	In conjunction with other tests
Takeoff and Landing	16,360	346.7	740	0 to 60	Skis ON	Running landings to both prepared and unprepared surfaces. Takeoff and land to and from hover.
	21,680	347.5	700	0 to 60		
Slope Landings	16,060	345.4	920	0	Skis ON	Limits: 10° left, right and nose-up. 6° nose-down
	20,360	344.1	0	0		
Low Speed Flight	16,540	347.5	260	0 to 45 (KTAS)[5]	Skis ON	Wheel height 30 feet
	22,260	348.3	700			

NOTES:

[1]Tests were conducted in both the normal utility configuration and with the ski assembly installed as noted with doors closed, AFCS ON, and PBA centered and locked. Rotor speed of 258 rpm and mid lateral center of gravity location.

[2]FS: Fuselage station.

[3]Test conducted in ball-centered flight.

[4]IRP: Intermediate rated power.

[5]KTAS = knots true airspeed.

RESULTS AND DISCUSSION

GENERAL

8. Testing was conducted to determine the handling qualities and performance decrement of the ski assembly on the UH-60A helicopter. The handling qualities of the UH-60A with the ski assembly installed were essentially unchanged from those previously reported for the normal utility UH-60A. Two previously reported shortcomings are still evident: neutral static longitudinal stability during intermediate rated power (IRP) climbs, and self-excited aircraft pitch oscillation with the collective control raised sufficiently for the aircraft to be "light" on its wheels. The equivalent flat plate area of the ski assembly was determined to be 3 square feet. Several miscellaneous observations were made regarding the effects of the ski installation.

LEVEL FLIGHT PERFORMANCE

9. Limited performance flight testing was conducted to determine the performance differences between the UH-60A helicopter in the normal utility configuration and the UH-60A configured with the ski assembly. Level flight performance tests were conducted in ball-centered flight at the conditions listed in table 1 to determine the power required at various airspeeds. Nondimensional level flight test results are presented in figures 1 through 3, appendix E. Dimensional test results for the UH-60A in the normal utility configuration are presented in figures 4 through 7. Dimensional test results for the UH-60A configured with the ski assembly are presented in figures 8 through 11. With the ski assembly installed on the UH-60A helicopter, change in equivalent flat plate area (ΔF_e) was determined to be 3 square feet.

HANDLING QUALITIES

General

10. A limited handling qualities evaluation of the UH-60A configured with the ski assembly was conducted to determine any changes caused by the ski installation. Handling qualities of the UH-60A with the ski assembly installed were quantitatively and qualitatively evaluated and found to be essentially the same as the UH-60A in the normal utility configuration. Two previously reported shortcomings were still evident.

Control Positions in Trimmed Forward Flight

11. Control positions in trimmed, ball-centered, forward flight were obtained in conjunction with level flight performance testing

and during IRP climbs and autorotational descents at the conditions presented in table 2. Representative level flight data are presented in figures 12 through 19. In level flight, above 60 knots calibrated airspeed (KCAS), the variation of longitudinal control position with airspeed during trimmed level flight generally required increased forward cyclic control with increased airspeed. Below 60 KCAS, the longitudinal control position with airspeed gradient was essentially neutral, as previously reported in reference 5, appendix A. Lateral cyclic control trim change of approximately one inch from 60 KCAS to V_H was noticeable, but not objectionable. Control positions, pitch attitudes and trimmability with the ski assembly installed during level flight were essentially the same as the UH-60A in the normal utility configuration and are satisfactory.

12. Representative data taken during IRP climbs and autorotational descents at two mission gross weights are presented in figures 20 through 23, appendix E. During IRP climbs, longitudinal control position variation with airspeed was essentially neutral and maintaining desired airspeed ±5 knots required some pilot compensation (Handling Qualities Rating Scale (HQRS) 3), partially due to uncommanded, continuous, small amplitude longitudinal pitch oscillations, as previously reported in reference 6, appendix A. Above 50 KCAS, increased airspeed generally resulted in a more nose-down pitch attitude. The pitch attitude change required at the lighter gross weight was much more noticeable. During autorotational descents, longitudinal control position variation with airspeed was essentially linear and conventional, providing excellent control position versus airspeed cues to the pilot. Pitch attitude was essentially constant at approximately 4° nose-up. Lateral control position variation with airspeed was large (increased airspeed over a 100 knot speed range required three inches of right lateral cyclic control change), but was not considered objectionable. The trimmed flight control positions during IRP climbs and autorotational descents with the ski assembly installed are essentially the same as the UH-60A in the normal utility configuration and are satisfactory.

Static Longitudinal Stability

13. The static longitudinal stability characteristics of the UH-60A configured with the ski assembly were evaluated at two mission gross weights during level flight, IRP climbs, and autorotational descents at the conditions presented in table 2. The helicopter was stabilized in ball-centered flight at the desired trim airspeed and flight condition. The collective control was held fixed while airspeed was varied approximately ±20 knots about trim in 5 knot increments. Representative level flight data are

presented in figures 24 and 25, appendix E. During level flight, the static longitudinal stability (as indicated by the variation of longitudinal cyclic control position with airspeed) was positive (forward longitudinal cyclic control position with increased airspeed) for both mission gross weights and airspeeds, similar to that reported in reference 5, appendix A. However, longitudinal cyclic control position variation about trim was so small that cyclic position changes were imperceptible to the pilot. Control force cues of longitudinal cyclic control displacement about trim were weak, but sufficient for airspeed control within ±2 knots (HQRS 3). During level flight, the static longitudinal stability of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration, is satisfactory, and met the requirements of the PIDS.

14. Representative data in IRP climbs are presented in figures 26 and 27, appendix E. During IRP climbs, the static longitudinal stability was essentially neutral (no longitudinal cyclic control variation with airspeed), providing poor longitudinal cyclic position versus airspeed cues to the pilot, similar to that previously reported in reference 5. Control force displacement cues about trim were weak. Maintaining airspeed ±5 knots required moderate pilot compensation (HQRS 4), and was aggravated by small, continuous longitudinal pitch oscillations (as previously discussed in paragraph 12). During IRP climbs, the neutral static longitudinal stability of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration (ref 5) and is a shortcoming. Neutral static longitudinal stability during IRP climbs fails the requirements of paragraph 10.3.3.1.3 of the PIDS.

15. Representative autorotational descent data are presented in figures 28 and 29, appendix E. During autorotational descents, the static longitudinal stability was positive with a moderate gradient, providing good longitudinal cyclic control position cues to the pilot. Airspeed was easily maintained ±2 knots (HQRS 2). At the higher gross weight, approximately one-half inch more forward cyclic and right pedal control were required throughout the airspeed range evaluated, but the slope of the curves was similar. Longitudinal control force displacement cues about trim were adequate. During autorotational descent, the static longitudinal stability of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration, is satisfactory, and met the requirements of the PIDS.

Static Lateral-Directional Stability

16. The static lateral-directional stability characteristics of the UH-60A configured with the ski assembly were evaluated at two mission gross weights during level flight, IRP climbs and autorotational descents at the conditions presented in table 2. The helicopter was stabilized in ball-centered flight at the desired trim airspeed and flight condition. With the collective control held fixed, the aircraft was then stabilized at incremental sideslip angles up to limit sideslip angle on each side of trim while maintaining a zero turn rate at the trim airspeed. Representative data are presented in figures 30 through 35.

17. Static directional stability (as indicated by the variation of directional control position with sideslip angle) was positive (increased left directional control required with increased right sideslip) at all test conditions. The directional control variation with sideslip was essentially linear and similar to findings reported in reference 5, appendix A. The directional stability characteristics of the UH-60A configured with the ski assembly were essentially the same as the UH-60A in the normal utility configuration, are satisfactory, and met the requirements of the PIDS.

18. Dihedral effect (as indicated by the variation of lateral cyclic control position with sideslip angle) was positive (increased right cyclic control with increased right sideslip) and essentially linear at all test conditions. The gradient of lateral cyclic control versus sideslip was more steep at the higher airspeeds and gross weights, but the difference was not perceptible to the pilot. There were no discontinuities in force or position cues and good out-of-trim cues were evident. Similar results were previously reported in reference 5. The dihedral effect of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration, is satisfactory, and met the requirements of the PIDS.

19. Sideforce characteristics (as indicated by the variation in bank angle with sideslip) were positive (increased right bank angle with increased right sideslip) at all test conditions. The most shallow gradient of bank angle versus sideslip (0.02 degrees/degree) was encountered during autorotational descent, but was considered adequate. The sideforce characteristics of the UH-60A configured with the ski assembly were essentially the same as the UH-60A in the normal utility configuration, are satisfactory, and met the requirements of the PIDS.

20. A pitch-due-to-sideslip coupling was evident in all test conditions. Generally, the longitudinal cyclic position versus sideslip required increased forward longitudinal cyclic control with increased right sideslip. The pitch-due-to-sideslip coupling exhibited was not considered objectionable and was similar to that previously reported in reference 5.

21. The UH-60A configured with the ski assembly exhibited different inherent sideslip angles for each test condition. During level flight at 70 KCAS, the average inherent sideslip angle was approximately 3° left at the lighter gross weight and 6° left at the higher gross weight. During level flight at V_H, the average inherent sideslip angle was 0° at both gross weights. Significant differences in inherent sideslip angle were noted during IRP climbs and autorotational descents. During IRP climbs, the average inherent sideslip angle was approximately 7° right and during autorotational descents the average inherent sideslip angle was approximately 14° left.

Dynamic Stability (Gust Response)

22. The dynamic stability characteristics of the UH-60A configured with the ski assembly were evaluated at the conditions presented in table 2. The short-term response was simulated in all control axes by making single-axis, 1 inch pulse inputs which were held for approximately 0.5 second and by control releases from limit sideslip values. Long-term longitudinal dynamic stability characteristics were evaluated by displacing the aircraft from trim airspeed approximately 10 to 15 knots, smoothly returning the longitudinal control to the trim position, and observing/recording the resultant response. Testing was conducted in calm to light turbulence meteorological conditions, as defined in the Flight Information Handbook (ref 9). The dynamic stability characteristics were essentially the same for all test conditions (level flight, IRP climbs, and autorotational descents). Representative time history data are presented in figures 36 through 47, appendix E.

23. The short-term response was heavily damped. Single axis disturbances in all axes were damped to one-half amplitude within one cycle, similar to that previously reported in reference 5. The short-term response of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration, is satisfactory, and met the requirements of the PIDS.

24. The long-term response was not easily excited by light turbulence. When disturbed, the aircraft returned at a moderate rate

to within ±2 knots of trim airspeed and ±2° of heading, which allowed "hands-off" flight for extended periods of time (over 1 minute), similar to that previously reported in reference 5. The long-term response of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration, is satisfactory, and met the requirements of the PIDS.

25. Lateral-directional oscillatory responses were highly damped during releases from steady heading sideslips, as indicated by a maximum of two small heading overshoots prior to returning to within ±2° of trim heading within 10 to 15 seconds. Flight in light turbulence also exhibited a damped lateral-directional response which required little pilot compensation (HQRS 2) to maintain ±2° of heading, similar to that previously reported in reference 5. The lateral-directional gust response of the UH-60A configured with the ski assembly was essentially the same as the UH-60A in the normal utility configuration, is satisfactory, and met the requirements of the PIDS.

Ground Handling Characteristics

26. The ground handling characteristics of the UH-60A, which included aircraft repositioning by ground personnel and ground taxiing conducted from hardtop taxiways, were evaluated concurrently with other tests under the conditions presented in table 2. Wind conditions were generally less than 15 knots.

27. In order for the aircraft to be repositioned by ground personnel, the standard aircraft tow-bar, typically connected to the tail wheel, had to be inverted to accommodate the tail ski installation. Additionally, when the aircraft was loaded to an aft center of gravity (cg), a "tail ski restrainer cable" was required to be attached from the lower spring cylinder attachment bracket to an eye bolt located just below the tail wheel rotation joint (photo 8, app B). This cable, 11-1/4 inches in length, was required to raise the front of the tail ski off the ground prior to ground tow. It was removed prior to flight. The following NOTE should be incorporated into the operator's manual.

NOTE

> When the aircraft is loaded to an aft center of gravity, a tail ski restrainer cable (approximately two inches shorter than the tail ski safety cable) should be attached to both ends of the tail ski spring cylinder to hold the spring compressed during towing.

28. Directional control while taxiing was easily accomplished and no differences in taxi characteristics, directly attributable to the skis installation, were noted by the pilots. The previously documented (ref 6) self-excited aircraft pitch oscillation with the collective control raised sufficiently for the aircraft to be "light" on its wheels remains a shortcoming.

Takeoff and Landing Characteristics

29. Takeoff and landing characteristics were evaluated in conjunction with other tests at two mission gross weights under the conditions presented in table 2. Additional running takeoffs and landings were conducted to and from prepared (paved runways) and unprepared (hard grassy terrain) surfaces. Running takeoffs were accomplished using the technique described in the Aircrew Training Manual (ref 10). Running landings were completed at three progressively higher speeds, qualitatively judged by the pilots to be approximately 30, 45, and 60 knots, respectively. The tail wheel was locked for all running takeoffs and landings. The skis were visually inspected for damage following each running takeoff and landing.

30. Qualitatively there was no perceptible difference between the UH-60A configured with the ski assembly and the UH-60A in the normal utility configuration. Pitch rates and acceleration were similar to the UH-60A in the normal utility configuration during takeoffs. Running landings were firm with no directional control problems noted. The skis were not damaged during any of the takeoffs or landings.

Slope Landing Characteristics

31. The slope landing capabilities of the UH-60A configured with the ski assembly were evaluated at two mission gross weights at the test conditions listed in table 2. The airworthiness release (ref 7) limited the test UH-60A to maximum slopes of 10° left, right, and nose-up and 6° nose-down. The landings and takeoffs were conducted on measured, hard grassy slopes. The main and tail wheel struts were serviced in accordance with the technical manual prior to conducting the test. Representative time history data are presented at figures 48 and 49, appendix E.

32. The slope landings were conducted in accordance with standard pilot techniques as described in the Aircrew Training Manual (ref 10, app A). The parking brake was set and the tail wheel was locked. Coordinated cyclic, collective, and directional inputs were required until the helicopter was firmly positioned on the slope. Once the helicopter was firmly on the slope the cyclic and directional controls were neutralized and

the collective was placed in the full down position. When resting on the slope, aircraft attitudes were measured on the cabin floor using an inclinometer and by reading the pilot and copilot's attitude indicators. The difference between aircraft attitude and measured slope angle was due to differential compression of the gear struts. The aircraft fuselage attitude (collective full down) for each slope orientation is presented as follows:

Table 3. Slope Landing Results

Slope (deg)	Aircraft Fuselage Attitude[1] (deg)	Gross Weight[2]
4.3 right wheel up	5.8 right wheel up	Approximately 16,000 lb
4.3 left wheel up	4.1 left wheel up	
5.4 nose up	4.4 nose up	
7.2 right wheel up	8.3 right wheel up	
6.8 left wheel up	6.5 left wheel up	
6.8 nose up	7.6 nose up	
9.2 right wheel up	10.2 right wheel up	
9.6 left wheel up	10.6 left wheel up	
9.7 nose up	10.8 nose up	
4.3 nose down	4.3 nose down	
6.0 nose down	6.8 nose down	
4.4 right wheel up	6.8 right wheel up	Approximately 20,300 lb
4.3 left wheel up	5.6 left wheel up	
5.4 nose up	5.2 nose up	
6.4 right wheel up	10.1 right wheel up	
6.2 left wheel up	8.4 left wheel up	
8.6 nose up	7.7 nose up	
10.7 right wheel up	15.3 right wheel up	
11.3 left wheel up	12.9 left wheel up	
10.6 nose up	8.8 nose up	
4.3 nose down	4.5 nose down	
5.6 nose down	5.6 nose down	

NOTE:

[1]Inclinometer reading from cabin floor.
[2]Forward longitudinal center of gravity.

33. For left and right cross-slope landings, the upslope main gear and the tail wheel contacted the ground almost simultaneously. Nose-up and down-slope landings required less pilot effort since roll attitude control was not as demanding as it was during the left and right cross-slope landings.

34. When attempting a nose up landing on a slope of 10.6°, at the heavy gross weight, the parking brake would not prevent the main wheels from turning (skis were not contacting the slope). The aircraft rolled down the hill approximately 3 feet prior to the pilot stopping the movement by manually applying pressure to the toe brakes. The following NOTE should be incorporated into the operator's manual.

NOTE

> When attempting a nose up slope landing at gross weights in excess of 16,000 pounds, the parking brake may not hold the aircraft in position. The pilot should be prepared to use the toe brakes.

35. A nose-down landing on a 6° slope was performed. After the tail wheel contacted the ground, the collective was slowly lowered to allow the main gear to contact the ground and the helicopter to settle. A perceptible roll oscillation developed and minor droop stop pounding was encountered. If the collective was either raised to allow the helicopter to again come to a hover, or lowered to allow the helicopter to settle quickly, the roll oscillations and droop stop pounding stopped. The helicopter was controllable throughout the maneuver, but the aft cyclic control margin decreased to less than one-half inch while landing at the higher gross weight. The aircraft was controllable throughout the landings and takeoffs on all slopes tested. The slope landing characteristics were essentially unchanged from the UH-60A in the normal utility configuration as reported in reference 6.

Low-Speed Flight Characteristics

36. The low-speed flight characteristics were evaluated at two mission gross weights at the conditions presented in table 2. Tests were conducted at true airspeeds up to 45 knots in forward and rearward (0° and 180° relative azimuths) and sideward (090°, 270°, and 315° relative azimuths) flight at a wheel height of 30 feet (as measured by the radar altimeter). Surface winds were 5 knots or less and a ground pace vehicle was used as a speed reference. The low speed flight test data are presented in figures 50 through 55, appendix E.

37. Pilot workload (frequency and magnitude of inputs) required to maintain speed, altitude, and heading control during forward and rearward flight was qualitatively assessed as HQRS 3 between 0 and 20 knots true airspeed (KTAS). Above 20 KTAS, the frequency of inputs noticeably decreased, but the overall pilot workload remained HQRS 3. Adequate control margins remained throughout the tested airspeed range during both forward and rearward flight. During forward and rearward flight, the low speed flight characteristics of the UH-60A with the ski assembly installed were similar to that of a UH-60A in the normal utility configuration and are satisfactory.

38. During left sideward flight, the lateral cyclic position cues were noticeably weaker than during right sideward flight. Additionally, during left sideward flight a small band of essentially neutral lateral cyclic control position versus airspeed is indicated between 15 and 30 KTAS. This anomaly was not perceived by the pilot and was not considered objectionable. Stabilator programming began to occur at approximately 15 KTAS during left sideward flight, while the stabilator remained programmed in the full trailing edge down (40°) position during right sideward flight. During left sideward flight, the frequency of control inputs was very high (almost continuous) in all control axes. Adequate control margins remained throughout this evaluation. During left and right sideward flight, the low speed flight characteristics of the UH-60A with the ski assembly installed were similar to that of a UH-60A in the normal utility configuration and are satisfactory.

39. The flight control variations during sideward flight at a relative wind azimuth of 315° were non-linear, but were not objectionable. The non-linearities occurred as the stabilator began to program inconsistently above approximately 15 KTAS. There were adequate control margins throughout the evaluation. Intermittent, variable intensity lateral accelerations referred to as "tail shake" by Sikorsky flight test personnel occurred at a higher frequency and greater magnitude than during the other wind azimuths evaluated. This is characteristic of the UH-60A in the normal utility configuration and not attributable to the ski assembly installation. During sideward flight at a relative wind azimuth of 315°, the low speed characteristics were similar to that of a UH-60A in the normal utility configuration and are satisfactory.

VIBRATION

40. Vibration characteristics obtained during level flight performance tests are presented as a function of airspeed.

Vertical, lateral, and longitudinal acceleration values for frequencies of 1, 4, and 8 per main rotor revolution are shown at the pilot's seat location (figs. 56 through 59, appendix E) and on the cargo compartment floor at fuselage station 345 (figs. 60 through 63). Both normal utility and skis installed aircraft configurations are shown for nominal thrust coefficient ($C_T \times 10^4$) values of 70 and 100. Aircraft vibration characteristics were qualitatively and quantitatively evaluated for the UH-60A configured with the ski assembly as being essentially the same as the UH-60A in the normal utility configuration.

MISCELLANEOUS

41. Several miscellaneous observations were made regarding the ski assembly.

a. With the ski assembly installed, the aircraft jacking points are not accessible. An alternate means of jacking the aircraft with the skis installed should be determined.

b. The tail ski rotates about the tail wheel mount point in flight, with the forward tip of the ski rotating upward approximately four inches from the static position at approximately 130 knots forward airspeed. The tip of the ski rotates downward to the static position as airspeed falls below approximately 100 knots. This movement was not perceived by the pilot and did not affect aircraft pitch attitude during flight.

c. The lock nut torque of the main ski tail wheel must be accurately adjusted such that a lateral force of 3 to 5 pounds on the wheel is required to rotate the wheel. Proper adjustment prevents main ski shimmy during running landings.

d. No maintenance procedure or repair parts manuals are presently available for the UH-60A ski assembly. Maintenance and repair parts manuals pertaining to the ski assembly should be developed for distribution along with the ski assembly.

e. Cabin entry/exit is partially restricted by the installation of the main skis, making the loading and unloading of cargo slightly more difficult. Additionally, the cockpit entry/exit paths are also partially obstructed by the main skis. The following NOTE should be incorporated into the operator's manual.

NOTE

> Cockpit entry/exit paths are partially restricted by the main skis making cockpit entry/exit slightly more difficult. Care should be taken to prevent tripping over the ski. Additionally, the forward half of the cabin entry/exit doors are partially restricted making the loading/unloading of cargo slightly more difficult.

f. Five tail wheel locking pins were bent and subsequently changed during this evaluation. However, upon further investigation it was determined that the tail gear mount bushings and tail wheel locking pin bushings were worn beyond acceptable limits, allowing the gear to vibrate during flight. This factor may have influenced the unexpected high frequency of bent tail wheel locking pins. It is also possible that the increased inertia of the tail wheel assembly due to the tail ski installation caused the increased frequency of bent tail wheel locking pins. An exact cause of this problem was not established.

CONCLUSIONS

GENERAL

42. Based on this evaluation, the following conclusions were reached regarding the installation of the ski assembly on the UH-60A helicopter.

a. The handling qualities of the UH-60A with the ski assembly installed were essentially the same as the UH-60A in the normal utility configuration (para 10).

b. Equivalent flat plate area of the ski assembly was determined to be 3 square feet (para 9).

c. Two previously reported shortcomings and one corresponding specification noncompliance were noted which were not attributed to the installation of the ski assembly (paras 14 and 28).

SHORTCOMINGS

43. The following previously reported shortcomings were again identified.

a. Neutral static longitudinal stability during IRP climbs (para 14).

b. The self-excited aircraft pitch oscillation with the collective control raised sufficiently for the aircraft to be "light" on it's wheels (para 28).

SPECIFICATION COMPLIANCE

44. The UH-60A helicopter with the ski assembly installed failed to meet the following requirement of the PIDS: Paragraph 10.3.3.1.3 - The static longitudinal stability during IRP climbs was neutral instead of positive (para 14).

RECOMMENDATIONS

45. The following recommendations are submitted:

a. The two previously identified shortcomings reported in paragraphs 14 and 28 should be corrected.

b. Maintenance and repair parts manuals pertaining to the ski assembly should be developed for distribution along with the ski assembly (para 41d).

c. An alternate means of jacking the aircraft with the skis installed should be determined (para 41a).

d. The following NOTES should be incorporated into the operator's manual (paras 27, 34, and 41e).

NOTE

When the aircraft is loaded to an aft center of gravity, a tail ski restrainer cable (approximately two inches shorter than the tail ski safety cable) should be attached to both ends of the tail ski spring cylinder to hold the spring compressed during towing.

NOTE

When attempting a nose up slope landing at gross weights in excess of 16,000 pounds, the parking brake may not hold the aircraft in position. The pilot should be prepared to use the toe brakes.

NOTE

Cockpit entry/exit paths are partially restricted by the main skis making cockpit entry/exit slightly more difficult. Care should be taken to prevent tripping over the ski. Additionally, the cabin entry/exit doors are partially restricted making the loading/unloading of cargo slightly more difficult.

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-8, 26 August 1986, subject: Airworthiness and Flight Characteristics Test of a Ski Assembly for the UH-60A Black Hawk Helicopter, Test Request.

2. Prime Item Development Specification, Sikorsky Aircraft Division, DARCOM CP-2222-S1000F, 18 December 1981.

3. Technical Manual, TM 55-1520-237-10, *Operator's Manual, UH-60A Helicopter*, Headquarters Department of the Army, 21 May 1979 with change 41 dated 7 May 1987.

4. Airglas Drawing L20500, Airglas Engineering Co, In., Anchorage, Alaska, Code Identification No. 175641.

5. Final Report, USAAEFA Project No. 81-16, *UH-60A Expanded Gross Weight and Center of Gravity Evaluation*, August 1985.

6. Final Report, USAAEFA Project No. 77-17, *Airworthiness and Flight Characteristics Evaluation UH-60A (Black Hawk) Helicopter*, September 1981.

7. Letter, AVSCOM, AMSAV-E, 9 April 1987, subject: Airworthiness Release for the Conduct of Airworthiness and Flight Characteristics (A&FC) Evaluation of a UH-60A Configured with Airglass Model L20500-00 Snow Ski.

8. Test Plan, AEFA Project No. 86-14, *Airworthiness and Flight Characteristics Test of a Ski Assembly for the UH-60A Black Hawk Helicopter*, November 1986.

9. DOD Flight Information Publication, Flight Information Handbook, *Defense Mapping Agency Aerospace Center*, 18 December 1986.

10. Aircrew Training Manual, *Utility Helicopter, UH-60A*, FC 1-212, dated 31 August 1984.

11. Pamphlet, U.S. Army Material Command, AMC Pamphlet 706-204, *Engineering Design Handbook, Helicopter Performance Testing*, 1 August 1974.

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

APPENDIX B. DESCRIPTION

GENERAL

1. The UH-60A (Black Hawk) is a twin turbine engine, single main rotor helicopter with nonretractable wheel-type landing gear. A movable horizontal stabilator is located on the lower portion of the tail rotor pylon. The main and tail rotor are both four-bladed with a capability of manual main rotor blade and tail pylon folding. The cross-beam tail rotor with composite blades is attached to the right side of the pylon. The tail rotor shaft is canted 20° upward from the horizontal. Primary mission gross weight is 16,260 pounds and maximum alternate gross weight is 20,250 pounds. The UH-60A is powered by two General Electric T700-GE-700 turboshaft engines each having an installed thermodynamic rating (30 minute) of 1553 shaft horsepower (shp) (power turbine speed of 20,900 revolutions per minute) at sea level, standard-day static conditions. Installed dual-engine power is transmission limited to 2828 shp. The aircraft also has an automatic flight control system and a command instrument system. The test helicopter, UH-60A U.S. Army S/N 84-23953, was manufactured by Sikorsky Aircraft Division of United Technologies Corporation and is a production Black Hawk equipped with fixed provision mounting points. The main differences between the test aircraft and a UH-60A in the normal utility configuration are the addition of the ski assembly and an external nose-mounted airspeed boom and the associated special test instrumentation. Photos 1 through 4 show views of the test aircraft with the skis installed. A more complete description of the UH-60A helicopter in the normal utility configuration can be found in reference 2, appendix A.

SKI ASSEMBLY

2. The ski assembly designed for each UH-60A main landing gear is a modification of the Airglas Model L44000-13, CH-47 aft ski. The UH-60A main landing gear skis (photos 5 through 7) are 114.8 inches long by 37.5 inches wide. The ski designed for the UH-60A tail wheel (photo 8) is 55.5 inches long by 32 inches wide. All three skis are constructed of molded fiberglass-reinforced plastic. The skis are mounted to the axle of each respective landing gear by means of a special axle adaptor kit. The initial installation of the adaptor kits on each aircraft requires that the styrofoam inner axle core of the main landing gear axles be removed by means of hand-drilling so as to not score the inside surface of the axle. The adaptor kits may then be removed from the aircraft anytime the ski installation is removed or left in place for ease of subsequent ski installations. A spring cylinder assembly (photo 9) mounted between the associated gear strut and the forward portion of each ski is designed to retain the desired

Photo 1. Front View - UH-60A Helicopter with Skis Installed

Photo 2. Left Quarter View - UH-60A Helicopter with Skis Installed

Photo 3. Left Sid. View - UH-60A Helicopter with Skis Installed

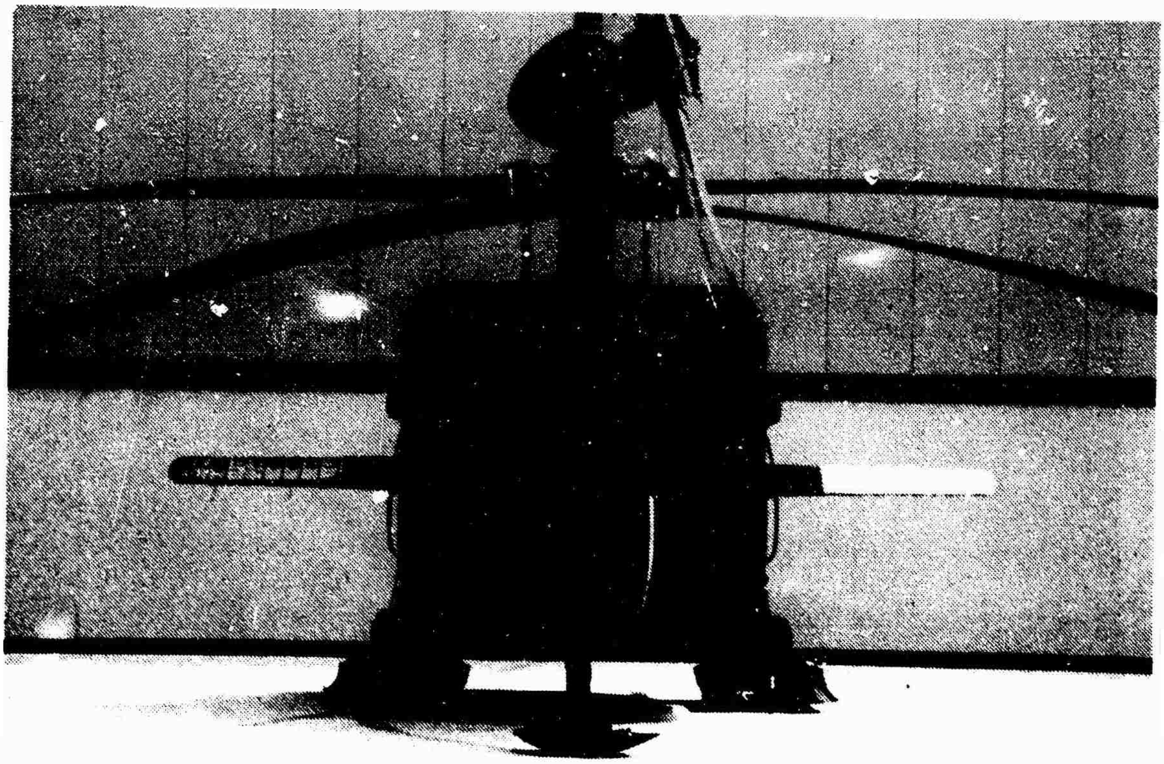


Photo 4. Rear View - UH-60A Helicopter with Skis Installed

Photo 5. Right Side View - UH-60A Main Landing Gear Ski Assembly

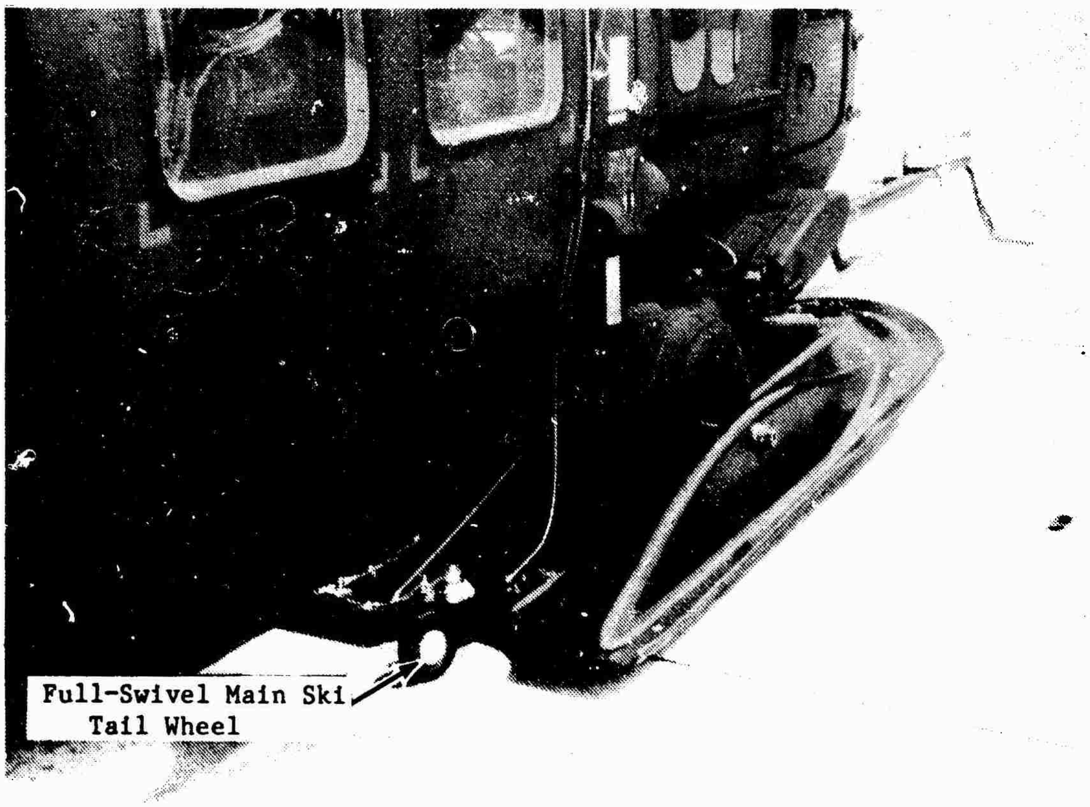


Photo 6. Right Quarter View - UH-60A Main Landing Gear Ski Assembly

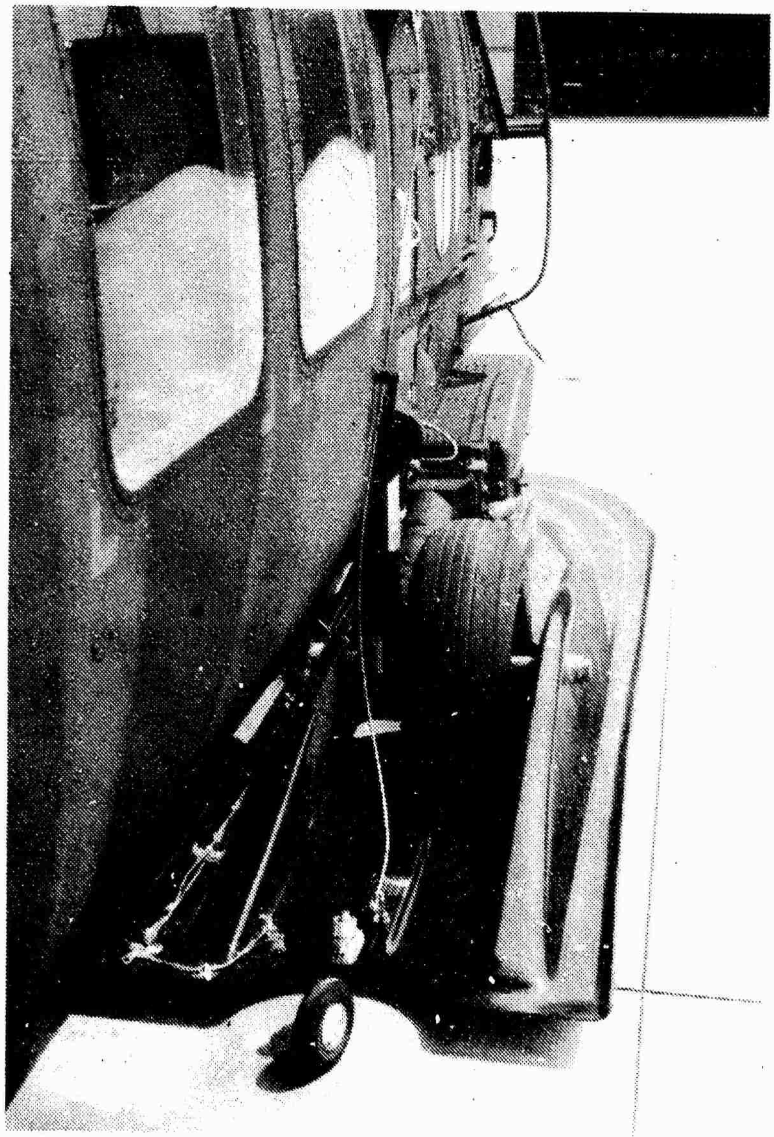


Photo 7. Rear View - UH-60A Main Landing Gear Ski Assembly

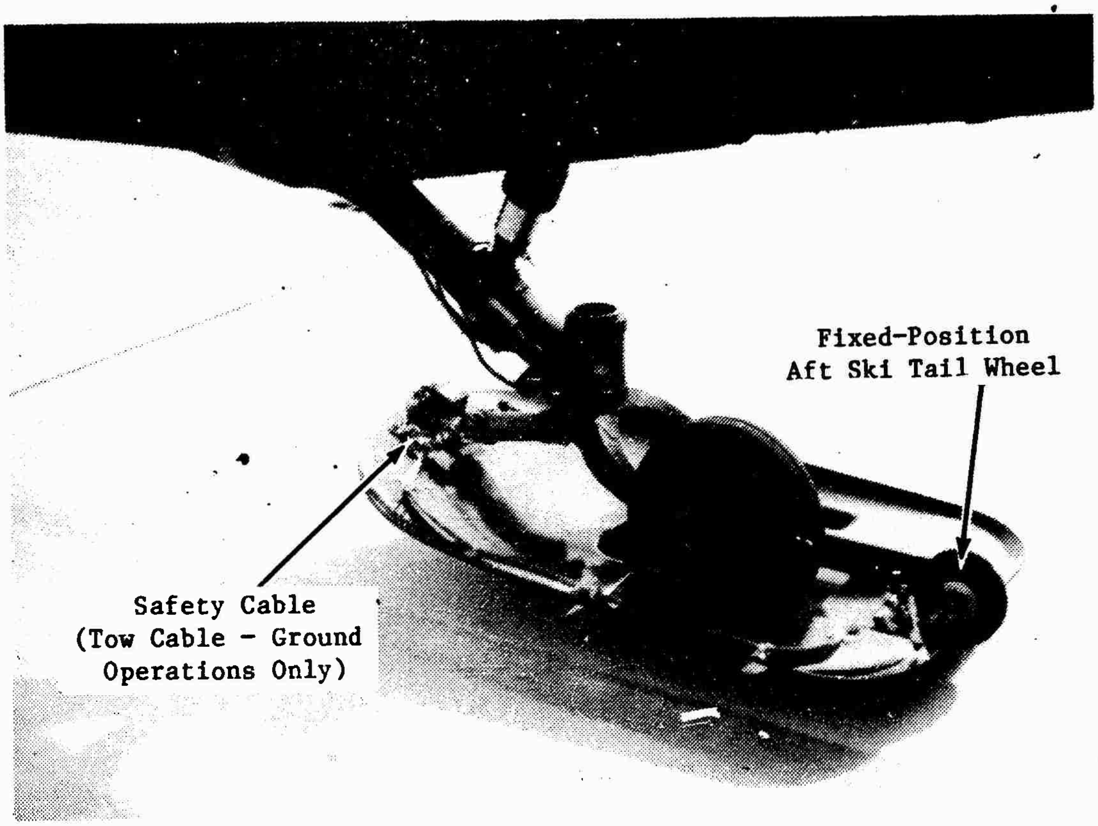


Photo 8. UH-60A Tail Wheel Ski Assembly

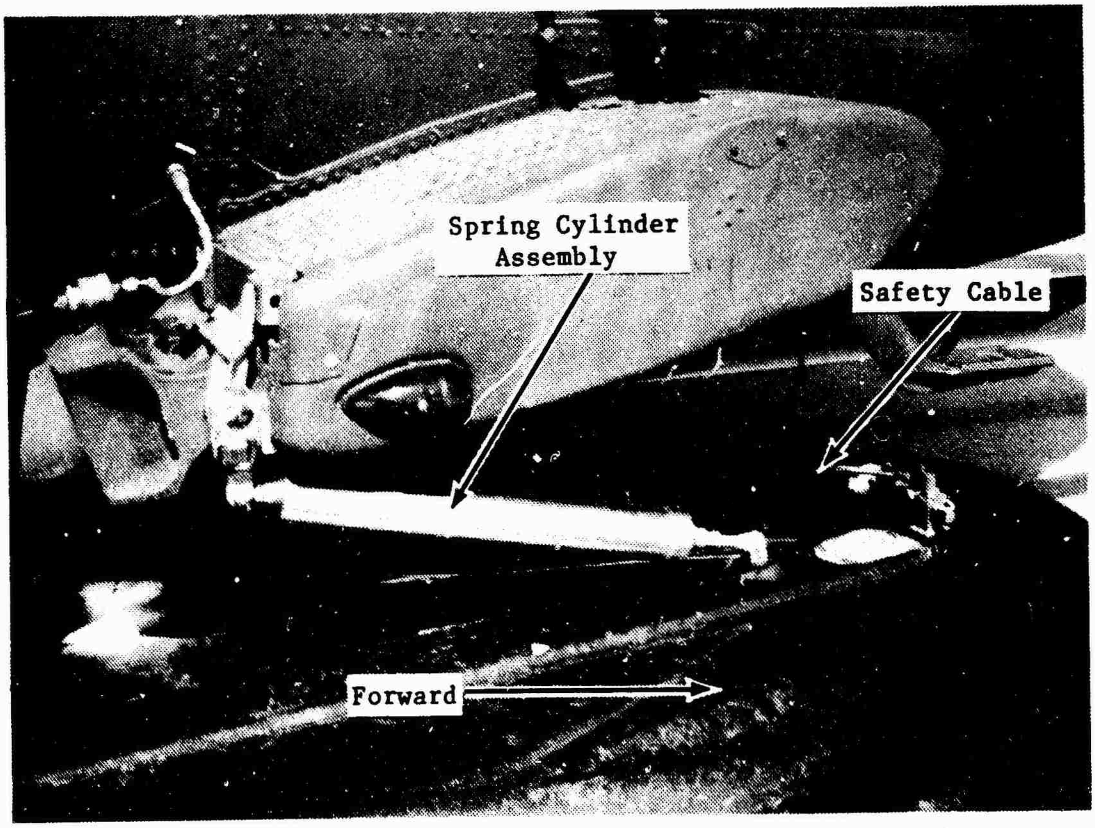


Photo 9. Spring Cylinder Assembly, Main Landing Gear Ski

ski pitch attitude while simultaneously allowing rotational movement of the ski against push and pull forces transmitted through the ski to the spring cylinder assembly. A safety cable (photos 8 and 9) is attached to each attachment point of the spring cylinder assembly to retain the ski in position should the spring cylinder assembly fail in flight. A check cable (photo 5) mounted between the main gear strut and the aft portion of the main skis is designed to maintain a 5° nose-up pitch a attitude on the skis during level flight. A tail ski restrainer cable (approximately 2 inches shorter than the tail ski saftey cable) is attached to both ends of the tail ski spring cylinder to hold the spring compressed during towing (to hold the forward portion of the ski off the ground). Each main landing gear ski incorporates a full swivel tail wheel (photo 6) mounted to the aft end of the ski to hold the aft portion of the ski off the ground during ground operations. The torque applied to the tail wheel locking nut should be checked to insure that a lateral force of 3 to 5 pounds applied to the wheel is required to swivel the wheel. At torque settings lower than 3 pounds, main ski shimmy during running landings was objectionable. The tail wheel ski incorporates a fixed position tail wheel (photo 8) which holds the aft portion of the tail ski off the ground during ground operations. Additional information is contained in Airglas drawing L20500 (ref 4, app A).

MODIFICATIONS

3. Several modifications were made to the test aircraft to accommodate ballast, instrumentation, or for safety purposes. These modifications were not part of the ski assembly or a UH-60A in the normal utility configuration. Four mounting provisions were used to accomodate ballast. These are shown in photos 1 through 3, appendix F. An instrumentation package was installed in the cargo compartment and can be seen in photos 4 and 5. Sikorsky drag estimates for the external items (photos 6 through 10) totalled 3.04 square feet of equivalent flat plate area. Each item is listed below:

ITEM

Standard size tail rotor slip ring
Medium size main rotor slip ring with cover
Nose boom
Tail-mounted TM antennas (2)
Belly-mounted TM antenna
Main rotor instrumentation

Ambient air temperature sensor
Emergency crew door handles (2)

APPENDIX C. INSTRUMENTATION

GENERAL

1. The test instrumentation was installed, calibrated and maintained by Sikorsky Aircraft personnel. A test boom, with a swiveling pitot-static tube and angle-of-attack and sideslip vanes, was installed at the nose of the aircraft (photo 8, app F). Three telemetry antennas were installed. Two were mounted to the top left side of the tail boom and one was mounted on the belly of the aircraft just forward of the tail boom (photo 9). Slip ring assemblies were installed on the main and tail rotor shafts (photos 6 and 7). All other instrumentation was installed inside the test aircraft (photos 3, 4, and 5). Data were obtained from calibrated instrumentation and displayed or recorded as indicated below.

Pilot Panel

Airspeed (boom)
Altitude (boom)
Rate of climb (boom)
Rotor speed
Engine torque* **
Turbine gas temperature* **
Power turbine speed (Np)* **
Gas producer speed (Ng)* **
Control positions
    Longitudinal
    Lateral
    Directional
    Collective
Horizontal stabilator position
Angle of sideslip

Copilot Panel

Airspeed*
Altitude*
Rotor speed*
Engine torque* **
Fuel remaining* **
Total air temperature
Instrumentation controls
Run number
Event switch

*Ship's system
** Both engines

2. Parameters recorded on board the aircraft in pulse code modulation format and available for telemetry include the following:

Airspeed (boom)
Altitude (boom)
Airspeed (ship's)
Altitude (ship's)
Radar altimeter (low range)
Total air temperature
Rotor speed
Gas generator speed**
Power turbine speed**
Engine fuel flow**
Engine fuel temperature**
Engine output shaft torque**
Turbine gas temperature**
Longitudinal acceleration at the cg
Lateral acceleration at the cg
Normal acceleration at the cg
Stabilator position
Control positions
    Longitudinal
    Lateral
    Directional
    Collective
Aircraft Attitude
    Pitch
    Roll
    Heading
Angular Acceleration
    Pitch
    Roll
    Yaw
SAS output position
    Longitudinal
    Lateral
    Directional
Main rotor shaft torque
Tail rotor shaft torque
Tail rotor impressed pitch (blade angle at 0.75 blade span)
Angle of sideslip
Angle of attack
Time of day
Run number
Pilot event switch

**Both engines

3. Vibration was measured in the following locations and directions and recorded in frequency modulation format onboard the aircraft:

Vertical pilot seat
Lateral pilot seat
Longitudinal pilot seat
Vertical copilot seat
Lateral copilot seat
Lateral pilot floor
Vertical copilot floor
Vertical pilot instrument panel
Vertical copilot instrument panel
Center of gravity vertical
Center of gravity lateral
Center of gravity longitudinal
No. 1 engine exhaust frame vertical
No. 2 engine exhaust frame horizontal
No. 1 engine front frame longitudinal
No. 2 engine front frame longitudinal
Vertical right main ski forward
Lateral right main ski forward
Vertical right main ski aft
Lateral right main ski aft
Vertical tail ski forward
Lateral tail ski forward
Vertical tail ski aft
Lateral tail ski aft

TEST BOOM AIRSPEED SYSTEM

4. The test boom airspeed system mounted at the nose of the test aircraft provided measurements of airspeed and altitude. Sensors for angles of attack and sideslip were also mounted on the test boom (photo 8, app F). The tip of the swiveling pitot-static tube was 79.6 inches forward of the nose of the aircraft (fuselage station 97), 25.7 inches to the right of the aircraft reference buttline, and 7 inches below the forward avionics bay floor, waterline 208.

5. The test boom airspeed system along with the ship's standard systems were calibrated in level flight (normal utility configuration) using a calibrated trailing bomb and Sikorsky's ground speed course to determine the position error during the UH-60A VOLCANO Preliminary Airworthiness Evaluation, AEFA Project No. 86-10 in February 1987. This same data was utilized for the ski assembly evaluation. The position error of the ship's airspeed

system and the boom airspeed system (normal utility configuration) is presented in figures 1 and 2.

ENGINE CALIBRATION

6. Calibrations of the engine torque sensor systems were conducted by the engine manufacturer, General Electric. Figures 3 and 4 present the calibrations used to determine engine power.

SPECIAL EQUIPMENT

Weather Station

7. A portable weather station consisting of an anemometer, sensitive temperature gauge, relative humidity sensor and barometer, was used to record wind speed, wind direction, ambient temperature and humidity and pressure altitude at 50 feet above ground level during the low airspeed handling qualities tests.

Ground Pace Vehicle

8. Pace vehicle speedometers were calibrated by Sikorsky personnel. The pace vehicles were used to establish precise ground speed during the low airspeed handling qualities tests.

FIGURE 1

SHIP AIRSPEED CALIBRATION

UH-60A USA S/N 84-23953

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TEST METHOD
○	15270	350.6	0.2	3350	13.5	TRAILING BOMB
△	18600	350.6	0.2	6200	17.5	TRAILING BOMB
⊡	17500	350.0	0.2	-10	16.0	GRND SPD CRSE

NOTES:
1. NORMAL UTILITY CONFIGURATION
2. LEVEL FLIGHT
3. BALL CENTERED TRIM CONDITION
4. MAIN ROTOR SPEED=258 RPM

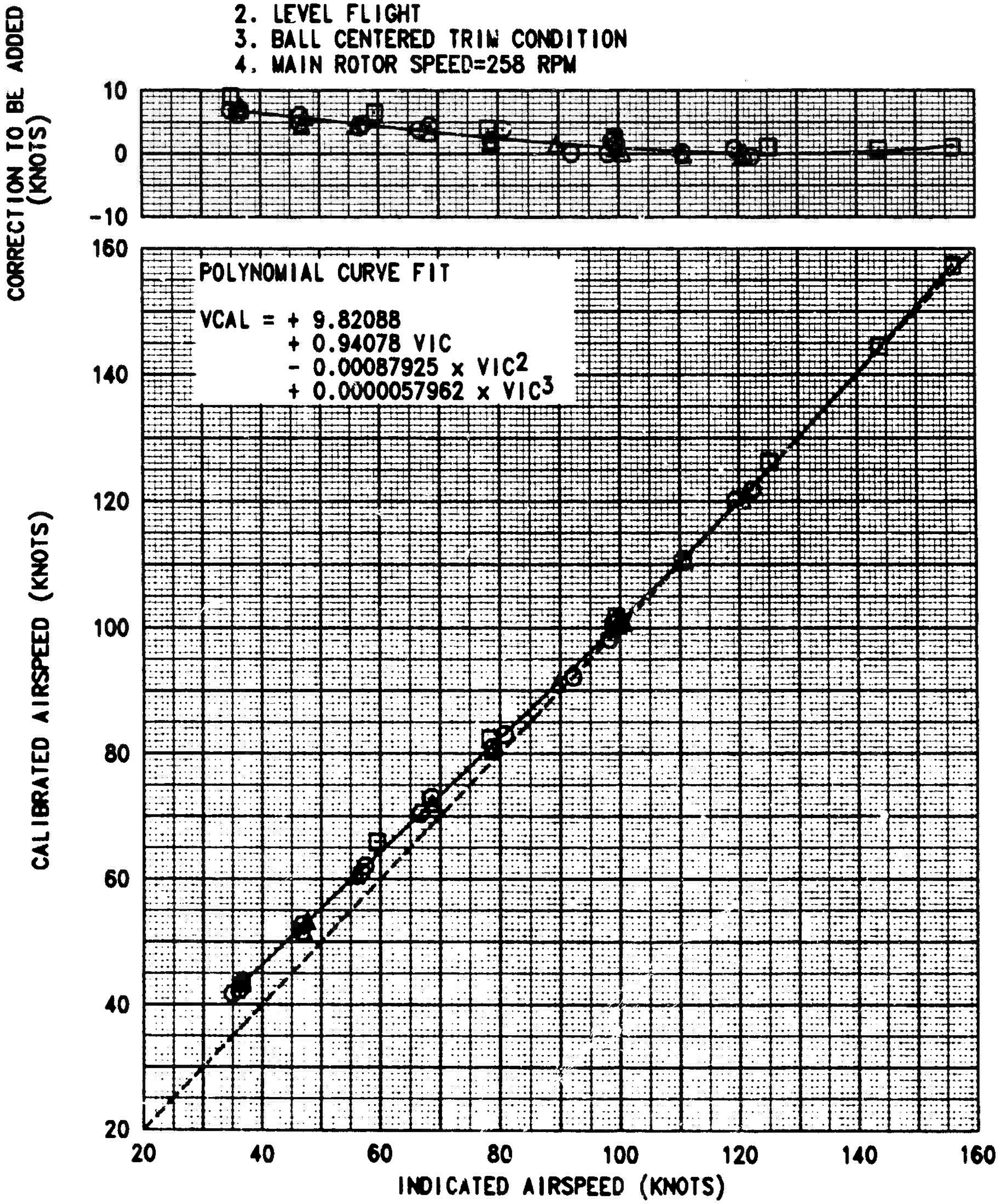


FIGURE 2

BOOM AIRSPEED CALIBRATION

UH-60A USA S/N 84-23953

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TEST METHOD
○	15270	350.6	0.2	3350	13.5	TRAILING BOMB
△	18600	350.6	0.2	6200	17.5	TRAILING BOMB
□	17500	350.0	0.2	-10	16.0	GRND SPD CRSE

NOTES:
1. NORMAL UTILITY CONFIGURATION
2. LEVEL FLIGHT
3. BALL CENTERED TRIM CONDITION
4. MAIN ROTOR SPEED=258 RPM

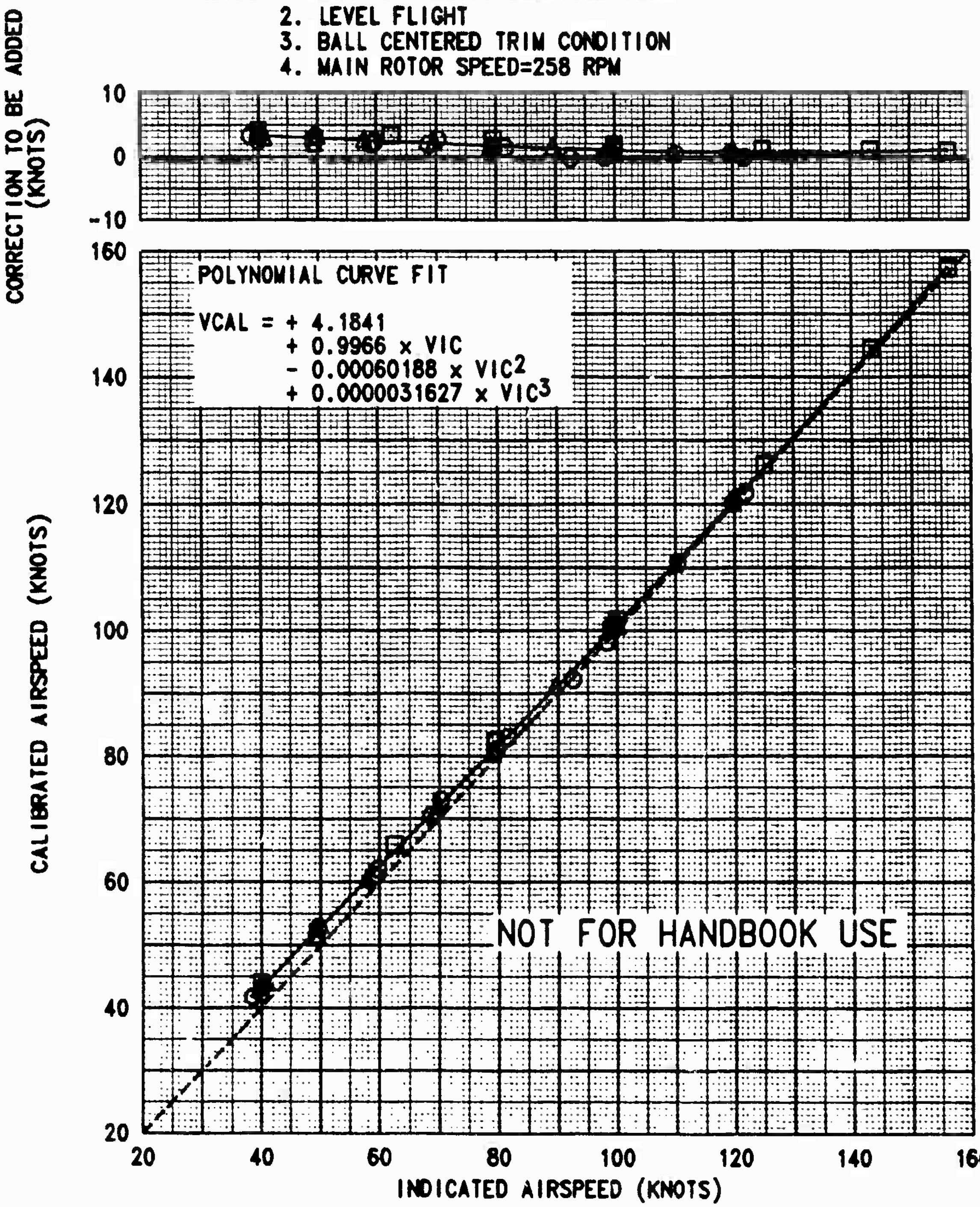


FIGURE 3
ENGINE TORQUEMETER CALIBRATION
UH-60A USA S/N 84-23953
T700-GE-700 S/N 306625

NOTES: 1. NUMBER ONE ENGINE
2. POWER TURBINE SPEED = 20,900 RPM
3. DATA OBTAINED FROM G E ENGINE PRODUCTION RATING SHEET

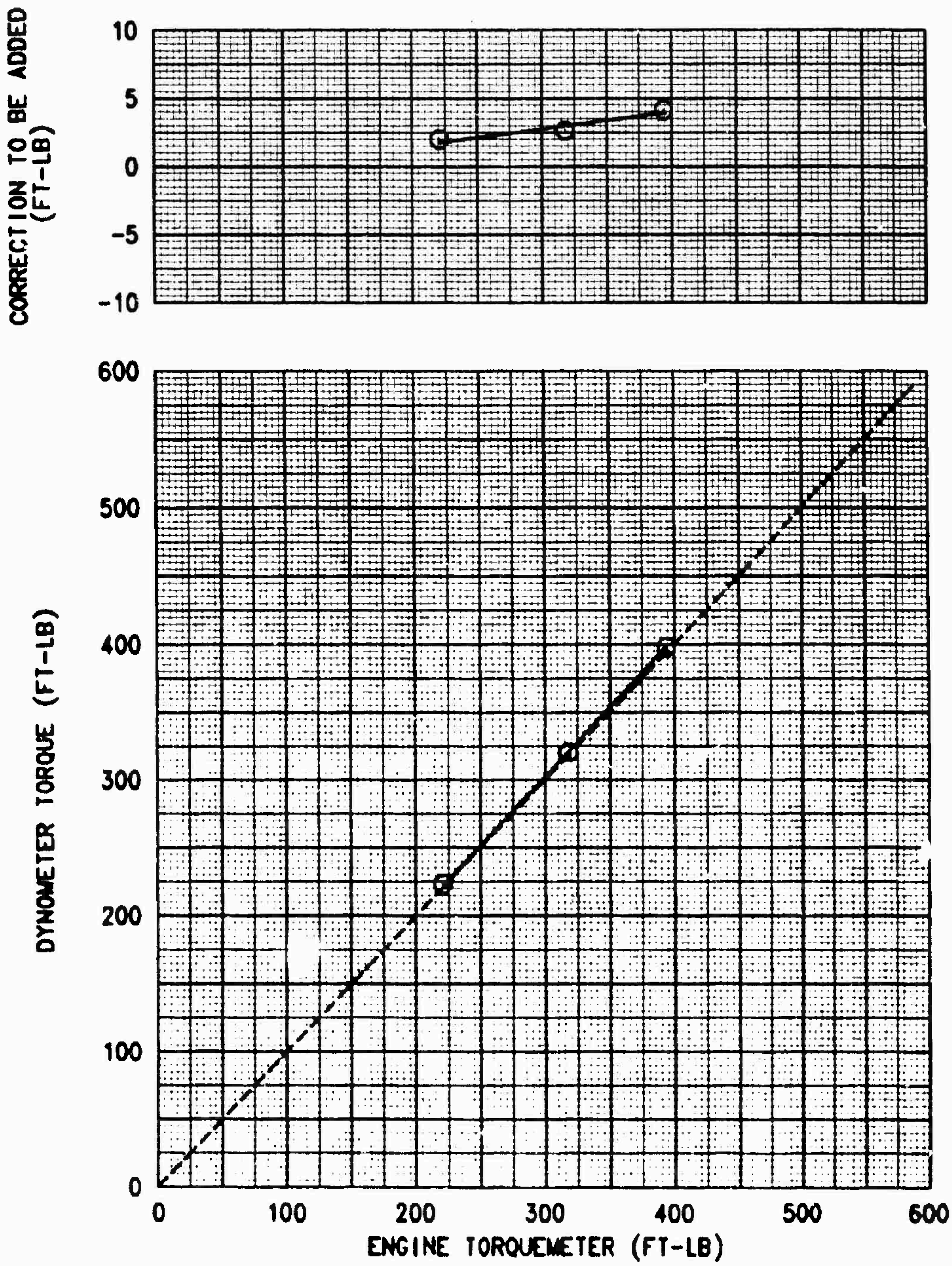


FIGURE 4

ENGINE TORQUEMETER CALIBRATION

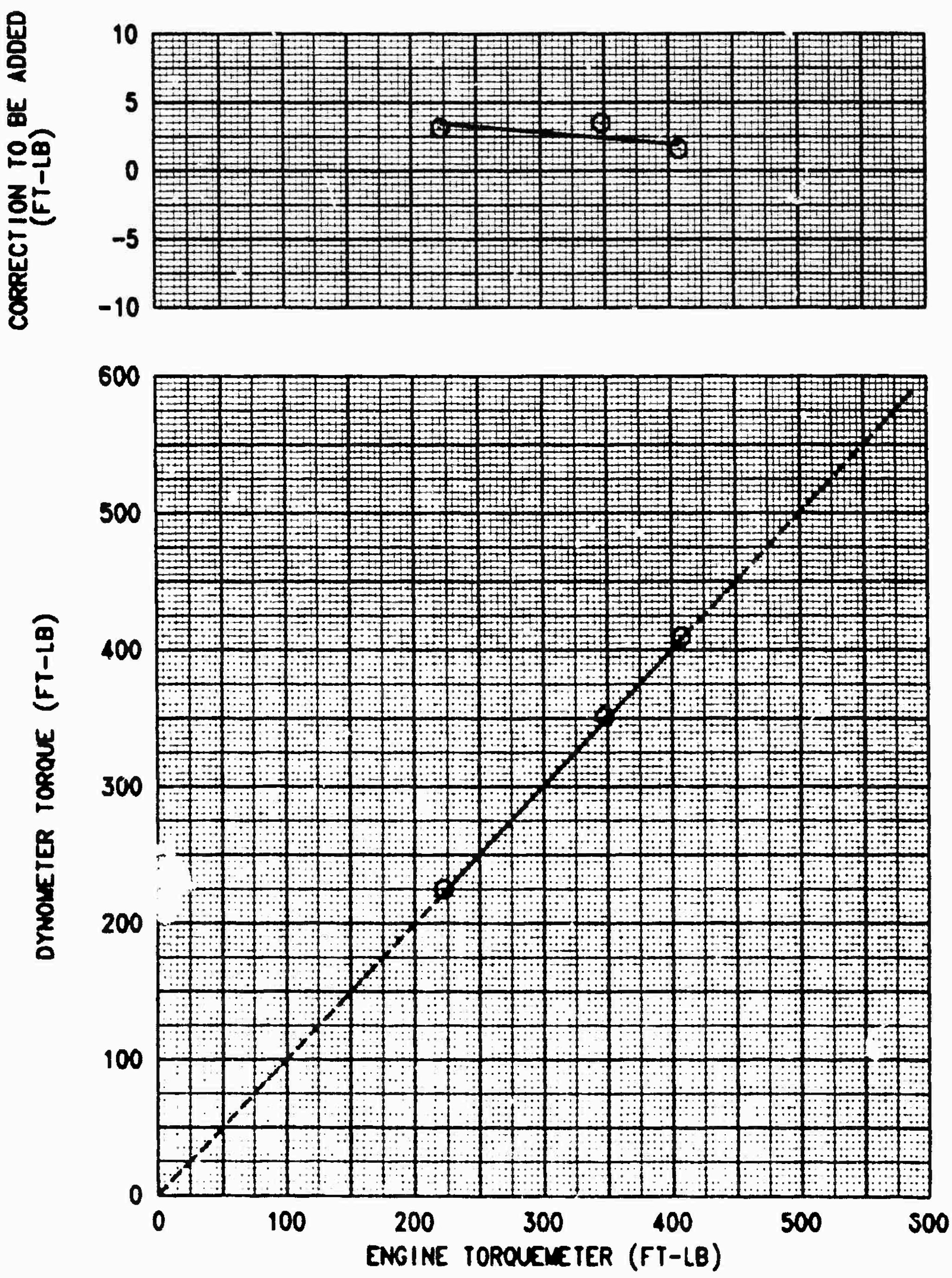
UH-60A USA S/N 84-23953

T700-GE-700 S/N 306629

NOTES: 1. NUMBER TWO ENGINE

2. POWER TURBINE SPEED = 20,900 RPM

3. DATA OBTAINED FROM G E ENGINE PRODUCTION RATING SHEET



APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

AIRCRAFT RIGGING

1. Prior to the start of testing, a flight controls engineering rigging check was performed on the main and tail rotors by Sikorsky Aircraft and monitored by the U.S. Army Aviation Engineering Flight Activity. The stabilator control system was also checked to ensure compliance with the production stabilator schedule. The rigging data are presented in table 1.

AIRCRAFT WEIGHT AND BALANCE

2. The test aircraft was weighed in both the normal utility configuration and with the ski assembly installed, with full oil and all fuel drained, all ballast removed, and test instrumentation system and ballast mounting provisions installed. The initial weight of the aircraft in the normal utility configuration was 12,941 pounds with a longitudinal center of gravity (cg) located at fuselage station 357.9 and a mid lateral cg. Installation of the ski assembly increased the empty weight of the aircraft by 362 lb. The fuel weight for each performance test flight was determined by pre- and post-flight aircraft weighings, fuel flowmeter instrumentation, and fuel specific gravity measurements.

PERFORMANCE

General

3. Performance data were obtained using the basic methods described in Army Material Command Pamphlet AMCP 706-204 (ref 11, app A). Level flight performance and control positions in level flight were obtained in coordinated (ball-centered) flight. Referred rotor speed was maintained constant for all performance tests at 258 rpm. Longitudinal center of gravity (cg) was allowed to vary ± 1.5 inch during each test flight, but for each data set (consisting of several flights in the same aircraft configuration at different thrust coefficient values) the average cg location was maintained constant near the proposed mission value. The data were analyzed to determine the power required difference between the UH-60A in the normal utility configuration and the UH-60A configured with the ski assembly in terms of change in equivalent flat plate area (ΔF_e).

Table 1. Main and Tail Rotor Rigging Information

Main Rotor Rigging

Flight Control Position				Blade Angle[1] (deg)				Flight Control Position (deg)		
Long	Lat	Coll	Pedal	0	90	180	270	Long Cont[2]	Lat Cont[3]	Coll Cont[4]
Aft	*[5]	*	*		20.0		-4.0	-12.0		
Block[6]	*	*	*		11.1		5.5	- 2.8		
Block	*	High	*	19.7	16.2	11.2	14.9	- 0.7	-4.3	15.5
Block	*	Low	*	2.1	5.4	-2.1	-6.0	- 5.7	-2.1	0.2
Aft	*	High	*		26.9		4.8	-11.2		
Fwd	Left	Low	*	8.2	-11.9	-8.3	11.0	11.5	-8.3	-0.3
Block	*	*	Right		6.7		9.6	1.5		
Block	*	*	Left		15.2		0.3	- 7.5		
Fwd	*	*	Right		-10.0		25.4	17.7		
Aft	Left	*	Left	15.8	19.6	-0.8	-4.5	-12.1	-8.3	7.5
Fwd	Right	*	Left	2.0	-5.2	13.9	20.4	12.8	6.0	7.8
Aft	*	High	Left		26.8		4.3	-11.3		
Fwd	*	High	Right		-1.0		31.9	16.5		
Fwd	Right	High	Left	9.9	-1.6	20.9	32.0	16.8	5.5	15.3
Aft	Left	High	Right	24.0	22.9	8.2	9.1	-6.9	-7.9	16.1
Aft	Right	Low	Right	-6.9	10.1	7.1	-10.3	-9.9	7.2	-0.3
Aft	Left	Low	Left	6.8	9.5	-8.5	-10.9	-10.2	-7.7	-0.6

Tail Rotor Rigging

Flight Control Position		Blade Angle (deg)[7]
Collective	Pedal	
*	Left	15.7
*	Right	-15.4
*	*	0.5
Low	*	-7.3
High	Left	15.8
High	Right	-6.0
Low	Right	-15.9
Low	Left	7.3

NOTES:

[1]Measured on the Black Blade at the cuff.
[2]270° reading minus 90° reading divided by 2.
[3]180° reading minus 0° reading divided by 2.
[4]Sum of all four readings divided by 4.
[5]* Indicates appropriate control was pinned at a rigged position.
[6]Indicates a block was inserted between the aft longitudinal control stop and the cyclic control such that no limiters are contacted to determine longitudinal to collective coupling.
[7]Measured on the Blue Blade at the cuff.

4. Helicopter performance was generalized through the use of non-dimensional coefficients as follows using the 1968 U.S. Standard Atmosphere:

a. Coefficient of Power (C_P):

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

b. Coefficient of Thrust (C_T):

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

c. Advance Ratio (μ):

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

Where:

SHP = Engine output shaft horsepower (both)
ρ = Ambient aft density (lb-sec^2/ft^4)
A = Main rotor disc area = 2262.03 ft^2
Ω = Main rotor angular velocity (radians/sec)
R = Main rotor radius = 26.833 ft
GW = Gross weight (lb)

$$V_T = \text{True airspeed (kt)} = \frac{V_E}{1.6878\sqrt{\rho/\rho_o}}$$

1.6878 = Conversion factor (ft/sec-kt)
ρ_o = 0.0023769 (lb-sec^2/ft^4)

5. The engine output shaft torque was determined by use of engine torque sensors. The power turbine shaft contains a torque sensor tube that mechanically displays the total twist of the shaft. A concentric reference shaft is secured by a pin at the front end of the power turbine drive shaft and is free to rotate relative to the power turbine shaft at the rear end. The relative

rotation is due to transmitted torque, and the resulting phase angle between the reference teeth on the two shafts is picked up by the torque sensor. This torque sensor was calibrated in a test cell by the engine manufacturer. The output from the engine torque sensor was recorded by the on-board data recording system. The output SHP was determined from the engine's output shaft torque and rotational speed by the following equation:

$$SHP = \frac{2\pi Q(Np)}{33,000} \qquad (4)$$

Where:

Q = Engine output shaft torque (ft-lb)
Np = Engine output shaft rotational speed (rpm)

Level Flight Performance

6. Each speed power data set was flown in ball-centered flight by reference to the ship's turn and slip indicators at a predetermined thrust coefficient (C_T) and referred rotor speed ($N_R/\sqrt{\theta}$). Both the pilot's and copilot's turn and slip indicators were checked for alignment with the aircraft positioned in a level attitude on the ground. To maintain the ratio of gross weight to pressure ratio (W/δ) constant, altitude was increased as fuel was consumed. To maintain $N_R/\sqrt{\theta}$ constant, rotor speed was varied as appropriate for the ambient air temperature. Corrections to power required were made for the installation of test instrumentation. The power consumption for the electrical operation of the instrumentation equipment was measured and determined to be 0.76 shaft horsepower (shp) and subtracted from the power required data. The effects of the external instrumentation and nonstandard aircraft equipment were estimated by the contractor to be the equivalent of 3.04 square feet of equivalent flat plate area.

7. The nondimensional coefficients (equations 1 through 3) can be expressed in terms of referred rotor speed as follows:

$$C_P = \frac{SHP\ (478935.3)}{\delta\sqrt{\theta}\left(\frac{N_R}{\sqrt{\theta}}\right)^3 (\rho_o A R^3)} \tag{5}$$

$$C_T = \frac{GW\ (91.19)}{\delta\left(\frac{N_R}{\sqrt{\theta}}\right)^2 (\rho_o A R^2)} \tag{6}$$

$$\mu = \frac{V_T\ (16.12)}{(R\sqrt{\theta})\left(\frac{N_R}{\sqrt{\theta}}\right)} \tag{7}$$

Test-day level flight data were corrected to standard day conditions by the following equations:

$$SHP_s = SHP_t \left(\frac{P_s}{P_t}\right)\left(\frac{N_{R_s}}{N_{R_t}}\right)^3 \tag{8}$$

$$V_{T_s} = V_{T_t}\left(\frac{N_{R_s}}{N_{R_t}}\right) \tag{9}$$

Where:

Subscript t = Test day
Subscript s = Standard day

$$\delta = \text{Pressure ratio} = 1 - \left(\frac{H_p}{145442.15}\right)^{5.255863}$$

$$\theta = \text{Temperature ratio} = \frac{T_A + 273.15}{288.15}$$

T_A = Ambient air temperature (°C)
N_R = Main rotor speed (rev/min)
478935.3 = Conversion factor (ft-lb-sec^2-rev^3/min^3-SHP)
91.19 = Conversion factor (sec^2-rev^2/min^2)
$\rho = \rho_o \times \sigma$
$\sigma = \delta / \theta$
16.12 = Conversion factor (ft-rev/min-kt)
ΔF_e = Change in equivalent flat plate area (ft^2)

Test data corrected for instrumentation electrical power consumption and corrected to standard altitude and ambient temperature are presented in figures 3 through 8, appendix E.

8. Changes in engine power coefficient due to changes in equivalent flat plate area were determined using the following equation:

$$\Delta F_e = \frac{\Delta C_p (2A)}{\mu^3} \quad (10)$$

The data obtained in the normal utility configuration were analyzed by use of a simulated three dimensional plot (C_T and μ versus C_P) for each configuration. The reduction of this simulated three dimensional plot to a family of curves of C_T versus Cp, for a constant μ value, allows determination of the power required as a function of airspeed for any value of C_T. The data obtained in both aircraft configurations were compared to determine change in the equivalent flat plate area using equation 10.

HANDLING QUALITIES

9. Handling qualities data were evaluated using standard test methods described in Naval Air Test Center Flight Test Manual, FTM No. 101 (ref 12). A Handling Qualities Rating Scale (HQRS) (fig. 1) was used to augment pilot comments regarding aircraft handling qualities.

VIBRATION

10. A Vibration Rating Scale (VRS) (fig. 2) was used to augment pilot comments relative to aircraft vibrations.

DEFINITION

11. Results were categorized as shortcomings in accordance with the following definition.

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 usability of the material or end product.

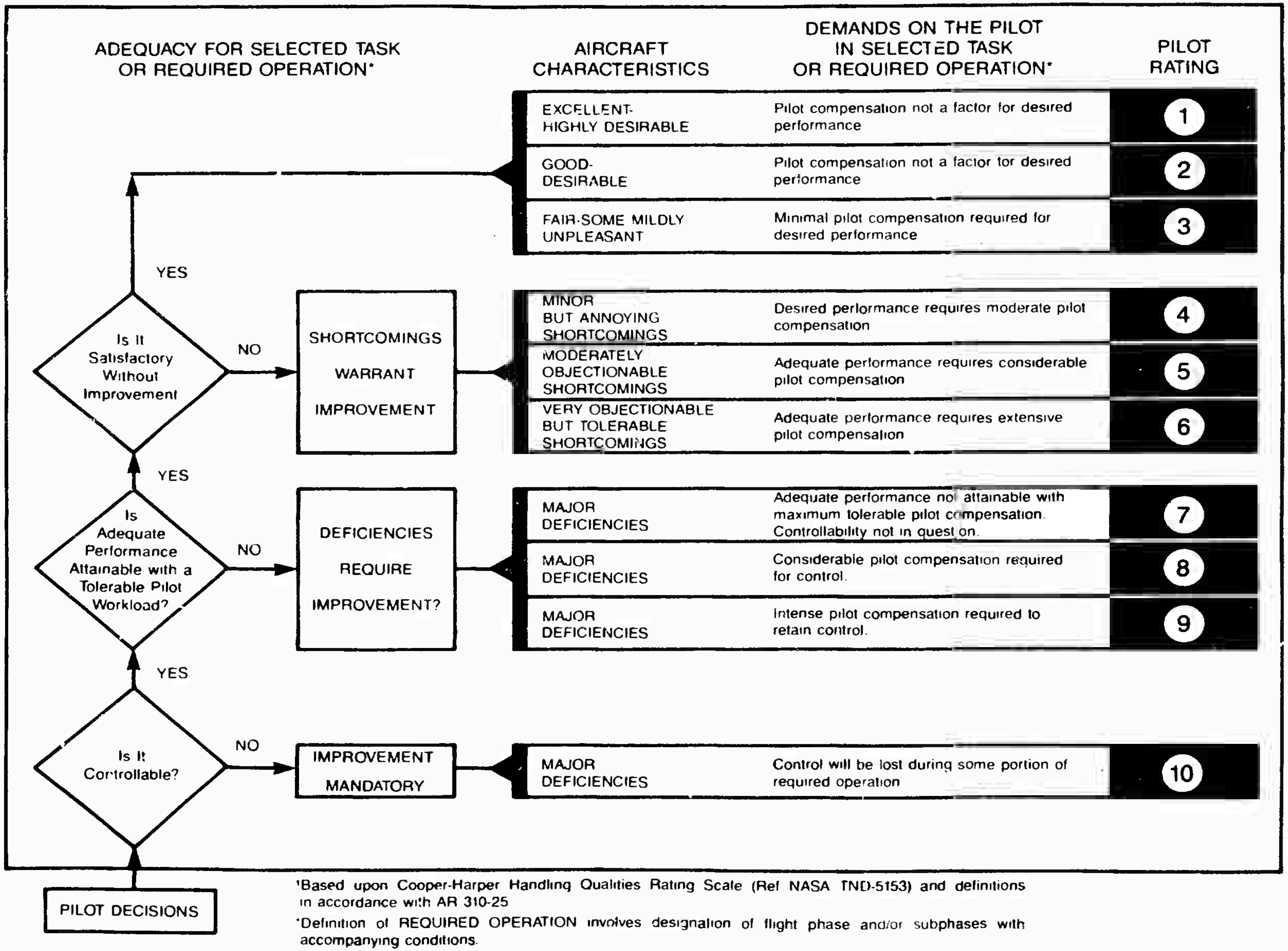


Figure 1. Handling Qualities Rating Scale

DEGREE OF VIBRATION	DESCRIPTION[1]	PILOT RATING
No vibration		0
Slight	Not apparent to experienced aircrew fully occupied by their tasks, but noticeable if their attention is directed to it or if not otherwise occupied.	1, 2, 3
Moderate	Experienced aircrew are aware of the vibration but it does not affect their work, at least over a short period.	4, 5, 6
Severe	Vibration is immediately apparent to experienced aircrew even when fully occupied. Performance of primary task is affected or tasks can only be done with difficulty.	7, 8, 9
Intolerable	Sole preoccupation of aircrew is to reduce vibration level.	10

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

Figure 2. Vibration Rating Scale

APPENDIX E. TEST DATA

INDEX

FIGURE 1
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

NOTES:
1. NORMAL UTILITY CONFIGURATION
2. BALL CENTERED TRIM CONDITION
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. REFERRED ROTOR SPEED = 258 RPM
5. POINTS DERIVED FROM FIGURES 4 THRU 7

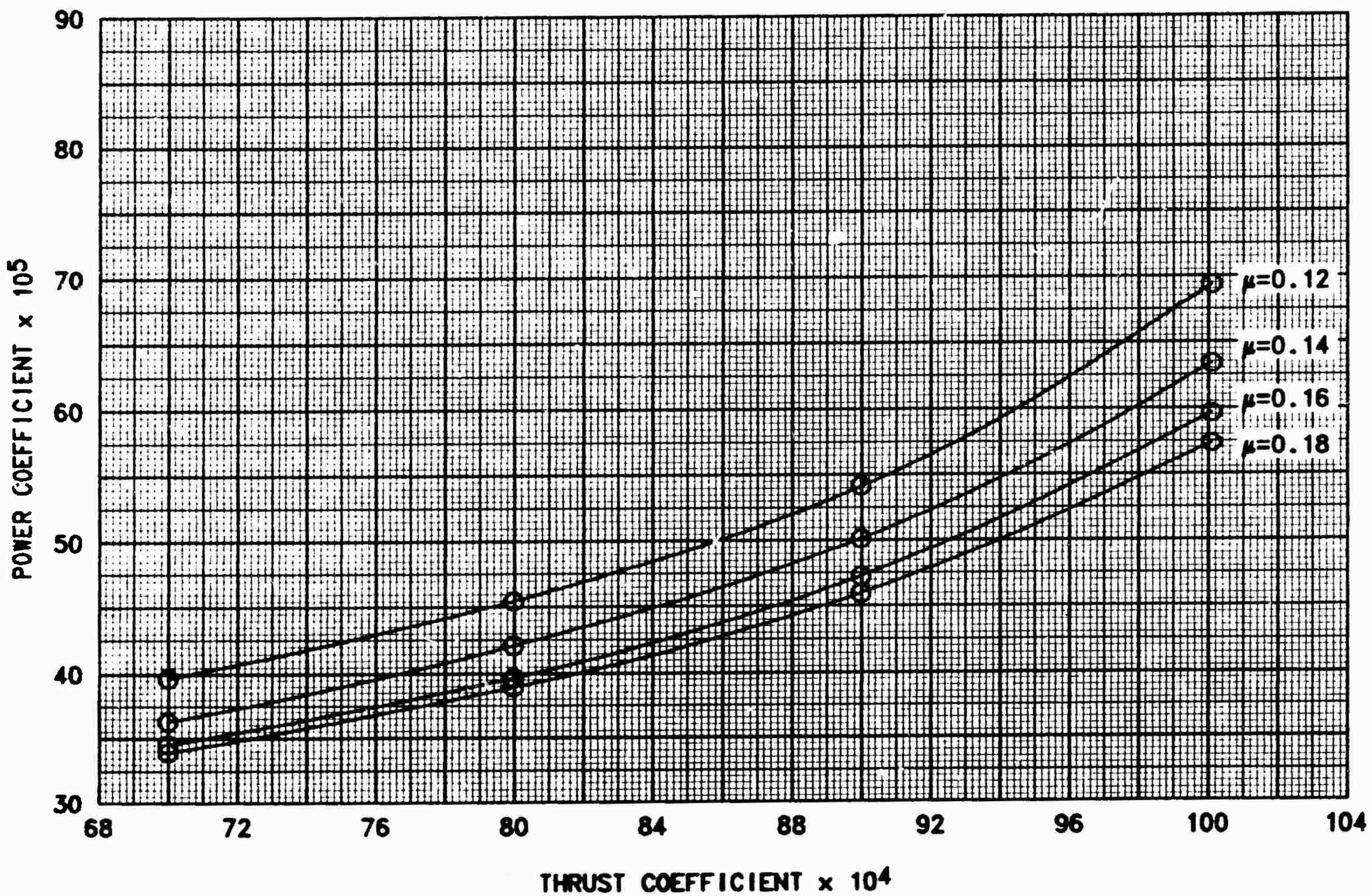


FIGURE 2
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

NOTES:
1. NORMAL UTILITY CONFIGURATION
2. BALL CENTERED TRIM CONDITION
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. REFERRED ROTOR SPEED = 258 RPM
5. POINTS DERIVED FROM FIGURES 4 THRU 7

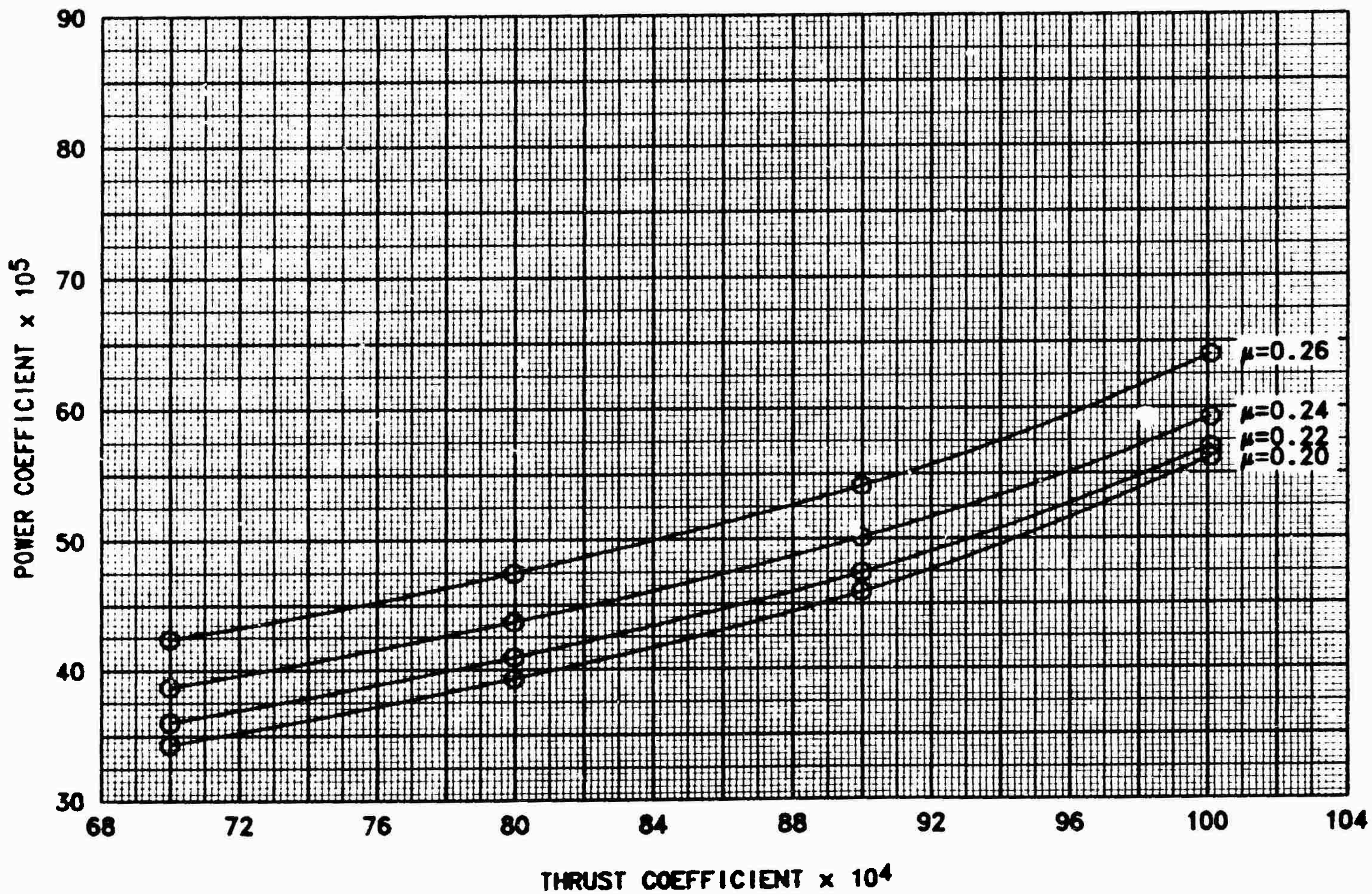


FIGURE 3
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

NOTES: 1. NORMAL UTILITY CONFIGURATION
2. BALL CENTERED TRIM CONDITION
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. REFERRED ROTOR SPEED = 258 RPM
5. POINTS DERIVED FROM FIGURES 4 THRU 7

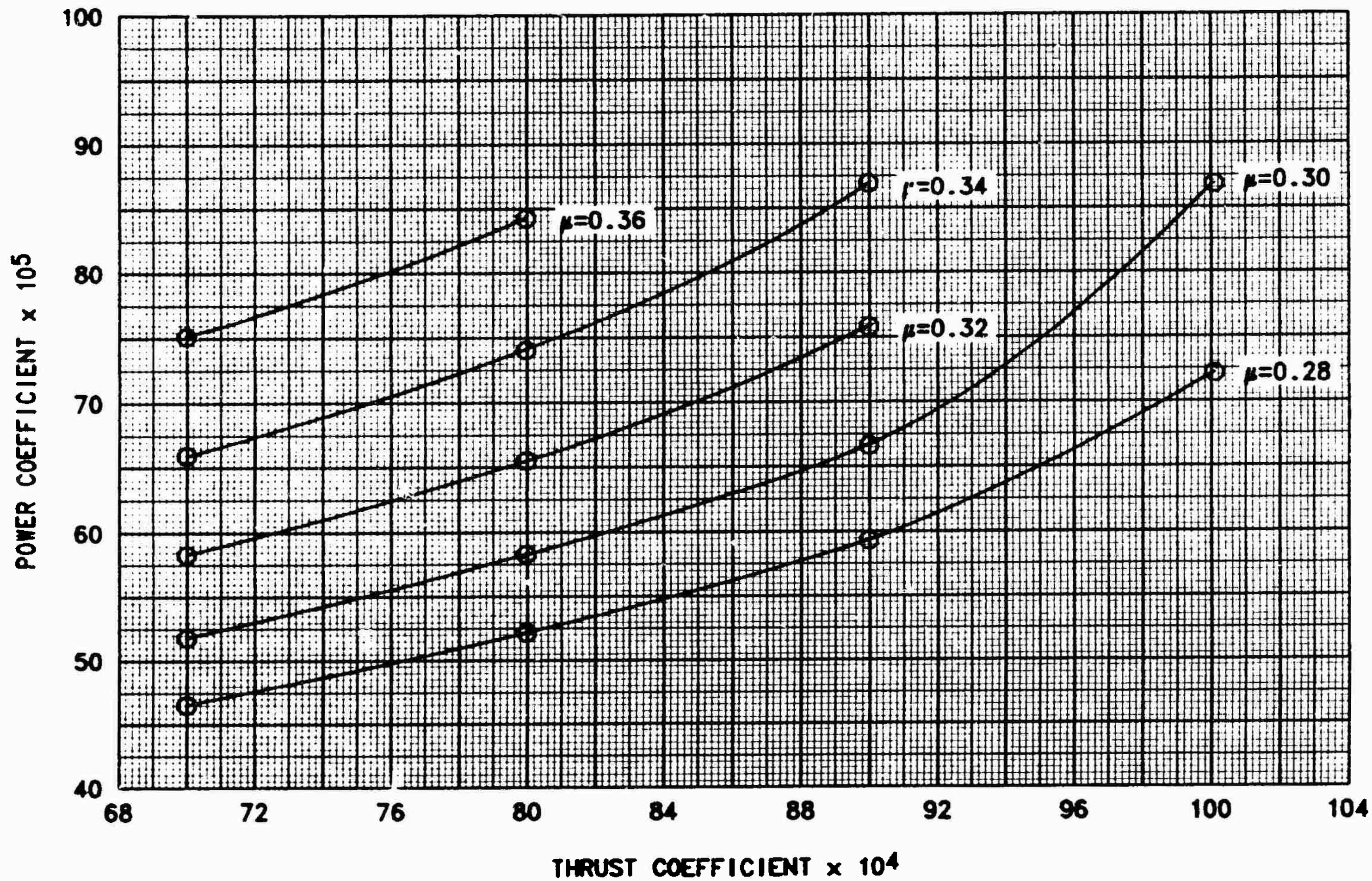


FIGURE 4
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18540	346.5(FWD)	0.2(RT)	1610	10.5	257.8	0.006999

NOTES:
1. NORMAL UTILITY CONFIGURATION
2. BALL CENTERED TRIM CONDITION

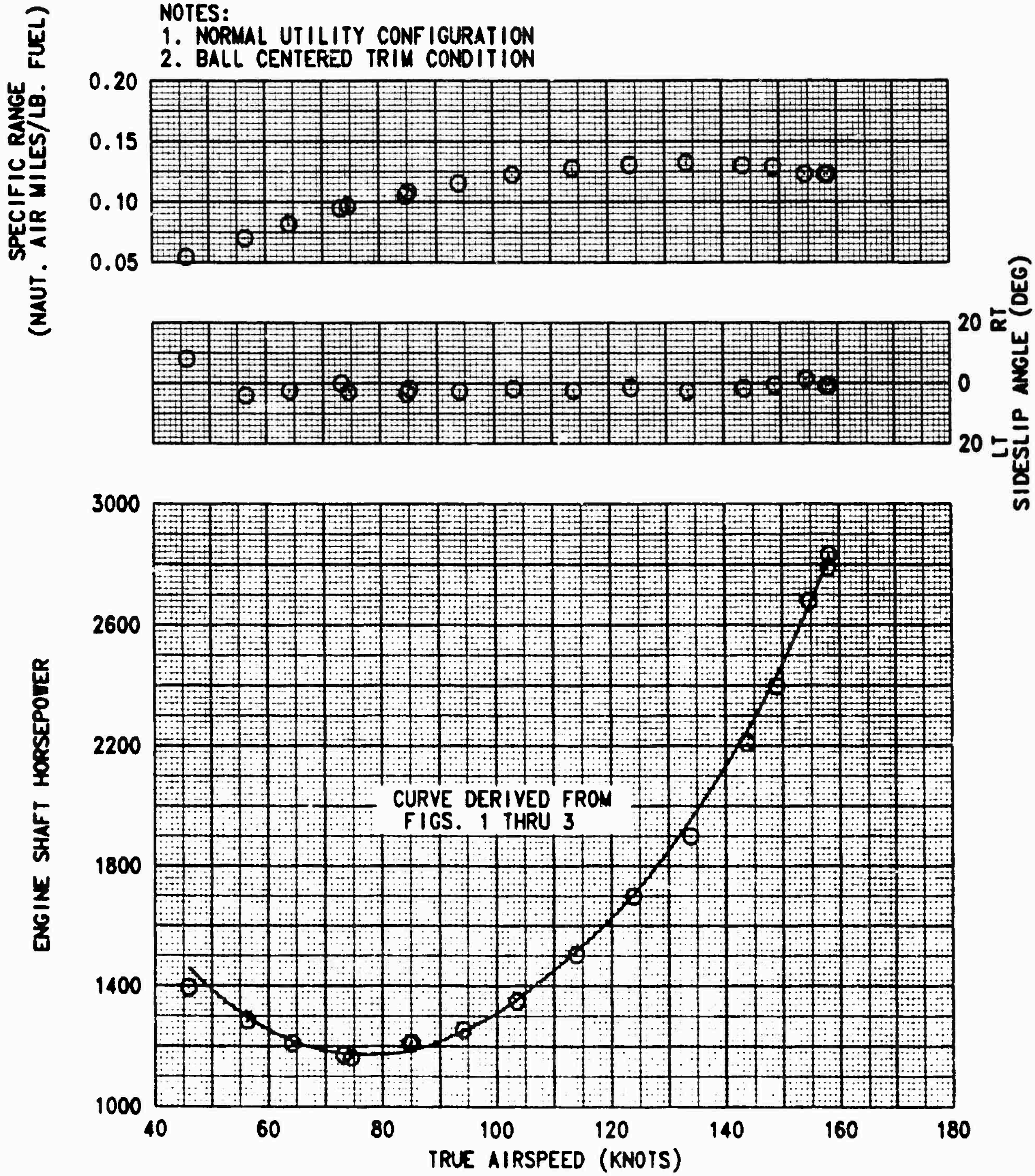


FIGURE 5
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18490	345.9(FWD)	0.2(RT)	6140	10.5	257.9	0.007996

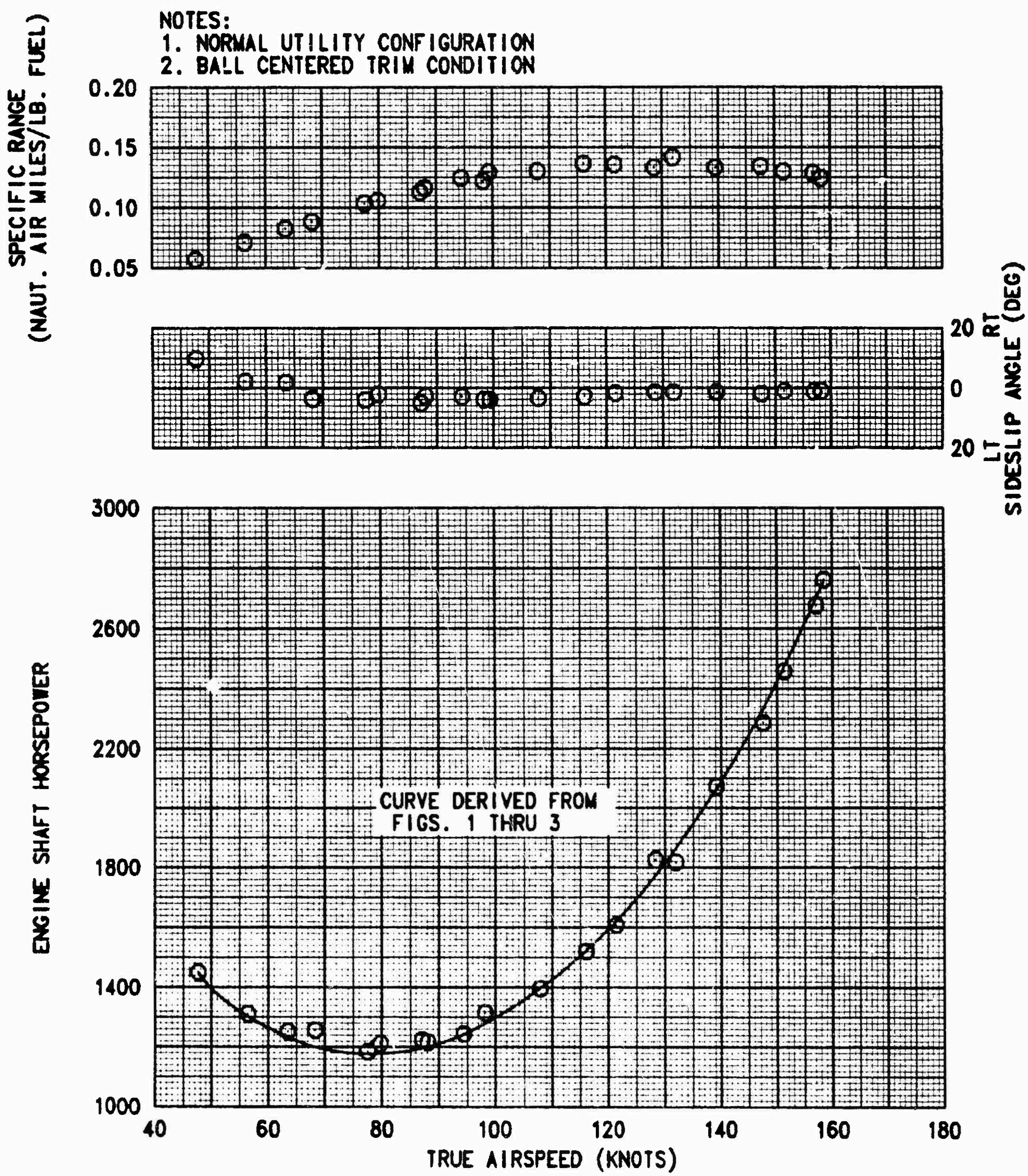


FIGURE 6
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18460	345.8(FWD)	0.2(RT)	9270	4.0	257.8	0.008998

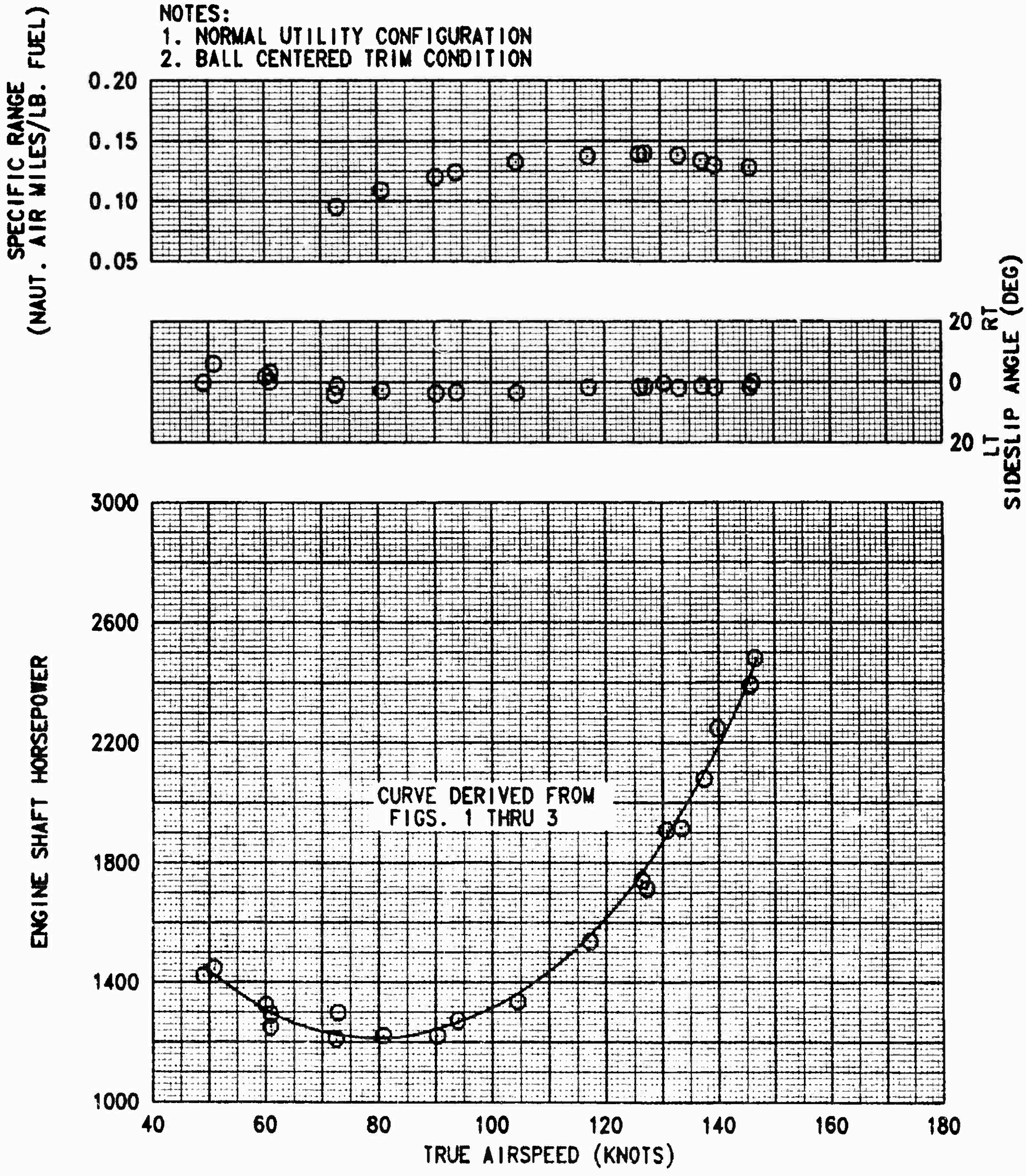


FIGURE 7
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18490	345.8(FWD)	0.2(RT)	12010	-1.0	257.7	0.010008

NOTES:
1. NORMAL UTILITY CONFIGURATION
2. BALL CENTERED TRIM CONDITION

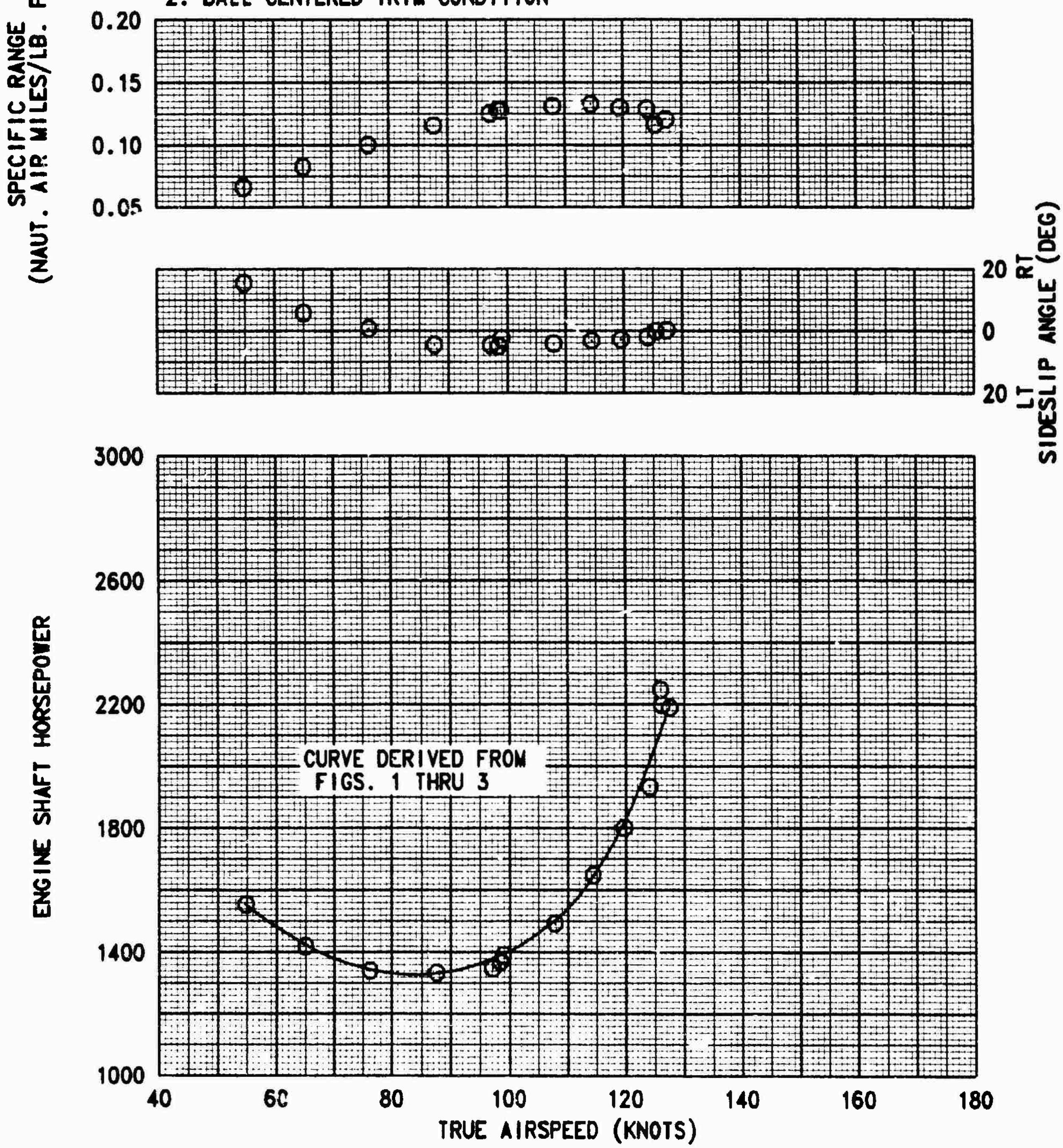


FIGURE 8

LEVEL FLIGHT PERFORMANCE

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18580	346.6(FWD)	0.2(RT)	1830	13.0	258.2	0.006976

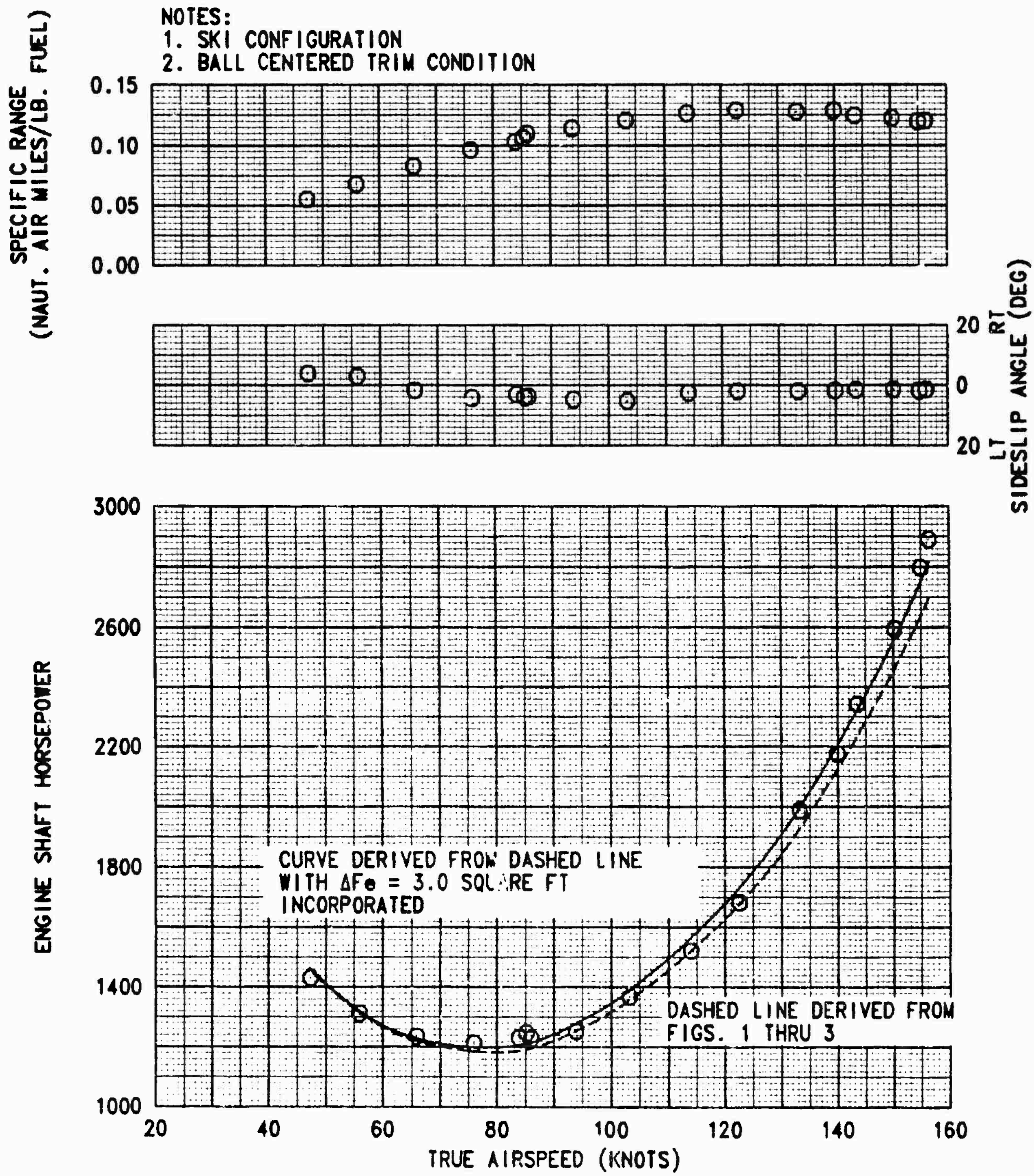


FIGURE 9

LEVEL FLIGHT PERFORMANCE

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18550	346.3(FWD)	0.2(RT)	5480	5.5	257.6	0.008012

NOTES:
1. SKI CONFIGURATION
2. BALL CENTERED TRIM CONDITION

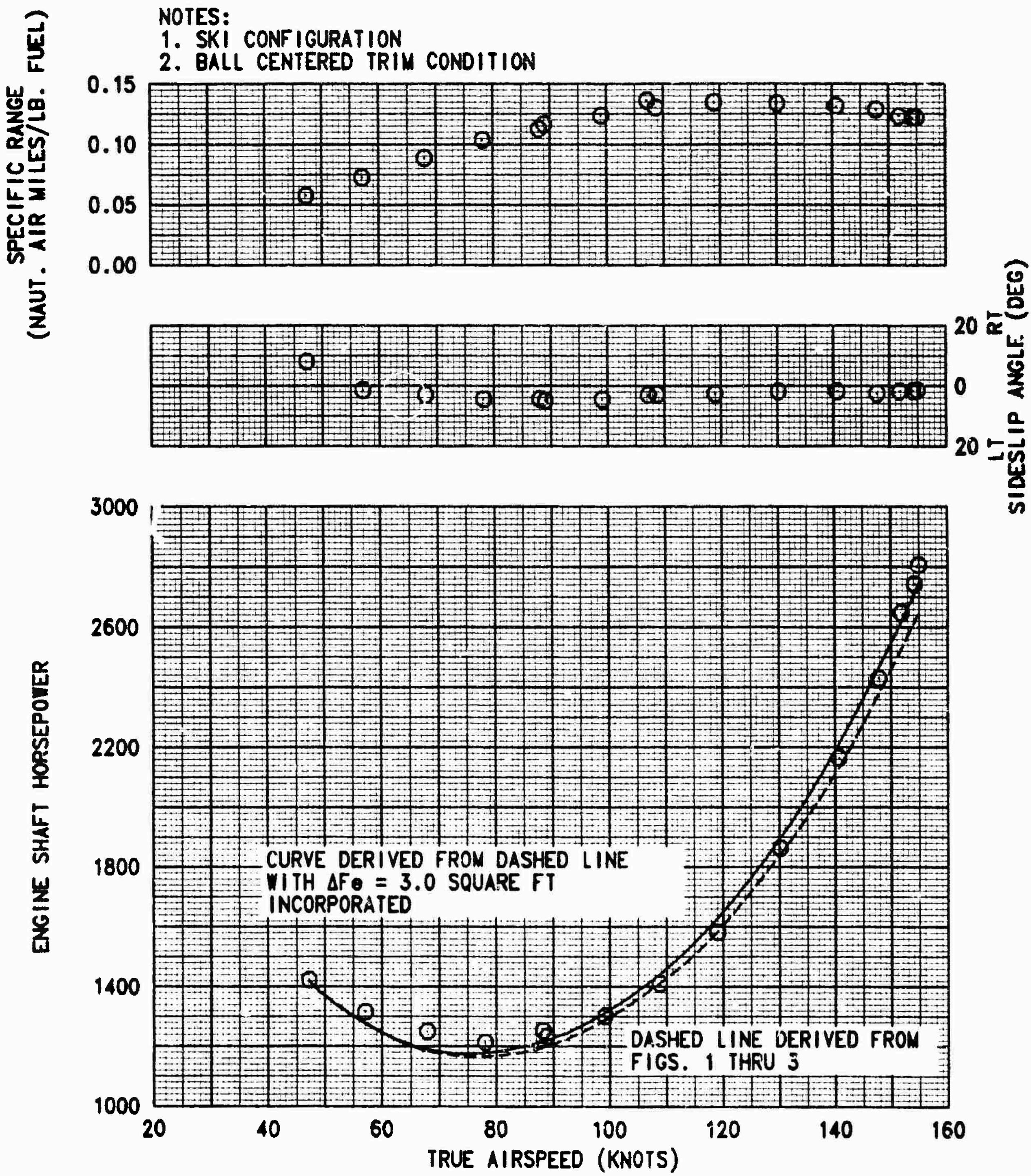


FIGURE 10
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18490	345.9(FWD)	0.2(RT)	9580	7.0	257.8	0.009012

NOTES:
1. SKI CONFIGURATION
2. BALL CENTERED TRIM CONDITION

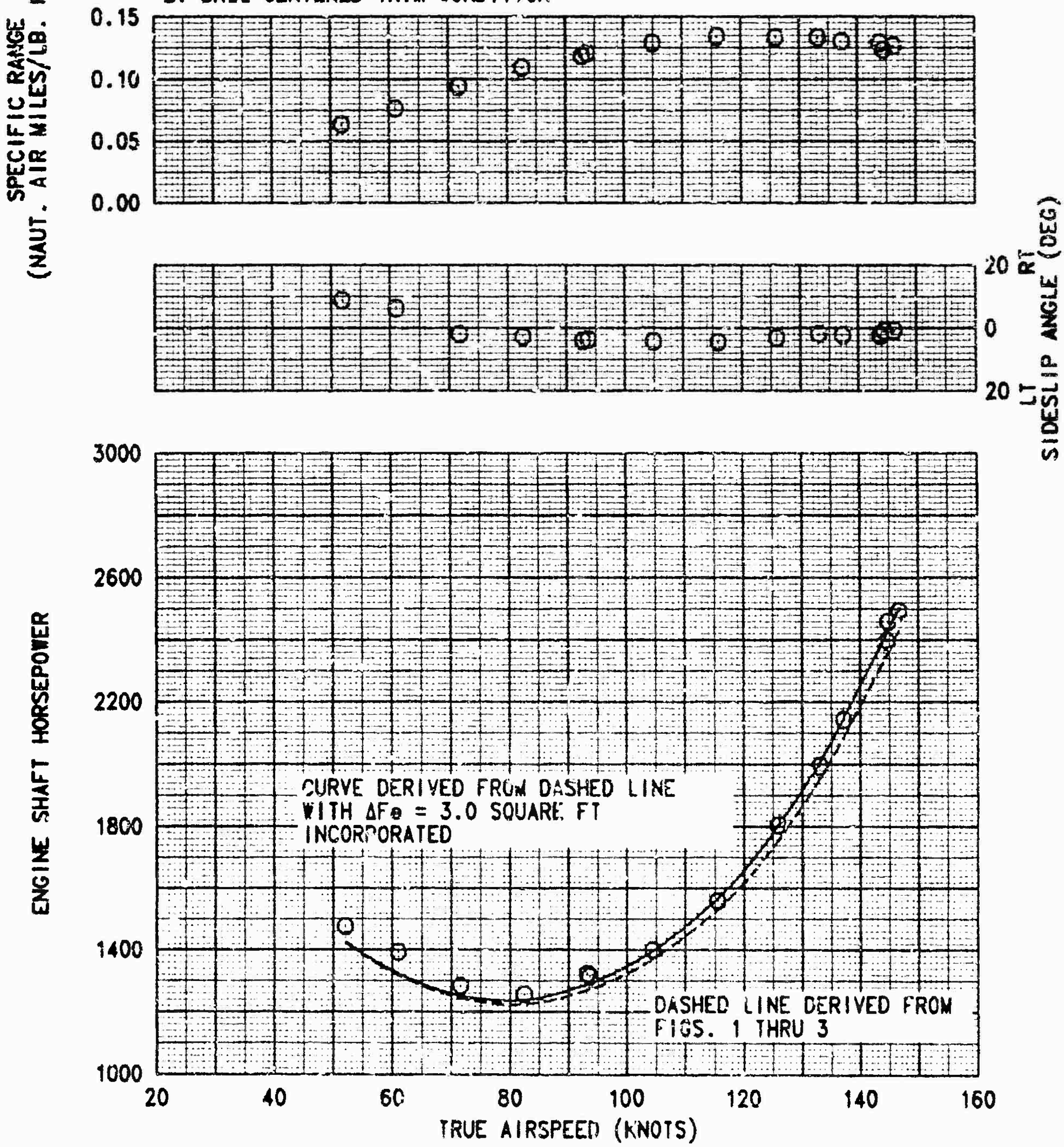


FIGURE 11
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18540	346.3(FWD)	0.2(RT)	12250	1.5	257.7	0.010036

NOTES:
1. SKI CONFIGURATION
2. BALL CENTERED TRIM CONDITION

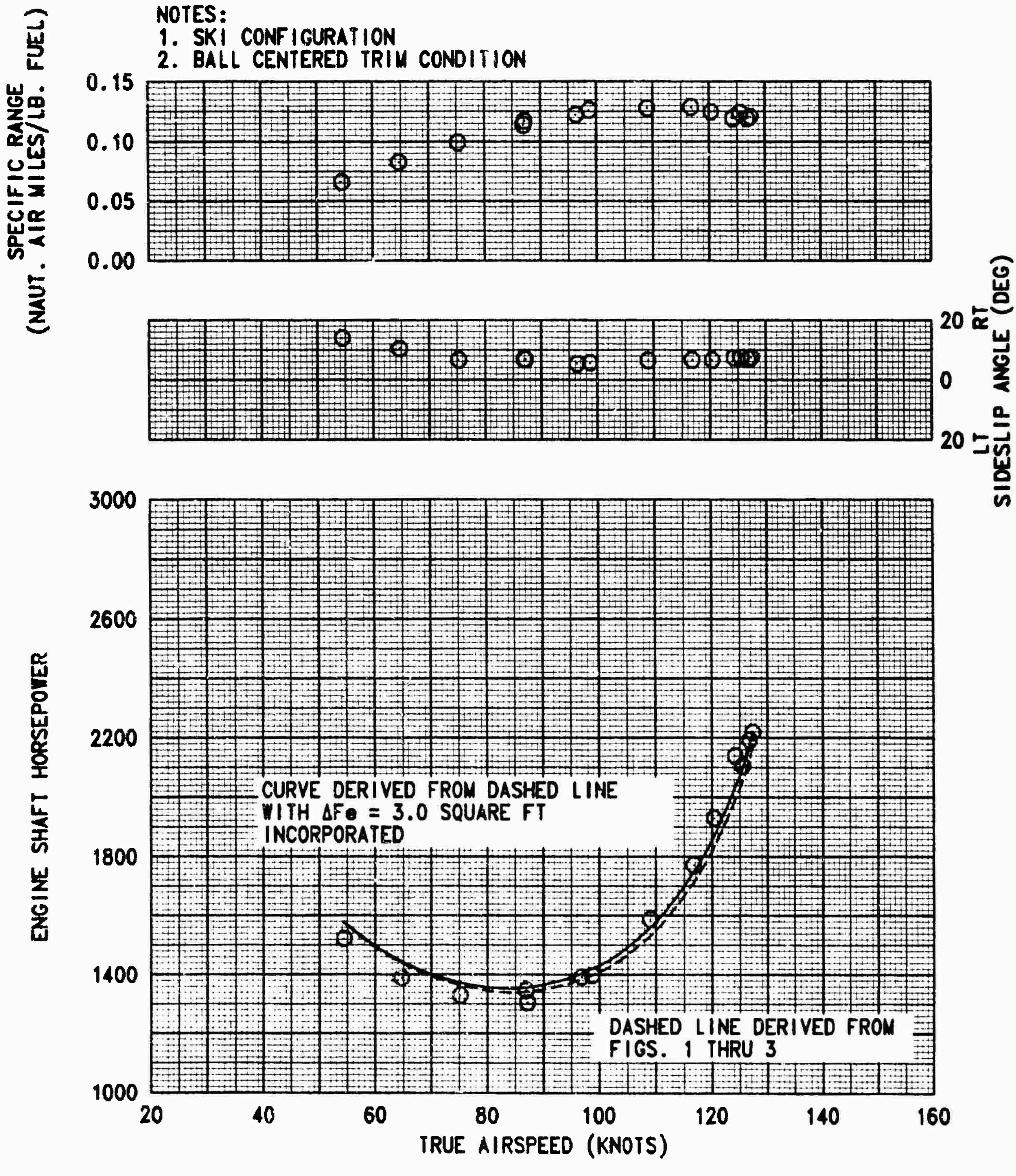


FIGURE 12

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18540	346.5	0.2RT	1620	10.5	256	.006999	NORMAL UTILITY

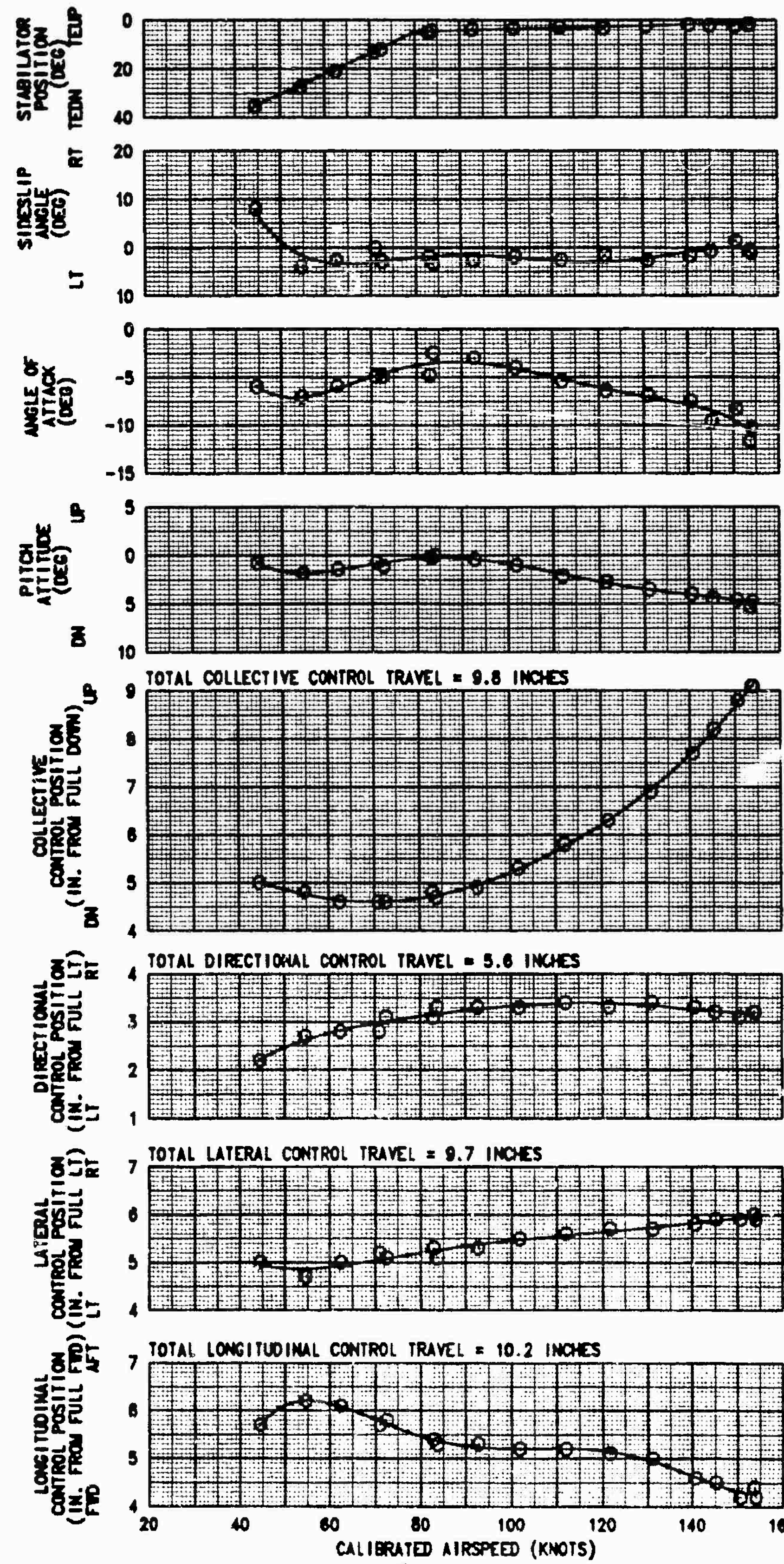


FIGURE 13

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18490	345.9	0.2RT	6140	10.5	258	.007998	NORMAL UTILITY

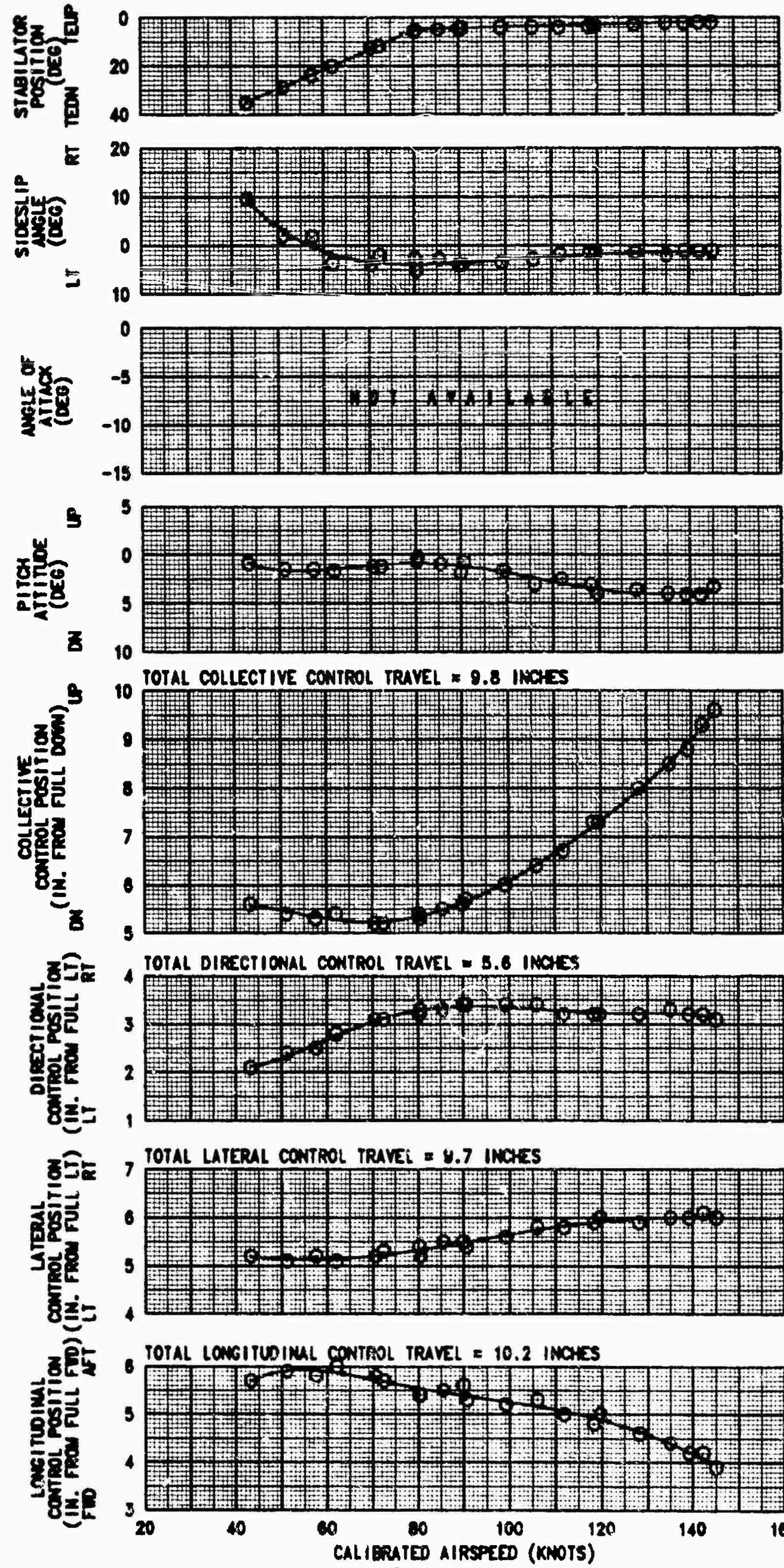


FIGURE 14

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18460	345.8	0.2RT	9270	4.0	253	.008998	NORMAL UTILITY

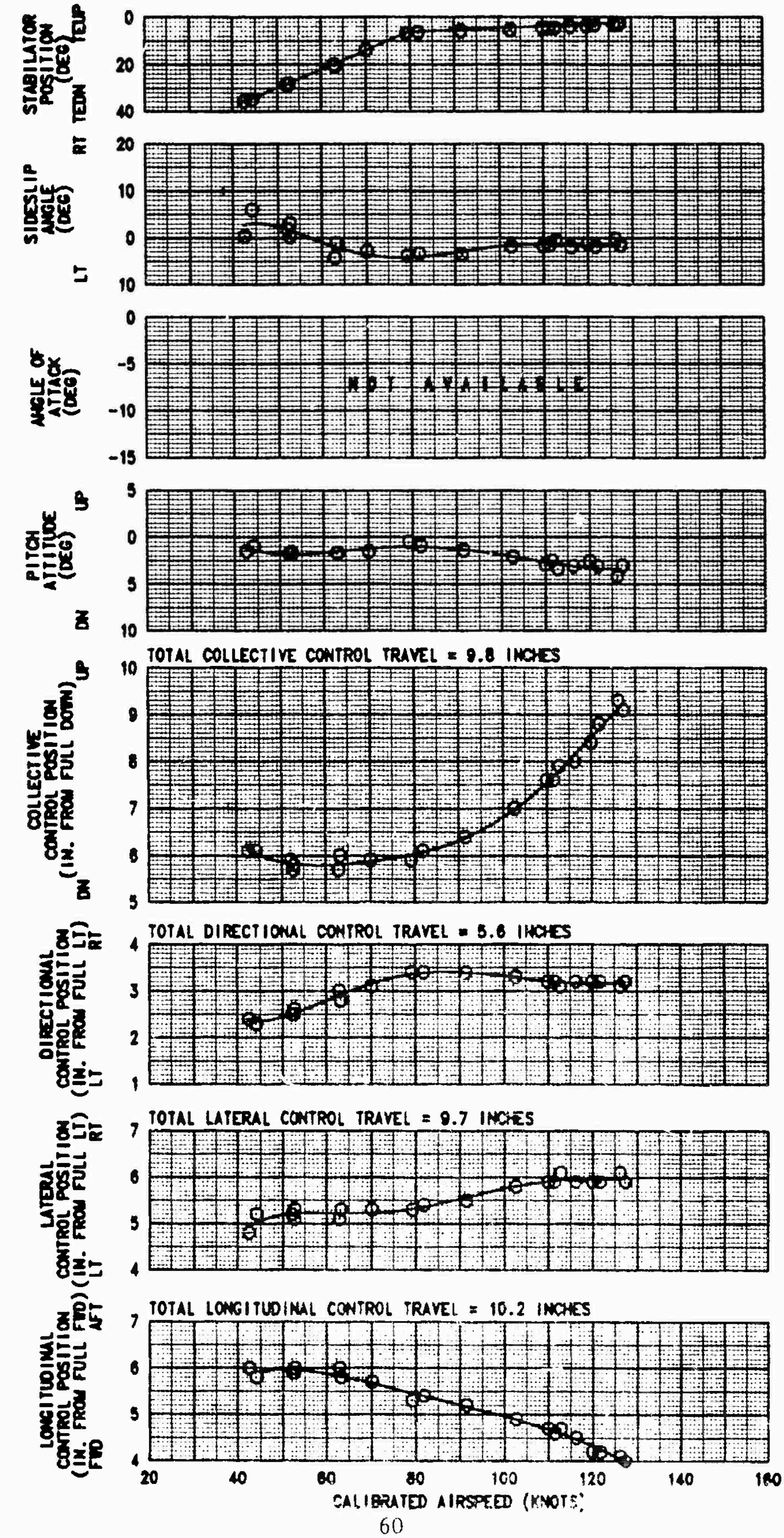


FIGURE 15
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18470	345.8	0.2RT	12000	-1.0	251	.010008	NORMAL UTILITY

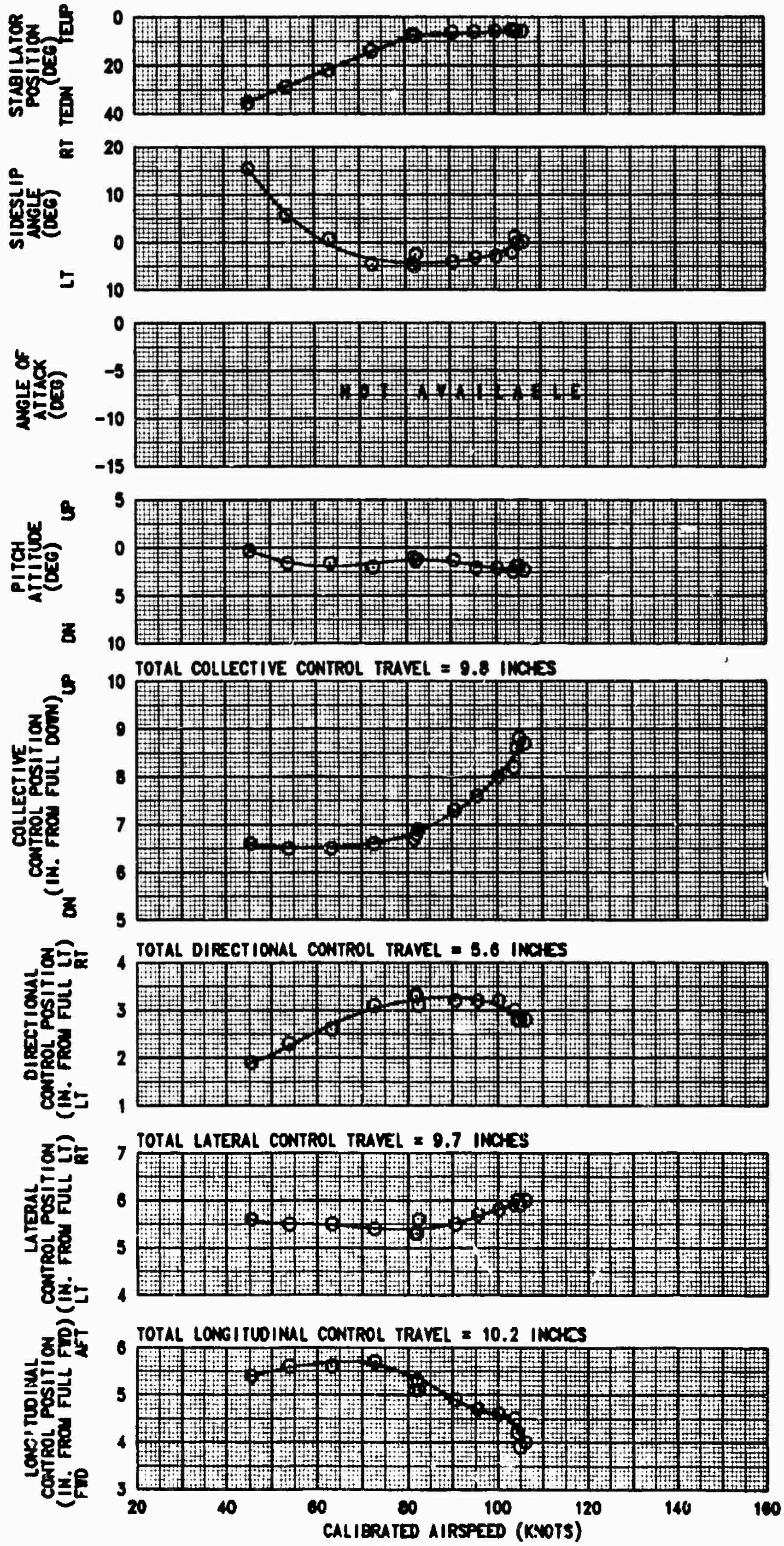


FIGURE 16

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18590	346.6	0.2RT	1830	13.0	257	.006976	SKIS INSTALLED

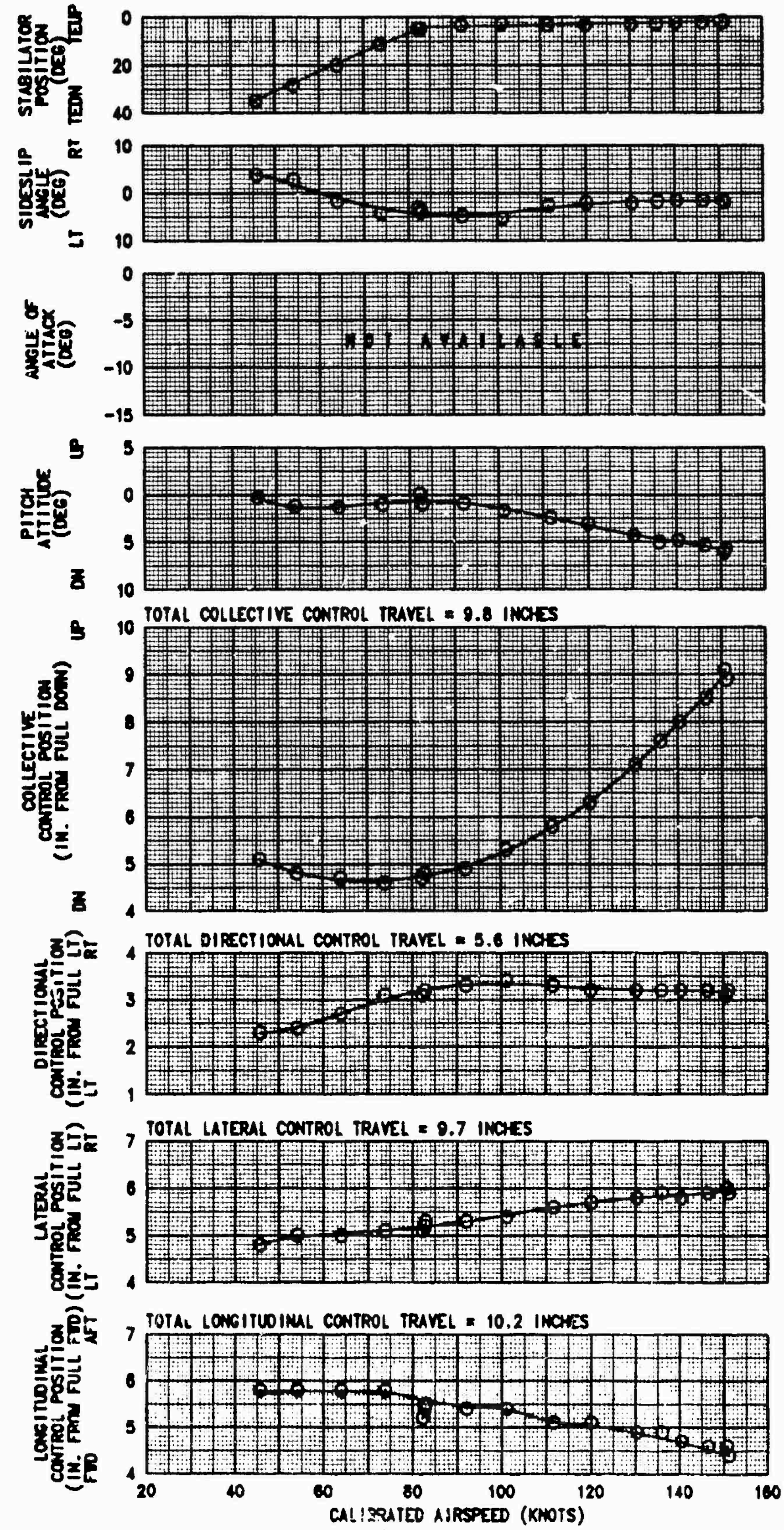
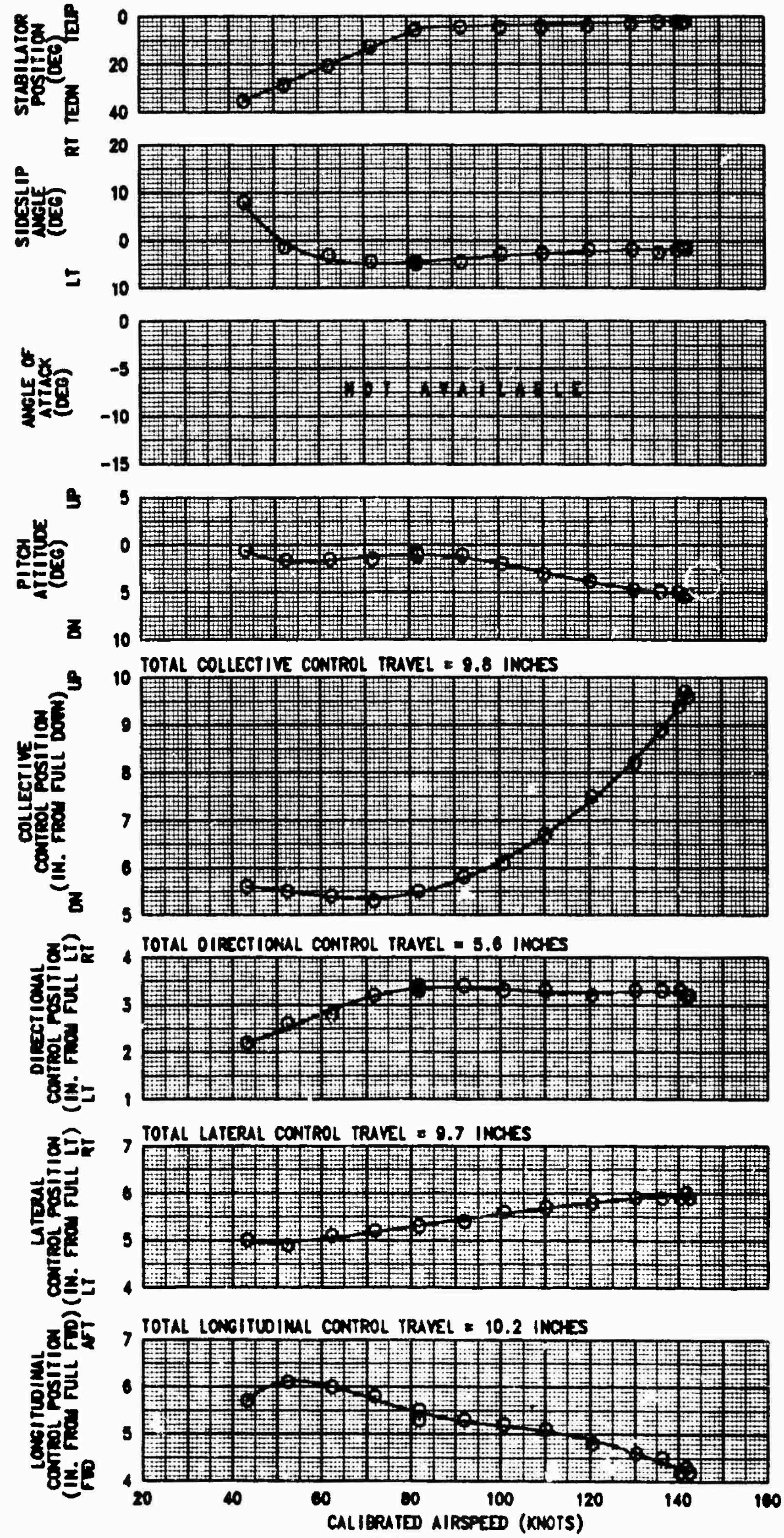


FIGURE 17

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18550	346.3	0.2RT	5480	5.5	253	.008012	SKIS INSTALLED



CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18490	345.9	0.2RT	9580	7.0	255	.009012	SKIS INSTALLED

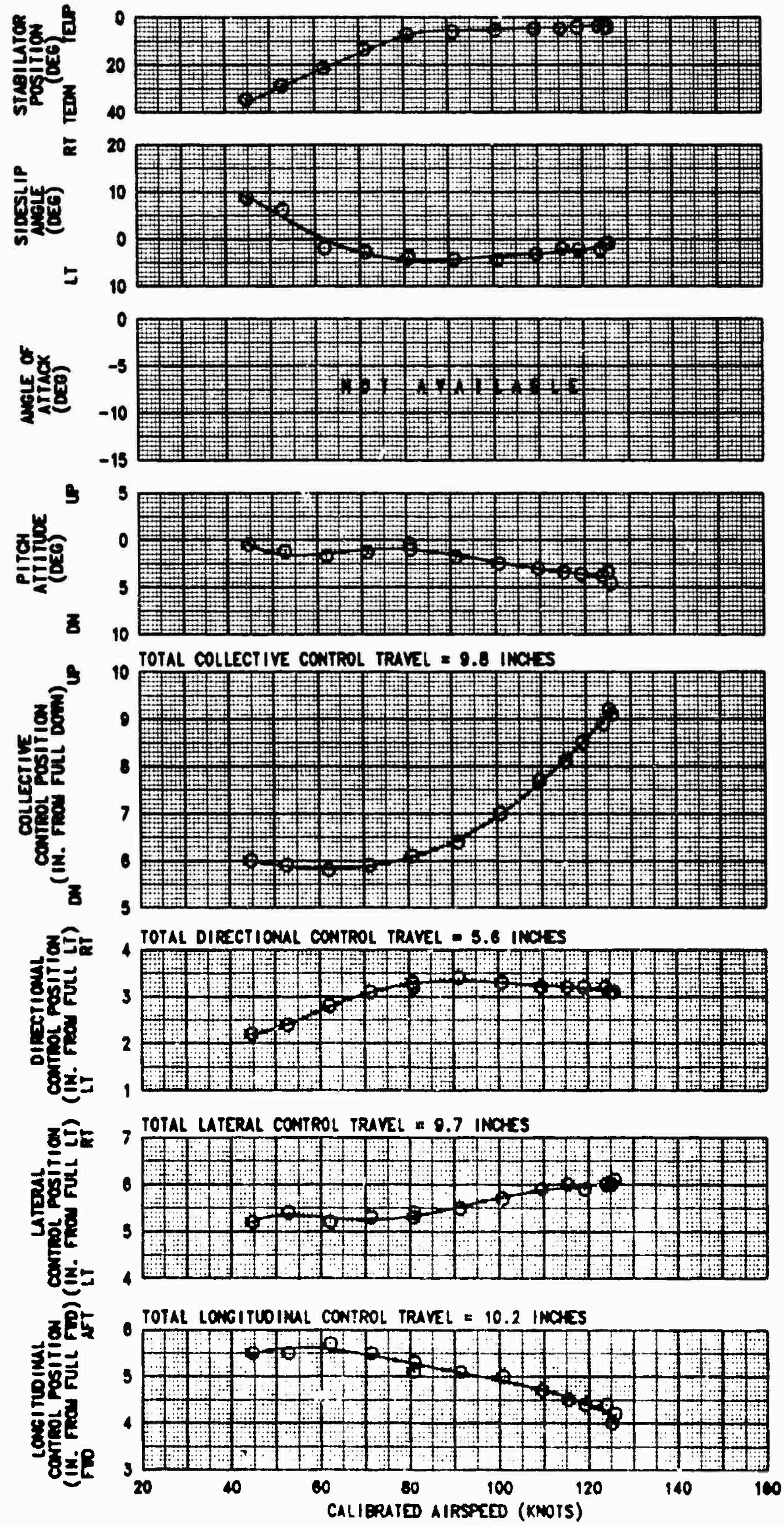


FIGURE 19

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFF.	AIRCRAFT CONFIGURATION
18530	346.3	0.2RT	12250	1.5	252	.010036	SKIS INSTALLED

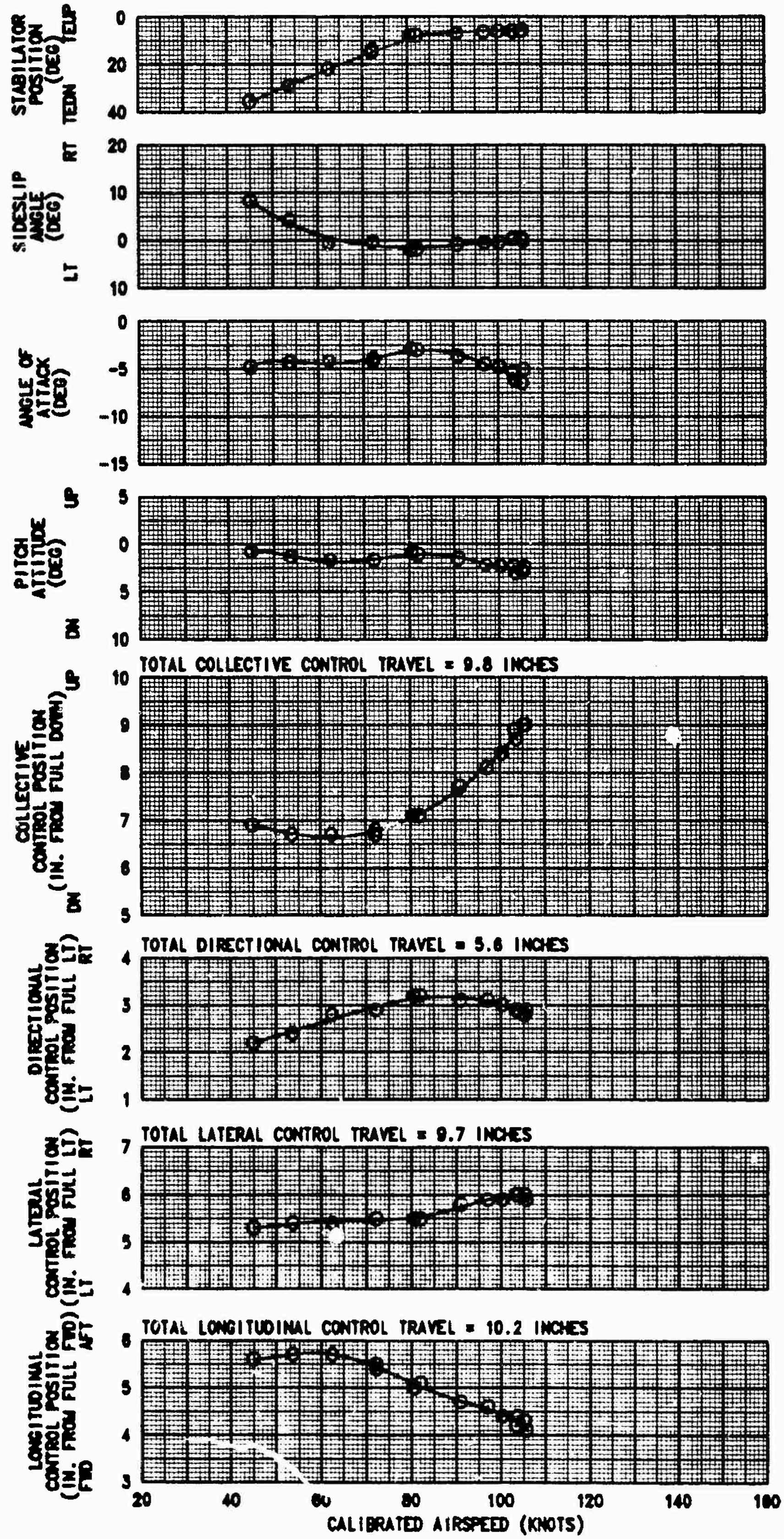


FIGURE 20

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AIRCRAFT CONFIGURATION	FLIGHT CONFIGURATION
16300	364.2	0.2RT	7220	13.0	256	SKIS INSTALLED	IRP CLIMB

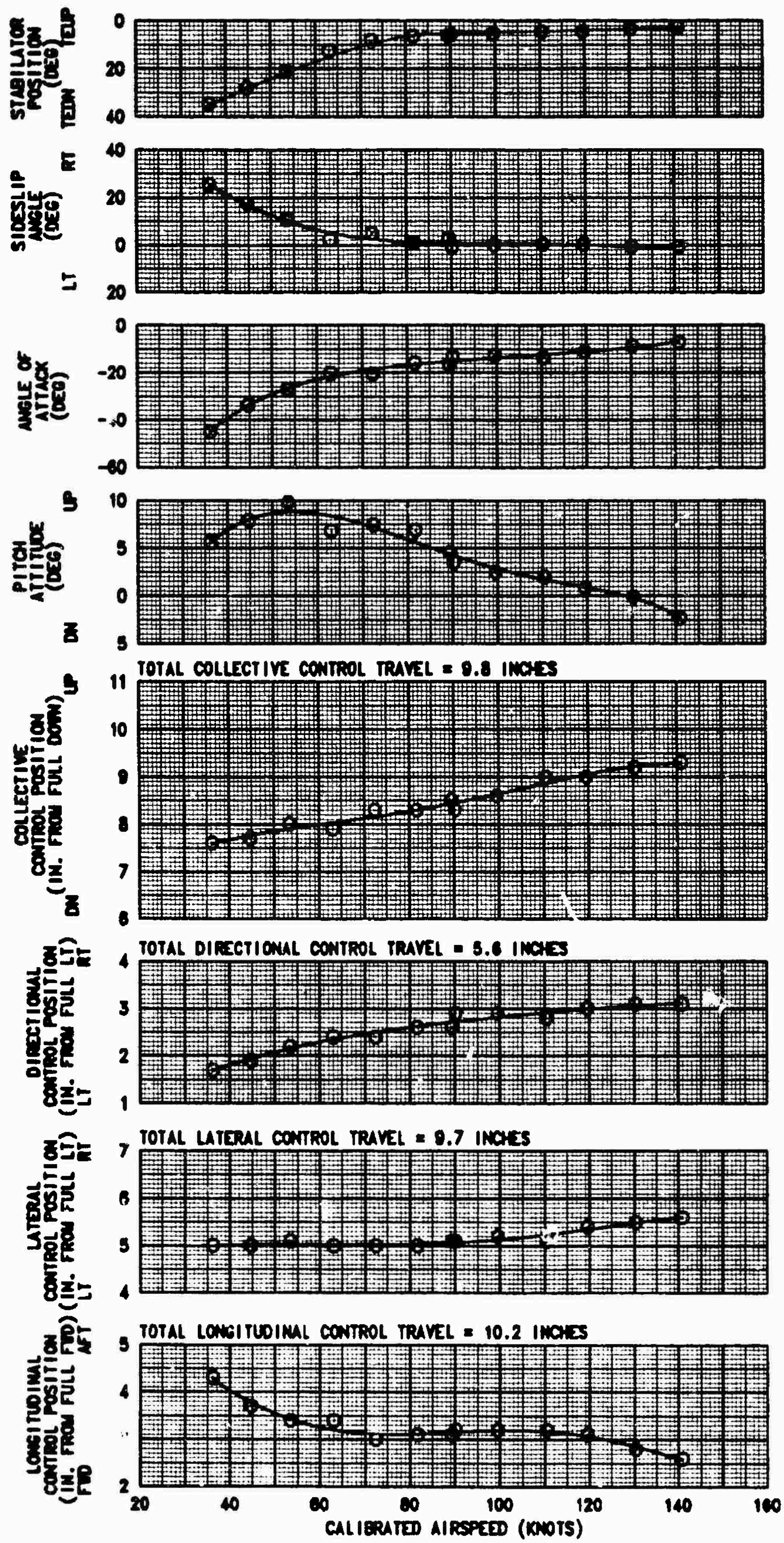


FIGURE 21

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AIRCRAFT CONFIGURATION	FLIGHT CONFIGURATION
22200	361.2	0.2RT	6000	15.0	256	SKIS INSTALLED	IRP CLIMB

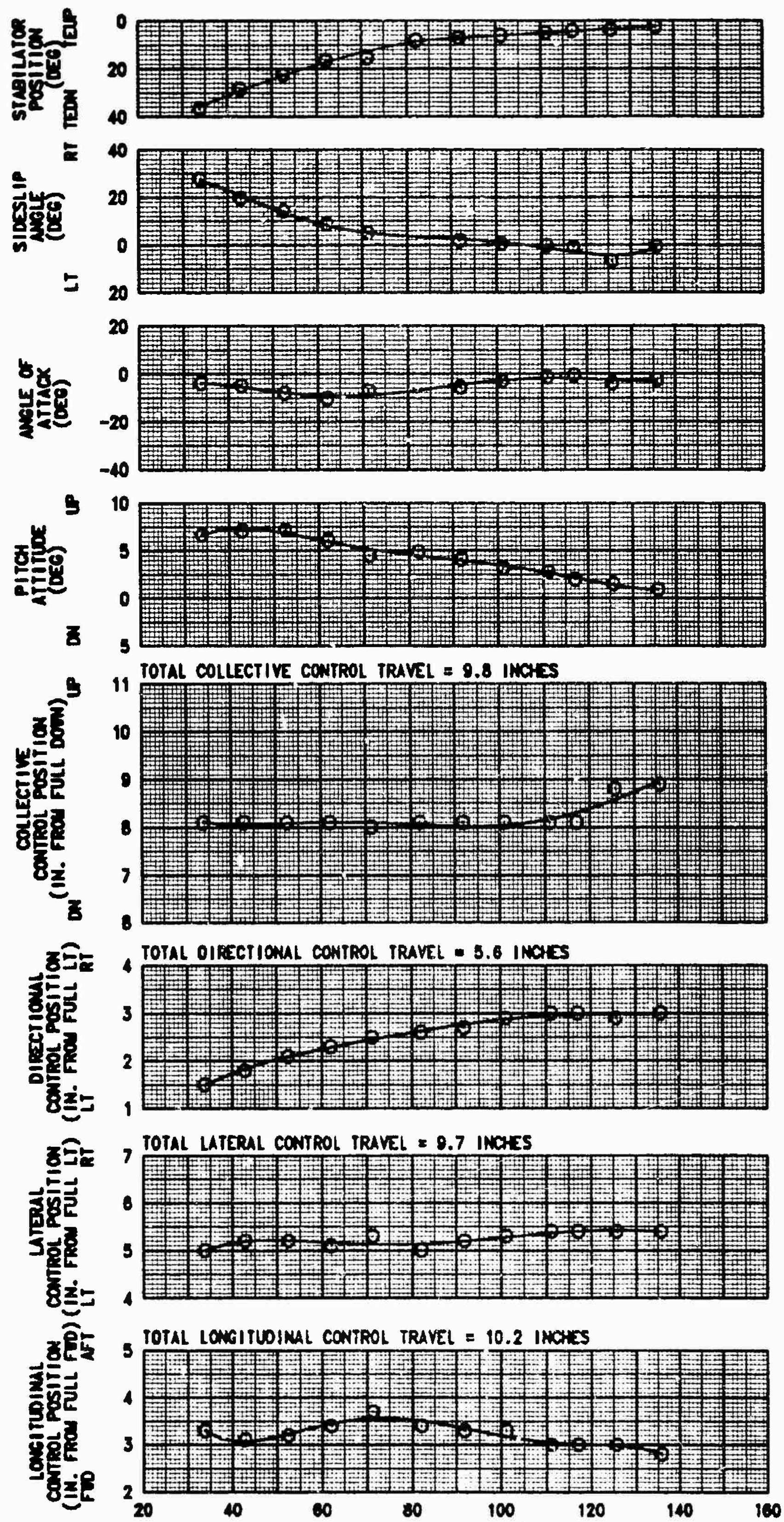


FIGURE 22

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AIRCRAFT CONFIGURATION	FLIGHT CONFIGURATION
16180	363.8	0.2RT	6390	13.0	261	SKIS INSTALLED	AUTO DESCENT

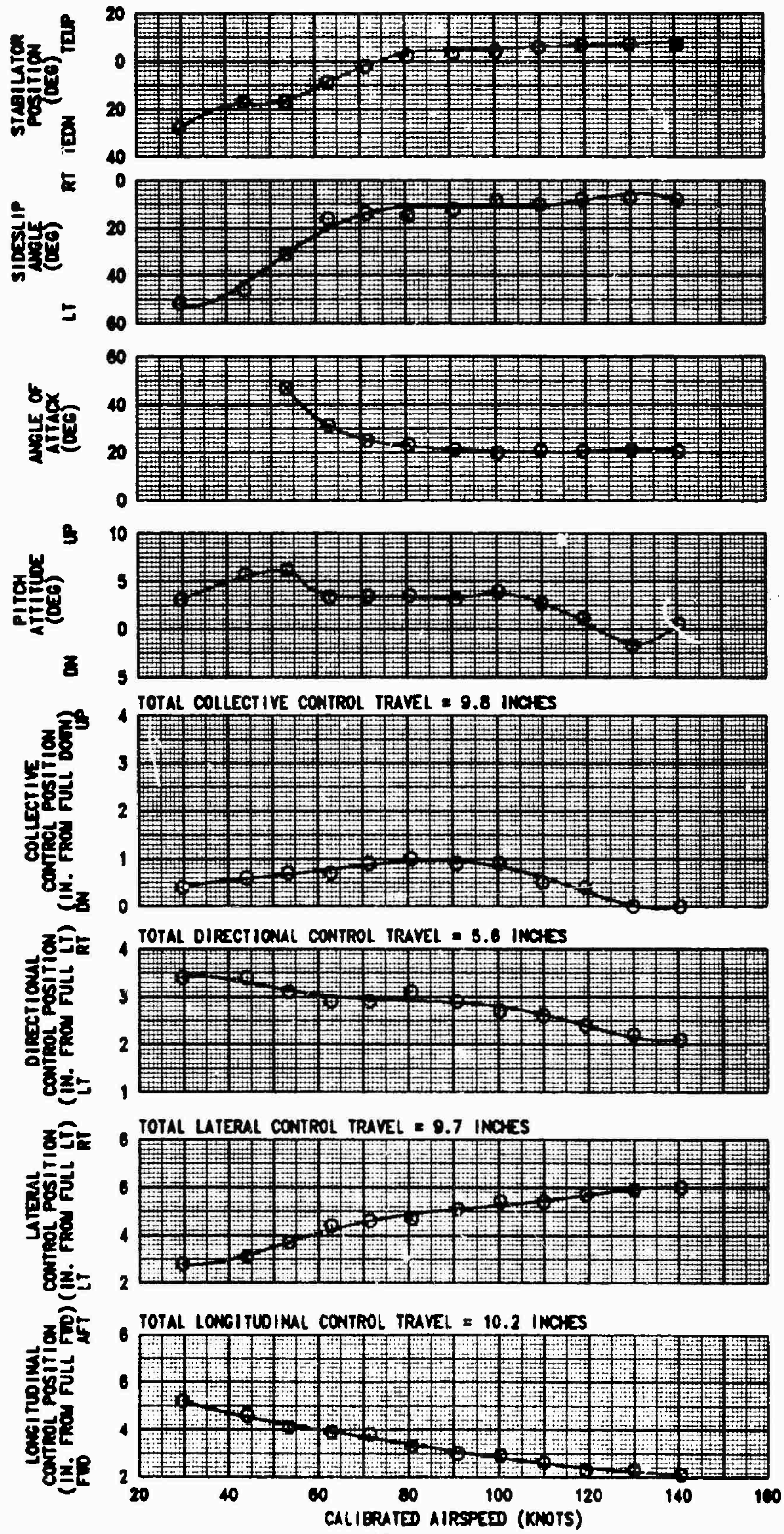


FIGURE 23

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AIRCRAFT CONFIGURATION	FLIGHT CONFIGURATION
22040	360.8	0.2RT	5730	14.0	260	SKIS INSTALLED	AUTO DESCENT

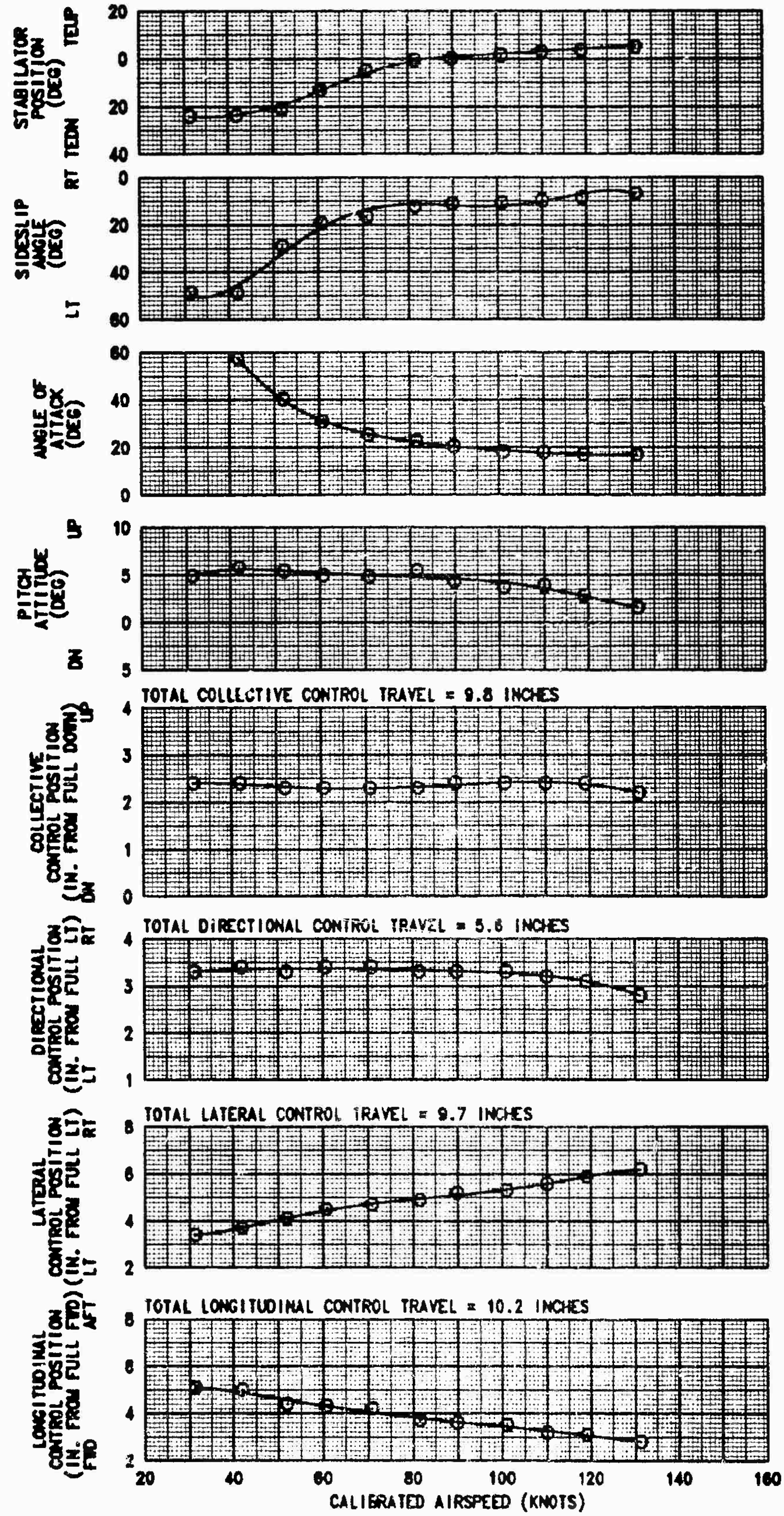


FIGURE 24

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
□	16510	364.9	0.2 RT	6300	15.5	258	72
○	16210	363.9	0.2 RT	6310	15.5	258	147

NOTE:
1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. BALL-CENTERED FLIGHT
5. PBA CENTERED AND LOCKED

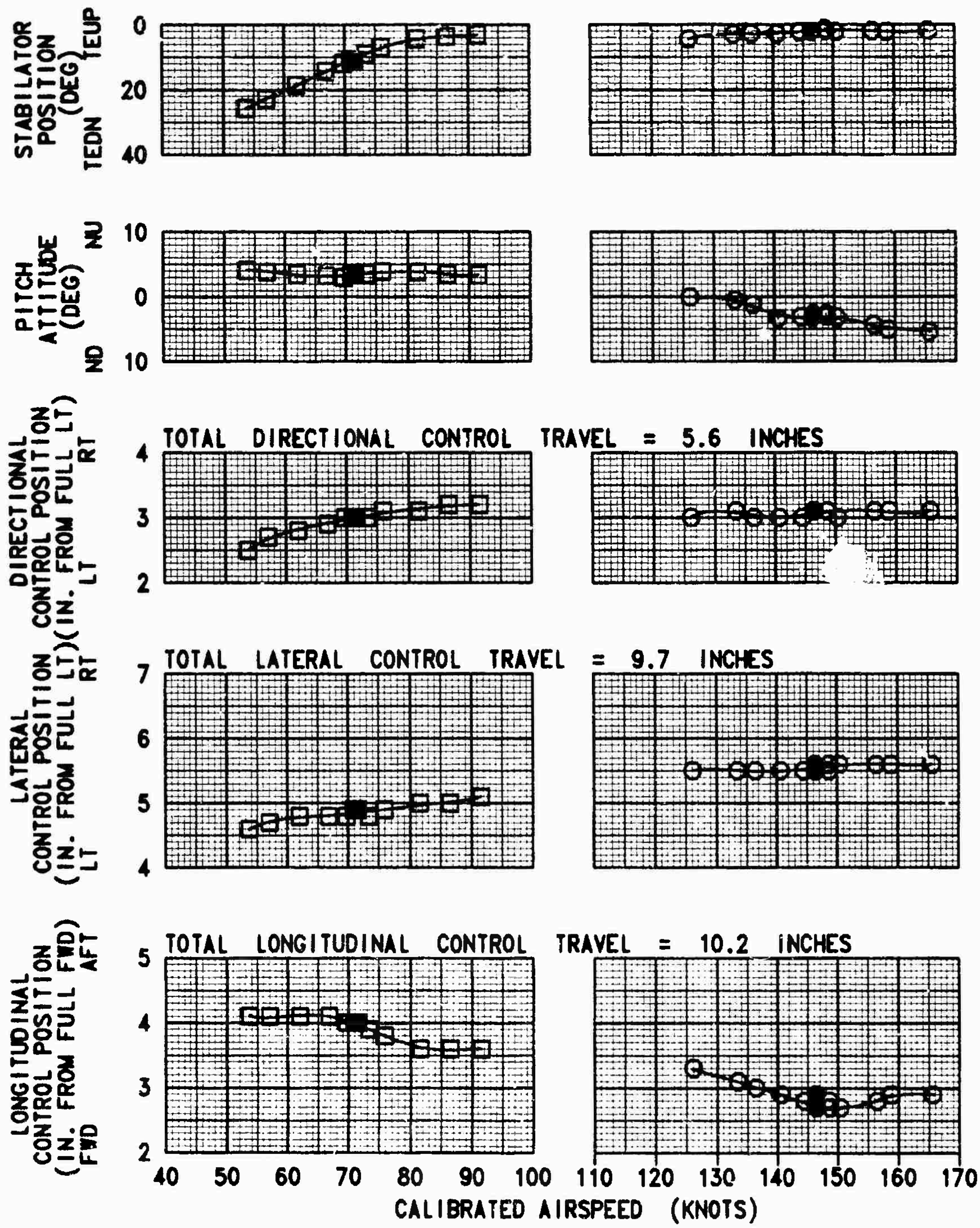


FIGURE 25

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
□	22260	361.4	0.2 RT	6220	15.0	258	71
⊙	21990	360.7	0.2 RT	6410	14.0	258	122

NOTE:
1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. BALL-CENTERED FLIGHT
5. PBA CENTERED AND LOCKED

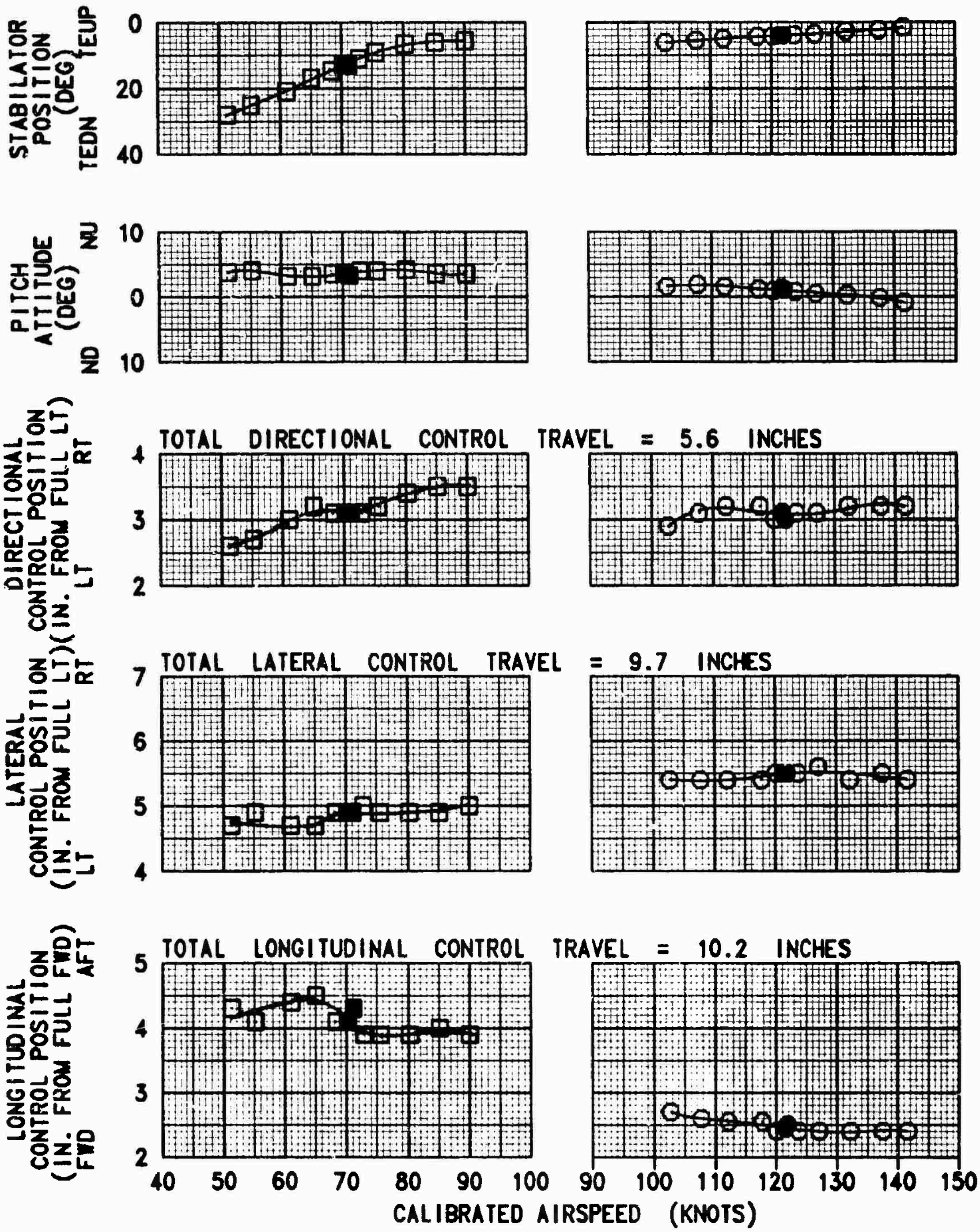


FIGURE 26
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
16400	364.5	0.2 RT	6480	14.5	258	73

NOTE:
1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. BALL-CENTERED FLIGHT
5. PBA CENTERED AND LOCKED

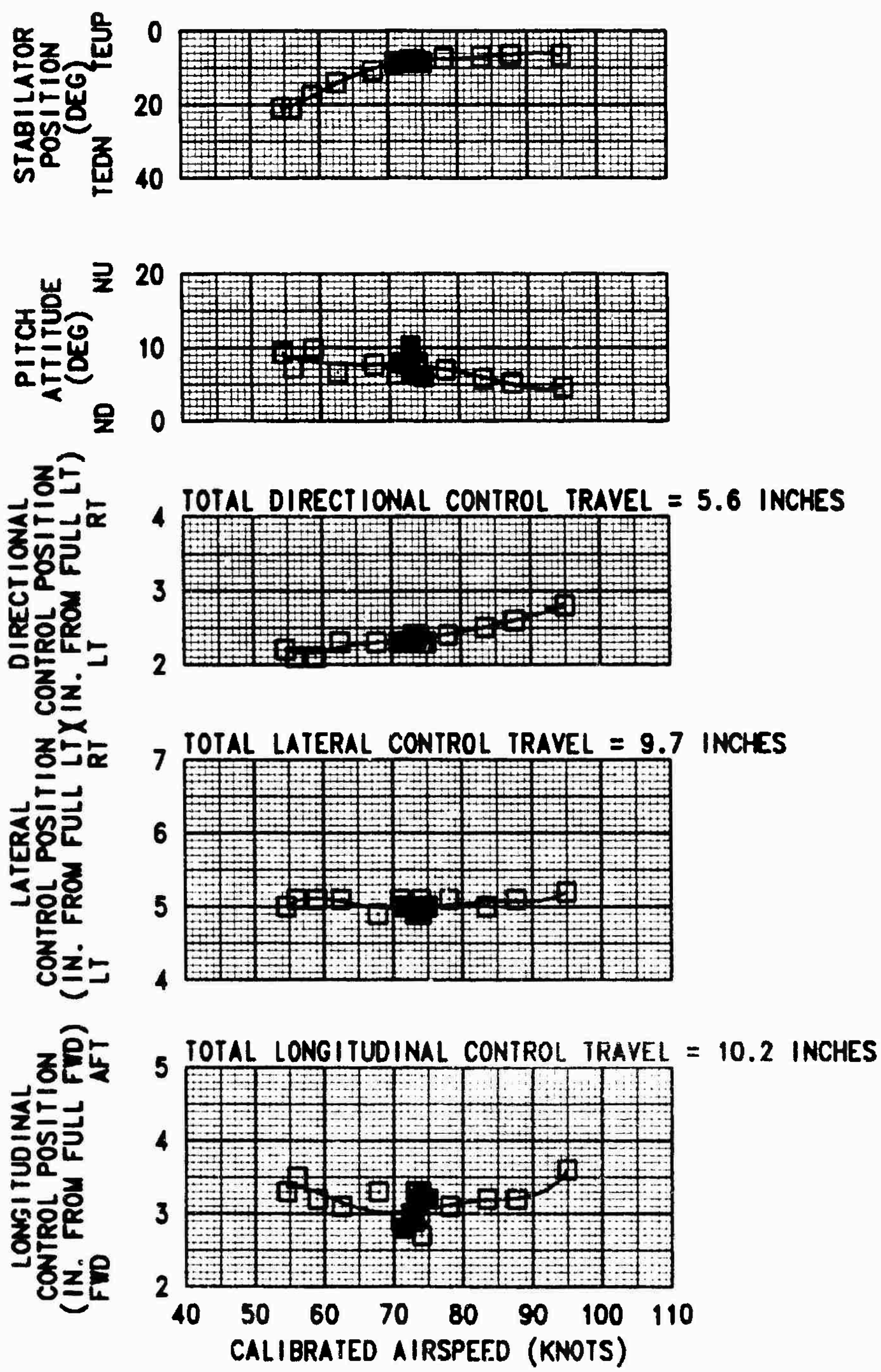


FIGURE 27

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
22160	361.1	0.2 RT	6490	14.5	258	73

NOTE:
1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. BALL-CENTERED FLIGHT
5. PBA CENTERED AND LOCKED

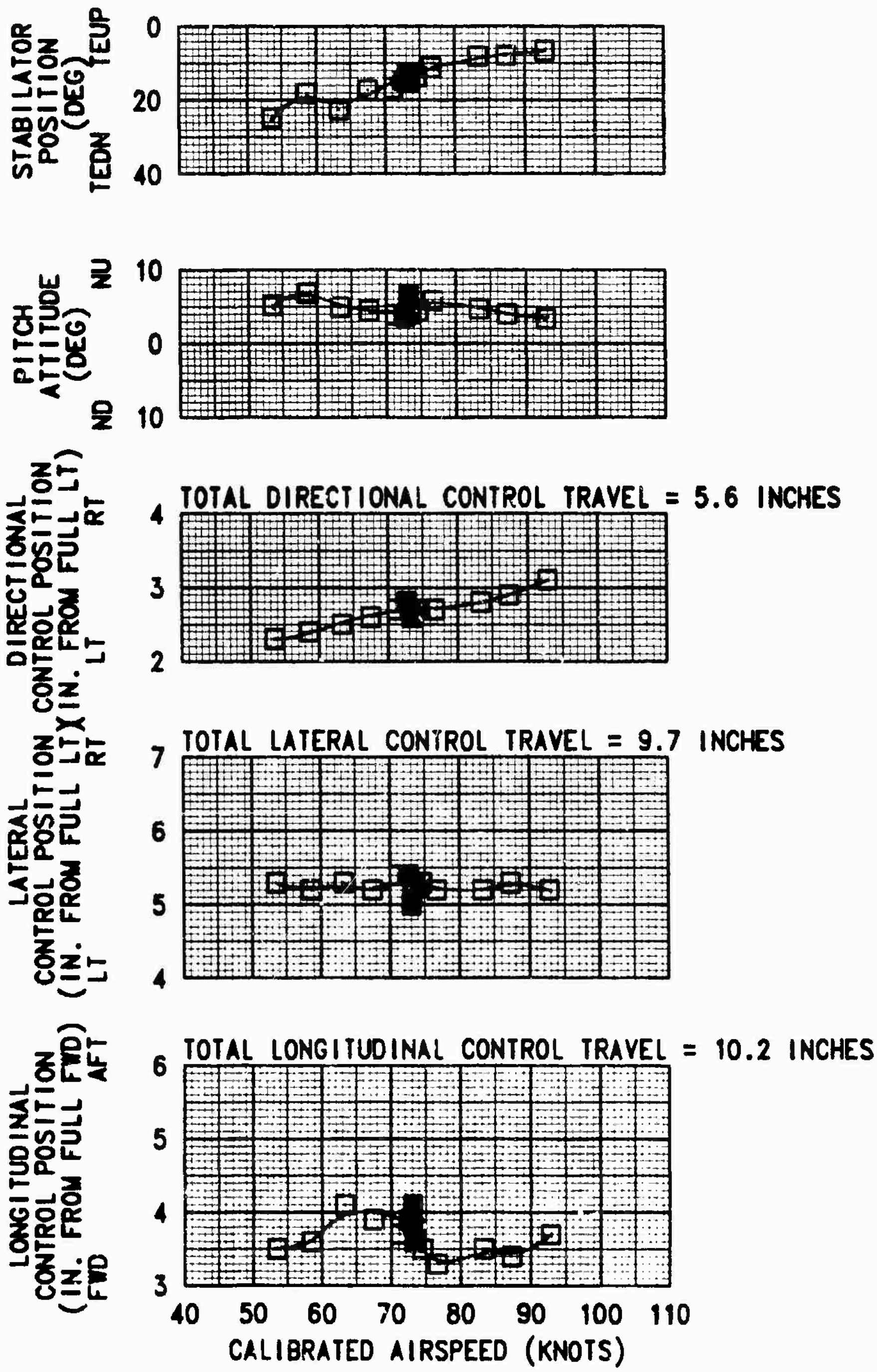


FIGURE 28

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
16460	364.8	0.2 RT	6310	14.5	258	72

NOTE:
1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. BALL-CENTERED FLIGHT
5. PBA CENTERED AND LOCKED

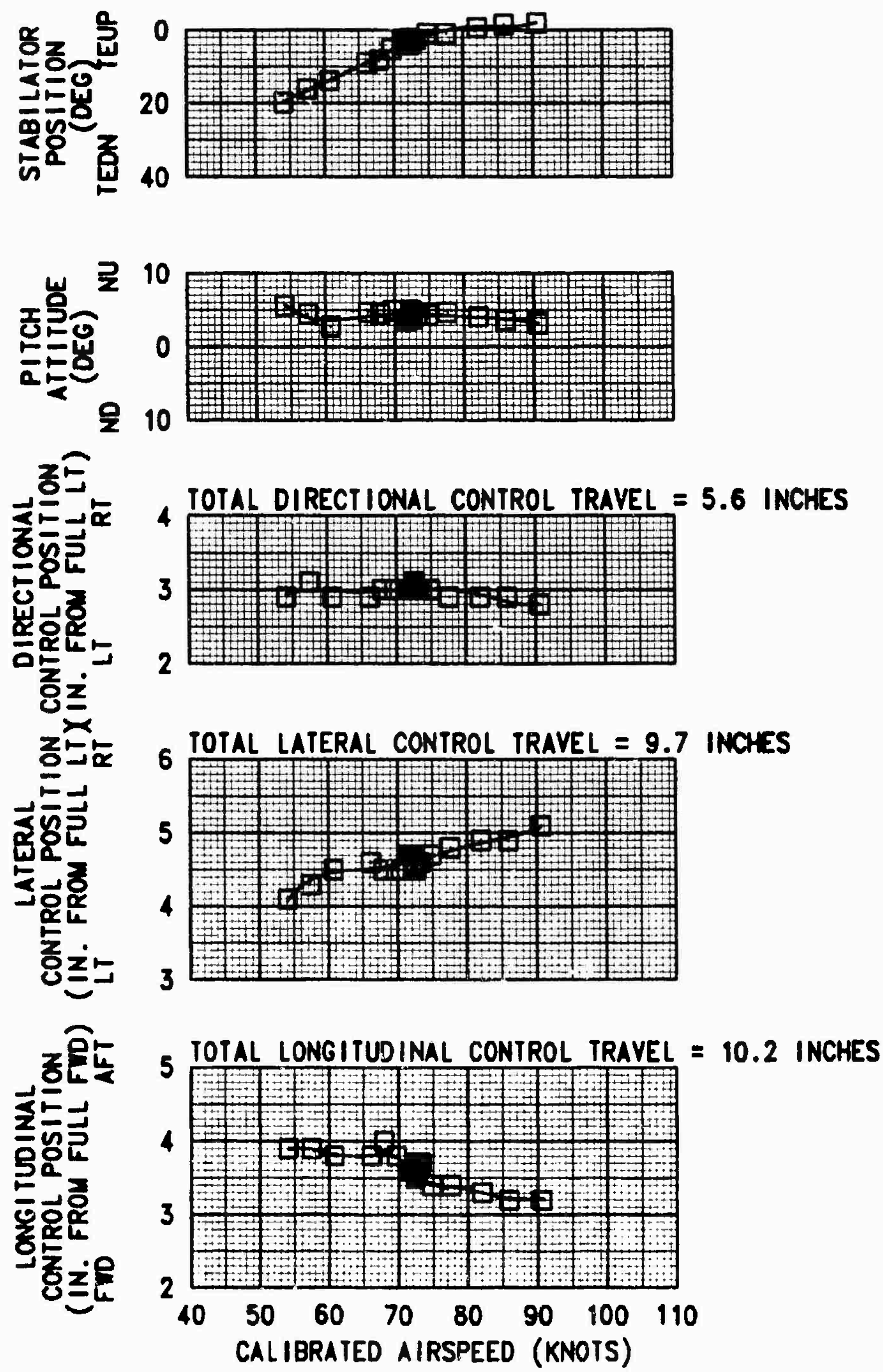


FIGURE 29

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
21990	360.6	0.2 RT	6150	14.0	258	72

NOTE: 1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. BALL-CENTERED FLIGHT
5. PBA CENTERED AND LOCKED

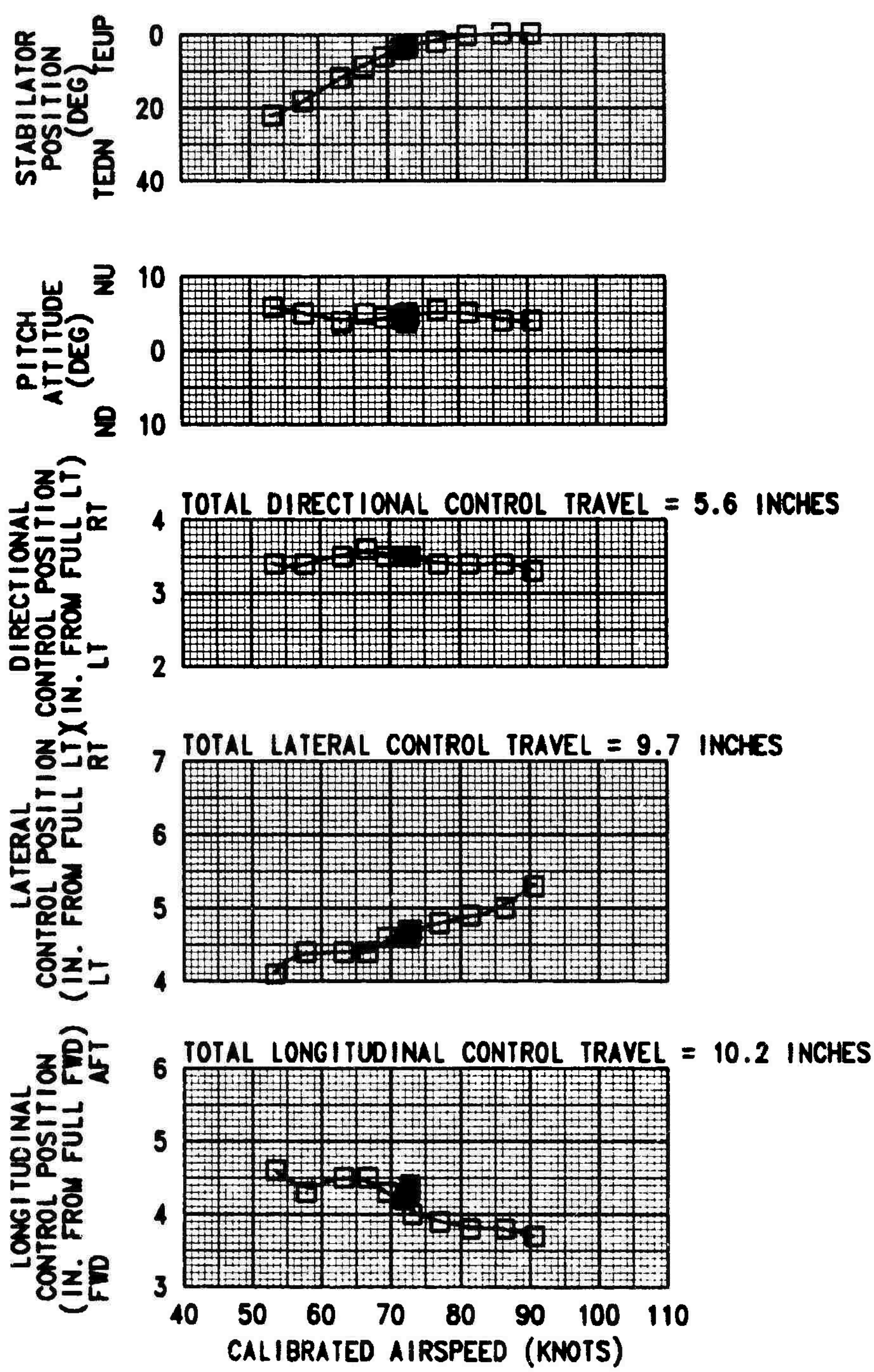


FIGURE 30

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
□	16170	363.7	0.2 RT	6040	12.5	258	73
⊙	15890	362.8	0.2 RT	6410	12.0	258	147

NOTE:
1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. PBA CENTERED AND LOCKED

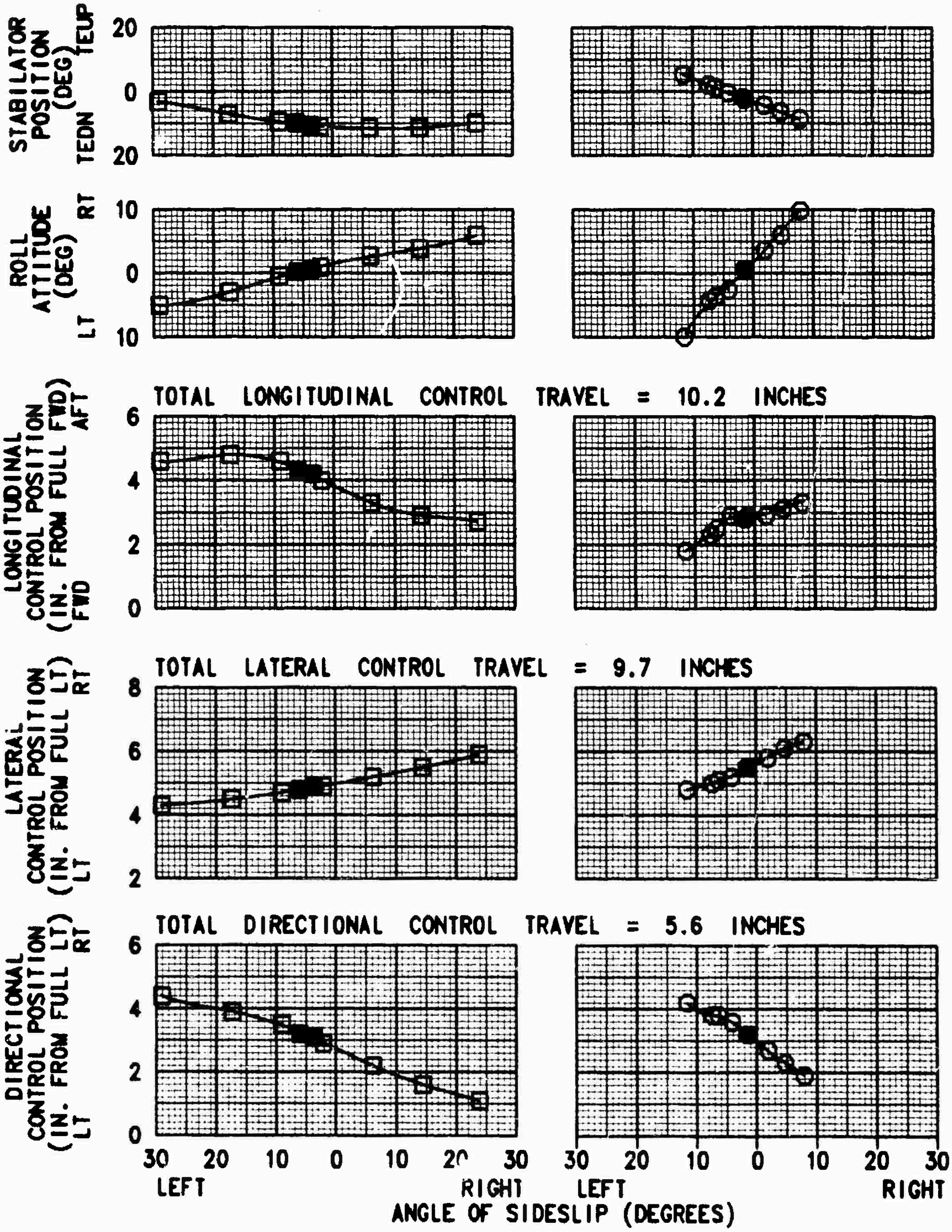


FIGURE 31

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
□	22160	361.0	0.2 RT	6250	14.5	258	71
⊙	21870	360.3	0.2 RT	6120	15.0	258	126

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. PBA CENTERED AND LOCKED

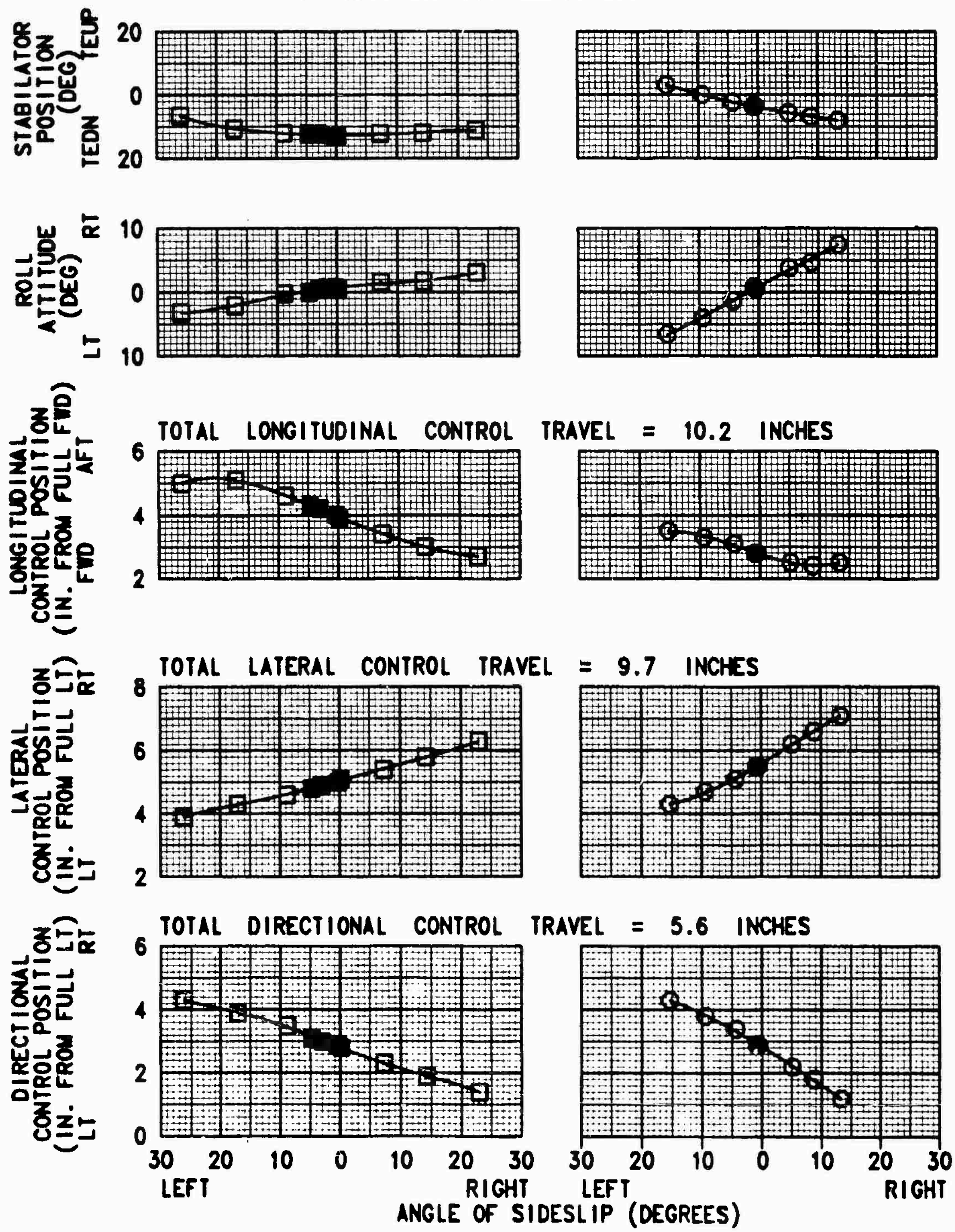


FIGURE 32

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
16400	364.5	0.2 RT	5980	10.5	258	75

NOTE:
1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. PBA CENTERED AND LOCKED

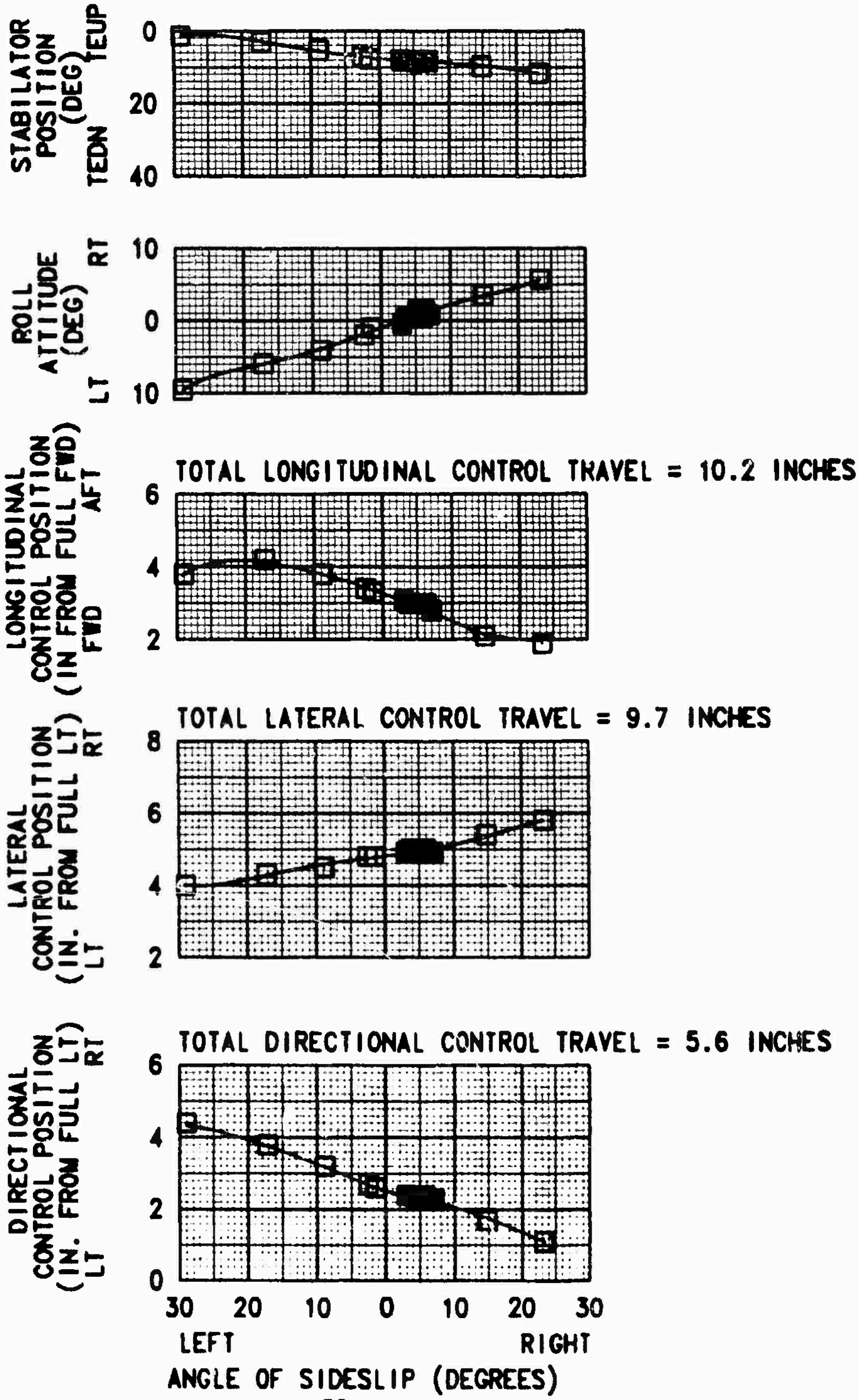


FIGURE 33

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
22270	361.4	0.2 RT	6410	14.5	258	70

NOTE:
1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. PBA CENTERED AND LOCKED

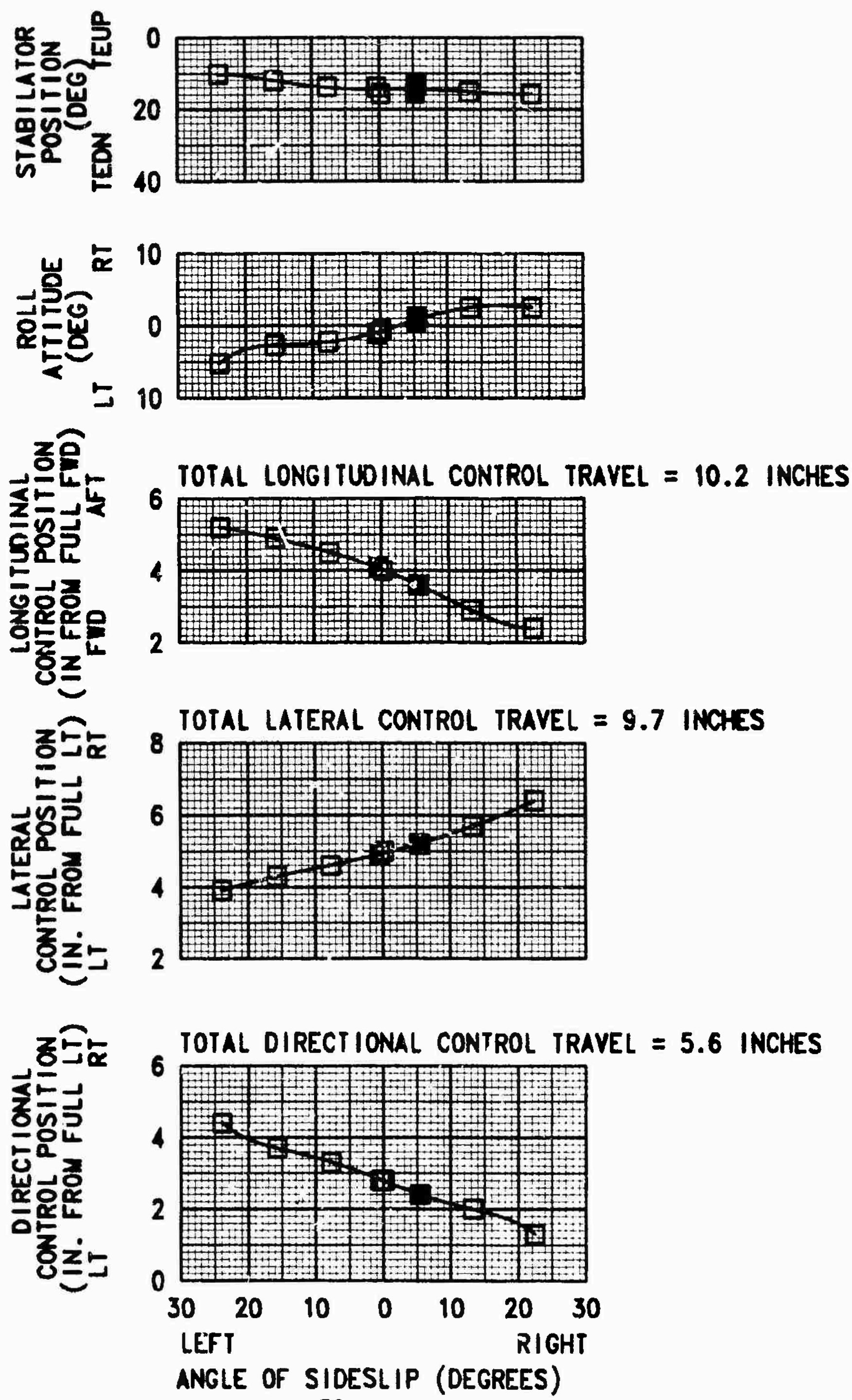


FIGURE 34

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
16450	364.7	0.2 RT	5850	10.5	258	73

NOTE:
1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. PPA CENTERED AND LOCKED

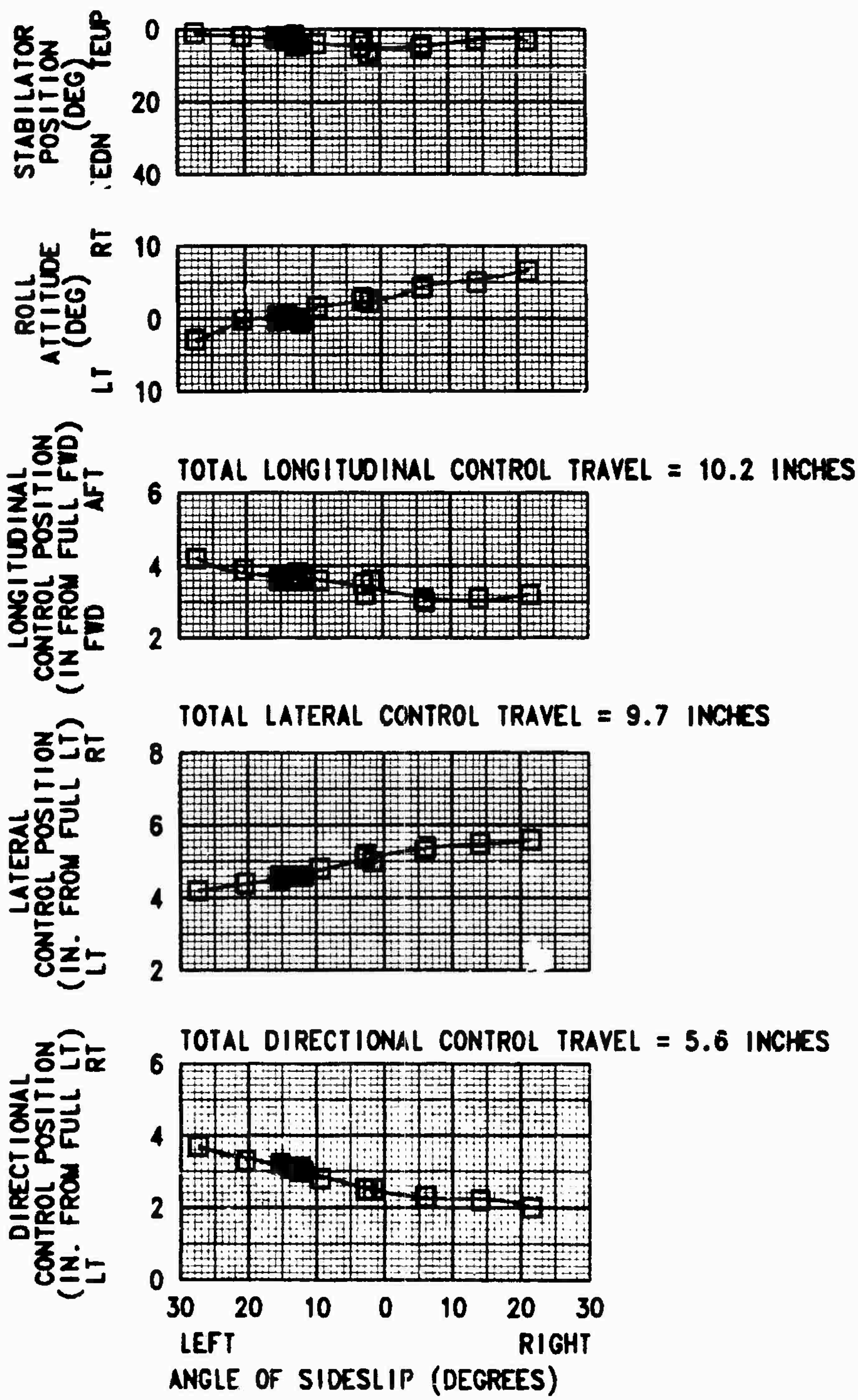


FIGURE 35

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)
22030	360.8	0.2 RT	6560	13.5	258	72

NOTE: 1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. PBA CENTERED AND LOCKED

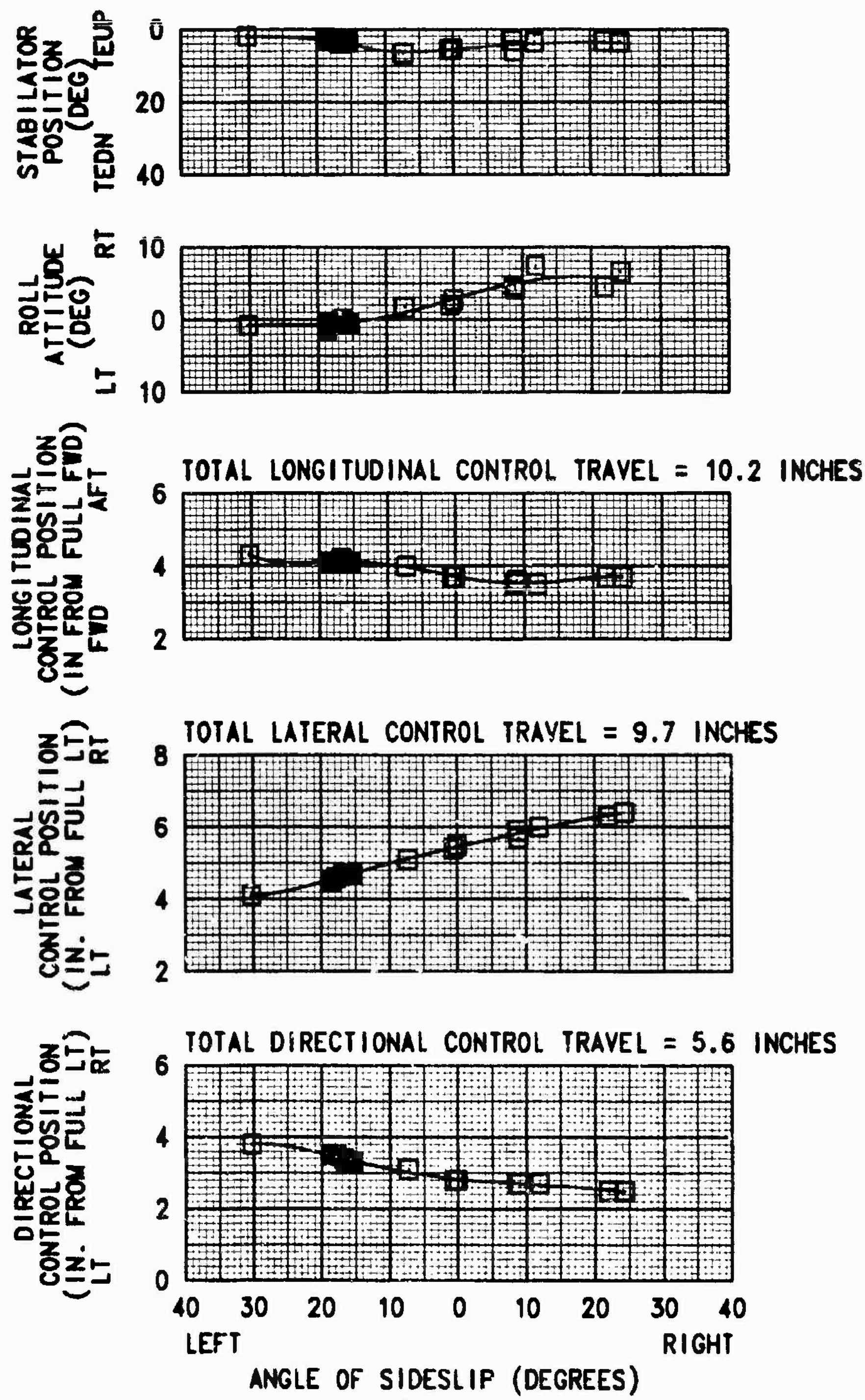


FIGURE 36
AFT LONGITUDINAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
22290	361.4	0.3 LT	6160	13.0	258	71	ON

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. PBA CENTERED AND LOCKED

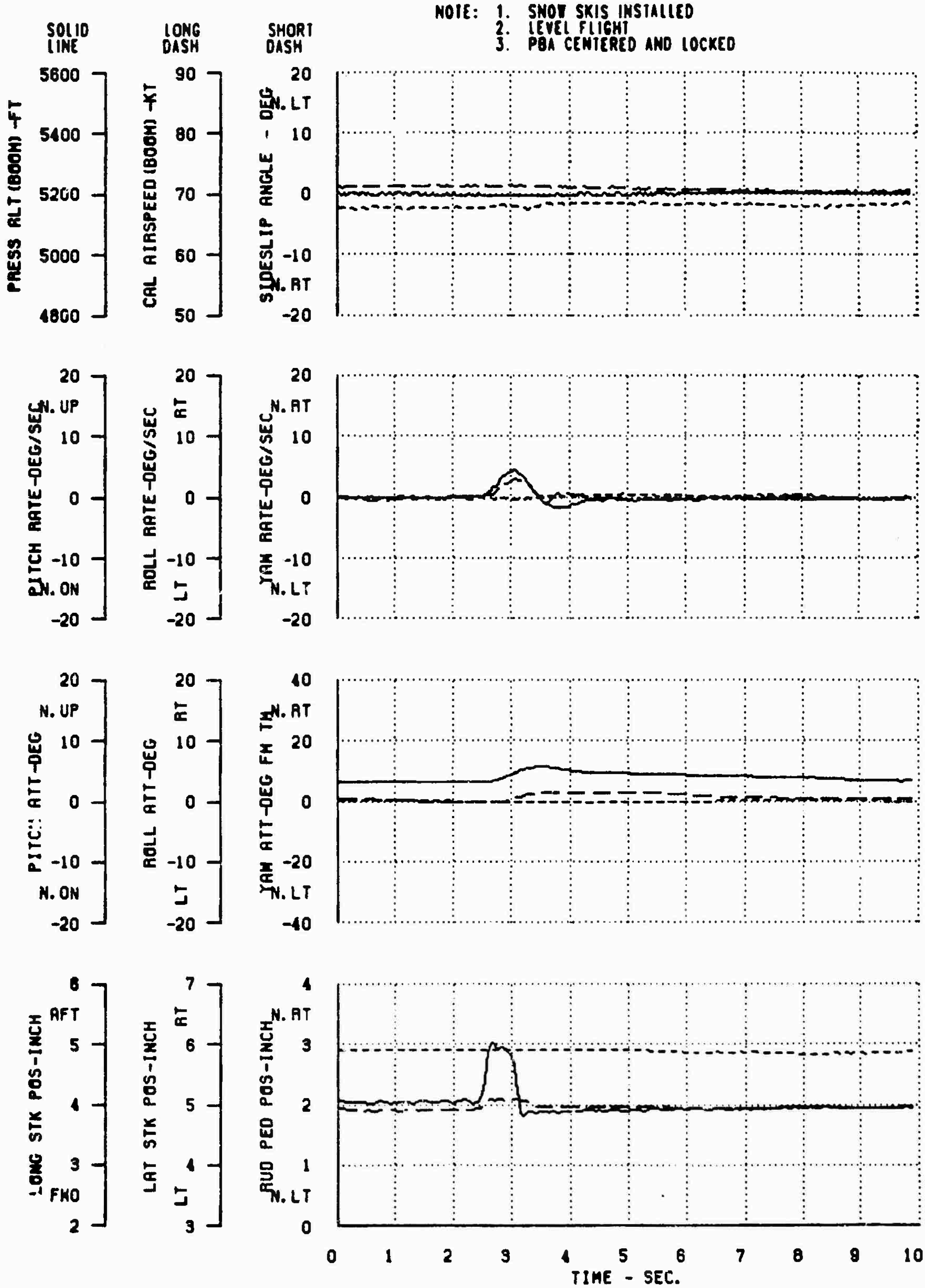


FIGURE 37
LEFT LATERAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
22270	361.4	0.3 LT	6200	13.0	258	72	ON

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. PBA CENTERED AND LOCKED

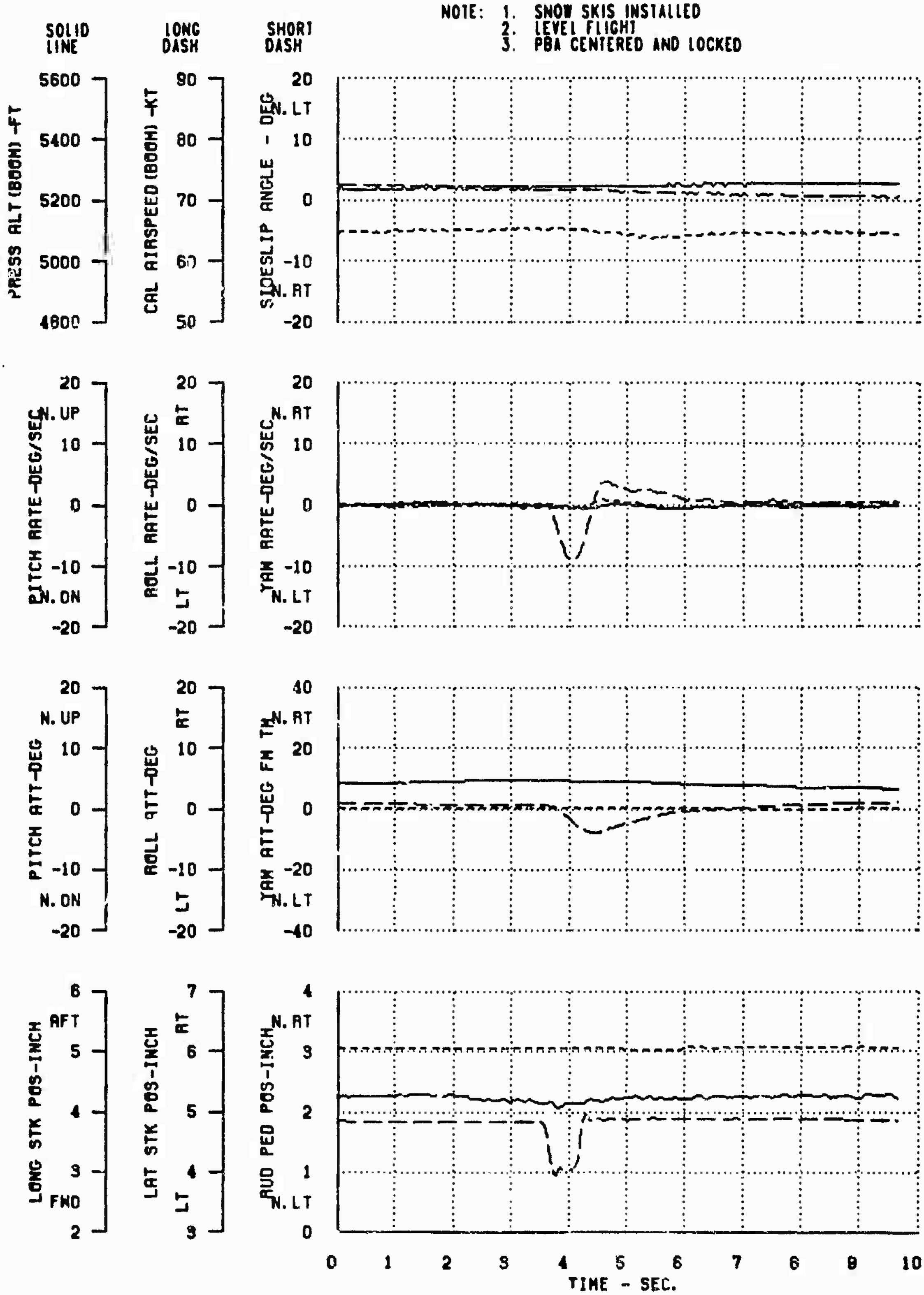


FIGURE 38
LEFT DIRECTIONAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
22240	361.3	0.3 LT	6220	13.0	258	71	ON

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. PBA CENTERED AND LOCKED

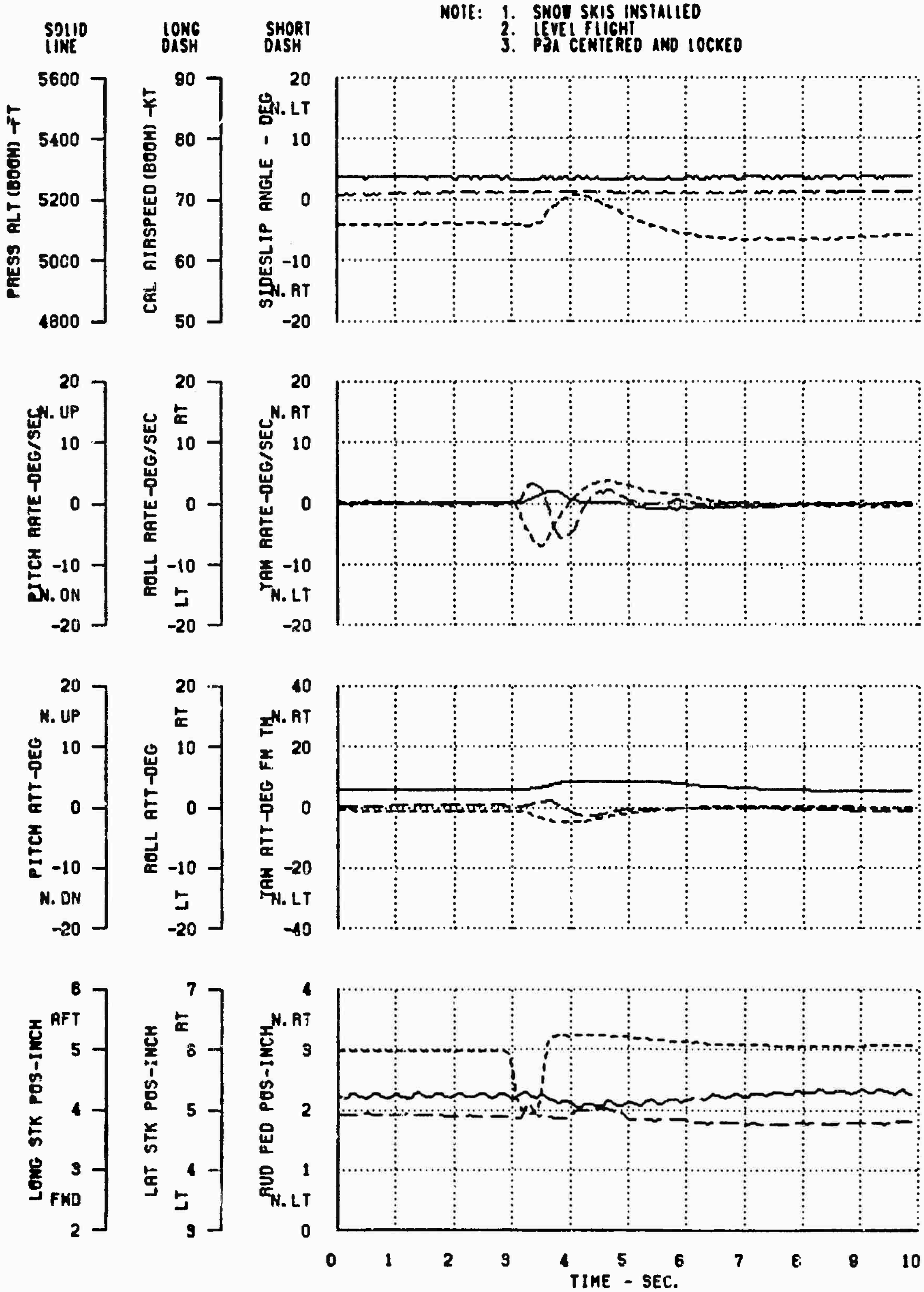


FIGURE 39

LEFT SIDESLIP RELEASE

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
22180	361.1	0.3 LT	8040	13.5	258	88	ON

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT
3. PBA CENTERED AND LOCKED

SOLID LINE | LONG DASH | SHORT DASH

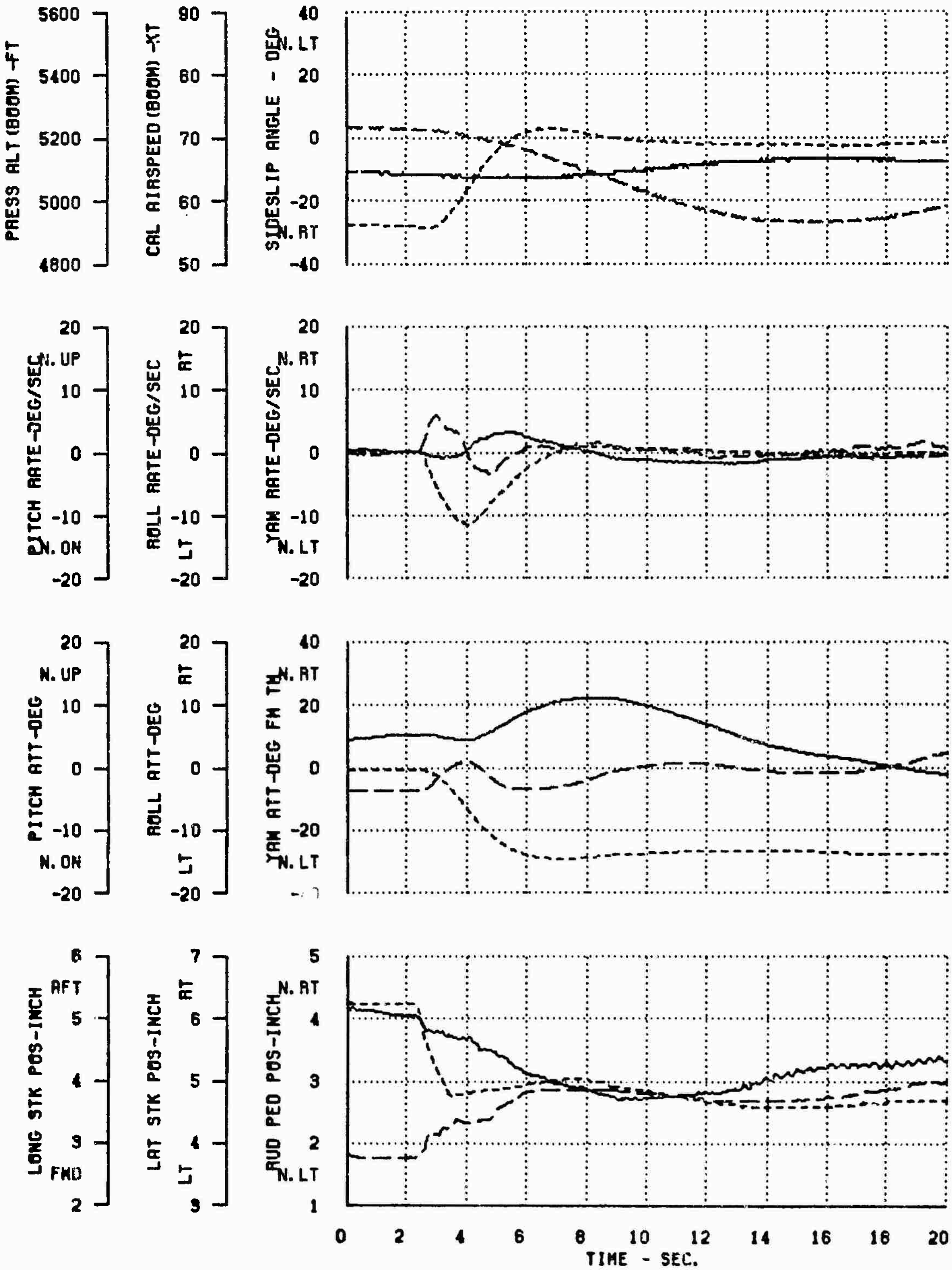


FIGURE 40
AFT LONGITUDINAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16370	364.4	0.3 LT	5220	13.0	256	75	ON

NOTE: 1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. PBA CENTERED AND LOCKED

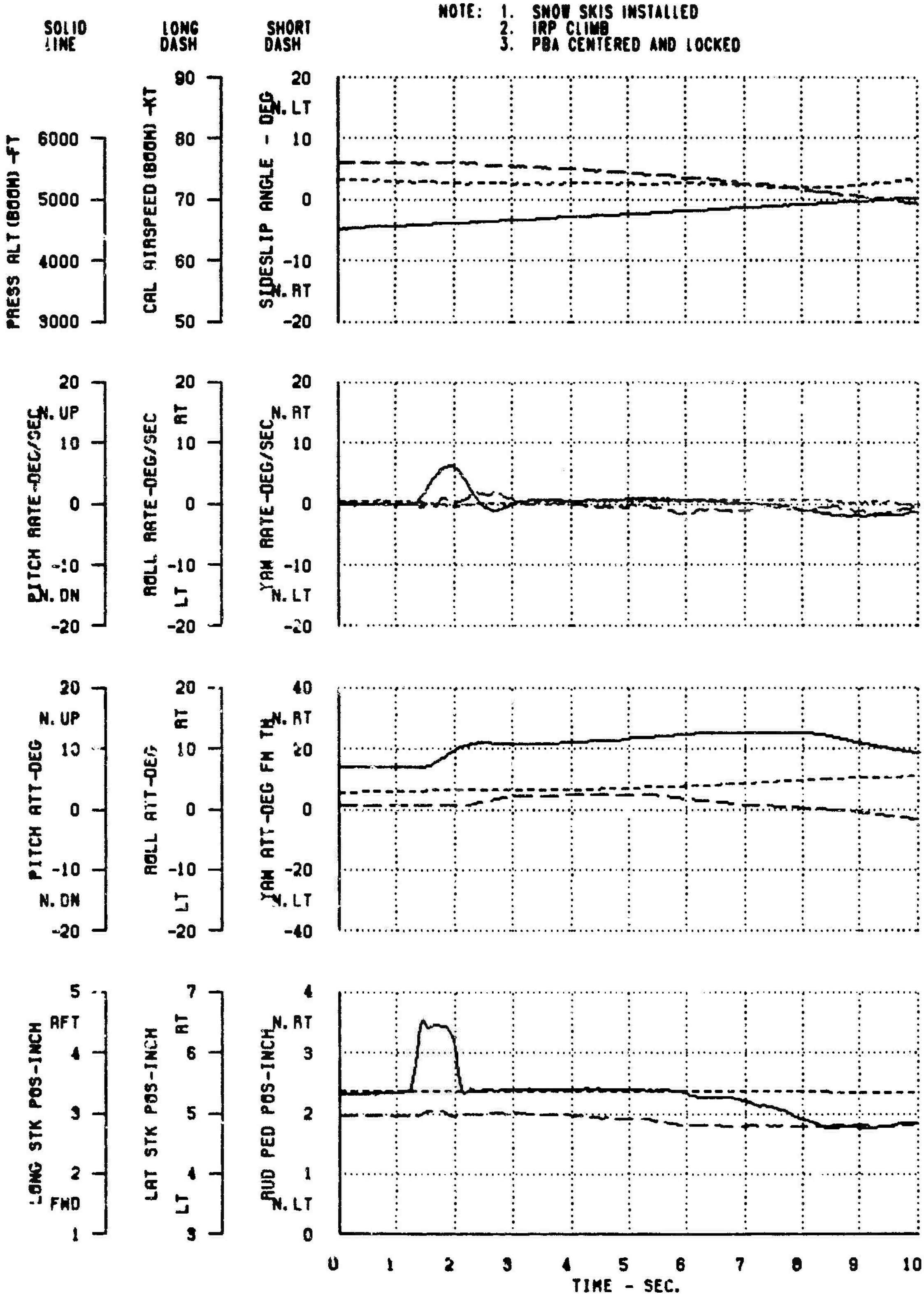


FIGURE 41
LEFT LATERAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16540	365.0	0.3 LT	5920	11.0	258	71	ON

NOTE: 1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. PBA CENTERED AND LOCKED

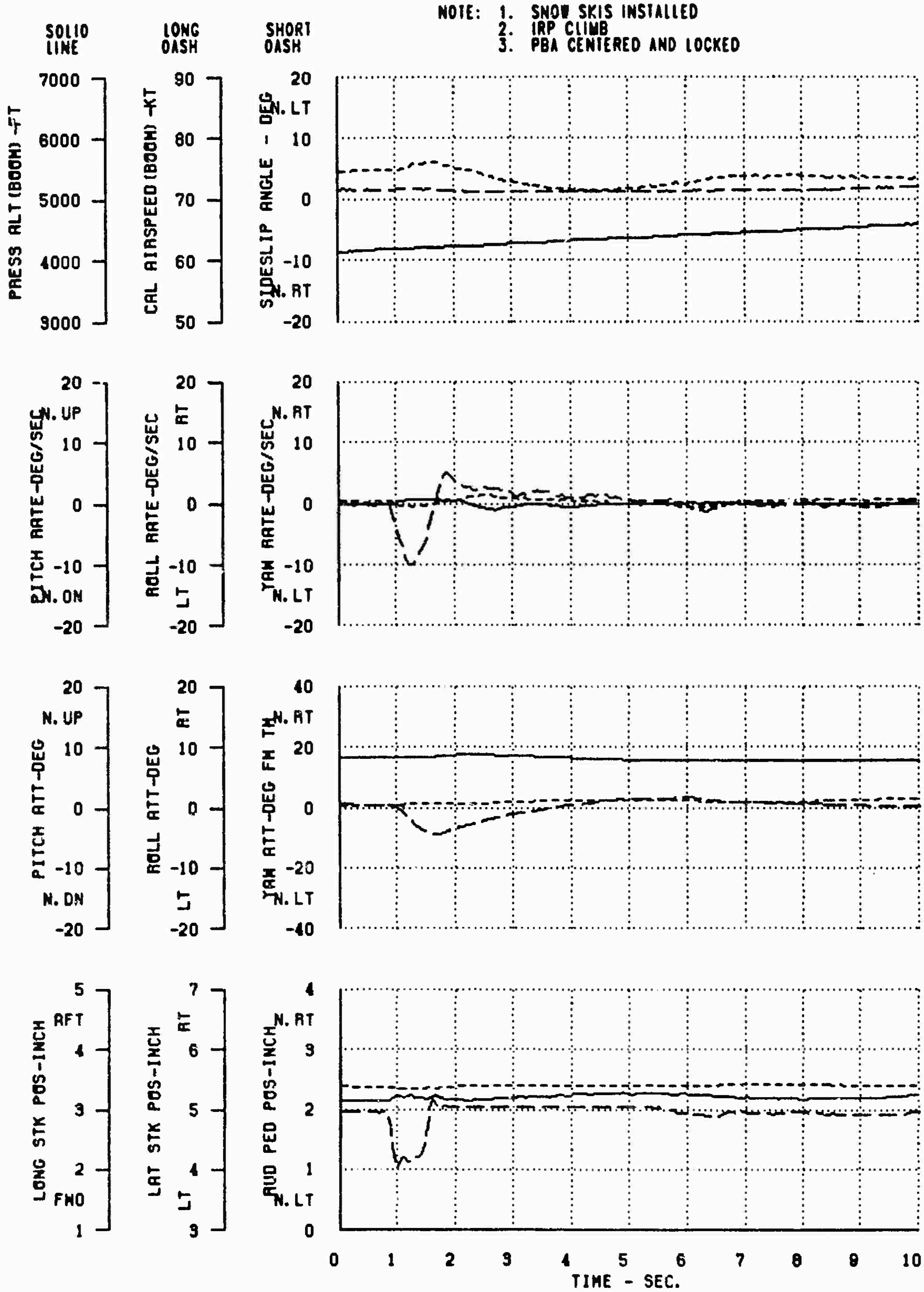


FIGURE 42
LEFT DIRECTIONAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
18300	364.2	0.3 LT	5280	13.0	258	78	ON

NOTE: 1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. PBA CENTERED AND LOCKED

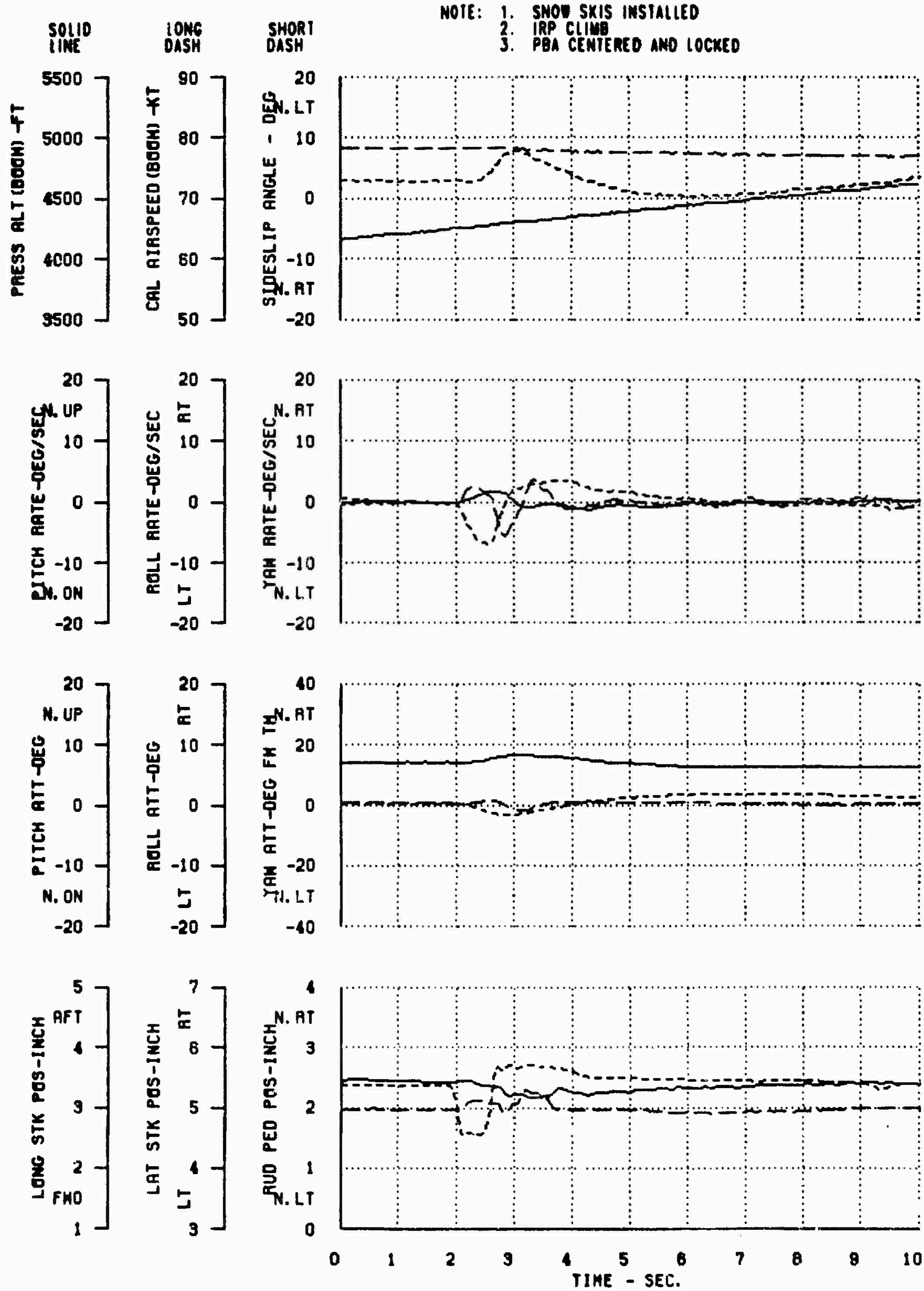


FIGURE 43
LEFT SIDESLIP RELEASE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16000	363.3	0.3 LT	6500	10.0	258	70	ON

NOTE: 1. SNOW SKIS INSTALLED
2. IRP CLIMB
3. PBA CENTERED AND LOCKED

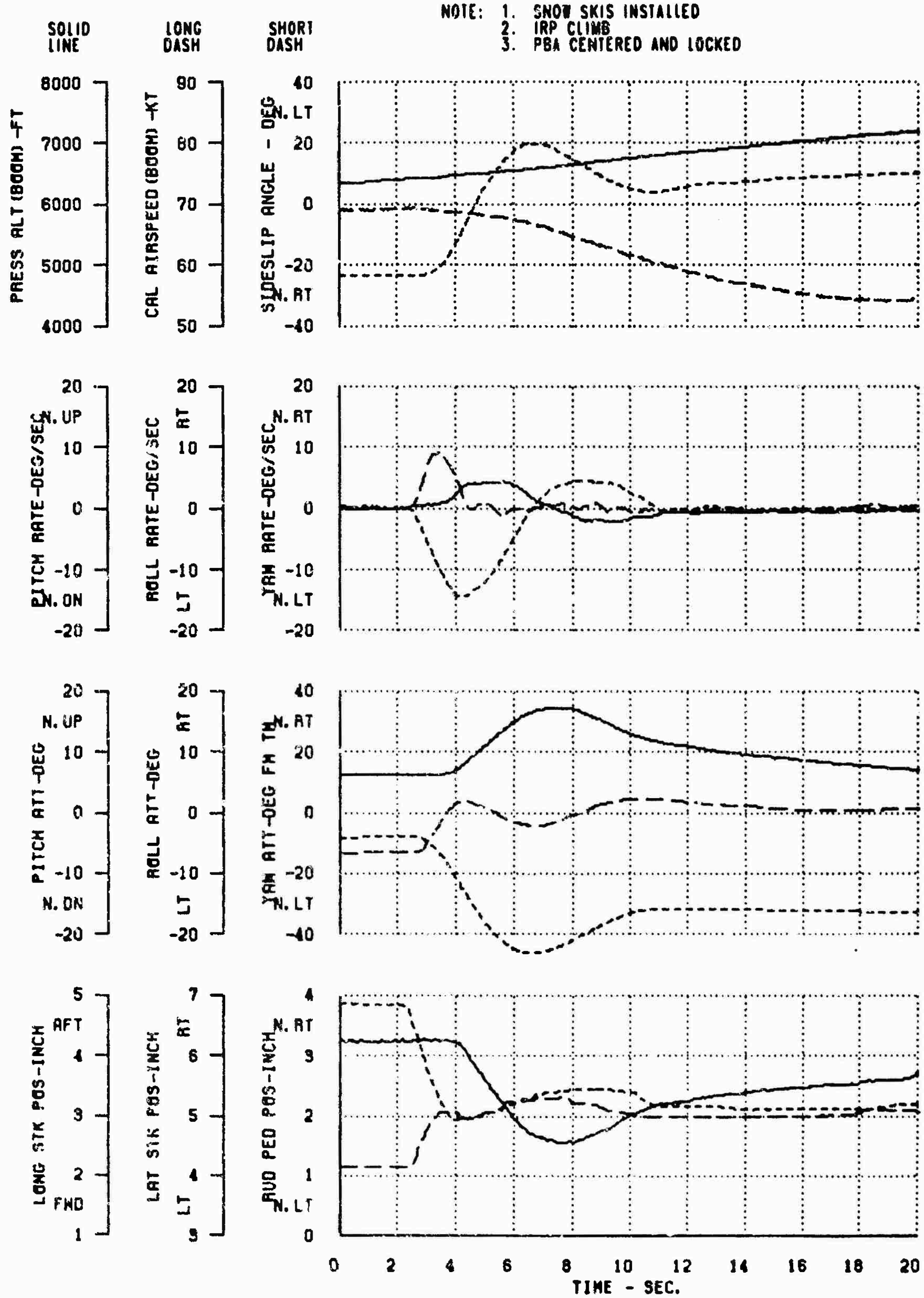


FIGURE 44
AFT LONGITUDINAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16590	365.2	0.3 LT	6680	9.0	258	69	ON

NOTE: 1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. PBA CENTERED AND LOCKED

SOLID LINE — LONG DASH — SHORT DASH

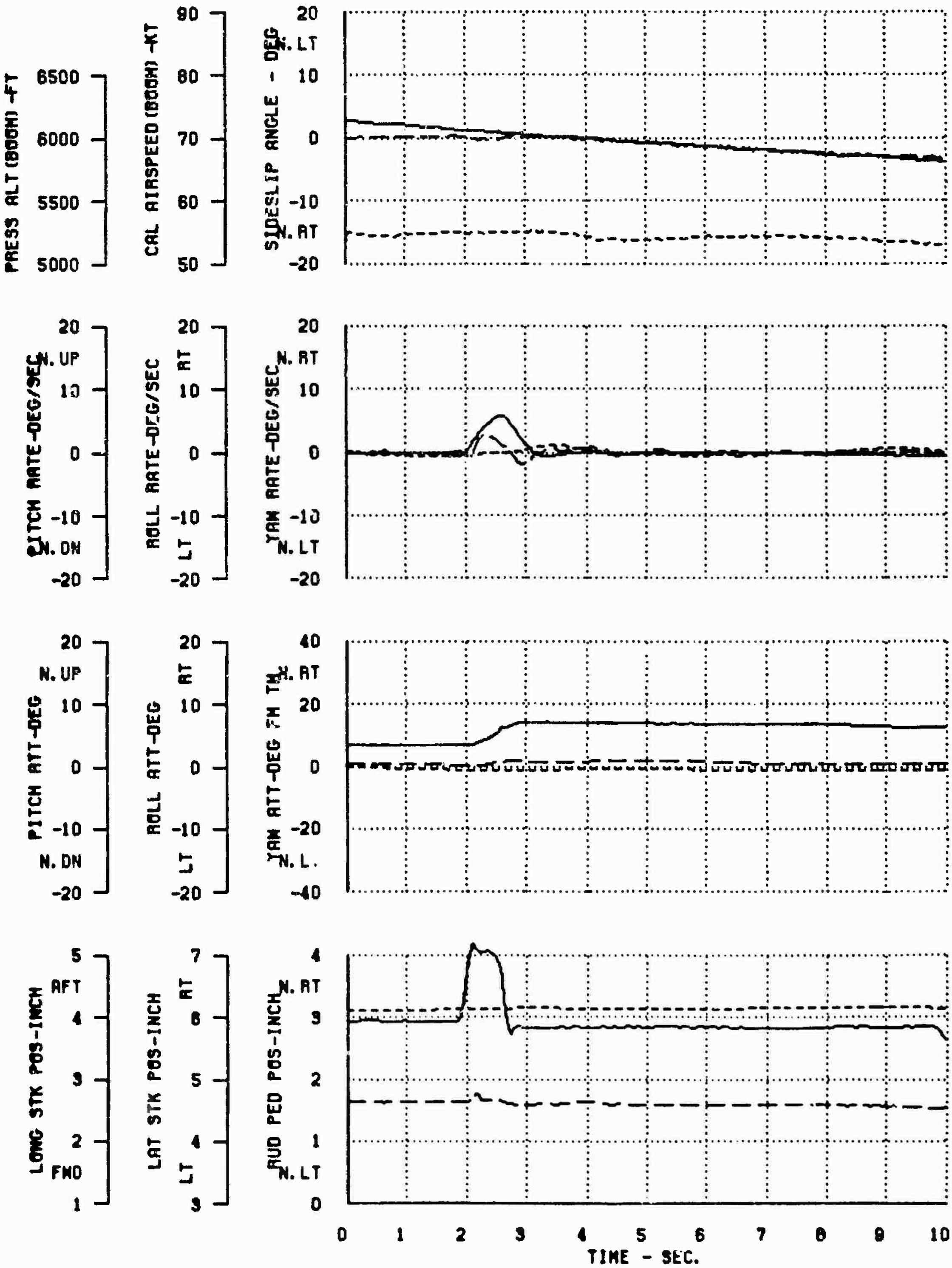


FIGURE 45
LEFT LATERAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
22290	361.4	0.3 LT	5780	15.0	261	71	ON

NOTE: 1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. PBA CENTERED AND LOCKED

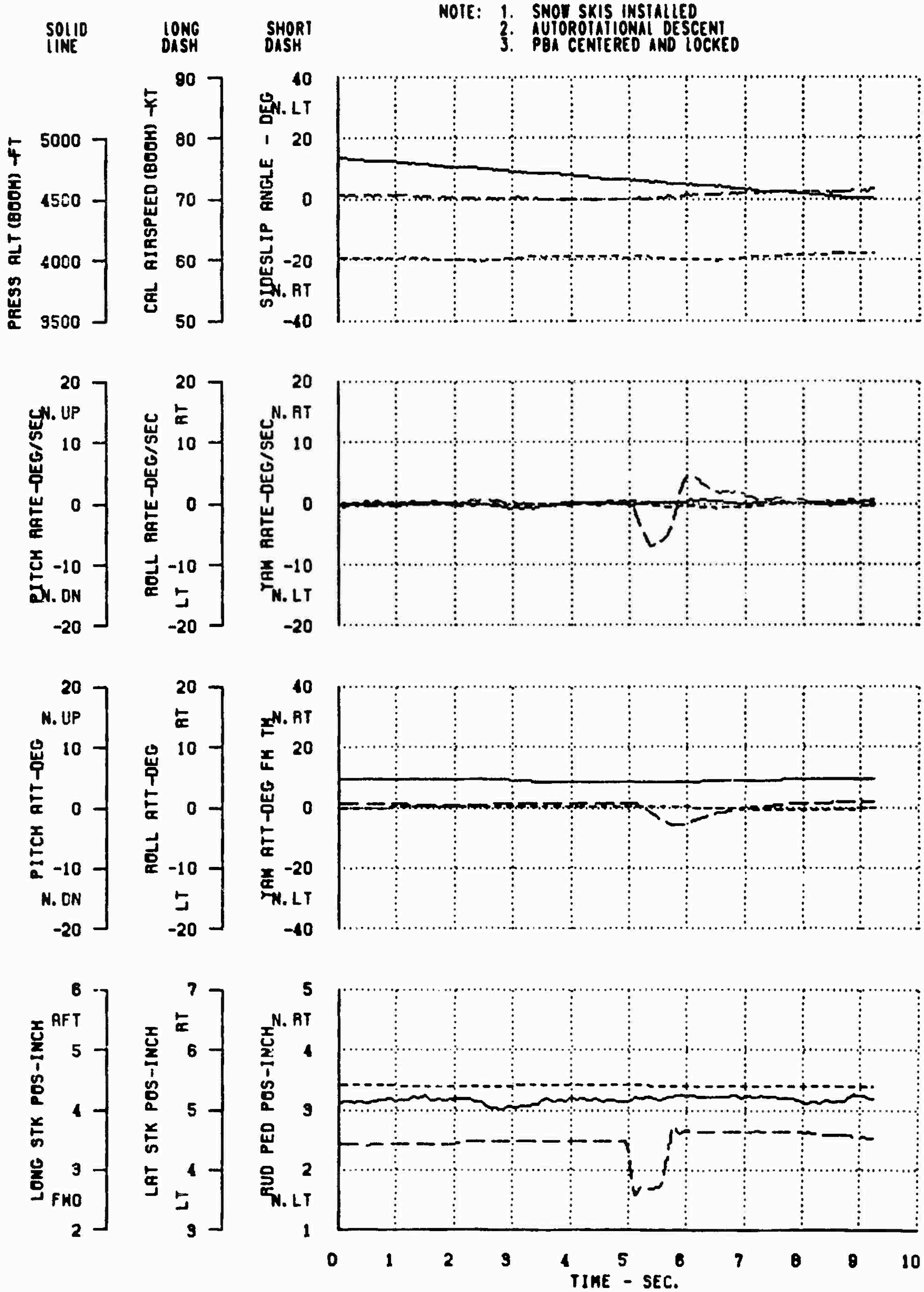


FIGURE 46
LEFT DIRECTIONAL PULSE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
22170	361.1	0.3 LT	7360	11.0	266	72	ON

NOTE: 1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. PBA CENTERED AND LOCKED

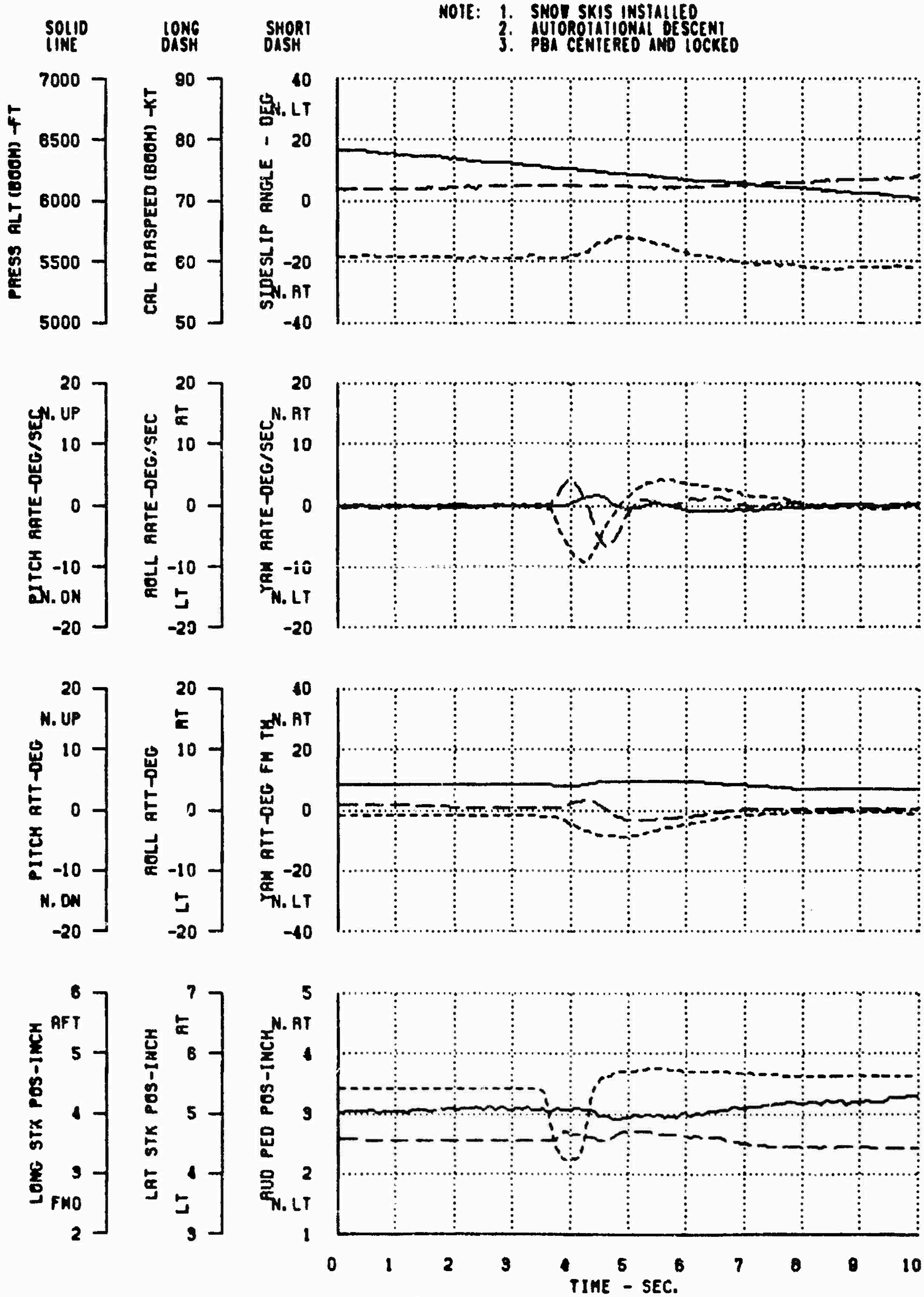


FIGURE 47
RIGHT SIDESLIP RELEASE
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16410	364.6	0.3 LT	3900	16.0	256	68	ON

NOTE: 1. SNOW SKIS INSTALLED
2. AUTOROTATIONAL DESCENT
3. PBA CENTERED AND LOCKED

SOLID LINE | LONG DASH | SHORT DASH

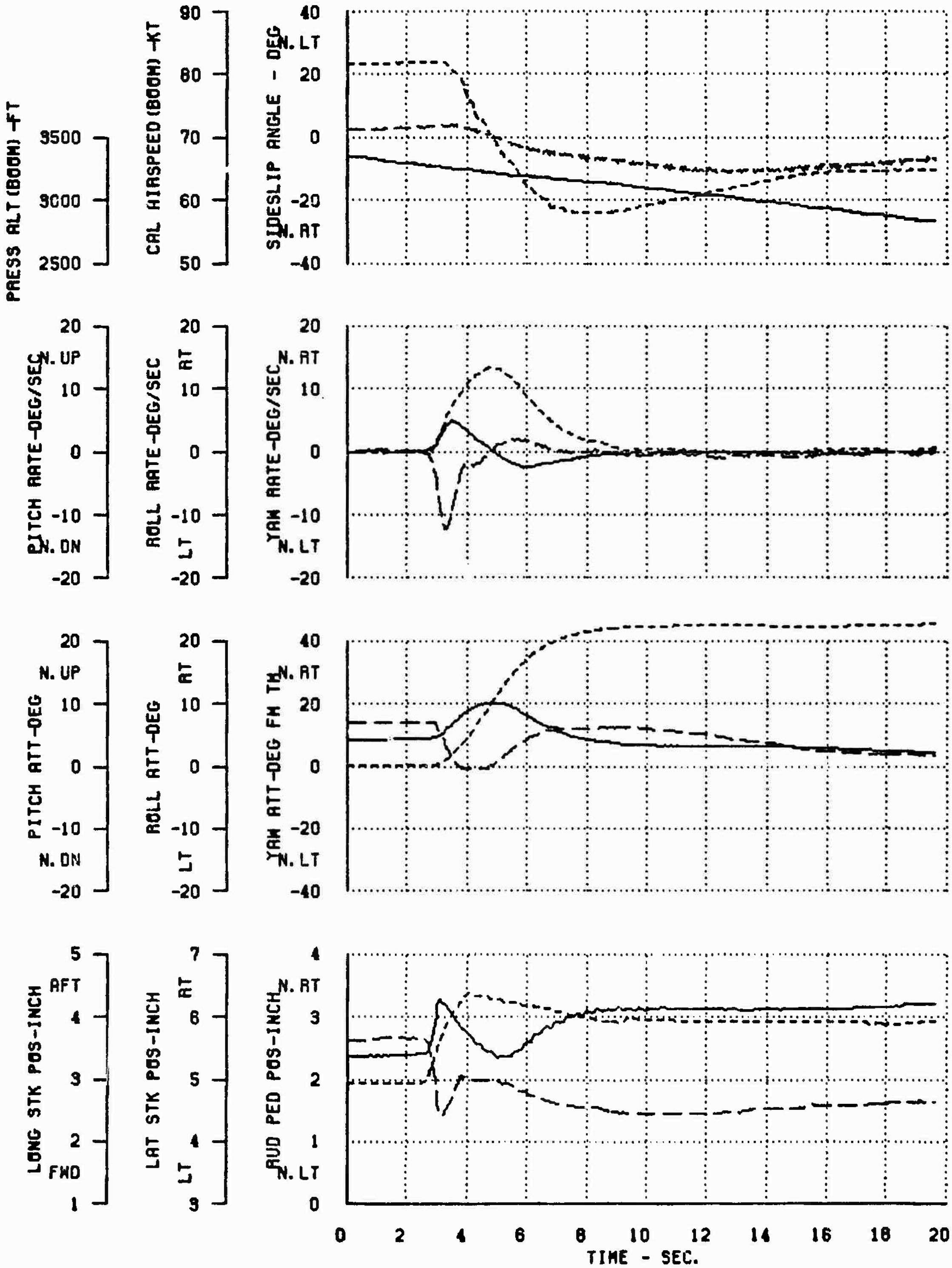


FIGURE 48
CROSS SLOPE LANDING
UH-60A USA S/N 84-23353

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16220	346.1	0.3 LT	810	22.2	258	00	ON

NOTE: 1. SNOW SKIS INSTALLED
2. GROUND SLOPE = 6.6 DEGREES
3. LEFT WHEEL UPHILL

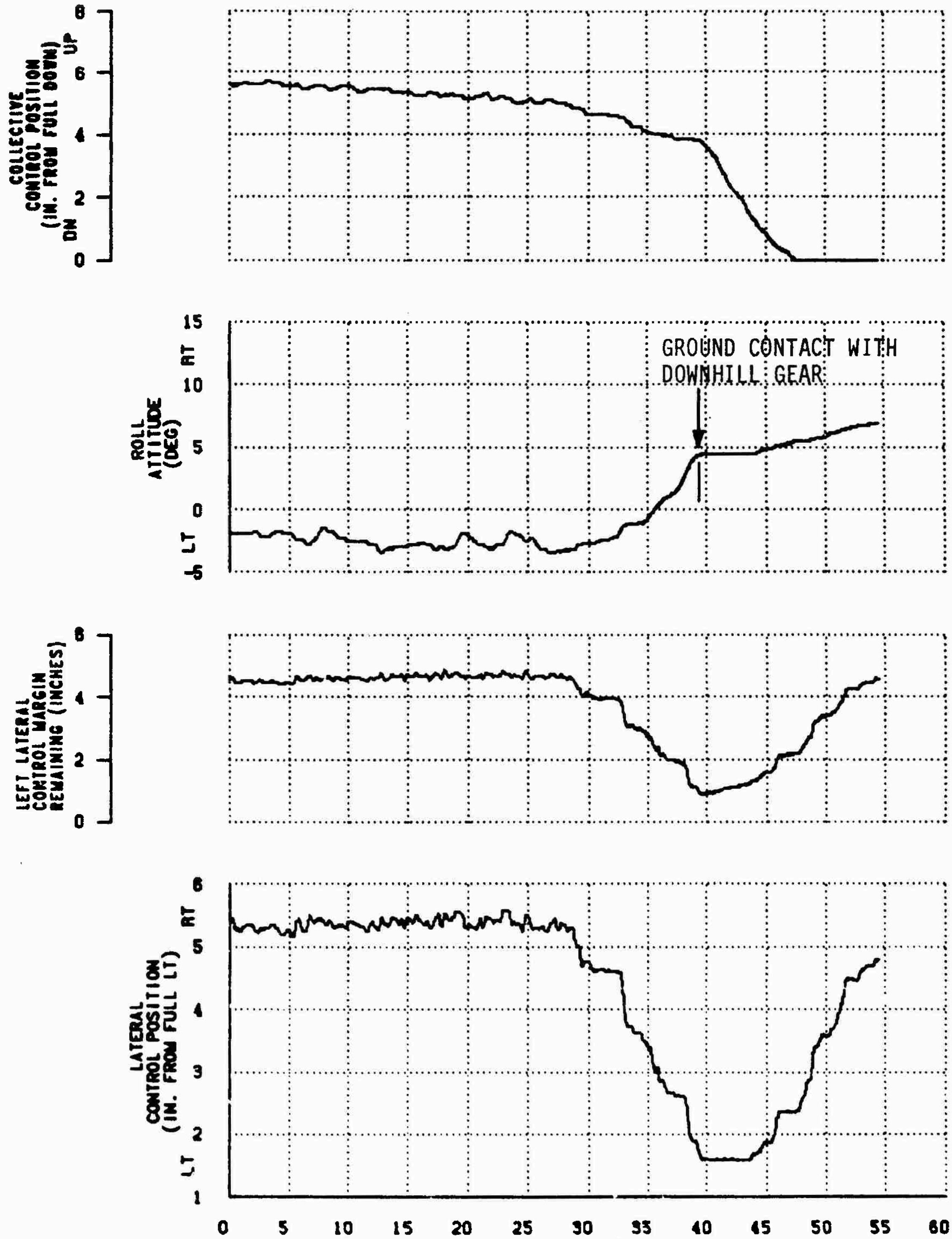


FIGURE 49
CROSS SLOPE LANDING
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	SAS CONDITION
16270	346.4	0.3 LT	810	21.9	258	00	ON

NOTE: 1. SNOW SKIS INSTALLED
2. GROUND SLOPE = 7.2 DEGREES
3. RIGHT WHEEL UPHILL

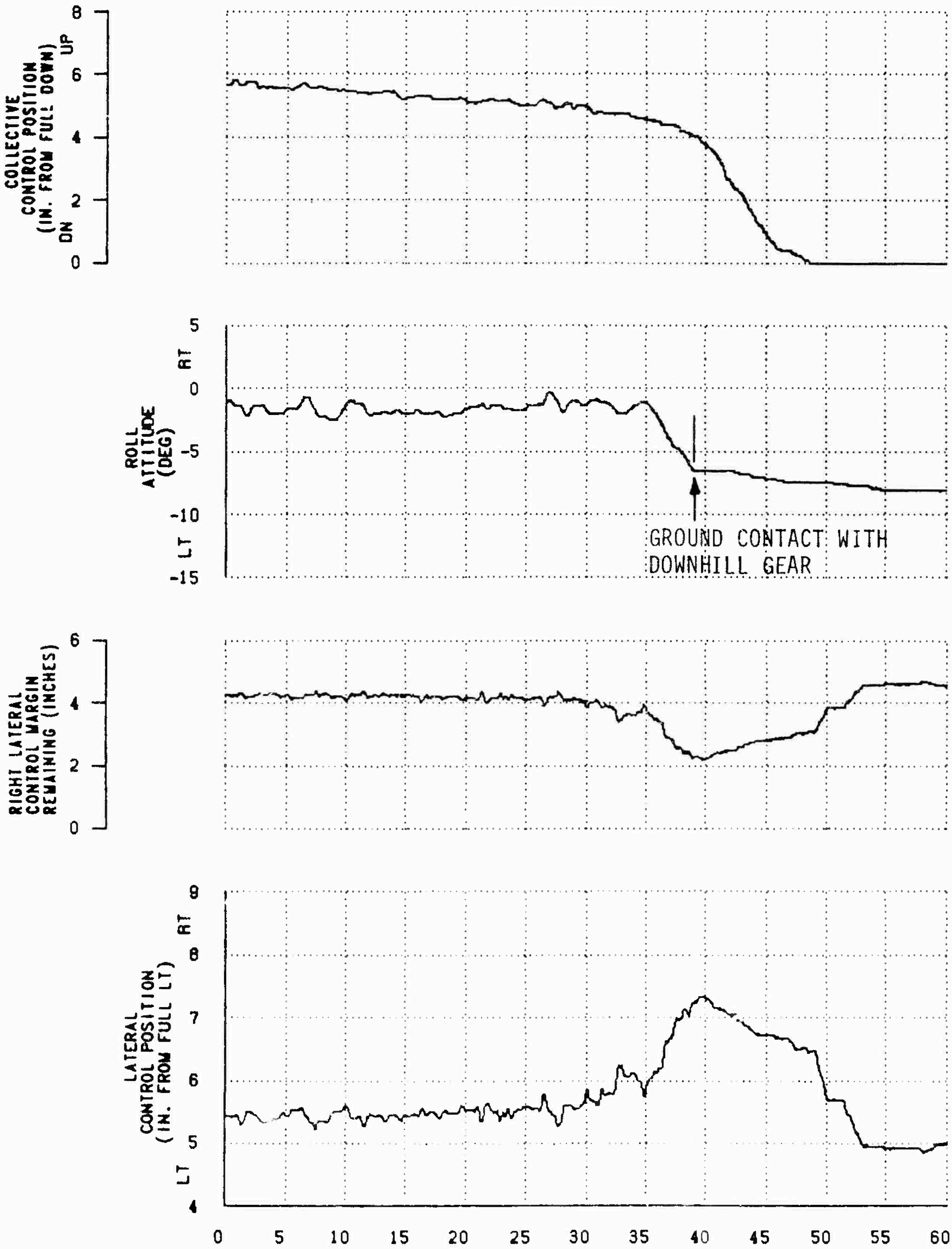


FIGURE 56

LOW SPEED FORWARD AND REARWARD FLIGHT CHARACTERISTICS

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
□	16660	347.6	0.2 RT	270	17.5	258	30	SKIS INSTALLED
○	16490	347.2	0.2 RT	110	16.5	258	30	SKIS INSTALLED

NOTE: 1. VERTICAL LINES DENOTE CONTROL EXCURSIONS
2. PBA CENTERED AND LOCKED

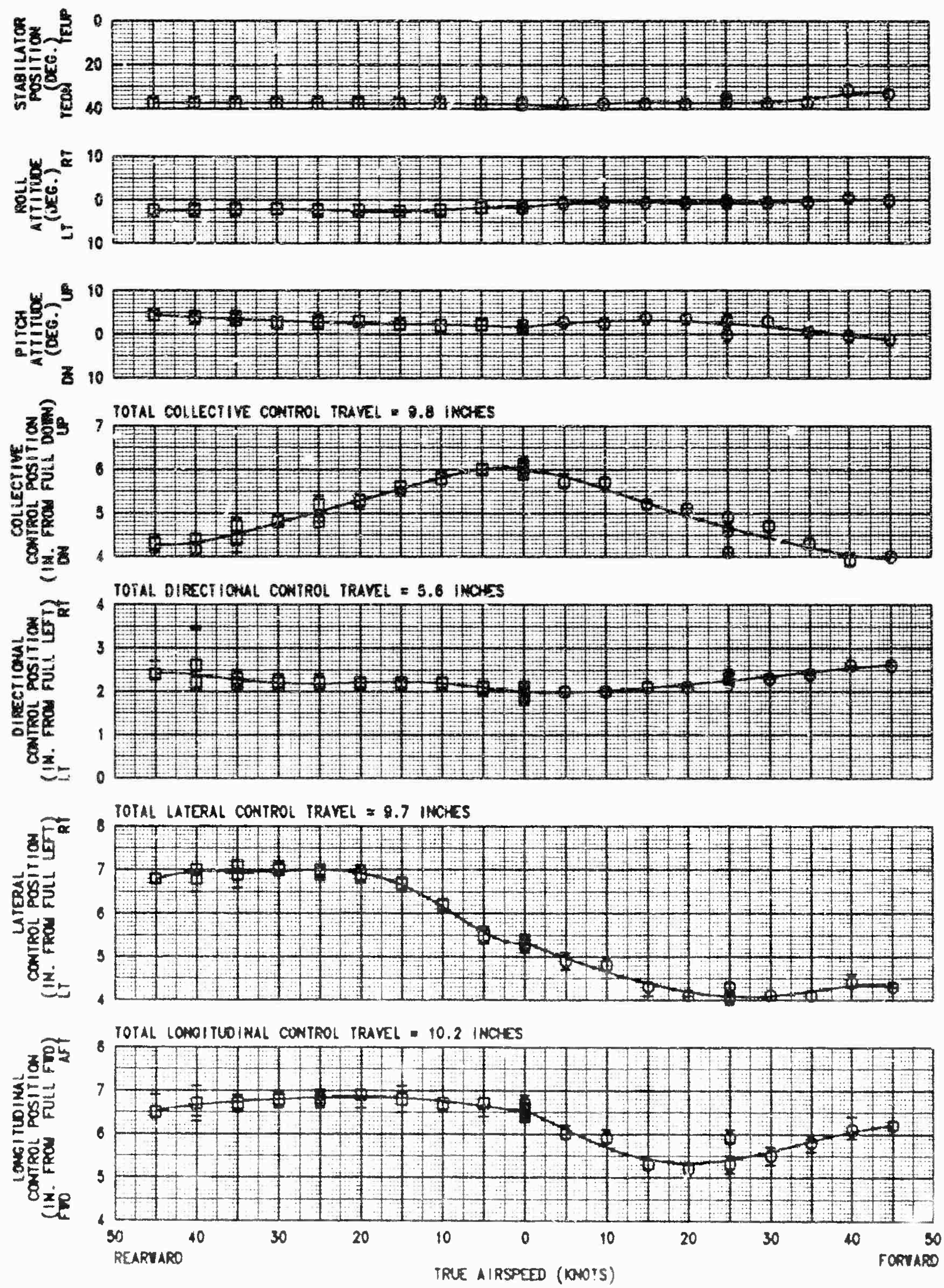


FIGURE 51

LOW SPEED RIGHT AND LEFT SIDEWARD FLIGHT CHARACTERISTICS

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
□	16540	347.3	0.2 RT	520	16.0	258	30	SKIS INSTALLED
○	16550	347.4	0.2 RT	200	17.0	258	30	SKIS INSTALLED

NOTE: 1. VERTICAL LINES DENOTE CONTROL EXCURSIONS
2. PBA CENTERED AND LOCKED

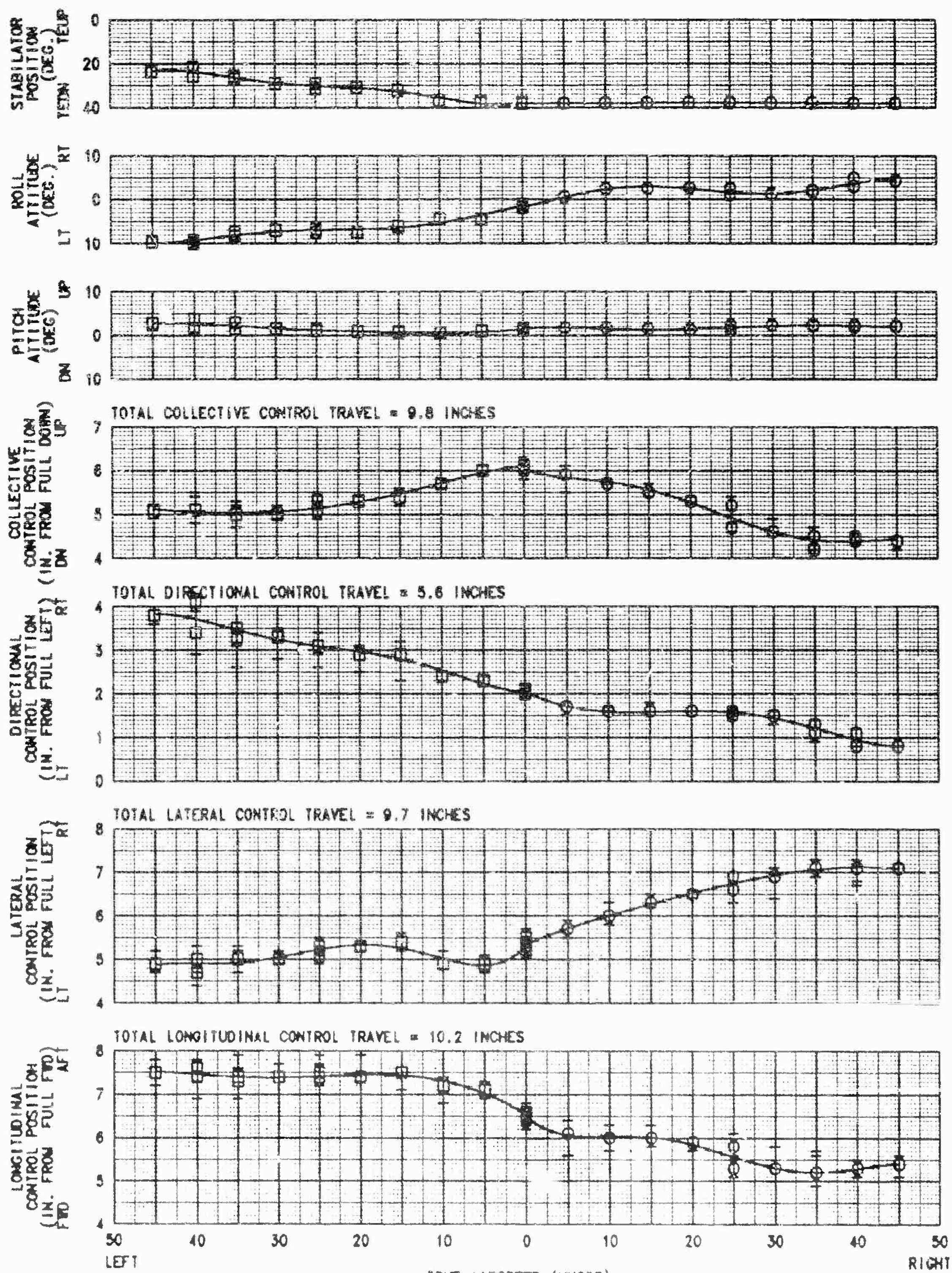


FIGURE 52

LOW SPEED 315 DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
16550	347.4	0.2 RT	300	18.5	258	30	SKIS INSTALLED

NOTE: 1. VERTICAL LINES DENOTE CONTROL EXCURSIONS
2. PBA CENTERED AND LOCKED

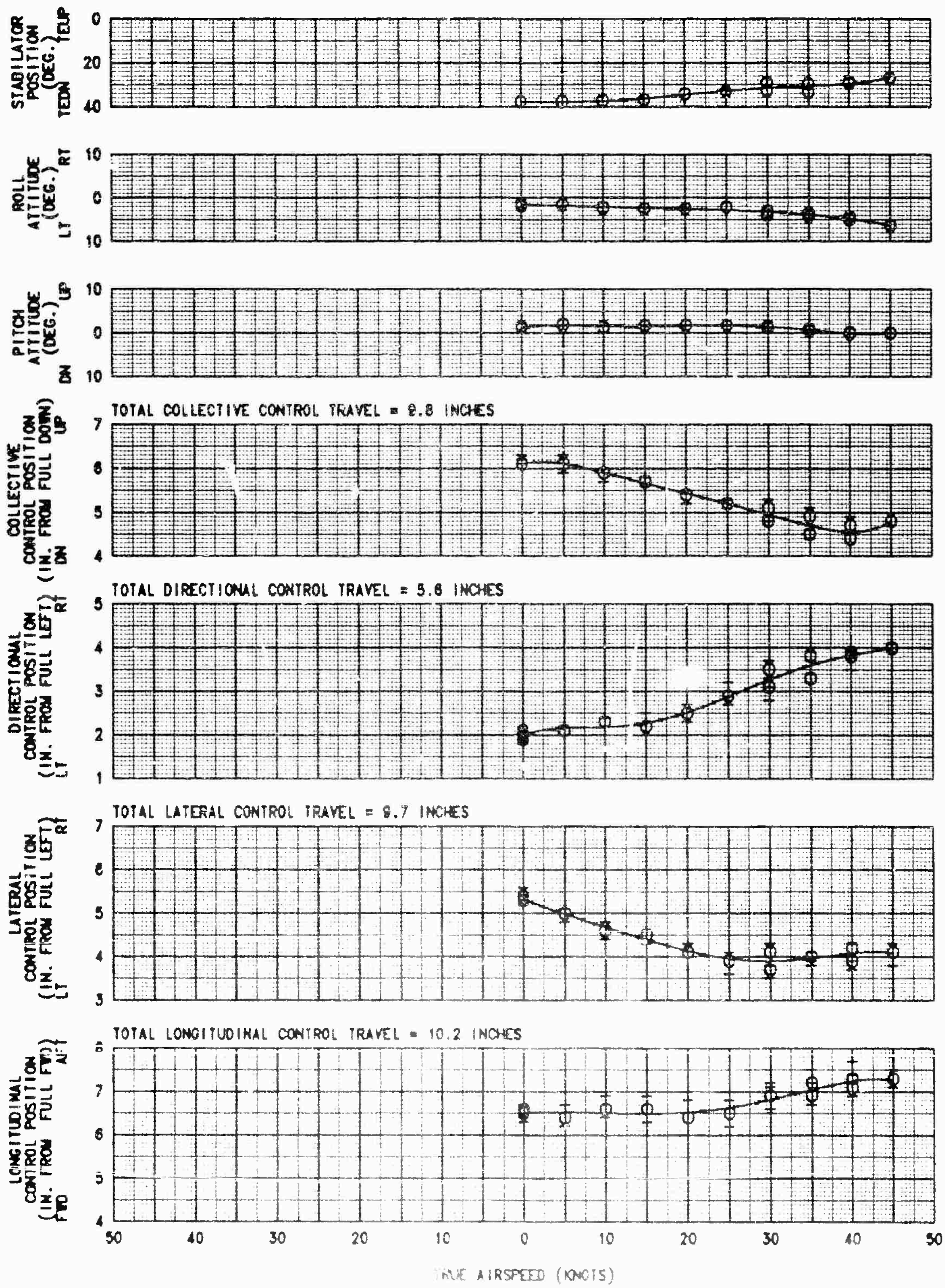


FIGURE 53

LOW SPEED FORWARD AND REARWARD FLIGHT CHARACTERISTICS

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
□	22280	348.2	0.2 RT	690	21.0	258	30	SKIS INSTALLED
○	22300	348.4	0.2 RT	870	21.0	258	30	SKIS INSTALLED

NOTE: 1. VERTICAL LINES DENOTE CONTROL EXCURSIONS
2. PBA CENTERED AND LOCKED

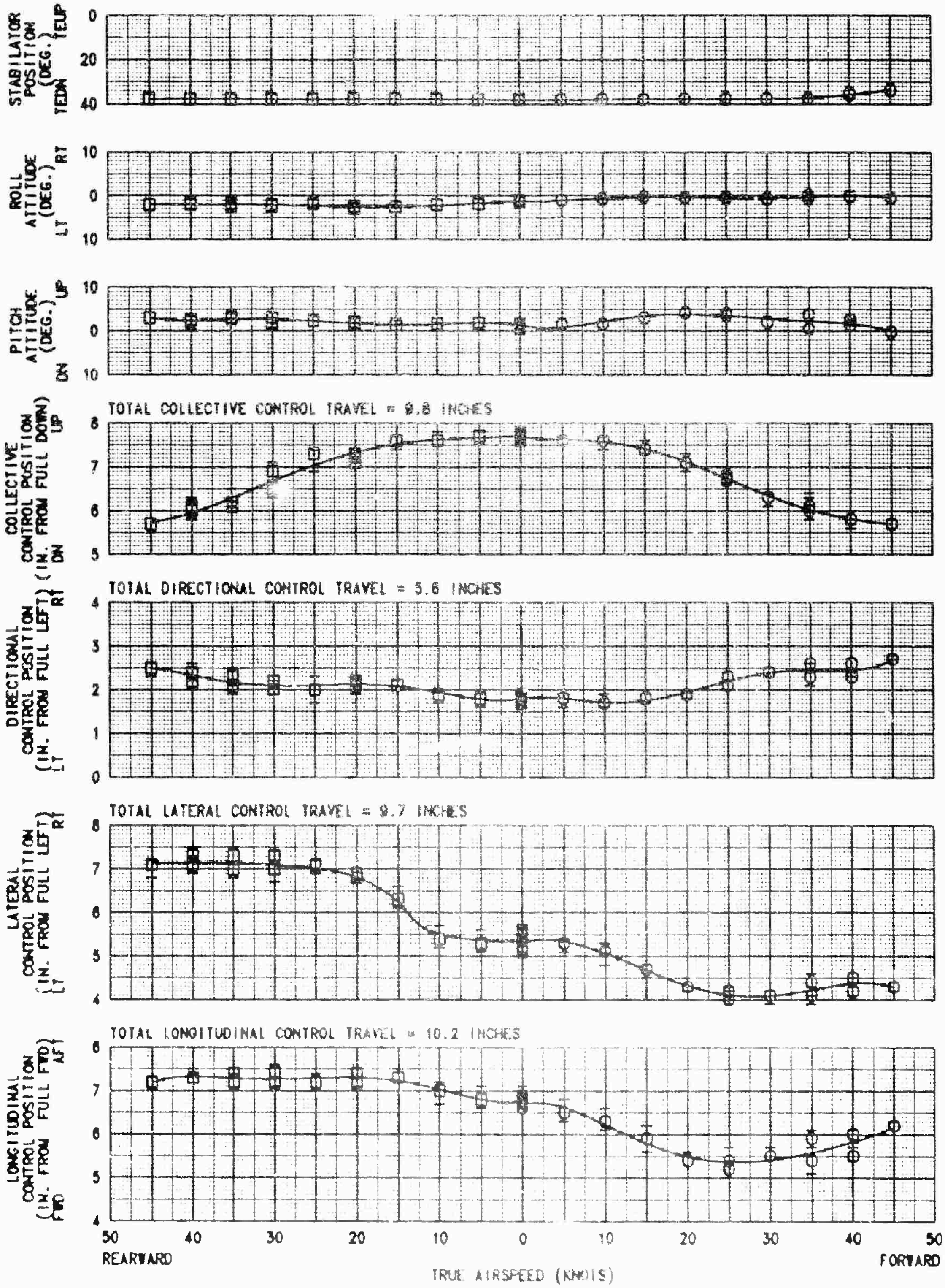


FIGURE 54

LOW SPEED RIGHT AND LEFT SIDEWARD FLIGHT CHARACTERISTICS

UH-60A USA S/N 84-23953

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
□	22310	348.5	0.2 RT	850	22.5	258	30	SKIS INSTALLED
○	22280	348.3	0.2 RT	770	22.0	258	30	SKIS INSTALLED

NOTE: 1. VERTICAL LINES DENOTE CONTROL EXCURSIONS
2. PBA CENTERED AND LOCKED

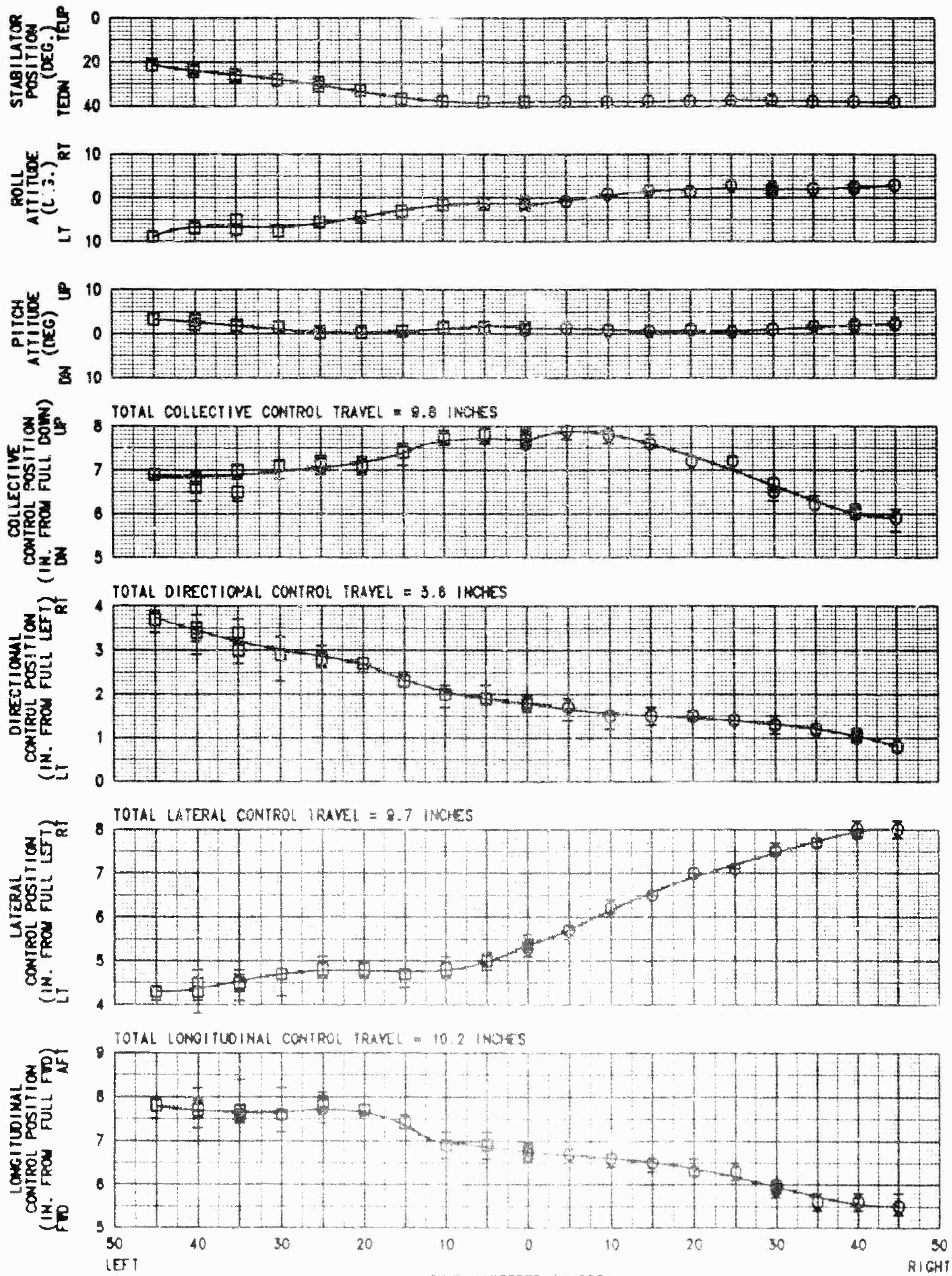


FIGURE 55

LOW SPEED 315 DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	CG LONG (FS)	AVG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
22210	348.1	0.2 RT	630	21.0	258	30	SKIS INSTALLED

NOTE: 1. VERTICAL LINES DENOTE CONTROL EXCURSIONS
2. PBA CENTERED AND LOCKED

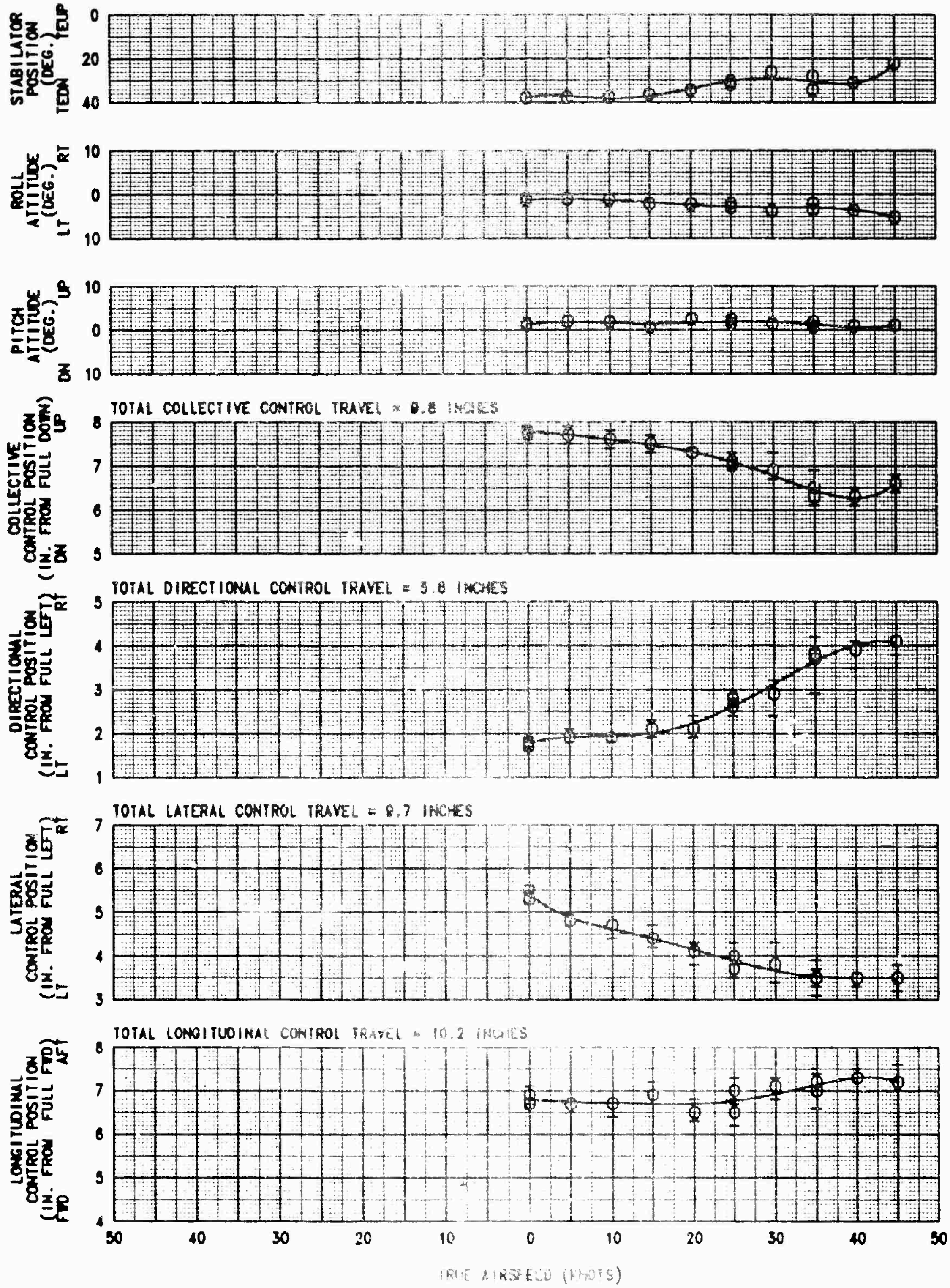


FIGURE 56

VIBRATION CHARACTERISTICS

PILOT SEAT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18540	346.5	0.2 RT	1620	10.5	256	0.006999

NOTE: 1. NORMAL UTILITY CONFIGURATION
2. LEVEL FLIGHT

○ 1/REV = 4.3 Hz
□ 4/REV = 17.2 Hz
△ 8/REV = 34.4 Hz

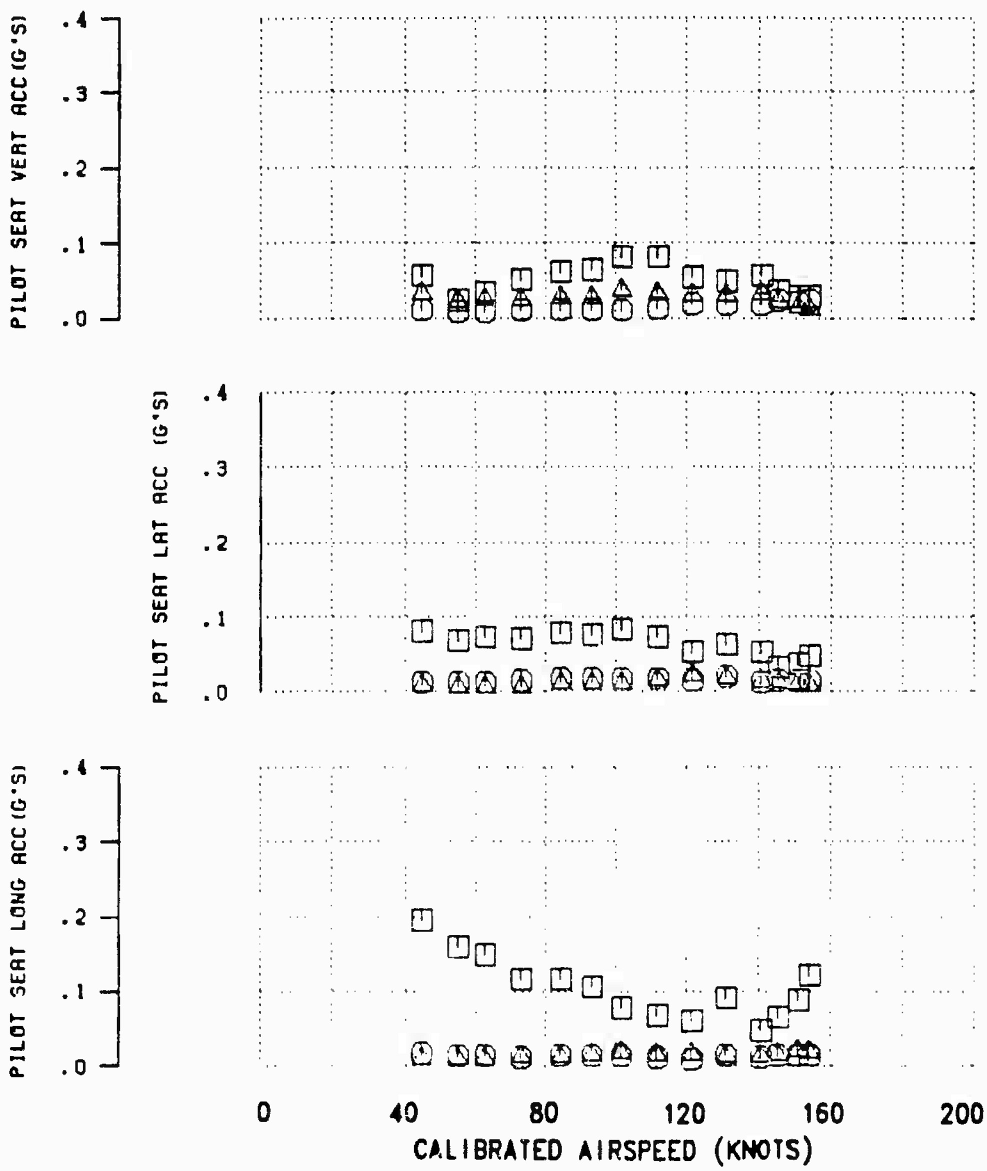


FIGURE 57
VIBRATION CHARACTERISTICS
PILOT SEAT
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18590	346.6	0.2 RT	1830	13.0	257	0.006976

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT

○ 1/REV = 4.3 Hz
□ 4/REV = 17.2 Hz
△ 8/REV = 34.4 Hz

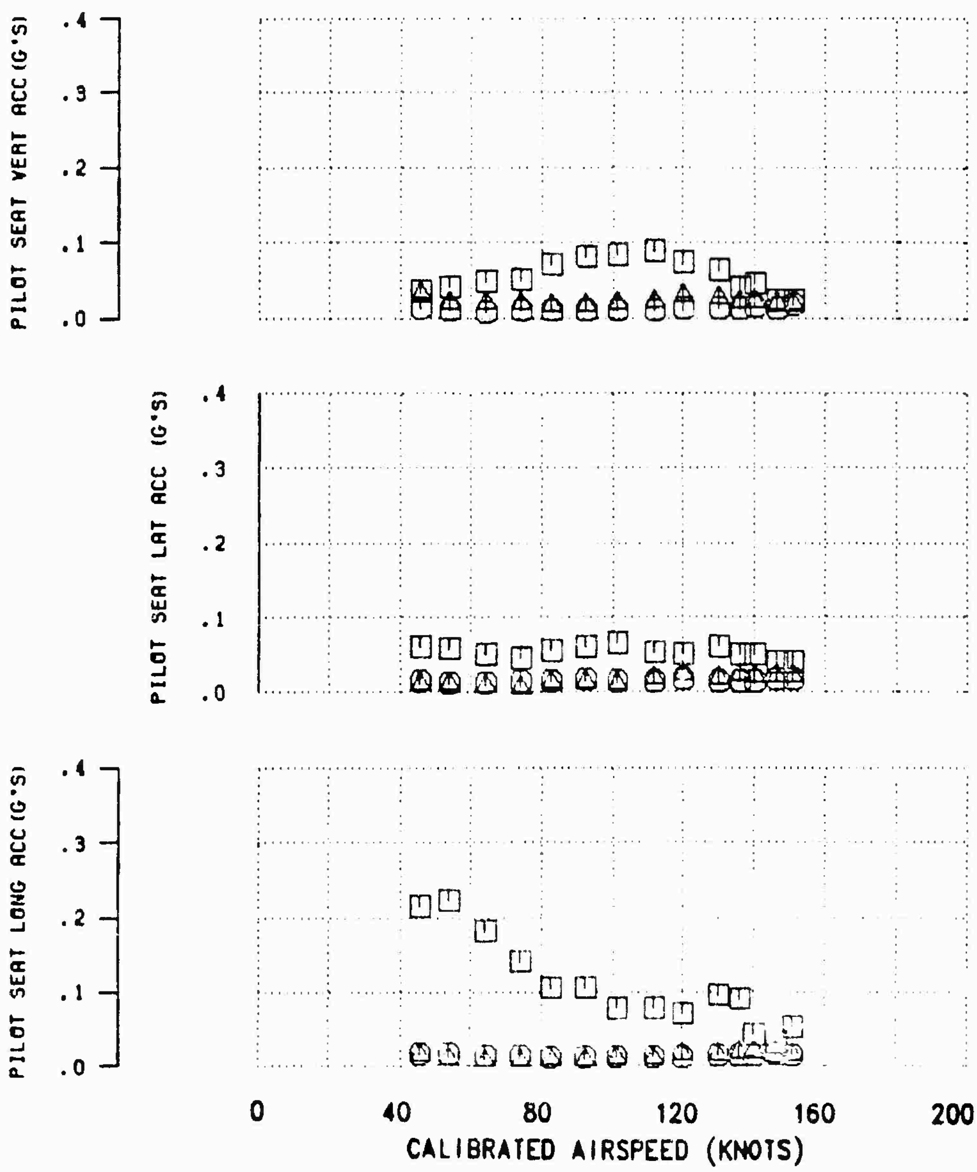


FIGURE 58

VIBRATION CHARACTERISTICS

PILOT SEAT

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18470	345.8	0.2 RT	12000	-1.0	251	0.010008

NOTE: 1. NORMAL UTILITY CONFIGURATION
2. LEVEL FLIGHT

○ 1/REV = 4.3 Hz
□ 4/REV = 17.2 Hz
△ 8/REV = 34.4 Hz

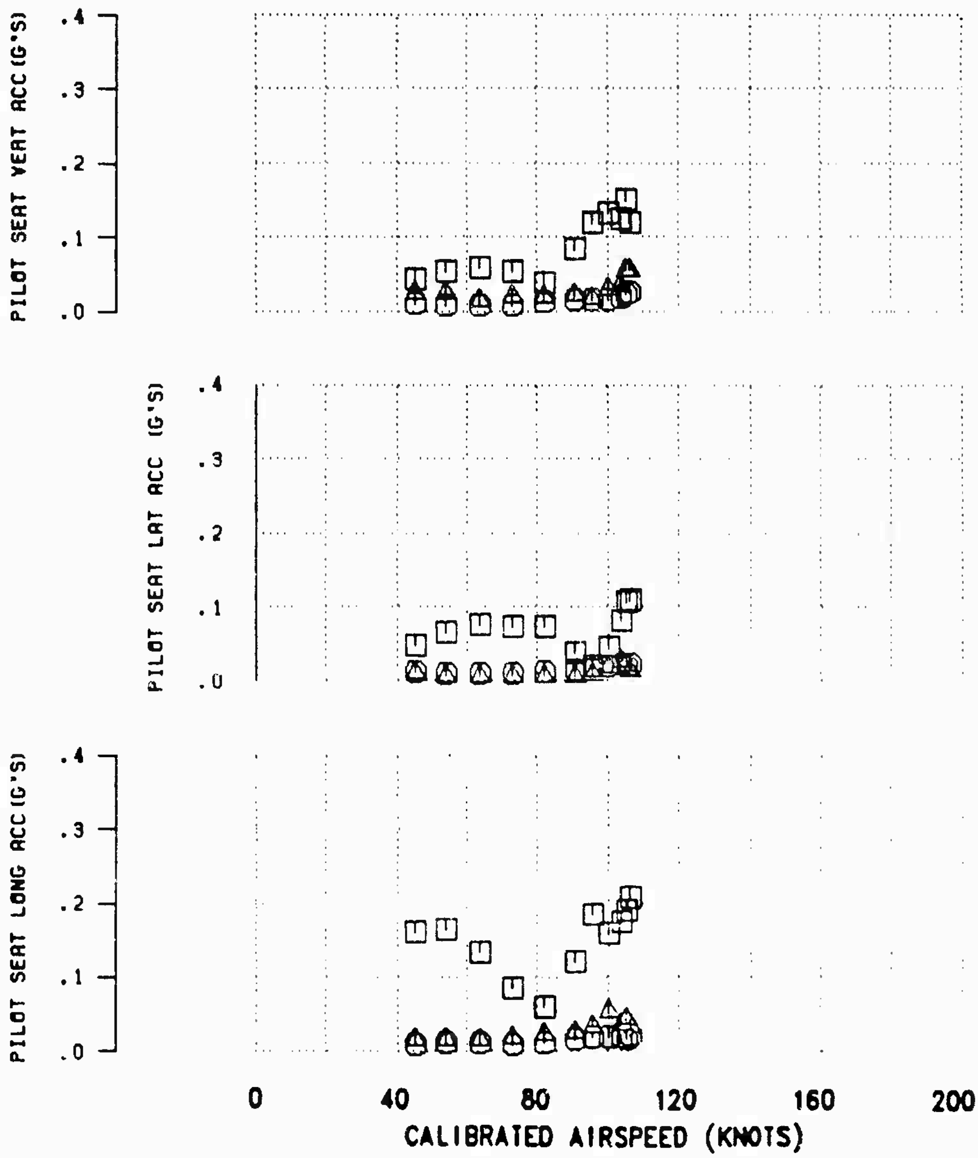


FIGURE 59
VIBRATION CHARACTERISTICS
PILOT SEAT
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18530	346.3	0.2 RT	12250	1.5	252	0.010036

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT

○ 1/REV = 4.3 Hz
□ 4/REV = 17.2 Hz
△ 8/REV = 34.4 Hz

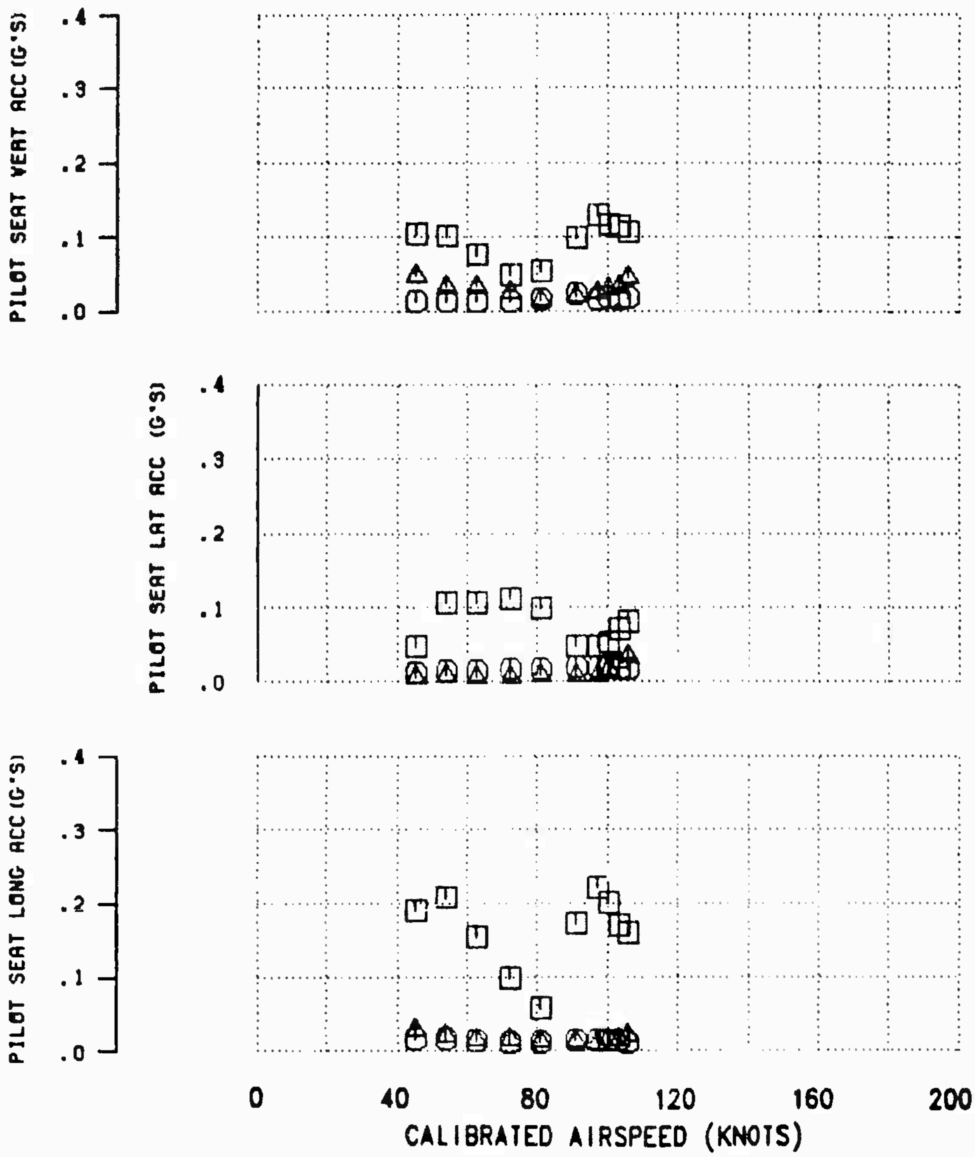


FIGURE 60

VIBRATION CHARACTERISTICS

CABIN FLOOR

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18540	346.5	0.2 RT	1620	10.5	256	0.006999

NOTE: 1. NORMAL UTILITY CONFIGURATION
2. LEVEL FLIGHT

○ 1/REV = 4.3 Hz
□ 4/REV = 17.2 Hz
△ 8/REV = 34.4 Hz

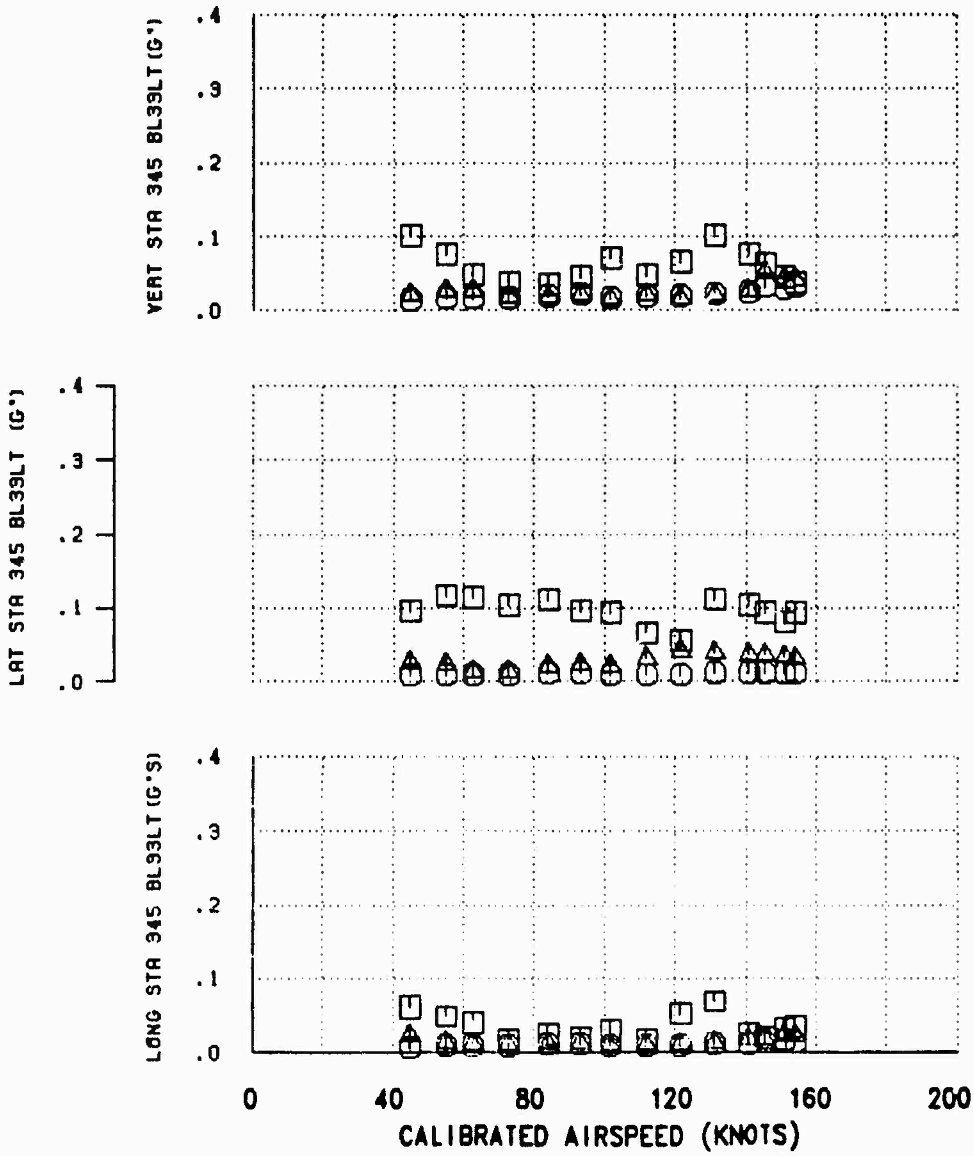


FIGURE 61

VIBRATION CHARACTERISTICS

CABIN FLOOR

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18590	346.6	0.2 RT	1830	13.0	257	0.006976

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT

○ 1/REV = 4.3 Hz
□ 4/REV = 17.2 Hz
△ 8/REV = 34.4 Hz

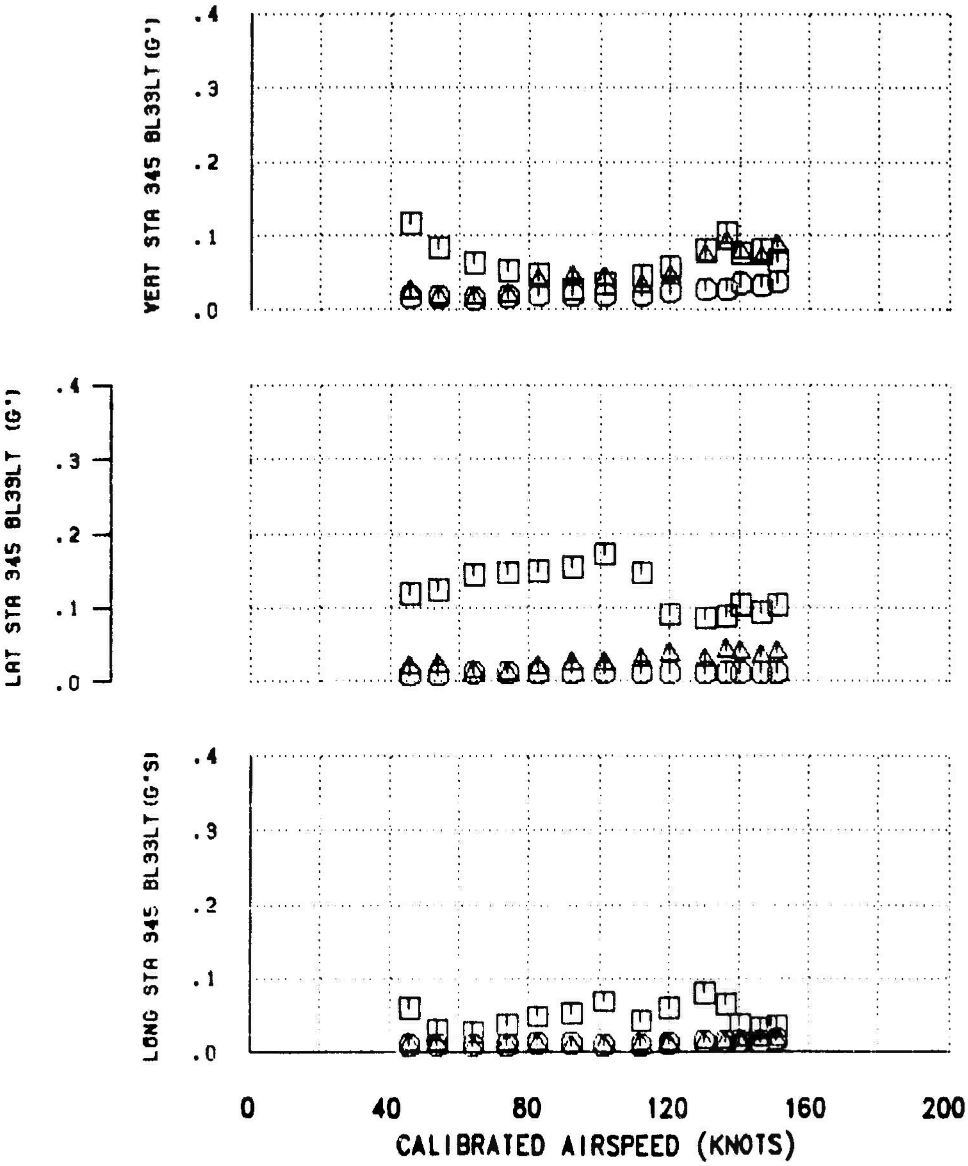


FIGURE 62

VIBRATION CHARACTERISTICS

CABIN FLOOR

UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18470	345.8	0.2 RT	12000	-1.0	251	0.010008

NOTE: 1. NORMAL UTILITY CONFIGURATION
2. LEVEL FLIGHT

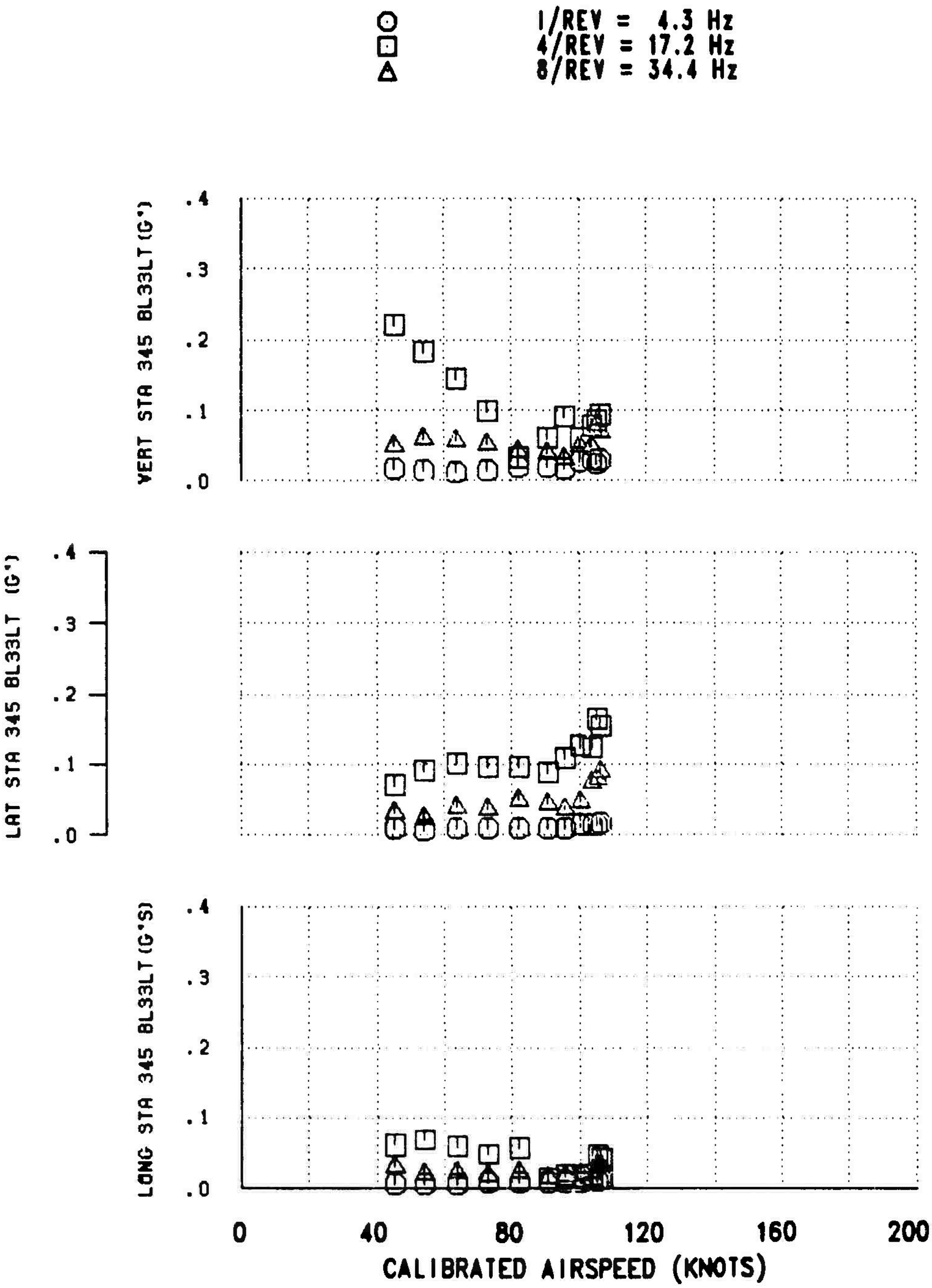
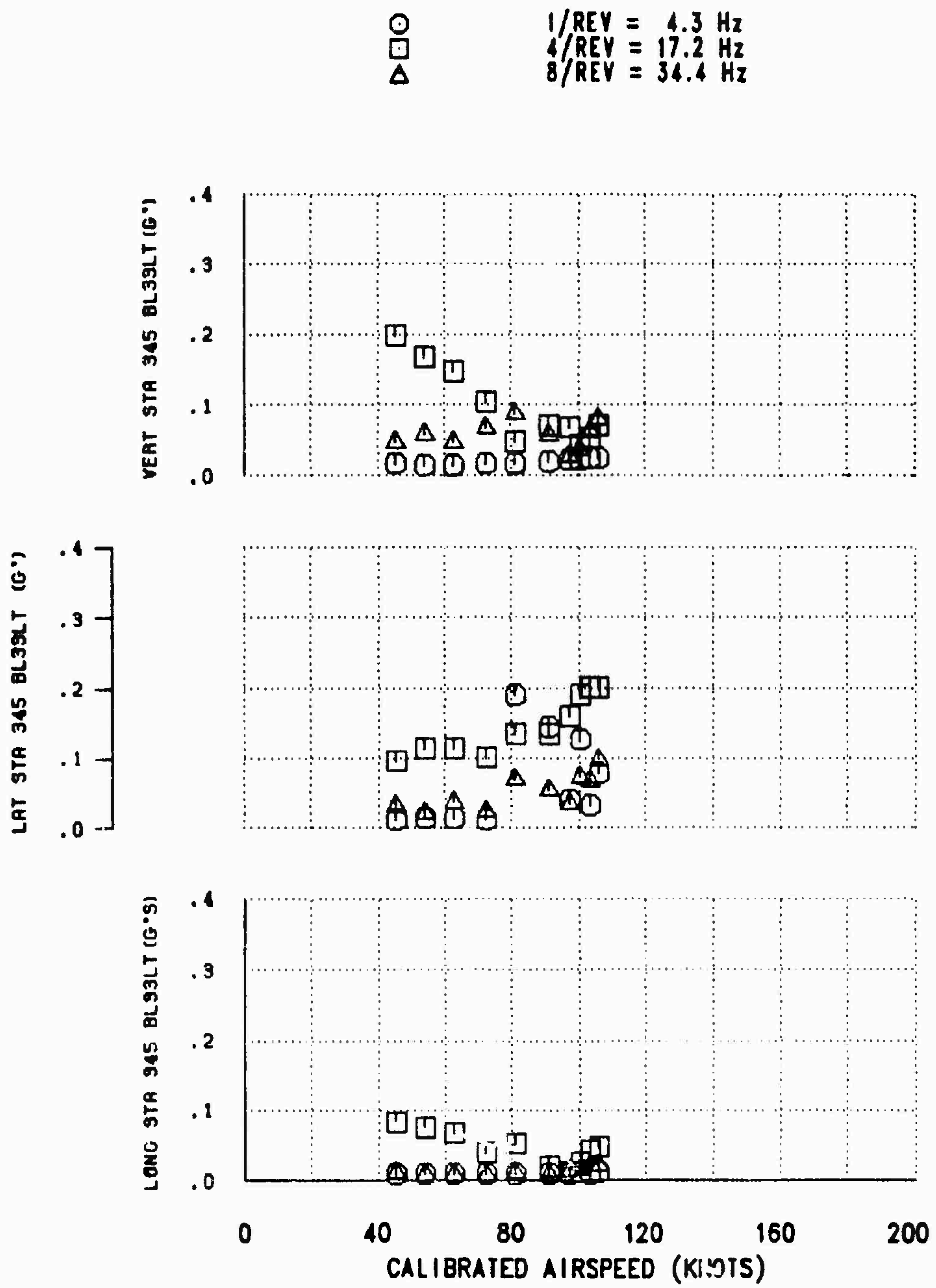


FIGURE 63
VIBRATION CHARACTERISTICS
CABIN FLOOR
UH-60A USA S/N 84-23953

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
18530	346.3	0.2 RT	12250	1.5	252	0.010036

NOTE: 1. SNOW SKIS INSTALLED
2. LEVEL FLIGHT



APPENDIX F. PHOTOGRAPHS

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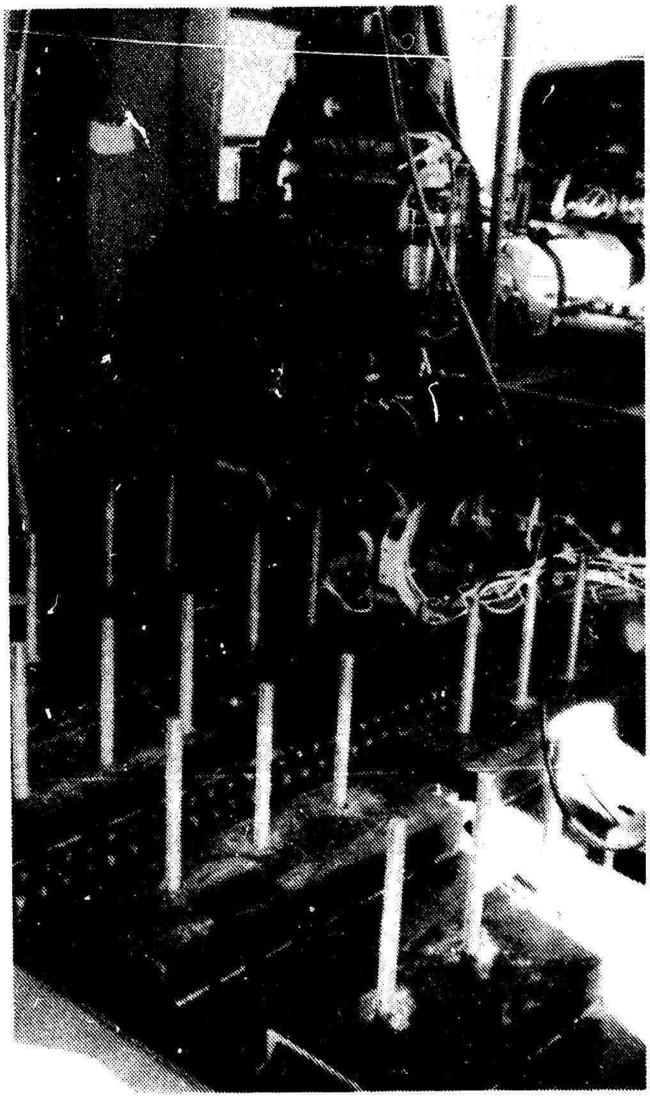

Photo 1. Forward Cabin Floor Ballast Fixture

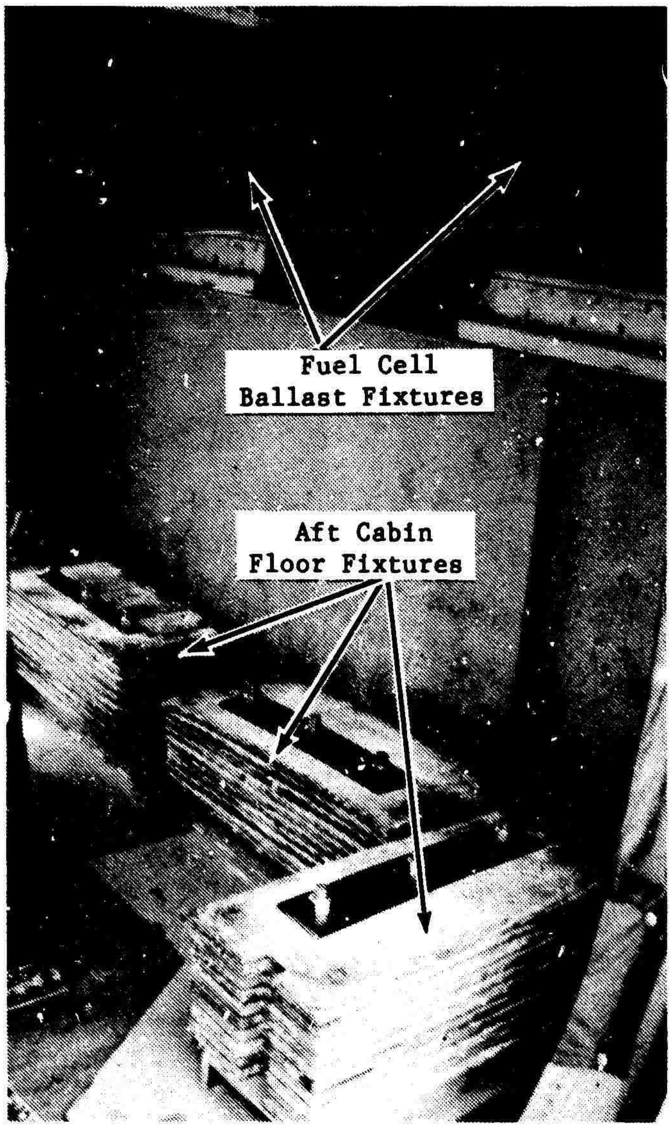

Photo 2. Aft Cabin Ballast Fixtures

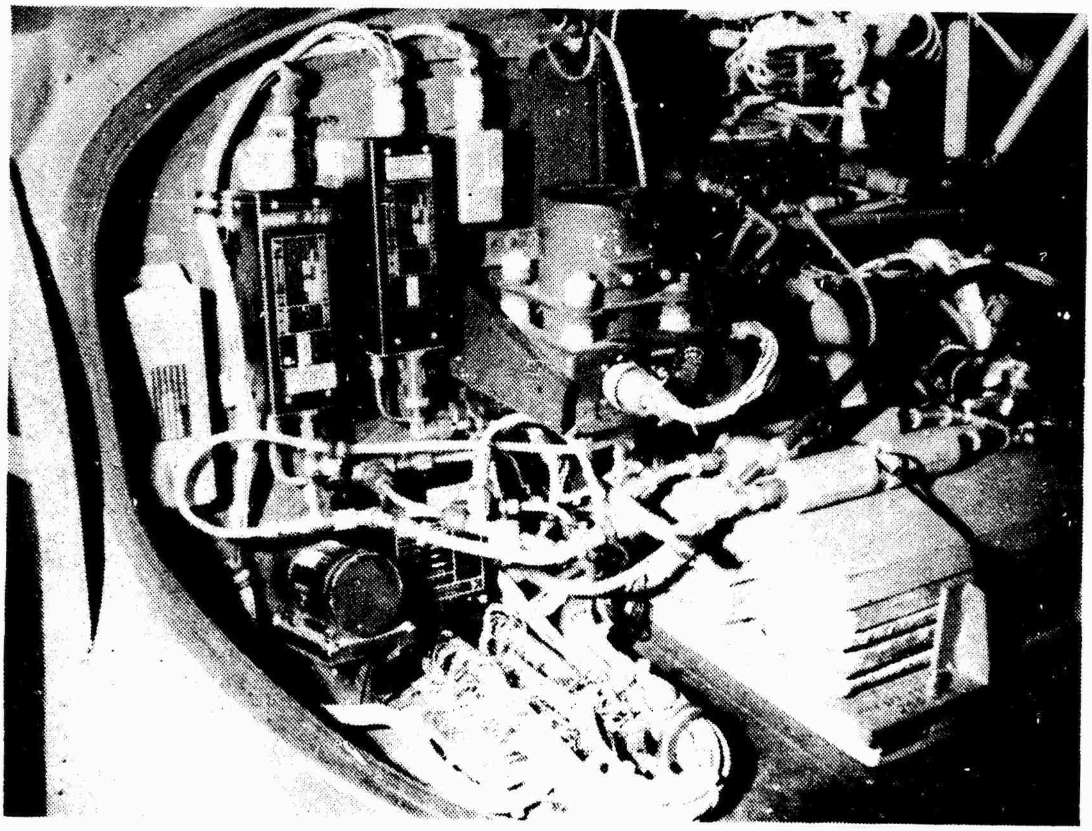

Photo 3. Nose Bay Ballast Fixture and Test Instrumentation

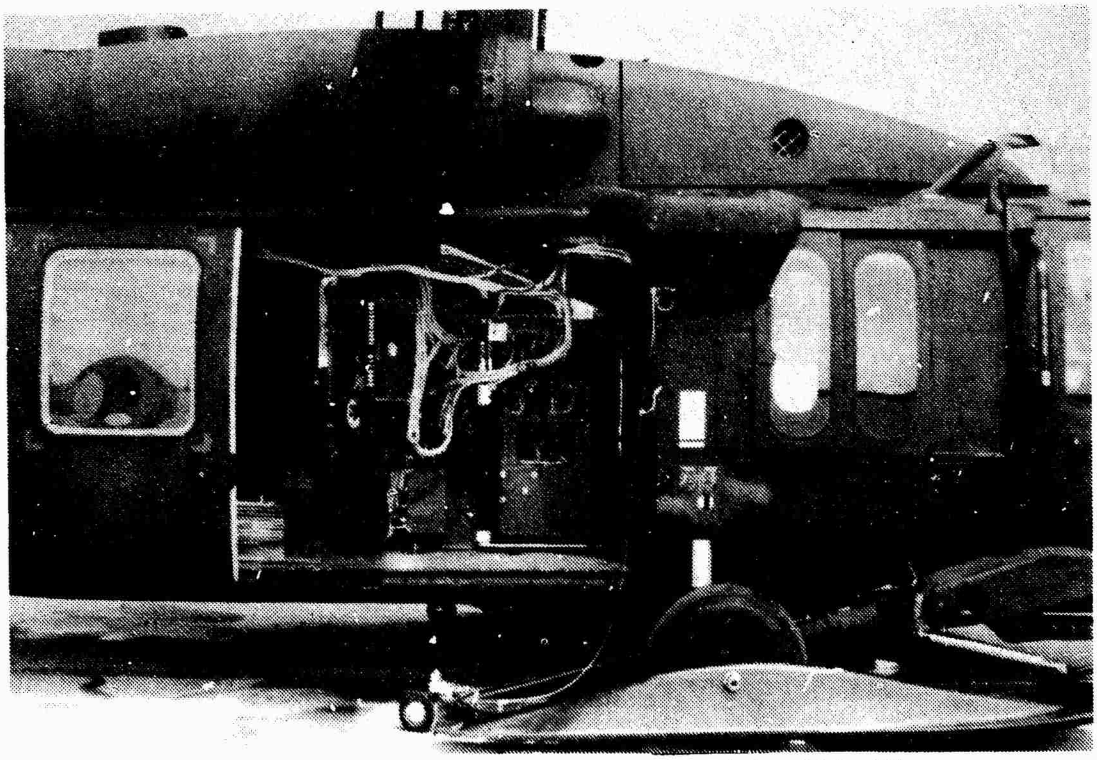

Photo 4. Instrumentation Package - Right Side View

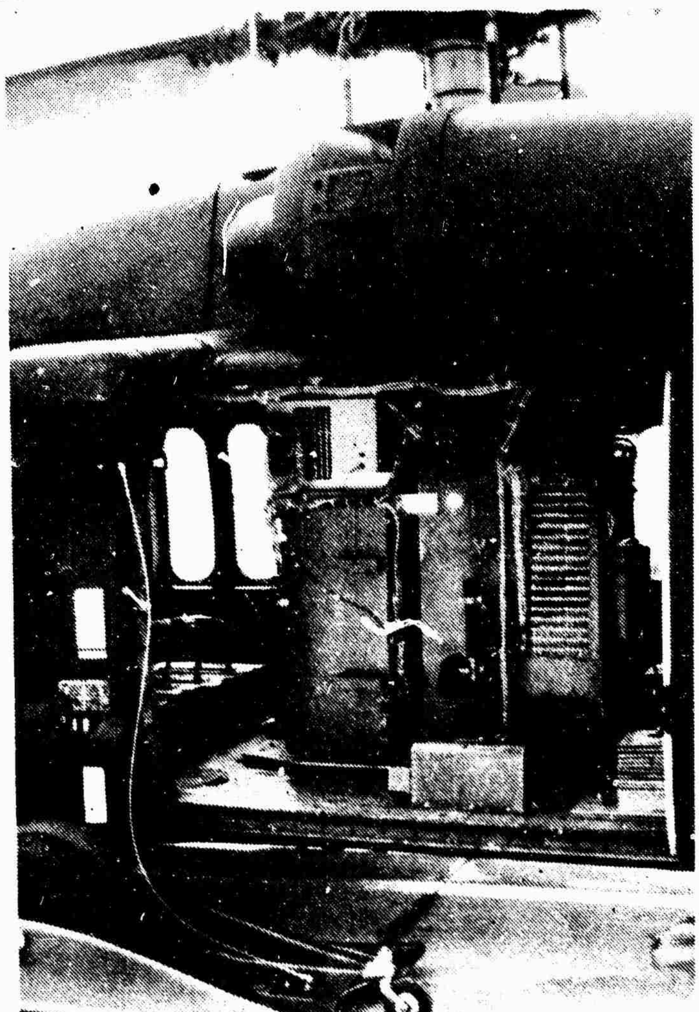

Photo 5. Instrumentation Package - Left Side View

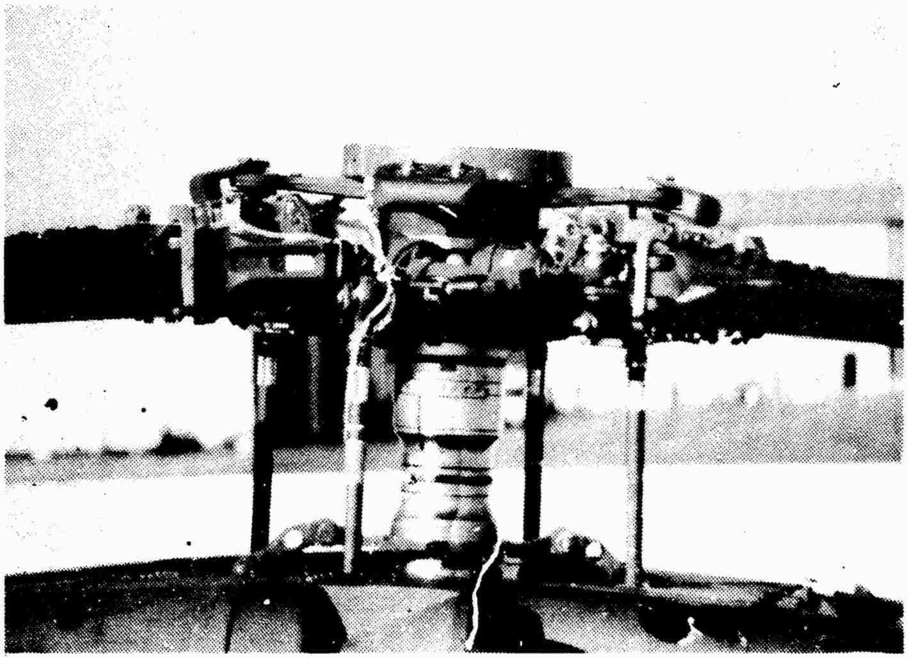

Photo 6. Main Rotor Slip Ring Assembly

Photo 7. Tail Rotor Slip Ring Assembly

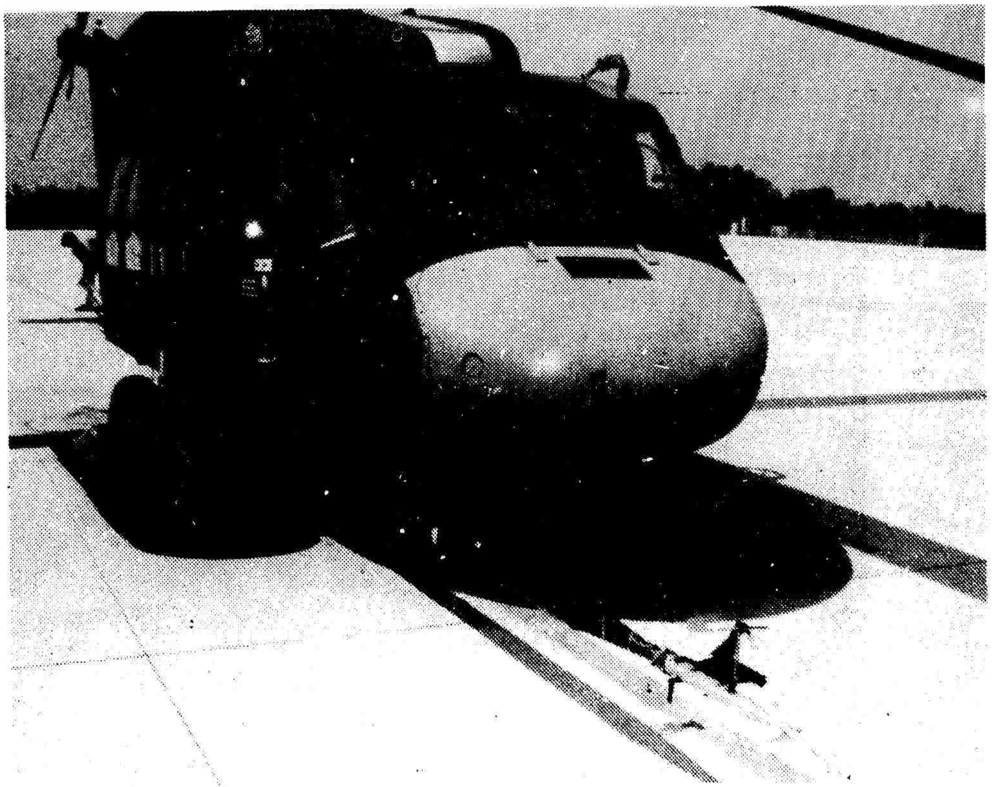

Photo 8. Nose Boom Assembly

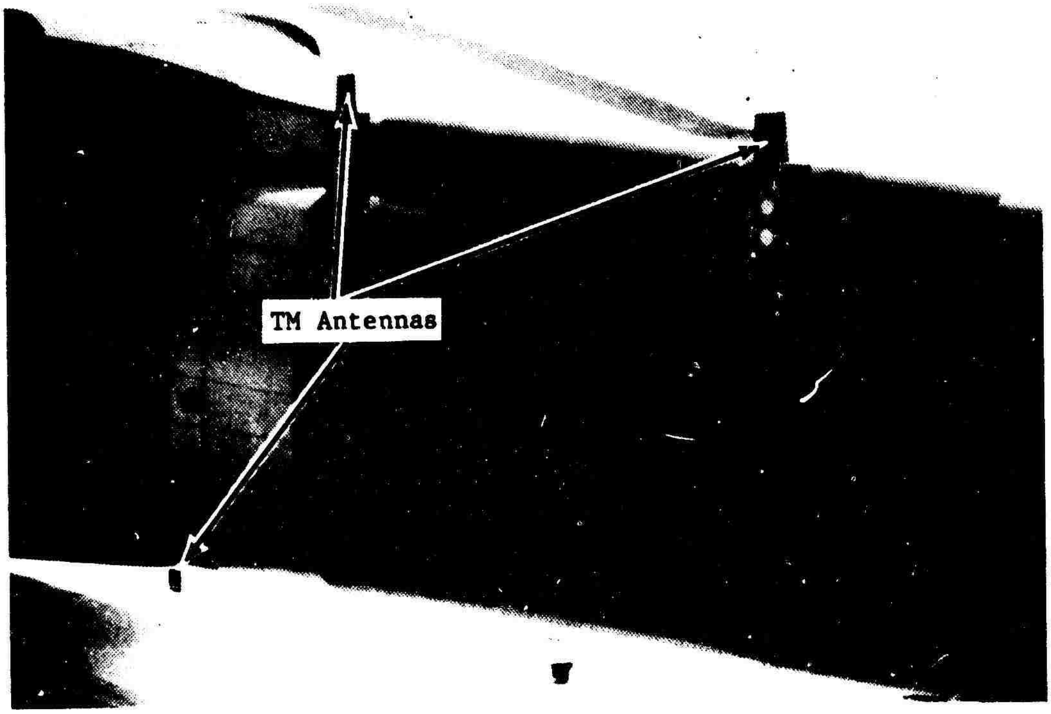

Photo 9. Tail Boom and Belly-Mounted Telemetry Antennas

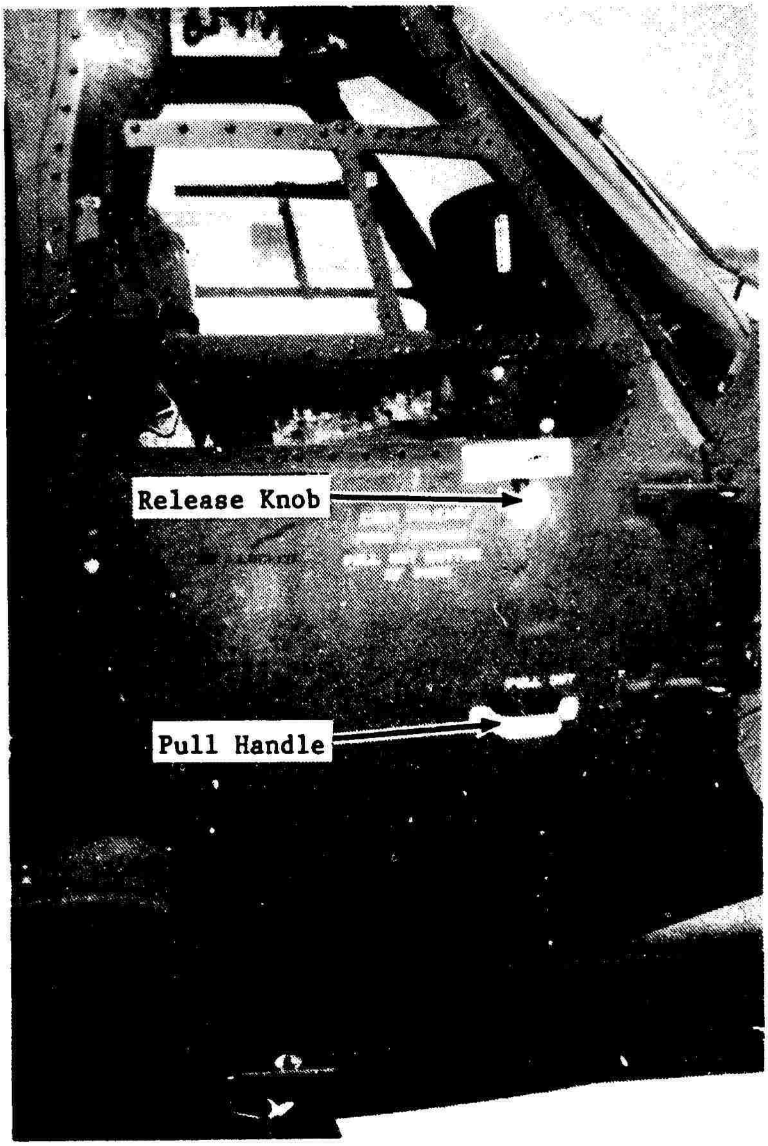

Photo 10. Emergency Crew Door Handles

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