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AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST OF THE UH-60A BLACK HAWK HELICOPTER EQUIPPED WITH THE XM-139 MULTIPLE MINE DISPENSING SYSTEM (VOLCANO)

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Final Report

AVIATION ENGINEERING FLIGHT ACTIVITY
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An Airworthiness and Flight Characteristics evaluation of the UH-60A helicopter (S/N 82-23748) with the XM-139 Multiple Mine Dispensing System (VOLCANO) installed was conducted by the U.S. Army Aviation Engineering Flight Activity. ~~The test was conducted at Edwards AFB and Bishop, California between 1 September 1987 and 28 January 1988.~~ The tests required 59 productive flight hours. Performance and handling qualities tests were conducted. The change in equivalent flat plate area in forward flight varied as a function of the thrust coefficient and airspeed from approximately 36 to 50 square feet. The out-of-ground effect hover capability was reduced by approximately 520 pounds. The handling qualities of the UH-60A with the VOLCANO installed were slightly degraded when compared to the normal utility configuration. Seven shortcomings were noted in this configuration: the large position error for this ship's airspeed system, the negative longitudinal static stability at 100 KCAS during level flight, the neutral static longitudinal stability during intermediate rated power (IRP) climbs, the neutral to slightly negative maneuver stability above a load factor of 1.4 at 116 KCAS. Three shortcomings similar to those previously reported were also noted. The UH-60A helicopter configured with the VOLCANO failed to meet the following requirements: Military Specification MIL-I-6115A, paragraph 4.2.6.3 in that the position error exceeded maximum allowable; the Prime Item Development Specification, paragraph 10.3.3.1.3 in that the static longitudinal stability was negative at

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100 KCAS during level flight and the static longitudinal stability was neutral during IRP climbs, pargraph 10.3.3.1.4 in that the stick-fixed maneuvering stability was neutral to negative in steady turning flight.

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INTRODUCTION

BACKGROUND

1. The XM-139 Multiple Mine Dispensing System (VOLCANO) is a rapid deployment system for launching a mix of antitank and antipersonnel mines from both helicopters and ground vehicles. The airborne system was developed by the Army Aviation Research Development and Engineering Center in conjunction with the Project Manager for Mines, Countermines and Demolition in response to an urgent requirement of the High Technology Light Division for a helicopter mine dispensing system. Prime contractor is Honeywell, Inc. The U.S. Army Armament, Munitions, and Chemical Command was tasked with system production and has requested support for airborne qualification of the system from the U.S. Army Aviation Systems Command (AVSCOM). At the request of AVSCOM, a Preliminary Airworthiness Evaluation of the UH-60A/ VOLCANO configuration was conducted by the U.S. Army Aviation Engineering Flight Activity (AEFA) under Project No. 86-10 (ref 1, app A). AVSCOM later requested the AEFA to conduct a limited airworthiness and flight characteristics (A&FC) test of the UH-60A helicopter with VOLCANO installed (ref 2).

TEST OBJECTIVE

2. The objective of this test was to determine the effects of the VOLCANO configuration on UH-60A performance and handling qualities.

DESCRIPTION

3. The UH-60A, Black Hawk, 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. The helicopter is equipped with conventional wheel-type landing gear. 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 having an uninstalled thermodynamic rating (30 minute) of 1553 shaft horsepower (shp) (power turbine speed of 20,900 rpm) each 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 82-23748) used for this evaluation was a sixth-year 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 detailed description of the UH-60A is available in the Prime Item Development Specification (ref 3, app A) and the operator's manual (ref 4). The test helicopter configured with the VOLCANO system, is depicted in figure 1.

5. The VOLCANO weapons system with related equipment is produced by Honeywell, Inc. The VOLCANO is an automated, scatterable mine delivery system capable of launching mines from host ground and air vehicles (5 ton dump and cargo trucks and the

Figure 1. Test Aircraft S/N 82-23748 Configured with XM-139 Multiple Mine Dispenser System (VOLCANO)

UH-60A helicopter). The mine dispenser system is modular and consists of four major components: (1) mounting hardware kits, (2) four launcher racks, (3) 160 mine canisters, and (4) a dispenser control unit (DCU). The mounting hardware is the only application-unique component and allows mounting to the Black Hawk fixed provision mounting points without any aircraft modifications. This hardware accepts up to four launcher racks (two per side), with each rack holding up to 40 individual XM-87 Mine Canisters. Each canister contains six mines giving the system a total delivery capability of 960 mines. For this test the VOLCANO system consisted of four launching racks loaded with 160 empty mine canisters, and fully operational rack jettison mechanisms. The Interface Control Panel (ICP) was installed to control emergency jettison, however, the DCU was not installed. A detailed description of the VOLCANO system is contained in the VOLCANO operator's manual (ref 5) and appendix B.

TEST SCOPE

6. The A&FC was conducted by AEFA personnel at Edwards AFB (elevation 2302 feet) and Coyote Flat (elevation 9980 feet), California. A total of 59 productive flight hours were flown during the period 1 September to 28 January 1988. Tests were conducted to determine the performance and handling qualities of the UH-60A with the VOLCANO mine dispensing system installed at average mission gross weights of 16,500 and 22,500 pounds at both forward and aft longitudinal center of gravity (cg) locations. Results were compared with previous test results (refs 1, 6, 7, 8 and 9, app A). Flight restrictions and operating limitations observed throughout the test are contained in the operator's manual (ref 4) and the airworthiness release (ref 10). Testing was conducted in accordance with the approved test plan (ref 11) 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 Remote Data Acquisition and Processing System. A detailed listing of test instrumentation is contained in appendix C. Flight test techniques and data analysis procedures are described in appendix D.

Table 1. Performance Test Conditions[1]

Type of Test	Average Gross Weight (lb)	Average Longitudinal Center of Gravity (FS)[2]	Average Density Altitude (ft)	Trim Airspeed (KTAS)[3]	Configuration
Hover 10 ft IGE and 100 ft OGE	14,850 to 20,570	354.0 (mid)	1260 to 9840	0	Normal Utility
	17,730 to 20,120	354.0 (mid)	2600	0	VOLCANO
Climb	20,150	347.0 (fwd)	5750	64 (KCAS[4])	VOLCANO
Level Flight	17,750 to 20,190	346.7 (fwd)	3530 to 9770	45 to 132	VOLCANO
	16,320 to 20,170	357.7	5430 to 6450	46 to 130	VOLCANO
	17,530 to 17,970	347.0 (fwd)	3320 9900	46 to 160	Normal Utility
Autorotation	19,330 to 19,700	347.0 (fwd)	5200	55 (KCAS[4]) to 112	VOLCANO

NOTES:

[1]Tests conducted with doors and windows closed, Automatic Flight Control System ON, Pitch Bias Actuator centered and electrically disconnected, bleed air system OFF, and mid lateral center of gravity.
[2]FS: Fusleage station.
[3]KTAS: Knots true airspeed.
[4]KCAS: Knots calibrated airspeed.

Table 2. Handling Qualities Test Conditions[1]

Test	Average Gross Weight (lb)	Average Longitudinal Center of Gravity	Average Density Altitude (ft)	Average Trim Calibrated Airspeed (knots)	External Configuraiton	Remarks
Control Positions in Trimmed Forward Flight	17,530 to 17,970	347.1 (fwd)	3320 to 9900	46 to 160	Normal Utility	In conjunction with level flight performacne $N_R/\sqrt{\theta}$ = approximately 258
	17,750 to 20,190	346.7 (fwd)	3530 to 9770	45 to 132	VOLCANO Installed[2]	In conjunction with level flight performance $N_R/\sqrt{\theta}$ = approximately 249, 258, 265
	16,320 to 20,170	357.7 (aft)	5430 to 6450	46 to 130		
	20,150	347.0 (fwd)	5750	64		In conjunction with climb performance.
	19,840	347.0 (fwd)	5200	55 to 112		In conjunction with autorotational performance
Static Longitudinal Stability[2]	16,710 and 20,610	359.2 (aft)	5810 and 5110	66 and 91	VOLCANO Installed[2]	Level flight
	16,800 and 20,490	359.3 (aft)	5590 and 6850	82 and 96		IRP[3] climb
	16,680 20,190	358.6 (aft)	4950 and 5640	77		Autorotation
Static Lateral-Directional Stability	16,660	358.6	6060	116	VOLCANO Installed[2]	Level flight
	16,910	359.5	6040	66		
	19,900	357.4	4990	67		
	20,230	358.5 (aft)	4900	114		
	16,690	358.8 (aft)	6000	95		IRP climb
	20,480	359.0 (aft)	6160	81		
	16,500	358.1	6190	78		Autorotation
	20,070	357.8 (aft)	5900	77		
Maneuvering Stability	16,555	358.2	6110	46, 68, 86 96, 116	VOLCANO Installed[2]	Level flight
	18,290	256.9 (mid)	9320	106		
	20,480	359.0 (aft)	6255	44 and 86		
	19,955	357.3 (mid)	5520	69 and 85		IRP climb
Dynamic Stability	16,740 and 20,330	359.2 (aft)	6080	54, 92 and 119	VOLCANO Installed[2]	Level flight
	16,610 and 20,350	359.1 (aft)	5550	56 and 91		IRP climb
	16,540 and 20,260	359.1 (aft)	5390	49 and 90		Autorotation
Controllability	16,360 and 20,440	359.1 (aft)	5700 and 5830	39, 77 and 117	VOLCANO Installed[2]	Level flight
	16,480 and 18,860	358.8 (aft)	3730 and 3980	0		Hover
Low Speed Flight	16,500	354 (mid)	2490	0 to 40 (KTAS)[5]	VOLCANO Installed[2]	Azimuth: 0, 90, 180 and 270 degrees, Edwards AFB, 25 ft IGE[4]
	16,380	355 (mid)	10,000	0 to 45 (KTAS)		Azimuth: 0, 90, 180 and 270 degrees, Coyote Flat, 25 ft IGE.
Simulated Engine Failure	20,370	346.3 (fwd)	5760	91, 110, and 115	VOLCANO Installed[2]	Level flight (dual-engine to single-engine)
	20,390	346.2 (fwd)	5450	83		IRP climbs (dual-engine to single-engine)

NOTES:

[1]Testing was conducted at 2[illegible]3 rpm, mid-lateral center of gravity, the Automatic Flight Control System ON, all doors closed, and the pitch bias actuator centered and electrically disconnected, except as noted otherwise.
[2]Empty canisters.
[3]IRP: Intermediate rated power.
[4]IGE: In-ground effect.
[5]KTAS: Knots true airspeed.

RESULTS AND DISCUSSION

GENERAL

8. An Airworthiness and Flight Characteristics (A&FC) test of the UH-60A with the XM-139 (VOLCANO) mine dispensing system installed was conducted at Edwards AFB and Coyote Flat, California. The VOLCANO system installation significantly reduced the UH-60A performance while only slightly degrading the handling qualities. Seven shortcomings, similar to those previously reported, were noted in this configuration: (1) the large position error for the ship's airspeed system; (2) the negative longitudinal static stability at 100 KCAS during level flight (3) the neutral static longitudinal stability during intermediate rated power (IRP) climbs; (4) the neutral to slightly negative maneuver stability above a load factor of 1.4 at 116 KCAS (5) the excessive sensitivity of rotor speed to collective movement during autorotative descent; (6) the excessive 4 per revolution vibration amplitude; (7) the excessive magnitude of tail shake with the VOLCANO installed. The UH-60A helicopter with the VOLCANO system installed failed to meet the following requirements: Military Specification MIL-I-6115A, paragraph 4.2.6.3 in that the position error exceeded maximum allowable; the Prime Item Development Specification (PIDS) (ref 3) paragraph 10.3.3.1.3 in that the static longitudinal stability was negative at 100 KCAS during level flight and neutral during IRP climbs. PIDS paragraph 10.3.3.1.4.1 in that the stick-fixed maneuvering stability was neutral to negative in steady turning flight. The intermittent lateral tail pulse "tail shake" previously reported (ref 1) was still evident at conditions of high gross weights and high airspeeds. The maximum airspeed during the test was limited to 120 knots indicated airspeed on the ships airspeed system in accordance with the requirements of the airworthiness release (ref 6).

PERFORMANCE

Hover Performance

9. Hover tests were conducted utilizing the tethered hover method at the conditions presented in table 1. The 10-foot main wheel height in-ground effect (IGE) and 100-foot main wheel height out-of-ground effect (OGE) tests were conducted at test sites with field elevations of 2302 and 9980 feet. A calibrated load cell was used to measure the tension in the tether cable and cable angle indicator were used to measure cable angle from vertical during the hover tests. Variations in thrust coefficient (C_T) were attained by varying tension in the cable while maintaining vertical cable alignment.

10. The nondimensional results of the hover test are presented in figure E-1 through E-4, appendix E. The standard day, sea level IGE and OGE hover capability of the UH-60A with the VOLCANO system installed was determined to be 23,709 and 20,855 pounds (lb), respectively using the transmission limit power of 2828 shp. The increased vertical drag caused by the VOLCANO system reduces the OGE hover capability of the Black Hawk by approximately 520 lb at sea level standard day conditions.

Climb Performance

11. Climb performance tests were conducted at the conditions presented in table 1. The airspeed for maximum rate of climb was determined by climbing at intermediate rated

power (IRP) at various airspeeds. Power was then varied in increments while climbing at the airspeed for maximum rate of climb to determine the power correction factor (K_P). Three data are presented in figures E-5 and E-6. The airspeed for maximum rate of climb was determined to be 64.5 knots calibrated airspeed (KCAS). The K_P was determined to be 0.75.

Level Flight Performance

12. Limited performance flight testing was conducted to determine the performance difference between the UH-60A in the normal utility configuration (fixed provision fairings installed) and the UH-60A configured with the VOLCANO system. Level flight performance tests were conducted at the conditions presented in table 1 to determine the power required at various airspeeds. Each test was flown in ball-centered flight. Nondimensional level flight test results in the VOLCANO configuration are presented in figures E-7 through E-9, appendix E. The results of each individual test are presented in figures E-10 through E-18. The normal utility configuration test results are presented in figures E-19 and E-20. With the VOLCANO system installed on the UH-60A helicopter, the change in equivalent flat plate area (ΔF_e) varied as a function of C_T and airspeed from approximately 36 sq ft at a CT of 0.0070 to approximately 50 sq ft at a C_T of 0.010. Inherent sideslip during level flight with the VOLCANO system installed, was essentially the same as the UH-60A in the clean configuration reported ref 8.

Autorotational Descent Performance

13. Autorotational descent performance tests were conducted at the conditions presented in table 1, to determine the airspeed for minimum rate of descent and maximum glide ratio. At these two airspeeds the rotor speed for minimum rate of descent was determined. Test results are presented in figures E-21 and E-22.

14. The minimum rate of descent at 19,500 lb gross weight and a rotor speed of 258.0 revolutions per minute (rpm) was 2270 ft/min at an airspeed of 74.5 KCAS. At the same gross weight and rotor speed, airspeed for maximum glide distance was 93 KCAS with a corresponding rate of descent of 2560 ft/min. At constant airspeeds of 73 and 93 KCAS, rotor speed was varied incrementally from approximately 232 rpm to 274 rpm. The data shows that the rpm for minimum rate of descent was 242 rpm.

15. Rotor speed control during entry into autorotational flight as well as during steady state autorotation required moderate pilot compensation to maintain the desired rotor speed $\pm$ (HQRS 5), as previously reported (ref 7). The sensitivity of rotor speed to collective movement during autorotative descent which detracts from the pilot's ability to maintain visual contact outside the cockpit and remains a shortcoming.

HANDLING QUALITIES

General

16. A handling qualities evaluation of the UH-60A configured with the VOLCANO mine dispensing system was conducted to determine any changes caused by the

VOLCANO system installation. Handling qualities of the UH-60A with the VOLCANO system installed were qualitatively and quantitatively evaluated and found to be essentially the same as the UH-60A in the normal utility configuration. A previously reported shortcoming during IRP climbs (ref 1) was still evident.

Control Positions in Trimmed Forward Flight

17. 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 E-23 through E-27. In level flight, above 60 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 references 1 and 6, appendix A. A lateral cyclic control trim change of approximately 3/4 inch to the right was evident as airspeed increased from 60 KCAS to VH, but was not objectionable. Installation of the VOLCANO system caused an increase in 2° nose down pitch attitude at 80 KCAS and approximately 5.5° at 120 KCAS.

18. Representative data taken during IRP climbs and autorotational descents at two mission gross weights are presented in figures E-28 and E-29, appendix E. During IRP climbs, there was no appreciable change in longitudinal control position with airspeed. An increase of 1/4 inch right lateral cyclic position was required with a 30 knot speed increase. Pitch attitude increased from 0° at 70 knots to 6° nose-down at 100 knots. During autorotational descents, more forward longitudinal control was required with increasing airspeed, providing excellent control position versus airspeed cues to the pilot. Lateral control position variation with airspeed was noticeable to the pilot, (increased airspeed over a 35 knot speed range required one inch of right lateral cyclic control change), but was not considered objectionable. The flight control position during trimmed IRP climbs and autorotational descents with the VOLCANO system installed are essentially the same as the UH-60A in the normal utility configuration and are satisfactory.

Static Longitudinal Stability

19. The static longitudinal stability characteristics of the UH-60A configured with the VOLCANO system 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 E-30 and E-31. During level flight, the static longitudinal stability (as indicted by the variation of longitudinal cyclic control position with airspeed) of the UH-60A configured with the VOLCANO, was slightly degraded from that in the normal utility configuration and at approximately 100 KCAS was negative. The negative static longitudinal stability during level flight at approximately 100 KCAS of the UH-60A configured with the VOLCANO is a shortcoming and failed the requirement of paragraph 10.3.3.1.3 of the PIDS.

20. Representative data in IRP climbs are presented in figures E-32 and E-33. 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 references 1 and 6. Control force displacement cues about trim were also neutral. Maintaining airspeed within 5 knots required moderate pilot compensation (HQRS 4), and was aggravated by small, continuous longitudinal pitch oscillations. During IRP climbs, the neutral static longitudinal stability of the UH-60A configured with the VOLCANO system was essentially the same as the UH-60A in the normal utility configuration (ref 6) and remains a shortcoming. Neutral static longitudinal stability during IRP climbs failed the requirements of paragraph 10.3.3.1.3 of the PIDS.

21. Representative autorotational descent data are presented in figures E-34 and E-35. 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 within ±2 knots (HQRS 2). Longitudinal control force displacement cues about trim were adequate. During autorotational descent, the static longitudinal stability of the UH-60A configured with the VOLCANO system 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

22. The static lateral-directional stability characteristics of the UH-60A configured with the VOLCANO system 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 sideslips up to limit sideslip angle (specified in ref 10) both left and right of trim while maintaining a zero turn rate at the trim airspeed. Autorotational descent flight was approximated with engine condition levels in the fly detent and minimum indicated torque (5-8%) applied to maintain 100% (258 rpm) rotor speed. Representative data are presented in figures E-36 through E-41.

23. 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 similar to findings reported in references 1 and 6. The directional stability characteristics of the UH-60A configured with the VOLCANO system were essentially the same as the UH-60A in the normal utility configuration, and are satisfactory.

24. Effective dihedral (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 increased slightly 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 references 1 and 6. The effective dihedral of the UH-60A configured with

the VOLCANO system was essentially the same as the UH-60A in the normal utility configuration, and is satisfactory.

25. 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. Weak proprioceptive cues to out-of-trim conditions were evident during autorotational descent, but were considered adequate. The sideforce characteristics of the UH-60A configured with the VOLCANO system were essentially the same as the UH-60A in the normal utility configuration, and are satisfactory.

26. A longitudinal to directional coupling was evident at all test conditions. Generally, the longitudinal cyclic position versus sideslip required increased forward longitudinal cyclic control with increased right sideslip. The longitudinal to directional coupling exhibited was not considered objectionable and was similar to that previously reported in references 1 and 6.

27. Inherent sideslip during IRP climbs with the VOLCANO system installed was 5° right at 95 KCAS and was essentially the same as the UH-60A in the clean configuration reported in references 7 and 8, appendix A. During autorotative descent (see para 22) the inherent sideslip was approximately 15° left at 78 KCAS. Level flight inherent sideslip was essentially unchanged with the VOLCANO system installed as noted in paragraph 12.

Maneuvering Stability

28. Maneuvering stability was evaluated at two mission gross weights in collective-fixed steady-state turns at the test conditions presented in table 2. The tests were accomplished by initially stabilizing the helicopter in ball-centered level flight at the trim airspeed and then incrementally increasing the normal acceleration (g) by increasing the bank angle in left and right turns. The test was repeated with the aircraft stabilized in ball-centered IRP climb flight. Collective control position was held fixed and constant airspeed maintained during the maneuvers. Test results are presented in figures E-42 through E-49 for level flight and figures E-50 and E-51 for IRP climbs.

29. The stick-fixed maneuvering stability, as indicated by the variation of longitudinal control position with load factor was evaluated at the conditions of table 2. A comparison of the UH-60A maneuvering stability in the VOLCANO and NORMAL UTILITY configurations shows slightly degraded maneuvering stability with the VOLCANO system installed. At 16,500 pounds gross weight, load factors above 1.4 and airspeeds of 116 KCAS, the maneuvering stability was neutral to negative exhibiting a "dig in" characteristic. This "dig in" (bank angles above 45 degrees) makes it difficult to maintain desired bank angle ±5 degrees and airspeed ±5 knots requiring frequent small longitudinal control inputs (HQRS 6). This characteristic is aggravated by increasing gross weight or airspeed. The neutral to negative maneuvering stability above a load factor of 1.4 at 116 KCAS is a shortcoming similar to that previously reported (ref 9). The neutral to negative stick-fixed maneuvering stability in steady turning flight failed the requirements of paragraph 10.3.3.1.4.1 of the PIDS.

Dynamic Stability

30. The dynamic stability characteristics of the UH-60A configured with the VOLCANO system (stability augmentation system (SAS) ON) were evaluated at two mission gross weights at the conditions presented in table 2. The short-term response was excited in all control axes by making single-axis, 1 inch control 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. Meteorological conditions during testing varied from calm to lightly turbulent as defined in the Flight Information Handbook (ref 13). Representative time history data are presented in figures E-52 through E-80.

31. The long short-term response was heavily damped. The short-term response of the UH-60A configured with the VOLCANO system was essentially the same as the UH-60A in the normal utility configuration and is satisfactory.

32. The lateral-directional oscillatory response resulting from steady heading sideslip releases were heavily damped. The lateral-directional oscillatory response of the UH-60A configured with the VOLCANO system was essentially the same as the UH-60A in the normal utility configuration and is satisfactory.

33. The long long-term response was heavily damped, returning to within 1 knot of trim after only two small overshoots. The long-term response of the UH-60A configured with the VOLCANO system was essentially the same as the UH-60A in the normal utility configuration and is satisfactory.

Controllability

34. Controllability tests were conducted during hover and forward flight at the conditions presented in table 2. Controllability was measured in terms of control power (pitch attitude change within one second), control response (maximum angular velocity attained in one second) and control sensitivity (maximum angular acceleration attained in one second) about an aircraft axis following a control step input of a measured size. Following the input, all controls were held fixed until a maximum rate was established or until recovery was necessary. The magnitude of inputs was varied by using an adjustable rigid control fixture on the cyclic control and by the copilot physically blocking the directional pedals. Real time telemetry monitoring was utilized to confirm the desired input size and shape.

35. Longitudinal controllability characteristics are presented in figures E-81 through E-88. Longitudinal control power and response similar in both the forward and aft directions. The rates and accelerations were linear with respect to control input magnitude. The longitudinal control response was predictable. Pilot overcontrol was not a problem. The longitudinal controllability characteristics of the UH-60A during hover and forward flight with the VOLCANO system installed are satisfactory.

36. Lateral controllability characteristics are presented in figures E-89 through E-92. The lateral control power, response, and sensitivity did not change with the direction of

input. The lateral controllability characteristics of the UH-60A during hover and forward flight with the VOLCANO system installed are satisfactory.

37. Directional controllability characteristics are presented in figures E-93 through E-99. Pilot overcontrol was not a problem. The rates and acceleration were linear with respect to control input magnitude. The directional controllability characteristics of the UH-60A during hover and forward flight with the VOLCANO system installed are satisfactory.

Low-Speed Flight Characteristics

38. The low-speed flight characteristics were evaluated at the conditions presented in table 2. Tests were conducted at true airspeeds up to 45 knots in forward, rearward (0 and 180 degrees relative azimuths) and sideward (090 and 270 degrees relative azimuths) flight at a wheel height of 20 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 E-100 through E-103.

39. Pilot workload (frequency and magnitude of inputs) required to maintain speed, altitude, and heading control during forward and rearward flight required minimal pilot compensation between 0 and 20 knots true airspeed (KTAS). Above 20 KTAS, in both forward and rearward flight, the frequency of inputs noticeably decreased, but the overall pilot workload. Adequate control margins remained throughout the tested airspeed range during both forward and rearward flight and no significant altitude effects were noted. During forward and rearward flight, the low speed flight characteristics of the UH-60A with the VOLCANO system installed were essentially the same as the UH-60A in the normal utility configuration and are satisfactory.

40. During left sideward flight, the lateral cyclic position gradient with airspeed was less than during right sideward flight. Additionally, during left sideward flight a small band of essentially neutral lateral cyclic control position versus airspeed was present between 10 and 30 KTAS. This anomaly was not perceived by the pilot and was not considered objectionable. Stabilator trailing edge up programming began to occur at approximately 20 KTAS during left sideward flight, while the stabilator remained in the full trailing edge down (40 degrees) position during right sideward flight. Pilot workload was higher in left sideward flight as compared to right sideward flight for all control axes. Adequate control margins remained throughout this evaluation and no significant altitude effects were noted. During left and right sideward flight, the low speed flight characteristics of the UH-60A with the VOLCANO system installed were essentially the same as the UH-60A in the normal utility configuration and are satisfactory.

Simulated Single-Engine Failure

41. Simulated single engine failures were evaluated at two mission gross weights at the conditions presented in table 2. Representative time histories of the simulated engine failures during level flight and IRP climb are presented in figures E-104 through E-109. The engine failures were simulated by pulling one engine power control lever from the flight position to the idle position and delaying pilot reaction for a minimum of 2 seconds or until the low rotor speed warning sounded. The simulated engine failures were

detected by an audible warning tone, the ENG OUT master caution light, a difference in cockpit engine parameters, and a noticeable 2 to 4 deg left yaw. Other than the yaw excursion, no unusual attitude changes or control forces were observed during the simulated engine failures and the subsequent transition to single-engine flight. There were no differences (handling qualities or failure cues) noted between a "failed" left engine or a "failed" right engine. At high collective pitch settings, main rotor speed decreased rapidly, but normal operating rotor speed was easily restored by reducing the collective pitch control. The simulated single-engine failure characteristics are satisfactory.

VIBRATION

42. Vibration characteristics of the UH-60A configured with the VOLCANO were qualitatively evaluated concurrently with other test. An increase in 4 per revolution (4/rev) vibration amplitude above 100 KCAS was observed. The vibration amplitude above 100 KCAS with the VOLCANO was noticeably higher than in the normal utility configuration. Vibration levels were assessed using the Vibration Rating Scale (VRS) shown in figure D-3. The increased pitch down attitude associated with the VOLCANO, discussed in paragraph 17, appeared to aggravate the 4/rev vibration. The excessive 4/rev vibration amplitude remains a shortcoming as previously reported in reference 6.

43. Stabilator vertical vibration was observed by the chase aircraft during level flight testing. Peak to peak stabilator tip vertical displacements observed were reported to be approximately two to three inches at conditions of high gross weight (20,000 lb) and high airspeed (above 100 knots). Stabilator mount bushing wear was monitored throughout testing and no significant increase in wear was noted during the limited flying hours.

44. The intermittent lateral tail pulse described as "tail shake" in reference 1, was still evident at high gross weight at airspeeds above 115 KIAS and at high speed descents in a left turn. Tail shake was aggravated in a left sideslip. The excessive magnitude of the tail shake with the VOLCANO installed remains a shortcoming. The following note should be incorporated into the aircraft operator's manual.

NOTE

> When operating the UH-60A configured with the VOLCANO system at high gross weight and high airspeeds, the pilot may encounter intermittent lateral tail pulses "Tail Shake". The intensity of the tail shake is further aggravated by left sideslip.

AIRSPEED CALIBRATION

45. Airspeed calibration tests were conducted to determine the position error of the UH-60A airspeed system with the VOLCANO system installed. The aircraft pilot-static system was calibrated during level flight up to 111 KCAS by use of a calibrated trailing bomb. Data are presented in figure E-110. The position error was 11 knots at 30 KIAS,

8 knots at 85 KIAS and 9 knots at 111 KIAS. The position error with the VOLCANO installed was greater by approximately 2 knots at 40 KIAS and 9 knots at 100 KIAS when compared to the normal utility configuration of the same aircraft reported in reference 8, appendix A. This large position error associated with the VOLCANO system installation will result in a discrepancy between the desired mine dispensing airspeed and the actual dispensing airspeed, affecting the mine field density, and is a shortcoming. The position error data presented in figure E-110, should be incorporated into the applicable VOLCANO mine dispensing system operator's manual and the aircraft operator's manual. The UH-60A with VOLCANO system failed the requirements of Military Specification MIL-I-6115A paragraph 4.2.6.3 in that the position error exceeded the maximum allowable by at least 4 knots throughout the range of airspeeds tested.

MISCELLANEOUS

46. Two miscellaneous observations were made regarding the installation of the VOLCANO system.

a. Cabin entry/exit is greatly restricted by the installation of the VOLCANO system, making the loading and unloading of passengers and cargo more difficult. Additionally, to open the cabin door, the person must first reach between the mounting rack and cargo door from the front of the VOLCANO system to release the door handle and then move to the rear of the VOLCANO system to finish opening the door. The following NOTE should be incorporated into the aircraft operator's manual.

NOTE

> The forward two-thirds of the cabin entry/ exit doors are restricted by the VOLCANO system making the loading and unloading of passengers and cargo more difficult. Internal loads should be planned accordingly.

b. Manual installation of the VOLCANO side panel was attempted but abandoned in favor of using a fork lift and sling arrangement. Installation procedures and/or equipment should be developed to improve manual installation of VOLCANO side panels.

CONCLUSIONS

GENERAL

47. Based on this evaluation, the installation of the XM-139 Multiple Mine Dispensing System (VOLCANO) caused a significant reduction in performance. The handling qualities of the UH-60A aircraft configured with the VOLCANO were slightly degraded. The following specific conclusions were reached (para 8).

Specific

a. With the VOLCANO system installed on the UH-60A helicopter, the change in flat plate area (ΔF_e) varied as a function of coefficient of thrust (C_T) from approximately 36 sq ft at a C_T of 0.007 to approximately 50 sq ft at a C_T of 0.010 (para 12).

b. An increase of 2 degree nose down pitch attitude at 80 KCAS and 5.5 degrees at 120 KCAS was attributable to the VOLCANO installation, was noted (para 17).

c. The standard day, sea level OGE hovering capability of the UH-60A with the VOLCANO system installed was determined to be 20,855 lb using intermediate rated power (para 10).

d. The standard day, sea level IGE hovering capability of the UH-60A with the VOLCANO system installed was determined to be 23,709 lb using intermediate rated power (para 10).

SHORTCOMINGS

48. The following shortcomings associated with the VOLCANO installation were identified and are listed in decreasing order of importance.

a. The large airspeed system position error (para 45).

b. The negative longitudinal static stability during level flight at approximately 100 KCAS (para 19).

c. The neutral static longitudinal stability during climbs at intermediate rated power (para 20).

d. The neutral to slightly negative stick-fixed maneuvering stability of the UH-60A above a load factor of 1.4 at 116 KCAS (para 29).

e. The excessive sensitivity of rotor speed to collective movement during autorotational descent (para 15)

f. The excessive 4 per revolution vibration amplitude (para 42).

g. The excessive magnitude of tail shake with the VOLCANO installed (para 44).

SPECIFICATION COMPLIANCE

49. The UH-60A helicopter with VOLCANO system installed failed to meet the following requirements of Military Specification MIL-I-6115A (ref 12): Paragraph 4.2.6.3. - The position error exceeded the maximum allowable by at least 4 knots throughout the range of airspeeds tested (para 45).

50. The UH-60A helicopter with the VOLCANO system installed failed to meet the following requirement of the PIDS (ref 3): Paragraph 10.3.3.1.3 - The static longitudinal stability was negative at 100 KCAS during level flight (para 19). Paragraph 10.3.3.1.3 - The static longitudinal stability was neutral during climbs at intermediate rated power (para 20). Paragraph 10.3.3.1.4.1 - The stick-fixed maneuvering stability in steady turning flight was neutral to negative (para 29).

RECOMMENDATIONS

51. The following recommendations are made.

a. The position error data presented in figure E-110, appendix E should be incorporated into the applicable VOLCANO mine dispensing system operator's manual (para 45).

b. The following NOTE should be incorporated into chapter 5 of the aircraft operator's manual (para 44):

NOTE

> When operating the UH-60A configured with the VOLCANO system at high gross weight and high airspeeds, the pilot may encounter intermittent lateral tail pulses "Tail Shake". The intensity of the tail shake is further aggravated by left sideslip.

c. The following NOTE should be incorporated into chapter 5 of the aircraft operator's manual (para 46).

NOTE

> The forward two-thirds of the cabin entry/ exit doors are restricted by the VOLCANO system making the loading and unloading of passengers and cargo more difficult. Internal loads should be planned accordingly.

d. Installation procedures and or equipment should be developed to improve manual installation of VOLCANO side panels (para 46b).

APPENDIX A. REFERENCES

1. Final Report, AEFA Project No. 86-10, *Preliminary Airworthiness Evaluation of the UH-60A Equipped with the XM-139 VOLCANO Mine Dispensing System*, August 1987.

2. Letter, AVSCOM, AMSAV-8, 6 April 1987, subject: Airworthiness and Flight Characteristics Test of the UH-60A Helicopter Equipped with the VOLCANO Mine Dispensing System. (Test Request)

3. Prime Item Development Specification, Sikorsky Aircraft Division, DARCOM CP-2222-S1000F, 18 December 1985.

4. Technical Manual, TM 55-1520-237-10, *Operator's Manual, UH-60 Helicopter*, Headquarters Department of the Army, 8 January 1988 with change 1 dated 29 March 1988.

5. Technical Manual, DEP 9-1095-208-10, *Operator's Manual for Multiple Delivery Mine Dispensing System (VOLCANO)*, Headquarters Department of the Army, June 1987.

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

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

8. Final Report, AEFA Project No. 83-24, *Airworthiness and Flight Characteristics Test of a Sixth Year Production UH-60A*, June 1985.

9. Final Report, AEFA Project No. 84-28, *Flight Evaluation of the UH-60A Helicopter with Pitch Bias Actuator Centered and Electrically Disconnected*, Septemer 1986.

10. Letter, AVSCOM, AMSAV-8, 20 July 1987, subject: Airworthiness Release for Conduct of an Airworthiness and Flight Characteristics Evaluation of a UH-60A S/N 82-23748, Configured with the VOLCANO XM-139 Universal Mine Dispenser System.

11. Test Plan, AEFA Project No. 86-12, *Airworthiness and Flight Characteristics Test of the UH-60A Black Hawk Helicopter Equipped with the XM-139 VOLCANO Mine Dispensing System*, May 1987.

12. Military Specification, MIL-I-6115A, 29 March 1951, with amendment 3, 31 December 1960.

13. DOD Flight Information Publication, *Flight Information Handbook*, Defense Mapping Agency Aerospace Center, 30 July 1987.

14. Pamphlet, US Army Material Command, AMCP 706-204, *Engineering Design Handbook, Helicopter Performance Testing*, 1 August 1974.

15. Flight Test Manual, Naval Air Test Center, FTM No. 105, *Helicopter Stability and Control*, November 1983.

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, the main rotor blades can be manually folded and two hinges on the tail boom provide for 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 degrees upward from the horizontal. Primary mission gross weight is 16,324 pounds and maximum alternate gross weight is 20,250 pounds. The proposed maximum gross weight is 22,000 pounds and the VOLCANO configured helicopter design gross weight is 20,572 pounds. The UH-60A is powered by two General Electric T700-GE-700 turboshaft engines having an installed thermodynamic rating (30 minute) of 1553 shaft horsepower (shp) (power turbine speed of 20,900 revolutions per minute) each 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 82-23748, was manufactured by Sikorsky Aircraft Division of United Technologies Corporation and is a production Black Hawk equipped with the external stores support system fixed provision mounting points. These points provide the mounting for the VOLCANO system hardware. The main differences between the test aircraft and a normal UH-60A are the addition of an external nose-mounted airspeed boom and special test instrumentation (app C), and the mounting of the VOLCANO system (figs. F-1 through F-5). A more complete description of the UH-60A helicopter can be found in reference 4, appendix A.

XM-139 MULTIPLE MINE DISPENSING SYSTEM (VOLCANO)

2. The VOLCANO weapons system with related equipment is produced by Honeywell, Inc. The VOLCANO is an automated, scatterable mine delivery system capable of launching mines from host ground and air vehicles (5 ton dump and cargo trucks and the UH-60A helicopter). The mine dispenser system is modular and consists of four major components: (1) mounting hardware kits, (2) four launcher racks, (3) 160 mine canisters, and (4) a Dispenser Control Unit (DCU). Dimensions and weights of these components are summarized in table B-1 and aircraft mounting locations are shown in figure B-1.

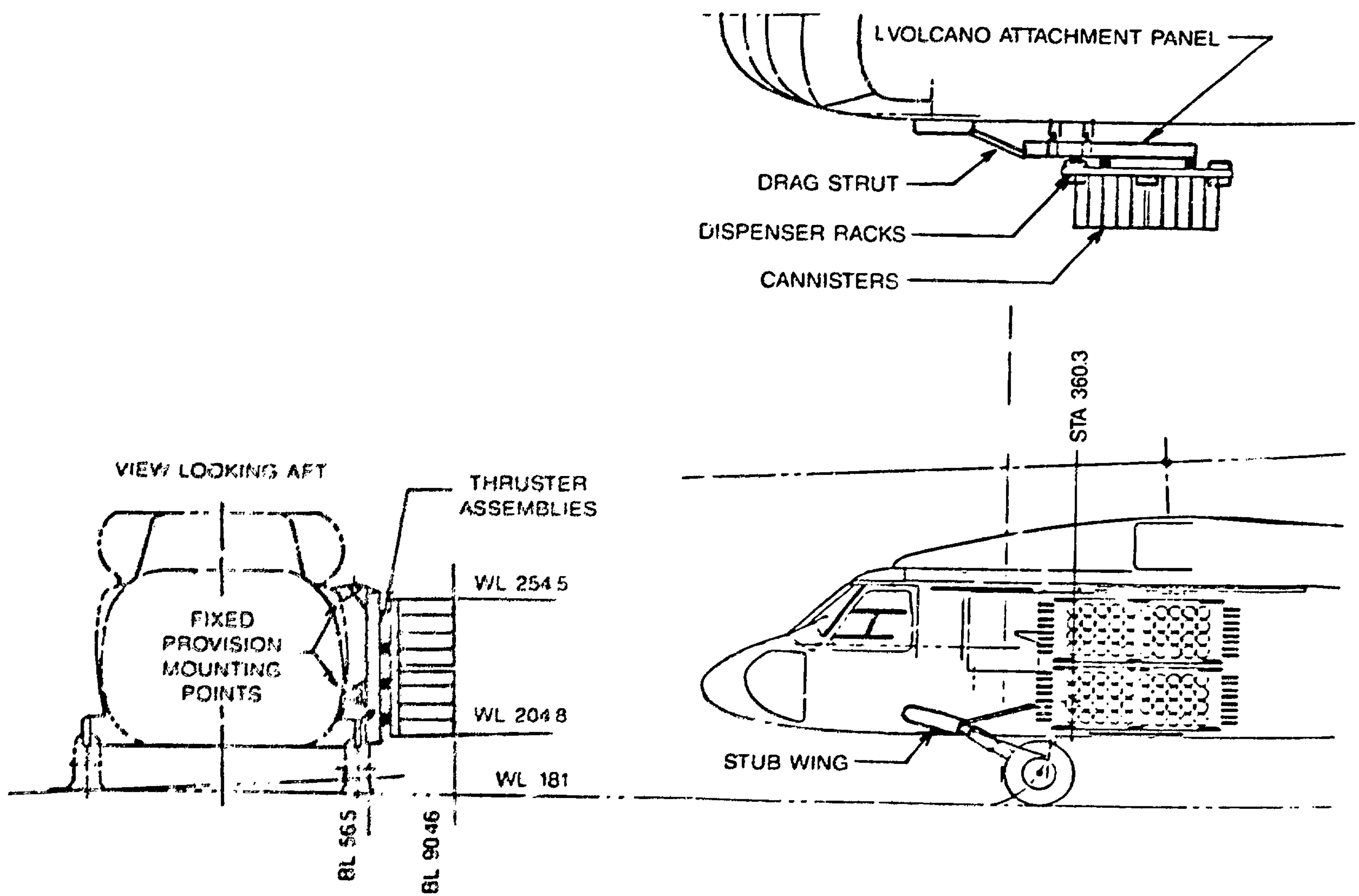


Figure B-1. XM-139 VOLCANO Mine Dispenser System, UH-60A Black Hawk

Table B-1. XM-139 Component Dimensions

	Dimensions (in.)			Weight (lb)
Component	Height	Length	Width	
UH-60A Side Panel (each)	58.5	57.25	6.25	238
Launcher Rack (each)	25.0	79.0	9.0	225
XM-87 Canisters (each)		24.0	5.0 (dia)	5
DCU	19	21	21	70

The mounting hardware (figs. F–6 through F–11) attaches directly to the Black Hawk fixed provision mounting points without any aircraft modifications. This hardware accepts up to four launcher racks (two per side) (fig. F–6), with each rack holding up to 40 individual XM–87 Mine Canisters (figs. F–8). Each canister contains a stack of five BLU–91/B antitank mines and one BLU–92/B anti-personnel GATOR mine giving the system a total delivery capability of 960 mines. A web assembly is interlaced between the mines providing dispersion and mine arming during firing. Empty XM–87 mine canisters capped with duct tape were used for this test. A frontal and side view of the completed installation is shown in figure F–7. The XM–139 DCU mounted in the cargo compartment, is programmed by the operator with the selected dispensing speed and mine self-destruct time. It is designed to control firing of one to four racks in a prescribed sequence on alternating sides of the aircraft. The DCU was not installed on the aircraft for this test. The interface control panel (fig. F–12), mounted on the center instrument console, and the go–around switch, located on both pilot and copilot cyclic controls, control the arming, firing and jettison of the launcher racks. The interface control panel also allows the pilot to conduct a continuity test of the jettison system. The test aircraft was equipped with jettison, but not firing, capability. A more complete description of the system can be found in reference 5, appendix A.

MODIFICATIONS

3. Several modifications were made to the test aircraft to accommodate ballast and instrumentation, or for safety purposes. These modifications were not part of the VOLCANO modifications or the standard UH-60A. Fixed ballast provisions were mounted in the nose compartment, on either side of the engineer station, over the fuel cells, and on the tail (figs. F-13 through F-16). A movable ballast cart (fig. F-17) was installed to maintain constant longitudinal cg. An instrumentation package was installed in the cargo compartment and can be seen in figures F-18 through F-22. Rotor head slip ring assembly is shown in figures F-23 and F-24. Tail rotor slip ring assembly is shown in figure F-25. The telemetry antenna mounted forward of the tail wheel strut is shown in figure F-26 and the nose boom airspeed system installation is shown in figure F-27. For safety purposes, idle stops were installed on the engine power controls as shown in figure F-28. Drag estimates for the external items (figs. F-19, F-20, F-21 and F-22) totalled 0.883 square feet of equivalent flat plate area. Each item is listed below:

Item

Medium size main rotor slip ring with cover
Nose boom
TM antennas
Main rotor instrumentation
Ambient air temperature sensor

APPENDIX C. INSTRUMENTATION

GENERAL

1. The test instrumentation was installed, calibrated and maintained by the U.S. Army Aviation Engineering Flight Activity (AEFA) 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 (fig. F-27, app F). Slip ring assemblies were installed on the main and tail rotor shafts (figs. F-23 through F-25). All other instrumentation was installed inside the test aircraft (figs. F-19 through F-22). Data were obtained from calibrated instrumentation and displayed or recorded as indicated below.

Pilot Panel

Airspeed (boom system)
Pressure altitude (boom system)
Airspeed (ship system)
Altitude (ship system)
Altitude (radar)*
Rate of climb*
Rotor speed*
Engine torque* **
Engine turbine gas temperature (T4.5)* **
Engine gas generator speed* **
Control positions
- Longitudinal
- Lateral
- Directional
- Collective

Stabilator position*
Angle-of-sideslip
Center of gravity (cg) normal acceleration
CG lateral acceleration (sensitive)
Tether cable angles
- Longitudinal
- Lateral

Tether cable tension

Copilot Panel

Airspeed*
Altitude*
Altitude (radar)*

*Ship's system
**Both eng...

Rate of climb*
Rotor speed*
Engine torque* **
Stabilator position*
Total air temperature*
Fuel remaining*
Ballast cart position
Event switch

Engineer Panel

Altitude
Ambient air pressure
Engine fuel flow**
Engine fuel used**
Auxiliary power unit (APU) fuel used
Total air temperature
Rotor speed (digital)
Time code display
Run number
Event switch
Instrumentation controls

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

Airspeed (boom system)
Altitude (boom system)
Airspeed (ship system)
Altitude (ship system)
Altitude (radar)
Total air temperature
Rotor speed
Engine torque**
Engine fuel flow**
Engine gas producer speed (N1)**
Engine turbine gas temperature**
Engine fuel used**
Engine fuel temperature (at fuel used transducer)**
APU fuel used
Main rotor shaft torque
Tail rotor drive shaft torque
Stabilator position
Ballast cart position
Tether cable angles

*Ship's system
**Both engines

Longitudinal
Lateral
Tether cable tension
Control positions
Longitudinal cyclic
Lateral cyclic
Directional pedal
Collective
Stability Augmentation System output positions
Longitudinal
Lateral
Directional
Control mixer input positions
Longitudinal
Lateral
Directional
Primary servo positions
Lateral
Forward
Aft
Angle of attack
Angle of sideslip
Aircraft heading
Aircraft attitudes
Pitch
Roll
Aircraft angular rates
Pitch
Roll
Yaw
Linear accelerations
CG normal
CG lateral
CG longitudinal
Time of day
Run number
Pilot event
Engineer event

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
Horizontal stabilator
    Fuselage attachment - vertical, left and right
                        - lateral, left and right
    Tip - vertical, left and right
        - longitudinal, left and right

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 (fig. F-27, app F). The tip of the swiveling pitot-static tube was 68.5 inches forward of the nose of the aircraft (fuselage station 97), 26.0 inches to the right of the aircraft reference buttline, and 5.75 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, climbs, and autorotational descents (normal utility configuration) using a calibrated trailing bomb to determine the position error. The position error of the boom airspeed system (normal utility configuration) is presented in figure C-1.

ENGINE CALIBRATION

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

SPECIAL EQUIPMENT

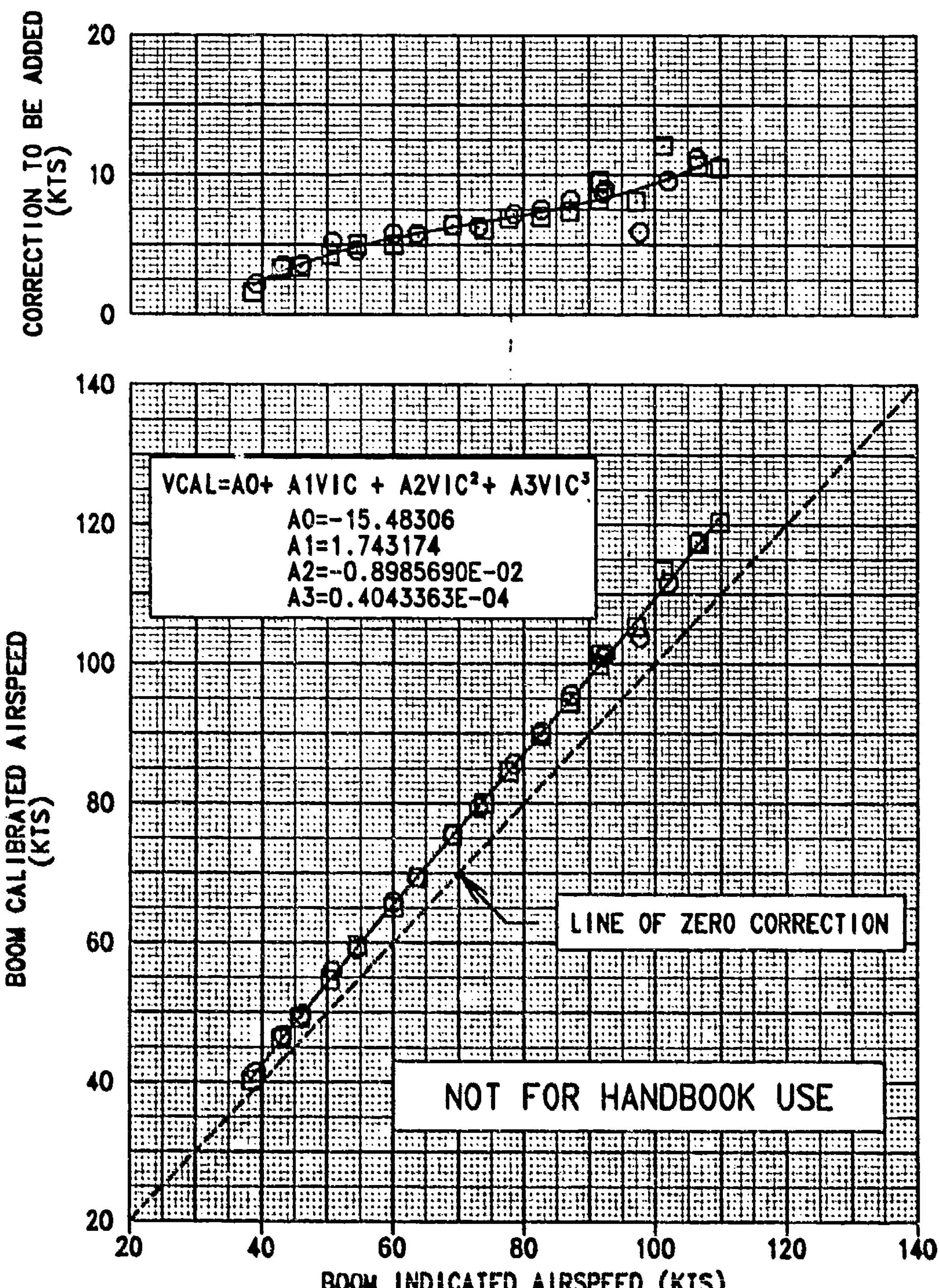
Weather Station

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 hover performance and low airspeed handling qualities tests.

FIGURE C-1
BOOM AIRSPEED CALIBRATION
UH-60A USA S/N 82-23748

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)	TEST METHOD
⊡	16860	353.5 (FWD)	0.2(LT)	7290	21.0	258	TRAILING BOMB
⊙	19060	361.3 (AFT)	0.2(LT)	6930	22.5	260	TRAILING BOMB

NOTE: 1. VOLCANO CONFIGURATION
2. LEVEL FLIGHT
3. BALL-CENTERED FLIGHT



Ground Pace Vehicle

8. Pace vehicle (provided by AEFA), with "fifth wheel" (calibrated ground speed device) installed, was used to establish precise airspeed during low airspeed handling qualities tests.

Load Cell

9. A load cell incorporated with the ship's cargo hook was used during tethered hover tests. Indicators provided the copilot with cable angle and tension. Outside observers were also used to assist in maintaining vertical alignment of the cable.

APPENDIX D. TEST TECHNIQUES AND DATA ANALYIS METHODS

AIRCRAFT RIGGING

1. Prior to the start of testing, a flight controls rigging check was performed on the main and tail rotors 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 rotor rigging data are presented in table D-1.

AIRCRAFT WEIGHT AND BALANCE

2. The test aircraft was weighed in both normal utility configuration and with the VOLCANO system 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 normal utility configuration was 12,141 pounds with a longitudinal center of gravity (cg) located at fuselage station (FS) 357.8 with the empty ballast cart at FS 301. Installation of the XM-139 VOLCANO mine dispensing system side panels, launcher racks, and 160 empty XM-88 mine canisters increased the empty weight of the aircraft by 2200 lb to a weight of 14,341 lb with a longitudinal cg at FS 353.3. The fuel weight for each performance test flight was determined by pre- and post-flight sight gage readings, fuel used instrumentation, and fuel specific gravity measurements. Aircraft cg was controlled by a movable ballast system which was manually positioned to maintain a constant cg while fuel was burned. The movable ballast system was a cart (2000 pound capacity) attached to the cabin floor by rails and driven by an electrical screw jack with a total longitudinal travel of 72.3 inches.

PERFORMANCE

General

3. Performance data were obtained using the basic methods described in Army Material Command Pamphlet AMCP 706-204 (ref 13, app A). Level flight performance and control positions in level flight were obtained in coordinated (ball-centered) flight. Referred rotor speeds of 250, 258, and 265 rpm were maintained for performance tests. Longitudinal cg was maintained nearly constant during each test flight by use of the movable ballast cart. 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 VOLCANO assembly in terms of change in equivalent flat plate area (ΔF_e).

4. Helicopter performance was generalized through the use of non-dimensional coefficients as follows using the 1976 U.S. Standard Atmosphere:

a. Coefficient of Power (C_P):

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

Table D-1. Main and Tail Rotor Rigging Information

Main Rotor Rigging

Flight Control Position				Blade Angle[1] (deg)				Flight Control Position (deg)		
Coll	Long	Lat	Pedal	0	90	180	270	Long Cont[2]	Lat Cont[3]	Coll Cont[4]
Dwn	*[5]	*	*	0.8	10.0	-1.8	-9.8	-9.9	-1.3	8.8
Up	*	*	*	19.0	20.3	11.2	11.0	-4.6	-3.9	24.4
Dwn	Aft	Left	*	7.0	10.0	-8.0	-9.8	-9.9	-7.5	8.8
Up	Aft	Left	*	23.2	24.6	6.9	7.3	-8.6	-8.1	24.5
Dwn	Fwd	Right	*	-6.3	-10.5	-7.0	11.0	10.7	-0.35	5.8
Up	Fwd	Right	*	8.0	-1.5	21.4	31.8	16.6	6.7	23.9
Up	Aft	Left	Left	22.6	26.4	7.1	4.5	10.9	7.7	24.2
*	Aft	Left	*	14.8	19.7	-0.5	-4.5	-12.1	-7.6	16.4
*	Fwd	Right	*	1.4	-9.0	13.9	24.8	16.9	6.2	16.8
*	*	*	*	10.8	15.2	4.9	1.0	-7.1	-2.9	17.0

Tail Rotor Rigging

Flight Control Position		Blade Angle (deg)[6]
Collective	Pedal	
*	Left	15.6
*	Right	-15.8
*	*	1.0
Down	*	-8.0
Up	*	7.4
Up	Left	15.0
Up	Right	-6.9
Down	Right	-16.7
Down	Left	7.0

NOTES:

[1]Measured on the Black Blade at the cuff.
[2]270° blade reading minus 90° blade reading divided by 2.
[3]180° blade reading minus 0° blade reading divided by 2.
[4]Sum of all four readings divided by 4 plus 9.0 for blade root reading.
[5]* Indicates appropriate control was pinned at a rigged position.
[6]Measured on the blue blade at the cuff.

b. Coefficient of Thrust (C_T):

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

c. Advance ratio (μ):

$$\mu = \frac{V_T(1.68781)}{\Omega R} \tag{3}$$

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 = 26.8333 ft
GW = Gross weight (lb)
V_T = True airspeed (kt) = $\dfrac{V_E}{1.68781\sqrt{\varrho/\varrho_o}}$
550 = Conversion factor (ft-lb/sec)
1.68781 = Conversion factor (ft/sec-kt)
ϱ_o = 0.002376892 (lb-sec^2/ft^4)

5. The engine output shaft torque was determined by use of engine torque sensors. The power turbine shaft twists as a function of torque. 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:

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

Where:

Q = Engine output shaft torque (ft-lb)
Np = Engine output shaft rotational speed (rpm)
33,000 = Conversion factor (ft-lb/min)
2π = Conversion factor (radian to revolution)

Shaft Horsepower

6. The shp available for the T700-GE-700 engine installed in the UH-60A was obtained from data received from U.S. Army Aviation Systems Command and presented in AEFA Project No. 77-17 (ref 6, app A). This data was calculated using the General Electric engine deck number 80024, dated 26 February 1981 with a power turbine shaft speed of 20,900 rpm. The installation losses used were based on 0.25 degree Centigrade engine inlet temperature rise in a hover, exhaust losses as obtained from the Sikorsky Aircraft Document Number SER-70410, Revision 2, dated 8 March 1979, inlet ram pressure recovery as obtained from the Sikorsky Prime Item Development Specification, and an inlet temperature rise in forward flight assuming an adiabatic rise referenced to ambient.

Hover Performance

7. Hover performance was obtained by the tethered hover technique. All hover tests were conducted in winds of less than 3 knots. Tethered hover consists of restraining the helicopter to the ground by a cable in series with a load cell. An increase in cable tension, measured by the load cell, is equivalent to increasing gross weight. Atmospheric pressure, relative humidity, temperature, and wind velocity were recorded from a ground weather station. All hovering data were reduced to nondimensional parameters C_P and C_T (equations 1 and 2, respectively), and grouped according to wheel height.

Climb Performance

8. A series of sawtooth climbs were flown to determine generalized climb performance. The climb airspeed for maximum rate of climb was determined by conducting a series of climbs at intermediate rated power and varying airspeed. The change in altitude with time (dHp/dt), was corrected to standard temperature at the test pressure altitude by using the following equation.

$$R/C_{tapeline} = \frac{dH_P}{dt} \quad \frac{T_t}{T_s} \tag{5}$$

Where:

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

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

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

9. Climb performance tests were conducted to determine the climb power correction coefficient, Kp. This factor indicates the climb efficiency by comparing the actual power required to climb to a rate of change of potential energy.

10. The climb power correction coefficient was calculated as shown below:

$$Kp = \frac{\Delta R/C}{\Delta SHP} \quad \frac{GW}{33,000} \tag{6}$$

Where:

$$\Delta R/C = R/C_2 - R/C_1$$

and

$$\Delta SHP = SHP@\ R/C_2 - SHP@\ R/C_1$$

Level Flight Performance

11. Tests were flown in ball-centered fight by reference to the ship's turn and slip indicators and a sensitive cg lateral accelerometer. 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. Each speed power was flown at a predetermined C_T and referred rotor speed $(N_R/\sqrt{\theta})$ which required also maintaining a constant ratio of gross weight to pressure ratio (W/δ). To maintain the 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 1.82 shp and was 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 0.883 square feet of equivalent flat plate area. Equation 2 can be rearranged to show that maintaining constant W/δ and $N_R/\sqrt{\theta}$ will also maintain a constant C_T as follows:

$$C_T = \frac{GW\ (91.19)}{\delta \left(\frac{N_R}{\sqrt{\theta}}\right)^2 \quad (\rho_o A R^3)} \tag{7}$$

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

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

T_A = Ambient air temperature (°C)
N_R = Main rotor speed (rev/min)
91.19 = Conversion factor (sec²-rev²/min²)

12. Each level flight data point was corrected to standard conditions for the flight by assuming that C_p and μ are unchanged. The following equations can then be derived from equations 1 and 3:

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

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

Where:

Subscript t = Test day
Subscript s = Standard

13. Changes in equivalent flat plate area calculated from changes in engine power coefficient were determined using the following equation:

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

Where:

ΔF_e = Change in equivalent flat plate area (ft²)

The data obtained in the normal utility configuration and with the VOLCANO system installed were analyzed by use of a simulated three dimensional plot (C_T and μ versus C_P). The reduction of this simulated three dimensional plot to a family of curves of C_T versus C_P, for 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.

14. The nondimensional level flight performance data in the VOLCANO configuration define the basic performance curves (fig. E-7 through E-9). Applying the ΔF_e technique to the level flight performance from AEFA Project No. 83-24 to produce a consistent fit to the VOLCANO configuration data (figs. E-10 through E-13) required the ΔF_e values to change with thrust coefficient and airspeed, as shown in figure D-1. The baseline ΔF_e shown here as a function of C_T applies to a level aircraft pitch attitude, which occurs at the extrapolated airspeed of 30 KCAS. Since aircraft pitch attitude varied as a function of calibrated airspeed and was consistent for all values of C_T flown (figs. E-23 and E-24), a percentage adjustment to the baseline ΔF_e could be obtained by calculating increase in projected frontal area of the VOLCANO system resulting from pitch attitude change. This projected area variation was solely based on geometric considerations resulting by tilting a rectangle that approximated the proportional dimensions of the VOLCANO system (assumed 50 unit height and 65 unit base). The percentage of ΔF_e adjustment as a function of calibrated airspeed shown in figure D-1 was added to the baseline ΔF_e using the expression:

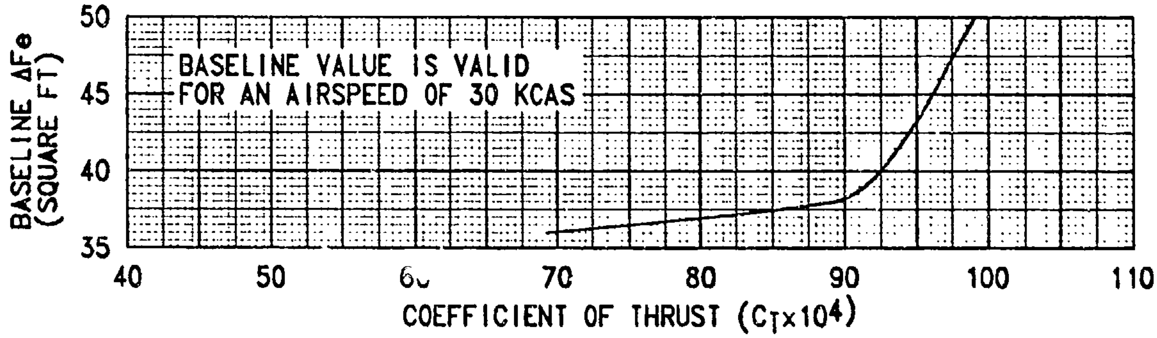
FIGURE D-1

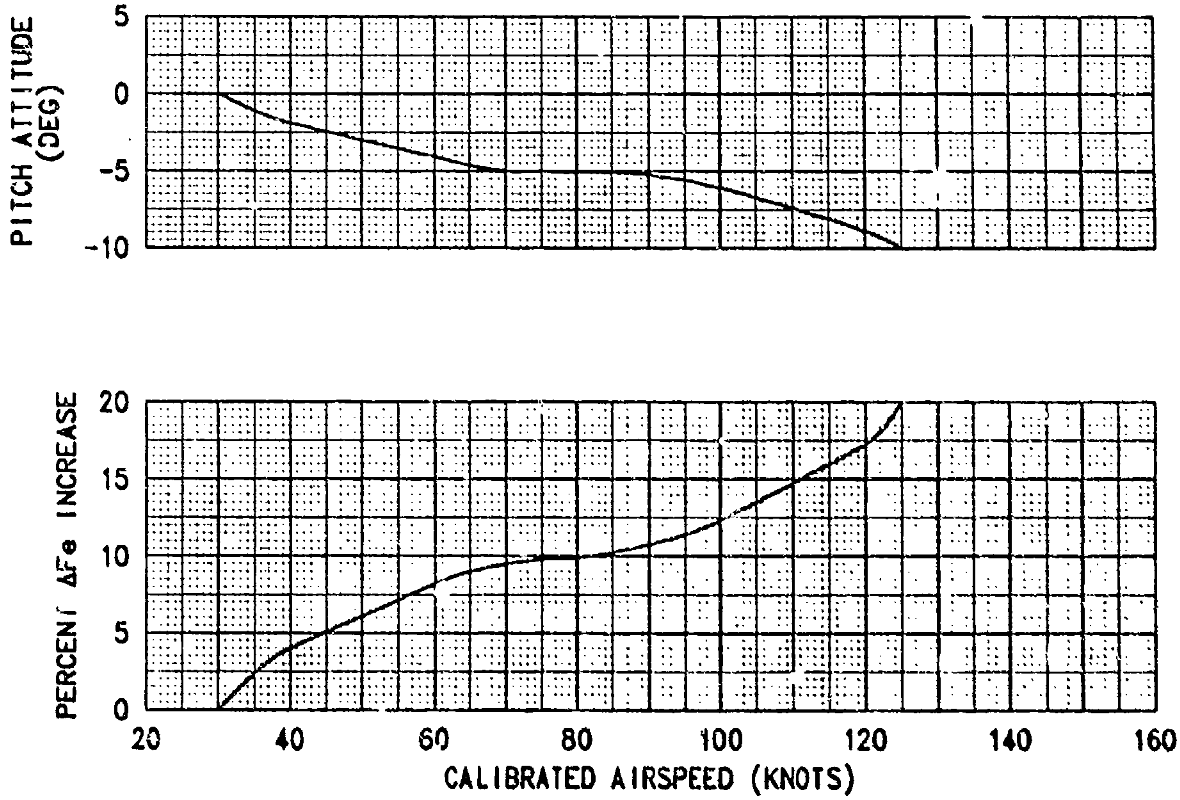
CHANGE IN ΔFe WITH AIRSPEED AND GROSS WEIGHT

UH-60A USA S/N 82-23748

NOTES:
1. VOLCANO CONFIGURATION
2. LEVEL FLIGHT
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. BALL CENTERED TRIM CONDITION
5. REFERRED MAIN ROTOR SPEED=258 RPM

BASELINE ΔFe OF VOLCANO INSTALLATION OVER NORMAL UTILITY CONFIGURATION APPLIES TO LEVEL AIRCRAFT ATTITUDE. PERCENT INCREASE IN ΔFe WITH AIRSPEED IS BASED ON GEOMETRIC CONSIDERATIONS AS PITCH ATTITUDE CHANGES AND IS VALID FOR ALL THRUST COEFFICIENTS.





$$\Delta F_e = (1.0 + \text{PERCENT } \Delta F_e \text{ increase}/100)\ \Delta F_{e_{baseline}}$$

Autorotational Descent Performance

15. Autorotational descent performance data were obtained at various airspeeds with constant rotor speed and at various rotor speeds with constant airspeed. With the collective at a minimum setting to maintain 100 percent (258) rotor speed, the aircraft was flown on reciprocal headings at each of several airspeeds to determine the airspeeds for minimum rate of descent and maximum glide ratio. At these two airspeeds, rotor speed was varied to determine the rotor speed for minimum rate of descent. The tapeline rates of descent were corrected for nonstandard temperature using the following equation.

$$R/D_{tapeline} = \frac{dH_P}{dt} \quad \frac{T_t}{T_s} \tag{11}$$

HANDLING QUALITIES

16. Handling qualities data were evaluated using standard test methods described in Naval Air Test Center Flight Test Manual, FTM No. 105 (ref 15) with the exception of controllability tests. Controllability data was obtained from time history traces of control position, aircraft attitudes and rates. Angular acceleration was derived from angular rate. The time to 0.63 maximum rate was measured from the initial rate build-up and the time to maximum acceleration was measured from the start of the control input. A Handling Qualities Rating Scale (HQRS) (fig. D-2) was used to augment pilot comments regarding aircraft handling qualities.

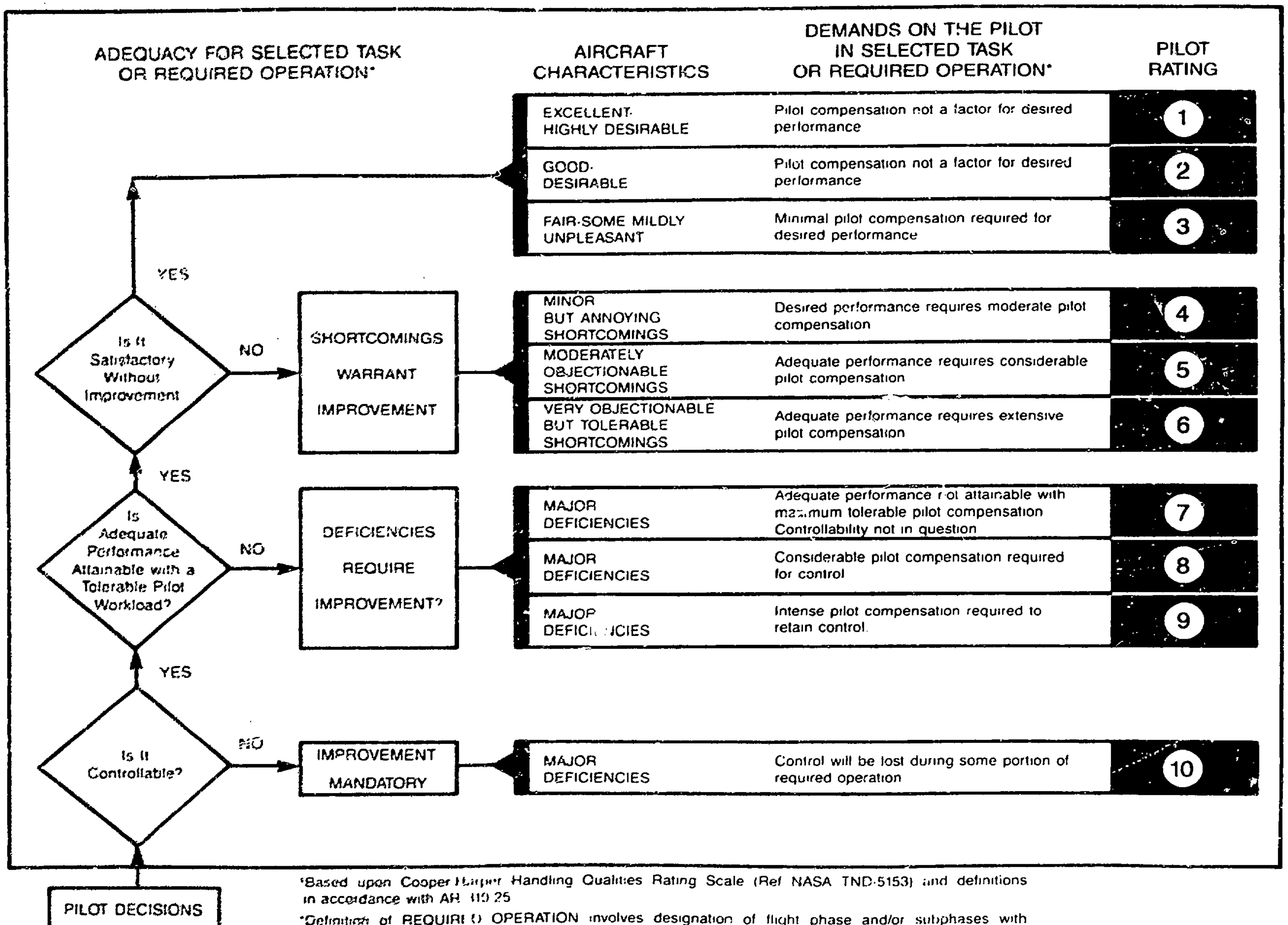
VIBRATION

17. A Vibration Rating Scale (VRS) (fig. D-3) was used to augment pilot comments relative to aircraft vibrations

DEFINITION

18. 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.



*Based upon Cooper-Harper Handling Qualities Rating Scale (Ref NASA TND-5153) and definitions in accordance with AR 110 25

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

Figure D-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 D-2. Vibration Rating Scale

APPENDIX E. TEST DATA

FIGURE E-1
NONDIMENSIONAL HOVER PERFORMANCE
UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION
10 FT WHEEL HEIGHT

SYMBOL	AVG DENSITY ALTITUDE (FT)	AVG REFERRED ROTOR SPEED (RPM)	AVG OUTSIDE AIR TEMP. (DEG C)
□	2570	246.6	14.5
⊙	2570	254.5	14.5
△	2570	261.5	14.5

NOTES: 1. WHEEL HEIGHT MEASURED FROM BOTTOM OF LEFT MAIN WHEEL
2. VERTICAL DISTANCE FROM BOTTOM OF MAIN WHEELS TO CENTER OF MAIN ROTOR HUB = 12 FT
3. TESTS CONDUCTED WITH THE AIRCRAFT TETHERED TO THE GROUND
4. WINDS LESS THAN THREE KNOTS

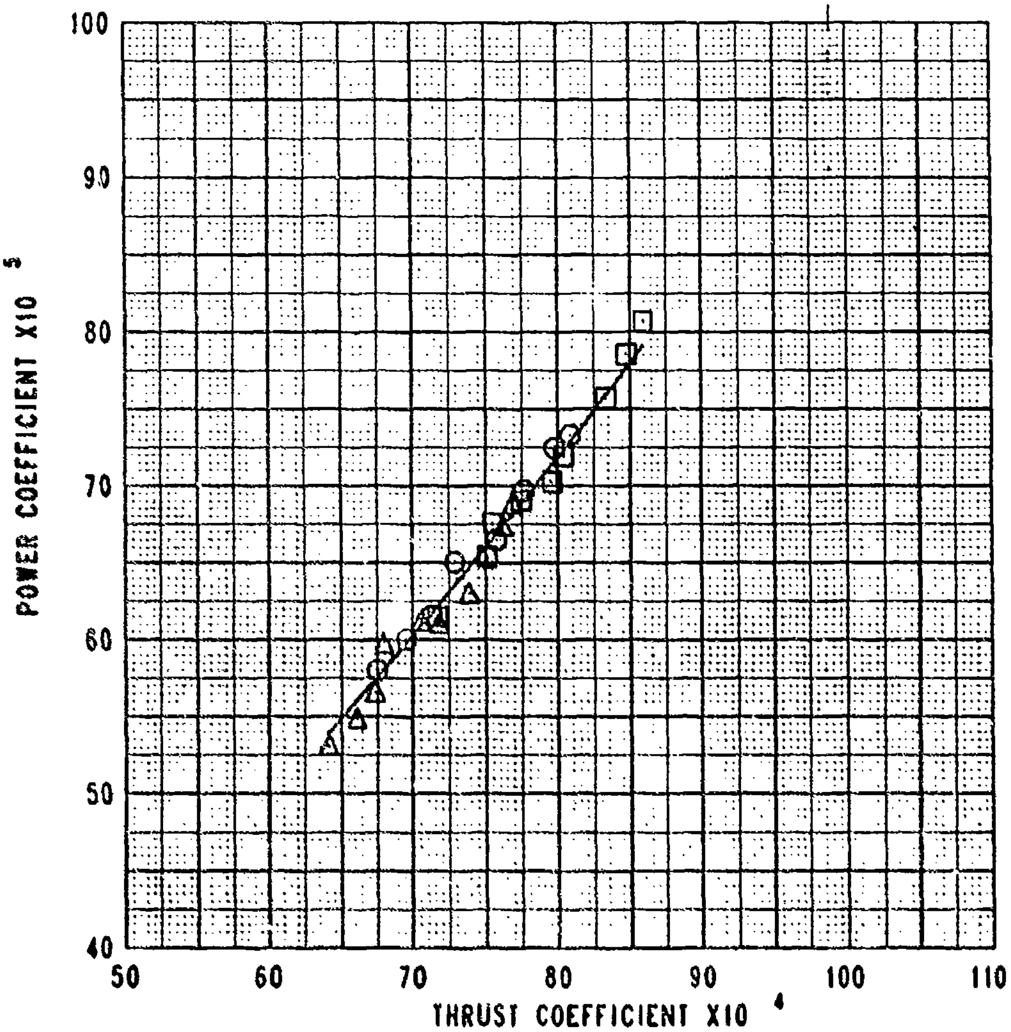


FIGURE E-2
NONDIMENSIONAL HOVER PERFORMANCE
UH-60 USA S/N 82-23748
NORMAL UTILITY CONFIGURATION
10 FT WHEEL HEIGHT

SYMBOL	AVG DENSITY ALTITUDE (FT)	AVG REFERRED ROTOR SPEED (RPM)	AVG OUTSIDE AIR TEMP. (DEG C)
□	9840	251.1	-1.5
⊙	9840	258.6	-1.5
△	9840	266.5	-1.5
+	2880	243.0	16.5
◇	2880	248.0	16.5
⊠	2880	253.5	16.5

NOTES: 1. WHEEL HEIGHT MEASURED FROM BOTTOM OF LEFT MAIN WHEEL
2. VERTICAL DISTANCE FROM BOTTOM OF MAIN WHEELS TO CENTER OF MAIN ROTOR HUB = 12 FT
3. TESTS CONDUCTED WITH THE AIRCRAFT TETHERED TO THE GROUND
4. WINDS LESS THAN THREE KNOTS

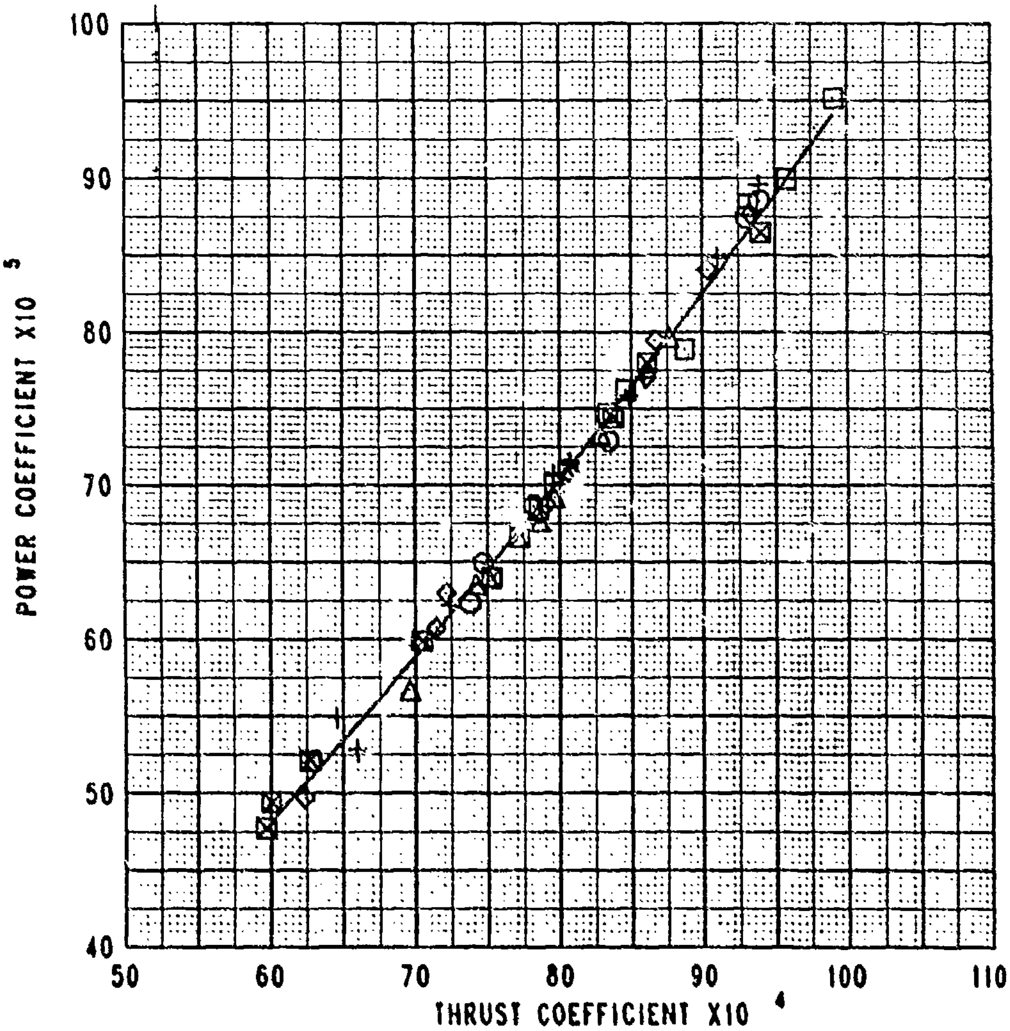


FIGURE E-3
NONDIMENSIONAL HOVER PERFORMANCE
UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION
100 FT WHEEL HEIGHT

SYMBOL	AVG DENSITY ALTITUDE (FT)	AVG REFERRED ROTOR SPEED (RPM)	AVG OUTSIDE AIR TEMP. (DEG C)
□	2620	247.1	15.0
○	2620	253.2	15.0
△	2620	261.5	15.0

NOTES: 1. WHEEL HEIGHT MEASURED FROM BOTTOM OF LEFT MAIN WHEEL
2. VERTICAL DISTANCE FROM BOTTOM OF MAIN WHEELS TO CENTER OF MAIN ROTOR HUB = 12 FT
3. TESTS CONDUCTED WITH THE AIRCRAFT TETHERED TO THE GROUND
4. WINDS LESS THAN THREE KNOTS

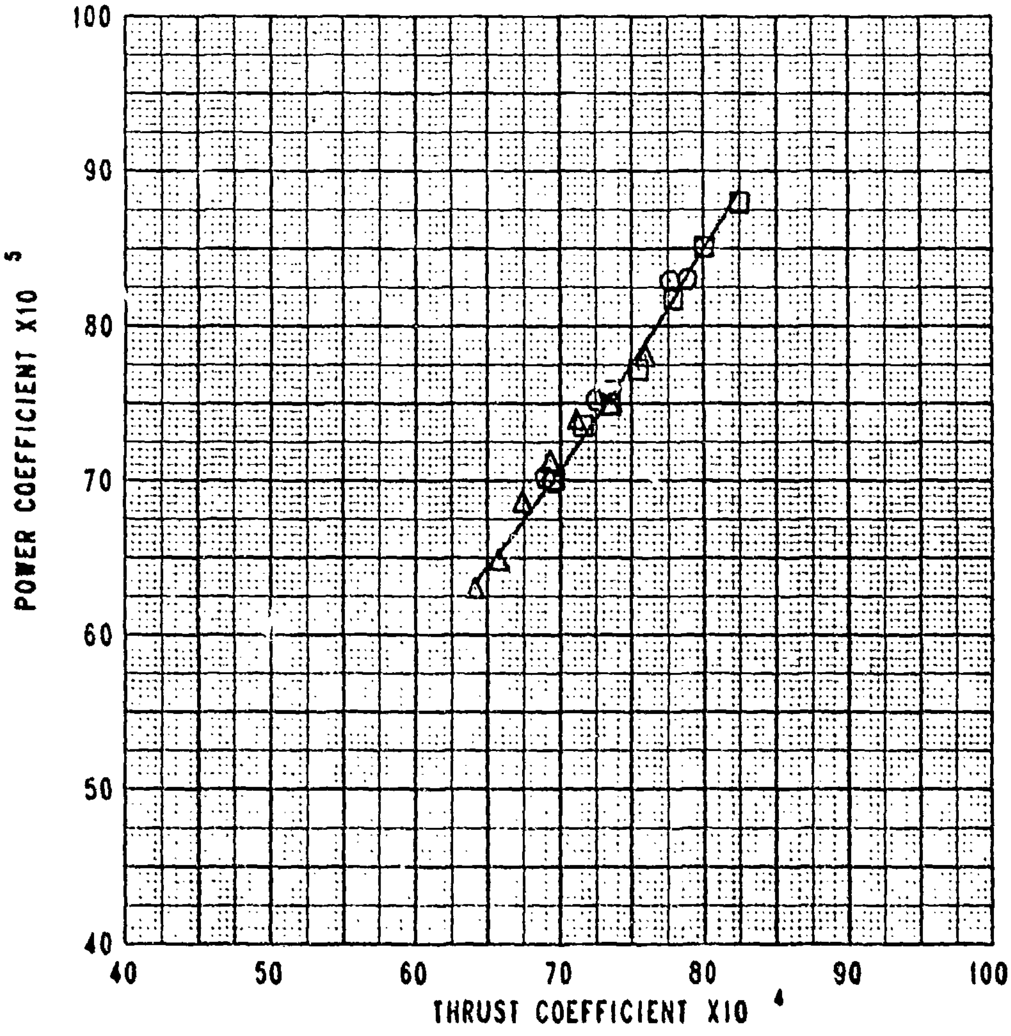


FIGURE E-4
NONDIMENSIONAL HOVER PERFORMANCE
UH-60 USA S/N 82-23748
NORMAL UTILITY CONFIGURATION
100 FT WHEEL HEIGHT

SYMBOL	AVG DENSITY ALTITUDE (FT)	AVG REFERRED ROTOR SPEED (RPM)	AVG OUTSIDE AIR TEMP. (DEG C)
□	1260	251.9	4.5
○	1260	257.9	4.5
△	1260	267.3	4.5

NOTES: 1. WHEEL HEIGHT MEASURED FROM BOTTOM OF LEFT MAIN WHEEL
2. VERTICAL DISTANCE FROM BOTTOM OF MAIN WHEELS TO CENTER OF MAIN ROTOR HUB = 12 FT
3. TESTS CONDUCTED WITH THE AIRCRAFT TETHERED TO THE GROUND
4. WINDS LESS THAN THREE KNOTS

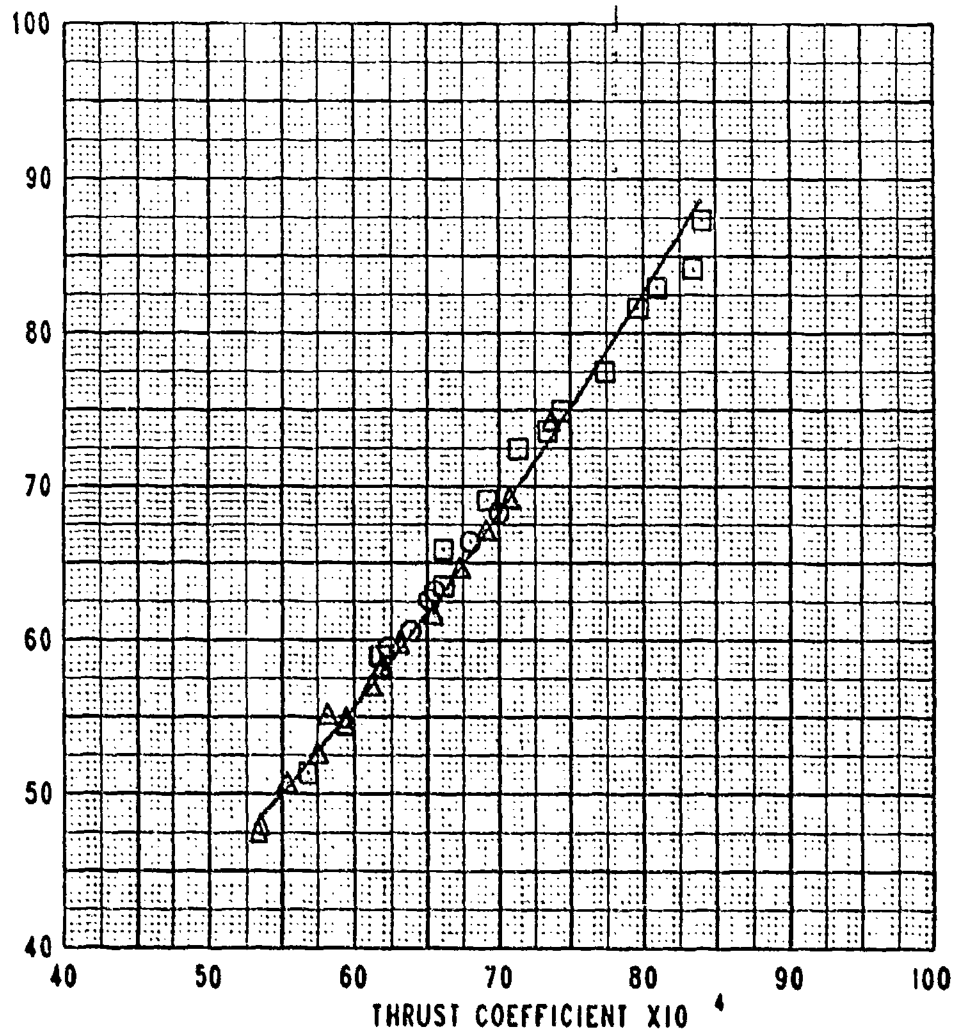


FIGURE E-5

CLIMB PERFORMANCE

UH-60A USA S/N 82-23748

VOLCANO CONFIGURATION

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
20,150	347.0(FWD)	0.2 LT	5750	1.0	258.0

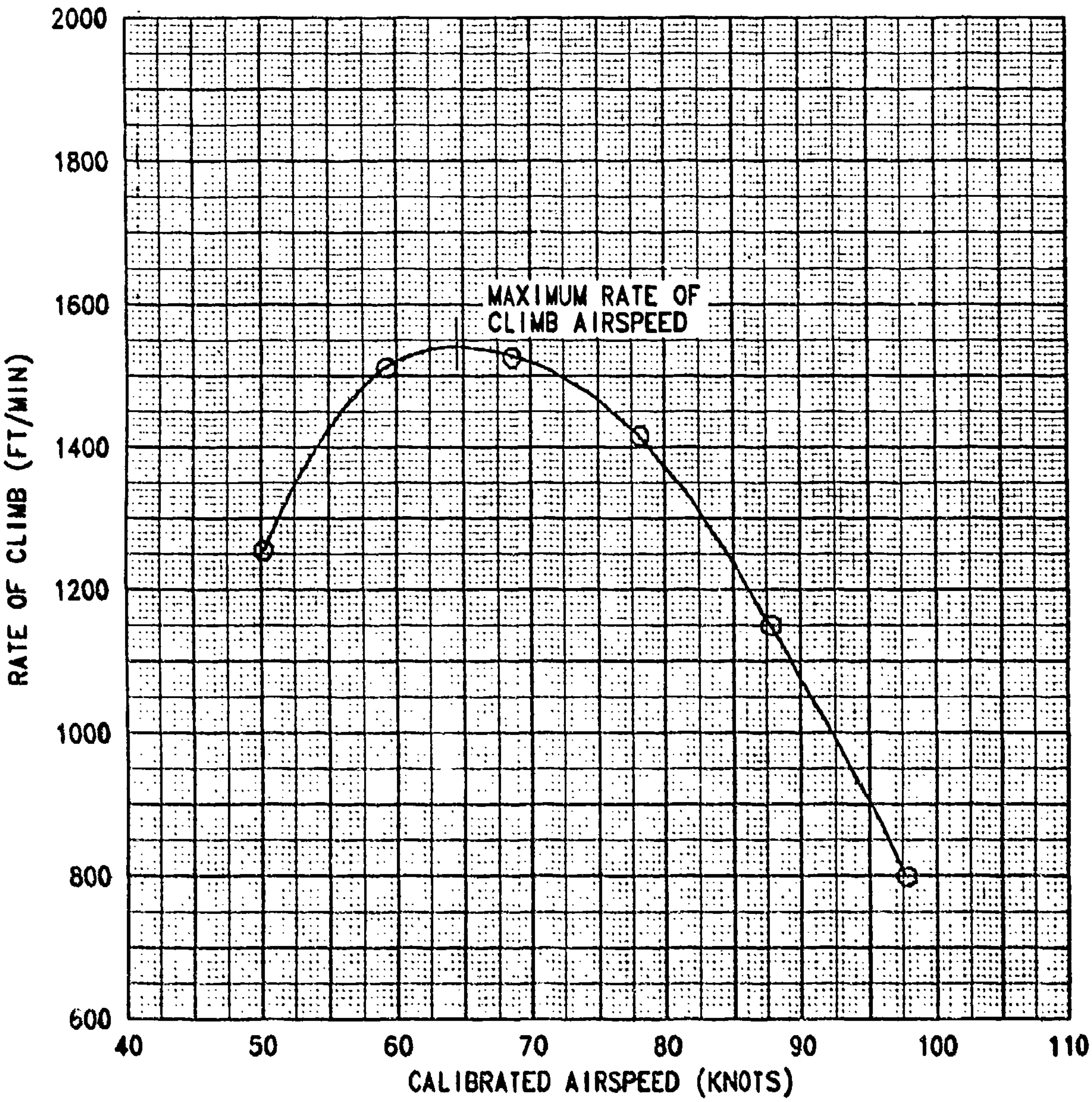


FIGURE E-6

VARIATION IN RATE OF CLIMB AS A FUNCTION OF SHAFT HORSEPOWER

UH-60A USA S/N 82-23748

AVERAGE DENSITY ALTITUDE (FT)	AVERAGE GROSS WEIGHT (LB)	AVERAGE ROTOR SPEED (RPM)
5750	20,150	258.0

NOTES: 1. TESTS CONDUCTED AT MAXIMUM RATE OF CLIMB SPEED (64.5 KCAS) USING INTERMEDIATE RATED POWER

2. $Kp = \frac{\Delta R/C}{\Delta SHP} \times \frac{GW}{33000}$ 0.75

3. VOLCANO CONFIGURATION

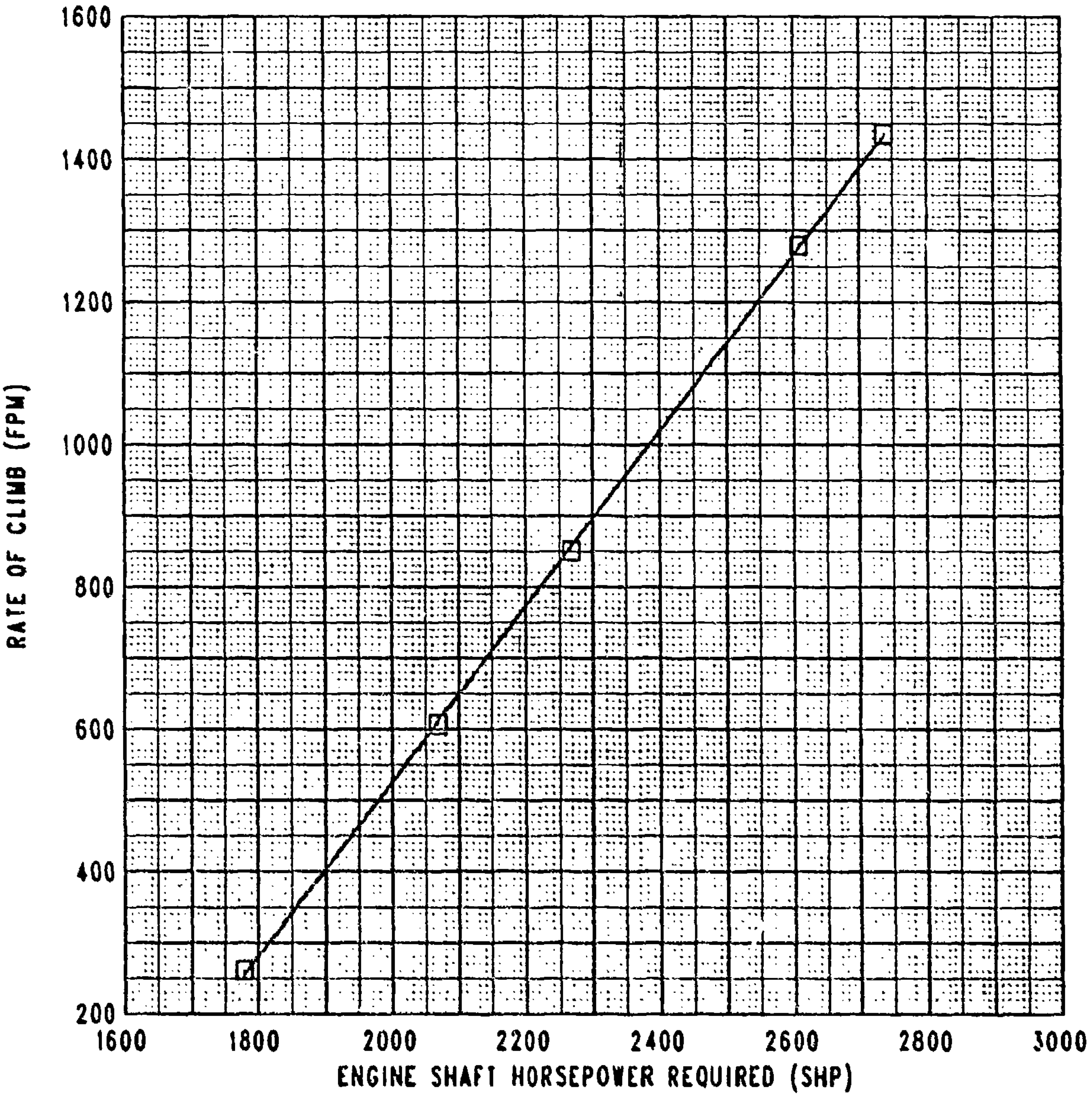


FIGURE E-7

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

NOTES:
1. VOLCANO CONFIGURATION
2. BALL CENTERED TRIM CONDITION
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. REFERRED ROTOR SPEED = 258 RPM
5. POINTS DERIVED FROM FIGURES E-10 THRU E-13

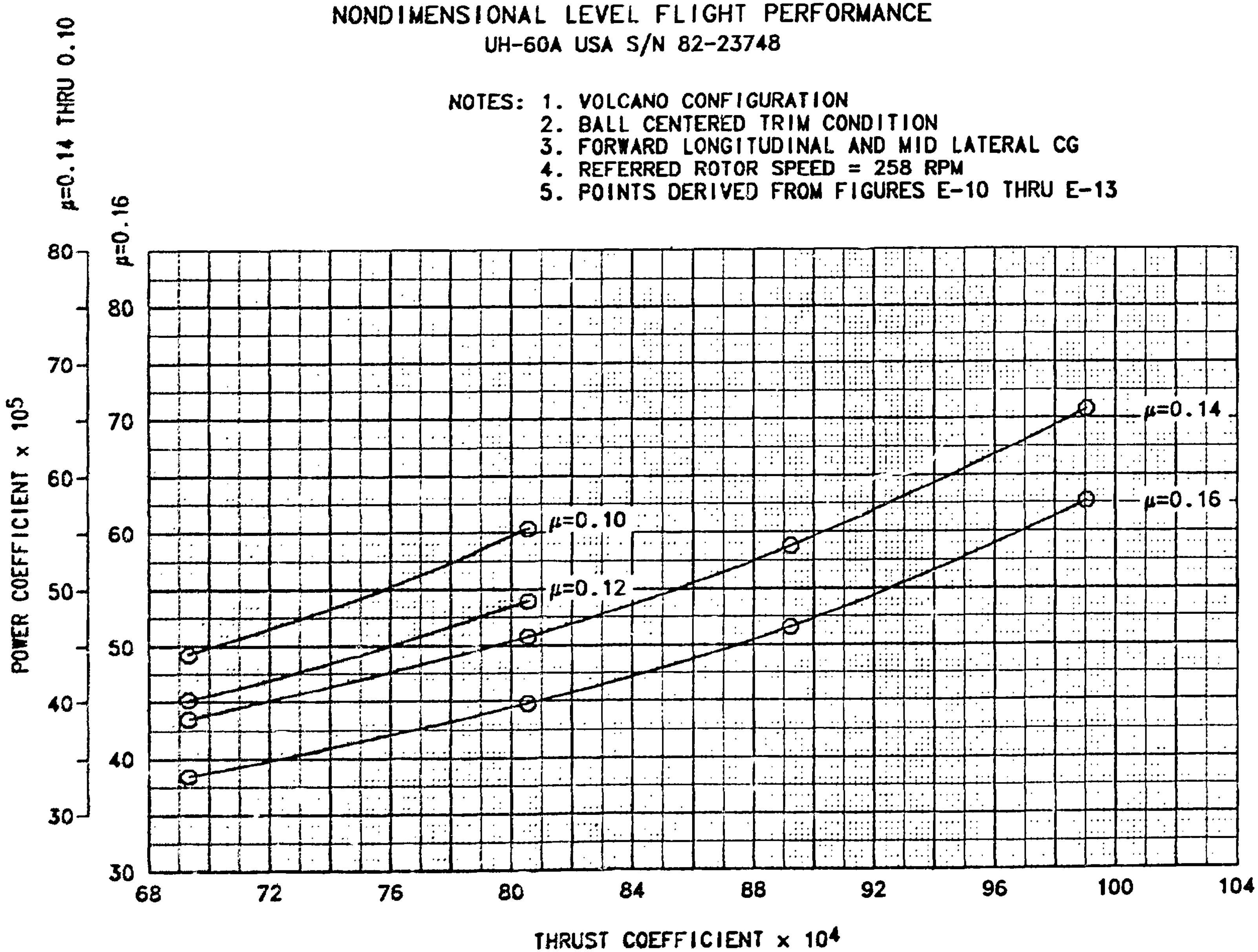


FIGURE E-8

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

NOTES:
1. VOLCANO CONFIGURATION
2. BALL CENTERED TRIM CONDITION
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. REFERRED ROTOR SPEED = 258 RPM
5. POINTS DERIVED FROM FIGURES E-10 THRU E-13

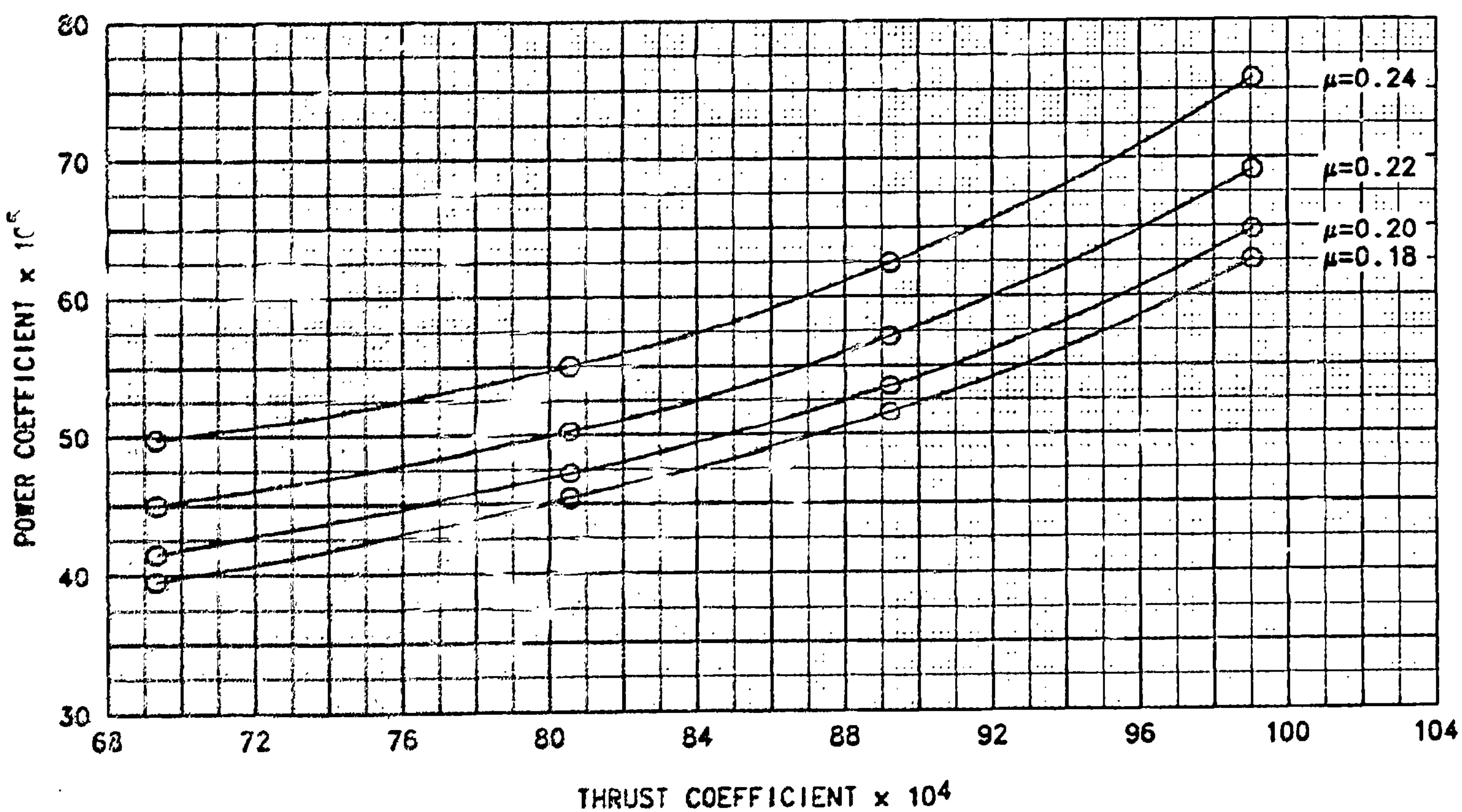


FIGURE E-9

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

NOTES:
1. VOLCANO CONFIGURATION
2. BALL CENTERED TRIM CONDITION
3. FORWARD LONGITUDINAL AND MID LATERAL CG
4. REFERRED ROTOR SPEED = 258 RPM
5. POINTS DERIVED FROM FIGURES E-10 THRU E-13

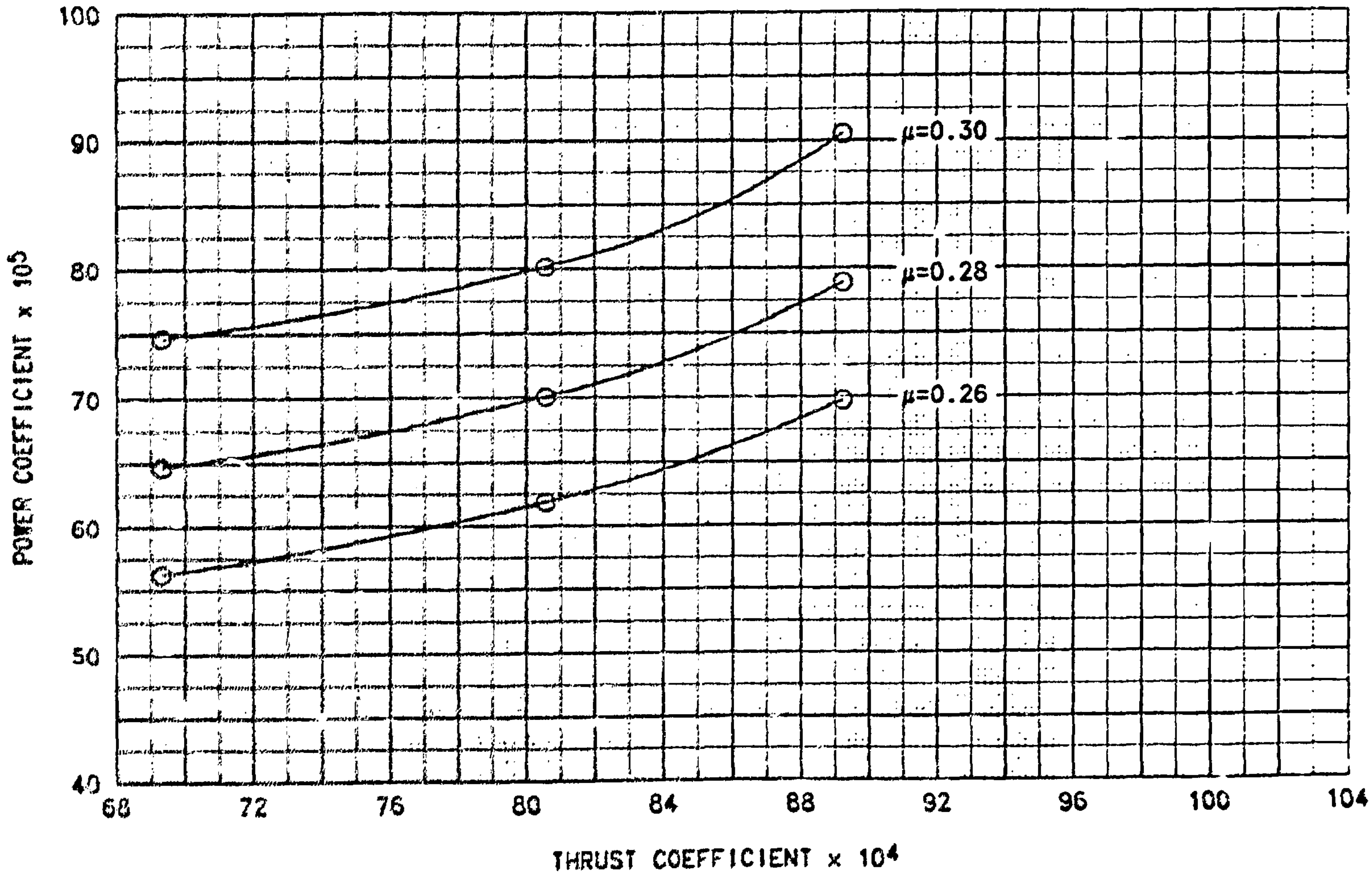
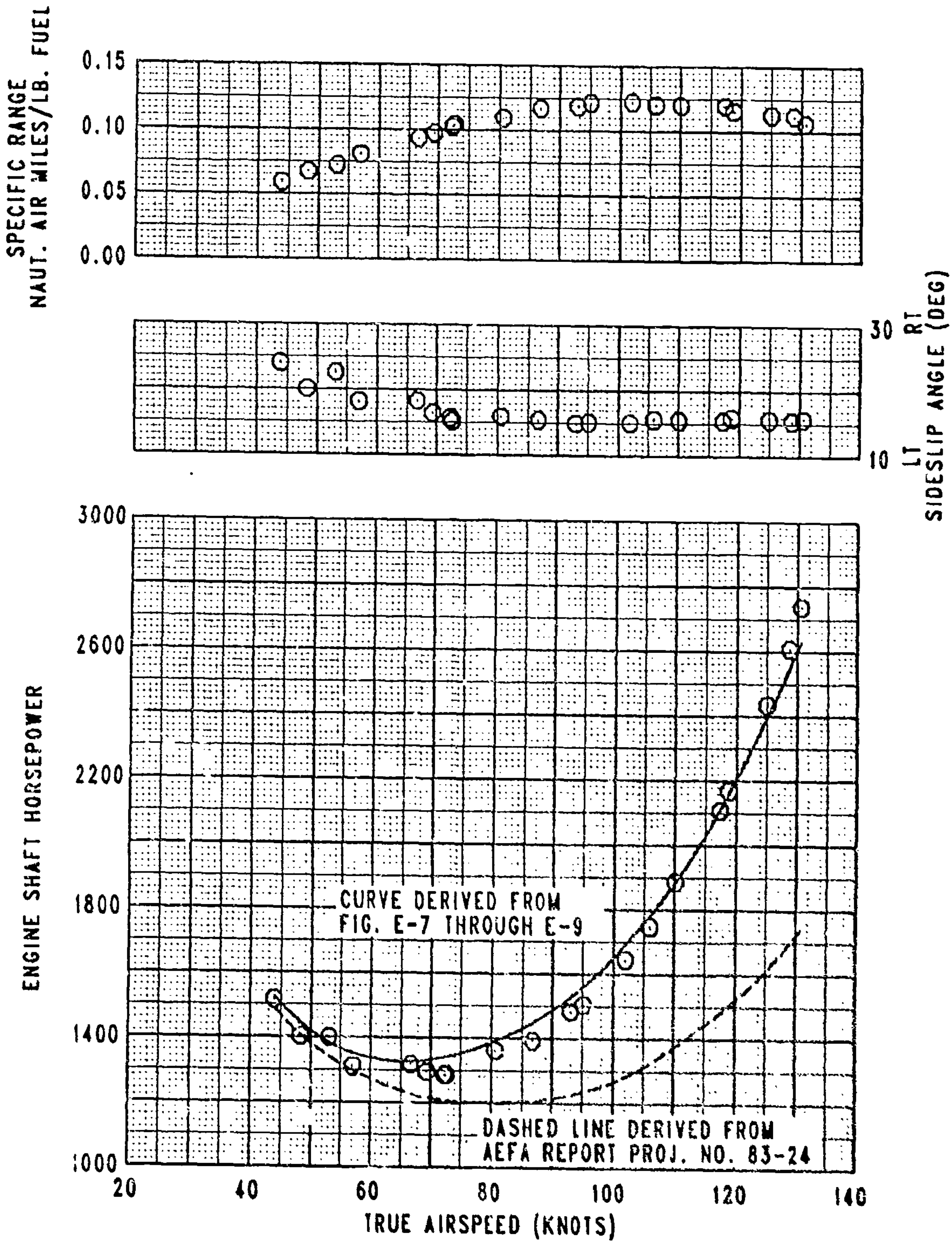


FIGURE E-10

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
18020	345.8(FWD)	0.2 LT	3430	18.0	259.0	0.006932



LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
20190	346.6(FWD)	0.2 LT	3530	13.0	257.0	0.008055

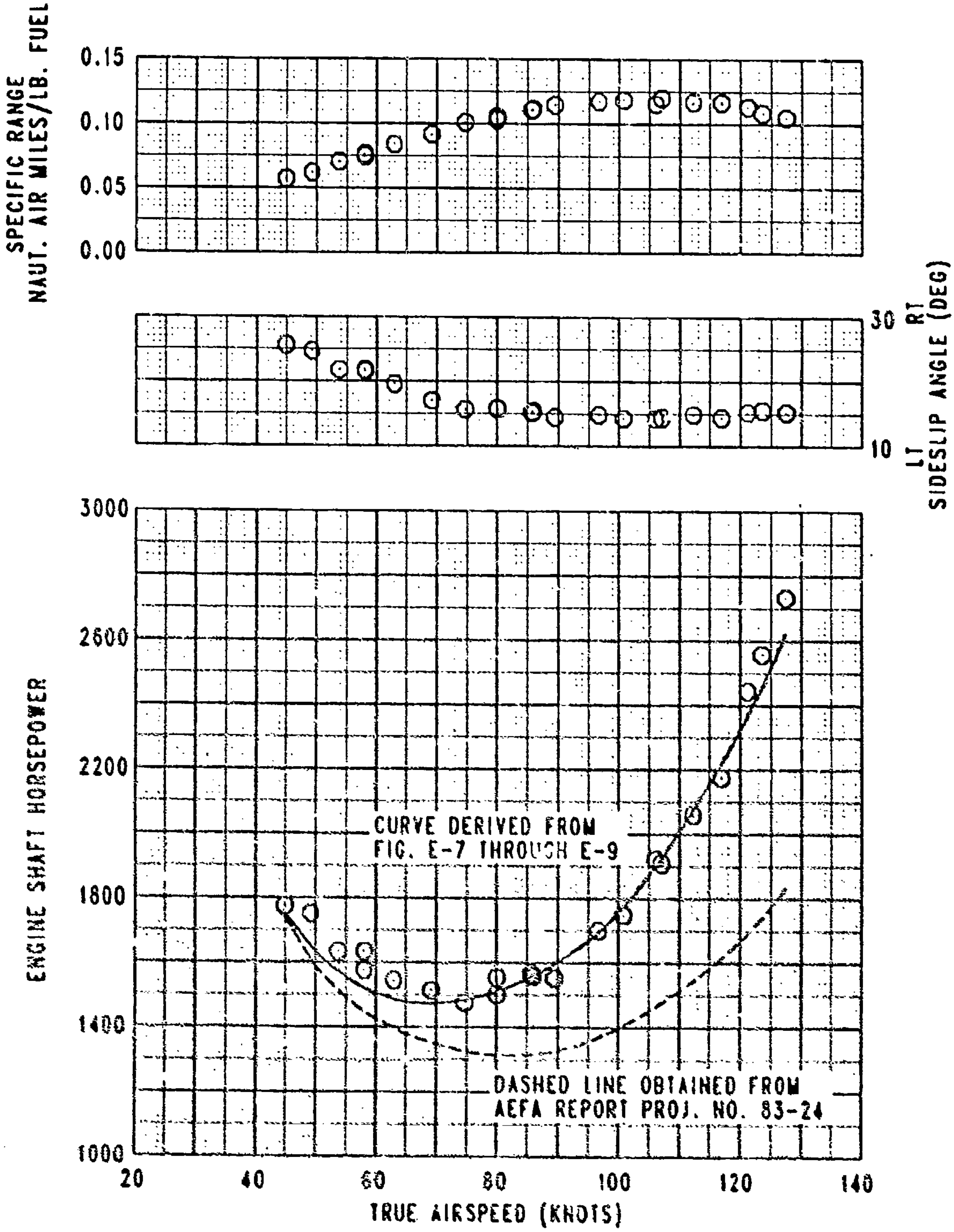
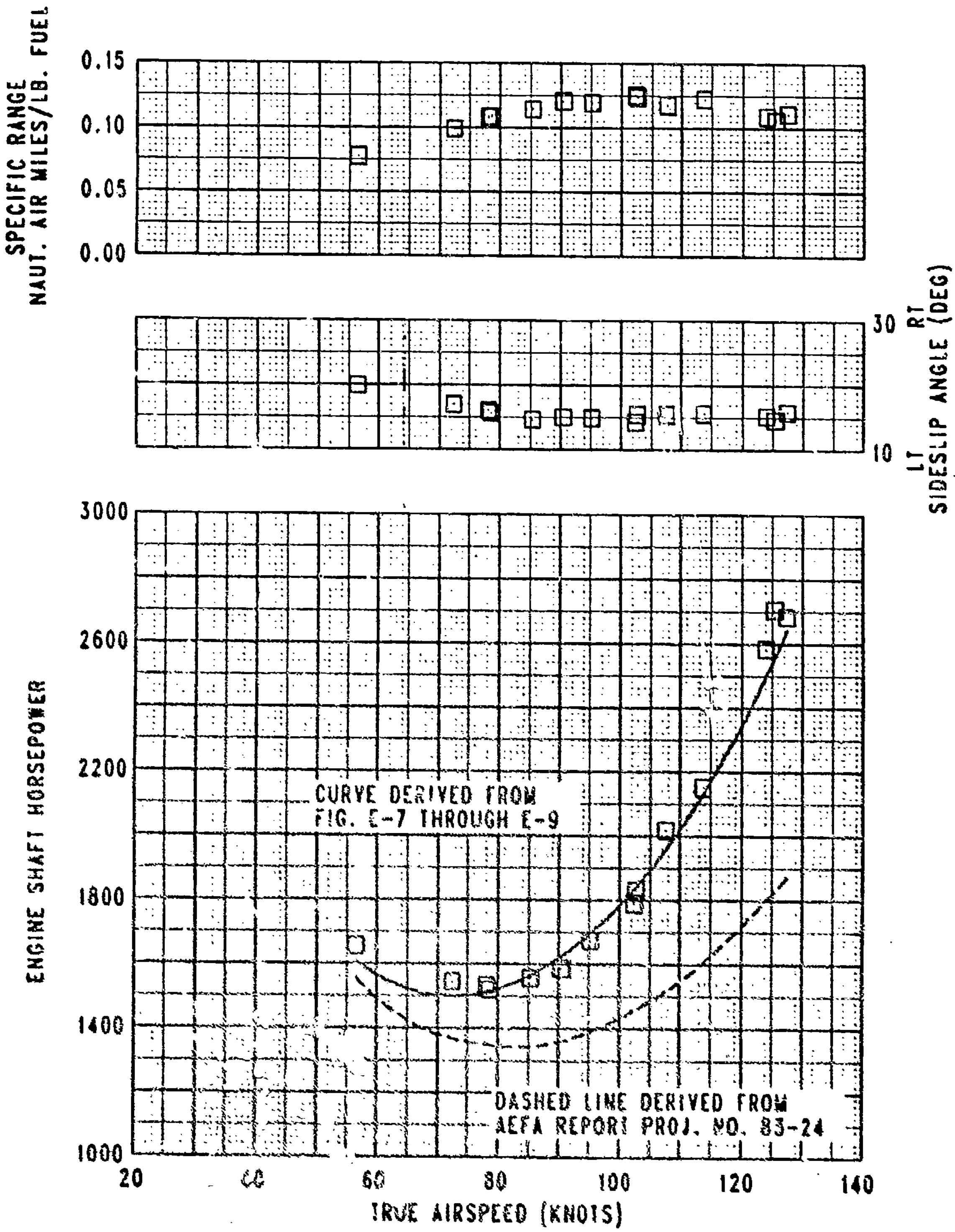


FIGURE E-12

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
19990	346.5(FWD)	0.2 LT	7170	8.0	259.0	0.008923



LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
20030	346.5(FWD)	0.2 LT	9770	2.0	259.0	0.009904

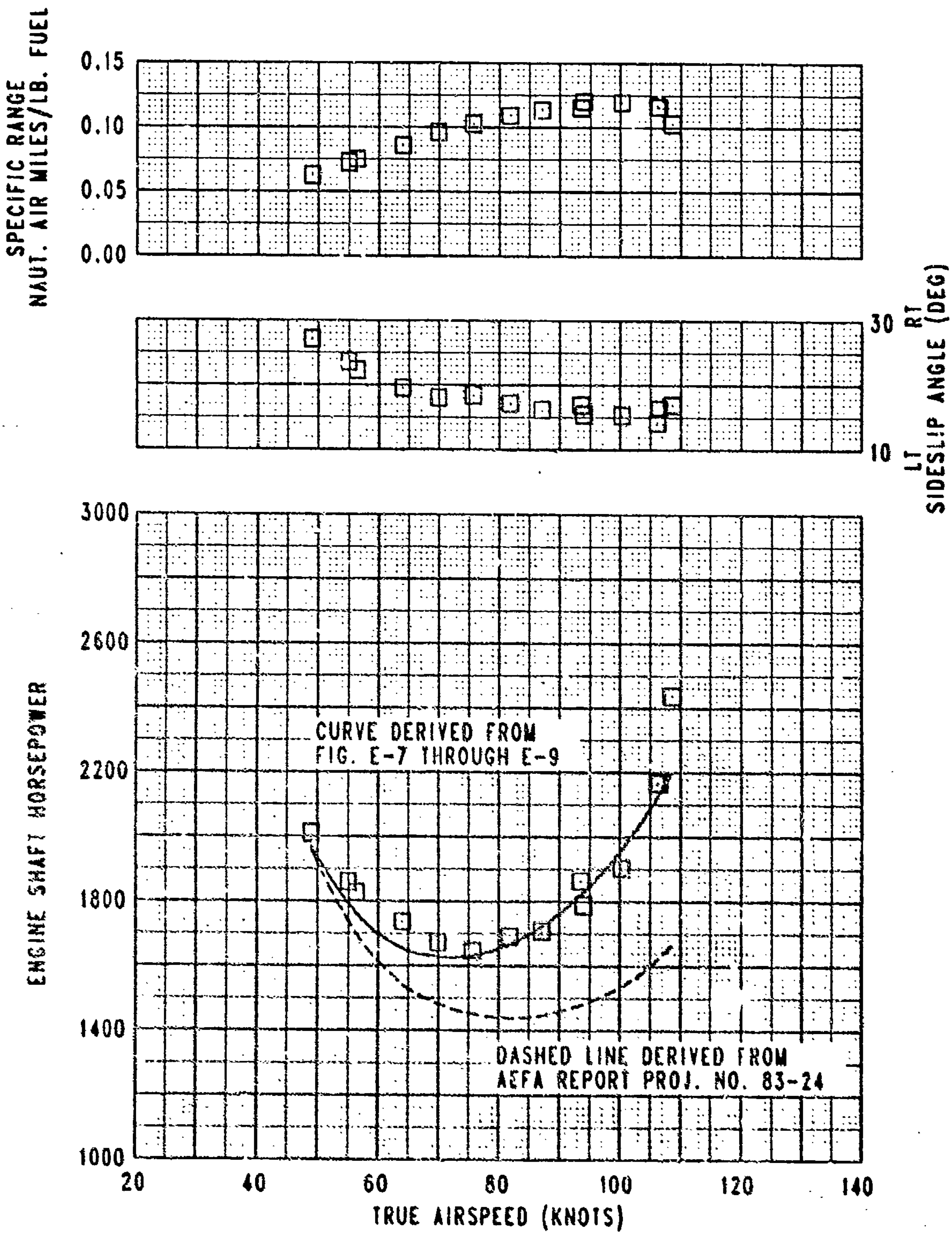
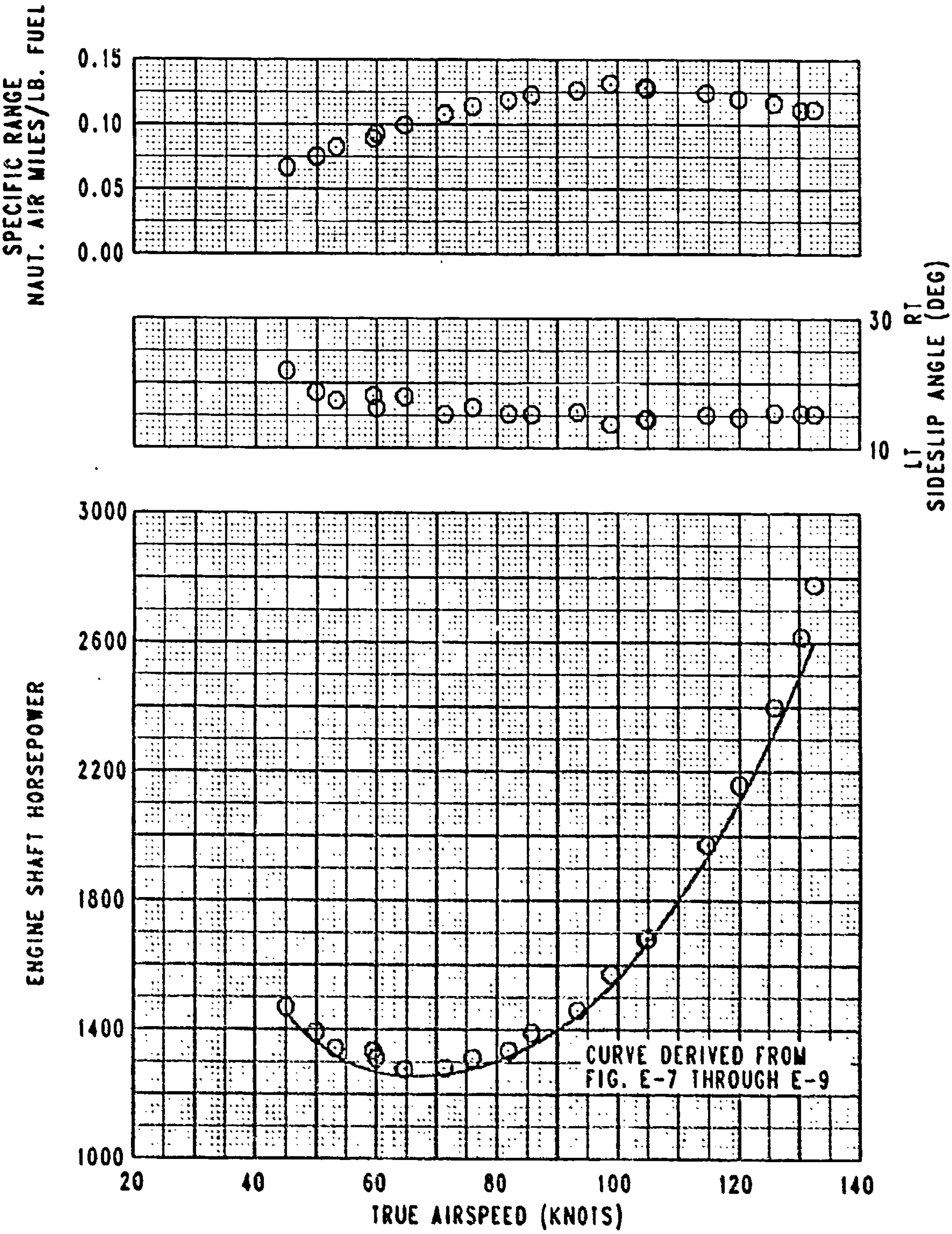


FIGURE E-14

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
17750	346.8(FWD)	0.2 LT	5510	13.0	250.0	0.007940



LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
19940	346.6(FWD)	0.2 LT	8720	6.0	266.0	0.008914

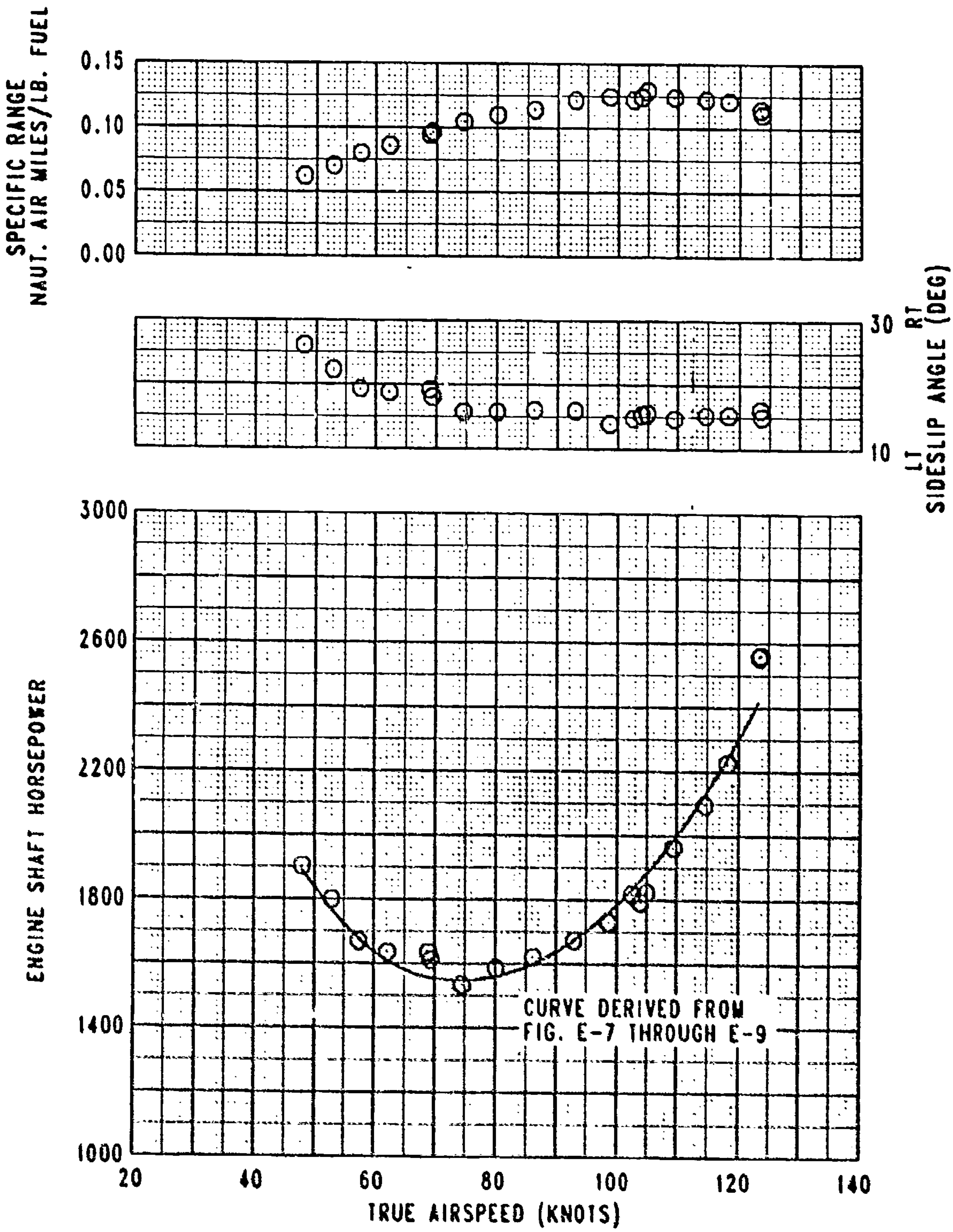


FIGURE E-16

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
17780	347.0(FWD)	0.2 LT	4110	5.0	266.0	0.006927

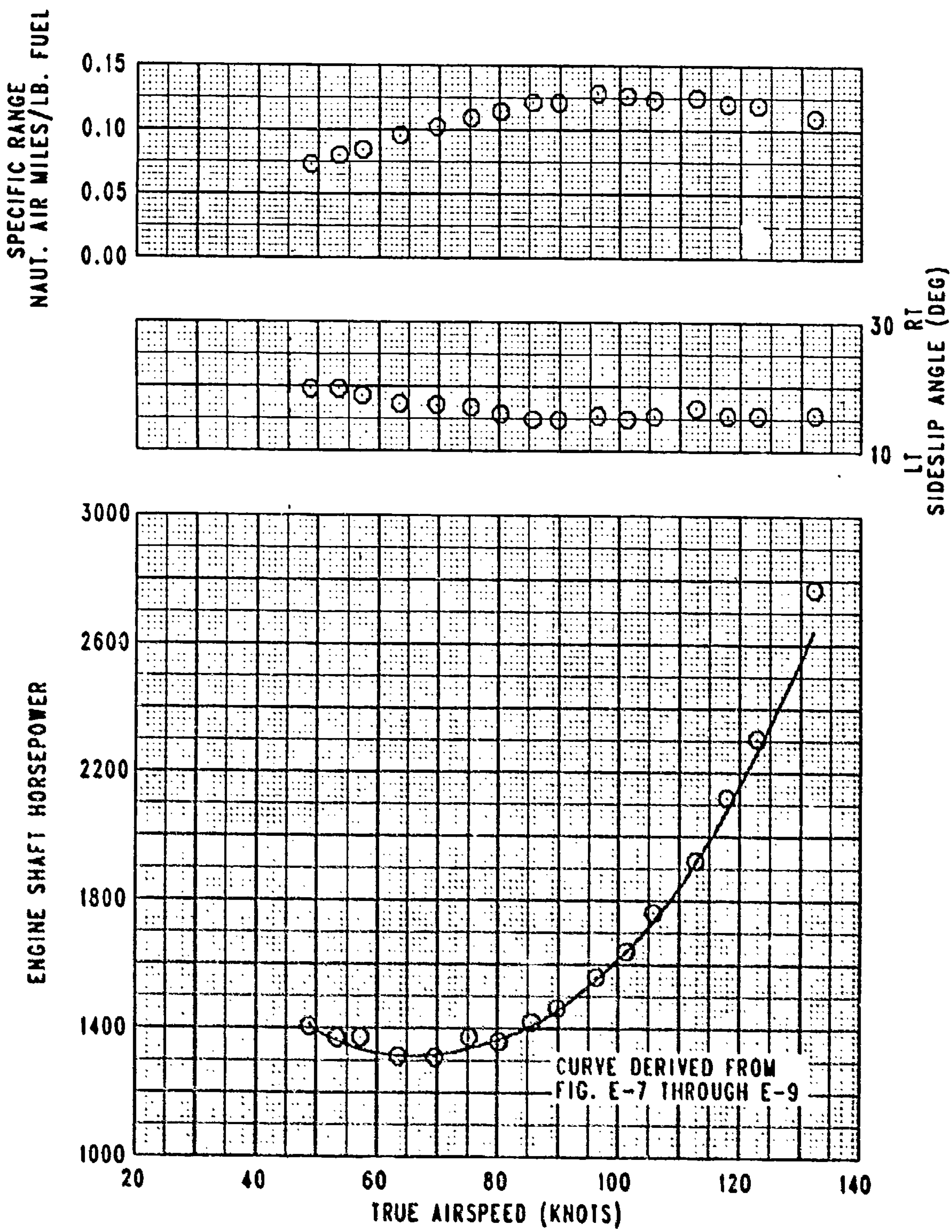


FIGURE E-17

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
16320	357.3	0.2 LT	5430	7.0	258.0	0.006984

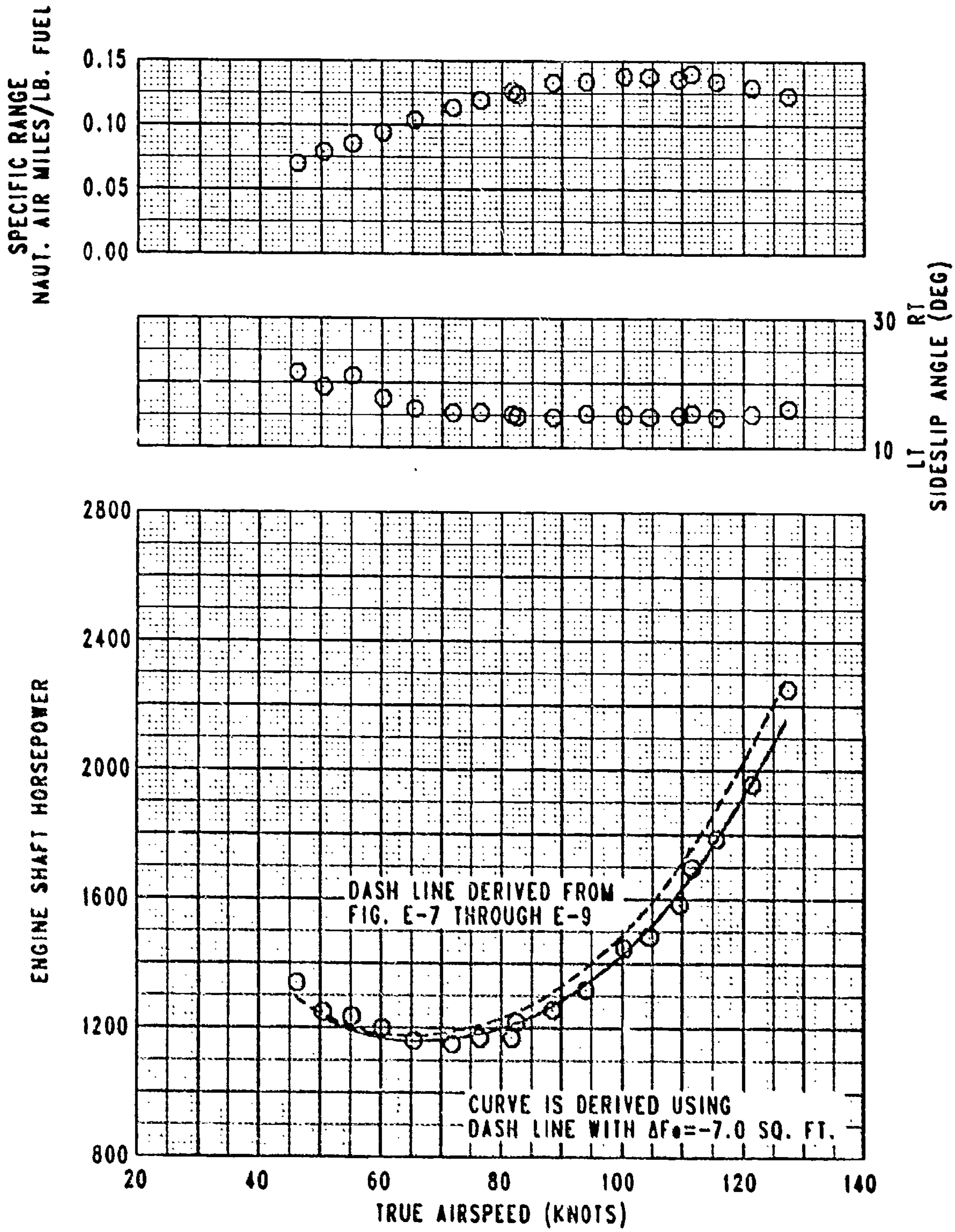


FIGURE E-18

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
VOLCANO CONFIGURATION

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
20170	358.1	0.2 LT	6450	4.0	259.0	0.008932

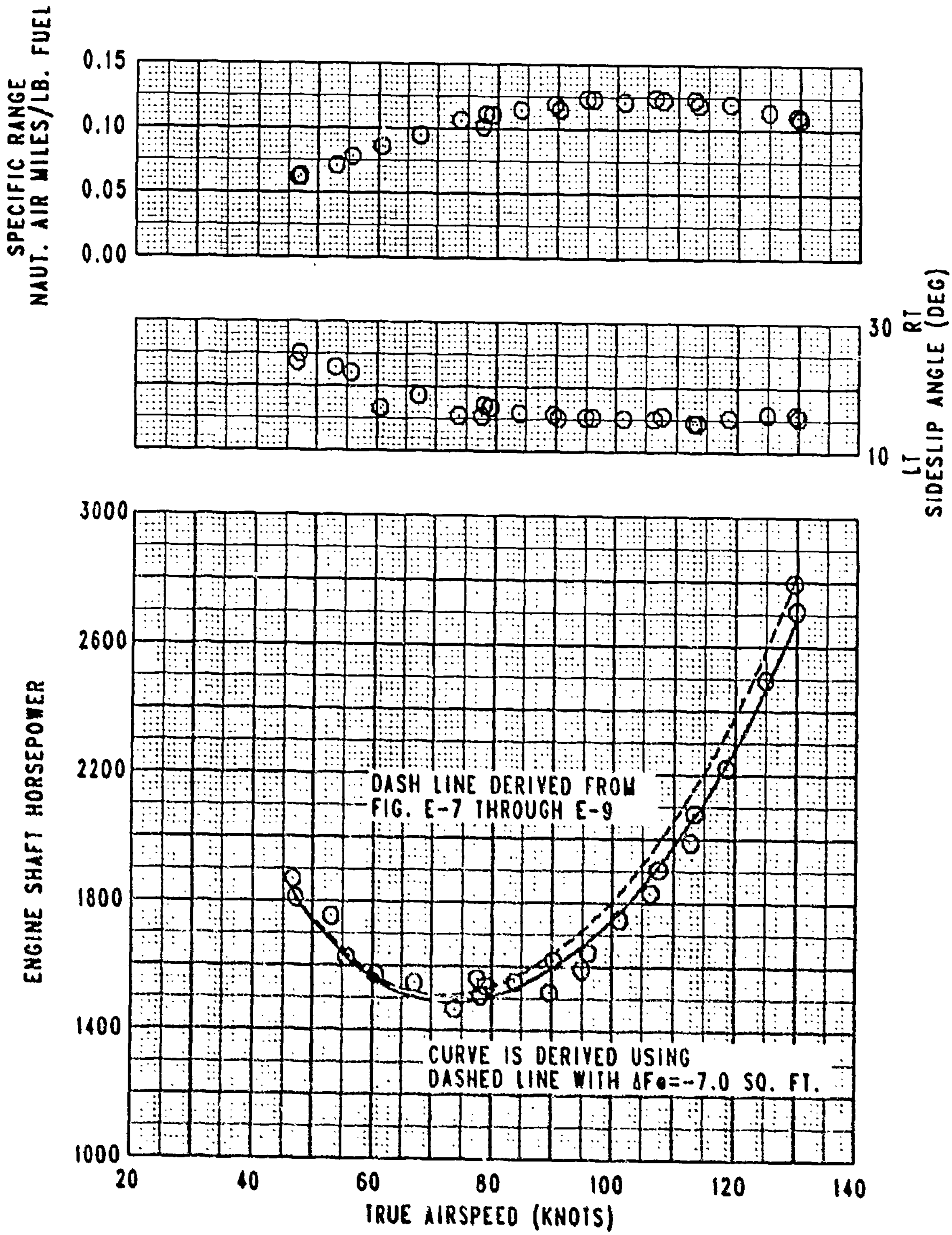


FIGURE E-19

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
NORMAL UTILITY CONFIGURATION

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
17530	346.7(FWD)	0.1 RT	3320	9.0	259.0	0.006936

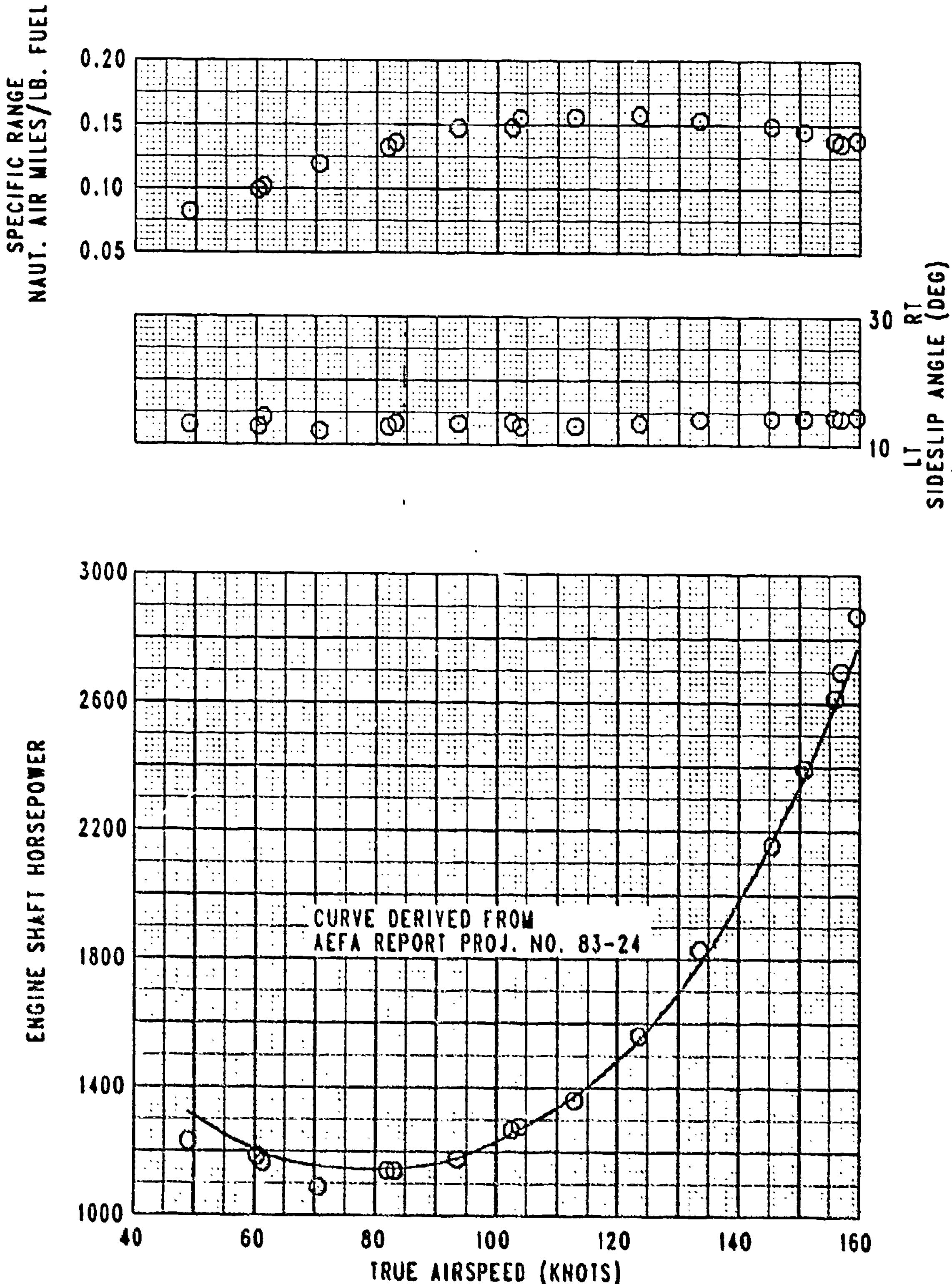
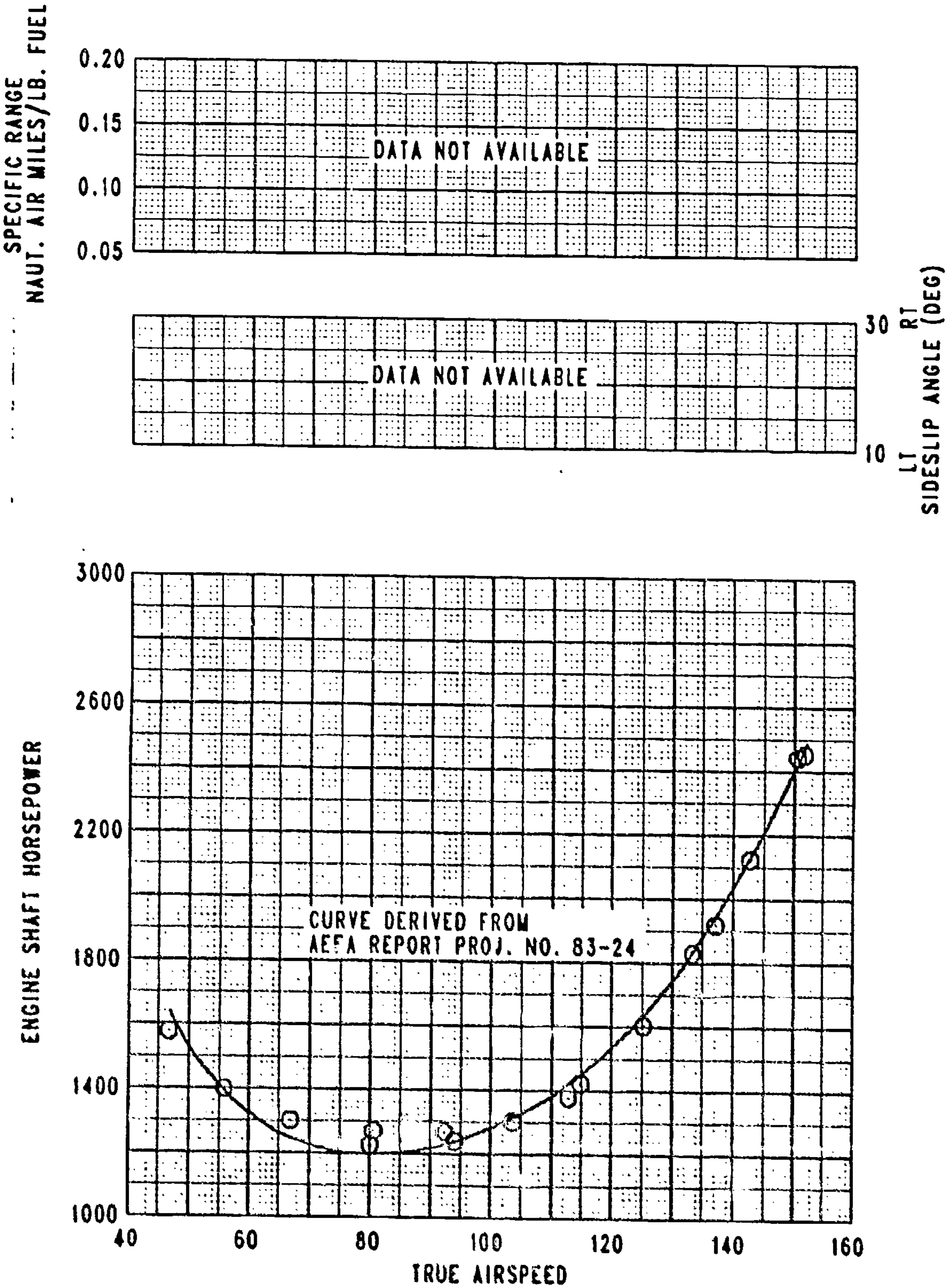


FIGURE E-20

LEVEL FLIGHT PERFORMANCE

UH-60 USA S/N 82-23748
NORMAL UTILITY CONFIGURATION

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
17970	347.4(FWD)	0.1 RT	9900	2.0	260.0	0.008853



AUTOROTATIONAL DESCENT PERFORMANCE

UH-60A USA S/N 82-23748

VOLCANO CONFIGURATION

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
19,500	347.4(FWD)	0.2 LT	5000	-6.5	258.0

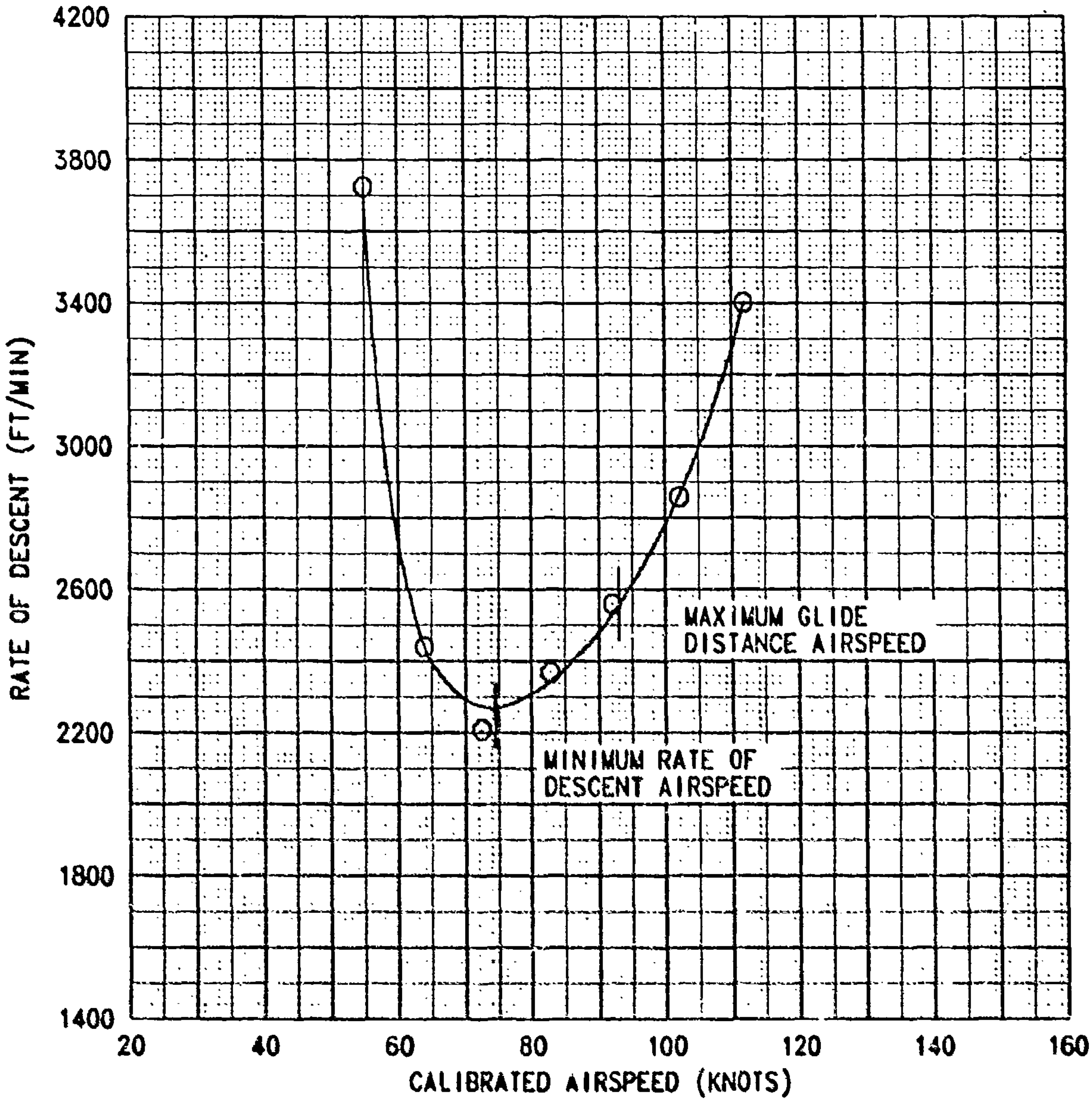


FIGURE E-22

AUTOROTATIONAL DESCENT PERFORMANCE
UH-60A USA S/N 82-23748
VOLCANO CONFIGURATION

SYMBOL	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG CALIB AIRSPEED (KT)
□	19330	345.0(FWD)	0.2 LT	5200	-6.5	73.0
⊙	19700	346.5(FWD)	0.2 LT	5400	1.0	93.0

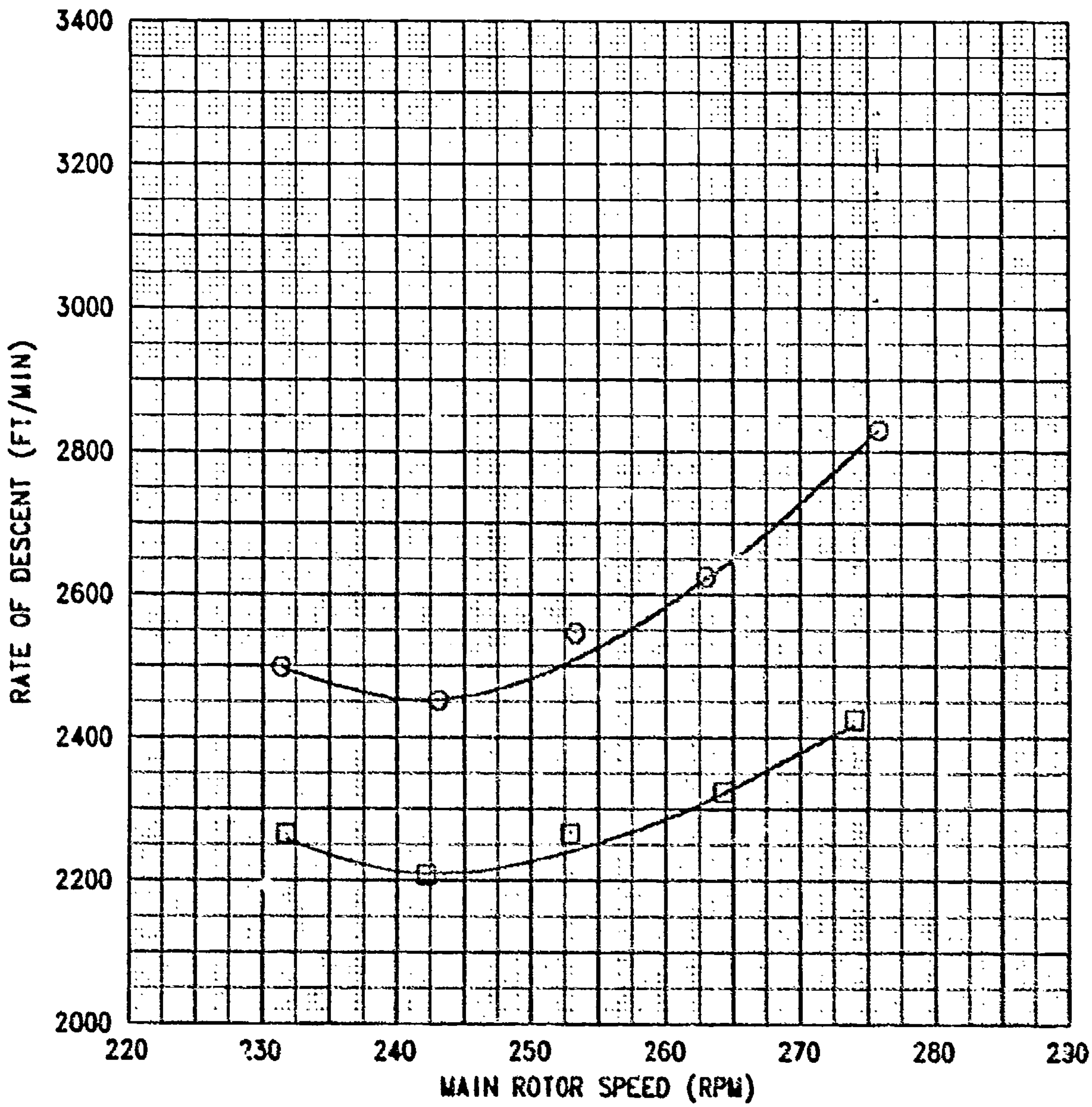


FIGURE E-23

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 82-23748

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 COEFF.	TRIM FLIGHT CONDITION	AIRCRAFT CONFIGURATION
18020	345.8(FWD)	0.2	3430	18.0	261	.006932	LEVEL	VOLCANO

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

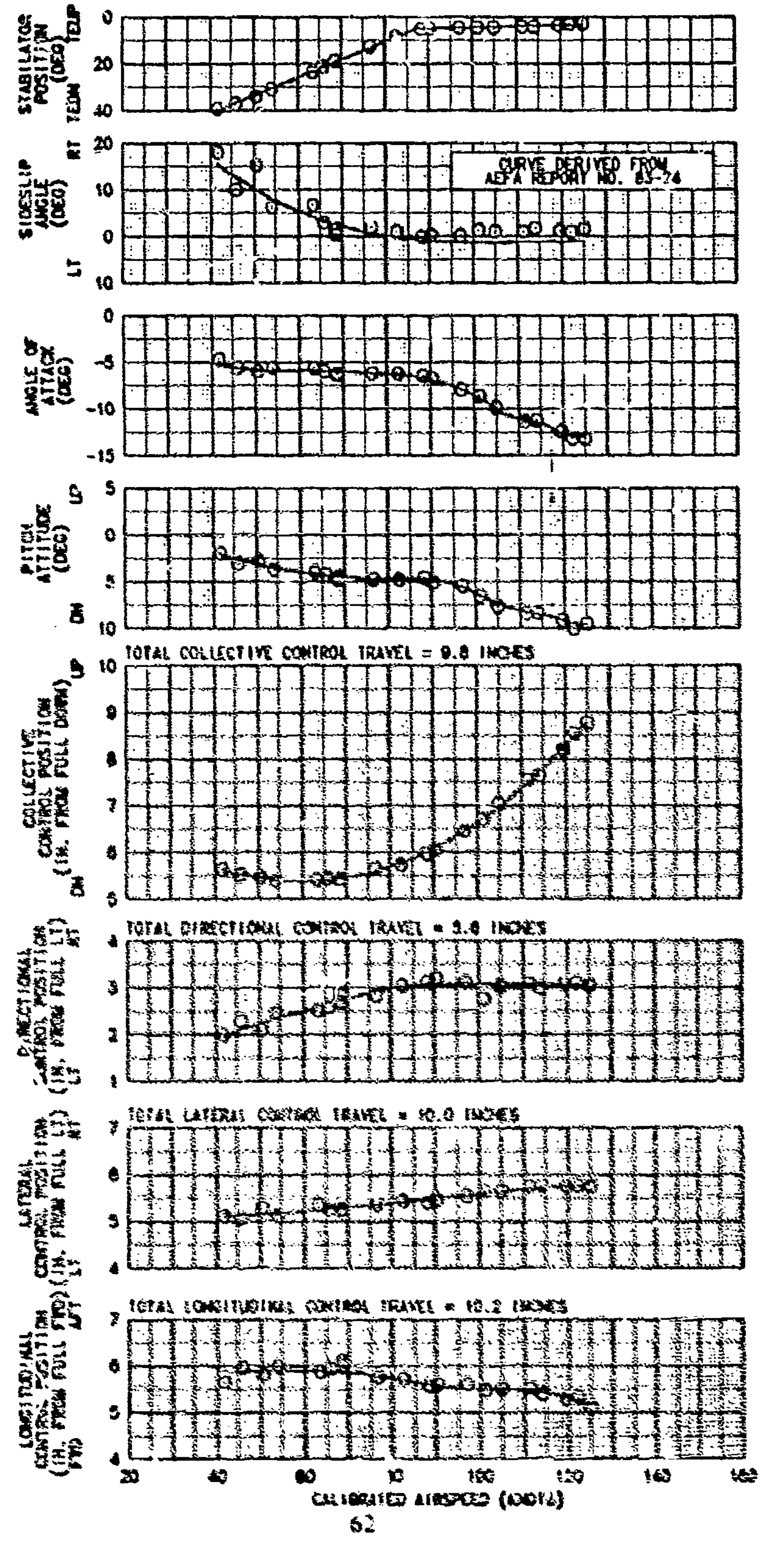


FIGURE E-24
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 82-23748

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.	TRIM FLIGHT CONDITION	AIRCRAFT CONFIGURATION
19990	346.5(FWD)	0.2	7170	8.0	255	.008923	LEVEL	VOLCANO

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

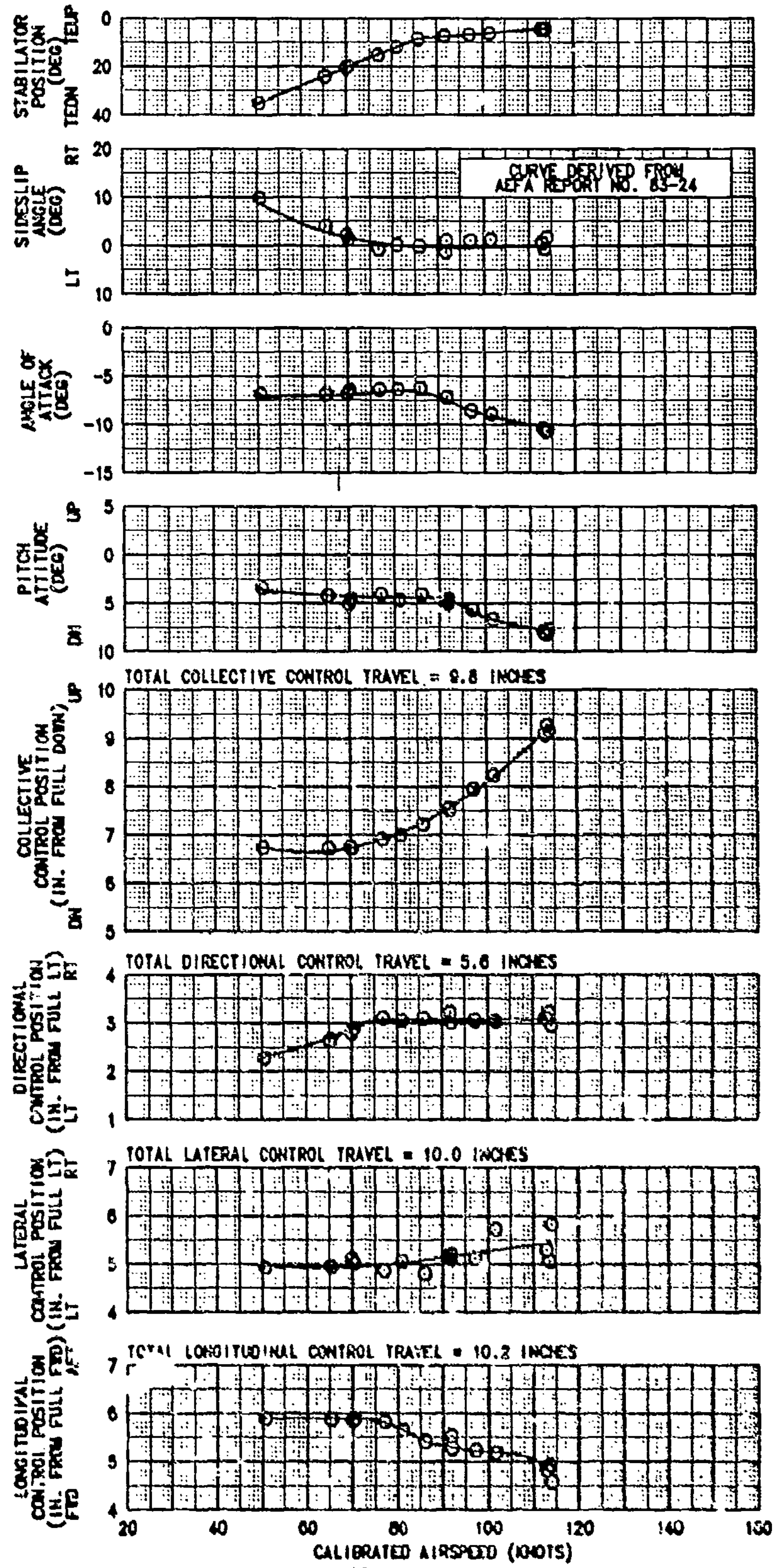


FIGURE E-25
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 82-23748

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.	TRIM FLIGHT CONDITION	AIRCRAFT CONFIGURATION
16320	357.3	0.2	5430	7.0	254	.006984	LEVEL	VOLCANO

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

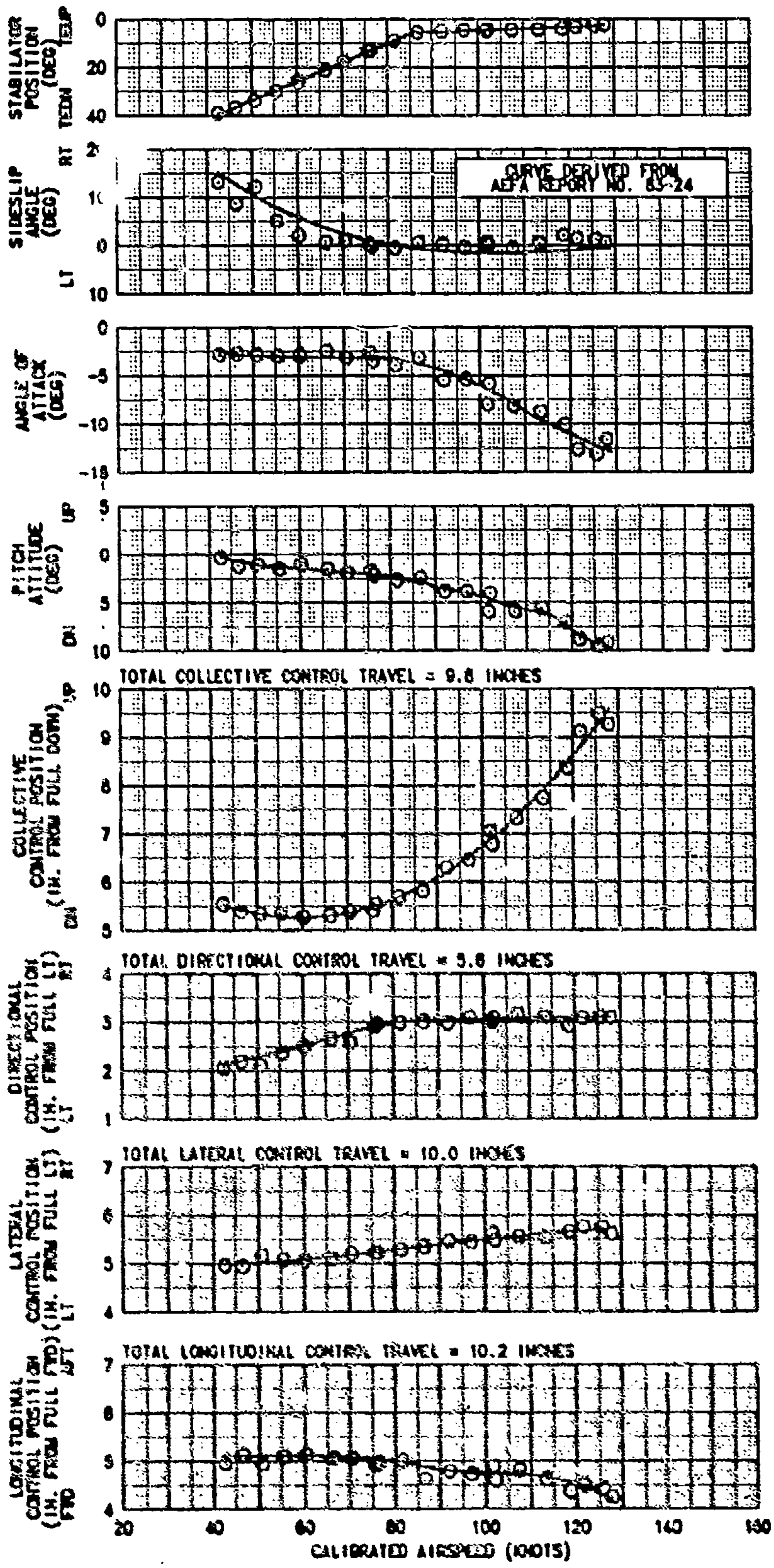


FIGURE E-28

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 82-23748

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.	TRIM FLIGHT CONDITION	AIRCRAFT CONFIGURATION
20170	358.1(AFT)	0.2	6450	4.0	254	.008932	LEVEL	VOLCANO

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

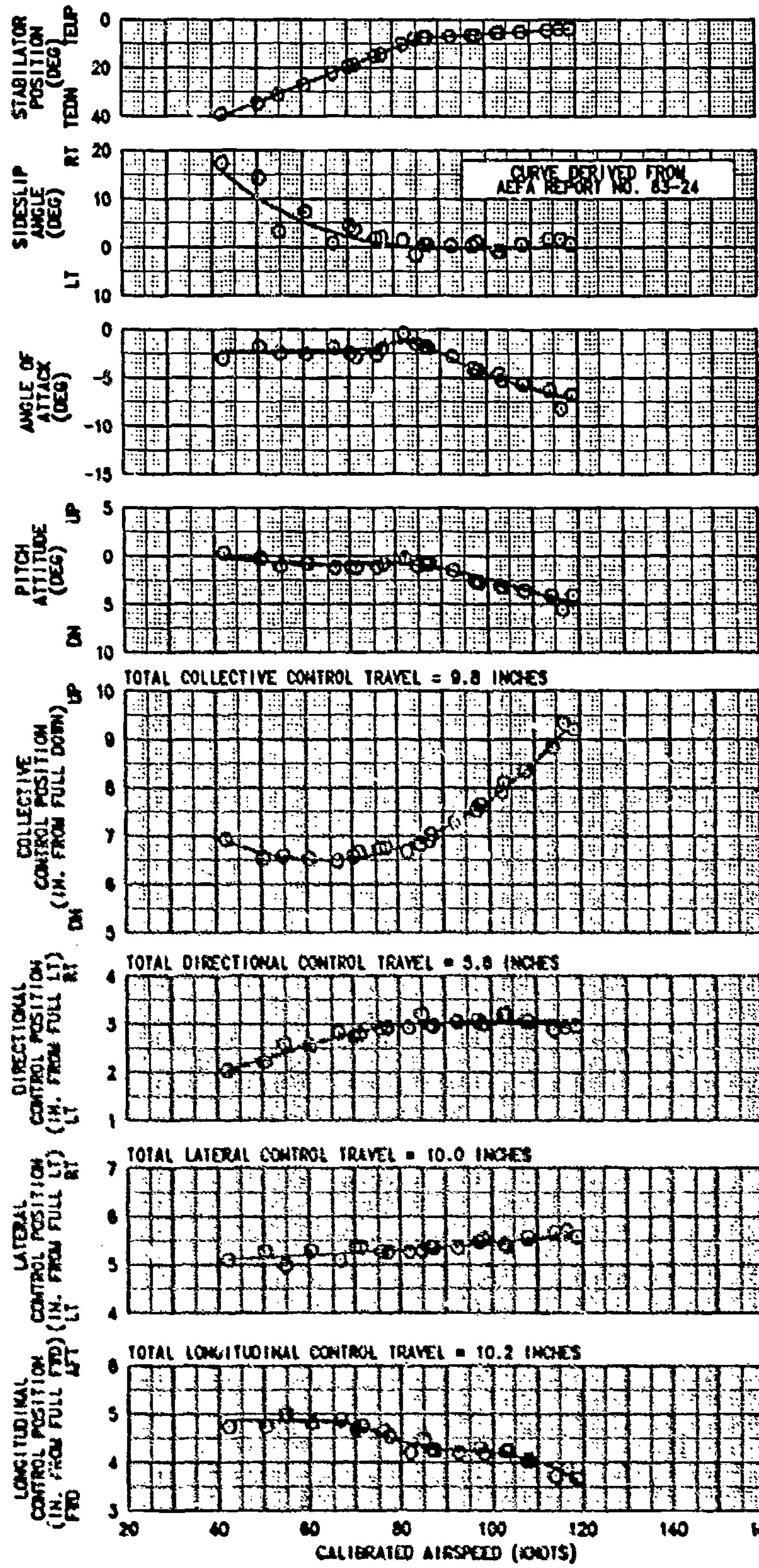


FIGURE E-27

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 82-23748

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.	TRIM FLIGHT CONDITION	AIRCRAFT CONFIGURATION
17970	347.4(FWD)	0.1	9900	2.0	253	.008853	LEVEL	NORMAL UTILITY

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

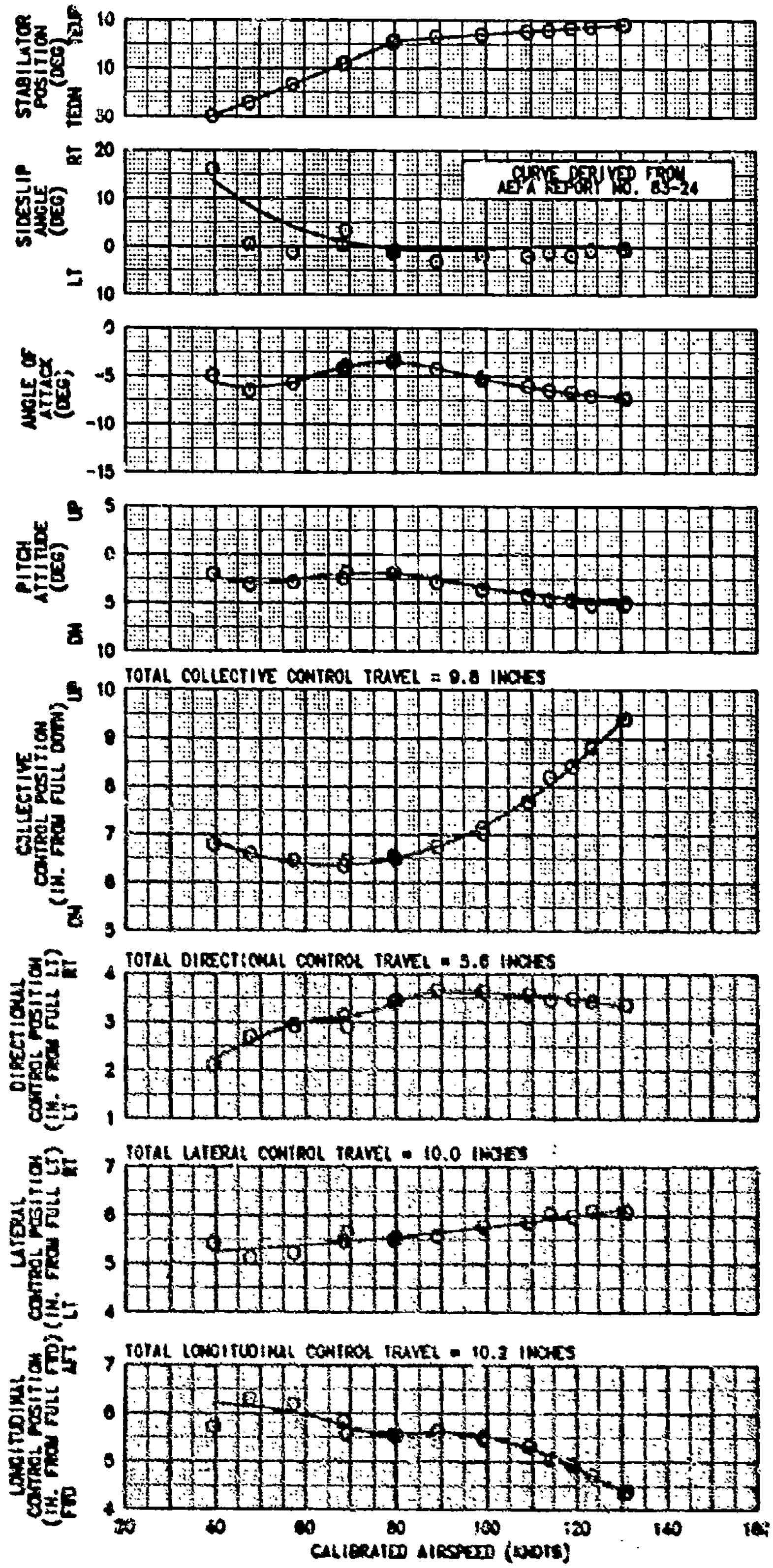


FIGURE E-28

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 82-23748

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 FLIGHT CONDITION	AIRCRAFT CONFIGURATION
20030	346.5(FWD)	0.2	6150	11.5	258	IRP CLIMB	VOLCANO

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

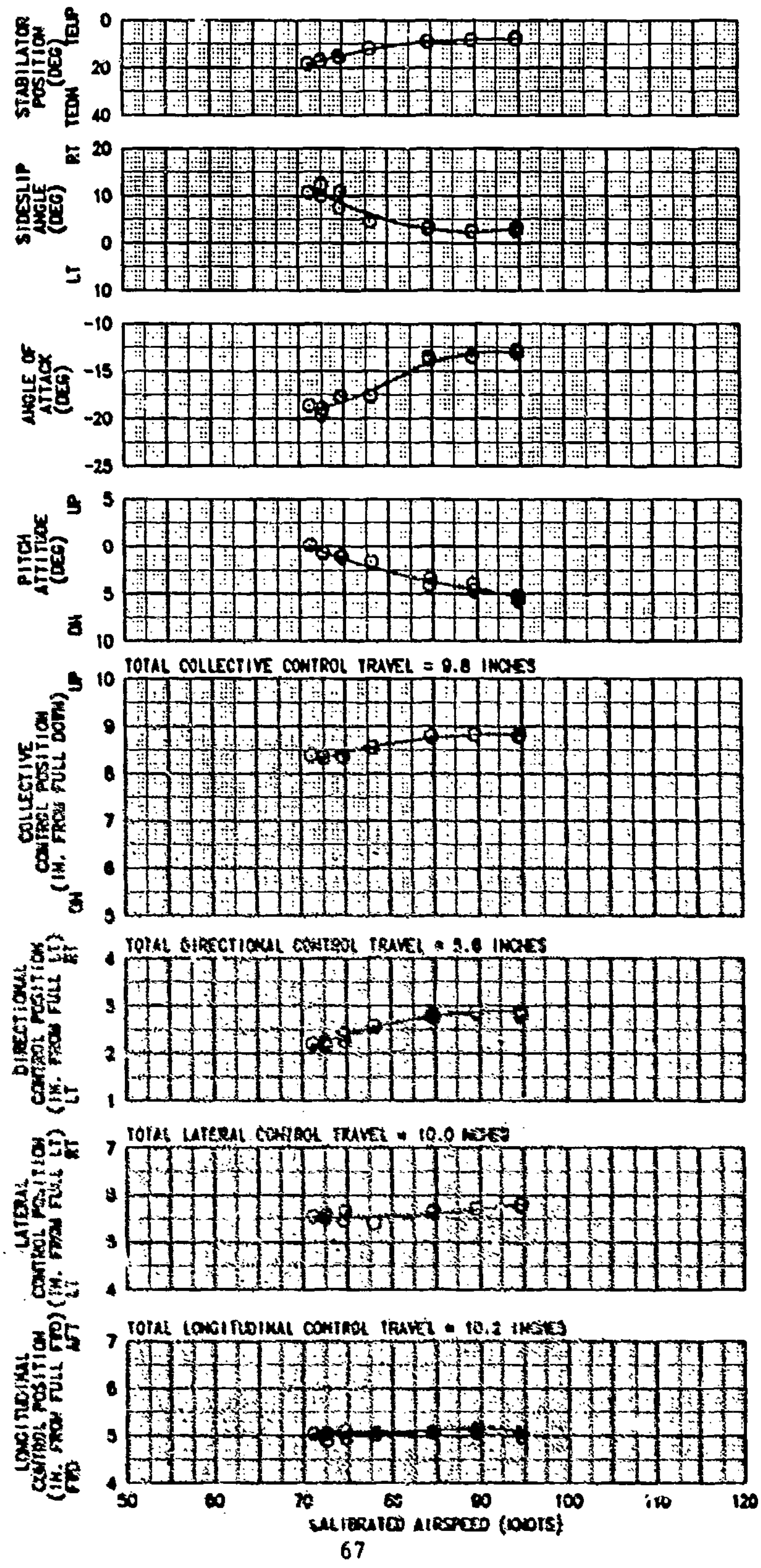


FIGURE E-29

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

UH-60A USA S/N 82-23748

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 FLIGHT CONDITION	AIRCRAFT CONFIGURATION
19840	346.6(FWD)	0.2	6010	10.5	257	AUTO DESCENT	VOLCANO

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

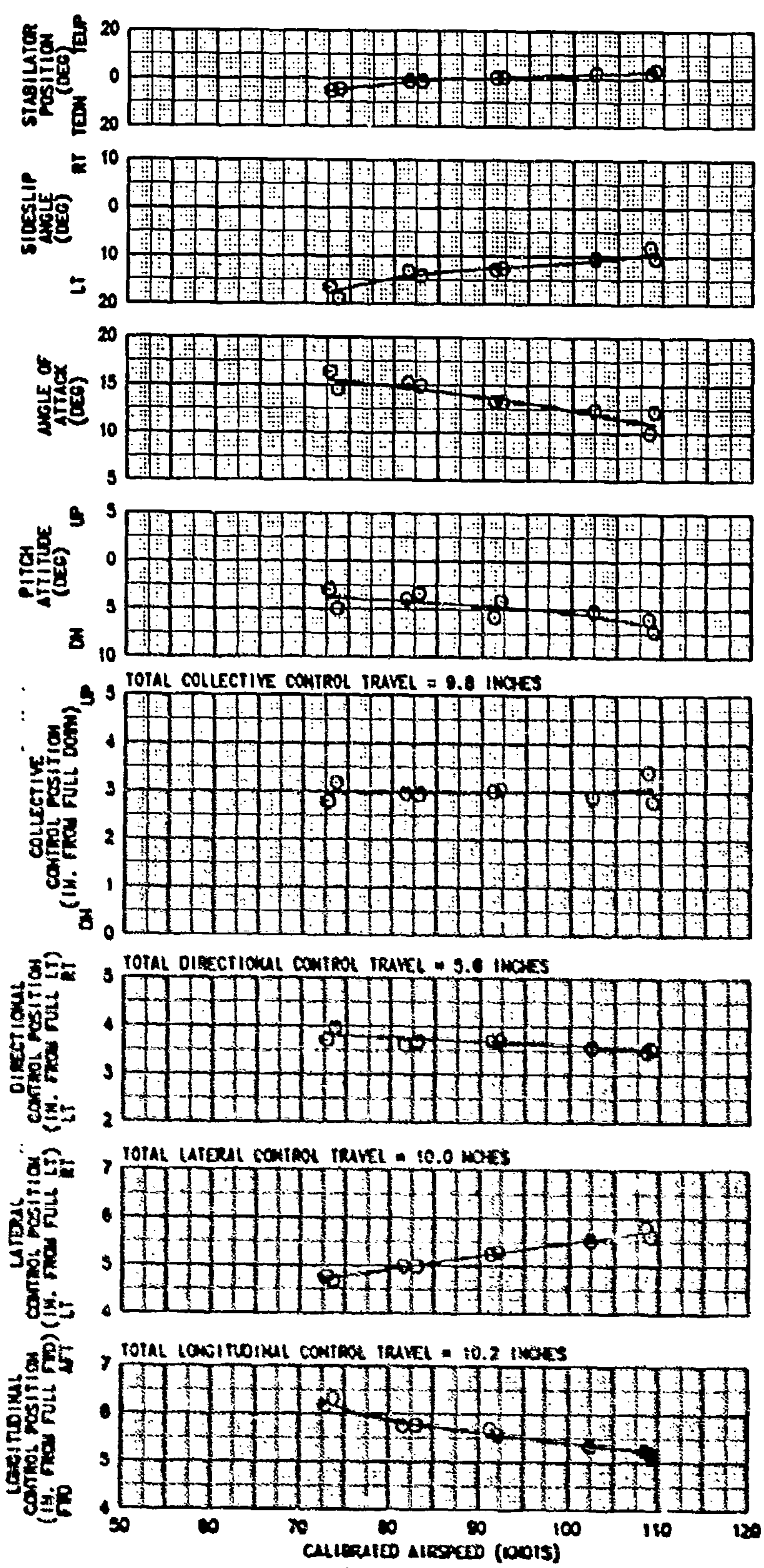


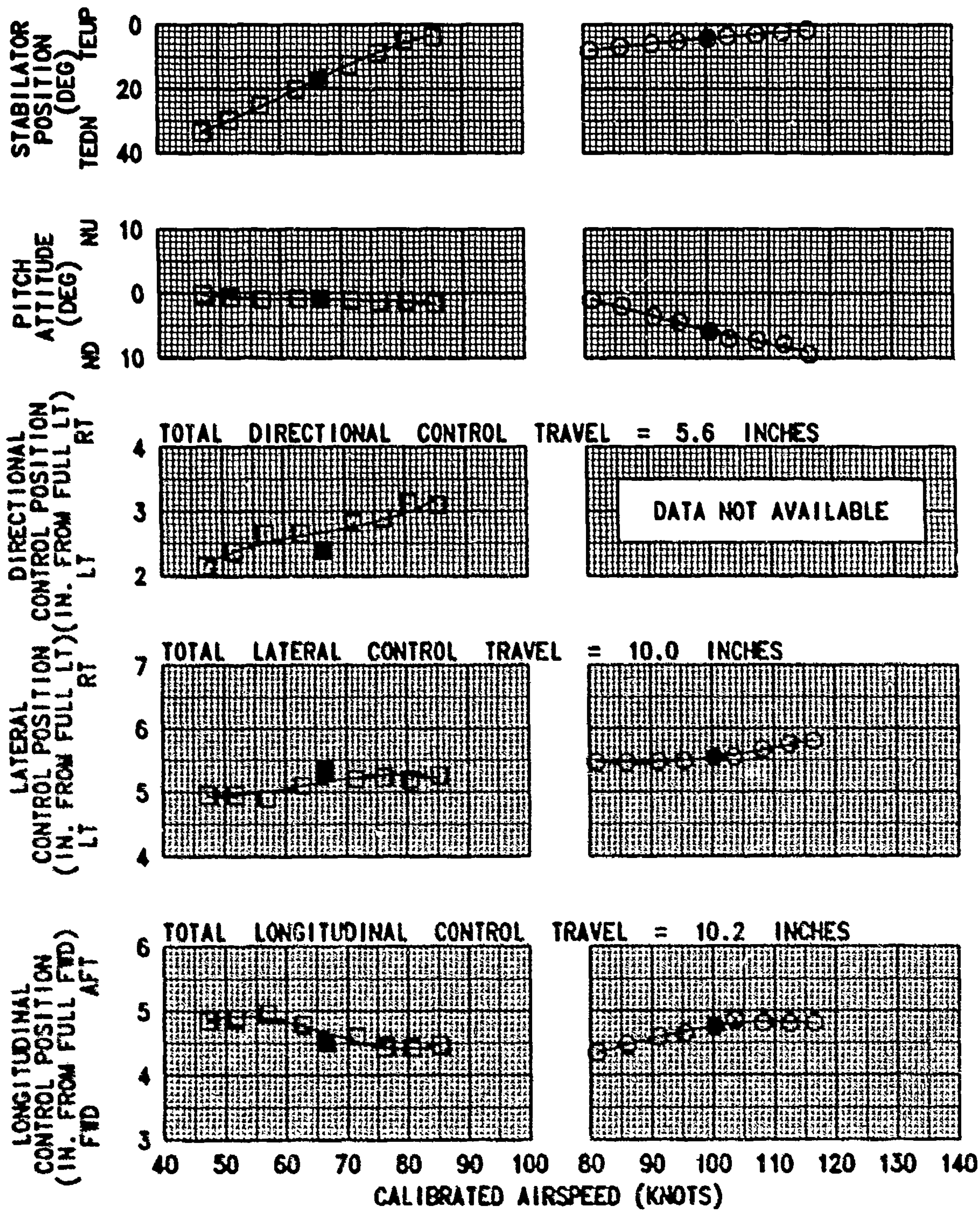
FIGURE E-30

COLLECTIVE FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	16850	359.4	0.2	5750	5.0	259	67	LEVEL
⊙	16580	358.4	0.2	5870	5.5	259	100	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED



COLLECTIVE FIXED STATIC LONGITUDINAL STABILITY
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	20520	359.3(AFT)	0.2	4970	11.5	258	66	LEVEL
⊙	20710	359.9(AFT)	0.2	5250	11.0	256	112	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

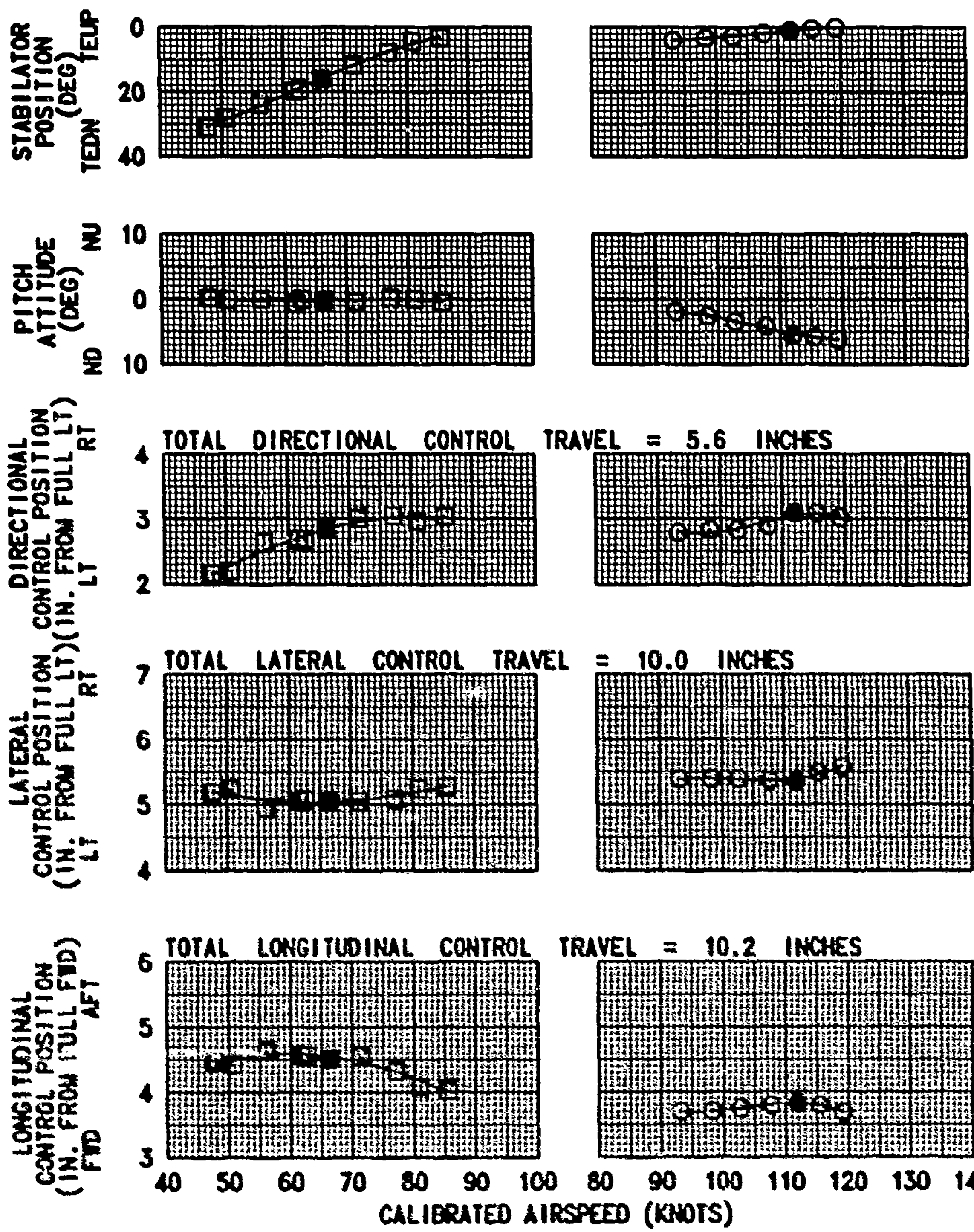


FIGURE E-32

COLLECTIVE FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
16800	359.2	0.2	6850	5.5	255	96	IRP CLIMB

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

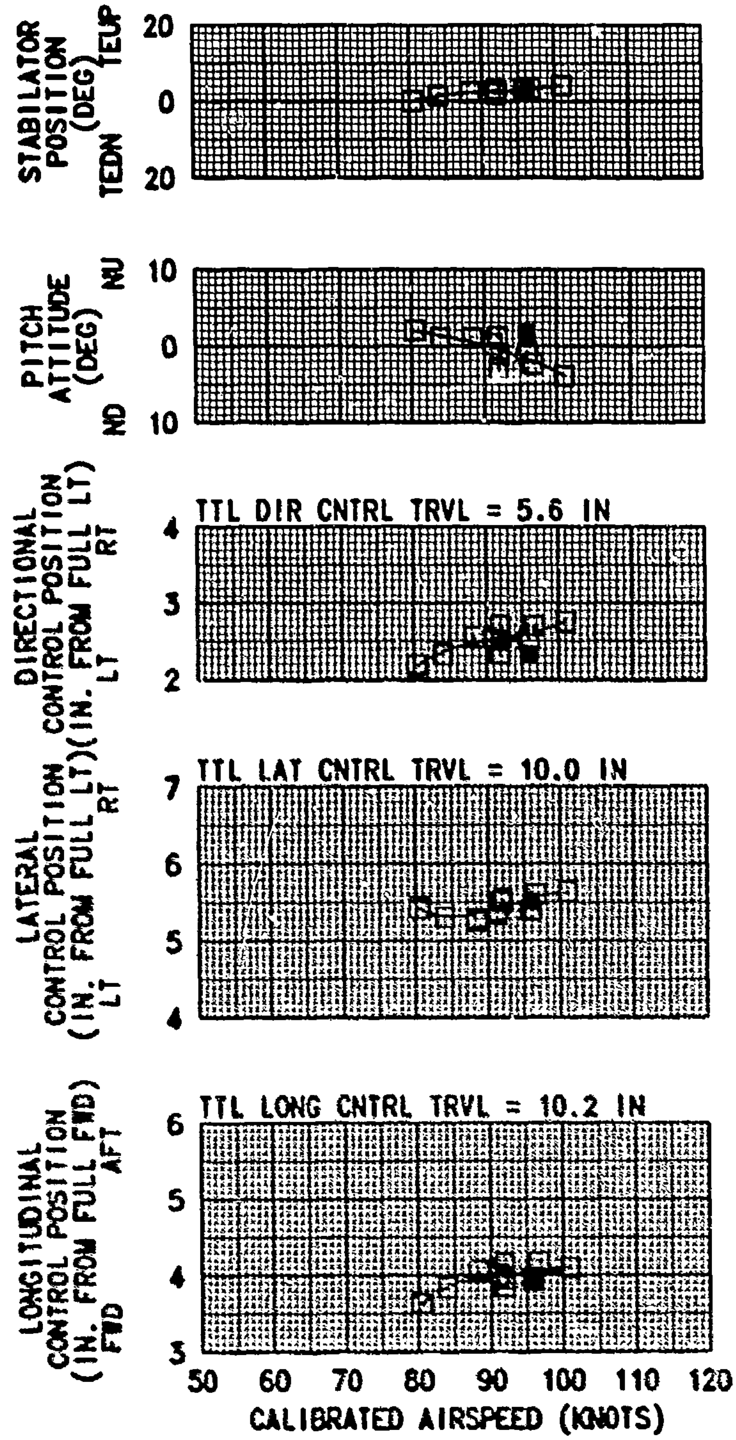


FIGURE E-33

COLLECTIVE FIXED STATIC LONGITUDINAL STABILITY

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)	TRIM FLIGHT CONDITION
20490	359.4 (AFT)	0.2	5590	12.0	258	81	IRP CLIMB

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

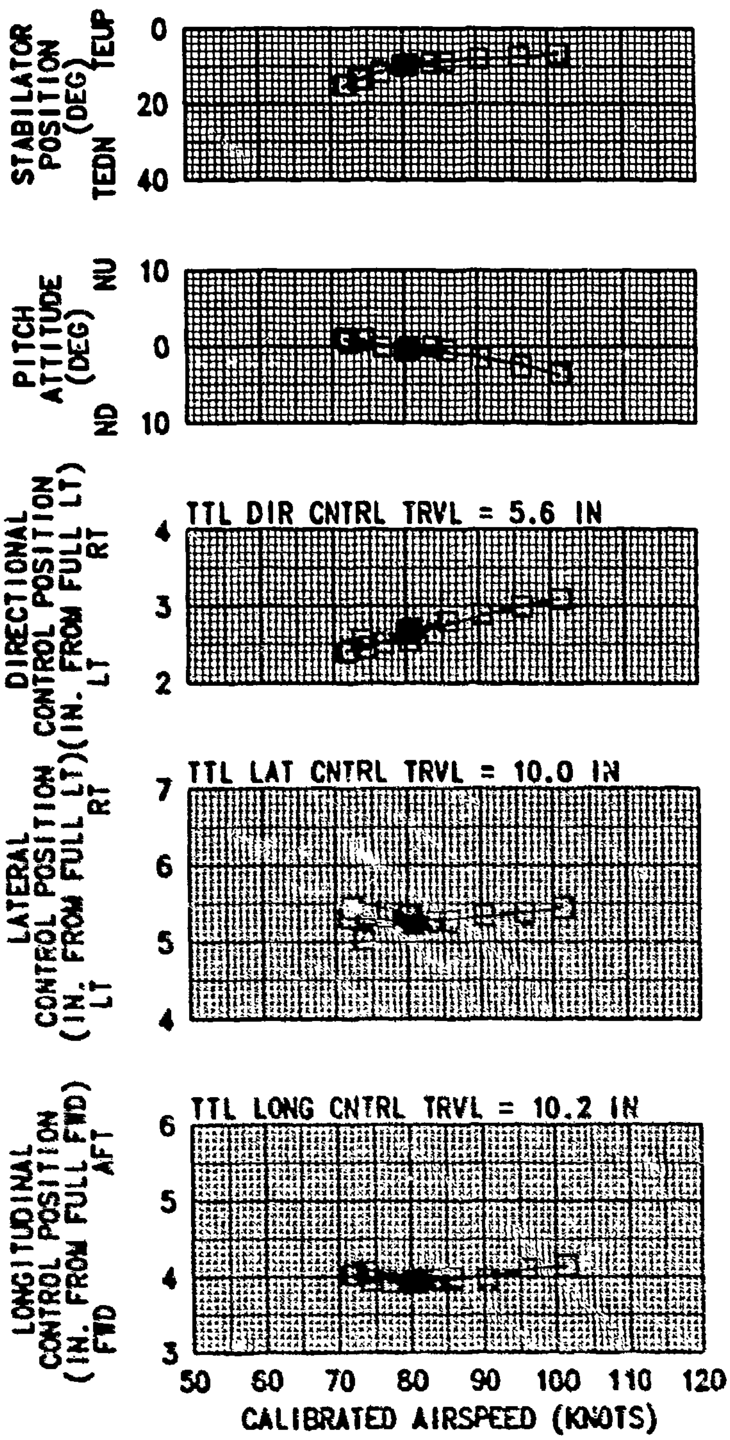


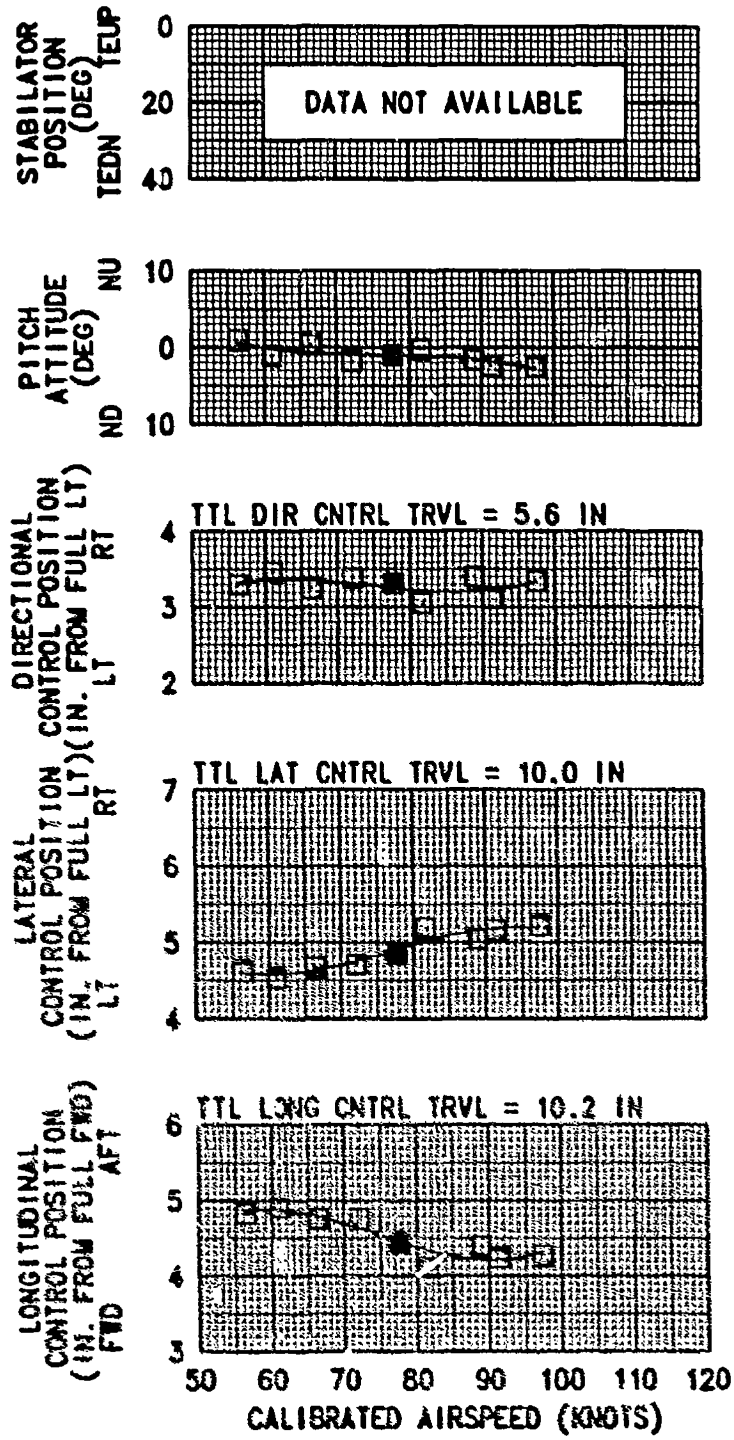
FIGURE E-34

COLLECTIVE FIXED STATIC LONGITUDINAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
16680	358.7	0.2	5640	5.5	259	78	AUTO DESCENT

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED



COLLECTIVE FIXED STATIC LONGITUDINAL STABILITY
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
20190	358.5 (AFT)	0.2	4950	13.0	260	77	AUTO DESCENT

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

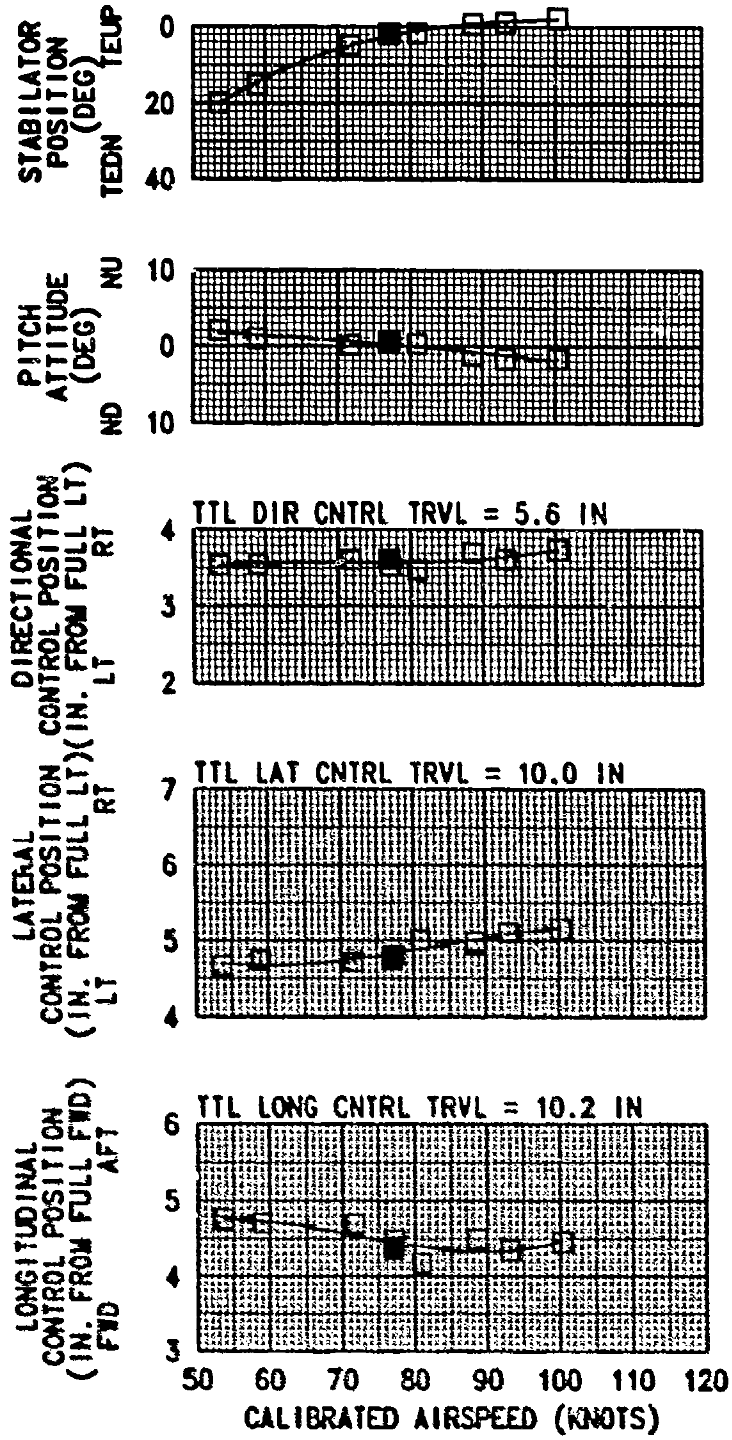
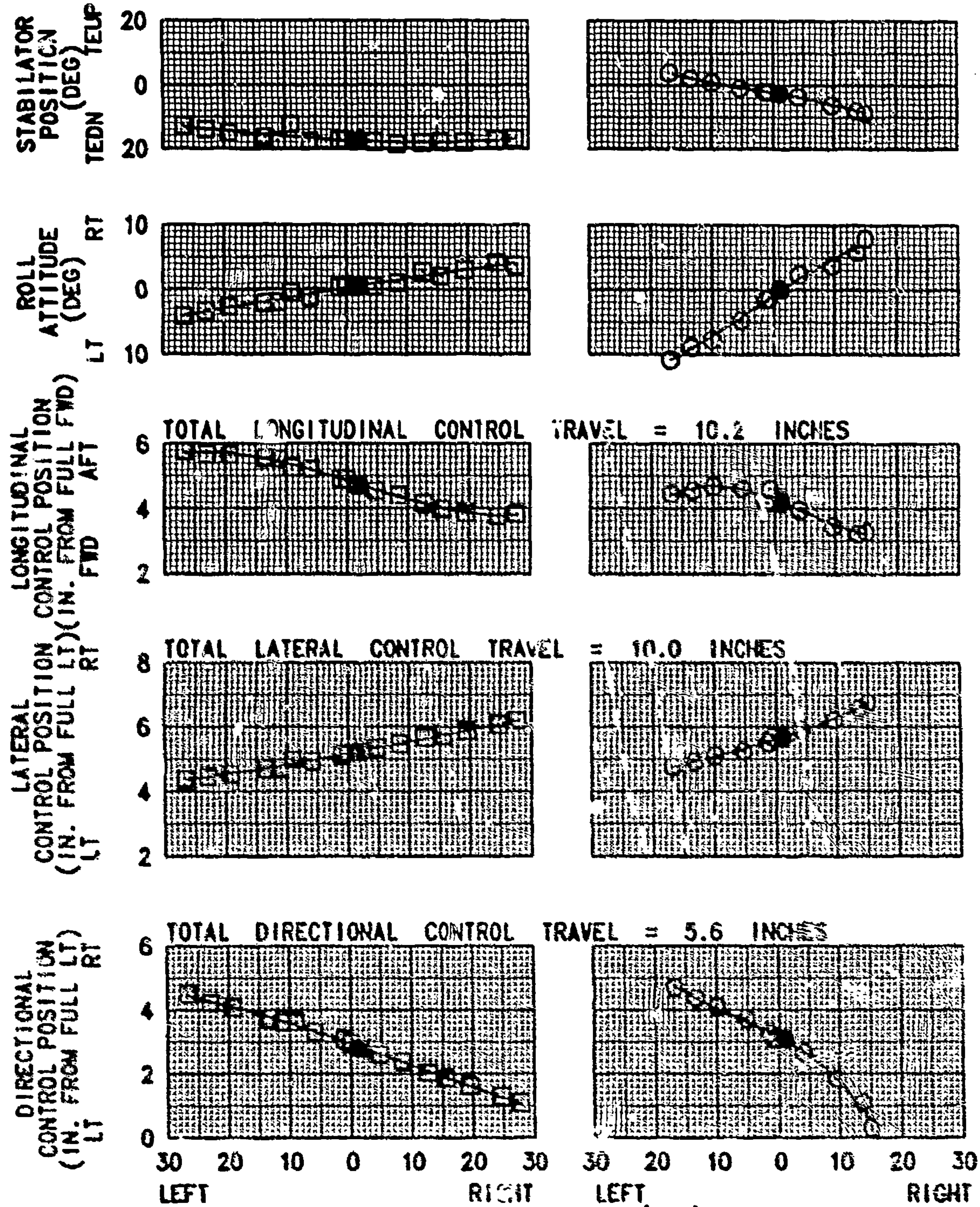


FIGURE E-36
STATIC LATERAL-DIRECTIONAL STABILITY
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	16910	359.5	0.2	6040	6.5	259	66	LEVEL
⊙	16660	358.6	0.2	6060	7.0	256	116	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED



STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	19900	357.4	0.2	4990	12.0	259	67	LEVEL
⊙	20230	358.5(AFT)	0.2	4900	12.0	257	114	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

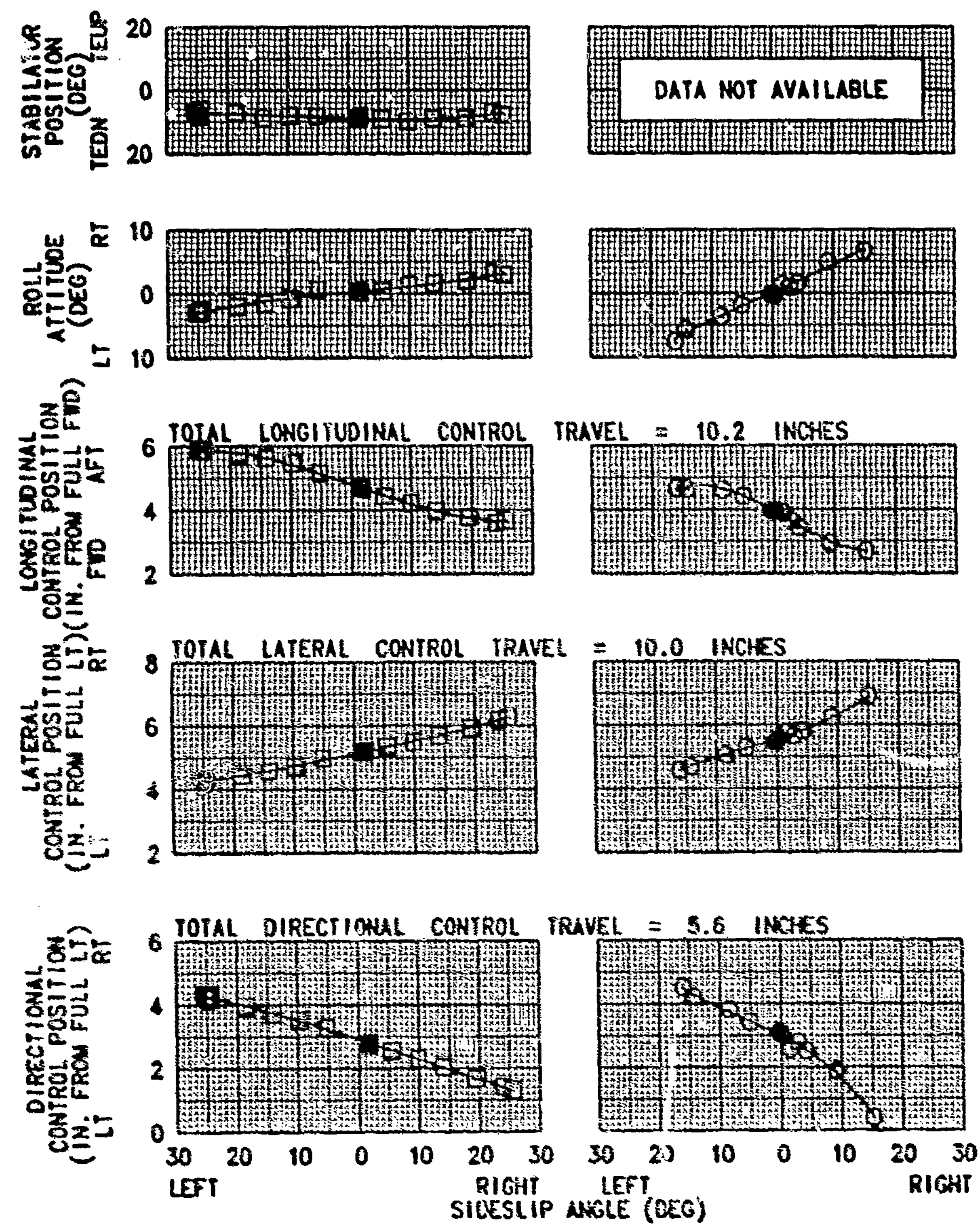


FIGURE E-38

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
16690	358.8	0.2	6000	6.5	257	95	IRP CLIMB

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

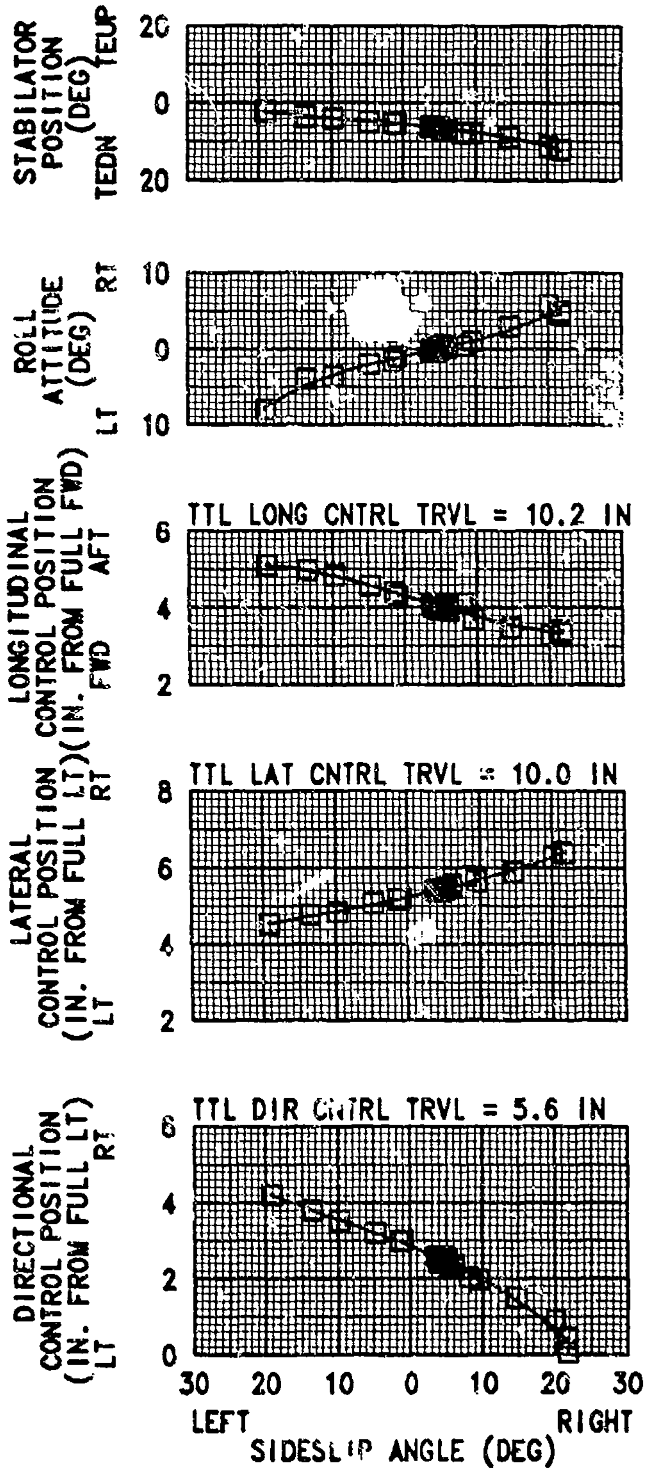


FIGURE E-39

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
20480	359.0 (AFT)	0.2	6160	15.5	257	81	IRP CLIMB

NOTE:
1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

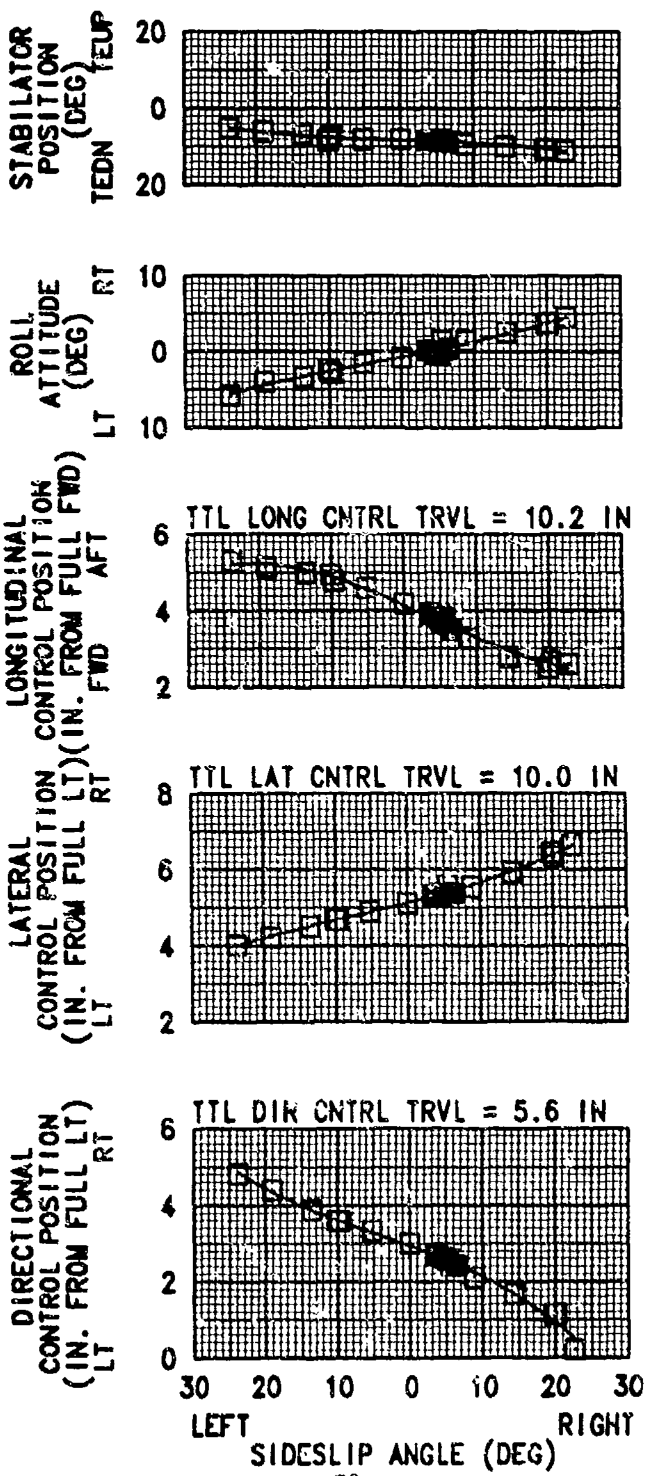


FIGURE E-40
STATIC LATERAL-DIRECTIONAL STABILITY
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
16500	358.1	0.2	6190	6.0	260	78	AUTO DESCENT

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

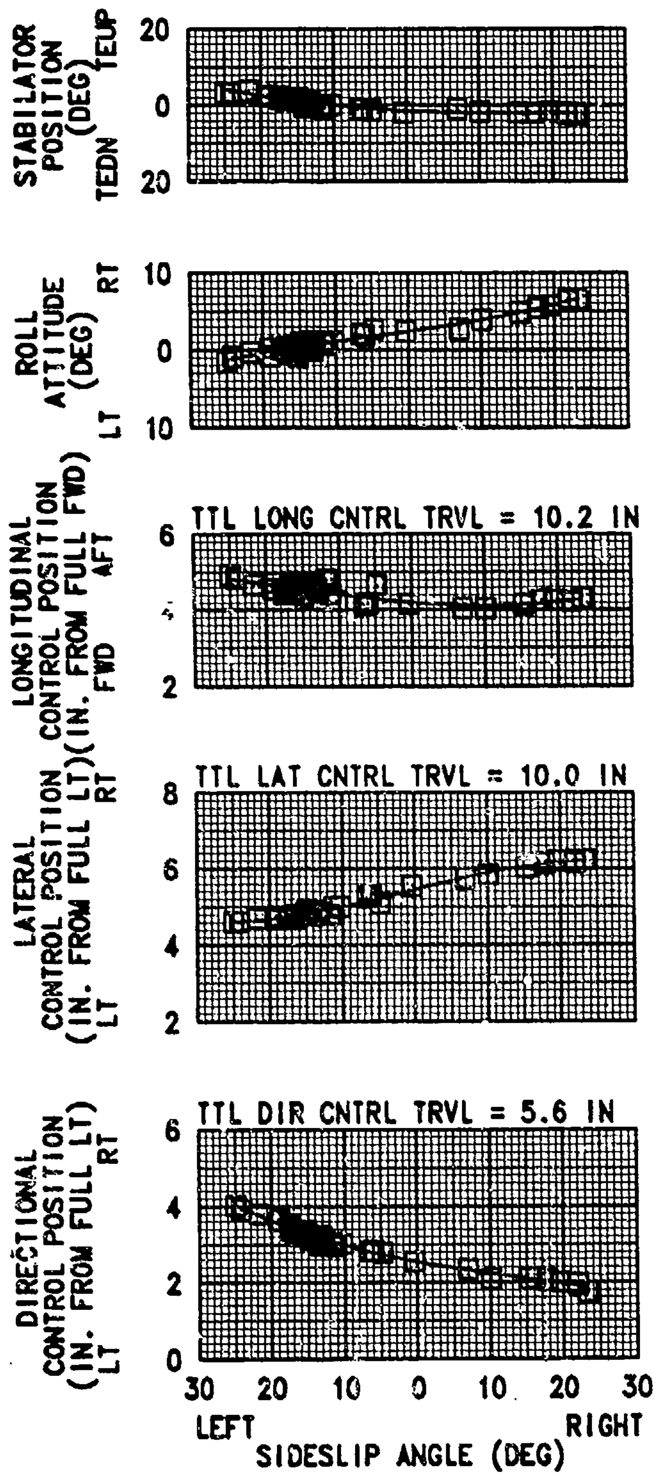


FIGURE E-41

STATIC LATERAL-DIRECTIONAL STABILITY

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
20070	357.8 (AFT)	0.2	5900	15.0	260	77	AUTO DESCENT

NOTE: 1. VOLCANO CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM POINTS
3. PBA CENTERED AND ELECTRICALLY DISCONNECTED

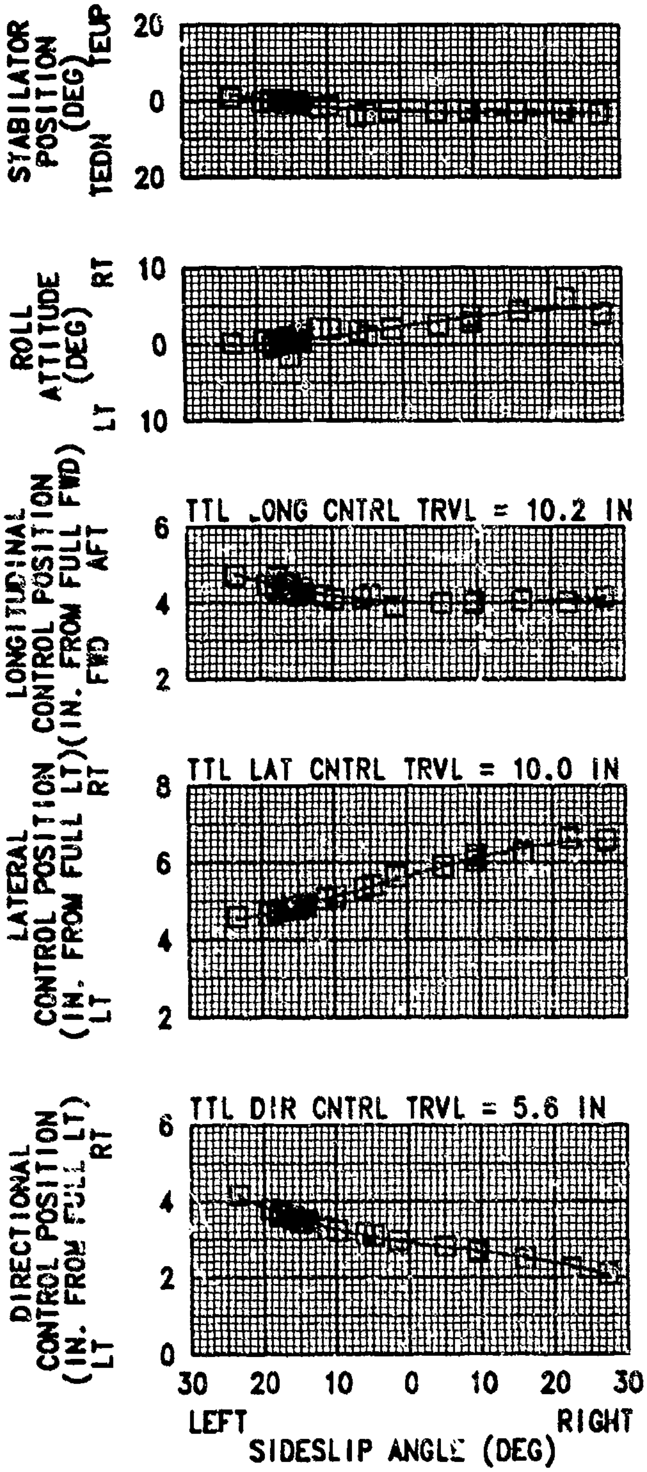


FIGURE E-42

MANEUVERING STABILITY

COLLECTIVE-FIXED TURNS

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	16190	356.9	0.2	6650	9.5	261	46	LEVEL FLIGHT
⊙	16070	356.4	0.2	6670	9.5	259	47	LEVEL FLIGHT

NOTE:
1. VOLCANO CONFIGURATION
2. PDA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

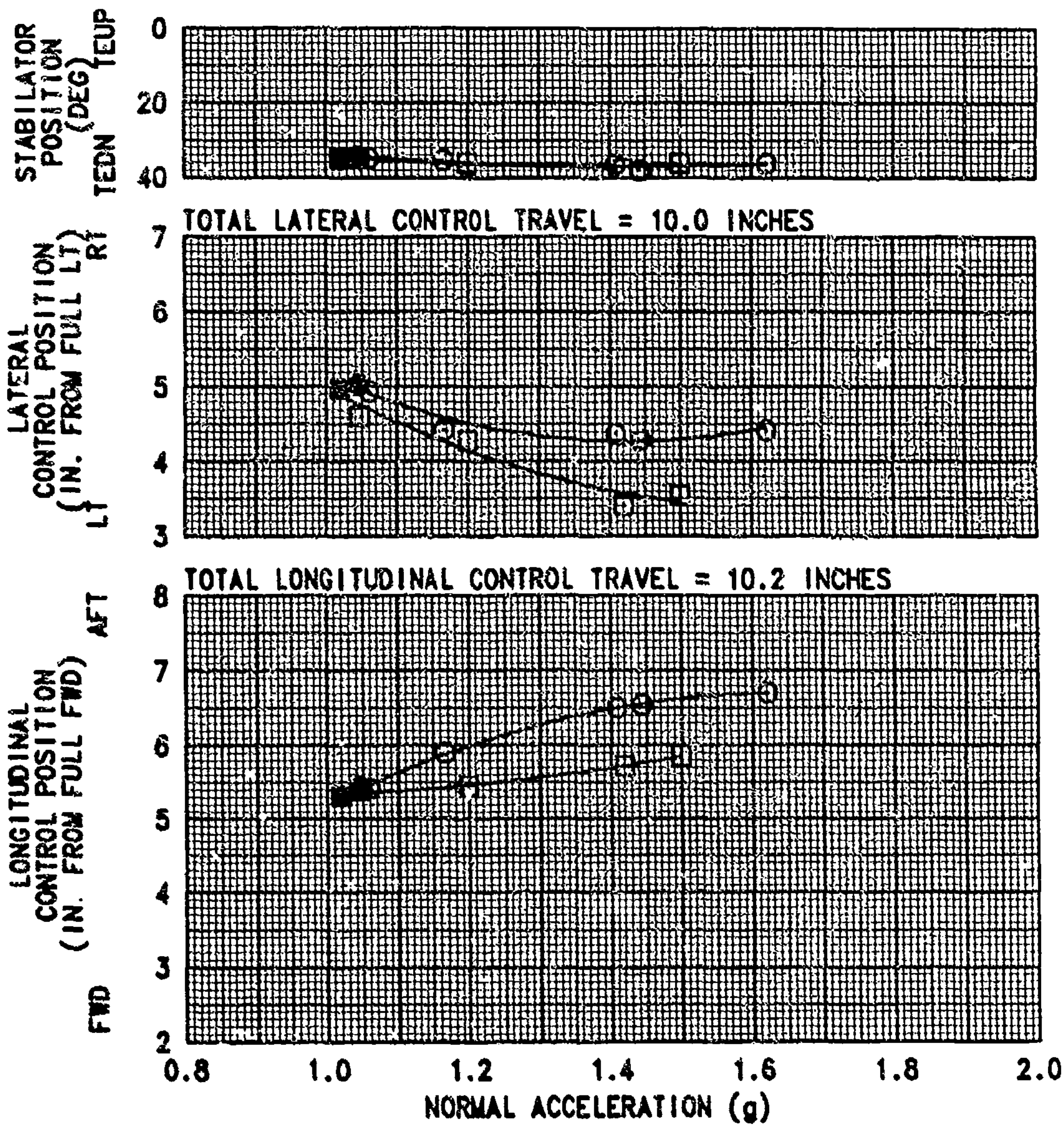


FIGURE E-43
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	16900	359.5	0.2	5900	10.0	259	86	LEVEL FLIGHT
⊙	16690	358.8	0.2	6630	9.0	259	86	LEVEL FLIGHT

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

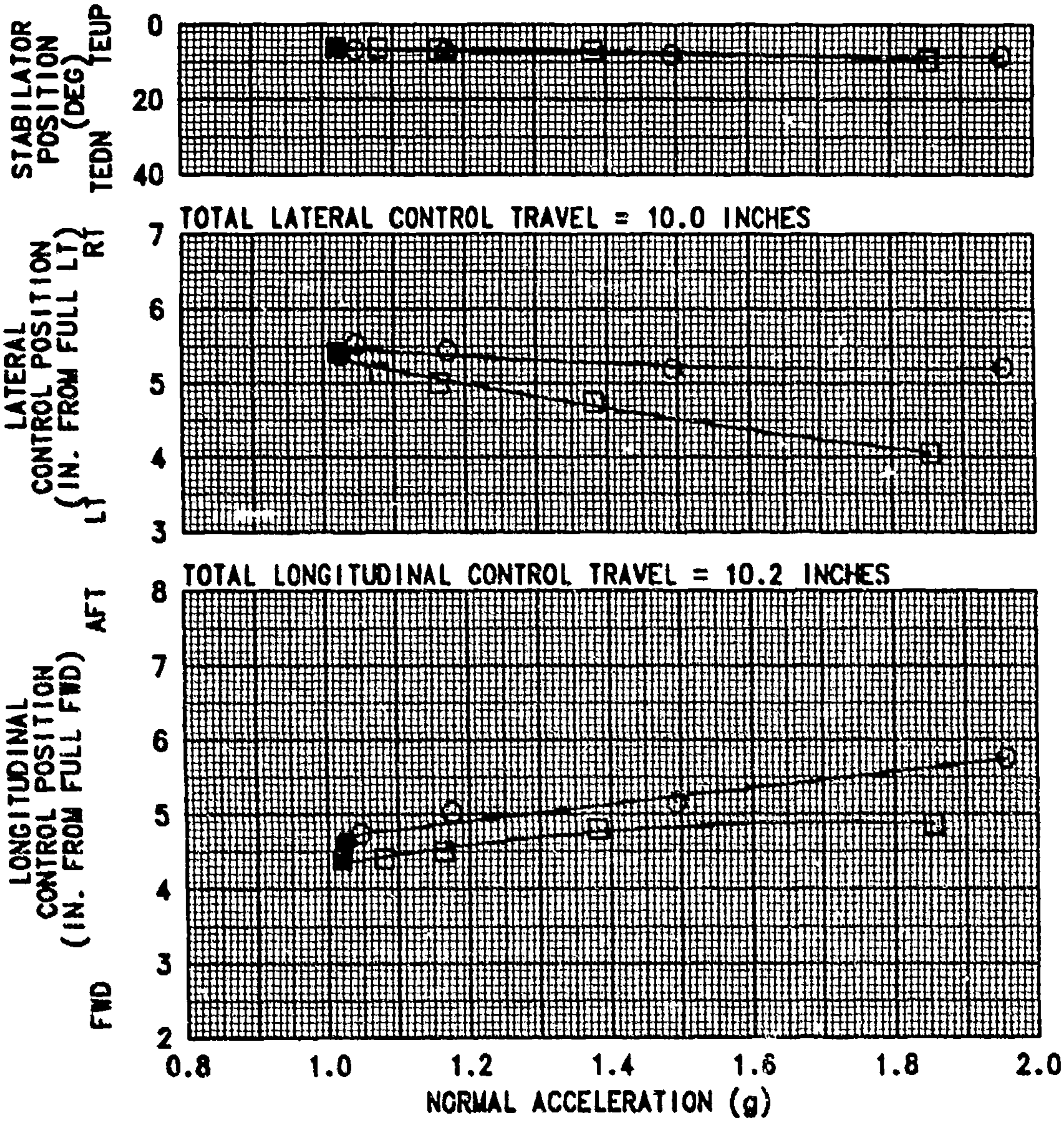


FIGURE E-44
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	16480	358.0	0.2	6880	8.5	259	116	LEVEL FLIGHT
⊙	16340	357.4	0.2	6740	9.0	262	116	LEVEL FLIGHT

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

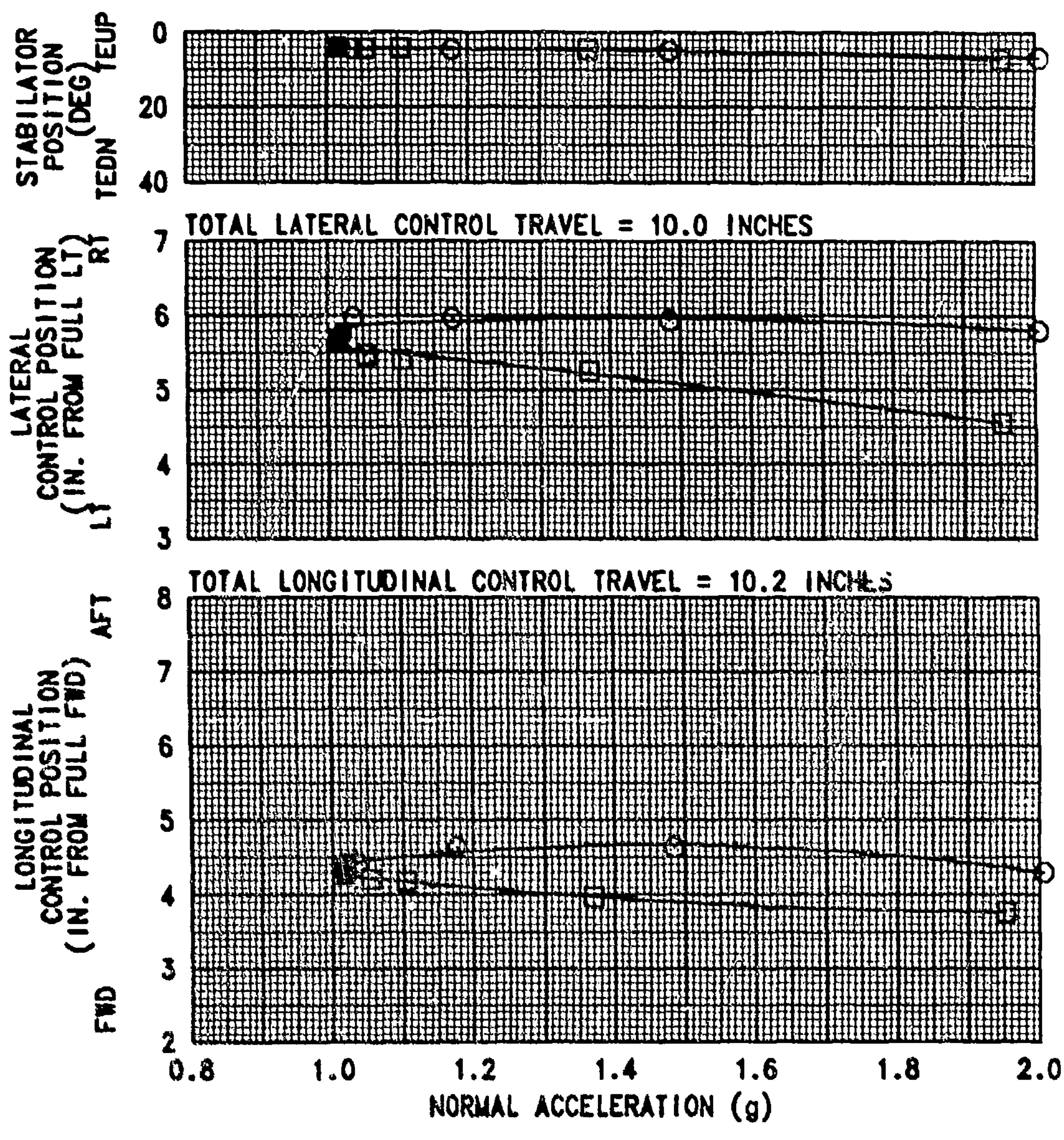


FIGURE E-45

MANEUVERING STABILITY

COLLECTIVE-FIXED TURNS

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	20590	359.3 (AFT)	0.2	6340	4.5	259	43	LEVEL FLIGHT
⊙	20330	358.6 (AFT)	0.2	6310	4.5	259	46	LEVEL FLIGHT

NOTE:
1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

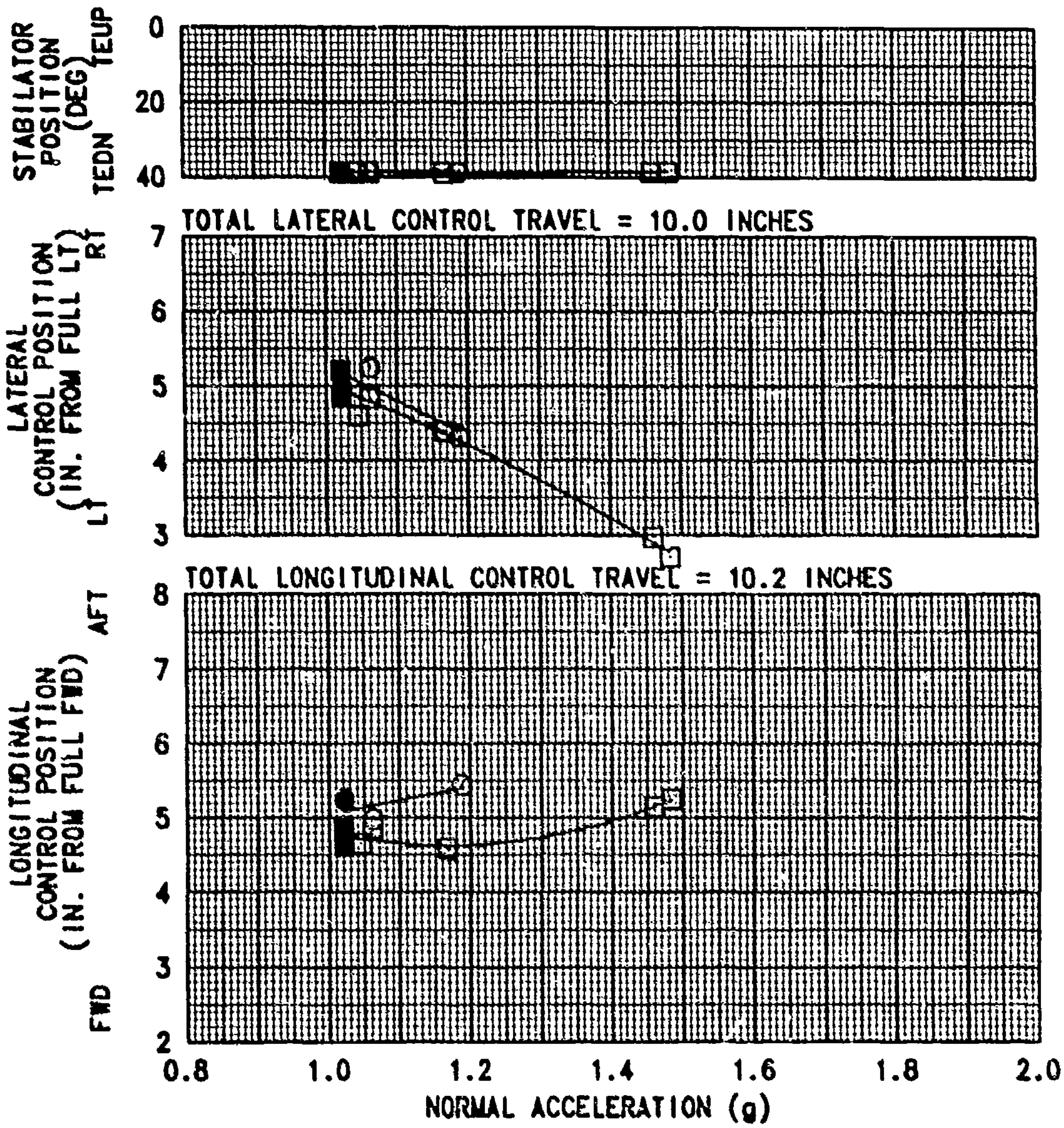


FIGURE E-46

MANEUVERING STABILITY

COLLECTIVE-FIXED TURNS

UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
□	20670	359.6 (AFT)	0.2	6200	4.5	258	86	LEVEL FLIGHT
⊙	20330	358.6 (AFT)	0.2	6190	4.5	260	86	LEVEL FLIGHT

NOTE:
1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. □ LEFT TURNS
5. ⊙ RIGHT TURNS

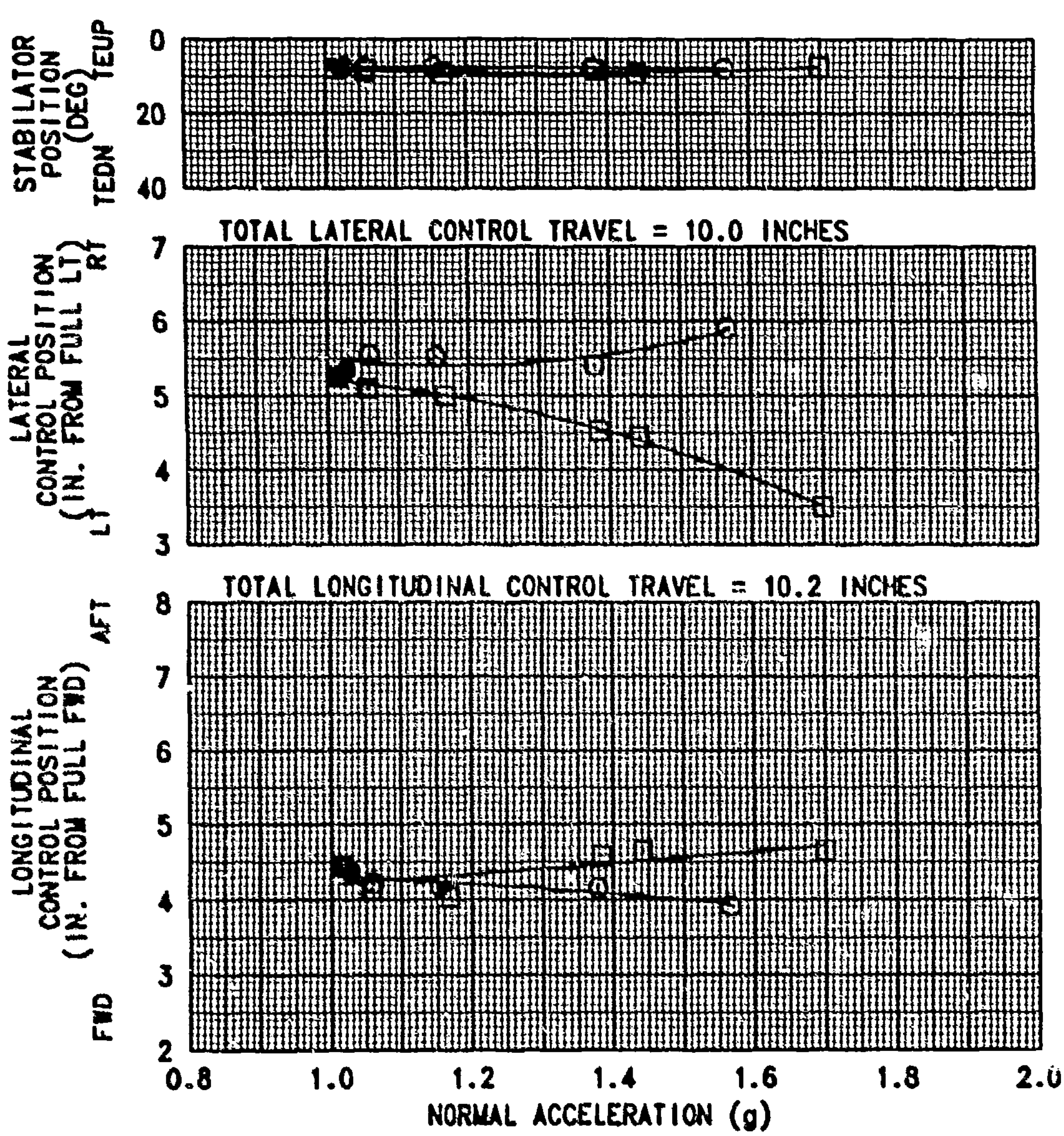


FIGURE E-47
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	19870	357.2	0.2	6280	4.0	259	107	LEVEL FLIGHT
⊙	19720	356.7	0.2	6370	4.0	259	106	LEVEL FLIGHT

NOTE:
1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

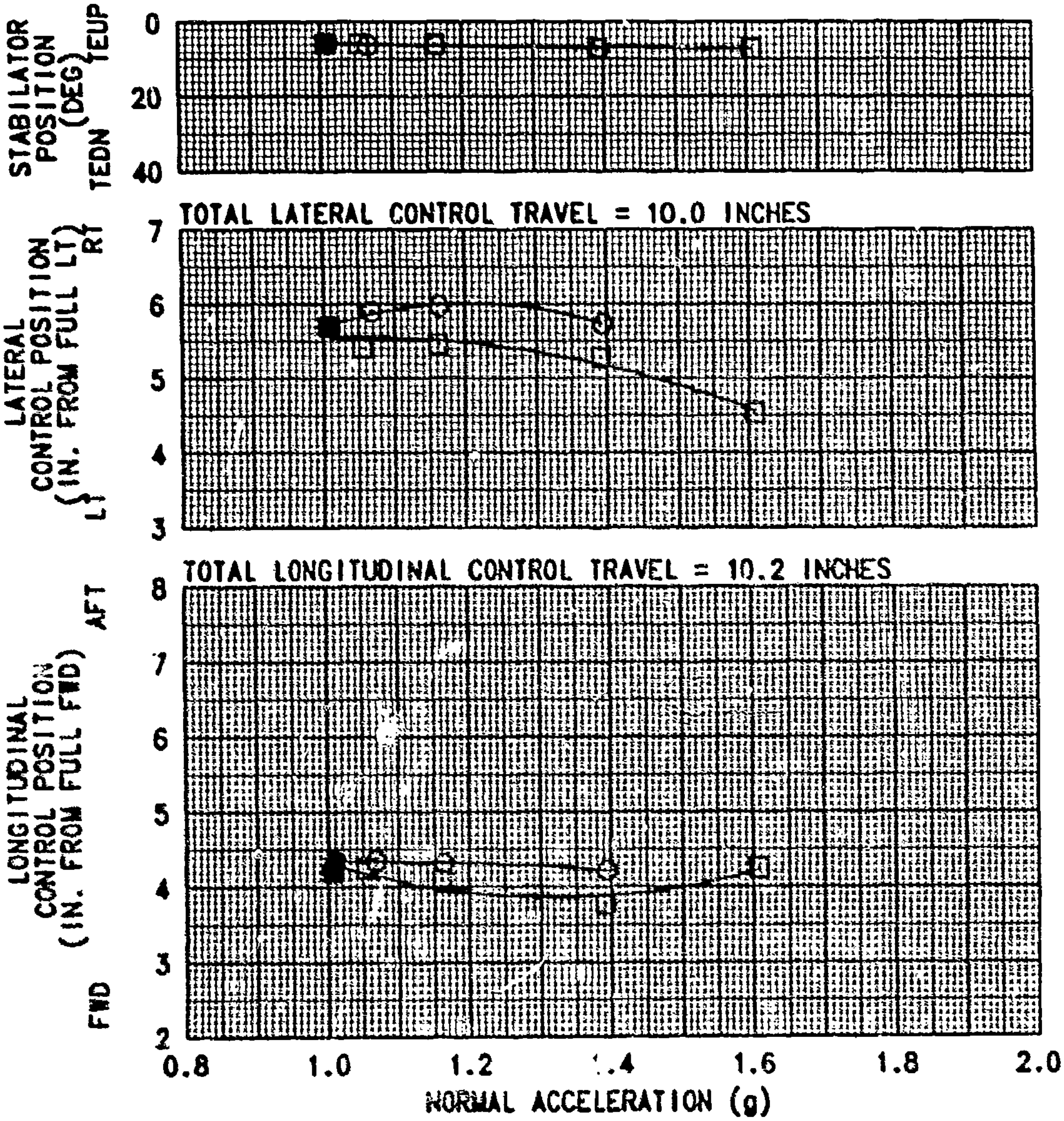


FIGURE E-48
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	16600	358.4	0.2	5320	11.0	259	67	LEVEL FLIGHT
⊙	16440	357.8	0.2	5160	11.0	260	70	LEVEL FLIGHT

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

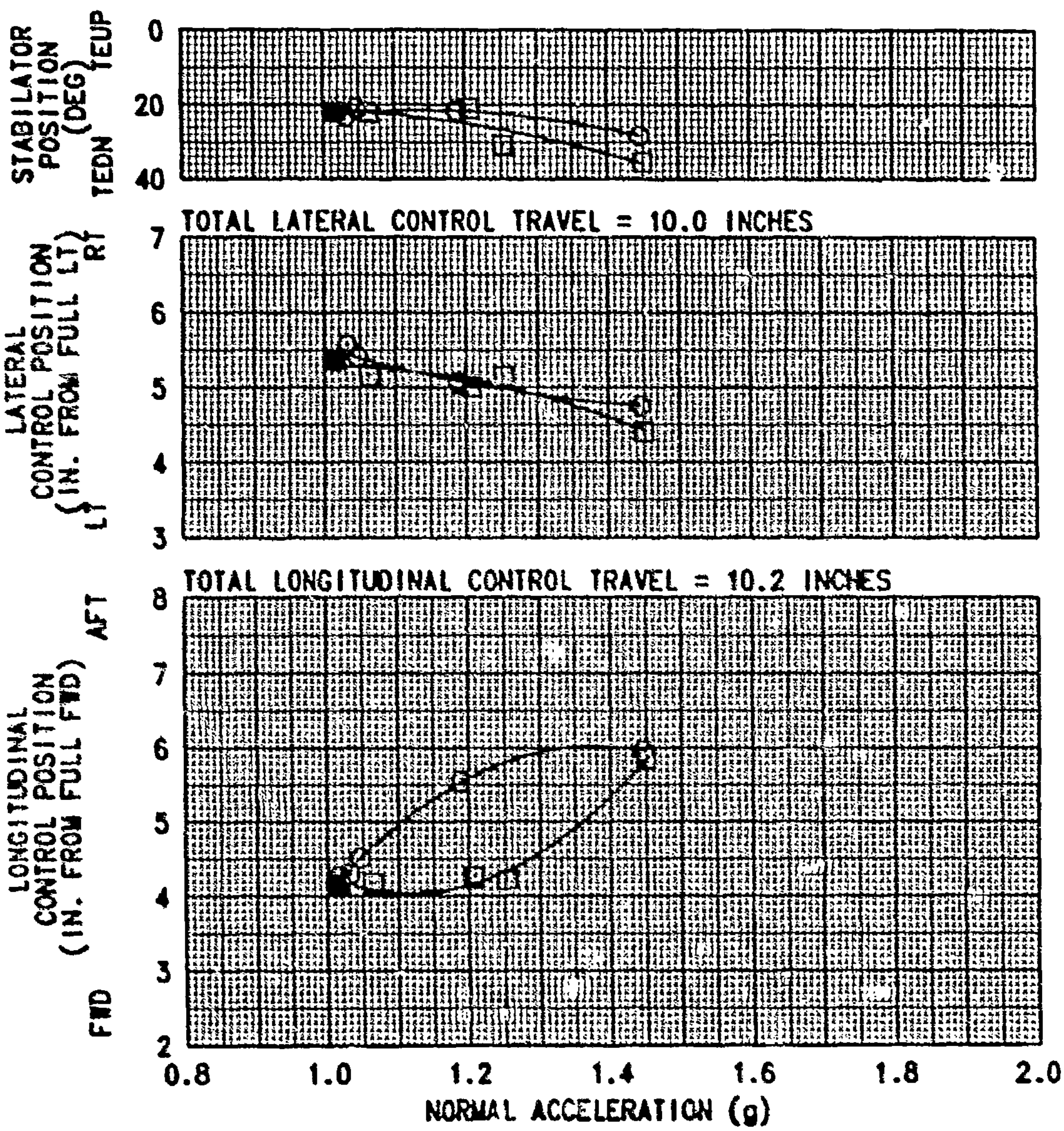


FIGURE E-49
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	17000	359.9	0.2	5470	11.0	259	97	LEVEL FLIGHT
⊙	16840	359.3	0.2	5740	10.5	259	96	LEVEL FLIGHT

NOTE:
1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

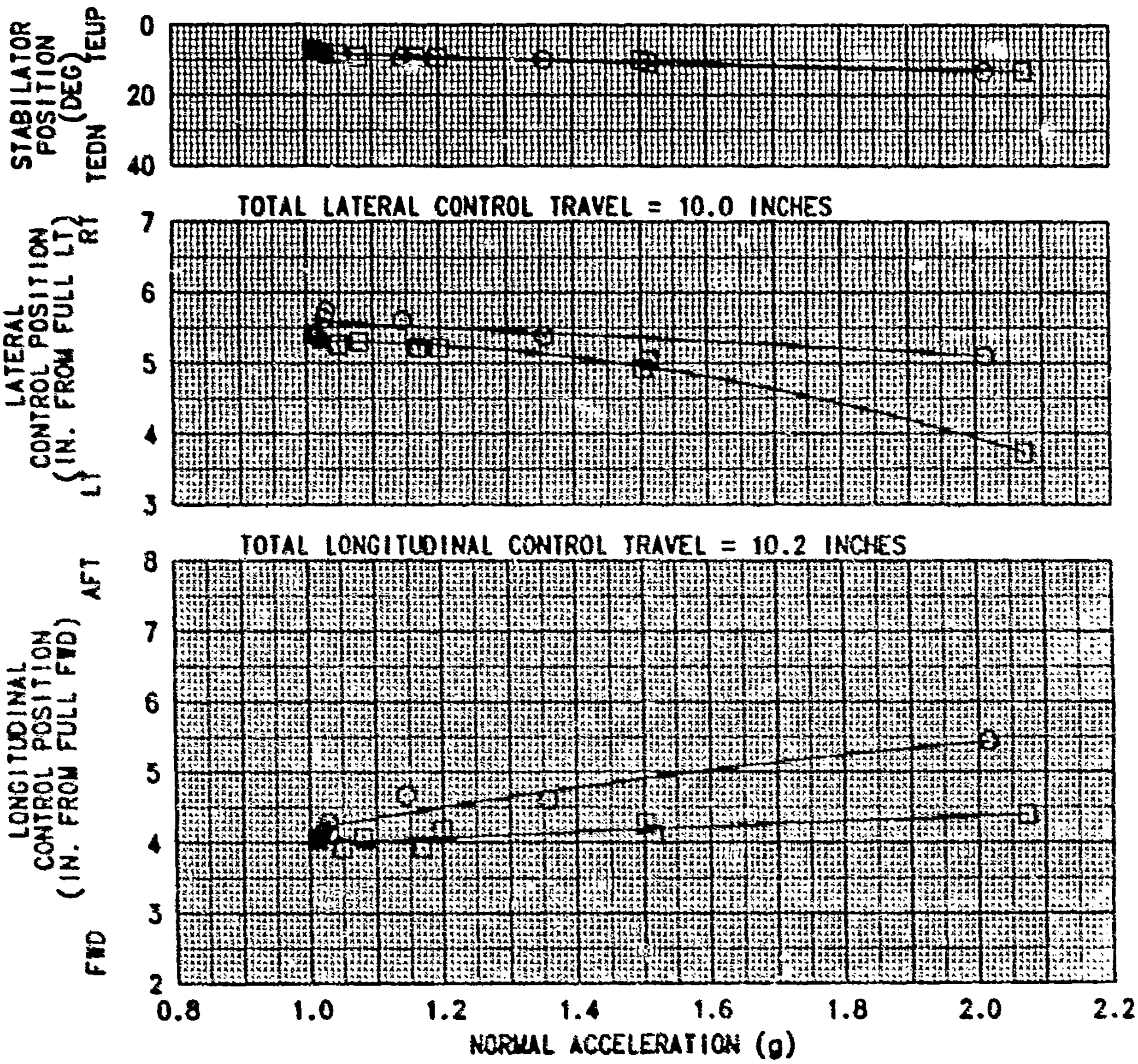


FIGURE E-50
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	20120	357.9	0.2	5670	7.0	259	69	IRP CLIMBS
⊙	20000	357.5	0.2	5590	6.5	259	69	IRP CLIMBS

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

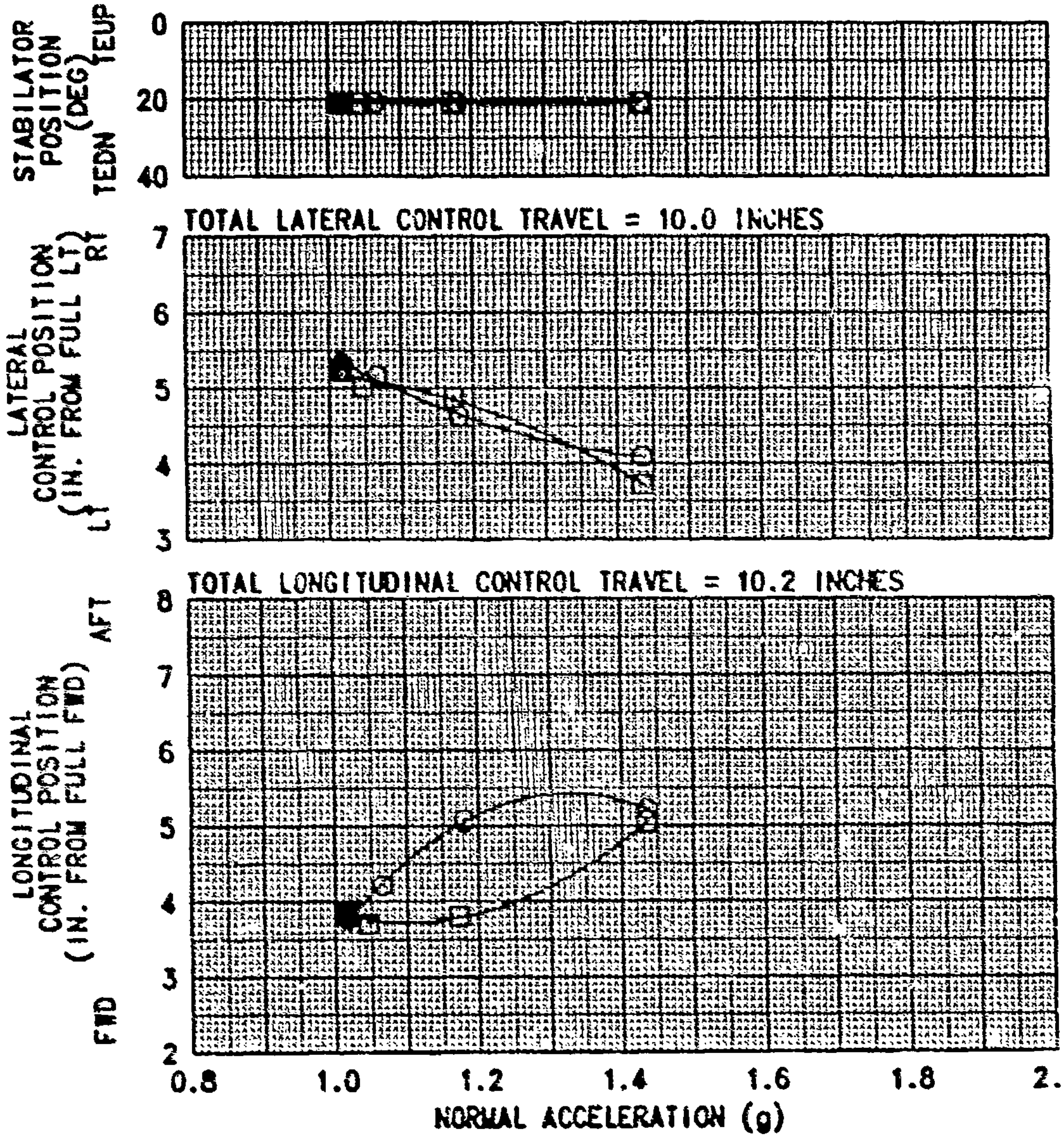


FIGURE E-51
MANEUVERING STABILITY
COLLECTIVE-FIXED TURNS
UH-60A USA S/N 82-23748

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)	TRIM FLIGHT CONDITION
⊡	19900	357.2	0.2	5480	7.0	259	85	IRP CLIMBS
⊙	19810	356.9	0.2	5340	7.0	259	85	IRP CLIMBS

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. SHADED SYMBOLS DENOTE TRIM POINTS
4. ⊡ LEFT TURNS
5. ⊙ RIGHT TURNS

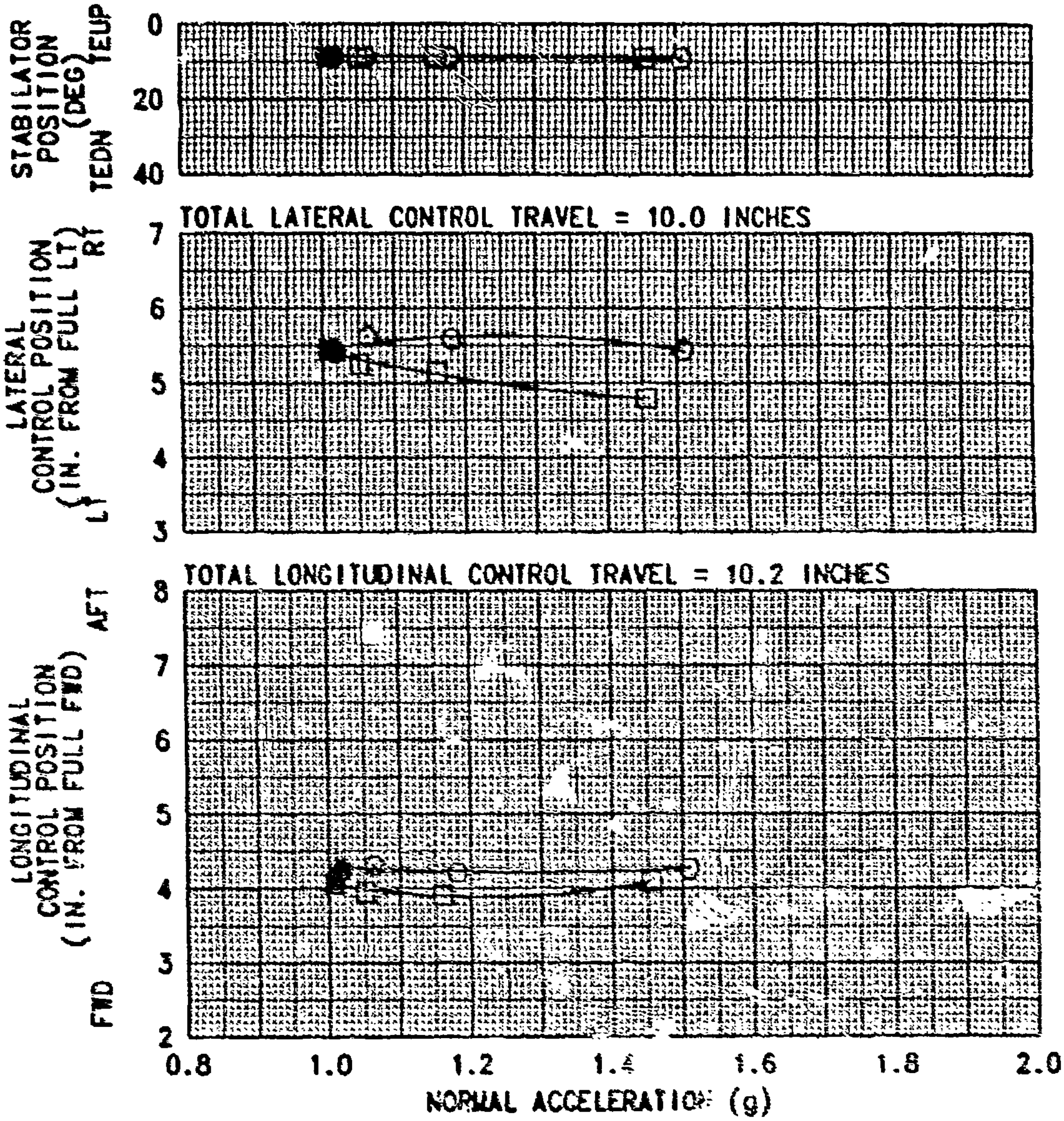


FIGURE E-52

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
20840	359.5 (AFT)	0.2 LT	5750	5.0	258	99	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

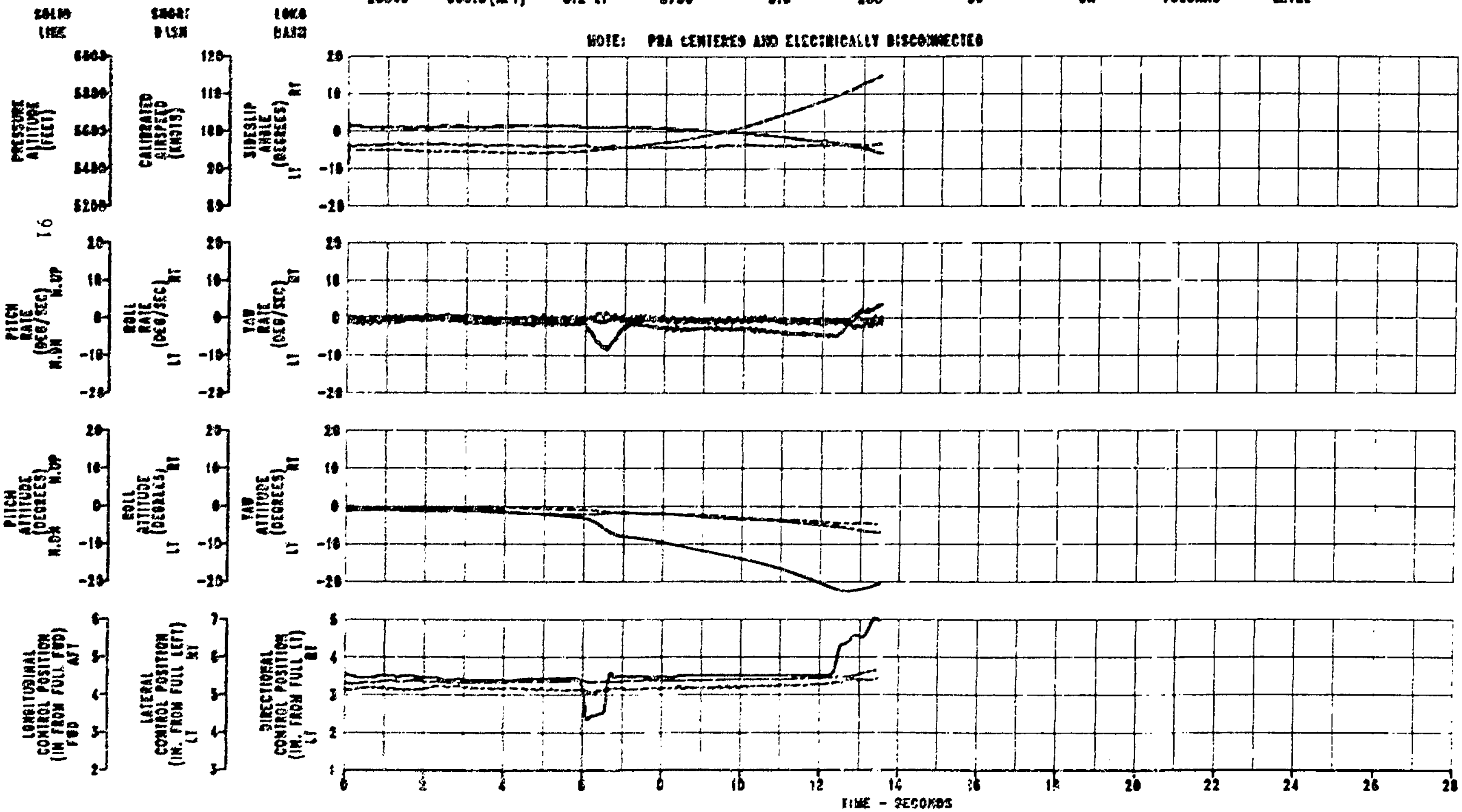


FIGURE E-53

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15590	350.5 (AFT)	0.2 LT	6810	5.0	258	90	ON	VOLCANO	LEVEL

NOTE: FPA CENTERED AND ELECTRICALLY DISCONNECTED

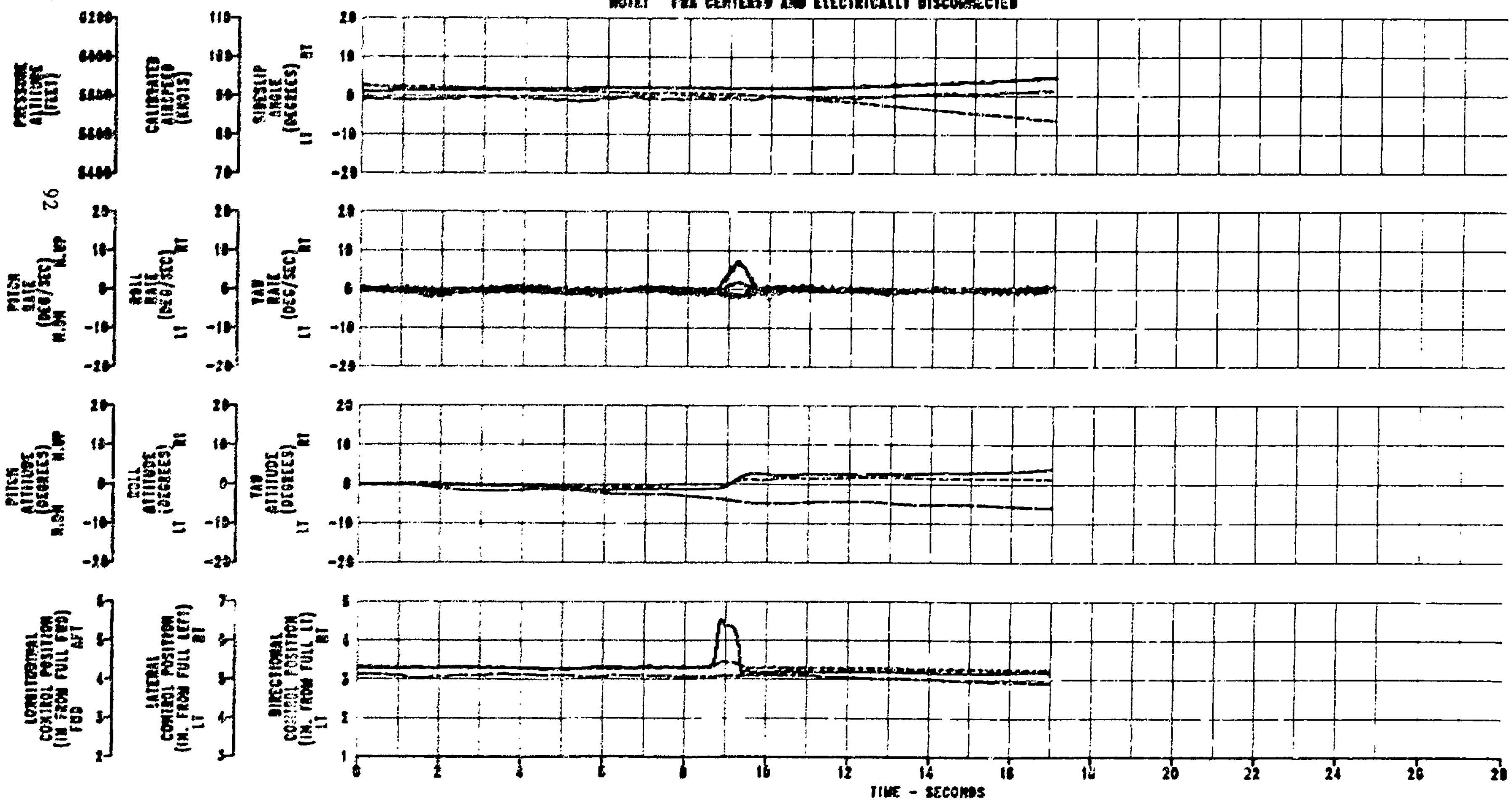


FIGURE E-54

LONGITUDINAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15890	358.1 (AFT)	0.2 LT	6470	16.5	258	119	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

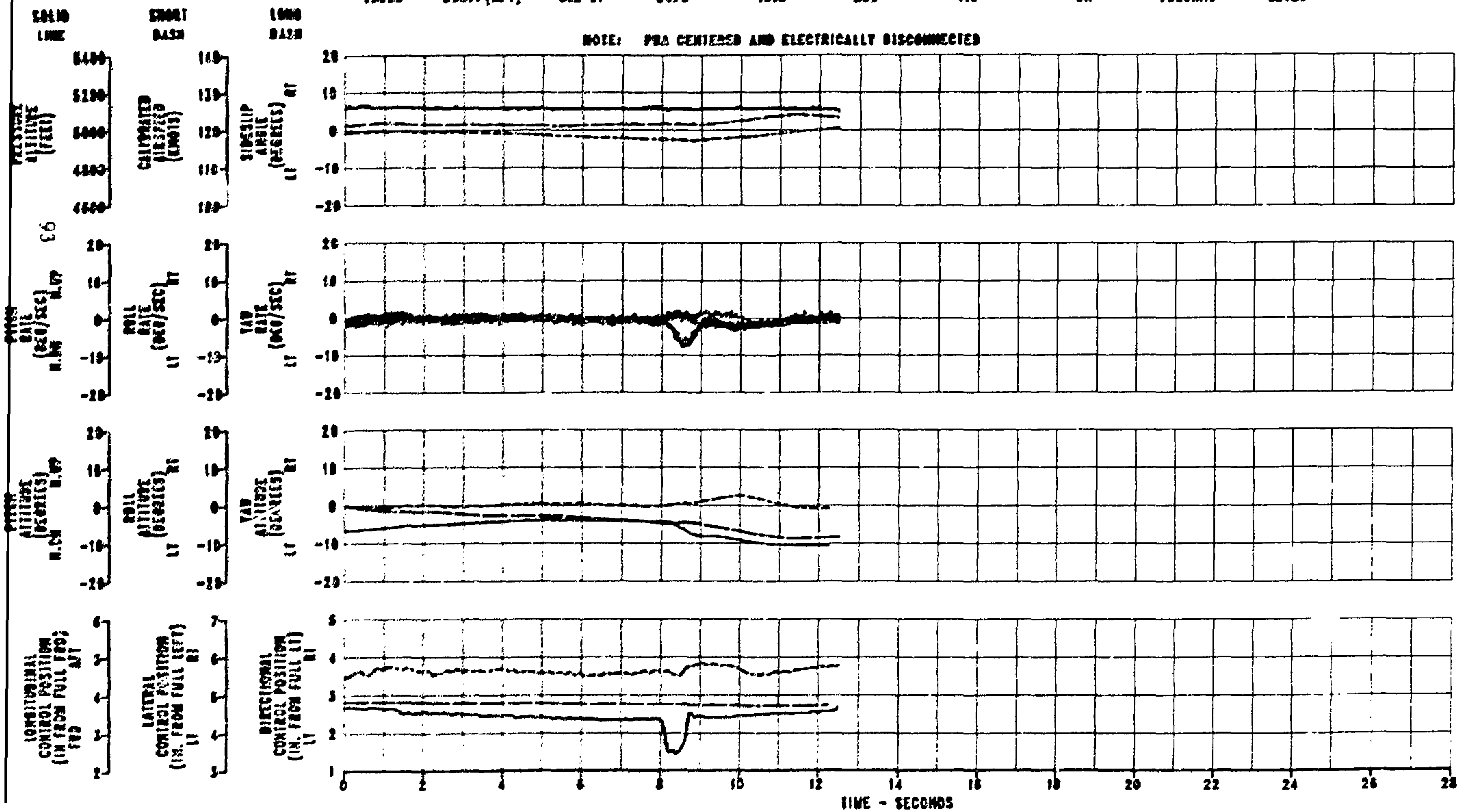


FIGURE E-55

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15660	358.0(AFT)	0.2 LT	6430	16.5	255	116	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

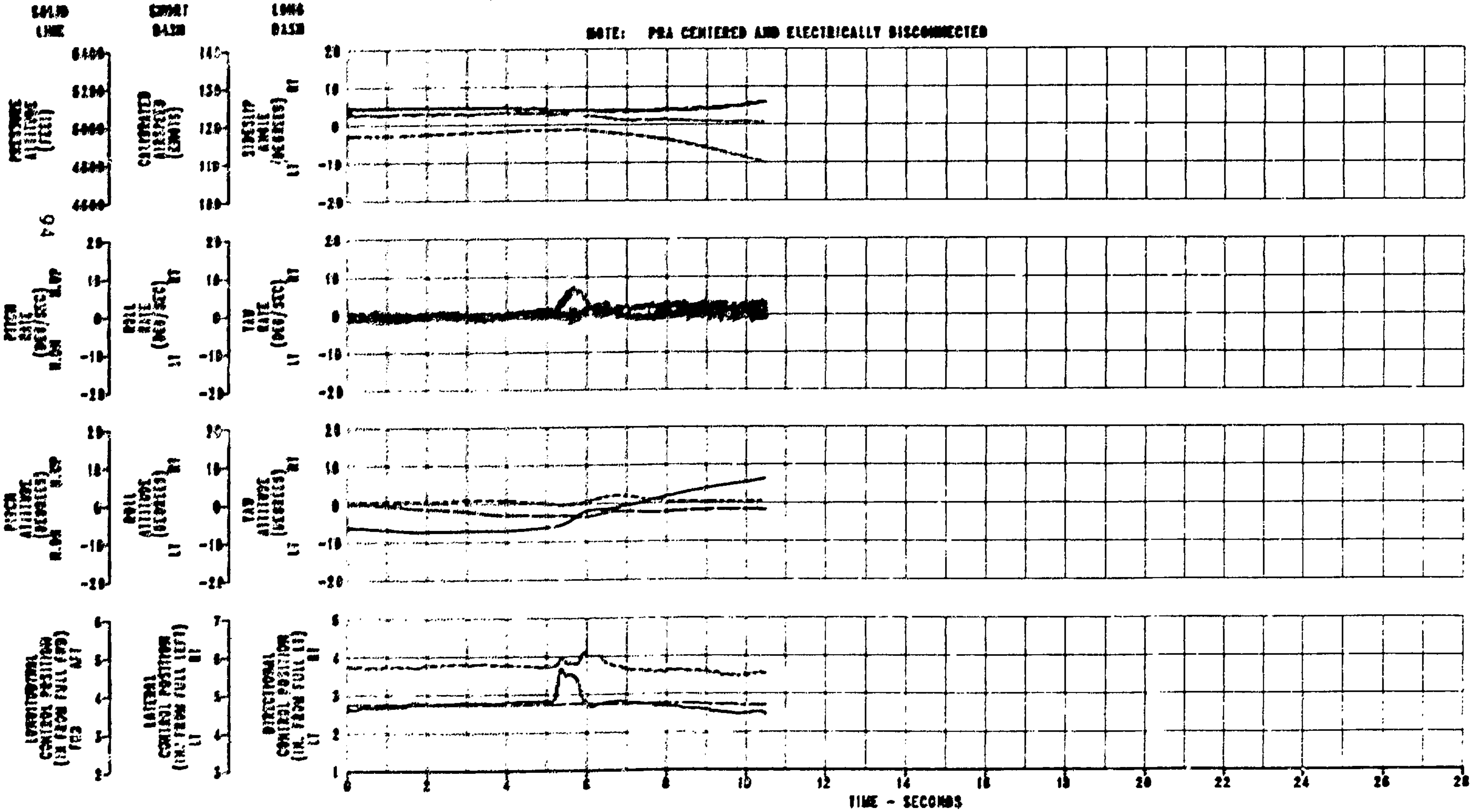


FIGURE E-58

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16510	358.2	0.2 LT	6180	7.0	255	62	ON	VOLCANO	IRP CLIMB

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

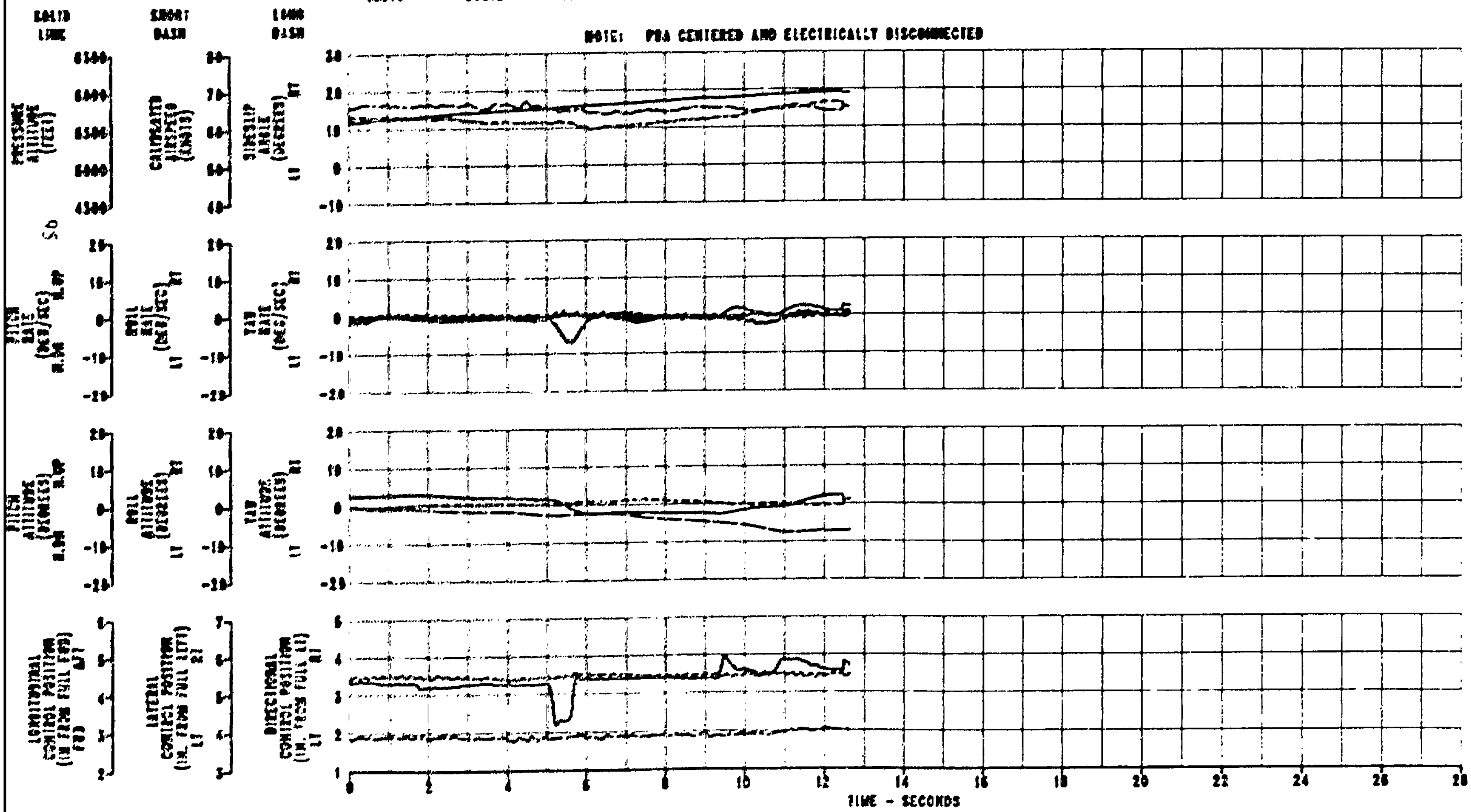


FIGURE E-57

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16500	350.2	0.2 LT	7050	6.0	255	66	ON	VOLCANO	IRP CLIMB

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

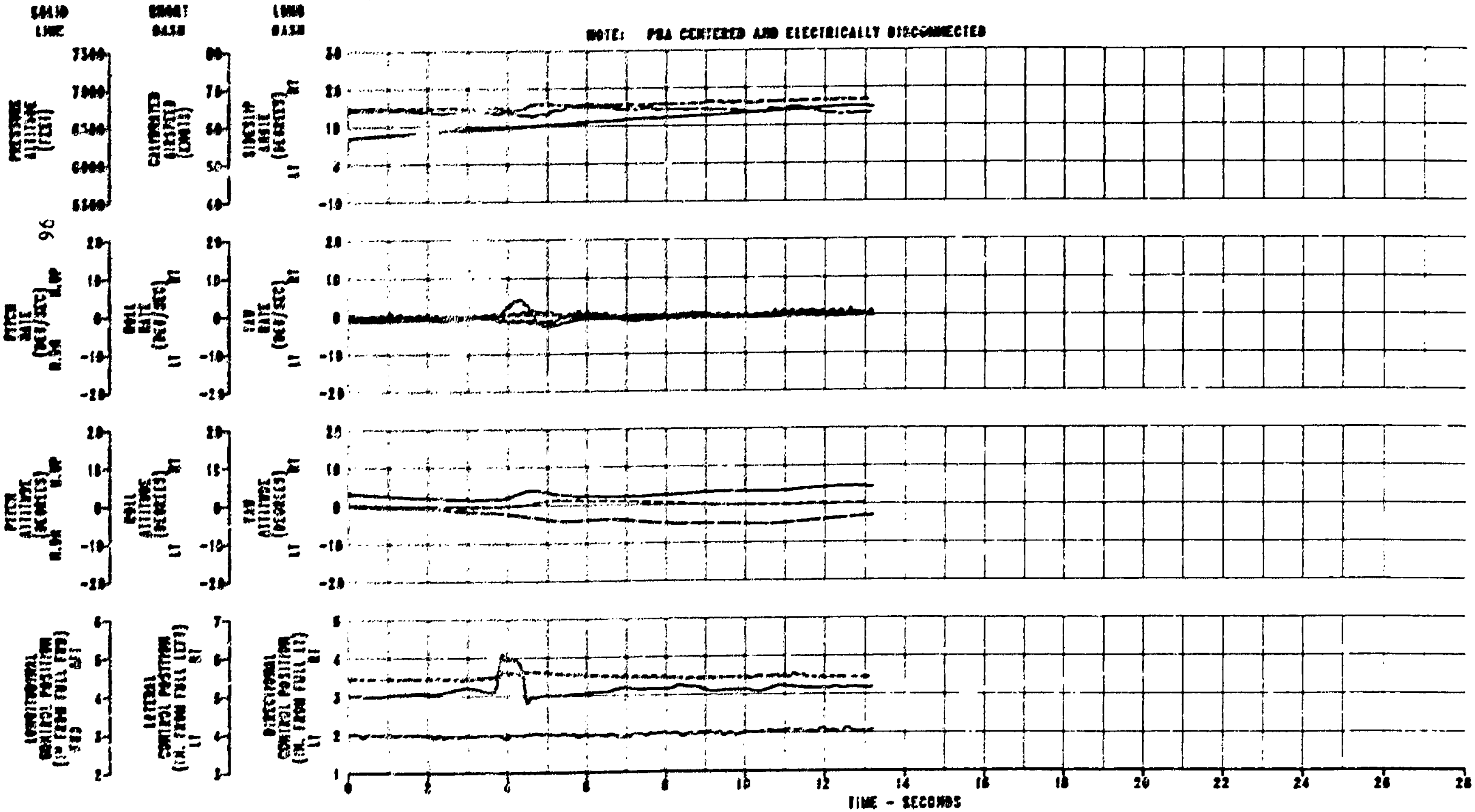


FIGURE E-58

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15810	359.5	0.2 LT	5060	7.5	258	95	ON	VOLCANO	IRP CLIMB

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

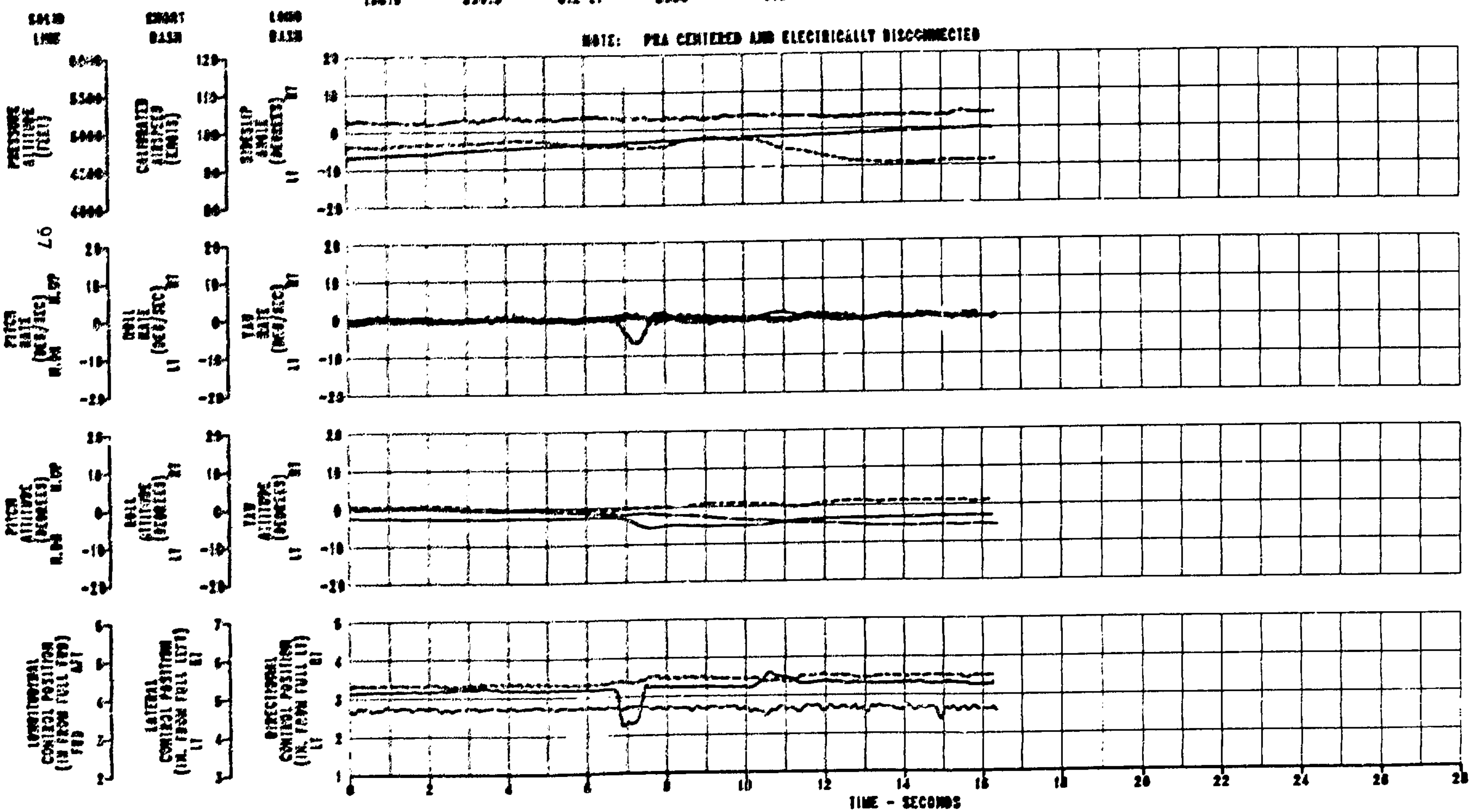


FIGURE E-59

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16500	359.5	0.2 LT	6950	5.0	259	94	ON	VOLCANO	IRP CLIMB

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

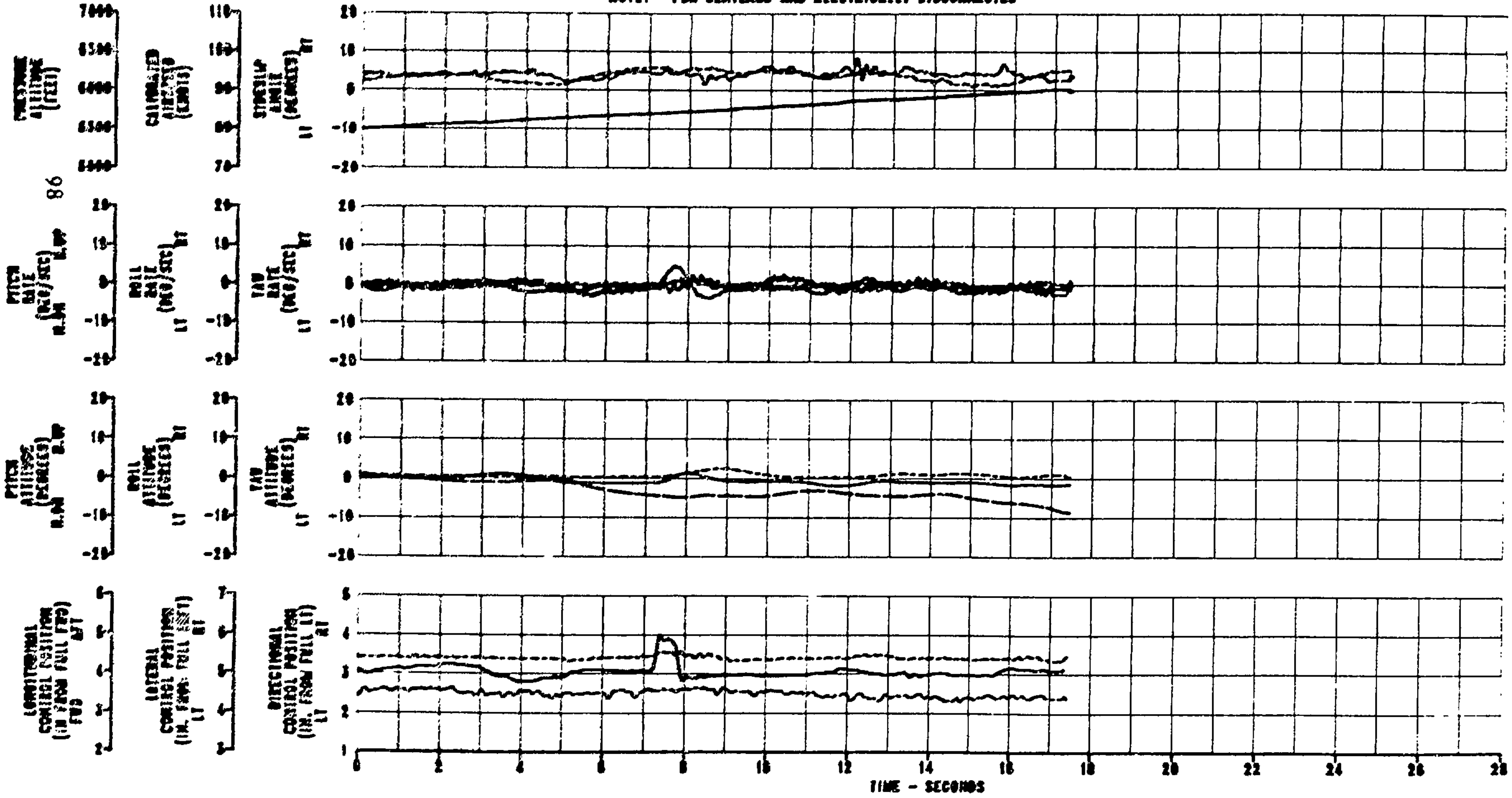


FIGURE E-[illegible]

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16700	350.9	0.2 LT	6540	5.5	258	79	ON	VOLCANO	AUTO DESCENT

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

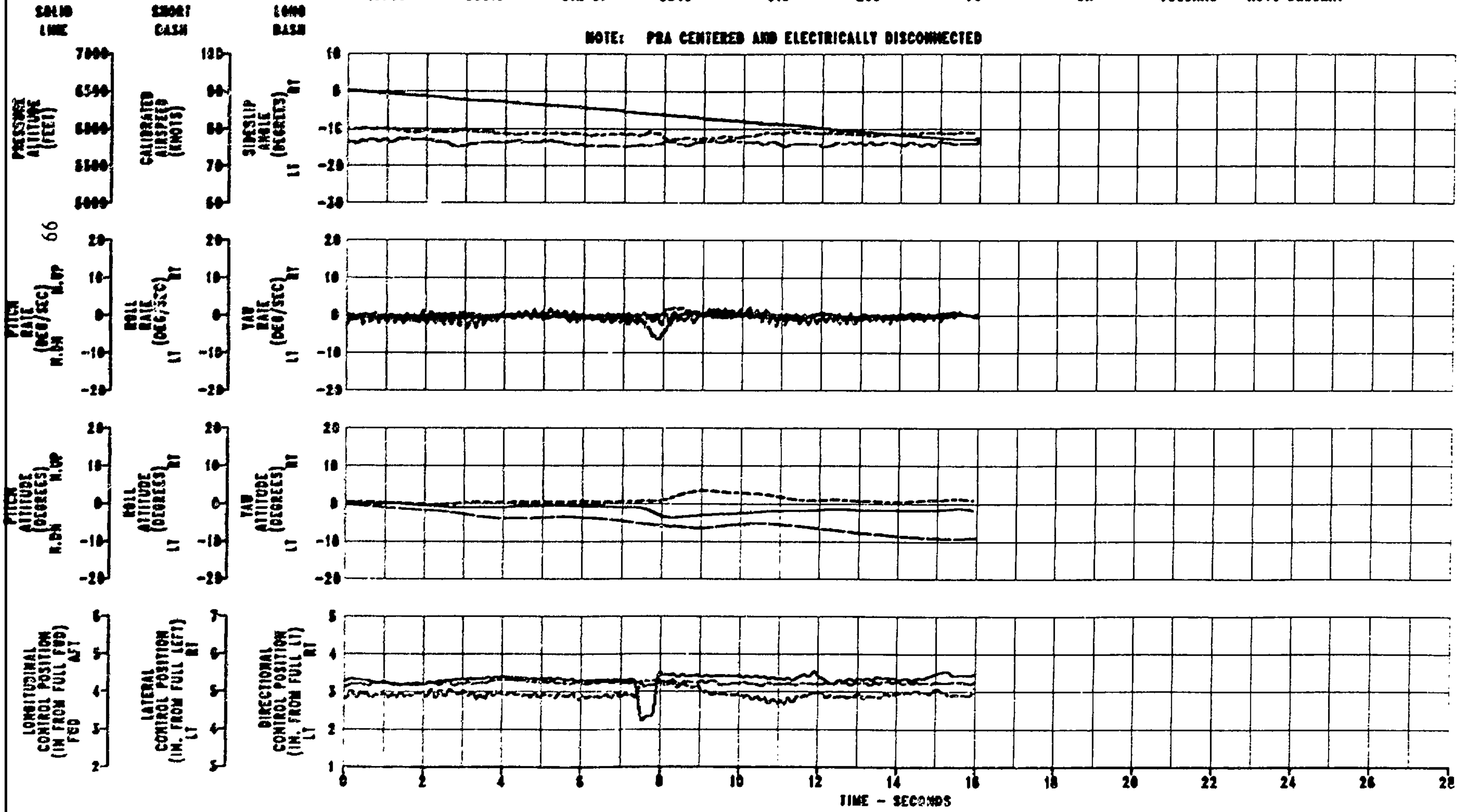


FIGURE E-81

LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16700	350.0	0.2 LT	4120	7.0	258	78	ON	VOLCANO	AUTO DESCENT

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

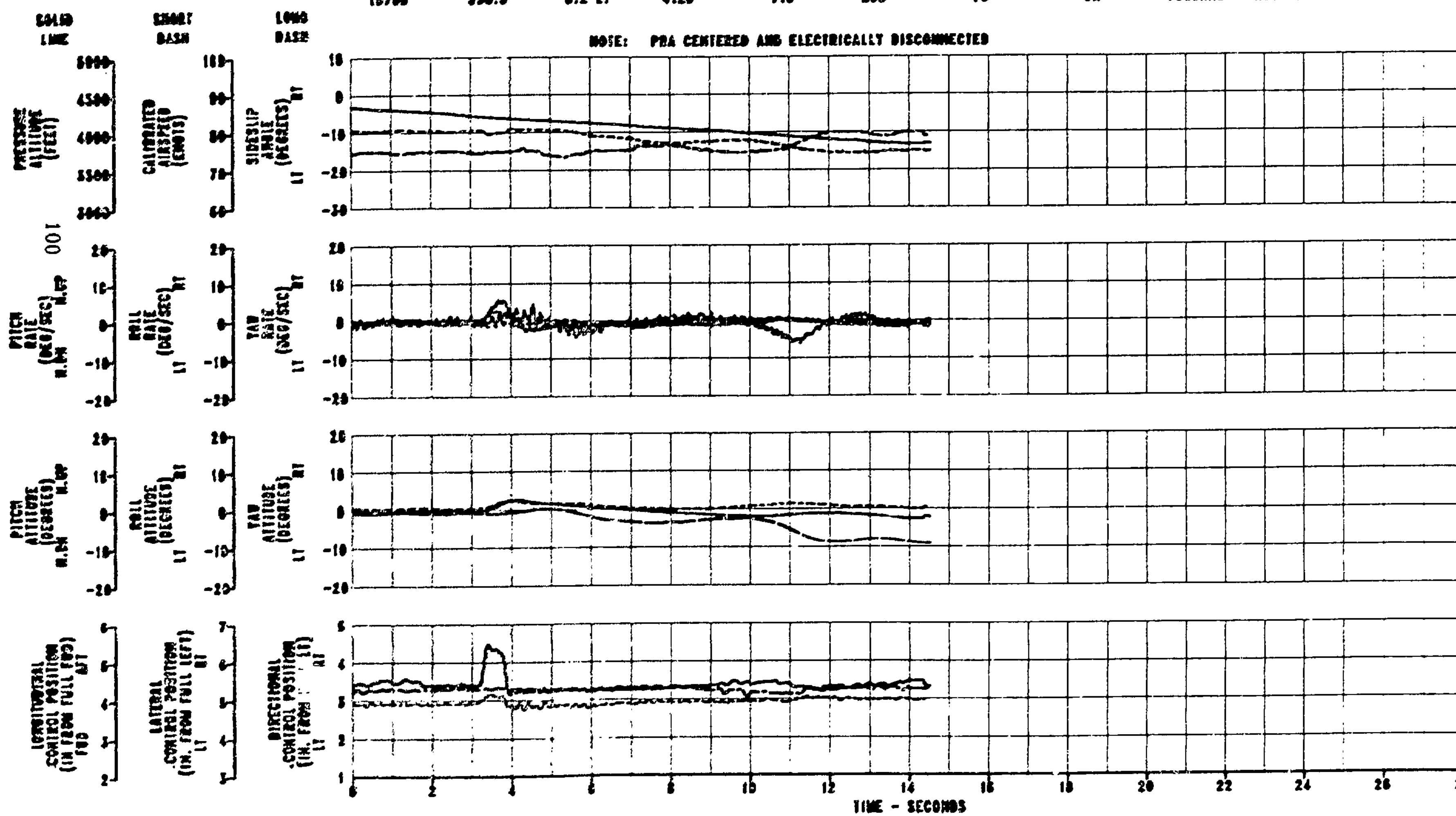


FIGURE E-62

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
21550	350.2 (AFT)	0.2 LT	6000	5.0	258	93	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

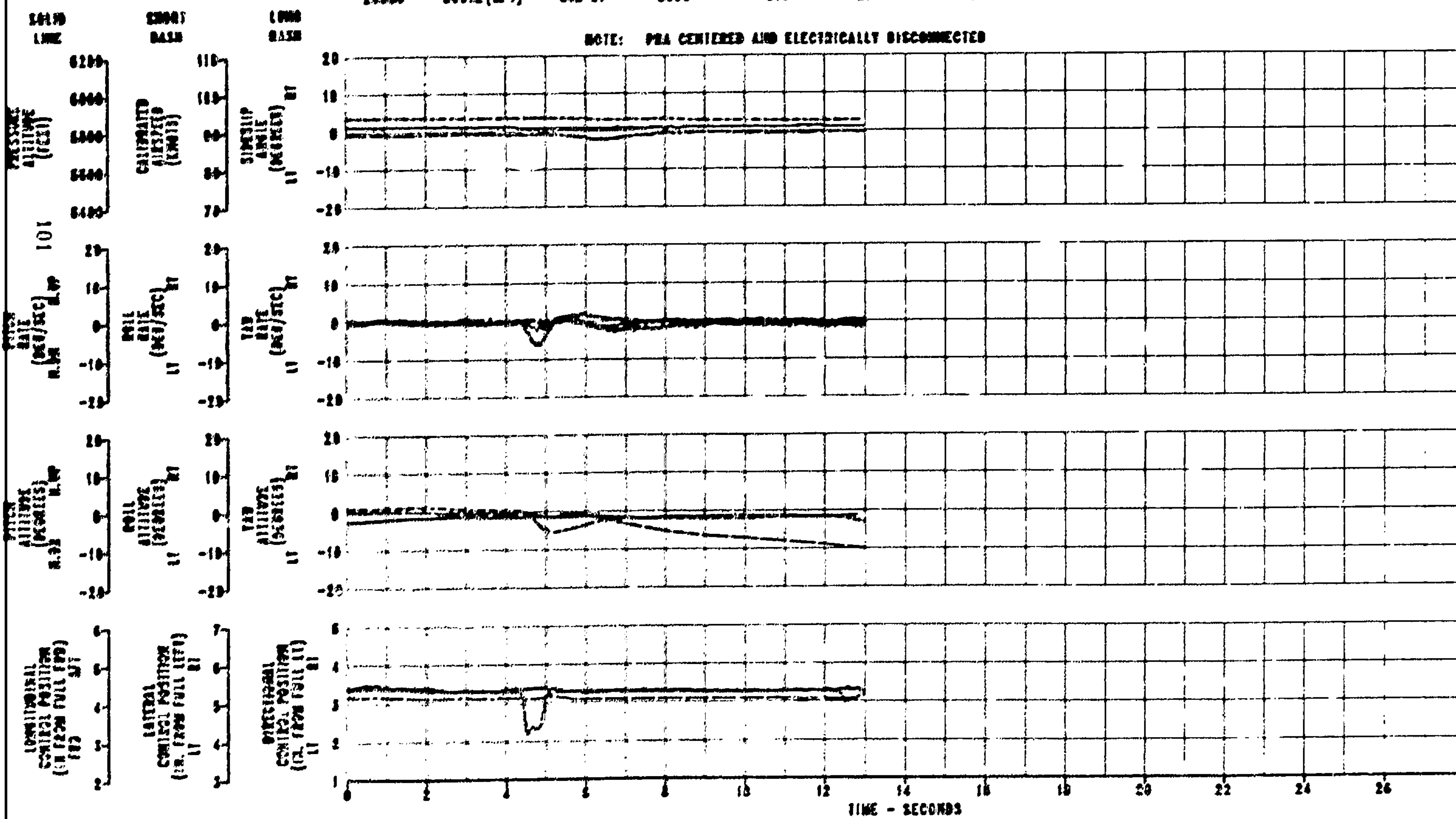


FIGURE C-63

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15520	359.1 (AFT)	0.2 LT	5560	4.5	259	84	ON	VOLCANO	LEVEL

NOTE: PSA CENTERED AND ELECTRICALLY DISCONNECTED

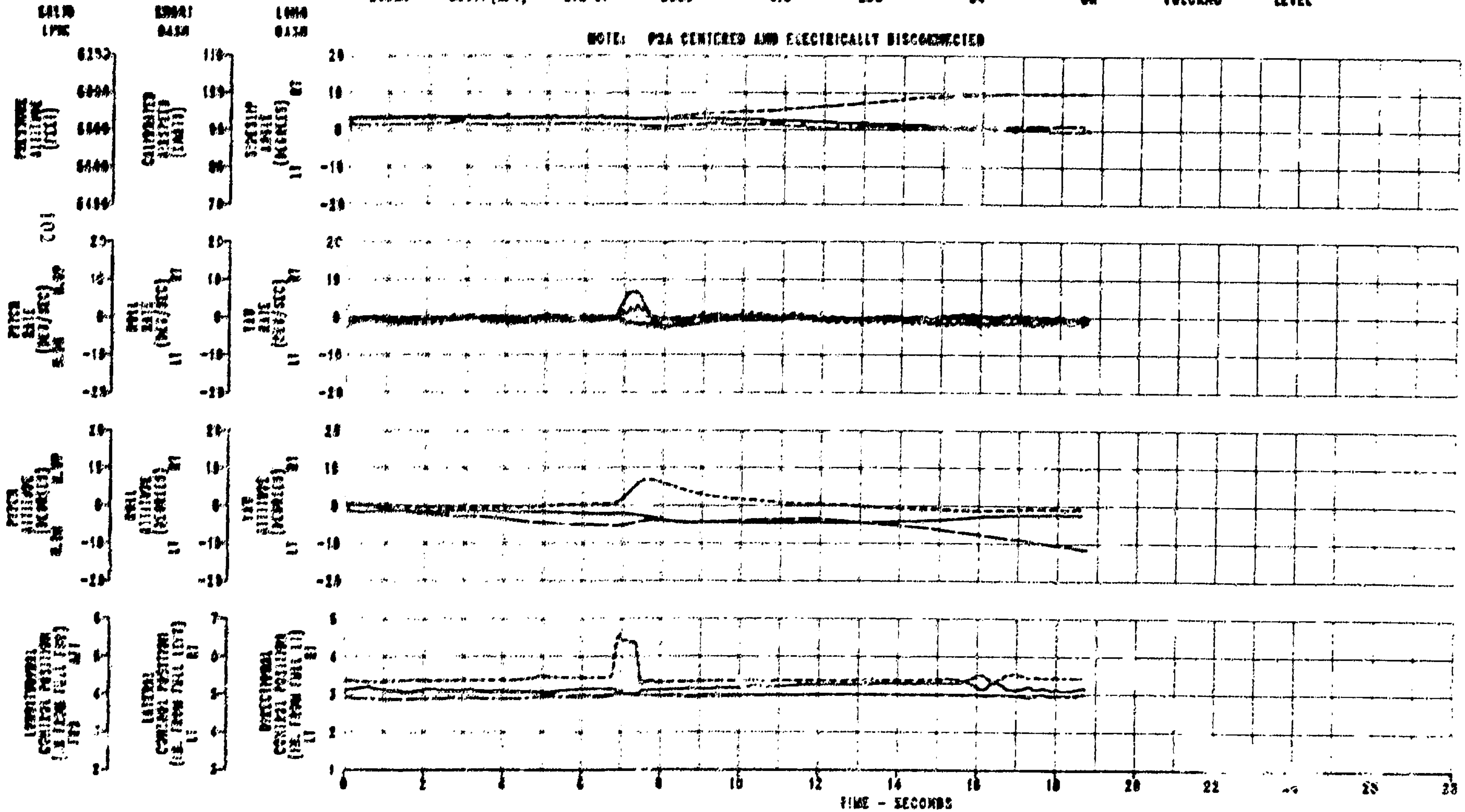


FIGURE E-64

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
19780	357.7 (AFT)	0.2 LT	6400	16.0	258	121	ON	VOLCANO	LEVEL

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

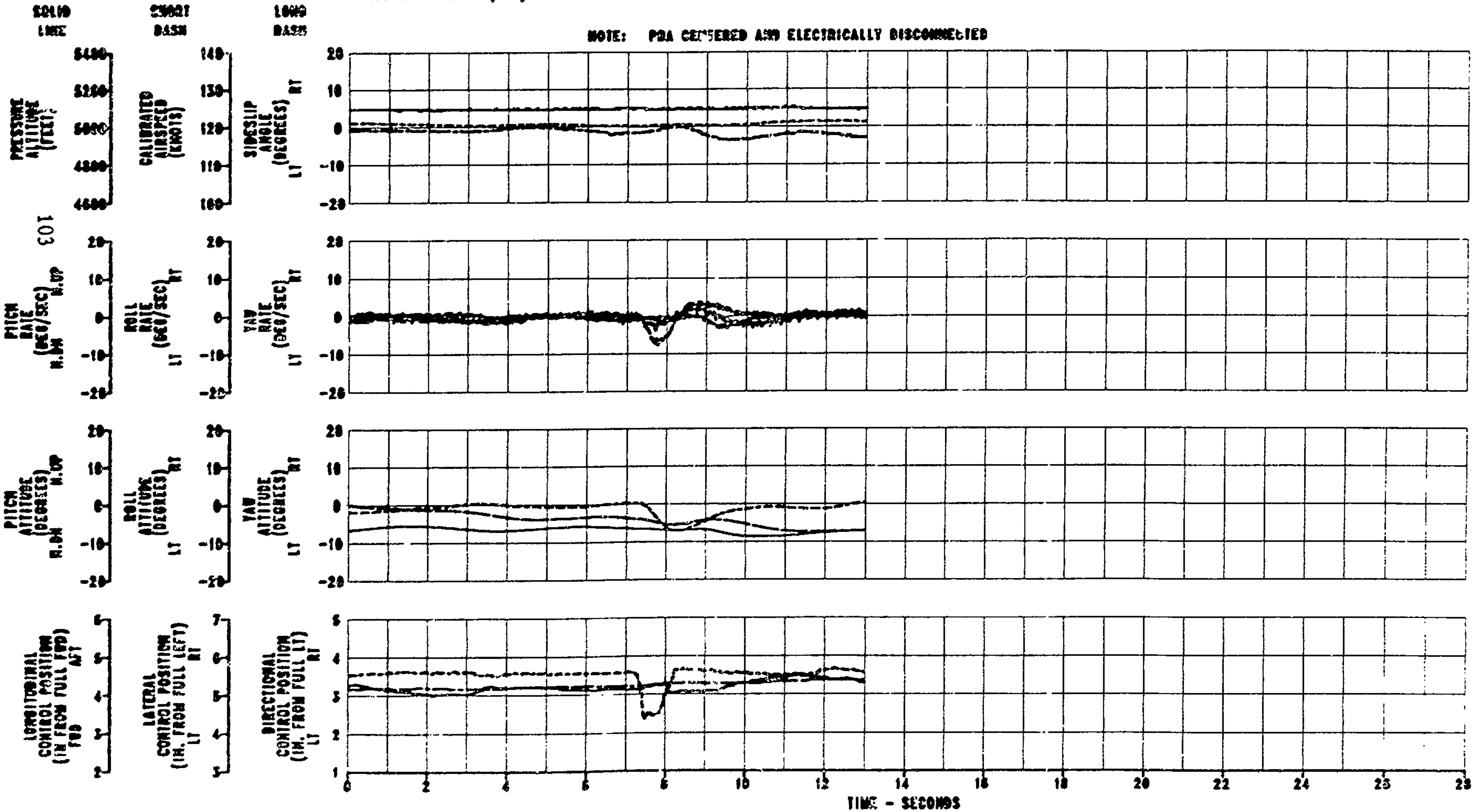


FIGURE E-65

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
18770	357.7 (AFT)	0.2 LT	6410	16.0	257	121	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

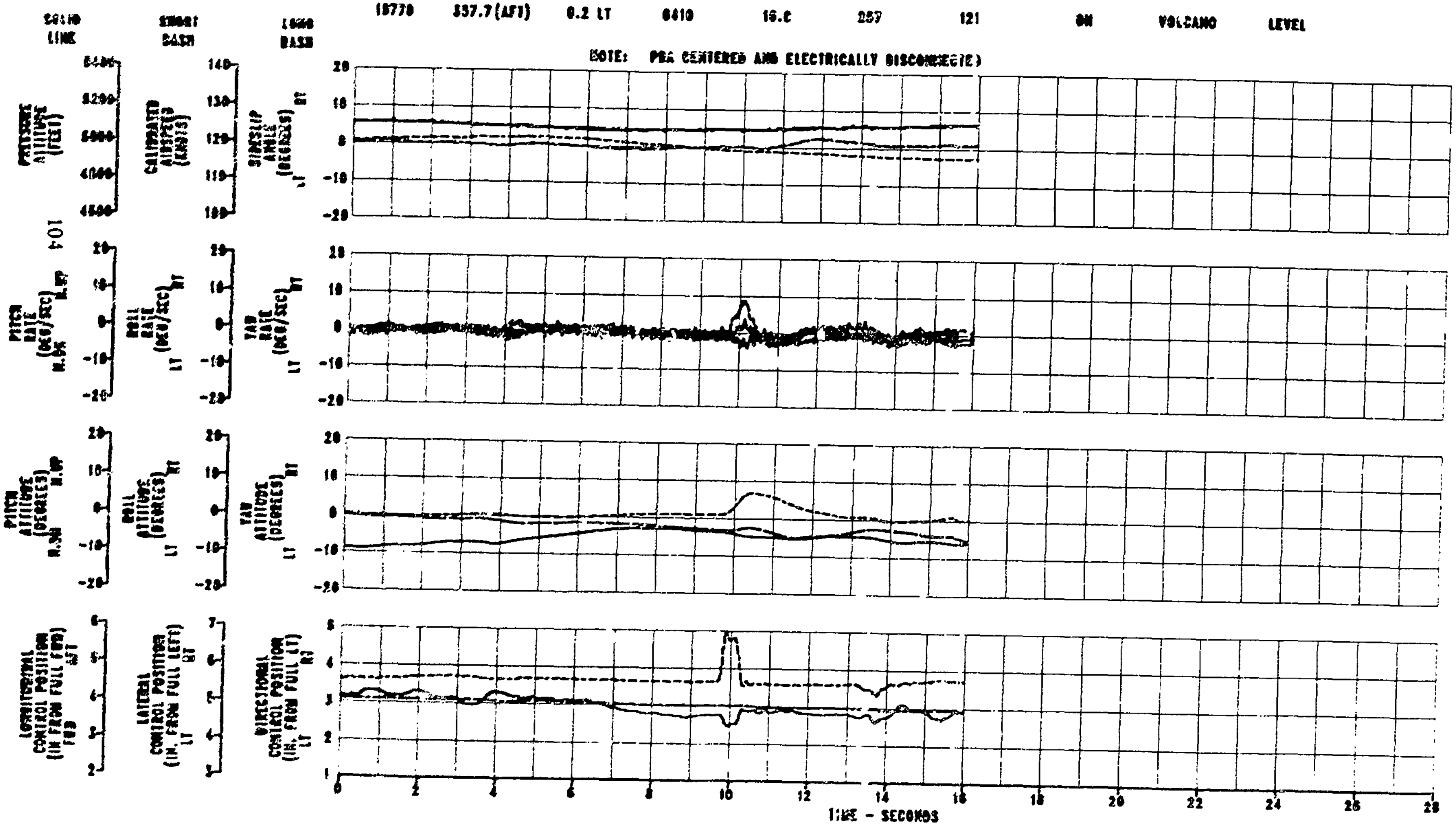


FIGURE E-68

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16470	358.0	0.2 LT	4820	6.0	258	66	ON	VOLCANO	IRP CLIMB

NOTE: FPA CENTERED AND ELECTRICALLY DISCONNECTED

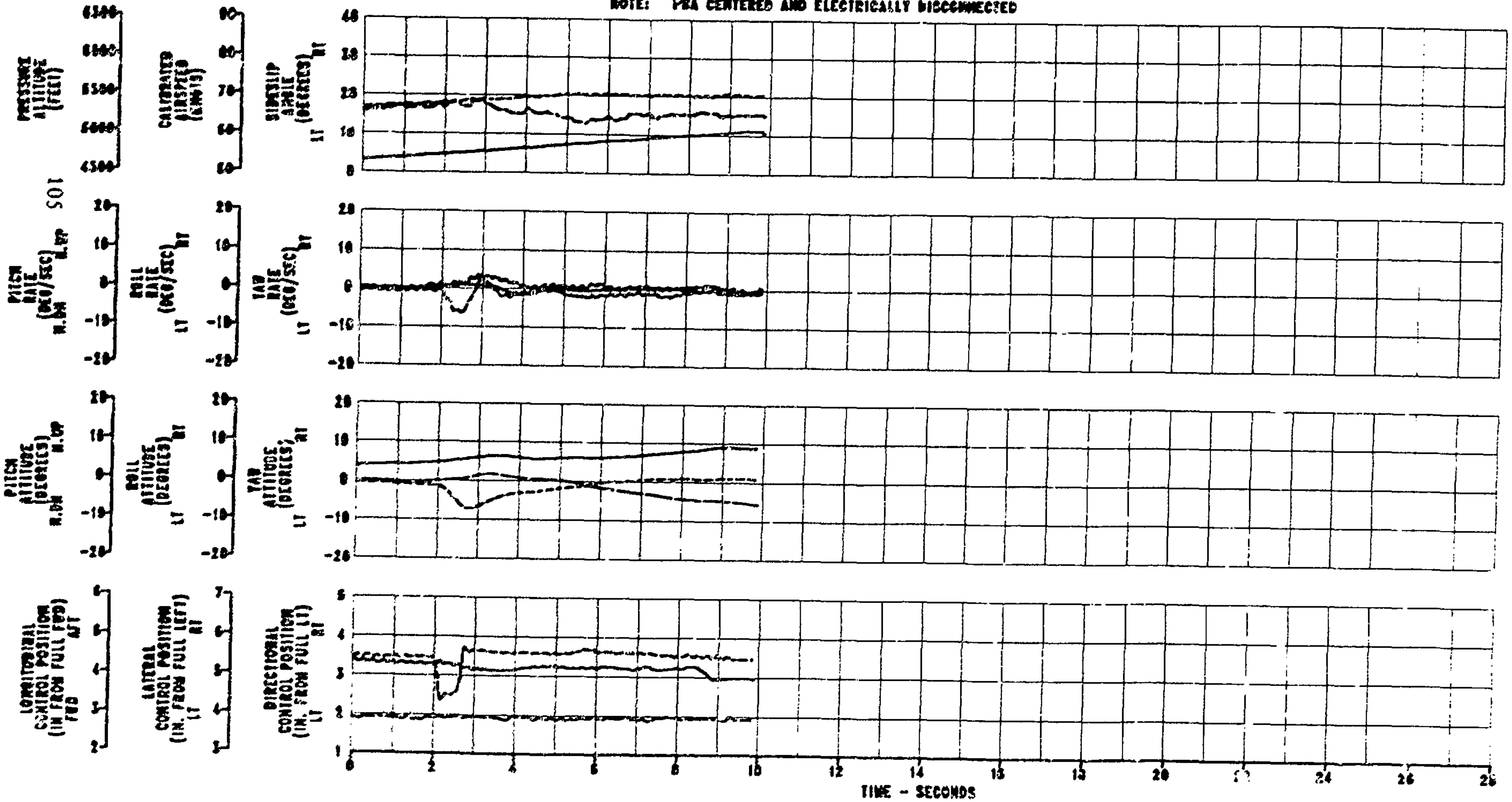


FIGURE E-67

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15740	350.1	0.2 LT	4810	6.5	259	95	ON	VOLCANO	IRP CLIMB

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

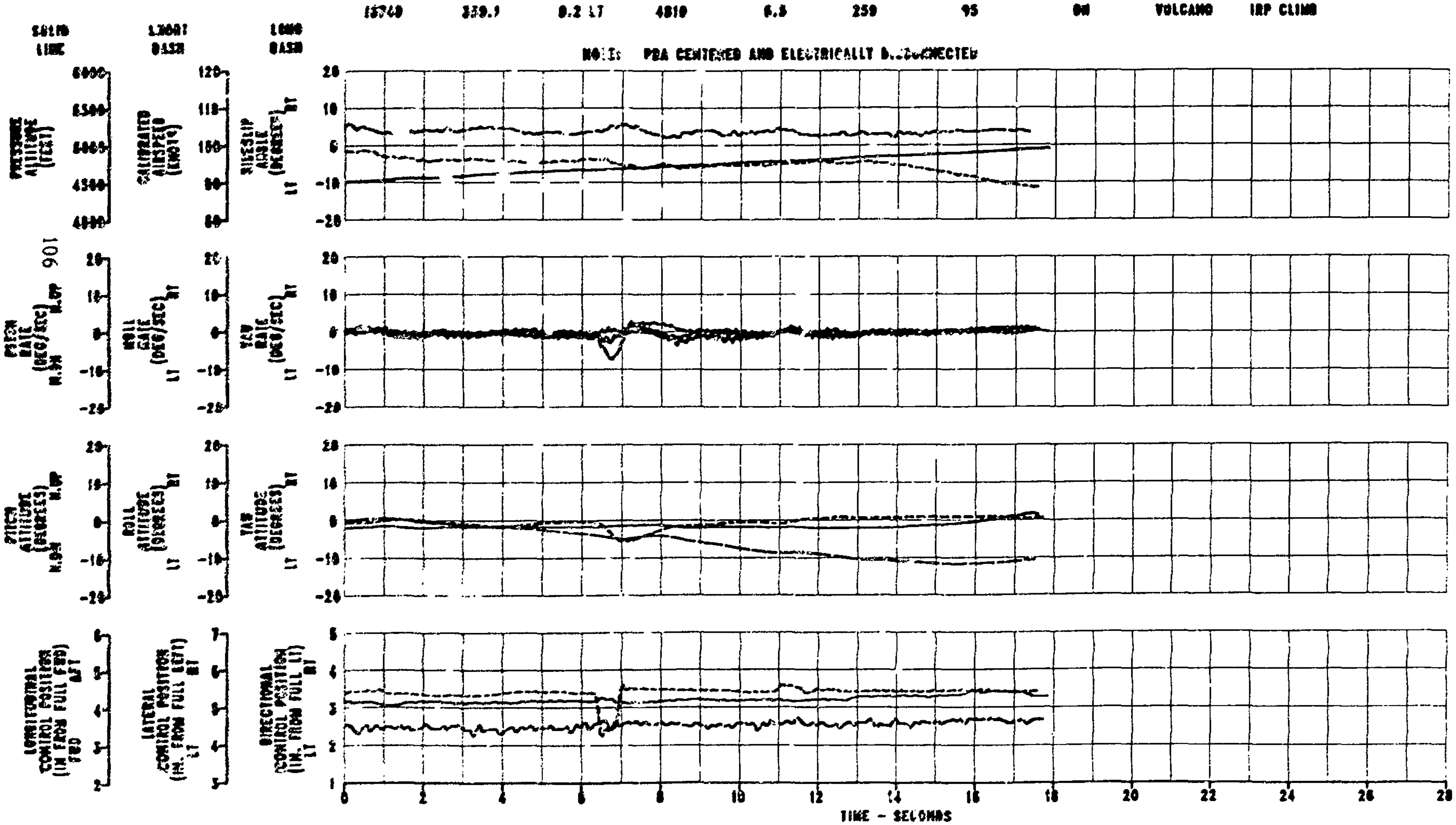


FIGURE E-68

LATERAL PULSE INPUT

UH-60A USA S/N 8[illegible]-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16720	359.0	0.2 LT	6490	5.5	259	80	ON	VOLCANO	IRP CLIMB

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

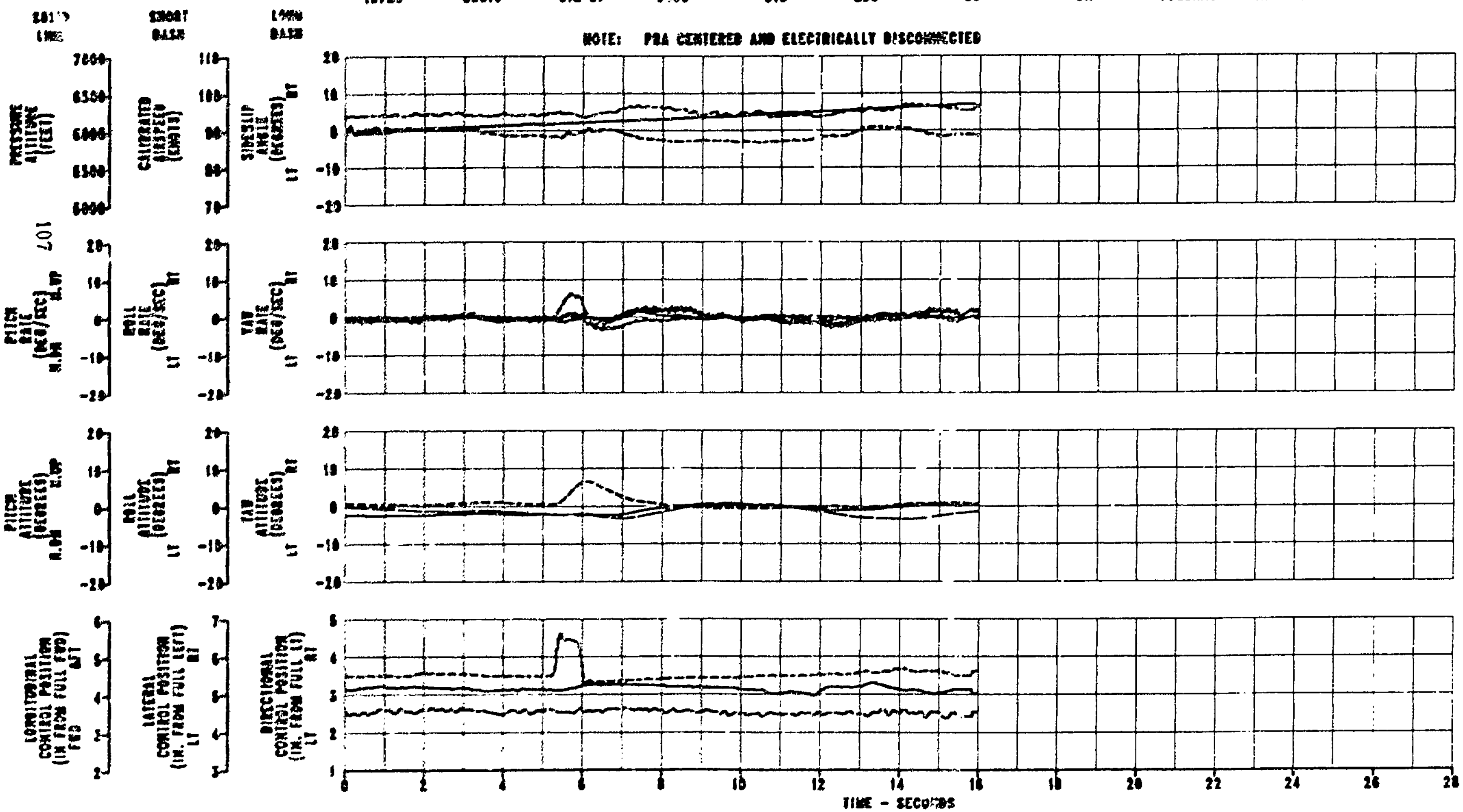


FIGURE E-69

LATERAL PULSE INPUT

CH-53A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15640	353.7	0.2 LT	6250	6.0	250	80	ON	VOLCANO	AUTO DESCENT

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

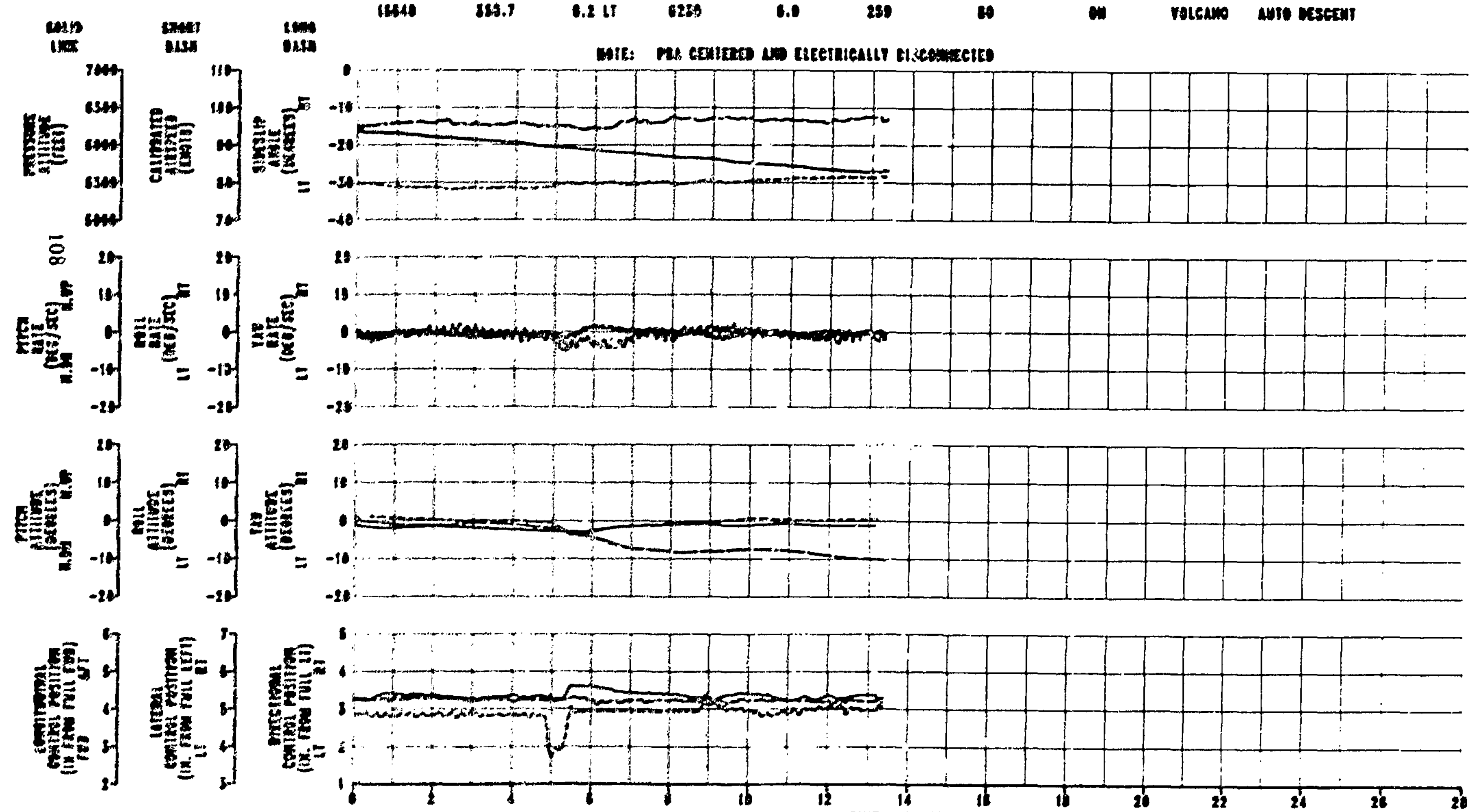


FIGURE E-78

LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15550	255.6	0.2 LT	6350	5.0	259	78	ON	VOLCANO	AUTO DESCENT

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

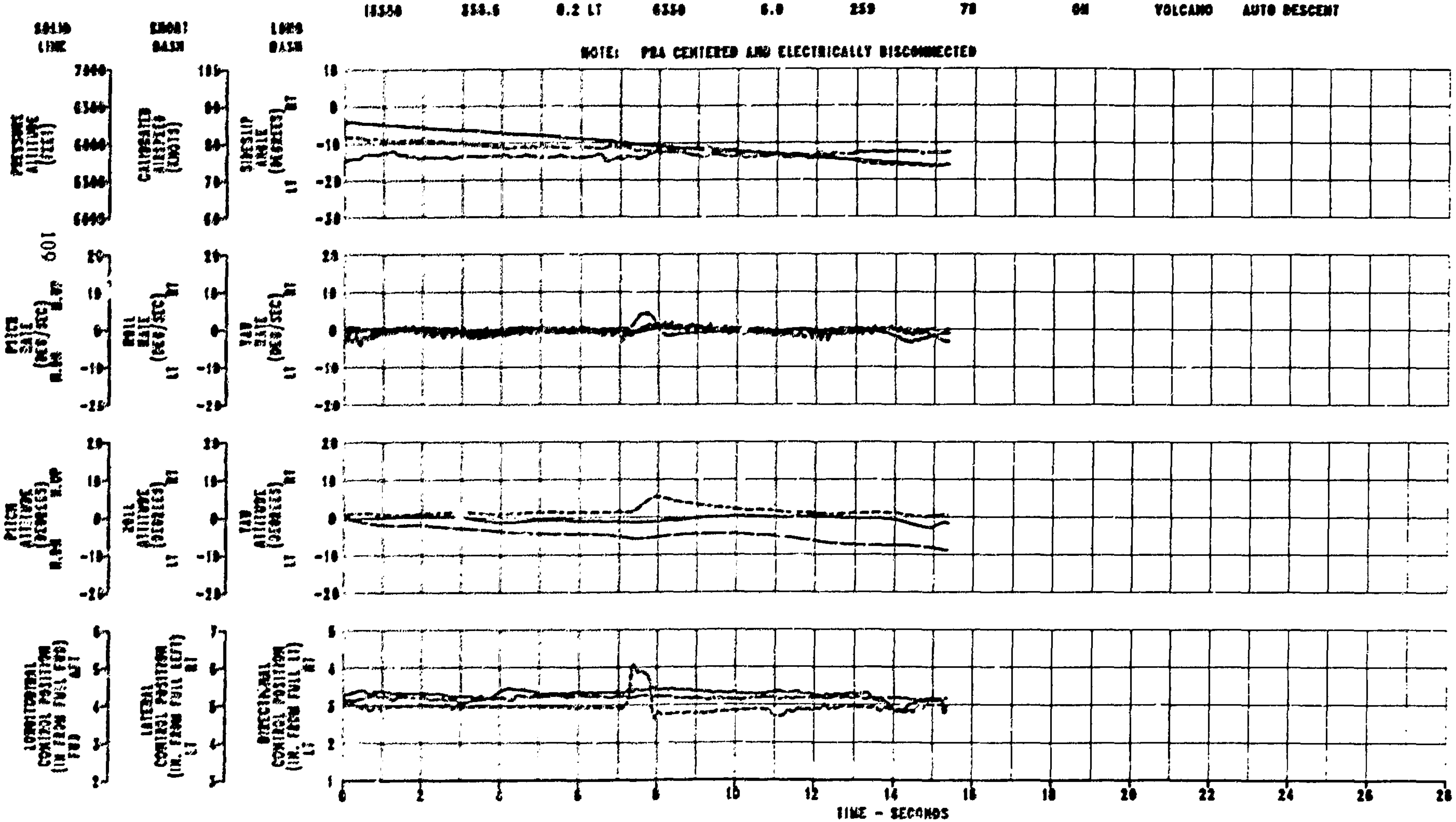


FIGURE E-71

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

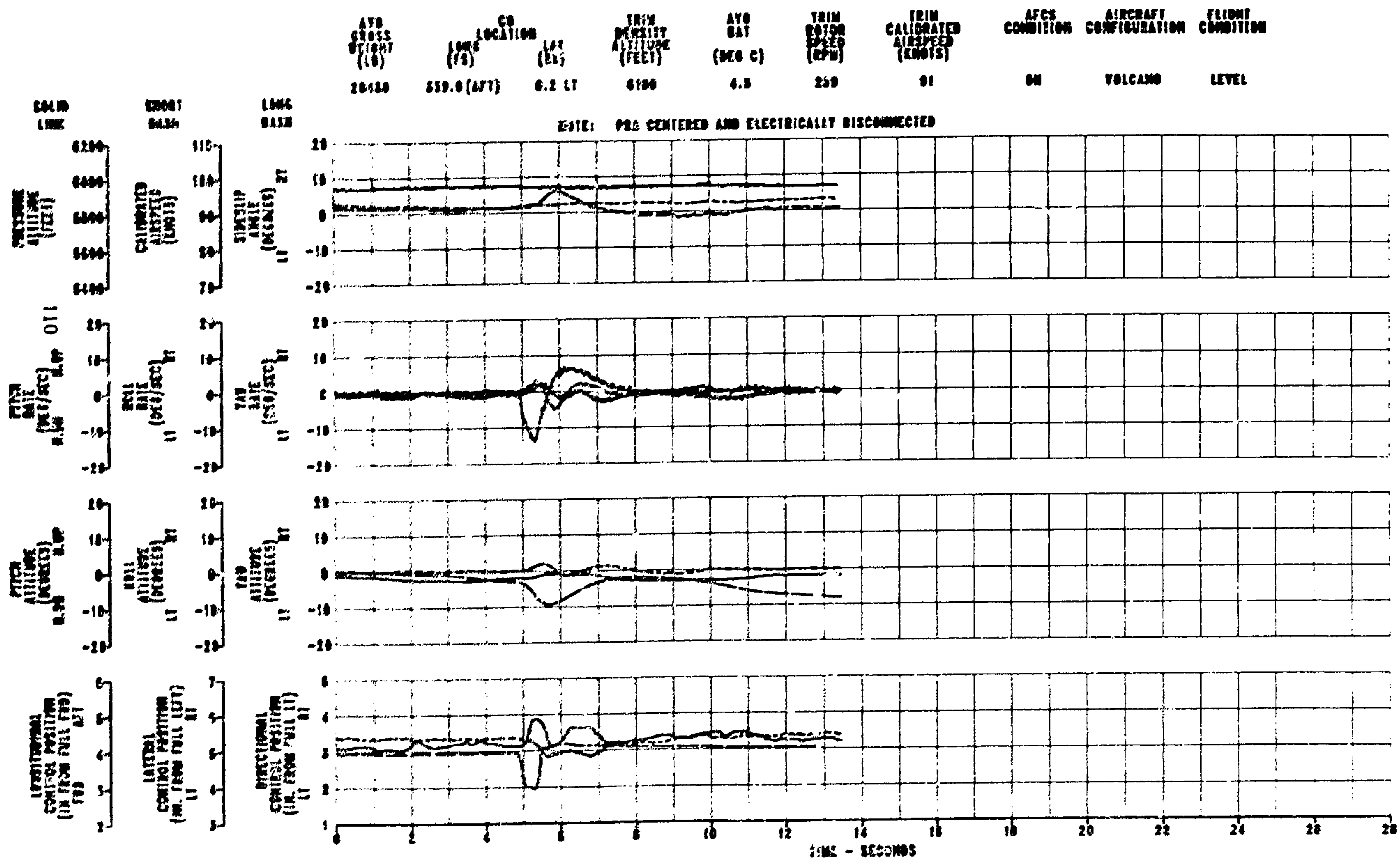


FIGURE E-72

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

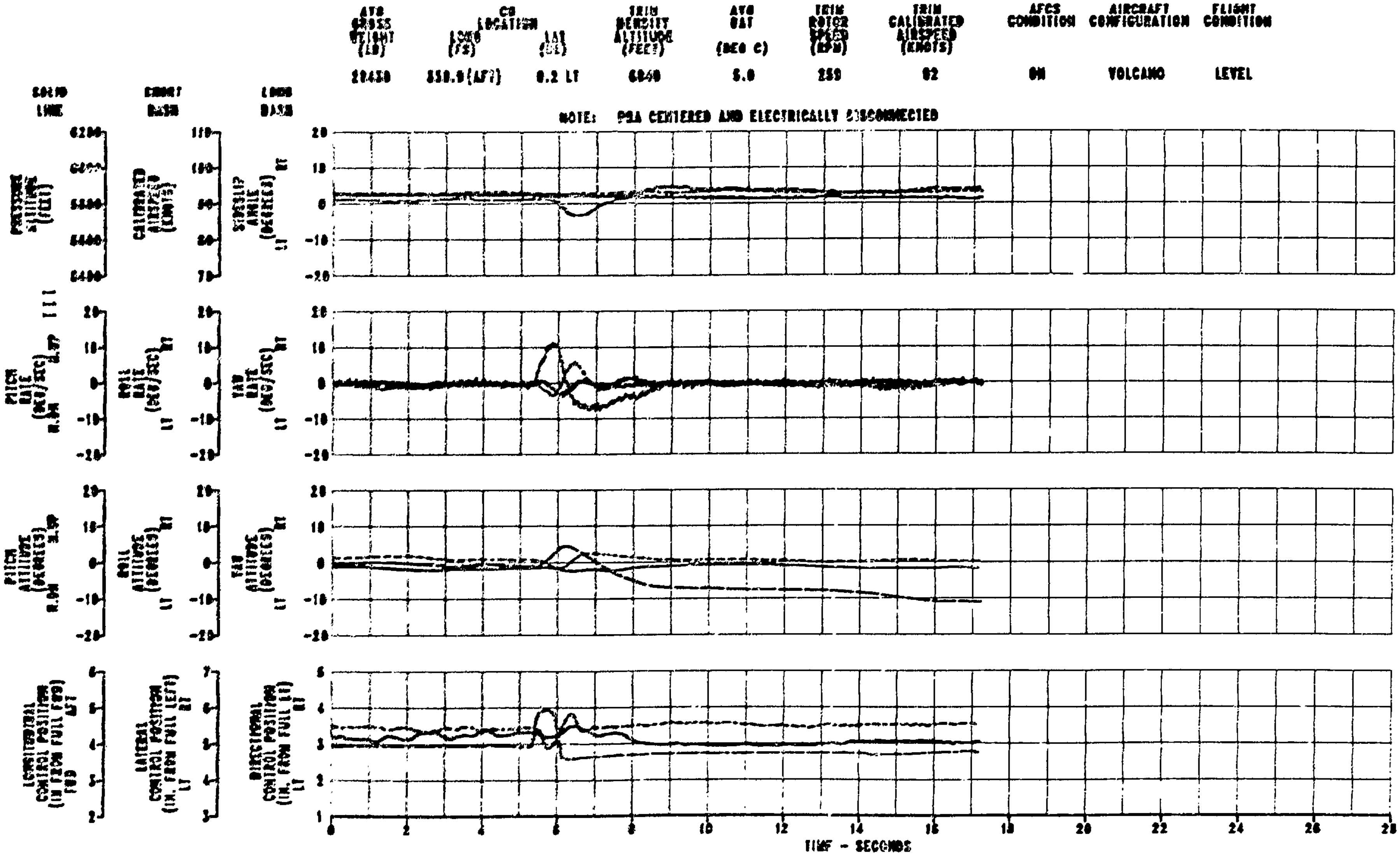


FIGURE E-73

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
19750	357.6 (AFT)	0.2 LT	6320	13.5	258	120	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

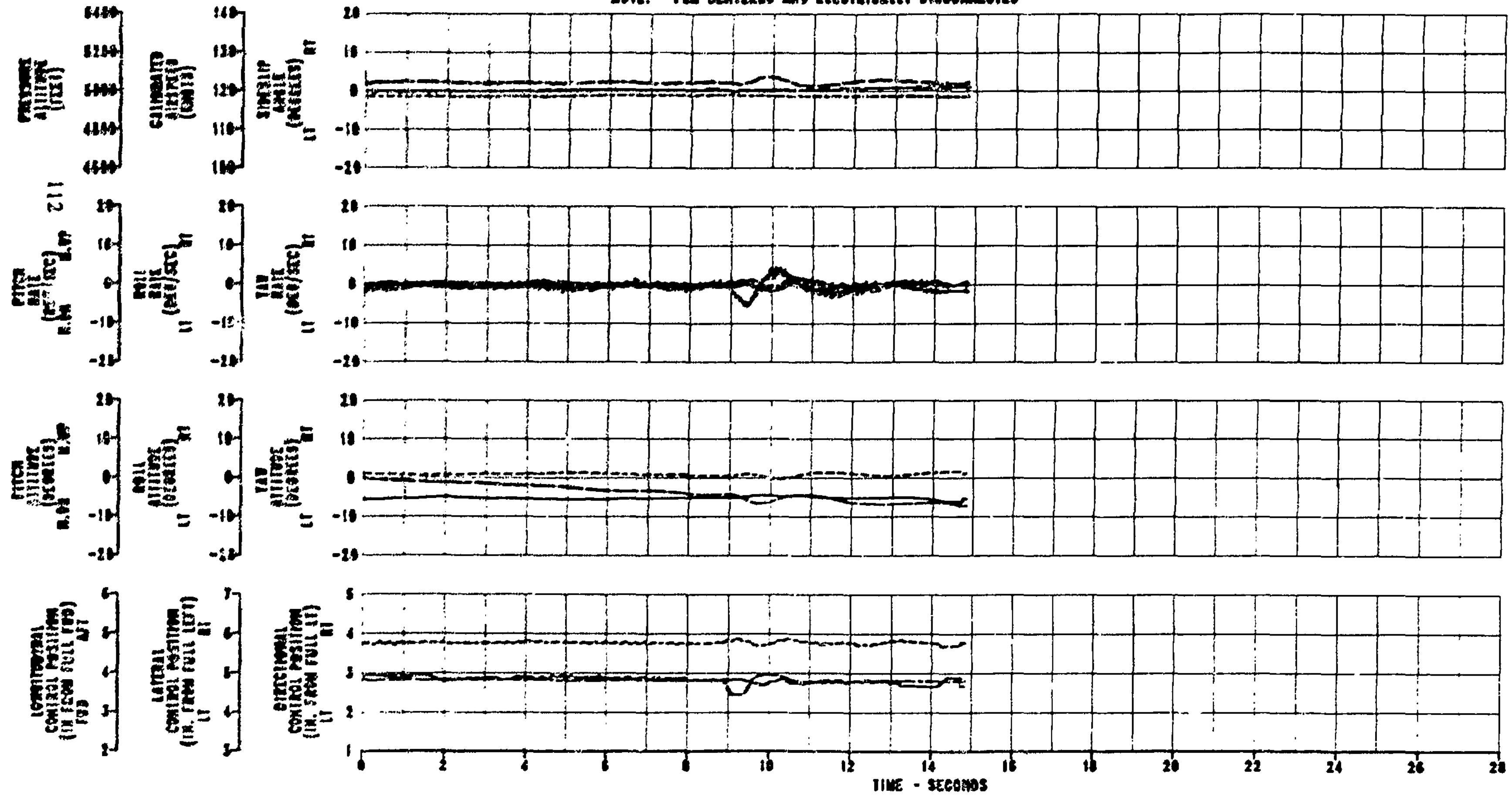


FIGURE E-74

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
17710	357.6	0.2 LT	6350	16.5	257	120	ON	VOLCANO	LEVEL

NOTE: PSA CENTERED AND ELECTRICALLY DISCONNECTED

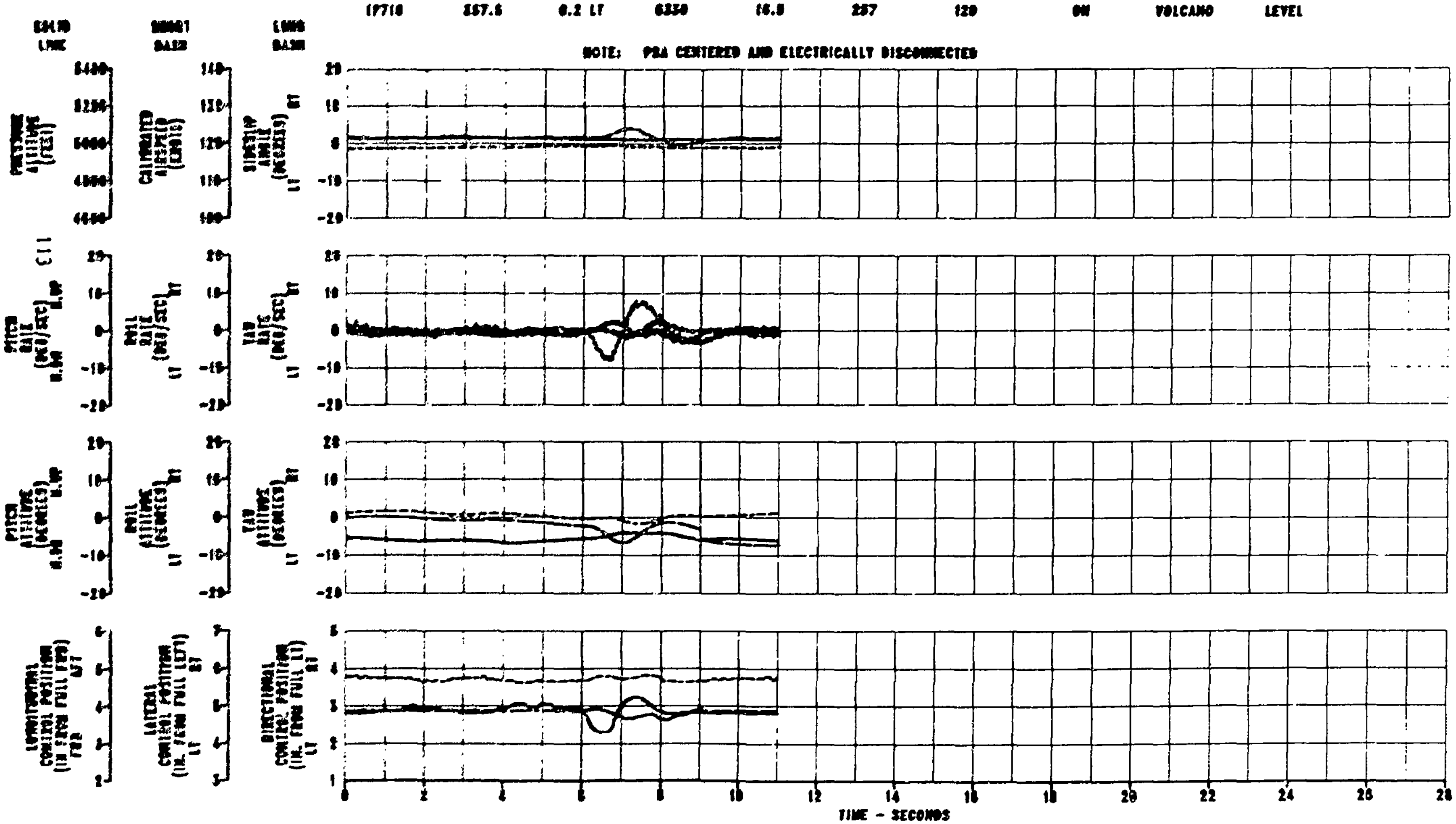


FIGURE E-75

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16420	357.8	0.2 LT	6290	6.5	258	83	ON	VOLCANO	IRP CLIMB

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

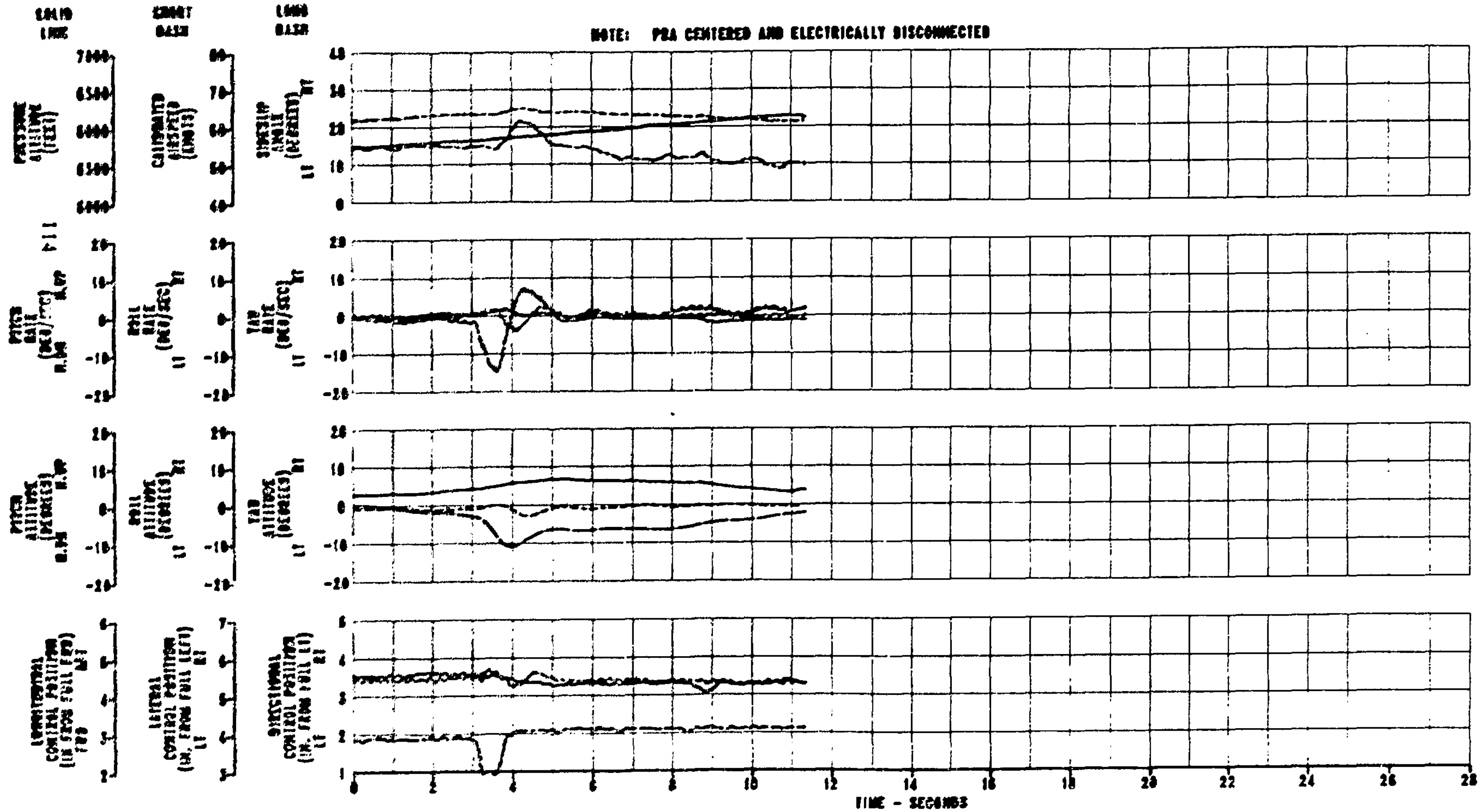


FIGURE E-76

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16570	357.7	0.2 LT	5740	7.0	257	82	ON	VOLCANO	IRP CLIMB

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

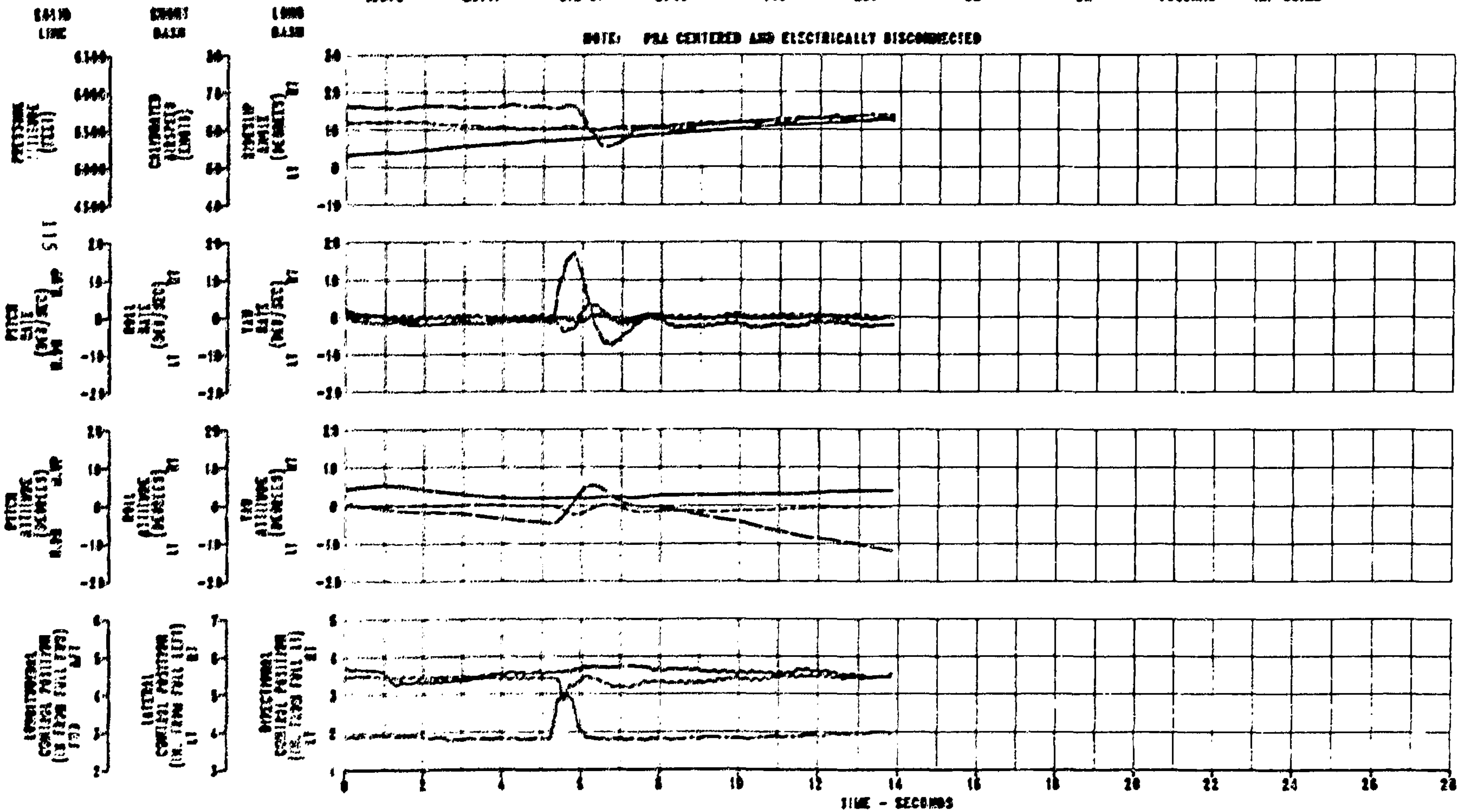


FIGURE C-77

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
15650	358.8	0.2 LT	4640	6.5	258	80	ON	VOLCANO	IRP CLIMB

NOTE: PWA CENTERED AND ELECTRICALLY DISCONNECTED

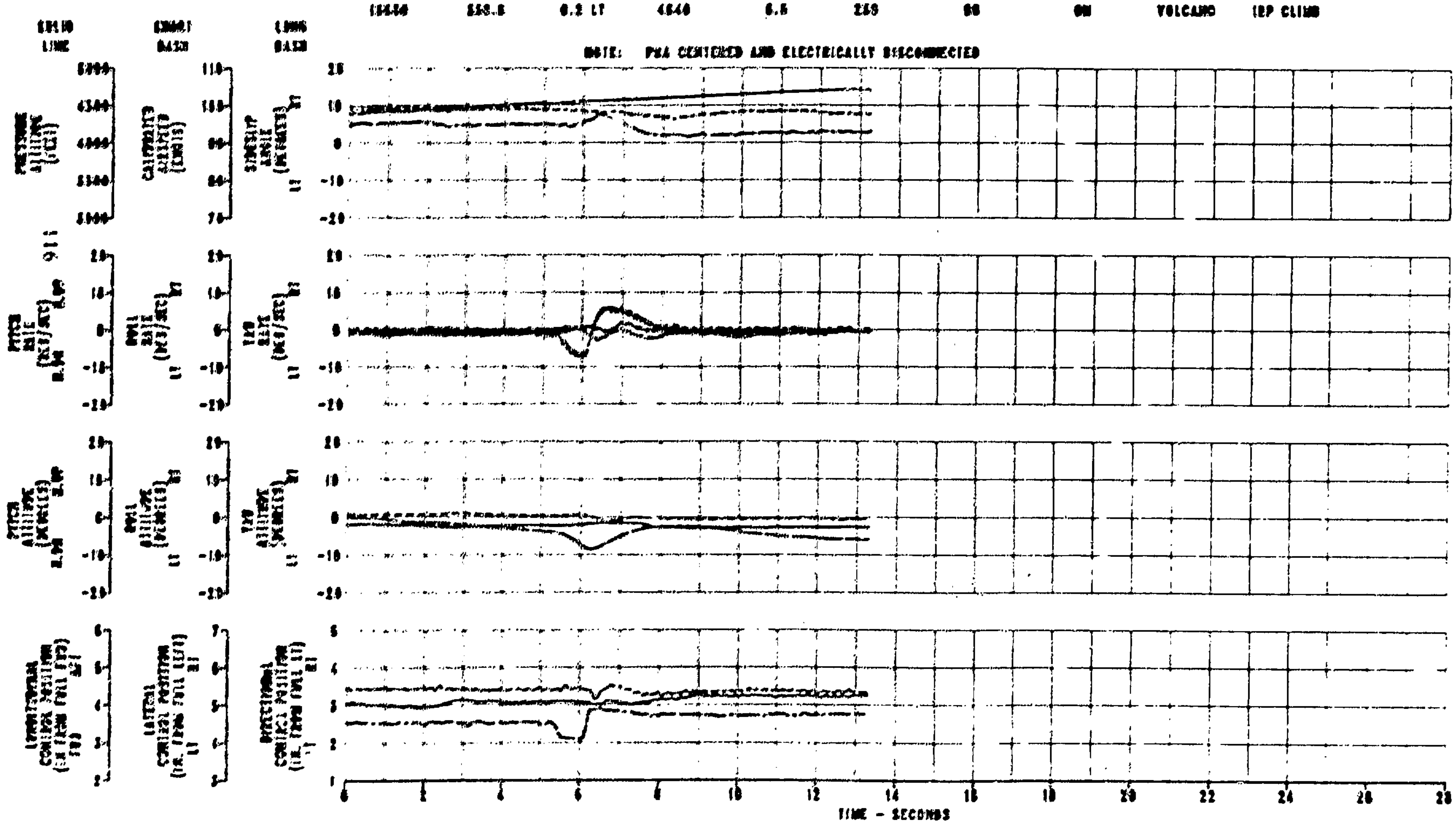


FIGURE E-78

DIRECTIONAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16610	356.8	0.2 LT	4530	7.0	259	97	ON	VOLCANO	IRP CLIMB

NOTE: PSA CENTERED AND ELECTRICALLY DISCONNECTED

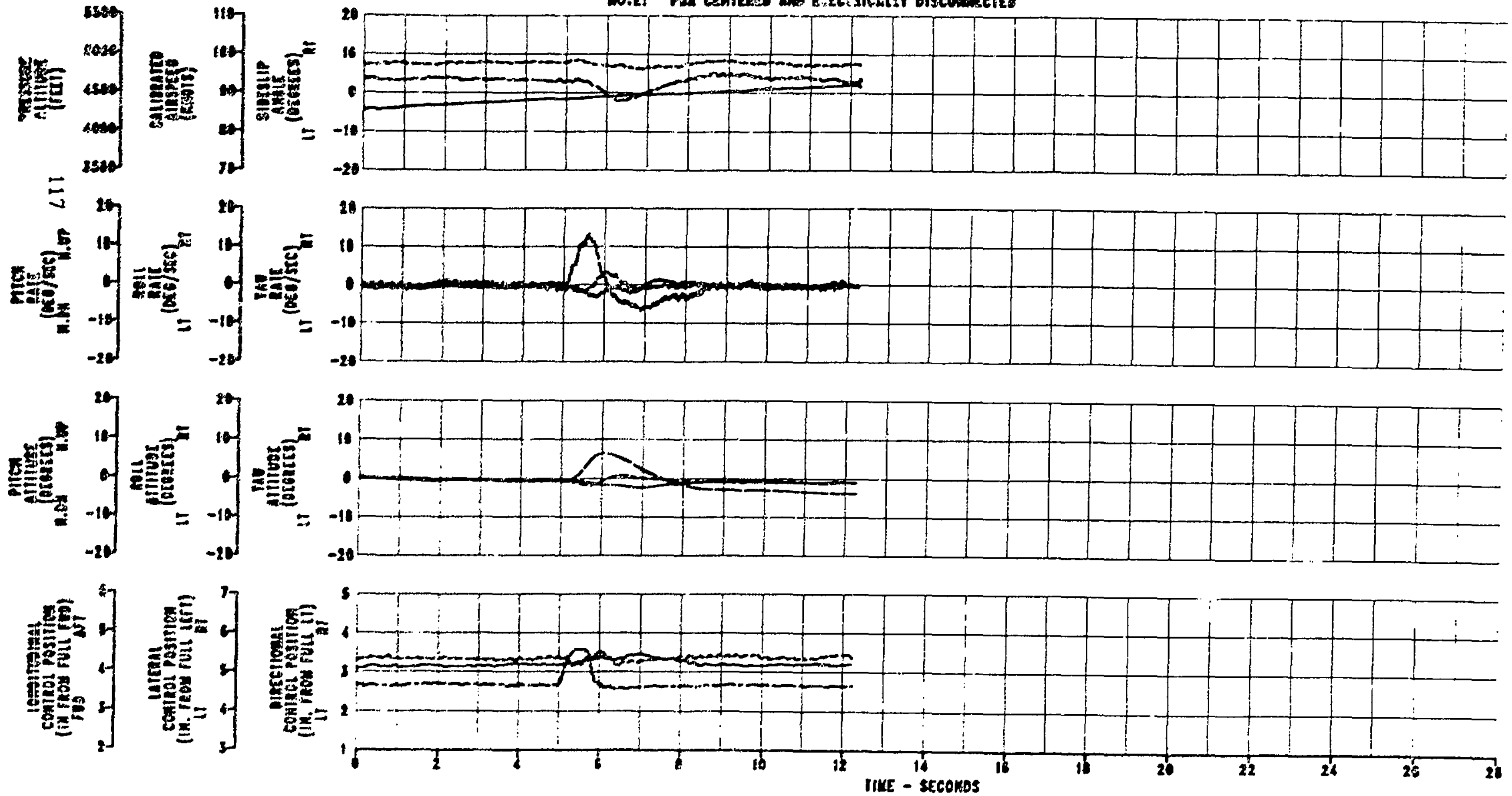


FIGURE E-79

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16580	358.5	0.2 LT	5010	7.0	258	80	ON	VOLCANO	AUTO DESCENT

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

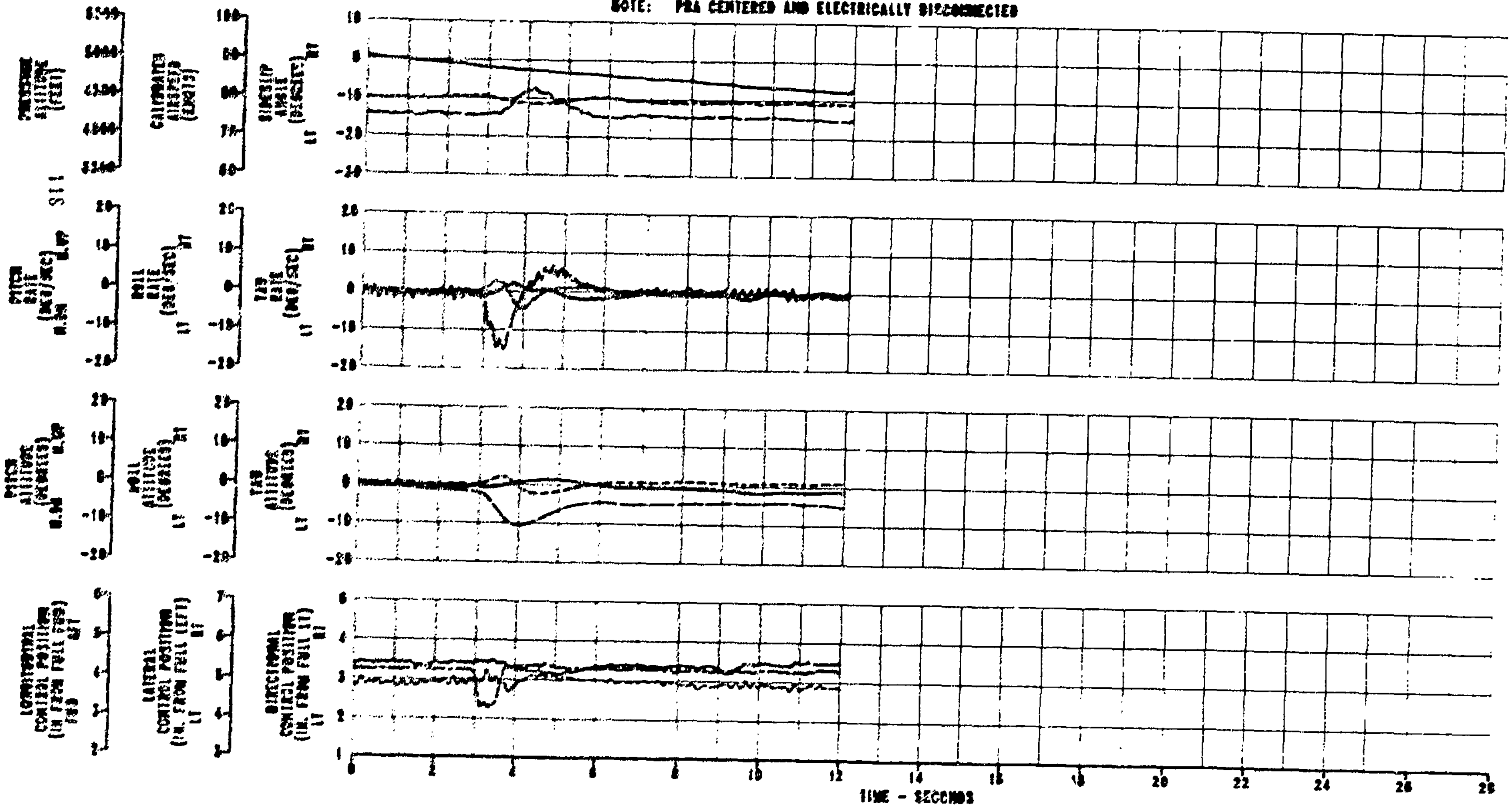


FIGURE C-80

DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
18540	358.3	0.2 LT	6420	5.5	259	81	ON	VOLCANO	AUTO DESCENT

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

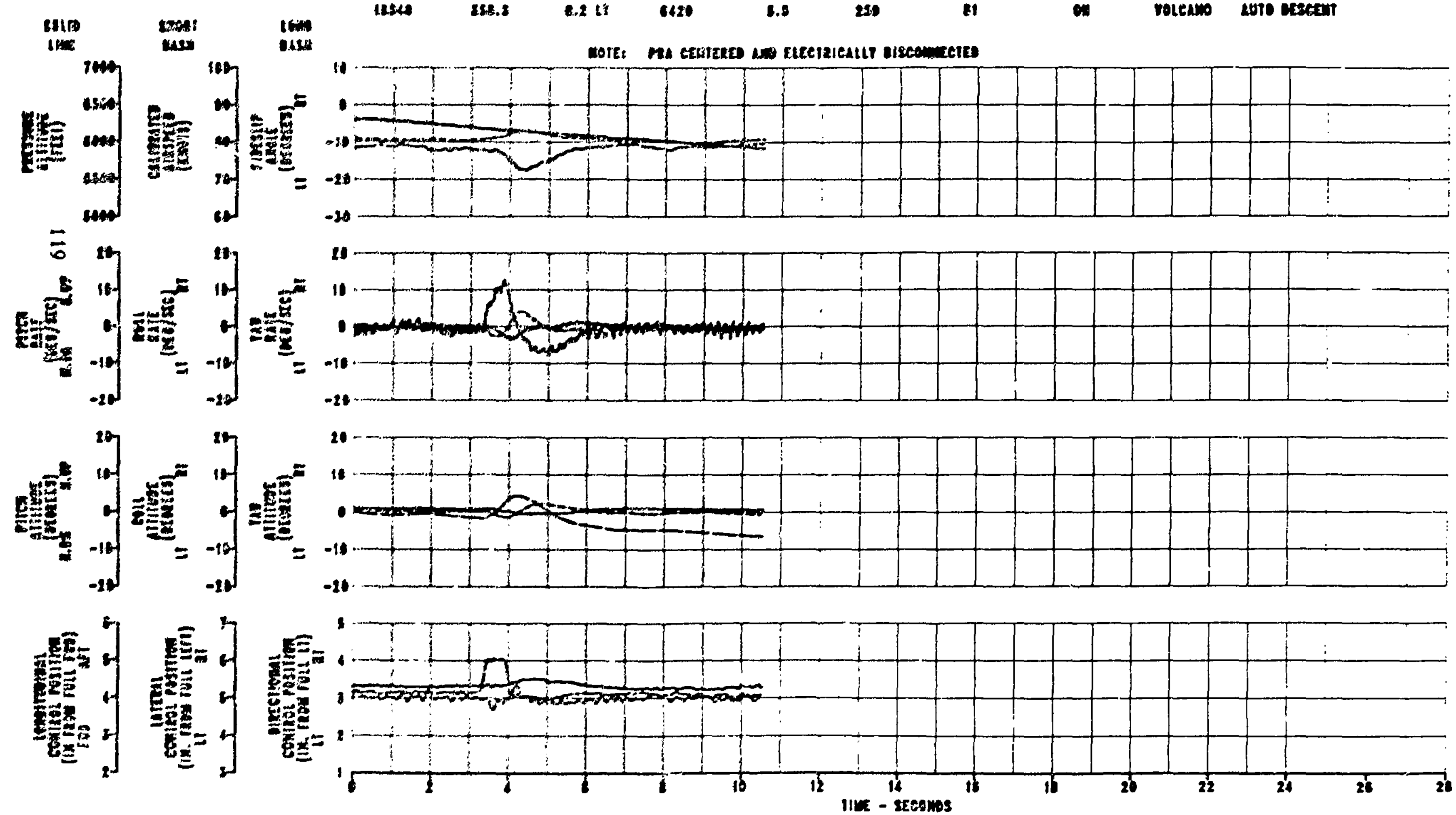


FIGURE E-81
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16640	359.9(AFT)	0.02(LT)	3650	25.0	258	0	HOVER

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

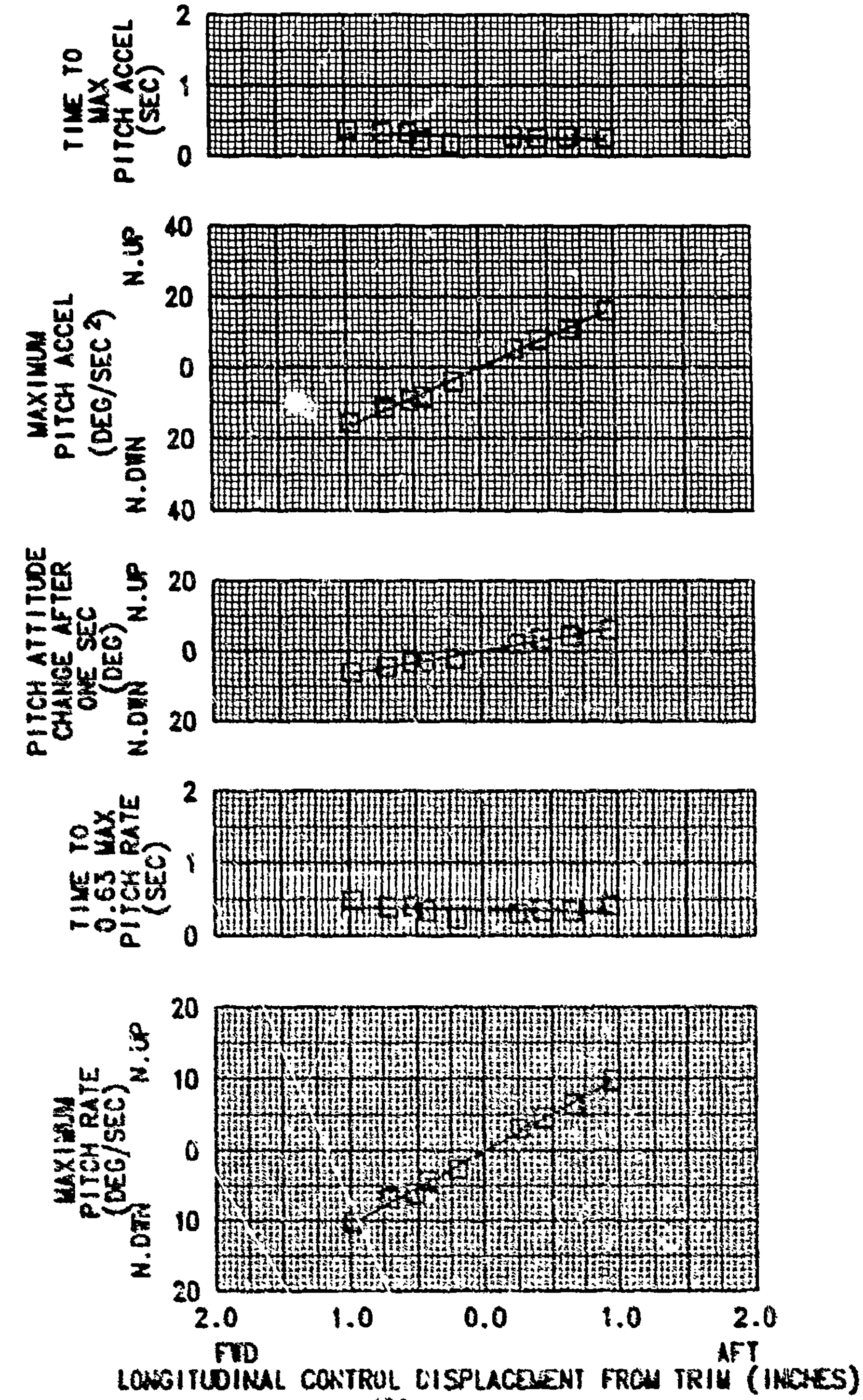


FIGURE E-82
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
19080	360.5 (AFT)	0.02(LT)	3930	26.0	259	0	HOVER

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

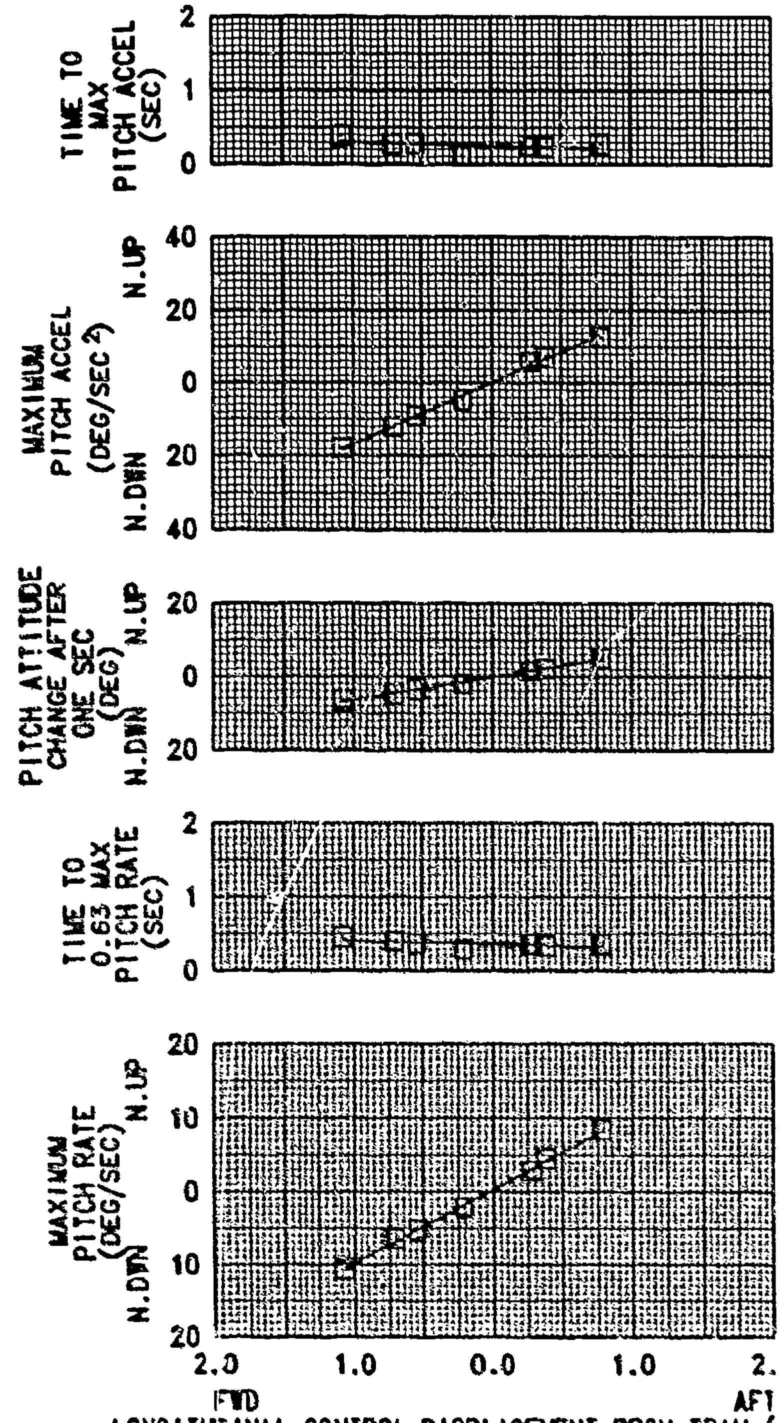


FIGURE E-83

LONGITUDINAL CONTROLLABILITY

UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16250	357.4 (MID)	0.02 (LT)	5700	18.0	259	40	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

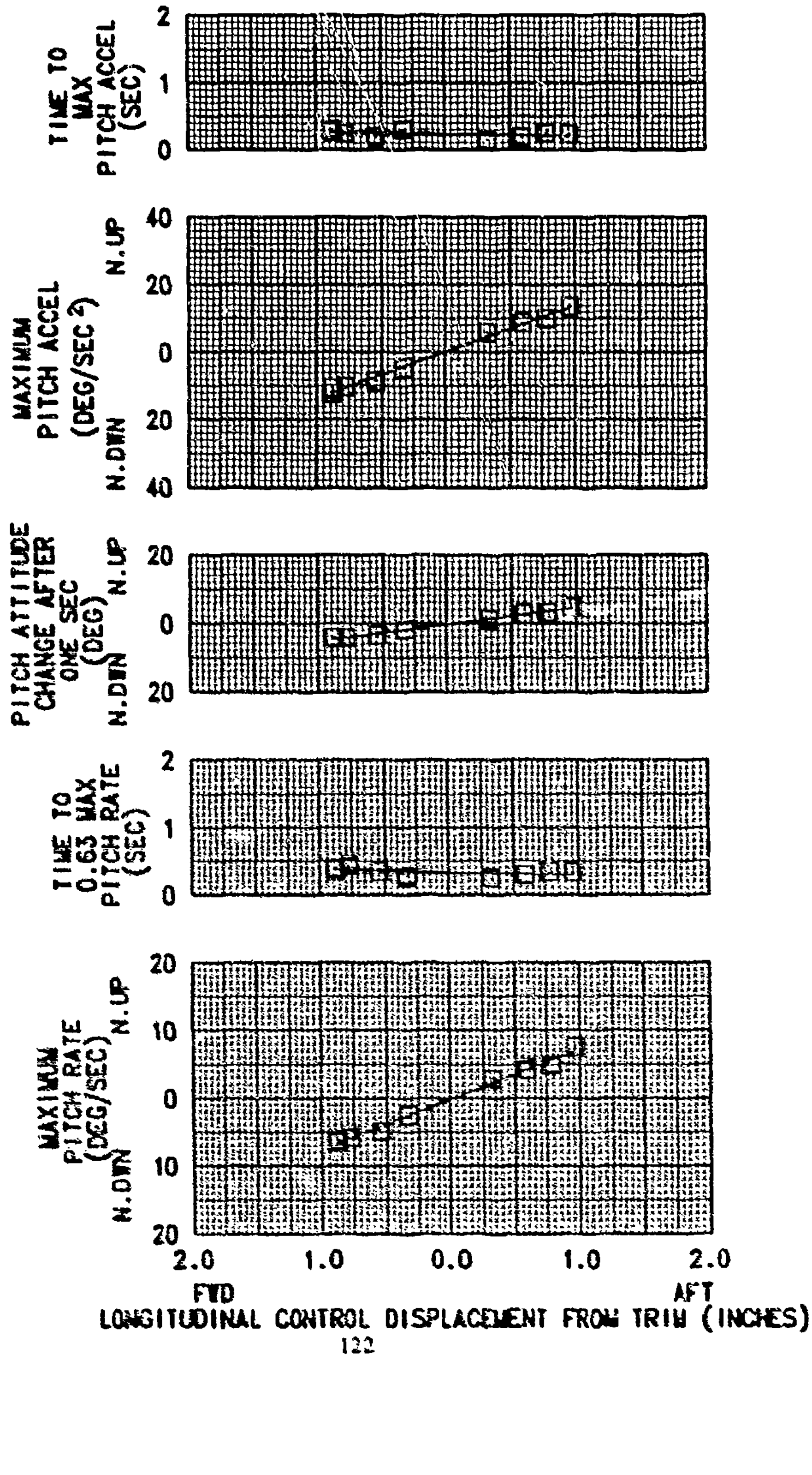


FIGURE E-84
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16790	359.5 (AFT)	0.02(LT)	5740	18.0	258	79	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

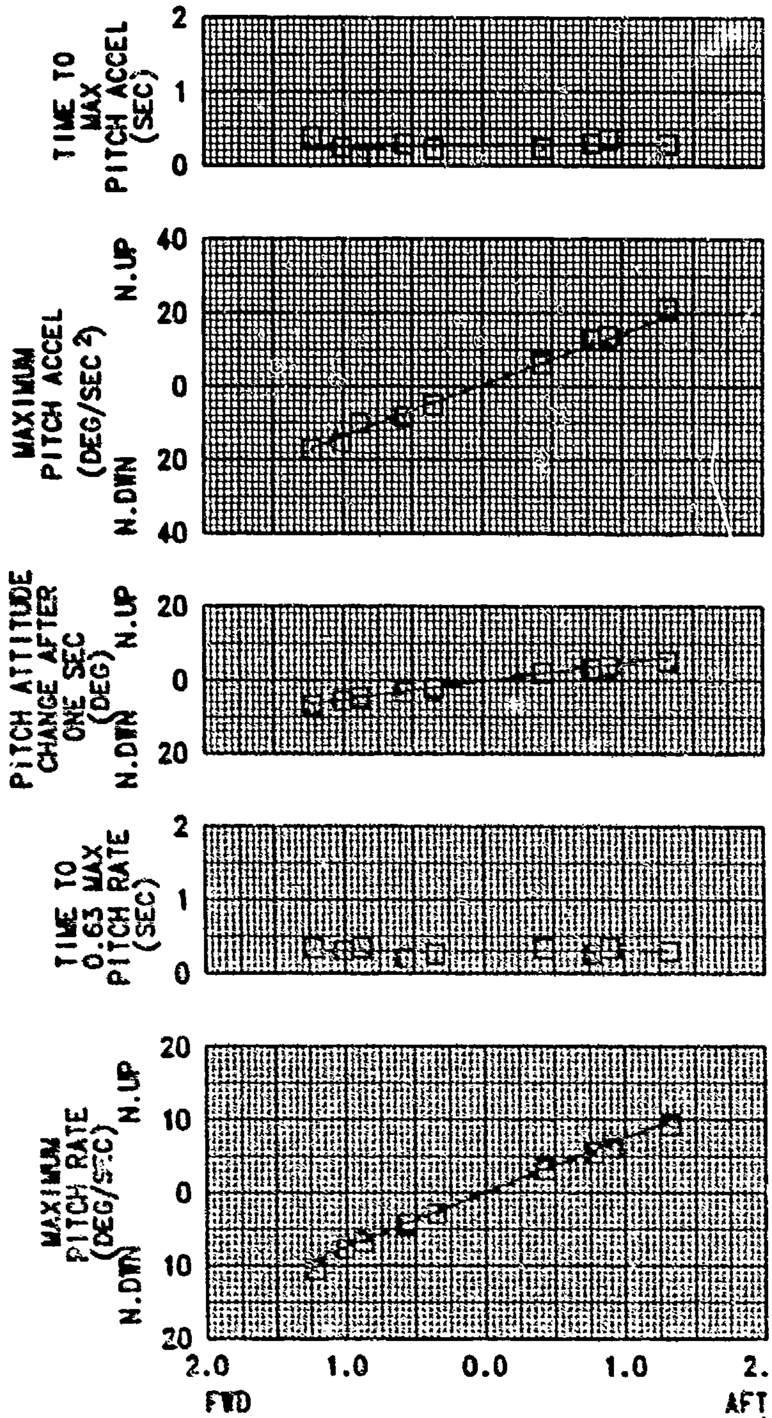


FIGURE E-85
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16670	358.6 (AFT)	0.02(LT)	5860	25.0	258	121	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

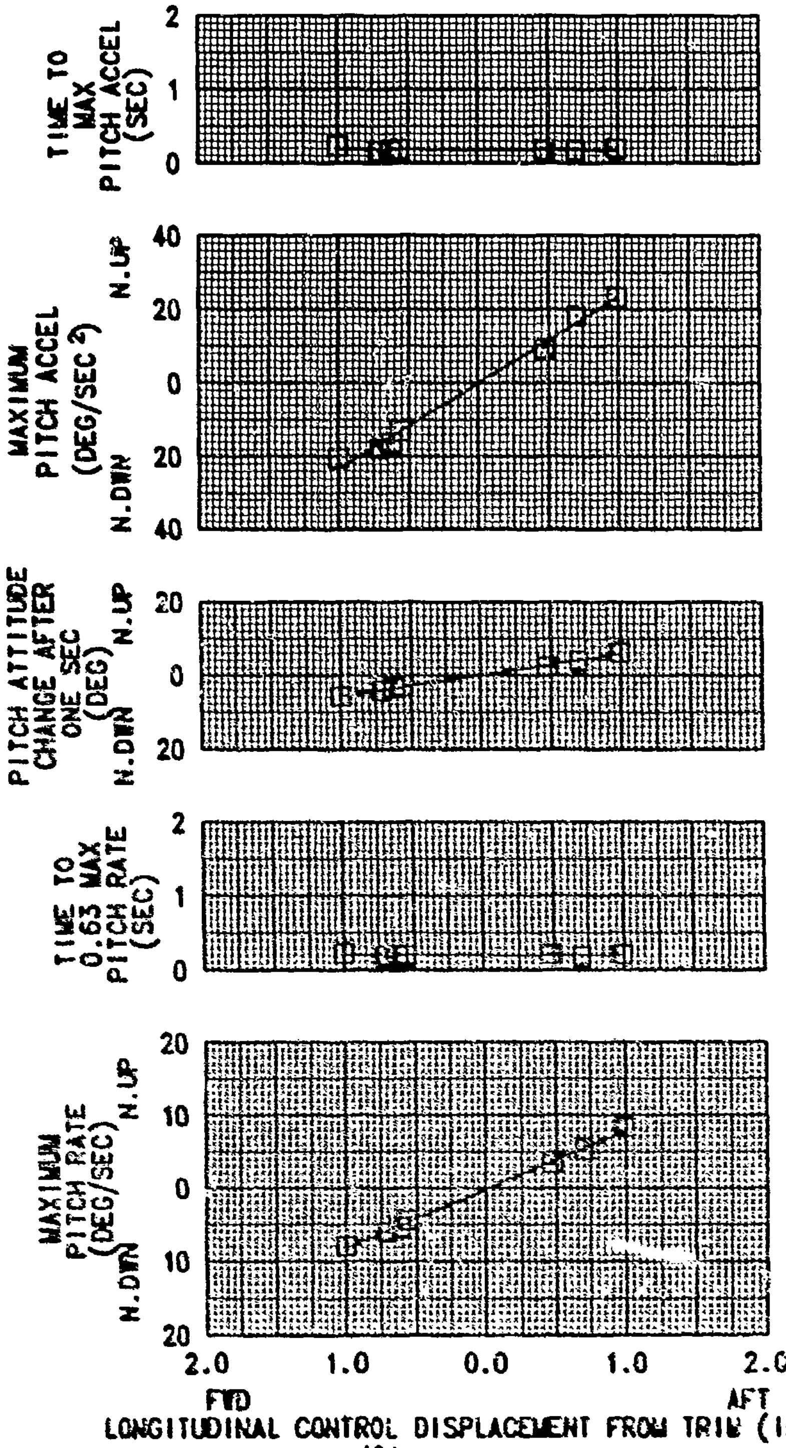


FIGURE E-86
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20370	359.9 (AFT)	0.02(LT)	5580	16.5	258	42	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

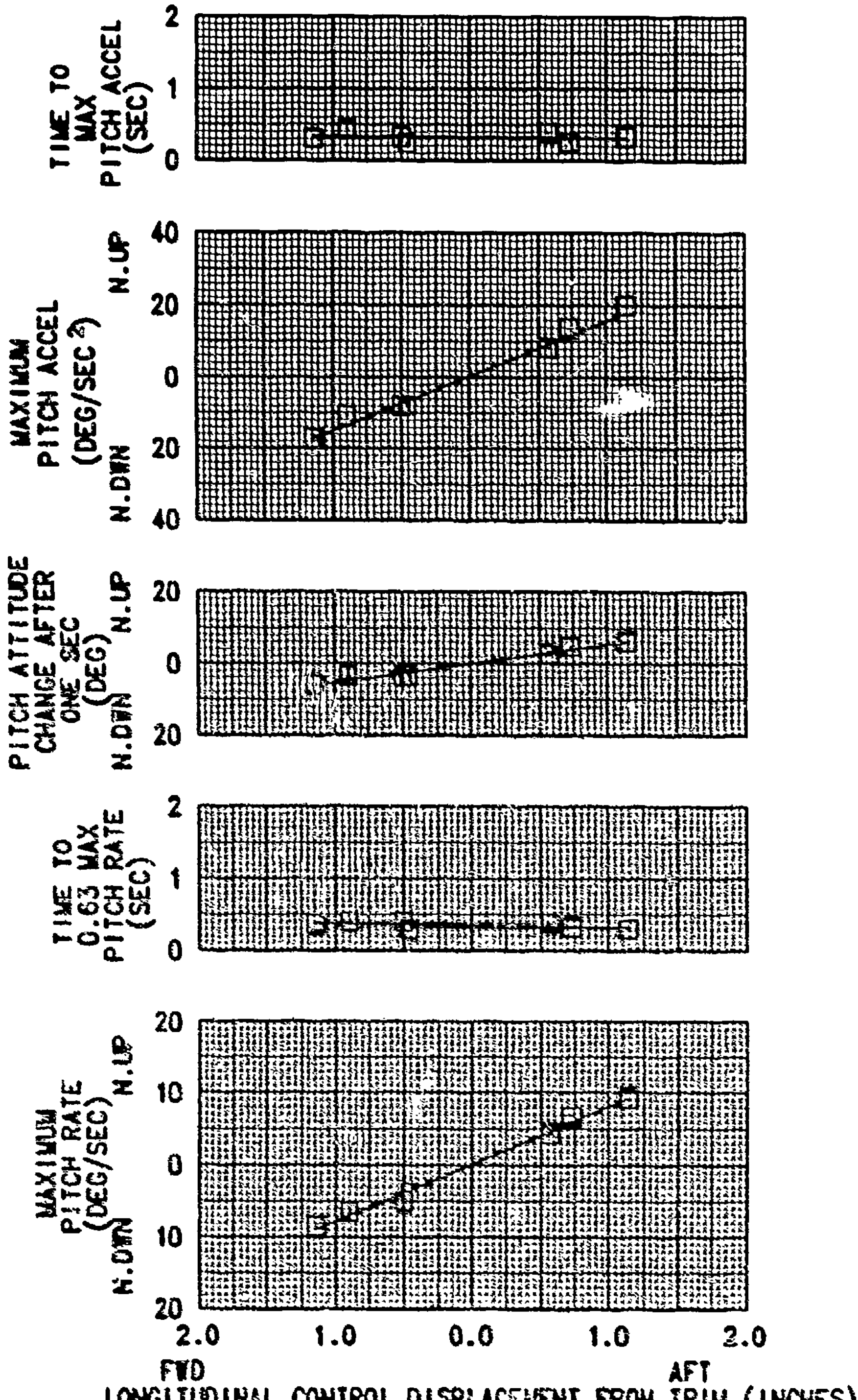


FIGURE E-87
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20780	360.5 (AFT)	0.02(LT)	5810	25.2	260	79	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

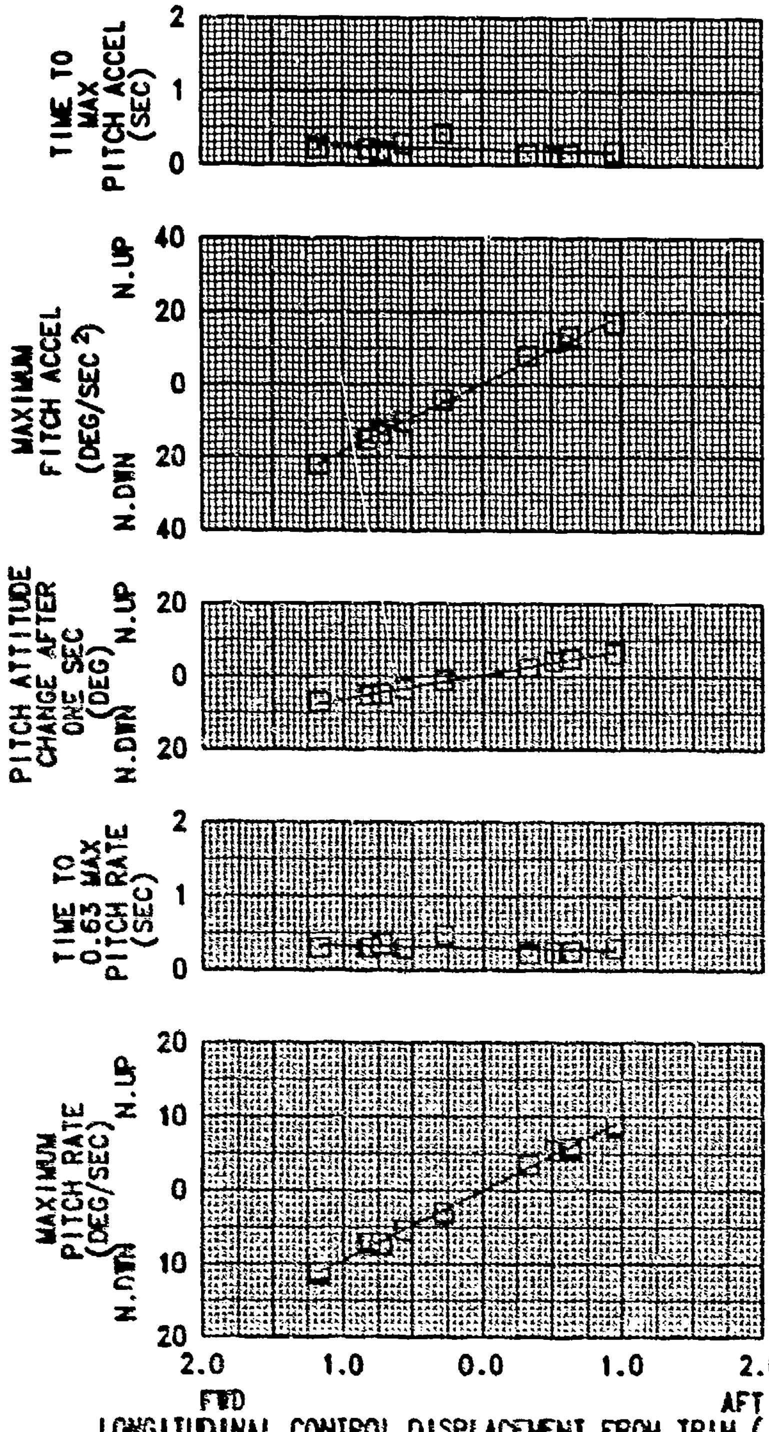


FIGURE E-88
LONGITUDINAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20670	360.7 (AFT)	0.02(LT)	3870	25.5	259	116	LEVEL

NOTE:
1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

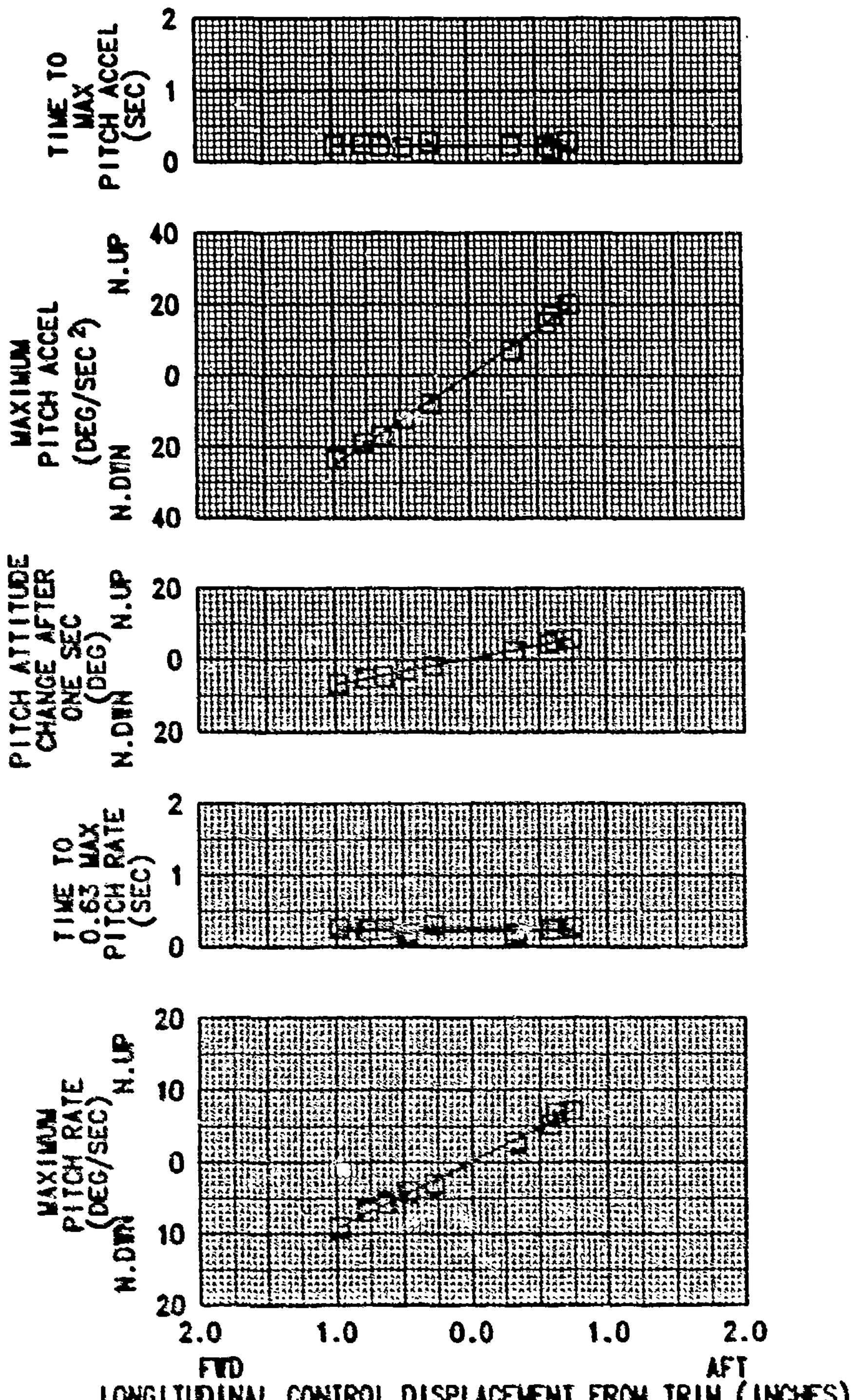


FIGURE E-89
LATERAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
18840	359.7 (AFT)	0.02(LT)	4002	26.5	259	0	HOVER

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

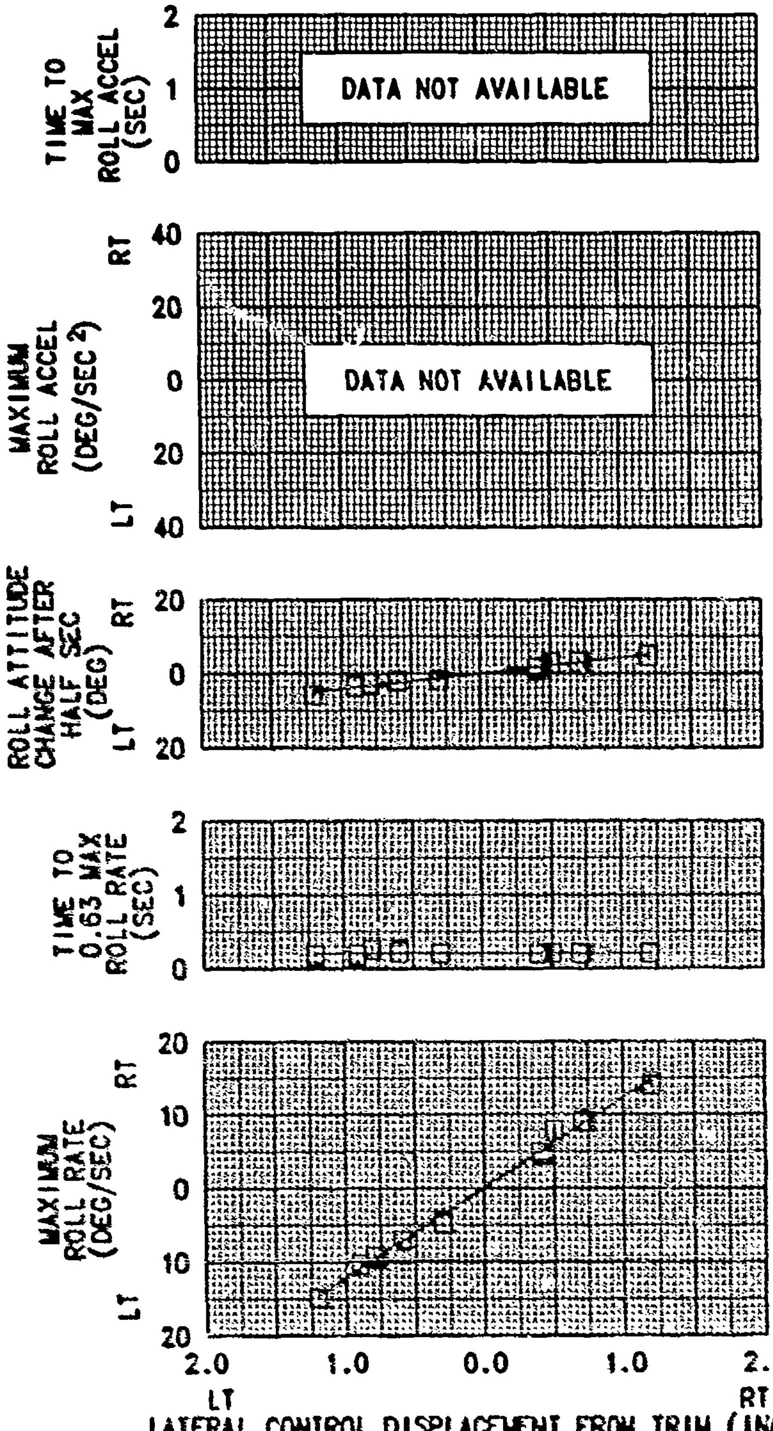


FIGURE E-90

LATERAL CONTROLLABILITY

UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20650	360.7 (AFT)	0.02(LT)	5850	17.0	258	38	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

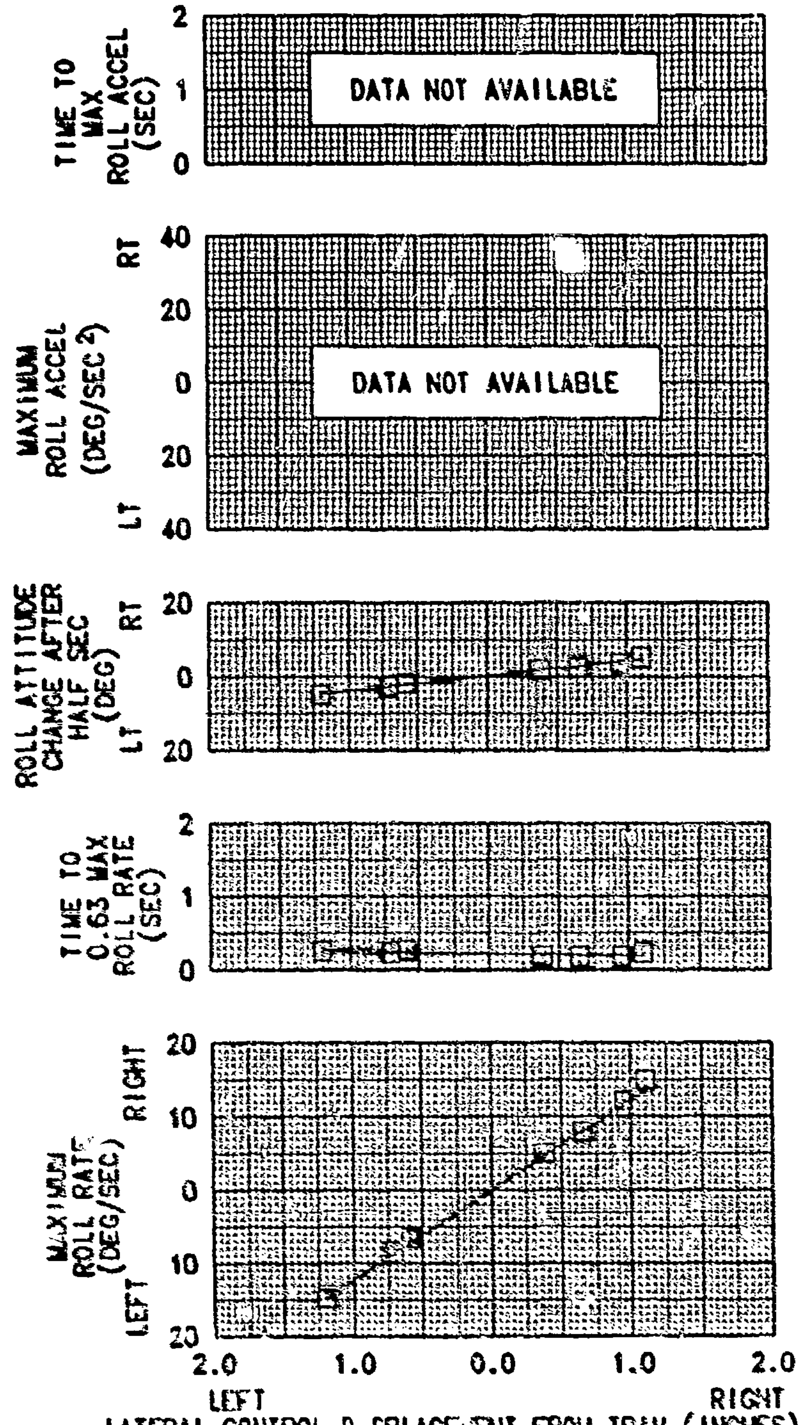


FIGURE E-91
LATERAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20650	360.1 (AFT)	0.02(LT)	5830	25.0	259	78	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

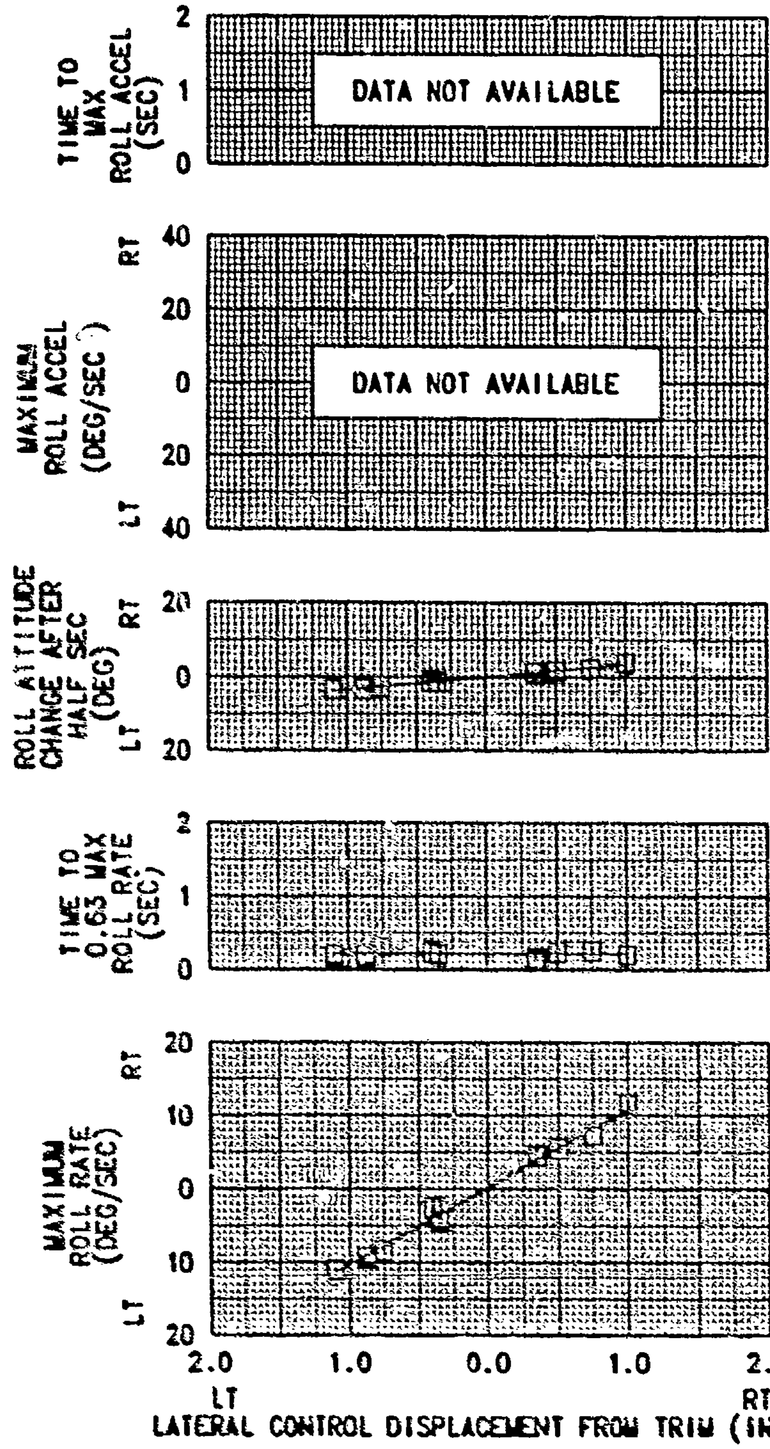


FIGURE E-92
LATERAL CONTROLLABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG CAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	FLIGHT CONDITION
20280	359.1 (AFT)	0.02(LT)	3870	25.5	256	109	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

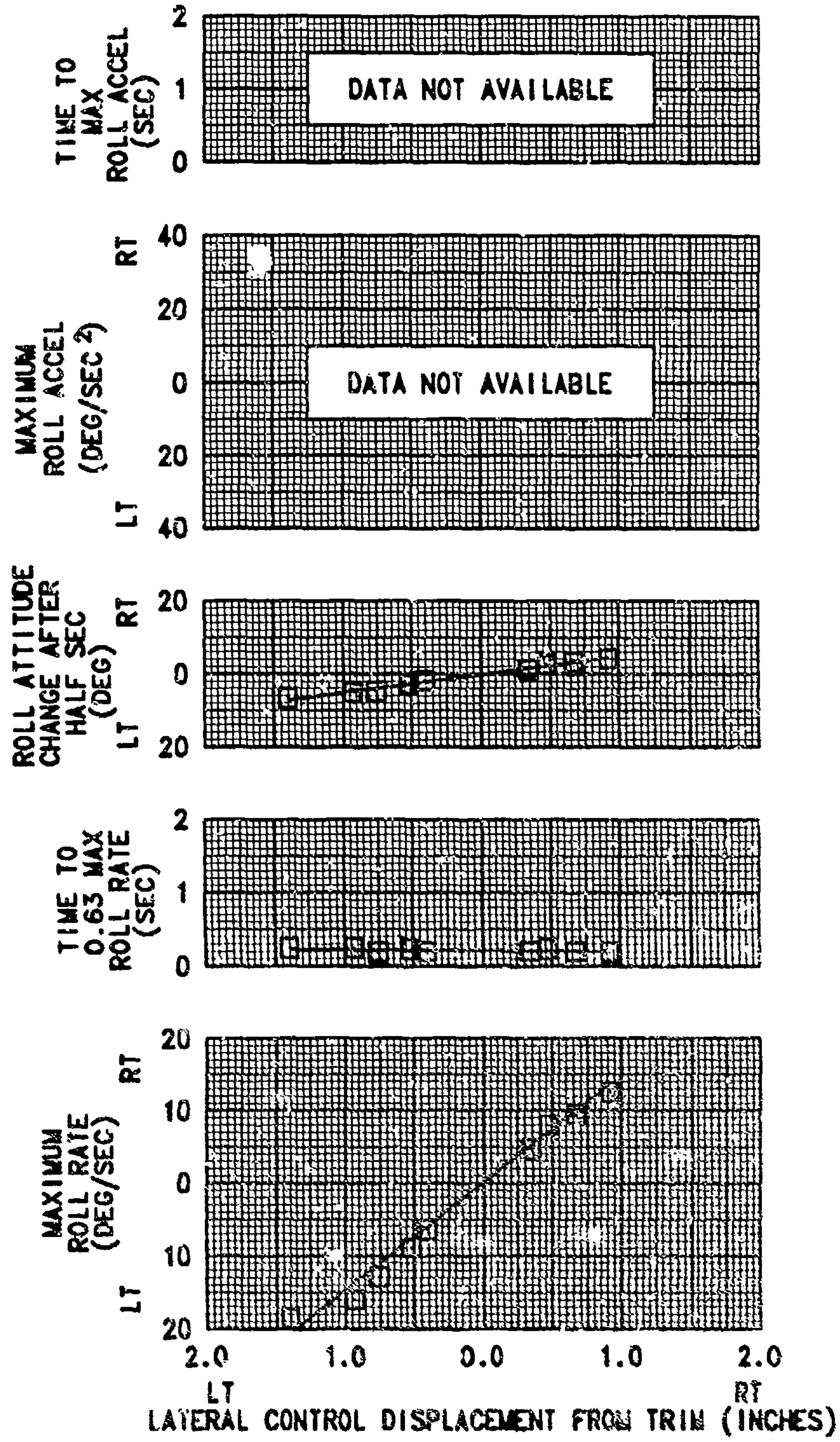


FIGURE E-93
DIRECTIONAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16320	358.7 (AFT)	0.02(LT)	3800	26.0	258	0	HOVER

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

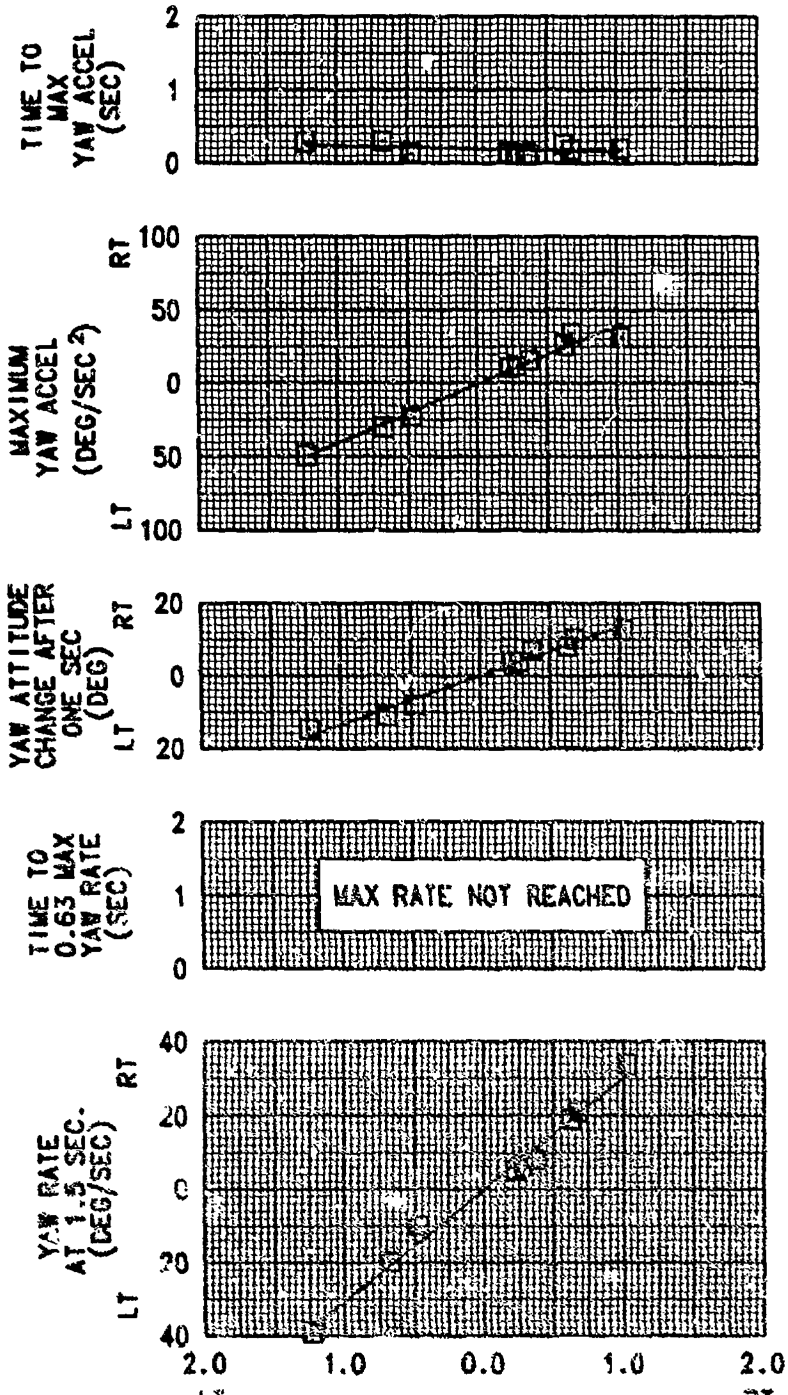


FIGURE E-94
DIRECTIONAL CONTROLLABILITY
UH-60A USA S/N 82-23743

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)	FLIGHT CONDITION
18650	359.1 (AFT)	0.02(LT)	4010	27.0	259	0	HOVER

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

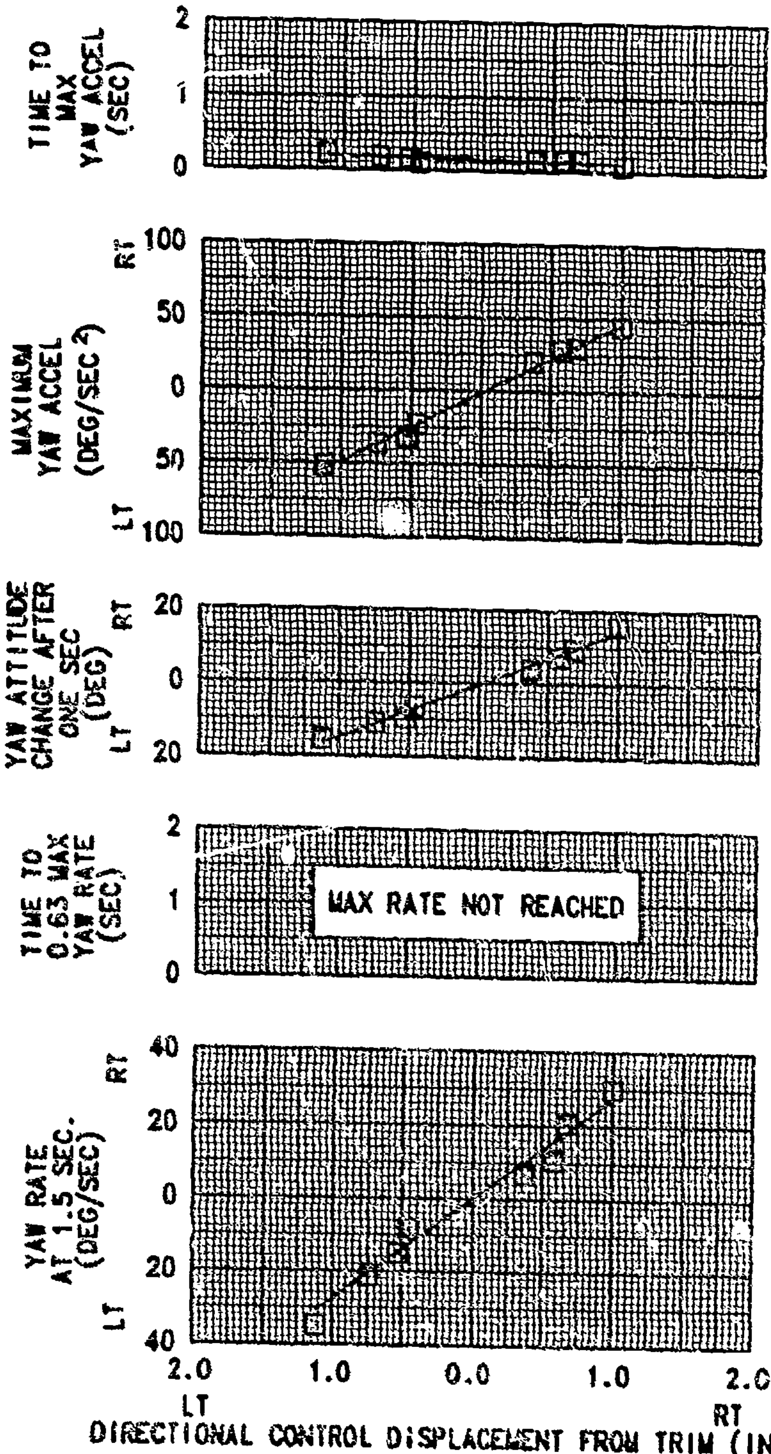


FIGURE E-95

DIRECTIONAL CONTROLLABILITY

UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16260	357.4 (MID)	0.02(LT)	5650	18.0	259	75	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

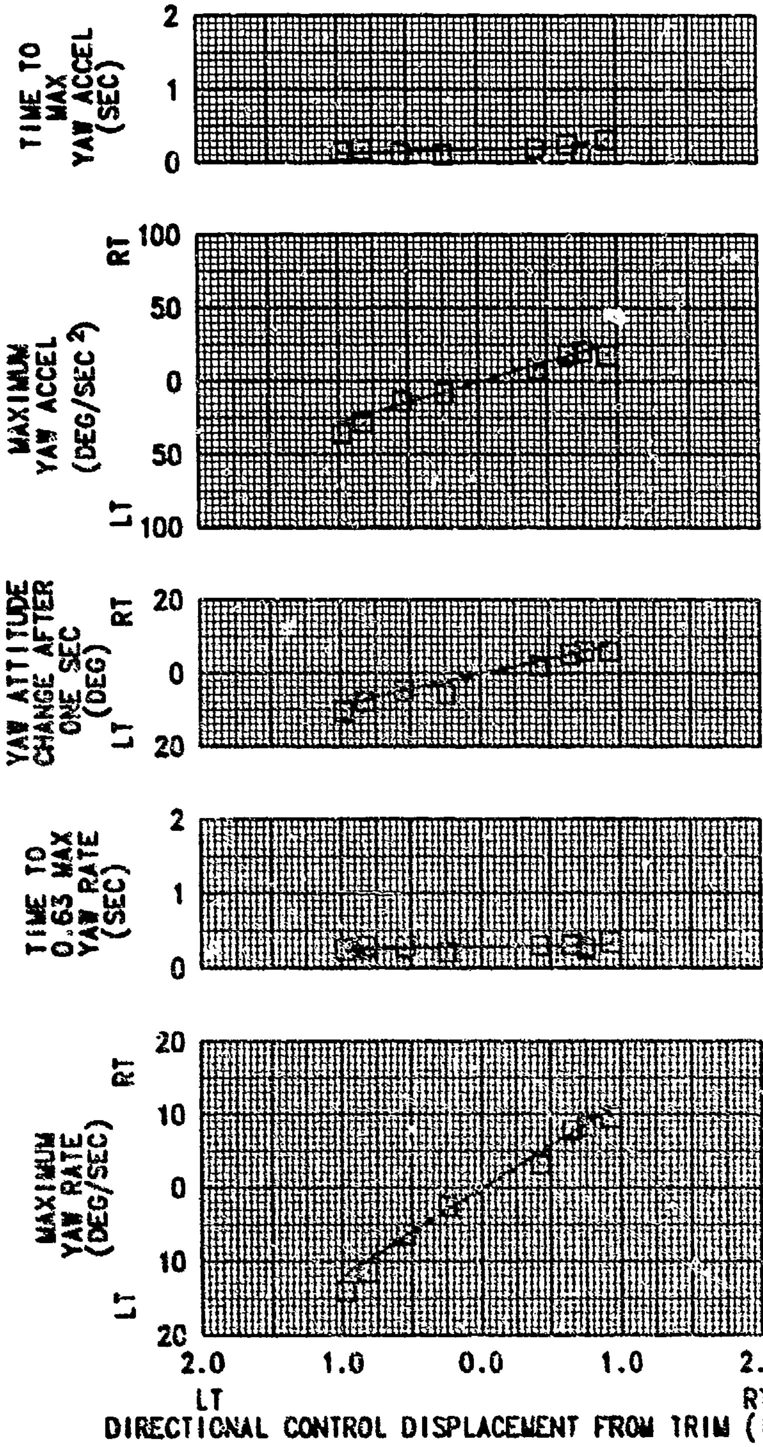


FIGURE E-96

DIRECTIONAL CONTROLLABILITY

UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
16110	356.4 (MID)	0.02(LT)	5790	25.5	257	122	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

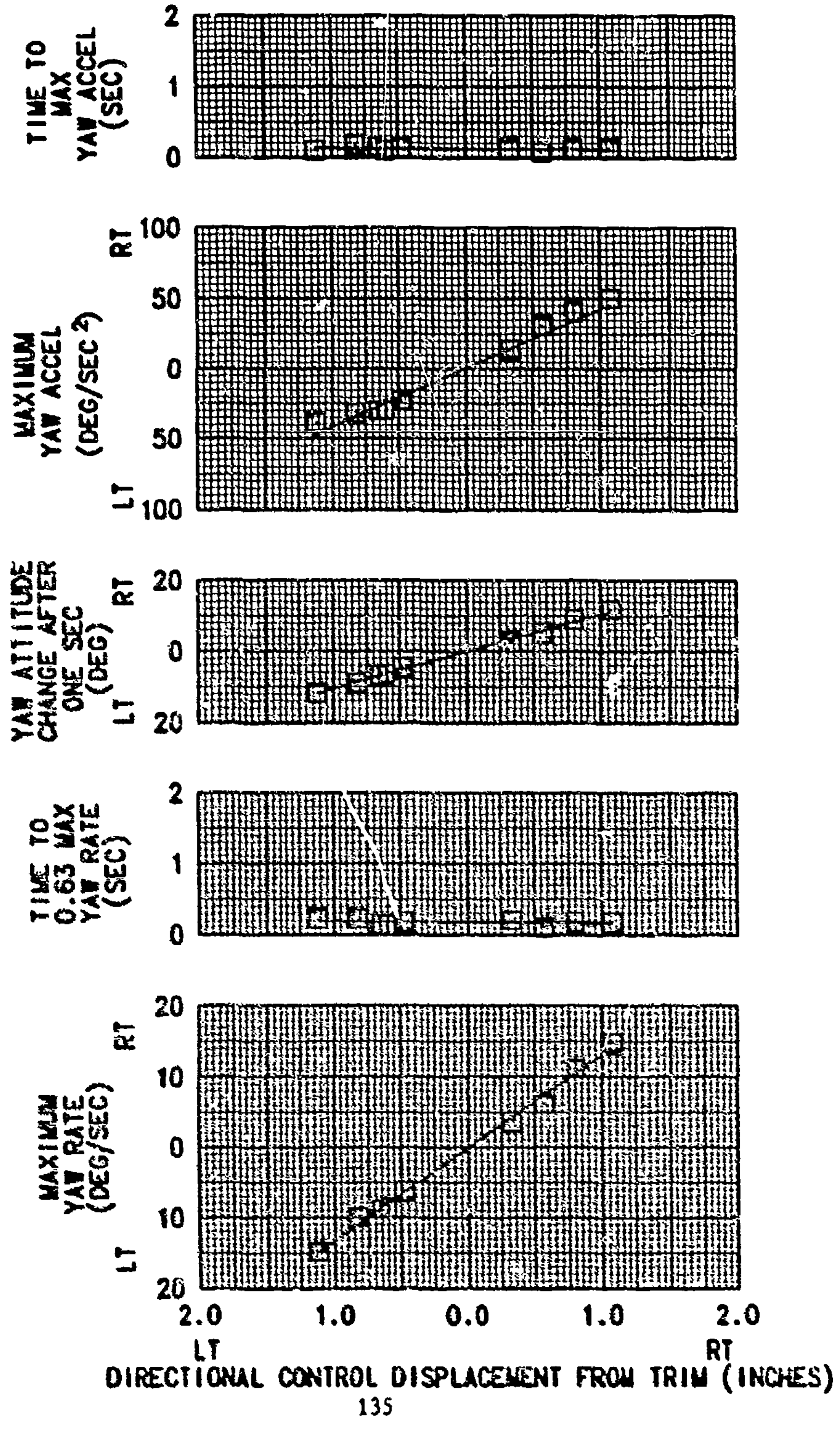


FIGURE E-97
DIRECTIONAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20120	359.1 (AFT)	0.02 (LT)	5950	16.5	259	38	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

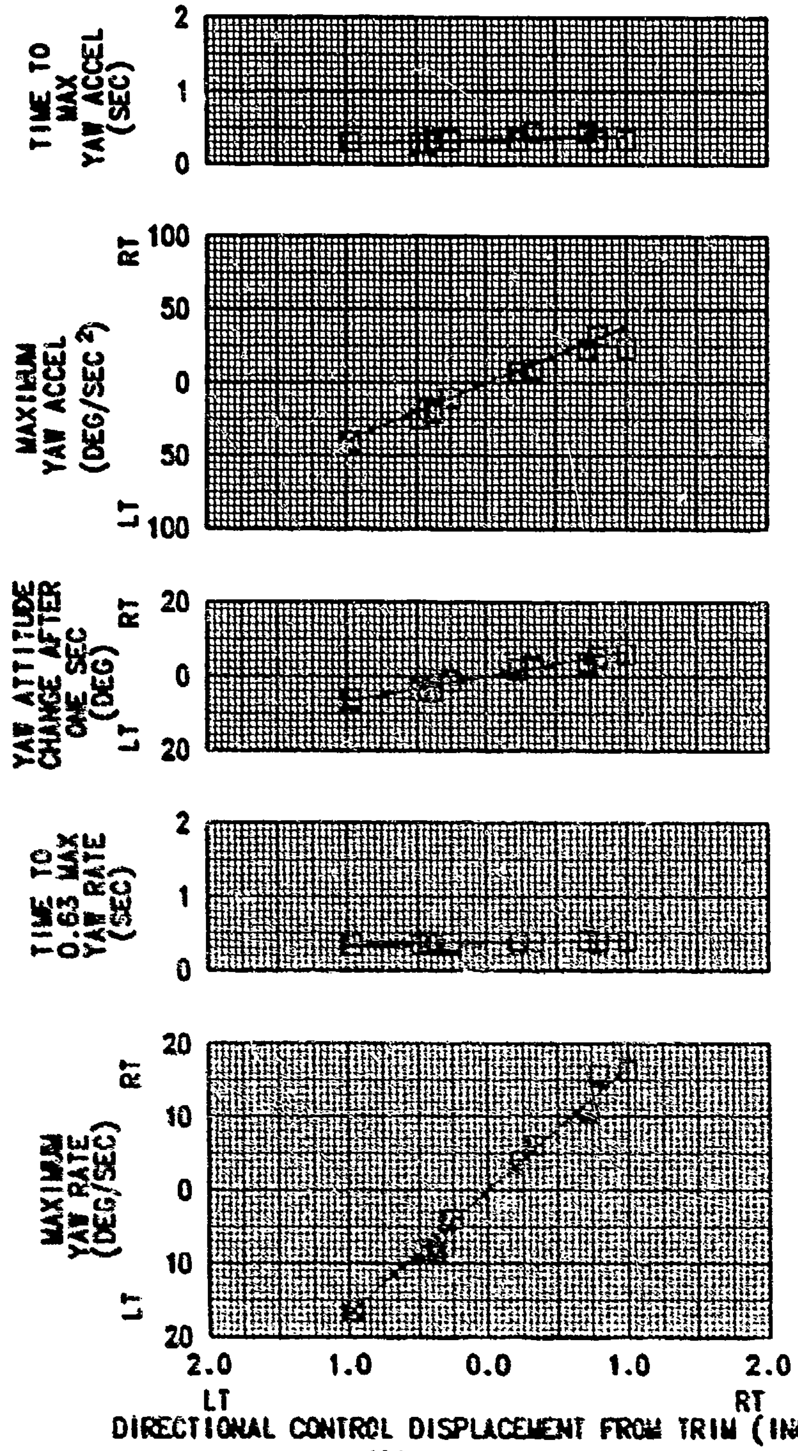


FIGURE E-98
DIRECTIONAL CONTROLLABILITY
UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
20540	360.1 (AFT)	0.02(LT)	5830	25.0	259	78	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

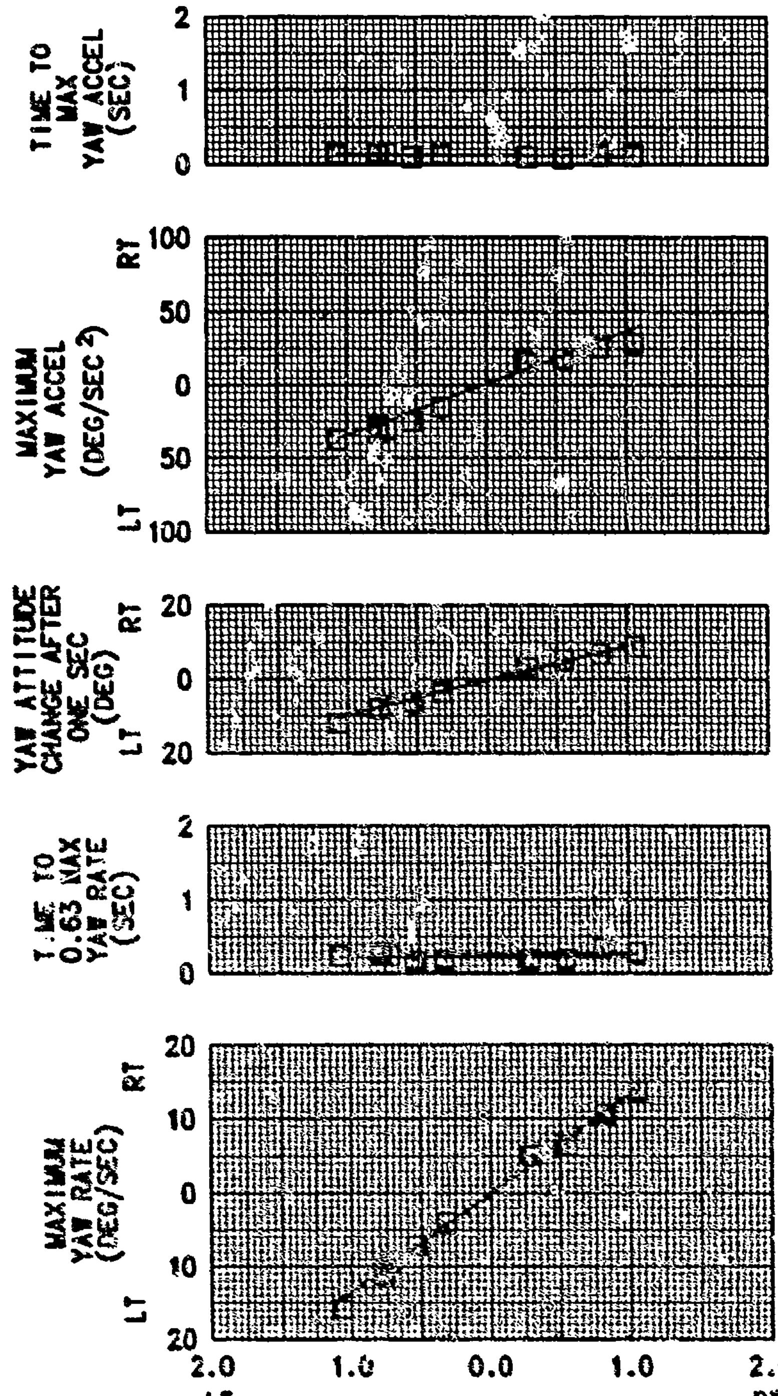


FIGURE E-69

DIRECTIONAL CONTROLLABILITY

UH-60A USA S/N 82-23748

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)	FLIGHT CONDITION
19920	358.4 (AFT)	0.02(LT)	3870	25.5	256	116	LEVEL

NOTE: 1. VOLCANO CONFIGURATION
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AFCS ON

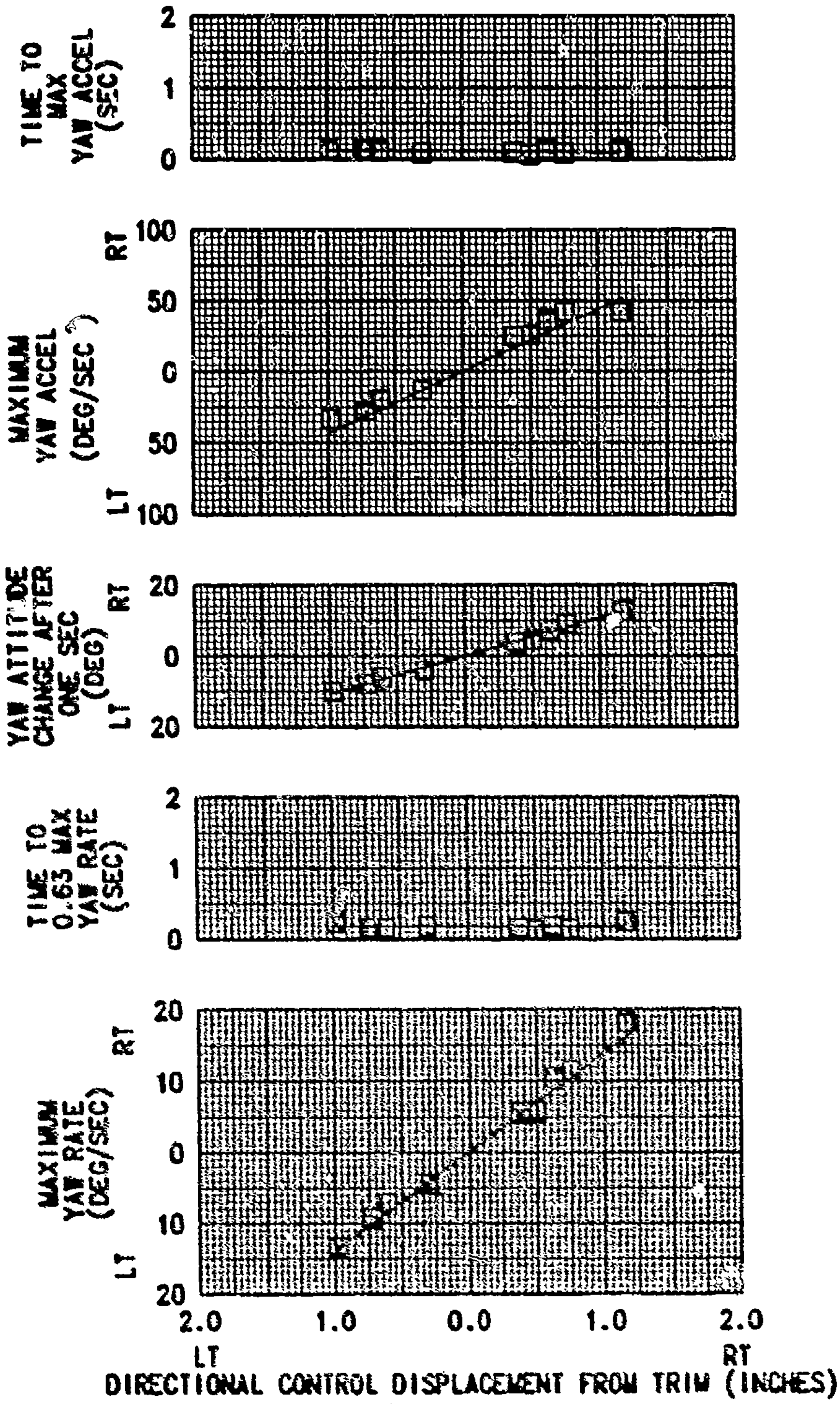


FIGURE E-100

LOW SPEED FORWARD AND REARWARD FLIGHT CHARACTERISTICS

UH-60A USA S/N 82-23748

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 WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
16740	358.4	0.2 LT	2880	17.6	258	20	VOLCANO

NOTE 1: VERTICAL LINES DENOTE CONTROL EXCURSIONS
2: PBA CENTERED AND ELECTRICALLY DISCONNECTED

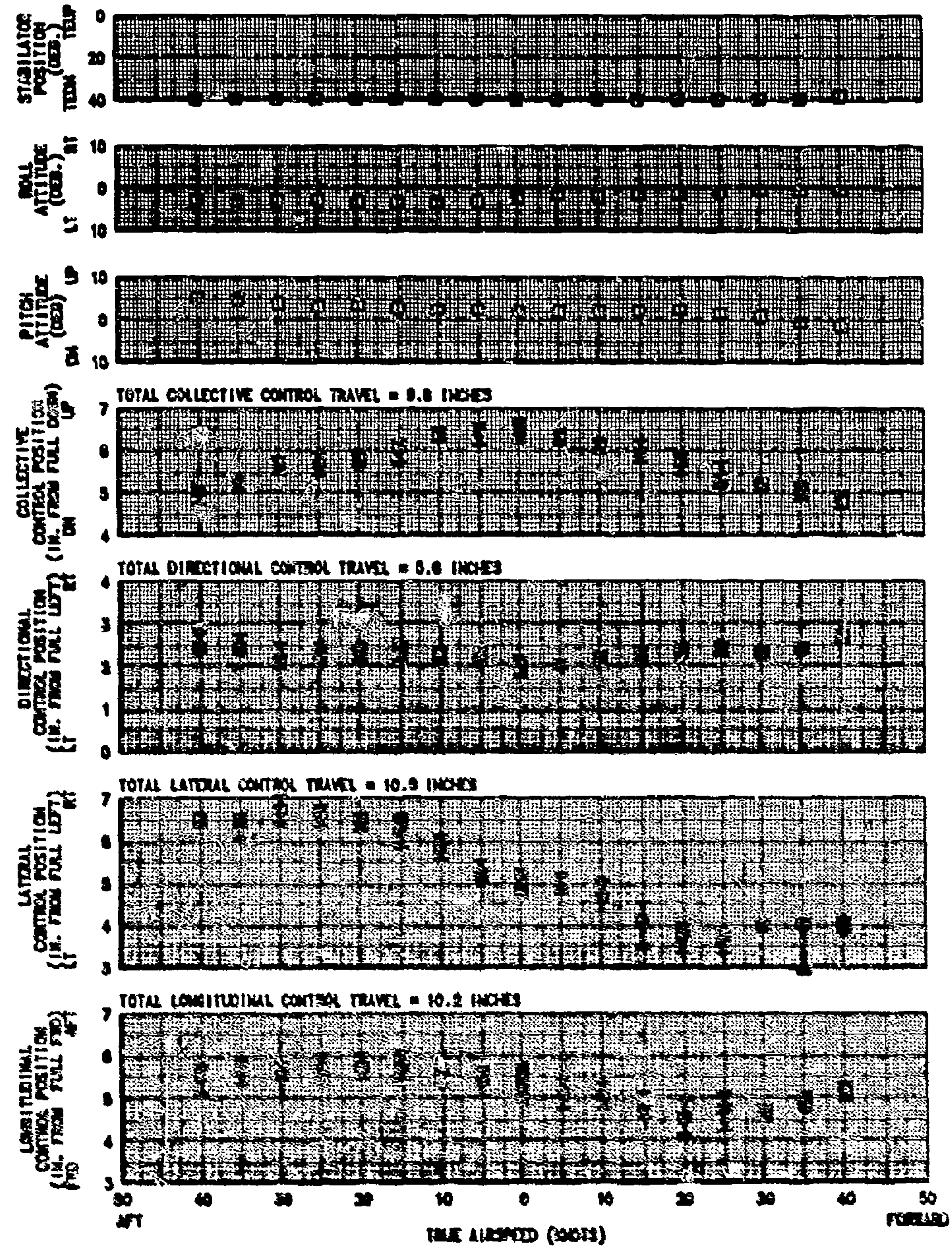


FIGURE E-101

LOW SPEED LEFT AND RIGHT FLIGHT CHARACTERISTICS

UH-60A USA S/N 82-23748

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 WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
16200	363.6	0.2 LT	3000	18.5	258	20	VOLCANO

NOTE 1: VERTICAL LINES DENOTE CONTROL EXCURSIONS
2: PBA CENTERED AND ELECTRICALLY DISCONNECTED

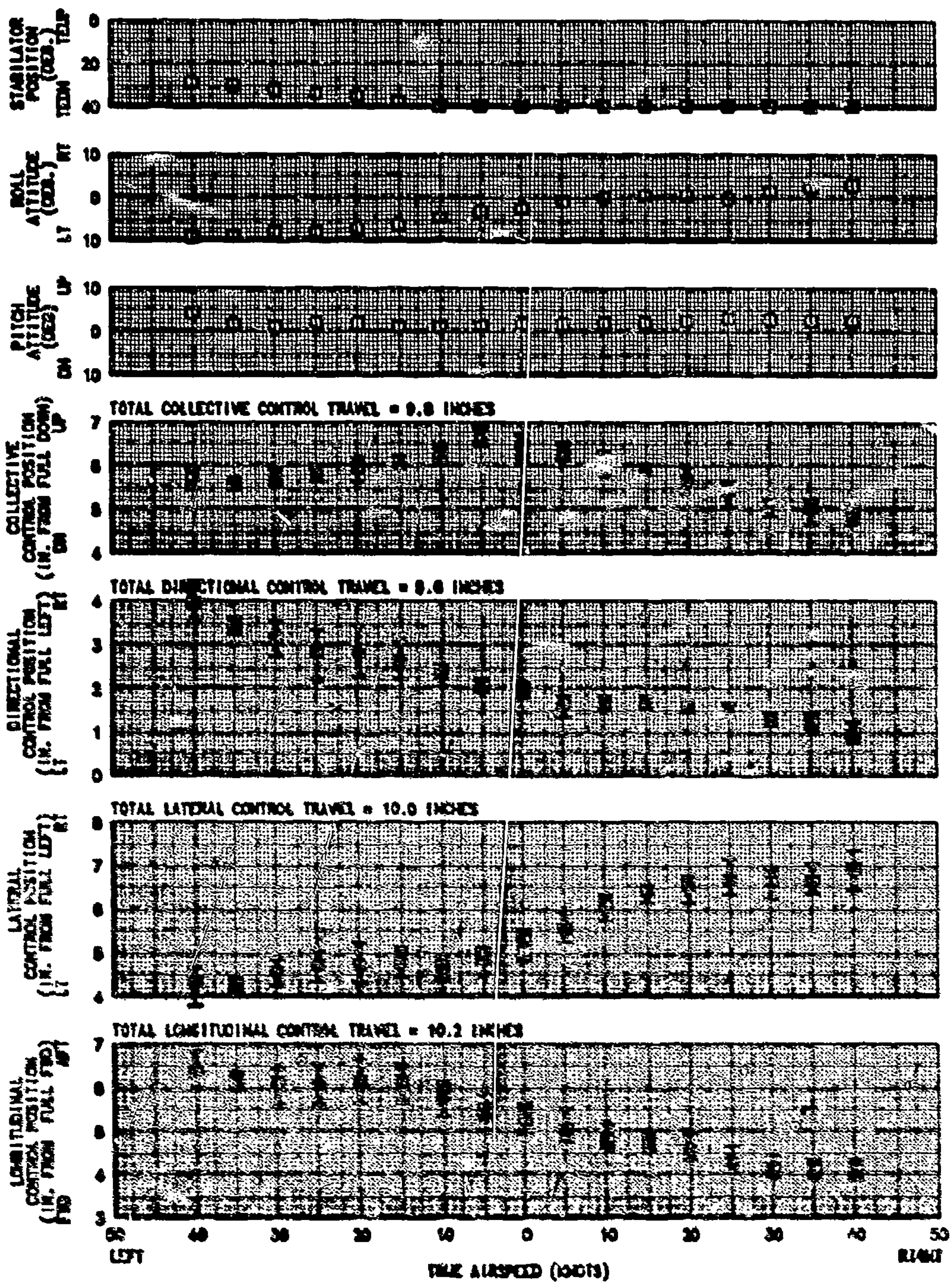


FIGURE E-102

LOW SPEED FORWARD AND REARWARD FLIGHT CHARACTERISTICS

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
16180	354.0	0.2 LT	10610	-8.0	258	20	VOLCANO

NOTE 1: VERTICAL LINES DENOTE CONTROL EXCURSIONS
2: PBA CENTERED AND ELECTRICALLY DISCONNECTED

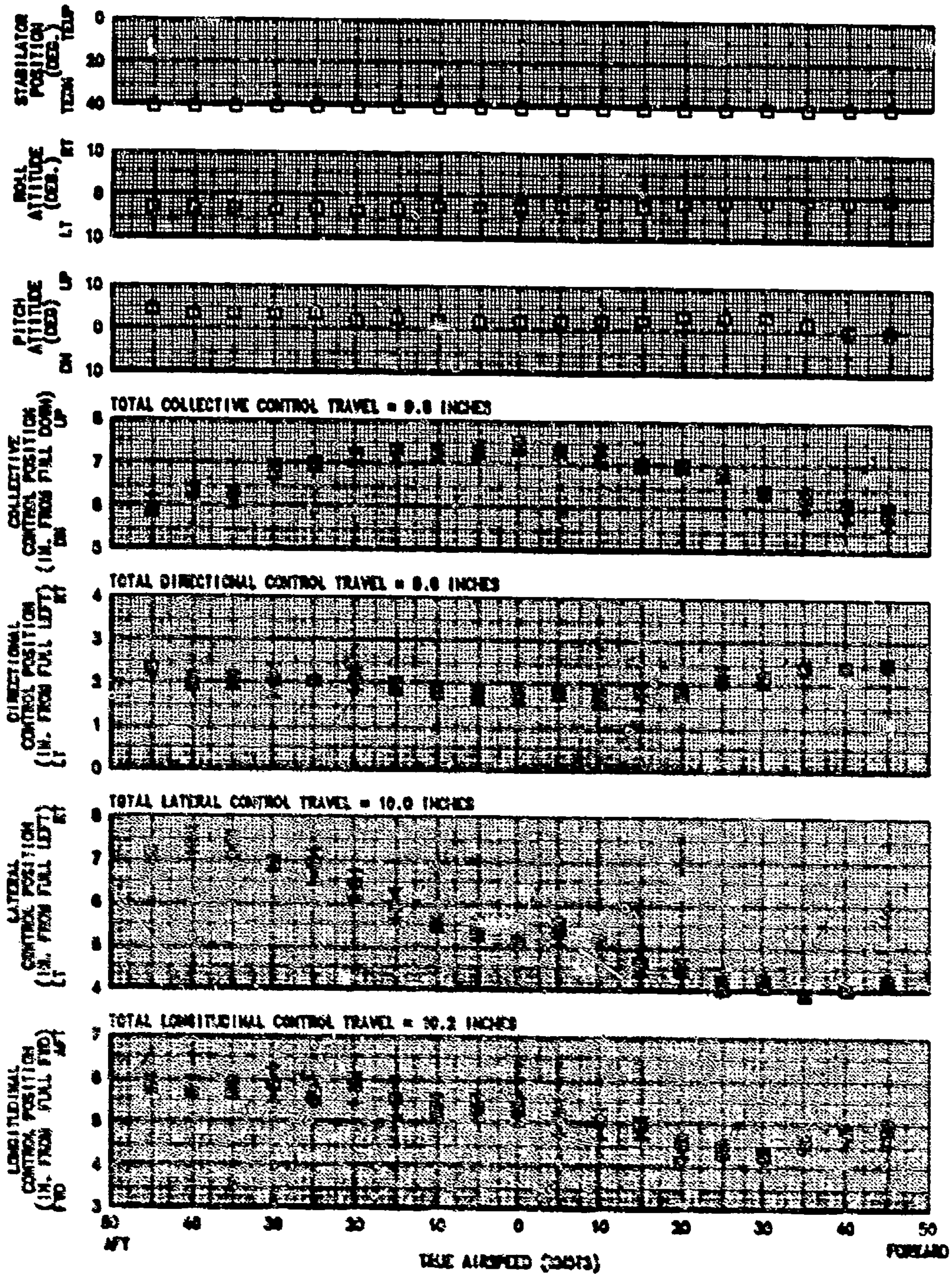


FIGURE E-103

LOW SPEED LEFT AND RIGHT FLIGHT CHARACTERISTICS

UH-60A USA S/N 82-23748

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 WHEEL HEIGHT (FT)	AIRCRAFT CONFIGURATION
16670	350.3	0.2 LT	8700	-2.0	258	20	VOLCANO

NOTE 1: VERTICAL LINES DENOTE CONTROL EXCURSIONS
2: PBA CENTERED AND ELECTRICALLY DISCONNECTED

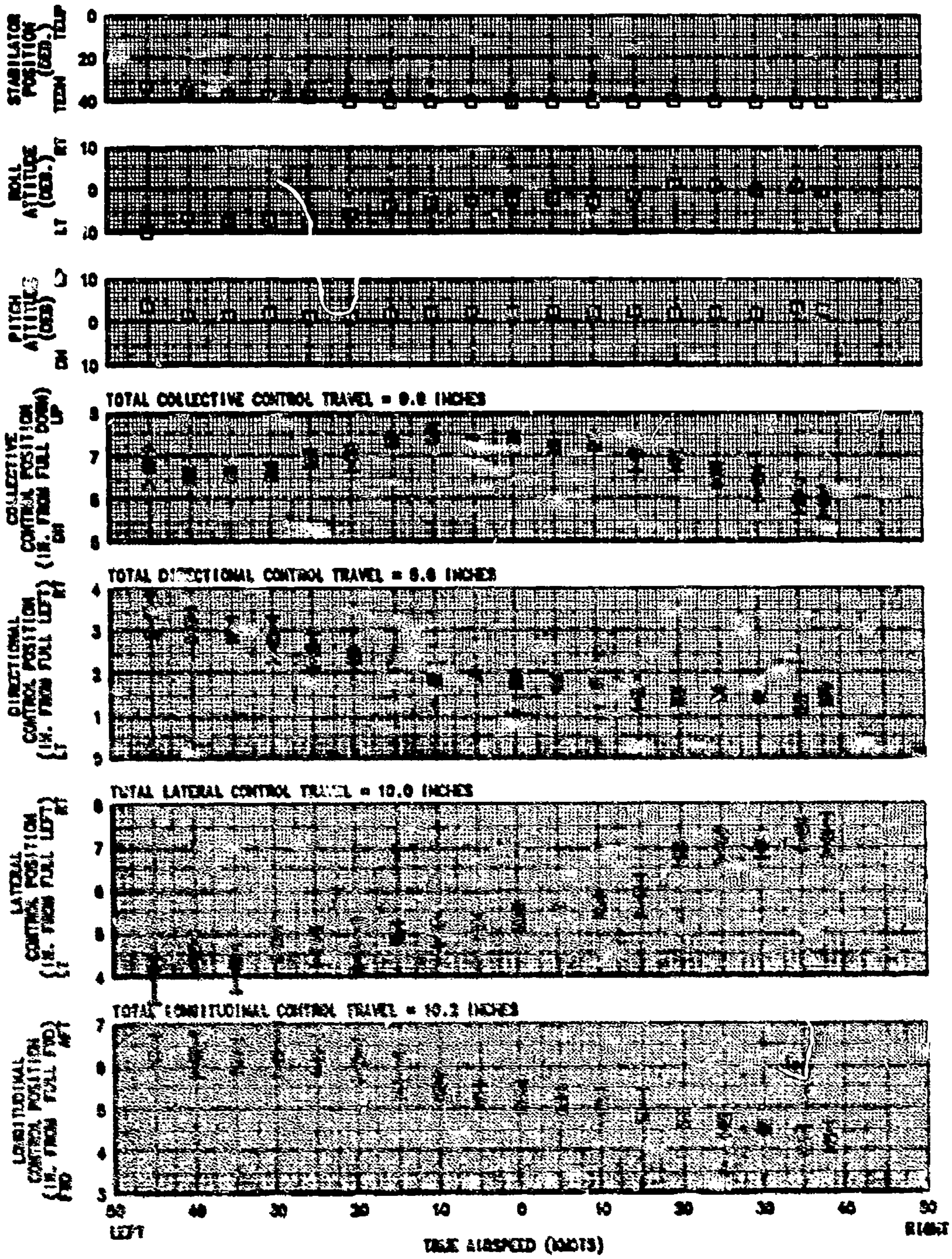


FIGURE E-104

SIMULATED SINGLE ENGINE FAILURE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
[illegible]	346.4(AFT)	0.2(LT)	5050	13.0	258	61	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

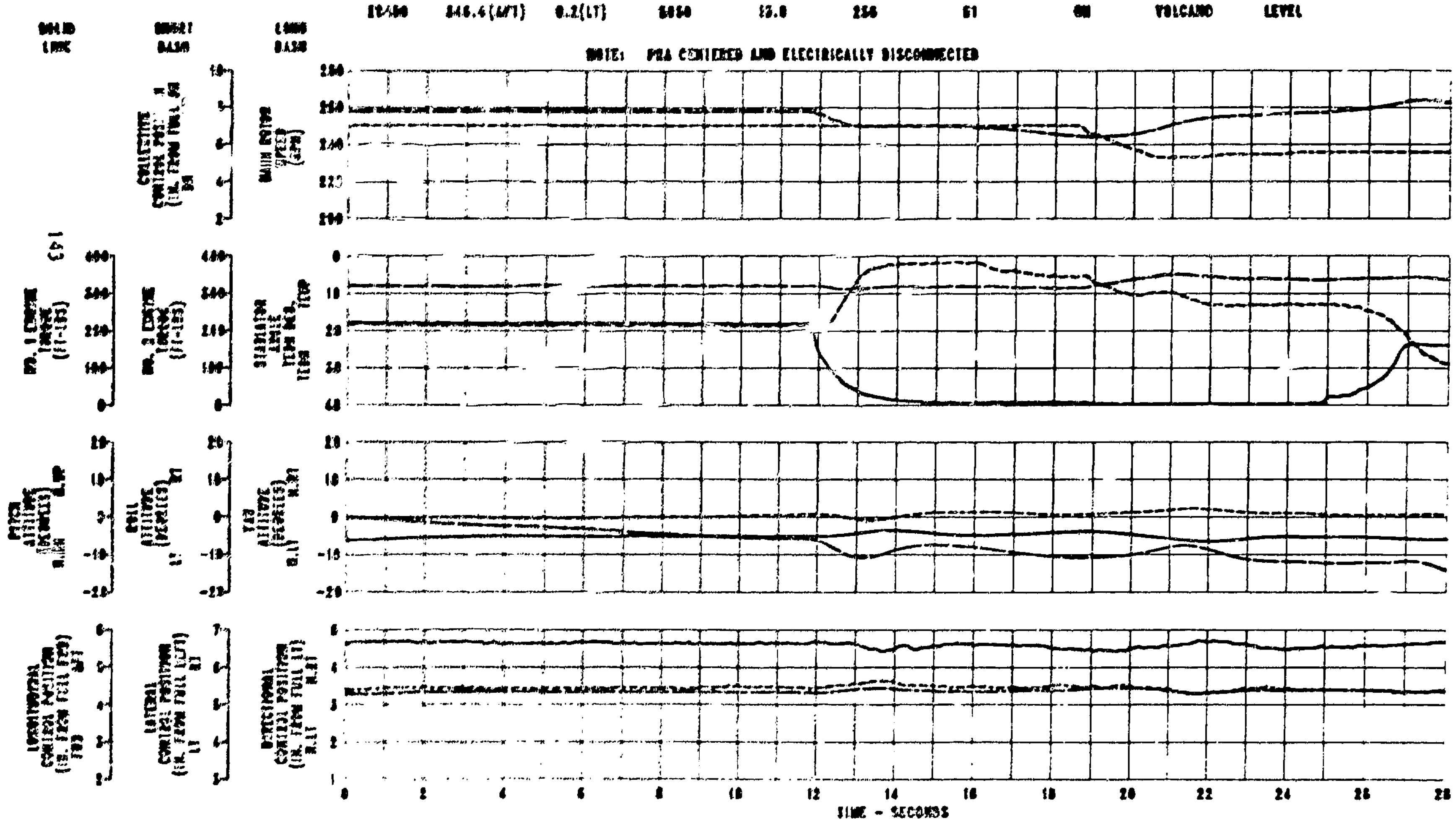


FIGURE C-103

SIMULATED SINGLE ENGINE FAILURE

UH-2A USA S/N 62-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
18460	340.4 (AFT)	0.2 (LT)	5610	15.5	250	91	ON	VOLCANO	LEVEL

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

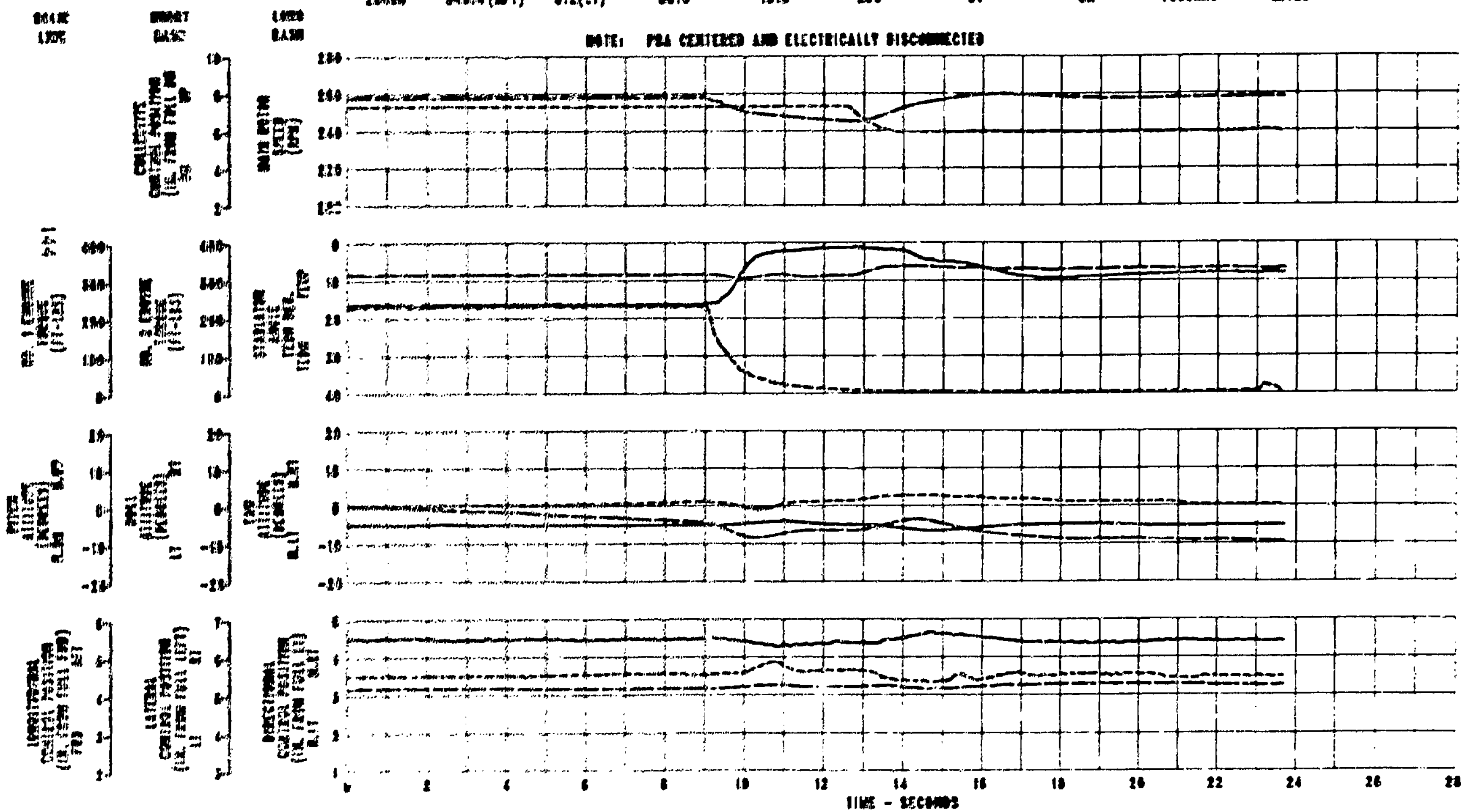


FIGURE E-106

SIMULATED SINGLE ENGINE FAILURE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
20260	348.3(AFT)	0.2(LT)	8520	14.8	257	115	ON	VOLCANO	LEVEL

NOTE: PCA CENTERED AND ELECTRICALLY DISCONNECTED

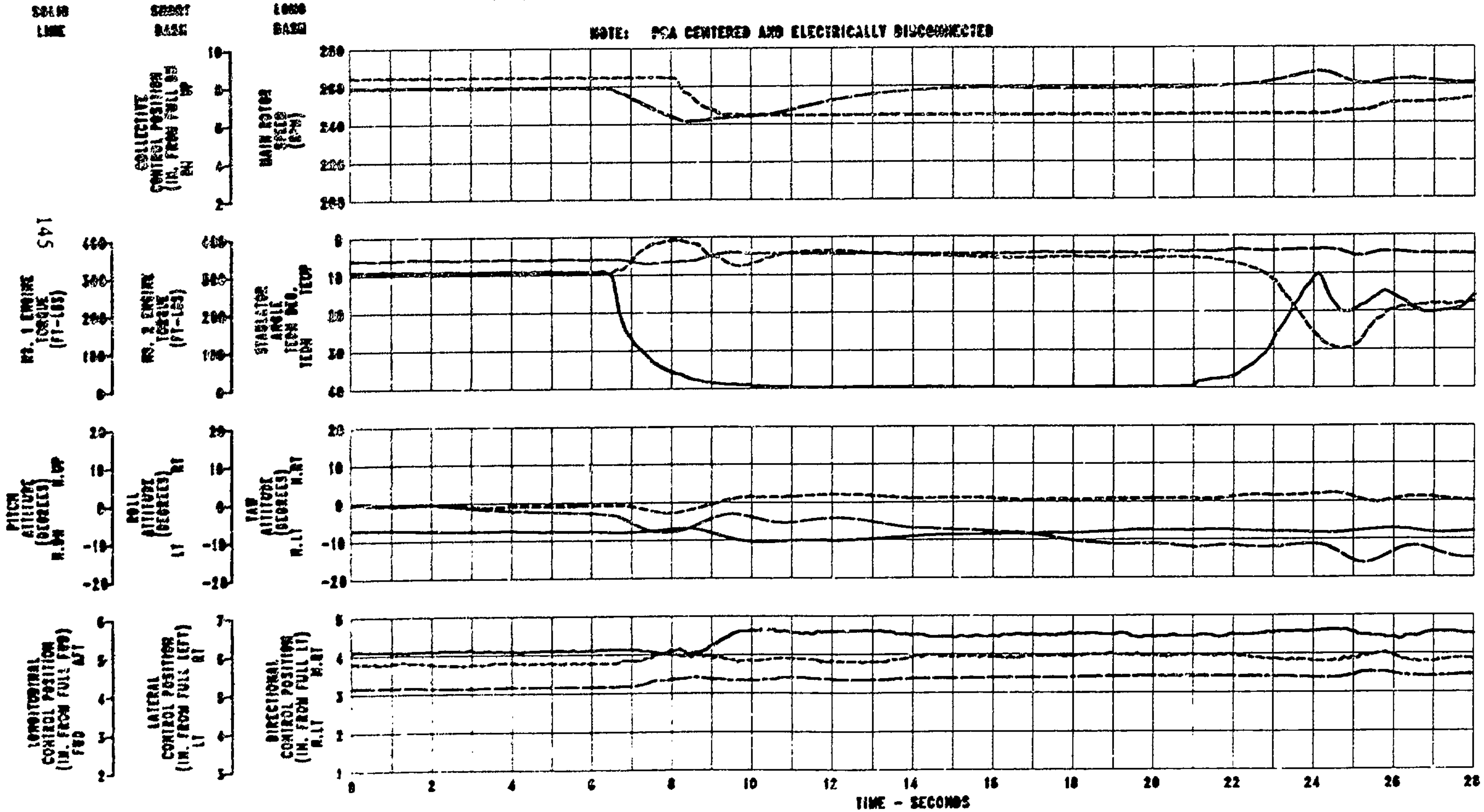


FIGURE E-107

SIMULATED SINGLE ENGINE FAILURE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
24250	340.5(AFT)	0.2(LT)	8760	15.0	258	110	ON	VOLCANO	LEVEL

NOTE: PBA CENTERED AND ELECTRICALLY DISCONNECTED

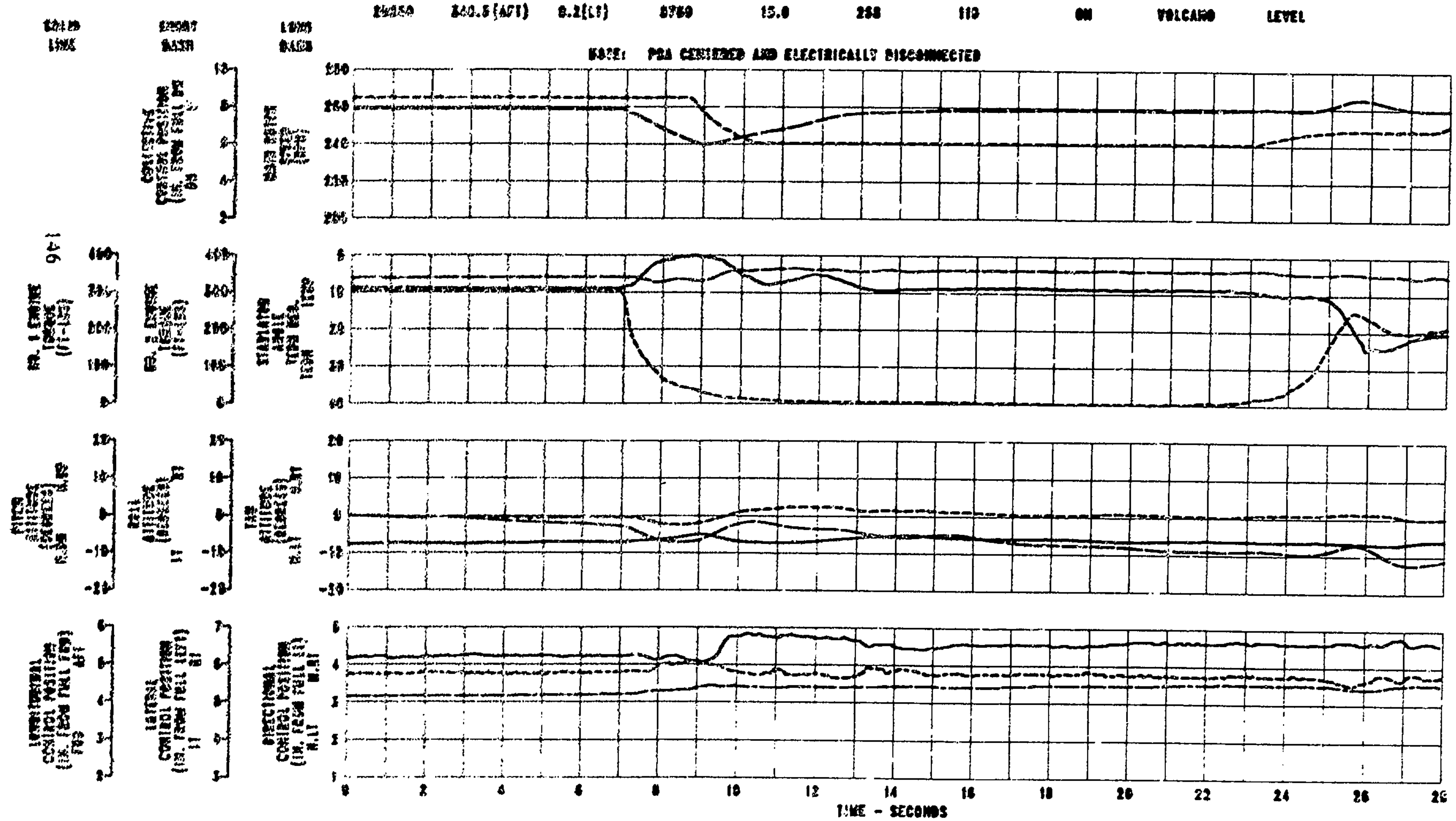


FIGURE E-108

SIMULATED SINGLE ENGINE FAILURE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
16400	348.2(AFT)	0.2(LT)	5160	13.5	257	83	ON	VOLCANO	IRP CLIMB

NOTE: PRA CENTERED AND ELECTRICALLY DISCONNECTED

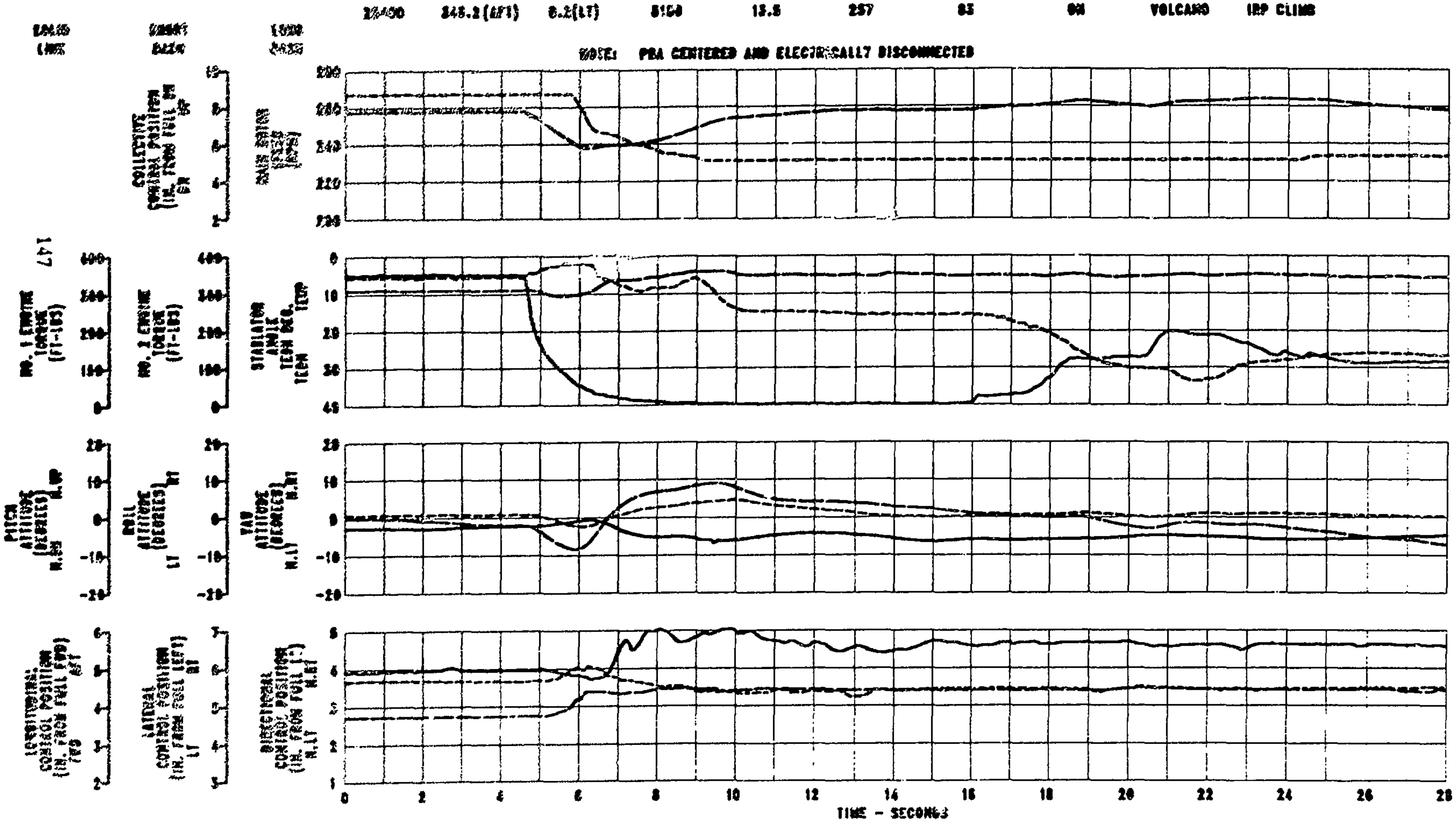


FIGURE C-109

SIMULATED SINGLE ENGINE FAILURE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	AFCS CONDITION	AIRCRAFT CONFIGURATION	FLIGHT CONDITION
20380	346.5(AFT)	0.2(LT)	5730	14.0	258	83	ON	VOLCANO	IRP CLIMB

NOTE: PSA CENTERED AND ELECTRICALLY DISCONNECTED

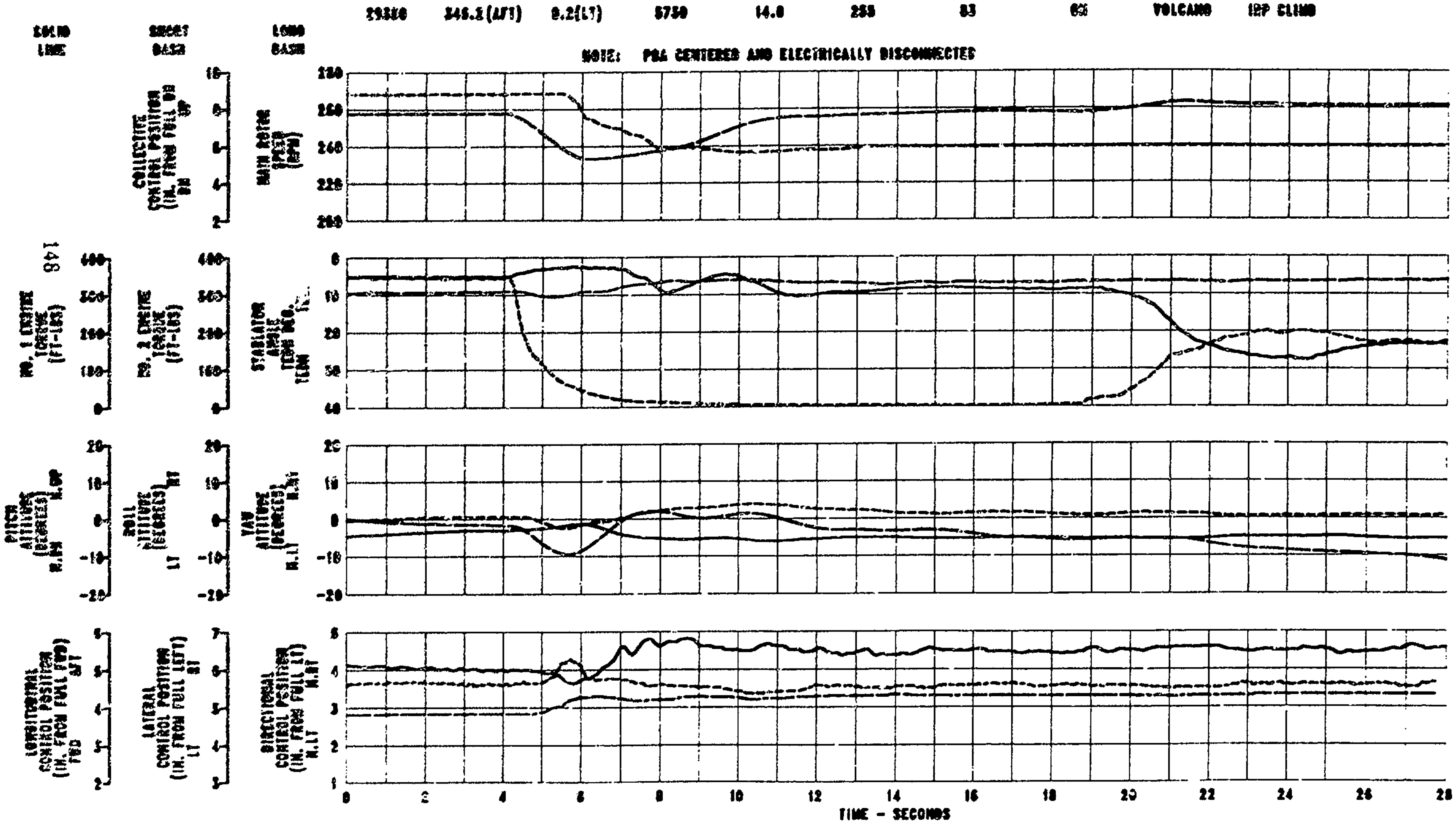
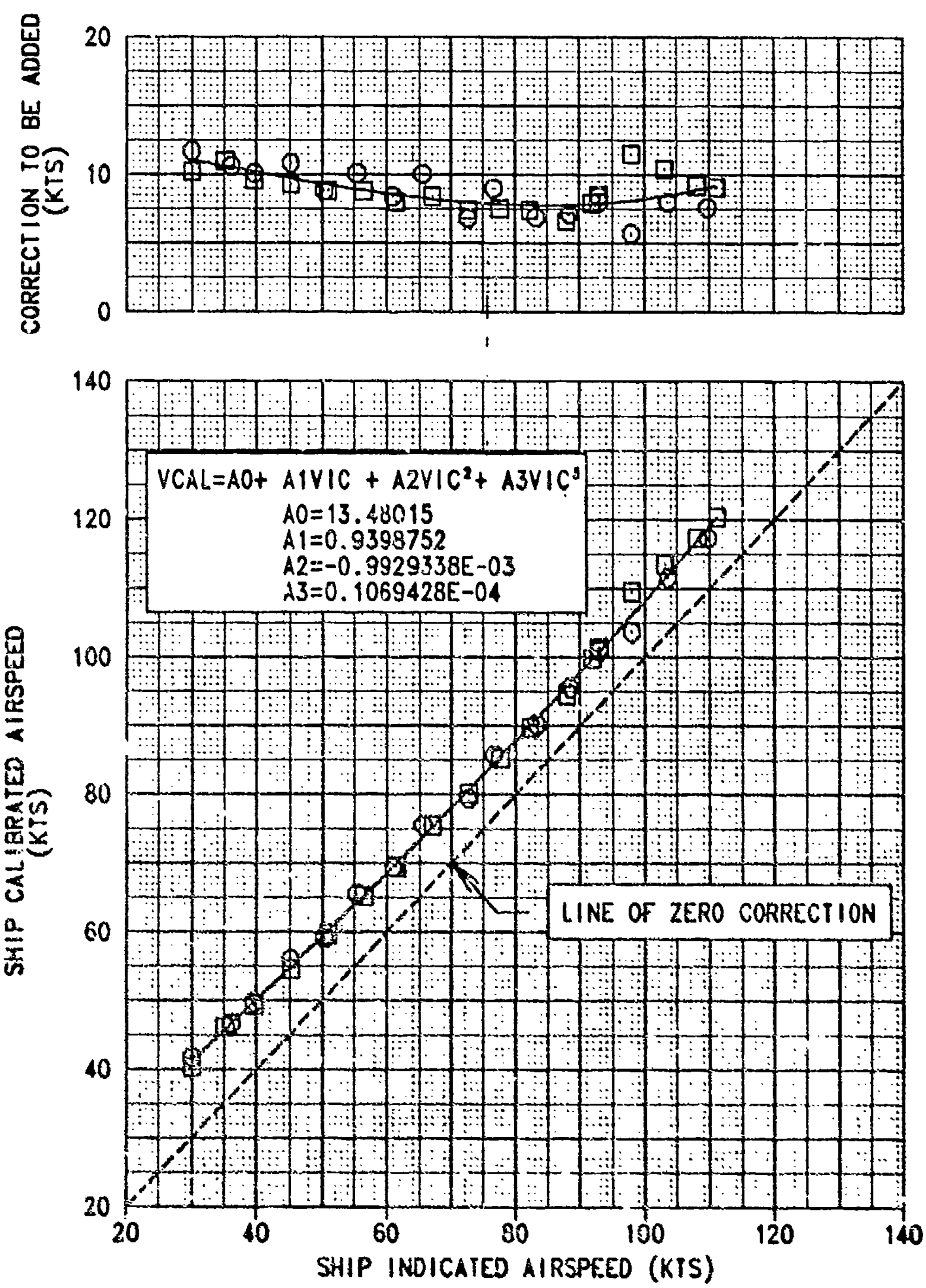


FIGURE E-110
SHIP AIRSPEED CALIBRATION
UH-60A USA S/N 82-23748

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)	TEST METHOD
□	16860	353.5	0.2 LT	7290	21.0	258	TRAILING BOMB
○	19060	361.3 (AFT)	0.2 LT	6930	22.5	260	TRAILING BOMB

NOTE: 1. VOLCANO CONFIGURATION
2. LEVEL FLIGHT
3. BALL-CENTERED FLIGHT



APPENDIX F. PHOTOGRAPHS

PHOTOGRAPH	FIGURE NUMBER
Test Aircraft	F-1 through F-5
VOLCANO Mounting Hardward	F-6 through F-10
Fixed Provision Mounting Points	F-11
Interface Control Panel	F-12
Ballast Locations	F-13 through F-18
Instrumentation Package	F-19 through F-25
External Modifications	F-26 and F-27
Idle Stop	F-28

Figure F-1. UH-60A Test Aircraft S/N 82-23748 Configured with XM-139 VOLCANO Mine Dispenser System

Figure F-2. Right Rear Quarter View of UH-60A Helicopter with XM-139 VOLCANO Installed

Figure F-3. Rear View of UH-60A with XM-139 VOLCANO Installed

Figure F-4. Left Side View of UH-60A Helicopter with XM-139 VOLCANO Installed

Figure F-5. Right Front View UH-60A with XM-139 VOLCANO Installed

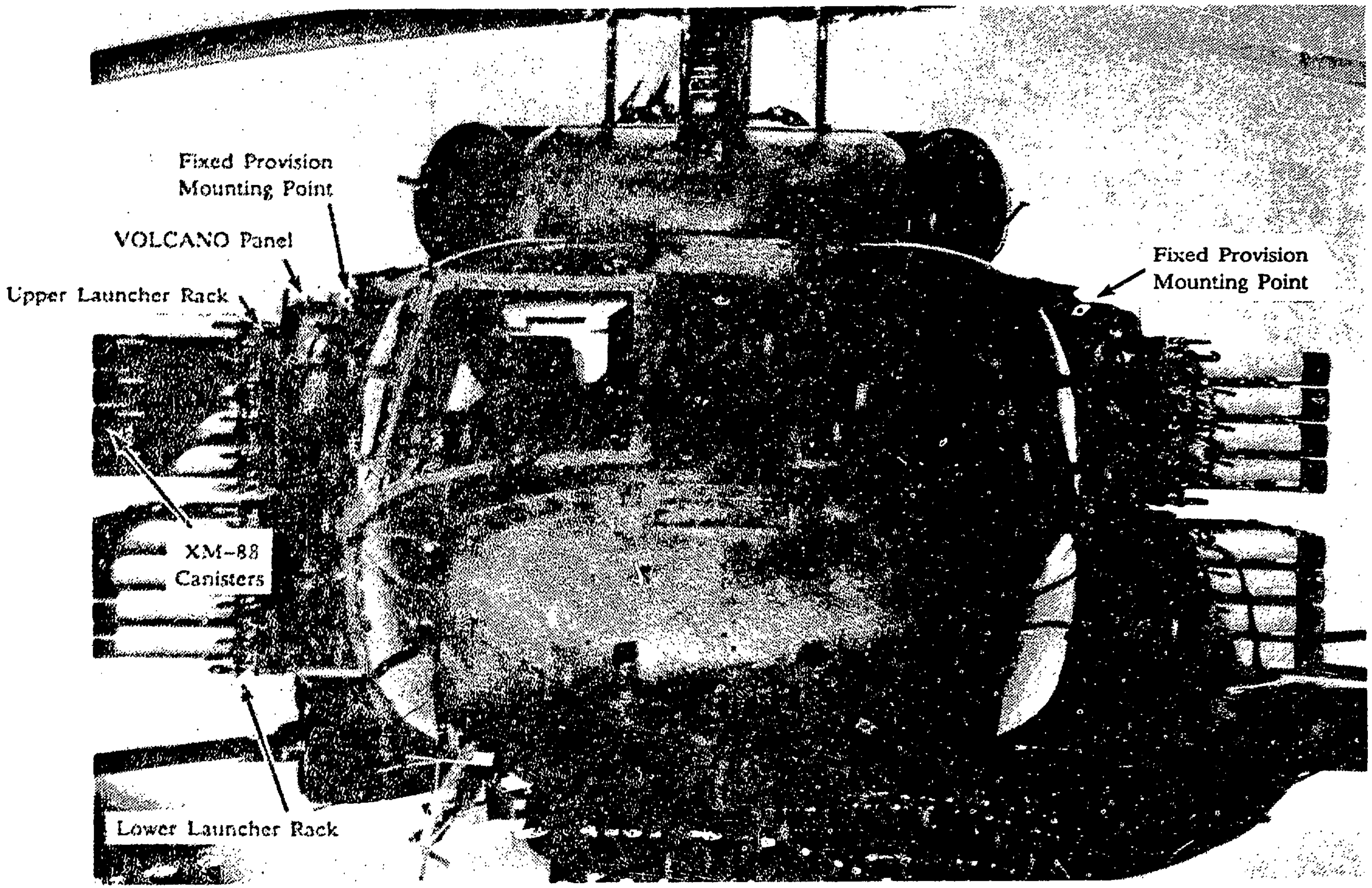


Figure F-6. Front View of UH-60A Helicopter with XM-139 VOLCANO Installed.

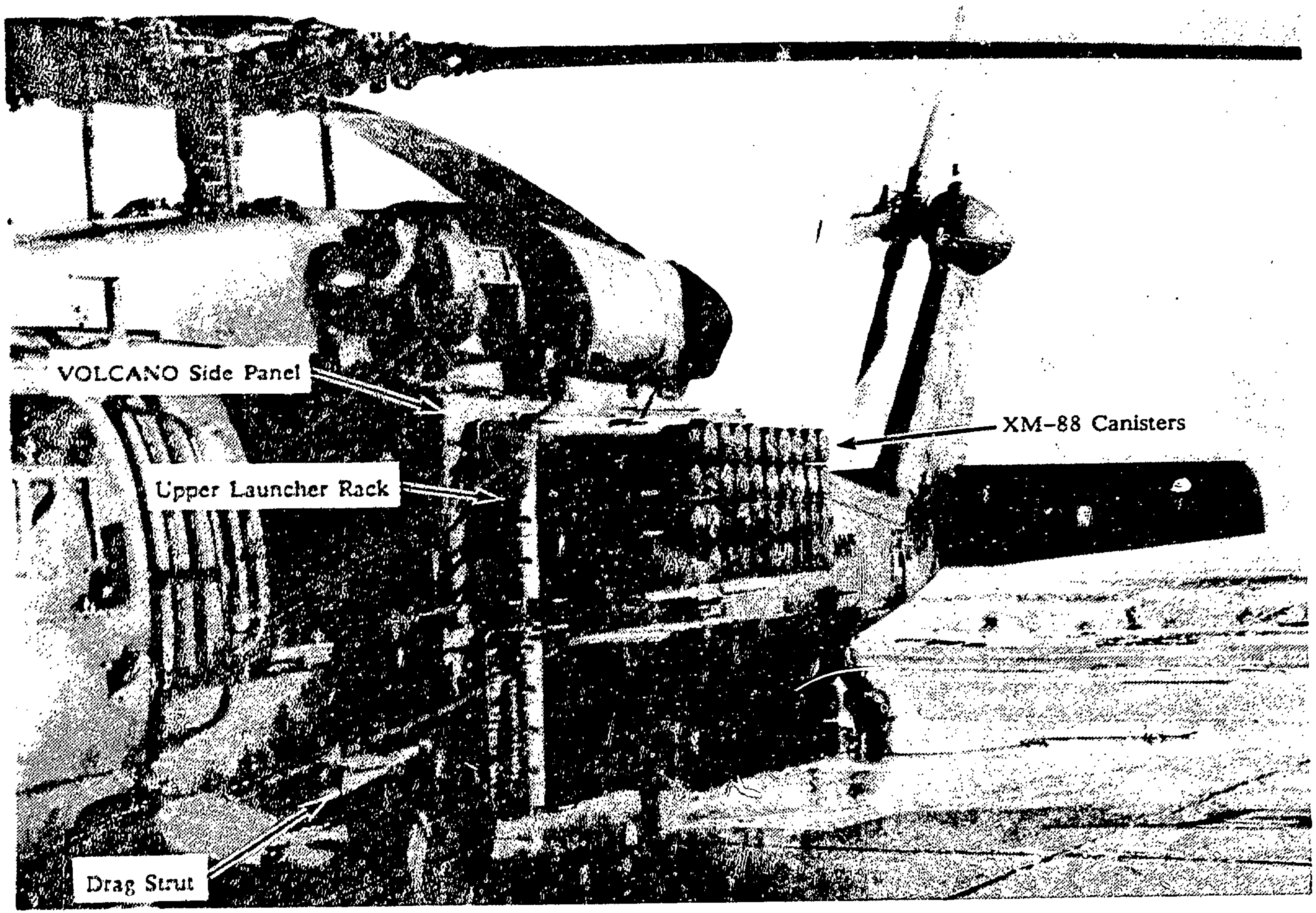


Figure F-7. View of VOLCANO Side Panel, Launcher Racks and XM-88 Canisters

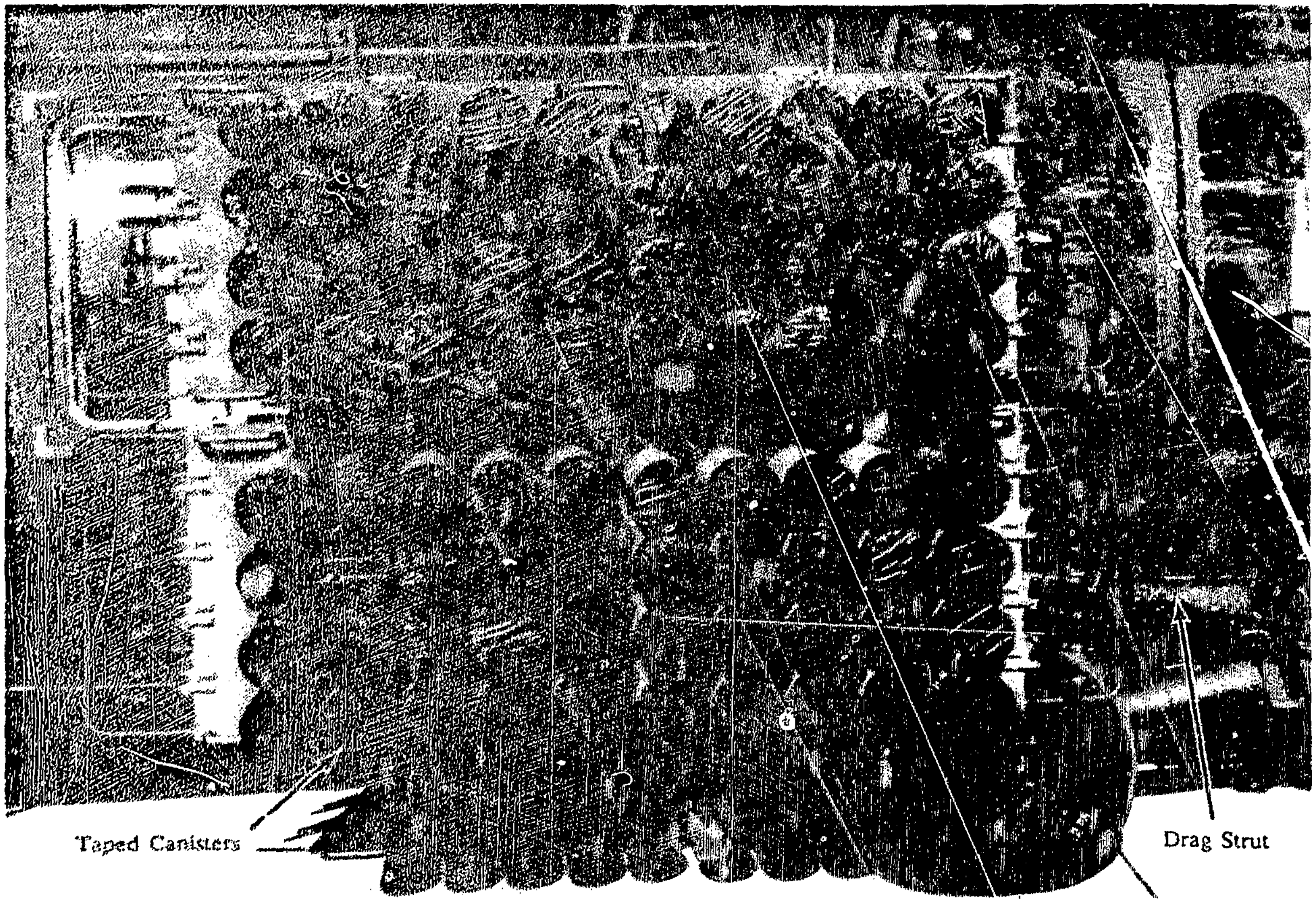


Figure F-8. Right Side View of VOLCANO Cargo and Gunners Door Closed

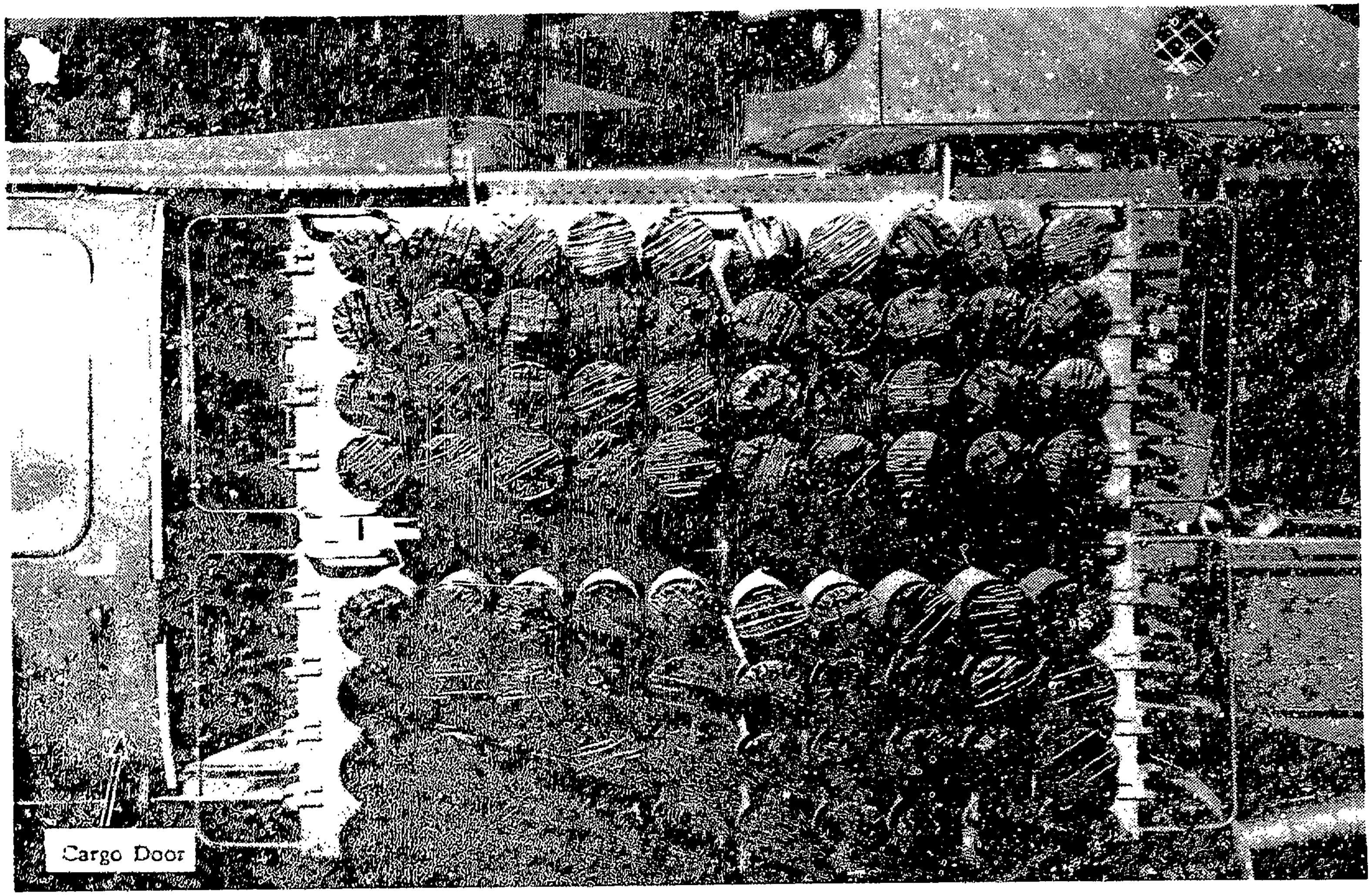


Figure F-9. Right Side View of VOLCANO Cargo and gunners Door Open

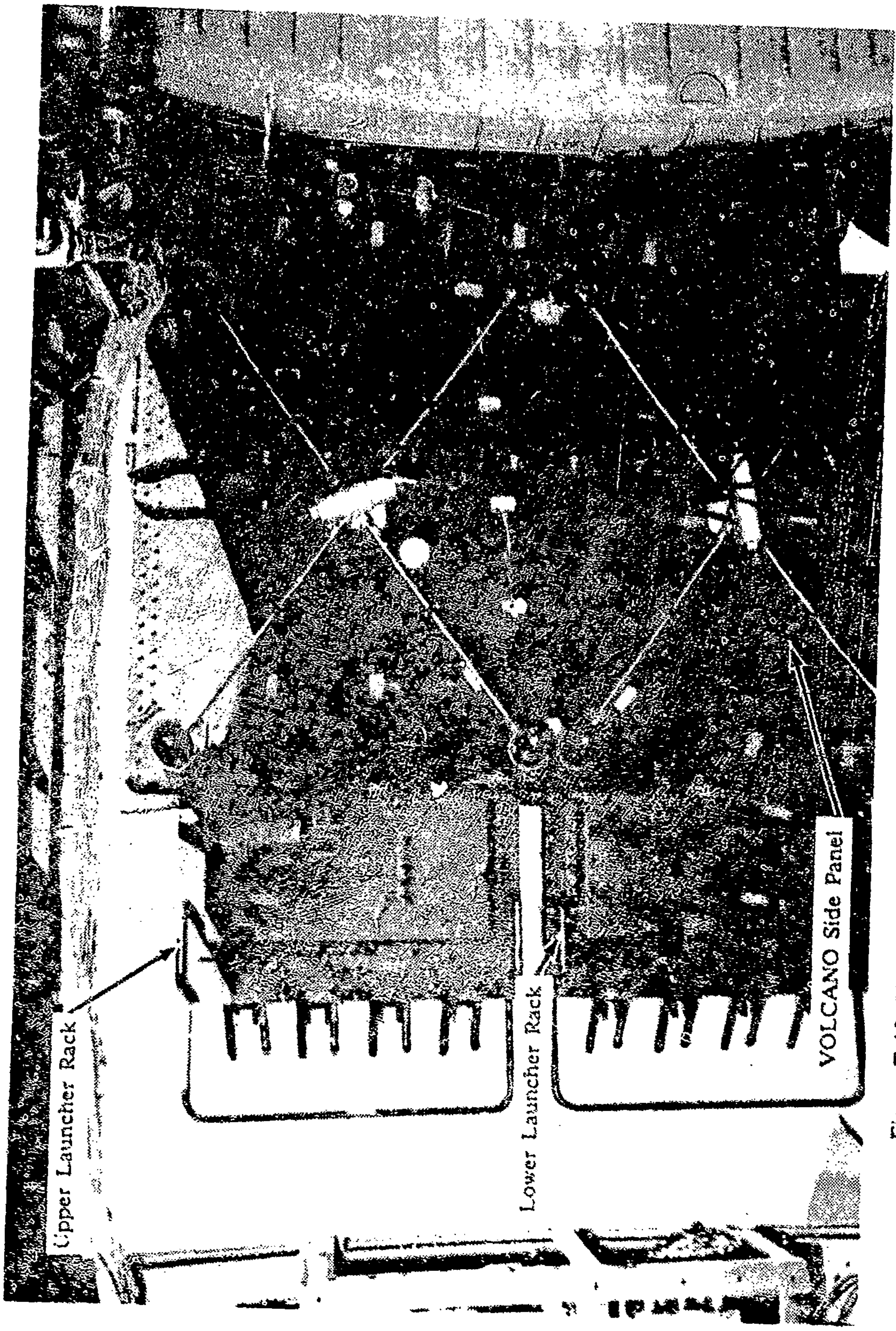


Figure F-10. View of VOLCANO Installation from Inside with Cargo Door Open

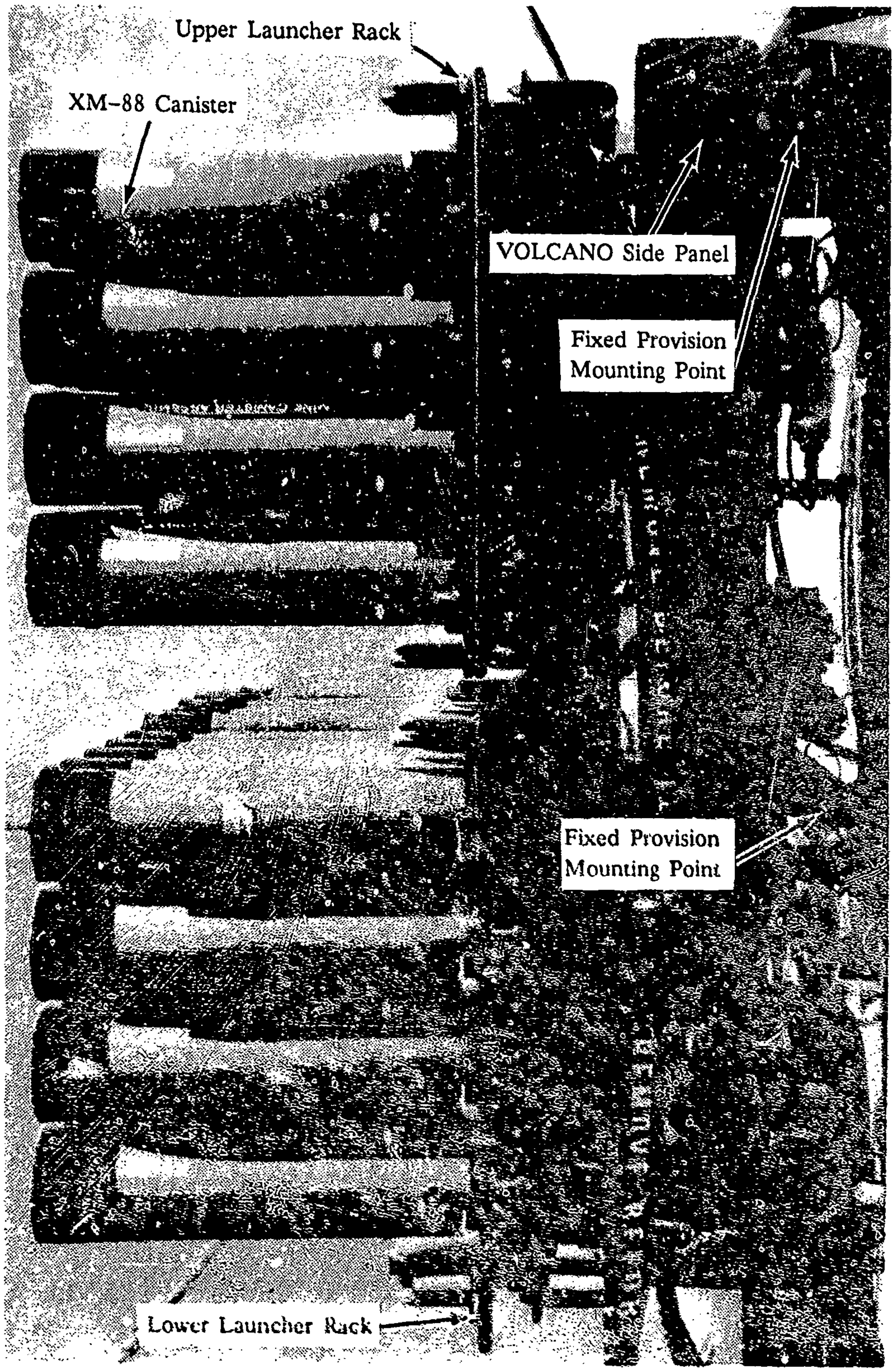


Figure F-11. Left End View of VOLCANO Installation

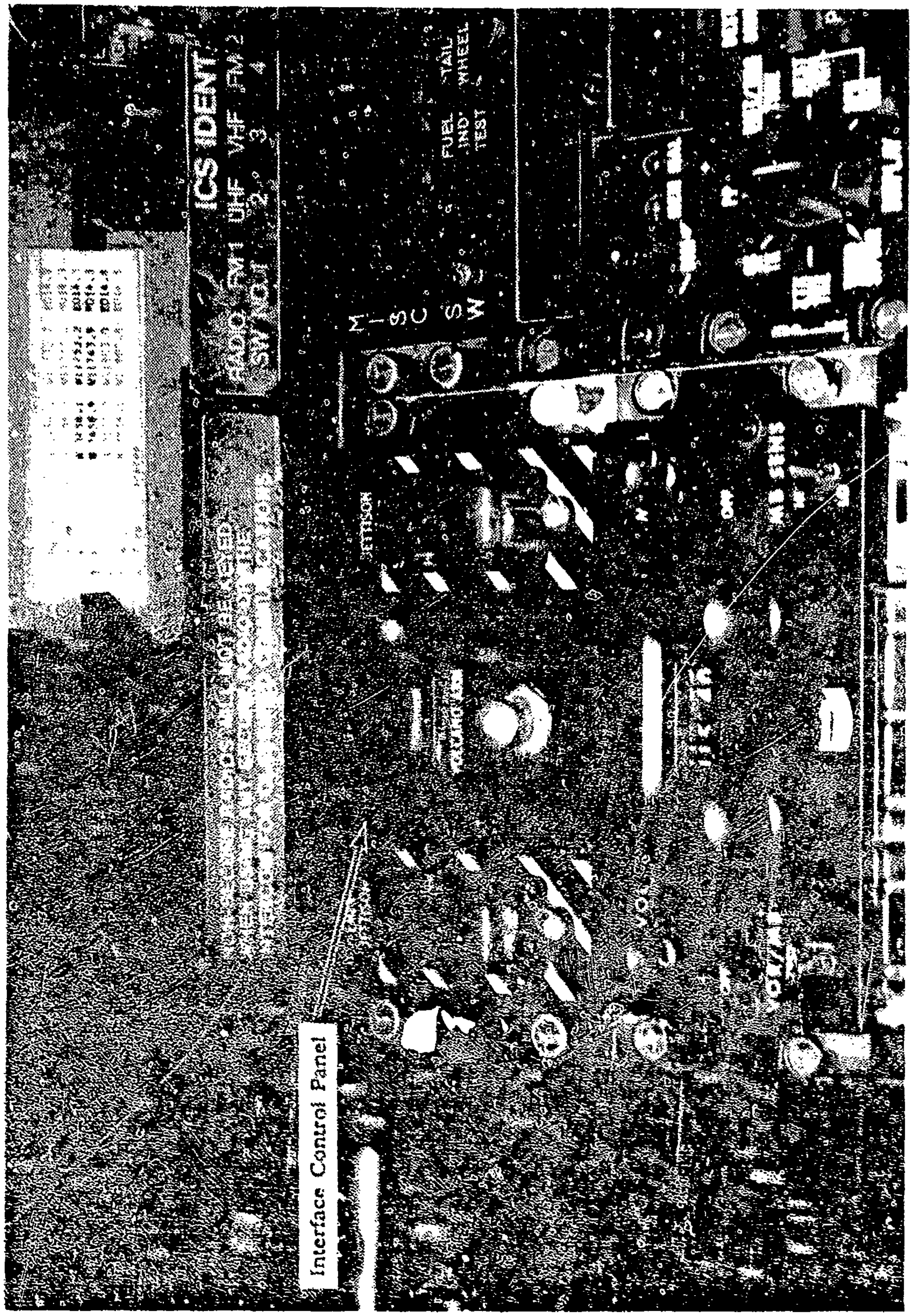


Figure F-12. Interface Control Panel

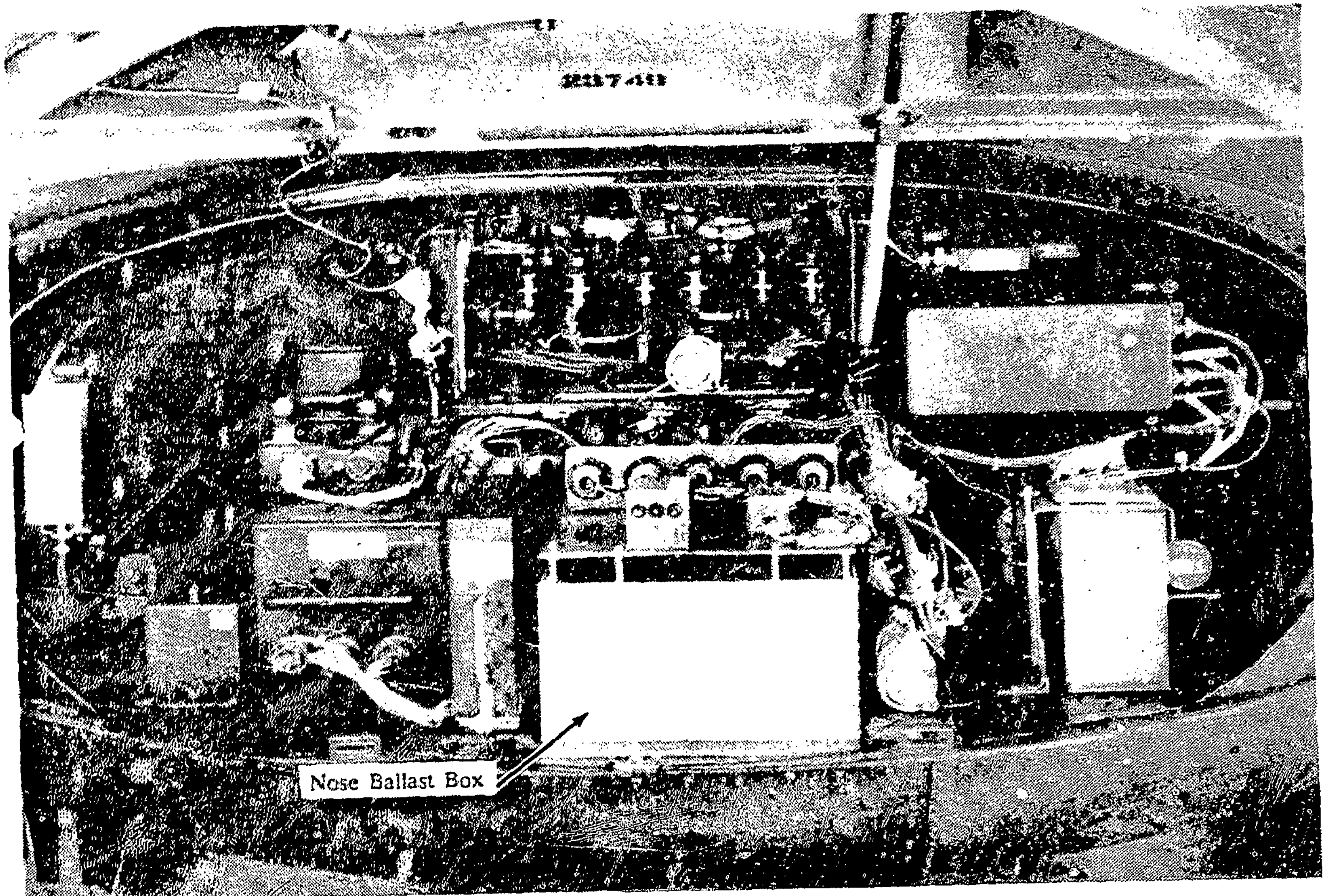


Figure F-13. Test Aircraft Nose Section

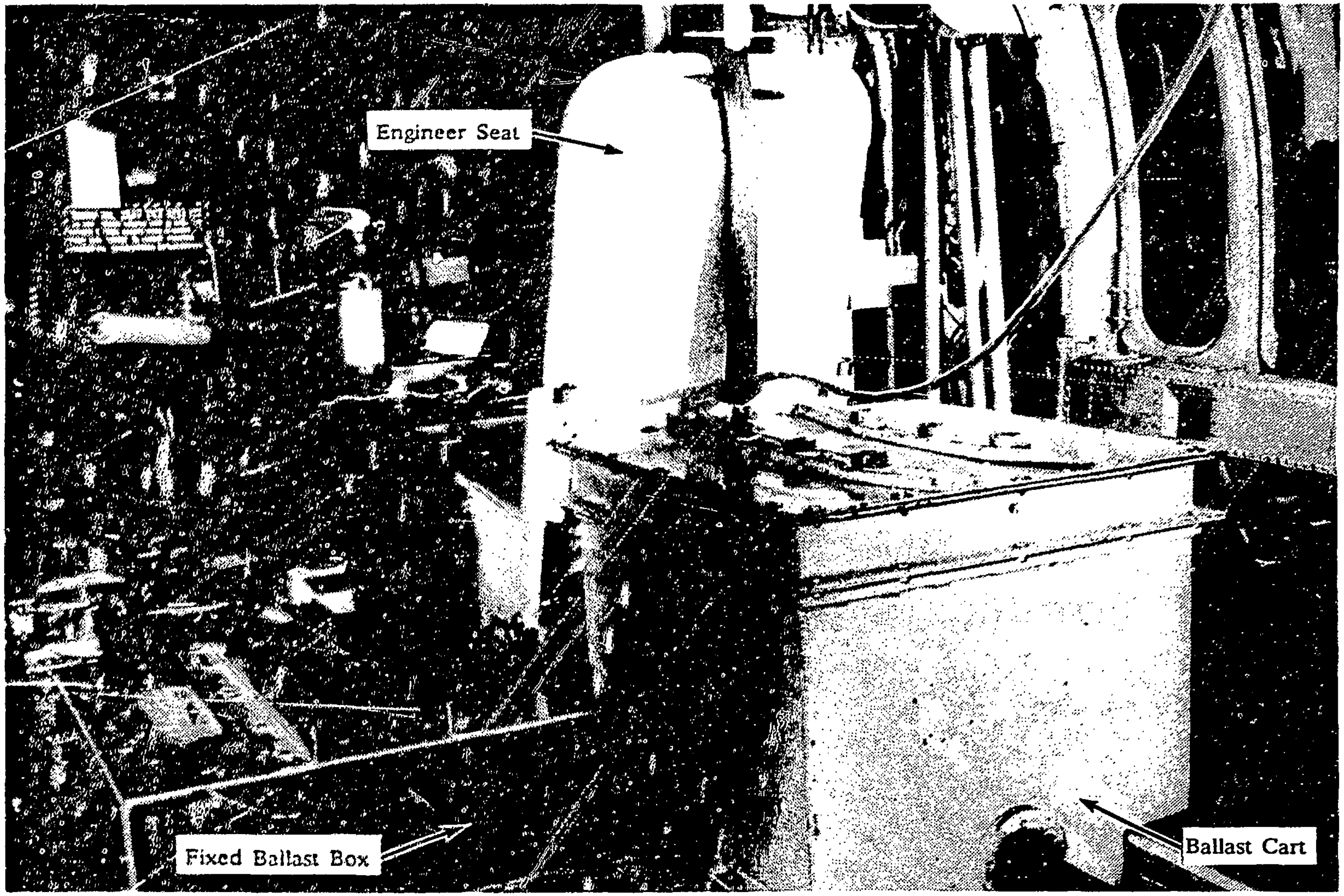


Figure F-14. Forward View of Engineer Station

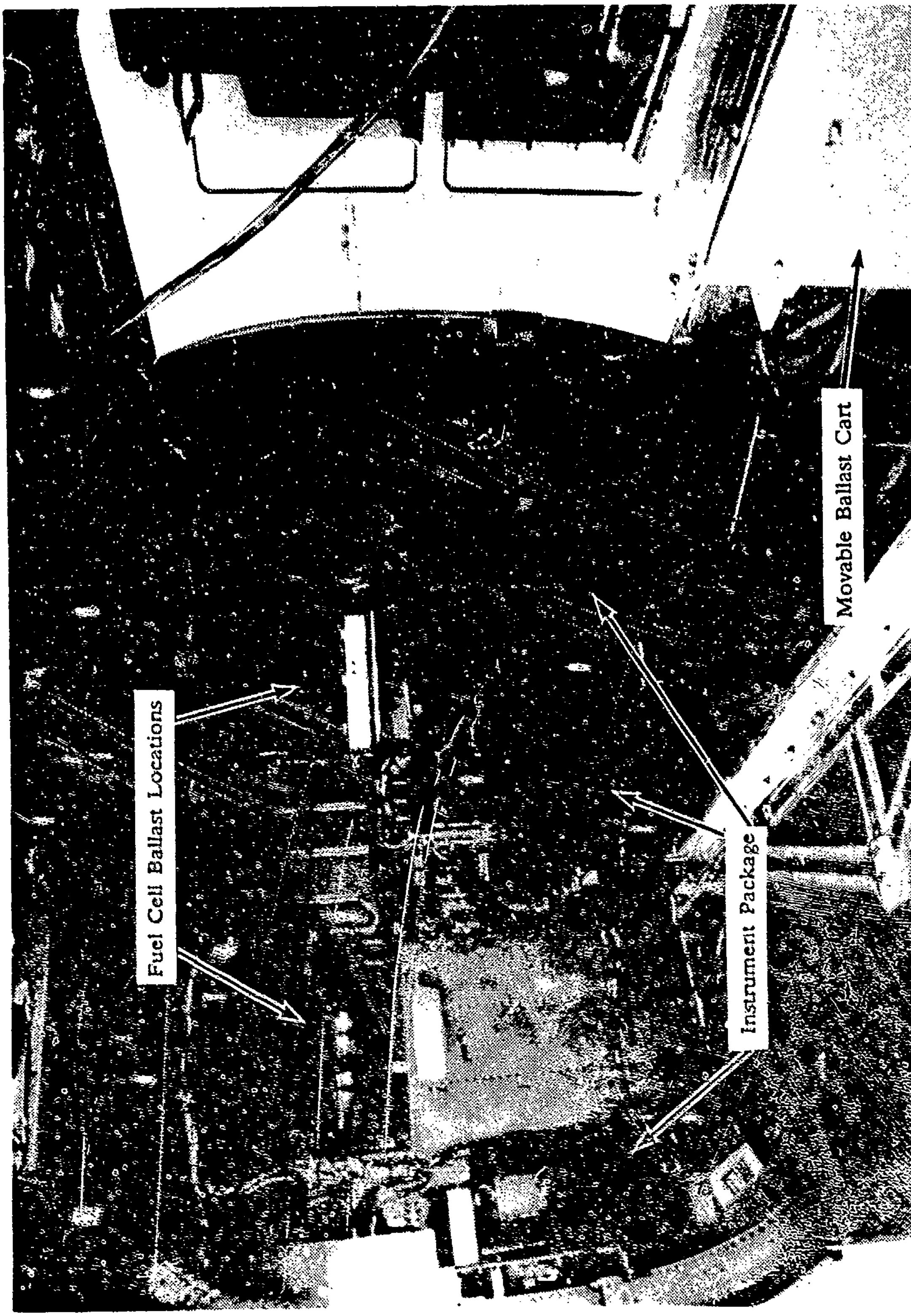


Figure F-15. UH-60A Cargo Compartment Instrumentation

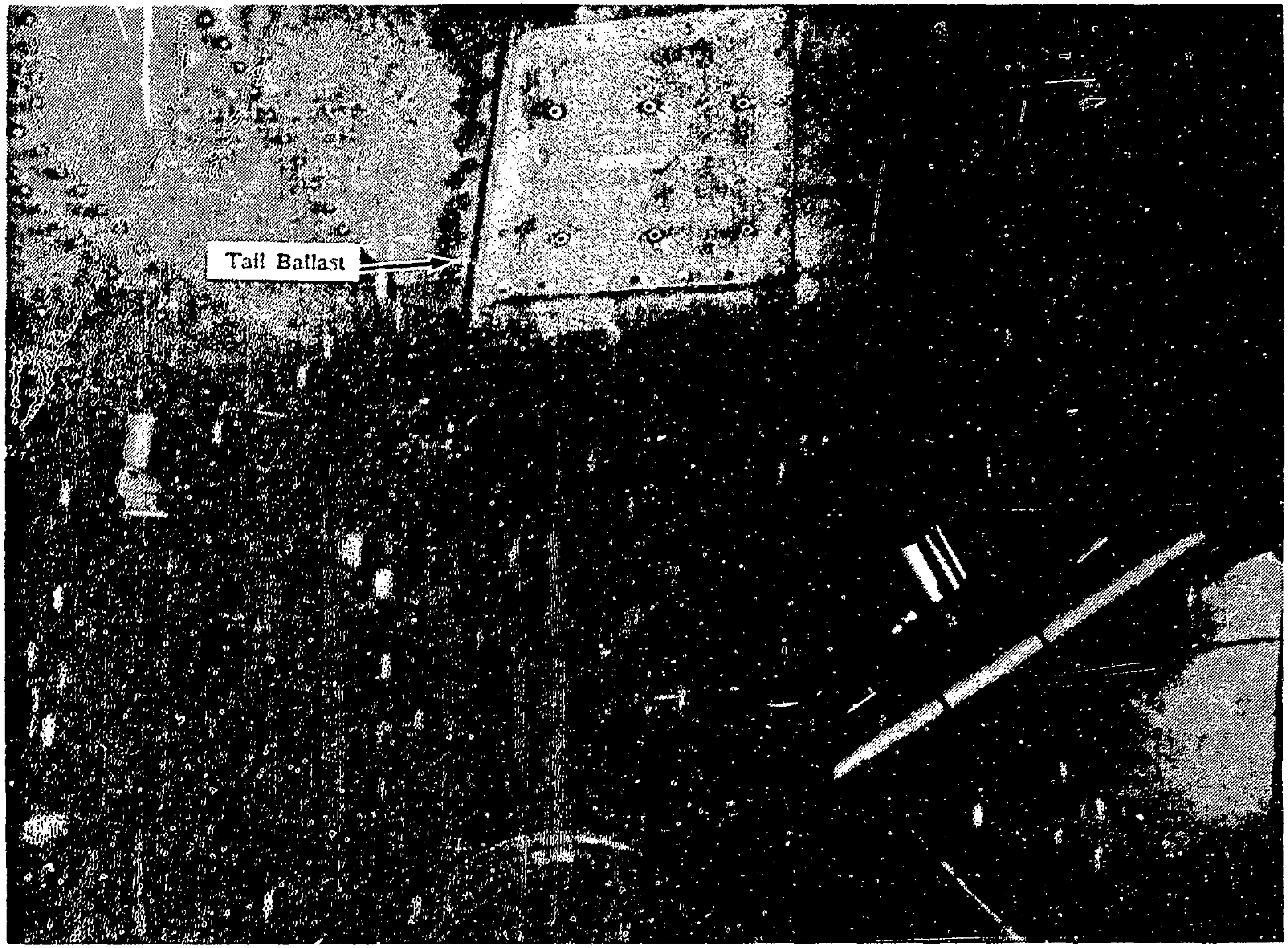


Figure F-16. Tail Ballast Location

Figure F-17. Engineer Station

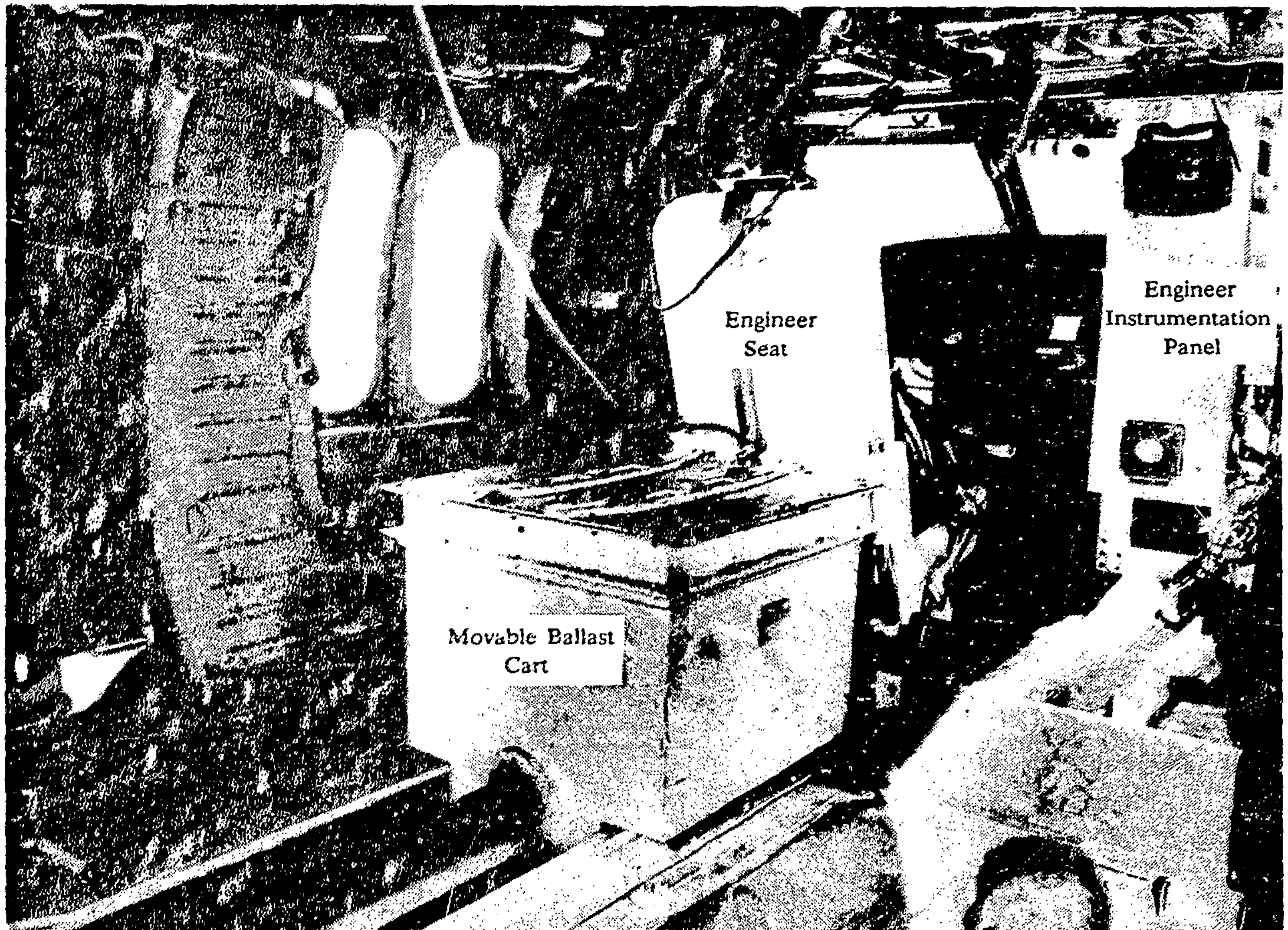


Figure F-18. Movable Ballast Cart

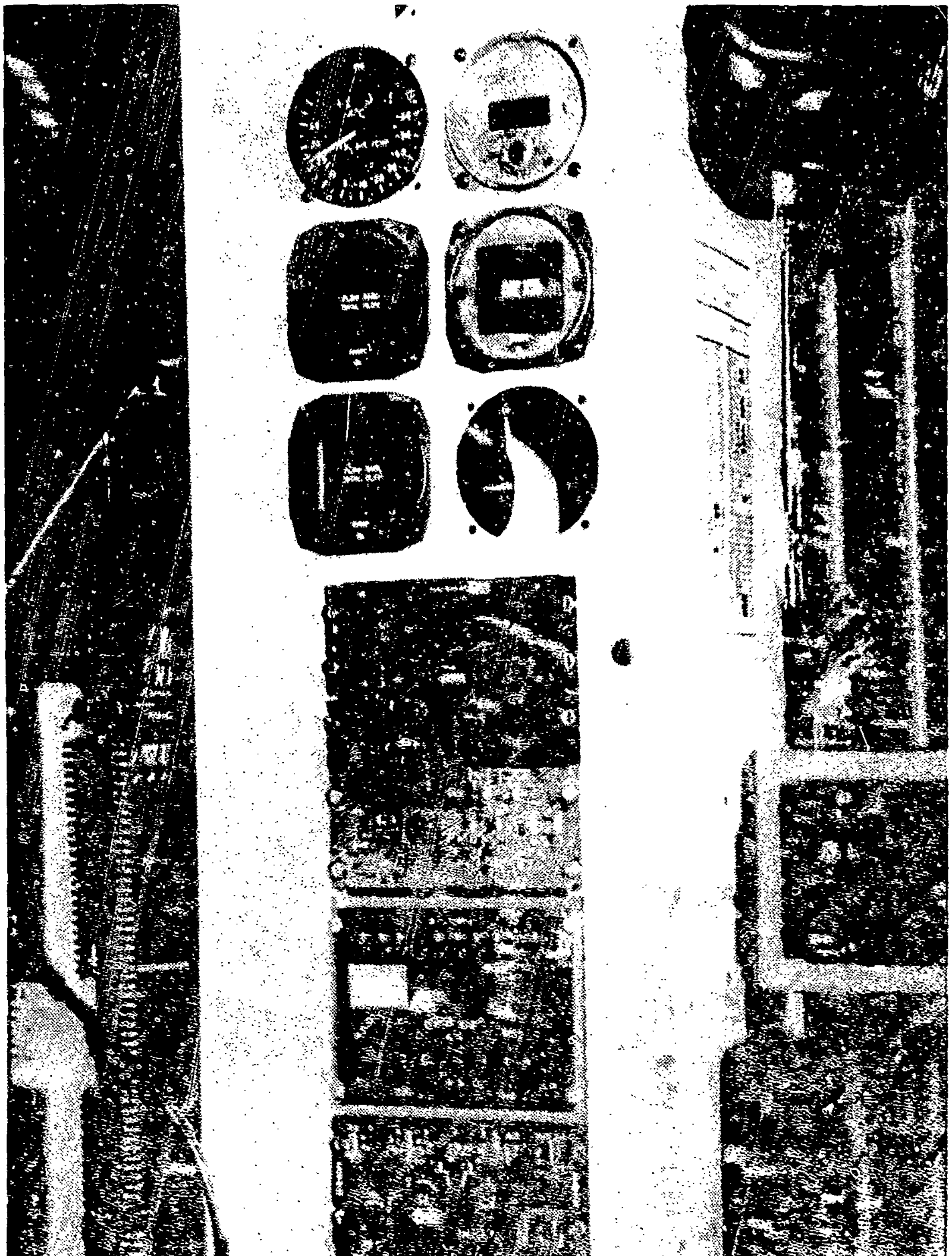


Figure F-19. Engineer Instrumentation Panel

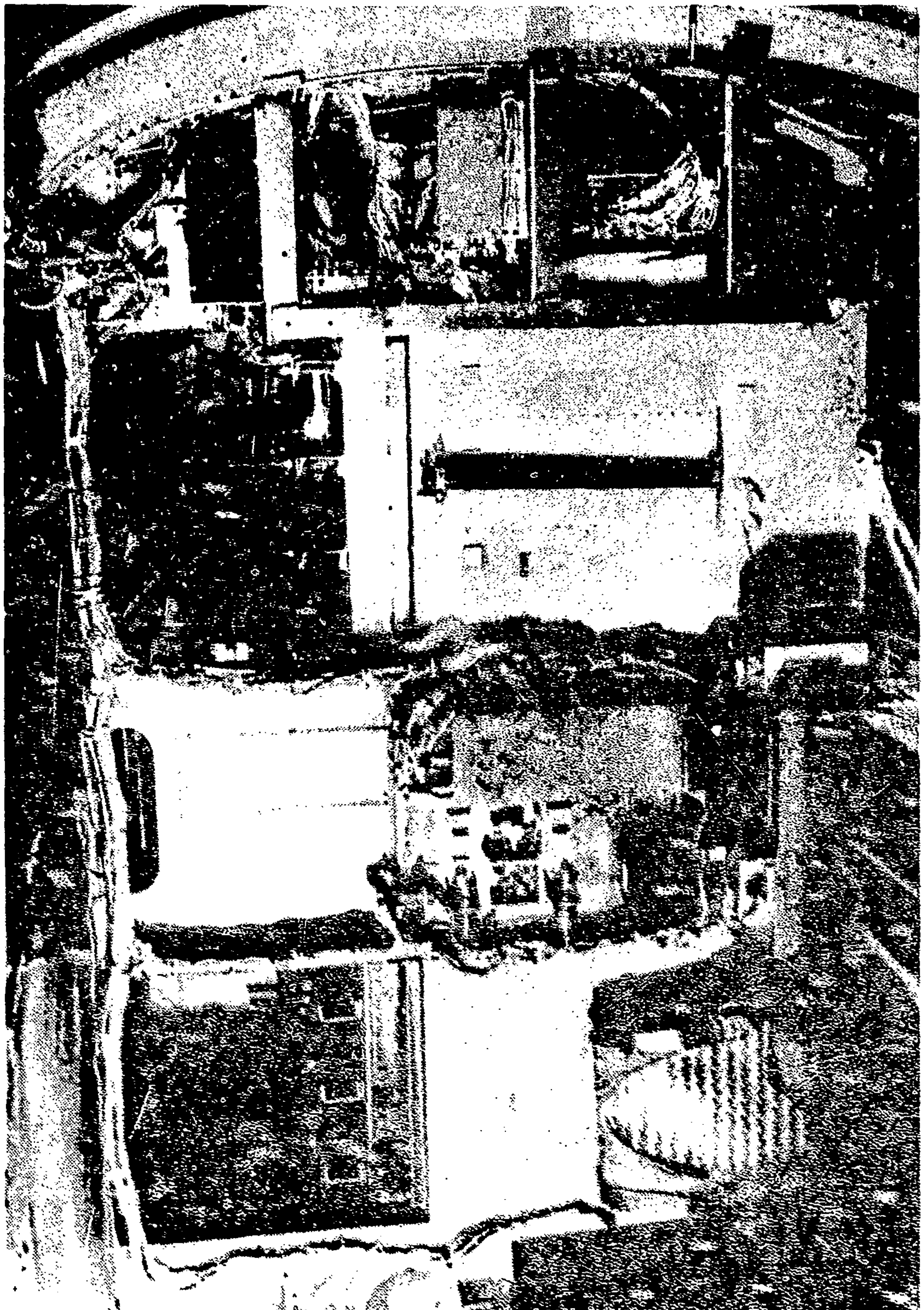


Figure F-20. Instrumentation Package Installation

Figure F-27. Right Side Instrumentation Installation

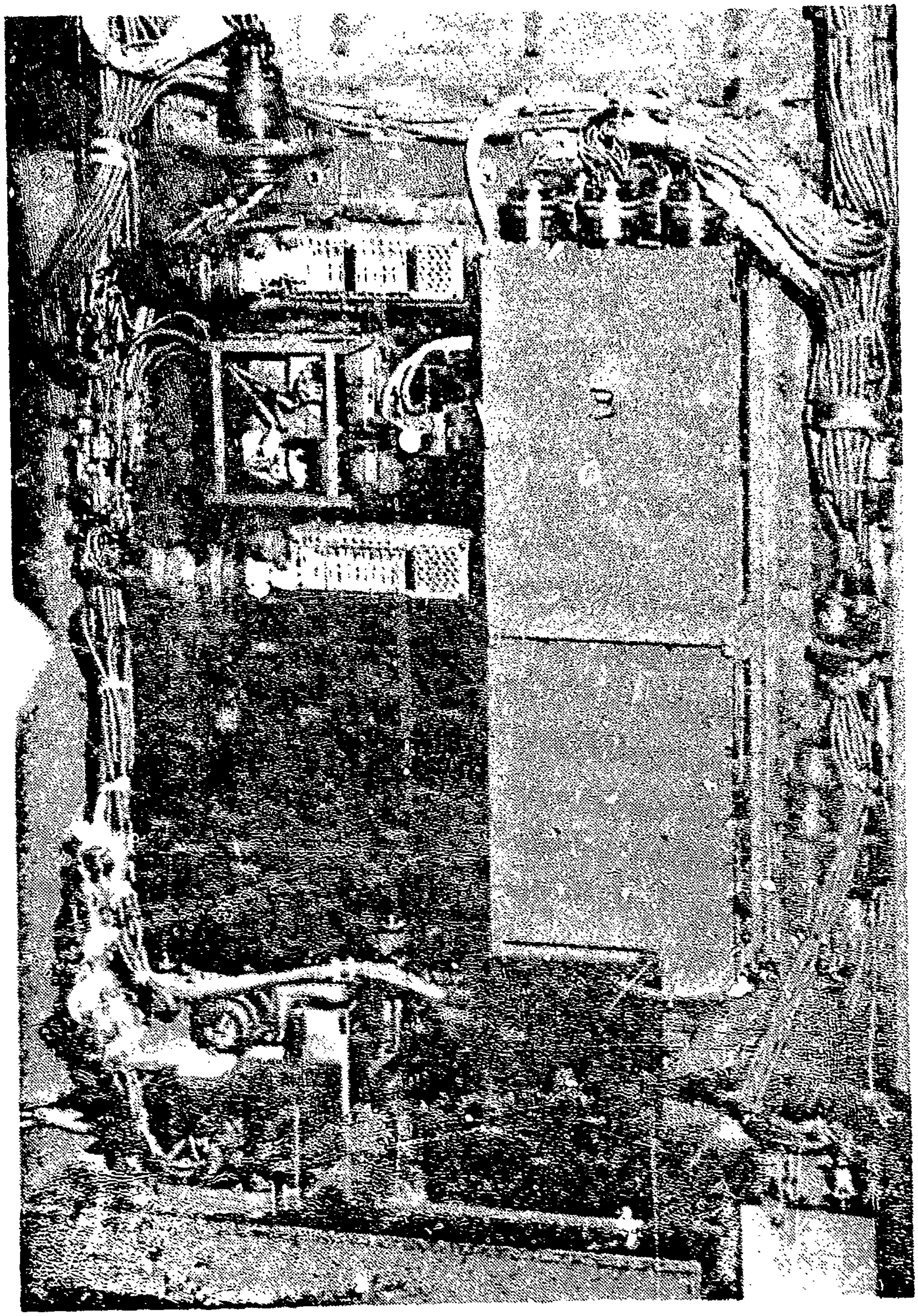


Figure F-22. Center Instrumentation Installation

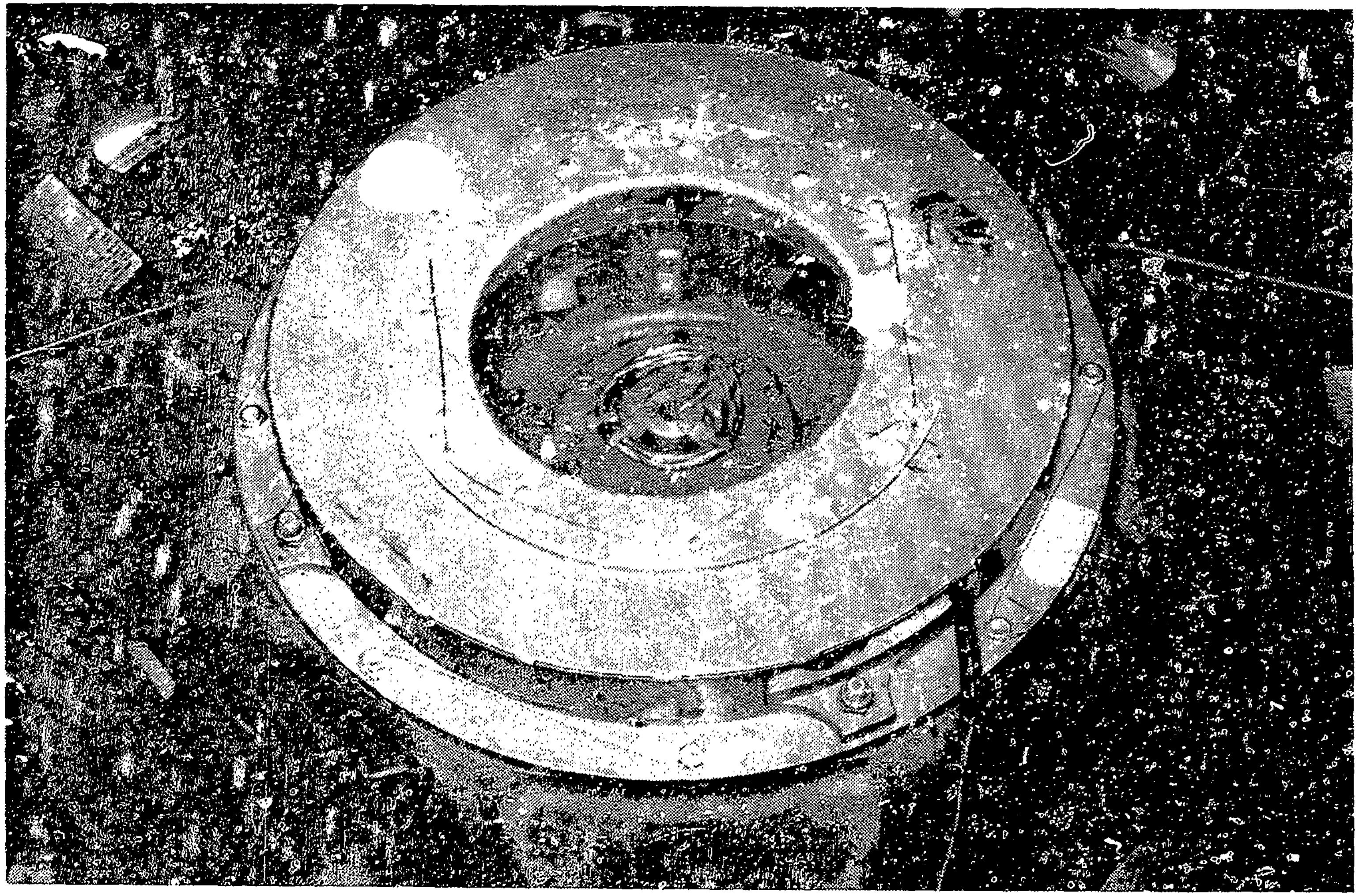


Figure F-23. Rotor Head Slip Ring Assembly Installation

Figure F-24. Slip Ring Assembly

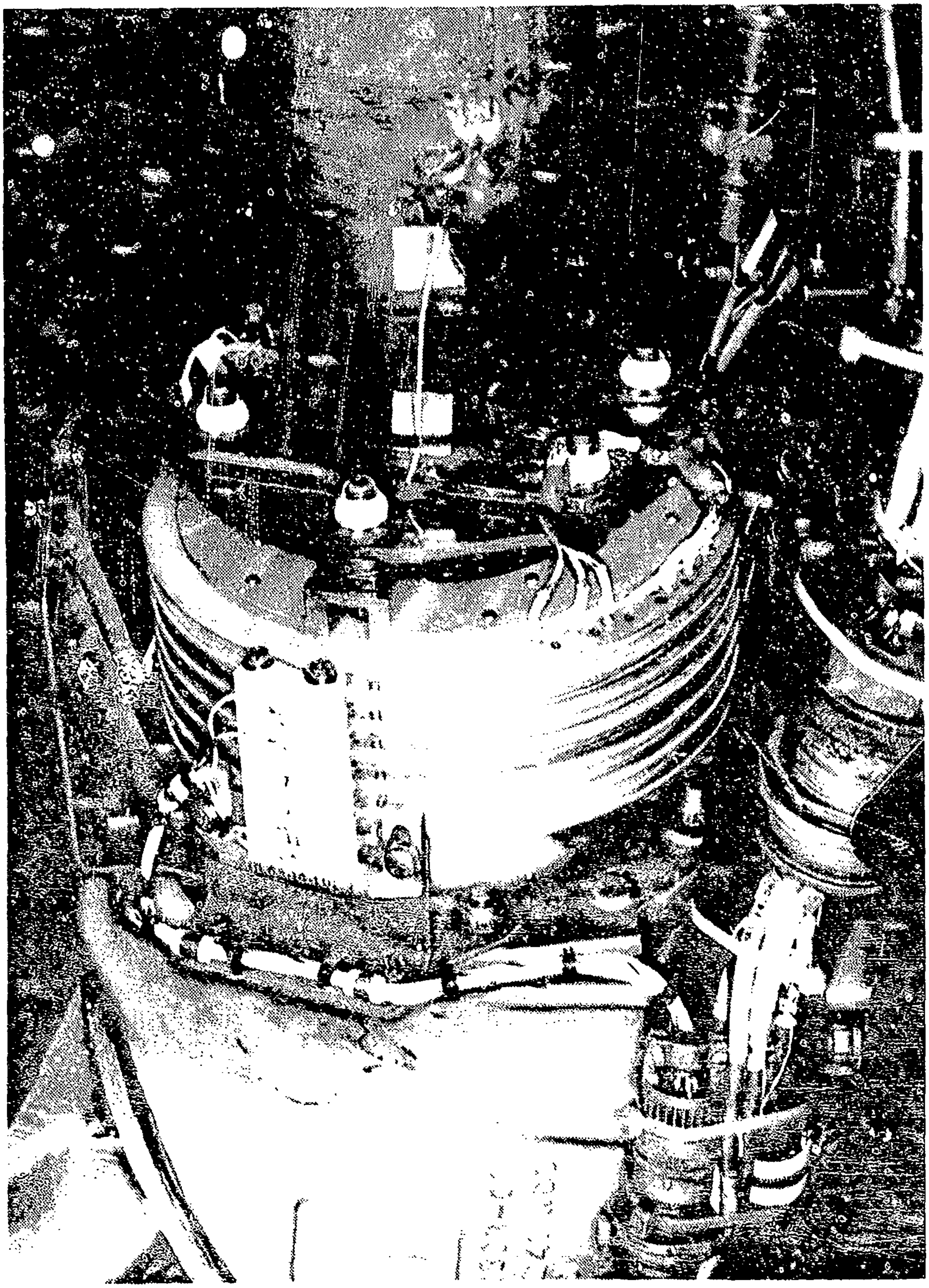


Figure F-25. Tail Rotor Drive Shaft Slip Ring Assembly

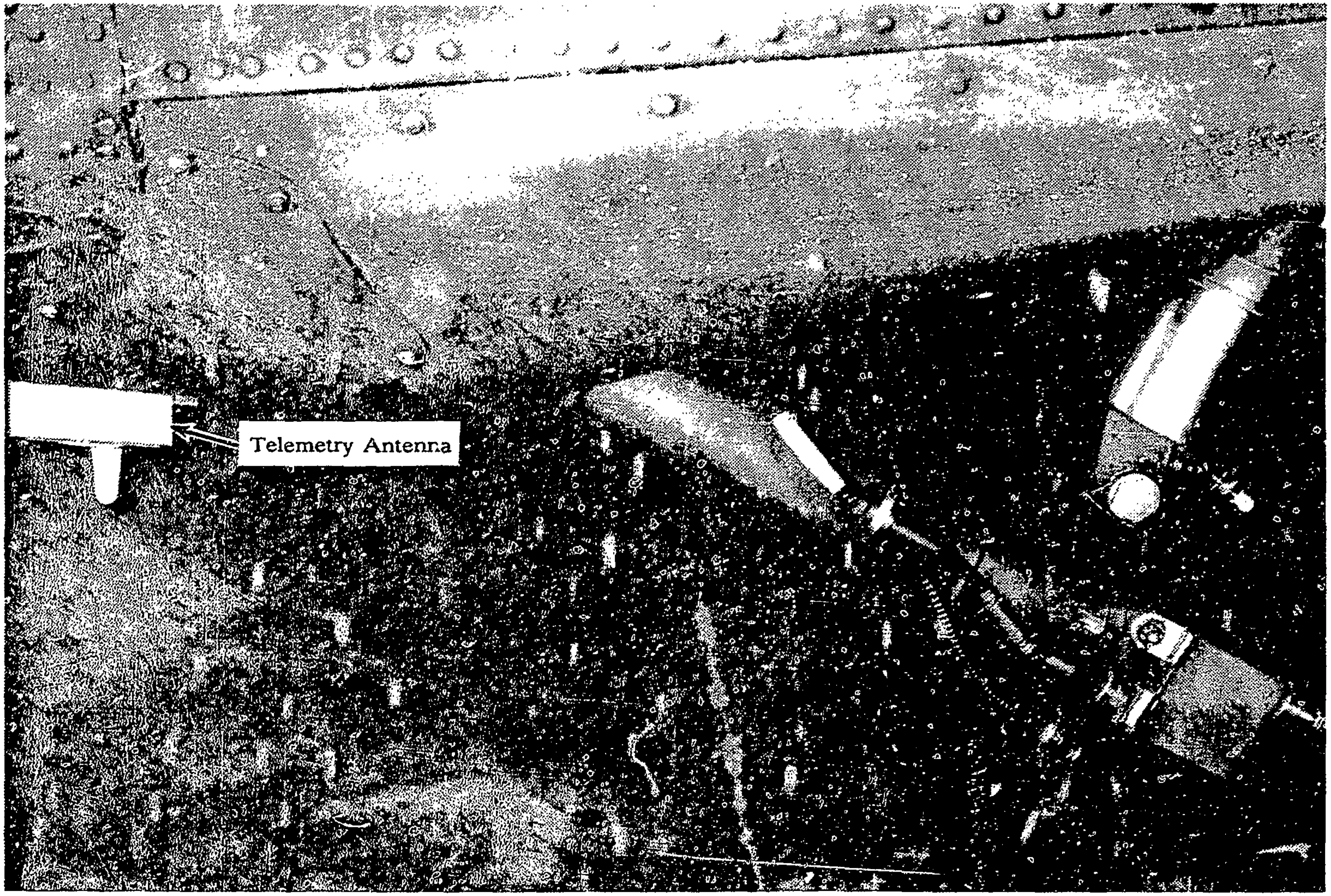


Figure F-26. Test Aircraft Telemetry Antenna Location

Figure F-27. Nose Boom Airspeed System

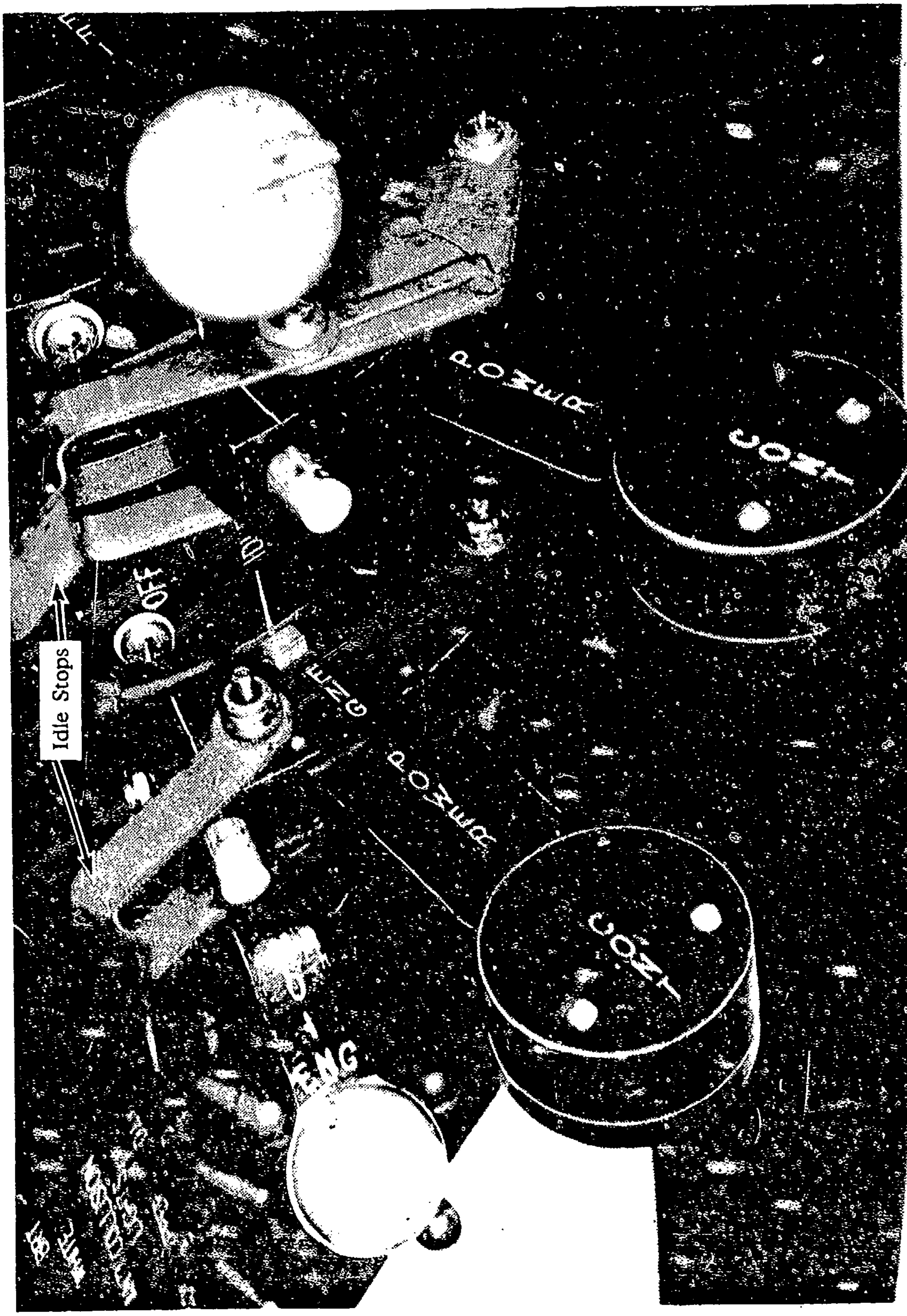


Figure F-28. Engine Power Control Modification

DISTRIBUTION

HQDA (DALO-AV)	1
HQDA (DALO-FDQ)	1
HQDA (DAMO-HRS)	1
HQDA (SARD-PPM-T)	1
HQDA (SARD-RA)	1
HQDA (SARD-WSA)	1
US Army Material Command (AMCDE-SA, AMCDE-P, AMCQA-SA, AMCQA-ST)	4
US Training and Doctrine Command (ATCD-T, ATCD-B)	2
US Army Aviation Systems Command (AMSAV-8, AMSAV-Q, AMSAV-MC, AMSAV-ME, AMSAV-L, AMSAV-N, AMSAV-GTD)	8
US Army Test and Evaluation Command (AMSTE-TE-V, AMSTE-TE-O)	2
US Army Logistics Evaluation Agency (DALO-LEI)	1
US Army Materiel Systems Analysis Agency (AMXSY-RV, AMXSY-MP)	8
US Army Operational Test and Evaluation Agency (CSTE-AVSD-E)	2
US Army Armor School (ATSB-CD-TE)	1
US Army Aviation Center (ATZQ-D-T, ATZQ-CDC-C, ATZQ-TSM-A, ATZQ-TSM-S, ATZQ-TSM-LH)	5
US Army Combined Arms Center (ATZL-TIE)	1
US Army Safety Center (PESC-SPA, PESC-SE)	2
US Army Cost and Economic Analysis Center (CACC-AM)	1
US Army Aviation Research and Technology Activity (AVSCOM) NASA/Ames Research Center (SAVRT-R, SAVRT-M (Library)	3

US Army Aviation Research and Technology Activity (AVSCOM) Aviation Applied Technology Directorate (SAVRT-TY-DRD, SAVRT-TY-TSC (Tech Library)	2
US Army Aviation Research and Technology Activity (AVSCOM) Aeroflightdynamics Directorate (SAVRT-AF-D)	1
US Army Aviation Research and Technology Activity (AVSCOM Propulsion Directorate (SAVRT-PN-D)	1
Defense Technical Information Center (FDAC)	2
US Military Academy, Department of Mechanics (Aero Group Director)	1
ASD/AFXT, ASD/ENF	2
US Army Aviation Development Test Activity (STEBG-CT)	2
Assistant Technical Director for Projects, Code: CT-24 (Mr. Joseph Dunn)	2
6520 Test Group (ENML)	1
Commander, Naval Air Systems Command (AIR 5115B, AIR 5301)	3
Defense Intelligence Agency (DIA-DT-2D)	1
School of Aerospace Engineering (Dr. Daniel P. Schrage)	1
Headquarters United States Army Aviation Center and Fort Rucker (ATZQ-ESO-L)	1
US Army Aviation Systems Command (AMSAV-EA)	1
US Army Aviation Systems Command (AMSAV-ECU)	1
US Army Aviation Systems Command (AMSAV-ESW)	1
US Army Aviation Systems Command (AMSAV-EF)	1
US Army Aviation Systems Command (AMCPM-BH)	2
Mines, Cjountermine, and Demolition, Project Manager (AMCPM-MCD)	2