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**PRELIMINARY AIRWORTHINESS
EVALUATION
EH-1H HELICOPTER QUICK FIX, PHASE 1A**

9
FINAL REPORT

19
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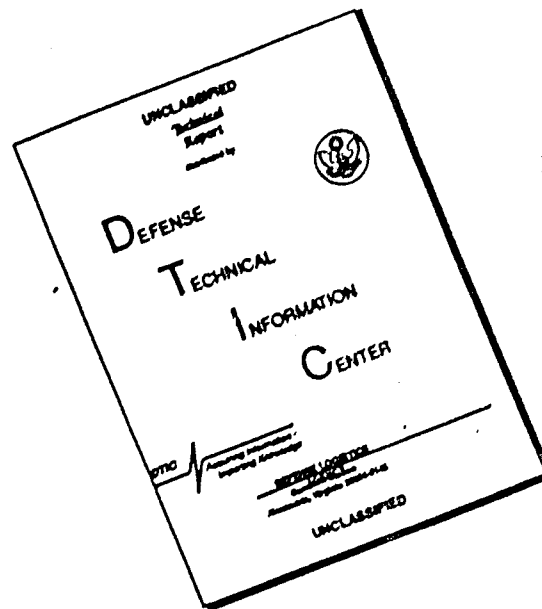
UNITED STATES ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
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20. Abstract

→ were flown. The handling qualities of the EH-1H helicopter were determined to be satisfactory with the exception of inadequate directional control in right sideward flight. An enhancing characteristic noted was the simultaneous antenna retraction systems. Inadequate directional control at right sideward velocities between 5 and 15 knots true airspeed was a deficiency. Two shortcomings were noted: the susceptibility to damage of the right FM 10-120 homing antenna during preflight/maintenance operations and the susceptibility to damage of the FM 10-242 communications antenna during running takeoff/landing maneuvers.

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DEPARTMENT OF THE ARMY
HQ, US ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND
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DRDAV-EQ

JUN 7 1978

SUBJECT: Preliminary Airworthiness Evaluation EH-1H
Helicopter Quick Fix Phase 1A

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1. The Directorate of Development and Engineering's position on the subject US Army Aviation Engineering Flight Activity (AEFA) report is provided herein:

a. Paragraph 23 and 30. Investigation was performed relative to the inadequate directional control in right sideward flight that was encountered in these tests and is described in the referenced paragraphs. Comparing the data in Figure 9 of Appendix E with the basic UH-1H and with the JUH-1H used for the testing of the Multiple Target Electronic Warfare System (MULTEWS) configuration, with the MULTEWS equipment removed resulted in the determination that the data contained in Figure 9 has an approximate one-inch shift in trim pedal position towards full left pedal. Unless this resulted from improper rigging of the aircraft, there is no known explanation for the shift. The shift is apparent in high speed forward flight from the control positions in trimmed level flight as well as in low speed flight. During the conduct of the right sideward flight case with the Quick Fix 1A aircraft, the pilot actually encountered the left pedal stop; however, the test instrumentation did not allow for full analysis of this contact. Normally the data is presented for the mean control position during sideward flight with an indication of the maximum excursion. It was not possible to perform this type of analysis for the subject test because the data recorded was from cockpit readings, and the apparent mean value in Figure 9 is in all likelihood an excursion. Future testing will be planned to determine the reasons for the shift in pedal position.

b. Paragraph 26 and 31.b. This location was picked as the optimum for the special communications antenna, and this mission equipment will not perform satisfactorily with other antenna locations. It must further be considered that this aircraft should not be evaluated as a

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SUBJECT: Preliminary Airworthiness Evaluation EH-1H
Helicopter Quick Fix Phase 1A

utility helicopter but rather a special mission electronics aircraft, hence the designation EH-1H. This means that the aircraft would tend to operate from fixed base areas remote to the Forward Edge of the Battle Area. Refueling operations would be the only practical exception. The probability of requiring a run-on landing due to tail rotor failure or hydraulic failure is considered extremely low. On the few occasions in the life of this system in which this might happen, replacement of the antenna is relatively easy; therefore, the current location is considered the optimum from an overall point of view and does not create any serious Airworthiness problems, therefore is not considered a shortcoming.

c. Paragraph 27 and 31.a. The location of the subject antenna is essentially the same as the location of the FM Homing antennas on OH-58 series helicopters. The location has not created serious field problems in that the LOH's are clearly marked NO HAND HOLD; therefore, a properly marked antenna should not constitute a shortcoming.

d. Paragraph 36. The data search included configuration which incorporated the upturn IR scoop, and it was determined that the scoop has no measurable effect on the directional control characteristics. Therefore, we do not agree with this recommendation.

2. Except as noted above, this Directorate concurs with the subject report.

FOR THE COMMANDER:



WALTER A. KATCLIFF
Colonel, GS
Director of Development
and Engineering

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INTRODUCTION

BACKGROUND

1. The United States Army Aviation Systems Command (AVSCOM)* awarded a contract to the Naval Air Rework Facility (NARF), Naval Air Station, Pensacola, Florida to fabricate, install and test an airborne radio countermeasures system installed in a UH-1H helicopter, redesignated the EH-1H. In June 1977, AVSCOM directed the US Army Aviation Engineering Flight Activity (USAAEFA) to conduct a Preliminary Airworthiness Evaluation (PAE) of the EH-1H Helicopter Quick Fix Phase 1A (ref 1, app A). A letter test plan for the PAE was published in July 1977 (ref 2).

TEST OBJECTIVE

2. The objective of the PAE was to evaluate the handling qualities of the EH-1H helicopter Quick Fix Phase 1A.

DESCRIPTION

3. The EH-1H (photo A) is an electronic configuration helicopter derived from the UH-1H helicopter by incorporating the AN/ARQ-33 radio countermeasures system and the AN/APR-39 radar signal detecting set. The EH-1H has a maximum gross weight of 9500 pounds. A detailed description of the UH-1H helicopter is included in the operator's manual (ref 3, app A). The test aircraft had a retractable antenna located under the aft section of the tail boom, a retractable antenna located under the fuselage, a fixed antenna under the nose of the aircraft, a fixed antenna mounted vertically aft of both the pilot and copilot doors, and four radar detecting set antennas, two mounted on the nose and two on the tail boom. A Bell Helicopter Textron (BHT) IR engine exhaust suppressor was also installed. A more detailed description of the EH-1H is contained in appendix B. The approximate weight of the system is 1000 pounds.

TEST SCOPE

4. The EH-1H evaluation was conducted at Naval Air Station, Pensacola, Florida (5-foot field elevation). Nine flights totaling 8.5 productive flight hours were conducted between 18 and 23 August 1977. USAAEFA installed, calibrated and maintained all instrumentation. NARF was responsible for test aircraft maintenance and logistical support during the tests. Flight restrictions and operating limitations

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

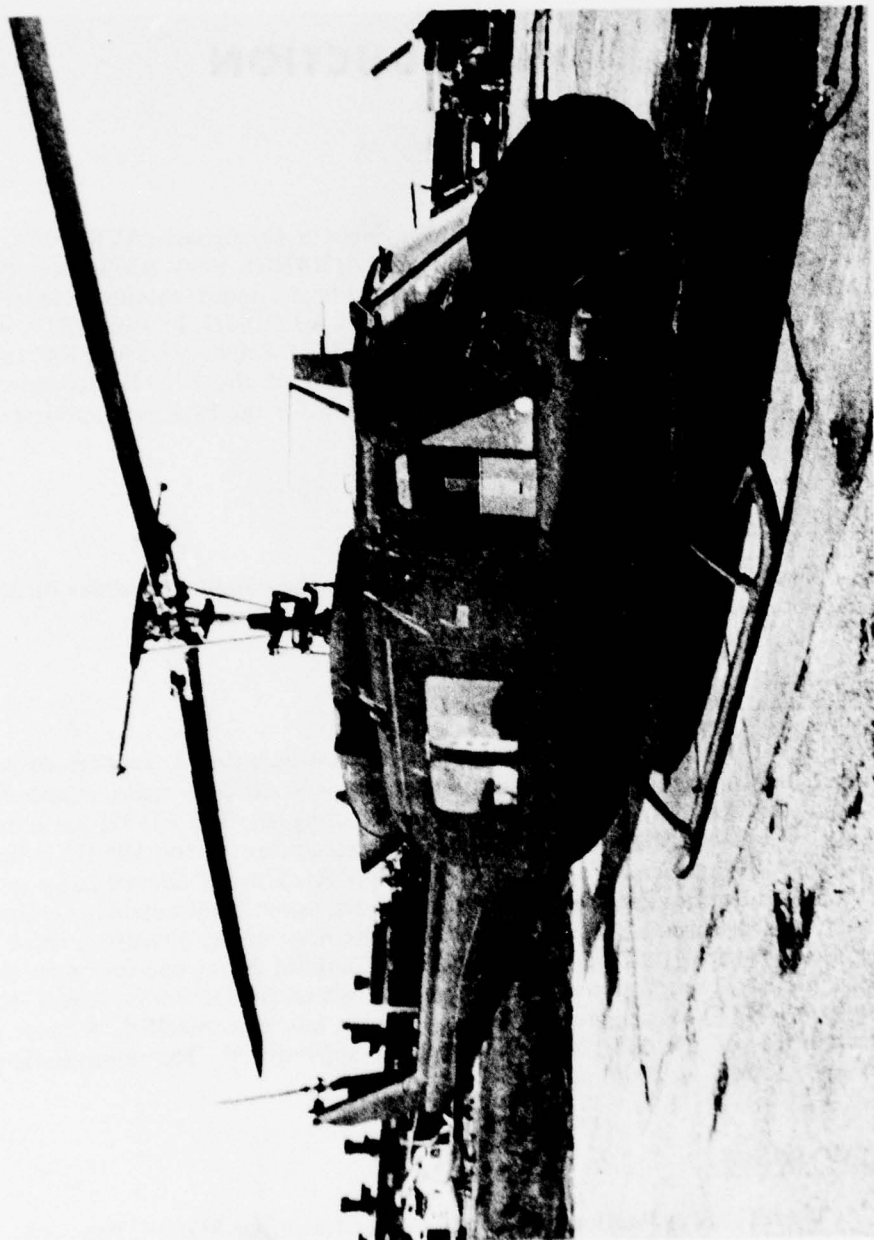


Photo A.

Table 1. Flight Test Conditions¹

Test	Gross Weight (lb)	Longitudinal Center of Gravity (in.)	Density Altitude (ft)	Calibrated Airspeed (kt)	Antenna Position
Control positions in trimmed forward flight	8320	142.1	5160	40 - 105	Ret ²
	8200	141.7	5180	40 - 105	Ext ³
Static longitudinal stability	8440, 8100	142.4, 141.4	5100, 5480	50, 77	Ret
	8320, 8200	142.1, 141.7	5100, 5500	50, 78	Ext
Static lateral-directional stability	7820, 8040	140.8, 141.1	4620, 5080	50, 77	Ret
	7900, 7980	140.7, 1460	4840, 5280	50, 77	Ext
Maneuvering and dynamic stability	7760 - 8460	140.7 - 142.4	3980 - 6200	77	Ret
	7780 - 8340	140.7 - 142.1	4100 - 6120	77	Ext
Low-speed flight characteristics	7980 - 8480	141.1 - 142.6	1020	Zero to 30 ⁴	Ret, ext
Simulated sudden engine failure	8400 - 8460	142.4	5120 - 5200	50, 77, LF ⁵	Ret, ext
				77 CL ⁶	
Aircraft reaction ⁷ during extension and retraction of antenna	8360 - 8440	142.2 - 142.4	5100 - 5400	50, 77	

¹Test conditions unless otherwise noted: Rotor speed 324 rpm, all aircraft doors closed, lateral cg 1.2 inches right.²Ret - Both retractable antennas retracted to the stowed position.³Ext - Both retractable antennas extended.⁴Knots true airspeed (KTAS).⁵LF - Level flight.⁶CL - Maximum power climb.⁷Test conducted at various rotor speeds from 314 to 324 rpm.

were established by the UH-1H operator's manual and the airworthiness release (ref 4, app A) issued by AVRADCOM. Primary emphasis was directed toward aircraft handling qualities. Aircraft test configurations included antennas extended and retracted. Flight test conditions are shown in table 1. Handling qualities were evaluated with respect to the applicable requirements of military specification MIL-H-8501A (ref 5).

TEST METHODOLOGY

5. The engineering flight test techniques described in reference 6, appendix A, were used in conducting the handling qualities tests. Flight test data were hand-recorded from calibrated test and standard cockpit instruments. A listing of test instrumentation is contained in appendix C. Pilot comments were used to aid in the analysis of data and to determine the overall qualitative assessment of the flying qualities of the EH-1H helicopter. A Handling Qualities Rating Scale (HQRS) (fig. 1, app D) was used to augment pilot comments relative to handling qualities. Data reduction analysis techniques are described in appendix D.

RESULTS AND DISCUSSION

GENERAL

6. The evaluation was conducted to determine the effects of the installation of the AN/ARQ-33 radio countermeasures system and its associated equipment on aircraft handling qualities. The handling qualities of the EH-1H helicopter were determined to be satisfactory, with the exception of inadequate directional control in right sideward flight. Inadequate directional control at right sideward velocities between 5 and 15 knots true airspeed (KTAS) is a deficiency. Two shortcomings were noted: The susceptibility to damage of the right FM 10-120 homing antenna during preflight/maintenance operations and the susceptibility to damage of the FM 10-242 communications antenna during running takeoff/landing maneuvers.

HANDLING QUALITIES

Control System Characteristics

7. Flight control system characteristics were evaluated on the ground with engine and rotor stopped, using externally supplied electric and hydraulic power. Control forces were measured with force trim ON. Cyclic and directional control system free play was negligible and control centering was positive but not absolute. Control dynamics in both systems were highly damped, with only one or two small overshoots. These characteristics were verified in flight. The control system characteristics of the EH-1H helicopter are satisfactory and are comparable to UH-1H helicopters.

Control Positions in Trimmed Forward Flight

8. Control positions in trimmed forward flight were determined under the conditions listed in table 1, using the technique described in appendix D. The data are presented in figure 1, appendix E.

9. During forward flight, the variation of longitudinal control position with airspeed was essentially linear, with increased forward cyclic required for increased airspeed. Lateral cyclic position was essentially neutral with increasing airspeed, moving 0.3 inch throughout the airspeed range tested. Directional control position moved right with increasing airspeed to approximately 70 knots calibrated airspeed (KCAS) and then moved left as airspeed was increased to never-exceed velocity (VNE). Total directional control variation was 0.5 inch throughout the airspeed range tested and was not discernible to the pilot. Antenna position had no noticeable effect on control positions. Within the scope of this test, the control positions of the EH-1H helicopter in trimmed forward flight are similar to the UH-1 helicopter and are satisfactory.

Static Longitudinal Stability

10. Collective-fixed static longitudinal stability was evaluated at the conditions listed in table 1, using the test technique described in appendix D. Test results are presented in figures 2 and 3, appendix E.

11. At a trim airspeed of 50 KCAS (fig. 2, app. E) the variation of longitudinal control position with forward airspeed indicated positive stability, although control position gradient was shallow (0.7 inch of forward cyclic from 32 to 68 KCAS). This shallow gradient made precise airspeed control difficult but normal mission tasks within this airspeed range were easily accomplished.

12. At a trim airspeed of 77 KCAS (fig. 3, app. E), the variation of longitudinal control position with forward airspeed indicated positive stability and control position gradient was shallow (0.6 inch of forward cyclic from 58 to 96 KCAS). Longitudinal control position gradient became more shallow at approximately 86 KCAS. At both trim airspeeds, antenna position had minimal effect on static longitudinal stability. Within the scope of this test the static longitudinal stability of the EH-1H is similar to the UH-1 helicopter and is satisfactory.

Static Lateral-Directional Stability

13. Static lateral-directional stability characteristics were evaluated at the conditions listed in table 1, using the test techniques described in appendix D. Test aircraft instrumentation did not allow sideslip to be measured; therefore, lateral-directional handling qualities were referred to side force (ball position), rather than sideslip. The side-force characteristics of the UH-1H, evaluated under similar conditions (ref 7, app. A), were positive (increasing ball displacement with increasing sideslip). Test results are presented in figures 4 and 5, appendix E.

14. Static directional stability, as indicated by the variation of directional control position with ball position, was positive (left pedal required to maintain right ball position) at the airspeeds and antenna positions tested. At a trim speed of 50 knots indicated airspeed (KIAS), directional control position with ball position gradient became shallow at higher ball positions (1/2 ball width and greater) but was not discernible to the pilot. Directional stability was qualitatively noted as being the same as UH-1H helicopters and was unchanged by antenna position. Ball-centered flight was easy to maintain during mission maneuvering tasks. Within the scope of this test, the directional stability of the EH-1H is satisfactory.

15. Dihedral effect and side force characteristics were qualitatively noted as being the same as UH-1H helicopters and were unchanged by antenna position. Within the scope of this test, the dihedral effect and side-force characteristics of the EH-1H helicopter are satisfactory.

Maneuvering Stability

16. Maneuvering stability characteristics were evaluated at the conditions shown in table 1, using the techniques described in appendix E. The variation of longitudinal control position with normal load factor was positive (aft control movement with increasing load factor) and similar to UH-1H helicopters. At bank angles in excess of 45 degrees, precise airspeed control required considerable pilot effort. Mission maneuvering tasks do not normally require precise airspeed control at large bank angles and this characteristic should not adversely affect mission accomplishment. Antenna position had minimal effect on maneuvering stability. Within the scope of this test, the maneuvering stability characteristics of the EH-1H helicopter are satisfactory.

Dynamic Stability

17. The longitudinal and lateral-directional dynamic stability characteristics of the EH-1H were evaluated at the conditions listed in table 1, utilizing the techniques described in appendix D. Short-term response was essentially deadbeat. The response to external gust input was also deadbeat. Antenna position had negligible effect on these responses.

18. Long-term dynamic response was evaluated at 80 KIAS. Aircraft response was oscillatory and well damped, with a period of approximately 35 seconds for antennas both extended and retracted.

19. Spiral stability was evaluated at 80 KIAS. After initiating a 5-degree right pedal-only turn and then returning pedal to trim, the aircraft slowly returned to level flight and then continued to slowly increase left bank angle. After initiating a 5-degree left bank angle and returning the pedal to trim, the aircraft slowly continued increasing left bank angle. The divergent spiral stability to the left occurs very slowly and should not prevent the pilot from conducting mission tasks. Antenna position had negligible effect on spiral stability. Within the scope of this test, the dynamic stability characteristics of the EH-1H helicopter are satisfactory and similar to previous UH-1H helicopters.

Low-Speed Flight Characteristics

20. The handling qualities of the EH-1H helicopter during low-speed flight were evaluated at the conditions shown in table 1, using the techniques described in appendix D. Winds during this test series were less than 5 knots. Test results are presented in figures 8 and 9, appendix E.

21. The variation of control position with true airspeed in low-speed rearward and forward flight (fig. 8, app. E) showed varying gradients in all axes. There were no objectionable control changes with the antenna in either position in low-speed rearward and forward flight. At no time was the directional control margin less than 10 percent. Within the scope of this test, the handling qualities

of the EH-1H helicopter during low-speed forward and rearward flight are satisfactory.

22. The variation of lateral and longitudinal control position with true airspeed in sideward flight (fig. 9, app. E) also showed varying gradients in both axes. As left sideward velocity was increased above 10 KTAS, a large right directional control position change was required. This change in directional control position was noticeable but not objectionable to the pilot and is similar to UH-1H helicopters (ref 8, app A).

23. As right sideward velocity was increased above 5 KTAS, large pedal position changes were required to maintain heading, which resulted in the directional control limit being reached. Further increases in sideward velocity to 15 KTAS required a rapid directional control position reversal. In gusty conditions during right sideward flight or while hovering in right crosswinds, directional control could be lost. Inadequate directional control at right sideward velocities between 5 and 15 KTAS constitutes a deficiency. This characteristic was not noted on previous UH-1H test programs (ref 8, app A) during which the BHT IR suppressor was not installed. Antenna position had a negligible effect on aircraft handling qualities in sideward flight. Future testing of a UH-1H or EH-1H with the BHT IR suppressor installed should be conducted to determine if the suppressor caused the inadequate directional control in right sideward flight. The low-speed flight characteristics of the EH-1H helicopter failed to meet the intent of paragraph 3.3.6 of MIL-H-8501A, in that insufficient directional control would be available to generate any yaw displacement while hovering in a 10-knot right crosswind.

Simulated Sudden Engine Failures

24. The response of the test helicopter to simulated sudden engine failures was evaluated at the conditions shown in table 1. During simulated sudden engine failures at 50 KIAS, the primary cue to loss of power was a left yaw acceleration, accompanied by a change in yaw attitude of approximately 20 degrees. The aircraft entered a mild left roll followed by a nose-down pitch. The maximum collective delay time during the tests was approximately 3 seconds. The maneuver was mild and the aircraft was easily controlled during the recovery (HQRS 2). Rotor speed decay stopped quickly on lowering the collective, and rotor speed control during recovery was excellent.

25. During simulated sudden engine failures at 77 KCAS in level flight and maximum power climbs, the primary cue to loss of power was a left roll. Collective delay time varied from 2 to 3 seconds. Aircraft control during the recovery required little pilot compensation (HQRS 2). Antenna position had no effect on aircraft response to a sudden engine failure. Within the scope of this test, the response of the EH-1H helicopter to a simulated sudden engine failure was satisfactory and was the same as in UH-1H helicopters.

MISCELLANEOUS TESTS

Antenna Locations

26. The EH-1H helicopter has seven additional external antennas, as compared to a standard UH-1H helicopter. An FM 10-242 communications antenna is mounted under the nose of the aircraft (fig. 1). This antenna is used with a second FM transceiver controlled by the mission equipment operators. The design/location of this fixed antenna provides minimum ground clearance and effectively precludes all operational running takeoff/landing maneuvers. A running landing required by an actual hydraulics failure or tail rotor failure could damage or destroy this antenna. Additionally, the use of unimproved tactical refueling sites could damage or destroy this antenna. The susceptibility to damage during running takeoff/landing maneuvers of the FM 10-242 communications antenna is a shortcoming.

27. One FM 10-120 homing antenna is mounted vertically aft of the pilot and copilot doors (fig. 1). The antenna mounted aft of the pilot door inhibits normal use of the two steps mounted in the bulkhead for climbing on top of the aircraft. The antenna location is conducive to its being used as a handhold or step: either use can easily damage the antenna. The susceptibility to damage during preflight/maintenance operations of the right FM 10-120 homing antenna is a shortcoming.

Antenna Cockpit Controls

28. The EH-1H helicopter has two retractable antennas mounted under the aircraft which are controlled and monitored by the pilot/copilot. Two covered switches, mounted on the center console (photo B) are used to control antenna position. Should an emergency exist, either the pilot or copilot can simultaneously retract both antennas by depressing the lowest button on the cyclic grip (fig. 2). Should the pilot forget to retract the antennas prior to landing, an automatic retraction will occur when the absolute altitude selected on the radar altimeter is passed. A worded light-segment is installed on the instrument panel to remind the pilot to turn on the radar altimeter. The simultaneous antenna retraction systems of the EH-1H helicopter are an enhancing characteristic and should be included in future designs.

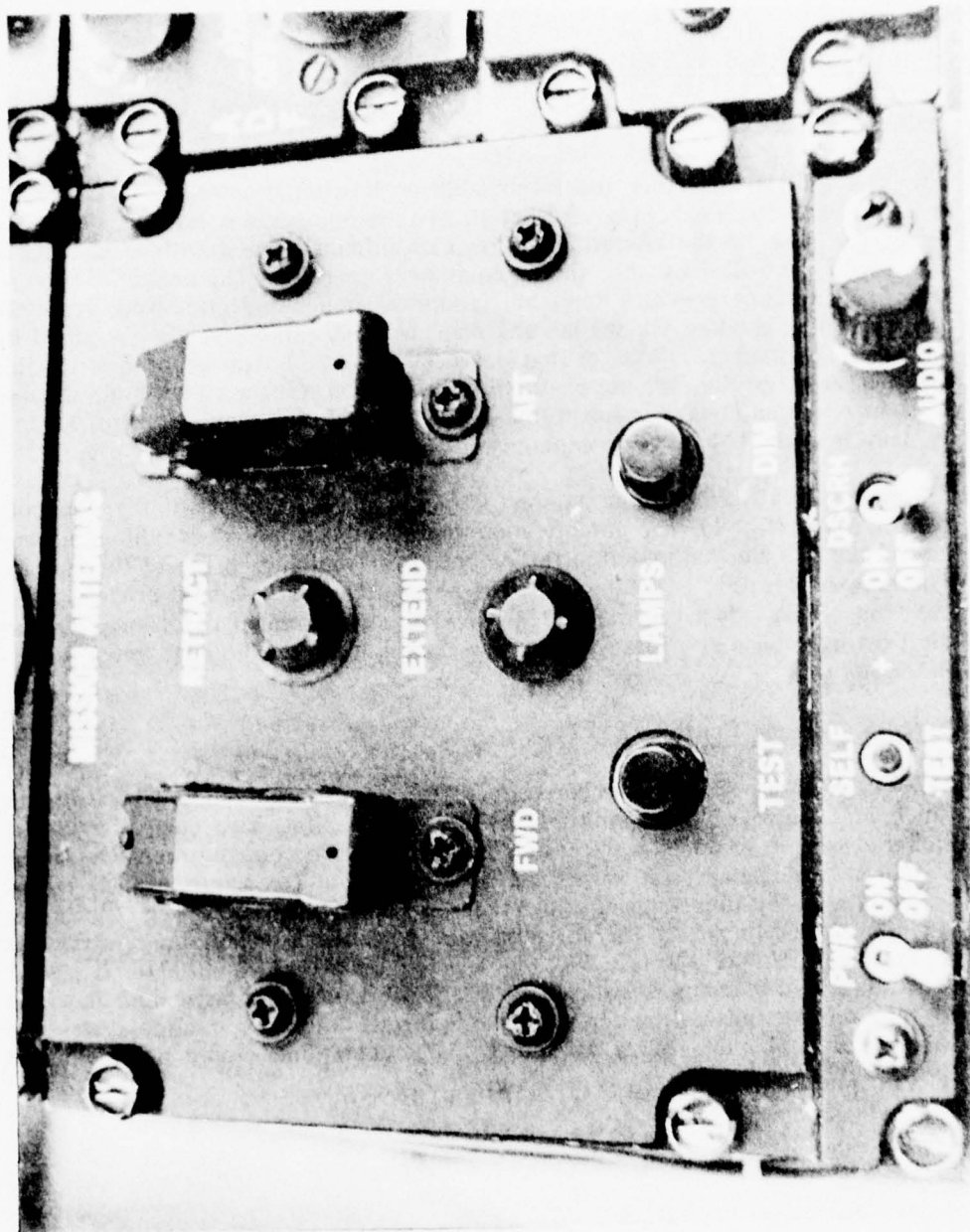


Photo B. Mission Antenna Switch Panel.

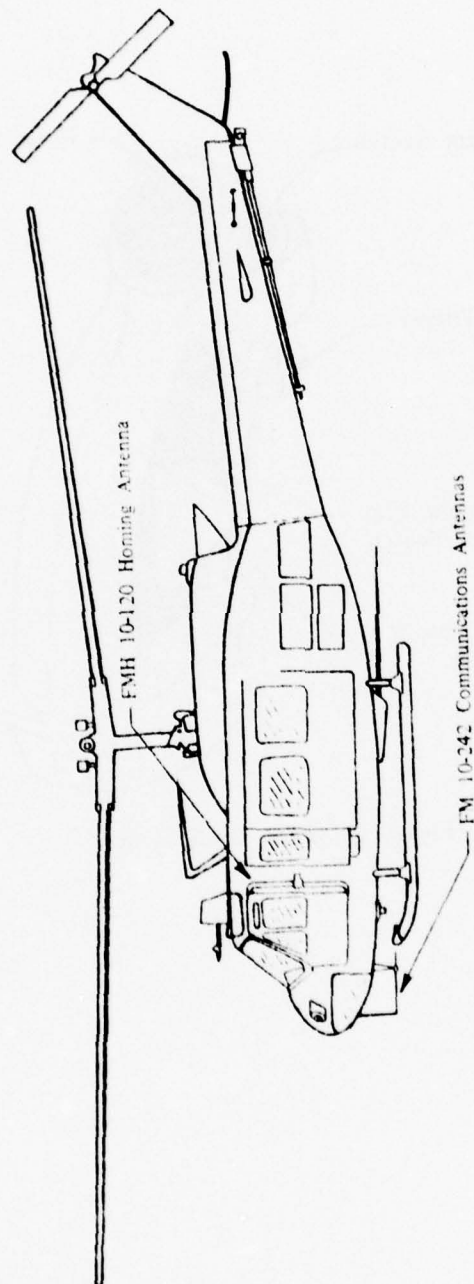


Figure 1. EH-1H Antenna Locations

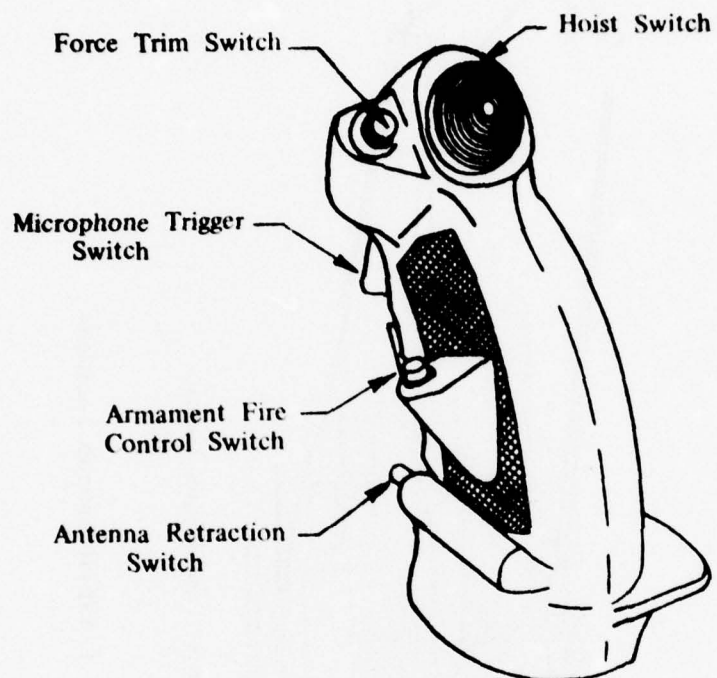


Figure 2. Pilot Cyclic Grip.

CONCLUSIONS

GENERAL

29. Within the scope of this evaluation, the following conclusions relating to the EH-1H helicopter were made:

- a. The handling qualities of the EH-1H helicopter are satisfactory with the exception of inadequate directional control in right sideward flight (para 23).
- b. The simultaneous antenna retraction systems are an enhancing characteristic (para 28).
- c. One deficiency and two shortcomings were noted.

DEFICIENCY

30. The following deficiency was identified during these tests: inadequate directional control at right sideward velocities between 5 and 15 KTAS (para 23).

SHORTCOMINGS

31. The shortcomings listed below were identified during these tests and are listed in order of relative importance.

- a. Susceptibility to damage during preflight/maintenance operations of the right FM 10-120 homing antennas (para 27).
- b. Susceptibility to damage during running takeoff/landing maneuvers of the FM 10-242 communications antenna (para 26).

SPECIFICATION COMPLIANCE

32. The low-speed flight characteristics of the EH-1H helicopter failed to meet the intent of paragraph 3.3.6 of MIL-H-8501A, in that insufficient directional control would be available to generate any yaw displacement while hovering in a 10-knot right crosswind (para 23).

RECOMMENDATIONS

33. The enhancing characteristic should be included in future designs (para 29).
34. The deficiency must be corrected (para 30).
35. The shortcomings should be corrected (para 31).
36. Future testing of an EH-1H or UH-1H with the BHT IR suppressor installed should be conducted to determine if the IR suppressor caused the inadequate directional control in right sideward flight (para 23).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, DRSAV-EQI, 6 June 1977, subject: EH-1H Helicopter Quick Fix Phase 1A.
2. Letter, USAAEFA, DAVTE-TB, 5 August 1977, subject: Abbreviated Test Plan, EH-1H Helicopter Quick Fix Phase 1A.
3. Technical Manual, TM 55-1520-210-10, *Operator's Manual, Army Model UH-1D/H Helicopters*, 25 August 1971.
4. Letter, AVRADCOM, DRDAV-EQI, 10 August 1977, subject: Airworthiness Release of EH-1H Helicopter for Quick Fix Phase 1A.
5. Military Specification, MIL-H-8501A, *Helicopter Flying and Ground Handling Qualities; General Requirements For*, 7 September 1961, with Admendment 1, 3 April 1962.
6. Flight Test Manual, Naval Air Test Center, FTM No. 101, *Helicopter Stability and Control*, 10 June 1968.
7. Final Report, US Army Aviation Systems Test Activity (USAASTA), Project No. 70-23, *Investigation of Engine Rigging, Airspeed and Rotor RPM Effects on Steady State Autorotational Performance*, December 1970.
8. Final Report, (USAASTA), Project No. 66-04, *Engineering Flight Test, YUH-1H Helicopter, Phase D (Limited)*, November 1970.

APPENDIX B. DESCRIPTION

GENERAL

1. The test helicopter, SN 69-15578, is a UH-1H helicopter incorporating an AN/ARQ-33 radio countermeasures system and AN/APR-39 radar signal detecting set and redesignated the EH-1H. The external modifications were the addition of retractable antennas under the fuselage and tail boom, a fixed antenna under the nose, fixed antennas mounted aft of the pilot and copilot doors, and two fixed antennas mounted on the nose and on the tail boom (fig. 1). A BHT IR engine exhaust suppressor was also installed. Cockpit instruments and controls were added to allow the pilot/copilot to control and monitor antenna position and voice security operation.

ELECTRONIC EQUIPMENT

2. The AN/ARQ-33 radio countermeasures system is capable of detecting radiated RF signals and of initiating countermeasure action against an RF emitter. The majority of the equipment is housed in three consoles within the helicopter cargo compartment, as shown in figure 2. Additional equipment is located in the aft radio compartments, aft electrical compartment, tail boom, nose, and cockpit. Antenna position is controlled and monitored by the pilot/copilot. Covered switches are provided on the center console to control individual antenna extension/retraction (photo 1). The pilot or copilot can retract both antennas simultaneously by depressing the lowest button on the cyclic grip (fig. 3). An automatic antenna retraction feature is provided using the installed radar altimeter. When the absolute altitude becomes less than that selected on the radar altimeter, the antennas automatically retract. Monitor lights are mounted on the center instrument panel which indicate antenna position, antenna in transit, radar altimeter inoperative, antenna stalled, and FM radio transmitting either secure or nonsecure.

3. The AN/APR-39 radar signal detecting set is capable of detecting radiated radar signals and discriminating between aerial surveillance and weapons systems radar signals. Radar site location and activity information are furnished the pilot by means of a cathode ray tube mounted in the cockpit.

ENGINE

4. A T53-L-13 turboshaft engine is installed in the EH-1H helicopter. This engine employs a two-stage, axial-flow, free-power turbine driving a five-stage axial and one-stage centrifugal compressor; variable inlet guide vanes; and an external annular combustor. A 3.2105:1 reduction gear located in the air inlet housing reduces power turbine speed to a nominal output shaft speed of 6600 rpm. The engine reduction gearbox is limited to 1175 ft-lb torque for 30 minutes and to 1110 ft-lb torque

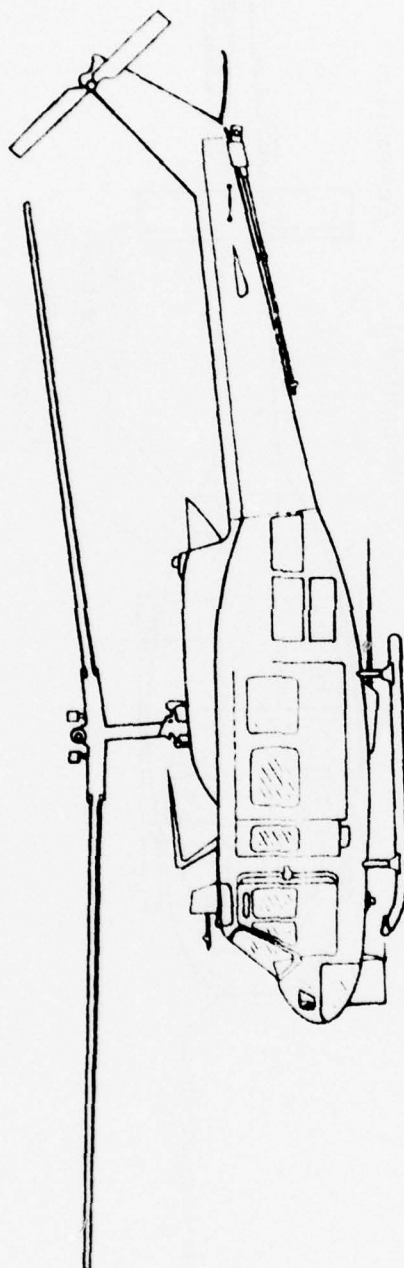


Figure 1. EH-1H Antenna Locations.

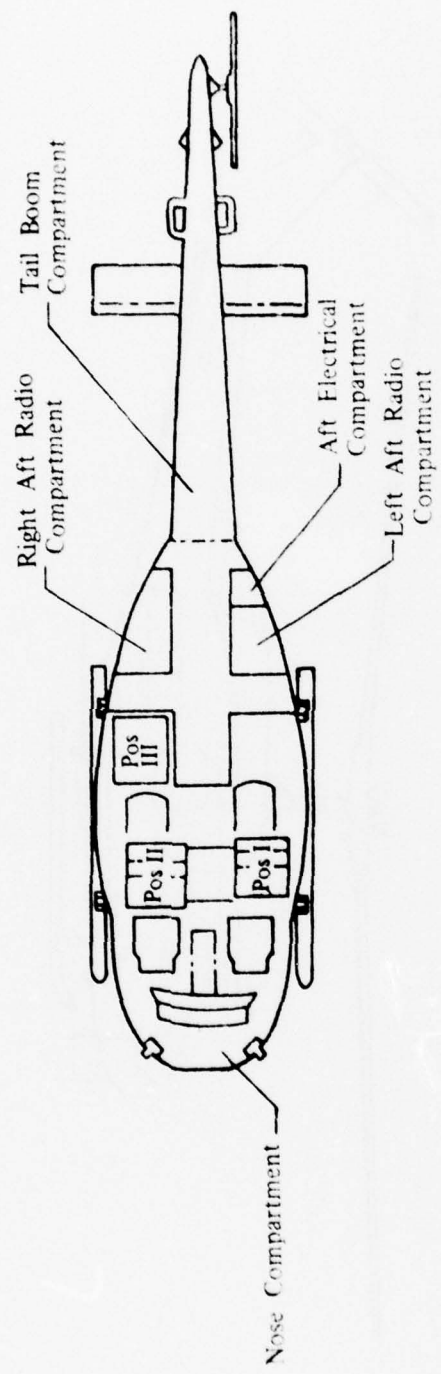


Figure 2. FH-1H Equipment Locations.

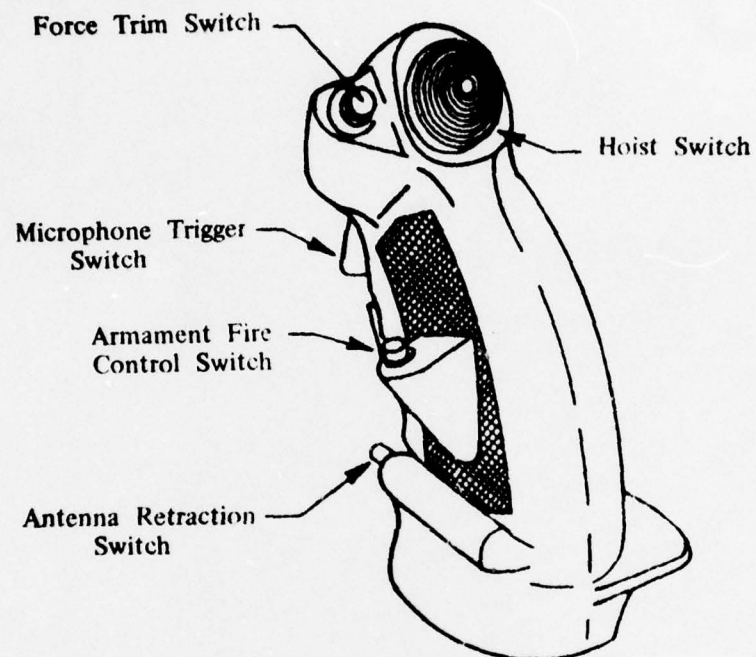


Figure 3. Pilot Cyclic Grip.

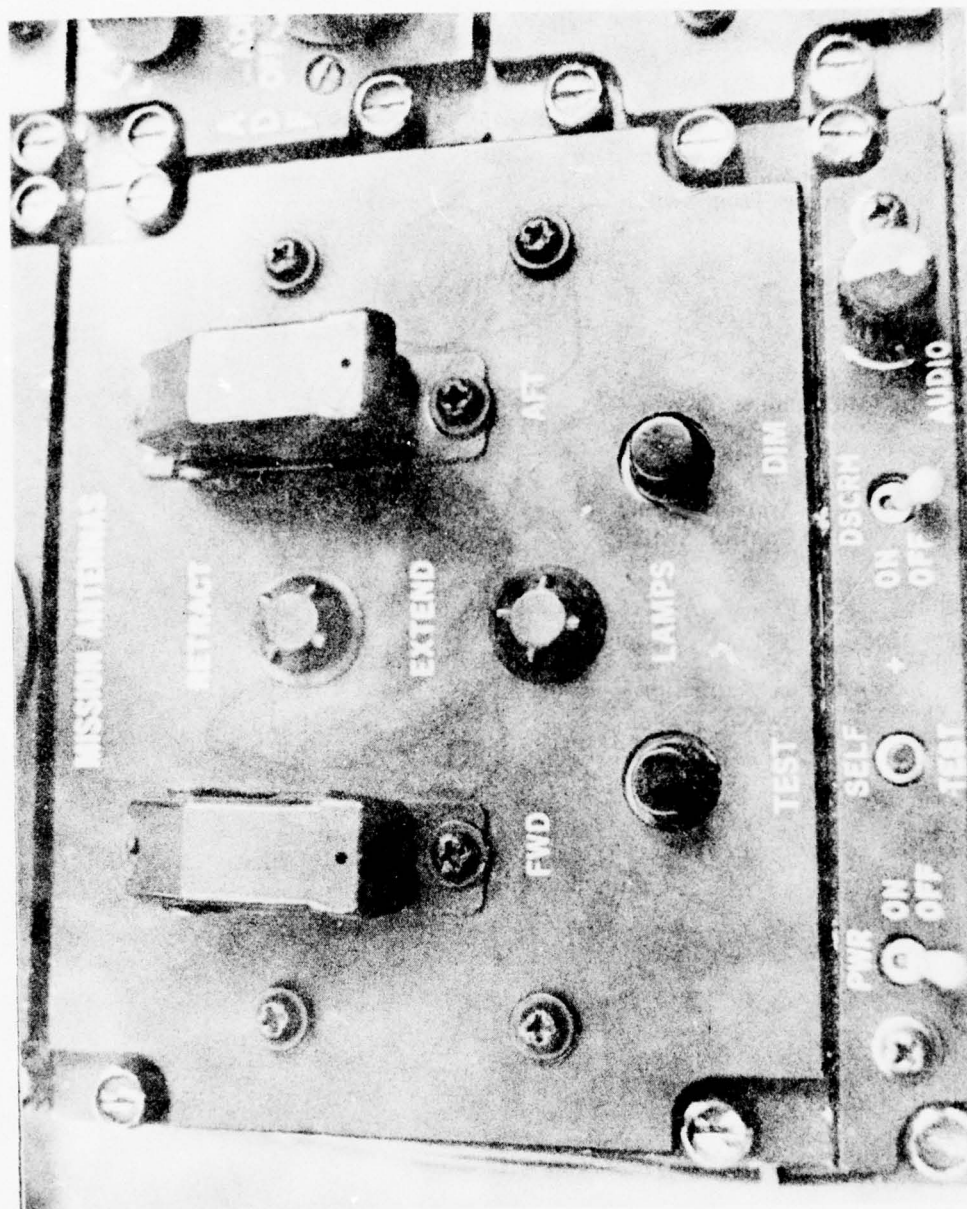


Photo 1. Mission Antenna Switch Panel.

for continuous operation. A thermocouple harness located in the exhaust diffuser measures exhaust gas temperature (EGT) and displays this information in the cockpit as EGT on the cockpit instrument.

TRANSMISSION AND TAIL ROTOR DRIVE

5. The transmission is mounted forward of the engine and is coupled to the engine by a short drive shaft. The transmission is basically a reduction gearbox which transmits engine power at reduced rotor speed to the main and tail rotors by means of a two-stage planetary gear train. The transmission is limited to 1100 shp. The transmission incorporates a free-wheeling unit at the input drive which provides a disconnect from the engine in case of a power failure and allows the aircraft to autorotate. The tail rotor is powered by a drive gear on the lower aft section of the transmission.

CONTROL SYSTEM

6. The control system of the EH-1H is identical to the UH-1H, a positive mechanical type boosted by a single hydraulic boost system. The system includes a cyclic control stick, a collective pitch control lever, directional control pedals, and a synchronized elevator connected mechanically to the longitudinal cyclic control system. The cyclic and directional controls feature a force trim device which provides centering and force gradient to the controls. The centering and force gradient are accomplished by springs and magnetic brake release assemblies which enable either pilot to trim the controls as desired.

7. A flight control rigging check during the tests, performed in accordance with the procedures outlined in TM-55-1520-210-20, demonstrated that the cyclic, collective pitch and directional controls were within prescribed limits.

BASIC AIRCRAFT INFORMATION

8. Principal dimensions and general data concerning the EH-1H helicopter are as follows:

Overall Dimensions

Length, rotor turning	57 ft, 1.1 in.
Height, tail rotor vertical	14 ft, 5.5 in.

Main Rotor

Diameter	48 ft
Disc area	1,809 ft ²
Solidity	0.0464
Number of blades	2
Blade chord	21 in. (constant)
Blade twist linear, root to tip	-10 deg
Airfoil	NACA 0012

Tail Rotor

Diameter	8 ft, 6 in.
Disc area	56.7 ft ²
Solidity	0.105
Number of blades	2
Blade chord	8.41 in. (constant)
Blade twist[	Zero deg
Airfoil	NACA 0015

Fuselage

Length (nose to tail)	41 ft, 5 in.
Height:	
Top of mast	14 ft, 0.7 in.
Top of cabin	7 ft, 11.6 in.
Width:	
Skid gear	8 ft, 6.6 in.
Synchronized elevator	9 ft, 4.3 in.

WEIGHT AND BALANCE

9. Aircraft weight and longitudinal and lateral cg were determined prior to testing. With fuel tanks drained, full oil trapped, and minimal instrumentation installed (see app C), the aircraft weight was 6286 pounds, with a longitudinal cg at fuselage station (FS) 148.1 and a lateral cg of 1.2 inches right of center line. A typical mission loading is shown in table 1.

Table 1. Weight and Balance - Typical Mission Loading.¹

Item	Weight	Moment/100
Basic aircraft	6286	9317
Oil	34	59
Pilots	400	187
Crew	400	468
Fuel (full)	1359	2078
Personal equipment	100	120
	8579	12229

¹Center of gravity: FS 142.5.

APPENDIX C. INSTRUMENTATION

1. Test instrumentation was installed, calibrated, and maintained by USAAEFA. The following parameters were displayed:

- Airspeed (ship's system)
- Altitude (ship's system)
- Main rotor speed
- Center-of-gravity normal acceleration

2. Cyclic and pedal positions were recorded on plotting boards mounted forward of the cyclic and on the floor adjacent to the copilot seat, respectively.

3. Ground speeds observed during low-speed flight tests were measured using a radar speedgun mounted on the toe of the left skid. A remote ground speed readout was mounted in the cockpit.

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

TEST TECHNIQUES

General

1. All tests were conducted with antennas retracted and repeated with antennas extended.

Control System Characteristics

2. Tests were conducted with the aircraft in a static condition on the ground, utilizing external power sources to pressurize both hydraulic flight control systems. Breakout forces (including friction) were measured by recording the force required to initiate first movement on the plotting board. Force gradients were determined by displacing the control from a trim position at a rate of 0.1 to 0.15 inch per second and recording the forces applied and the stick displacement.

Control Positions in Trimmed Forward Flight

3. Control positions in trimmed level flight were evaluated. Data were obtained by stabilizing at ball-centered flight in 10-knot increments, trimming control forces to zero, and recording control position.

Collective-Fixed Static Longitudinal Stability

4. Data were obtained by trimming the aircraft in ball-centered level flight at the desired airspeed and securing the collective control in that position. Airspeed was then varied ± 20 knots from trim in 5-knot increments, utilizing the cyclic and directional controls only, and allowing altitude to vary as necessary. Control positions were recorded at each airspeed.

Static Lateral-Directional Stability

5. Tests were conducted in level flight by trimming the aircraft in ball-centered flight at the desired airspeed and securing the collective control. Data were obtained by varying ball position incrementally to the limits of the sideslip envelope. Collective position, airspeed, and aircraft ground track were held constant and altitude allowed to vary as required. Control positions and aircraft attitude were recorded at each stabilized point.

Maneuvering Stability

6. Maneuvering stability tests were accomplished by initially stabilizing the helicopter in ball-centered level flight at the desired airspeed and recording the

trim condition. Load factor was then increased by stabilizing the helicopter at increasing bank angles in left and right turns. Airspeed and collective were maintained constant and altitude allowed to vary. Ball-centered flight was maintained throughout all the maneuvers.

Dynamic Stability

7. Tests were initiated in ball-centered level flight. Data were qualitatively obtained by evaluating the aircraft motions that resulted from pulse-type inputs about the longitudinal, lateral, and directional axes. Each input was accomplished by rapidly displacing the particular control approximately 1 inch from trim, holding in this position for 0.5 second, then rapidly returning to the trim position and holding until aircraft motions were damped or corrective action became necessary. All controls other than the input control remained fixed during the test. Additional lateral-directional characteristics were evaluated by returning the controls to level flight trim from a sideslip condition and noting the subsequent aircraft motions. Long-term dynamic response in forward flight was observed by displacing the aircraft from the trim airspeed using longitudinal cyclic. When an airspeed change of 20 knots was achieved, the control was returned to the trim position and held fixed at trim while the response of the aircraft was observed. The spiral stability was determined by stabilizing the aircraft in level flight, then initiating a turn in either direction using pedal only. After a 5-degree bank was reached, the pedal was returned to trim and aircraft response observed.

Low-Speed Flight Characteristics

8. Data were obtained by trimming the aircraft at 25 feet altitude in sideward, rearward, and forward flight at various ground speeds up to limit airspeeds. A skid-mounted radar speedgun provided ground speed information. Control positions were recorded at each airspeed.

Simulated Sudden Engine Failures

9. Tests were initiated in ball-centered level and climbing flight by rapidly closing the throttle to the flight-idle position to simulate a loss in power. Following the simulated engine failure, all flight controls were held fixed until collective application was necessary to maintain rotor speed within established limits. Aircraft response subsequent to a sudden engine failure and the capability of the aircraft to transition safely into power-off autorotation were qualitatively evaluated.

Data Analysis Methods

10. Handling qualities data were evaluated using standard test methods described in reference 6, appendix A. Handling qualities ratings were quantified using figure 1.

APPENDIX E. TEST DATA

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<u>Figure</u>	<u>Figure Number</u>
Control Positions in Trimmed Forward Flight	1
Collective-Fixed Static Longitudinal Stability	2 and 3
Static Lateral-Directional Stability	4 and 5
Maneuvering Stability	6 and 7
Low-Speed Forward and Rearward Flight	8
Sideward Flight	9

FIGURE 1
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
EH-TH USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION	ANTENNA POSITION
		LONG (IN.)	LAT (IN.)					
○	8320	142.1(AFT)	1.2(RT)	5160	17.5	324	LEVEL	RETRACTED
□	8200	141.7(AFT)	1.2(RT)	5180	17.5	324	LEVEL	EXTENDED

NOTE: BALL-CENTERED TRIM CONDITION.

TOTAL DIRECTIONAL CONTROL TRAVEL = 6.2 INCHES

DIRECTIONAL
CONTROL POSITION
(IN. FROM FULL LEFT)

RT 5
4
3
2
LT 1

TOTAL LATERAL CONTROL TRAVEL = 12.6 INCHES

LATERAL
CONTROL POSITION
(IN. FROM FULL LEFT)

RT 8
7
6
LT 4

TOTAL LONGITUDINAL CONTROL TRAVEL = 12.7 INCHES

LONGITUDINAL
CONTROL POSITION
(IN. FROM FULL FWD)

AFT 4
3
2
FWD 0

CALIBRATED AIRSPEED (KNOTS)

FIGURE 2
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
 EH-1H HSA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	ANTENNA POSITION
		LONG (IN.)	LAT (IN.)				
⊙	8440	142.4(AFT)	1.2(RT)	5100	17.5	324	RETRACTED
⊖	8320	142.1(AFT)	1.2(RT)	5100	17.5	324	EXTENDED

NOTES: 1. SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM POINT.
 2. BALL-CENTERED TRIM CONDITION.

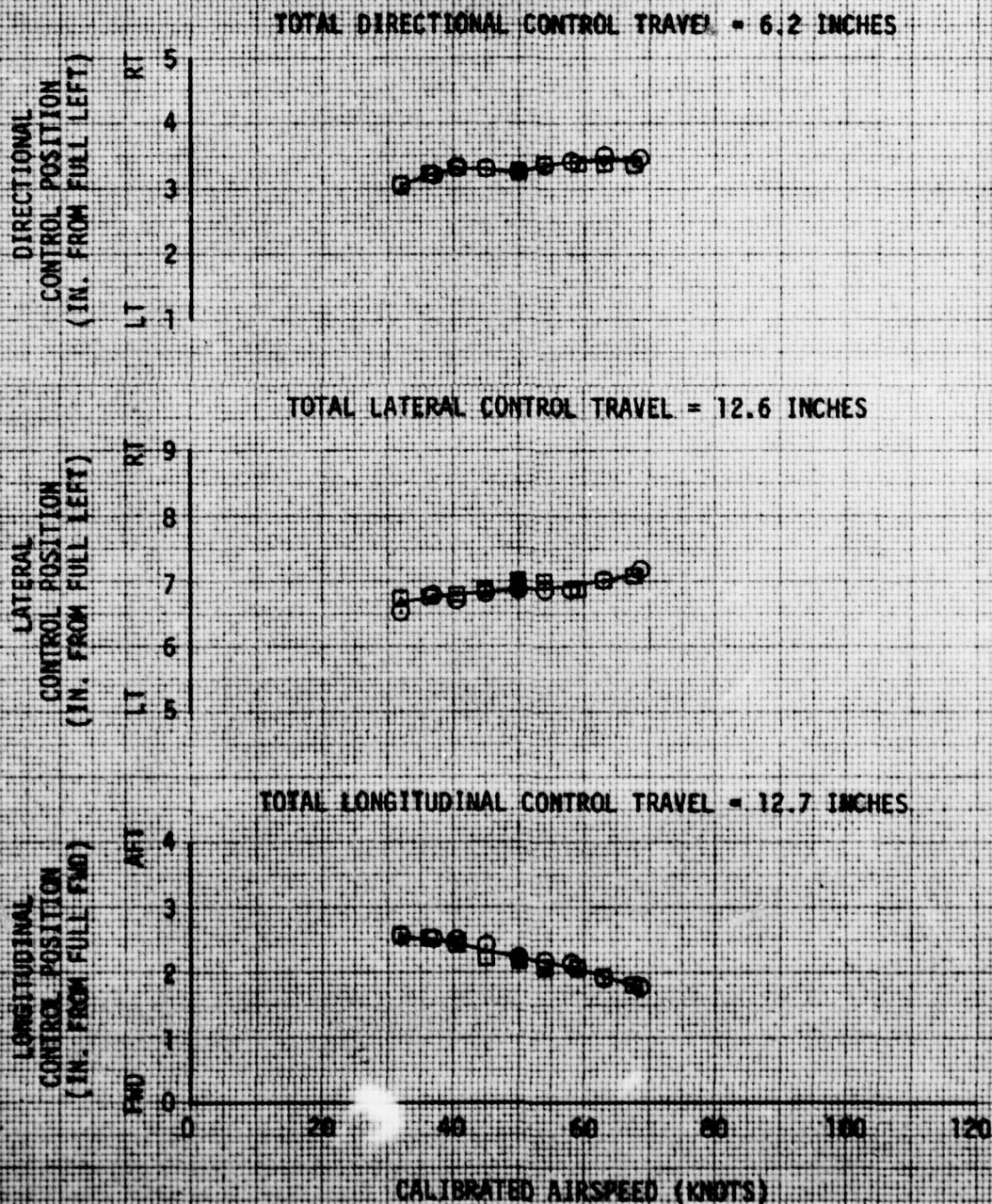
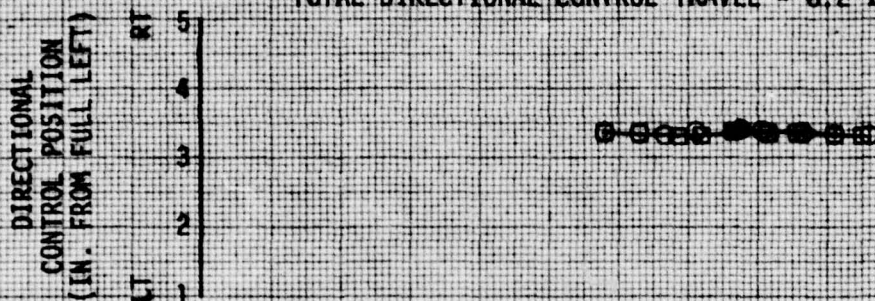


FIGURE 3
COLLECTIVE-PIED STATIC LONGITUDINAL STABILITY
IN-1N USA S/N 55-15076

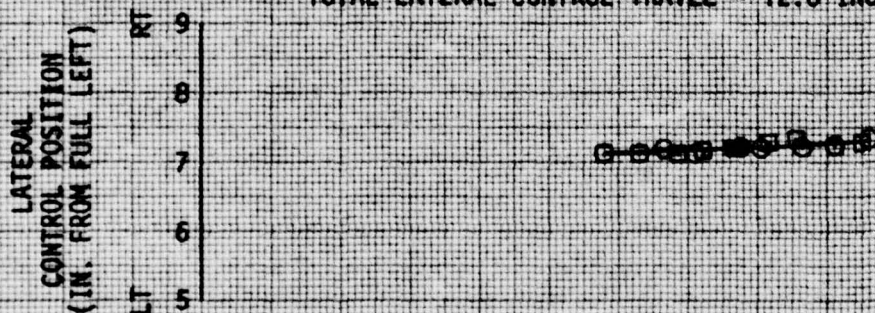
SYN	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	ANTENNA POSITION
		LONG (IN.)	LAT (IN.)				
⊙	8100	141.4(AFT)	1.2(RT)	6480	17.5	324	RETRACTED
⊙	8200	141.7(AFT)	1.2(RT)	5500	17.5	324	EXTENDED

NOTES: 1. SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM POINT.
 2. BALL-CENTERED TRIM CONDITION.

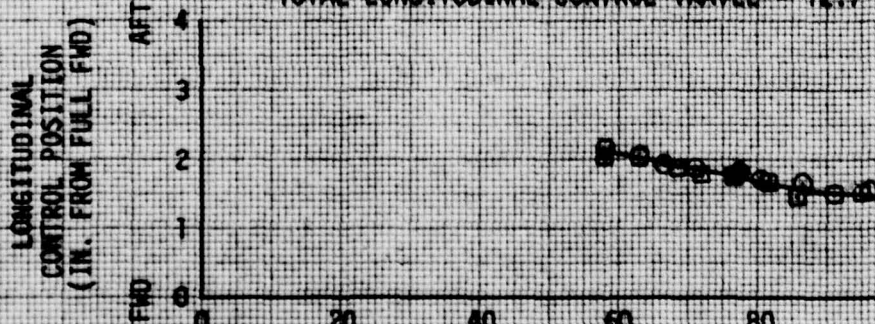
TOTAL DIRECTIONAL CONTROL TRAVEL = 6.2 INCHES



TOTAL LATERAL CONTROL TRAVEL = 12.6 INCHES



TOTAL LONGITUDINAL CONTROL TRAVEL = 12.7 INCHES



CALIBRATED AIRSPEED (KNOTS)

FIGURE 4
STATIC LATERAL DIRECTIONAL STABILITY
 EH-1M USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	ANTENNA POSITION
		LONG (IN.)	LAT (IN.)					
⊙	7820	140.2(AFT)	1.2(RT)	4620	18.0	324	50	RETRACTED
□	7900	140.7(AFT)	1.2(RT)	4840	17.5	324	50	EXTENDED

NOTES: 1. COLLECTIVE CONTROL POSITION HELD FIXED DURING TEST.
 2. SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM POINT.

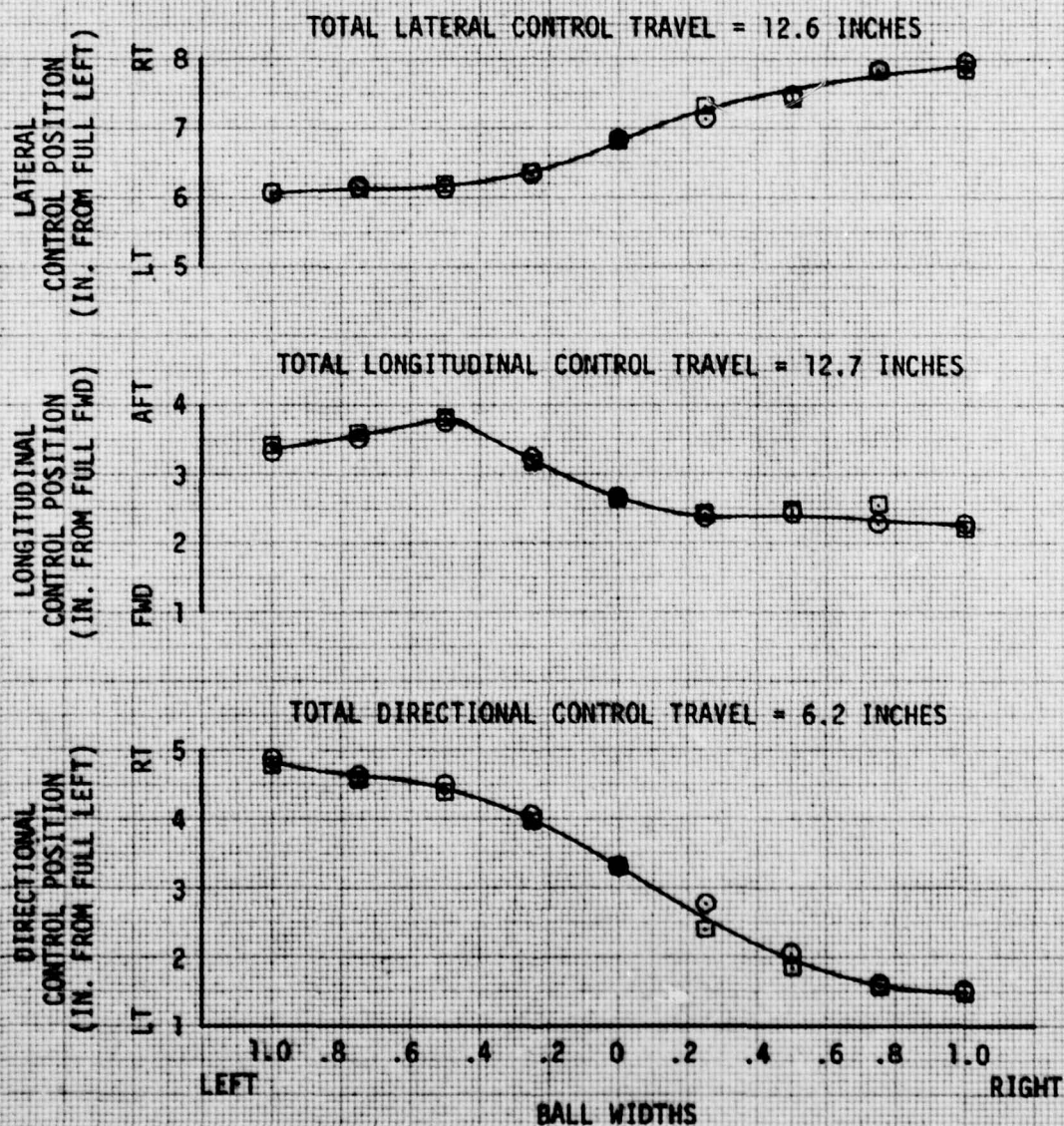


FIGURE 5
 STATIC LATERAL DIRECTIONAL STABILITY
 EH-1H USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (IN.)	AVG CG LOCATION LAT (IN.)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KTS)	ANTENNA POSITION
⊗	8040	141.1(AFT)	1.2(RT)	5080	17.5	324	77	RETRACTED
⊠	7980	141.0(AFT)	1.2(RT)	5280	17.5	324	78	EXTENDED

NOTES: 1. COLLECTIVE CONTROL POSITION HELD FIXED DURING TEST.
 2. SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM POINT.

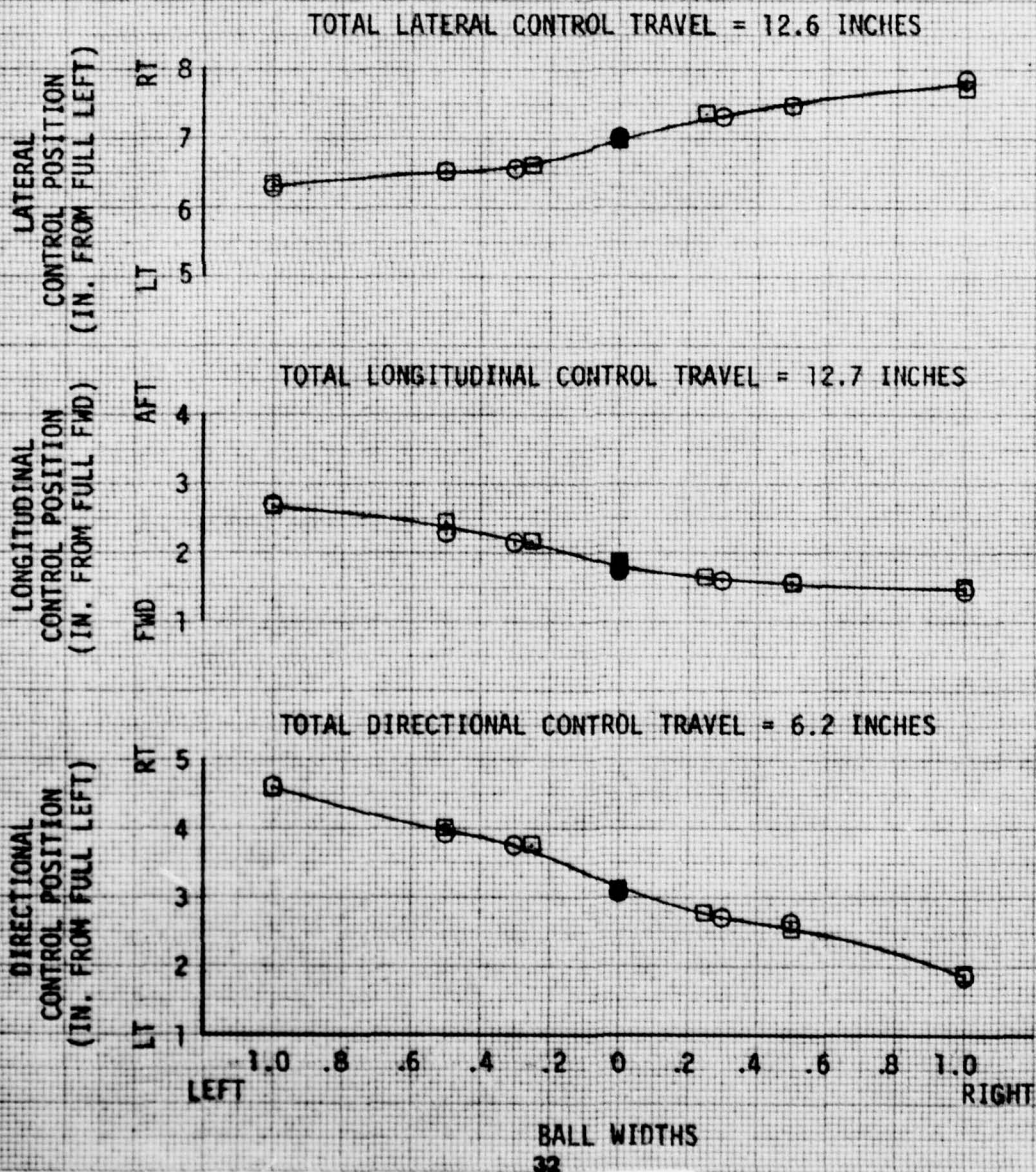


FIGURE 6
MANEUVERING STABILITY
 EH-1H USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
		LONG (IN.)	LAT (IN.)				
⊙	8480	142.5(AFT)	1.2(RT)	5180	17.0	324	LT TURN
⊠	8400	142.4(AFT)	1.2(RT)	5060	17.0	324	RT TURN

NOTES: 1. SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM POINT.
 2. BALL-CENTERED TRIM CONDITION.

TRIM CALIBRATED AIRSPEED = 77 KNOTS

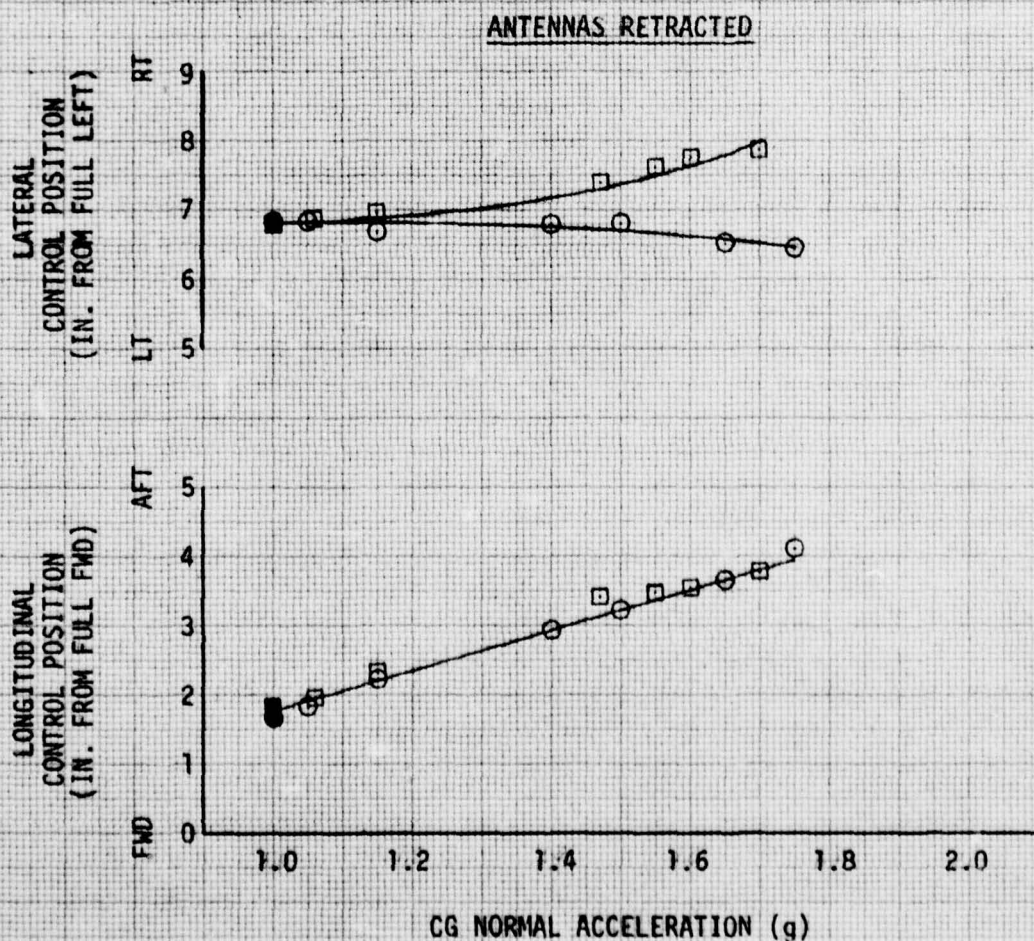


FIGURE 7
MANEUVERING STABILITY
EH-1H USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
		LONG (IN.)	LAT (IN.)				
○	8480	142.4(AFT)	1.2(RT)	5080	17.0	324	LT TURN
□	8300	142.1(AFT)	1.2(RT)	5020	17.0	324	RT TURN

NOTES: 1. SHADED SYMBOLS DENOTE LEVEL FLIGHT TRIM POINT.
2. BALL-CENTERED TRIM CONDITION.

TRIM CALIBRATED AIRSPEED = 77 KNOTS

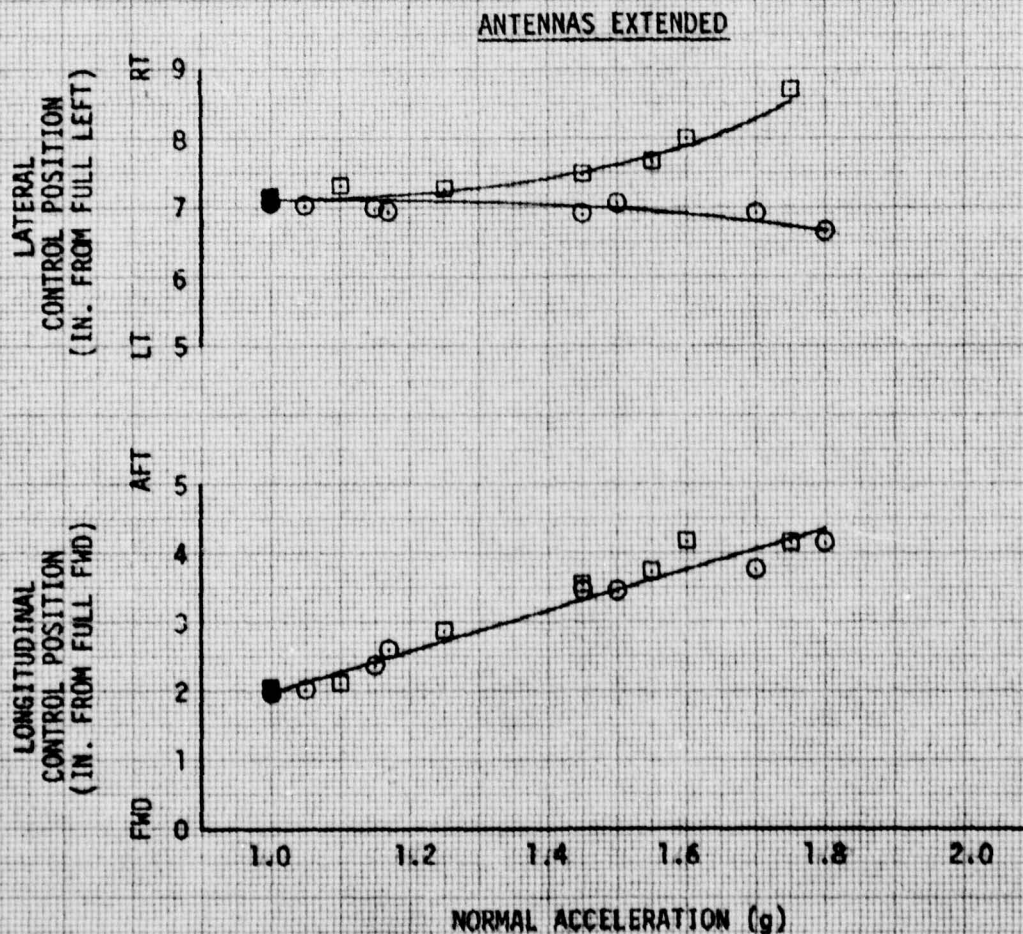


FIGURE 8
LOW SPEED FORWARD AND REARWARD FLIGHT
 EH-1H USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	ANTENNA POSITION
		LONG (IN.)	LAT (IN.)				
⊙	8120	141.4(AFT)	1.2(RT)	1040	24.0	324	RETRACTED
□	7980	141.1(AFT)	1.2(RT)	1040	24.0	324	EXTENDED

NOTE: SKID HEIGHT = 25 FT.

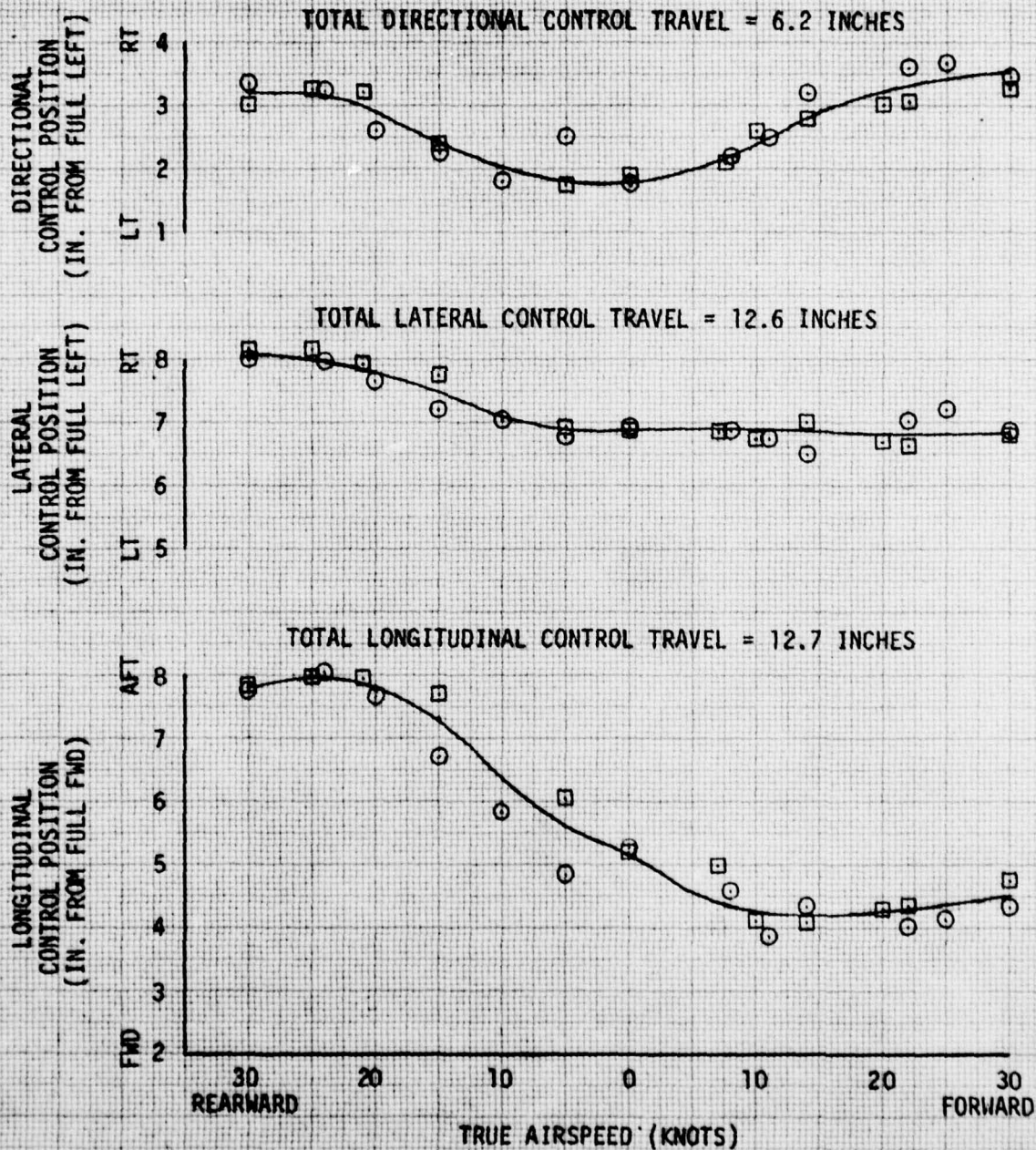
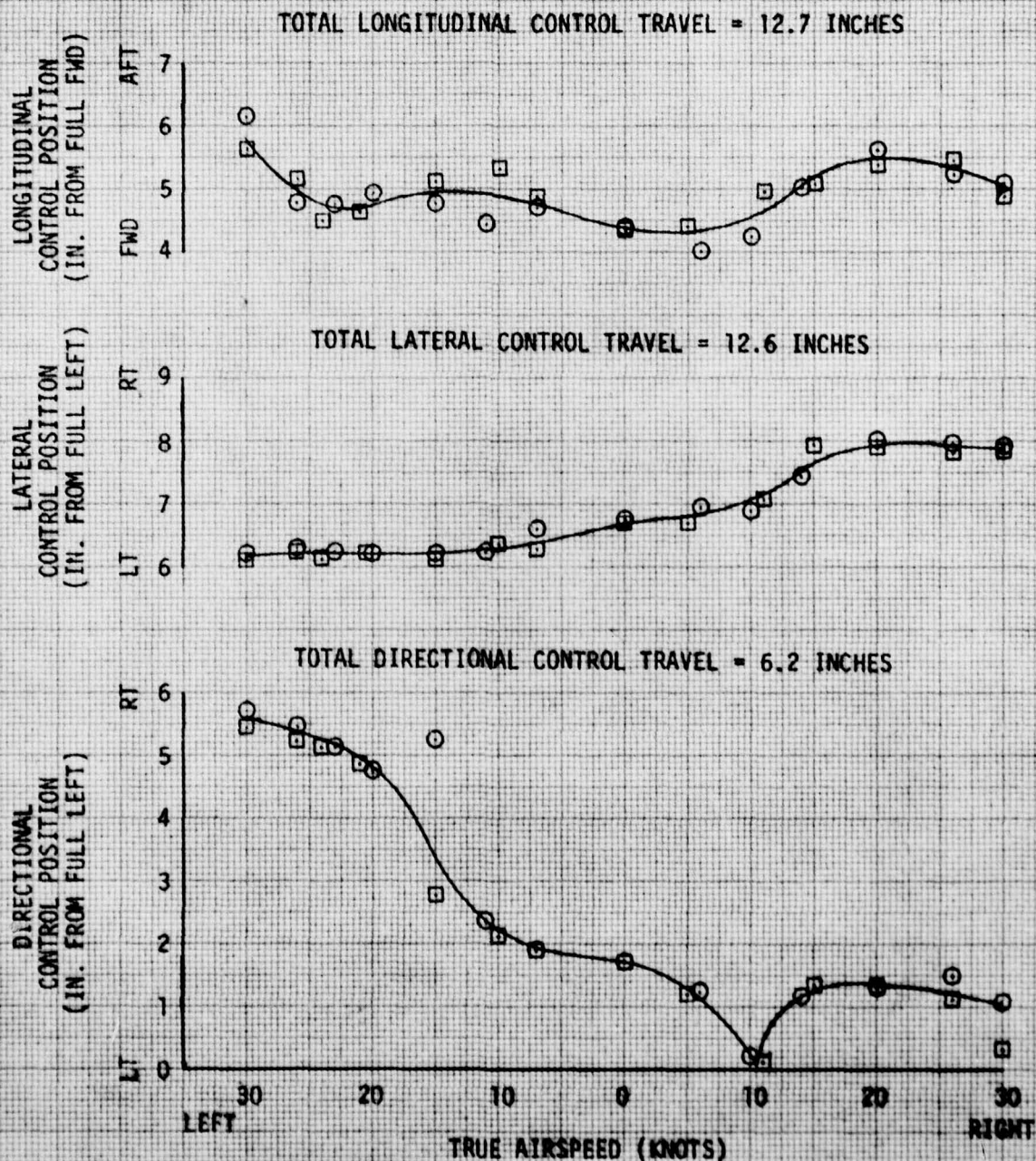


FIGURE 9
SIDEWARD FLIGHT

EH-1H USA S/N 68-15578

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION		AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	ANTENNA POSITION
		LONG (IN.)	LAT (IN.)				
○	8480	142.6(AFT)	1.2(RT)	1040	24.0	324	RETRACTED
□	8300	142.1(AFT)	1.2(RT)	1040	24.0	324	EXTENDED

NOTE: SKID HEIGHT = 25 FT.



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