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PRELIMINARY AIRWORTHINESS EVALUATION OF THE UH-1H HELICOPTER WITH THE T53-L-703 ENGINE INSTALLED

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JUNE 1986

FINAL REPORT

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

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)
The U.S. Army Aviation Engineering Flight Activity conducted a Preliminary Airworthiness Evaluation of the UH-1H aircraft with a T53-L-703 engine installed from 12 June through 18 October 1985. Performance, handling qualities, and overall engine-airframe compatibility were evaluated to substantiate an airworthiness release and appropriate restrictions in the operator's manual. These tests were conducted at Bakersfield, Edwards AFB, Bishop, and Coyote Flats, California. Thirty-four flights were conducted for a total of 26.3 productive flight hours. The performance, handling qualities, and overall engine-airframe compatibility of the aircraft with the T53-L-13B engine are unchanged from those with the T53-L-13B engine when the aircraft is operated within the power-available capability of the -13B. Two shortcomings were identified: (1) poor torque gauge readability, and (2) ignition key location. Engine exhaust impingement on the tail boom produced skin temperatures high enough to cause loss of tail boom structural strength. No engine installation or maintenance problems were encountered during the evaluation.

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TABLE OF CONTENTS

INTRODUCTION

BACKGROUND

1. The UH-1H aircraft is currently powered by the T53-L-13B engine. The US Army is considering the T53-L-703 engine as the war reserve engine for the UH-1H. The T53-L-703 is currently installed in the AH-1S aircraft.

2. In October 1984 the US Army Aviation Engineering Flight Activity was tasked by the US Army Aviation Systems Command to plan, conduct, and report on a Preliminary Airworthiness Evaluation (PAE) of handling qualities, performance, and overall engine-airframe compatibility of the UH-1H aircraft with the T53-L-703 engine installed (ref 1, app A).

TEST OBJECTIVE

3. The objective of the PAE was to obtain qualitative and quantitative handling qualities, performance, and engine-airframe compatibility data to substantiate an airworthiness release and appropriate restrictions in the UH-1H operator's manual (ref 2), and to determined the relationship of pitch link adjustment to main rotor blade pitch.

DESCRIPTION

4. The test aircraft is a standard UH-1H, USA S/N 69-15532 except that the standard T53-L-13B engine has been replaced with the T53-L-703 engine, S/N LE09807Z. A special flight test instrumentation package has been installed. A detailed description of the aircraft is presented in appendix B.

TEST SCOPE

5. The PAE was conducted at Bakersfield (488 feet (ft) mean sea level (MSL)), Edwards AFB (2302 ft MSL), Bishop (4120 ft MSL), and Coyote Flats (9980 ft MSL), California. The evaluation consisted of 34 flights conducted between 12 June and 18 October 1985, for a total of 26.3 productive flight hours. Flight restrictions and operating limitations observed during the PAE are contained in the operator's manual and the airworthiness release (ref 3, app A). Testing was conducted in accordance with the test plan (ref 4) at the conditions shown in table 1.

Table 1. Test Conditions

Test	Average Gross Weight (lb)	Average Longitudinal Center of Gravity (FS)	Average Density Altitude (ft)	Trim Airspeed (KCAS)	Average Referred Rotor Speed (rpm)	Flight Condition
Tethered Hover	7,730[1]	135.5	11,320	0	326.9	10-ft skid height (IGE[2])
		135.3	11,260		316.5	
		135.4	11,170		307.8	
		134.6	11,440		295.7	
	7,720[1]	136.0	11,260		328.2	50-ft skid height (OGE[3])
		134.9	11,460		317.2	
		134.5	11,440		307.1	
		134.5	11,520		297.8	
Free Hover	7,700	136.8	11,210	0	328.4	6.5- to 48.5-ft radar altitude
Rotor Speed in Autorotation	7,240	135.3	16,670[4]	61	339[5]	
	9,390	136.3	12,050[4]	65	330[5]	
Low Speed Flight Characteristics	8,540	130.8	2,890	0 to 32 KTAS[6]	324[7]	10-ft skid height (IGE)
	8,560	131.4	11,250	0 to 13 KTAS		
	8,520	130.6	3,840	0 to 30 KTAS	314[7]	
	8,560	130.8	3,370	0 to 32 KTAS	324[7]	50-ft skid height (OGE)
	8,540	130.8	1,940	0 to 29 KTAS	314[7]	
Simulated Engine Failure	7,190	134.8	9,740	74	324[7]	Level
Engine Response During Takeoff	7,090	134.5	610	0	324[7]	Takeoff to 2-ft-skid-height hover
	8,280	136.9	510			
	9,460	136.8	440			
	7,050	134.6	3,350			
	9,400	136.4	4,750			
	6,920	135.0	6,560			
	8,200	136.9	6,480			
	9,500	138.3	6,740			
	7,190	134.5	11,270			
	8,250	136.7	11,560			

NOTES:

[1]Engine start gross weight
[2]In-ground effect
[3]Out-of-ground effect
[4]Density altitude at start of autorotation
[5]Actual rotor speed at start of autorotation
[6]Knots true airspeed
[7]Actual trim rotor speed

Table 1. Test Conditions (con't)

Test	Average Gross Weight (lb)	Average Longitudinal Center of Gravity (FS)	Average Density Altitude (ft)	Trim Airspeed (KCAS)	Average Referred Rotor Speed (rpm)	Flight Condition
Engine Acceleration	7,600	136.7	4,880	60	----	Entry from descent
	9,560	136.9	5,040			
	7,500	136.3	9,870			
	8,460	138.0	9,750			
	9,390	136.3	9,850			
	7,450	136.1	14,790			
	9,440	136.5	14,810			
Engine Deceleration	7,500	136.3	4,810	60	----	Entry from climb
	9,420	136.4	4,620			
	7,320	135.7	9,740			
	8,330	137.6	9,740			
	9,250	135.9	9,740			
	7,370	135.9	14,940			
Autorotational Recovery	7,430	136.1	4,970	60	----	Entry from autorotation
	9,330	136.2	4,980			
	7,290	135.5	9,960			
	8,210	137.1	9,860			
	9,150	135.6	9,850			
	7,310	135.6	14,910			
Pull-Up	7,320	135.6	9,980	60		Entry from pushover
Pushover	7,250	135.3	9,710	60		Entry from pullup
Exhaust Impingement	7,560	136.2	11,210	0	324[7]	Free hover
	8,540	130.8	1,940	0 to 29 KTAS	314[7]	45, 90 and 135 deg azimuth OGE flt

TEST METHODOLOGY

6. Flight test data were obtained from test instrumentation mounted on the aircraft instrument panel and the flight test instrumentation package. A detailed listing of test instrumentation is contained in appendix C. Data analysis procedures used are detailed in appendix D.

RESULTS AND DISCUSSION

GENERAL

7. A Preliminary Airworthiness Evaluation (PAE) of the UH-1H aircraft with T53-L-703 engine installed in place of the T53-L-13B engine in the standard UH-1H was conducted at gross weights of approximately 7000 lb to 9500 lb and at density altitudes of approximately 500 ft to 15,000 ft. The performance, handling qualities, and overall engine-airframe compatibility of the aircraft with the T53-L-703 engine are unchanged from those with the T53-L-13B engine when the aircraft is operated within the power-available capability of the T53-L-13B. The additional power available from the T53-L-703 engine cannot be used because the UH-1H with the T53-L-13B is limited by airframe factors other than power available. Maneuvers that place greatly changing power demands on the engine were satisfactorily accomplished and do not cause the engine or rotor to operate outside limits. The sudden engine failure response of the aircraft was determined to be critical under certain operating conditions within the operation envelope of the UH-1H with the T53-L-13B engine. This response is not adequately addressed in the operator's manual. Two shortcomings were identified. These are engine torque gauge readability and ignition key location. The standard UH-1H oil cooling system maintained the engine and transmission oil temperatures within normal operating limits throughout the evaluation. During operation within T53-L-13B power limits, engine exhaust impingement on the tail boom produced tail boom skin temperatures high enough to cause both temporary and increasing permanent loss of material strength of the tail boom. No engine installation or maintenance problems were encountered during the evaluation.

PERFORMANCE

General

8. Hovering performance tests and tests of rotor speed in autorotation were performed. Hovering performance tests were performed in both tethered hover and free hover.

Hovering Performance

9. In-ground effect (IGE) tethered hovering tests were conducted at the conditions of table 1. Test results are presented in figures 1 through 3, appendix E. These results agree closely with the results reported in reference 5, appendix A for the UH-1H with the T53-L-13B engine. Available directional control restricts the IGE hovering performance of the UH-1H to thrust coefficients below .0043.

The additional power available at altitude from the -703 engine does not, therefore, improve the IGE hovering capability of the UH-1H.

10. Out-of-ground effect (OGE) tethered hovering tests were conducted at the conditions of table 1. Test results are presented in figures 4 through 6, appendix E. These results agree closely with the results reported in references 5 and 6, appendix A, except that the additional power available at altitude from the T53-L-703 engine allows OGE hovering flight at higher gross weights at these conditions than the UH-1H with the T53-L-13B engine. The transmission torque limit was reached at all rotor speeds, but directional control remaining was less than 10 percent for thrust coefficients greater than approximately 0.0047.

11. Free flight hovering tests were conducted at the conditions of table 1. The test result for OGE free flight hover is shown in figure 4, appendix E.

Rotor Speed in Autorotation

12. Tests of rotor speed in autorotation were conducted at the conditions of table 1 to determine main rotor speed in autorotation as a function of density altitude and gross weight. Test results are presented in figures 7 and 8, appendix E.

13. As part of this test, the relationship of pitch link adjustment to main rotor blade pitch was determined. Using a standard propeller protractor, one main blade of the test helicopter was set to a blade hub angle of 6.5 degrees. The pitch change link was then rotated 240 degrees (shortened), and the protractor indicated a blade hub angle of 8.5 degrees.

HANDLING QUALITIES

General

14. Low speed tests and simulated engine failure tests were performed at the conditions of table 1.

Low Speed

15. Low airspeed tests were conducted at the conditions of table 1. Surface winds were 3 knots or less and a calibrated ground pace vehicle was used as a speed reference. Test results are presented in figures 9 through 23, appendix E. The results

of the tests conducted at Coyote Flats, California (density altitude approximately 11,000 ft), are presented in figures 9 through 11. At the conditions of figures 9 through 11, a stable attitude could not be maintained and partial loss of control was experienced at airspeeds above those shown due to inadequate directional control. These results agree closely with the results reported in reference 6, appendix A. The additional power available at altitude from the T53-L-703 engine does not, therefore, improve the low airspeed capabilities of the UH-1H at these conditions. At the same conditions, the aircraft flying qualities were marginal.

16. The results of the tests conducted at Edwards AFB (density altitudes approximately 2000 ft to 4000 ft), California are presented in figures 12 through 23, appendix E. For rotor speeds of 314 and 324 rpm and skid heights of 10 and 50 feet, true airspeeds of 30 knots could be achieved without difficulty at relative wind azimuths at 90 and 135 degrees. At a relative wind azimuth of 45 degrees, however, an airspeed of 30 knots could not be achieved. The worst case was a rotor speed of 314 rpm and a skid height of 50 ft at true airspeeds greater than 15 knots. At these conditions, a stable attitude could not be maintained, and partial loss of directional control resulted.

Simulated Engine Failure

17. Simulated engine failure tests were conducted at the conditions of table 1. Test results are presented in figure 24. The aircraft was stabilized in level flight and engine failure was simulated by rapidly reducing the throttle to flight-idle. For the case presented in figure 24, the collective control was held fixed for approximately 0.9 seconds after the throttle reached the flight-idle position (MIL-H-8501B requires a 2-second delay to simulate pilot reaction time). By that time the rotor speed had drooped to 295 rpm. Collective control was lowered to full down in approximately 1.5 seconds; during this time load factor dropped to 0.2 (operator's manual limit is 0.5). Minimum rotor speed was 277 rpm (17 rpm below minimum allowable rotor speed) and maximum roll attitude was 21 degrees, reached approximately 3.5 seconds after the throttle reached flight-idle. At that time, the aircraft had also yawed 22 degrees from its initial heading. By the time the pilot had arrested the yaw, returned the aircraft to level roll attitude and returned his attention to rotor speed, the rotor speed had risen to 332 rpm. Maximum rotor speed was 337 rpm, 2 rpm below the overspeed limit. This test point is within the operational envelope of the UH-1H with the T53-L-13B engine. The sudden engine failure response of the aircraft is not adequately addressed in the operator's manual.

The operator's manual should be revised to emphasize: (1) the potential for rapid rotor speed droop, roll rate, and yaw rate immediately following sudden engine failure, (2) the potential for the pilot reaction of rapidly lowering collective, resulting in a load factor of less than 0.5, (3) the potential for excessive main rotor flapping if excessive lateral control is input, and (4) the potential for rapidly overspeeding the rotor while the pilot's attention is concentrated on arresting yaw and returning the aircraft to level roll attitude.

ENGINE-AIRFRAME COMPATIBILITY

General

18. Engine-airframe compatibility tests were performed at the conditions of table 1. Engine/rotor system response tests included tests of engine response during takeoff, engine acceleration and deceleration, autorotational recovery, and symmetrical pullups and pushovers. Two shortcomings were identified during the evaluation. These were engine torque readability and ignition key location. Engine and transmission oil temperatures were recorded on magnetic tape throughout the evaluation. Temperatures on the tail rotor drive shaft cover, tail boom, and stabilator were measured during selected tests.

Engine/Rotor System Response

19. Tests of engine response during takeoff were conducted at the conditions of table 1. Test results are presented in figures 25 through 32, appendix E. The aircraft was stabilized in a 2 foot hover with rotor rpm set at 324 rpm. A lanyard, attached to the cockpit floor, was pulled taut and held on the collective stick grip between the grip and the pilot's hand. The aircraft was then landed and the rotor rpm was reset to 324 rpm with the collective control full down. The collective control was then raised until the lanyard was taut and the engine/rotor response characteristics observed. The test was repeated at varying rates of collective input. The maximum transient rotor speed droop recorded was 17 rpm (5.2 percent), from 324 rpm to 307 rpm. The maximum transient rotor overspeed recorded was 7 rpm (2.2 percent), to 331 rpm. The engine/rotor system response to rapid takeoff was adequate for all conditions tested. The torque oscillations observed during some of these takeoffs did not cause any problems during normal takeoffs.

20. Engine acceleration tests were conducted at the conditions of table 1. Test results are presented in figures 33 through 38, appendix E. The aircraft was stabilized in a takeoff power climb

with rotor speed set at 324 rpm and the collective position was noted. The collective control was then lowered to the minimum that did not exceed rotor limit speed without using the throttle or turbine speed control, and without disengaging the clutch. The collective control was then returned to the stabilized takeoff power climb position and the engine/rotor response characteristics observed. The test was repeated at varying rates of collective input. The maximum transient rotor speed droop recorded was 25 rpm (7.4 percent) from 338 rpm to 313 rpm. The maximum transient rotor overspeed recorded was 4 rpm (1.2 percent) to 328 rpm. The engine/rotor system response during these tests were adequate for all conditions tested.

21. Engine deceleration tests were conducted at the conditions of table 1. Test results are presented in figures 39 through 43. The aircraft was stabilized in autorotational descent with the rotor speed set at 324 rpm. Takeoff power was then applied and the aircraft was stabilized in climb at takeoff power without using the turbine-speed control. The collective control was then lowered to the full down position and the engine/rotor response characteristics observed. The test was repeated at varying rates of collective input. The maximum transient rotor speed overshoot recorded was 4 rpm (1.2 percent) to 328 rpm. The engine/rotor system response during these tests was adequate for all conditions tested.

22. Autorotational recovery tests were conducted at the conditions of table 1. Test results are presented in figures 44 through 48, appendix E. The aircraft was stabilized in autorotational descent with the engine at flight-idle. Throttle and collective were then applied simultaneously to transition to a takeoff power climb and engine/rotor response characteristics observed. The maximum transient rotor speed droop and overshoot, engine torque, gas generator speed, and interstage turbine temperatures were strongly dependent on pilot technique; i.e., relationship between rates of throttle and collective control input. No transients outside limits were recorded.

23. Symmetrical pull-up tests were conducted at the conditions of table 1. Test results are presented in figure 49. The aircraft was placed in powered descent with rotor speed set at 324 rpm. With collective control fixed, aft longitudinal control was applied to a maximum load factor of 2.0. Transients were small compared to those in the engine/rotor system response tests described in paragraphs 19 through 22 above.

24. Symmetrical pushover tests were conducted at the conditions of table 1. Test results are presented in figure 50. The aircraft

was placed in a climb with a rotor speed of approximately 324 rpm. With the collective control fixed, forward longitudinal control was applied to a minimum load factor of 0.5. Transients were small compared to those in the engine/rotor system response tests described in paragraphs 19 through 22 above.

25. Longitudinal flare deceleration tests were attempted at altitude without ground reference; however, the aircraft could not be slowed to a hover due to inadequate directional control. Further longitudinal flare deceleration tests and aircraft acceleration tests were deleted from the test program.

Engine Rigging

26. The aircraft and engine used in this PAE were those used in USAAEFA Project No. 81-01-6, Fuel Conservation Evaluation. During that project, a severe compressor stall occurred while reducing power slowly at a pressure altitude of 14,770 feet, an ambient temperature of 1.0°C, a gas generator speed of 94.3 percent, and a main rotor speed of 302 rpm. A time history of this stall is shown in figure 51, appendix E. Postflight inspection revealed no damage or out-of-tolerance condition. The compressor was clean and in good condition. Variable inlet guide vane (VIGV) and bleed band schedules were within allowable tolerances of reference 7, appendix A. The engine manufacturer suggested that the stall could have been caused by hysteresis or friction in the VIGV linkage. A sudden change of VIGV position from completely open to correct scheduling as gas generator speed was slowly reduced was suspected of having caused the stall. The engine manufacturer suggested changing the VIGV rigging to the maximum speed allowed by reference 7 and reducing power more rapidly. These suggestions were complied with and no further stalls occurred during project 81-01-6. The prestall and poststall VIGV riggings are shown in figure 52. For this PAE, the VIGV's and bleed bands were instrumented. The VIGV and bleed band rigging were unchanged from the poststall rigging shown in figure 52. No stalls were encountered during the PAE. Figure 53 is a time history of VIGV movement during an engine deceleration test as described in paragraph 21. This time history shows the VIGV's operating smoothly and in accordance with the schedule shown in figure 52. The cause of this stall should be determined and a correction made and flight-tested.

Engine Torque Gauge

27. The engine torque gauge is difficult to read because of its placement on the panel and its small size. Photo 1 shows the gauge, and the AH-1S gauge for comparison, as seen by the pilot. The UH-1H gauge has 5 pound per square inch (psi) graduations,

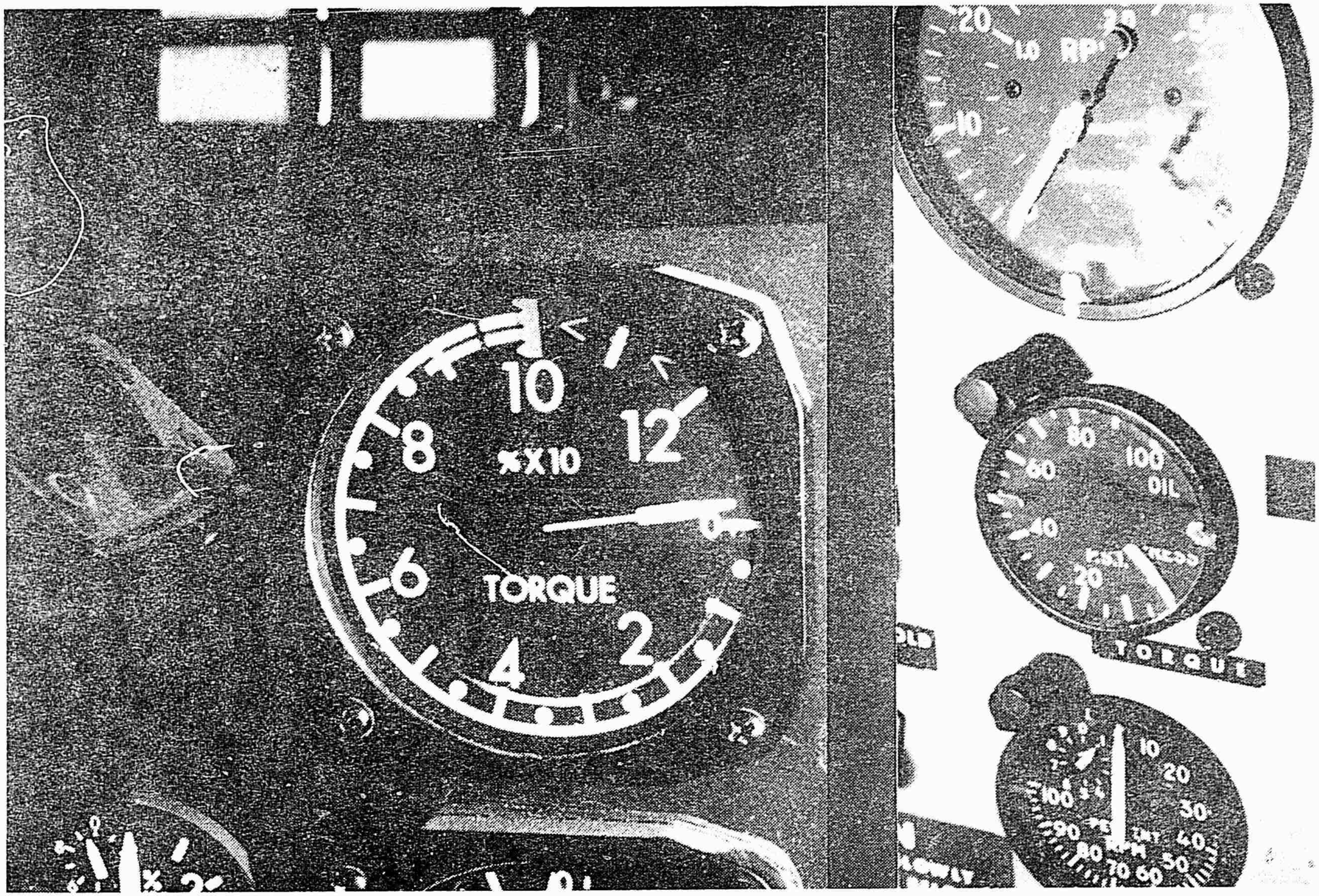


Photo 1. UH-1 Torque Gauge (Right) and AH-1 Torque Gauge, as Seen by the Pilot. UH-1 Gauge is Difficult to Read.

compared to the 5 percent (2.5 psi) graduations of the AH-1 gauge. The poor readability of the engine torque gauge makes it difficult for the pilot to utilize power at or near the transmission torque limit without exceeding the transmission torque limit, and is therefore a shortcoming.

Ignition Key Location

28. With the T53-L-13B engine, the key remains in the ON position from the time it is turned on before the pilot's walk around inspection until shutdown. The T53-L-703 engine starting sequence, however, requires the pilot to turn the ignition key to the OFF position during the engine starting sequence, to turn off start fuel. Photo 2 shows the location of the ignition key, by the pilot's left ankle. This position makes it difficult to reach, and could cause a hot start, and is therefore a shortcoming.

Oil Cooling

29. Engine and transmission oil temperatures were recorded on magnetic tape throughout the evaluation. Maximum engine oil temperature recorded was 86°C and maximum transmission oil temperature recorded was 87°C. These temperatures were recorded simultaneously, during tethered OGE hovering flight at maximum allowable transmission torque with a rotor speed of 294 rpm. Ambient temperature was 10.5°C and density altitude was 11,520 feet. Tests at high ambient temperatures were not conducted. Testing at high ambient temperatures is required to determine the adequacy of the oil cooling system. Maximum allowable oil temperatures for the AH-1, with the T53-L-703 engine, are 93°C for engine oil and 110°C for transmission oil (ref 8, app A). The engine and transmission oil cooling systems were the standard UH-1H systems as described in appendix B. The engine and transmission oil cooling heat exchangers and the oil cooling fan installed on the UH-1H have less cooling capacity than those on the AH-1S. The fixed bleed air limiting orifice on the UH-1H has a smaller diameter than the orifice on the AH-1S.

Exhaust Impingement

30. The straight exhaust stack was installed on the engine throughout this project (photo 1, app B). Temperatures on the tail rotor drive shaft cover, tail boom, and stabilator were measured and recorded as described in appendix C at the conditions of table 1. These temperatures were recorded following operation within T73-L-13B power limits. The temperatures are presented

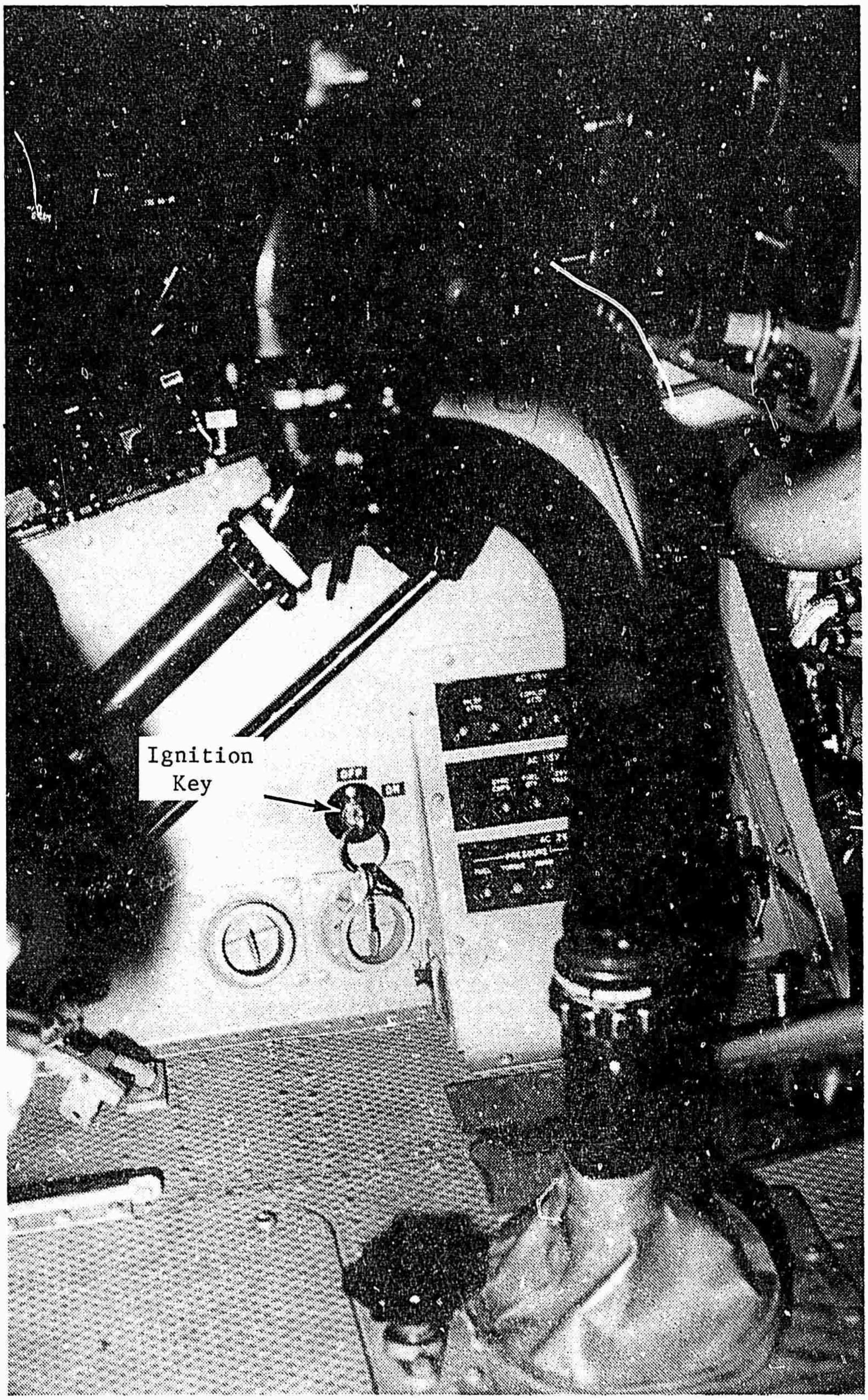


Photo 2. Ignition Key Location. Key is Difficult to Reach During Engine Starting Sequence.

in table 1, appendix E. Highest temperature recorded was 224°C, on top of the tail rotor drive shaft cover at boom station (BS) 59.5, as defined in reference 9, appendix A.

31. The highest temperature recorded on the tail rotor drive shaft cover at a tailshaft bearing location was 166°C, above tail rotor drive shaft bearing no. 3, at BS 80.5. The bearing lubricant meets the requirements of reference 10, appendix A, which states that the lubricant is intended for use at temperatures as high as 177°C. The bearing temperatures can be assumed to be less than that of the tail rotor drive shaft cover; therefore, exhaust impingement should not adversely affect the operation of the bearing. No evidence of lubricant being thrown from any of the bearings was found during daily inspection of the tail rotor drive shaft bearings during this project.

32. The highest temperature recorded on the tail boom was 204°C, at BS 59.5. This temperature was recorded following free hovering flight at the conditions shown in table 1. The tail boom skin at BS 59.5 is aluminum alloy 2024-T3. The effects of temperature on the structural properties of this alloy are presented in reference 11, appendix A. The magnitudes of the effects of a temperature of 204°C, taken from reference 11, are presented in tables 2 and 3. It is important to note that the reductions of strength tabulated in table 3 are both cumulative and permanent. The permanent reduction in tensile yield strength after a total of 100 hours at 204°C (22 percent) is approximately the same as the temporary reduction experienced after 0.5 hours at the same temperature.

33. The temperatures recorded at BS 80.5 and BS 101.5 following free hover were 160°C and 110°C, respectively. Following 45, 90, and 135 degrees azimuth flight, temperatures of 143°C and 121°C were recorded at BS 122.5 and BS 164.0, respectively. This indicates that substantial heating and, therefore, continuing loss of strength occurs over a large part of the tail boom during flight conditions encountered in routine operation. An evaluation should be made of the effects of exhaust impingement on tail boom structural integrity.

Table 2. Temporary Effects of Heating Aluminum Alloy 2024-T3 to 204°C for 0.5 Hours

	Reduction (percent)
Ultimate tensile strength	25
Tensile yield strength	23
Compressive yield strength	14
Ultimate shear strength	17
Ultimate bearing strength	20
Bearing yield strength	11
Tensile and compressive moduli	11

Table 3. Permanent Cumulative Effects of Heating Aluminium Alloy 2024-T3 to 204°C

Time at 204°C, Hours	0.5	10	100	1,000
Reduction of room temperature ultimate tensile strength, percent	6	10	25	31
Reduction of room temperature tensile yield strength, percent	13	13	22	36

CONCLUSIONS

GENERAL

34. Based on this preliminary evaluation of the UH-1H with the T53-L-703 engine installed, the following conclusions were reached.

a. The performance, handling qualities, and overall engine/airframe compatibility of the UH-1H with the T53-L-703 engine installed are unchanged from those of the aircraft with the T53-L-13B installed when the aircraft is operated within the power-available capability of the T53-L-13B (para 7).

b. Airframe limitations preclude exploiting the additional power available with the T53-L-703 engine (para 7).

c. The response of the aircraft to sudden engine failure is not adequately addressed in the operator's manual (para 17).

d. Engine exhaust impingement on the tail boom at operation within T53-L-13B power limits produces skin temperatures high enough to cause loss of material strength of the tail boom (para 33).

e. Two shortcomings were identified (paras 27 and 28).

SHORTCOMINGS

35. The following shortcomings were identified:

a. Poor torque gauge readability (para 27).

b. Ignition key location (para 28).

RECOMMENDATIONS

36. The following recommendations are made:

a. If the T53-L-703 is installed in the UH-1H, power should be limited to that available with the T53-L-13B engine (para 7).

b. The shortcomings identified in paragraph 35 should be corrected (paras 27 and 28).

c. The following should be added to paragraph 9-9., subparagraph b of the operator's manual (para 17):

(5) At high power settings, sudden engine failure will result in rapid rotor speed droop and rapid left roll. Caution should be used to avoid a load factor of less than 0.5 and to minimize lateral cyclic control inputs when entering autorotation.

(6) At high altitude, rotor acceleration is rapid. A rotor overspeed will occur if the collective control is left in the full down position after entering autorotation.

d. The cause of the compressor stall experienced with the engine installed in the UH-1H should be determined and a correction made and flight-tested (para 26).

e. Testing at high ambient temperatures should be conducted to determine the adequacy of the engine and transmission oil cooling system (para 29).

f. An evaluation should be made of the effects of exhaust impingement on tail boom structural integrity (para 32).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-ED, 24 October 1984, subject: Preliminary Airworthiness Evaluation (PAE) of the UH-1H with the T53-L-703 Engine Installed, USAAEFA Project No. 84-25.

2. Technical Manual, TM 55-1520-210, *Operator's Manual, Army Model UH-1H/V, Helicopter,* 15 July 1985.

3. Letter, AVSCOM, AMSAV-E, 16 January 1984, subject: Airworthiness Release for UH-1H S/N 69-15532 for USAAEFA Project No. 84-25, Preliminary Airworthiness Evaluation, UH-1H Helicopter with T53-L-703 Engine Installed, with revision 1 dated 1 February 1984, revision 2 dated 26 July 1984, revision 3 dated 6 June 1985, revision 4 dated 3 October 1985, and revision 5 dated 17 December 1985.

4. Test Plan, USAAEFA Project No. 84-25, *Preliminary Airworthiness Evaluation UH-1H Helicopter with T53-L-703 Engine Installed,* December 1984.

5. Final Report, USAASTA Project No. 71-18, *Tail Rotor Performance and Translational Flight Handling Qualities Tests UH-1H Helicopter,* January 1972.

6. Final Report, USAASTA Project No. 66-04, *Engineering Flight Test, YUH-1H Helicopter, Phase D (Limited),* November 1970.

7. Technical Manual, TM 55-2840-229-23-1, *Aviation Unit and Aviation Intermediate Maintenance Manual, Engine Assembly,* 9 March 1981, with changes 1-4.

8. Technical Manual, TM 55-1520-236-10, *Operator's Manual, Army Model AH-1S (Prod), AH-1S (ECAS), AH-1S (Modernized Cobra) Helicopters,* 11 January 1980, with changes 1-10.

9. Technical Manual, TM 55-1520-210-23-1, *Aviation Unit and Intermediate Maintenance Instructions, Army Model UH-1D/H/EH-1H Helicopters,* 20 February 1979, with changes 1-53.

10. MIL SPEC G-81322D, Grease, Aircraft, General Purpose, Wide Temperature Range, NATO Code Number G-395, 2 August 1982.

11. MIL-HDBK-5D, Metallic Materials and Elements for Aerospace Vehicle Structures, 1 June 1983.

12. Lycoming Model Specification No. 104.43, *T53-L-703 (LTC1K-4G) Turboshaft Engine,* 1 May 1974, with revisions dated 15 October 1975 and 15 February 1981.

APPENDIX B. DESCRIPTION

SOURCES OF INFORMATION

1. The information in this appendix was obtained from the operator's manuals (refs 2 and 7, app A), the engine model specification (ref 12), the airframe manufacturer, the engine manufacturer, and by measurement of the test aircraft.

TEST AIRCRAFT CONFIGURATION

Variation from Standard Configuration

2. The standard T53-L-13B engine was replaced by the T53-L-703 engine for this evaluation (photo 1). The engine accessories were removed from the -13B and installed on the -703. The airframe-mounted equipment of the UH-1H, including the engine torque-pressure gauge and the engine and transmission oil cooling systems, was not changed.

Engine Description

5. The Lycoming T53-L-703 engine is a growth version of the Lycoming T53-L-13B engine. There are no changes in the internal geometry of the engine except for the provision for turbine cooling described below. Both the -703 and the -13B engines are turboshaft engines with a two-stage axial-flow free power turbine, and a two-stage axial flow turbine driving a combination five-stage axial one-stage centrifugal compressor with both interstage air bleed and variable inlet guide vanes for surge avoidance. The power growth is achieved by increased turbine temperature and gas generator speed made possible by the following changes:

Improved air cooling of the first-stage gas generator nozzles

Introduction of air cooling of the first-stage gas generator turbine blades and second-stage gas generator turbine disk

Improved materials in the second-stage gas generator turbine blades, the first stage power turbine blades, and the second stage power turbine disk.

A comparison of the limits of the two engines is presented in table 1. The turbine gas temperature sensors in the -703 engine are located between the gas generator turbine and the power turbine, whereas in the -13B the sensors are located downstream of the power turbine. This change produces higher temperature indications on the cockpit gauge and also produces a faster temperature indication rise during engine starting than with the

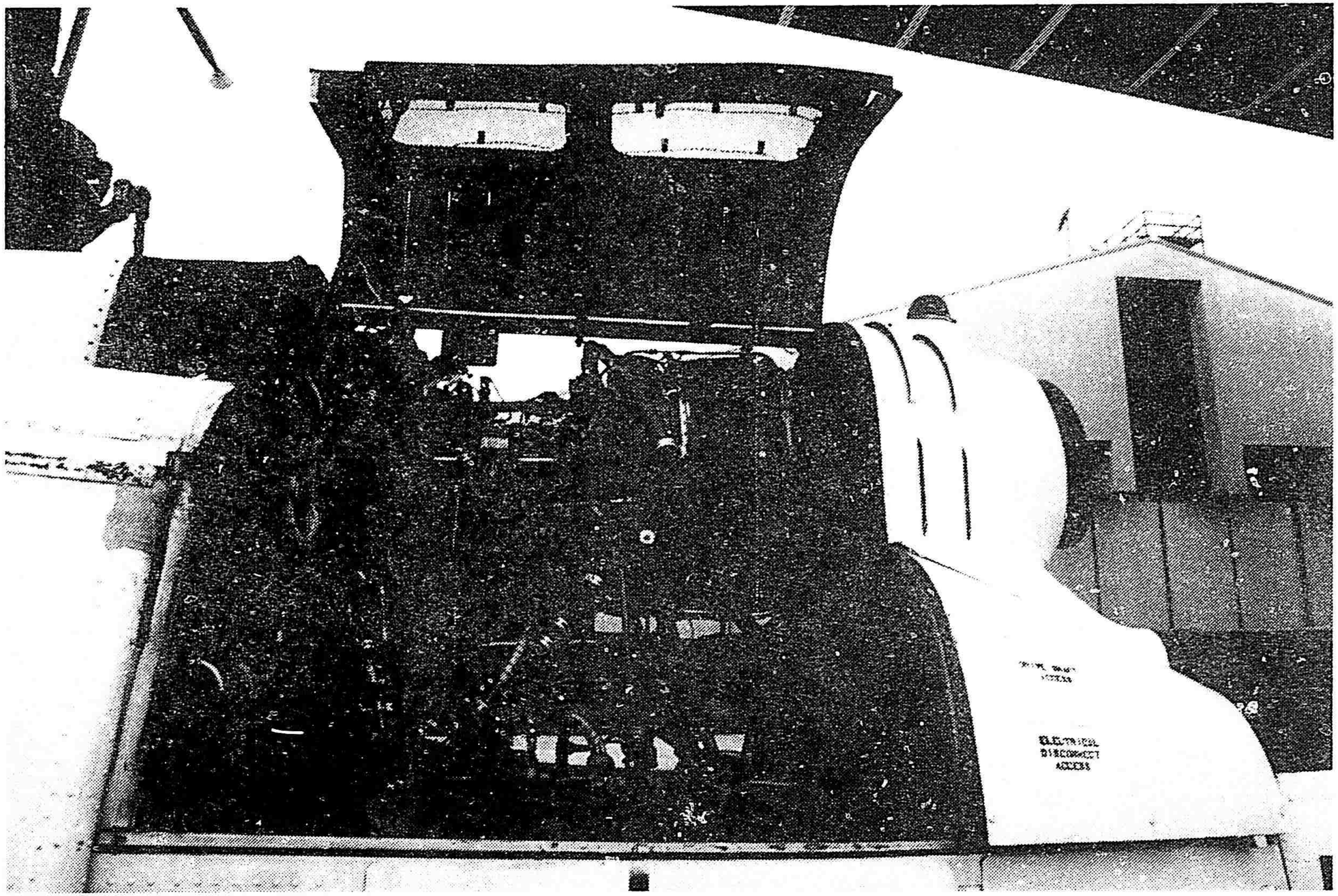


Photo 1. T53-L-703 Engine Installed in UH-1H Aircraft. No Installation or Maintenance Problems Encountered During Evaluation.

Table 1. Comparison of Limitations of T53-L-703 and T53-L-13B Engines

	T53-L-703	T53-L-13B
Power ratings		
Military power (30-min.) limit	1800 shp	1400 shp
Maximum continuous power	1500 shp	1250 shp
Gas Temperature[1]		
Maximum continuous	400°C to 820°C	625°C
30-minute limit	820°C to 880°C	625°C to 645°C
Starting and acceleration (4-sec limit)	880°C to 950°C	675°C
Maximum for starting and acceleration	------	760°C
Gas producer maximum speed	26,650 rpm (106.0%)	25,600 rpm (101.8%)

NOTE:

[1]For the T53-L-703 engine, the temperature measured is the interstage turbine temperature (i.e., the temperature of the gas between the gas generator turbine and the power turbine). For the T53-L-13B engine, the temperature measured is the tailpipe temperature, downstream of the power turbine.

-13B engine. The standard UH-1H gauge can be used, however, without modification, with the T53-L-703 engine. The straight exhaust stack was installed in the aircraft throughout the project.

Oil Cooling System

6. The engine and transmission oil cooling systems consist of individual heat exchangers for engine and transmission oil and a single fan providing cooling air to the heat exchangers. The fan is driven by engine compressor bleed air driving a tip turbine; therefore, the fan is powered at all times when the engine is operating. Fan speed is regulated solely by a fixed bleed air limiting orifice.

BASIC AIRCRAFT INFORMATION

Airframe Data

Overall length (main rotor fore and aft and tail rotor horizontal)	684.67 in.
Overall width (rotor trailing)	114.6 in.
Center line of main rotor to center line of tail rotor	345.9 in.
Center line of main rotor to elevator hinge line	246.5 in.
Elevator area (including projected area of tail boom	23.7 ft^2
Elevator area (both panels)	19.8 ft^2
Elevator airfoil section	11% Clark Y (inverted)
Vertical stabilizer area	11.3 ft^2
Vertical stabilizer airfoil section	NACA 0015
Vertical stabilizer aerodynamic center	FS 443.9, WL 112.1

Main Rotor Data

Number of blades	2
Diameter	48 ft
Disk area	1809.6 ft^2
Blade chord	21 in.
Blade area (both blades)	84 ft^2
Blade airfoil	NACA 0012
Linear blade twist (root to tip)	-10 deg
Hub precone angle	2.75 deg
Mast angle (relative to horizontal reference)	5 deg forward tilt
Test aircraft control travel:	
Collective (measured at center of grip)	10.7 in.
Longitudinal cyclic (measured at center of grip)	12.3 in.
Lateral cyclic (measured at center of grip)	12.2 in.
Directional (measured at center of pedal)	7.2 in.
Blade travel:	
Flapping (any direction)	$\pm$11 deg
Longitudinal cyclic	+12 to -12 deg
Lateral cyclic (rigged 2 deg down, left)	+9 to -11 deg

Antitorque Rotor Data

Number of blades	2
Diameter	8.5 ft
Disk area	56.7 ft^2

Blade chord	8.41 in.
Rotor solidity	0.105
Blade airfoil	NACA 0015
Blade twist	Zero deg
Blade travel (average):	
Full left pedal	18 deg
Full right pedal	-10 deg

Gross Weight/Center of Gravity (cg) Envelope

Forward cg limit:

Below 8,600 pounds, fuselage station (FS) 130.0; linear increase from 8,600 pounds, FS 130.0 to FS 134.0 at 9,500 pounds.

Aft cg limit:

Below 8,600 pounds, FS 144.0; linear decrease from 8,600 pounds, FS 144.0 to FS 143.0 at 9,500 pounds.

Rotor and T53-L-703 Engine Speed Limits (Steady State)

Power on:	
Engine rpm	6,400 to 6,600
Rotor rpm	314 to 324
Transient rpm	331
Power off:	
Rotor rpm	294 and 339

Temperature and Pressure Limits

Engine oil temperature	93°C
Transmission oil temperature	110°C
Engine oil pressure	25 to 100 psi
Transmission oil pressure	30 to 70 psi

Gear Ratios

Power turbine to engine output shaft	3.2105:1
Engine output shaft to main rotor	20.370:1
Engine output shaft to anti-torque rotor	3.990:1
Engine output shaft to anti-torque drive system	1.535:1
Gas producer turbine to tachometer pad (100% = 25,150 rpm)	5.988:1

T53-L-703 Engine and Drive Train Limits

Power ratings:

Military power (30-min. limit)	1,800 shp derated to 1,100 shp
Maximum continuous power	1,500 shp derated to 1,100 shp

Torque limits:

Maximum continuous	50 psi
Transient overtorque (not to be used intentionally) (no maintenance required)	50 to 54 psi
Transient overtorque (inspect drive train)	54 to 61 psi
Transient overtorque (replace all drive train and rotor components)	Over 61 psi

Output shaft speed:

Maximum steady state	6,600 rpm
Minimum steady state	6,400 rpm
Minimum steady state below 7,500 pounds	6,000 rpm
Maximum transient (not to be used intentionally)	6,750 rpm

T53-L-703 Interstage Turbine Temperature

Continuous	400°C to 820°C
30-minute limit	820°C to 880°C
5-second limit for starting and acceleration	880°C to 950°C

T53-L-703 Gas Producer

Maximum speed	26,650 (106.0 percent)
Flight-idle speed	15,900 to 17,000 rpm (63 to 68 percent)
Ground idle/start speed	12,100 to 13,100 rpm (48 to 52 percent)

Airframe

Loading:	
Design weight	6,600 lb
Maximum overload weight	9,500 lb
Maximum floor loading	300 lb/ft^2
Maximum cargo hook capacity	4,000 lb
Maximum lateral cg	±5 in.
Limit load factors:	
Positive 6,600 lb	+3.0
9,500 lb	+2.1
Negative 6,600 lb	+0.5
9,500 lb	+0.5

Maximum airspeed:

Forward flight	123.6 KTAS at 2,000 ft
Sideward and rearward flight	30 knots

APPENDIX C. INSTRUMENTATION

GENERAL

1. Data were obtained from calibrated pulse code modulated instrumentation and displayed or recorded as indicated below. A test boom with a swiveling pitot-static probe and angle-of-attack and sideslip vanes was installed on the aircraft. Self-adhesive temperaturesensitive labels were attached to the aircraft tail boom to measure effects of exhaust impingement.

Pilot's Panel

Airspeed (boom)
Pressure altitude (boom)
Radar altitude
Angle of sideslip
Main rotor speed
Gas producer speed
Interstage turbine temperature
Engine torque
Tail rotor maximum torque
Fuel remaining
Tether cable angles
Collective control position

Copilot's Panel

Airspeed (standard system)
Pressure altitude (standard system)
Fuel quantity used
Free air total temperature
Tether cable tension
Record number

Center Console

Reference time of day (digital presentation of time recorded on magnetic tape)

Magnetic Tape

Record number
Time of day
Airspeed (boom)
Pressure altitude (boom)
Radar altitude
Angle of attack
Angle of sideslip

Control positions
- Longitudinal
- Lateral
- Directional
- Collective

Attitudes
- Roll
- Pitch
- Heading

Rates
- Roll
- Pitch
- Yaw

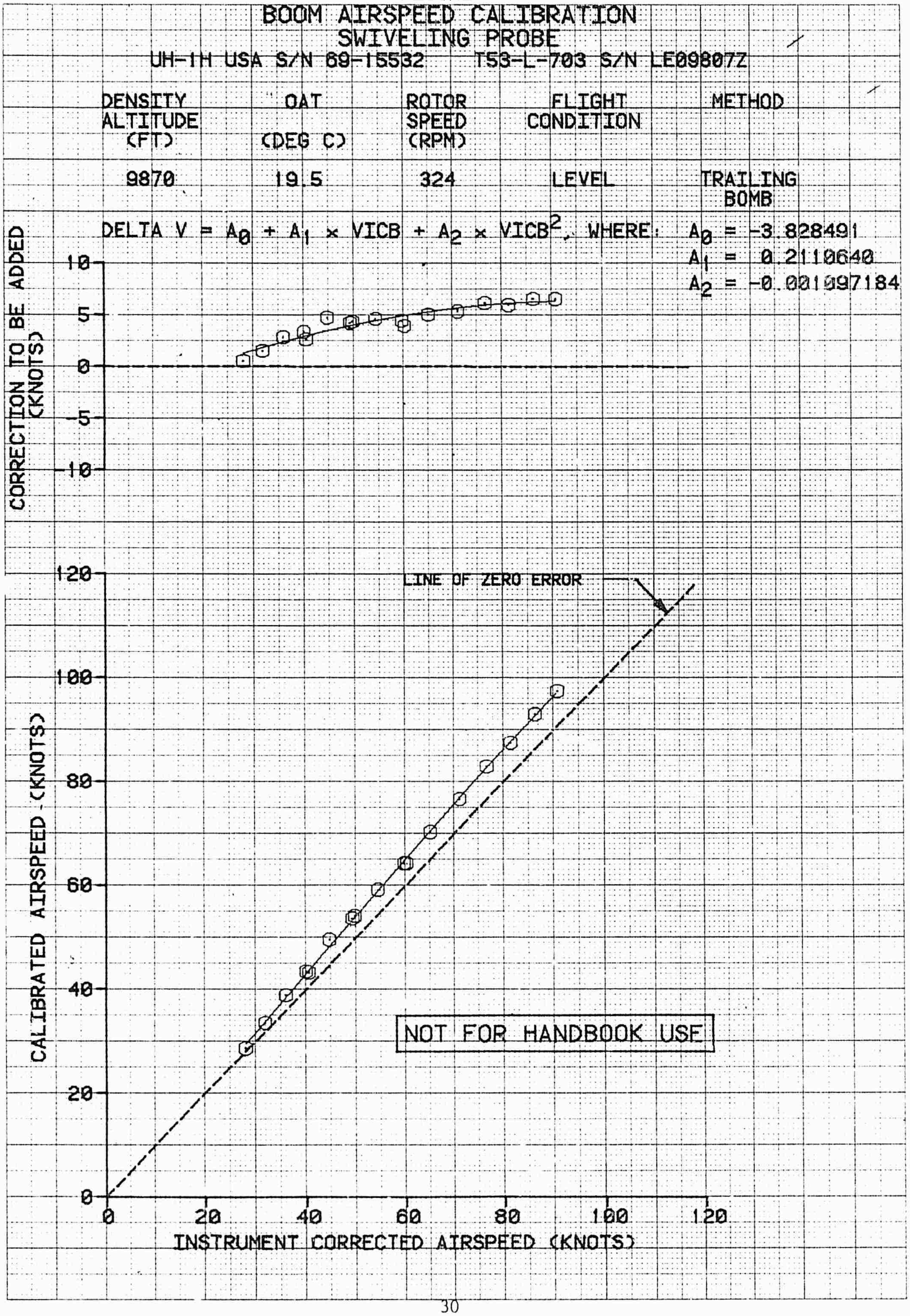
Acceleration (triaxial accelerometer at aircraft center of gravity)
Fuel pressure
Fuel flow rate
Fuel quantity used
Free air total temperature
Main rotor speed
Main rotor torque
Tail rotor torque
Tail rotor flapping
Main rotor mast bending
Main rotor pitch link loads
Tether cable tension
Tether cable angles
Engine
- Compressor discharge pressure
- Torque
- Gas producer speed
- Turbine gas temperature
- Throttle position
- Inlet guide vane position
- Inlet guide vane actuator pressure
- Bleed band position
- Inlet air static pressure
- Inlet air total pressure
- Inlet air total temperature

Engine oil temperature at oil cooler inlet
Engine oil temperature at oil cooler outlet
Transmission oil temperature at oil cooler inlet
Transmission oil temperature at oil cooler outlet

Airspeed Calibration

2. The standard and test boom airspeed systems were calibrated at the beginning of the evaluation. The position error correction for the boom airspeed system is presented in figure 1.

FIGURE 1



BOOM AIRSPEED CALIBRATION
SWIVELING PROBE
UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z
DENSITY ALTITUDE (FT)
OAT (DEG C)
ROTOR SPEED (RPM)
FLIGHT CONDITION
METHOD
9870
19.5
324
LEVEL
TRAILING BOMB
DELTA V = A0 + A1 × VICB + A2 × VICB2, WHERE:
A0 = -3.828491
A1 = 0.2110640
A2 = -0.001097184
CORRECTION TO BE ADDED (KNOTS)
10
5
0
-5
-10
LINE OF ZERO ERROR
CALIBRATED AIRSPEED (KNOTS)
120
100
80
60
40
20
0
NOT FOR HANDBOOK USE
0
20
40
60
80
100
120
INSTRUMENT CORRECTED AIRSPEED (KNOTS)

Engine Calibration

3. The relationship between differential torque pressure and engine torque developed in US Army Aviation Engineering Flight Activity Project No. 81-01-6, Fuel Conservation Evaluation, was used to determine engine torque. This relationship is presented in figure 2, where it is compared to posttest calibration data.

Temperature-Sensitive Labels

4. Self-adhesive temperature-sensitive labels were attached to the aircraft tailshaft cover, tailboom, and stabilator as shown in figure 3 to measure effects of exhaust impingement. Temperatures were read and manually recorded after selected flights. After the labels were read, they were removed and replaced with new labels.

SPECIAL EQUIPMENT

Weather Station

5. A portable weather station consisting of an anemometer, sensitive thermometer, and barometer was used to record wind speed and direction and ambient temperature and pressure. The anemometer was mounted on a tower whose height could be adjusted between 10 and 100 feet above ground level.

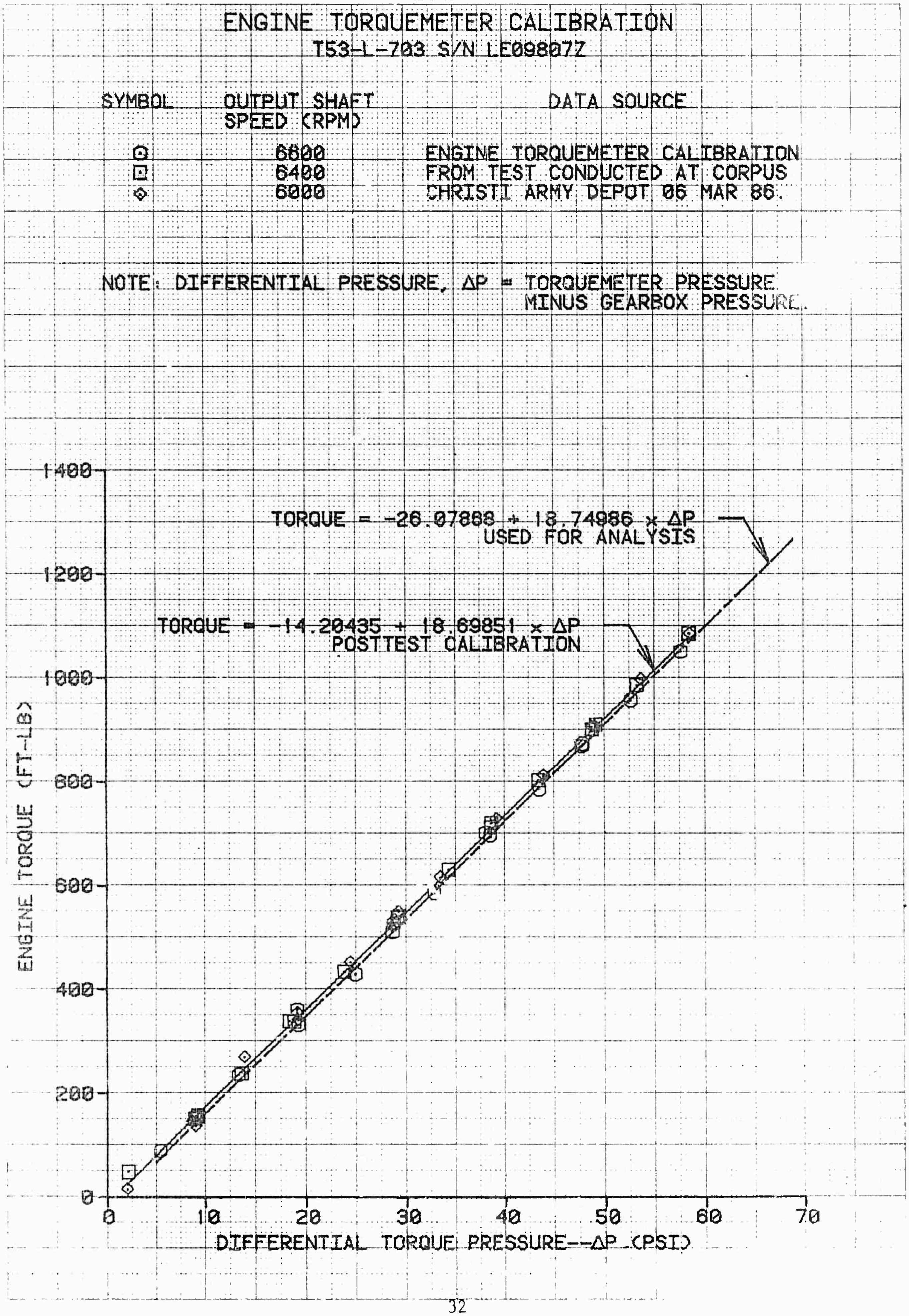
Load Cell

6. A calibrated load cell and sensitive accelerometers were incorporated with the aircraft cargo hook to measure cable tension and longitudinal and lateral cable angles during the tethered hover tests.

Ground Pace Vehicle

7. A calibrated "fifth wheel" ground speed indicating system was attached to a ground pace vehicle to provide a ground speed reference during the low airspeed handling qualities tests.

FIGURE 2


ENGINE TORQUEMETER CALIBRATION
T53-L-703 S/N LE09807Z
SYMBOL
OUTPUT SHAFT SPEED (RPM)
DATA SOURCE
6600
6400
6000
ENGINE TORQUEMETER CALIBRATION FROM TEST CONDUCTED AT CORPUS CHRISTI ARMY DEPOT 06 MAR 86.
NOTE: DIFFERENTIAL PRESSURE, ΔP = TORQUEMETER PRESSURE MINUS GEARBOX PRESSURE.
TORQUE = -26.07888 + 18.74986 x ΔP
USED FOR ANALYSIS
TORQUE = -14.20435 + 18.69851 x ΔP
POSTTEST CALIBRATION
ENGINE TORQUE (FT-LB)
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
50
60
70
DIFFERENTIAL TORQUE PRESSURE--ΔP (PSI)

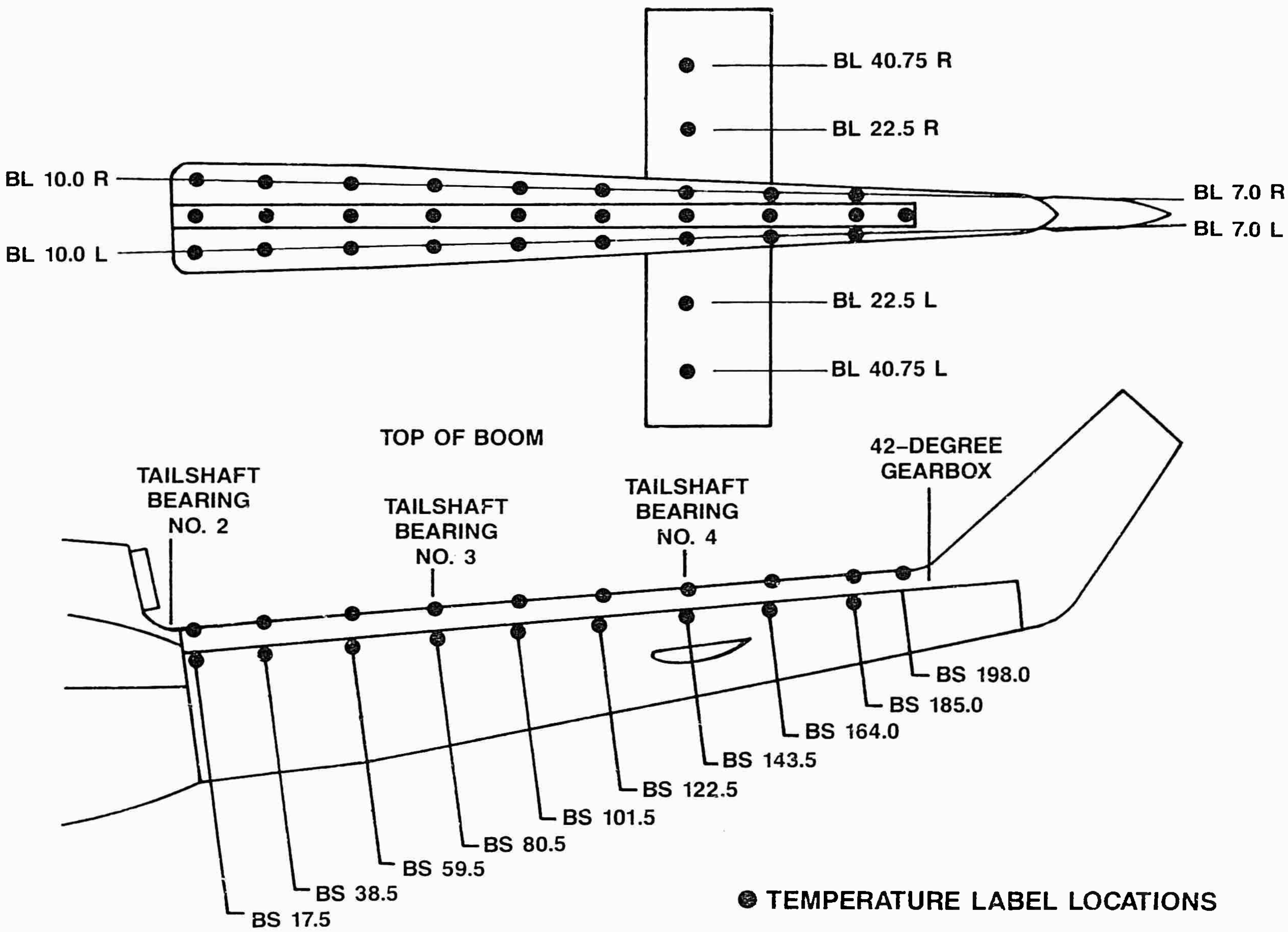


Figure 3. Temperature Label Locations

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

AIRCRAFT WEIGHT AND BALANCE

1. Before start of testing, the instrumented aircraft was weighed with full oil, trapped fuel, and without crew. The weighing was performed by the US Army Aviation Engineering Flight Activity personnel using a calibrated electronic weighing kit. The initial weight of the aircraft was 6181 pounds with the longitudinal center of gravity (cg) located at fuselage station 140.9 and the lateral cg located at butt line 0.1 right. The fuel cell external sight gauge calibration and fuel-quantity-consumed indicating system calibrations used in USAAEFA Project No. 81-01-6 were used for this evaluation. The fuel weight for each test flight was determined before each flight by using the sight gauge to determine fuel volume and measuring the specific gravity of the fuel.

PERFORMANCE

General

2. Aircraft performance was generalized through the use of nondimensional coefficients as follows:

a. Coefficient of Power (C_P):

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

b. Coefficient of Thrust (C_T):

$$C_T = \frac{GW + \text{Cable Tension}}{\rho A(\Omega R)^2}$$

c. Referred rotor speed $\frac{N_R}{\sqrt{\theta}}$:

Where:

SHP = Engine output shaft horsepower
ρ = Ambient air density ($lb\text{-}sec^2/ft^4$)
A = Main rotor disc area = 1809.6 ft^2

Ω = Main rotor angular velocity (radians/sec)
R = Main rotor radius = 24.000 ft
GW = Gross weight
N_R = Main rotor speed (rpm) (100 percent = 324 rpm)
θ = Temperature ratio = $(T_A + 273.15)/288.15$
T_A = Ambient temperature (°C)

At N_R = 324 rpm:

$A(\Omega R)^2 = 1.199892 \times 10^9$
$A(\Omega R)^3 = 9.770729 \times 10^{11}$

3. Engine output shaft torque was determined by measuring torquemeter pressure and gearbox pressure and calculating torque using the following relationship, developed in USAAEFA Project No. 81-01-6:

$$Q = -26.07868 + 18.74986\ \Delta P \tag{3}$$

Where:

Q = Engine output shaft torque, ft-lb
ΔP = Torquemeter pressure minus gearbox pressure, lb/ft^2

This relationship is compared to posttest calibration data in figure 2, appencix C.

4. Engine output shaft power was determined by the following equation:

$$SHP = \frac{Q(N_p)}{5252.113} \tag{4}$$

Where:

N_p = Engine output shaft rotational speed (rpm)
5252.113 = conversion factor (ft-lb-rev/min-shp)

Hover Performance

5. Hover performance was obtained by the tethered hover technique and in free hover. All hover tests were conducted in winds of less than 3 knots.

6. Tethered hover consists of tethering the aircraft to the ground by a cable in series with a load cell incorporated with

the cargo hook. The cable lengths were adjusted to give skid heights of 10 feet and 50 feet, measured at the rear of the left skid. The calculated actual gross weight of the aircraft plus

the cable tension measured by the load cell equals the equivalent gross weight for calculating C_T. Atmospheric pressure, temperature, and wind speed and direction were measured by a ground weather station. All hovering data were reduced to nondimensional parameters C_P and C_T as shown in equations 1 and 2 above, and grouped by skid height. A least-squares regression of the form $C_P = A_0 + A_1 C_T^{1.5}$ was calculated for each skid height.

7. Free hover performance tests were performed at average radar altitudes of 6.5 feet to 48.5 feet in approximately 5-foot increments.

HANDLING QUALITIES

Low Airspeed

8. Low airspeed tests were performed by using a ground pace vehicle equipped with a calibrated "fitch wheel" ground speed indicating system as a speed reference. Wind velocity (speed and direction) were measured by a ground weather station and recorded at each test point. True airspeed is the algebraic sum of ground pace vehicle speed and the component of wind velocity in the direction of flight. All low airspeed tests were conducted in winds of less than 3 knots.

9. For those conditions where a ground speed of 30 knots could be attained, the test was conducted at ground speeds from 5 knots through 30 knots in 5-knot increments, with the aircraft keeping formation with the ground pace vehicle. For those conditions where a ground speed of 30 knots could not be attained, the highest speed attainable was determined by the ground pace vehicle keeping formation with the aircraft.

Engine/Rotor System Response

10. Detailed descriptions of the engine/rotor sytem response tests are presented in paragraphs 17 through 25 of the Results and Discussion section.

APPENDIX E. TEST DATA

INDEX

FIGURE 1

NONDIMENSIONAL HOVER PERFORMANCE

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

SKID HEIGHT = 10 FT

SYMBOL	DENSITY ALTITUDE (FT)	REFERRED ROTOR SPEED (RPM)	OAT (DEG C)
○	11,320	326.9	11.5
□	11,260	316.5	10.5
◇	11,170	307.8	10.0
△	11,440	295.7	12.5

NOTES: 1. SKID HEIGHT MEASURED FROM BOTTOM OF AFT END OF LEFT SKID.
2. VERTICAL DISTANCE FROM BOTTOM OF SKIDS TO CENTER OF MAIN ROTOR HUB = 13 FEET.
3. TESTS CONDUCTED WITH AIRCRAFT TETHERED TO GROUND.
4. WINDS LESS THAN THREE KNOTS.

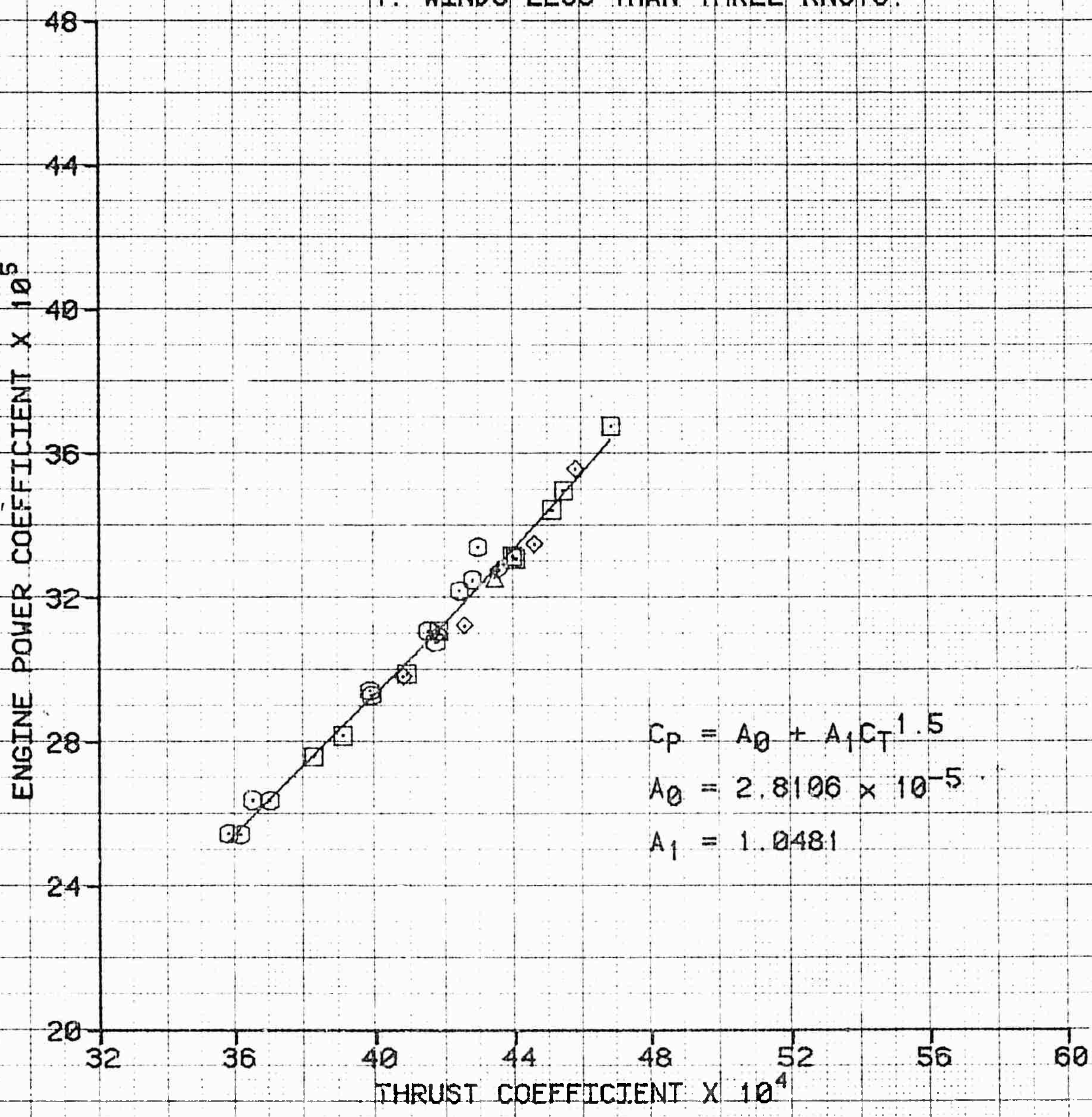


FIGURE 2

DIRECTIONAL CONTROL MARGINS IN HOVER

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

SKID HEIGHT = 10 FT

SYMBOL	DENSITY ALTITUDE (FT)	REFERRED ROTOR SPEED (RPM)	OAT (DEG C)
○	11,320	326.9	11.5
□	11,260	316.5	10.5
◇	11,170	307.8	10.0
△	11,440	295.7	12.5

NOTES:
1. VERTICAL LINES AND HORIZONTAL BARS SHOW CONTROL EXCURSIONS.
2. SKID HEIGHT MEASURED FROM BOTTOM OF AFT END OF LEFT SKID.
3. VERTICAL DISTANCE FROM BOTTOM OF SKIDS TO CENTER OF MAIN ROTOR HUB = 13 FEET.
4. TESTS CONDUCTED WITH AIRCRAFT TETHERED TO GROUND.
5. WINDS LESS THAN THREE KNOTS.
6. TOTAL DIRECTIONAL CONTROL TRAVEL = 7.2 INCHES.

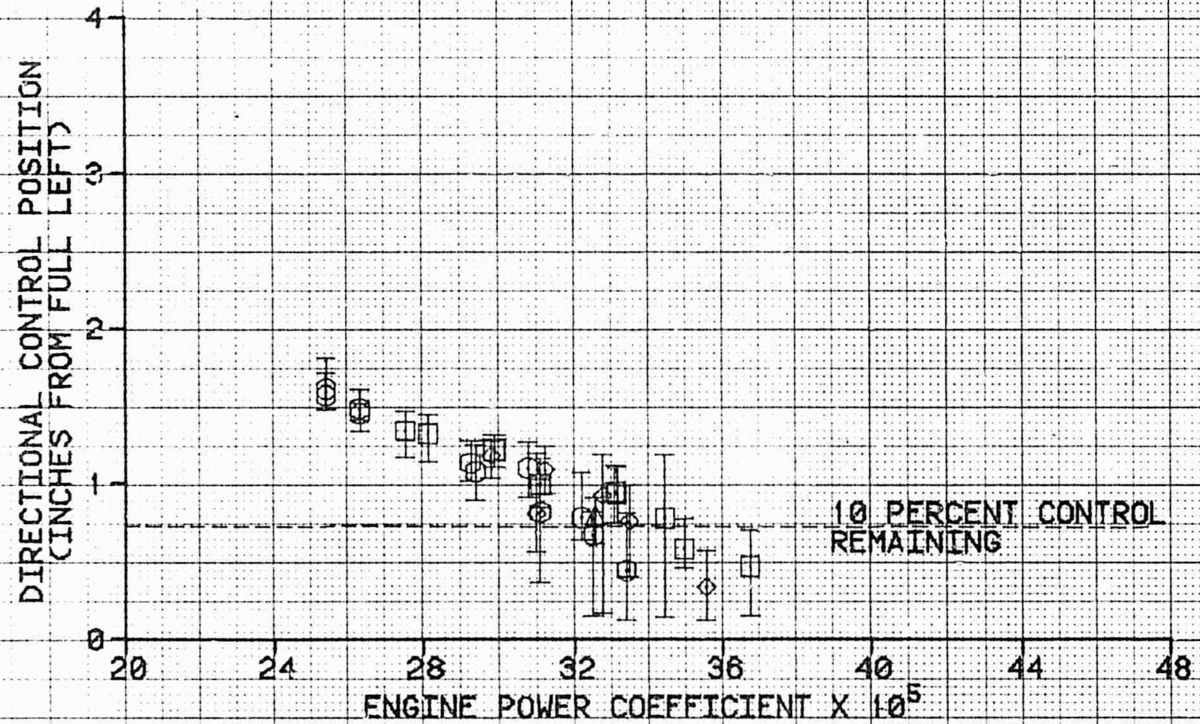


FIGURE 3

DIRECTIONAL CONTROL MARGINS IN HOVER

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

SKID HEIGHT = 10 FT

SYMBOL	DENSITY ALTITUDE (FT)	REFERRED ROTOR SPEED (RPM)	OAT (DEG C)
○	11,320	326.9	11.5
□	11,260	316.5	10.5
◇	11,170	307.8	10.0
△	11,440	295.7	12.5

NOTES:
1. VERTICAL LINES AND HORIZONTAL BARS SHOW CONTROL EXCURSIONS.
2. SKID HEIGHT MEASURED FROM BOTTOM OF AFT END OF LEFT SKID.
3. VERTICAL DISTANCE FROM BOTTOM OF SKIDS TO CENTER OF MAIN ROTOR HUB = 13 FEET.
4. TESTS CONDUCTED WITH AIRCRAFT TETHERED TO GROUND.
5. WINDS LESS THAN THREE KNOTS.
6. TOTAL DIRECTIONAL CONTROL TRAVEL = 7.2 INCHES.

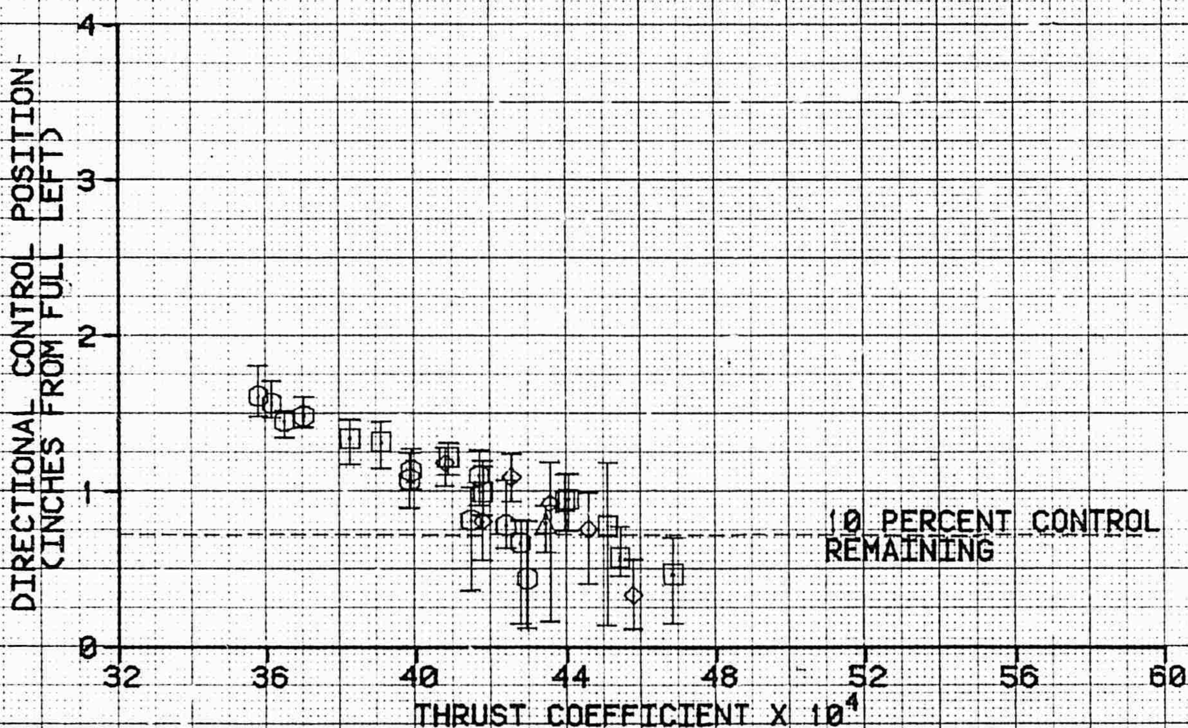


FIGURE 4

NONDIMENSIONAL HOVER PERFORMANCE
UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z
SKID HEIGHT = 50 FT

SYMBOL	DENSITY ALTITUDE (FT)	REFERRED ROTOR SPEED (RPM)	OAT (DEG C)
○	11,260	328.2	8.0
□	11,460	317.2	10.0
◇	11,440	307.1	9.5
△	11,520	297.8	10.5

NOTES:
1. SKID HEIGHT MEASURED FROM BOTTOM OF AFT END OF LEFT SKID.
2. VERTICAL DISTANCE FROM BOTTOM OF SKIDS TO CENTER OF MAIN ROTOR HUB = 13 FEET.
3. TESTS CONDUCTED WITH AIRCRAFT TETHERED TO GROUND.
4. WINDS LESS THAN THREE KNOTS.
5. SOLID SYMBOL DENOTES FREE OGE HOVER.

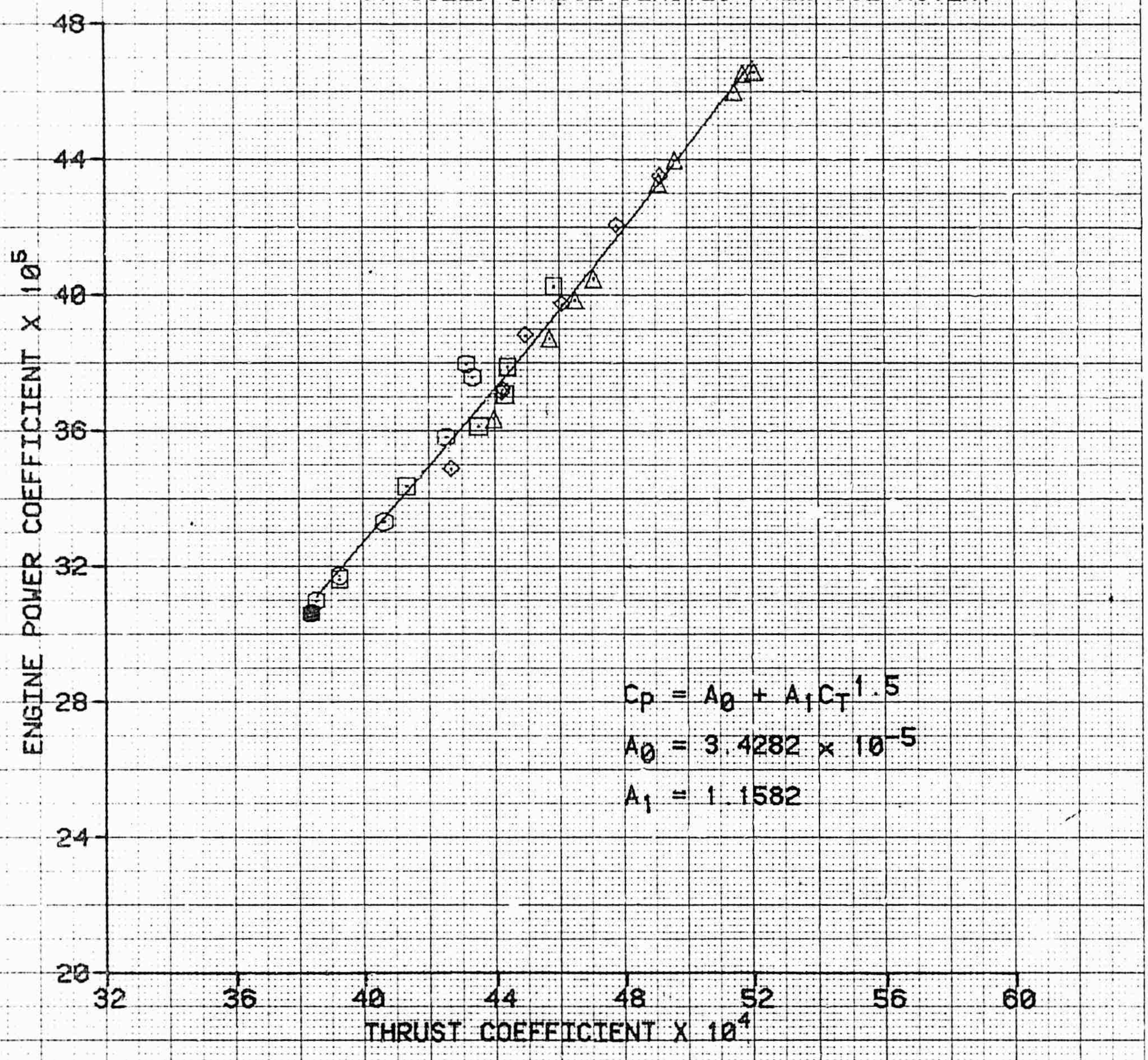


FIGURE 5

DIRECTIONAL CONTROL MARGINS IN HOVER

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

SKID HEIGHT = 50 FT

SYMBOL	DENSITY ALTITUDE (FT)	REFERRED ROTOR SPEED (RPM)	OAT (DEG C)
○	11,260	328.2	8.0
□	11,460	317.2	10.0
◇	11,440	307.2	9.5
△	11,520	297.8	10.5

NOTES:
1. VERTICAL LINES AND HORIZONTAL BARS SHOW CONTROL EXCURSIONS.
2. SKID HEIGHT MEASURED FROM BOTTOM OF AFT END OF LEFT SKID.
3. VERTICAL DISTANCE FROM BOTTOM OF SKIDS TO CENTER OF MAIN ROTOR HUB = 13 FEET.
4. TESTS CONDUCTED WITH AIRCRAFT TETHERED TO GROUND.
5. WINDS LESS THAN THREE KNOTS.
6. TOTAL DIRECTIONAL CONTROL TRAVEL = 7.2 INCHES.

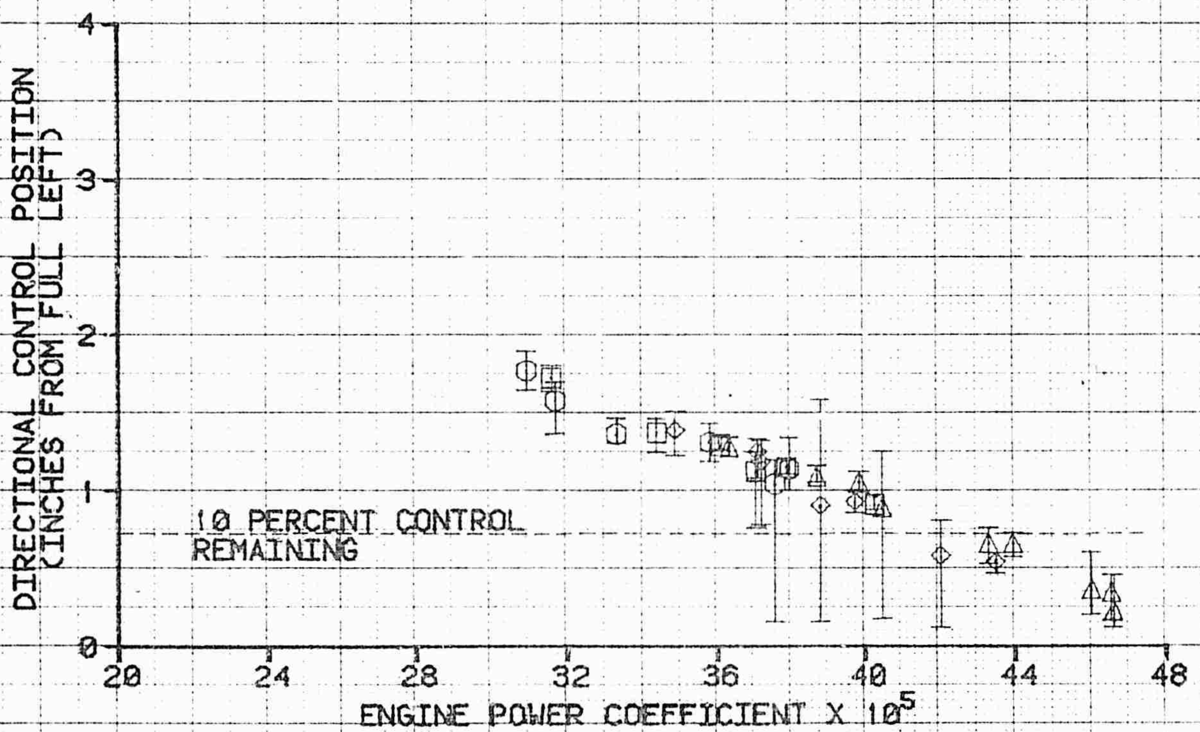


FIGURE 6

DIRECTIONAL CONTROL MARGINS IN HOVER

UH-1H USA S/N 69-15532   T53-L-703 S/N LE098077

SKID HEIGHT = 50 FT

SYMBOL	DENSITY ALTITUDE (FT)	REFERRED ROTOR SPEED (RPM)	OAT (DEG C)
○	11,260	328.2	8.0
□	11,460	317.2	10.0
◇	11,440	307.1	9.5
△	11,520	297.8	10.5

NOTES:
1. VERTICAL LINES AND HORIZONTAL BARS SHOW CONTROL EXCURSIONS.
2. SKID HEIGHT MEASURED FROM BOTTOM OF AFT END OF LEFT SKID.
3. VERTICAL DISTANCE FROM BOTTOM OF SKIDS TO CENTER OF MAIN ROTOR HUB = 13 FEET.
4. TESTS CONDUCTED WITH AIRCRAFT TETHERED TO GROUND.
5. WINDS LESS THAN THREE KNOTS.
6. TOTAL DIRECTIONAL CONTROL TRAVEL = 7.2 INCHES.

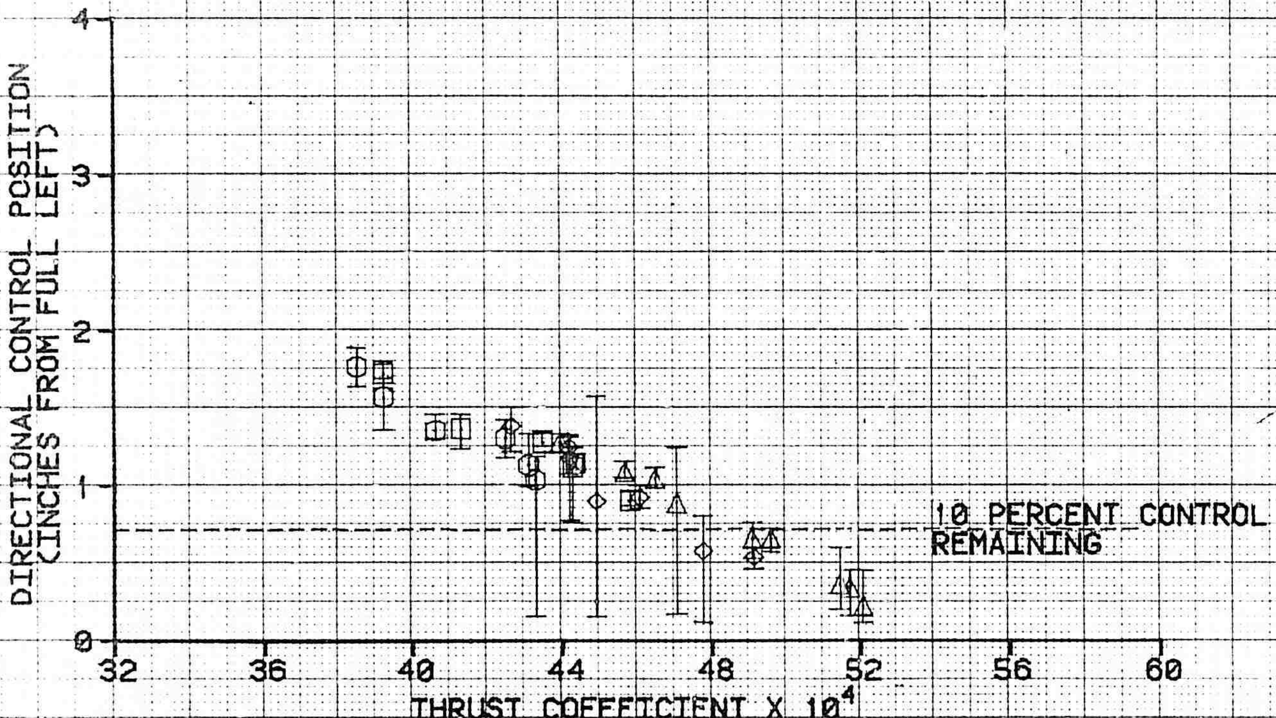


FIGURE 7

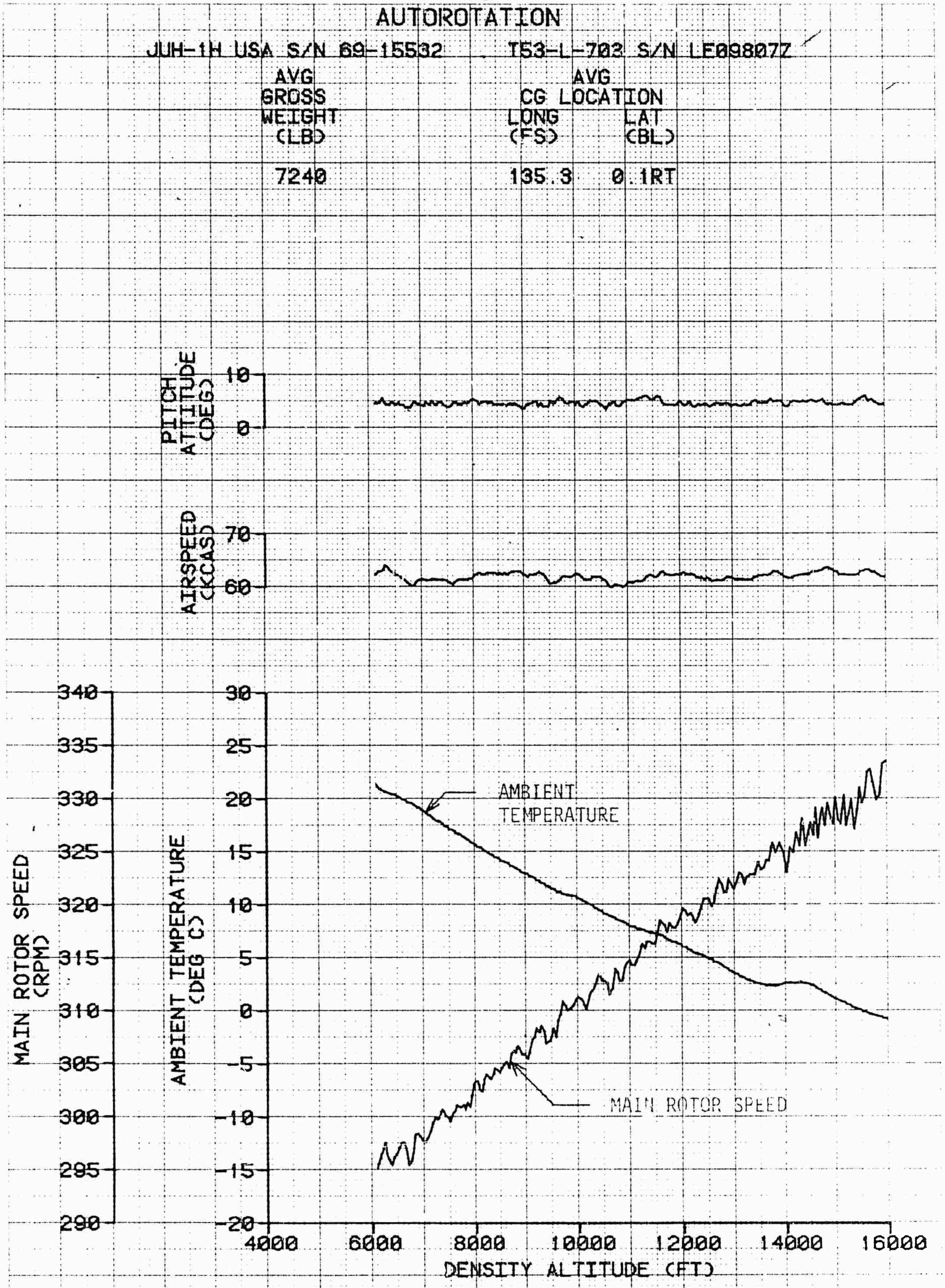

AUTOROTATION
JUH-1H USA S/N 69-15532   T53-L-703 S/N LE09807Z
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
7240
135.3
0.1RT
PITCH ATTITUDE (DEG)
10
0
AIRSPEED (KCAS)
70
60
MAIN ROTOR SPEED (RPM)
340
335
330
325
320
315
310
305
300
295
290
AMBIENT TEMPERATURE (DEG C)
30
25
20
15
10
5
0
-5
-10
-15
-20
AMBIENT TEMPERATURE
MAIN ROTOR SPEED
4000
6000
8000
10000
12000
14000
16000
DENSITY ALTITUDE (FT)

FIGURE 8

AUTOROTATION

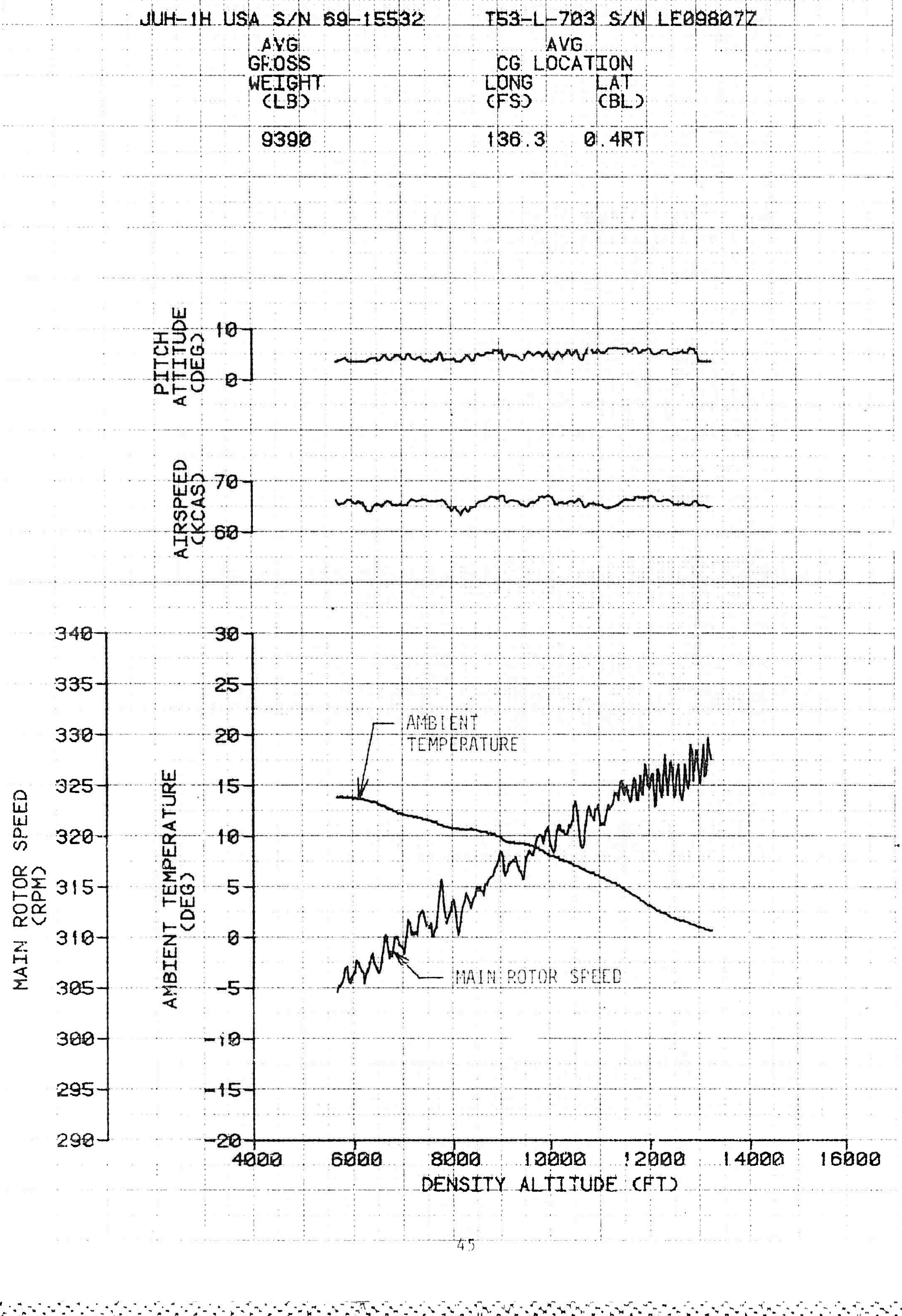


FIGURE 9

LOW-AIRSPEED 45-DEGREE AZIMUTH FLIGHT CHARACTERISTICS
UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8540	132.2	0.0	11,130	10.0	324	10

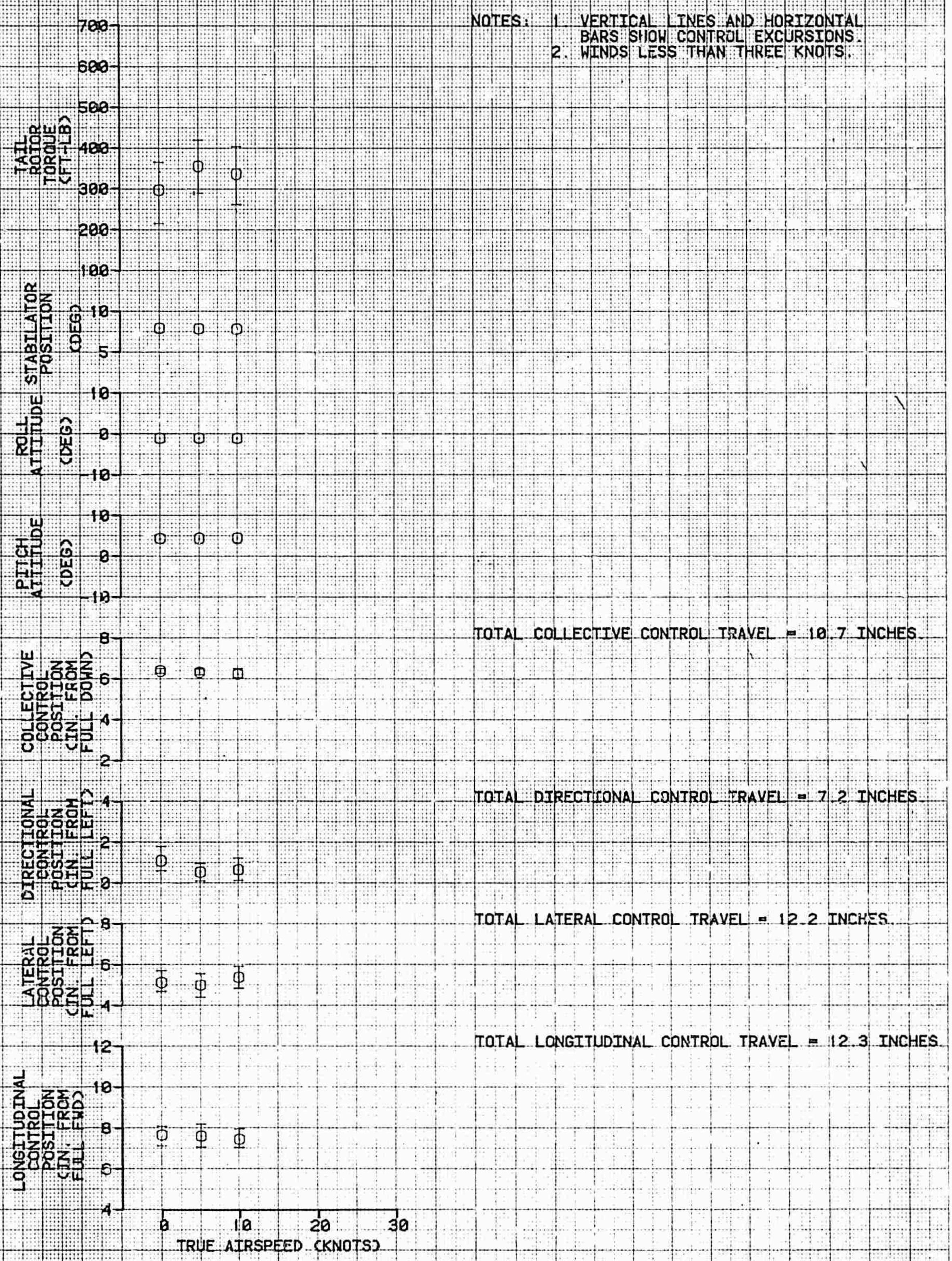


FIGURE 10

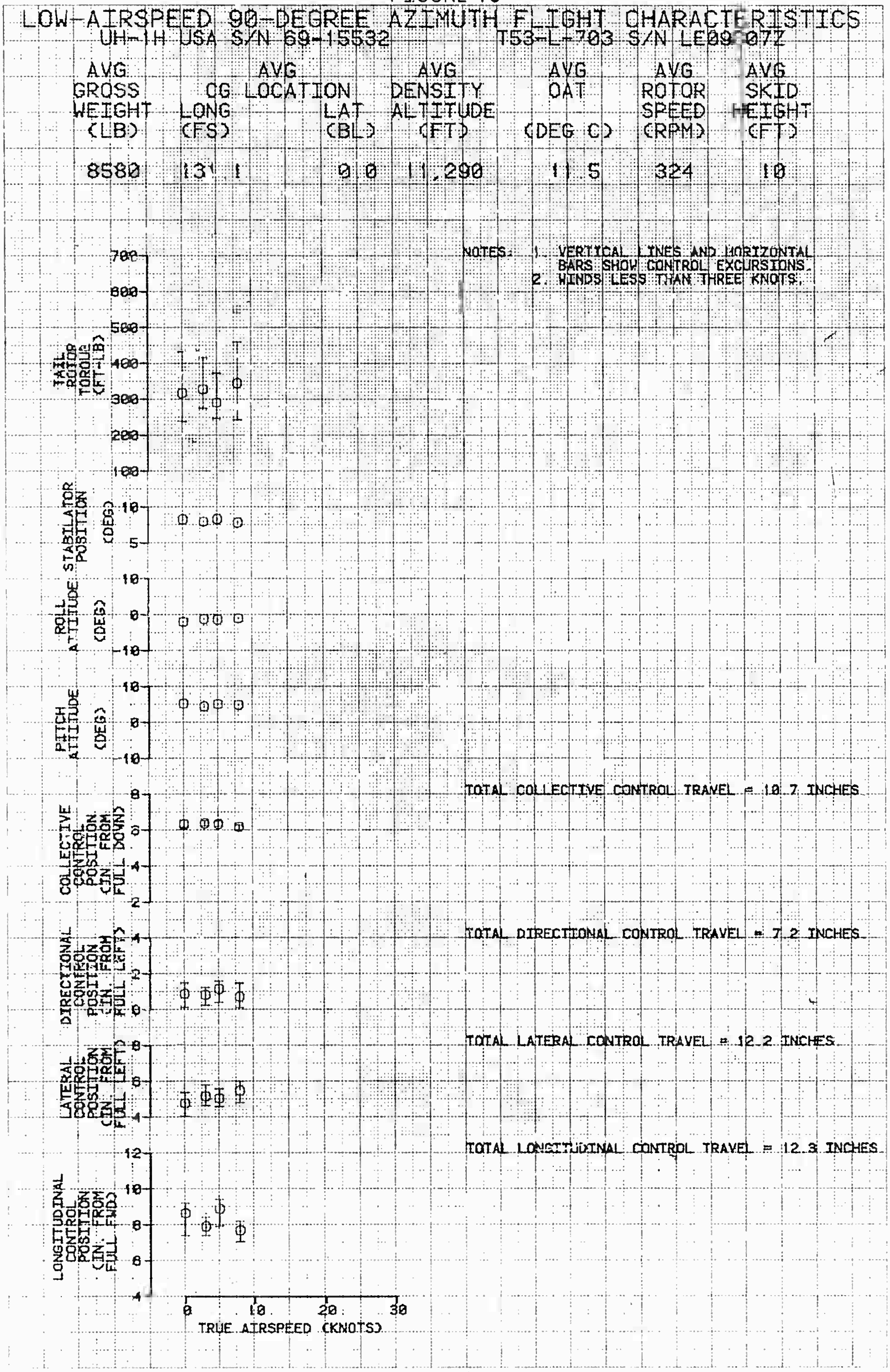

LOW-AIRSPEED 90-DEGREE AZIMUTH FLIGHT CHARACTERISTICS
UH-1H USA S/N 69-15532
T53-L-703 S/N LE09107Z
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
AVG SKID HEIGHT (FT)
8580
131.1
0.0
11,290
11.5
324
10
NOTES: 1. VERTICAL LINES AND HORIZONTAL BARS SHOW CONTROL EXCURSIONS.
2. WINDS LESS THAN THREE KNOTS.
TAIL ROTOR TORQUE (FT-LB)
STABILATOR POSITION (DEG)
ROLL ATTITUDE (DEG)
PITCH ATTITUDE (DEG)
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL COLLECTIVE CONTROL TRAVEL = 10.7 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL DIRECTIONAL CONTROL TRAVEL = 7.2 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.3 INCHES
TRUE AIRSPEED (KNOTS)

FIGURE 11

LOW-AIRSPEED 135-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8550	130.9	0.0	11,320	12.0	324	10

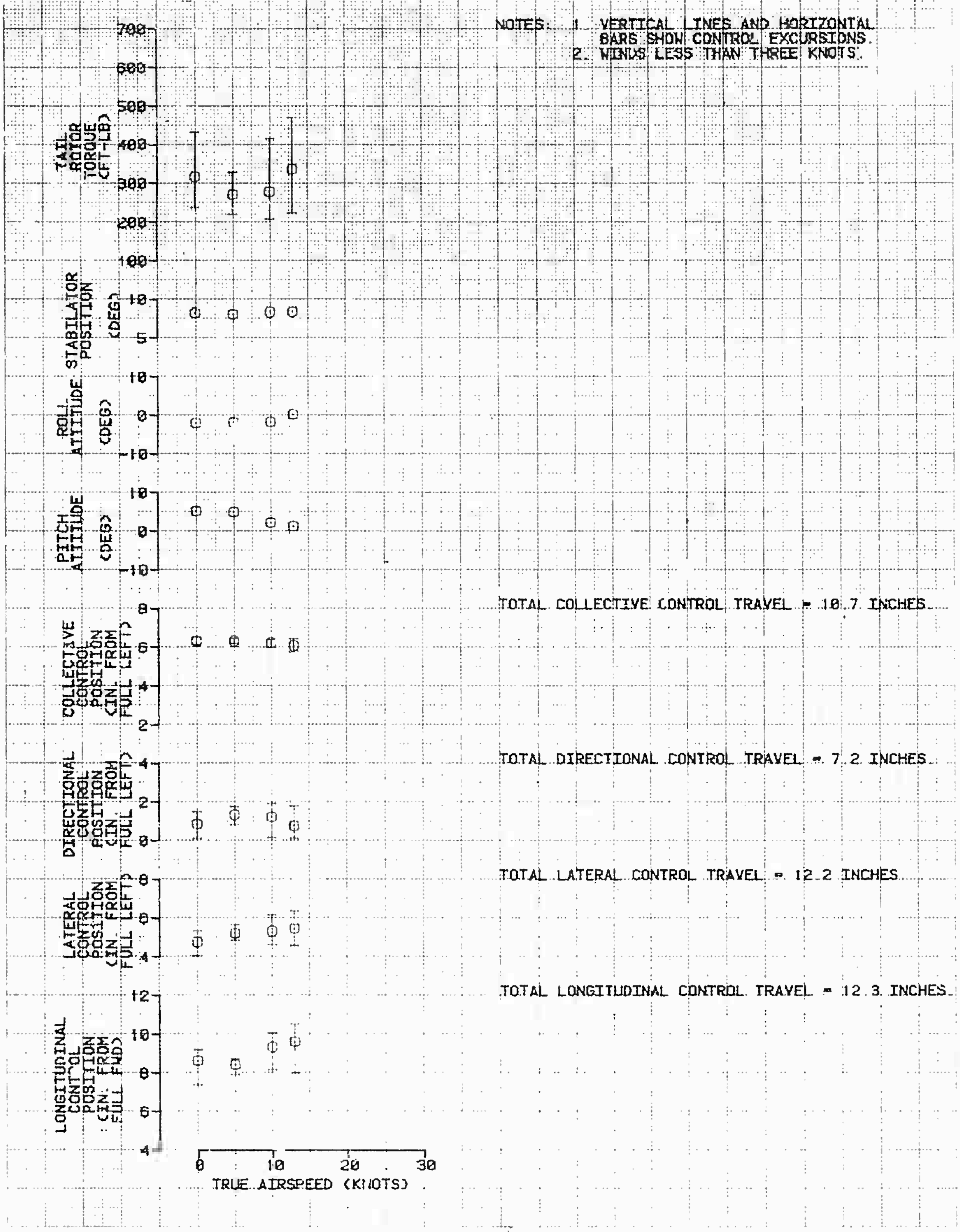


FIGURE 12

LOW-AIRSPEED 45-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8550	131.1	0.1LT	2900	16.5	324	10

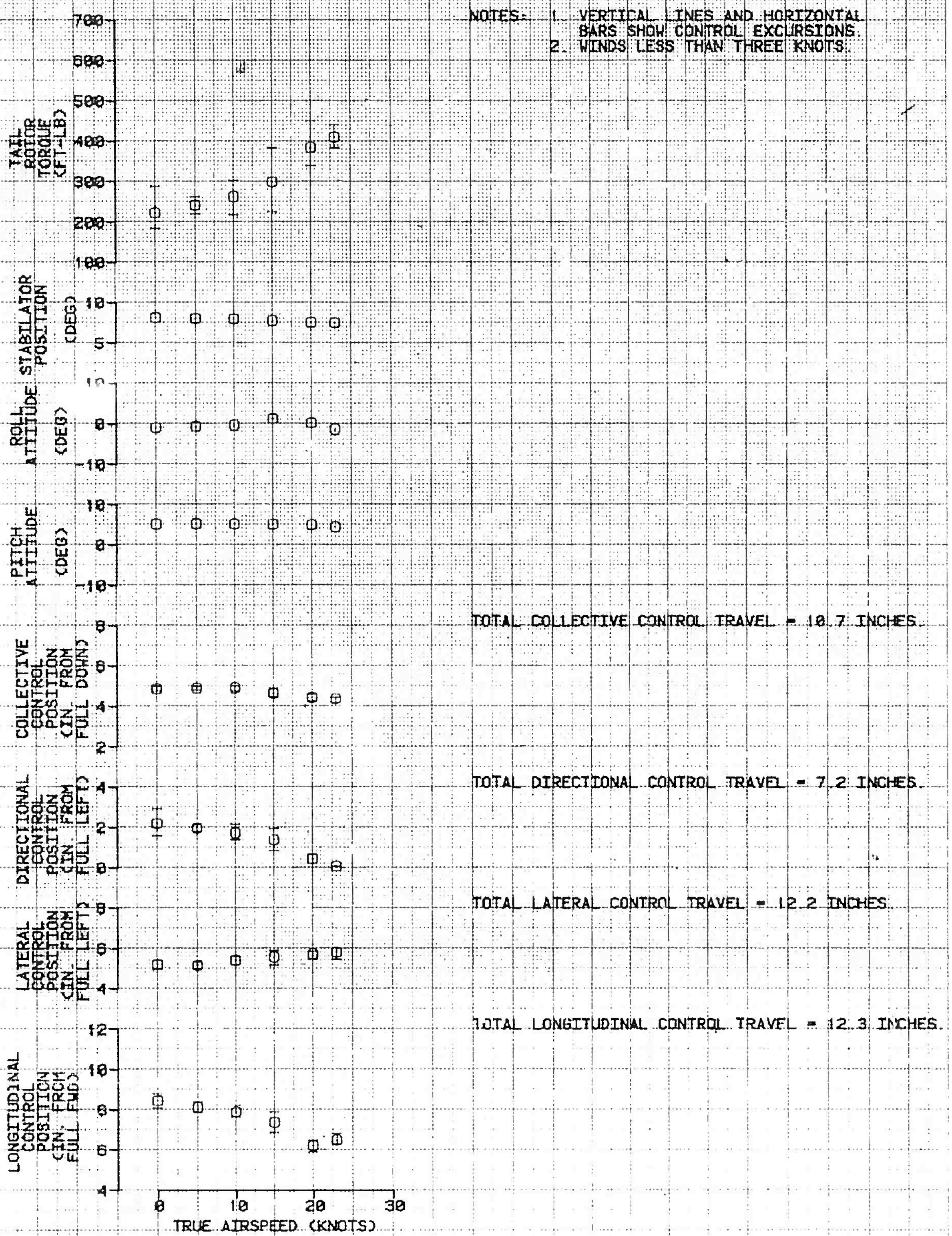


FIGURE 13

LOW-AIRSPEED 90-DEGREE AZIMUTH FLIGHT CHARACTERISTICS
UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8540	130.7	0.1LT	2890	16.0	324	10

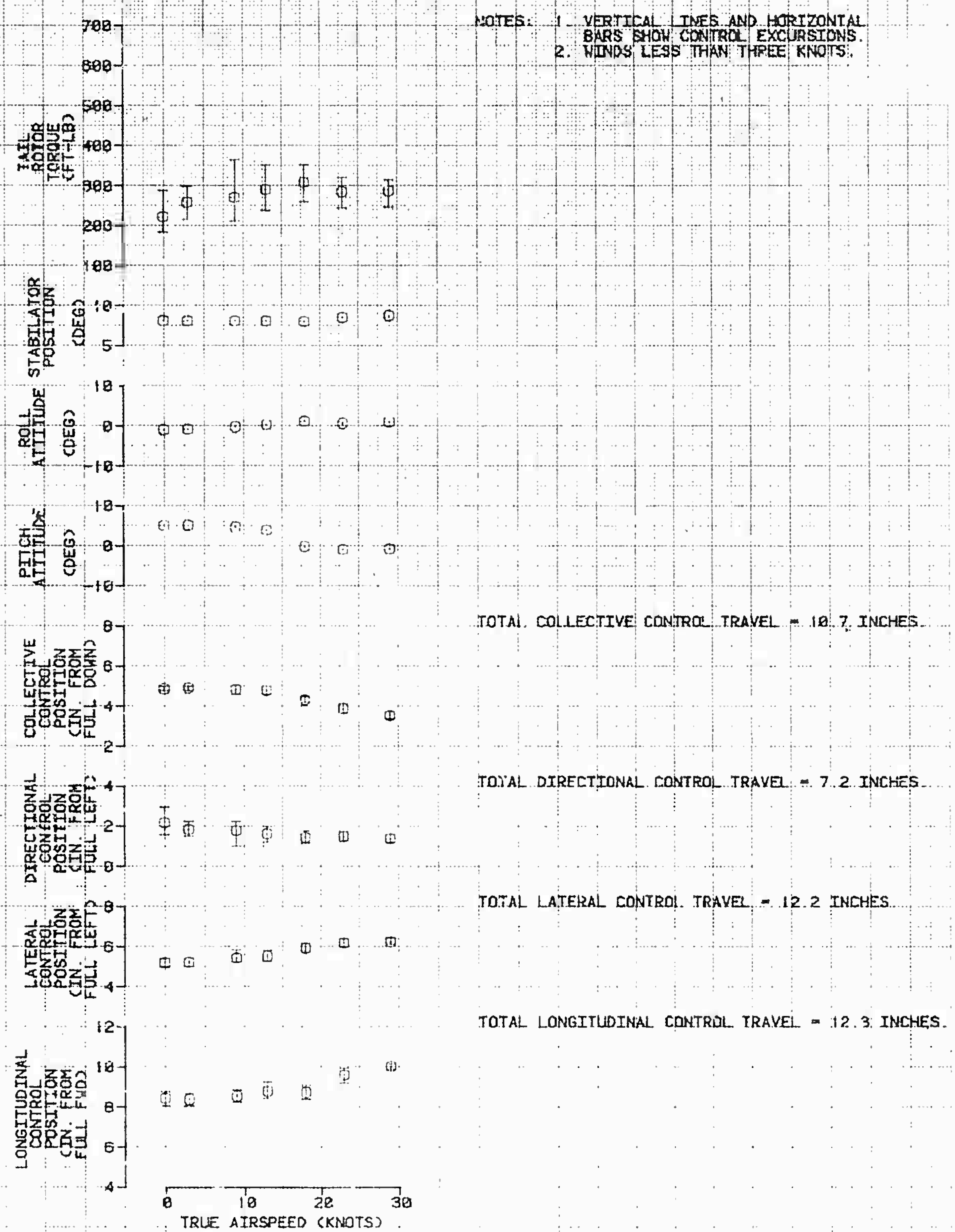


FIGURE 14

LOW-AIRSPEED 135-DEGREE AZIMUTH FLIGHT CHARACTERISTICS
UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8540	130.6	0.1LT	2870	16.0	324	10

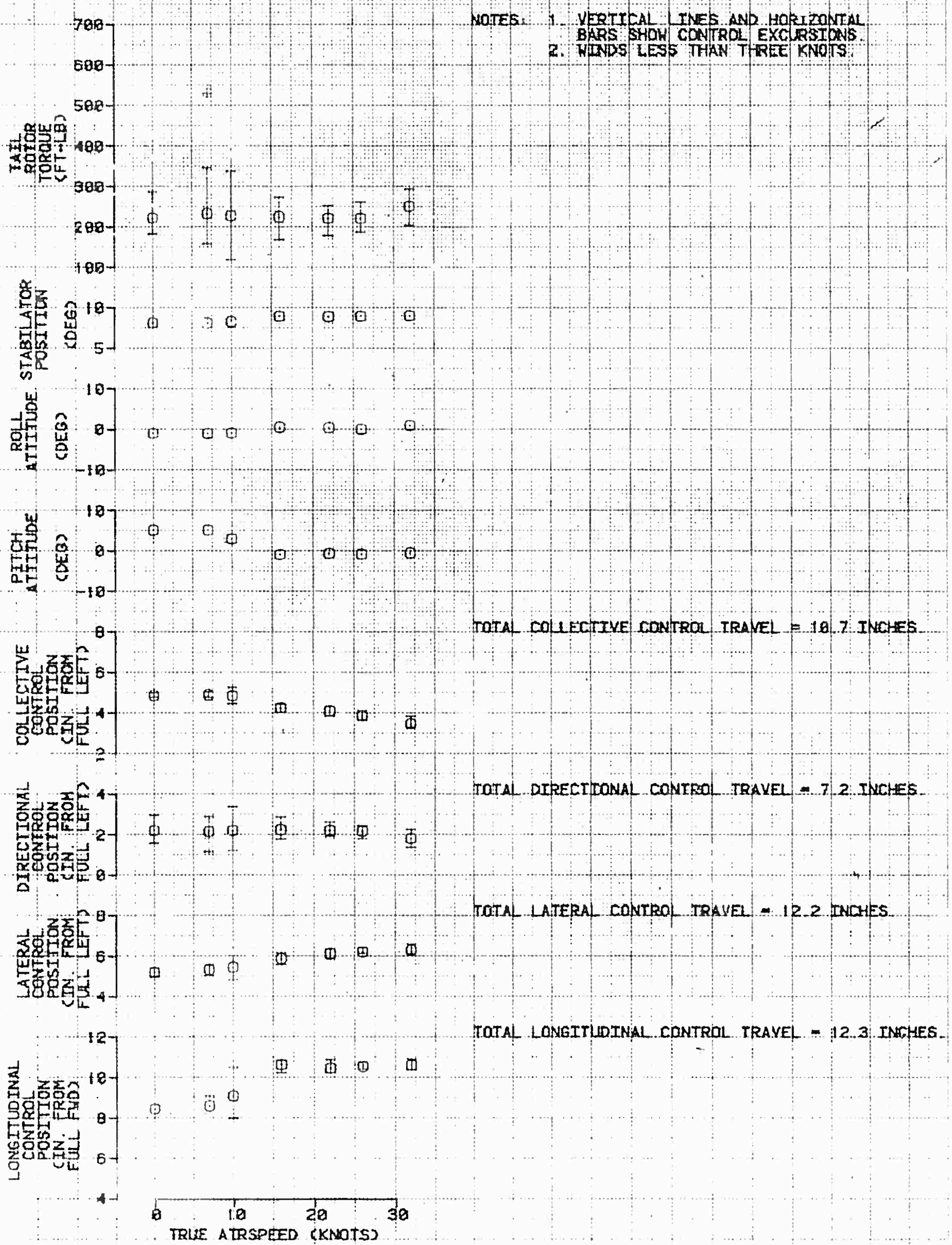


FIGURE 15

LOW-AIRSPEED 45-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8590	131.3	0.1LT	3530	21.5	324	50

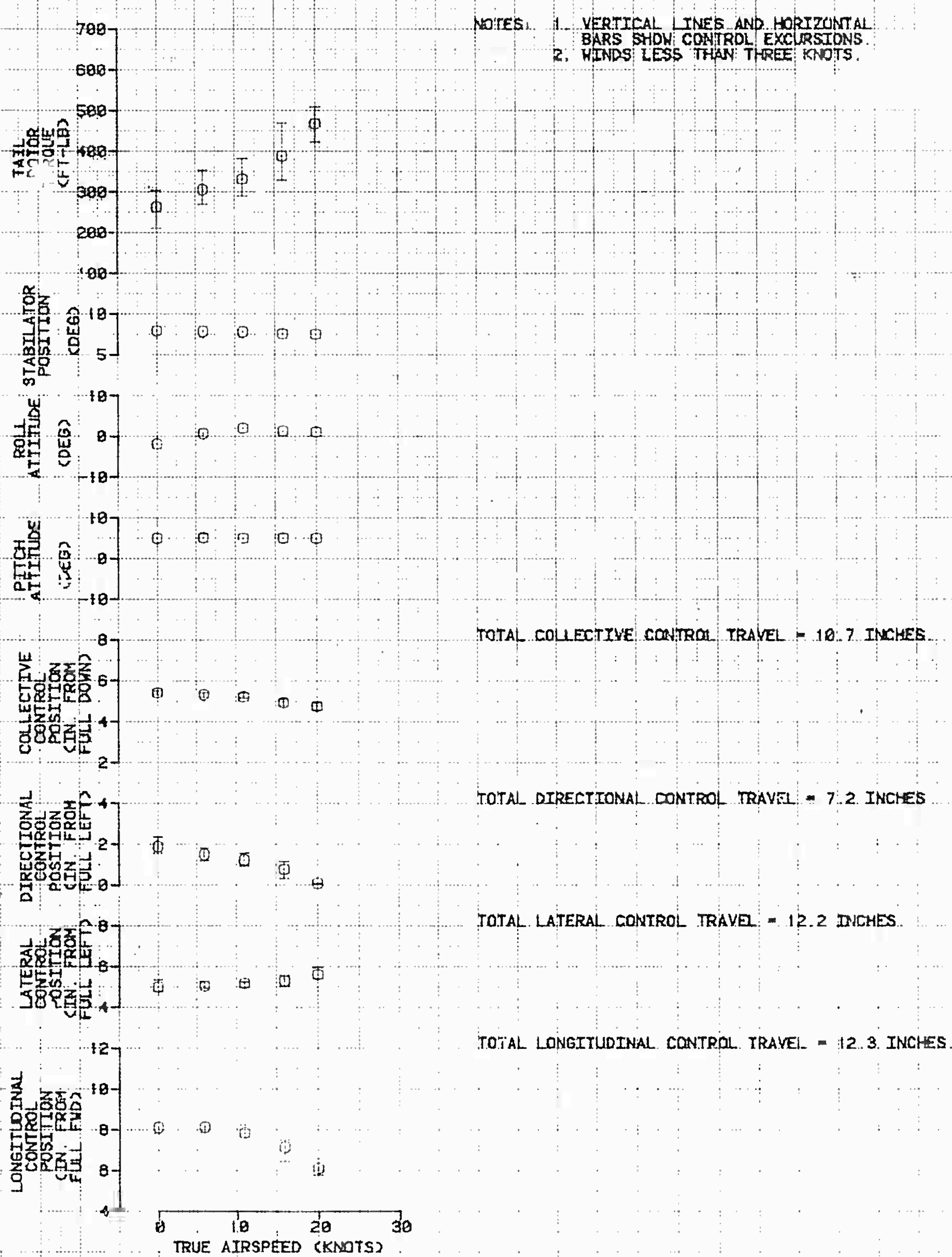


FIGURE 16

LOW-AIRSPEED 90-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8530	130.5	0.1LT	3030	17.0	324	50

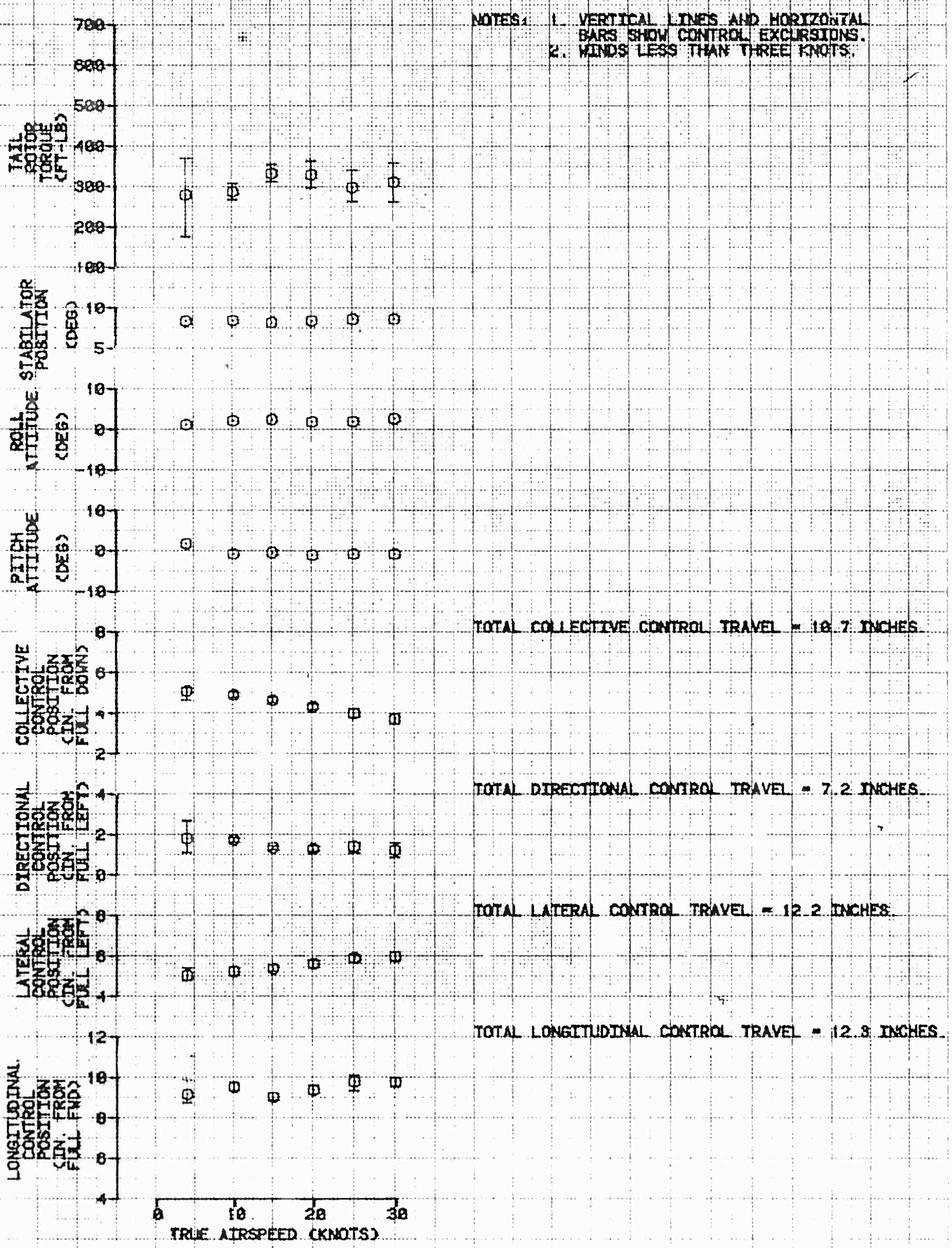


FIGURE 17

LOW-AIRSPEED 135-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE08807Z

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 SKID HEIGHT (FT)
8560	130.7	0.1LT	3550	21.5	324	50

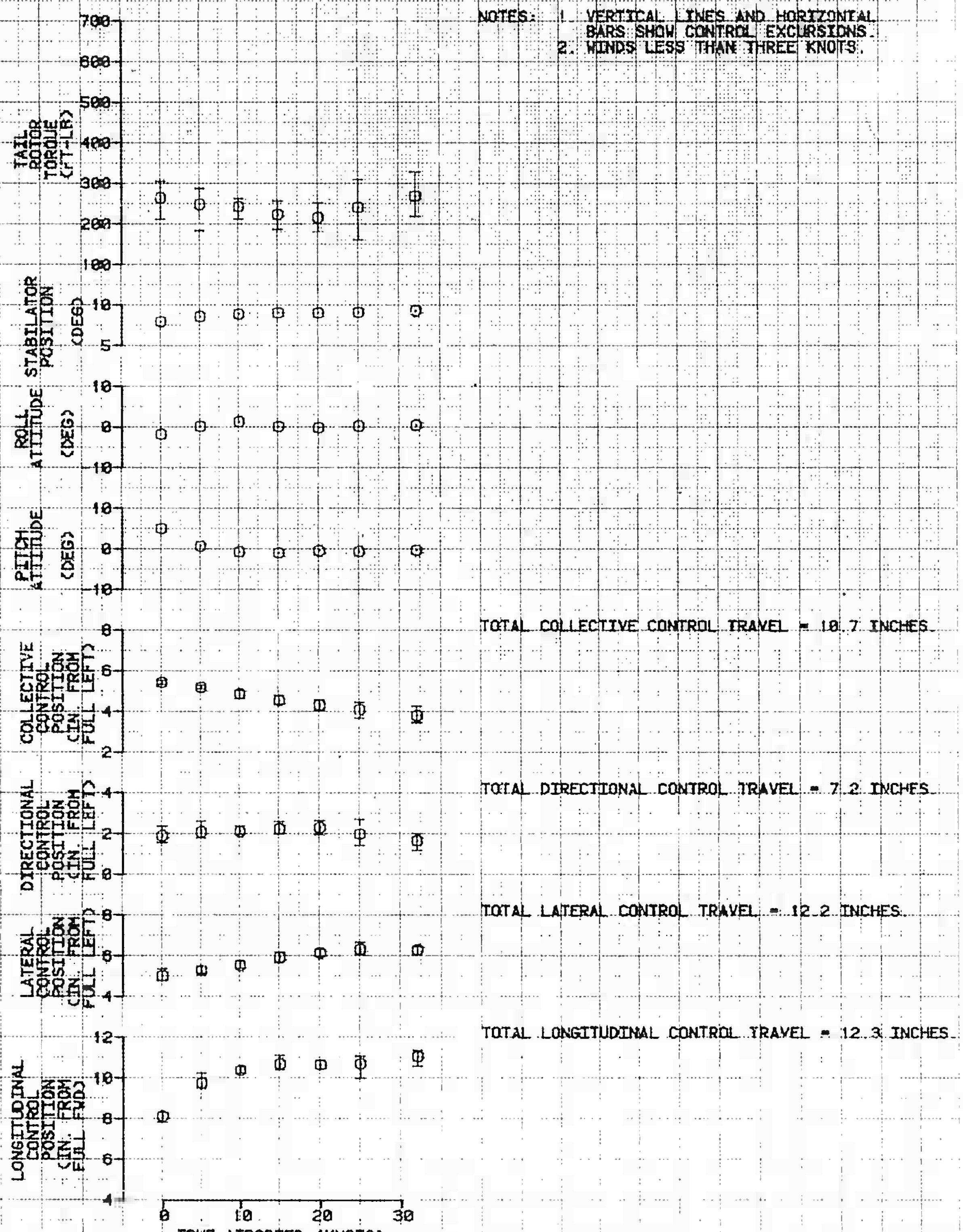


FIGURE 18

LOW-AIRSPEED 45-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8540	130.5	0.1LT	3890	25.0	314	10

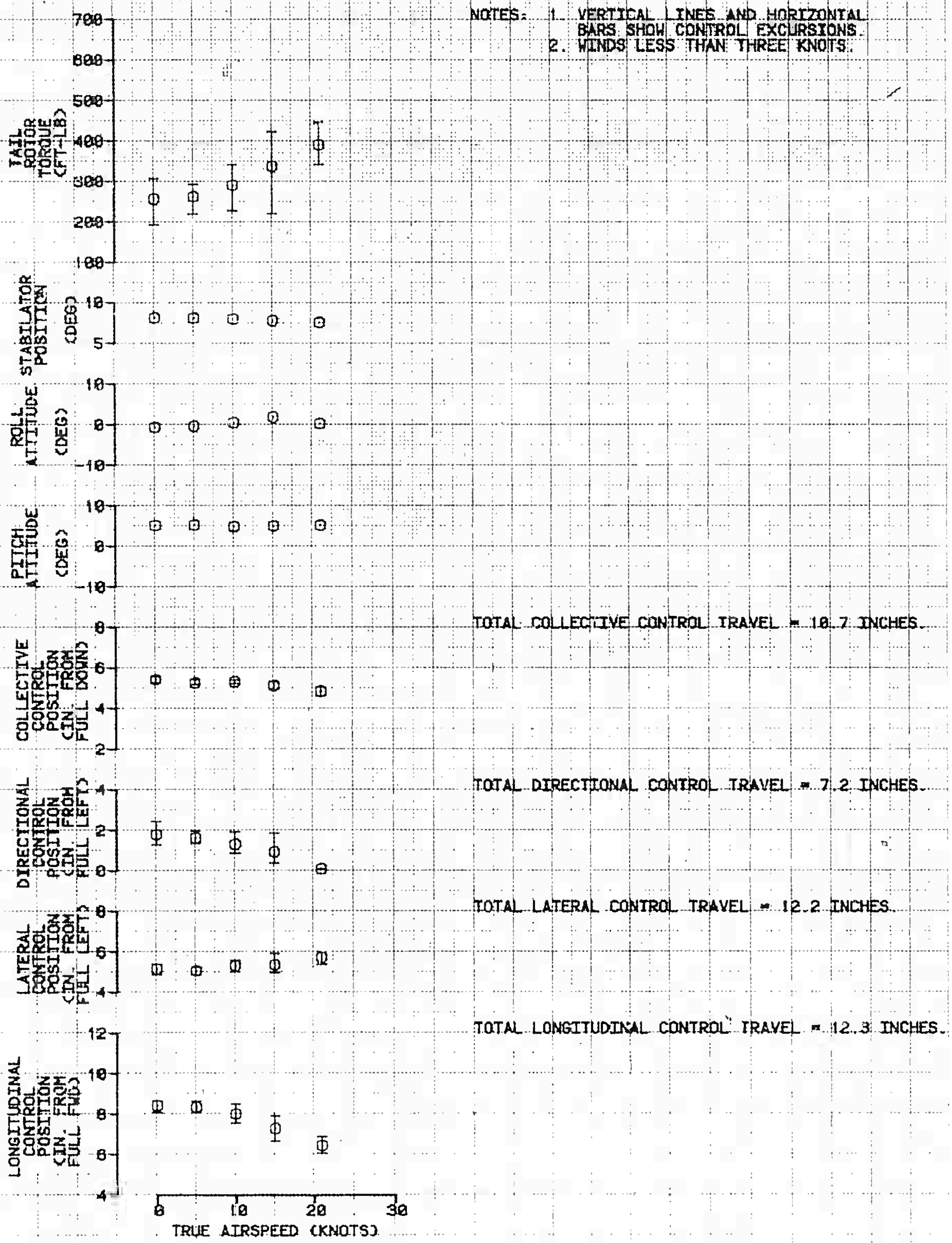


FIGURE 19

LOW-AIRSPEED 90-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8530	130.7	0.1LT	3760	24.0	314	10

NOTES: 1. VERTICAL LINES AND HORIZONTAL BARS SHOW CONTROL EXCURSIONS.
2. WINDS LESS THAN THREE KNOTS.

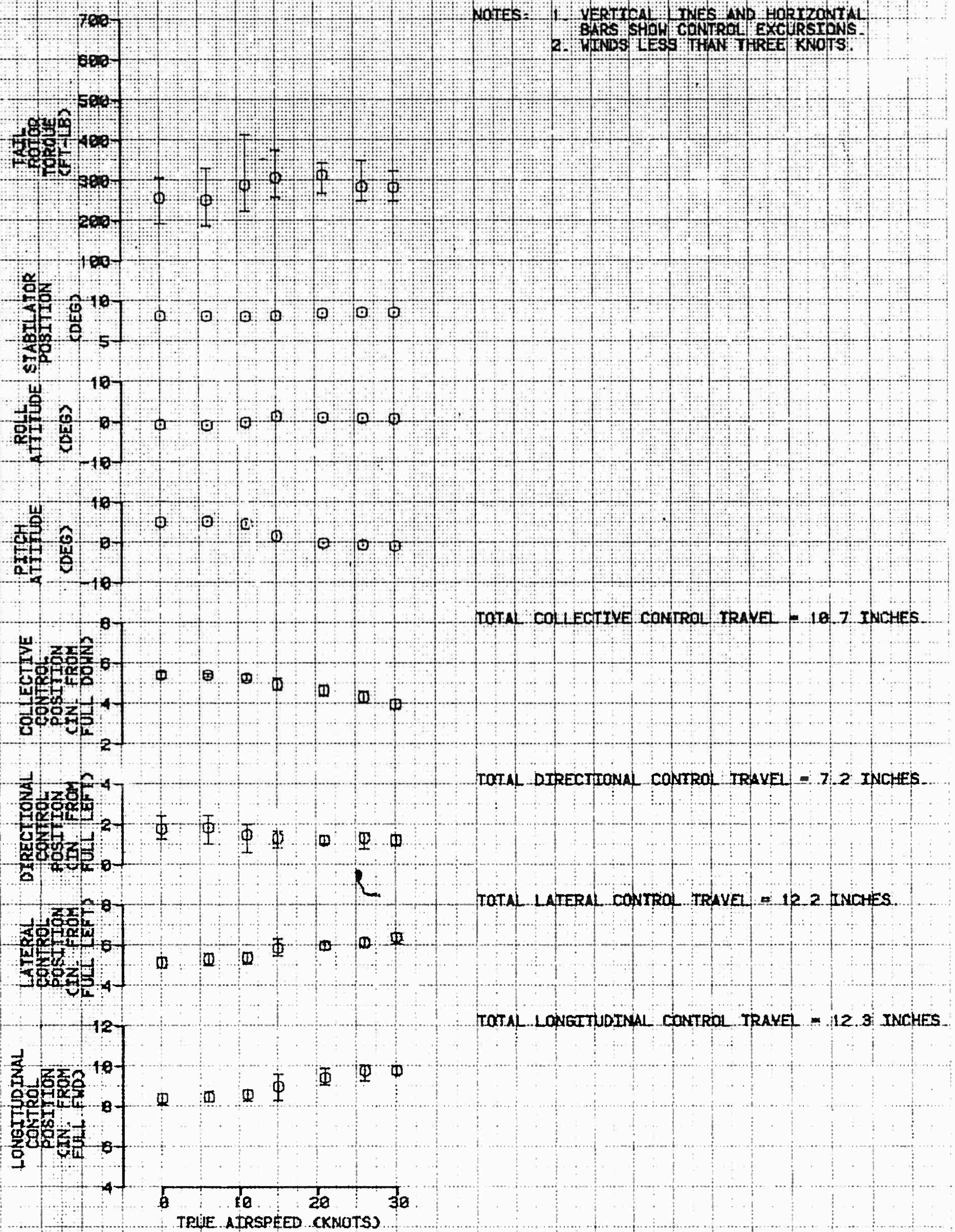


FIGURE 20

LOW-AIRSPEED 135-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8500	130.5	0.1LT	3870	25.0	314	10

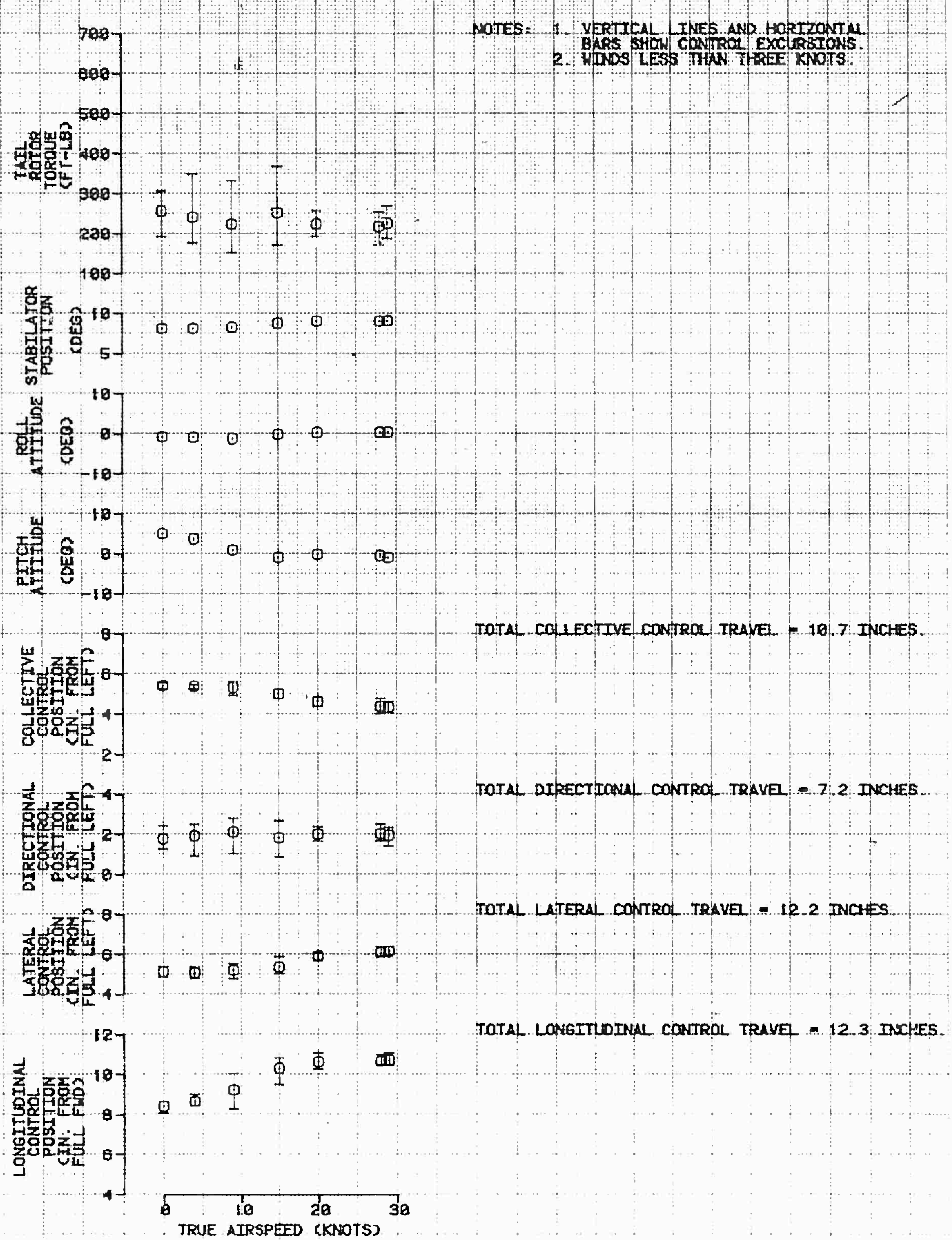


FIGURE 21

LOW-AIRSPEED 45-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8540	131.1	0.0	1910	7.5	314	50

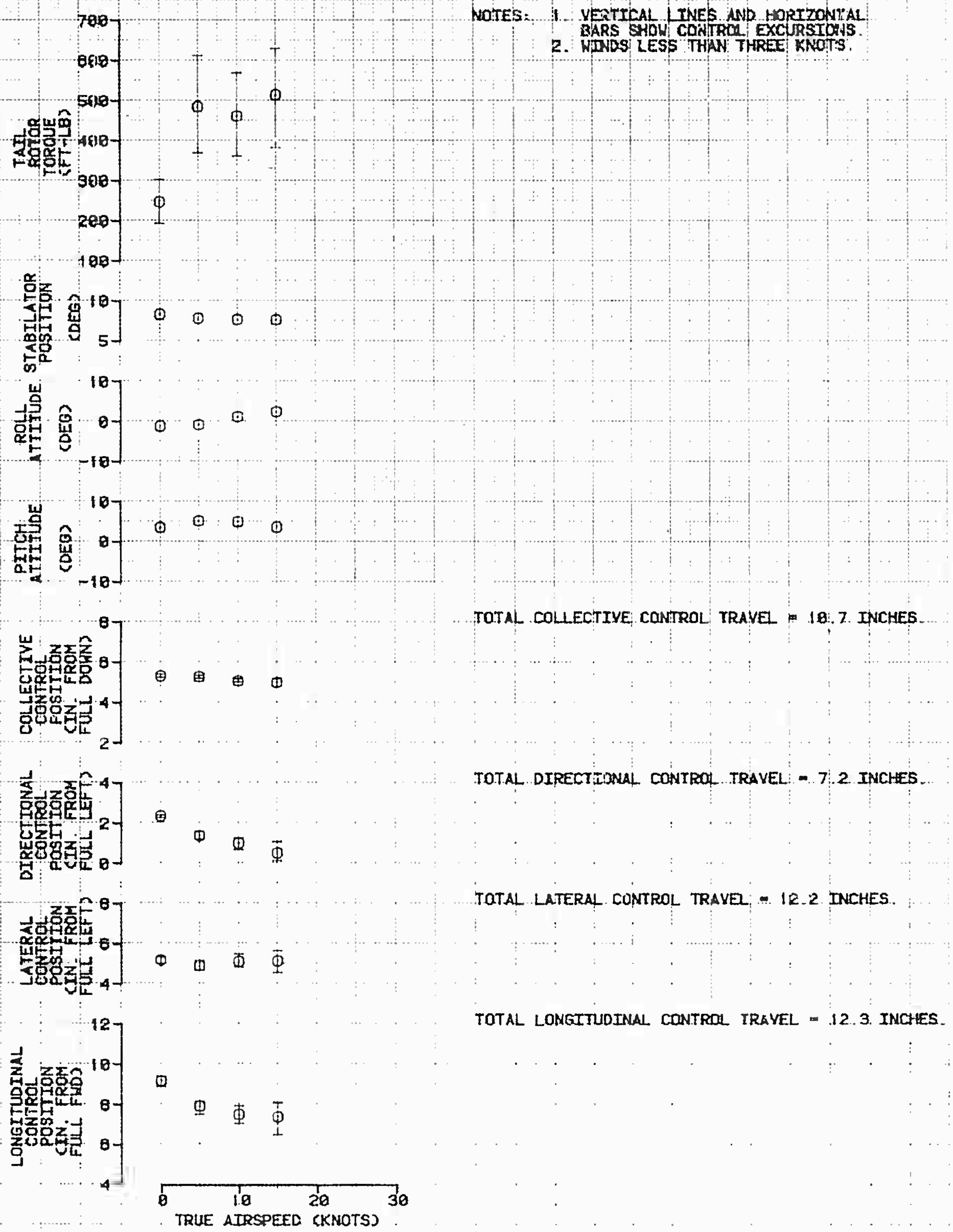


FIGURE 22

LOW-AIRSPEED 90-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8550	130.6	0.0	1910	6.5	314	50

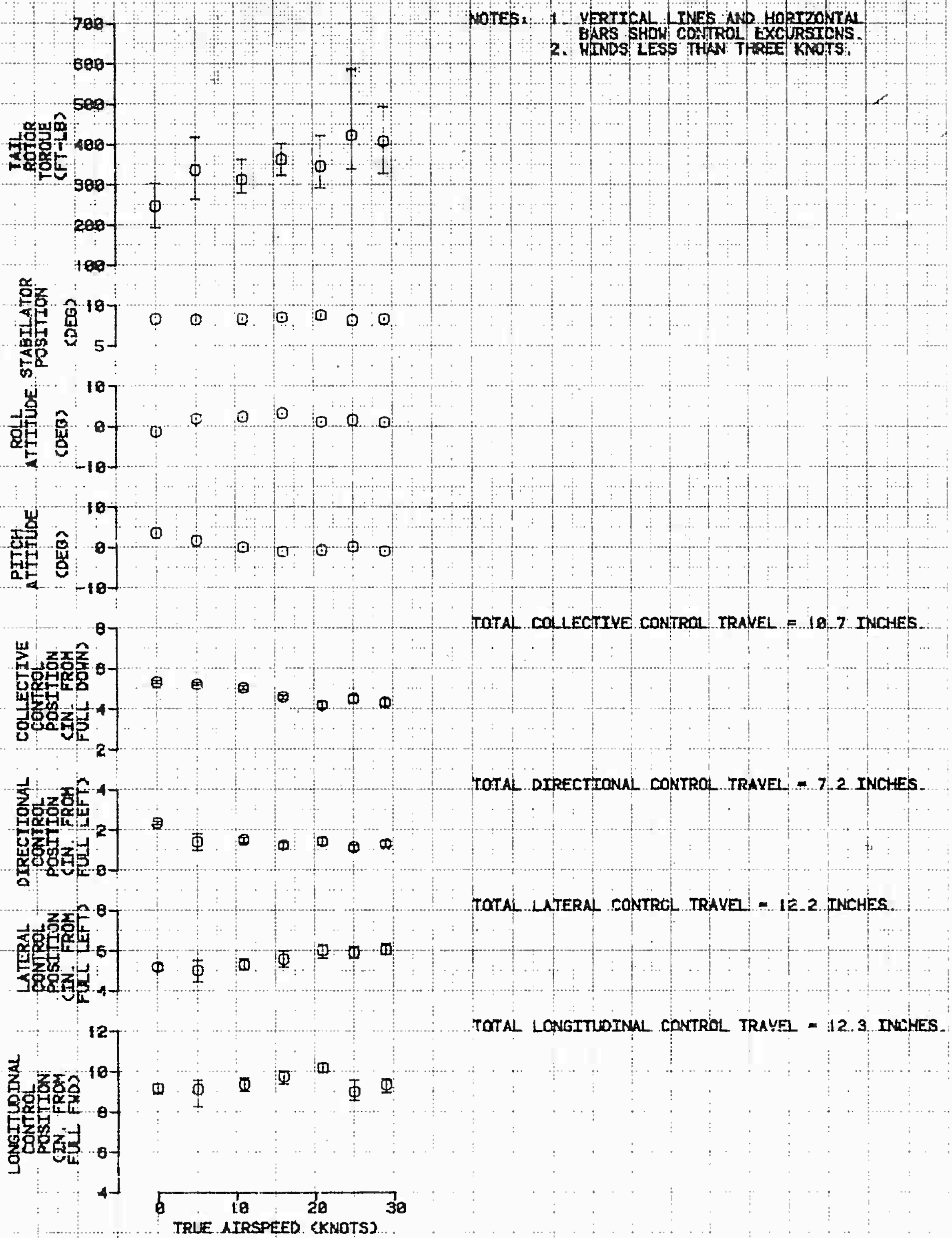


FIGURE 23

LOW-AIRSPEED 135-DEGREE AZIMUTH FLIGHT CHARACTERISTICS

UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

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 SKID HEIGHT (FT)
8520	130.8	0.1RT	1990	7.5	314	50

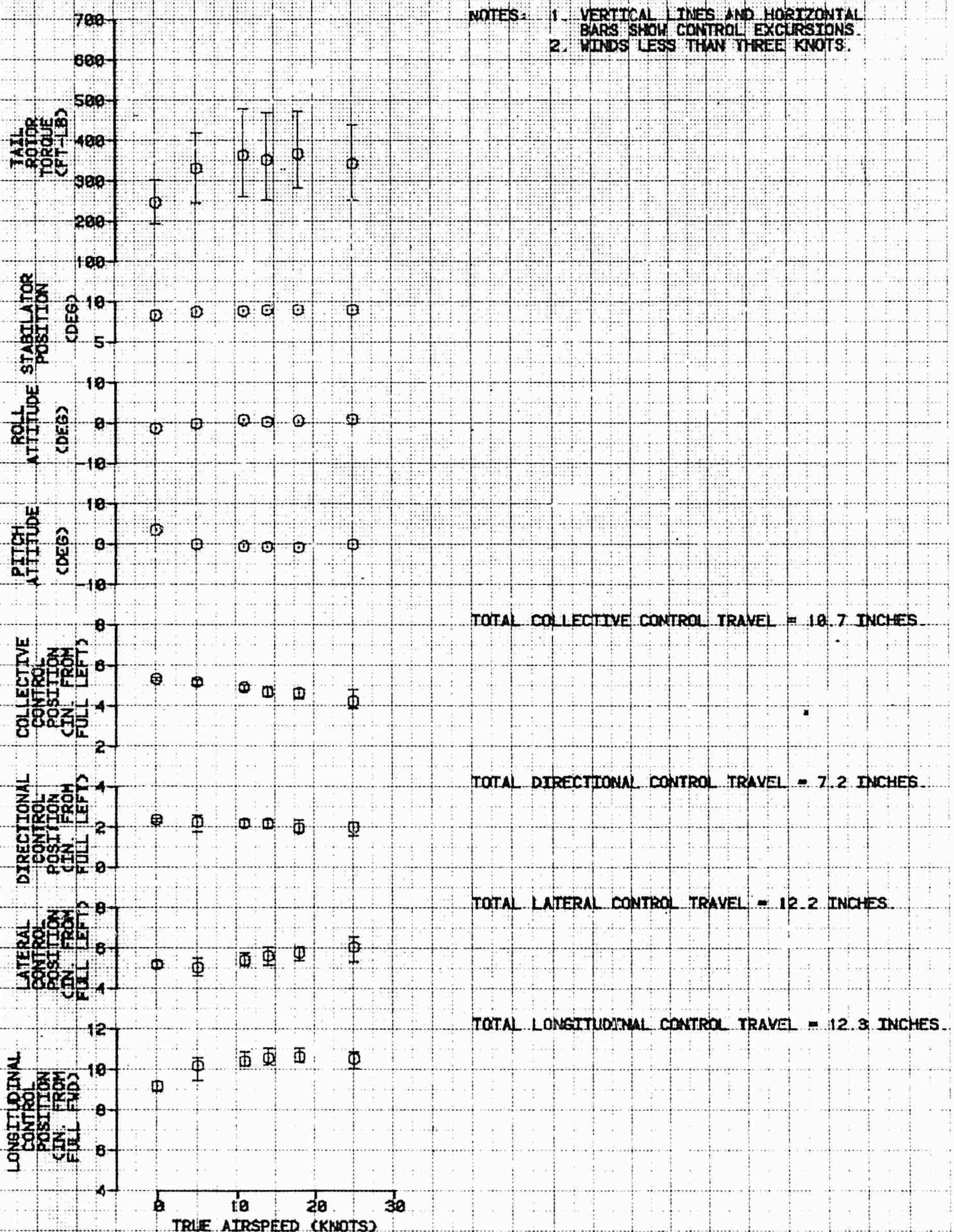


FIGURE 24

SIMULATED ENGINE FAILURE

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
7180	134.7	0.1RT	9820	68	8.0

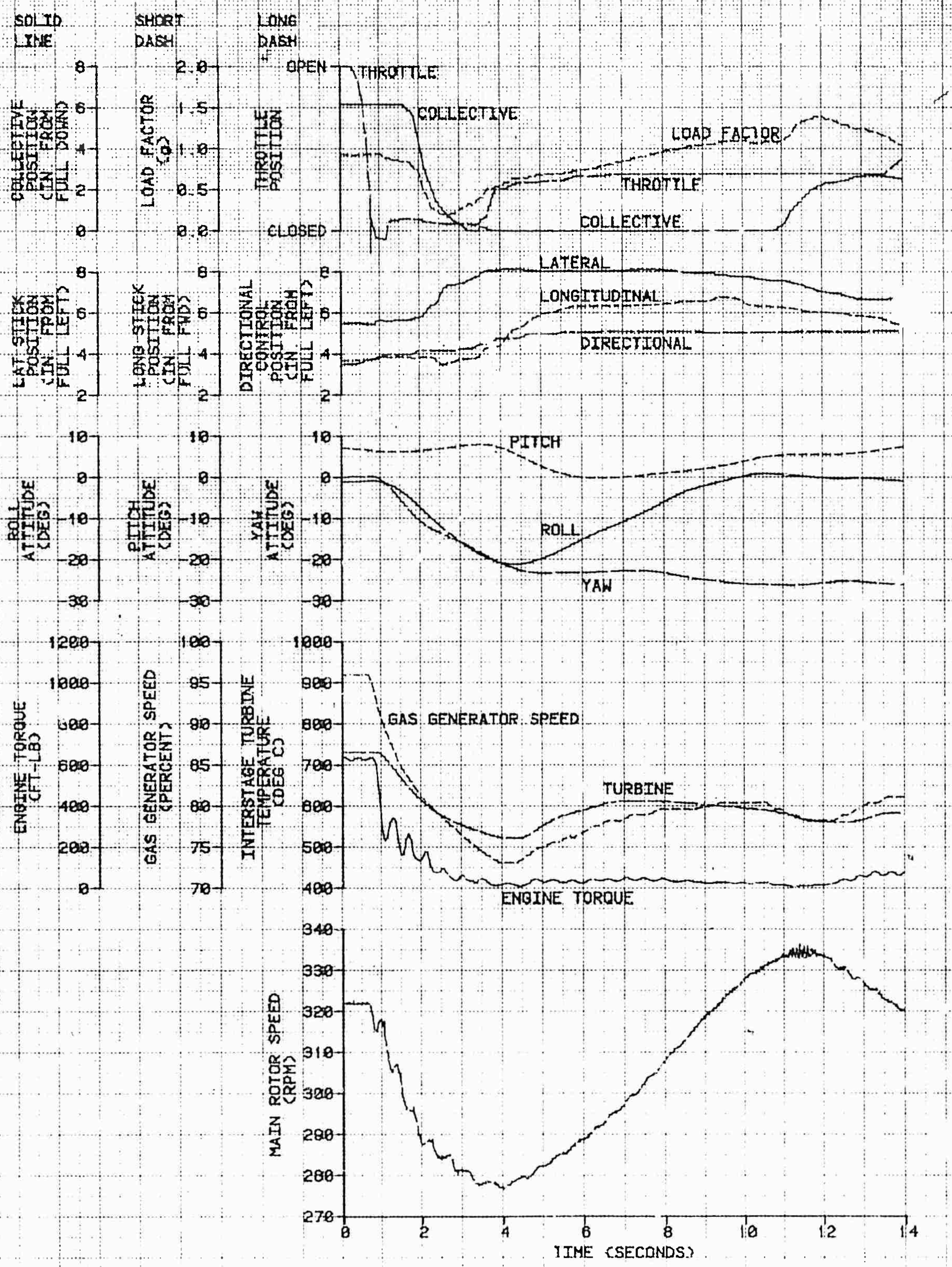


FIGURE 25

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
7090	134.5	0.1RT	620	15.0

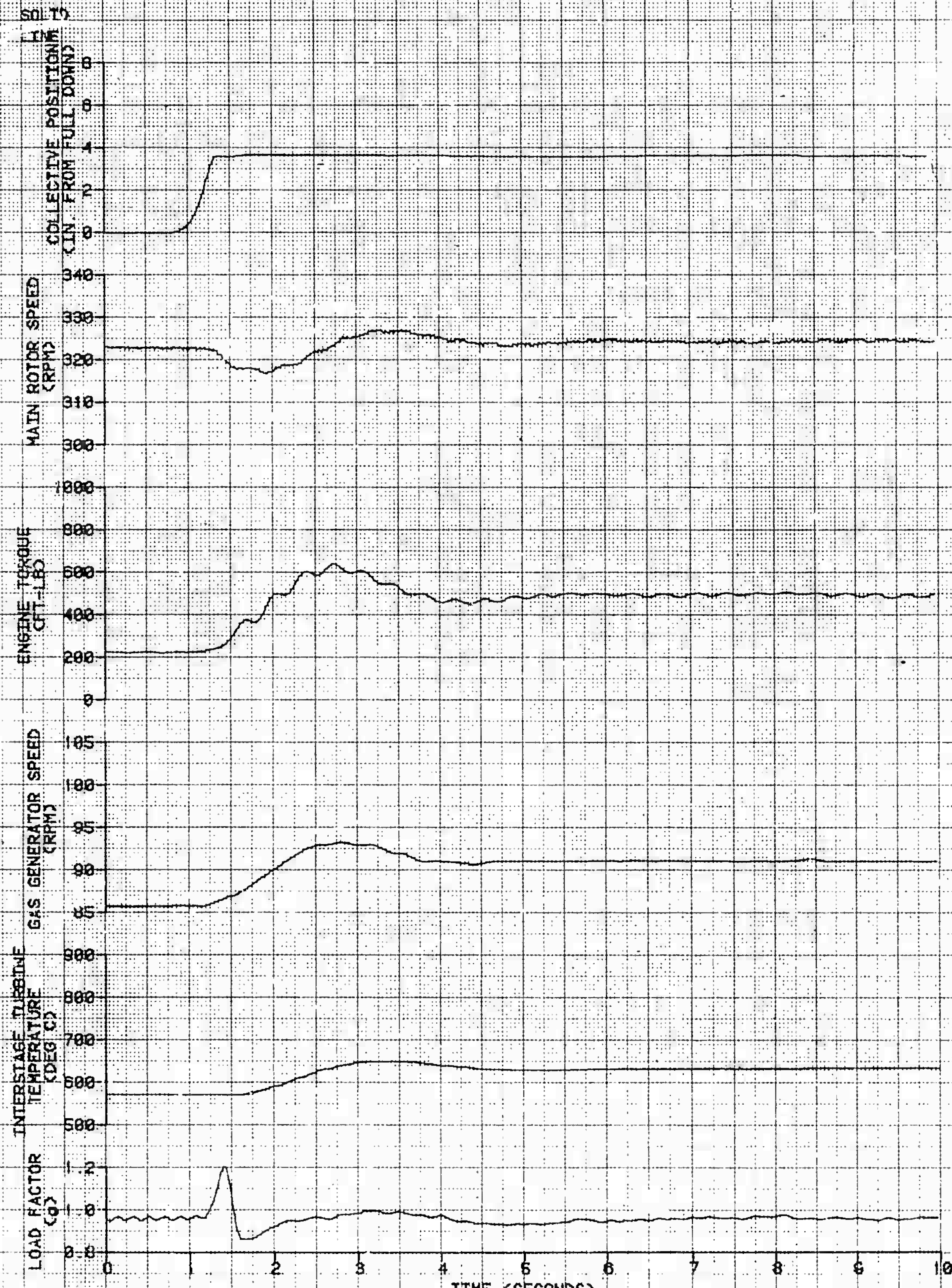


FIGURE 26

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
8270	136.8	0.4RT	520	14.0

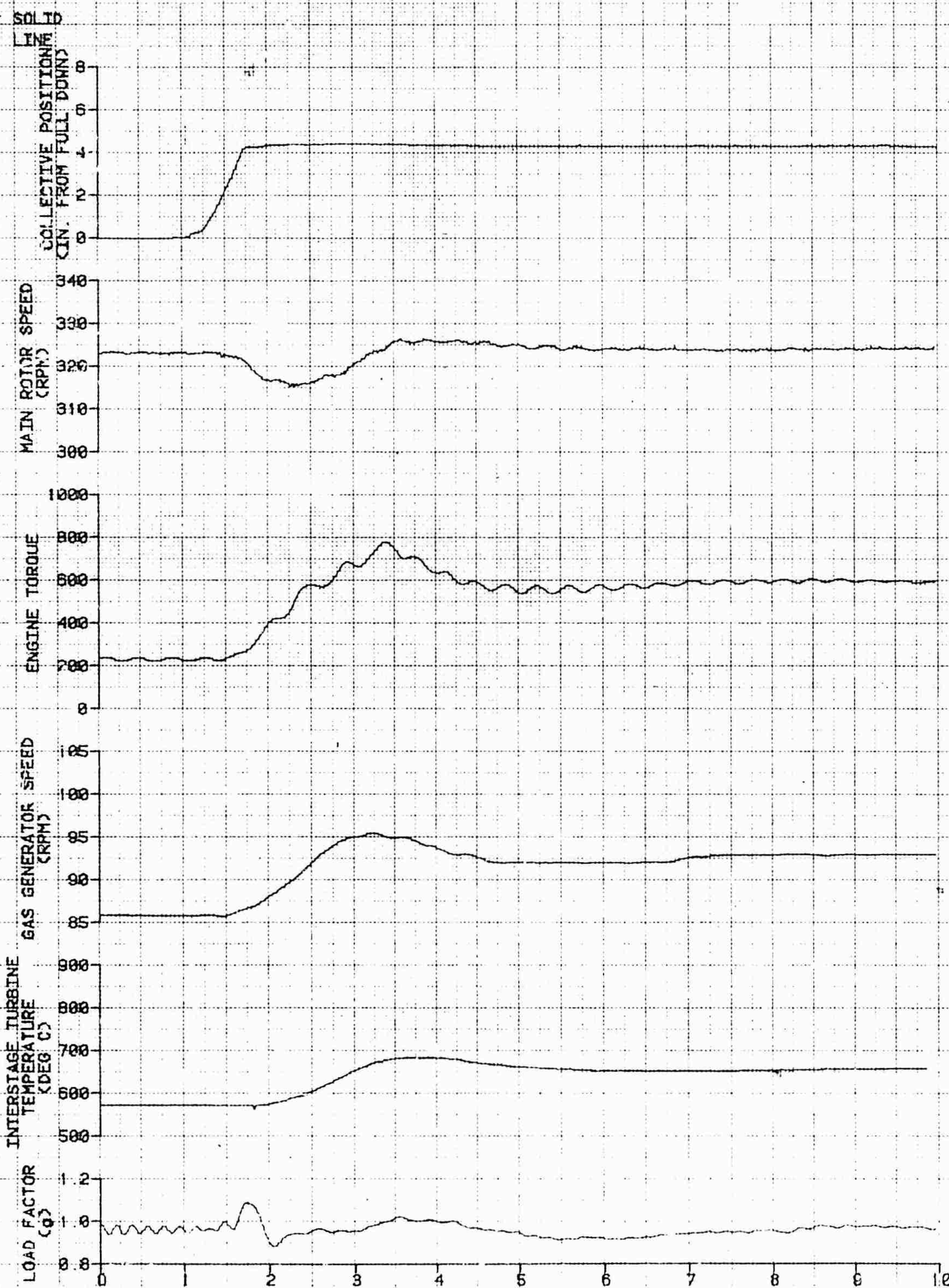


FIGURE 27

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
9460	136.8	0.5RT	450	13.5

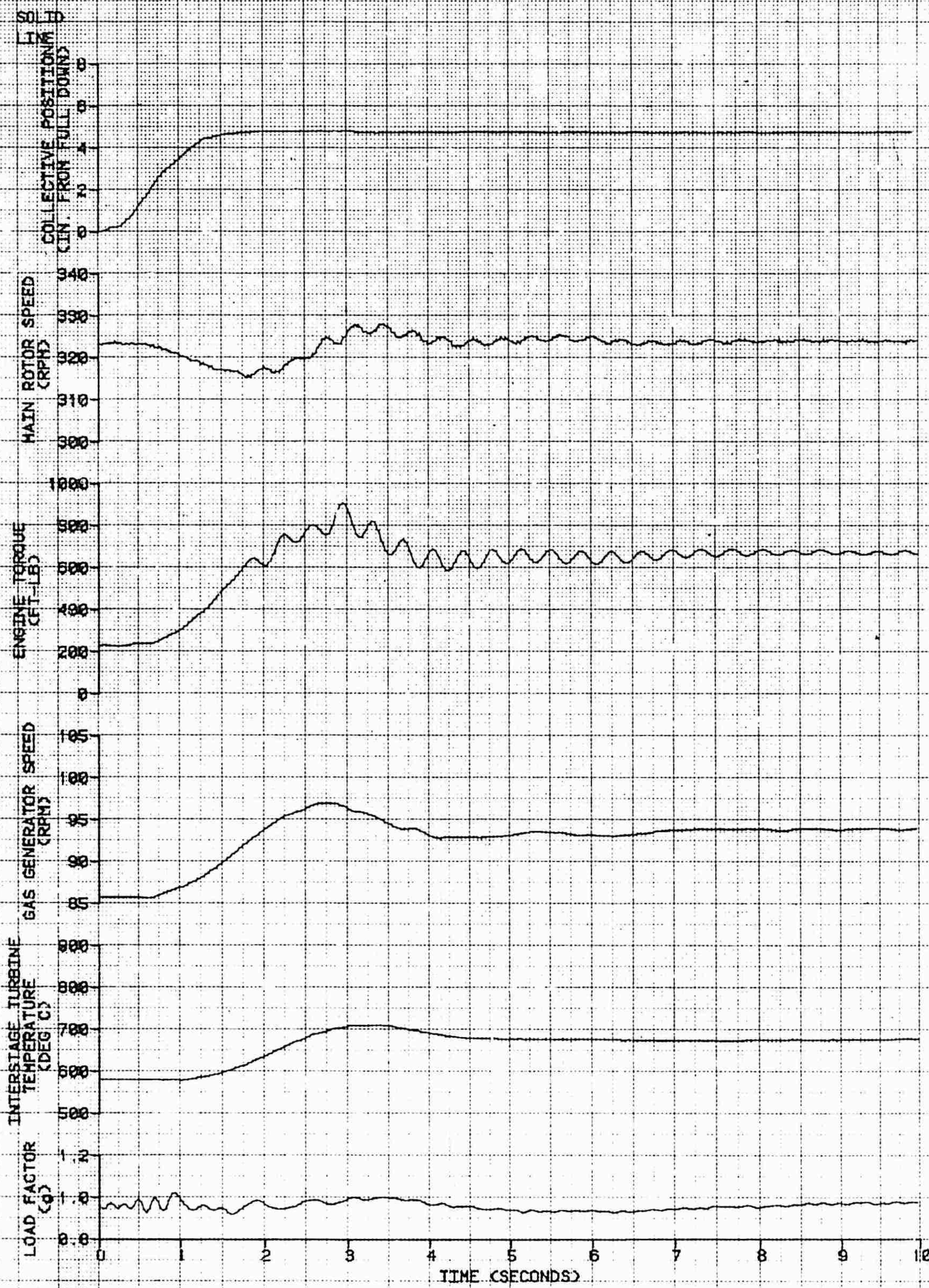


FIGURE 28

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
6910	135.0	0.1RT	6550	29.5

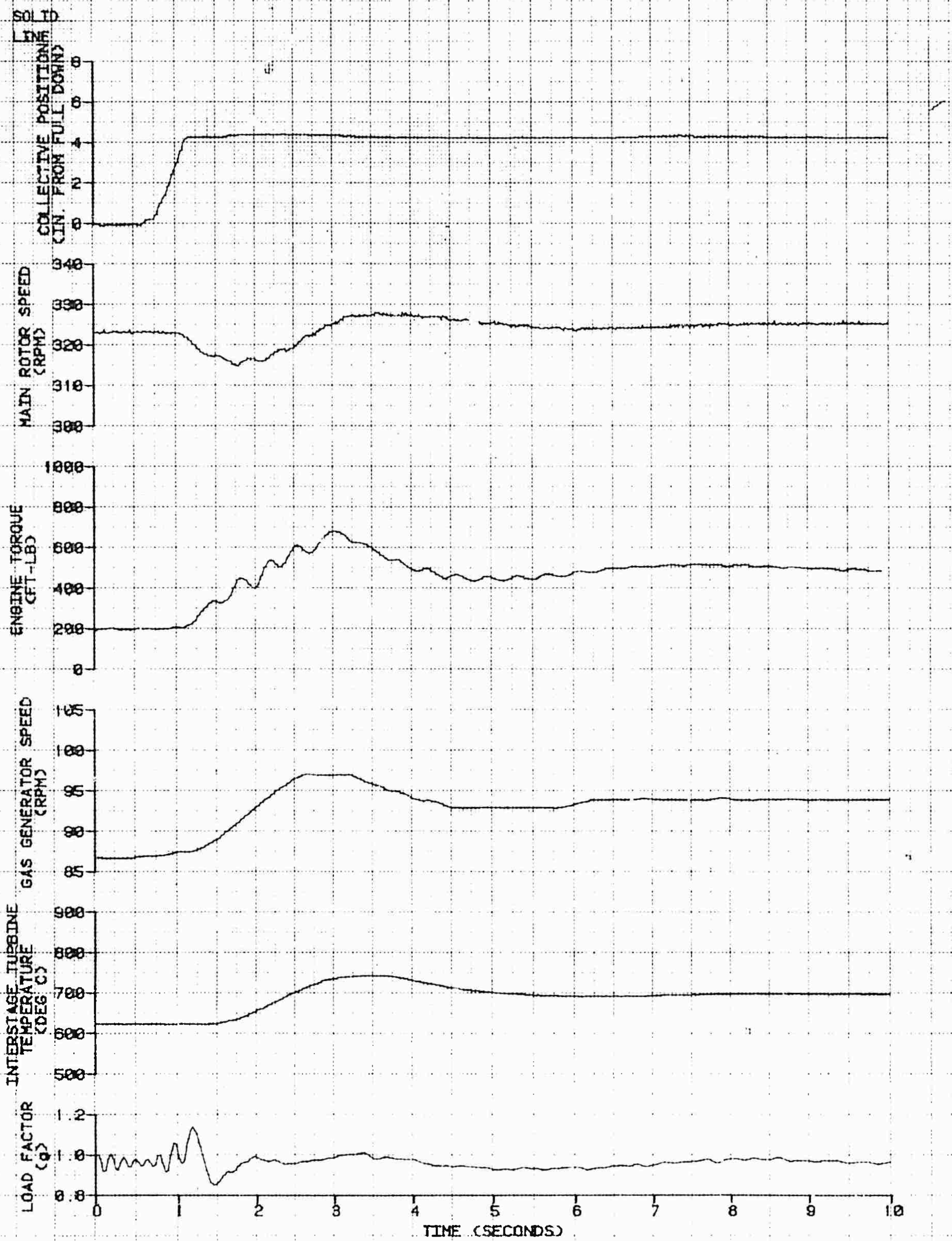


FIGURE 29

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
8190	137.0	0.2RT	6510	29.5

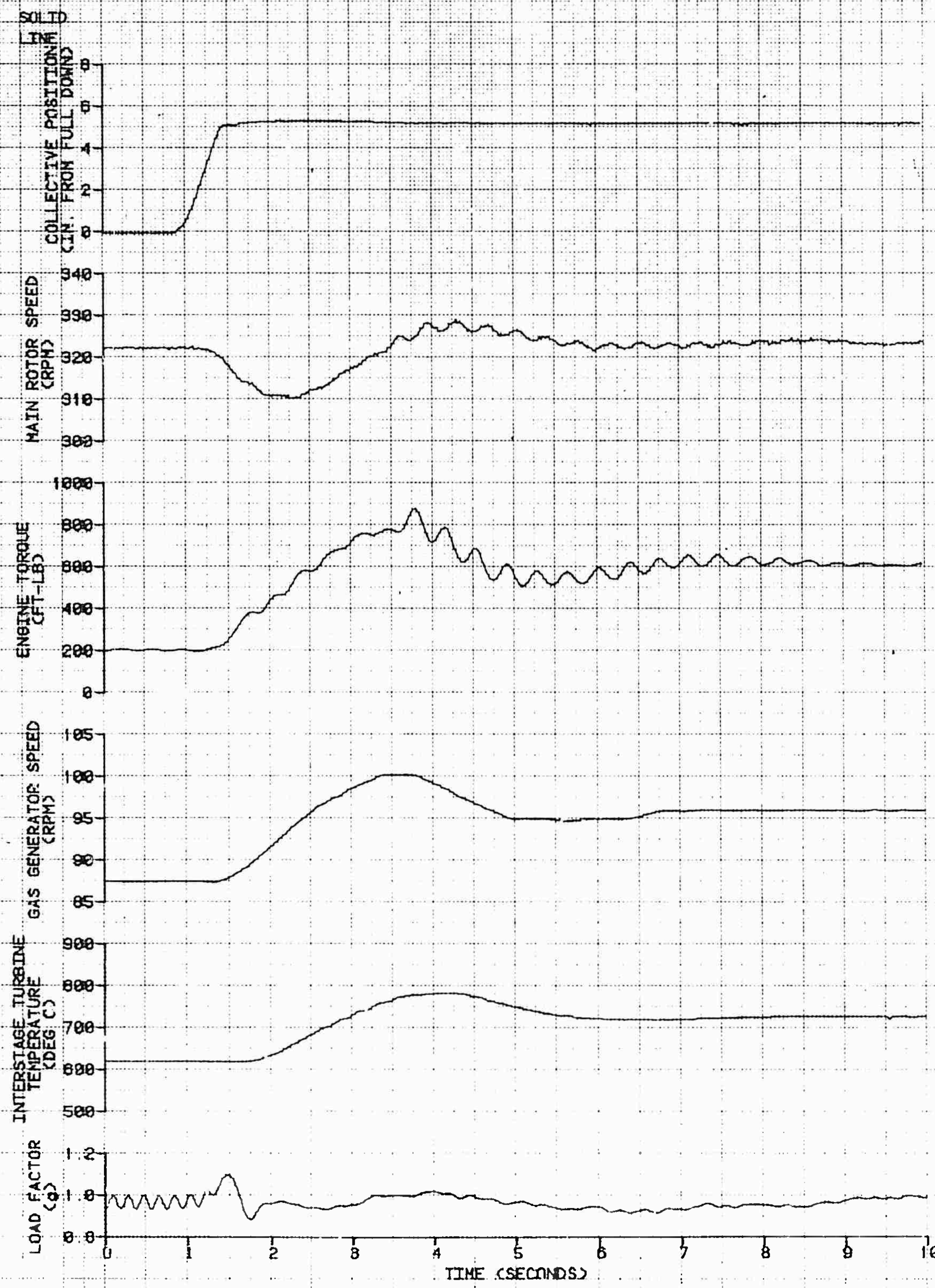


FIGURE 30

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
9500	138.3	0.2RT	6730	31.5

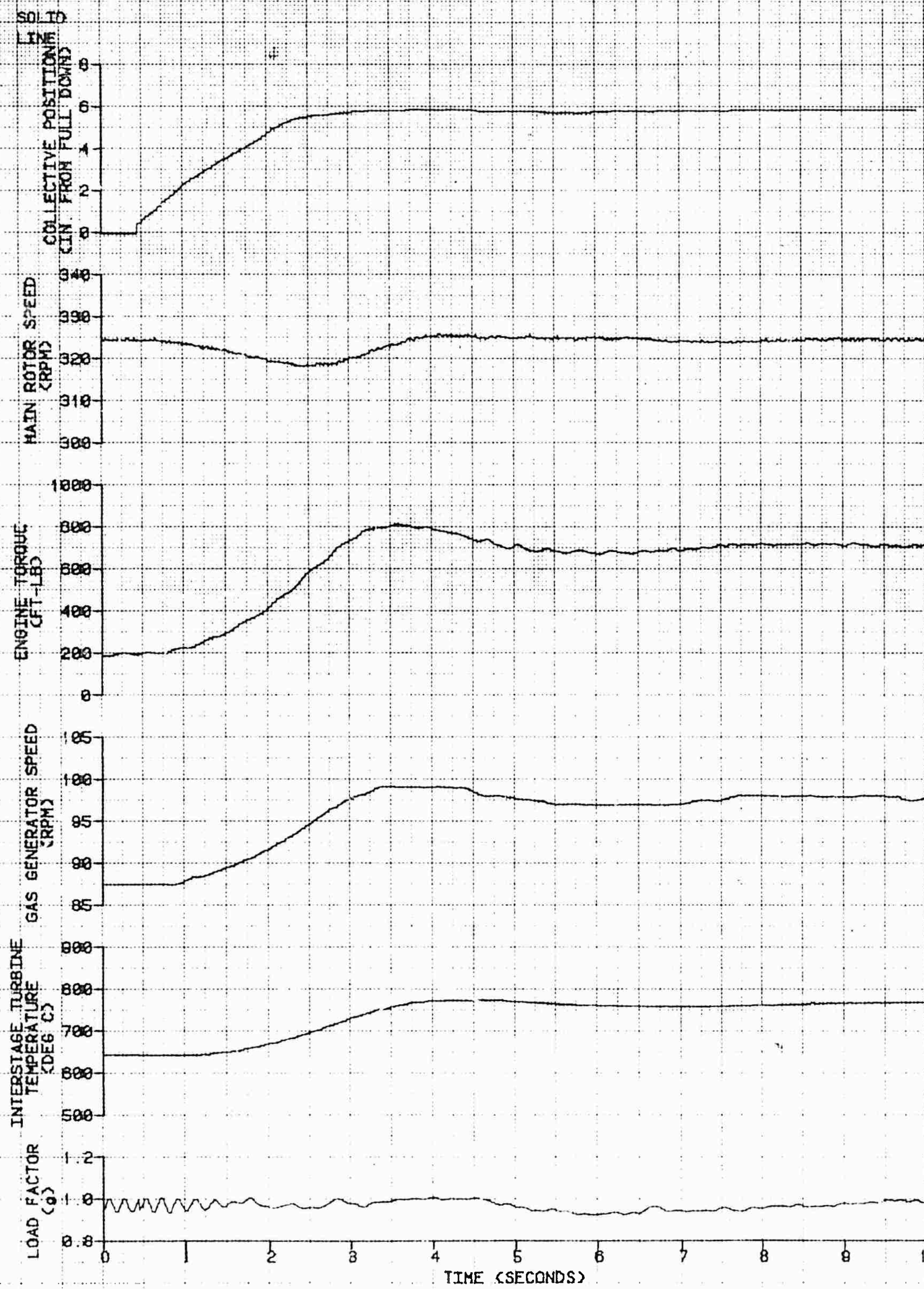


FIGURE 31

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
7,180	134.5	0.1RT	11,290	11.5

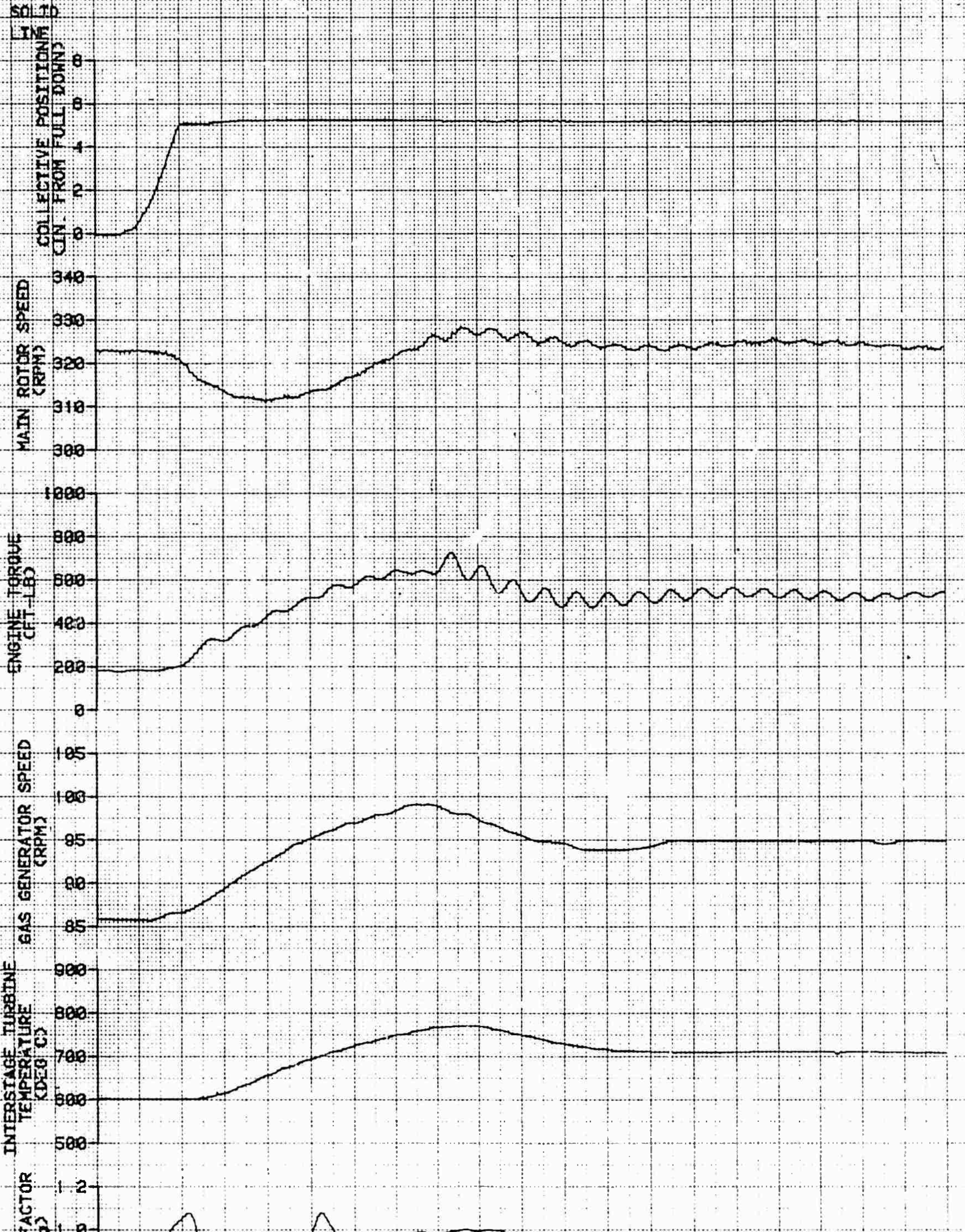


FIGURE 32

ENGINE RESPONSE DURING TAKEOFF

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
8,240	136.6	0.3RT	11,590	14.5

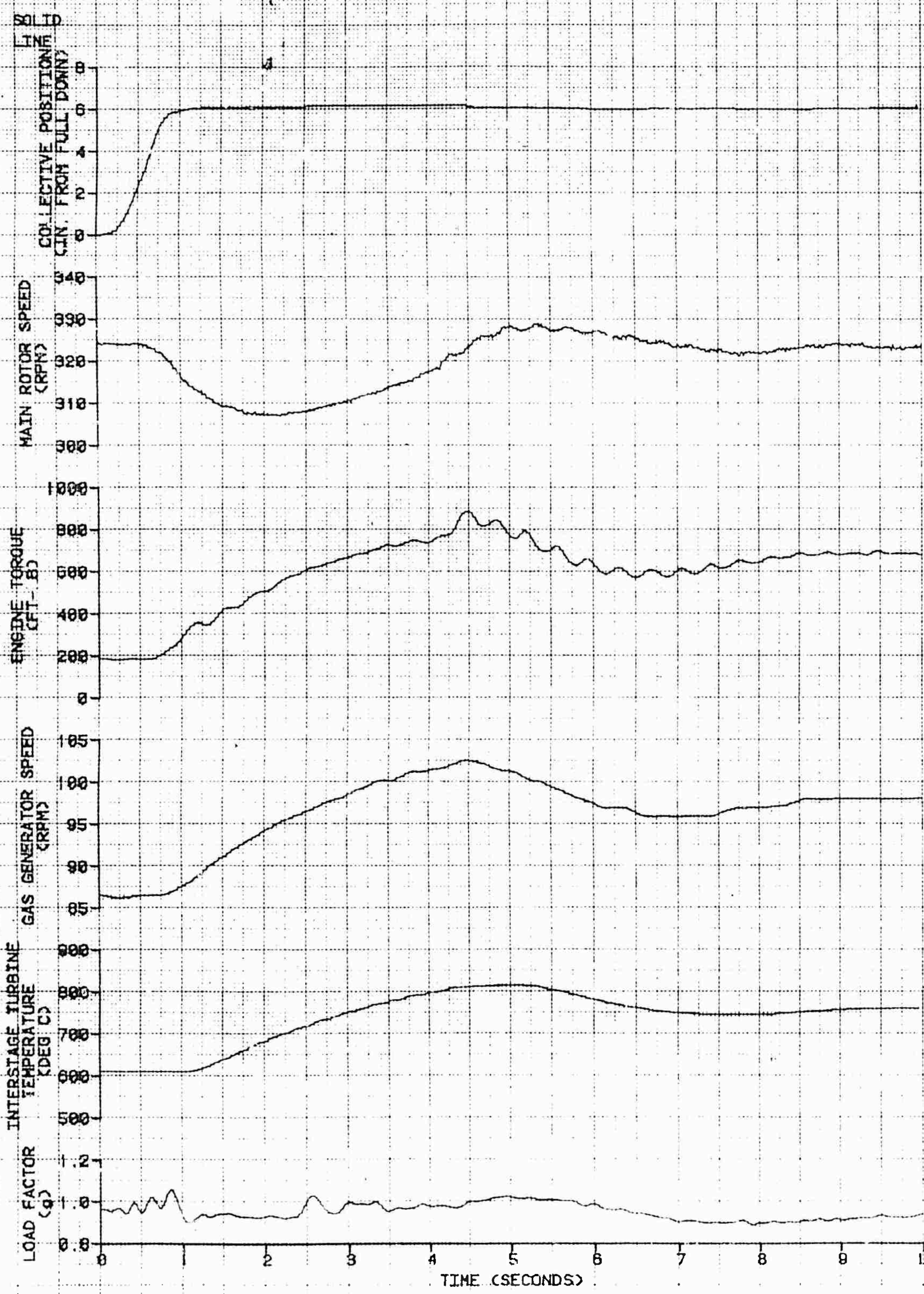


FIGURE 33

ENGINE ACCELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
7590	136.7	0.1RT	4990	60	20.5

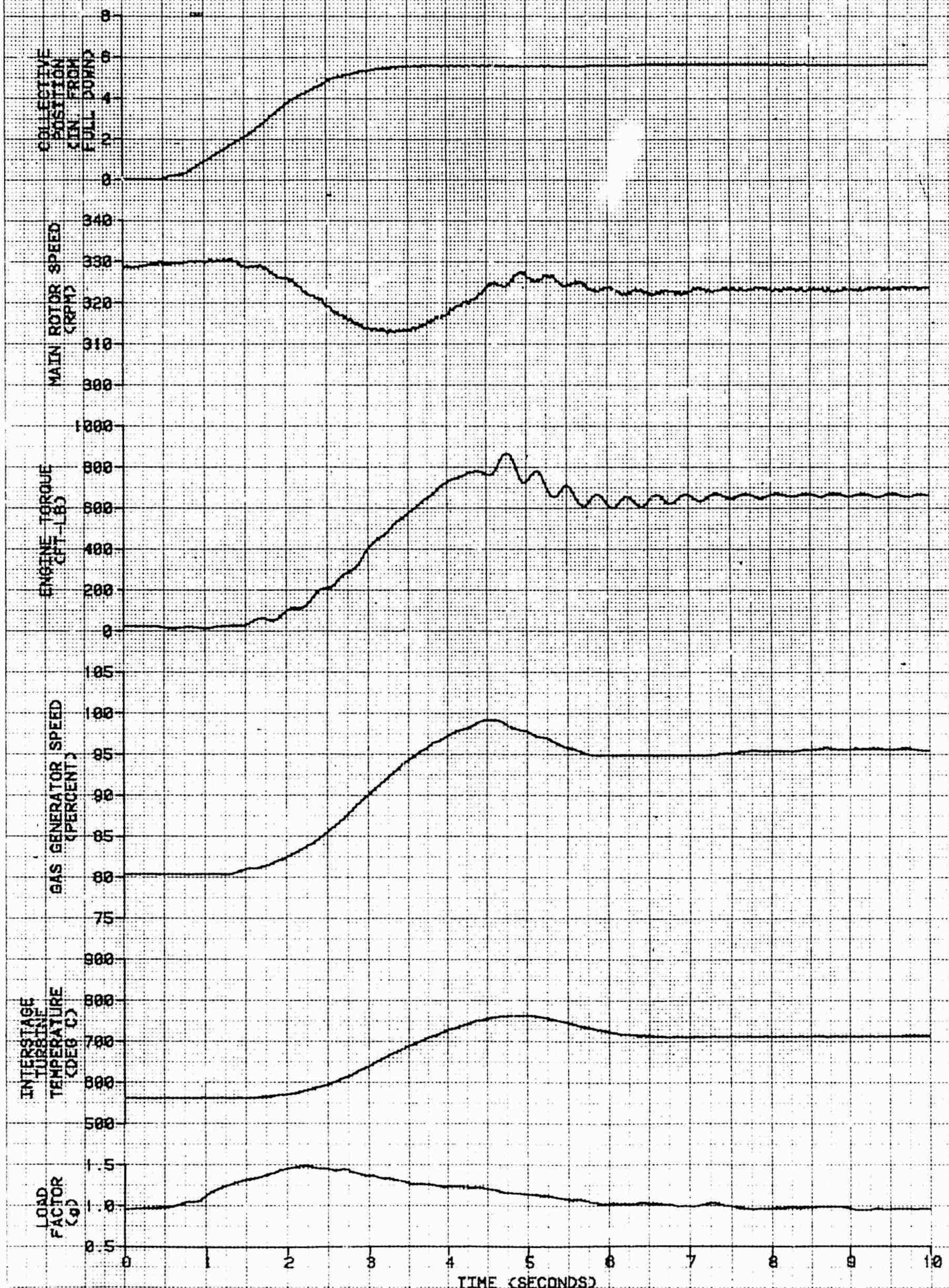


FIGURE 34

ENGINE ACCELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
7480	136.2	0.1RT	9460	60	1.5

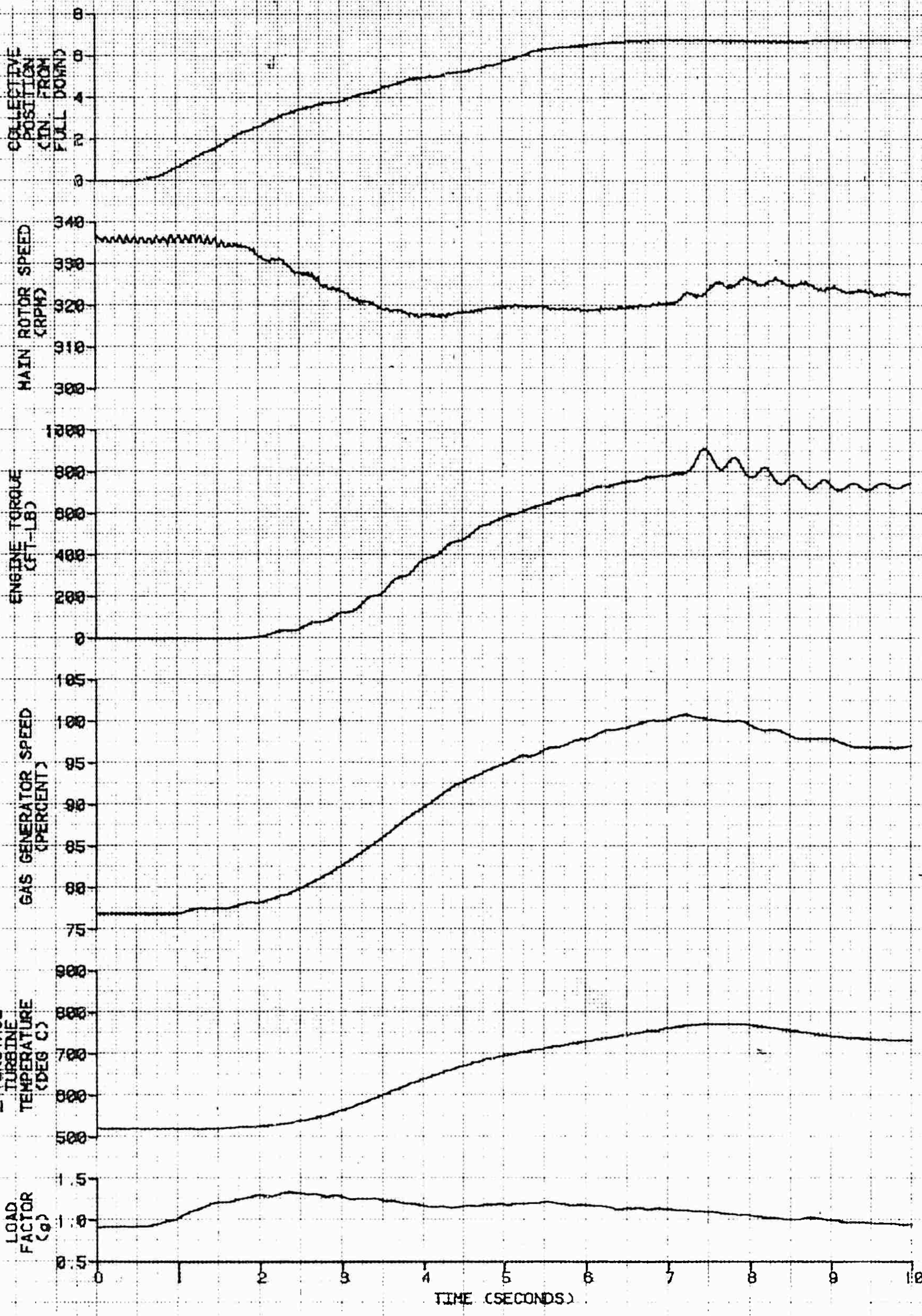


FIGURE 35

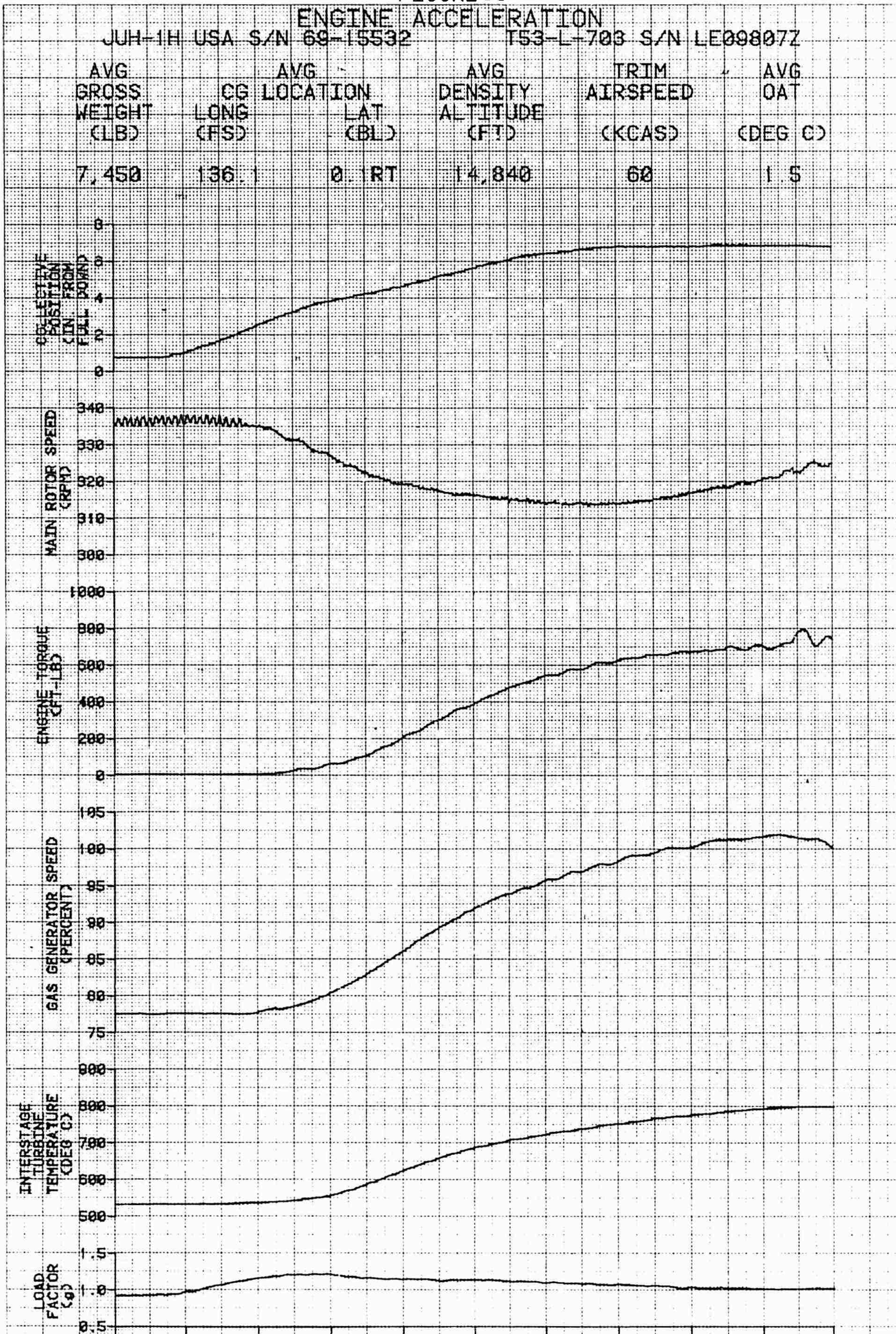

ENGINE ACCELERATION
JUH-1H USA S/N 69-15532
T53-L-703 S/N LE09807Z
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
TRIM AIRSPEED (KCAS)
AVG OAT (DEG C)
7,450
136.1
0.1RT
14,840
60
1.5
COLLECTIVE POSITION (IN. FROM FULL DOWN)
MAIN ROTOR SPEED (RPM)
ENGINE TORQUE (FT-LB)
GAS GENERATOR SPEED (PERCENT)
INTERSTAGE TURBINE TEMPERATURE (DEG C)
LOAD FACTOR (g)
TIME (SECONDS)

FIGURE 36

ENGINE ACCELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
9520	136.8	0.4RT	5000	60	15.5

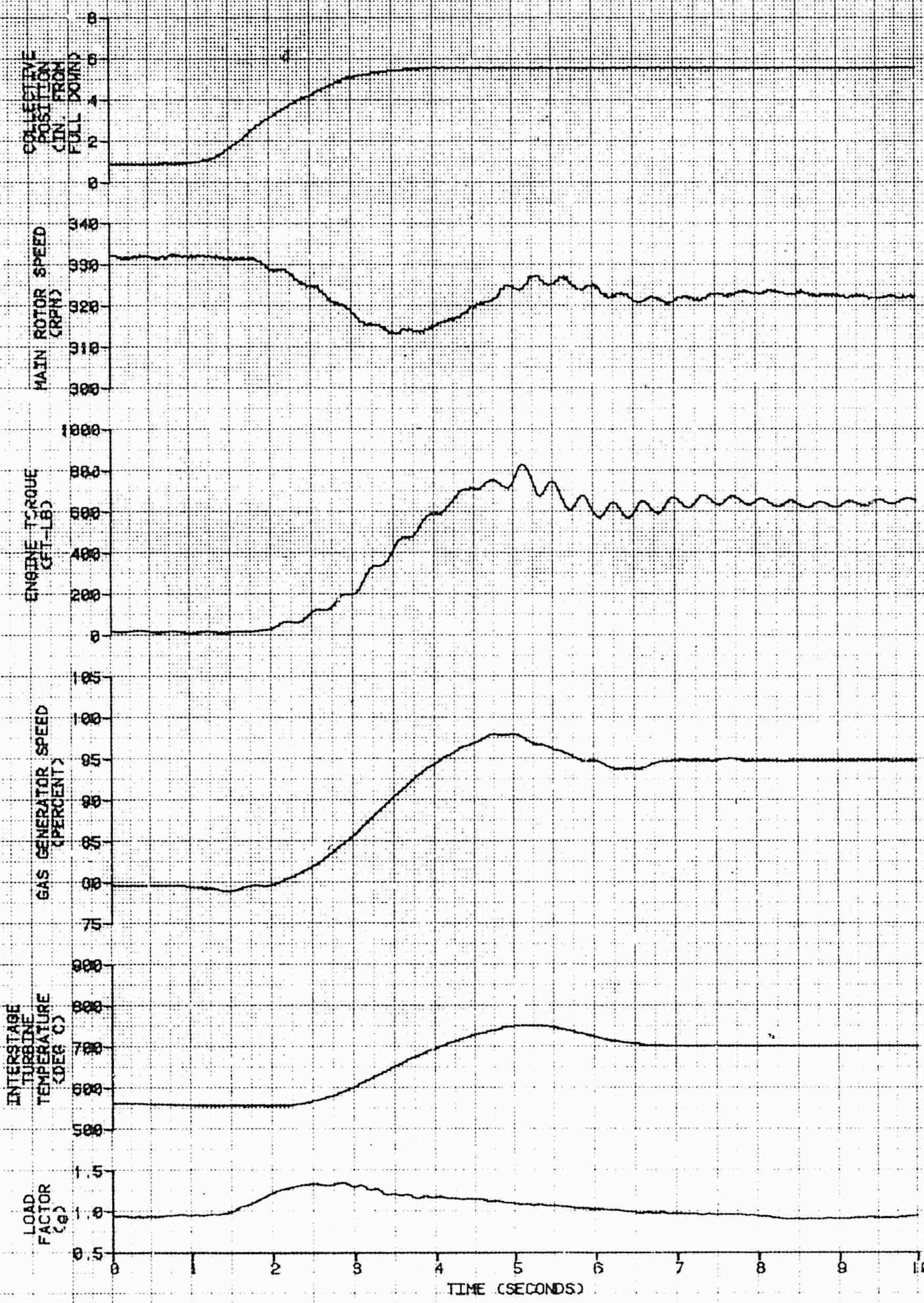


FIGURE 37

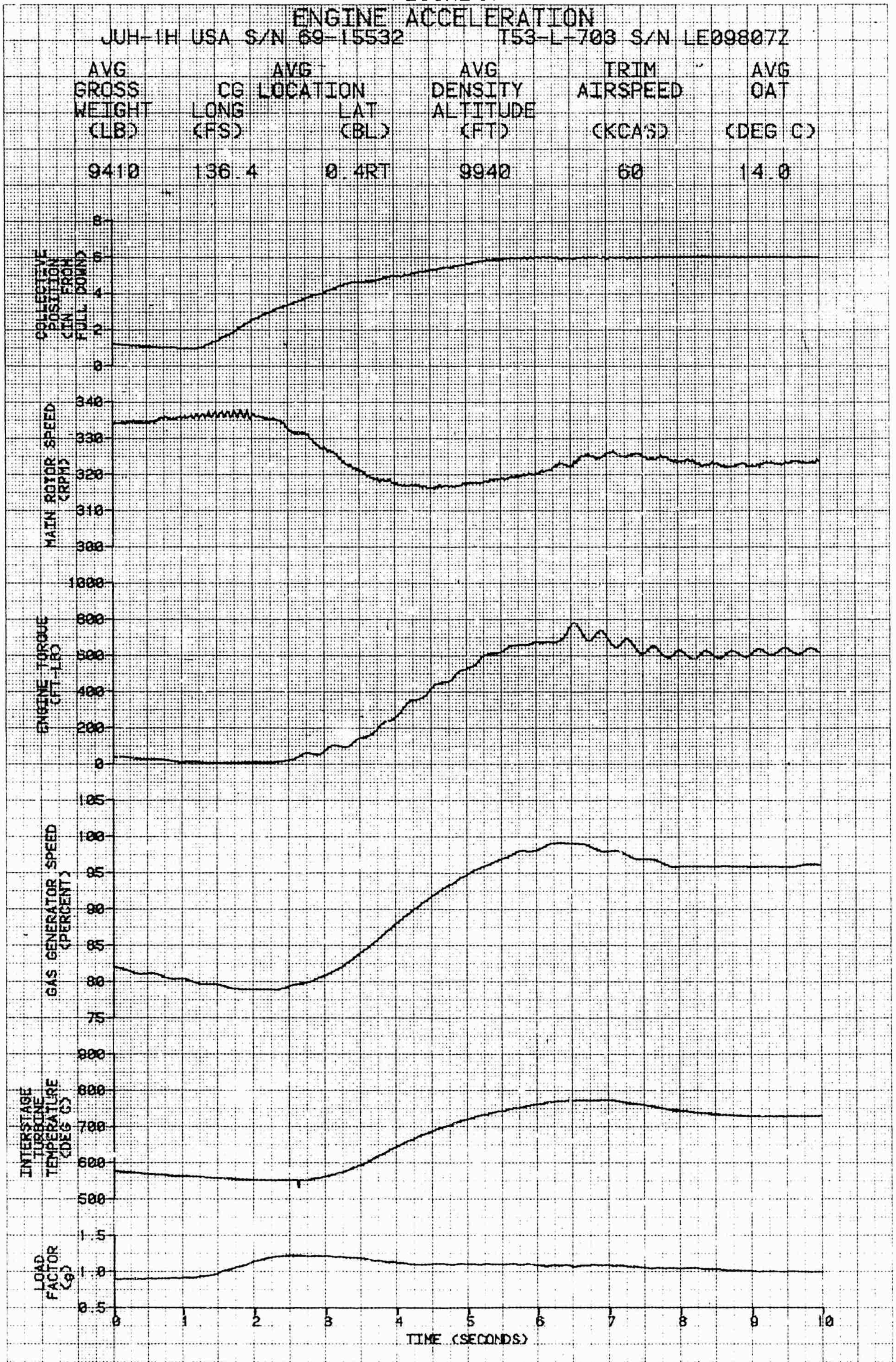

ENGINE ACCELERATION
JUH-1H USA S/N 69-15532
T53-L-703 S/N LE09807Z
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
TRIM AIRSPEED (KCAS)
AVG OAT (DEG C)
9410
136.4
0.4RT
9940
60
14.0
COLLECTIVE POSITION (IN. FROM FULL DOWN)
MAIN ROTOR SPEED (RPM)
ENGINE TORQUE (FT-LB)
GAS GENERATOR SPEED (PERCENT)
INTERSTAGE TURBINE TEMPERATURE (DEG C)
LOAD FACTOR (g)
TIME (SECONDS)

FIGURE 38

ENGINE ACCELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
9,420	136.5	0.4RT	14,980	60	-2.5

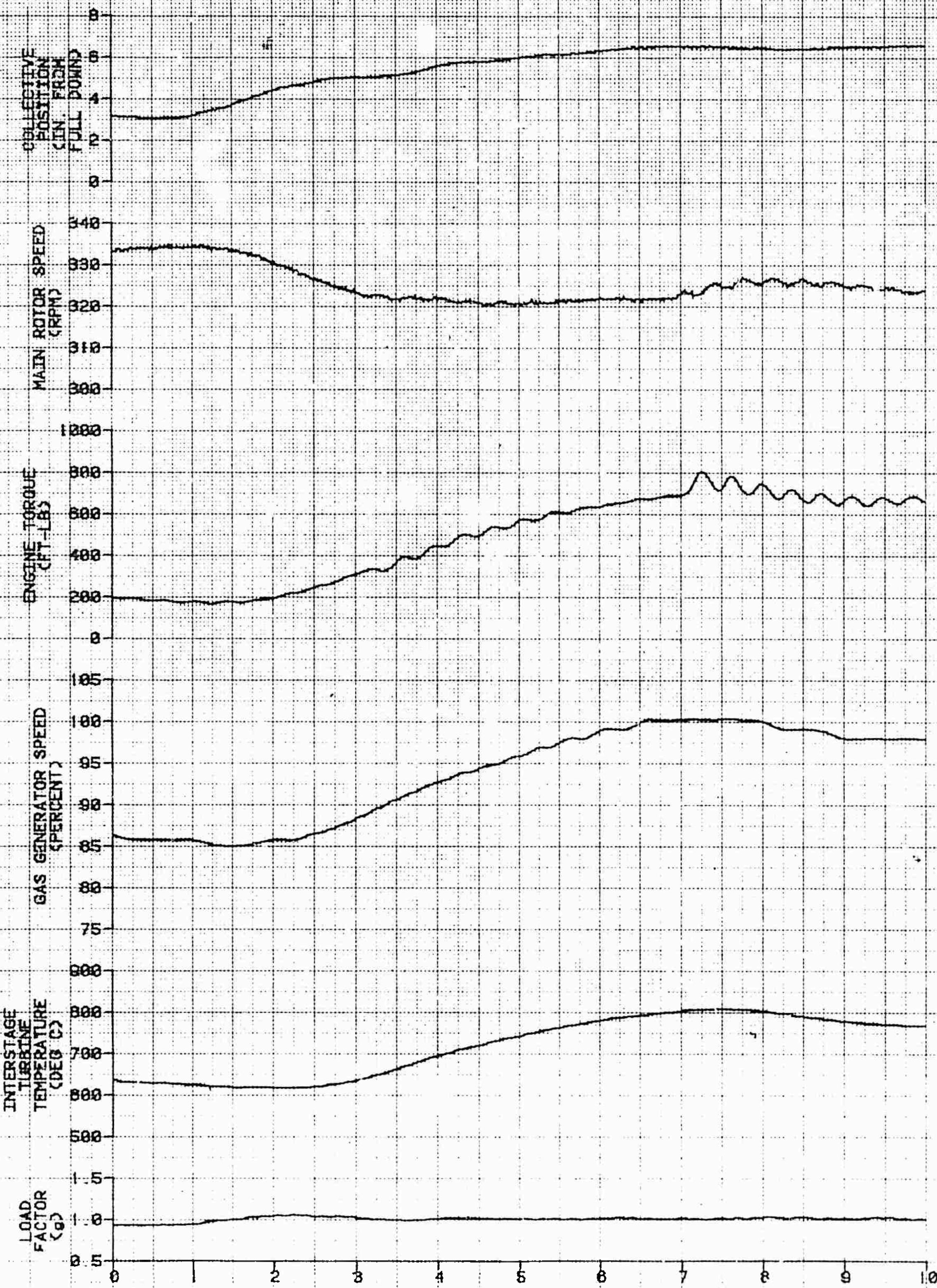


FIGURE 39

ENGINE DECELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
7480	136.2	0.1RT	4710	60	20.5

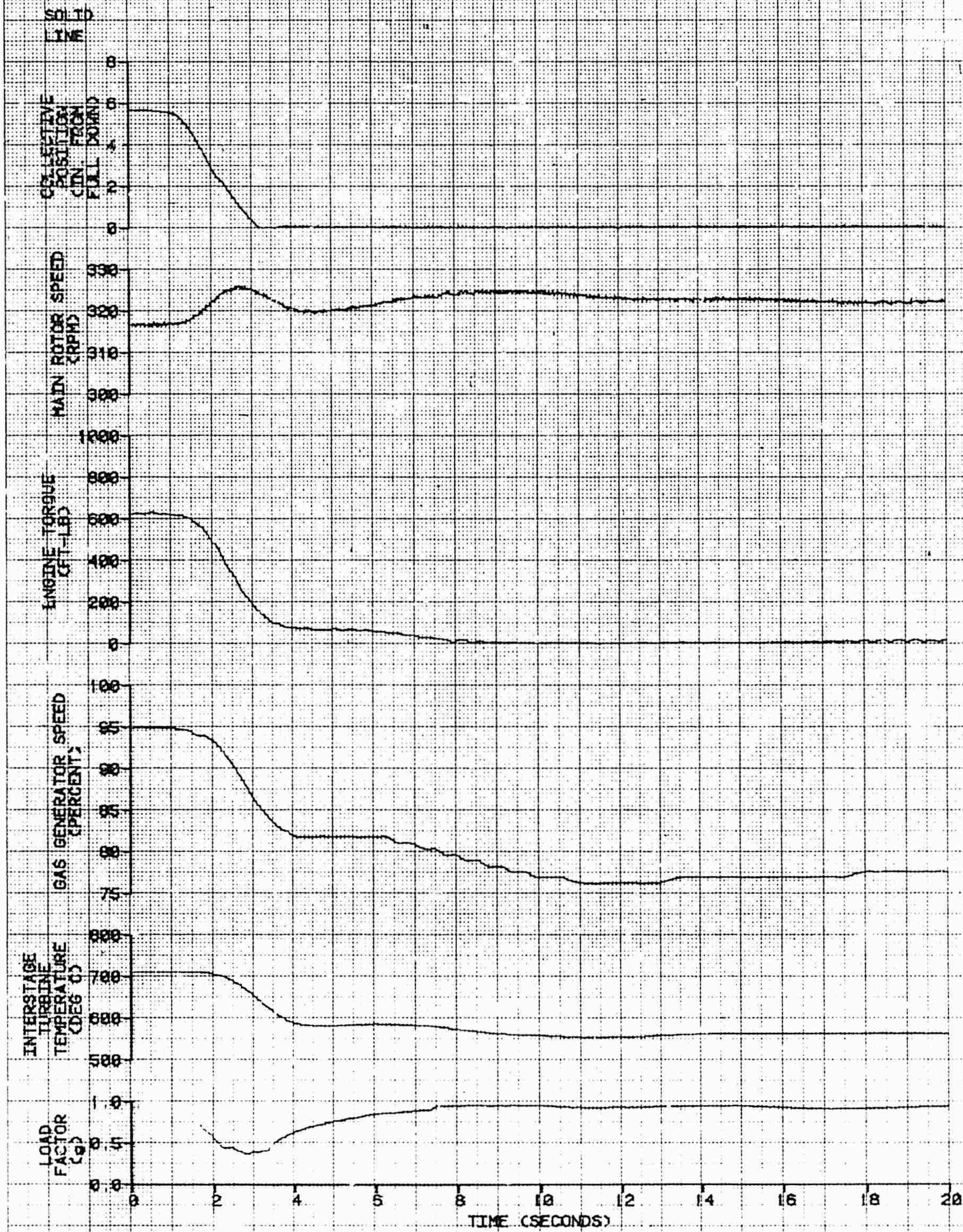


FIGURE 40

ENGINE DECELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
7330	135.7	0.1RT	9740	60	11.5

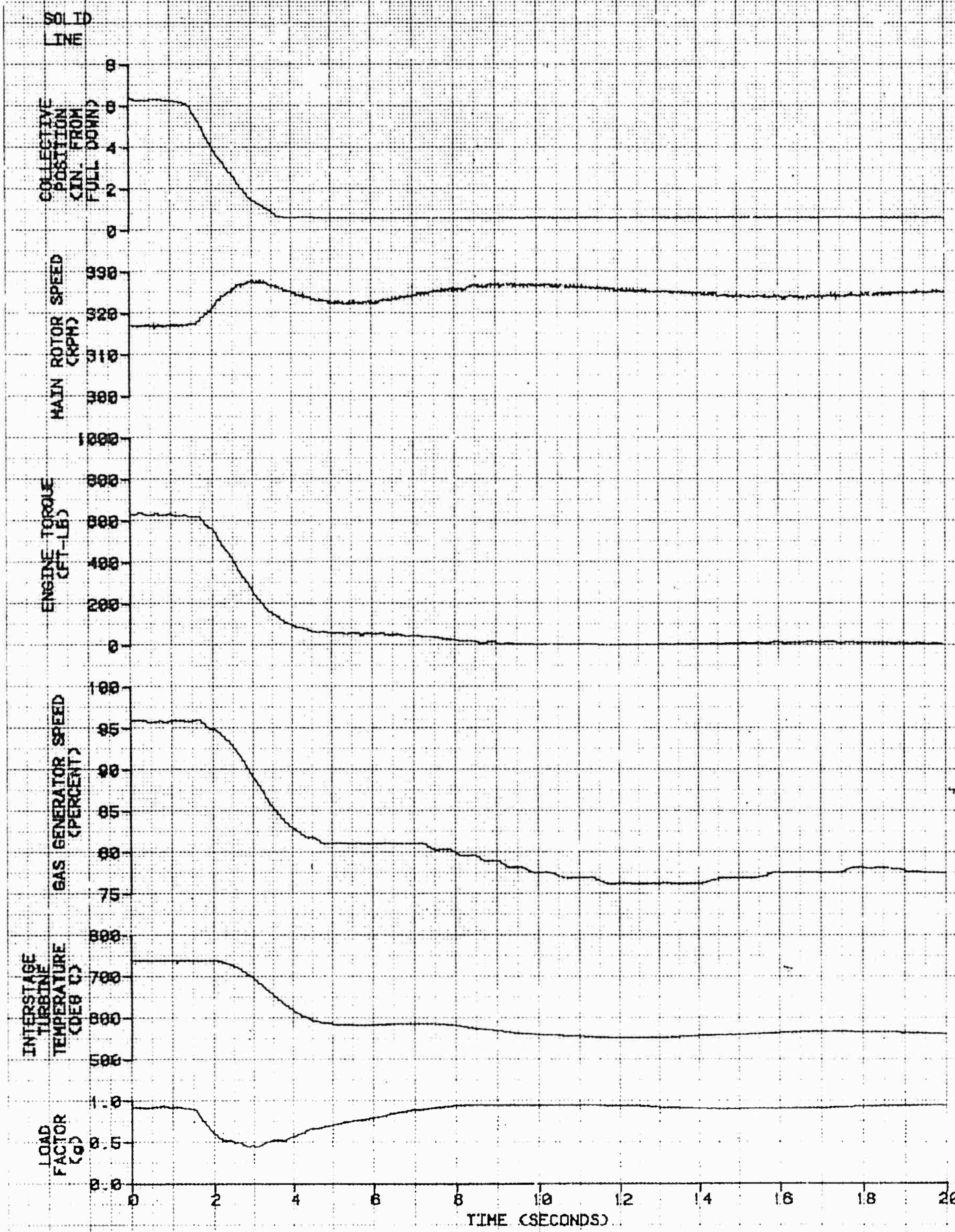


FIGURE 41

ENGINE DECELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
7,360	135.8	0.1RT	14,840	60	2.0

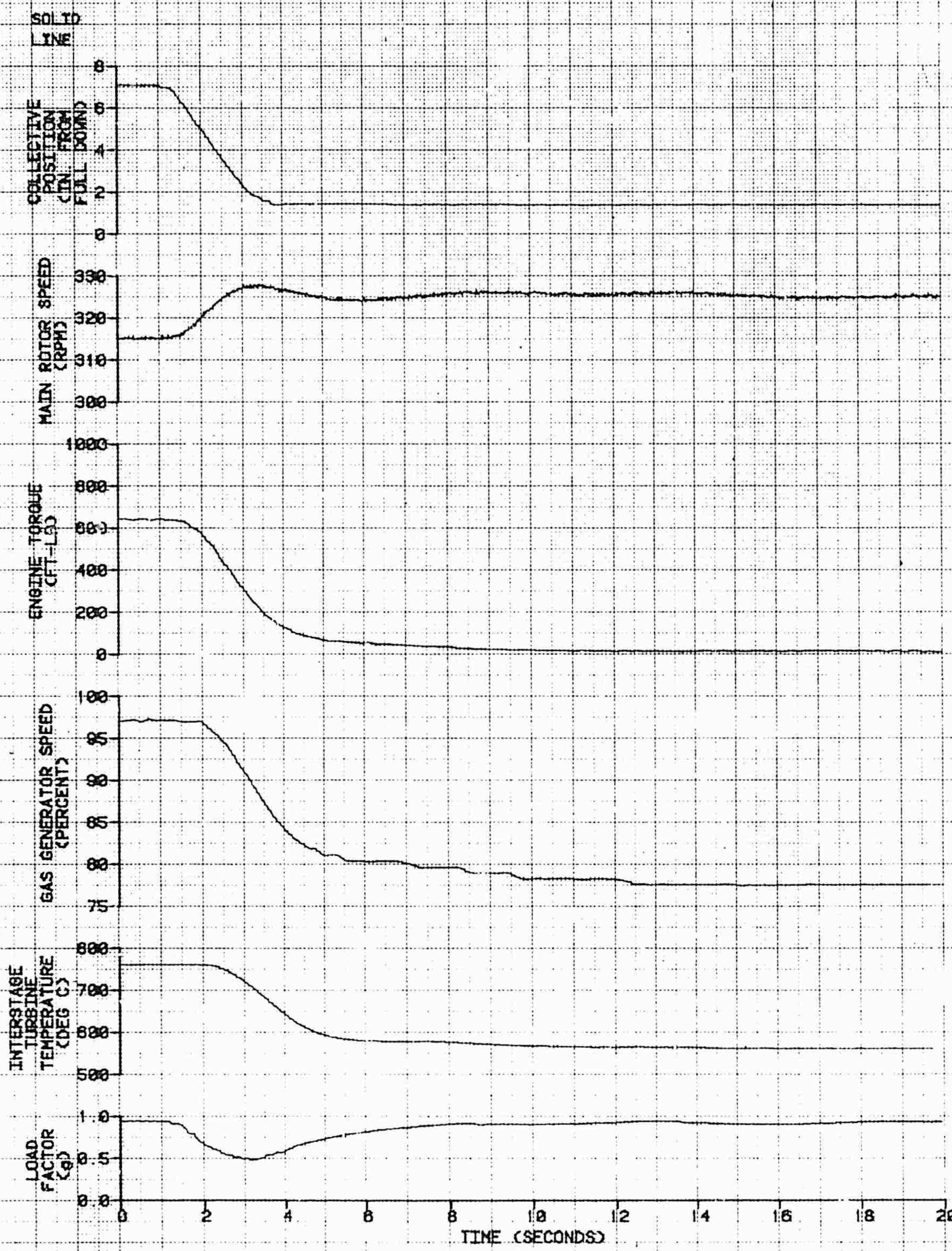


FIGURE 42

ENGINE DECELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
9430	136.5	0.4RT	4640	60	15.5

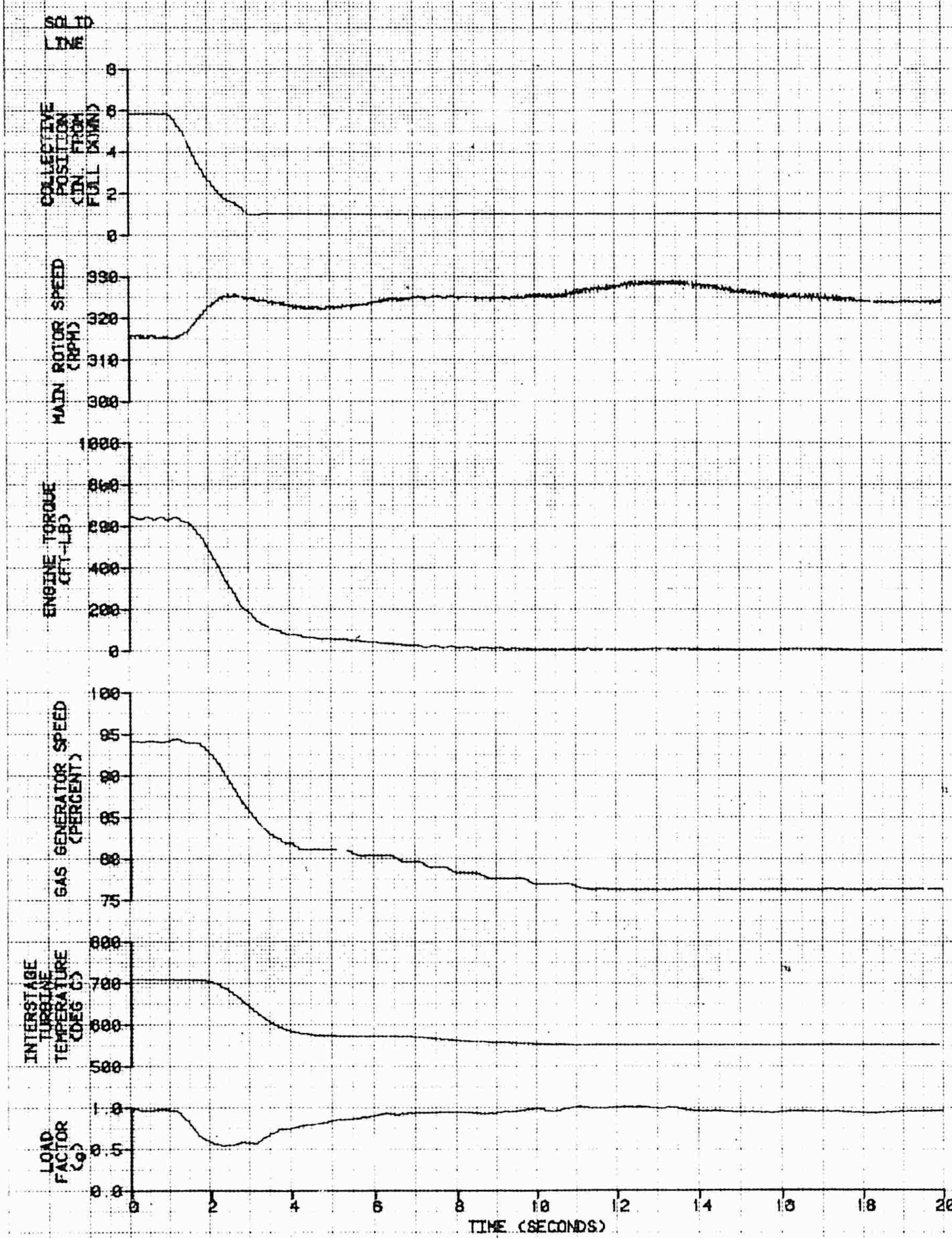


FIGURE 43

ENGINE DECELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)
9230	135.9	0.4RT	9730	60	14.0

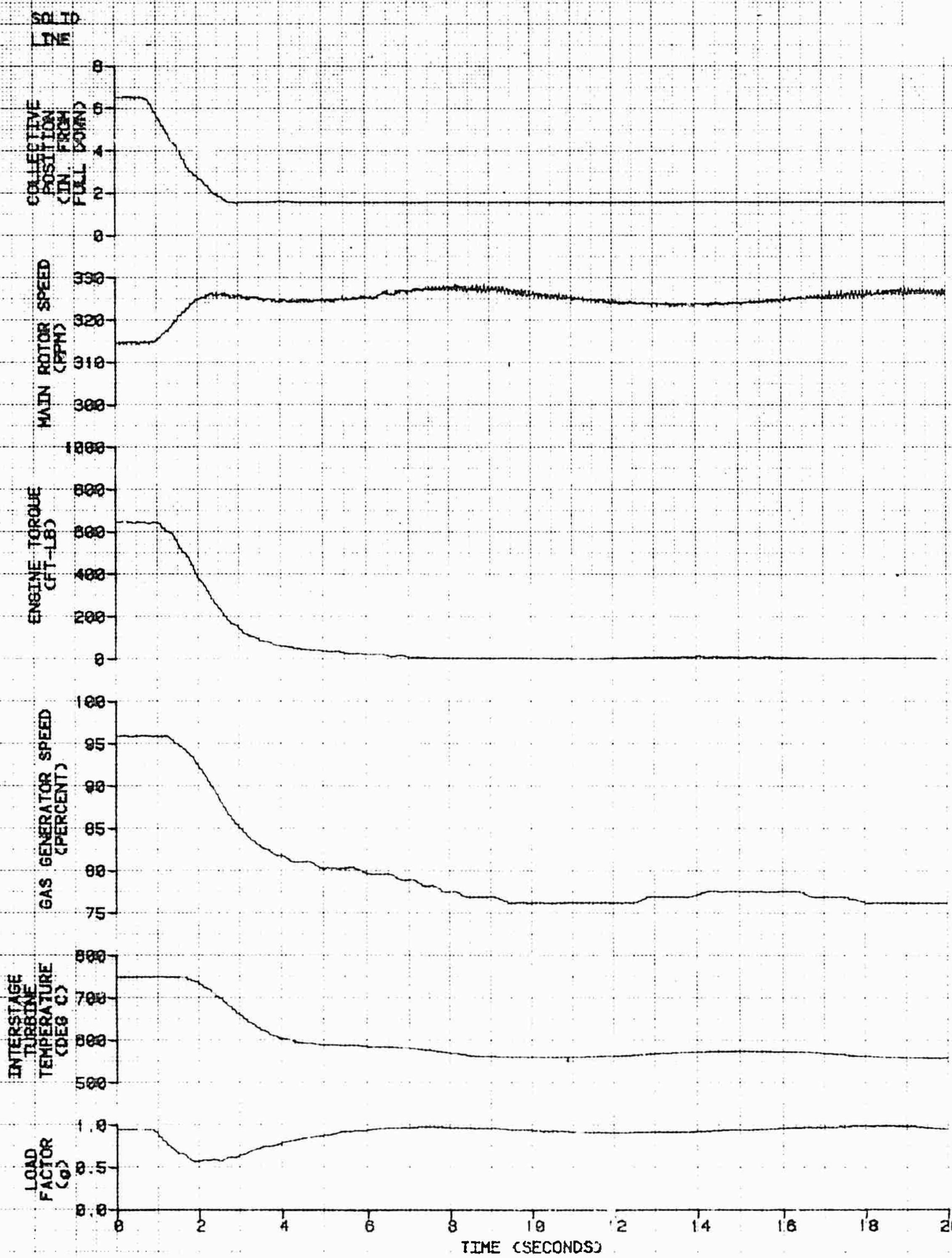


FIGURE 44

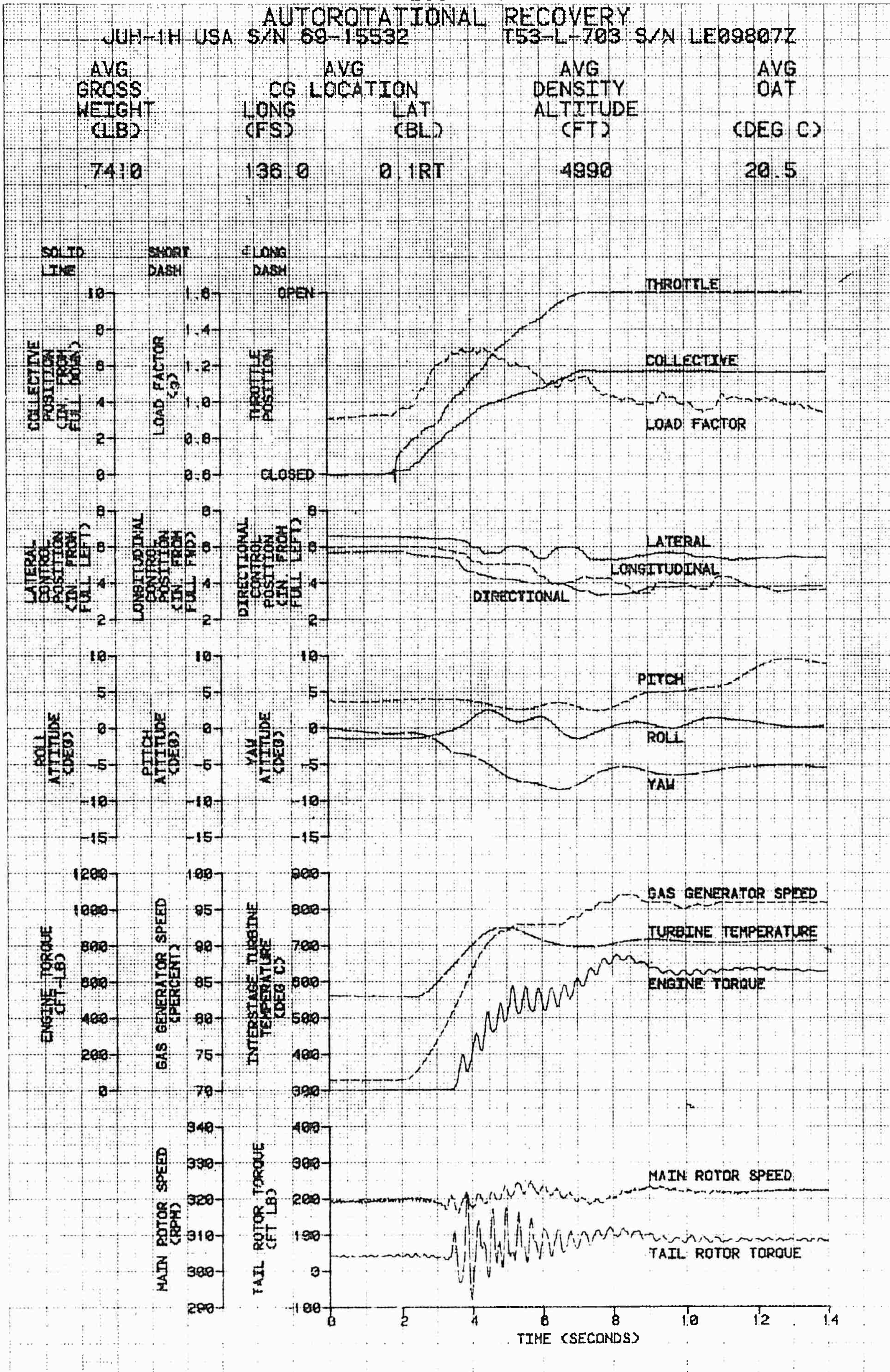

AUTOROTATIONAL RECOVERY
JUH-1H USA S/N 69-15532
T53-L-703 S/N LE09807Z
AVG GROSS WEIGHT (LB) 7410
AVG CG LOCATION LONG (FS) 136.0
LAT (BL) 0.1RT
AVG DENSITY ALTITUDE (FT) 4990
AVG OAT (DEG C) 20.5
SOLID LINE
SHORT DASH
LONG DASH
COLLECTIVE POSITION (IN. FROM FULL DOWN)
LOAD FACTOR (G)
THROTTLE POSITION
OPEN
CLOSED
THROTTLE
COLLECTIVE
LOAD FACTOR
LATERAL CONTROL POSITION (IN. FROM FULL LEFT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
LATERAL
LONGITUDINAL
DIRECTIONAL
ROLL ATTITUDE (DEG)
PITCH ATTITUDE (DEG)
YAW ATTITUDE (DEG)
PITCH
ROLL
YAW
ENGINE TORQUE (FT-LB)
GAS GENERATOR SPEED (PERCENT)
INTERSTAGE TURBINE TEMPERATURE (DEG C)
GAS GENERATOR SPEED
TURBINE TEMPERATURE
ENGINE TORQUE
MAIN ROTOR SPEED (RPM)
TAIL ROTOR TORQUE (FT LB)
MAIN ROTOR SPEED
TAIL ROTOR TORQUE
TIME (SECONDS)

FIGURE 45

AUTOROTATIONAL RECOVERY

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
7270	135.4	0.1RT	9910	1.5

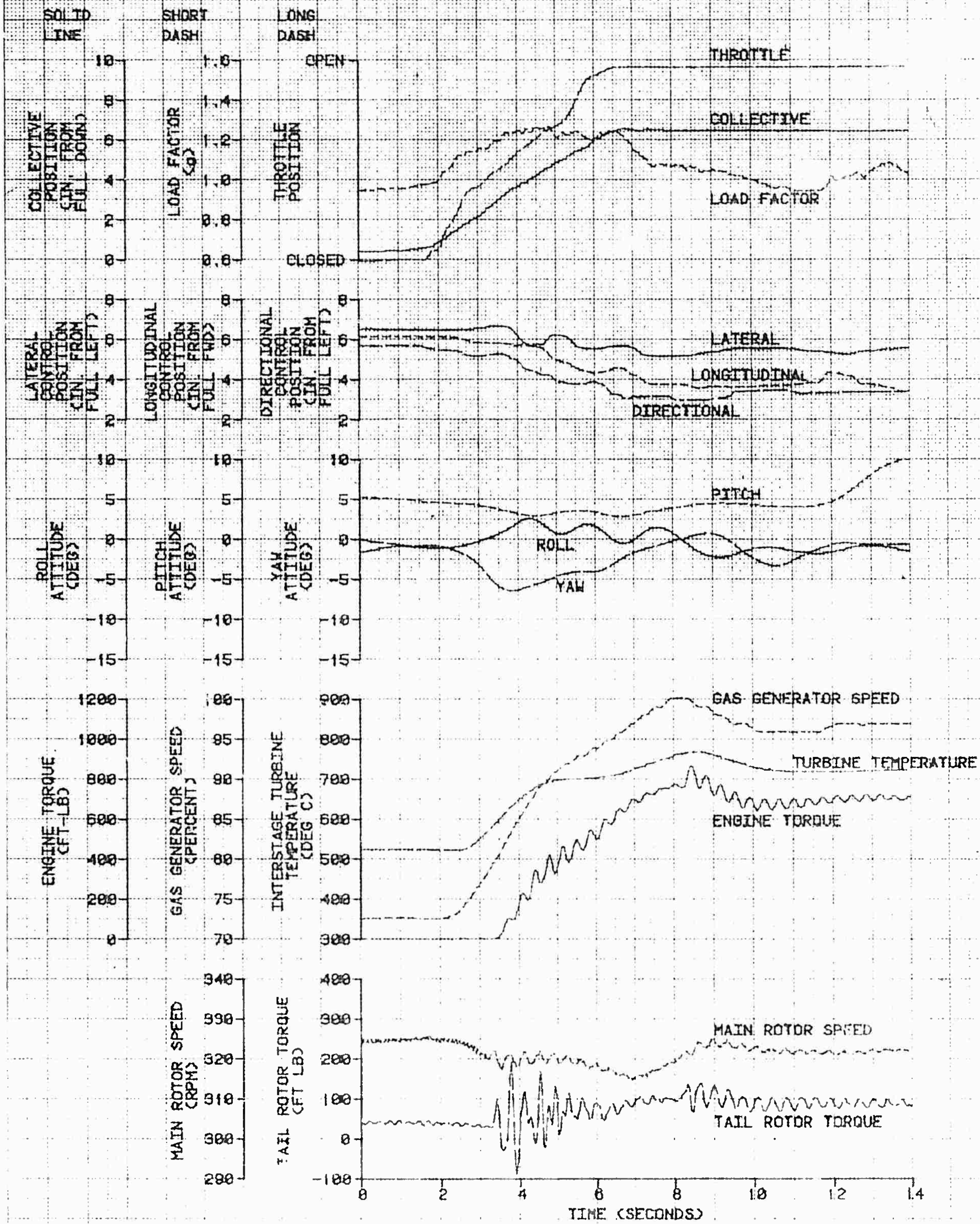


FIGURE 46

AUTOROTATIONAL RECOVERY

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
7300	135.5	0.1RT	14,970	1.5

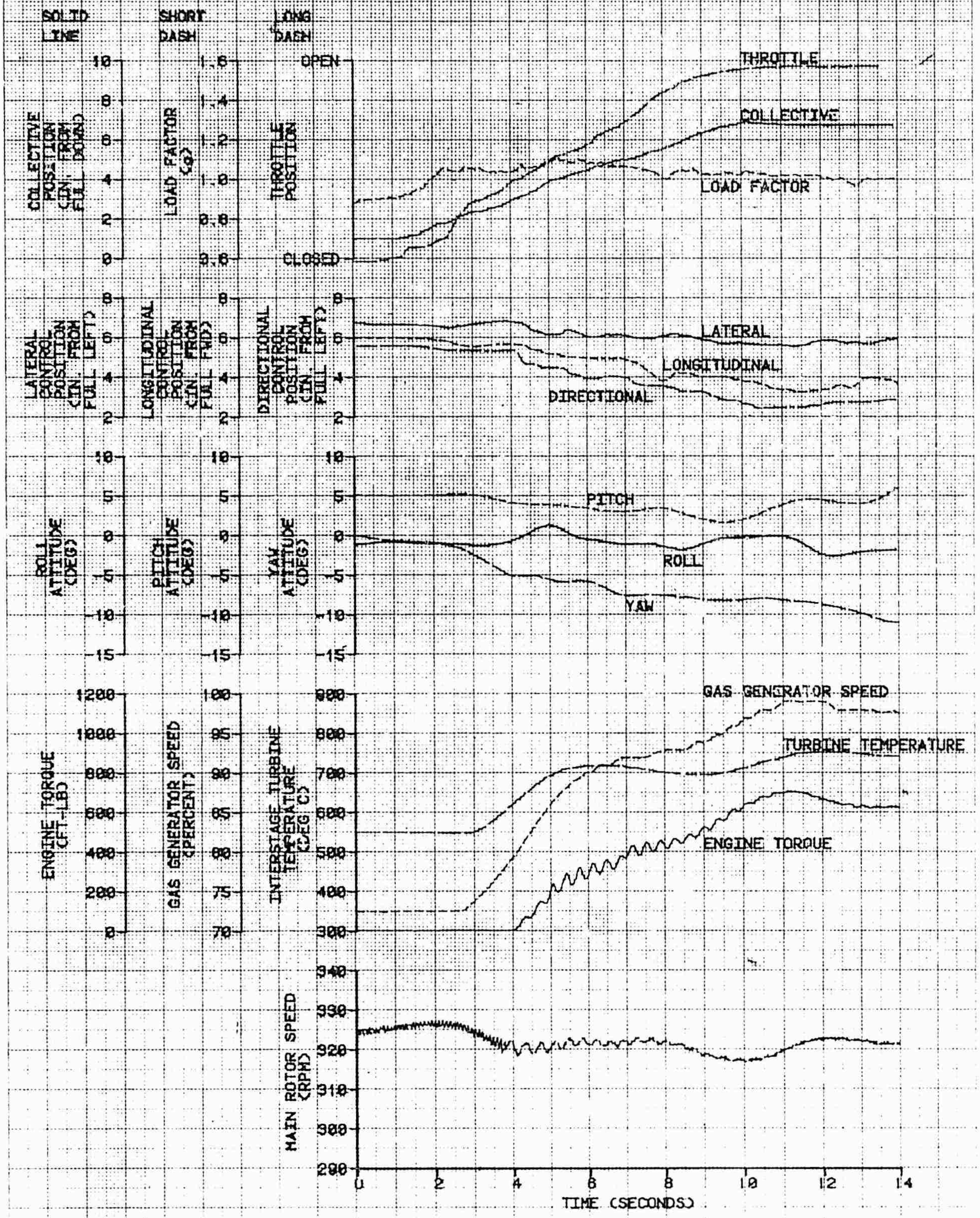


FIGURE 47

AUTOROTATIONAL RECOVERY

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
9300	136.1	0.4RT	5140	15.0

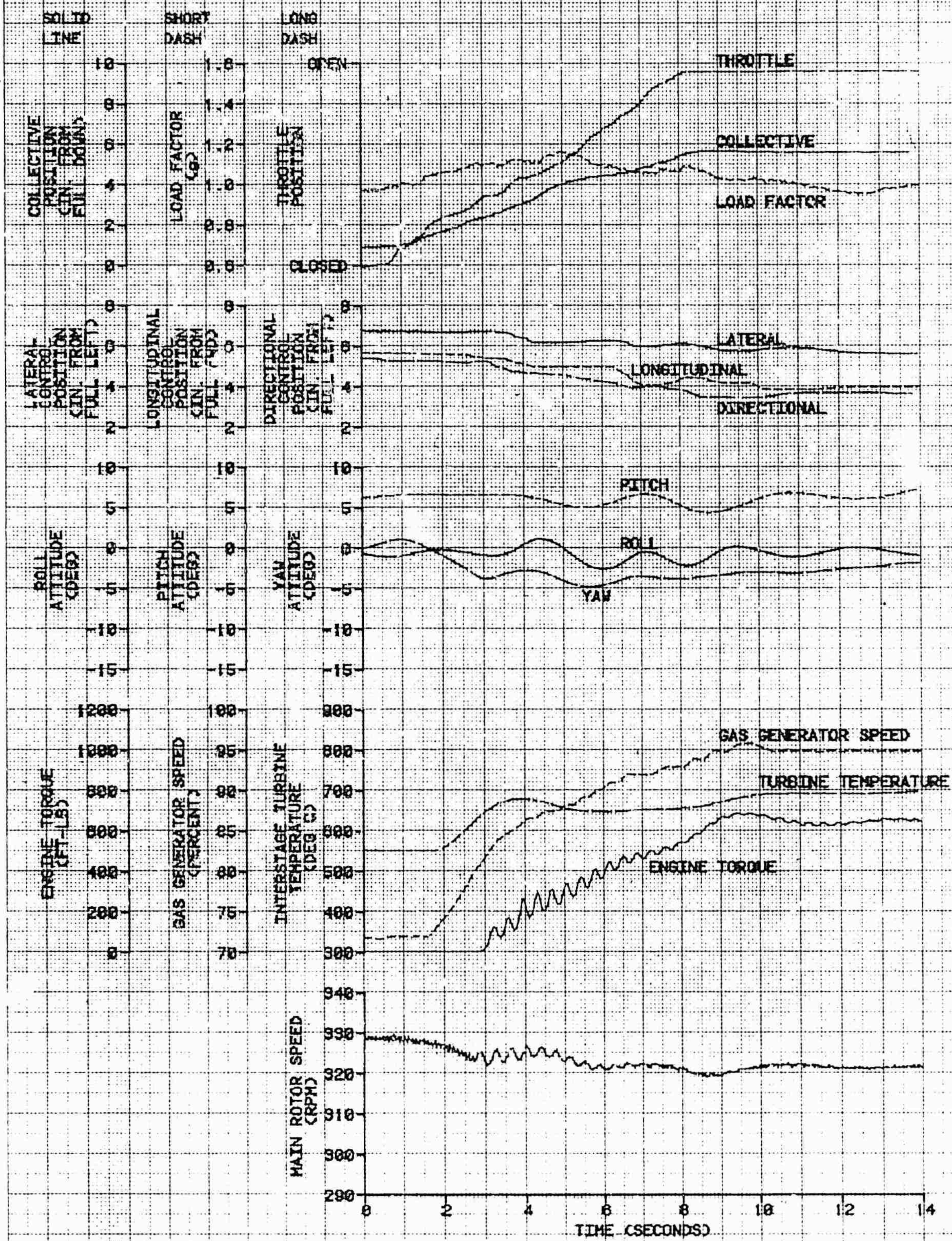


FIGURE 48

AUTOROTATIONAL RECOVERY

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
9160	135.7	0.4RT	9880	14.0

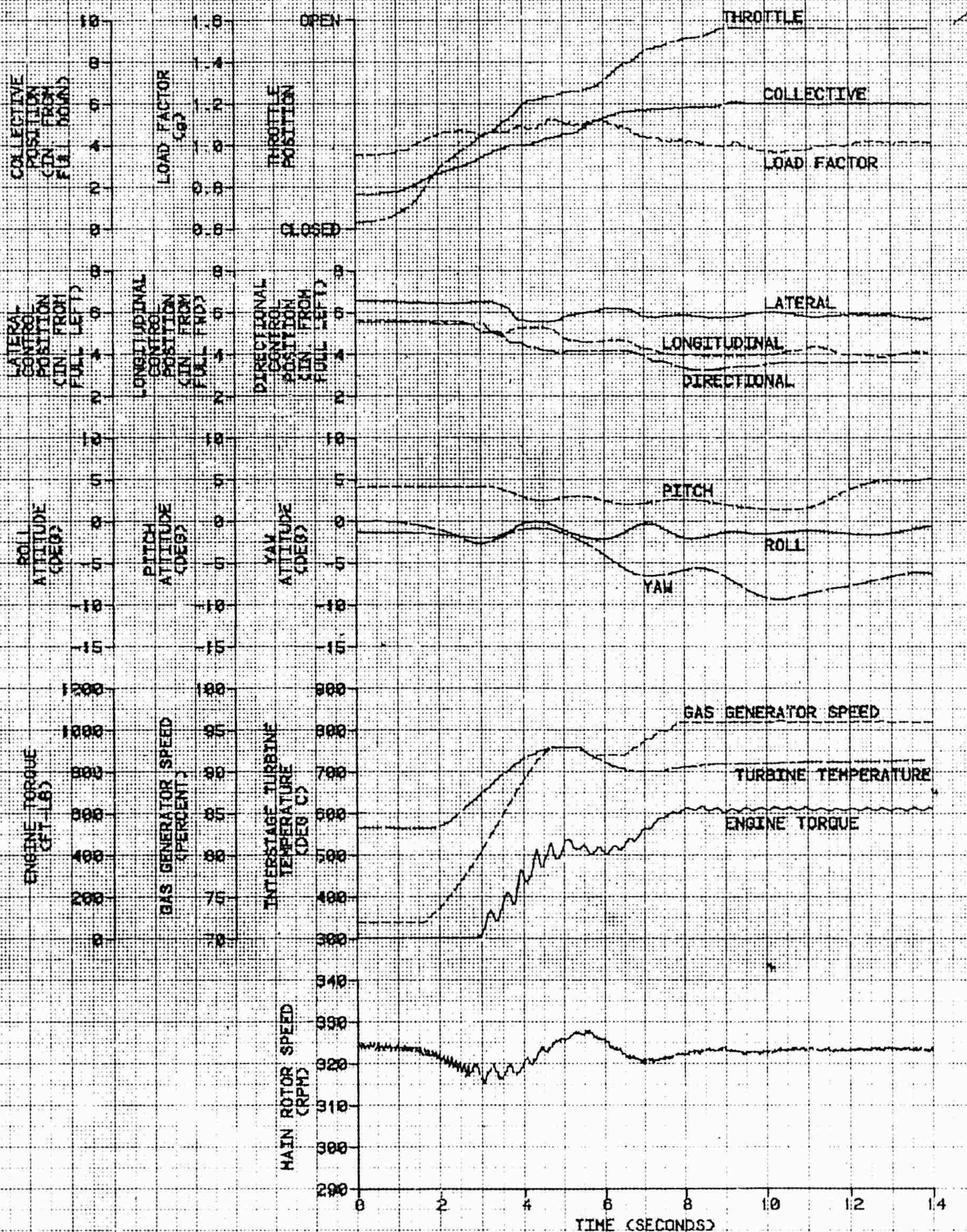


FIGURE 49

PULLUP

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG POSITION LONG (FS)	AVG CG POSITION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
7300	135.6	0.1RT	9860	7.5

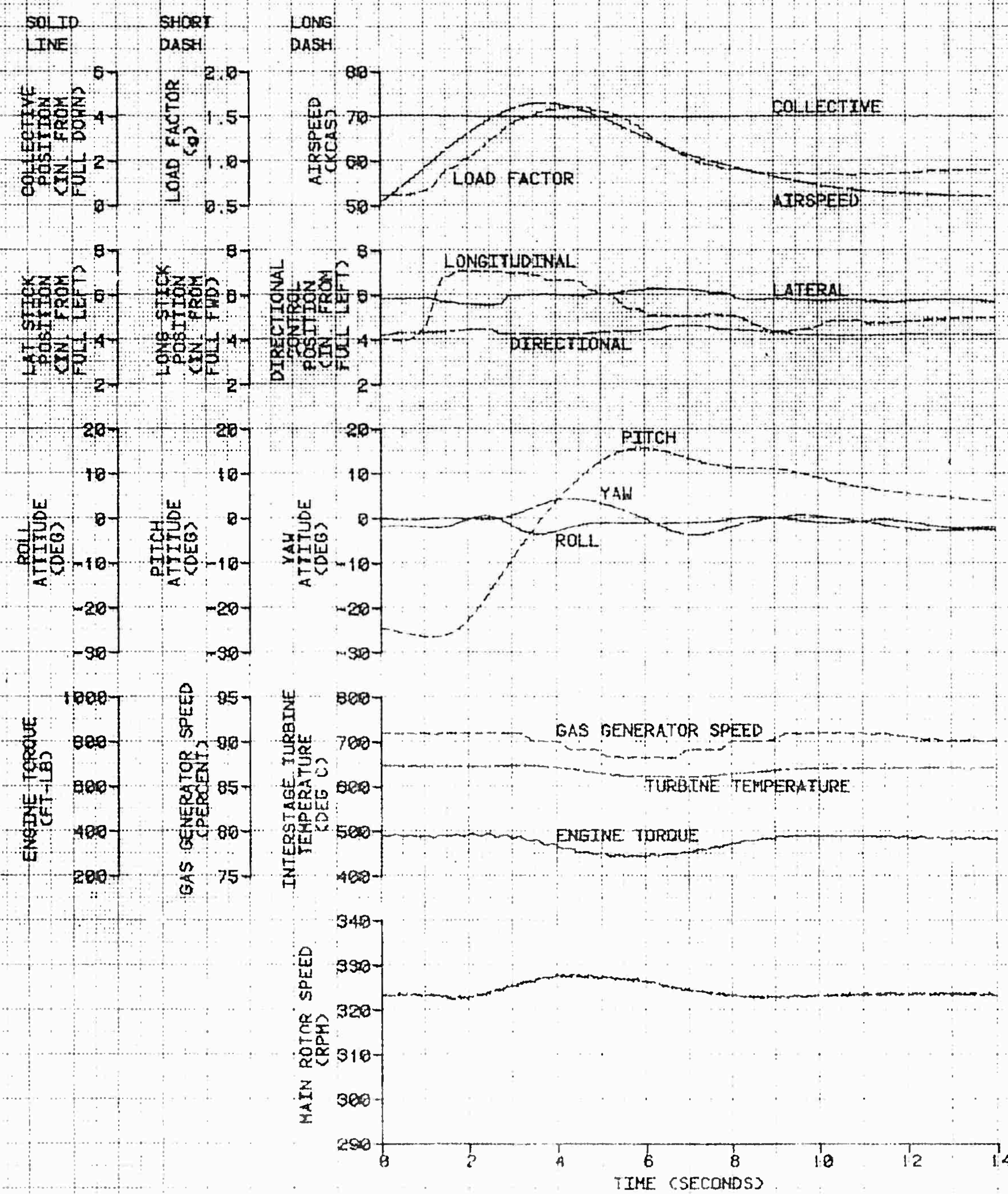


FIGURE 50
PUSHOVER
JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG GROSS WEIGHT (LB)	AVG CG POSITION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)
7250	135.3	0.1RT	9650	8.0

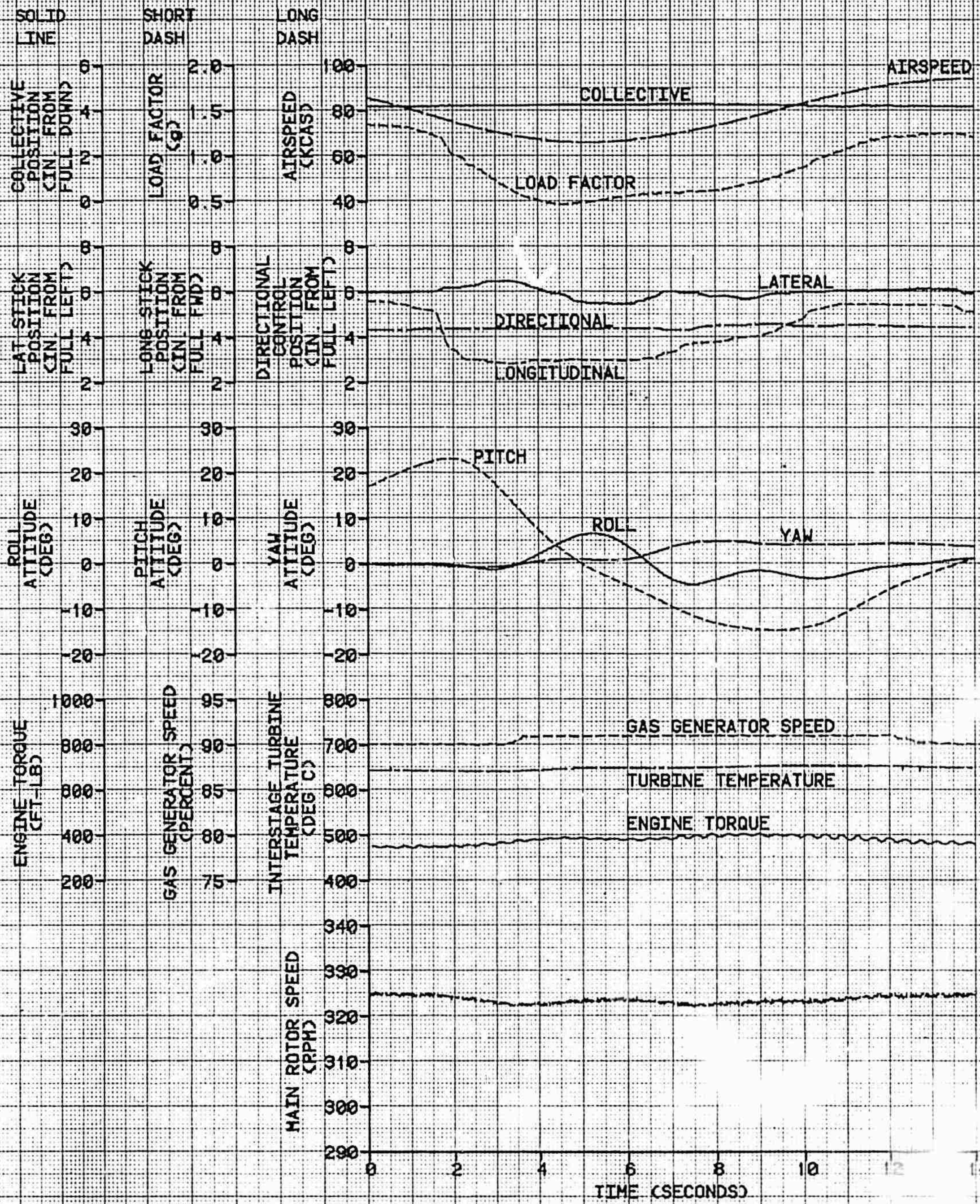


FIGURE 51

COMPRESSOR STALL
UH-1H S/N 69-15532 T53-L703 S/N LE09897Z

GROSS WEIGHT (LBS)	CENTER OF GRAVITY LONG (FS)	LAT (BL)	VERT (WL)	PRESSURE ALTITUDE (FEET)	AIR TEMP (DEG C)	TRUE AIRSPEED (KNOTS)
7835	137.48	-.06	58.14	14770	1.0	75.

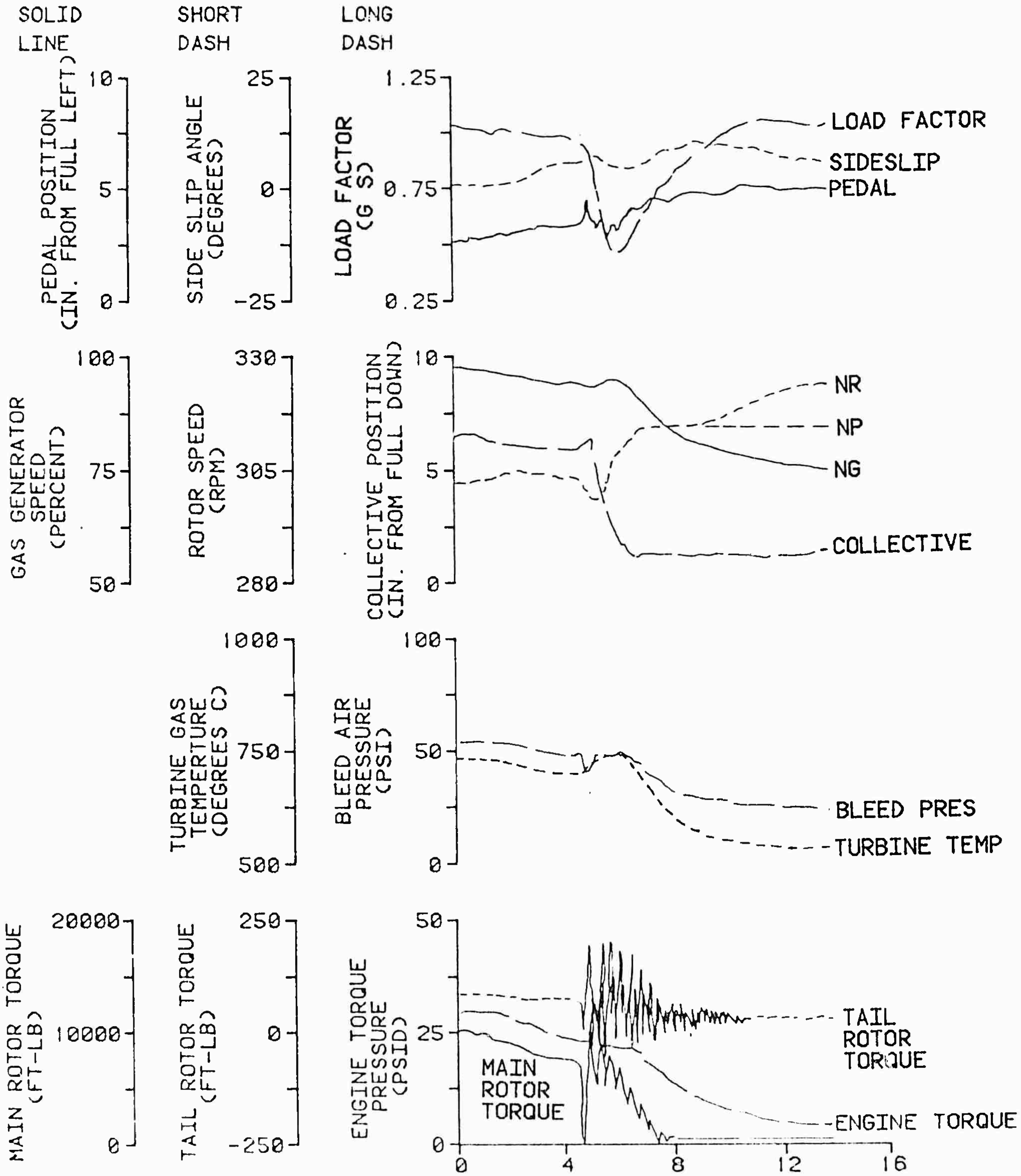


FIGURE 52

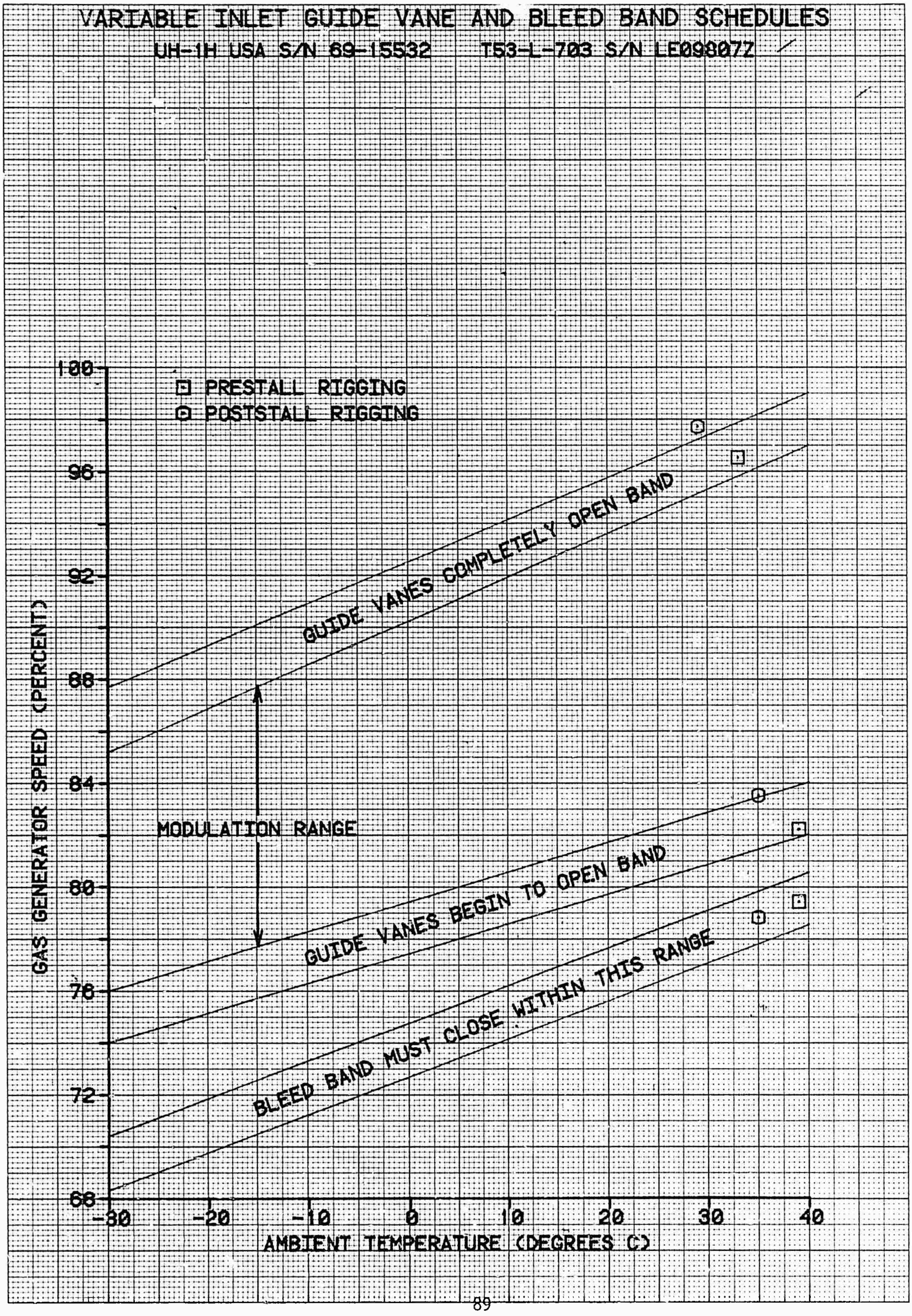

VARIABLE INLET GUIDE VANE AND BLEED BAND SCHEDULES
UH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z
PRESTALL RIGGING
POSTSTALL RIGGING
GUIDE VANES COMPLETELY OPEN BAND
MODULATION RANGE
GUIDE VANES BEGIN TO OPEN BAND
BLEED BAND MUST CLOSE WITHIN THIS RANGE
GAS GENERATOR SPEED (PERCENT)
100
96
92
88
84
80
76
72
68
-30
-20
-10
0
10
20
30
40
AMBIENT TEMPERATURE (DEGREES C)

FIGURE 53

ENGINE VARIABLE INLET GUIDE VANE ACTIVITY DURING ENGINE DECELERATION

JUH-1H USA S/N 69-15532 T53-L-703 S/N LE09807Z

AVG PRESSURE ALTITUDE (FT)	TRIM AIRSPEED (KCAS)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)
13,420	60	2.5	314

NOTE: TOTAL VIGV ACTUATOR TRAVEL = 0.68 INCHES

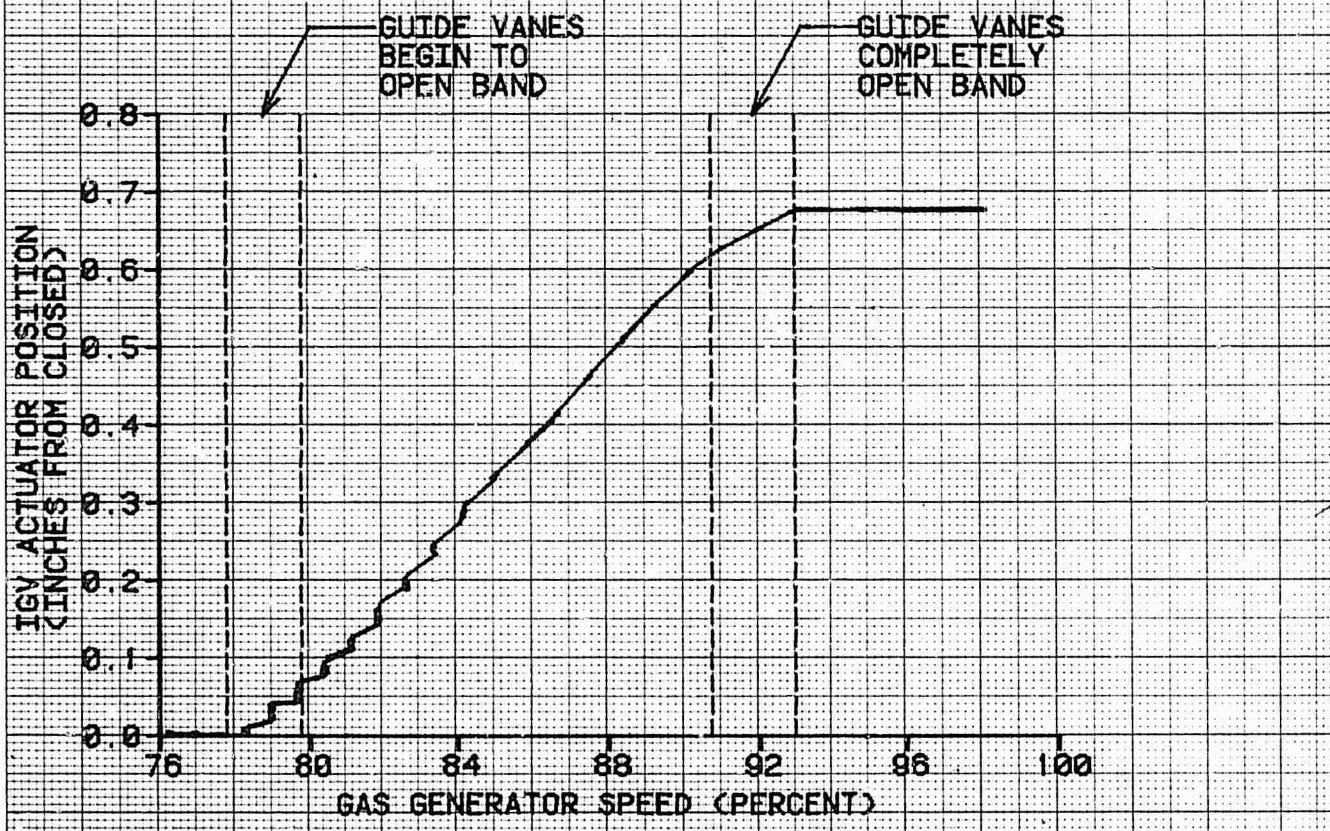


Table 1. Tail Shaft Cover, Tail Boom, and Stabilator Temperature Survey

Boom Station (BS)	Butt Line (BL)	Temperature, Degrees Celsius[1,2] Following Free Hover	Following 45, 90, and 135 degree azimuth flight at 10 and 50 ft skid height
17.5	L[3]	<77	<77
	C[4]	<77	88
	R[5]	<77	<77
38.5	L	99	Labels Missing
	C	216	Labels Missing
	R	93	127
59.5	L	204	Labels Missing
	C	224	Labels Missing
	R	160	154
80.5	L	160	127
	C	121	166
	R	121	121
101.5	L	110	121
	C	121	Labels Missing
	R	110	99
122.5	L	99	143
	C	110	116
	R	93	116
143.5	L	99	Labels Missing
	C	99	116
	R	77	116
	40.75 L[6]	<77	88
	22.5 L[6]	77	143
	22.5R[6]	77	99
	40.75 R[6]	<77	93
164.0	L	99	121
	C	93	110
	R	77	104
185.0	L	82	110
	C	82	110
	R	<77	82
198.0	C		104
Maximum Interstage Turbine Temperature		78.5	712
Maximum Ambient Temperature		11.5	10.5

NOTES:

[1]Temperature-sensitive tapes graduated in 10-degrees-Fahrenheit increments.
[2]Temperatures presented are the highest indicated by tape converted to degrees Celsius.
[3]Left side of top of tail boom as shown in figure 3, appendix C.
[4]Center (top) of tail shaft cover as shown in figure 3, appendix C.
[5]Right side of top of tail boom as shown in figure 3, appendix C.
[6]Top surface of stabilator as shown in figure 3, appendix C.

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