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AIRWORTHINESS AND FLIGHT CHARACTERISTICS OF THE JOH - 58C (OH-58X SURROGATE) HELICOPTER

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FINAL REPORT

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US ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The US Army Aviation Engineering Flight Activity conducted a limited airworthiness and flight characteristics test of the JOH-58C Light Combat Helicopter (LCH) from 27 June through 23 October 1985. The JOH-58C LCH configuration includes a stability augmentation system manufactured by the SFENA Corporation and a larger-diameter tail rotor. Handling qualities were evaluated at test sites from near sea level (488 feet) to 9980 feet. A total of 49 flights were conducted for a total of 34.6 productive flight test hours. Primary emphasis

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) during the evaluation was placed on evaluating the handling qualities of the JOH-58C in comparison to the standard OH-58C. The overall handling qualities of the JOH-58C were significantly improved as compared to the standard OH-58C. The JOH-58C exhibited less than 10% longitudinal control margin in rearward flight at speeds of approximately 17 knots and above at azimuths between 180 and 210 degrees. This characteristic is a deficiency. The pitch, roll and yaw excursions during low speed flight of the JOH-58C are significantly reduced as compared to the standard OH-58C. These handling qualities characteristics, which were a deficiency in the OH-58C, have been improved to shortcomings or were eliminated under the conditions tested in the JOH-58C. Two additional shortcomings were identified in maneuvering flight.

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INTRODUCTION

BACKGROUND

1. The US Army Development and Employment Agency (ADEA) and the Ninth Infantry Division (9th ID) have investigated the potential of using a modified OH-58C helicopter (JOH-58C) to perform the light scout/attack mission. Several similarly-configured JOH-58C helicopters were issued a limited Airworthiness Release (ref 1, app A) to conduct the ADEA Scout II test in mid-1984. On 5 February 1985, the US Army Aviation Engineering Flight Activity (USAAEFA) was tasked by the US Army Aviation Systems Command (AVSCOM) to support a stability augmentation system (SAS) optimization program and conduct a follow-on Airworthiness and Flight Characteristics (A&FC) evaluation (ref 2). A test plan (ref 3) was submitted and approved.

2. While the A&FC evaluation was in progess, the 9th ID stopped procurement of the JOH-58C helicopters and initiated deconfiguration of those already obtained. A full-scale A&FC was no longer necessary. However, because of interest in the SAS for possible application to the OH-58 fleet, a plan for an abbreviated test (ref 4) was approved and implemented. The A&FC evaluation was preceded by a SAS optimization program, conducted by the system's manufacturer (SFENA Corporation) at their facilities in Grand Prairie, Texas.

TEST OBJECTIVE

3. The objective of this test was to evaluate the handling qualities characteristics of the JOH-58C with a SAS and a larger diameter tail rotor.

DESCRIPTION

4. The test helicopter, US Army S/N 70-15349, was a modified OH-58C configured for the light combat helicopter (LCH) mission. The OH-58C is built by Bell Helicopter Textron, Inc. (BHTI). The OH-58C has a single two-bladed, semi-rigid, teetering-type main rotor and a single two-bladed, delta-hinged, semi-rigid teetering-type tail rotor. Maximum gross weight is 3200 pounds. The aircraft is powered by an Allison T63-A-720 engine with an uninstalled intermediate power rating (30 minutes) of 420 shaft horsepower (shp) at standard sea level conditions, derated to 317 shp by the main transmission. A detailed description of the standard OH-58C is contained in the operator's manual (ref 5, app A). Major modifications to configure to the JOH-58C LCH configuration are described in the airworthiness release (ref 1)

and are briefly discussed in appendix B. Major modifications include:

a. SFENA Stability Augmentation System
b. Improved communication/navigation equipment
c. Direct View Optics (DVO) roof-mounted sight
d. Forward Looking Infrared (FLIR) system with roof-mounted turret
e. Fuel range extenders (590 lb fuel total)
f. Two-position landing gear
g. Folding vertical tail fin
h. Improved tail rotor (BHTI 206L-3 rotor system)
i. High-frequency (HF) antenna

A hydraulic boost for the tail rotor was installed during SAS optimization at SFENA Corporation and was utilized throughout the A&FC. Portions of the test were conducted with the DVO pod, FLIR pod and HF antenna removed (modified clean configuration).

TEST SCOPE

5. The aircraft was ferried to SFENA in Grand Prairie, Texas (elevation 590 ft), and the SAS optimization program was conducted by SFENA prior to the start of the A&FC. The A&FC was conducted at Edwards AFB, California (elevation 2302 ft), with high altitude testing conducted at Bishop (elevation 4120 ft), and Coyote Flats, California (elevation 9980 ft). Low altitude tests were conducted at Bakersfield, California (elevation 488 ft). Tests in the modified clean configuration were conducted at Edwards AFB. Test conditions are presented in table 1. SAS optimization required 25 flights for a total of 24.6 productive flight test hours between 9 May and 27 June 1985. The A&FC required 49 flights for a total of 34.6 productive flight test hours between 27 June and 23 October 1985. Testing was accomplished within the constraints of the airworthiness release and the operator's manual (refs 1 and 5, app A). Handling qualities were evaluated using MIL-H-8501A (ref 6) as a guide.

TEST METHODOLOGY

6. Flight test data were recorded on magnetic tape using an on-board instrumentation package (app C). Established flight test techniques were used (ref 7, app A). Test techniques and data analysis methods are briefly discussed in appendix D. A Handling Qualities Rating Scale (HQRS) (fig. 1, app D) was used to augment pilot comments relative to handling qualities. A Vibration Rating

Scale (VRS) (fig. 2, app D) was used to augment pilot comments relative to vibrations.

RESULTS AND DISCUSSION

GENERAL

7. A limited airworthiness and flight characteristics evaluation of the JOH-58C was conducted at test sites near sea level (488 feet) to 9980 feet at the general test conditions listed in table 1. Primary emphasis during the flight testing was placed on evaluating the handling qualities of the JOH-58C in comparison to the standard OH-58C. The overall handling qualities of the JOH-58C were significantly improved as compared to the standard OH-58C. The JOH-58C exhibited less than 10% longitudinal control margin in rearward flight at speeds of approximately 17 knots and above at azimuths between 180 and 210 degrees. This characteristic is a deficiency. The pitch, roll and yaw excursions during low speed flight of the JOH-58C are significantly reduced as compared to the OH-58C. These handling qualities characteristics, which were a deficiency in the OH-58C, have been improved to shortcomings or were eliminated under the conditions tested in the JOH-58C. Two additional shortcomings were identified in maneuvering flight.

HANDLING QUALITIES

Control System Characteristics

8. The mechanical characteristics of the JOH-58C hydraulically-boosted flight control system were measured on the ground with the rotor and engine stopped. Hydraulic and electrical power were provided by an external source. All adjustable control friction devices were set to minimum friction. The SAS had no effect on control system characteristics. Force trim was ON and collective was full down. Control forces were measured using a hand-held force gauge and were qualitatively verified in flight.

9. The limits of longitudinal and lateral cyclic control travel are presented in figure 1, appendix E. The variation of control position with applied control force for the longitudinal and lateral controls is presented in figures 2 and 3. The longitudinal and lateral cyclic control force gradients were positive and essentially linear with no discontinuities. Breakout forces, including friction, were high (1.5 lb laterally, 2.8 lb aft and 3.8 lb forward longitudinally). High breakout forces increased pilot fatigue during mission maneuvers (para 37). Lateral centering characteristics were positive and absolute (returned the control precisely to the original position). Longitudinal centering characteristics were positive but not absolute, resulting in a 1.0-inch longitudinal trim control displacement band. This large control displacement band increased pilot workload during

Table 1. Test Conditions[1]

Type of Test	Average Gross Weight (lb)	Average[2] Longitudinal Center of Gravity (FS)	Average Density Altitude (ft)	Trim Calibrated Airspeed (KCAS)	Remarks
Control Positions in Trimmed Forward Flight	2910 2980 3100 3110	110.7 109.2 109.6 109.7	3790 5270 8370 11,210	28-103	Level flight, zero sideslip
Static Longitudinal Stability	3050	109.3	5790	61, 91	Level flight
Static Lateral Directional Stability	3120	108.9	5900	61, 91	Level flight
Maneuvering Stability	3030	108.6	6050	90-94	Right and left steady turns
Dynamic Stability	3040 3100 3130	109.5 109.3 109.2	2630 5900 6130	0 60 92	Hover Climb Level flight SAS ON/OFF
Controllability	3060 3120 3050	109.0 107.2 109.0	460 5040 6150	0 0 90	Hover; Level flight — DVO, FLIR, HF ON and OFF
Simulated Engine Failures	3150	109.0	4340	59, 94	Level flight and IRP climb
Simulated SAS Failures	3180 3160 3110	109.4 107.1 109.2	1770 990 5840	0 20 KTAS[3] 91	Hover; Low speed flight; Level flight — FLIR, DVO, HF ON and OFF
Low Speed Flight	3130 3120 2940 3100	107.6 107.1 109.9 109.6	1130 4700 10,750 2330	Sideward: 0-35 KTAS Rearward: 0-30 KTAS Forward: 0-35 KTAS	FLIR, DVO, HF ON; FLIR, DVO, HF OFF — Skid height 10 ft SAS ON and OFF
Loss of Tail Rotor Effectiveness	3130	107.2	6780	0-42	FLIR, DVO, HF ON Masking and unmasking 40 knot approach with 90° right turn to crosswind hover. 40 knot approach with 180° right turn to downwind hover SAS ON and OFF
Airspeed Calibration	3110	108.9	5400	33-100	Trailing bomb method
Simulated Hydraulics Failures	3090	108.9	A/R[4]	0-80 KIAS[5]	FLIR, DVO, HF ON and OFF Simulated failure in flight, approach to hover, running landing. SAS ON and OFF.
Instrument Meteorological Conditions Evaluation	3090	109.2	2500-5000	50-90 KIAS	Simulated inadvertent instrument conditions, turns, climbs, descents, ground-controlled approach
Mission Maneuvers	3090	109.2	A/R	A/R	FLIR, DVO, HF ON and OFF Mask/unmask, NOE[6], confined area, slopes. SAS ON and OFF

NOTES:

[1]Tests conducted doors ON; mid lateral cg; SAS ON; FLIR, DVO and HF antenna removed (modified clean configuration) and ball-centered flight except where noted.
[2]Aircraft cg limits: forward 107.0, aft lesser of 112.5 or operator's manual limit.
[3]Knots true airspeed.
[4]As required.
[5]Knots indicated airspeed.
[6]Nap-of-the-earth

maneuvering flight (para 14). The large longitudinal trim control displacement band and high breakout force are a shortcoming. The longitudinal control system characteristics failed to meet the requirements of paragraph 3.2.7 of MIL-H-8501A in that breakout including friction force exceeded the maximum allowable.

10. Data for directional control system characteristics are presented in figure 4, appendix E. The total directional control travel was 5.0 inches. The directional control breakout force (including friction) was approximately half that of the standard OH-58C. The directional control system did not incorporate a force trim mechanism, therefore no control centering existed. Although there was no directional control centering, the directional control system characteristics are satisfactory. The directional control system characteristics failed to meet the requirements of paragraph 3.3.10 of MIL-H-8501A in that there was no positive self-centering characteristic.

Control Positions in Trimmed Forward Flight

11. Control positions in trimmed forward flight were evaluated at the conditions listed in table 1. Test results are presented in figures 5 through 8, appendix E. The variation of longitudinal control position was conventional in that increased forward cyclic was required to trim at increased airspeed. The lateral and directional control displacements required with increased airspeed were minimal and control margins at all conditions tested were adequate. The level flight control positions in trimmed forward flight of the JOH-58C in the modified clean configuration were similar to the standard OH-58C helicopter (ref 8, app A) and are satisfactory.

Static Longitudinal Stability

12. The static longitudinal stability characteristics of the JOH-58C were evaluated in level flight at the conditions listed in table 1. Test results are presented in figures 9 and 10, appendix E. The static longitudinal stability was nearly neutral at both conditions tested. Although the position cues for an off trim airspeed condition were slight, it was easy to maintain trim airspeed (HORS 3). Even though the longitudinal control gradients of the JOH-58C failed to meet the requirements of MIL-H-8501A, paragraph 3.2.10, in that there was no positive control position stability near trim cruise airspeed, the static longitudinal stability of the JOH-58C is satisfactory.

Static Lateral-Directional Stability

13. The static lateral-directional stability characteristics of the JOH-58C were evaluated in level flight at the conditions listed in table 1. Test results are presented in figures 11 and 12, appendix E. Static directional stability, as indicated by the variation of directional control position with sideslip, was positive at all test conditions. Dihedral effect, as indicated by the variation of lateral control position with sideslip, was positive for all conditions tested. Side force characteristics, as indicated by the variation of roll attitude with sideslip, were positive for all conditions tested. The gradient at the lower airspeed was slightly shallower than in the standard OH-58C (ref 8, app A). The pilot had adequate cues of an out-of-trim condition and was able to correct it easily. The static lateral-directional stability characteristics of the JOH-58C are satisfactory.

Maneuvering Stability

14. The maneuvering stability characteristics of the JOH-58C were evaluated in left and right steady turns at the conditions listed in table 1. Maneuvering stability data are presented in figure 13, appendix E. Maneuvering stability, as indicated by the variation of longitudinal control position with center of gravity (cg) normal acceleration, was positive at normal accelerations up to 1.25g. Airspeed control of ±2 KIAS in a bank angle of 45 degrees (near 1.3g) required ±1 inch of longitudinal control displacement. Maintaining bank angle at 45 degrees was difficult because of the aircraft's pitch up divergence ("dig in" tendency), the large trim control displacement band and moderate vibrations (VRS 5). Subsequent investigation revealed that the longitudinal SAS actuators were saturated at bank angles of 45 degrees which made the aircraft's longitudinal control characteristics similar to the standard OH-58C. The standard OH-58C had a similar "dig in" tendency and high pilot workload at bank angles at 45 degrees. However, in bank angles less than 45 degrees, the workload in the JOH-58C was significantly less than in the standard OH-58C. The pitch up divergence ("dig in" tendency) at load factors near 1.3g at cruise airspeeds is a shortcoming.

Dynamic Stability

Short-Term (Gust Response):

15. The short-term dynamic stability characteristics of the JOH-58C were evaluated at the test conditions shown in table 1. Data are presented in figures 14 through 17, appendix E. Gust

response characteristics were simulated by single-axis control pulse inputs of up to 1 inch for 0.5 seconds and by releases from steady-heading sideslips. The short-term dynamic stability characteristics observed in all axes were deadbeat. The aircraft was also flown in light to moderate turbulence with SAS ON and OFF. With SAS ON, the short-term rate damping combined with SAS attitude retention to improve the aircraft's gust response. The deadbeat lateral-directional response was a significant improvement over the easily excited lateral-directional oscillations of the standard OH-58C (ref 8, app A). With SAS OFF, the JOH-58C response was essentially unchanged from the standard OH-58C. The deadbeat gust response characteristics of the JOH-58C will significantly reduce pilot workload in turbulence. The short-term dynamic stability characteristics of the JOH-58C are satisfactory.

Long-Term (Longitudinal):

16. The longitudinal long-term response of the JOH-58C was evaluated at the conditions shown in table 1. No natural excitation of the long-term longitudinal response was noted. Artificial excitation produced the results presented in figure 18, appendix E. A 10-knot decrease in airspeed from the trim point at 80 KIAS resulted in a further decrease to 55 KIAS when controls were returned to trim. Displacement of the longitudinal control momentarily disabled the pitch attitude retention. When the control was returned to the trim position, the SAS attitude retention feature attempted to maintain the pitch attitude present at that time. This nose-up attitude resulted in a slower airspeed, but that attitude was then maintained by the SAS, eliminating any noticeable long-term oscillatory response. This was an improvement over the lightly-damped convergent oscillations of the standard OH-58C (ref 8, app A). The long-term longitudinal response was also evaluated with the aircraft in climbs of over 1000 feet per minute in an attempt to excite the divergent pitch oscillation noted in the operator's manual (ref 5) for aircraft equipped with infrared exhaust stacks (JOH-58C also incorporated these stacks). No pitch oscillation was noted with either natural or artificial excitation during climbs. The pitch attitude retention feature of the JOH-58C will reduce the pilot's workload in maintaining airspeed, freeing him to concentrate on his observation mission and/or providing a more stable platform for aircraft systems. The long-term longitudinal response of the JOH-58C is satisfactory.

Controllability

17. The longitudinal, lateral and directional control response (maximum angular rate per one-inch control displacement) and control sensitivity (maximum angular acceleration per one-inch control displacement) of the JOH-58C were evaluated at the conditions shown in table 1. All three axes were investigated in a hover while only the pitch and roll axes were evaluated in level flight. During controllability testing, it was determined that aircraft response was dependent on SAS actuator position at the time of step input. This was especially apparent in the directional axis. The actuator would often trim up to 75% to one side of neutral, providing greater or lesser damping depending on the direction of input. This made aircraft response unpredictable in the yaw axis but this characteristic was not objectionable. Aircraft responses are presented in figures 19 through 27, appendix E. Controllability characteristics for the LCH configuration were qualitatively compared to the modified clean configuration and are essentially unchanged.

Directional:

18. Data for directional controllability characteristics in a hover are presented in figures 19 through 21, appendix E. The aircraft responded in the proper direction within 0.2 second after the input and no objectionable coupling was noted. The JOH-58C had increased yaw rate damping as compared to the standard OH-58C (ref 8, app A). Directional response was satisfactory and no tendency to overcontrol was noted. At the heavy gross weights tested, insufficient power margin required constant attention to torque limits with large (± 1 inch) but smooth control movement to arrest right yaw rate. The directional controllability characteristics of the JOH-58C are satisfactory.

Longitudinal:

19. The longitudinal controllability characteristics of the JOH-58C were evaluated at a hover and at 90 knots calibrated airspeed (KCAS) at the conditions listed in table 1. Longitudinal controllability data are presented in figures 22 through 25, appendix E. The aircraft responded in the appropriate direction within 0.2 sec with no objectionable coupling. With inputs up to approximately 2 inches, the longitudinal response was sufficiently damped, resulting in a shorter time required to achieve a steady state rate. The pilot will have predictable and adequate longitudinal control response and will not have to focus increased attention on pitch attitude control. The longitudinal controllability characteristics of the JOH-58C are satisfactory.

Lateral:

20. Lateral controllability characteristics of the JOH-58C were evaluated at a hover and at 89 KCAS at the conditions listed in table 1. Lateral controllability data are presented in figures 26 and 27, appendix E. The aircraft responded in the appropriate direction within 0.2 sec with no objectionable coupling. The aircraft exhibits predictable lateral response primarily because of the quick achievement of steady state rates in response to control displacement. The lateral response of the JOH-58C was qualitatively more damped than the standard OH-58C. The lateral controllability characteristics of the JOH-58C are satisfactory.

Low Speed Flight Characteristics

General:

21. Low speed flight characteristics were evaluated to determine the effects on handling qualities due to the installation of the SAS and the improved tail rotor. The low speed flight testing was conducted by stabilizing in formation with a ground pace vehicle at a skid height of approximately 10 feet at relative azimuths (measured clockwise from the nose of the aircraft) from 0 degrees to 360 degrees in 30 degree increments. The low speed flight characteristics for this aircraft can be discussed by reference to one of three regions (fig. A): 300 degrees clockwise to 150 degrees (region A), 150 degrees clockwise to 210 degrees (region B) and 210 degrees clockwise to 300 degrees (region C).

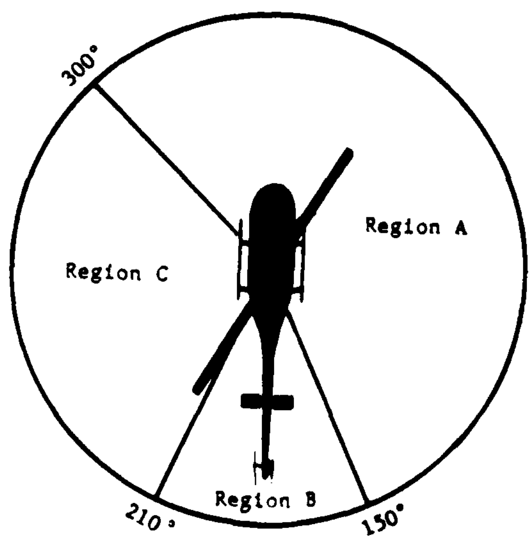


Figure A. Low Speed Flight Regions

22. Low speed handling characteristics were evaluated by maintaining the aircraft within ±3 degrees of desired heading and ±2 feet of desired skid height (evaluation performance criteria). Low speed flight was conducted SAS ON and OFF at the test conditions shown in table 1. Low speed flight characteristics data are presented in figures 28 through 60, appendix E. Low speed flight was conducted in the LCH configuration for quantitative and qualitative data, then qualitatively evaluated in the modified clean configuration. The handling qualities characteristics for both configurations were essentially the same.

Region A:

23. With the improved tail rotor and SAS ON, handling qualities ratings in Region A (up to approximately 5000 ft) were improved from HQRS 3 in the standard OH-58C (ref 8, app A) to HQRS 2 in that little or no directional control inputs were required to maintain desired heading within ±1 degree. At the 90 degree azimuth, the standard OH-58C (with a smaller diameter tail rotor) had less than 10% directional control margin remaining (reported deficiency) at 31 KTAS and 5000 ft. At similar conditions, the JOH-58C had more than 20% margin remaining at 35 KTAS (fig 43, app E). At the 120 deg azimuth and at airspeeds of 25 KTAS and above, the average longitudinal control margin was adequate. Momentary control excursions decreased this control margin to below 10%, but never less than one inch (fig. 45, app E). The low speed handling qualities of the JOH-58C aircraft in Region A are satisfactory.

Region B:

24. In Region B, handling qualities ratings were improved from HQRS 5 (standard OH-58C) to HQRS 3 in that minimal directional control inputs (±1/8-inch) were required to maintain the desired performance criteria. The large aft longitudinal control displacement during rearward flight between 10 to 20 KTAS was similar to that required for the standard OH-58C. At near maximum gross weight and up to 4670 feet density altitude (figs. 48 through 51, app E) less than 10% (1.2 inches) aft longitudinal control margin remained at rearward (180-210 deg) airspeeds of 17 KTAS and above (worse than the standard OH-58C). The less than 10% longitudinal control margin of the JOH-58C at airspeeds above 17 KTAS between azimuths of 180 and 210 deg is a deficiency. The longitudinal control margin at azimuths of 180 to 210 deg failed to meet the intent of paragraph 3.2.1 of MIL-H-8501A in that less than 10% longitudinal control margin remained. The following CAUTION should be incorporated into the airworthiness release and/or the operator's manual:

CAUTION

When hovering with tailwinds greater than 17 knots and a forward center of gravity, less than 10% longitudinal control margin may be available.

Region C:

25. In left sideward flight (Region C) the SAS and improved tail rotor system reduced the ±8 degrees yaw attitude excursions of the standard OH-58C (ref 8, app A) to approximately ±3 degrees. Handling qualities ratings were improved from HQRS 7 (standard OH-58C) to HQRS 4 due to reduced frequency and amplitude of control inputs required in all axes. Critical azimuth and airspeed, determined by pilot workload, was approximately 240 degrees at 15 to 25 KTAS. Figure 28, appendix E presents data at the 240 degree azimuth and 21 KTAS. Large SAS actuator inputs (sometimes saturated) as well as moderate and frequent control inputs in all axes (±1/2-inch) were required (HQRS 4) to maintain desired performance criteria. The SAS and improved tail rotor system significantly improved the overall low speed flight characteristics of the JOH-58C in Region C, however, workload remains high at the critical azimuth and airspeed. The high pilot workload at 240 degrees relative azimuth from 15 to 25 KTAS during low speed flight is a shortcoming.

SAS OFF Flight:

26. Certain portions of low speed flight were conducted SAS OFF. Data are presented in figure 33, appendix E. Larger and more frequent control inputs were required for all azimuths and airspeeds tested than were required with SAS ON. There was no artificial rate damping with SAS OFF, which was especially apparent in the yaw axis. The directional control was qualitatively more sensitive than the standard OH-58C. The pilots were accustomed to flying with an augmented flight control system and, when required to fly unaugmented, over-controlled the aircraft, resulting in pilot-induced oscillations of up to ±6 degrees. Time to adapt to the degraded mode will vary from pilot to pilot, depending on how accustomed he is to flying SAS OFF. SAS OFF flight is a degraded mode and should be incorporated in the aviator's annual Aircrew Training Manual (ATM) evaluation and performed periodically as an ATM maneuver. The following NOTE should be incorporated into the airworthiness release and/ or the operator's manual:

NOTE

> SAS OFF flight is a degraded mode and may result in attitude excursions of ±6 degrees in all axes. These excursions should decrease as the pilot becomes accustomed to SAS OFF flight.

Yaw Oscillation:

27. With SAS ON, A yaw oscillation was noticed during low speed flight and was frequently evident at all azimuths and speeds. It was also present in forward flight, but most noticeable in low speed flight. Heading excursions of ±1 to ±2 degrees during low speed flight were experienced once this mode was excited. Heading excursions in level flight decreased with increased airspeed to approximately ±1/2 to ±1 degree at 90 knots indicated airspeed (KIAS). A time history to illustrate this oscillation is presented in figure 29, appendix E. The data indicate that the SAS was driving this oscillation. This high frequency (period of 1.5 sec) small amplitude oscillation became aggravated in amplitude when the pilot tried to maintain more precise heading control. Several times the pilot contributed to this oscillation so that heading control could only be maintained within ±3 degrees. In many cases, yaw oscillations damped after approximately 15 seconds if the pilot held the controls fixed and let the SAS attitude retention feature dampen out oscillations. The occasional yaw oscillation is a shortcoming. Recommend further optimization be conducted to eliminate this yaw oscillation.

Aircraft System Failures

Simulated Engine Failure:

28. Simulated engine failures were evaluated at the conditions listed in table 1. Data are presented in figure 61, appendix E. Sudden engine failures were simulated by stabilizing at the test conditions and then rapidly reducing the throttle to flight idle. All flight controls were held fixed for approximately two seconds or until recovery was required (due to low rotor speed, excessive rates, attitudes, etc.). The predominant cues of an engine failure were the aircraft rotor RPM light and audio warning signals. Only 7-1/2° of yaw attitude excursions from trim were observed. Delay times of 2.0 seconds could not be achieved due to rapid decrease of rotor speed at the high gross weights tested. Following reduction of the collective control, rotor speed increased rapidly to safe levels. Except for the smaller yaw attitude

excursions, these characteristics are similar to those of a standard OH-58C. The SAS prevented the normal large yaw excursions which occurred in a simulated engine failure, but the other cues (audio, visual, reduced engine noise, etc.) remained adequate to advise the pilot of a sudden engine failure. The simulated engine failure characteristics of the JOH-58C are satisfactory. The simulated engine failure characteristics of the JOH-58C failed to meet the requirement of paragraph 3.5.5 of MIL-H-8501A in that delay times of 2.0 seconds could not be achieved prior to initiation of recovery.

Hydraulic System Failure:

29. Hydraulic system failures were qualitatively evaluated at the conditions listed in table 1. Failures were simulated by turning the HYD BOOST switch to the OFF position. With the standard OH-58C, as the aircraft is slowed below the airspeed for effective translational lift (ETL) with hydraulics OFF, there is an increased level of pilot-induced oscillations in all three axes (particularly noticeable in roll). In the JOH-58C, the pilot-induced oscillations were still apparent (± 1 to $\pm 3°$, all axes), but much reduced. Pedal forces were qualitatively higher than those on the standard OH-58C. Control forces in all axes were moderate when hydraulics were failed at 80 KIAS and the aircraft was decelerated to 50 KIAS. The first indication of a failure was illumination of the MASTER CAUTION light and HYD PRESS caution light, followed by slight control feedback when the controls were moved. An approach to a hover was accomplished, but the small power margin, increased oscillations, large control movements and high control forces made precise control of the aircraft difficult (HQRS 5). The pilot will be able to continue his mission only if he maintains airspeeds above that required for ETL. In the event of hydraulic failure, the optimum recovery procedure should remain a run-on landing as prescribed in the operator's manual (ref 5, app A). The handling qualities of the JOH-58C with a simulated hydraulics failure are satisfactory for degraded mode operation.

Stability Augmentation System Failures:

30. Simulated SAS failures were evaluated at the conditions listed in table 1. SAS actuator hardovers were introduced into the system using a SFENA SAS hardover control unit. Single-axis SAS hardovers were accomplished in all three axes. Hardovers were induced when actuators were centered (as indicated by the SAS actuator position indicators in the cockpit). Delay times of up to three seconds during level flight and up to one second delays for hover and low speed flight were evaluated.

Total system failure was simulated by removing power from the SAS. Time history data obtained from these tests are presented in figures 62 through 70, appendix E.

31. SAS actuator hardovers conducted during a hover with zero time delay produced mild aircraft reactions in all axes. Generally, only a bump (similar to a gust) could be felt when the hardover was injected. Minimal pilot control inputs (±1/2 inch) were required to maintain aircraft attitudes within ±2 degrees (HQRS 3). A one second delay produced a 28 deg/sec yaw rate, 14 deg/sec roll rate or a 7 deg/sec pitch rate after the hardover in the respective axis (figs. 65 through 67). These rates produced attitude changes which were not considered excessive and normal pilot reaction was adequate to effect recovery. All aircraft reactions with a one second delay provided adequate cues to the pilot that a SAS hardover had occurred. Hardovers with zero time delay were also conducted with a pilot wearing night vision goggles (NVG) with day filters. The pilot was frequently unaware that a hardover had occurred. Initial accelerations provided inadequate cues that a hardover had occurred. No significant rates or attitude changes developed since the pilot reacted instantaneously. SAS hardover characteristics of the JOH-58C in a hover are satisfactory.

32. SAS hardovers during low speed flight at the critical azimuth/speed were also accomplished (figs. 68 through 70, app E). With zero delay time, the aircraft produced mild reactions which were similar to those produced with zero time delay at a hover (para 31). The initial acceleration provided inadequate cues that a hardover had occurred. No significant rates or attitude changes developed and minimum pilot compensation was required to maintain heading and attitude criteria. SAS hardover characteristics during low speed flight at the critical azimuth/speed are satisfactory.

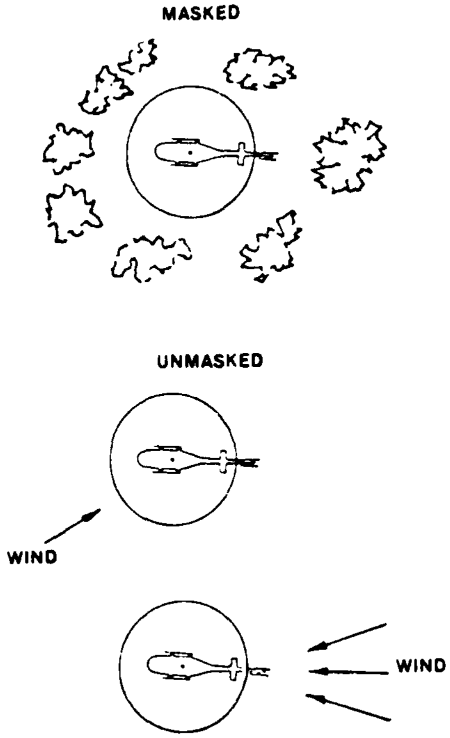
33. SAS actuator hardovers conducted at 90 KCAS in level flight resulted in only mild aircraft reaction in the pitch and yaw axes (figs. 62 through 64, app E). After 3 seconds, attitude changes were approximately 5 degrees. The moderate angular acceleration and attitude changes provided adequate cues that a failure or hardover had occurred. The highest rates were produced in the roll axis, where rates of 20 deg/sec were achieved (fig. 63). The initial rapid acceleration (18 to 20 deg/sec^2) and high roll rate prompted the pilot to recover after 2.5 seconds as the aircraft passed 35 degrees of bank. The aircraft continued to 40 degrees before the roll rate was arrested. Normal proprioceptive and visual cues alerted the pilot that a SAS hardover had occurred. Under all conditions tested, recovery was accomplished

with minimal pilot compensation. Hardovers were also conducted while the pilot was wearing NVG with day filters. The pilot was allowed to react normally (with no delay time) and was unaware at times that a SAS failure had occurred. The initial acceleration provided inadequate cues that a hardover had occurred. No significant rates or attitude changes developed since the pilot reacted instantaneously. Pilot reaction to a SAS hardover required minimal compensation. Aircraft control was not a problem in any of these tests. The simulated SAS hardover characteristics of the JOH-58C helicopter in level flight are satisfactory. The SAS hardover characteristics of the JOH-58C in level flight failed to meet the requirements of paragraph 3.5.8 of MIL-H-8501A in that roll rates exceeded 10 deg/sec in less than 3 seconds.

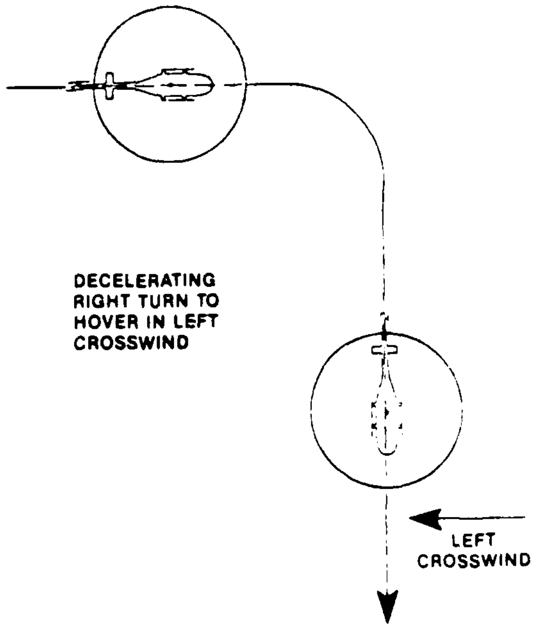
34. SAS OFF flight was conducted during several tests to determine the flight characteristics during this degraded mode. SAS OFF during low speed flight was discussed in paragraph 26. SAS OFF flight during hover, level flight, low speed flight and loss of tail rotor effectiveness (LTE) tests was characterized by larger and more frequent control inputs than were required with SAS ON. In many cases, with zero time delay, there were no cues to the pilot that a total or partial SAS failure had occurred, except that attitude excursions increased in all axes (paras 31 through 33). The yaw axis was qualitatively more sensitive. Overcontrol of the aircraft resulted in oscillations in all axes of ± 3 degrees at the higher speeds (above 60 KIAS) and ± 6 degrees at a hover, low speed and LTE tests. The excursions decreased as the pilot became accustomed to SAS OFF flight. Aircraft control was not in question but the pilot workload for SAS OFF flight was significantly increased. There was no SAS failure advisory light available to the pilot to indicate to him that a total or partial failure had occurred. Recommend that a SAS failure advisory light be installed in the JOH-58C aircraft to indicate when a total or partial failure occurs.

Loss of Tail Rotor Effectiveness

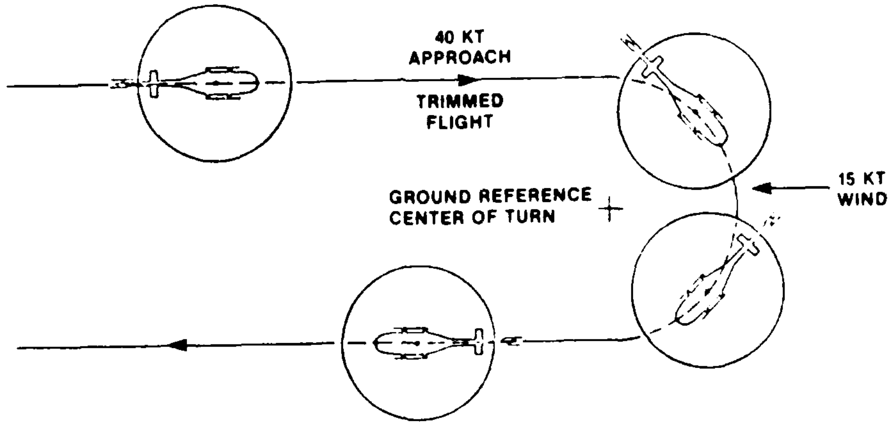
35. Tail rotor effectiveness was evaluated SAS ON and OFF by flying the three maneuvers shown in figure B. A time history of maneuver B is presented in figure 71, appendix E. The pilot workload and control movements were significantly less than those required with SAS OFF (fig. 72). Loss of tail rotor effectiveness did not occur during any of the tests. Although this was not an in-depth investigation of LTE, the SAS and improved tail rotor should assist in reducing the yaw rates that are conducive to LTE.



Maneuver A. Masking/Unmasking



Maneuver B. Right Turn to Hover in Crosswind



Maneuver C. Right Turn to Downwind

Figure 8. Loss of Tail Rotor Effectiveness Maneuvers

Mission Maneuvers

36. Mission maneuvers were evaluated qualitatively at the conditions presented in table 1. The maneuvers were conducted in accordance with the ATM and were evaluated SAS ON and OFF. Pilot workload increased with the SAS OFF for all maneuvers conducted. Aircraft controllability was not in question, but SAS OFF flight required considerable pilot compensation to maintain the ATM standards of each maneuver. SAS ON flight, however, significantly reduced pilot workload which enhanced mission capability. Slope landings, masking/unmasking and nap-of-the-earth flight were significantly easier to accomplish since rate damping provided reduced aircraft attitude excursions. Pilots felt that they could maneuver the aircraft more aggressively without fear that aircraft rates would exceed the aircraft's capability. The mission maneuver characteristics of the JOH-58C helicopter with a three-axis SAS significantly improved mission capability, but high control forces (para 9) will be fatiguing. To relieve high forces during maneuvering flight, the pilot may turn the force trim system off, thus eliminating the attitude retention feature of the SAS or repeatedly depress the force trim interrupt, increasing his workload. Consideration should be given to installing the SAS and improved tail rotor on all OH-58C helicopters.

Instrument Flight Evalution

37. Handling qualities of the JOH-58C in simulated instrument meteorological conditions (IMC) were evaluated at the conditions listed in table 1. IMC were simulated by having the pilot wear a hood which restricted his field of view to the interior of the cockpit. In IMC flight (altitude changes, level flight, turns, etc.), the stability provided by the SAS significantly reduced the pilot workload in maintaining basic aircraft attitudes. The altitude hold (ALT HOLD) feature further reduced workload in maintaining altitude. In level flight, the aircraft was easily kept within 50 feet of the desired altitude and ±1 to ±2 degrees of desired attitudes with no pilot inputs on the collective or pedals and inputs no larger than 1/2 inch on the cyclic control (HQRS 3). The aircraft was not tested for certification under instrument flight rules. However, in inadvertent IMC, with the improved stability of the JOH-58C the pilot will be able to devote less of his time and attention to basic flying and will instead be able to concentrate on IMC recovery. The ALT HOLD feature of the JOH-58C is an enhancing characteristic in inadvertent IMC flight.

CONCLUSIONS

GENERAL

38. The following conclusions were reached upon completion of testing.

a. The flying qualities of the JOH-58C were significantly improved in comparison to the standard OH-58C.

b. One deficiency and four shortcomings were identified.

ENHANCING CHARACTERISTIC

39. The following enhancing characteristic was identified: ALT HOLD feature of JOH-58C in inadvertent IMC flight (para 37).

DEFICIENCY

40. The following deficiency was identified: less than 10% longitudinal control margin at airspeeds above 17 KTAS between azimuths of 180 and 210 degrees (para 24).

SHORTCOMINGS

41. The following shortcomings were identified:

a. High pilot workload at the critical azimuth in low speed flight (para 25).

b. Occasional yaw oscillation at low speeds (para 27).

c. Pitch up divergence ("dig in" tendency) at load factors near 1.3g at cruise airspeeds (para 14).

d. Large longitudinal trim control displacement band and high control forces (para 9).

SPECIFICATION COMPLIANCE

42. The JOH-58C failed to meet the following requirements of MIL-H-8501A:

a. Paragraph 3.2.1 - less than 10% longitudinal control margin (180 to 210 deg) (para 24).

b. Paragraph 3.2.7 - longitudinal breakout including friction force exceeded the maximum allowable (para 9).

c. Paragraph 3.2.10 - the longitudinal control position stability near trim cruise airspeeds was not positive (para 12).

d. Paragagaraph 3.3.10 - no positive self-centering characteristics for the directional control system (para 10).

e. Paragararaph 3.5.5 - delay times of 2.0 seconds could not be achieved during simulated sudden engine failure (para 28).

f. Paragararaph 3.5.8 - SAS hardover roll rates exceeded 10 deg/sec in less than 3.0 sec (para 33).

RECOMMENDATIONS

43. The deficiency reported in paragaraph 40 should be corrected prior to operational deployment of JOH-58C.

44. The shortcomings reported in paragraph 41 should be corrected as soon as possible.

45. The following CAUTION should be added to the airworthiness release and/or the operator's manual (para 24) until the correction of the deficiency reported in paragraph 40.

CAUTION

When hovering with tailwinds greater than 17 knots and a forward center of gravity, less than 10% longitudinal control margin may be available.

46. The following NOTE should be added to the airworthiness release and/or the operator's manual (para 26).

NOTE

SAS OFF flight is a degraded mode and may result in attitude excursions of ± 6 degrees in all axes. These excursions should decrease as the pilot becomes accustomed to SAS OFF flight.

47. Recommend optimization of the SAS to eliminate the yaw oscillation (para 27).

48. Recommend a SAS failure advisory light be installed in the JOH-58C to indicate a total or partial SAS failure (para 34).

49. SAS OFF flight is a degraded mode and should be incorporated in the aviator's annual Aircrew Training Manual evaluation (para 26).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-E, 16 February 1983, with revision 5 dated 17 December 1984, subject: Airworthiness Release for Flight Operation of JOH-58C Helicopter S/N 70-15349 in the Light Combat Helicopter (LCH) Configuration.

2. Letter, AVSCOM, AMSAV-ED, 5 February 1985, subject: Airworthiness and Flight Characteristics Evaluation of the JOH-58C (OH-58X Surrogate) Helicopter. (Test Request)

3. Test Plan, USAAEFA Project No. 85-03, *Airworthiness and Flight Characteristics Evaluation of the JOH-58C (OH-58X Surrogate) Helicopter*, March 1985

4. Test Plan, USAAEFA Project No. 85-03, *Airworthiness and Flight Characteristics Evaluation of the JOH-58C (OH-58X Surrogate) Helicopter*, Revision 1, October 1985.

5. Operator's Manual, TM 55-1520-235-10, *Army OH-58C Helicopter*, 7 April 1978, with change 35, 17 February 1984.

6. Military Specification, MIL-H-8501A, *Helicopter Flying and Ground Handling qualities; General Requirements for*, 7 September 1961, with amendment 1, 3 April 1962.

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

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

9. Aviation Unit and Intermediate Maintenance Manual, *OH-58A and OH-58C*, TM 55-1520-228-23-1, dated 4 August 1978, with change 39, 1 December 1985.

APPENDIX B. AIRCRAFT DESCRIPTION

GENERAL

1. The test helicopter, JOH-58C US S/N 70-15349, was a standard OH-58C (built by Bell Helicopter Textron, Inc. (BHTI)), modified to the light combat helicopter (LCH) configuration. The standard OH-58C has a single two-bladed, semi-rigid, teetering-type main rotor and a single two-bladed, delta-hinged, semi-rigid, teetering-type tail rotor. A detailed description of the OH-58C is included in the operator's manual (ref 5, app A). The major aircraft modifications for the LCH configuration included the Bell 206L-3 tail rotor with accompanying drive shafting and gearbox, shortened main rotor blades and a three-axis limited authority stability augmentation system (SAS). The JOH-58C LCH configuration also included pods for Direct View Optics (DVO) and a Forward Looking Infrared (FLIR) system, a High Frequency (HF) antenna and improved communication and navigation avionics. Photo 1 shows the test aircraft with external mission equipment. Photos 2 through 4 show the DVO, FLIR and HF antenna. Most of the internally mounted mission equipment was not installed for the test, due to test instrumentation requirements. Portions of the test were accomplished with the DVO, FLIR and HF antenna removed (modified clean configuration). Photo 5 shows the modified clean configuration. A more detailed description of the LCH modifications is contained in the airworthiness release (ref 1).

WEIGHT AND BALANCE

2. The test helicopter was weighed in the LCH and modified clean configurations with and without fuel by the US Army Aviation Engineering Flight Activity personnel prior to any testing. The weight and longitudinal center of gravity (cg) data are presented below:

Configuration	Empty Fuel Weight (lb)/cg (fs)	Full Fuel Weight (lb)/cg (fs)
LCH	2537/113.70	3063/115.00
Modified clean	2438/116.05	2964/116.52

Control Rigging

3. A complete flight control rigging check was performed by SFENA Corporation and witnessed by USAAEFA quality control personnel prior to the initiation of testing. All flight control rigging

Photo 1. JOH-58C Light Combat Helicopter

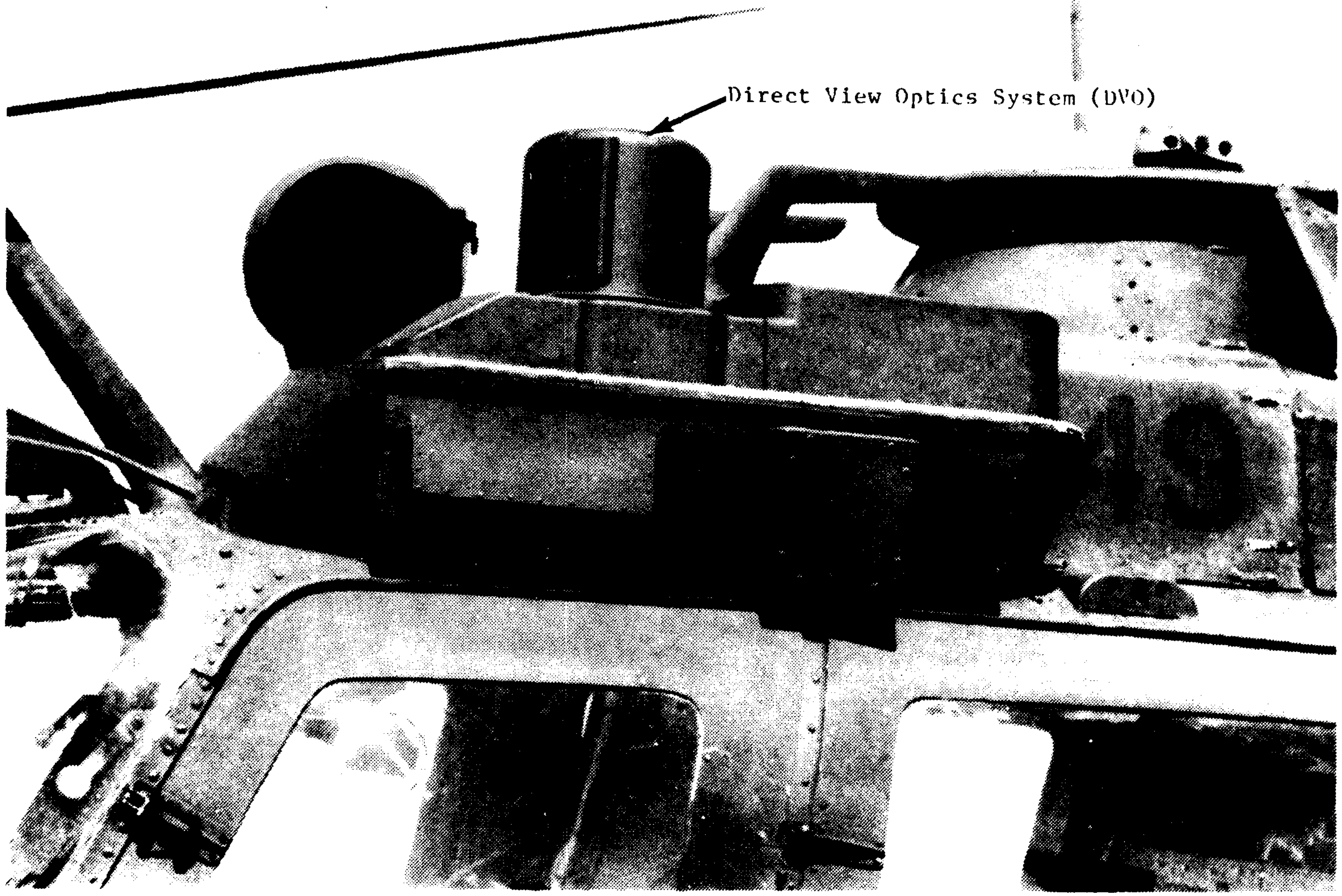


Photo 2. Externally Mounted Direct View Optics (DVO)

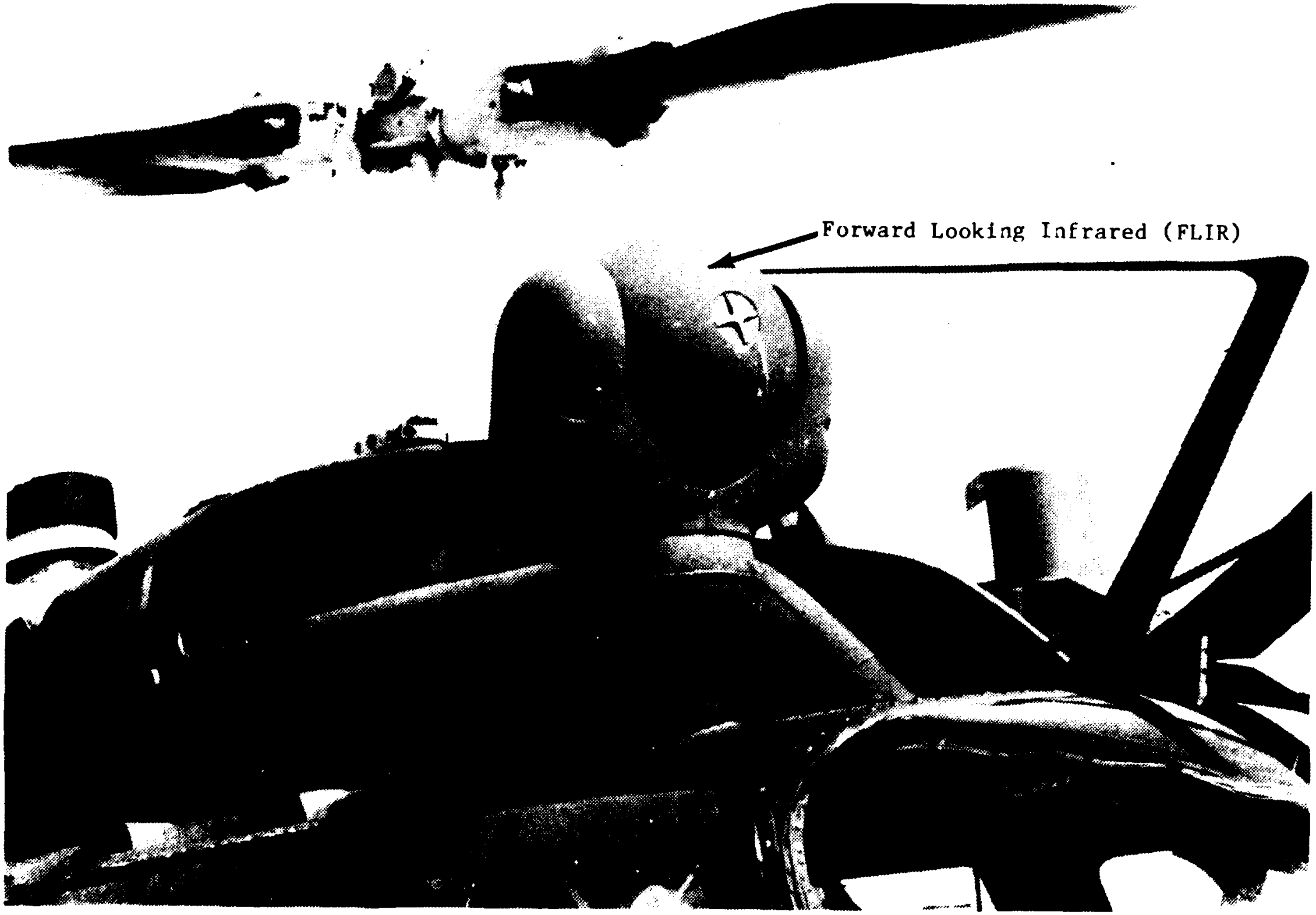


Photo 3. Externally Mounted Forward Looking Infrared (FLIR) System

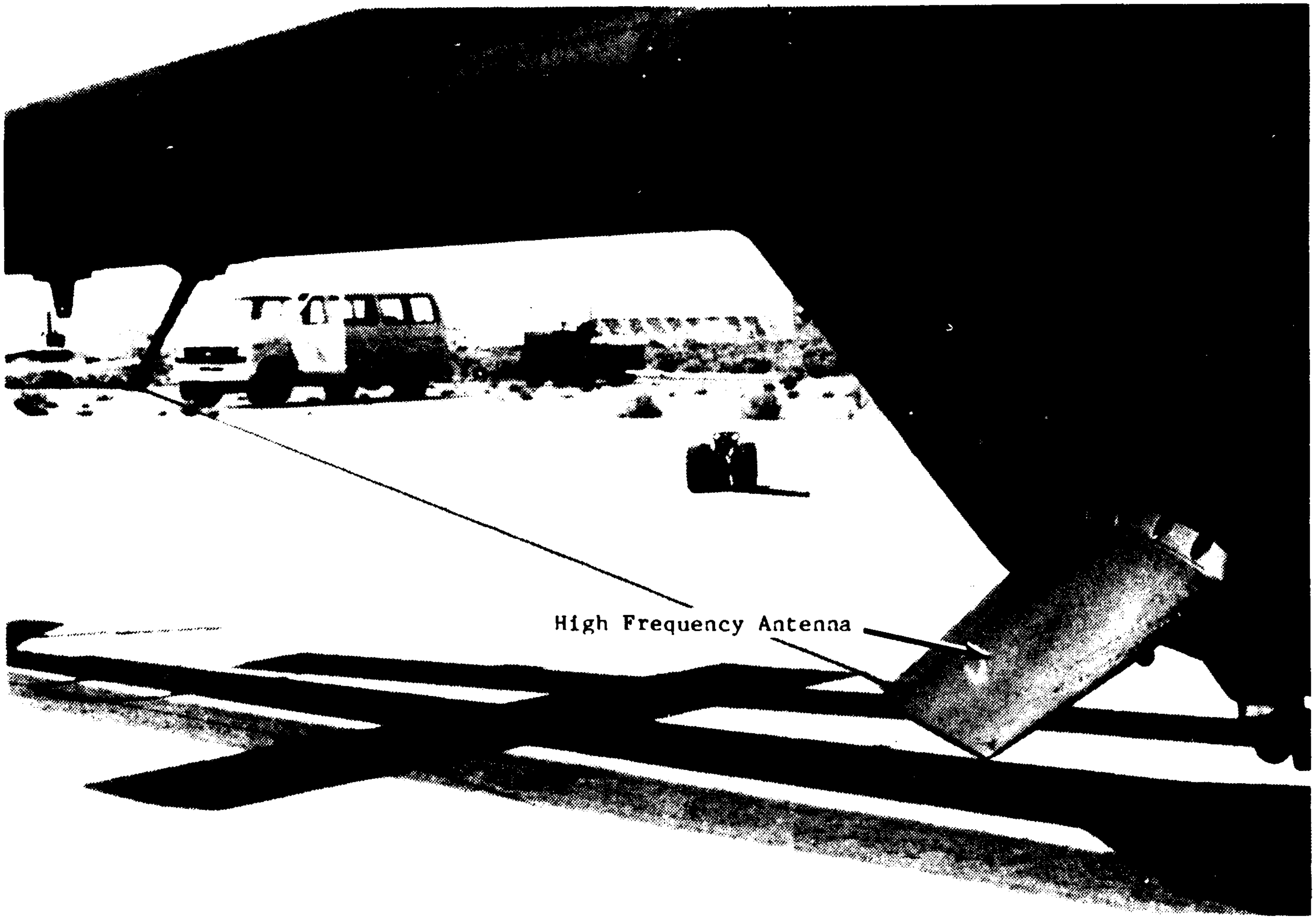


Photo 4. Externally Mounted High Frequency (HF) Antenna

Photo 5. JOH-58C Modified Clean Configuration (DVO, FLIR and HF Antenna Removed)

was within tolerances specified in reference 9, appendix A. The data for the 206L-3 tail rotor rigging check is presented below:

	Direction	Blade Angle
206L-3 tail rotor	Left	22° 30'
	Right	-7° 30'

ROTOR SYSTEM

Tail Rotor

4. The improved tail rotor (BHTI 206L-3 tail rotor) is depicted in photo 6. It incorporates the same airfoil section as the standard OH-58C tail rotor but the diameter is increased by 3 inches. Maximum pitch angle values are increased to the values shown in paragraph 3.

5. SAS optimization was conducted by SFENA Corporation. Various SAS gains and two actuator systems (electrical/mechanical and electrical/hydraulic) were evaluated. The electrical/hydraulic system (hydraulically-boosted tail rotor) was selected by SFENA and installed for this test.

Tail Rotor Drive Shaft and Gearbox

6. The tail rotor drive shafting and gearbox were changed to the 206L-3 configuration. The drive shaft is a seven piece shaft. Each piece in the shaft is identical and has a larger diameter than the one-piece standard drive shaft. The tail rotor gearbox continuous rating is increased from 65 to 85 shaft horsepower.

Main Rotor

7. In order to maintain main rotor clearance, each main rotor tip cap was shortened by 1.5 inches.

STABILITY AUGMENTATION SYSTEM

General

8. The JOH-58C had a limited-authority, prototype three-axis SAS. The SAS uses rate gyros to provide rate damping in each axis. Rate integration was used to provide attitude retention capability. Force trim is provided in the pitch and roll axes. An altitude hold (ALT HOLD) feature, functioning through the

Photo 6. JOH-58C Tail Rotor (BHTI 206L-3)

longitudinal control, is also provided in cruise flight. The system includes the following components:

SAS Component	Part No.	Qty	Location
SAS Computer	75258V1M2	3	Passenger compartment
Cyclic rod/actuator		2	Center control closet
Assy	10110-001		
Directional rod/			
actuator assy	10110-001	1	Entrance to tail boom
Air data computer	10980-002	1	Passenger compartment
Junction Box	153-51219-300	1	Passenger compartment
Yaw Stop Assy	11530	1	Entrance to tail boom
Force trim unit		2	Under pilot/copilot
Pitch	L1088BM		seat
Roll	L1088DM		
SAS control panel	K28AJM	1	Instrument panel
Pre-Fabricated Harness		1	Passenger compartment
Cyclic	11362		
Yaw	11368		
50 VA Inverter	PC 50	1	Under pilot's seat
Hydraulic/boosted		1	Entrance to tail boom
T/R/Assy	206-001-739-7		
Actuator Position			
Indicator	K60ACM	1	Instrument panel

The preceding components are interconnected as shown by the block diagram of figure 1.

SAS Computer

9. A SAS computer for each axis incorporates logic and gain networks to provide rate damping, altitude hold (pitch axis), integration cutoff and attitude retention via rate integration. A rate gyro in each computer senses changes of angular rate of 0.01 deg/sec.

Control Panel

10. The SAS control panel is shown in photo 7. The panel includes a STAB button (SAS ON/OFF), a button to engage altitude hold, switches to engage or disengage each SAS actuator and a system test switch. SAS actuator positions are indicated on three galvanometers, one for each axis.

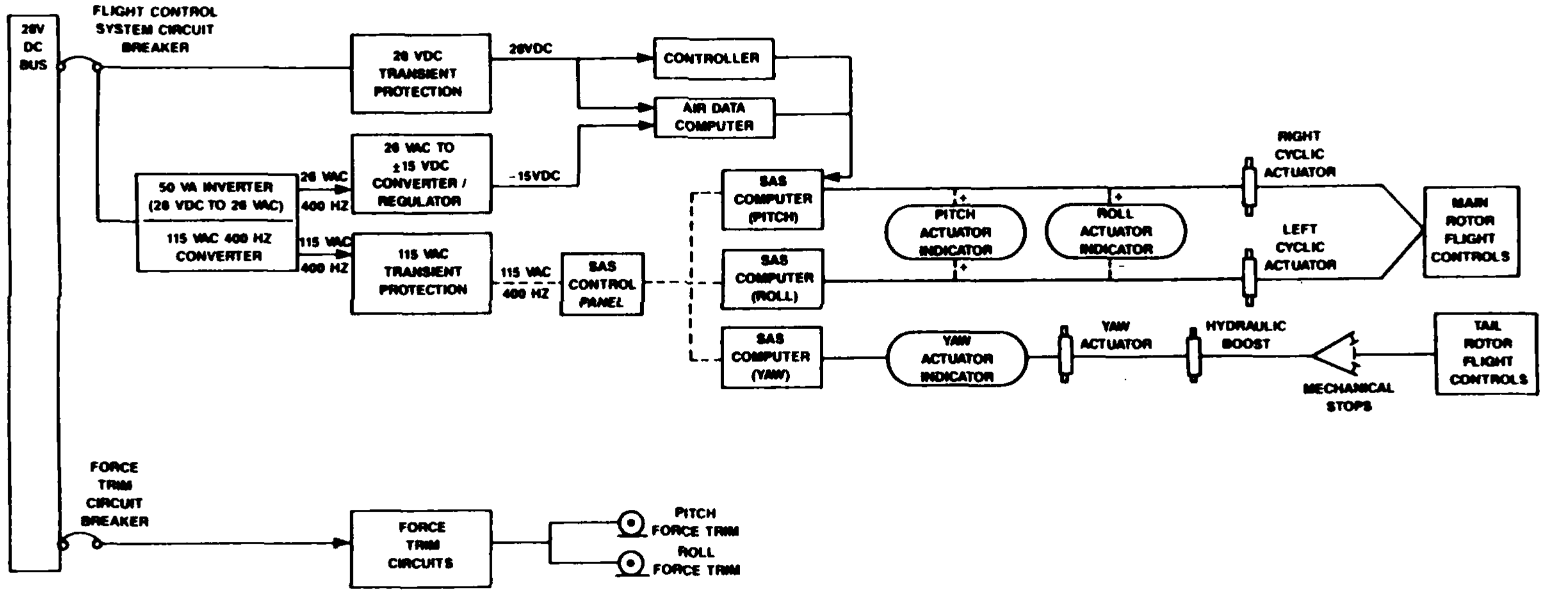


Figure 1. Stability Augmentation System Block Diagram

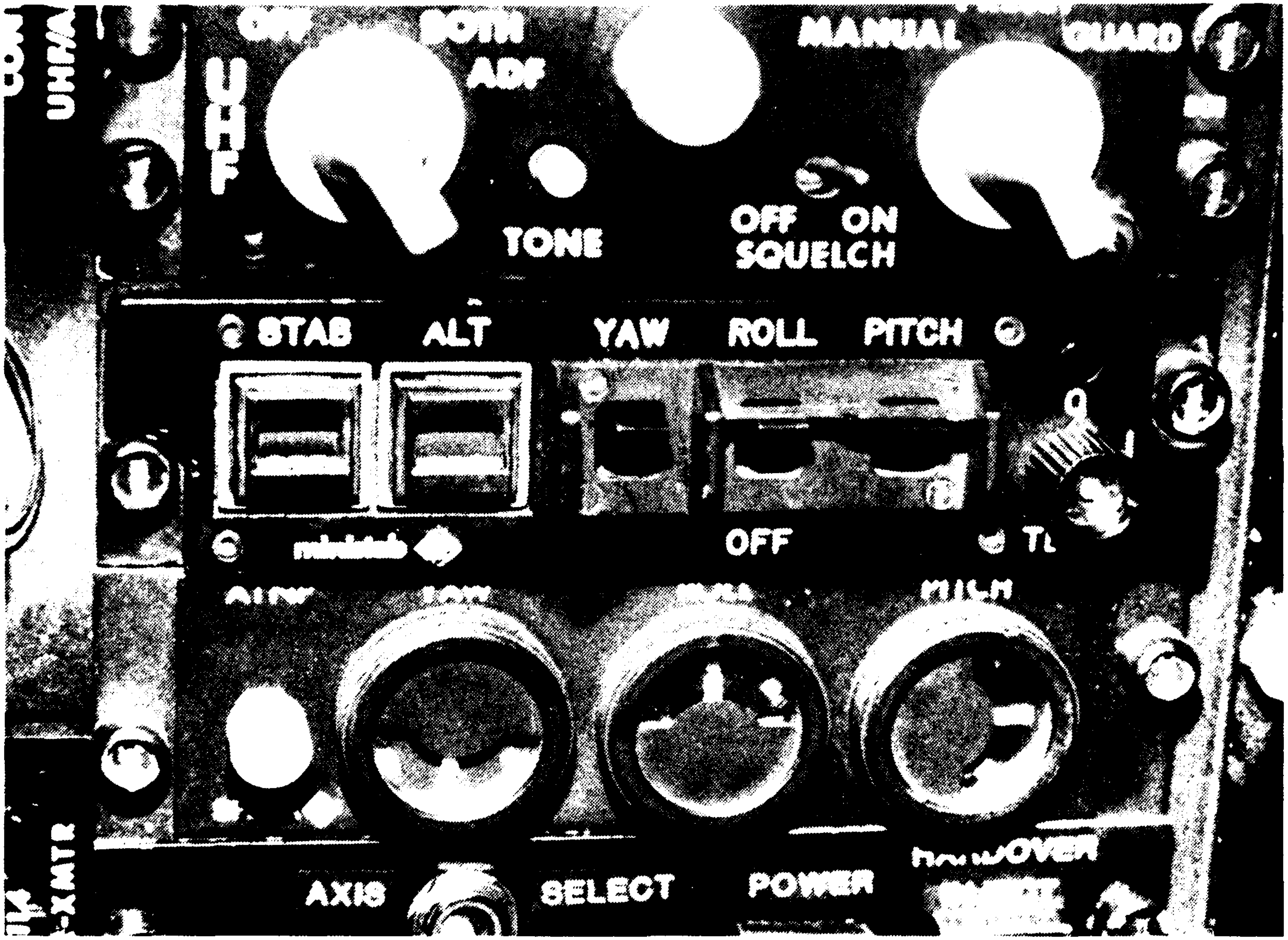


Photo 7. Stability Augmentation System Control Panel

Electrical Power Distribution

11. The SAS power distribution is shown in figure 1. The system requires 28V DC, 26V AC and 115V AC single phase electrical power. The 115V AC, 400 Hz, single phase power, provided by the upgraded solid state inverter, is for the rate gyro motor and for the computer internal power supplies. The rate gyro output signal is demodulated and applied to a servo amplifier which drives the rate and integrated rate (damping and attitude retention) channels. Both paths are switched OFF when the system is off, resulting in a zero signal to the servo amplifier and centering of the actuator. The actuators are mounted in control tubes and contain DC permanent magnet motors driven by a pulse-width modulating type of servo-amplifier. The ±27V motor drive voltages and the ±15V feedback pot excitation voltages are derived in the computer power supply.

Actuators

12. The SAS uses three actuators mounted in series with the control tubes. The actuators have low force output and are used in conjunction with hydraulically-boosted controls. They are installed as close as possible to the input valves of the hydraulic boosters to isolate the actuator motion from the pilot controls. The mass and friction on the booster side of the actuators is low compared to the pilot's side of the actuators. Cyclic artificial feel break-out force aids in this isolation. In cyclic, the actuators are installed downstream of the mechanical collective and cyclic mixing and the two cyclic actuators have a mixed motion of lateral and longitudinal control. This mixing is accomplished electronically by applying the roll computer output differentially to the left and right actuators while the pitch computer output is applied additively to the two actuators. The SAS actuator strokes are limited to give the following SAS authorities of full control travel:

Axis	Authority
pitch	±6.43%
roll	±10.67%
yaw	±6.79%

SAS Release Switch

13. A SAS release switch is located on the pilot cyclic grip as shown in figure 2. If the switch is depressed, all axes of SAS will disengage.

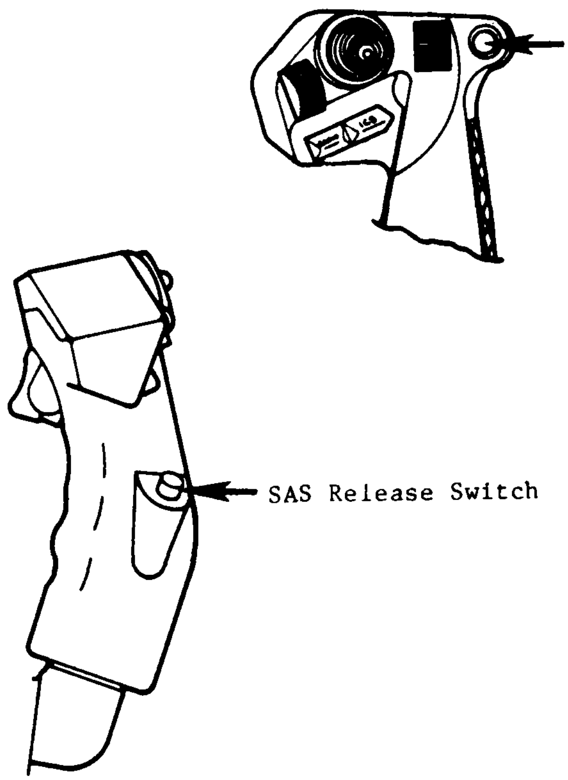


Figure 2. Cyclic Controls

Force Trim System

14. The force trim system includes a force trim switch located on the instrument panel and a force trim interrupt switch located on the pilot's and copilot's cyclic (fig. 2). There is no force trim system in the directional axis. The functions include stick trim point retention, artificial feel gradient for stick movements away from trim, and viscous damping of stick inputs. Transparency ("fly through") logic interfaces with the SAS attitude retention channels.

Flight Control System Caution Light

15. A flight control system (FCS) caution light is provided in the segmented caution panel (fig. 3). When the FCS is disengaged, the series actuators automatically center and the FCS caution light illuminates. The FCS light does not illuminate, however, if a SAS failure should occur.

Altitude Hold Function

16. An altitude hold function is installed in the SAS. The altitude error signal is derived in the Air Data Computer (ADC) from an electromechanical absolute pressure transducer and an associated electronics synchronizing hold circuit. The error signal is applied to additional circuitry in the controller, resulting in longitudinal control inputs in response to altitude errors. The altitude hold function is designed to maintain altitude within ± 50 feet in light or no turbulence. The system is engaged when the "ALT" switch is turned on with the aircraft above 40 knots airspeed.

Integration Cut Off

17. To enable the pilot to maneuver the aircraft, it is necessary to inhibit the attitude retention feature, which may try to oppose pilot inputs. This is done by driving the integrated rate input term to zero as the pilot commences his movement of the flight controls. The rate term is retained, however, and continues to damp out rapid oscillations over and above the pilot's control movements. Cancelling the integrated rate term is called integration cut off (ICO). ICO occurs intentionally under the following conditions.

a. When "altitude hold" mode is engaged (ICO only in the pitch axis).

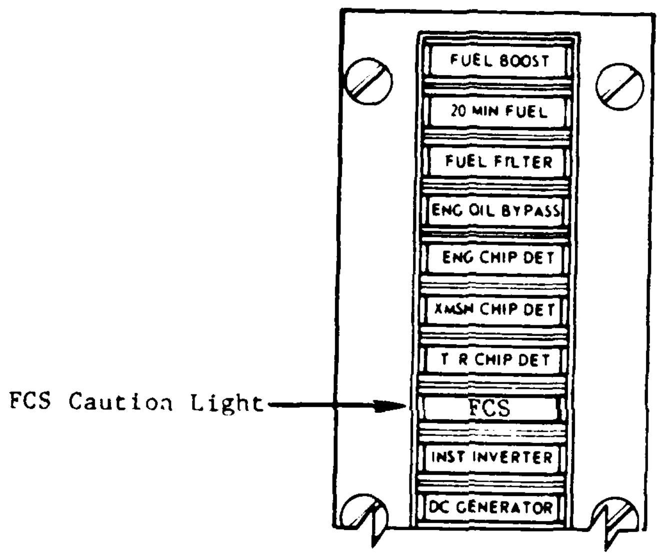


Figure 3. FCS Caution Light

b. When the pilot moves the flight controls, without operating the force trim button on the cyclic grip (the axes affected are the ones in which the control movement is made).

c. When the pilot depresses the force trim button on the cyclic grip.

d. When the force trim is disengaged at the instrument panel.

e. When angular rates exceed 1.5 deg/sec, ICO will occur only in the affected axis.

SYSTEM OPERATION

General

18. SAS operation is accomplished using the SAS control panel and actuator position indicators shown in photo 7.

Self-Test

19. Prior to flight, a system self-test may be performed. Individual axis engagement switches should be up. With the SAS OFF, the TEST knob is turned clockwise to the position labeled "1". The STAB indicator will show green and white diagonal stripes, the ALT indictor will show red and white diagonal stripes. The FCS caution light will illuminate and the three actuator position indicators will be centered. Position "1" tests only the system indicators. When the TEST knob is turned further clockwise to "2", the STAB and ALT indicators are initially black. Position "2" tests the system amplifiers and input/output logic. When the STAB indicator is depressed, the green and white stripes reappear. Depressing the ALT indicator results in a display of red and white stripes alternating with the blacked-out indication for approximately 10 seconds. The ALT indicator then becomes a steady display of green and white diagonal stripes. The FCS caution light remains illuminated and the actuator position indicators remain centered. When the test knob is rotated counter-clockwise to the "0" position, the STAB indicator remains green, the ALT indicator becomes black and the FCS caution light extinguishes. The SAS is then operational for flight.

Normal Operation

20. The SAS operates normally when the STAB indicator is depressed and individual actuator engagement switches are up. Green and

white diagonal stripes appear in the STAB indicator, indicating that power is applied to the system and rate damping is in effect. Attitude retention will be in effect in all axes unless one of the following conditions occurs:

a. If the force trim switch on the console is turned off, there will be no attitude retention in any axis. Turning it on will regain all attitude retention.

b. If either cyclic force trim interrupt switch is depressed, there will be no attitude retention in the pitch and roll axes. Yaw attitude retention will not be affected.

c. If the pedals are moved, a control motion sensor detects the movement and eliminates yaw attitude retention. Pitch and roll attitude retention will not be affected.

d. If airspeed is above 40 knots indicated airspeed (KIAS), lateral cyclic is displaced and roll rate is above 1.5 deg/sec, there will be no attitude retention in any axis.

e. If airspeed is above 40 KIAS, roll rate is above 1.5 deg/sec and the lateral cyclic is not displaced, there will be no pitch or yaw attitude retention.

f. If ALT HOLD is engaged and the aircraft is beyond 100 feet of the selected altitude, there will be no pitch attitude retention.

Altitude Hold

21. The altitude hold feature is engaged by depressing the ALT indicator. Green and white diagonal stripes should appear in the indicator. The ALT HOLD can be engaged in climbs and descents as well as in level flight or turns as long as airspeed is above 40 KIAS. Altitude is maintained through variation of pitch attitude. It disengages automatically when altitude is more than 100 feet from the selected altitude. The ALT HOLD is disengaged by depressing the ALT HOLD indicator. Disengaging ALT HOLD causes the MASTER CAUTION and FCS caution light to illuminate for 10 to 12 sec.

FCS Light

22. The FCS caution light and master caution light illuminate momentarily when the SAS is disengaged. Both also momentarily illuminate when the ALT HOLD is engaged and the aircraft is more than 100 feet from the selected altitude. The FCS light does not illuminate when the SAS fails.

SAS Shutdown

23. The SAS is disengaged by depressing the STAB indicator. The SAS can also be disengaged by depressing the SAS release switch on the pilot's cyclic (fig. 2). Disengagement does not remove power from system gyroscopes.

Degraded Flight

24. With a hardover in any actuator, the SAS will continue to provide rate damping and attitude retention in the other axes. If the yaw actuator has a hardover, pitch and roll will respond normally. If the left or right cyclic actuator has a hardover, yaw will respond normally, but pitch and roll will be slightly degraded due to system control mixing. Individual actuators can be disengaged using the individual actuator engagement switches. Yaw is disengaged with the yaw actuator engagement switch. The pitch and roll actuator engagement switches disengage the right and left cyclic actuator indicators.

APPENDIX C. INSTRUMENTATION

1. The test instrumentation system was designed, calibrated, installed, and maintained by the US Army Aviation Engineering Flight Activity. Digital and analog data were obtained from calibrated instrumentation and were recorded on magnetic tape and/or displayed in the cockpit. The instrumentation system consisted of various transducers, signal conditioning units, a ten-bit pulse code modulation encoder, and an Ampex AR 700 tape recorder. Time correlation was accomplished with an onboardrecorded and -displayed Inter-Range Instrumentation Group B format time of day. Various specialized test indicators displayed data to the pilot and engineer continuously during the flight. A boom with the following sensors was mounted on the nose of the aircraft: swiveling pitot-static head, sideslip vane and angle-of-attack vane. Photos 1 through 4 show the instrumentation installation. The boom airspeed system calibration is shown in figures 1 through 3.

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

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

3. The following parameters were recorded on magnetic tape:

Time code
Run number
Fuel used
Airspeed (boom)
Altitude (boom)
Airspeed (ship)
Altitude (ship)
Main rotor speed
Outside air temperature
Angle of sideslip
Angle of attack

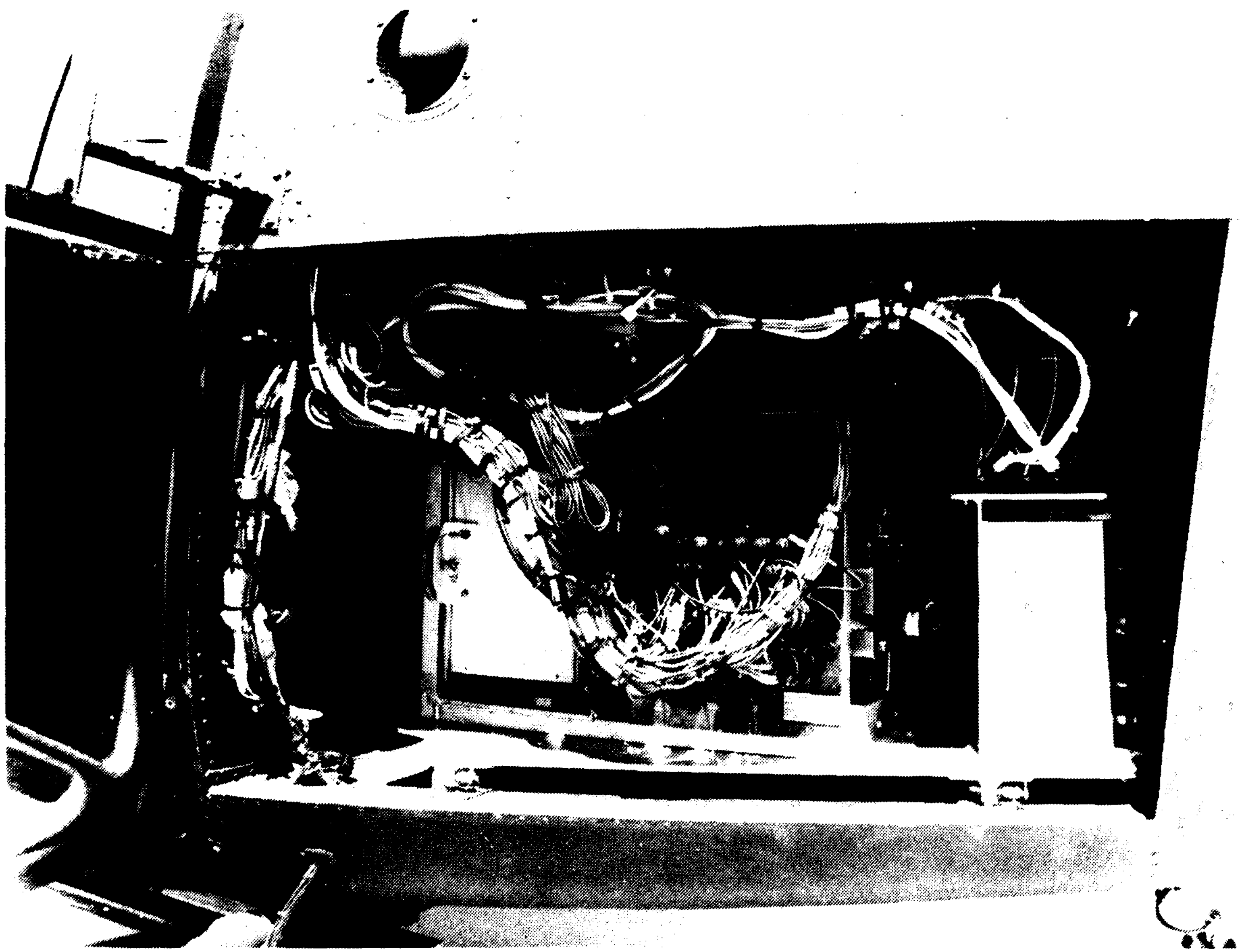


Photo 1. Rapid Acquisition Package System (RAPS) Installed in Avionics Compartment

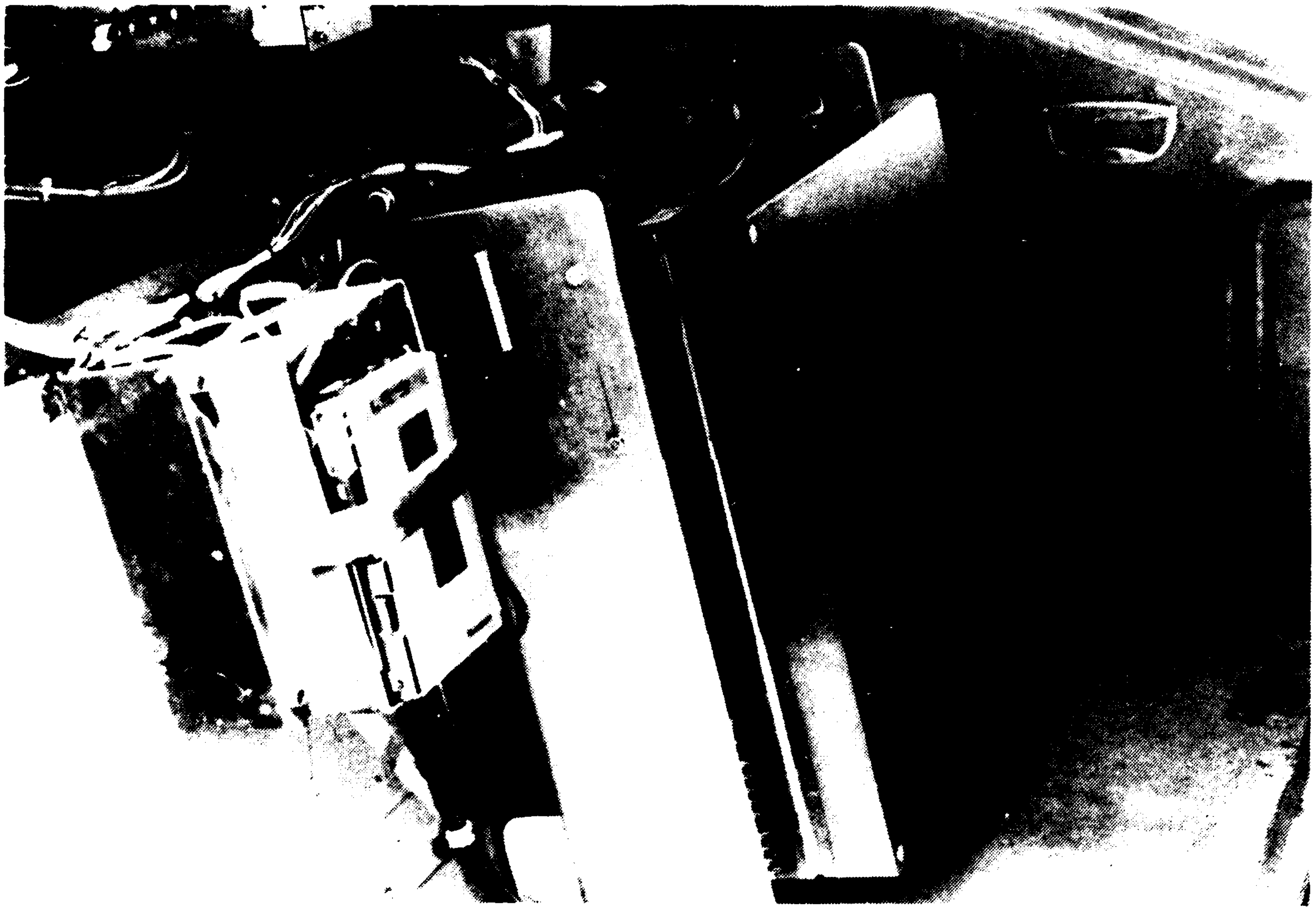


Photo 2. Voice and Pulse Code Modulation Recorders Installed in Passenger Compartment

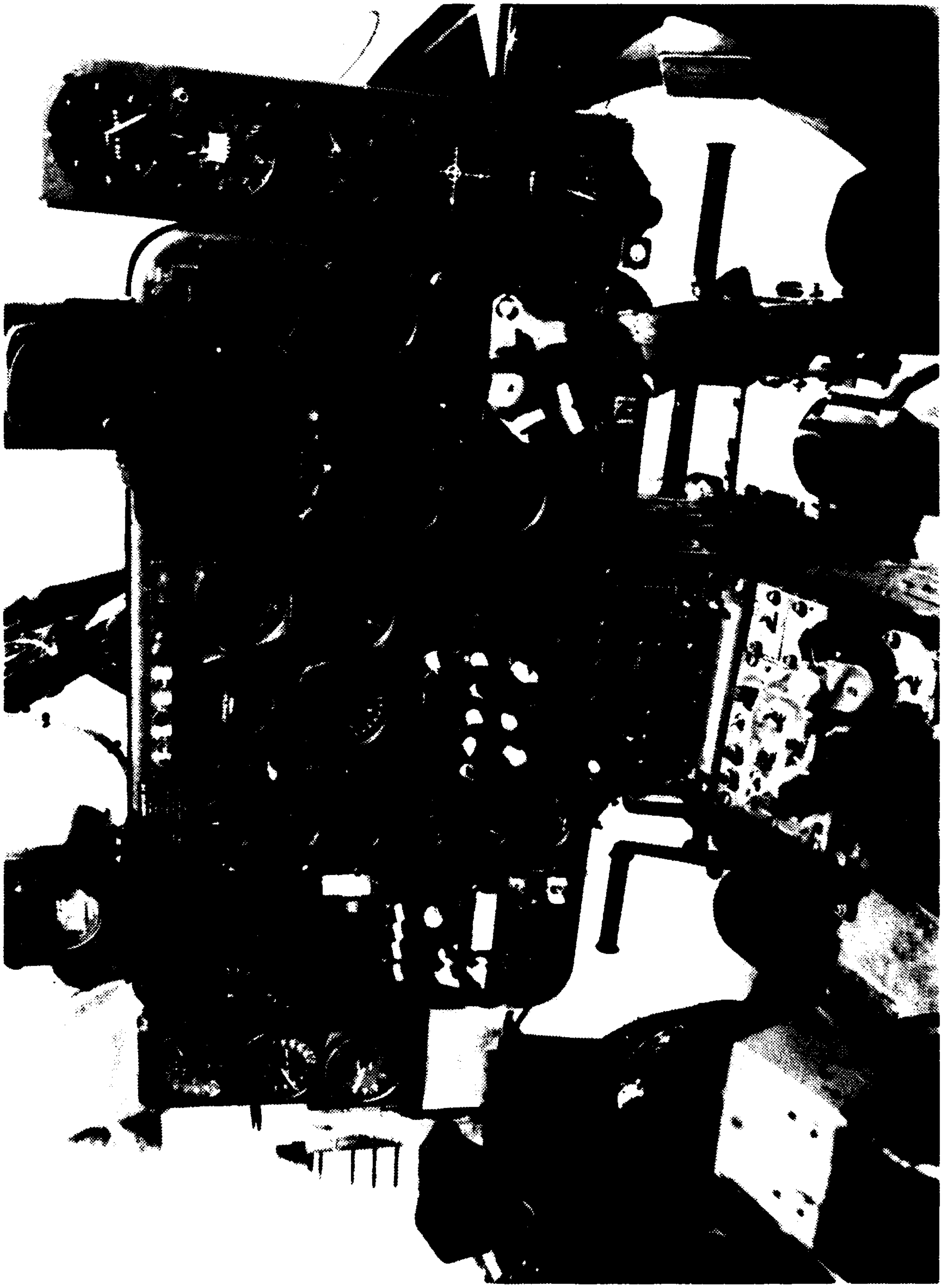


Photo 3. Cockpit Instrumentation

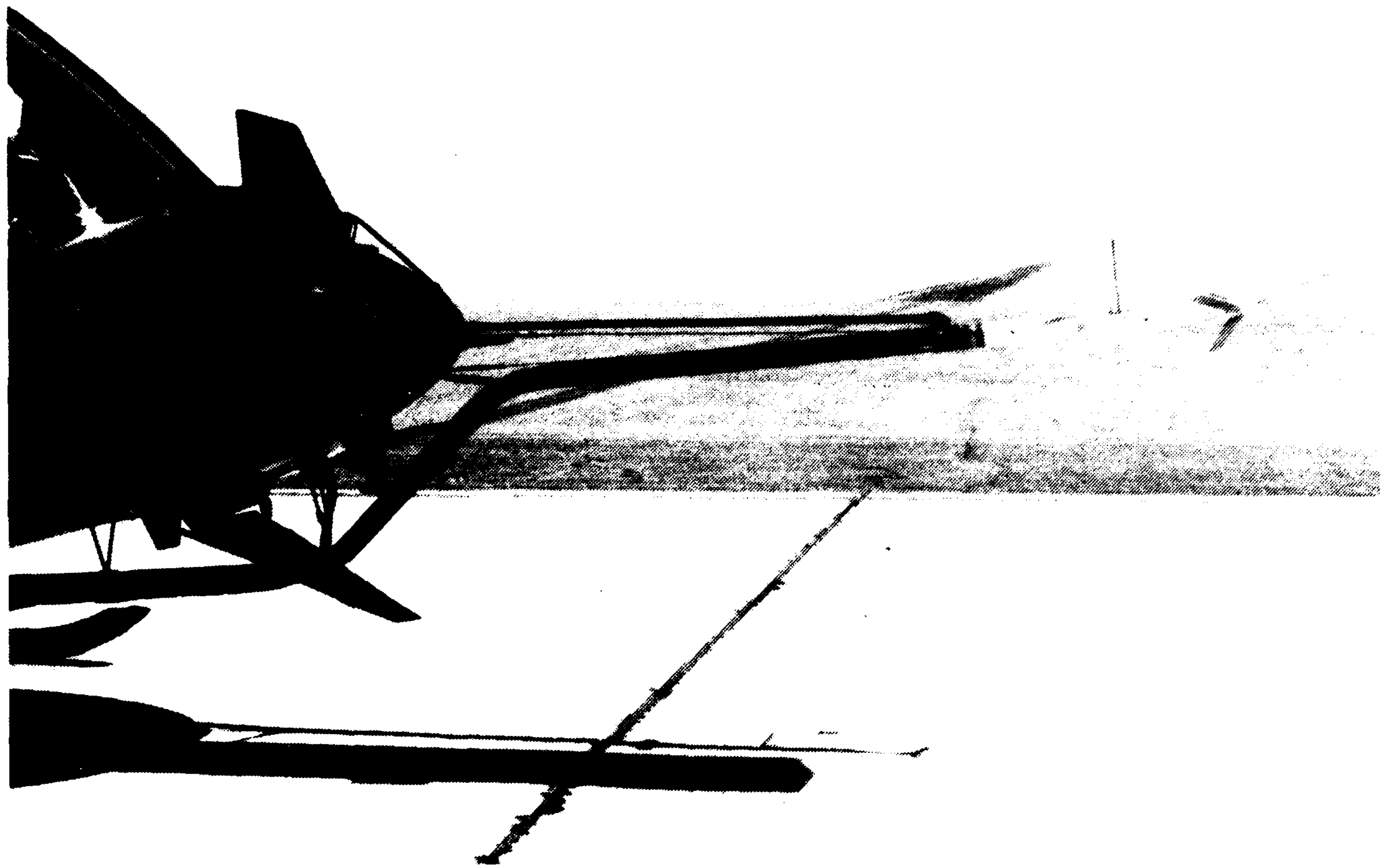


Photo 4. Airspeed Boom (Attached to Underside of Aircraft)

FIGURE 1
AIRSPEED CALIBRATION
JOH-58C USA S/N 70-15340
BOOM SYSTEM POSITION ERROR

AVG GROSS WEIGHT (LBS)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVERAGE ROTOR SPEED (RPM)	FLIGHT CONDITION
3086	108.5(FWD)	6100	20.0	354	LEVEL

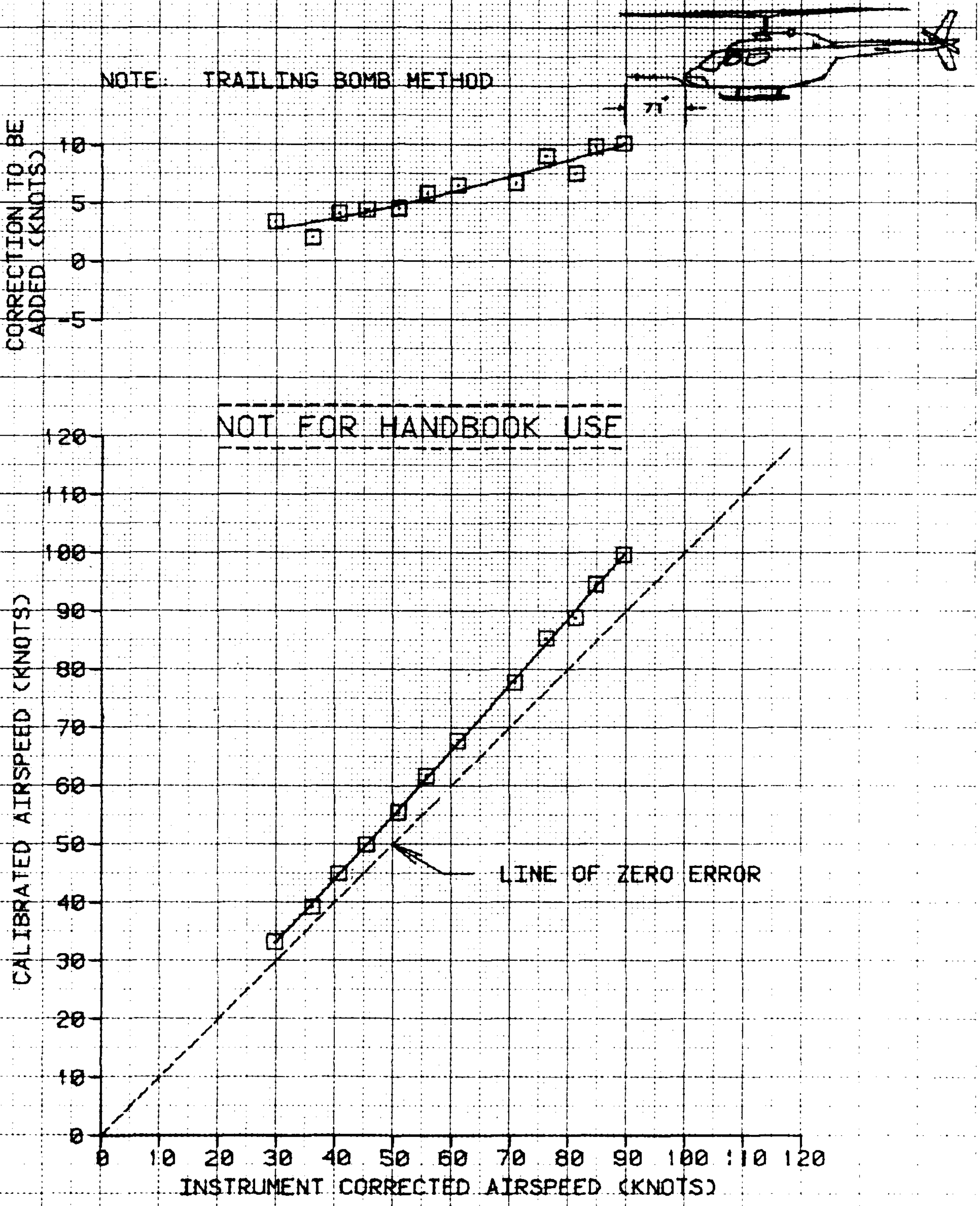


FIGURE 2
AIRSPEED CALIBRATION
JOH-58C USA S/N 70-15349
BOOM SYSTEM POSITION ERROR

AVG GROSS WEIGHT (LBS)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVERAGE ROTOR SPEED (RPM)	FLIGHT CONDITION
3080	108.7(FWD)	8600	20.0	354	IRP CLIMB

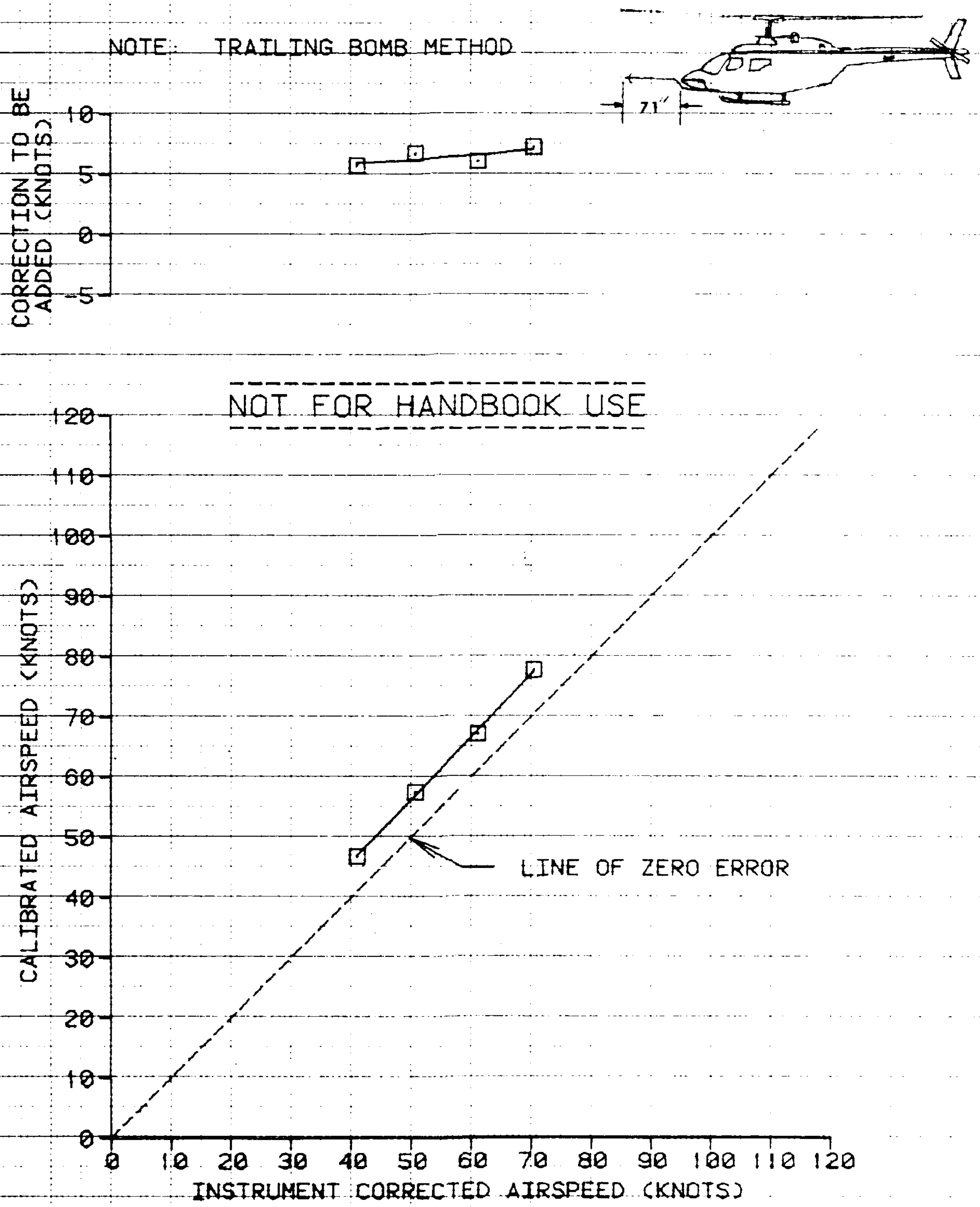
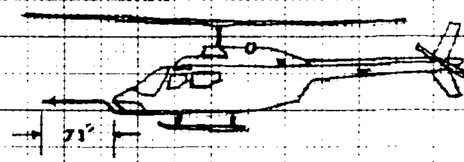
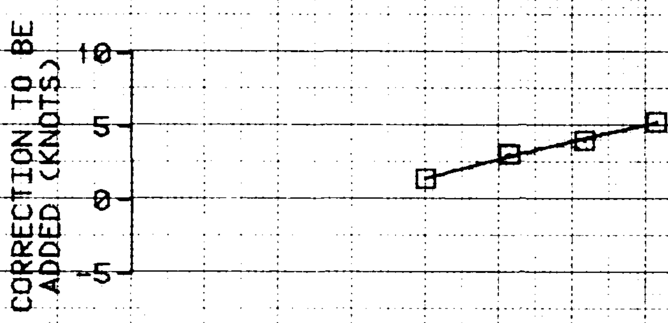


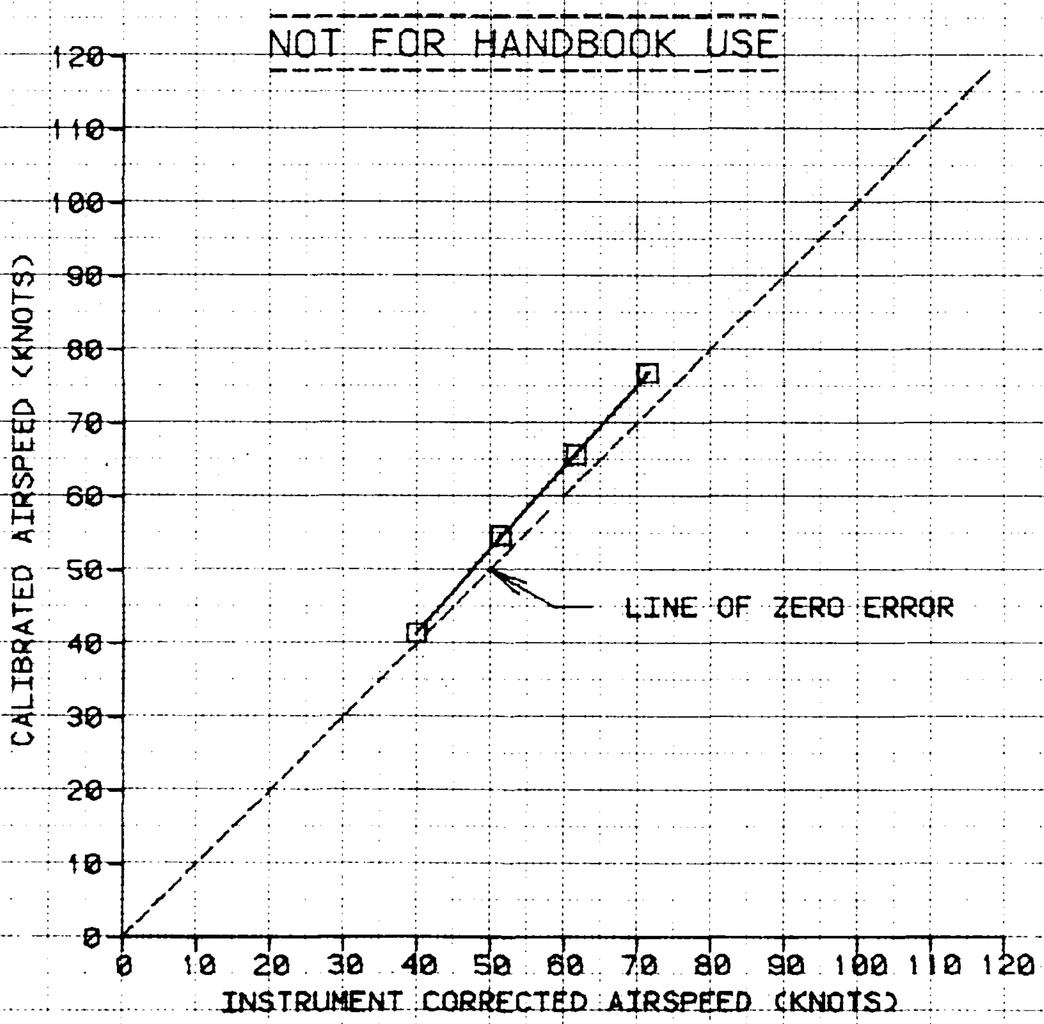
FIGURE 3
AIRSPEED CALIBRATION
JOH-58C USA S/N 70-15349
BOOM SYSTEM POSITION ERROR

AVG GROSS WEIGHT (LBS)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVERAGE ROTOR SPEED (RPM)	FLIGHT CONDITION
3050	108.7(FWD)	6500	20.0	355	AUTOROTATION

NOTE: TRAILING BOMB METHOD







Engine torque
Turbine outlet temperature
Gas producer speed
Power turbine output shaft speed
Fuel flow rate
Control positions
- Longitudinal
- Lateral
- Directional
- Collective

Aircraft attitudes and rates
- Pitch
- Roll
- Yaw

Aircraft vertical center of gravity acceleration
SAS actuator positions
- Left hand cyclic
- Right hand cyclic
- Directional

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

HANDLING QUALITIES

Test Techniques

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

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

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

AIRSPEED CALIBRATION

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

$$V_{cal} = V_i + \Delta V_{ic} + \Delta V_{pc} \qquad (1)$$

Weight and Balance

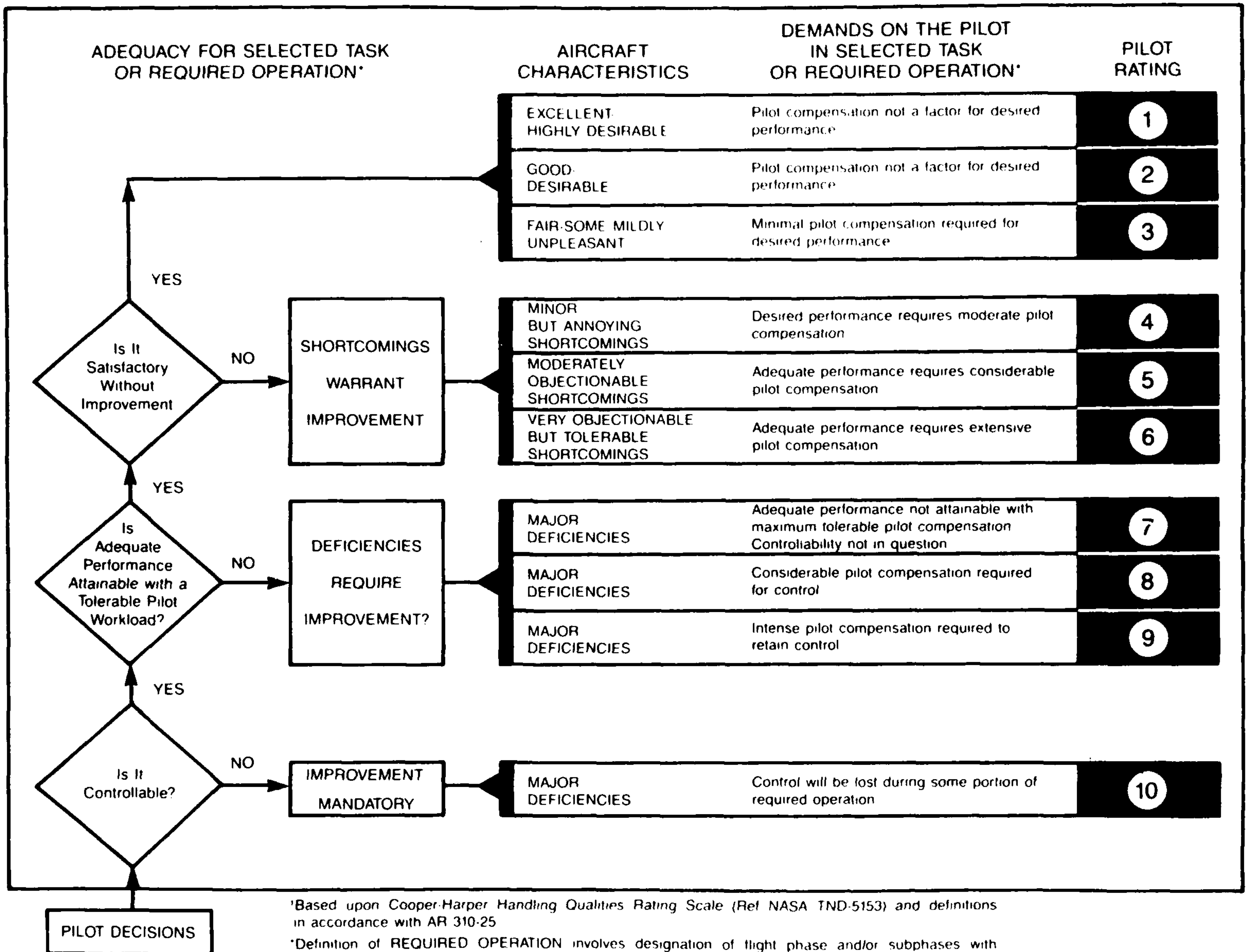
3. Prior to testing, the aircraft gross weight and center of gravity (cg) location were determined using calibrated scales. The aircraft was weighed with full instrumentation on board and without fuel. The aircraft weight was 2537 pounds with a longitudinal cg location at fuselage station 113.70. After removal of the Forward-Looking Infrared System, Direct View Optics and High Frequency Antenna, the aircraft was reweighed and the weight was 2438 pounds with a longitudinal cg at fuselage station 116.05.

HANDLING QUALITIES RATING SCALE

4. The Handling Qualities Rating Scale presented in figure 1 was used to augment pilot comments relative to handling qualities and workload.

VIBRATION RATING SCALE

5. The Vibration Rating Scale presented in figure 2 was used to augment pilot comments relative to vibrations.



*Based upon Cooper-Harper Handling Qualities Rating Scale (Ref NASA TND-5153) and definitions in accordance with AR 310-25

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

Figure 1. Handling Qualities Rating Scale

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

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

Figure 2. Vibration Rating Scale

APPENDIX E. TEST DATA

INDEX

FIGURE 1
LIMITS OF CYCLIC CONTROL TRAVEL
JOH-58C USA S/N 70-15349

NOTES: 1. ROTORS STATIC
2. CONTROL POSITION MEASURED AT CENTER OF GRIP
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS
4. COLLECTIVE CONTROL FULL DOWN

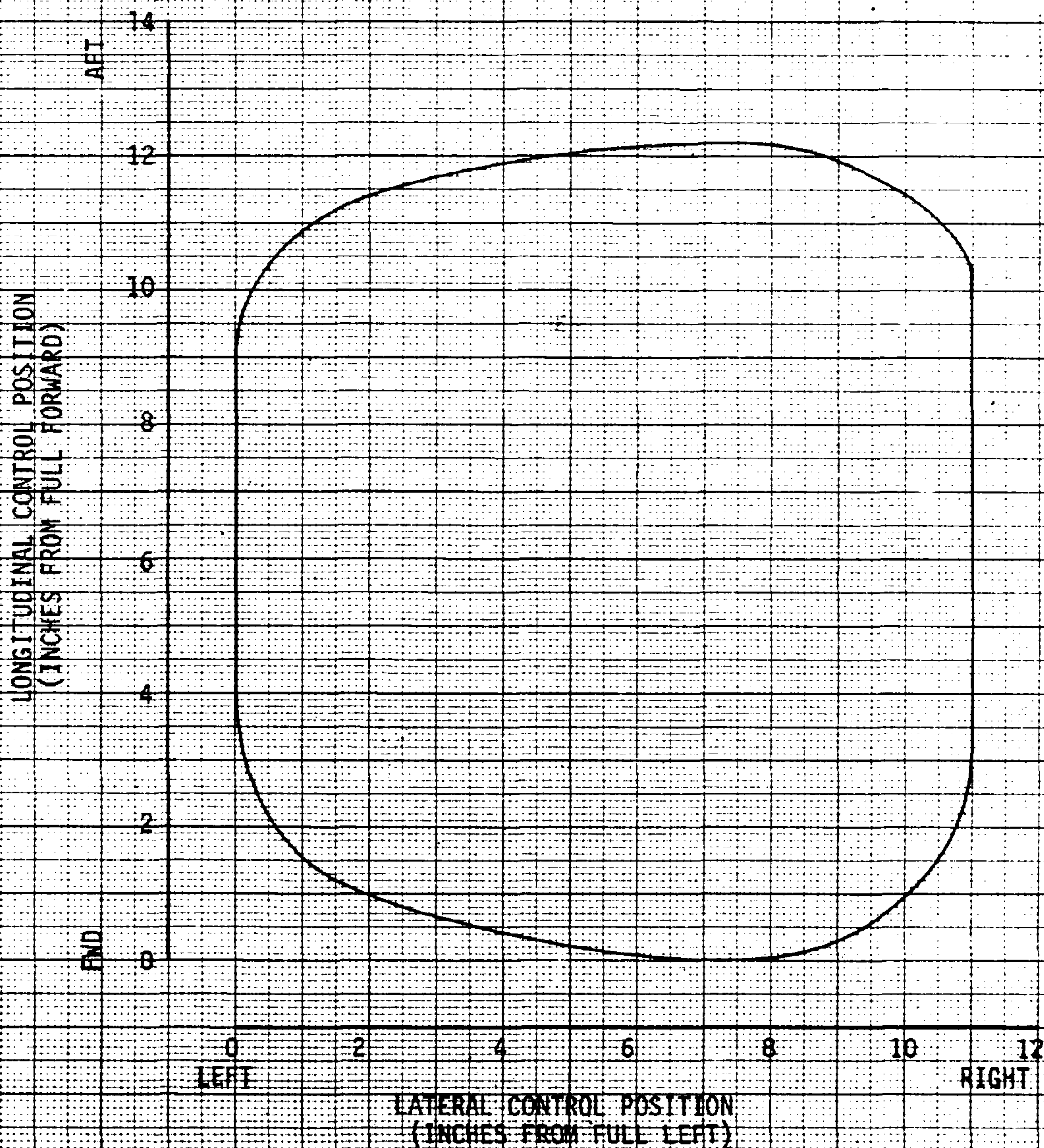


FIGURE 2
LONGITUDINAL CONTROL SYSTEM CHARACTERISTICS
JOH-58C USA S/N 70-15349

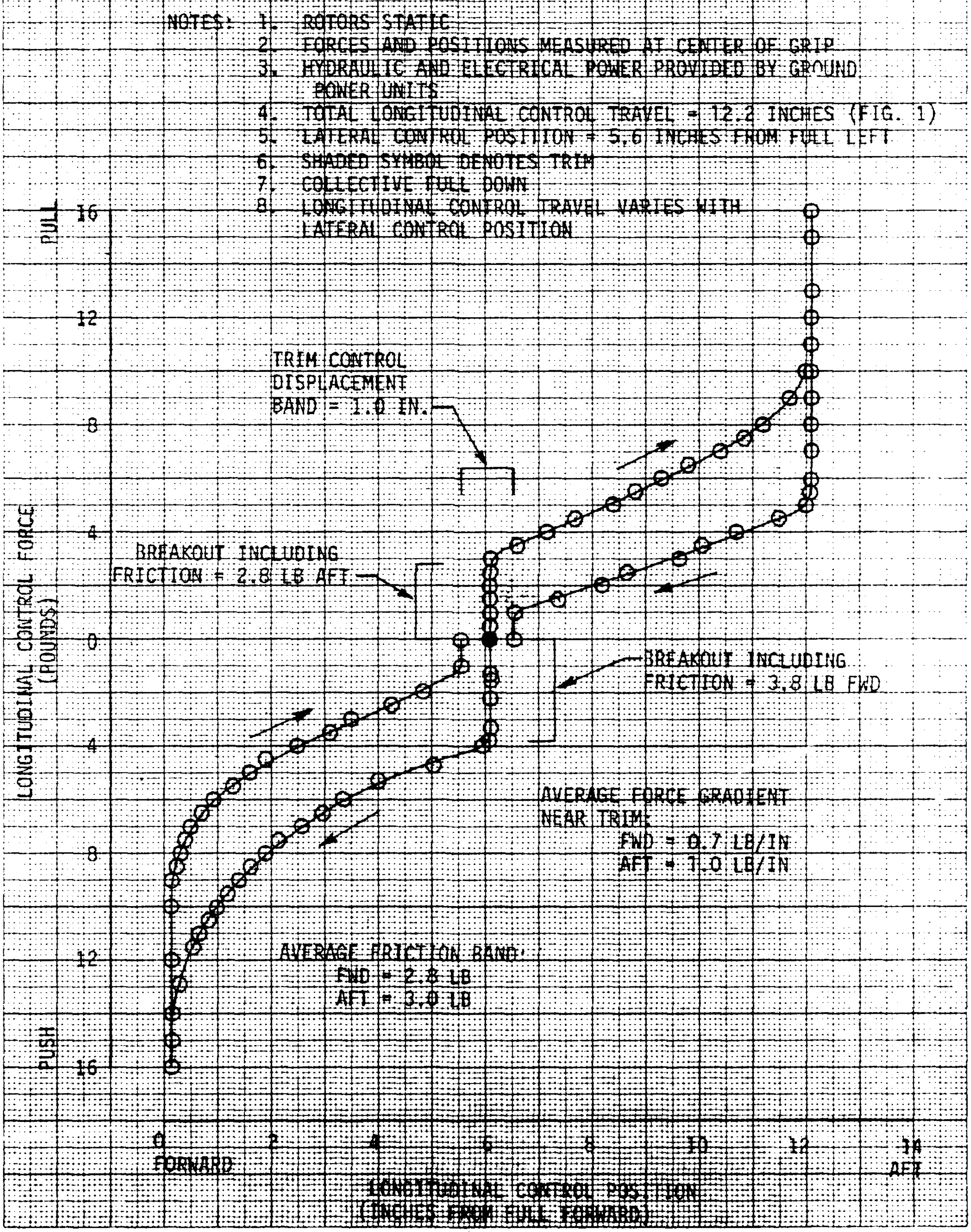


FIGURE 3
LATERAL CONTROL SYSTEM CHARACTERISTICS
JOH-58C USA S/N 70-15349

NOTES:
1. ROTORS STATIC
2. FORCES AND POSITIONS MEASURED AT CENTER OF GRIP
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS
4. TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
5. LONGITUDINAL CONTROL POSITION = 6.1 INCHES FROM FULL FORWARD
6. SHADED SYMBOL DENOTES TRIM

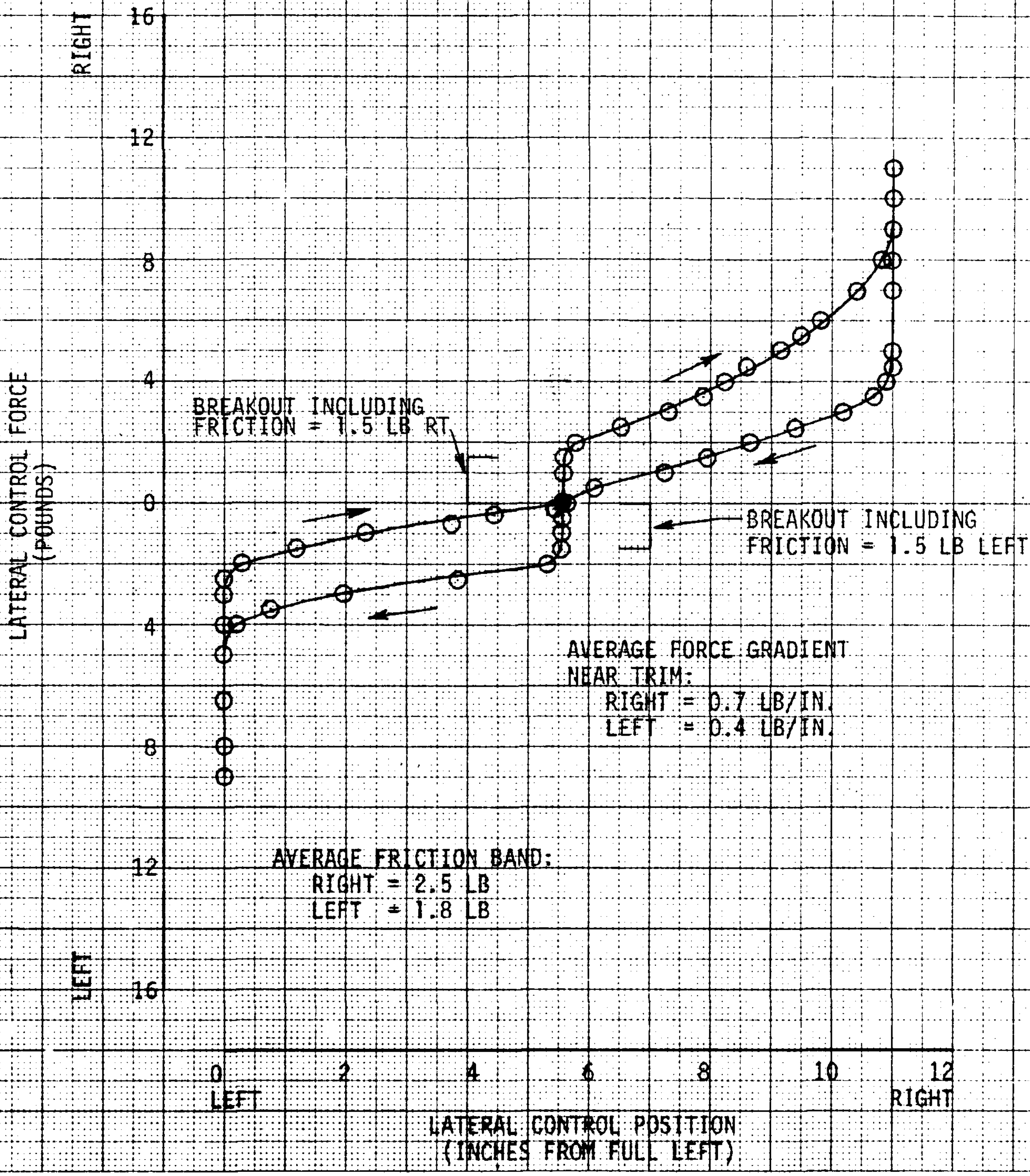


FIGURE 4
DIRECTIONAL CONTROL SYSTEM CHARACTERISTICS
JOH-58C USA S/N 70-15349

NOTES:
1. ROTORS STATIC
2. FORCES MEASURED AT THE DIRECTIONAL CONTROL
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS
4. TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
5. SHADED SYMBOL DENOTES TRIM

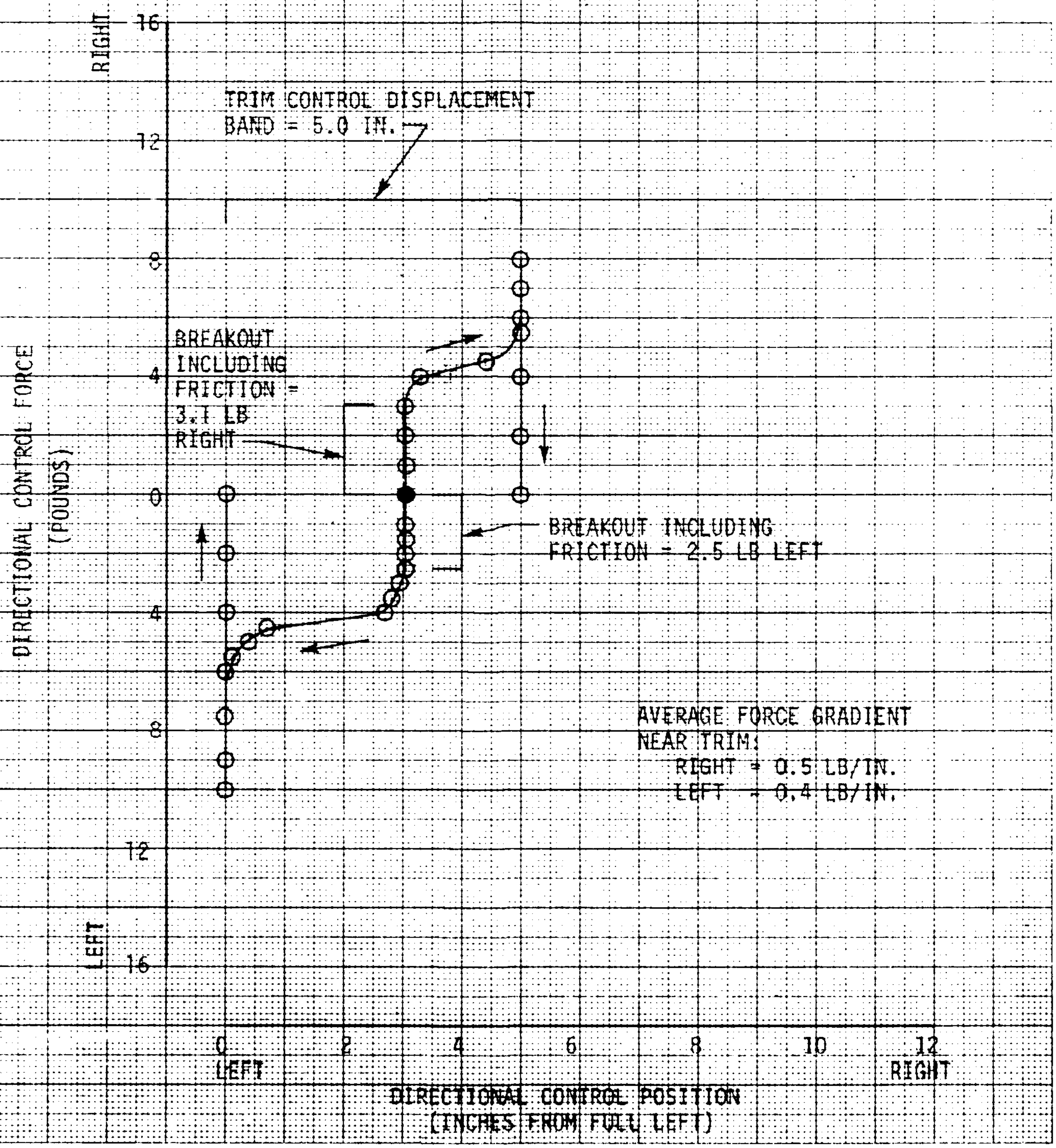
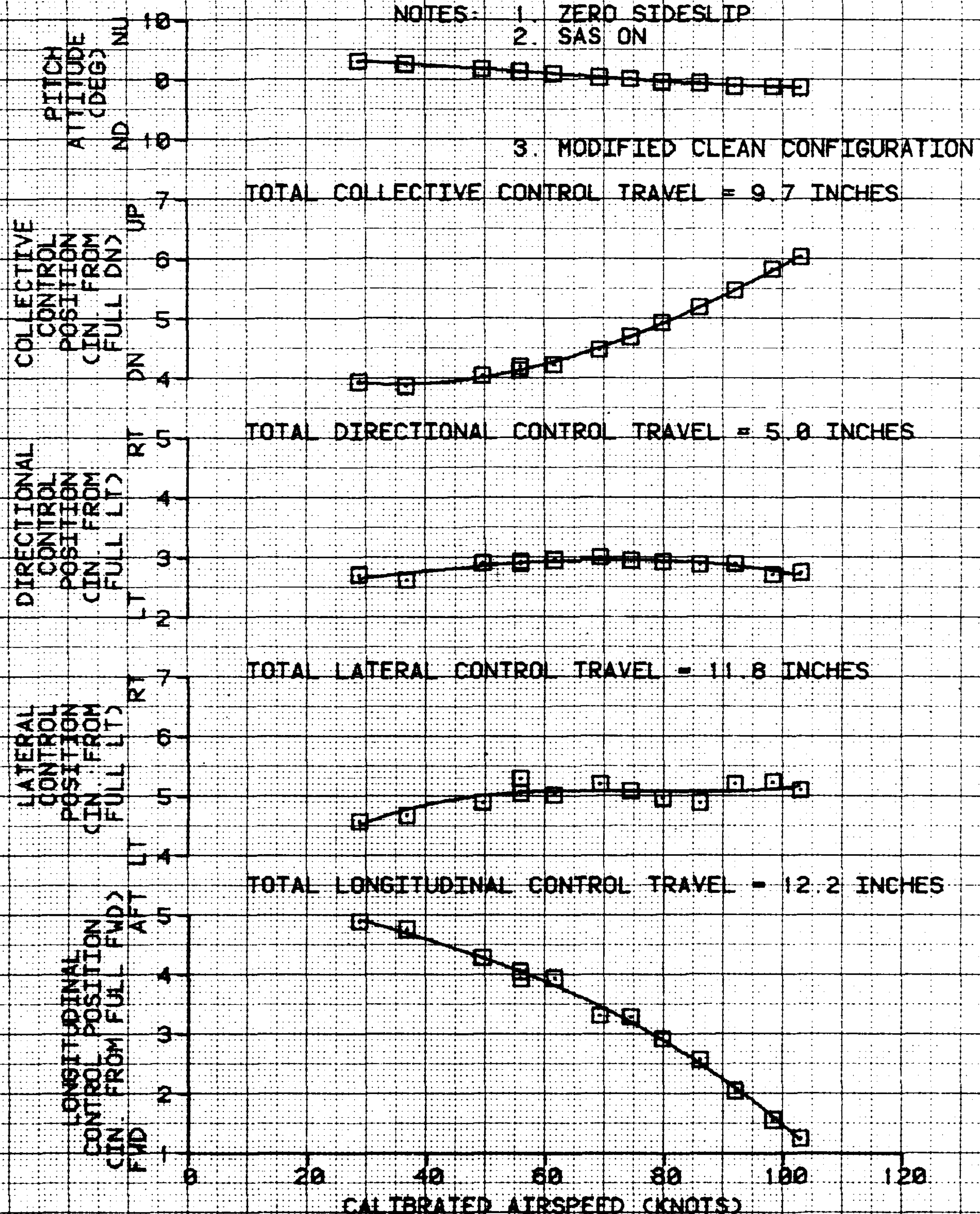


FIGURE 5
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	FLIGHT CONDITION
2910	110.7 (AFT)	3790	11.0	350	LEVEL



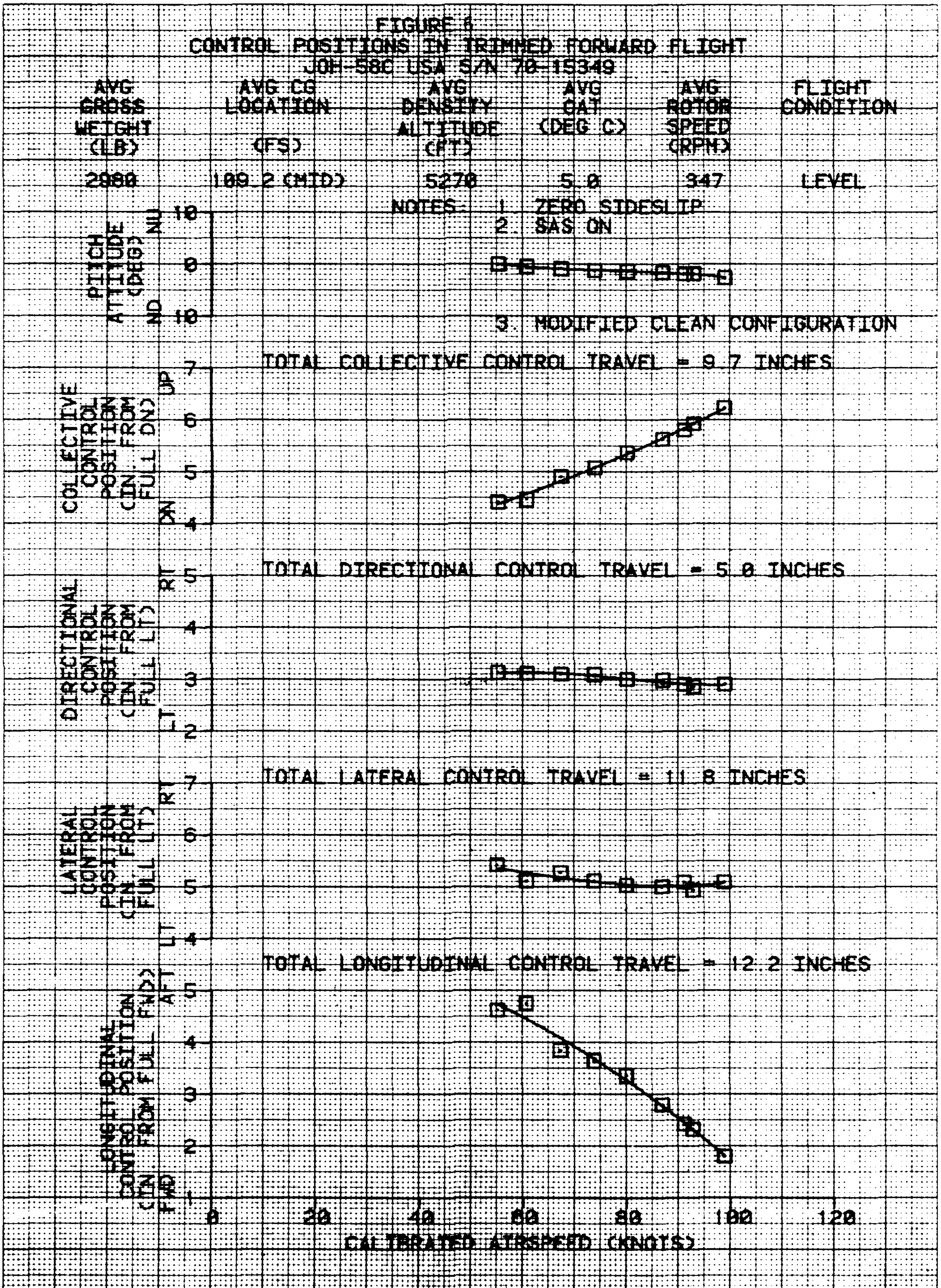


FIGURE 6
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB)
AVG CG LOCATION (FS)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
FLIGHT CONDITION
2980
109.2 (MID)
5270
5.0
347
LEVEL
NOTES: 1. ZERO SIDESLIP
2. SAS ON
3. MODIFIED CLEAN CONFIGURATION
PITCH ATTITUDE (DEG)
NU
ND
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 11.8 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
CALIBRATED AIRSPEED (KNOTS)

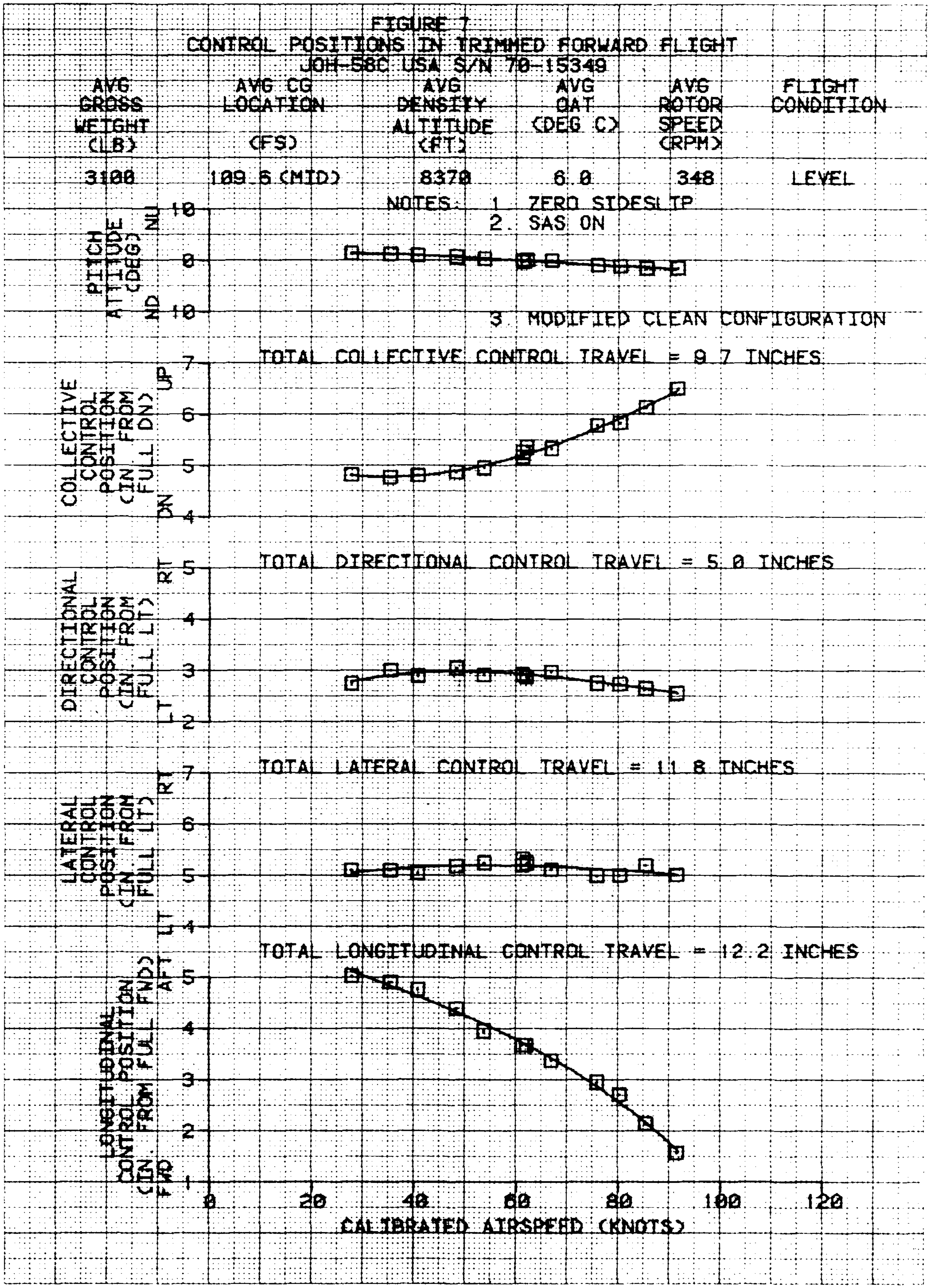


FIGURE 7
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB)
AVG CG LOCATION (FS)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
FLIGHT CONDITION
3100
109.6 (MID)
8370
6.0
348
LEVEL
NOTES: 1. ZERO SIDESLIP
2. SAS ON
3. MODIFIED CLEAN CONFIGURATION
PITCH ATTITUDE (DEG)
NU
ND
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 11.8 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
0
20
40
60
80
100
120
CALIBRATED AIRSPEED (KNOTS)

FIGURE 8
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	FLIGHT CONDITION
3110	109.7 (MID)	11210	5.5	347	LEVEL

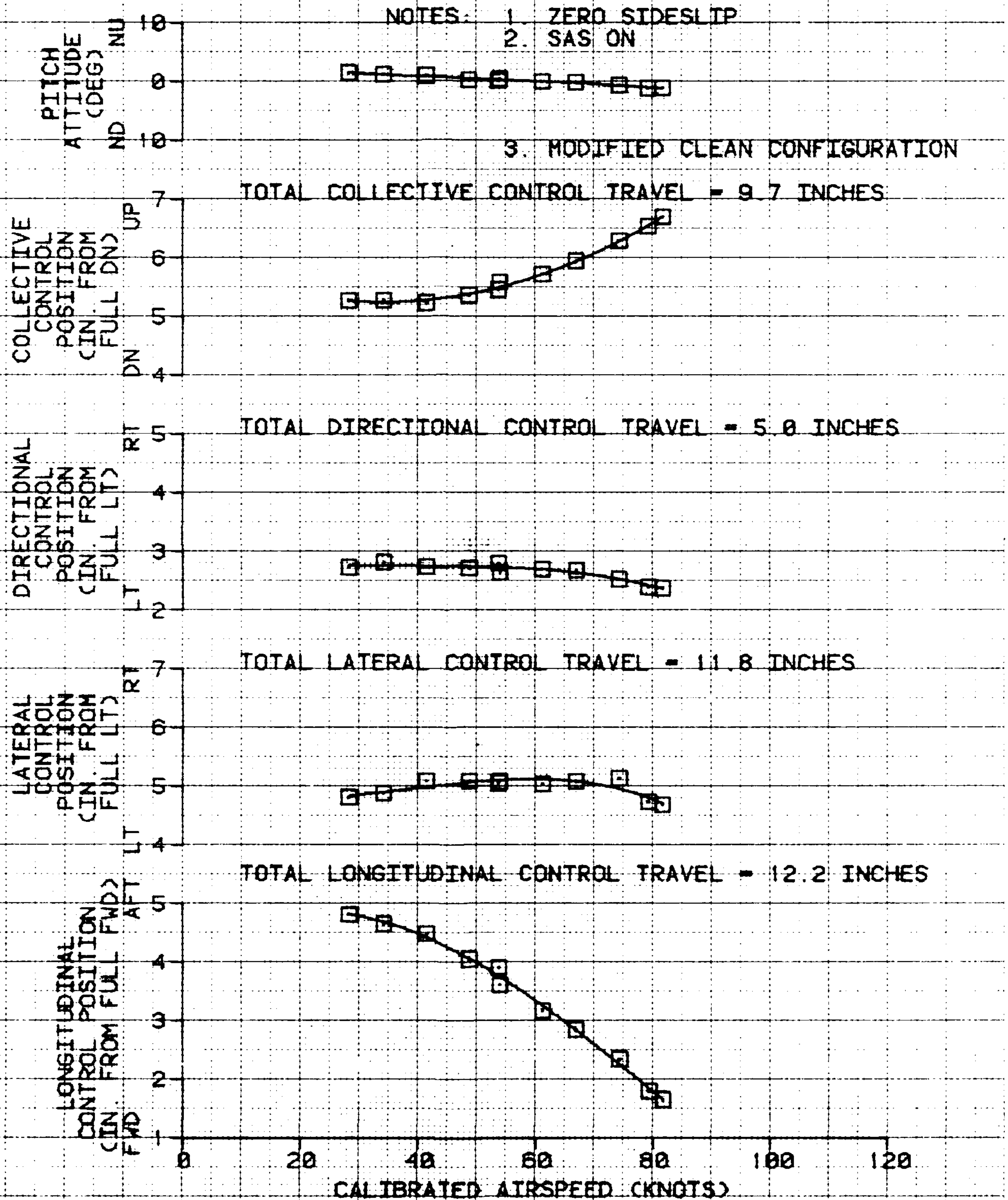
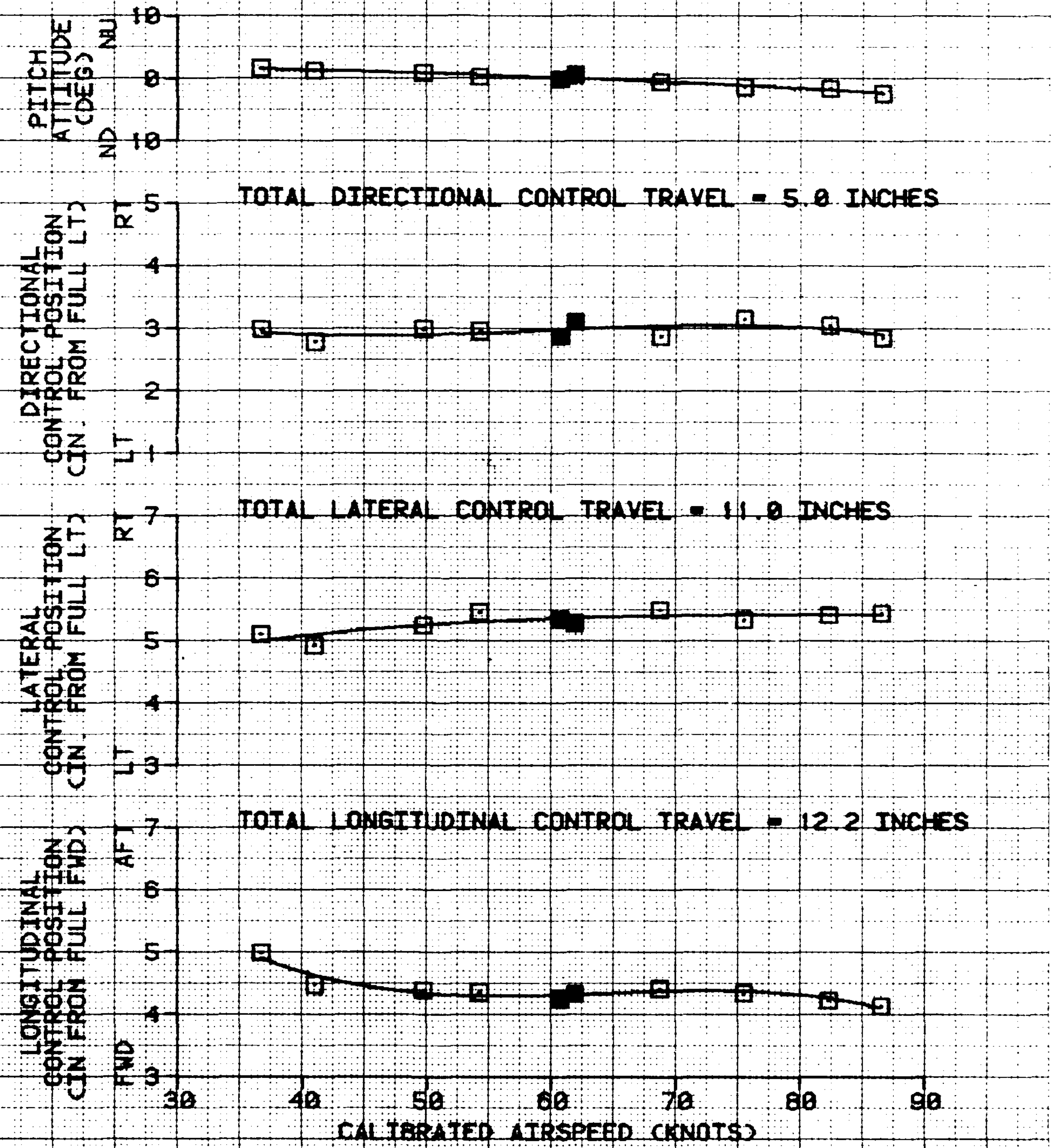


FIGURE 9

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	FLIGHT CONDITION
3090	109.4 (MID)	5320	15.5	355	LEVEL

NOTES: 1. SHADED SYMBOLS DENOTE TRIM
2. SAS ON
3. MODIFIED CLEAN CONFIGURATION



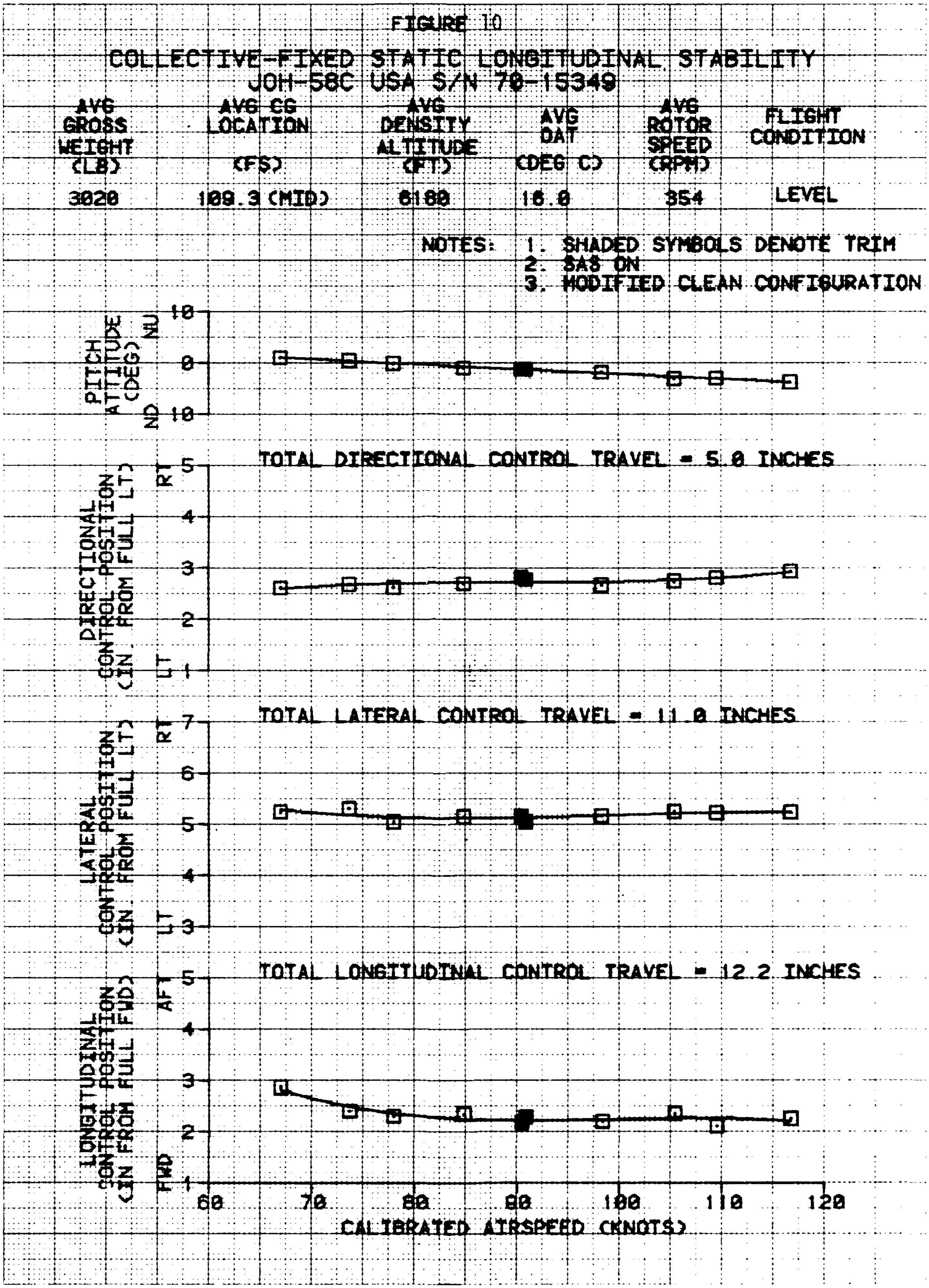
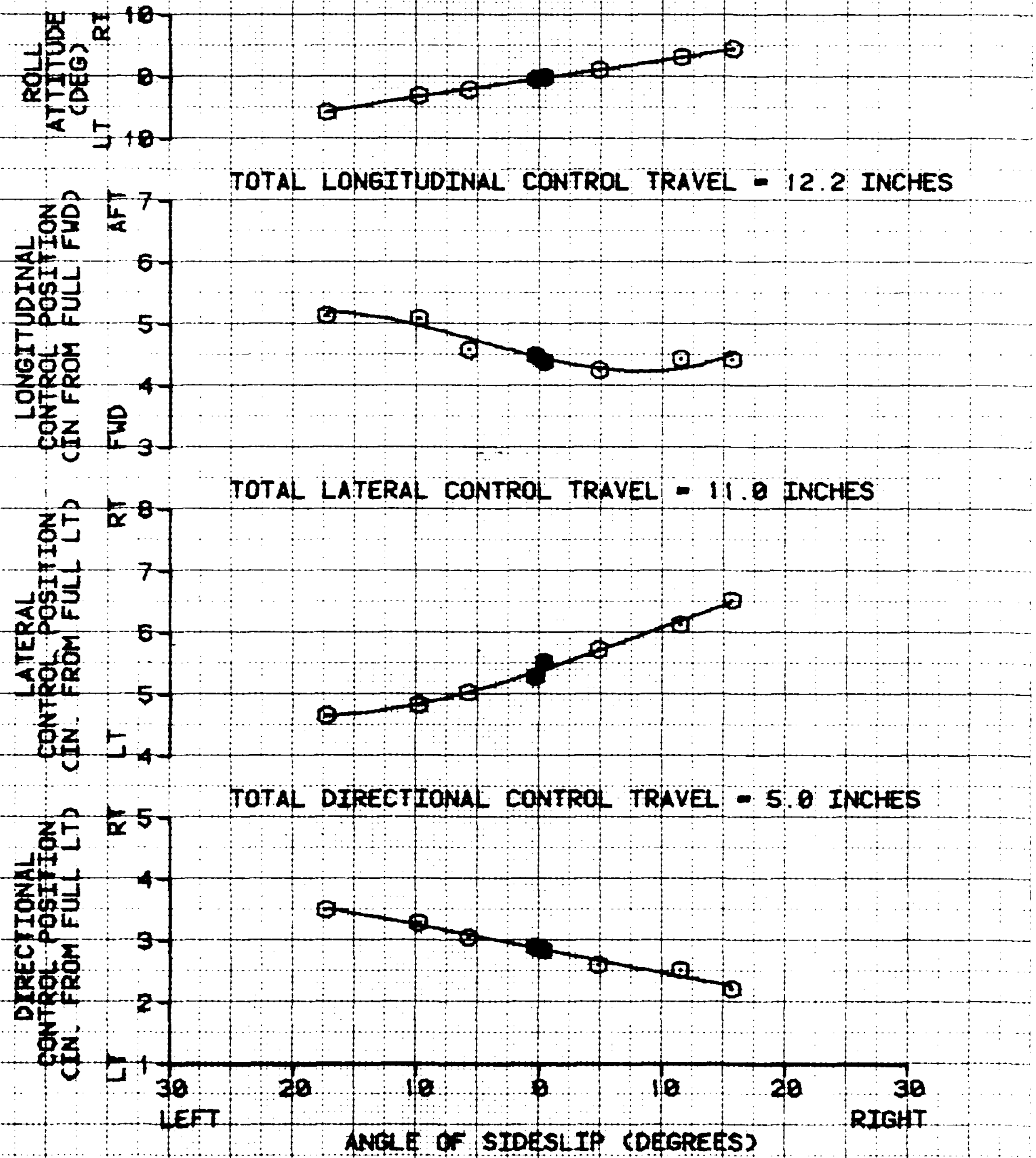


FIGURE 10
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB)
AVG CG LOCATION (FS)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
FLIGHT CONDITION
3020
109.3 (MID)
6180
16.0
354
LEVEL
NOTES: 1. SHADED SYMBOLS DENOTE TRIM
2. SAS ON
3. MODIFIED CLEAN CONFIGURATION
PITCH ATTITUDE (DEG)
NU
ND
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (IN FROM FULL FWD)
AFT
FWD
CALIBRATED AIRSPEED (KNOTS)

FIGURE 11
STATIC LATERAL-DIRECTIONAL STABILITY
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KTS)
3160	109.0 (MID)	5780	15.5	352	61

NOTES: 1. TRIM FLIGHT CONDITION: LEVEL
2. SHADED SYMBOL DENOTES TRIM
3. SAS ON
4. MODIFIED CLEAN CONFIGURATION



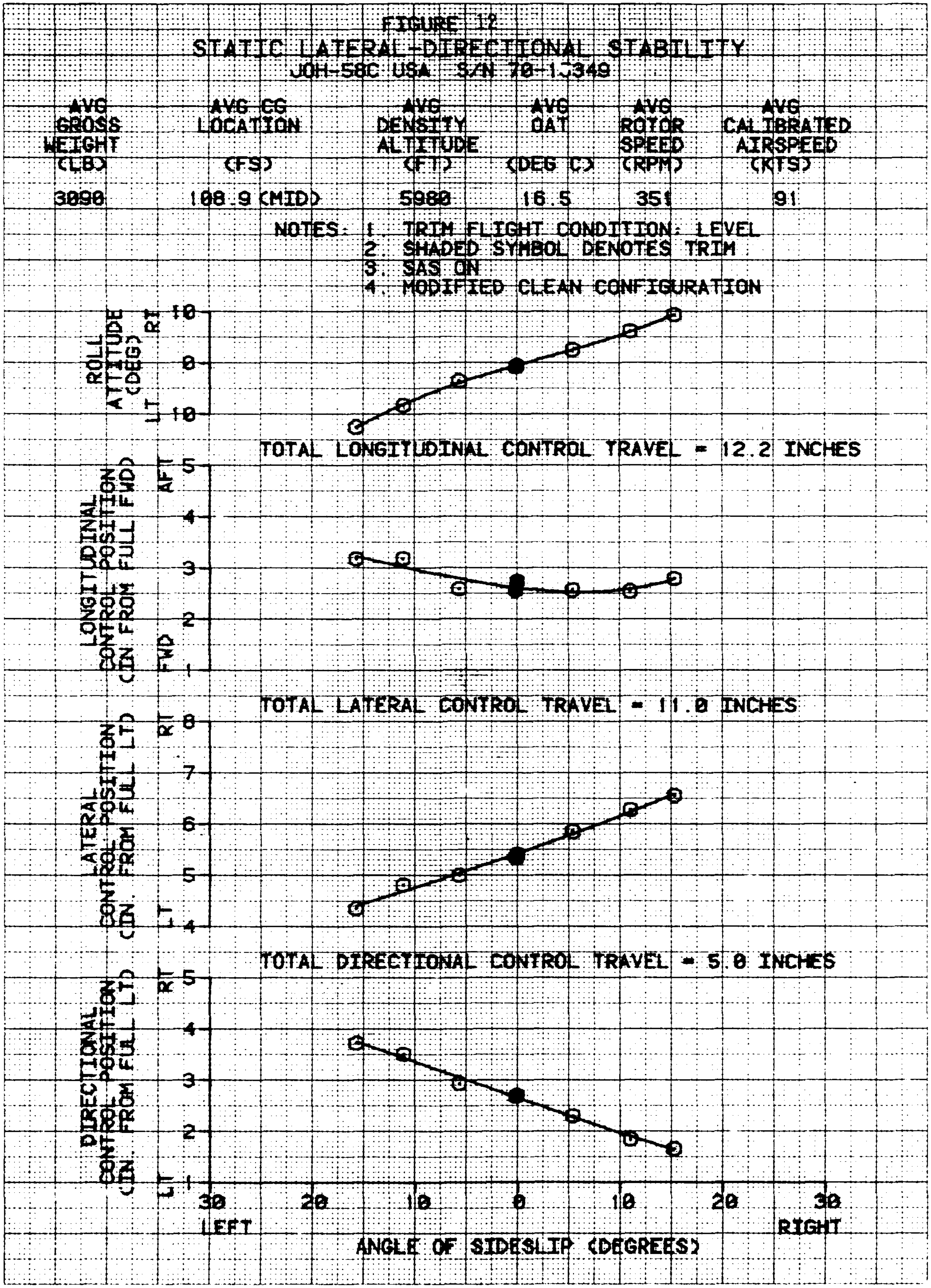


FIGURE 12
STATIC LATERAL-DIRECTIONAL STABILITY
JOH-58C USA S/N 70-1?349
AVG GROSS WEIGHT (LB)
3090
AVG CG LOCATION (FS)
108.9 (MID)
AVG DENSITY ALTITUDE (FT)
5980
AVG OAT (DEG C)
16.5
AVG ROTOR SPEED (RPM)
351
AVG CALIBRATED AIRSPEED (KTS)
91
NOTES: 1. TRIM FLIGHT CONDITION: LEVEL
2. SHADED SYMBOL DENOTES TRIM
3. SAS ON
4. MODIFIED CLEAN CONFIGURATION
ROLL ATTITUDE (DEG)
RT
LT
10
0
10
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (IN FROM FULL FWD)
AFT
FWD
5
4
3
2
1
TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
8
7
6
5
4
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
5
4
3
2
1
30
20
10
0
10
20
30
LEFT
RIGHT
ANGLE OF SIDESLIP (DEGREES)

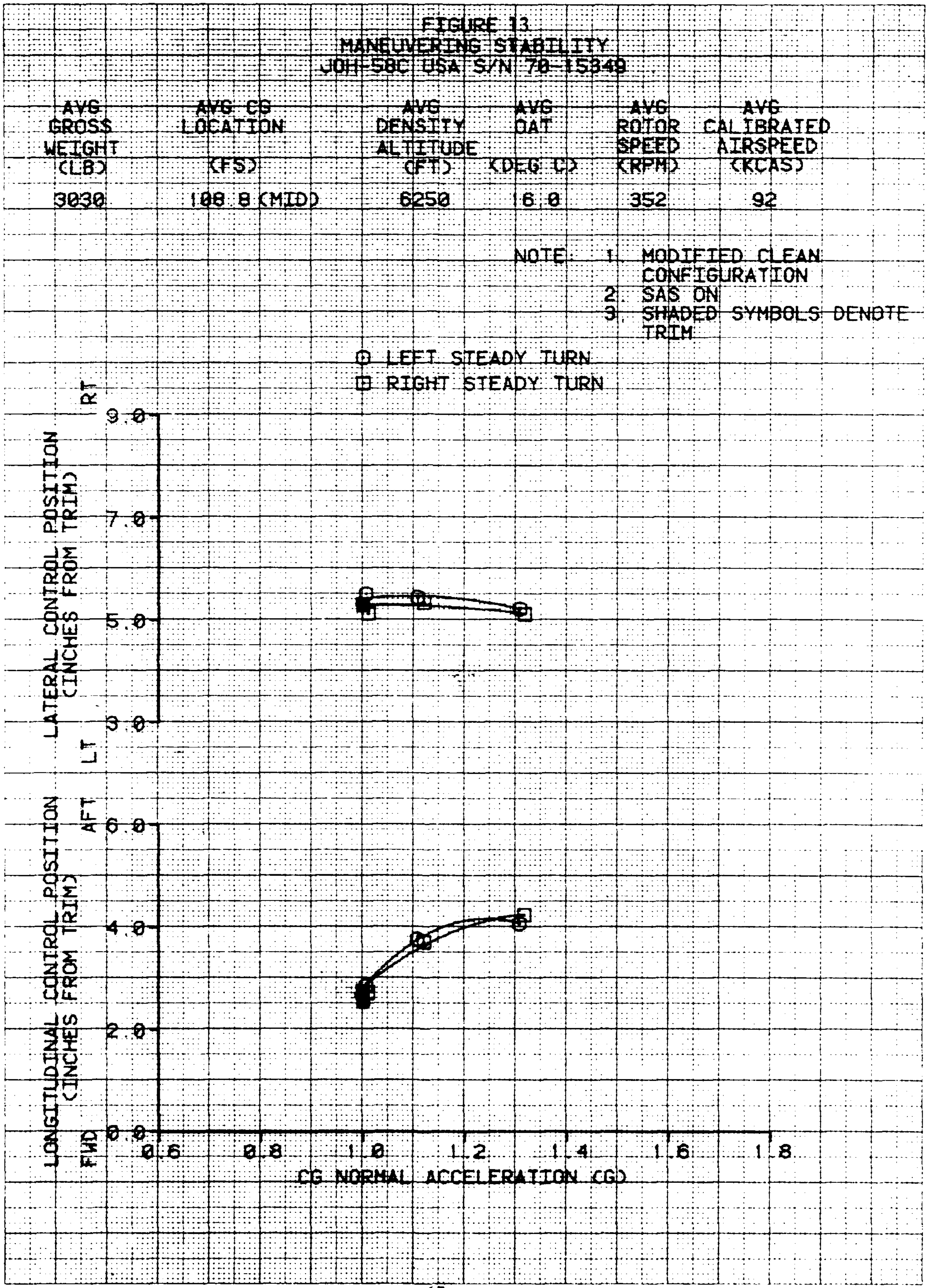


FIGURE 13
MANEUVERING STABILITY
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB)
AVG CG LOCATION (FS)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
AVG CALIBRATED AIRSPEED (KCAS)
3030
108.8 (MID)
6250
16.0
352
92
NOTE: 1. MODIFIED CLEAN CONFIGURATION
2. SAS ON
3. SHADED SYMBOLS DENOTE TRIM
LEFT STEADY TURN
RIGHT STEADY TURN
RT
LATERAL CONTROL POSITION (INCHES FROM TRIM)
LT
9.0
7.0
5.0
3.0
AFT
LONGITUDINAL CONTROL POSITION (INCHES FROM TRIM)
FWD
6.0
4.0
2.0
0.0
0.6
0.8
1.0
1.2
1.4
1.6
1.8
CG NORMAL ACCELERATION (G)

FIGURE 14
DYNAMIC STABILITY
OH-58C USA S/N 69-15349

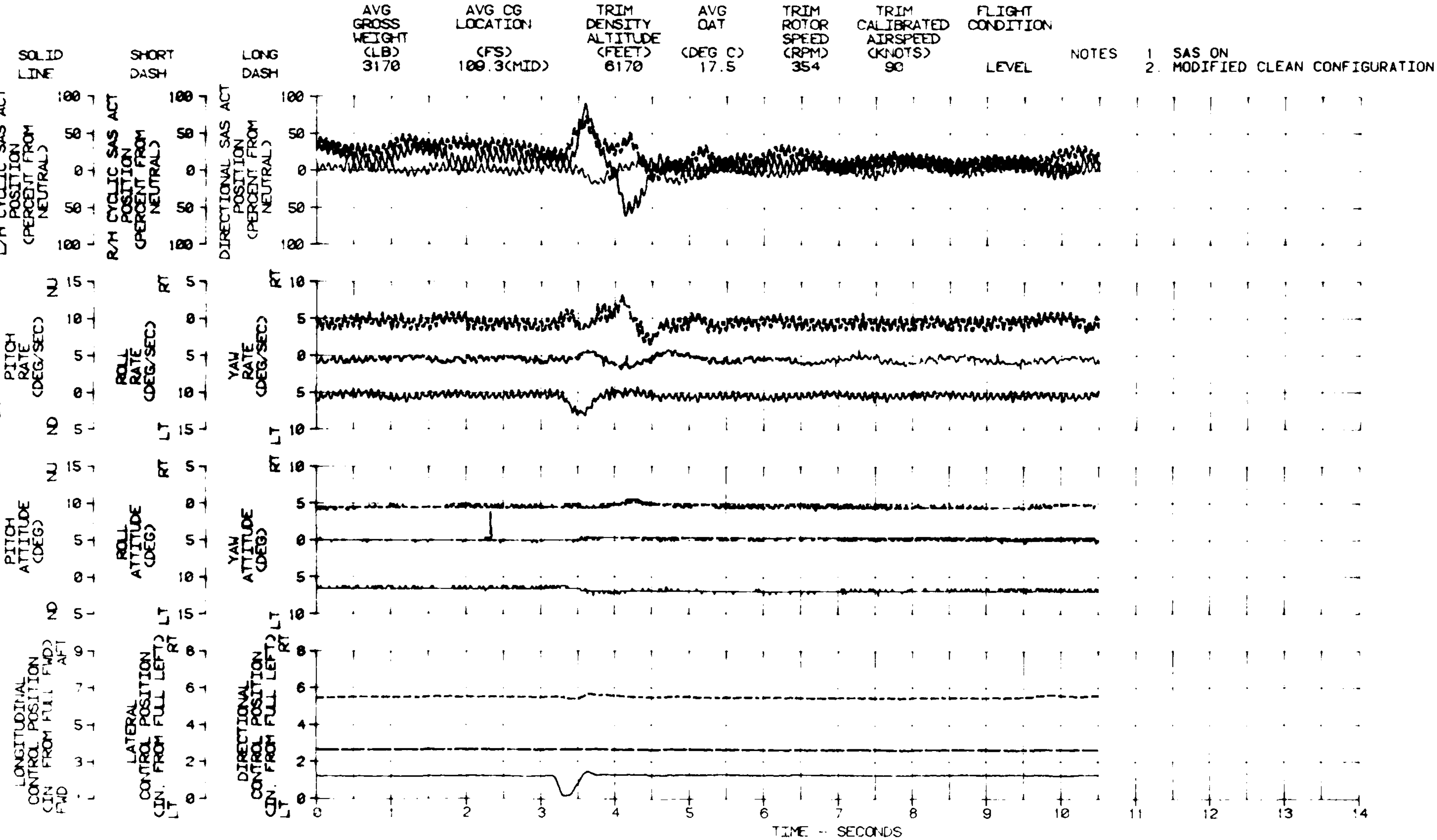


FIGURE 15
DYNAMIC STABILITY
JOH-58C USA S/N 69-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3160	109.2(MID)	6160	17.5	354	90	LEVEL

NOTES
1 SAS ON
2 MODIFIED CLEAN CONFIGURATION

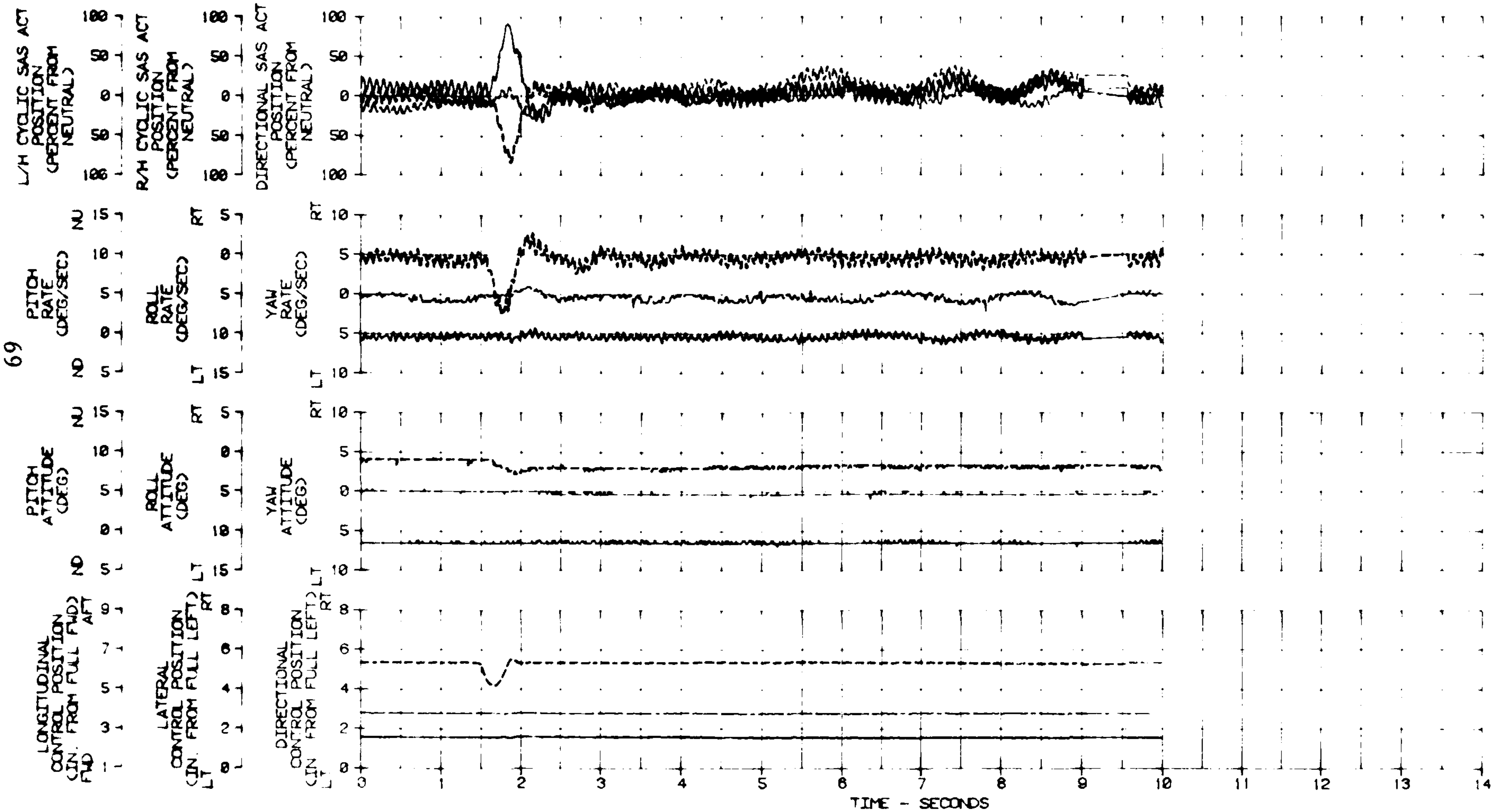


FIGURE 16
DYNAMIC STABILITY
JOH-58C USA S/N 69-15349

SOLID LINE	SHORT DASH	LONG DASH	AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
			3120	109.1(MID)	6000	18.0	354	90	LEVEL

NOTES: 1. SAS ON
2. MODIFIED CLEAN CONFIGURATION

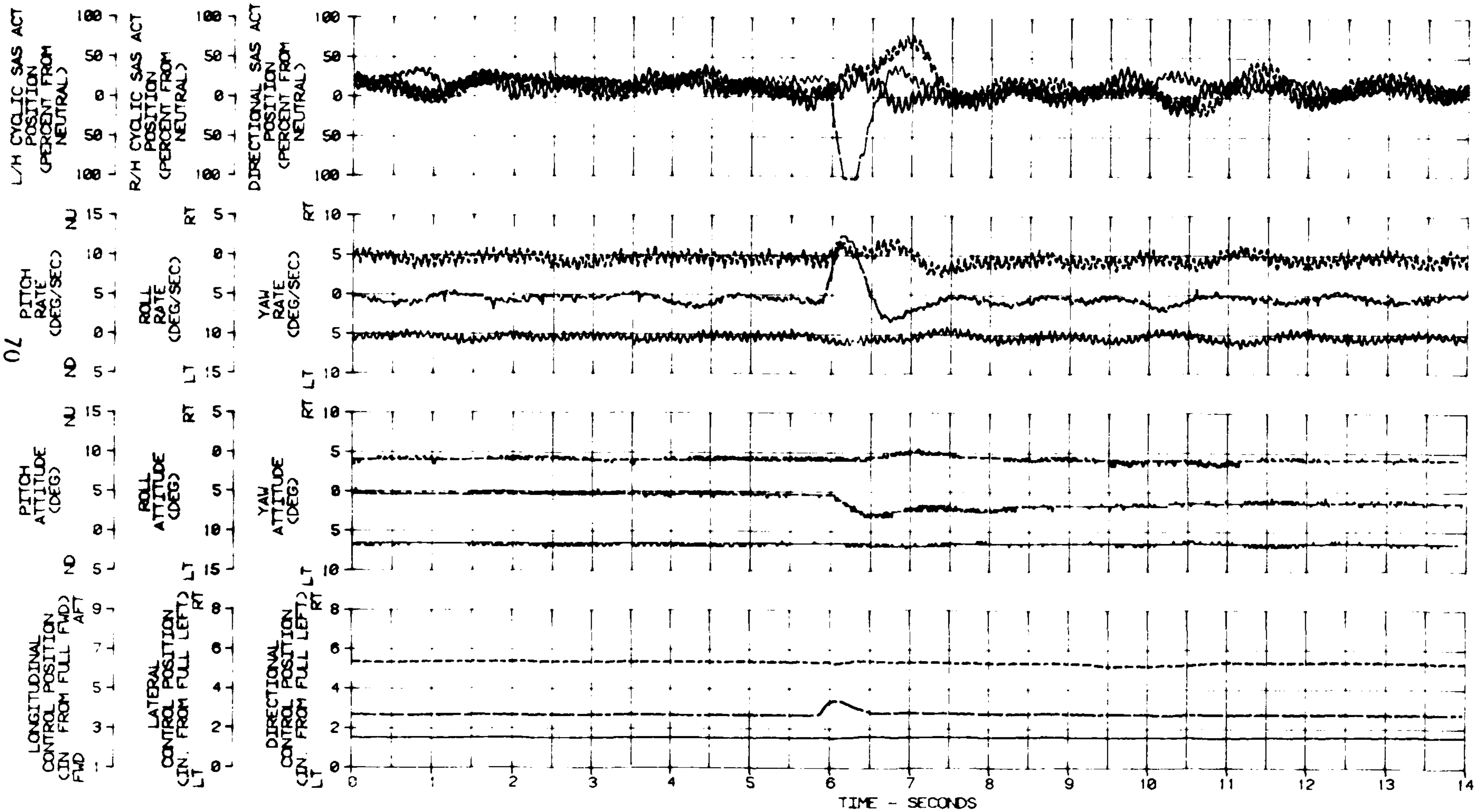


FIGURE 17
RELEASE FROM SIDESLIP
JOH-58C USA S/N 69-15349

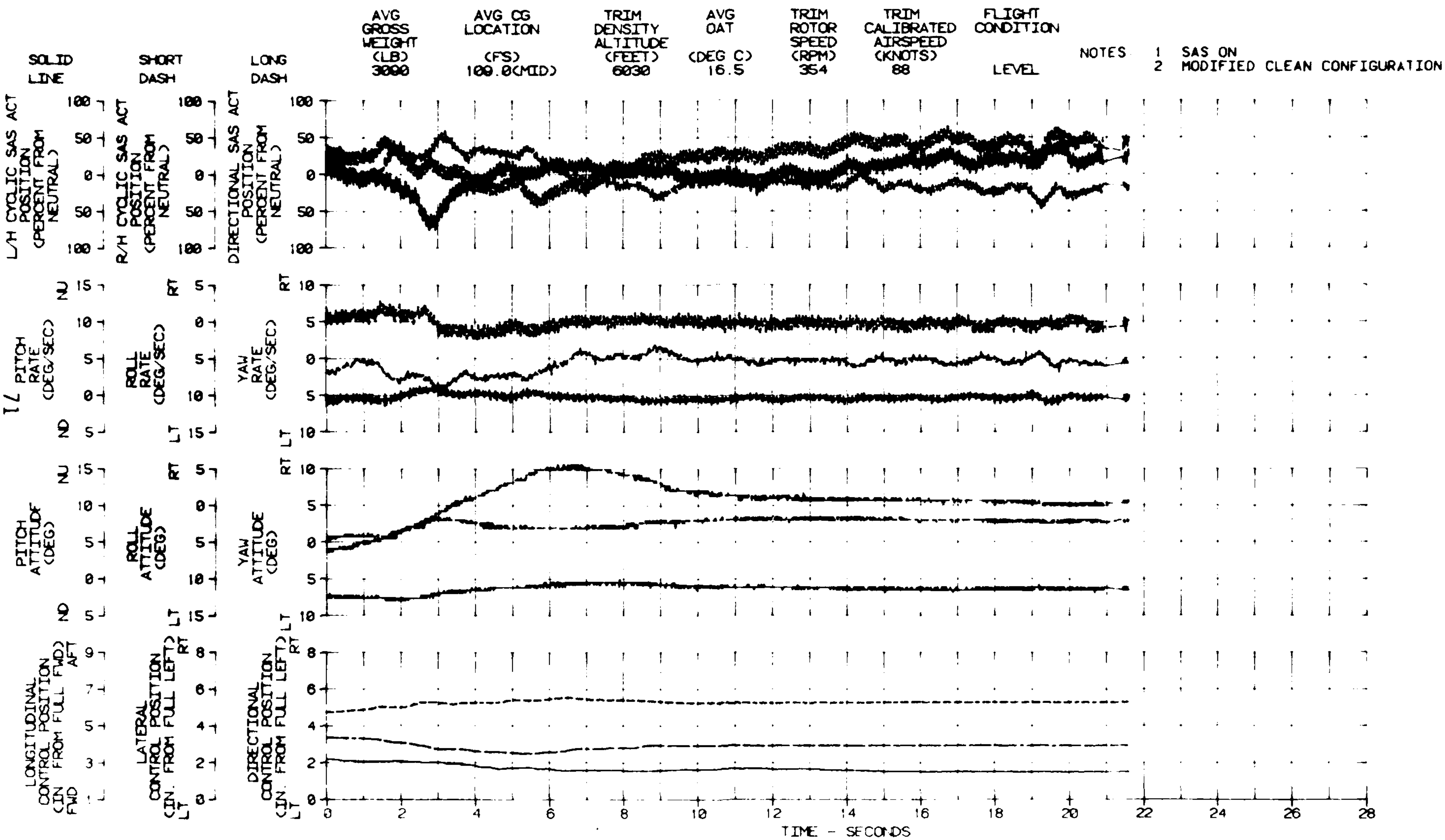


FIGURE 18
LONGITUDINAL LONG-TERM RESPONSE
JOH-58C USA S/N 70-15349

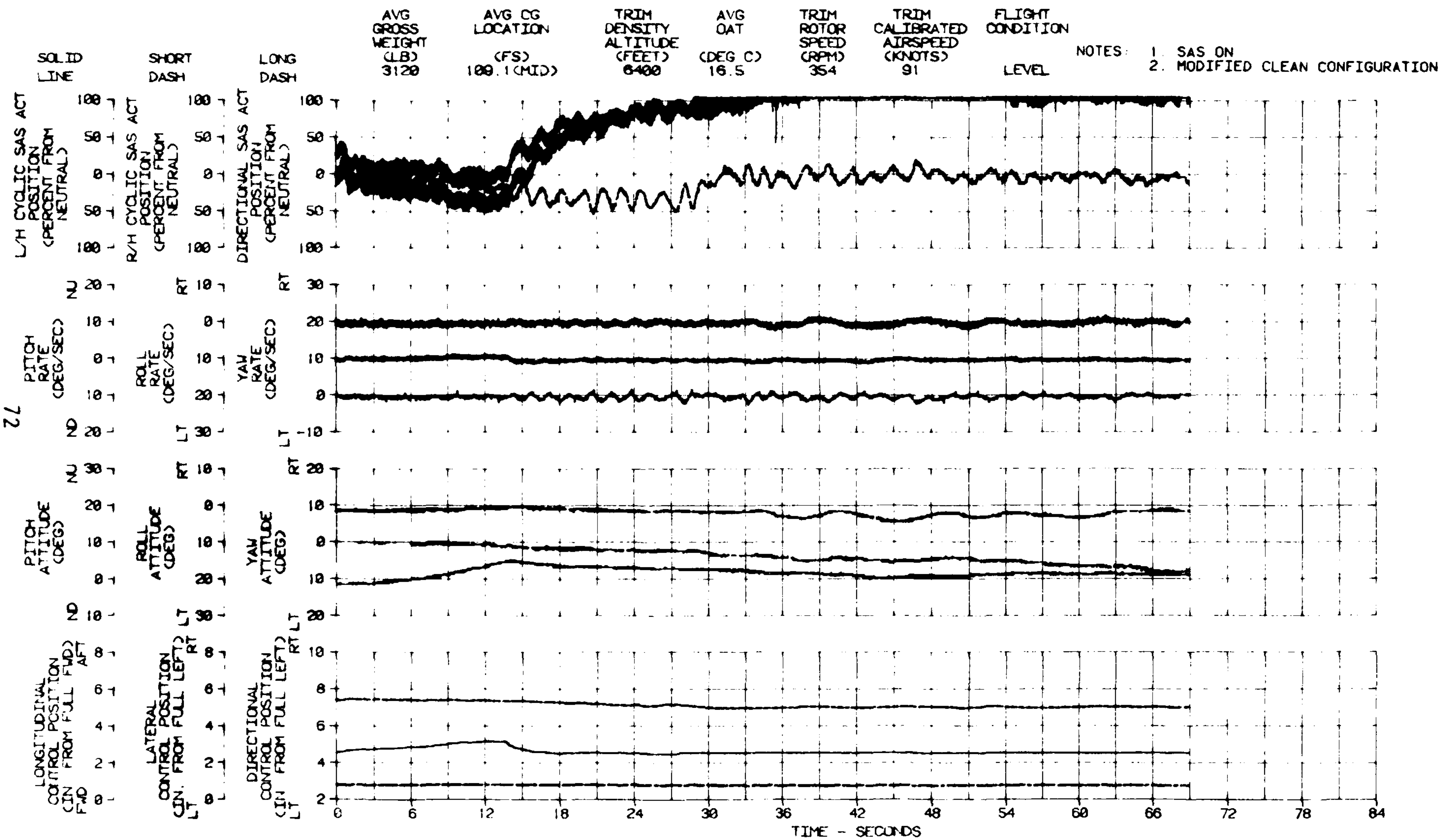
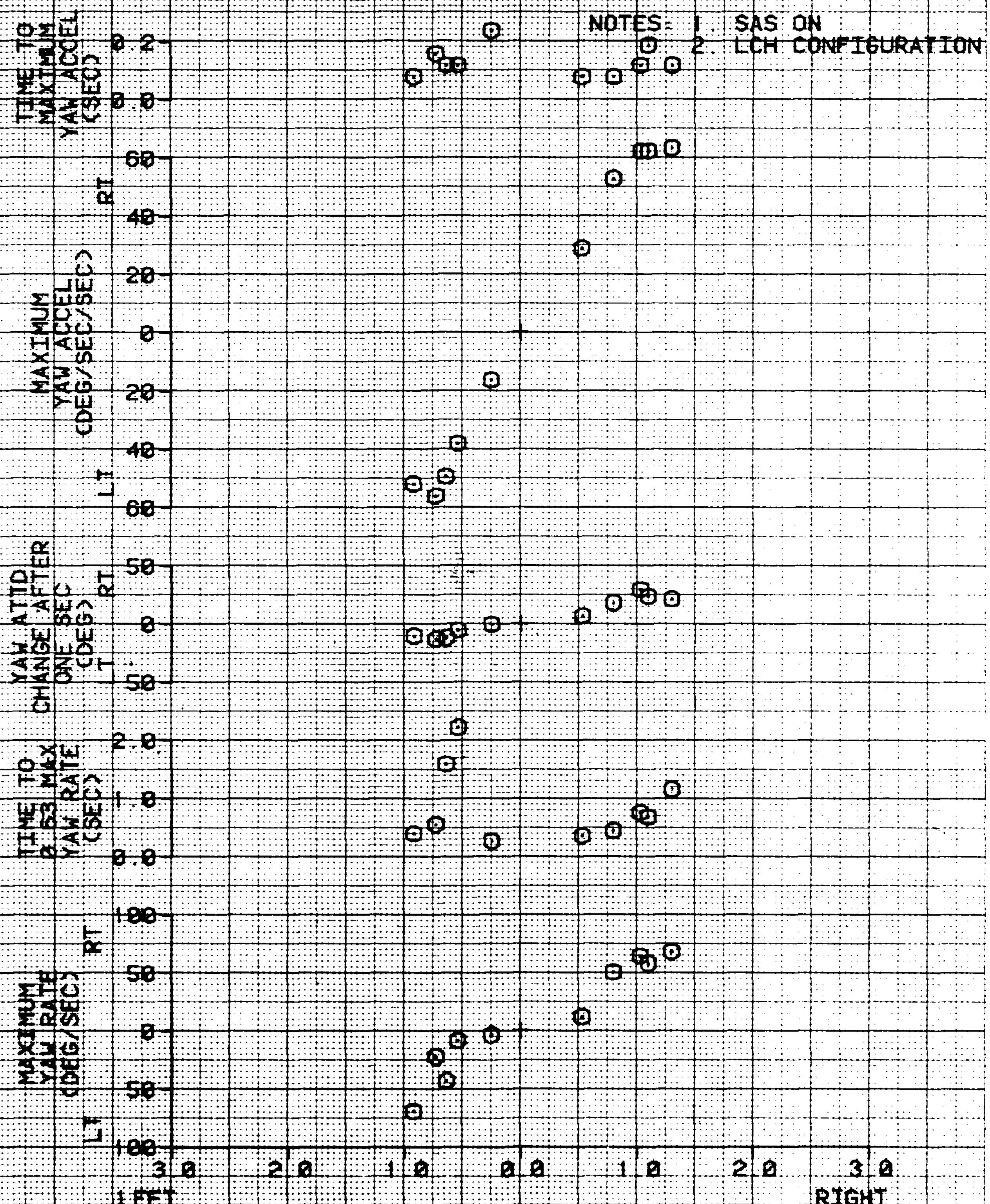


FIGURE 19
DIRECTIONAL CONTROLLABILITY
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
3110	107.1(FWD)	4770	18.5	354	HOVER

NOTES: 1. SAS ON
⊡ 2. LCH CONFIGURATION



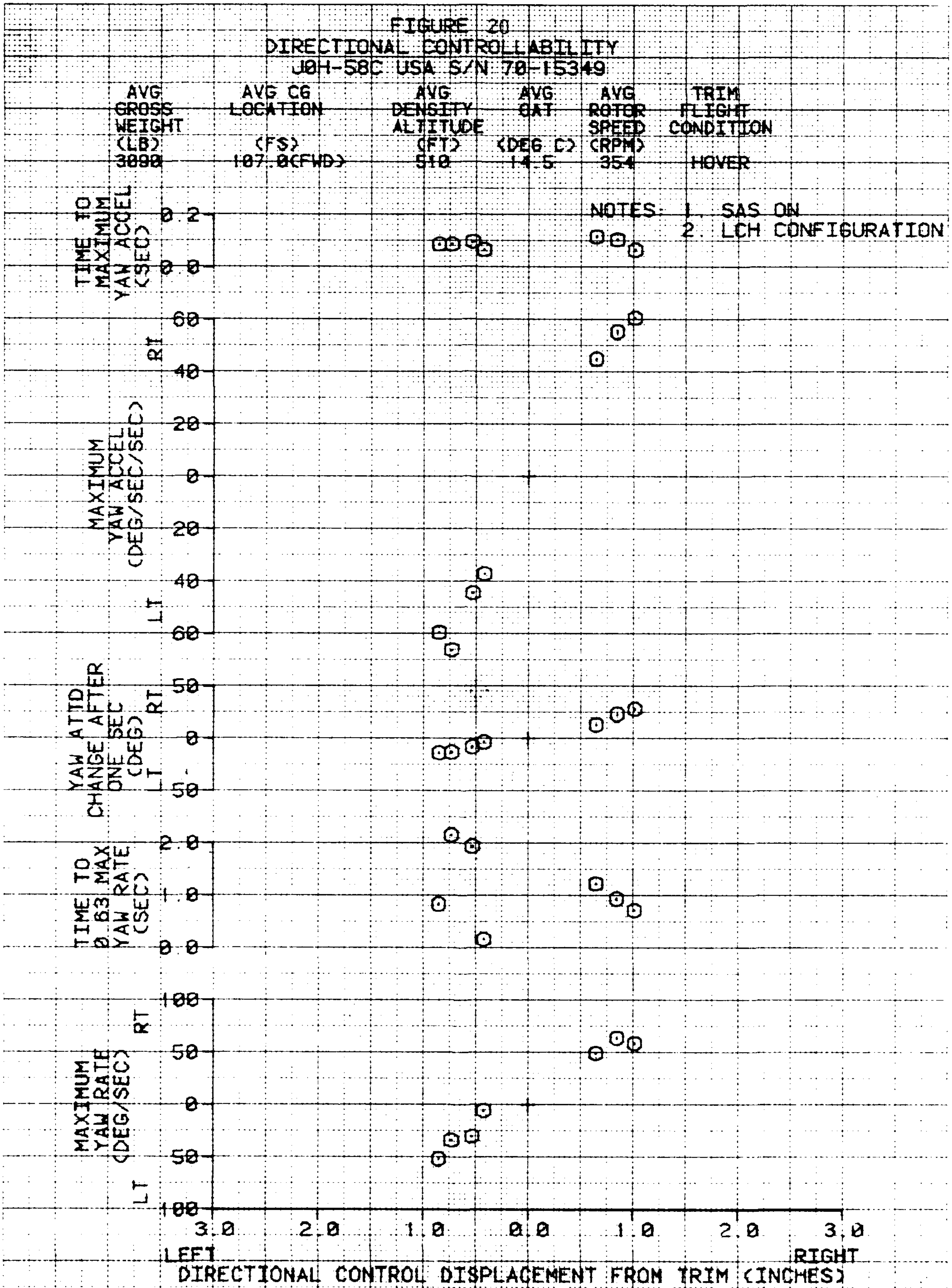


FIGURE 20
DIRECTIONAL CONTROLLABILITY
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 3090
AVG CG LOCATION (FS) 107.0(FWD)
AVG DENSITY ALTITUDE (FT) 510
AVG OAT (DEG C) 14.5
AVG ROTOR SPEED (RPM) 354
TRIM FLIGHT CONDITION HOVER
NOTES: 1. SAS ON
2. LCH CONFIGURATION
TIME TO MAXIMUM YAW ACCEL (SEC)
MAXIMUM YAW ACCEL (DEG/SEC/SEC)
RT
LT
YAW ATTD CHANGE AFTER ONE SEC (DEG)
TIME TO 0.63 MAX YAW RATE (SEC)
MAXIMUM YAW RATE (DEG/SEC)
LEFT
RIGHT
DIRECTIONAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

FIGURE 21

DIRECTIONAL CONTROLLABILITY

JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3080	107.0(FWD)	550	15 0	354	0	HOVER

NOTES: 1. SAS ON
2. LCH CONFIGURATION

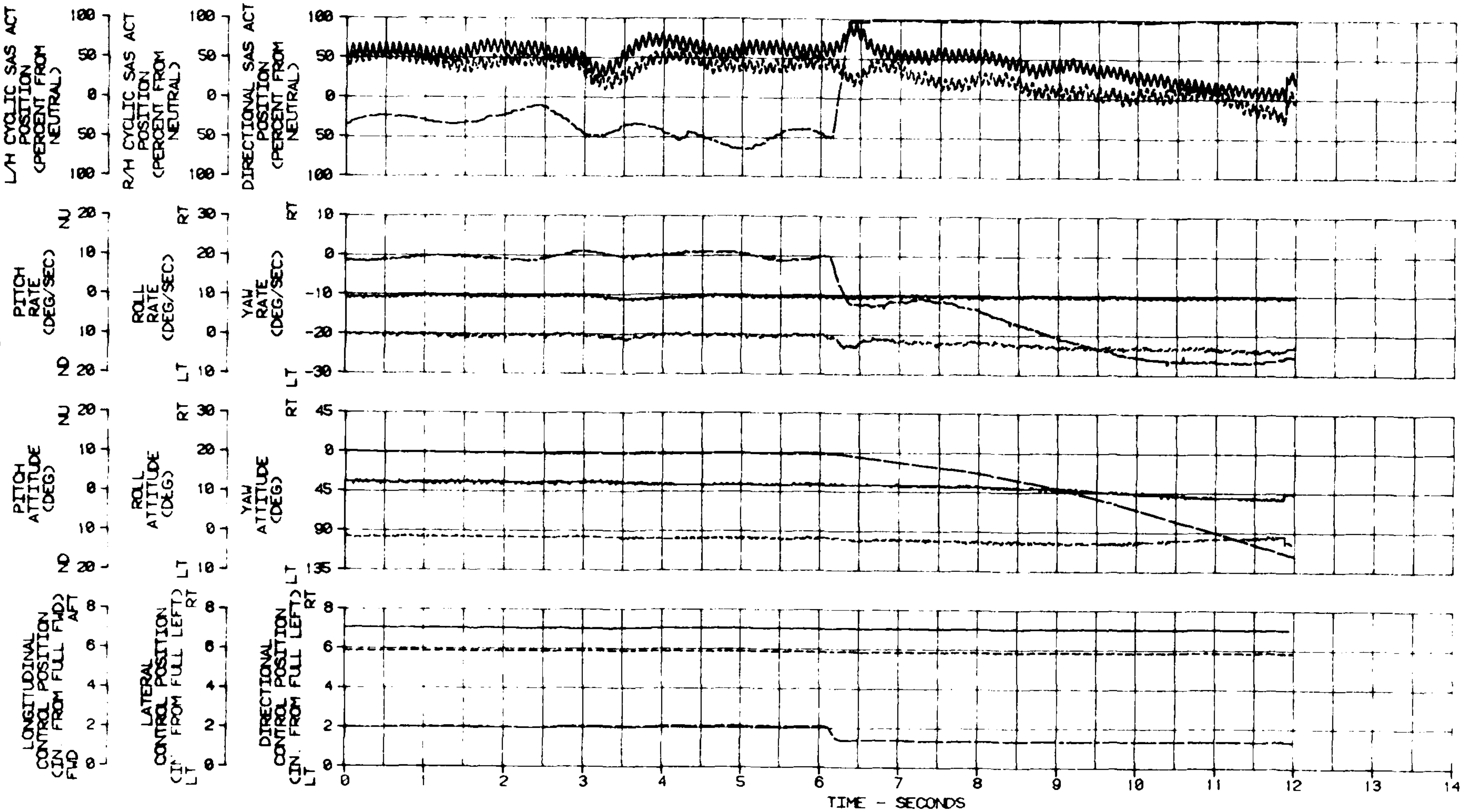
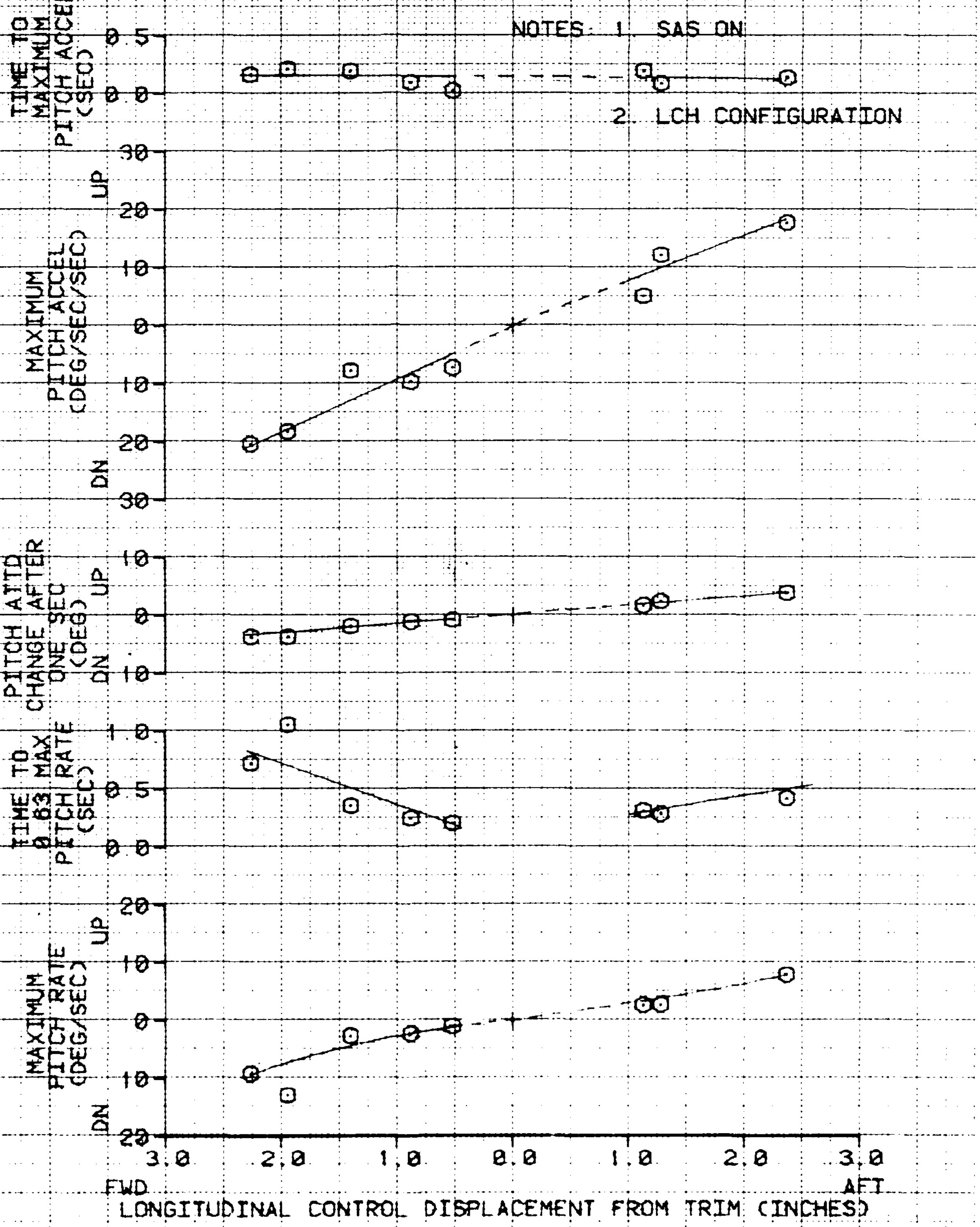


FIGURE 22
LONGITUDINAL CONTROLLABILITY
J0H-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
3170	107.2(FWD)	440	14.0	353	HOVER



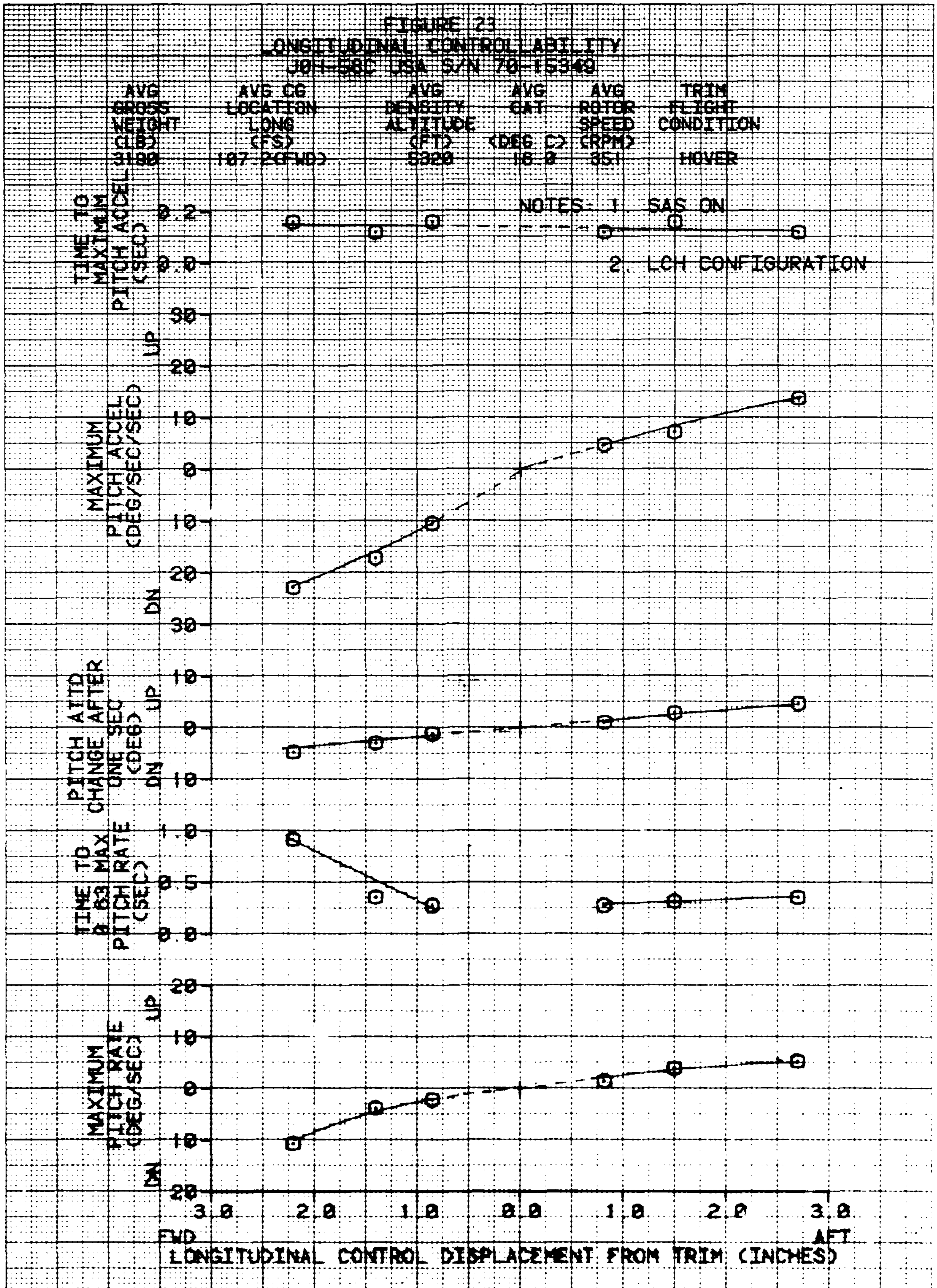


FIGURE 23
LONGITUDINAL CONTROLLABILITY
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 3180
AVG CG LOCATION LONG (FS) 107.2(FWD)
AVG DENSITY ALTITUDE (FT) 5320
AVG OAT (DEG C) 16.0
AVG ROTOR SPEED (RPM) 351
TRIM FLIGHT CONDITION HOVER
NOTES: 1. SAS ON
2. LCH CONFIGURATION
TIME TO MAXIMUM PITCH ACCEL (SEC)
0.2
0.0
MAXIMUM PITCH ACCEL (DEG/SEC/SEC)
UP
DN
30
20
10
0
10
20
30
PITCH ATTD CHANGE AFTER ONE SEC (DEG)
UP
DN
10
0
10
TIME TO 0.63 MAX PITCH RATE (SEC)
1.0
0.5
0.0
MAXIMUM PITCH RATE (DEG/SEC)
UP
DN
20
10
0
10
20
3.0
2.0
1.0
0.0
1.0
2.0
3.0
FWD
AFT
LONGITUDINAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

FIGURE 24
LONGITUDINAL CONTROLLABILITY
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3070	108.9(FWD)	6100	17.0	354	90	LEVEL

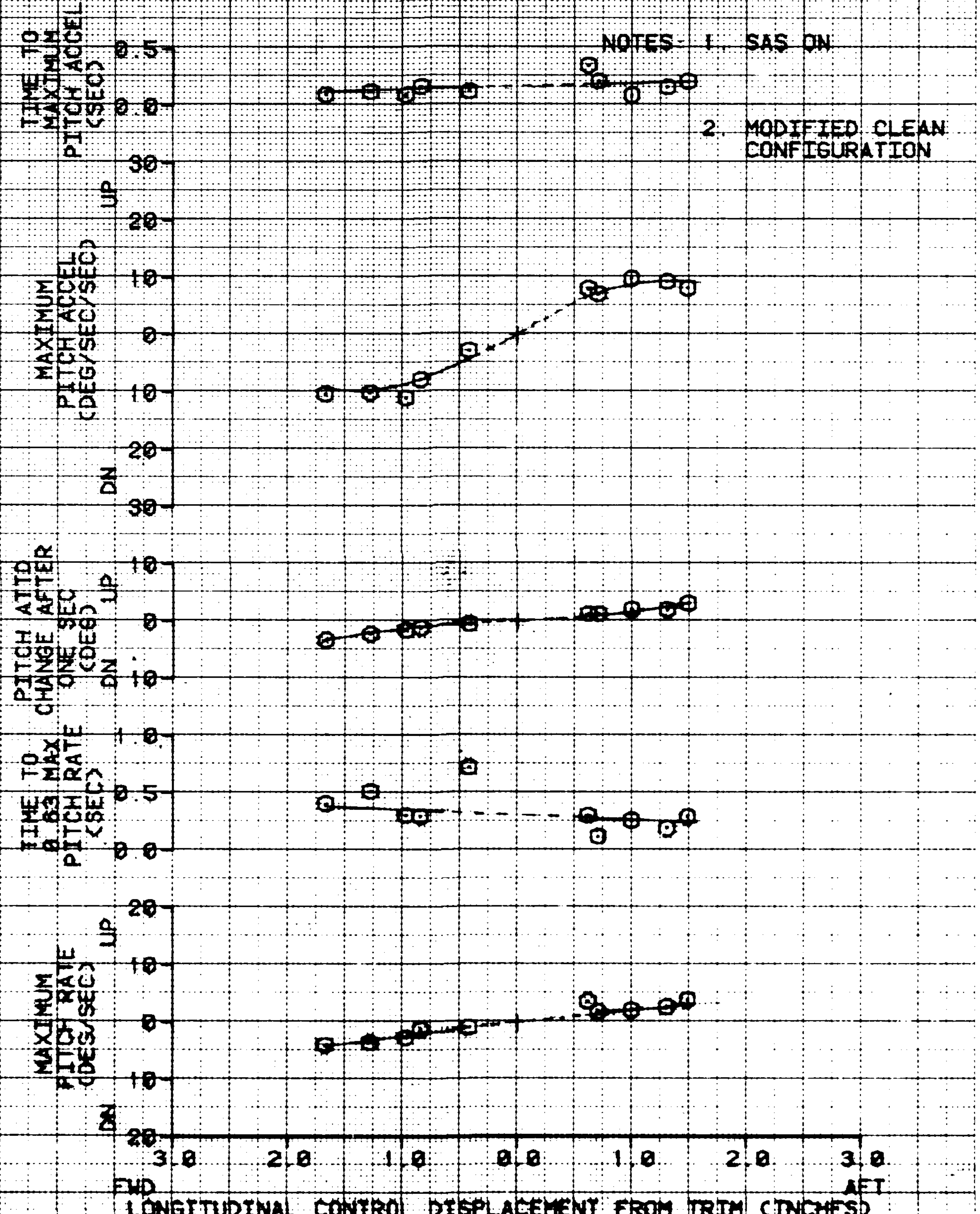
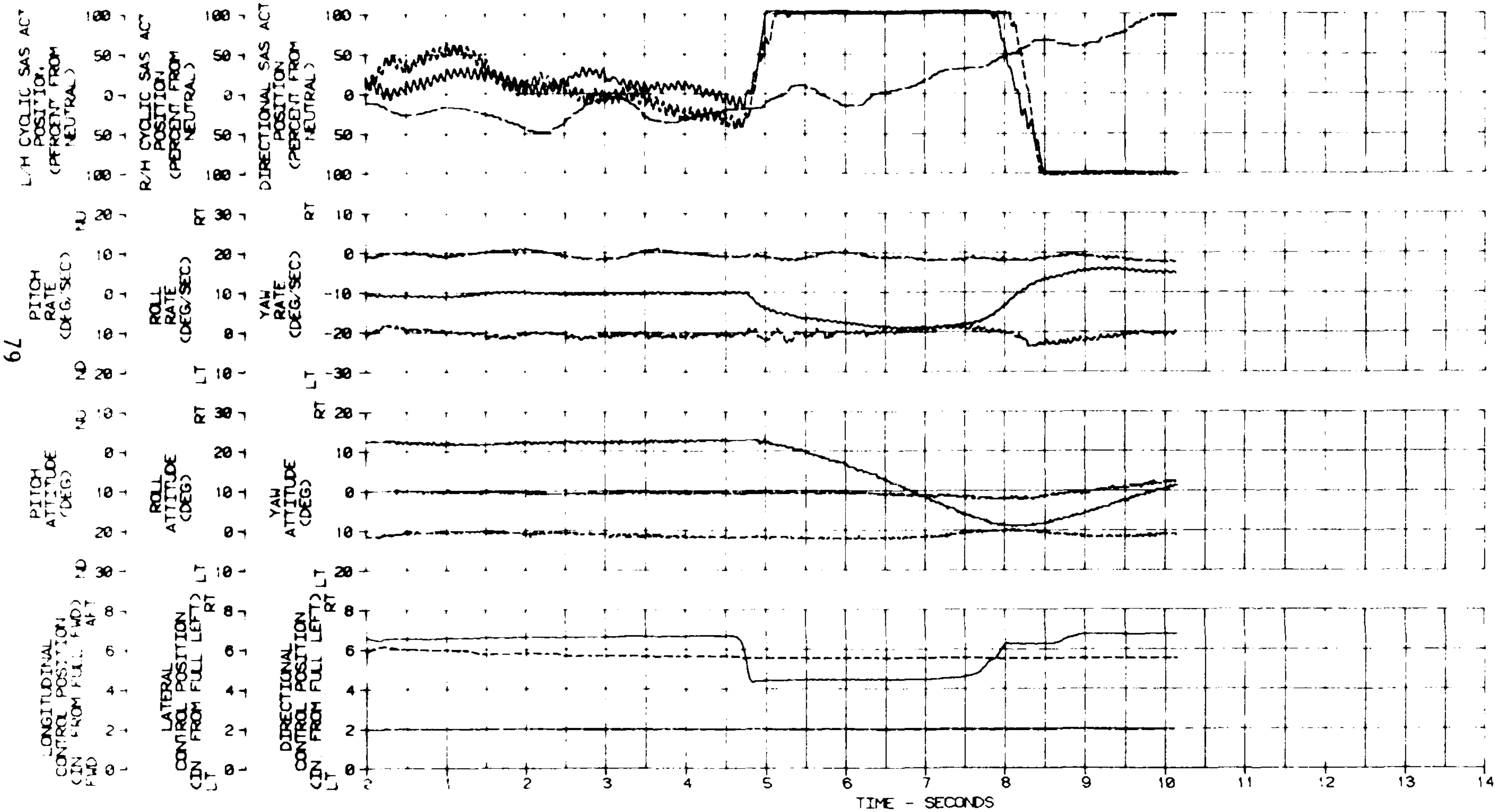


FIGURE 25
LONGITUDINAL CONTROLLABILITY
JOH-58C USA S/N 70-15340

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3170	107.2(FWD)	400	13.5	354	0	HOVER

NOTES: 1. SAS ON
2. LCH CONFIGURATION



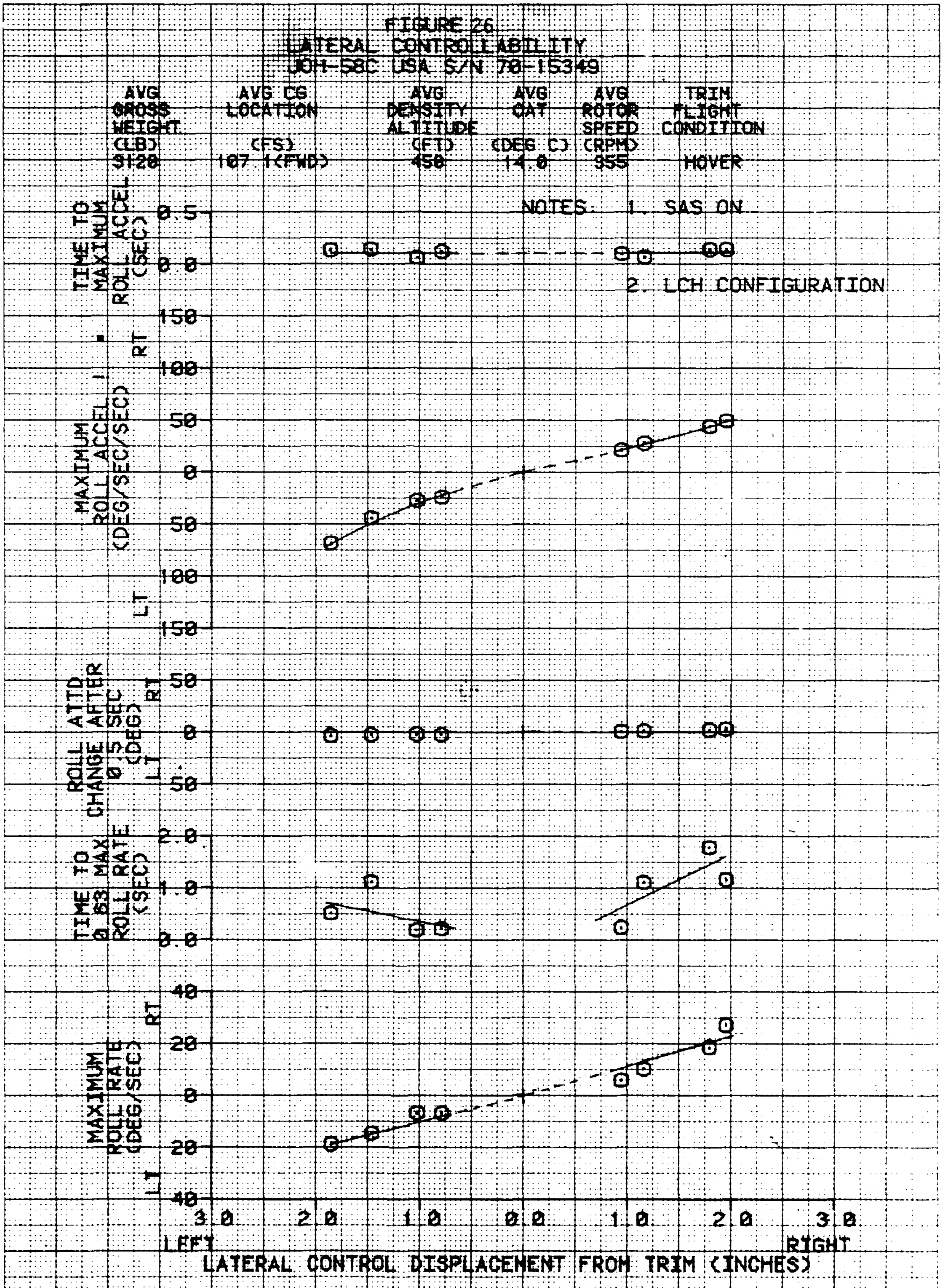


FIGURE 26
LATERAL CONTROLLABILITY
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 3120
AVG CG LOCATION (FS) 107.1(FWD)
AVG DENSITY ALTITUDE (FT) 450
AVG OAT (DEG C) 14.0
AVG ROTOR SPEED (RPM) 355
TRIM FLIGHT CONDITION HOVER
NOTES: 1. SAS ON
2. LCH CONFIGURATION
TIME TO MAXIMUM ROLL ACCEL (SEC)
0.5
0.0
MAXIMUM ROLL ACCEL (DEG/SEC/SEC)
RT
LT
150
100
50
0
50
100
150
ROLL ATTD CHANGE AFTER 0.5 SEC (DEG)
RT
LT
50
0
50
TIME TO 0.63 MAX ROLL RATE (SEC)
2.0
1.0
0.0
MAXIMUM ROLL RATE (DEG/SEC)
RT
LT
40
20
0
20
40
3.0
2.0
1.0
0.0
1.0
2.0
3.0
LEFT
RIGHT
LATERAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

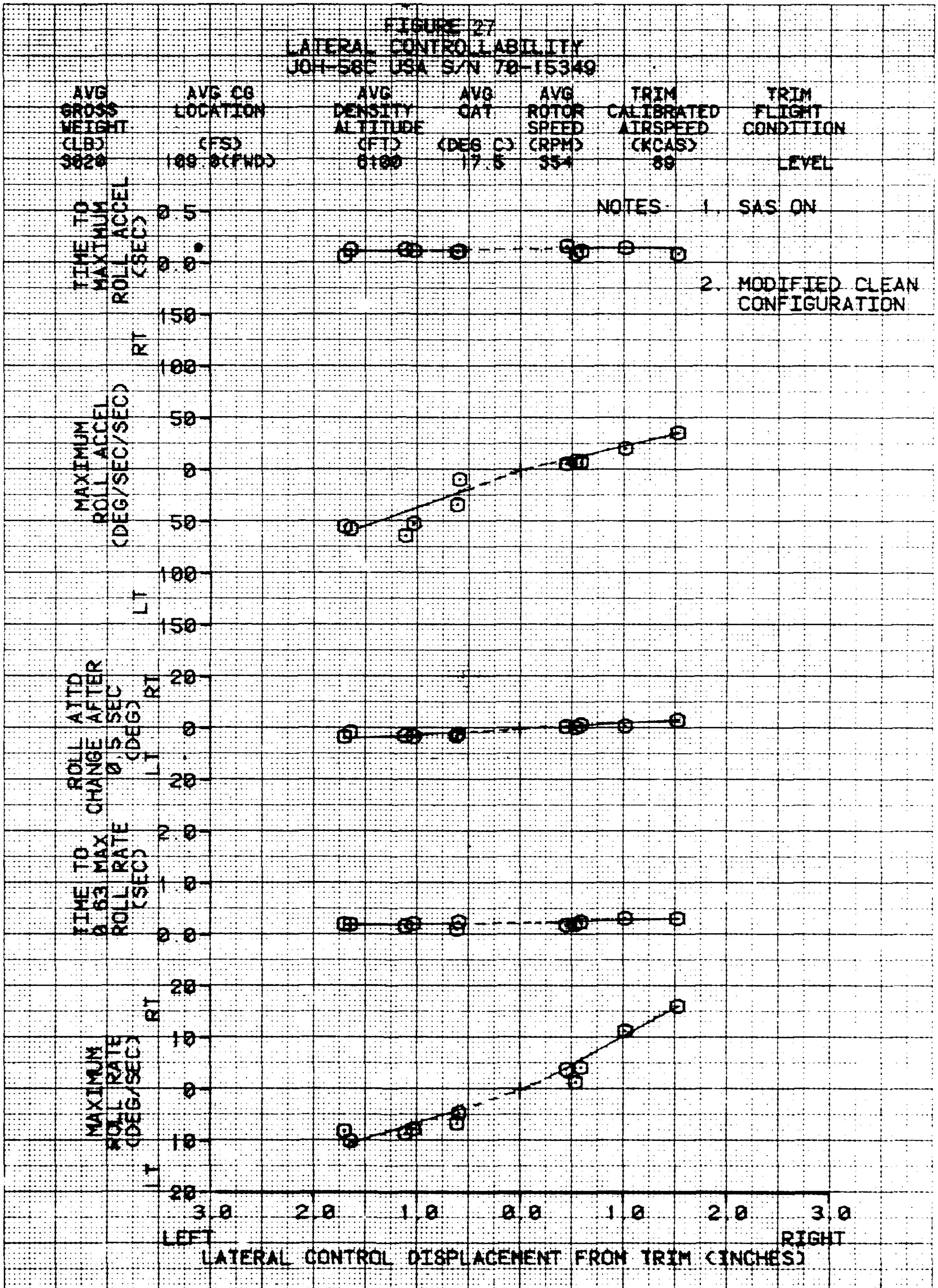


FIGURE 27
LATERAL CONTROLLABILITY
JOH-58C USA S/N 70-15349

FIGURE 28
LOW SPEED FLIGHT
AZIMUTH: 240 DEG. 21 KTS
JOH-58C USA S/N 70-15340

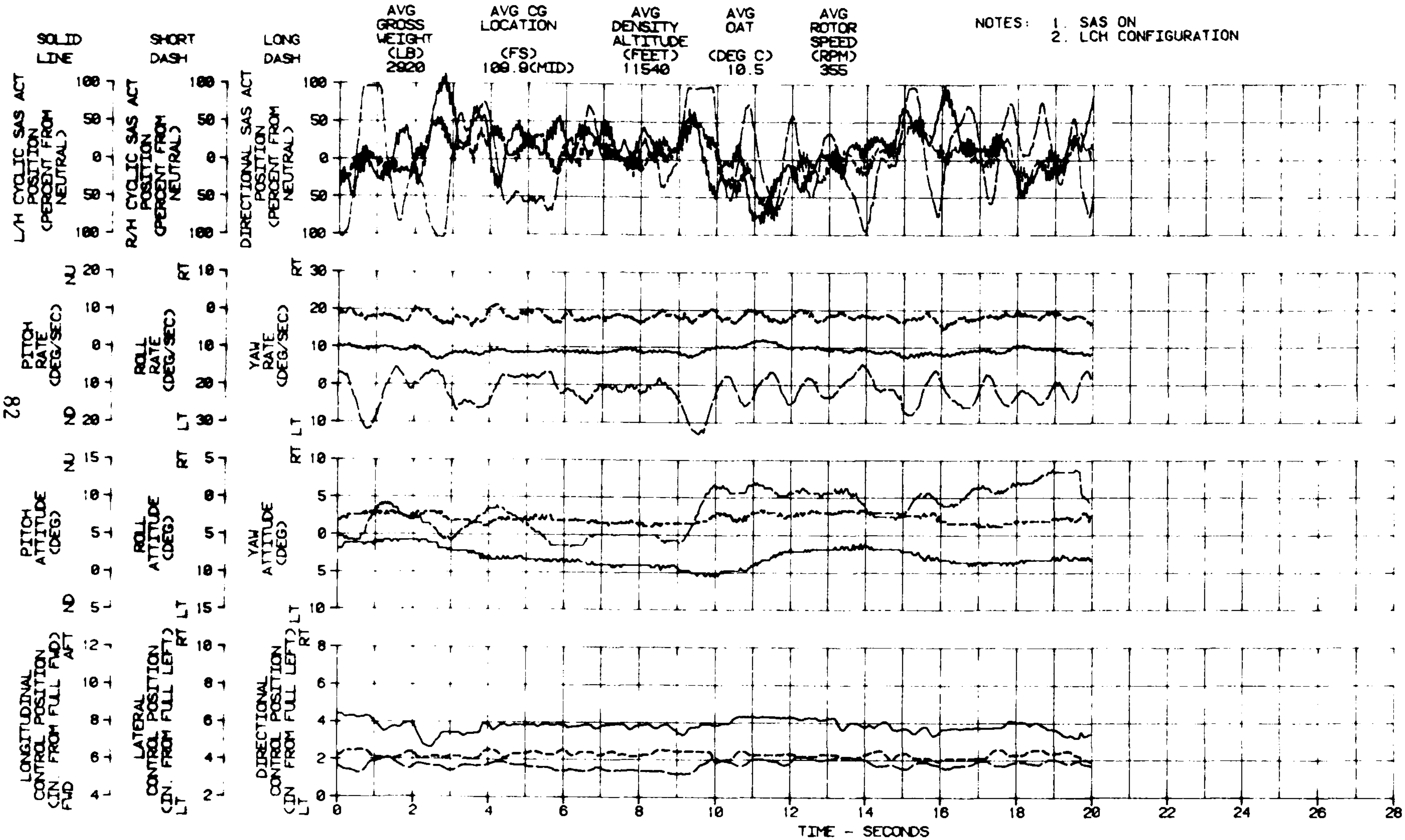


FIGURE 29
LOW SPEED FLIGHT
AZIMUTH: 225 DEG. 20 KTS
JOH-58C USA S/N 70-15349

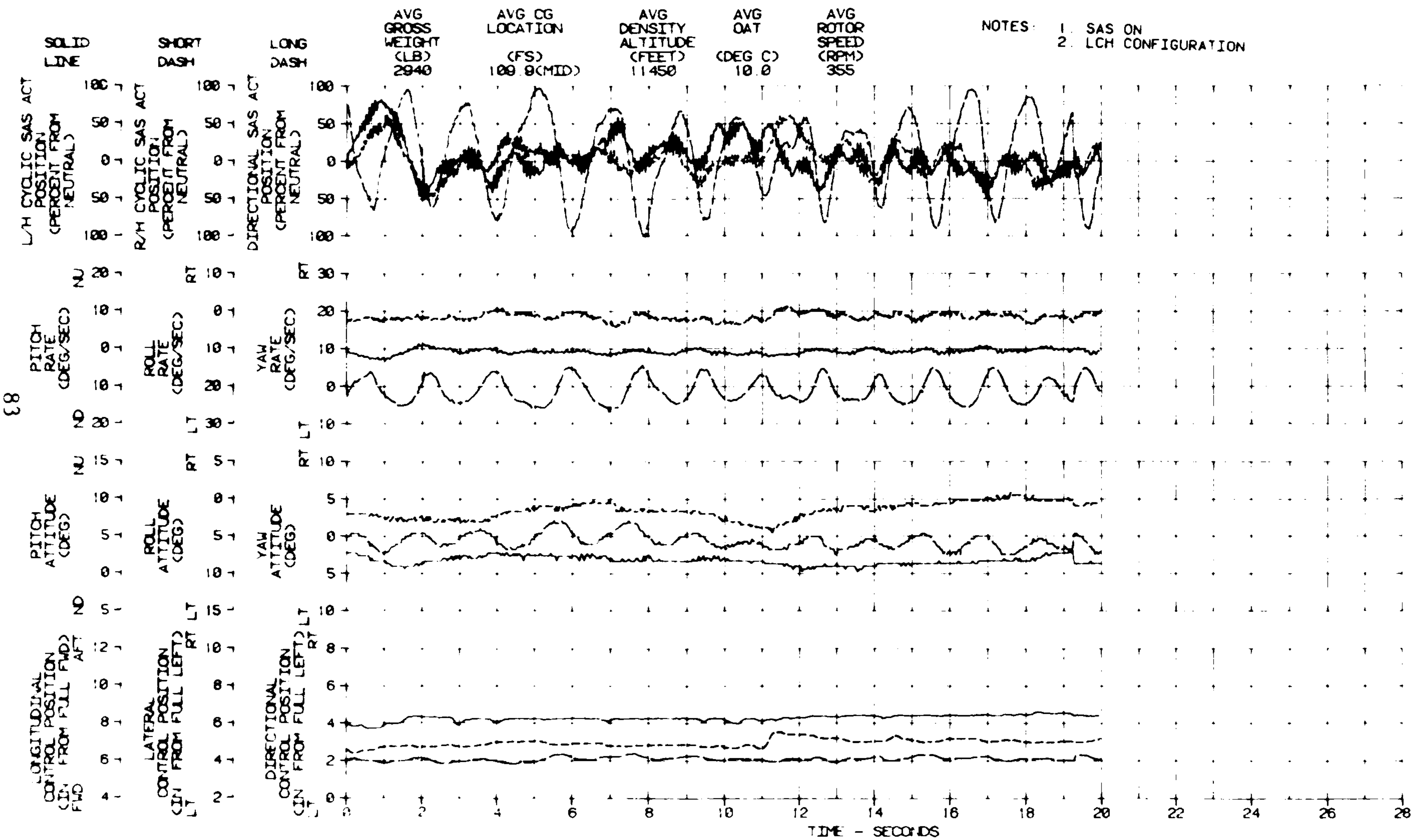


FIGURE 30
LOW SPEED FLIGHT
AZIMUTH: 240 DEG. 21 KTS
JOH-58C USA S/N 70-15340

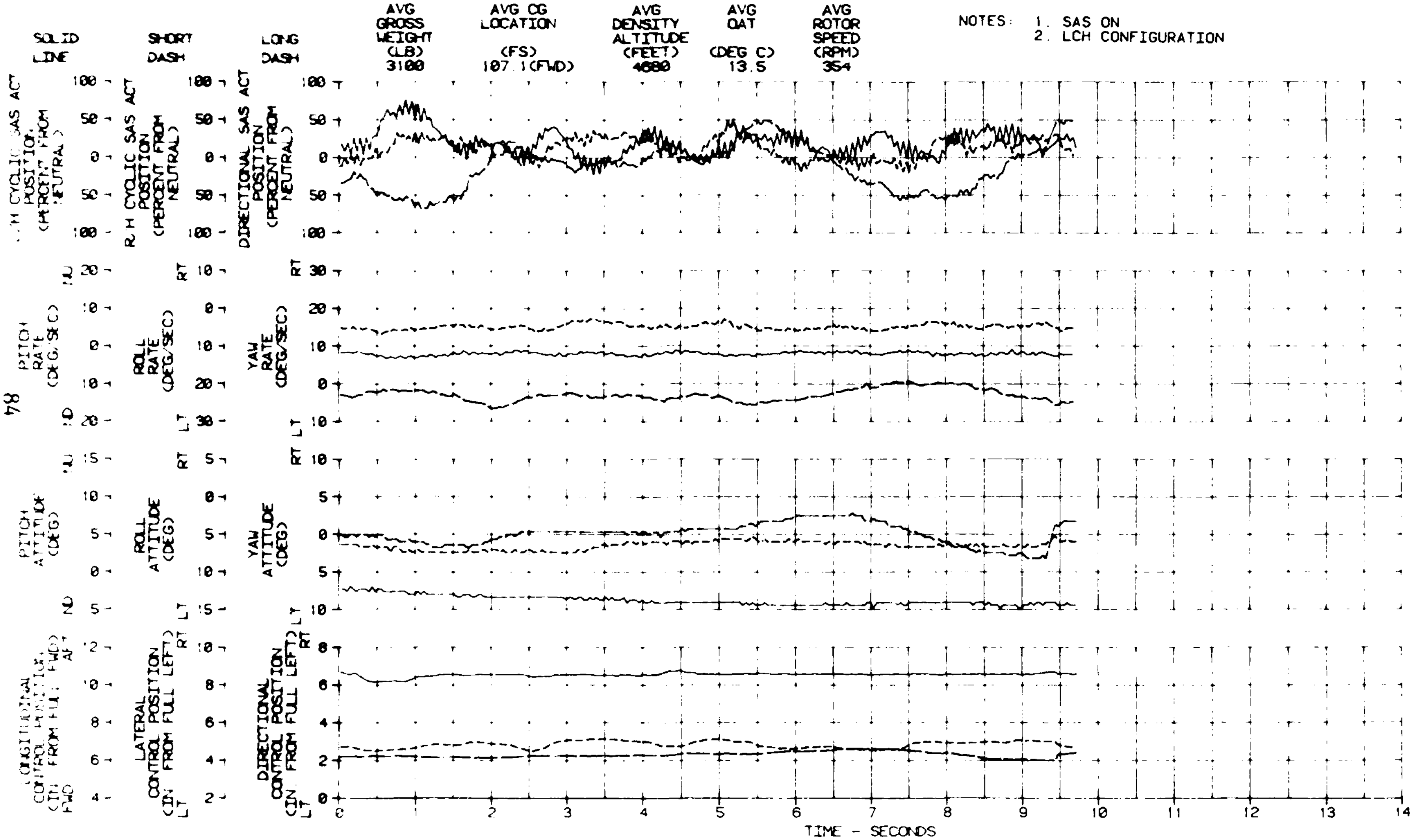


FIGURE 31
LOW SPEED FLIGHT
AZIMUTH 225 DEG 20 KTS
JOH-58C USA S/N 70-15349

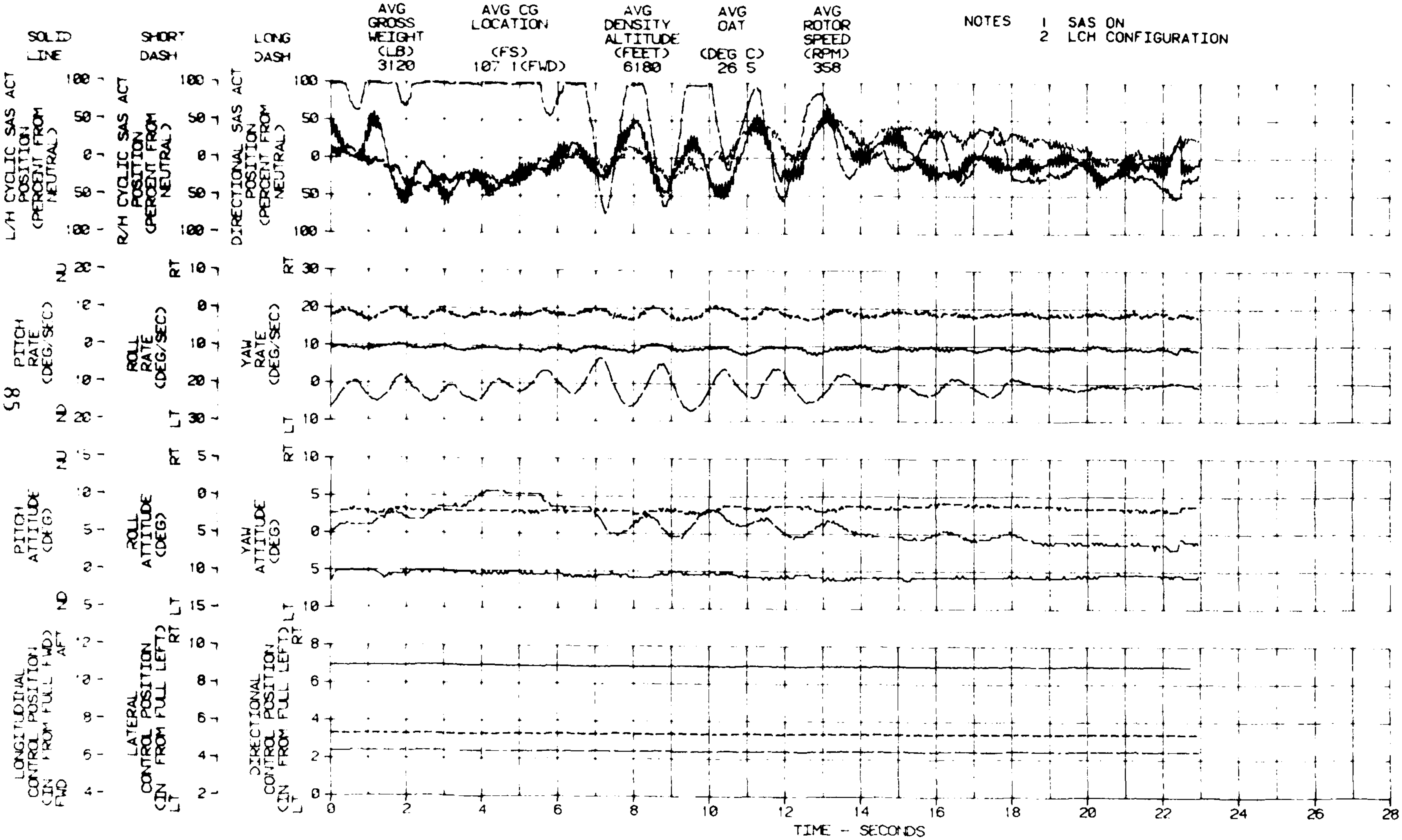


FIGURE 32
LOW SPEED FLIGHT
AZIMUTH: 240 DEG. 15 KTS
JOH-58C USA S/N 70-15349

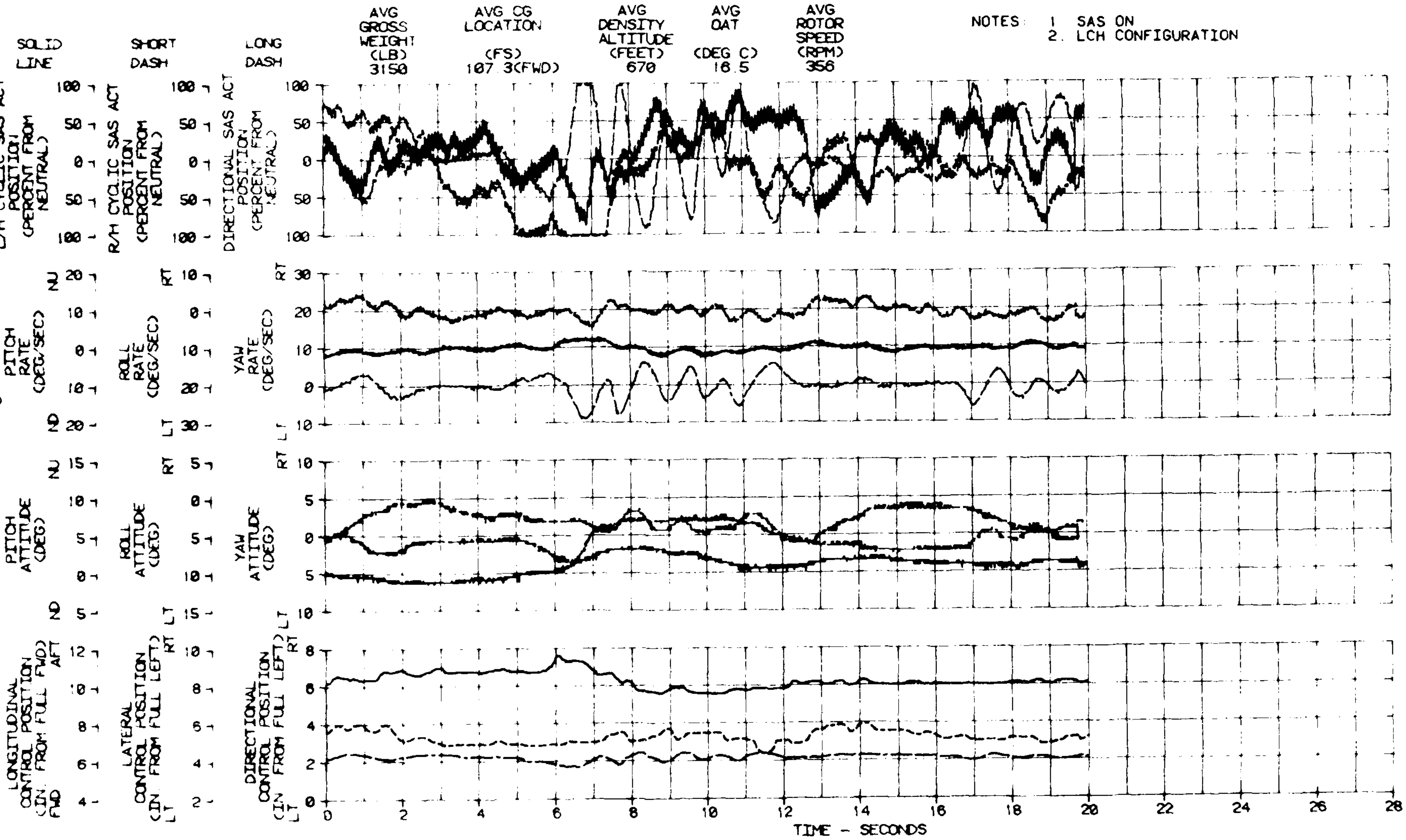


FIGURE 33
LOW SPEED FLIGHT
AZIMUTH: 240 DEG. 15 KTS
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
3140	107.3(FWD)	740	17.0	356

NOTES: 1. SAS OFF
2. LCH CONFIGURATION

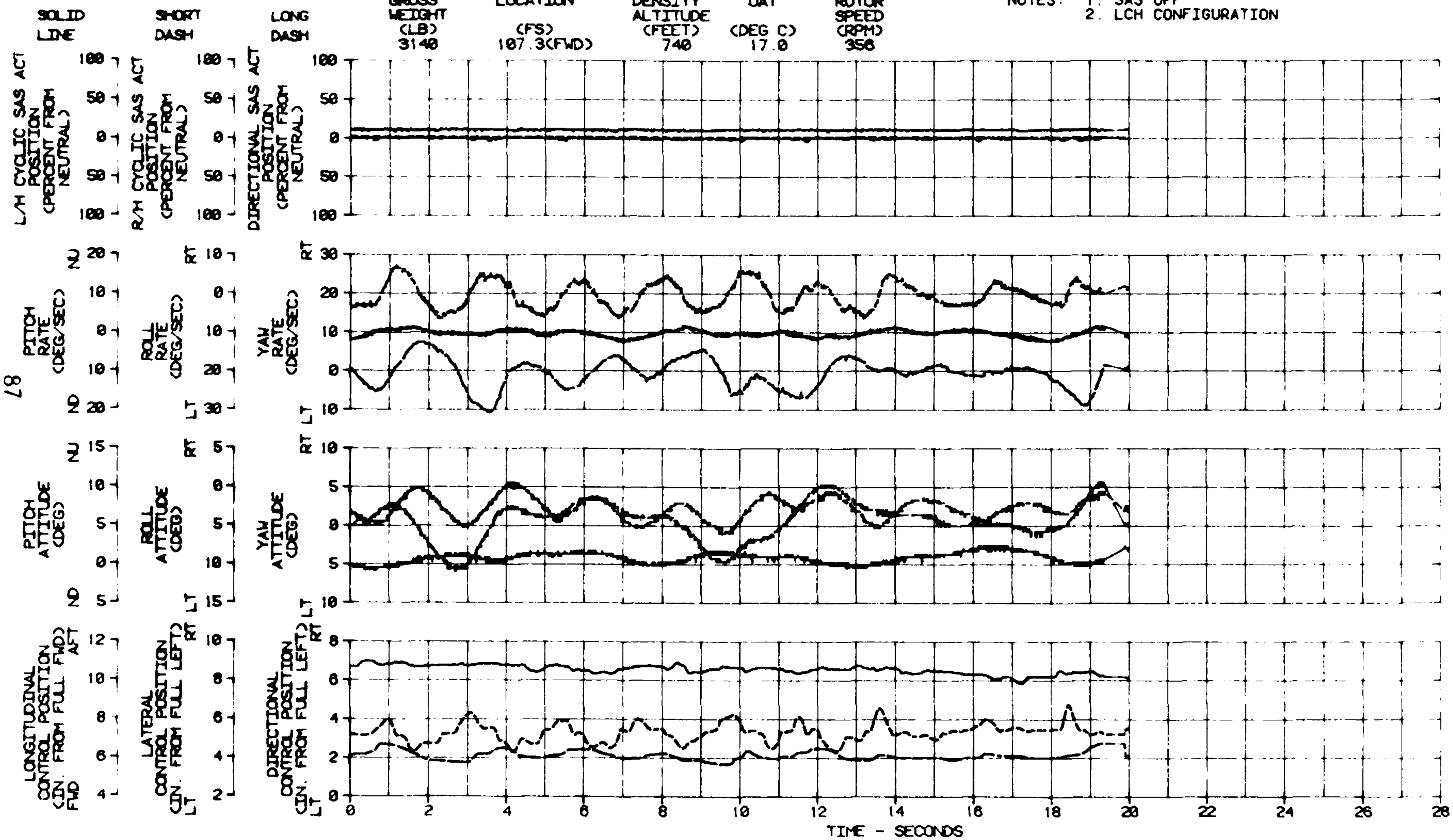


FIGURE 34
LOW SPEED FLIGHT 330 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3160	107.6 (FWD)	1160	20.5	354	10	ON

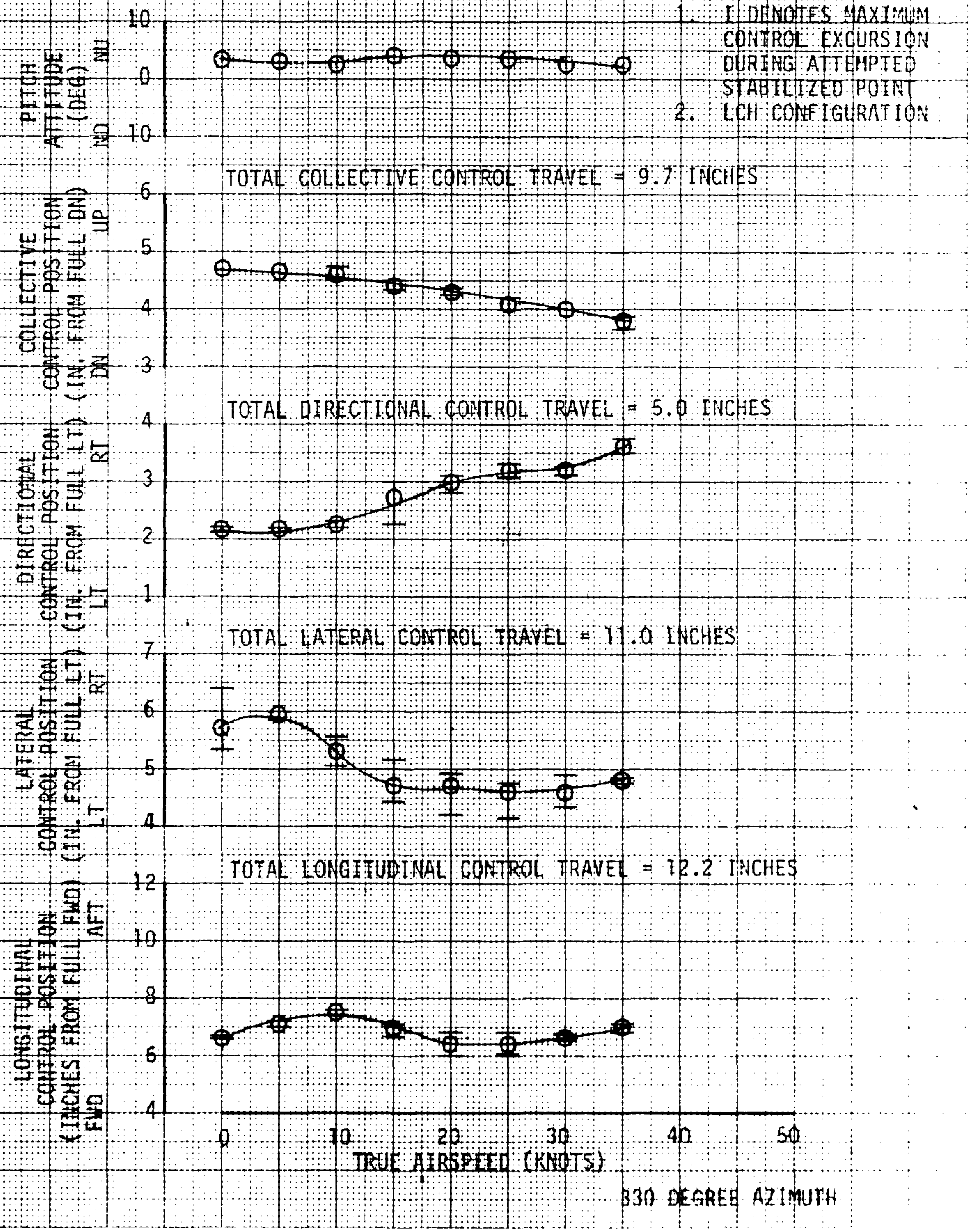
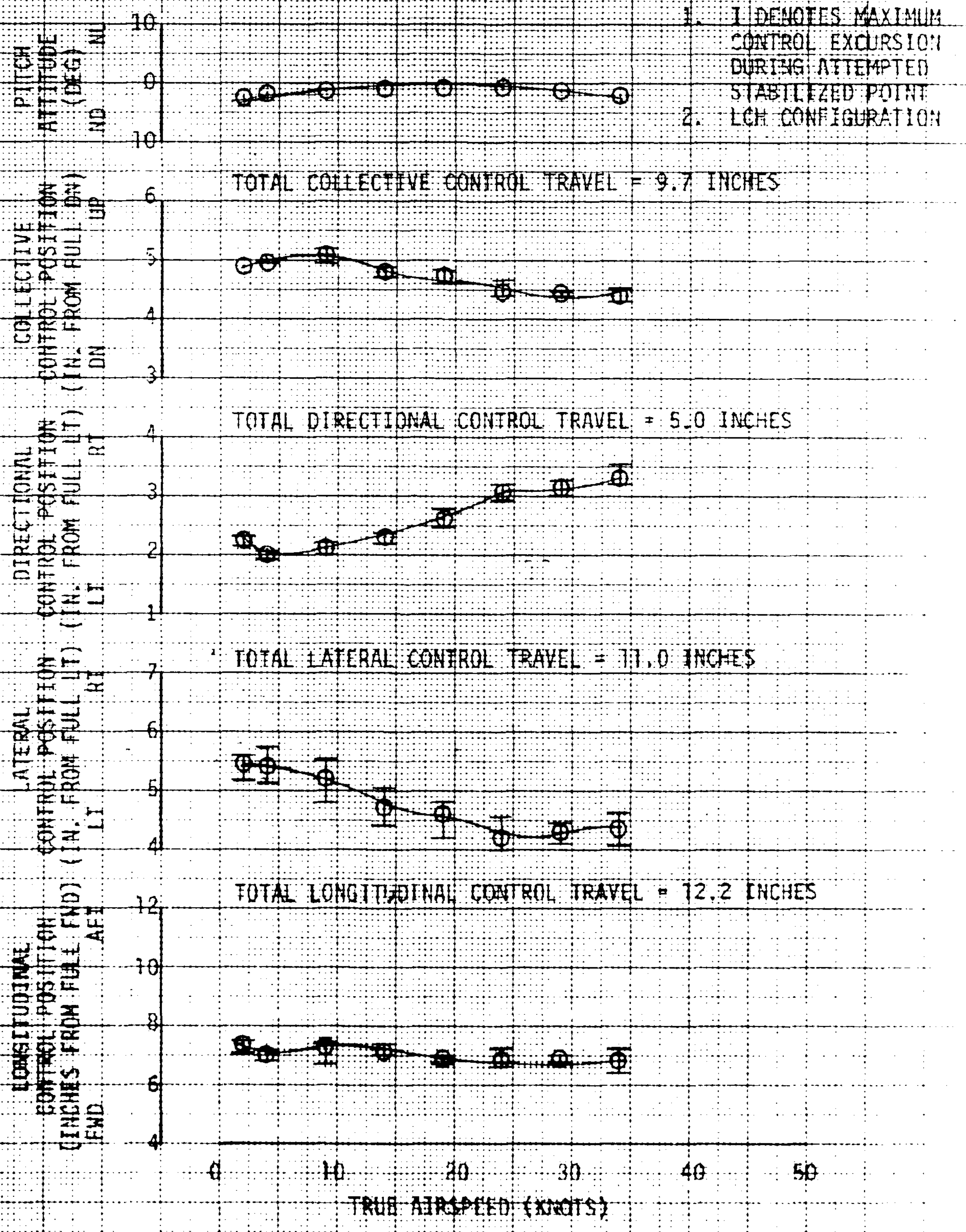


FIGURE 35
LOW SPEED FLIGHT 330 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

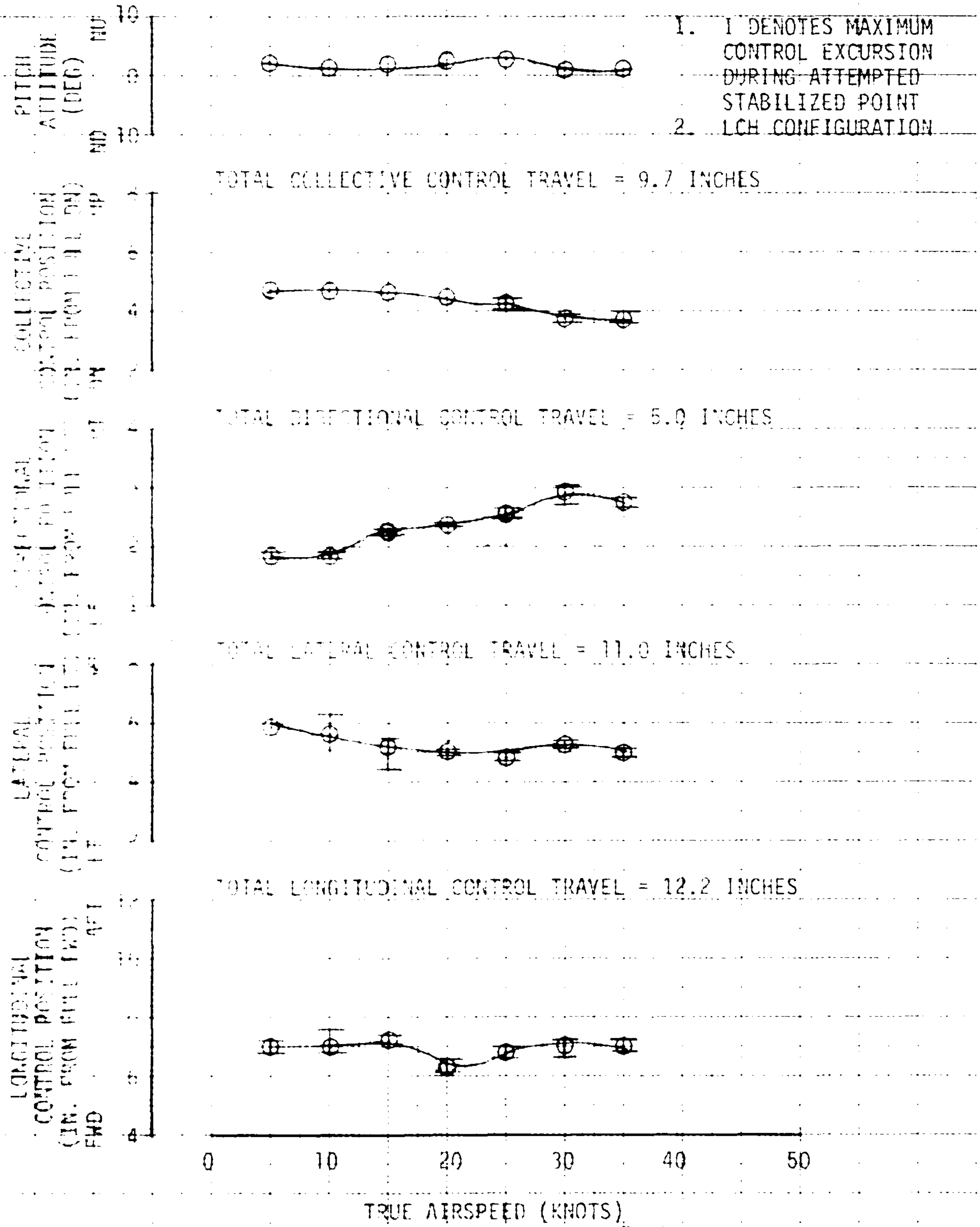
AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3090	107.0(FWD)	4670	12.0	354	10	ON



330 DEGREE AZIMUTH

FIGURE 36
LOW-SPEED FORWARD FLIGHT
JOH-58C USA S/N 70-15349

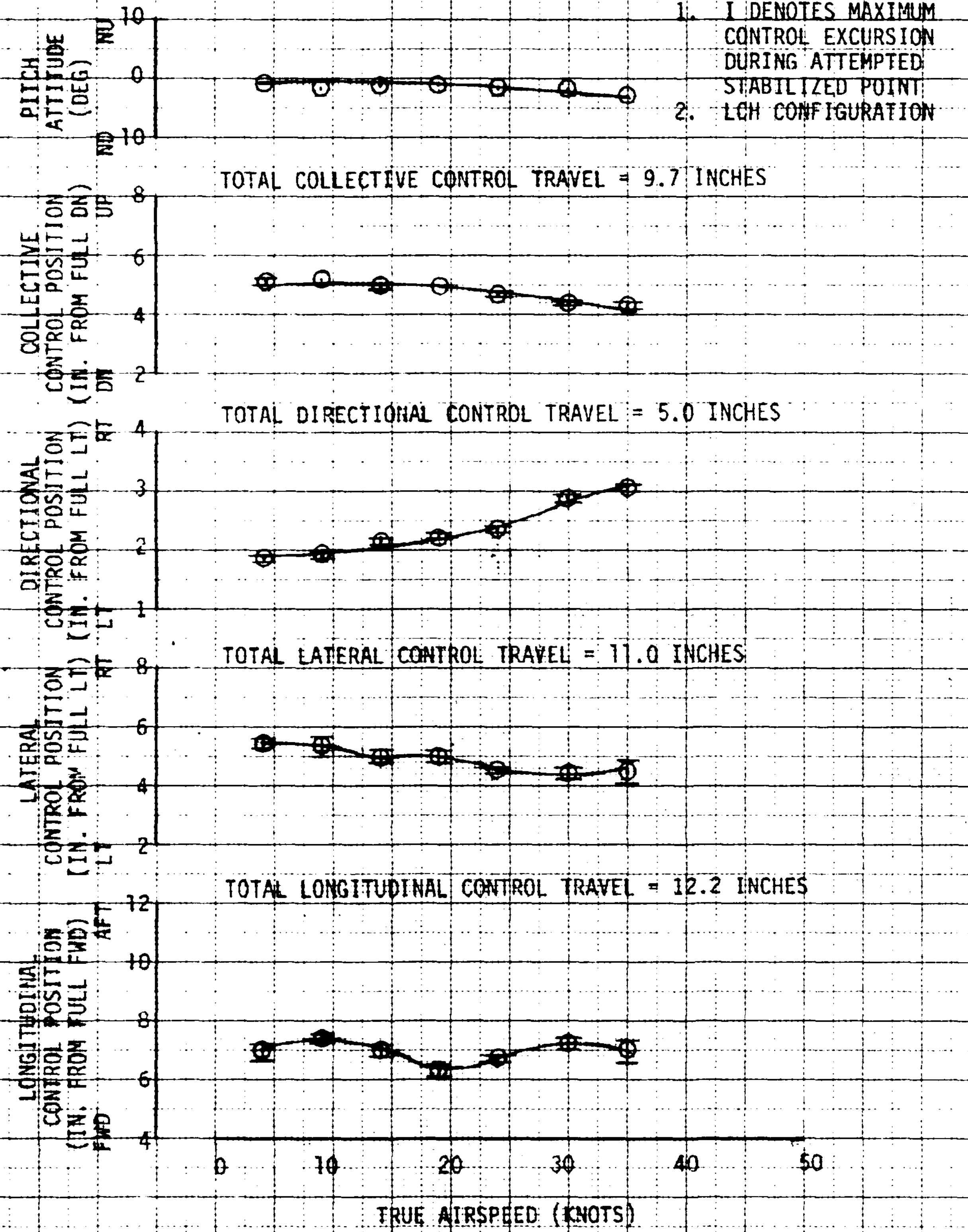
AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3130	107.6 (FWD)	920	18.5	354	10	ON



ZERO DEGREE AZIMUTH

FIGURE 37
LOW-SPEED FORWARD FLIGHT
JOH-58C USA S/N 70-15349

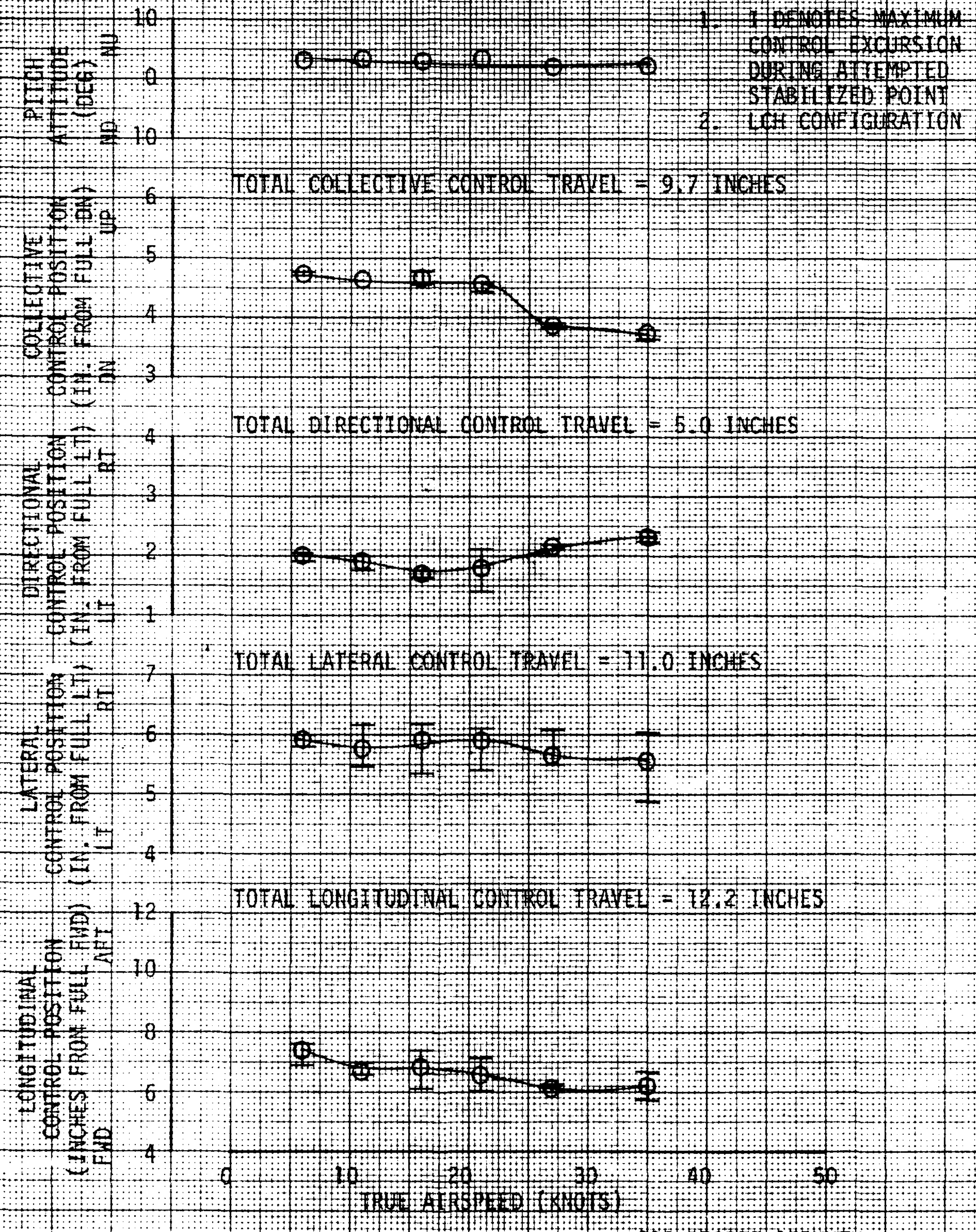
AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3180	107.2(FWD)	4630	11.5	354	10	ON



ZERO DEGREE AZIMUTH

FIGURE 38
LOW SPEED FLIGHT 030 DEGREE AZIMUTH
OH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3080	107.5 (FWD)	990	19.0	354	10	ON



030 DEGREE AZIMUTH

FIGURE 39
LOW SPEED FLIGHT 030 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3150	107.2(FWD)	4680	11.5	354	10	ON

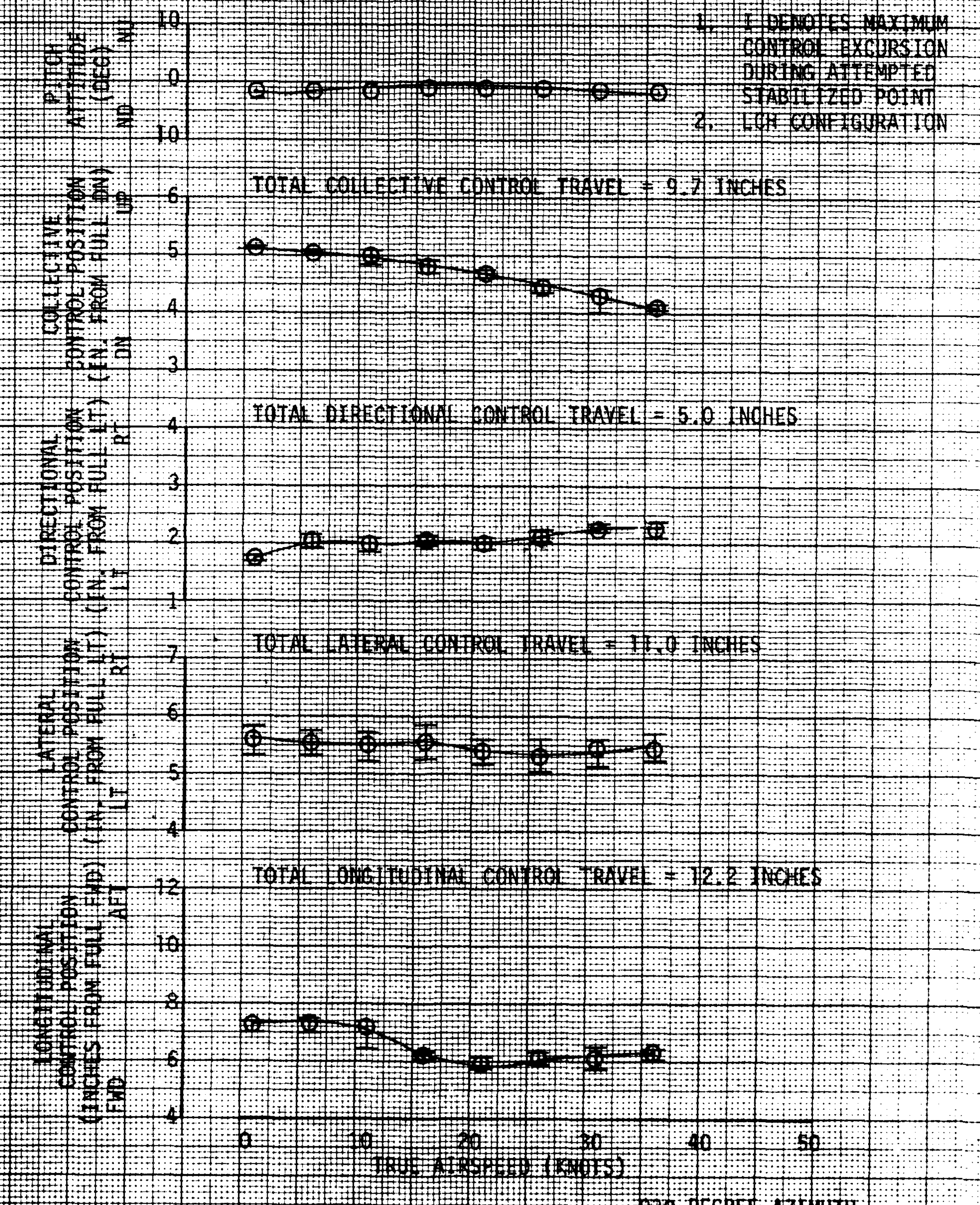
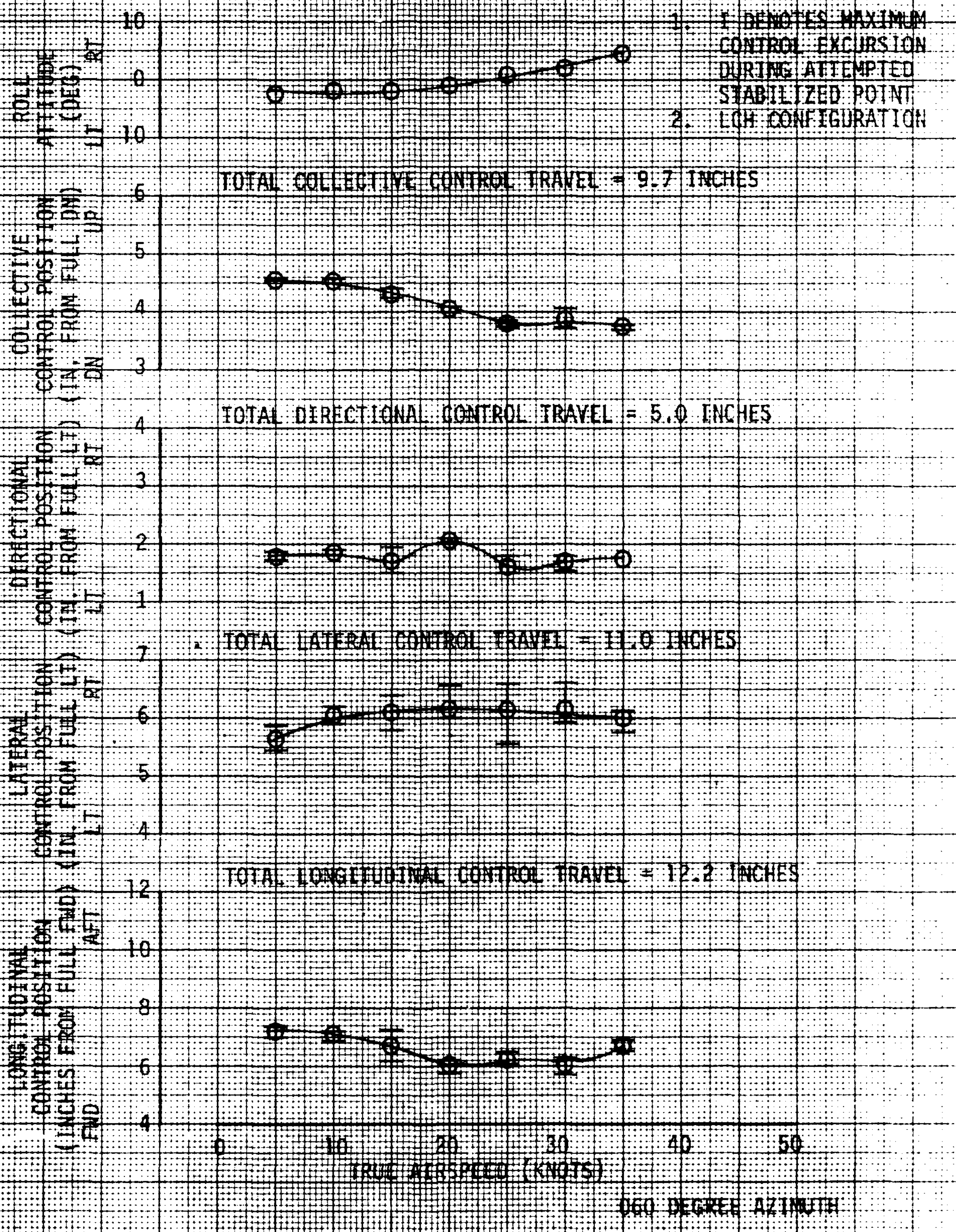


FIGURE 40
LOW SPEED FLIGHT 060 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3060	107.4 (FWD)	960	19.0	354	10	ON



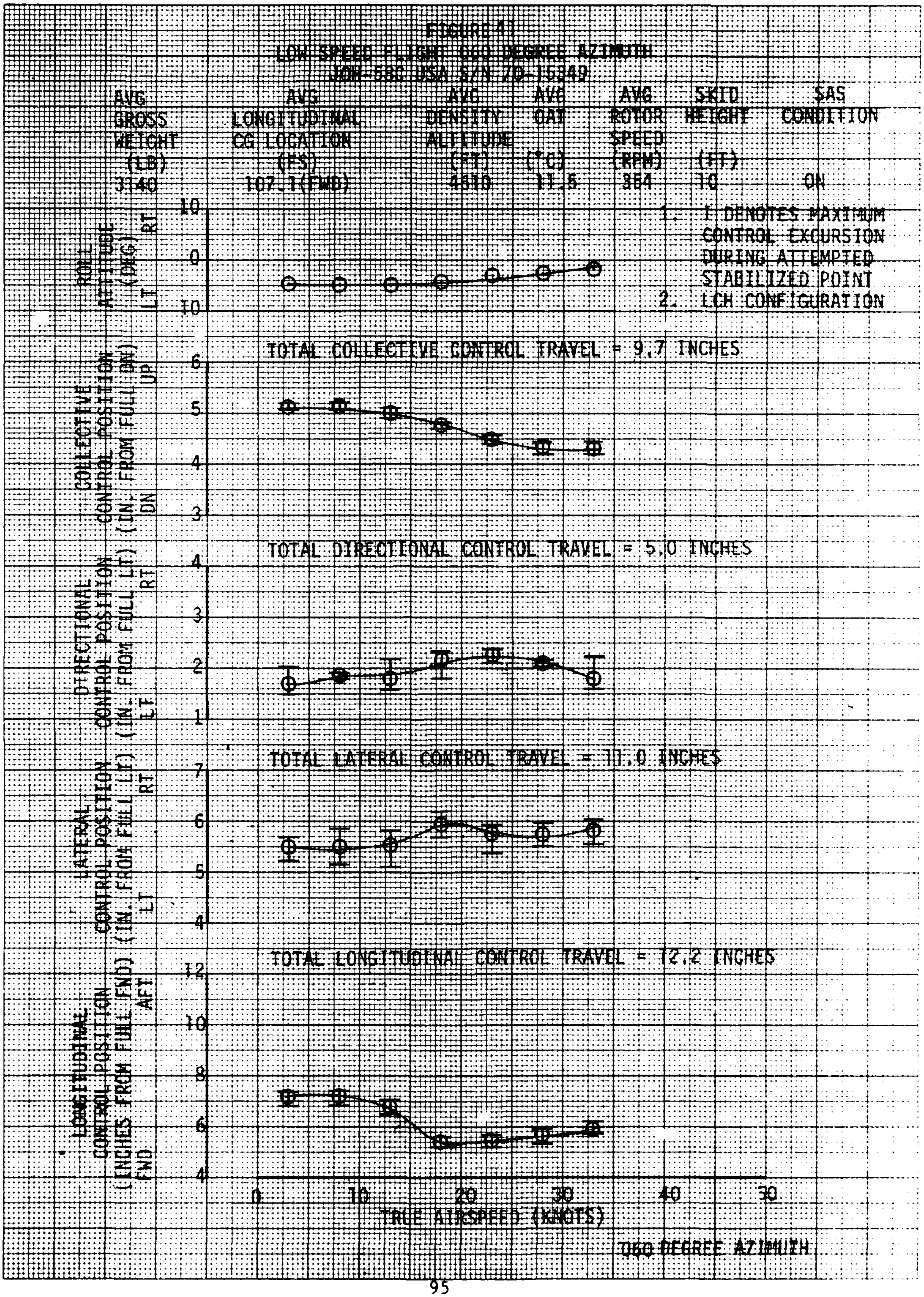


FIGURE 47
LOW SPEED FLIGHT 060 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 3140
AVG LONGITUDINAL CG LOCATION (FS) 107.1(FWD)
AVG DENSITY ALTITUDE (FT) 4810
AVG OAT (°C) 11.5
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
SAS CONDITION ON
1. I DENOTES MAXIMUM CONTROL EXCURSION DURING ATTEMPTED STABILIZED POINT
2. LCH CONFIGURATION
ROLL ATTITUDE (DEG) LT RT
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN) DN UP
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT) LT RT
TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT) LT RT
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (INCHES FROM FULL FWD) FWD AFT
TRUE AIRSPEED (KNOTS)
060 DEGREE AZIMUTH

FIGURE 42
RIGHT SIDEWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3130	107.6 (FWD)	920	18.5	354	10	ON

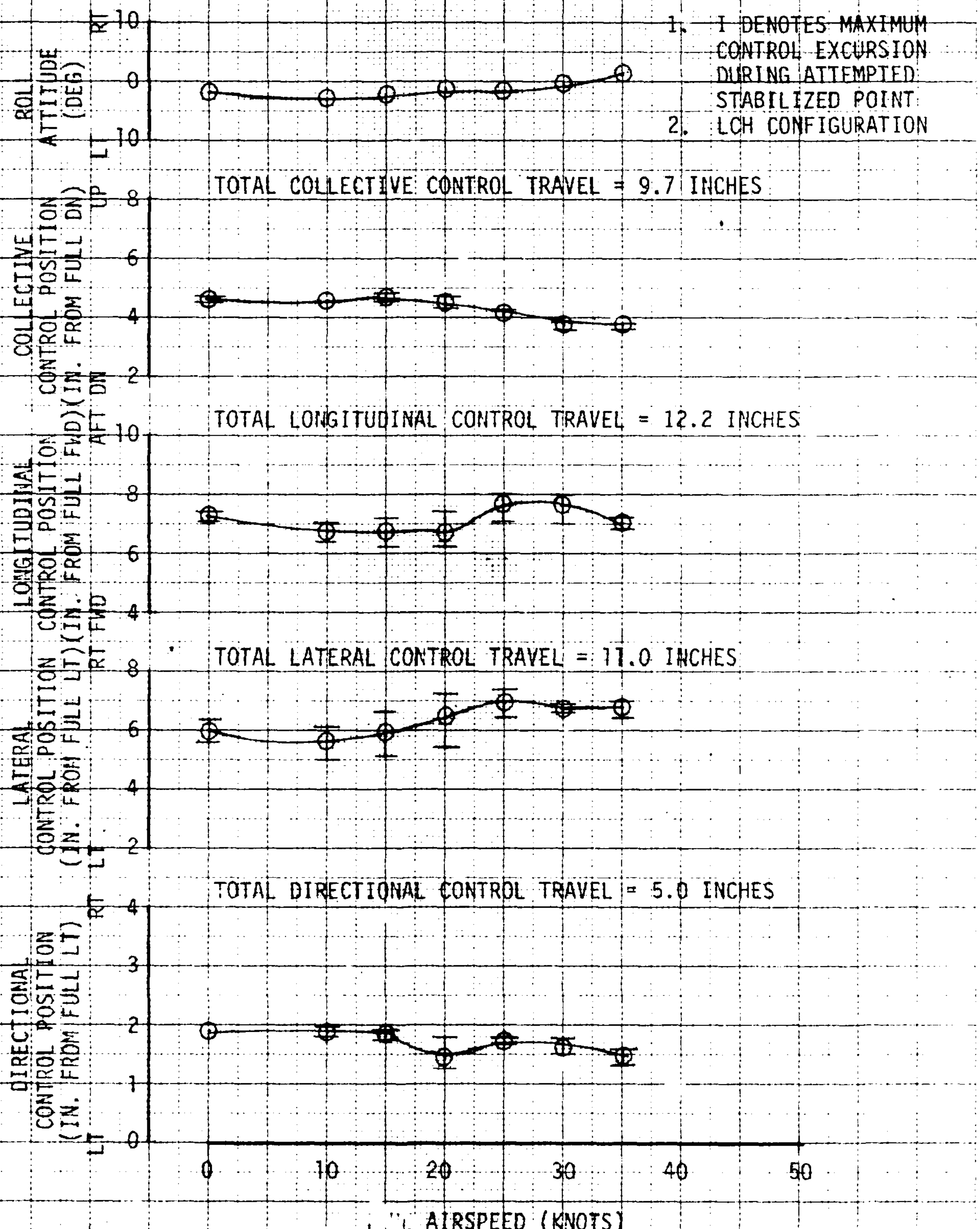
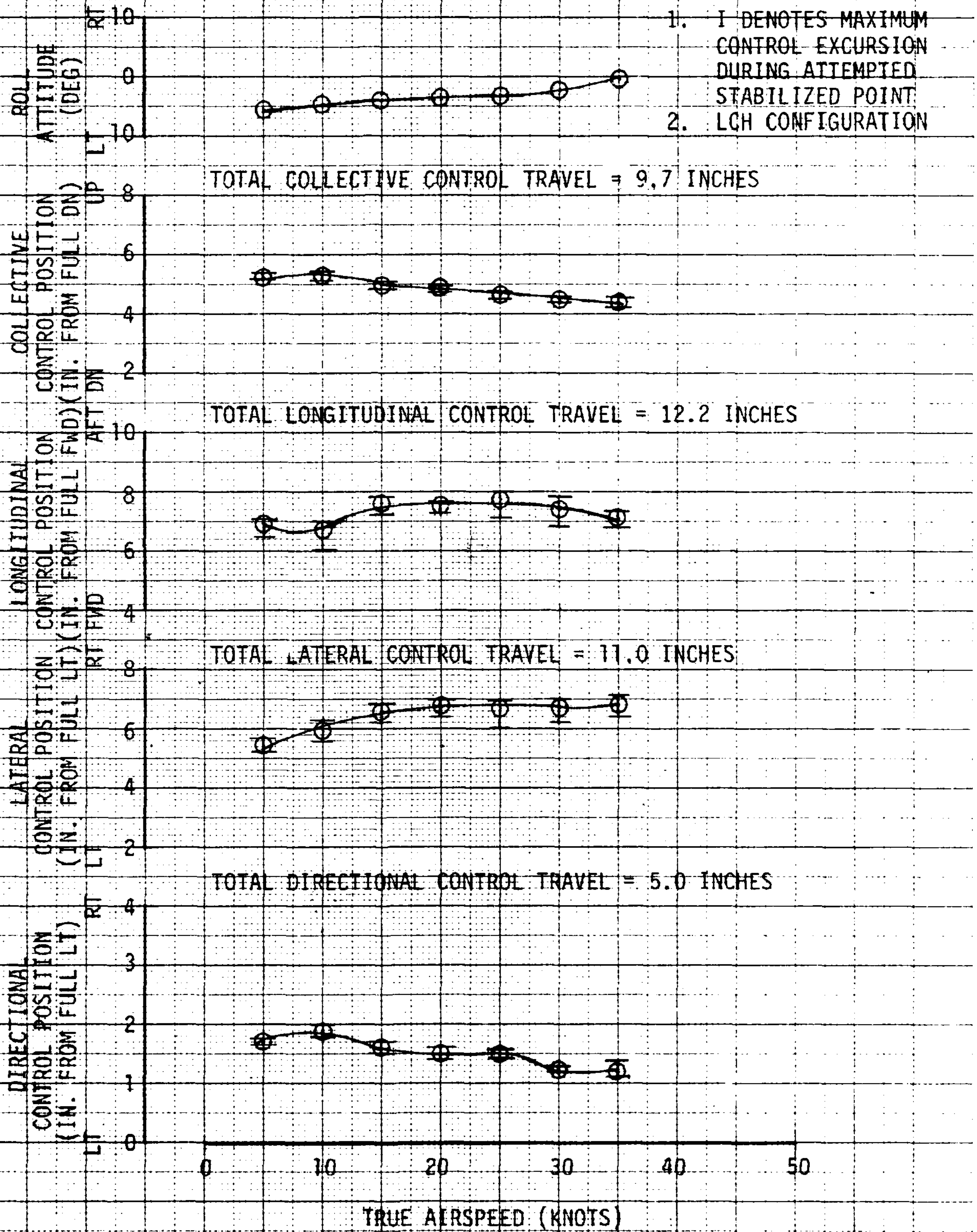


FIGURE 43
RIGHT SIDEWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3180	107.2 (FWD)	4500	10.5	354	10	ON



90 DEGREE AZIMUTH

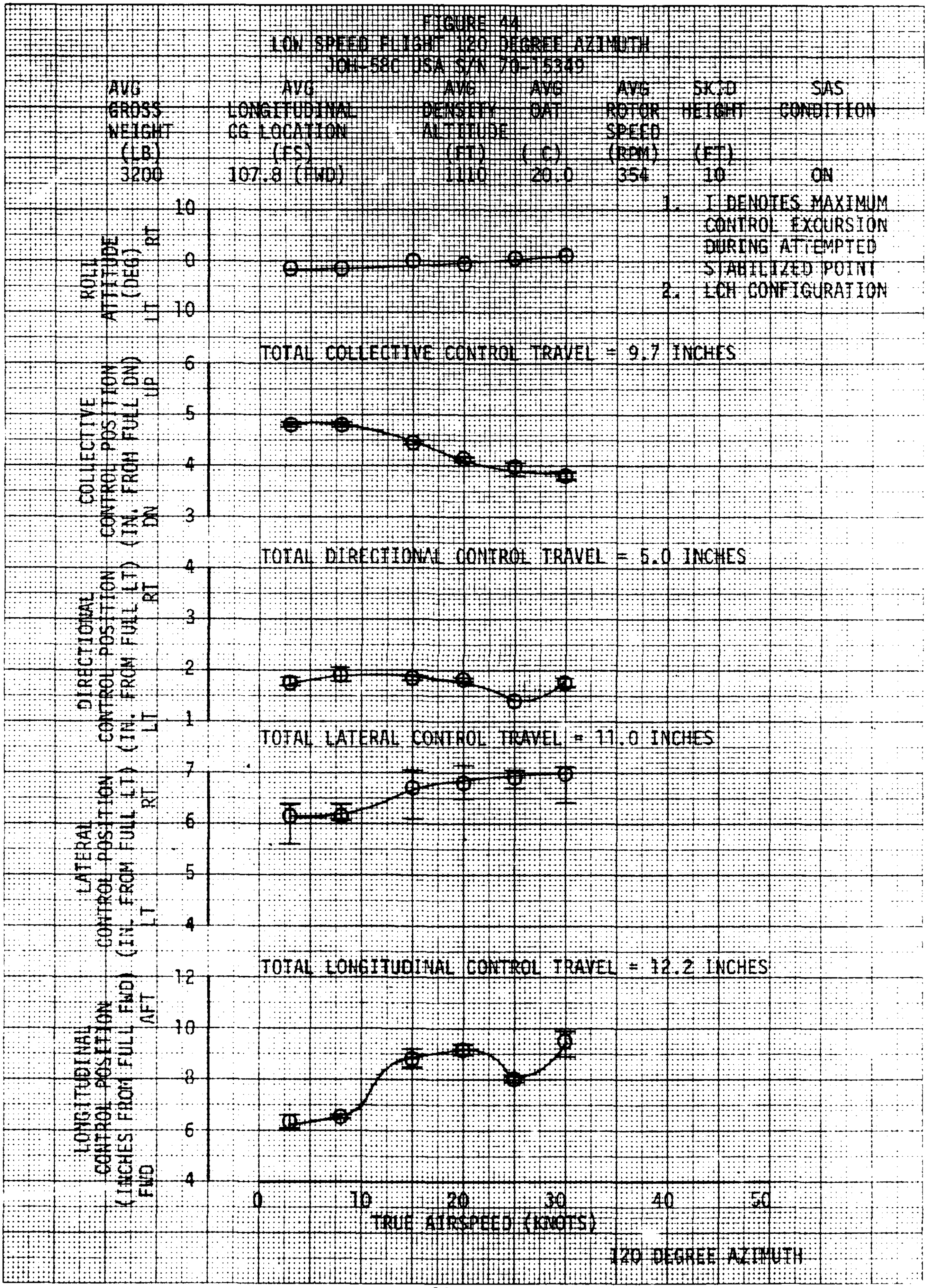


FIGURE 44
LOW SPEED FLIGHT 120 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 3200
AVG LONGITUDINAL CG LOCATION (FS) 107.8 (FWD)
AVG DENSITY ALTITUDE (FT) 1110
AVG OAT (°C) 20.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
SAS CONDITION ON
1. I DENOTES MAXIMUM CONTROL EXCURSION DURING ATTEMPTED STABILIZED POINT
2. LCH CONFIGURATION
ROLL ATTITUDE (DEG) LT RT
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN) DN UP
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT) LT RT
TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT) LT RT
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (INCHES FROM FULL FWD) FWD AFT
TRUE AIRSPEED (KNOTS)
120 DEGREE AZIMUTH

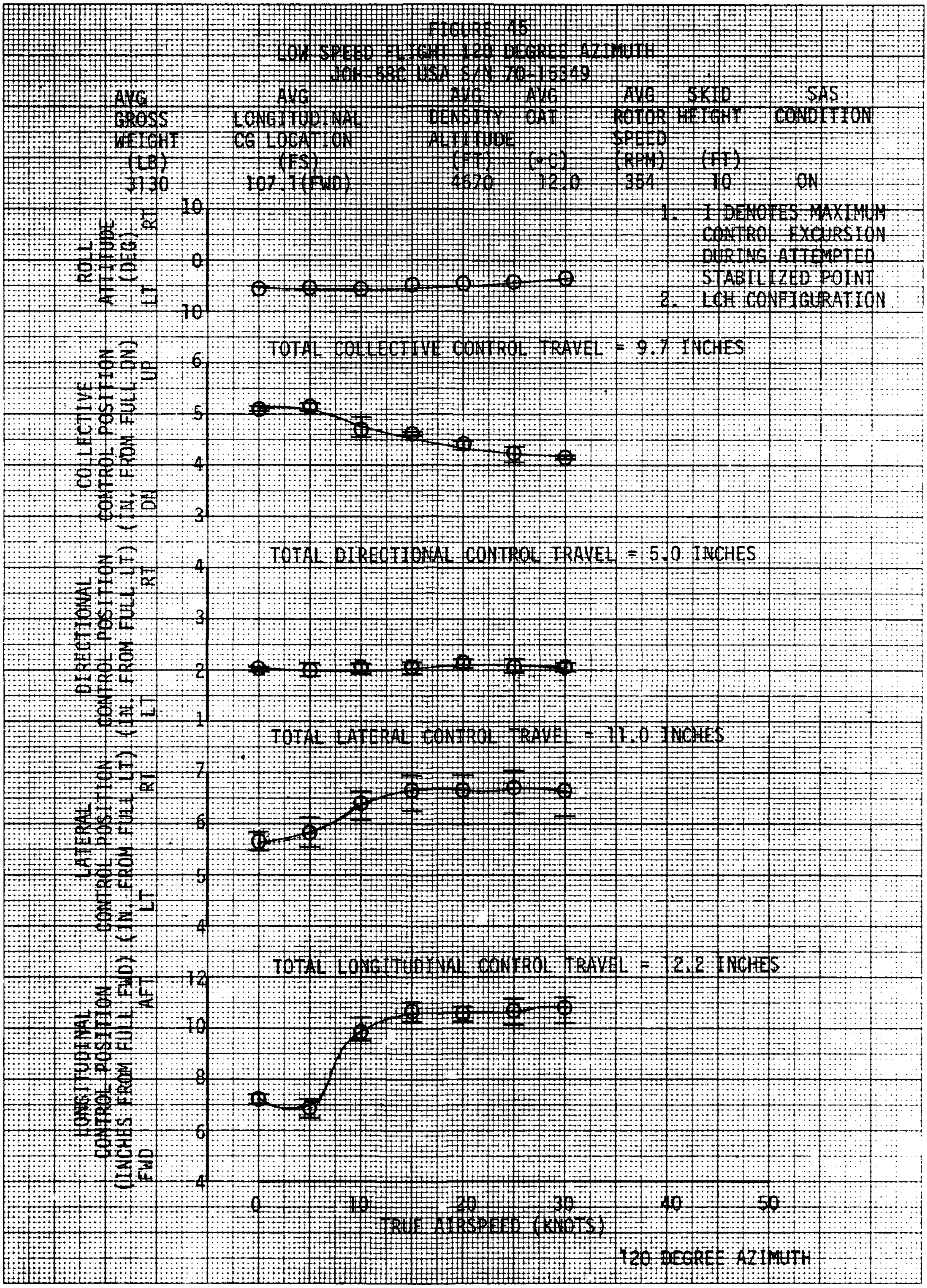


FIGURE 45
LOW SPEED FLIGHT 120 DEGREES AZIMUTH
JOH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 3130
AVG LONGITUDINAL CG LOCATION (FS) 107.1(FWD)
AVG DENSITY ALTITUDE (FT) 4670
AVG OAT (°C) 12.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
SAS CONDITION ON
1. I DENOTES MAXIMUM CONTROL EXCURSION DURING ATTEMPTED STABILIZED POINT
2. LCH CONFIGURATION
ROLL ATTITUDE (DEG) LT RT
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN) DN UP
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT) LT RT
TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT) LT RT
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (INCHES FROM FULL FWD) FWD AFT
TRUE AIRSPEED (KNOTS)
120 DEGREE AZIMUTH

FIGURE 46
LOW SPEED FLIGHT 150 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3190	107.7 (FWD)	1150	20.5	354	10	ON

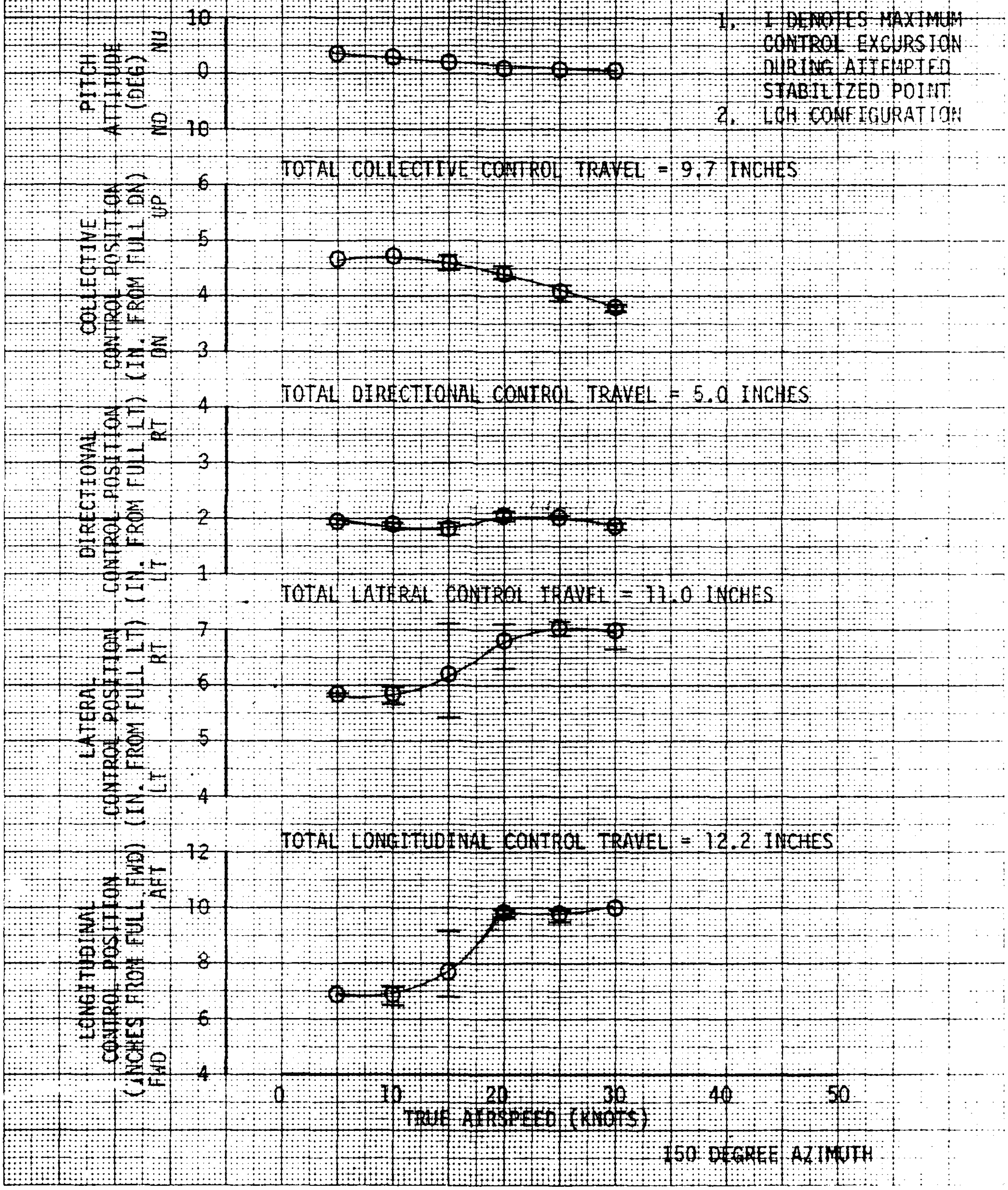


FIGURE 47
LOW SPEED FLIGHT 150 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3070	107.0(FWD)	4800	13.5	354	10	ON

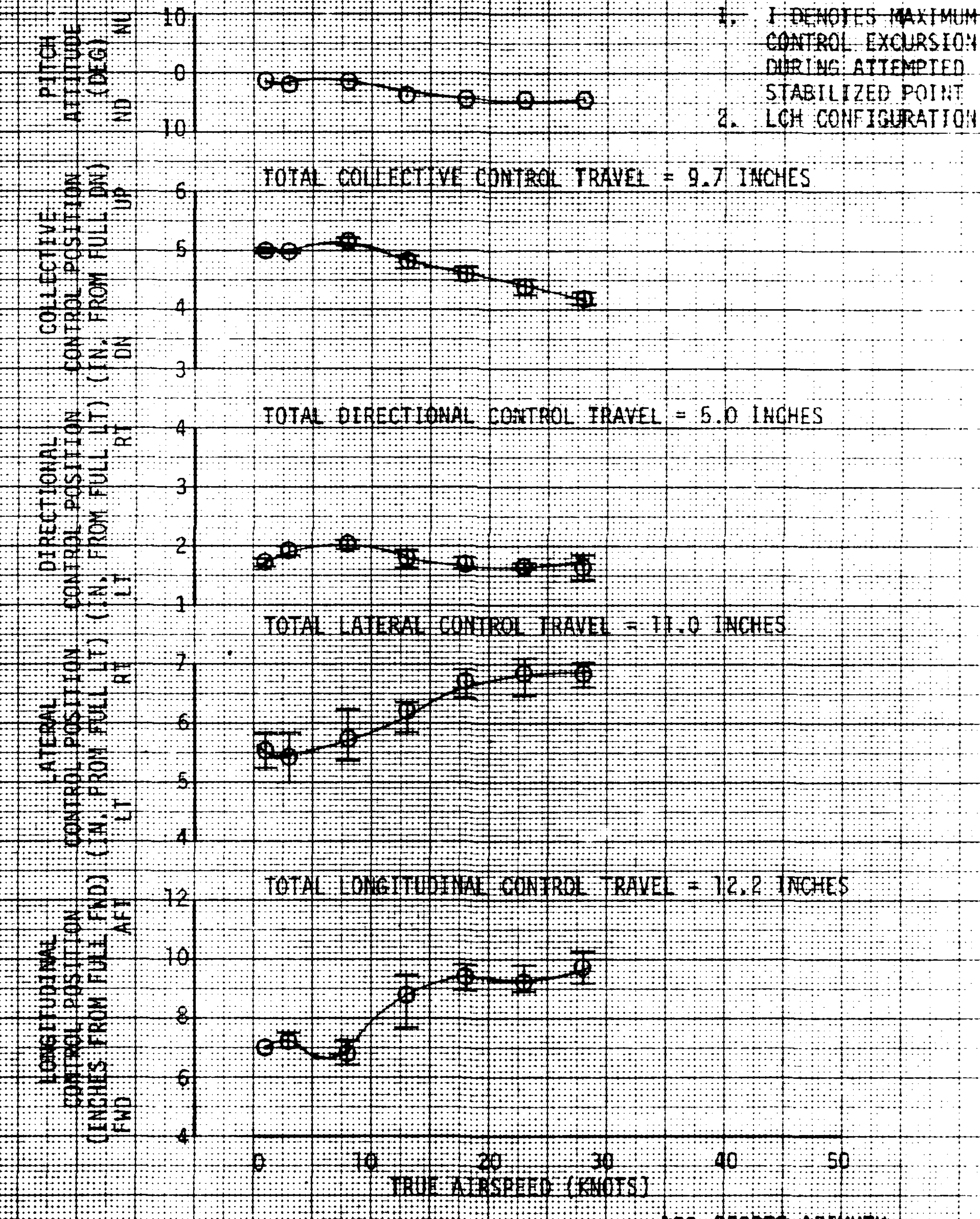
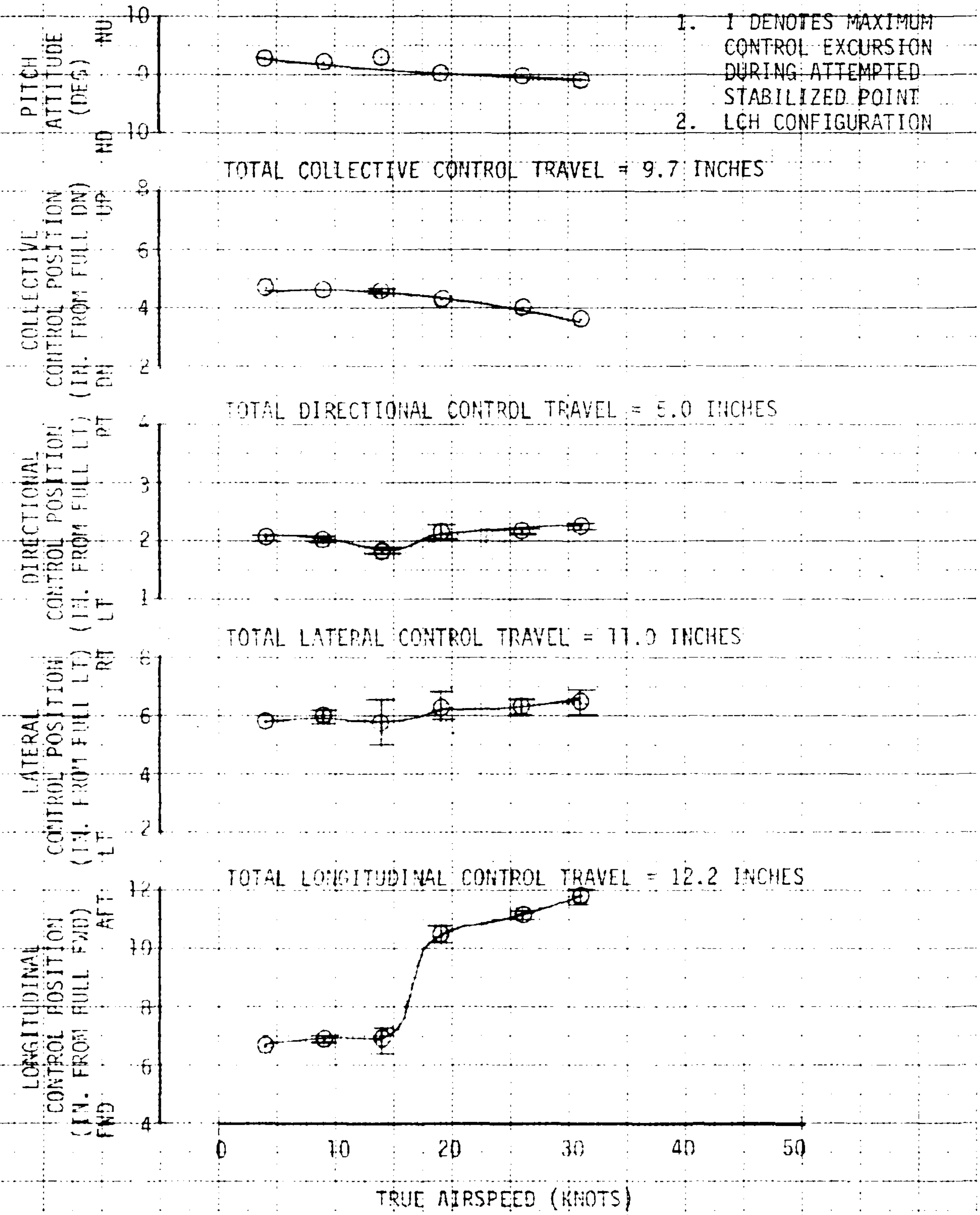


FIGURE 48
LOW-SPEED REARWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3130	107.6 (FWD)	920	18.5	354	10	ON



180 DEGREE AZIMUTH

FIGURE 49
LOW-SPEED REARWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3180	107.2 (FWD)	4630	11.5	354	10	ON

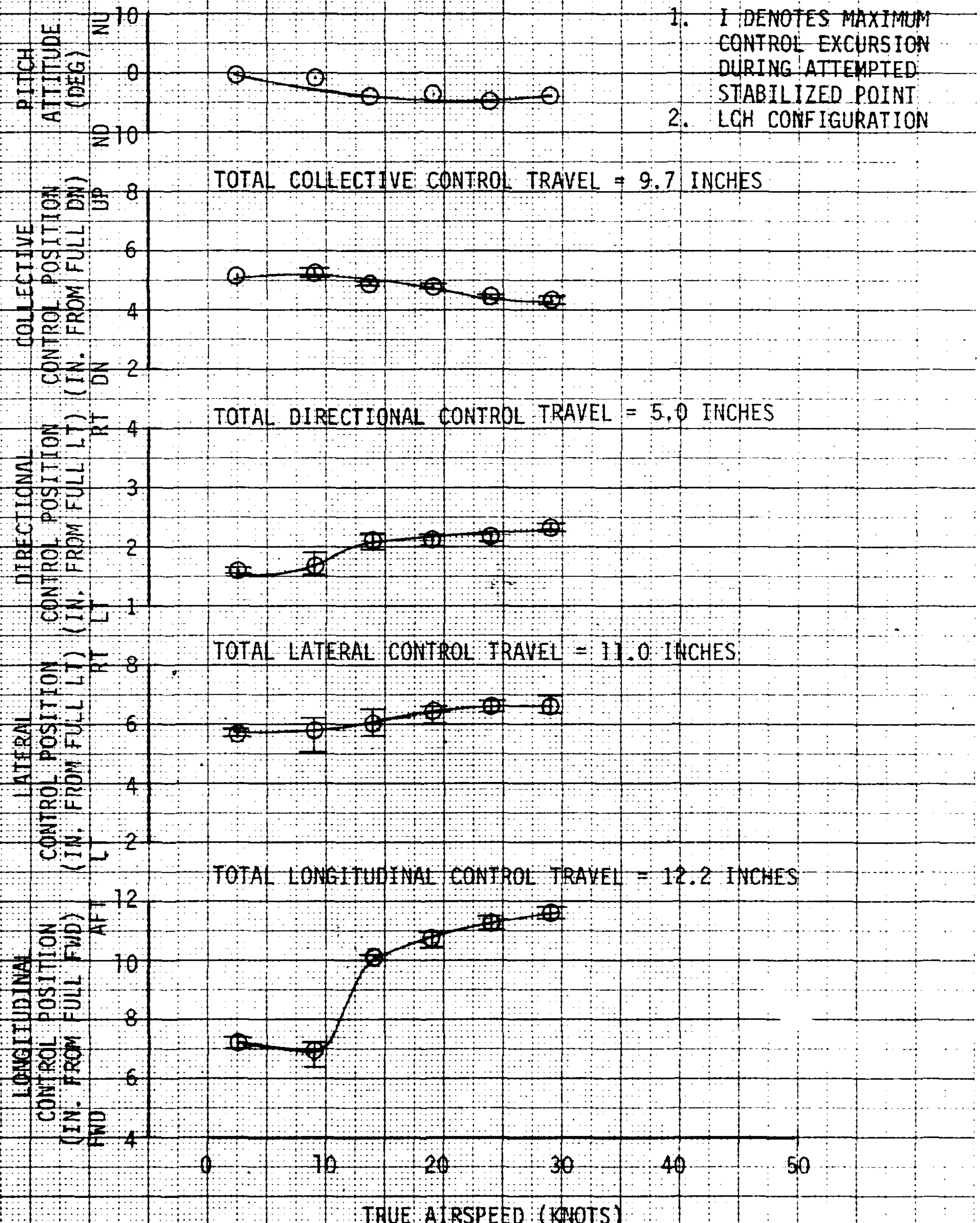
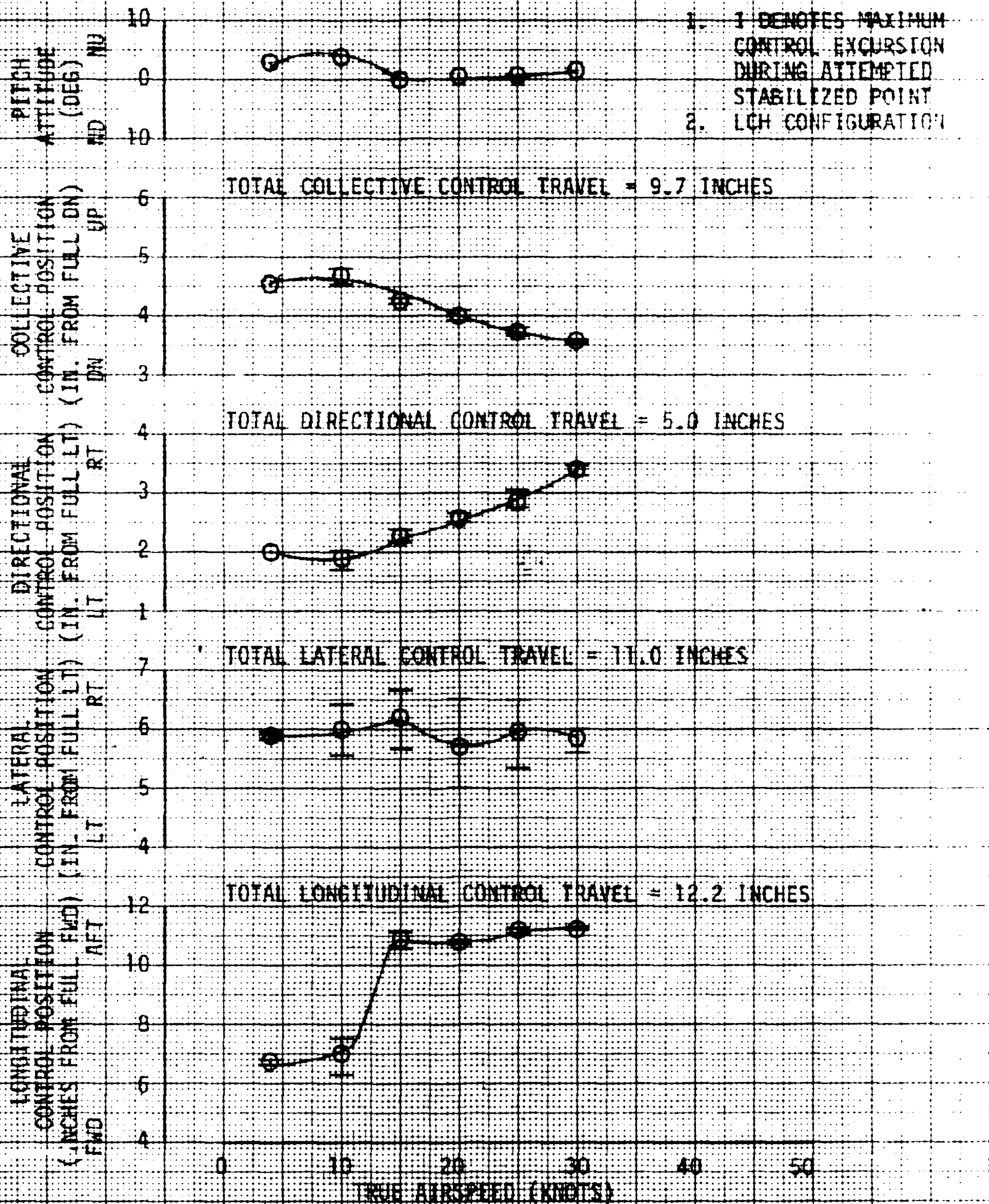


FIGURE 50
LOW SPEED FLIGHT 210 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3060	107.4 (FWD)	1340	22.0	354	10	ON



210 DEGREE AZIMUTH

FIGURE 51
LOW SPEED FLIGHT 210 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3120	107.1(FWD)	4670	12.0	354	10	ON

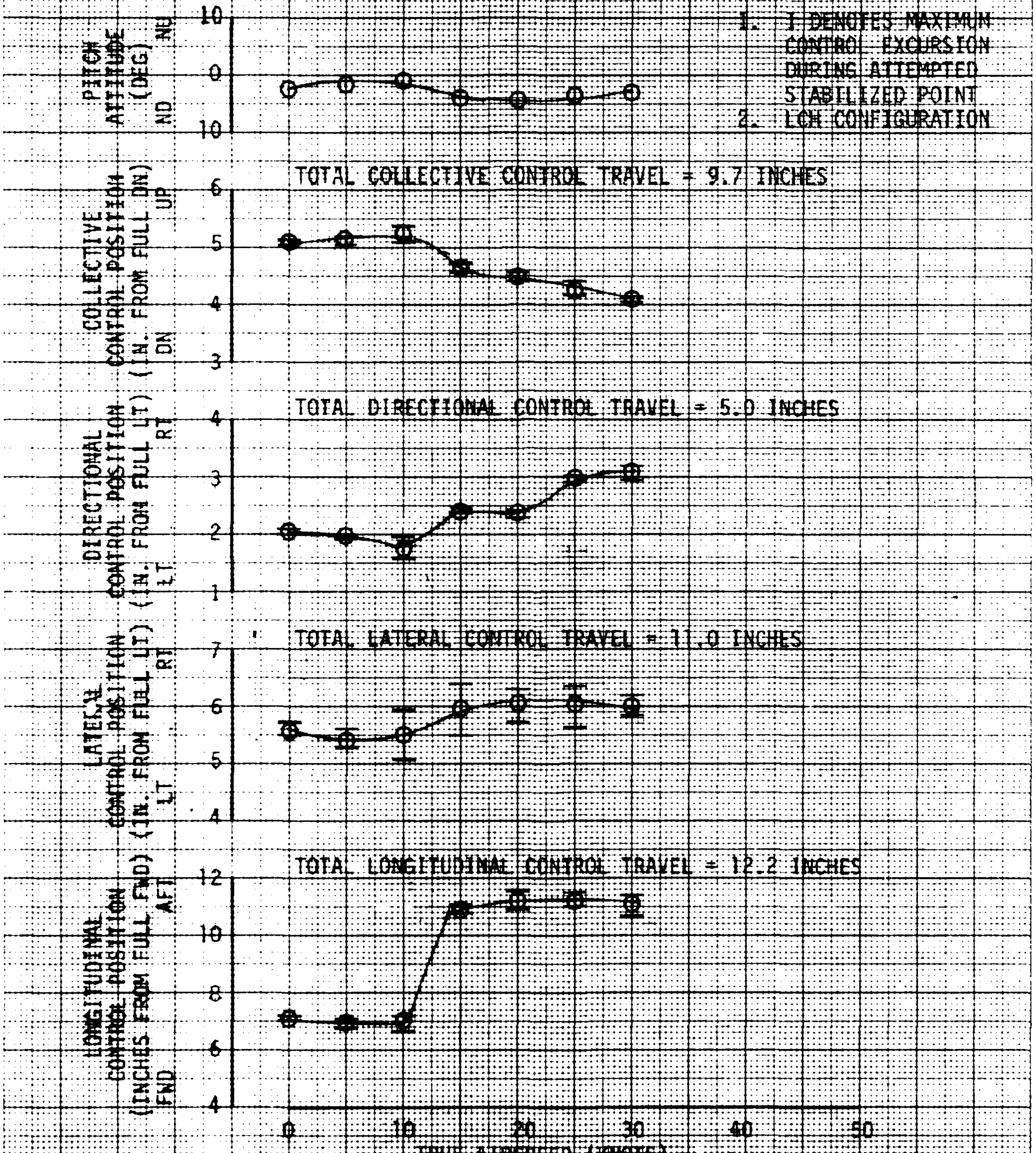
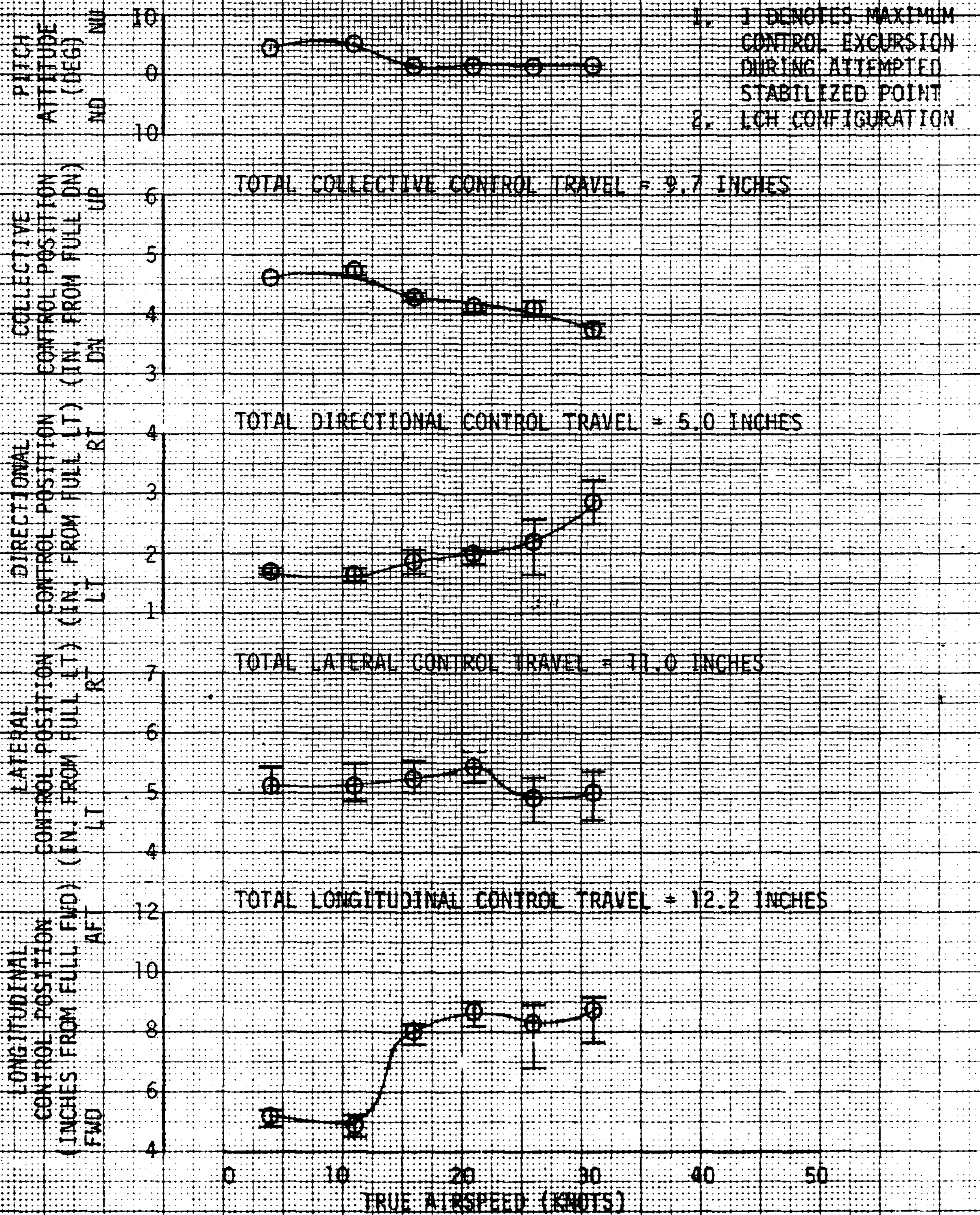


FIGURE 52
LOW SPEED FLIGHT 210 DEGREE AZIMUTH
OH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
2960	109.9(MID)	10,700	6.0	354	10	ON



210 DEGREE AZIMUTH

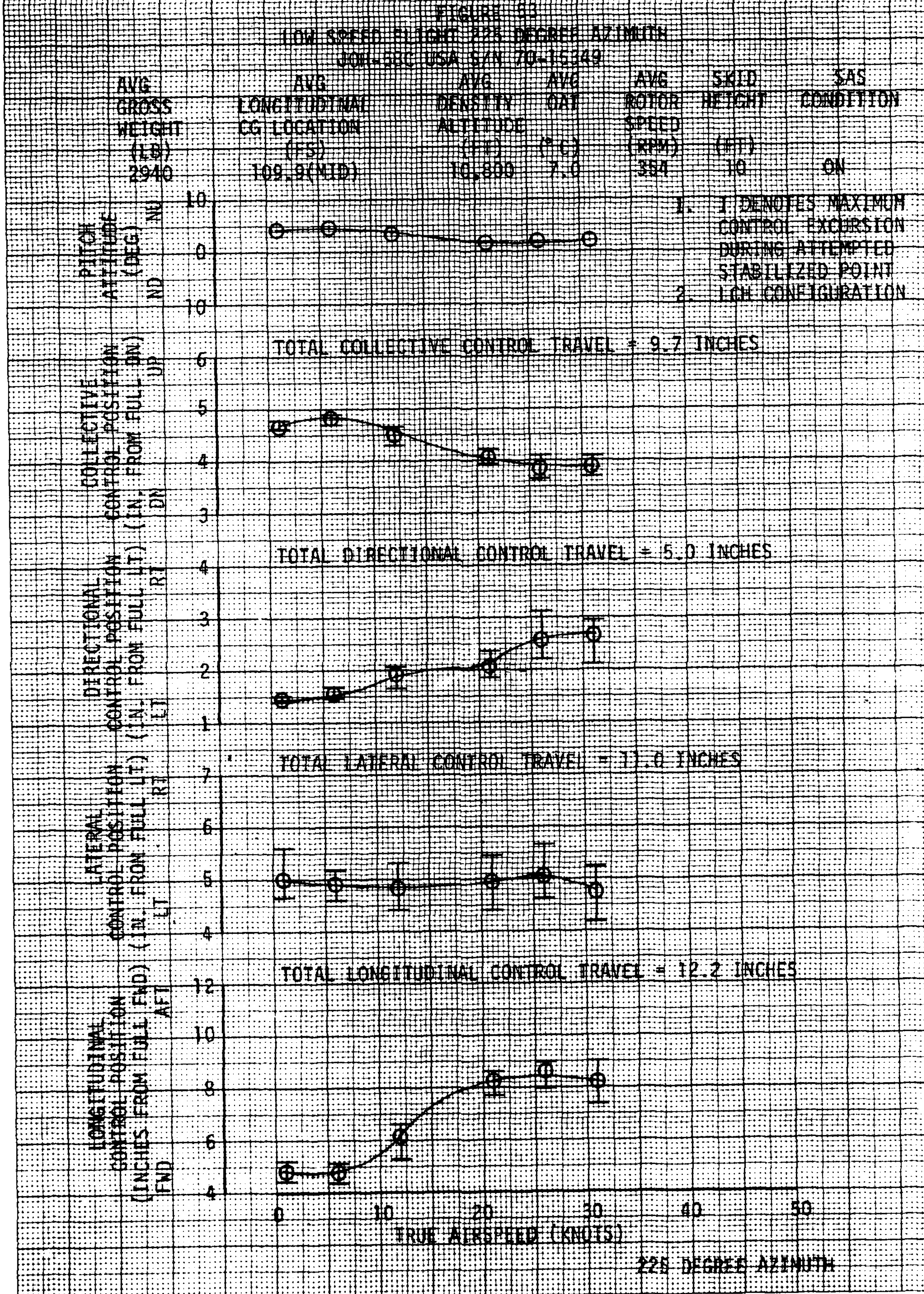
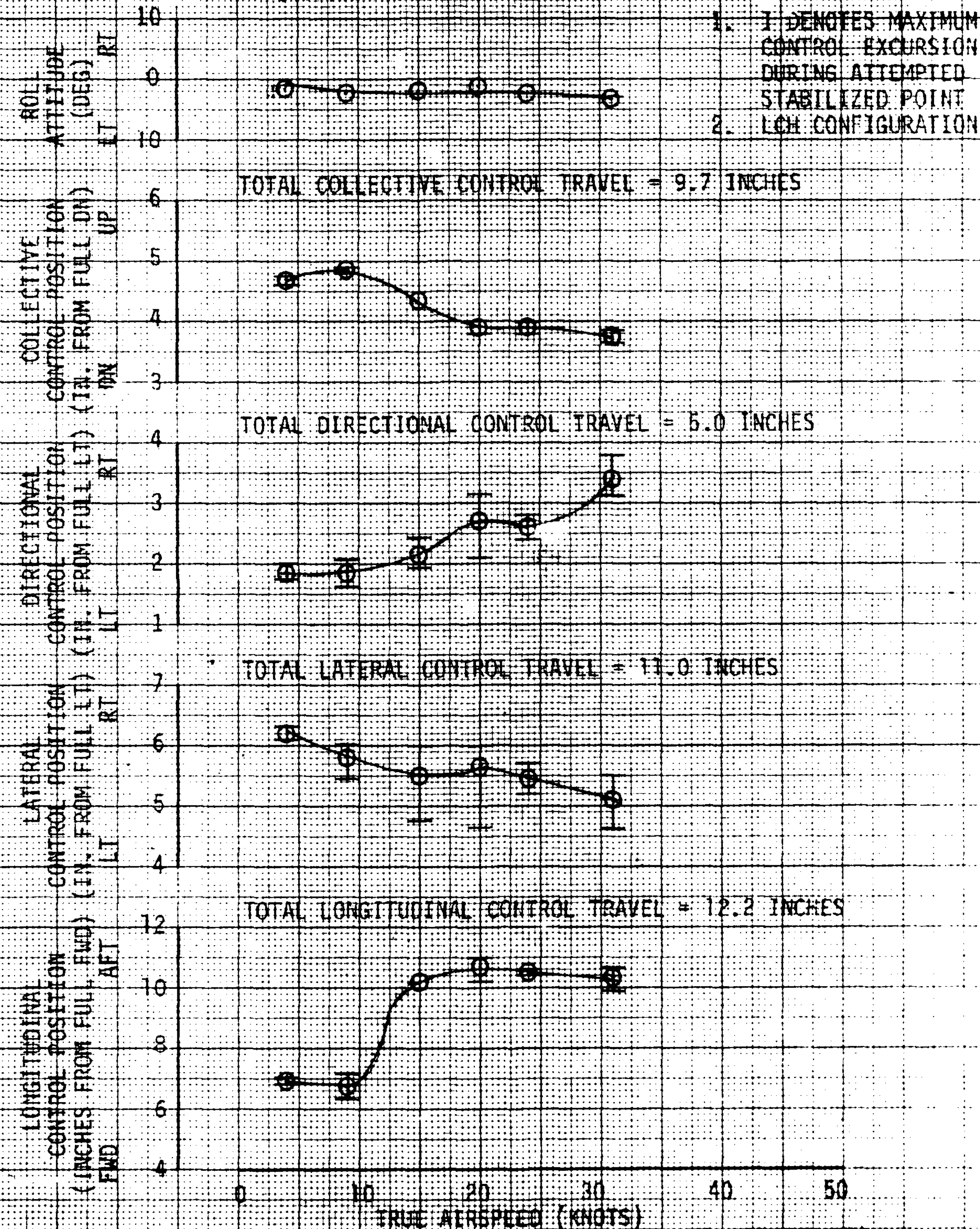


FIGURE 93
LOW SPEED FLIGHT 225 DEGREE AZIMUTH
OH-58C USA S/N 70-15349
AVG GROSS WEIGHT (LB) 2940
AVG LONGITUDINAL CG LOCATION (FS) 109.9(MID)
AVG DENSITY ALTITUDE (FT) 10,800
AVG OAT (°C) 7.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
SAS CONDITION ON
1. I DENOTES MAXIMUM CONTROL EXCURSION DURING ATTEMPTED STABILIZED POINT
2. LCH CONFIGURATION
PITCH ATTITUDE (DEG) NU ND
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN) UP DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT) RT LT
TOTAL LATERAL CONTROL TRAVEL = 11.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT) RT LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 12.2 INCHES
LONGITUDINAL CONTROL POSITION (INCHES FROM FULL FWD) AFT FWD
TRUE AIRSPEED (KNOTS)
225 DEGREE AZIMUTH

FIGURE 54
LOW SPEED FLIGHT 240 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3100	107.5 (FWD)	1300	21.5	354		ON



240 DEGREE AZIMUTH

FIGURE 55
LOW SPEED FLIGHT 240 DEGREE AZIMUTH
JOH-58C USA S/N 70-15849

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3100	107.1(FWD)	4670	12.0	354	10	ON

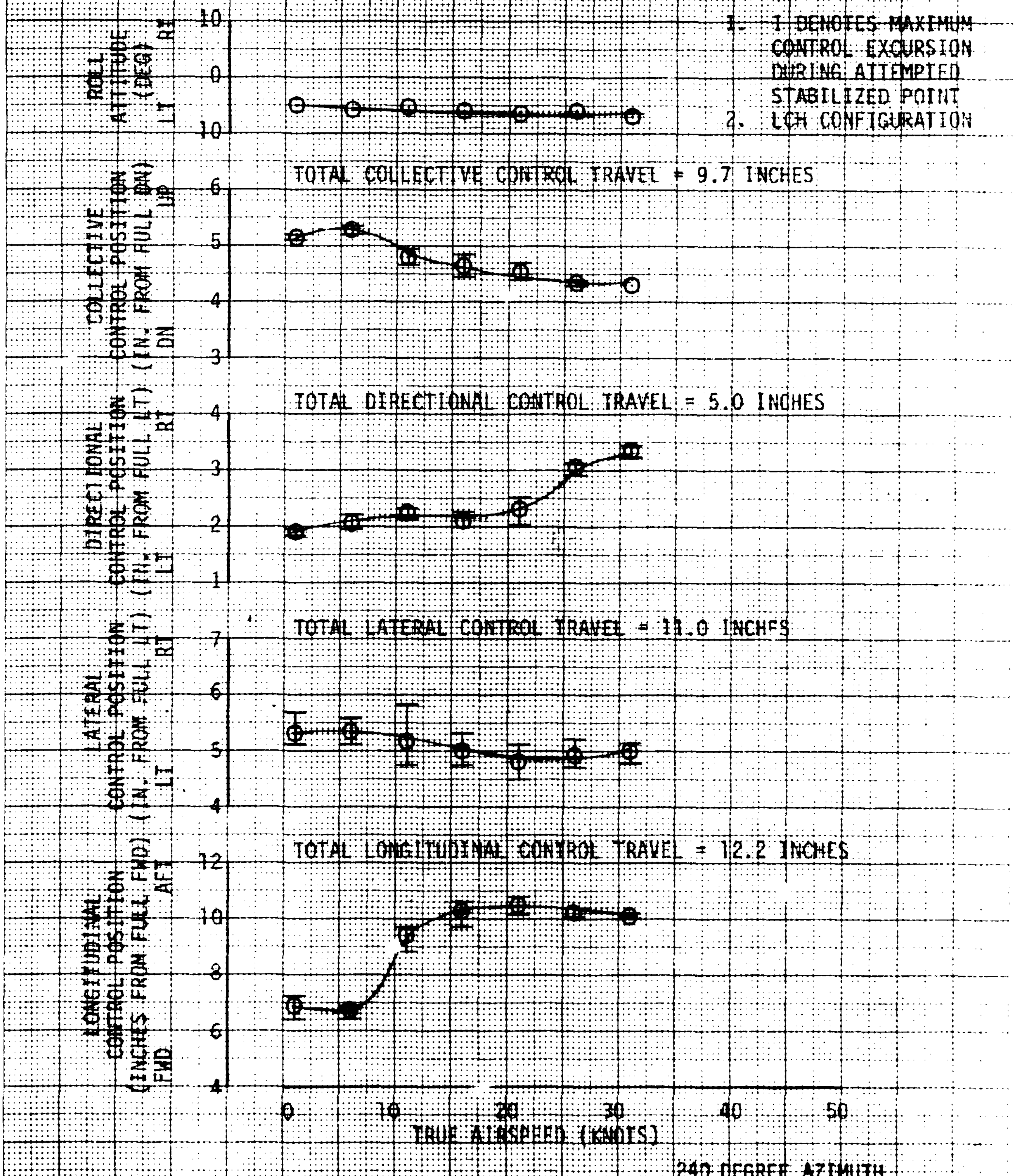


FIGURE 66
LOW SPEED FLIGHT 240 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

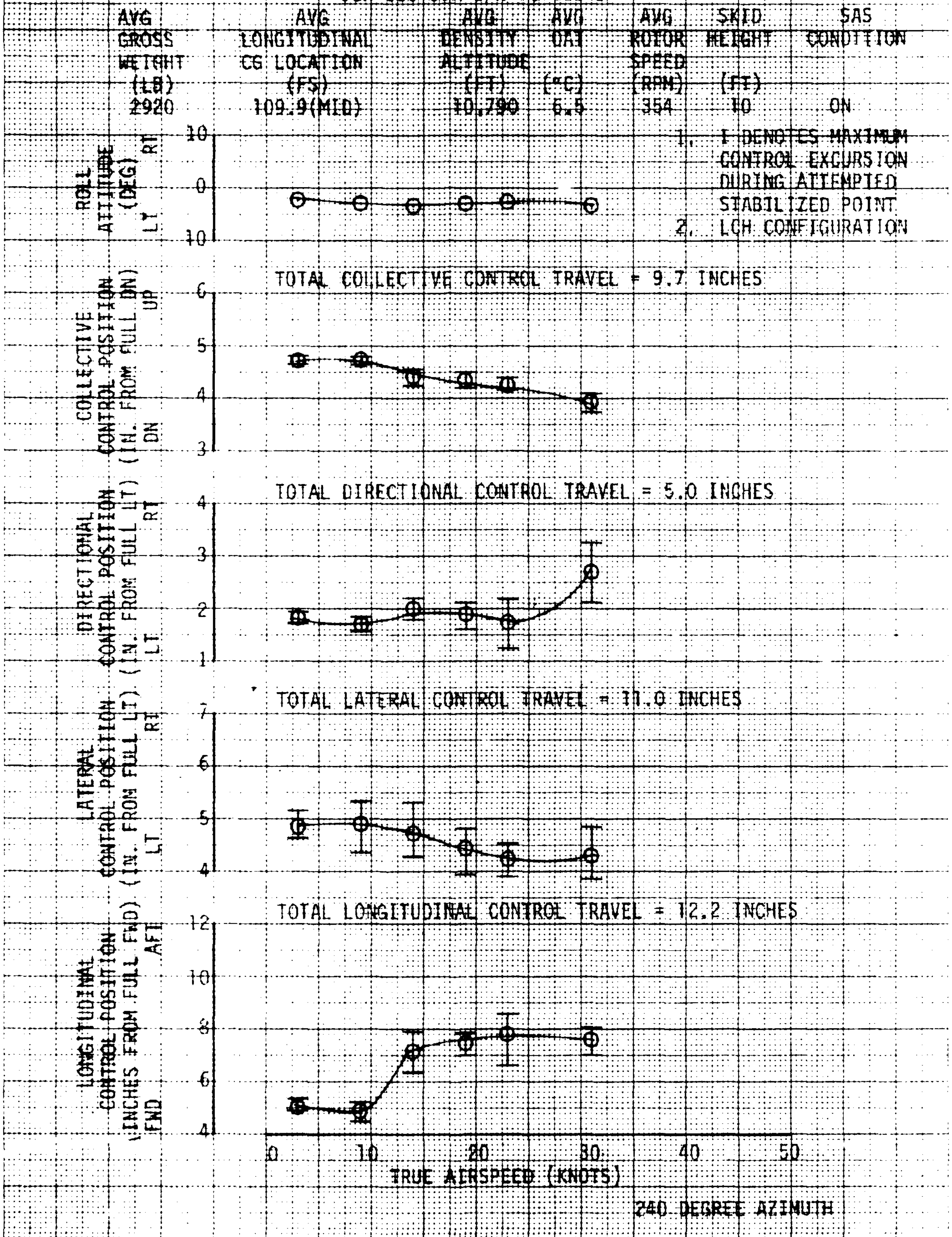
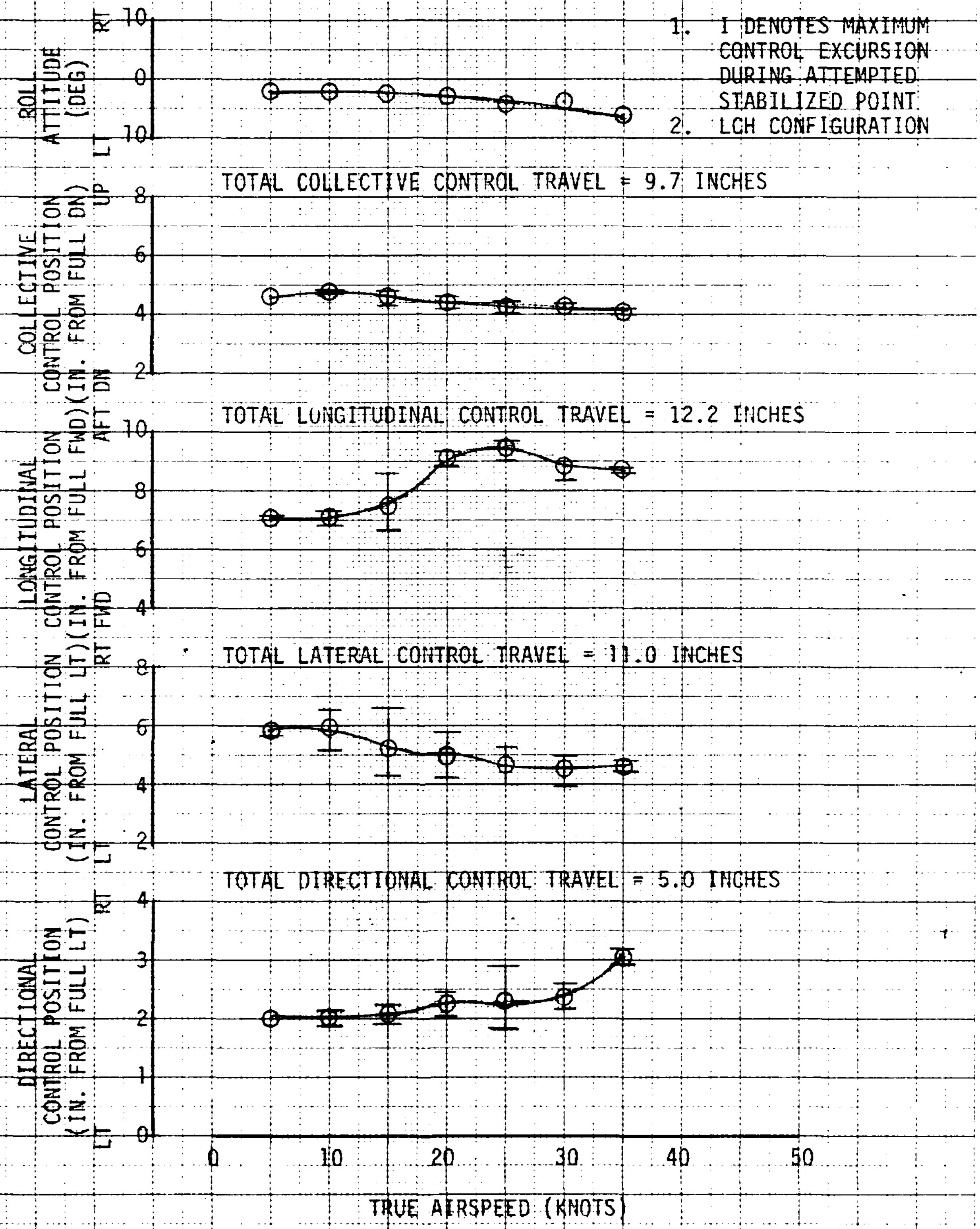


FIGURE 57
LEFT SIDEWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3130	107.6 (FWD)	920	18.5	354	10	ON



270 DEGREE AZIMUTH

FIGURE 58
LEFT SIDEWARD FLIGHT
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3180	107.2 (FWD)	4500	10.5	354	10	ON

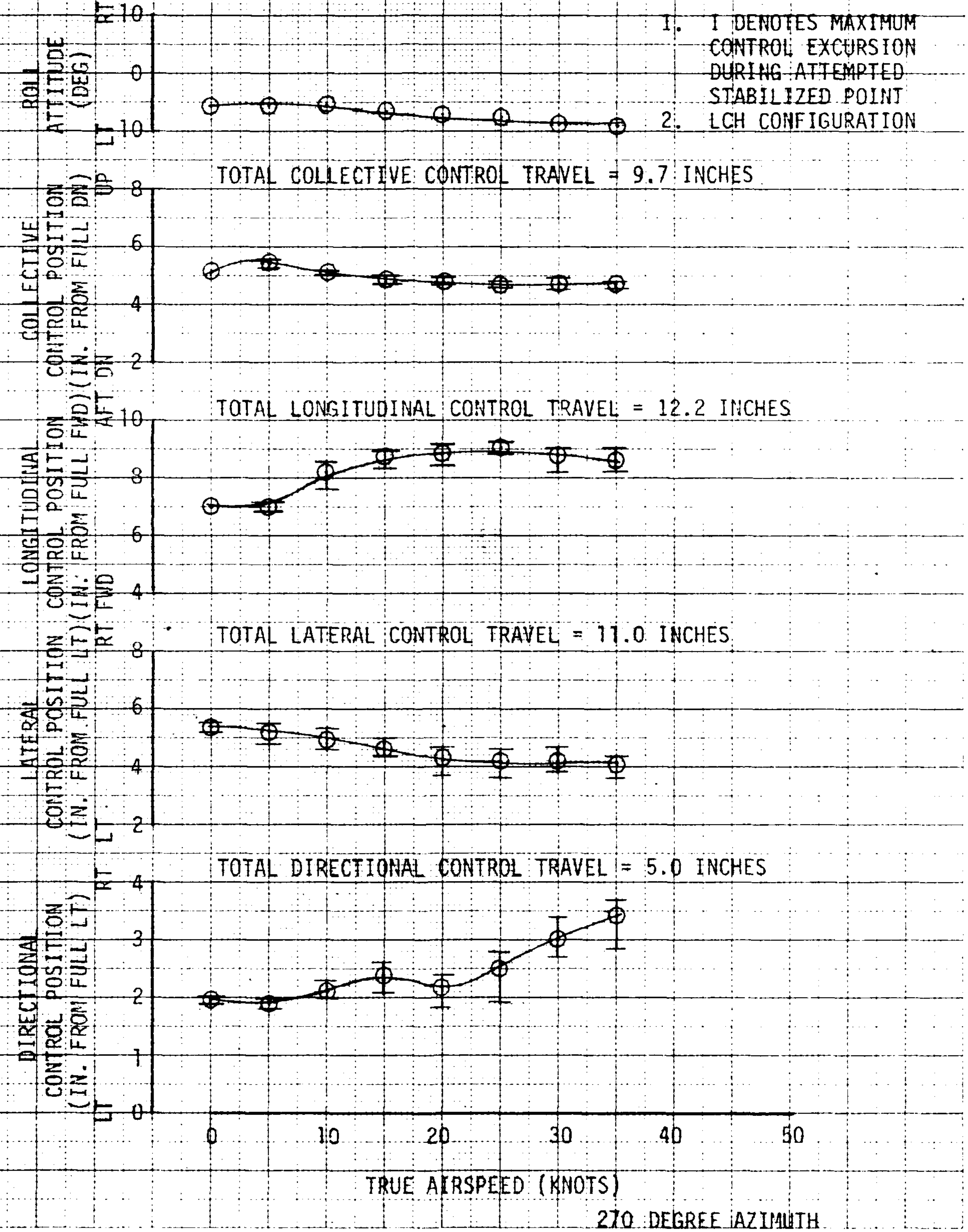
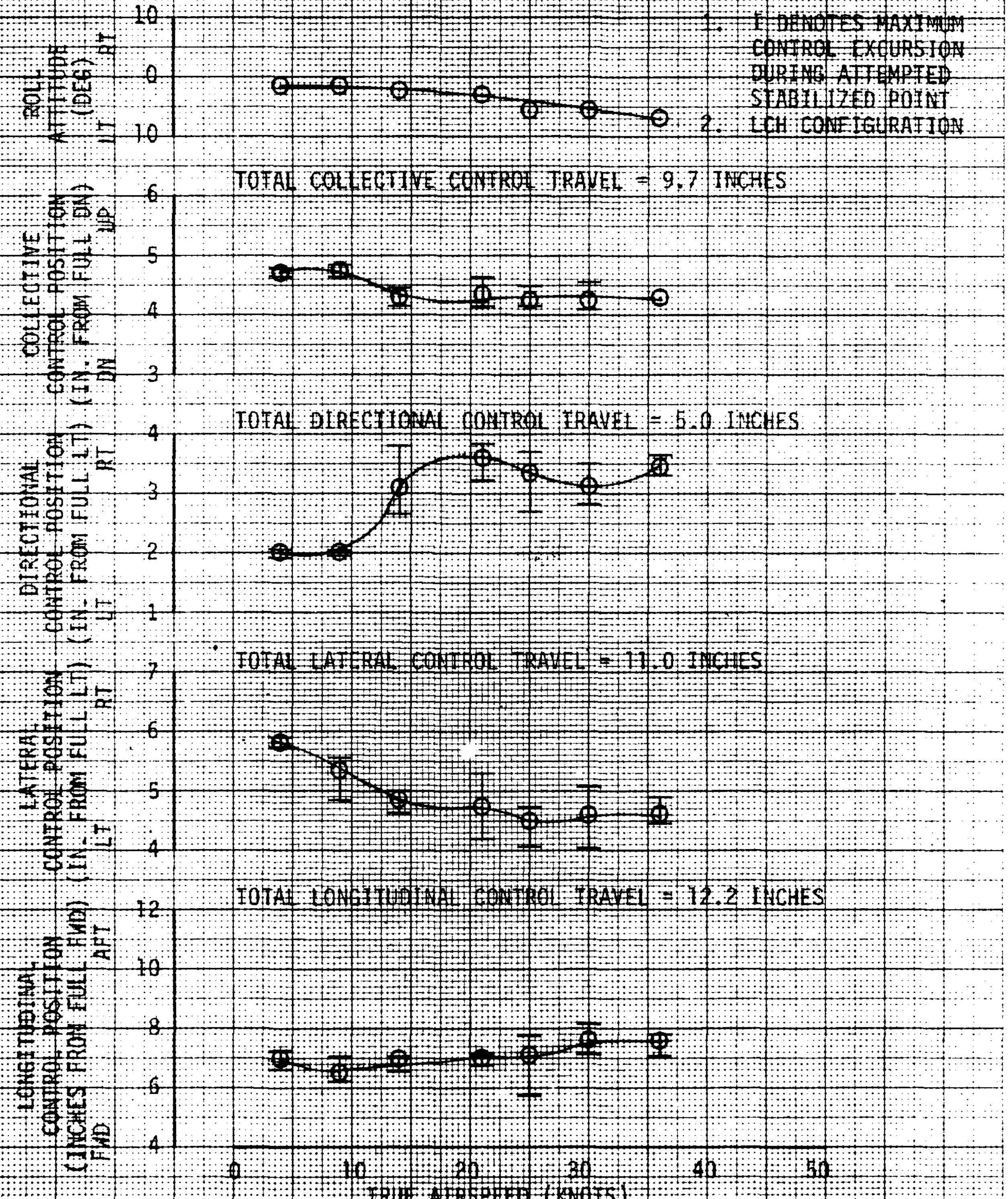


FIGURE 59
LOW SPEED FLIGHT 300 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

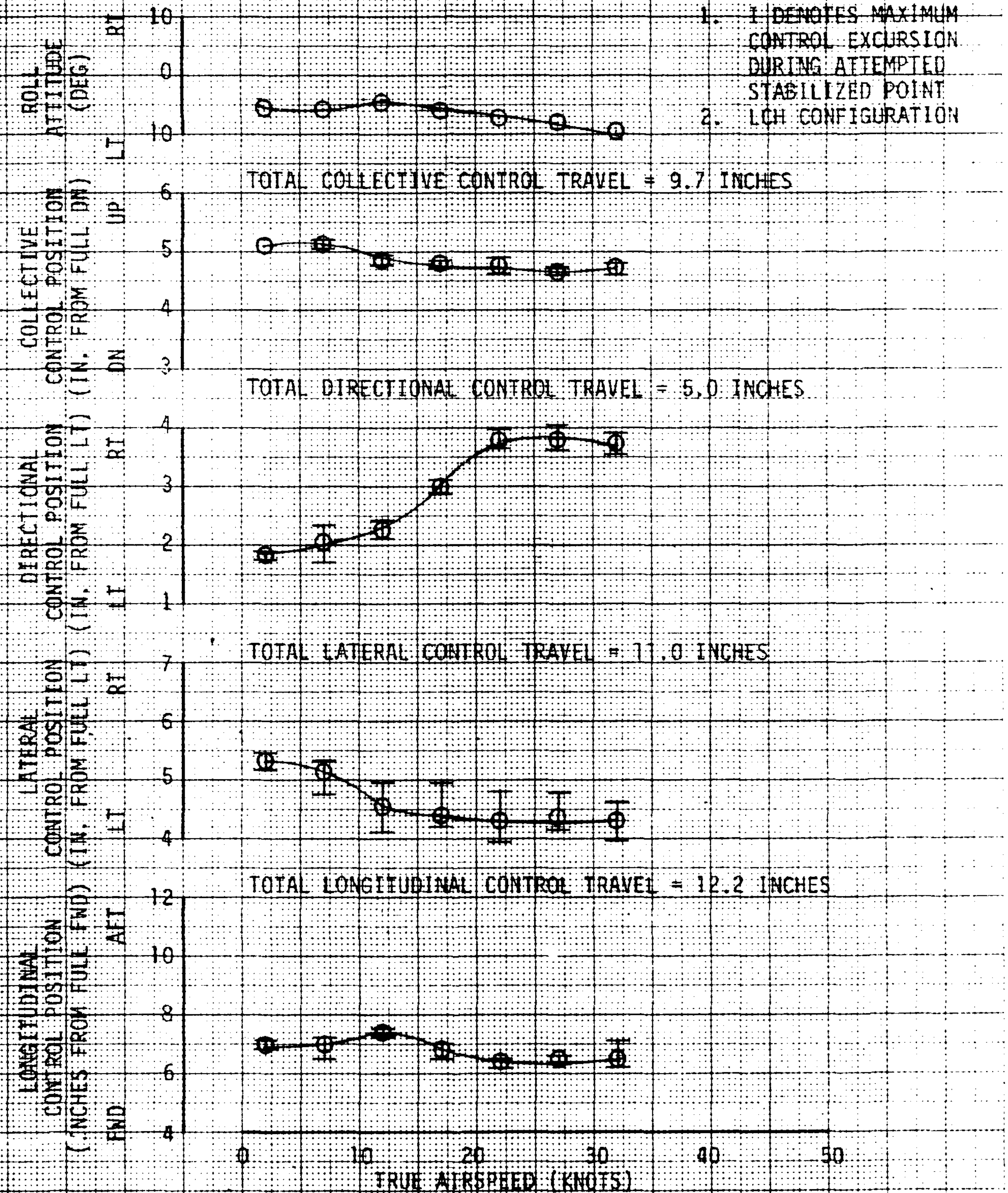
AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3130	107.5 (FWD)	1270	21.5	354	10	ON



300 DEGREE AZIMUTH

FIGURE 60
LOW SPEED FLIGHT 300 DEGREE AZIMUTH
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)	SAS CONDITION
3080	107.0(FWD)	4770	13.0	354	10	ON



300 DEGREE AZIMUTH

FIGURE 61
SIMULATED ENGINE FAILURE
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3030	108 9(MID)	5000	16.0	354	90	LEVEL

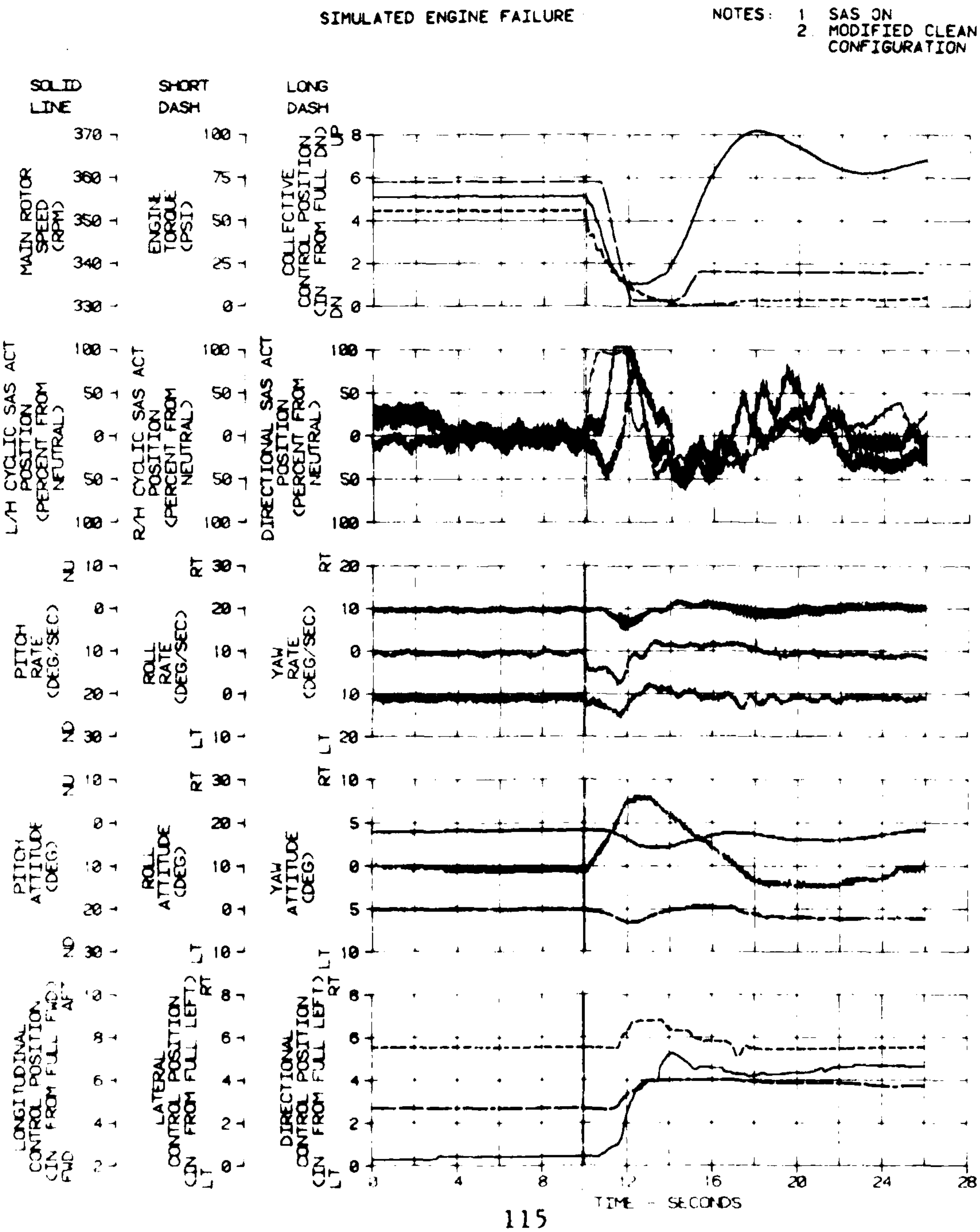


FIGURE 62
PITCH SAS HARDOVER
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3130	100.2(MID)	5880	10.5	355	90	LEVEL

NOTE: MODIFIED CLEAN CONFIGURATION

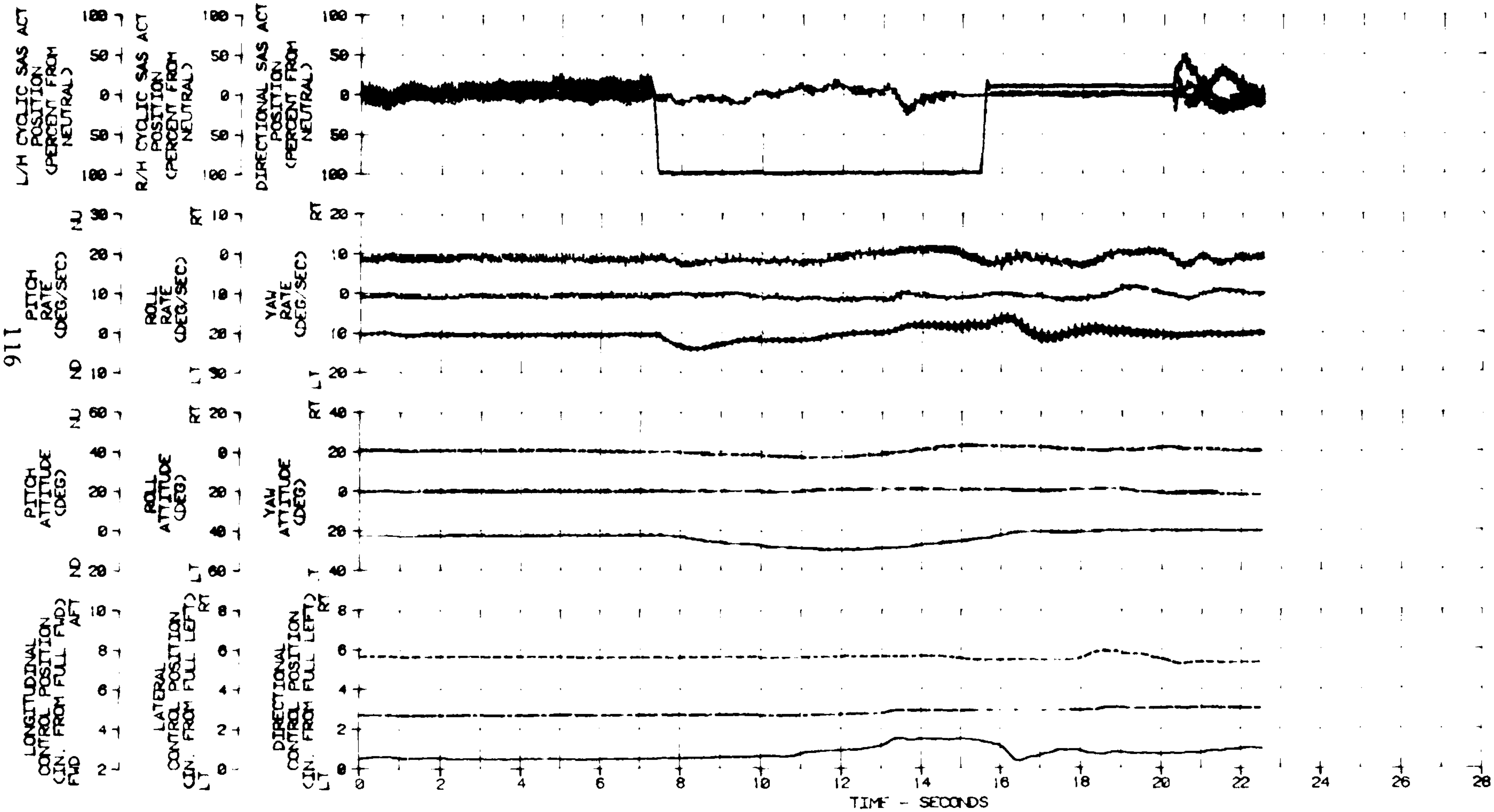


FIGURE 63
ROLL SAS HARDOVER
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3130	109.2(MID)	6040	10 5	355	89	LEVEL

NOTE: MODIFIED CLEAN CONFIGURATION

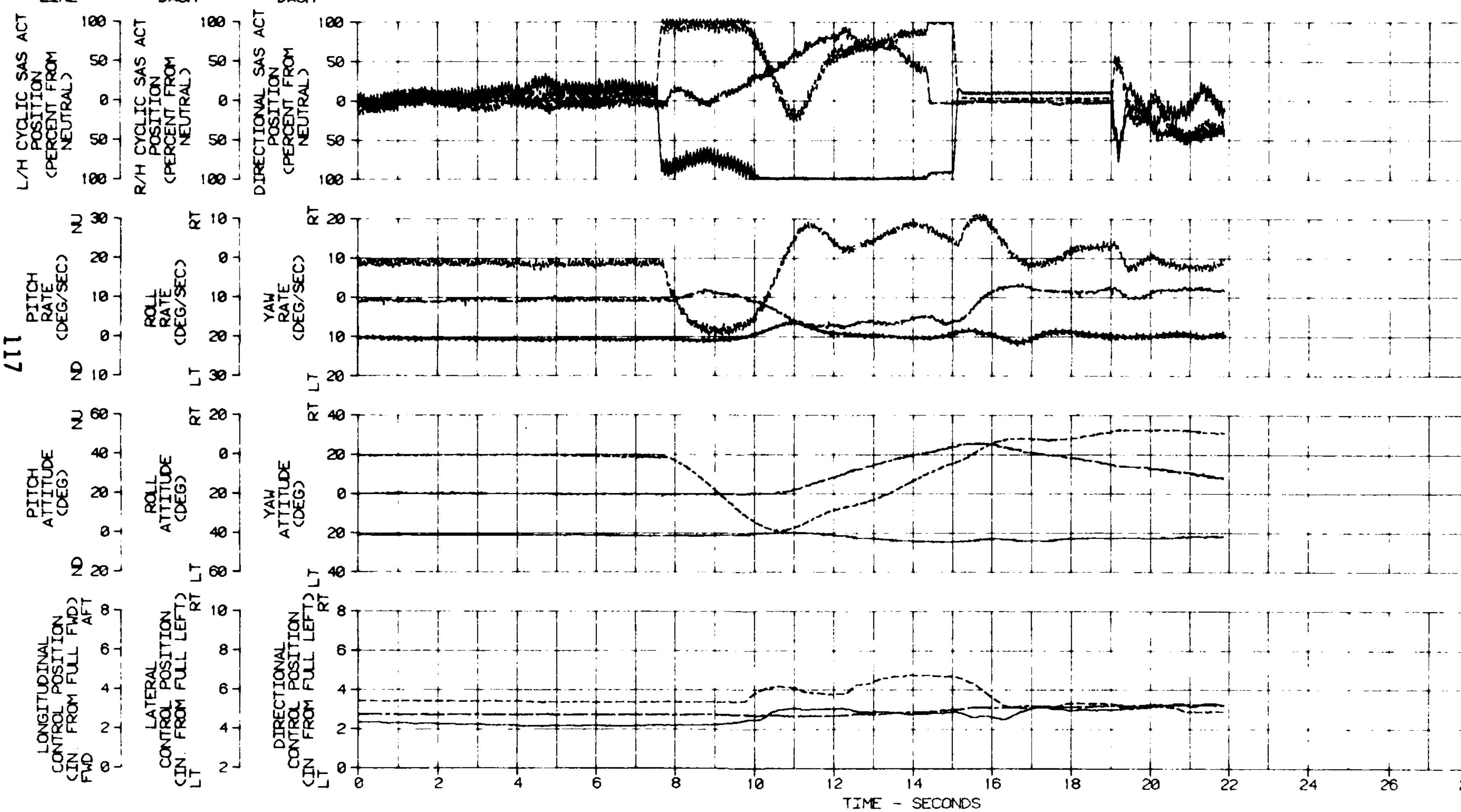


FIGURE 64
YAW SAS HARDOVER
JOH-58C USA S/N 70-15340

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3120	100.2(MID)	5720	11.0	354	86	LEVEL

NOTE: MODIFIED CLEAN CONFIGURATION

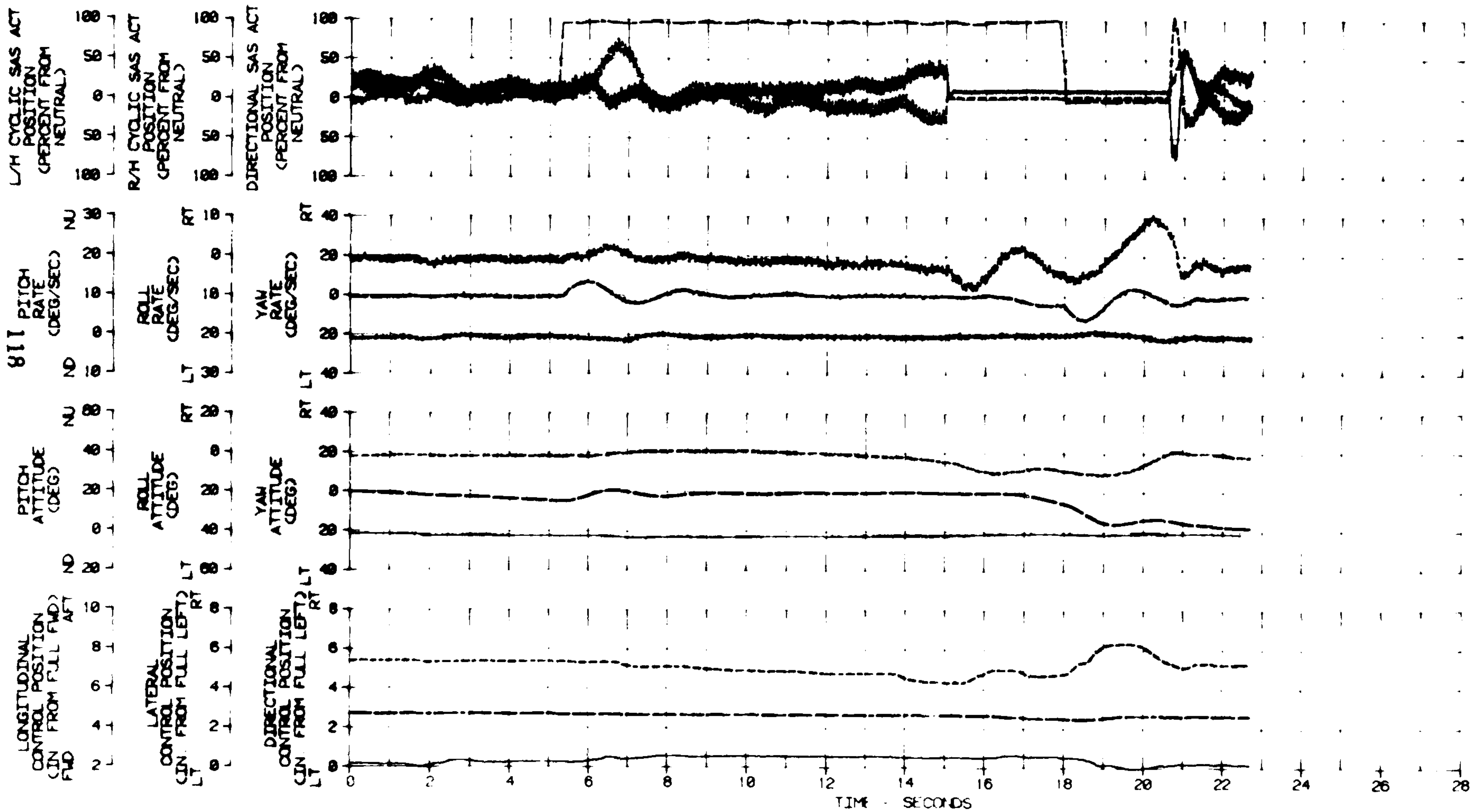


FIGURE 65

PITCH SAS HARDOVER

JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	FLIGHT CONDITION
3180	109 4(MID)	1530	6 0	353	0	HOVER

NOTE: MODIFIED CLEAN CONFIGURATION

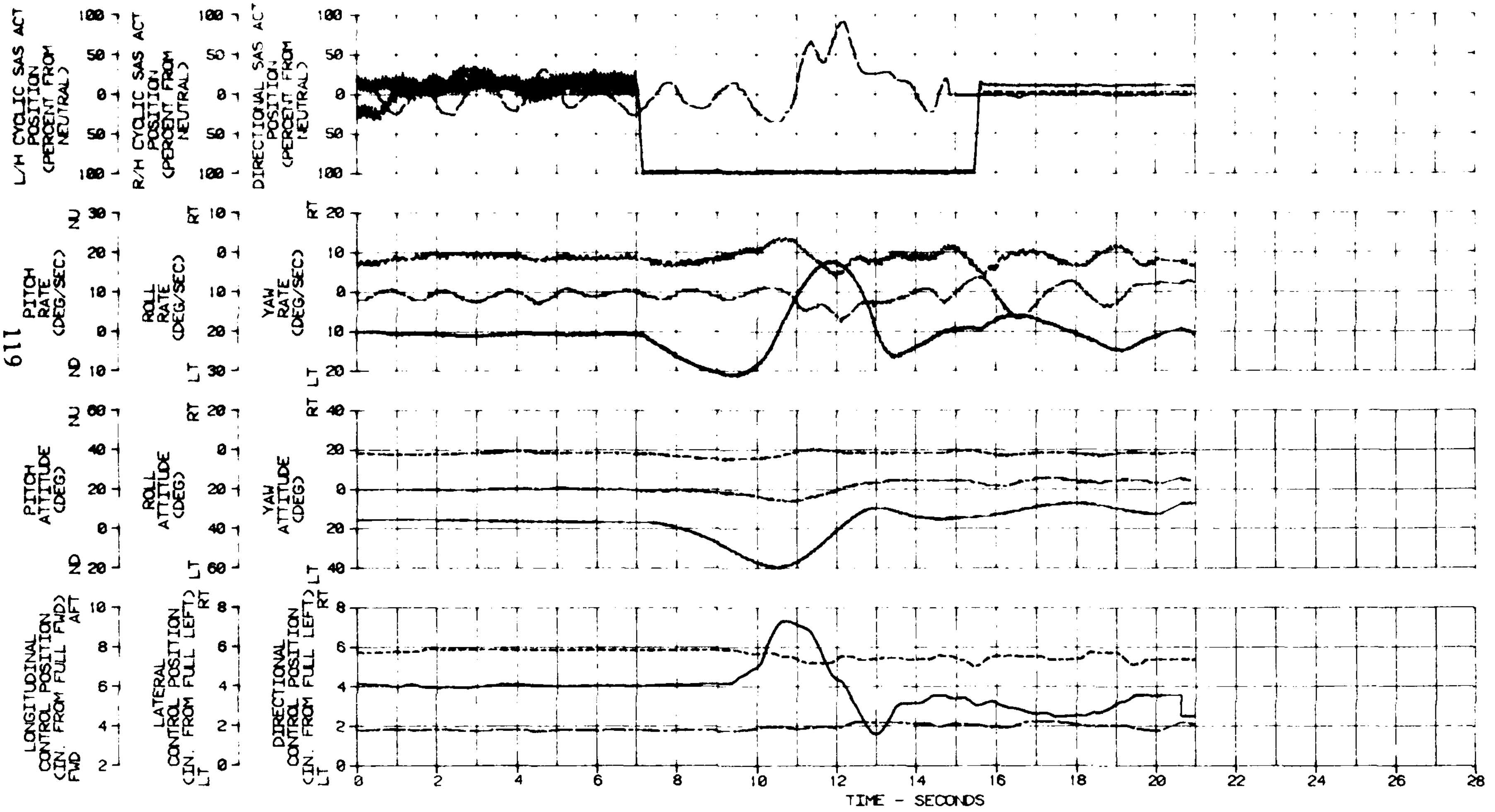


FIGURE 66
ROLL SAS HARDOVER
JOH-58C USA S/N 70-15349

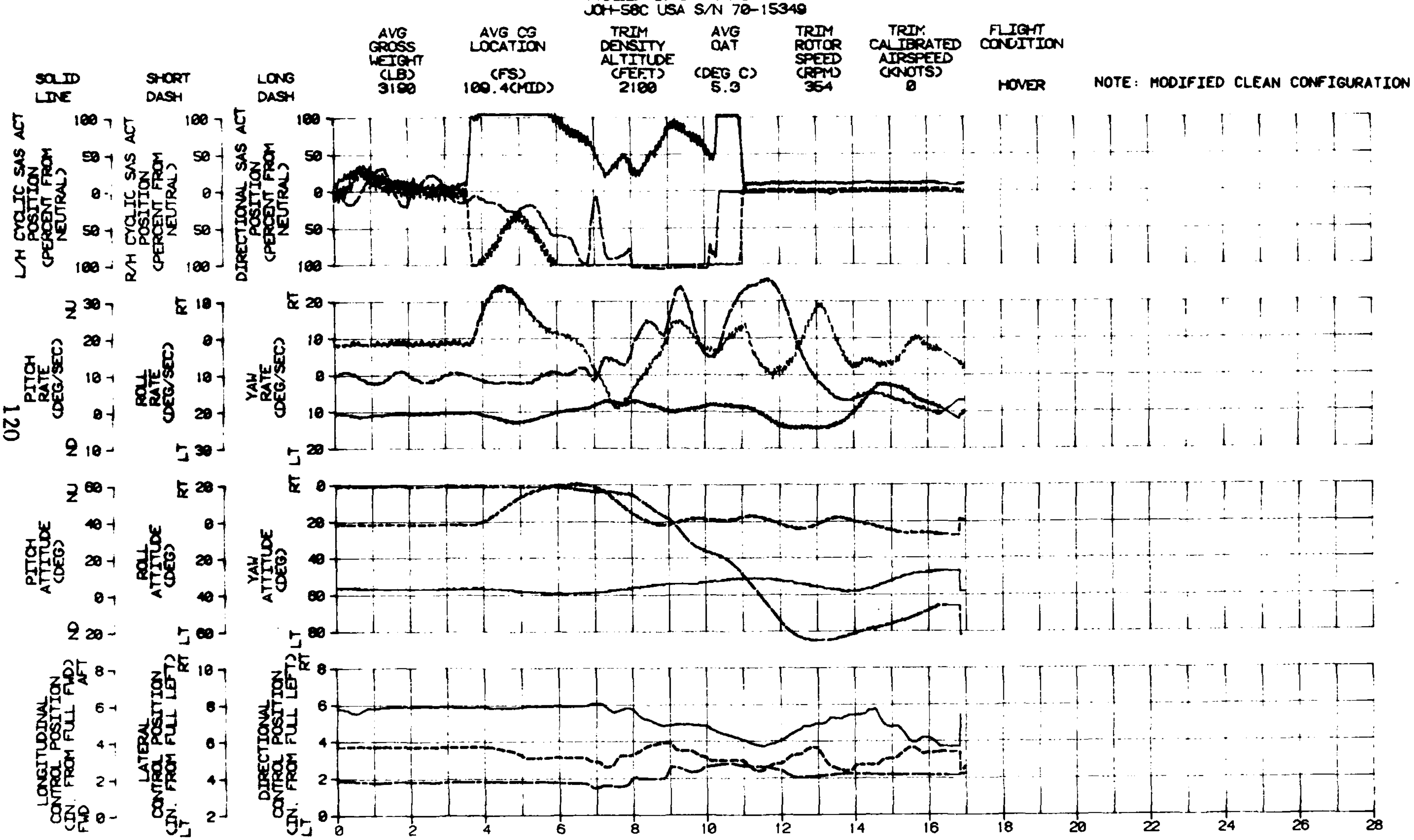


FIGURE 67
YAW SAS HARDOVER
JOH-58C USA S/N 70-15349

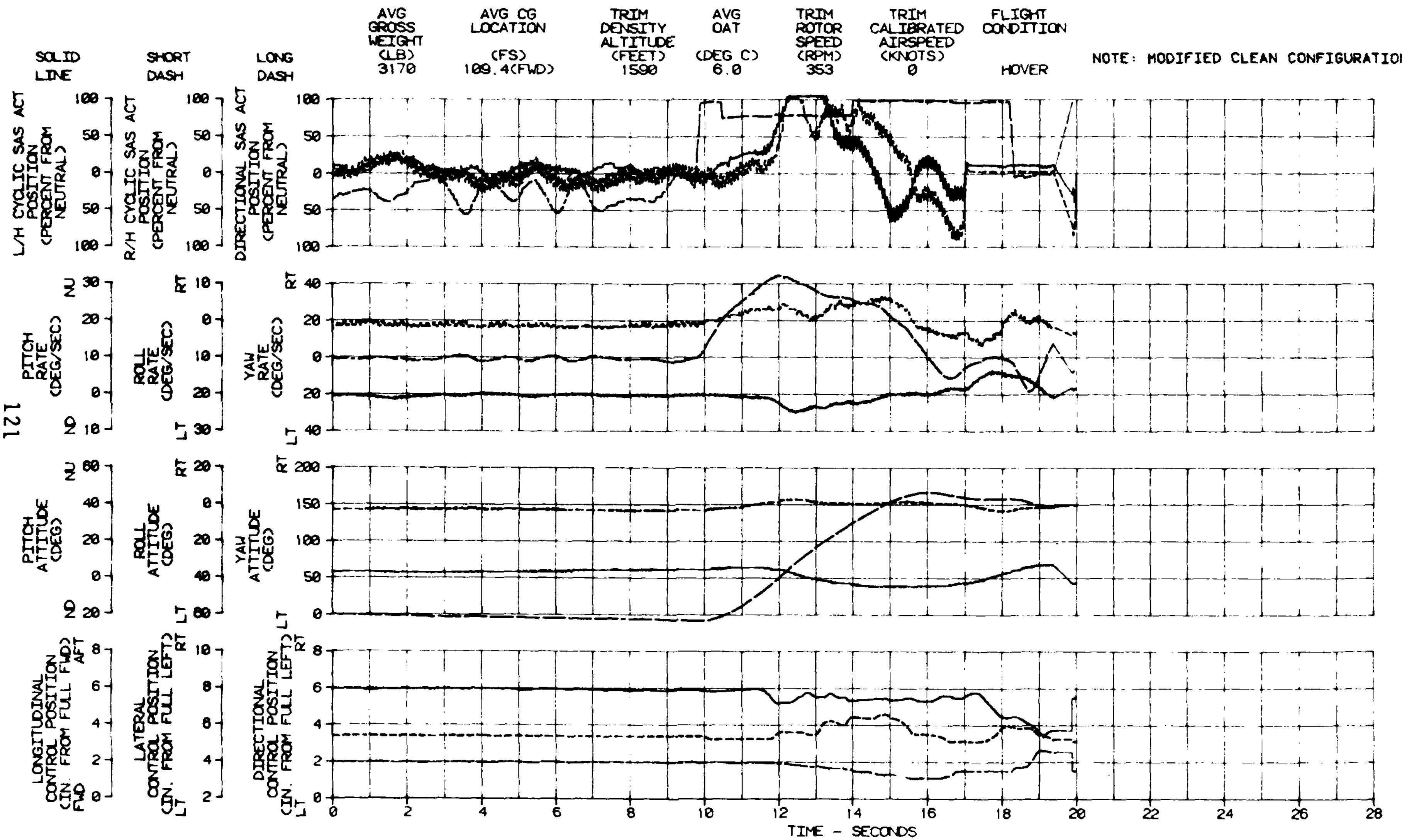


FIGURE 68
PITCH SAS HARDOVER
240 DEG. AZIMUTH, 15 KTS
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	FLIGHT CONDITION
3170	107.2(FWD)	1000	19.5	355	LOW SPEED FLIGHT

NOTE: LCH CONFIGURATION

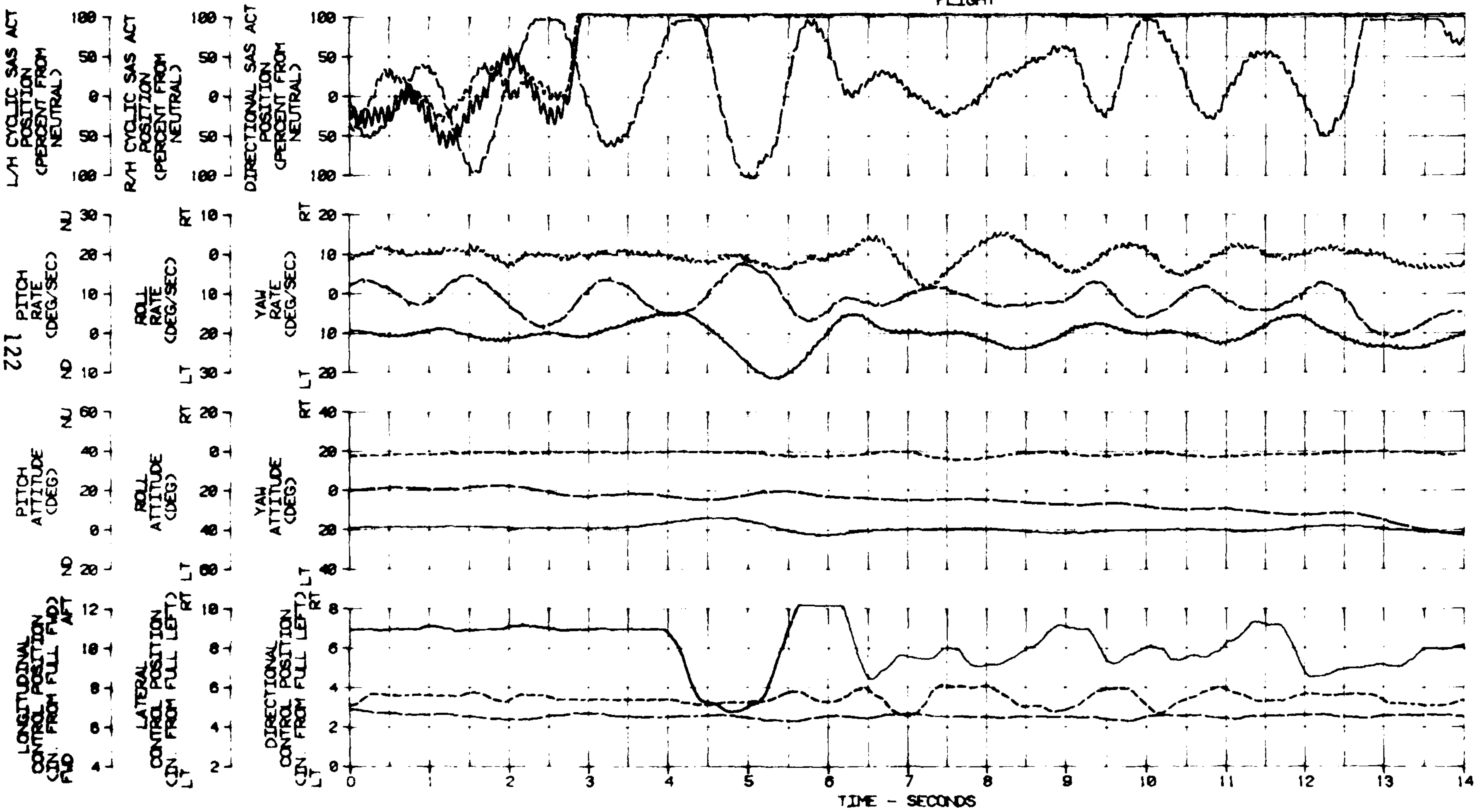


FIGURE 69
ROLL SAS HARDOVER
240 DEG. AZIMUTH, 15 KTS
JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	FLIGHT CONDITION
3160	107.2(FWD)	1070	20.0	355	LOW SPEED FLIGHT

NOTE: LCH CONFIGURATION

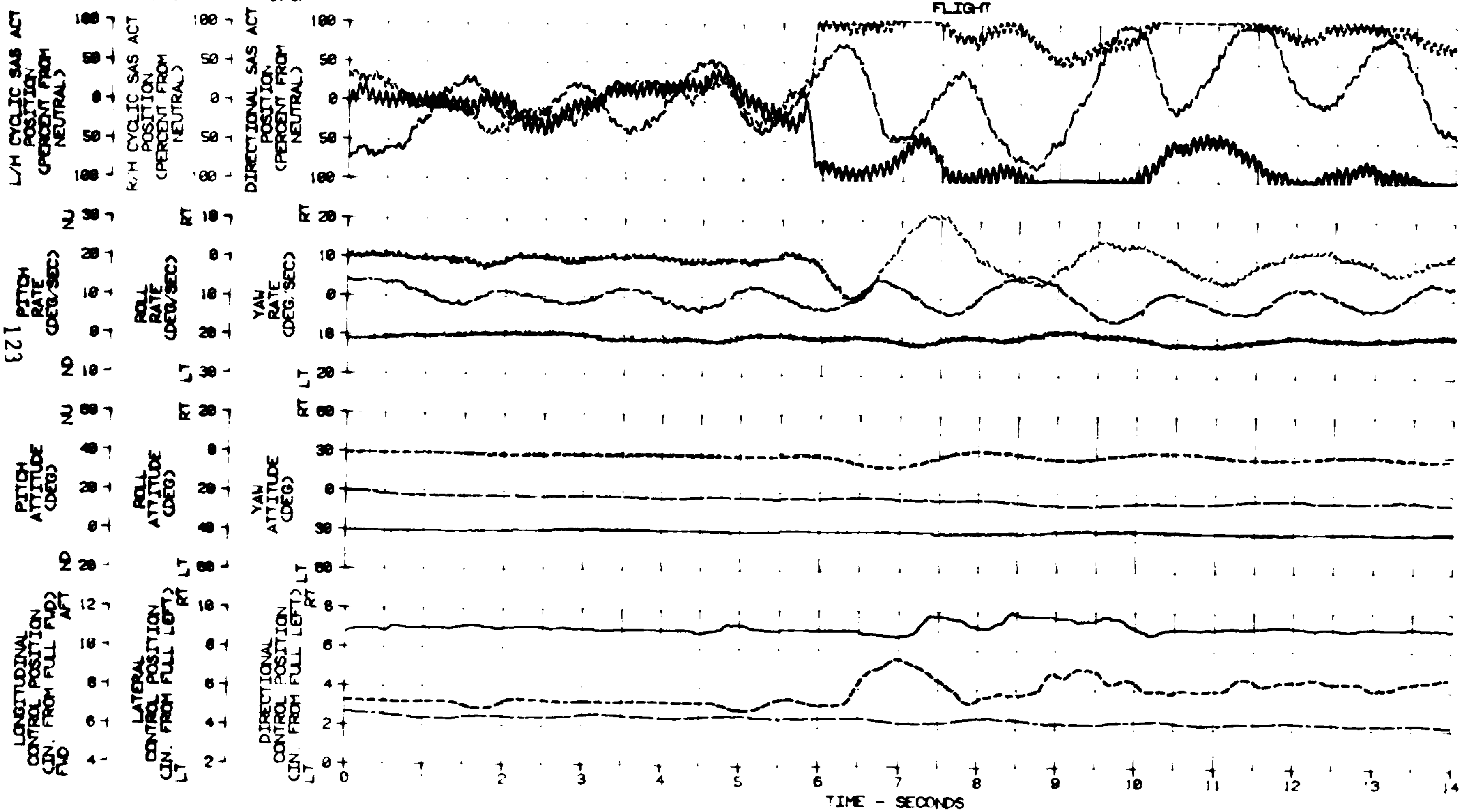


FIGURE 70
YAW SAS HARDOVER
240 DEG. AZIMUTH, 15 KTS
JOH-58C USA S/N 70-15340

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	FLIGHT CONDITION
3180	107.2(FWD)	970	19.5	355	LOW SPEED FLIGHT

NOTE: LCH CONFIGURATION

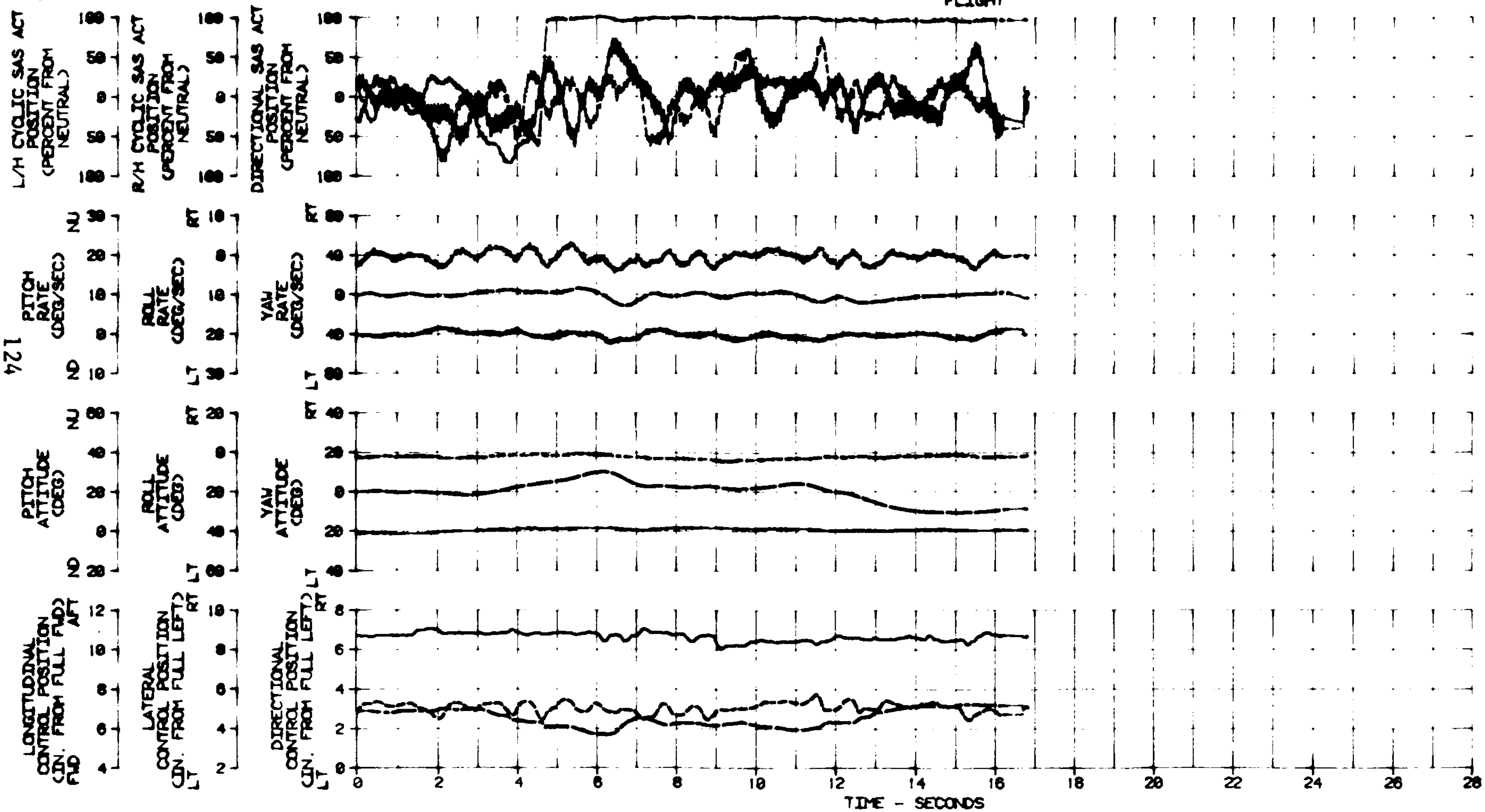


FIGURE 71

LOSS OF TAIL ROTOR EFFECTIVENESS INVESTIGATION

JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)
3090	107 1(FWD)	6780	29.0	354	40

NOTES:
1. 40 KNOT APPROACH WITH 90 DEGREE RIGHT TURN TO CROSSWIND HOVER
2. WIND SPEED 13 - 16 KNOTS
3. SAS ON
4. LCH CONFIGURATION

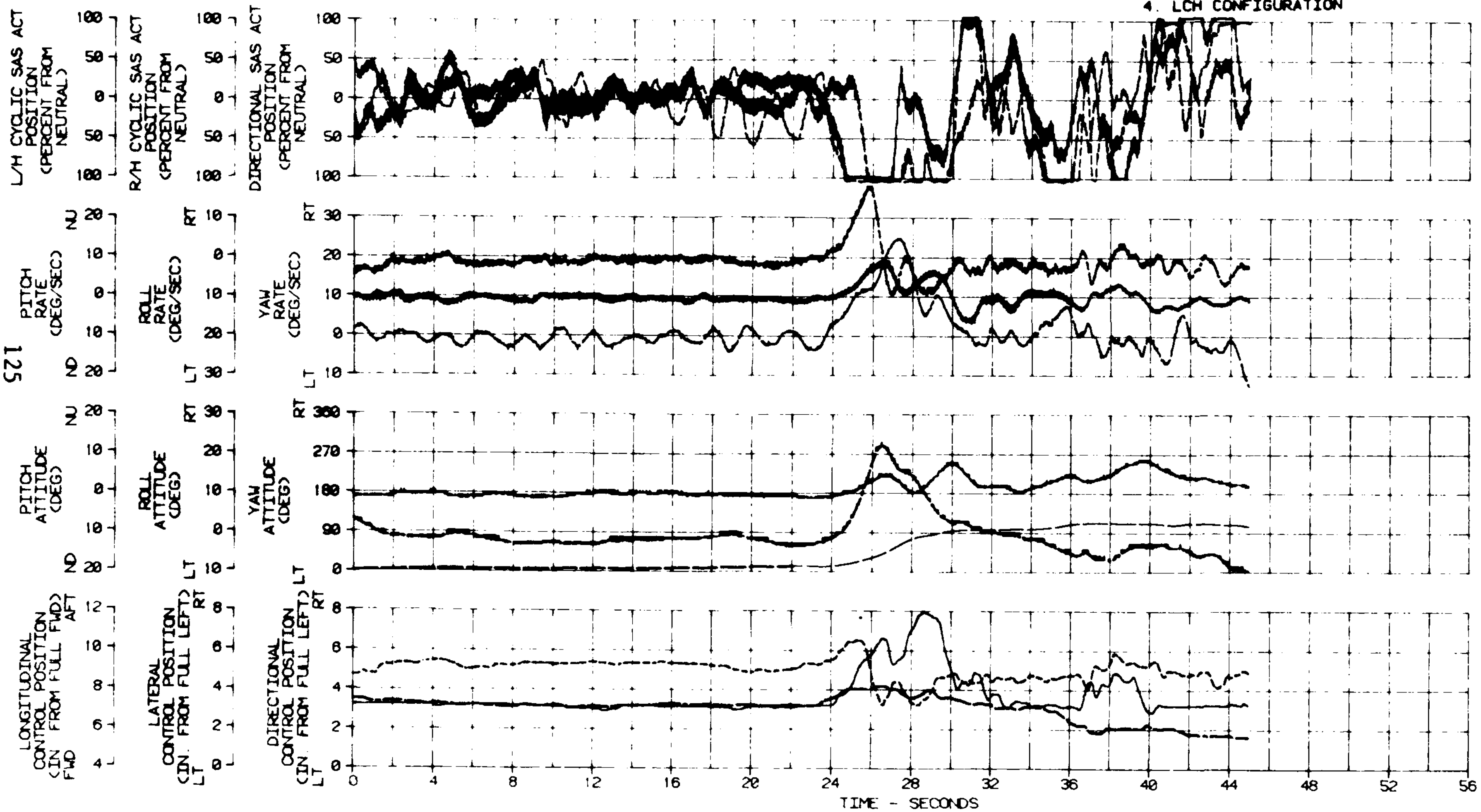


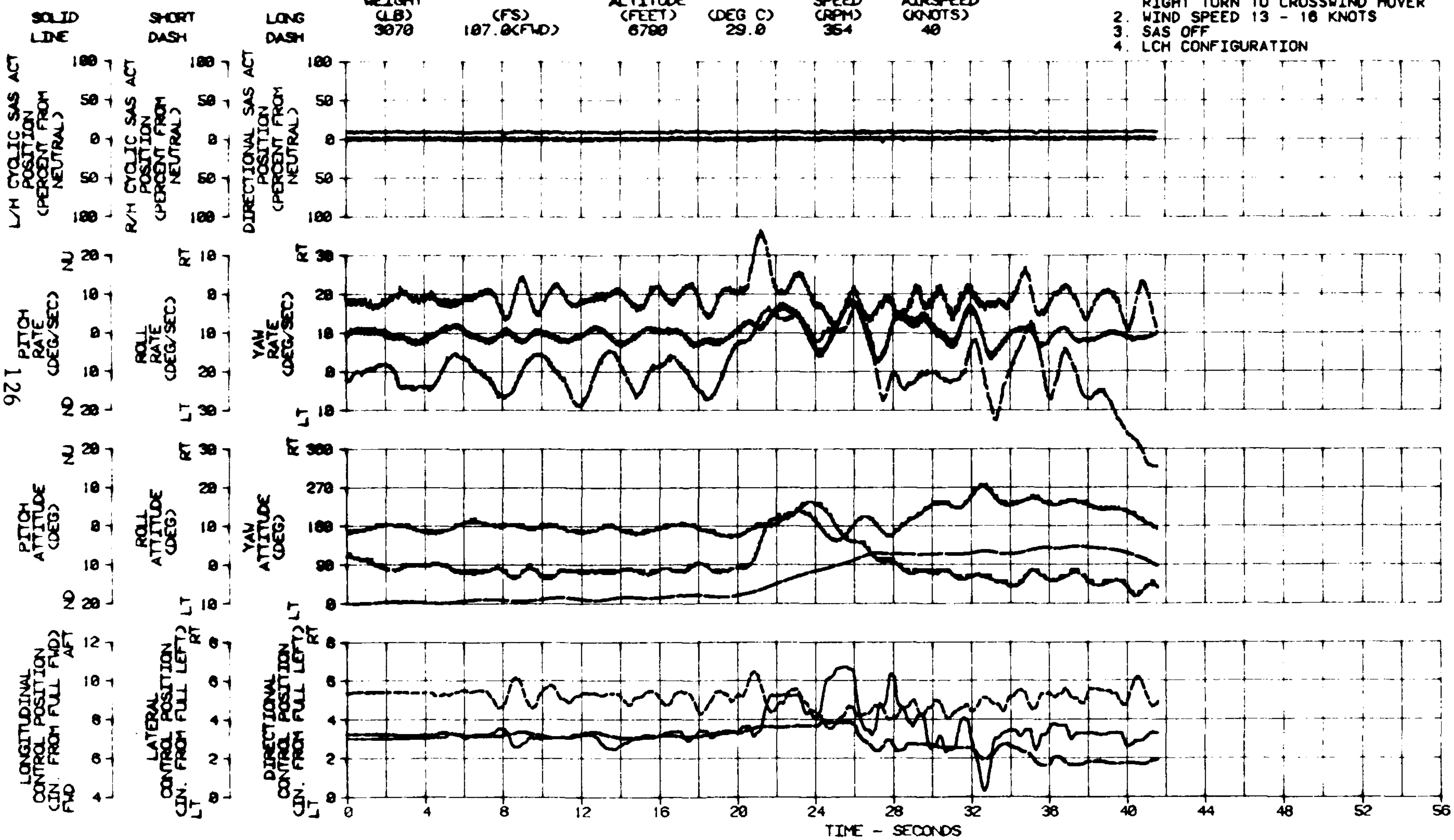
FIGURE 72

LOSS OF TAIL ROTOR EFFECTIVENESS INVESTIGATION

JOH-58C USA S/N 70-15349

AVG GROSS WEIGHT (LB)	AVG CG LOCATION (FS)	TRIM DENSITY ALTITUDE (FEET)	AVG OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)
3070	107.0(FWD)	6700	29.0	354	40

NOTES:
1. 40 KNOT APPROACH WITH 90 DEGREE RIGHT TURN TO CROSSWIND HOVER
2. WIND SPEED 13 - 16 KNOTS
3. SAS OFF
4. LCH CONFIGURATION



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