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AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST OF THE RC-12D GUARDRAIL V

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FINAL REPORT

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UNITED STATES ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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The US Army Aviation Engineering Flight Activity conducted a limited Airworthiness and Flight Characterisitcs test of the RC-12D (Improved Guardrail V) aircraft with both standard and infrared (IR) suppressor exhaust stacks installed from 10 May through 1 June 1984 at Wichita, Kansas. During the test program, 12 flights were conducted for a total of 25.7 hours, of which 14.6 were productive. All tests were performed in a normal mission configuration ballasted to a maximum takeoff gross weight of 14,200 pounds and a center of gravity at

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fuselage station 190.1 (fwd). Test results were compared with data obtained during previous testing, and evaluated against military specification MIL-F-8785C. Takeoff and landing performance presented in the operator's manual were confirmed as was the Beech Aircraft Corporation provided drag polar plot of the standard stack configured aircraft. A slight degradation in performance was noted with IR suppressor exhaust stacks installed. The RC-12D aircraft has marginal climb performance capabilities with a combat ceiling below 24,000 feet density altitude. The handling qualities of the RC-12D with both standard and IR suppressor exhaust stacks installed were essentially unchanged from the standard C-12D aircraft with the exception of improved stall characteristics. The fluctuation of cabin pressurization with the data link antenna radome anti-ice ON was identified as a deficiency. A previously reported deficiency of main landing gear wheel lockup during landings with maximum braking still exists. Five shortcomings were identified of which the following three were directly related to the RC-12D configuration: the possibility of inadvertent activation of chaff dispenser during normal operation; inconvenient location of the pitch synchronization switch on the control yoke; and erroneous stall warning indication during liftoff.

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION SYSTEMS COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120-1798

REPLY TO
ATTENTION OF

AMSAV-ED

SUBJECT: Directorate for Engineering Position on the Final Report of USAAEFA Project No. 84-02, Airworthiness and Flight Characteristics Test of the RC-12D Guardrail V

SEE DISTRIBUTION

1. The purpose of this letter is to establish the Directorate for Engineering position on the subject report. The report documents the flight test results of the Beech Aircraft Corporation (BAC) RC-12D airplane.

2. The Directorate for Engineering agrees with the subject report Conclusions and Recommendations, with the exceptions identified herein. Conclusions and Recommendations are discussed by paragraph as indicated.

a. Paragraph 42. The fluctuation of cabin pressurization with data link radome anti-ice system ON was a deficiency. BAC recognized this deficiency and determined the temperature control valve to be at fault. The problem was an over-sensitivity in the dynamics of the temperature control valve, causing rapid cycling between full open and full closed. A slower acting valve has been installed and tested on other RC-12D aircraft with satisfactory results. There have been no cabin pressure fluctuations with the new valve installed. Retrofitting of the new valve is in progress and will be complete prior to fielding of the aircraft.

b. Paragraph 43a. The location of the chaff dispenser switch in the RC-12D Improved Guardrail V airplane is the same as in the RU-21H Guardrail V airplane. This position was chosen so the pilot would be able to dispense chaff while maneuvering the airplane. The majority of pilots transitioning to the RC-12D will be those who have flown the same Guardrail mission in the RU-21H and will already be familiar with this switch location. Pilots transitioning to the RC-12D from the C-12 will have to learn this switch function along with other mission equipment operation. While inadvertent switch activation is always a possibility, it is not considered a shortcoming.

c. Paragraph 43b. The pitch synchronization switch was located in this position on the control yoke to provide a location for the chaff dispenser switch as discussed in paragraph 2.b above. The RU-21H Guardrail V does not have an auto pilot, thus it does not have this switch. This switch location is considered acceptable for normal mission operation and is not considered a shortcoming.

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d. Paragraph 43c. The erroneous stall warning indication during liftoff is a shortcoming. However, since this is an anomaly of the stall warning system and it does not occur on all takeoffs, there is no plan to correct it. The recommended NOTE in the operator's manual is considered sufficient.

e. Paragraph 43d. Activation of the artificial stall warning system during accelerated stalls is a shortcoming. However, this is characteristic of the C-12 airframe and not peculiar to the RC-12D Guardrail V and no corrective action is planned.

f. Paragraph 43e. The excessive airspeed position error is a shortcoming. However, the RC-12D Guardrail V airplane uses the basic C-12 airframe. Redesign of the pitot-static system is considered cost prohibitive and no corrective action is planned.

g. Paragraph 45. The deficiency referenced in Paragraph 45 has been corrected as described in Paragraph 2a. above.

h. Paragraphs 47, 48 and 49. We agree that the V_{MC} test results, CAUTION and NOTE should be incorporated into the RC-12D operator's manual. These items will be included in the first manual update which is scheduled for early 1985.

3. The RC-12D Guardrail V airplane is considered qualified based on all the testing accomplished by AEFA and the contractor.

FOR THE COMMANDER:

RONALD E. GORMONT
Acting Director of Engineering

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INTRODUCTION

BACKGROUND

1. The Special Electronics Mission Aircraft Project Manager issued a contract to Electronic Systems Laboratory (ESL) of TRW Incorporated to provide an Improved Guardrail V System. ESL then contracted with Beech Aircraft Corporation (BAC) to provide the model RC-12D Provisioned Aircraft and to conduct the testing of the Airworthiness Qualification Specification (AQS). Following AQS testing by BAC, the Federal Aviation Administration will issue a limited Airworthiness Certificate which will meet the requirements of an Airworthiness Approval per AR 70-62 (ref 1, app A). The US Army Aviation Engineering Flight Activity (USAAEFA) was tasked by the US Army Aviation Systems Command (AVSCOM) (ref 2) to conduct a limited Airworthiness and Flight Characteristics Test (A&FC) of the RC-12D (Improved Guardrail V) aircraft.

TEST OBJECTIVES

2. The objectives of the A&FC were as follows:

a. Provide quantitative and qualitative engineering flight test data on flying qualities to insure that flight characteristics of the RC-12D Provisioned Aircraft are not degraded with the Improved Guardrail V installation.

b. Verify performance data as presented in the operator's manual for the FWC-12D (Big Apple) (ref 3).

c. Obtain additional engineering flight test data with infrared (IR) suppression exhaust stacks installed.

DESCRIPTION

3. The RC-12D (Improved Guardrail V) is a C-12D aircraft which has been modified to accomodate the Improved Guardrail V mission equipment and antenna array. The RC-12D manufactured by BAC, is a pressurized, all-weather transport with all-metal construction. The aircraft is powered by two Pratt-Whitney PT6A-41 turboprop engines, rated at 850 shaft horsepower at sea level standard day static conditions, manufactured by United Aircraft of Canada Ltd. The aircraft is equipped with dual flight controls and the pilot and copilot are seated side by side. The retractable tricycle landing gear is electrically driven. The flight control system is fully reversible. A pneumatic rudder boost is installed to help compensate for asymmetrical thrust and a yaw damper system is provided to improve directional stability. The IR

suppressor exhaust stacks are manufactured by BAC. A more detailed description of the RC-12D (Improved Guardrail V) aircraft is contained in the operator's manual (ref 4) and Beech Specification BS-23525 (ref 5). Appendix B contains a brief description and photographs of the test aircraft.

TEST SCOPE

4. A limited A&FC test was conducted on RC-12D (Improved Guardrail V), USA S/N 80-23371, equipped with both standard and IR suppressor exhaust stacks. The evaluation was conducted at the BAC facility in Wichita, Kansas. Tests were conducted from 10 May to 1 June 1984 for a total of 25.7 hours of which 14.6 were productive. The flight evaluation was conducted in a normal mission configuration ballasted to a maximum takeoff gross weight of 14,200 pounds and longitudinal center of gravity (cg), at fuselage station (FS) 190.1 (fwd). The test aircraft handling qualities were compared to the requirements of military specification MIL-F-8785C (ref 6). Flight restrictions and operation limitations contained in the operator's manual and the airworthiness release (ref 7) were observed. The aircraft configurations are presented in table 1 and the test conditions are shown in table 2.

TEST METHODOLOGY

5. Established flight test techniques and data reduction procedures were used during this test program (refs 8 and 9). The test methods are described briefly in the Results and Discussion section of this report. During crew training, prior to the start of this test, a qualitative evaluation (approximately 20 hours) was conducted in C-12D aircraft to be used as a baseline for comparison to the RC-12D aircraft. Flight test data were hand recorded using calibrated cockpit instruments. Control positions were measured utilizing tape measures, and a test airspeed boom system was mounted under the left wing. A list of the test instrumentation is contained in appendix C. Test techniques (other than the standard techniques described in the appropriate references), weight and balance, and data reduction techniques are described in appendix D. A Handling Qualities Rating Scale (HQRS) (fig. 1, app D) was used to augment pilot comments relative to the aircraft handling qualities. Control system rigging check, fuel cell calibration, and aircraft weight and balance were performed by BAC and monitored by USAAEFA personnel. A pitot-static system calibration was provided to USAAEFA personnel by BAC. Deficiencies and shortcomings are in accordance with the definitions presented in appendix D.

Table 1. Aircraft Configurations

Configuration	Landing Gear Position	Flap Setting (%)	Power Setting	Propeller Speed (RPM)
Takeoff (TO)	Down	0, 40	Takeoff	2000
Cruise (CR)	Up	Zero	As required	As required
Landing (L)	Down	100	Flight idle	2000
Power approach (PA)	Down	100	Power to maintain 5 deg descent angle	2000
Glide (GL)	Up	Zero	Power off, propellers feathered	Zero
Go-around (GA)	Down	100	Takeoff	2000

Table 2. Test Conditions

Test	Average[1] Gross Weight (lb)	Average[2] Longitudinal CG Location (FS)	Density Altitude (ft)	Trim Calibrated Airspeed (KCAS)	Configuration
Airspeed Calibration	13,480	189.2 (fwd)	3300-4300	120-207	CR
Takeoff Performance	14,200	190.1 (fwd)	2200	94-105	TO
Glide[3] Performance	13,550	189.3 (fwd)	9000-22,000	118-196	GL
Landing Performance	12,600	188.9 (fwd)	2200	97	L
Static Lateral-Directional Stability	13,250	189.2 (fwd)	6000-24,500	94-154	PA, CR
Dynamic Longitudinal Stability	13,650	189.6 (fwd)	6000-26,200	90-129	PA, CR
Dynamic Lateral-Directional Stability	13,620	189.5 (fwd)	24,800	129-154	CR
Roll Control Effectiveness	13,540	189.2 (fwd)	24,800	129-154	CR
Dual Engine[4] Stall Characteristics	12,800	189.0 (fwd)	14,450	72-131	TO, CR, PA, L
Single Engine Stall Characteristics	12,800	189.0 (fwd)	14,450	72-96	TO, PA
Single Engine[3,5] Characteristics	13,400	189.2 (fwd)	8000-25,200	70-105	CR, TO, GA

NOTES:

[1]Maximum gross weight: 14,200 lb (takeoff only).
[2]Center of gravity: FS 190.1 (fwd) at takeoff.
[3]Tests conducted with both standard and IR suppressor exhaust stacks installed.
[4]Unaccelerated and accelerated (2G) stalls.
[5]Static and Dynamic V_{MC} (minimum airspeed for which control can be maintained).

RESULTS AND DISCUSSION

GENERAL

6. Limited performance and handling qualities tests of the RC-12D provisioned aircraft were conducted at the BAC facility in Wichita, Kansas. Tests were conducted with both standard and IR suppressor exhaust stacks installed. The aircraft was tested in the normal mission configuration ballasted to the mission gross weight and cg at the test conditions listed in table 2. The RC-12D in the present configuration has marginal climb performance capabilities with a combat ceiling below 24,000 feet density altitude. Use of the data link antenna radome anti-ice at pressure altitudes above 20,000 feet caused cabin pressurization fluctuations and is a deficiency. A previously report deficiency of main landing gear wheel lockup during landings with maximum braking still exists. With the exception of improved stall characteristics, the handling qualities of the RC-12D were essentially unchanged from the standard C-12D aircraft. Five shortcomings were also identified of which three were directly related to the RC-12D configuration.

PERFORMANCE

General

7. The performance characteristics of the RC-12D aircraft were evaluated in the normal mission configuration near the mission gross weight (14,079 lb) and longitudinal cg (FS 189.1 (fwd)). Tests were conducted with both standard and IR suppressor exhaust stacks installed. Takeoff and landing performance was conducted at the BAC facility on a dry, hard surface runway. The RC-12D met or exceeded the takeoff and landing performance data presented in the operator's manual. A previously reported deficiency of main landing gear wheel lockup during landings with brakes has not been corrected and remains a deficiency. Propeller feathered glide tests confirmed the baseline drag polar developed by BAC for the RC-12D with standard exhaust stacks. Installation of IR suppressors resulted in a 0.85 ft^2 increase in equivalent flat plate area (F_e). Throughout the test, the RC-12D exhibited marginal climb performance capabilities with a combat ceiling below 24,000 feet density altitude.

Takeoff Performance

8. Takeoff performance was quantitatively and qualitatively evaluated at the beginning of each test flight at the conditions presented in table 2. All takeoffs were conducted by aligning the aircraft on the centerline of the runway with the nose wheel

straight. Full takeoff power was applied prior to brake release. The takeoff data are presented in table 3. The rotation and liftoff airspeeds were those presented in the operator's manual (ref 3). Trim was set for takeoff (four degrees up elevator, aileron and rudder set to zero). Takeoffs were conducted at zero and 40 percent flap settings. Ground roll distances were determined by the use of runway ground observers. During all takeoff tests conducted, the observed ground roll distances were less than those specified in the operator's manual.

Glide Performance

9. The propeller feathered glide test method was used to verify BAC's glide drag polar for the RC-12D aircraft with standard stacks installed, and to determine the drag difference between the standard stack and IR suppressor stack installations. Tests were conducted in the glide configuration with both engines shut down and propellers feathered through a target pressure altitude (Hp) band of 22,000 to 8,000 feet. The test aircraft was stabilized and trimmed (ball-centered) in a descent at incremental airspeeds from 118 knots calibrated airspeed (KCAS) to 196 KCAS. Comparative results are presented in figure 1, appendix E. Results of the standard stack configured RC-12D aircraft confirmed the drag polar provided by BAC. Installation of the IR suppressor stacks resulted in an F_e increase of 0.85 square feet.

10. The level flight performance capabilities of the RC-12D configured with either exhaust stacks installed were compared by computing thrust horsepower required as a function of airspeed. Thrust horsepower was calculated from the glide drag polar (fig. 1, app E). The level flight performance capabilities of the IR stack configured RC-12D and the standard stack configured aircraft for a nominal mission gross weight (13,000 lb) at standard day 24,000 feet Hp conditions are presented in figure A. The F_e increase of 0.85 square feet for the IR suppressor stacks in the cruise configuration reduced the level flight speed capability of the RC-12D by approximately 5 knots true airspeed (KTAS).

Stall Performance

11. Stall performance was evaluated at the conditions listed in table 2. Unaccelerated stalls were conducted wings level at 1 kt/sec or less deceleration, and accelerated stalls were conducted using windup turns at constant load factor with a deceleration of 2 kt/sec or less. Stall speeds for the various aircraft configurations, along with stall warning and buffet speeds are shown in table 4. A summary of stall performance is presented in figure 2, appendix E. The stall performance of the RC-12D aircraft as presented in the operator's manual was verified.

Table 3. Takeoff Performance[1]

Flap Setting (%)	Exhaust Stack Configuration	OAT (°C)	Head Wind Component (kts)	Handbook Distance (ft)	Measured Distance (ft)
0	STD	20.0	6	3000	2660
0	STD	15.5	-3	3200	2760
0	IR	24.5	18	2800	2500
40	STD	18.0	0	2400	2270
40	STD	16.0	5	2250	2050
40	IR	24.0	20	2200	2050

NOTE:

[1]Takeoff gross weight = 14,200 pounds; pressure altitude = 1050 feet

FIGURE A
LEVEL FLIGHT PERFORMANCE
RC-12D USA S/N 80 - 23371

GROSS WEIGHT = 13,000 POUNDS
PRESSURE ALTITUDE = 24,000 FEET
AMBIENT TEMPERATURE = -32.5 DEG C

NOTE: DATA OBTAINED FROM FIG. 1, APP. E.

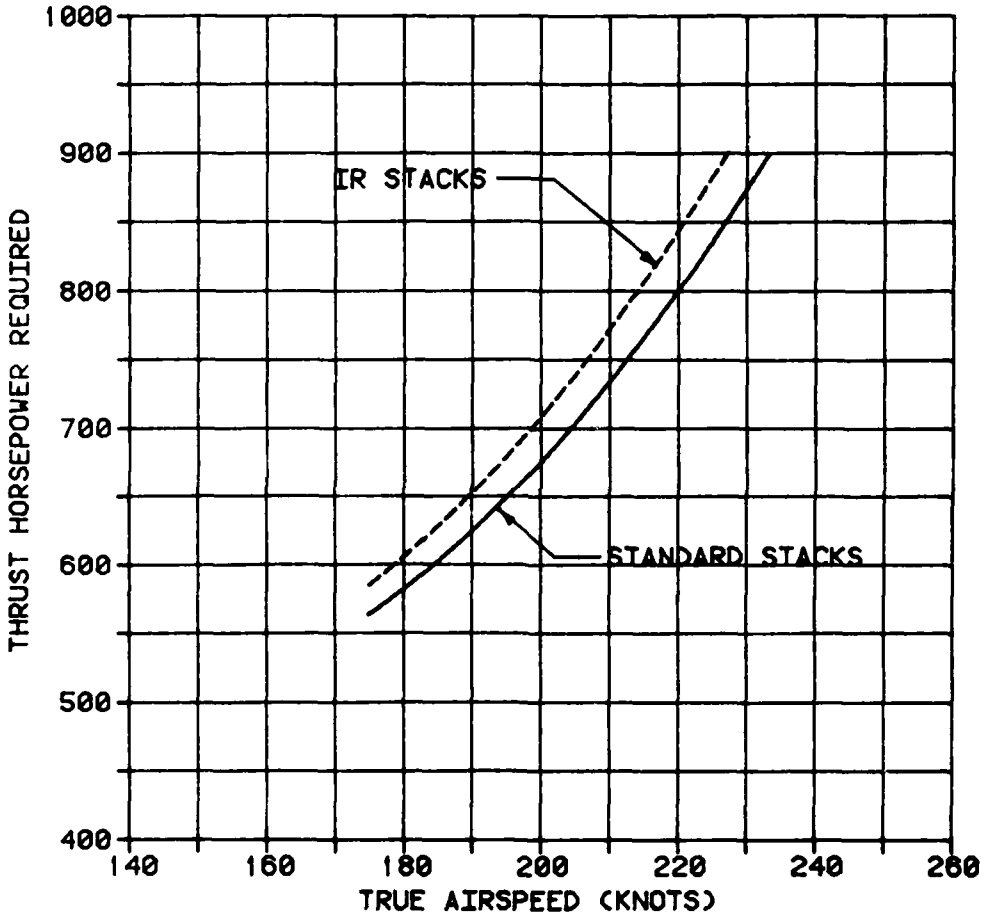


Table 4. Stall Airspeeds

Aircraft Configuration	Engine Torque L/R (psi)	Avg Gross Weight (lb)	Avg Density Altitude (ft)	Longitudinal Center of Gravity (FS)	Artificial Stall Warning Indicated Airspeed (kt)	Aerodynamic Buffet Indicated Airspeed (kt)	Stall Indicated Airspeed (kt)	Remarks
CR	400/400				112	102	100	
PA	300/300				82	74	73	
TO[1]	800/800	13100		189.0 (fwd)	86	76	74	1 g stall
TO[2]	800/800				101	87	86	
L	100/100				86	78	77	
PA	0/700				86	74	73	
TO[1]	0/800	12800	14450	189.0 (fwd)	94	80	79	Single Engine
TO[2]	0/800				105	97	96	
CR	400/400				146	134	133	
PA	300/300				121	105	104	
TO[1]	800/800	12500		188.9 (fwd)	117	101	98	2g Accelerated Stall
TO[2]	800/800				131	118	117	
L	100/100				131	100	99	

NOTES:

[1]40 percent flaps
[2]Zero percent flaps

12. In all configurations tested, aerodynamic warning of impending stall was virtually nonexistent. Prestall buffet was light and was followed very closely by stall (1 to 2 knots) and, therefore, provided inadequate stall warning. Artificial stall warning was provided by a stall warning horn. The activation of the stall warning horn during unaccelerated stalls occurred within the specification warning margin and was satisfactory. During accelerated stalls (2g) the artificial stall warning system activated at 13 to 32 knots above stall depending on power setting and aircraft configuration. The stall warning system did not meet the requirements of MIL-F-8785C during accelerated (2g) stalls, in that stall warning sometimes occurred at an airspeed greater than the maximum allowed and is a shortcoming.

Single-Engine Performance

13. Single-engine flight tests were conducted to determine the static and dynamic V_{MC} (minimum airspeed for which control can be maintained) for the RC-12D aircraft. Tests were conducted at the conditions presented in table 2 and the data are presented in table 5. Test techniques for static and dynamic V_{MC} tests are presented in paragraphs 32 and 34. At 24,000, 16,000, and 12,000 feet density altitude (Hd), both static and dynamic V_{MC} were defined by stall or simultaneous stall and loss of directional control. At 8000 feet Hd with standard exhaust stacks, V_{MC} was determined by loss of directional control. The installation of IR stacks resulted in V_{MC} always being defined by stall.

14. As shown by the test results, the operator's manual V_{MC} airspeed of 86 knots indicated airspeed (KIAS) is greater than the V_{MC} airspeed observed for the conditions tested, except for the takeoff (zero flap) and cruise configurations. V_{MC} tests in the takeoff configuration with zero flaps were not evaluated, however, single-engine stall airspeed under the same conditions (table 4) was 96 KIAS (10 knots above handbook V_{MC}). The operator's manual V_{MC} airspeed of 86 KIAS provides information which is incomplete and inadequate for the operating range of the aircraft. The data obtained during this evaluation should be incorporated in the operator's manual to provide V_{MC} airspeeds for various configurations and atmospheric conditons.

Power Available

15. Climb performance data presented in the operator's manual (ref 3) at the mission gross weight and verified during flight tests indicate that the RC-12D aircraft with standard exhaust stacks has marginal climb performance capabilities with a combat ceiling below 24,000 feet Hd. With both engines at maximum

Table 5. Minimum Control Airspeed[1,2]

Configuration	Average Density Altitude (ft)	Static			Dynamic[4]	Remarks
		Minimum Trim Airspeed (KCAS)				
		Full Aileron Trim	Full Rudder Trim	V_{MC}[3] (KIAS)	V_{MC} (KIAS)	
CR	24000	106	---	104[5]	104[5]	Standard Stacks
TO[7]	16000	101	103	78[5]	83[5]	Standard Stacks
	12000	88	93	80[6]	80[5]	
	8000	95	88	81	81	
	16000	101	97	83[5]	83[5]	IR Stacks Installed
	12000	104	92	83[5]	83[5]	
	8000	102	83	83[5]	83[5]	
GA	16000	83	89	74[5]	79[5]	Standard Stacks
	12000	81	82	73[6]	77[5]	
	8000	95	83	72	76	
	16000	100	92	74[5]	74[5]	IR Stacks
	12000	105	75	71[5]	71[5]	
	8000	104	---	69[5]	69[5]	

NOTES:

[1]Test conditions were 14,000 pounds gross weight and a cg at FS 189.4 (fwd).
[2]Operator's manual V_{MC} is 86 KIAS.
[3]5-deg roll angle into operating engine.
[4]Trim settings were those required for dual engine flight.
[5]V_{MC} determined by stall.
[6]Single-engine stall and loss of directional control simultaneously.
[7]40% flaps only.

continuous climb power, the aircraft had a maximum rate of climb of 230 feet per minute (well below combat ceiling criteria). Performance capabilities may further be reduced while operating the aircraft in icing conditions (added power required to operate bleed air anti-ice systems) and with IR stacks installed. Aircraft icing may decrease the airspeed margin between maximum power dual engine stall and V_{LOIT} (130 KIAS mission operating airspeed). The margin between maximum power dual engine stall and V_{LOIT} is less than 26 KIAS with no aircraft ice accretion.

Landing Performance

16. Landing performance was quantitatively and qualitatively evaluated at the end of each test flight at the conditions presented in table 2. Landings were performed with flaps set at 100 percent in accordance with the procedures described in the Aircrew Training Manual (ATM) (ref 10) by maintaining the operator's manual recommended reference airspeed (V_{ref}) at 50 feet above the landing threshold. Normal pilot technique was then utilized to obtain the predetermined touchdown point. After touchdown on the main wheels, the nose wheel was lowered to the ground immediately with maximum braking applied to smoothly and rapidly stop the aircraft in a straight line. Propeller reverse thrust was not used to stop the aircraft. Landing distances were determined by a runway ground observer with results presented in table 6. Landing distances obtained for all configurations were equal to or less than those presented in the operator's manual. Maximum braking had a tendency to lockup the main landing gear wheels which caused the tires to skid. The previously reported (ref 11) deficiency of main landing gear wheel lockup on other C-12 aircraft during landings with maximum braking has not been corrected and remains a deficiency. The following CAUTION should be placed in the operator's manual.

CAUTION

During landing, maximum braking will cause wheel lockup and may result in damaged or blown main landing gear tires.

HANDLING QUALITIES

General

17. A limited handling qualities and pilot workload evaluation of the RC-12D aircraft was conducted to determine stability and control characteristics at the test conditions listed in table 2.

Table 6. Landing Performance[1]

Exhaust Stack Configuration	Gross Weight (lb)	OAT (°C)	Head Wind Component (kts)	Handbook Distance (ft)	Measured Distance (ft)
STD	12,920	21.0	6.5	1530	1390
STD	13,050	24.0	5.0	1550	1550
IR	11,700	25.0	22.0	1300	1300
IR	12,900	24.0	22.0	1270	1160

NOTE:

[1]Flap settings at 100%; pressure altitude = 1050 feet.

Emphasis was placed on operation at the maximum mission gross weight of 14,079 pounds and nominal mission cg, FS 189.1 (fwd). All coordinated flight maneuvers were flown in ball-centered flight. With the exception of improved stall characteristics, the handling qualities of the RC-12D aircraft are essentially unchanged from the standard C-12D aircraft.

Trimmability

18. The capability to trim the aircraft to a given airspeed and zero control force was evaluated concurrently with other testing. The trim system of the RC-12D aircraft was identical to the basic C-12D aircraft. A detailed description of the trim system is presented in the operator's manual (ref 4). Manual trim of all controls was satisfactory and easily accomplished for all configurations tested. The slow rate of travel (57 seconds from full nose-down to full nose-up) of the electrical pitch trim system remains objectionable as previously reported (ref 11).

Static Lateral-Directional Stability

19. Static lateral-directional stability tests were performed at the conditions listed in table 2. Tests were conducted by trimming the aircraft (ball-centered), and then stabilizing at various sideslip angles up to 1-1/4 ball width deflections in 1/4 ball increments at a constant airspeed and engine power while maintaining zero turn rate. Test data are presented in figures 3 through 5, appendix E. Apparent dihedral (variation of lateral control position with sideslip) and apparent directional stability (variation of directional control position with sideslip) were both positive. The rudder force gradient became zero at sideslips greater than 1/4 ball width left and right in the PA configuration and at right sideslip greater than 3/4 ball width in the CR configuration at 129 KIAS. A lightening of aileron force with increasing aileron deflection occurred in the PA configuration at 1 ball width right sideslip but was not objectionable. Some nose-down pitch coupling was present, as indicated by the requirement for increasing aft elevator control displacement and force with increasing sideslip angles in both directions. The side-force cues (variation of bank angle with sideslip) provided an excellent indication of out-of-trim conditions. The static lateral-directional stability characteristics of the RC-12D aircraft are essentially unchanged from the standard C-12D aircraft and are satisfactory.

Dynamic Longitudinal Stability

20. The dynamic longitudinal stability characteristics were evaluated at the conditions shown in table 2. The long-term

(phugoid) dynamic characteristics were evaluated by varying airspeed 10 knots above or below the trim airspeed, then returning the longitudinal control to the trim position. The stick-fixed and stick-free long-term response was evaluated during level flight with the auto pilot system ON and OFF with the standard exhaust stacks only. Time histories of representative response characteristics with the auto pilot system OFF are presented in figure 6, appendix E. The aircraft longitudinal long-term response for a given aircraft configuration and auto pilot condition tested was generally the same regardless of airspeed and altitude. During flights with the auto pilot engaged, the long-term response was heavily damped (one overshoot). With stick-fixed (auto pilot-OFF) the long-term response was lightly damped (5 to 6 overshoots), and during stick-free (auto pilot-OFF), the long-term response was very lightly damped (fig 6, app E). With the auto pilot disengaged (simulated failure mode) at 24,000 feet H_p, continual longitudinal stick inputs ($\pm$1/4 inch) were required to maintain airspeed within $\pm$3 knots and altitude within $\pm$50 feet which increased pilot workload (HQRS 4). The long-term response of the RC-12D met the requirements of MIL-F-8785C. The dynamic longitudinal stability of the RC-12D is satisfactory and essentially unchanged from the standard C-12D aircraft.

Dynamic Lateral-Directional Stability

Dutch Roll Characteristics:

21. The dynamic lateral-directional stability characteristics (lateral-directional damping and dutch roll characteristics) were evaluated at the condition shown in table 2. These tests were conducted by exciting the aircraft from a coordinated level flight trim condition with rudder doublets and releases from sideslips. Tests were conducted with yaw damper ON and with controls fixed and free. Estimated values of the period and the roll-to-sideslip angle (ϕ/β) ratio are presented in table 7. The lateral-directional oscillations (dutch roll mode) were heavily damped and not easily excited. In light turbulence without pilot inputs, the dutch roll tends to damp out in one to two cycles. The dutch roll characteristics of the RC-12D aircraft are satisfactory and essentially unchanged from the standard C-12D aircraft.

Spiral Stability:

22. The spiral stability characteristics of the RC-12D aircraft were evaluated at the conditions shown in table 2. These tests were conducted by establishing 10 degree bank angles (both left and right) from trim conditions, using aileron only, and after stabilizing at the prescribed bank angle, the control was slowly

Table 7. Dutch-Roll Characteristics[1]

Indicated Airspeed (kt)	Aircraft Configuration	Test Method	Average Density Altitude (ft)	Period (sec)	Roll to Yaw Ratio
130	CR	Control Fixed	25,000	2	1.2/1
130		Control Free			
154		Control Fixed		1.7	1/1
154		Control Free			

NOTE:

[1]Yaw damper ON

returned to the trim position. Spiral stability, as indicated by change in bank angle with elapsed time was neutral for both left and right turns. The spiral stability characteristics of the RC-12D aircraft are satisfactory and essentially unchanged from the standard C-12D aircraft.

Roll Control Effectiveness

23. Roll control effectiveness was evaluated at the conditions shown in table 2 with the yaw damper ON. These tests were initiated from trimmed unaccelerated flight conditions by applying 1/4 to full lateral control inputs (in 0.2 second) without changing longitudinal or rudder control position. Data are presented in figure 7, appendix E. Time required to roll 45 degrees left and right for full control deflection was 1.6 sec for 130 and 154 KIAS. Lateral control forces were qualitatively determined to be moderate (40 to 60 lb) and proportional to control displacement. There was a perceptable, but not objectionable, adverse yaw associated with the lateral control inputs. The aircraft was responsive in roll, and the roll and pitch control harmony was satisfactory. The roll control effectiveness of the RC-12D are satisfactory and essentially unchanged from the standard C-12D aircraft.

Takeoff and Landing Characteristics

24. Takeoff characteristics of the RC-12D were evaluated using the procedures outlined in the ATM. During the initial portion of the takeoff roll (below 60 KIAS) runway heading was easily maintained within ± 2 degrees with nose wheel steering and rudder (HQRS 3). A four degree nose-up trim was determined to give the best elevator control effectiveness making nose wheel lift-off easily attainable at the handbook predicted rotation airspeed during normal takeoffs. During several takeoffs, the stall warning horn activated momentarily (approximately 2 seconds) at lift-off airspeed (V_{LOF}) indicating the possibility of stall. Based on the stall performance data of table 4 for the takeoff configuration, the activation of the stall warning horn near V_{LOF} is incorrect. The erroneous indication of impending stall by the stall warning horn at lift-off during normal takeoff is a shortcoming. The following NOTE should be placed in the operator's manual.

NOTE

The stall warning horn may activate erroneously at lift-off during normal takeoff.

25. Landing characteristics were conducted using the procedures outlined in the ATM. Maintaining a precise airspeed (±2 knot) during the approach was an easy task requiring minimal pilot effort (HQRS 2). A full stall landing to a predetermined touchdown point, however, required moderate pilot effort during the landing flare due to the aircraft's tendency to float. Directional control during roll out was easily maintained. During maximum braking, the wheels have a tendency to lockup causing the tires to skid. This is a previously reported deficiency (ref 11, app A) which remains uncorrected.

Stall Characteristics

General:

26. Dual and single-engine stall characteristics of the RC-12D aircraft were evaluated in conjunction with stall performance testing (para 11) at the conditions listed in table 2. Stall warning, stall, and stall recovery characteristics were evaluated.

Unaccelerated Stalls:

27. The RC-12D unaccelerated dual-engine stalls were characterized by: (1) buffet onset; (2) pitch oscillations (±5 to 7 degrees); (3) mild wing rock (5 to 10 degrees left and right); (4) a significant increase in rate of sink (in excess of 3000 fpm); and (5) erratic ship's system airspeed indications (±10 KIAS). Lateral and directional control effectiveness remained good throughout the approach to the stall and with no discernible nonlinear increase in elevator control force occurring prior to the stall. The RC-12D unaccelerated dual-engine stalls were free from any adverse departure or poststall gyration. The dual-engine stall characteristics of the RC-12D were satisfactory and are improved over the standard C-12D aircraft.

28. Unaccelerated single-engine stall characteristics were evaluated with the left engine inoperative and propeller feathered, at the conditions listed in table 2. The single-engine stall characteristics were essentially the same as the dual-engine stall characteristics except that a slight left roll (5 to 10 degree) accompanied the stall. The single-engine unaccelerated stall characteristics of the RC-12D are satisfactory and are improved over the standard C-12D aircraft.

Accelerated Stalls:

29. Dual-engine accelerated (2g) stalls were evaluated at the conditions listed in table 2 using windup turns to the left. At

stall, the aircraft exhibited the same characteristics as in the unaccelerated stall, except that the elevator control forces were high (40 to 60 pounds in a 60 degree banked turn). The aircraft had a mild tendency to roll out of the stall (prorecovery), requiring the pilot to hold the airplane into the turn. This inherent rollout tendency, as well as a decrease in load factor, initiated the recovery. The dual-engine accelerated stall characteristics of the RC-12D are satisfactory and are improved over the standard C-12D aircraft.

Stall Recovery:

30. The RC-12D aircraft was recovered from all normal dual-engine stalls by relaxing aft longitudinal control force, returning the airplane to a level flight attitude and adding power to minimize altitude loss. Prompt recovery from all stalls was readily accomplished and no secondary stall tendency (recurrence of buffet) was encountered. Altitude loss during stall recovery was generally 200 to 800 feet.

31. Single-engine stall recovery was best achieved by slightly reducing power on the operating engine at the pitch break, lowering the nose of the aircraft to the horizon, and accelerating to the best single-engine rate of climb airspeed; then coordinating maximum controllable power to minimize altitude loss. Altitude loss during single-engine stall was 500 to 800 feet.

Single-Engine Characteristics

Static V_{MC}:

32. Static single-engine V_{MC} tests were conducted at the conditions presented in table 2. Tests were conducted with the left (critical) engine inoperative and propeller feathered, decelerating at 1 knot per second while banking 5 degrees into the operating engine in constant heading flight. The operating engine was set at takeoff power with a propeller speed of 2000 rpm. The airspeed at which maximum lateral or directional control deflection was reached and heading or bank angle could not be maintained was defined as static V_{MC}. If single-engine stall occurred prior to V_{MC}, the stall speed defined static V_{MC}. Additionally, minimum trim airspeed was determined. Test results are presented in table 5.

33. All tests conducted with the IR suppressors installed resulted in V_{MC} being defined by single-engine stall speed. V_{MC} was also defined by single-engine stall speed with the standard stacks at 24,000 and 16,000 feet Hd. A 200 to 300 feet loss of altitude was observed during the maneuver and stall recovery was easily

achieved (para 30). At 12,000 feet Hd, V_{MC} was defined by the simultaneous application of full right directional control and single engine stall. Altitude loss of less than 200 feet was observed and recovery was also easily achieved. At 8000 feet Hd, V_{MC} was evaluated at three power settings (takeoff power, 80%, and 70%). At the highest power setting, V_{MC} was defined by the loss of directional control. No valid data were obtained at the two lower power settings since V_{MC} was defined by stall. The single-engine static V_{MC} characteristics are satisfactory.

Dynamic V_{MC}

34. Dynamic V_{MC} tests were conducted by reducing the power lever to idle and feathering the propeller on the left (critical) engine while trimmed in symmetrical full power flight. The controls were held fixed for one second simulating a pilot delay reaction time. All flight controls were then used to return the aircraft to stabilized flight at the trim airspeed without reducing power on the operating engine or adding power from the simulated failed engine. The aircraft was tested at the conditions presented in table 2 with test results presented in table 5.

35. For all tests conducted with IR suppressors installed, dynamic V_{MC} was defined by static V_{MC}. With standard stacks installed, dynamic V_{MC} was also defined by static V_{MC} at the conditions tested except in the GA configuration and at 16,000 feet Hd in the TO configuration. At these conditions, the aircraft stalled in the dual-engine configuration before dynamic V_{MC} could be reached, therefore, dynamic V_{MC} was defined at the dual-engine stall airspeed. Normally, dual-engine stall airspeeds would be either lower than or equal to single-engine stall airspeeds. The large variation of airspeed position error with right sideslip and single-engine operation is considered responsible for these abnormalities. When boom airspeed indications were used, the results showed a normal trend. At 12,000 feet Hd, two test methods were used to determine dynamic V_{MC}. One method was to simulate an engine failure (power to flight idle, propeller feathered) and the other method consisted of an actual engine shutdown. No significant differences were observed using either method. The dynamic V_{MC} characteristics are satisfactory.

MISCELLANEOUS

Chaff Dispenser Switch

36. The chaff dispenser switch has replaced the normal location of the pitch synchronization switch (photo A) on the control

yoke of the RC-12D aircraft. Through normal habit transfer from the standard C-12 aircraft, the pilot may inadvertently activate the chaff dispenser instead of the pitch synchronization, possibly expending the only active radar countermeasure. The possibility of inadvertent activation of the chaff dispenser due to its switch location is a shortcoming.

Pitch Synchronization Switch

37. The pitch synchronization switch was moved to a new location on the control yoke (photo A). This new location requires the pilot to move his hand from the normal position (fore finger on the communications switch) in order to utilize the pitch synchronization switch. The pitch synchronization switch allows the pilot to disengage the auto pilot in order to make aircraft attitude adjustments. The pilot depresses and holds the synchronization switch with the left hand and manually trims the aircraft with the right hand (trim wheel and/or power lever adjustments). Upon releasing the switch, the auto pilot reengages and the new flight mode is maintained. The inconvenient location of the pitch synchronization switch on the control yoke is a shortcoming.

Data Link Antenna Radome Anti-Ice

38. A limited evaluation of the data link antenna radome anti-ice system was performed. The forward radome anti-ice system utilizes engine bleed air to prevent the formation of ice on the radome. Normal scheduled cabin pressurization (6.0 PSID) could not be maintained with the radome anti-ice ON. With the radome anti-ice ON the cabin pressurization fluctuated $\pm$700 fpm. An ice free radome is required for the Guardrail V mission and a reliable anti-ice system should be installed. The fluctuation of cabin pressurization with the data link antenna radome anti-ice system ON is a deficiency.

Pitot-Static System Calibration

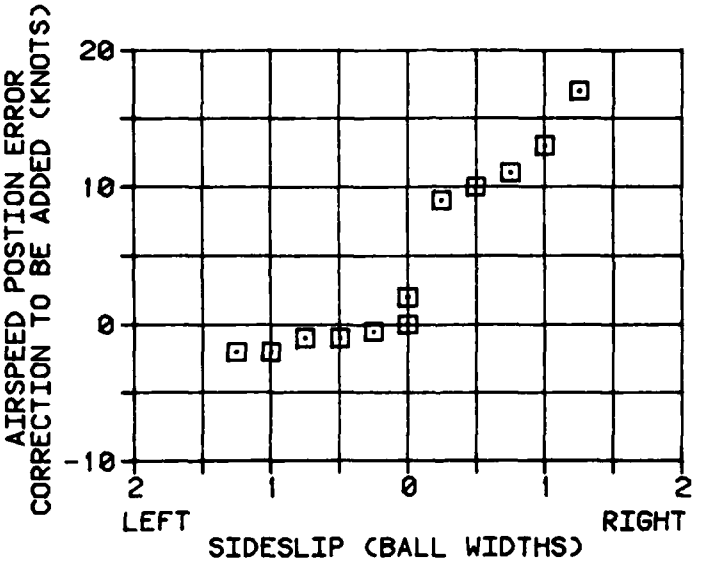
39. The pitot-static position error of the standard ship's system furnished by BAC was verified at the conditions presented in table 2 using the ground speed course method. Test results are presented in figure 8, appendix E.

40. Static ports are located on both sides of the aircraft toward the rear and aft of the wings (photos 2 and 3, app B). During steady heading sideslip in the PA configuration, large airspeed position errors were observed in sideslips. The variation of airspeed position error of the pilot's system with sideslip is presented in figure B. At right sideslips the calibrated airspeed

Photo A. Pilot's Control Yoke

FIGURE B
AIRSPEED POSITION ERROR IN SIDESLIPS
RC-12D USA S/N 80 - 23371
PILOT'S SHIP SYSTEM

GROSS WEIGHT = 14,050 POUNDS
LONGITUDINAL CG LOCATION = 189.8 FS
DENSITY ALTITUDE = 6,000 FEET
AMBIENT TEMPERATURE = 5.0 DEG C
CALIBRATED AIRSPEED = 94 KNOTS
PROPELER SPEED = 2,000 RPM
POWER APPROACH CONFIGURATION



position error increased rapidly from 0 knots in ball-centered flight to +9 knot at 1/4 ball width out-of-trim. Similar airspeed position errors were observed on the copilot's airspeed indicator during left sideslips. During V_{MC} testing (para 35), variation in pilot's airspeed position error was also observed in GA configuration. The excessive airspeed position error of the ship's airspeed system at combinations of sideslip, aircraft configuration (TO, GA, PA) and single-engine operation is a shortcoming.

CONCLUSIONS

GENERAL

41. The following conclusions were reached based on the A&FC evaluation of the RC-12D (Improved Guardrail V) aircraft.

a. Takeoff and landing performance data presented in the operator's manual were verified (paras 8 and 16).

b. BAC's glide drag polar of the standard stack configured RC-12D aircraft was verified (para 9).

c. The RC-12D aircraft has marginal climb performance capabilities with a combat ceiling below 24,000 feet (para 15).

d. With the exception of improved stall characteristics, the handling qualities of the RC-12D were essentially unchanged from the standard C-12D aircraft (paras 18 through 35).

e. A slight degradation in performance (0.85 ft^2 of equivalent flat plate area) was noted with IR suppressor stacks installed, however, handling qualities were essentially the same (para 10).

f. A previously reported deficiency of main landing gear wheel lockup during landing with maximum braking remains a deficiency (para 16).

DEFICIENCY

42. The fluctuation of cabin pressurization with data link antenna radome anti-ice system ON (para 38).

SHORTCOMINGS

43. The following shortcomings were identified and are listed in decreasing order of relative importance:

a. Possibility of inadvertent activation of chaff dispenser during normal aircraft operation (para 36).

b. Inconvenient location of the pitch synchronization switch on the control yoke (para 37).

c. Erroneous stall warning indication during liftoff (para 24).

d. Activation of the artificial stall warning system during accelerated (2g) stalls at as much as 32 knots above stall depending on power setting and aircraft configuration (para 12).

e. Excessive airspeed position error of the ship's airspeed system at combinations of sideslip, aircraft configuration (TO, GA, PA) and single-engine operation (para 40).

SPECIFICATION COMPLIANCE

44. The RC-12D aircraft met all the requirements of the specification, MIL-F-8785C against which it was tested except for paragraph 3.4.2.1.1.2 in that the artificial stall warning system activated at an airspeed greater than the maximum allowed (para 12).

RECOMMENDATIONS

45. The deficiency identified during this evaluation should be corrected prior to aircraft delivery to the user (para 42).

46. Correct the shortcomings prior to production (para 43).

47. Incorporate the results of V_{MC} testing in the operator's manual (para 14).

48. Incorporate the following CAUTION from paragraph 16 of this report in the operator's manual:

CAUTION

During landing, maximum braking will cause wheel lockup and may result in damaged or blown main landing gear tires.

49. Incorporate the following NOTE from paragraph 24 of this report in the operator's manual:

NOTE

The stall warning horn may activate erroneously at lift-off during normal takeoff.

APPENDIX A. REFERENCES

1. Army Regulation, AR 70-62, *Research and Development Airworthiness Qualification of US Army Aircraft Systems,* 15 July 1978.

2. Letter, AVSCOM, DRSAV-ED, 15 February 1984, subject: Airworthiness and Flight Characteristics Test of the RC-12D, Guardrail V. (Test Request).

3. Beech Aircraft Corporation, FWC-12D, *Operator's Manual, (Part No. 92-30094), Preliminary Draft,* unpublished.

4. Technical Manual, TM 55-1510-219-10, *Operator's Manual for Army RC-12D Aircraft,* unpublished.

5. Beech Specification, BS-23525, Rev B, *Model Specification Model RC-12D Improved Guardrail V,* 26 August 1982.

6. Military Specification, MIL-F-8785C, *Flying Qualities of Piloted Airplanes,* 5 November 1980.

7. Letter, AVSCOM, DRSAV-E, 13 March 1984, with revision 1, 10 May 1984, subject: Airworthiness Release, RC-12D (Improved Guardrail V) Aircraft, Conduct of Airworthiness and Flight Characteristics (A&FC) Flight Tests, S/N 80-23371.

8. Flight Test Manual, Naval Air Test Center, FTM No. 104, *Fixed Wing Performancea,* July 1977.

9. Flight Test Manual, Naval Air Test Center, FTM No. 103, *Fixed Wing Stability and Control,* 1 January 1975.

10. Training Circular, TC No. 1-145, *Aircrew Training Manual (Utility Airplane),* 10 October 1980 through change 1, 27 July 1982.

11. Final Report, USAAEFA Project No. 75-08, *Airworthiness and Flight Characteristics Evaluation C-12A Aircraft,* October 1976.

APPENDIX B. DESCRIPTION

GENERAL

1. The RC-12D aircraft is a modified C-12D utility aircraft configured for the Improved Guardrail V mission. Four views of the test aircraft are shown in photos 1 through 4 and photos 5 and 6 show the IR suppressor exhaust stack installation. Aircraft drawings are presented in figures 1 through 3. A detailed description of the RC-12D aircraft is contained in the Model Specification (Beech Specification BS 23525, Revision B, dated 3 May 1982).

FLIGHT CONTROL SYSTEM

2. The aircraft primary flight control system is reversable and consists of conventional rudder, elevator and aileron as on the standard C-12D. An aileron high torque mode operation incorporated in the Automatic Flight Control System (AFCS) allows the aileron servo to operate in the high torque mode from surface to 10,000 ft. The servo then automatically returns to normal torque above 10,000 ft.

ELECTRICAL SYSTEM

3. The RC-12D uses both direct current (DC) and alternating current (AC) electrical power. The primary DC power source consists of two engine-driven 28 volt, 400 ampere generators. The output of each generator passes to a respective generator bus, then power is distributed to DC buses. When a generator is not operating, reverse current and over-voltage protection is automatically provided. Two inverters (750 volt amperes, 115 volts and 26 volts 400 Hz) operating from DC power produce the aircraft required single phase AC power. The three phase mission AC (3000 volt amperes 400 Hz) electrical power for inertial navigation and mission avionics is supplied by two DC powered inverters. Battery voltage is displayed on an independent meter located on the mission control panel.

ENVIRONMENTAL SYSTEM

4. The environmental system consists of the bleed air pressurization, heating and cooling system with associated controls. Cabin ducting is routed to exhaust on the mission equipment to include the data link.

Photo 1. Left Front Quartering View

Photo 2. Left View

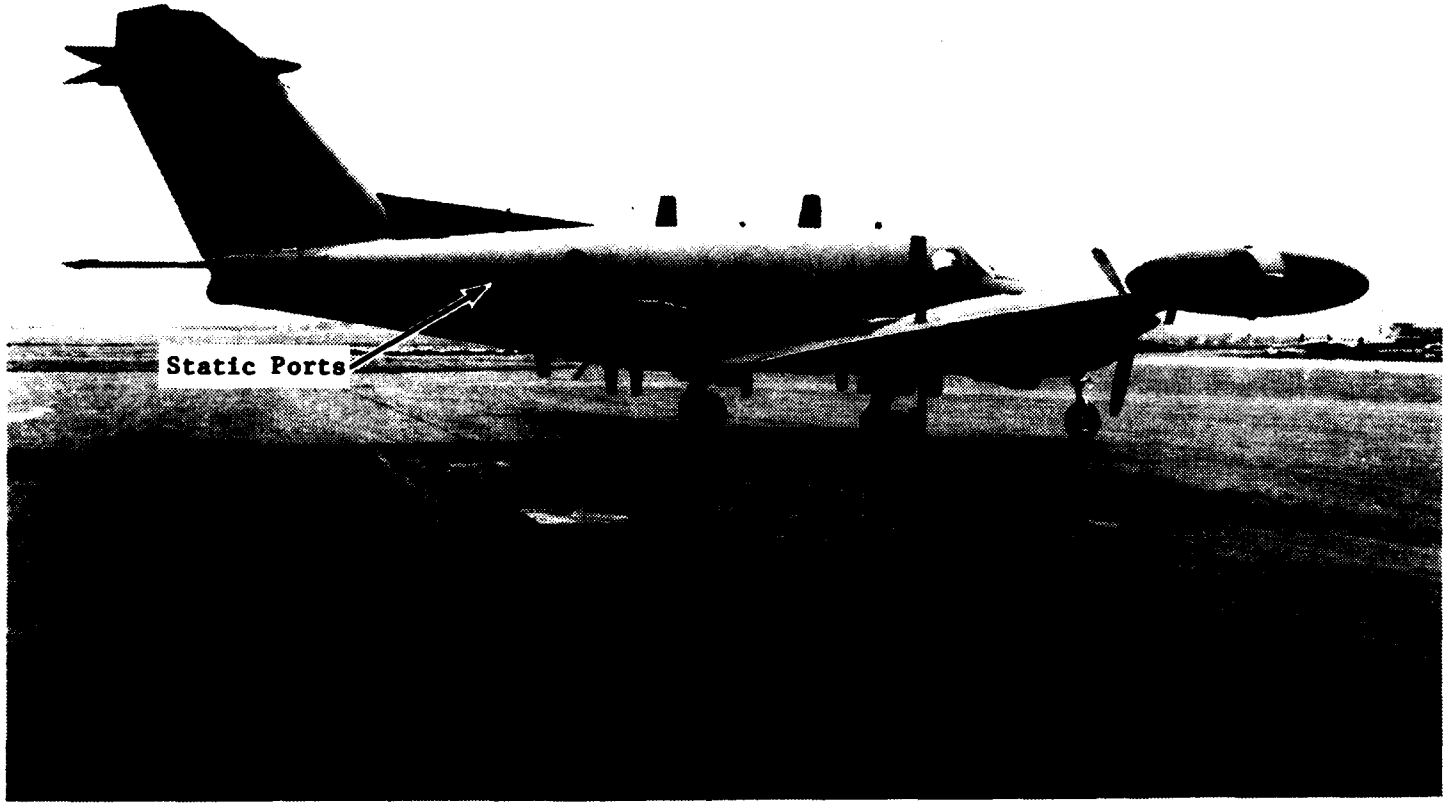


Photo 3. Right Rear Quartering View

Photo 4. Right Front Quartering View

Photo 5. IR Suppressor Exhaust Stack, Top View

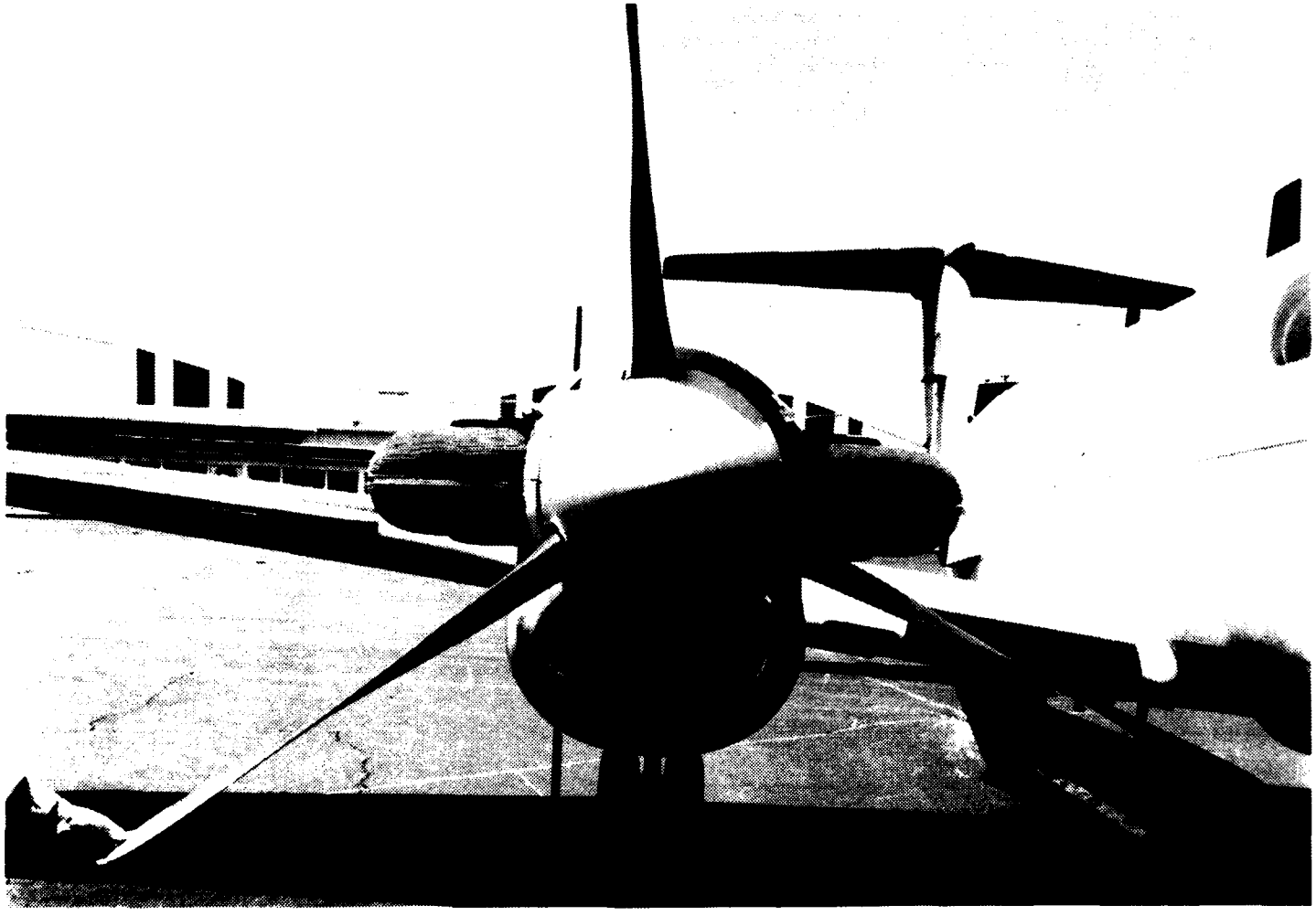


Photo 6. IR Suppressor Exhaust Stacks, Front View

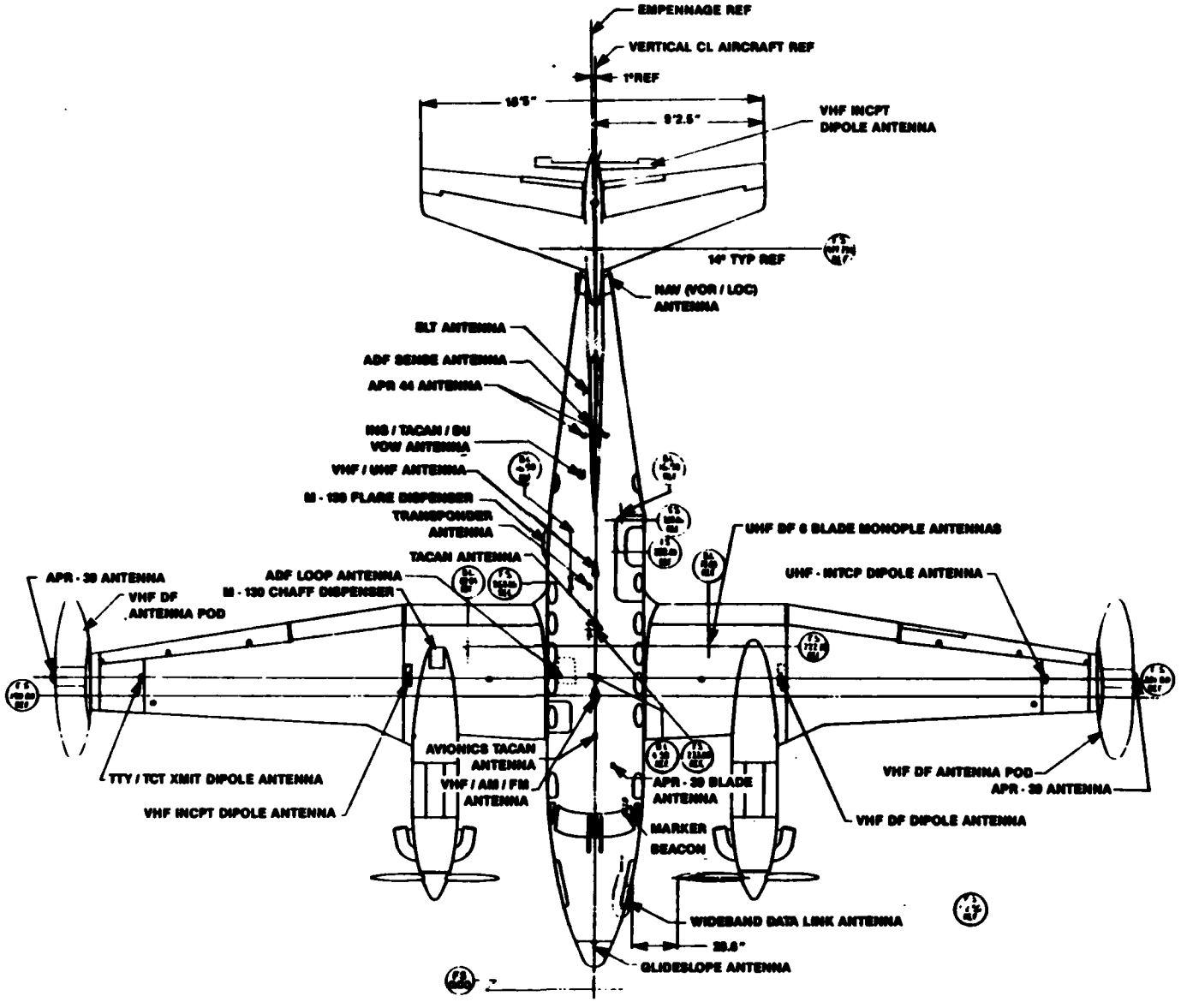


Figure 1. General Description, Top View

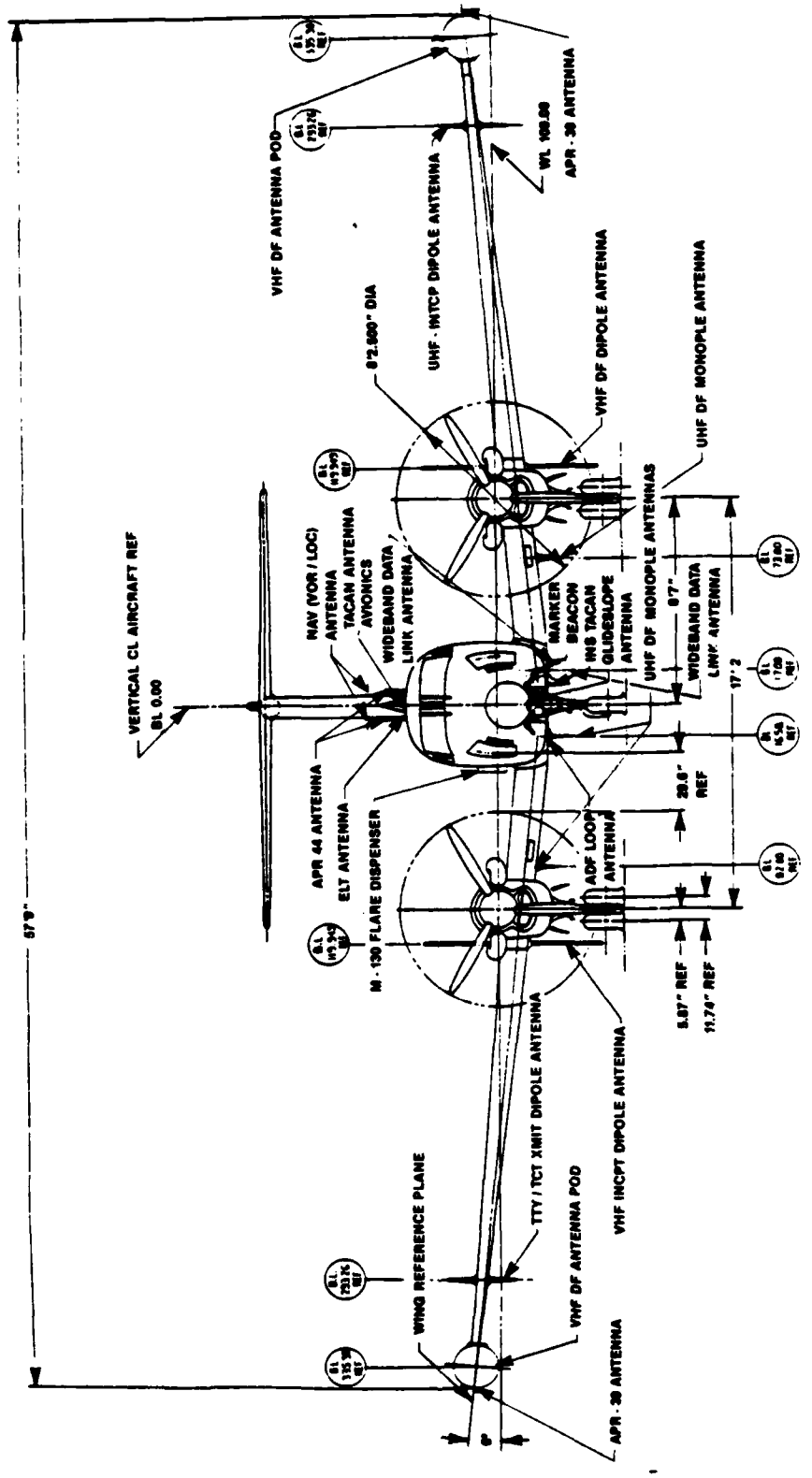


Figure 2. General Description, Front View

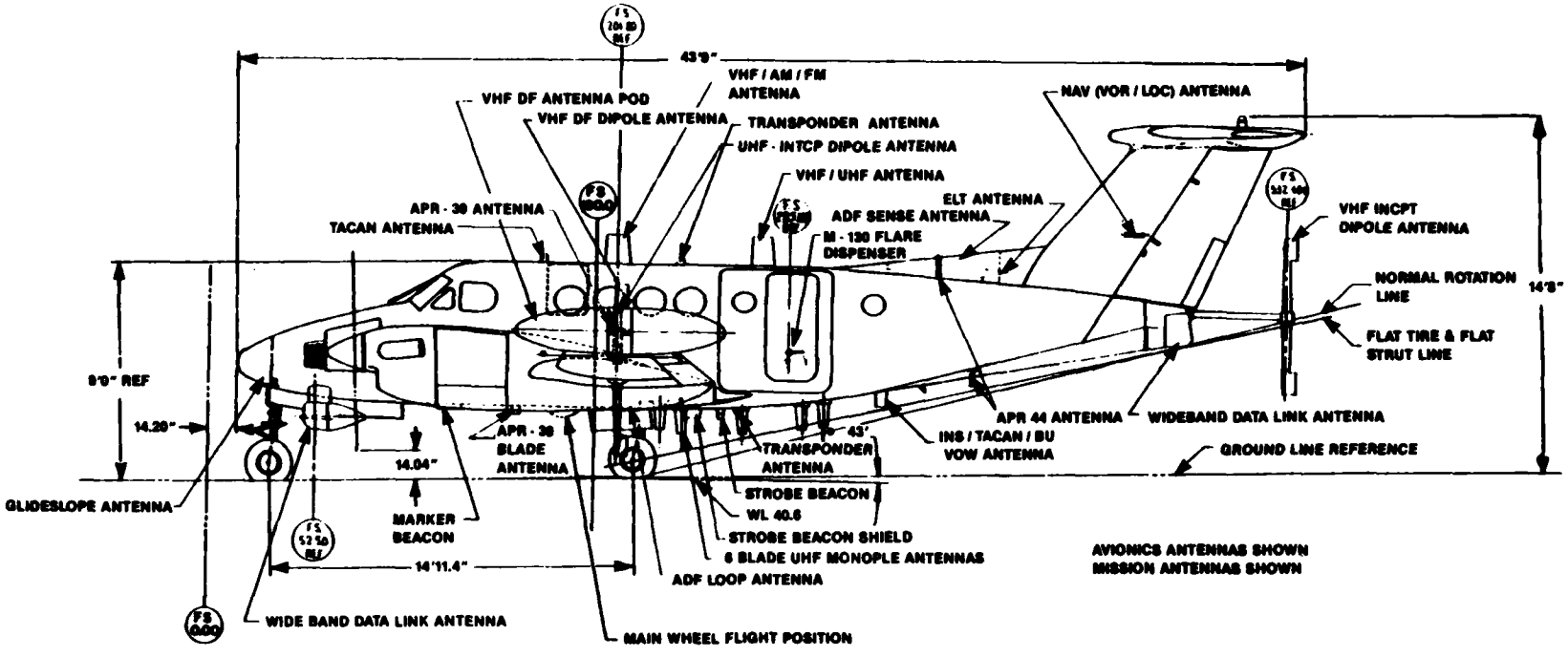


Figure 3. General Description, Left Side View

DEICING

5. The windshield panel in front of each pilot is electrically anti-iced and defogged by air from the cabin heating system. Aircraft surface deicing is by pneumatic deicer boots. Certain mission antennas are deiced by pneumatic boots and control is accomplished through a timing circuit and an antenna deicer switch. Data link antenna anti-ice is provided for the forward data link randome through the use of engine bleed air.

GENERAL INTERIOR ARRANGEMENT

6. The interior arrangement consists of the crew compartment and the mission equipment area. The crew compartment is separated from the mission equipment area by a curtain which may be opened or closed.

7. The total interior space available for mission equipment is 299 cubic feet. Seat tracks and upper floor ceiling are reinforced to support equipment racks. Provisions for the stowage of two chest parachutes is incorporated on the emergency exit door.

MISSION ANTENNAS

8. Mission antennas are provided as depicted in figures 1 through 3. A detailed description of mission equipment and operation is contained in the operator's manual (ref 4, app A).

Table 1. Dimensions and General Data.

Wing	
Span, maximum	57.75 ft
Chord:	
At root (centerline of fuselage)	85.75 in.
At root Station 123.99 (disregarding leading edge extension)	79.07 in.
At Station 328.74	35.64 in.
Mean aerodynamic	70.41 in.
Leading edge of mean aerodynamic chord	Fus Sta 171.23
Airfoil section designation:	
At Station 25	NACA 23018 (modified)
At Station 298.74	NACA 23012
Incidence (degrees)	
At root (theoretical centerline of fuselage)	3.48 degrees
At Station 328.74	-1.07 degrees
Sweepback:	
Outer panel at 25 percent chord	0 degrees
Center section at 100 percent chord	0 degrees
Dihedral, degrees	6.0 degrees
Aspect ratio	9.8
Height over highest fixed part of aircraft (tail) (airplane in normal-ground attitude)	14.71 ft
Length, maximum (normal-ground attitude)	43.85 ft
Distance from wing MAC quarter chord point to horizontal tail MAC quarter chord point	25.19 ft
Distance from wing MAC quarter chord point to vertical tail MAC quarter chord point	20.96 ft
Angle between reference line and wing zero-lift line	-2 degrees
Ground angle, degrees	1.72 degrees
Propeller clearance, (normal design) loading condition reference line level	14.04 in.
Propeller diameter	98.5 in.
Wheel size	
Main wheels	6.50 x 10
Nose wheel	6.50 x 10
Tire size	
Main wheels	22 x 6.75 - 10
Nose wheel	22 x 6.75 - 10
Tread of main wheels	17.2 ft
Wheel base	14.9 ft
Wing Area	
Wing area, total, including ailerons and flaps to G_L of airplane	306.0 sq ft
Wing flap area total	44.9 sq ft
Aileron area, aft of hinge line, total including 0.84 sq ft of tab area	18.0 sq ft

Horizontal Tail Surface	
Horizontal tail area, total	68.00 sq ft
Elevator, aft of hinge line, including 1.16 sq ft of tab area	19.25 sq ft
Vertical Tail Surface	
Vertical tail area, total	52.26 sq ft
Rudder, aft of hinge line, including 1.79 sq ft of tab area	15.12 sq ft

Control

Control and control surface movements on each side of neutral position for full movement, as limited by stops.

Rudder	25 degrees right, 25 degrees left
Rudder pedals	3.82 inches forward, 3.46 inches aft
Rudder tab or trim surface	15 degrees right, 15 degrees left
Rudder tab or trim surface control	4 turns for 30 degrees of tab or trim surface movement
Ailerons	24 degrees trailing edge up 16 degrees trailing edge down
Aileron control wheel	70 degrees right, 70 degrees left
Aileron tab control	4 turns for 30 degrees tab movement
Wing flap (maximum)	35 degrees
Aileron tab or trim surface	15 degrees trailing edge up 15 degrees trailing edge down

APPENDIX C. INSTRUMENTATION

1. Flight test data were recorded by hand from calibrated cockpit instruments located in the pilot's panel. Longitudinal, lateral, and pedal control positions were measured using tape measures located on the copilot control yoke and pedal. Aileron, elevator, and rudder control forces were measured using a strain gaged control yoke and pedals. A test boom pitot-static system was installed under the left wing to measure airspeed.

2. Instrumentation and related special equipment installed are presented below. Photos 1 through 7 show the cockpit instrument panel, instrumented control yokes, instrumented pedals, control force special equipment, and test boom installation.

Pilot/copilot panel

Airspeed (boom system)
Airspeed (standard system)
Altitude (standard system)
Propeller speed (left and right)
Gas producer speed (left and right)
Engine torque (left and right)
Fuel flow (left and right)
Fuel quantity (left and right)
Outside air temperature
Control force
    Aileron
    Elevator
    Rudder
Control position (tape measure)
    Longitudinal
    Lateral
    Pedal

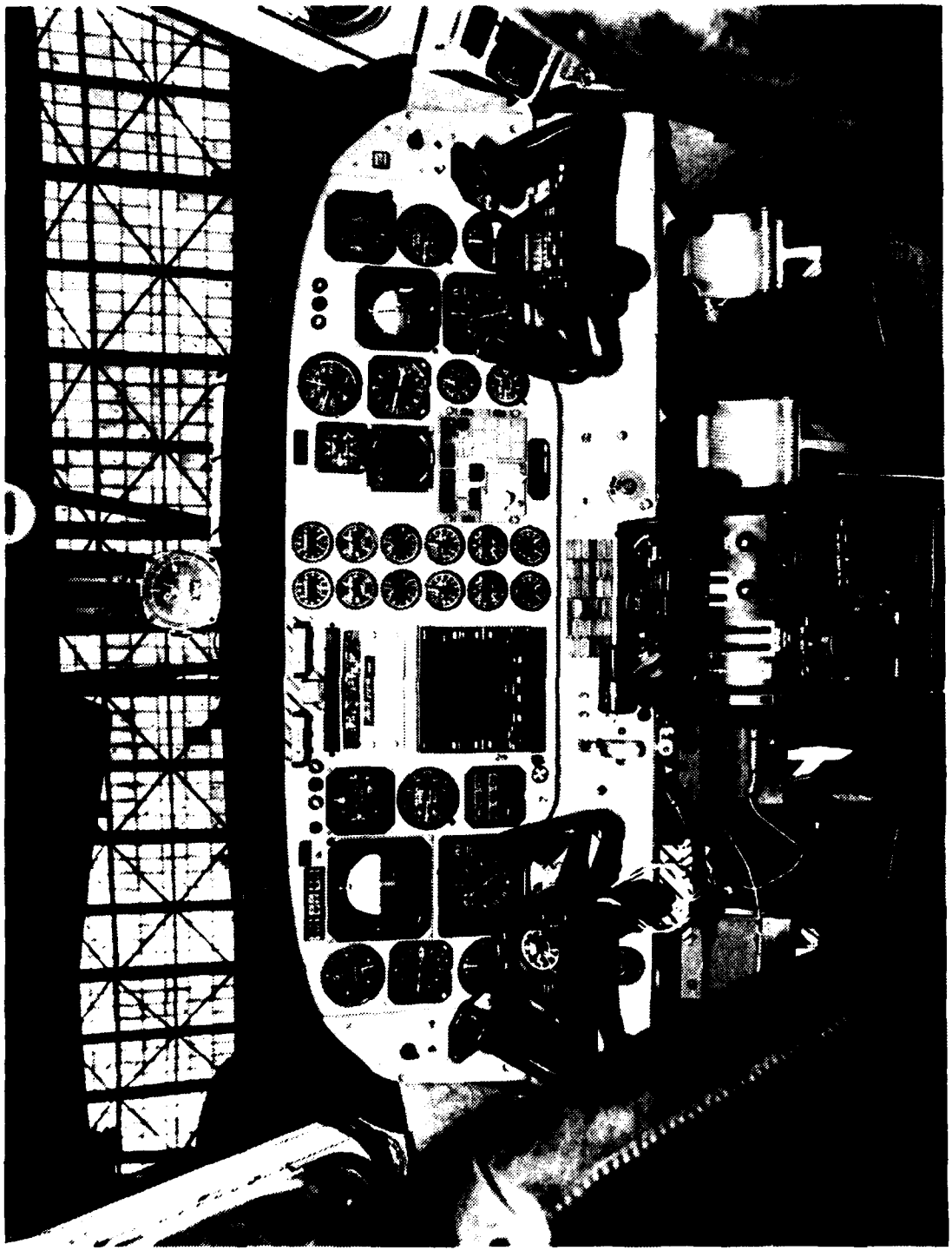


Photo 1. Cockpit Instrument Panel

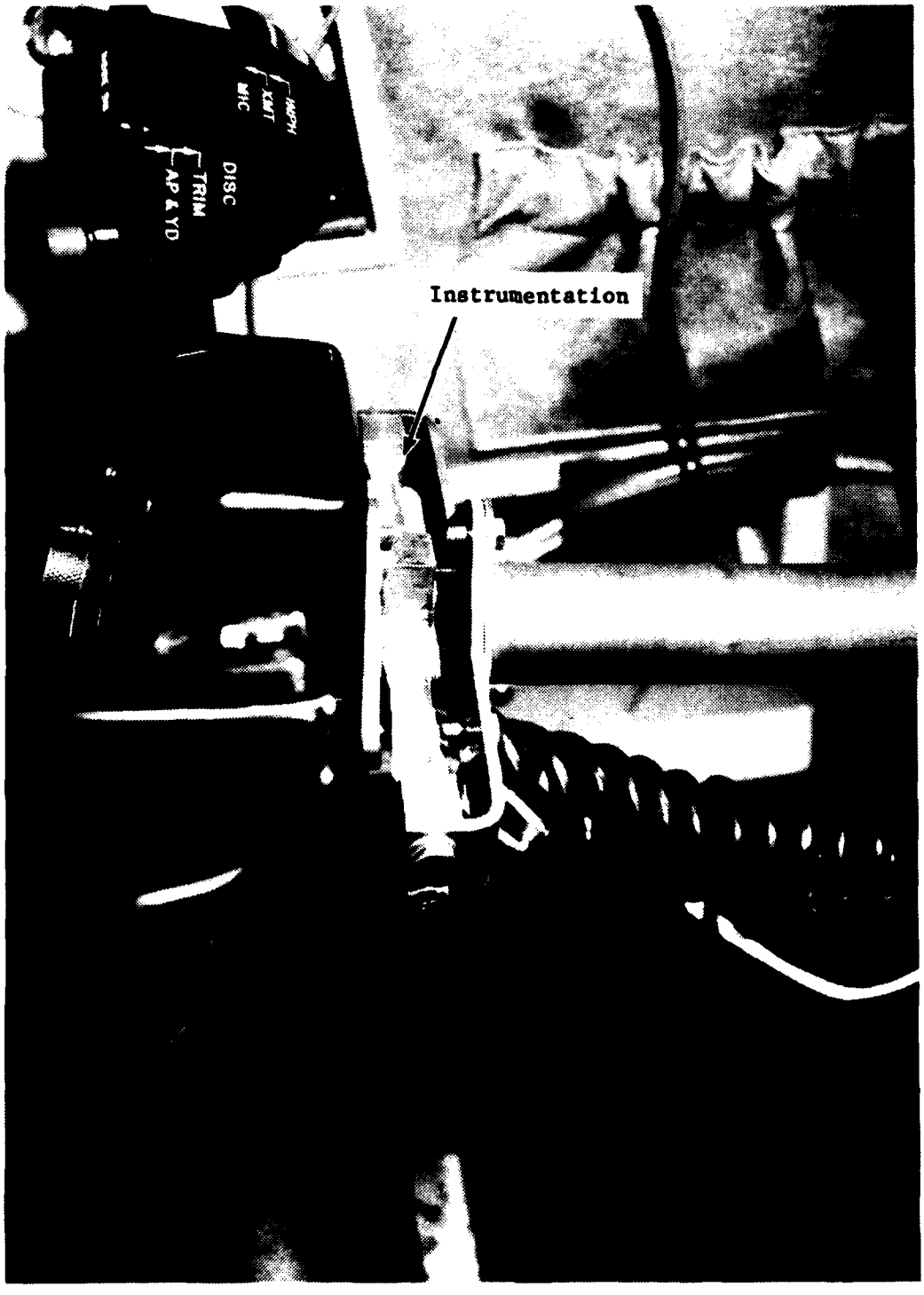


Photo 2. Pilot's Instrumented Control Yoke

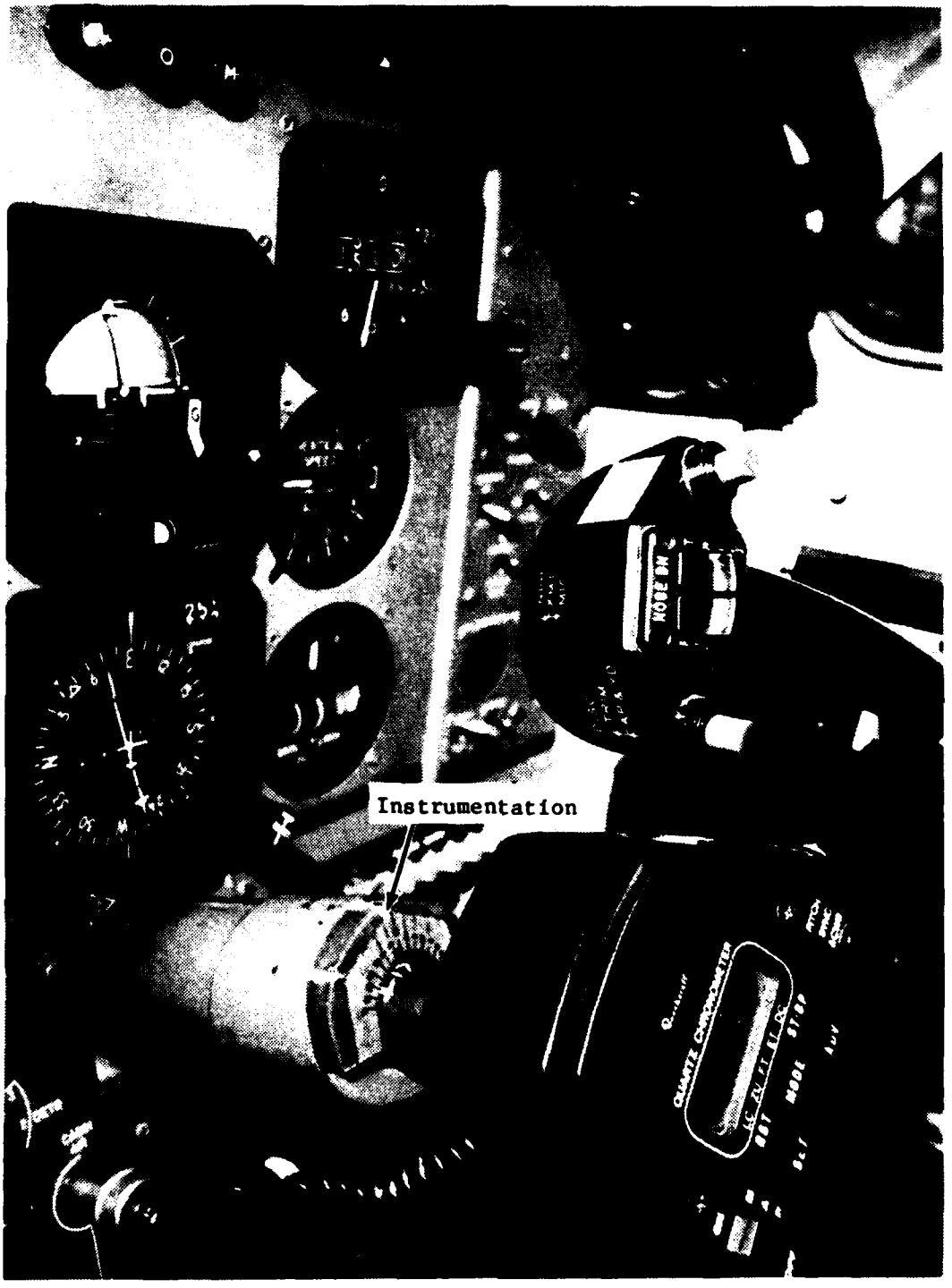


Photo 3. Copilot's Instrumented Control Yoke

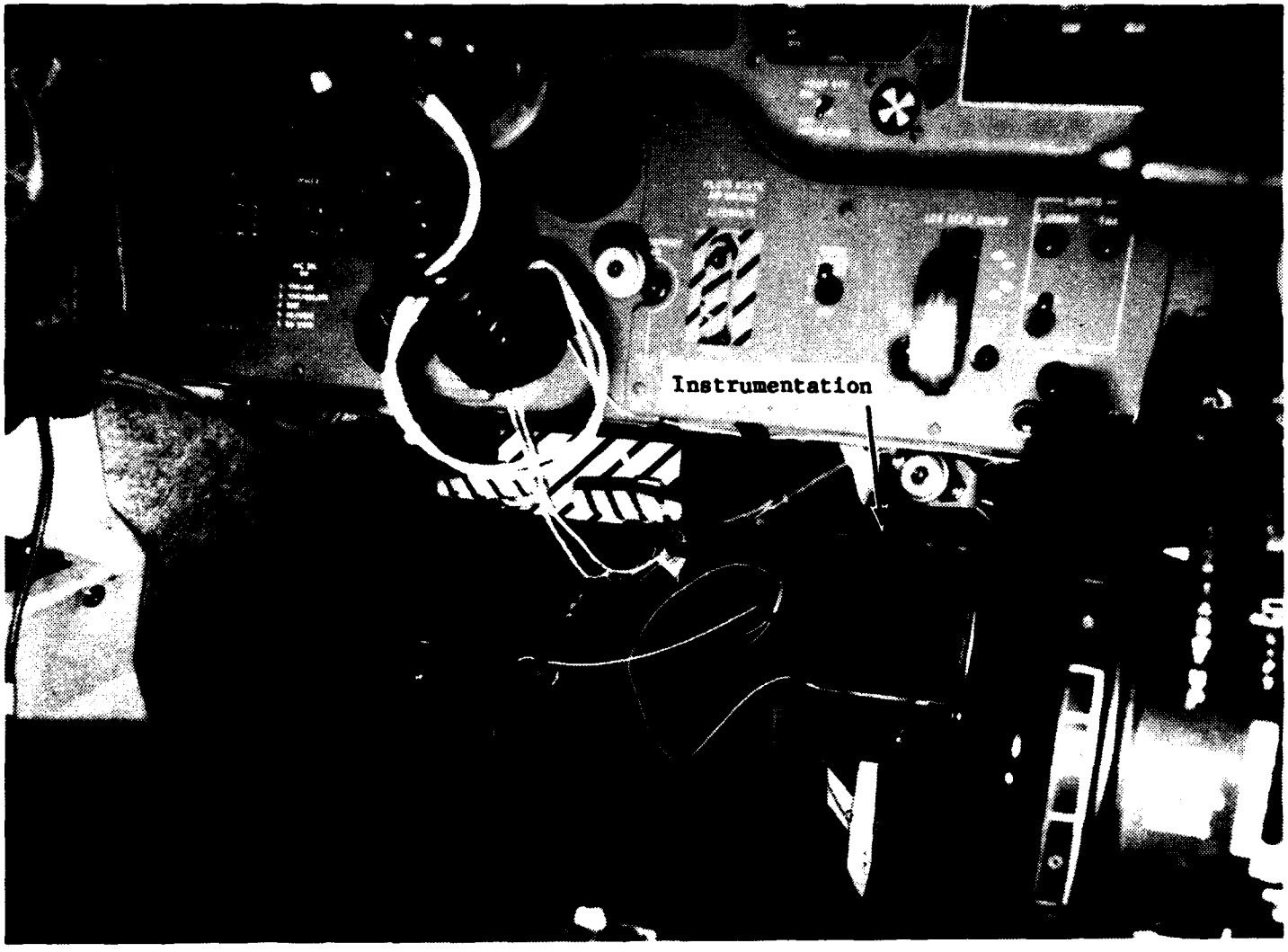


Photo 4. Pilot's Pedal Force

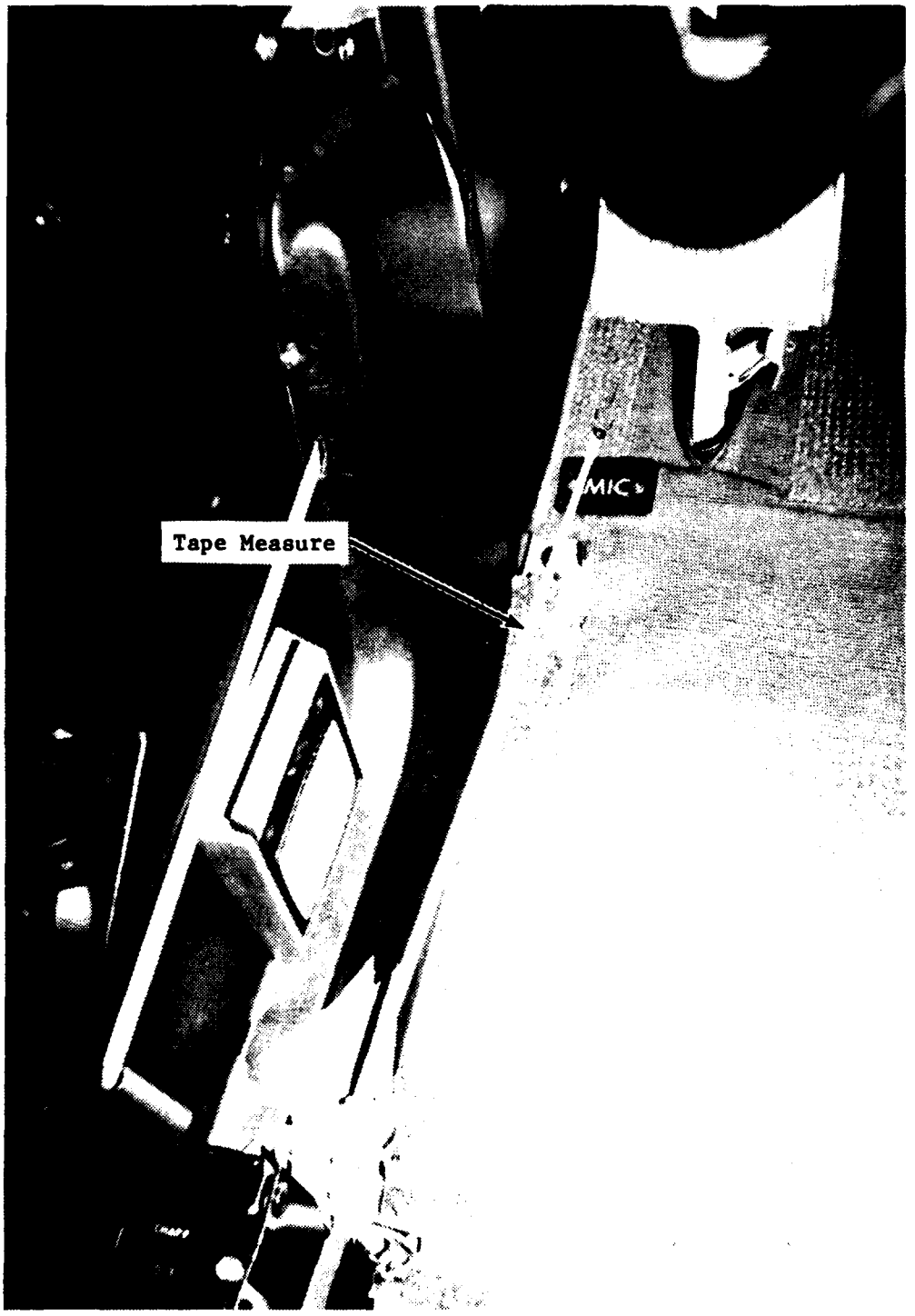


Photo 5. Copilot Instrumented Pedal Position

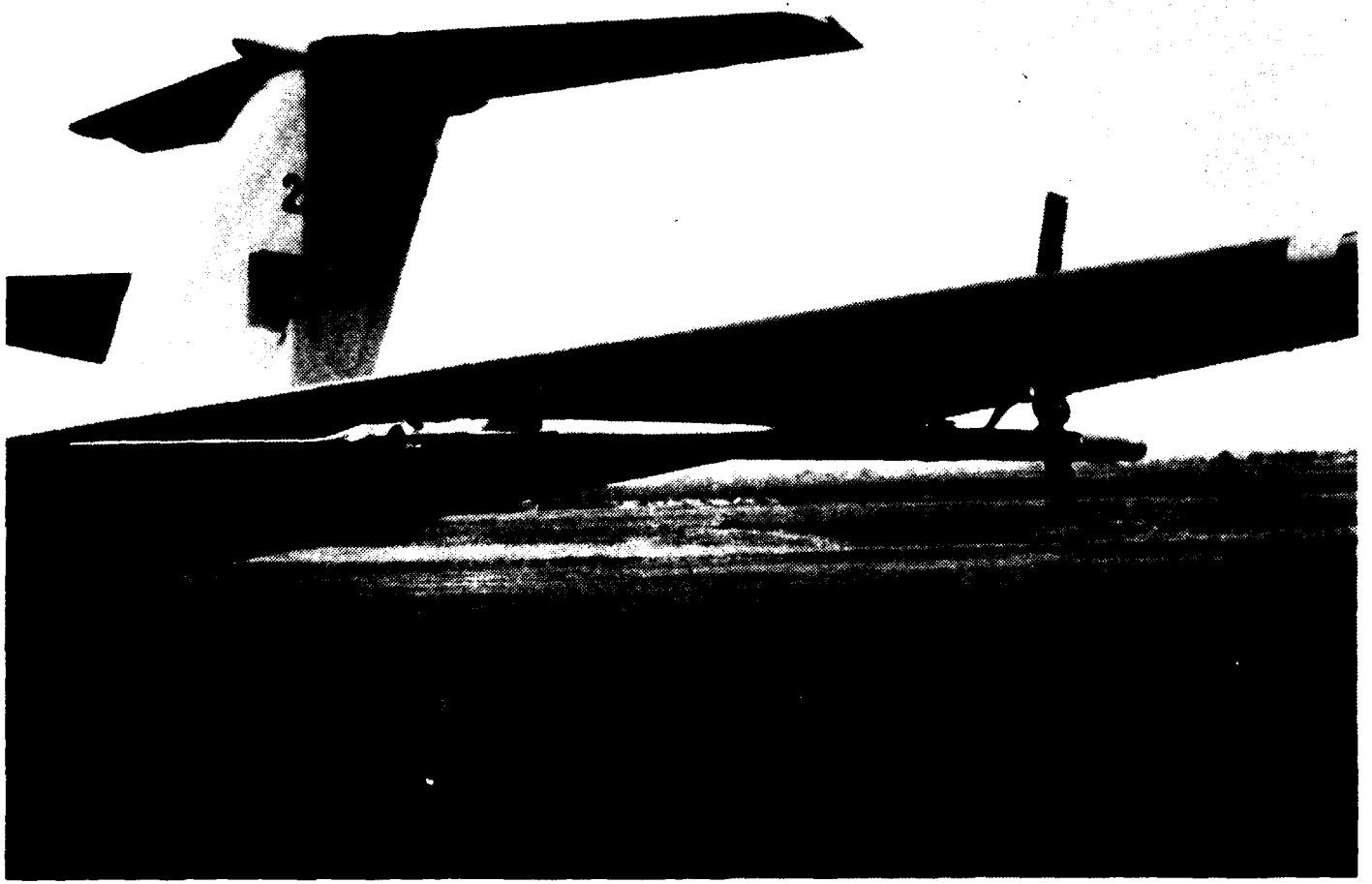


Photo 6. Test Boom Installation

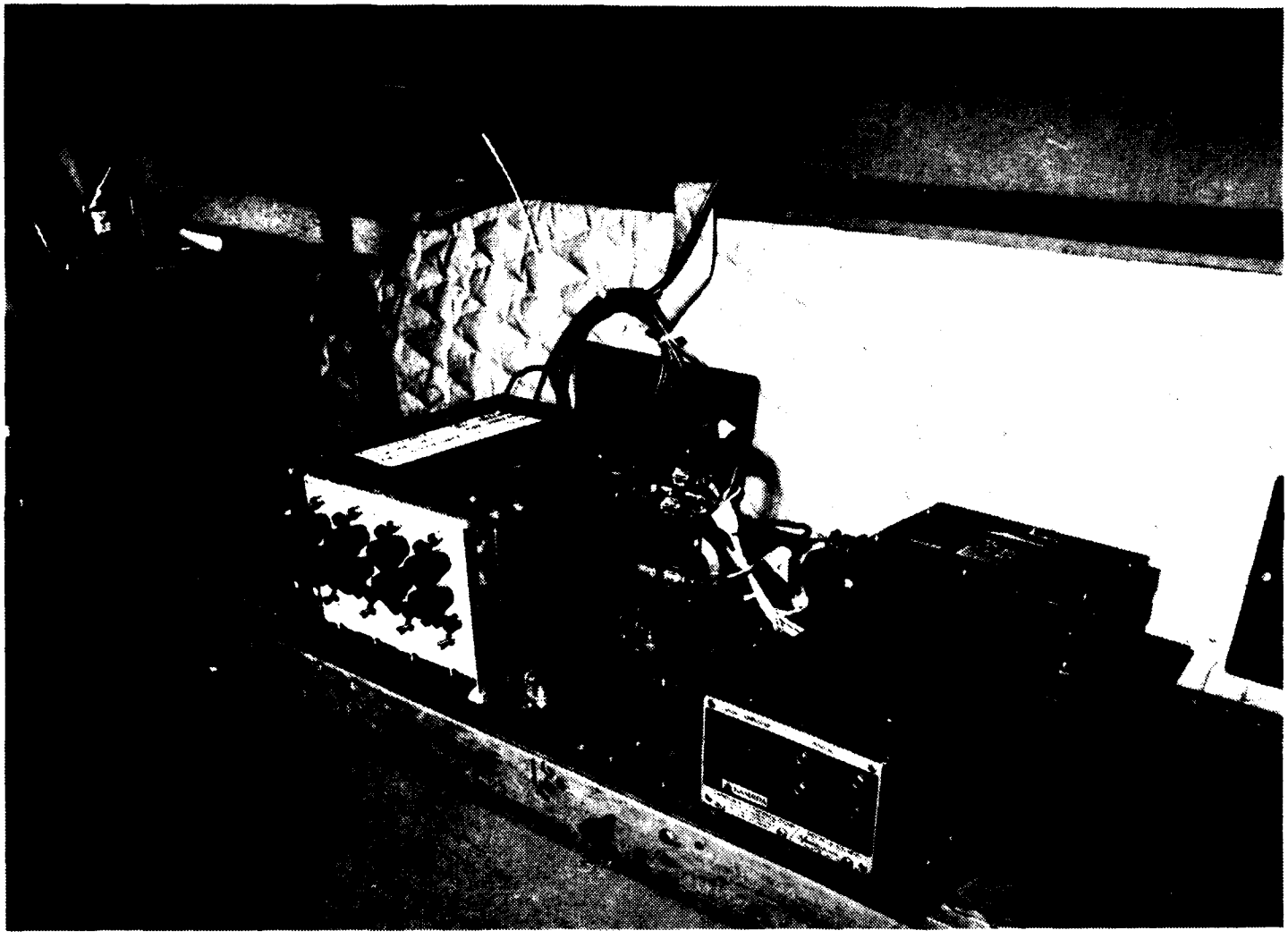


Photo 7. Control Force Special Equipment

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

GENERAL

1. This appendix contains some of the data reduction techniques and analysis methods used to evaluate the RC-12D aircraft. Topics discussed include glide, level flight, takeoff and landing performance, airspeed calibration, and weight and balance.

GLIDE

2. The propeller stopped glide method was used to define the drag of the RC-12D aircraft in the cruise configurations. The method involved obtaining flight data while the aircraft was stabilized in a constant-airspeed descent with both engines shutdown and propellers feathered and stopped. Parameters measured included airspeed, pressure altitude, outside air temperature, gross weight, and elapsed time. The airspeed range from 120 to 200 knots indicated airspeed with the propeller stopped was investigated for a target pressure altitude (H_P) band of 22,000 to 8,000 feet. The technique used to develop the baseline-drag equation is shown below.

$$L = W \cos \theta \tag{1}$$

$$D = T + W \sin \theta \tag{2}$$

$$DV_T = TV_t + WV_t \sin \theta \tag{3}$$

$$-V_T \sin \theta = \frac{dh}{dt} = \frac{TV_t - DV_t}{W} \tag{4}$$

Where:

L = Lift force (lb)

W = Aircraft gross weight (lb)

θ = Descent angle (deg) = $\sin^{-1} \frac{dhp/dt}{V_T}$

T = Net thrust (lb) = zero with propeller stopped.

D = Drag force (lb)

V_t = Aircraft true airspeed on flight path (ft/sec)

$$\frac{dh}{dt} = \text{Tapeline rate of descent (ft/sec)} \frac{dHp}{dt} \frac{T_{a_t}}{T_{a_s}} \quad (5)$$

$\frac{dHp}{dt}$ is measured

where:

T_{a_t} = test day ambient temperature (°K)

T_{a_s} = standard day ambient temperature (°K)

Considering the drag and lift force equations and applying power-off glide conditions, the following non-dimensional relationships can be developed:

$$C_D = \frac{D}{qs} \quad (6)$$

$$C_D = \frac{W \sin \theta}{qs} \quad (7)$$

$$C_L = \frac{L}{qs} \quad (8)$$

$$C_L = \frac{W \cos \theta}{qs} \quad (9)$$

Where:

C_D = Coefficient of drag

$q = 1/2\ \rho\ V_T^2$ (lb/ft^2) dynamic pressure

S = Total wing area (ft^2)

C_L = Coefficient of lift

ρ = Air density ($slug/ft^3$)

TAKEOFF AND LANDING PERFORMANCE

3. Takeoff roll distance was obtained by noting and measuring the start and liftoff points with ground observers. Wind velocity was measured using a Dwyer hand-held wind meter. The measured ground roll distance was then compared to the predicted ground roll distance as depicted in the operator's manual.

4. Landing performance was evaluated similar to takeoff performance except that touchdown and stop points were noted and measured.

AIRSPEED CALIBRATION

5. The ship's standard pitot-static system was calibrated using the ground speed course method to determine the airspeed position error. The RC-12D was flown over a measured, straight course marked on the ground. The aircraft was flown at constant indicated airspeeds for two passes over the course on reciprocal headings. True airspeed for each direction was calculated from the time and distance and the two airspeeds were averaged. Calibrated airspeed was calculated from the average true airspeed and using the test pressure altitude and temperature as a reference.

Weight and Balance

6. Prior to flight testing, a weight and balance determination was conducted on the aircraft using calibrated electronic scales located under the aircraft jacking points. The aircraft basic weight and cg were 8779.0 lb at FS 186.79. With full fuel and crew, the aircraft was ballasted to an engine start gross weight of 14290.0 lb at FS 190.1.

Rigging Check

7. Mechanical rigging of engine and flight controls was checked for compliance with applicable BAC documents.

DEFINITIONS

8. Results were categorized as deficiencies or shortcomings in accordance with the following definitions.

Deficiency.

9. 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.

Shortcoming

10. An imperfection or malfuntion 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.

11. A Handling Qualities Rating Scale was used to augment pilot comments relative to handling qualities. This scale is presented in figure 1.

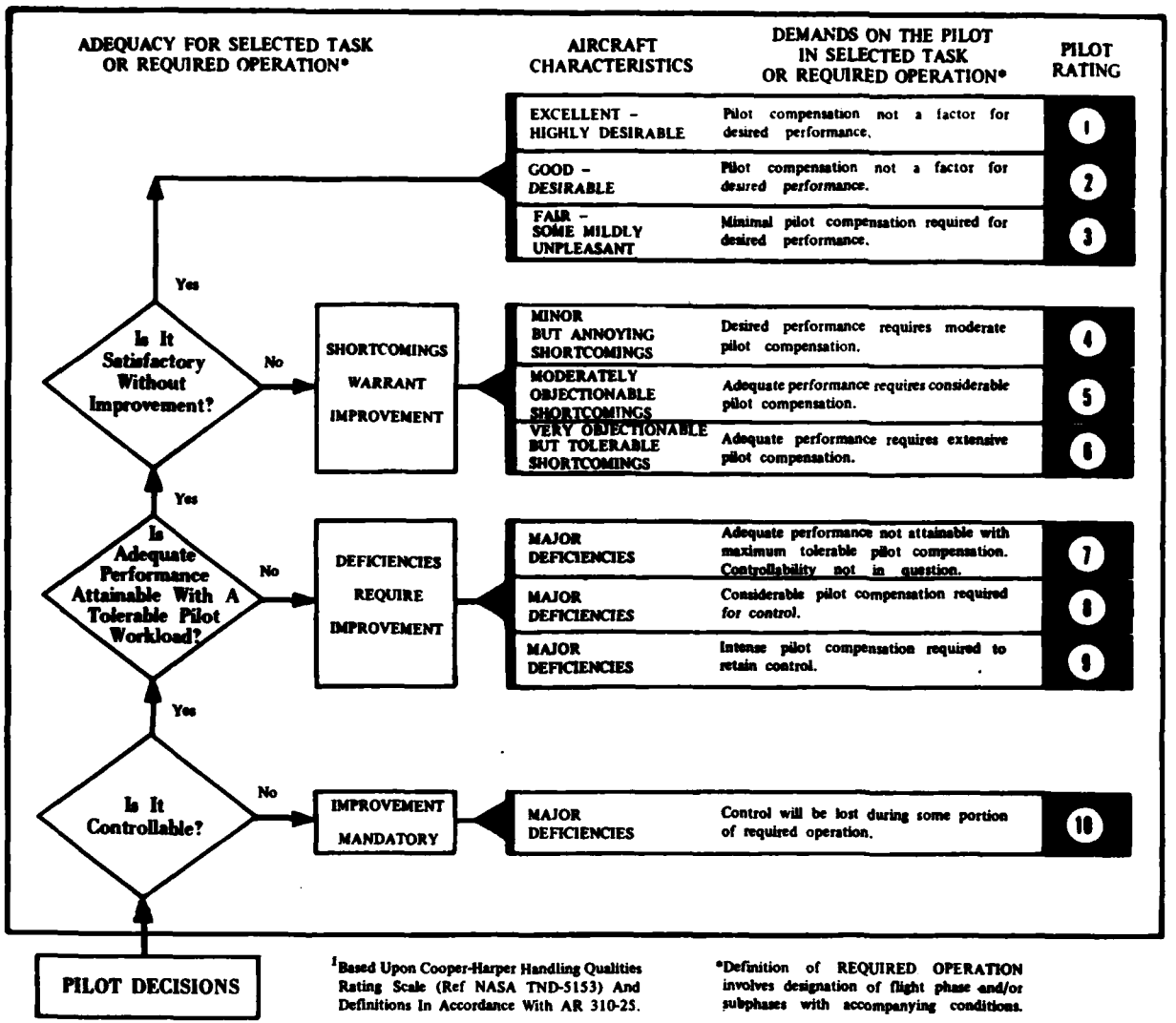


Figure 1. Handling Qualities Rating Scale

APPENDIX E. TEST DATA

INDEX

FIGURE 1
PROPELLER STOPPED GLIDE DRAG POLAR
RC-12D USA S/N 80 - 23371

SYM	AVG GROSS WEIGHT (POUNDS)	AVG LONGITUDINAL CG LOCATION (FS)	AVG PRESSURE ALTITUDE (FEET)	AVG OAT (DEG C)	AIRCRAFT CONFIGURATION
□	13600	189.4(FWD)	13500	0.0	CRUISE W/STD STACKS
△	13500	189.3(FWD)	13570	5.5	CRUISE W/IR STACKS

NOTE: DASH LINE FURNISHED BY BEECH AIRCRAFT COMPANY.

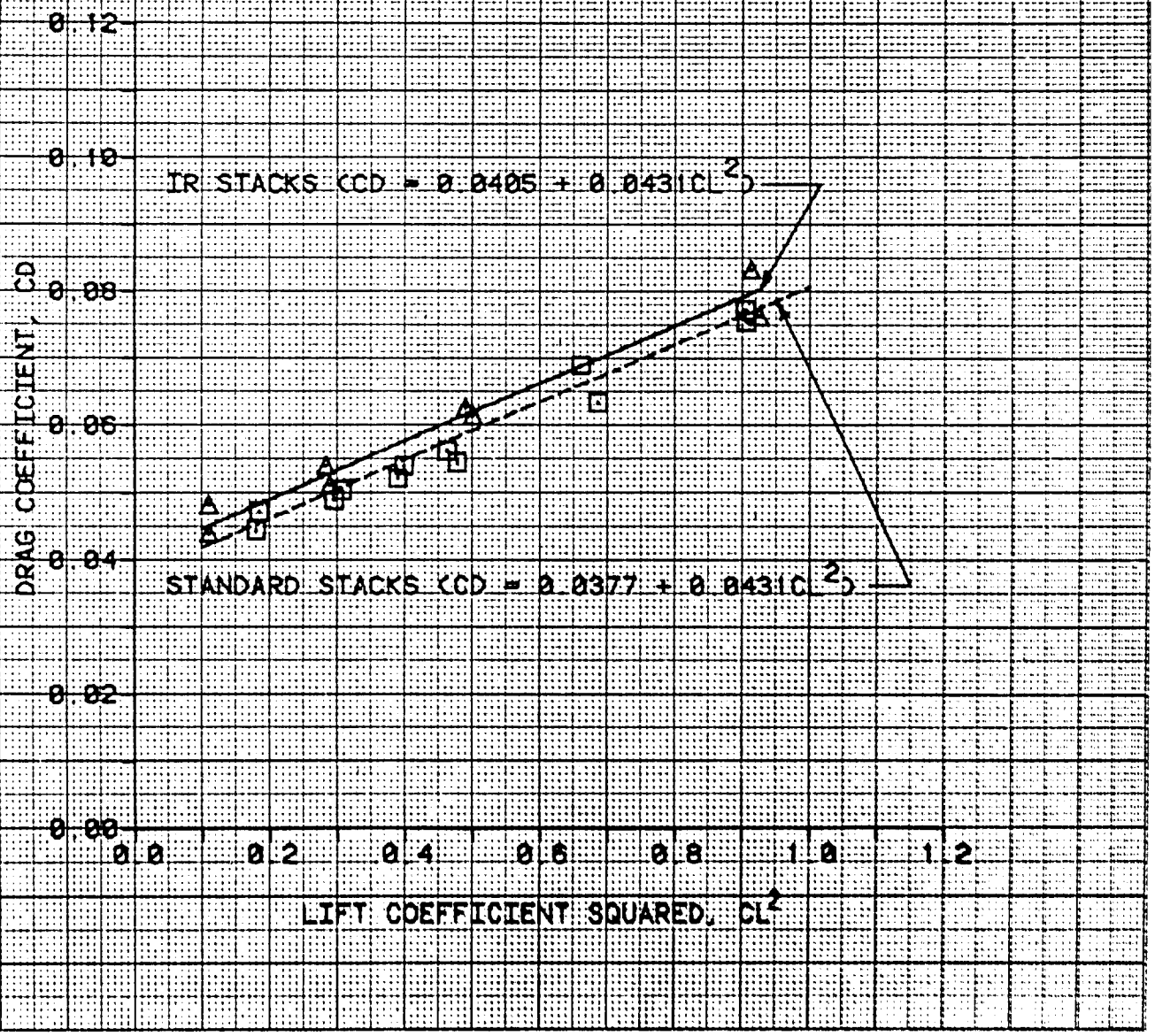


FIGURE 2
STALL PERFORMANCE SUMMARY
RC-12D USA S/N 80-23371

AVG GROSS WEIGHT = 12800 LB AVG DENSITY ALTITUDE = 14450 FT
AVG LONGITUDINAL CG = 189.0(FWD)

SYM	AVERAGE VERTICAL ACCELERATION (G)	PROPELLER SPEED (RPM)	FLAP POSITION (PERCENT)	CONFIGURATION	NUMBER OF OPERATING ENGINES
⊞	1.0	1700	0	CRUISE	2
◇	1.0	2000	100	POWER APPROACH	2
△	1.0	2000	40	TAKEOFF	2
○	1.0	2000	0	TAKEOFF	2
+	1.0	2000	100	LANDING	2
⊠	1.0	2000	100	POWER APPROACH	1
▽	1.0	2000	40	TAKEOFF	1
⊡	1.0	2000	0	TAKEOFF	1
◁	2.0	1700	0	CRUISE	2
★	2.0	2000	100	POWER APPROACH	2
*	2.0	2000	40	TAKEOFF	2
X	2.0	2000	0	TAKEOFF	2
▷	2.0	2000	100	LANDING	2

NOTES: 1. AREA INSIDE DASHED LINES REPRESENTS STALL WARNING LIMITS AS PER MIL-8785C
2. SINGLE ENGINE STALLS CONDUCTED WITH LEFT ENGINE INOPERATIVE AND PROPELLER FEATHERED

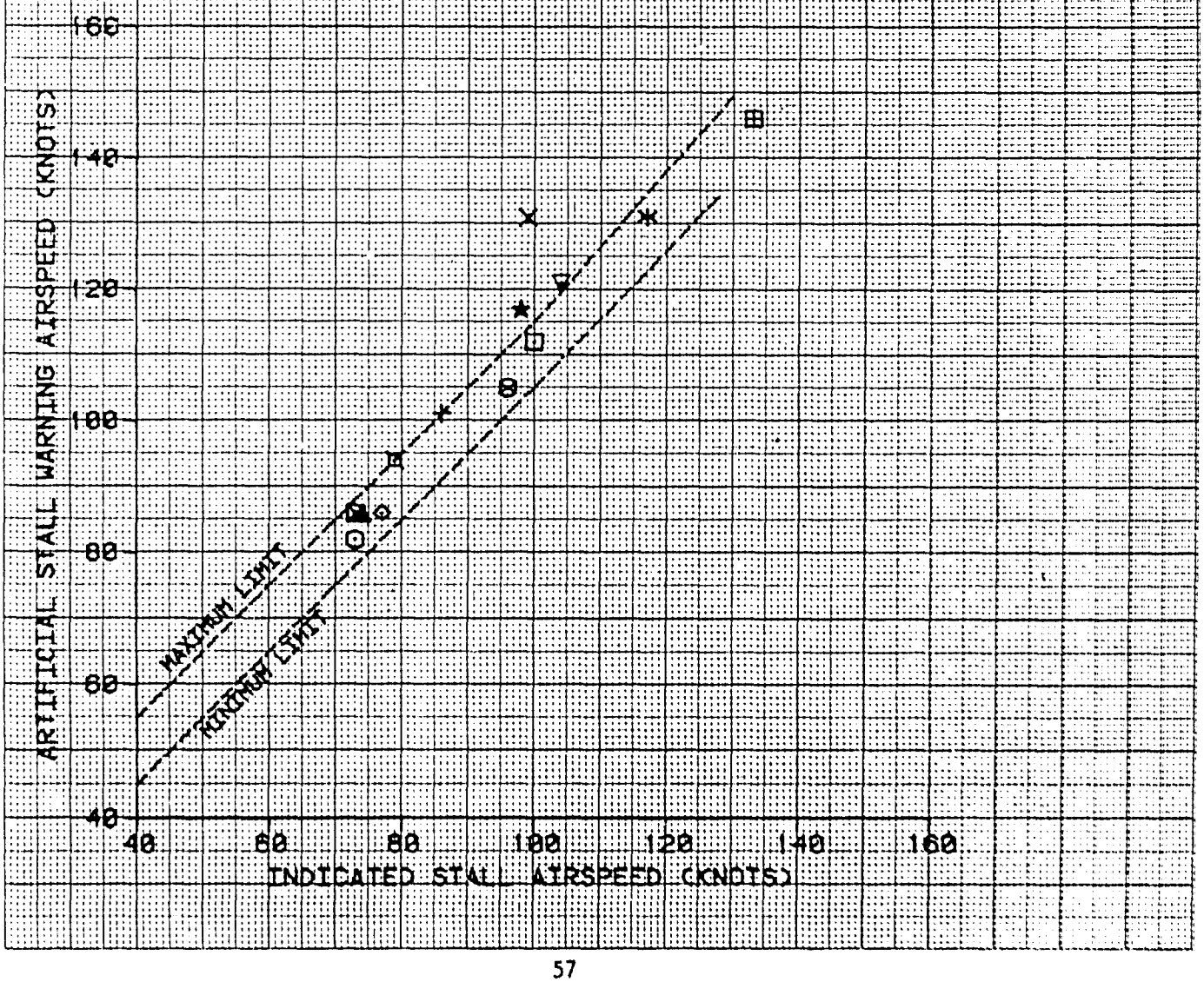


FIGURE 3

STATIC LATERAL-DIRECTIONAL STABILITY

RC-12D USA S/N 80-23371

AVG GROSS WEIGHT (LB)	AVG LONG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM CALIBRATED AIRSPEED (KNOTS)	PROPELLER SPEED (RPM)	CONFIGURATION
13000	180.8 (FWD)	24500	-26.8	120	1700	CRUISE

NOTES: 1. SHADED SYMBOL DENOTES TRIM
2. YAW DAMPER ON

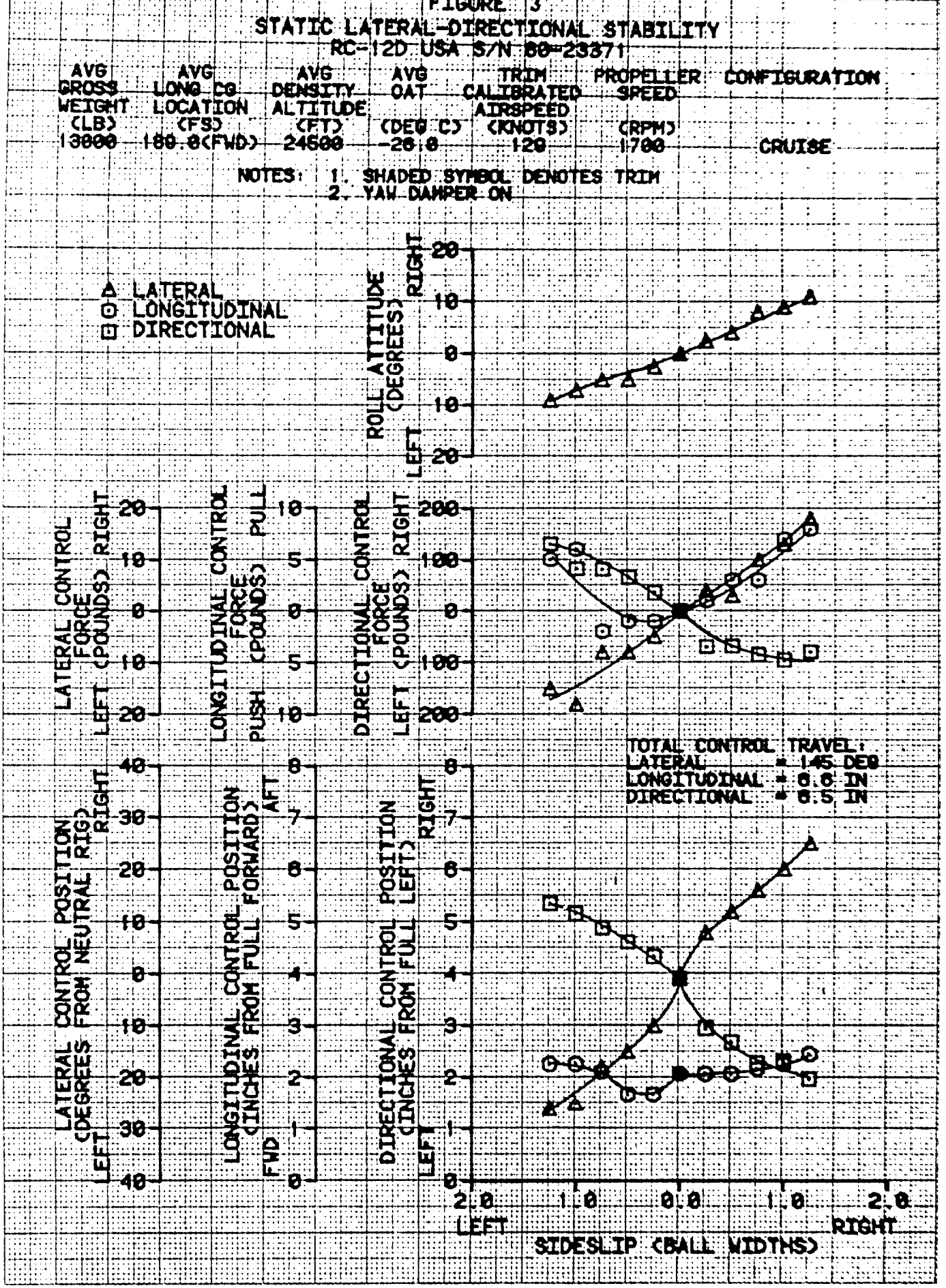


FIGURE 4

STATIC LATERAL-DIRECTIONAL STABILITY

RC-12D USA S/N 80-23371

AVG GROSS WEIGHT (LB)	AVG LONG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM CALIBRATED AIRSPEED (KNOTS)	PROPELLER SPEED (RPM)	CONFIGURATION
12700	188.8(FWD)	24500	-26.0	154	1700	CRUISE

NOTES: 1. SHADED SYMBOL DENOTES TRIM
2. YAW DAMPER ON

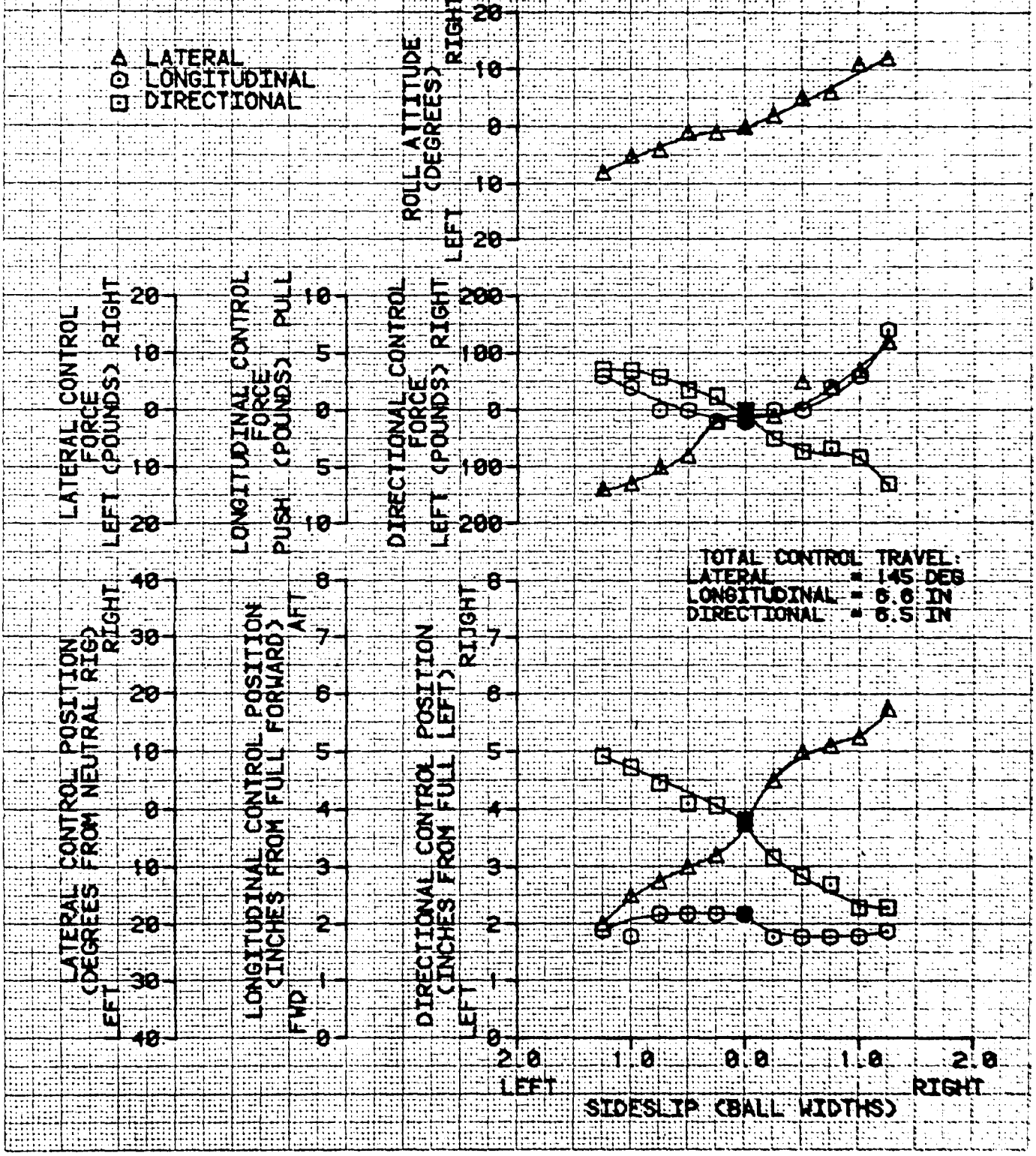


FIGURE 5

STATIC LATERAL-DIRECTIONAL STABILITY

RC-12D USA S/N 80-23371

AVG GROSS WEIGHT (LB)	AVG LONG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM CALIBRATED AIRSPEED (KNOTS)	PROPELLER SPEED (RPM)	CONFIGURATION
14050	189.8(FWD)	6000	5.0	94	2000	POWER APPROACH

NOTES: 1. SHADED SYMBOL DENOTES TRIM
2. YAW DAMPER OFF

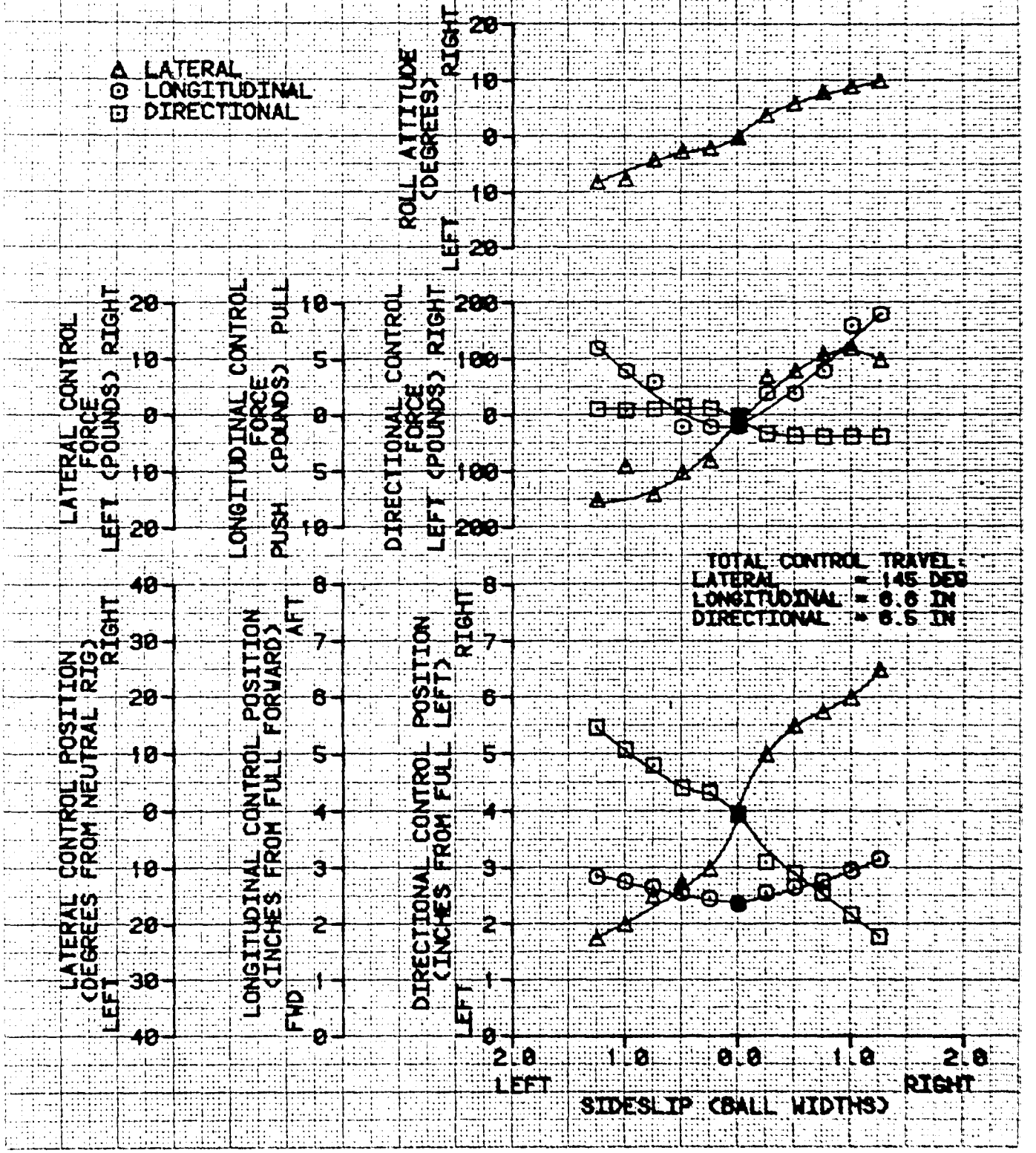


FIGURE 6

DYNAMIC LONGITUDINAL STABILITY

RC-12D USA S/N 80-23371

SYM	AVG GROSS WEIGHT (LB)	AVG LONG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM CALIBRATED AIRSPEED (KNOTS)	CONFIGURATION
○	13700	189.5(FWD)	26200	-22.0	120	CRUISE
□	13500	189.7(FWD)	26200	-22.0	120	CRUISE

NOTES: 1. INITIAL AIRSPEED DISPLACEMENT FROM TRIM = 10 KNOTS.
2. YAW DAMPER ON.

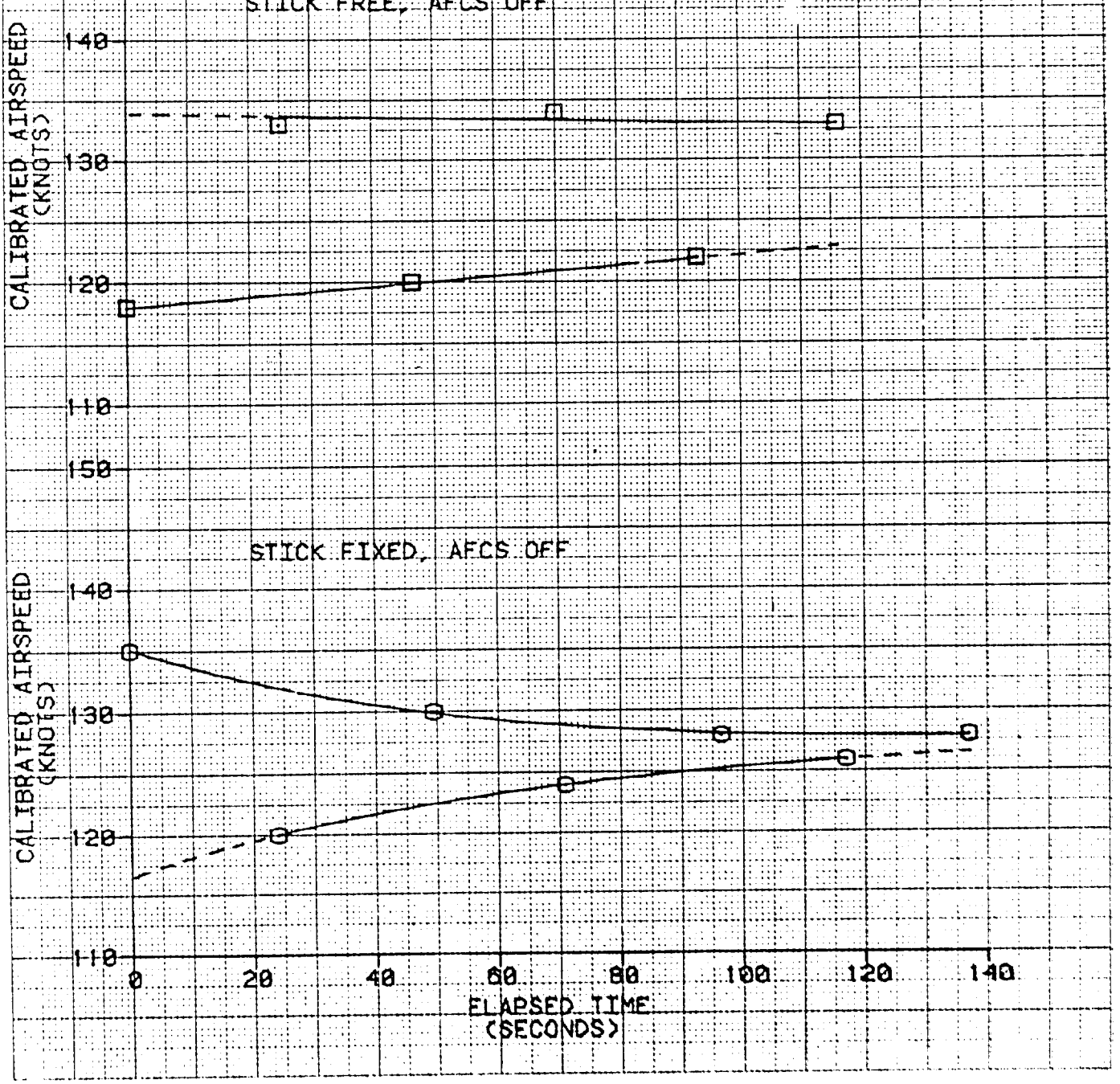


FIGURE 7

ROLL CONTROL EFFECTIVENESS

RC-12D USA S/N 80-23371

SYM	AVG GROSS WEIGHT (LB)	AVG LONG CG LOCATION (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	TRIM CALIBRATED AIRSPEED (KNOTS)	CONFIGURATION
□	13470	189.2(FWD)	24800	-20.0	129	CRUISE
○	13610	189.1(FWD)	24800	-20.0	154	CRUISE

NOTES: 1. TRIMMED AT ZERO BANK ANGLE
2. FULL LATERAL CONTROL YOKE TRAVEL = 75 DEGREES.

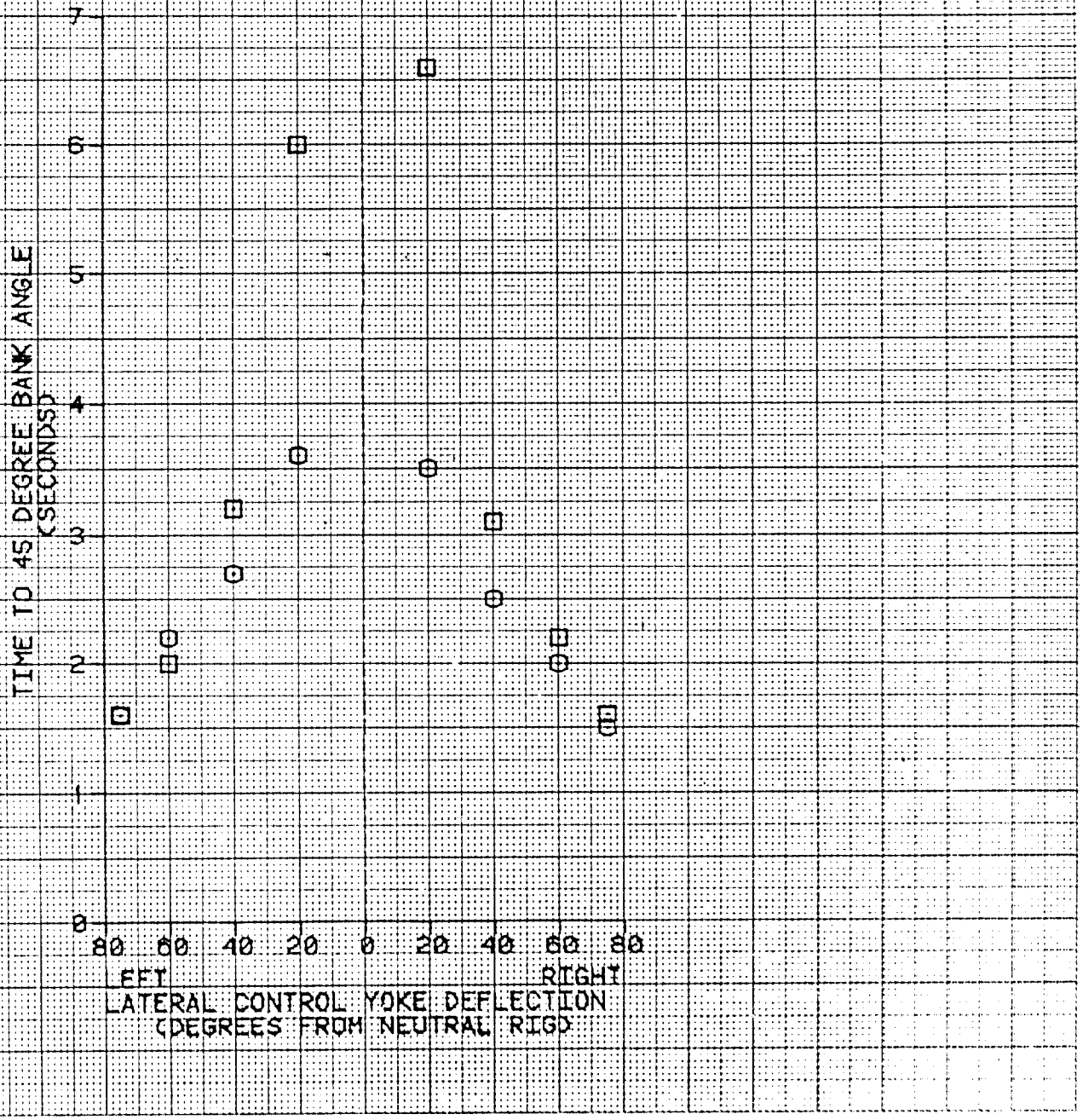
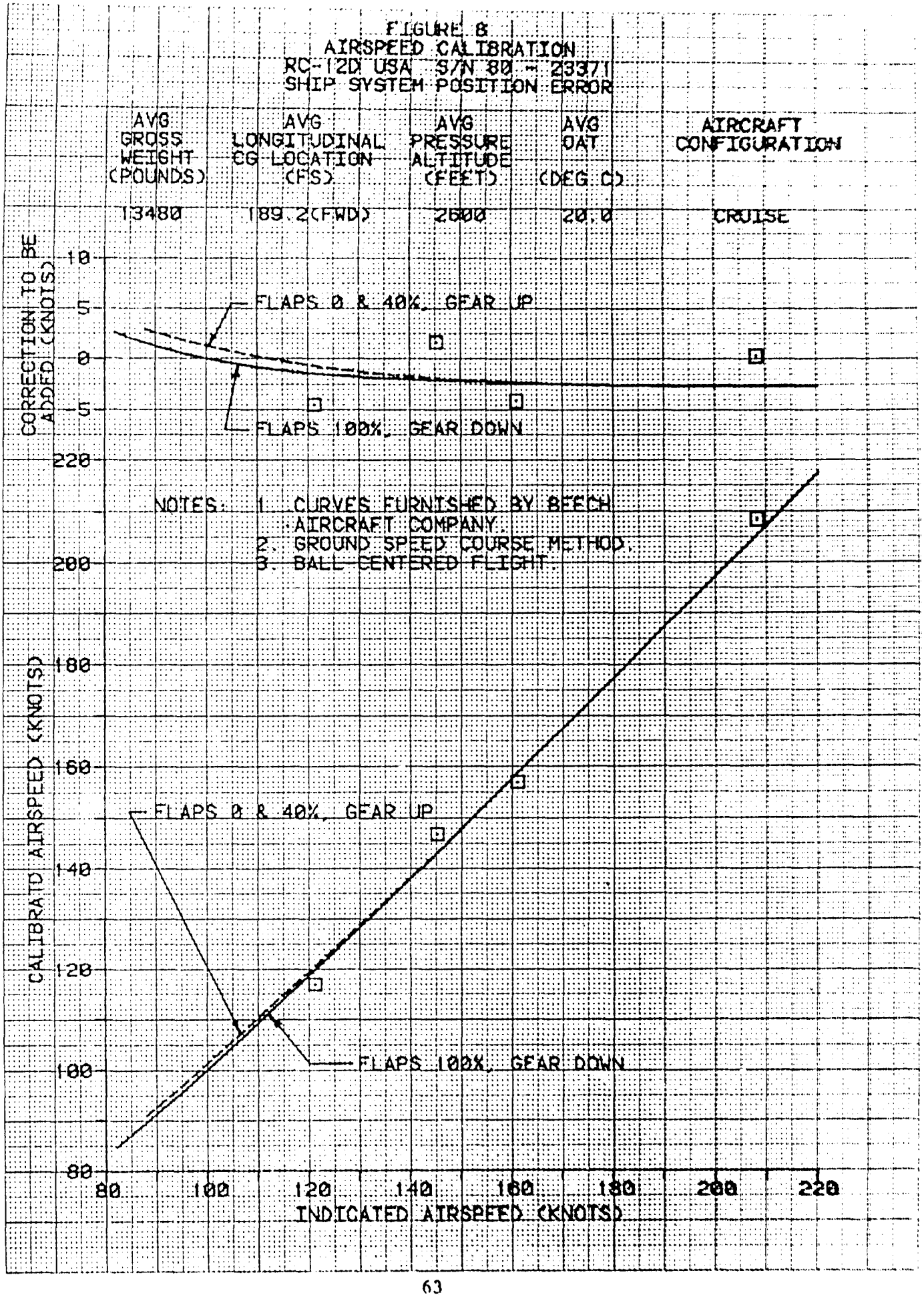


FIGURE 8
AIRSPEED CALIBRATION
RC-12D USA S/N 80 - 23371
SHIP SYSTEM POSITION ERROR

AVG GROSS WEIGHT (POUNDS)	AVG LONGITUDINAL CG LOCATION (FS)	AVG PRESSURE ALTITUDE (FEET)	AVG OAT (DEG C)	AIRCRAFT CONFIGURATION
13480	189.2(FWD)	2600	20.0	CRUISE



NOTES: 1. CURVES FURNISHED BY BEECH AIRCRAFT COMPANY.
2. GROUND SPEED COURSE METHOD.
3. BALL-CENTERED FLIGHT.

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