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ARMY PRELIMINARY EVALUATION I.
RV-1D/QUICK LOOK II AIRCRAFT

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Army Aviation Engineering Flight Activity
Edwards Air Force Base, California

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The United States Army Aviation Engineering Flight Activity conducted a limited handling qualities evaluation of the RV-1D/Quick Look II aircraft, manufactured by Grumman Aerospace Corporation. The aircraft was tested at the Grumman facility in Stuart, Florida, on 16 and 17 July 1974. Testing included stability and control and miscellaneous engineering tests necessary to verify the flight envelope. No deficiencies were found during these tests. Two shortcomings were		

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20. Abstract

identified: inadequate stall warning in the power-approach and landing configurations, and the degraded single-engine performance and maneuvering capability caused by the inability to jettison the Quick Look II antenna pods. Within the scope of this test, the flight handling qualities of the RV-1D/Quick Look II aircraft are satisfactory.

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INTRODUCTION

BACKGROUND

1. Two preproduction OV-1D aircraft were modified by Grumman Aerospace Corporation (GAC) to incorporate the Quick Look II airborne noncommunication location system (AN/ALQ-133). The aircraft underwent limited qualitative airworthiness flight testing conducted by GAC and are to be used as test beds for developing the Quick Look II electronic systems. The United States Army Aviation Systems Command (AVSCOM) requested (ref 1, app A) that the United States Army Aviation Engineering Flight Activity (USAAEFA) conduct an Army Preliminary Evaluation of one of these aircraft (designated the RV-1D/Quick Look II aircraft).

TEST OBJECTIVES

2. The primary objective of these tests was to provide data which will serve as a basis for a safety-of-flight release for Quick Look II system testing.
3. The evaluation was also intended to identify any airworthiness or flight characteristics changes in the aircraft caused by installation of the Quick Look II system. Also, compliance with the appropriate sections of military specification MIL-F-8785(ASG) (ref 2, app A) was checked, where possible.

DESCRIPTION

4. The test aircraft is a modified preproduction OV-1D. The preproduction OV-1D is a mid wing, triple vertical stabilizer, twin turboprop aircraft powered by two Lycoming Model T53-L-15 engines. A more complete description is contained in the OV-1D operator's manual (ref 3, app A). The test airplane was modified to incorporate the Quick Look II system, which consists of two large antenna pods carried on the existing outboard wing store stations (stations 1 and 6) and various electronic packages carried internally. The antenna pods weigh 350 pounds each and measure 20 inches high by 12 inches wide by 120 inches long. Provisions for the side-looking airborne radar (SLAR) (APS-94D) and infrared (IR) (AAS-24) electronics systems have been removed from the aircraft. Fuel tanks can be carried at wing store stations 3 and 4. Typical mission loading of the aircraft for takeoff is 16,820 pounds gross weight at an aft center-of-gravity (cg) location (28.8 percent mean aerodynamic chord) (MAC).

TEST SCOPE

5. This evaluation was accomplished during three flights totaling 5.3 test hours. The tests were conducted on 16 and 17 July 1974 at the GAC facility in Stuart, Florida. All tests were conducted at a nominal 8000-foot pressure altitude with buildup points flown at 12,000 feet. Takeoff gross weight and cg for all three flights were 16,690 pounds and 28.8 percent MAC. The tests conducted and test conditions are presented in table 1. The flight envelope limits observed during this evaluation are contained in the safety-of-flight release (ref 4, app A) and the operator's manual. Compliance with the appropriate sections of MIL-F-8785(ASG) was also checked.

TEST METHODOLOGY

6. Standard engineering flight test techniques were used during this evaluation and are discussed briefly in the Results and Discussion section of this report. Airspeed position-error calibration from the operator's manual was used for these tests. All data were obtained from uncalibrated cockpit indicators. Indicator errors were assumed to be zero in the data reduction. Data reduction procedures are discussed in appendix B.

Table 1. Test Conditions.

Test	Trim Calibrated Airspeed (kt)	Configuration ¹	Average Gross Weight (lb)
Static longitudinal stability	108	² PA1	15,220
	140, 216	CR ³	
Static lateral-directional stability	108	PA1	15,910
	140, 218	CF	
Maneuvering stability	140	PA1	16,090
	140	CR	
Dynamic stability	108	PA1	15,560
	140, 218	CR	
Lateral controllability	108	PA1	15,780
	140, 218	CR	
Stalls	120	PA1	15,800
	114	L ⁴ , ⁵ PA2	
Minimum trim airspeed	---	PA1, CR	15,150
Minimum control airspeed	---	PA1, CR	15,150

¹PA: Power approach.

CR: Cruise.

L: Landing.

²Gear down, flaps down one-third (15 degrees), power required for level flight (PLF), speed brakes in.³Gear and flaps up, PLF, speed brakes in.⁴Gear down, flaps full down (45 degrees), power at ground-idle, speed brakes in.⁵Gear down, flaps full down (45 degrees), PLF, speed brakes in.

RESULTS AND DISCUSSION

HANDLING QUALITIES

General

7. The handling qualities of the RV-1D/Quick Look II aircraft were evaluated for a limited test scope with emphasis on operation at a maximum mission takeoff gross weight of 16,690 pounds and an aft cg location (28.8 percent MAC). The test results were compared to MIL-F-8785(ASG). No items of noncompliance with the specification were found during these tests. No deficiencies were found attributable to the Quick Look II system installation. Two shortcomings were found: inadequate stall warning in the PA1, PA2, and L configurations, and the degraded single-engine performance and maneuvering capability caused by the inability to jettison the Quick Look II antenna pods.

Dual-Engine Trimmability

8. Trimmability was qualitatively evaluated throughout the test program. The trim rates and sensitivities were satisfactory. For all configurations tested, control forces could be trimmed to zero, with no tendency for the trim devices to float. Within the scope of this test, the trimmability of the RV-1D/Quick Look II aircraft is satisfactory.

Single-Engine Trimmability

9. The single-engine trimmability was evaluated in the CR and PA1 configurations with wings level and a 5-degree right bank at the test conditions shown in table 1. The test was accomplished with the right engine at military rated power (MRP) and normal rated power (NRP) and the left engine operating at flight-idle with the propeller feathered. For each configuration, power was held constant and the airspeed was reduced in 5-knot increments until a trim limit was reached. Single-engine trimmability results are presented in table 2. Using 5 degrees of bank toward the operating engine, a lower minimum trim airspeed could be obtained for all configurations. The limiting parameter was right rudder trim for all tested conditions. The single-engine trimmability of the RV-1D/Quick Look II aircraft is satisfactory.

Table 2. Single-Engine Minimum Trim Airspeeds.

Configuration	Power	Minimum Trim Indicated Airspeed ¹ (kt)	Bank Angle (deg)
CR	MRP ²	139	Zero
	MRP	128	5
	NRP ²	135	Zero
	NRP	121	5
PA1	MRP	130	Zero
	MRP	115	5

¹Limiting parameter was rudder trim.

²Propeller speed: 1678 rpm.

Single-Engine Minimum Control Airspeed

10. The lowest airspeed at which wings-level, steady-heading flight could be maintained was defined as the single-engine minimum control airspeed (VMC) and was evaluated at the conditions shown in table 1. The test was accomplished with the right engine at MRP and the left engine operating at flight-idle with the propeller feathered. The control forces were trimmed to zero at 120 knots indicated airspeed (KIAS) and the trim system remained unchanged for the rest of the test. Elevator control was used to slowly reduce airspeed until full lateral or directional control displacement was reached and wings-level flight could no longer be maintained. The single-engine VMC was 92 KIAS for the PA1 configuration and 93 KIAS for the CR configuration. The rudder was the limiting control in the CR configuration. Lateral and directional control limits were reached simultaneously in the PA1 configuration. A very slight airframe buffet was identified at VMC in both configurations, with no tendency to stall. Pedal forces were extremely high in both configurations and were estimated to be in excess of 100 pounds.

Static Longitudinal Stability

11. The static longitudinal stability characteristics of the RV-1D/Quick Look II aircraft were evaluated at the conditions shown in table 1. The aircraft was trimmed in steady-heading, coordinated level flight at the desired trim airspeed. While maintaining constant power and trim settings, the aircraft was stabilized at

incremental airspeeds greater than and less than the trim airspeed. Control positions were measured and control forces were estimated by the pilot. The quantitative test results are presented in figure 1, appendix C.

12. The elevator control force versus airspeed gradients were qualitatively evaluated by the pilot to be positive about all trim airspeeds in the CR and PA1 configurations. The elevator control position versus airspeed gradients were positive except at 216 knots calibrated airspeed (KCAS), where the gradient was neutral. Although the force and displacement gradients were shallow to neutral, adequate cues are available for satisfactory airspeed control. Within the scope of this test, the static longitudinal stability of the RV-1D/Quick Look II aircraft is satisfactory.

Static Lateral-Directional Stability

13. The static lateral-directional stability characteristics were evaluated at the conditions presented in table 1. The aircraft was initially trimmed for steady-heading, coordinated level flight at the desired trim airspeed. The heading was then incrementally varied while maintaining trim airspeed, constant ground track, and constant power. In each case, the maximum sideslip angle obtained was limited by the pedal force required. Test results are presented in figures 2 through 4, appendix C.

14. The side-force characteristics, as indicated by the variation of bank angle with sideslip angle, were positive and essentially linear. Dihedral effect, as indicated by the variation of aileron control displacement with sideslip angle, was positive. The static directional stability, as indicated by the variation of sideslip angle with rudder pedal deflection and rudder pedal force, was positive for the conditions tested. A nonlinear variation of rudder pedal deflection with sideslip was present in the PA1 configuration at 108 KCAS, but was not objectionable. Within the scope of this test, the static lateral-directional stability characteristics of the RV-1D/Quick Look II aircraft are satisfactory.

Maneuvering Stability

15. The maneuvering stability characteristics were evaluated at the conditions shown in table 1. The airplane was trimmed in wings-level flight at 140 KIAS. The trim airspeed and power setting were maintained constant as the bank angle was gradually increased until the desired normal load factor was reached. Stick-fixed maneuvering stability data are presented in figure 5, appendix C. The control position versus normal acceleration gradients were positive for CR and PA1 configurations. The stick-free maneuvering stability was qualitatively evaluated to be positive (increasing aft control force with increasing normal acceleration) for the conditions tested. A decreasing position gradient with increasing load factor was apparent in the PA1 configuration; however, it was not objectionable. The increasing aft control force required provided sufficient pilot cues of increasing load factor during steady-state maneuvering. However, during qualitative tests involving rapid left and right rolling maneuvers at airspeeds less than 140 KIAS, insufficient control position and force cues were present to warn the pilot of

increasing load factor. As discussed in paragraph 21, the high lateral control forces are not compatible with the relatively light longitudinal forces. During these tests, the pilot was required to closely monitor the load factor indicator to avoid exceeding the flight envelope. A normal load factor indicator is therefore required to prevent unintentionally exceeding the flight envelope during rapid rolls at airspeeds less than 140 KIAS. Except during rapid rolling maneuvers at low airspeeds, maneuvering stability of the RV-1D/Quick Look II aircraft is satisfactory.

Dynamic Stability

16. The dynamic longitudinal stability characteristics were qualitatively evaluated at the conditions shown in table 1. The phugoid mode was evaluated by slowing the aircraft from the trim airspeed with aft elevator control and then returning the control to the trim position. The resulting response was oscillatory and lightly damped in all configurations. The period varied from 33 to 43 seconds. Within the scope of this test, the phugoid mode was satisfactory.

17. The short-period mode was qualitatively evaluated at the conditions shown in table 1. Elevator control doublets and 1-inch pulse inputs for a duration of 0.5 second were used in simulating gust disturbances. The short-period response appeared to be deadbeat for all conditions tested. Within the scope of this test, the short-period longitudinal dynamic characteristics are satisfactory.

18. The Dutch-roll mode was qualitatively evaluated at the conditions shown in table 1. The dynamic response was investigated by exciting the aircraft with rudder doublets, rudder pulses, and releases from steady-heading sideslips. The response was characterized as a moderately damped oscillation. The period was approximately 1 second and the motion damped within 2 cycles for all configurations. Within the scope of these tests, the Dutch-roll mode of the RV-1D/Quick Look II aircraft was satisfactory.

Controllability

19. Lateral controllability tests were conducted to determine the adequacy of roll control power with increased roll inertia. The test conditions are shown in table 1. Quantitative tests were conducted by stabilizing in a 45-degree bank, making a rapid 3-inch lateral control step input (safety-of-flight release envelope limit), and recording the time to reach a 45-degree bank in the opposite direction. Qualitative evaluations were made using rudder-fixed and coordinated rolls and turns.

20. In configurations PA1 and CR at 108 and 140 KCAS, respectively, 5 to 6 seconds were required to roll from a 45-degree bank in one direction to 45 degrees in the other direction. At 218 KCAS in the CR configuration, 4 seconds were required.

21. During qualitative tests (rudder-fixed turns and roll reversals), a slight amount of adverse yaw was noted and at the lower airspeeds (less than 140 KIAS) some cross-coupling with pitch was present, but neither was a problem. During rapid rolling maneuvers, poor control harmony was noted. The lateral control forces were high in comparison to the longitudinal forces. This degraded control harmony and made it very easy to reach the load factor limit during rapid maneuvering (para 15). Normal load factor indication to the pilot is therefore required. Within the scope of this test, lateral controllability is satisfactory.

Stalls

22. The unaccelerated stall characteristics with symmetrical power of the RV-1D/Quick Look II aircraft were evaluated at the conditions shown in table 1. These tests were conducted by establishing a trim configuration at 120 KIAS and then decelerating at a rate of 1 knot per second or less until achieving a stall. Stall was defined by uncontrollable nose-down pitching motion. Test results are presented in table 3.

Table 3. Stall Data.¹

Configuration	Stall Warning Indicated Airspeed (kt)	Stall Indicated Airspeed (kt)
PA1	81	76
	82	77
	82	77
	80	76
L	No warning	81
PA2	75	70
	75	70

¹Average gross weight: 15,800 pounds.
Pressure altitude: 8000 feet.

23. Control effectiveness was adequate about all axes during the approach to the stall. The aircraft was responsive to all control inputs with no observed reduction in longitudinal control forces as the stall was approached. Stall warning (when present) was a very light airframe and control system buffet commencing 4 to 10 KIAS before the stall. The buffet did not provide the pilot adequate stall warning. The inadequate stall warning in the PA1, PA2, and L configurations is a shortcoming. Installation of a stall warning device and/or angle-of-attack indicator is required for improved flight safety (ref 5, app A).

24. The stall was characterized by an abrupt decrease in aircraft pitch attitude, with generally no tendency to roll in the L and PA1 configurations. A low rate of roll was observed during the stall in the PA2 configuration. Lateral and directional control was adequate during the approach to stall, stall, and recovery. No secondary stall tendencies were noted. Recovery from the stall was accomplished by decreasing the aft stick pressure and increasing to takeoff power. With this technique, altitude loss during the recovery was 180 feet. Within the scope of these tests, the stall characteristics of the RV-1D/Quick Look II aircraft are satisfactory, except as discussed in paragraph 23.

Specification Compliance

25. The test results were compared to MIL-F-8785(ASG). No items of noncompliance with the specification were found during these tests.

STORES JETTISON

26. The antenna pods mounted on the aircraft at wing stations 1 and 6 are not jettisonable. The ability to release the combined pod weight of 700 pounds would enhance aircraft performance during a single-engine emergency and during evasive maneuvers. The degraded single-engine performance and maneuvering capability caused by the inability to jettison the antenna pods is a shortcoming. Installation of an electrical and/or mechanical jettison system is recommended for improved flight safety.

CONCLUSIONS

GENERAL

27. Within the scope of this test, the handling qualities of the RV-1D/Quick Look II aircraft are satisfactory.

28. The lateral-longitudinal control harmony was degraded by installation of the Quick Look II system (paras 15 and 21).

SPECIFICATION COMPLIANCE

29. No items of noncompliance with MIL-F-8785(ASG) were found.

SHORTCOMINGS

30. The following shortcomings were identified:

- a. Inadequate stall warning in the PA1 and L configurations (para 23).
- b. Degraded single-engine performance and maneuvering capability caused by the inability to jettison the antenna pods (para 26).

RECOMMENDATIONS

- 31. The shortcomings listed in paragraph 30 should be corrected.
- 32. A normal acceleration indicator should be installed (para 15).
- 33. A stall warning device and/or angle-of-attack indicator should be installed (para 23).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-EFT, 29 May 1974, subject: Test Directive for Quick Look II Evaluation, AEF&A Project Number 74-36.
2. Military Specification, MIL-F-8785(ASG), *Flying Qualities of Piloted Airplanes*, Amendment 2, 17 October 1955.
3. Technical Manual, TM 55-1510-204-10/5, *Operator's Manual, OV-1D Aircraft*, February 1970.
4. Message, AVSCOM, AMSAV-EFT, R032032Z, 3 July 1974, subject: Safety-of-Flight Release for Quick Look II Aircraft with Two ALQ-133 Pods Installed.
5. Final Report, USAASTA, Project No. 70-03, *Army Preliminary Evaluation II, OV-1D Airplane*, March 1971.

APPENDIX B. INSTRUMENTATION AND DATA REDUCTION PROCEDURES

Grumman Aerospace Corporation provided a mechanical accelerometer to measure normal acceleration and the USAAEFA test team attached cloth tape measures to the controls to measure control positions. No direct measurement of sideslip was available on the aircraft. Therefore, static lateral-directional stability tests were conducted by maintaining a constant ground track while incrementally varying heading. The sideslip recorded was the difference between the reference (ball-centered) heading and the indicated heading at each point.

APPENDIX C. TEST DATA

FIGURE 1
 STATIC LONGITUDINAL STABILITY
 RV-1D/QUICK LOOK II
 USA S/N 67-18905

SYMBOL	AVG GROSS WEIGHT (lb)	AVG CG LOCATION (% MAC)	AVG PRESSURE ALTITUDE (ft)	OUTSIDE AIR TEMP (°C)	CONFIGURATION
○	15220	28.7 (AFT)	8000	5°	CR
□	15220	28.7 (AFT)	8000	5°	PA 1

NOTE: Shaded symbols denote trim.
 Full longitudinal control travel = 11.6 inches.

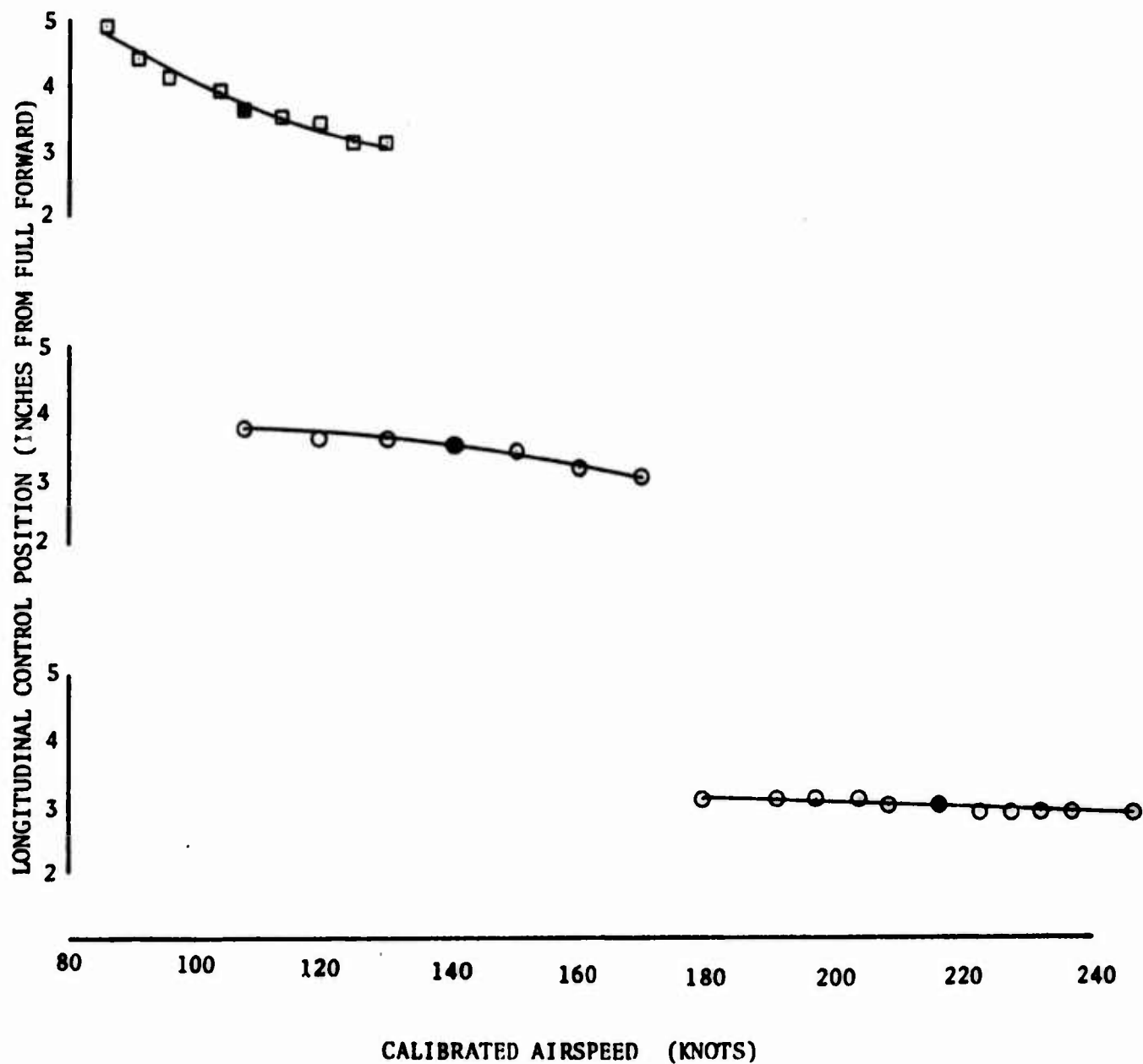


FIGURE 2
 STATIC LATERAL-DIRECTIONAL STABILITY
 RV-1D/QUICK LOOK II
 USA S/N 67-18905

AVG GROSS WEIGHT (lb)	AVG CG LOCATION (% MAC)	AVG PRESSURE ALTITUDE (ft)	OUTSIDE AIR TEMP (°C)	TRIM CALIB. AIRSPEED (KT)	CONFIGURATION
15890	28.7 (AFT)	8000	6	218	CR

NOTE: Shaded symbols denote trim.

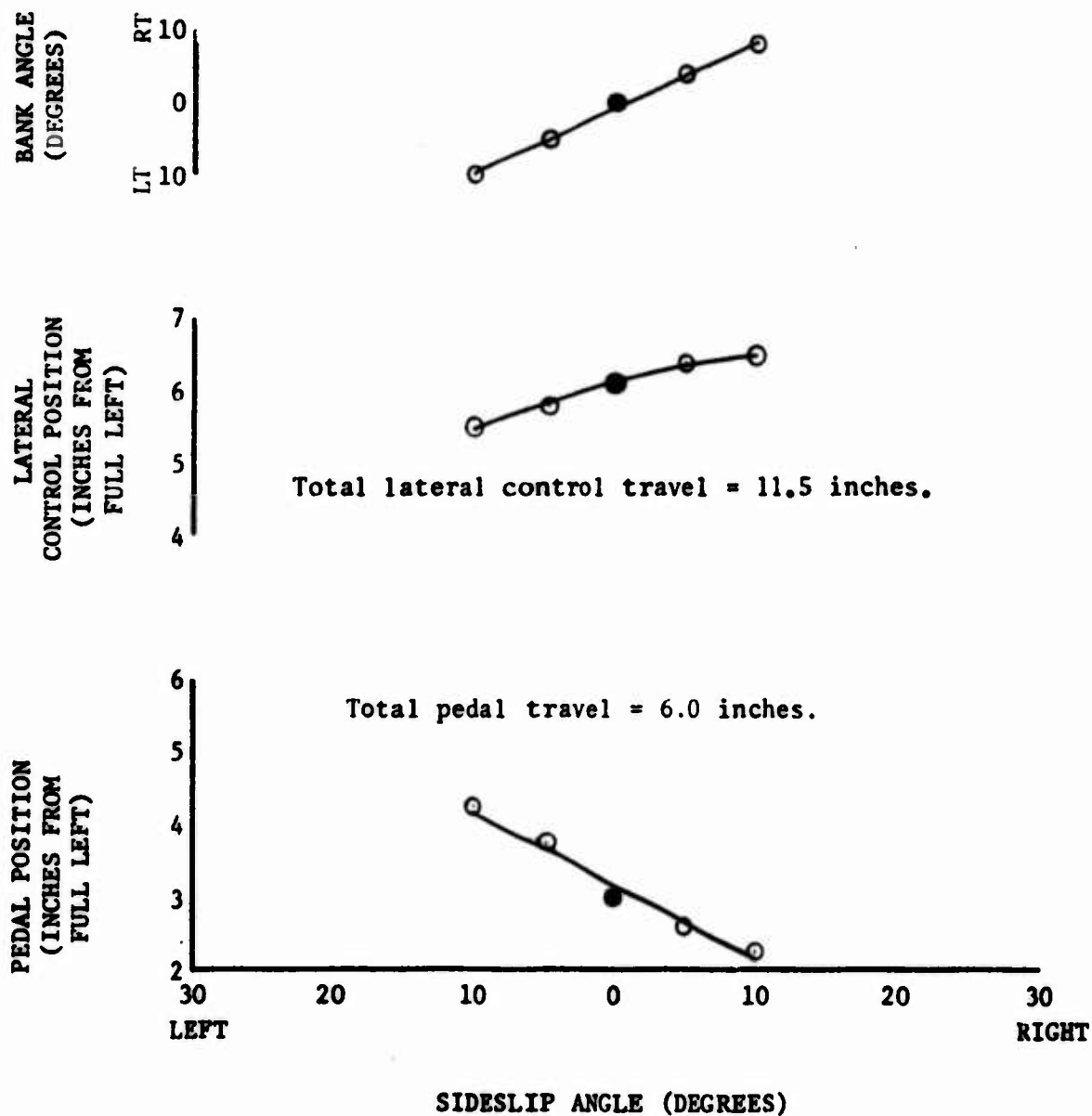


FIGURE 3
STATIC LATERAL-DIRECTIONAL STABILITY
RV-1D/QUICK LOOK II
USA S/N 67-18905

AVG GROSS WEIGHT (lb)	AVG CG LOCATION (% MAC)	AVG PRESSURE ALTITUDE (ft)	OUTSIDE AIR TEMP (°C)	TRIM CALIB. AIRSPEED (KT)	CONFIGURATION
15680	28.7(AFT)	8000	6	140	CR

NOTE: Shaded symbols denote trim.

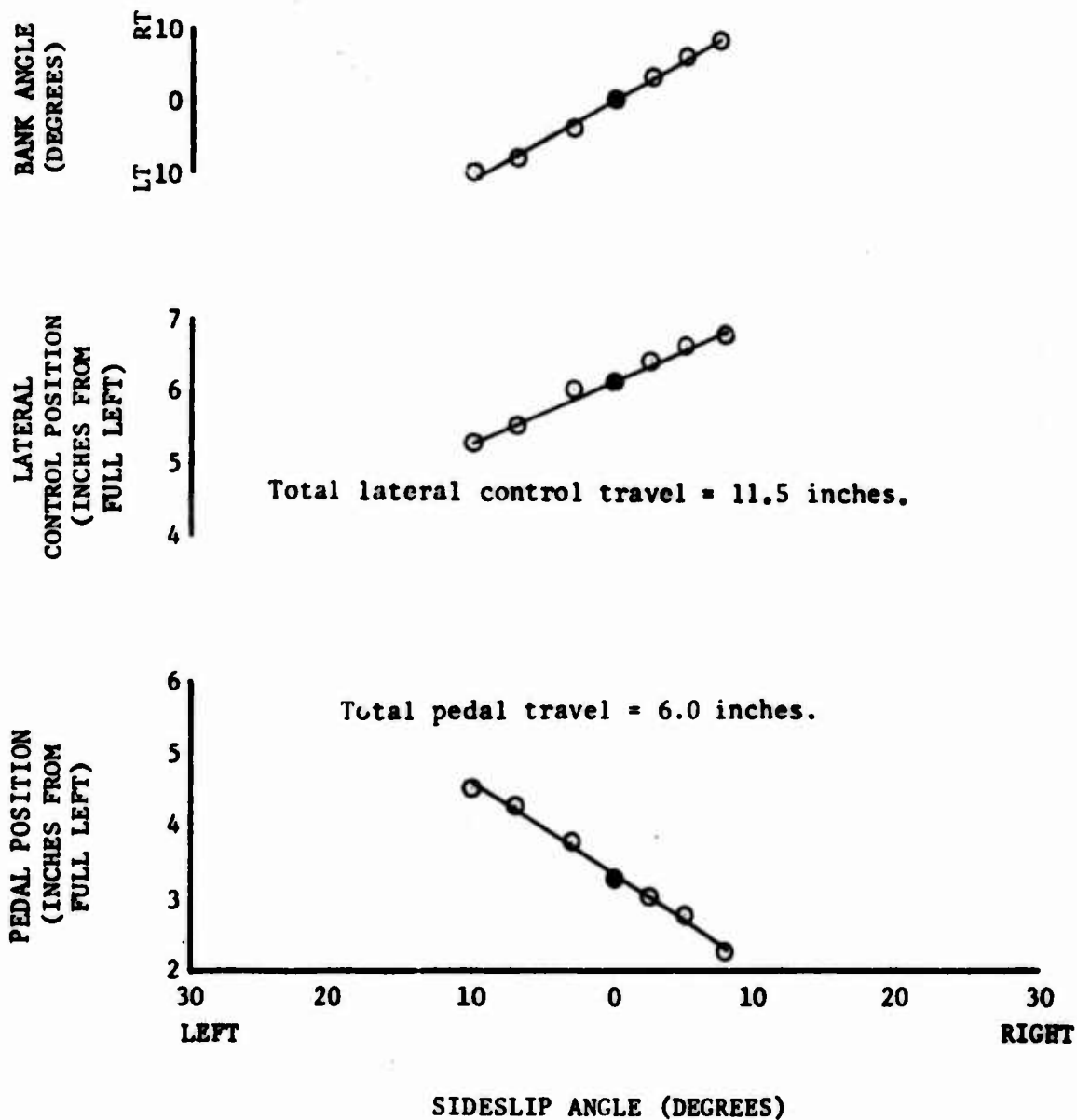


FIGURE 4
STATIC LATERAL-DIRECTIONAL STABILITY
RV-1D/QUICK LOOK II
USA S/N 67-18905

AVG GROSS WEIGHT (lb)	AVG CG LOCATION (% MAC)	AVG PRESSURE ALTITUDE (ft)	OUTSIDE AIR TEMP (°C)	TRIM CALIB. AIRSPEED (KT)	CONFIGURATION
16170	28.8(AFT)	8000	6	108	PAI

NOTE: Shaded symbols denote trim.

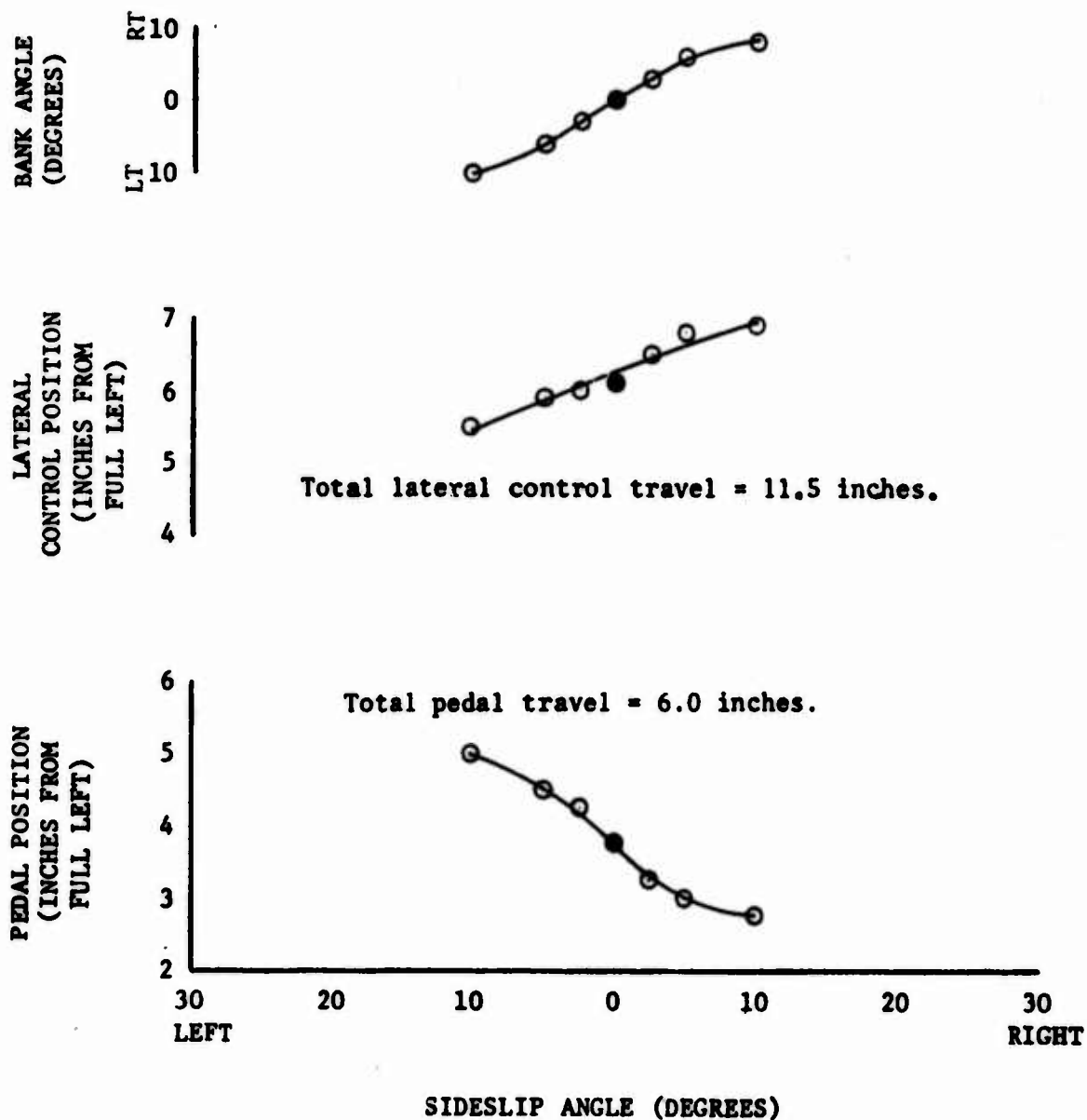


FIGURE 5
MANEUVERING STABILITY
RV-1D/QUICK LOOK II
USA S/N 67-18905

AVG GROSS WEIGHT (1b)	AVG CG LOCATION (% MAC)	AVG PRESSURE ALTITUDE (ft)	OUTSIDE AIR TEMP (°C)	TRIM CALIB AIRSPEED (KT)
16090	28.8 (AFT)	8000	6°	140

- NOTES: 1. Circles denote CR configuration.
 2. Squares denote PAI configuration.
 3. Full longitudinal control travel = 11.6 inches.

