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LIMITED EVALUATION CANADAIR CL-215 AMPHIBIOUS AIRPLANE.(U)
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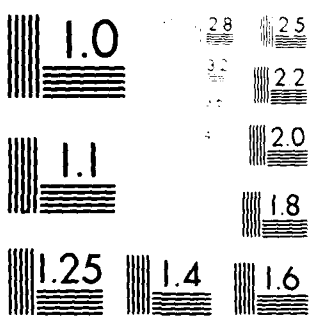

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AVSCOM PROJECT NO. 72-02
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LIMITED EVALUATION
CANADAIR CL-215 AMPHIBIOUS AIRPLANE

FINAL REPORT

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OCTOBER 1972

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UNITED STATES ARMY AVIATION SYSTEMS TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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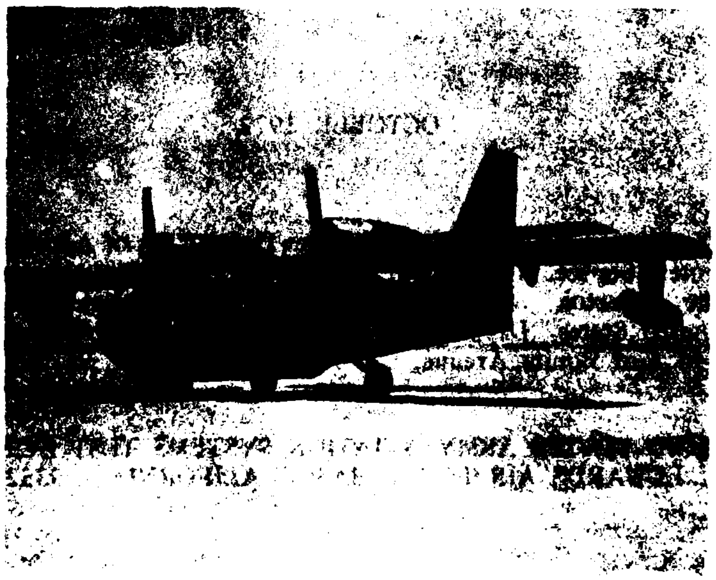
ABSTRACT

A limited evaluation of the Canadair CL-215 amphibious airplane was conducted for the United States Forest Service by the United States Army Aviation Systems Test Activity at Edwards Air Force Base, California; Bishop, California; Lake Mead, Nevada; Marana, Arizona; and Prescott, Arizona. A total of 58.8 flight hours were accumulated during the period 29 March to 26 May 1972. Engineering flight tests were conducted to evaluate the performance, handling qualities, airplane cockpit, and bio-environmental conditions and to provide information for use by the United States Forest Service Screening and Evaluation Board. Compliance with the provisions of the United States Forest Service desirable criteria, and military specifications MIL-F-8785(ASG) and MIL-A-8806A was determined. The performance characteristics of the CL-215 airplane, as presented in the airplane flight manual, are serviceable. The excellent water-handling characteristics and functional cockpit layout enhanced the mission suitability of the CL-215 airplane. No deficiencies and 14 shortcomings were identified during the evaluation. Correction of the following shortcomings affecting flying qualities is recommended for improved mission accomplishment: excessive longitudinal control force in maneuvering flight and during configuration changes, limited rolling performance, excessive lateral control force during rolling maneuvers, and inadequate flight control system harmony during maneuvering flight. Nine additional shortcomings were identified and correction recommended. The handling qualities were acceptable for the airtanker mission. If the airplane is used to transport personnel, acoustical protection and heating and ventilating should be provided in the passenger/cargo compartment. The maximum landing weight limitation should be increased to allow landing with a full retardant payload.



FOREWORD

Technical and logistical assistance throughout the flight test program was provided by personnel from Canadair Limited, Montreal, Canada, and the Air Service. Department of Transports, Quebec Government, Quebec City, Canada. During the water performance and handling qualities tests, support was provided by personnel from the United States National Park Service, Boulder City, Nevada, and United States Air Force personnel from Nellis Air Force Base, Nevada. Photographic coverage was provided by the United States Forest Service, San Dimas Equipment Development Center, San Dimas, California. The bio-environmental measurements were provided by personnel from the United States Air Force Hospital, Edwards Air Force Base, California.

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INTRODUCTION

BACKGROUND

1. In response to a request from the United States Forest Service (USFS), the United States Army Aviation Systems Test Activity (USAASTA) conducted a qualitative evaluation of the Canadair CL-215-1A10 amphibious airplane on 3 October 1970 (ref 1, app A). This evaluation consisted of one flight at one loading condition. The USFS subsequently requested that USAASTA conduct a more detailed investigation of the CL-215 performance and flying qualities for use by the National Airtanker Screening and Evaluation Board. The United States Army Aviation Systems Command (AVSCOM) issued Test Directive No. 72-02 (ref 2) which directed USAASTA to conduct an evaluation of the CL-215 aircraft for the USFS.

TEST OBJECTIVE

2. The objective of this test was to conduct a limited evaluation of the performance and handling qualities of the CL-215 airplane to include water operations. In addition, an evaluation of the cockpit and bio-environmental characteristics was conducted.

DESCRIPTION

3. The CL-215-1A10, Canadian registration CF-YWP, is a twin-engine, all-metal, cantilever high-wing amphibious airplane equipped with retractable tricycle landing gear. The aircraft is manufactured by Canadair Limited, Division of General Dynamics Corporation. Power is supplied by two Pratt and Whitney R-2800-83AM2AH engines equipped with Hamilton Standard 43E60-581 three-bladed, constant speed, full feathering propellers. Each engine is rated at 2100 brake horsepower (bhp) for takeoff at sea level. The CL-215 airplane has a boat hull and wing-mounted floats. Fuel is carried in flexible wing cells with a total capacity of 1162 US gallons.

4. The airplane is a special-purpose aircraft designed to be operated by a crew of two. Its primary mission is to combat brush and forest fires. The airplane can carry up to 1411 US gallons of water (1176 Imperial gallons) in two internal tanks. These tanks can be filled through two retractable probes which scoop water while the aircraft is planing on water or they can be filled through external connectors during land-based operations. The tanks are emptied through two electrically controlled, hydraulically actuated doors in the bottom of the hull (photo 1, app B). A manually operated emergency dump handle, that can be activated by either pilot, is also provided to open the tank doors. The aircraft

can also be used in a utility role to carry cargo, smokejumpers, or passengers. A more detailed description of the CL-215 is contained in appendix C.

SCOPE OF TEST

5. The limited evaluation of the CL-215 airplane was conducted at Edwards Air Force Base, California; Lake Mead, Nevada; Bishop, California; and Marana, Arizona. In addition, the airplane was flown for a USFS operational evaluation on the 28,000-acre "Battle" fire located in the Prescott National Forest near Prescott, Arizona. Test flights were conducted by personnel from USAASTA. Personnel from the Quebec Air Service (QAS), Province of Quebec, Canada, monitored airplane operations during flight tests, participated in the water handling and operational forest fire fighting evaluation and provided all maintenance support. During this program, 51 flights were conducted for a total of 58.8 hours which included 23.1 hours of productive testing, 26.8 hours of ferry and nonproductive time, and 8.9 hours of operation during actual fire fighting. Aircraft operating procedures, limitations, and restrictions as contained in references 3 and 4, appendix A, were observed during the evaluation.

6. The CL-215 airplane was evaluated primarily for its special-purpose airtanker mission. Flight test results were compared with applicable paragraphs of military specification MIL-F-8785(ASG) (ref 5, app A), MIL-A-8806A (ref 6), and the USFS memorandum "Desirable Criteria for Selecting Fixed Wing Air Tankers" (ref 7). These results along with pilot qualitative evaluations were used to determine deficiencies and shortcomings. The terms "deficiency" and "shortcoming," as defined in Army Regulation AR 310-25 (ref 8), are presented in appendix D.

7. Test configurations used during the evaluation are presented in table 1. Performance tests were conducted at the conditions shown in table 2. Stability and control tests were conducted at the conditions shown in table 3, unless otherwise noted.

Table 1. Test Configurations.

Configuration	Symbol	Landing Gear Position	Flap Setting (deg)	Power
Takeoff	TO	Down	10	Takeoff
Climb	CL	Up	Zero	Climb
Climb (one engine inoperative)	CL (OEI)	Up	Zero	Maximum continuous
Cruise	CR	Up	Zero	Power for level flight (PLF)
Power approach	PA	Down	10	PLF at $1.5V_{stall}$
Landing	L	Down	25	Idle[1]
Waveoff	WO	Down	25	Maximum allowable
Drop	DR	Up	15	As required
Water scooping	WS	Up	15	As required

[1]Partial power was used during water landing approach.

Table 2. Performance Test Conditions.

Test	Configuration	Average Test Gross Weight (lb)	Center of Gravity (% MAC)[1]	Density Altitude (ft)	Temperature (°C)
Takeoff (land)	TO	42,830	28.9 (mid)	2,430	10.5
		43,190	28.9 (mid)	5,800	20.0
		30,720	29.8 (mid)	2,430	10.5
		31,170	29.8 (mid)	5,800	20.0
Takeoff (water)	TO[2]	32,430	29.8 (mid)	900	11.0
Takeoff (water scooping)	WS	37,500	29.0 (mid)	900	11.0
Climb (dual engine)	CL	43,000	30.3 (aft)	4,000 to 12,000	--
		31,520	29.3 (mid)	3,000 to 14,000	--
Climb (single engine)	CL (OEI)	31,690	29.3 (mid)	3,000 to 7,000	--
Turning performance	DR	42,600	28.8 (mid)	7,150	16.5
Landing (land)	L	30,900	29.8 (mid)	2,430	10.5
		31,070	29.8 (mid)	5,800	20.0
Landing (water)	L[2]	32,240	29.8 (mid)	900	11.0

[1]Percent mean aerodynamic chord.
[2]Landing gear position up.

Table 3. Stability and Control Test Conditions.

Test	Configuration	Average Test Gross Weight (lb)	Center of Gravity (% MAC)	Density Altitude (ft)	Temperature (°C)	Trim Indicated Airspeed (kt)
Static longitudinal stability	CR	33,420	22.3 (fwd)	6700	3.5	140
		42,880	28.5 (mid)	6500	3.5	
	PA	33,670	22.3 (fwd)	7020	7.5	105
		42,890	29.0 (mid)	6800	11.0	
		31,020	31.4 (aft)	6980	16.0	
Static lateral-directional stability	CR	32,540	29.4 (mid)	6700	16.5	140
		31,960	31.4 (aft)	6500	13.0	
	PA	31,220	29.3 (mid)	6500	7.5	105
		31,540	31.5 (aft)	6870	14.5	
Dynamic longitudinal stability	CR	42,640	28.4 (mid)	7000	10.0	140
	PA	31,140	28.3 (mid)	7000	10.0	105
		30,720	31.5 (aft)	6900	16.0	
Dynamic lateral-directional stability	CR	42,450	28.3 (mid)	7000	10.0	140
	PA	31,140	28.3 (mid)	7000	10.0	105
		30,720	31.5 (aft)	6900	16.0	
Maneuvering stability	CR	42,450	28.6 (mid)	6800	8.5	140
	DR	43,190	29.4 (mid)	7100	18.5	105
Lateral control	CR	32,320	29.3 (mid)	7000	18.5	100 to 143
	DR	32,670	29.4 (mid)	7000	18.5	104 to 130
Asymmetric power	TO and CR	30,240	29.1 (mid)	7150	16.0	85
Longitudinal trim changes	--	32,140	28.5 (mid)	6320	16.0	129
Control force harmony	CR	31,000	29.3 (mid)	6700	12.5	140

METHODS OF TEST

8. Standard engineering flight test methods used are briefly described in the Results and Discussion section. The test aircraft was instrumented with sensitive and calibrated ship system instruments, and data were recorded on an oscillograph or manually in the cockpit (photos 2 through 4, app B). Longitudinal and lateral control forces were obtained from a hand-held force gage. Takeoff and landing performance was recorded with a Fairchild Flight Analyzer. Wind velocity was recorded during takeoff and landing tests using the wind measuring device shown in photograph 5. A listing of the instrumentation used is contained in appendix E. Data analysis methods used to reduce performance data are contained in appendix F. Qualitative ratings of the handling qualities are based on the Handling Qualities Rating Scale (HQRS) (app D).

CHRONOLOGY

9. The chronology of the CL-215 evaluation is as follows:

Test directive received	10 January 1972
Test aircraft received	31 January 1972
Flight tests initiated	29 March 1972
Flight tests completed	23 May 1972
Test aircraft released	26 May 1972
Preliminary report submitted to the USFS	22 August 1972

RESULTS AND DISCUSSION

GENERAL

10. A limited performance and handling qualities evaluation was conducted to determine the capability of the CL-215 amphibious airplane to perform its special-purpose airtanker and utility mission. The airplane cockpit and bio-environmental conditions were also evaluated. The performance characteristics of the CL-215 airplane, as presented in the airplane flight manual, are serviceable and satisfactory for the intended mission. The excellent water handling characteristics and functional cockpit layout enhanced the mission suitability of the CL-215 airplane. No deficiencies and 14 shortcomings, for which correction is recommended, were identified during the evaluation. There were four shortcomings affecting the flight characteristics: (1) excessive longitudinal control force in maneuvering flight and during configuration changes, (2) limited rolling performance for the airtanker mission, (3) excessive lateral control force during rolling maneuvers, and (4) inadequate flight control force harmony during maneuvering flight. The airplane failed to satisfy the rolling performance requirements of MIL-F-8785(ASG) in the cruise and drop configurations and the maximum acceptable noise levels of MIL-A-8806(A) at normal cruise power in the passenger/cargo area. Within the scope of the test, handling qualities characteristics of the CL-215 airplane are acceptable for the airtanker and utility mission. If the airplane is used to transport personnel, acoustical protection and heating and ventilating should be provided in the passenger/cargo compartment. The maximum landing weight limitation should be increased to allow landing with a full retardant payload.

PERFORMANCE

General

11. Tests were conducted to determine takeoff, climb, stall, turning, and landing performance characteristics of the CL-215 airplane. Takeoff distances on land to clear a 50-foot obstacle at 2281 feet mean sea level (MSL) were 2560 feet for a gross weight of 43,500 pounds, and 1730 feet for a gross weight of 31,000 pounds. At 4108 feet MSL, the takeoff distances were 2980 feet for a gross weight of 43,500 pounds, and 1740 feet for a gross weight of 31,000 pounds. The water takeoff results show that approximately 2200 feet were required to clear a 50-foot obstacle with a takeoff gross weight of 32,430 pounds at a water elevation of 1200 feet MSL. Climb results show that the CL-215 airplane was capable of a 500-foot-per-minute (ft/min) rate of climb at 10,000 feet on a standard day with a gross weight of 43,000 pounds. Stall airspeeds in unaccelerated flight ranged from 94 knots indicated airspeed (KIAS) with power ON and a gross weight of 42,850 pounds to 63 KIAS with power OFF and a gross weight of 30,225 pounds. The turning radius of the CL-215 airplane was

1580 feet at an airspeed of 83 KIAS and a bank angle of 30 degrees. At an airspeed of 98 KIAS and a bank angle of 50 degrees, the turning radius was reduced to 860 feet. Results of landing performance over a 50-foot obstacle show that 2670 feet are required with a gross weight of 30,895 pounds at a runway elevation of 2281 feet MSL. With a gross weight of 31,065 pounds and a runway elevation to 4108 feet MSL, 2570 feet are required. For water landings over a 50-foot obstacle with a gross weight of 32,240 pounds and a water elevation of 1200 feet MSL, 2080 feet are required. Within the scope of the test, the performance characteristics of the CL-215 airplane, as presented in the airplane flight manual, are serviceable and satisfactory for the airtanker and utility mission.

Takeoff Performance

12. Takeoff performance tests were conducted at the conditions shown in table 2 at airfields with runway elevations of 2281 feet MSL and 4108 feet MSL, and waterways with a water level of 1200 feet MSL. The contractor's recommended procedures were used during all takeoffs. All takeoff tests were performed with surface winds of 8 knots or less. For land takeoffs, the pilot used the brakes to hold the airplane while applying 30 inches of manifold pressure. After brake release, power was applied smoothly to takeoff power. Brakes and/or differential power were used to maintain runway alignment until the rudder became effective at approximately 40 KIAS. Forward pressure on the elevator control was used, as required, to ensure nose wheel contact with the runway. A rotation speed of 91 KIAS was used. After lift-off, the single-engine climb speed of 95 KIAS was established and the landing gear was retracted. The flaps were retracted at 100 KIAS. Water takeoff procedures with empty tanks were similar to those performed on land, except engine power was applied smoothly from idle to takeoff power. The water scooping operation consisted of a descent from 50 feet above the water to landing on the water, lowering the probes, applying necessary power to maintain 70 KIAS, and filling the tank with water while planing. After the tanks were filled, the probes were retracted and a water takeoff was completed.

13. A summary of land takeoff performance is presented in table 4. The takeoff distances to clear a 50-foot obstacle were shorter than the contractor published figures. Water takeoff performance (not corrected to standard day) indicated that 2200 feet were required to clear a 50-foot obstacle at a gross weight of 32,430 pounds, as compared with the distance of 2050 feet cited by the contractor. The distance required to accomplish the water scooping operation was approximately 5040 feet, as compared to 5400 feet shown by the contractor. Approximately 17 seconds were required to fill the two internal tanks with water. Takeoff performance of the CL-215 airplane is satisfactory for the intended mission.

Table 4. Summary of Takeoff Performance (Land).

Runway Elevation (ft MSL)	Gross Weight (lb)	Average Lift-Off Indicated Airspeed (kt)	Average Takeoff Distance[1]	
			Test Results[2] (ft)	Contractor's Data[3] (ft)
2281	43,500	96	2560	2950
2281	31,000	93	1730	2150
4108	43,500	89	2980	3250
4108	31,000	88	1740	2350

[1]Distance to clear a 50-foot obstacle.
[2]Takeoff distances shown are the takeoff test distances corrected to standard-day, no-wind conditions for the gross weight indicated. Dry hard runway surface condition with an approximate coefficient of friction of 0.02 used during all tests.
[3]Takeoff distance required based on standard-day, no-wind conditions for the gross weight indicated.

Climb Performance

14. Climb performance tests were conducted at the conditions shown in table 2. Dual-engine continuous climbs were conducted using climb power. A single-engine continuous climb was performed with the most critical engine, as indicated by the contractor's data (number one, left), inoperative, the propeller feathered, and the right engine developing maximum continuous power. The contractor's climb schedules were used during these tests (refs 3 and 4, app A).

15. The results of the continuous climb performance tests are presented in figures 1 and 2, appendix G. Dual-engine climb performance resulted in a 500-ft/min rate of climb at a 10,000-foot pressure altitude for an average gross weight of 43,000 pounds. At this same altitude and for an average gross weight of 31,515 to 31,520 pounds, the rate of climb was 1090 ft/min. The dual-engine climb performance met the USFS desirable criteria (ref 7, app A). During single-engine continuous climb, the rate of climb was 200 ft/min at a 7000-foot pressure altitude for an average gross weight of 31,690 pounds. For the conditions investigated, the contractor's climb performance data compared satisfactorily with the test results. The climb performance is satisfactory for the intended mission.

Stall Performance

16. Stall performance tests were conducted at the conditions shown in table 5. The stalls were initiated from a trim airspeed dependent upon the configuration being evaluated. Approach to the stall was executed by decreasing the airspeed at a rate of approximately 1 knot per second to minimize dynamic effects. Airspeed, altitude, and qualitative pilot comments were recorded during each stall. The results of the stall tests are presented in table 5. Handling qualities during the stall are discussed in paragraph 31. Stall speed data are presented in terms of indicated airspeed. For similar conditions, the contractor stall speeds compared satisfactorily with the test results. The stall airspeeds obtained in the DR configuration, power ON and power OFF, were well below the recommended minimum drop speed (100 KIAS). For the conditions investigated, the stall performance is satisfactory for the airtanker mission.

Turning Performance

17. Turning performance tests were conducted at the conditions shown in table 2. The CL-215 airplane was stabilized in a coordinated turn at a predetermined bank angle and an airspeed just above the stall speed. The test altitude was maintained during the turn. The normal acceleration and airspeed were recorded and used to calculate the minimum turning radius. For an angle of bank of 30 degrees and an airspeed of 83 KIAS, the turning radius was 1580 feet. For an angle of bank of 50 degrees and an airspeed of 98 KIAS, the turning radius was 860 feet. The turning performance is satisfactory for the airtanker mission.

Landing Performance

18. Landing tests were conducted at the conditions shown in table 2 at airfields with runway elevations of 2281 feet MSL and 4108 feet MSL, and waterways with a water elevation of 1200 feet MSL. All landing tests were performed with surface winds of 8 knots or less. For each landing on land, the airplane was aligned with the runway at a height of 700 to 800 feet above the runway elevation and at an indicated airspeed of 95 to 100 knots. The landing configuration and the contractor's recommended approach airspeed were established. The airplane attitude was adjusted to hold the desired approach airspeed until flare height (approximately 75 feet above the runway) was reached. When the flare height was reached, aft longitudinal control movement was initiated to complete the flare, and touchdown was completed at an airspeed above the stall. Wheel braking was begun to bring the airplane to a rapid stop after the airplane had all wheels on the runway. Maximum braking was not used to reduce the chance of skidding and tire damage. For water landings, an approach speed of 90 to 95 KIAS was maintained with partial power which was reduced to idle at touchdown.

19. A summary of the landing performance is presented in table 6. The landing distance on land exceeded the performance figures provided by the contractor. This discrepancy in distance can be attributed to pilot technique: primarily braking procedure. Although the landing distance exceeded that presented by the

Table 5. Stall Performance.

Configuration	Average Test Density Altitude (ft)	Average Test Gross Weight (lb)	Center of Gravity (% MAC)	Bank Angle (deg)	Stall Warning Indicated Airspeed (kt)	Stall Indicated Airspeed (kt)
CR (power ON)	7200	42,850	28.6 (mid)	Zero 30 (left) 30 (right)	98 103 100	94 98 97
DR (power ON)	7200	42,540	28.6 (mid)	Zero 30 (left) 30 (right)	82 91 86	77 83 82
TO (power ON)	7200	42,150	28.3 (mid)	Zero 30 (left) 30 (right)	84 90 89	76 79 80
DR (power OFF)	8150	30,460	29.1 (mid)	Zero 30 (left) 30 (right)	70 75 76	65 70 69
WO (power ON)	8150	30,430	29.1 (mid)	Zero	69	62
L (power OFF)	8150	30,230	29.2 (mid)	Zero	69	63

contractor, the difference was not considered significant, as the landing performance will satisfy known requirements for the airtanker mission. The water landing distance achieved during this test is better than the contractor's data and, possibly, can be attributed to pilot experience and technique. The landing performance is satisfactory for the intended mission.

Table 6. Summary of Landing Performance (Land and Water).

Runway Elevation (ft MSL)	Gross Weight (lb)	Average Touchdown Indicated Airspeed (kt)	Average Landing Distance[1]	
			Test Results (ft)	Contractor's Data[2] (ft)
2281	30,900	77	[3]2670	2340
4108	31,070	73	[3]2570	2430
1200	32,240	74	[4]2080	2400

[1]Distance to clear a 50-foot obstacle to stop.
[2]Landing distance required, based on standard-day and similar wind conditions for the gross weight indicated.
[3]Landing test distances (land) corrected to standard-day, no-wind conditions for the gross weight indicated. Dry hard runway surface conditions with an approximate coefficient of friction of 0.02 used during all tests.
[4]Water landing test distance. No corrections applied.

STABILITY AND CONTROL

General

20. Stability and control testing was conducted to determine the flying qualities of the CL-215 airplane. No deficiencies were noted. There were five shortcomings affecting the flight characteristics: (1) excessive longitudinal control force per g in maneuvering flight, (2) excessive longitudinal control forces encountered during configuration changes, (3) limited rolling performance for the airtanker mission, (4) excessive lateral control force during rolling maneuvers, and (5) inadequate flight control force harmony during maneuvering flight. For the conditions investigated, the stability and control characteristics of the CL-215 airplane are acceptable for the airtanker and utility mission.

Control Systems Characteristics

21. The flight control system was evaluated in the CR configuration during trimmed level flight to determine breakout force including friction, free play, and centering. The mechanical control system breakout force including friction was determined by recording the minimum force applied to each flight control to disturb the airplane from trim. The breakout force including friction was 1.5 pounds or less for each control. Free play was negligible, and the centering capability of the flight controls was satisfactory. The flight control system characteristics are satisfactory for the airtanker mission.

Static Longitudinal Stability

22. Static longitudinal stability characteristics were evaluated at the conditions shown in table 3. The tests were conducted by stabilizing the aircraft in coordinated level flight in the desired configuration at the trim airspeed and then, without changing power or trim settings, stabilizing in coordinated flight at both slower and faster airspeeds. Test results are presented in figures 6 and 7, appendix G. The CL-215 possesses static longitudinal stability for the forward (fwd) and mid center-of-gravity (cg) locations, as indicated by a forward control movement and a push force required to increase airspeed and the opposite to reduce airspeed. For the aft cg location in the PA configuration (fig. 6), the static longitudinal control position gradient became essentially neutral above 113 KIAS; but this was not objectionable, as sufficient control force changes occurred to provide adequate cues to the pilot of changes in airspeeds from trim (HQRS 3). For the conditions investigated, the static longitudinal stability characteristics are satisfactory for the intended mission.

Static Lateral-Directional Stability

23. Static lateral-directional stability characteristics were evaluated at the conditions shown in table 3. These tests were conducted by stabilizing the aircraft in coordinated flight in the desired configuration at the trim airspeed and then incrementally increasing sideslip angles while maintaining the trim airspeed. Test results are presented in figures 8 and 9, appendix G. In all configurations and cg locations tested, the aircraft exhibited positive directional stability (left rudder required for right sideslip and vice versa), positive dihedral effect (right lateral control force required for right sideslip and vice versa), and positive side-force characteristics (right bank angle required for right sideslip and vice versa). The variation of lateral control position with sideslip angle was essentially neutral for both configurations, but not objectionable because the lateral control force and bank angle required to maintain the desired sideslip angle provided the pilot with adequate cues to the flight condition. For the conditions investigated, the static lateral-directional stability characteristics are satisfactory for the intended mission.

Dynamic Longitudinal Stability

24. Dynamic longitudinal stability characteristics were evaluated at the conditions shown in table 3. Short-period characteristics were evaluated by applying pulse inputs of approximately 1 inch, held for 0.5 second, to the longitudinal control. Long-period characteristics were evaluated by reducing airspeed approximately 20 knots below the trim speed with aft longitudinal control, and then returning the flight control to the near trim condition. For both configurations tested, the short-period oscillations recorded following a control pulse input were well damped and no residual control oscillations occurred. The long-period oscillations for both configurations were convergent. For the conditions investigated, the dynamic longitudinal stability characteristics are satisfactory for the intended mission.

Dynamic Lateral-Directional Stability

25. Dynamic lateral-directional characteristics were evaluated at the conditions shown in table 3. The lateral-directional oscillations (Dutch-roll mode) were excited by applying pulse inputs to the rudder and by releasing the aircraft from steady-heading sideslips. For the configurations tested, the roll and yaw oscillations were well damped. The roll-to-yaw ratio was 1 to 2 for each configuration. For the conditions investigated, the dynamic lateral-directional stability characteristics are satisfactory for the intended mission.

26. Spiral stability characteristics were evaluated only in the CR configuration. The airplane was disturbed from trim by opening and closing either the left or right engine cowl flap and the resulting motion recorded. The airplane's spiral mode was slightly divergent to the left for both conditions. After the airplane was disturbed from trimmed flight, a left roll of 7 degrees after 20 seconds increasing to 10 degrees after 40 seconds was noted. The divergent spiral mode was not objectionable. For the conditions investigated, the spiral stability characteristics are satisfactory for the intended mission.

Maneuvering Stability

27. Maneuvering stability characteristics were evaluated at the conditions shown in table 3. Tests were conducted using steady turns to the left and right. The test results are presented in figures 10 and 11, appendix G. The longitudinal control force per g encountered in the DR configuration was approximately 53 pounds per g at the 2g level, was approximately equal to the maximum recommended value of MIL-F-8785(ASG), and was considered excessive. The excessive longitudinal control force per g will increase pilot workload during the water dropping mission, and requires considerable pilot compensation to obtain desired precision during maneuvering flight (HQRS 5). Excessive longitudinal control force per g in maneuvering flight is a shortcoming which warrants correction for improved mission accomplishment.

Lateral Control

28. Lateral control characteristics were evaluated at the conditions shown in table 3 during rolling maneuvers. Both full and approximately 90-degree control deflections were used to perform both left and right rolling maneuvers. Tests were conducted at airspeeds from 113 to 160 knots true airspeed (KTAS) in the CR configuration and 116 to 147 KTAS in the DR configuration. The test results are shown in figure 12, appendix G. For the conditions tested, with 90-degree wheel throws left and right, the rate of roll was less than 18 degrees per second (deg/sec) in all cases: 7 deg/sec below the USFS desirable criteria of 25 deg/sec in the DR configuration (ref 7, app A). The rolling performance also failed to satisfy the requirements of MIL-F-8785(ASG) (ref 5). The limited rolling performance with 90 degrees of wheel throw for the airtanker mission reduces the airplane maneuverability and is a shortcoming, correction of which is desirable for improved airtanker mission accomplishment. In addition, the lateral control forces were excessive (90-degree wheel input required approximately 45 pounds) and required considerable pilot compensation to perform maneuvering flight and to compensate for gust disturbances (HQRS 5). The excessive lateral control force during the rolling maneuvers is a shortcoming, correction of which is desirable for improved mission accomplishment.

Asymmetric Power

29. Single-engine flight characteristics were evaluated at the conditions shown in table 3. The minimum trim and minimum control airspeeds were evaluated in the CR configuration, with the number-one engine inoperative and the propeller feathered, by reducing airspeed while maintaining a constant power setting and steady-heading wings-level flight. The minimum dynamic control airspeed was evaluated in the TO configuration during a simulated engine failure at selected airspeeds (number-one engine mixture control moved to idle cutoff and propeller windmilling). During the minimum control airspeed test, both the flight controls and the associated trim systems were effective down to 78 KIAS: 8 knots below the contractor's stated 86-KIAS single-engine control speed (ref 3, app A). During the simulated engine failure test, control of the airplane was satisfactory at 82 KIAS, 4 knots below the minimum single-engine control speed. Within the scope of the test, the asymmetric power characteristics are satisfactory for the airtanker mission.

Longitudinal Trim Changes

30. Longitudinal trim changes resulting from configuration changes under conditions representative of operational procedures were determined at the conditions shown in table 3. The evaluation was conducted by manually recording the longitudinal control forces during gear, flap, and power changes. The longitudinal control force resulting during each configuration change is shown in table 7. The peak longitudinal control force encountered was 47 pounds push which occurred as the power was increased from idle to takeoff power during a simulated waveoff maneuver. High control forces were also encountered when

flaps were raised or lowered and as power was changed from that required for level flight to idle. The excessive longitudinal control force encountered during the configuration changes was objectionable, required moderate pilot compensation, in that retrimming was required to maintain satisfactory precision in the maneuver (HQRS 4), and is a shortcoming, correction of which is desirable for improved mission accomplishment. The peak longitudinal control force encountered exceeded the 20-pound limit of MIL-F-8785(ASG) by 27 pounds (135 percent).

Table 7. Longitudinal Trim Changes.

Initial Configuration			Configuration Change	Trim Indicated Airspeed (kt)	Parameter Held Constant	Control Force (lb)
Gear	Flaps	Power				
Up	Up	PLF	Gear down	110	Altitude	6.5 (pull)
Down	Up	PLF	Flaps down (25 degrees)	110	Altitude	20 (push)
Down	Down	PLF	Power to idle	91	Airspeed	20 (pull)
Down	Down	PLF	Power to takeoff	75	Altitude	47 (push)
Down	TO	TO	Gear up	91	Rate of climb	Zero
Up	TO	TO	Flaps up	105	Rate of climb	25.5 (pull)
Up	Up	TO	Power takeoff to idle	150	Altitude	17 (push)

Stall Characteristics

31. Stall characteristics for the airtanker mission were evaluated in the configurations and at the conditions shown in table 5. During the stall investigation, the airplane was stabilized in coordinated flight at the desired airspeed and altitude. The airspeed was gradually reduced at a rate of approximately 1 knot per second until the stall or loss of control occurred. The stall was defined by a loss of lift and a nose-down pitching motion. A limited stall investigation in uncoordinated flight was also conducted. The electrical stall warning device, which incorporated a stall warning horn to alert the crew to impending stall, was excellent and provided stall warning between 1.05 and 1.14 times the stalling speed. Flight controls were effective into the stall condition for both coordinated and uncoordinated flight, and recovery was accomplished by normal application of controls. The stall

characteristics obtained in uncoordinated flight were similar to the characteristics obtained in coordinated flight. For the conditions investigated, the stall characteristics are satisfactory for the airtanker mission.

32. The stall characteristics for the utility mission were evaluated in the CR, L, and WO configurations of a gross weight of 33,300 pounds and a cg location of 22.3-percent (fwd) mean aerodynamic chord (MAC). At this loading, the full aerodynamic stall could not be achieved due to insufficient longitudinal control. The limited stall condition achieved was characterized by random pitching and rolling motions. To maintain wings-level flight, large lateral control inputs were required. For the conditions investigated, the stall characteristics are satisfactory for the utility mission.

Control Force Harmony

33. Flight control force harmony was evaluated at the conditions shown in table 3 during maneuvering flight (rolling pullouts left and right). During the rolling-pullout maneuvers to the left, the ratio of the longitudinal-directional-lateral control forces was approximately 1.5-2-1. The ratio of the control forces during right rolling pullouts was similar. As compared to the longitudinal control force, the directional control force was low and the lateral control force was high. (MIL-F-8785(ASG) recommended ratio is 2-7-1 for longitudinal-directional-lateral control forces.) The inadequate flight control system harmony during maneuvering flight required moderate pilot compensation to obtain the desired precision (HQRS 4) and is a shortcoming, correction of which is desirable for improved mission accomplishment.

Control System Trimming Devices

34. Control system trimming devices were evaluated in the CR configuration at a density altitude of 6300 feet, a gross weight of 32,000 pounds, a cg location of 29.3-percent (mid) MAC, and a trim airspeed of 129 KIAS. The trimming devices were evaluated throughout their operational range. Forces created and the travel time required for full trim deflections are presented in table 8. Full forward and full aft elevator trim created longitudinal control forces of 95 and 97 pounds, respectively. These control forces are high; however, they are acceptable because an adequate overriding emergency trimming system is provided in the elevator control system. Forces created by full trim deflection in the aileron and rudder control trim systems could be satisfactorily controlled by the pilot to allow a safe return to base and landing. The trimming system characteristics are satisfactory for the airtanker mission.

Takeoff and Landing Characteristics (Land and Water)

35. The takeoff and landing characteristics were evaluated throughout the test program at the conditions shown in table 2. On land, control effectiveness and directional control in crosswinds were determined during the takeoff roll and during landing. The rudder control became effective at 40 KIAS and the aileron at 55 KIAS. The elevator was effective in lifting the nose wheel on takeoff at

60 KIAS and holding the airplane off the runway during landings at airspeeds down to 65 KIAS. Directional control, as obtained with rudder control, braking, and differential power, was adequate to maintain desired headings in crosswinds up to 20 knots. (In lieu of the absence of published crosswind limits, the requirements of *MIL-F-8785(ASG)* were used.)

Table 8. Trimming Device Characteristics.

Trim	Direction (full deflection)	Time[1] (sec)	Force (lb)
Elevator	Forward	6.3	95
	Aft	8.5	97
Aileron	Right	4.5	35
	Left	4.5	32
Rudder	Right	5.7	180
	Left	5.2	150

[1]Time measured from the zero trim position to the extreme trim limit.

36. The airplane stability and directional control on water were evaluated during water takeoff, landing, and scooping operations. Takeoffs and landings were conducted with lake surface conditions from near calm to conditions with wave heights estimated to be 18 inches, crest to trough. During both landings and takeoffs, the bow spray strip was effective in controlling the hull spray pattern. The observed main blister envelope (a thin continuous sheet of water raised by the forward motion of the hull and separated from the free water surface by an air space) was quite small. Qualitatively, hull stability (maintaining desired airplane attitude while planing) was satisfactory during takeoff and landings. During water takeoffs, the airplane had only minimal tendency towards porpoising, which was relieved by applying aft pressure on the control wheel. This is contrary to most flying boat procedures where porpoising is relieved by releasing back pressure on the control wheel. Directional control was easily maintained with differential power and rudder control. The scooping operation (photo 6, app B) did not affect the stability or directional control of the airplane while planing and resulted in only a minimal deceleration which occurred when the probes were lowered. For the conditions investigated, the takeoff and landing characteristics on land and water are satisfactory for the airtanker mission.

MISCELLANEOUS

Water and Fire Retardant Drops

37. Numerous water drops were made in the DR configuration in level and descending flight. Payloads of up to 12,000 pounds of water or retardant were dropped in the salvo (both tanks simultaneously) and trail (both tanks sequentially) modes at airspeeds from 104 to 127 KIAS. A photograph of a salvo drop is shown in appendix B (photo 7). Drops were made with controls free or with the pilot attempting to minimize the pitch-up. The aircraft response to a salvo water drop made at 113 KIAS in level flight with controls free, is shown in figure 10, appendix G. The aircraft pitched up approximately 18 degrees after the drop. This pitch-up (photo 8, app B) is characteristic of present-day airtankers. The pilot can easily compensate for this response through the use of the longitudinal flight control. Figure 13, appendix G, shows the aircraft response to a salvo and trail drop made at 107 and 109 KIAS with the pilot using the longitudinal control to reduce the amount of pitch-up.

38. Figure 14 shows the maximum cg normal accelerations recorded following salvo and trail water drops. During salvo water drops with controls free, a cg normal acceleration of 2.0g was recorded at 104 KIAS, and a normal acceleration of 2.6g was recorded at 127 KIAS. During salvo water drops using the longitudinal control to minimize the pitch-up, a cg normal acceleration of 1.8g was recorded at 107 KIAS and 2.2g at 127 KIAS. During trail drops using the longitudinal control to minimize the pitch-up, a cg normal acceleration of approximately 1.7g was recorded at airspeeds from 108 to 122 KIAS. No difficulty was experienced in maintaining control of the airplane following a drop.

39. During the operational evaluation conducted jointly by QAS and USAASTA pilots and observed by USFS personnel on the "Battle" fire, four chemical fire retardant drops (3 salvo and 1 trail) were recorded. These drops were made from a slight dive (approximately 500-ft/min rate of descent) with pilot inputs to the longitudinal control to maintain the desired flight path. A rolling pullout was made after the drops. The weight of fire retardant dropped was approximately 10,000 pounds. Light-to-moderate turbulence was encountered during the drops. The maximum cg normal acceleration recorded during the salvo drops was 2.6g at 129 KIAS. The maximum cg normal acceleration recorded during the trail drop (approximately 1-second delay) was 1.7g at 123 KIAS. If moderate or severe turbulence is encountered during a rolling pullout from a retardant drop, the normal acceleration limit (3.25g with 15 degrees of flaps) could be exceeded. The present cockpit instrumentation does not include an accelerometer to allow the pilot to monitor the acceleration loads. The lack of a cockpit accelerometer is a shortcoming, in that the pilots are unable to monitor normal accelerations and may inadvertently encounter conditions where the aircraft structural limits could be exceeded. In addition, maneuverability during retardant drops required considerable pilot effort (HQRS 5) due to the excessive longitudinal and lateral control forces. For the conditions investigated, the water and retardant dropping characteristics are acceptable for the airtanker mission.

40. A qualitative evaluation of the emergency payload drop procedure was conducted. The emergency dump handle could be activated easily by either the pilot or copilot to salvo the payload. The resultant aircraft motion was the same as that using the normal procedure. The emergency drop procedure is satisfactory for the airtanker mission.

Retardant Loading Procedure

41. The retardant loading procedure was evaluated during the forest fire fighting operation (para 5). The two internal tanks had to be filled separately (with retardant) through fixtures located on each side of the airplane, which caused a considerable delay in the loading operation. The inability to load retardant from one location is a shortcoming, correction of which is desirable for improved mission accomplishment. In addition, dual payload quantity gages (similar to those in the cockpit) are not available on the outside of the aircraft for land reloading operations. At present, a crewmember has to signal the ground personnel when to terminate the filling operation for each tank. These signals cannot be readily seen or heard due to the aircraft size and tanker base operational noise. The lack of exterior payload quantity gages for retardant loading procedures is a shortcoming, correction of which is desirable for improved mission accomplishment.

Ground Handling Characteristics

42. Ground handling characteristics were evaluated throughout the test program. Taxi maneuvers were performed on hard-surface areas at the maximum aircraft takeoff weight of 43,500 pounds. To properly taxi the CL-215 airplane required considerable attention and practice. The dual nose wheel is free to swivel and is not mechanically steerable. Wheel brakes and differential engine power were used to maintain directional control. The wheel brakes were effective, but the brakes were very sensitive to pilot operation. Power management required to obtain the desired directional control was difficult until experience was acquired. An airplane of this weight category should incorporate a power nose-wheel steering system, particularly considering the confined fire retardant loading areas observed. The lack of nose-wheel steering is a shortcoming, correction of which is desirable for improved mission accomplishment.

Water Handling Characteristics

43. Water handling characteristics were qualitatively evaluated at Lake Mead, Nevada, during water taxi and 360-degree turns on the water surface. Turns were made to the left and to the right with the inboard engine idling while the outboard engine power was gradually increased in uniform increments of propeller speed for each turn up to maximum propeller speed. The elevator and ailerons were held in the neutral position and the rudder was used to assist in the turn. The motion of the plane through the water, as indicated by a dye marker dispensed in the water, made a distinctive pattern which was photographed from a helicopter flying overhead (photo 9, app B). Turns were made through 360 degrees with a minimum turn radius of approximately one-half a wing span (47 feet).

Figure-eight maneuvers were easily made while planing on the water at approximately 45 KIAS. The spray strip was effective in controlling the bow spray. Any splash on the windshield was effectively eliminated by the windshield wipers. For the condition investigated, the water handling characteristics are excellent and enhance mission suitability.

Control Gust Locks

44. Flight control gust locks are provided to secure the controls when the airplane is parked and during taxi operations. It is extremely difficult to properly engage the rudder gust lock during cross wind or tail wind conditions due to the spring bar mechanism in the rudder control system. To facilitate engagement of the rudder gust lock, it is accomplished during landing rollout or when the airplane is headed into the wind. The engagement during the landing rollout can be distracting to the pilot, especially when a cross wind condition exists and, if improperly engaged, will result in minor structural damage. Inability to engage the rudder control gust lock during strong cross wind or tail wind conditions is a shortcoming, correction of which is desirable for improved mission accomplishment.

Cockpit Evaluation

45. Cockpit features and displays were evaluated throughout the test program. The instruments, switches, and circuit breakers are well grouped and logically placed. The seats are adjustable fore-and-aft and in height. The rudder pedals are adjustable, fore and aft. The functional layout of the cockpit enhances mission suitability. Three cockpit shortcomings were noted, correction of which is desirable for improved mission accomplishment: (1) poor cockpit instrument panel lighting, a row of lights across the top of the panel, which does not provide adequate light to enable ease of reading some engine instruments during night operations, (2) inadequate length of the carburetor heat control and mixture levers above the engine control console reduces ease of control, and (3) inability to start the ground power unit located in the aft section of the airplane from the cockpit. The ground power unit can only be started with controls located in the aft fuselage section. It can be shut down by either crewmember from the cockpit.

46. The pilot's field of vision was determined while the aircraft was parked on the ramp. From the crew seats, the pilots could see approximately 140 degrees to either side relative to the nose of the aircraft (110 degrees desired, ref 7, app A) and approximately 22 degrees down over the nose (20 degrees desired, ref 7). The field of vision through the side window was from approximately 40 degrees below the horizon to approximately 50 degrees above with the pilot seated in a normal position. The field of vision is satisfactory for the airtanker mission.

Bio-Environmental Evaluation

47. Interior and exterior noise measurements were made to determine compliance with the military specification, MIL-A-8806A, and the noise levels the crewmembers, passengers, and ground support personnel would be exposed to

during normal operations. Interior noise measurements made during operations at takeoff power, maximum continuous power and normal cruise power are shown in table 9. Exterior noise measurements made during ground operations at idle power are shown in table 10. Noise levels in the crew compartment during operations at takeoff, maximum continuous, and normal cruise power settings met the requirements of MIL-A-8806A. The noise level in the passenger/cargo compartment significantly exceeded the maximum acceptable limits of MIL-A-8806A in the following octave bands by the indicated amount: overall decibel (db), 6db; 2400 to 4800 Hz, 8db; and 4800 to 9600 Hz, 9db. The interior noise levels are satisfactory for the airtanker mission. Acoustical protection should be installed in the passenger/cargo compartment if the aircraft is used to transport personnel. Exterior noise measurements approached the noise level (85db) at which ear protection is recommended (between 300 and 4800 Hz) for continuous 8-hour-day exposure (ref 9, app A).

48. Tests were conducted to determine the level of carbon monoxide and carbon dioxide in both the crew and passenger/cargo compartments. No carbon monoxide or carbon dioxide was detected.

49. Heating and ventilating were qualitatively evaluated at different in-flight temperatures. Heating and ventilating were provided only in the crew compartment area and were excellent. Heating and ventilating should be provided in the passenger/cargo area for passenger comfort if passengers are transported. The airplane heating and ventilating are satisfactory for the airtanker mission.

Airspeed Calibration

50. An airspeed calibration was conducted to determine the position error for the test airspeed boom system and to verify the contractor's calibration of the airplane's airspeed system (ship system). An 8-foot test airspeed boom was mounted on the nose of the airplane (photo 2, app B). The systems were calibrated with the airplane in the CR configuration at a gross weight of 41,590 pounds and cg location of 29.1-percent (mid) MAC, and in the PA configuration at a gross weight of 40,210 pounds and cg location of 29.0-percent (mid) MAC using the ground speed course method. The results are shown in figures 15 and 16, appendix G. For both configurations tested, the airplane's airspeed system calibration agreed with the contractor's airspeed calibration and is satisfactory for the intended mission.

Weight and Balance

51. The test airplane was weighed prior to first test flight. The test basic weight, including test airplane, test instrumentation, full oil, and trapped fuel, was 28,139 pounds. Test instrumentation weight was 298 pounds. The maximum zero fuel weight (all weight in excess of the zero fuel weight must consist of usable fuel in the wing) is 39,000 pounds for the airtanker mission. With a crew of two (400 pounds), the maximum payload capability of the airplane, 10,759 pounds, is 1241 pounds less than the contractor-stated 12,000-pound payload. The

Table 9. Interior Noise Measurements.

Test Condition	Data Source	Noise Level							
		Overall (db)	Octave Band						
			75 to 150 Hz (db)	150 to 300 Hz (db)	300 to 600 Hz (db)	600 to 1200 Hz (db)	1200 to 2400 Hz (db)	2400 to 4800 Hz (db)	4800 to 9600 Hz (db)
Takeoff power (54 in. Hg, 2800 rpm)	Crew compartment[1]	114	109	112	102	87	85	80	75
	Specification limit[2]	120	118	118	118	112	106	100	94
Maximum continuous power (46 in. Hg, 2600 rpm)	Crew compartment[1]	111	108	108	96	87	84	79	79
	Specification limit[3]	113	111	111	111	105	99	93	87
Normal cruise power (33 in. Hg, 2000 rpm)	Crew compartment[1]	107	96	99	93	88	87	83	84
	Passenger/cargo compartment[4]	112	106	99	96	88	86	83	84
	Specification limit[5]	106	104	104	104	96	90	75	75

[1]Noise level measured between pilot and copilot at chest level.
[2]Maximum acceptable noise level (MIL-A-8806A, paragraph 3.1-2, table II B).
[3]Maximum acceptable noise level (MIL-A-8806A, paragraph 3.1-1, table I B).
[4]Average noise level measured in the passenger/cargo compartment.
[5]Maximum acceptable noise level (MIL-A-8806A, paragraph 3.1-4, table IV B).

Table 10. Exterior Noise Measurements.

Test Condition	Data Source[2]	Noise Level[1]							
		Overall (db)	Octave Band						
			75 to 150 Hz (db)	150 to 300 Hz (db)	300 to 600 Hz (db)	600 to 1200 Hz (db)	1200 to 2400 Hz (db)	2400 to 4800 Hz (db)	4800 to 9600 Hz (db)
Idle power (17 in. Hg, 1000 rpm)	Front	99	95	91	86	83	82	79	79
	Left front	100	97	90	85	81	80	78	78
	Left rear	101	96	91	83	80	79	79	81
	Right rear	97	94	87	82	76	77	78	77
	Right front	98	95	89	84	78	82	78	79

[1]Noise level approximately 50 feet from the aircraft.
[2]Given with respect to the nose of the aircraft.

maximum landing weight (land) is 34,400 pounds. This landing weight limitation precludes landing with a fire retardant payload. The inability to land with the fire retardant payload does not satisfy USFS desirable criteria (ref 7, app A). The maximum landing weight limit should be increased to allow landing with a full retardant payload.

Nose-Gear Safety-Lock Assembly

52. The nose-gear safety-lock assembly, installed when the aircraft is secured on the ramp, cannot be installed or removed without crawling under the aircraft. This condition is undesirable for the crewmember if the aircraft is parked on a wet ramp or sod area. The undesirable installation and removal procedure for the nose-gear safety-lock assembly is a shortcoming, correction of which is desirable for improved mission accomplishment.

Engine Oil Cooler System

53. The engine oil cooler system was evaluated throughout the test program. Frequent monitoring of the engine oil temperature gages and manual control of the oil cooler cowl flaps was required to maintain the desired engine oil temperature because of frequent power changes. This required additional pilot attention, especially during the fire fighting operations. Oil cooler flaps that are controlled automatically would eliminate this situation.

CONCLUSIONS

GENERAL

54. The following conclusions were reached upon completion of the limited performance and handling qualities evaluation of the CL-215 amphibious airplane:

a. Within the scope of the test, the performance characteristics of the CL-215 airplane presented in the airplane flight manual are serviceable and are satisfactory for the airtanker and utility mission.

b. The handling qualities of the CL-215 airplane are acceptable for the airtanker and utility mission.

c. Excellent water handling characteristics enhance mission suitability (para 43).

d. The functional layout of the cockpit enhances mission suitability (para 45).

e. Maximum payload capability of the airplane, 10,759 pounds, is 1241 pounds less than the contractor-stated 12,000-pound payload (para 51).

f. No deficiencies and 14 shortcomings were noted during the evaluation.

SHORTCOMINGS AFFECTING MISSION ACCOMPLISHMENT

55. Correction of the following shortcomings is desirable for improved mission accomplishment:

a. Excessive longitudinal control force per g in maneuvering flight (para 27).

b. Limited rolling performance for the airtanker mission (para 28).

c. Excessive lateral control force during rolling maneuvers (para 28).

d. Excessive longitudinal control forces encountered during configuration changes (para 30).

e. Inadequate flight control force harmony during maneuvering flight (para 33).

f. Lack of a cockpit accelerometer (para 39).

g. Inability to load retardant from one location (para 41).

h. Lack of exterior payload quantity gages for retardant loading procedures (para 41).

i. Lack of nose-wheel steering (para 42).

j. Inability to engage the rudder control gust lock during strong crosswind or tail wind conditions (para 44).

k. Poor cockpit instrument panel lighting (para 45).

l. Inadequate length of the carburetor heat control and mixture levers above the engine control console (para 45).

m. Inability to start the ground power unit from the cockpit (para 45).

n. Undesirable installation and removal procedure for the nose-gear safety-lock assembly (para 52).

MILITARY SPECIFICATION AND USFS DESIRABLE CRITERIA COMPLIANCE

56. Within the scope of the test, the CL-215 amphibious airplane failed to meet the following requirements of the military specifications, MIL-F-8785(ASG) and MIL-A-8806A, and the *USFS Desirable Criteria for Selecting Fixed Wing Airtankers*:

a. Paragraph 3.4.16, MIL-F-8785(ASG) – The minimum rolling performance requirement of 0.07 in the CR configuration by 0.02 or 28.6 percent and in the DR configuration by 0.017 or 24.3 percent (para 28).

b. Paragraph 3k, *USFS Desirable Criteria for Selecting Fixed Wing Airtankers* – The minimum rolling performance of 25 deg/sec in the DR configuration by 7 deg/sec or 28 percent (para 29).

c. Paragraph 3.3.19, MIL-F-8785(ASG) – The peak longitudinal control force of 20 pounds by 27 pounds or 135 percent (para 30).

d. Paragraph 3.1.4, MIL-A-8806A – The maximum acceptable overall noise level at normal cruise power of 106db by 6db, the 2400- to 4800-Hz range by 8db and the 4800- to 9600-Hz range by 9db (para 47).

e. Paragraph 2c, *USFS Desirable Criteria for Selecting Fixed Wing Airtankers* – The ability to land with a fire retardant payload (para 51).

RECOMMENDATIONS

57. The shortcomings noted should be corrected for improved mission accomplishment.

58. Acoustical protection should be installed in the passenger/cargo compartment if the aircraft is used to transport personnel (para 47).

59. Heating and ventilating should be provided in the passenger/cargo area for passenger comfort if passengers are transported (para 49).

60. The maximum landing weight limit should be increased to allow landing with a full retardant payload (para 51).

61. Oil cooler flaps that are controlled automatically should be provided (para 53).

APPENDIX A. REFERENCES

1. Letter, USAASTA, SAVTE-C(TI), 5 November 1970, subject: Limited Evaluation of Canadair's *CL-215 Water Bomber/Utility Aircraft*, Project 70-39.

2. Letter, AVSCOM, AMSAV-EFT, 10 January 1972, subject: Test Directive for Canadair CL-215 Evaluation, USAASTA Project No. 72-02.

3. Airplane Flight Manual, Canadair Limited, *CL-215 Utility Category and Restricted Category Limit*, 7 March 1969, with Revisions 1 through 5, and Supplements A, B, and C.

4. Report, Canadair Limited, RAA-215-194, *Canadair CL-215 Operating Notes*, 13 March 1969.

5. Military Specification, MIL-F-8785(ASG), *Flying Qualities, Piloted Airplanes*, 1 September 1954, with Amendment 4, 17 April 1965.

6. Military Specification, MIL-A-8806A, *Acoustical Noise Level in Aircraft: General Specification For*, 11 July 1966, with Amendment 1, 12 September 1967.

7. Memorandum, United States Forest Service, 21 October 1971, Unclas, subject: Desirable Criteria for Selecting Fixed Wing Airtankers.

8. Army Regulation, AR 310-25, *Dictionary of United States Army Terms*, 1 March 1969.

9. Air Force Regulation, AFR 160-3, *Medical Service, Hazardous Noise Exposure*, 29 October 1956.

APPENDIX B. PHOTOGRAPHS

Photo 1. Water Scoops: 5-Inch Internal Diameter. Tank Doors: 30 x 60 Inches. Cam Locks: 2.5-Inch Fire Hose Connector.

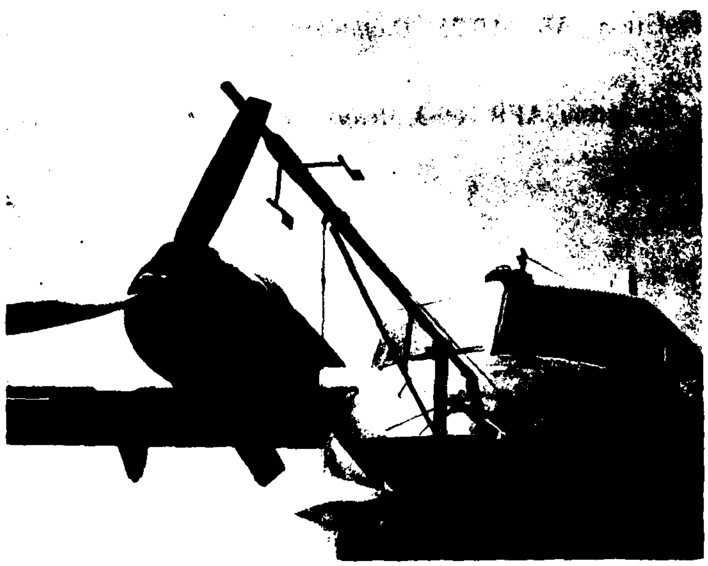


Photo 2. Airspeed Boom with Sideslip and Angle-of-Attack Vane.

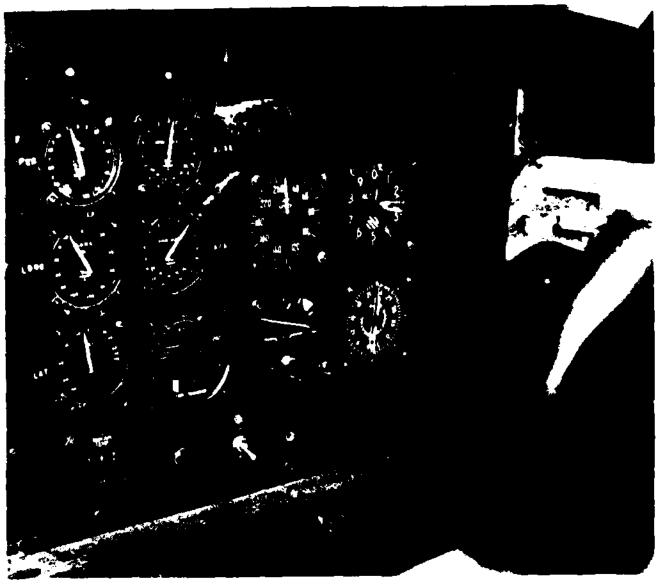


Photo 3. Copilot Instrument Panel with Control Position Angle-of-Attack and Angle-of-Sideslip Indicators.

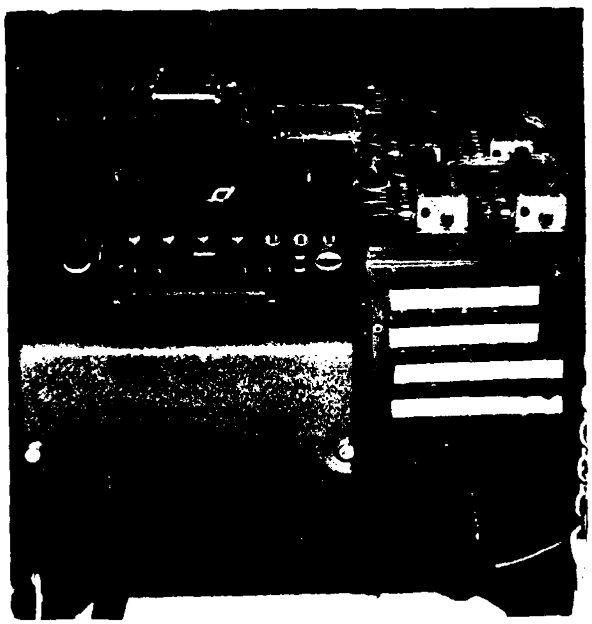


Photo 4. 50-Channel Oscillograph Recorder Installed in Aft Cabin Area.

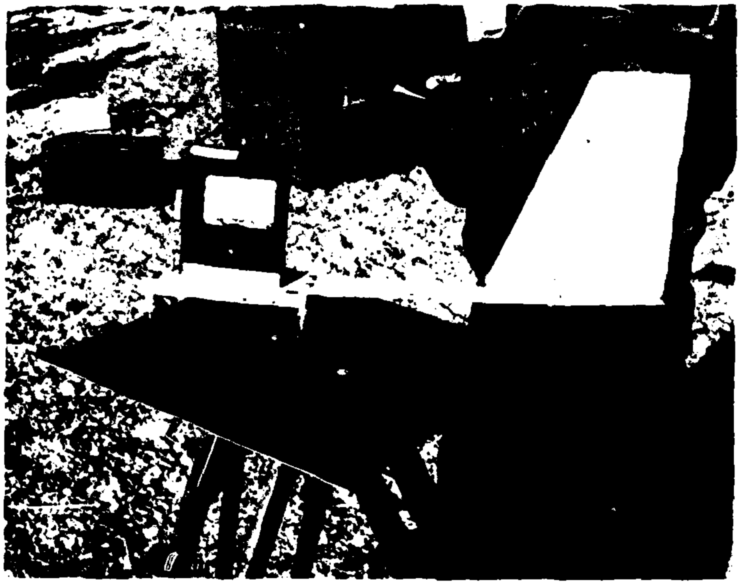


Photo 5. Wind Measuring Device (Voltmeter) for Recording Wind Conditions During Takeoff and Landing Tests.

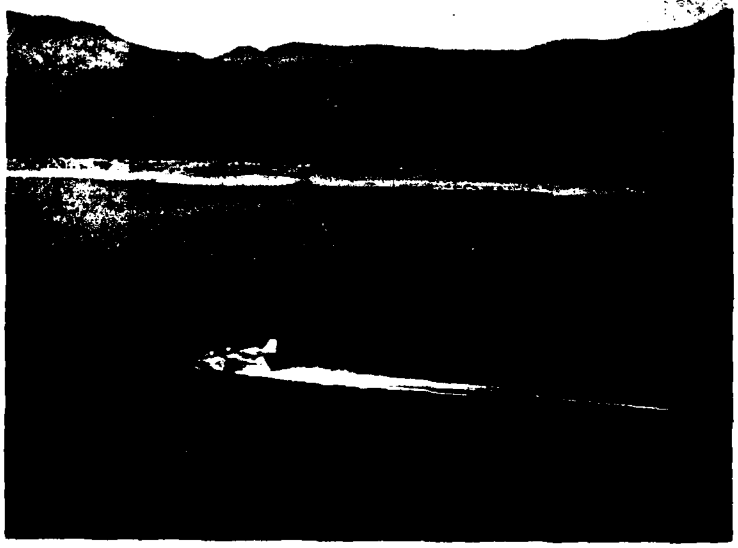


Photo 6. Airplane Scooping Water While Planing.

Photo 7. Salvo (BOTH) Water Drop from Level Flight Condition.

Photo 8. Airplane Pitch Up Following a Trail Water Drop.

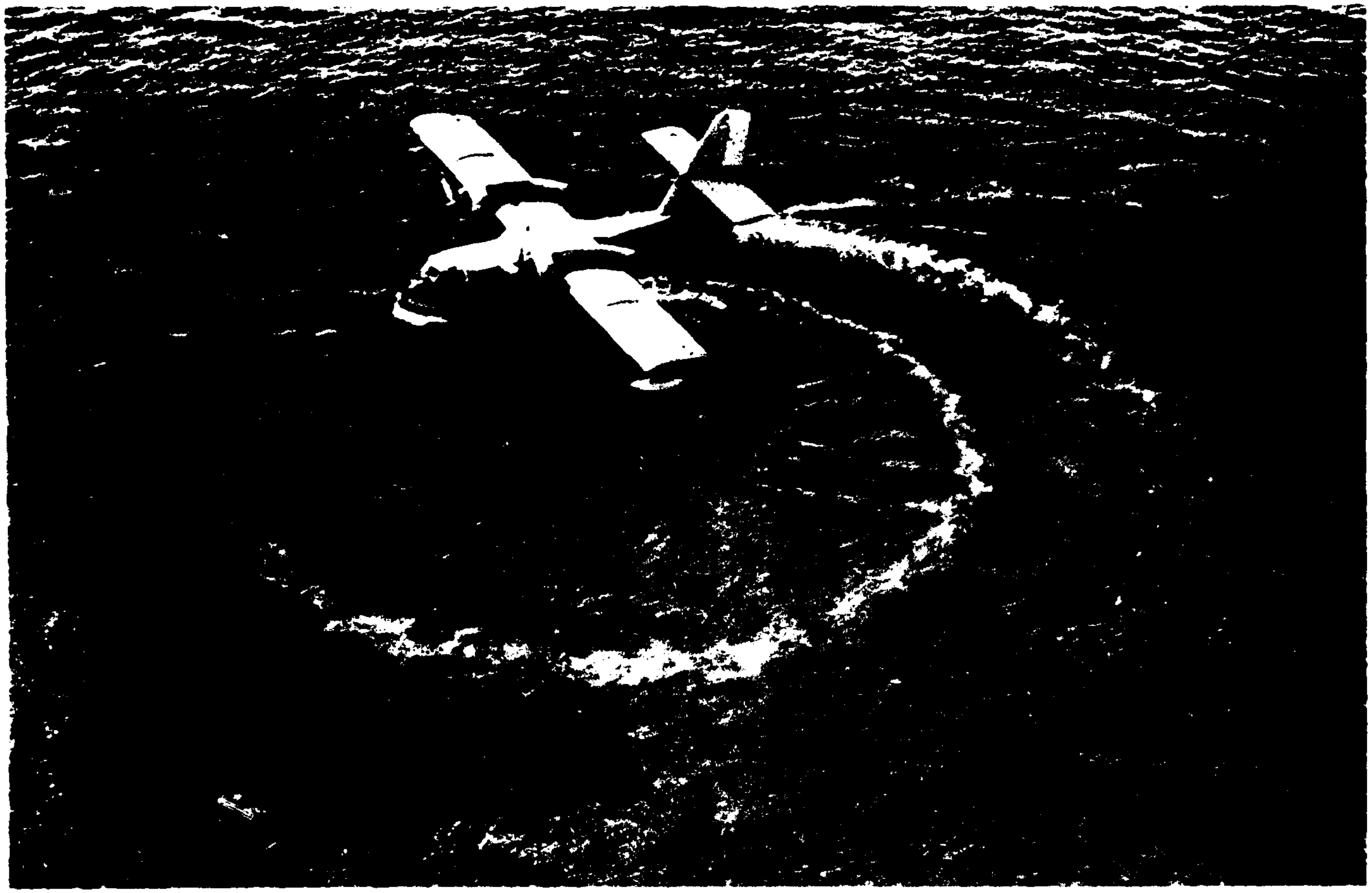


Photo 9 Minimum Turning Radius of Airplane on Water, Gear Down

APPENDIX C. AIRCRAFT DESCRIPTION AND LIMITATIONS

1. Principal dimensions and general data for the CL-215-1A10 amphibious airplane are as follows:

DIMENSION AND DESIGN DATA

Overall Dimensions

Span	93 ft, 10 in.
Height of vertical tail over static ground line	29 ft, 3 in.
Overall length	65 ft, 0.2 in.
Main wheel track	17 ft, 4 in.

Wing

Chord (constant)	11 ft, 7.3 in.
Incidence	2 deg
Sweep	Zero deg
Dihedral	Zero deg
Aspect ratio	8.15
Airfoil section	NACA 4418 modified
Chord thickness	17 percent

Horizontal Stabilizer and Elevator

Span	36 ft
Chord (constant)	8 ft, 8 in.
Incidence	-1 deg
Dihedral	Zero deg
Aspect ratio	4.24

Airfoil section	NACA 0015 modified
Chord thickness	14 percent

Vertical Stabilizer and Rudder

Height above fuselage	17 ft
Root chord	15 ft, 10 in.
Tip chord	5 ft, 11.95 in.
Aspect ratio	1.56
Airfoil section	NACA 0015 modified
Chord thickness	14 percent at the root 10.4 percent at the tip

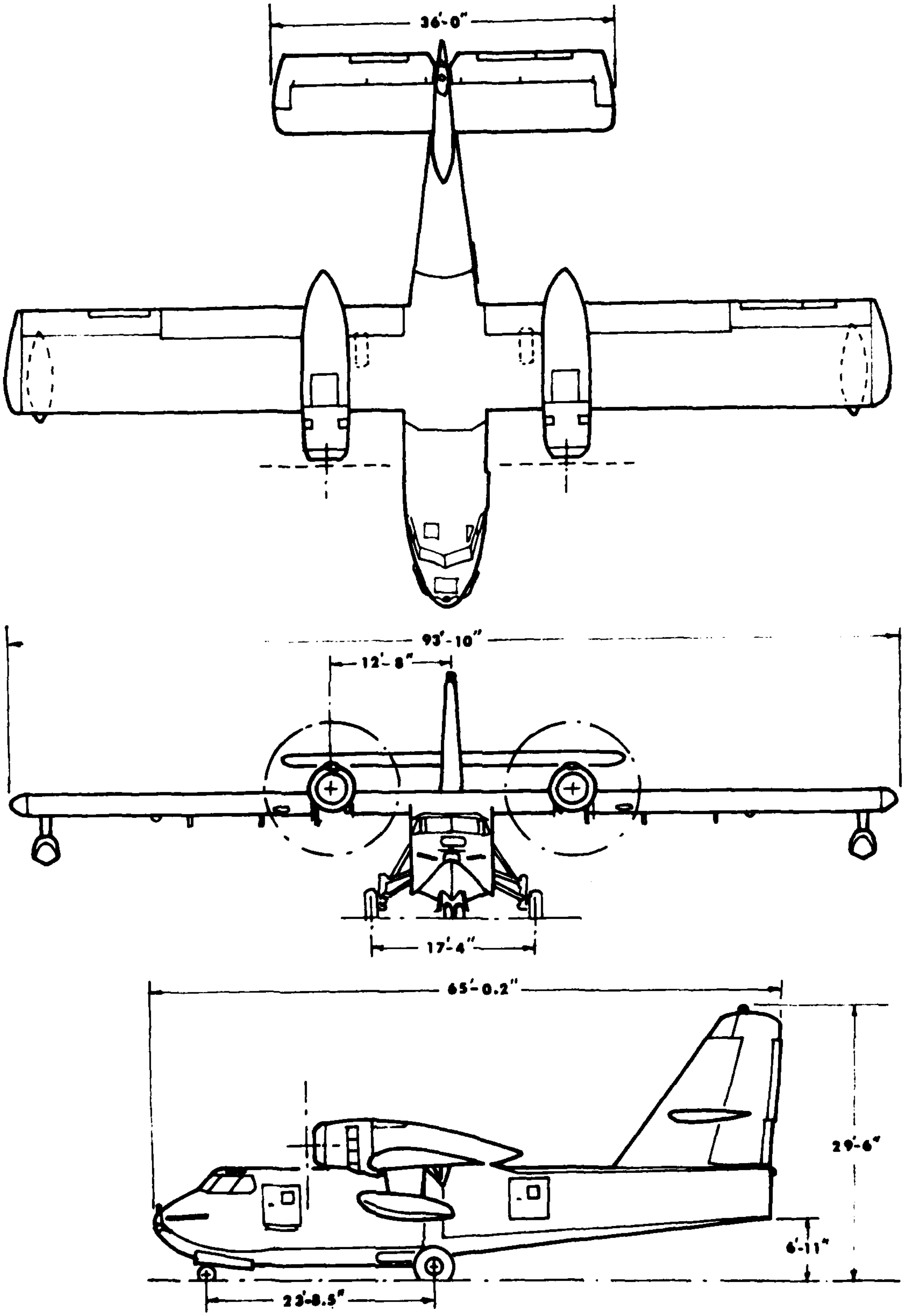
Fuselage

Internal cabin height (maximum)	6 ft, 3 in.
External width (beam)	8 ft, 6 in.
Internal floor width (maximum)	7 ft, 10 in.
Wheel base	23 ft, 8.5 in.
Propeller/fuselage clearance	2 ft

Areas

Nominal total wing area (flaps retracted)	1080 sq ft
Total effective wing flap area	241 sq ft
Aileron area, each	43.3 sq ft
Aileron trim tab (left only)	2.9 sq ft
Aileron geared tab (left only)	3.6 sq ft
Rudder/aileron interconnect tab (right only)	3.6 sq ft

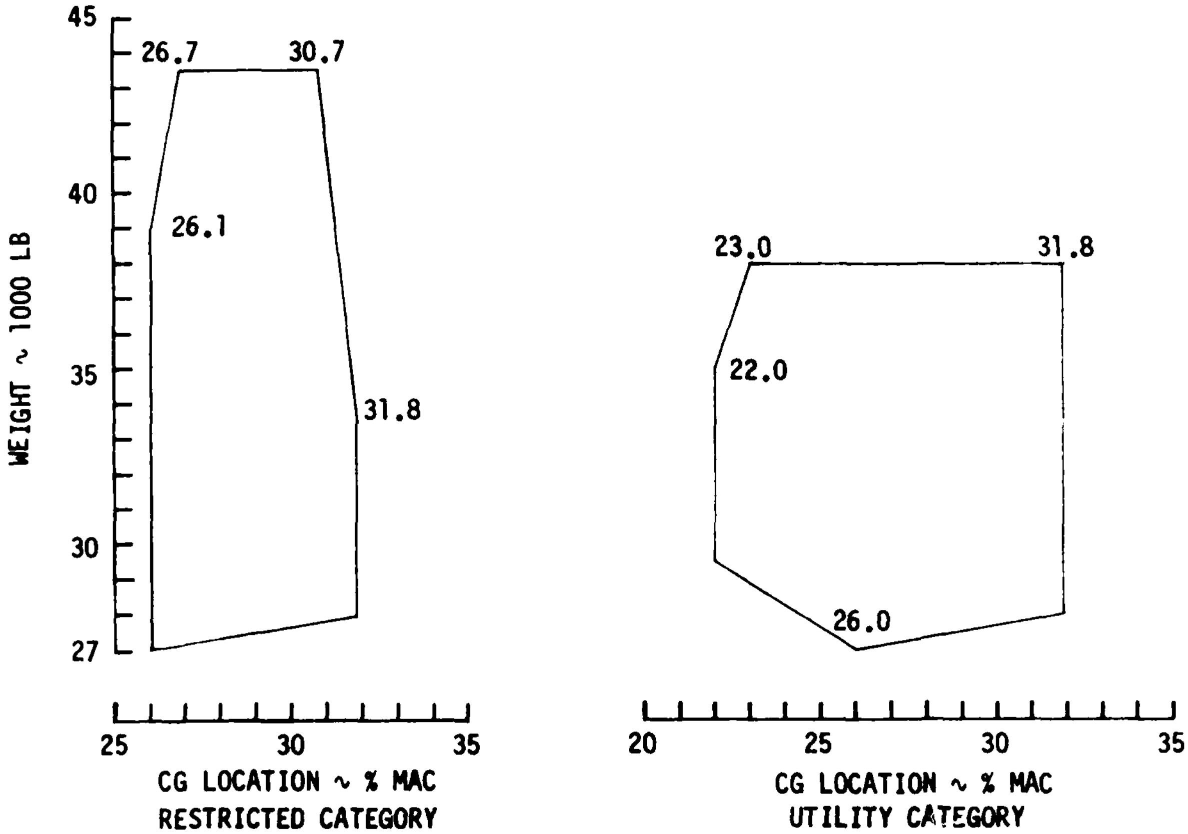
Total horizontal stabilizer and elevator area	306 sq ft
Elevator area (each)	42.4 sq ft
Elevator trim tab (left only)	5.5 sq ft
Elevator servo tab (each)	4.4 sq ft
Total vertical stabilizer and rudder area	185.5 sq ft
Rudder area	64.75 sq ft
Rudder geared trim tab	7.8 sq ft
Rudder servo tab	5.0 sq ft



Three-View CL-215 Airplane.

LIMITATIONS

Flight Limits



Center-of-Gravity Limits.

Gross Weight Limit

Takeoff:

Carrying disposable cargo	43,500 lb
Carrying nondisposable cargo and/or persons employed in support	37,700 lb
Landing (maximum fuel weight is 6869 pounds; landing with disposable cargo is prohibited)	34,400 lb

Static flotation	38,000 lb
Ramp weight	43,500 lb
Touchdown for water pickup	33,500 lb
Zero fuel weight	39,000 lb

Airspeed Limits

Maximum operating limit speed:	
From sea level to 12,000 feet	190 KCAS
From 12,000 to 20,000 feet	160 KCAS
Maximum speed with flaps extended:	
At 25 degrees	112 KCAS
At 15 degrees	140 KCAS
At 10 degrees	140 KCAS
Maximum speed at which landing gear may be extended or retracted	130 KCAS
Maximum speed at which the water door may be opened	130 KCAS
Minimum control speed	85 KCAS

Sideslip Limits

Maximum sideslip angle to 150 KCAS	25 deg
Maximum bank angle during sideslip to 150 KCAS	25 deg
Maximum sideslip angle at 150 to 190 KCAS	12.5 deg
Maximum bank angle during sideslip at 150 to 190 KCAS	12.5 deg

Load Limit Factor

Flaps up	-1.0g to +3.0g
Flaps 15 degrees	-1.0g to +3.25g

Engine Limitations

Takeoff (5 min):	
Brake horsepower	2100
Altitude	Sea level
Manifold pressure	54.0 in. Hg
Revolutions per minute	2800 rpm
Brake mean effective pressure	212 psi
Takeoff (5 min):	
Brake horsepower	2100
Altitude	3000 ft
Manifold pressure	53.0 in. Hg
Revolutions per minute	2800 rpm
Brake mean effective pressure	212 psi
Maximum continuous:	
Brake horsepower	1800
Altitude	Sea level
Manifold pressure	46.5 in. Hg
Revolutions per minute	2600 rpm
Brake mean effective pressure	196 psi
Maximum continuous:	
Brake horsepower	1800
Altitude	5300 ft
Manifold pressure	45.2 in. Hg
Revolutions per minute	2600 rpm
Brake mean effective pressure	196 psi

Cylinder head temperature limit:	
Takeoff, maximum-continuous power	260 deg
Engine oil inlet temperature limit	100 deg
Engine oil pressure limits:	
Maximum	100 psi
Minimum	60 psi

Engine Speed Restriction

Except for transient conditions, propellers must not be operated in the engine speed range 1550 to 1750 rpm.

Ground Running Limitation

During any 20-minute period of engine operation with aircraft stationary, the use of manifold pressure greater than field barometric pressure must not exceed total duration of 1 minute.

FLIGHT CONTROL SYSTEM

2. The flight control system employed on the CL-215 is reversible about all axes. The flight control surfaces are mechanically actuated by cables, bell cranks, push/pull rods, and pulleys; except for the trim system, which is electrically actuated, and the flap system, which is hydraulically actuated.

Longitudinal Control System

3. Longitudinal control is obtained by fore-and-aft movement of the dual, interconnected, control columns. Movement of the control column mechanically actuates servo tabs located on the elevators. Movement of the servo tabs generates forces and moments which cause the elevator to move. A spring bar is incorporated to provide a force feel and to move the elevators when the aerodynamic forces are insufficient. A trim tab located on the left-hand elevator and electrically actuated by a dual switch on the control wheel is used to obtain longitudinal trim.

Lateral Control System

4. Lateral control is obtained by means of ailerons mechanically actuated by dual, interconnected, control wheels mounted on the control columns. Two geared

servo tabs, one on each aileron, are used to reduce lateral force gradients. A trim tab located on the left-hand aileron and electrically actuated by a dual switch on the pilot center control pedestal is used to obtain lateral trim. A tab located on the right-hand aileron is mechanically linked to the rudder and is actuated by rudder movement to improve the dihedral characteristics of the airplane. The aileron neutral position is 2 degrees, up, to improve lateral stability.

Directional Control System

5. Directional control is obtained by means of a vertical stabilizer/rudder mechanically actuated by dual, interconnected, rudder pedals. A general servo/trim tab and a servo tab are located at the trailing edge of the rudder. A spring bar is incorporated to provide force feel and to move the rudder when the aerodynamic forces are insufficient. A trim actuator electrically operated by a dual switch on the pilot center control pedestal is incorporated with the geared servo tab and is used to obtain directional trim. The servo tab neutral position is 5 degrees, left to compensate for the torque effect with the critical engine (number one) out.

Flap System

6. The slotted flap system is hydraulically actuated and electrically controlled from the cockpit. Four positions (zero-, 10-, 15-, and 25-degree stops) are available. The flaps are interconnected by cables to provide redundant operation. Asymmetry switches mounted on the actuators arrest flap movement when an asymmetrical condition exceeds 3 degrees.

STALL WARNING SYSTEM

7. An artificial stall warning system consisting of wing-mounted lift transducers and an electrically operated horn is incorporated in the airplane. The transducers are activated by vanes located in the leading edge of the right wing which are sensitive to the movement of the aerodynamic stagnation point.

CONTROL GUST LOCK SYSTEM

8. Control gust locks are provided to secure the aileron, elevator, and rudder surfaces. The control gust lock lever is located in the pilot center control pedestal. Application of the control gust lock causes the movement of locking pins into corresponding locking pin holes in the aileron, elevator, and rudder control systems.

APPENDIX D. DEFICIENCY, SHORTCOMING, AND HANDLING QUALITIES RATING SCALE

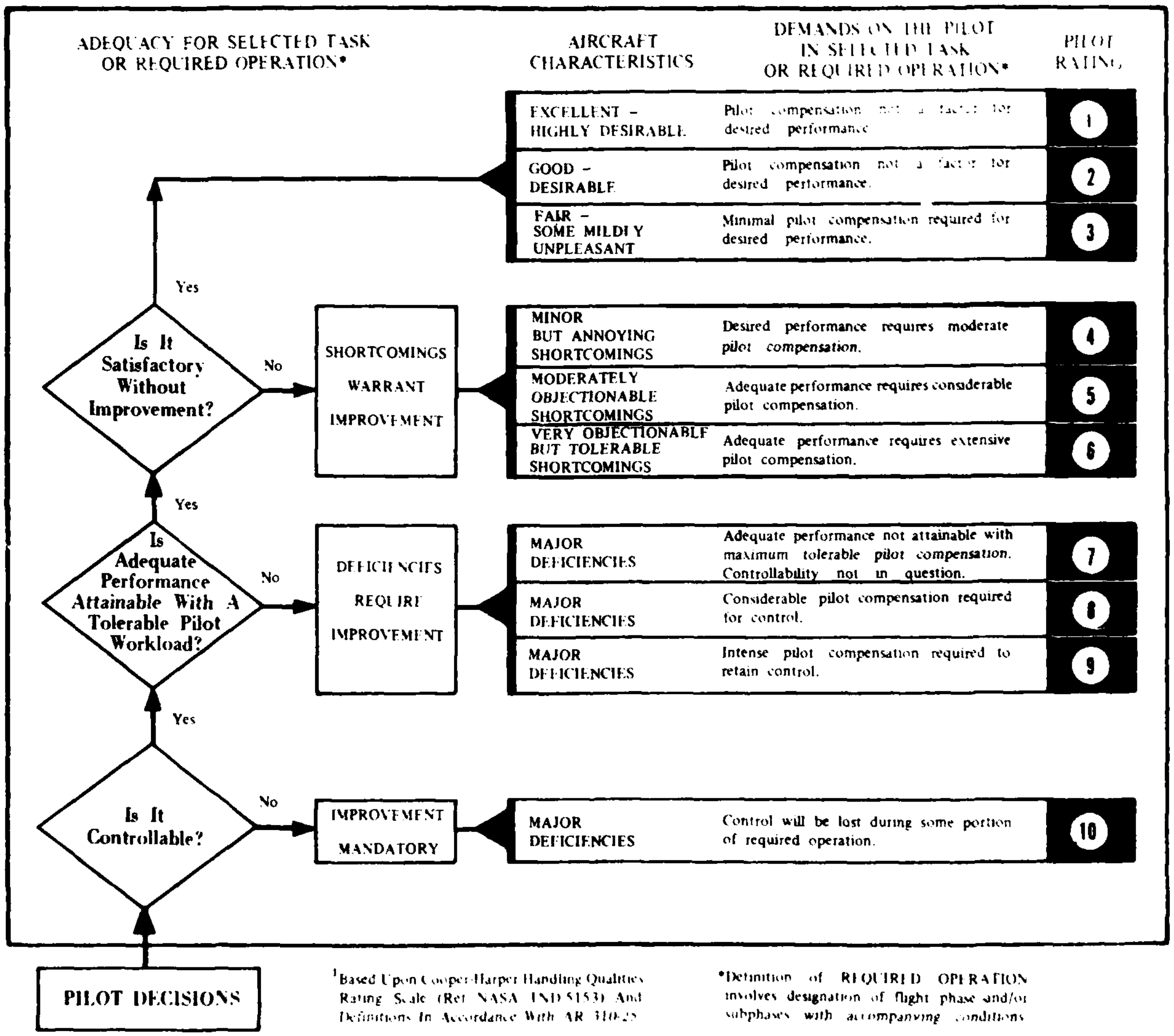
DEFICIENCY

1. A defect or malfunction discovered during the life cycle of an equipment that constitutes a safety hazard to personnel; will result in serious damage to the equipment if operation is continued; indicates improper design or other cause of an item or part, which seriously impairs the equipment's operational capability. A deficiency normally disables or immobilizes the equipment; and, if occurring during test phases, will serve as a bar to type classification action.

SHORTCOMING

2. An imperfection or malfunction occurring during the life cycle of equipment, which should be reported and which must 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. If occurring during test phases, the shortcoming should be corrected, if it can be done without unduly complicating the item or inducing another undesirable characteristic such as increased cost, weight, etc.

HANDLING QUALITIES RATING SCALE



[1]Based Upon Cooper-Harper Handling Qualities Rating Scale (Ref NASA TND 5153) And Definitions In Accordance With AR 310-25

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

APPENDIX E. TEST INSTRUMENTATION

1. Test instrumentation to record the parameters listed below was calibrated. installed (where necessary), and maintained by USAASTA:

Oscillograph

Longitudinal control position
Lateral control position
Directional control position
Directional control force
Pitch attitude
Roll attitude
Yaw attitude
Pitch rate
Roll rate
Yaw rate
Sideslip angle
Angle of attack
Center-of-gravity normal acceleration
Longitudinal acceleration
Airspeed (boom)
Altimeter
Manifold pressure
Oscillograph record counter
Pilot event
Engineer event

Cockpit

Longitudinal control position
Lateral control position
Directional control position
Longitudinal control force
Lateral control force
Directional control force
Sideslip angle
Angle of attack
Airspeed (ship's system)
Airspeed (boom)
Altimeter
Manifold absolute pressure, left and right
Outside air temperature
Carburetor air temperature, left and right
Oscillograph record counter

APPENDIX F. DATA ANALYSIS METHOD

GENERAL

1. The equations and the analysis methods used to reduce the performance data of the CL-215 are briefly described in this appendix. A detailed discussion of the analysis methods can be found in Air Force Technical Report No. 6273, *Flight Test Engineering Handbook*, June 1964.

2. The definition of the symbols used in the analysis equations is as follows:

Symbols	Description	Units
BHP_c	Chart brake horsepower	$\frac{ft\text{-}lb}{min} \times \frac{1}{33{,}000}$
BHP_s	Standard-day brake horsepower	$\frac{ft\text{-}lb}{min} \times \frac{1}{33{,}000}$
BHP_t	Test-day brake horsepower	$\frac{ft\text{-}lb}{min} \times \frac{1}{33{,}000}$
CAT_t	Test-day carburetor air temperature	°K
g	Acceleration due to gravity	32.2
n_t	Aircraft normal acceleration, test	g
P_{a_s}	Standard-day ambient pressure based on the US standard atmosphere	psi
P_{a_t}	Test-day ambient pressure based on the US standard atmosphere	psi
R/C_s	Standard-day rate of climb	feet per minute
R/C_t	Test-day rate of climb, rate of change of pressure altitude with time	feet per minute
$\Delta R/C_{HP}$	Power correction to the standard-day rate of climb	feet per minute
S_a	Wind-corrected test-day takeoff air distance	feet

S_{a_t}	Test-day takeoff air distance measured from point of lift-off to 50 feet above the ground	feet
S_{a_s}	Standard-day takeoff air distance	feet
S_{g_t}	Test-day ground roll distance measured from start of ground roll to point of lift-off	feet
S_g	Wind-corrected test-day ground roll distance	feet
S_{g_s}	Standard-day ground roll distance	feet
$S_{L_{a_t}}$	Test-day landing air distance measured from 50 feet above the ground to touchdown	feet
S_{L_a}	Wind-corrected landing air distance	feet
$S_{L_{a_s}}$	Standard-day landing air distance	feet
$S_{L_{g_t}}$	Test-day landing ground roll distance measured from point of touchdown to the end of the ground roll	feet
$S_{L_{g_s}}$	Standard-day landing ground roll distance	feet
T_{a_s}	Standard-day ambient temperature based on US standard atmosphere	°K
T_{a_t}	Test-day ambient temperature, outside air temperature +273°	°K
V_T	True airspeed, calibrated airspeed times $1/\sqrt{\sigma}$	knots, feet per second
V_{TO}	Takeoff airspeed, airspeed at lift-off	feet per second
V_w	Wind component along the runway	feet per second

σ_s Standard-day density altitude ratio

σ_t Test-day density altitude ratio

η_p Propeller efficiency

3. The engines used were uncalibrated. Brake horsepower was determined using the manufacturer's engine calibration charts for the Double Wasp CA15 Engine, Curve No. 1745-1B and Curve No. 1745-2, PWA 0.1.80, *Special Operating Instructions*, Pratt and Whitney Aircraft, February 1954.

4. Test brake horsepower was determined by correcting chart brake horsepower for carburetor air temperature rise:

$$BHP_t = BHP_c \left(\frac{T_{a_s}}{CAT_t}\right)^{0.5}$$

Standard-day brake horsepower available was determined from

$$BHP_s = BHP_t \left(\frac{CAT_t}{T_{a_s} + \left(CAT_t - T_{a_t}\right)}\right)^{0.5}$$

5. Figures 3 through 5, appendix G, show the power available for the R-2800-83AM2AH engine. For the takeoff and maximum-continuous power conditions, the engine's critical altitude was determined from the engine limit specifications (app C). The manifold absolute pressure (MAP) and brake horsepower (BHP) above the critical altitude for the R-2800-83AM2AH engine were determined by first extrapolating the chart MAP and BHP to determine the MAP and BHP at the R-2800-83AM2AH engine's critical altitude and then assuming that the difference between the extrapolated chart MAP and BHP and the R-2800-83AM2AH engine MAP and BHP at the critical altitude is constant for all altitudes above that. For the maximum recommended climb condition, there is no apparent difference in the chart MAP and BHP and the R-2800-83AM2AH MAP and BHP.

CLIMB

6. Observed rate-of-climb data were corrected for the effects of temperature on change in altitude and power. Corrections for wind effects, acceleration effects, and weight differences were not applied.

7. Standard-day rate of climb was obtained using the equation:

$$R/C_s = R/C_t \left(\frac{T_{a_t}}{T_{a_s}} \right)^{0.5} + \Delta R/C_{HP}$$

Power correction to the standard-day rate of climb was obtained using the equation:

$$\Delta R/C_{HP} = \frac{33,000}{W_t} BHP_t \left(1 - \frac{T_{a_s}}{T_{a_t}} \right) \eta_p$$

The value of W_t used was the test average gross weight. The value of η_p used was obtained from the airplane manufacturer and are as follows:

η_p (dual engine) = 80 percent

η_p (single engine) = 76 percent

TAKEOFF

8. Takeoff data obtained from the Fairchild Flight Analyzer were corrected to standard-day, no-wind conditions. Runway slope corrections were not applied. No corrections were applied to the water takeoff distances.

Ground roll distance was corrected for wind using the equation:

$$S_g = S_{g_t} \left(\frac{V_{TO} + V_w}{V_{TO}} \right)^{1.85}$$

Air distance was corrected for wind using the equation:

$$S_a = S_{a_t} + V_w t$$

Where: T = time from lift-off to 50 feet above the ground

The wind-corrected distances were then corrected to standard-day conditions using the following relationships:

$$S_{g_s} = S_g \left[\left(\frac{W_s}{W_t}\right)^{2.6} \left(\frac{\sigma_s}{\sigma_t}\right)^{-1.7} \left(\frac{P_{a_s}}{P_{a_t}}\right)^{-0.9} \right]$$

$$S_{a_s} = S_a \left[\left(\frac{W_s}{W_t}\right)^{2.6} \left(\frac{\sigma_s}{\sigma_t}\right)^{-1.5} \left(\frac{BHP_s}{BHP_t}\right)^{-1.1} \right]$$

The total horizontal distance to clear a 50-foot obstacle is $S_{g_S} + S_{a_S}$.

LANDING

9. Landing data obtained from the Fairchild Flight Analyzer were corrected to standard-day, no-wind conditions. Runway slope corrections were not applied. No corrections were applied to the water landing data. Air distance was corrected for wind using the equation:

$$S_{L_a} = S_{L_{a_t}} + V_w t$$

Where: t = time from 50 feet above the ground to touchdown

Ground roll distance was corrected for wind using the equation:

$$S_{L_g} = S_{L_{g_t}} \left(\frac{V_{TO} + V_w}{V_{TO}}\right)^{1.85}$$

The wind-corrected distances were then corrected to standard-day conditions using the following relationships:

$$S_{L_{a_s}} = S_{L_a}$$

$$S_{L_{g_s}} = S_{L_g}\left(\frac{\sigma_t}{\sigma_s}\right)$$

The standard-day air distance is assumed equal to the wind-corrected test air distance. No weight correction was applied to the landing ground roll distance.

The total horizontal distance to clear a 50-foot obstacle is $S_{L_{a_s}} + S_{L_{g_s}}$.

APPENDIX G. TEST DATA DISTRIBUTION

INDEX

FIGURE 7
CLIMB PERFORMANCE (DUAL ENGINE)
STANDARD DAY
CL-215 CF-YNP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)
○	CL	29.[illegible] (MID)	37520
□	CL	30.[illegible] (AFT)	43000

NOTES: 1. MAXIMUM RECOMMENDED CLIMB POWER - SEE FIGURE 5
2. WING FLAPS - 0 DEGREES
3. COWL FLAPS - 7 DEGREES
4. OIL COOLER FLAPS - AS REQUIRED
5. MIXTURE - AUTO RICH
6. AIRSPEED = 105 KIAS, SL TO 10000 FT
= 102 KIAS, 10000 FT TO 12000 FT
= 99 KIAS, 12000 FT TO 14000 FT
7. SOLID LINE DENOTES CONTRACTOR DATA

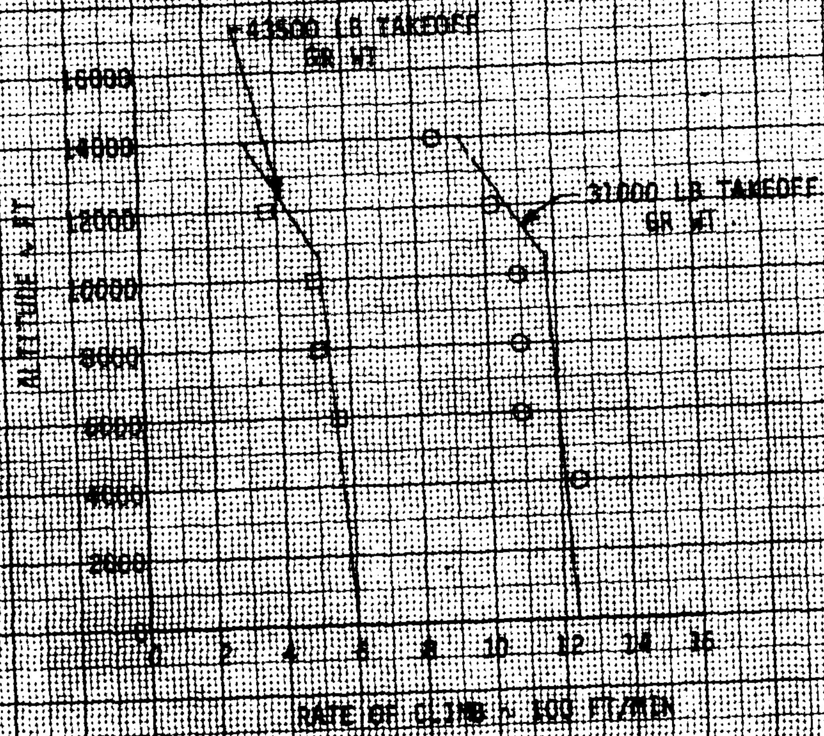


FIGURE 2
CLIMB PERFORMANCE (SINGLE ENGINE)
STANDARD DAY
CL-215 CF-[illegible]

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)
O	CL (OEI)	29.2 (MID)	31690

NOTES:
1. NUMBER 1 ENGINE INOPERATIVE WITH PROPELLER FEATHERED
2. MAXIMUM CONTINUOUS POWER - SEE FIGURE 4
3. WING FLAPS - 0 DEGREES
4. COWL FLAPS - 6 DEGREES ON OPERATIVE ENGINE, CLOSED ON INOPERATIVE ENGINE
5. OIL COOLER FLAPS - AS REQUIRED
6. AIRSPEED = 100 KIAS
7. SOLID LINE DENOTES CONTRACTOR DATA

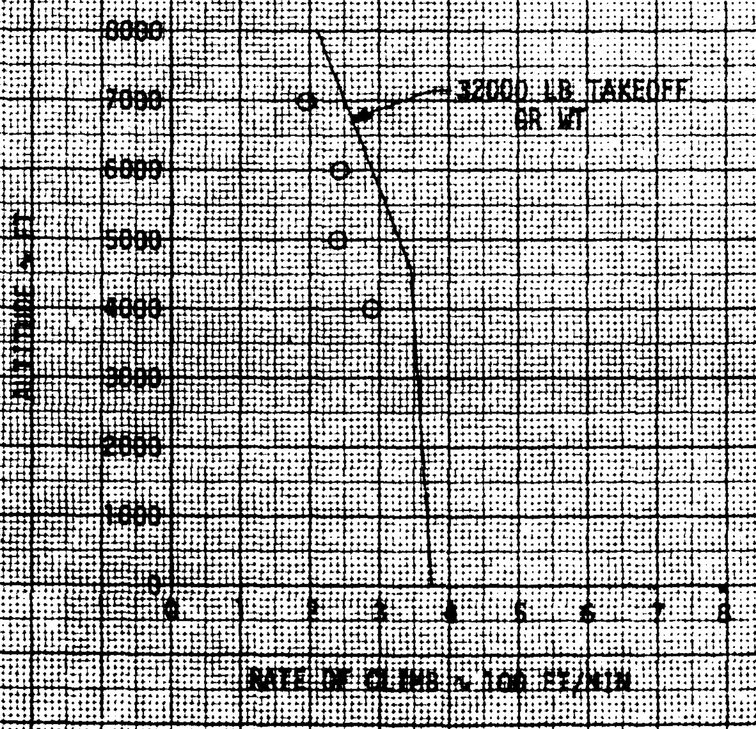
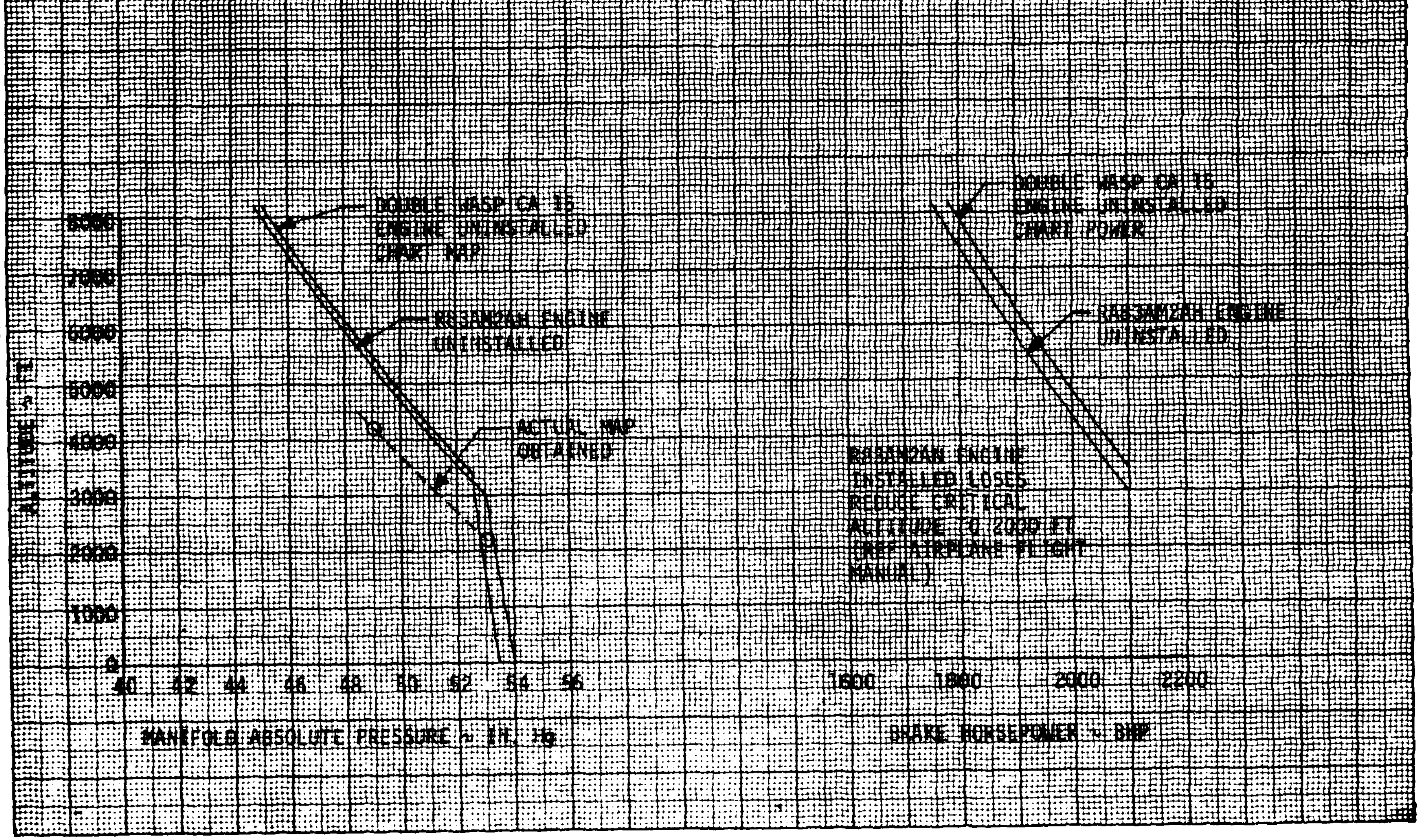


FIGURE 3
POWER AVAILABLE - TAKEOFF
RB3AM2AH ENGINE 2800 RPM
STANDARD DAY
NOTE: POWER AVAILABLE FOR THE RB3AM2AH ENGINE BASED ON DOUBLE WASP CA 15 ENGINE



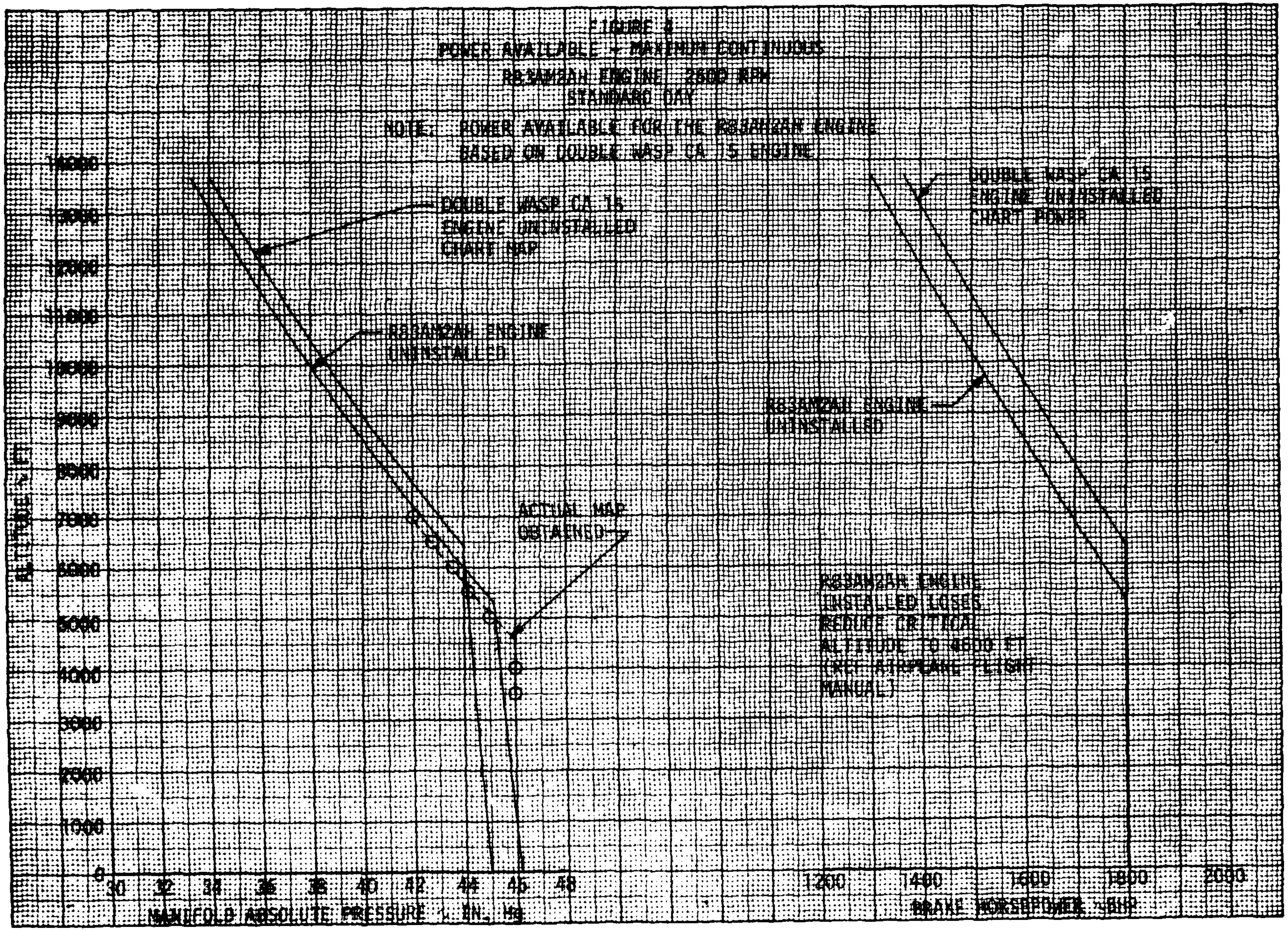


FIGURE 4
POWER AVAILABLE - MAXIMUM CONTINUOUS
R83AM2AH ENGINE 2800 RPM
STANDARD DAY
NOTE: POWER AVAILABLE FOR THE R83AM2AH ENGINE
BASED ON DOUBLE WASP CA 15 ENGINE
DOUBLE WASP CA 15
ENGINE UNINSTALLED
CHART MAP
R83AM2AH ENGINE
UNINSTALLED
ACTUAL MAP
OBTAINED
DOUBLE WASP CA 15
ENGINE UNINSTALLED
CHART POWER
R83AM2AH ENGINE
UNINSTALLED
R83AM2AH ENGINE
INSTALLED LOSES
REDUCE CRITICAL
ALTITUDE TO 4800 FT
(REF AIRPLANE FLIGHT
MANUAL)
ALTITUDE ~ FT
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
30
32
34
36
38
40
42
44
46
48
MANIFOLD ABSOLUTE PRESSURE ~ IN. Hg
1200
1400
1600
1800
2000
BRAKE HORSEPOWER ~ BHP

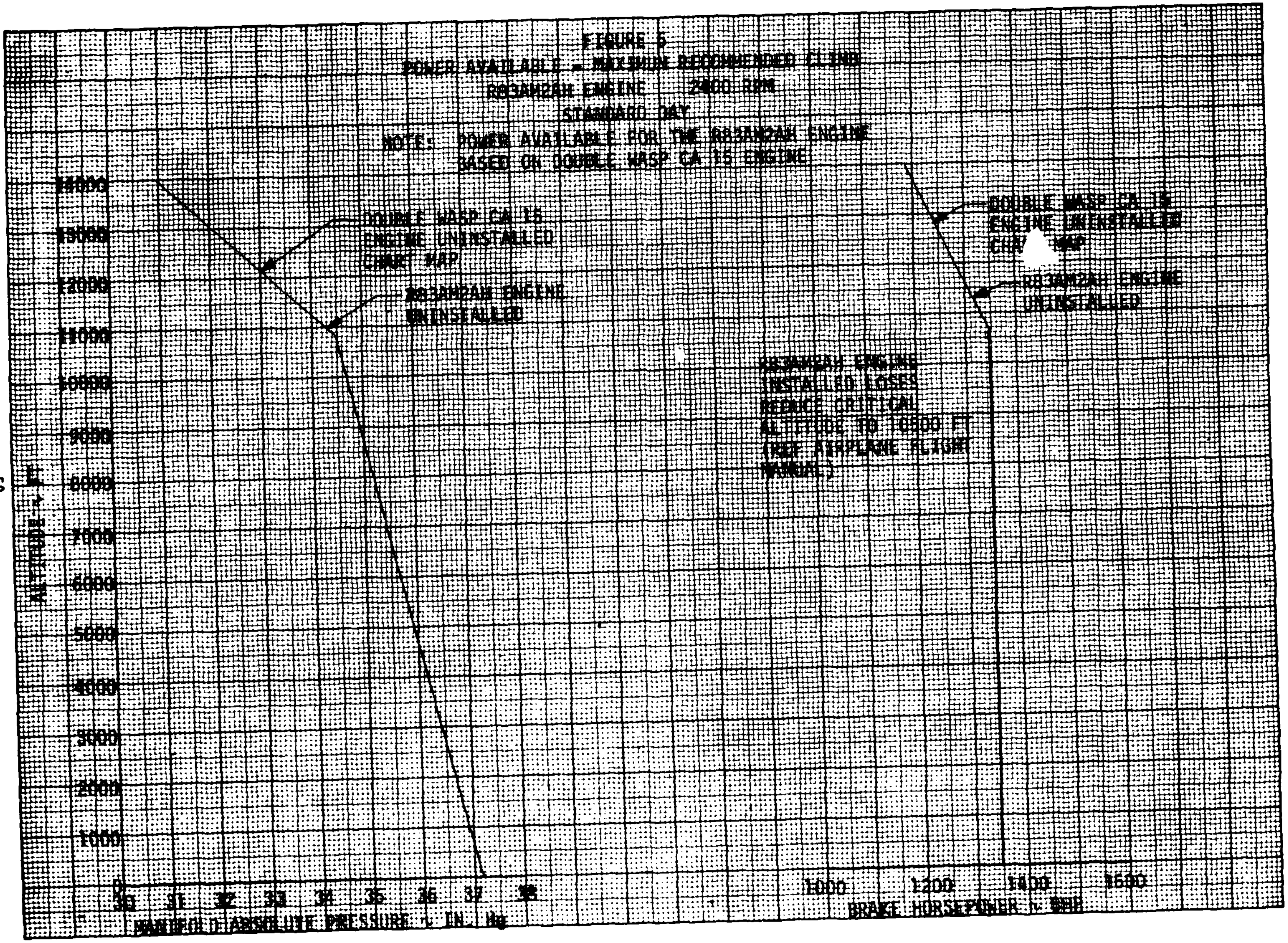


FIGURE 6
POWER AVAILABLE - MAXIMUM RECOMMENDED CLIMB
R83AM2AH ENGINE 2400 RPM
STANDARD DAY
NOTE: POWER AVAILABLE FOR THE R83AM2AH ENGINE BASED ON DOUBLE WASP CA 15 ENGINE

FIGURE 6
STATIC LONGITUDINAL STABILITY
CL-215 CF-YWP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
□	PA	29.0 (MID)	42890	6800	11.0
○	PA	31.4 (AFT)	31020	6980	[illegible]
△	PA	22.4 (FWD)	33670	7020	[illegible]

NOTES: 1. SOLID SYMBOLS DENOTE TRIM POINTS
2. FULL LONGITUDINAL CONTROL TRAVEL = 5.75 INCHES

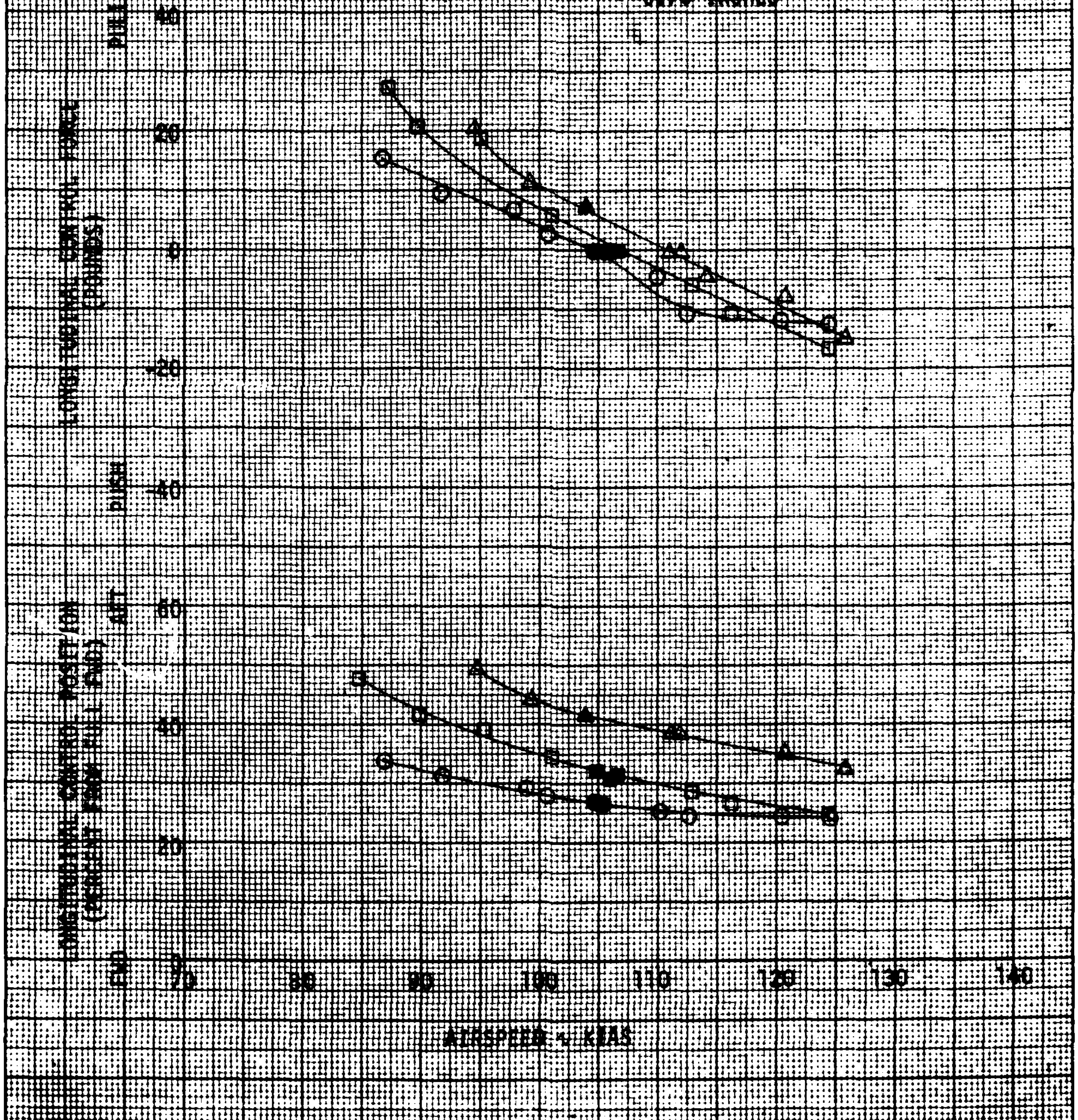
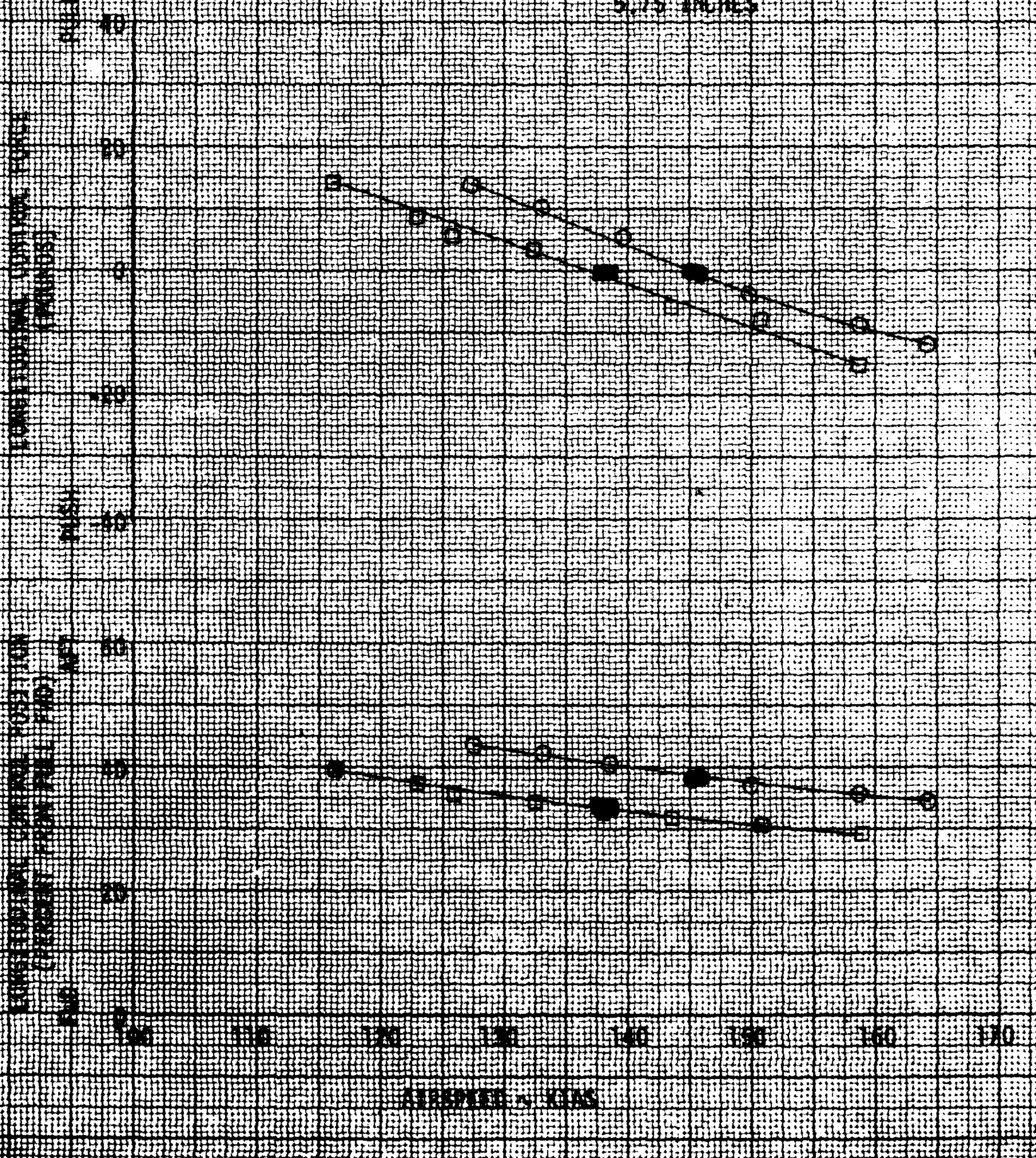


FIGURE 7
STATIC LONGITUDINAL STABILITY
CL-215 CF-YWP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
□	CR	28.5 (MID)	42880	6500	3.5
○	CR	22.3 (FWD)	33420	6700	3.5

NOTES: 1. SOLID SYMBOLS DENOTE TRIM POINTS
2. FULL LONGITUDINAL CONTROL TRAVEL = 5.75 INCHES



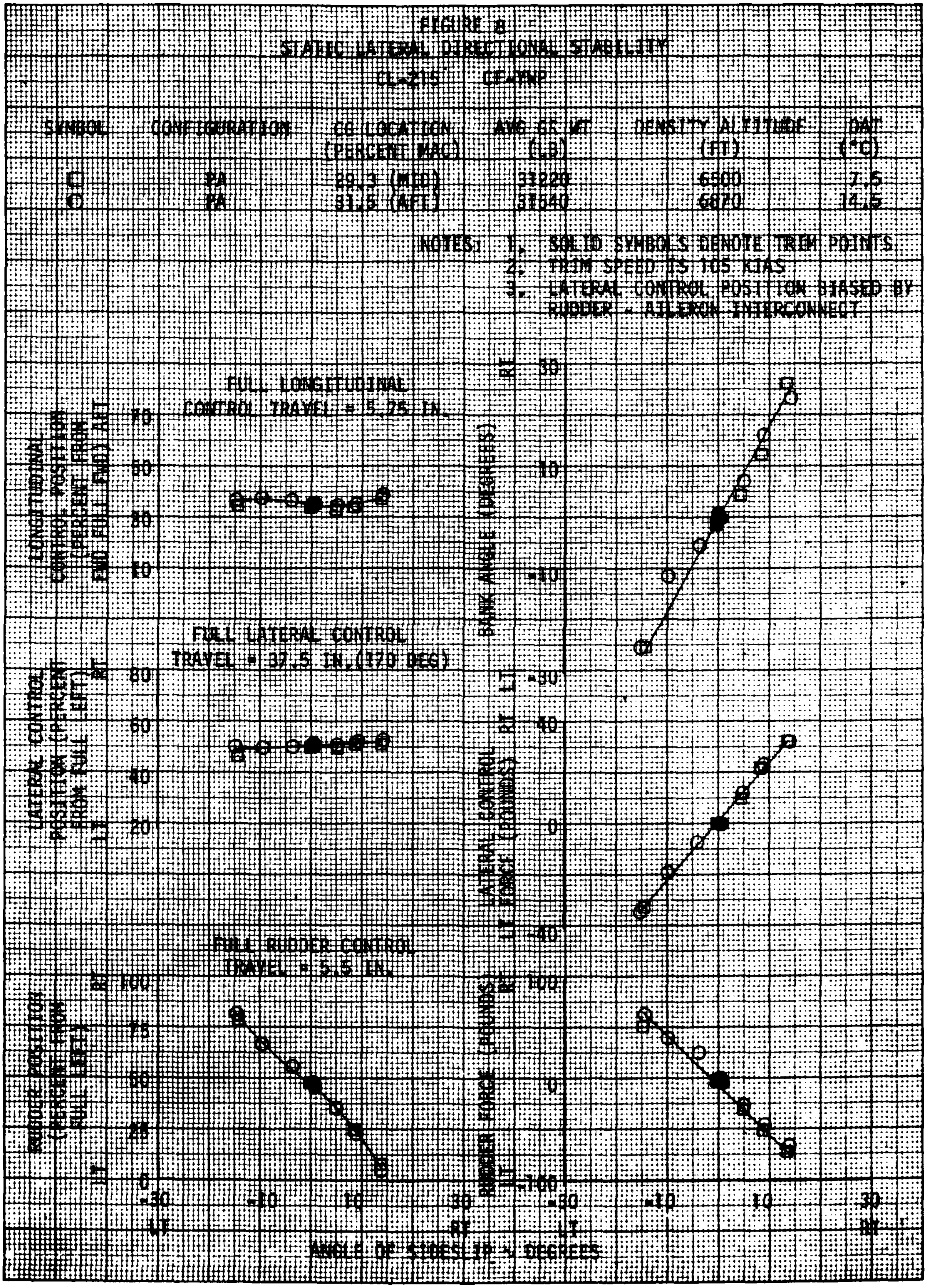


FIGURE 8
STATIC LATERAL DIRECTIONAL STABILITY
CL-215
SYMBOL CONFIGURATION CG LOCATION (PERCENT MAC) AVG GR WT (LB) DENSITY ALTITUDE (FT) OAT (°C)
PA 29.3 (MID) 31820 6500 7.5
PA 31.5 (AFT) 31640 6870 14.5
NOTES: 1. SOLID SYMBOLS DENOTE TRIM POINTS
2. TRIM SPEED IS 105 KIAS
3. LATERAL CONTROL POSITION BIASED BY RUDDER - AILERON INTERCONNECT
FULL LONGITUDINAL CONTROL TRAVEL = 5.75 IN.
LONGITUDINAL CONTROL POSITION (PERCENT FROM FWD FULL FWD) AFT
FULL LATERAL CONTROL TRAVEL = 37.5 IN. (170 DEG)
LATERAL CONTROL POSITION (PERCENT FROM FULL LEFT)
FULL RUDDER CONTROL TRAVEL = 5.5 IN.
RUDDER POSITION (PERCENT FROM FULL LEFT)
BANK ANGLE (DEGREES)
LATERAL CONTROL FORCE (POUNDS)
RUDDER FORCE (POUNDS)
ANGLE OF SIDESLIP ~ DEGREES

FIGURE 9
STATIC LATERAL DIRECTIONAL STABILITY
CL-215 CF-TXP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
□	CR	29.6 (MID)	32540	6700	16.5
○	CR	31.4 (AFT)	31960	6500	13.0

NOTES: 1. SOLID SYMBOLS DENOTE TRIM POINTS
2. TRIM SPEED IS 140 KIAS
3. LATERAL CONTROL POSITION BIASED BY RUDDER - AILERON INTERCONNECT

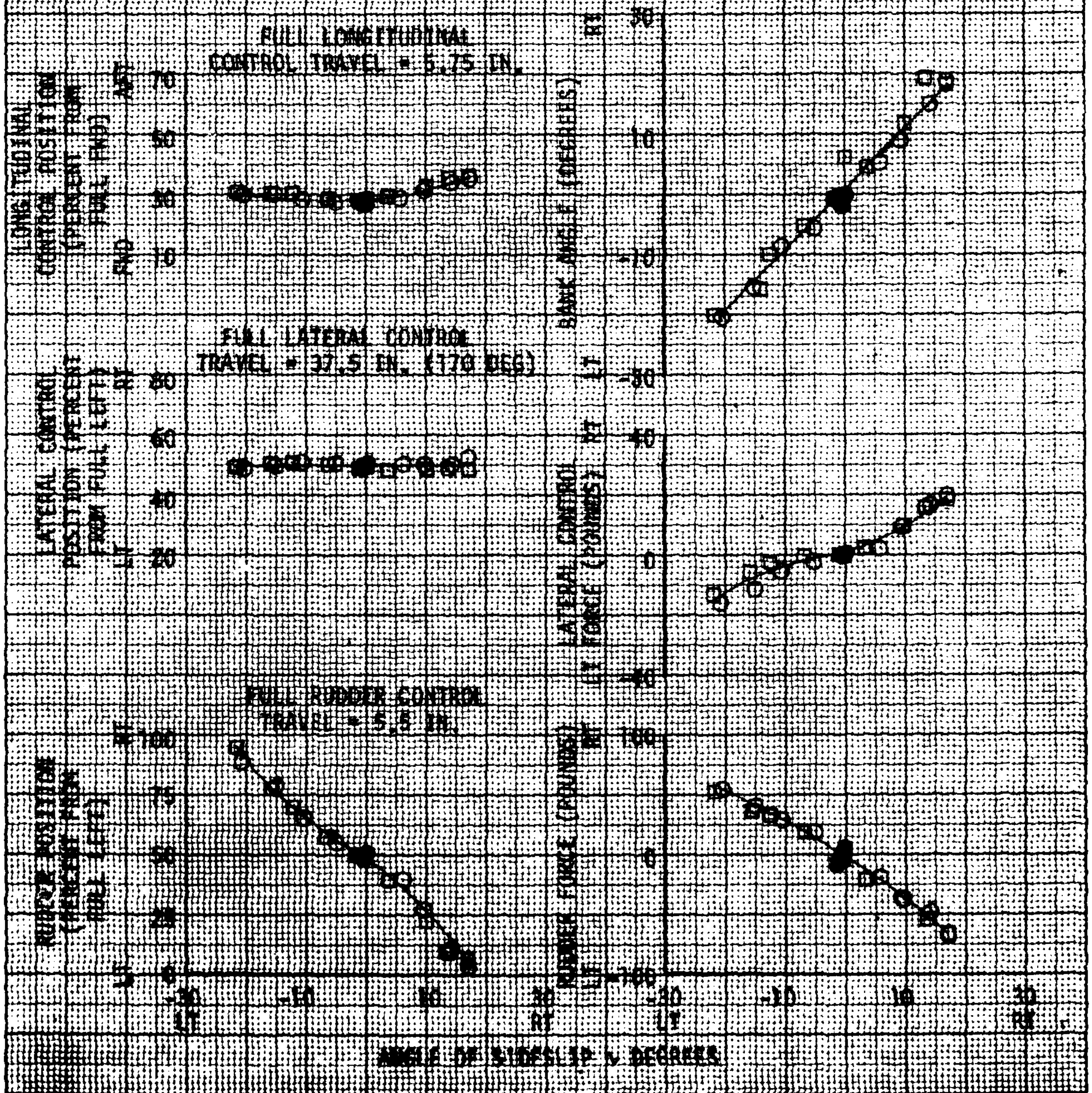


FIGURE 10
MANEUVERING STABILITY
CL-215 CF-YXP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
□	CR	29.4 (MID)	43190	7100	18.5

NOTES: 1. □ DENOTES STEADY TURN TO RIGHT
2. ◿ DENOTES STEADY TURN TO LEFT
3. SOLID SYMBOL DENOTES TRIM POINT
4. TRIM AIRSPEED = 105 KIAS

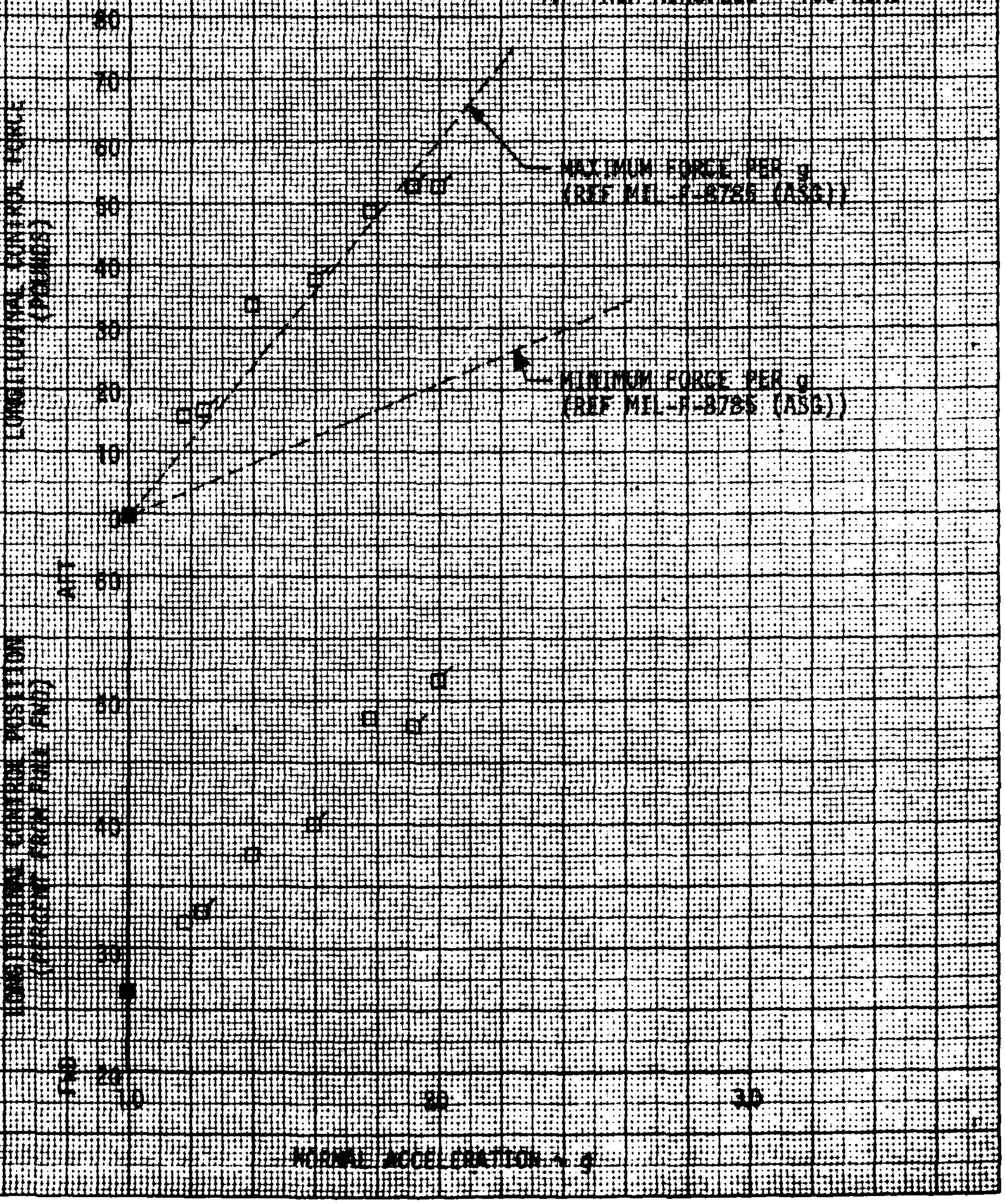


FIGURE 11
MANEUVERING STABILITY
CL-215 CF-YXP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
☐	CR	28.6 (MID)	42450	6800	8.5

NOTES: 1. ◫ DENOTES STEADY TURN TO RIGHT
2. ◫ DENOTES STEADY TURN TO LEFT
3. SHADED SYMBOL DENOTES TRIM POINT
4. TRIM AIRSPEED = 140 KIAS

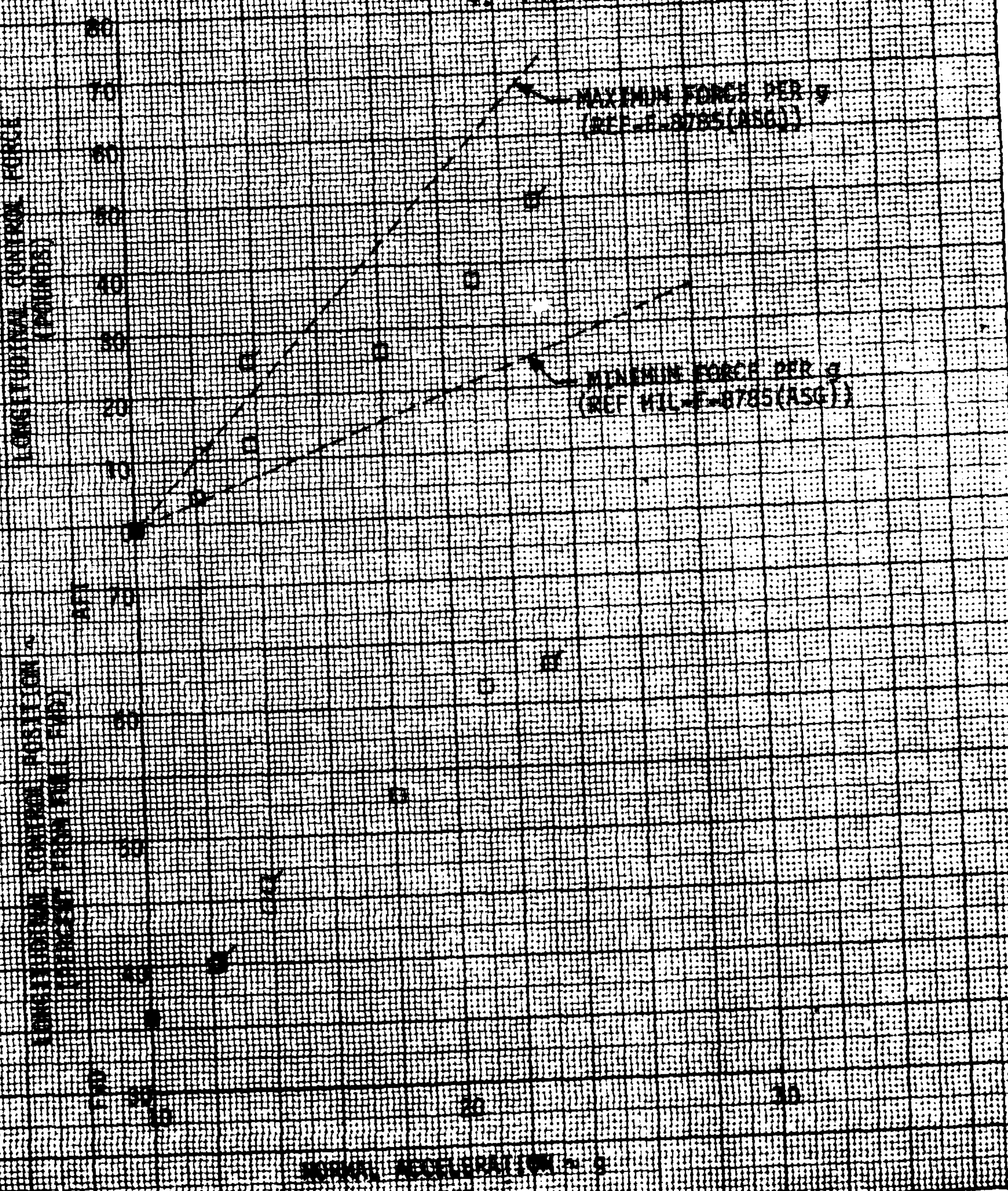


FIGURE 12
LATERAL CONTROL
CL-215 CF-YXP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
□	DR	29.4 (MID)	32670	7000	18.5
○	DR	29.4 (MID)	32670	7000	18.5
△	CR	29.3 (MID)	32320	7000	18.5
◇	CR	29.3 (MID)	32320	7000	18.5

NOTES: 1. □△ DENOTE RIGHT ROLL AND 90 DEG CONTROL DEFLECTION
2. ○◇ DENOTE LEFT ROLL AND 90 DEG CONTROL DEFLECTION
3. FLAGGED SYMBOLS DENOTE FULL CONTROL DEFLECTION

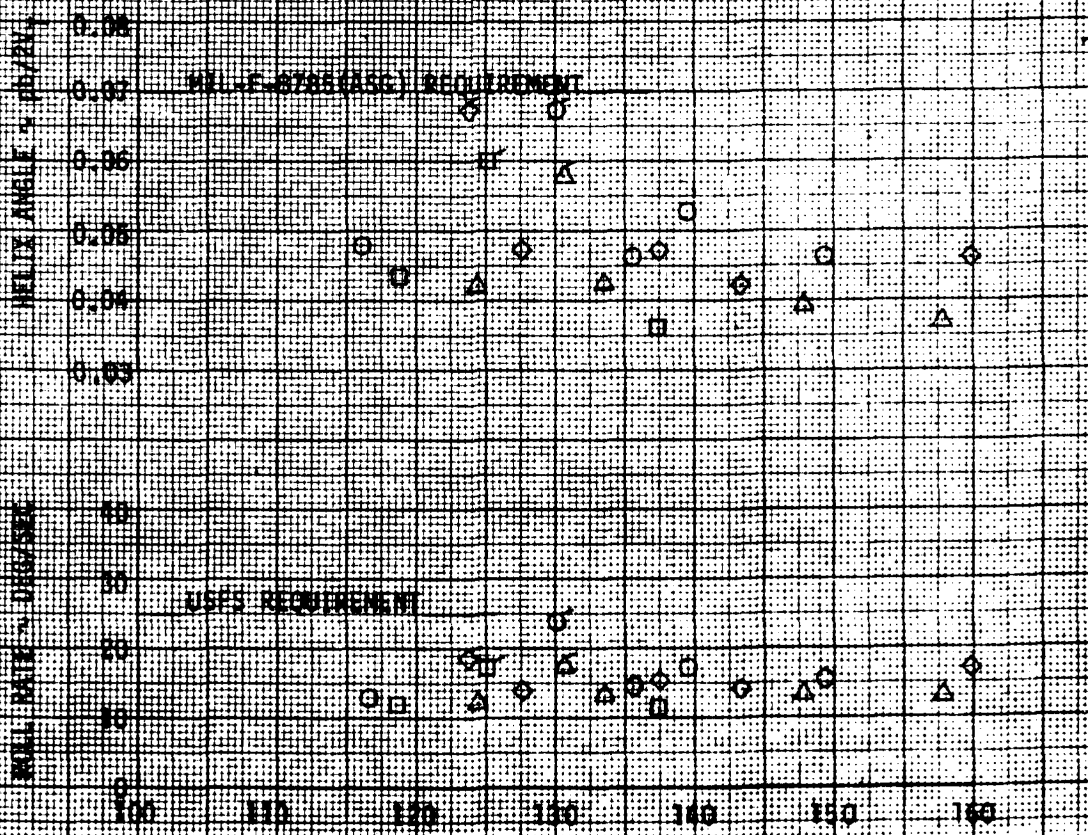


FIGURE 13
AIRCRAFT RESPONSE TO A WATER DROP
CL-215 CF-YWP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
———	DR	28.9 (MID)	42750	3200	8.0
– – – –	DR	28.5 (MID)	42650	9800	9.0
— - —	DR	29.0 (MID)	43500	2000	9.0

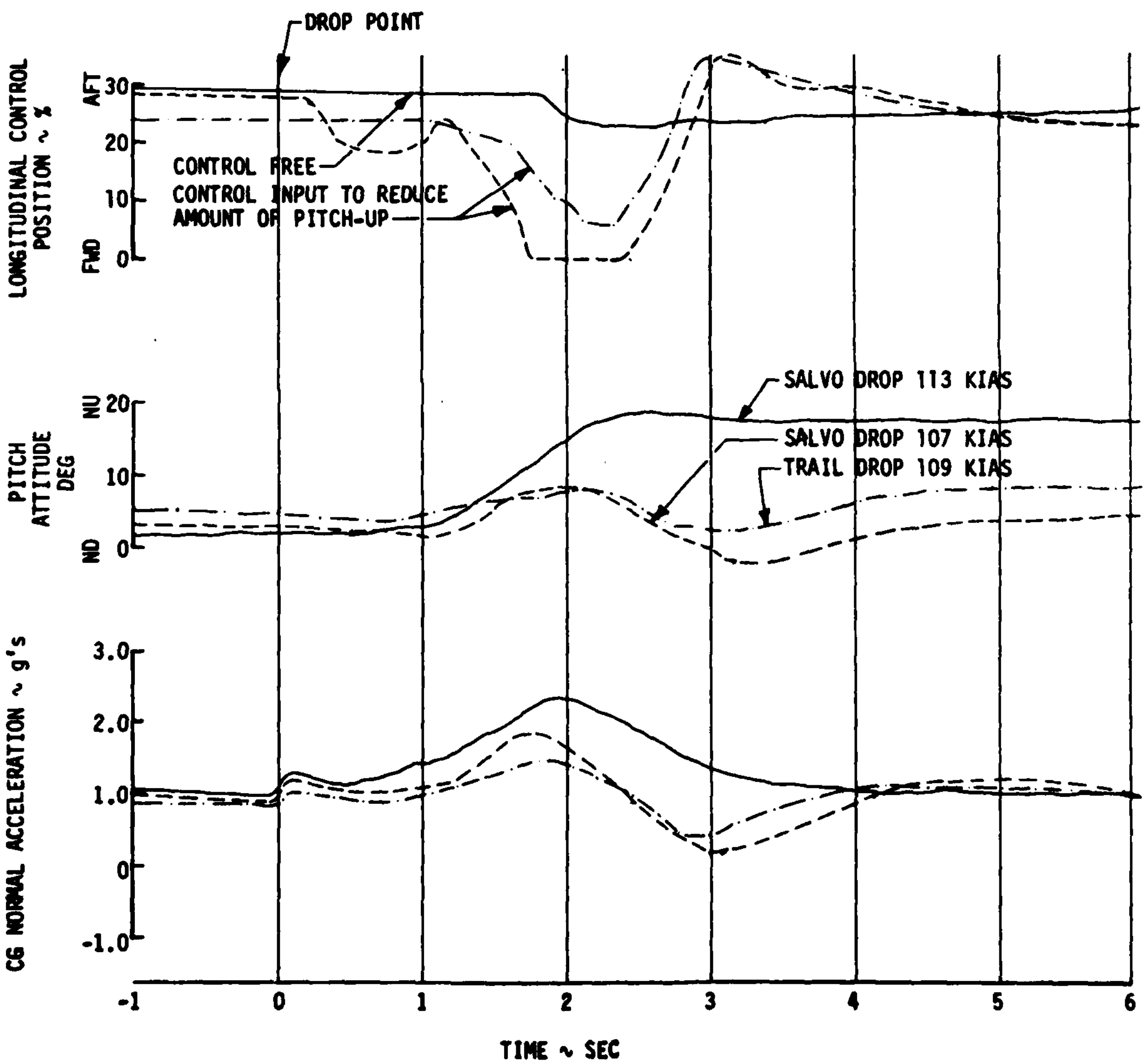


FIGURE 14
WATER DROP SUMMARY
CL-215 CF-YWP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
○	DR	28.9 (MID)	42750	3200	8.0
○	DR	28.6 (MID)	43250	6700	12.0
□	DR	29.1 (MID)	43150	7050	17.5
□	DR	28.5 (MID)	42650	9800	9.0
□	DR	29.0 (MID)	43500	3000	7.0
△	DR	29.0 (MID)	42530	6850	14.0
△	DR	29.0 (MID)	43500	2000	9.0

NOTES:
1. ○ DENOTES SALVO WATER DROPS WITH CONTROLS FREE
2. □ DENOTES SALVO WATER DROPS WITH LONGITUDINAL CONTROL INPUTS TO REDUCE AMOUNT OF PITCH-UP
3. △ DENOTES TRAIL WATER DROPS WITH LONGITUDINAL CONTROL INPUTS TO REDUCE AMOUNT OF PITCH-UP
4. MAXIMUM ACCELERATION = 3.24g AND MAXIMUM AIRSPEED = 129 KIAS FOR DR CONFIGURATION

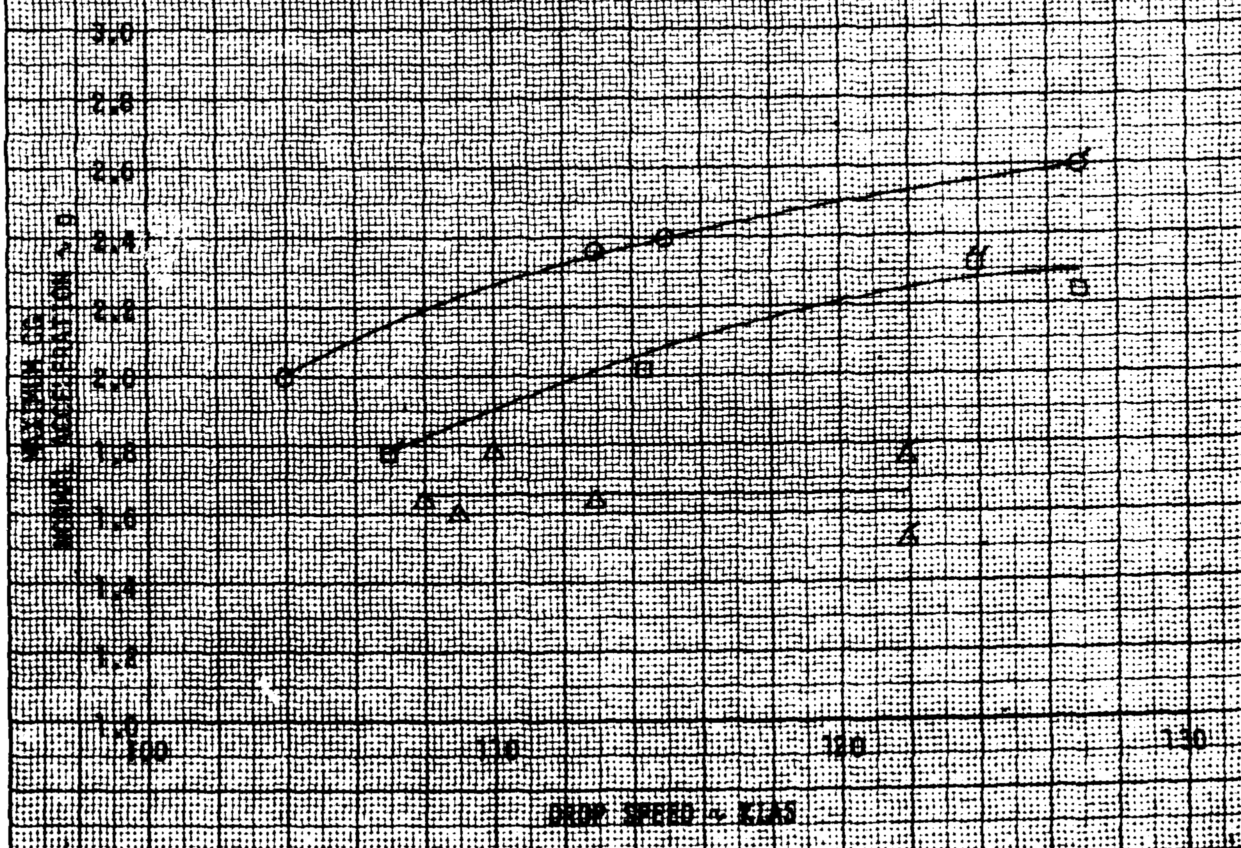
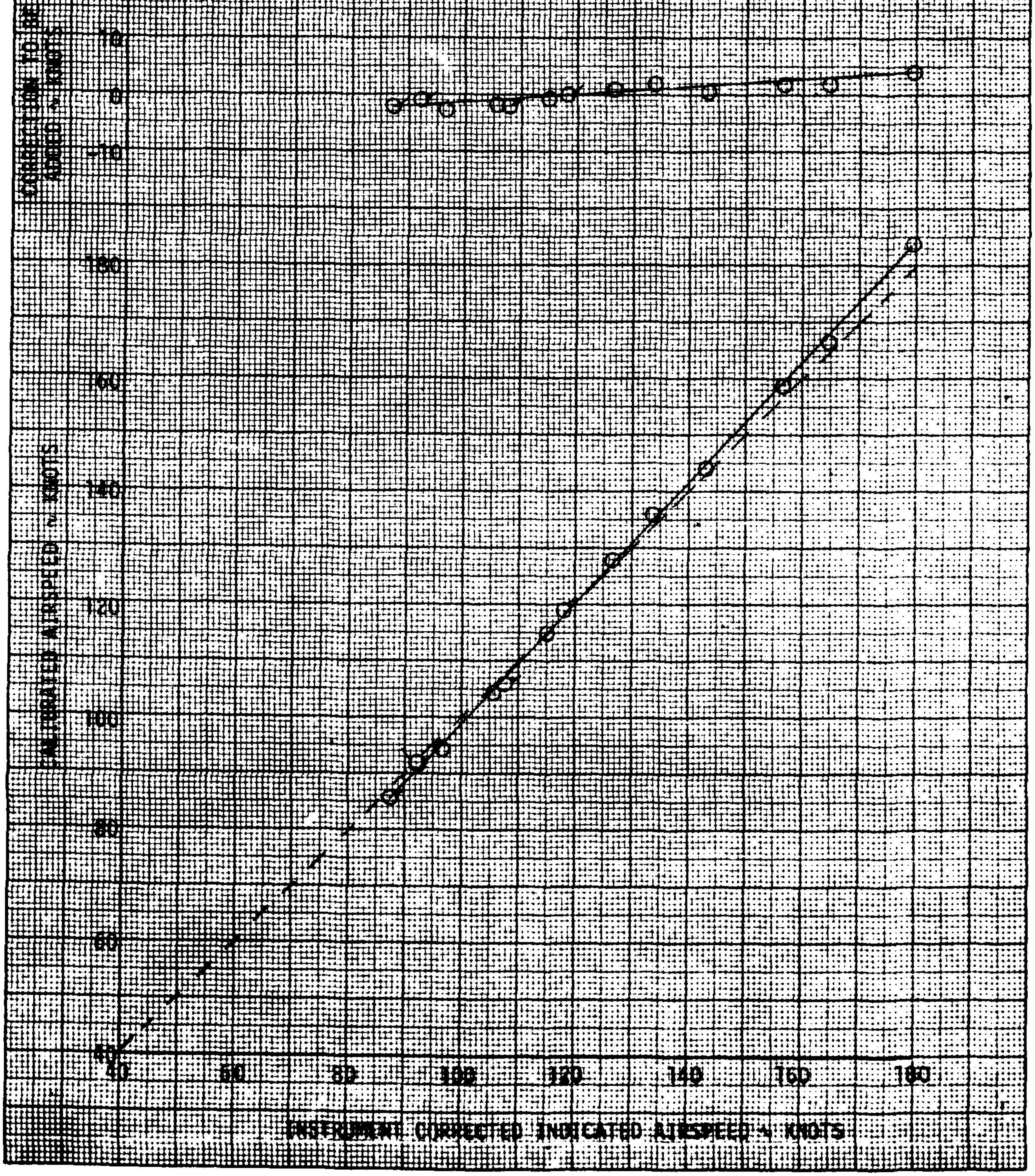


FIGURE 15
AIRSPEED CALIBRATION
SHIP SYSTEM
CL-215 CF-YXP

SYMBOL	CONFIGURATION	CG LOCATION (PERCENT MAC)	AVG GR WT (LB)	DENSITY ALTITUDE (FT)	OAT (°C)
○	CR	29.1 (MID)	41590	2100	10
○	PA	29.0 (MID)	40210	2800	16



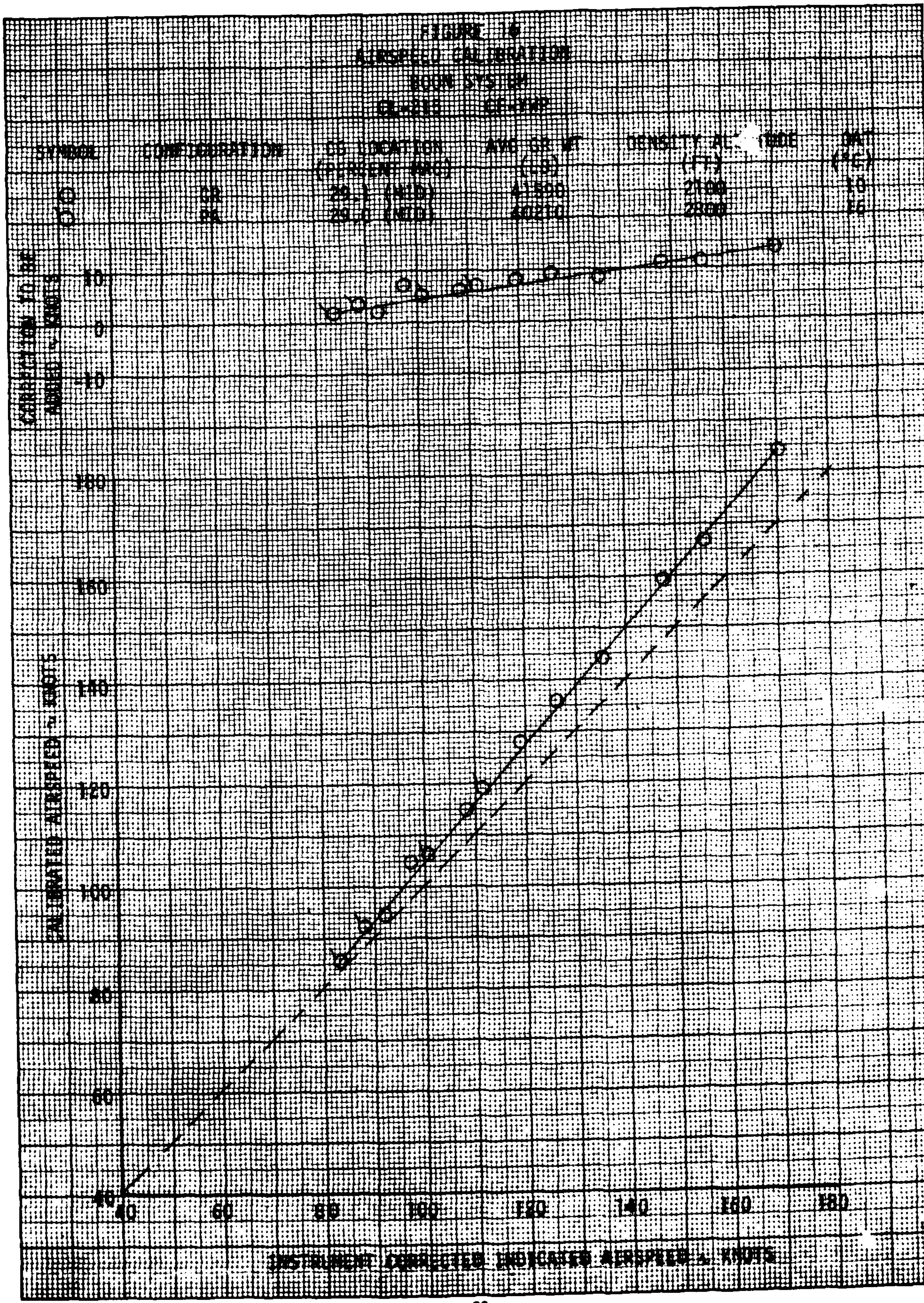


FIGURE 16
AIRSPEED CALIBRATION
BOOM SYSTEM
SYMBOL
CONFIGURATION
CG LOCATION (PERCENT MAC)
AVG GR WT (LB)
DENSITY ALTITUDE (FT)
OAT (°C)
CR
PA
29.1 (MID)
29.0 (MID)
40210
2100
2800
CORRECTION TO BE ADDED ~ KNOTS
CALIBRATED AIRSPEED ~ KNOTS
INSTRUMENT CORRECTED INDICATED AIRSPEED ~ KNOTS

DISTRIBUTION

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Commander United States Army Aviation Systems Command ATTN: AMSAV-EFT PO Box 209 St. Louis, Missouri 63166	12

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) US ARMY AVIATION SYSTEMS TEST ACTIVITY EDWARDS AIR FORCE BASE, CALIFORNIA 93523	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

LIMITED EVALUATION
CANADAIR CL-215 AMPHIBIOUS AIRPLANE

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

FINAL REPORT 10 January through 26 May 1972

5. AUTHOR(S) (First name, middle initial, last name)

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6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
OCTOBER 1972	79	9

8a. CONTRACT OR GRANT NO. b. PROJECT NO. AVSCOM PROJECT NO. 72-02 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) USAASTA PROJECT NO. 72-02 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) NA

10. DISTRIBUTION STATEMENT

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Director, San Dimas Equipment Development Center US Department of Agriculture, Forest Service 444 East Bonita Avenue San Dimas, California 91773

13. ABSTRACT

A limited evaluation of the Canadair CL-215 amphibious airplane was conducted for the United States Forest Service by the United States Army Aviation Systems Test Activity at Edwards Air Force Base, California; Bishop, California; Lake Mead, Nevada; Marana, Arizona; and Prescott, Arizona. A total of 58.8 flight hours were accumulated during the period 29 March to 26 May 1972. Engineering flight tests were conducted to evaluate the performance, handling qualities, airplane cockpit, and bio-environmental conditions and to provide information for use by the United States Forest Service Screening and Evaluation Board. Compliance with the provisions of the United States Forest Service desirable criteria, and military specifications MIL-F-8785(ASG) and MIL-A-8806A was determined. The performance characteristics of the CL-215 airplane, as presented in the airplane flight manual, are serviceable. The excellent water-handling characteristics and functional cockpit layout enhanced the mission suitability of the CL-215 airplane. No deficiencies and 14 shortcomings were identified during the evaluation. Correction of the following shortcomings affecting flying qualities is recommended for improved mission accomplishment: excessive longitudinal control force in maneuvering flight and during configuration changes, limited rolling performance, excessive lateral control force during rolling maneuvers, and inadequate flight control system harmony during maneuvering flight. Nine additional shortcomings were identified and correction recommended. The handling qualities were acceptable for the airtanker mission. If the airplane is used to transport personnel, acoustical protection and heating and ventilating should be provided in the passenger/cargo compartment. The maximum landing weight limitation should be increased to allow landing with a full retardant payload.

DD FORM 1 NOV 65 1473

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Limited evaluation Engineering flight tests Canadair CL-215 amphibious airplane Performance Handling qualities Airplane cockpit Bio-environmental conditions evaluation Water handling characteristics						

DATE
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